Integration and Synthesis Summary for Bivalves (Mussels)

This Integration and Synthesis Summary includes our jeopardy analysis for any species that we or EPA determined will "likely be adversely affected" by the proposed action. Our jeopardy analysis of the proposed action's impacts to listed species is split into three major factors: vulnerability, exposure, and toxicity. The tables below contain summaries of our rankings (high, medium, low) for vulnerability, exposure, and toxicity. Data and information used to determine individual species' rankings and a template worksheet to show how rankings were assessed and combined are in Appendix E. Ranges for all species in this assessment group are entirely within the conterminous United States.

Vulnerability

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

Our assessment of vulnerability focuses on six factors: (1) the species listing status and recent 5-year status review recommendation (if available), (2) distribution, (3) number of populations, (4) species population trends, (5) if pesticides have been noted as a threat, and (6) impacts from activities associated with environmental baseline and cumulative effects. We obtained the information to create the vulnerability summary from the *Status of the Species* accounts (Appendix B), overarching *Environmental Baseline* section of this opinion, listing rules, 5-year species status reviews, species recovery plans, species status assessments, and other sources containing the best available scientific information for the species. For many of the species, pesticides were mentioned in species' listing or recovery documents as either a potential concern or previously identified threat or stressor. In some cases, specific pesticides were mentioned. In other cases, the general term "pesticides" was mentioned, but the description did not further identify or exclude methomyl from the analysis. This information is shown, where available, in the vulnerability accounts for the species below. We considered whether the use of the generic term "pesticide" without further definition or classification in a species' listing or recovery documents should be indicative of methomyl exposure for making our determinations for the species. We recognize there are many pesticides that have been and are currently used in agricultural and non-agricultural use sites, and that patterns in pesticide usage and application practices change over time. All these factors influence the degree to which methomyl may or may not currently act as a stressor to listed species. Therefore, without methomyl-specific information in the information provided below (primarily from species listing and recovery documents), we did not assume that generic use of the word "pesticides" should have a greater weight on our determinations than exposure and toxicity information available for each 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 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 methomyl primarily through contact with contaminated water in their habitats. We assume all methomyl that is transported off-site, whether through spray drift or runoff, is likely to end up in local waterbodies, which may distribute methomyl residues throughout the entire watershed. Methomyl 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.

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

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

Toxicity

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

We consider estimated concentrations of methomyl on the landscape or within the environment and effects reported in available toxicity studies to determine the level of direct and indirect adverse effects 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 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.

Concentrations of methomyl can vary greatly among different regions and aquatic habitat types. We do not expect methomyl to be persistent in the environment where it is able to dissipate or dilute quicky. Where methomyl 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*

[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.

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 methomyl 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 methomyl, we anticipate additional food resources from upstream sources will quickly recolonize affected areas. We do not anticipate phytoplankton and detritus will be impacted by methomyl 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.

Summary of Bivalve (Mussel) Conclusions

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of methomyl, and the cumulative effects, it is our biological opinion that the registration of methomyl, as proposed, is not likely to jeopardize the continued existence of 102 mussel species in this Appendix, and we provide additional information about these species below.

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.

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 and 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.

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

The species in Table 1 are grouped together as they have low exposure informed by low overlap with agricultural sites where methomyl is registered for use. While we present some specific information about the species in Table 1 below, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species accounts can be found in Appendix B.

Table 1. Species with low baseline exposure as informed by low overlap between the species' range and agricultural land uses, high vulnerability, and medium/high toxicity.

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Total Action Area Overlap	Determination
Alasmidonta atropurpurea	Cumberland elktoe	High	Low	Medium	2.2	No Jeopardy
Alasmidonta raveneliana	Appalachian elktoe	High	Low	High	2.1	No Jeopardy
Arcidens wheeleri	Ouachita rock pocketbook	High	Low	Medium	1.4	No Jeopardy
Cyprogenia sp. cf. aberti	Ouachita fanshell	High	Low	Low	0	No Jeopardy
Dromus dromas	Dromedary pearlymussel	High	Low	Medium	4.0	No Jeopardy
Epioblasma brevidens	Cumberlandian combshell	High	Low	Medium	3.6	No Jeopardy
Epioblasma capsaeformis	Oyster mussel	High	Low	Medium	3.1	No Jeopardy
Epioblasma florentina walkeri (=E. walkeri)	Tan riffleshell	High	Low	Medium	0.3	No Jeopardy
Fusconaia cor	Shiny pigtoe	High	Low	Medium	4.2	No Jeopardy
Fusconaia cuneolus	Finerayed pigtoe	High	Low	Medium	3.4	No Jeopardy
Hamiota altilis	Finelined pocketbook	High	Low	Medium	3.2	No Jeopardy
Lampsilis bergmanni	Guadalupe fatmucket	High	Low	Low	1.1	No Jeopardy
Lampsilis bracteata	Texas fatmucket	High	Low	High	3.9	No Jeopardy
Lampsilis powellii	Arkansas fatmucket	High	Low	High	0.3	No Jeopardy

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

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Total Action Area Overlap	Determination
Lampsilis streckeri	Speckled pocketbook	High	Low	Medium	0.1	No Jeopardy
Lemiox rimosus	Birdwing pearlymussel	High	Low	High	3.1	No Jeopardy
Margaritifera marrianae	Alabama pearlshell	High	Low	High	3.8	No Jeopardy
Medionidus acutissimus	Alabama moccasinshell	High	Low	Medium	4.3	No Jeopardy
Medionidus parvulus	Coosa moccasinshell	High	Low	High	3.9	No Jeopardy
Parvaspina collina	James spinymussel	High	Low	Medium	2.8	No Jeopardy
Pleurobema athearni	Canoe Creek clubshell	High	Low	Low	1.7	No Jeopardy
Pleurobema furvum	Dark pigtoe	High	Low	Medium	3.9	No Jeopardy
Pleurobema georgianum	Southern pigtoe	High	Low	Medium	3.7	No Jeopardy
Pleurobema riddellii	Louisiana pigtoe	High	Low	Low	1.0	No Jeopardy
Popenaias popeii	Texas hornshell	High	Low	Medium	0.7	No Jeopardy
Potamilus amphichaenus	Texas heelsplitter	High	Low	Low	2.4	No Jeopardy
Potamilus metnecktayi	Salina mucket	High	Low	Low	0	No Jeopardy
Ptychobranchus greenii	Triangular kidneyshell	High	Low	Medium	3.2	No Jeopardy
Quadrula cylindrica strigillata	Rough rabbitsfoot	High	Low	Medium	0.8	No Jeopardy
Theliderma sparsa	Appalachian monkeyface (pearlymussel)	High	Low	High	1.6	No Jeopardy
Villosa perpurpurea	Purple bean	High	Low	Medium	0.6	No Jeopardy
Villosa trabalis	Cumberland bean (pearlymussel)	High	Low	Medium	3.0	No Jeopardy

All the species listed in Table 1 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 methomyl 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 pigtoes and shiny pigtoes have never been reintroduced into the Tennessee, French Broad, or Holston Rivers.

Toxicity varies from low to high for the mussel species in this group based on predicted levels of methomyl exposure and their relationship to host fish. Based on the estimated environmental concentrations in the waterways where these mussels are found, we do not anticipate direct adverse effects to mussels, but expect that exposure will result in 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 reproductive success.

However, while these species are highly vulnerable and loss of host fish and prey items is expected, we anticipate, at most, a very small number of individuals will be exposed to methomyl. All the species listed in Table 1 have a low extent of overlap between the action area and their ranges (overlaps are 0%-4.3%). 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 methomyl usage. As such, we expect that exposure of these species to methomyl will occur on an even smaller portion of the species' ranges than indicated by overlap with methomyl use sites alone.

We anticipate that over the duration of the proposed action, exposure will be limited to small portions of the species ranges and will impact very small numbers of the species in Table 1. 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 1.

After reviewing the current status of the species, environmental baseline for theaction area, effects of the proposed registration of methomyl (including conservation measures), and cumulative effects for the species in Table 1, it is our biological opinion that the registration of methomyl, as proposed, is not likely to jeopardize the continued existence of these species. As discussed, even though these species' vulnerability rankings are high and their toxicity rankings are medium or high, we anticipate the likelihood of methomyl 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 likely to appreciably reduce survival and recovery of the species in Table 1 in the wild.

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

The species in Table 2 are grouped together because they have low exposure confirmed by low levels of past insecticide usage within their ranges (% range treated), as informed by the U.S. Department of Agriculture's Census of Agriculture (CoA) data. These species have medium to high vulnerability and low to high toxicity rankings. 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. 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
Epioblasma penita	Southern combshell	High	Low	High	4.4	No Jeopardy
Fusconaia escambia	Narrow pigtoe	High	Low	High	2.6	No Jeopardy
Hamiota australis	Southern sandshell	High	Low	High	3.7	No Jeopardy
Hamiota perovalis	Orangenacre mucket	High	Low	Medium	2.0	No Jeopardy
Hemistena lata	Cracking pearlymussel	High	Low	Low	3.4	No Jeopardy
Lasmigona decorata	Carolina heelsplitter	High	Low	High	3.3	No Jeopardy
Obovaria choctawensis	Choctaw bean	High	Low	Low	3.7	No Jeopardy
Pegias fabula	Littlewing pearlymussel	High	Low	Medium	3.7	No Jeopardy
Pleurobema curtum	Black clubshell	High	Low	Low	3.3	No Jeopardy
Pleurobema decisum	Southern clubshell	High	Low	Medium	2.0	No Jeopardy
Pleurobema hanleyianum	Georgia pigtoe	High	Low	Low	1.5	No Jeopardy
Pleurobema perovatum	Ovate clubshell	High	Low	Low	1.8	No Jeopardy
Pleurobema strodeanum	Fuzzy pigtoe	High	Low	High	3.7	No Jeopardy
Pleurobema taitianum	Heavy pigtoe	High	Low	High	3.9	No Jeopardy

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	% Range Treated	Determination
Pleuronaia gibber	Cumberland pigtoe	High	Low	High	4.3	No Jeopardy
Potamilus inflatus	Alabama (inflated) heelsplitter	Medium	Low	High	2.0	No Jeopardy
Ptychobranchus jonesi	Southern kidneyshell	High	Low	High	3.9	No Jeopardy
Ptychobranchus subtentus	Fluted kidneyshell	High	Low	Medium	3.2	No Jeopardy
Quadrula fragosa	Winged mapleleaf	High	Low	Medium	2.2	No Jeopardy
Reginaia rotulata	Round ebonyshell	High	Low	Low	3.1	No Jeopardy
Theliderma intermedia	Cumberland monkeyface (pearlymussel)	High	Low	Medium	3.7	No Jeopardy

Most of the species listed in Table 2 have high vulnerability rankings, indicating that they may not be able to withstand additional stressors in their environment, including reduced reproductive capacity from methomyl 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. 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, Cumberland monkeyface (pearlymussels) have never been reintroduced into the Tennessee, French Broad, or Holston Rivers.

Toxicity varies from low to high for the mussel species in this group based on predicted levels of methomyl exposure and their relationship to host fish. Based on the estimated environmental concentrations in the waterways where these mussels are found, we do not anticipate direct adverse effects to mussels. When exposed, we expect that such exposure will result in 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 reproductive success.

However, while these species have medium to high vulnerability rankings and we expect loss of host fish and/or prey items hen exposed, we anticipate, at most, a very small number of individuals and their host fish will be exposed to methomyl. For the species in Table 2, a low percent of their range has been treated with insecticides in the past based on CoA reporting (1.5-4.4%). Low CoA usage indicates that very little insecticide usage (of any type) occurred in the past in the counties where these species' ranges occur. Given that this reporting includes all insecticide usage, we consider CoA data to be a conservative estimate of methomyl usage. For these species, very little of the species' ranges are likely to be treated with methomyl. We anticipate that over the duration of the proposed action, very small numbers of the species in Table 2 will experience exposure to methomyl, and exposure will be limited to small portions of the species ranges. 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 methomyl (including conservation measures), and cumulative effects for the species in Table 2, it is our biological opinion that the registration of methomyl, as proposed, is not likely to jeopardize the continued existence of these species. As discussed, even though these species' vulnerability rankings are high and some toxicity rankings are medium or high, we anticipate the likelihood of methomyl 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 likely to appreciably reduce survival and recovery of the species in Table 2 in the wild.

Species with Individual Integration and Synthesis summaries

For the species in Table 3, our preliminary exposure and toxicity rankings indicated that the proposed action may result in moderate to high adverse effects. As such, we discuss each species in more detail in individual Integration and Synthesis summaries below. In some cases, we modified initial exposure and toxicity rankings due to additional information regarding exposure and effects for individual species, as described below.

Table 3. 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
Epioblasma obliquata obliquata	Purple cat's paw (pearlymussel)	No Jeopardy
Epioblasma obliquata perobliqua	White cat's paw (pearlymussel)	No Jeopardy
Lampsilis higginsii	Higgins eye (pearlymussel)	No Jeopardy
Lampsilis virescens	Alabama lampmussel	No Jeopardy
Toxolasma cylindrellus	Pale lilliput (pearlymussel)	No Jeopardy
Lampsilis abrupta	Pink mucket (pearlymussel)	No Jeopardy
Epioblasma florentina curtisii	Curtis pearlymussel	No Jeopardy
Plethobasus cicatricosus	White wartyback (pearlymussel)	No Jeopardy
Pleurobema plenum	Rough pigtoe	No Jeopardy
Plethobasus cooperianus	Orangefoot pimpleback (pearlymussel)	No Jeopardy
Obovaria retusa	Ring pink (mussel)	No Jeopardy
Potamilus capax	Fat pocketbook	No Jeopardy
Leptodea leptodon	Scaleshell mussel	No Jeopardy
Parvaspina steinstansana	Tar River spinymussel	No Jeopardy
Pleurobema clava	Clubshell	No Jeopardy
Alasmidonta heterodon	Dwarf wedgemussel	No Jeopardy
Margaritifera hembeli	Louisiana pearlshell	No Jeopardy
Elliptoideus sloatianus	Purple bankclimber (mussel)	No Jeopardy
Cyprogenia stegaria	Fanshell	No Jeopardy
Pleurobema pyriforme	Oval pigtoe	No Jeopardy
Hamiota subangulata	Shinyrayed pocketbook	No Jeopardy
Epioblasma torulosa rangiana	Northern riffleshell	No Jeopardy
Amblema neislerii	Fat threeridge (mussel)	No Jeopardy
Medionidus penicillatus	Gulf moccasinshell	No Jeopardy
Medionidus simpsonianus	Ochlockonee moccasinshell	No Jeopardy

Elliptio chipolaensis	Chipola slabshell	No Jeopardy
Quadrula cylindrica cylindrica	Rabbitsfoot	No Jeopardy
Elliptio lanceolata	Yellow lance	No Jeopardy
Lampsilis rafinesqueana	Neosho mucket	No Jeopardy
Elliptio spinosa	Altamaha spinymussel	No Jeopardy
Cumberlandia monodonta	Spectaclecase (mussel)	No Jeopardy
Epioblasma triquetra	Snuffbox mussel	No Jeopardy
Villosa fabalis	Rayed bean	No Jeopardy
Fusconaia burkei	Tapered pigtoe	No Jeopardy
Pleuronaia dolabelloides	Slabside pearlymussel	No Jeopardy
Fusconaia masoni	Atlantic pigtoe	No Jeopardy
Medionidus walkeri	Suwannee moccasinshell	No Jeopardy
Plethobasus cyphyus	Sheepnose mussel	No Jeopardy
Truncilla macrodon	Texas fawnsfoot	No Jeopardy
Cyclonaias petrina	Texas pimpleback	No Jeopardy
Lasmigona subviridis	Green floater	No Jeopardy
Fusconaia mitchelli	False spike	No Jeopardy
Cyprogenia aberti	Western fanshell	No Jeopardy
Simpsonaias ambigua	Salamander mussel	No Jeopardy
Truncilla cognata	Mexican fawnsfoot	No Jeopardy
Alasmidonta triangulata	Southern elktoe	No Jeopardy
Obovaria subrotunda	Round hickorynut	No Jeopardy
Fusconaia subrotunda	Longsolid	No Jeopardy
Cyclonaias necki	Guadalupe orb	No Jeopardy

Integration and Synthesis Summary: - Purple cat's paw (pearlymussel)

Scientific Name:	Common Name:	Entity ID:
Epioblasma obliquata	Purple cat's paw (=pearlymussel)	323

Species Overview

After reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 1). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium, and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not likely to appreciably reduce the survival and recovery of the species. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the purple cat's paw pearlymussel. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 1/20/2023; Wherever found; Except where listed as Experimental Populations; *States within the range:* KY, OH, TN, WV. Figure 1 depicts the species' range.

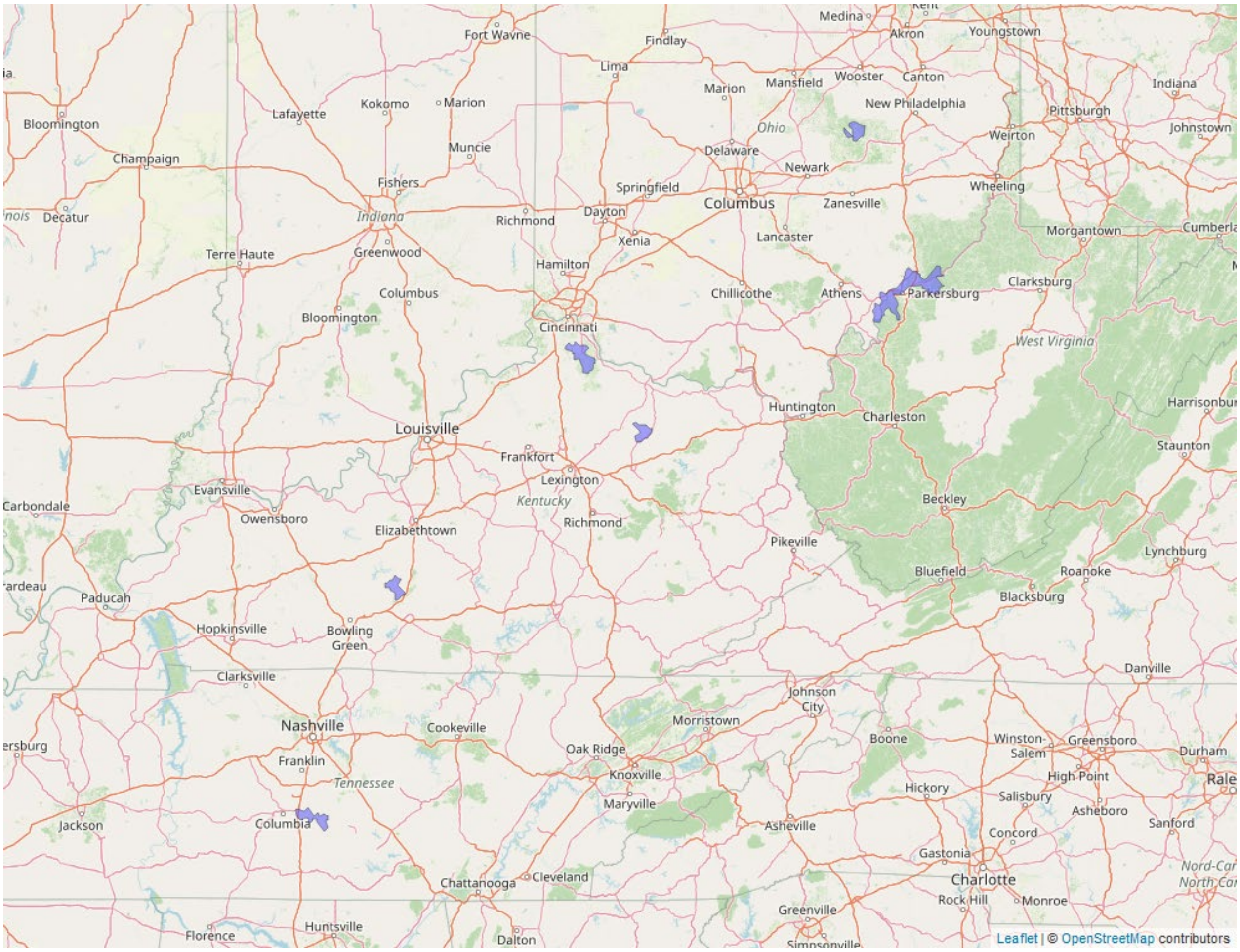

Figure 1. Range map of purple cat's paw (=pearlymussel) (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/5602.

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

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); sensitive to stochastic events (natural and/or anthropogenic)

Number of Populations: Multiple populations (few); small number of individuals in one or more populations

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

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

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

The purple cat's paw was historically distributed in the Ohio, Cumberland, and Tennessee River systems in Ohio, Illinois, Indiana, Kentucky, Tennessee, and Alabama (USFWS 2005). Currently the subspecies occurs in the Ohio River and four of its tributaries: Killbuck Creek, Ohio; Walhonding River, Ohio; Green River Kentucky; Licking River, Kentucky; and one Tennessee River tributary, Duck River, Tennessee. Except for the Killbuck Creek population, all these populations were reintroduced into these streams in 2017 (USFWS 2020). Although recruitment occurred in the past several years based on the finding of young individuals, long term viability of the Killbuck Creek population is questionable due to the very small population size that appears to be concentrated in one riffle. The species is likely extirpated from the Cumberland River as no individuals have been observed there in over 30 years. Their extirpation is believed to be from commercial mussel fishing for other species (USFWS 1992). Reintroduced populations in the Walhonding River, Ohio River, Licking River, Green River, and Duck River currently only harbor juveniles and young adults and natural reproduction of the species has not yet been documented in these populations (USFWS 2020). In 2001, an experimental population of purple cat's paw (pearlymussels) was established in the Tennessee River downstream of Wilson Dam with unknown success (EXPN Entity ID 8349).

Many of the historic populations of the purple cat's paw were apparently lost when the river sections they inhabited were impounded. These impoundments seriously reduced the availability of riverine habitat and likely affected the distribution and availability of the mussel's fish hosts. The Green River in Kentucky also experienced water quality problems related to the impacts from oil and gas production in the watershed (USFWS 1992). Ahlstedt (2007) reported that mussel habitat in Killbuck Creek is "severely degraded." The substrate is severely embedded and relatively hard packed which doesn't allow for mussel colonization. The riparian zone is impacted by timber removal, field crops, and cattle accessing the stream. Ahlstedt (2007) also noted that "fish are noticeably absent and Asian clams were abundant" in Killbuck Creek. The Killbuck watershed contains many operating oil and gas wells, though it is unknown if these wells impact the creek (USFWS 2010).

Climate change likely constitutes a threat for the species. Current climate change predictions in the Northern Hemisphere indicate warmer air temperatures and more intense precipitation events are likely to occur in the future (IPCC 2007). The predicted impact on streams includes changes in the distribution of algae, plankton, and fish as well as changes in water temperatures and oxygen levels. Warming of waters in rivers and streams may make these habitats less able to support their current fish and mussel fauna (IPCC 2007). Highly specialized species, such as freshwater mussels, are likely to be most susceptible to the additional stresses of a changing climate. The most recent literature on climate change includes predictions of hydrological changes, higher temperatures, and expansion of drought areas, resulting in a northward and/or upward elevation shift in range for many species (IPCC 2007). Although the specific effects of climate change on the purple cat's paw pearlymussel are unknown, altered hydrology in rivers, increased frequency of extreme weather events, and a changing abundance and distribution of fish species have the potential to adversely affect this species. The magnitude of the climate threat to the purple cat's paw pearlymussel is unknown.

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 15.1% of the species range will contain methomyl use sites (Table 4).

Usage

Past usage data indicate that up to 1% of the species' range has been treated with methomyl annually (Table 4). Use layers with the highest usage include soybeans (0.7%), alfalfa (0.1%), other row crops (0.1%), and vegetables and ground fruit (0.1%).

Table 4. Overlap and usage data for the purple cat's paw (=pearlymussel).

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	0.5	0.1
Citrus	NA	NA
Corn	12.8	0.6
Cotton	<0.1	<0.1
Other Grains	0.2	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	0.3	0.1

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Soybeans[2]	14	0.7
Vegetables and Ground Fruit	<0.1	0.1
Wheat	NA	NA
Total	**15.1**	**1**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the high overlap between the action area and the species' range (15.1%). However, based on past usage data, we expect a smaller portion of the range is likely to be treated with methomyl (1%) annually. Therefore, we expect a moderate number of individuals are likely to experience exposure over the duration of the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 5 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found as a result of this rain restriction measure.

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

[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.

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

EPA's aquatic exposure modeling indicates that predicted environmental concentrations within the regions and aquatic habitats that the purple cat's paw (pearlymussel) occupies will likely be exposed to methomyl at concentrations ranging from 14 to 230 µg/L, depending on the type of habitat (Table 5). Based on this range of potential exposures, we expect 0-0.08% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. The purple cat's paw (pearlymussel) is a host fish generalist and can likely use a variety of fish species as hosts such as rock bass, mottled sculpin, greenside darter, stonecat, logperch, and blackside darter. Because the fish host species are varied and found in multiple aquatic habitats, we anticipate low adverse effects to the reproductive cycle of the mussel.

While we do expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Table 5. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality (%)
High flow waterbodies	HUC_5	23.72	0
Large volume waterbodies	HUC_5	13.85	0
Low flow/Low volume waterbodies	HUC_5	229.50	0.08

Overall Toxicity: Low

Effects of the Action Summary

We expect the purple cat's paw (pearlymussel) could be exposed to methomyl in 15.1% of the species range based on methomyl use sites and up to 1% of the range may be treated with methomyl annually (Table 5) based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the purple cat's paw (pearlymussel). We anticipate some 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 purple cat's paw mussel has a variety of fish hosts their glochidia can successfully parasitize and we expect mortality of exposed fish will be low (0-0.08%). In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. Therefore, we anticipate low impacts to the reproductive cycle of the mussel. We expect some reductions in zooplankton from methomyl exposure and any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a very small number of individual mussels will experience adverse effects.

Conclusion

The purple cat's paw (pearlymussel) is listed as endangered and is found in one Tennessee River tributary and four Ohio River tributaries. All but one (Killbuck Creek, Ohio River) are reintroduced populations. All populations are either very small or seem to only harbor juveniles and young adults, making their future viabilities uncertain. The species is extirpated from the Cumberland River system. Threats to the species include effects of impoundments (lack of riverine habitat and host fish), water quality issues, impacted sediment, and climate change.

The species range occurs near methomyl use sites overlapping 15.1% of the range, but a small portion of the range has experienced methomyl usage in the past (1% annually). Therefore, we consider the purple cat's paw (pearlymussel) to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The purple cat's paw (pearlymussel) is a host fish generalist and can likely use a variety of fish for reproduction, including rock bass, mottled sculpin, greenside darter, stonecat, logperch, and blackside darter. The purple cat's paw (pearlymussel) and its host fish occur in both low flow/low volume waterbodies and high flow waterbodies; some host fish also occur in large volume waterbodies. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. Host fish mortality estimates range from 0-0.08%, with low rates of mortality anticipated for host fish in all aquatic habitats. We do not anticipate significant reductions in mussel food availability, as any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources.

Even though the species has high vulnerability and medium exposure, its host fish are abundant and common, host fish use various components of aquatic habitats throughout their life cycles, and we anticipate low host fish mortality (<0.1%) where methomyl exposure occurs. Therefore, we expect impacts to the mussel to be low and a very small number of individuals will be adversely affected over the course of the action. After incorporating conservation measures into the effects of the action, accounting for 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 purple cat's paw (pearlymussel) in the wild.

References

U.S. Fish and Wildlife Service. 2020. Purple Cat's Paw Pearlymussel (*Epioblasma obliquata obliquata*) 5-Year Review: Summary and Evaluation. Columbus, Ohio. 21 pp.

U.S. Fish and Wildlife Service. 2015. Purple cat's paw Pearlymussel (*Epioblasma obliquata obliquata*) 5-Year Review: Summary and Evaluation. Columbus, Ohio. 21 pp.

U.S. Fish and Wildlife Service. 2010. Purple cat's paw Pearlymussel (*Epioblasma obliquata obliquata*) 5-Year Review: Summary and Evaluation. Columbus, Ohio. 15 pp.

U.S. Fish and Wildlife Service. 1992. Recovery Plan for Purple Cat's Paw Pearlymussel. Asheville, North Carolina. 32 pp.

Integration and Synthesis Summary: - White cat's paw (pearlymussel)

Scientific Name:	Common Name:	Entity ID:
Epioblasma perobliqua	White cat's paw (pearlymussel)	324

Species Overview

After reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 2). Exposed individuals are unlikely to die and are likely to experience moderate levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not likely to appreciably reduce the survival and recovery of the species. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the white cat's paw (pearlymussel). We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 5/22/2020; Wherever found; *States within the range:* IN, OH. Figure 2 depicts the species' range.

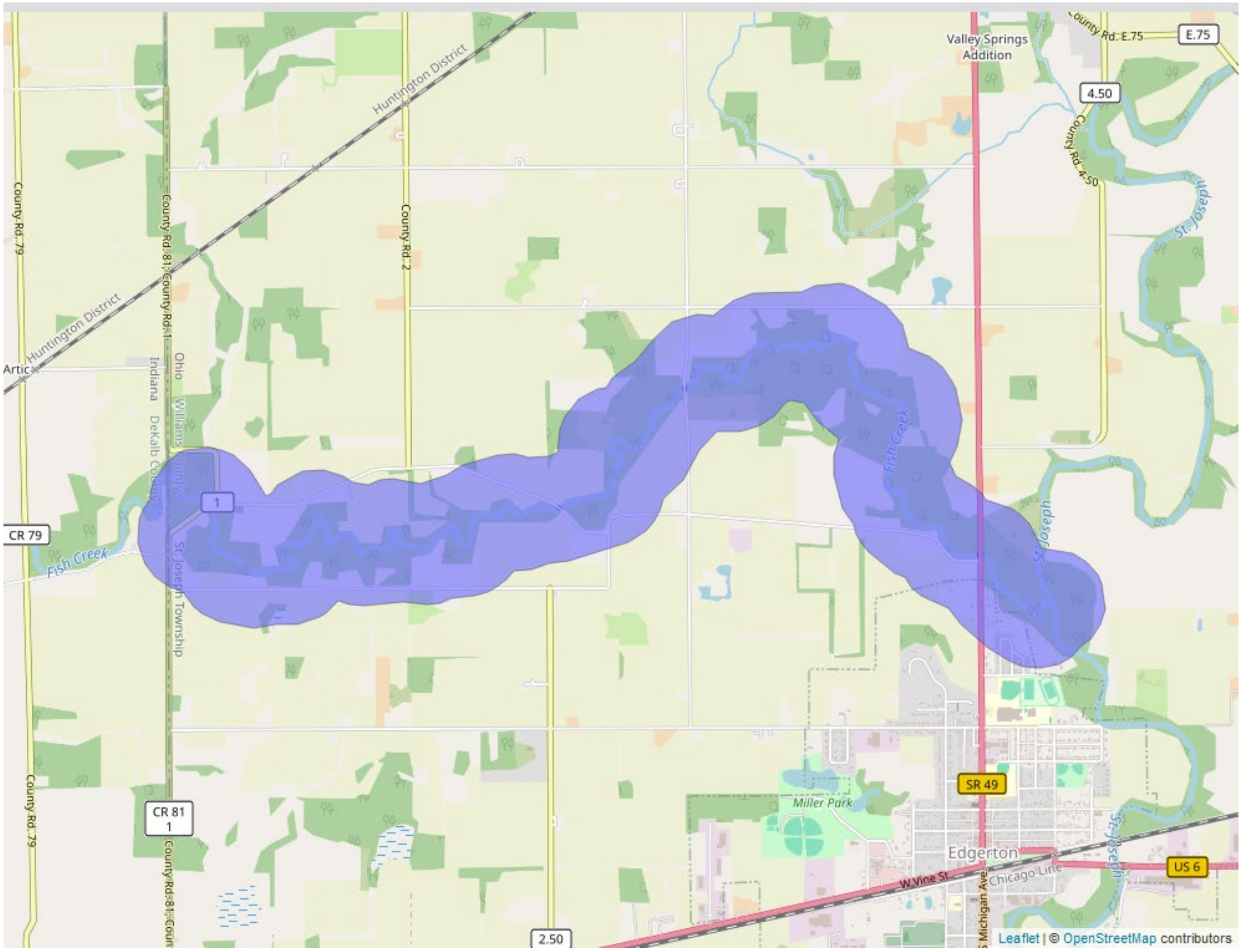

Figure 2. Range map of white cat's paw (pearlymussel) (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/6893.

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: 2/5/2021

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

Number of populations: Single population

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

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

Environmental Baseline/Cumulative Effects (EB/CE) Summary

As reported in the 2021 Five Year Review, the white cat's paw (pearlymussel) exists in only a 3-mile portion of Fish Creek in Williams County in northwest Ohio (USFWS 2021). Museum records indicate that the white cat's paw (pearlymussel) historically occurred in Indiana in the Wabash, White, Tippecanoe, Maumee, and St. Joseph Rivers, and in Ohio in the Maumee and St. Joseph Rivers and Fish Creek. It may have also occurred in the Ohio River though the museum record is questionable because this subspecies is usually restricted to smaller streams (Service 1990). The last observation of a live white cat's paw (pearlymussel) occurred in 1999 after dead individuals were recorded in 1975, 1985, and 1988. Fish Creek was surveyed, system-wide, in 1975, 1988, 1996, 1999, 2004, 2005, and 2012 and no mussel surveys of Fish Creek have been conducted since 2012 (USFWS 2021). The biology of the white cat's paw (pearlymussel) is similar to other bivalved mollusks belonging to the Unionidae family. However, due in large part to its rarity, relatively little is known about its specific life history requirements (Service 1990).

In 1993, a pipeline ruptured, discharging an estimated 30,000 gallons of #2 diesel fuel into a crop field in DeKalb County, Indiana. The diesel fuel ran off into Fish Creek, spread downstream, crossed into Williams County, Ohio, and contaminated the lower 7 miles of the creek. The spill occurred where the only remaining population of white cat's paw (pearlymussel) was known to occur. The magnitude of the impact on the white cat's paw pearly mussel is not known, though there were acute and likely sublethal impacts to freshwater mussels from the spill (Service 2013).

A $2.5 million Natural Resource Damage Assessment settlement was reached in 1995. After the settlement, the Ohio and Indiana trustees worked jointly on projects to restore, protect, and preserve the land along the creek. More than 1,500 acres of the Fish Creek watershed has been protected through acquisitions, conservation easements, reforestation, stream bank stabilization and wetlands restoration. Educational and research projects included mussel surveys, stream flow analysis, and promotion of best management projects to local landowners. Channelization for flood control and other forms of substrate disturbance (e.g., gravel dredging operations, channel maintenance dredging, instream construction, and removal of logs and other obstructions to flow) and siltation due to poor agricultural practices and deforestation are probably the leading factors in the decline of the white cat's paw (pearlymussel). They are threatened by other sources of pollution and climate change (i.e., increased water temperatures and changes to fish host populations) (Service 2013).

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 56.6% of the species range will contain methomyl use sites (Table 6).

Usage

Past usage data indicate that up to 3.1% of the species' range has been treated with methomyl annually (Table 6). Use layers with the highest usage include soybeans (2.7%) and alfalfa (0.4%).

Table 6. Overlap and usage data for the white cat's paw (pearlymussel).

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	2.8	0.4
Citrus	NA	NA
Corn	47.6	2.4
Cotton	<0.1	<0.1
Other Grains	0.3	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	<0.1	<0.1
Soybeans[3]	53.5	2.7
Vegetables and Ground Fruit	<0.1	<0.1
Wheat	NA	NA
Total	**56.6**	**3.1**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the high overlap between the action area and the species' range (56.6%). Based on past usage data, we expect a

[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.

smaller portion of the range is likely to be treated with methomyl (3.1%) annually. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: “Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office.” This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 7 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the white cat’s paw (pearlymussel) occupies, EPA’s aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 24 to 245 µg/L, depending on the type of habitat and region (Table 7). Based on this range of potential exposures, we expect between 0 and 0.12% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. Even though there is no available information on what species the white cat’s paw (pearlymussel) can use as host fish, we anticipate small reductions in fish availability, including potential fish host species. Therefore, we expect low adverse effects to the reproductive cycle of the mussel.

Table 7. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_4	24.17	0
High flow waterbodies	HUC_5	23.72	0
Low flow/Low volume waterbodies	HUC_4	244.80	0.12
Low flow/Low volume waterbodies	HUC_5	229.50	0.08

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the white cat's paw (pearlymussel) could be exposed to methomyl in 56.6% of the species range based on methomyl use sites and up to 3.1% of the range may be treated with methomyl (Table 7) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the white cat's paw mussel. 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 (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. While we do not know what species the white cat's paw (pearlymussel) uses as host fish, we conservatively assume it is a specialist. Even if exposure occurs, we anticipate a small impact to the reproductive cycle of the mussel because expected fish mortality is low (0-0.12%). In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual mussels will experience adverse effects.

Conclusion

The white cat's paw (pearlymussel) is listed as endangered and is found in a 3-mile portion of Fish Creek in Williams County, Ohio. Fish Creek has not been surveyed since 2012 and the last live individual of this species was seen in 1999. A devastating diesel fuel spill in 1993 affected the remaining occupied habitat for the species in Fish Creek; restoration efforts for the contaminated creek began after a settlement was reached in 1995. The species remains threatened by pollution, climate change, and substrate disturbance and siltation from agricultural practices and deforestation.

The species range occurs near methomyl use sites overlapping 56.6% of the range, but a small portion of the range has experienced methomyl usage in the past (3.1% annually). Therefore, we consider the white cat's paw (pearlymussel) to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. Host fish for the white cat's paw (pearlymussel) are unknown and we conservatively assume they are a specialist. The species occurs in both low flow/low volume waterbodies and high flow waterbodies across two HUCs (4 and 5). Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), host fish mortality estimates range from 0-0.12%, with low rates of mortality anticipated for host fish in all aquatic habitats. The white cat's paw (pearlymussel) could be a host fish specialist and the mussels are only known from a 3-mile stretch of one creek in Ohio. However, because we expect low fish host mortality in the white cat's paw (pearlymussel)'s range, we anticipate the overall adverse effects to host fish, and subsequently the white cat's paw (pearlymussel), will be low. 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 the species has high vulnerability, medium exposure, and we assume the species is a host fish specialist, we expect a small number of individual mussels will be adversely affected through effects to host fish due to low fish mortality (0-0.12%) in all aquatic habitats where the mussel is found. After incorporating conservation measures into the effects of the action, accounting for 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 white cat's paw (pearlymussel) in the wild.

References

U.S. Fish and Wildlife Service. 2021. 5-year Review White Cat's Paw Pearly Mussel (*Epioblasma obliquata perobliqua*). Columbus, Ohio. 2 pp.

U.S. Fish and Wildlife Service. 2013. White Cat's Paw Pearly Mussel (*Epioblasma obliquata perobliqua*) 5-year Review: Summary and Evaluation. Columbus, Ohio. 14 pp.

U.S. Fish and Wildlife Service. 1990. Recovery Plan White Cat's Paw Pearly Mussel. Twin Cities, Minnesota. 47 pp.

Integration and Synthesis Summary: - Higgins eye (pearlymussel)

Scientific Name:	Common Name:	Entity ID:
Lampsilis higginsii	Higgins eye (pearlymussel)	325

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 is high overlap of the action area with the species' range and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 3). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not likely to appreciably reduce the survival and recovery of the species. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Higgins eye (pearlymussel). We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 9/9/2022; Wherever found; *States within the range:* IA, IL, MN, MO, NE, SD, WI. Figure 3 depicts the species' range.

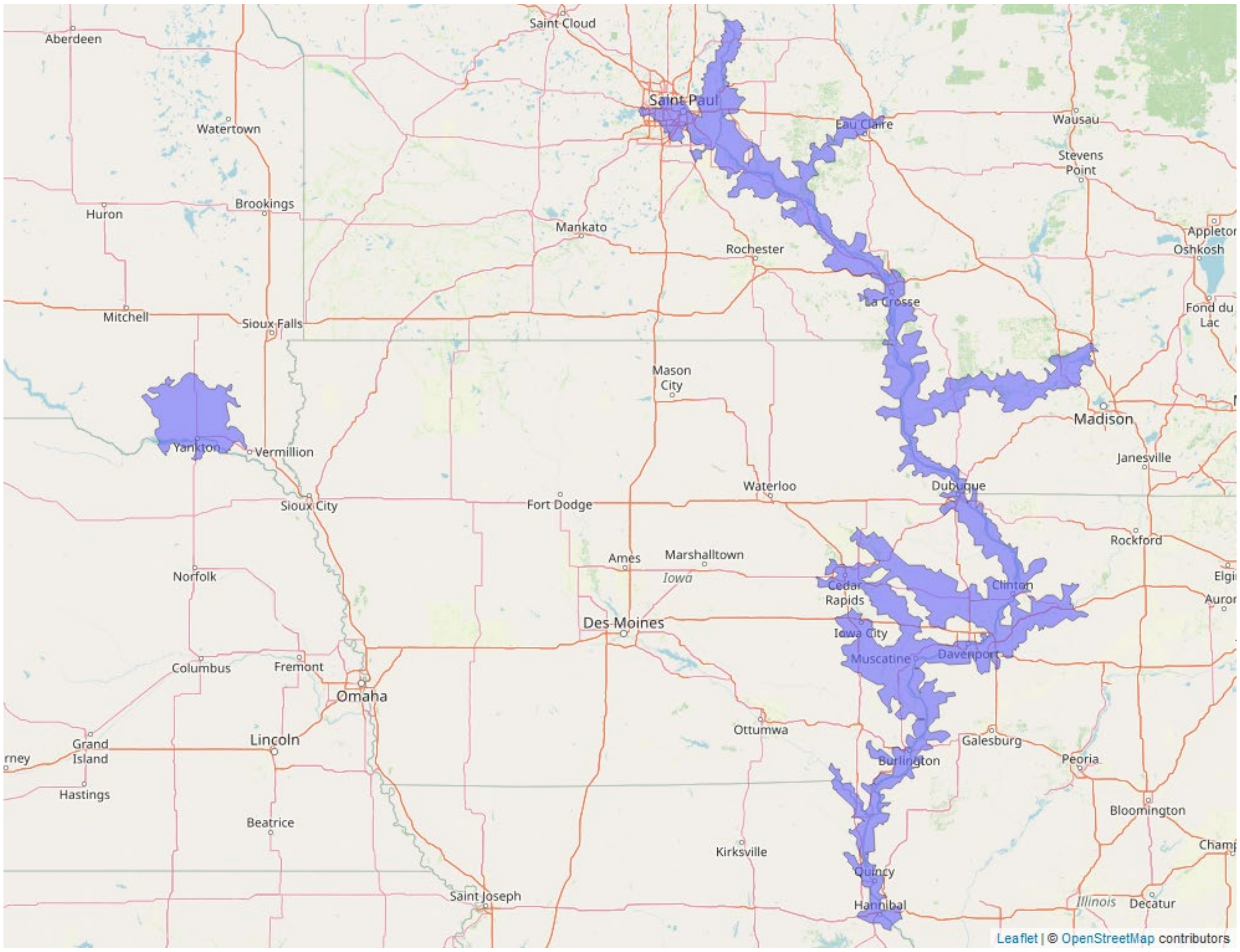

Figure 3. Range map of Higgins eye (pearlymussel) (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/5428.

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: 8/27/2020

Distribution: Species/Populations widespread or wide-ranging

Number of populations: Multiple populations (numerous)

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

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

Environmental Baseline/Cumulative Effects (EB/CE) Summary

There is some uncertainty regarding the historical distribution of Higgins eye (pearlymussel), but it is believed to have been distributed widely, inhabiting the Upper Mississippi River main stem from just north of St. Louis, Missouri to Minneapolis-St. Paul, Minnesota. It also was found in several Upper Mississippi River tributaries including the Ohio, Illinois, Sangamon, Iowa, Cedar, Wapsipinicon, Rock, Wisconsin, Black, Minnesota, St. Croix Rivers (USFWS 2004), and the Chippewa River in Wisconsin. The range of Higgins eye has been reduced from its historical distribution and now includes the Upper Mississippi River upstream of Lock and Dam 22 near Hannibal, Missouri, the lower St. Croix River between Wisconsin and Minnesota, the lower Wisconsin River, Wisconsin, and the lower Rock River in Illinois (USFWS 2020). The species has been recently reintroduced to two locations on the Chippewa River in Wisconsin, but it is too soon to determine if these efforts were successful.

The primary threats to Higgins eye (pearlymussel) are habitat changes (primarily, impoundments), water quality problems, and non-native species, both as predators (carp) and competitors (zebra mussels and Asian clams). Toxic chemical spills have killed mussels and fish throughout the range of Higgins eye (pearlymussel), particularly in the Mississippi River where several spills have occurred. Various alien or non-native aquatic species are established firmly in the Higgins eye's range, the most significant of which are the zebra mussel, Asian clam, non-native carp, and round goby. Since listing, most extant sites have had encroachment of zebra mussels. Only the Chippewa River and Interstate populations are free from zebra mussel encroachment. Conservation work, including monitoring, captive propagation and release, outreach, and funding acquisition, has been active for Higgins eye (pearlymussel) since the last review in 2006 (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 50.8% of the species' range will contain methomyl use sites (Table 8).

Usage

Past usage data indicate that up to 3.8% of the species' range has been treated with methomyl annually. Use layers with the highest usage are corn (2.1%), alfalfa (0.9%), and vegetables and ground fruit (0.7%) (Table 8).

Table 8. Overlap and usage data for the Higgins eye (pearlymussel).

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	5.9	0.9
Citrus	NA	NA
Corn[4]	42.9	2.1
Cotton	<0.1	<0.1
Other Grains	1.2	0.1
Other Orchards	<0.1	<0.1
Other Row Crops	<0.1	<0.1
Soybeans	36.2	1.8
Vegetables and Ground Fruit	0.7	0.7
Wheat	NA	NA
Total	**50.8**	**3.8**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the high overlap between the action area and the species' range (50.8%). Based on past usage data, we expect a smaller portion of the range is likely to be treated with methomyl (3.8%). Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply

[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. Total overlap is capped at 100%.

when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 9 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the Higgins eye (pearlymussel) occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 248 µg/L, depending on the type of habitat and region (Table 9). Based on this range of potential exposures, we expect between 0-0.13% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. In addition, the Higgins eye is a host fish generalist and can likely use a variety of fish species as hosts such as sauger, walleye, yellow perch, largemouth and smallmouth bass, and freshwater drum. Because the fish host species are varied and found in multiple aquatic habitats, and we expect fish mortality to be low (0-0.13%), we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 9. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_10a	23.26	0
High flow waterbodies	HUC_7	23.72	0
Large volume waterbodies	HUC_10a	12.45	0
Large volume waterbodies	HUC_7	12.21	0
Low flow/Low volume waterbodies	HUC_10a	248.40	0.13
Low flow/Low volume waterbodies	HUC_7	209.70	0.04

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the Higgins eye (pearlymussel) could be exposed to methomyl in 50.8% of the species range based on methomyl use sites and up to 3.8% of the range may be treated with methomyl (Table 9) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the Higgin's eye (pearlymussel). We anticipate mortality to fish hosts, particularly in low flow/low volume waterbodies. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. The Higgins eye (pearlymussel) has a variety of fish hosts that their glochidia can successfully parasitize, and we expect mortality of exposed fish will be low (0-0.13%). In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. Therefore, we anticipate low impacts to the reproductive cycle of the mussel. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individuals will experience adverse effects.

Conclusion

The Higgins eye (pearlymussel) is listed as endangered and found in a reduced area from its historical range: the Upper Mississippi River upstream of Lock and Dam 22 near Hannibal, Missouri, the lower St. Croix River between Wisconsin and Minnesota, the lower Wisconsin River, Wisconsin, and the lower Rock River in Illinois. The species was reintroduced to two locations on the Chippewa River in Wisconsin with unknown success. The species is threatened by habitat changes (primarily from water impoundments), effects to water quality, and non-native aquatic predators and competitors.

The species range occurs near methomyl use sites overlapping 50.8% of the range, but a small portion of the range has experienced methomyl usage in the past (3.8% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The Higgins eye (pearlymussel) is a host fish generalist and can likely use a variety of fish for reproduction, including sauger, walleye, yellow perch, largemouth and smallmouth bass, and freshwater drum. The Higgins eye (pearlymussel) and its host fish occur in many aquatic habitats across two HUCs (7, 10a). Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), host fish mortality estimates range from 0-0.13%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, its host fish are abundant and common, host fish occur in multiple river systems, and we anticipate low host fish mortality (0-0.13%). Therefore, we expect impacts to the Higgins eye (pearlymussel) to be low and a small number of individual mussels will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 Higgins eye (pearlymussel) in the wild.

References

U.S. Fish and Wildlife Service. 2020. Higgins Eye (pearlymussel) (*Lampsilis higginsii*) 5-Year Review: Summary and Evaluation. Bloomington, Minnesota. 28 pp.

U.S. Fish and Wildlife Service. 2004. Higgins Eye (pearlymussel) (*Lampsilis higginsii*) Recovery Plan: First Revision. Ft. Snelling, Minnesota. 141 pp.

Integration and Synthesis Summary: - Alabama lampmussel

Scientific Name:	Common Name:	Entity ID:
Lampsilis virescens	Alabama lampmussel	326

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 medium overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 4). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 Alabama lampmussel. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 1/13/2023; Wherever found; Except where listed as Experimental Populations; *States within the range:* AL, MS, TN. Figure 4 depicts the species' range.

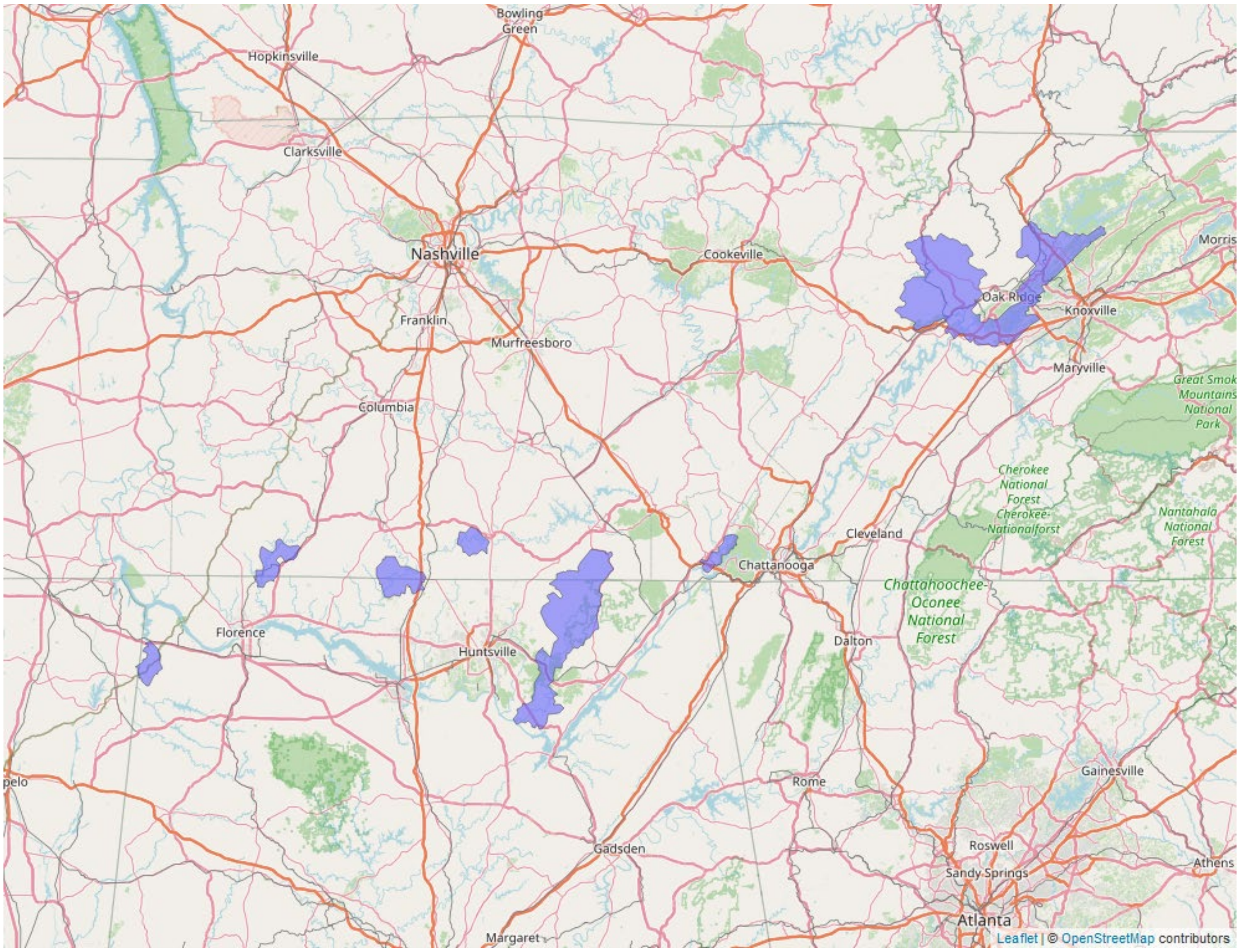

Figure 4. Range map of Alabama lampmussel (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/916.

Vulnerability

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

Summary of status

Listing status: Endangered

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

Most recently completed 5-Year Review: 4/23/2020

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 Alabama lampmussel historically occurred from the headwaters of the Tennessee River in eastern Tennessee downstream to Bear Creek in northwestern Alabama. It used to occur in various waterway types, from small creeks to large rivers, but it now only persists in small streams in areas of slow to moderate current within sand and gravel substrates. Natural Alabama lampmussel populations are restricted to the headwaters of the Paint Rock River and the upper Emory River, and they tend to occur in low numbers where found. Since 2004, reintroduction events have occurred in 11 northern Alabama and southern Tennessee watersheds, and an experimental population was established in the Tennessee River with unknown success (Service 2020; EXPN Entity ID 1680).

The Paint Rock River was substantially altered in the 1960s from a series of channel engineering projects which involved extensive stream channelization and removal of snags and riverbank timber in the mainstem Paint Rock River, Larkin Fork, Estill Fork, and Hurricane Creek. Riffle and shoal habitats have never recovered from this effort and the restoration of natural hydromorphology continues to be aggravated by non-point source pollution associated with agricultural runoff. The mussel fauna may continue to decline until measures are taken to reduce these substantial stream alterations and perturbations. The Emory River population may have suffered from mining activity along the river, but most mines adjacent to the river are now abandoned and affected stream miles appear to be recovering. However, impairment caused by livestock accessing the river is now apparent in these reaches. Habitat destruction or modification is presently the greatest threat to this species. Since agriculture is the predominant stream-side land use, partnerships with private landowners to implement conservation practices, easements, and/or best management practices on their properties are vital to the continued existence of the Alabama lampmussel (Service 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 9.9% of the species range will contain methomyl use sites (Table 10).

Usage

Past usage data indicate that up to 0.5% of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (0.4%) and cotton (0.1%) (Table 10).

Table 10. Overlap and usage data for the Alabama lampmussel.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn	6.6	0.3
Cotton	2.1	0.1
Other Grains	0.1	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	<0.1	<0.1
Soybeans[5]	7.6	0.4
Vegetables and Ground Fruit	<0.1	<0.1
Wheat	NA	NA
Total	**9.9**	**0.5**

Exposure Summary

A medium portion of the species range could be exposed to methomyl given the medium overlap between the action area and the species' range (9.9%). Based on past usage data, we expect a smaller portion of the range is likely to be treated with methomyl (0.5%) annually, suggesting a small portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

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

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 11 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the Alabama lampmussel occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations will likely be from 12 to 230 µg/L, depending on the type of habitat and region (Table 11). Based on this range of potential exposures, we expect between 0-0.08% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. The Alabama lampmussel is a host fish generalist and can likely use a variety of fish species as hosts such as rock bass, green sunfish, bluegill sunfish, smallmouth bass, spotted bass, largemouth bass, redeye bass, and banded sculpin. Because the fish host species are varied and found in multiple aquatic habitats, and we expect fish mortality to be low (0-0.08%), we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 11. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Low flow/Low volume waterbodies	HUC_5	229.50	0.08
Low flow/Low volume waterbodies	HUC_6	164.70	0.01

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the Alabama lampmussel could be exposed to methomyl in 9.9% of the species range based on methomyl use sites and up to 0.5% of the range may be treated with methomyl (Table 11) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the Alabama lampmussel. We anticipate mortality to host fish, particularly in low flow/ low volume waterbodies. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. The Alabama lampmussel has a variety of fish hosts that their glochidia can successfully parasitize and we expect mortality of exposed fish will be low (0-0.08%). In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. Therefore, we anticipate low impacts to the reproductive cycle of the mussel. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual mussels will experience adverse effects.

Conclusion

The Alabama lampmussel is listed as endangered and found in small streams in the Paint Rock River in Alabama and upper Emory River in Tennessee. Historically, they were found in many sizes and types of waterways from the headwaters of the Tennessee River downstream to Bear Creek in Alabama. The species has been reintroduced to several locations in northern Alabama and southern Tennessee since 2004. The species is threatened by habitat destruction or modification, including effects of livestock accessing the river and agricultural runoff.

The species range occurs near methomyl use sites overlapping 9.9% of the range, but a small portion of the range has experienced methomyl usage in the past (0.5% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The Alabama lampmussel is a host fish generalist and can likely use a variety of fish for reproduction, including rock bass, green sunfish, bluegill sunfish, smallmouth bass, spotted bass, largemouth bass, and redeye bass banded sculpin. The Alabama lampmussel and its host fish occur in many aquatic habitats across two HUCs (3, 6). Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), host fish mortality estimates range from 0-0.08%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, its host fish are abundant and common, and we anticipate low host fish mortality (0-0.08%). Therefore, we expect impacts to the mussel to be low and a small number of individuals will be adversely affected over the course of the action. After incorporating conservation measures into the effects of the action, accounting for 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 Alabama lampmussel in the wild.

References

U.S. Fish and Wildlife Service. 2020. Alabama Lampmussel (*Lampsilis virescens*) 5-Year Review: Summary and Evaluation. Daphne, Alabama. 38 pp.

Integration and Synthesis Summary: - Pale lilliput (pearlymussel)

Scientific Name:	Common Name:	Entity ID:
Toxolasma cylindrellus	Pale lilliput (pearlymussel)	327

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 medium overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 5). Exposed individuals are unlikely to die but are likely to experience medium levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 pale lilliput (pearlymussel). We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 6/15/2016; Wherever found; *States within the range:* AL, TN. Figure 5 depicts the species' range.

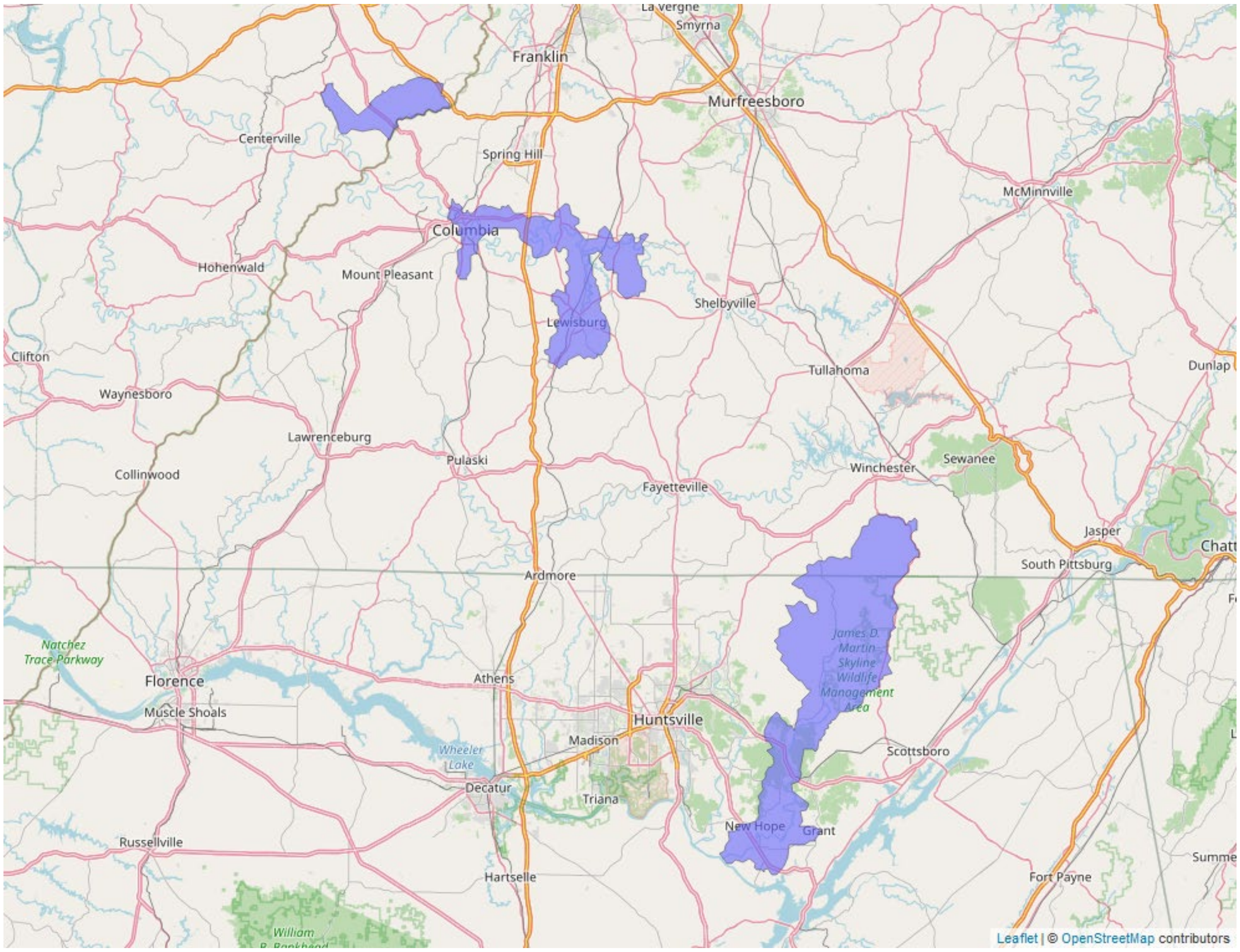

Figure 5. Range map of pale lilliput (pearlymussel) (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/3118.

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: 9/23/2021

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 pale lilliput (pearlymussel) historically occurred from the middle reaches of the Tennessee River system, across northern Alabama, and in the Duck River system in central Tennessee. It was considered extirpated from the Duck River, but a population is now known to occur in Lick Creek, a tributary to Duck River in Maury County, Tennessee. The only other known natural population of pale lilliput (pearlymussel) is believed to be limited to the upper reaches of the Paint Rock River system, Jackson County, Alabama, and potentially in its headwaters in Franklin County, Tennessee. There is also a single record of pale lilliput (pearlymussels) from Swamp Creek, Whitfield County, Georgia, a Mobile River system tributary, which is possibly an exception to its distribution, a mistaken identification, or an invalid record; therefore, we do not consider this part of the current or historical range for the species. The pale lilliput appears to occur in extremely low numbers and has been increasingly difficult to locate. Since 2014, over 8,500 individuals have been reintroduced into several stream reaches within the species' historical range in Alabama and Tennessee. Limited surveys and captures in natural and reintroduced habitats have prevented an assessment of population or abundance trends (USFWS 2021).

Some development has occurred in the Painted Rock River watershed, but it has been relatively low compared to other areas in the Tennessee Valley. One of the most damaging modifications may have been the U.S. Army Corps of Engineers' channelization projects of the 1960s, which involved extensive stream channelization and removal of snags and riverbank timber in the Paint Rock River main stem, Larkin Fork, Estill Fork, and Hurricane Creek. Riffle and shoal habitats have never recovered from those events and continue to be aggravated by non-point source pollution associated with agricultural runoff. The mussel fauna may continue to decline until measures are taken to reduce and remediate these stream perturbations. In 1995, 100 potential non-point source impacts were found across 85 surveyed sites. Of the 100 impacts, 75 impacted sites were within the Paint Rock River main stem, 18 in Estill Fork, 5 in Hurricane Creek, and 2 within Larkin Fork. The most common impact was lack of riparian vegetation (47%), followed by cattle access to the stream (19%) and fording sites for agricultural vehicles (14%). Other documented impacts were sedimentation from mining and off-road vehicles (4% each), cropland erosion and timber harvest sites (3% each) and dumping of debris (2%). Additional impacts noted include: sewage inflow, major logjam, siltation from construction, and drainage pipes. Lilliput habitat has also been disturbed and degraded by unauthorized removal of creek gravel from within the stream channel at several locations within the Paint Rock River drainage basin. Habitat destruction or modification is presently the greatest threat to this species. Since agriculture is the predominant land use, partnerships with private 17 landowners to implement conservation practices, easements, and/or best management practices on their properties are vital to the continued existence of the pale lilliput (USFWS 2021).

In recent years, improvements have been made to the pale lilliput (pearlymussel)'s habitat and to the areas surrounding its range.

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 9.8% of the species range will contain methomyl use sites (Table 12).

Usage

Past usage data indicate that up to 0.5% of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (0.4%) and vegetables and ground fruit (0.1%) (Table 12).

Table 12. Overlap and usage data for the pale lilliput (pearlymussel).

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn	7.3	0.4
Cotton	0.7	<0.1
Other Grains	0.1	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	<0.1	<0.1
Soybeans[6]	8.8	0.4

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

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Vegetables and Ground Fruit	<0.1	0.1
Wheat	NA	NA
Total	**9.8**	**0.5**

Exposure Summary

A medium portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (9.9%). Based on past usage data, we expect a smaller portion of the range is likely to be treated with methomyl (0.5%) annually, suggesting a small portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 13 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the pale lilliput (pearlymussel) occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 230 µg/L, depending on the type of habitat and region (Table 13). Based on this range of potential exposures, we expect between 0-0.08% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. The pale lilliput is a host fish specialist and suitable host fish within the species range include northern studfish (*Fundulus caetenotus*), blackspotted topminnow (*F. olivaceus*), and blackstripe topminnow (*F. notatus*) (Johnson 2018). These fish hosts are common within the mussel's range. Because the fish host species are varied and found in multiple aquatic habitats, and we expect fish mortality to be low (0-0.08%), we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 13. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Low flow/Low volume waterbodies	HUC_5	229.50	0.08
Low flow/Low volume waterbodies	HUC_6	164.70	0.01

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the pale lilliput (pearlymussel) could be exposed to methomyl in 9.8% of the species range based on methomyl use sites and up to 0.5% of the range may be treated with methomyl (Table 12) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the pale lilliput (pearlymussel). We anticipate mortality to fish host fish, particularly in low flow/ low volume waterbodies. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. The pale lilliput (pearlymussel) has one known fish host and it is common in low flow waterways where we expect mortality will be low. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. We anticipate low impacts to the reproductive cycle of the mussel, and a small number of individuals will experience adverse effects.

Conclusion

The pale lilliput (pearlymussel) is listed as endangered and found in Lick Creek, a tributary of Duck River, in Tennessee and the upper reaches of the Paint Rock River system in Alabama. It may be found in the Paint Rock River headwaters in Franklin County, Tennessee. Over 8,500 individuals have been reintroduced into several stream reaches in Alabama and Tennessee. The species is threatened by habitat destruction or modification, including effects of livestock accessing the river, sedimentation, and agricultural runoff.

The species range occurs near methomyl use sites overlapping 9.8% of the range, but a small portion of the range has experienced methomyl usage in the past (0.5% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The pale lilliput (pearlymussel) is a host fish specialist and its only known host fish is the blackspotted topminnow. The pale lilliput and its host fish occur in low flow/low volume waterbodies and high flow waterbodies across two HUCs (3, 6). The mussel also occurs in high flow and high-volume waterbodies in both HUCs 3 and 6. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), host fish mortality estimates range from 0-0.08%, with low rates of mortality anticipated for host fish in all waterbodies. The species' host fish is only found in two aquatic habitats, and both have low anticipated mortality from methomyl. We do not anticipate significant reductions in food availability, as any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources.

Even though the species is a host fish specialist, has high vulnerability, and medium exposure, its fish host species are abundant and common, host fish use various components of aquatic habitats throughout their life cycles, and we expect low host fish mortality (0-0.08%) from methomyl exposure and low reproductive effects to the pale lilliput. After incorporating conservation measures into the effects of the action, accounting for 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 pale lilliput (pearlymussel) in the wild.

References

U.S. Fish and Wildlife Service. 2021. Pale Lilliput (*Toxolasma cylindrellus*) 5-Year Review: Summary and Evaluation. Daphne, Alabama. 28 pp.

Integration and Synthesis Summary: - Pink mucket (pearlymussel)

Scientific Name:	Common Name:	Entity ID:
Lampsilis abrupta	Pink mucket (pearlymussel)	331

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 6). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 pink mucket (pearlymussel). We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 1/19/2023; Wherever found; *States within the range:* AL, AR, GA, IL, IN, KY, LA, MO, MS, OH, TN, VA, WV. Figure 6 depicts the species' range.

