Integration and Synthesis Summary for Fishes

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

Vulnerability

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

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

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

Exposure

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

Exposure to Agricultural Uses

We characterize the expected level of exposure using overlaps between the species' ranges and agricultural land uses where carbaryl is registered for use (i.e., overlap data, including a 30 meter off-site transport area adjacent to use sites), past carbaryl usage data (when available; the amount and location where carbaryl has been used in the past), any species-specific considerations such as life history information (e.g., habitat preferences, dispersal behavior), and existing protections or conservation actions (e.g., existing label measures, conservation measures from the action agency). Species with greater than 10% overlap between their range and agricultural carbaryl use sites are assigned a high overlap score, species with 5-10% overlap are assigned a medium overlap score, and species with less than 5% total overlap are assigned a low overlap score. In addition to range overlaps with carbaryl use sites, we considered past carbaryl usage data within a species' range to determine how much of a species' range we expect to be treated with carbaryl each year of the proposed action. Except where otherwise noted, usage data is provided by EPA applying data from their National and State Summary Use and Usage Matrix, as described in the Usage Analysis section of this biological opinion. Species that data indicate will have a large portion of their range (>10%) treated with carbaryl each year are assigned a high usage score. Species with 5-10% total usage are assigned a medium usage score, and species with less than 5% total usage are assigned a low usage score. Agricultural uses of carbaryl in the state of Hawai'i are no longer registered; however, agricultural uses are still registered for other island territories.

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

Exposure to Non-Agricultural Uses

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

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

Additionally, based on application information, we anticipate carbaryl use in these UDLs are restricted to small treatment areas that are treated infrequently over long periods of time. Use patterns like forestry, rangeland, or rights of way may even be geographically restricted as available past usage data indicate carbaryl usage is only in certain areas of the country, such as the western conterminous United States. Available usage data from the U.S. Forest Service indicate that, over a five-year period (from 2016-2020), the Forest Service treated 322 acres of forests in California and 557 acres of forests across three Forest Service Regions (covering North Dakota, Montana, South Dakota, Idaho, Kansas, Nebraska, Colorado, Wyoming, Utah, and Nevada), with the majority of applications taking place in small areas (less than 1 acre in size). Similarly, usage data from the U.S. Department of Agriculture Animal and Plant Health

Inspection Service (APHIS) show limited past carbaryl usage as well. From 2019-2023, APHIS treated 92,309 acres of rangeland in seven states (Arizona, Idaho, Montana, Nevada, Utah, Washington, Wyoming) and 25 counties. While this represents a large area overall, when distributed across the areas within the seven states where usage occurs, we anticipate only a small percentage of any species' range is likely to be treated for this use pattern. Additionally, all but one of these applications were made using carbaryl bait, which we expect has a much lower risk profile as bait applications are less likely to cause off target exposures as there is no spray drift exposure likely to occur.

Additionally, there are several existing conservation and mitigation measures for non-agricultural uses of carbaryl that will reduce the likelihood of exposure to listed species. For example, from the 2022 FIFRA Proposed Interim Decision and the 2024 NMFS biological opinion for carbaryl, residential treatments are limited to spot and crack treatments (defined as a 2 foot^2 area), crack-and-crevice treatment, or narrow perimeter bands around urban structures (from 1 inch to 6 feet). This limitation in application method renders off-site spray drift unlikely and greatly reduces the extent of area that can be treated in the developed and nurseries UDLs. Similarly, we anticipate all rangeland applications of carbaryl will be carried out in association with USDA APHIS as part of their grasshopper and Mormon cricket suppression program (USFWS 2024), which include many conservation measures that are meant to protect listed species from exposure. Examples of measures included a reduced agent area treatment strategy that minimizes the amount of pesticide applied within a treatment block, allowance of only one application per year, reduced application rates, minimized treatment area size within 500 feet and 1,000 feet from listed species' ranges for ground and aerial applications, respectively, and extended application buffers when applications are made near the listed species' habitat (e.g., up to 750 feet for some ground applications and up to a mile for some aerial applications). To assess the likelihood of exposure to non-agricultural uses of carbaryl, we conducted a habitat assessment for each listed species, incorporating available information regarding habitat preferences, known occurrences, relevant life history traits or behaviors, as well as relevant available usage data (summarized in the above sections). For species whose habitat is known or presumed to occur in or adjacent to non-agricultural use sites, we consider, individually and qualitatively, the extent and manner of non-agricultural carbaryl usage within the species' range to generally determine whether a small, moderate, or large number of individuals are likely to be exposed and the expected level of adverse effects from non-agricultural exposure of carbaryl.

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

[1] [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

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

We consider estimated concentrations of carbaryl on the landscape or within the environment and effects reported in available toxicity studies to determine the level of direct and indirect adverse effects to listed species or critical habitat. Concentrations of carbaryl can vary greatly depending on where exposure takes place. For instance, exposures on or near carbaryl use sites are at higher levels than exposures that occur in areas far away from carbaryl use sites. Based on available toxicity data, we anticipate fish may experience mortality with exposure, but only at high exposure concentrations. While sublethal effects, such as reduced growth or reproduction, are also possible with carbaryl exposure, we do not anticipate sublethal effects are likely to occur before the onset of mortality for fish.

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

We determine the overall toxicity ranking for fish by qualitatively assessing both the expected levels of direct adverse effects (e.g., mortality) and indirect effects (e.g., prey or habitat loss). Given that mortality is the most adverse of direct effects to an individual of a species, we assign the most weight to direct adverse effects resulting in mortality when determining the toxicity ranking. As mentioned previously, available toxicity data indicate fish may be sensitive to carbaryl and are likely to die at higher estimated environmental concentrations.

Summary of Fishes Conclusions

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our biological opinion that the registration of carbaryl, as proposed, is not likely to jeopardize the continued existence of the 122 fish species in this Appendix. In our analysis below, some species that had the same or very similar rationales for their conclusions were grouped together, to increase efficiency and avoid repetition. Relevant information and data unique to each individual species was considered when

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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.

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 fish species in the consultation: boulder darter, bull trout, Colorado pikeminnow (=squawfish), duskytail darter, Rio Grande silvery minnow, slender chub, smoky madtom, spotfin chub, Topeka shiner, woundfin, and yellowfin madtom. We do not provide separate analyses or make jeopardy determinations for these populations independently. Rather, we treat any experimental and non-experimental populations as a single listed species for the purposes of conducting jeopardy analyses and making jeopardy determinations. By definition, a "non-essential experimental population" is not essential to the continued existence of the species. In cases where our assessment of the non-experimental population(s) of the species leads to a "not likely to jeopardize" determination, we generally assume any added effects to the experimental population will not change these determinations. However, we consider the role of the experimental population in the survival and recovery of the species and consider this information in our jeopardy analyses as appropriate.

Species proposed for delisting

The following species are proposed for delisting (Table 1).

Table 1. Fish species recommended for delisting.

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Change in status	Determination
Etheostoma sellare	Maryland darter	High	High	Low	Recommend delisting due to extinction	No Jeopardy

The 2021 5-Year Review for the Maryland darter recommended delisting the species due to extinction. Available information indicates this species is no longer extant in the wild, and there are no captive individuals. After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not likely to appreciably reduce the survival and recovery of the species. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Maryland darter.

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

The species listed here are grouped together as they all have low exposure informed by low overlap with agricultural sites where carbaryl is registered for use (Table 2). 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. Fish species with low exposure (informed by low overlap with agriculture).

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Total Action Area Overlap (% Range)	Determination
Acipenser oxyrinchus (=oxyrhynchus) desotoi	Gulf sturgeon	Medium	Low	Low	1.1	No Jeopardy
Amblyopsis rosae	Ozark cavefish	Medium	Low	Low	3.8	No Jeopardy
Catostomus discobolus yarrowi	Zuni bluehead sucker	High	Low	Low	0.0	No Jeopardy
Catostomus santaanae	Santa Ana sucker	High	Low	High	2.2	No Jeopardy
Catostomus warnerensis	Warner sucker	High	Low	Low	1.4	No Jeopardy
Chasmistes cujus	Cui-ui	High	Low	Low	0.8	No Jeopardy
Chrosomus saylori	Laurel dace	High	Low	Low	2.2	No Jeopardy
Cottus paulus (=pygmaeus)	Pygmy sculpin	High	Low	Low	1.8	No Jeopardy
Crenichthys baileyi baileyi	White River springfish	Medium	Low	Low	0.5	No Jeopardy
Crenichthys baileyi grandis	Hiko White River springfish	High	Low	Low	0.4	No Jeopardy
Crenichthys nevadae	Railroad Valley springfish	Medium	Low	Low	0.4	No Jeopardy
Crystallaria cincotta	Diamond darter	High	Low	Low	4.3	No Jeopardy
Cyprinella caerulea	Blue shiner	High	Low	Low	2.4	No Jeopardy
Cyprinella formosa	Beautiful shiner	Medium	Low	Low	0.4	No Jeopardy

Appendix C-A5. Fishes: Integration and Synthesis Summaries

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Total Action Area Overlap (% Range)	Determination
Cyprinodon bovinus	Leon Springs pupfish	High	Low	Low	1.4	No Jeopardy
Cyprinodon diabolis	Devils Hole pupfish	High	Low	Low	0.1	No Jeopardy
Cyprinodon elegans	Comanche Springs pupfish	High	Low	Low	2.5	No Jeopardy
Cyprinodon nevadensis mionectes	Ash Meadows Amargosa pupfish	High	Low	Low	0.2	No Jeopardy
Cyprinodon nevadensis pectoralis	Warm Springs pupfish	Medium	Low	Low	0.3	No Jeopardy
Cyprinodon radiosus	Owens pupfish	High	Low	Low	0.3	No Jeopardy
Dionda diaboli	Devils River minnow	High	Low	High	0.5	No Jeopardy
Empetrichthys latos	Pahrump poolfish	High	Low	Low	0.4	No Jeopardy
Eremichthys acros	Desert dace	Medium	Low	Low	0.2	No Jeopardy
Erimonax monachus	Spotfin chub	High	Low	Low	1.5	No Jeopardy
Erimystax cahni	Slender chub	High	Low	Low	0.9	No Jeopardy
Etheostoma akatulo	Bluemask darter	Medium	Low	Low	3.5	No Jeopardy
Etheostoma chermocki	Vermilion darter	High	Low	Low	0.6	No Jeopardy
Etheostoma etowahae	Etowah darter	High	Low	Low	0.8	No Jeopardy
Etheostoma moorei	Yellowcheek darter	High	Low	Low	0.1	No Jeopardy
Etheostoma nianguae	Niangua darter	High	Low	Medium	2.9	No Jeopardy
Etheostoma nuchale	Watercress darter	High	Low	Low	0.4	No Jeopardy
Etheostoma percnurum	Duskytail darter	High	Low	Low	0.7	No Jeopardy
Etheostoma phytophilum	Rush darter	High	Low	Low	3.1	No Jeopardy
Etheostoma rubrum	Bayou darter	High	Low	Low	4.2	No Jeopardy

Appendix C-A5. Fishes: Integration and Synthesis Summaries

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Total Action Area Overlap (% Range)	Determination
Etheostoma scotti	Cherokee darter	Medium	Low	Low	0.7	No Jeopardy
Etheostoma spilotum	Kentucky arrow darter	High	Low	Low	0.3	No Jeopardy
Etheostoma susanae	Cumberland darter	High	Low	Low	0.4	No Jeopardy
Eucyclogobius newberryi	Tidewater goby	Low	Low	High	3.3	No Jeopardy
Gambusia gaigei	Big Bend gambusia	High	Low	High	0.1	No Jeopardy
Gambusia heterochir	Clear Creek gambusia	High	Low	High	1.5	No Jeopardy
Gambusia nobilis	Pecos gambusia	High	Low	Low	2.9	No Jeopardy
Gasterosteus aculeatus williamsoni	Unarmored threespine stickleback	High	Low	High	2.7	No Jeopardy
Gila bicolor ssp.	Hutton tui chub	High	Low	High	0.0	No Jeopardy
Gila bicolor ssp. mohavensis	Mohave tui chub	High	Low	Low	0.6	No Jeopardy
Gila bicolor ssp. snyderi	Owens Tui chub	High	Low	Low	0.4	No Jeopardy
Gila cypha	Humpback chub	Medium	Low	Low	0.1	No Jeopardy
Gila ditaenia	Sonora chub	Medium	Low	Low	0.0	No Jeopardy
Gila intermedia	Gila chub	High	Low	Low	2.1	No Jeopardy
Gila nigrescens	Chihuahua chub	High	Low	Low	4.1	No Jeopardy
Gila robusta jordani	Pahranagat roundtail chub	High	Low	Low	0.5	No Jeopardy
Gila seminuda (=robusta)	Virgin River chub	High	Low	Low	1.3	No Jeopardy
Hybognathus amarus	Rio Grande silvery minnow	High	Low	Low	0.9	No Jeopardy
Lepidomeda albivallis	White River spinedace	High	Low	Low	0.5	No Jeopardy
Lepidomeda mollispinis pratensis	Big Spring spinedace	High	Low	Low	0.3	No Jeopardy
Lepidomeda vittata	Little Colorado spinedace	High	Low	Low	0.0	No Jeopardy
Meda fulgida	Spikedace	High	Low	Low	1.0	No Jeopardy

