Habitat Conservation Plan

Least Brook Lamprey, *Lampetra aepyptera*
Indiana Crayfish, *Orconectes indianensis*

City of Marion, Illinois

Kenneth S. Mierzwa
Tanya E. Copeland

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TAMS Consultants, Inc.
AN *EARTH TECH* COMPANY
1 E. Wacker Drive Suite 1200
Chicago, IL 60601

Section 1

Project Description

Introduction

This document is an updated and expanded version of a Conservation Plan originally submitted to the Ilinois Department of Natural Resources (IDNR) on July 5, 2001. New information, based for the most part on field work conducted in the spring of 2002, has been included throughout the document. The additional field work, and interpretation and analysis based on that field work, was conducted in response to February 2002 requests for additional information by the Illinois Department of Natural Resources.

The Conservation Plan addresses incidental take of the state threatened least brook lamprey, *Lampetra aepyptera*, and the state endangered Indiana crayfish, *Orconectes indianensis*. A third state listed species, the Northern Harrier, *Circus cyaneus*, was recently reported from the project vicinity. The documented nest site is outside of the proposed reservoir basin and is not on land controlled by the applicant, and there will be no take of this species. As a result, that species is addressed only briefly by this document. IDNR has agreed to monitor the nest site in future years. Only a narrow buffer strip of upland habitat will exist post-project; if Northern Harriers should nest on City owned land at some time in the future, the City will attempt to minimize access and disturbance in the nest vicinity and will confer with IDNR to determine if any additional action is necessary.

Description of the Project Area

The proposed Marion Reservoir project area is located just south of Creal Springs, and includes portions of Williamson and Johnson Counties, Illinois. Approximately 6.2 miles of Sugar Creek, a medium-sized stream, about 3.0 miles of Maple Branch, a tributary of Sugar Creek, and a segment of another small, unnamed tributary will be directly impacted by the proposed actions. The project area is within the Shawnee Hills, and about 1,172 acres of rolling to hilly upland adjacent to the streams will also be affected (Figure 1-1).

The proposed project area includes all land under the normal pool elevation of 496 feet (msl), and upstream of the dam location south of Illinois Route 166. A narrow buffer strip above the 496 foot contour is intended to include the 100 year floodplain. A narrow riparian corridor between the dam location and Route 166 is also included in the project area. The City of Marion has acquired all land within the project area (Figure 1-2).

Sugar Creek consists mostly of a series of deep pools, and much of the lower half of the project area is too deep to be easily wadeable under normal flow conditions. Shallow gravel and cobble riffles are interspersed throughout this stream segment, but make up a relatively small percentage of total stream length. Several small to moderate size rock outcrops are present along the stream.

Maple Branch is much smaller and consists of alternating shallow pools, riffles, and runs. A few deeper pools are present. The middle portion of Maple Branch includes areas of bedrock substrate. Headwater reaches are shallow and ephemeral.

Upland surrounding both streams is for the most part level close to the bank, rising into surrounding hills. Vegetation consists of early successional shrubs, tree saplings, and dense herbaceous growth. The lowermost part of the stream corridor, close to Route 166, is forested, as are some surrounding hills above the proposed pool elevation.

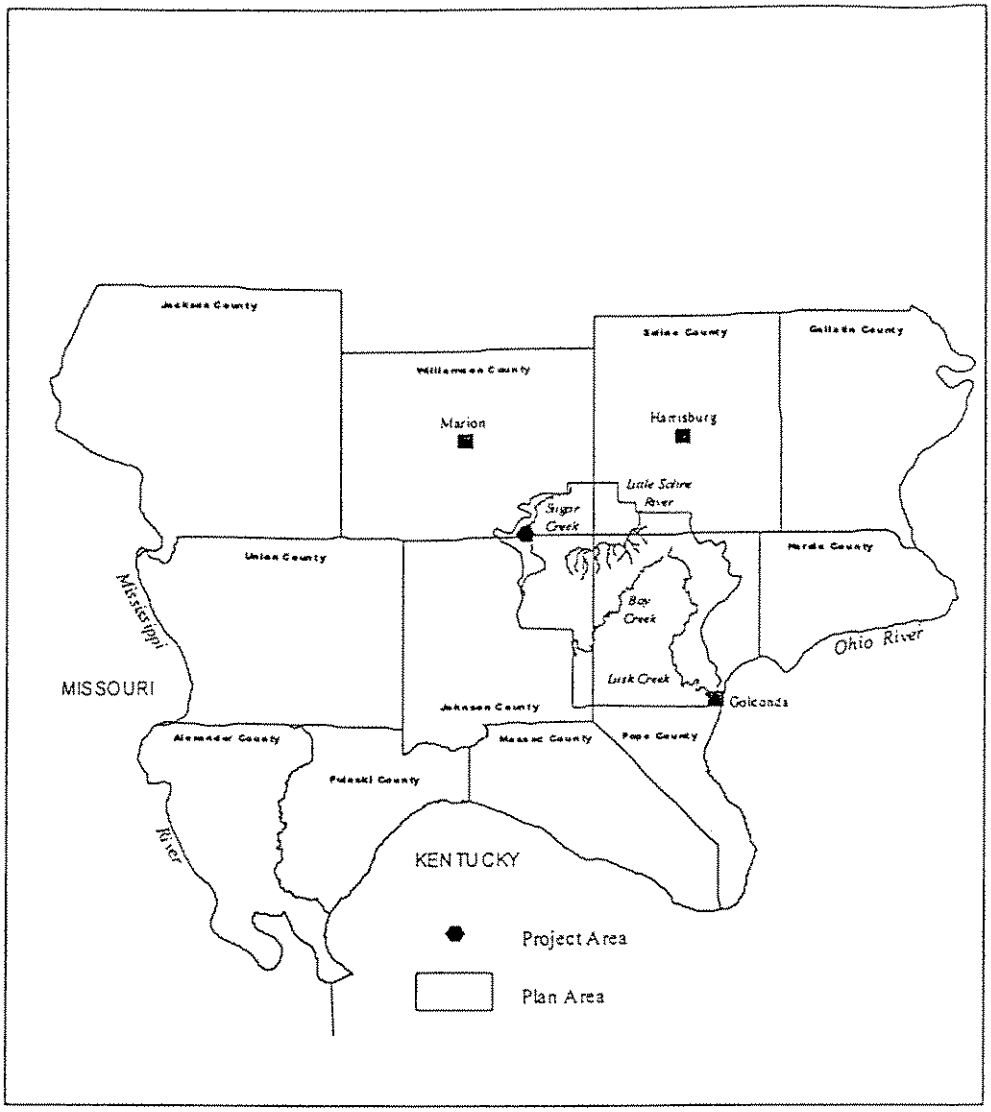

Figure 1-1. Vicinity map, showing the proposed Marion Reservoir project area and the larger plan area.

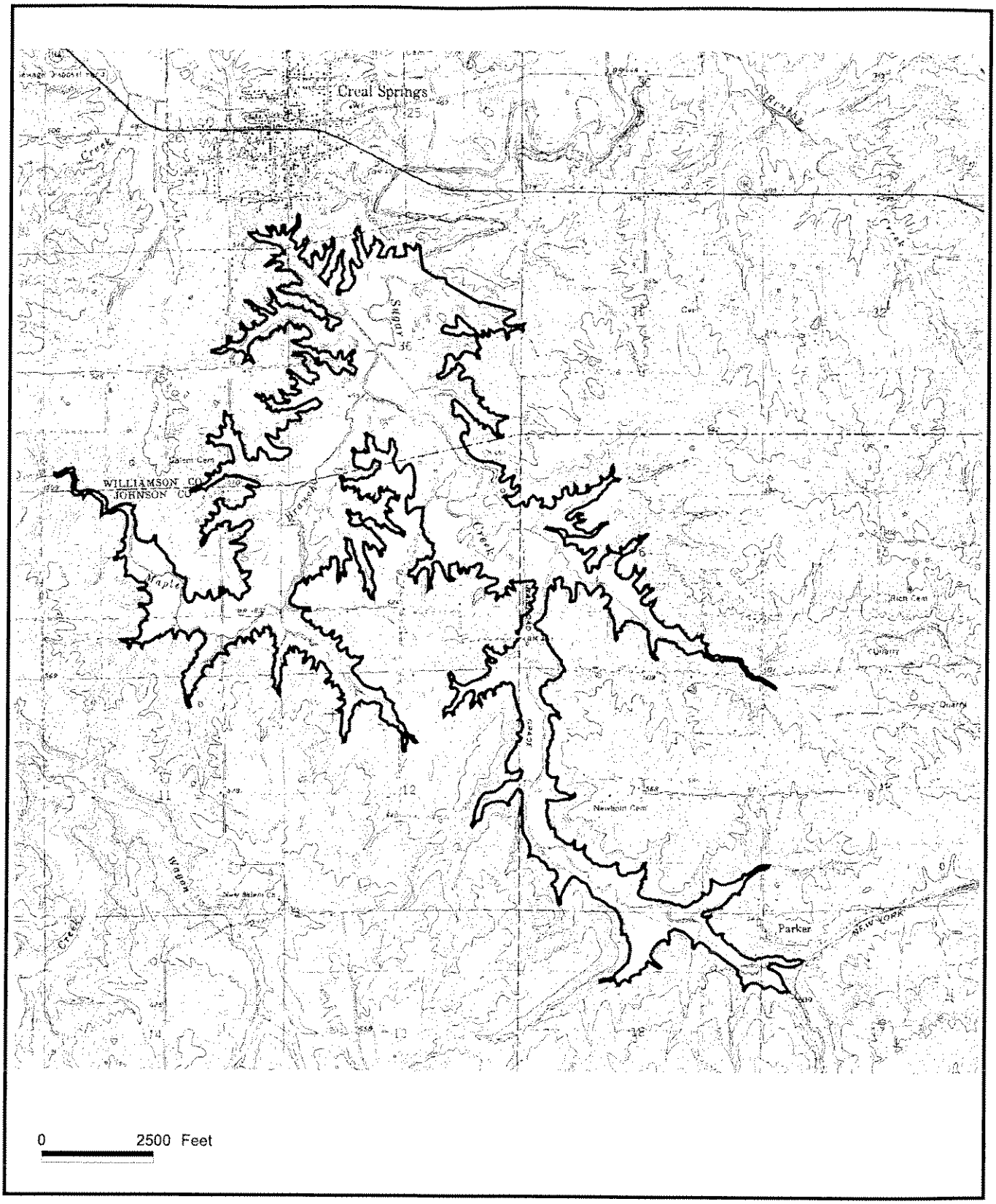

Figure 1-2. The proposed Marion Reservoir project area.

Basemap: Creal Springs, USGS Quadrangle, Digital Raster Graphic

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Sugar Creek is part of the Saline River drainage, and other segments of the overall stream system will be referenced in this document.

The lower 4.5 miles of Sugar Creek have been severely impacted by runoff from the abandoned Palzo mine. No live fish were collected from the lower reaches of Sugar Creek in 1993 (Day et al., 1995). Degradation continues into the South Fork of the Saline River. Much of the Saline drainage has been affected by mine runoff, oil field contamination, channelization and agricultural activity. Although most of the South Fork of the Saline River has been affected to some degree by these activities, good quality segments remain. The upper portion of Sugar Creek, above the Palzo mine, has been identified as one of the higher quality streams in the Saline drainage (Day et al., 1995). Portions of the Little Saline River and some of its tributaries are also of relatively good quality.

Description of the Proposed Activity

The City of Marion has proposed construction of a dam on Sugar Creek approximately 7.9 miles above the confluence with the South Fork of the Saline River. The resulting reservoir would inundate 1,172 acres of surrounding land, to an elevation of 496 feet (msl). An additional 203 acres of land have been acquired as a buffer strip around the reservoir. Details of the proposed activity are included in a separate Environmental Impact Statement issued by the U.S. Army Corps of Engineers (2001). Impoundment of Sugar Creek would permanently flood areas known to support populations of the state threatened least brook lamprey and the state endangered Indiana crayfish.

Quantification of Anticipated Take

The least brook lamprey is known to occur at one location within the proposed reservoir basin, and at a second location downstream of the proposed impact area. The Indiana crayfish has been reported historically from four locations within the project area, and we have documented presence at numerous additional locations during the present study.

Habitat will be lost for both species as a result of the proposed activity. It is not known whether individual animals will be able to move upstream in advance of slowly rising lake waters, or whether the replacement of riverine by lacustrine habitat will result in mortality. The least brook lamprey and Indiana crayfish are almost certainly unable to utilize lacustrine habitat, which has very different temperature profiles, dissolved oxygen levels, and other physical characteristics. Fish and invertebrate assemblages in lakes tend to differ considerably from those in streams. Approximately 6.2 miles, or 32,736 feet, of the mainstem of Sugar Creek and 3.0 miles, or 15,840 feet, of Maple Branch will be within the proposed impoundment.

To determine the number of individual animals within the project area, we modified methods developed in the Pacific Northwest for endangered salmonids (Hankin and Reeves, 1988) and stream amphibians (Welsh et al. 1997). Application of these methods, utilizing a stratified random start and systematic sample design, resulted in an estimate of area for each habitat type within each stream in the project area. Direct stream sampling produced Indiana crayfish density figures for each habitat type in each stream segment, allowing an estimate of total crayfish abundance.

Details of sampling methods are provided in the monitoring portion of Section 3 of this document. Detailed sampling was conducted March 22-28 and June 2-11, 2002, with some subsequent habitat area estimates for deeper portions of lower Sugar Creek completed on August 13. Water levels and flow rates were slightly higher than normal during the March and June events.

We were able to capture Indiana crayfish relatively easily, and are thus able to provide detailed quantitative information on abundance in the project area. We did not capture any least brook lampreys in Sugar Creek, even though we were able to locate the species with relative ease during the March sampling period on Hunting Branch and Lusk Creek. On each of those streams, we captured a least brook lamprey within the first 15 minutes of effort. On Sugar Creek, we did not observe any during 23 hours of instream effort in March or 42 hours of instream effort in June.

Most historical sampling events in Sugar Creek have produced either one or no least brook lampreys. Only two visits have produced multiple captures (Sauer and Schanzle, 1993; Weitzell et al., 1998), and those papers include only raw abundance (not density) data. We found little information in the literature on related species.

Least brook lamprey estimated take

No least brook lampreys were captured in Sugar Creek during 2002 sampling. Because of the random and systematic study design, we did not sample the two historic riffles. However, we did sample others which included potentially suitable habitat, without success. A review of the literature and of museum specimens indicates that despite a considerable amount of effort, a total of only 11 least brook lampreys have been captured in Sugar Creek since the 1952 discovery of the species in Illinois. None have been reported there since 1999. Given the apparent rarity of the species in Sugar Creek and the very small available sample size, direct abundance estimates from field data are not possible. Instead, we have been forced to rely on a combination of historic adult capture data for Sugar Creek, larval (ammocoete) size class information from other streams where the species is more common, and detailed habitat information for the project area. This requires reliance on several assumptions, and the resulting estimates must be considered approximate.

We assume that size class data reported by Burr and Stewart (1999) for Illinois populations correlates with age classes. Growth rates will vary to some extent among individuals and populations, but we assume that discrepancies are minor.

Because young of the year are clearly under-represented in available datasets, we assume that linear extrapolation of abundance curves can provide a reasonable estimate of the actual (larger) age-0 size class abundance. We are also forced to extrapolate to correlate adult and larval numbers. We further assume that mortality is greater for the youngest animals and that survival rates increase with age, as has been shown for many better-studied animals. This method estimates that 105 ammocoetes are present for every one adult (99.1 percent ammocoetes). This figure exceeds the maximum 83 percent ammocoete ratio cited by Stone et al. (2002) for a composite sample of two western species. Their sample included one migratory species with longer-lived adults, so would be expected to differ.

We assume that most but not all breeding adults are present in a given riffle at peak spring season. Available evidence for this and other species of *Lampetra* indicates that males may spend more time at breeding sites than females (Burr and Stewart, 1999; J. Bayer, pers. comm.).

Finally, for our maximum impact estimate, we make the conservative assumption that all four Sugar Creek riffles with coarse rocky substrate, high spring flow rates, appropriate depths, and nearby sand and organic bottomed pools are capable of supporting breeding aggregations; that each riffle supports more than the maximum number of adults taken in the single most productive historical sample; and that impacts will extend well downstream of the dam. The species has actually been documented at only two of the four riffles which meet the above description. One of these is above the proposed dam site, and one is about one-half mile downstream.

The minimum impact estimate assumes that the species is only present at the sites where it has actually been documented, at slightly over the maximum number documented at each site; and that impacts will be limited to direct habitat loss within the reservoir basin.

Based on these assumptions, we estimate a maximum take of 2,548 least brook lampreys, and a minimum take of 636.

Indiana crayfish estimated take

Indiana crayfish sampling was very successful, with a total of 49 specimens observed in March and another 126 in June. We were able to calculate density and total estimated abundance by habitat type for Sugar Creek and Maple Branch. Total population estimates are presented in Table 1.1. The precise level of take will vary depending on when the impact occurs.

We estimate the maximum Indiana crayfish take in the project area at 18,876 individuals, and the minimum take at 3,285 individuals. These estimates are based on quantitative seasonal sampling and size class data. The maximum population size occurs in late May or early June, just after young of the year have become free swimming. Predation rates on juvenile crayfish are probably high, and population size is expected to gradually decrease to an annual low in March, after winter stress but before juvenile recruitment. If most reservoir fill occurs in winter and early spring, it will be possible to minimize take. Details and documentation for these estimates are included in Sections 2 and 3 of this document.

Table 1.1. Indiana crayfish estimated abundance within the project area, by stream segment

Stream segment	Available stream area (m2)	Estimated maximum no. of crayfish (June)	Estimated minimum no. of crayfish (March)
Upper Sugar Creek	32,768	5,336.3	1,009.3
Lower Sugar Creek	28,542	7,890.4	1,294.4
Maple Branch	7,656	5,649.5	981.2
Total	**68,967**	**18,876.2**	**3,284.9**

Section 2

Characterization of Affected Species

Least Brook Lamprey *Lampetra aepyptera*

Lampreys are primitive jawless fishes, with cartilaginous skeletons. They are widely distributed. The larval form, known as an ammocoete, burrows in soft substrate or detritus and is a filter feeder. After several years the larvae achieve metamorphosis. There are two general post-metamorphosis strategies. Some species migrate to the ocean or to large freshwater bodies, become parasitic on larger fish, and then return to the stream of origin to spawn and die. Other species, including the least brook lamprey, are non-parasitic. They remain in streams, do not feed as adults, and spawn within several months of reaching the adult stage.

Seven species of lampreys are known historically from Illinois (Smith, 1979). The best known of these is the sea lamprey, a parasitic species which invaded Lake Michigan around 1930 and became a destructive pest. Three species are presently known to occur in extreme southern Illinois: The parasitic chestnut lamprey, *Ichthyomyzon castaneus*, the parasitic silver lamprey, *Ichthyomyzon unicuspis*; and the non-parasitic least brook lamprey, *Lampetra aepyptera*.

