Benton County Cave Crayfish
(*Cambarus aculabrum*)
5-Year Status Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Southeast Region
Arkansas Ecological Services Field Office
Conway, Arkansas

June 2024

5-YEAR STATUS REVIEW

Benton County Cave Crayfish (*Cambarus aculabrum*)

GENERAL INFORMATION

Current Classification: Endangered

Lead Field Office: Arkansas ES Field Office, Pedro Ardapple (501) 513-4470

Lead Regional Office: Southeast Region, Carrie Straight, (404) 679-7226

Cooperating Field Office(s): Missouri Ecological Services Field Office, Trisha Crabill, (573) 234-5016

Date of original listing: May 27, 1993 (58 FR 25742, April 27, 1993)

Methodology used to complete this review:

In accordance with section 4(c)(2) of the Endangered Species Act of 1973, as amended (Act), the purpose of a status review is to assess each threatened species or endangered species to determine whether its status has changed and if it should be classified differently or removed from the Lists of Threatened and Endangered Wildlife and Plants (50 CFR 424.11). The U.S. Fish and Wildlife Service (Service) evaluated the best available information about *C. aculabrum* biology, habitat, and threats of to inform this status review.

We announced initiation of this review in the Federal Register on May 11, 2023 (88 FR 30324) with a 60-day comment period and received no public comments. The primary sources of information used in this analysis were the 1993 final listing rule (58 FR 25742), the 1996 Cave Crayfish (*Cambarus aculabrum*) Recovery Plan (Recovery Plan), 2019 Amendment to the Recovery Plan (Recovery Plan Amendment; Service 2019a), peer-reviewed reports, agency reports, unpublished survey data and reports, and personal communication with recognized experts. This review was completed by the U.S. Fish and Wildlife Service, Arkansas Ecological Services Field Office, Conway, Arkansas. All literature and documents used for this review are on file at the Arkansas Field Office. All recommendations resulting from this review are the result of thoroughly reviewing the best available information on *C. aculabrum*.

FR Notice citation announcing the species is under active review:

May 11, 2023 (88 FR 30324)

Species' Recovery Priority Number at start of 5-year review (48 FR 43098): 5C.

Cambarus aculabrum is a species with a high degree of threat and a low recovery potential. A "C" indicates that the recovery activities of the species "are, or may be, in conflict with construction or other development projects or other forms of economic activity."

Review History:

Two previous 5-year reviews recommending no change in status were published May 10, 2013 and June 20, 2019 (Service 2013, Service 2019b).

REVIEW ANALYSIS

Listed Entity

Taxonomy and nomenclature

We are not aware of any changes to the taxonomy of this entity, thus *C. aculabrum* is still considered a valid species by the Service.

Distinct Population Segment (DPS) (61 FR 4722)

The Act defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing of a DPS to only vertebrate species. Because the species under review is a not a vertebrate, the DPS policy does not apply.

Recovery Criteria

Recovery Plan

Cambarus aculabrum Recovery Plan, October 30, 1996.

Amendment to The Cave Crayfish (*Cambarus aculabrum*) Recovery Plan, October 24, 2019.

Recovery plans are not regulatory documents and are intended to provide guidance to the Service, States, and other partners on methods of minimizing threats to listed species and on criteria that may be used to determine when recovery is achieved. If the recovery criteria defined in the plan are still valid, meeting recovery criteria can indicate that the species no longer requires protections under the Act. However, when recommending whether a listed species should be delisted, the Service must apply the factors in section 4(a) of the Act (84 FR 45020).

Delisting Recovery Criteria found in the Amendment to the Recovery Plan (Service 2019a) are as follows.

C. aculabrum may be considered for delisting when the following criteria are met:

1) Populations at Bear Hollow Cave, Logan Cave, and one additional population exhibit a stable or increasing trend, natural recruitment, and multiple age classes (Factors A, B, C, & E).

2) Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future (Factors A, B, C, D, & E).

No delisting criteria have been met at this time.

