# Leopard Darter
## *(Percina pantherina)*

## 5-Year Review:
## Summary and Evaluation


**U.S. Fish and Wildlife Service**
**Oklahoma Ecological Services Field Office**
**Tulsa, Oklahoma**

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**August 2012**

# 5-YEAR REVIEW

**Species reviewed:** Leopard darter (*Percina pantherina*)

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# 5-YEAR REVIEW
# Leopard darter (*Percina pantherina*)

## 1.0 GENERAL INFORMATION

## 1.1 Reviewers

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## 1.2 Purpose of 5-Year Reviews

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since the time it was listed or since the most recent 5-year review. Based on the outcome of the 5-year review, we recommend whether the species should: 1) be removed from the list of endangered and threatened species; 2) be changed in status from endangered to threatened; 3) be changed in status from threatened to endangered; or 4) remain unchanged in its current status. Our original decision to list a species as endangered or threatened is based on the five threat factors described in section 4(a)(1) of the Act. These same five factors are considered in any subsequent reclassification or delisting decisions. In the 5-year review, we consider the best available scientific and commercial data on the species, and we review new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process that includes public review and comment.

## 1.3 Methodology used to complete the review

The U.S. Fish and Wildlife Service (Service) conducts status reviews of species on the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12) as required by section 4(c)(2)(A) of the Endangered Species Act (ESA) (16 U.S.C. 1531 *et seq.*). The 5-year review is an assessment of the best scientific and commercial data available at the time of the review. Materials used in the analysis include the revised recovery plan (U.S. Fish and Wildlife Service 1984), peer-reviewed manuscripts, unpublished survey data and reports, and personal communications with species experts.

Outreach for this 5-year review consisted of a Federal Register Notice (71 FR 20714) requesting any new information related to leopard darter population trends, distribution, habitat conditions, threats, and conservation measures from the public, concerned governmental agencies, Tribes, the scientific community, industry, non-profit conservation organizations, and any other interested parties. An "Interested Party Letter" also was mailed directly to 109 individuals, researchers, tribes, state and federal agencies, and nonprofit conservation organizations listed in the leopard darter contact file maintained at the Oklahoma Field Office. We received one response to the FR notice (Appendix A) from the U.S. Forest Service – Ouachita National Forest which provided summaries of existing information and recommended the species be retained as threatened. No significant new information was provided.

This review was prepared by Daniel Fenner, Fish and Wildlife Biologist in the Service's Oklahoma Ecological Services Field Office (OKESFO) (918/382-4524). Biologists from the Arkansas Ecological Services Field Office and the Oklahoma Fish and Wildlife Conservation Office provided assistance and information for this review. No part of this review was contracted to an outside agency.

## 1.4 Background

### 1.4.1 Federal Register (FR) Notice citation announcing initiation of this review:

April 21, 2006. Endangered and Threatened Wildlife and Plants; 5 Year Review of 25 Southwestern Species (71 FR 20714).

### 1.4.2 Listing History:

<u>Original Listing:</u>
Federal Register Notice: Vol. 43, No. 19, 3711-3716
Date Listed: January 27, 1978
Entity Listed: species: Leopard darter (*Percina pantherina*)
Classification: Threatened

### 1.4.3 Associated rulemakings:

None

### 1.4.4 Review History:

Final Recovery Plan: 1984
5-Year Review: 1988
Draft Revised Recovery Plan: 1993
Recovery Data Calls: 2000-2011

### 1.4.5 Species' Recovery Priority Number at start of 5-year review:

At the start of the 5-year review, the Recovery Priority Number for the leopard darter was 11C. This number indicated that: (1) the leopard darter was listed as a full species; (2) populations face a moderate degree of threat; (3) recovery potential is low; and (4) recovery of the leopard darter may be in conflict with construction or other development projects (see Table 1).

Table 1. The below ranking system for determining Recovery Priority Numbers was established in 1983 (48 FR 43098, September 21, 1983 as corrected in 48 FR 51985, November 15, 1983).

| Degree of Threat | Recovery Potential | Taxonomy | Priority | Conflict |
|---|---|---|---|---|
| High | High | Monotypic Genus | 1 | 1C |
| | | Species | 2 | 2C |
| | | Subspecies/DPS | 3 | 3C |
| | Low | Monotypic Genus | 4 | 4C |
| | | Species | 5 | 5C |
| | | Subspecies/DPS | 6 | 6C |
| **Moderate** | High | Monotypic Genus | 7 | 7C |
| | | Species | 8 | 8C |
| | | Subspecies/DPS | 9 | 9C |
| | **Low** | Monotypic Genus | 10 | 10C |
| | | **Species** | **11** | **11C** |
| | | Subspecies/DPS | 12 | 12C |
| Low | High | Monotypic Genus | 13 | 13C |
| | | Species | 14 | 14C |
| | | Subspecies/DPS | 15 | 15C |
| | Low | Monotypic Genus | 16 | 16C |
| | | Species | 17 | 17C |
| | | Subspecies/DPS | 18 | 18C |

### 1.4.6. Recovery Plan or Outline

**Name of plan:** Leopard Darter Recovery Plan, Draft Revised
**Date issued:** Drafted 1993, Final not yet issued
**Dates of previous revisions:** 1984 Leopard Darter Recovery Plan, Original Final

# 2.0 REVIEW ANALYSIS

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

**2.1.1 Is the species under review a vertebrate?** Yes

**2.1.2 Is there relevant information that would lead you to re-consider the classification of this species with regard to designation of DPS?** No

**2.1.3 Is there any new information for this species regarding the application of the DPS policy?** No

## 2.2 Recovery Criteria

**2.2.1 Does the species have a final, approved recovery plan?** Yes. The FWS issued a final recovery plan for this fish in 1984. A draft revision was issued in 1993.

**2.2.1.1 Does the recovery plan contain objective, measureable criteria?**
The 1984 final recovery plan does not contain objective, measurable criteria. However, the draft revision contains tasks that are objective and measurable, and these tasks are treated as criteria in that plan. This draft plan is being used to guide recovery actions at this time.

**2.2.2 Adequacy of recovery criteria**

**2.2.2.1 Do the recovery criteria reflect the best available (i.e., most up-to-date) information on the biology of the species and its habitat?**
No. New information has revealed that the tasks identified in the draft revised plan from 1993 will likely not be sufficient to accomplish recovery of this species. See section 2.2.3 for more details.

**2.2.2.2 Are all of the five listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?**
No. Additional threats are discussed in the "Five Factor Analysis" section.

