Alabama Cavefish (*Speoplatyrhinus poulsoni*)

5-Year Review:
Summary and Evaluation

Photo 1
Alabama Cavefish, photo by Dante Fenolio, San Antonio Zoo

Photo 2
Key Cave Entrance, Drennen, USFWS

U.S. Fish and Wildlife Service
Southeast Region
Mississippi Ecological Services Field Office
Jackson, Mississippi

5-YEAR REVIEW

Alabama Cavefish (*Speoplatyrhinus poulsoni*)

I. GENERAL INFORMATION

A. Methodology used to complete the review: In conducting this 5-year review, we relied on available information pertaining to historic and current distributions, life histories, and habitats of this species. We announced initiation of this review and requested information in a published *Federal Register* notice (75 FR 18233). We reviewed information in our files and solicited information from all knowledgeable individuals including those associated with academia and state conservation programs. Our sources included the final rule listing this species under the Endangered Species Act; the Recovery Plan; peer reviewed scientific publications; unpublished field observations by the Service, U.S. Geological Survey, State and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists or experts. The completed draft was sent to four peer reviewers for their review. Comments were reviewed and incorporated into this final document as appropriate (see Appendix A).

B. Reviewers

Lead Region – Southeast Region: Kelly Bibb, 404-679-7132

Lead Field Office –Mississippi Ecological Services: Daniel J. Drennen, 601-321-1127

Cooperating Field Offices –Alabama, Ecological Services: Evan Collins, 251-441-5837.

C. Background

1. **Federal Register Notice citation announcing initiation of this review:** April, 9, 2010 (75 FR 18233)

2. **Species status:** Presumed stable. The Alabama cavefish is known only from Key Cave in Lauderdale County, Alabama, which is within the Tennessee River Drainage. The last surveys for this species were conducted between 2008 and 2009. This fish is extremely rare, with an estimated population size of fewer than 100 individuals at last count.

3. **Recovery achieved:** 1 (1= 0-25% species recovery objectives achieved). Though progress has been made toward the protection of the single population on the Key Cave National Wildlife Refuge (NWR), there is still much to be accomplished to achieve significant quantitative progress toward the recovery criteria, most notably long-term monitoring and locating additional populations.

4. **Listing history**

   Original Listing
   FR notice: 42 FR 45526
   Date listed: September 9, 1977
   Entity listed: Species
   Classification: Threatened

   Reclassification
   FR notice: 53 FR 37968
   Date listed: September 28, 1988
   Entity listed: Species
   Classification: Endangered

5. **Review History:**

   Final Recovery Plan: 1990

   Each year the Service reviews and updates listed species information to benefit the required Recovery Report to Congress. Through 2013, we did a recovery data call that included showing status recommendations like "stable" for this fish. We continue to show status recommendations in 5-year reviews. The most recent evaluation for this fish was completed in 2016.

   Five-year Review: July 7, 1987 (52 FR 25522); November 6, 1991 (56 FR 56882). In these reviews, multiple species were simultaneously evaluated with no species-specific, in-depth assessment of the five factors or threats as they pertained to each species' recovery. No changes were proposed for the status of the Alabama cavefish either time.

6. **Species' Recovery Priority Number at start of review (48 FR 43098):** 1

   Degree of Threat: High
   Recovery Potential: High
   Taxonomy: Species

7. **Recovery Plan:**

Name of Plan: Alabama Cavefish (*Speoplatyrhinus poulsoni*)
Recovery Plan
Date issued: October 25, 1990

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy

1. **Is the species under review listed as a DPS?** No

2. **Is there relevant new information that would lead you to consider listing this species as a DPS in accordance with the 1996 policy?** No

B. Recovery Criteria

1. **Does the species have a final, approved recovery plan containing objective, measurable criteria?** Yes.

2. **Adequacy of recovery criteria.**

   a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? Not entirely, more up-to-date information is needed to determine population viability. Obtaining an adequate survey or sampling measure to assess the population status and dynamics is difficult because of species' rarity and locality in remote areas of the cave.

   b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? The 5 listing factors are relevant but need expanding due to new information since the last revision of the recovery plan in 1990.

3. **List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.**

   The Alabama cavefish will be considered for down listing to threatened when:

   Criteria (1): three other viable populations are found in discontinuous aquatic systems outside the Key Cave area.

   Status: Criteria not met.

To date, only one population of the species is known. Attempts to find additional Alabama cavefish populations within caves similar to Key Cave and within the same general area have been unsuccessful.

Criteria: (2) The recharge areas for all four populations are protected.