Biology and Habitat Summary

The recovery plan summarizes *Cambarus aculabrum* description and taxonomy (Service 1996). No new information pertaining to the species taxonomy, life history or ecology is available since publication of the Recovery Plan. The species is stygobitic (i.e., a species that lives exclusively in groundwater), lacks pigment and eyes, and has an overall body length reaching about 1.8 inches. *C. aculabrum* biology and life history are not understood as no data is available regarding life span, fecundity, survival of eggs and young, or other aspects of the species' ecology.

Cambarus aculabrum is currently known from four populations (i.e., Logan Cave, Bear Hollow Cave, Old Pendergrass, and Elm Springs Upwelling) in northwestern Arkansas and southwestern Missouri (Figure 1). At the time of listing *C. aculabrum* was only known from two cave streams, one in Benton County, Arkansas (Logan Cave) and another that crosses from Benton County, Arkansas, into McDonald County, Missouri (Bear Hollow Cave). Since being listed, a third population in a cave stream in Benton County, Arkansas (Old Pendergrass), and a fourth population at a groundwater upwelling in Washington County, Arkansas (Elm Springs Upwelling), have been identified. Additional populations are likely to exist, but are believed to be inaccessible to humans. Both populations discovered post listing are believed to be previously overlooked populations as the species has limited range expansion capabilities due to limited connectivity between independent cave stream habitats.