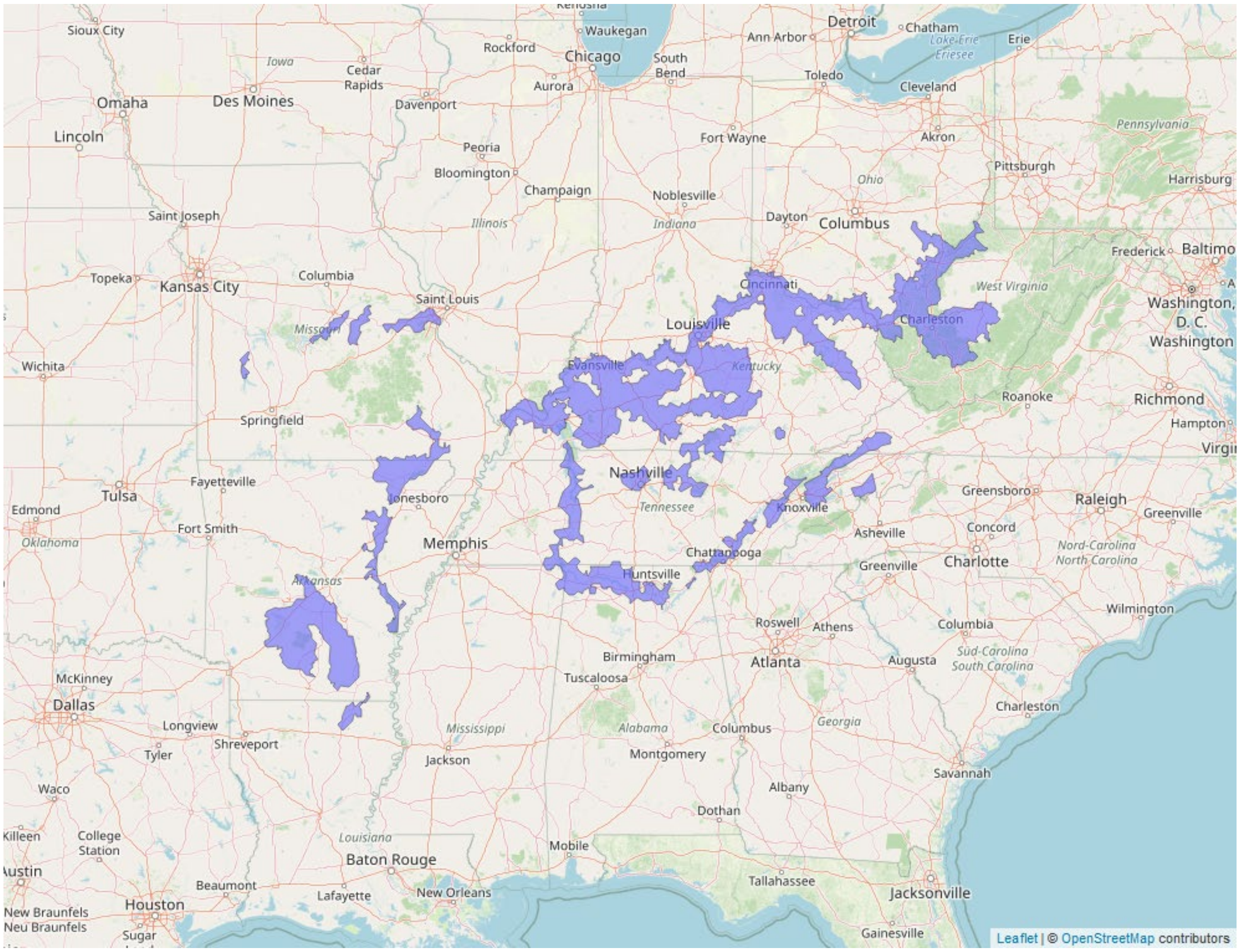

Figure 6. Range map of pink mucket (pearlymussel) (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/7829.

Vulnerability

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

Summary of status

Listing status: Endangered

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

Most recently completed 5-Year Review: 7/23/2019

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

Pink mucket has always been an uncommon or rare species. Historically, they were found in the middle White River drainage, including in major tributaries like the Black and Spring rivers. Thousands of miles of former range habitat have been lost and neither historical nor current abundance estimates are available. Habitat in the lower river reach in Tennessee is likely unsuitable due to cold tailwaters and inundation, suggesting species extirpation. They are also extirpated from the Little Black River, Missouri, and Pennsylvania, Indiana, and Virginia. The species is found in 29 extant stream populations and only in the Cumberland River does the population have a comparatively high abundance. In all other stream or stream reaches, the species is sporadic or occasional in distribution and generally considered rare or uncommon in abundance. With few exceptions, its extant populations are: 1) small and have low relative abundance; 2) sporadically or occasionally distributed in most rivers and nearly all river reaches; 3) generally limited in linear extent; and 4) typically lacking evidence of recent recruitment. Over one-third of the extant populations had only one or two individuals found over the past 30 years (Service 2018).

General threats to the species include habitat degradation from impoundments, sedimentation, and pollution. A historical threat, commercial harvest, is now nearly non-existent. Threats that were not mentioned in the Recovery Plan but exist today include the deleterious effects of habitat fragmentation and population isolation, environmental stochasticity, toxic pharmaceuticals and personal care products, and emerging issues such as climate change that threaten pink mucket populations. Extant populations are now primarily affected by navigational activities, reservoir releases, mining practices, inadequately treated wastewater discharges, and factors associated with small disjunct populations (e.g., stochasticity, low genetic diversity, habitat fragmentation and population isolation) (USFWS 2018).

Overall Vulnerability: High

Effects of the Action: Exposure

Overlap

We do not expect the pink mucket (pearlymussel) 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 13% of the species range will contain methomyl use sites (Table 14).

Usage

Past usage data indicate that up to 0.8% of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (0.6%), other row crops (0.1%), and vegetables and ground fruit (0.1%) (Table 14).

Table 14. Overlap and usage data for the Pink mucket (pearlymussel).

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	0.2	<0.1
Citrus	NA	NA
Corn	8	0.4
Cotton	0.4	<0.1
Other Grains	0.4	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	0.2	0.1
Soybeans[7]	11.6	0.6
Vegetables and Ground Fruit	<0.1	0.1
Wheat	NA	NA
Total	**13**	**0.8**

Exposure Summary

There is high overlap between the action area and the species' range (13%). Based on past usage data, we expect a low level of usage (0.8% annually) within the species' range. Given that the extent of overlap is high and expected usage is low, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply

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

when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office.” This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 15 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the pink mucket occupies, EPA’s aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 248 μg/L, depending on the type of habitat and region (Table 15). Based on this range of potential exposures, we expect between 0-0.61% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. The pink mucket (pearlymussel) is a host fish generalist and can likely use a variety of fish species as hosts such as sauger, freshwater drum, largemouth bass, smallmouth bass, spotted bass, and walleye which are all abundant and common in the water systems where the pink mucket is found. Because the fish host species are varied and found in multiple aquatic habitats, we anticipate low adverse effects to the reproductive cycle of the mussel.

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl’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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Table 15. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_10a	23.26	0
High flow waterbodies	HUC_11a	48.83	0
High flow waterbodies	HUC_3	34.82	0
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0
Large volume waterbodies	HUC_10a	12.45	0
Large volume waterbodies	HUC_11a	29.03	0
Large volume waterbodies	HUC_3	18.67	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Large volume waterbodies	HUC_7	12.21	0
Large volume waterbodies	HUC_8	31.29	0
Low flow/Low volume waterbodies	HUC_10a	248.40	0.13
Low flow/Low volume waterbodies	HUC_11a	321.30	0.61
Low flow/Low volume waterbodies	HUC_3	171.00	0.01
Low flow/Low volume waterbodies	HUC_5	229.50	0.08
Low flow/Low volume waterbodies	HUC_6	164.70	0.01
Low flow/Low volume waterbodies	HUC_7	209.70	0.04
Low flow/Low volume waterbodies	HUC_8	225.90	0.07

Overall Toxicity: Low

Effects of the Action Summary

We expect the pink mucket (pearlymussel) could be exposed to methomyl in 13% of the species range based on methomyl use sites and up to 0.8% of the range may be treated with methomyl (Table 15) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the pink mucket (pearlymussel). We anticipate mortality to fish hosts, particularly in low flow/low volume waterbodies, but this mortality would be very low. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. The pink mucket has a variety of fish hosts that their glochidia can successfully parasitize and we expect mortality of exposed fish will be low (0-0.61%). In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. Therefore, we anticipate low impacts to the reproductive cycle of the mussel. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual mussels will experience adverse effects.

Conclusion

The pink mucket (pearlymussel) is listed as endangered and is found in 29 extant populations in Missouri, Ohio, West Virginia, Kentucky, Illinois, Tennessee, Alabama, Arkansas, and Louisiana, many of which are very small (1-2 individuals found over 30 years). The species has been extirpated from Indiana, Pennsylvania, and Virginia and the Little Black River in Missouri. Pink muckets are threatened by habitat degradation from impoundments, sedimentation, and pollution.

The species range occurs near methomyl use sites overlapping 13% of the range, but a small portion of the range has experienced methomyl usage in the past (0.8% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The pink mucket is a host fish generalist and can likely use a variety of fish for reproduction, including sauger, freshwater drum, largemouth bass, smallmouth bass, spotted bass, and walleye. The pink mucket (pearlymussel) and its host fish occur in high flow waterbodies (HUCs 3, 5, 6, 7, 8, 10a, and 11a) and its host fish occur in many habitat types, including low flow/low volume waterbodies across the same seven HUCs. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), host fish mortality estimates range from 0-0.61%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, its host fish are abundant and common, host fish are found in multiple river systems, and we anticipate low host fish mortality (0-0.61%). Therefore, we expect impacts to the pink mucket (pearlymussel) to be low and a small number of individual mussels will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 pink mucket in the wild.

References

U.S. Fish and Wildlife Service. 2018. Pink mucket *Lampsilis abrupta* 5-Year Review: Summary and Evaluation. Asheville, North Carolina. 68 pp.

Integration and Synthesis Summary: - Curtis' pearlymussel

Scientific Name:	Common Name:	Entity ID:
Epioblasma florentina curtisii	Curtis' pearlymussel	333

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 7). Exposed individuals are unlikely to die but are likely to experience medium levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 Curtis' pearlymussel. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 3/5/2021; Wherever found; *States within the range:* AR, MO. Figure 7 depicts the species' range.

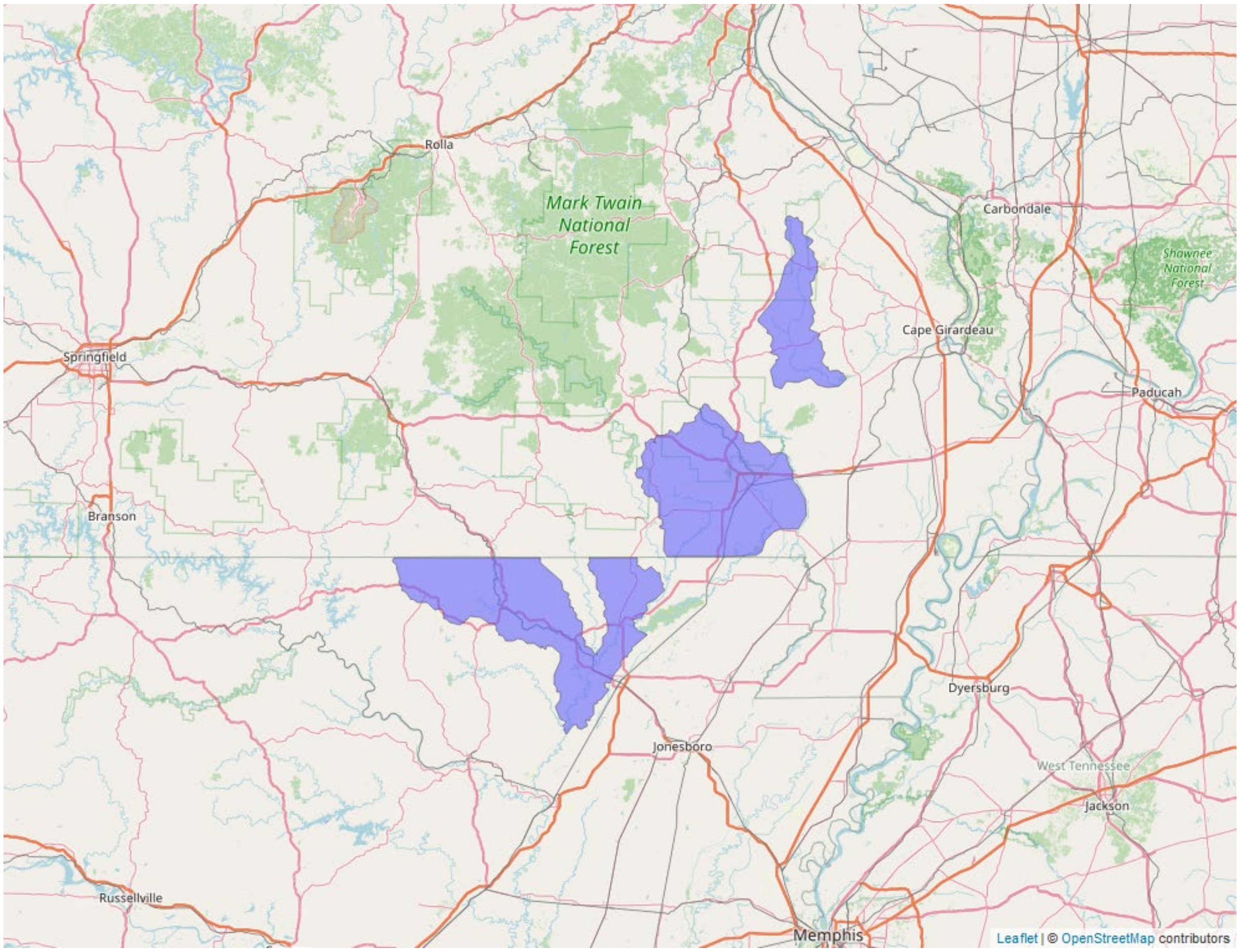

Figure 7. Range map of Curtis pearlymussel (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/5628.

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: 2/23/2021

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

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

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 Curtis' pearlymussel has a small historical range within the Ozark Highlands and is known from the Black, St. Francis, and White River drainages in southeastern Missouri and northeastern Arkansas. By 2010, a living population could not be located; it was last seen alive in 1993 at the Mudpuppy Conservation Area on the Little Black River in Missouri (USFWS 2010). Since 2010, only one mussel survey has been conducted within its historical range. In 2017, the following Little Black River tributaries were surveyed and no evidence of Curtis' pearlymussels were found: South Prong Little Black River (2 sites), North Prong Little Black River (3 sites), Beaverdam Creek (2 sites), Logan Creek (2 sites), and Harris Creek (1 site). The mussel communities had not recovered from the rapid mussel decline observed in the late 1980s and early 1990s as evidenced by low mussel abundance and species richness compared to previous surveys (USFWS 2010, 2021). No other information is available on the status of the species within its known range in Missouri and Arkansas and we are unsure if an extant population exists. Some streams within the White and Black River basins appear to provide suitable habitat and are near historical streams. As recently as the 2010s, the Service conducted mussel surveys on the Current River and Big Barren Fork Creek in Missouri, which are a part of the Black River watershed, and surveys have been conducted in Arkansas within the White River Basin including the Strawberry River and War Eagle, the North Fork Sylamore, Richland, and Falling Water creeks. While mussel communities were documented in these streams, no evidence of the Curtis' pearlymussel was found in any of these surveys (USFWS 2021).

Habitat alteration has been the principal threat to the Curtis' pearlymussel throughout its historical range. Flowing water and a stable substrate are important habitat requirements. Stream impoundments, gravel dredging, and channelization have eliminated these habitat components in several streams including the White, Castor, and Black Rivers. The largest population in the White River was eliminated by the construction of reservoirs including Lake Tanycomo and Table Rock, Bull Shoals, and Beaver. The Castor River was channelized and diverted into the Mississippi River in 1913, which eliminated most of the stream entirely and cut it off from the St. Francis River Basin. The Black River populations have been affected by gravel dredging and are currently greatly affected by the operation of Clearwater Reservoir upstream. If there was a population in the St. Francis River, it is now the location of Lake Wappapello. Today, no major impoundments or channelization projects are proposed within the historical range of the Curtis' pearlymussel, but gravel dredging is an ongoing activity. Other ongoing threats to the Curtis' pearlymussel include water quality degradation, sedimentation, and increased nutrient loading throughout the species' range. The cause of the decline of the last known population in the Little Black River remains unknown, but water quality degradation and head-cutting (channel degradation) were suspected as the main causes. Recent studies indicate that mussels are among the most sensitive organisms to ammonia, which is a common pollutant. Ammonia is a degradation product of nitrogenous organic matter and is associated with municipal wastewater treatment plants, industrial wastes, and runoff from agricultural areas including animal wastes and nitrogenous fertilizers. These sources are nearly ubiquitous throughout the historical range of the Curtis' pearlymussel in Missouri and Arkansas (USFWS 2021).

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. Data for methomyl uses indicate up to 21.3% of the species range will contain methomyl use sites (Table 16).

Usage

Past usage data indicate that up to 1.3% of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (1%) and other row crops (0.2%) (Table 16).

Table 16. Overlap and usage data for the Curtis' pearlymussel.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn	5.8	0.3
Cotton	0.3	<0.1
Other Grains	0.9	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	0.4	0.2

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Soybeans[8]	19.5	1
Vegetables and Ground Fruit	0.1	0.1
Wheat	NA	NA
Total	**21.3**	**1.3**

Exposure Summary

There is high overlap between the action area and the species' range (21.3%). Based on past usage data, we expect a low level of usage (1.3% annually) within the species' range. Given that the extent of overlap is high and that expected usage is low we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in **Table 17** the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

[8]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.

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the Curtis' pearlymussel occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 24 to 321 µg/L, depending on the type of habitat and region (Table 17). Based on this range of potential exposures, we expect between 0-0.61% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. Curtis' pearlymussel is a host fish generalist and can likely use a variety of fish species as hosts such as rainbow darter (*Etheostoma caeruleum*) and potentially, fantail darter (*E. flabellare*), greenside darter (*E. blennioides*), redline darter (*E. rufilineatum*), snubnose darter (*E. simoterum*), and multiple sculpin species which are all abundant and common in the water systems where Curtis' pearlymussel is found. Fish hosts are common within its range, and we anticipate low reductions in fish host species availability due to the multiple aquatic habitats where the mussel and host fish are found, resulting in low adverse effects to the reproductive cycle of the mussel.

Table 17. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_11a	48.83	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0
Low flow/Low volume waterbodies	HUC_11a	321.30	0.61
Low flow/Low volume waterbodies	HUC_7	209.70	0.04
Low flow/Low volume waterbodies	HUC_8	225.90	0.07

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect Curtis' pearlymussel could be exposed to methomyl in 21.3% of the species range based on methomyl use sites and up to 1.3% of the range may be treated with methomyl (Table 17) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to Curtis' pearlymussel. We anticipate mortality to fish hosts, particularly in low flow/low volume waterbodies. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. The Curtis' pearlymussel can attach their glochidia to a number of common fish host species. We anticipate a low impact to the reproductive cycle of the mussel because they use a variety of host fish, those host fish are found in multiple habitat types, and we expect low host fish mortality (0-0.61%) from methomyl exposure. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual mussels will experience adverse effects.

Conclusion

The Curtis' pearlymussel is listed as endangered and was last seen alive in 1993. Its range includes the Black, St. Francis, and White River drainages in southeastern Missouri and northeastern Arkansas. Surveys of suitable habitat have occurred as recently as the 2010s and Curtis' pearlymussels were not found. Threats include habitat alterations (e.g., stream impoundments, gravel dredging, and channelization), water quality degradation, sedimentation, and nutrient loading. Agricultural runoff (e.g., animal wastes and fertilizers) are also mentioned as threats.

The species range occurs near methomyl use sites overlapping 21.3% of the range, but a small portion of the range has experienced methomyl usage in the past (1.3% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The Curtis' pearlymussel is a host fish generalist and can likely use a variety of fish species as hosts and successfully reproduce in the presence of rainbow darter and potentially, fantail darter, greenside darter, redline darter, snubnose darter, and multiple sculpin species that are all abundant and common in the water systems where Curtis' pearlymussel is found. The Curtis' pearlymussel and its host fish occur in both low flow/low volume waterbodies and high flow waterbodies, each of which occur in three HUCs (7, 8, and 11a); some of the host fish also occur in high flow and high volumes waterbodies. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), host fish mortality estimates range from 0-0.61%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the Curtis' pearlymussel can use numerous species of host fish, hosts are generally common throughout the range of the mussel, hosts use various components of aquatic habitats throughout their life cycles, and we expect fish mortality will be low (0-0.61%), we expect impacts to the mussel to be low and a small number of individuals will be adversely affected over the course of the action. After incorporating conservation measures into the effects of the action, accounting for 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 Curtis' pearlymussel.

References

U.S. Fish and Wildlife Service. 2021. The Curtis' Pearlymussel (*Epioblasma florentina curtisii*) 5-Year Review: Summary and Evaluation. Columbia, Missouri. 24 pp.

U.S. Fish and Wildlife Service. 2010. 5-Year Review The Curtis' Pearlymussel (*Epioblasma florentina curtisii*). Columbia, Missouri. 28 pp.

Integration and Synthesis Summary: - White wartyback (pearlymussel)

Scientific Name:	Common Name:	Entity ID:
Plethobasus cicatricosus	White wartyback (pearlymussel)	336

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 8). Exposed individuals are unlikely to die and are unlikely to experience 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 exposure is medium, we do not expect indirect effects from loss of host fish and we determine the risk of adverse effects to the species is low. As such, we do not expect individuals are likely to experience reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 white wartyback (pearlymussel). We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 12/16/2021; Wherever found; *States within the range:* AL, TN. Figure 8 depicts the species' range.

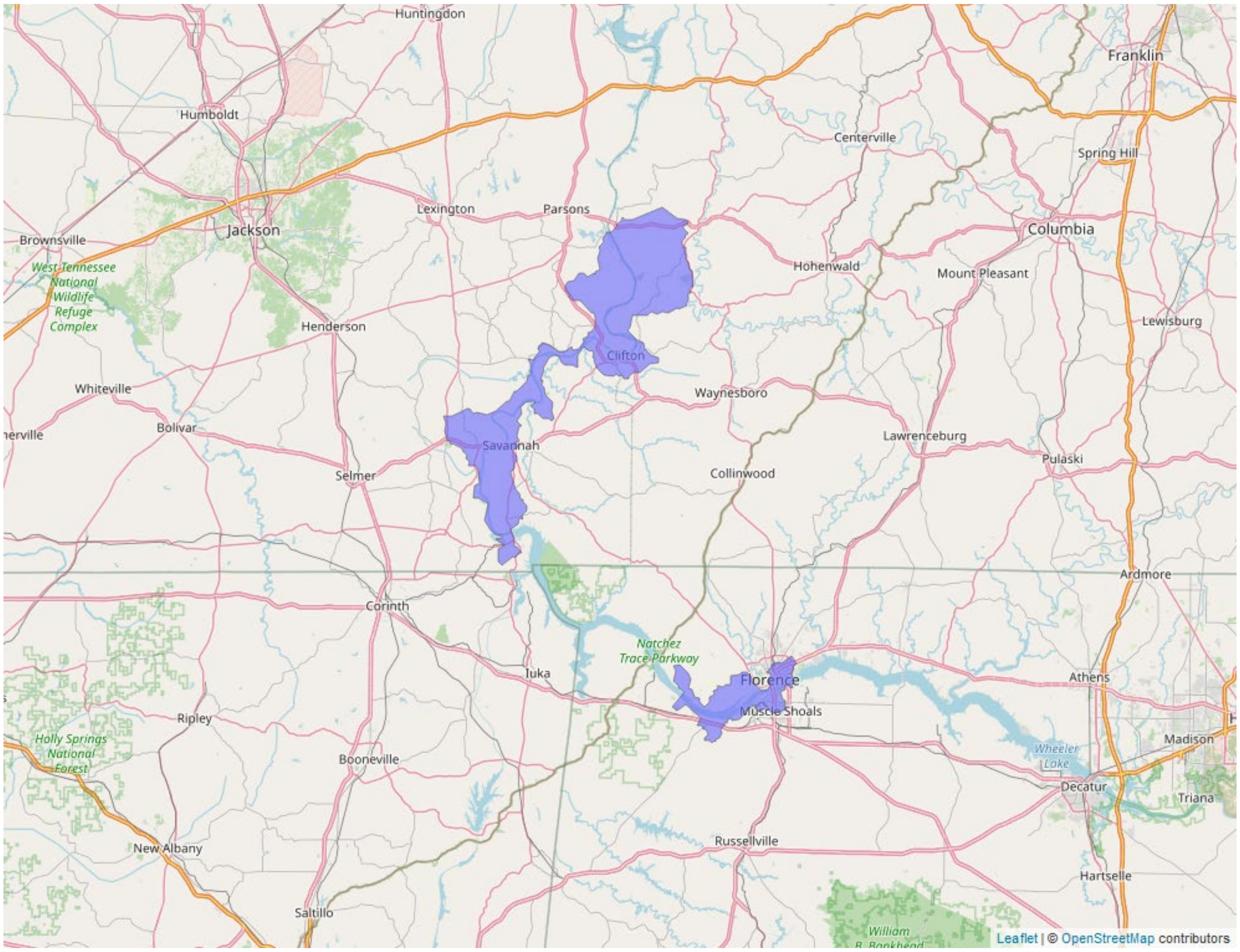

Figure 8. Range map of white wartyback (pearlymussel) (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/2549.

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: 1/9/2023

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

Number of populations: Single population

Species trends: Unknown population trends

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

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The species range once included major rivers in Alabama, Illinois, Indiana, Kentucky, Ohio, Tennessee, and West Virginia. These include the Tennessee River (Tennessee, Alabama, Kentucky), Holston River (Tennessee), Cumberland River (Tennessee, Kentucky), Ohio River (Ohio, Illinois, Indiana, Kentucky, West Virginia), Wabash River (Indiana, Illinois), and Kanawha River (West Virginia)). Despite decades of surveys by numerous federal agencies, state agencies, and partners individuals of this species have not been found in these systems in contemporary times. The only known extant members of this species are presently confined to a small population, comprised of individuals at low densities in the Tennessee River downstream of Wilson Dam between Tennessee River mile 245 to 256 in Lauderdale and Colbert Counties, Alabama (USFWS 2022). In 2007, an experimental population of white wartyback (pearlymussels) was established in portions of the French Broad and Holston Rivers in Tennessee with unknown success (EXPN Entity ID 9501).

The white wartyback is threatened by habitat destruction and modification resulting from impoundment, sand and gravel dredging/mining, navigation activities, operation of water control facilities, and construction and operation of barge loading and fleeting facilities on the Ohio River and lower Tennessee River. A combination of these stressors may have contributed to the extirpation of this species from much of its former range in the Tennessee River (Tennessee, Alabama, Kentucky), Holston River (Tennessee), Cumberland River (Tennessee, Kentucky), Ohio River (Ohio, Illinois, Indiana, Kentucky, West Virginia), Wabash River (Indiana, Illinois), and Kanawha River (West Virginia). Though they have not been observed outside of the Tennessee River since 1885, cold water releases from Wolf Creek Dam (Cumberland River, Kentucky), Dale Hollow Dam (Obey River, Tennessee), and Center Hill Dam (Caney Fork River, Tennessee) could still adversely affect rare, undetected white wartybacks among resident mussel populations in the middle reach of the Cumberland River (between Old Hickory Dam and Cordell Hull Dam). These releases have adversely affected other listed and non-listed mussels by inhibiting reproduction. However, increased water temperatures of three to seven degrees Fahrenheit during drawdowns for dam repairs on some dams and through cooperative agreements at others have enabled non-listed mussels in that reach of the river to spawn (i.e., gravid females are being collected). It is possible that if white wartyback persists undetected at low density in these waterways, they too might benefit from the change in temperature below dams (USFWS 2022).

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 15.1% of the species range will contain methomyl use sites (Table 18).

Usage

Past usage data indicate that up to 0.7% of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (0.6%) and cotton (0.1%) (Table 18).

Table 18. Overlap and usage data for the white wartyback (pearlymussel).

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn	8.2	0.4
Cotton	2.7	0.1
Other Grains	0.6	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	<0.1	<0.1
Soybeans[9]	11.8	0.6
Vegetables and Ground Fruit	<0.1	<0.1
Wheat	NA	NA
Total	**15.1**	**0.7**

Exposure Summary

There is a high extent of overlap between the action area and the species' range (15.1%). Based on past usage data, we expect a low level of usage (0.7% annually) within the species' range.

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

Given that the extent of overlap is high and that expected usage is low, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 19 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the white wartyback (pearlymussel) occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 13 to 45 µg/L, depending on the type of habitat and region (Table 19). Based on this range of potential exposures, we expect 0% of exposed host fish will die, which is not likely to impact the availability of fish hosts needed for successful reproduction. The white wartyback (pearlymussel) fish host species is unknown. Because no mortality is expected for all aquatic habitats for the white wartyback mussel (0%), we do not anticipate loss of fish host species availability will likely result in adverse effects to the reproductive cycle of the mussel overall.

Table 19. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_8	45.74	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Large volume waterbodies	HUC_8	31.29	0

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the white wartyback pearlymussel could be exposed to methomyl in 15.1% of the species range based on methomyl use sites and up to 0.7% of the range may be treated with methomyl (Table 19) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the white wartyback (pearlymussel). The fish host species for the white wartyback (pearlymussel) are unknown, but we do not expect fish host mortality from methomyl exposure and thus, no reductions in mussel reproduction from loss of host fish. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Therefore, methomyl is not likely to cause adverse effects to the white wartyback (pearlymussel).

Conclusion

The white wartyback (pearlymussel) is listed as endangered and the extant populations are known only from a reach of the Tennessee River downstream of Wilson Dam, in Alabama, and near Savannah, Tennessee. Surveys over the last few decades have only detected a few individuals of this species and evidence of reproduction is scant. Those individuals that persist in this reach of river do so in suboptimal habitat that is at perpetual risk of alteration by activities at Wilson Dam, non-point source pollution, and area discharge into the Tennessee River.

The species range occurs near methomyl use sites overlapping 15.1% of the range, but a small portion of the range has experienced methomyl usage in the past (0.7% annually). Therefore, we consider the species to have a medium exposure ranking. However, we do not expect direct mortality of mussels from methomyl exposure, and we do not expect mussels to be indirectly affected through impacts to their host fish. The white wartyback (pearlymussel) fish host species is unknown. The species occurs in high flow waterbodies and the fish hosts presumably also occur in high volume waterbodies. All aquatic habitats occur in three HUCs (5, 6, and 8), each of which has a different predicted environmental concentration range. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), we do not expect methomyl concentrations in any of these habitats that will result in fish mortality. Therefore, we do not anticipate impacts to the white wartyback (pearlymussel) through loss of host fish from methomyl exposure. Additionally, we do not anticipate any significant reductions in food availability, as any localized reductions in zooplankton as a food source will be minimal and quickly replenished by upstream sources.

Even though the species has high vulnerability and medium exposure, we anticipate no host fish mortality from methomyl exposure. Therefore, we expect impacts to the mussel to be discountable and no individuals will be adversely affected through loss of host fish. After incorporating conservation measures into the effects of the action, accounting for 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 white wartyback (pearlymussel) in the wild.

References

U.S. Fish and Wildlife Service. 2022. White Wartyback (*Plethobasus cicatricosus*) Status Review: Summary and Evaluation. Daphne, Alabama. 10 pp.

Integration and Synthesis Summary: - Rough pigtoe

Scientific Name:	Common Name:	Entity ID:
Pleurobema plenum	Rough pigtoe	338

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 9). Exposed individuals are unlikely to die or experience 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 exposure is medium, we do not expect indirect effects from loss of host fish and we determine the risk of adverse effects to the species is low. As such, we do not individuals are likely to experience reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 rough pigtoe. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 9/10/2020; Wherever found; *States within the range:* AL, IN, KY, TN, VA. Figure 9 depicts the species' range.

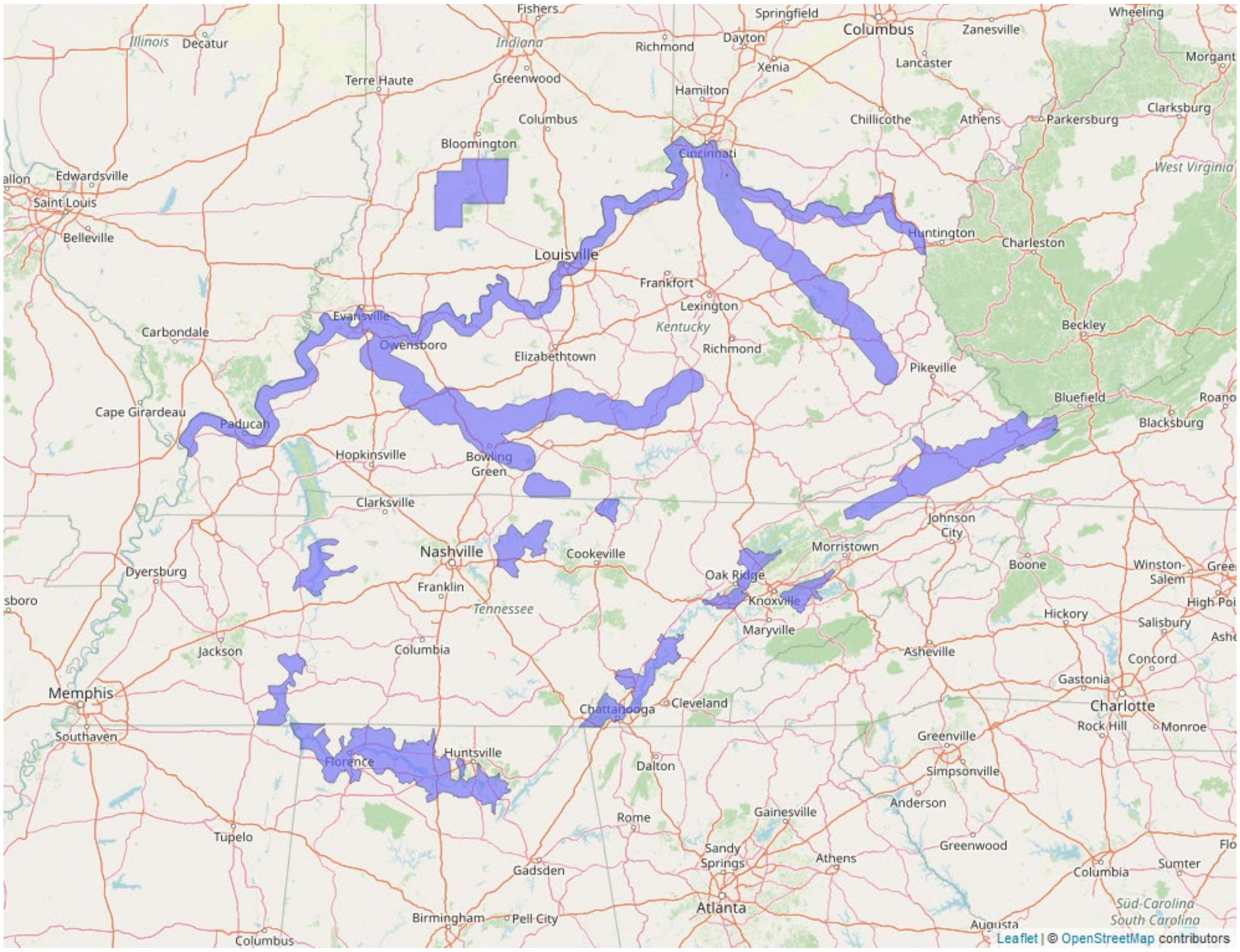

Figure 9. Range map of rough pigtoe (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/6894.

Vulnerability

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

Summary of status

Listing status: Endangered

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

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

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

Populations of the rough pigtoe mussels currently exist in portions of the Clinch, Tennessee, Cumberland, Green, Barren, and Licking rivers. The species was observed in the East Fork White River in Indiana in 1992, but the species has not been observed there since that time. Currently, the Clinch (Tennessee) and Green (Kentucky) rivers represent the only populations with evidence of successful reproduction. Rough pigtoe mussels typically do not exist in populations large enough to support translocation. However, recent host trials may provide hope that propagation can be successful in producing juvenile mussels for recovery actions (reintroductions at extirpated sites or augmentation of existing populations). As such, future reintroductions, augmentations, and translocations of individuals will likely be accomplished through introductions of captively-propagated juveniles (USFWS 2021). In 2007, an experimental population of rough pigtoe mussels was established in portions of the French Broad and Holston Rivers in Tennessee with unknown success (EXPN Entity ID 9499).

Numerous threats persist for rough pigtoe populations, including habitat alteration (e.g., impoundments), land use changes, competition from invasive species, large-scale die-offs and subsequent small population size, and point and non-point source pollution. The species continues to show declines; it is limited to only a few small populations, with evidence of reproduction in only the Clinch River and Green River; it continues to be influenced by high magnitude threats; and the criteria for delisting or downlisting have not been met (USFWS 2021).

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 12.7% of the species range will contain methomyl use sites (Table 20).

Usage

Past usage data indicate that up to 0.8% of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (0.6%) and vegetables and ground fruit (0.1%) (Table 20).

Table 20. Overlap and usage data for the rough pigtoe.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	0.2	<0.1
Citrus	NA	NA
Corn	9.5	0.5
Cotton	0.7	<0.1
Other Grains	0.2	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	0.3	0.1
Soybeans[10]	11.2	0.6
Vegetables and Ground Fruit	<0.1	0.1
Wheat	NA	NA
Total	**12.7**	**0.8**

Exposure Summary

There is a high extent of overlap between the action area and the species' range (12.7%). Based on past usage data, we expect a low level of usage (0.8% annually) within the species' range. Given that the extent of overlap is high and that expected usage is low, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater.

[10] 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.

Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 21 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the rough pigtoe mussel occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 23 to 46 µg/L, depending on the type of habitat and region (Table 21). Based on this range of potential exposures, we do not expect exposed host fish will die, and this we do not expect a methomyl reduce the availability of fish hosts needed for successful reproduction. The rough pigtoe is a host fish specialist and is likely to successfully reproduce only in the presence of a few species of fish hosts, including the spotfin shiner (*Cyprinella spiloptera*), striped shiner (*Luxilus chrysocephalus*), longnose dace (*Rhinichthys cataractae*), and western blacknose dace (*R. obtusus*). These fish hosts are common within the mussel's range. Because no fish mortality is expected for all aquatic habitats for the rough pigtoe mussel, we do not anticipate loss of fish host species availability, and as such, no adverse effects to the reproductive cycle of the mussel overall.

Table 21. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_3	34.82	0
High flow waterbodies	HUC_5	23.72	0

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the rough pigtoe mussels could be exposed to methomyl in 12.7% of the species range based on methomyl use sites and up to 0.8% of the range may be treated with methomyl (Table 21) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the rough pigtoe. The fish host species for the rough pigtoe are common in mussels' range, and we do not expect fish host mortality from methomyl exposure and as such, no reductions in mussel reproduction from loss of host fish. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Therefore, methomyl is not likely to cause adverse effects to the rough pigtoe mussel.

Conclusion

Populations of the rough pigtoe mussel currently exist in portions of the Clinch, Tennessee, Cumberland, Green, Barren, and Licking rivers. Numerous threats persist for rough pigtoe mussel populations, including habitat alteration (e.g., impoundments), land use changes, competition from invasive species, large-scale die-offs and subsequent small population size, and point and non-point source pollution. The species continues to show declines; it is limited to only a few small populations, with evidence of reproduction in only the Clinch River (Tennessee) and Green River (Kentucky), and it continues to be influenced by high magnitude threats.

The species range occurs near methomyl use sites overlapping 12.7% of the range, but a small portion of the range has experienced methomyl usage in the past (0.8% annually). Therefore, we consider the species to have a medium exposure ranking. However, we do not expect direct mortality of mussels from methomyl exposure, nor do we expect rough pigtoe mussels to be indirectly affected through impacts to their host fish. The rough pigtoe mussel is a host fish specialist and is likely only able to successfully reproduce in the presence of a few species of fish hosts, including the spotfin shiner, striped shiner, longnose dace, and western blacknose dace. However, these fish hosts are common within the species' range. Both the species and fish hosts occur in high flow waterbodies within five HUCs (3, 5, 6, 7, and 8), each of which has a different predicted environmental concentration range and expected fish mortality percentage. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), we do not expect methomyl concentrations in any of these habitats that will result in fish mortality Therefore, we do not anticipate impacts to the rough pigtoe through loss of host fish from methomyl exposure. Additionally, 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 the species has high vulnerability and medium exposure, its host fish are common in the mussel's range, and we anticipate no host fish mortality. Therefore, we expect impacts to the mussel to be discountable and no individuals will be adversely affected through loss of host fish. After incorporating conservation measures into the effects of the action, accounting for 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 rough pigtoe mussel in the wild.

References

U.S. Fish and Wildlife Service. 2021. Rough Pigtoe (Pleurobema plenum) 5-Year Review: Summary and Evaluation. Frankfort, Kentucky. 26 pp.

Integration and Synthesis Summary: - Orangefoot pimpleback (pearlymussel)

Scientific Name:	Common Name:	Entity ID:
Plethobasus cooperianus	Orangefoot pimpleback (pearlymussel)	340

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 10). Exposed individuals are unlikely to die or experience 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 exposure is medium, we do not expect indirect effects from loss of host fish and we determine the risk of adverse effects to the species is low. As such, we do not expect individuals are likely to experience reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 orangefoot pimpleback (pearlymussel). We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 9/9/2020; Wherever found; *States within the range:* AL, IL, KY, TN. Figure 10 depicts the species' range.

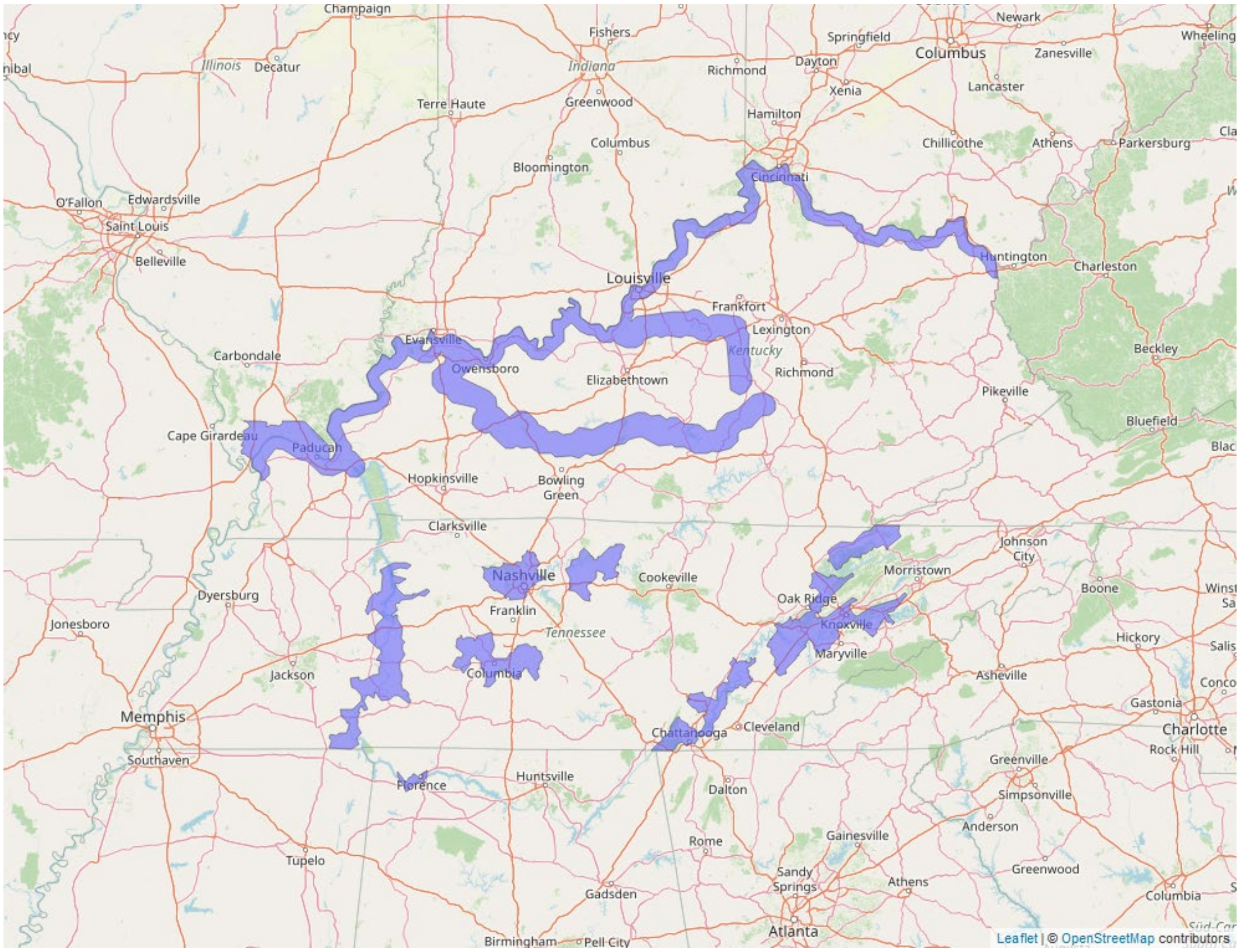

Figure 10. Range map of orangefoot pimpleback (pearlymussel) (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/1132.

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: 1/30/2023

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

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

Species trends: Unknown population trends

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

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The only known remaining extant populations of orangefoot pimpleback (pearlymussels) and potentially occupied reaches are in the Ohio River (a 34-mile reach downstream of the mouth of the Tennessee River); three locations in the Tennessee River: 1) a mainstem reach of approximately 45 miles in Tennessee downstream of Pickwick Landing Dam and largely upstream of Kentucky Lake, 2) a 22-mile riverine reach downstream of Kentucky Lock and Dam, and 3) a 35-mile reach downstream of Chickamauga Lock and Dam and upstream of Nickajack Lake; and in the Cumberland River in Tennessee. In 2007, an experimental population of orangefoot pimpleback (pearlymussels) was established in portions of the French Broad and Holston Rivers in Tennessee with unknown success (EXPN Entity ID 9496).

The orangefoot pimpleback (pearlymussel) inhabits silt-free sand or gravel in clean, fast flowing stretches of large rivers. Due to the rarity of the species, little is known about the abundance, population trends, or the demographics of the orangefoot pimpleback (pearlymussel). The species is difficult to detect because, like other freshwater mussels, it can burrow into bottom substrates and spend long periods buried below the surface, making it challenging to obtain information about this species' abundance and distribution.

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

The host fish for this species is still unknown; however, in 2016, Dr. Monte McGregor, malacologist with the Kentucky Department of Fish and Wildlife Resources, successfully used in-vitro metamorphosis to transform 5,000 larvae into juveniles. However, subsequent culturing and rearing were not successful. Between 2013-2022, a total of 55 orangefoot pimpleback individuals have been placed within a grid formation in the Tennessee River and are to be used as a source stock for propagation efforts. Given the low abundance of the species throughout its range, the proximity of males and females within the grid allow for natural fertilization. In 2022, a check for gravid orangefoot pimpleback (pearlymussels) in the grid was conducted resulting in the retrieval of 32 individuals. Six gravid female orangefoot pimpleback (pearlymussels) were found and subsequently transported to a holding station located on Lake Cumberland, Kentucky. These individuals will be used for propagation activities in upcoming years.

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

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 12.6% of the species range will contain methomyl use sites (Table 22).

Usage

Past usage data indicate that up to 0.8% of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (0.6%) and other row crops (0.1%) and vegetables and ground fruit (0.1%) (Table 22).

Table 22. Overlap and usage data for the orangefoot pimpleback (pearlymussel).

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	0.2	<0.1
Citrus	NA	NA
Corn	9.9	0.5
Cotton	0.2	<0.1
Other Grains	0.2	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	0.2	0.1
Soybeans[11]	11.6	0.6
Vegetables and Ground Fruit	<0.1	0.1
Wheat	NA	NA
Total	**12.6**	**0.8**

Exposure Summary

There is a high extent of overlap between the action area and the species' range (12.6%). Based on past usage data, we expect a low level of usage (0.8% annually) within the species' range. Given that the extent of overlap is high and that expected usage is low, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 23 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting

[11]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.

concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the orangefoot pimpleback (pearlymussel) occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 46 μg/L, depending on the type of habitat and region (Table 23). Based on this range of potential exposures, we do not expect exposed host fish will die or impact the availability of fish hosts needed for successful reproduction. The orangefoot pimpleback (pearlymussel) fish host species is unknown. The congener *Plethobasus cyphyus,* sheepnose mussel, has been observed to use mimic shiner (*Notropis volucellus*) and sauger (*Sander canadensis*) as host fish; however, it can use many more species of fish to complete this critical life stage within a laboratory setting. Because we expect no mortality for all aquatic habitats, we do not anticipate loss of host fish species availability will likely result in adverse effects to the reproductive cycle of the mussel overall.

Table 23. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (μg/L)	Percent fish mortality
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Large volume waterbodies	HUC_7	12.21	0
Large volume waterbodies	HUC_8	31.29	0

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the orangefoot pimpleback (pearlymussel) could be exposed to methomyl in 12.6% of the species range based on methomyl use sites and up to 0.8% of the range may be treated with methomyl (Table 23) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the orangefoot pimpleback (pearlymussel). Mussels depend on host fish to accomplish their reproductive lifecycle and glochidia (mussel larvae) that do not attach to a host fish will not survive. Even though the fish host species for the orangefoot pimpleback (pearlymussel) are unknown, we do not expect fish host mortality from methomyl exposure and, as such, no reductions in mussel reproduction from loss of host fish. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Therefore, methomyl is not likely to cause adverse effects to the orangefoot pimpleback (pearlymussels).

Conclusion

The orangefoot pimpleback (pearlymussel) is a mussel native to large rivers in sand and gravel substrates. We are aware of three remaining populations or potentially occupied reaches: the Tennessee River, Ohio River, and Cumberland River. These populations are unlikely to experience genetic exchange or survive a catastrophic event. The species is extremely rare compared to other native mussels, even where it is found. This may put the species at risk from limiting genetic exchange and a subsequent decrease in fitness, and it may also impact recruitment because of limitations in proximity of reproductive adults. The species is still at risk of water quality impacts, dredging, damming, and adjacent land development that have fragmented and degraded the species' habitat. In addition, invasive species and climate change also may affect the species.

The species range occurs near methomyl use sites overlapping 12.6% of the range, but a small portion of the range has experienced methomyl usage in the past (0.8% annually). Therefore, we consider the species to have a medium exposure ranking. However, we do not expect direct mortality of mussels from methomyl exposure, nor do we expect mussels to be indirectly affected through impacts to their host fish. The orangefoot pimpleback (pearlymussel) fish host species is unknown. The congener sheepnose mussel has been observed to use mimic shiner and sauger as host fish; however, it can use many more species of fish to complete this critical life stage within a laboratory setting. Orangefoot pimplebacks occur in high flow waterbodies and the fish hosts occur in high flow or large volume waterbodies. All aquatic habitats occur in four HUCs (5, 6, 7, and 8), each of which has a different predicted environmental concentration range. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), we do not expect methomyl concentrations in any of these habitats that will result in fish mortality. Therefore, we do not anticipate impacts to the orangefoot pimpleback (pearlymussel) through loss of host fish from methomyl exposure. 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 the species has high vulnerability and medium exposure, its host fish are abundant and common, and we anticipate no host fish mortality from methomyl exposure. Therefore, we expect impacts to the mussel to be discountable and no individuals will be adversely affected through loss of host fish. After incorporating conservation measures into the effects of the action, accounting for 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 orangefoot pimpleback (pearlymussel) in the wild.

References

U.S. Fish and Wildlife Service. 2022. Orangefoot Pimpleback (*Plethobasus cooperianus*) Status Review: Summary and Evaluation. Frankfort, Kentucky. 10 pp.

U.S. Fish and Wildlife Service. 2018. Orangefoot Pimpleback (*Plethobasus cooperianus*) 5-Year Review: Summary and Evaluation. Frankfort, Kentucky. 18 pp.

Integration and Synthesis Summary: - Ring pink (mussel)

Scientific Name:	Common Name:	Entity ID:
Obovaria retusa	Ring pink (mussel)	341

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 11). Exposed individuals are unlikely to die or experience 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 exposure is medium, we do not expect indirect effects from loss of host fish and we determine the risk of adverse effects to the species is low. As such, we do not expect individuals are likely to experience reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 ring pink mussel. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 9/10/2020; Wherever found; *States within the range:* AL, KY, TN. Figure 11 depicts the species' range.

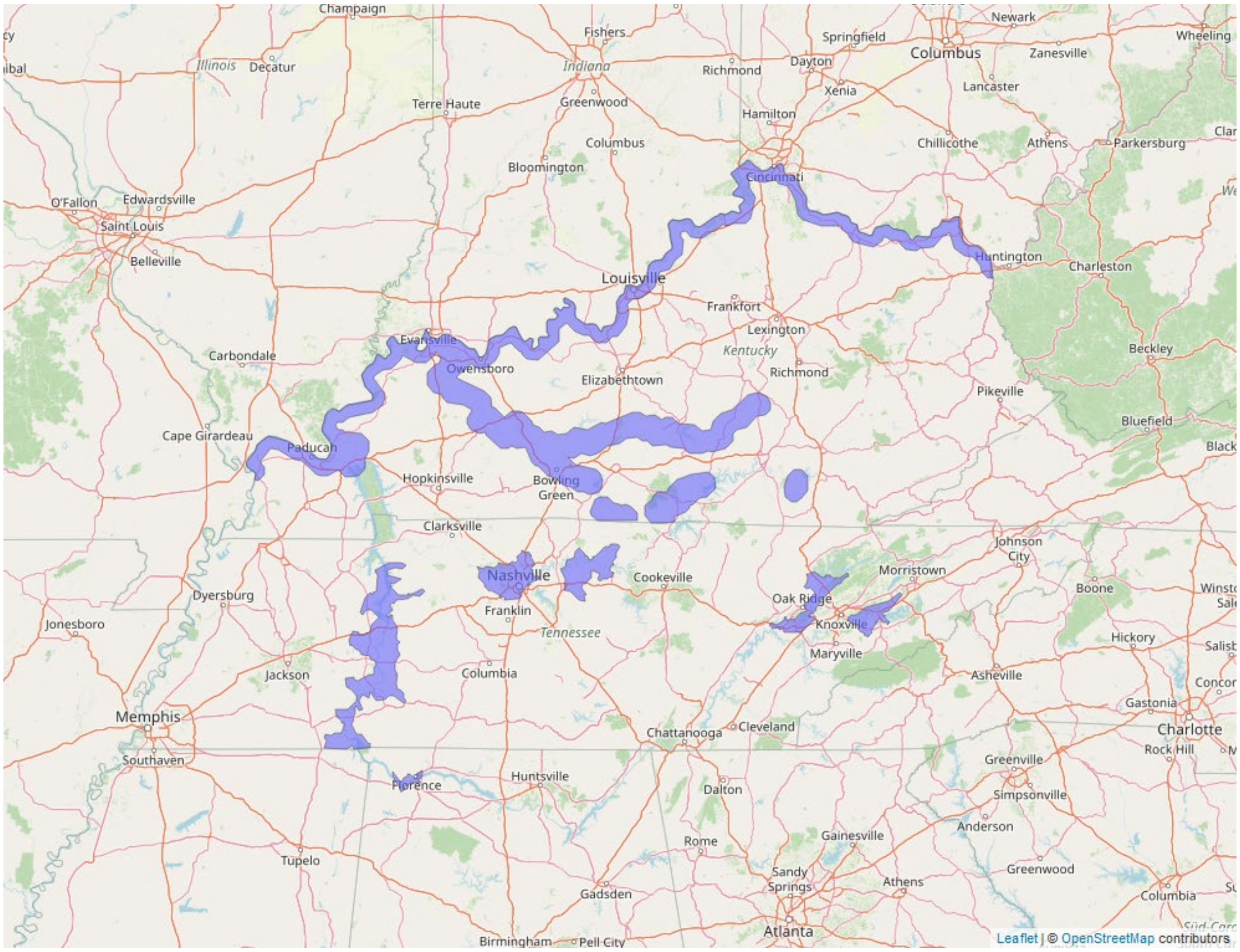

Figure 11. Range map of ring pink (mussel) (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/4128.

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: 9/27/2019

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 species' historical range is the Ohio River basin including the states of Alabama, Illinois, Indiana, Kentucky, Ohio, Pennsylvania, Tennessee, and West Virginia. In the last 15 years (2003-2018), only two live specimens have been found, both in the Green River, Kentucky. Based on the low number of observed individuals in the Green River, it is likely that this population is not viable. At present, we believe that no viable populations of the species persist anywhere within its historical range (USFWS 2019).

At the time the recovery plan was completed in 1991, five populations were known; however, even these populations were considered to be relic and possibly non-reproducing. The record from the Kanawha River in West Virginia was a misidentification and the species is considered extirpated from West Virginia. Records from the Tennessee River are 25 or more years old. The most-recent record from the Tennessee River downstream of Wilson Dam is from the early 1990s due to a commercial mussel harvest. The species likely has been extirpated from all but the following five river reaches: the Green River in Kentucky, the Tennessee River downstream of Wilson Dam in Alabama, the Tennessee River downstream of Pickwick Landing Dam in Tennessee, portions of the Cumberland River, and the Tennessee River downstream of Kentucky Dam in Kentucky. The most recent records are from the Green River, where four live adults have been found since 1998. We assume the species still exists in the Green River, but in extremely low numbers that hamper detection efforts. It may occur in other river systems, but the likelihood of detecting this species is extremely low. Ring pink mussels are rare and occur in such low densities that they are unlikely to be detected during typical mussel surveys, which are often of limited scope and duration. They are also a relatively long-lived mussel species, so a population may persist for many decades, which can provide future opportunities to locate individuals. These factors, combined with the recent progress in mussel in-vitro culture methods, suggest that numerous juvenile Ring Pinks could be produced for recovery efforts from only one or a few gravid females if those females can be found (USFWS 2019). In 2007, an experimental population of ring pink (mussels) was established in portions of the French Broad and Holston Rivers in Tennessee with unknown success (EXPN Entity ID 9498).

Threats to the remaining populations identified in the recovery plan included water quality problems due to oil and gas production, gravel dredging, channel maintenance, commercial mussel fishing, and reduced natural reproduction. Current threats to the ring pink mussel are primarily associated with its restricted range, small population size (i.e., undetectable due to low densities), and low recruitment into the population. In addition, the conversion of free-flowing large rivers to a series of long, linear impoundments has seriously reduced the availability of its preferred riverine gravel and sand habitat and likely affected the distribution and availability of the ring pink mussel's fish host. Habitat improvements, if any, are either considered negligible and/or have not been studied sufficiently to document improvements and/or a reduction of habitat degradation. The Green River population may benefit from the 2017 removal of Green River Lock and Dam 6 (which occurred in spring 2017). Initial surveys indicated that water flowed more freely following dam removal, but it will likely require many years or decades to determine if the dam removal benefitted the species (Compton et al. 2017, 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 13.8% of the species range will contain methomyl use sites (Table 24).

Usage

Past usage data indicate that up to 0.9% of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (0.6%) and vegetables and ground fruit (0.1%) (Table 24).

Table 24. Overlap and usage data for the ring pink (mussel).

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	0.2	<0.1
Citrus	NA	NA
Corn	10.9	0.5
Cotton	0.3	<0.1
Other Grains	0.2	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	0.4	0.2

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Soybeans[12]	12.7	0.6
Vegetables and Ground Fruit	<0.1	0.1
Wheat	NA	NA
Total	**13.8**	**0.9**

Exposure Summary

There is a high extent of overlap between the action area and the species' range (13.8%). Based on past usage data, we expect a low level of usage (0.9% annually) within the species' range. Given that the extent of overlap is high and that expected usage is low, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 25 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

[12] 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.

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the ring pink (mussel) occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 23 to 46 µg/L, depending on the region (Table 25). Based on this range of potential exposures, we do not expect 0 exposed host fish will die or otherwise impact the availability of fish hosts needed for successful reproduction. The ring pink (mussel) fish host species is unknown because the number of ring pinks seen in the wild is too low to assess host fish success. Host fish of the congener *Obovaria unicolor* (Alabama hickorynut) include *Ammocrypta beanii* (naked sand darter), *A. meridiana (*southern sand darter*)*, and *Etheostoma artesiae* (redspot darter). Host fish of the congener *Obovaria subrotunda* (round hickorynut) include five darter species (Percidae)—*Etheostoma baileyi* (emerald darter), *E. blennioides* (blenny darter), *E. gore* (Cumberland darter), *E. variatum* (variegate darter), and *Percina stictogaster* (frecklebelly darter). Therefore, we assume this species also uses darters as host fish (USFWS 2019). Because no mortality is expected for all aquatic habitats for the ring pink, we do not anticipate loss of fish host species availability and thus will not likely result in adverse effects to the reproductive cycle of the mussel overall.

Table 25. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the ring pink mussel could be exposed to methomyl in 13.8% of the species range based on methomyl use sites and up to 0.9% of the range may be treated with methomyl (Table 25) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the ring pink mussel. Mussels depend on host fish to accomplish their reproductive lifecycle and glochidia (mussel larvae) that do not attach to a host fish will not survive. Even though fish host species for the ring pink mussel are unknown, we believe they may be similar to another mussel species, the round hickorynut. Assuming the same host fish as round hickorynut, we do not expect mortality for fish host nor reproductive impacts for ring pink mussels. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Therefore, methomyl is not likely to cause adverse effects to the ring pink mussel.

Conclusion

Historically, the ring pink mussel was widespread in medium to large rivers in the Ohio River basin. It is now one of the rarest mussels in North America. At the time the recovery plan was completed in 1991, it was believed that five populations remained; however, even these populations were considered to be relic and likely non-reproducing. A population currently is presumed to exist in the Green River in Kentucky, where a live individual was found as recently as 2015. Elsewhere, populations may still occur in small segments of the Tennessee River downstream of Wilson Dam, Pickwick Landing Dam, and/or Kentucky Dam and in the Cumberland River near Hartsville, Tennessee. However, recent survey efforts in portions of these rivers have not documented presence of the species. Current threats to the ring pink mussel are primarily associated with its restricted range, small population size, and low recruitment into the population. In addition, the conversion of free-flowing large rivers to a series of long, linear impoundments has seriously reduced the availability of its preferred riverine gravel and sand habitat and likely affected the distribution and availability of the ring pink mussel's fish host.

The species range occurs near methomyl use sites overlapping 13.8% of the range, but a small portion of the range has experienced methomyl usage in the past (0.9% annually). Therefore, we consider the species to have a medium exposure ranking. However, we do not expect direct mortality of mussels from methomyl exposure, nor do we expect mussels to be indirectly affected through impacts to their host fish. The ring pink mussel's fish host species is unknown. Host fish of the congener Alabama hickorynut include naked sand darter, southern sand darter, and redspot darter. Congener of round hickorynut metamorphosed on five darter species (Percidae)—emerald darter, blenny darter, Cumberland darter, variegate darter, and frecklebelly darter. We assume the ring pink uses similar host fish species and that both ring pinks and potential fish hosts occur in high flow waterbodies within four HUCs (5, 6, 7, and 8). After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), we do not expect methomyl concentrations in any of these habitats that will result in fish mortality. Additionally, 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 the species has high vulnerability and medium exposure, its presumed host fish are common, and we do not anticipate host fish mortality from methomyl exposure. Therefore, we expect impacts to the mussel to be discountable and no individuals will be adversely affected through loss of host fish. After incorporating conservation measures into the effects of the action, accounting for 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 ring pink mussel in the wild.

References

Compton, M.C, B. D. Yahn, and L. T. Phelps. 2017. Preliminary ecological assessment of the Green and Nolin rivers in Mammoth Cave National Park, Kentucky, following the removal of lock and dam #6. Kentucky State Nature Preserves Commission. 72 pp.

U.S. Fish and Wildlife Service. 2019. Ring Pink (*Obovaria retusa*, Lamarck, 1819) 5-Year Review: Summary and Evaluation. Frankfort, Kentucky. 13 pp.

Integration and Synthesis Summary: - Fat pocketbook

Scientific Name:	Common Name:	Entity ID:
Potamilus capax	Fat pocketbook	342

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 low. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 12). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 fat pocketbook. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 8/13/2021; Wherever found; *States within the range:* AR, IL, IN, KY, LA, MO, MS, TN. Figure 12 depicts the species' range.

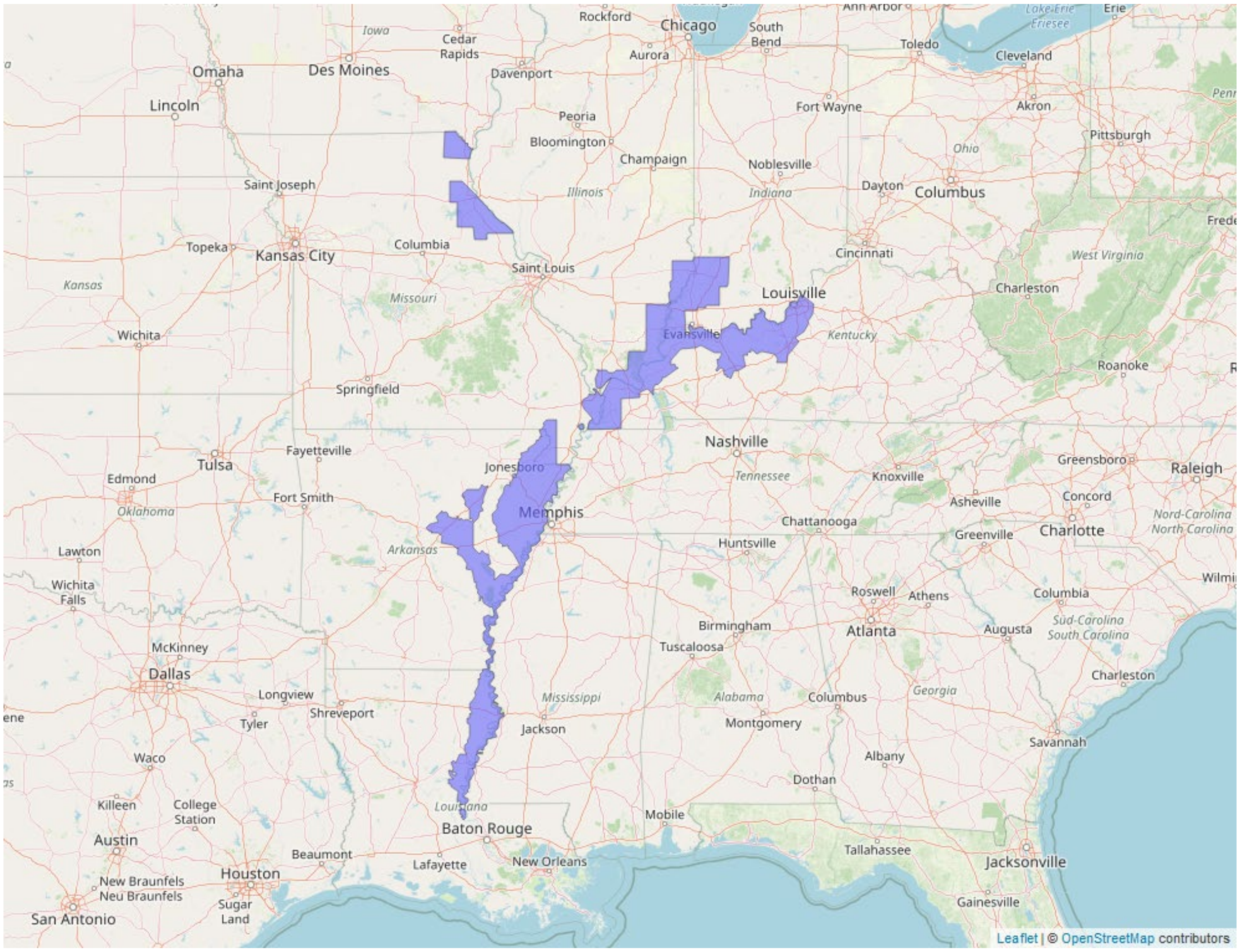

Figure 12. Range map of fat pocketbook (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/2780.

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: Delist: The species does not meet the definition of an endangered species or a threatened species

Most recently completed 5-Year Review: 12/26/2019

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

Number of populations: Multiple populations (few)

Species trends: Increasing population(s)

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

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

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. The fat pocketbook was historically distributed in the Mississippi River drainage from the confluence of the Minnesota and St. Croix Rivers downstream to the White River System. Collection records from the St. Francis River drainage since listing show a significant expansion in spatial distribution of fat pocketbook in the St. Francis River drainage, from a historical range of less than 100 km (60 mi) to a current range of about 480 km (300 mi) of river and stream reaches. At the time of listing, the fat pocketbook was believed to be extirpated from the Ohio River drainage. Over the past three decades, however, the species has been reported from scattered locations along 260 km (150 mi) of the Wabash River, and from the lower reaches of other major tributaries (Saline, Tennessee, White, Cumberland, Clarks, and Green Rivers) in Kentucky, Illinois, and Indiana. While the fat pocketbook appears to remain extirpated from the upper Mississippi River, it has expanded its range in the lower Mississippi River. Overall, the fat pocketbook is now known to occupy approximately 1,000 channel miles in three distinct drainages and 33 river or stream reaches. In the 2019 species review, we recommended the species for delisting (USFWS 2019).

The primary threats identified for the fat pocketbook include the destruction, modification, and curtailment of its habitat and range due to navigation and flood control activities (e.g., impoundment, channel maintenance, dredging) on the rivers where it was once found (USFWS 1989). Construction of impoundments for flood control and navigation in some of the river basins in which fat pocketbook historically occurred (e.g., upper Mississippi River, Ohio River, White River) inundated habitats, changed flow distributions, and likely contributed to local extirpations of fat pocketbook populations. The 2012 5-year review identified on-going threats to habitat and range as impoundment, hydropower and hydrokinetic power development, channel dredging, and illegal discharges and spills. Potential stressors to the species include sedimentation and non-point source pollution (USFWS 2012). Since the 2012 5-year review, impoundment and hydropower projects with potentially adverse effects on the fat pocketbook have been completed with minimal impact to the species, while hydrokinetic development on the Lower Mississippi River has been abandoned. Potential threats have been further reduced by development and implementation of U.S. Army Corps of Engineers programs protective of the species and its habitats in the St. Francis, Mississippi, and Ohio River drainages. The species' increase in abundance and range, including within channelized ditches highly affected by agricultural runoff and in navigable river channels subject to dredging, shows resiliency to non-point source pollution and channel maintenance activities. According to the 2019 5-year review summary and evaluation, the best available information indicates that the fat pocketbook mussel no longer meets the definition of an endangered or threatened species under the ESA and should be proposed for delisting (USFWS 2019).

Overall Vulnerability: Low

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 55.3% of the species range will contain methomyl use sites (Table 26).

Usage

Past usage data indicate that up to 3.6% of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (2.3%), cotton (0.3%) and other orchards (0.3%) (Table 26).

Table 26. Overlap and usage data for the fat pocketbook.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	0.1	<0.1
Citrus	NA	NA
Corn	27.1	1.4
Cotton	5.1	0.3
Other Grains	3.2	0.2
Other Orchards	0.3	0.3
Other Row Crops	0.3	0.1

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Soybeans[13]	45.9	2.3
Vegetables and Ground Fruit	0.4	0.4
Wheat	NA	NA
Total	**55.3**	**3.6**

Exposure Summary

There is a high extent of overlap between the action area and the species' range (55.3%). Based on past usage data, we expect a low level of usage (3.6% annually) within the species' range. Given that the extent of overlap is high and that expected usage is low we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 27 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.
Aquatic habitat buffers: The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fishponds and natural, permanent streams, marshes or natural, permanent ponds".

[13]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.

