

**Recovery Plan  
For  
Four Salamander Species of Cherokee County, Kansas:**

**Cave salamander, *Eurycea lucifuga* (Rafinesque)**

**Many-ribbed salamander, *Eurycea multiplicata griseogaster*  
(Moore and Hughes)**

**Grotto salamander, *Typhlotriton spelaeus* (Stejneger)**

**Longtail salamander, *Eurycea longicauda melanopleura* (Cope)**



**Cave Salamander**



**Many-ribbed Salamander**



**Grotto Salamander**



**Longtail Salamander**

Photos by Suzanne Collins

**March, 2002**

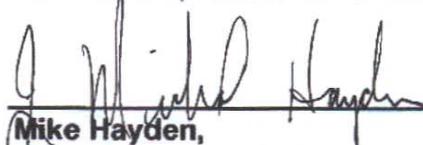
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**for**

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## I. Introduction

This plan addresses the recovery needs of four salamander species known in Kansas only from Cherokee County. These salamanders are the cave salamander, *Eurycea lucifuga* (Rafinesque); many-ribbed salamander, *Eurycea multiplicata griseogaster* (Moore and Hughes); grotto salamander, *Typhlotriton spelaeus* (Stejneger); and the longtail salamander, *Eurycea longicauda melanopleura* (Cope). The first three species are currently listed as endangered in Kansas while the latter is listed as threatened (K.A.R. 115-5-1 and 115-5-2).

This plan, as governed by K.A.R. 115-5-4, outlines specific strategies and methods to recover and eventually delist these four salamander species.

## II. Species Accounts

### A. Cave Salamander, *Eurycea lucifuga* (Rafinesque)

#### 1. Taxonomy and Description

**Original Description:** *Eurycea lucifuga* Rafinesque, 1822:3. Type-locality, "near Lexington," [Fayette County, Kentucky]. Holotype not known to exist. Collector, a "Mr. Crockett" (Hutchison 1966).

**Taxonomic Discussion:** The species was also described as "*Spelerpes lucifuga* (Rafinesque 1832). Cope (1890) deduced the *E. lucifuga* was a synonym for *E. longicauda* and therefore erected a new name, *Gyrinophilus maculicaudus* Cope. The species was transferred by Hay (1891) to the Genus *Spelerpes*. The ending was changed from *maculicaudus* to *maculicauda* by Blatchley (1897). Mittleman (1942) reduced the organism to *E. longicauda lucifuga*. Neill (1954) provided evidence to refute Mittleman (1942). No recognized subspecies exist.

**Description:** Adult cave salamanders vary from dull yellow to orange to a bright orange-red color. Black, oval shaped spots ranging from 1 to 3 mm in size are found on dorsal and lateral areas of the trunk and tail. Younger specimens often tend to a yellowish ground color. Large adult specimens often have darker sides and lower spots may fuse. The underside is yellow and lack spots. Average snout-vent length for males is 60 mm; for females 62 mm. The largest Kansas specimen had a snout-vent length of 69 mm (Collins 1993). Eye diameter is about equal to snout length. Legs, though slender, are well developed with four digits on the forelimbs and five short toes webbed at the base on the hind limbs. A detailed description of eggs, larva, and adults has been published (Hutchison, 1966:24.1.) Melanistic populations do occur (Grobman 1943) but are not reported from Kansas.

#### 2. Historical and Current Distribution

The species is found in limestone areas notably near and in cave areas, from southern Indiana and southwestern Ohio, through Tennessee, and into northern Georgia and Alabama. It occurs easterly to portions of Virginia and West Virginia and westward through southern Missouri and northeastern Oklahoma. It is found in Kansas only in Cherokee County in the southern corner of the state.

Collins (1993) summarizes occurrences of collections and sightings of cave salamanders in Cherokee County. The Kansas Biological Survey lists six records of occurrence for *E. lucifuga*. Most notable among occurrence data is Schermerhorn Park located approximately one mile south of Galena on the east side of Kansas Highway 26. Schermerhorn Cave located in the park has provided many observations of the cave salamander (Rundquist and Collins 1977; Collins 1982; Beard 1986; Young 1986; Taggart 1992).