**2.2.3 List the recovery criteria as they appear in the recovery plan and discuss how each criterion has or has not been met, citing information:**
The final recovery plan does not contain recovery criteria. However, the 1993 Draft Revised Recovery Plan identifies three tasks that, if accomplished, would allow us to consider delisting. This plan is currently being used to guide recovery actions and therefore, those tasks are treated as criteria for the purposes of this 5-year review. According to the plan, the leopard darter may be considered for delisting when task 1.1 and 1.2 (discussed below) have been completed, provided that the results of task 3.1 (also discussed below) indicate that prognosis for long-term recovery is favorable.

**Task 1.1 – Deauthorize the proposed Lukfata Reservoir project**

This task has been completed. The Lukfata Reservoir project was deauthorized on April 16, 2002 under the provisions of Section 1001(b)(2), Public Law 99-662, 33 U.S.C 579a(b)(2). The notice to deauthorize Lukfata Reservoir was published in the Federal Register on June 26, 2003 (68 FR 38022). Prior to April 16, 2002 Lukfata Reservoir was an authorized, but not funded, U.S. Army Corps of Engineers (Corps) impoundment proposed for construction on the Glover River near river kilometer 27.8. Authorized uses included flood control and water supply.

Listing factors addressed by this criterion:

*Factor A: Present or threatened destruction, modification or curtailment of its habitat or range.* Lukfata reservoir would eliminate 25 percent (34.7 mi) of leopard darter designated critical habitat and an unknown number of individual darters. The conservation pool proposed would inundate up to 17.1 miles on the mainstem Glover River and 9.5 miles of the East and West Forks of the Glover River for a total of 26.6 stream miles. Approximately 14 miles of the Glover River's three major tributaries (Pine, Carter, and Cedar Creeks) and numerous smaller streams would be inundated. Another direct impact of Lukfata reservoir involved altering the quantity and quality of flows. Little River system impoundments have eliminated leopard darter populations and habitat in stream reaches downstream (Eley et al. 1975, Hubbs and Pigg 1976, Robison 1978). Approximately 8.1 stream miles of leopard darter critical habitat occur downstream of the proposed Lukfata damsite. Consequently, in a 1985 Biological Opinion, the Service concluded that this project would result in the adverse modification of critical habitat and jeopardize the continued existence of the leopard darter. No reasonable and prudent alternatives to this project were identified.

**Task 1.2 – Ensure protection of essential habitat and stream water quality.**

This task has not been completed. Conservation efforts with the private sector to protect habitat and water quality have been limited to stream crossing enhancements to improve fish passage. Although a majority of stream reaches within the Little River Basin have adequate riparian areas, there are no agreements or regulatory mechanisms in place to ensure the protection of those areas into the future. Agricultural activities such as logging, poultry and swine feeding operations and cattle grazing highlight the need for ensured protection of riparian areas in watersheds where essential leopard darter habitat exists. The development of a complete and updated riparian land ownership map is still needed to facilitate communication with landowners and begin development of conservation efforts for the species.

Regulatory mechanisms to help protect water quality are currently in place but the adequacy of those regulations is unclear. In recent years, the Service has observed an increase in filamentous algae throughout the Little River Basin which threatens leopard darter habitats. Growth of filamentous algae is likely caused by an increase of nutrients in the system on which filamentous algae thrives. Increased nutrients are likely correlated with the increase of animal feeding operations within the drainage, as well as increased erosion from logging practices and inadequate riparian buffers in many areas.

As stated in the Recovery Plan, public ownership provides the most permanent form of protection, however since the Plan was developed, only small amounts of private land have been converted to public lands. The Ouachita National Forest has purchased additional lands since this plan was developed, including an area containing 14 miles of leopard darter critical habitat, however in recent years the Forest has offered some of its land for sale or lease, which could set back increased habitat protection for the species.

<u>Listing factors addressed by this criterion:</u>

*Factor A: Present or threatened destruction, modification or curtailment of its habitat or range.* Until long term protection of essential leopard darter habitats and water quality are in place, this factor will continue to be a threat to recovery of the leopard darter.

*Factor D: Inadequacy of existing regulatory mechanisms:* As stated above, regulatory mechanisms for water quality criteria are in place, however their effectiveness at improving and maintaining water quality are uncertain.

*Factor E: Other natural or manmade factors affecting its continued existence:* Water quality and available habitat are directly affected by precipitation, which in recent years has been limited. When drought conditions persist, there is a decrease in available, preferred habitats and water quality is affected by a decrease in a stream's ability to dilute nutrient loads. As a result of long term drought, impacts to water quality and available habitat can potentially be detrimental to the species long term survival.

**Task 3.1 – Determine the amount of genetic variation among populations within and between major streams**

<u>This is an ongoing task.</u> Echelle *et al.* (1999) used protein electrophoresis to analyze genetic structure of the leopard darter among seven different drainages. Allele frequency analysis revealed three primary clades: (1) populations in the Little and Glover Rivers, (2) populations from the Mountain Fork drainage, and (3) populations in the Robinson Fork and Cossatot Rivers (Figure 1). Populations in the Little and Glover Rivers were more closely related to the Robinson Fork and Cossatot River populations than they were to the Mountain Fork River population. Polymorphism and heterozygosity was lowest in the Robinson Fork River and highest in the Mountain Fork River. However, these values were low when compared to related species of *Percina* and for most fishes in general. Most of the polymorphism was due to rare alleles, although the species as a whole harbored considerable allele diversity. The researchers suggested that even a small amount of gene flow could affect the probability of extinction of the leopard darter and management of the species should include artificial gene flow among isolated populations.

A more recent study by Echelle and Schwimm (2012, pers. comm.) used fine microsatellite DNA markers to evaluate leopard darter genetic diversity and distinctiveness, which is a more effective methodology than allele frequency analysis previously conducted. According to their results, overall genetic diversity appears to be relatively low throughout the drainage (Little, Glover, Mountain Fork, and Cossatot Rivers). Both mitrochondrial and microsatellite DNA analysis showed significant subdivisions between these major tributaries, which can be attributed to the inability of leopard darters to disperse and mix among major tributaries, as a result of constructed reservoirs. The Cossatot River in Arkansas had significantly lower diversity than all other drainages.

Echelle and Schwimm (2012, pers. comm.) also examined effective population size ($N_e$) of leopard darters within each major tributary (Little, Glover, Mountain Fork, and Cossatot Rivers) and found that $N_e$ throughout the drainage has declined 4-5 orders of magnitude, with the start of its decline within the last 200 years, suggesting anthropogenic effects such as reservoir construction. According to Echelle and Schwimm, $N_e$ of leopard darter is lower than reported for any other fish. Most concerning is their estimate of effective population size of leopard darter within the Cossatot River ($N_e = 5$) and Buffalo Creek ($N_e = 6$), which is considered inadequate to maintain genetic viability in the long term (Echelle et al. 2010; Lynch and Lande 1998).