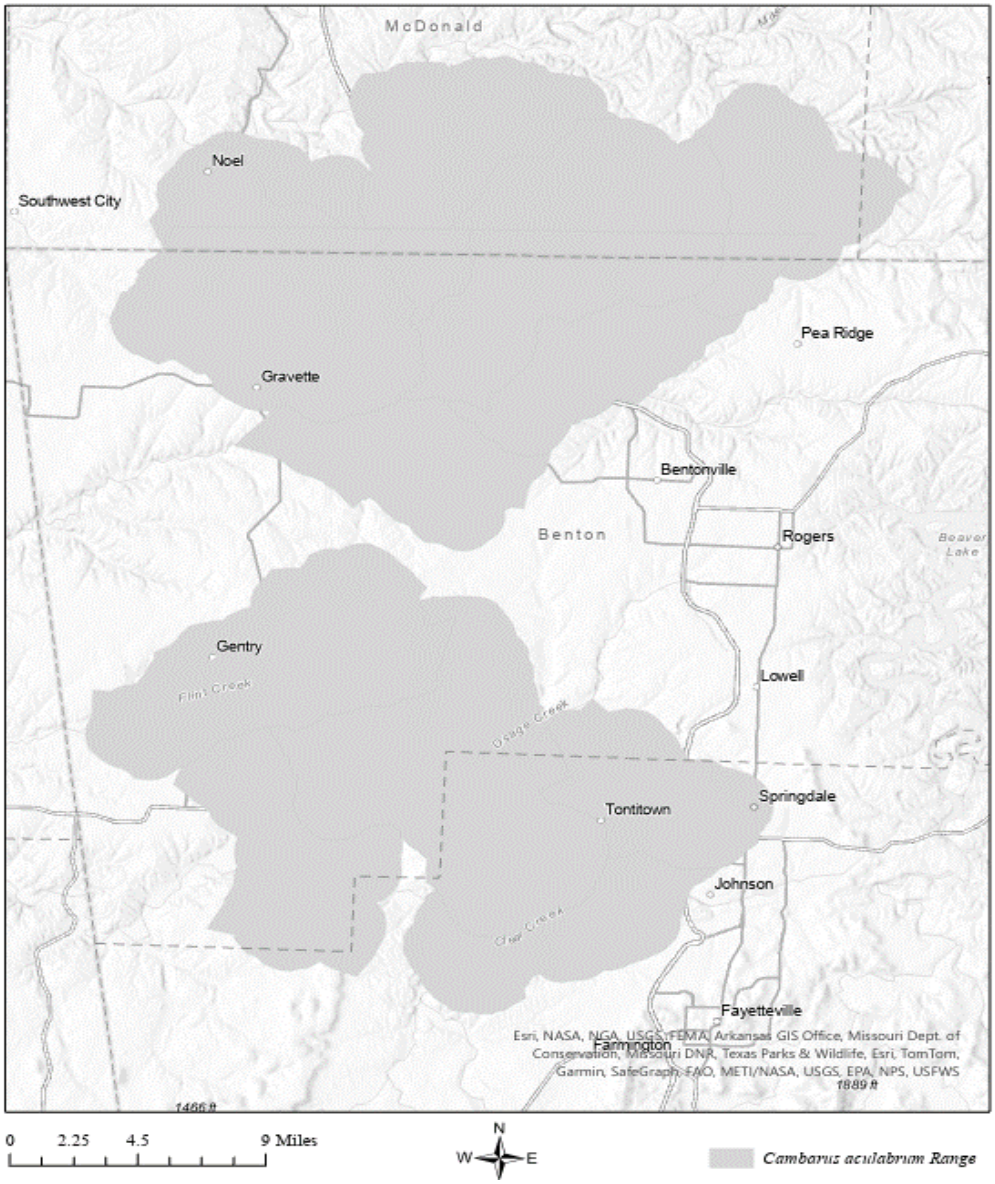

Figure 1. Species range map of *Cambarus aculabrum* in northwest Arkansas and southwest Missouri.

Surveys at Logan Cave and Bear Hollow Cave are conducted biennially, but access to all other sites is limited by cave structure. Surveys results are indicative of small population numbers (Table 1) and no data are available to assess whether sufficient levels of reproduction and recruitment are occurring to sustain populations at historical levels. Surveys at Logan Cave are believed to have been standardized by 2013 and results indicate an increasing population. Results of surveys at Bear Hollow Cave also indicate an increasing population. However, additional data are needed to better inform population trends at both sites.

Old Pendegrass Cave is accessible to humans, but *C. aculabrum* are only observed when high water events flush them into the cave passage where they can be observed as waters recede. Only two observations have occurred at that site (December 1999 and July 2004) and the population status is unknown. A single *C. aculabrum* flushed out of Farris Sink in the Elm Springs Upwelling system in July 2004, but no portion of that system is accessible to humans and the population status is unknown.

Table 1. Total number and total number by size class, small (<1 inch), medium (1-2 inches), and large (>2 inches), of *C. aculabrum* detected during biennial surveys at Logan Cave and Bear Hollow Cave (US Fish and Wildlife Service, Arkansas Natural Heritage Commission, and the Nature Conservancy data). Data include surveys conducted by walking or snorkeling, but data at Logan Cave is not believed to be standardized prior to 2013. Blank cells (e.g., "-") represent years without complete surveys at the respective sites.

Year	Logan Cave; (# Individuals)	Logan Cave; small: medium: large	Bear Hollow Cave; (# Individuals)	Bear Hollow Cave; small: medium: large
1985	-	-	6	-
1985	-	-	7	-
1987	8	-	9	-
1990	10	-	1	-
1995	-	-	4	-
1999	24	-	-	-
2000	42	-	5	-
2000	-	-	7	-
2002	47	-	-	-
2003	38	-	-	-
2004	-	-	9	-
2006	31	4:23:4	6	-
2009	43	5:29:9	13	1:7:5
2012	41	3:26:12	13	2:9:2
2013	-	-	-	-
2015	-	-	9	2:5:2
2017	26	1:18:7	17	2:10:5
2019	19	1:11:7	1	0:1:0
2022	30	1:20:9	9	0:4:5
2024	28	2:22:4	-	-

Threats (Five-Factor Analysis) Summary

The status of a species is determined from an assessment of factors specified in section 4 (a)(1) of the Act. A summary of this assessment is detailed below.

Factor A. The present or threatened destruction, modification, or curtailment of its habitat or range.