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the fat pocketbook occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 321 µg/L, depending on the type of habitat and region (Table 27). Based on this range of potential exposures, we expect between 0-0.61% of exposed host fish will die, which is not likely to reduce the availability of fish hosts needed for successful reproduction. 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 of all aquatic habitats available to them, so we anticipate low adverse effects to the reproductive cycle of the mussel from loss of host fish.

Table 27. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_11a	48.83	0
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0
Large volume waterbodies	HUC_11a	29.03	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Large volume waterbodies	HUC_7	12.21	0
Large volume waterbodies	HUC_8	31.29	0
Low flow/Low volume waterbodies	HUC_11a	321.30	0.61

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
Low flow/Low volume waterbodies	HUC_5	229.50	0.08
Low flow/Low volume waterbodies	HUC_6	164.70	0.01
Low flow/Low volume waterbodies	HUC_7	209.70	0.04
Low flow/Low volume waterbodies	HUC_8	225.90	0.07

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the fat pocketbook could be exposed to methomyl in 55.3% of the species range based on methomyl use sites and up to 3.6% of the range may be treated with methomyl (Table 27) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the fat pocketbook. We anticipate some 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. Even though the mussel only uses one host fish, the expected mortality is low (0-0.61%) due to the fish host preference for large rivers, lakes, and reservoirs and typically large deep pools. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. So, we anticipate a small amount of fish host mortality, and the reproduction for a small number of individual fat pocketbook mussels will be adversely impacted. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources.

Conclusion

The fat pocketbook is listed as endangered but was recommended for delisting due to recovery in the most recent 5-year status review (USFWS 2019). Its range includes the Black, St. Francis, and Mississippi River drainages in Arkansas, Illinois, Indiana, Kentucky, Louisiana, Missouri, Mississippi, and Tennessee. Over the last 30 years, new populations have been discovered and known populations have increased. Threats include habitat modification (e.g., impoundments, dredging, and channelization), discharges, and spills.

The species range occurs near methomyl use sites overlapping 55.3% of the range, but a small portion of the range has experienced methomyl usage in the past (3.6% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The fat pocketbook is a host fish specialist and is known only to use the freshwater drum for reproduction. The fat pocketbook and its host fish occur in high flow waterbodies across five HUCs (5, 6, 7, 8, and 11a). The host fish is also known to use low flow/low volume waterbodies and high-volume waterbodies across the same five HUCs. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), host fish mortality estimates range from 0-0.61%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species uses only one host fish and exposure is medium, the fish host (i.e., freshwater drum) mortality is low (0-0.61%) in all aquatic habitats and they prefer large rivers, lakes, reservoirs, and large deep pools where we expect no fish mortality. Freshwater drum also occur in multiple river systems and are common and abundant throughout the range of the mussel. Therefore, we expect a small number of individual mussels will be adversely affected through loss of host fish. In addition, the fat pocketbook has recovered to a point that we recommended it for delisting. After incorporating conservation measures into the effects of the action, accounting for 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 fat pocketbook in the wild.

References

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

U.S. Fish and Wildlife Service. 2012. Fat Pocketbook Pearly Mussel (*Potamilus capax*) 5-Year Review: Summary and Evaluation. Jackson, Mississippi. 22 pp.

U.S. Fish and Wildlife Service. 1989. Fat Pocketbook Pearly Mussel Recovery Plan. Atlanta, Georgia. 27 pp.

Integration and Synthesis Summary: - Scaleshell mussel

Scientific Name:	Common Name:	Entity ID:
Leptodea leptodon	Scaleshell mussel	345

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 13). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 scaleshell mussel. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 3/14/2022; Wherever found; *States within the range:* AR, IL, MO, NE, OK, SD. Figure 13 depicts the species' range.

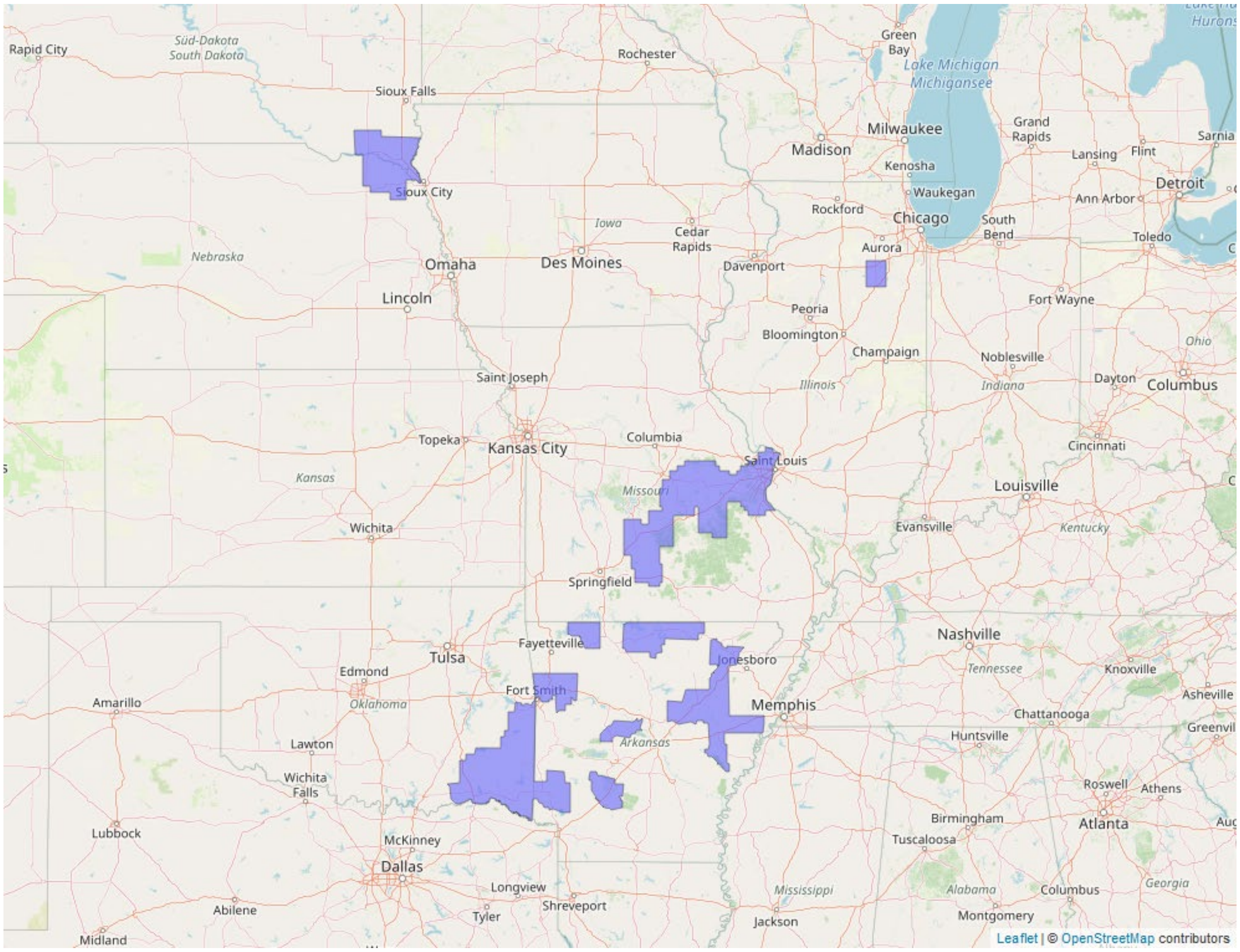

Figure 13. Range map of scaleshell mussel (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/5881.

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: 3/23/2021

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 scaleshell is still present, although rare, within its strong-hold populations in the Meramec, Bourbeuse, and Gasconade rivers in Missouri. It was also collected live in the last 10 years in three streams where it has been documented previously in Arkansas, Missouri, and Illinois. No other collections have been reported for the scaleshell during the review period from 2011 to the present (USFWS 2021). Overall, the species distribution remains the same as described in our 2011 review (USFWS 2011) and this information does not alter our understanding of the species' current distribution. Likewise, the evaluation of threats affecting the species under the factors in 4(a)(1) of the Act and analysis of the status of the species in the 2011 status review and recovery plan remains an accurate reflection of the species current status. The major causes of habitat loss are still present in streams throughout its range including water quality degradation, sedimentation, channelization, sand and gravel mining, dredging, and impoundments (USFWS 2010). The Service recently documented new information on water quality and effects to the scaleshell. Ammonia is a common pollutant in streams occupied by the scaleshell range-wide and is associated with both point and non-point sources. Ammonia is associated with animal feedlots, nitrogenous fertilizers, industrial effluents, and municipal wastewater treatment plants. Ammonia is highly toxic to aquatic species, in particular freshwater mussels. In 2013, the Environmental Protection Agency (EPA) finalized the updated ammonia criteria. These criteria are applicable nationally and consider the latest toxicity information for freshwater species, including unionid mussels (USFWS 2021). In addition, declines of mussel populations in the Big River have been attributed to the effects of past and present lead mining (USFWS 2010). Recent studies have confirmed that stream sediments in the Big River are contaminated with high levels of heavy metals (e.g., lead, zinc, cadmium) from lead mining in the upper portion of the watershed. These contaminated sediments have greatly affected mussel populations in the Big River. Sites with impacted mussel communities included over 158.7 km (98.6 mi) of the river, including the reach from river mile 113 to 14.4. The scaleshell is known to occur at two sites in the lower 16.1 km (10 mi). If contaminated sediments continue to migrate downstream, scaleshell populations in the lower Big River will be impacted, as well as populations in the Meramec River downstream from the confluence of the two rivers. We are currently monitoring mussel populations and sediment contamination in the lower 10 miles of the Big River (USFWS 2010, 2021).

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 20.4% of the species range will contain methomyl use sites (Table 28).

Usage

Past usage data indicate that up to 1.2% of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (0.9%), alfalfa (0.1%), other grains (0.1%), and other orchards (0.1%) (Table 28).

Table 28. Overlap and usage data for the scaleshell mussel.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	0.7	0.1
Citrus	NA	NA
Corn	11.5	0.6
Cotton	0.4	<0.1
Other Grains	1.2	0.1
Other Orchards	<0.1	0.1
Other Row Crops	<0.1	<0.1
Soybeans[14]	17.9	0.9
Vegetables and Ground Fruit	<0.1	<0.1
Wheat	NA	NA
Total	**20.4**	**1.2**

Exposure Summary

There is a high extent of overlap between the action area and the species' range (20.4%). Based on past usage data, we expect a low level of usage (1.2% annually) within the species' range.

[14]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.

Given that the extent of overlap is high and that expected usage is low, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 27 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the scaleshell mussel occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 321 µg/L, depending on the type of habitat and region (Table 29). Based on this range of potential exposures, we expect between 0-0.61% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. The scaleshell mussel 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, where we expect low fish mortality from methomyl exposure. Although the mussel is limited to one fish host species, freshwater drums are relatively common and use of all aquatic habitats available to them, so we anticipate low adverse effects to the reproductive cycle of the mussel from loss of host fish.

Table 29. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_10a	23.26	0
High flow waterbodies	HUC_11a	48.83	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0
Large volume waterbodies	HUC_10a	12.45	0
Large volume waterbodies	HUC_11a	29.03	0
Large volume waterbodies	HUC_7	12.21	0
Large volume waterbodies	HUC_8	31.29	0
Low flow/Low volume waterbodies	HUC_10a	248.40	0.13
Low flow/Low volume waterbodies	HUC_11a	321.30	0.61
Low flow/Low volume waterbodies	HUC_7	209.70	0.04
Low flow/Low volume waterbodies	HUC_8	225.90	0.07

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the scaleshell mussel could be exposed to methomyl in 20.4% of the species range based on methomyl use sites and up to 1.2% of the range may be treated with methomyl (Table 28) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the scaleshell mussel. We anticipate mortality to fish hosts, particularly in low flow/low volume waterbodies. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. The scaleshell mussel has one fish host their glochidia can successfully parasitize, but the freshwater drum is common and abundant across its range and not typically associated with low flow/low volume aquatic habitats where high fish mortality is anticipated. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual mussels will experience adverse effects.

Conclusion

The scaleshell mussel, an endangered species, is still present, although rare, within its stronghold populations in the Meramec, Bourbeuse, and Gasconade rivers in Missouri. Since 2011, either live or dead individuals have been documented in the Strawberry River and South Fourche LaFave River in Arkansas, Big River and Lower Osage River in Missouri, and the Illinois River in Illinois. As described when the species was listed, the scaleshell mussel remains a very rare species in Missouri and only occurs sporadically elsewhere within its range. The major causes of habitat loss are still present in streams throughout its range including water quality degradation (e.g., high ammonia levels), sedimentation, channelization, sand and gravel mining, dredging, and impoundments.

The species range occurs near methomyl use sites overlapping 20.4% of the range, but a small portion of the range has experienced methomyl usage in the past (1.2% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The scaleshell mussel is a host fish specialist and is likely to successfully reproduce only in the presence of the freshwater drum (*Aplodinotus grunniens*). The scaleshell mussel occurs in high flow waterbodies, and the fish host occurs in many aquatic habitats. All aquatic habitats occur in four HUCs (7, 8, 10a, and 10b), each of which has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), host fish mortality estimates range from 0-0.61%, with low rates of mortality anticipated for host fish in all aquatic habitats. Freshwater drum are common and abundant in larger streams throughout the range of the scaleshell, live most of their lives on or near the bottom, and are usually found in large pools where we expect methomyl concentrations to be low. 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 the species has high vulnerability and medium exposure, its host fish is abundant and commonly found in waterbodies with low anticipated fish mortality (0-0.61%). Therefore, we expect a small number of individuals will be adversely affected and low adverse impacts to the scaleshell mussel. After incorporating conservation measures into the effects of the action, accounting for 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 scaleshell mussel in the wild.

References

U.S. Fish and Wildlife Service. 2021. Scaleshell Mussel (*Leptodea leptodon*) 5-Year Review: Summary and Evaluation. Columbia, Missouri. 31 pp.

U.S. Fish and Wildlife Service. 2011. Scaleshell Mussel (*Leptodea leptodon*) 5-Year Review: Summary and Evaluation. Columbia, Missouri. 19 pp.

U.S. Fish and Wildlife Service. 2010. Scaleshell Mussel Recovery Plan (*Leptodea leptodon*). Fort Snelling, Minnesota. 118 pp.

U.S. Environmental Protection Agency. 2013. Aquatic Life Ambient Water Quality Criteria For Ammonia – Freshwater. 255p.

Integration and Synthesis Summary: - Tar River spinymussel

Scientific Name:	Common Name:	Entity ID:
Parvaspina steinstansana	Tar River spinymussel	351

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 medium past usage of methomyl within the species' range (Figure 14), indicating a high extent of exposure. Most exposed individuals are unlikely to die but are likely to experience medium levels of 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 exposure is high, the level of indirect effects is low 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 Tar River spinymussel. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 10/10/2018; Wherever found; *States within the range:* NC. Figure 14 depicts the species' range.

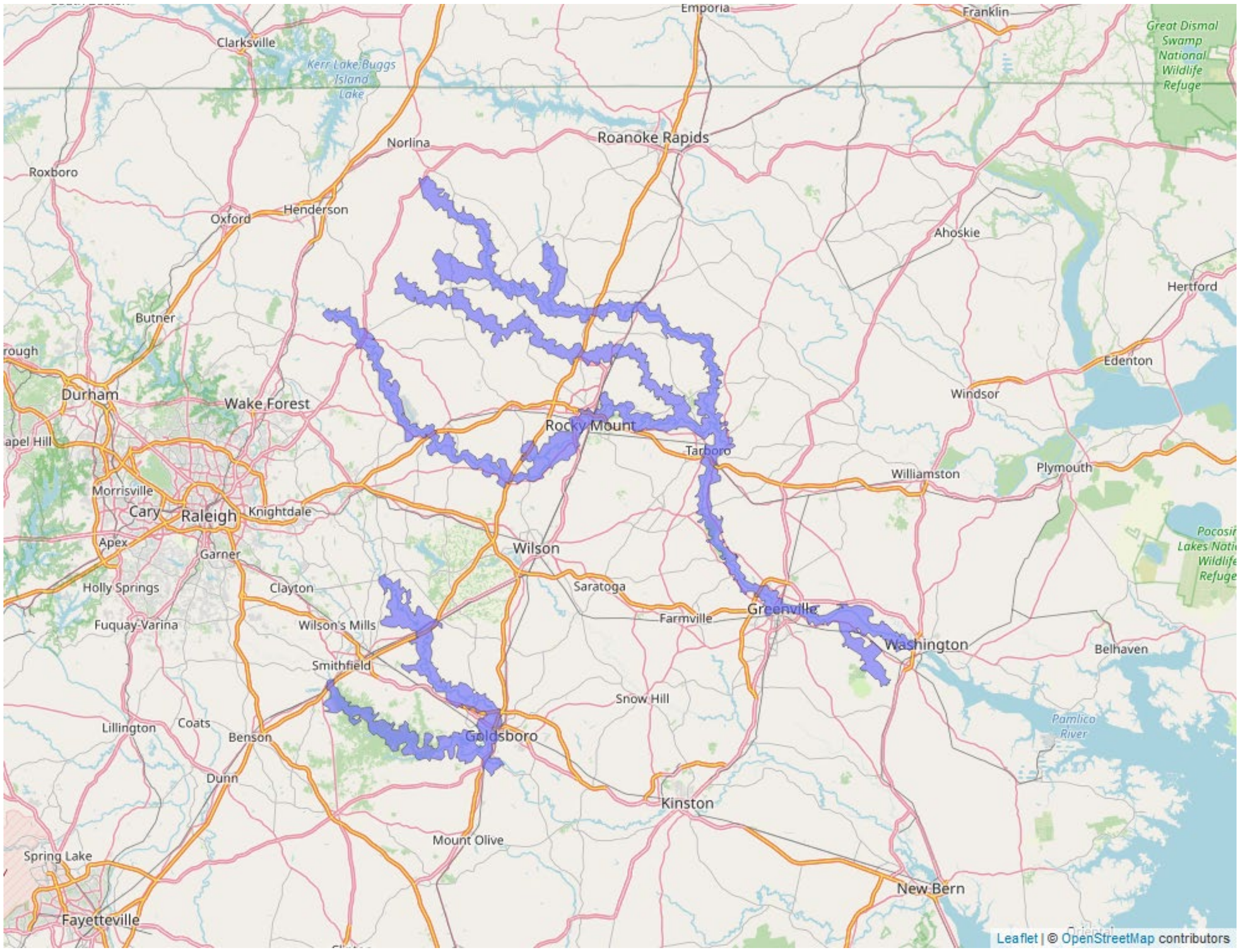

Figure 14. Range map of Tar River spinymussel (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/1392.

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: 11/2/2020

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: yes

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The species is endemic to the Tar River and Neuse River systems in North Carolina. In the Tar River system, the species has been documented only from the mainstem of the Tar River and a few of its tributaries: Shocco Creek, Fishing Creek, Little Fishing Creek, Swift Creek, and Sandy Creek – Sandy Creek is a headwater stream forming Swift Creek. In the Neuse River system, the species has been documented from the mainstems of the Little River and the Neuse River. The species may be extirpated from the mainstem of the Tar River (last observation was two live individuals in 2001; no live or shells were found during surveys in 2002, 2007, or 2013) and Shocco Creek (last and only record was a shell found in 1993, many surveys since have not located the species). Surveys in Swift Creek from 1987-2002 found 353 spinymussels, yet only one individual was found during surveys there in 2005 and none during surveys since (2006-2014). In addition, none have been recorded from Sandy Creek since 1988. A maximum of 67 individuals were observed in Little Fishing Creek between 1993-2014; only 7 individuals were found in Fishing Creek between 1999-2014. Only 4 individuals have ever been recorded from the Little River (Neuse River basin) – one each in 1998, 2005, 2010, and 2011; repeated surveys since have not recorded any additional specimens. Two unusually large specimens have been documented from the mainstem of the Neuse River. Monitoring and other surveys for the Tar River spinymussel have documented a continued decline in nearly all surviving populations. Despite substantial time invested in surveying for Tar River spinymussels between 2015-2020, only 11 wild individuals were encountered: ten in the Fishing/Little Fishing Creeks and one in the Little River within the Neuse River population. Three of the mussels found were gravid, indicating mussels are attempting to reproduce; however, sparse detection of mussels and no documentation of wild recruitment suggest that the species has limited capability to reproduce, maintain gene flow, and recover without intervention. Although limited levels of reproduction and recruitment may be occurring within the Little Fishing Creek/Fishing Creek and the Little River populations, the amount of recruitment occurring does not appear to be at levels high enough to maintain these populations. The North Carolina Wildlife Resources Commission stocked more than 35,000 propagated mussels into the Fishing Creek, Swift-Sandy Creek, and Tar River subpopulations since 2014. Monitoring surveys since 2015 documented survival, growth, and gravidity in tagged mussels that were released, and augmentation and monitoring will continue (USFWS 2020).

Threats to the species include habitat fragmentation, loss, and alteration resulting from impoundments, wastewater discharges, loss of forested lands and riparian buffers, and the runoff of silt and other pollutants from ground disturbance activities. For example, despite repeated surveys, no live individuals of the species have been observed in the Sandy-Swift Creek watershed since 2005, which can be attributed to the cumulative effects of pesticide-induced die off, drought, and large scale clearing of timber within the watershed. The Neuse River basin population(s) will likely face development-related pressures as several Wake County municipalities (e.g., Raleigh, Rolesville, Zebulon and Wendell) expand and grow. If the water supply reservoir and wastewater discharge on the Little River in Wake County are pursued, the population in the Little River will be under imminent threat from decreased flows and chemical contaminants from discharged effluent. Water quality continues to be an issue affecting habitat quality, as freshwater mussels are some of the most sensitive forms of aquatic life to toxicity of common pollutants in surface waters, such as ammonia, chlorine, chloride, copper, nickel, lead, potassium, sulfate, and zinc. Tar River spinymussels are sensitive to some contaminants, including some types of pesticides, thus pollutants are important to consider in managing Tar River spinymussel populations (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 43.9% of the species range will contain methomyl use sites (Table 30).

Usage

Past usage data indicate that up to 7.8 % of the species' range has been treated with methomyl annually. Use layers with the highest usage include vegetables and ground fruit (3.2%), other row crops (2.8%), and soybeans (1.2%) (Table 30).

Table 30. Overlap and usage data for the Tar River spinymussel.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn	8.7	0.4
Cotton	9.6	0.5
Other Grains	1.3	0.1
Other Orchards	<0.1	<0.1

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Other Row Crops	6.3	2.8
Soybeans[15]	23.5	1.2
Vegetables and Ground Fruit	3.2	3.2
Wheat	NA	NA
Total	**43.9**	**7.8**

Exposure Summary

A high portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (43.9%). Based on past usage data, we expect a smaller portion of the range is likely to be treated with methomyl (7.8% annually). As such, we expect a large portion of the range will likely experience exposure. Therefore, we expect a large number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: High

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 31 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

[15]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.

Effects of the Action: Toxicity

Direct Effects:

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects:

Within the regions and aquatic habitats that the Tar River spinymussel occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 35 to 171 µg/L, depending on the type of habitat (Table 31). Based on this range of potential exposures, we expect between 0-0.01% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. The Tar River spinymussel is a host fish specialist and is likely only able to successfully reproduce in the presence of a few species of fish hosts, including the bluehead chub (*Nocomis leptocephalus*), satinfin shiner (*Cyprinella analostana*), white shiner (*Luxilus albeolus*), and pinewoods shiner (*L. matutinus*). We anticipate low (0-0.01%) reductions in fish host species availability in low flow/low volume waterbodies. Because the species requires a few species of fish hosts that are found in multiple aquatic habitats and overall fish mortality is expected to be low, we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 31. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_3	34.82	0
Low flow/Low volume waterbodies	HUC_3	171.00	0.01

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the Tar River spinymussel could be exposed to methomyl in 43.9% of the species range based on methomyl use sites and up to 7.8% of the range may be treated with methomyl (Table 31) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the Tar river spinymussel. We anticipate some 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. Known fish hosts for the Tar River spinymussel include bluehead chub, satinfin shiner, white shiner, and pinewoods shiner. Expected fish mortality is low (0-0.01%) in low flow/low volume waterbodies, and even though host species are few, they are found in multiple aquatic habitats. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual mussels will experience adverse effects.

Conclusion

The Tar River spinymussel was listed as endangered in 1985. Since listing, the species continues to have a very fragmented, relict distribution and available trend information indicates that the species is rapidly declining throughout its range. Based on available survey data, all extant populations are extremely small in numbers and three of the populations in the Tar River, Shocco Creek, and Neuse River may be extirpated, though additional surveys are needed to confirm. Surveys in the Sandy/Swift Creek basin have also shown dramatic declines in numbers, and intensive survey efforts are needed to determine whether the species persists. Since 2015, only 11 wild individuals have been encountered. Ten were in the Fishing/Little Fishing Creeks (Fishing Creek sub-population of Tar River Basin) and one was in the Little River within the Neuse River population. Three mussels found gravid, indicating they are attempting to reproduce; however, sparse detection of mussels and no documentation of wild recruitment suggest that the species has limited capability to reproduce, maintain gene flow, and recover without intervention. Continued land use activities and projected land use changes in the watersheds contribute to primary threats to Tar River spinymussel, including habitat degradation via sedimentation and effects on water quality. Because of the species' limited abundance and range, the small populations that remain are highly vulnerable to extirpation via singular stochastic events (e.g., drought) or stream-adjacent activities (e.g., sediment influx). Beginning in 2014, propagated Tar River spinymussels have been released at three sub-population sites. Augmentation and reintroduction through the captive breeding program have potential to assist in the species' recovery.

The species range occurs near methomyl use sites overlapping 43.9% of the range, but a moderate portion of the range has experienced methomyl usage in the past (7.8% annually). Therefore, we consider the species to have a high exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The Tar River spinymussel is a host fish specialist and is likely to successfully reproduce only in the presence of bluehead chub, satinfin shiner, white shiner, and pinewoods shiner. The Tar River spinymussel occurs in high flow waterbodies and the fish hosts also occur in both high flow and low flow/low volume waterbodies. All aquatic habitats occur in HUC 3, and each has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), host fish mortality estimates range from 0-0.01%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and high exposure, its host fish are use various components of aquatic habitats throughout their life cycles, and we anticipate low host fish mortality (up to 0.01%) where methomyl exposure occurs. Therefore, we expect impacts to the mussel to be low and a small number of individuals will be adversely affected over the course of the action. After incorporating conservation measures into the effects of the action, accounting for 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 Tar River spinymussel in the wild.

References

U.S. Fish and Wildlife Service. 2020. Tar River Spinymussel (*Elliptio steinstansana*) 5-Year Review: Summary and Evaluation. Raleigh, North Carolina. 44 pp.

Integration and Synthesis Summary: - Clubshell

Scientific Name:	Common Name:	Entity ID:
Pleurobema clava	Clubshell	352

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 15). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 clubshell. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 2/18/2021; Wherever found; Except where listed as Experimental Populations; *States within the range:* IL, IN, KY, MI, MS, NY, OH, PA, TN, WV. Figure 15 depicts the species' range.

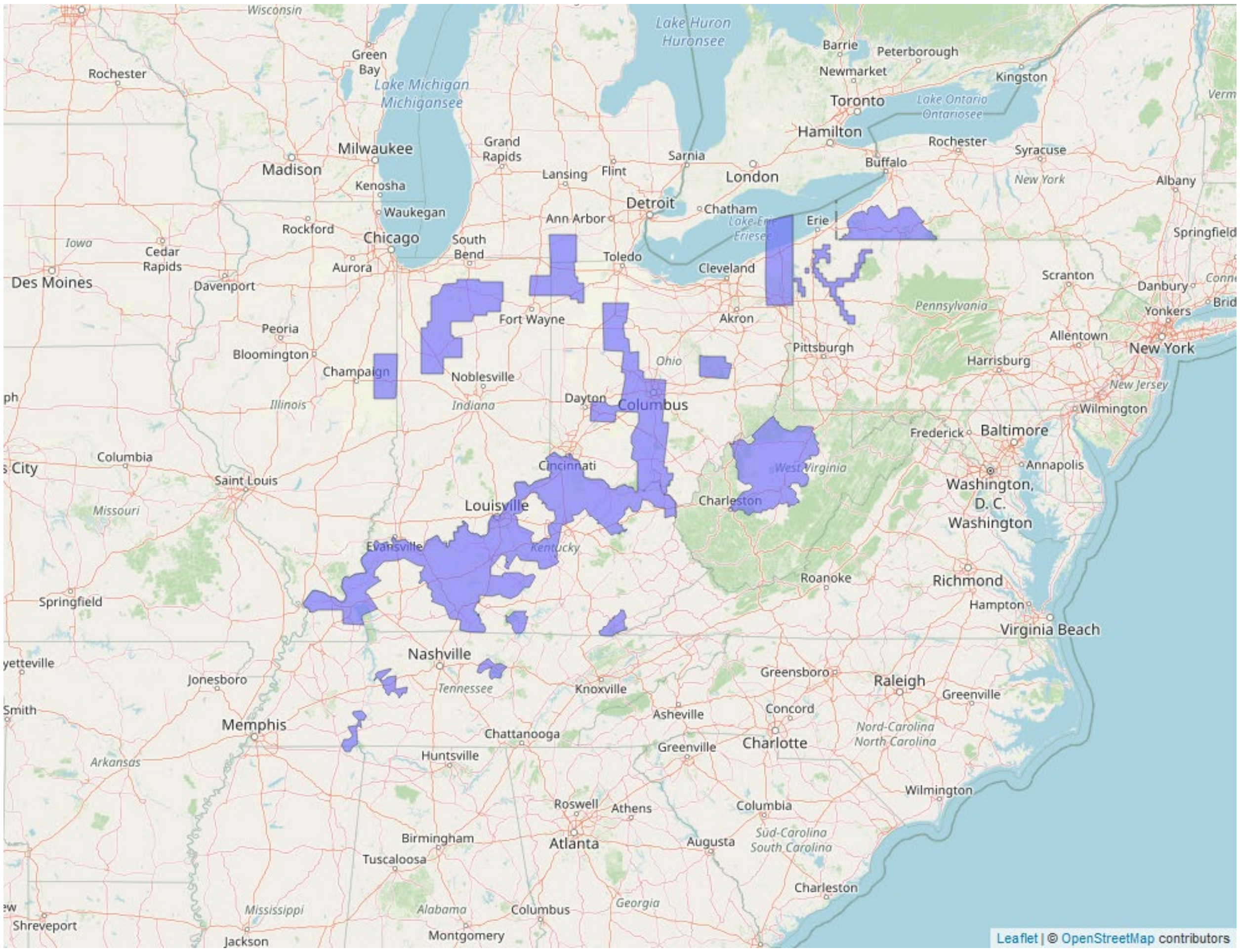

Figure 15. Range map of clubshell (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/3789.

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: 8/28/2019

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

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

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

Clubshells have been moved from the Allegheny River to several streams (including in New York, Pennsylvania, West Virginia, Ohio, Kentucky, Indiana, and Illinois) in the historical range to augment existing populations or reintroduce the species to increase redundancy and species recovery. These relocations occurred from 2014 to 2018, and no evidence of successful recruitment has been documented; however, juvenile clubshells take several years to reach a size that is likely to be detected. An experimental population of clubshells was established in the Tennessee River downstream of Wilson Dam, but no individuals are believed to survive there (USFWS 2019; EXPN Entity ID 1897).

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

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

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

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

Development has also resulted in an increased number of sewage treatment plants in drainages that support clubshell as well as an increase in the amount of sewage discharged from existing plants. Mounting evidence indicates that freshwater mussels are more sensitive to several components of treated sewage effluent (e.g., ammonia, chlorine, and copper) than are the typical organisms used to establish criteria protective of aquatic life. Small streams, such as Conneaut

Outlet, are particularly vulnerable to sewage effluent, which can comprise a significant portion of the total stream flow.

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

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 25.3% of the species range will contain methomyl use sites (Table 32).

Usage

Past usage data indicate that up to 2.1 % of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (1.2%), vegetables and ground fruit (0.6%), and alfalfa (0.2%) (Table 32).

Table 32. Overlap and usage data for the clubshell.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	1.2	0.2
Citrus	NA	NA
Corn	22.4	1.1
Cotton	<0.1	<0.1
Other Grains	0.2	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	0.2	0.1

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Soybeans[16]	23.1	1.2
Vegetables and Ground Fruit	0.6	0.6
Wheat	NA	NA
Total	**25.3**	**2.1**

Exposure Summary

A high portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (25.3%). Based on past usage data, we expect a smaller portion of the range is likely to be treated with methomyl (2.1% annually), suggesting a small portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 33 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

[16] 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.

Effects of the Action: Toxicity

Direct Effects:

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects:

Within the regions and aquatic habitats that the clubshell occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 245 µg/L, depending on the type of habitat and region (Table 33). Based on this range of potential exposures, we expect between 0-0.12% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. The clubshell mussel is a host fish generalist and can successfully reproduce in the presence of several common species of fish hosts, including the striped shiner (*Luxilus chrysocephalus*), blackside darter (*Percina maculate*), central stoneroller (*Campostoma anomalum*), and logperch (*Percina caprodes*). Because the fish host species are varied and found in multiple aquatic habitats, and fish mortality is very low, we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 33. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_4	24.17	0
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0
Large volume waterbodies	HUC_4	11.86	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Large volume waterbodies	HUC_7	12.21	0
Large volume waterbodies	HUC_8	31.29	0
Low flow/Low volume waterbodies	HUC_4	244.80	0.12
Low flow/Low volume waterbodies	HUC_5	229.50	0.08

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
Low flow/Low volume waterbodies	HUC_6	164.70	0.01
Low flow/Low volume waterbodies	HUC_7	209.70	0.04
Low flow/Low volume waterbodies	HUC_8	225.90	0.07

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the clubshell mussel could be exposed to methomyl in 25.3% of the species range based on methomyl use sites and up to 2.1% of the range may be treated with methomyl (Table 33) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the clubshell mussel. We anticipate some 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. Clubshell fish host species are varied and found in multiple aquatic habitats. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. Because we expect fish host mortality to be low, we anticipate low adverse effects to the reproductive cycle of the mussel. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual clubshell mussels will experience adverse effects.

Conclusion

The clubshell was listed as endangered in 1993. Historically, the clubshell was once abundant and appears to have been a highly successful species occupying a range of riverine habitats throughout the Ohio River basin and tributaries of western Lake Erie (Stansbery et al. 1982). It has been documented in over 100 streams throughout its range, although it now appears to be limited to 11 populations distributed in 30 streams. Only eight clubshell populations show evidence of recent reproductive success. Adult clubshells were relocated to a number of streams required to achieve species recovery between 2014 and 2018, including in New York, Pennsylvania, West Virginia, Ohio, Kentucky, Indiana, and Illinois. As of 2019, no juvenile clubshells have been found that demonstrate that reproduction of augmented or reintroduced animals has occurred; however, due to slow growth of the species, recruitment may not be observed for several years. Development of adjacent uplands continues to be a significant and pervasive threat to remaining populations because of the resulting sedimentation and contaminant releases.

The species range occurs near methomyl use sites overlapping 25.3% of the range, but a small portion of the range has experienced methomyl usage in the past (2.1% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The clubshell is a host fish generalist and can successfully reproduce in the presence of several common species of fish hosts, including the striped shiner, blackside darter, central stoneroller, and logperch. The clubshell occurs in high flow waterbodies and the fish hosts occur across many aquatic habitats. All aquatic habitats occur in five HUCs (4, 5, 6, 7, and 8), each of which has a different predicted maximum environmental concentration and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), host fish mortality estimates range from 0-0.12%, with low rates of mortality anticipated for host fish in all aquatic habitats. The clubshell's fish hosts are common throughout the range of the mussel and use various components of aquatic habitats throughout their life cycles. 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 the species has high vulnerability and medium exposure, its host fish are abundant and common, they occur in multiple aquatic habitats, and we anticipate low host fish mortality (0-0.12%). Therefore, we expect impacts to the mussel to be low and a small number of individuals will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 clubshell in the wild.

References

U.S. Fish and Wildlife Service. 2019. Clubshell (*Pleurobema clava*) 5-Year Review: Summary and Evaluation. State College, Pennsylvania. 34 pp.

Integration and Synthesis Summary: - Dwarf wedgemussel

Scientific Name:	Common Name:	Entity ID:
Alasmidonta heterodon	Dwarf wedgemussel	363

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 16). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 dwarf wedgemussel. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 1/12/2022; Wherever found; *States within the range:* CT, DE, MA, MD, NC, NH, NJ, NY, PA, VA, VT. Figure 16 depicts the species' range.

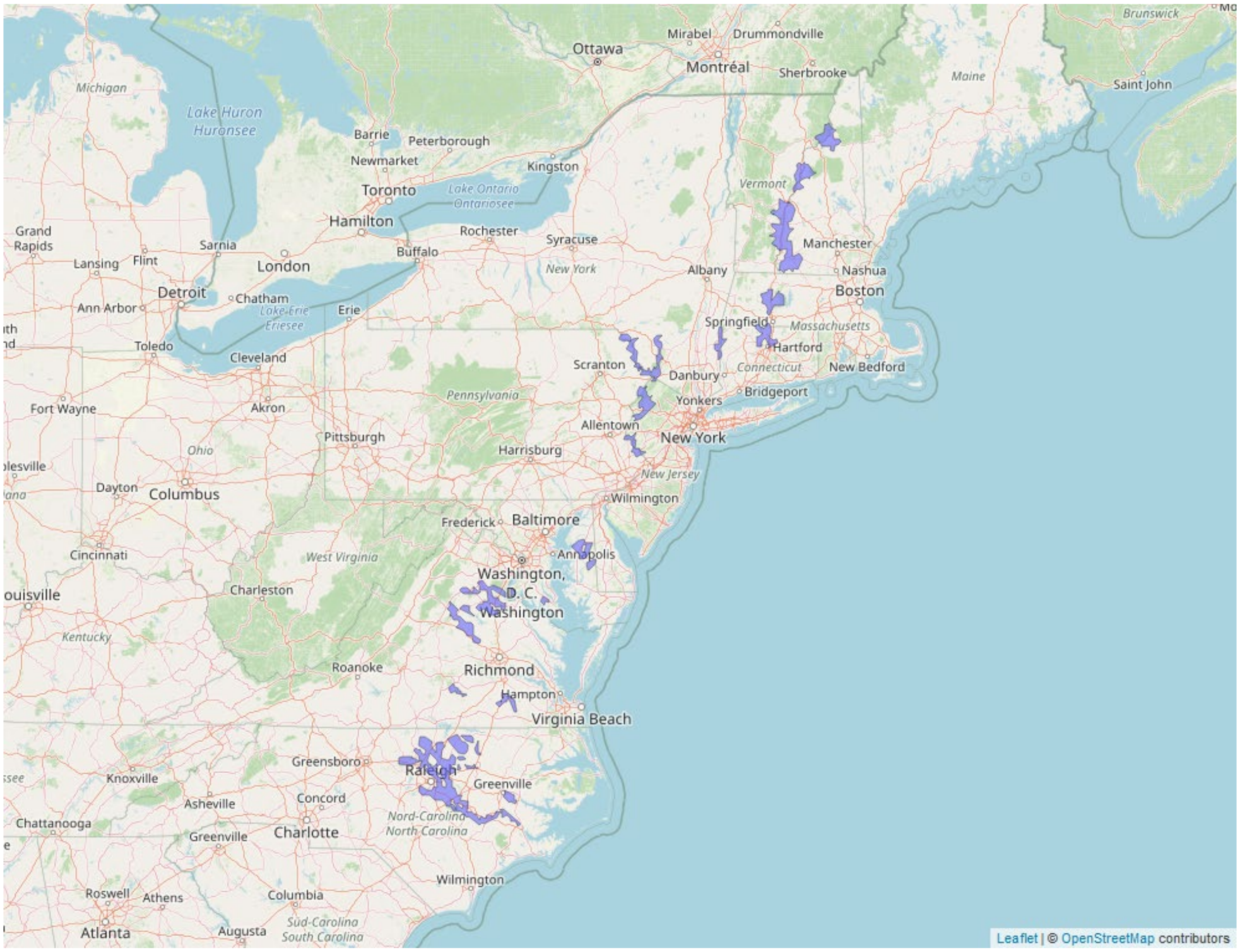

Figure 16. Range map of dwarf wedgemussel (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/784.

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: 8/28/2019

Distribution: Species/Populations neither constrained nor widespread

Number of populations: Multiple populations (few)

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

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

Environmental Baseline/Cumulative Effects (EB/CE) Summary

Many populations in the northern portion of the range (New Hampshire, Massachusetts, and Connecticut) appear to be healthy, while populations in the Delaware River (New York/ New Jersey) watershed may have been affected by flooding, with the most recent floods between 2011-2012. The largest remaining dwarf wedgemussel populations are in Upper Connecticut River mainstem subpopulation in northern New Hampshire and Vermont and the species is found in the Connecticut River Drainage Basin, including tributaries to the Middle Connecticut River (Massachusetts) and the Ashuelot River (New Hampshire). The lower two subpopulations have far fewer occupied sites with lower catch per unit estimates per site (generally less than 10 individuals). In the free-flowing reach downstream of Wilder Dam, no live or dead dwarf wedgemussels were found at 39 survey sites in 2013. Other less common species associated with the dwarf wedgemussel were also extremely rare. The 2011 and 2013 field studies detected few dwarf wedgemussels in the upper Wilder and Bellows Falls impoundments (about one-fourth of the sites surveyed), and where they were found, a typical survey lasting 1 to 2 hours usually detected fewer than two or three animals. Populations in North Carolina, Virginia, Maryland are declining, as evidenced by low densities, lack of reproduction, and/or inability to locate any dwarf wedgemussels in follow-up surveys. Although a few new sites have been discovered in Maryland and North Carolina, the prognosis for dwarf wedgemussel recovery in the southern portion of its range is not as positive as in the northern portion. In 2015, North Carolina Water Resources Commission approved an augmentation proposal for captive propagation and stocking into the Neuse Basin, and in vitro propagation efforts are continuing for the Neuse and Tar Basins (S. McRae, pers. Comm.). Big and Little Flat Brook and the Paulins Kill in New Jersey, as well as the Upper Fishing Creek in a portion of the Tar River Basin in New Hampshire, remain in healthy condition. Additional studies are planned for the Neversink River and Delaware River (USFWS 2019).

The damming and channelization of rivers throughout the species' range eliminated formerly occupied habitat. Dwarf wedgemussels, like all aquatic species, require a certain stream flow regime to persist. Among the greatest threats mussel species face is the alteration of the natural flow regime of a river or stream they occupy. Impoundments, flow diversions, water withdrawals, and other human activities may alter this flow regime. In the Delaware River, drought and an ever-increasing demand for water in New York City and New Jersey can decrease available stream flow, threatening dwarf wedgemussel populations. Additionally, large storm events may trigger flooding in the basin and scour, bury, or relocate individual mussels or entire beds to downstream locations. Siltation generated by road construction, agriculture, forestry activities, and removal of streambank vegetation are considered important factors in the decline of many freshwater mussel species, including the dwarf wedgemussel.

The continuing decline and ultimate loss of the dwarf wedgemussel from most of its historical sites can best be explained by agricultural, domestic, and industrial pollution of its aquatic habitat. Mussels are known to be sensitive to potassium (a common pollutant associated with paper mills and irrigation return water), zinc, copper, cadmium, and other elements. Pesticides, chlorine, excessive nutrients, and silt carried by agricultural runoff also present a threat to this species. Other threats affecting dwarf wedgemussels include invasive species (e.g., flathead catchfish; prey upon mussels and host fish), beaver dams (i.e., change flow regimes in suitable habitat), flood and drought, and climate change (USFWS 1993, 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 14.9% of the species range will contain methomyl use sites (Table 34).

Usage

Past usage data indicate that up to 2.2% of the species' range has been treated with methomyl annually. Use layers with the highest usage include vegetables and ground fruit (0.8%), soybeans (0.5%), and other row crops (0.5%) (Table 34).

Table 34. Overlap and usage data for the dwarf wedgemussel.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	0.6	0.1
Citrus	NA	NA
Corn	6.9	0.3
Cotton	1.4	0.1
Other Grains	1.2	0.1
Other Orchards	<0.1	0.1
Other Row Crops	1.2	0.5

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Soybeans[17]	9.6	0.5
Vegetables and Ground Fruit	0.8	0.8
Wheat	NA	NA
Total	**14.9**	**2.2**

Exposure Summary

There is a high extent of overlap between the action area and the species' range (14.9%). Based on past usage data, we expect a low level of usage (2.2% annually) within the species' range. Given that the extent of overlap is high and that expected usage is low, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 35 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

[17]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.

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the dwarf wedgemussel occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 6 to 263 µg/L, depending on the type of habitat and region (Table 35). Based on this range of potential exposures, we expect between 0-0.19% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. The dwarf wedgemussel is a host fish generalist and can likely use a variety of fish species as hosts and successfully reproduce in the presence of tessellated darter (*Etheostoma olmstedi*), Johnny darter (*Etheostoma nigrum*), mottled sculpin (*Cottus bairdii*), slimy sculpin (*Cottus cognatus*), Atlantic salmon (*Salmo salar*), bluegill (*Lepomis macrochirus*), and green sunfish (*Lepomis cyanellus*). Because the fish host species are varied and found in multiple aquatic habitats, and we expect low fish mortality, we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 35. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_1	36.23	0
High flow waterbodies	HUC_2	11.67	0
High flow waterbodies	HUC_3	34.82	0
Large volume waterbodies	HUC_1	22.03	0
Large volume waterbodies	HUC_2	6.24	0
Large volume waterbodies	HUC_3	18.67	0
Low flow/Low volume waterbodies	HUC_1	262.80	0.19
Low flow/Low volume waterbodies	HUC_2	141.30	0
Low flow/Low volume waterbodies	HUC_3	171.00	0.01

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the dwarf wedgemussel could be exposed to methomyl in 14.9% of the species range based on methomyl use sites and up to 2.2% of the range may be treated with methomyl (Table 35) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the dwarf wedgemussel. We anticipate some 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 dwarf wedgemussel has a variety of fish hosts that their glochidia can successfully parasitize, so if exposure occurs, we anticipate low impacts to the reproductive cycle of the mussel. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual mussels will experience adverse effects.

Conclusion

The dwarf wedgemussel was listed as endangered in 1990. In the northern portion of the range, populations in the Upper Connecticut River and tributaries to the Middle Connecticut River appear to be heathier than those in the Lower Connecticut River. The Delaware River (New York/Pennsylvania) and Neversink River in New York may have experienced declines due to changes in water flow due to water withdrawal and extreme flooding. The status of these populations is unknown until further surveys are conducted. The Middle Delaware, Flat Brook, and Paulins Kill remain in healthy condition. The populations in North Carolina, Virginia, and Maryland are declining, as evidenced by low densities, lack of reproduction, and/or inability to relocate any mussels in follow-up surveys. Although a few new sites have been discovered since 2013 in Maryland and North Carolina, the prognosis for dwarf wedgemussel recovery in the southern portion of its range is not as positive as in the northern portion. Threats include anthropomorphic changes in the landscape (e.g., development that result in impervious surfaces, infrastructure, agricultural practices, dams, water regimes, erosion controls, bank stabilization) and natural causes (e.g., flooding, drought) that may be exacerbated by climate change. Sediments and contaminants impact water quality and aquatic barriers (e.g., culverts, hydroelectric dams, beaver dams, reservoir dams) impede fish migration that limits dispersal of glochidia and impacts reproduction and recruitment.

The species range occurs near methomyl use sites overlapping 14.9% of the range, but a small portion of the range has experienced methomyl usage in the past (2.2% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The dwarf wedgemussel is a host fish generalist and can likely use a variety of fish species as hosts and successfully reproduce in the presence of tessellated darter, Johnny darter, mottled sculpin, slimy sculpin, Atlantic salmon, bluegill, and green sunfish, among numerous others. The dwarf wedgemussel occurs in low flow/low volume waterbodies and high flow waterbodies and the fish hosts occur in many aquatic habitats. All aquatic habitats occur in three HUCs (1, 2, and 3), each of which has a different predicted maximum environmental concentration and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), host fish mortality estimates range from 0-0.19%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, its host fish are abundant and common, they use numerous aquatic habitats throughout their life cycles, and we anticipate low host fish mortality (0-0.19%). Therefore, we expect impacts to the dwarf wedgemussel to be low and a small number of individuals will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 dwarf wedgemussel in the wild.

References

U.S. Fish and Wildlife Service. 2019. Dwarf Wedgemussel (*Alasmidonta heterodon*) 5-Year Review: Summary and Evaluation. Cortland, New York. 47 pp.

U.S. Fish and Wildlife Service. 1993. Dwarf Wedgemussel (*Alasmidonta heterodon*) Recovery Plan. Hadley, Massachusetts. 48 pp.

Integration and Synthesis Summary: - Louisiana pearlshell

Scientific Name:	Common Name:	Entity ID:
Margaritifera hembeli	Louisiana pearlshell	364

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is moderate overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 17). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 Louisiana pearlshell. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 3/5/2021; Wherever found; *States within the range:* AR, LA. Figure 17 depicts the species' range.

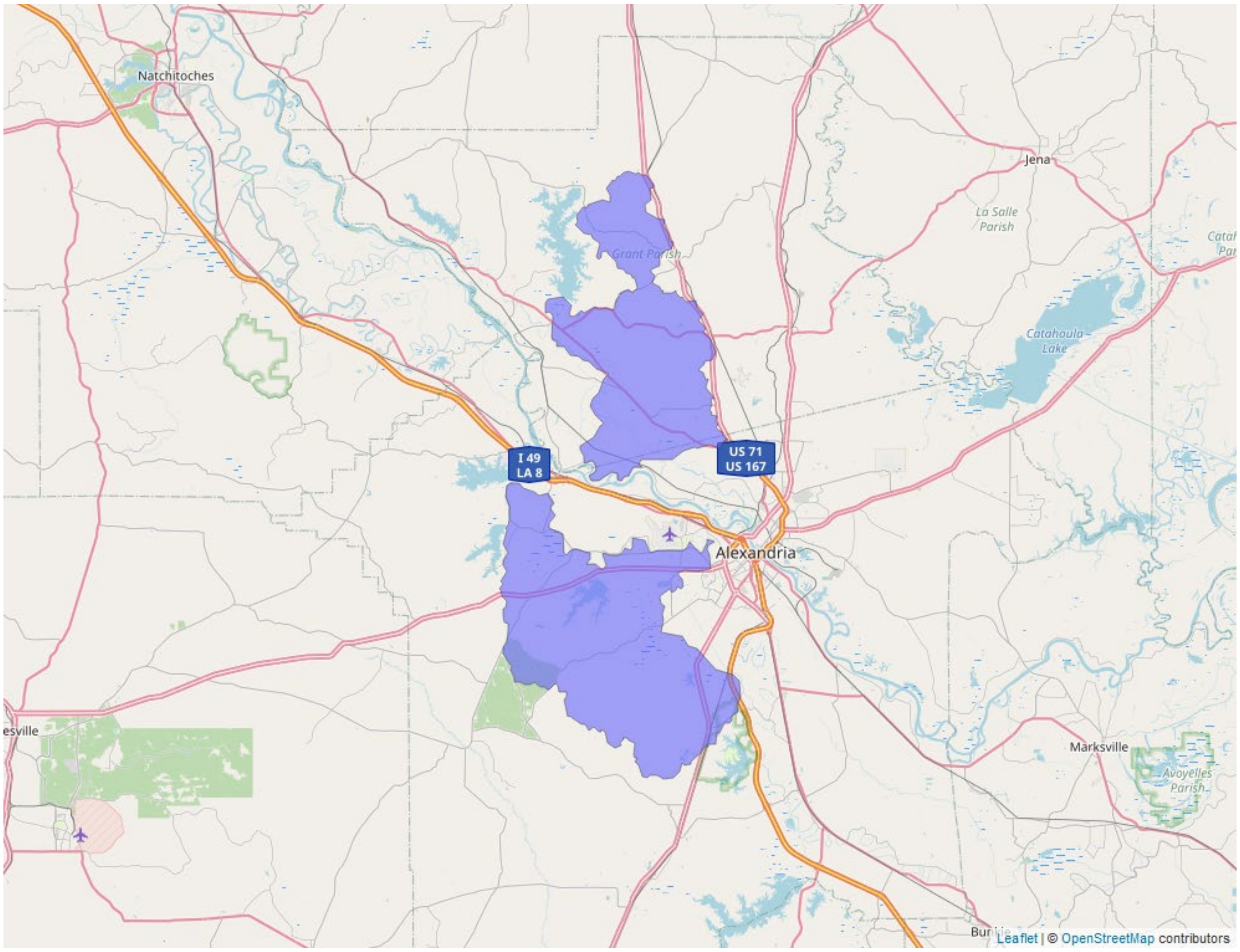

Figure 17. Range map of Louisiana pearlshell (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/8468.

Vulnerability

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

Summary of status

Listing status: Threatened

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

Most recently completed 5-Year Review: 9/26/2022

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

Louisiana pearlshell is a freshwater mussel endemic to Louisiana. It is a habitat specialist and is only found in shallow, oligotrophic streams with high water quality, moderate flow, a gravel substrate component, and an intact riparian zone.

The 2019 Species Status Assessment delineated nine extant populations and four extirpated populations distributed across four management watersheds, which are Bayou Rapides and Bayou Boeuf management watersheds south of the Red River in Rapides Parish, Louisiana, and Black Creek and Bayou Rigolette management watersheds north of the Red River in Grant Parish, Louisiana (USFWS 2019a). Each individual management watershed is delineated within different HUC10 watersheds by aggregating only those HUC12 subwatersheds having Louisiana pearlshell in a way that reflects higher connectivity and potential for genetic exchange within delineated management watersheds and lower or no connectivity between them (Quantitative Ecological Services, Inc. 2014). Extant populations include Bayou Clear, Black Creek, Brown Creek, Castor Creek, Coleman Branch, Gray Creek, Long Branch, Loving Creek, and Valentine Creek. Of the extant populations, there are currently five populations with high resilience, three with moderate resilience, and one with low resilience (SSA USFWS 2019a). Extirpated populations include James Branch, Little Bayou Clear, Mack Branch, and Moccasin Branch. Extirpated populations historically supported aggregations and now do not, although they may still support low numbers of scattered mussels.

The greatest threats to the Louisiana pearlshell include fragmented spatial distribution of populations caused by permanent impoundments that pre-date species' listing and corresponding impacts to population genetic structure; altered hydrology and disrupted spatial distribution from beaver dams and other in-stream obstructions leading to small impoundments, stranding, drowning, or crushing of mussels; declines in water quality from sediment loading, turbidity, decreased flow, lower levels of dissolved oxygen, and changes in stream geomorphology caused by improperly installed stream crossings, construction, forestry, and land use practices when there is failure to implement and maintain applicable Best Management Practices (BMPs); and all-terrain vehicle use and other recreational activity that impacts Louisiana pearlshell habitat (Factor A; USFWS 2019a). We expect these threats to continue into the future.

Populations of the Louisiana pearlshell mussel continue to be fragmented and isolated by impoundments. Results from a recent genetic study (Roe 2009) indicate genetic structuring and increased genetic distance between mussels on either side of the Red River, indicating that the Red River is an effective barrier to migration. That study also indicates that future impacts to genetic composition of fragmented and isolated populations are likely, with those populations upstream of Lake Iatt beginning to show signs of genetic isolation.

Published survey data from the Kisatchie Nation Forest and private lands show that beaver activity in 77% of all Louisiana pearlshell mussel streams continue to cause direct effects to individuals and populations of Louisiana pearlshell mussels through inundation or stranding. Although the level of threat has been somewhat reduced via beaver control on the Kisatchie Nation Forest and private land, this threat is still significant across the range based on the distribution and number of large beds, i.e., a beaver dam could have a large impact on the total population were it to cause local extirpation of numerous beds or extremely large ones.

Other threats to Louisiana pearlshell mussels result from soil disturbance and sedimentation that occurs from detrimental forestry practices, all-terrain vehicle use, and construction with inadequate erosion control. Without proper installation and maintenance of temporary and long-term erosion control measures; soil disturbance, accelerated erosion, and run-off from project sites have the potential to affect Louisiana pearlshell mussels downstream, whether on private or public land.

Since the Louisiana pearlshell mussel was reclassified, restrictions on forestry activities in the Kisatchie Nation Forest within stream-side management zones (USFS 1999) have been developed to protect Louisiana pearlshell mussel beds and stream water quality. Timber harvest within those zones is restricted to selective cutting for the purpose of wildlife habitat improvement. In addition to those restrictions on timber harvest, all-terrain vehicular use is restricted to designated trails only and cross-country travel is prohibited (USFS 2007a). On private land, there are voluntary BMPs associated with forestry operations but no requirements preventing the use of all-terrain vehicles in or near Louisiana pearlshell mussel habitat. Widespread adherence to the forestry BMPs will reduce the threat to the species associated with forestry practices on private land; however, to date, not all landowners are enacting the BMPs. The Louisiana Forestry Association holds private landowner workshops on forestry BMPs.

The Louisiana Department of Wildlife and Fisheries is helping interested private landowners protect Louisiana pearlshell mussel streams on their properties from detrimental uses through education and through programs like the Natural Areas Registry program. Threats to the species have been reduced on both the Kisatchie Nation Forest and private lands via beaver control and habitat restoration activities; however, those threats identified at the time of reclassification continue to affect the species. Also, there is the potential of new threats on the horizon that warrant further investigation, i.e., feral hog activity, possible increasing predation by otters, possible raw sewage discharge into streams, stream invasion by the Asiatic clam, and possibility of extended, range-wide drought conditions.

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 8% of the species range will contain methomyl use sites (Table 36).

Usage

Past usage data indicate that up to 0.7% of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (0.2%) and other orchards (0.3%) (Table 36).

Table 36. Overlap and usage data for the Louisiana pearlshell.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn	1.4	0.1
Cotton	0.8	<0.1
Other Grains	1.9	0.1
Other Orchards	0.3	0.3
Other Row Crops	<0.1	<0.1
Soybeans[18]	4.9	0.2
Vegetables and Ground Fruit	<0.1	0.1
Wheat	NA	NA
Total	**8**	**0.7**

Exposure Summary

A medium portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (8%). Based on past usage data, we expect a smaller

[18] 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.

portion of the range is likely to be treated with methomyl (0.7% annually), suggesting a medium portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 37 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the Louisiana pearlshell occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 29 to 321 μg/L, depending on the type of habitat and region (Table 37). Based on this range of potential exposures, we expect between 0-0.61% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. The Louisiana pearlshell is a host fish generalist and can likely use a variety of fish species as hosts such as the striped shiner (*Notropis chrysocephalus*), redfin shiner (*Lythrurus umbratilis*), golden shiner (*Notemigonus crysoleucas*), brown madtom (*Notorus phaeus*), and black spotted topminnow (*Fundulus olivaceus*). Because the fish host species are varied and found in multiple aquatic habitats, and we expect low fish mortality, we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 37. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_11a	48.83	0
High flow waterbodies	HUC_8	45.74	0
Large volume waterbodies	HUC_11a	29.03	0
Large volume waterbodies	HUC_8	31.29	0
Low flow/Low volume waterbodies	HUC_11a	321.30	0.61
Low flow/Low volume waterbodies	HUC_8	225.90	0.07

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the Louisiana pearlshell could be exposed to methomyl in 8% of the species range based on methomyl use sites and up to 0.7% of the range may be treated with methomyl (Table 37) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the Louisiana pearlshell. We anticipate some 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 Louisiana pearlshell has a variety of fish hosts that their glochidia can successfully parasitize and we expect mortality of exposed fish will be low (0-0.61%). In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. Therefore, we anticipate low impacts to the reproductive cycle of the mussel. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual mussels will experience adverse effects.

Conclusion

The Louisiana pearlshell is a threatened freshwater mussel endemic to narrow streams in dense riparian forests with closed canopies and low gradients in a limited area of Grant and Rapides Parishes in Louisiana. Occupied habitat in Grant Parish is mostly privately owned, while most Louisiana pearlshells in Rapides Parish occur on public land. Influences on the viability of the species that result in the destruction or modification of Louisiana pearlshell habitat include impoundments, beaver activity, water quality degradation, forestry practices, gravel pits, cattle grazing, gravel and mineral mining, and construction activities.

The species range occurs near methomyl use sites overlapping 8% of the range, but a small portion of the range has experienced methomyl usage in the past (0.7% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The Louisiana pearlshell is a host fish generalist and can successfully reproduce in the presence of several common species of host fish, including the striped shiner, redfin shiner, golden shiner, brown madtom, and black spotted topminnow. The Louisiana pearlshell occurs in low flow/low volume waterbodies and the host fish occur in across types of aquatic habitats All aquatic habitats occur in two HUCs (8 and 11a), each of which has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), host fish mortality estimates range from 0-0.61%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, its host fish are abundant and common, they use various components of aquatic habitats throughout their life cycles, and we anticipate low host fish mortality (0-0.61%). Therefore, we expect impacts to the mussel to be low and a small number of individuals will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 Louisiana pearlshell in the wild.

References

U.S. Fish and Wildlife Service. 2022. Louisiana Pearlshell Mussel (*Margaritifera hembeli*) Status Review: Summary and Evaluation. Lafayette, Louisiana. 15 pp.

U.S. Fish and Wildlife Service. 2017. Louisiana Pearlshell Mussel (*Margaritifera hembeli*) 5-Year Review: Summary and Evaluation. Lafayette, Louisiana. 55 pp.

Integration and Synthesis Summary: - Purple bankclimber (mussel)

Scientific Name:	Common Name:	Entity ID:
Elliptoideus sloatianus	Purple bankclimber (mussel)	366

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 high past usage of methomyl within the species' range, indicating a high extent of exposure within the action area across the species' range (Figure 18). Exposed individuals are unlikely to die but are likely to experience medium levels of 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 exposure is high, the level of indirect effects is low 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 purple bankclimber (mussel). We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 2/4/2022; Wherever found; *States within the range:* AL, FL, GA. Figure 18 depicts the species' range.

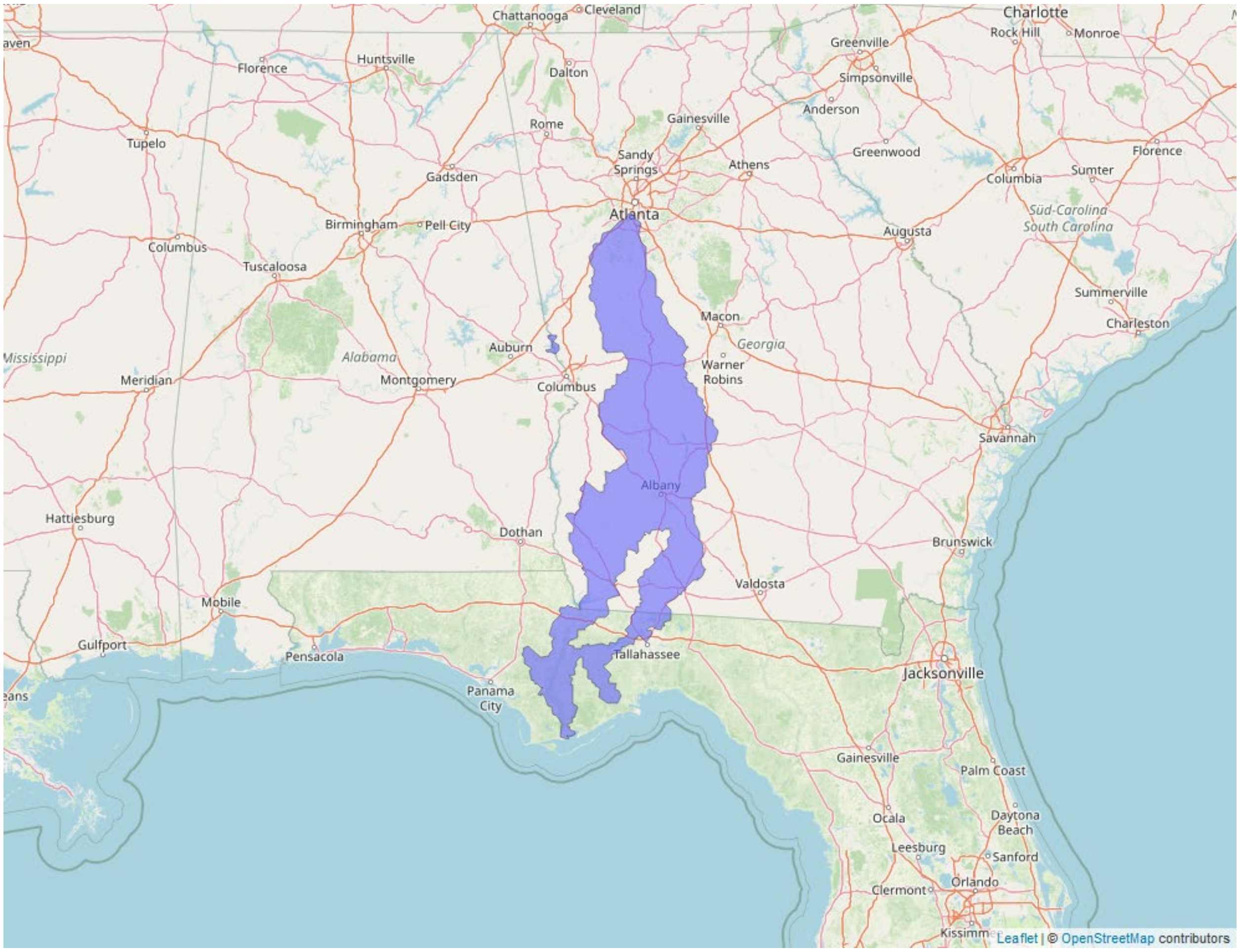

Figure 18. Range map of purple bankclimber (mussel) (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/7660.

Vulnerability

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

Summary of status

Listing status: Threatened

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

Most recently completed 5-Year Review: 5/1/2020

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: yes

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The purple bankclimber historically occurred in ten sub-basins (USFWS 2003) and currently occupies the Upper Flint, Middle Flint, Lower Flint, Ichawaynochaway, Apalachicola, Chipola, Upper Ochlockonee, and Lower Ochlockonee sub-basins. Within the historical range, it is extirpated from localized areas, and is likely completely extirpated from the Chattahoochee River. Within the Flint and Ochlockonee river drainages, the species is relatively common, but occurs at fewer sites than historically due in part to two main stem dams. Five populations appear stable with varying numbers of juveniles and/or sub-adults: Apalachicola, Chipola, Middle Flint, Lower Flint, and Lower Ochlockonee. However, evidence of natural recruitment is limited, and the species is presumably relying on secondary host fish within most of its range. Despite an estimated large subpopulation in the upper reaches of the Apalachicola River, the species occurs sporadically, in low numbers in the rest of the river and in the Upper Flint and Chipola sub-basins. The species is also experiencing an apparent decline in abundance in the Upper Ochlockonee sub-basin (USFWS 2020).

The decline in range and abundance of the purple bankclimber was due to activities that decreased water quality, changed natural flow regimes, increased isolation, and directly altered riverine habitat. These effects were the result of dams, dredging, mining, channelization, pollution, sedimentation, and water withdrawals. Overall, the species and its habitat continue to be impacted by excessive sediment, channel instability, reduced water quality, developmental activities, water withdrawal, drought, impoundments, and invasive species. The degree of threat to the persistence of this threatened species remains moderate, and the potential for recovery remains low (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 33.8% of the species range will contain methomyl use sites (Table 38).

Usage

Past usage data indicate that up to 10.3% of the species' range has been treated with methomyl annually. Use layers with the highest usage include other row crops (4.5%) and other orchards (4.3%) (Table 38).

Table 38. Overlap and usage data for the purple bankclimber (mussel).

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn[19]	5.5	0.3
Cotton	11.9	0.6
Other Grains	1.7	0.1
Other Orchards	4.3	4.3
Other Row Crops	9.9	4.5
Soybeans	2.7	0.1
Vegetables and Ground Fruit	0.5	0.5
Wheat	NA	NA
Total	**33.8**	**10.3**

Exposure Summary

A high portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (33.8%). Based on past usage data, we also expect a high portion of the range is likely to be treated with methomyl (10.3% annually), suggesting a high portion of the range will likely experience exposure. Therefore, we expect a high number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: High

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply

[19]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.

when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 39 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the purple bankclimber (mussel) occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 15 to 245 µg/L, depending on the type of habitat and region (Table 39). Based on this range of potential exposures, we expect between 0-0.12% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. The purple bankclimber (mussel) is a host fish generalist and can likely use a variety of fish species as hosts such as blackbanded darter (*Percina nigrofasciata*), halloween darter (*Percina crypta*), holiday darter (*Etheostoma brevirostrum*), lake sturgeon (*Acipenser fluvescens*), shortnose sturgeon (*Acipenser brevirostrum*), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), and Gulf sturgeon (*Acipenser oxyrinchus desotoi*). Because the fish host species are varied, and estimated mortality within the aquatic habitats where the purple bankclimber (mussel) is found is low (0-0.12%), we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 39. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_3	28.93	0
Large volume waterbodies	HUC_3	14.60	0
Low flow/Low volume waterbodies	HUC_3	244.80	0.12

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the purple bankclimber (mussel) could be exposed to methomyl in 33.8% of the species range based on methomyl use sites and up to 10.3% of the range may be treated with methomyl (Table 38) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the purple bankclimber (mussel). We anticipate some 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. Because the fish host species are varied, and the mortality estimated within the aquatic habitats where the purple bankclimber (mussel) is found is low (0-0.12%), we anticipate low adverse effects to the reproductive cycle of the mussel. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual purple bankclimber (mussel) will experience adverse effects.

Conclusion

The purple bankclimber (mussel) is listed as threatened and its range includes eight sub-basins across Alabama, Florida, and Georgia. Some populations seem stable, several others are declining, and it is likely completely extirpated from the Chattahoochee River. Threats include decreased water quality, changed natural flow regimes, increased isolation, and altered habitat.

The species range occurs near methomyl use sites overlapping 33.8% of the range and a high portion of the range has experienced methomyl usage in the past (10.3% annually). Therefore, we consider the species to have a high exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The purple bankclimber (mussel) is a host fish generalist and can likely use a variety of fish species as hosts such as blackbanded darter, halloween darter, holiday darter, lake sturgeon, shortnose sturgeon, Atlantic sturgeon, and Gulf sturgeon for reproduction. The purple bankclimber (mussel) and its host fish occur in high flow waterbodies of HUC 3, and its host fish also occur in low flow/low volume waterbodies and large volume waterbodies in HUC 3. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), host fish mortality estimates range from 0-0.12%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and high exposure, the mussel uses several species of host fish, we anticipate low host fish mortality (0-0.12%), and we expect a small number of individual mussels will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 purple bankclimber (mussel) in the wild.

