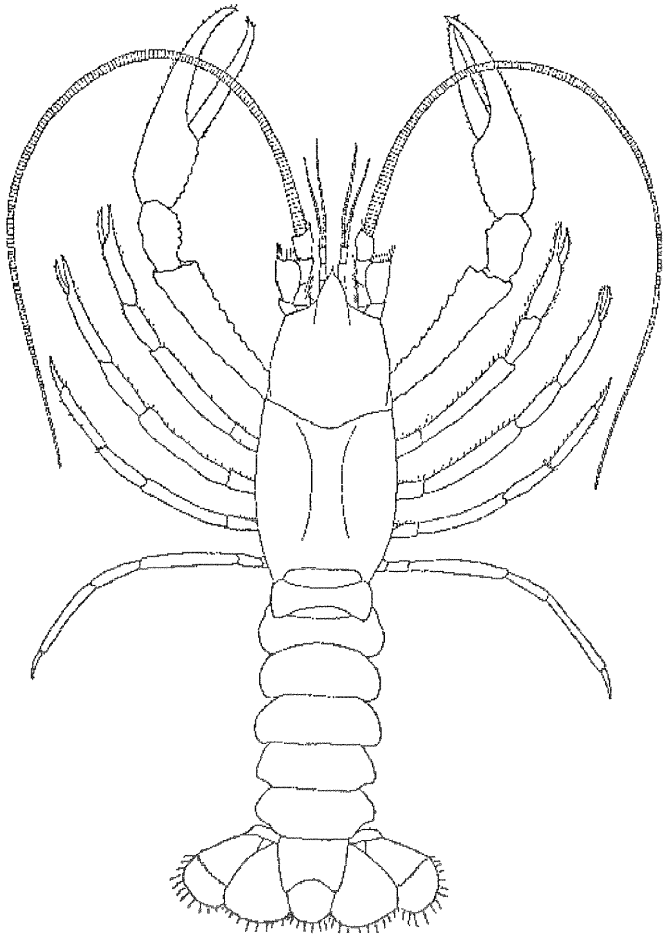
Cambarus zophonastes

RECOVERY PLAN



U.S. Fish and Wildlife Service
Atlanta Georgia

A Recovery Plan for the Cave Crayfish

Cambarus zophonastes

Prepared by

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For

Southeast Region

U.S. Fish and Wildlife Service

Atlanta, Georgia

Approved: _____

Regional Director, Southeast Region

Date: September 26, 1988

Disclaimer

This is the completed *Cambarus zophonastes* recovery plan. It has been approved by the U.S. Fish and Wildlife Service. It does not necessarily represent official positions or approvals of cooperating agencies, and it does not necessarily represent the views of all individuals who played a role in preparing this plan. This plan is subject to modification as directed by new findings, changes in species status, and completion of tasks described in the plan. Goals and objectives will be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints.

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RECOVERY PLAN EXECUTIVE SUMMARY

1. Point or condition when the species can be considered recovered?

   At present, the only known population of Cambarus zophonastes is in Hell Creek Cave, Arkansas. If the recharge area for this cave, as identified by Aley and Aley (1985), is properly protected, and at least two other viable populations are discovered and also protected, the species could be considered for downlisting to threatened. If seven additional populations are discovered, and a total of five viable populations are fully protected, the species could be considered for delisting. However, due to the apparent limited potential for discovering new populations, the delisting objective may be unattainable.

2. What specifically must be done to reach "recovery"?

   Protect Hell Creek Cave and its recharge area by: developing a cooperative agreement with Arkansas Natural Heritage Commission and the Arkansas Game and Fish Commission to secure the cave entrance; identifying properties in the recharge area; protecting these properties by agreement, zoning, proper sewage treatment, and other appropriate means; surveying caves to find additional populations, and developing baseline population and water quality data.

3. What management/maintenance needs have been identified to keep the species recovered?

   Periodic monitoring of water quality and population levels, and maintenance of conservation agreements and other measures to protect the caves and their water supplies will have to be continued indefinitely.

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Part 1: Introduction

Background

On April 7, 1987, the U.S. Fish and Wildlife Service published in the Federal Register a final rulemaking indicating its determination that the cave crayfish, Cambarus zophonastes, is an endangered species under the Endangered Species Act of 1973, as amended. C. zophonastes is known only from Hell Creek Cave, Arkansas.

