U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Cottus* sp., sp. nov.

COMMON NAME: Grotto Sculpin

LEAD REGION: 3

INFORMATION CURRENT AS OF: May 2011

STATUS/ACTION:
___ Species assessment - determined species did not meet the definition of endangered or threatened under the Act and, therefore, was not elevated to Candidate status
___ New candidate
_X_ Continuing candidate
___ Non-petitioned
_X_ Petitioned - Date petition received: May 11, 2004
_ 90-day positive - FR date:
_ 12-month warranted but precluded - FR date:
_ Did the petition requesting a reclassification of a listed species? No
FOR PETITIONED CANDIDATE SPECIES:
a. Is listing warranted (if yes, see summary of threats below)? Yes

b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? Yes, until recently. However, we are now working on a proposed listing rule that we expect to publish prior to making the next annual resubmitted petition 12-month finding.

c. If the answer to a. and b. is "yes", provide an explanation of why the action is precluded. No longer precluded as we are working on a proposed listing rule.

___ Listing priority change
Former LP: ___
New LP: ___
Date when the species first became a Candidate (as currently defined): June 13, 2002
___ Candidate removal: Former LP: ___
___ A – Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
___U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.

___ F – Range is no longer a U.S. territory.
___ I – Insufficient information exists on biological vulnerability and threats to support listing.
___ M – Taxon mistakenly included in past notice of review.
___ N – Taxon does not meet the Act's definition of "species."
___ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Fish; Family Cottidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Missouri

CURRENT STATES/ COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Perry County, Missouri

LAND OWNERSHIP: The entire known range of grotto sculpin is under private ownership, approximately 64,000 acres.

LEAD REGION CONTACT: Karl Tinsley, 612-713-5330, karl_tinsley@fws.gov

LEAD FIELD OFFICE CONTACT: Columbia, Missouri Ecological Services Field Office, Shauna Marquardt, 573-234-2132, shauna_marquardt@fws.gov.

BIOLOGICAL INFORMATION:

The following information is a summary of observations recorded in Burr et al. (2001), from Ginny Adams, Department of Zoology and Center for Systematic Biology, Southern Illinois University, Carbondale, IL, in litt., February 4, 2002, or Adams, pers. comm.., March 7, 2002.

Species Description
Grotto sculpin is a small (approximately 2.5 inches long) cave-dwelling fish. Typical of other troglomorphic organisms, it is nearly blind and pale-colored.

Taxonomy
The grotto sculpin (*Cottus* sp., sp. nov.) is within the banded sculpin (*Cottus carolinae*) complex that exhibits distinct cave-adapted features. The banded sculpin complex includes both hypogean (below surface) and epigean (surface, primarily non-cave dwelling) forms. Grotto sculpin is most likely the only hypogean form within the banded sculpin complex and can be distinguished from epigean fish within this complex by several cave-adapted features. These features include smaller, nearly non-functional eyes; reduced skin pigmentation; smaller optic nerves; larger anterior portion of the brain; fewer pelvic fin rays; and lower metabolic rates. Poly and Boucher (1996) and Burr et al. (2001) documented the presence of banded sculpin in about 25 caves from several states with known karst environments. Although the occurrence of *C. carolinae* in subterranean waters is well known none of these sculpin show evidence of cave adaption to the extent exhibited by grotto sculpin, and none are known to be permanent cave

residents. Burr et al. (2001) clearly demonstrated that grotto sculpin are morphologically distinct from the epigean forms of banded sculpin. Adams et al. (2003) collected data that support the genetic distinctiveness of grotto sculpin. Additional data are being compiled in a manuscript that will be submitted for publication by the end of summer 2011. This manuscript by Adams et al. will include the official description of grotto sculpin as a unique species based on morphological and genetic data. Differences in eye size, head depth, pigmentation, and pelvic fin ray counts are the primary morphological separations. The combination of morphological and genetic differentiation is sufficient to support distinction of grotto sculpin from other species in the banded sculpin complex (Ginny Adams, pers. comm.).