References

U.S. Fish and Wildlife Service. 2020. Purple Bankclimber (*Elliptoideus sloatianus*) 5-Year Review: Summary and Evaluation. Panama City, Florida. 26pp.

Integration and Synthesis Summary: - Fanshell

Scientific Name:	Common Name:	Entity ID:
Cyprogenia stegaria	Fanshell	368

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 19). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 fanshell. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 9/9/2020; Wherever found; *States within the range:* AL, IL, IN, KY, OH, TN, VA, WV. Figure 19 depicts the species' range.

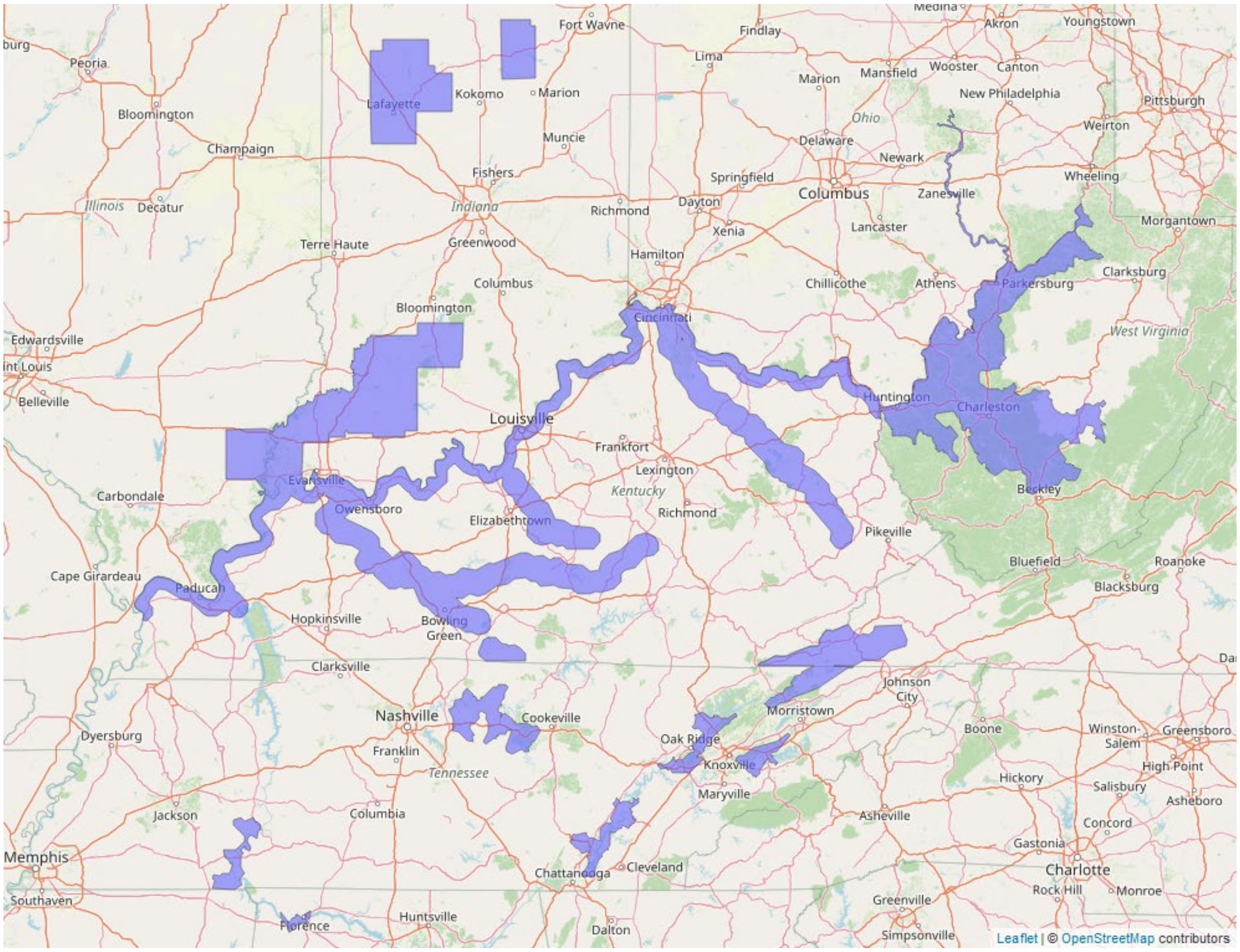

Figure 19. Range map of fanshell (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/4822.

Vulnerability

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

Summary of status

Listing status: Endangered

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

Most recently completed 5-Year Review: 7/8/2019

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 fanshell mussel occurs in the Ohio River basin and is sparsely distributed within most of its highly restricted range. Extant populations of the fanshell mussel exist in portions of the Muskingum, Kanawha, Ohio, Wabash, East Fork White, Tippecanoe, Tennessee, Green, Licking, and Rolling Fork Rivers in Indiana, Kentucky, Ohio, Tennessee, Virginia, and West Virginia.

In the Tennessee River System, the Clinch River fanshell population occupies river mile 159 at Grissom Island, Tennessee, upstream to river mile 213 at Clinchport, Virginia. This population has continued to recruit and maintain density over the last 30 years. The fanshell is considered extremely rare in the Tennessee River mainstem and it likely occurs in densities too low to detect using typical survey efforts. In the Cumberland River System, persistent cold-water discharges from Wolf Creek, Dale Hollow, and Center Hill Dams for over 50 years have nearly eliminated the entire mussel fauna of the Cumberland River, including most common and commercially valuable mussels. In 2007, an experimental population of fanshell was established in portions of the French Broad and Holston Rivers in Tennessee with unknown success (EXPN Entity ID 9494).

In the Ohio River System, there are records since 2000 of live fanshell mussels from the mainstem Ohio River where it borders West Virginia and Ohio, specifically the Belleville and Racine pools. Fanshells are rarely observed in these pools, but a small population persists based on these detections. Restoration efforts have been ongoing within the Belleville pool since 2007. In 2010, 200 fanshells from the Licking River in Kentucky were used to augment the population at Muskingum Island. In 2016, 99 fanshells from the Licking River in Kentucky were established within the Greenup Pool of the Ohio River at river mile 284. The species may occur elsewhere in the Ohio River; however, more extensive and thorough mussel surveys are needed to determine the species' status in the Ohio River mainstem.

The fanshell is extant in the upper two-thirds of the Marmet Pool of the Kanawha River in West Virginia. The low-density population at Kanawha Falls was augmented in 2010 with 203 individuals from the Licking River in Kentucky. Additionally, naturally recruited individuals continue to be observed within the Kanawha River. The Licking River harbors the healthiest population of fanshell mussels in Kentucky based on densities and year classes. The fanshell's range within the Licking River extends from Kenton and Campbell Counties about 75 river miles to near the mouth of the river in northern Kentucky, upstream to the Clay Wildlife Management Area in Nicholas County, Kentucky. There are multiple sites within the Licking River where recruitment is occurring. The Rolling Fork River supports at least one reproducing population of fanshell mussels, but its range in the Rolling Fork River appears to be restricted to Nelson County, Kentucky, where individuals can be found in a few locations over approximately 9 miles. The Green River in Kentucky supports a healthy, reproducing population of fanshells based on densities and year classes present. The fanshell's range within the Green River extends approximately 60 miles from near the mouth of the Barren River upstream to Green River Lake. Obvious recruitment has been observed at several sites. Fanshell populations appear to be doing best in free-flowing portions of the Green River. Observations of fanshells from the Barren River (tributary from Green River) are restricted to an area downstream of Lock and Dam No. 1 near Greencastle and below Bowling Green, Kentucky. This species may still be extant in the Barren River; however, only relic individuals have been recorded, most recently in 2008.

In the Wabash River System, the fanshell occurs in the East Fork White River from Williams Dam, Lawrence County, downstream to the confluence of the West Fork and East Fork White Rivers, Pike/Daviess/Knox Counties. The highest concentrations of the species occur from Williams Dam downstream to Hindustan Falls, Martin County. Although this population is extant, fanshells are not abundant. The Tippecanoe River population is similar to those found in the East Fork White River. They are regularly observed but never in large numbers. Evidence suggests that they are still reproducing to some extent, with one five-year old individual observed in 2008. The fanshell is rare in the mainstem Wabash River and likely not reproducing, based on only old individuals observed.

In the Muskingum River System, the fanshell is extant in the lower reaches of the Muskingum River in Morgan and Washington Counties, Ohio with occasional observations of juveniles and adults suggesting recruitment. Only relic and subfossil individuals have been observed in the Walhonding River and Killbuck Creek. In 2010, about 200 adult fanshell were stocked in the lower Muskingum River just below Devola Dam a couple of miles upstream of the Ohio River.

In the Allegheny River System, the fanshell mussel is currently considered extirpated in the Allegheny River and other portions of Pennsylvania; however, there is a need for additional survey work in Pennsylvania to examine areas either not surveyed or inadequately surveyed, since other species presumed extirpated have been recently documented (Anderson 2017).

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

Ongoing threats to the fanshell include water quality degradation from point and non-point sources, particularly in tributaries that have limited capability to dilute and assimilate sewage, agricultural runoff, and other pollutants. In addition, the species is affected by hydrologic and water quality alterations resulting from the operation of impoundments. The presence of impoundments may have ameliorated the effects of downstream siltation on fanshells, but these structures also control river discharges and the many environmental parameters influenced by discharge, which may profoundly affect the ability of these populations to occupy or successfully reproduce in downstream habitats. A variety of instream activities (e.g., sand and gravel dredging, road construction, etc.) continue to threaten fanshell populations. Protecting these populations from the direct physical disturbance of such activities depends on accurately identifying the location of the populations. Altering the streambed configuration may cause changes in previously suitable habitat. Coal, oil, and natural gas resources are present in some of the watersheds known to support fanshell mussels. Exploration and extraction of these resources can result in increased siltation, an altered hydrograph, and degraded water quality. Land-based development including residential and agricultural activities near streams often results in loss of riparian habitat, increased stormwater runoff due to increased impervious surfaces, increased sedimentation due to loss of streamside vegetation, and subsequent degradation of streambanks. The species has a number of predators including muskrats, raccoons, otters, molluscivorous fish, and some invertebrates. Zebra mussel populations in the Ohio River could possibly be negatively impacting fanshell mussel populations. In USFWS 1991, we note "The distribution and reproductive capacity of this species has been seriously impacted by the construction of impoundments and navigation facilities, dredging for channel maintenance, sand and gravel mining, and water pollution."

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 17.5% of the species range will contain methomyl use sites (Table 40).

Usage

Past usage data indicate that up to 1.4% of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (0.8%), vegetables and ground fruit (0.4%), and other row crops (0.1%) (Table 40).

Table 40. Overlap and usage data for the fanshell.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	0.4	0.1
Citrus	NA	NA
Corn	15.5	0.8
Cotton	0.1	<0.1
Other Grains	0.2	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	0.2	0.1
Soybeans[20]	16.2	0.8
Vegetables and Ground Fruit	0.4	0.4
Wheat	NA	NA
Total	**17.5**	**1.4**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (17.5%). Based on past usage data, we expect a smaller portion of the range is likely to be treated with methomyl (1.4% annually), suggesting a medium portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in **Table 17** the maximum predicted

[20] 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.

EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the fanshell occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 229 µg/L, depending on the type of habitat and region (Table 41). Based on this range of potential exposures, we expect between 0-0.08% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. The fanshell is a host fish generalist and can likely use a variety of fish species as hosts such as the mottled sculpin (*Cottus bairdi),* banded sculpin (*Cottus carolinae),* greenside darter *(Etheostoma blennioides),* snubnose darter *(Etheostoma simoterum),* banded darter *(Etheostoma zonale),* tangerine darter *(Percina aurantiaca),* blotchside logperch *(Percina burtoni),* logperch *(Percina caprodes),* Roanoke darter *(Percina roanoka)* and blackside darter *(Percina maculate).* Fish host species are varied and found in multiple aquatic habitats, and mortality estimated within the aquatic habitats where the fanshell is found is low (0-0.08%). Therefore, we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 41. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).Table 41

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Large volume waterbodies	HUC_7	12.21	0
Large volume waterbodies	HUC_8	31.29	0
Low flow/Low volume waterbodies	HUC_5	229.50	0.08
Low flow/Low volume waterbodies	HUC_6	164.70	0.01
Low flow/Low volume waterbodies	HUC_7	209.70	0.04
Low flow/Low volume waterbodies	HUC_8	225.90	0.07

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the fanshell could be exposed to methomyl in 17.5% of the species range based on methomyl use sites and up to 1.4% of the range may be treated with methomyl (Table 41) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the fanshell. We anticipate some 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. Mortality estimated within the aquatic habitats where the fanshell is found is low (0-0.08%), and the fish host species are varied and found in multiple aquatic habitats. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. Therefore, we anticipate low adverse effects to the reproductive cycle of the mussel. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual fanshell mussels will experience adverse effects.

Conclusion

The fanshell mussel is listed as endangered and the most robust populations of fanshell mussel occur in the Licking, Green, and Rolling Fork rivers in Kentucky, and in the Clinch River in Tennessee and Virginia. These populations are considered healthy with evidence of recruitment over several years or even decades, with multiple year classes present. The Rolling Fork River population adds one more known reproducing population since the recovery plan was written, but it is a relatively small population compared to the Licking River, Green River, and Clinch River populations. Other locations (Muskingum, Kanawha, Wabash, East Fork White, Tippecanoe, Tennessee, and Ohio Rivers) appear to have small and restricted, extant populations with limited evidence of recruitment. Ongoing threats to the fanshell mussel include water quality degradation from point and non-point sources, particularly in tributaries that have limited capability to dilute and assimilate sewage, agricultural runoff, and other pollutants. In addition, the species is affected by hydrologic and water quality alterations resulting from the operation of impoundments.

The species range occurs near methomyl use sites overlapping 17.5% of the range, but a small portion of the range has experienced methomyl usage in the past (1.4% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The fanshell mussel is a host fish generalist and can likely use a variety of fish species as hosts such as the mottled sculpin, banded sculpin, greenside darter, snubnose darter, banded darter, tangerine darter, blotchside logperch, logperch, Roanoke darter, and blackside darter. The fanshell mussell occurs in high flow waterbodies, and the host fish occur across numerous aquatic habitats. All aquatic habitats occur in four HUCs (5, 6, 7, and 8), each of which has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), host fish mortality estimates range from 0-0.08%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, its host fish are abundant and common, they occur in multiple aquatic habitats, and we anticipate low host fish mortality (0-0.08%). Therefore, we expect impacts to the mussel to be low and a small number of individuals will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 fanshell mussel in the wild.

References

U.S. Fish and Wildlife Service. 2019. Fanshell (*Cyprogenia stegaria*) 5-Year Review: Summary and Evaluation. Frankfort, Kentucky. 22 pp.

Integration and Synthesis Summary: - Oval pigtoe

Scientific Name:	Common Name:	Entity ID:
Pleurobema pyriforme	Oval pigtoe	371

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 high past usage of methomyl within the species' range, indicating a high extent of exposure within the action area across the species' range (Figure 20). Exposed individuals are unlikely to die but are likely to experience medium levels of 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 exposure is high, the level of indirect effects is low 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 oval pigtoe. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 2/9/2022; Wherever found; *States within the range:* AL, FL, GA. Figure 20 depicts the species's range.

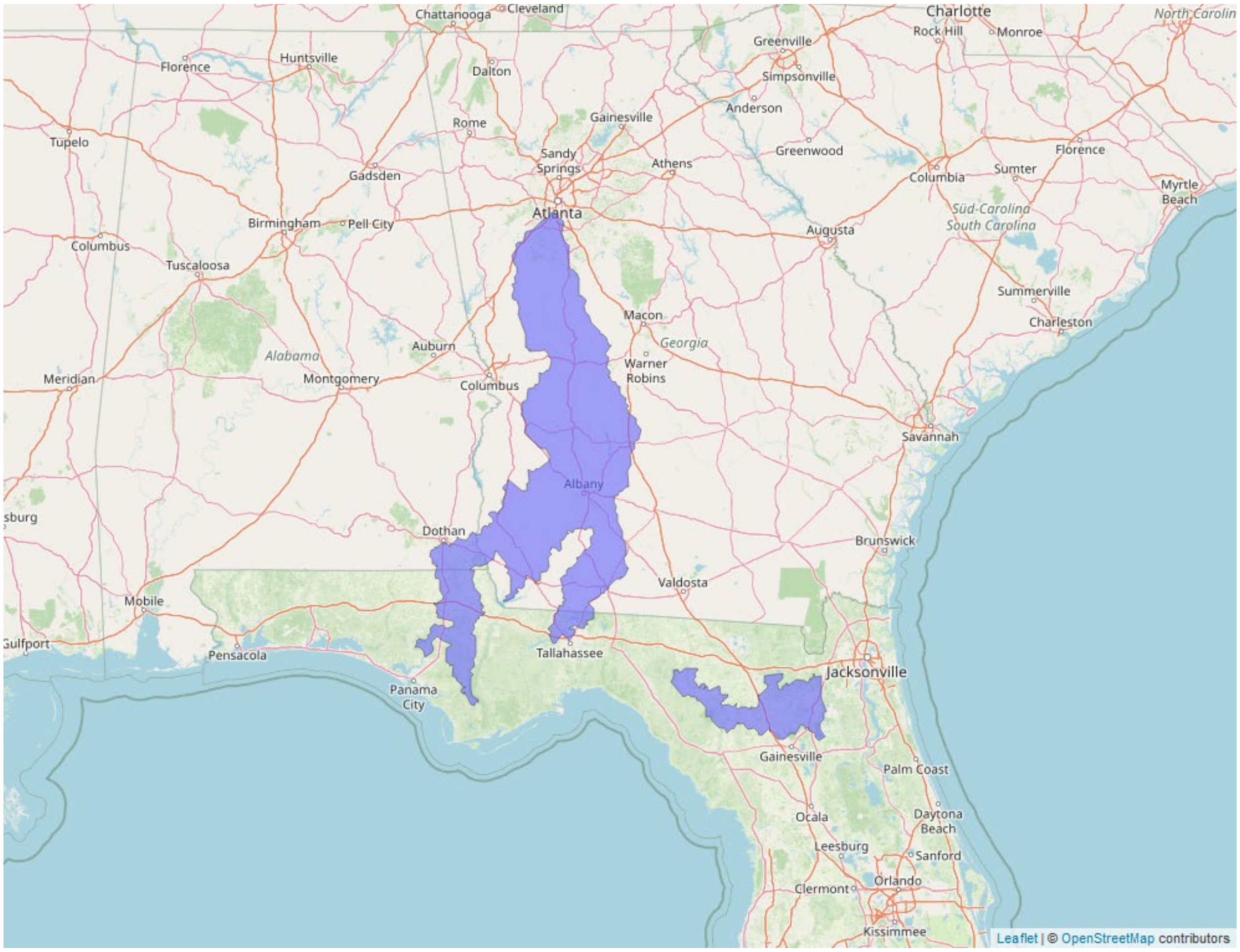

Figure 20. Range map of oval pigtoe (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/4132.

Vulnerability

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

Summary of status

Listing status: Endangered

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

Most recently completed 5-Year Review: 5/1/2020

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: yes

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

The oval pigtoe historically occurred in 14 sub-basins and currently occupies ten sub-basins in Georgia, Alabama, and Florida: Upper Flint, Middle Flint, Kinchafoonee-Muckalee, Ichawaynochaway, Spring Creek, Lower Chattahoochee, Chipola, Santa Fe, Lower Suwannee, and Econfina Creek. Most sub-basins consist of localized, fragmented sites with generally small numbers of individuals. Between 2007-2020, survey data illustrates mussel distribution varied by sub-basin with potential localized extirpations (e.g., Upper Ochlockonee), potential stability and recruitment (e.g., Chipola, Econfina Creek, Lower Chattahoochee, Middle Flint, and Spring Creek), and possible expansion (e.g., Lower Suwanee). The Lower Chattahoochee, Middle Flint, and Spring Creek populations are isolated and limited in distribution to short stream reaches, and thus are susceptible to human or naturally caused catastrophic events and environmental variability. Five sub-basins (e.g., Upper Flint, Kinchafoonee-Muckalee, Ichawaynochaway, Santa Fe, and Lower Suwannee) have minimal numbers of individuals and have no evidence of recruitment. Loss of any of these populations may reduce species redundancy and representation. Overall, the species continued to decline in distribution within its historical range (USFWS 2020).

The decline in range and abundance of the oval pigtoe was due to activities that decreased water quality, changed natural flow regimes, increased isolation, and directly altered riverine habitat. These effects were the result of dams, dredging, mining, channelization, pollution, sedimentation, and water withdrawals. Overall, the species and its habitat continue to be impacted by excessive sediment, channel instability, reduced water quality, developmental activities, water withdrawal, drought, impoundments, and invasive species. Runoff from adjacent lands can introduce harmful contaminants into streams (e.g., sediment, pesticides, spills, point-source discharges), especially those without riparian buffers. The degree of threat to the persistence of this endangered species remains high, and the potential for recovery remains low (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 34.1% of the species range will contain methomyl use sites (Table 42).

Usage

Past usage data indicate that up to 10.3% of the species' range has been treated with methomyl annually. Use layers with the highest usage include other row crops (4.8%) and other orchards (3.7%) (Table 42).

Table 42. Overlap and usage data for the oval pigtoe.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn[21]	5.3	0.3
Cotton	11.6	0.6
Other Grains	2.1	0.1
Other Orchards	3.7	3.7
Other Row Crops	10.6	4.8
Soybeans	2.5	0.1
Vegetables and Ground Fruit	0.8	0.8
Wheat	NA	NA
Total	**34.1**	**10.3**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (34.1%). Based on past usage data, we expect a large portion of the range is likely to be treated with methomyl (10.3% annually), suggesting a large portion of the range will likely experience exposure. Therefore, we expect a large number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: High

[21] 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.

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 43 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the oval pigtoe occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 15 to 245 µg/L, depending on the type of habitat and region (Table 43). Based on this range of potential exposures, we expect between 0-0.12% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. The oval pigtoe is a host fish generalist and can likely use a variety of fish species as hosts such as the sailfin shiner (*Pteronotropis hypselopterus*), eastern mosquitofish (*Gambusia holbrooki*), and guppy (*Poecilia reticulata*). The fish host species are varied, and the mortality estimated within the aquatic habitats where the oval pigtoe is found is low (0-0.12%). As such, we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 43. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_3	28.93	0
Large volume waterbodies	HUC_3	14.60	0
Low flow/Low volume waterbodies	HUC_3	244.80	0.12

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the oval pigtoe could be exposed to methomyl in 34.1% of the species range based on methomyl use sites and up to 10.3% of the range may be treated with methomyl (Table 43) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the oval pigtoe. We anticipate some 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 fish host species are varied, and the mortality estimated within the aquatic habitats where the oval pigtoe is found is low (0-0.12%). In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. As such, we anticipate low adverse effects to the reproductive cycle of the mussel. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of oval pigtoe mussels will experience adverse effects.

Conclusion

The oval pigtoe is listed as endangered and its range includes ten sub-basins across Alabama, Florida, and Georgia. One population is believed to be extirpated, one may have recently expanded its distribution, five may be stable with successful recruitment, and three are heavily fragmented, not recruiting, and believed to be declining. All populations are threatened by environmental variability, sedimentation, runoff contaminants including pesticides, channelization and dredging, and increased isolation.

The species range occurs near methomyl use sites overlapping 34.1% of the range and a high portion of the range has experienced methomyl usage in the past (10.3% annually). Therefore, we consider the species to have a high exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The oval pigtoe is a host fish generalist and can likely use a variety of fish species as hosts such as sailfin shiner, eastern mosquitofish, and guppy for reproduction. The oval pigtoe and its host fish occur in high flow waterbodies of HUC 3 and its host fish also occur in low flow/low volume waterbodies in HUC 3. Each aquatic habitat/HUC has a different predicted maximum environmental concentration and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), host fish mortality estimates range from 0-0.12%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and high exposure, the mussel and its host fish occur in multiple river systems, the host fish are common and abundant throughout the range of the mussel, and we anticipate low host fish mortality (0-0.12%) and a small number of oval pigtoe mussels will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 oval pigtoe in the wild.

References

U.S. Fish and Wildlife Service. 2020. Oval Pigtoe (*Pleurobema pyriforme*) 5-Year Review: Summary and Evaluation. Panama City, Florida. 27pp.

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 determine there is high overlap of the action area with the species' range, and high past usage of methomyl within the species' range, indicating a high extent of exposure within the action area across the species' range (Figure 21). Exposed individuals are unlikely to die but are likely to experience medium levels of 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 exposure is high, the level of indirect effects is low 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 shinyrayed pocketbook. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 4/7/2022; Wherever found; *States within the range:* AL, FL, GA. Figure 21 depicts the species' range.

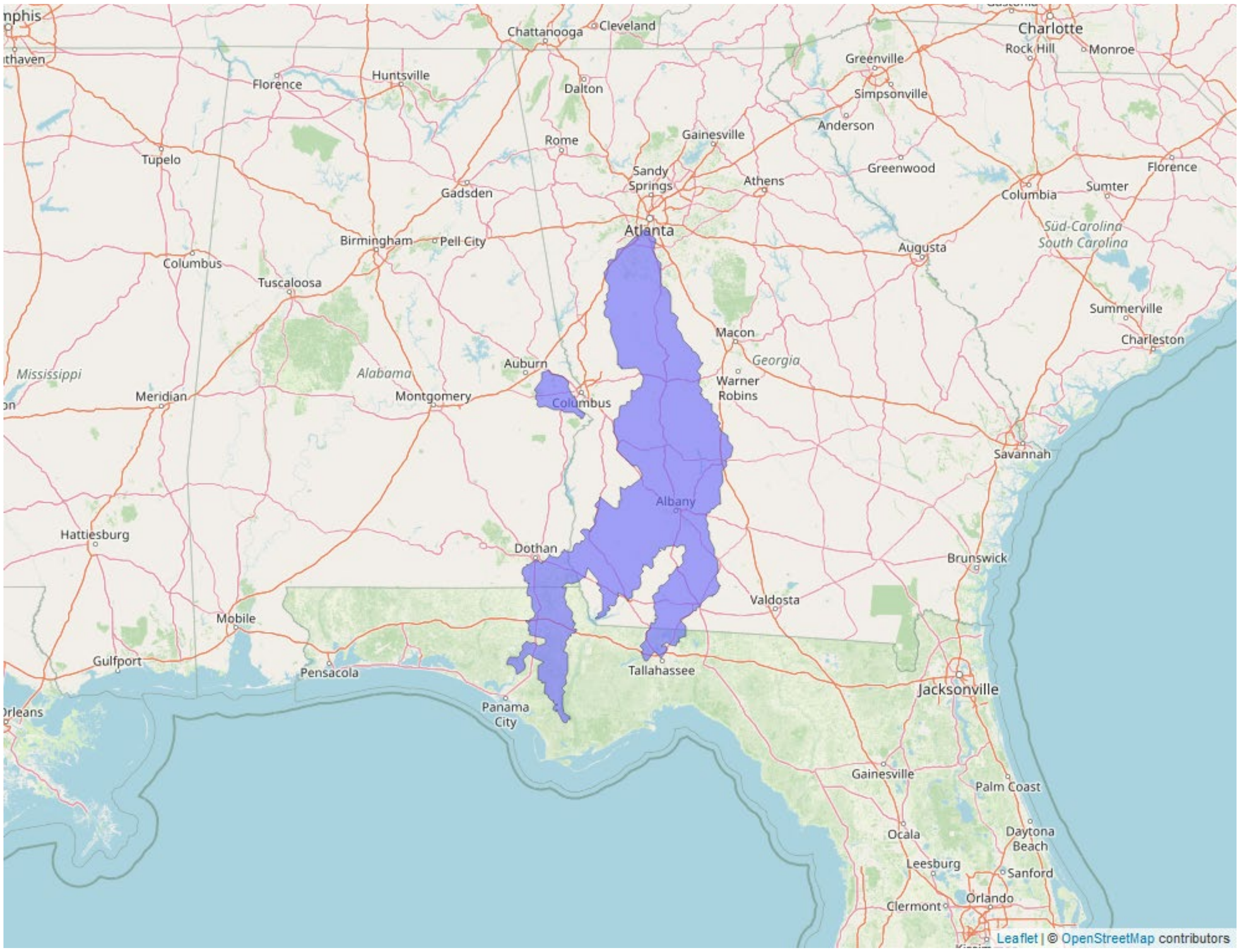

Figure 21. Range map of shinyrayed pocketbook (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/6517.

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 41.7% of the species range will contain methomyl use sites (Table 44).

Usage

Past usage data indicate that up to 12.5% of the species' range has been treated with methomyl annually. Use layers with the highest usage include other row crops (5.6%) and other orchards (5%) (Table 44).

Table 44. Overlap and usage data for the shinyrayed pocketbook.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn[22]	6.5	0.3
Cotton	14.7	0.7
Other Grains	2.2	0.1
Other Orchards	5	5
Other Row Crops	12.5	5.6
Soybeans	3.1	0.2
Vegetables and Ground Fruit	0.8	0.8
Wheat	NA	NA
Total	**41.7**	**12.5**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (41.7%). Based on past usage data, we also expect a large portion of the range is likely to be treated with methomyl (12.5% annually), suggesting a large portion of the range will likely experience exposure. Therefore, we expect a high number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: High

Conservation Measures

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

[22]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.

period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 45 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the shinyrayed pocketbook occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 15 to 245 µg/L, depending on the type of habitat and region (Table 45). Based on this range of potential exposures, we expect between 0-0.12% of exposed host fish will die, which is not likely to reduce the availability of fish hosts needed for successful reproduction. The shinyrayed pocketbook is a host fish generalist and can likely use a variety of fish species as hosts such as the spotted bass (*Micropterus punctulatus*), eastern mosquitofish (*Gambusia holbrooki*), guppy (*Poecilia reticulata*), and bluegill (*Lepomis macrochirus*). The fish host species are varied and common, and the mortality estimated within the aquatic habitats where the shinyrayed pocketbook is found is low (0-0.12%), therefore we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 45. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_3	28.93	0
Large volume waterbodies	HUC_3	14.60	0

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
Low flow/Low volume waterbodies	HUC_3	244.80	0.12

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the shinyrayed pocketbook could be exposed to methomyl in 41.7% of the species range based on methomyl use sites and up to 12.5% of the range may be treated with methomyl (Table 45) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the shinyrayed pocketbook. We anticipate some 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. For shinyrayed pocketbooks, fish host species are varied and common, and mortality estimated within the aquatic habitats where the shinyrayed pocketbook is found is low (0-0.12%). In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. We therefore we anticipate low adverse effects to the reproductive cycle of the mussel. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of shinyrayed pocketbooks will experience adverse effects.

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 species range occurs near methomyl use sites overlapping 41.7% of the range and a high portion of the range has experienced methomyl usage in the past (12.5% annually). Therefore, we consider the species to have a high exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. 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, and bluegill for reproduction. The shinyrayed pocketbook and its host fish occur in high flow waterbodies of HUC 3. Its host fish also occur in low flow/low volume waterbodies and large volume waterbodies in HUC 3. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.12%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and high exposure, host fish are varied and occur in multiple aquatic habitats, and we anticipate low host fish mortality (0-0.12%) and small number of shinrayed pocketbooks will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 shinyrayed pocketbook in the wild.

References

U.S. Fish and Wildlife Service. 2020. 5-Year Review: Shinyrayed Pocketbook (*Lampsilis subangulata*) and Gulf Moccasinshell (*Medionidus penicillatus*). Athens, Georgia. 25 pp.

Integration and Synthesis Summary: - Northern riffleshell

Scientific Name:	Common Name:	Entity ID:
Epioblasma rangiana	Northern riffleshell	374

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 22). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 northern riffleshell. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 12/30/2022; Wherever found; *States within the range:* IL, IN, KY, MI, NY, OH, PA, WV. Figure 22 depicts the species' range.

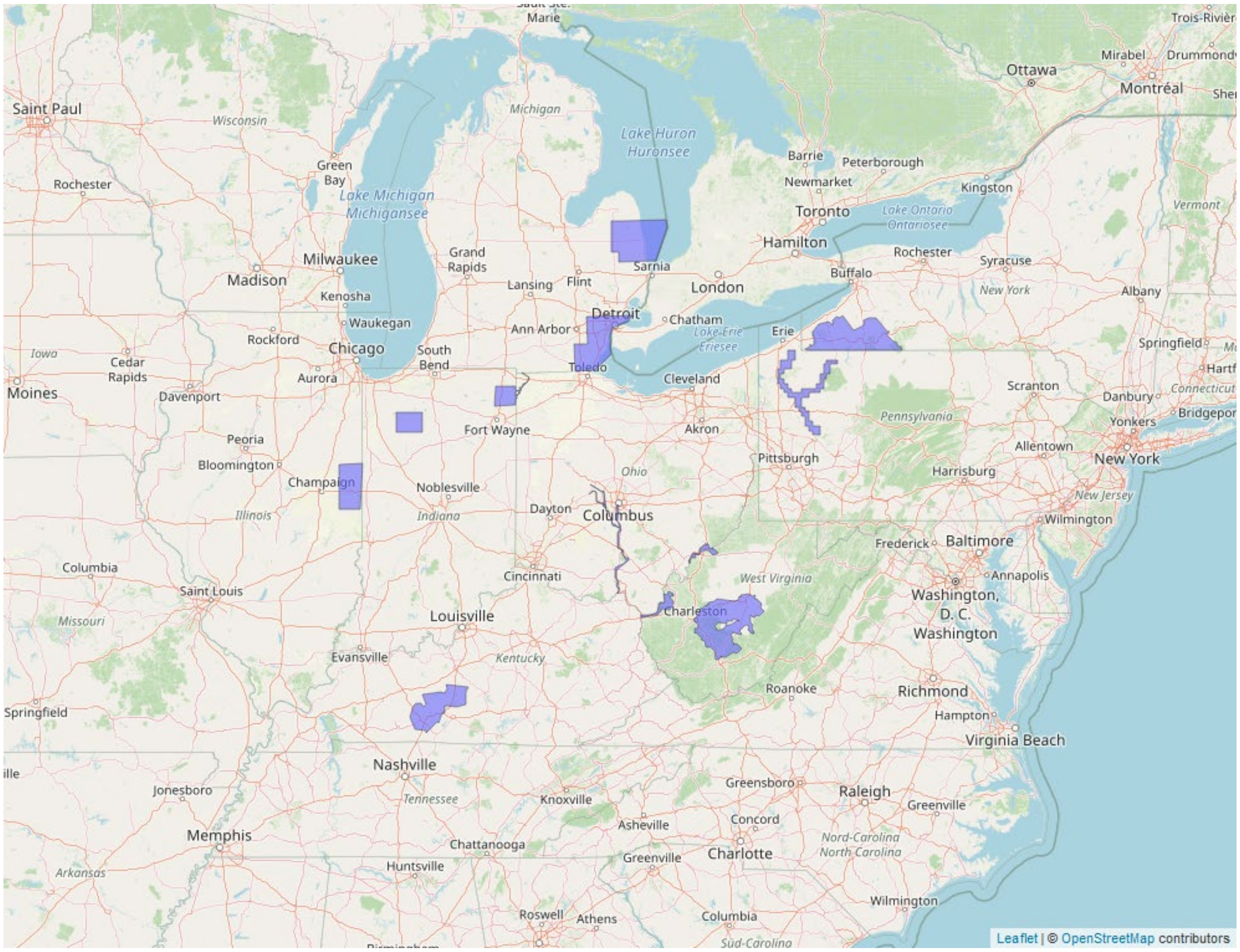

Figure 22. Range map of northern riffleshell (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/527.

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: 8/28/2019

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 best available information indicates that the northern riffleshell currently occurs in 13 populations, four of which are stable and recruiting. Of the four recruiting populations, three are apparently large and occur in the Allegheny River, French Creek, and East Branch Sydenham River. As of 2006, a fourth, smaller population occurs in the Ausable River. Each of these populations is susceptible to both natural stochastic events, such as floods and anthropogenic threats like toxic spills. Although northern riffleshells have been documented in one additional Allegheny River tributary (besides French Creek) and two French Creek tributaries, the species occurs in the lower reaches of these streams, and these occurrences may not be self-sustaining if the mainstem population is damaged. In contrast to the above populations, five northern riffleshell populations have declined since the species was listed in 1994, and some may be extirpated. Extirpated or nearly extirpated populations include: the Detroit River, following zebra mussel infestation; the Green River, possibly due to point and non-point inputs and hydrologic controls on flow and temperature from Green River Reservoir; Big Darby Creek, as a result of urban and agricultural runoff; Fish Creek, following a 1993 diesel fuel spill; and the Tippecanoe River, where no living or freshly dead northern riffleshells have been observed since the 1970s. A few individual specimens have been reported from the Elk River in West Virginia; however, no evidence of successful reproduction has been reported from this stream since 2003. The large populations of the northern riffleshell in Pennsylvania provide a potential source of animals to implement recovery actions described in the Recovery Plan. For example, in 2015-2016, 27,506 individuals were removed from bridge and pipeline project sites to augment populations in 11 rivers elsewhere in the species' range. Translocations may bolster populations in some streams such as Big Darby Creek, which has received several thousand northern riffleshells from the Allegheny River between 2010 and 2018, and the Tippecanoe River, which has received over 3,000 northern riffleshells from the Allegheny River from 2016 to 2018. However, translocation and population augmentation will work only to the extent that historical habitat is now suitable (USFWS 2019).

Although specific events are cited as causing the apparent loss of several northern riffleshell populations, these events likely worked in concert with other events that cumulatively reduced overall population levels to the extent that a single event likely resulted in extirpation. In many cases, diverse freshwater mussel populations persist where northern riffleshells have not. Like other *Epioblasma*, this species may be more sensitive to environmental perturbations than other mussel species either because life history traits make recovery from a disturbance less likely than with other mussels or because this species is more sensitive to silt and contaminants. Because the reasons for the original decline of the northern riffleshell have often not been identified, translocated animals may not survive. Declining populations and loss of habitat in the Ohio

River basin are not compensated for by the locally abundant but geographically limited populations in Pennsylvania and Ontario. Numerous threats persist for the remaining northern riffleshell populations, including invasive species, the effects of small population sizes, habitat alteration, land-use changes, changing precipitation and temperature patterns, and point and non-point source pollution. Agricultural runoff is specifically mentioned as a threat (USFWS 2019), which could include pesticides, sediment, nutrients, and/or other concerns.

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 30.9% of the species range will contain methomyl use sites (Table 46).

Usage

Past usage data indicate that up to 4.3% of the species' range has been treated with methomyl annually. Use layers with the highest usage include vegetables and ground fruit (2.2%) and corn (1.2%) (Table 46).

Table 46. Overlap and usage data for the northern riffleshell.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	1.9	0.3
Citrus	NA	NA
Corn[23]	25	1.2
Cotton	<0.1	<0.1
Other Grains	0.4	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	1.4	0.6

[23]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)
Soybeans	24.4	1.2
Vegetables and Ground Fruit	2.2	2.2
Wheat	NA	NA
Total	**30.9**	**4.3**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (30.9%). Based on past usage data, we expect a smaller portion of the range is likely to be treated with methomyl (4.3% annually), suggesting a medium portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 47 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the northern riffleshell occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 245 µg/L, depending on the type of habitat and region (Table 47). Based on this range of potential exposures, we expect between 0-0.12% of exposed host fish will die, which is not likely reduce the availability of fish hosts needed for successful reproduction. The northern riffleshell is a host fish generalist and can likely use a variety of fish species as hosts such as the mottled sculpin (*Cottus bairdii*), banded darter (*Etheostoma zonale*), bluebreast darter (*E. camurum*), and brown trout (*Salmo trutta*). Because the fish host species are varied and found in multiple aquatic habitats, and we expect low mortality of host fish, we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 47. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_4	24.17	0
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_7	23.72	0
Large volume waterbodies	HUC_4	11.86	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_7	12.21	0
Low flow/Low volume waterbodies	HUC_4	244.80	0.12
Low flow/Low volume waterbodies	HUC_5	229.50	0.08
Low flow/Low volume waterbodies	HUC_7	209.70	0.04

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the northern riffleshell could be exposed to methomyl in 30.9% of the species range based on methomyl use sites and up to 4.3% of the range may be treated with methomyl (Table 46) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the northern riffleshell. We anticipate low mortality to fish hosts, up to 0.12% in low flow/low volume waterbodies. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. The northern riffleshell has a variety of fish hosts their glochidia can successfully parasitize, so if exposure occurs, we anticipate low impacts to the reproductive cycle of the mussel. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual mussels will experience adverse effects.

Conclusion

The northern riffleshell is listed as endangered and it occurs in 13 sub-basins across Illinois, Indiana, Kentucky, Michigan, New York, Ohio, Pennsylvania, and West Virginia. Four populations are believed to be stable and recruiting, five are believed to be declining, and five others may be extirpated. Translocations have been conducted but their success is unknown. Threats include habitat loss, invasive species, effects of small population sizes, land-use changes, precipitation and temperature changes, and pollution. Agricultural runoff is specifically mentioned as a threat, which could include pesticides, sediment, nutrients, and/or other concerns.

The species range occurs near methomyl use sites overlapping 30.9% of the range, but a low portion of the range has experienced methomyl usage in the past (4.3% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The northern riffleshell is a host fish generalist and can likely use a variety of fish species as hosts such as mottled sculpin, banded darter, bluebreast darter, and brown trout for reproduction. The northern riffleshell and its host fish occur across numerous aquatic habitats of HUCs 4, 5, and 7. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.12%, with low rates of mortality anticipated for host fish in all aquatic habitats. The species' host fish use various components of aquatic habitats throughout their life cycles. 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 the species has high vulnerability and medium exposure, its host fish are abundant and common, they occur in multiple aquatic habitats, and we anticipate low host fish mortality (0-0.12%). Therefore, we expect impacts to the mussel to be low and a small number of individuals will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 northern riffleshell in the wild.

References

U.S. Fish and Wildlife Service. 2019. Northern Riffleshell (*Epioblasma torulosa rangiana*) 5-Year Review: Summary and Evaluation. State College, Pennsylvania. 33 pp.

Integration and Synthesis Summary: - Fat threeridge (mussel)

Scientific Name:	Common Name:	Entity ID:
Amblema neislerii	Fat threeridge (mussel)	375

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 high past usage of methomyl within the species' range, indicating a high extent of exposure within the action area across the species' range (Figure 23). Exposed individuals are unlikely to die but are likely to experience low levels of 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 exposure is high, the level of indirect effects is low 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 fat threeridge (mussel). We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 8/9/2022; Wherever found; *States within the range:* FL, GA. Figure 23 depicts the species' range.

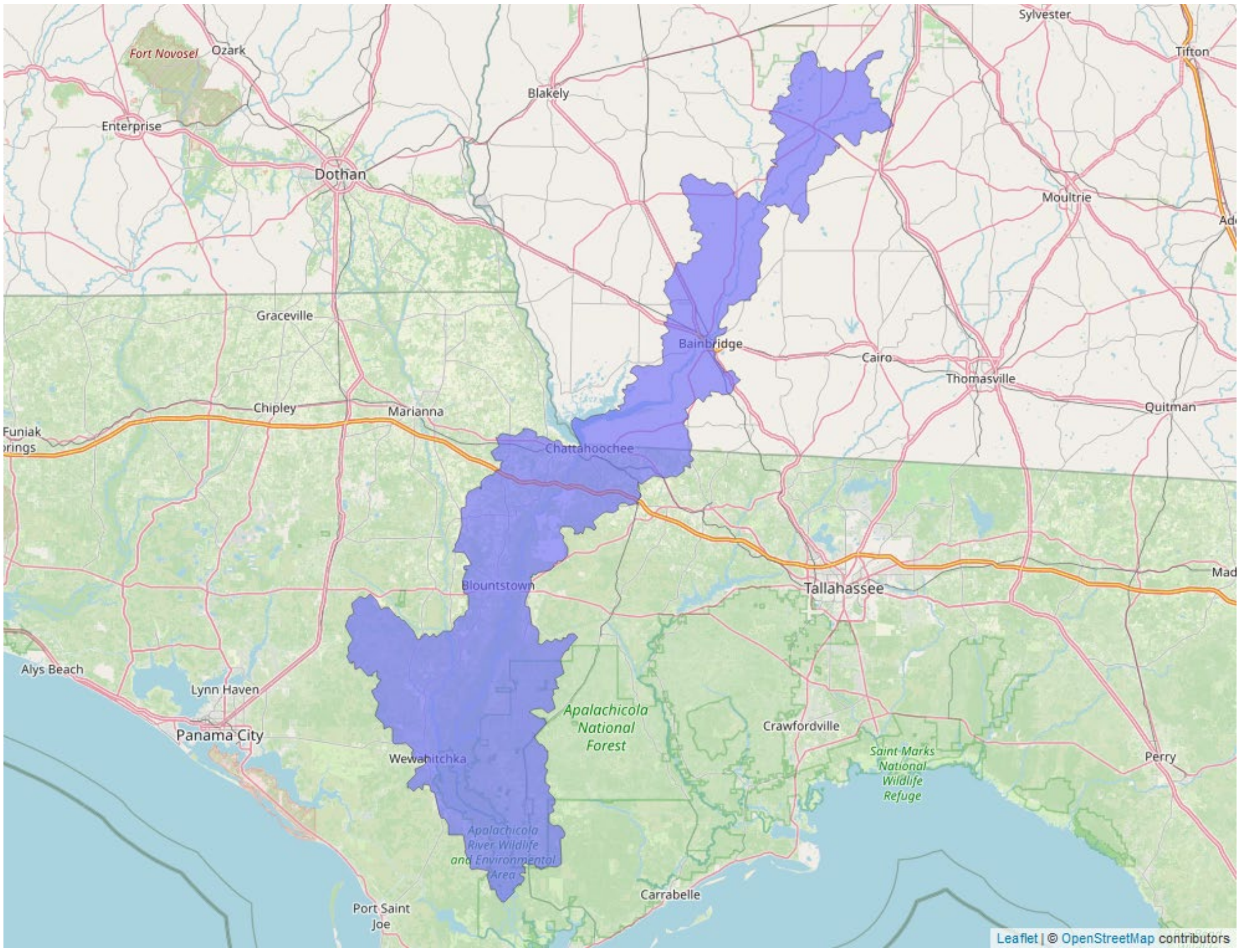

Figure 23. Range map of fat threeridge (mussel) (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/2574.

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, Proposed for Delisting in 2024

Most recent 5-Year Review recommendation: No change in most recent 5-Year Review (2007), but change in listing status was proposed in 2024

Most recently completed 5-Year Review: 9/17/2007

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 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).

Threats to fat threeridge (mussels) include habitat alterations from excessive sediment, channel instability, gravel mining, reduced water quality, developmental activities, water withdrawal, impoundments, and invasive species. Their limited distributions and small populations render them vulnerable to random natural or human-induced events such as droughts or spills. Water quality is not meeting designated use criteria (CWA- Section 305(b)) and stream channels are not stable with intact riparian zones throughout the range of the species. Further, recent research indicates some numerical criteria for pollutants are not protective of early life stages of these mussels. The degree of threat to the persistence of the species remains high, and the potential for recovery remains low (USFWS 2007). Primary threats to the species are from historical land use changes that removed or modified habitat (USFWS 2024).

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 37.3% of the species range will contain methomyl use sites (Table 48).

Usage

Past usage data indicate that up to 11.5% of the species' range has been treated with methomyl annually. Use layers with the highest usage include other row crops (5.8%) and other orchards (3.5%) (Table 48).

Table 48. Overlap and usage data for the fat threeridge (mussel).

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn[24]	6.7	0.3
Cotton	11.7	0.6
Other Grains	1.3	0.1
Other Orchards	3.5	3.5
Other Row Crops	12.9	5.8
Soybeans	1.4	0.1
Vegetables and Ground Fruit	1.2	1.2
Wheat	NA	NA
Total	**37.3**	**11.5**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (37.3%). Based on past usage data, we also expect a large portion of the range is likely to be treated with methomyl (11.5% annually). As such, we expect a large portion of the range will likely experience exposure. Therefore, we expect a large number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: High

[24] 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.

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 49 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the fat threeridge (mussel) occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 59 to 814 µg/L, depending on the type of habitat and region (Table 49). Based on this range of potential exposures, we expect between 0-24% of fish species will die, which could reduce the availability of fish hosts needed for successful reproduction. 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 them, we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 49. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_3	112.05	0
Large volume waterbodies	HUC_3	58.79	0
Low flow/Low volume waterbodies	HUC_3	813.60	24.41

While we do expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the fat threeridge (mussel) could be exposed to methomyl in 37.3% of the species range based on methomyl use sites and up to 11.5% of the range may be treated with methomyl (Table 48) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the fat threeridge (mussel). We anticipate mortality to fish hosts, particularly in low flow/low volume waterbodies. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Even though past methomyl usage reported is 11.5% annually, and reductions in host fish up to 24% are considered, host fish abundance is not considered a limiting factor for the fat threeridge (mussel) and anticipated mortality of the fish hosts is low in most habitats where the mussel is found. We anticipate a low impact to the reproductive cycle of the mussel. We also expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual fat threeridge (mussels) will experience adverse effects.

Conclusion

The fat threeridge (mussel) is listed as endangered and it occurs in three sub-basins in Florida and Georgia: Apalachicola, Chipola, and Flint Rivers. Population numbers are low in the Flint

River, but the species is considered common in the Apalachicola and Chipola Rivers. Threats to the species include habitat alterations from excessive sediment, channel instability, gravel mining, reduced water quality, developmental activities, water withdrawal, impoundments, and invasive species. Due to recovery and reduction of threats, we proposed the species for delisting in 2024.

The species range occurs near methomyl use sites overlapping 37.3% of the range and a high portion of the range has experienced methomyl usage in the past (11.5% annually). Therefore, we consider the species to have a high exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The fat threeridge (mussel) is a host fish generalist and can likely use 23 species of common river fish as hosts, including bluegill and largemouth bass, for reproduction. The fat threeridge and its host fish occur in high flow waterbodies of HUC 3. Its host fish also occur in low flow/low volume waterbodies and large volume waterbodies in HUC 3. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), mortality estimates range from high rates of mortality anticipated for host fish in low flow/low volume waterbodies (24%) to no mortality anticipated in high flow and large volume waterbodies (0%). The species' host fish use various components of aquatic habitats throughout their life cycles. Larvae and juvenile fish are more likely to be exposed to methomyl in low flow/low volume waterbodies because these life stages are more likely to inhabit more shallow waters to avoid predation. Host fish mortality may be high (ranging from 0-24%) if exposed, but we expect mortality to be limited to areas where low flow habitats occur and where methomyl use and subsequent spray drift or runoff occurs. 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 the species has high vulnerability and high exposure, it uses 23 different host fish species that are abundant and common. In addition, we anticipate low effects to the mussel from loss of host fish because the mussel is primarily found in high flow and high-volume waterbodies where expected host fish mortality is low. Therefore, we expect a small number of individuals will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 fat threeridge (mussel) in the wild.

References

U.S. Fish and Wildlife Service. 2024. Endangered and Threatened Wildlife and Plants; Removing Chipola Slabshell and Fat Threeridge From the Federal List of Endangered and Threatened Wildlife. Proposed Rule. Federal Register 89(209):85909-85934.

U.S. Fish and Wildlife Service. 2019. Recovery Plan for Fat Threeridge (*Amblema neislerii*). Atlanta, Georgia. 10 pp.

U.S. Fish and Wildlife Service. 2007. 5-Year Review: Fat Threeridge (*Amblema neislerii*), Shinyrayed Pocketbook (*Lampsilis subangulata*), Gulf Moccasinshell (*Medionidus penicillatus*), Ochlockonee Moccasinshell (*Medionidus simpsonianus*), Oval Pigtoe (*Pleurobema pyriforme*), Chipola Slabshell (*Elliptio chipolaensis*), Purple Bankclimber (*Elliptoideus sloatianus*). Panama City, Florida. 31 pp.

Integration and Synthesis Summary: - Gulf moccasinshell

Scientific Name:	Common Name:	Entity ID:
Medionidus penicillatus	Gulf moccasinshell	384

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 preliminary 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 high past usage of methomyl within the species' range, indicating a high extent of exposure within the action area across the species' range (Figure 24). Exposed individuals are unlikely to die but are likely to experience medium levels of 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. Given that exposure is high and the level of indirect effects is medium, we determined the risk of adverse effects to the species was high. As such, we expected a moderate number of individuals were likely to experience 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 Gulf moccasinshell to be low. After incorporating conservation measures into the effects of the action, accounting for 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 Gulf moccasinshell. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 4/7/2022; Wherever found; *States within the range:* AL, FL, GA. Figure 24 depicts the species' range.

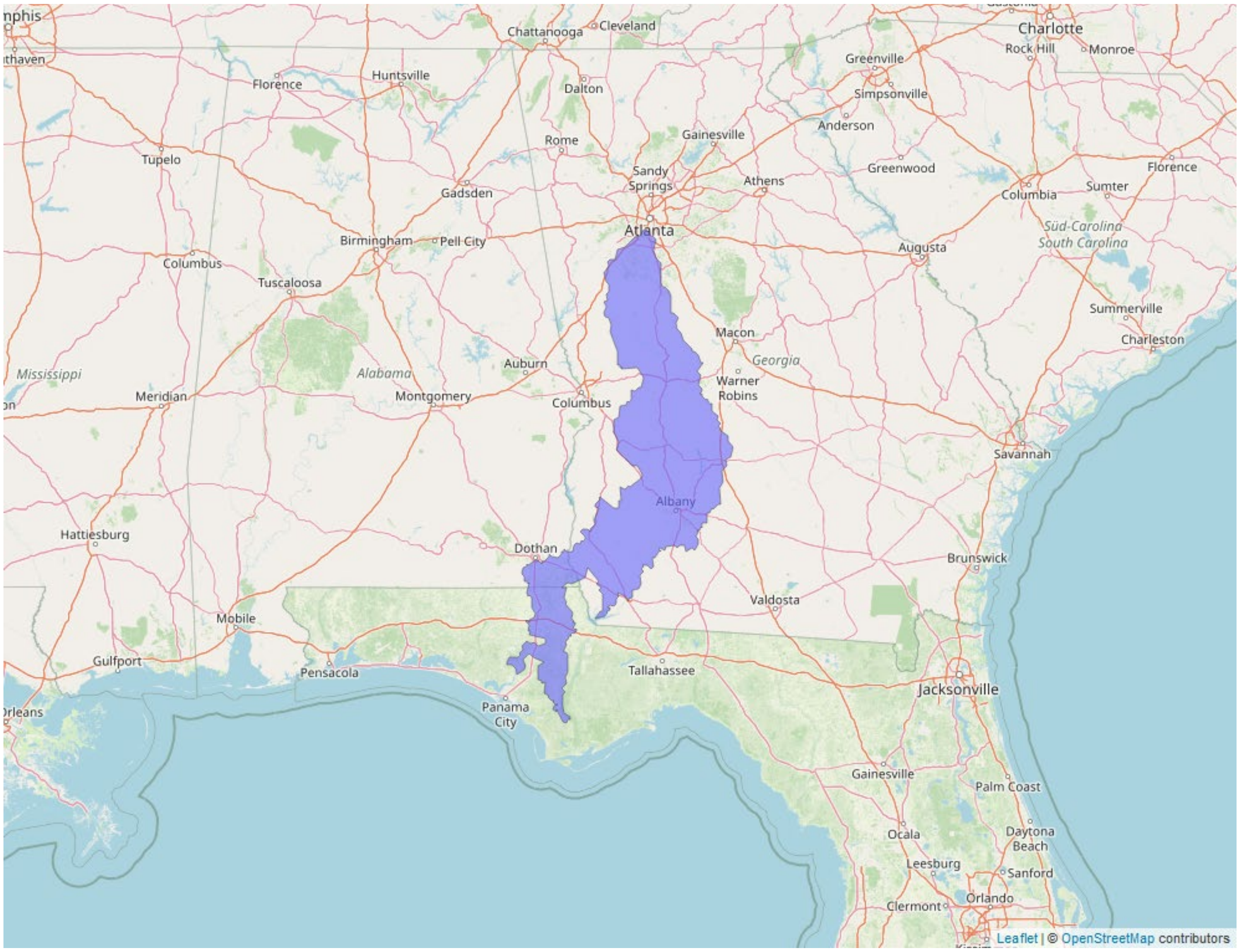

Figure 24. Range map of Gulf moccasinshell (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/7663.

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 Gulf moccasinshell historically occurred in 11 sub-basins and currently occupies Econfina, Chipola, Lower Chattahoochee, Ichawaynochaway, Middle Flint, and Upper Flint sub-basins in Florida, Alabama, and Georgia. Most population are small, localized, and have low densities. Overall, the species has continued to decline in numbers and distribution within its historical range with probable extirpation in Upper and Middle Chattahoochee and Spring sub-basins. The Econfina, Lower Chattahoochee (Sawhatchee and Sheffield Mill Creeks), Middle Flint (Chokee Creek), and Chipola populations (i.e., sub-basins) have remained stable and/or have evidence of recruitment for the Gulf moccasinshell. The remaining sub-basins (Upper and Lower Flint, Kinchafoonee-Muckalee, Ichawaynochaway, Middle Chattahoochee) have minimal numbers of individuals and have no evidence of recruitment. Most stable populations are restricted to short stream reaches (USFWS 2020).

The declining range and abundance of the species is due mostly to changes in the river systems resulting from dams, dredging, mining, channelization, pollution, sedimentation, and water withdrawals resulting in habitat loss, fragmentation, and degradation. Severe drought contributes to further fragmentation and habitat loss. These threats occur throughout all the basins to some degree but is greatest in the Flint, Apalachicola, and Ochlockonee Rivers, which are downstream of major main-stem dams or in areas of relatively high municipal, industrial, or agricultural water use. The species and its habitat continue to be impacted by excessive sediment, channel instability, gravel mining, reduced water quality, developmental activities, water withdrawal, impoundments, and invasive species. Its limited distribution and small populations render the Gulf moccasinshell vulnerable to random natural or human-induced events such as droughts or spills. The degree of threat to the persistence of the species remains high, and the potential for recovery remains low. Water quality is not meeting designated use criteria (CWA- Section 305(b)) and stream channels are not stable with intact riparian zones throughout the range of the seven species (USFWS 2007, 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 43.7% of the species range will contain methomyl use sites (Table 50).

Usage

Past usage data indicate that up to 13.1% of the species' range has been treated with methomyl annually. Use layers with the highest usage include other row crops (6%) and other orchards (5.1%) (Table 50).

Table 50. Overlap and usage data for the Gulf moccasinshell.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn[25]	7.1	0.4
Cotton	15	0.7
Other Grains	2.5	0.1
Other Orchards	5.1	5.1
Other Row Crops	13.2	6
Soybeans	3.4	0.2
Vegetables and Ground Fruit	0.8	0.8
Wheat	NA	NA
Total	**43.7**	**13.1**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (43.7%). Based on past usage data, we also expect a large portion of the range is likely to be treated with methomyl (13.1% annually). As such, we expect a high portion of the range will likely experience exposure. Therefore, we expect a large number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: High

[25] 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.

General Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 51 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the Gulf moccasinshell occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 112 to 814 µg/L, depending on the type of habitat and region (Table 51). Based on this range of potential exposures, we expect between 0-24% of fish species will die, which could reduce the availability of fish hosts needed for successful reproduction. The Gulf moccasinshell is a host fish generalist and can likely use a variety of fish species as hosts, including the turquoise darter (*Etheostoma inscriptum*), gulf darter (*E. swaini*), halloween darter (*Percina crypta*), and blackbanded darter (*P. nigrofasciata*). We anticipate high (0-24%) reductions in fish host species availability due to the mortality estimated in low flow aquatic habitats where the mussel is found. Therefore, we anticipate moderate adverse effects to the reproductive cycle of the mussel.

Table 51. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (μg/L)	Percent fish mortality
High flow waterbodies	HUC_3	112.05	0
Low flow/Low volume waterbodies	HUC_3	813.6	24.41

While we do expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Medium

Effects of the Action Summary

We expect the Gulf moccasinshell could be exposed to methomyl in 43.7% of the species range based on methomyl use sites and up to 13.1% of the range may be treated with methomyl (Table 50) annually based on past usage data. Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the Gulf moccasinshell. Two of the fish host species for the Gulf moccasinshell are uncommon and two are common in the waterbodies where this mussel is found. Despite the Gulf moccasinshell being a fish host generalist, we anticipate a moderate amount of fish host mortality because two of four host fish are uncommon, and mortality is estimated to be high (24%) in one of two waterbodies where the fish are found. Reproduction of a moderate number of individual Gulf moccasinshell mussels will be adversely impacted. We also expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a moderate number of individual Gulf moccasinshells will experience adverse effects.

Preliminary Conclusion (with General Conservation Measures)

The Gulf moccasinshell is listed as endangered and it occurs in six sub-basins across Florida, Alabama, and Georgia. It is extirpated from at least three sub-basins. Most populations are small, fragmented, and low in density, and only four populations are believed to be recruiting. Threats to the species include dams, dredging, mining, channelization, pollution, sedimentation, and water withdrawals resulting in habitat loss, fragmentation, and degradation.

The species range occurs near methomyl use sites overlapping 43.7% of the range and a high portion of the range has experienced methomyl usage in the past (13.1% annually). Therefore, we consider the species to have a high exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The Gulf moccasinshell can likely use the turquoise darter, gulf darter, halloween darter, and blackbanded darter for reproduction. The Gulf moccasinshell and its host fish occur in high flow waterbodies of HUC 3. Its host fish also occur in low flow/low volume waterbodies in HUC 3. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), mortality estimates range from high anticipated for host fish in low flow/low volume waterbodies (24%) to none anticipated in high flow waterbodies (0%). The species' host fish use various components of aquatic habitats throughout their life cycles. Larvae and juvenile fish are more likely to be exposed to methomyl in low flow/low volume waterbodies because these life stages are more likely to inhabit more shallow waters to avoid predation. We expect mortality to be limited to areas where low flow/low volume habitats occur and where methomyl use and subsequent spray drift or runoff occurs. 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.

Most populations are small, localized, and occur in low densities, and the species has continued to decline in numbers and distribution since listing. Because the species has high vulnerability, high exposure, and high anticipated host fish mortality, we expect impacts to the mussel to be medium and a moderate number of individuals will be adversely affected.

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 Gulf moccasinshell:

1) *Methomyl must be applied using the following buffers: 50 feet for aerial applications, 10 feet for ground applications, and 25 feet for airblast applications. Based on AgDRIFT modeling, the buffers will reduce spray drift from entering habitat for the Gulf moccasinshell by 74 to 99%. These buffer distances may be reduced using other measures identified as equivalent mitigations (i.e., reducing spray drift by similar magnitude) as specified in EPA's Draft Insecticide Strategy and as described in Appendix A-1 of this Opinion.*
2) *Applicators need 3 points of mitigation as outlined in EPA's Draft Insecticide Strategy. This will reduce methomyl loads in the habitat of the Gulf moccasinshell by an order of magnitude (i.e., a 10-fold reduction).*

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

We anticipate that with the measures described above that these pathways of exposure will be greatly limited and result in exposure of very low numbers of individuals over the course of the action. After reviewing the current status of the listed species, environmental baseline for the action area, effects of the proposed action, cumulative effects, and species-specific 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 methomyl, as proposed, is not likely to jeopardize the continued existence of the Gulf moccasinshell.

References

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

U.S. Fish and Wildlife Service. 2007. 5-Year Review: Fat Threeridge (*Amblema neislerii*), Shinyrayed Pocketbook (*Lampsilis subangulata*), Gulf Moccasinshell (*Medionidus penicillatus*), Ochlockonee MoccasinshelI (*Medionidus simpsonianus*), Oval Pigtoe (*Pleurobema pyriforme*), Chipola Slabshell (*Elliptio chipolaensis*), Purple Bankclimber (*Elliptoideus sloatianus*). Panama City, Florida. 31 pp.

Integration and Synthesis Summary: - Ochlockonee moccasinshell

Scientific Name:	Common Name:	Entity ID:
Medionidus simpsonianus	Ochlockonee moccasinshell	385

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 high past usage of methomyl within the species' range, indicating a high extent of exposure within the action area across the species' range (Figure 25). Exposed individuals are unlikely to die or experience 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 exposure is high, we do not expect indirect effects from loss of host fish and we determine the risk of adverse effects to the species is low. As such, we do not expect individuals are likely to experience reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 Ochlockonee moccasinshell. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 2/9/2022; Wherever found; *States within the range:* FL, GA. Figure 25 depicts the species' range.

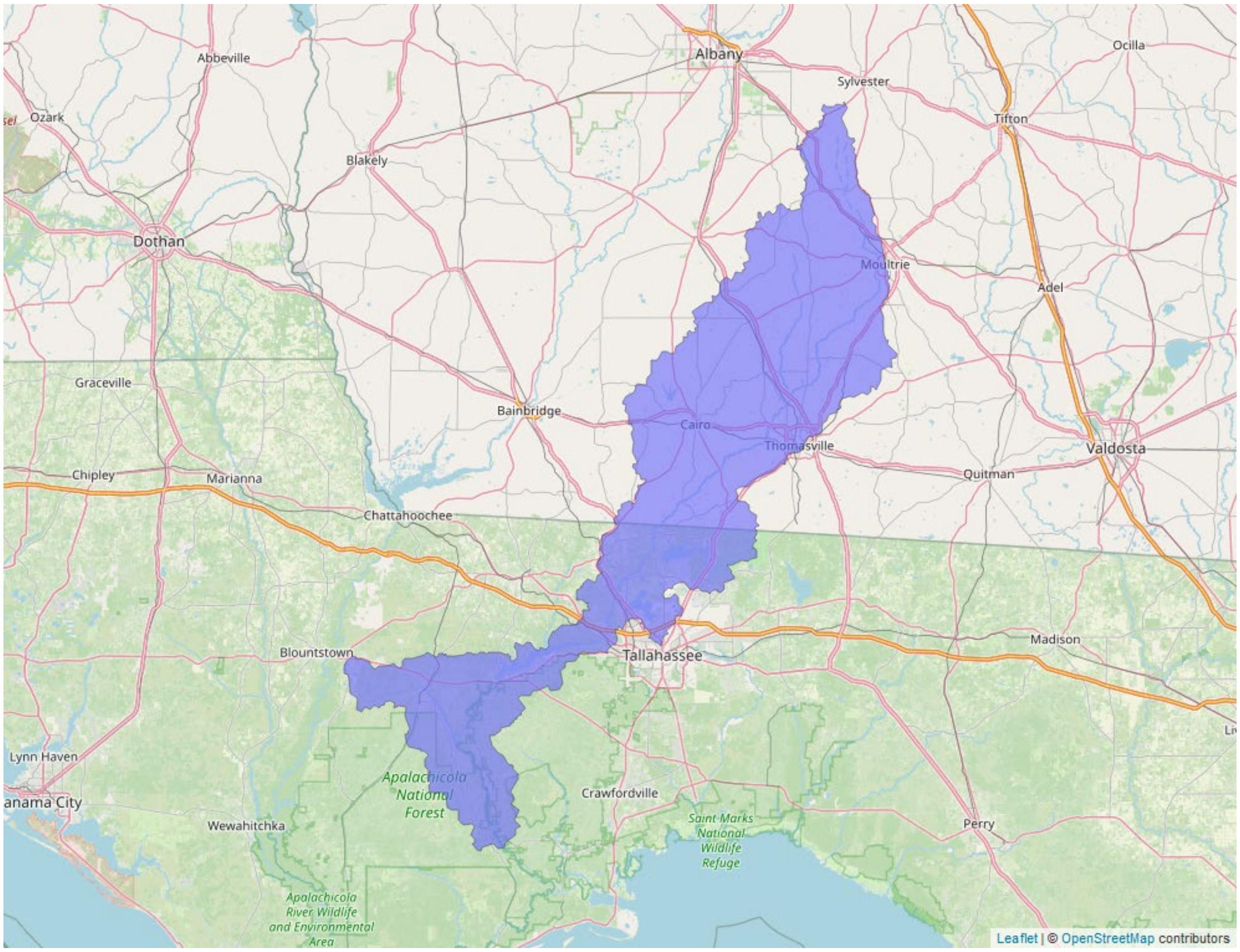

Figure 25. Range map of Ochlockonee moccasinshell (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/8083.

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: 8/28/2020

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

Number of populations: Single population

Species trends: Unknown population trends

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

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The Ochlockonee moccasinshell is currently known from one population in the lower Ochlockonee River (Liberty and Walkulla counties, Florida). Abundance of this population is very low, and surveys conducted from 2006 to 2017 located only 30 live individuals and shells of 7 dead individuals. Surveys indicate the species is possibly extirpated from the upper basin (upstream of Jackson Bluff Dam). Its present range is restricted to a 23 km (14 mi) reach of the lower Ochlockonee River, which represents 11% of its known historical range (USFWS 2020).

The main threats to the species are habitat degradation and loss. The upper basin has been impacted by intensive agricultural activities, urban development, industrial and municipal wastewater discharges, groundwater consumption, drought, surface mining, and a mainstem impoundment. Channel instability, altered flow regimes, and contaminants are thought to be the primary reasons for the species' decline in the upper basin. Threats to the newly discovered population in the lower basin include dam-related impacts (e.g., altered flow, sediment, and temperature regimes, and channel incision), pollution, extreme storm surge and flood events, and saltwater encroachment. Without resilient populations in the upper basin, the species lacks the ability to withstand catastrophic events and maintain adaptive potential. The degree of threat to species persistence remains high and the potential for recovery remains low. There is still uncertainty in the resiliency of the population and the number needed to reduce isolation and increase the potential for genetic exchange (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 33.9% of the species range will contain methomyl use sites (Table 52).

Usage

Past usage data indicate that up to 10.9 % of the species' range has been treated with methomyl annually. Use layers with the highest usage include other row crops (4.4%) and other orchards (4.8%) (Table 52).

Table 52. Overlap and usage data for the Ochlockonee moccasinshell.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn[26]	3.9	0.2
Cotton	13.3	0.7
Other Grains	1.3	0.1
Other Orchards	4.8	4.8
Other Row Crops	9.9	4.4
Soybeans	1.4	0.1
Vegetables and Ground Fruit	0.7	0.7
Wheat	NA	NA
Total	**33.9**	**10.9**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (33.9%). Based on past usage data, we also expect a large portion of the range is likely to be treated with methomyl (10.9% annually). As such, we expect a high portion of the range will likely experience exposure. Therefore, we expect a large number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: High

Conservation Measures

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

[26] 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.

period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 53 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the Ochlockonee moccasinshell occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be approximately 29 µg/L (Table 53). Based on this estimated exposure, we do not expect exposed host fish will die, which is not likely to reduce the availability of fish hosts needed for successful reproduction. A recent publication confirms that members of the genus *Medionidus* are host specialists and depend on darters (Percidae) for reproduction (Johnson et al. 2016). The Ochlockonee moccasinshell likely relies primarily on the blackbanded darter (*Percina nigrofasciata*) as host for its parasitic larval stage. Blackbanded darters are common in the southeastern U.S. Because no mortality is expected for all aquatic habitats for the Ochlockonee moccasinshell, we do not anticipate loss of fish host species availability will likely result in adverse effects to the reproductive cycle of the mussel overall.