Because *C. aculabrum* occurs in underground environments that are typically inaccessible to humans it is difficult to assess Factor A. Because the species evolved to exist in relatively stable karst groundwater (Service 1996), and karst landscapes are characterized by rapid contribution of water from the surface to groundwater systems (Greene et al. 2006, De Waele et al. 2011), the best indicator of destruction, modification or curtailment of the range are activities occurring on the landscape above karst environments that impact water quality. Having a natural forested landscape above reduces contribution of contaminants to karst groundwaters via reduced uptake of contaminants and increased filtration of water prior to entering karst systems. Land conversion from natural forested landscapes typically increases the risk of contamination of karst resources from sedimentation, chemicals and nutrification resulting in reductions in species viability. Therefore, we provide an assessment of those activities by population below.

Logan Cave

Land in the recharge area of Logan Cave is primarily forested (48%), with an almost equal amount of pastureland (47%), and a smaller portion being used for development (5%). Forested area in the Logan Cave recharge area decreased between 1.0 and 5.1% during each five year period from 2001 – 2021 (National Land Cover Database 2021). During the same time intervals developed land in the recharge area increased between 0.0 and 19.1% during each five year period, with the largest increase (19.1%) occurring in the most recent five year period (National Land Cover Database 2021). Based on these data, we assume developed area will continue to increase at a rate between 0.0 and 19.1% per five year period for the next 20 years.

Approximately 124 acres of the Logan Cave recharge area, including the gated and fenced cave entrances, are owned by the Service and Arkansas Natural Heritage Commission, but protected property represents less than 0.5% of the extremely high vulnerability area and 0% of the high, moderate and low vulnerability areas. The total protected area is 1.6% of the 7,507 acre recharge area. Aley and Goers (2023) of Ozark Underground Laboratory conducted a review of hazards at biologically significant springs and caves in Arkansas and identified the following hazards within the Logan Cave recharge area:

1) agricultural uses, including 36, confined animal feeding buildings and spreading of animal waste on fields,
2) onsite sewage disposal (septic),
3) subdivision of lots for housing development that will be serviced by septic,
4) one transportation/transmission route.

The number of confined animal feeding operations in the recharge area decreased since last assessed in 1985 (Aley and Goers 2023), but are still present in the moderate, high and extremely high vulnerability areas. Houses with septic systems are located in all vulnerability areas and risk contamination of groundwater from leaky septic drain fields and toxic pollutants from human activities. From 2010 to 2022, the population in Benton County increased 36.1% (USA Facts 2022b) and subdivision of lands is occurring throughout the recharge area. Subdivision is most

prevalent in the northwestern portion of the recharge area which is located in the high vulnerability area.

Bear Hollow Cave

Land in the Bear Hollow Cave recharge area is primarily forested (70%), with smaller portions being developed (22%) and pasture lands (8%, National Land Cover Database 2021). Forested area decreased 4.0, 0.1, 0.4 and 3.0% from 2001 – 2006, 2006 – 2011, 2011 – 2016 and 2016 – 2021, respectively (National Land Cover Database 2021). Over the same time intervals developed land in the recharge area increased between 0.0 and 13.3% every five years, with the largest increase of 13.3% occurring in the most recent five year time interval. Based on these data, we assume developed area will continue to increase at a rate between 0.0 and 13.3% every five years, for the next 20 years.

The primary threat within the Bear Hollow Cave recharge area is associated with contaminants from residential uses but also includes threats from agricultural practices, commercial uses and transportation routes. Aley and Goers (2023) identified the following hazards within the Bear Hollow Cave recharge area:

1) onsite sewage disposal facilities (septic) in the City of Bella Vista and surrounding rural areas.
2) agricultural uses including 3 poultry barns,
3) dumps,
4) transportation routes,
5) one petroleum storage site.