While most occurrences have been documented in caves they also occur in springs (Collins 1982; Lorraine 1983) however, cold springs near caves usually provide the most optimal habitat (Lorraine 1983). The cave salamander is described as occupying the twilight zone of caves, crevices in limestone rocks around springs, and beneath rocks and logs in moist forested areas near caves (Collins 1993). In Schermerhorn Cave, an adult cave salamander was located 2,400 feet from the cave entrance (see Collins 1993).

Locations of known collection sites were tabulated (Table 1, Figure 2).

### **3. Species Associations**

All four species of salamanders addressed in this report have been found in Schermerhorn Cave and are known to occupy similar habitats (Young and Beard 1993). However, Hutchison (1958) and Meyers (1958) suggest microhabitats differ between *E. lucifuga* and *E. longicauda* and may lead to competition influencing local distribution.

Collins (1982) reported observing *Typhlotriton* larvae, *Rana catesbeinna*, *Eurycea longicauda* and *E. lucifuga* in the same spring. The same organisms were recorded on a visit to Schermerhorn Park Cave

(Collins 1982). It would appear that all four salamander species may occur in some instances at the same locations in Cherokee County .

### **4. Population Sizes and Abundance**

From examining records, it appears no quantifiable population estimates exist for this species at known sites of occurrence. However, numbers of specimens observed at sites were often recorded (Table 1). Juvenile and adult observations were often delineated. Lorraine (1983) conducted observations of seven sites for *E. lucifuga*. He observed twenty-one specimens in Schermerhorn Cave; two adults at a second site; thirty-seven specimens at a third spring emanating from limestone crevices, including juveniles; and a total of four adults in one small cave on five visits. Taggart (1992) observed thirty-three specimens in Schermerhorn Cave. As the cave salamander often seeks crevices and hiding places, exact population counts are difficult. Observed numbers at night in varying locations may reflect relative populations levels.

## 5. Reproduction

For Kansas, Collins (1993) reports that breeding may occur twice a year from October to May. No known courtship activity has been described for Kansas populations. Females lay between 50-90 eggs, which attach to submerged rocks in cave streams. Newly hatched larvae are approximately 10 mm in length and cannot withstand strong currents (Myers 1958). Maximum length of larvae is reported to be 58 mm. Eggs and larvae occur only in waters of caves or springs emanating from caves.

## 6. Food and Feeding Requirements

Collins (1993) and Collins et al. (1995) report an exclusive diet of insects for the cave salamander .

## B. Many Ribbed Salamander *Eurycea multiplicata griseogaster*

### 1. Taxonomy and Description

**Original description:** *Eurycea griseogaster* Moore and Hughes, 1941:139. Type-locality, "Swimmer's Creek, near its junction with the Illinois River , 10 miles north of Gore, Sequoyah County , Oklahoma." Holotype, Chicago N at. Hist. Mus. 37832, adult female, collected by Aaron Seamaster, 3 May 1940. *Eurycea multiplicata griseogaster*: Schmidt, 1953:55. New combination; based on personal communications with H.A. Dundee. (From Dundee 1965:21.1).

**Taxonomic discussion:** The form of the many ribbed salamander occurring in Kansas is a subspecies with the common name gray-bellied salamander .Two forms exist with the many-ribbed salamander, *E. multiplicata multiplicata* (Cope ) occurring more southerly in north central Arkansas and ranging through west central Arkansas into southeast Oklahoma. The gray-bellied salamander occurs from south central Missouri to northwest Arkansas. Interestingly, Dundee (1965 :21.1) does not show the range into Kansas or extreme northeast Oklahoma. Intergrades are known.

**Description:** The adult is characterized by a brown middorsal stripe bordered by a dark line on each side. Sides are flecked with silvery-white marks. Venter is pale gray to yellow with large patches of dark pigment. Larvae reach 106 mm in length. Neotony is reported from some cave populations (Dundee 1965:21.1).