Appendix C-A5. Fishes: Integration and Synthesis Summaries

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Total Action Area Overlap (% Range)	Determination
Moapa coriacea	Moapa dace	Medium	Low	Low	0.1	No Jeopardy
Notropis cahabae	Cahaba shiner	High	Low	Low	1.3	No Jeopardy
Notropis simus pecosensis	Pecos bluntnose shiner	Medium	Low	Low	3.4	No Jeopardy
Noturus baileyi	Smoky madtom	High	Low	Low	0.7	No Jeopardy
Noturus flavipinnis	Yellowfin madtom	Medium	Low	Low	0.7	No Jeopardy
Noturus munitus	Frecklebelly madtom	High	Low	Low	1.6	No Jeopardy
Oncorhynchus aguabonita whitei	Little Kern golden trout	Medium	Low	High	0.1	No Jeopardy
Oncorhynchus clarkii henshawi	Lahontan cutthroat trout	Medium	Low	Low	1.4	No Jeopardy
Oncorhynchus clarkii seleniris	Paiute cutthroat trout	Medium	Low	Low	1.0	No Jeopardy
Oncorhynchus clarkii stomias	Greenback cutthroat trout	High	Low	Low	4.4	No Jeopardy
Oncorhynchus gilae	Gila trout	Medium	Low	Low	1.3	No Jeopardy
Percina antesella	Amber darter	High	Low	Low	1.4	No Jeopardy
Percina aurolineata	Goldline darter	Medium	Low	Medium	1.6	No Jeopardy
Percina aurora	Pearl darter	High	Low	Low	1.8	No Jeopardy
Percina jenkinsi	Conasauga logperch	High	Low	Low	2.4	No Jeopardy
Percina pantherina	Leopard darter	High	Low	Low	0.3	No Jeopardy
Percina williamsi	Sickle darter	High	Low	Low	1.2	No Jeopardy
Phoxinus cumberlandensis	Blackside dace	Medium	Low	Low	1.5	No Jeopardy
Plagopterus argentissimus	Woundfin	High	Low	Low	1.4	No Jeopardy
Poeciliopsis occidentalis	Gila topminnow (incl. Yaqui)	Medium	Low	Low	2.5	No Jeopardy
Ptychocheilus lucius	Colorado pikeminnow	Medium	Low	Low	3.5	No Jeopardy

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Total Action Area Overlap (% Range)	Determination
Rhinichthys osculus lethoporus	Independence Valley speckled dace	High	Low	Low	0.4	No Jeopardy
Rhinichthys osculus nevadensis	Ash Meadows speckled dace	High	Low	Low	0.2	No Jeopardy
Rhinichthys osculus oligoporus	Clover Valley speckled dace	High	Low	Low	0.7	No Jeopardy
Rhinichthys osculus thermalis	Kendall Warm Springs dace	High	Low	Low	0.0	No Jeopardy
Salmo salar	Atlantic salmon	Medium	Low	Low	1.1	No Jeopardy
Tiaroga cobitis	Loach minnow	High	Low	Low	1.0	No Jeopardy
Xyrauchen texanus	Razorback sucker	Medium	Low	Low	3.9	No Jeopardy

The species listed in Table 2 have a range of vulnerability rankings. Species like the amber smoky madtom, blue shiner, leopard darter, and loach minnow have high vulnerability rankings due to a number of factors, such as small or restricted population distributions, declining population trends, and/or low population numbers. Additionally, these species have pesticides noted as a specific threat to individuals. As such, we anticipate these species may be more susceptible to adverse effects that occur to individuals as a result of carbaryl exposure. Other species, like the Owens pupfish, and Lahontan cutthroat trout, may not have pesticides listed as a specific threat, but still have high vulnerability rankings, indicating that the species may still be susceptible to adverse effects to individuals from carbaryl exposure. Species like the Colorado pikeminnow, Warm Springs pupfish, and humpback chub, have medium vulnerability rankings, indicating that, while they may still be susceptible to adverse effects to individuals resulting from carbaryl exposure, may be somewhat more robust to population level effects due to factors like a wider species distribution, larger population numbers, or stable or increasing population trends. The tidewater goby is the only species in this group that has a low vulnerability ranking. Pesticides are not noted to be a specific threat to this species. As such, we anticipate the tidewater goby will be more robust to any adverse effects that occur to individuals as a result of exposure to carbaryl.

All the species in Table 2 have low total overlap with registered agricultural use sites of carbaryl, indicating that only a small number of individuals, at most, are likely to experience any exposure to carbaryl. Given the conservative nature of total overlap (e.g., does not consider information on past carbaryl usage, does not fully account for redundancy between crop use sites, assumes exposure is occurring in all possible areas at the same time), we have high confidence that these species will experience low levels of exposure from agricultural uses. We anticipate the inclusion of usage data would further reduce the extent and likelihood of exposure to individuals of these species.

Of these species, the Ash Meadows Amargosa pupfish, Ash Meadows speckled dace, Big Bend gambusia, and Kendall Warm Springs dace all primarily occur on federal lands (e.g., national parks, national wildlife refuge) where agricultural activities are less likely to occur, further reducing the likelihood of exposure to individuals. Similarly, Zuni bluehead sucker, Sonora chub, and the Little Colorado spinedace's ranges do not overlap with agricultural carbaryl use sites (i.e., 0% overlap), indicating that no individuals are likely to be exposed to carbaryl from these uses. Thus, while these species have a high vulnerability ranking and would experience high levels of adverse effects if exposed, we anticipate no individuals will experience any mortality or adverse effects to growth or reproduction.

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

For rangeland uses, fish mitigations from the USDA-APHIS grasshopper and Mormon cricket consultation are the following: a 2500-foot buffer for all ultra-low volume aerial applications of carbaryl and a 300-foot buffer for all ground applications of carbaryl. For carbaryl bait applications all fish are protected by a 750-foot buffer for aerial applications and a 100-foot buffer for ground applications. These specific buffers apply for the following species in this grouping that fall in the action area for the USDA-APHIS consultation: Devils Hole pupfish, Ash Meadows Amargosa pupfish, Pahrump poolfish, desert dace, Pecos gambusia, Hutton tui chub, humpback chub, Sonora chub, Gila chub, Chihuahua chub, Pahranagat roundtail chub, Virgin River chub, Rio Grande silvery minnow, White River spinedace, Big Spring spinedace, Little Colorado spinedace, spike dace, Moapa dace, Pecos bluntnose shiner, Lahontan cutthroat trout, Gila trout, woundfin, Colorado pikeminnow, Independence Valley speckled dace, Ash Meadows speckled dace, Clover Valley speckled dace, Kendall Warm Springs dace, loach minnow, and razorback sucker. For the remaining fishes in this grouping, we anticipate there is a low likelihood of the need to apply these program measures as grasshopper and Mormon cricket populations do not reach the level where they would need to be suppressed in the areas where their respective ranges are located. However, we anticipate the buffers and other mitigation measures outlined in the biological assessment would be applied if there were a need to use carbaryl applications for this reason within the remaining fish species' habitats in the future. We expect these mitigation measures will be sufficient to result in no adverse effects or incidental take from future uses of carbaryl within rangeland areas that occur in the species' range. As such, we anticipate low exposure from rangeland use of carbaryl.

Nearly all species in this group have a low toxicity ranking as we anticipate estimated environmental concentrations of carbaryl within their habitats will be low. With a few exceptions, we anticipate none of these species will be exposed to estimated environmental concentrations (for agricultural and non-agricultural uses of carbaryl) that exceed the HC_{05} for fish mortality calculated by the EPA in the BE. We consider the HC_{05} a conservative threshold for qualitatively estimating anticipated mortality to listed fish as data representing a wide diversity of fish species are used to generate HC_{05} estimates. Since the maximum estimated environmental concentrations are well below the level where we anticipate 95% of fish species will not experience high levels of mortality, we anticipate there is a high likelihood that these listed fish species will also not experience high levels of mortality. In the case of the Clear Creek gambusia, unarmored threespine stickleback, Little Kern golden trout, Hutton tui chub, Devils River minnow, goldline darter, tidewater goby, and Santa Ana sucker, we anticipate the highest environmental concentrations predicted to occur in their habitats will exceed the HC_{05}, indicating the potential for mortality in a high proportion of exposed individuals . However, this degree of mortality is only associated with carbaryl use on crops that are not very prevalent within the species' ranges (e.g., overlaps ranging from <0.1% to 1.1%). Thus, we anticipate these adverse effects would be limited to a very small portion of the range and would only affect a small number of individuals.

While non-agricultural uses of carbaryl may contribute to the overall exposure of each of the species in the table above, estimated environmental concentrations associated with all non-agricultural uses (including developed, open space developed, nursery, managed forests, rangeland, and rights of way uses) will not exceed the HC_{05}. As such, we anticipate there is a high likelihood that these fish species will not experience high levels of mortality when exposed to non-agricultural uses of carbaryl. While sublethal effects to reproduction may occur at the high end of exposure estimates, we do not anticipate more than low levels of sublethal impacts to these species as we anticipate more typical exposures will be below levels where toxicity studies have observed sublethal adverse effects.

In summary, we expect all these species are likely to experience no more than low levels of exposure to carbaryl based on the low level of exposure as informed by the low level of total overlap. The total overlap metric does not fully account for redundancy between use site layers, assumes exposure is occurring in all possible overlapping areas, and does not consider information on past carbaryl usage, providing us with high confidence that these species will not experience more than low levels of exposure. While pesticides are noted as a threat to many of the fish species in this group, and while some species may experience mortality or sublethal effects, we expect these adverse effects will be limited to only a small number of individuals. After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not expected to appreciably reduce survival and recovery of these species in the wild. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the species listed in Table 2.

Note: The spotfin chub (EXPN Entity ID: 9505, 1934, 9061), slender chub (EXPN Entity ID: 9504), duskytail darter (EXPN Entity ID: 9502, 6503), Rio Grande silvery minnow (EXPN Entity ID: 10052), smoky madtom (EXPN Entity ID: 5981), yellowfin madtom (EXPN Entity IDs: 2956, 4496, 9506), woundfin (EXPN Entity ID: 2599), and Colorado pikeminnow (EXPN Entity ID: 2142) have non-essential experimental populations.

Species with low exposure (informed by low past usage from California Department of Pesticide Regulation data)

The species in Table 3 are grouped together because they all occur completely within California and have low exposure confirmed by low levels of past carbaryl usage within their ranges (% range treated), as informed by the California Department of Pesticide Regulation Pesticide Use Reporting (CalPUR) data. While we present some specific information about the species in Table 3below, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species accounts can be found in Appendix B.

Table 3. Fish species with low exposure informed by low past usage from the California Department of Pesticide Regulation, Pesticide Use Reporting (CalPUR) Data

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	% Range treated (CalPUR)	Determination
Hypomesus transpacificus	Delta smelt	High	Low	Low	0.6	No Jeopardy
Spirinchus thaleichthys	Longfin smelt	High	Low	Low	0.6	No Jeopardy

Both the Delta smelt and longfin smelt have high vulnerability rankings as each species consists of only a single population experiencing declining trends. Pesticides are a noted threat to both species. While there is a high extent of overlap between both species' ranges and registered agricultural use sites, with 72.1% and 47.4% total overlap for the Delta smelt and longfin smelt, respectively, available data from the California Department of Pesticide Regulations' California Pesticide Usage Report (CalPUR) indicate very little carbaryl usage has been used within the two species' ranges. From 2013-2022, only 0.6% of both the Delta smelt and longfin smelt's ranges have been treated with carbaryl, indicating that only a small number of individuals are likely to experience any exposure. While CalPUR data include all agricultural usage, it is also inclusive of certain non-agricultural uses, such as those performed by professional commercial applicators. Given that this usage data is mandated by the state of California and that these data are provided regularly at a relatively high spatial resolution, we have high confidence that only a small percent of the species' ranges is likely to be exposed to carbaryl.

Additionally, both species have a low toxicity ranking, as we anticipate only low levels of carbaryl are likely to accumulate within the habitats of the Delta smelt and longfin smelt. Maximum estimated environmental concentrations of carbaryl (from both agricultural and non-agricultural uses) within the ranges of the Delta smelt and longfin smelt range will not exceed 252.2 µg/L. This maximum exposure is one order of magnitude (or 10-fold) lower than the HC_{05} and is below levels where available toxicity studies have observed any mortality in fish species. While sublethal effects to reproduction may occur at these highest exposure estimates, we do not anticipate more than low levels of impacts to reproduction are likely as we anticipate more typical exposure will be below levels that toxicity studies have observed sublethal adverse effects.