Description

The least brook lamprey, *Lampetra aepyptera*, is a small (up to about seven inches, or 180 mm; most individuals 3.5 to 5.0 inches), non-parasitic lamprey (Figure 2-1). The long dorsal fin is divided by a deep notch. Adults are gray, with lateral mottling often present, and usually with a dark blotch in front of the gill opening (Etnier and Starnes, 1993; Smith, 1971).

Life History

Least brook lampreys spawn in the spring, at water temperatures of 10-16 degrees C (Etnier and Starnes, 1993). Pflieger (1975) observed spawning in Missouri from mid-March until mid-April. Individual lampreys clear a small pit nest by attaching to a stone and using rapid undulations of the body to clear away gravel (Brigham, 1973). Each female deposits over 1,100 eggs (Seversmith, 1953). The larval, or ammocoete stage lasts at least three years (Pflieger, 1975), and probably four years in Illinois (Burr and Stewart, 1999). Metamorphosis occurs in the fall. Adults overwinter and spawn the following spring.

In Pope County, Illinois spawning occurs from mid-March to mid-April at water temperatures of 8 to 16 degrees C (Burr and Stewart, 1999). Males arrived at the spawning sites first. Gravid females ranged from 122 to 168 mm in total length, and contained from 1,921 to 4,142 eggs (Burr and Stewart, 1999).

Population Structure and Demographics

Burr and Stewart (1999) provide measurements for 28 adult and 59 ammocoete least brook lampreys collected in 1998 and 1999 in southern Illinois. Table 2.1 shows frequency by size class for ammocoetes, using the dataset supplied by Burr and Stewart (1999).

Table 2.1 Least brook lamprey size classes

Category	Size range	No.
Size class 0	68-71mm	6
Size class I	75-105mm	27
Size class II	106-128mm	17
Size class III	131-145mm	8
Size class IV	159-165mm	3

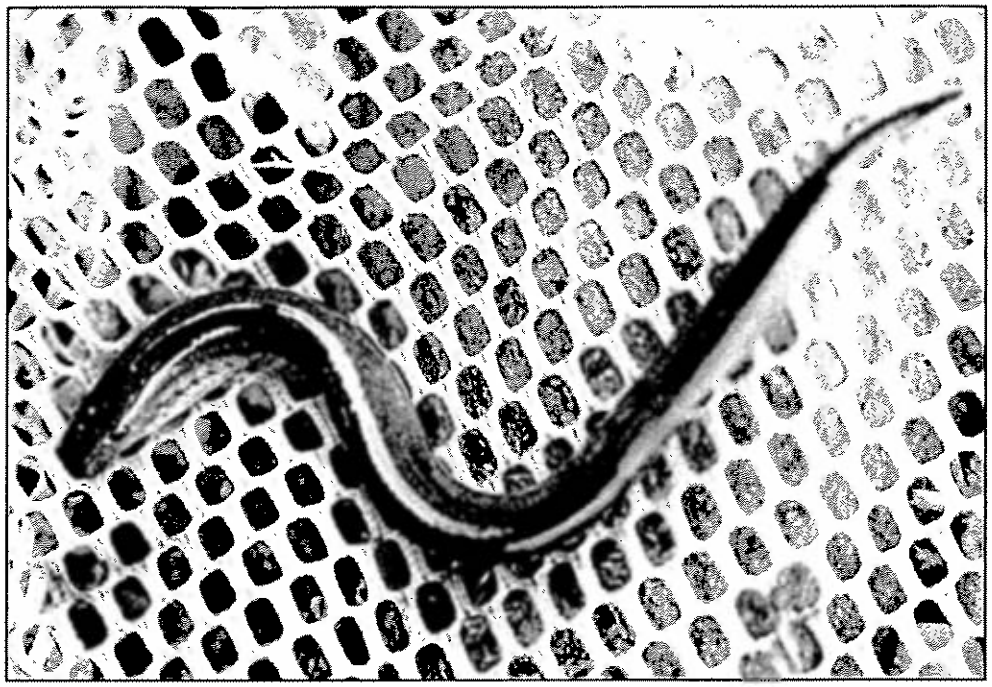

Figure 2-1. A least brook lamprey from Lusk Creek, Pope County, Illinois. The photograph was taken on March 28, 2001.

Figure 2-2. Least brook lamprey spawning habitat on Lusk Creek.

Burr and Stewart (1999) inferred that size classes were approximately equivalent to age classes, and that the life span of the least brook lamprey extends for about 4.5 years in the ammocoete stage, and approximately an additional six months as an adult. Based on other literature and on an examination of their dataset, we believe this to be a reasonable assumption.

Size class 0 animals appear to be under-represented in the southern Illinois sample. It is not unusual for very young juveniles of many species to be cryptic and difficult to collect. Burr and Stewart (1999) noted that very small ammocoetes were sometimes found buried in loose sand, so habitat differences may account for some of the sampling difficulty.

Dispersal

No information is available on dispersal capabilities of the least brook lamprey. Ammocoetes are thought to drift downstream after hatching, with the distance presumably influenced by flow rates, distance to suitable habitat, and the presence or absence of obstructions.

Some other species of lampreys are migratory and are capable of moving long distances. Least brook lampreys are not migratory, in the sense that the entire life cycle is spent in streams. The present distribution in Illinois, in five different streams, implies that over a long time scale at least some individuals are capable of longer distance movements. Repeated captures of least brook lampreys in a few riffles but not in other nearby riffles implies that breeding site fidelity may be the more typical condition. In the absence of specific information, we assume that like many better studied animals, the majority of least brook lampreys spend their entire lives in relatively short stream segments, while a very small percentage of animals attempt much longer movements.

Stone et al. (2002) found that in the Columbia River basin, small ammocoetes of the pacific lamprey (*Lampetra tridentata*) moved involuntarily in association with high flow events, while larger ammocoetes moved independently of discharge. The pacific lamprey is a migratory species, so results may not be directly comparable.

Habitat

Adults inhabit small to medium sized streams, ranging from second to fifth order in Illinois, with clean gravel riffles. Ammocoetes drift downstream to quieter water, and are usually found among silt or detritus.

Pflieger (1975) provided a thorough description of habitat in the Missouri Ozarks: "decidedly a creek fish, occurring most abundantly both as adults and larvae in headwater streams and spring branches. Clear water, permanent flow, stable beds of silt and organic debris, and clean gravelly riffles are basic requirements for a stream if it is to support a population of the least brook lamprey."

Trautman (1957) also mentioned the use of small high-gradient brooks with sand and gravel riffles in Ohio. He noted that "ammocoetes... were particularly vulnerable to siltation, for the silting over of the beds of sand and organic debris destroyed their habitat... mine wastes and other pollutants had similar effects."

In Illinois, spawning takes place in streams which are on average 8.8m wide, 23cm deep, have a mean velocity of 0.46m/s, and with a substrate of gravel (73%), pebble, cobble, and sand (Burr and Stewart, 1999).

Stone et al. (2002) reported correlations between stream gradient, substrate type, water velocity, and dissolved oxygen and the presence of *Lampetra tridentata* and *L. richardsoni*. Their quantitative results appear to be consistent with more qualitative findings of earlier Midwestern studies.

The best known large Illinois population inhabits a segment of Lusk Creek. The stream is within a well developed floodplain, more than 50 meters wide on each side of the stream, and includes extensive riffle/run sequences extending for several hundred meters. Riffle substrate is about 60 percent gravel, 30 percent pebble, and 10 percent cobble over a bed layer of sand. Spring mean water depth at nest sites was 20cm, and mean water velocity was 0.51 m/s. A deep silt and organic detritus bottomed pool downstream of the riffles provides excellent larval habitat (Weitzell et al. 1998).

All of the known large populations in Illinois, in parts of Lusk Creek, Bay Creek, and Hunting Branch, are associated with streams of exceptional quality. We inspected the Hunting Branch site in late March 2002, and we were able to see nearly to the bottom of even the deepest pools despite recent heavy rainfall. We saw little evidence of siltation in any habitat type at that location.

General Distribution

The least brook lamprey is common in small streams draining uplands over much of the Ohio River basin, with disjunct groups of populations in the mid-Atlantic states and in part of the Ozarks.

Illinois Distribution

In Illinois, the species is known from five streams in the eastern part of the Shawnee Hills: From west to east, Sugar Creek, Bay Creek, Lusk Creek, Big Grand Pierre Creek, and Big Creek (Figure 2-3). Sugar Creek is part of the Saline River drainage, while the other four streams drain directly into the Ohio River. Rohde (1976) identified the first Illinois occurrence, and Smith (1979) verified two additional Illinois records. These records were based on specimens which had been collected much earlier but either overlooked or misidentified; the Sugar Creek specimens had been called *Entosphenus lamottenii* by Gunning and Lewis (1956). Weitzell et al. (1998) subsequently confirmed the presence of the least brook lamprey at all historical localities, and added new localities. Additional localities on the same streams were added by Burr and Stewart (1999).

Table 2-2. Illinois Localities for the Least Brook Lamprey

Locality Name
Sugar Creek (two, probably three locations within or adjacent to the project area)
Bay Creek drainage (six locations)
Lusk Creek (one location)
Big Creek (two locations)
Big Grand Pierre Creek drainage (four locations)

Extensive areas of the Shawnee Hills have not been sampled, or even inspected for the presence of potentially suitable habitat. For example, previous studies of this species have sampled fairly intensively on short segments of Bay and Lusk Creeks but not on other segments, and at only one location in the Little Saline River drainage (Burr and Stewart, 1999). It is possible that additional localities remain undiscovered.

Sugar Creek Distribution

We have been able to document only 11 verified reports of the least brook lamprey in Sugar Creek in the 51 years of available sampling data. Three of these were below the proposed impoundment, at the Illinois Route 166 bridge. The other eight were within the proposed reservoir basin. There have been three additional unverified observations of lampreys which eluded capture. Two of these were at the upper end of the proposed impoundment. Only one other lamprey species, the chestnut lamprey (*Ichthyomyzon castaneus*) has been reported to coexist with the least brook lamprey in Illinois, and it is not known from Sugar Creek. If the unverified observations are included, the total number of Sugar Creek reports is raised to 14. The following may help to place the apparent rarity of the least brook lamprey in Sugar Creek in regional context: More specimens have been captured in single day events at discrete sites in two other streams (Lusk Creek, August 4, 1998; Hunting Branch, April 6, 1999; each locality produced 19 specimens; from Burr and Stewart, 1999) than have been reported in 51 years from all of Sugar Creek.

Table 2.3 Chronology of least brook lamprey captures in Sugar Creek.

	Rt. 166 bridge ATHG-02	Low water crossing ATHG-04	Source
Jul 1952	1	-	Gunning and Lewis (1956) INHS 26942
Jan 1953	1	-	Gunning and Lewis (1956) INHS 26943
Sep 1989	0	1 adult	IDOC unpublished data INHS 65260
Jun 1993	0	0	Day et al. (1995)
Sep 1993	1 ammocoete	1 ammocoete	Sauer and Schanzle (1993) SIUC 22218, 22224
Mar 1998	0	5 adults	Weitzell et al. (1998)
Mar 1999	0	1 ammocoete	Burr and Stewart (1999)

Although there has to date been no direct observation of breeding activity in Sugar Creek, the repeated observation of adult lampreys in riffle habitat during the breeding season and of ammocoetes nearby, provides strong evidence of successful breeding. The two probable breeding sites are at the Illinois Route 166 bridge, and at the low water crossing. The unverified report of ammocoetes at Parker City in 1993 (Sauer and Schanzle, 1993) implies that another breeding riffle may exist somewhere upstream of Parker City. However, samples at several locations in that area by Burr and Stewart (1999) did not locate any lampreys.

The Illinois Rt. 166 site (IDOC/IDNR site ATHG-02) includes a small gravel and cobble riffle just under and upstream of the bridge. Early reports of the least brook lamprey (1952 and 1953) were from this location (Gunning and Lewis, 1956). A total of two adults and one ammocoete have been captured at this site, with the most

recent report in 1993 (Sauer and Schanzle, 1993). Although bedrock is present for some distance above and below this riffle, we noted no other potential breeding habitat nearby. Most of this reach consists of deep runs or pools over bedrock, with a few short bedrock riffles with little cover.

The low water crossing site (IDOC/IDNR site ATHG-04) has been erroneously referred to as "at the confluence of Sugar Creek and Maple Branch" (Weitzell et al., 1998). In fact, it is about 250 to 300 meters downstream of Maple Branch, where a small unnamed tributary joins Sugar Creek. The use of "MBR" as a site code by Weitzell et al. (1998) has led other writers to erroneously report this species in Maple Branch. The least brook lamprey has never been documented in Maple Branch proper, and Suger Creek at the confluence consists of deep silt-bottomed pool habitat. Weitzell et al. (1998) and others have noted the scarcity of potential habitat within Maple Branch, and attempts to sample for this species in Maple Branch by IDOC/IDNR, SIU, and TAMS have been unsuccessful (Sauer and Schanzle, 1993; Weitzell et al., 1998; Burr and Stewart, 1999; this report).

The low water crossing site in its current configuration was created by placement of rip-rap in the stream to allow heavy equipment to ford the stream at the site of an abandoned railroad bed. Presumably this location was naturally shallow, and it may have historically been a riffle. The extent of modifications when the rail line was constructed are unknown. The most recent addition of course substrate was in approximately 1997. Sand input is from two small tributary streams, one on each side of Sugar Creek. Considerable sand is present in a deep pool downstream of the riffle, and probably is an important part of ammocoete habitat.

The low water crossing site has been the most productive least brook lamprey locality on Sugar Creek. Six adults, two verified ammocoetes, and one additional ammocoete probably of this species have been captured or observed at this location over a 13-year period. Five adults (three males and two females) were captured here on March 8, 1998 (Weitzell et al., 1998; Burr and Stewart, 1999). The most recent report was of a single 145mm ammocoete on March 30, 1999 (Burr and Stewart, 1999).

Two additional riffles of extensive area and with coarse substrate and suitable flow rates and depths have been sampled for lampreys without success. Both are associated with sandstone outcrops along the margin of Sugar Creek. One of these is approximately 1.1 km upstream of the Maple Branch confluence, and was sampled by TAMS in March, 2002. The other is in the northwest corner of Section 7, just below the site of an abandoned county road crossing. This site (ATHG-06) was sampled by IDOC (Sauer and Schanzle, 1993).

Other riffles on Sugar Creek are relatively small and typically consist of fine gravel partially embedded in silt. A few riffles on Maple Branch have coarse substrate, but flow rates and depths are well below those reported at other Illinois lamprey localities. Maple Branch is a small and mostly shallow stream, and when we sampled in early June water temperatures were already as high as 25 degrees C in upper reaches. Meeuwig et al. (2002) documented adverse effects at 22 degrees C for hatching success and abnormality rate for western brook lampreys (*Lampetra richardsoni*).

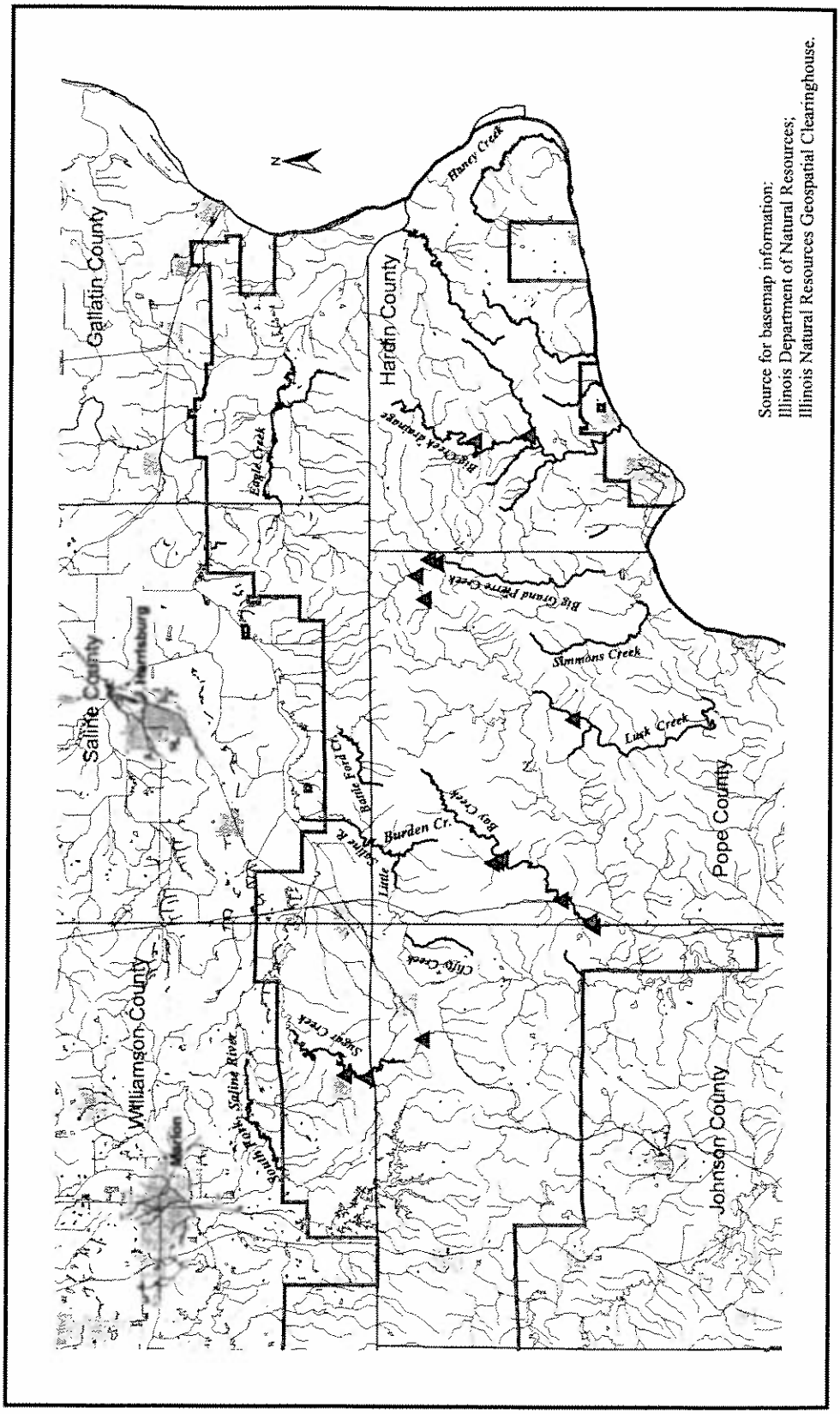

Figure 2-3. Distribution of the least brook lamprey in Illinois.