Status: Criteria partially met. There is only one known population. The portion of the recharge area on the Key Cave NWR that is protected accounts for the cave entrance and the cave under 429 ha (1060 ac) or about 10 percent of the total known recharge area for this population.

Criteria: (3) All four populations are demonstrated to be stable or increasing over at least a 20-year period.

Status: Criteria not met. There is only one known population and its status is presumed stable but there has not been consistent monitoring. This population in Key Cave has not been surveyed since 2009 due to the concern of possibly spreading white-nose syndrome (WNS), a fungal disease causing population-level impacts to bats.

C. Updated Information and Current Species Status

1. Range and Status

The Alabama cavefish is known only from Key Cave (formerly known as Coffee Cave) (Aley 1990)) in Key Cave NWR, a satellite unit of the Wheeler NWR complex situated on Tennessee Valley Authority (TVA) land in Lauderdale County, northwest Alabama. This species is considered extremely rare with a total population estimate of less than 100 individuals (Kuhajda 2004a). Surveys of caves for additional populations of the species were last conducted between 1992 and 1997 by Kuhajda and Mayden (2001) and were unsuccessful. It is unknown whether this species has ever had a wider range as troglobytic (cave) fish generally occur at restricted localities with small population sizes (Romero *et al.* 2010). However, this species' single occurrence is Key Cave represents one of the most restricted range when compared to other Amblyopsids (fish commonly referred to as cavefish) and may represent a relict population of a once more widely distributed species (Niemiller and Poulson 2010).

Kuhajda and Mayden (2001) considered the Alabama cavefish population within Key Cave to be relatively stable between 1967 through 1997. The most recent survey of Key Cave was in 2009 where Kuhajda and Fluker noted a total of 19 specimens in five visits from October 2008 through February 2009. During these surveys, Kuhajda and Fluker (2010) considered the population stable based on the representation of different size/age classes. They found the species in the following pools (See Appendix 1, Map 1): Pool A- 4 individuals; Pool B-12 individuals; and, Pool D-3 individuals. None were found in Pools C, E-J and Lynnys Pool. Water depth and clarity within the cave influences sampling results. For example, during relatively low and clear water conditions on three separate surveys in October and November 2008 and in February 2009, four to six Alabama cavefish were observed compared to no Alabama cavefish observed in January 2009 when water conditions were high and turbid. A summary of the number of Alabama cavefish collected and number of trips into Key Cave from 1967-1997 shows highest numbers of specimens collected from 1985-1986 and 1995-1996 (Appendices Table 1). The smaller numbers in the more recent collection attempts may be a reflection of the inaccessibility to some of the pools and variability in sampling efforts, water levels, and other factors.

2. Habitat and Biology

Habitat

Key Cave is in the recharge area of the Mississippian-aged Tuscumbia Limestone aquifer that approximately lies along the ancient Cretaceous shoreline of the Mississippi Embayment (Cooper and Kuehne 1974). The cave has a mapped groundwater recharge area of approximately 26 square km (16 square mi). Groundwater flowing through the cave is likely discharged into the Tennessee River via Collier Spring, which is submerged under Pickwick Reservoir, and Woodland Spring. There is only one above-ground stream in the recharge area (Kuhajda 2004b, U.S. Fish and Wildlife Service 2007). Therefore, most of the surface water enters the Key Cave karst system through sinkholes or seeps (U.S. Fish and Wildlife Service 2007). Aley (1987) estimated the mean annual discharge from the Key Cave aquifer as 0.42 to 0.57 cubic meters per second (15 to 20 cubic feet per second). In general, water levels tend to vary within the cave (U.S. Fish and Wildlife Service 1990) and may correspond to above-ground conditions, along with water elevations in Pickwick Lake (Aley 1990), suggesting that droughts may negatively impact the Key Cave aquifer.