Table 53. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_3	28.93	0

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the Ochlockonee moccasinshell could be exposed to methomyl in 33.9% of the species range based on methomyl use sites and up to 10.9% of the range may be treated with methomyl (Table 52) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the Ochlockonee moccasinshell. The Ochlockonee moccasinshell is a host fish specialist that likely relies primarily on blackbanded darter. Being a specialist suggests that the Ochlockonee moccasinshell may be less resilient to possible changes in the fish host community and make it more susceptible to indirect effects of methomyl. However, we do not expect host fish mortality based on the presumption that Ochlockonee moccasinshell uses darters as hosts. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Therefore, methomyl is not likely to cause adverse effects to the Ochlockonee moccasinshell.

Conclusion

The Ochlockonee moccasinshell is listed as endangered and is currently known from one population in the lower Ochlockonee River (Liberty and Walkulla counties, Florida). Abundance of this population is very low, and surveys conducted from 2006 to located only 30 live individuals and shells of 7 dead individuals (FFWCC unpubl. Data, Pursifull et al., in review). Surveys indicate the species is possibly extirpated from the upper basin (upstream of Jackson Bluff dam). Its present range is restricted to a 23 km (14 mi) reach of the lower Ochlockonee River, and this represents 11% of its known historical range. The main threat to the species is habitat degradation and loss. The upper basin has been impacted by intensive agricultural activities, urban development, industrial and municipal wastewater discharges, groundwater consumption, drought, surface mining, and a mainstem impoundment. Channel instability, altered flow regimes, and contaminants are thought to be the primary reasons for the species' decline in the upper basin. Threats to the newly discovered population in the lower basin includes dam related impacts (e.g., altered flow, sediment, and temperature regimes, and channel incision), pollution, extreme storm surge and flood events, and saltwater encroachment.

The species range occurs near methomyl use sites overlapping 33.9% of the range and a large portion of the range has experienced methomyl usage in the past (10.9% annually). Therefore, we consider the species to have a high exposure ranking. However, we do not expect direct mortality of mussels from methomyl exposure, nor do we expect mussels to be indirectly affected through impacts to their host fish. The Ochlockonee moccasinshell is a host fish specialist and likely relies primarily on blackbanded darter, a fish in the southeastern U.S. The Ochlockonee moccasinshell and host fish occur in high flow waterbodies in HUC 3, which has a maximum predicted environmental concentration of 29 µg/L. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), we do not expect these methomyl concentrations to result in fish mortality. Therefore, we do not anticipate impacts to the Ochlockonee moccasinshell through loss of host fish from methomyl exposure. Additionally, 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 the species has high vulnerability and high exposure, its host fish is common, they occur in high-flow waterbodies, and we anticipate no host fish mortality from methomyl exposure. Therefore, we expect impacts to the mussel to be discountable and no individuals will be adversely affected through loss of host fish. After incorporating conservation measures into the effects of the action, accounting for 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 Ochlockonee moccassinshell in the wild.

References

U.S. Fish and Wildlife Service. 2020. 5-Year Review: Summary and Evaluation, Ochlockonee Moccasinshell (*Medionidus simpsonianus*). Panama City, Florida. 21 pp.

Integration and Synthesis Summary: - Chipola slabshell

Scientific Name:	Common Name:	Entity ID:
Elliptio chipolaensis	Chipola slabshell	386

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 medium. 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 medium past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 26). Because the species threats are greatly reduced and the species has increased since listing, we proposed the species for delisting in 2024. Exposed individuals are unlikely to die but are likely to experience medium levels of indirect effects resulting from loss of reproductive host species, primarily in low flow/volume waterbodies where the mussel is less likely to occur. 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. Given exposure is medium and the level of indirect effects is medium, we determine the risk of adverse effects to the species is medium. As such, we expect a moderate number of individuals are likely to experience reduced reproductive success from the proposed action. Because the species is more commonly found in large creeks and rivers where we expect no fish mortality, we do not expect species-level effects to occur. After incorporating conservation measures into the effects of the action, accounting for 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 Chipola slabshell. We discuss our rationale for this conclusion for the species in the sections below.

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Species range

Based on range map dated: 2/18/2022; Wherever found; *States within the range:* AL, FL. Figure 26 depicts the species' range.

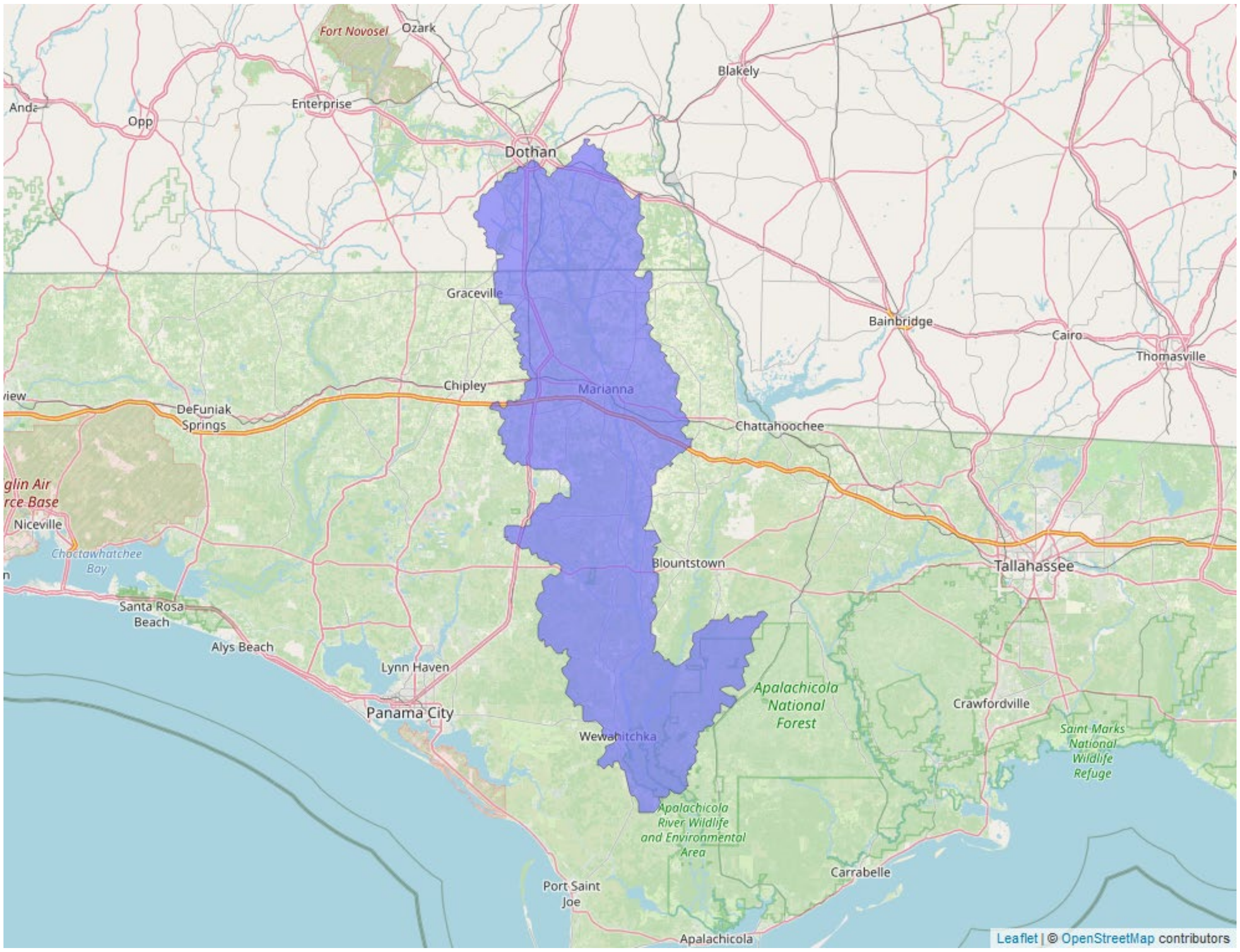

Figure 26. Range map of Chipola slabshell (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/1775.

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, Proposed for Delisting in 2024

Most recent 5-Year Review recommendation: No change in most recent 5-Year Review (2007), but change in listing status was proposed in 2024

Most recently completed 5-Year Review: 9/17/2007

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

Number of populations: Single population

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

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

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The 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 declining range and abundance of the Chipola slabshell is due mostly to changes in its riverine habitats resulting from dams, dredging, mining, channelization, pollution, sedimentation, and water withdrawals. These threats continue today. Additional threats to the Chipola slabshell include point source pollution (e.g., sedimentation, as from livestock in streams) and barriers to fish passage (e.g., unpaved road crossings). EPA (in 2013) and the Florida Department of Environmental Water (in 2016) released and adopted new ammonia criteria for improving water quality standards related to freshwater mussel ammonia toxicity (USFWS 2007). Primary threats to the species are from historical land use changes that removed or modified habitat (USFWS 2024).

Overall Vulnerability: Medium

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 26.5% of the species range will contain methomyl use sites (Table 54).

Usage

Past usage data indicate that up to 7 % of the species' range has been treated with methomyl annually. Use layers with the highest usage include other row crops (5.1%) and cotton (0.5%) (Table 54).

Table 54. Overlap and usage data for the Chipola slabshell.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn[27]	1.7	0.1
Cotton	10.4	0.5
Other Grains	2	0.1
Other Orchards	0.1	0.1
Other Row Crops	11.2	5.1
Soybeans	1.5	0.1
Vegetables and Ground Fruit	1.1	1.1
Wheat	NA	NA
Total	**26.5**	**7**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (26.5%). Based on past usage data, we expect a smaller portion of the range is likely to be treated with methomyl (7% annually), suggesting a medium portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

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

[27] 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.

period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 55 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the Chipola slabshell occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 59 to 814 µg/L, depending on the type of habitat and region (Table 55). Based on this range of potential exposures, we expect between 0-24% of fish species will die, which could reduce the availability of fish hosts needed for successful reproduction in low flow/volume waterbodies. The Chipola slabshell is a host fish specialist and is likely able to successfully reproduce only in the presence of a few species of sunfishes as fish hosts, including the bluegill (*Lepomis macrochirus*) and redbreast sunfish (*L. auritus*). Both host fish species are quite abundant throughout the mussel's range. Even though we anticipate a potentially high (0-24%) reduction in fish host species availability due to the mortality estimated in the aquatic habitats where the mussel is found, we anticipate a moderate level of adverse effects to the reproductive cycle of the mussel.

Table 55. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_3	112.05	0

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
Large volume waterbodies	HUC_3	58.79	0
Low flow/Low volume waterbodies	HUC_3	813.60	24.41

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Medium

Effects of the Action Summary

We expect the Chipola slabshell could be exposed to methomyl in 26.5% of the species range based on methomyl use sites and up to 7% of the range may be treated with methomyl (Table 54) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the Chipola slabshell. The fish host species for the Chipola slabshell are unknown but likely include sunfishes like the common bluegill. While the Chipola slabshell may only use sunfishes as host fish, sunfishes are common and abundant throughout the mussel's range. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. We anticipate high (up to 24%) reduction in fish host species availability in low flow/volume waterbodies where the mussel is found, but we anticipate a moderate level of adverse effects overall to the reproductive cycle of the Chipola slabshell.

Conclusion

The Chipola slabshell is listed as threatened and it occurs in the Chipola River system in Alabama and Florida. Abundance has always been low, and the species is extirpated from a third of its historical range. Threats include dams, dredging, mining, channelization, pollution, sedimentation, and water withdrawals resulting in habitat loss, fragmentation, and degradation. Due to recovery and reduction of threats, we proposed the species for delisting in 2024.

The species range occurs near methomyl use sites overlapping 26.5% of the range and a medium portion of the range has experienced methomyl usage in the past (7% annually). Therefore, we consider the species to have a high exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. 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, however this group of fishes are common and abundant throughout their range. The Chipola slabshell and its host fish occur in high flow waterbodies of HUC 3. Its host fish also occur in low flow/low volume waterbodies and large volume waterbodies in HUC 3. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), mortality estimates range from high rates of mortality anticipated for host fish in low flow/low volume waterbodies (24%) to no mortality anticipated in high flow and large volume waterbodies (0%). Larvae and juvenile fish are more likely to be exposed to methomyl in low flow/low volume waterbodies because these life stages are more likely to inhabit more shallow waters to avoid predation. We expect mortality to be limited to areas where low flow habitats occur and where methomyl use and subsequent spray drift or runoff occurs. Glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality, and thus it is less likely that methomyl will impact the reproductive cycle of the mussel. 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.

Chipola slabshell abundance has always been low. The species' vulnerability is medium and in 2024, we proposed it for delisting due to recovery and reduction of threats. Even though we expect medium exposure and high host fish mortality in low flow/volume waterbodies, we expect impacts to the mussel to be medium because we do not expect mortality in high flow or high-volume waterbodies where the mussels are more likely to be found. We expect a moderate number of individuals will be adversely affected over the duration of the action, and we do not expect species-level effects to occur. After incorporating conservation measures into the effects of the action, accounting for 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 it is our biological opinion that the registration of methomyl, as proposed, is not likely to jeopardize the continued existence of the Chipola slabshell.

References

U.S. Fish and Wildlife Service. 2024. Endangered and Threatened Wildlife and Plants; Removing Chipola Slabshell and Fat Threeridge From the Federal List of Endangered and Threatened Wildlife. Proposed Rule. Federal Register 89(209):85909-85934.

U.S. Fish and Wildlife Service. 2019. Recovery Plan Amendment for the Chipola Slabshell (*Elliptio chipolaensis*). Atlanta, Georgia. 8 pp.

U.S. Fish and Wildlife Service. 2007. 5-Year Review: Fat Threeridge (*Amblema neislerii*), Shinyrayed Pocketbook (*Lampsilis subangulata*), Gulf Moccasinshell (*Medionidus penicillatus*), Ochlockonee MoccasinshelI (*Medionidus simpsonianus*), Oval Pigtoe (*Pleurobema pyriforme*), Chipola Slabshell (*Elliptio chipolaensis*), Purple Bankclimber (*Elliptoideus sloatianus*). Panama City, Florida. 31 pp.

U.S. Fish and Wildlife Service. 2003. Recovery Plan for Endangered Fat Threeridge, Shinyrayed Pocketbook, Gulf Moccasinshell, Ochlockonee Moccasinshell, Oval Pigtoe, and Threatened Chipola Slabshell, and Purple Bankclimber. Atlanta, Georgia. 149 pp.

Integration and Synthesis Summary: - Rabbitsfoot

Scientific Name:	Common Name:	Entity ID:
Quadrula cylindrica cylindrica	Rabbitsfoot	3645

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 27). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 rabbitsfoot. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 8/4/2022; Wherever found; *States within the range:* AL, AR, IL, IN, KS, KY, LA, MO, MS, OH, OK, PA, TN. Figure 27 depicts the species' range.

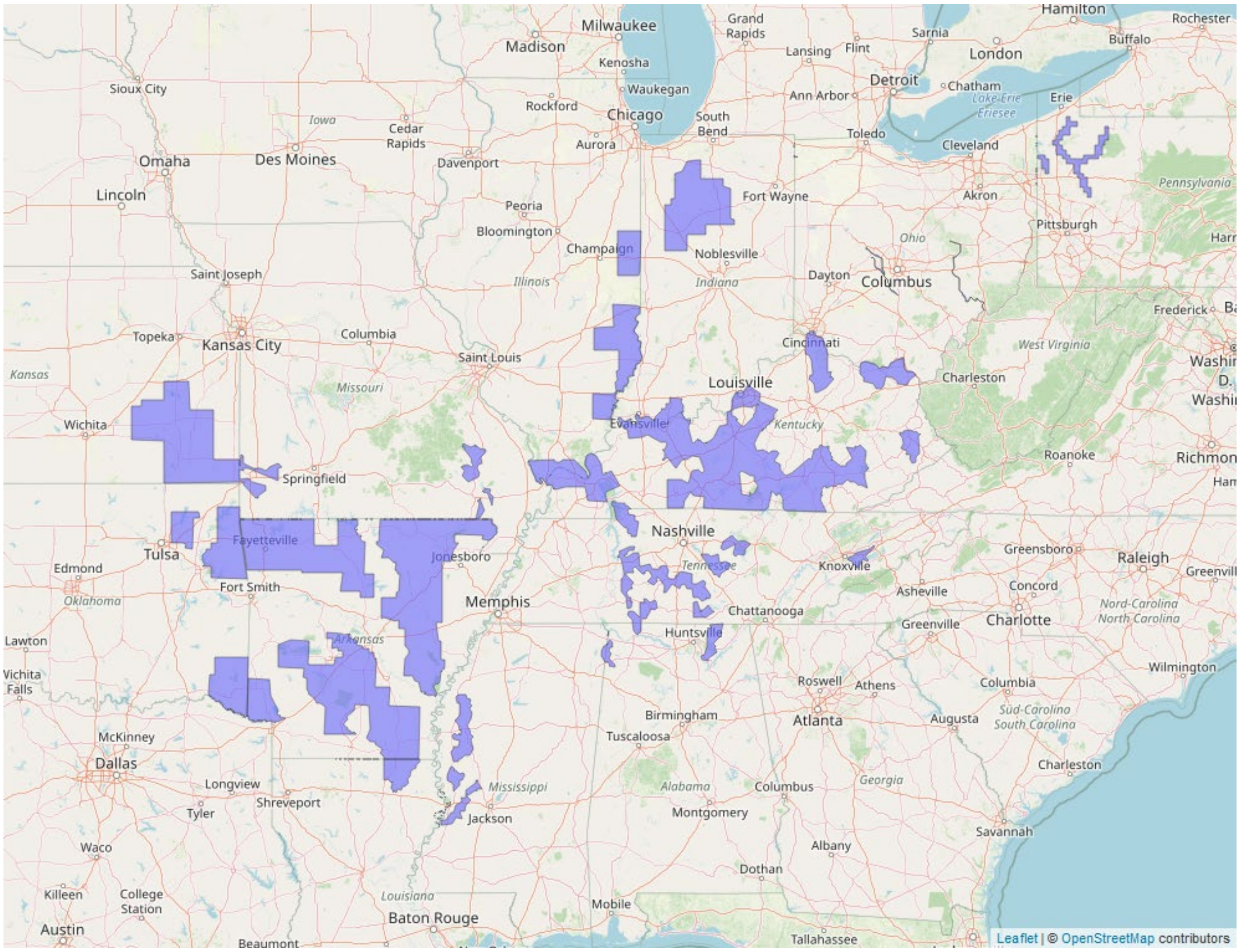

Figure 27. Range map of rabbitsfoot (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/5165.

Vulnerability

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

Summary of status

Listing status: Threatened

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

Most recently completed 5-Year Review: 6/17/2020

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

Number of populations: Multiple populations (numerous)

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

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

Environmental Baseline/Cumulative Effects (EB/CE) Summary

At the time of listing, the historical range of the rabbitsfoot included Alabama, Arkansas, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Mississippi, Missouri, Ohio, Oklahoma, Pennsylvania, Tennessee, and West Virginia. Biologists considered the rabbitsfoot extirpated in Georgia and West Virginia.

Within the lower Great Lakes Sub-basin and Mississippi River Basin, biologists documented occurrence of the rabbitsfoot in 139 rivers or creeks. Of those 139 rivers or creeks, they determined status of 51 of the populations as extant (stable, improving, declining, or unknown), a 63% decline in historical occurrence. Butler (2005) determined status of a population as extirpated when results of mussel surveys from the past few decades failed to detect the presence of live individuals or fresh dead specimens. Since publication of the proposed listing rule in 2012, biologists have reported records of occurrence for the rabbitsfoot from 10 additional rivers or creeks, some of which pre-date listing. In 2008, biologists with the U.S. Army Corps of Engineers, Memphis District, reported the first record of occurrence from the Hatchie River, which occurs in the Lower Mississippi River Sub-basin. Biologists located a fresh dead specimen at the Highway 70 crossing, southwest of Brownsville, Haywood County, Tennessee. This is the first record of occurrence for the rabbitsfoot from a direct tributary of the Mississippi River in west Tennessee. In 1995, biologists reported two live specimens from the North Fork Spring River, near Neck City, Jasper County, Missouri. The North Fork Spring River is a tributary of the Spring River and occurs in the Arkansas River Basin. Biologists reported records of occurrence from additional rivers or creeks in the Ohio River Basin. In 2010, biologists collected the first record, one live specimen, from Jordan Creek, Vermilion County, Illinois. Jordan Creek is a tributary of the Middle Branch North Fork Vermilion River. In 2012, biologists also reported one live specimen from Sugar Creek, a tributary of the East Fork White River, Shelby County, Indiana, and an unknown number of weathered shells from the creek in Shelby and Johnson counties, Indiana. This is the first record of occurrence for this creek and the current status of this population is unknown. The Sugar Creek population included in the proposed listing rule is a tributary of the Wabash River and its current status remains extirpated. In 2006 and 2008, biologists reported the first record of occurrence, a weathered dead specimen, from both Big Monon Creek, White County, Indiana, and Pipe Creek, Madison County, Indiana, respectively. Big Monon Creek is a tributary of the Tippecanoe River and Pipe Creek a tributary of the West Fork White River. From 2005-2013, biologists reported weathered dead specimens from the Salamonie River, Huntington and Wells Counties, Ohio. The Salamonie River is a tributary of the Wabash River. The last three additional rivers where biologists reported the first records of occurrence are in the Red River Basin. In 2017, biologists reported two live specimens from Bayou D’Arbonne upstream of Louisiana Highway 143 at the boundary of D’Arbonne National

Wildlife Refuge, Ouachita Parish, Louisiana. Three live specimens from two sites in Sevier County, Arkansas were found (abundance 0.20%) after 34 sites were surveyed. Six live specimens were found among five sites (abundance 0.40%) along the Saline River (tributary of the Little River) in Sevier County also, out of 45 sites surveyed. Currently, we consider rabbitsfoot extant in 63 of 149 rivers, a 58% decline in historical occurrence. Of the 63 extant rivers, 25% are stable or improving, 17% are declining, and 57% are unknown (USFWS 2020).

The rabbitsfoot faces a variety of threats from declines in water quality, altered hydrology, riparian habitat fragmentation, and deterioration of instream habitat. These threats, which urbanization may exacerbate within portions of the range coupled with climate change, are important factors affecting future viability of the rabbitsfoot. Captive propagation, augmentation, and reintroduction may be necessary to increase resiliency and achieve sufficient redundancy in the future. Due to the restricted range of the rabbitsfoot, geographic isolation of most extant populations, and small population size, this mussel species is likely suffering genetic isolation and reduced adaptive capacity throughout much of its range, resulting in lower representation. Given current and expected future decreases in resiliency, populations become more vulnerable to extirpation from stochastic events resulting in concurrent losses in representation and redundancy. The current status of the rabbitsfoot is similar to its status at time of listing with widely scattered individuals in isolated populations with low abundance. Since publication of the proposed listing rule, biologists have reported records of occurrence for the rabbitsfoot from 10 additional rivers or creeks, some of which pre-date listing. The status of 7 of these population is unknown and the other 3 are extirpated. Results of surveys conducted since listing found that 5 populations whose status biologists determined as extirpated still persist. However, few extant populations (22%) are stable or improving. Threats associated with impoundments, sedimentation, chemical contaminants, mining, inadequacy of state and federal water quality programs, population fragmentation, climate change, and invasive species continue at levels similar to at the time of listing and continue to threaten extant populations (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 22.9% of the species range will contain methomyl use sites (Table 56).

Usage

Past usage data indicate that up to 1.5 % of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (1%) and vegetables and ground fruit (0.3%) (Table 56).

Table 56. Overlap and usage data for the rabbitsfoot.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	0.3	<0.1
Citrus	NA	NA
Corn	15.2	0.8
Cotton	0.8	<0.1
Other Grains	0.7	<0.1
Other Orchards	0.1	0.1
Other Row Crops	0.2	0.1
Soybeans[28]	20.5	1
Vegetables and Ground Fruit	0.3	0.3
Wheat	NA	NA
Total	**22.9**	**1.5**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (22.9%). Based on past usage data, we expect a smaller portion of the range is likely to be treated with methomyl (1.5% annually), and a medium portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

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

[28]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.

period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office.” This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 57 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.
Aquatic habitat buffers: The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states “Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds”.

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the rabbitsfoot occupies, EPA’s aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be 12 to 321 µg/L, depending on the type of habitat and region (Table 57). Based on this range of potential exposures, we expect between 0-0.61% of exposed host fish will die, which is not likely to reduce the availability of fish hosts needed for successful reproduction. The rabbitsfoot is a host fish generalist and can likely use a variety of fish species as hosts to successfully reproduce, including the blacktail shiner (*Cyprinella venusta*), mimic shiner (*Notropis volucellus*), emerald shiner (*Notropis atherinoides*), cardinal shiner (*Luxilus cardinalis*), red shiner (*Cyprinella lutrensis*) , spotfin shiner (*Cyprinella spiloptera*), bluntface shiner (*Cyprinella camura*) , rosyface shiner (*Notropis rubellus*), striped shiner (*Luxilus chrysocephalus*), scarlet shiner (*Lythrurus fasciolaris*), and bluegill (*Lepomis macrochirus*). Because the fish host species are varied and found in multiple aquatic habitats, and we expect fish mortality to be low (0-0.61%), we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 57. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species’ range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_10a	23.26	0
High flow waterbodies	HUC_11a	48.83	0

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_3	34.82	0
High flow waterbodies	HUC_4	24.17	0
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0
Large volume waterbodies	HUC_10a	12.45	0
Large volume waterbodies	HUC_11a	29.03	0
Large volume waterbodies	HUC_3	18.67	0
Large volume waterbodies	HUC_4	11.86	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Large volume waterbodies	HUC_7	12.21	0
Large volume waterbodies	HUC_8	31.29	0
Low flow/Low volume waterbodies	HUC_10a	248.40	0.13
Low flow/Low volume waterbodies	HUC_11a	321.30	0.61
Low flow/Low volume waterbodies	HUC_3	171.00	0.01
Low flow/Low volume waterbodies	HUC_4	244.80	0.12
Low flow/Low volume waterbodies	HUC_5	229.50	0.08
Low flow/Low volume waterbodies	HUC_6	164.70	0.01
Low flow/Low volume waterbodies	HUC_7	209.70	0.04
Low flow/Low volume waterbodies	HUC_8	225.90	0.07

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the rabbitsfoot could be exposed to methomyl in 22.9% of the species range based on methomyl use sites and up to 1.5% of the range may be treated with methomyl (Table 56) annually based on past usage data.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the rabbitsfoot. We anticipate some 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 fish host species for the rabbitsfoot include several species of shiner that are commonly found in the waterbodies where the mussel is found. We anticipate up to 0.61% reductions in fish host species, thus we anticipate a low level of adverse effects to the reproductive cycle of the mussel. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual rabbitsfoot mussels will experience adverse effects.

Conclusion

The rabbitsfoot is a threatened species and is considered extant in 63 of 148 (43%) rivers or creeks. Fifteen populations (25%) are stable or improving and 11 are declining (17%). The status of 36 (57%) extant populations is unknown due to no new information since publication of the proposed listing rule. Reservoir construction isolated most populations within river basins. These results demonstrate a need to conduct more surveys to assess status of populations of the rabbitsfoot. Individuals are widely scattered in isolated concentrations with low abundance in many extant populations with few exceptions (e.g., Green River, Little River). The rabbitsfoot faces a variety of threats from declines in water quality, altered hydrology, riparian habitat fragmentation, and deterioration of instream habitat. These threats, which urbanization may exacerbate within portions of the range coupled with climate change, are important factors affecting future viability of the rabbitsfoot. Due to the restricted range of the rabbitsfoot, geographic isolation of most extant populations, and small population size, this mussel species is likely suffering genetic isolation and reduced adaptive capacity throughout much of its range, resulting in lower representation. Given current and expected future decreases in resiliency, populations become more vulnerable to extirpation from stochastic events resulting in concurrent losses in representation and redundancy.

The species range occurs near methomyl use sites overlapping 22.9% of the range, but a small portion of the range has experienced methomyl usage in the past (1.5% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The rabbitsfoot is a host fish generalist can likely use a variety of fish species as hosts to successfully reproduce, including the blacktail shiner, bluntface shiner, cardinal shiner, mimic shiner, spotfin shiner, red shiner, rosyface shiner, scarlet shiner, striped shiner, emerald shiner and bluegill. The rabbitsfoot and its host fish occur across numerous aquatic habitats. All aquatic habitats occur in 8 HUCs (3, 4, 5, 6, 7, 8, 10a, and 11a), each of which has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.61%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, its host fish are abundant and common, they occur in multiple aquatic habitats, and we anticipate low host fish mortality (0-0.61%). Therefore, we expect impacts to the mussel to be low and a small number of individuals will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 rabbitsfoot in the wild.

References

U.S. Fish and Wildlife Service. 2020. 5-Year Review: Summary and Evaluation for Rabbitsfoot (*Quadrula cylindrica cylindrica*). Conway, Arkansas. 107 pp.

Integration and Synthesis Summary: - Yellow lance

Scientific Name:	Common Name:	Entity ID:
Elliptio lanceolata	Yellow lance	4074

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 28). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 yellow lance. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 7/16/2021; Wherever found; *States within the range:* DC, MD, NC, VA. Figure 28 depicts the species' range.

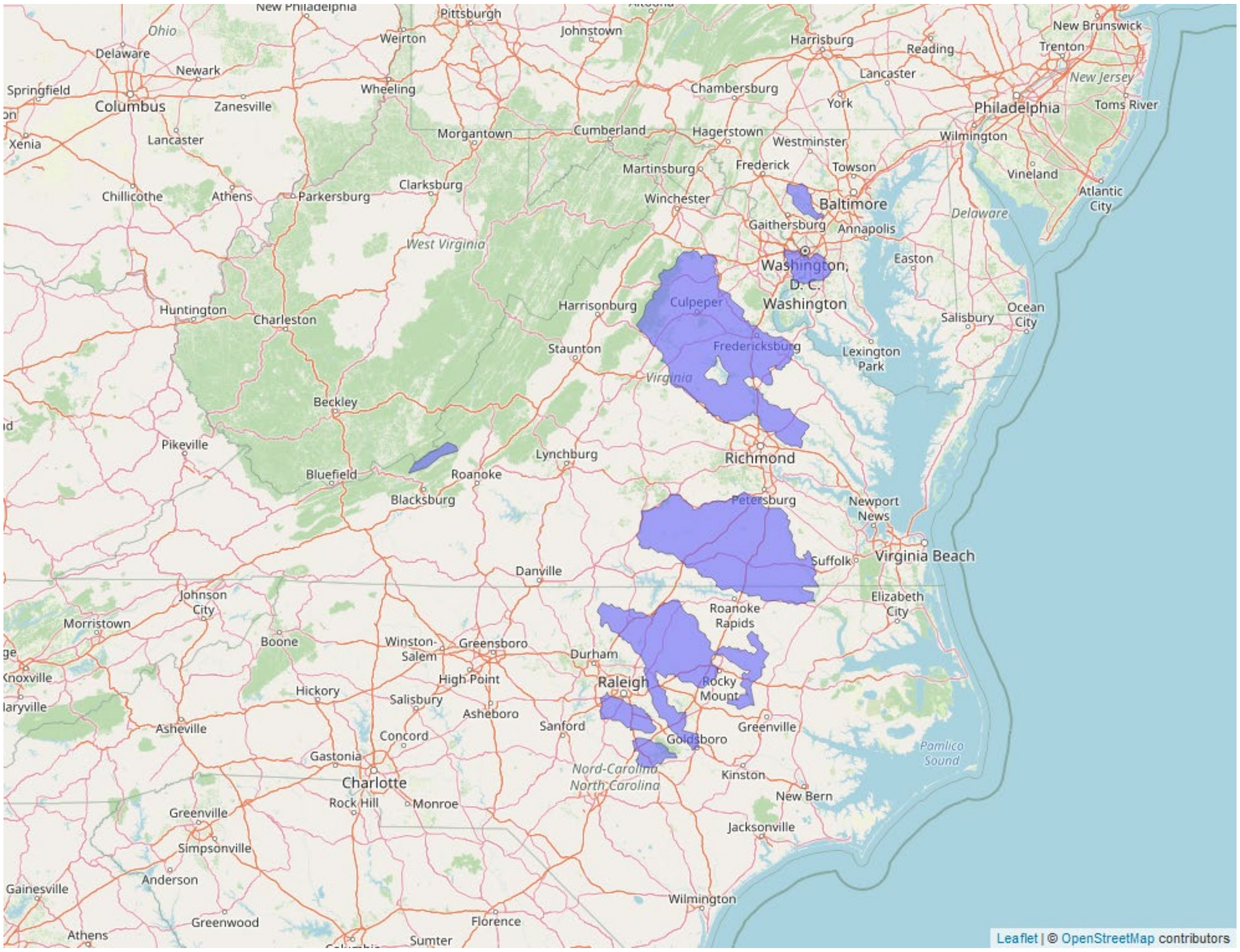

Figure 28. Range map of yellow lance (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/4511.

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:

Most recently completed 5-Year Review: 8/28/2023

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

Number of populations: Multiple populations (few)

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

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

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The yellow lance's documented historical range spans eight Atlantic Slope river basins, including the Patuxent, Potomac, Rappahannock, York, James, Chowan, Tar-Pamlico, and Neuse drainages; however, the species is presumed extirpated in the Potomac River basin (USFWS 2019; Figure 1). An analysis of the species' status conducted in 2016 estimated that six extant populations had low resiliency, meaning they are likely not self-sustaining populations, lack evidence of recruitment, and have very limited or fragmented distribution (i.e., Patuxent, Rappahannock, York, James, Chowan, and Neuse populations). Only the Tar River population had an overall moderate resiliency with self-sustaining subpopulations, exhibiting evidence of multiple age classes, and with recruitment rates exceeding mortality rates (USFWS 2019).

Recent surveys (August – October 2018; June – September 2020) in the Patuxent River basin in Maryland indicate that the yellow lance occupies more habitat in the Hawlings River than previous detections indicated (total of 6.15 km now documented), and there was some evidence of reproduction (i.e., gravid mussel observed). However, the abundance of yellow lance appears to be declining in the Hawlings River (Ashton et al. 2019, 2020; McCann 2021, 2022). Confirmation of historical mussel specimens as yellow lance also increased the number of historically occupied watersheds in the Patuxent basin; confirmed historical locations now include Cattail Creek (new HUC12 within known HUC10) and the Little Patuxent River (new HUC10, 0206000602; Ashton et al. 2019). These reports also noted difficulties accessing and surveying Cattail Creek and the Little Patuxent River near historical records (e.g., private land; unexploded ordnance), and they suggested incorporating eDNA sampling techniques. The Service's Northeast Fisheries Center is currently working on eDNA marker development for the yellow lance to support surveys at the Patuxent National Wildlife Research Refuge, in partnership with the Refuge, the Chesapeake Bay Field Office, the Maryland Fish and Wildlife Conservation Office, and the state Department of Natural Resources (Cullen 2023).

In Virginia, no yellow lance were found in surveys on Fort Pickett, including portions of the Nottoway River and its tributaries (Carey and Emrick 2020). In a survey of Johns Creek, a fresh shell of yellow lance was found at one site (Orcutt 2021). In the Rappahannock and Rapidan River basins, Carey and Ostby (2022) reported apparent declines based on a survey of 65 sites. Their survey sites included 15 historical locations and were distributed among the two rivers and their major tributaries (n = 37 sites for Rappahannock and n = 28 sites for Rapidan). They also documented yellow lance at eight sites with no previous historical records and reported evidence of recruitment in one tributary (Beautiful Run; Carey and Ostby 2022). Other notable findings included low detection rates, a temporal trend in capture probabilities – higher in late June through early August, and declining through late September in their study area, and observations of deeper burrowing (i.e., 30 – 60 cm) by yellow lance mussels than previous data have indicated (Ostby and Beaty 2021; Carey and Ostby 2022).

Surveys in North Carolina have focused on augmentation sites. The North Carolina Wildlife Resources Commission stocked 9,373 yellow lance between May 2019 and November 2022 at augmentation sites in the Tar River and Fishing, Shocco, and Sandy Creeks, all in the Tar River basin. Stocked mussels were propagated in the 2016, 2017, 2019, and 2020 cohorts at North Carolina State University and the North Carolina Wildlife Resources Commission Marion Conservation Aquaculture Center. A subset of augmentation sites have been monitored since 2020, resulting in 437 recaptured yellow lance that averaged about 4 mm growth (range 0 – 9 mm growth) since being released. Evidence of gravid females has been observed at the Tar River augmentation site (NCWRC 2020, 2021, 2022; Fisk 2023).

The largest threats to the future viability of the yellow lance are habitat degradation from stressors influencing water quality, water quantity, instream habitat, and habitat connectivity. Continuing or past stressors to yellow lance habitat degradation include development, agricultural practices, forest management, barriers such as dams and impoundments, and invasive species (e.g., Corbicula and catfishes). Threats from climate change continue throughout that species' range, and disease is a potential concern due to several recent unexplained die-offs observed in other mussel species.

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 20.8% of the species range will contain methomyl use sites (Table 58).

Usage

Past usage data indicate that up to 2.8% of the species' range has been treated with methomyl annually. Use layers with the highest usage include vegetables and ground fruit (1%) and other row crops (1%) (Table 58).

Table 58. Overlap and usage data for the yellow lance.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn	6	0.3
Cotton	4	0.2
Other Grains	1	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	2.2	1
Soybeans[29]	12.4	0.6
Vegetables and Ground Fruit	1	1
Wheat	NA	NA
Total	**20.8**	**2.8**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (20.8%). Based on past usage data, we expect a smaller portion of the range is likely to be treated with methomyl (2.8% annually), and a medium portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 59 the maximum predicted

[29] 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.

EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.
Aquatic habitat buffers: The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds".

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the yellow lance occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 229 µg/L, depending on the type of habitat and region (Table 59). Based on this range of potential exposures, we expect between 0-0.08% of exposed host fish will die, which is not likely to reduce the availability of fish hosts needed for successful reproduction. The yellow lance requires appropriate host fish species to complete its life cycle. The white shiner (*Luxilus albeolus*) and pinewoods shiner (*Lythrurus matutinus*) have been identified in laboratory trials as effective hosts for its parasitic larval life stage (Eads and Levine 2009); however, other fish species likely serve as effective hosts because both shiners have a narrower geographic range than the yellow lance (Page and Burr 2011). We anticipate low (0-0.08%) reduction in fish host species availability due to the estimated mortality in the aquatic habitats where the mussel is found, and we anticipate a low level of adverse effects to the reproductive cycle of the mussel.

Table 59. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_2	11.67	0
High flow waterbodies	HUC_3	34.82	0
High flow waterbodies	HUC_5	23.72	0
Low flow/Low volume waterbodies	HUC_2	141.30	0
Low flow/Low volume waterbodies	HUC_3	171.00	0.01

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
Low flow/Low volume waterbodies	HUC_5	229.50	0.08

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the yellow lance could be exposed to methomyl in 20.8% of the species range based on methomyl use sites and up to 2.8% of the range may be treated with methomyl annually (Table 58) thus exposure is likely to be moderate.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the yellow lance. We anticipate some 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 fish host species for the yellow lance are likely species of shiner such as the white shiner and pinewoods shiners that are commonly found in the waterbodies where the mussel is found. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. The expected mortality to the host fish is low (0-0.08%), and we anticipate low impacts to the reproductive cycle of the mussel. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual yellow lance mussels will experience adverse effects.

Conclusion

The yellow lance, listed as threatened, is a freshwater mussel species native to Atlantic Slope rivers in Maryland, Virginia, and North Carolina. Populations are currently known from seven of eight historically occupied river basins; six have low resiliency and one has moderate resiliency. Although some augmentation efforts have improved abundance in portions of the Tar River population and recent monitoring efforts showed some limited evidence of reproduction in the

Patuxent, Rappahannock, and Tar populations, surveys indicate that detection and abundance of the yellow lance remain in decline. Threats from habitat degradation, invasive species (e.g., Corbicula and catfishes), and climate change continue throughout the species' range, and disease is a potential concern due to several recent unexplained die-offs observed in other mussel species.

The species range occurs near methomyl use sites overlapping 20.8% of the range, but a small portion of the range has experienced methomyl usage in the past (2.8% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The yellow lance can successfully reproduce in the presence of both the white shiner and pinewoods shiner. Because both host species have a smaller geographic range than the yellow lance, it is thought that other shiner species or other genera of fish also serve as host fish. There is no indication that host fish is a limiting factor in the decline of the yellow lance. The yellow lance occurs in high flow waterbodies, the host fish occur in two aquatic habitats (high flow and low flow/low volume waterbodies) in three HUCs (2, 3, and 5), each of which has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.08%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, its host fish are abundant and common, the occur in various aquatic habitats, and we anticipate low host fish mortality (0-0.08%). Therefore, we expect impacts to the mussel to be low and a small number of individuals will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 yellow lance in the wild.

References

U.S. Fish and Wildlife Service. 2023. 5-Year Status Review: Summary and Evaluation for Yellow Lance (*Elliptio lanceolata*). Raleigh, North Carolina. 12 pp.

U.S. Fish and Wildlife Service. 2018. Endangered and Threatened Wildlife and Plants; Determination of Threatened Species Status for the Yellow Lance; Final Rule. Federal Register. 83 (64): 14189-14198.

Integration and Synthesis Summary: - Neosho mucket

Scientific Name:	Common Name:	Entity ID:
Lampsilis rafinesqueana	Neosho mucket	4086

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 29). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 Neosho mucket. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 8/13/2021; Wherever found; *States within the range:* AR, KS, MO, OK. Figure 29 depicts the species' range.

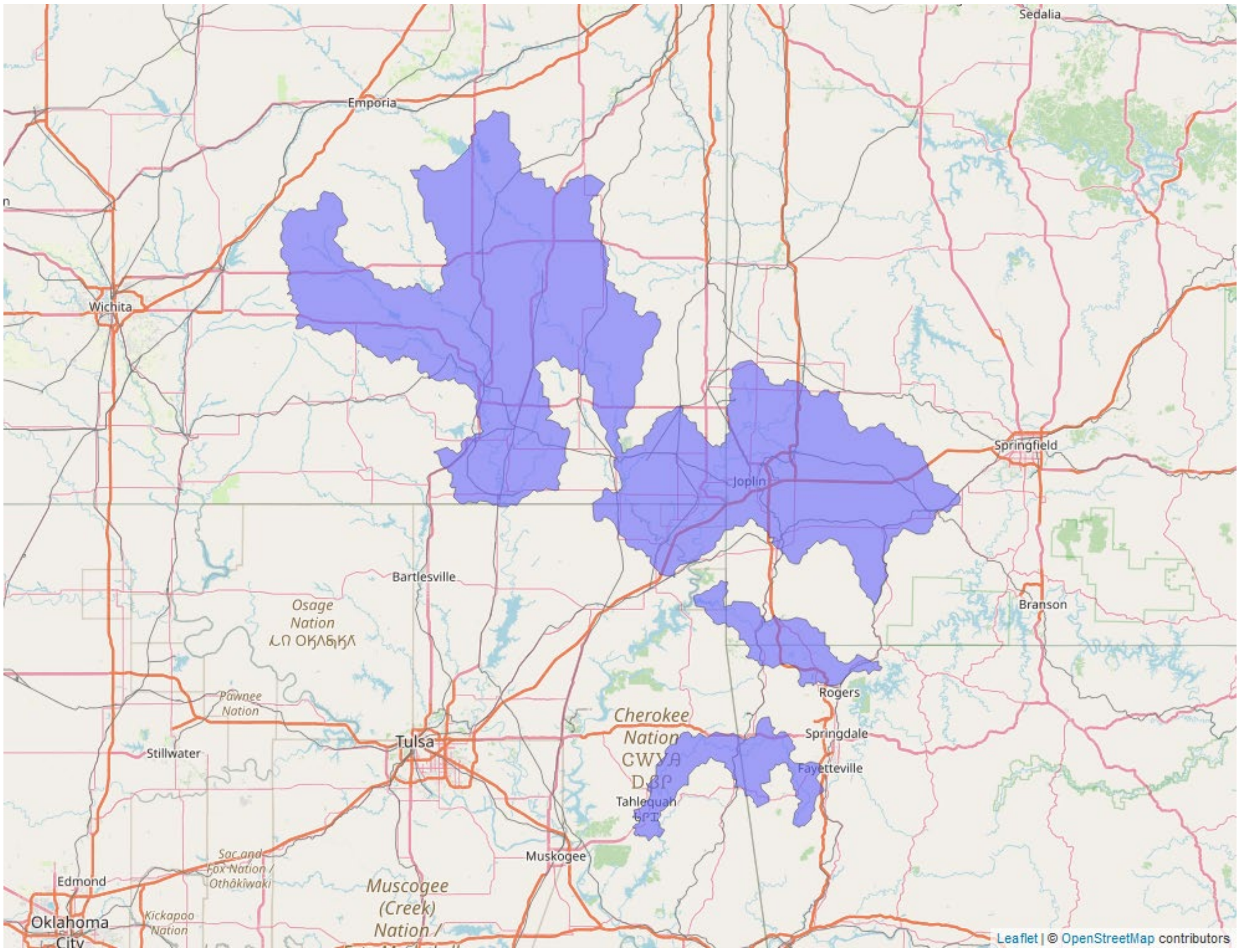

Figure 29. Range map of Neosho mucket (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/3788.

Vulnerability

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

Summary of status

Listing status: Endangered

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

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

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: yes

Environmental Baseline/Cumulative Effects (EB/CE) Summary

Neosho Mucket historically occurred in at least 17 streams within the Illinois, Neosho, and Verdigris River basins covering four states (Arkansas, Kansas, Oklahoma, and Missouri). It is endemic to the Arkansas River system (Gordon 1981; Harris and Gordon 1987; Mather 1990; Obermeyer 1996; Vaughn 1996; Obermeyer et al. 1997a; Harris et al. 2009). Based on historical and current data, Neosho Mucket no longer occurs in approximately 1,317 km (818 mi) of its historical range (61 percent). Most of this extirpation has occurred within the Oklahoma and Kansas portions of its range. Extant populations are disjunct (not contiguous) in approximately 844 km (524 mi) of its range (78 FR 57076).

Two Neosho Mucket populations persist within the Verdigris River basin, one population within the Illinois River basin, and five populations within the Neosho River basin, while its persistence in Cow Creek is unknown and Cottonwood River is questionable due to its recent (2015) reintroduction (Neosho River basin). Reservoir construction isolated each river basin and most populations within the river basins. The Spring and North Fork Spring River populations are the only extant populations connected without barriers (e.g., dams) in the Neosho River basin, and the North Fork may be a meta-population depending upon results from ongoing genetics work. There also is connectivity between the two extant stream populations in the Verdigris River basin. Neosho Mucket individuals are widely scattered in isolated concentrations with low abundance within each population (river), except the Spring River where relatively high abundance still occurs at extant sites.

The Neosho Mucket faces a variety of threats from declines in water quality, altered hydrology, riparian habitat fragmentation, and deterioration of instream habitat. These threats, which urbanization may exacerbate within portions of the range coupled with climate change, are important factors affecting future viability of Neosho Mucket. Captive propagation, augmentation, and reintroduction are necessary to increase resiliency and achieve sufficient redundancy. Due to the restricted range, geographic isolation of most extant populations, and small population size, the species is likely suffering genetic isolation and reduced adaptive capacity throughout much of its range, resulting in lower representation. An ongoing conservation genomics study of Neosho Mucket will better inform within-river and among-population genetic variation for development of future management and recovery strategies. Given current and expected future decreases in resiliency, populations become more vulnerable to extirpation from stochastic events resulting in concurrent losses in representation and redundancy. The status of Neosho Mucket is similar to its status at time of listing with widely scattered individuals in isolated populations with low abundance, except the Spring River where this species persists in relatively high abundance. No new information indicates curtailment of threats to the species. Threats associated with impoundments, sedimentation, chemical contaminants, mining, inadequacy of state and federal water quality programs, population fragmentation, climate change, and invasive species continue to threaten extant populations.

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 13.3% of the species range will contain methomyl use sites (Table 60).

Usage

Past usage data indicate that up to 0.8 % of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (0.6%) and other orchards (0.2%) (Table 60).

Table 60. Overlap and usage data for the Neosho mucket.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	0.3	<0.1
Citrus	NA	NA
Corn	9	0.5
Cotton	<0.1	<0.1
Other Grains	0.9	<0.1
Other Orchards	0.2	0.2
Other Row Crops	<0.1	<0.1
Soybeans[30]	11.9	0.6
Vegetables and Ground Fruit	<0.1	<0.1
Wheat	NA	NA

[30] 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)
Total	**13.3**	**0.8**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (13.3%). Based on past usage data, we expect a smaller portion of the range is likely to be treated with methomyl (0.8% annually). As such, a medium portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 61 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.
Aquatic habitat buffers: The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds".

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the Neosho mucket occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 321 µg/L, depending on the type of habitat and region (Table 61). Based on this range of potential exposures, we expect between 0-0.61% of exposed host fish will die, which is not likely to reduce the availability of fish hosts needed for successful reproduction. The Neosho mucket is likely to successfully reproduce in the presence of a few species of fish hosts, including the smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), and spotted bass (*Micropterus punctulatus*) to complete its lifecycle, suggesting that it is a host fish specialist. Even though the fish host species are few, they are common and host fish mortality is low in all habitats. Thus, we anticipate a low level of adverse effects to the reproductive cycle of the mussel.

Table 61. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_10a	23.26	0
High flow waterbodies	HUC_11a	48.83	0
Large volume waterbodies	HUC_10a	12.45	0
Large volume waterbodies	HUC_11a	29.03	0
Low flow/Low volume waterbodies	HUC_10a	248.40	0.13
Low flow/Low volume waterbodies	HUC_11a	321.30	0.61

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the Neosho mucket could be exposed to methomyl in 13.3% of the species range based on methomyl use sites and up to 0.8% of the range may be treated with methomyl annually (Table 60) thus exposure is likely to be moderate.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the Neosho mucket. The fish host species for the Neosho mucket are several species of bass that are commonly found in the waterbodies where the mussel is also found. While the potential exposure to methomyl in the range of this mussel is medium, we anticipate a low amount of fish host mortality (0-0.61%). We also expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual Neosho mucket mussels will experience adverse effects.

Conclusion

The Neosho mucket is listed as endangered. Two Neosho mucket populations persist within the Verdigris River basin, one population within the Illinois River basin, and five populations within the Neosho River basin, while its persistence in Cow Creek is unknown and Cottonwood River is questionable due to its recent (2015) reintroduction (Neosho River basin). Reservoir construction isolated each river basin and most populations within the river basin from each other. The Spring and North Fork Spring River populations are the only extant populations connected without barriers (e.g., dams) in the Neosho River basin, and the North Fork may be a meta-population depending upon results from ongoing genetics work. There also is connectivity between the two extant stream populations in the Verdigris River basin. Neosho Mucket individuals are widely scattered in isolated concentrations with low abundance within each population (river), except the Spring River where relatively high abundance still occurs at extant sites. The Neosho mucket faces a variety of threats from declines in water quality, altered hydrology, riparian habitat fragmentation, and deterioration of instream habitat. Due to the restricted range, geographic isolation of most extant populations, and small population size, the species is likely suffering genetic isolation and reduced adaptive capacity throughout much of its range, resulting in lower representation.

The species range occurs near methomyl use sites overlapping 13.3% of the range, but a small portion of the range has experienced methomyl usage in the past (0.8% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The Neosho mucket is likely only able to successfully reproduce in the presence of a few species of host fish, including the smallmouth bass, largemouth bass, and spotted bass. The Neosho mucket occurs in low flow/low volume waterbodies and high flow waterbodies, and the host fish occur in these waterbodies as well as large volume waterbodies. All aquatic habitats occur in two HUCs (10a and 11a), each of which has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.61%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, its host fish are common and abundant, they occur in multiple aquatic habitats, and we anticipate low host fish mortality (0-0.61%). Therefore, we expect impacts to the mussel to be low and a small number of individuals will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 Neosho mucket in the wild.

References

U.S. Fish and Wildlife Service. 2020. 5-Year Review: Summary and Evaluation for Neosho Mucket (*Lampsilis rafinesqueana*). Conway, Arkansas. 49 pp.

Integration and Synthesis Summary: - Altamaha spinymussel

Scientific Name:	Common Name:	Entity ID:
Elliptio spinosa	Altamaha spinymussel	4210

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 medium past usage of methomyl within the species' range, indicating a high extent of exposure within the action area across the species' range (Figure 30). Exposed individuals are unlikely to die or experience 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 exposure is medium, we do not expect indirect effects from loss of host fish and we determine the risk of adverse effects to the species is low. As such, we do not expect individuals are likely to experience reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 Altamaha spinymussel. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 12/4/2019; Wherever found; *States within the range:* GA. Figure 30 depicts the species' range.

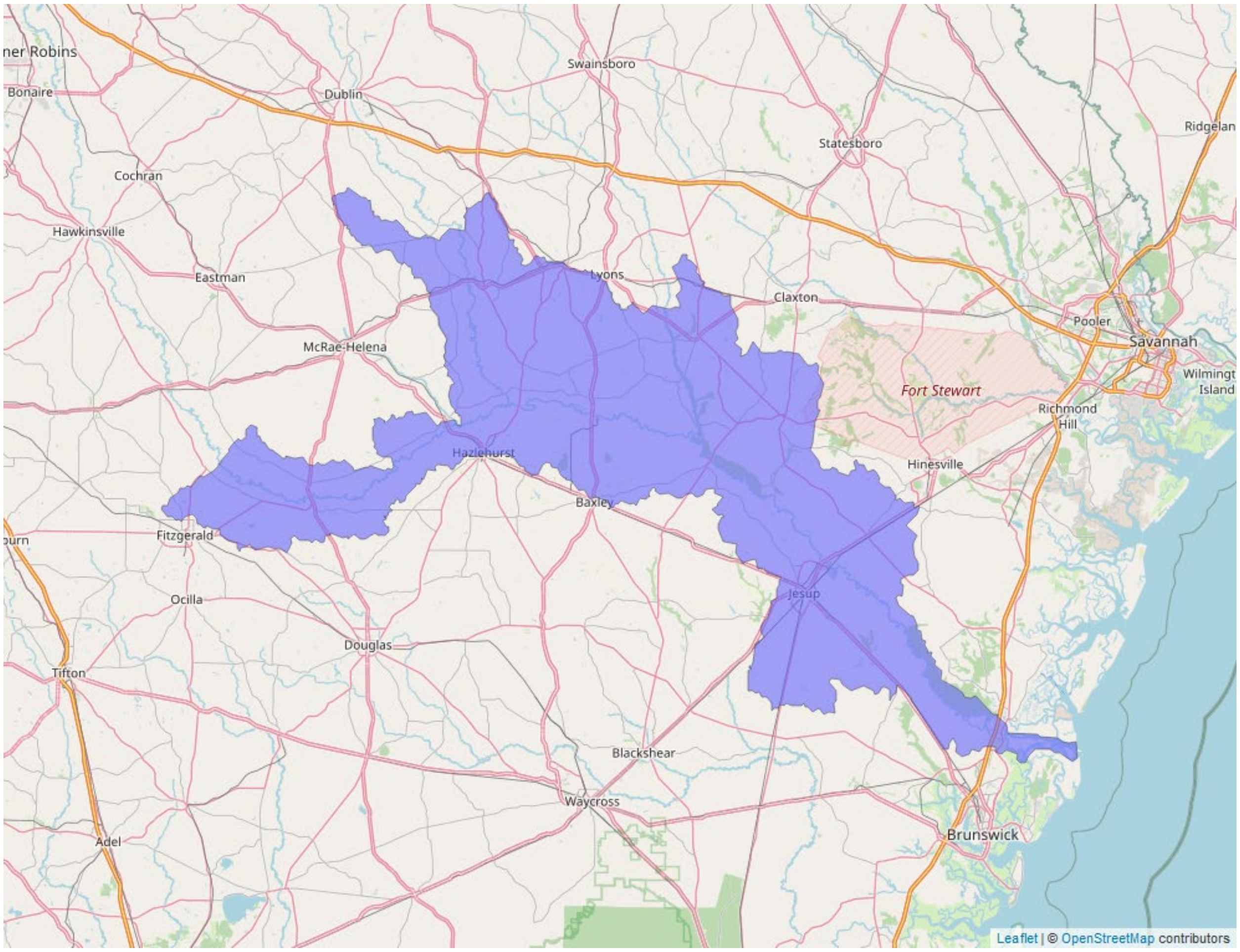

Figure 30. Range map of Altamaha spinymussel (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/6920.

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: 3/13/2024

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 Altamaha spinymussel is a freshwater mussel endemic to the Altamaha River and its major tributaries in southeastern Georgia. The Altamaha spinymussel is endemic to the main stem of the Altamaha River and its larger tributaries (greater than 500 cubic feet per second mean monthly discharge (MMD)), and is not known to occur in smaller tributaries, lakes, or ponds. The Species Status Assessment (USFWS 2021) identifies four historical population units of the Altamaha spinymussel: Oconee, Ohoopee, Lower Altamaha, and Ocmulgee/Altamaha. Two populations (Oconee and Lower Altamaha) are presumed extirpated, and the other two (Ohoopee and Ocmulgee/Altamaha) have rapidly declined, with densities so low that surveys since 2011 have failed to detect individuals. Low genetic diversity, limited recruitment, and gaps in our knowledge of its life history (e.g., unknown host species) further hinder the species' potential for recovery and limit the species' viability. Current population status, distribution, and recruitment remain unconfirmed. Because of the species' rarity on the landscape, additional population details are unknown (USFWS 2021, 2024).

The loss and modification of habitat is a significant threat to the Altamaha spinymussel. Degradation from sedimentation and contaminants threatens the habitat and water quality necessary to support the Altamaha spinymussel. Sediment from unpaved roads, kaolin mines, past and current agriculture practices, silviculture, and construction sites within the Altamaha River Basin can suffocate Altamaha spinymussels and make stable sandbars required by Altamaha spinymussels unstable or change the texture of the substrate, rendering them unsuitable for the species. Contaminants associated with industrial and municipal effluents (e.g., heavy metals, ammonia, chlorine, numerous organic compounds) may cause decreased oxygen, increased acidity, and other water chemistry changes that are lethal to mussels, particularly the highly sensitive early life stages of mussels. Exposure to sub-lethal levels of toxic metals can alter growth, filtration efficiency, enzyme activity, and behavior. Other pollutants threatening this species include pesticides, fertilizers, livestock waste, and nutrients from agriculture (USFWS 2021, 2024).

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 18.4% of the species range will contain methomyl use sites (Table 62).

Usage

Past usage data indicate that up to 5.3% of the species' range has been treated with methomyl annually. Use layers with the highest usage include other orchards (1.6%) and vegetables and ground fruit (1.2%) (Table 62).

Table 62. Overlap and usage data for the Altamaha spinymussel.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn	2.8	0.1
Cotton	7.4	0.4
Other Grains	0.9	<0.1
Other Orchards	1.6	1.6
Other Row Crops	4.5	2
Soybeans[31]	2.6	0.1
Vegetables and Ground Fruit	1.2	1.2
Wheat	NA	NA
Total	**18.4**	**5.3**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (18.4%). Based on past usage data, we expect a medium portion of the range is likely to be treated with methomyl (5.3% annually), and a high portion of the range will still likely experience exposure. Therefore, we expect a large number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

[31] 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.

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: “Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office.” This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 63 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the Altamaha spinymussel occupies, EPA’s aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be approximately 28 µg/L, depending on the type of habitat and region (Table 63). Based on this range of potential exposures, we expect 0% of exposed host fish will die, which is not likely to reduce the availability of fish hosts needed for successful reproduction. The Altamaha spinymussel fish hosts are unknown, but several fish retained encysted glochidia for more than 30 days: redbreast sunfish (*Lepomis auritus*), bluehead chub (*Nocomis leptocephalus*), flat bullhead (*Ameiurus platycephalus*), pirate perch (*Aphredoderus sayanus*), largemouth bass (*Micropterus salmoides*), and the eastern mosquitofish (*Gambusia holbrooki*), suggesting the mussel can use many fish hosts. In another study, glochidia had sloughed from the potential host fish within 5 days after attachment but remained attached to lake sturgeon and redbreast sunfish the longest (4 and 5 days, respectively; USFWS 2021). We suspect that Altamaha spinymussel is a host fish generalist. Because no mortality is expected for all aquatic habitats for the Altamaha spinymussel, we do not anticipate loss of fish host species availability will likely result in adverse effects to the reproductive cycle of the mussel overall.

Table 63. Range of predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_3	28.93	0

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the Altamaha spinymussel could be exposed to methomyl in 18.4% of the species range based on methomyl use sites and up to 5.3% of the range may be treated with methomyl annually (Table 62) thus exposure is likely to be high.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the Altamaha spinymussel. The fish host species for the Altamaha spinymussel are likely several species commonly found in the waterbodies where the mussel is also found based on recent studies looking at glochidia retention on gills. We anticipate no fish host mortality from methomyl exposure and no reductions in mussel reproduction from loss of host fish. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual Altamaha spinymussels will experience adverse effects.

Conclusion

The Altamaha spinymussel is endangered and occurs in the Altamaha River and its major tributaries in southeastern Georgia. Of the four historical populations, two are believed to be extirpated and two have declined so much that individuals have not been observed since 2011. Very little is known about the species' viability or life history due to its rarity. Threats to the species include habitat loss and modification from sedimentation and contamination (specifically, pesticides, fertilizers, livestock waste, and nutrients from agriculture).

The species range occurs near methomyl use sites overlapping 18.4% of the range and a medium portion of the range has experienced methomyl usage in the past (5.3% annually). Therefore, we consider the species to have a high exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The Altamaha spinymussel's host fish are unknown, but the mussel is believed to be a generalist based on recent studies in which glochidia were documented on redbreast sunfish, bluehead chub, flat bullhead, pirate perch, largemouth bass, and eastern mosquitofish for over 30 days. The Altamaha spinymussel and its host fish occur in high flow waterbodies of HUC 3. Its host fish also occur across numerous aquatic habitats in HUC 3. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), we do not expect fish mortality in the waterbodies where this species and its host fish are found. Therefore, we do not anticipate impacts to the Altamaha spinymussel through loss of host fish from methomyl exposure. 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 the species has high vulnerability and medium exposure, its host fish are presumed to be abundant and common, occur in high-volume waterbodies, and we anticipate no host fish mortality. Therefore, we expect impacts to the mussel to be discountable and no individuals will be adversely affected through loss of host fish. After incorporating conservation measures into the effects of the action, accounting for 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 Altamaha spinymussel in the wild.

References

U. S. Fish and Wildlife Service. 2024. Altamaha spinymussel (*Elliptio spinosa*) 5-Year Status Review: Summary and Evaluation. Athens, Georgia. 11 pp.

U. S. Fish and Wildlife Service. 2021. Species Status Assessment Report for the Altamaha spinymussel (*Elliptio spinosa*). Version 1.0. Atlanta, Georgia. 97 pp.

Integration and Synthesis Summary: - Spectaclecase (mussel)

Scientific Name:	Common Name:	Entity ID:
Cumberlandia monodonta	Spectaclecase (mussel)	4490

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 31). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 spectaclecase. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 2/21/2023; Wherever found; *States within the range:* AL, AR, IA, IL, KY, MN, MO, TN, VA, WI, WV. Figure 31 depicts the species' range.

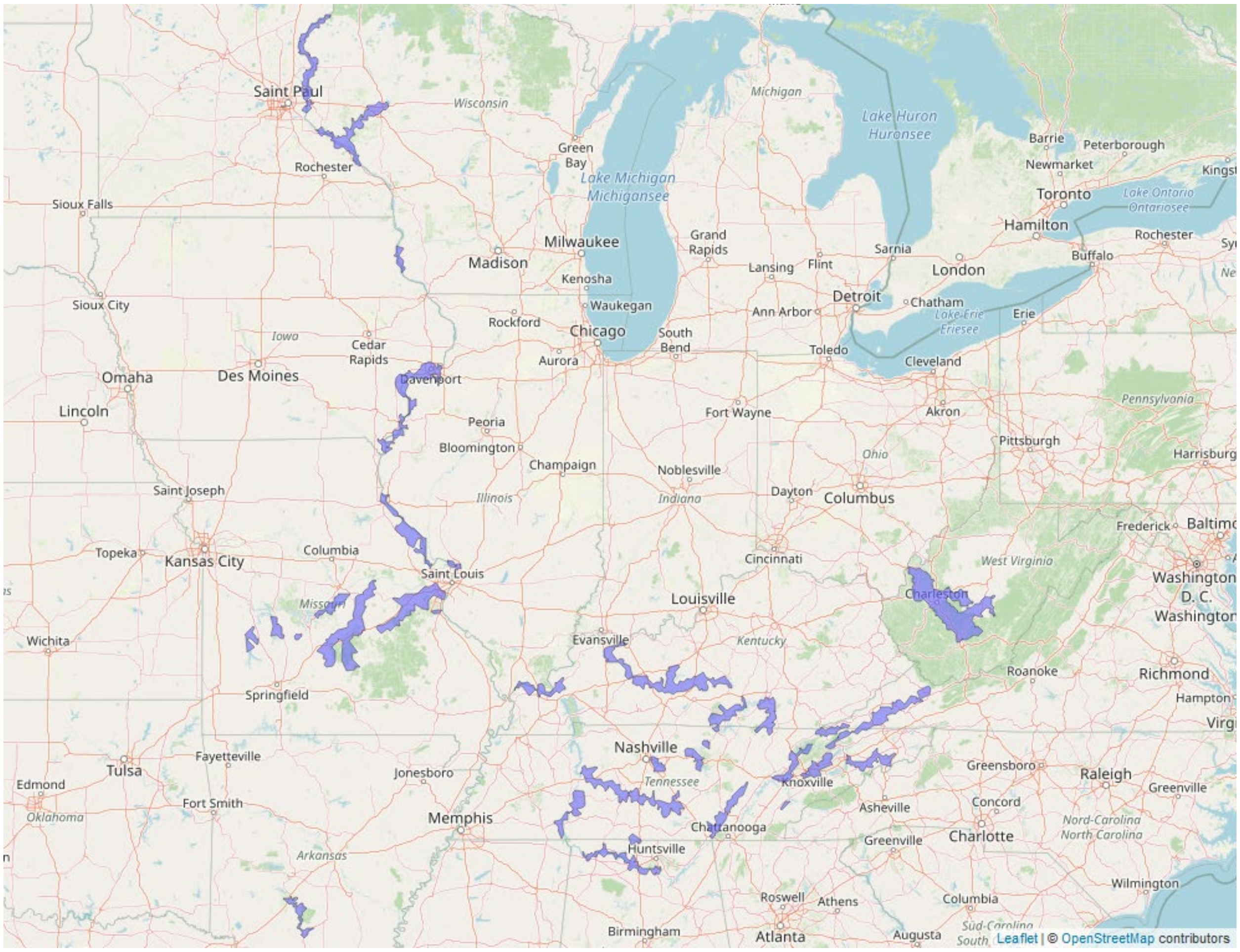

Figure 31. Range map of spectaclecase (mussel) (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/7867.

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: 8/12/2019

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 spectaclecase is a federally listed endangered species that is currently considered extant in 20 streams in Alabama, Arkansas, Illinois, Kentucky, Minnesota, Missouri, Tennessee, Virginia, West Virginia, and Wisconsin. Records indicate that the species historically occurred in Indiana, Kansas, and Ohio and at least 44 streams across the range. In the 20 streams, the species status was declining in five streams, stable in five streams, and unknown in ten streams. No streams were categorized as improving at the time of listing. Since the time of listing, a relatively large spectaclecase population was discovered on the Ouachita River in Arkansas and an apparent reproducing population was found in the Green River in Kentucky in 2012 (Lewis Environmental Consulting 2013). Both rivers with these new populations were known to be occupied at the time of listing. Two streams (Ohio River (Illinois) and Duck River (Tennessee)) where the species was thought to be extant at the time of listing are now questionable due to the small number of individuals observed and the number of years since the last detection of the species (1994 and 1999, respectively) despite more recent surveys. The species is now presumed extirpated in the Mullberry River in Arkansas (it was considered unknown at the time of listing). In summary, the species' status has not significantly changed since the time of listing.

Large-river habitat throughout most of the spectaclecase's range has been impounded, leaving short, isolated patches of habitat in areas between dams. Other threats include impoundments, point and nonpoint source pollution, sedimentation, and physical changes in streambed structure. These threats are exacerbated as a result of the small size and isolation of remaining populations. See the 2012 listing rule (77 FR 14914) for a detailed discussion of these factors.

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 19.1% of the species range will contain methomyl use sites (Table 64).

Usage

Past usage data indicate that up to 1.3 % of the species' range has been treated with methomyl annually. Use layers with the highest usage include corn (0.8%) and alfalfa (0.3%) (Table 64).

Table 64. Overlap and usage for the spectaclecase (mussel).

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	2	0.3
Citrus	NA	NA
Corn[32]	16.3	0.8
Cotton	0.1	<0.1
Other Grains	0.5	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	<0.1	<0.1
Soybeans	15.3	0.8
Vegetables and Ground Fruit	0.2	0.2
Wheat	NA	NA
Total	**19.1**	**1.3**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (19.1%). Based on past usage data, we expect a low portion of the range is likely to be treated with methomyl (1.3% annually). As such, we expect a medium portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater.

[32] 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.

Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 65 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the spectaclecase occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 321 μg/L, depending on the type of habitat and region (Table 65). Based on this range of potential exposures, we expect between 0-0.61% of exposed host fish will die, which is not likely to reduce the availability of fish hosts needed for successful reproduction. Two host fish for the spectaclecase mussel were confirmed in 2017 and include the mooneye (*Hiodon tergisus*) and goldeye (*H. alosoides*) (Sietman et al. 2017, p. 18), with research efforts continuing to identify new host fish. While the goldeneye is common in the rivers within the spectaclecase range, the mooneye is less abundant in these areas and is a state-listed threatened species in Michigan, New York, and North Carolina where the spectaclecase is found. The goldeye prefers muddy, open waters of medium to large-sized rivers with low gradient and firm sand substrates. In Iowa and Minnesota, goldeneyes live in quiet backwaters of larger streams and muddy shallows of lakes. The mooneye is found in larger pools of streams and the open waters of reservoirs, so low flow and larger static water bodies. Even though the mussel is a host fish specialist and one of the host fish is found in low flow waters in lower abundance (i.e., mooneye), we anticipate a low level of adverse effects to the reproductive cycle of the mussel due to low expected fish mortality.