While these species are highly vulnerable to adverse effects, we anticipate only a small number of individuals are likely to experience any exposure to agricultural uses of carbaryl, and exposed individuals are not likely to die and only a few individuals will experience adverse effects to reproduction. After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not likely to appreciably reduce the survival and recovery of these species in the wild in Table 3. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of these fish species in the wild.

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

The species in Table 4 are grouped together because they all have low exposure (% range treated) confirmed by low levels of past insecticide usage within their ranges, as informed by the USDA's Census of Agriculture (CoA). While we present some specific information about the species in Table 4 below, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species accounts can be found in Appendix B.

Table 4. Fish species with low exposure (informed by the USDA Census of Agriculture).

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	% Range Treated (CoA)	Determination
Acipenser transmontanus	White sturgeon	High	Low	High	3.0	No Jeopardy
Chasmistes brevirostris	Shortnose sucker	High	Low	Medium	0.6	No Jeopardy
Chasmistes liorus	June sucker	Medium	Low	Low	3.0	No Jeopardy
Cyprinodon macularius	Desert pupfish	High	Low	Low	4.2	No Jeopardy
Deltistes luxatus	Lost River sucker	High	Low	Medium	0.9	No Jeopardy
Etheostoma fonticola	Fountain darter	High	Low	High	1.5	No Jeopardy
Etheostoma osburni	Candy darter	High	Low	Low	0.1	No Jeopardy
Etheostoma trisella	Trispot darter	High	Low	Low	2.2	No Jeopardy
Gila elegans	Bonytail	High	Low	Low	0.5	No Jeopardy
Gila purpurea	Yaqui chub	Medium	Low	Low	1.7	No Jeopardy
Ictalurus pricei	Yaqui catfish	High	Low	Low	2.1	No Jeopardy
Notropis albizonatus	Palezone shiner	High	Low	Low	3.2	No Jeopardy
Notropis buccula	Smalleye shiner	High	Low	Low	3.6	No Jeopardy
Notropis mekistocholas	Cape Fear shiner	High	Low	Low	3.2	No Jeopardy
Notropis oxyrhynchus	Sharpnose shiner	High	Low	Low	3.6	No Jeopardy

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	% Range Treated (CoA)	Determination
Percina rex	Roanoke logperch	Medium	Low	Low	4.0	No Jeopardy
Salvelinus confluentus	Bull trout	Medium	Low	Low	0.7	No Jeopardy

All the species in Table 4 have either a medium or high vulnerability ranking. Species like the fountain darter, sharpnose shiner, and bonytail have high vulnerability rankings as they have a restricted distribution and have pesticides noted as a threat. We anticipate these species may be more susceptible to impacts to individuals resulting from exposure to carbaryl. Species like the Yaqui chub, bull trout, Roanoke logperch, and June sucker have a medium vulnerability ranking. While these species may be more robust in general to adverse effects than high vulnerability species, we anticipate these species may still be susceptible to adverse effects from carbaryl exposure.

Despite the medium to high vulnerability of these species, we anticipate only a small number of individuals are likely to experience any exposure to agricultural uses of carbaryl as the USDA Census of Agriculture (CoA) indicates very little insecticide usage (of any active ingredient) occurred within the agricultural crops in the past in the counties where these species' ranges occur. Given that this reporting broadly includes all insecticide usage, we consider CoA data to be conservative estimates of carbaryl usage that indicate very little of the species' ranges are likely to be treated. As such, we anticipate no more than a small number of individuals are likely to be exposed to carbaryl through agricultural uses.

The shortnose sucker, Palezone shiner, and bull trout among others may co-occur within watersheds with non-agricultural carbaryl use sites, including utility rights of way, and may be exposed to carbaryl through this non-agricultural use. However, available data on past non-agricultural usage indicate that very little insecticides, in general, are applied to utility rights of way nationwide, indicating that there is a low likelihood of exposure to these mussels. Less than 500 pounds of carbaryl are applied along roadways nationally each year. While this may result in a large treatment footprint if all rights of way usage were concentrated in one location or within one species' range, we expect this is highly unlikely to occur and rather expect rights of way usage is likely to be sporadic across the national landscape, with only small amounts, if any, used within the species' range. Applications made for nurseries and residential areas (developed use layer) are mostly limited to spot and crack treatments or narrow perimeter bands around structures (as discussed above in the exposure section of this document) that limit the amount of runoff that may enter nearby aquatic habitats where these mussels may be found. Available usage data indicate only low levels of past carbaryl usage occurred in open space developed areas (including golf courses) with, at most, up to 2.5% of open space developed areas receiving treatment each year nationally.

For rangeland uses, mussel mitigations from the USDA-APHIS grasshopper and Mormon cricket consultation are the following: a 2500-foot buffer for all ultra-low volume aerial applications of carbaryl and a 300-foot buffer for all ground applications of carbaryl. For carbaryl bait applications all mussels are protected by a 750-foot buffer for aerial applications and a 100-foot buffer for ground applications. These specific buffers apply for the following species in this grouping that fall in the action area for the USDA-APHIS consultation: white sturgeon, shortnose sucker, June sucker, desert pupfish, bonytail, Yaqui chub, Yaqui catfish, smalleye shiner, sharpnose shiner, and bull trout. As such, we expect non-agricultural usage of carbaryl will be low and not meaningfully add to the level of concern for the species in this grouping. For the remaining fishes in this grouping, we anticipate there is a low likelihood of the need to apply these program measures as grasshopper and Mormon cricket populations do not reach the level where they would need to be suppressed in the areas of where those species' ranges are found. However, we anticipate the buffers and other mitigation measures outlined in the biological assessment would be applied if there were a need to use carbaryl applications for this reason within the remaining mussel species' habitats in the future. As such, we anticipate low exposure from rangeland use of carbaryl. Furthermore, nearly all species in Table 4 have a low toxicity ranking as predicted environmental concentrations from both agricultural and non-agricultural uses of carbaryl within these species' habitats are low. With a few exceptions, maximum estimated environmental concentrations of carbaryl (from both agricultural and non-agricultural uses) range from 252-785.6 µg/L, which is an order of magnitude (or 10-fold) below the HC_{05} for fish mortality calculated by EPA in the BE. We consider the HC_{05} a conservative threshold for qualitatively estimating anticipated mortality to listed fish as data representing a wide diversity of fish species are used to generate HC_{05} estimates. Since the maximum estimated environmental concentrations are well below the level where we anticipate 95% of fish species will not experience high levels of mortality, we anticipate there is a high likelihood that these listed fish species will also not experience high levels of mortality. While sublethal effects to reproduction may occur at the high end of exposure estimates, we do not anticipate more than low levels of sublethal impacts to these species as we anticipate more typical exposures will be below levels that toxicity studies have observed sublethal adverse effects.

In the case of the fountain darter and white sturgeon, we anticipate maximum estimated environmental concentrations of carbaryl agricultural uses can range from 317.1-1397.8 µg/L. The high-end estimates of exposure exceed the HC_{05} for fish mortality and the fish sub-lethal threshold as well, indicating the potential for mortality and reduced fecundity in a high proportion of exposed individuals, at least occasionally. However, given that we anticipate only a small portion of the range is likely to be treated with any insecticide from agricultural uses, we anticipate only small numbers of individuals are likely to be exposed to carbaryl. As such, even in high exposure scenarios, we anticipate mortality will be limited to a small portion of populations. While maximum estimated environmental concentrations of carbaryl may cause sublethal adverse effects (e.g., reduced reproduction) to all species in Table 4, we anticipate these high level exposures will only occur on occasion and that typical exposure concentrations are likely to be lower than levels where toxicity studies have observed sublethal effects in fish, resulting in only low levels of sublethal adverse effects to these species.

In summary, while sublethal adverse effects may occur to all species in Table 4, and for some species, a high proportion of exposed individuals may die or have reduced fecundity, we expect these adverse effects will be limited to only a small portion of individuals as available usage data indicate only low levels of carbaryl usage are likely to occur within these species' ranges. After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not likely to appreciably reduce the survival and recovery of these species in Table 4. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of these species in the wild.

Note: The bull trout (EXPN Entity ID: 10037) has a non-essential experimental population.

Species with moderate to high exposure but low toxicity

These species listed below have either medium or high vulnerability rankings, medium to high exposure rankings, and low toxicity rankings. While we present some specific information about the species in Table 5 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 5. Fish species with medium to high vulnerability and exposure and low toxicity.

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Maximum EEC range (µg/L)	Determination
Cottus specus	Grotto sculpin	High	High	Low	723.9-785.6	No Jeopardy
Elassoma alabamae	Spring pygmy sunfish	Medium	High	Low	723.9-785.6	No Jeopardy
Etheostoma boschungi	Slackwater darter	High	High	Low	723.9-785.6	No Jeopardy
Etheostoma chienense	Relict darter	Medium	High	Low	723.9-785.6	No Jeopardy
Etheostoma wapiti	Boulder darter	High	High	Low	723.9-785.6	No Jeopardy
Fundulus julisia	Barrens topminnow	High	High	Low	723.9-785.6	No Jeopardy
Macrhybopsis tetranema	Peppered chub	High	High	Low	61.1-103.8	No Jeopardy
Menidia extensa	Waccamaw silverside	High	High	Low	723.9-785.6	No Jeopardy
Notropis topeka (=tristis)	Topeka shiner	Medium	High	Low	723.9-785.6	No Jeopardy
Noturus furiosus	Carolina madtom	High	High	Low	647.7-780.4	No Jeopardy
Noturus placidus	Neosho madtom	High	High	Low	67.9-84.9	No Jeopardy
Scaphirhynchus albus	Pallid sturgeon	Medium	High	Low	723.9-785.6	No Jeopardy
Speoplatyrhinus poulsoni	Alabama cavefish	High	High	Low	723.9-785.6	No Jeopardy

All the species in Table 5 have either a medium or high vulnerability ranking. Species like the Waccamaw shiner and peppered chub have high vulnerability rankings because they have a restricted distribution, pesticides noted as a threat, or very small populations. We anticipate highly vulnerable species may be more susceptible to impacts to individuals resulting from exposure to carbaryl. Species like the pallid sturgeon and spring pygmy sunfish have a medium vulnerability ranking. While these species may be more robust in general to adverse effects than high vulnerability species, we anticipate these species may still be susceptible to adverse effects from carbaryl exposure.

We anticipate the species in Table 5 likely will be exposed to carbaryl through agricultural uses as there is a substantial level of overlap between their ranges and agricultural use sites and varying levels of past usage. The species in Table 5 have a high level of overlap between their ranges and agricultural use sites (ranging from 13.4-73.8% total overlap) and a high level of past usage (ranging from 9.2-32.7% range treated annually). As such, these species all have high exposure rankings as we anticipate a large number of individuals are likely to be exposed over the duration of the proposed action. Non-agricultural uses of carbaryl may also occur within the ranges of these species.

The Waccamaw silverside, Carolina madtom, and Topeka shiner, among others may co-occur within watersheds with non-agricultural carbaryl use sites, including utility rights of way, and may be exposed to carbaryl through this non-agricultural use. However, available data on past non-agricultural usage indicate that very little insecticides, in general, are applied to utility rights of way nationwide, indicating that there is a low likelihood of exposure to these mussels. Less than 500 pounds of carbaryl are applied along roadways nationally each year. While this may result in a large treatment footprint if all rights of way usage were concentrated in one location or within one species' range, we expect this is highly unlikely to occur and rather expect rights of way usage is likely to be sporadic across the national landscape, with only small amounts, if any, used within the species' range. Applications made for nurseries and residential areas (developed use layer) are mostly limited to spot and crack treatments or narrow perimeter bands around structures (as discussed above in the exposure section of this document) that limit the amount of runoff that may enter nearby aquatic habitats where these mussels may be found. Available usage data indicate only low levels of past carbaryl usage occurred in open space developed areas (including golf courses) with, at most, up to 2.5% of open space developed areas receiving treatment each year nationally.

For rangeland uses, fish mitigations from the USDA-APHIS grasshopper and Mormon cricket consultation are the following: a 2500-foot buffer for all ultra-low volume aerial applications of carbaryl and a 300-foot buffer for all ground applications of carbaryl. For carbaryl bait applications all fish are protected by a 750-foot buffer for aerial applications and a 100-foot buffer for ground applications. These specific buffers also apply for the following species in this grouping that fall in the action area for the USDA-APHIS consultation: peppered chub, Topeka shiner, Neosho madtom, and pallid sturgeon. As such, we expect non-agricultural usage of carbaryl will be low and not meaningfully add to the level of concern for the species in this grouping. For the remaining fishes in this grouping, we anticipate there is a low likelihood of the need to apply these program measures as grasshopper and Mormon cricket populations do not reach the level where they would need to be suppressed in these areas. However, we anticipate the buffers and other mitigation measures outlined in the biological assessment would be applied if there were a need to use carbaryl applications for this reason within the remaining mussel species' habitats in the future. As such, we anticipate low exposure from rangeland use of carbaryl.