C. zophonastes was described by Hobbs and Bedinger in 1964 from a type series of five specimens (Hobbs and Bedinger 1964) from the only known locality, Hell Creek Cave in Arkansas. The entire known zoological collection consists of eight individuals (Smith 1984). C. zophonastes is one of eight troglobitic Cambarus species. Four of these occur in the Interior Highlands, "a series of mountain ranges, plateaus and valleys, of Arkansas, Missouri, and Oklahoma", with only C. zophonastes described from Arkansas (Smith 1984).

Description

This obligate cave crayfish lacks pigment in the body and eyes and has a rostrum with strongly convergent margins bearing spines. The areola is narrow, and the cervical spine, if present, is very small (Hobbs and Bedinger 1964). The overall body length reaches about 64 millimeters (mm) or 2.5 inches. Its closest relative is C. sestosus, which differs by having a wider areola and one to several spines (Smith 1984). C. tartarus has a wider areola than C. zophonastes (Hobbs and Cooper 1972). The third closely related cambarid in the Interior Highlands is C. causeyi, which is pigmented and has well developed pigmented eyes. A fourth troglobitic crayfish occurring in the Interior Highlands is C. hubrichti, the only troglobitic member of its subgenus. Its body is unpigmented but the eyes have pigment spots (Smith 1984).

Distribution

The only known population of C. zophonastes is in Hell Creek Cave, Stone County, Arkansas. The type locality is in the Ozark Mountains in Plattin Limestone formation (Hobbs and Bedinger 1964). The cave is a solution channel with considerable permanent water. The Arkansas Natural Heritage Commission owns the cave's entrance and 160 surrounding acres. The cave's recharge area is about 3.5 square miles (Aley and Aley 1985) and is largely privately owned. Surveys of over 170 caves in north-central Arkansas and 436 caves in Missouri failed to find C. zophonastes in any other cave than Hell Creek Cave (Smith 1984).

Status

C. zophonastes has only been found in the deep pool a short distance into the cave. Bedinger and Stephens found the type series in this pool in 1961 (Bedinger and Hobbs 1965). Smith (1984) observed a single female crayfish

on two occasions in 1980. In 1983, a scuba diver under contract to the Arkansas Natural Heritage Commission located 15 individuals (Smith 1984). Sufficient data to estimate population size or trends is lacking.

Habitat Requirements

The cave environment is generally considered to be very stable with low temperature and a lack of visible light. The aquatic portion of a cave is not as stable due to flooding but is better buffered against abrupt changes than is the surface aquatic habitat (Poulson 1963). In the vast majority of caves, the lack of primary producers results in dependency of primary consumers on the import of organic matter. Hell Creek Cave was a summer roost for the endangered gray bat, Myotis grisescens, at some time in the past (Harvey, et al 1981). Evidence suggests a maternity colony of some 16,000 gray bats used the cave but that a large number of gray bats have not used Hell Creek Cave in several years. The impact of the loss of this energy source on the crayfish population cannot be measured but must be significant. The energy input for this cave is now primarily the result of flood waters. In only a few hours after rains in the recharge area, the cave stream rises and becomes turbid, bringing organic matter into the cave.

The environmental triggers which stimulate growth and reproduction in cave species are apparently associated with seasonal flooding (Poulson 1963). The discovery of an ovigerous female in May 1975 suggests the reproductive cycle of C. zophonastes is similar to other troglobites (Smith 1984).

Limiting Factors

Factors which are most likely to limit or cause the decline of C. zophonastes include: (1) destruction of the habitat; (2) collecting; (3) disturbance by amateur cavers; and (4) lack of reproduction. Destruction of the habitat includes ground water degradation by toxins, nutrient fertilizers and sewage; alteration of drainage and hydrologic patterns; lower ground water levels; and physical destruction of the cave. Threats to the habitat include spills from highway accidents, runoff from commercial operations, and residential septic tanks. The major potential threat to water quality in Hell Creek Cave is future residential land development. This threat can be substantially reduced through improved location, design, construction, and operation of on-site sewage systems (Aley and Aley 1985).

Collecting poses a significant threat. Obligate cave species generally have a very low reproductive rate and take a relatively long period to reach maturity. The largest number of individuals ever observed on a single trip is 15, with the total population estimated at fewer than 50 individuals (Smith 1984). Collection of any of these individuals would significantly impact the gene pool, total population and reproduction for several years.

