Illinois Cave Amphipod
Gammarus acherondytes

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service, Midwest Region
Rock Island Ecological Services Field Office
Moline, Illinois

5-YEAR REVIEW
Illinois cave amphipod/*Gammarus acherondytes*

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office:
Carlita Payne, Recovery Coordinator, Midwest Region (612-713-5339)

Lead Field Office:
Kristen Lundh, Rock Island Ecological Services Field Office, Rock Island, IL (309-757-5800)

Cooperating Field Office:

1.2 Methodology used to complete the review

The U.S. Fish and Wildlife Service (USFWS) solicited information from the public through a Federal Register notice (73 FR 21643) requesting new information on Illinois cave amphipod (*Gammarus acherondytes*) that may have a bearing on its classification as endangered. The USFWS reviewed reports and scientific papers that had been completed since the 1998 listing final rule, including the 2002 approved recovery plan. We relied on the census data of Dr. Julian J. Lewis to help determine the current status of the species populations. Peer review of this document was determined to be unnecessary because new information was from peer reviewed literature and census data, and the review resulted in a recommendation to leave the status unchanged. This review was completed by Kristen Lundh, Rock Island, Illinois Field Office, Ecological Services.

1.3 Background

1.3.1 FR Notice citation announcing initiation of this review:

Federal Register vol. 73, No. 78, April 22, 2008, pp. 21643-21645

1.3.2 Listing history

Original Listing
FR notice: Final rule to list the Illinois cave amphipod as endangered.
September 3, 1998; 63 FR 46900

Entity listed: Species
Classification: Endangered

1.3.3 Associated rulemakings

NA

1.3.4 Review History

There has been no review since the listing.

1.3.5 Species' Recovery Priority Number at start of review

Recovery Priority number 11C: The recovery priority number of 11 reflects that the Illinois cave amphipod occurs in multiple drainages which moderates the threats, and also indicates the low recovery potential since there are few regulatory mechanisms for managing groundwater pollution. The C reflects the rapid development of suburban St. Louis and the possible encroachment on Illinois cave amphipod watersheds.

1.3.6 Recovery Plan

Name of plan: Illinois Cave Amphipod Recovery Plan
Date issued: September 20, 2002
Dates of previous revisions: NA

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

No. The species is an invertebrate that is listed in its entire range; therefore, the DPS policy is not applicable to this listing.

2.2 Recovery Criteria

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

Yes

2.2.2 Adequacy of recovery criteria

2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?

Yes

2.2.2.2 Are all of the five listing factors that are relevant to the species addressed in the Recovery criteria (and is there no new information to consider regarding existing or new threats?)

Yes

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

Recovery criteria:

The Illinois cave amphipod may be considered for reclassification from endangered to threatened when five viable, stable populations in five separate groundwater basins with distribution in two of three sub-regions remain extant and there is a significant increase in use of best management practices in the

groundwater recharge areas in each of the five groundwater basins. The sub-regions are Columbia, Waterloo, and Renault Sub-regions of the Illinois Salem Plateau.

The Illinois cave amphipod may be considered for delisting when five viable, stable populations in five separate groundwater basins with distribution in two of three sub-regions remain extant and are supported by persistent use of best management practices substantially protecting the groundwater recharge areas of the five groundwater basins. The sub-regions are Columbia, Waterloo, and Renault Sub-regions of the Illinois Salem Plateau.

Neither the criteria for reclassification from endangered to threatened, nor the delisting criteria have been met for this species. There are 14 caves with populations of Illinois cave amphipods that stretch across eight separate groundwater basins, within two of the three sub-regions (Table 1). The Renault Sub-region includes three groundwater basins (Fogelpole, Illinois Caverns, and Krueger-Dry Run) containing four caves inhabited with Illinois cave amphipods. Of these four caves, three populations appear to be stable or increasing (Lewis 2007), and one with insufficient information as its last collection was in 1995 (Webb 1995; Webb *et al*. 1998). Within the Waterloo Sub-region, there are five groundwater basins (Pautler, Frog Cave, Annbriar, Luhr Spring, Dual Spring) with ten caves inhabited with Illinois cave amphipod. Of these ten populations, five appear to be stable or increasing (Table 1), three are populations represented by one collection only, and one was censused only once after it was discovered (Lewis *et al*. 1999; Lewis 2007). This data indicates that there are eight stable and reproducing populations of Illinois cave amphipods spread across eight groundwater basins within two of the three sub-regions, which fulfills a part of both the downlisting and delisting criteria (stating that five viable, stable populations in five separate groundwater basins with distribution in two of the three sub-regions remain extant).