### 2. Life History and Ecological Information

Little is known of this species in Kansas. Ireland (1970) collected the only known specimens ( all larvae ) from a single site in Schermerhorn Cave spring in Cherokee County. Collins (1993) reports internal fertilization with breeding occurring from October to June. Larvae are gilled and occur in cave waters or loose gravel of springs. Larvae may metamorphose into adults or remain neotenic. It is speculated that the diet consists of small invertebrates.

## C. Grotto Salamander *Typhlotriton spelaeus* Stejneger

### 1. Taxonomy and Description

**Original description:** *Typhlotriton spelaeus* Stejneger, 1893:116. Type-locality, "Rock House Cave, [Barry County], Missouri." Holotype, U.S. Nat. Hist. Mus. 17903, collected 24 July 1891, by F.A. Sampson. No subspecies are described (Brandon 1965).

**Taxonomic discussion:** Two species of Grotto salamanders are described: *T. spelaeus* and *T. nereus*. *T. nereus* designation is suspect. Dowling (1957) synonymizes it with *T. spelaeus*. *T. nereus* is described as exhibiting neotony and having 20 -21 trunk vertebrae; while *T. spelaeus* has 19 (Bishop 1944).

**Description:** Usual adult size is between 45-55 mm, snout to vent. Total length for adults ranges from 75-121 mm (Collins 1993). The tail makes up 54 percent of total length. The salamander has very small eyes as an adult, often fused shut. The head is broad and flattened. Dark pigment uniformly distributed over the dorsum provides a light flesh to brownish purple color.

### 2. Life History Information and Habitats

This specimen as an adult, is restricted to cave interiors. Larvae however can be found in streams and springs on the surface.

The Kansas Biological, Survey (2000) records list seven locations of occurrence in Kansas. Most collections of specimens have been made in Schermerhorn Cave and spring. Several other locations include spring-fed pools, springs along Shoal Creek, pools near Riverton, and even two ponds in a pasture.

Schermerhorn Cave has been the site of several collections and observations. Collins (1982) found larvae in the twilight zone as well as a nearby spring. Beard (1986) and Young (1986) found larval specimens far into the cave interior. Lorraine (1983) found larvae in the cave as well as in a roadside spring below a forested slope. Rundquist and Collins (1977) estimated 5 to 10 larvae per square meter of the stream at Schermerhorn Cave. Most recently, collections by Taggart (1992) confirm the grotto salamander's continued presence.

The smallest larvae known were 23 mm. Transformation to adults occurs between 85-96 mm. Eyes of larvae are functional but degenerate. Only one adult specimen has been collected in Kansas, all others being larvae (Collins 1993). Collins (1993) speculates that this species most often occurs in the state in a sexually mature larval form.

Courtship and egg deposition have not been observed in Kansas nor have food habits been investigated. Clarke (1970) speculates that food items consist of small aquatic invertebrates.

## D. Long-tailed Salamander

### 1. Taxonomy and Description

**Original Description:** *Eurycea longicauda* (Green) S(alamandra) *longicauda* Green, 1818:351. Type-locality, New jersey," restricted to the "vicinity of Princeton" by Schmidt (1953:33).

No type known to exist. *Eurycea longicauda* Stejneger and Barbour, 1917:19. New combination.

### Kansas Form

*Spelerpes melanopleurus* Cope, 1893:383. Type-locality, "Railey's (Riley's?) Creek, one of the head tributaries of the White River," Missouri, Syntypes: Acad. Natur. Sci. Philadelphia 10456-60 (10457-10459, examined by author, are recently transformed individuals that do not show adult color pattern). (Ireland 1979).

*Spelerpes stejnegeri* Eigenmann, 1901: 189, Type-locality, "Rock House Cave [Barrie County], Missouri." Location of holotype unknown. "Co type" (parotype) Mus. Comp. Zool. 2551 identified by author as *E. l. melanopleura*.

*Eurycea melanopleura*: Stejneger and Barbour , 1917: 19. First use of combination.