From 2010 to 2022, the population in Benton County, Arkansas, increased 36.1% (USA Facts 2022b) and simultaneously the population in McDonald County, Missouri, grew 2.2% (USA Facts 2022c). Housing development in the Bear Hollow Cave recharge area is typically serviced by septic. An ordinance requiring properties in the Bella Vista area to connect to sewer when sold has been implemented, but enforcement is lacking and sewer is not available in the majority of the Bear Hollow Cave recharge area. At this time, the majority, if not all houses in the Bear Hollow Cave recharge area, are serviced by septic field systems placed in soils that do not provide effective treatment capabilities (Aley and Goers 2023).

The majority of housing development in the Bear Hollow Cave recharge area occurs in the high vulnerability area, but housing is also prevalent in the extremely high and moderate vulnerability areas. All agricultural hazards and dumps are confined to the moderate vulnerability areas. The one petroleum storage tank in the recharge area is located in the high vulnerability area. Transportation routes occur in the moderate, high and extremely high vulnerability areas.

Old Pendergrass Cave

Land in the recharge area of the Old Pendergrass Cave is primarily forestland (67%) with smaller portions being developed (29%) and open water (4%, National Land Cover Database 2021). Forested area in the recharge area increased 0.1% from 2011 – 2016 and decreased 1.1, 0.1 and 4.6% from 2001 – 2006, 2011 – 2016 and 2016 – 2021, respectively (National Land Cover Database 2021). Over the same time intervals developed land in the recharge area increased from 0.3 to 14.0 every five years with the largest increase occurring during the most recent time interval. Based on these data, we assume developed area will continue to increase at a rate between 0.3 and 14.0% every five years, for the next 20 years.

The primary threats within the Old Pendergrass recharge area are associated with residential uses but also include threats from agricultural practices, commercial uses and transportation routes. Aley and Goers (2023) identified the following hazards within the Old Pendergrass recharge area:

1) onsite sewage disposal facilities (septic) in the City of Bella Vista, Town of Hiwasse, and rural areas as well as a sewage lagoon at an RV and boat storage facility,
2) agricultural uses including 28 poultry barns and four hog barns,
3) transportation routes,
4) five petroleum storage sites,
5) six other chemical storage sites,
6) a golf course.

Almost all of Old Pendergrass Cave recharge area is in the City of Bella Vista which is a large suburban development that initially relied almost exclusively on septic field systems. Additional onsite sewage disposal systems within the recharge area are located in the Town of Hiwasse, throughout the rural areas and at a sewage lagoon associated with a recreational vehicle and boat storage facility. Soils in the Old Pendergrass recharge area are generally not capable of effective treatment of wastewater from septic field systems (Aley and Goers 2023). An ordinance requiring properties to connect to sewer when sold has been implemented, but enforcement is lacking and the number of houses that have transitioned to sewer is unknown.

Highways 279 and 72 and Interstate 49 occur within the recharge area and at least three fueling stations, a street department base yard and a mechanics garage occur in the recharge area. In addition an autobody shop and golf course are located in the recharge area. All hazards except the golf course and numerous septic systems are located in the moderate vulnerability area. The golf course and numerous septic systems are located in the high vulnerability area.

Elm Springs Upwelling

Land in the recharge area of the Elm Springs Upwelling is primarily hay/pasture (53%), with almost equal developed lands (42%) and a smaller portion of forested (4%, National Land Cover Database 2021). Forested area decreased 9.7 and 4.6% from 2001 – 2006 and 2006 – 2011 and increased 3.8 and 1.9% from 2011 – 2016 and 2016 – 2021 (National Land Cover Database 2021). Over the same time intervals developed land in the recharge area increased between 3.9 and 51.1% every five years with the largest increase of 51.1% occurring during the most recent time interval. Based on these data, we assume developed area will continue to increase at a rate between 3.89 and 51.1% every five years, for the next 20 years.

The primary threats within the Elm Springs Upwelling recharge area are associated with runoff from residential and commercial developments, but also include threats from transportation routes. Aley and Goers (2023) identified the following hazards within the Elm Springs Upwelling recharge area:

1) commercial developments including, four industrial hazards, three petroleum storage sites and one chemical storage site,
2) urban development, including subdivision and associated stormwater runoff,
3) transportation routes, including Highways 112 and 412.