Illinois cave amphipod habitat is most threatened by groundwater contamination (USFWS 2002). The Illinois cave amphipod is only known from at 230 square kilometer area within the Salem Plateau karst region (USFWS 2002). This karst area is made up of surface sinkholes which overlay solutionary modified limestone. The sinkholes drain directly through the subsurface into the caves. Much of the surface water in the area rapidly flows through the karst topography and does not benefit from filter of fine-grained materials (USFWS 2002). These recharge waters often contain contaminants. The recovery plan (USFWS 2002) indicates that the landuse in the area is dominated by agricultural uses and rural housing; however, the proximity to the St. Louis metro area has caused an increased threat of urbanization (Lewis *et al.* 2003). The quality of water within Illinois cave amphipod habitat is intimately tied to the land use practices of the area which is why the development and adoption of best management practices are so important to the species recovery.

Both the downlisting and delisting criteria include the adoption of best management practices into the landscape to protect Illinois cave amphipod recharge areas. The downlisting criteria states there must be a significant increase in best management

practices in each of the five groundwater recharge areas in the five groundwater basins, and the delisting criteria states populations must be supported by persistent use of best management practices substantially protecting the groundwater recharge areas of the five groundwater basins. Discussions with Natural Resource Conservation Service (NRCS) personnel, Illinois cave amphipod researchers, and the Illinois Department of Natural Resources (IDNR) area heritage biologist indicate that there has been no significant increase in the use of best management practices in the groundwater basins with known populations of Illinois cave amphipods and there are no specific mechanisms in place to do so (Johanning 2011; Lewis 2011; Moss 2011; Kemper 2011). Therefore, the second parts of the downlisting and delisting criteria regarding the implementation of best management practices have not been met.

Table 1. Collections of Illinois cave amphipod by year (see text in section 2.3.1.2)

Subregion	Groundwater basin	Cave	Year censused and number of Illinois cave amphipods collected
Renault	Fogelpole	Fogelpole	1965 (1), 1986 (1), 1993 (10), 1995 (33), 1995 (9% of amphipods collected), 2000 (7), 2001 (17), 2003 (1), 2007 (11)
	Illinois caverns	Illinois Caverns	1938 (25), 1965 (14), 1974 (6), 1992 (20), 1993 (1), 1995 (56), 1995 (25.1% of amphipods collected), 2000 (7), 2001 (5), 2007 (16)
	Krueger-Dry Run	Krueger – Dry Run	1965 (1), 1986 (0), 1993 (0), 1995 (2), 1995 (3.1% of amphipods collected),
		Spider Cave	1998 (25), 2000 (0), 2001 (0), 2003 (0), 2003 (28), 2007 (12)
Waterloo	Madonnaville	Madonnaville	1986 (1), 1995 (0), 1998 (0)
	Pautler	Pautler	1965 (4), 1999 (60), 2001 (36), 2003 (18), 2007 (2)
		Danes Cave	1999 (12)
		Rose Hole	1999 (32)
	Frog Cave	Frog Cave	1999 (21), 2001 (80), 2003 (20), 2007 (24)
	Annbriar	Cedar Ridge	1998 (6)
		Wednesday Cave	1999 (9), 2001 (2), 2007 (9)
		Reverse Stream Cave	2001 (9), 2003 (23), 2007 (70)
		Triple delight	Noted in 2001, 2007 (17)
	Luhr Spring	Pump House Cave	Noted in 2001, 2003 (7), 2007 (6)
	Dual Spring	Snow White	Noted in 2001, 2003 (2), 2007(1)
Columbia	Stemler	Stemler Cave	None collected since 1965 although there have been surveys in 1993, 1995, 1998, 1999, 2003, 2006

2.3 Updated Information and Current Species Status

2.3.1. Biology and Habitat

2.3.1.1 New Information on the species' biology and life history:

Wilhelm *et al*. (2006) found that Illinois cave amphipods have a lower metabolic rate than *Gammarus trolgophilus*. Cave environments can be food limiting and the lower metabolic rate helps these stygobites which are aquatic cave obligates. Researchers hypothesized that this adaptation may be damaging to Illinois cave amphipods because during times of high nutrient input to a cave system, if food is no longer a limiting factor, stygophiles (which can live outside of the cave environment) such as *Gammarus trolgophilus* may out-compete them.