Disturbance by amateur cavers impacts the physical condition of individual crayfish. Obligate cave dwellers have a low metabolic level and have very limited opportunities to feed. Any physical activity resulting from disturbance uses up energy that would be used in feeding or possibly reproduction. Replacement of this lost energy is difficult in the scarce food situation of a cave.

Lack of reproduction obviously causes a decline in population levels. In a cave environment, the loss of reproduction one year may have long-term impacts. Poulson (1963) found individuals of some cavefish species reproduced at intervals of up to 5 years. Should an ovigerous female be collected or disturbed so as to lose the eggs, the reproductive potential of the entire population is reduced. With such a limited known population, the loss of any reproduction can have serious and long-term impacts on survival of the species.

Recovery Actions Already Accomplished

The Arkansas Natural Heritage Commission (NHC) owns a 160-acre tract that includes the mouth of Hell Creek Cave and gives that agency the ability to regulate entrance to the cave. The recharge area (Figure 1) has been delineated by Ozark Underground Laboratory under contract to NHC.

Figure 1. Map of recharge area from Ozark Underground Laboratory under contract to the Arkansas Natural Heritage Commission.

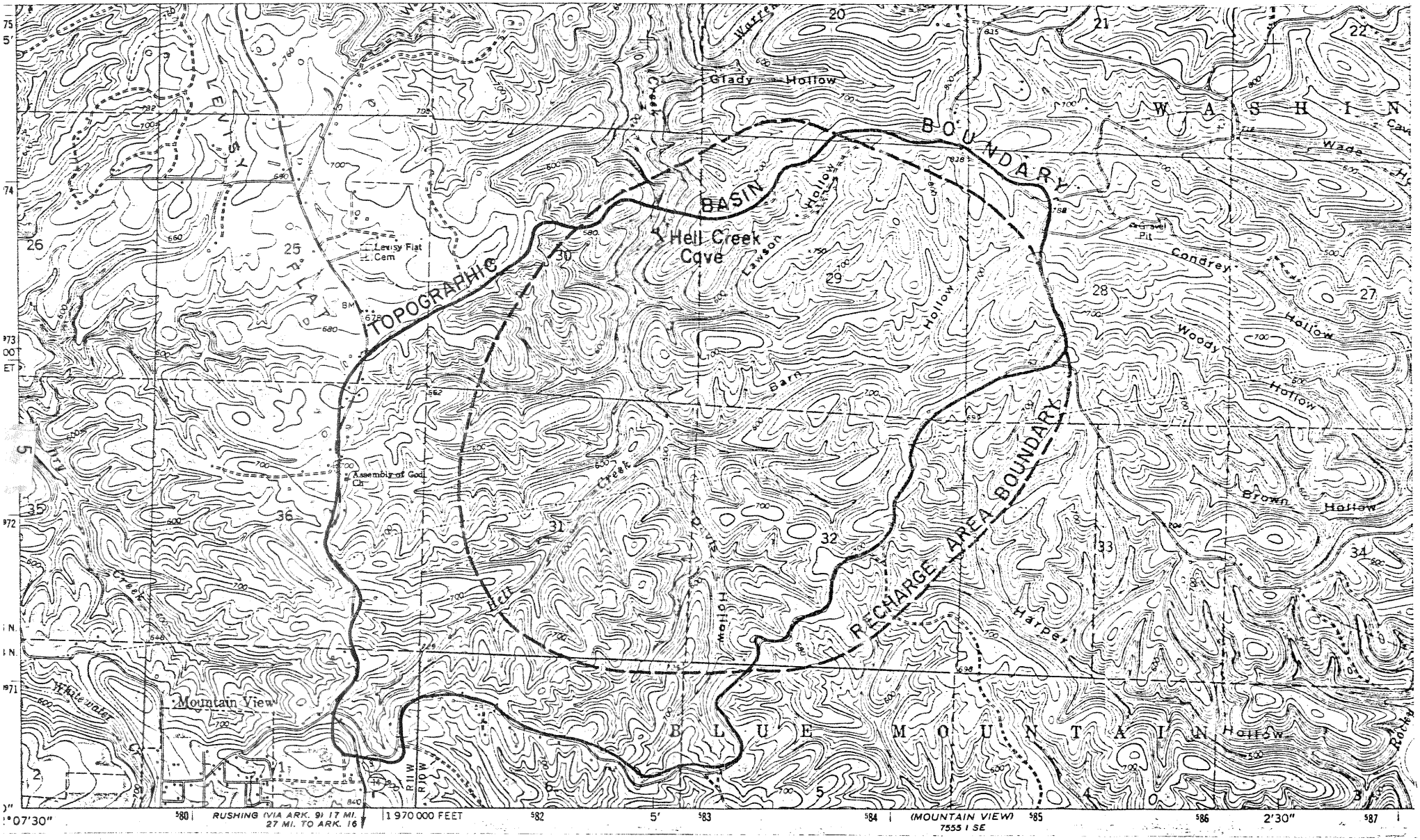

Figure 1 Delineation of the Hell Creek topographic basin and the Hell Creek Cave recharge area.

Part II: Recovery

A. Recovery Objective:

Objective: To remove Cambarus zophonastes from the list of threatened and endangered species.

The first step would be to recover the species to the point it can be reclassified from endangered to threatened. This would be possible if 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 (Figure 2).

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.

Ideally, the final step would be to recover C. zophonastes to the point it can be removed from the Act's protection, although the existing data suggest that accomplishing this is unlikely. The currently known population in Hell Creek Cave is also the historically known population level. The Hell Creek Cave population is extremely low and individuals are not likely to ever be available for relocation or captive propagation studies. However, should other viable populations be discovered, the species could be considered for delisting 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.

B. Step-down Outline

1. Protect Hell Creek Cave and its recharge area.

   1.1 Develop a cooperative agreement with the Arkansas Natural Heritage Commission and the Arkansas Game and Fish Commission to protect the entrance of Hell Creek Cave and exclude unauthorized cavers.

Figure 2. Hazard map for recharge area. Present and future threats could be minimized by land use regulations, conservation agreements, or acquiring fee title on the private lands within the Extremely High Hazard area.