From 2010 to 2022, the population in Washington County, Arkansas, increased 25.5% (USA Facts 2022a). Most of the Elm Springs Upwelling recharge area is experiencing suburban and to

a lesser extent commercial development (Aley and Goers 2023). The commercial development includes a complex of warehouse and manufacturing business, a trucking facility, a farm equipment dealership and a construction equipment rental (Aley and Goers 2023). Commercial development is wholly contained within the high vulnerability area. Urban development is extensive throughout the high and extremely high vulnerability areas. The expansion of Highway 112 from two lanes to four lanes is scheduled to begin during 2025 and transects the majority of the extremely high vulnerability area.

Factor B. Overutilization for commercial, recreational, scientific, or educational purposes
Overutilization for commercial, recreational scientific or educational purposes is not considered a significant threat at this time. This is due to limited access to the known populations, including the presence of a cave gates or fences on Bear Hollow Cave and Logan Cave, inaccessibility to Elm Springs, and the extreme difficulty in locating individuals at Old Pendergrass Cave.

Factor C. Disease or predation
Disease or predation is not considered a significant threat. Cave species' endemicity suggests that the potential exists for transport of unknown parasites or diseases from cave to cave by researchers or recreational cavers, but this has not been documented for *C. aculabrum* and it is a standard protocol that all cave gear be cleaned and decontaminated before biennial surveys. We have no evidence of predation on *C. aculabrum*, although numerous surface crayfish, fish, and small mammals enter caves making predation likely. Regardless, predation is likely minimal and not believed to be a threat to the continued existence of the species.

Factor D. The inadequacy of existing regulatory mechanisms.
Inadequacy of existing regulatory mechanisms is still a significant threat to *C. aculabrum.* While surface streams have water quality standards that are monitored and enforced, existing regulatory mechanisms regarding the protection of groundwater resources are limited. The Arkansas Department of Environmental Quality conducts groundwater quality monitoring throughout the state, but *C. aculabrum* sites are not included in their scheduled sampling. Similarly, the U.S. Environmental Protection Agency (EPA) has regulations and standards outlining water quality conditions for groundwater based on human health standards. However, EPA regulations and management guidance necessary to protect groundwater from nonpoint source pollution do not exist. "States report that nonpoint source pollution is the leading current cause of water quality problems. The effects of nonpoint source pollutants on specific waters vary and may not always be fully assessed. However, we know that these pollutants have harmful effects on drinking water supplies, recreation, fisheries and wildlife." (EPA 2023).

The objective of the Federal Water Pollution Control Act, commonly referred to as the Clean Water Act (CWA; 33 U.S.C. 1251 et seq.), is to restore and maintain the chemical, physical, and biological integrity of the nation's waters by preventing point and nonpoint pollution sources and a stated goal that "…wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983." States are responsible for setting and implementing water quality standards that align with the requirements of the CWA. Overall, implementation of the CWA could benefit *C. aculabrum* through the conservation efforts to minimize point and nonpoint pollution sources.

Sources of nonpoint pollution within the recharge areas occupied by *C. aculabrum* include timber harvest, use of chemicals, clearing of riparian vegetation, urbanization, road construction,

and other practices that allow bare earth to enter streams, sinkholes, and other conduits that transport surface waters, additional organic materials, and pollutants to groundwater systems. Currently, the CWA may not adequately protect *C. aculabrum* habitat from nonpoint source pollution. Because there is very little information known about water quality parameters necessary to fully protect cave crayfish and general water quality conditions at these sites, it is difficult to determine whether the CWA is adequately addressing nonpoint and point source pollution threats to this species. Given that a goal of the CWA is to establish water quality standards that protect aquatic life, we take a conservative approach in favor of the species and conclude that the CWA regulations are insufficient to provide adequate protection and significantly reduce or remove threats from point-source or nonpoint source pollution.