Table 65. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_10a	23.26	0
High flow waterbodies	HUC_11a	48.83	0
High flow waterbodies	HUC_3	34.82	0
High flow waterbodies	HUC_4	24.17	0
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0
Large volume waterbodies	HUC_10a	12.45	0
Large volume waterbodies	HUC_11a	29.03	0
Large volume waterbodies	HUC_3	18.67	0
Large volume waterbodies	HUC_4	11.86	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Large volume waterbodies	HUC_7	12.21	0
Large volume waterbodies	HUC_8	31.29	0
Low flow/Low volume waterbodies	HUC_10a	248.40	0.13
Low flow/Low volume waterbodies	HUC_11a	321.30	0.61
Low flow/Low volume waterbodies	HUC_3	171.00	0.01
Low flow/Low volume waterbodies	HUC_4	244.80	0.12
Low flow/Low volume waterbodies	HUC_5	229.50	0.08
Low flow/Low volume waterbodies	HUC_6	164.70	0.01
Low flow/Low volume waterbodies	HUC_7	209.70	0.04

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
Low flow/Low volume waterbodies	HUC_8	225.90	0.07

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the spectaclecase mussel could be exposed to methomyl in 19.1% of the species range based on methomyl use sites and up to 1.3% of the range may be treated with methomyl annually (Table 64) thus exposure is likely to be moderate.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the spectaclecase. We anticipate some 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 fish host species for the spectaclecase mussel are the mooneye and goldeye. The expected mortality to the fish host is low (0-0.61%) and reproduction for a small number of mussels will be adversely impacted. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual spectaclecase mussels will experience adverse effects.

Conclusion

The spectaclecase is a federally listed endangered species that is currently considered extant in 20 streams in Alabama, Arkansas, Illinois, Kentucky, Minnesota, Missouri, Tennessee, Virginia, West Virginia, and Wisconsin. Records indicate that the species historically occurred in at least 44 streams and also historically occurred in Indiana, Kansas, and Ohio. Large-river habitat throughout most of the spectaclecase's range has been impounded, leaving short, isolated patches of habitat in areas between dams. Other threats include impoundments, point and nonpoint source pollution, sedimentation, and physical changes in streambed structure. These threats are exacerbated as a result of the small size and isolation of remaining populations. Threats persist for the remaining spectaclecase populations, including habitat degradation and effects of climate change.

The species range occurs near methomyl use sites overlapping 13.9% of the range, but a small portion of the range has experienced methomyl usage in the past (1.3% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The fish host species for the spectaclecase are the mooneye and goldeye. The spectaclecase occurs in high flow waterbodies and the host fish occur across numerous aquatic habitats. All aquatic habitats occur in eight HUCs, each of which has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.61%, with low rates of mortality anticipated for host fish in all aquatic habitats. One of the spectaclecase's host fish (i.e., goldeneye) is commonly dispersed throughout the range of the mussel and uses various components of aquatic habitats throughout their life cycles. The other host fish (i.e., mooneye) is state-listed as threatened and uncommon. 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 the species has high vulnerability and medium exposure, we anticipate low host fish mortality (<0.1%) where methomyl exposure occurs. Therefore, we expect impacts to the mussel to be low and a very small number of individuals will be adversely affected over the course of the action. After incorporating conservation measures into the effects of the action, accounting for 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 spectaclecase in the wild.

Reference

U.S. Fish and Wildlife Service. 2019. 5-Year Review: Summary and Evaluation for Spectaclecase mussel (*Cumberlandia monodonta*). Bloomington, Minnesota. 19 pp.

Integration and Synthesis Summary: - Snuffbox mussel

Scientific Name:	Common Name:	Entity ID:
Epioblasma triquetra	Snuffbox mussel	5281

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 32). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 snuffbox mussel. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 1/23/2023; Wherever found; *States within the range:* AL, AR, IL, IN, KY, MI, MN, MO, MS, NY, OH, PA, TN, VA, WI, WV. Figure 32 depicts the species' range.

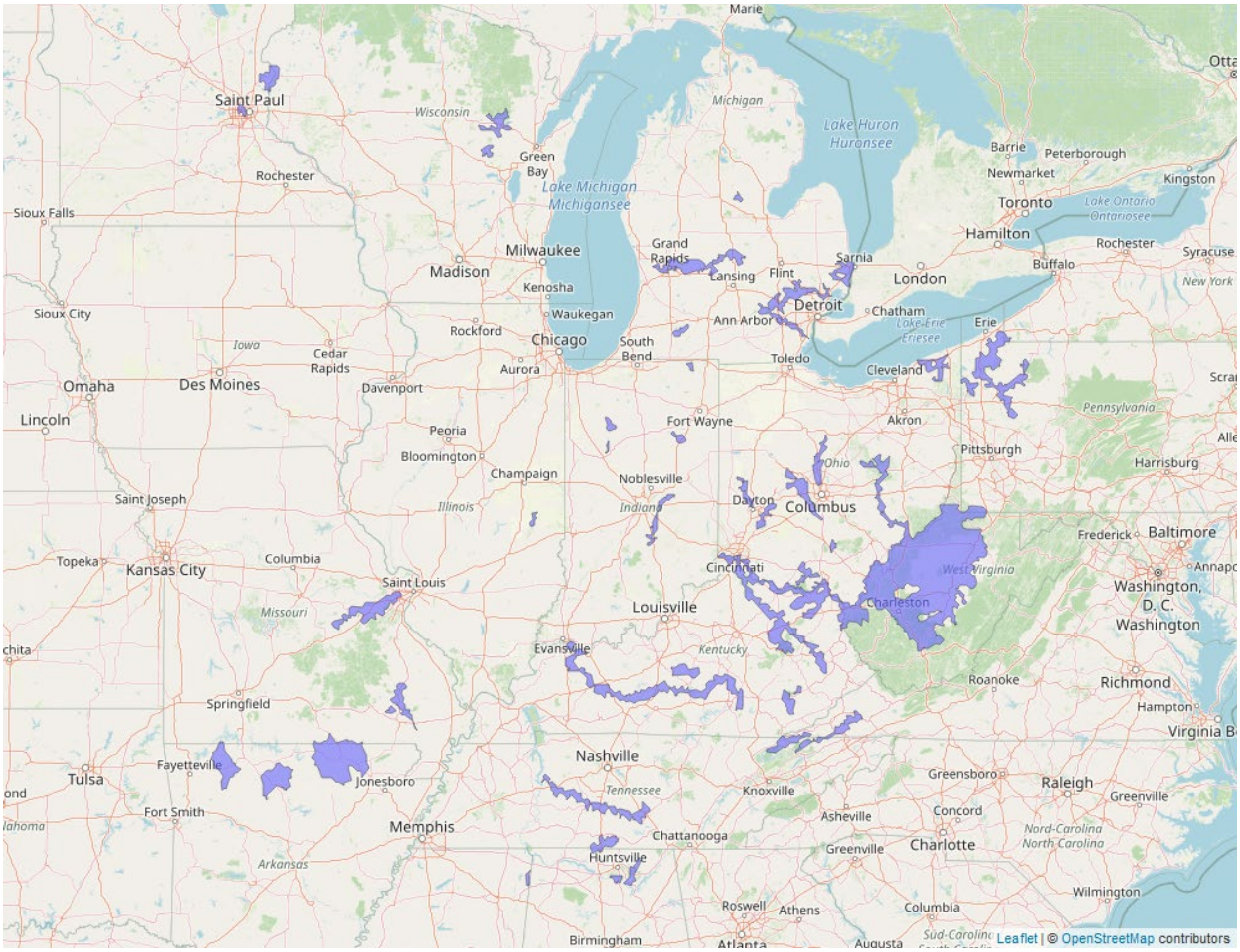

Figure 32. Range map of snuffbox mussel (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/4135.

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: 3/19/2024

Distribution: Species/Populations widespread or wide-ranging

Number of populations: Multiple populations (numerous)

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

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

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The snuffbox is a federally listed endangered species that is currently considered extant in 85 streams in 14 states including Alabama, Arkansas, Illinois, Indiana, Kentucky, Michigan, Minnesota, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, Wisconsin, and Ontario, Canada. At the HUC8 unit level, these 85 occupied streams are considered to be 55 populations. The snuffbox was historically distributed in at least 211 streams and lakes in the Great Lakes (~21% of streams), Ohio River (~50%), Tennessee River (~25%), Upper Mississippi River (~10%), Lower Mississippi River (<1%), Arkansas-White-Red (~6%), and Lower Missouri River Basins (~4%) in 18 states: Alabama, Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Mississippi, Missouri, New York, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin; and Ontario, Canada. At the time of the previous 5-year review in 2019, the species was known to be extant in 82 streams in 14 states: Alabama, Arkansas, Illinois, Indiana, Kentucky, Michigan, Minnesota, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, Wisconsin, and Ontario, Canada.

In 2023, a new location for snuffbox was found in a small section of the Thornapple River in Michigan near the confluence with the Grand River (Johnson 2023, pers. comm.). This is a small range expansion in the Lower Grand population. A live female snuffbox was found in Spring Creek, a tributary to the Little Kanawha River in West Virginia in 2018 (USFWS 2018). Prior to this record, the species was not known from Spring Creek. This is a small range expansion in the Little Kanawha population.

The 2022 SSA found that of the 55 extant populations, 32 (57%) have a low demographic condition and 6 (11%) have a very low/functionally extirpated demographic condition. Only 8 (14%) have a high current demographic condition while 9 (16%) have a moderate demographic condition (USFWS 2022a).

Successful propagation techniques for the snuffbox are well established. Propagation and augmentation and/or reintroduction of snuffbox are ongoing in Indiana, Tennessee, Wisconsin, and Virginia. The methods being used include host fish inoculation and in vitro culture of glochidia without utilizing host fish. Where host fish are being utilized, the fish are inoculated with larvae then either released into a stream or kept in cages or tanks to grow juvenile mussels to a stockable size. Streams with ongoing efforts include the Wolf River (Wisconsin), Tippecanoe River (Indiana), Clinch River (Tennessee, Virginia), Powell River (Tennessee, Virginia), and Duck River (Tennessee).

The status of the snuffbox remained relatively constant since listing and the previous 5-year review. Additionally, threats persist for the remaining snuffbox populations, including habitat degradation and climate change effects. Many of the remaining populations are small and restricted to short river reaches making them vulnerable to stochastic events such as spills and drought. Although there are ongoing attempts to alleviate some threats, there appear to be no populations without current significant threats and many threats are without obvious or readily available solutions.

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 21% of the species range will contain methomyl use sites (Table 66).

Usage

Past usage data indicate that up to 2.2 % of the species' range has been treated with methomyl annually. Use layers with the highest usage include vegetables and ground fruit (0.8%), corn (0.8%), and alfalfa (0.4%) (Table 66).

Table 66. Overlap and usage data for the snuffbox mussel.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	2.5	0.4
Citrus	NA	NA
Corn[33]	16.5	0.8
Cotton	0.2	<0.1
Other Grains	0.5	<0.1
Other Orchards	0.1	0.1
Other Row Crops	0.3	0.1

[33] 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)
Soybeans	16.4	0.8
Vegetables and Ground Fruit	0.8	0.8
Wheat	NA	NA
Total	**21**	**2.2**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (21%). Based on past usage data, we expect a small portion of the range is likely to be treated with methomyl (2.2% annually). As such, we expect a medium portion of the range and a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 67 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.
Aquatic habitat buffers: The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds".

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the snuffbox mussel occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 321 µg/L, depending on the type of habitat and region (Table 67). Based on this range of potential exposures, we expect between 0-0.61% of exposed host fish will die, which is not likely to reduce the availability of fish hosts needed for successful reproduction. The verified snuffbox host fish are the logperch (*Percina caprodes*), blackside darter (*P. maculata*), rainbow darter (*Etheostoma caeruleum*), Iowa darter (*E. exile*), blackspotted topminnow (*Fundulus olivaceous*), mottled sculpin (*Cottus bairdii*), banded sculpin (*C. carolinae*), Ozark sculpin (*C. hypselurus*), largemouth bass (*Micropterus salmoides*), and brook stickleback (*Culaea inconstans*). We anticipate a low level of adverse effects to the reproductive cycle of the mussel because they use many common and abundant fish host species that are found in a variety of aquatic habitats.

Table 67. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_10a	23.26	0
High flow waterbodies	HUC_11a	48.83	0
High flow waterbodies	HUC_3	34.82	0
High flow waterbodies	HUC_4	24.17	0
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0
Large volume waterbodies	HUC_10a	12.45	0
Large volume waterbodies	HUC_11a	29.03	0
Large volume waterbodies	HUC_3	18.67	0
Large volume waterbodies	HUC_4	11.86	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Large volume waterbodies	HUC_7	12.21	0
Large volume waterbodies	HUC_8	31.29	0
Low flow/Low volume waterbodies	HUC_10a	248.40	0.13

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
Low flow/Low volume waterbodies	HUC_11a	321.30	0.61
Low flow/Low volume waterbodies	HUC_3	171.00	0.01
Low flow/Low volume waterbodies	HUC_4	244.80	0.12
Low flow/Low volume waterbodies	HUC_5	229.50	0.08
Low flow/Low volume waterbodies	HUC_6	164.70	0.01
Low flow/Low volume waterbodies	HUC_7	209.70	0.04
Low flow/Low volume waterbodies	HUC_8	225.90	0.07

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the snuffbox mussel could be exposed to methomyl in 21% of the species range based on methomyl use sites and up to 2.2% of the range may be treated with methomyl annually (Table 66) thus exposure is likely to be moderate.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the snuffbox mussel. We anticipate some 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 snuffbox mussel is a fish host generalist and our mortality estimates are low (0-0.61%). In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. We anticipate reproduction for a low number of individual snuffbox mussels will be adversely impacted. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual snuffbox mussels will experience adverse effects.

Conclusion

The snuffbox is a federally listed endangered species that is known to be extant in 85 streams in Alabama, Arkansas, Illinois, Indiana, Kentucky, Michigan, Minnesota, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, Wisconsin, and Ontario, Canada. At the HUC8 unit level, these 85 occupied streams are considered to be 55 populations. Successful propagation techniques for the snuffbox are well established. Propagation and augmentation and/or reintroduction of snuffbox are ongoing in Indiana, Tennessee, Wisconsin, and Virginia. Threats persist for the remaining snuffbox populations, including habitat degradation and climate change effects. Many of the remaining populations are small and restricted to short river reaches making them vulnerable to stochastic events such as spills and drought. Although there are ongoing attempts to alleviate some threats, there appear to be no populations without current significant threats and many threats are without obvious or readily available solutions.

The species range occurs near methomyl use sites overlapping 21% of the range, but a small portion of the range has experienced methomyl usage in the past (2.2% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The snuffbox mussel is a host fish generalist and verified host fish include the logperch, blackside darter, rainbow darter, Iowa darter, blackspotted topminnow, mottled sculpin, banded sculpin, Ozark sculpin, largemouth bass, and brook stickleback. The snuffbox and its host fish occur across numerous aquatic habitats. All aquatic habitats occur in eight HUCs (3, 4, 5, 6, 7, 8, 10a, and 11a), each of which has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.61%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, its host fish are abundant and common, they occur in multiple aquatic habitats, and we anticipate low host fish mortality (0-0.61%). Therefore, we expect impacts to the mussel to be low and a small number of individuals will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 snuffbox in the wild.

References

U.S. Fish and Wildlife Service. 2024. Snuffbox (*Epioblasma triquetra*) Statis Review: Summary and Evaluation. Columbus, Ohio. 13 pp.

U.S. Fish and Wildlife Service. 2019. Snuffbox (*Epioblasma triquetra*) 5-Year Review: Summary and Evaluation. Columbus, Ohio. 60 pp.

Integration and Synthesis Summary: - Rayed bean

Scientific Name:	Common Name:	Entity ID:
Villosa fabalis	Rayed bean	6062

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 33). Exposed individuals are unlikely to experience morality but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 rayed bean. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 1/19/2023; Wherever found; *States within the range:* IN, KY, MI, NY, OH, PA, TN, WV. Figure 33 depicts the species' range.

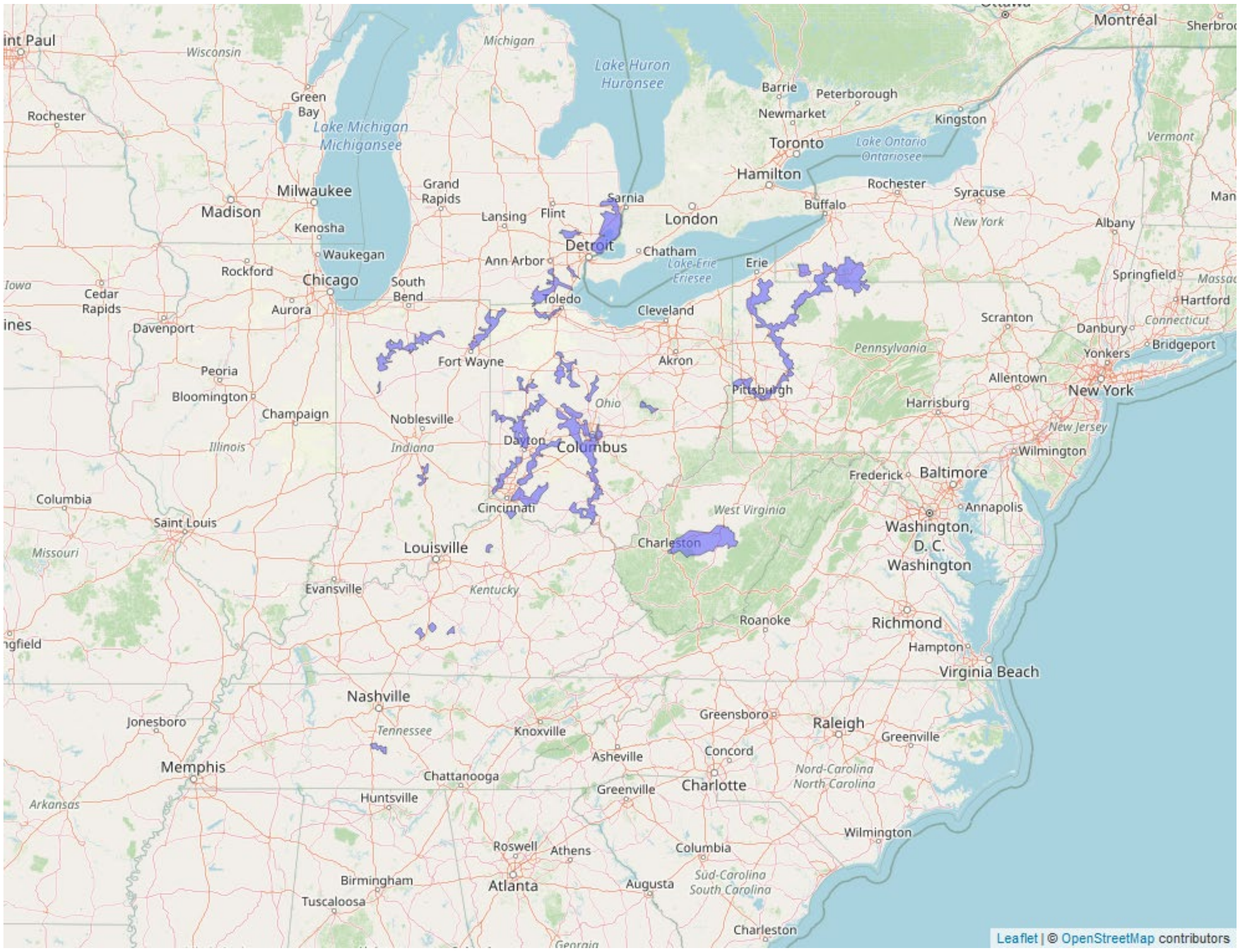

Figure 33. Range map of rayed bean (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/5862.

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: 11/28/2023

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

Number of populations: Multiple populations (few)

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

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

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The rayed bean is a federally listed endangered species that was historically distributed in at least 115 streams, lakes, and some human-made canals in the Great Lakes (~26%), Ohio (~64%), and Tennessee River (~10%) systems in 10 states: Illinois, Indiana, Kentucky, Michigan, New York, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia; and Ontario, Canada. At the time of the previous 5-year review in 2018, the species was known to be extant in 34 streams and one lake in 7 states: Indiana, Michigan, New York, Ohio, Pennsylvania, Tennessee, and West Virginia; and Ontario, Canada. Four Ohio streams where the species was thought to be extant during the previous five year review are now considered to be extirpated: the Walhonding River, Scioto Brush Creek, Little Miami River, and East Fork Little Miami River.

Currently the rayed bean occurs in seven states, as well as the Canadian province of Ontario. In Ohio in 2022, live rayed bean were found in the Auglaize River and fresh dead rayed bean were found in the Olentangy River and Little Darby Creek (Lawhon & Associates 2022; Hoggarth 2022; Gable 2023, pers. comm). Prior to these 2022 records, the rayed bean was thought to be extirpated in these three Ohio streams. A fresh dead rayed bean was also found in Pennsylvania in 2022 in Honeoyo Creek, a stream where the species had never been documented (Anderson 2022, pers. comm.). In 2020, the rayed bean was reintroduced into Kentucky in the Licking and Green Rivers using adults collected from the Allegheny River in Pennsylvania (McGregor 2022, pers. comm.). Currently, the rayed bean is known to be extant in 37 streams and one lake in Indiana, Kentucky, Michigan, New York, Ohio, Pennsylvania, Tennessee, West Virginia, and Ontario, Canada. Of the remaining populations, five (14 percent) are considered to be large and stable. This is unchanged since the species was listed. These five populations are the Sydenham River (Ontario), Swan Creek (Ohio), Blanchard River (Ohio), Allegheny River (Pennsylvania), and French Creek (Pennsylvania). Within these streams, the rayed 17 bean populations appear to be robust, with recent recruitment and harboring multiple year classes with no recent evidence of a decline in number. Thus, the status of the rayed bean has remained relatively constant since both listing and the previous five year review.

At the time of listing, destruction, modification, and curtailment of the species range was considered to be a threat to the species. Several projects have adversely affected some rayed bean populations since the time of listing. Bridge projects that affected rayed bean occurred in Swan Creek (Ohio), Allegheny River (Pennsylviania), and French Creek (Pennsylviania). A petroleum spill remediation project also affected rayed bean in the Allegheny River (New York). The rayed bean has experienced significant curtailment of its occupied range. The species has been eliminated from about 70 percent of the streams in which it historically occurred. This species has also been eliminated from long reaches of former habitat in hundreds of miles of the

Maumee, Ohio, Wabash, and Tennessee Rivers, and from numerous stream reaches in their tributaries. Furthermore, extant populations, with few exceptions, are highly fragmented and restricted to short stream reaches. The primary cause of range curtailment is modification and destruction of river and stream habitats, primarily by the construction of impoundments. Other factors contributing to the reduction in range include dredging and channelization, chemical contamination, oil and gas production, sand and gravel mining, siltation, and climate change effects.

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 29% of the species range will contain methomyl use sites (Table 68).

Usage

Past usage data indicate that up to 2.7% of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (1.3%) and vegetables and ground fruit (1%) (Table 68).

Table 68. Overlap and usage data for the rayed bean.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	1.8	0.3
Citrus	NA	NA
Corn	25.4	1.3
Cotton	<0.1	<0.1
Other Grains	0.2	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	0.2	0.1

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Soybeans[34]	25.7	1.3
Vegetables and Ground Fruit	1	1
Wheat	NA	NA
Total	**29**	**2.7**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (29%). Based on past usage data, we expect a low portion of the range is likely to be treated with methomyl (2.7% annually). As such, we expect a medium portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 69 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.
Aquatic habitat buffers: The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds".

[34] 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.

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the rayed bean occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 244 µg/L, depending on the type of habitat and region (Table 68). Based on this range of potential exposures, we expect between 0-0.12% of exposed host fish will die, which is not likely to reduce the availability of fish hosts needed for successful reproduction. The rayed bean is a host fish specialist, and they are only known to reproduce with the assistance of the Tippecanoe darter (*Etheostoma tippecanoe*) and spotted darter (*Etheostoma maculatum*). Both fish hosts are common, have short life spans, and are reproductive in their first year. They also tend to be associated with higher flow/volume waters. While mortality is varied based on the aquatic habitats where the mussel and its host fish are found, the Tippecanoe darter is likely common and abundant, and the spotted darter is common with unknown abundance. Therefore, we anticipate a low level of adverse effects to the reproductive cycle of the mussel.

Table 69. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_4	24.17	0
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_7	23.72	0
Large volume waterbodies	HUC_4	11.86	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Large volume waterbodies	HUC_7	12.21	0
Low flow/Low volume waterbodies	HUC_4	244.80	0.12
Low flow/Low volume waterbodies	HUC_5	229.50	0.08
Low flow/Low volume waterbodies	HUC_6	164.70	0.01

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
Low flow/Low volume waterbodies	HUC_7	209.70	0.04

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the rayed bean could be exposed to methomyl in 29% of the species range based on methomyl use sites and up to 2.7% of the range may be treated with methomyl annually (Table 68) thus exposure is likely to be moderate.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the rayed bean. We anticipate some 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 fish host species for the rayed bean mussel include the Tippecanoe and spotted darters, both of which are common, have short life spans, and are reproductive in their first year. They also tend to be associated with higher flow/volume waters. Expected mortality to the fish host is low (0-0.12%). In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual rayed bean mussels will experience adverse effects.

Conclusion

The rayed bean is a federally listed endangered species that is currently known to be extant in 37 streams and one lake in Indiana, Kentucky, Michigan, New York, Ohio, Pennsylvania, Tennessee, West Virginia, and Ontario, Canada. The status of the rayed bean has remained relatively constant since both listing and the previous 5-year review (they have been extirpated from four steams and found or reintroduced into seven additional streams). Additionally, threats persist for the remaining rayed bean populations, including habitat degradation and climate change effects. Many of the remaining populations are small and restricted to short river reaches, making them vulnerable to stochastic events such as spills and drought. The life history of the species is poorly known, and captive propagation has not been initiated, thereby preventing efforts to improve the species status using augmentation and reintroduction.

The species range occurs near methomyl use sites overlapping 29% of the range, but a small portion of the range has experienced methomyl usage in the past (2.7% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The rayed bean is a host fish specialist and is known to reproduce only with the assistance of the Tippecanoe darter and spotted darter. The rayed bean and its host fish occur across numerous aquatic habitats in four HUCs (4, 5, 6, and 7), each of which has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.12%, with low rates of mortality anticipated for host fish in all aquatic habitats. Tippecanoe darters inhabit fourth- order and larger streams and rivers and prefer riffles and runs with rocky bottom substrates and adequate water flow to keep spaces between and under rocks free from sediment. Spotted darters are found in medium sized rivers and streams, typically in areas of swift current at the top or bottom end of a riffle where there are many very large boulders or flat slabs of rock. Both fish species have short lifespans, reproduce quickly, and are more commonly found in higher flow/volume waters. 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 the species has high vulnerability and medium exposure, host fish are common, they occur in multiple aquatic habitats and prefer higher flow/volume waterbodies, and we anticipate low host fish mortality (0-0.12%). We expect impacts to the mussel to be low and a small number of individuals will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 rayed bean in the wild.

References

U.S. Fish and Wildlife Service. 2023. Rayed Bean (*Villosa fabalis*) Status Review: Summary and Evaluation. Columbus, Ohio. 11 pp.

U.S. Fish and Wildlife Service. 2018. Rayed Bean (*Villosa fabalis*) 5-Year Review: Summary and Evaluation. Columbus, Ohio. 27 pp.

Integration and Synthesis Summary: - Tapered pigtoe

Scientific Name:	Common Name:	Entity ID:
Fusconaia burkei	Tapered pigtoe	6534

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 is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 34). Exposed individuals are unlikely to die but are likely to experience high levels of 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. Given that exposure is medium and the level of indirect effects is high, we determine the risk of adverse effects to the species is high. As such, we expected a moderate number of individuals were likely to experience 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 tapered pigtoe to be low. After incorporating conservation measures into the effects of the action, accounting for 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 tapered pigtoe. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 2/9/2022; Wherever found; *States within the range:* AL, FL. Figure 34 depicts the species' range.

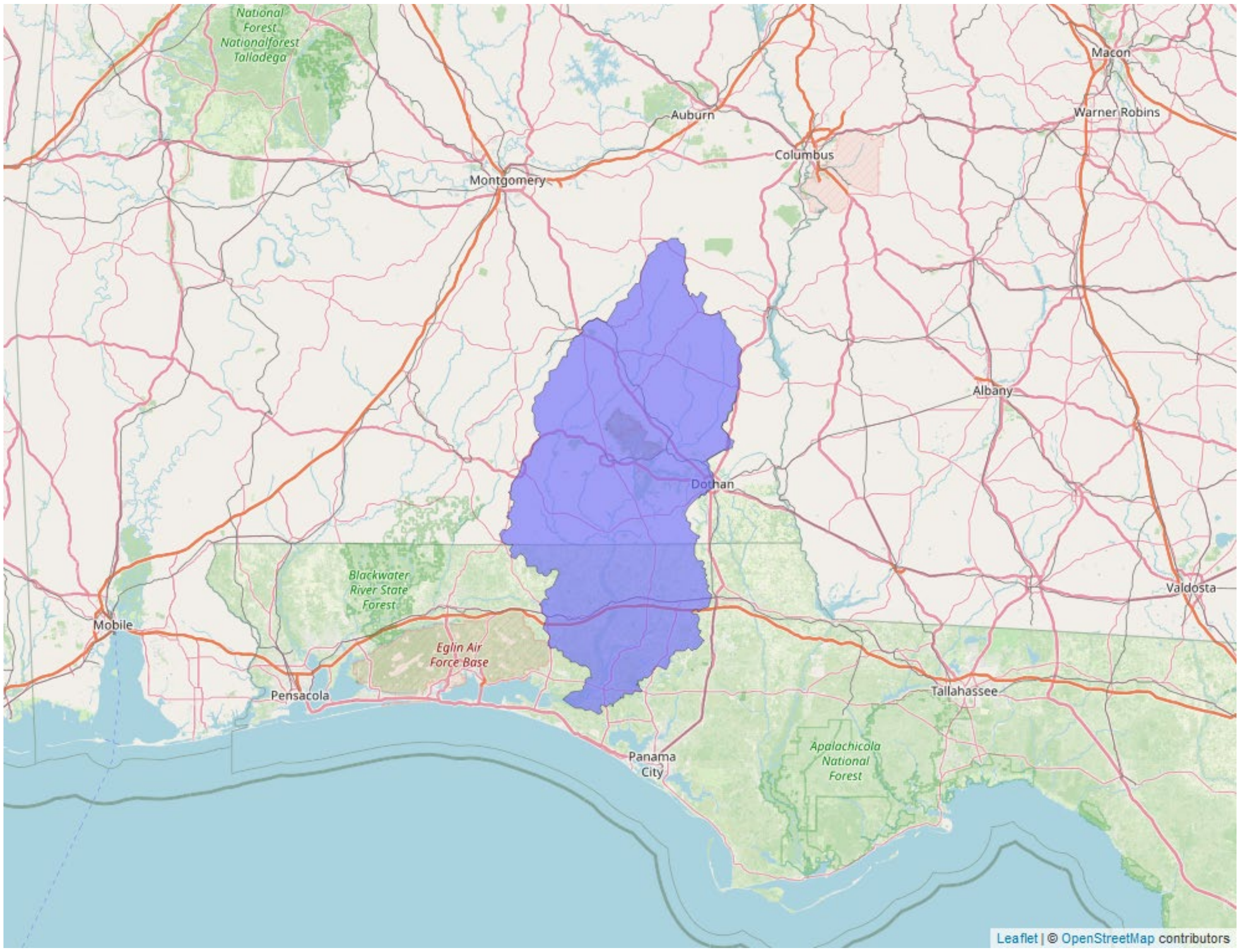

Figure 34. Range map of tapered pigtoe (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/5046.

Vulnerability

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

Summary of status

Listing status: Threatened

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

Most recently completed 5-Year Review: 9/13/2022

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 tapered pigtoe is a threatened species. Records are known from the Choctawhatchee River basin in Alabama and Florida. Overall, the species exists in low abundance at most locations and appears extirpated in several historical reaches. New information indicates the species is relatively abundant in some high-quality stream systems, including Eightmile Creek (Alabama) and Bruce Creek (Florida). In the Pea sub-basin, 355 live individuals have been observed since 2000. Most of these individuals (n = 285) were collected during a long-term monitoring study in Eightmile Creek, a tributary to the lower Pea River. The species is less common in the sub-basin's upper reaches, where 25 live individuals were observed. Recent surveys in the Upper Choctawhatchee sub-basin detected 19 individuals at four locations. The species is likely extirpated in many historical Upper Choctawhatchee sub-basin stream systems, and the remaining populations are small and possibly isolated. The tapered pigtoe appears to be maintaining populations within the Lower Choctawhatchee sub-basin, where recent sampling documented at least 705 live individuals. Observations made during a long-term monitoring study in Bruce Creek (Florida) found a relatively large and reproducing population (USFWS 2022).

The primary cause of the decline of this mussel species has been the modification and destruction of their stream and river habitat, with sedimentation as the leading cause. Their stream habitats are subject to pollution and alteration from a variety of sources including adjacent land use activities, in-water activities, effluent discharges, and impoundments. Nonpoint-source pollution from land surface runoff originates from virtually all land use activities and includes sediments, fertilizer, herbicide and pesticide residues; animal wastes; septic tank leakage and gray water discharge; and oils and greases. Current activities and land uses that can negatively tapered pigtoes include unpaved road crossings, improper silviculture and agriculture practices, highway construction, housing developments, pipeline crossings, and cattle grazing. These activities can result in physical disturbance of stream substrates or the riparian zone, excess sedimentation and nutrification, decreased dissolved oxygen concentration, increased acidity and conductivity, and altered flow. Freshwater mussels are more sensitive than previously known to some chemical contaminants including chlorine, ammonia, copper, the pesticides chlorothalonil and glyphosate, and the surfactant MON 0818 (USFWS 2022).

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 21.2% of the species range will contain methomyl use sites (Table 70).

Usage

Past usage data indicate that up to 4.6% of the species' range has been treated with methomyl annually. Use layers with the highest usage include other row crops (3.3%) and vegetables and ground fruit (0.4%) (Table 70).

Table 70. Overlap and usage data for the tapered pigtoe.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn[35]	2.4	0.1
Cotton	6.8	0.3
Other Grains	4	0.2
Other Orchards	0.3	0.3
Other Row Crops	7.2	3.3
Soybeans	2	0.1
Vegetables and Ground Fruit	0.4	0.4
Wheat	NA	NA
Total	**21.2**	**4.6**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (21.2%). Based on past usage data, we expect a low

[35] 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.

portion of the range is likely to be treated with methomyl (4.6% annually), and a medium portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

General Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 71 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the tapered pigtoe occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 59 to 814 μg/L, depending on the type of habitat and region (Table 71). Based on this range of potential exposures, we expect between 0-24% of exposed host fish will die, which could reduce the availability of fish hosts needed for successful reproduction. The tapered pigtoe is a fish host specialist and is likely to reproduce only with the assistance of the blacktail shiner (*Cyprinella venusta*). While there are a few different aquatic habitats where the tapered pigtoe is found, and mortality may vary to the fish host, this mussel has only one known fish host. Thus, we anticipate a high level of adverse effects to the reproductive cycle of the mussel.

Table 71. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_3	112.05	0
Large volume waterbodies	HUC_3	58.79	0
Low flow/Low volume waterbodies	HUC_3	813.60	24.41

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: High

Effects of the Action Summary

We expect the tapered pigtoe could be exposed to methomyl in 21.2% of the species range based on methomyl use sites and up to 4.6% of the range may be treated with methomyl annually (Table 70) thus exposure is likely to be moderate.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the tapered pigtoe. The fish host species for the tapered pigtoe mussel is likely only the blacktail shiner and mortality to the fish host is high (0-24%) in low flow/low volume waterbodies. As such, we anticipate a high amount of fish host mortality in low flow/low volume waterbodies where they likely breed. We also expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a high number of individual tapered pigtoe mussels will experience adverse effects.

Preliminary Conclusion (with General Conservation Measures)

The tapered pigtoe is listed as threatened and is known to exist from the Choctawhatchee River basin in Alabama and Florida. There is no indication that the species' distribution has changed substantially since it was listed. Overall, the species exists in low abundance at most locations and appears extirpated in several historical reaches including areas of the Upper Choctawhatchee subbasin, including the Little Choctawhatchee River system. New information indicates the species is relatively abundant in some high-quality stream systems, including Eightmile Creek (Alabama) and Bruce Creek (Florida). The primary cause of the decline of tapered pigtoe has been the modification and destruction of its stream and river habitat, primarily from sedimentation and pollution (including pesticide residues).

The species range occurs near methomyl use sites overlapping 21.2% of the range, but a low portion of the range has experienced methomyl usage in the past (4.6% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The tapered pigtoe is a host fish specialist that can only use the blacktail shiner for reproduction. The tapered pigtoe and its host fish occur in high flow and large volume waterbodies of HUC 3. Its host fish also occurs in low flow/low volume waterbodies and high volume waterbodies in HUC 3. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), mortality estimates range high rates of mortality anticipated for host fish in low flow/low volume waterbodies (0-24%) and no mortality anticipated in high flow and large volume waterbodies (0%). Larvae and juvenile fish are more likely to be exposed to methomyl in low flow/low volume waterbodies because these life stages are more likely to inhabit more shallow waters to avoid predation. We expect mortality to be limited to areas where low flow habitats occur and where methomyl use and subsequent spray drift or runoff occurs. 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.

Tapered pigtoes occur in low abundance and are extirpated from much of their historical range. Even though the host fish uses various aquatic habitats throughout its life cycle, host fish for the tapered pigtoe are very specific and we expect mortality to be high where the blacktail shiner likely breeds, in low flow/low volume waterbodies. Because the species has high vulnerability, medium exposure, one host fish, and high anticipated host fish mortality, we expect impacts to the mussel to be high and a large number of individuals will be adversely affected. Tapered pigtoes occur in low abundance and are extirpated from much of their historical range.

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 tapered pigtoe:

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

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

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

We anticipate that with the measures described above that these pathways of exposure will be greatly limited and result in exposure of very low numbers of individuals over the course of the action. After reviewing the current status of the listed species, environmental baseline for the action area, effects of the proposed action, cumulative effects, and species-specific conservation measures, 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 tapered pigtoe in the wild.

References

U.S. Fish and Widlife Service. 2022. Status Review: Summary and Evaluation for Round Ebonyshell (*Reginaia rotulata*), Southern Kidneyshell (*Ptychobranchus jonesi*), Choctaw Bean (*Obovaria choctawensis*), Tapered Pigtoe (*Fusconaia burkei*), Narrow Pigtoe (*Fusconaia Escambia*), Southern Sandshell (*Hamiota australis*), and Fuzzy Pigtoe (*Pleurobema strodeanum*). Panama City, Florida. 54 pp.

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants; Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat; Final Rule. Federal Register. 77 (196): 61664-61719.

Integration and Synthesis Summary: - Slabside pearlymussel

Scientific Name:	Common Name:	Entity ID:
Pleuronaia dolabelloides	Slabside pearlymussel	6841

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 35). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 slabside pearlymussel. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 11/5/2019; Wherever found; *States within the range:* AL, KY, MS, TN, VA. Figure 35 depicts the species' range.

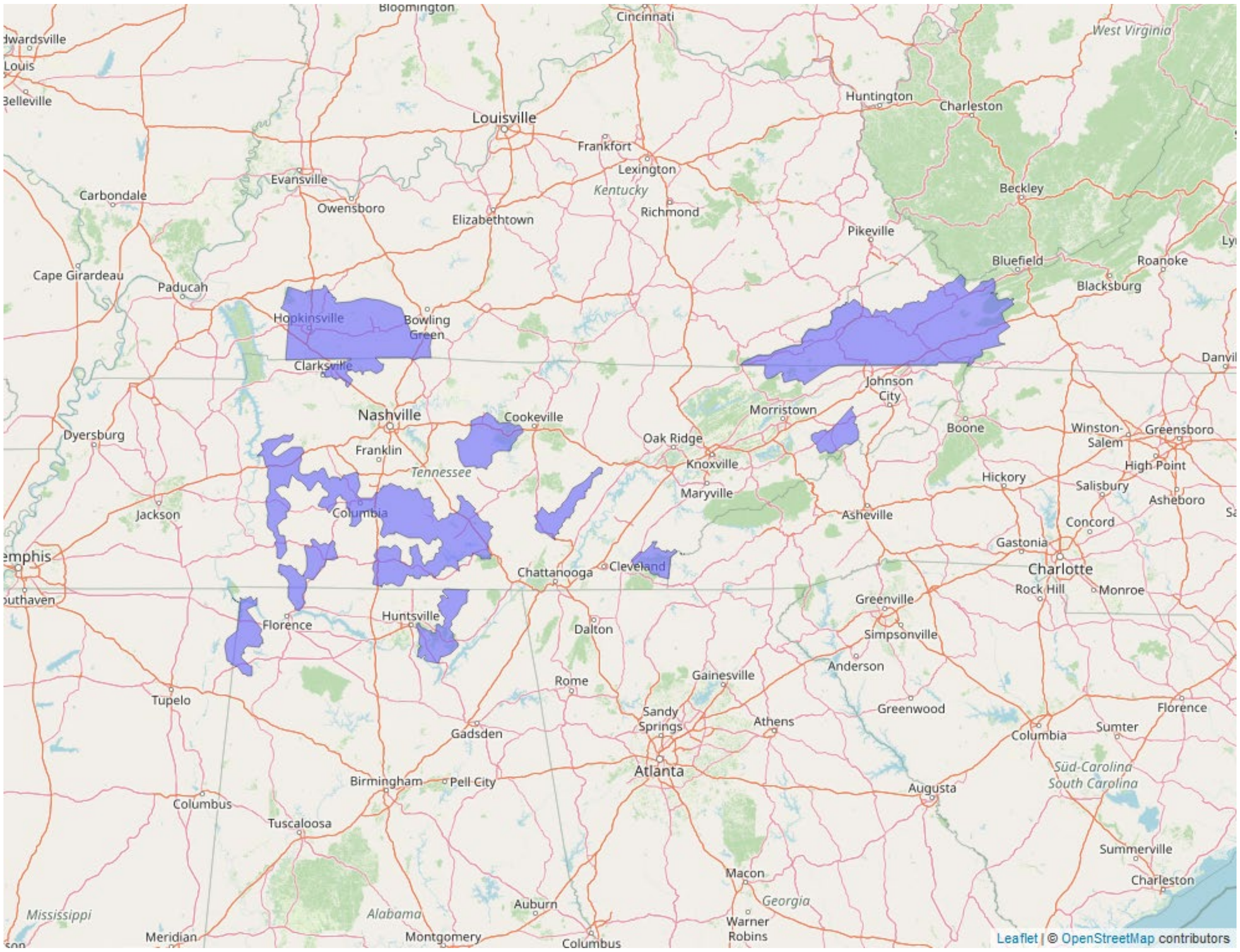

Figure 35. Range map of slabside pearlymussel (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/1518.

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: 8/9/2021

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 slabside pearlymussel is currently known from approximately 1,300 river kilometers. The slabside pearlymussel is endemic to the Cumberland and Tennessee River drainage of the Ohio River Basin, and has been reported from Alabama, Kentucky, Mississippi, Tennessee, and Virginia. While it is currently considered extirpated from the entire Cumberland River drainage, historically it was found in the main channel Cumberland River (Tennessee) and its tributaries, Caney Fork River (Tennessee) and the Red River (Tennessee/Kentucky) (Haag and Cicerello 2016). More widespread in the Tennessee River drainage, it was known to occur from headwaters in southwestern Virginia, downstream through Tennessee, Alabama, Mississippi, to, and including the Duck River (Tennessee) (Parmalee and Bogan 1998; Williams et al. 2008). The species is thought to be extirpated from the Tennessee River mainstem and from numerous of its larger tributaries and has suffered substantial population losses and range reductions across the drainage. However, the slabside pearlymussel does survive within the Tennessee River drainage, and is currently extant within the following tributaries (presented from upstream to downstream): Powell River (Virginia/Tennessee); Clinch River (Virginia/Tennessee) and its tributaries Plum Creek (Virginia), Little River (Virginia), and Copper Creek (Virginia); North Fork Holston River (Virginia) and its tributary Big Moccasin Creek (Virginia); Middle Fork Holston River (Virginia); Little River (Tennessee); Nolichucky River (Tennessee); Little Pigeon River (Tennessee); Hiwassee River (Tennessee); Sequatchie River (Tennessee); Paint Rock River (Alabama) and its tributaries Estill Fork (Alabama), Larkin Fork (Alabama), and Hurricane Creek (Alabama); Flint River (Alabama); Elk River (Tennessee/Alabama); Bear Creek (Alabama/Mississippi) and its tributary Cedar Creek (Mississippi); and the Duck River (Tennessee) and its tributaries Big Rock Creek (Tennessee) and the Buffalo River (Tennessee).

Reservoir construction has impounded and fragmented much of the habitat within the species' range; these habitat changes continue to have lasting effects through isolation of extant populations. Habitat degradation and water quality threats from land use activities (e.g., agriculture, development) continue at varying levels across the species' range. Additionally, climate change, pathogens, and/or other undefined threats may be affecting the species or could affect the species in the future; however, we do not know which specific factor or combination of factors are most significant in the continued decline of the species. The recent die-offs in the Clinch River and the enigmatic declines that have occurred in other populations demonstrate the precarious status of these populations and reveal our poor understanding of the threats to the species.

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 10.4% of the species range will contain methomyl use sites (Table 72).

Usage

Past usage data indicate that up to 0.7% of the species' range has been treated with methomyl annually. Use layers with the highest usage include soybeans (0.5%), vegetables and ground fruit (0.1%), and other row crops (0.1%) (Table 72).

Table 72. Overlap and usage data for the slabside pearlymussel.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn	8.5	0.4
Cotton	0.5	<0.1
Other Grains	0.2	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	0.2	0.1
Soybeans[36]	9.3	0.5
Vegetables and Ground Fruit	<0.1	0.1
Wheat	NA	NA
Total	**10.4**	**0.7**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (10.4%). Based on past usage data, we expect a low

[36] 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.

portion of the range is likely to be treated with methomyl (0.7% annually). As such, we expect a medium portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 73 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the slabside pearlymussel occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 229 μg/L, depending on the type of habitat and region (Table 73). Based on this range of potential exposures, we expect between 0-0.08% of exposed host fish will die, which is not likely to reduce the availability of fish hosts needed for successful reproduction. The slabside pearlymussel is a fish host generalist and is likely to reproduce with the assistance of several species of fish hosts such as the popeye shiner (*Notropis ariommus*), rosyface shiner (*N. rubellus*), saffron shiner (*N. rubricroceus*), silver shiner (*N. photogenis*), telescope shiner (*N.*

telescopus), Tennessee shiner (*N. leuciodus*), whitetail shiner (*Cyprinella galactura*), striped shiner (*Luxilus chrysocephalus*), warpaint shiner (*L. coccogenis*), white shiner (*L. albeolus*), and eastern blacknose dace (*Rhinichthys atratulus*) which are all common in the waterbodies where they are found. We anticipate a low (0-0.08%) reduction in fish host species availability in all habitats. Therefore, we anticipate a low level of adverse effects to the reproductive cycle of the mussel.

Table 73. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_3	34.82	0
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
Large volume waterbodies	HUC_3	18.67	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Low flow/Low volume waterbodies	HUC_3	171.00	0.01
Low flow/Low volume waterbodies	HUC_5	229.50	0.08
Low flow/Low volume waterbodies	HUC_6	164.70	0.01

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the slabside pearlymussel could be exposed to methomyl in 10.4% of the species range based on methomyl use sites and up to 0.7% of the range may be treated with methomyl annually (Table 72) thus exposure is likely to be moderate.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the slabside pearlymussel. We anticipate some 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. Fish hosts for the slabside pearlymussel mussel include several species of shiners and dace, and we expect mortality of exposed fish will be low (0-0.08%). In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual slabside pearlymussels will experience adverse effects.

Conclusion

The slabside pearlymussel is listed as endangered and has been eliminated from more than 70 percent of its historical range. The status of the slabside pearlymussel remains largely unchanged since the time of listing. Of remaining populations, the majority seem to be declining or suffering low resiliency and are at risk of extirpation. The Paint Rock River and Duck/Buffalo River populations remain the strongest populations and are characterized by recent recruitment and a multiple age class structure. Reservoir construction has impounded and fragmented much of the habitat within the species' range; these habitat changes continue to have lasting effects through isolation of extant populations. Habitat degradation and water quality threats from land use activities (e.g., agriculture, development) continue at varying levels across the species' range. Additionally, climate change, pathogens, and/or other undefined threats may be affecting the species or could affect the species in the future.

The species range occurs near methomyl use sites overlapping 10.4% of the range, but a small portion of the range has experienced methomyl usage in the past (0.7% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The slabside pearlymussel is a fish host generalist and is likely able to reproduce with the assistance of several species of fish hosts such as the popeye shiner, rosyface shiner, saffron shiner, silver shiner, telescope shiner, Tennessee shiner, whitetail shiner, striped shiner, warpaint shiner, white shiner, and eastern blacknose dace. The slabside pearlymussel occurs in high flow waterbodies and the host fish occurs across a range of aquatic habitats. All aquatic habitats occur in three HUCs (3, 5, and 6), each of which has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.08%, with low rates of mortality anticipated for host fish in all aquatic habitats.

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 the species has high vulnerability and medium exposure, its host fish are abundant and common, they occur in multiple aquatic habitats, and we anticipate low host fish mortality (0-0.08%). Therefore, we expect impacts to the mussel to be low and a small number of individuals will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 slabshell pearlymussel in the wild.

References

U.S. Fish and Wildlife Service. 2021. Slabside Pearlymussel (*Pleuronaia dolabelloides*) 5-Year Review: Summary and Evaluation. Cookeville, Tennessee. 20 pp.

Integration and Synthesis Summary: - Atlantic pigtoe

Scientific Name:	Common Name:	Entity ID:
Fusconaia masoni	Atlantic pigtoe	7048

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 36). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 Atlantic pigtoe. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 12/22/2021; Wherever found; *States within the range:* NC, VA. Figure 36 depicts the species' range.

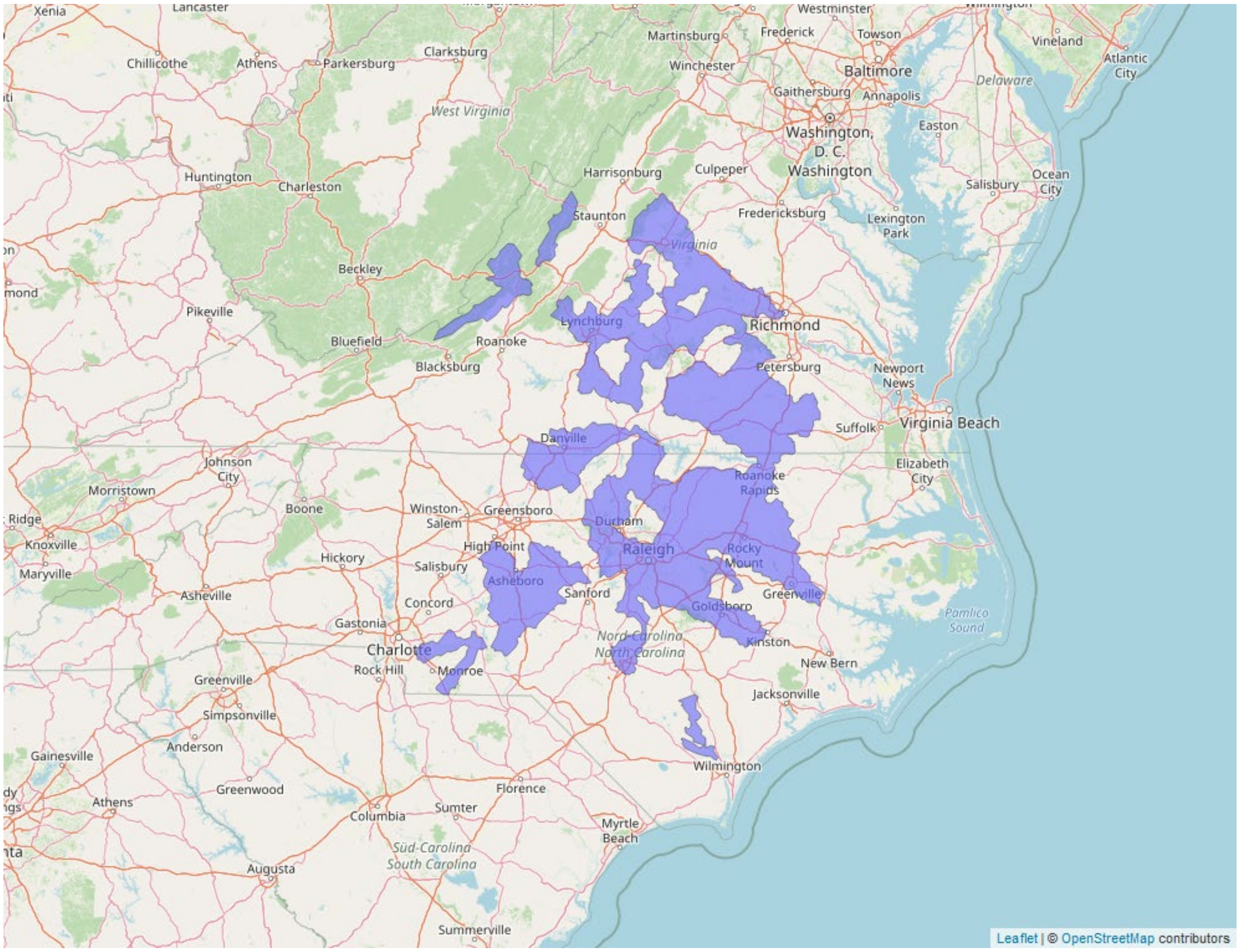

Figure 36. Range map of Atlantic pigtoe (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/5164.

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:

Most recently completed 5-Year Review:

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 Atlantic pigtoe was historically known from 81 HUC-10 watersheds within 12 river basins in Virginia, North Carolina, South Carolina, and Georgia. It is presumed extirpated from the southern portions of its range and is believed to be extant in seven populations across 32 HUC-10 watersheds in Virginia and North Carolina (James, Chowan, Roanoke, Tar-Pamlico, Neuse, Cape Fear, and Yadkin-Pee Dee River basins). Extant populations had observations in the last 10 years, many of which are fragmented (USFWS 2022). The Atlantic pigtoe has been documented from multiple physiographic provinces, from the foothills of the Appalachian Mountains through the Piedmont and into the Coastal Plain, in streams ranging in size from < 1 m wide up to some of the largest Atlantic Slope rivers within the species' range.

Atlantic pigtoe are threatened by habitat degradation (i.e., changes to water quality, water quantity, instream habitat, and habitat connectivity), pollution from municipal effluent outfalls and runoff, sedimentation, in-stream barriers, invasive species, and effects of climate change (Service 2022).

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 17.2% of the species range will contain methomyl use sites (Table 74).

Usage

Past usage data indicate that up to 2.4% of the species' range has been treated with methomyl annually. Use layers with the highest usage include other row crops (0.9%) and vegetables and ground fruit (0.8%) (Table 74).

Table 74. Overlap and usage data for the Atlantic pigtoe.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn	5.3	0.3
Cotton	3.1	0.2
Other Grains	0.7	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	1.9	0.9
Soybeans[37]	10.5	0.5
Vegetables and Ground Fruit	0.8	0.8
Wheat	NA	NA
Total	**17.2**	**2.4**

Exposure Summary

A large portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (17.2%). Based on past usage data, we expect a low portion of the range is likely to be treated with methomyl (2.4% annually). As such, we expect a medium portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 75 the maximum predicted

[37] 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.

EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the Atlantic pigtoe occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 12 to 230 µg/L, depending on the type of habitat and region (Table 75). Based on this range of potential exposures, we expect between 0-0.08% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. The Atlantic pigtoe is a fish host generalist and is likely able to reproduce with the assistance of several species of fish hosts such as the rosefin shiner (*Lythrurus ardens*), creek chub (*Semotilus atromaculatus*), longnose dace (*Rhynichthys cataractae*), white shiner (*Luxilus albeolus*), satinfin shiner (*Cyprinella analostana*), bluehead chub (Nocomis leptocephalus), rosyside dace (*Clinostomus funduloides*), pinewoods shiner (*Lythrurus matutinus*), swallowtail shiner (*Notropis procne*), mountain redbelly dace (*Chrosomus oreas*), red shiner (*C. lutrensis*), and blacktail shiner (*C. venusta*). Because the Atlantic pigtoe is a fish host generalist that can be found in numerous aquatic habitats and we expect low fish mortality, we anticipate a low level of adverse effects to the reproductive cycle of the mussel.

Table 75. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_2	11.67	0
High flow waterbodies	HUC_3	34.82	0
High flow waterbodies	HUC_5	23.72	0
Low flow/Low volume waterbodies	HUC_2	141.30	0

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
Low flow/Low volume waterbodies	HUC_3	171.00	0.01
Low flow/Low volume waterbodies	HUC_5	229.50	0.08

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the Atlantic pigtoe could be exposed to methomyl in 17.2% of the species range based on methomyl use sites and up to 2.4% of the range may be treated with methomyl annually (Table 74) thus exposure is likely to be moderate.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the Atlantic pigtoe. We anticipate some 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. The fish host species for the Atlantic pigtoe mussel include several species of chub, shiners, and dace, and we expect low fish mortality (0-0.08%) where exposure occurs. These fish species are common in the waterbodies where the mussel and the fish host are found. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate reproduction for a small number of Atlantic pigtoe individuals will be adversely impacted.

Conclusion

The Atlantic pigtoe is listed as threatened. The historical range of the Atlantic pigtoe included streams and rivers in the Atlantic Slope drainages from the James River Basin to the Altamaha River Basin with the documented historical distribution in 28 management units within twelve former populations. The Atlantic pigtoe is presumed extirpated from 54% (15/28) of the historically occupied management units. Of the remaining 13 occupied management units, only three (21%) are estimated to be highly resilient, five (36%) are moderately resilient, and five (43%) have low resiliency. Scaling up from the management unit to the population level, one of twelve former populations (the Tar Population) was estimated to have high resiliency, one population (the Neuse Population) was estimated to have moderate resiliency, five populations (James, Chowan, Roanoke, Cape Fear, Pee Dee) had low estimated resiliency, and five of the former 12 populations are presumed extirpated, thus eliminating 42%, or the entire southern portion, of the species' range. 71% of streams that remain part of the current species' range are estimated to be in low condition, potentially putting the Atlantic pigtoe at risk of extirpation. Once known to occupy streams in three physiographic regions, the species has also lost substantial physiographic representation. An estimated 67% loss has occurred in the Mountain watersheds, 48% loss in the Piedmont, and 76% loss in the Coastal Plain watersheds. The Atlantic pigtoe faces a variety of threats from declines in water quality, loss of stream flow, riparian and instream habitat fragmentation, and deterioration of instream habitats and these threats are expected to be exacerbated by urbanization and climate change.

The species range occurs near methomyl use sites overlapping 17.2% of the range, but a small portion of the range has experienced methomyl usage in the past (2.4% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The Atlantic pigtoe is a fish host generalist and is likely to reproduce with the assistance of several species of fish hosts such as the rosefin shiner, creek chub, longnose dace, white shiner, satinfin shiner, bluehead chub, rosyside dace, pinewoods shiner, swallowtail shiner, mountain redbelly dace, red shiner, and blacktail shiner. The Atlantic pigtoe occurs in high flow waterbodies and the host fish occur in low flow/low volume waterbodies and high flow waterbodies. All aquatic habitats occur in three HUCs (2, 3, and 5), each of which has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.08%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, its host fish are abundant and common, they occur in multiple aquatic habitats, and we anticipate low host fish mortality (0-0.08%). Therefore, we expect impacts to the mussel to be low and a small number of individuals will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 Atlantic pigtoe in the wild.

References

U.S. Fish and Wildlife Service. 2022. Recovery Outline for Atlantic Pigtoe (*Fusconaia masoni*). Raleigh, North Carolina. 11pp.

U.S. Fish and Wildlife Service. 2021. Species status assessment report for the Atlantic Pigtoe (*Fusconaia masoni*). Version 1.4. Atlanta, GA.

Integration and Synthesis Summary: - Suwannee moccasinshell

Scientific Name:	Common Name:	Entity ID:
Medionidus walkeri	Suwannee moccasinshell	7372

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 37). Exposed individuals are unlikely to die but are likely to experience medium levels of 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. Given that exposure is medium and the level of indirect effects is medium, we determined the risk of adverse effects to the species is medium. As such, we expected a moderate number of individuals were likely to experience 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 Suwannee moccasinshell to be low. After incorporating conservation measures into the effects of the action, accounting for 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 Suwannee moccasinshell. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 2/9/2022; Wherever found; *States within the range:* FL, GA. Figure 37 depicts the species' range.

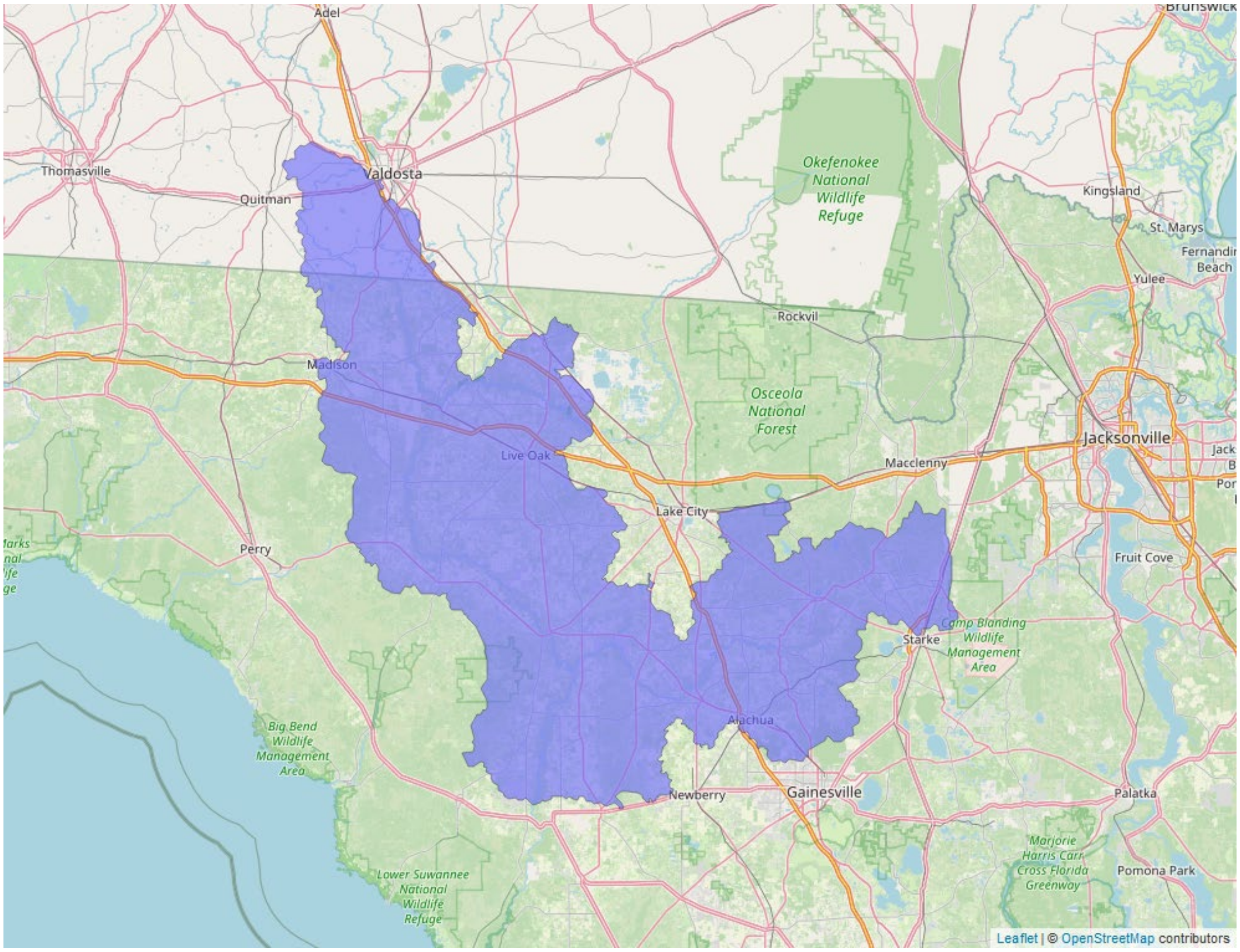

Figure 37. Range map of Suwannee moccasinshell (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/533.

Vulnerability

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

Summary of status

Listing status: Threatened

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

Most recently completed 5-Year Review: 9/14/2022

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 Suwannee moccasinshell is a small freshwater mussel endemic to the Suwannee River basin in southeast Georgia and north-central Florida. Its historical range is restricted to the mainstem of the Suwannee River and its two largest tributaries—the Santa Fe River sub-basin and the lower portion of the Withlacoochee River. The Suwannee River basin has unique hydrology in that it transitions from a tributary fed system to a karst, spring-fed system downstream of the Cody Scarp in Florida, where 90% of the flow of the lower Suwannee River is from spring and groundwater sources. The Santa Fe River runs underground for about 5 kilometers (3.1 miles) but is intermittently connected during high flow events. It is extirpated from the Withlacoochee River, upper Santa Fe sub-basin, and lower Suwannee River. It is known presently from the lower Santa Fe mainstem and Lower Suwannee sub-basin. Both populations are declining; the last observation in Santa Fe was in 2015 and only 88 live individuals and 11 shells have been detected in Lower Suwannee since 2005. The species likely has a limited ability to disperse and, therefore, may not be able recolonize areas from which it has been extirpated (USFWS 2022).

The primary reason for the Suwannee moccasinshell's decline is the degradation of its habitat due to polluted runoff from agricultural lands, polluted discharges from industrial and municipal facilities and mining operations, decreased flows due to groundwater extraction and drought, and stream channel instability. These threats occur throughout its range but are more intense in the Withlacoochee and Santa Fe River systems. In portions of its range, sedimentation has also impacted its habitat. Other threats to the species include state and federal water quality standards that are inadequate to protect sensitive aquatic organisms like mussels; accidental contaminant releases from industrial, municipal, and mining sources, and as a result of transportation accidents; increased drought frequency and higher temperatures as a result of changing climatic conditions; greater vulnerability to certain threats because of small population size and range; and competition and disturbance from the introduced Asian clam (*Corbicula fluminea*). These threats have resulted in the decline of the species throughout its range and pose the highest risk to populations in the two tributary systems, as evidenced by the species' decline and possible disappearance in the Withlacoochee River, and its decline in the Santa Fe River sub-basin. In the middle and lower reach of the Suwannee River main channel, the two greatest threats, pollutants and reduced flows, are attenuated by higher flow volumes. Suwannee moccasinshell populations in the Withlacoochee and Santa Fe River sub-basins are facing threats that are high in magnitude. Most of these threats, including reduced flows, pollution, degraded water quality, and channel instability, are expected to increase in the future due to human population growth and climate change (USFWS 2022).

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 15.7% of the species range will contain methomyl use sites (Table 76).

Usage

Past usage data indicate that up to 4.8% of the species' range has been treated with methomyl annually. Use layers with the highest usage include other row crops (2.6%) and vegetables and ground fruit (1.3%) (Table 76).

Table 76. Overlap and usage data for the Suwannee moccasinshell.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn[38]	3.9	0.2
Cotton	2	0.1
Other Grains	2.4	0.1
Other Orchards	0.5	0.5
Other Row Crops	5.7	2.6
Soybeans	1.4	0.1
Vegetables and Ground Fruit	1.3	1.3
Wheat	NA	NA
Total	**15.7**	**4.8**

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

Exposure Summary

A high portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (15.7%). Based on past usage data, we expect a low portion of the range is likely to be treated with methomyl (4.8% annually). As such, we expect a medium portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

General Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 77 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.
Aquatic habitat buffers: The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds", which includes vernal pools.

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the Suwannee moccasinshell occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 112 to 814 µg/L, depending on the type of habitat and region (Table 77). Based on this range of potential exposures, we expect between 0-24% of fish species will die, which could reduce the availability of fish hosts needed for successful reproduction. There is little information on the fish hosts for the Suwannee moccasinshell but, they are likely the blackbanded darter (*Percina nigrofasciata*) and brown darter (*Etheostoma edwini*). The brown darter and blackbanded darter are both common across the Suwannee moccasinshell's range; brown darters are more commonly found in shallow, flowing streams. Therefore, we anticipate moderate adverse effects to the reproductive cycle of the mussel.

Table 77. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_3	112.05	0
Low flow/Low volume waterbodies	HUC_3	813.60	24.41

While we do expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Medium

Effects of the Action Summary

We expect the Suwannee moccasinshell could be exposed to methomyl in 15.7% of the species range based on methomyl use sites and up to 4.8% of the range may be treated with methomyl annually (Table 76) thus exposure is likely to be moderate.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the Suwannee moccasinshell. The Suwannee moccasinshell mussel fish hosts are unknown but may use blackbanded darters and brown darters. Being a potential host fish specialist suggests that the Suwanne moccasinshell may be less resilient to possible changes in the fish host community and more susceptible to indirect effects of methomyl. We also expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a moderate amount of fish host mortality, and thus we anticipate reproduction for a moderate number of individual Suwannee moccasinshell mussels will be adversely impacted.

Preliminary Conclusion (with General Conservation Measures)

The Suwannee moccasinshell is a threatened species found only in the Suwannee River and in a short reach of the lower Santa Fe River southeastern Georgia and north-central Florida. Since being listed as threatened in 2016, the species' distribution remains limited to approximately

160-kilometers (99-miles) of stream channel. They occur in two sub-basins, both of which are declining in abundance and one of which has not been observed since 2015. They are extirpated from the Withlacoochee River, upper Santa Fe sub-basin, and lower Suwannee River. Threats to the species include pollution (e.g., agriculture, industrial and municipal discharges, mining), decreased flows (e.g., water withdrawals, drought), stream channel instability, and competition from invasive *Corbicula*. Groundwater and surface water withdrawals and nitrate levels have increased in recent years, and reduced flows and nutrient pollution are presently major drivers limiting the species' viability. Saltwater intrusion is an imminent threat to individuals remaining in the lower-most reach of the Suwannee mainstem (USFWS 2022).