Habitat/Life History

Grotto sculpin inhabit cave systems, occupying pools and riffles with moderate stream flow and low to moderate stream depth. These fish can be found in the open water or hidden under rocks and occur over a variety of substrates including silt, gravel, cobble, rock rubble that originated from cave breakdown material, or solid bedrock. Rare cave systems formed beneath a sinkhole plain that provides substantial organic input and an abundance of invertebrates may be the only habitats that provide enough food and sustained flow to support sculpin populations (Burr et al. 2001). A recent population ecology study shows that grotto sculpin disappear from resurgence sites after December, which might indicate a subterranean migration for spawning (Day et al. 2008). According to this study, young-of-the-year appear between March to May at resurgence sites and from April to May in caves, whereas adults dominate caves and are found only seasonally at resurgence sites.

Range/Distribution

This species is restricted to two karst (limestone regions characterized by sink holes, abrupt ridges, caves and underground streams) areas, the Central Perryville Karst and Mystery-Rimstone Karst in Perry County, southeast Missouri. Grotto sculpin have been found within three surficial stream systems within Perry County: Blue Springs Branch, Cinque Homes Creek, and Apple Creek (Brad Pobst, pers. comm.). In determining the overall distribution of grotto sculpin, Burr et al. (2001) sampled over 27 cave streams within six karst regions in Perry County and documented the species in only five cave systems (Crevice, Moore, Mystery, Rimstone River, and Running Bull/Maple Leaf Cave). To date, over 153 additional caves in Arkansas, Illinois, Indiana, Missouri, and Tennessee have been searched for grotto sculpin and epigean or hypogean forms of banded sculpin. Of these, *Cottus carolinae* was documented in 25 caves, but only fish in the 5 caves listed above exhibited the cave adaptations reported for grotto sculpin (Burr et al. 2001). The current overall range of grotto sculpin has been estimated to encompass approximately 260 square kilometers (100 square miles).

Population Estimates/Status

The total number of grotto sculpin that currently exist is unknown, but based on estimates obtained from Mystery (60 grotto sculpins) and Running Bull Cave (at least 150 grotto sculpins), the population probably does not exceed a few thousand fish (Burr et al. 2001). Most studies show that troglomorphic species are found in lower abundances than epigean fishes. Based on a tagging study from August 2005 to January 2008 it is estimated that grotto sculpin abundance is

0.075/m^2 within caves (Adams et al. 2008b, p. 5), compared with Ozark cavefish (*Ambloyopsis rosae)* at 0.005-0.15/ m^2, northern cavefish (*Amblyopsis spelaea*) at 0.05/ m^2 and southern cavefish (*Typhlichthys subterraneus)* at 0.03/ m^2. Grotto sculpin densities were much lower in caves (0.075/m^2) compared to the surface streams (0.371/m^2). Sculpin densities in caves were highest during summer (0.11/m^2), followed by fall (0.072/m^2), spring (0.071/m^2) and finally winter (0.04/m^2) (Adams et al. 2008b). On the surface, sculpin densities were highest during summer (0.647/m^2), followed by fall (0.379/m^2), spring (0.308/m^2), and winter (0.159/m^2) (Adams et al. 2008b). This same study also showed that the majority of recaptured sculpins moved 0-50 meters (68 percent), which is typical of many benthic species. However, substantial migrations were seen and may be seasonal in relation to spawning.

THREATS:

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>.

Two caves (Crevice and Moore) containing grotto sculpins are located down-gradient of the city of Perryville, Missouri. Dye trace studies of water movement suggest that urban runoff from Perryville and the surrounding area enters cave streams occupied by grotto sculpin (Burr et al. 2001). Hydrological monitoring by Fox et al. (2010) showed a short lag time between rainfall and the arrival of storm water runoff in cave systems in Perry County. Such a short lag time indicated that little filtration of runoff was occurring prior to entering cave streams. Through a conservation agreement with MDC buffers around caves, streams, and sinkholes and livestock exclusion fencing are being installed to alleviate contamination and sedimentation from these sources.