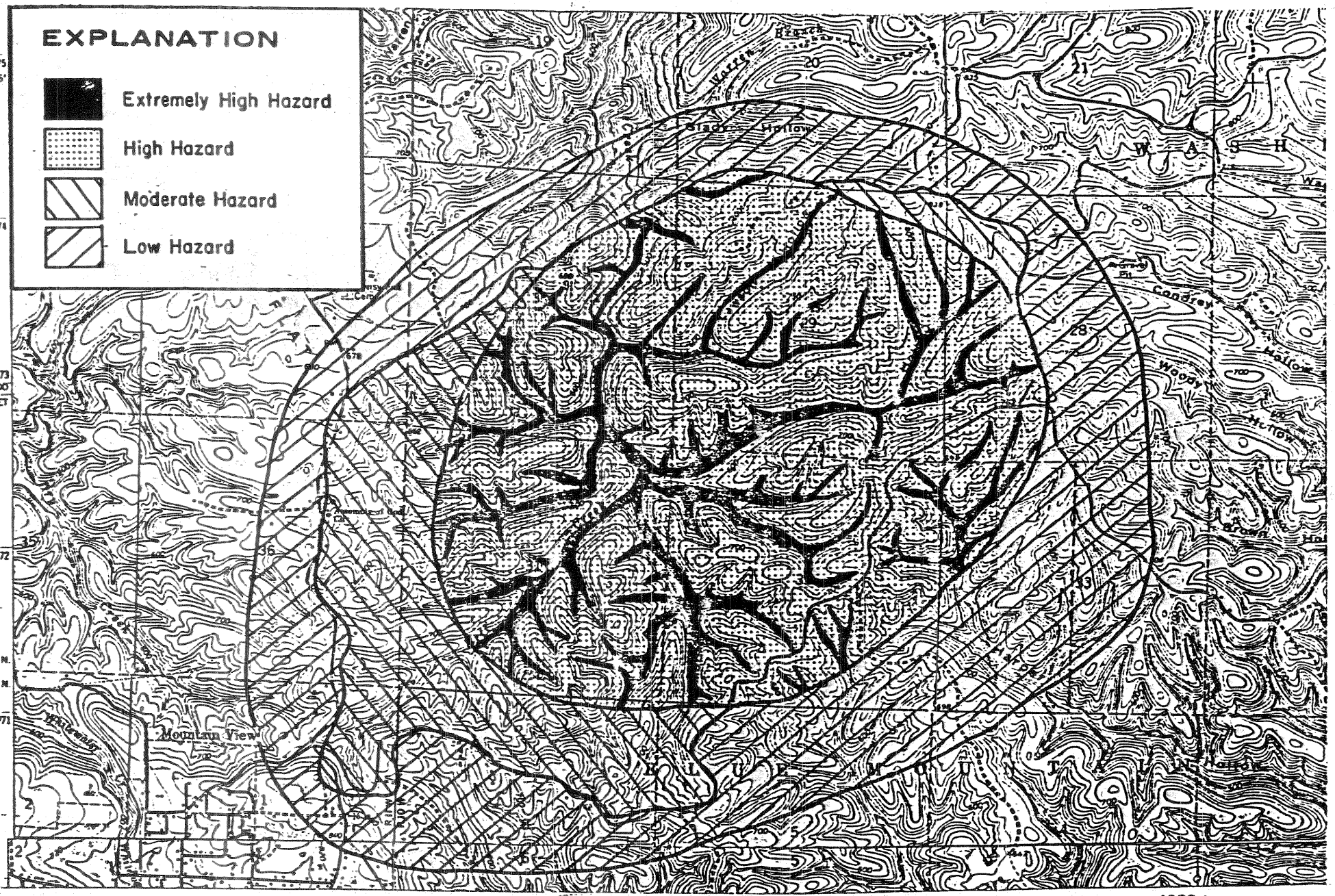

Figure 2 Hazard area map for the Hell Creek Cave recharge area.

1.2 Identify properties which provide recharge to the cave.

1.3 Protect properties identified in 1.2 through management agreements, conservation agreements, donation, acquisition, or other means as appropriate.

1.4 Closely review for impacts to C. zophonastes all activities requiring State or Federal approval.

1.5 Inform local interests of the importance of C. zophonastes and the fragility of the cave.

1.6 Recruit local contact to report events that have potential impacts to Hell Creek Cave.

2. Survey additional caves for C. zophonastes.

2.1 Identify and survey caves in north Arkansas that have not been surveyed for crayfish.

2.2 Identify and re-survey those caves that provide good aquatic habitat and have not had crayfish previously identified.

3. Conduct a population study of C. zophonastes.

3.1 Utilizing scuba divers, search Hell Creek Cave for C. zophonastes three times over a 5-year period.

3.2 Survey any new populations of C. zophonastes to develop baseline population data.

3.3 Following completion of baseline data, resurvey protected caves at 4-year intervals, utilizing scuba gear, to monitor population levels.

4. Gather baseline data on water quality.

4.1 Conduct water sampling of certain physical, chemical, and bacteriological parameters for 1 year.

4.2 Conduct water sampling of parameters in 4.1 at prescribed intervals.

C. Recovery Outline Narrative

1. Protect Hell Creek Cave and its recharge area.