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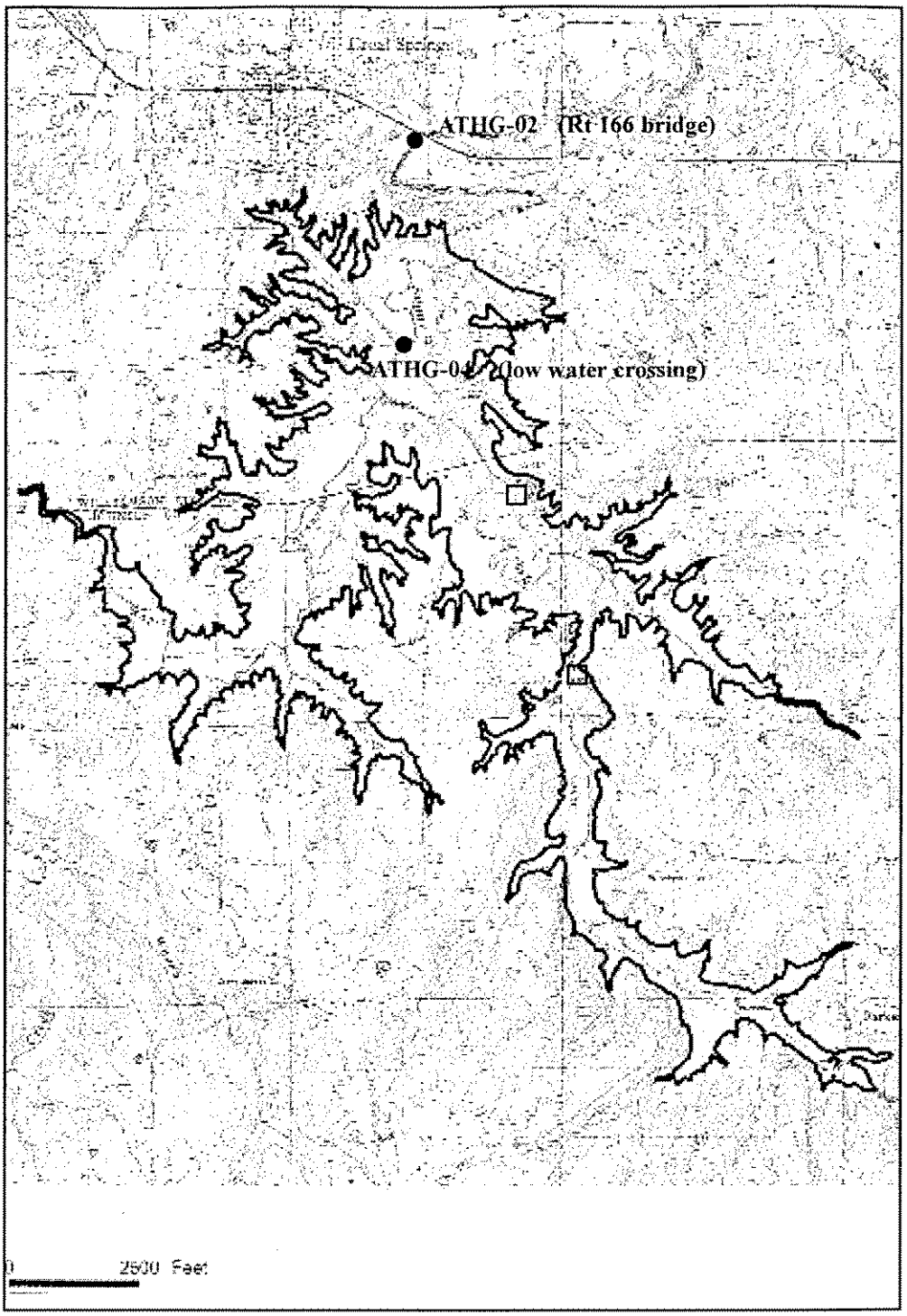
Figure 2-4. Distribution of the least brook lamprey, *Lampetra aepyptera*, in Sugar Creek within and near the project area. The two solid symbols represent historical (1952-1999) localities. The southern-most location at Parker City, indicated by (?), represents a 1993 IDOC report of larval lampreys which w ere not captured. Open squares indicate potential breeding habitat (extensive riffles with gravel/cobble substrate) where sampling has not located the species to date.



Indiana crayfish
Orconectes indianensis

The Indiana crayfish, *Orconectes indianensis*, is a dark brown crayfish, with a yellow-brown thorax and red tips and black bands on the chelae (Figure 2-5). Page (1985) recorded 2-year-old Indiana crayfish ranging in size from 25 to 33 mm carapace length (CL). The largest Illinois specimen measured 35mm CL. A detailed description is included in Page (1985).

Life History

Female crayfish carry eggs in the spring. Young do not leave the adult female until they have reached their third instar, which may be six to 19 days after hatching. Individuals may subsequently experience six to 10 molts before growth is halted in the autumn. Adult females are of one form, but adult males molt between two forms (Form I and Form II). Only first form males are able to reproduce (Pennak, 1953).

Life history data specific to the Indiana crayfish is limited, but consistent with generalizations made for crayfish as a whole. Form I males have been observed in early spring (Page, 1985), summer (Reitz, 1912; Page, 1985;1994), and fall (Reitz, 1912; Brown, 1955; Page, 1985). Page (1994) reported "it appears that fertilization can occur in spring, summer, or fall, and that eggs are laid the following spring." He noted female Indiana crayfish carrying eggs in March and April, and females with young attached in May. Page (1985) reported 121 to 178 eggs per female (mean = 149, n = 3), plus one female carrying 132 young and 21 unhatched eggs.

We did not count eggs during the present study, but of 49 specimens observed on March 22-28, 14 were females with eggs. These individuals ranged from 20 to 35mm CL. Of the 14 egg bearing females, 11 were captured in two high-gradient riffles with abundant large flat rocks, implying some aggregation in particular habitat types. In early June we observed many free-swimming young of the year, and no eggs or young were seen attached to females.

Page (1994) stated that "maximum longevity for the species is probably two or three years." In our late March sample, age classes were not well defined, with some apparent overlap in size. Using approximate size class breaks, one-year old animals had a mean size of 18.6mm (range = 13-22mm, n = 32), while two-year old animals had a mean size of 27.5mm (range = 23-35mm, n = 13).

In June samples, three distinct size classes were noted. Young of the year (mean = 9.1mm; n = 117) dominated the sample. Age 1+ (mean = 21.6mm; n = 9) and age 2+ (mean = 29.7mm; n = 6) animals were much less common.

Boyd and Page (1978) provided detailed life history information for the related *Orconectes kentuckiensis* in nearby Big Creek.

Dispersal

Indiana crayfish mobility is relatively limited and the life span is not long. As a result voluntary dispersal must be over limited distances. Involuntary downstream movement of juveniles associated with high flow events must be more common. In Maple Branch, near the upper limits of Indiana crayfish distribution in that stream, we observed several large adults but only one juvenile. Juveniles were abundant downstream in Maple Branch. This implies that juveniles move downstream, that adults move upstream, or both.

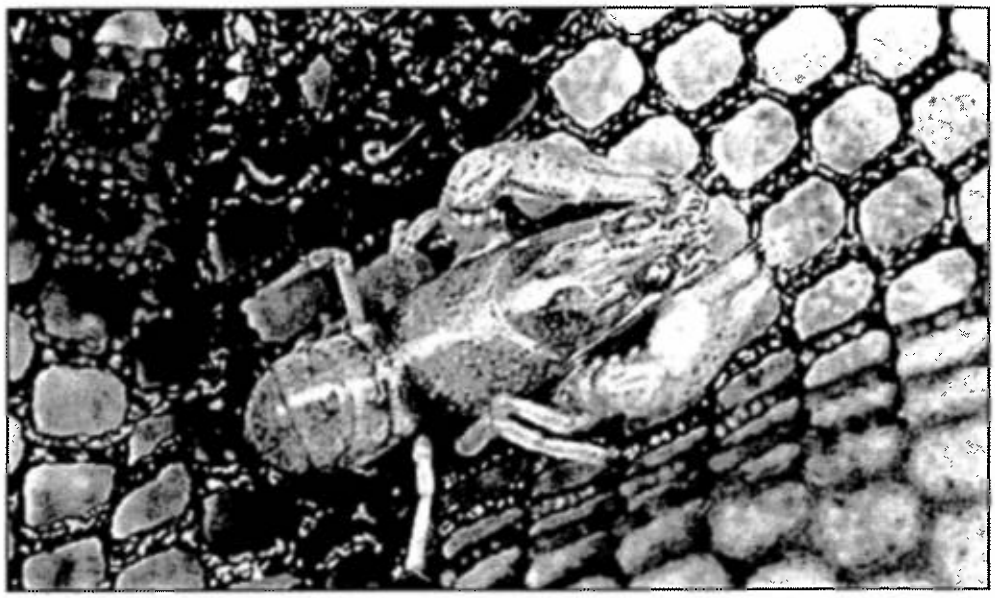


Figure 2-5. An Indiana crayfish from Katy Reid Hollow, Pope County, Illinois. Note the red tips and sub-distal black bands on the chelae.

Figure 2-6. Indiana crayfish habitat in Katy Reid Hollow, Pope County, Illinois. Six Indiana crayfish were observed in this stream segment in March 2001.

Habitat

Page (1994) provides the best summary of Indiana crayfish habitat:

"The Indiana crayfish always was found among coarse substrate, primarily large rocks or woody debris, and usually was found in slow to moderate current. Very few individuals were found in quiet water or over sand and mud away from rocks and woody debris, and none were found in burrows. All were collected in water less than 50cm deep, and most were found in water less than 30cm deep. A few individuals were found among or near emergent or submerged vegetation; however, aquatic vegetation was absent or uncommon at most localities and did not appear to be an important predictor of *O. indianensis*."

This species is tolerant of moderate to high turbidity (Rietz, 1912; Brown, 1955; Page, 1994). Large submerged or partially submerged stones provide daytime cover for adult crayfish and are an important habitat element (Pennak, 1953). Brown (1955) located one half of all collected specimens underneath stones within and along the streambed.

Our 2002 results were generally consistent with those of Page (1994) and other authors. Because our monitoring protocol segregated major mesohabitat types and used a random start and systematic sample design, we are able to provide more detailed information at least for the project area.

We captured Indiana crayfish in high density in riffle and run habitat in both Sugar Creek and Maple Branch. Larger animals were often associated with larger rocks, but small crayfish utilized a variety of substrate sizes including fine gravel.

In Sugar Creek, crayfish densities were very low in pools, which tended to be more than one meter deep. Most pool captures were in shallow margins or in transitions from adjacent riffles or runs, and almost always where at least scattered rocky or woody debris was present.

In Maple Branch, some pools are shallow and bedrock-bottomed with cover provided by flat slabs of sandstone. Crayfish density in Maple Branch pools remained lower than in riffles or runs, but was much higher than in deep Sugar Creek pools.

Crayfish were generally much easier to locate in riffle and run habitat. The casual observer would be led to believe that abundance was highest there. However, despite low density, the estimated total number of individuals was high in pools because pools made up the majority of habitat area (89 percent of upper Sugar Creek, and 90 percent of Maple Branch).

In Sugar Creek, Indiana crayfish were generally distributed wherever suitable habitat was present. In Maple Branch, crayfish were present but not abundant in the predominantly silt-bottomed lowermost reaches, common in much of the higher-gradient lower to middle reaches where small gravel riffles and runs and rock-bottomed pools were common, and absent in most of the upper half of the stream where it becomes shallow, warm, and ephemeral. We observed only three adults and one juvenile above the Creal Springs Road bridge, and no Indiana crayfish were seen upstream of a point 200 meters below the westernmost Wagon Creek Road bridge.

Indiana crayfish density and maximum abundance data for each mesohabitat type are provided in Table 2.4.

Table 2.4. Indiana crayfish density and maximum abundance, by stream segment and habitat type.

	Crayfish density (#/m2)	Habitat area (m2)	Estimated number of crayfish
Upper Sugar Creek			
Riffles	1.52	640	972.8
Runs	0.94	2,768	2,601.9
Pools	0.06	29,360	1,761.6
Subtotal		32,768	5,336.3
Lower Sugar Creek *			
Riffles	1.52	1,903	2,892.6
Runs	0.94	3,863	3,631.2
Pools	0.06	22,776	1,366.6
Subtotal		28,542	7,890.4
Maple Branch			
Riffles	1.86	394	732.8
Runs	2.93	473	1,385.9
Pools	0.52	6,789	3,530.3
Subtotal		7,656	5,649.5
TOTAL		68,967	18,876.2

Table 2.5. Relative abundances of adult and juvenile Indiana crayfish by stream segment and habitat type, June samples

	Total crayfish (June)	Percent adults (June)	Adult crayfish (June)
Upper Sugar Creek			
Riffles	972.8	0.13	126.5
Runs	2,601.9	0.14	364.3
Pools	1,761.6	0.30	528.5
Subtotal	5,336.3		1,009.3
Maple Branch			
Riffles	732.8	0.04	29.3
Runs	1,385.9	0.05	69.3
Pools	3,530.3	0.25	882.6
Subtotal	5649.5		981.2

General Distribution

The distribution of Indiana crayfish is limited to small portions of southeastern Illinois and southwestern Indiana. Indiana localities include the Patoka and Black River systems (Wabash River drainage) and small tributaries to the Ohio River in Vanderburg, Warrick, Spencer, and Perry counties (Page, 1994).

Illinois Distribution

A considerable amount of historical information exists for the Indiana crayfish within southern Illinois. Reitz (1912) examined well over 2000 museum specimens of a variety of species collected throughout the state, and summarized the known distribution at that time. She was the first investigator to note the presence of *Orconectes indianensis* within Illinois. Brown (1955) added additional localities.

Page (1985) sampled various statewide localities, including several historical localities. Page (1994) visited many historical localities for this species, and confirmed continued presence at all but three.

Extant Illinois populations occur primarily within the South Fork Saline River drainage in Gallatin, Saline, Williamson, Johnson, Pope and Hardin counties (Page, 1994). Known localities include the Little Saline and the South Fork of the Saline rivers, as well as a number of smaller tributary streams, including: Sugar Creek, Clifty Creek, Burden Creek, Battle Ford Creek, and Eagle Creek (Figure 2-7). Additional Illinois localities have been identified within Honey and Rock Creeks (Hardin County, Ohio River drainage) and Brushy Slough (White County, Wabash River drainage). Brushy Slough is the only known locality for Indiana crayfish within the Wabash River drainage in Illinois. Presence at this site was last verified in 1987 (Page, 1994). At least one historical record is available from the North Fork of the Saline (Reitz, 1912), but the species apparently no longer occurs there.

During preparation of this document we confirmed the continued presence of this species at historical localities in Burden Creek, Clifty Creek, and the Little Saline River, and observed specimens at previously unreported localities in Katy Reid Hollow and in the Little Saline River below the confluence with Allen Branch. We almost always found Indiana crayfish in close proximity to both adult and larval forms of the southern two-lined salamander, *Eurycea cirrigera*, another species which requires permanent water and with a similar distribution within the Shawnee Hills.

Sugar Creek Distribution

Brown (1955) sampled a number of localities throughout Illinois, including five where he collected *Orconectes indianensis*. Three of these localities were on Sugar Creek: one mile northeast of Tunnel Hill; east of Creal Springs (presumably at or near the Rt. 166 bridge); and one mile northeast of Palzo. These were apparently the first documented reports of the Indiana crayfish in Sugar Creek.

Subsequent reports of the Indiana crayfish in Sugar Creek are from IDOC (unpublished data, 1989), Sauer and Schanzle (1993), and TAMS (2001 and 2002).

A summary of Indiana crayfish reports in Sugar Creek is provided in Table 2.6.

Table 2.6. Sugar Creek records of the Indiana crayfish, 1955-2001.

Sugar Creek 1 mile NE Palzo. Unknown number of specimens collected by Brown (1955).
Sugar Creek at County Road 652A bridge. This is the closest unimpacted location to the historical Palzo locality (INHS).
Sugar Creek at Rt. 166 Bridge. Sampled by Brown (1955), IDOC (1989), Sauer and Schanzle (1993) [22 specimens]; and TAMS (2001) [2 specimens].
Sugar Creek at extension of County Road 5 (Wagon Creek Road). Sampled by Sauer and Schanzle (1993) [site ATHG-06; 3 specimens].
Sugar Creek at Parker City. Sampled by Sauer and Schanzle (1993) [site ATHG-07; 2 specimens]

The most extensive historical samples were those completed by IDOC in 1993. Several localities on Sugar Creek were sampled, including four within the project area (Sauer and Schanzle, 1993). In 2002, TAMS ecologists initiated a more comprehensive quantitative survey of the entire project area. In March, 18 riffles were sampled, and Indiana crayfish were captured in 10 of these. In June, 23 sites including a variety of habitat types were sampled; 17 of these produced Indiana crayfish. Sample sites with crayfish were located throughout Sugar Creek between Route 166 and Parker City, and in the lower half of Maple Branch. Indiana crayfish distribution within the project area is shown in Figure 2-8.

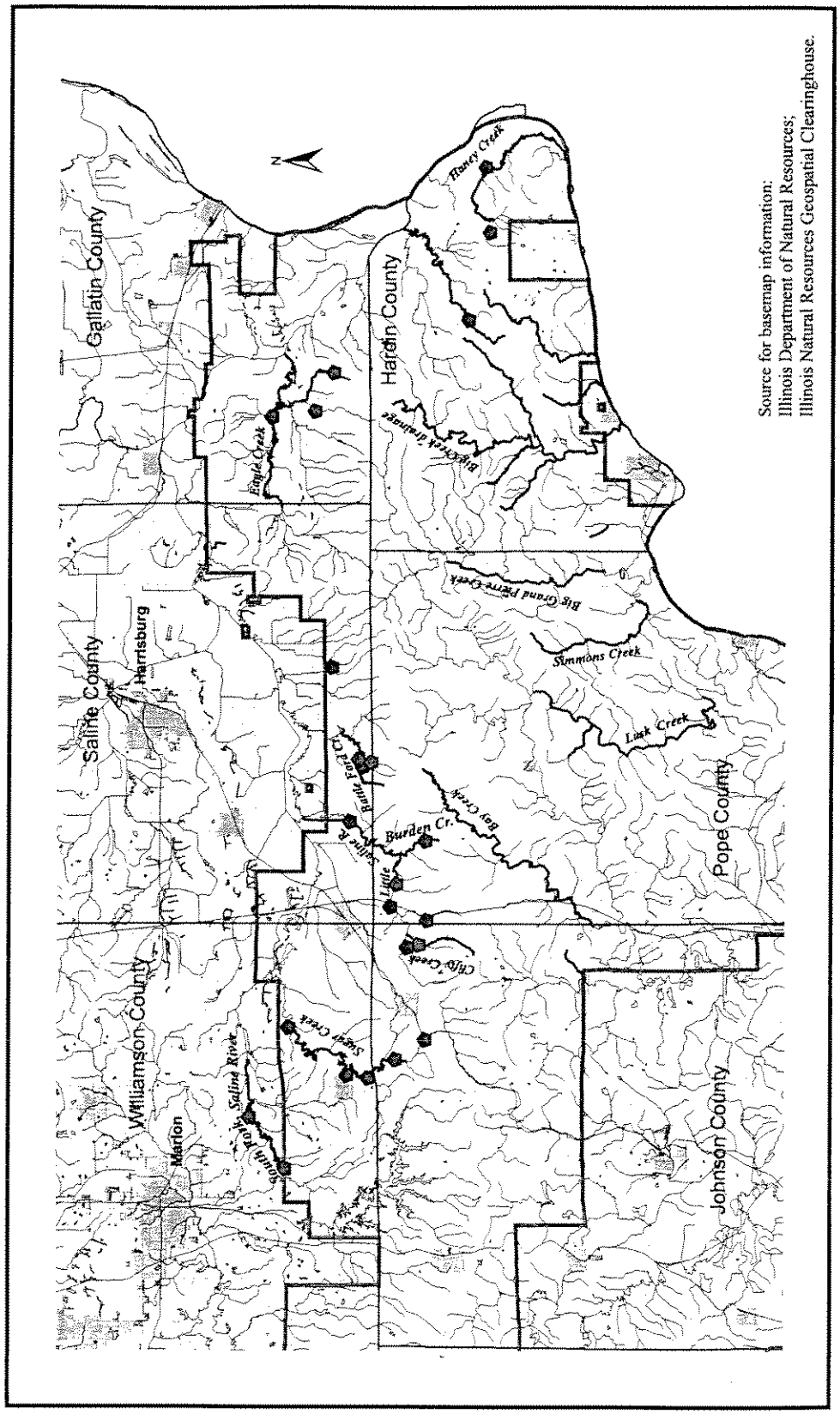


Figure 2-7. Distribution of the Indiana crayfish in Illinois.