Industrial-source pollutants, such as phenanthrene and pyrene, were found at moderately high levels within Grotto Sculpin habitat during sampling conducted in 2008 (Fox et al., 2009). Vandike (1985) analyzed the deposition of various agricultural chemicals within the Perryville Karst area and reported detections of ammonia, nitrite/nitrate, chloride, and potassium from cultivation at levels high enough to be detrimental to aquatic life. Fox et al. (2010) sampled the five cave systems that are the only known habitat for grotto sculpin for a variety of contaminants. They detected a mixture of organic pollutants considered to be current-use agricultural pesticides as well as legacy-use chemicals. In all locations they detected acetochlor, diethatyl-ethyl, atrazine, and desethylatrazine (DEA). Presence of current-use pesticides and herbicides in cave streams was attributed to the predominance of agricultural land use on the surrounding landscape. Water quality samples collected monthly by the Missouri Department of Conservation (MDC) between December 2007 – 2009 indicate that nitrate/nitrite, phosphorus, atrazine, and acetochlor have been found at high levels from 11 springs and 8 surface streams. Atrazine is the most frequently detected herbicide in surface and ground water and is known to disrupt normal reproductive function in fishes. Tillett et al. (2010) documented atrazine to reduce egg production and cause gonadal abnormalities in fathead minnows. Water samples collected by the MDC also indicated the presence of E. coli at high levels, which might correspond to high inputs of phosphorus from septic systems (Brad Pobst, pers. comm.).

Of the five cave systems documented to have grotto sculpin, populations in two cave systems have had fish kills in recent times. Historically Running Bull Cave had the highest density of grotto sculpin (Burr et al. 2001). However, a fish kill occurred in 1999 that resulted in a mass mortality of the observable population and subsequent surveys did not find sculpin until 2005. In 2005, Running Bull Cave was sampled on two different occasions and 9 and 35 individuals were found, respectively (Brad Pobst pers. comm.). It is unknown whether these individuals survived the pollution event in 1999, or if they emigrated from another cave system. This massive fish kill was caused from an unknown source. In August 2005, there was a major fish kill that eliminated grotto sculpin from 69 sections (690 meters) of Mystery Cave (Adams et al. 2008b). The population is currently recovering, but is not yet up to previous levels (Brad Pobst, pers. comm.)

B. Overutilization for commercial, recreational, scientific, or educational purposes.

Although some specimens of grotto sculpin have been taken for scientific investigations, such collecting activities do not appear to be at a level that poses a significant threat to this fish.

C. Disease or predation.

Predatory fish occur in all of the caves occupied by the grotto sculpin; these fish are potential predators on the eggs and young of sculpin (Burr et al. 2001). The predatory fish found in grotto sculpin caves include: common carp (*Cyprinus carpio*), fat-head minnow (*Pimephales promelas)*, yellow bullhead (*Ameiurus natalis*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), and channel catfish (*Ictalurus punctatus*) (Burr et al. 2001). These potential predators, normally excluded from cave environments, most likely have escaped surface farm ponds that unexpectedly drain through sinkholes into the underground cave systems and enter grotto sculpin habitat. Burr et al. (2001) indicates that these escaped fishes have increased the potential predation pressure on grotto sculpin.

D. The inadequacy of existing regulatory mechanisms.

Because the grotto sculpin has not been formally recognized as a distinct taxonomic entity, it is currently not protected under the Missouri State Endangered Species Law 252.240, but it still has some protection under other sections of the Missouri Wildlife Code. The MDC has a ranking system for species of concern. The grotto sculpin is ranked as a S2 which indicates that it is imperilled. The MDC maintains two references relating to the status of listed plants and animals in Missouri; the Missouri Species of Conservation Concern Checklist and the Wildlife Code of Missouri. All species in the State of Missouri are protected as biological diversity elements unless a method of legal harvest is described in the Wildlife Code. Grotto sculpin is currently being formally described by Dr. Ginny Adams of the University of Central Arkansas with funding assistance through a conservation agreement. Once the taxonomy has been resolved and a manuscript published in a peer-reviewed journal, the species can be afforded greater protection through regulatory means.