Key Cave is a multi-level (different levels of passages that can be both horizontal and vertical; Ford and Williams 2007) complex cave. Aley (1990) estimated that Key Cave has about 3,774 m (12,381 ft) of linear solution passageways, much of which are inundated throughout the year. The pools inhabited by the Alabama cavefish lie in a zone of seasonal oscillation of the water table where pools that form during high water become isolated during drier conditions (Trajano 2001). Most pools and all cavefish observations to date have occurred within the eastern half of the cave, although more habitat potentially exists in areas that are difficult to access and survey. Surveyed pools within Key Cave are designated with a letter name A-J, with the exception of one pool called Lynnys Pool (Kuhajda and Fluker 2010). Pools A-D, F, G and I are likely connected, with Alabama cavefish observations restricted to Pools A-D and F. Pools A and B have been sporadically sampled for the species over the last 49 years. Pool A is located at the bottom of a long steep slope of bat guano near the cave entrance. The main channel to Pool A is about 1.5 m by 12 m (4.9 ft. to 39 ft.) with pool water depth to 5 m (16.4 ft.). There is a slight current in Pool A. Pool B is 15 m (49.2 ft.) long, 1m to 5 m (3 ft. to16.4 ft.) wide, and up to 3 m (9.8 ft.) deep and is at the bottom of a long, tube-shaped passage. Pool C is less frequently sampled and is a long and complex narrow watered passage with an unknown depth. Access further into Key Cave is limited due to fluctuating water conditions and an impassable connection between Pools C and D at times. Pool D averages 1.5 m (4.9 ft.) deep; Pool E is a 5 m (16.4 ft.) deep waterless hole in the passage floor; and Pool F measures 3 m x 5 m (9.8 ft. x 16.4 ft.), and is 0.5 m to 1 m (1.6 ft. to 3.2 ft.) deep. Pools G and I are small and have water that may be connected to other pools within Key Cave, however no cavefish have been observed in these. Pool H, Lynnys Pool, and the disjunct Pool J on the western edge of Key Cave are isolated drip pools with no apparent subterranean water connections with the other pools. In these pools, the water is consistently clear and appearing to be devoid of any visible aquatic life (Kuhajda and Mayden 2001, Kuhajda and Fluker 2010).

Biology

Very little is actually known about the biology of this species. Opportunities for surveying and sampling are limited due to the difficulty of working in these habitats and fragility of the species (Boschung and Mayden 2004).

The species' large head and branchial cavity suggests oral incubation (a type of parental care of the eggs or offspring).

Reproduction potential is low, as typical of other cave dwelling species (Boschung and Mayden 2004). Cavefish are believed to rely on increased flow and small temperature changes associated with cave flood events during winter and spring to coordinate reproduction and spawning (Poulson 1963; Poulson and White1969). Because most populations of cavefish are reportedly small (*S. poulsoni* in particular), the importance of successful timing of sexual maturation and spawning is magnified (Kuhajda 2004a). It is known that the Alabama cavefish does not reproduce every year and has low fecundity. Due to a longer life, and fewer spawning events, decreased recruitment within a population will not be immediately realized (Kuhajda 2004b). Cavefish in general and the Alabama cavefish specifically show an increase in longevity and a decrease in population growth rate as habitat availability is reduced (Poulson 1961, Hobbs 1992, Poulson 2001, Kuhajda 2004b).

The primary consumers in the Key Cave aquatic community are the Alabama cavefish; southern cavefish (*Typhlichthys subterraneus*); two species of crayfish, the Alabama cave crayfish (*Cambarus jonesi*) and the phantom cave crayfish (*Procambarus pecki*); and, an undescribed cave shrimp (*Palaemonias* sp. cf. *alabamae)* (Kuhajda and Fluker 2010). The food of the Alabama cavefish has not been determined but undoubltedly includes copepods, isopods, amphipods, small crayfish, and shrimp. Flooding in caves brings changes in water level temperature, food availability, turbidity, and water chemistry (U.S. Fish and Wildlife Service 1990).

Since little is known about this species, we must infer aspects of its biology from knowledge of other related species. Cavefish adults quickly respond and move toward a water surface that is disturbed by falling water droplets or bat guano, but they also scavenge for food, perhaps relying on chemosensory organs, originally adapted for bottom feeding, that allow the fish to perceive chemicals in the water that are related to food sources. In contrast, relatively small, younger fish scavenge for food exclusively at the bottom, again possibly using chemosensation (Yoshizawa 2015).

Bats in general and the gray bat (*Myotis grisescens*) in particular, are important in the conservation and management of the Alabama cavefish (Tuttle 1979). In Key Cave, the gray bat colony is likely the primary source of organic matter through the deposition of guano (U.S. Fish and Wildlife Service 1990). Additional nutrient sources for cavefish, other than the guano dropped by bats living at the cave ceiling, is the organic matter brought into the cave system through sink holes, sinking streams, and cave entrances by seasonal flooding (Yoshizawa 2015). In another cavefish, the optimum Ozark cavefish (*Amblyopsis rosae*) habitat also occurs in caves with large colonies of gray bats (Brown and Todd 1987) or comparatively large sources of allochthonous (outside surface runoff) matter (U.S. Fish and Wildlife Service 1989). Diminished organic matter input adversely impacts the aquatic food base in caves. This disruption of food resources triggers hormonal and other changes in aquatic organisms (Poulson 1961).