*Eurycea longicauda melanopleura*: Bishop, 1943:428. First use of trinomial.

**Taxonomic Discussion:** Three subspecies on *Eurycea longicauda* are recognized: *longicauda*, *melanopleura*, and *guttollineata*. Intergrades between *E. l. melanopleura* and *E. lucifuga* are known from Arkansas (Smith 1964). Some records of various reported intergrade of subspecies have been examined without consensus.

**Description:** *E. l. melanopleura* is reported to be the smallest form of this species; the largest specimen examined by Ireland (1979) being 64 mm SVL. Collins (1993) describes the largest Kansas specimen having an S-V length of 55 mm and a total length of 143 mm. Collins (1993) describes the salamander as very slender; with fourteen or less vertical grooves between front and hind limbs, and dark areas positioned laterally running from the snout to the tail. Black spots on the dorsal surface may be in rows or appear irregular. Belly is dull white or pale yellow.

### 2. Historical and Current Distribution

The species, *E. longicauda*, occurs from southeast Kansas and northeastern Oklahoma across northern Arkansas and southern Missouri all the way to the east coast of the U.S., northward to southern New York and southward through Mississippi, Alabama, and Georgia.

The form found in Kansas, *E. l. melanopleura*, is limited in distribution to those portions of Kansas, Arkansas, Oklahoma, and Missouri which are made up by the Boston Mountains and the Ozark Plateau. The subspecies occurs eastward in west-central Illinois where its range overlaps with *E. l. longicauda*. Intergrades of these forms occur in this area and eastern Missouri.

Distributions in Kansas are limited to Cherokee County where its occurrence has been reported in streams, under the ground, or in caves depending on temperature (Collins 1993). Collins (1993) describes Kansas collections and reported sites are plotted (Figure 5).

### **3. Life History Information**

Population data is lacking in Kansas and food habits for Kansas individuals have not been reported, however Collins (1993) indicates invertebrates such as spiders probably comprise *E. l. melanopleura* diets.

Breeding occurs from November to February. Internal fertilization results in approximately 90 eggs being laid on the underside of rocks, in single rows.

Larval individuals metamorphosize at seven months and larvae possess gills. Habitat of the larvae appear to be in streams.

## **III. Ownership of Species' Habitats**

Of significance, Schermerhorn Cave is located within a city park owned by the city of Galena, Kansas. The cave and its management are overseen by the Kansas Department of Wildlife and Parks. The U.S. Fish and Wildlife Service has provided support in a number of maintenance activities associated with the cave. Most other areas of occurrence for all listed species are on private land.

## **IV. Potential Threats to Species or their Habitats**

Collins et al. (1995) suggests groundwater contamination and human disturbance as the primary threats to all species and habitats reviewed in this report. Because locations of occurrence are often in areas of rock outcrops, the threat of land disturbance by development is somewhat minimized. However, development in more upland areas which contribute to recharge of springs and cave springs is of concern.

Generally stream banks and associated rock outcrops containing springs are areas not utilized for any particular purpose (Collins 2000, personal communication). Such areas could be afforded long term protection through fencing and in some cases, conservation easements.

## **V. Protective Laws**

### **A. Federal**

A number of federal laws may be of use in the protection of these species and their habitats. Most notably the U.S. Army Corps of Engineers administer a permit program under Section 404 of the Clean Water Act. This governs fill placed into streams and stream realignment projects. Section 401 of the Clean Water Act provides for state review of water quality impacts from such activities and while authorized by federal law is administered by the Kansas Department of Health and Environment (KDHE). KDHE also issues NPDES permits from point source discharge. The U.S. Fish and Wildlife Coordination Act provides for review and comment of both state and federal agencies concerning fish and wildlife impacts for any federal or nonfederal project which is approved by a federal agency that serves to impound, deepen the channel of, or otherwise control, pollute, or modify waters of the U.S. for any purpose whatsoever. Other federal laws may be relevant in specific instances. For review of applicable major federal laws affecting Kansas fish and wildlife, see Layher (1985).