The Suwannee moccasinshell is associated with substrates of muddy sand or sand with some gravel where it typically occurs near bank margins with a moderate slope, and in areas with moderate flow and slightly depositional conditions (USFWS 2015). A recent study provided important information on its habitat requirements and the influence of survey effort on detection of the mussel. Using survey data collected during 2013-2016 at 220 locations, researchers found that detection of the species is strongly and positively correlated to survey effort, and that sites with cumulative spring discharge greater than 28 cubic meters per second were the most likely to support Suwannee moccasinshell populations. The findings suggest that springs are a critical resource for the Suwannee moccasinshell and its darter hosts (e.g., *Etheostoma* and *Percina* species), as they might buffer tannic surface waters and maintain adequate flow and temperature during periods of drought (USFWS 2022).

The species range occurs near methomyl use sites overlapping 15.7% of the range and a medium portion of the range has experienced methomyl usage in the past (4.8% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The Suwannee moccasinshell's host fish are believed to be blackbanded darters and brown darters. The Suwannee moccasinshell and its presumed host fish occur in high flow waterbodies of HUC 3. Its host fish also occurs in low flow/low volume waterbodies in HUC 3. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), mortality estimates range from high rates of mortality anticipated for host fish in low flow/low volume waterbodies (24%) to no mortality anticipated in high flow waterbodies (0%). Larvae and juvenile fish are more likely to be exposed to methomyl in low flow/low volume waterbodies because these life stages are more likely to inhabit more shallow waters to avoid predation. Host fish mortality is limited to low flow habitats where methomyl use and subsequent spray drift or runoff occurs. Presumed host fish for the Suwannee moccasinshell are common throughout the range of the mussel, but the brown darter is more common in shallow, flowing streams, where we expect mortality will be higher. 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 the species has high vulnerability, medium exposure, and medium anticipated host fish mortality, we expect impacts to the mussel to be medium and a moderate number of individuals will be adversely affected.

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 Suwannee moccasinshell:

1) *Methomyl must be applied using the following buffers: 50 feet for aerial applications, 10 feet for ground applications and, 25 feet for airblast applications. Based on AgDRIFT modeling, the buffers will reduce spray drift from entering habitat for the Suwannee moccasinshell by 74 to 99%. These buffer distances may be reduced using other measures identified as equivalent mitigations (i.e., reducing spray drift by similar magnitude) as specified in EPA's Draft Insecticide Strategy and as described in Appendix A-1 of this Opinion.*
2) *Applicators need 3 points of mitigation as outlined in EPA's Draft Insecticide Strategy. This will reduce methomyl loads in the habitat of the Suwannee moccasinshell by an order of magnitude (i.e., a 10-fold reduction).*

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

We anticipate that with the measures described above that these pathways of exposure will be greatly limited and result in exposure of very low numbers of individuals over the course of the action. After reviewing the current status of the listed species, environmental baseline for the action area, effects of the proposed action, cumulative effects, and species-specific conservation measures, 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 Suwannee moccasinshell in the wild.

References

U.S. Fish and Wildlife Service. 2022. Suwannee Moccasinshell (*Medionidus walker*) Statue Review: Summary and Evaluation. Panama City, Florida. 13 pp.

U.S. Fish and Wildlife Service. 2015. Endangered and Threatened Wildlife and Plants; Proposed Threatened Species Status for the Suwannee Moccasinshell. Proposed Rule. Federal Register 80(193): 60335-60348.

Integration and Synthesis Summary: - Sheepnose mussel

Scientific Name:	Common Name:	Entity ID:
Plethobasus cyphyus	Sheepnose mussel	7816

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 38). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 sheepnose mussel. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 1/19/2023; Wherever found; *States within the range:* AL, IA, IL, IN, KY, MN, MO, MS, OH, PA, TN, VA, WI, WV. Figure 38 depicts the species' range.

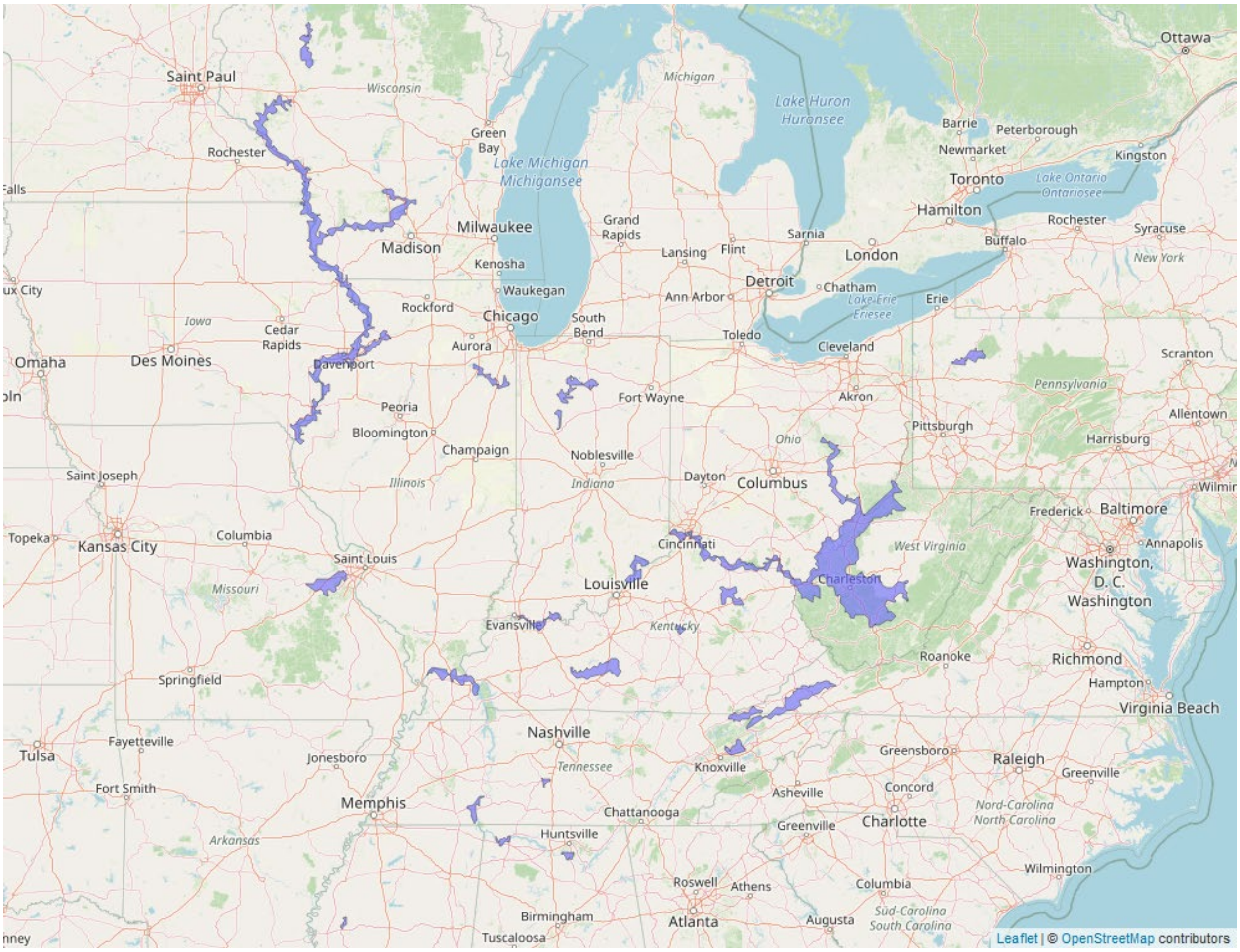

Figure 38. Range map of sheepnose mussel (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/6903.

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: 8/28/2020

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: yes

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The sheepnose is a federally listed endangered species with records indicating the species historically occurred in at least 76 streams in 14 states, including Alabama, Illinois, Indiana, Iowa, Kentucky, Minnesota, Mississippi, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin. The May 2012 final rule identified extant populations to include 25 streams in all 14 states of historical occurrence. At the time of listing, the sheepnose was considered to be improving in two streams, stable in ten streams, declining in 8 streams, and unknown in five streams. Currently, populations are considered to be stable to increasing in ten streams, stable in eight streams, declining in four streams, and unknown in 11 streams. Collectively, the last known and/or recent survey efforts have identified juvenile specimens in ten of the 25 populations, from three of the five extant river basin. Two of the extant basins, the Lower Missouri River Basin (Osage Fork Gasconade River) and the Lower Mississippi River Basin (Big Sunflower River), have not reported any new live or fresh dead specimens collected since 1999 and 2005, respectively, or recent evidence of recruitment (last known from the Big Sunflower River in 2003). The populations within these two basins are considered unknown due to the lack of new information. Should the populations in these two systems decline to the point of extirpation, the extant sheepnose range will be reduced from five to three occupied river basins (HUC 2).

Since the time of listing, a larger abundance of sheepnose was identified within Pool 15 of the Mississippi River than previously known, representing the species' only "extra large" population, with evidence of recent recruitment. This is the first evidence of sheepnose recruitment within the Mississippi River since 2001. Reproducing populations have been documented above Lock and Dam 5 on the Green River (Kentucky) and the Six Mile Dam on the Walhonding River (Ohio), with adult specimens identified below each of the dams. Both dams are currently being proposed for removal, resulting in the potential for range expansion within these two systems (USFWS 2020).

The decline of the sheepnose in the eastern U.S. is primarily the result of habitat loss and degradation. These losses have been well documented since the mid- 19th century. Chief among the causes of decline are impoundments, channelization, chemical contaminants, mining, and sedimentation. These stressors have had profound impacts on sheepnose populations and their habitat. The majority of the remaining populations of the sheepnose are generally small and geographically isolated. The patchy distributional pattern of populations in short river reaches makes them much more susceptible to extirpation from single catastrophic events, such as toxic chemical spills. Furthermore, this level of isolation makes natural repopulation of any extirpated population virtually impossible without human intervention. Although there are ongoing attempts to alleviate some of these threats at some locations, there appear to be no populations without significant threats, and many threats are without obvious or readily available solutions. Recruitment reduction or failure is a threat for many small sheepnose populations rangewide, a condition exacerbated by reduced range and increasingly isolated populations. If these trends continue, further significant declines in total sheepnose population size and consequent reduction in long-term viability may soon become apparent. Various exotic species of aquatic organisms are firmly established in the range of the sheepnose. The exotic species that poses the most significant threat to the sheepnose is the zebra mussel. The invasion of the zebra mussel poses a serious threat to mussel faunas in many regions, and species extinctions are expected from its continued spread in the eastern U.S. (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 30.5% of the species range will contain methomyl use sites (Table 78).

Usage

Past usage data indicate that up to 2.3% of the species' range has been treated with methomyl annually. Use layers with the highest usage include corn (1.3%) and vegetables and ground fruit (0.6%) (Table 78).

Table 78. Overlap and usage data for the sheepnose mussel.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	2.8	0.4
Citrus	NA	NA
Corn[39]	26.1	1.3
Cotton	0.4	<0.1

[39] 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 Grains	0.6	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	<0.1	<0.1
Soybeans	24.5	1.2
Vegetables and Ground Fruit	0.6	0.6
Wheat	NA	NA
Total	**30.5**	**2.3**

Additional Exposure Considerations

In addition to the sauger (*Sander canadensis*), 30 native host fish species have now been identified for the species, with indications that the sheepnose is a cyprinid specialist. Eleven species had higher production of sheepnose juveniles (denoted with a "*"): Central stoneroller (*Campostoma anomalum*)*, largescale stoneroller (*Campostoma oligolepis*), southern redbelly dace (*Chrosomus erythrogaster*), whitetail shiner (*Cyprinella galactura*)*, red shiner (*Cyprinella lutrensis*), spotfin shiner (*Cyprinella spiloptera*)*, blacktail shiner (*Cyprinella venusta*)*, steelcolor shiner (*Cyprinella whipplei*), brassy minnow (*Hybognathus hankinsoni*), Mississippi silvery minnow (*Hybognathus nuchalis*), common shiner (*Luxilus cornutus*)*, bleeding shiner (*Luxilus zonatus*), silver chub (*Macrhybopsis storeriana*)*, Allegheny pearl dace (*Margariscus margarita*), hornyhead chub (*Nocomis biguttatus*), golden shiner (*Notemigonus crysoleucas*)*, emerald shiner (*Notropis atherinoides*), river shiner (*Notropis blennius*), spottail shiner (*Notropis hudsonius*), Ozark minnow (*Notropis nubilus*)*, Topeka shiner (*Notropis topeka*)*, mimic shiner (*Notropis volucellus*), suckermouth minnow (*Phenacobius mirabilis*), bluntnose minnow (*Pimephales notatus*), fathead minnow (*Pimephales promelas*), bullhead minnow (*Pimephales vigilax*), eastern blacknose dace (*Rhinichthys atratulus*), longnose dace (*Rhinichthys cataractae*)*, creek chub (*Semotilus atromaculatus*)*, and striped shiner (*Luxilus chrysocephalus*) (USFWS 2020).

Exposure Summary

A high portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (30.5%). Based on past usage data, we expect a low portion of the range is likely to be treated with methomyl (2.3% annually), and a low portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: “Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office.” This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 79 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the sheepnose mussel occupies, EPA’s aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 9 to 321 µg/L, depending on the type of habitat and region (Table 79). Based on this range of potential exposures, we expect between 0-0.61% of exposed host fish will die, which is not likely to significantly reduce the availability of fish hosts needed for successful reproduction. The sheepnose mussel is a host fish generalist and a likely cyprinid specialist and has been found to use at least 30 species of host fish such as sauger, central stoneroller, largescale stoneroller, southern redbelly dace, whitetail shiner, red shiner, spotfin shiner, blacktail shiner, steelcolor shiner, brassy minnow, Mississippi silvery minnow, common shiner, bleeding shiner, silver chub, Allegheny pearl dace, hornyhead chub, golden shiner, emerald shiner, river shiner, spottail shiner, Ozark minnow, Topeka shiner, mimic shiner, suckermouth minnow, bluntnose minnow, fathead minnow, bullhead minnow, eastern blacknose dace, longnose dace, creek chub, and striped shiner. We expect a low level of adverse effects to the reproductive cycle of the mussel because there are many host fish species that are common in the waterbodies where the mussels are found and fish mortality is expected to be low.

Table 79. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_10a	23.26	0
High flow waterbodies	HUC_11a	48.83	0
High flow waterbodies	HUC_3	34.82	0
High flow waterbodies	HUC_4	24.17	0
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0
High flow waterbodies	HUC_9	18.85	0
Large volume waterbodies	HUC_10a	12.45	0
Large volume waterbodies	HUC_11a	29.03	0
Large volume waterbodies	HUC_3	18.67	0
Large volume waterbodies	HUC_4	11.86	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Large volume waterbodies	HUC_7	12.21	0
Large volume waterbodies	HUC_8	31.29	0
Large volume waterbodies	HUC_9	9.84	0
Low flow/Low volume waterbodies	HUC_10a	248.40	0.13
Low flow/Low volume waterbodies	HUC_11a	321.30	0.61
Low flow/Low volume waterbodies	HUC_3	171.00	0.01
Low flow/Low volume waterbodies	HUC_4	244.80	0.12
Low flow/Low volume waterbodies	HUC_5	229.50	0.08

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
Low flow/Low volume waterbodies	HUC_6	164.70	0.01
Low flow/Low volume waterbodies	HUC_7	209.70	0.04
Low flow/Low volume waterbodies	HUC_8	225.90	0.07
Low flow/Low volume waterbodies	HUC_9	161.10	0.01

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the sheepnose mussel could be exposed to methomyl in 30.5% of the species range based on methomyl use sites and up to 2.3% of the range may be treated with methomyl annually (Table 78) thus exposure is likely to be moderate.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the sheepnose mussel. We anticipate some 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 sheepnose mussel is a fish host generalist, and we expect low host fish mortality (0-0.61%) from methomyl exposure. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate reproduction for a small number of individual sheepnose mussels will be adversely impacted.

Conclusion

The sheepnose is a federally listed endangered species with records indicating the species historically occurred in at least 76 streams in 14 states, including Alabama, Illinois, Indiana, Iowa, Kentucky, Minnesota, Mississippi, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin. The May 2012 final rule identified extant populations to include 25 streams in all 14 states of historical occurrence. Currently, populations are considered to be stable to increasing in 2 streams, stable in 8 streams, declining in 4 streams, and unknown in 11 streams. Collectively, the last known and/or recent survey efforts have identified juvenile specimens in 10 of the 25 populations, from three of the five extant river basins. Large-river habitat throughout most of the sheepnose's range has been impounded, leaving short, isolated patches of habitat in areas between dams. These conditions result in population fragmentation, isolation, and other genetic related concerns. Other previously identified threats include, channelization, chemical contaminants, mining, sedimentation, disease or predation, invasive species, oil and gas development, temperature, and climate change.

The species range occurs near methomyl use sites overlapping 30.5% of the range, but a small portion of the range has experienced methomyl usage in the past (2.3% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The sheepnose is a host fish generalist and can successfully reproduce in the presence of at least 30 different species of fish. The sheepnose occurs in high flow waterbodies and the host fish occur across numerous aquatic habitats. All aquatic habitats occur in nine HUCs (3 4, 5, 6, 7, 8, 9, 10a, and 11a), each of which has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.61%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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.

The species is found in 25 streams across 14 states, eighteen of which are stable or increasing. Even though the species has high vulnerability and medium exposure, its host fish are abundant and common, they occur in multiple aquatic habitats, and we anticipate low host fish mortality (0-0.61%). Therefore, we expect impacts to the mussel to be low and a small number of individuals will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 sheepnose in the wild.

References

U.S. Fish and Wildlife Service. 2020. Sheepnose (*Plethobasus cyphyus*) 5-Year Review: Summary and Evaluation. Moline, Illinois. 32 pp.

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for the Sheepnose and Spectaclecase Mussels Throughout Their Range. Federal Register 77 (49): 14914-14949.

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 determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 39). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 39 depicts the species' range.

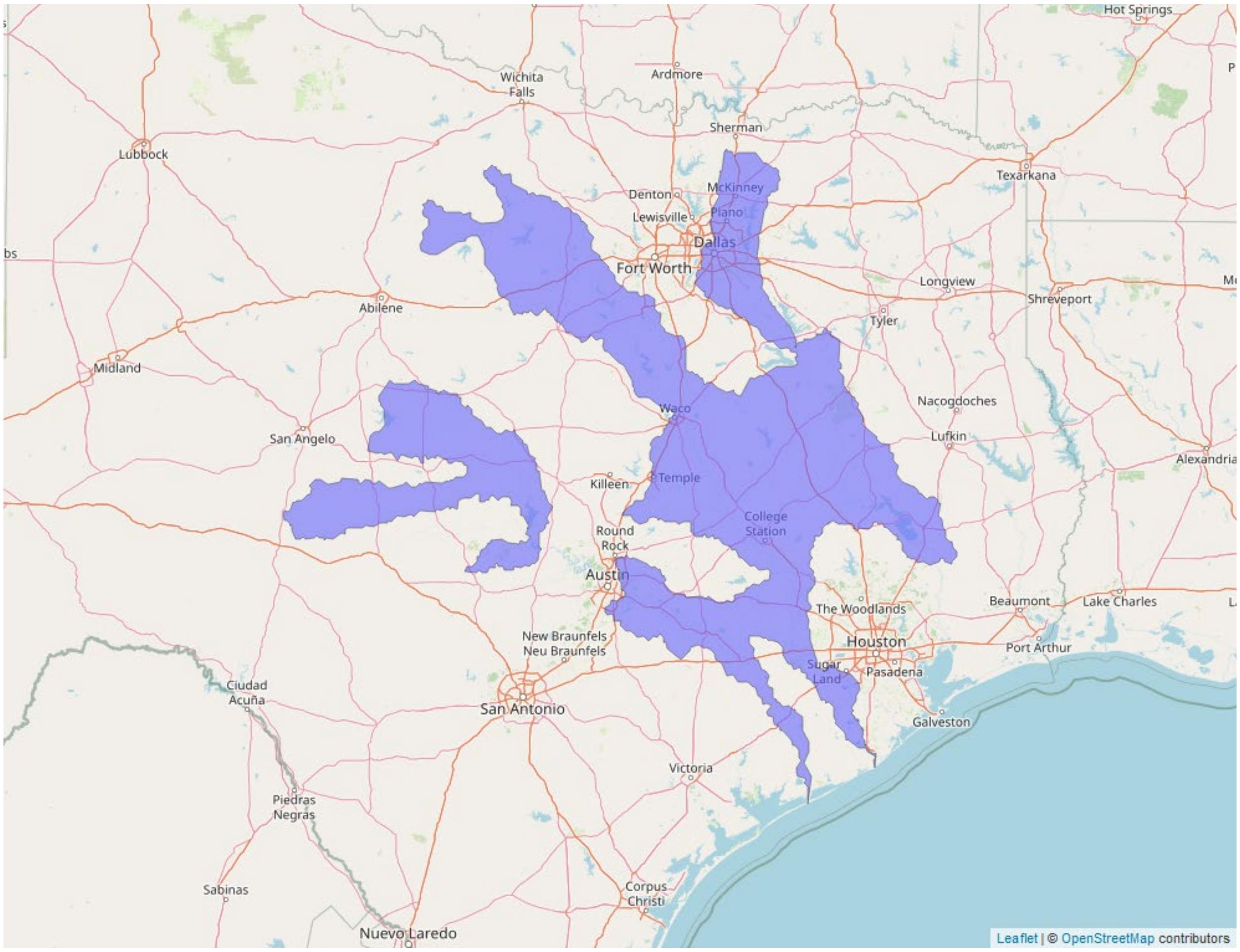

Figure 39. Range map of Texas fawnsfoot (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/8965.

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 fawnfoot 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 13% of the species range will contain methomyl use sites (Table 80).

Usage

Past usage data indicate that up to 0.8% of the species' range has been treated with methomyl annually. Use layers with the highest usage include other orchards (0.3%), other gains (0.2%), and corn (0.2%) (Table 80).

Table 80. Overlap and usage data for the Texas fawnsfoot.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn[40]	5	0.2
Cotton	2.7	0.1
Other Grains	4.9	0.2
Other Orchards	0.3	0.3
Other Row Crops	0.1	<0.1
Soybeans	0.6	<0.1
Vegetables and Ground Fruit	<0.1	<0.1
Wheat	NA	NA
Total	**13**	**0.8**

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

Exposure Summary

A high portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (13%). Based on past usage data, we expect a low portion of the range is likely to be treated with methomyl (0.8% annually). As such, we expect a medium portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 81 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the Texas fawnsfoot occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 7 to 475 µg/L, depending on the type of habitat and region (Table 81). Based on this range of potential exposures, we expect between 0-4% of exposed host fish will die, which could reduce the availability of fish hosts needed for successful reproduction. The fish host for the Texas fawnsfoot is unknown but likely is 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 of all aquatic habitats available to them, so we anticipate low adverse effects to the reproductive cycle of the mussel from loss of host fish.

Table 81. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_11a	18.86	0
High flow waterbodies	HUC_11b	22.69	0
High flow waterbodies	HUC_12a	15.17	0
High flow waterbodies	HUC_12b	17.57	0
Large volume waterbodies	HUC_11a	9.86	0
Large volume waterbodies	HUC_11b	11.30	0
Large volume waterbodies	HUC_12a	7.39	0
Large volume waterbodies	HUC_12b	8.82	0
Low flow/Low volume waterbodies	HUC_11a	309.6	0.49
Low flow/Low volume waterbodies	HUC_11b	475.2	4.06
Low flow/Low volume waterbodies	HUC_12a	155.7	0
Low flow/Low volume waterbodies	HUC_12b	148.5	0

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the Texas fawnsfoot could be exposed to methomyl in 13% of the species range based on methomyl use sites and up to 0.8% of the range may be treated with methomyl annually (Table 80).

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the Texas fawnsfoot. We anticipate some 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 fish hosts for the Texas fawnsfoot are unknown but believed to be freshwater drum. The Texas fawnsfoot may be less resilient to possible changes in the fish host community and more susceptible to indirect effects of methomyl because of its presumed reliance on one fish species. However, expected mortality to the fish host is low (0-4%), and the fish host is found in several different aquatic habitats where mortality varies. Freshwater drum are more common in high flow/volume waterbodies where we expect no mortality from methomyl exposure. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. Therefore, we anticipate low fish host mortality and reproduction for a small number of individual Texas fawnsfoot mussels will be adversely impacted. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources.

Conclusion

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 methomyl use sites overlapping 13% of the range, but a low portion of the range has experienced methomyl usage in the past (0.8% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The Texas fawnsfoot's host fish are unknown but believed to be the freshwater drum. The Texas fawnsfoot and its host fish occur in low flow/low volume waterbodies of four HUCs (11a, 11b, 12a, 12b). Its host fish also occur in high flow and large volume waterbodies in the same HUCs. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-4%, with very low rates of mortality anticipated for host fish in most aquatic habitats. We assume the host fish for the Texas fawnsfoot is freshwater drum, which is common throughout the range of the mussel and uses various components of aquatic habitat throughout their life cycles. Freshwater drum are most common in high flow/volume waterbodies. We expect overall adverse effects to host fish, and subsequently the Texas fawnsfoot, to be low. 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 the species has high vulnerability and medium exposure, we expect impacts to the mussel to be low because its presumed host fish is common and abundant in the mussel's range and toxicity is expected to be relatively low (up to 4%). A small number of individual mussels will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 in the wild.

References

U.S. Fish and Wildlife Service. 2021. Endangered and Threatened Wildlife and Plants; Endangered Species Status With Critical Habitat for Guadalupe Fatmucket, Texas Fatmucket, Guadalupe Orb, Texas Pimpleback, and False Spike, and Threatened Species Status With Section 4(d) Rule and Critical Habitat for Texas Fawnsfoot. Proposed Rule. Federal Register. 86(163): 47916-48011.

U.S. Fish and Wildlife Service. 2019. Species Status Assessment Report for the Central Texas Mussels. Version 1.5. Albuquerque, New Mexico. 244 pp.

U.S. Fish and Wildlife Service. 2011. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition to List Texas Fatmucket, Golden Orb, Smooth Pimpleback, Texas Pimpleback, and Texas Fawnsfoot as Threatened or Endangered; Proposed Rule. Federal Register. 76(194): 62165-62212.

Integration and Synthesis Summary: - Texas pimpleback

Scientific Name:	Common Name:	Entity ID:
Cyclonaias petrina	Texas pimpleback	9968

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 40). Exposed individuals are unlikely to die but are likely to experience medium levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 pimpleback. 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 40 depicts the species' range.

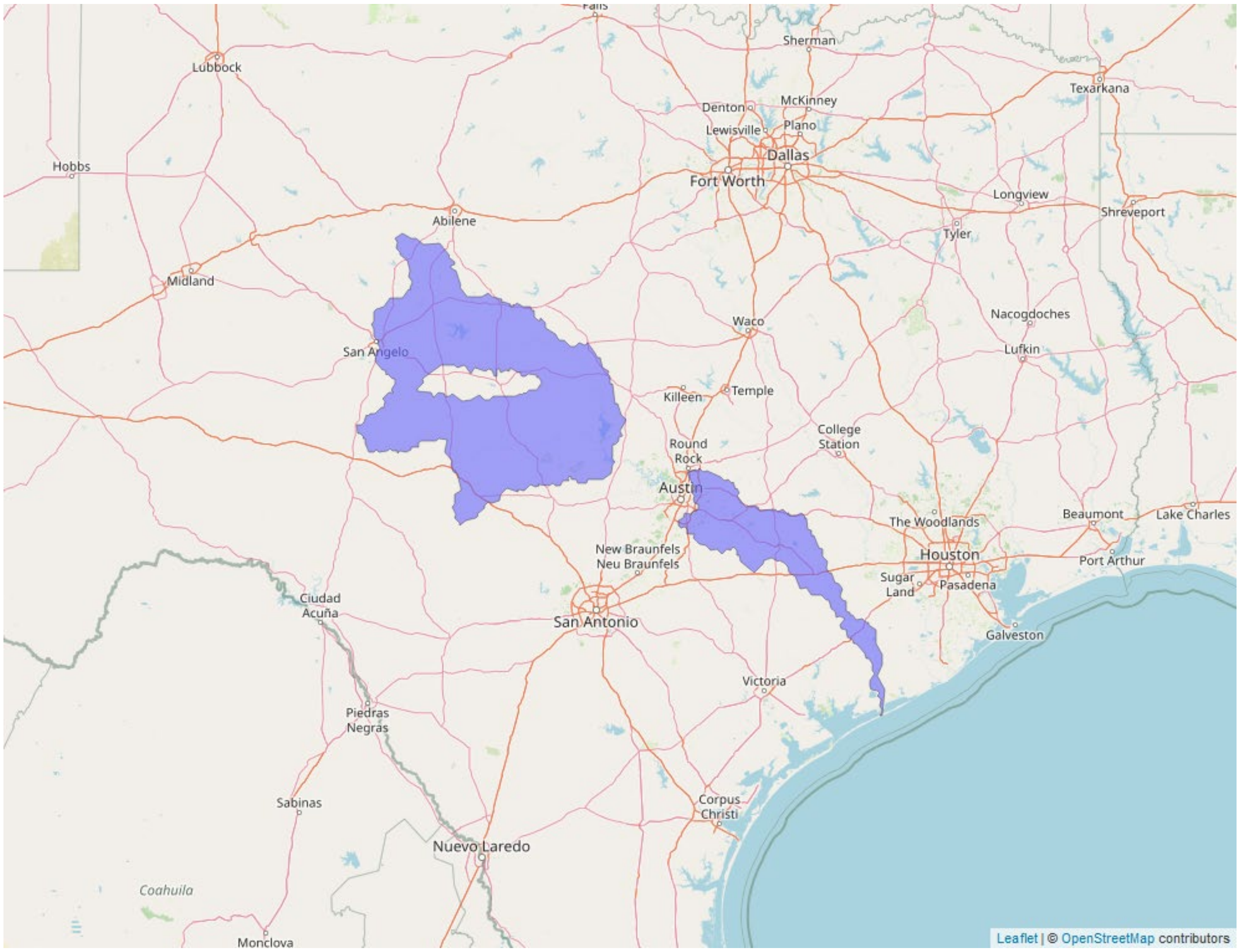

Figure 40. Range map of Texas pimpleback (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/8966.

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:

Texas pimpleback occurs in the Colorado River basin in five isolated populations: Concho River, Upper San Saba River, Lower San Saba River/ Colorado River, Llano River, and the Lower Colorado River. Only the Lower San Saba and Llano River populations are known to be successfully reproducing, and the species is likely extirpated from the Pedernales River. Texas pimpleback was historically distributed throughout the Colorado River basin. As of 2019, they are found in 325 river miles, which is about 21% of its historical range and all known populations are small and 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). The Texas pimpleback occurs within the Concho River watershed, which has been documented as having particularly high nitrates for nearly 20 years, likely due to intensive agriculture in the area.

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 13.4% of the species range will contain methomyl use sites (Table 82).

Usage

Past usage data indicate that up to 1% of the species' range has been treated with methomyl annually. Use layers with the highest usage include other orchards (0.3%), cotton (0.3%), other grains (0.2%), and corn (0.2%) (Table 82).

Table 82. Overlap and usage data for the Texas pimpleback.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn[41]	3.1	0.2
Cotton	5.3	0.3
Other Grains	4.7	0.2
Other Orchards	0.3	0.3
Other Row Crops	<0.1	<0.1
Soybeans	0.6	<0.1
Vegetables and Ground Fruit	<0.1	<0.1
Wheat	NA	NA
Total	**13.4**	**1**

Exposure Summary

A high portion of the species range could be exposed to methomyl given the overlap between the action area and the species' range (13.4%). Based on past usage data, we expect a low portion of

[41]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.

the range is likely to be treated with methomyl (1% annually), As such, we expect a medium low portion of the range will likely experience exposure. Therefore, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 83 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.
Aquatic habitat buffers: The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds".

Effects of the Action: Toxicity

Direct Effects

Based on available toxicity data on carbamates in mollusks, we do not expect exposures of methomyl at predicted environmental concentrations are likely to cause any adverse effects.

Indirect Effects

Within the regions and aquatic habitats that the Texas pimpleback occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 16 to 352 µg/L, depending on the type of habitat and region (Table 83). Based on this range of potential exposures, we expect between 0-0.99% of exposed host fish will die, which is not likely to reduce the availability of fish hosts needed for successful reproduction. The fish host for the Texas pimpleback is unknown but it likely uses similar host fish as the closely related Guadalupe orb (*Cyclonaias necki*), including channel catfish, flathead catfish, yellow bullhead, and tadpole madtom (USFWS 2022). Because the presumed fish host species are varied and found in multiple aquatic habitats, and we expect fish mortality to be low (0-0.99%), we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 83. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_12a	33.47	0
High flow waterbodies	HUC_12b	34.76	0
Large volume waterbodies	HUC_12a	16.48	0
Large volume waterbodies	HUC_12b	17.01	0
Low flow/Low volume waterbodies	HUC_12a	334.80	0.76
Low flow/Low volume waterbodies	HUC_12b	351.90	0.99

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Overall Toxicity: Low

Effects of the Action Summary

We expect the Texas pimpleback could be exposed to methomyl in 13.4% of the species range based on methomyl use sites and up to 1% of the range may be treated with methomyl annually (Table 82) thus exposure is likely to be moderate.

Due to the low sensitivity of mollusks to carbamates, we do not anticipate any direct effects to the Texas pimpleback. We anticipate some 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 fish hosts for the Texas pimpleback are unknown, suggesting that the Texas pimpleback may be less resilient to possible changes in the fish host community and make it more susceptible to indirect effects of methomyl. However, several common and abundant fish species are likely the fish hosts based on what we know from a closely related species, the Guadalupe orb (*C. necki*). Expected mortality to the fish host is low (0-0.99%) in all waterbodies, and if fish host assumptions are correct, they are common and varied. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. Therefore, we anticipate a small amount of fish host mortality and reproduction for a small number of individual Texas pimpleback mussels will be adversely impacted. We also expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources.

Conclusion

The Texas pimpleback is listed as endangered, and it occurs in the Colorado River system of Texas in five isolated populations. Abundance is low and it is extirpated from over 80% of its historical range. 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 methomyl use sites overlapping 13.4% of the range, but a low portion of the range has experienced methomyl usage in the past (1% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we do expect mussels to be indirectly affected through impacts to their host fish. The Texas pimpleback's host fish are unknown, but believed to be the channel catfish, flathead catfish, yellow bullhead, and tadpole madtom. The Texas pimpleback and its host fish occur in high flow waterbodies of HUCs 12a and 12b. Its host fish also occur in low flow/low volume waterbodies and large volume waterbodies in the same HUCs. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.99%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, presumed host fish occur in multiple aquatic habitats and anticipated host fish mortality is low (0-0.99%). We expect a small number of individual mussels will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 pimpleback in the wild.

References

U.S. Fish and Wildlife Service. 2021. Endangered and Threatened Wildlife and Plants; Endangered Species Status With Critical Habitat for Guadalupe Fatmucket, Texas Fatmucket, Guadalupe Orb, Texas Pimpleback, and False Spike, and Threatened Species Status With Section 4(d) Rule and Critical Habitat for Texas Fawnsfoot. Federal Register. 86(163): 47916-48011.

U.S. Fish and Wildlife Service. 2019. Species Status Assessment Report for the Central Texas Mussels. Version 1.5. Albuquerque, New Mexico. 244 pp.

Integration and Synthesis Summary: Green floater

Scientific Name:	Common Name:	Entity ID:
Lasmigona subviridis	Green floater	2643

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 41). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 green floater. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 8/9/2023; Wherever found; *States within the range:* GA, MD, NC, NJ, NY, PA, TN, VA, WV

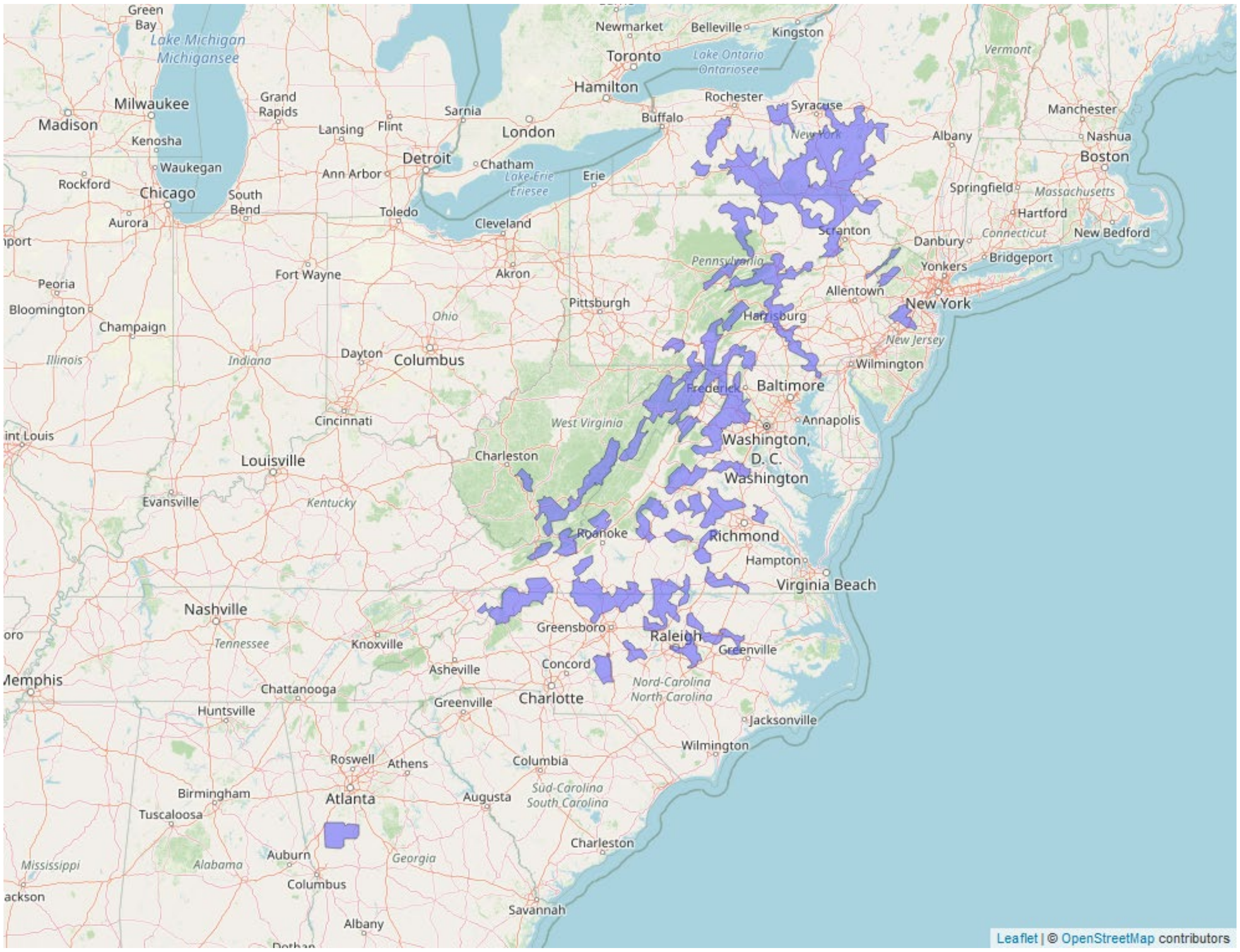

Figure 41. Range map of green floater (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/7541.

Vulnerability

Vulnerability of the species considers the status of the species, environmental baseline, and cumulative effects, as summarized below.

Summary of status

Listing status: Proposed 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 (numerous)

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

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

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

Green floaters are small, greenish brown freshwater mussels found in small streams to large rivers with slow to moderate flows in areas that provide refugia (i.e., eddies, ponded areas) with stable sang and gravel substrate with good water quality. They require connectivity between populations (i.e., free-flowing streams and rivers without barriers) for genetic exchange and may maximize population growth during periods of favorable conditions as evidenced by variable annal recruitment. Some green floaters require host fish like other freshwater mussels. They are hermaphroditic and have the ability to self-fertilize, increasing the probability of fertilization. Green floaters are omnivores and presumably feed on microscopic particulate matter like bacteria and algae. Historically, they were found from the District of Columbia and ten states: Alabama, Georgia, Maryland, New Jersey, New York, North Carolina, Pennsylvania, Tennessee, Virginia, and West Virginia. As of 2021, they were extirpated from Alabama, Georgia, and District of Columbia and remain across 179 analysis units (i.e., hydrologic units) in eight states. Six units (3%) are in high condition, 24 (13%) are in medium condition, 64 (36%) are in low condition, 25 (14%) were presumed extirpated, and 60 (34%) are considered historical/unknown. We anticipate a continued declining status of the green floater due to present and future ongoing and increasing threats primarily related to increase in developed land use by 2060 (USFWS 2021).

Primary stressors to the green floater include habitat loss and fragmentation, changes in water flows, and degraded water quality. Increases in sediment load can accumulate on the stream/river bottom and may lead to bottom scour, embeddedness of rocks, gravel and cobble, and affect some baseline water quality parameters (e.g., turbidity). Impacts to mussels from excess sedimentation include abrasion of mussels by suspended particles, burial of mussels, increased mortality of host fish eggs and clogging of gills and respiratory systems in mussels and host fish. Reduced sediment can also destabilize stream channels. Freshwater mussels are sensitive to changes in water quality parameters and need clean water with adequate dissolved oxygen and low salinity. Specifically, we mentioned concerns about chlorine, ammonia, copper, fungicides, herbicide surfactants, ammonia, manganese, sodium chloride, Polycyclic Aromatic Hydrocarbons (PAHs), and Polychlorinated Biphenyls (PCBs). Effects of climate change will also affect mussels and their habitat, including changes to water temperature, precipitation, runoff, and extreme weather events. Mussels are adapted to deal with seasonal variability in water flows, but extreme drought and flooding can adversely affect mussel populations that are already stressed. Novel threats (e.g., disease, new invasive species) may emerge for the green floater (USFWS 2021).

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 11.7% of the species range will contain use sites (Table 84).

Usage

Past usage data indicate that up to 2.3% of the species' range has been treated with methomyl annually (Table 84).

Table 84. Overlap and usage data for the green floater.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	1.9	0.2
Citrus	NA	NA
Corn	7.5	0.9
Cotton	0.4	<0.1
Other Grains	0.7	<0.1
Other Orchards	0.3	0.1
Other Row Crops	0.5	0.5
Soybeans	5.8	0.7
Vegetables and Ground Fruit	0.5	0.5
Wheat	NA	NA
Total	11.7	2.3

Additional Exposure Considerations

Spawning and reproduction likely occurs during late summer or early fall. Over the winter, some self-fertilized juveniles will be released into the water column during the spring. Green floater glochidia have the fairly unique ability among freshwater mussels in that they are able to metamorphose without a host fish (USFWS 2021) but are also known to metamorphose using several species of fish.

Exposure Summary

There is a high extent of overlap between the action area and the species' range. Based on past usage data, we expect a low level of usage within the species' range. As such, we expect a moderate number of individuals are likely to experience exposure from the proposed Action.

Overall Exposure Ranking: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 85 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Available toxicity data in mollusks suggests that no direct adverse effects to individuals, such as mortality, reduced growth, or reduced reproduction, are likely to occur at predicted concentrations of methomyl within the green floater's habitat.

Indirect Effects

Within the regions and aquatic habitats that the green floater occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 6.24 to 244.8 μg/L, depending on the type of habitat and region (Table 85). Based on this range of potential exposures, we expect very few exposed host fish will die (0.12% of exposed individuals), which is not likely to reduce the availability of fish hosts needed for successful reproduction.

In addition, as discussed above, green floater glochidia have the fairly unique ability among freshwater mussels in that they are able to metamorphose without a host fish (USFWS 2021) but are also known to metamorphose using the mottled sculpin (*Cottus bairdii*), rock bass (*Ambloplites rupestris*), central stoneroller (*Campostoma anomalum*), blacknose dace (*Rhinichthys atratulus*), and margined madtom (*Noturus insignis*).

Table 85. **Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).**

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_2	11.67	0
High flow waterbodies	HUC_3	34.82	0
High flow waterbodies	HUC_4	24.17	0
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
Large volume waterbodies	HUC_2	6.24	0
Large volume waterbodies	HUC_3	18.67	0
Large volume waterbodies	HUC_4	11.86	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Low flow/Low volume waterbodies	HUC_2	141.30	0
Low flow/Low volume waterbodies	HUC_3	171.00	0.01
Low flow/Low volume waterbodies	HUC_4	244.80	0.12
Low flow/Low volume waterbodies	HUC_5	229.50	0.08
Low flow/Low volume waterbodies	HUC_6	164.70	0.01

Toxicity Summary

Based on the predicted environmental concentrations of methomyl within the aquatic habitats that the green floater is found in, we expect no direct adverse effects (i.e., mortality, reduced growth, reduced reproduction) are likely to occur. We expect a low level of indirect effects are likely to occur as host fish are not likely to die. As such, we determine the green floater has a low toxicity ranking.

Toxicity Ranking: Low

Effects of the Action Summary

The green floater has a medium exposure ranking. While there is a low level of past methomyl usage within the species' range, there is a large extent of overlap between the species' range and the action area. As such, we anticipate a moderate number of individuals are likely to be exposed over the duration of the proposed action.

The green floater has a low toxicity ranking. We do not expect any direct adverse effects (e.g., mortality, reduced growth, reduced reproduction) to individuals are likely to occur as available toxicity data shows that mollusks are not sensitive to methomyl exposure. We expect a low level of indirect effects are likely as fish hosts are not likely to die at estimated environmental concentrations and the green floater may be able to continue its lifecycle without a fish host. Thus, fish host mortality, in some circumstances, may not be as relevant to mussel viability but we are uncertain as to whether green floaters use one or both strategies at a time.

Given that we expect a moderate number of individuals are likely to experience exposure but that exposed individuals are not likely to experience any direct adverse effects and only low levels of indirect adverse effects, we anticipate the overall risk of adverse effects to the species is low.

Conclusion

The green floater is proposed for listing as threatened. It occurs in eight states from Alabama to New York. Of 179 historical management units, most have low resilience or are believed to be extirpated; only 30 are in high or medium condition. Threats to the species include habitat loss and fragmentation, changes in water flows, and degraded water quality (including pesticides).

The species range occurs near methomyl use sites overlapping 11.7% of the range and a low portion of the range has experienced methomyl usage in the past (2.3% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The green floater is believed to be use mottled sculpin, rock bass, central stoneroller, blacknose dace, and margined madtom. The green floater and its host fish occur in high flow waterbodies of five HUCs (i.e., 2, 3, 4, 5, 6). Its host fish also occurs in low flow/low volume waterbodies in the same HUCs. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.12%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, host fish vary and occur in multiple aquatic habitats. Anticipated host fish mortality is low (0-0.12%) in all waterbodies. We expect a small number of individual mussels will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 green floater in the wild.

References

U.S. Fish and Wildlife Service. 2021. Species status assessment report for the green floater (*Lasmigona subviridis*). Cortland, New York. 154 pp.

Integration and Synthesis Summary: False spike

Scientific Name:	Common Name:	Entity ID:
Fusconaia mitchelli	False spike	5380

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 42). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 false spike. 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

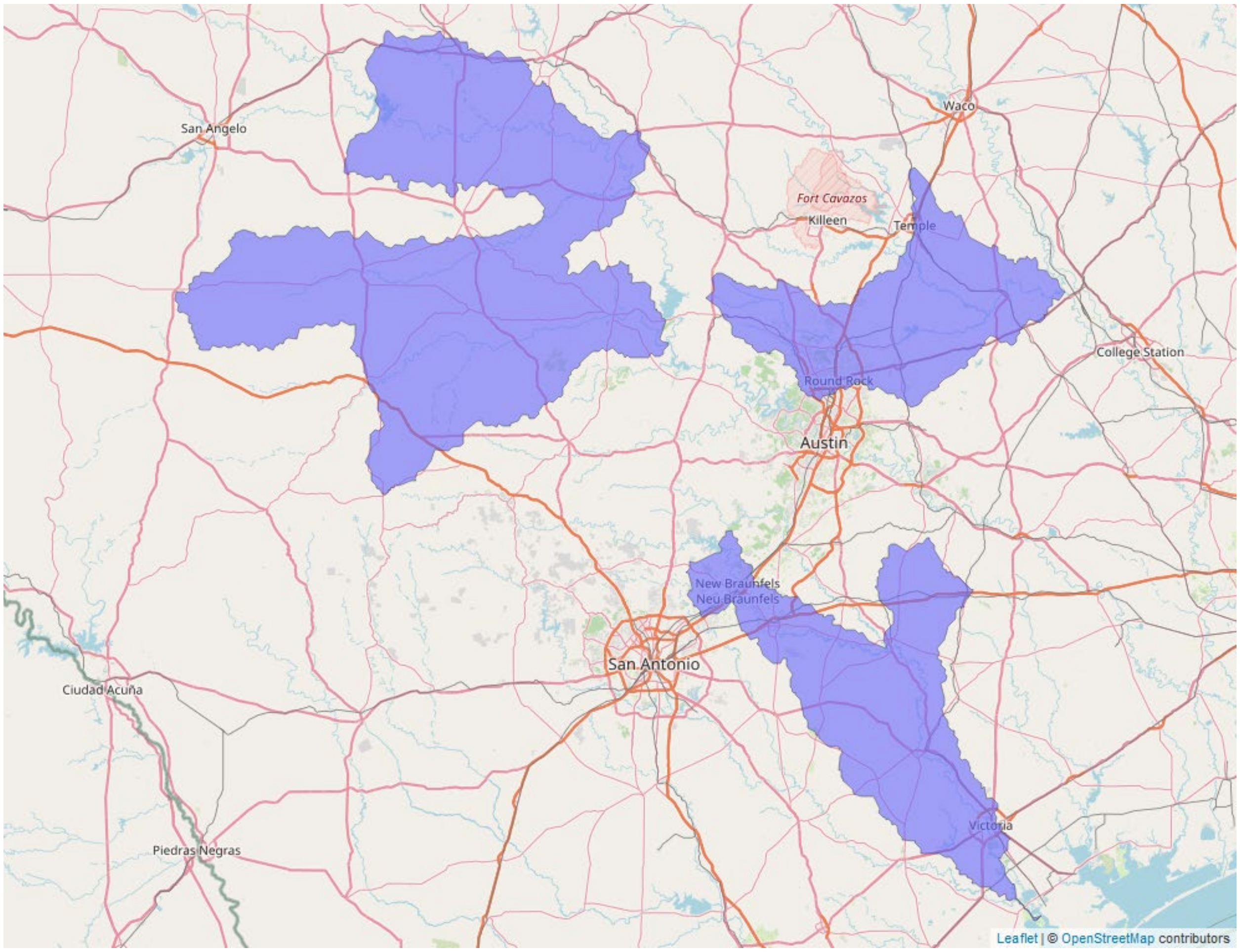

Figure 42. Range map of false spike (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/3963.

Vulnerability

Vulnerability of the species considers the status of the species, environmental baseline, and cumulative effects, as summarized below.

Summary of status

Listing status: Proposed Endangered

Most recent Five Year Status Review recommendation: N/A

Most recently completed Five Year Status Review: N/A

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

Number of populations: Single population

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

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

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The false spike is native to the Guadalupe Basin in central Texas. They ideally occur in riffle and run habitats with gravel and cobble substrates and low evidence of excessive sedimentation. False spike was suspected of being extinct until living individuals were discovered in the Guadalupe River basin in 2011-2013. As of 2022, 20% of the presumed 512 stream miles in the historical range remain occupied (102.6 stream miles) and they occur in one population in moderate condition. The species was believed to also occur in the Brazos and Colorado basins, but they are now considered a different species (i.e., Balcones spike, *Fusconaia iheringi*). In addition, it was thought to have historically occurred in the Rio Grande based on the presence of fossil and subfossil shells there, but those specimens have now been attributed to *Sphenonaias taumilapana* Conrad 1855 (no common name). Currently, the false spike occurs in one population in the lower Guadalupe River. False spike was once considered common where it was found, but beginning in the 1970s, it became rarer.

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. We expect up to 11.8% of the species range will contain use sites (Table 86).

Usage

Past usage data indicate that up to 4.8% of the species' range has been treated with methomyl annually (Table 86).

Table 86. **Overlap and usage data for the false spike**

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn	5	1
Cotton	1.8	2.1
Other Grains	4.6	1.7
Other Orchards	0.5	<0.1
Other Row Crops	<0.1	<0.1
Soybeans	<0.1	0.2
Vegetables and Ground Fruit	<0.1	<0.1
Wheat	NA	NA
Total	**11.8**	**4.8**

Exposure Summary

There is a high extent of overlap between the action area and the species' range. Based on past usage data, we expect a low level of usage within the species' range. As such, we expect a moderate number of individuals are likely to experience exposure from the proposed Action.

Overall Exposure Ranking: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 87 the maximum predicted

EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Available toxicity data in mollusks suggests that no direct adverse effects to individuals, such as mortality, reduced growth, or reduced reproduction, are likely to occur at predicted concentrations of methomyl within the False spike ’s habitat.

Indirect Effects

Within the regions and aquatic habitats that the false spike occupies, EPA’s aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 10 to 408 µg/L, depending on the type of habitat and region (Table 87). Based on this range of potential exposures, we expect up to 2.05% of exposed host fish will die, which is not likely to reduce the availability of fish hosts needed for successful reproduction. The false spike is a host fish specialist and is likely to successfully reproduce only in the presence of blacktail shiner and red shiner. Both of these fish hosts are common within the mussel’s range.

Table 87. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species’ range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_12a	43.24	0
High flow waterbodies	HUC_12b	65.12	0
High flow waterbodies	HUC_13	10.94	0
Low flow/Low volume waterbodies	HUC_12a	387.90	1.61
Low flow/Low volume waterbodies	HUC_12b	407.70	2.05
Low flow/Low volume waterbodies	HUC_13	330.30	0.70

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Toxicity Summary

Based on the predicted environmental concentrations of methomyl within the aquatic habitats that the false spike is found in, we expect no direct adverse effects (i.e., mortality, reduced growth, reduced reproduction) are likely to occur. We expect a low level of indirect effects are likely to occur as host fish are not likely to die at estimated environmental concentrations. As such, we determine the false spike has a low toxicity ranking.

Toxicity Ranking: Low

Effects of the Action Summary

The false spike has a medium exposure ranking. While there is a low level of past methomyl usage within the species' range, there is a large extent of overlap between the species' range and the action area. As such, we anticipate a moderate number of individuals are likely to be exposed over the duration of the proposed action.

The false spike has a low toxicity ranking. We do not expect any direct adverse effects (e.g., mortality, reduced growth, reduced reproduction) to individuals are likely to occur as available toxicity data shows that mollusks are not sensitive to methomyl exposure. We expect a low level of indirect effects are likely as fish hosts are not likely to die at estimated environmental concentrations. We anticipate some 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 fish host species for the false spike include the red shiner and blacktail that are commonly found in the waterbodies where the mussel is found. We anticipate up to 2.05% reductions in fish host species. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. Thus, we anticipate a low level of adverse effects to the reproductive cycle of the mussel. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual false spike mussels will experience adverse effects.

Given that we expect a moderate number of individuals are likely to experience exposure but that exposed individuals are not likely to experience any direct adverse effects and only low levels of indirect adverse effects, we anticipate the overall risk of adverse effects to the species is low.

Conclusion

The false spike is proposed for listing as endangered. It occurs in the Guadalupe basin of central Texas in a single population that is in moderate condition. The species has been extirpated from 80% of its historical range and until 2011, we believed it was extinct. Threats to the species include increased fine sediment, changes in water quality (including pesticides), altered hydrology in the form of inundation, altered hydrology in the form of loss of flow and scour of substrate, predation and collection, and barriers to fish movement.

The species range occurs near methomyl use sites overlapping 11.8% of the range and a low portion of the range has experienced methomyl usage in the past (4.8% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The false spike is believed to be a host fish specialist that uses blacktail shiner and red shiner, both of which is common in the species' range. The false spike and its host fish occur in high flow waterbodies of three HUCs (i.e., 12a, 12b, 13). Its host fish also occurs in low flow/low volume waterbodies in the same HUCs. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-2.05%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, presumed host fish occur in multiple aquatic habitats and are abundant and common. Anticipated host fish mortality is low (0-2.05%) in all waterbodies. We expect a small number of individual mussels will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 false spike in the wild.

References

U.S. Fish and Wildlife Service. 2022. 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 petrina*) Guadalupe fatmucket (*Lampsilis bergmanni*) Guadalupe orb (*Cyclonaias necki*). Version 2.1. Albuquerque, New Mexico. 267 pp.

U.S. Fish and Wildlife Service. 2021. Endangered and Threatened Wildlife and Plants; Endangered Species Status With Critical Habitat for Guadalupe Fatmucket, Texas Fatmucket, Guadalupe Orb, Texas Pimpleback, and False Spike, and Threatened Species Status With Section 4(d) Rule and Critical Habitat for Texas Fawnsfoot. Federal Register. 86 (163): 47916-48011.

Integration and Synthesis Summary: Western fanshell

Scientific Name:	Common Name:	Entity ID:
Cyprogenia aberti	Western fanshell	5391

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 high past usage of methomyl within the species' range, indicating a high extent of exposure within the action area across the species' range (Figure 43). Exposed individuals are unlikely to die or experience 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 exposure is high, we do not expect indirect effects from loss of host fish and we determine the risk of adverse effects to the species is low. As such, we do not individuals are likely to experience reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 western fanshell. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 4/18/2024; Wherever found; *States within the range:* AR, KS, MO, OK

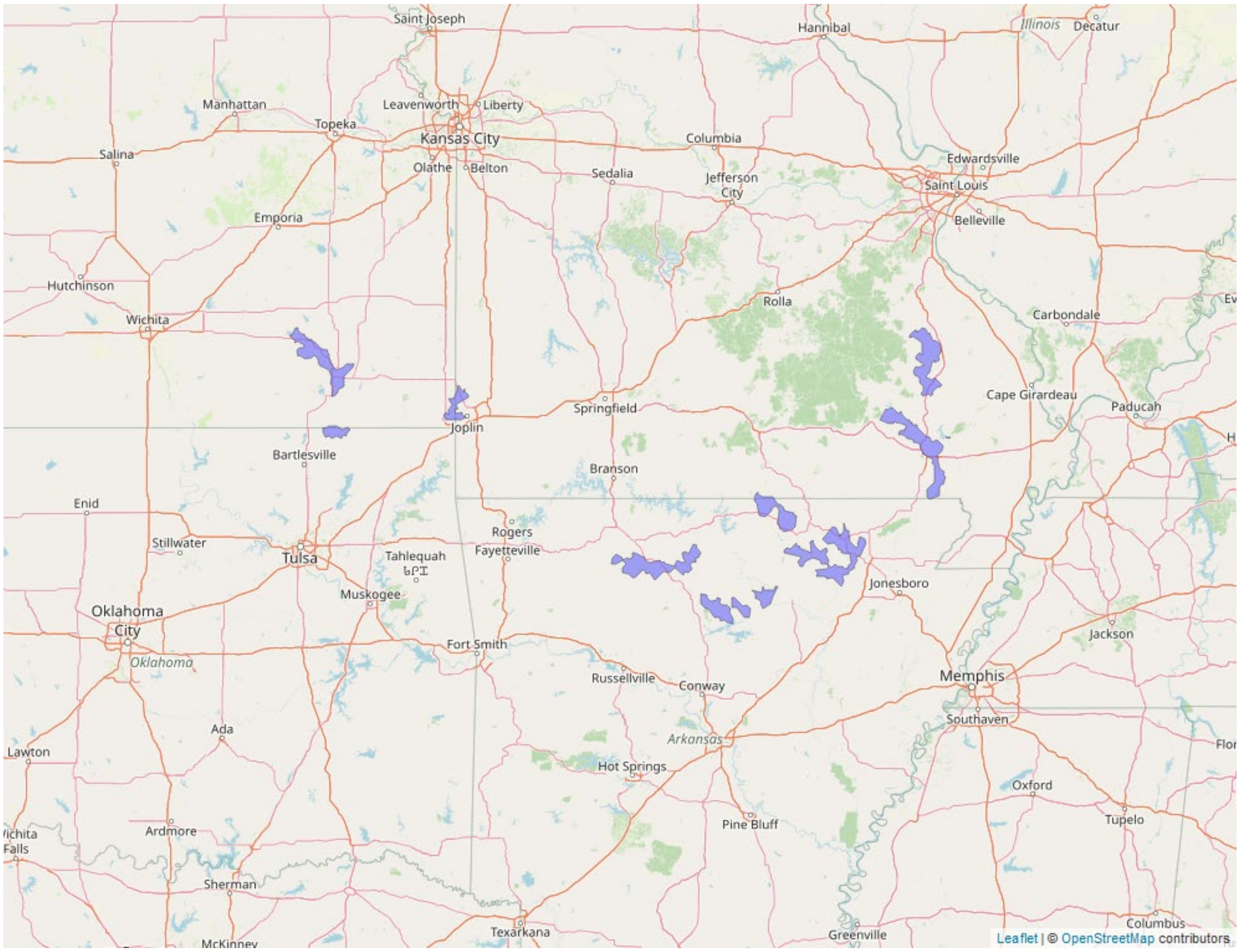

Figure 43. Range map of western fanshell (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/6895.

Vulnerability

Vulnerability of the species considers the status of the species, 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:

Western fanshells are freshwater mussels found in large creeks and rivers with good water quality, moderate to swift current, and gravel-sand substrates. They primarily feed on microscopic particulate matter suspended in the water column like phytoplankton, zooplankton, bacteria, detritus, and dissolved organic matter. Their historical range includes multiple rivers within the Neosho-Verdigris, lower Arkansas, Lower Mississippi-St. Francis, and upper White river drainages of Arkansas, Missouri, Kansas, and Oklahoma. They may have occurred in and are believed to be extirpated from Mississippi. Western fanshells occur in 11 of 26 historical management units, 45% of which are in low condition. They suffered a 60% reduction in stream length occupation. Western fanshells rely on fish hosts for reproduction and dispersal and travel upstream and against current in rivers and streams through fish. Their host fish differ between river systems, suggesting fanshells in those systems are ecologically different from one another (USFWS 2022).

Risks to the western fanshell include water quality degradation, altered flow, landscape changes, and habitat fragmentation. Fanshell mussels require naturally clean water and are sensitive to point and nonpoint source contaminants that deteriorate water quality and habitat. Noted contaminants include ammonia, chlorine, trace metals, dissolved solids, pharmaceuticals, and pesticides. Large and small run of river impoundments and culverted and non-culverted (e.g., concrete pads) low water crossings act as barriers to fish passage, and therefore inhibit mussel dispersal and recolonization (USFWS 2022).

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 13.6% of the species range will contain use sites (Table 88).

Usage

Past usage data indicate that up to 13.5% of the species' range has been treated with methomyl annually (Table 88).

Table 88. Overlap and usage data for the western fanshell.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn	6.7	6.7
Cotton	0.2	0.2
Other Grains	0.2	0.2
Other Orchards	<0.1	<0.1
Other Row Crops	0.1	0.1
Soybeans	12.9	12.9
Vegetables and Ground Fruit	<0.1	<0.1
Wheat	NA	NA
Total	**13.6**	**13.5**

Exposure Summary

There is a high extent of overlap between the action area and the species' range. Based on past usage data, we expect a high level of usage within the species' range. As such, we expect a large number of individuals are likely to experience exposure from the proposed action.

Overall Exposure Ranking: High

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 89 the maximum predicted

EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Available toxicity data in mollusks suggests that no direct adverse effects to individuals, such as mortality, reduced growth, or reduced reproduction, are likely to occur at predicted concentrations of methomyl within the western fanshell’s habitat.

Indirect Effects

Within the regions and aquatic habitats that the western fanshell occupies, EPA’s aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 24 to 49 µg/L, depending on the type of habitat and region (Table 89). Based on this range of potential exposures, we do not expect any exposed host fish will die, which will not adversely impact reproduction of the species. The western fanshell is a host fish generalist and is likely to successfully reproduce in the presence of fantail darter, logperch, and banded sculpin however, these fish hosts are common within the mussel’s range. Logperch (*Percina caprodes*) is a suitable fish host in all river basins. The rainbow darter (*Etheostoma caeruleum*) is a good fish host in the St. Francis River, but poor host in the Arkansas River basin. Slenderhead, fantail, rainbow, and orangebelly darters are suitable hosts only for their respective sympatric fanshell mussel population. This adaptation indicates that fanshell mussels in each river system are ecologically different. Because no mortality is expected for all aquatic habitats for the western fanshell, we do not anticipate loss of fish host species availability will likely result in adverse effects to the reproductive cycle of the mussel overall.

Table 89. **Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species’ range (includes rain restriction conservation measure).**

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_11a	48.83	0
High flow waterbodies	HUC_11b	43.11	0
High flow waterbodies	HUC_7	23.72	0

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_8	45.74	0

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Toxicity Summary

Based on the predicted environmental concentrations of methomyl within the aquatic habitats that the western fanshell is found in, we expect no direct adverse effects (i.e., mortality, reduced growth, reduced reproduction) are likely to occur. We expect a low level of indirect effects are likely to occur as host fish are not likely to die. As such, we determine the western fanshell has a low toxicity ranking.

Toxicity Ranking: Low

Effects of the Action Summary

The western fanshell has a high exposure ranking. There is a high extent of overlap between the species' range and the action area as well as a high level of past usage within the range. As such, we anticipate a large number of individuals are likely to be exposed over the duration of the proposed action.

The western fanshell has a low toxicity ranking. We do not expect any direct adverse effects (e.g., mortality, reduced growth, reduced reproduction) to individuals are likely to occur as available toxicity data shows that mollusks are not sensitive to methomyl exposure. We expect a low level of indirect effects are likely as fish hosts are not likely to die at estimated environmental concentrations.

The fish host species for the western fanshell include the fantail darter, logperch, and banded sculpin that are commonly found in the waterbodies where the mussel is found. We do not anticipate reductions in fish host species. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources.

While we expect a large number of individuals are likely to experience exposure, exposed individuals are not likely to experience any direct adverse effects or indirect adverse effects. In addition, the western fanshell is a host fish generalist and is able to reproduce with the assistance of many different host fish species. As such, we anticipate methomyl is not likely to cause adverse effects to the western fanshell.

Conclusion

The western fanshell is listed as threatened in river systems in Arkansas, Kansas, Missouri, and Oklahoma. It is extant in 11 of 26 historical management units, 45% of which are in low condition. Threats to the species include water quality degradation (including pesticides), altered flow, landscape changes, and habitat fragmentation.

The species range occurs near methomyl use sites overlapping 13.6% of the range and a high portion of the range has experienced methomyl usage in the past (13.5% annually). Therefore, we consider the species to have a high exposure ranking. However, we do not expect direct mortality of mussels from methomyl exposure. The western fanshell and its host fish occur in high flow waterbodies of four HUCs (i.e., 7, 8, 11a, 11b). After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), we do not expect methomyl concentrations in any of these habitats that will result in fish mortality. Therefore, we do not anticipate impacts to the western fanshell through loss of host fish from methomyl exposure. Additionally, 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 the species has high vulnerability and high exposure, we anticipate no fish host mortality. Therefore, we expect impacts to the mussel to be discountable and no individuals will be adversely affected through loss of hosts. After incorporating conservation measures into the effects of the action, accounting for 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 western fanshells in the wild.

References

U.S. Fish and Wildlife Service. 2022. Species Status Assessment Report for western fanshell (*Cyprogenia aberti*) and "Ouachita" fanshell (*Cyprogenia cf. aberti*). Version 1.2. Bloomington, Minnesota. 137 pp.

Integration and Synthesis Summary: Salamander mussel

Scientific Name:	Common Name:	Entity ID:
Simpsonaias ambigua	Salamander mussel	8134

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 44). Exposed individuals are unlikely to die or experience 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. Given that exposure is medium and we do not expect indirect effects from loss of host salamanders, we determine the risk of adverse effects to the species is low. As such, we do not individuals are likely to experience reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 salamander mussel. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 9/1/2023; Wherever found; *States within the range:* AR, IA, IL, IN, KY, MI, MO, NY, OH, PA, TN, WI, WV

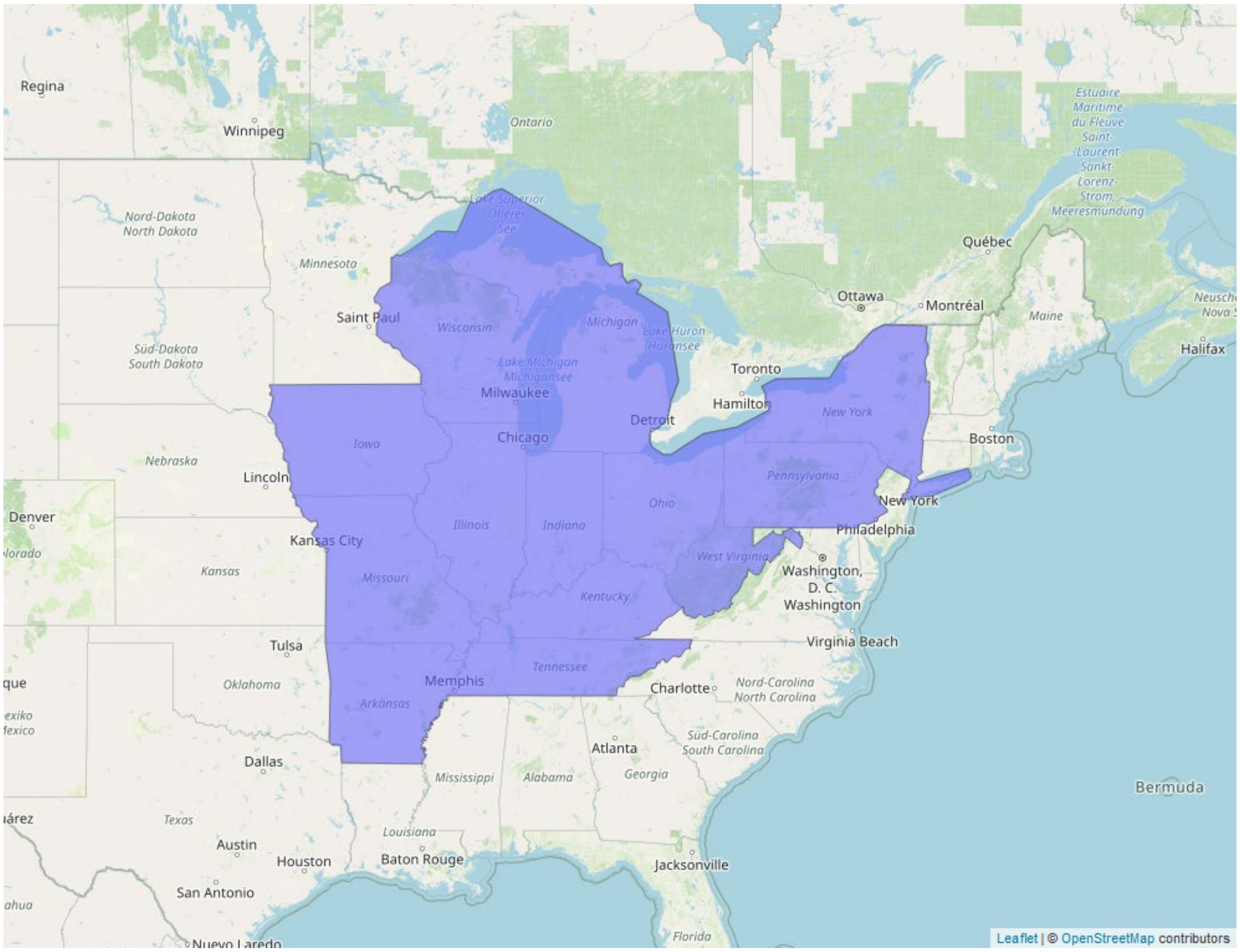

Figure 44. Range map of salamander mussel (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/6208.