The Missouri Department of Natural Resources has the authority for establishing water quality standards that are protective of aquatic life. According to state statutes, it is illegal to dump waste materials into sinkholes. Clean Water Act regulations would apply if a point source for the pollution could be determined. Discrete pollution events that impact cave systems are problematic even if a point source can be determined because it can be extremely difficult to assess damages to natural resources such as troglobitic biota that live underground. Cave systems are recharged by surface and ground water that typically travels several miles before resurfacing from cave openings and spring heads.

E. Other natural or manmade factors affecting its continued existence.

Karst regions are unique in that sinkholes, a significant component of the habitat, allow chemicals and pollutants to reach groundwater directly, without being filtered. Household trash is found in at least one sinkhole on nearly every historic farm in the sinkhole plain within Perry County (Aley and Moss 2008). However, a typical farm has some tens of sinkholes. This can be a significant amount of sinkholes but it is less than half of the sinkholes in Perry County. These sinkholes contain anthropogenic refuse, ranging from household cleansers and sewage to used pesticide containers. As a result, potential water contamination from various sources of point and non-point source pollution poses a significant threat to the grotto sculpin. Fox et al. (2010) indicate that chemical leaching of sinkholes likely is a major contributor to dieldrin contamination of grotto sculpin caves. Measures are being taken by the MDC to remove trash and debris from sinkholes that influence grottos sculpin caves. Four cleanouts have been completed with additional projects planned for 2011 with funding from a conservation agreement with MDC. Additionally, as the city of Perryville expands closer to grotto sculpin caves potential threats from these sources of pollution become greater.

The small population size and endemism (i.e., restricted to five cave systems in one county) of the grotto sculpin make it vulnerable to extinction due to genetic drift, inbreeding depression, and random or chance changes to the environment (Smith 1974). Inbreeding depression can result in death, decreased fertility, smaller body size, loss of vigor, reduced fitness, and various chromosome abnormalities (Smith 1974). Despite evolutionary adaptations for rarity, habitat loss and degradation increase a species' vulnerability to extinction (Noss and Cooperrider 1994). Numerous authors (e.g., Noss and Cooperrider 1994; Thomas 1994) have indicated that the probability of extinction increases with decreasing habitat availability. Although changes in the environment may cause populations to fluctuate naturally, small and low-density populations are more likely to fluctuate below a minimum viable population, the minimum or threshold number of individuals needed for a population to persist in a viable state for a given interval (Gilpin and Soule 1986; Shaffer 1981; Shaffer and Samson 1985). Current threats to the habitat of the grotto sculpin may exacerbate potential problems associated with its low population numbers and increase the likelihood of extinction.

The impact of climate change on the grotto sculpin is uncertain. This species relies on surficial streams for some of the input of food into the cave system, for some of the recharge of the groundwater in which it mostly resides, and for surficial habitat in which a portion of the

population sometimes resides. Similar to the impact of hotter temperatures and lower rainfall on wetlands in the central states, surficial streams may become drier (National Research Council 2008). It is unknown whether a reduction of stream flow would negatively impact the population of grotto sculpin or positively impact this species through reduction of competitor species or other ecological parameter.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED:

Two conservation agreements currently are in place for grotto sculpin.

Agreement 301815J033 with the Missouri Department of Conservation includes two task orders (30181AT043 and 301819T047).