However, all species in Table 5 have a low toxicity ranking as we expect estimated environmental exposures will be low. Carbaryl residues in aquatic habitats where these fish species occur will vary depending on the crops treated as application rates will vary across use sites. Estimated environmental concentrations of carbaryl will further vary based on environmental conditions where individuals are exposed (e.g., water body size, flow rate). Based on known habitat preferences of these listed species and the use layers with the highest overlaps with each of the species' range, we anticipate maximum estimated environmental concentrations for agricultural uses within these species' habitats will range from 54.8-785.6 µg/L. Even at the highest concentrations predicted, we do not anticipate exposures will occur at levels that exceed the HC_{05} calculated by the EPA in their BE (i.e., 95% of tested fish species would not experience high levels of mortality). We consider the HC_{05} a conservative threshold for qualitatively estimating anticipated mortality to listed fish as a wide breadth and variability of fish species are used to generate HC_{05} estimates. Because the maximum estimated environmental concentrations are well below the level where we anticipate 95% of fish species will not experience high levels of mortality, we anticipate there is a low likelihood that a large proportion of exposed individuals will die.

For non-agricultural uses, maximum estimated environmental concentrations of carbaryl range from 177-958 µg/L. However, these values do not exceed the HC_{05} calculated by the EPA in their BE (i.e., 95% of tested fish species would not experience high levels of mortality). We consider the HC_{05} a conservative threshold for qualitatively estimating anticipated mortality to listed fish as a wide breadth and variability of fish species are used to generate HC_{05} estimates.

While sublethal effects to reproduction may occur at the high end of exposure estimates for both agricultural and non-agricultural uses, we do not anticipate more than low levels of sublethal impacts to these species as we anticipate these high level exposures will only occur on occasion and that typical exposure concentrations are likely to be lower than levels where toxicity studies have observed sublethal effects in fish, resulting in only low levels of sublethal adverse effects to these species.

In summary, we do not anticipate more than low levels of mortality or sublethal adverse effects will occur to any of the species within this grouping and we expect these adverse effects will be limited to only a small number of individuals.

After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not likely to appreciably reduce the survival and recovery of these species in Table 5. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the species listed in Table 5 in the wild.

Appendix C-A5. Fishes: Integration and Synthesis Summaries

Note: The boulder darter (EXPN Entity ID: 8921) and Topeka shiner (EXPN Entity ID: 10910) have non-essential experimental populations.

Species with low exposure (based on habitat characteristics)

The species in Table 6 occur in the Edwards Aquifer system, where we expect no more than low levels of carbaryl will accumulate and we expect exposure to the species will be low.

Table 6. Fish species with low exposure (based on the characteristics of their preferred habitat)

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	% Range Treated	Determination
Satan eurystomus	Widemouth blindcat	High	Low	Low	0.8	No Jeopardy
Trogloglanis pattersoni	Toothless blindcat	High	Low	Low	0.8	No Jeopardy

The widemouth and toothless blindcats have high vulnerability rankings, indicating that they may be especially susceptible to species-level impacts from additional stressors in their environment, such as adverse effects to individuals from carbaryl exposure. Additionally, pesticides are noted as a threat. Available toxicity data indicate that the species would experience low levels of mortality (up to 1%) in the low flow/volume waterbodies where they are found if exposure occurs. The widemouth blindcat feeds on amphipods, decapods, and isopods, all of which are expected to be sensitive to carbaryl exposure. The toothless blindcat feeds on detritus and microbial food, which we do not expect to be affected by carbaryl exposure.

Despite having high vulnerability and toxicity rankings, we anticipate only a small number of individuals, at most, are likely to be exposed to carbaryl based on the unique characteristics of the habitat they occupy. The widemouth and toothless blindcats are subterranean fish species endemic to the San Antonio segment of the Edwards Aquifer in Bexar County, Texas. Carbaryl is not able to reach the springs associated with this aquifer system because of its low persistence in water. In addition, high flow rate waters where these fish are found dilute carbaryl to minimal concentrations. As such, we anticipate only a small number of individuals, if any, are likely to be exposed to carbaryl.

In addition, while the ranges for both species encompass the entire state of Texas, these fish are exclusively found within the unique subterranean ecosystem of the Edwards Aquifer in Bexar County. The rest of the state, outside of this aquifer system, does not provide suitable habitat for these species. Therefore, the species range as described for data analysis purposes includes extensive areas where the species are not present. Consequently, the percentage of the range treated with carbaryl (as presented above) is based on the entire range and overestimates the actual level of exposure that is reasonably likely to occur within the aquifer where these fish reside.

In summary, we anticipate the Edwards Aquifer where blindcats are found is not likely to accumulate more than low levels of carbaryl as we expect the majority of carbaryl residues will degrade before entering the aquifer. In addition, high flow rate waters where these fish are found will dilute any residues that do enter the aquifer to minimal concentrations. Thus, while some individuals could die if exposed and pesticides are noted as a threat to the species, we anticipate very few, if any, individuals are likely to experience exposure. We determine the overall risk of adverse effects of carbaryl to the widemouth and toothless blindcats is low and losses of very small numbers of individuals from the proposed action will not likely appreciably reduce the survival and recovery of these fish species. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the species in Table 6 in the wild.

Species with Individual Integration and Synthesis Summaries

For the species in Table 6, our preliminary exposure and toxicity rankings indicated that the proposed action may result in moderate to high adverse effects, or their high vulnerability warranted further analysis as even low exposure and toxicity may result in outsize adverse effects to the overall species. As such, we discuss each species in more detail in individual Integration and Synthesis summaries below. In some cases, we modified initial exposure and toxicity rankings due to additional information regarding exposure and effects for individual species, as described below. For species that had a jeopardy determination in the draft Opinion, EPA incorporated species-specific conservation measures that the registrants agreed to incorporate into the description of the actin to minimize exposure to the species. When relevant, we retained our evaluation that lead to our Preliminary Conclusion and the need for species-specific measures and added an updated Final Conclusion to reflect the impacts of these species-specific measures.

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

Table 7. Fish 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
Scaphirhynchus suttkusi	Alabama sturgeon	No Jeopardy
Notropis girardi	Arkansas River shiner	No Jeopardy
Noturus crypticus	Chucky madtom	No Jeopardy

Integration and Synthesis Summary: Alabama sturgeon

Scientific Name:	Common Name:	Entity ID:
Scaphirhynchus suttkusi	Alabama sturgeon	252

Species Overview

In reviewing the status of the Alabama sturgeon, alongside the environmental baseline and cumulative effects within the action area, we determined that the species' vulnerability is high. Our evaluation of the effects of the proposed action on the species reveals a low overlap of the action area with the species' range, and low past usage of carbaryl within the species' range, indicating a low extent of exposure. Most exposed individuals are unlikely to experience significant mortality but may face low levels of adverse sublethal effects (i.e., reduced reproduction). In addition, low levels of indirect effects may occur primarily through reductions in the availability of prey. Given that the exposure is low, and the level of indirect effects is low, we determine the risk of adverse effects to the species is low. As such, we expect only a small number of individuals may suffer sublethal effects (i.e., impaired reproduction) from the proposed action. After reviewing the current status of the species, environmental baseline for the action area, effects of the proposed registration of carbaryl, and cumulative effects for the species, it is our biological opinion that the registration of carbaryl, as proposed, is not likely to appreciably reduce the survival and recovery of the Alabama sturgeon in the wild. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 3/29/2021; Wherever found; *States within the range:* AL. Figure 4 depicts the species' range.

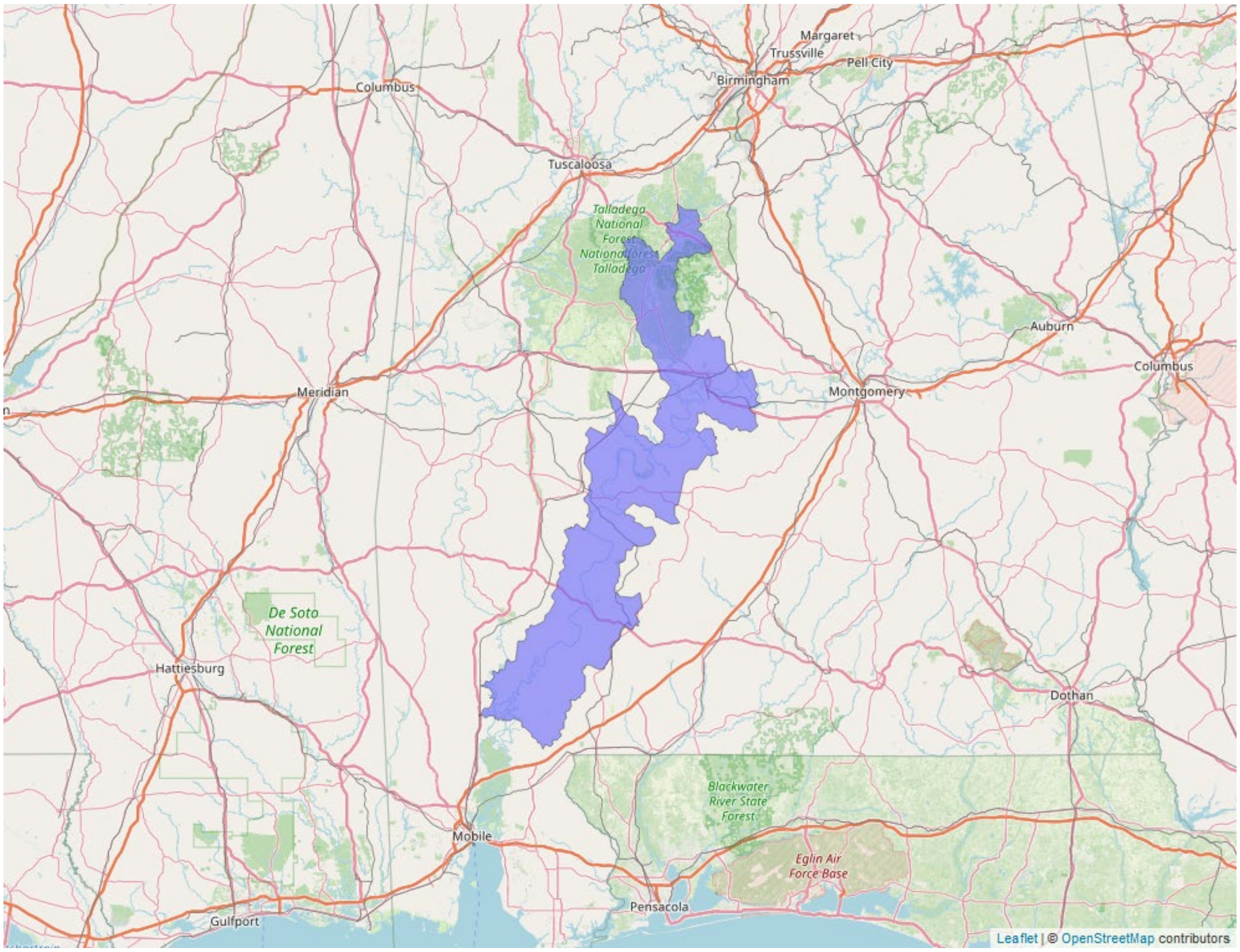

Figure 1. Range map of Alabama sturgeon (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/2552.

Vulnerability

As mentioned above, vulnerability considers the present and likely future condition of the species to determine its vulnerability to additional stressors. In making our jeopardy determination, vulnerability of the species is a function only of its status, but also the environmental baseline and cumulative effects. These are summarized below for this species.