3. Five-Factor Analysis

a. The present or threatened destruction, modification, or curtailment of its habitat or range:

The Key Cave aquifer and recharge area are threatened by urban and industrial growth which can lead to lowering of the water table, diminished winter flows (cues to synchronize spawning), and acute and chronic water pollution (Kuhajda 2004b, 2009). Reduced input of surface runoff in recharge zones could have dramatic impacts on reproduction of Amblyopsid cavefishes by disrupting the environmental cues necessary for successful reproduction which in turn could lead to greater susceptible to extirpation (Poulson 1963, 1969; Kuhajda 2004a).

In Key Cave, the gray bat colony is likely the primary source of organic matter through the deposition of guano (U.S. Fish and Wildlife Service 1990). Because gray bats provide a major source of nutrients to the cave ecosystem, we can infer that a positive relationship exists between the gray bat and Alabama cavefish populations, therefore conservation of the cavefish may depend on conservation actions undertaken for the bat (Tuttle 1979). Survey reports of caves in the area showed large populations of gray bats in the late 1990s (Hudson 1997). However, during the last 15 years the reduction of bat populations and guano deposits in Key Cave (Gates 2015, 2014, pers. comm.) may have reduced the nutrient cycling in cave waters (Kuhajda 2004b), as it has at: Mammoth Cave in Kentucky (Barr 1967, Olson 2004); Cave Springs Cave (1979 to 2013), Fern Cave (1993 to 2013), Sauta Cave (1976 to 2013), and Collier cave (2010 to 2015) (Gates 2015, 2014, pers. comm.). White-nose syndrome is causing increased bat mortality and population losses due to impacts on the species during hibernation and emergence (Reeder *et al.* 2012, Verant *et al.* 2014). Thus, the amount of nutrients in the form of bat guano may be decreasing and the overall carbon exchange in the groundwater declining.

Samples of gray bats from Cave Springs Cave on Wheeler NWR proper, 88 km (55 mi) east of Key Cave have shown that bats are a sensitive indicator of both the level and geographic extent of Tennessee River contamination from the former DDT plant near Huntsville, Alabama (Clark *et al.* 1988). Pesticide residue in guano of gray bats has been well documented in caves throughout the Southeast (Clark *et al.* 1983a, 1983b, 1980) and has been attributed to bats feeding on arthropods exposed to pesticides following agricultural application (Clark *et al.* 1978; Clawson 1991, Clawson and Clark 1989). Direct leaching of pesticides from guano into the cave water may threaten the physiology and behavior of the Alabama cavefish (Kuhajda 2016, pers. comm.), and it may reduce food resources such as arthropods.

Contaminants of emerging concern (CECs) such as polybrominated diphenyl ethers, pharmaceuticals and personal care products detected in bats have the potential to affect hibernation, immune function, and response to WNS (Janicki *et al.* 2015, Secord *et al.* 2015). Thus, activities related to chemical contamination of bats that occur outside of the recharge area of the cave, or even the aquifer, have the potential to negatively affect the cave environment and the Alabama cavefish.

Comparable to surface water fish species, declining groundwater quality as a result of surface activities threatens cavefish species. Non-point source pollution, in particular, from land surface runoff, originating from agricultural or forestry activities, along with stormwater runoff carrying sediments, fertilizers, herbicides, pesticides, animal wastes, petroleum products and other pollutants, may enter Key Cave from various sink holes or fissures common to karst geology and topography (Culver and Pipan 2009). These pollutant sources may increase concentrations to toxic levels in the water and alter the chemistry of subsurface waters, negatively impacting the species and its prey source (Culver and Pipan 2009, Kuhajda 2004b). Fawcett (1989) (in Aley 1990) emphasized the role of point-source pesticide contamination of groundwater due to spilling and or dumping pesticides, washing pesticide containers near wells, and siphoning accidents that introduce pesticides into wells. Karst systems are very vulnerable to pollution (Muller 1981). Once pollutants have reached aquifers, degradation times are long making groundwater environments vulnerable and difficult to rehabilitate (Travis and Doty 1990).

Earth-moving or soil disturbing activities, such as cultivation in farming or road maintenance may increase sediment loads into the groundwater by entering via storm water through karst fissures or sink holes. Sediment has been shown to disrupt aquatic invertebrate communities, and negatively impact fish growth, physiology, behavior, reproduction and survivability (Knight and Welch 2001, Waters 1995).