- Task Order 301819T047 was effective on 07/31/2009 and included $20,000 of FY09 funds. Conservation actions to be implemented included sinkhole cleanout in Perry County karst areas that contribute to streams in grotto sculpin caves; water quality monitoring, contaminant analysis, dye tracing, GIS analysis/mapping, population surveillance, and outreach activities.
    - Progress Report 2011: $10,000 was budgeted in MDCs FY11 and MDC also provided an additional $4,000 making the annual total for FY11 $14,000. The remaining $10,000 will be budgeted in FY12. Two sinkholes that contained anthropogenic refuse were cleaned out. A total of 115.76 tons of trash were removed from the two sinkholes. Dye tracing studies of the Moore Cave, Ball Mill, and Keyhole Spring systems were updated. Geologist Phillip Moss was hired to inspect caves for potential habitation by grottos sculpin. Snow and Briar caverns were considered to have high potential; a follow-up inventory of these caves in planned in 2011.
- Task Order 30181AT043 was effective on 08/11/2010 and included $15,000 of FY10 funds. Conservation actions to be implemented included securing landowner access agreements that would allow MDC access to grottos sculpin caves and establishment of buffers around streams, caves, and sinkholes.
    - Progress Report 2011: $8,000 was budgeted in MDCs FY11 and the remaining $7,000 will be budgeted in FY12. A ten-year agreement is being developed with the Missouri Cave and Karst Conservancy (MCKC) for access to Berome Moore Cave. Access would facilitate research and surveys. Funds have also been provided to install exclusion fence for livestock from the entrance of the cave and associated sinkholes on the property. Additional access agreements are being pursued in 2011.

Agreement 30181AG122 with the University of Central Arkansas

- The agreement was effective on 08/01/2011 and provided $5,000 in FY10 funds to assist Recipient, Dr. Ginny Adams, in officially describing and naming the grotto sculpin (*Cottus* sp.). The Recipient will write and submit a manuscript that describes and names the Grotto Sculpin (*Cottus* sp) in a peer-reviewed scientific journal prior to December

2010. This action is necessary to add grotto sculpin to the Threatened and Endangered Species list. The recipient will be reimbursed $2500 after proof of submissions supplied to the Service project officer. The remaining $2500 will be reimbursed to the Recipient after the manuscript is published. The parties hereto have agreed that the project period of this agreement is from the signature of the Service Contracting Officer through December 31, 2011.

- Progress Report 2011: At this time Dr. Adams is waiting on the higher level genetics analysis as well as an estimation of the molecular clock to continue with the manuscript. They have all the data necessary to warrant the description of grotto sculpin as a unique species. The description will be based on morphology (initially outlined in Burr et al. 2001 with additional data added) and genetics. Dr. Adams and co-authors are revising the manuscript to resubmit to Conservation Genetics or potentially to Zootaxa but the co-authors are in satellite locations so completing the revision is limited by our ability to communicate and transfer data. Submission of the manuscript is planned by the end of the summer and accepted for publication by the end of 2011. There is no guarantee that the review process will go smoothly or that the paper will be accepted but the authors feel they have a very strong case for the species description.

Major Conservation Actions Planned or Implemented by the Missouri Department of Conservation:

1. A high priority action item was to attain information on the drainage area and the connectivity of cave systems containing grotto sculpin. To accomplish this objective, $124,400 was secured to conduct a recharge delineation study that began in the spring of 2006 and was completed in June 2010. The final report was completed June 2010 with the updated final report completed November 2010. Land use shapefiles also were developed for all recharge areas. Water traces have been conducted to obtain groundwater recharge information, recharge delineations and hazards to be mapped within Mystery, Running Bull, Rimstone, Crevice, and Moore Cave systems (Aley and Moss. 2008).

2. Physical parameters were collected with Hydrolab DataSode 4X and 5X multi-probe units at four permanent cave sites and, when available, at two additional sites from January 2006 thru December 2009. This allows researchers to determine impacts associated with urban and agricultural runoff, livestock waste, and septic runoff in the study area. Parameters measured include: temperature, pH, conductivity, ammonia, depth, turbidity, and dissolved oxygen. Data were analyzed with the use of Aquarius software program. A report will be completed in 2011. A water quality report will be completed by November 2011 that will include the monthly water sampling and vertical drain data.

3. To better understand the impacts of installing vertical drains in sinkholes by the Perry County Soil and Water Conservation District, a minimum of 40 water samples will be collected from four vertical drains and one natural sinkhole. This study will provide

information on the best BMP's to manage sinkholes. Sampling will continue through July 2011.