The recharge area for the ground water system in Hell Creek Cave has been delineated to include approximately 3.5 square miles. Protection of the recharge area is critical to protecting the cave system.

1.1 Develop a cooperative agreement with the Arkansas Natural Heritage Commission and the Arkansas Game and Fish Commission to protect the entrance of Hell Creek Cave and exclude unauthorized cavers. The ANHC owns a 160-acre tract that includes the entrance to Hell Creek Cave. The AGFC has personnel and financial resources that could assist in implementing this recovery plan. An agreement should be developed and implemented to install admonitory signs warning cavers of the damage which recreational caving may cause to this fragile cave system and its biota. A barrier to exclude unauthorized cavers should also be erected and trespassers should be prosecuted.

1.2 Identify properties which provide recharge to the cave. Within the 3.5 square mile recharge area there are numerous sinkholes where surface water directly enters the ground water. Much of Hell Creek upstream of the cave is a losing stream that contributes significant amounts of water to the subsurface system. Aley and Aley (1985) identified the area where large volumes of water and organic material enter the Hell Creek Cave ground water system as an Extremely High Hazard Area (0.74 square miles). Other lands which are known or presumed to lie within the ground water recharge area were identified by Aley and Aley (1985) as High Hazard Areas (2.77 square miles). Meeting criterion 1 of the recovery objective will require an examination of land ownership plats to identify individual owners in these two areas.