*Factor A: Present or threatened destruction, modification or curtailment of its habitat or range.* Barriers such as dams and low water crossings limit or remove the leopard darter's ability to move within and among different drainages, affecting gene flow of the species. Until these barriers are removed or a long term artificial gene flow program is implemented, barriers will continue to be a threat to the species.

*Factor E: Other natural or manmade factors affecting its continued existence:* Drought limits available habitat and affects the leopard darter's ability to move within and among different drainages. If drought conditions worsen, gene flow between populations may be limited which may be detrimental to the species long term survival without an artificial gene flow program.

To date, progress has been made on all three of these tasks. However, the continued threat of potential reauthorization of the Lukfata Reservoir and other water withdrawals, the continued lack of permanent protection of most essential habitat and the extremely small effective populations sizes clearly indicate a need for additional work.

## 2.3 Updated Information and Current Species Status

### 2.3.1 Species Information

#### 2.3.1.1 Species Description

The leopard darter is a small (up to 8.7 centimeters (cm) total length), percid fish, tan to olive in color, with a distinctive pattern of 11-14 round black spots along each side. This species is endemic to the Little River Basin of southeast

Oklahoma and southwest Arkansas and has always been reported as rare (Figure 1). Several ichthyologists recommended providing special protection to the leopard darter (Miller 1972, Cloutman and Olmstead 1974, Robison et al. 1974, Hubbs and Pigg 1976). On January 27, 1978, the leopard darter was listed as a threatened species under the Act, and several areas within the Little River Basin were designated as critical habitat (43 FR 3711).

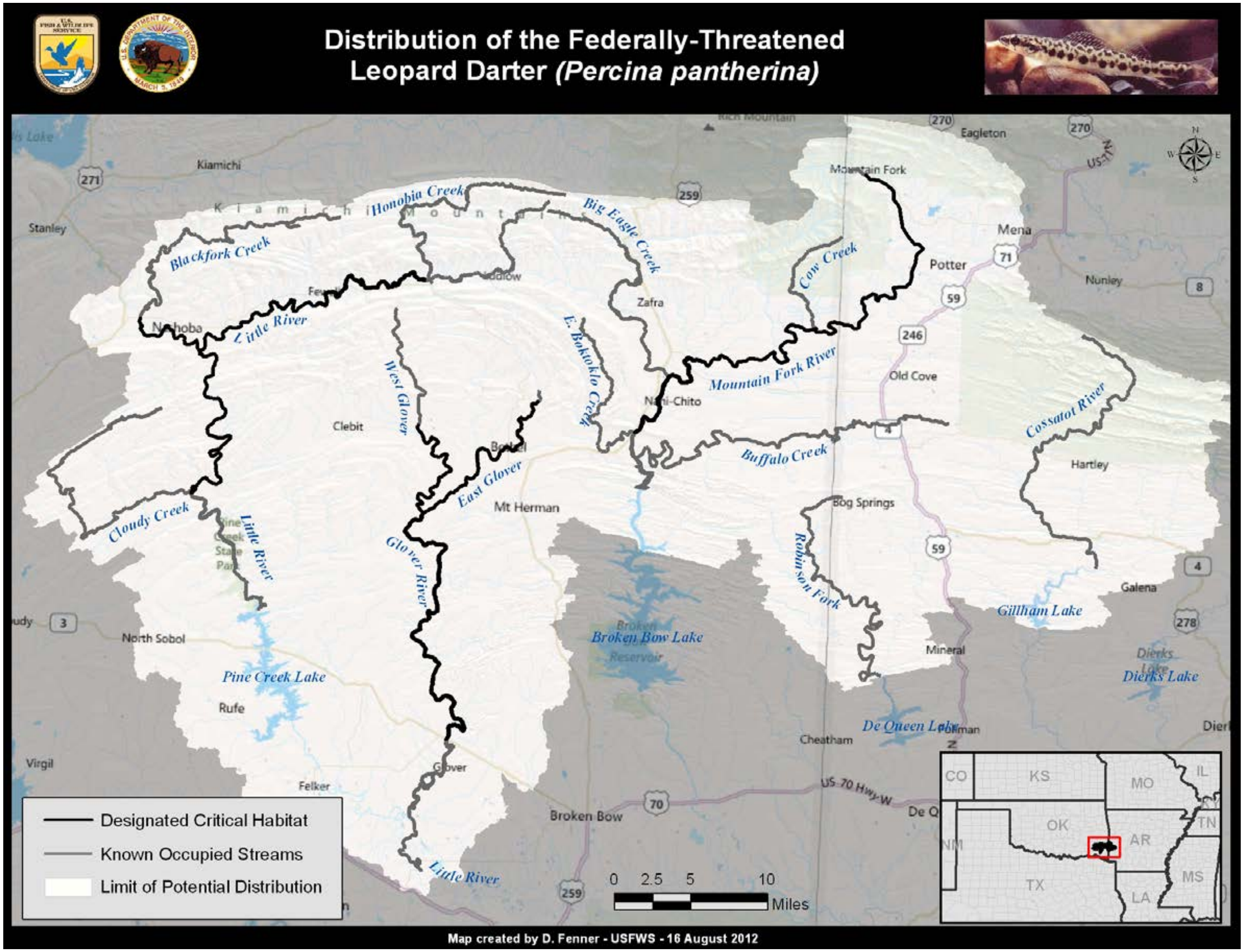


Figure 1. Current distribution and designated critical habitat for the leopard darter.

#### 2.3.1.2 Habitat

The leopard darter typically inhabits pools having predominantly rubble and boulder substrates with current velocities less than 48 centimeters/second (Jones 1984, Lechner et al. 1987). Preferred water depths are generally 20-102 cm (Jones et al. 1984; James 1989), although joint Service/U.S. Forest Service surveys over the past 10 years have observed leopard darters from depths over 4.0 meters. Leopard darter juveniles and adults inhabit pools almost exclusively from June through early February. However, during the spring and winter, riffles and runs may occasionally be used. Riffle habitats become extremely import during the reproductive season (February through April).

#### 2.3.1.3 Reproduction

Leopard darters migrate from pools to riffle tailwaters in search of suitable spawning habitat during February and early March when water temperatures reach 10-12°C (James 1988, James and Maughan 1989). Spawning occurs from mid-March through mid-April on riffles at water temperatures of 12-17$^{o}$C (James 1988). The non-adhesive, demersal eggs are buried in patches of fine gravel (3-10 mm in diameter) at water depths of 30-90 cm and current velocities of 10-35 cm/second (James 1988, James and Maughan 1989). Eggs hatch in about 7 days at 20$^{o}$C, and larvae presumably drift downstream into pools (James 1989).