TAMS

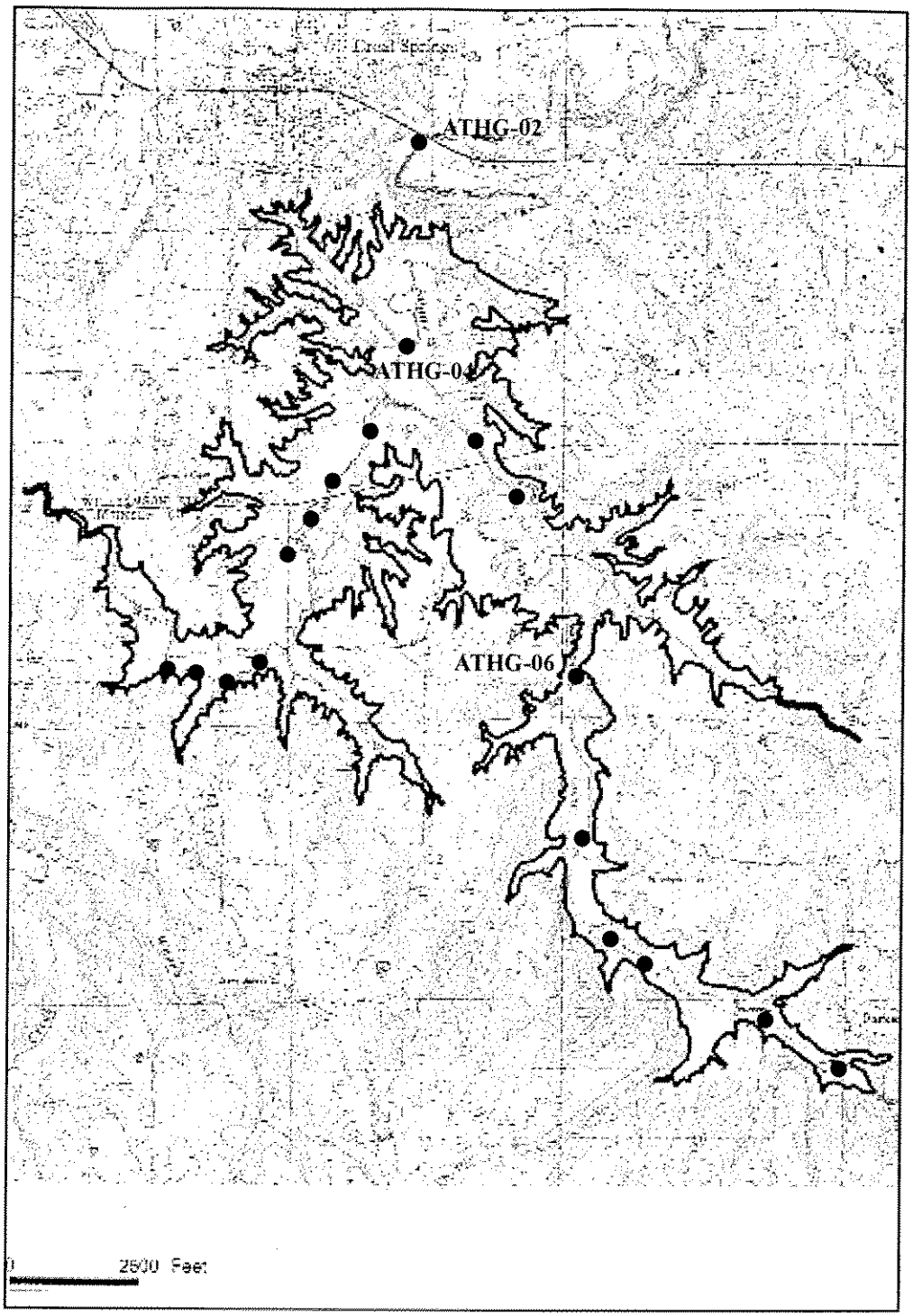


Figure 2-8. Distribution of the Indiana crayfish, *Orconectes indianensis*, within the project area. Some symbols represent more than one locality. Presence was confirmed at all locations in 2002 by TAMS/Earth Tech except ATHG-04 and ATHG-06, which are historical (IDOC) localities and which were not sampled by us.

Section 3

Minimization and Mitigation of Impacts

OTHER ALTERNATIVES CONSIDERED

A detailed analysis of numerous alternatives was included in the Environmental Impact Statement for the proposed Marion Reservior. Here, we provide a brief summary of alternatives which might have had lesser impacts on the least brook lamprey and the Indiana crayfish. This summary is from the Final Environmental Impact Statement (FEIS) issued in 1998. A Draft Supplement to the FEIS was recently released by the Corps of Engineers, and public comments have been received, but a final document is not yet available as of this writing.

No action alternative

Without construction of an impoundment and with no conversion of riverine to lacustrine habitat, there would be no further impacts on the least brook lamprey or Indiana crayfish. However, much of the area within the proposed reservoir was logged several years ago, with resulting siltation of streams. Although no documentation is available, this probably also affected water temperature and various other physical factors. Surrounding slopes are largely revegetated with grasses, forbs, and shrubs at present. Instream habitat structure has at least partially recovered, although siltation is evident in upstream reaches as well and must be a result of recent or ongoing land use practices on private land.

Water from the Rend Lake Conservancy District

Rend Lake is located approximately 20 miles north of the city limits of Marion in Franklin and Jefferson Counties, Illinois.

Treated Water from Rend Lake

The available water supply at Rend Lake is 40 mgd, of which 17.5 mgd is contracted to the Rend Lake Conservancy District (RLCD). Delivering treated water from Rend Lake to the City of Marion and LEWD would require expansion of the RLCD water treatment facility and extension of the distribution system. Extension of the Rend Lake Intercity Water System would require construction of 16 miles of additional pipeline, and purchase of new easements totaling 37 acres. The expansion of Rend Lake as a water supply source raises several safety issues. The Rend Lake distribution system is located within an active fault area and is underlain by mined-out areas. Because the distribution system is susceptible to service interruption, the Illinois Emergency Services and Disaster Agency and the Illinois EPA have expressed concern that too many communities within the region are using Rend Lake as a sole source of water. There would be no known impacts on the least brook lamprey or Indiana crayfish.

Raw water from Rend Lake

Delivering raw water from Rend Lake to Marion and LEWD water treatment plants would require installation of a new intake structure and construction of a new pipeline system. Approximately 26 miles of pipeline would be required to deliver water from Rend Lake to the City of Marion. An additional 9.2 miles and one additional station would be needed to deliver water to LEWD. Approximately 19 miles of the proposed pipeline would pass through areas with increased risk of subsidence, due to underground mining of coal. In order to complete construction, new right-of-way totaling 85 acres would need to be acquired. Water capacity at Rend Lake is sufficient to supply both the City of Marion and the Lake of Egypt Water District (LEWD). However, in accordance with 65 ILCS 5/11-138-1, the City of Marion and LEWD are prohibited from using Rend Lake as a water supply because the draw off point would be located greater than 20 miles from the corporate limits of the City of Marion. There would be no known impacts on the least brook lamprey or Indiana crayfish.

Water from Cedar Lake

Cedar Lake, constructed by the City of Carbondale, has a water supply storage of about 14 mgd. Obtaining raw or treated water from Cedar Lake would require construction of a pipeline system connecting water treatment facilities in Carbondale, Marion and LEWD. Two routes were considered - a northern route and a southern route - in order to minimize impacts to Crab Orchard National Wildlife Refuge and Crab Orchard Lake.

The northern route crosses Federal refuge property and several arms of Crab Orchard Lake. New easements for 33.0 miles of pipeline would require approximately 80 acres of land. The southern route passes south of Crab Orchard Lake, but crosses Federal refuge property at several locations. New easements for 29.3 miles of pipeline would require approximately 72 acres of land. The action proposed in this alternative would fall under the jurisdiction of the U.S. Army Corps of Engineers, St. Louis District, rather than the Louisville District. Additional permits from the Department of the Army may be required for crossing of Crab Orchard Lake. Any mitigation resulting from crossing of Crab Orchard Wildlife Refuge would be subject to review by the U.S. Fish and Wildlife Service. There would be no known impacts to the least brook lamprey or Indiana crayfish.

Water from the Cache River aquifer

The City of Marion rejected the option of using groundwater as a water source because of water quality concerns, and the substantial modification to treatment facilities that would be required. Treatment plant modifications would include equipment to manage manganese, iron, pH and water hardness. Bulk lime storage facilities, lime treatment equipment, sludge handling equipment, and a plan for sludge disposal would also be required. A location for a new well field was identified near Perks in Pulaski County. This alternative would require construction of 35.6 miles of pipeline and purchase of new easements totaling 87 acres. The Cache River aquifer is located 40 miles from the corporate limits of Marion. In accordance with 65 ILCS 5/11-138-1, Marion and LEWD are prohibited from developing this alternative for a water supply. There would be no known impacts to the least brook lamprey or Indiana crayfish.

Water from the Saline Valley Conservancy District

Purchase of treated water from the Saline Valley Conservancy District (SVCD) would require installation of a new raw water line between well fields near Junction and the Harrisburg water treatment facility. Additional pipeline connecting the Harrisburg, Marion, and LEWD treatment plants would also be required. The majority of pipeline would be installed within existing easements along county and state roads. Approximately 15.5 miles of pipeline would be installed in mined out areas.

Transfer of raw water from SVCD would require construction of a raw water pipeline between well fields near Junction and treatment facilities at Marion and LEWD. The majority of pipeline would be installed within existing easements along county and state roads. Approximately 15.5 miles of pipeline would be installed in mined out areas. Treatment plants in Marion and LEWD would require modifications to manage for manganese, iron, pH and water hardness. Bulk lime storage facilities, lime treatment equipment, sludge handling equipment, and a plan for sludge disposal would also be required. The SVCD is located 50 miles from the corporate limits of Marion. In accordance with 65 ILCS 5/11-138-1, Marion and LEWD are prohibited from developing this alternative for a water supply.

Develop a reservoir near Goreville

This alternative proposes construction of a dam on Little Saline Creek in Johnson County. The reservoir would inundate 1.3 miles of the Little Saline Creek, six intermittent tributaries, and approximately 44.2 acres of wetlands. The proposed Goreville reservoir would have a raw water yield of approximately 3.6 mgd, which is sufficient to supply either Marion or LEWD, but not both.

Minimization of impacts: Preferred alternative

Since any action involving creation of an impoundment on Sugar Creek will result in direct and permanent loss of known least brook lamprey and Indiana crayfish habitat, minimization of impacts must center on short-term construction activities, and longer-term conditions on the periphery of the project area. Timing of impacts will also have an effect. Since most reservoir fill will likely occur in winter and early spring, assuming near-normal precipitation patterns, crayfish populations will be near annual lows at the time of impact.

Management of Downstream Area

The least brook lamprey has been reported from the area around the Illinois Route 166 bridge, just below the proposed dam location (Weitzell et al., 1998; Sauer, 1993). The Indiana crayfish is relatively common at that location (Sauer and Schanzle, 1993) and has been reported well downstream in Sugar Creek to just above the area impacted by acid mine drainage (IDNR unpublished information).

Maintaining populations of both species downstream of the dam at the Route 166 bridge will require care during construction activities as well as under normal operating conditions. Water flows will be regulated by an interagency agreement designed to ensure adequate water flows to maintain existing habitat. Flow will be maintained at low levels even during late summer periods currently subject to unpredictable water availability. The Reservoir Release Plan is included as Appendix A.

Standard erosion control practices should be followed during and immediately after construction under IEPA regulations, although some short-term construction related siltation may be unavoidable in the immediate dam area. Release water temperatures should also be monitored and adjusted if necessary, particularly during the March spawning season of the lamprey. Once construction is complete and banks revegetated, stream flow should be relatively free of silt. Least brook lampreys are known to persist below an impoundment on Bay Creek, so the construction period is likely the most critical. The Indiana crayfish is more tolerant of siltation, but is most abundant in areas which are relatively free of silt input.

Management of upstream area

Based on observations of both species near Parker (Sauer, 1993), segments of Sugar Creek upstream of the proposed impoundment may also provide some habitat. Construction activities, if any, should be limited to the smallest practical footprint at upstream limits of the project.

Identification of the Plan Area

For purposes of this document, we identify the plan area, or the area considered for mitigation activities, as including the watersheds of the South Fork Saline River (including Sugar Creek, the Little Saline River, and other tributaries), Bay Creek, and Lusk Creek, and with the U.S. Forest Service Shawnee Purchase Unit as an arbitrary north/south boundary. This area includes most known populations of the target species. The project area is a much smaller subset of the plan area (Fig. 1-1).

Impacts to be Mitigated

Draft versions of this document utilized stream length as a measure of the amount of necessary mitigation, because that was the best information available at the time. However, stream length measurements do not account for actual available habitat area. Detailed sampling of least brook lamprey and Indiana crayfish habitat was subsequently completed during the spring and summer of 2002. As a result, area measurements are now available for each major habitat type in the project area.

We utilize the total area of potential Indiana crayfish habitat as the most accurate available measure of impacts. This is actually an overestimate of area for that species, since the Indiana crayfish seldom if ever utilizes deep pool habitat. Least brook lamprey habitat is apparently far more restricted within the project area, but for the most part is included within and is a subset of crayfish habitat. Least brook lamprey ammocoetes may be able to utilize some of the deeper pool habitat referenced above, at least where pools include sandy substrate and where organic detritus is present. Some but not all pools within the project area include possibly suitable ammocoete habitat.

Using these measures, the area of potentially impacted habitat within the project area is shown in Table 3.1.

Table 3.1. Impact area by stream habitat type within the project area

Habitat type	Impact area
Riffles	2,937 m^2
Run	7,104 m^2
Pool	58,925 m^2
Total	**68,967 m^2**

MITIGATION

The U.S. Fish and Wildlife Service encourages the following hierarchy of mitigation actions for the federal HCP process:

1. Acquisition of existing habitat
2. Conservation easements or other legal protections of existing habitat
3. Enhancement or restoration of disturbed or former habitats
4. Creation of new habitats

It is noted in the same document that these are guidelines and that "flexibility is often required to adjust to individual circumstances."

Thus, mitigation actions can be based on a strategy of protecting existing habitat, restoring degraded habitat, or creating new habitat. Protecting existing habitat at known localities is the preferred strategy for mitigating impacts to threatened and endangered species. Target species for this project are both aquatic, inhabiting small to medium sized streams.

Alternative Mitigation Scenarios Considered

In reviewing potential mitigation strategies, in addition to the Illinois distribution of the two affected species, we considered known threats to those species, feasible and effective means to counter or reduce those threats, and the political and economic realities of implementing conservation strategies in southern Illinois. For example, we ruled out extensive land acquisition because much of Johnson and Pope Counties is already in federal ownership. As a result local landowners and residents have frequently expressed concern over any further reduction of the tax base. Although we do not preclude small-scale acquisition if requested by specific landowners, other means of protection such as easements are likely to be received more favorably by residents. The City of Marion acquired the project area without the use of eminent domain; and there are no plans to utilize eminent domain during implementation of this conservation plan. Various methods of mitigation are listed in Table 3-2.

Table 3-2. Types of restoration and protection for aquatic habitat

Protection
Acquisition of habitat
Conservation easements placed on streambank buffer
Voluntary landowner protection of streambank buffer
Restoration (on either public or private land)
Instream habitat restoration, including creation of riffles
Bank stabilization and erosion control
Restoration of channelized segments
Planting buffer strips of native vegetation along stream corridors

General mitigation strategies

Within the context of this project, protection of stream habitat is best achieved through establishment of conservation easements within riparian corridors. A conservation easement is a legal agreement between a landowner and permit applicant, in which the landowner agrees to land use restrictions on all or a portion of a property in exchange for some negotiated compensation. Ownership is retained by the landowner, rather than transferred to the applicant. In the case of stream protection, easements protecting lands adjacent to and upstream of known localities would be sought. Depending on topography and other local conditions, easements providing for 50 to 200 feet of vegetated corridor on either side of targeted streams should adequately buffer aquatic species.

For this project, the core of the proposed mitigation is protection of habitat. Each habitat type will be mitigated through protection (conservation easements on buffer or other appropriate methods as detailed elsewhere in this chapter) at a minimum ration of 1.1 to 1. Because the proportion of habitat types in mitigation areas will not be known until monitoring is initiated, meeting the minimum ratio for all three habitat types may result in protection of some excess area (above and beyond the proposed ratio) for at least one habitat type. Riffle habitat will be protected at or above the percentage in impact areas. Additional mitigation value will be obtained through restoration or creation of instream habitat, and funding of research.

Mitigation Accountability

Habitat protected for mitigation purposes will be measured in the same way as impact habitat. Details are included in the section on monitoring. If only one streambank is buffered, only half of the habitat area in that segment will be counted toward mitigation credit. Additional mitigation value added through restoration and creation can also be measured on the basis of area (length and width of a created riffle, or length of stabilized streambank). Research funding is an entirely different type of activity, and is more difficult to quantify except as amount of funding.

Mitigation Alternatives Analysis

A total of 10 alternative stream segments were identifed as potential locations for habitat protection and/or restoration during early stages of conservation plan preparation. Each segment includes known or potential habitat for one or both target species, and currently is not subject to any form of habitat protection. The matrix used to compare alternative stream segments is shown in Table 3.3. Stream segment locations are shown in Figure 3.1.

Table 3.3. Alternative stream protection segments

	Lampetra aepyptera ~/1km?	*Orconectes indianensis* ~/1km?	No. of land owners	Equip. access?
Sugar Creek dam to Rt 166	yes	yes	1	yes
Sugar Creek Rt 166 to Palzo	yes	yes	>10	yes
Little Saline headwaters	no	?	>10	?
Little Saline Westvaco	no	yes*	1	partial
Little Saline/ Allen Branch	no	yes	>5	yes
Little Saline Saline Co.	no	yes	>5	?
Clifty Creek	no	yes	>5	no
Katy Reid Hollow	no	yes*	>5	no
Bay Creek headwaters	yes*	no	>10	partial
Lusk Creek	yes*	no	>10	partial

* indicates a stream segment where the species is relatively common by regional standards

Figure 3-1. Stream segments evaluated for potential mitigation activities

NOTE: GRAPHIC IN PREPARATION

After evaluation of the matrix, four stream segments were identified for top priority protection. Two of these are on Sugar Creek, the only stream known to support both the least brook lamprey and the Indiana crayfish. One is on Bay Creek, which supports the largest known aggregation of least brook lamprey localities. One is on the Little Saline River, in a segment with high densities of Indiana crayfish.