The NWR consists of rolling hills and crop land, including a 15-ha (38 ac) sinkhole pond. The sinkhole and associated waterways are buffered by at least 10 m (32 ft) of standing vegetation and are protected by at least a 30 m (100 ft) buffer from pesticide spraying. Past farming practices have led to severe soil erosion problems; however, current management efforts by the NWR include erosion control to enhance the water quality for the endangered species inhabiting Key Cave. Aley (1987) mapped and characterized the sinkholes and sinking streams of the Key Cave aquifer and noted that many of the sinkholes are broad and shallow, thus conducive to row crop farming and they also may demonstrate a ponding effect after runoff from significant rain events. The gradual shape of these sinkholes may allow pesticides to enter the aquifer at a greater rate in contrast to pesticides entering the groundwater through non-sinkhole areas. Aley (1987) states that sinkholes pose significant high hazards (entry) for pesticides to enter groundwater. Aley (1987) also designated as *High Hazard* areas (where there is a high probability of pesticides entering the aquifer) within 3084 m (10000 ft) of Key Cave and all sinkholes within the Key Cave Aquifer recharge area. Because monitoring or testing of groundwater has not occurred, specific information regarding the effects of this change are unknown (Hurt 2016, pers. comm.).

Prior to 2013, the Cooperative Farming Program at Key Cave NWR allowed planting of Genetically Modified Organism (GMO) crops in 12 managed and rotated agricultural fields. The change of pesticide type and application rate when converting from GMO to non-GMO agriculture has been shown to increase pesticide accumulation in bat guano (Clark *et al.* 1988, 1983a, 1983b, 1980; Clawson 1991, Clawson and Clark 1989), possibly increase pesticide runoff into the aquifer, and correspondingly increase pesticide concentrations in groundwater, fish, and fish prey sources (Hurt 2015, pers. comm.). Currently, approximately 119 ha (295 ac) of Key Cave NWR are seasonally_ managed for row crop production and 127 ha (315 ac) are managed and rotated as early successional fields or for native warm season grasses (big bluestem (*Andropogon geradii)*, little bluestem (*Schizachyrium* *scoparium*), indiangrass (*Sorghastrum nutans*), sideoats gramma (*Bouteloua curtipendula)*, switchgrass (*Panicum virgatum*), and eastern gamagrass (*Tripscum dactyloides*) (U.S. Fish and Wildlife Service 2007).

Due to increasing urban development in the Florence area within the recharge area for Key Cave, the species is likely to be subjected to developmental impacts in the future (Kuhajda 2004b). Planned industrial development of the Key Cave recharge area could alter drainage and hydrological patterns within the recharge area for Key Cave (U.S. Fish and Wildlife Service1990) through increases in groundwater pumping, stormwater runoff, urbanization and ancillary construction projects such as houses, small businesses, roads, utilities and easements (KPS Group 2007).

b. Overutilization for commercial, recreational, scientific, or educational purposes:

There was concern, at the time of listing, that collecting would increase the adverse impacts on the species; however this concern has not materialized as a threat. Scientific collecting, which has not involved lethal take, is controlled by the State of Alabama, through the issuance of collection permits.

c. **Disease or predation:**

Predation undoubtedly occurs within the pools and channels of the subterranean aquatic habitat of the Alabama cavefish possibly by the two cave crayfish species and the southern cavefish. However there is no evidence to suggest that natural predators, such as these, nor disease, pose a threat to the species.

d. Inadequacy of existing regulatory mechanisms:

The Alabama cavefish and immediate recharge area are protected within the Key Cave NWR including approximately 242 ha (598 ac) of farm land and old fields. The NWR System Improvement Act of 1997 requires that every NWR develop a Comprehensive Conservation Plan (CCP) and revise it every 15 years, as needed. The CCPs identify management actions necessary to fulfill the purpose for which a NWR was enacted. In addition, CCPs allow NWR managers to take actions that support State Wildlife Action Plans, improve the condition of habitats and that benefit wildlife including fish species such as the Alabama cavefish. The CCPs focus on individual NWR actions that contribute to larger, landscape-level goals. The CCPs also address conservation of fish, wildlife, and plant resources and their related habitats, while providing opportunities for compatible wildlife-dependent recreation uses.