Summary of status

Listing status: Endangered

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

Most recently completed 5-Year Review: 8/11/2020

Distribution: Species/Populations neither constrained nor widespread

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

Since 1990, all reports or collections of the Alabama sturgeon have been extremely rare, despite significant publicity and notoriety surrounding the species, and concentrated efforts to capture the species. Collections and reports have been restricted to the Alabama River and the Cahaba River. Only nine confirmed Alabama sturgeon captures have occurred, despite focused efforts to collect the species. Of these, two were released apparently unharmed, five died in captivity, one is known to have died shortly after release, and the fate of one is unknown. Additional efforts and observations have been made, although not all have been confirmed as Alabama sturgeon. The collection history of the Alabama sturgeon, supported by anecdotal reports from commercial fishermen, suggest that the species has disappeared from at least 85% of its historical range, and has experienced a significant decline in the remaining range since the 1960s. The species has been extirpated from the upper Tombigbee, lower Black Warrior, lower Tallapoosa, upper Alabama, and middle Cahaba rivers, where it was last reported in the 1960s; the Mobile-Tensaw Delta, last reported in 1985; the lower Coosa River, last reported ca. 1970; the lower Tombigbee River, last reported ca. 1975; (Clemmer et al., 1975; Burke and Ramsey 1985, 1995; Williams and Clemmer, 1991; Mayden and Kuhajda, 1996; M. Mettee, GSA, pers comm., 2005). The species continues to be only rarely collected from the lower portion of the Cahaba River and in the Alabama River from R.F. Henry Lock and Dam downstream to its confluence with the Tombigbee River (Burke and Ramsey 1985, 1995; N. Nichols, ADCNR, pers comm. 2005; Rider and Hartfield 2007; Rider et al. 2009; Rider and Powell 2009). The primary issue currently affecting the Alabama sturgeon is its small population size and its apparent inability to offset mortality rates with current recruitment rates. As noted previously, incidental captures of the Alabama sturgeon have steadily diminished over the last two decades. Although there are no population estimates available for the Alabama sturgeon, recent collection efforts demonstrate its increasing rarity. It is possible that Alabama sturgeon currently number fewer than 50 individuals and it is unknown at this point, given the current operations at the Alabama River dams, the amount of suitable riverine habitat available. It is likely that Alabama sturgeon migrate upstream during late winter and spring to spawn. Post-spawning downstream movements of shovelnose sturgeon, a similar species, have also been documented (Delonay, 2005). The capture of 12 individuals (including several gravid females) during a single collection trip near the mouth of the Cahaba River on 21 March 1969 suggests directional movements during the spawning season (Williams and Clemmer, 1991). Sexual maturity of the Alabama Sturgeon is believed to occur between 5 to 7 years of age. Spawning frequency of both sexes is likely influenced by food supply and fish condition, and presumably like the similar shovelnose sturgeon, may only occur at 2-3 year intervals (Mayden and Kuhajda 1996). Life span of the Alabama sturgeon is unknown. Although few individuals probably exceed 12 to 15 years of age (Mayden and

Kuhajda 1996), it is possible the species may live longer. Adult Alabama sturgeon may exhibit seasonal downstream migrations in search of feeding and summer refugia.

The historical decline of the Alabama sturgeon was presumably triggered by unrestricted commercial harvesting between the end of the 19th century and the early 20th century (CAS 2000). Although there are no reports of commercial harvests of Alabama sturgeon after the U.S. Comm. Fish & Fisheries 1898 report, it is likely that the sturgeon continued to be affected by commercial fishing, even if there was no market. Although commercial harvesting may have significantly reduced sturgeon numbers initially, the more recent decline in the Alabama Sturgeon's range and numbers, since 1960, is more likely the result of cumulative impacts as the rivers of the Mobile River basin were developed for navigation, hydropower production, flood control, recreation, waste assimilation and other human uses (65 FR 26438). While these existing structures and activities appear to be permanent in the Mobile Basin, the present effects of their operations, such as flow regulation and navigation maintenance activities, on the Alabama sturgeon are poorly understood. The majority of rivers in the Mobile River basin are now controlled by more than 25 locks and/or dams forming a series of impoundments that are interspersed with short, free-flowing reaches. Prior to the construction of locks and dams (L&Ds) in the Mobile Basin, Alabama sturgeon could move freely between feeding areas, and from feeding areas to sites that were suitable for spawning and development of eggs and larvae. Additionally, the sturgeon may have also used large tributary streams or deep mainstem pools as thermal refugia during the summer months. Sturgeon movements were likely extensive and covered long distances. Other Scaphirhynchus species like the pallid (S. albus) and shovelnose (S. platorynchus) have been reported to migrate greater than 250 km (155 mi) (Moos 1978, Bramblet 1996, Delonay in litt. 2005).

With their migration routes impeded by dams, isolated subpopulations of Alabama sturgeon were unable to successfully recruit adequate numbers to replenish the population. Reduced numbers of recruited sturgeon and surviving adult fish became more vulnerable to localized declines in water and habitat quality caused by hydropower releases, local riverine and land management practices, or by polluted discharges. Dams also reduced the possibility that sturgeon could re-colonize certain areas when subpopulations became extirpated (CAS 2000). Several conservation efforts, including those by state and federal agencies, universities, and private organizations, have been implemented since about 1990 to prevent further population declines and extinction of the Alabama sturgeon. These include (1) a report jointly prepared by the U.S. Army Corps of Engineers (Corps) and Service to address Corps activities in the Alabama River, (2) a conservation plan developed by the Alabama Department of Conservation and Natural Resources (DNR), (3) a voluntary conservation agreement and strategy prepared by the Corps, Alabama DNR, Alabama-Tombigbee Rivers Coalition, and the Service, (4) a multi-species recovery plan for the Mobile Basin, (5) a sturgeon sound detection study, (6) creation of a national repository for tissues and specimens, and (7) a habitat and feeding investigation.

Overall Vulnerability: High

Effects of the Action: Exposure

Overlap

We do not expect listed fish 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 4.9% of the species range will contain use sites (Table 7).

Usage

Past usage data indicate that up to 2.6% of the species' range has been treated with carbaryl annually (Table 7).

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

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	<0.1	<0.1
Citrus	<0.1	<0.1
Corn[2]	1.6	1.5
Grapes	0	0
Other Crops	1.0	1.0
Other Grains	0.1	2.0
Other Orchards	<0.1	<0.1
Other Row Crops	1.0	<0.1
Soybeans	1.0	0.6
Vegetables and Ground Fruit	<0.1	<0.1
Total	**3.9**	**2.6**

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

Additional Exposure Considerations

The low usage rate presented above is corroborated by additional data from USDA's Census of Agriculture, which indicates that only 2.5% of the range has been treated with any insecticides in recent years. Given that carbaryl usage is likely only a small portion of insecticides included in the Census of Agriculture and that this usage data is specific to the counties that the species' range occurs in, we have high confidence that little carbaryl is likely used within the species' range.

Exposure Summary

There is a low 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, which is corroborated by the low level of insecticide usage within the species' range as reported by the USDA Census of Agriculture. The additional information from the Census of Agriculture increases our confidence that exposure is unlikely to occur. As such, we expect only a small number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Low

General Conservation Measures

Rain restriction: Carbaryl is prohibited from being applied within 48 hours of a forecasted rain event or when soil in the treatment area is saturated. This rain restriction reduces the concentration of carbaryl in aquatic habitats by providing time for carbaryl to degrade before runoff into aquatic habitats can occur, decreasing the likelihood of exposure and risk. We have incorporated this mitigation measure in the information we provide in Table 8, which lists the maximum predicted EEC from the highest overlap use site within the species range.

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

We anticipate that in many cases, these buffers will significantly reduce exposure to the Alabama sturgeon and subsequent direct effects and indirect risk to prey items.

Effects of the Action: Toxicity

Direct Effects

Estimated environmental concentrations of carbaryl in the Alabama sturgeon's habitat will vary depending on the crops treated within the watershed as application rates vary widely across different crops. Based on known habitat preferences of the Alabama sturgeon and the use layers with the highest overlaps with the species' range (i.e., corn, other row crops, and other crops), we expect maximum predicted environmental concentrations of carbaryl can reach up to 647.7-785.6 µg/L (Table 8). Even the highest concentrations predicted do not exceed the HC_{05} calculated by the EPA in their BE (i.e., more than 95% of tested fish species would not experience high levels of mortality at predicted environmental concentrations). We consider the HC_{05} a conservative threshold for qualitatively estimating anticipated mortality to listed fish as data representing a wide diversity of fish species are used to generate HC_{05} estimates. Since the maximum estimated environmental concentrations are well below the level where we anticipate 95% of fish species will not experience high levels of mortality, we anticipate a low likelihood that a large proportion of fish exposed at these concentrations will die. We anticipate individuals exposed in low flow or low volume waterbodies that do not die are likely to experience sublethal adverse effects (i.e., reduced reproduction).

However, based on available habitat preference information available, we anticipate most individuals are likely to inhabit the main channels of large coastal plain rivers. Most captured individuals were taken in areas of moderate to swift current at depths of 6-14 meters, indicating that the species likely prefers large volume waterbodies. As such, we anticipate most individuals are likely to experience lower levels of exposure to carbaryl as estimated environmental concentrations of carbaryl in these larger waterbodies range from 41.8-103.8 µg/L. These exposure concentrations are well below levels where available toxicity studies in fish have observed any adverse effects to survival, growth, or reproduction. As such, we anticipate a low likelihood that any Alabama sturgeon will experience adverse effects.

Table 9. Maximum estimated environmental concentrations of carbaryl associated with the highest overlapping use layers within the Alabama sturgeon's range.

Use Layers	Habitat	Maximum estimated environmental concentration (µg/L)
Corn	Low flow/low volume waterbodies	723.9
Corn	High flow/large volume waterbodies	103.8
Other Row Crops	Low flow/low volume waterbodies	647.8
Other Row Crops	High flow/large volume waterbodies	41.8
Other Crops	Low flow/low volume waterbodies	785.6

Other Crops	High flow/large volume waterbodies	54.8

While non-agricultural uses of carbaryl may contribute to the overall exposure of the Alabama sturgeon, estimated environmental concentrations associated with all non-agricultural uses (including developed, open space developed, nursery, managed forests, rangeland, and rights of way uses) will not exceed 71.9 µg/L. This non-agricultural carbaryl exposure is well below levels where available toxicity studies in fish have observed any adverse effects to survival, growth, or reproduction.

Indirect Effects

The Alabama sturgeon is an opportunistic forager and can consume a wide range of prey species, including larval aquatic insects, oligochaetes, mollusks, fish eggs, and fishes. While available toxicity data indicate that arthropod species (like aquatic insects) are generally sensitive to carbaryl, available data on mollusks, annelids, and other benthic invertebrates indicate that these species of invertebrates are not sensitive to carbaryl and are not likely to experience any mortality or sublethal effects as a result of exposure. Thus, while we anticipate a reduction in the abundance of sensitive prey species (like aquatic insect larvae), we expect this will not result in substantial levels of adverse indirect effects as individuals can easily switch to prey resources that are not sensitive to carbaryl and will remain abundant. As such, we anticipate the Alabama sturgeon will not experience more than low levels of adverse indirect effects.

Toxicity Summary

We anticipate only low levels of adverse effects are likely to occur as maximum estimated environmental concentrations in the habitats that the species likely prefers (i.e., high flow, large volume waterbodies) resulting from both agricultural and non-agricultural uses are well below levels where adverse effects have been observed in fish toxicity studies. Similarly, while carbaryl residues will cause a high level of mortality in sensitive arthropod prey species, as an opportunistic forager, we expect individuals will be able to use alternative food resources available as many of their non-arthropod prey species are not likely to experience any adverse effects from carbaryl exposure. As such, the species has a low toxicity ranking.

Overall Toxicity Ranking: Low

Effects of the Action Summary

The Alabama sturgeon has a low exposure ranking. There is a low extent of overlap between its range and the action area (3.9% total overlap) and a low level of past carbaryl usage (up to 2.6% range treated annually). This low level of usage is corroborated by all insecticide usage data from

USDA's Census of Agriculture, which reports up to 2.5% of the range is likely to be treated with any insecticide. Given the additional support of the Census of Agriculture data, we are confident that only a small portion of the range is likely to be treated, resulting in only a small number of individuals experiencing exposure.

The Alabama sturgeon has a low toxicity ranking. We do not anticipate more than low levels of mortality and sublethal adverse effects to reproduction are likely to occur at predicted environmental exposures of carbaryl. Given that the Alabama sturgeon is an opportunistic forager than can consume a wide range of prey (including taxa that are not likely to experience adverse effects from carbaryl exposure), we anticipate only low levels of indirect adverse effects in the form of prey loss are likely to occur.

While the species is highly vulnerable to adverse effects given that there are very few individuals estimated to remain in the wild, the low concentrations of carbaryl anticipated to occur within the sturgeon's preferred habitat suggests that the risk of adverse effects to the species is low.

Conclusion

The Alabama sturgeon is listed as endangered, populations are declining, and they occur across a restricted range. There is a 3.9% overlap between the action area and the species' range, indicating a low level of exposure to carbaryl. There is also a low risk of adverse effects based on the low likelihood of mortality or sublethal impacts to growth and reproduction at estimated environmental concentrations. Furthermore, based on available habitat preference information available, we anticipate most individuals are likely to inhabit the main channels of large coastal plain rivers, which include areas of moderate to swift current at depths of 6-14 meters (i.e., large volume rivers), where estimated environmental concentrations of carbaryl are much lower (60.89-115 µg /L). Additionally, the species' opportunistic foraging habits allow it to adapt to fluctuations in prey availability due to carbaryl exposure. This adaptability ensures the maintenance of its nutritional intake and reduces the overall severity of indirect effects from the pesticide. After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not likely to appreciably reduce the survival and recovery of the species. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Alabama sturgeon in the wild.