### **B. State**

#### **1. Permitting Requirements**

Several state statutes, regulations and procedures may be invoked related to habitat alteration associated with the four species of salamanders. K.A.R. 115-5-1 and 2 list species, which are declared to be threatened and endangered. K.A.R. 115-15-3 provides for a permit system including review of habitat alterations. The permit program and review system is administered by the Kansas Department of Wildlife and Parks. This allows for the critical review of projects potentially affecting salamander habitats. Based upon the review, projects may be accepted, modified, or revoked.

Various permit requirements of other agencies require permits if such developments alter stream discharges; request dam construction, or alter streams and/or floodplains. Most such requirements come under the scrutiny of the Division of Water Resources of the State Board of Agriculture. Permits applied for through this office are sent out to be reviewed by KDWP as a result of the Water Projects Coordination Act, which was designed to simplify the state's overall permitting systems and allow fish and wildlife interest review. Projects identified as potentially impacting a threatened or endangered species would require appropriate permits as well as from KDWP.

KDWP has entered into several Memorandum of Understandings (MOU's) with other agencies, notably the Kansas Department of Transportation, which aids in the identification of road and bridge projects in areas with threatened or endangered species. This MOU has been in force for years and was recently revised February 2000.

Many other permit systems may be activated through a variety of agencies. For a comprehensive review see Monda et al. (1992).

## 2. Critical Habitat Designation

The Kansas Department of Wildlife and Parks has designated the following locations as critical habitat for the four salamander species discussed herein as follows:

For *Typhlotriton spelaeus*; *Eurycea multiplicata griseogaster*; and *Eurycea lucifuga*: All caves and associated spring flows within that portion of Cherokee County lying south and east of a line beginning at the Kansas -Missouri border junction with U.S. Highway 66 at Sec. 13, T34S, R23E, then extending westerly and southerly along

U.S. 66 to the Kansas -Oklahoma border at Sec. 14, T35S, R24E. For *Eurycea longicauda melanopleura*: All suitable wetlands, waters, and moist woodland bottomlands occurring within that portion of Cherokee County lying south and east of a line starting at the Kansas-Missouri border at Kansas Highway 96 in the Southeast 1/4 Sec. 12, T33S, R23E, then extending west along K-96 to its junction with U.S. Highway 26 at the northeast corner Sec. 18, T33S, R23E, then south along K-26 to its junction with U.S. Highway 66 at southeast corner Sec. 18, T34S, R23E, then south, and west along U.S. 66 to the Kansas -Oklahoma border at Sec. 14, T33S, R24E.

## VI. Recovery Criteria

### A. Additional species information needs

#### 1. Biology -life history

Of the four species discussed in this report, none are listed federally as threatened or endangered. The range in Kansas however is quite restricted to a small area overlying the Ozark Plateau and represents an edge of the range of each species reviewed. There is currently a paucity of data to clearly indicate that population or range reductions for these species have occurred in Kansas. However, Lorraine (1983) notes several previous locals of occurrence no longer contain suitable habitats for noted salamander species. Collins et al. (1995) indicates "human disturbance and groundwater pollution in Cherokee County limestone caves and in streams flowing outside these caves have caused a decline in populations of these amphibians in Kansas". This is reported for all four species.

Generally, similar information is needed for the cave salamander, longtail salamander, and grotto salamander in Kansas. Little is known of the distribution of the species except that they are restricted to the Ozark Plateau. Most collections have occurred over the years at the same locales sampled time and again. Therefore, an intensive survey of tributaries of Shoal Creek and the Spring River are needed. It is suspected that many springs, seeps, crevices, and small caves exist which may provide habitat for this species.

Little life history details of Kansas populations of these species have been studied. A paucity of information exists ranging from courtship, food habits, age distributions to microhabitat use. We would recommend a comparative ecology study of the three species, especially at a locale where all three occur such as Schermerhorn Cave.