The Alabama cavefish and its habitats are afforded some protection through Section 7 and 9 of the ESA. In the State of Alabama the species is protected by Code of Alabama §§ 220-2-92 which makes it unlawful to attempt to take or to take, capture, or kill the species. The species is afforded some protection from water quality and habitat degradation under the Clean Water Act of 1972 (33 U.S.C. 1251 et seq.) and the Alabama Water Pollution Control Act, as amended, 1975 (Code of Alabama, §§ 22-22-1 to 22-22-14). However, the recent Clean Water Rule defining the waters of the United States (FR: 80:124. 2015) excludes groundwater. Groundwater allocation in Alabama is considered *reasonable use* where the landowner owns the water. There exists no preference for groundwater allocation in Alabama for different water uses such as domestic, agricultural, industrial, or mining at a rate of 100,000 gallons or more per day (Sanjaya 2005). Because of this, public land owners may extract water on private land from the same aquifer that supplies the habitat for the species in Key Cave. Additionally, the inconsistency in implementation of Clean Water Act regulations and other best management practices, and existing regulatory mechanisms in Alabama, are still inadequate.

e. Other natural or manmade factors affecting its continued existence:

The long-term viability of the Alabama cavefish is based on conservation of numerous local populations throughout its geographic range (Harris 1984). These features are essential for the species to recover and adapt to environmental change (Noss and Cooperrider 1994, Harris 1984). This highly endemic species with an extremely localized range makes Alabama cavefish populations vulnerable to extirpation from catastrophic events, such as toxic spills, or changes in flow regime, and changes in aquifer recharge due to pumping for public water supply or irrigation. Loss of connectivity between pools occupied by Alabama cavefish, due to decreased water recharge or increased water removal, could limit recovery of the species (George *et al.* 2008).

D. Synthesis

The Alabama cavefish is an extremely rare species that continues to be known from only a single cave system in northwest Alabama, despite repeated attempts to locate other populations. Though the Key Cave entrance and 429 ha (1060 ac) of surface property above the cave is partially protected (about 10 % of the total known recharge area) due to its ownership by the U.S. Fish and Wildlife Service, full protection is not afforded to habitat on private lands, including portions of the aquifer and especially the sinkholes throughout the recharge area. This species exists in a fragile ecosystem and continues to face threats from groundwater degradation, lower groundwater levels, in addition to a diminished organic matter input by bats. This species' small population size also contributes to its vulnerability. Though progress has been made towards the conservation of this species' and its habitat, to date none of the recovery criteria have been met. Therefore, the Alabama cavefish continues to meet the definition of an endangered species under the Act.

III. RESULTS

A. Recommended Classification:

No change is needed.

B. New Recovery Priority Number: 4

While the magnitude of threats remains high for this single population of Alabama cavefish, recovery potential is now considered low since surveying for additional populations have been unsuccessful thus far. Additional populations will need to be discovered and fully protected to achieve recovery.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Characterize the hydrological functions and character (such as aquifer size and connectivity to other caves, sinkholes and entry points etc., time frame of water cycling through the system) of the recharge area for Key Cave.

2. Initiate traditional and exploratory survey methods for new populations of the species with environmental DNA survey technique and acoustic survey techniques.

3. Initiate real-time water monitoring for estimation of aquifer size and recharge rates.

4. Identify areas (up-gradient and within cave) for long-term monitoring stations to assess changes in groundwater quality and quantity.

5. Determine biological, hydrological and physical relationships between Key Cave, Collier Bone Cave, Persimmon, Thomason, Bell, Elbow and McKinney Pit caves.

6. Work with neighboring landowners on projects to protect groundwater and initiate water extraction conservation.

7. Determine and implement consistent sampling rates and intervals of all pools for the species. Determine connectivity and water flow through the pools.

8. Periodically analyze bat populations and bat guano for pesticides and other toxic residue.

10. Initiate selected long-term monitoring of the species and its habitat at sites within Key Cave pools.

11. Monitor impacts of NWR cooperative farming by monitoring chemical usages and testing groundwater for those chemicals (may be in conjunction with action 2).

12. Revise recovery plan to reflect new information, revise criteria, and continue implementation of other pertinent recovery actions from the recovery plan.

13. Develop an Alabama Cavefish Recovery Group.

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Rob Hurt, Wheeler NWR. August 2015. Telephone conversation with Daniel Drennen concerning the possibility that increased pesticide usages my also include increased pesticides in bat guano, increased pesticide runoff into the aquifer and correspondingly increased pesticide concentrations in groundwater.

Dr. Bernie Kuhajda, Tennessee Aquarium Conservation Institute. Chattanooga, TN. 2009 and 2015. Telephone conversations and email messages about collection efforts and conservation of the Alabama Cavefish.

Bill Gates, Wheeler NWR. 2014 and 2015. Email messages concerning cave locations and bat ecology, population numbers and white nose syndrome disease in bats within local caves.