To date, it has been feasible to inspect streams for restoration opportunities only on Sugar Creek, where the City of Marion already owns some land and has established contacts with some private landowners. The practicality of restoration in other drainages is not yet well known. Where feasible, habitat restoration may focus on stream bank stabilization and the creation of additional riffle habitat. The stone toe protection method could be used to simultaneously stabilize stream banks and add large substrate to the stream channel. This would improve both water quality and the physical habitat for crayfish and lamprey. Improved stream banks may be revegetated with native plant species. In some cases, bank shaping and revegetation may be sufficient for stream bank stabilization. Artificial riffles may also be constructed in conjunction with or independent of bank stabilization. Instream work is subject to approval by the Corps of Engineers and other agencies.

Pulliam (2001) provided an example of a voluntary public-private partnership which resulted in restoration of aquatic habitat. The Missouri Department of Conservation worked closely with a landowner who had been experiencing severe and progressive streambank erosion. Through the use of bank stabilization, revegetation, and relocation of part of a small levee, the stream course was stabilized and erosion effectively halted. With the removal of excessive sediment loads, a threat to a downstream population of the federally threatened Niangua darter was removed. In this case, state and federal money was used to address both impacts to a listed species and the direct loss of private land. In return, the landowner agreed to maintain a vegetated buffer strip along the stream.

Mitigation activities for the proposed Marion reservoir are complex because the target species are so far known to co-exist only within and adjacent to the project area. Other least brook lamprey localities are in streams which flow south directly into the Ohio River, while most Indiana crayfish populations are in the South Fork Saline River drainage.

Specific locations will be identified after initial negotiations with participating landowners within the affected drainages.

Specific mitigation proposals

Mitigation for incidental take of Indiana crayfish and least brook lamprey will be concentrated in the Little Saline River drainage, unimpacted segments of Sugar Creek, and in Bay and Lusk Creeks.

To address the complexity of issues affecting the least brook lamprey and Indiana crayfish, we are proposing a multi-faceted mitigation strategy:

1. Protection and restoration of habitat downstream of the proposed dam location. This component of the mitigation is intended to ensure short-term preservation of existing populations of both species, so that the potential for longer-term conservation strategies (translocations, restoration of mine impacted downstream segments, etc.) is not precluded.

2. Protection of segments of the Little Saline River drainage. This will protect known and probable localities for the Indiana crayfish.

3. Protection of segments of the upper Bay Creek drainage. This will protect habitat upstream of known localities for the least brook lamprey.

4. Financial or other contribution to ongoing protection and restoration efforts in the Lusk Creek watershed, where one of the largest known least brook lamprey populations is located.

5. Financial support of research relevant to the conservation biology of the least brook lamprey and/or the Indiana crayfish.

Specifics of each mitigation component follow.

Protection and restoration in Sugar Creek between the reservoir and Route 166

Weitzell et al., (1998) and others have noted that very little riffle habitat is present within a 1000 meter segment of Sugar Creek centered on the Illinois Route 166 bridge. Within that stream segment, the target species have been collected only in the riffle directly under the bridge.

Water flowing from the proposed dam structure will be relatively free of silt, which will have settled out in the reservoir basin. It will be possible to control discharge volume and, to some extent, temperature (by drawing water from different depths). The least brook lamprey is able to persist below the Bay Creek No. 5 impoundment, and it has also been reported from man-made riffles at that location and in Sugar Creek.

Adverse effects of a reservoir on the least brook lamprey, including direct loss of habitat and fragmentation, have been discussed elsewhere in this document. However, the rarity of the species in Sugar Creek (11, possibly 14 specimens in 51 years after considerable sampling by some of the more experienced aquatic biologists in the region) attests to the less than optimal existing habitat in the stream. Readily apparent problems in Sugar Creek are high silt loads, high summer temperatures, and little or no flow during dry summers. Some of the silt originates from bank slumps within the project area, but the stream is already turbid as it enters the upper end of the project area.

The Indiana crayfish is apparently somewhat more tolerant of variable environmental conditions. This species is common in much of the project area, and is present in low densities even in areas of relatively severe siltation.

The applicant controls much of the riparian corridor between the proposed dam location and Route 166, and under existing wetland mitigation agreements is already required to enhance stream buffer conditions. Opportunities also exist for instream restoration, and will greatly enlarge the amount of available habitat for both target species. The applicant has also agreed to work with landowners for six miles downstream of Route 166 to establish easements or initiate best management practices.

Pool habitat is already prevalent in the area below the proposed dam. Riffles will be constructed a short distance below the dam. After biologists place block nets and clear the work area of any individuals of the target species and other native aquatic species, a bed of sand will be placed on the stream bed. Rip-rap will then be placed on top of the sand, to an elevation sufficient to create riffles at normal spring flows. Rip-rap size will be similar to that used at the low-water crossing, which has been stable for approximately five years. Because construction equipment will already be active in the area for dam construction, stream bank access is assured at this location.

Protection and restoration in Sugar Creek between Route 166 and Palzo

Preliminary field reconnaissance has identified potential protection and restoration opportunities below Route 166. We have noted a variety of habitats in this reach, ranging from narrow wooded riparian buffers in predominantly agricultural landscapes, to wide forested floodplains set between 50 to 75 foot high sandstone bluffs. Two landowners have allowed inspection access to their property to date. At least two locations have been identified where it may be feasible to conduct some habitat restoration. The extent and location of any protection or restoration is subject to further negotiations with landowners. A digital orthophotoquad showing land use along this segment of Sugar Creek is included as Appendix B.

The Indiana crayfish is known to occur in the lower part of this reach, and based on our field work in the project area and preliminary inspection of downstream habitat, we expect it to occur in a number of locations between Route 166 and Palzo. Least brook lamprey presence is less certain given the apparent rarity of the species in this stream, but is possible.

Lamprey and crayfish populations in Sugar Creek will remain isolated between the dam and the area of acid mine drainage several miles downstream, so this is not considered a long-term solution. However it will likely enable any existing population to persist and possibly expand. If the downstream mine impacted areas can eventually be remediated by others, it may also provide a dispersal source for recolonization of restored areas.

Protection and restoration in the Little Saline River drainage

The Little Saline River has been identified in the past as a potential protection and restoration area (Illinois Department of Conservation, 1995). In addition, Page (1992) identified portions of the Little Saline River and some tributaries, including Burden Creek and Clifty Creek, as biologically significant streams.

Land ownership in the Little Saline drainage is a mix of Forest Service, corporate, and individual. With a few exceptions, land along stream corridors is forested, with a substantial amount of pasture and some cropland on uplands. A digital orthophotoquad showing land use in the Little Saline drainage is included as Appendix C. In a few areas streambank buffer is limited, and in one location we noted moderate siltation a short distance downstream of an area with little buffer.

There are numerous opportunities for protection along the Little Saline River and tributaries. For evaluation, we identified five different stream reaches. Along the Little Saline River itself, headwater reaches are small and possibly ephemeral, there are numerous small landowners, and presence of target species is not known.

Upper-mid reaches are most promising, because the Indiana crayfish reaches high densities there, suitable habitat is common, and there are relatively few landowners. Lower-mid and lower reaches also include known crayfish localities but good habitat is more scattered. Known habitat and potential protection opportunities also exist along two tributaries: Katy Reid Hollow and Clifty Creek.

Initial landowner contact will be made to determine the level of interest in easements or other protection strategies. Restoration opportunities are thought to be present, especially in several areas badly in need of streambank stabilization (see Fig 3-2), but may not be feasible because in many areas heavy equipment access is not available. It has thus far not been possible to conduct detailed inspections on private land away from road crossings.

Protection and restoration in the Bay Creek Drainage

Portions of Bay Creek and Hunting Branch within Bell Smith Springs support relatively large populations of the least brook lamprey. Bay Creek is the only Illinois drainage currently known to include more than one locality where the least brook lamprey is relatively common. Much, but not all, of the headwaters of this drainage is within Shawnee National Forest, including Bay Creek Wilderness. However, some headwaters stream segments originate on private land. Easements on selected riparian lands could help to ensure the continued high quality of portions of Bay Creek which are already protected.

Protection and restoration in the Lusk Creek drainage

Public-private partnerships have initiated conservation activities within a few southern Illinois watersheds, including the Cache River and Lusk Creek. In March 2001 we met with representatives of the Lusk Creek group to learn more about the status of their effort. Lusk Creek is considered one of the better quality streams in southern Illinois (Lusk Creek Planning Committee, 2001). Much of the drainage is in public land, and a high percentage of land in the drainage is either forested or is being managed in a way not detrimental to stream quality. The stream flows through a Forest Service Wilderness Area and a State Nature Preserve. A large population of the least brook lamprey occurs in Lusk Creek.

Some streambank stabilization has already been completed within the Lusk Creek drainage, and other protection or restoration initiatives are anticipated. One of the factors reportedly limiting the pace of conservation is the difficulty of locating matching funds for grant applications. Assuming that projects can be identified which help to ensure the future of the known least brook lamprey population on Lusk Creek, money contributed to meet matching fund requirements for federal or state grant applications could speed progress toward overall conservation goals. A formula for determining credit toward mitigation needs, presumably based on percentage of the total grant funded and the area of stream affected, would need to be negotiated in advance. Although Lusk Creek is already largely protected and of excellent quality, we assume that some opportunities for mitigation credit will remain available within this drainage, although they may be limited in extent.

Research

The City of Marion will solicit research proposals from qualified investigators, and may fund work directly or indirectly relevant to the conservation of the target species. Activities assessing population size or trends, demographics, mobility, aspects of life history, or response to environmental changes related to project impacts or mitigation might be considered.

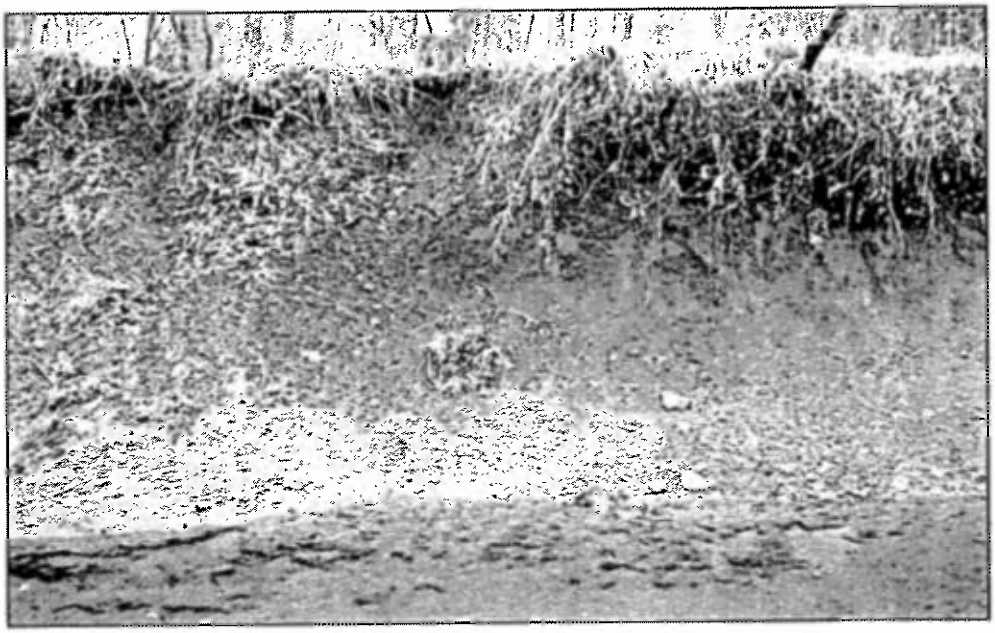


Figure 3-2. A portion of Little Saline River streambank near the County Road 14 bridge. Note the recent bank slumping in the left of the photo. Very little riffle habitat was present at this location, and moderate siltation was evident.

MONITORING

Monitoring will consist of two related but discrete items: Quantification of the area of stream habitat protected or restored; and monitoring of the target species.

Determination of success

The primary measure of success shall be the area of stream habitat protected or restored. This will be directly measured in the field, with some use of remote sensing to assist with mapping of habitat units. Monitoring is intended to quantify the amount and type of habitat protected and restored; to document the relative success and stability of habitat restoration; and to attempt to detect any trends in population size of the target species.

Frequency and duration of monitoring

Monitoring will be conducted annually for three years after completion of project construction. Quantification of habitat area will occur once, as each unit is protected or restoration is completed. Repeat habitat monitoring will be needed only if habitat has been restored or created, to document success and stability. In Sugar Creek, monitoring of the target species will occur pre-project, during construction, and for three years after completion of construction. This monitoring will occur in restoration areas downstream of the proposed impoundment.

Pre-project monitoring of habitat

Relevant features such as area of each habitat type, substrate type, degree of siltation, and extent of bank erosion or instability, will be measured between the dam site and Route 166 before the onset of any protection and restoration work. Sampling for the target species has already occurred within and below the proposed reservoir site, and will take place once again below the reservoir prior to the beginning of construction.

Monitoring methods

To determine the number of individual animals within the project area (Sections 1 and 2 of this document), we modified methods developed in the Pacific Northwest for endangered salmonids (Hankin and Reeves, 1988) and stream amphibians (Welsh et al. 1997). These same methods will be used in the future to characterize habitat in stream segments protected or restored as part of mitigation.

Quantification of habitat area

Various methods of stream habitat classification are available (Bisson et al. 1982; Hawkins et al. 1993). We utilize a relatively simple classification, with two mesohabitat types characterized by visible flow (riffle and run) and one mesohabitat type characterized by no visible flow (pool). Substrate type is also noted during field work, allowing the option of a third hierarchical level.

Observers wade or boat the entire length of sample reaches, stratifying habitat into riffle, run, and pool components and visually estimating width and length of each habitat unit. Using independent random starts and systematic sampling, accurate measurements are then obtained for a subset of each habitat type. Visual estimates and actual measurements are compared using the methods of Hankin and Reeves (1988). This results in a correction factor (Q) which allows an adjusted estimate of area for each habitat type for each stream in the project area.

Least brook lamprey and Indiana crayfish monitoring

Each habitat unit selected for accurate measurements is also sampled for Indiana crayfish and/or least brook lamprey. Beginning at a randomly selected distance from the downstream end of the habitat unit, belt transects extending across the entire width of the stream are established. For most sampling events, three one-meter belts are used (but see below).

In flowing water (riffles and runs), a seine is placed across the downstream end of the belt, while one person methodically kicks the substrate within the area to be sampled. In quiet water (pools) the seine is pulled across the width of the stream while one person moves in front and kicks the substrate. Each belt is sampled twice using these methods, and the total count for the two sample passes is noted.

Data analysis is conducted as in Welsh et al. (1997), producing density and total abundance estimates for each stream segment and mesohabitat type.

We tested these methods in March and June 2002. They were effective for sampling Indiana crayfish in Sugar Creek and a few other streams in the region. No least brook lamprey were captured in Sugar Creek, where the species is apparently rare. Use of these methods was effective for March riffle samples in Hunting Branch, where the least brook lamprey is more common. For sampling lamprey ammocoetes in pool habitat, the most effective method is generally use of a specially tuned electrofishing unit (Sauer and Schanzle, 1993; Burr and Stewart, 1999; Jen Bayer, pers. comm.). Use of this method is consistent with the overall sample design, but may require larger individual sampling units.

Monitoring of habitat in the project area

The amount of habitat restoration downstream of the proposed dam structure will be directly measured after completion of work. The amount of riffle habitat is expected to be the item of primary interest in this location, although any other relevant habitat features will also be recorded.

Monitoring of habitat elsewhere in the plan area

The amount of habitat protection in drainages other than Sugar Creek will be monitored and measured. The amount of available riffle, run and pool habitat will be visually estimated in any locations sampled. In cases of protection through easement or otherwise, the adequacy of existing habitat features will be documented at the approximate time of protection.

Monitoring of the least brook lamprey

Monitoring of the adult least brook lamprey is seasonally constrained, requires specialized sampling techniques, and has the potential to cause injury to individual animals. Therefore, we recommend that any sampling of this species be done only after consultation with experienced IDNR fisheries biologists. We recommend that the benefits and risks of monitoring be weighed before any decision is reached on monitoring frequency. Ammoceotes may be more difficult to locate than spawning adults, but the risks associated with sampling may also be lower.

We recommend that some sampling for least brook lampreys take place, with proper precautions, in restored areas downstream of the proposed dam. At this time the status of the least brook lamprey in Sugar Creek is uncertain.

Monitoring of the Indiana crayfish

Monitoring for the Indiana crayfish is relatively simple and easily quantified, and the risk of damage to a population is relatively low. The species has been observed in 2001 and 2002 throughout the project area, and at several locations in the Little Saline River drainage. In both drainages, we recommend use of the methods described above.

Coordination of monitoring and research

The applicant will review proposals for research on the least brook lamprey or Indiana crayfish. Funding may be provided to qualified individuals or institutions for research applicable to the conservation or management of these species, especially where the research compliments monitoring, adds detail to monitoring, or addresses items of interest but beyond the scope of monitoring. Specific proposals will be included in endangered species research permit applications and will be subject to IDNR approval.

Projected Costs

Total costs for protection, restoration, and three years of monitoring are projected at approximately $210,000. Estimates assume a fair market value for Shawnee Hills land of $1,500 per acre, an average easement value at 75 percent of fair market value, and a mean buffer width of 75 feet. Some stream buffer between the proposed dam site and Route 166 has already been acquired, and those costs are not included in the present amount. Streambank stabilization and construction of riffles in Sugar Creek is estimated at approximately $5,000 per riffle. Preparation of the HCP is not included in the above amounts.

Potential cost-share funds for Lusk Creek protection or restoration have been tentatively budgeted at $3,000. The actual amount allocated will depend on the structure of grants prepared by the Lusk Creek Conservancy. Research funding is anticipated to be up to $6,000 to $10,000, spread over two to three years depending on the timing and type of applications received.

Projected costs are broken out below by year, assuming protection and restoration to 75 percent of area requirements in year one, and construction in year two. Costs are subject to revision depending on final permit requirements and completion of detailed design.

Year	1	2	3	4	5
Easements @ $1,125/acre	$71,340	$30,448			
Riffle/bank restoration	$36,250	$18,750			
Lusk Creek cost share		$3000			
Research funding		$3000	$3000	$3000	
Constr. animal movement		$4000			
Construction monitoring	$7750	$8250			
Annual monitoring			$7000	$7000	$7000
Totals	**$115,340**	**$67,448**	**$10,000**	**$10,000**	**$7000**
PROJECT TOTAL					**$209,788**

Adaptive Management Practices

Threatened and endangered species targeted in Habitat Conservation Plans are often poorly understood in terms of their biology and/or ecology. Such knowledge gaps can make long-term conservation planning difficult. Adaptive management accommodates uncertainty in conservation planning by allowing mitigation strategies to be modified as monitoring results become available.