In 2007, Vernasky *et al.* attempted to determine the life span, growth rate, and reproductive timing of the Illinois cave amphipod. Researchers collected samples from Reverse Stream Cave from October 2003 – March 2005. Researchers collected ovigerous females year-round and found that their numbers peaked during two distinct periods of recruitment, one from later winter to late spring (February to May), the second from late summer to fall (August to October). An incubation time of 90 – 120 days was estimated for young first sampled in spring which coincided with lower water temperatures, and 30 – 60 days for young first sampled in summer when water temperatures were warmer. They found that Illinois cave amphipods reached the immature stage in 7 – 8 months, and estimated the time to reach maturity at 14-16 months. Although they found the amphipod to live to 14-16 months, life expectancy could not be calculated. Vernasky *et al.* also found that at times when flow was high, the density of Illinois cave amphipods was markedly low.

Venarsky *et al*. (2007) recognized conservation implications for Illinois cave amphipod from this study. First, Illinois cave amphipod populations may recover rapidly after pollution events based on its short time period to maturity and given two reproductive events per year. Also, if there are specific times for recruitment, anthropogenic surface activities may have more deleterious effects on populations depending when they happen. It may be possible to outline specific time periods when disturbance to a population should minimized.

2.3.1.2 Abundance, population trends, demographic features, or demographic trends:

At the time of the listing, the Illinois cave amphipod was known to occur in three of the original six cave systems in which it was historically found (Fogelpole Cave, Illinois Caverns, and Krueger Dry Run Cave system). Since the listing, there have been several additional caves and groundwater basins added to the Illinois cave amphipod's range. A survey of caves within the sinkhole plain in

1998 - 1999 revealed six new sites (Lewis *et al.* 1999). Four additional sites were also added in 2001 (Lewis 2001).

In 2000, Lewis established a protocol for surveying Illinois cave amphipod (Lewis 2000). Lewis utilized this methodology in his population census of 2001, 2003, and 2007 to established population baselines in some of the caves with known occurrences. In those caves where more than one census has occurred, population trends are starting to emerge (Lewis 2003; Lewis 2007).

Table 2. Illinois cave amphipod localities rank-ordered (from most to least) by the number of Illinois cave amphipods present per square foot as measured in sampled quadrats (Lewis 2007)

ICA Quadrat ft^2				
Cave	2007	2003	2001	2000
Reverse Stream Cave	7.0	2.3	n/m	n/m
Frog Cave	2.4	2.0	1.35/2.65	n/m
Triple Delight Cave	1.7	n/m	n/m	n/m
Spider Cave	1.2	0.0[1]	0.0[2]	0.0[2]
Fogelpole Cave (Northwest Entrance Area)	1.1	0.1	1.7[3]	n/m
Illinois Caverns Transect 1	1/0	0.4	0.3/0.4	0.2/0.1
Wednesday Cave	0.9	n/m	n/m	n/m
Pump House Cave (Rick's Pit)	0.6	0.7	n/m	n/m
Illinois Caverns Transect 2	0.6	n/m	n/m	0.0
Pautler Cave	0.2/0.0	1.8	1.3/1.3	n/m
Snow White Cave	0.1	0.2	n/m	n/m
Illinois Caverns Transect 3	0.0	n/m	n/m	0.0[4]

n/m: not measured that year
[1]Equivocal census due to flooding
[2]Same area, roughly equivalent transects
[3]Transect upstream from present one
[4]Transect placed just upstream of Roaring River Passage

Following is a summary of the Illinois cave amphipod collection records, distribution, and trends by Sub-region and Groundwater Basin. Some of the collection records are taken from the 2002 recovery plan (USFWS 2002) and the number of individuals which were collected is noted in parenthesis with the year of collection, and reference to the collector.