References

U.S. Fish and Wildlife Service. 2013. Recovery Plan for the Alabama Sturgeon (*Scaphirhynchus suttkusi*). Jackson, Mississippi. pp.

Integration and Synthesis Summary: Arkansas River shiner

Scientific Name:	Common Name:	Entity ID:
Notropis girardi	Arkansas River shiner	299

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determined there was high overlap of the action area with the species' range, and high past usage of carbaryl within the species' range, indicating a high extent of exposure. We expected most exposed individuals would die or were likely to experience high levels of sublethal effects during low flow events. We do not anticipate any significant reductions in food availability, as carbaryl is not likely to cause any adverse effects to plant-based food resources, which this species relies on. Given that we anticipated exposure would be high, and the level of direct and sublethal effects would be medium, we determined the risk of adverse effects to the species would likewise be medium.

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 Arkansas River shiner to be low. After incorporating conservation measures into the proposed action, adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not likely to appreciably reduce the survival and recovery of the species. Thus, we anticipate that the proposed action is not likely to jeopardize the continued existence of the Arkansas River shiner. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 9/9/2022; Arkansas River Basin (AR, KS, NM, OK, TX); *States within the range:* KS, NM, OK, TX. Figure 7 depicts the species' range.

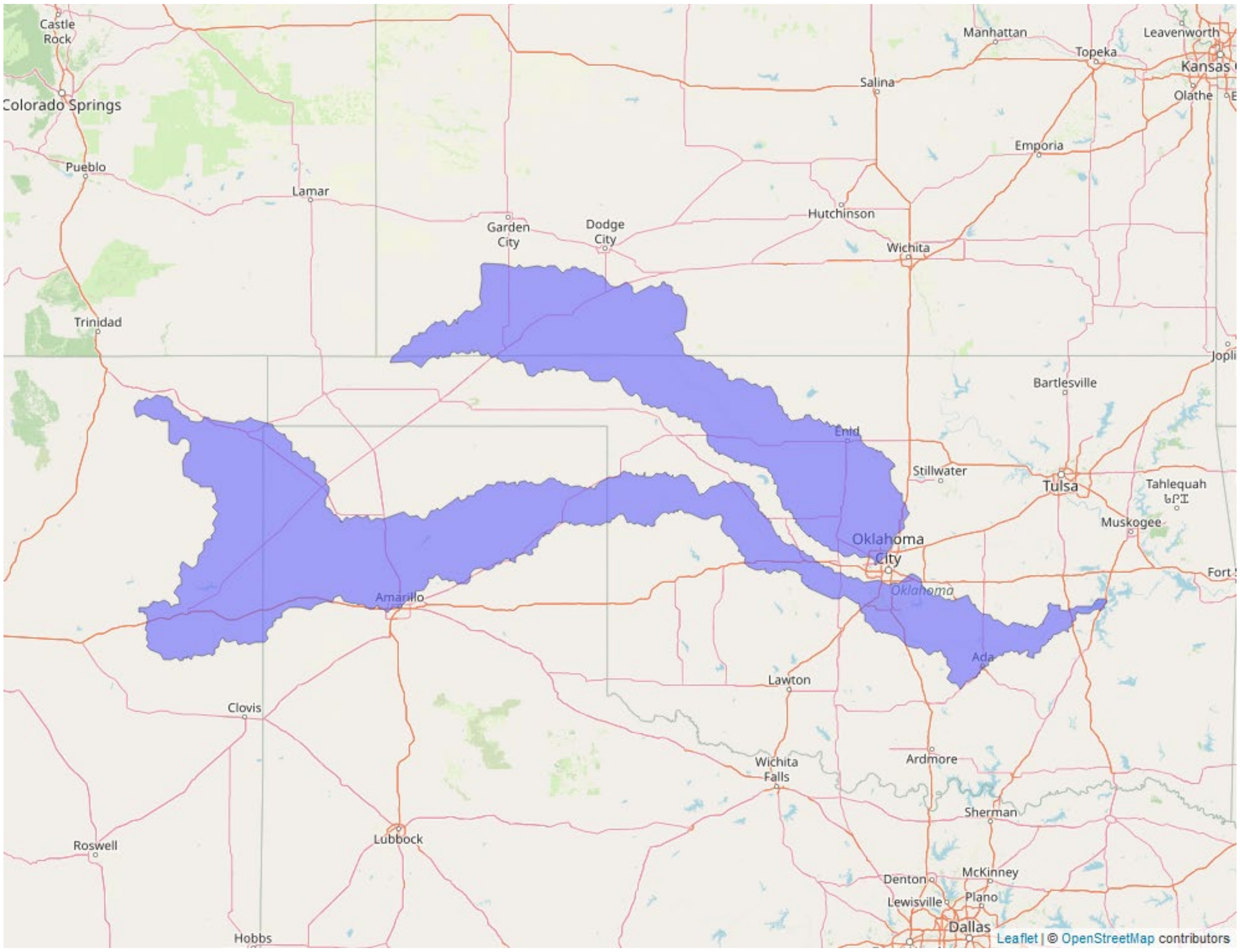

Figure 2. Range map of Arkansas River shiner (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/4364.

Vulnerability

As mentioned above, vulnerability considers the present and likely future condition of the species to determine its vulnerability to additional stressors. In making our jeopardy determination, vulnerability of the species is a function only of its status, but also the environmental baseline and cumulative effects. These are summarized below for this species.

Summary of status

Listing status: Threatened

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

Most recently completed 5-Year Review: 9/29/2020

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 Arkansas River shiner is a minnow (family Cyprinidae) once widespread and common in the western portion of the Arkansas River basin in Kansas, New Mexico, Oklahoma, Arkansas, and Texas. Adults prefer shallow channels where currents flow over clean fine sand, and generally avoid calm waters and silted stream bottoms. They have a high capacity to endure elevated temperatures and low dissolved oxygen concentrations that are typical in their drought-prone habitats. This species is no longer found in over 83% of its historical range (3,896 river miles) and now appears to be entirely restricted to portions of the South Canadian River (identified as Canadian River on U.S. Geological Survey topographic maps) in eastern New Mexico, the Texas panhandle, and Oklahoma (673 river miles). The species occurs in two self-sustaining populations: one in the upper South Canadian River and one in the lower South Canadian River. The resiliency of each population is currently considered to be at moderate level, making it less vulnerable to a catastrophic event as compared to a population with low resiliency. A non-native introduced population of the Arkansas River shiner occurs in the Pecos River in New Mexico, just outside of the species' historical native range. The species has experienced a downward trend and we expect that population resiliency for Arkansas River basin populations of the Arkansas River shiner will be further reduced from current condition. This reduction could lead to low resiliency of both remaining populations within 20 years, with potential extirpation of one of those two populations within 50 years. Given that redundancy is currently limited (only two remaining populations) and with future (USFWS 2018) anticipated declines in population resiliency, the remaining populations of Arkansas River shiner will be more vulnerable to extirpations as compared to current condition.

Stressors affecting the viability of the Arkansas River shiner include altered flow regimes, impoundments and other stream fragmentation, modified geomorphology, decreased water quality, and the introduction of invasive species. The source of many of these stressors is related to the construction of dams and their impoundments (a body of water confined within an enclosure) which, in most cases, has drastically altered the natural flow regime and fragmented habitat. Water demands, primarily through surface and groundwater extraction, have also resulted in significant declines to the species' habitat, affecting its overall distribution.

Overall Vulnerability: High

Effects of the Action: Exposure

Overlap

We do not expect listed fish species will occur on-field, and thus expect exposure will only result from off-field transport via spray drift or runoff. Given that the ranges for listed aquatic species are generally delineated using the relevant HUC 12 watersheds, we anticipate that all residues that leave use sites will be collected in the waterbodies within the species range where individuals occur regardless of how residues leave treated sites or where in the range they are deposited. As such, we do not extend overlap metrics off-field as this will not functionally change the expected exposures that listed aquatic species are likely to experience. We expect up to 27.5% of the species range will contain use sites (Table 9).

Usage

Past usage data indicate that up to 12.4 % of the species' range has been treated with carbaryl annually (Table 9).

Table 10. Agricultural use overlap and annual usage data (% Range Treated) for the Arkansas River shiner.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	1.1	0.2
Citrus	0	0
Corn[3]	6.5	1.9
Grapes	<0.1	<0.1
Other Crops	8.3	8.3
Other Grains	11.1	2.0
Other Orchards	<0.1	<0.1
Other Row Crops	0.1	<0.1
Soybeans	1.8	0.9
Vegetables and Ground Fruit	0.4	0.1
Total	**27.5**	**12.4**

[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.

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

Overall Exposure: High

General Conservation Measures

Rain restriction: Carbaryl is prohibited from being applied within 48 hours of a forecasted rain event or when soil in the treatment area is saturated. This rain restriction reduces the concentration of carbaryl in aquatic habitats by providing time for carbaryl to degrade before runoff into aquatic habitats can occur, decreasing the likelihood of exposure and risk. We have incorporated this mitigation measure in the information we provide in Table 10, which lists the maximum predicted EEC from the highest overlap use site within the species range.

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

We anticipate that in many cases, these buffers will significantly reduce exposure to the Arkansas River shiner and subsequent direct effects and indirect risk to prey items.

Effects of the Action: Toxicity

Direct Effects

Estimated environmental concentrations of carbaryl in the Arkansas River shiner's habitat will vary depending on the crops treated within the watershed as application rates vary widely across different crops. Based on the use layers with the highest overlaps with the species' range (i.e., other grains, other crops, and corn), we expect maximum predicted environmental concentrations of carbaryl can reach up to 732-1397 µg/L (Table 10). We expect high levels of mortality are likely to occur at high end estimates as these concentrations exceed HC_{05} calculated by the EPA in the BE for fish species, suggesting that a high proportion of exposed Arkansas River shiner exposed at these concentrations will die.

However, this level of exposure is only associated with low flow or low water volume habitats within the species' range. Available life history data indicate that the species typically inhabits the main channels of wide, shallow, sandy bottom rivers and larger streams and generally avoid calm waters during normal flow conditions. However, during low flow events (e.g., excessive water withdrawals and droughts), Arkansas River shiners can be found in relatively slow current velocities, backwater habitats, shallow waters, and shaded pools along shorelines. Additionally, impoundments trap streamflow, reducing the availability of water downstream, leading to more frequent lack of flow, channel drying, and pool isolation, leaving Arkansas River shiners in locations that are not typically preferred by the species. As such, we expect individuals to be exposed to higher levels of EECs during low flow periods of the year. During time of low flows, we expect a high proportion of exposed Arkansas River shiners occupying low volume/low flow habitats will die.

Table 11. Maximum estimated environmental concentrations of carbaryl associated with the highest overlapping use layers within the Arkansas River shiner's range.

Use Layers	Habitat	Max EEC (µg/L)
Other Grains	Low flow/low volume waterbodies	1397.8
Other Grains	High flow/large volume waterbodies	76.4
Other Crops	Low flow/low volume waterbodies	785.6
Other Crops	High flow/large volume waterbodies	54.8
Corn	Low flow/low volume waterbodies	723.9
Corn	High flow/large volume waterbodies	103.8

Similarly, we anticipate individuals exposed in low flow or low volume waterbodies that do not die are likely to experience sublethal adverse effects (i.e., reduced reproduction). In contrast, individuals that are exposed in high flow or large volume waterbodies are not likely to experience any sublethal adverse effects as estimated environmental concentrations within these areas are well below levels where toxicity studies have observed any adverse effects in fish species.

While non-agricultural uses of carbaryl may contribute to the overall exposure of the Arkansas River shiner, estimated environmental concentrations associated with all non-agricultural uses (including developed, open space developed, nursery, managed forests, rangeland, and rights of way uses) will not exceed 71.9 µg/L. This non-agricultural carbaryl exposure is well below levels where available toxicity studies in fish have observed any adverse effects to survival, growth, or reproduction.

Indirect Effects

Available life history information for the Arkansas River shiner indicates that it only requires plant-based food resources and does not rely on invertebrate species for food. Available data for carbaryl show no toxicity to plant species, suggesting that there will likely not be any reductions in the abundance of plant-based food resources for the shiner. As such, we do not expect any adverse indirect effects are likely to occur with carbaryl use.