Vulnerability

Vulnerability of the species considers the status of the species, environmental baseline, and cumulative effects, as summarized below.

Summary of status

Listing status: Proposed 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 salamander mussel is the only unionid freshwater mussel with a non-fish host; mussel glochidia parasitize mudpuppy salamanders (*Necturus maculosus*). Mudpuppies do not travel long distances during the time of year when glochidia are attached. The mussel is found in rivers, streams, creeks, or lakes under flat rocks in areas of moderate flow and bedrock, sand, gravel, or mud substrates. Salamander mussels feed on phytoplankton, zooplankton, rotifers, protozoans, detritus, and dissolved organic matter from the water column or sediments. They occur in 14 U.S. states and the Canadian province of Ontario and are analyzed by hydrological unit: Upper Mississippi, Ohio, Tennessee, Great Lakes, and Arkansas-White-Red. Out of 110 historical populations, 66 are extant and presumed extant and 98.5% are at high risk. The Ohio basin is the only representation unit with populations experiences moderate and not high risk (USFWS 2023).

The six primary risk factors for salamander mussels include water quality/contaminants, hydrological regime, landscape, connectivity, invasive species, and host species vulnerability. Contaminants include point (i.e., wastewater treatment and industrial effluents, targeted lampricide treatments) and non-point (i.e., runoff with fertilizers, pesticides, road salts, grease, oil) sources. Coal mining poses a catastrophic risk due to accidental spills and contamination runoff (e.g., acid mine and saline drainage). Alteration to the natural thermal regime of mussels is one of the greatest threats freshwater ecosystems face today, particularly from increases in surface temperatures and decreases in precipitation. Changes in hydrological regime include barriers to movement like dams, water diversions, levees, and other channelization methods. Many of these structures also serve as barriers to mussel and salamander movements and affect water temperatures and flow, food availability, and host availability. Invasive species with detrimental effects to freshwater mussels include zebra mussel, corbicula (freshwater clam), black carp, rusty crayfish, spiny waterflea, brown trout, quagga mussel, common carp, and bighead carp, though we believe threats from invasive species are moderate compared to other threats. Mudpuppies are susceptible to many of the same threats that affect mussels including contaminants, habitat degradation and fragmentation, lack of water quality and quantity, known disease issues or die-offs, and potential overharvest and collection (USFWS 2023).

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 30.3% of the species range will contain use sites (Table 90).

Usage

Past usage data indicate that up to 1.5 % of the species' range has been treated with methomyl annually (Table 90).

Table 90. **Overlap and usage data for the salamander mussel.**

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	2.6	<0.1
Citrus	NA	NA
Corn	25	0.9
Cotton	0.5	<0.1
Other Grains	0.7	<0.1
Other Orchards	0.2	<0.1
Other Row Crops	0.2	0.2
Soybeans	25.4	1
Vegetables and Ground Fruit	0.6	0.1
Wheat	NA	NA
Total	30.3	1.5

Additional Exposure Considerations

Salamander mussels spawn in the spring and females hold glochidia in their marsupial gills over the winter until they are released in the following spring or summer. Salamander mussels use mudpuppy salamanders as glochidial hosts, which are sensitive to water quality and contaminant concerns like the mussel glochidia. In acute toxicity tests, adult salamander mussels have not been found to be as sensitive as glochidia or juveniles (USFWS 2023).

Exposure Summary

There is a high extent of overlap between the action area and the species' range. Based on past usage data, we expect a low level of usage within the species' range. As such, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure Ranking: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 91 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.
Aquatic habitat buffers: The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds".

Effects of the Action: Toxicity

Direct Effects

Available toxicity data in mollusks suggests that no direct adverse effects to individuals, such as mortality, reduced growth, or reduced reproduction, are likely to occur at predicted concentrations of methomyl within the salamander mussel 's habitat.

Indirect Effects

Within the regions and aquatic habitats that the salamander mussel occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 6 to 49 µg/L, depending on the type of habitat and region (Table 91). Based on this range of potential exposures, we do not expect any exposed host salamanders will die. As such, we do not anticipate any indirect effects are likely to occur. The salamander mussel is a host specialist and may only successfully reproduce in the presence of the mudpuppy salamander (*Necturus maculosus*). The mudpuppy is common within the mussel's range and there are current studies being conducted and confirm that other salamander species are able to be parasitized by this mussel.

Table 91. **Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).**

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent host mortality
High flow waterbodies	HUC_1	36.23	0
High flow waterbodies	HUC_10a	23.26	0
High flow waterbodies	HUC_10b	12.33	0
High flow waterbodies	HUC_11a	48.83	0
High flow waterbodies	HUC_11b	43.11	0
High flow waterbodies	HUC_2	11.67	0
High flow waterbodies	HUC_3	34.82	0
High flow waterbodies	HUC_4	24.17	0
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0
Large volume waterbodies	HUC_1	22.03	0
Large volume waterbodies	HUC_10a	12.45	0
Large volume waterbodies	HUC_10b	6.98	0
Large volume waterbodies	HUC_11a	29.03	0
Large volume waterbodies	HUC_11b	21.56	0
Large volume waterbodies	HUC_2	6.24	0
Large volume waterbodies	HUC_3	18.67	0
Large volume waterbodies	HUC_4	11.86	0
Large volume waterbodies	HUC_5	13.85	0
Large volume waterbodies	HUC_6	12.86	0
Large volume waterbodies	HUC_7	12.21	0
Large volume waterbodies	HUC_8	31.29	0

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Toxicity Summary

Based on the predicted environmental concentrations of methomyl within the aquatic habitats that the salamander mussel is found in, we expect no direct adverse effects (i.e., mortality, reduced growth, reduced reproduction) are likely to occur. We expect a low level of indirect effects are likely to occur as we do not anticipate any host fish are likely to die. As such, we determine the Salamander mussel has a low toxicity ranking.

Toxicity Ranking: Low

Effects of the Action Summary

The salamander mussel has a medium exposure ranking. While there is a low level of past methomyl usage within the species' range, there is a large extent of overlap between the species' range and the action area. As such, we anticipate a moderate number of individuals are likely to be exposed over the duration of the proposed action.

The salamander mussel has a low toxicity ranking. We do not expect any direct adverse effects (e.g., mortality, reduced growth, reduced reproduction) to individuals are likely to occur as available toxicity data shows that mollusks are not sensitive to methomyl exposure. The host species for the salamander mussel is the mudpuppy salamander which is commonly found in the waterbodies where the mussel is found. We do not anticipate reductions in the salamander host species. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources.

Given that we expect a moderate number of individuals are likely to experience exposure but that exposed individuals are not likely to experience any direct adverse effects and no indirect adverse effects, we anticipate the overall risk of adverse effects to the species is low.

Conclusion

The salamander mussel is proposed for listing as endangered. It occurs in fourteen states from Mississippi to the Great Lakes and Ontario, Canada. About half of the historical populations are extant and 98.5% of the remaining populations are at high risk. Threats to the species include water quality/contaminants (including pesticides), hydrological regime, landscape, connectivity, invasive species, and host species vulnerability.

The species range occurs near methomyl use sites overlapping 30.3% of the range and a high portion of the range has experienced methomyl usage in the past (1.5% annually). Therefore, we consider the species to have a medium exposure ranking. However, we do not expect direct mortality of mussels from methomyl exposure, nor do we expect mussels to be indirectly affected through impacts to their glochidia host; for this species, the mudpuppy salamander. The salamander mussel is the only species of freshwater mussel in the U.S. to use a non-fish glochidial host. The salamander mussel and mudpuppies occur in high flow waterbodies of twelve HUCs (i.e., 1, 2, 3, 4, 5, 6, 7, 8, 10a, 10b, 11a, 11b). After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), we do not expect methomyl concentrations in any of these habitats that will result in fish mortality. Therefore, we do not anticipate impacts to the salamander mussel through loss of hosts from methomyl exposure. Additionally, 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 the species has high vulnerability and medium exposure, we anticipate no mudpuppy mortality. Therefore, we expect impacts to the mussel to be discountable and no individuals will be adversely affected through loss of hosts. After incorporating conservation measures into the effects of the action, accounting for 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 salamander mussel in the wild

References

U.S. Fish and Wildlife Service. 2023. Species Status Assessment Report for the salamander mussel (*Simpsonaias ambigua*). Version 1.1. Minneapolis, Minnesota. 201 pp.

Integration and Synthesis Summary: Mexican fawnsfoot

Scientific Name:	Common Name:	Entity ID:
Truncilla cognata	Mexican fawnsfoot	8229

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 45). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 Mexican fawnsfoot. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 8/23/2016; Wherever found; *States within the range:* TX

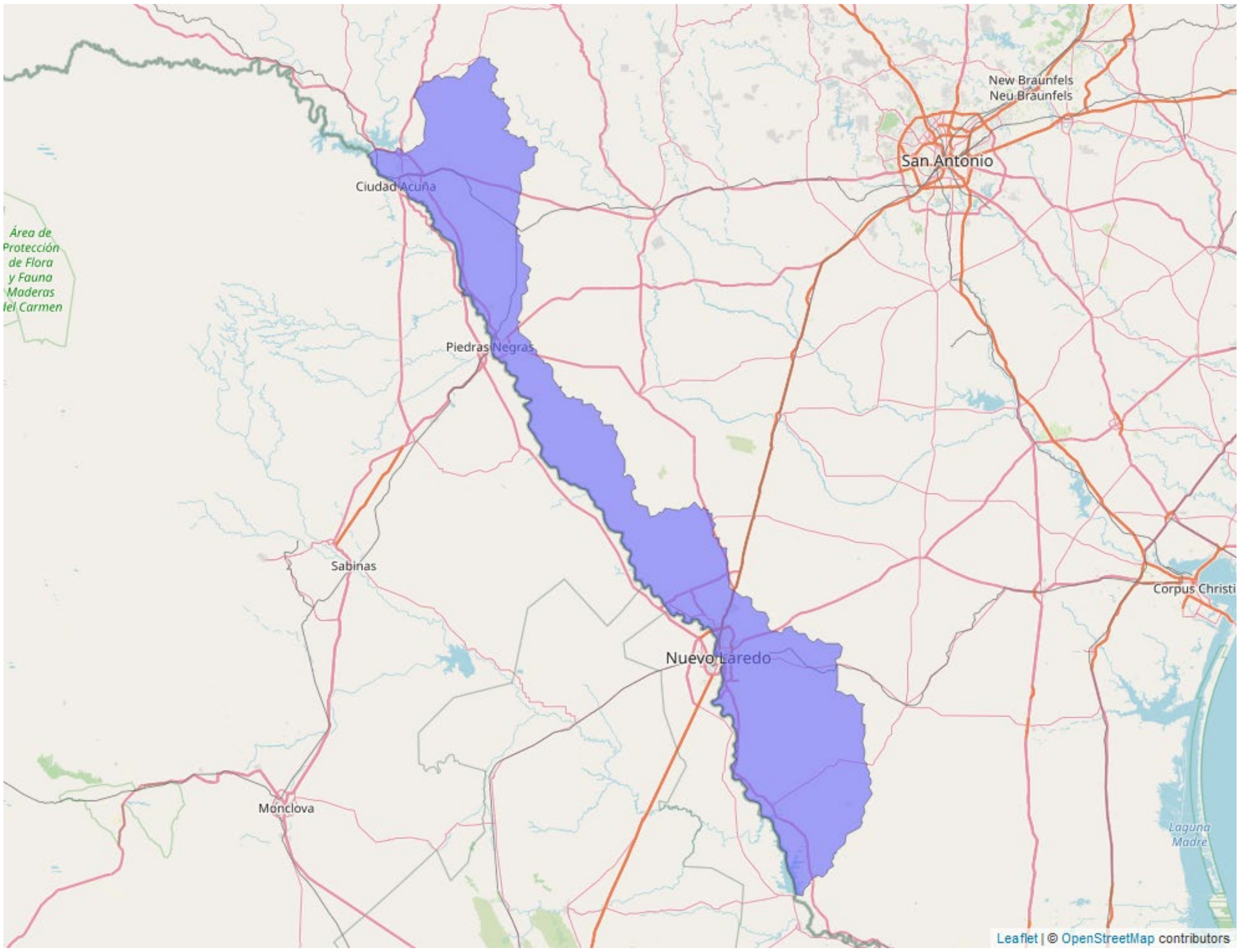

Figure 45. Range map of Mexican fawnsfoot (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/7870.

Vulnerability

Vulnerability of the species considers the status of the species, environmental baseline, and cumulative effects, as summarized below.

Summary of status

Listing status: Proposed 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: Single population

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:

Mexican fawnsfoot is a small freshwater mussel that occurs in medium to large rivers, in or adjacent to riffle and run habitats and stream banks. It is a filter feeder that we presume siphons suspended phytoplankton and detritus from the water column. We presume it uses freshwater drum (*Aplodinotus grunniens*) as host fish like other mussels in the genus *Truncilla*. They may use other reproductive strategies, like broadcast of free glochidia or cryptic lures, for glochidial dispersal. Mexican fawnsfoot anchor to substrate that helps them avoid being swept away during the flooding events common in the river system where the mussel occurs. It historically occurred in the lower Rio Grande drainage in Texas and Mexico, and it is believed to be extirpated from Rio Salado. As of 2022, Mexican fawnsfoot occur in one population in Texas between Eagle Pass and Laredo in the Rio Grande (90 river km). Abundance for all segments of the single population is believed to be low, and limited evidence of recruitment has been documented (USFWS 2023).

Threats to the Mexican fawnsfoot include changes to water quality (i.e., dissolved oxygen, salinity, ammonia, pollutants including pesticides, and increased fine sediment), development, hydrological alteration, barriers to fish movement, predation, and effects of climate change. Ammonia is of particular concern downstream of agricultural areas and water treatment plant outfalls as freshwater mussels have been shown particularly sensitive to increased ammonia levels at multiple life stages. Several wastewater treatment plants discharge into the Rio Grande River, likely limiting occurrences of Mexican fawnsfoot. Falcon Dam, completed in 1954, presumably caused the extirpation of Mexican Fawnsfoot in the 40-mile length of river inundated by the impoundment (USFWS 2023).

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 16.7% of the species range will contain use sites (Table 92).

Usage

Past usage data indicate that up to 0.8 % of the species' range has been treated with methomyl annually (Table 92).

Table 92. Overlap and usage data for the Mexican fawnsfoot.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	0.1	<0.1
Citrus	NA	NA
Corn	3	<0.1
Cotton	7.6	0.2
Other Grains	5.3	0.2
Other Orchards	0.2	<0.1
Other Row Crops	0.3	0.3
Soybeans	0.3	<0.1
Vegetables and Ground Fruit	0.2	<0.1
Wheat	NA	NA
Total	16.7	0.8

Exposure Summary

There is a high extent of overlap between the action area and the species' range. Based on past usage data, we expect a low level of usage within the species' range. As such, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure Ranking: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 93 the maximum predicted

EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.
Aquatic habitat buffers: The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds".

Effects of the Action: Toxicity

Direct Effects

Available toxicity data in mollusks suggests that no direct adverse effects to individuals, such as mortality, reduced growth, or reduced reproduction, are likely to occur at predicted concentrations of methomyl within the Mexican fawnsfoot's habitat.

Indirect Effects

Within the regions and aquatic habitats that the Mexican fawnsfoot occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 9 to 352 µg/L, depending on the type of habitat and region (Table 93). Based on this range of potential exposures, we expect very few exposed host fish will die (up to 1% exposed individuals), which is not likely to reduce the availability of fish hosts needed for successful reproduction.

The primary host fishes for the Mexican fawnsfoot are unknown; however, based on other *Truncilla* spp., they likely can parasitize freshwater drum (*Aplodinotus grunniens*). 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 possibly one fish host species, freshwater drum are relatively common and use of all aquatic habitats available to them, so we anticipate low adverse effects to the reproductive cycle of the mussel from loss of host fish.

Table 93. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_11a	50.21	0
High flow waterbodies	HUC_11b	33.31	0
High flow waterbodies	HUC_12a	33.47	0

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_12b	34.76	0
High flow waterbodies	HUC_13	9.39	0
High flow waterbodies	HUC_8	36.28	0
Low flow/Low volume waterbodies	HUC_11a	298.80	0.40
Low flow/Low volume waterbodies	HUC_11b	230.40	0.08
Low flow/Low volume waterbodies	HUC_12a	334.80	0.76
Low flow/Low volume waterbodies	HUC_12b	351.90	0.99
Low flow/Low volume waterbodies	HUC_13	186.30	0.02
Low flow/Low volume waterbodies	HUC_8	342.90	0.86

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Toxicity Summary

Based on the predicted environmental concentrations of methomyl within the aquatic habitats that the Mexican fawnsfoot is found in, we expect no direct adverse effects (i.e., mortality, reduced growth, reduced reproduction) are likely to occur. We expect a low level of indirect effects are likely to occur as few host fish are likely to die at estimated environmental concentrations. As such, we determine the Mexican fawnsfoot has a low toxicity ranking.

Toxicity Ranking: Low

Effects of the Action Summary

The Mexican fawnsfoot has a medium exposure ranking. While there is a low level of past methomyl usage within the species' range, there is a large extent of overlap between the species' range and the action area. As such, we anticipate a moderate number of individuals are likely to be exposed over the duration of the proposed action.

The Mexican fawnsfoot has a low toxicity ranking. We do not expect any direct adverse effects (e.g., mortality, reduced growth, reduced reproduction) to individuals are likely to occur as available toxicity data shows that mollusks are not sensitive to methomyl exposure. We expect a low level of indirect effects are likely as fish hosts are not likely to die at estimated environmental concentrations. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources.

The fish host species for the Mexican fawnsfoot include are unknown; however, based on other *Truncilla* spp., they likely can parasitize freshwater drum (*Aplodinotus grunniens*). 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 possibly one fish host species, freshwater drum are relatively common and use of all aquatic habitats available to them, so we anticipate low adverse effects to the reproductive cycle of the mussel from loss of host fish.

We anticipate up to a 1% reduction in fish host species, thus we anticipate a low level of adverse effects to the reproductive cycle of the mussel. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual false spike mussels will experience adverse effects. Given that we expect a moderate number of individuals are likely to experience exposure but that exposed individuals are not likely to experience any direct adverse effects and only low levels of indirect adverse effects, we anticipate the overall risk of adverse effects to the species is low.

Conclusion

The Mexican fawnsfoot is proposed for listing as endangered. It occurs in a single population in the Rio Grande between Eagle Pass and Laredo in central Texas. Abundance for all occupied sections of the river is low and recruitment is limited. Threats to the species include changes to water quality (i.e., dissolved oxygen, salinity, ammonia, pollutants including pesticides, and increased fine sediment), development, hydrological alteration, barriers to fish movement, predation, and effects of climate change.

The species range occurs near methomyl use sites overlapping 16.7% of the range and a low portion of the range has experienced methomyl usage in the past (0.8% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The Mexican fawnsfoot is believed to be a host fish specialist that uses freshwater drum as a host fish, like other species of *Truncilla* mussels. The Mexican fawnsfoot and its host fish occur in high flow waterbodies of six HUCs (i.e., 8, 11a, 11b, 12a, 12b, 13). Its host fish also occurs in low flow/low volume waterbodies in the same HUCs. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.99%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, presumed host fish occur in multiple aquatic habitats and are abundant and common. Anticipated host fish mortality is low (0-0.99%) in all waterbodies. We expect a small number of individual mussels will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 Mexican fawnsfoot in the wild.

References

U.S. Fish and Wildlife Service. 2023. Species Status Assessment Report for two Rio Grande Mussels: Salina Mucket (*Potamilus metnecktayi*) Mexican Fawnsfoot (*Truncilla cognata*). Albuquerque, New Mexico. 109 pp.

Integration and Synthesis Summary: Southern elktoe

Scientific Name:	Common Name:	Entity ID:
Alasmidonta triangulata	Southern elktoe	10829

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 high past usage of methomyl within the species' range, indicating a high extent of exposure within the action area across the species' range (Figure 46). Exposed individuals are unlikely to die or experience 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 exposure is high, we do not expect indirect effects from loss of host fish and we determine the risk of adverse effects to the species is low. As such, we do not individuals are likely to experience reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 southern elktoe. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 7/20/2022; Wherever found; *States within the range:* FL, GA

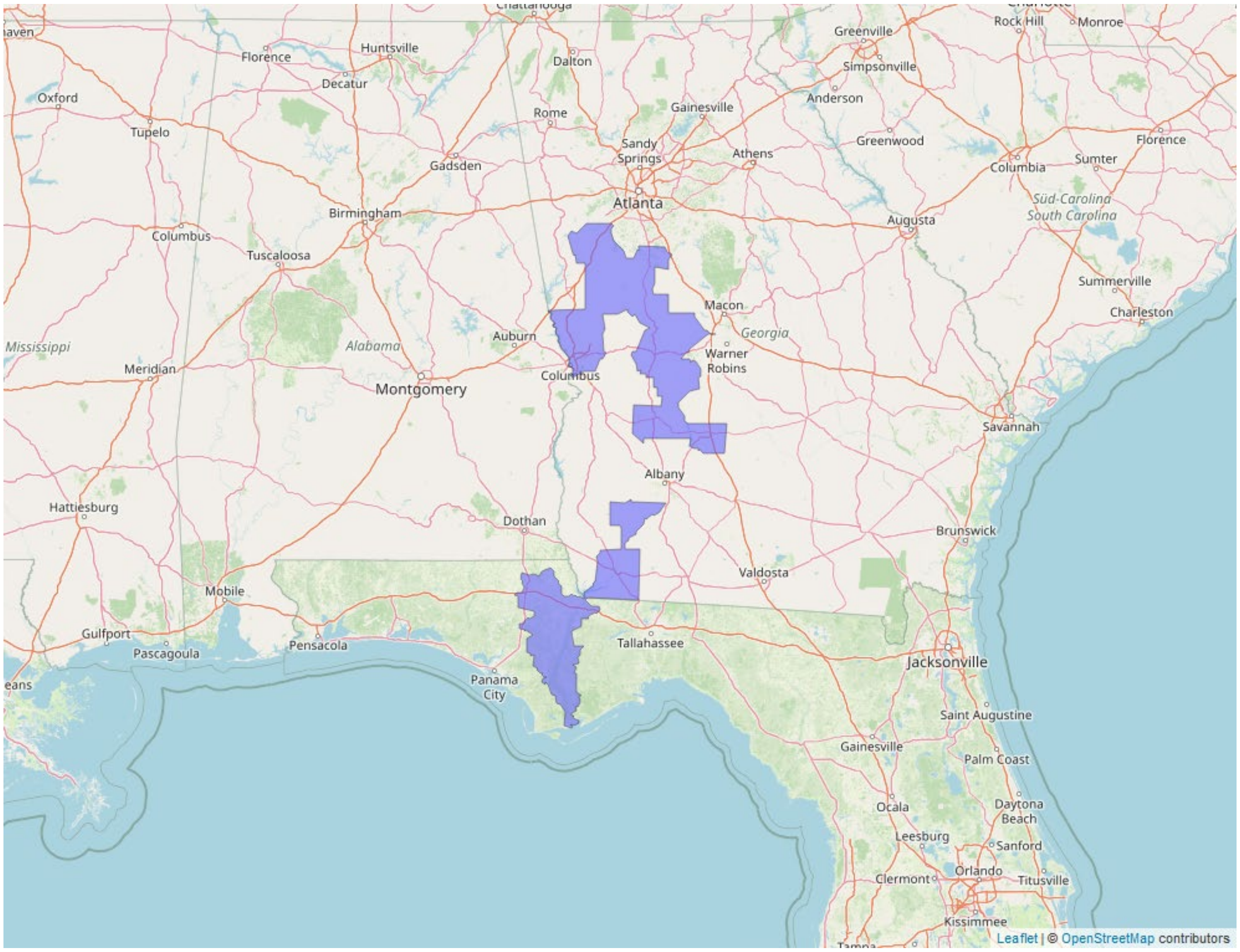

Figure 46. Range map of southern elktoe (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/9871.

Vulnerability

Vulnerability of the species considers the status of the species, environmental baseline, and cumulative effects, as summarized below.

Summary of status

Listing status: Proposed 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:

Southern elktoes are freshwater mussels endemic to the Apalachicola, Chattahoochee, and Flint River basins of Alabama, Florida, and Georgia. They most often occur in areas with permanently flowing, slow current along stream margins with silty mud, sand, and gravel substrates. Because the species is long-lived (15-40 years) and relatively immobile, they require stable habitats with optimal substrate and limited accumulation of sand, silt, or detritus. Southern elktoes filter feed on algae, bacteria, detritus, and microscopic animals from the water column. Known host fish include suckers (Catostomidae). The southern elktoe historically occurred in various stream sizes from smaller tributaries to large mainstream rivers of the Apalachicola-Chattahoochee-Flint River Basin. They currently occur in six populations across, each of which with fair to low resilience (USFWS 2023).

Primary limiting factors include habitat degradation, altered flow regimes, and barriers to fish movement. They are sensitive to changes in water quality (e.g., low dissolved oxygen, elevated temperature, excessive total suspended solids). About 20% of the Apalachicola-Chattahoochee-Flint River Basin is cropland, effects of which include nutrient enrichment, contaminants (including pesticides), and channel scouring from runoff. Agriculture is the largest water user in the Basin, accouting for 35% of all water withdrawals in 2010. Water withdrawals from the nearby cities (e.g., Atlanta) also threaten the southern elktoe and its habitat. Most water removed from the basin for municipal and industrial water demands is returned to the basin as treated waste, but demands can alter natural channel flow. Barriers to fish movement include dams, impoundments, and other structures that prevent fish from being able to travel through an area, particularly limiting glochidia dispersal. Effects of climate change, including changes to precipitation and temperature, may also affect southern elktoes and their habitat. There is uncertainty as to whether host fish availability is a limiting factor for the mussel. Non-native and invasive species like the Asian clam (*Corbicula fluminea*) may also threaten the southern elktoe through competition (USFWS 2023).

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 28% of the species range will contain use sites (Table 94).

Usage

Past usage data indicate that up to 11.5 % of the species' range has been treated with methomyl annually (Table 94).

Table 94. Overlap and usage data for the southern elktoe.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn	4.9	0.7
Cotton	10.3	1.1
Other Grains	1	<0.1
Other Orchards	2.5	0.3
Other Row Crops	8.6	8.6
Soybeans	1.4	0.2
Vegetables and Ground Fruit	0.6	0.6
Wheat	NA	NA
Total	**28**	**11.5**

Exposure Summary

There is a high extent of overlap between the action area and the species' range. Based on past usage data, we expect a high level of usage within the species' range. As such, we expect a large number of individuals are likely to experience exposure from the proposed Action.

Overall Exposure Ranking: High

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-

line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 95 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.
Aquatic habitat buffers: The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds".

Effects of the Action: Toxicity

Direct Effects

Available toxicity data in mollusks suggests that no direct adverse effects to individuals, such as mortality, reduced growth, or reduced reproduction, are likely to occur at predicted concentrations of methomyl within the Southern elktoe's habitat.

Indirect Effects

Within the regions and aquatic habitats that the southern elktoe occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be around 29 µg/L, in the high flow habitats within the region where this mussel is found (Table 95). Based on this range of potential exposures, we do not expect any exposed host fish will die. As such, we do not anticipate any indirect effects are likely to occur to the southern elktoe.

The southern elktoe is a host fish generalist. Southern elktoe glochidia primarily metamorphosed on Apalachicola redhorse (*Moxostoma* sp. cf. *poecilurum*), greater jumprock (*M. lachneri*), creek chubsucker (*Erimyzon oblongus*), and lake chubsucker (*E. sucetta*). In addition, blacktail redhorse (*M. poecilurum*) from the Cahaba River Basin exhibited high metamorphosis success. Five species exhibited marginal success (four Catostomids and one Cyprinid). Overall, successful metamorphosis of glochidia was observed on 10 of 27 species tested and 2 of 9 families of fish. Because no mortality is expected for all aquatic habitats for the southern elktoe mussel, we do not anticipate loss of fish host species availability will likely result in adverse effects to the reproductive cycle of the mussel overall.

Table 95. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_3	28.93	0

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Toxicity Summary

Based on the predicted environmental concentrations of methomyl within the aquatic habitats that the southern elktoe is found in, we expect no direct adverse effects (i.e., mortality, reduced growth, reduced reproduction) are likely to occur. We expect a low level of indirect effects are likely to occur as we do not expect host fish will die. As such, we determine the southern elktoe has a low toxicity ranking.

Toxicity Ranking: Low

Effects of the Action Summary

The southern elktoe has a high exposure ranking. There is a high extent of overlap between the species' range and the action area as well as a high level of past methomyl usage within the range. As such, we anticipate a large number of individuals are likely to be exposed over the duration of the proposed action.

The southern elktoe has a low toxicity ranking. We do not expect any direct adverse effects (e.g., mortality, reduced growth, reduced reproduction) to individuals are likely to occur as available toxicity data shows that mollusks are not sensitive to methomyl exposure. The fish host species for the southern elktoe include the Apalachicola redhorse, greater jumprock, creek chubsucker, and lake chubsucker. In addition, blacktail redhorse from the Cahaba River Basin are commonly found in the larger high flowing waterbodies where the mussel is found. A few other species of cyprinids and catostomids were marginally successful as host fish for the southern elktoe. We do not anticipate reductions in fish host species. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources.

While we expect a large number of individuals are likely to experience exposure, exposed individuals are not likely to experience any direct adverse effects nor indirect adverse effects. As such, we anticipate methomyl is not likely to cause adverse effects to the southern elktoe and overall risk of adverse effects to the species is low.

Conclusion

The southern elktoe is proposed for listing as endangered. It occurs in the Apalachicola, Chattahoochee, and Flint River basins in Alabama, Florida, and Georgia. As of 2023, they occur in six populations, each of which has fair to low resilience. Threats to the species include habitat degradation (e.g., pesticide contamination, altered flow regimes, and barriers to fish movement.

The species range occurs near methomyl use sites overlapping 28% of the range and a high portion of the range has experienced methomyl usage in the past (11.5% annually). Therefore, we consider the species to have a high exposure ranking. However, we do not expect direct mortality of mussels from methomyl exposure, nor do we expect mussels to be indirectly affected through impacts to their host fish. The southern elktoe is believed to be a host fish generalist that uses Apalachicola redhorse, greater jumprock, creek chubsucker, lake chubsucker, and blacktail redhorse as host fish. The southern elktoe and its host fish occur in high flow waterbodies of HUC 3. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), we do not expect methomyl concentrations in any of these habitats that will result in fish mortality. Therefore, we do not anticipate impacts to the southern elktoe through loss of host fish from methomyl exposure. Additionally, 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 the species has high vulnerability and medium exposure, its host fish are common in the mussel's range, and we anticipate no host fish mortality. Therefore, we expect impacts to the mussel to be discountable and no individuals will be adversely affected through loss of host fish. After incorporating conservation measures into the effects of the action, accounting for 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 southern elktoe mussel in the wild.

References

U.S. Fish and Wildlife Service. 2023. Species Status Assessment Report for the southern elktoe (*Alasmidonta triangulata*). Version 1.2. Atlanta, Georgia. 143 pp.

Integration and Synthesis Summary: Round hickorynut

Scientific Name:	Common Name:	Entity ID:
Obovaria subrotunda	Round hickorynut	10837

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 47). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 round hickorynut. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 12/14/2023; Wherever found; *States within the range:* AL, IN, KY, MI, MS, OH, PA, TN, WV

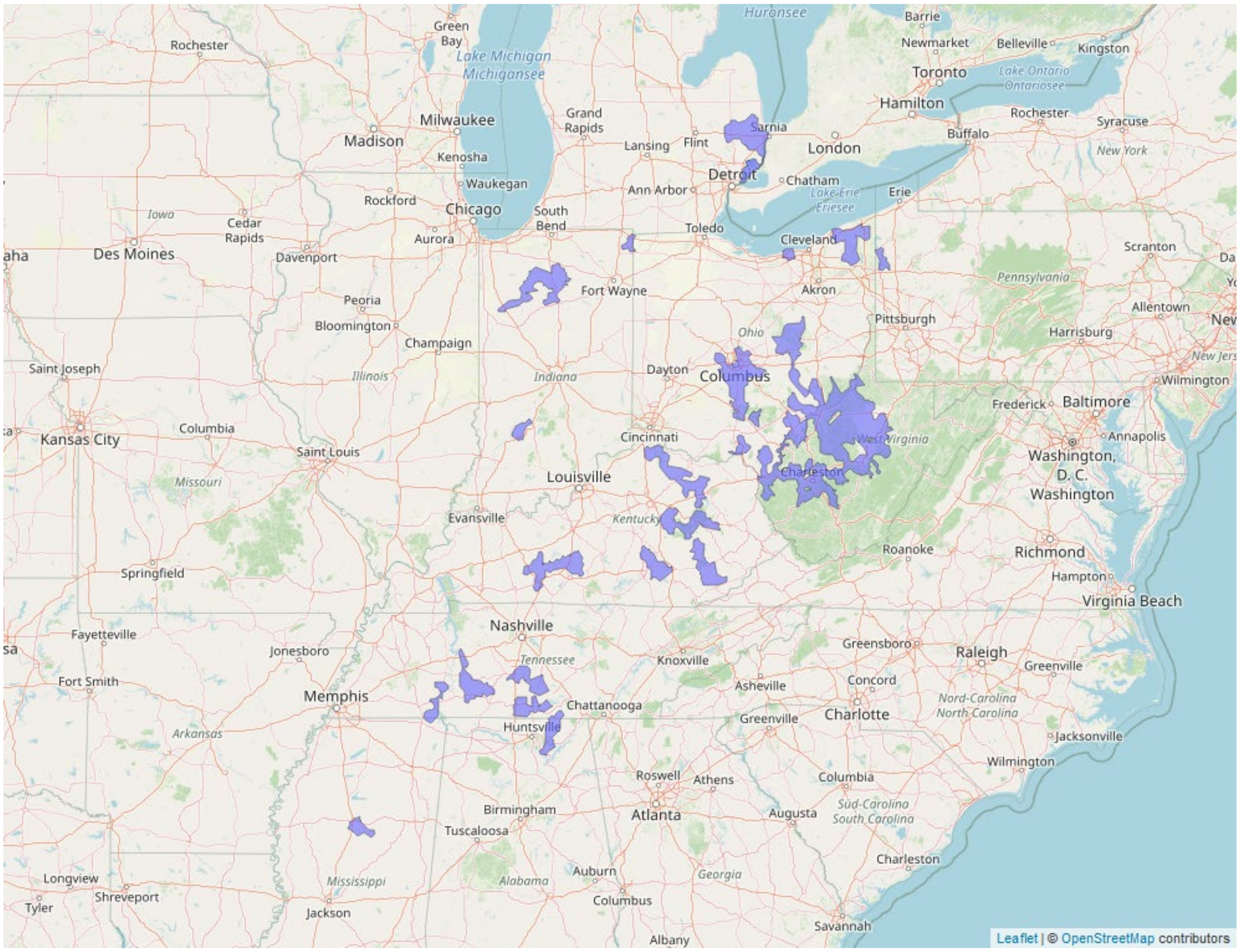

Figure 47. Range map of round hickorynut (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/9879.

Vulnerability

Vulnerability of the species considers the status of the species, environmental baseline, and cumulative effects, as summarized below.

Summary of status

Listing status: Threatened

Most recent Five Year Status Review recommendation: N/A

Most recently completed Five Year Status 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 USFWS documents as a threat to the species: yes

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The current range of the round hickorynut extends over nine states, including Alabama, Indiana, Kentucky, Michigan, Mississippi, Ohio, Pennsylvania, Tennessee, and West Virginia; the species is now considered extirpated in Georgia, Illinois, and New York. This range encompasses five major river basins (Great Lakes, Ohio River, Cumberland River, Tennessee River, and Lower Mississippi River). Round hickorynut representation in the Cumberland River basin is restricted to two linear populations within two management units, while it exists in the Lower Mississippi River basin in a single population. Therefore, while the species currently maintains representation from historical conditions, it is at immediate risk of losing 40% (2 of 5 basins) of its representation due to these small, isolated populations under a high degree of threats that have resulted from habitat loss and water quality degradation. Overall, the round hickorynut has lost approximately 232 of 297 known populations (78%) and 104 of 138 management units (75%). This includes 25 populations in the Great Lakes basin, 150 populations in the Ohio River basin, 23 populations in the Cumberland River basin, 29 populations in the Tennessee River basin, and 9 populations in the Lower Mississippi River basin (see Appendix B in the SSA report: USFWS 2019). Of the current populations, 4 (6%) are estimated to be highly resilient, 16 (23%) are estimated to be moderately resilient, and 45 (69%) are estimated to have low resiliency.

Factors currently affecting the round hickorynut include those that are systemic and contribute to the greatest threats impacting the species and its resource needs across its range, including: habitat loss and alteration, water quality impairment, and more site-specific threats, such as invasive species. Impacts to freshwater mussels and benthic riverine aquatic organisms, in general, often involve multiple interrelated actions, involve compounded stressors, and rarely lack a single causative agent; therefore, they are not easy to observe and may be difficult to quantify after they occur. While factors such as climate change, host fish availability, disease, or predation may affect the species, the best available information does not suggest they are currently acting as significant contributors to round hickorynut decline. Commercial harvest was likely a significant threat that previously/historically contributed to species decline, but it is not currently affecting the round hickorynut, and is unlikely to be a future threat. The current resiliency, redundancy, and representation of the round hickorynut is directly tied to population and habitat fragmentation by the construction of impoundments throughout the species range. Habitat loss and alteration from dam operations continue to impact populations specifically in the Ohio, Tennessee, and Cumberland basins. Impoundments fragment and isolate populations from one another, prevent dispersal that reduces gene flow, and compounds stressors such as the introduction of contaminants and pollution. Across all basins in which the round hickorynut currently occurs, there are one or more threats to the species, which results in effects to individuals and populations at a more rapid rate. The combined impacts of dams and barriers, resource extraction, agricultural activities (including use of pesticides), and nonnative species have led to localized extirpations of the round hickorynut, and a cumulative loss of 80% of its populations compared to its historical distribution. Overall, the greatest threats currently to the round hickorynut are habitat alteration and loss, water quality degradation, nonnative species, and genetic isolation, which affect resource and demographic needs for the species. A variety of stressors contribute to these threats, which may vary in intensity and duration based on temporal and spatial considerations, but similar prevalent impacts have been observed on the round hickorynut resiliency, redundancy, and representation of the species throughout its range. In the Great Lakes basin, the primary stressors are nonnative species, impoundments, and genetic isolation. In the Ohio River basin, the primary stressors are impoundments, resource extraction, and agricultural activities. In the Cumberland River basin, the primary stressors are impoundments, resource extraction, and agricultural activities. In the Tennessee River basin, the primary stressors are impoundments, agricultural activities, and urbanization. In the Lower Mississippi River basin, the primary stressors are genetic isolation, agricultural activities, and impoundments. Throughout the species range, impacts of contaminants and mussel die-offs are difficult to measure and almost impossible to predict, but have been documented in the Fish Creek in the Great Lakes basin and Big Darby Creek in the Ohio basin, and other secondary factors such as predation and climate change are increasingly concerning as small populations become more isolated. Agricultural activities include chemical control using pesticides (e.g., herbicides, fungicides, insecticides, and their surfactants and adjuvants) and waste from confined animal feeding and commercial livestock operations. Though not currently documented, concentrations of pesticides and other contaminants from fields or pastures could reach levels that can affect entire round hickorynut populations, especially given the highly fragmented distribution of the species.

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 14.5% of the species range will contain use sites (Table 96).

Usage

Past usage data indicate that up to 4.7% of the species' range has been treated with methomyl annually (Table 96).

Table 96. Overlap and usage data for the round hickorynut.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	1	0.4
Citrus	NA	NA
Corn	11.4	3.6
Cotton	0.3	0.2
Other Grains	0.2	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	0.2	0.2
Soybeans	12.3	3.7
Vegetables and Ground Fruit	0.5	0.1
Wheat	NA	NA
Total	**14.5**	**4.7**

Exposure Summary

There is a high extent of overlap between the action area and the species' range. Based on past usage data, we expect a low level of usage within the species' range. As such, we expect a moderate number of individuals are likely to experience exposure from the proposed Action.

Overall Exposure Ranking: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 97 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.
Aquatic habitat buffers: The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language

states “Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds”.

Effects of the Action: Toxicity

Direct Effects

Available toxicity data in mollusks suggests that no direct adverse effects to individuals, such as mortality, reduced growth, or reduced reproduction, are likely to occur at predicted concentrations of methomyl within the round hickorynut’s habitat.

Indirect Effects

Within the regions and aquatic habitats that the round hickorynut occupies, EPA’s aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 23 to 230 µg/L, depending on the type of habitat and region (Table 97). Based on this range of potential exposures, we expect very few exposed host fish will die (up to 0.1% exposed individuals), which is not likely to reduce the availability of fish hosts needed for successful reproduction.

The round hickory nut is host fish generalist. Several host fish species have been documented for the round hickorynut, but the dominant host fishes appear to be darters of the genera *Ammocrypta*, *Etheostoma*, and *Percina.* The host fish species for the round hickory nut are likely eastern sand darter, emerald darter, greenside darter, Iowa darter, fantail darter, Cumberland darter, spangled darter, variegate darter, blackside darter, frecklebelly darter, and banded sculpin.

Table 97. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species’ range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_4	24.17	0
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0
Low flow/Low volume waterbodies	HUC_4	244.80	0.12
Low flow/Low volume waterbodies	HUC_5	229.50	0.08

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
Low flow/Low volume waterbodies	HUC_6	164.70	0.01
Low flow/Low volume waterbodies	HUC_7	209.70	0.04
Low flow/Low volume waterbodies	HUC_8	225.90	0.07

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Toxicity Summary

Based on the predicted environmental concentrations of methomyl within the aquatic habitats that the round hickorynut is found in, we expect no direct adverse effects (i.e., mortality, reduced growth, reduced reproduction) are likely to occur. We expect a low level of indirect effects are likely to occur as we expect very few exposed host fish will die (up to 0.1% exposed individuals). As such, we determine the round hickorynut has a low toxicity ranking.

Toxicity Ranking: Low

Effects of the Action Summary

The round hickorynut has a medium exposure ranking. While there is a low level of past methomyl usage within the species' range, there is a large extent of overlap between the species' range and the action area. As such, we anticipate a moderate number of individuals are likely to be exposed over the duration of the proposed action.

The round hickorynut has a low toxicity ranking. We do not expect any direct adverse effects (e.g., mortality, reduced growth, reduced reproduction) to individuals are likely to occur as available toxicity data shows that mollusks are not sensitive to methomyl exposure. The fish host species for the round hickory nut include the eastern sand darter, emerald darter, greenside darter, Iowa darter, fantail darter, Cumberland darter, spangled darter, variegate darter, blackside darter, frecklebelly darter, and banded sculpin. We anticipate 0.1% reductions in fish host species thus we anticipate a low level of adverse effects to the reproductive cycle of the mussel. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. While we expect a moderate number of individuals are likely to experience exposure, exposed individuals are not likely to experience direct adverse effects and only low levels of indirect adverse effects. Thus, the overall risk of adverse effects to the species is low.

Conclusion

The round hickorynut is listed as threatened. It occurs in nine states from Pennsylvania to Michigan to Alabama and is extirpated from 78% of its historically occupied populations. Of the current populations, 45 (69%) are estimated to have low resiliency. Threats to the species include habitat loss and alteration, water quality impairment (e.g., pesticides), and more site-specific threats, such as invasive species.

The species range occurs near methomyl use sites overlapping 14.5% of the range and a low portion of the range has experienced methomyl usage in the past (4.7% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The round hickorynut is believed to be a host fish generalist that uses eastern sand darter, emerald darter, greenside darter, Iowa darter, fantail darter, Cumberland darter, spangled darter, variegate darter, blackside darter, frecklebelly darter, and banded sculpin as host fish. The round hickorynut and its host fish occur in high flow waterbodies of five HUCs (i.e., 4, 5, 6, 7, and 8). Its host fish also occur in low flow/low volume waterbodies in the same HUCs. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.12%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, presumed host fish occur are varied, occur in multiple aquatic habitats, and are abundant and common. Anticipated host fish mortality is low (0-0.12%) in all waterbodies. We expect a small number of individual mussels will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 round hickorynut in the wild.

References

U.S. Fish and Wildlife Service. 2022. Species Status Assessment Report for the Round Hickorynut Mussel (*Obovaria subrotunda*), Version 1.1. Asheville, North Carolina.

U.S. Fish and Wildlife Service. 2020. Endangered and Threatened Wildlife and Plants; 12-Month Finding for Purple Lilliput; Threatened Species Status with Section 4(d) Rule for Longsolid and Round Hickorynut and Designation of Critical Habitat; Proposed Rule; Announcement of 12-Month Finding. Federal Register. 85 (189): 61384-61458.

Integration and Synthesis Summary: Longsolid

Scientific Name:	Common Name:	Entity ID:
Fusconaia subrotunda	Longsolid	10838

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is moderate overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 48). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 longsolid. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 12/14/2023; Wherever found; *States within the range:* AL, GA, IL, IN, KY, MO, MS, NC, NY, OH, PA, SC, TN, VA, WV

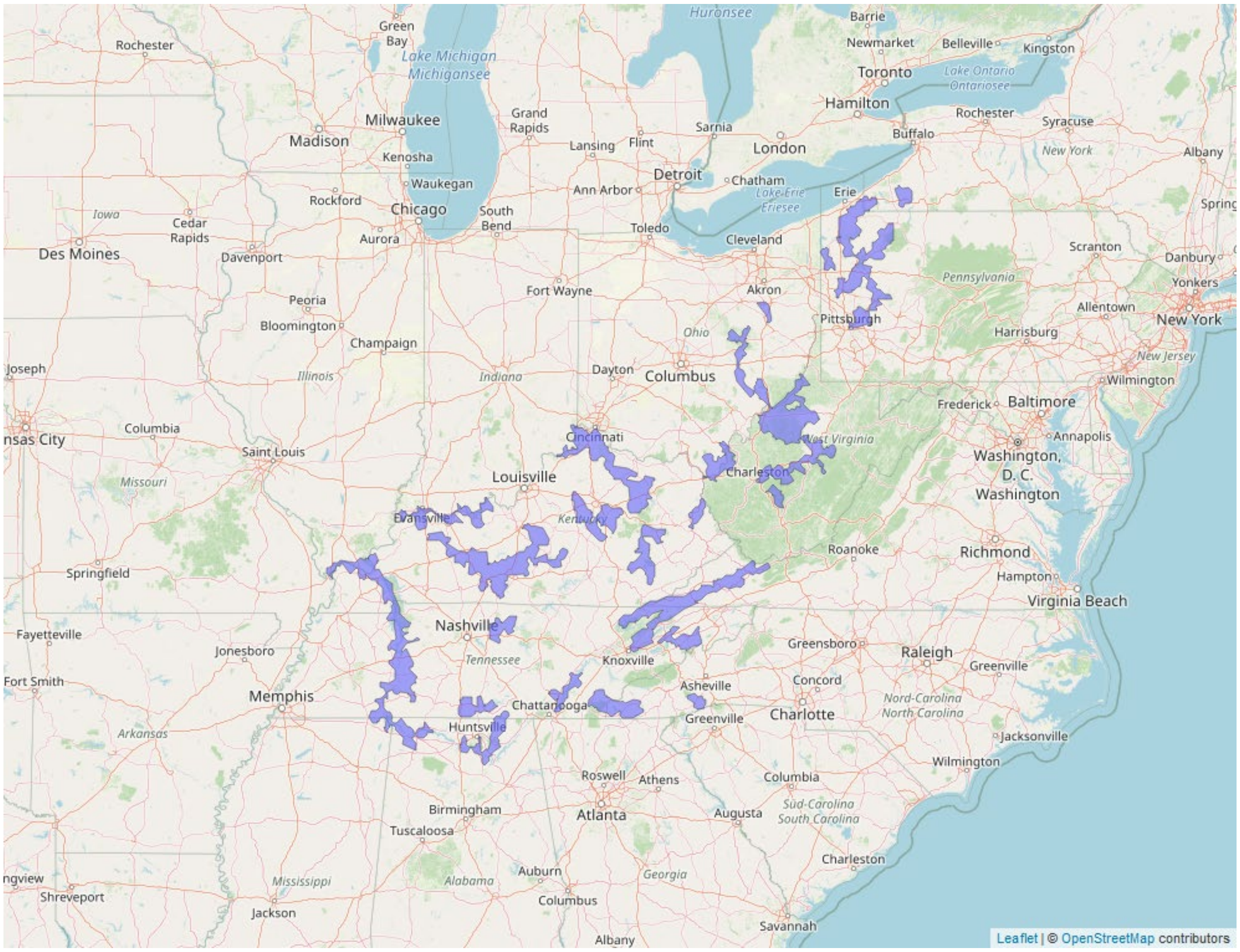

Figure 48. Range map of longsolid (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/9880.

Vulnerability

Vulnerability of the species considers the status of the species, environmental baseline, and cumulative effects, as summarized below.

Summary of status

Listing status: Threatened

Most recent Five Year Status Review recommendation: N/A

Most recently completed Five Year Status 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 USFWS documents as a threat to the species: yes

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The longsolid's current range extends over nine States, including New York, Pennsylvania, West Virginia, Ohio, Kentucky, Virginia, Tennessee, North Carolina, and Alabama; the species is now considered extirpated in Georgia, Illinois, and Indiana. This range encompasses three major river basins (the Ohio, Cumberland, and Tennessee basins); the species no longer exists in the Great Lakes basin (loss of six historical populations and four management units). In addition, its representation in the Cumberland River basin is currently within a single population and management unit (loss of nine historical populations and eight management units). Overall, the longsolid is presumed extirpated from 63% (102 of 162 populations) of its historically occupied populations, including 6 populations (the entirety) in the Great Lakes basin, 65 populations in the Ohio River basin, 9 populations in the Cumberland River basin, and 26 populations in the Tennessee River basin (see Appendix B in the SSA report: USFWS 2018). Of the current populations, 3 (5%) are estimated to be highly resilient, 9 (15%) are estimated to be moderately resilient, and 48 (80%) are estimated to have low resiliency.

Factors currently affecting the longsolid include those that are systemic and contribute to the greatest threats to the species throughout its range: habitat loss and alteration, water quality impairment, and more site-specific threats, such as invasive species. Impacts to freshwater mussels, and benthic riverine aquatic organisms in general, often involve multiple interrelated actions, involve compounded stressors, and rarely lack a single causative agent, therefore they are not easy observe and may be difficult to quantify after they occur. While factors such as climate change, host fish availability, disease, or predation may affect the species currently or in the future, we do not have sufficient data or information to suggest that these are currently contributing to longsolid decline. Commercial harvest was likely a significant threat which previously contributed to species decline, but it is not currently directly affecting the longsolid, and is unlikely to be a future threat. The current resiliency, redundancy, and representation of the longsolid is directly tied to population and habitat fragmentation by the construction of impoundments throughout the species' range. Hypolimnetic discharges downstream from dams continue to impact populations specifically in the Tennessee and Cumberland river basins. Impoundments fragment and isolate populations from one another, prevent dispersal which reduces gene flow, and compounds stressors such as the introduction of contaminants and pollution; whether the result of mining, oil and gas exploration, agricultural runoff, or untreated or poorly treated wastewater discharges. The threats to the longsolid are synergistic, and result in effects to individuals and populations at a more rapid rate. The combined impacts of dams and barriers, resource extraction, agricultural activities, and non-native species have led to localized extirpations of the longsolid, and a cumulative loss of 63% of its formerly occupied range.

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 9.4% of the species range will contain use sites (Table 98).

Usage

Past usage data indicate that up to 3% of the species' range has been treated with methomyl annually (Table 98).

Table 98. Overlap and usage data for the longsolid.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	0.7	0.1
Citrus	NA	NA
Corn	7.3	2.3
Cotton	0.3	0.1
Other Grains	0.2	<0.1
Other Orchards	<0.1	<0.1
Other Row Crops	0.2	0.2
Soybeans	7.9	2.4
Vegetables and Ground Fruit	0.1	<0.1
Wheat	NA	NA
Total	**9.4**	**3**

Exposure Summary

There is a medium extent of overlap between the action area and the species' range. Based on past usage data, we expect a low level of usage within the species' range. As such, we expect a moderate number of individuals are likely to experience exposure from the proposed action.

Overall Exposure Ranking: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 99 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.
Aquatic habitat buffers: The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds".

Effects of the Action: Toxicity

Direct Effects

Available toxicity data in mollusks suggests that no direct adverse effects to individuals, such as mortality, reduced growth, or reduced reproduction, are likely to occur at predicted concentrations of methomyl within the longsolid's habitat.

Indirect Effects

Within the regions and aquatic habitats that the longsolid occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 23 to 230 µg/L, depending on the type of habitat and region (Table 99). Based on this range of potential exposures, we expect very few exposed host fish will die (up to 0.1% of exposed individuals), which is not likely to reduce the availability of fish hosts needed for successful reproduction.

The longsolid is host fish generalist. Several host fish species have been documented for the longsolid such as the central stoneroller, whitetail shiner, striped shiner, river chub, and warpaint shiner which are common and abundant within the waterbodies and HUC 2 regions where the longsolid is found.

Table 99. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_3	34.82	0
High flow waterbodies	HUC_4	24.17	0
High flow waterbodies	HUC_5	23.72	0
High flow waterbodies	HUC_6	23.40	0
High flow waterbodies	HUC_7	23.72	0
High flow waterbodies	HUC_8	45.74	0
Low flow/Low volume waterbodies	HUC_3	171.00	0.01
Low flow/Low volume waterbodies	HUC_4	244.80	0.12
Low flow/Low volume waterbodies	HUC_5	229.50	0.08
Low flow/Low volume waterbodies	HUC_6	164.70	0.01
Low flow/Low volume waterbodies	HUC_7	209.70	0.04
Low flow/Low volume waterbodies	HUC_8	225.90	0.07

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Toxicity Summary

Based on the predicted environmental concentrations of methomyl within the aquatic habitats that the longsolid is found in, we expect no direct adverse effects (i.e., mortality, reduced growth, reduced reproduction) are likely to occur. We expect a low level (0.1%) of indirect effects are likely to occur as fish hosts are not likely to die at estimated environmental concentrations. As such, we determine the longsolid has a low toxicity ranking.

Toxicity Ranking: Low

Effects of the Action Summary

The longsolid has a medium exposure ranking. While there is a low level of past methomyl usage within the species' range, there is a large extent of overlap between the species' range and the action area. As such, we anticipate a moderate number of individuals are likely to be exposed over the duration of the proposed action.

The longsolid has a low toxicity ranking. We do not expect any direct adverse effects (e.g., mortality, reduced growth, reduced reproduction) to individuals are likely to occur as available toxicity data shows that mollusks are not sensitive to methomyl exposure. The fish host species for the longsolid include the central stoneroller, whitetail shiner, striped shiner, river chub, and warpaint shiner. We anticipate <0.1% reductions in fish host species thus we anticipate a low level of adverse effects to the reproductive cycle of the mussel. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. While we expect a moderate number of individuals are likely to experience exposure, exposed individuals are not likely to experience direct adverse effects and only low levels of indirect adverse effects. As such, we anticipate methomyl is not likely to cause adverse effects to the longsolid, thus we anticipate the overall risk of adverse effects to the species is low.

Conclusion

The longsolid mussel is listed as threatened. It occurs in nine states from New York to Alabama and is extirpated from 63% of its historically occupied populations, including all of the Great Lakes basin, Georgia, Illinois, and Indiana. Of the current populations, 48 (80%) are estimated to have low resiliency. Threats to the species include habitat loss and alteration, water quality impairment (e.g., pesticides), and more site-specific threats, such as invasive species.

The species range occurs near methomyl use sites overlapping 9.4% of the range and a low portion of the range has experienced methomyl usage in the past (3% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The longsolid is believed to be a host fish generalist that uses central stoneroller, whitetail shiner, striped shiner, river chub, and warpaint shiner as host fish. The longsolid and its host fish occur in high flow waterbodies of six HUCs (i.e., 3, 4, 5, 6, 7, and 8). Its host fish also occur in low flow/low volume waterbodies in the same HUCs. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-0.12%, with low rates of mortality anticipated for host fish in all aquatic habitats. 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 the species has high vulnerability and medium exposure, presumed host fish occur are varied, occur in multiple aquatic habitats, and are abundant and common. Anticipated host fish mortality is low (0-0.12%) in all waterbodies. We expect a small number of individual mussels will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 longsolid in the wild.

References

U.S. Fish and Wildlife Service. 2020. Endangered and Threatened Wildlife and Plants; 12-Month Finding for Purple Lilliput; Threatened Species Status with Section 4(d) Rule for Longsolid and Round Hickorynut and Designation of Critical Habitat; Proposed Rule; Announcement of 12-Month Finding. Federal Register. 85 (189): 61384-61458.

U.S. Fish and Wildlife Service. 2018. Draft Species Status Assessment Report for the Longsolid Mussel (*Fusconaia subrotunda*), Version 1.3. Asheville, North Carolina.

Integration and Synthesis Summary: Guadalupe orb

Scientific Name:	Common Name:	Entity ID:
Cyclonaias necki	Guadalupe orb	11577

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is moderate overlap of the action area with the species' range, and moderate past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 49). Exposed individuals are unlikely to die but are likely to experience low levels of 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. Given that exposure is medium and the level of indirect effects is low, 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 reduced reproductive success from the proposed action. After incorporating conservation measures into the effects of the action, accounting for 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 Guadalupe orb. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 8/4/2021; *States within the range:* TX

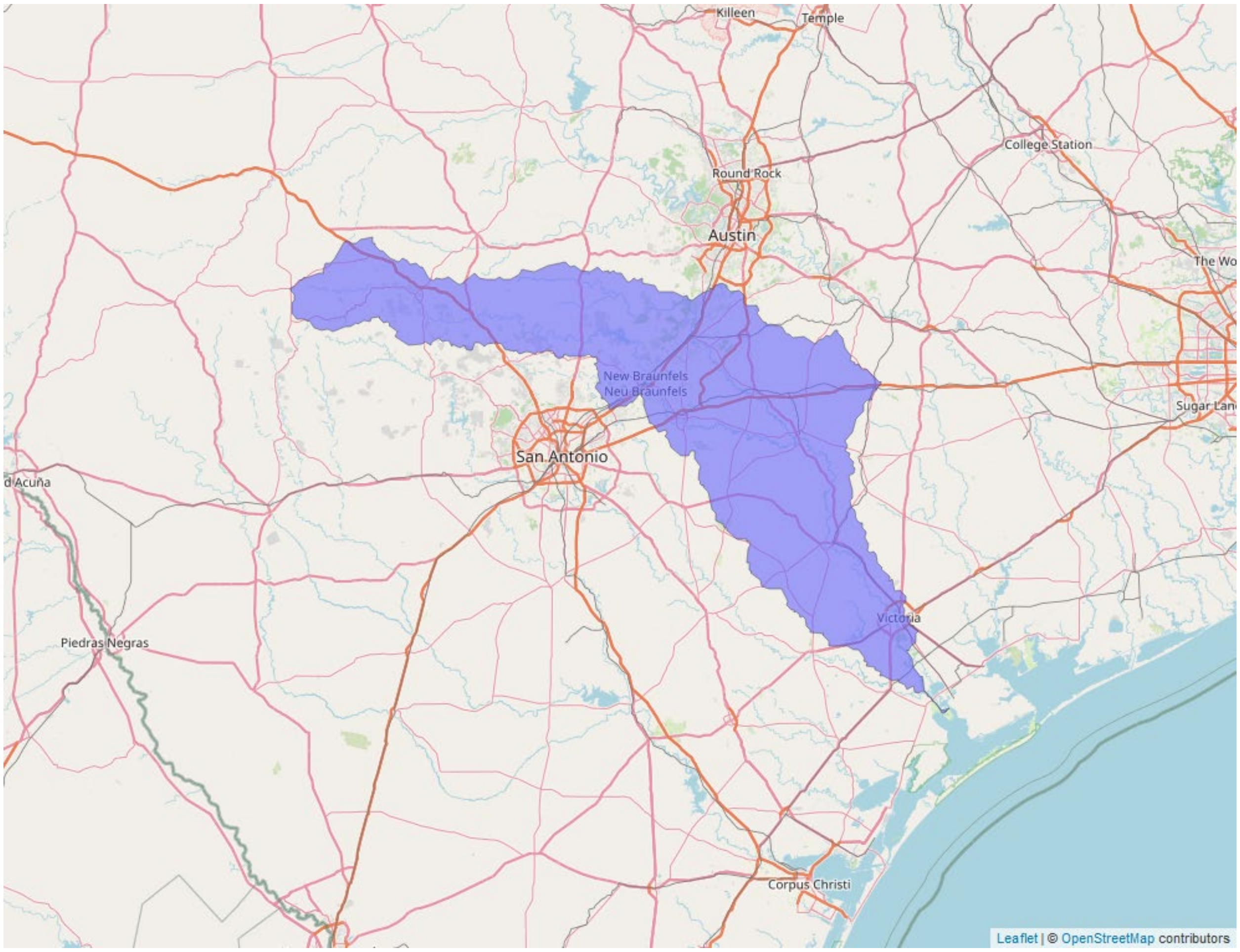

Figure 49. Range map of Guadalupe orb (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/10781.

Vulnerability

Vulnerability of the species considers the status of the species, environmental baseline, and cumulative effects, as summarized below.

Summary of status

Listing status: Endangered

Most recent Five Year Status Review recommendation: N/A

Most recently completed Five Year Status 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 USFWS documents as a threat to the species: yes

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The Guadalupe orb was previously recognized as a “small variety” of the Texas pimpleback (*Cyclonaias petrina*) occurring in the Guadalupe River basin of Central Texas. However, following morphological and genetic analyses, it is now recognized to be a separate species. For this reason, what are now considered Guadalupe orb populations are referred to as Texas pimpleback in the literature documenting its occurrences prior to 2018. Guadalupe orb historically occurred throughout most of the length of the Guadalupe and Blanco Rivers within the Guadalupe River basin. In the Guadalupe River, the species ranged from Comal, Guadalupe, Kendall, Kerr, and Victoria Counties. The Guadalupe orb currently occupies about 54% of its potential historical range (506 river miles total) and is currently found along 276 river miles of the Guadalupe River. Two populations of the Guadalupe orb are known: one in unhealthy condition in the upper reaches of the Guadalupe River and another in moderate condition in the lower Guadalupe River, which extends upstream into the San Marcos River.

Our analysis of the past, current, and future influences on what the Central Texas mussels need for long term viability revealed that there are three influences that pose the largest risk to the future viability of the species. These risks are primarily related to habitat changes: the accretion of fine sediments, the loss of flowing water, and degradation of water quality; these are all exacerbated by climate change. Changes in hydrology including floods leading to scour and subsequent substrate unsuitability, inundation under reservoirs, the degradation of water quality, predation, collection, disease, and invasive species. 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.

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 8% of the species range will contain use sites (Table 100).

Usage

Past usage data indicate that up to 6.6% of the species' range has been treated with methomyl annually (Table 100).

Table 100. Overlap and usage data for the Guadalupe orb.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	NA	NA
Corn	3.1	2.1
Cotton	1.4	1.8
Other Grains	3.3	2.7
Other Orchards	0.2	<0.1
Other Row Crops	<0.1	<0.1
Soybeans	0.2	0.1
Vegetables and Ground Fruit	<0.1	<0.1
Wheat	NA	NA
Total	**8**	**6.6**

Exposure Summary

There is a medium extent of overlap between the action area and the species' range. Based on past usage data, we expect a medium level of usage within the species' range. As such, we expect a moderate number of individuals are likely to experience exposure from the proposed Action.

Overall Exposure Ranking: Medium

Conservation Measures

Rain restriction: The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk. Thus, we provide in Table 101 the maximum predicted EEC from the highest overlap use site within the species range to illustrate the resulting concentrations of methomyl in the aquatic habitats where this species is found, as a result of this rain restriction measure.

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

Effects of the Action: Toxicity

Direct Effects

Available toxicity data in mollusks suggests that no direct adverse effects to individuals, such as mortality, reduced growth, or reduced reproduction, are likely to occur at predicted concentrations of methomyl within the Guadalupe orb's habitat.

Indirect Effects

Within the regions and aquatic habitats that the Guadalupe orb occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of methomyl will likely be from 43 to 407 µg/L, depending on the type of habitat and region (Table 101). Based on this range of potential exposures, we expect up to 2% of exposed host fish will die. The Guadalupe orb is considered a host fish generalist. The fish host for the Guadalupe orb (*Cyclonaias necki*) include channel catfish, flathead catfish, yellow bullhead, and tadpole madtom (USFWS 2022). Because the fish host species are varied and found in multiple aquatic habitats, and we expect fish mortality to be low, we anticipate low adverse effects to the reproductive cycle of the mussel.

Table 101. Maximum predicted environmental concentrations based on HUC 2 region and aquatic habitat within the species' range (includes rain restriction conservation measure).

Aquatic Habitat Bin	HUC 2 Region	Max EEC (µg/L)	Percent fish mortality
High flow waterbodies	HUC_12a	43.24	0
High flow waterbodies	HUC_12b	65.12	0
Low flow/Low volume waterbodies	HUC_12a	387.90	1.61
Low flow/Low volume waterbodies	HUC_12b	407.70	2.05

While we expect some reductions in zooplankton from methomyl exposure, based on methomyl'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 methomyl exposure to detritus or any other aquatic debris on which mussels feed.

Toxicity Summary

Based on the predicted environmental concentrations of methomyl within the aquatic habitats that the Guadalupe orb is found in, we expect no direct adverse effects (i.e., mortality, reduced growth, reduced reproduction) are likely to occur. We expect a low level of indirect effects are likely to occur as host fish are not likely to die. As such, we determine the Guadalupe orb has a low toxicity ranking.

Toxicity Ranking: Low

Effects of the Action Summary

The Guadalupe orb has a medium exposure ranking. There is a moderate extent of overlap between the species' range and the action area as well as a moderate level of past methomyl usage within the species' range. As such, we anticipate a moderate number of individuals are likely to be exposed over the duration of the proposed action.

The Guadalupe orb has a low toxicity ranking. We do not expect any direct adverse effects (e.g., mortality, reduced growth, reduced reproduction) to individuals are likely to occur as available toxicity data shows that mollusks are not sensitive to methomyl exposure. We anticipate some 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 fish host species for the Guadalupe orb include channel catfish, flathead catfish, yellow bullhead, and tadpole madtom that are commonly found in the waterbodies where the mussel is found. We anticipate up to 2% reductions in fish host species. In addition, glochidia typically parasitize adult fish, which are less likely than larval and juvenile fish to occur in habitats where methomyl exposure is expected to cause mortality. Thus, we anticipate a low level of adverse effects to the reproductive cycle of the mussel. We expect some reductions in zooplankton from methomyl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Thus, we anticipate a small number of individual false spike mussels will experience adverse effects.

Given that we expect a moderate number of individuals are likely to experience exposure but that exposed individuals are not likely to experience any direct adverse effects and only low levels of indirect adverse effects, we anticipate the overall risk of adverse effects to the species is low.

Conclusion

The Guadalupe orb is listed as endangered, and it occurs in the Guadalupe River basin of Central Texas along 276 river miles (54% of its potential historical range). In one extant population, abundance is low, reproduction is limited, and it is considered unhealthy. In the other extant population, abundance is healthy, reproduction is moderate, and it is considered to be in moderate health. Threats to the species include accretion of fine sediments, loss of flowing water, and degradation of water quality (e.g., presence of pesticides).

The species range occurs near methomyl use sites overlapping 8% of the range and a moderate portion of the range has experienced methomyl usage in the past (6.6% annually). Therefore, we consider the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from methomyl exposure, we expect mussels to be indirectly affected through impacts to their host fish. The Guadalupe orb is believed to be a host fish generalist that uses channel catfish, flathead catfish, yellow bullhead, and tadpole madtoms as host fish. The Guadalupe orb and its host fish occur in high flow waterbodies of HUCs 12a and 12b. Its host fish also occur in low flow/low volume waterbodies and large volume waterbodies in the same HUCs. Each aquatic habitat/HUC has a different predicted environmental concentration range and expected fish mortality percentage. We expect mortality to be limited to areas where low flow habitats occur, and where methomyl use and subsequent spray drift or runoff occurs. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to methomyl in low flow/low volume waterbodies where they go to avoid predation. After accounting for the general conservation measures listed above (rain restriction and aquatic habitat buffer), fish host mortality estimates range from 0-2.05%, with no mortality anticipated for host fish in high-flow aquatic habitats. 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 the species has high vulnerability and medium exposure, presumed host fish occur in multiple aquatic habitats and anticipated host fish mortality is low (0-2.05%). We expect a small number of individual mussels will be adversely affected. After incorporating conservation measures into the effects of the action, accounting for 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 Guadalupe orb in the wild.

References

U.S. Fish and Wildlife Service. 2022. Species status assessment report for the Central Texas Mussels, Version 2.1. Albuquerque, New Mexico. 267 pp.