1.3 Protect properties identified in 1.2 through management agreements, conservation agreements, donation, acquisition, or other means as appropriate. Protect properties identified in 1.2 through management agreements, conservation agreements, donation, acquisition, or other means as appropriate. Evaluate the degree of hazard by the existence of sinkholes and losing streams on the identified lands. Work with landowners to inform them of the importance of protecting these areas. Where possible, seek donation or obtain management or conservation agreements to protect the recharge area. If necessary, critical areas should be acquired through a joint effort involving Federal/State/private funds.

1.4 Closely review for impacts to C. zophonastes all activities requiring State or Federal approval. Future residential and light commercial land development is a major threat to water quality in Hell Creek Cave. Regulating agencies must review these development plans to ensure adequate sewage treatment facilities are included. Developments, such as those producing animal waste and land fills, should not be permitted within the Hell Creek Cave recharge area.

1.5 Inform local interests of the importance of C. zophonastes and the fragility of the cave. Lack of knowledge may be the greatest barrier to protection of unique ecosystems. Develop a program to explain the importance of ground water systems, the fragility of cave environments and the significance of protecting Hell Creek Cave and its biota. Present this program to scientific, educational, and civic groups in north Arkansas and solicit their assistance in protecting cave systems.

1.6 Recruit local contact to report events that have potential impacts to Hell Creek Cave. Sudden events, such as highway accidents, that would degrade water quality in Hell Creek Cave must be immediately reported to the appropriate agency(s) for protective response. This task includes the development of an agreement with a local individual or organization that will immediately report potentially catastrophic events to the appropriate agency(s).

2. Survey additional caves for C. zophonastes.

The possibility this species exists in other caves is supported by the distribution patterns of most aquatic cave species. However, the topography and geology of the area may limit this crayfish to one cave system, and the presence of other species of crayfish may have limited dispersal of C. zophonastes by competition for food and space. Surveys, outside Hell Creek Basin, should be conducted for other populations of C. zophonastes. Only an experienced and permitted biospeleologist should take any unidentified individuals for species confirmation.

2.1 Identify and survey caves in north Arkansas that have not been surveyed for crayfish. Contact local cavers and encourage them to search for C. zophonastes in caves in areas outside the Hell Creek Basin. Caution them to not collect cave biota but to report the occurrence to the appropriate agency(s). Identify caves with aquatic habitat and conduct surveys for cave crayfish. Where cave crayfish are observed, have an experienced biospeleologist take no more than two voucher specimens for identification by recognized crayfish taxonomists.

2.2 Identify and re-survey those caves that provide good aquatic habitat and have not had crayfish previously identified. Aquatic cave species are easily overlooked by cavers or may not be in the observable habitat when the cave is being surveyed. Identify those caves in north-central Arkansas that provide good aquatic habitat and do not contain identified species of crayfish. Conduct at least two surveys of these caves by experienced biospeleologists for the presence of cave crayfish. Where crayfish are observed, take voucher specimens as in 2.1.

3. Conduct a population study of C. zophonastes.

A baseline population estimate and subsequent trends are necessary in planning protective and management actions. With one exception, surveys of Hell Creek Cave have been random, opportunistic cave trips that did not use scuba gear. Only 15 individuals were observed on the single trip where scuba gear was used and this survey was less than one hour.

3.1 Utilizing scuba divers, search Hell Creek Cave for C. zophonastes three times over a 5-year period. The species has only been observed in the deep pool in Hell Creek Cave. Since this pool is up to 20 feet deep with overhanging ledges, the use of scuba gear is mandatory in deriving population estimates. The survey should be for a specified period and at selected observation stations so subsequent surveys will be comparable.

3.2 Survey any new populations of C. zophonastes to develop baseline population data. Any new populations of C. zophonastes should be surveyed as in 3.1 at 2-year intervals until a population baseline is established that will allow the determination of population trends.

3.3 Following acquisition of baseline data, resurvey protected caves at four year intervals, utilizing scuba gear, to monitor population levels. Following acquisition of baseline data, resurvey protected caves at 4-year intervals, utilizing scuba gear, to monitor population levels. Using baseline data gathered in 3.1 and 3.2, resurvey C. zophonastes populations every four years to evaluate impacts and protective measures, and to develop management activities for the recovery of the species.