Central to an adaptive management approach is the articulation of biological objectives and establishment of criteria by which mitigation success will be evaluated. Biological monitoring conducted at regular intervals provide the basis for any changes to the mitigation strategy (Noss et al. 1997). If monitoring results indicate that biological objectives are not being achieved, modifications designed to improve the mitigation strategy may be implemented. It may also be in the best interest of all parties to modify a strategy in the event additional information on distribution or status of the target species should become available. Political realities must also be considered; for example, if the applicant is unable to locate a sufficient amount of least brook lamprey habitat available for protection or restoration in a particular stream segment, then protection in an allternate location may become necessary

Translocations are also included within the realm of adaptive management. Because of concerns about mortality risk, disease transmission, and carrying capacity of existing habitat, the mitigation concept includes only limited movement of animals from within the impact area to nearby downstream sites. However, additional translocations may be considered on a case by case basis depending on monitoring or research results, or information originating elsewhere.

Assurance of Funding

Funding for mitigation and monitoring activities will be included as part of a bond issue after all project approvals have been obtained. No construction activity will begin in proximity to Sugar Creek or Maple Branch until at least 75 percent of the mitigation requirements have been met. This requirement is also incorporated into the Implementing Agreement (Appendix D).

MITIGATION SUMMARY

This document proposes the following mitigation actions:

1. Protection, primarily through negotiated conservation easements, of riparian buffer adjacent to 75,864 square meters of stream habitat including at least 3,230 square meters of riffle habitat (impacted area at a 1:1.1 ratio). Protection will occur in multiple drainages in proximity to known or probable localities for the least brook lamprey or Indiana crayfish.

2. Restoration or creation of riffle habitat, along with bank stabilization, in at least two distinct segments of Sugar Creek downstream of the project area. Restoration may be considered in other drainages, subject to appropriate locations, equipment access (which is limited by steep wooded banks and lack of roads) and regulatory approvals.

3. Provision of matching funds for restoration activity in Lusk Creek, if feasible, and provision of research funding related to conservation of the target species.

4. Monitoring during construction and for three years thereafter.

Section 4

Probability of Continued Survival in Illinois

Least Brook Lamprey

The least brook lamprey has so far been reported from 13 stream segments in five drainages within Illinois (Burr and Stewart, 1999). One of these locations is in Sugar Creek within the proposed impoundment area, and another is a short distance below the proposed dam location.

The largest known Illinois populations of least brook lampreys, and the only ones where spawning has been observed, are located in Bay Creek, Hunting Branch, and Lusk Creek in Pope County.

The Bay Creek and Hunting Branch locations are within Bell Smith Springs Recreation Area. Bell Smith Springs is a National Natural landmark, and it is managed as a natural area by the Forest Service. Most of the Bay Creek headwaters originate within Bay Creek Wilderness, a designated roadless area. Intervening portions of Bay Creek and the headwaters of Hunting Branch are also within areas which the Forest Service has formally designated for non-logging uses. Except for a few inholdings of private land around Watkins Ford and at the origin of a few small Bay Creek tributaries, almost all of the upper drainage is within public land managed in a way consistent with least brook lamprey protection. Little siltation is evident in upper Bay Creek, and there are no known threats.

Lusk Creek is a stream of outstanding natural quality, and it too is largely within the boundaries of Shawnee National Forest. The Lusk Creek locality is located south (downstream) of the 4,796 acre Lusk Creek Wilderness Area. A few private inholdings exist upstream of the known locality, but a recent inspection indicated that these are for the most part being managed in ways which do not have a high level of adverse impact on Lusk Creek. There is a considerable amount of available habitat in the stream segment where lampreys have been found (Weitzell et al., 1998), and this population is thought to be reasonably secure. Only a few attempts have been made to sample other segments of Lusk Creek, and it remains possible that this species may occur in other portions of the same stream.

Populations on Big Grand Pierre Creek and Big Creek are apparently smaller, based on the limited available information (Weitzell et al., 1998; Burr and Stewart, 1999).

There is evidence that least brook lampreys are capable of survival below impoundments. Weitzell et al. (1998) documented the presence of this species in Bay Creek just below the Number 5 impoundment despite the limited availability of suitable habitat there. Because reservoirs trap silt, they may actually buffer the effects of upstream logging or other activites which may result in erosion. At least three additional localities are known above the impoundment.

The available segment of Sugar Creek between the impoundment and downstream areas impacted by acid mine drainage will be relatively short (a few miles), and will probably limit the potential size of any population there. Because of limited habitat area and isolation from other populations, the risk of stochastic extinction must be considered higher than average. Even without a project, the least brook lamprey has apparently never been common in Sugar Creek, and protecting the species there will be more challenging than in streams where it is more abundant.

No information is available on the level of genetic divergence, if any, between least brook lamprey populations in different streams. In the absence of such information, it would seem wise to attempt to maintain multiple viable populations of the species.

The presence of the least brook lamprey in Sugar Creek implies that at least historically it must have occurred elsewhere in the South Fork Saline River drainage. We are aware of only a few recent attempts to sample for this species within the Saline River drainage outside of Sugar Creek (Burr and Stewart, 1999), The species is relatively difficult to document except in spring; aquatic sampling is traditionally done later in the season under lower water conditions. We recommend that more extensive spring sampling be done in areas of suitable habitat, especially in Biologically Significant segments of the Little Saline River system, to determine whether this species is present.

If least brook lampreys are able to successfully become established in restored riffle-pool habitat below the proposed impoundment, the apparently small Sugar Creek population may be able to increase in size over time. Although the probability of success is unknown, man-made riffles in at least two other locations have been colonized by this species.

Because of the uncertainty of the Sugar Creek effort, protection or restoration upstream of the largest known Illinois populations in the Bay and Lusk Creek drainages will reduce the risk of future catastrophic siltation or pollution events. These watersheds are already extensively protected, and threats to aquatic life are already lower than in most Illinois drainages. Least brook lamprey populations there are apparently stable, and efforts associated with this conservation plan emphasize further reduction of already relatively low upstream risks.

Indiana Crayfish

Page (1994) found Indiana crayfish at all but three of the then-known historical Illinois localities, and the species was subsequently located at one of those locations (U.S. Forest Service files, Vienna Ranger District). Several new localities have been documented since the Page (1994) inventory, including two by us during field work for this document. Although we targeted only locations with suitable gradient and substrate based on the literature, we found the species at half of the new locations we sampled as well as at three known historical locations. Many other areas of potential habitat exist on both public and private land in the northern part of Shawnee Hills, and we believe that a number of additional populations remain undiscovered. Relatively few sites away from road crossings have been sampled to date.

We found the Indiana crayfish to be common in parts of Sugar Creek and Maple Branch, the Little Saline River, and Katy Reid Hollow.

In Maple Branch, the highest densities are a few hundred meters downstream from an area of massive bank slumping (apparently from natural causes, since adjacent steep uplands remained forested at that location). This species has shown an ability to survive intervals of severe siltation as long as some instream cover remains. The Indiana crayfish is today common in areas which were clearcut 10 years ago, and some dense aggregations are in locations which must have only recently recovered from high silt loads.

At least 22 localities for the Indiana crayfish are presently known from within Illinois. These are concentrated within a relatively small geographic area, and some populations may be at risk from a variety of direct or indirect threats. However, based on the number of known localities, the availablity of extensive stream reaches with suitable habitat which have never been sampled for this species, and the continued existence of the species at almost all historical localities despite locally severe impacts, we believe it is unlikely that there is any serious short-term threat to the continued presence of this species in Illinois.

We are confident that Indiana crayfish will persist above and below the proposed impoundment. The best populations are in locations with considerably less flow than lower Sugar Creek, so dam related alterations in flow rate are not likely to harm this species. Reductions in silt load may be beneficial. Construction of riffles below the dam will diversify habitat there, and could support higher crayfish densities than at present.

A variety of protection and restoration strategies in the Little Saline basin should also help to ensure long-term survival of the species. Any reduction of silt loads, either through protection and natural stream recovery, or active bank stabilization in selected localities, could allow local increases in density and abundance.

Although habitat utilized by a substantial number of Indiana crayfish will be lost to the proposed impoundment, the species will remain common elsewhere in Sugar Creek. Increased crayfish density is expected in restored riffle complexes downstream of the impoundment, and can be documented through monitoring. Protection activities proposed for the Little Saline River will serve primarily to protect existing populations which are apparently common and widespead. Localized restoration activities may help to augment densities in specific locations.

Assessment of extinction risk

We do not believe that either species is at short-term risk of extinction in Illinois because 1) populations of both species occur in multiple drainages; 2) some populations of each species are within designated federal wilderness areas, National Natural Landmarks, or other land with high levels of legal protection; 3) populations of both species persist on private land which has been subject to high levels of disturbance in the past; 4) almost all historically known populations of both species are extant; 5) both species have demonstrated an ability to colonize man-made riffle habitat; and 6) recent field work (1998-2002) has located previously unknown populations of both species, with many miles of stream remaining uninventoried. Although the proposed project will result in some loss of known habitat, mitigation will decrease risk to other populations by protecting additional habitat, and by restoring or creating breeding habitat. The proposed mitigation will help to reduce longer-term threats to both species.

Section 5

Implementing Agreement

Draft implementing agreement

Upon completion of a Habitat Conservation Plans, involved parties typically enter into an implementing agreement intended to:

1. Establish an operating program for the conservation, mitigation, and monitoring of listed species

2. Define the obligations, authorities, liabilities, benefits, rights, and the priviledges of all signatories.

3. Assign responsibility for the planning, approving, and implementing of specific measures, including day to day operation

4. Outline the role of agencies in monitoring progress and success.

A Draft Implementing Agreement, edited and modified from a template provided by the U.S. Fish and Wildlife Service, is included as Appendix D. The Draft Implementing Agreement may be subject to modification after completion of negotiations between the City of Marion and the Illinois Department of Natural Resources.

Acknowledgements

Richard Booth (Earth Tech Canada) assisted with 2002 field studies. Brooks Burr (Southern Illinois University, Carbondale) provided reports and discussed results of his southern Illinois lamprey surveys. Jen Bayer (USGS/BRD, Cook, WA) provided extensive information on lamprey research in the Pacific Northwest.

The Illinois Department of Natural Resources provided element occurrence data for the target species, and issued permits to collect state listed species. The Illinois Natural History Survey shared information on Indiana crayfish and provided maps and relevant reference material.

The U.S. Forest Service allowed access to streams and adjacent land in Shawnee National Forest, and authorized sampling in selected watersheds. We especially thank Beth Shimp, Mike Widowski, and Chad Stinson.

Lisa Ollivier of the U.S. Forest Service Redwood Sciences Laboratory, Arcata, CA, contributed articles and information which we used to formulate portions of our monitoring protocol.

Section 6

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Appendices

Appendix A

Reservoir Release Plan for the Proposed City of Marion Reservoir

RESERVOIR RELEASE PLAN
FOR
THE CITY OF MARION
RESERVOIR ON SUGAR CREEK
Prepared by Clarida Engineering Co.

RELEASE SCHEDULE

This reservoir release plan was developed in order to provide for the in stream flow needs of that section of Sugar Creek downstream from the reservoir. An interagency (Corps of Engineers, U.S. Fish and Wildlife Service, and U.S. Environmental Protection Agency) review resulted in the release schedule as outlined herein.

Pre-construction Sugar Creek discharges were estimated based on a gauging station on Hayes Creek at Glendale. This stream was chosen for comparison because of the proximity to Sugar Creek and because the size and type of watershed tributary to the creek is similar to the Sugar Creek watershed. Based on Hayes Creek data, the mean annual discharge in Sugar Creek in the reach near the dam site has been estimated to be about 32.9 cfs. Monthly mean stream discharge in Sugar Creek at this location likely varies from less than 3 cfs in dry periods to about 70 cfs in wet periods. Periods of no flow in Sugar Creek can be expected to occur, on average, for about 18 percent of the year or about 65 days (not necessarily continuous) in any year.

A strategy has been developed for post-construction Sugar Creek releases that will be made up of a mixture of controlled reservoir releases through the outlet works combined with uncontrolled spillway releases. The existing stream receives considerable variation in flow, including peaks and droughts, and it is important that a similar pattern be provided. It is also important that the stream be assured certain base flows in every month.

The release strategy provides a dependable base flow from the outlet works of about two-thirds existing average monthly flow in the months of May, June, July and August, based on the determination that spawning and juvenile life stages in this stream reach require a substantial minimum amount of water. It was determined that the months of September and October would need a dependable base flow somewhat lower, therefore one-half the existing average monthly flow was established. The remaining months were determined to need somewhat less dependable base flow, therefore four-tenths existing average monthly flow was established.

Because the consumptive use, evaporation, and low flow releases are less than the anticipated inflow for a number of months, the dependable base flow for January through May is expected to be supplemented with considerable volumes of water over the uncontrolled spillway. Large portions of the months of December and June will also have excess water that will flow over the spillway. In the remaining months, the reservoir level will be below spillway level. Reservoir draw down will continue during remaining summer and early fall months with little flow over the spillway anticipated.

It was also determined that the stream should have periodic events when minimal flow will occur. The reservoir releases through the outlet works will be reduced for a five-day period during the months of July, August, September, and October to flow in the 1 ½-inch pipe only, a discharge of 0.25 cfs. This low flow period will provide for a short number of days during times when the existing stream normally approaches zero flow. Average monthly pre-project and post-project Sugar Creek discharges with the new interagency plan are shown in the table below.

SUGAR CREEK DISCHARGE BELOW DAM SITE (CFS)

Month	Natural Stream Flow	Flow Through Outlet Works 16"	1 ½ "	Spillway Discharge	Total Discharge	Net % of Natural Discharge
JAN	60.02	27.39	0.25	28.22	55.87	93
FEB	58.74	27.38	0.25	26.56	54.20	92
MAR	70.24	27.39	0.25	39.67	67.31	96
APR	57.47	27.39	0.25	23.63	51.27	89
MAY	45.97	27.39	0.25	6.54	34.19	74
JUN	15.32	9.66	0.25		9.92	65
JUL	9.07	5.68	0.25		5.94	65
AUG	6.50	3.97	0.25		4.23	65
SEP	4.85	2.18	0.25		2.44	50
OCT	2.94	1.20	0.25		1.46	50
NOV	22.94	8.98	0.25		9.24	40
DEC	42.14	27.39	0.25	8.51	36.16	86

RELEASE MECHANICS

During Construction

The dam embankment and spillways have been designed to allow for minimal disruption to Sugar Creek during construction of the reservoir. Due to the location of the primary spillway, it can be constructed while at the same time leaving Sugar Creek to flow unimpeded.

The sequence of construction is as follows: First, the contractor shall install all sediment and erosion control structures along Sugar Creek. Then, the intake structure, 48" drain line, primary spillway, and primary spillway outlet channel can be constructed. Construction of these structures is expected to take approximately 12 to 18 months to complete. Once this construction has been completed, the embankment can be constructed across Sugar Creek. Once again, before any embankment fill is placed in the creek, sediment and erosion control structures will be

placed in the creek to prevent pollutants from the construction from entering the creek. The section of the embankment in the area of the creek will then be constructed. However, construction will be limited to that time of year when stream flow is at a minimum, typically during the months of August through October. This will minimize the chances of any downstream pollution. Construction of that portion of the embankment should not take longer than two to three months. Should the area receive more than the usual amount of rainfall during the construction of the embankment, water can still be released downstream of the construction through the 48 inch draw down pipe.

During the filling process, water will be released downstream, first through the draw down pipe, then as the water level in the reservoir rises, through the raw water intake ports in the intake structure.

Post Construction

The City of Marion will be able to comply with the release schedule as outlined both herein and in the Environmental Impact Statement through the methods described herein and as shown on drawings.

First, both the 1 ½ " and 16 " water release lines discharge into the 48 " draw down pipe that runs through the dam. This 48 " diameter line has a flow-measuring device near the discharge end of the pipe that is connected to a chart recorder in the pump station that will continuously record the flow through the line.

Secondly, The 1 ½ " line will discharge a continuous 0.25 cfs downstream. This is due to the fact that there is no flow shut-off device on this line.

Thirdly, the 16 " water release line will be controlled by an adjustable electrically operated valve that can be opened incrementally to allow the desired flow through the 16 " line. This valve will be remotely controlled, with the adjusting apparatus placed in the pump station.

To insure the proper amount of downstream flow, City of Marion personnel will match the chart recording of the flow through the 48 " outlet with the valve percent open by simply adjusting a knob that controls the valve.

City personnel will make the necessary adjustments to the valve on the first day of each month with the exception of January through May when no adjustments will be necessary. For the months of July through October, and additional adjustment will be made on the 26th day of each month when the 16 " valve will be completely closed, allowing only the flow through the 1 ½ " line. Drawing have been prepared to show in more detail how the proposed water release system will function.

Appendix B

Aerial view of a portion of the Sugar Creek watershed, showing land use. Source: USGS Digital Orthophotoquad, Creal Springs and Crab Orchard 7.5' quandrangles.

Appendix C

Aerial view of a portion of the Little Saline River watershed, showing land use. Source: USGS Digital Orthophotoquad, Stonefort 7.5' quadrangle.

Appendix D

Implementing agreement

IMPLEMENTING AGREEMENT

by and between

CITY OF MARION

and the

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

TO ESTABLISH A PROGRAM FOR THE CONSERVATION OF ENDANGERED SPECIES AT THE PROPOSED MARION RESERVOIR.

The implementing Agreement ("Agreement") made and entered into as of the _____ day of _____, 2002, by and among the CITY OF MARION, and the ILLINOIS DEPARTMENT OF NATURAL RESOURCES (IDNR), hereinafter collectively called the "Parties", defines the Parties' roles and responsibilities and provides a common understanding of actions that will be undertaken for the conservation of the subject listed and unlisted species and their habitats during construction and operation of the proposed Marion Reservoir near Creal Springs, Illinois.

The parties enter into this Agreement in accordance with Section 5.5 of the Illinois Endangered Species Protection Act [520 ILCS 10/5.5

1.0 Recitals

WHEREAS, the proposed Marion Reservoir site selected after environmental review has been determined to be habitat for the state threatened least brook lamprey, and the state endangered Indiana crayfish; and,

WHEREAS, the City of Marion, through consultation with the IDNR, and with the agreement of that agency, has developed a series of measures, described in the Conservation Plan, to conserve the subject listed and unlisted species and their associated habitats during project activities; and,

WHEREAS, procedures to obtain permits allowing incidental take of listed species pursuant to Title 17, Chapter 1, subchapter c, part 1080 also require a binding agreement commuting the parties to implement specified conservation measures for the subject listed species in the Conservation Plan;

THEREFORE, for and in consideration of the mutual covenants and conditions herein, the Parties hereto do hereby understand and agree as follows:

2.0 DEFINITIONS

The following terms as used in this Agreement shall have the meanings set forth below:

2.1 The term "Permit" shall mean an incidental take permit issued by IDNR to the City of Marion pursuant to Title 17(1)(c) part 1080.