The number of mature and immature ova examined in seven specimens varied from 260 to 2,302 (Robison 1978). James et al. (1991) examined 5 preserved specimens and found that distinguishable ova varied from 294-757, with a mean of 465 ova per female. Observations of spawning females in captivity by James et al. (1991) indicated that clutch size averaged 58.5 and fertilized, water hardened eggs had a mean diameter of 1.4 mm.

All spawning individuals appeared to be age-I (see discussion of size classes below in section 2.3.1.4) and high mortality of these individuals apparently occurs following spawning season (James 1989, James et al. 1991). Continued survival of leopard darter populations is dependent upon age-I individuals because of the small number of adults surviving to age-II or older (see section 2.3.1.4).

#### 2.3.1.4 Age and Growth

Jones et al. (1983) measured the total length of 137 leopard darter individuals collected in the Glover River. Total lengths varied from 45 to 92 mm, with a mean of 70 mm. Leon et al. (1987) provided information on total and standard lengths of 16 leopard darter individuals collected from the Cossatot and Robinson Fork Rivers. Total lengths varied from 24 to 69 mm and standard lengths varied from 21 to 59 mm. Mean standard lengths reported by James et al. (1991) from the Glover River varied from 18 to 81 mm. Growth of young-of-the-year appears to be extremely rapid with most individuals attaining an adult size within 5 to 6 months.

Scale analysis of 14 preserved specimens by Jones et al. (1983) determined that leopard darters 53 to 74 mm total length were one year of age and those 74 to 80 mm total length were two years of age. Based on this information, Jones et al. (1983) assigned ages to the following size classes: <50 mm total length - age 0, 51 to 71 mm - age I, 72 to 87 - age II, and >87 mm total length - age III. Using these measurements, the distributions of captured individuals within the various age groupings were: 0+ - 1.5 percent, I+ - 63.5 percent, II+ - 32.0 percent, and III+ - 3.0 percent (Jones et al. 1983). Robison (1978) collected a mature female, 77 mm standard length, which was reported to be III+ years of age. Jones et al. (1983) also reported the capture of four individuals exceeding 88 mm total length equivalent to the III+ age category.

#### 2.3.1.5 Food Habits/Feeding Behavior

Darters are typically first- and second-order carnivores that feed mainly on micro crustaceans as juveniles and on immature aquatic insects as adults (Page 1983). Mayfly nymphs (Ephemeroptera: Baetidae and Heptageniidae), blackfly larvae (Diptera: Simuliidae), and midge larvae (Diptera: Chironomidae) were the only food items found in stomachs of 19 leopard darter individuals examined by James et al. (1991). Blackfly larvae *Simulium* sp., and mayfly *Pseudocloen* sp. nymphs were the major food items in seven leopard darter stomachs examined by Robison (1978). A more recent study by Williams et al. (2006) which examined leopard darter food habits from 1994 to 1997 found Baetidae, Chironomidae, and Heptageniidae to be the most common families of aquatic insects found in leopard darter stomachs.

No information on feeding behavior, such as time of feeding, feeding intensity, or seasonal shifts in feeding patterns exists for the leopard darter. Page (1983) states that darters, as a group, have keen vision and are likely to be diurnal, visual feeders. Examination of published literature indicates that considerable dietary overlap may exist between leopard darters and other sympatric *Percina* species. For example, dietary preferences of logperch (*Percina caprodes)* and channel darter (*P. copelandi)* in the Glover River consisted largely of dipterans (chironomids) and ephemeropterans (Jones and Maughan 1987).

#### 2.3.1.6 Population Dynamics

The leopard darter is considered an annual species, meaning that it typically only spawns once in its lifetime, although in exceptional cases, individuals will spawn twice. This species exhibits very high mortality rates. James et al. (1991) observed that leopard darter mortalities in the Glover River between July and September averaged about 60 percent during 1987 and 1988. These observations led to the conclusion that maximum longevity for leopard darters is about 18 months, on average. P. W. James (1992, pers. comm.) tracked the growth of two complete cohorts in the Glover River and found no individuals which could be considered as age III+. Many individuals were between 70 and 80 mm standard length.

Estimates of density (number of individuals/unit area of habitat), although highly variable, can be a useful indicator of the number of organisms occurring within a particular portion of their habitat. However, densities of leopard darters within the basin are not well documented. Jones et al. (1983) first reported densities for the Glover River as a measurement of the number of fish per length of stream. Using electro-fishing techniques, they reported leopard darter densities of 0 to 27 individuals per 100 m of stream. Since that time, several others have reported leopard darter densities on a unit area basis for a few additional localities. Observed densities have varied from 0.0 to 0.65 darters/$m^2$, depending upon the method used to determine leopard darter abundance.

Leopard darters are generally more abundant in the Mountain Fork, Glover and Little River Basins than in the Cossatot and Robinson Fork drainages (James 1989, USFWS unpublished data 1998-2011). The largest population(s) of leopard darters likely occurs in the main channel of the Glover River (Taylor and Wade 1972, Eley et al. 1975, James 1989, Zale et al. 1994, USFWS unpublished data 1998-2011). Prior to 1985, 125 separate collecting attempts from approximately 56 different localities resulted in collection or capture of only 333 leopard darter individuals: 31 from 10 locations within the upper Little River Basin, 197 from 25 locations in the Glover River drainage, 48 from 13 locations in the Mountain Fork River drainage, and 57 from 8 locations in the Cossatot River (Eley et al. 1975, Jones et al. 1984). Since that time, leopard darters have been captured from several additional localities (Zale et al. 1994, Collins 1993, 1995, 1998, USFWS unpublished data 1998-2011). Number of individuals observed or captured from any one site within the drainage basin varied from 1 to 128.

In 1983, Jones et al. estimated the number of leopard darter individuals inhabiting the Glover River to be more than 2,800, including 786 in the river main stem. Later, James (1996) estimated that the leopard darter population in the Glover River ranged from 3,000 to 10,000 individuals. Subsequently, Williams, et al. (1999) attempted to estimate the abundance of leopard darters within the Little River basin (Figure 1) using densities estimated from mark-recapture studies and the estimated amount of suitable habitat within the occupied reaches of each river system. The number of leopard darters was estimated to vary between 156,157 and 1,636,669 individuals. The average population size was estimated to be 777,976. The largest population was estimated to occur in the Mountain Fork River, followed by the Little River and then the Glover River. Leopard darter abundance in the Mountain Fork was estimated to be more than double the Little or Glover River populations and almost 100 times larger than the Robinson Fork River population. The Cossatot River was the smallest population.