4. MDC will work with other agencies to develop Best Management Practices (BMP) and secure funding to manage sinkholes on private land. A watershed management plan will be completed by November 2011. This plan will have recommendations on BMPs for sinkhole and stream management.

5. MDC will work with the grotto clubs and invite them to participate in the recovery effort.

SUMMARY OF THREATS:

The Grotto sculpin is restricted to two karst areas (limestone regions characterized by sink holes, abrupt ridges, caves and underground streams), the Central Perryville Karst and Mystery-Rimstone Karst in Perry County, southeast Missouri. Grotto sculpin have been documented in only five cave systems. The current overall range of grotto sculpin has been estimated to encompass approximately 260 square kilometers (100 square miles). The small population size and endemism of the grotto sculpin make it vulnerable to extinction due to genetic drift, inbreeding depression, and random or chance changes to the environment. The species karst habitat is located down-gradient of the city of Perryville, Missouri, which poses a potential threat if contaminants from this urban area enter cave streams occupied by grotto sculpins. Various agricultural chemicals, such as ammonia, nitrite/nitrate, acetochlor, dieldrin, and atrazine, have been detected at levels high enough to be detrimental to aquatic life within the Perryville Karst area. At least one sinkhole on every farm in Perry County contains anthropogenic refuse, ranging from household cleansers and sewage to used pesticide and herbicide containers. As a result, potential water contamination from various sources of point and non-point pollution poses a significant threat to the grotto sculpin. Two of the five known cave systems with grotto sculpins experienced massive mortality in the last ten years, presumably from point source pollution. Predatory fish such as common carp, fat-head minnow, yellow bullhead, green sunfish, bluegill, and channel catfish occur in all of the caves occupied by grotto sculpin. These predators may escape surface farm ponds that unexpectedly drain through sinkholes into the underground cave systems and enter grotto sculpin habitat. The only regulatory mechanism in place that would provide protection to the grotto sculpin is through the MDC Wildlife Code. Current threats to the habitat of the grotto sculpin may exacerbate potential problems associated with its low population numbers and increase the likelihood of extinction. We find that this species is warranted for listing throughout all its range, and, therefore, it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range. Due to the high magnitude of threats that are imminent, we assign this species a listing priority number of 2.

For species that are being removed from candidate status:

____Is the removal based in whole or in part on one or more individual conservation efforts that you determined met the standards in the Policy for Evaluation of Conservation Efforts

When Making Listing Decisions (PECE)?

RECOMMENDED CONSERVATION MEASURES:

- Promote and encourage landowners to enroll in the many cost share vegetation buffer practices through government agencies. This would include the CP33 (Habitat Buffers for Upland Birds), CP22 (Riparian Buffers), and CP21 (Filter Strips) through the Farm Service Agency, the EQUIP and WHIP programs through NRCS, the cost share practices through the Perry County SWCD, and the MDC in the Perry County karst. The goal is to combine resources from different agencies that will allow establishment of riparian buffers/cattle exclusion and/or filter strips for three miles of stream and ten sinkholes within the next four years. High levels of nutrient runoff can be significantly reduced through buffer strip management (Ducnuigeen et al. 1997, p. 9).

- Reduce application of agricultural chemicals within the karst plain that can impact water quality and the health of grotto sculpin via enrollment in cost-share programs, such as nutrient management plans, or other means.

- Clean out trash-laden sinkholes and haul off debris to appropriate landfill. The sinkholes sometimes harbor chemical containers or solid waste that can migrate into the underground system and degrade the health of the underground ecosystem.

- Secure landowner access agreements to grotto sculpin sites to facilitate research and population monitoring.

- Complete and publish species description so that more legal protection can be afforded to the species.