2.2 The term "Permit Area" shall mean the Marion Reservoir project area consisting of approximately 1,172 acres in Township 10 South, Range 3 East, portions of Sections 26, 35, and 36; and Township 10 South, Range 4 East, portions of Section 31, in Williamson County, Illinois; Township 11 South, Range 3 East, portions of Sections 1, 2, 11, and 12; and Township 11 South, Range 4 East, portions of Sections 6, 7, 8, 17, and 18, in Johnson County, Illinois as depicted in Figure 1.2 of the Marion Reservoir Habitat Conservation Plan.

2.3 The term "Permittee" shall mean the City of Marion.

2.4 The term "Conservation Plan" shall mean the Conservation Plan prepared for the Marion Reservoir project.

2.5 The term "Plan Species" shall mean the two state listed species identified in Section 1.0 of this Agreement.

2.6 The term "Compensation Land" shall mean the stream corridor protected by the City of Marion through conservation easement or other means for management in perpetuity as habitat for the Plan Species pursuant to Section 11.1(b) of this Agreement.

2.7 The term "Unforeseen Circumstances" shall mean any significant adverse change in the population of candidate species, or in the habitat or natural resources of the compensation lands, or in the anticipated impacts of the project or other factors upon which the Conservation Plan is based, or any significant new information relevant to the Conservation Plan (including information presented during a public comment period on the Permit application) that was unforeseen by the Parties on the date hereof.

3.0 CONSERVATION PLAN

Pursuant to the provisions of Title 17(1)(c) part 1080 and the Illinois Endangered Species Act [520 ILCS 10/5.5], the City of Marion has prepared a Conservation Plan and submitted it to IDNR with a request that IDNR issue a Permit to allow subject listed species to be incidentally taken, as the term is defined in Title 17(1)(c) part 1080, within the Permit Area as depicted and described in Figure 1.2 of the Conservation Plan. The Conservation Plan proposed a program of conservation for the subject listed species and their habitat through protection and/or restoration of crucial replacement habitat.

4.0 INCORPORATION OF CONSERVATION PLAN

The Conservation Plan and each of its provisions are intended to be, and by this reference are, incorporated herein. In the event of any direct contradiction between the terms of this Agreement and the Conservation Plan, the terms of this Agreement shall control. In all other cases, the terms of this Agreement and the terms of the Conservation Plan shall be interpreted to be supplementary to each other.

5.0 LEGAL REQUIREMENTS

In order to fulfill the requirements that will allow the IDNR to issue the Permit, the Conservation Plan provides measures that are intended to ensure that any take occurring within the Permit Area will be incidental; that the impacts of the take will, to the maximum extent practicable, be minimized and mitigated; that adequate funding for the Conservation Plan will be provided; and that the take will not appreciably reduce the likelihood of the survival and recovery of the Plan Species in the wild.

6.0 COOPERATIVE EFFORT

In order that each of the legal requirements as set forth in Paragraph 5.0 hereof are fulfilled, each of the Parties to this Agreement must perform certain specific tasks. The Conservation Plan thus describes a cooperative program by Federal and State agencies and private interests to conserve the Plan Species.

7.0 TERMS USED

Terms defined and utilized in the Conservation Plan and the IESPA shall have the same meaning when utilized in this Agreement, except as specifically noted.

8.0 Purposes

The purposes of this Agreement are:

8.1 To ensure the implementations of each of the terms of the Conservation Plan;

8.2 To contractually bind each Party to fulfill and faithfully perform the obligations, responsibilities, and tasks assigned to it pursuant to the terms of the Conservation Plan; and,

8.3 To provide remedies and recourse should any Party fail to perform its obligations, responsibilities, and tasks as set forth in this Agreement.

9.0 TERM

9.1 State Term. This Agreement shall become effective on the date that the IDNR issues the Permit requested in the Conservation Plan and shall remain in full force and effect for a period of 50 years [or longer, as appropriate] or until termination of the Permit, whichever occurs sooner.

9.2 Notwithstanding the stated term as herein set forth, the Parties agree and recognize that once the Plan Species have been taken and their habitat modified within the Permit Area during [Project Activity], the take and habitat modification will be permanent. The Parties, therefore, agree that the acquisition and maintenance of the compensation habitat shall likewise be permanent and extend beyond the terms of this Agreement.

10.0 FUNDING

10.1 As detailed in Sections 11.1(b) and 11.4 of this Agreement, the City of Marion will provide the funds to carry out the conservation measures within the Permit Area cited in the Conservation Plan and, prior to site disturbing activities, will protect and/or restore, through means approved by IDNR, offsite habitat compensation lands as described in the Conservation Plan, or will guarantee performance of those duties through an irrevocable Letter of Credit in favor of the IDNR or other third party approved by IDNR and secured against the City of Marion. Such Letter of Credit shall be delivered to IDNR or approved third party within 30 days of issuance of the Permit and prior to site disturbing activities.

10.2 IDNR shall include in annual budget requests sufficient funds to fulfill its obligations under the Conservation Plan and its statutory requirements to protect the Plan Species.

11.0 RESPONSIBILITIES OF THE PARTIES IN CONSERVATION PROGRAM IMPLEMENTATION

11.1 The City of Marion shall undertake those actions for conservation of the Plan Species as detailed in Section 3 of the Conservation Plan and summarized here during construction and operation of the Marion Reservoir near Creal Springs, Illinois.

a. Implement the following measures to minimize and mitigate the impacts of incidental take of the listed Plan Species within the Permit Area:

(1) Hire a qualified biologist subject to approval by IDNR, who shall conduct a pre-activity survey of the Permit Area not more than 60 days prior to onset of site disturbing activities;

(2) Conduct a least brook lamprey and Indiana crayfish live trapping, collecting, and/or release program within the Permit Area immediately prior to site disturbing activities, if determined to be necessary by IDNR. Said program shall be conducted in accordance with Section 3 of the Conservation Plan;

(3) Prior to site disturbing activities, establish fenced exclusion zones around construction areas (if applicable). The fencing shall be accomplished in accordance with Section 3 of the Conservation Plan;

(4) Prior to site disturbing activities, clearly delineate and mark project construction boundaries to reduce potential for straying of vehicles and equipment onto adjacent habitats;

(5) As soon as practicable after onset of site disturbing activities, remove any least brook lamprey, and Indiana crayfish found within the facility pursuant to the methods and approvals set forth in Section 3 of the Conservation Plan.

(6) Confine equipment storage and parking during construction activities to the Permit Area or to previously disturbed off-site areas that are not habitat for listed species;

(7) Restrict all project-related vehicles to established roads, construction areas, storage areas, and staging and parking areas;

(8) Designate a specific individual as a contact representative between the City of Marion and IDNR to oversee compliance with protection measures detailed in the Conservation Plan;

(9) Develop and implement an employee orientation package which includes a discussion of the Plan Species on-site, the habitat needs of these species, the protection measures being implemented to reduce the potential for incidental take of these species and the penalties under IESPA for unlawful take of such species;

(10) Restrict project-related vehicle speed limits to 15 MPH in all project areas, except on County roads and State and Federal highways;

(11) Contain and promptly remove all food-related trash items and refrain from any deliberate feeding of wildlife;

(12) Prohibit domestic pets on-site unless confined or leashed;

(13) Consult IDNR prior to on-site rodenticide use outside of facility buildings, and use such rodenticides in a manner acceptable to IDNR, and limit all herbicide use to inside the fenced Permit Area;

(14) Prior to initiation of night time operations, consult with IDNR to develop a plan for mitigating vagrant light impacts to the maximum extent practicable. At a minimum, the plan shall include providing

approved directional, anti-glare lighting of the entire facility to reduce vagrant light into adjacent wildlife habitat areas;

(15) Immediately notify IDNR of the finding and circumstances surrounding discovery of any dead or injured listed species on-site following notification procedures in Section 3 of the Conservation Plan. Within 3 working days provide a written report to IDNR detailing the circumstances, location, etc. of any such finding;

(16) Within 45 days of completion of construction of the project facility, the City of Marion shall forward to the IDNR a brief post-construction compliance report prepared by a qualified biologist. This report shall detail the following: 1) dates that construction occurred; 2) an evaluation of the City of Marion's success in meeting project mitigation measure; 3) an explanation of failure to meet such measures, if any; 4) known project effects on the Plan Species, including the amount of habitat destroyed, if any; and 5) other pertinent information.

(17) If requested by IDNR, upon completion of construction of the project facility, the City of Marion shall accompany IDNR personnel on an on-site inspection of the Permit Area to determine project impacts to the Plan Species.

b. Implement those measures provided in the Conservation Plan to offset the unavoidable loss within the Permit Area of habitat of the Plan Species through the establishment, maintenance, and monitoring of replacement habitat, as described below:

(1) Within 30 days of issuance of the Permit and prior to any site disturbing activities, the City of Marion shall either:

i. Protect and/or restore, through methods approved by IDNR, riparian buffer lands adjacent to 75,864 square meters of stream habitat, primarily offsite, as habitat compensation lands for the Plan species, at a location or locations approved by the IDNR within the Sugar Creek, Little Saline River, Bay Creek, and Lusk Creek drainages as depicted in Figure 1-1 and Appendices B and C of the Conservation Plan, or the immediate proximity thereof; OR

ii. Secure performance of such land protection and/or restoration through an irrevocable Letter of Credit from a Bank in favor of IDNR or third party approved by IDNR or cash security issued by a bank in the amount of $210,000; and,

iii. Secure funds through an irrevocable Letter of Credit from a Bank in favor of IDNR or a third party approved by IDNR or cash security issued by a Bank, for [$__,___] for long term maintenance and management of the stream habitat compensation lands; and,

iv. Deliver the Letter(s) of Credit provided for under Paragraphs 11.1(b)(1)(ii)-(iv) to IDNR or the third party approved by IDNR.

v. Notwithstanding the cost estimate in 11.1(b)(1)(ii) above, in the event that habitat protection and/or restoration costs exceed the projected amounts, the City of Marion shall not be released from performance of the duties contained herein and shall ensure that adequate funding for land protection and/or restoration is available at all times.

Accordingly, should IDNR determine at any time prior to protection and/or restoration by the City of Marion of the stream habitat compensation lands, that the Letter of Credit described in Paragraph 11.1(b)(1)(ii) is inadequate to ensure funding of the protection of the habitat compensation lands (e.g. if

average easement values or construction costs within the Plan Area substantially exceed the cost estimates included in the Conservation Plan), then the city of Marion shall provide additional Letters of Credit or cash securities in the amounts necessary as determined by IDNR in consultation with the City of Marion to ensure adequate funding. Prior to requiring additional Letters of Credit or cash securities, IDNR shall inform the City of Marion in writing of the basis for their conclusion that additional security is required. Failure by the City of Marion to provide necessary securities within 60 days of receipt of demand for such securities from IDNR shall constitute a breach of the Permit and may result in suspension, revocation, or termination of the Permit as described in Section 14.2(a) below.

vi. In the event that costs of performance of protection and/or restoration, endowment, and enhancement duties are less than estimated, the City of Marion shall retain title to any funds not expended.

(2) Prior to the beginning of any construction which may result in take of the Plan Species, the City of Marion shall make arrangements to protect and/or restore at least 75 percent of the required compensation lands, as described in Section 3 of the Conservation Plan, the completion of which is secured pursuant to Paragraph 11.1(b)(1)(ii) above, at no charge to IDNR or a third party approved by IDNR, for protective management of the Plan Species and their habitats. The balance of the compensation lands shall be protected or restored within 12 months after the beginning of construction. The City of Marion or its agent may apply for a 12-month extension for land protection and/or restoration if The City of Marion demonstrates, to the satisfaction of IDNR, a good faith effort to protect and/or restore habitat within the initial 12-month time frame;

(3) In the event the City of Marion secures it's obligation for habitat protection and/or restoration with said Letter(s) of Credit, and does not complete protection and/or restoration of the required habitat compensation lands, together with any other obligations specified in this agreement, within 12 months of the beginning of construction activities or within 24 months if an extension is granted by IDNR, then IDNR or the third party shall execute upon the Letters of Credit or cash securities and shall complete the habitat compensation, ensure enhancement of compensation lands, and ensure management and maintenance in perpetuity of habitat compensation lands for the conservation of the Plan Species;

(4) Prior to approval by IDNR of the transfer of management responsibility for habitat compensation lands by the City of Marion to a party other than IDNR, the third party shall execute a "Management Agreement" with the IDNR which shall bind and obligate the third party to manage and maintain in perpetuity the habitat compensation lands for the conservation of the Plan Species.

11.2 The IDNR agrees to undertake the following actions to implement the Conservation Plan

a. Upon issuance of the Permit, the IDNR shall monitor the implementation of the Permit, the Conservation Plan and the activities thereunder, including but not limited to, the selection, modification, protection, restoration, management, operations and maintenance of offsite habitat compensation lands in order to ensure compliance with the Conservation Plan and this Agreement.

b. Provide assistance during Conservation Plan implementation as described below:

(1) Review credentials of any biologist(s) under consideration by the City of Marion to determine if qualified to undertake protection and monitoring actions for the Plan Species;

(2) Assist the City of Marion in the establishment of appropriate methodologies and monitoring procedures for the least brook lamprey and Indiana crayfish live trapping, collection, and release program as described in Section 3 of the Conservation Plan;

(3) Assist the City of Marion with processing of any permits necessary to authorize designated project biologist(s) to undertake live trapping, collection, handling, marking, monitoring, other actions as specified in Section 3 of the Conservation Plan and as determined to be appropriate by the FWS and IDNR;

(4) Provide such guidance as may be needed by the City of Marion relating to the effects of ground-disturbing activities at or near least brook lamprey and Indiana crayfish habitat;

(5) Maintain open communication with the City of Marion and project representatives to assist with compliance procedures for the Plan Species;

(6) Assist the City of Marion with the identification of off-site compensation lands that the City of Marion will protect, restore, or manage for the Plan Species;

(7) Assist the City of Marion in establishing a habitat compensation credit program for of habitat compensation lands as specified in Section 3 of the Conservation Plan and Paragraph 11.3 of this Agreement;

(8) Assist the City of Marion in identifying projects which meet the habitat compensation credit transaction criteria and approve habitat compensation credit transactions.

(9) Accept any dead or injured listed species found during project activities, subject animals to be retained by IDNR for care, analysis, and disposition;

11.3 HABITAT COMPENSATION CREDITS

a. As mutually agreed between IDNR and the City of Marion, habitat compensation credits shall be established for stream habitat compensation lands acquired by the City of Marion pursuant to Part 11.1(b) of this Agreement. The City of Marion may sell habitat compensation credits to other project applicants whose projects require acquisition of habitat compensation lands, subject to the following conditions.

(1) A habitat compensation credit is defined as the equivalent of one square meter of any stream corridor habitat compensation lands which IDNR has designated in writing to be available for sale to other project applicants. Other project applicants may purchase such compensation credits in lieu of acquiring or otherwise protecting habitat to satisfy habitat compensation requirements for certain projects as described in Paragraph 11.4(a)(2).

(2) The project of any applicant or other project proponent to which habitat compensation credits may be sold by the City of Marion shall be located outside the HCP protection area, as depicted in Figure 1-1 of the HCP, or any other reserve area designated by FWS and/or IDNR.

(3) Compensation lands acquired by the City of Marion, if any, may be deeded to IDNR or an approved third party prior to any compensation credit transaction, if so agreed by the parties.

(4) All compensation credit transactions shall be approved in advance and in writing by IDNR.

(5) The City of Marion shall retain the right to determine the sales price of habitat compensation credits. The City of Marion is under no obligation to sell habitat compensation credits and may choose to retain these credits indefinitely. The City of Marion shall bear all costs associated with mitigation credit transactions.

b. Upon documentary evidence of sale of habitat compensation credits, the City of Marion may request that IDNR, as the beneficiary of the Letter of Credit, join with the City of Marion to request from the issuer an equitable reduction of the Principle Sum of the Letter of Credit. However, the Principal Sum of the Letter of Credit shall not be reduced below an amount determined by IDNR to be reasonably necessary to cure any potential future default by the City of Marion.

12.0 ENVIRONMENTAL REVIEW

Construction and operation of the proposed Marion Reservoir is an action subject to NEPA review. The U.S. Army Corps of Engineers (USACE), Louisville District, has completed a Draft Environmental Impact Study (DEIS) addressing project actions pursuant to NEPA Guidelines. Issuance of a part 1080 permit to the City of Marion by IDNR is not subject to NEPA review, although state endangered species issues are included as part of the DEIS. USACE is the "lead" agency under NEPA.

13.0 ISSUANCE OF THE PERMIT

13.1 FINDINGS

Upon finding after opportunity for public comment with respect to the Permit application and the Conservation Plan that:

a. INCIDENTAL TAKE

Any permitted taking of the subject listed species will be incidental to the carrying out of otherwise lawful activities; and,

b. MINIMIZE AND MITIGATE

The Conservation Plan and this Implementation Agreement will, to the maximum extent practicable, minimize and mitigate the impacts of such incidental taking; and,

c. ADEQUATE FUNDING

The funding sources identified and provided for herein will ensure that adequate funding for the Conservation Plan will be provided; and,

d. NO LIKELY JEOPARDY

Any permitted taking of the subject listed species will not appreciably reduce the likelihood of the survival and recovery of the Plan Species in the wild; and,

e. OTHER MEASURES

Any other measures set forth in the Conservation Plan and required by IDNR as being necessary or appropriate for the purposes of the Conservation Plan (including any measures determined by the Parties to be necessary to deal with Unforeseen Circumstances) will be fulfilled; IDNR shall issue a Permit allowing incidental take of listed Plan Species to the City of Marion. Such Permit shall be issued concurrently with the execution of this Agreement by the Parties, and it is specifically agreed that this Agreement shall not become effective nor binding upon the Parties hereto until and unless the Permit has been issued.

13.2 ISSUANCE AND MONITORING

After issuance of the Permit, IDNR shall monitor the implementation thereof, including each of the terms of this Agreement and the Conservation Plan, including, but not limited to the management, maintenance, and monitoring of the habitat compensation lands in order to ensure compliance with the Permit, the Conservation Plan and this Agreement. In addition, IDNR shall, to the maximum extent possible, ensure the availability of its staff to cooperate with and provide technical and research assistance to the Parties.

14.0 REMEDIES AND ENFORCEMENT

14.1 REMEDIES IN GENERAL

Except as set forth hereinafter, each Party hereto shall have all of the remedies available in equity (including specific performance and injunctive relief) and at law to enforce the terms of this Agreement and the Permit and to seek remedies and compensation for any breach hereof, consistent with and subject to the following:

a. NO MONETARY DAMAGES

None of the Parties shall be liable in damages to the other Parties or to the person for any breach of this Agreement, any performance or failure to perform a mandatory or discretionary obligation imposed by this Agreement or any other cause of action arising from this Agreement. Notwithstanding the foregoing:

(1) Retain Liability

Each Party shall retain whatever liability it would possess for its present and future acts or failure to act without existence of this Agreement.

(2) Land Owner Liability

The City of Marion shall retain whatever liability it possesses as an owner of interest in land.

b. INJUNCTIVE AND TEMPORARY RELIEF

The Parties acknowledge that the Plan Species are unique and that their loss as species would result in irreparable damage to the environment and that therefore injunctive and temporary relief may be appropriate in certain instances involving a breach of this Agreement.