Williams et al. (1999) conducted a population viability analysis for the leopard darter. The species appeared to be reasonably secure considering its relatively large population sizes and high fecundity (Echelle et al. 1998). However, the researchers acknowledged that their PVA model could represent underestimates because of the potential for unknown or cumulative effects that were not included in the model. Modeled extinction probabilities were not significantly different for small populations, such as those in the Robinson Fork, in comparison to larger populations like that of the Glover River or for the metapopulation as a whole. The researchers suggested that these results were likely due to the relatively high population size and high fecundity compared to other species subjected to a PVA model. The probability and severity of drought and migration had the greatest effect on persistence of the species. The leopard darter has been described as being very sensitive to water quality and habitat degradation (Jester et al. 1992).

#### 2.3.1.7 Status and Distribution

The leopard darter is endemic to the Little River Basin in southeastern Oklahoma and southwestern Arkansas (Figure 1). The species currently occupies portions of the Little River upstream of Pine Creek Reservoir, Glover River upstream of the vicinity of the community of Glover, Oklahoma, Mountain Fork River upstream of Broken Bow Reservoir, Robinson Fork River upstream of its confluence with Rolling Fork River, and Cossatot River upstream of Gillham Reservoir. Populations have also been found in some of the larger tributaries of these rivers.

Since 1998, the Oklahoma Ecological Services Field Office in cooperation with the Oklahoma Fishery Resources Office and the Ouachita National Forest has conducted annual monitoring of the species at 17 permanent sites within the Little River Basin (Figure 2). These surveys are primarily intended to monitor leopard darter populations and record annual fluctuations in distribution and abundance of the species. Surveys are conducted entirely by underwater observation. At each site, transects have been assigned for comparable observations among years and catch per unit effort (CPUE) at each site is estimated by calculating number of fish observed per unit time.

To assess temporal trends of our leopard darter counts we performed the nonparametric Mann-Kendall test (Kendall 1938 and Thompson et al. 1998) using MAKESENS software (Salmi et al. 2002). Coefficient of variation (CV) was calculated to further evaluate those analyses showing no significant trends. Ellison et al. (2003) used this methodology and explained that failure to reject the null hypothesis (no significant trend) could be due to high variation in counts (CPUE in our case). As done in Ellison et al. (2003) we provide CV calculations to allow the reader to make a judgment as to why no significant trend was detected (Table 2).

Leopard darter counts as a whole (all sites combined) fluctuate from year to year (Table 2, Figure 3) and although the population appears to be declining, no statistically significant trend of increasing or decreasing was detected. We also examined leopard darter count trends by drainage (Table 2, Figures 4-9). Although all drainages had a negative Z value (decreasing trend), only one of the six had a decreasing trend determined to be statistically significant (Big Eagle Creek). Big Eagle Creek counts have significantly declined over the past 13 years, but results from 2010 and 2011 suggest that the leopard darter may be rebounding, although the reasons for this are unclear at this time. Other sites that appear to be declining, but without statistically significant trends, had high variability in the count data, which suggests that significant trends (increasing or decreasing) may not be detectable. Additional data collection and further refinement of data collection and analysis (decreasing variability) will be necessary to monitor long term trends of the species.

The Service and Ouachita National Forest have also monitored an additional 150 sites since 1998. The objective of monitoring these sites is to detect presence or absence of leopard darters throughout their known or potential range. Many sites have become inaccessible due to road closures, however approximately 25 different sites are surveyed per year, with a target of surveying all sites over a three to four year period. Notable observations from these surveys include the following:

- Leopard darters have not been observed in the Robinson Fork of the Rolling Fork River in Arkansas since 2005. Trend analysis shows no statistically significant trend; however, high variation in our count data may explain why a significant trend was not detected (Table 2, Figure 7).

- In September, 2010, two leopard darter individuals were collected in the Little River downstream of the Glover River confluence near Garvin, OK. Range wide surveys in 2010 indicated that leopard darter population numbers were well above average, suggesting that these individuals could have been spawned upstream in the Glover River, but somehow made their way downstream to occupy the Little River below Pine Creek Reservoir. Additional surveys were conducted in 2011, resulting in no observations of leopard darters in this portion of the Little River. It is unlikely that a viable self-sustaining population persists in the Little River below the reservoir; however, additional surveys within this reach of the Little River are warranted.

As stated above, leopard darter population numbers can shift dramatically from year to year. These relatively large shifts appear to be related to climatological conditions, in particular precipitation. For example, in the year 2006, leopard darter counts were lower than all other years surveyed (1998-2011), which coincided with a drought in Oklahoma that was second worst on record (since 1920) and driest during our period of surveys (1998-2011). Over half of the permanent monitoring sites where leopard darters are typically observed, yielded no leopard darter individuals. Possible explanations for this observed correlation include a loss of available habitat during low flows, above average temperatures not preferable to leopard darter, and exacerbated effects to water quality as a result of lower flows and high temperatures. Conversely, the year 2001 yielded our highest survey counts which coincided with the highest level of annual precipitation throughout our study period.

Because the leopard darter, generally spawns only once in their lifetime, climatological conditions such as precipitation and temperature could have significant affects to the population. If drought like conditions occur over multiple years or continue to worsen, the leopard darter population could be at risk of decline. A more thorough analysis of the correlation between climatological conditions and leopard darter populations, including seasonal effects, and the impact of indirect effects related to climatological changes is needed to assist with future recovery efforts.