With regards to the many-ribbed salamander (graybelly salamander) in Kansas; the most urgent requirement is documentation of occurrence. While previously listed as a Kansas resident, the few specimens collected by Ireland (1970) appear suspect, and may represent misidentified larval forms of another species (Collins 2000, personal communication). Reviews are currently underway and publication of this information and proper identification of the larval specimens will soon be forthcoming. It appears that this species may not actually occur in Kansas, however until specimens are reviewed and positively identified, the only recorded location currently showing the species existence is given on page 28, which is now suspect.

**B. Management activities for maintaining species populations and for species recovery**

1. Areas of known collections for all species discussed should be reviewed for eligibility of enrollment in EQIP, WHIP or similar programs. EQIP can often pay up to 90% of the cost of fencing and other practices to protect sensitive stream-type habitats. Springs, seeps, and associated environs should be eligible for such assistance. Identifiable streams without riparian corridors are eligible for Conservation Reserve Program continuous signups to revegetate stream banks (CP 21).
2. Recharge areas for cave streams should be identified, especially that of Schermerhorn Park Cave.
3. Once identified, a program to educate the public as to the cave's uniqueness should be implemented. This could perhaps be approached through media, schools, 4-H clubs, etc.
4. An effort to clean the recharge area of items which might contribute to nonpoint source pollution and contamination of the underground stream passing through Schermerhorn Cave should be implemented.
5. The crevice or drain in the twilight area of Schermerhorn Cave should be evaluated by a competent archeologist to determine if it is natural or man-made. If man-made, sealing this drain would produce pooling in the twilight zone and afford increased salamander habitat and continuity from cave to outside streamflow transition.
6. Kansas should gain representation in the Karst Ecosystem Support Team. This is a team designed to work across state borders and contains members from the U .S. Forest Service, the U .S. Fish and Wildlife Service, the National Park Service, state wildlife agencies, state heritage commissions, universities, and the Nature Conservancy . Chairman of the group is currently Ms. Ray Nilus, U .S. Fish and Wildlife Service, Ecological Services Office, 1500 Museum Road, Suite 105, Conway, AR 72032 (phone 501-513-4472). This group formulates avenues to address research needs and management opportunities across the Ozark Plateau.

7. The State of Kansas (KDWP) should request assistance from the Nature Conservancy regarding implementation of items 1 through 5. This organization currently employs a biologist to address protection of Ozark caves across the Springfield Plateau. While current efforts are restricted to this plateau future plans include expanding to the other two plateaus of the Ozarks. This expansion should include that portion of Cherokee County where the discussed salamanders occur. This organization has already conducted community cleanup days in recharge areas, implemented conservation techniques on private lands, and protected karst habitats in Oklahoma, Arkansas, and Missouri. For further information contact:

Western Ozarks Karst Ecosystem Project  
Tim Snell, Project Director  
The Nature Conservancy  
P.O. Box 222  
Winslow, AR 72959

8. All habitats and locales of occurrence identified in an intensive survey (see VI. A) should be evaluated as to potential disturbance. Due to the rocky stream banks and nature of areas where these organisms occur, it may be that little threat from agricultural land use exists. All areas identified should be evaluated for potential enrollment in a conservation easement program which would allow landowners to retain all private property rights including control of trespass, but afford habitat protection in perpetuity. Easements may be paid for or donated and used as tax deductions. The tax credit program available for sensitive species (K.S.A. 79-32,203) should be employed as applicable for this area and these species.

**C. Information and educational programs for public and private lands**

1. Provide brochures or informational leaflets to landowners, cities, and schools near areas of or in areas potentially affecting habitat of the three salamanders discussed in this report known to exist in southeast Kansas.
2. Encourage local individual and group (biology classes, 4-H clubs, etc.) to participate in a plan to adopt certain areas of known salamander populations. Activities could include cleanups of cave recharge areas, fencing, etc.
3. Relay results of surveys in report form to other agencies in Kansas engaged in permitting activities that may affect habitats of the salamanders .
4. Provide reports and brochures for public awareness to the Cherokee County Conservation District and USDA office to encourage and accelerate conservation plan development on farms containing suitable habitat or known salamander populations.