Renault Sub-region

Fogelpole Groundwater Basin

Fogelpole Cave is the longest known cave system in Illinois with 16 miles of mapped passages. The main entrance to the cave is located in a dedicated Illinois

Nature Preserve. There are collection records for Illinois cave amphipod from Fogelpole Cave in 1965 (J. Holsinger collection (1)), 1986 (Illinois Natural History Survey (INHS) (1)), 1993 (INHS (10)), and 1995 (INHS (33)) (USFWS 2002). Webb (1995; Webb *et al*. 1998) found the Illinois cave amphipod to make up 9% of the 363 amphipods collected from five sites within Fogelpole Cave, and 15% in two riffle sites surveyed. Lewis established three transects in Fogelpole Cave in 2000 and found seven total individuals (Lewis 2000). Two of these transects were surveyed again in July 2001 but no Illinois cave amphipods were found (Lewis 2001). In September 2001, Lewis returned to Fogelpole and added a new transect in the first riffle upstream of the Northwest Entrance where he found 17 individuals. In 2003, Lewis returned to the same area near the Northwest entrance, but moved the transect to the next riffle downstream and found only one individual. He learned that a pond had overflowed into a sinkhole connected to Fogelpole Cave and subsequently infested the system with pond organisms (Lewis 2003). In his 2007 census, Lewis collected 11 Illinois cave amphipod representing a rebound in the population (Lewis 2007).

Illinois Caverns Groundwater Basin

The primary cave in the Illinois Caverns Basin is Illinois Caverns. Illinois cave amphipod has been collected in Illinois Caverns in 1938 (U.S. National Museum collection (+25)), 1965 (J. Holsinger Collection (14)), 1974 (INHS (6)), 1992 (INHS (20)), 1993 (INHS (1)), 1995 (INHS (56)) (USFWS 2002). Webb surveyed 19 sites within Illinois Caverns in 1995 and found Illinois cave amphipods in the gravel-cobble riffles and pools of the main cave (Webb 1995; Webb *et al*. 1998). Illinois cave amphipod made up 25.1% of the 233 amphipods Webb collected (Webb 1995; Webb *et al*. 1998). In his 2000 census of Illinois Caverns, Lewis surveyed nine transects and found Illinois cave amphipods only in the entrance passage upstream of the T intersection (Lewis 2000). Below the T intersection Lewis found evidence of groundwater degradation. A 100-foot transect was established by Lewis in the upstream passage in 2000 and censused again in 2001 and 2003 with the following results; 2000 (3 individuals), 2001 (7 individuals), and 2003 (4 individuals) (Lewis 2003). In 2007, the same transect was again sampled by Lewis as well as two additional transects above the T intersection (Lewis 2007). Lewis found ten individuals in the established transect (Transect 1), 13 in Transect 2, and none in Transect 3. The area downstream of the T intersection was examined by Lewis in 2007 and two Illinois cave amphipods were found. According to Lewis' findings from Transect 1, the population of Illinois cave amphipods in Illinois Caverns has increased; with 0.1 amphipod/square foot in 2000, 0.4 amphipods/square foot in 2003, and 1.0 amphipods/square foot in 2007 (Table 2). Lewis postulated that the change may be due to a change in land management around the entrance to the cave from agricultural row crop to native prairie (Lewis 2007).

Krueger-Dry Run Basin

Krueger-Dry Run Basin contains two caves where Illinois cave amphipods have been found, Kruger-Dry Run Cave and Spider Cave. Kruger-Dry Run Cave is the main cave in this system and downstream of Spider Cave. Collections of Illinois cave amphipods were made in Kruger-Dry Run Cave in 1965 (J. Holsinger Collection (1)) and 1995 (INHS (2)) but not during surveys in 1986 or 1993 (Webb *et al.* 1993; Webb *et al.* 1998; USFWS 2002). Webb surveyed two sites in Kruger-Dry Run Cave in 1995 and found Illinois cave amphipods to make up 3.1% of the 64 amphipods collected (Webb 1995; Webb *et al*. 1998). Permission to enter the main entrance to Krueger-Dry Run Cave was denied to Lewis in 2001 and so he concentrated his efforts in Spider Cave.

Spider Cave is an upstream tributary to Kruger-Dry Run Cave. In 1998, 25 Illinois cave amphipods were collected in Spider Cave (Lewis *et al.* 1999). In July 2000, a census of the cave was attempted by Lewis who found a putrid smell and a microbial mat covering the cave substrate (Lewis 2000). An additional census was done in September 2000 and although the smell and microbial mat were gone, the Illinois cave amphipod was absent. In 2001, Lewis surveyed Spider Cave in July and September and no Illinois cave amphipods were found (Lewis 2001). In June of 2003, Illinois cave amphipods were still absent from the cave; however, conditions for the survey were poor with a high rain event occurring on the day of the survey (Lewis 2007). They were collected again in the entrance room of the cave by Wilhelm in September 2003 (Lewis 2003; Wilhelm 2011). Lewis found 12 Illinois cave amphipods in his 2007 survey confirming that the population had bounced back after the 2000 pollution event (Lewis 2007).