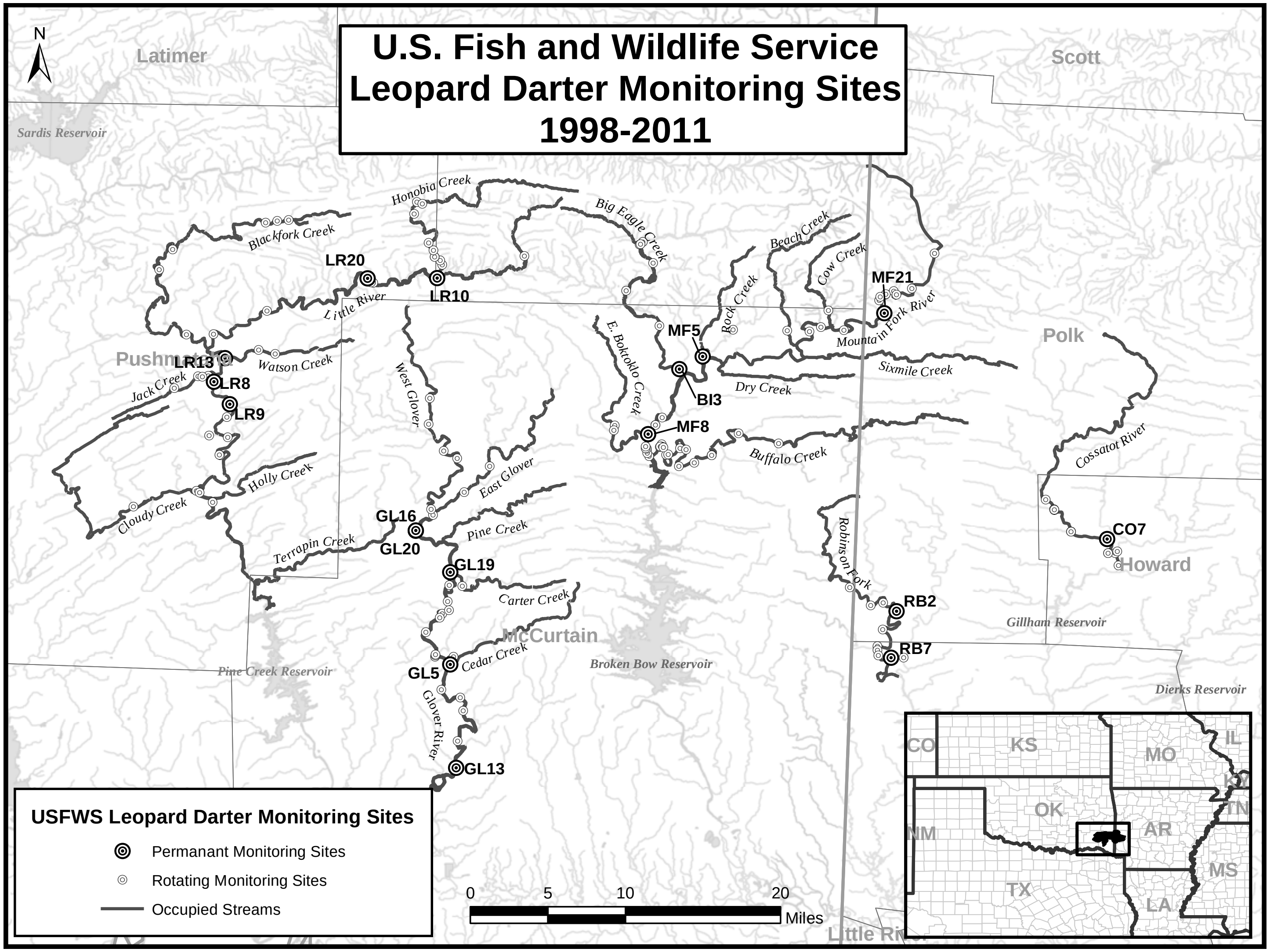


Figure 2. Leopard darter monitoring sites from 1998 to 2011.

Table 2. Results of statistical trends of leopard darter counts from years 1998-2011. Coefficient of variation was calculated for sites with no significant trend to determine if high variability (>50%) may explain failure to reject null hypothesis (no trend).

| Drainage name | Number of surveys | Trend | Probability value* | Coefficient of variation, CV) |
|---|---|---|---|---|
| Little River | 70 | No trend detected | 0.547 | 37% |
| Glover River | 67 | No trend detected | 0.112 | 69% |
| Mountain Fork River | 42 | No trend detected | 0.870 | 43% |
| Big Eagle Creek | 13 | **Decreasing** | **0.017** | - |
| Robinson Fork | 28 | No trend detected ** | 0.139 | 156% |
| Cossatot River | 14 | No trend detected | 0.152 | 176% |
| All Sites Combined | 234 | No trend detected | 0.113 | 46% |