LISTING PRIORITY:

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	**Imminent**	Monotypic genus	1
		Species	**2***
		Subspecies/population	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/population	6
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
		Subspecies/population	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

The magnitude of threats is high due to a number of ongoing threats. The entire population of grotto sculpin is found in only 5 cave systems in Perry County, Missouri. The landscape in Perry County is dominated by agriculture and is continuously being impacted by activities associated with these practices, such as the installation of vertical drains in karst systems and contamination of surface and subsurface streams by agricultural chemicals. Two fish kills have occurred since 1999 that decimated grotto sculpin populations in Running Bull and Mystery Caves. Grotto sculpin have recolonized the caves but at dramatically lower numbers. Another source of chemical contamination is anthropogenic refuse in sinkholes in Perry County. Burr et al. (2001) and Missouri Department of Conservation staff have noted that many of the sinkholes contain anthropogenic refuse ranging from household cleansers and sewage, to used pesticide and herbicide containers. Further compounding the threats to the grotto sculpin are potential predation by invasive fish, developmental pressures from the nearby city of Perryville, and loss of genetic diversity.

The immediacy of threats is imminent. Chemical contamination, modified hydrology, sedimentation, and predation by invasive fish are occurring at the present time. Furthermore the continuation and expansion of the use of vertical drains will increase the introduction of pollutants into grotto sculpin habitat and alter the natural hydrology of the system because the structure and function of natural sinkholes are modified for their installation.

Yes Have you promptly reviewed all of the information received regarding the species for the

purpose of determining whether emergency listing is needed?

Is Emergency Listing Warranted? Emergency listing is not warranted at this time. Although the magnitude and immediacy of threats to the grotto sculpin are high, expected losses to populations during the normal listing process would not risk the continued existence of the entire species or loss of significant recovery potential.

DESCRIPTION OF MONITORING:

The MDC was contacted in May 2010 to review the latest species assessment and to provide any new information. MDC has regular contact and project coordination with species experts at the University of Central Arkansas and they also provided updated research results. Data continues to be analyzed and collected on population size, movement, habitat, age and growth, and genetic makeup of the species. A population ecology study was completed in 2008 by graduate students at the University of Central Arkansas and the results are included this CNOR. The MDC continues to monitor the water quality and habitat of the grotto sculpin and will be developing a watershed management plan and completing a water quality report by November 2011. MDC also has established a long term water quality monitoring project with other agencies and local entities that will provide useful information on habitat quality and threats. This contaminant assessment report is expected to be completed in 2010.

Once the vertical drain sampling is completed (July 2011) all of the water quality data will be incorporated into a water quality report that should be completed by November 2011. At the same time a watershed management plan, which is part of the 319 Grant, should be completed and submitted to DNR and EPA.

Very little is known about grotto sculpin and the monitoring that is planned and/or ongoing will be beneficial in describing the species, continuing to update the status and applying the proper management. Prior to the population ecology study nothing was known about the seasonal movements of grotto sculpin. The study also provides some data on population densities. Water quality monitoring will provide data on several parameters and identify potential pollution sources. A recharge delineation study was completed in 2010 that will provide information on connectivity of the cave systems and allow mapping of recharge areas where management practices can be implemented.

COORDINATION WITH STATES:

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment: Missouri

Indicate which State(s) did not provide any information or comments: None

The Perry karst system is currently included in the State Wildlife Action Plan as part of the River Hills Conservation Opportunity Area (COA). The Perry County Karst Area is currently being considered as an independent COA.

LITERATURE CITED:

Adams, G., D. Keeney, and B.M. Burr. 2003. Population genetics of grotto sculpin, *Cottus carolinae*, in Perry County, Missouri. Report to the U.S. Fish and Wildlife Service, Columbia, Missouri. 22 pp.

Adams, G., J. Fox, and K. Steelman. 2008a. Contaminant Concentration Analysis in Streams Utilized by Grotto Sculpin (*Cottus carolinae*) in Perry County, Missouri. University of Central Arkansas. Progress reported submitted to Missouri Department of Conservation and Perry County Soil and Water Conservation District. 18 pp.