Waterloo Sub-region

Madonnaville Cave Groundwater Basin

There has been only one collection of an Illinois cave amphipod from Madonnaville Cave in 1986 (INHS (1)) (Webb *et al*. 1998; USFWS 2002). Additional surveys occurred in 1995 and 1998, however no Illinois cave amphipods were found.

Pautler Groundwater Basin

The Pautler Groundwater System includes several caves, three of which have been confirmed to contain the Illinois cave amphipod: Pautler Cave, Danes Cave, and Rose Hole Cave. Illinois cave amphipods were collected in Pautler Cave in 1965 (J. Holsinger Collection (4)) (Webb *et al.* 2008) and noted by Peck and Lewis in 1978 (USFWS 2002). During the inventory conducted in 1992 and 1993, the entrance to Pautler Cave was closed (Webb *et al.* 1993; Webb *et al.* 1998). Lewis found that the entrance was reopened for the 1999 survey where 53

individuals were collected in the main stream passage and seven found in a small tributary (Lewis *et al.* 1999). In 2001, Lewis established two transects both of which were surveyed in May and September (Lewis 2001). He collected four individuals in May and six in September in the first transect, and 13 individuals during each survey in the second transect (Lewis 2001). In 2003, Lewis collected 18 Illinois cave amphipods in the second transect from 2001 (Lewis 2007). In 2007, Lewis found the entrance to Pautler Cave to be dry on his July and November trips, likely due to drought conditions in the area during the summer (Lewis 2007). When he resampled the same transect from 2001 and 2003, he collected two individuals in July and none in November (Lewis 2007). Based on Lewis' results, the population in Pautler Cave showed an increase from 2001 to 2003, and then declined in 2007 (Table 1). A new entrance was opened in 2007 which allowed access to downstream areas of Pautler Cave and areas of the main trunk which were previously accessible only through Danes Cave, a difficult passage (Lewis 2007). Although the habitat in the main passage downstream of Pautler Cave was characterized as "excellent" by Lewis (2007), Illinois cave amphipods have not been found there.

In two sampling efforts, 32 total Illinois cave amphipods were found in Rose Hole Cave in 1999 (Lewis *et al.* 1999). Rose Hole Cave contains a small stream which is described as no more than a foot wide in the areas sampled. Twelve Illinois cave amphipods were also found in Danes Cave during the 1999 survey (Lewis *et al.* 1999)

Frog Cave Groundwater Basin

The first collection of the Illinois cave amphipod in Frog Cave was in 1999 when 21 individuals were collected (Lewis *et al.* 1999). In 2001, two transects were established in the cave by Lewis and a total of 27 individuals were collected in May, and 53 in July (Lewis 2001). Lewis noted the population of Illinois cave amphipods in Frog Cave was between 0.6-3.3 amphipods/square foot which was the highest found among the caves in his 2001 census. One transect was sampled in 2003 with 20 individuals collected (Lewis 2003). In 2007, Lewis collected 24 individuals in one transect (Lewis 2007).

Annbriar Groundwater Basin

The Annbriar Groundwater Basin includes four caves with known populations of the Illinois cave amphipod: Cedar Ridge Cave, Wednesday Cave, Reverse Stream Cave, and Triple Delight Cave. Six Illinois cave amphipods were collected in Cedar Ridge Cave in 1998 (Lewis *et al.* 1999). The cave consists of two parts; the first, a belly crawl that gradually opens to a larger passage, and the second a floor drain that was cleared to reveal a 10-12 foot tube which opens to a larger stream passage (Lewis *et al.* 1999). The second section is only passable by a very, thin person and the cave has not been surveyed since the initial discovery of individuals in 1998.

Illinois cave amphipods were first discovered in Wednesday Cave in 1999 (Lewis *et al*. 1999) when nine individuals were collected. Wednesday Cave consists of 30 feet of passage which flows into a large rimstone pool, falls and flows across gravel and root matts before disappearing into the floor (Lewis 2007). In 2001, Lewis found one individual in each of his two surveys (Lewis 2001). In 2007, Lewis moved his transect to better represent the stream environment and collected nine individuals (Lewis 2007).