Factor E. Other natural or manmade factors affecting its continued existence.
Threats from other natural or manmade factors affecting the continued existence of *C. aculabrum* are unchanged from the previous five-year review. *C. aculabrum* are cave stream/groundwater obligates that require sufficient stream flow for long-term survival and are endemic to the Springfield Plateau Aquifer System. Changes in recharge of the aquifer can lead to substantial changes in water levels within the system, both seasonally and across longer time spans. Research suggests that climate change will impact availability of ground and surface water, but the impacts to specific areas are hard to predict (Kumar 2012). Clark et al. (2019) modeled water levels in the Ozark Plateaus Aquifer system and projects that by 2060, water levels in the aquifer will be an average of 0 to 24 feet less than in 1900. If climate change negatively impacts ground and surface water availability in the area or depletion of the aquifer for anthropogenic purposes continues, it may threaten species persistence. In addition, the species' limited range and low genetic diversity are likely to inhibit the ability of *C. aculabrum* to adapt to changing habitat conditions.

Synthesis

The Benton County Cave crayfish (*Cambarus aculabrum*) is a stygobitic crayfish without pigment or eyes that is endemic to the Ozark Mountains in northwestern Arkansas and the southwestern Missouri. At the time of listing only two populations were known, Logan Cave and Bear Hollow Cave. The species is now known to have a broader distribution with a total of four confirmed locations (Logan Cave, Bear Hollow Cave, Old Pendergrass and the Elms Springs Upwelling). The density of individuals observed during species surveys is low at all sites. However, the extreme difficulty of conducting surveys and accessing much of the habitat make population estimates and trends challenging. Populations at Bear Hollow and Logan Caves appear to be increasing. The status of populations at Old Pendergrass Cave and the Elm Springs upwelling are unknown due to the inability to survey either site effectively. Primary threats to the species include point and nonpoint source contaminants from onsite sewage disposal (septic fields and sewage lagoons), agricultural land practices, urban land practices, discharge of urban storm water and climate change. An assessment of land use within all *C. aculabrum* recharge areas indicates forest loss and a large shift towards developed areas due to increasing local populations. Because of ongoing threats and current condition of the species, this species continues to meet the definition of an endangered species.

RECOMMENDED FUTURE ACTIVITIES

A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 1996) and the Recovery Plan Amendment (Service 2019a). In the course of this status review new and/or targeted potential recovery activities were identified and are included below.

Recovery Activities

- Additional work should be focused on perpetual protection of lands in the recharge areas via a conservation easement or fee-simple purchase. Prioritization should be for the extremely high and high vulnerability areas as defined in Aley and Goers 2023 at Logan Cave and Bear Hollow Cave due to the fact that they have the most intact recharge areas but should occur in all species locations.

Monitoring and Research Activities

- Surveys should be completed to identify additional *C. aculabrum* sites.
- Genetic variation in *C. setosus, C. zophonastes and C. aculabrum,* starting with *C. setosus,* should be mapped across the species range such that sites with unknown cave crayfish species can be accurately identified.

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RESULTS / SIGNATURES

U.S. Fish and Wildlife Service
Status Review of The Cave Crayfish (*Cambarus aculabrum*)

Status Recommendation:

On the basis of this review, we recommend the following status for this species. A 5-year review presents a recommendation of the species status. Any change to the status requires a separate rulemaking process that includes public review and comment, as defined in the Act.

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist:
____ *The species is extinct*
____ *The species does not meet the definition of an endangered or threatened species*
____ *The listed entity does not meet the statutory definition of a species*
_X_ No change needed

Field Office Approval:

Acting Field Supervisor, Arkansas Ecological Services Field Office, Fish and Wildlife Service

Approve CHRISTOPHER DAVIDSON Digitally signed by CHRISTOPHER DAVIDSON Date: 2024.06.26 14:50:14 -05'00'

COOPERATING REGIONAL OFFICE APPROVAL:
We emailed this 5-year review to the Midwest Regional Office for their concurrence prior to finalizing the document. We will retain any comments that we received, as well as verification of concurrence from other regions, in the administrative record for this 5-year review.