## **D. Downlisting and delisting criteria**

### ***Eurycea multiplicata* (Moore and Hughes), many-ribbed salamander**

This species appears to be listed as occurring in Kansas based upon misidentification of larval specimens and has only been reported from Schermerhorn Cave (Collins 2000, personal communication). As soon as results of analysis of species are reported in the literature verifying the misidentification, this species should be removed from all lists: endangered, threatened, and species in need of conservation (SINC) as no known records of occurrence exists other than the misidentified individuals. This can be executed in 2001.

### ***Eurycea lucifuga* (Rafinesque), cave salamander**

### ***Typhlotriton spelaeus* (Stejneger), grotto salamander**

These two species have been reported from approximately seven locations each. We would recommend that after the intensive survey (see VI. A.1.), if twenty or more locations of occurrence are documented, that the respective species be downlisted from endangered status to threatened. If 80% of conservation easements or areas are enrolled under EQIP or related plans (at least 16 such sites), the species should be downlisted to SINC status. If populations remain with no habitat degradation after five years, the respective species should be removed from all lists. The survey could be completed in 2002. Conservation program implementation should be accelerated in 2002 after survey results are available to depict sites of occurrence. Habitat surveys should be completed in 2006 to document any changes to habitats over the five year period.

### ***Eurycea longicauda melanopleurus* (Cope), long-tailed salamander**

This species is currently listed as threatened by Kansas statutes. It has been reported at nearly 14 sites in Cherokee County. If after survey results, the species occurs at upwards of twenty locations, it should be downlisted to SINC status, if 80% of the sites or 16 locations have protective measures applied such as conservation easements or appropriate farm plan programs. After a five year period, sites should be sampled to ascertain continued occurrence. If all sites continue to harbor the species, it should be removed from SINC status. Conservation program implementation should be accelerated in 2002 after survey results are available to depict sites of occurrence. Habitat surveys should be completed in 2006 to document any changes to habitats over the five year period.

## **VII. Costs for Recovery Plan Implementation**

Life history information for all four salamander species addressed in this report are needed for Kansas populations. The most urgent need is a survey of streams, caves, seeps and ponds within the designated critical habitat area. Such a survey would require \$10,000 to \$15,000 to complete.

Life history and comparative ecology studies for the species, once locations of populations were identified, could be completed for approximately \$10,000 utilizing a graduate student(s) from local universities.

**The following costs are estimated for management activities listed by numbers corresponding to items found in section VI. B.**

- Item 1:** No additional costs. KDWP personnel can coordinate and cooperate with the district conservationist to utilize existing USDA programs to protect habitats.
- Item 2:** Costs not estimated.
- Item 3:** Costs could be part of existing KDWP programs in the area and duties assumed by local personnel.
- Item 4:** Volunteer efforts could be fostered to conduct cleanups within the recharge area with coordination performed by local KDWP personnel.
- Item 5:** Primary costs would be for a competent individual to examine this cave area and determine if the drain is natural or man-made. Costs to seal this drain have not been estimated.
- Item 6:** This representation by Kansas would not require finances except for travel to attend meetings. This should be a duty assigned to an existing KDWP or related agency individual.
- Item 7:** This item reflects a coordination role which can be accomplished with existing agency personnel.
- Item 8:** This evaluation of sites of occurrence would be conducted most easily as a part of the survey for sites of occurrence. If done in this manner it would not require additional funds.

**Costs for items listed under Section VI. C are as follows:**

- Item 1:** Color brochures can be developed and printed for approximately \$1,500 per 1,000 brochures.
- Item 2:** Encouragement of local group participation in conservation efforts should be an ongoing task of locally stationed KDWP personnel.
- Item 3:** The distribution of survey results to offices conducting work potentially benefiting or disturbing salamander habitats is not expensive. Related entities should be coordinated with and receive reports in mailings.
- Item 4:** These costs would be limited to distribution of materials whose costs to develop have already been estimated.

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