4. Gather baseline data on water quality.

Degradation of water quality in Hell Creek Cave (or in any new populations that may be discovered) poses the greatest threat to the crayfish's continued existence. To determine the appropriate protective measures, we must have baseline data for comparative purposes.

4.1 Conduct water sampling of certain physical, chemical, and bacteriological parameters for 1 year. Sampling monthly for a one year period is necessary to record seasonal fluctuations and to provide a baseline for future samples. Sample analysis will include pH, water and air temperature, turbidity, dissolved oxygen, carbon dioxide, nitrates, specific conductivity, total dissolved and suspended solids, and total and fecal coliform bacteria. Metals and pesticides will be sampled annually.

4.2 Conduct water sampling of parameters in 4.1 at prescribed intervals. Conduct water sampling of parameters in 4.1 at prescribed intervals. Monitor water and air temperatures, turbidity, dissolved oxygen and pH at quarterly intervals after the first year. Monitor metals and pesticides annually. Monitor all other parameters semiannually. After 4 years, evaluate the trends and develop future monitoring needs. Any significant deviation from monthly baseline data will require a return to the monitoring schedule in 4.1.

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PART III

KEY TO IMPLEMENTATION SCHEDULE COLUMNS 1 & 4

General Category (Column 1):

Information Gathering - I or R (research)

1. Population status
2. Habitat status
3. Habitat requirements
4. Management techniques
5. Taxonomic studies
6. Demographic studies
7. Propagation
8. Migration
9. Predation
10. Competition
11. Disease
12. Environmental contaminant
13. Reintroduction
14. Other information

Acquisition - A

1. Lease
2. Easement
3. Management agreement
4. Exchange
5. Withdrawal
6. Fee title
7. Other

Other - O

1. Information and education
2. Law enforcement
3. Regulations
4. Administration

Management - M

1. Propagation
2. Reintroduction
3. Habitat maintenance and manipulation
4. Predator and competitor control
5. Depredation control
6. Disease control
7. Other management

Priority (Column 4):

1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

3 - All other actions necessary to provide full recovery of the species.

Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency			Estimated Fiscal Year Costs			Comments/Notes
					FWS						
					Region	Division	Other	FY 1	FY 2	FY 3	
A3	Develop cooperative agreement to protect Hell Creek Cave	1.1	2	Continuous	4	FWE	ANHC AGFC	$ 500			
I2	Identify properties which provide recharge to Hell Creek Cave	1.2	1	2 yrs.	4	FWE	ANHC AGFC	$2,000	$2,000		
O1, A2, 3 6	Protect properties identified in 1.2	1.3	1	Continuous	4	FWE LE	ANHC AGFC	$5,000	$5,000	$5,000	Does not include funds for acquisition.
O3	Review for impacts to C. zophonastes all activities requiring State or Federal approval	1.4	1	Continuous	4	FWE	ANHC AGFC COE USDA FHA EPA AHTD	$2,500	$2,500	$2,500	
O1	Inform local interests of Hell Creek and recruit local contact to report impacts	1.5 1.6	2	Continuous	4	FWE	ANHC AGFC	$5,000	$2,500	$2,500	
I1	Survey additional caves for C. zophonastes	2	3	3 yrs.	4	FWE	ANHC AGFC	$3,000	$1,500	$1,500	
I1	Search Hell Creek Cave for C. zophonastes	3.1	2	Continuous	4	FWE	ANHC AGFC	$1,500		$1,500	
I1	Survey any new populations of C. zophonastes	3.2	3	Continuous	4	FWE	ANHC AGFC	$1,500	$1,500	$1,500	
I1	Monitor protected caves at four year intervals	3.3	3	Continuous	4	FWE	ANHC AGFC				

Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency			Estimated Fiscal Year Costs			Comments/Notes
					FWS						
					Region	Division	Other	FY 1	FY 2	FY 3	
I2, 12	Gather baseline data on water quality	4	1	Continu-ous	4	FWE	ANHC AGFC	$15,000	$12,000	$12,000	

FWE = Fish and Wildlife Enhancement
LE = Law Enforcement
ANHC = Arkansas Natural Heritage Commission
AGFC = Arkansas Game and Fish Commission
COE = U.S. Army Corps of Engineers
USDA = U.S. Department of Agriculture
FHA = Farmers Home Administration
EPA = Environmental Protection Agency
AHTD = Arkansas Highway and Transportation Department

APPENDIX

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