The stream flow into Reverse Stream Cave originates in a spring pool adjacent to its entrance, which flows through its low crawlway entrance and through approximately 150 feet of low passage before it disappears underground (Lewis, 2001; Lewis 2003; Lewis 2007). The existence of Illinois cave amphipods in Reverse Stream Cave was first discovered by J. Lewis and P. Moss in 2001 when nine individuals were collected (Lewis 2001). Lewis added Reverse Stream Cave to his census in 2003 and collected 23 individuals. In 2007, Lewis collected 70 individuals. Lewis extrapolated the population of Illinois cave amphipods at 184 in his 10-foot linear belted transect in 2003, and 560 in 2007. Based on these collections, Reverse Stream Cave represents the highest known density of Illinois cave amphipod.

Triple Delight Cave is a multiple entrance cave that is surrounded by a growing subdivision (Lewis 2007). Illinois cave amphipods were first collected in 2001 by J. Lewis and P. Moss (Lewis 2001). Lewis surveyed a 10-foot linear transect within a 6- to 8-foot wide stream passage of Triple Delight Cave during his 2007 census and collected 17 individuals (Lewis 2007).

Luhr Spring Groundwater Basin

The entrance to Pumphouse Cave is a low, wide stream passage which slowly increases to standing height and is entered through Rick's Pit, an approximately 16-foot deep sinkhole (Lewis 2003). Illinois cave amphipods were first collected by J. Lewis and P. Moss in 2001 (Lewis 2001). Lewis added Pump House Cave to his census in 2003 and collected seven individuals (Lewis 2003). In his 2007 survey, Lewis (2007) collected six individuals.

Dual Spring Groundwater Basin

The main entrance to Snow White Cave is at the bottom of a sinkhole which provides access to an approximately 2000-foot stream passage that starts as a crawlway and slowly increases to a walking height (Lewis 2003). Illinois cave amphipods were first collected in Snow White Cave by J. Lewis and P. Moss in 2001 (Lewis 2001). Lewis (2003) added Snow White Cave to his census and collected two individuals in 2003, and one in 2007 (Lewis 2003; Lewis 2007).

Columbia Sub-region

Stemler Groundwater Basin

Stemler Cave is the main cave in the Stemler Groundwater Basin. No Illinois cave amphipods have been collected in Stemler Cave since 1965 although there has been sampling in the system in 1993, 1995, 1998, 1999, 2003, and 2006 (Webb *et al.* 1993; Webb 1995; Webb *et al.* 1998; Lewis *et al.* 1999; Lewis 2003; Panno *et al.* 2006).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

In 2008, Venarsky *et al*. completed a population genetics study on Illinois cave amphipod by comparing individuals from the Renault and Waterloo Sub-regions, and within multiple caves and multiple recharge areas within these sub-regions. The nine populations sampled were from Rick's Pit (Pumphouse Cave), Snow White Cave, Pautler Cave, Pautler Cave/Danes Cave, Reverse Stream Cave, and Frog Cave in the Waterloo Sub-region; Spider Cave, Illinois Caverns, and Fogelpole Cave in the Renault Sub-region. DNA was isolated from Illinois cave amphipods and the mitochondrial cytochrome c oxidase subunit I (COI) gene was used to evaluate whether gene flow was occurring between sub-regions, or between recharge areas within the sub-regions. Researchers identified 11 unique haplotypes from the 80 Illinois cave amphipods sampled (five from Waterloo, six from Renault). They found that the haplotypes were not shared by the two sub-regions and that the populations in the Waterloo and Renault Sub-regions are genetically distinct. Three of the haplotypes were shared by populations in two or more caves and recharge areas indicating some gene flow exists between them, most likely during high water events. The research suggested that source populations for future artificial augmentation be located as closely as possible to the reintroduction site, preferably within the same recharge area.

2.3.1.4 Taxonomic classification or changes in nomenclature:

No changes.

2.3.1.5 Spatial distribution, trends in spatial distribution or historic range

The Illinois cave amphipod is endemic to an approximately 230 square kilometer area within the Salem Plateau karst region of southwestern Illinois of Monroe and St. Clair Counties (USFWS 2002). Although the number of caves in which the Illinois cave amphipod has been found has increased since its listing (see section 2.3.1.2), the species is limited to this distinct habitat in this region (USFWS 2002). Additional surveys should

be completed to ensure that all locations for this species within the known range are located.