APPENDICE 1

Map 1 of Key Cave, Lauderdale County, Alabama, modified from map by Huntsville Grotto (National Speleological Society). Letters represent pools studied (From Kuhajda and Mayden 2001, Figure 2, p.217)

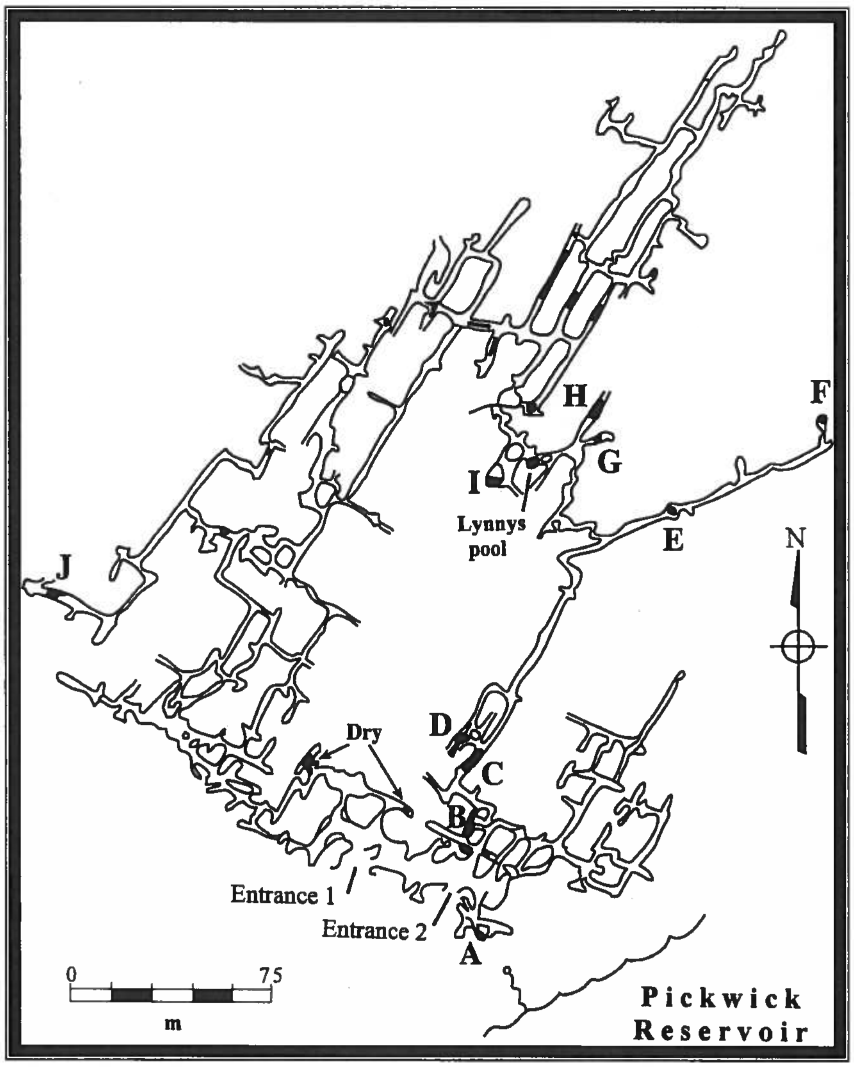

Table 1. Number of trips into Key Cave and number of *Speoplatyrhinus poulsoni* observed during various time periods. Data divided into number of pools visited to standardize comparisons.

Year	Number of trips	Number of trips with fish	Total number of fish	Range	Mean number of fish per trip
1 or 2 pools visited					
1967–1970 (Cooper)[1]	7	5	9	0–3	1.3
1985–1986 (Cobb)[1]	12	12	55	2–9	4.6
1992–1997	6	4	10(16)[2]	0–3(6)[2]	1.7 (2.7)[2]
3 pools visited – high water					
1995	5	4	4	0–1	0.8
At least 4 pools visited					
1983 (Stewart)[1]	1	1	10	—	10.0
1995–1996	5	5	39(42)[2]	5–10(12)[2]	7.8 (8.4)[2]

[1]Authors of data from previous surveys.
[2]Higher number in parentheses may include recount of the same specimens.

(From Kuhajda and Mayden 2001, p.219)

U.S. FISH AND WILDLIFE SERVICE
5-year Review for the Alabama cavefish (*Speoplatyrhinus poulsoni*)

Current Classification: Endangered
Recommendation resulting from the 5-Year Review

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist**
__X__ **No change is needed**

Review Conducted By: Daniel J. Drennen, Mississippi Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve: Cary Norquist Date: 7/11/17

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

for Approve: M P. D Date: 8/21/17

Matthew P. Dekar

APPENDIX A: Summary of peer review for the 5-year review of Alabama cavefish ((Speoplatyrhinus poulsoni)

A. Peer Review Method:

This document was peer-reviewed internally by Cary Norquist, Jackson, Mississippi Field Office and Evan Collins of the Daphne, Alabama Field Office. Additionally we shared the draft 5-year review to five outside reviewers via email. These outside peer reviewers were chosen based on their qualifications and knowledge of the species and its habitat. Individual responses were received from three of the peer reviewers.