*Mann-Kendall test

**Leopard darters not observed since 2005

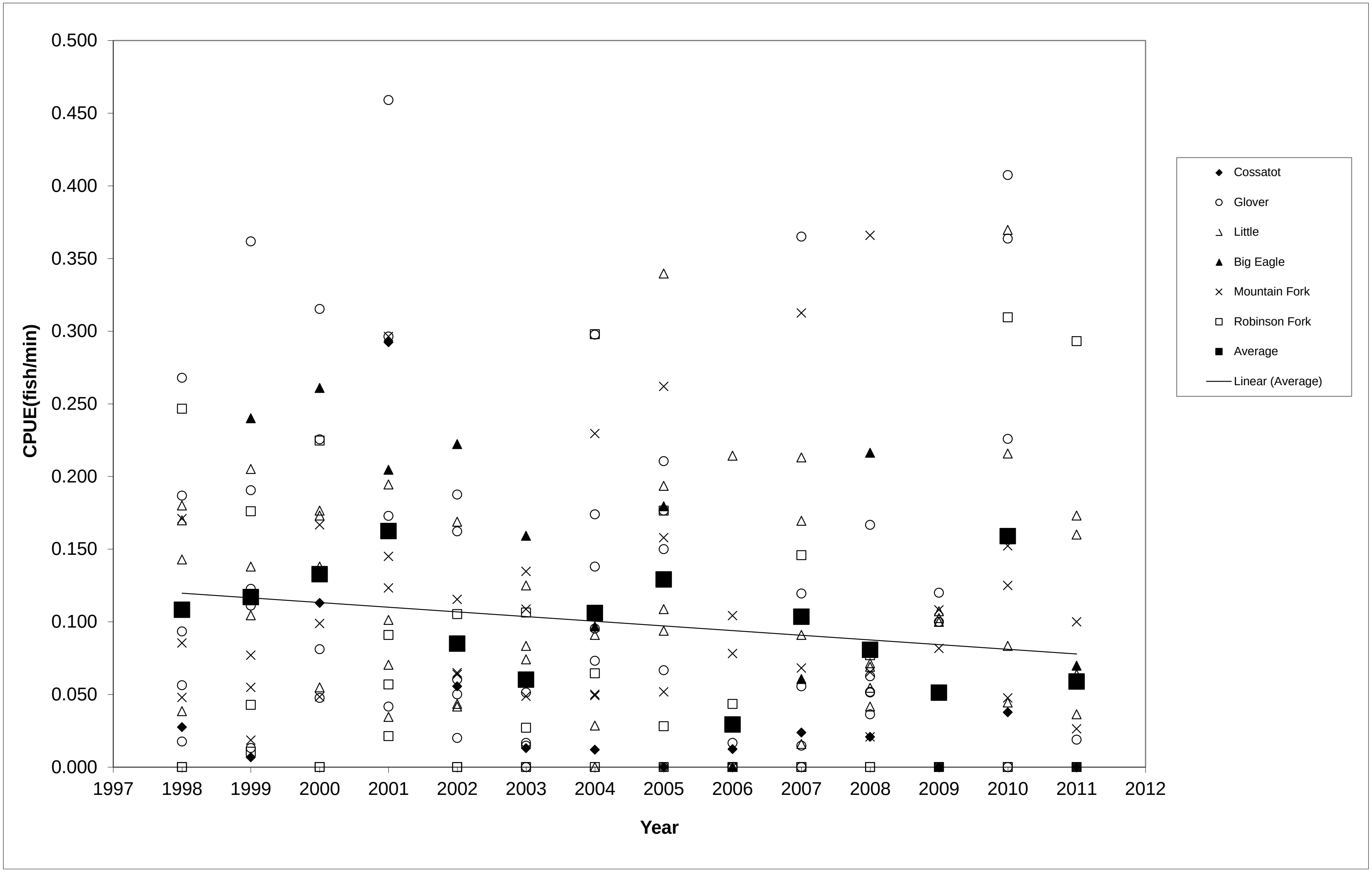


Figure 3. Catch per unit effort (CPUE) estimates for the leopard darter. Linear trend line is calculated based on the mean CPUE, per year (black squares).

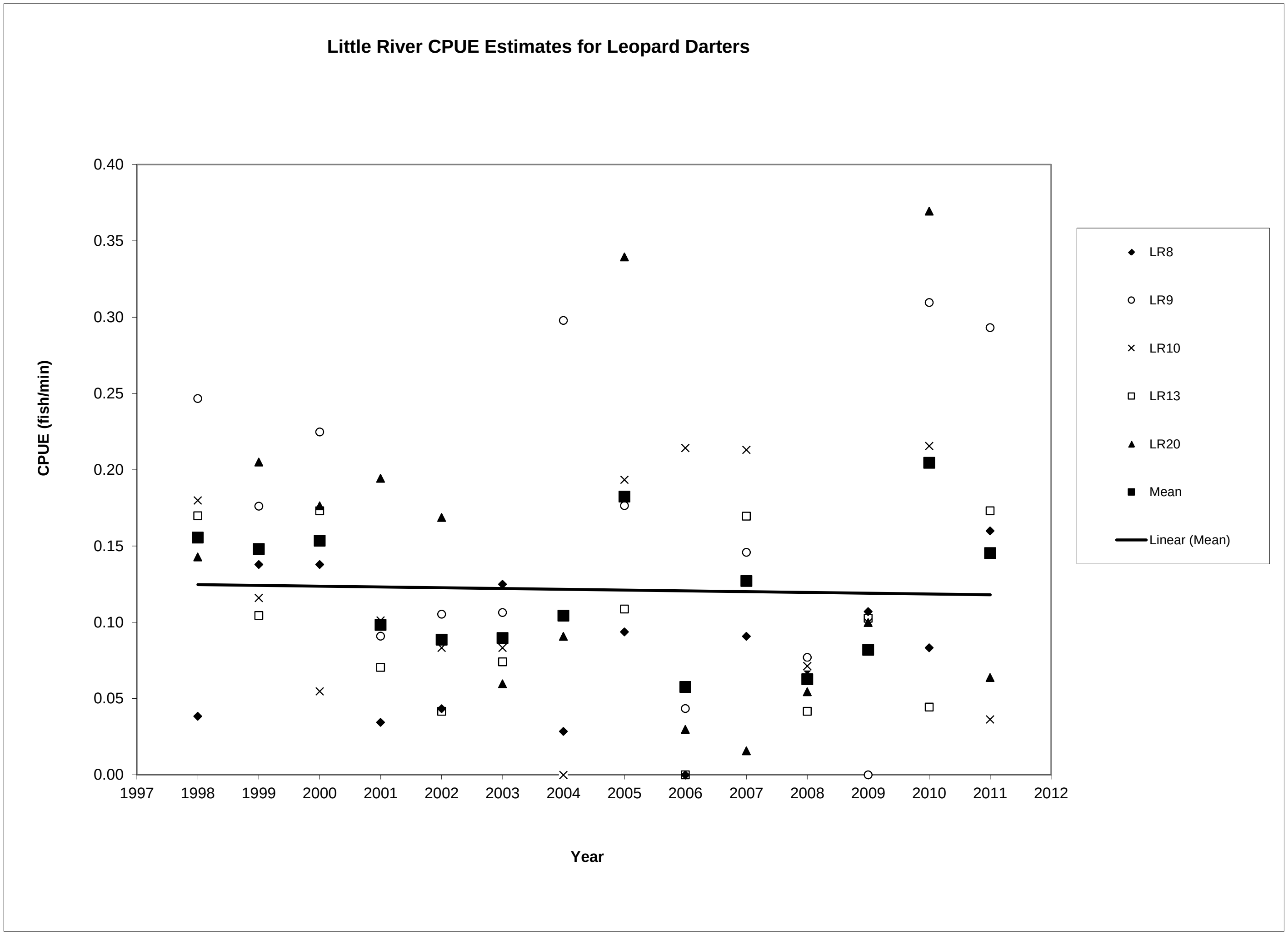


Figure 4. Little River catch per unit effort (CPUE) estimates at five permanent monitoring sites for the leopard darter. Linear trend line is calculated based on the mean CPUE, per year (black squares).