2.3.1.6 Habitat or ecosystem conditions:

The Illinois cave amphipod is a troglobitic species inhabiting the dark zone of caves within the Salem Plateau in southwestern Illinois. It is endemic to this area, and although it has been found in additional groundwater basins and caves within its historic range, it is not known to occur outside of the Renault, Waterloo, and Columbia Sub-regions (USFWS 2002). This limited cave habitat is further constricted by its relationship to the landuse practices in the area.

The Illinois cave amphipod was collected in Stemler Cave in the Columbia Sub-region in 1965 (USFWS 2002); however, subsequent attempts to find it have failed (USFWS 2002; Panno *et al.* 2006). Panno *et al.* (2006) looked at differences in water quality between Stemler Cave and Illinois Caverns, where the Illinois cave amphipod is also known to occur. They found that although the landuse surrounding both caves is mostly agricultural, the Stemler Cave groundwater basin contained more urban land, 4.1% compared to .53% around Illinois Caverns and calculated that there may be as many as eight times more private septic systems surrounding the Stemler Cave system.

According to test results, higher levels of TOC (total organic carbon), potassium, silica, chloride, fluoride, sulfate, iron, manganese, and lower nitrate and pH were present in Stemler Cave. Stemler Cave had significantly lower dissolved oxygen concentrations than Illinois Caverns, during low flow conditions. Researchers found that the water flowing into Stemler Cave was categorized in two different ways: water flowing through the soil in the groundwater, and wastewater effluent or animal waste that is discharged into sinkholes and directly into the cave system. The water in Stemler Cave is also influenced by the oxidation of pyrite within the limestone bedrock. All of these factors may affect the water chemistry which causes the DO (dissolved oxygen) in Stemler Cave to be reduced, However, researchers indicated that the soil-water contributions alone were not enough to explain the low DO, and was more likely the result of surface contaminants entering into the system.

Researchers also speculated that the range of the Illinois cave amphipod within Stemler Cave may be limited due to the metabolic advantage of stygophilic invertebrates (see section 2.3.1.1) in this nutrient rich environment (Wilhelm e*t al.* 2006). Coupled with the low DO, this may explain why the Illinois cave amphipod has been extirpated from Stemler Cave.

2.3.1.7 Other:

None

2.3.2 Five-Factor Analysis

2.3.2.1 Present or threatened destruction, modification, or curtailment of its habitat or range:

The threats to the Illinois cave amphipod outlined in the listing (USFWS 1998), and the recovery plan (USFWS 2002) still apply. The degradation of habitat through groundwater contamination was noted as the primary threat in the listing (USFWS 1998). Development in Monroe and St. Clair Counties where the Illinois cave amphipod occurs continues to be a factor. The population of Monroe County increased by 19.3% from 2000 to 2010, and the population of St. Clair County increased by 5.5% over the same time period (www.census.gov). Threats associated with population increases and residential development (such as residential pesticide and fertilizer use, surface runoff, and bacterial contamination of groundwater due to septic system effluent) continue. Acute pollution events have degraded Illinois cave amphipod habitat, and based on researcher's findings, have reduced populations. For example, a 2000 pollution event in Spider Cave adversely affected the population and resulted in no collections until September 2003 (Lewis 2000; Lewis 2007; Wilhelm 2011). Also, a pond near Fogelpole Cave overflowed into a connecting sinkhole and infested the Illinois cave amphipod population with pond organisms (Lewis 2003). Lewis detected several pond species in the cave and the census indicated a population drop from 2001 – 2003. Although both of these populations rebounded in 2007 (Lewis 2007), the threat of pollution events remains throughout the range of the Illinois cave amphipod.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

No new information exists since the listing.