14.2 THE PERMIT

a. PERMIT SUSPENSION, REVOCATION OR TERMINATION

(1) Suspension

In the event of any significant violation or breach of the Permit or this Agreement, IDNR may suspend the Permit; however, except where IDNR determines that emergency action is necessary to protect the Plan Species, it will not suspend the Permit without first:

(i) Requesting the City of Marion to take appropriate remedial, enforcement or management actions; and

(ii) Providing the City of Marion notice in writing of the facts or conduct which may warrant the suspension and an opportunity for the City of Marion to demonstrate or achieve compliance with the IESPA, regulations issued thereunder, the Permit and this Agreement.

(2) Reinstatement

In the event the Permit is suspended, as soon as possible, but not later than ten (10) working days after any suspension, IDNR shall consult with the City of Marion concerning actions to be taken to effectively redress the violation, and after consultation IDNR shall make a determination of the actions necessary to effectively redress the violation or breach. In making this determination IDNR shall consider the requirements of the IESPA, regulations issued thereunder, the conservation needs of the Plan Species, the terms of the Permit and of this Agreement and any comments or recommendations received during the consultations. As soon as possible, but not later than thirty (30) days after the conclusion of the consultations, IDNR shall transmit to the City of Marion written notice of the actions necessary to effectively redress the violation or breach. Upon full performance of the necessary actions specified by IDNR in its written notice, IDNR shall immediately reinstate the Permit. It is the intent of the Parties hereto that in the event of any suspension of the Permit all Parties shall act expeditiously to cooperate to rescind any suspension to carry out the objective of this Agreement.

(3) Revocation or Termination

(i) IDNR agrees that it will revoke or terminate the Permit for violation of the Permit or breach of this Agreement only if IDNR determines that:

(A) Such violation cannot be effectively redressed by other remedies or enforcement action; and,

(B) Revocation or termination is required to fulfill a responsibility of IDNR under IESPA or regulations issued thereunder.

(ii) IDNR agrees that it will not revoke or terminate the Permit without first:

(A) Requesting the City of Marion to take appropriate remedial action; and,

(B) Providing the City of Marion notice in writing of the facts or conduct which may warrant the revocation or termination and a reasonable opportunity (but not less than sixty (60) days) to demonstrate or achieve compliance with the IESPA, regulations issued thereunder, the Permit and this Agreement.

14.3 LIMITATIONS AND EXTENT OF ENFORCEABILITY

a. NO FURTHER MITIGATION FOR PERMIT SITE

It is acknowledged that the purpose of this Agreement is to set forth the obligations and rights of the Parties hereto with respect to the Conservation Plan and to provide for the conservation of the Plan Species and the mitigation and compensatory measures required in connection with incidental taking of the listed Plan Species in the course of otherwise lawful activities within the Permit Area. Accordingly, except as otherwise required by law and/or provided under the terms of the Conservation Plan, including Unforeseen Circumstances, no further mitigation or compensation will be required by IDNR.

In the event that the status of a Plan Species changes, for example if the state threatened least brook lamprey should be elevated to state endangered pursuant to the IESPA after the Permit has been issued and the Conservation Plan and Implementing Agreement have been approved by IDNR, the Conservation

Plan shall be adequate documentation, in the absence of Unforeseen Circumstances, to support an amendment of the part 1080 permit to take such listed species.

b. PRIVATE PROPERTY RIGHTS AND LEGAL AUTHORITIES UNAFFECTED

Except as otherwise specifically provided in this Agreement, nothing herein contained shall be deemed to restrict the rights of the City of Marion to manage the use of and exercise all of the incidents of land ownership over those lands and interests in lands constituting the Permit Area subject to such other limitations as may apply to such rights under the Constitution and laws of the United States and the State of Illinois. Furthermore, nothing herein contained is intended to limit the authority or responsibility of the State of Illinois to invoke the penalties or otherwise fulfill its responsibilities under the IESPA.

15.0 AMENDMENTS

15.1 AMENDMENTS TO THE IMPLEMENTATION AGREEMENT

Except as otherwise set forth herein, this Agreement may be amended only with the written consent of each of the Parties hereto.

15.2 AMENDMENTS TO THE HCP

Material changes to the Conservation Plan proposed by the City of Marion after the effective date of the Permit, shall be processed by IDNR as an amendment to the Permit in accordance with the IESPA and permit regulations at Title 17(1)(c) part 1080 and shall be subject to appropriate environmental review.

16.0 MISCELLANEOUS PROVISIONS

16.1 NO PARTNERSHIP

Except as otherwise expressly set forth herein, neither this Agreement nor the Conservation Plan shall make or be deemed to make any Party to this Agreement the agent for or the partner of any other Party.

16.2 SUCCESSORS AND ASSIGNS

This Agreement and each of its covenants and conditions shall be binding on and shall inure to the benefit of the Parties hereto and their respective successors and assigns.

16.3 NOTICE

Any notice permitted or required by this Agreement shall be delivered personally to the person set forth below or shall be deemed delivered five (5) days after deposit in the United States mail, certified and postage prepaid, return receipt requested and addressed as follows or at such other address as any Party may from time to time specify to the other Party in writing.

Name/Title
Illinois Department of Natural Resources
524 South Second Street
Springfield, IL 62701-1787

Mayor Robert L. Butler
City of Marion

1102 Tower Square Plaza
Marion, IL 62959

16.4 ENTIRE AGREEMENT

This Agreement supersedes any and all other Agreements, either oral or in writing among the Parties hereto with respect to the subject matter hereof and contains all of the covenants and agreements among them with respect to said matters, and each Party acknowledges that no representation, inducement, promise or agreement, oral or otherwise, has been made by the other Party or anyone acting on behalf of the other Party and is not embodied herein.

16.5 ATTORNEY'S FEES

If any action at law or equity, including any action for declaratory relief, is brought to enforce or interpret the provisions of this Agreement, each Party to the litigation shall bear its own attorney's fees and costs provided that attorneys' fees and costs recoverable against the United States shall be governed by applicable Federal law.

16.6 ELECTED OFFICIALS NOT TO BENEFIT

No member of or delegate to Congress or the Illinois Legislature shall be entitled to any share or part of this Agreement, or to any benefit that may arise from it.

16.7 AVAILABILITY OF FUNDS

Implementation of this Agreement by IDNR shall be subject to the availability of appropriated funds.

16.8 DUPLICATE ORIGINALS

This Agreement may be executed in any number of duplicate originals. A complete original of this Agreement shall be maintained in the official records of each of the Parties hereto.

16.9 THIRD PARTY BENEFICIARIES

Without limiting the applicability of the rights granted to the public pursuant to the provisions of 16 U.S.C. § 1540(g), this Agreement shall not create the public or any member thereof as a third Party beneficiary hereof, nor shall it authorize anyone not a Party to this agreement to maintain a suit for personal injuries or property damages pursuant to the provisions of this Agreement. The duties, obligations and responsibilities of the Parties to this Agreement with respect to third Parties shall remain as imposed by general law.

17.0 ALTERATION OF DOCUMENTS

Any alteration of a Conservation Plan or associated document by any representative of the applicant or the State or Federal government, at any time after agreement has been reached between the responsible IDNR Office and the applicant with respect to Conservation Plan measures, conditions, or other contents, without express written notification to or agreement by all other parties to the Conservation Plan and the Implementing Agreement, shall subject any incidental take permit issued in accordance with any Conservation Plan or associated document subsequently found to have been altered to potential suspension or revocation pursuant to Section 14.0 of the Implementing Agreement, and shall entitle the injured party or parties to all remedies allowed by law or as otherwise appropriate.

IN WITNESS WHEREOF, THE PARTIES HERETO have executed this Implementing Agreement to be in effect as of the date last signed below.

Appendix E

Indiana crayfish density and abundance data analysis for Sugar Creek and Maple Branch

Table E-1. Riffle mesohabitat, upper Sugar Creek

riffle habitat unit	width (m)	length (m)	area (m2)	estimate or actual?	belt number	Indiana crayfish captures	number of belts sampled	mean belt captures	variance among belts	total # of crayfish present	mean crayfish density (#/m2)	total # belts possible	second stage variance
1	8.0	4.0	32.0	e									
2	8.0	20.0	160.0	e									
3	7.8	11.5	89.7	a	1	3	3	1.00	3.00	11.50	0.13	11.5	97.75
					2	0							
					3	0							
4	8.0	6.0	48.0	e									
5	6.0	6.0	36.0	e									
6	3.0	5.0	15.0	e									
7	6.0	4.0	24.0	e									
8	2.8	10.5	29.4	a	1	2	3	1.67	0.33	17.54	0.60	10.5	8.66
					2	2							
					3	1							
9	2.0	12.0	24.0	e									
10	3.0	4.0	12.0	e									
11	2.0	4.0	8.0	e									
12	3.0	7.0	21.0	e									
13	1.4	6.0	8.4	a	1	13	3	7.33	30.33	43.98	5.24	6.0	181.98
					2	7							
					3	2							
14	1.0	8.0	8.0	e									
15	1.5	20.0	30.0	e									
16	2.0	4.0	8.0	e									
17	3.0	4.0	12.0	e									
18	2.2	9.0	19.8	a	1	0	3	0.33	0.33	1.32	0.11	4.0	0.44
					2	1							
					3	0							
		Mo =	585.3							mean d =	1.52		

Table E-2. Run mesohabitat, upper Sugar Creek

run habitat unit	width (m)	length (m)	area (m2)	estimate or actual?	belt number	Indiana crayfish captures	number of belts sampled	mean belt captures	variance among belts	total # of crayfish present	mean crayfish density (#/m2)	total # belts possible	second stage variance
1	14.0	16.0	224.0	e									
2	8.3	13.4	111.2	a	1	0	2	0	0	0	0	13.4	0
					2	0							
3	7.0	30.0	210.0	e									
4	8.0	28.0	224.0	e									
5	8.0	7.0	56.0	e									
6	8.0	25.0	200.0	e									
7	8.0	9.5	76.0	a	1	2	3	4.67	21.33	44.37	0.58	9.5	13051.02
					2	2							
					3	10							
8	8.0	11.0	88.0	e									
9	9.0	54.0	486.0	e									
10	8.0	20.0	160.0	e									
11	5.0	5.0	25.0	e									
12	2.6	4.9	12.7	a	1	2	1	2.00	n/a	9.80	0.77	4.9	n/a
13	6.0	19.0	114.0	e									
14	4.0	20.0	80.0	e									
15	5.0	14.0	70.0	e									
16	3.0	14.0	42.0	e									
17	7.2	18.5	13.3	a	1	1	3	2.00	9.00	37.00	2.78	18.5	3774.00
					2	5							
					3	0							
18	3.0	31.0	93.0	e									
19	3.0	11.0	33.0	e									
20	5.0	28.0	140.0	e									
21	3.5	42.0	147.0	e									
22	3.4	17.5	59.5	a	1	3	3	2.00	1.00	35.00	0.59	17.5	369.6
					2	2							
					3	1							
23	1.5	7.0	10.5	e									
24	5.0	5.0	25.0	e									
25	3.0	5.0	15.0	e									
		Mo =	2715.3							mean d =	0.94		

Table E-3. Pool mesohabitat, upper Sugar Creek

pool habitat unit	width (m)	length (m)	area (m2)	estimate or actual?	belt number	Indiana crayfish captures	number of belts sampled	mean belt captures	variance among belts	total # of crayfish present	mean crayfish density (#/m2)	total # belts possible	second stage variance
1	15	36	540	e									
2	16	21	336	e									
3	15	260	3900	e									
4	8	210	1680	e									
5	8	40	320	e									
6	10	54	540	e									
7	9.4	28	263.2	a	1	0	1	0	n/a	0	0	28	n/a
8	9	45	405	e									
9	9	28	252	e									
10	8	54	432	e									
11	7.9	12	94.8	a	1	6	3	2.33	10.33	27.96	0.295	12	371.88
					2	0							
					3	1							
12	10	800	8000	e									
13	10	142	1420	e									
14	8	52	416	e									
15	8	160	1280	e									
16	6.4	11.8	75.5	a	1	0	3	0	0	0	0	11.8	0
					2	0							
					3	0							
17	9	40	360										
18	7	14	98										
19	6	11	66										
20	7	50	350										
21	5.7	48	273.6		1	0	3	0	0	0	0	48	0
					2	0							
					3	0							
22	8	242	1936										
23	7	82	574										
24	6	84	504										
25	10	51	510										

Table E-3. Pool mesohabitat, upper Sugar Creek (continued)

pool habitat unit	width (m)	length (m)	area (m2)	estimate or actual?	belt number	Indiana crayfish captures	number of belts sampled	mean belt captures	variance among belts	total # of crayfish present	mean crayfish density (#/m2)	total # belts possible	second stage variance
26	7.5	17.3	129.8	a	1	0	3	0	0	0	0	17.3	0
					2	0							
					3	0							
27	6	116	696										
28	6	176	1056										
29	5	100	500										
30	5	26	130										
31	7.6	18.9	143.6	a	1	0	3	0.33	0.33	6.24	0.043	18.9	33.06
					2	1							
					3	0							
		Mo =	27281.5							mean d =	0.056		

Table E-4. Riffle mesohabitat, Maple Branch

riffle habitat unit	width (m)	length (m)	area (m2)	estimate or actual?	belt number	Indiana crayfish captures	number of belts sampled	mean belt captures	variance among belts	total # of crayfish present	mean crayfish density (#/m2)	total # belts possible	second stage variance
1	1	4	4	e									
2	1	7	7	e									
3	1	7	7	e									
4	2.3	8.5	19.55	a	1	0	2	1.5	20.25	12.75	0.65	8.5	1387.76
					2	3							
5	1.5	7	10.5	e									
6	1.5	7	10.5	e									
7	2	4	8	e									
8	1	8	8	e									
9	1	3	3	e									
10	1	5	5	e									
11	1	5	5	e									
12	1	3	3	e									
13	2.8	8.5	23.8	a	1	0	2	1	36.00	8.50	0.36	8.5	994.5
					2	2							
14	1	3	3	e									
15	2	3	6	e									
16	2	15	30	e									
17	1.5	5	10	e									
18	1.5	5	10	e									
19	1	3	3	e									
20	1	5	5	e									
21	3	4	12	e									
22	2	6	12	e									
23	1	6	6	e									
24	1	10	10	e									
25	1.4	4.2	5.88	a	1	16	2	9	373.00	37.80	6.42	4.2	252379.26
					2	6							
26	1	4	4	e									
27	1	10	10	e									
28	1	3	3	e									

Table E-4. Riffle mesohabitat, Maple Branch (continued)

riffle habitat unit	width (m)	length (m)	area (m2)	estimate or actual?	belt number	Indiana crayfish captures	number of belts sampled	mean belt captures	variance among belts	total # of crayfish present	mean crayfish density (#/m2)	total # belts possible	second stage variance
29	1.5	19	28.5	e									
30	2	7	14	e									
31	1	2	2	e									
32	1	1	1	e									
33	1.5	2	3	e									
34	1	1	1	e									
35	1	8	8	e									
36	3.6	5.1	18.36	a	1	0	2	0	0.00	0.00	0.00	5.1	0.00
					2	0							
37	2	7	14	e									
38	1	3	3	e									
39	1	5	5	e									
		Mo =	342.09							mean d =	1.86		

Table E-5. Run mesohabitat, Maple Branch

run habitat unit	width (m)	length (m)	area (m2)	estimate or actual?	belt number	Indiana crayfish captures	number of belts sampled	mean belt captures	variance among belts	total # of crayfish present	mean crayfish density (#/m2)	total # belts possible	second stage variance
1	1	24	24	e									
2	0.9	9.2	8.28	a	1	2	3	7.67	54.33	70.56	8.52	9.2	86330.98
					2	5							
					3	16							
3	1	5	5	e									
4	1.5	25	37.5	e									
5	2	25	50	e									
6	1.5	17	25.5	e									
7	1.5	12	18	e									
8	2	2	4	e									
9	1.5	26	39	e									
10	2	22	44	e									
11	2	2	4	e									
12	1	4	4	e	1	0	1	0.00	n/a	0.00	0.00	4.0	n/a
13	1	5	5	e									
14	1	15	15	e									
15	1	20	20	e									
16	2	10	20	e									
17	1	7	7	e									
18	2.5	8.2	20.5	a	1	0	3	0.67	0.33	5.49	0.27	8.2	1.50
					2	1							
					3	1							
19	2	7	14	e									
20	2.5	13	32.5	e									
21	2	18	36	e									
22	2.5	9	22.5	e									
23	1	1.5	1.5	e									
24	1	7	7	e									
25	1.5	8	12	e									
		Mo =	476.28							mean d =	2.93		

Table E-6. Pool mesohabitat, Maple Branch

pool habitat unit	width (m)	length (m)	area (m2)	estimate or actual?	belt number	Indiana crayfish captures	number of belts sampled	mean belt captures	variance among belts	total # of crayfish present	mean crayfish density (#/m2)	total # belts possible	second stage variance
1	4	96	384	e									
2	0.9	9.2	8.3	a	1	1	3	1.33	0.33	12.24	1.47	9.2	12.44
					2	2							
					3	1							
3	3	109	327	e									
4	2	64	128	e									
5	2	14	28	e									
6	2	41	82	e									
7	3	22	66	e									
8	3	10	30	e									
9	3	23	69	e									
10	3	13	39	e									
11	3.5	77	269.5	e									
12	2.9	13.5	39.2	a	1	0	3	0.00	0.00	0.00	0.00	13.5	0.00
					2	0							
					3	0							
13	1.5	6	9	e									
14	4	7	28	e									
15	4	10	40	e									
16	4	38	152	e									
17	3	21	63	e									
18	2.5	18	45	e									
19	2	4	8	e									
20	4	31	124	e									
21	4	11	44	e									
22	3	2	6	e									
23	4	172	688	e									
24	4	177	708	e									
25	2	50	100	e									
26	2	56	112	e									
27	3	65	195	e									

Table E-6. Pool mesohabitat, Maple Branch (continued)

pool habitat unit	width (m)	length (m)	area (m2)	estimate or actual?	belt number	Indiana crayfish captures	number of belts sampled	mean belt captures	variance among belts	total # of crayfish present	mean crayfish density (#/m2)	total # belts possible	second stage variance
28	1.5	35	52.5	e									
29	1.5	28	42	e									
30	3	280	840	e									
31	4	19	76	e									
32	4	45	180	e									
33	3	15	45	e									
34	4	85	340	e									
35	5.3	39	206.7	a	1	0	3	2.67	6.33	104.13	0.50	39.0	22219.71
					2	3							
					3	5							
36	5	61	305	e									
37	3	5	15	e									
38	4	20	80	e									
39	2	7	14	e									
40	3	18	54	e									
41	3.2	19.8	63.36	a	1	0	3	0.33	0.33	6.53	0.10	19.8	2.54
					2	0							
					3	1							
42	1.5	10	15	e									
43	3	20	60	e									
44	5	20	100	e									
45	3	11	33	e									
46	4	14	56	e									
47	5	50	250	e									
48	5	78	390	e									
		Mo =	7009.56							mean d =	0.52		