Peer Reviewers:

Dr. Marlon R. Cook,
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B. **Peer Review Charge:** See attached guidance.

C. **Summary of Peer Review Comments:**

Dr. Bernie Kuhajda, Tennessee Aquarium Conservation Institute:

Suggestions were made by Dr. Kuhajda concerning sentence structure and arrangement of facts in the narrative. Some corrections to the descriptions of the diffèrent cave pools, collection survey methods and individuals collected were offered and accepted in the narrative. Statements addressing pesticide usages by the Key Cave NWR cooperative farmering practices and the possibility of increased pesticide rates and applications around Key Cave NWR and their possible impact were noted in the narrative. An additional publication was added as reference as was minor edits to the literature cited. A factual statement that the only Alabama cavefish population occurs in Key Cave NWR and that finding other populations in different caves, as the recovery plan dictates, are low. Nutrients and groundwater flow with respect to cave dwelling organisms were updated by a recent publication (Venarsky *et al* 2014). Suggestions that the recovery plan be updated was included in the narrative.

Mr. Roger Holt, Partners for Fish and Wildlife, Wheeler NWR:

Clarification was given for white nosed syndrome in bats and the neighboring caves along with approximate bat population numbers. Also questions were made about the size of the recharge area where 70% of refuge property is within the mapped high risk zone. The refuge makes up only about a 1/3 of total area mapped as high risk. The total recharge area (including high, moderate and low risk zones) is much larger (about 16 sq miles) as citing by Aley (1987).

Mr. Rob Hurt, Private lands Biologist/Assistant Refuge Manager Wheeler NWR

Suggestions were made concerning style and clarity of writing. Clarification was made that Key Cave should be described as Key Cave NWR, a satellite refuge of Wheeler NWR. Key Cave NWR is a USFWS overlay on Tennessee Valley Authoritty (TVA) property, where the USFWS manages the property. TVA owns the cave entrance and the USFWS owns about 1060 surface acres above the cave, way short of the entire recharge area which is not well known. Corrections and clarification was made concerning the cooperative farming program on Key Cave NWR, the historical crop and pesticide record along with the acreages planted.

Mr. Evan Collins, Fish and Wildlife Biologist, Alabama Ecological Services Office, provided clarity to certain key hydrological and biological points, along with sentence structure and presentation.

Dr. Marlon R. Cook, Geological Survey of Alabama, Tuscaloosa, AL. No peer review comments received.

Mr. Steve Rider, Alabama Division Wildlife and Freshwater Fisheries, Montgomery, Alabama No peer review comments received.

D. **Response to Peer Review** – Peer reviewer edits were evaluated and incorporated into the revised document as appropriate. Summary below:

All comments from the peer reviewers were evaluated and incorporated into the documents as appropriate.

Guidance for Peer Reviewers of Five-Year Status Reviews
U.S. Fish and Wildlife Service, Mississippi Field Office

As a peer reviewer, you are asked to adhere to the following guidance to ensure your review complies with U.S. Fish and Wildlife Service (Service) policy.

Peer reviewers should:

1. Review all materials provided by the Service.

2. Identify, review, and provide other relevant data apparently not used by the Service.

3. Not provide recommendations on the Endangered Species Act classification (e.g., endangered, threatened) of the species.

4. Provide written comments on:
   - Validity of any models, data, or analyses used or relied on in the review.
   - Adequacy of the data (e.g., are the data sufficient to support the biological conclusions reached). If data are inadequate, identify additional data or studies that are needed to adequately justify biological conclusions.
   - Oversights, omissions, and inconsistencies.
   - Reasonableness of judgments made from the scientific evidence.
   - Scientific uncertainties by ensuring that they are clearly identified and characterized, and that any potential implications of uncertainties for the technical conclusions drawn are clear.
   - Strengths and limitations of the overall product.

5. Keep in mind the requirement that the Service must use the best available scientific data in determining the species' status. This does not mean the Service must have statistically significant data on population trends or data from all known populations.

All peer reviews and comments will be public documents and portions may be incorporated verbatim into the Service's final decision document with appropriate credit given to the author of the review.

Questions regarding this guidance or the peer review process should be referred to Daniel Drennen, Fish and Wildlife Biologist, Mississippi Ecological Services Field Office, at (601) 321-1127, e-mail: daniel_drennen@fws.gov.