Toxicity Summary

Maximum estimated environmental concentrations in parts of the species' habitat (i.e., low flow or low volume waterbodies) may occasionally be high enough to cause high levels of mortality During low flow events (e.g., excessive water withdrawals and droughts), Arkansas River shiners can be found in relatively slow current velocities, backwater habitats, shallow waters, and shaded pools along shorelines. Additionally, impoundments trap streamflow, reducing the availability of water downstream, leading to more frequent lack of flow, channel drying, and pool isolation, leaving Arkansas River shiners in locations that are not typically preferred by the species. As such, we expect high toxicity to Arkansas River shiners during these low flow events which may occur in some parts of their range but not throughout their entire range as they do prefer higher flowing larger water bodies. We do not anticipate any effects to the Arkansas River shiner from non-agricultural uses of carbaryl and we do not anticipate any indirect adverse effects are likely to occur as carbaryl is not likely to cause any adverse effects to plant-based food resources.

Overall Toxicity Ranking: Medium

Effects of the Action Summary

The Arkansas River shiner has a high exposure ranking as there is a high extent of overlap between agricultural use sites and the species' range as well as a high level of past agricultural 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 Arkansas River shiner has a medium toxicity ranking. Though estimated environmental concentrations of carbaryl can occasionally exceed the HC_{05}, causing a high proportion of exposed individuals to die, we anticipate these exposures will be limited to low flow or low volume areas within the species' habitat. Given that the species prefers to inhabit areas of higher flow rates and carbaryl concentrations anticipated to cause mortality are associated with low flow waterbodies, and we anticipate medium levels of mortality and sublethal effects are reasonably certain to occur. We do not anticipate any indirect adverse effects will occur as the species primarily relies on plant-based food resources that are not likely to be adversely affected by carbaryl exposure.

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

Preliminary Conclusion

The Arkansas River shiner is highly vulnerable due to its restricted and fragmented habitat within the Arkansas River basin, where it has already lost a significant portion of its historical range. Ongoing threats include habitat fragmentation and water quality issues. The high overlap of 27.5% between agricultural uses of carbaryl and the species' remaining habitat, coupled with high past usage of carbaryl (up to 12.4% of the range treated), suggested that a high portion of the shiner's range may be exposed to the pesticide.

In our draft Opinion, before incorporating species-specific conservation measures, we anticipated mortality would occur to a high proportion of individuals exposed to carbaryl during low water events (whether from water withdrawals, impoundment collection, or drought) as individuals are typically located in isolated pools, backwaters, and lower volume and velocity waters where we expect concentrations of carbaryl to be higher. With the combined high likelihood of exposure and high concentrations of carbaryl during low flow events, which are common in this species habitats, we anticipated high levels of mortality in our draft Opinion, before incorporating species-specific conservation measures, as discussed below.

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 Arkansas River shiner:

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

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

We anticipate that with the measures described above, these pathways of exposure will be greatly limited and result in exposure of a very small number of individuals over the course of the action. After reviewing the current status of the listed species, environmental baseline for the action area, cumulative effects, and effects of the proposed action (including the species-specific conservation measures that are now incorporated into the proposed action), we have determined the proposed action is not likely to appreciably reduce the survival and recovery of the Arkansas

River shiner. Thus, it is our biological opinion that the registration of carbaryl, as proposed, is not likely to jeopardize the continued existence of the Arkansas River shiner.

References

U.S. Fish and Wildlife Service. 2020. Arkansas River Shiner (*Notropis girardi*) 5-Year Review: Summary and Evaluation. Tulsa, Oklahoma. 20 pp.

U.S. Fish and Wildlife Service. 2018. Species status assessment report for the Arkansas River shiner (*Notropis girardi*) and peppered chub (*Macrhybopsis tetranema*), version 1.0, with appendices. October 2018. Albuquerque, NM. 172 pp.

Integration and Synthesis Summary: Chucky madtom

Scientific Name:	Common Name:	Entity ID:
Noturus crypticus	Chucky madtom	7150

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 low overlap of the action area with the species' range, and low past usage of carbaryl within the species' range, indicating a low extent of exposure. Most exposed individuals are likely to die or experience reduced fecundity. We anticipated high levels of arthropod prey mortality, however, as an invertivore generalist, we anticipated individuals would still be able to consume other, less sensitive prey species. Given that exposure was low, and the level of direct and sublethal effects was medium, we determined the risk of adverse effects to the species was likewise medium. As such, we expected a small number of individuals were likely to experience mortality or sublethal effects from the proposed action. However, considering the extremely limited population of chucky madtoms and the extremely limited range, we determined any loss of individuals would be detrimental to the survival and recovery of the species.

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 chucky madtom to be unlikely to occur. After incorporating conservation measures into the proposed action, adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not likely to appreciably reduce the survival and recovery of the Chucky madtom. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the chucky madtom. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 4/12/2021; Wherever found; *States within the range:* TN. Figure 14 depicts the species' range.

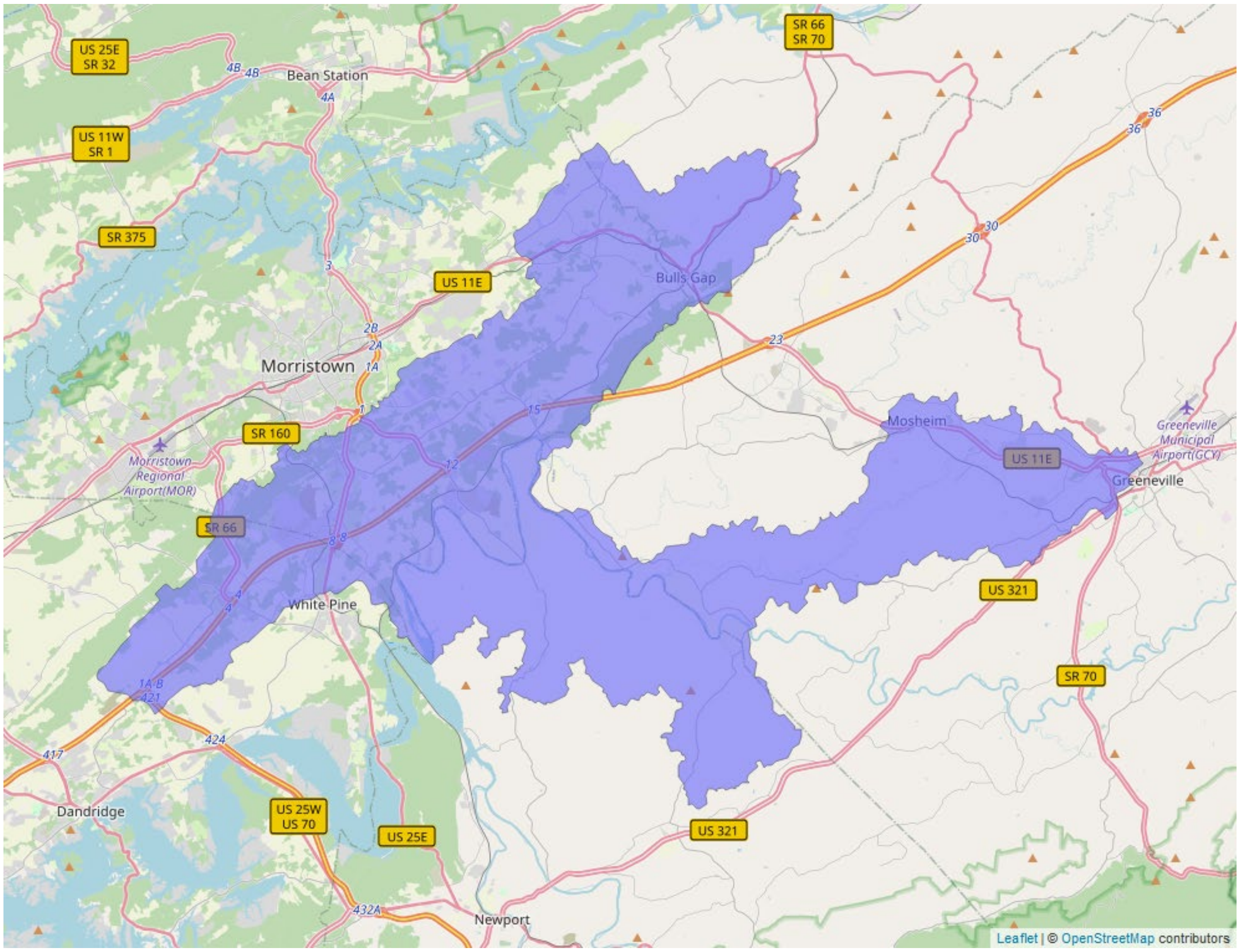

Figure 3. Range map of chucky madtom (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/7735.

Vulnerability

As mentioned above, vulnerability considers the present and likely future condition of the species to determine its vulnerability to additional stressors. In making our jeopardy determination, vulnerability of the species is a function only of its status, but also the environmental baseline and cumulative effects. These are summarized below for this species.

Summary of status

Listing status: Endangered

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

Most recently completed 5-Year Review: 4/10/2024

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

Past habitat fragmentation, habitat alteration, and degradation (e.g., increased sedimentation and impaired water quality) appear to have resulted in increased rarity and possible extirpation of the species across the chucky madtom's historical range. The primary cause of habitat loss and degradation is likely agricultural management. The species' habitat is within an agricultural watershed, leaving aquatic systems susceptible to a variety of problems including sedimentation, algal blooms from nutrient runoff, anoxic conditions, contamination, and other water quality impairment. The chucky madtom's current range is believed to be restricted to a 1.8-mile stretch of Little Chucky Creek in Greene County, Tennessee. This limited range has led to habitat fragmentation, genetic isolation, and increased extinction risk (Burkhead et al., 1997; Hallerman, 2003). Only 14 specimens have been collected since its discovery in 1991, with none found since 2004, suggesting the population may be below the size needed for long-term viability (Franklin and Frankham, 1998; Lande, 1995).

Habitat fragmentation and sedimentation from agricultural activities pose significant threats to the chucky madtom. The species relies on clean, gravelly substrates, which are sparse in Little Chucky Creek (Burr and Eisenhour, 1994; Burr et al., 2005). Predation by native fish and competition from non-native crayfish also threaten its survival (Emmett and Cochran, 2010; Dinkins, 2014). Additionally, agricultural runoff introduces sediment and agrochemicals into the creek, degrading water quality and habitat (Jones et al., 2000; Middle Nolichucky Watershed Alliance, 2006). As relatively sedentary animals, madtoms must tolerate the full range of parameters that occur within the streams where they persist. In general, the species survives in areas where the magnitude, frequency, duration, and seasonality of water flow is adequate to remove fine particles and sediments (silt-free) without causing degradation, and where water quality is adequate for year-round survival (for example, moderate to high levels of dissolved oxygen, low to moderate input of nutrients, and relatively unpolluted water and sediments). (USFWS 2012).

Climate change is expected to increase the frequency and intensity of droughts and storms, further impacting the chucky madtom's habitat (Cook et al., 2004; Thomas et al., 2004). These events can lead to habitat loss, reduced water quality, and increased stress on the species. Although the species and its habitat are protected under the Clean Water Act and Tennessee Water Quality Control Act, these regulations have not fully mitigated habitat degradation (TDEC, 2012).

Efforts to implement agricultural best management practices in the Little Chucky Creek watershed are ongoing. Partners, including the Greene County Soil Conservation District, NRCS, TVA, and the Service, have worked on projects to improve habitat, such as installing riparian fencing and creating alternate water sources. These efforts aim to reduce sedimentation and improve water quality, ensuring the long-term survival of the chucky madtom (NRCS; TVA; Service).

Overall Vulnerability: High

Effects of the Action: Exposure

Overlap

We do not expect listed aquatic 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 3.3% of the species range will contain use sites (Table 12).

Usage

Past usage data indicate that up to 3.2 % of the species' range has been treated with carbaryl annually (Table 12).

Table 12. Overlap and annual usage data (% Range Treated) for the Chucky madtom. Where specific crops are not registered for carbaryl use in a state where the species is found, rows are designated as NA (not applicable).

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	0	0
Citrus	0	0
Corn[4]	2.9	2.9
Grapes	<0.1	<0.1
Other Crops	0.1	0
Other Grains	0.1	0.1
Other Orchards	<0.1	<0.1
Other Row Crops	<0.1	<0.1

[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.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Soybeans	2.9	2.9
Vegetables and Ground Fruit	0.2	0.2
Total	**3.3**	**3.2**

Additional Exposure Considerations

The low level of usage reported above is corroborated by data from the USDA Census of Agriculture, which reports low levels of past insecticide usage within the species' range. Only up to 1.3% of the species' range has been treated annually with any insecticides. Given that the Census of Agriculture data aggregates all insecticides into one metric, we expect the reported level of usage is an overestimate of the percent range treated with carbaryl. However, the species' is found in a single location with its habitat surrounded by areas of intense agricultural activity, indicating that stressors associated with agricultural runoff (like pesticide exposure) are a major threat to the species.