Adams, G., J. Day, J. Gerken, and C. Johnson. 2008b. Population Ecology of the Grotto Sculpin, *Cottus carolinae*, in Perry County, Missouri. University of Central Arkansas. Progress Report submitted to Missouri Department of Conservation. 25 pp.

Aley, T. and P. Moss. 2008. Karst Dye Tracing Perry County, Missouri. Progress Report 1. Ozark Underground Laboratory. Progress report submitted to the Perry County Soil and Water Conservation District. 33 pp.

Burr, B.M., G.L. Adams, J.K. Krejca, R.J. Paul, and M.L. Warren, Jr. 2001. Troglomorphic sculpins of the *Cottus carolinae* species group in Perry County, Missouri: distribution, external morphology, and conservation status. Environmental Biology of Fishes 62:279-296.

Day, J. L., C. R. Johnson, J. E. Gerken, and G. Adams. 2008. Population Ecology of Grotto Sculpin (Cottus carolinae) in Cave and Resurgence Streams. Department of Biology, University of Central Arkansas, Conway AR; USGS Fish & Wildlife Cooperative Research Unit, Kansas State University, Manhattan KS. Poster presentation American Fisheries Society. 1 p.

Ducnuigeen, J., K. Williard, and R. C. Steiner. 1997. Relative Nutrient Requirements of Plants Suitable for Riparian Vegetated Buffer Strips. Virginia Department of Environmental Quality, Interstate Commission on the Potomac River Basin. Report No. 97-4. 17 pp + appendices.

Fox, J. T, G. Adams, M. Sharum, and K. L. Steelman. 2010. Passive Sampling of Bioavailable Organic Chemicals in Perry County, Missouri Cave Streams. Environmental Science and Technology 44(23):8835–8841.

Fox, K., G. Adams, and J. Steelman. 2009. Contaminant Concentration Analysis of Perry County, Missouri Cave Streams Utilized by Grotto Sculpin (*Cottus carolinae*). University of Central Arkansas. Final report submitted to Missouri Department of Conservation and Perry County Soil and Water Conservation District. 51 pp.

Gilpin, M. E., and M. E. Soule. Minimum viable populations: The processes of species extinctions. Pages 13-34 *in* Conservation Biology: The Science of Scarcity and Diversity, M.E. Soule, (ed.). Sunderland: Sinauer Associates, 1986.

National Research Council. The Ecological Impacts of Climate Change. Washington, D.C.: National Academies Press, 2008.

Noss, R. F., and A. Y. Cooperrider. Saving nature's legacy. Protecting and restoring biodiversity. Washington, D.C.: Island Press, 1994.

Poly, W. J. and C. E. Boucher. 1996. Nontroglobitic fishes in caves: their abnormalities, ecological classification and importance. American Midland Naturalist 136:187-198.

Shaffer, M. L. 1981. Minimum population sizes for species conservation. BioScience 31:131-134.

Shaffer, M. L., and F. B. Samson. 1985. Population size and extinction: a note on determining critical population size. American Naturalist 125:144-152.

Smith, R. L. Ecology and Field Biology. Second Edition. New York: Harper & Row, 1974.

Thomas, C. D. 1994. Extinction, colonization, and metapopulations: environmental tracking by rare species. Conservation Biology 8(2): 373-378.

Tillett, D.E., D. M. Papoulias, J. J. Whyte, C. A. Richter. 2010. Atrazine reduces reproduction in fathead minnow (*Pimephales promelas*). Aquatic Toxicology 99(2):149-159.

Vandike, J. E. 1985. Movement of shallow groundwater in the Perryville karst area, southeastern Missouri. Missouri Department of Natural Resources, Division of Geology and Land Survey, Miscellaneous Publication Number 44. 57 pp.

APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: Thomas O. Melius
Regional Director, Fish and Wildlife Service Date June 9, 2011

Concur: _____
Director, Fish and Wildlife Service Date

Do not concur: _____
Director, Fish and Wildlife Service Date

Director's Remarks:

Date of annual review:
Conducted by: