

Hell Creek Cave Crayfish
(*Cambarus zophonastes*)
5-Year Status Review:
Summary and Evaluation



U.S. Fish and Wildlife Service
Southeast Region
Arkansas Ecological Services Field Office
Conway, Arkansas
February 2024

5-YEAR STATUS REVIEW
Hell Creek Cave Crayfish (*Cambarus zophonastes*)

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

Date of original listing: May 7, 1987 (52 FR 11170; April 7, 1987)

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 the *Cambarus zophonastes* 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 comments. The primary sources of information used in this analysis were the 1987 final listing rule (52 FR 11170), the 1988 recovery plan, peer-reviewed reports, agency reports, unpublished survey data and reports, and personal communication with recognized experts.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. zophonastes*.

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](#)): 5. *C. zophonastes* is a species with a high degree of threat and a low recovery potential.

Review History:

A status assessment conducted in December of 1984 recommended the species be listed as endangered (Smith 1984). Three five-year reviews have been published since listing. The first five-year review was published on November 6, 1991, second on August 15, 2012, and third on April 17, 2019. All three five-year reviews recommended no change in status (Service 1991, Service 2012, Service 2019).

REVIEW ANALYSIS

Listed Entity

Taxonomy and nomenclature

We are not aware of any changes to the taxonomy of this entity, thus *C. zophonastes* 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 zophonastes Recovery Plan, September 6, 1988.

Recovery plans are not regulatory documents and 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](#)).

The Recovery Plan establishes that *C. zophonastes* can be downlisted when the following criteria are met:

1. Protection of the existing Hell Creek Cave population by minimizing present and future threats within the cave and the recharge area by developing and implementing land use regulations and obtaining conservation agreements or acquiring fee title on all private lands in the Extremely High Hazard Area.
2. Excluding recreational cavers and collectors from the cave.
3. Location and protection (as above) of at least two other viable populations of *C. zophonastes* sufficiently removed from Hell Creek Cave and each other so that a single event is unlikely to impact any two populations. Viable populations are those with different age classes including males and females.

The Recovery Plan establishes that *C. zophonastes* can be delisted when the following criteria are met:

1. The Hell Creek Cave population and at least nine others are known to exist.

2. At least five viable populations and their habitat are protected from present and foreseeable human related and natural threats that may interfere with the survival of any of the populations.

Downlisting criteria 2 has been met for the intended cave, Hell Creek Cave, via acquisition of the cave by Arkansas Natural Heritage Commission and construction of a cave gate to exclude recreational cavers and collectors from the cave. Downlisting criteria 1 and 3 and delisting criteria 1 and 2 have not been met.

Biology and Habitat Summary

Cambarus zophonastes was first described based on five specimens collected from Hell Creek Cave (Hobbs and Bedinger 1964). This cave crayfish is stygobitic (i.e., a species that lives exclusively in groundwater), lacks pigment and eyes, and has an overall body length reaching 2.5 to 3.0 inches. *C. zophonastes* 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.

The species is an Arkansas endemic (Figure 1). Hell Creek Cave was the only known population until the Nesbitt Spring population was verified in 2005, Legion Spring in 2009, and Cave River Cave and Flitterin Pit in 2021. Populations may also exist at Dozens Den Cave and Ennis Cave, but sufficient genetic confirmation of individuals observed at those sites is lacking. All newly discovered populations are believed to be previously overlooked populations as the species has limited range expansion capabilities due to limited connectivity between independent cave stream habitats.

Genetic data have been useful in confirming the identification of specimens from newly discovered populations of cave crayfish throughout the species range, but samples from Dozen's Den Cave have not been confirmed due to an inability to differentiate that population from the bristly cave crayfish (*C. setosus*). This lack of differentiation at that site is believed to be due limited genetics data for *C. setosus* (Matt Niemiller, pers. comm.).

Surveys at Hell Creek Cave, Cave River Cave and Flitterin Pit are conducted biennially, but access to all other sites is limited by cave structure or a lack of landowner permission. Surveys at confirmed sites are indicative of small population numbers (Table 1) and no data is available to assess whether sufficient levels of reproduction and recruitment are occurring to sustain populations at historical levels. However surveys conducted by divers have been indicative of slightly higher population counts at Hell Creek Cave with 15, 13 and 8 individuals being observed in 1983, 1990 and 2001, respectively. Similarly surveys conducted by divers at Nesbitt springs recorded dozens of individuals in 1992 and 9 in 2005.



Figure 1. Species range map of *Cambarus zophonastes* in northern Arkansas.

Table 1. *Cambarus zophonastes* survey data (number of individuals) for Hell Creek Cave, Nesbitt Spring Cave, Legion Spring, Cave River Cave, and Flitterin Pit 1961 – 2017; collected by U.S. Fish and Wildlife Service, Arkansas Natural Heritage Commission, and the Nature Conservancy. Data includes surveys conducted by walking and snorkeling, but excludes data conducted via scuba gear. Blank cells represent years without surveys at the respective sites.

<i>Year</i>	<i>Hell Creek Cave</i>	<i>Legion Spring</i>	<i>Nesbitt Spring Cave</i>	<i>Cave River Cave</i>	<i>Flitterin Pit</i>
1961	5				
1972	2				
1980	2				
1983					
1990					
1992	2				
2000a	6		0		
2000b	2				
2001			0		
2002			2		
2004	6		0		
2005					
2007	12				
2008		1			
2009	2	3			
2011		1			
2012		1			
2013	4				
2015	1				
2017	2				
2019	0				
2021				1	14
2022	6				

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. zophonastes* occurs in underground environments that are typically inaccessible to humans it is difficult to assess Factor A. Due to the fact that the species has evolved to exist in relatively stable karst groundwater (Service 1988), 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. A natural forested landscape 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 nitrification resulting in reductions in viability of the species in those areas. Therefore, we provide an assessment of those activities by population below.

Hell Creek Cave

Land in the recharge area of Hell Creek Cave is primarily forested, with a smaller portion being used for development and agricultural purposes. Forested area in the Hell Creek Cave recharge area decreased between 1.5 and 5.8% 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 0.6 and 22.7% during each five year period, with the largest increase (22.7%) 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 0.6 and 22.7% per five year period for the next 20 years.

Approximately 264 acres including the gated cave entrance and much of the area overlaying the cave is owned by Arkansas Natural Heritage Commission, but protected property only represents 44% of the extremely high vulnerability area, 10% of the high vulnerability area, 0% of the moderate vulnerability area and less than 1% of the low vulnerability area. The total protected area is 7% of the 3,695 acre recharge area. Aley and Goers (2023) of Ozark Underground Laboratory (OUL) conducted a review of hazards at biologically significant springs and caves in Arkansas and identified the following hazards within the Hell Creek Cave recharge area:

- 1) Onsite sewage disposal at numerous sites across the recharge area, including an RV park with more than 50 units,
- 2) Nine documented dumps associated with private residences and historic businesses,
- 3) Industrial businesses, including a concrete ready mix supplier, the Stone County recycling center and a large sawmill,
- 4) Three transportation/transmission routes,
- 5) Two petroleum storage sites,
- 6) One chemical storage site.

The use of onsite sewage disposal (septic tanks) within the recharge area is believed to have increased significantly since last assessed by OUL in 2010 (Aley and Goers 2023). From 2010 to 2022, the population in stone county increased 1.5% (USA Facts 2022) The increase in onsite sewage disposal is primarily due to the development of subdivisions, and to a lesser degree business development along the Highway 5/9/14 corridor, within the recharge area.