In addition, non-agricultural use sites within developed and open space developed areas, and rights of way occur within the range of the species. However, given that most applications made for nurseries and residential areas (developed use layers) are limited to spot and crack treatments or narrow perimeter bands around structures (as discussed above in the exposure section of this document), the amount of runoff that may enter nearby aquatic habitats where these fishes may be found is limited. In addition, available usage data indicate very little carbaryl usage is likely to occur in rights of way, with less than 500 pounds of carbaryl applied to roadways nationally each year. While this may result in a large treatment footprint if all rights of way usage were concentrated in one location or within the species' range, we expect this is highly unlikely to occur and rather expect rights of way usage is likely to be sporadic across the national landscape, with only small amounts, if any, used within the species' range. Available usage data indicate only low levels of past carbaryl usage occurred in open space developed areas (including golf courses) with, at most, up to 2.5% of open space developed areas receiving treatment each year nationally.

Exposure Summary

There is a low extent of agricultural overlap between the action area and the species' range (3.3% total overlap). Based on past usage data, we expect a low level of usage within the species' range, which is corroborated by additional data on insecticide usage from the USDA's Census of Agriculture. We do not anticipate that non-agricultural uses will meaningfully add to the overall level of anticipated exposure. Given that the extent of overlap is low, and that expected usage is low, we expect a small number of individuals are likely to experience exposure from the proposed action.

Overall Exposure: Low

General Conservation Measures

Rain restriction: Carbaryl is prohibited from being applied within 48 hours of a forecasted rain event or when soil in the treatment area is saturated. This rain restriction reduces the concentration of carbaryl in aquatic habitats by providing time for carbaryl to degrade before runoff into aquatic habitats can occur, decreasing the likelihood of exposure and risk. We have incorporated this mitigation measure in the information we provide in Table 13, which lists the maximum predicted EEC from the highest overlap use site within the species range.

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

We anticipate that in many cases, these buffers will significantly reduce exposure to the Chucky madtom and subsequent direct effects and indirect risk to prey items.

Effects of the Action: Toxicity

Direct Effects

Estimated environmental concentrations of carbaryl in the chucky madtom's habitat will vary depending on the crops treated within the watershed as application rates vary widely across different crops. Based on the use layers with the highest overlaps with the species' range (i.e., other grains, corn, vegetables and ground fruit), we expect maximum predicted environmental concentrations of carbaryl can reach up to 76.4-1735 µg/L (Table 13).

Corn accounts for the highest extent of agriculture within the range at 2.9% of the species' range. We do not anticipate carbaryl applications to corn fields will likely result in more than low levels of mortality as maximum estimated environmental concentrations of carbaryl associated with these crops are well below the HC_{05} calculated by EPA in their BE, ranging from 103.8-723.9 µg/L. We consider the HC_{05} a conservative threshold for qualitatively estimating anticipated mortality to listed fish as data representing a wide diversity of fish species are used to generate HC_{05} estimates. Since these estimated environmental concentrations are well below the level where we anticipate 95% of fish species will not experience high levels of mortality, we anticipate a low likelihood that the chucky madtom will experience high levels of mortality with exposure to these concentrations.

We anticipate that use of carbaryl on crops within the Other Grains and Vegetables and Ground Fruit use layers will result in the highest estimated environmental concentrations. The high end estimates of environmental concentrations exceed the HC_{05}calculated by EPA in their BE, suggesting that a high proportion of individuals will die when exposed at these levels. However, only 0.2% of the chucky madtom's range overlaps with vegetables and ground fruit use sites and only 0.1% of the chucky madtom's range overlaps with other grains, indicating that this level of exposure will be limited to only a small portion of the species' range. Furthermore, we anticipate these high environmental concentrations are only likely to occur in low flow or shallow areas of habitat as maximum estimated environmental concentrations of carbaryl in areas of high flow or large volume are not likely to cause any adverse effects to survival or growth, further limiting the extent of these adverse effects.

We also anticipate impacts to reproduction (reduced fecundity) is likely at estimated environmental concentrations in low volume/low flow habitats as well for Corn, Other Grains, and Vegetables and Ground Fruit. In contrast, carbaryl exposures in high flow or large volume waterbodies are not likely to cause any sublethal adverse effects (e.g., reduced reproduction) as maximum estimated environmental concentrations of carbaryl in these areas of habitat are well below levels where available fish toxicity studies have observed any adverse effects.

Table 13. Maximum estimated environmental concentrations of carbaryl associated with the highest overlapping use layers within the Chucky madtom's range.

Use Layers	Habitat	Maximum estimated environmental concentration (µg/L)
Other Grains	Low flow/low volume waterbodies	1397.8
Other Grains	High flow/large volume waterbodies	76.4
Corn	Low flow/low volume waterbodies	723.9
Corn	High flow/large volume waterbodies	103.8
Vegetables and Ground Fruit	Low flow/low volume waterbodies	1735.0
Vegetables and Ground Fruit	High flow/large volume waterbodies	162.5

While non-agricultural uses of carbaryl may contribute to the overall exposure of the chucky madtom, estimated environmental concentrations associated with all non-agricultural uses (including developed, open space developed, nursery, managed forests, rangeland, and rights of way uses) will not exceed 958.7 µg/L. We do not expect these exposures will exceed the HC_{05} for fish mortality, even at the maximum predicted exposure (which we do not expect will occur very frequently). However, we do anticipate sublethal effects (reduced fecundity) from exposure to these estimated environmental concentrations. Thus, we anticipate the chucky madtom is likely to experience reduced fecundity from non-agricultural uses of carbaryl.

Indirect Effects

The chucky madtom's prey items are unknown, but based on information available for other madtom species, we presume the chucky madtom is a generalist invertivore and primarily consumes small aquatic benthic insects and macroinvertebrates. Available toxicity data indicate that invertebrate species, particularly arthropods, are sensitive to carbaryl and are likely to die with exposure at predicted environmental concentrations. As such, we anticipate indirect effects to the species through the loss of prey resources is likely. However, we do not expect all invertebrate species will be equally sensitive to carbaryl exposure. As such, we anticipate there will be large reductions in abundance of some invertebrate species while other species may experience only small reductions in abundance. Since we presume the chucky madtom is an invertebrate prey generalist, we anticipate individuals are likely more robust to temporary losses of certain invertebrate prey species as they can likely switch to use other species whose abundance is not as greatly reduced. As such, we anticipate a temporary loss of certain invertebrate prey species will result in no more than low levels of adverse indirect effect to the chucky madtom.

Toxicity Summary

Based on the predicted environmental concentrations of carbaryl, we expect a high proportion of exposed individuals will die in low flow or low volume waterbodies when carbaryl is applied to crops within the Vegetables and Ground Fruit and Other Grains use sites (which are crops that are not very prevalent within the species' range as they only overlap with 0.2% and 0.1%, respectively, of the range). We also anticipate impacts to reproduction (reduced fecundity) are likely at estimated environmental concentrations in low volume/low flow habitats but do not anticipate mortality or sublethal adverse effects are likely to occur in areas of high flow or large water volume. We anticipate only low levels of adverse indirect effects are likely to occur as we presume the species is an invertebrate prey generalist and anticipate individuals will be able to capitalize on more abundant prey resources when sensitive prey species are adversely affected by carbaryl. Given that high levels of adverse effects are likely to occur in low flow and low volume habitats, and the chucky madtom is surrounded by intensive agricultural areas as well as non-agricultural areas where there is potential for carbaryl concentrations to be high enough to cause sub-lethal effects, the chucky madtom has a medium toxicity ranking.

Overall Toxicity Ranking: Medium

Effects of the Action Summary

The chucky madtom has a low exposure ranking. There is a small extent of overlap between the species' range and the action area (3.3% total overlap) and a low level of past usage (up to 3.2% range treated annually), which is corroborated by a low level of past insecticide usage as reported by the Census of Agriculture (up to 1.3% range treated annually with any insecticide). As such, we anticipate only a small number of individuals are likely to be exposed.

The chucky madtom has a medium toxicity ranking. Estimated environmental concentrations of carbaryl may occasionally cause mortality in exposed individuals and we anticipate these occurrences are only associated with carbaryl applications on Vegetables and Ground Fruit and Other Grains use layers (which are not highly prevalent in its range) and are limited to areas of low flow or low water volume. In addition, we also anticipate reduced fecundity from applications on crops in Corn, Vegetables and Ground Fruit, and Other Grains use layers and non-agricultural uses of carbaryl within the range of the species. While we anticipate high levels of arthropod prey mortality, we anticipate this impact will be temporary as the prey community will recover once carbaryl residues degrade. Furthermore, as an invertivore generalist, we anticipate individuals will still be able to consume other, less sensitive prey species.

While the species is highly vulnerable to adverse effects given that the species occupies a very restricted range and is declining in numbers, and despite the low extent of overlap and the additional usage data indicating low levels of past usage within the range, estimated environmental concentrations of carbaryl suggest mortality and reduced fecundity is likely within the species range. Therefore, the risk of adverse effects to the species is medium.

Preliminary Conclusion

The chucky madtom is listed as endangered and is primarily restricted to a 1.8-mile section of Little Chucky Creek in Greene County, Tennessee, where habitat fragmentation, inadequate water quality (i.e., runoff with significant sediment, nutrient, and chemical loads), and invasive crayfish species have severely limited its population. No chucky madtoms have been detected in this 1.8-mile section since 2004. However, due to its small size, cryptic nature, and low detectability (i.e., rarity), low numbers of individuals are believed to still inhabit this 1.8 mile stretch of river. An eDNA study is expected to provide updated information about the species' possible presence in 2024.

While the species' habitat is within an agricultural watershed highly susceptible to sedimentation, nutrient runoff, and water quality impairments, the overall exposure to carbaryl from the proposed action was expected to be low. The overlap between the agricultural use sites and the species' range is minimal (3.3%), and past carbaryl usage in the species' range has been similarly low (up to 3.2% annually). Data from the Census of Agriculture shows that up to 1.3% of the species' range has been treated annually with any insecticides. Given that the Census of Agriculture data aggregates all insecticides into one metric, we expected the reported level of usage (3.2% annually) was an overestimate of the percent range treated with carbaryl. However, it is important to note that this low overlap pertains to the overall range and not the 1.8 mile known occupied stretch of river where this species is anticipated to still be extant. The last five-year review (USFWS 2014) stated that the remaining occupied habitat is located within a highly agricultural watershed, so actual overlap with carbaryl use sites and usage may actually be higher.

In our draft Opinion, before incorporating species-specific conservation measures, we estimated environmental concentrations of carbaryl could occasionally cause mortality in a high proportion of exposed individuals, though we anticipated these occurrences would only be associated with carbaryl applications on vegetables and ground fruit and other grains use sites (which are not highly prevalent in its range; 0.2% and 0.1%, respectively) and would be limited to areas of low flow or low water volume. Additionally, we anticipated reduced fecundity from applications on crops within the Corn, Vegetables and Ground Fruit, and Other Grains use layers and from non-agricultural uses of carbaryl within the range of the chucky madtom. While we anticipated mortality and sublethal were to be low across the species' range due to limited overlap with these uses and the small anticipated annual usage, we expected the extent of exposure may be greater in the 1.8 mile stretch of occupied habitat in the Little Chucky Creek, and the extremely small numbers of individuals likely to still persist within the range of the species are highly susceptible to any ongoing threats, including any mortality or reduced fecundity related to carbaryl use. The loss of even small numbers of individuals can have long-term negative consequences to the survival and recovery of the species.

We expected the chucky madtom would likely experience only low levels of indirect effects, given that it is a generalist invertivore capable of switching to less sensitive prey species in the event of a reduction in sensitive prey populations. This dietary flexibility is expected to mitigate the impact of carbaryl on the species' food resources.

Although we anticipated only a small number of individuals would likely be exposed, which in turn would result in mortality or reduced fecundity, the extremely limited population of chucky madtoms would be unlikely to persist under such circumstances without the conservation measures subsequently adopted as part of the action, as discussed below.

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 chucky madtom:

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

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

We anticipate that with the measures described above 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, cumulative effects, and effects of the proposed action (including the species-specific conservation measures incorporated into the proposed action), we have determined the proposed action is not likely to appreciably reduce the survival and recovery of the chucky madtom. Thus, it is our biological opinion that the registration of carbaryl, as proposed, is not likely to jeopardize the continued existence of the chucky madtom.

References

Tennessee Aquarium Conservation Institute and U.S. Fish and Wildlife Service. (undated). Species Biological Report for Chucky Madtom (*Noturus crypticus*). Chattanooga, Tennessee and Cookeville, Tennessee, respectively. 23 pp. (Downloaded February 16, 2017, available at https://www.fws.gov/office/tennessee-ecological-services.)

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U.S. Fish and Wildlife Service. 2024. Chucky Madtom (*Noturus crypticus*) 5-Year Status Review: Summary and Evaluation. Cookeville, Tennessee. 8 pp. + Appendices.