2.3.2.3 Disease or predation:

No new information exists since the listing.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

There has been very little change in regulatory mechanisms or additions to the protection of individual caves since the listing. None of the caves which contain Illinois cave amphipods fall under the Cave Resources

Protection Act because they are not on Federal land. The Illinois cave amphipod is listed as endangered under the Illinois Endangered Species Protection Act and is protected from direct take. However, this Act does not preclude indirect take and actions undertaken by landowners (which are lawful) that degrade or destroy Illinois cave amphipod habitat. Several entrances to caves containing the species are dedicated Illinois Nature Preserves. This limits the human use of these caves to some degree. The recharge areas of three caves that are Illinois Nature Preserves (Stemler, Paulter and Fogelpole) have been designated as Class III Special Resource Groundwater by the Illinois Environmental Protection Agency. Currently, this designation provides very little additional protection as specific water quality standards protective of Illinois cave amphipods have not been developed. Additionally, it does not affect the land use within the recharge area of the caves which is mostly in private ownership.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Climate change including warming trends is a potential threat to the habitat of the Illinois cave amphipod. Warming of the climate and the potential effects on wildlife has been well documented (Hansen *et al.* 2006; Inkley *et al.* 2004). Illinois cave amphipod has a very restricted habitat range which is intimately tied to the surface hydrology. Changes in rainfall and subsequent run-off due to climate change could directly affect Illinois cave amphipod populations.

2.4 Synthesis

The Illinois cave amphipod is endemic to a 230 square kilometer area within the Salem Plateau Karst Region (USFWS 2002). Since its listing, 10 new populations have been discovered, resulting in 14 known populations. One portion of both the downlisting and delisting recovery criteria have been met as there are at least five viable, stable populations of Illinois cave amphipod in five separate groundwater basins.

The portion of the recovery criteria that relates to an increase in the use of best management practices has not been met for either the downlisting or delisting criteria. At this time, there has not been a significant increase in the use of best management practices to protect groundwater quality (Johanning 2011; Lewis 2011; Moss 2011; Kemper 2011). Pollution events have been shown to affect Illinois cave amphipod populations (Lewis 2000; Lewis 2003; Lewis 2007; Wilhelm 2011) and there is evidence that the higher level of urban development surrounding the Stemler Cave has contributed to the extirpation of Illinois cave amphipod in this cave, and thus the Columbia Sub-region (Panno *et al.* 2006). The intimate relationship between Illinois cave amphipod habitat and surrounding land use continues to threaten the species. Changes in hydrology due to climate change may also be an increasing new threat to the Illinois cave amphipod.

There is new life history information for Illinois cave amphipod since its listing which may have conservation implications for the species. Wilhelm *et al.* (2006) discovered that the Illinois cave amphipod has a lower metabolic rate than *G. trolgophilus* which may cause it to be out-competed by stygophiles when food is abundant. Vernasky *et al.* (2007) estimated the growth rate and life span of Illinois cave amphipod in Reverse Stream Cave and found that they had two major recruitment events per year. These findings may indicate that sensitive times for Illinois cave amphipod populations should be identified, and management regimes designed to avoid them.

The status of the Illinois cave amphipod should remain endangered because the original threats outlined in the final listing rule, recovery plan, and the additional threat of global warming, have not been reduced. Illinois cave amphipod still meets the definition of endangered throughout all of its range and therefore, no change in the classification is recommended.

3.0 RESULTS

3.1 Recommended Classification:

__x_ No change is needed

3.2 New Recovery Priority Number _NA____

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4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Following are recommendations for future actions for the Illinois cave amphipod.

- A working group of USFWS, NRCS, ILDNR, researchers, and non-government agencies should be assembled to:
  - Develop a suite of best management practices designed to protect Illinois cave amphipod habitat, and the sinkholes and recharge areas that affect Illinois cave amphipod water quality in both agricultural and the increasingly urban landscape. Landowners should be contacted and provided information on the use of best management practices to protect the Illinois cave amphipod. The group could also devise a plan to reach existing and new landowners and help them to incorporate these practices.
  - Evaluate sites where conditions are suitable for the Illinois cave amphipod and determine where and how often future surveys should be conducted.
  - Identify sites that can be protected through land acquisition and conservation easements.
  - Research the potential impacts of global warming on the Illinois cave amphipod.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Illinois cave amphipod *(Gammarus acherondytes)*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review

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

Appropriate Recovery Priority Number: 11C

Review Conducted By: Kristen Lundh

FIELD OFFICE APPROVAL:
Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 9/27/11
Richard C. Nelson, Field Supervisor

REGIONAL OFFICE APPROVAL:
Acting **Assistant Regional Director, Ecological Services, Fish and Wildlife Service, Midwest Region**

Approve _____ Date 9/30/11