Industrial businesses and chemical storage sites within the recharge area have increased since the 2010 OUL study. Threats from petroleum storage sites have declined within the recharge area since the 2010 OUL study and only two petroleum storage facilities were documented in 2022. Twelve of fifteen identified threats from industrial businesses and chemical storage activities are contained within the moderate vulnerability area along the highway 5/9/14 corridor. The only exceptions are the Stone County Recycling Center, a large sawmill and a paint and body shop, which all occur in the low vulnerability area. No known industrial businesses or chemical storage activities are known to occur in the high or extremely high vulnerability areas.

Nesbitt Springs Cave

Access to Nesbitt Spring Cave has been restricted by the landowner since 2005, therefore our knowledge of land use is limited to observations of land use from aerial photos or points in the recharge area that we can access. Aley and Goers (2023) did not evaluate this site due to access denial by the property owner. Threats within the Nesbitt Springs recharge area were listed as those from agricultural and timber practices in the previous five-year review. These threats still remain, but there has been some residential developments that utilize septic tanks within portions of the recharge area.

Land in the recharge area of Nesbitt Springs is primarily forested, with a smaller portion being used for development and agricultural purposes. Forested area in the recharge area increased from 1.5 to 2.2% from 2001 – 2016 and decreased 1.8% from 2016 – 2021 (National Land Cover Database 2021). Over the same time intervals developed land in the recharge area increased from 0.0 to 24.6%. The increase in developed land from 2016-2021 was due to land conversion for farming and residential practices. Based on these data, we assume developed area will continue to increase at a rate between 0.0% and 24.6% every five years for the next 20 years.

Legion Spring

Forested area in the Legion Spring recharge area decreased 0.5 to 2.5% from 2001 – 2011 and 2016 – 2021 and increased 0.4% from 2011 – 2016 (National Land Cover Database 2021). Over the same time intervals developed land in the recharge area increased from 0.0 to 9.8%. Based on these data, we assume developed area will continue to increase at a rate between 0.0 and 9.8% every five years, for the next 20 years.

The primary threats are associated with runoff from residential and commercial developments in the City of Yellville, but some agricultural threats are also present in the recharge area. Aley and Goers (2023) identified the following hazards within the Legion Spring recharge area :

- 1) Agricultural hazards, including six turkey rearing barns,
- 2) The Yellville Transfer and Recycling Station,
- 3) Industrial hazards, including a recently developed industrial park,
- 4) Nine petroleum storage sites,
- 5) Three chemical storage sites,
- 6) Failing sanitary sewer lines throughout the city of Yellville,

Agricultural and petroleum storage threats in the Legion Spring recharge area are similar to 2010 levels while threats from dumps, landfills and junkyards declined (Aley and Goers 2022). Threats from Industrial and chemical storage sites increased with the establishment of an industrial park and hazardous waste collection facility in the recharge area (Aley and Goers 2023). The City of Yellville's failing sanitary sewer lines also present a significant and ongoing threat to water quality in the recharge area.

Cave River Cave and Flitterin Pit

The Cave River Cave and Flitterin Pit populations were recently discovered and the recharge area is not mapped, but a recharge area boundary was estimated for analysis purposes of this five year review. Flitterin Pit and Cave River Cave are believed to be connected and share a recharge area which would be owned by a single landowner. Some timber thinning has occurred within the topographic recharge area. Logging is expected to result in increased sediment entering groundwater systems occupied by *C. zophonastes*, but has been of low intensity and therefore any increases in sediment input are believed to be minimal and temporary.

Forested area in the estimated recharge area of Cave River Cave and Flitterin Pit increased 0.2 to 1.4% from 2001 – 2016 and decreased 0.4% from 2016-2021 (National Land Cover Database 2021). Over the same time intervals developed land in the recharge area increased from 0.0 to 7.1%. Based on these data, we assume developed area will continue to increase at a rate between 0.0 and 7.1% per five year period for the next 20 years.

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 gate on Hell Creek Cave inaccessibility to the Legion Spring population and limited access by landowners to the other populations.

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. zophonastes* 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. zophonastes*, although numerous surface crayfish, fish, and small mammals enter the cave 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. zophonastes*. 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 (ADEQ) conducts groundwater quality monitoring throughout the state, but *C. zophonastes* 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 non-point 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, these pollutants have harmful effects on fisheries and wildlife.

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. zophonastes* through the point and nonpoint programs.

Sources of nonpoint-source pollution within the recharge areas occupied by *C. zophonastes* include timber harvest, 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. zophonastes* habitat from nonpoint-source pollution. Point-source discharges within the range of *C. zophonastes* are primarily restricted to Legion Spring and Hell Creek Cave. However, because there is very little information known about water quality parameters necessary to fully protect cave crayfish and in general water quality at these sites, it is difficult to determine whether the CWA is adequately addressing nonpoint- and point-source 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. zophonastes* are unchanged from the previous five-year review. *C. zophonastes* are cave stream/groundwater obligates that require sufficient stream flow for long-term survival and are endemic to the Ozark Aquifer. Because the Ozark Aquifer is confined, changes in recharge of the aquifer can lead to substantial changes in water levels within the aquifer 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 Aquifer and determined that between 1900 and 2009 the aquifer was depleted between 1 and 49 feet and will decline between 0 and 24 feet by 2060. 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. The species’ limited range and low genetic diversity are likely to inhibit the ability of *C. zophonastes* to adapt to changing habitat conditions.

Synthesis

Cambarus zophonastes is a stygobitic crayfish without pigment or eyes that is endemic to the North-Central region of the Ozark mountains of Arkansas. The species was originally described and listed based on a single population at Hell Creek Cave. The species is now known to have a broader distribution with a total of five confirmed locations (Hell Creek Cave, Nesbitt Springs Cave, Legion Spring, Cave River Cave, and Flitterin Pit). Two of the most recently confirmed locations (Cave River Cave and Flitterin Pit) are believed to be connected. The density of individuals observed during species surveys is very low in all sites except Flitterin Pit. However, the extreme difficulty of conducting surveys and accessing much of the habitat make population estimates and trends challenging. The extremely low number of individuals observed at Hell Creek Cave and the failure to detect individuals at Legion Spring may be indicative of highly impacted populations or populations with low viability due to other unknown reasons. The status of the Nesbitt Springs population is unknown due to access denial, but there has been an increase in threats from development since the last five-year review. The Cave River Cave/Flitterin Pit

population appears to have good population numbers but was only recently discovered and there is limited understanding of the recharge area and no water quality nor long-term monitoring data available.

Primary threats for the species include point and nonpoint-source contaminants from dumps, businesses, yards, malfunctioning septic systems, agricultural and land management practices, discharge of urban storm water and treated municipal sewage, and climate change. Assessment of land use within all *C. zophonastes* recharge areas is indicative of a shift towards developed areas ranging from very minimal shifts of only a couple residences in the Nesbitt Springs recharge area to substantive urban and commercial development in the Hell Creek Cave recharge area. Because of ongoing threats and the 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 1988). 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. Perpetual protection of Cave River Cave, Flitterin Pit and Nesbitt Springs recharge areas are of particularly high priority because significant portions of all three are currently owned by one conservation interested landowner, presenting a rare opportunity to provide significant protection to over 50% of the known individuals via a single action.
- The City of Yellville has aging/failing clay sewer lines that are leaking into the Legion Spring recharge area. The Service should work with City staff to facilitate the replacement of those failing lines.

Monitoring and Research Activities

- Surveys should be completed to identify additional *C. zophonastes* sites.
- Genetic variation in *C. setosus* should be mapped across the species range such that sites with unknown cave crayfish species, such as Dozens Den Cave, can be confirmed or denied as *C. zophonastes*.

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RESULTS / SIGNATURES

U.S. Fish and Wildlife Service
Status Review of Hell Creek Cave Crayfish (*Cambarus zophonastes*)

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

No change needed

Field Office Approval:

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

Approve _____