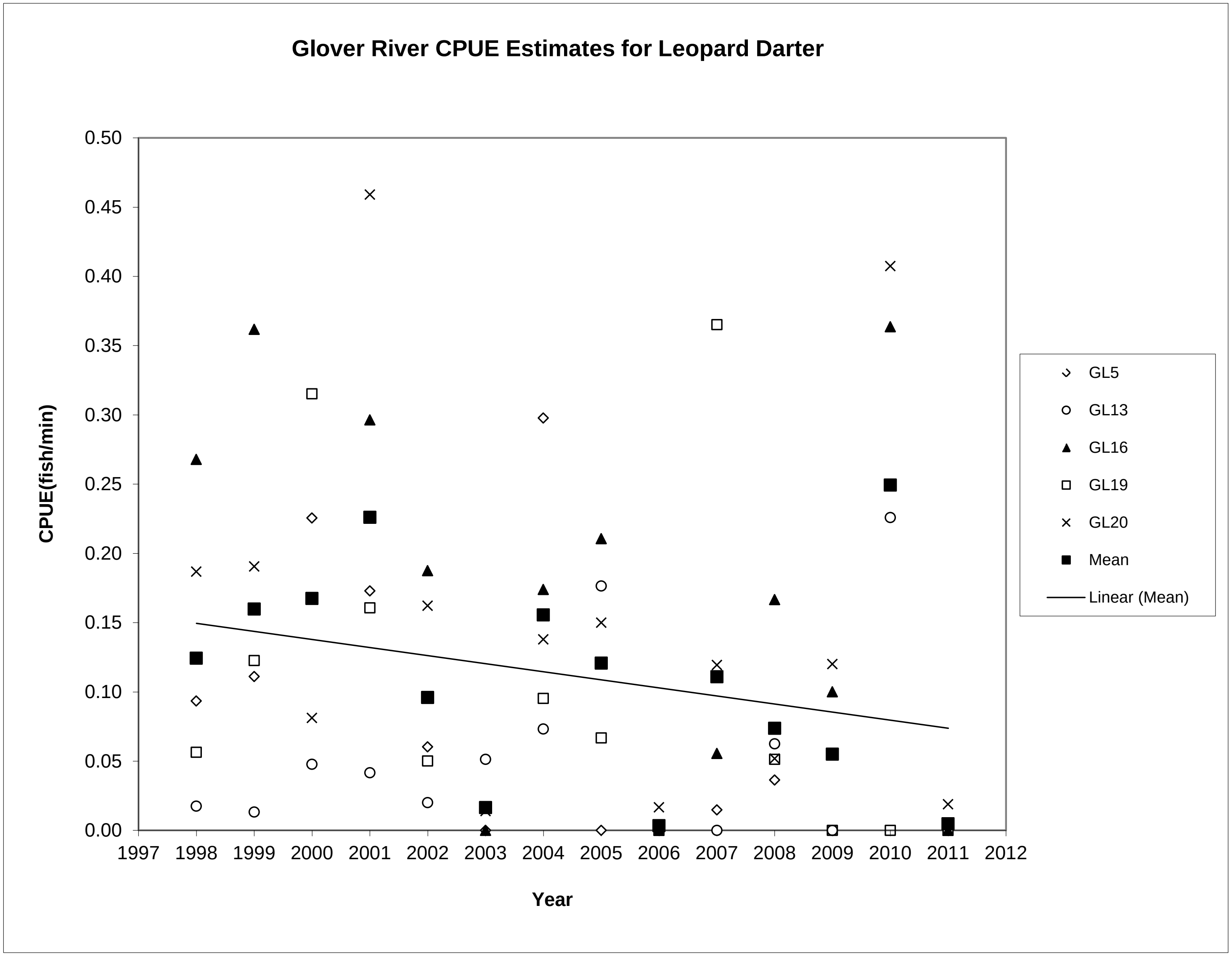


Figure 5. Glover River catch per unit effort (CPUE) estimates at five permanent monitoring sites for the leopard darter. Linear trend line is calculated based on the mean CPUE, per year (black squares).

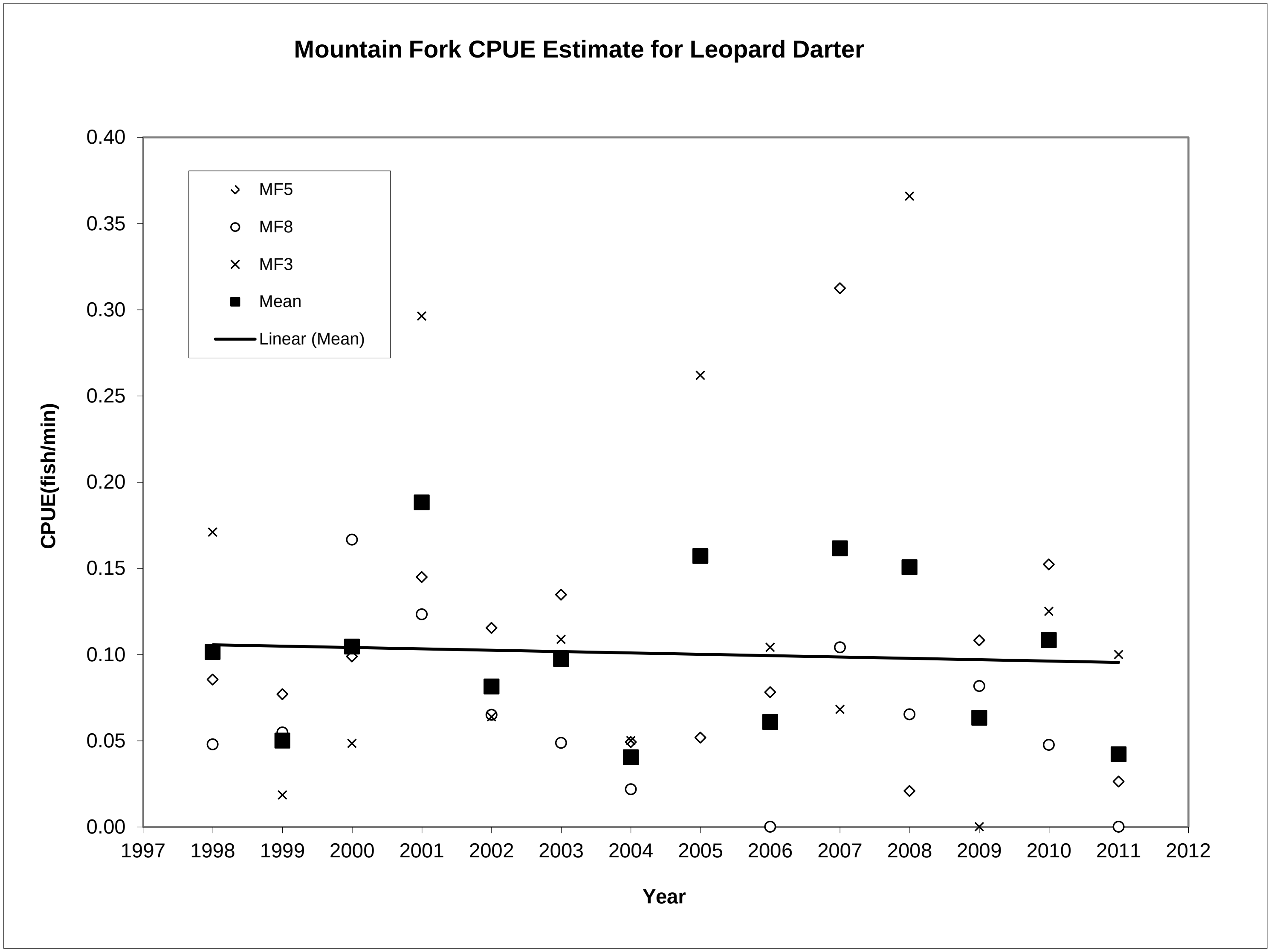


Figure 6. Mountain Fork catch per unit effort (CPUE) estimates at three permanent monitoring sites for the leopard darter. Linear trend line is calculated based on the mean CPUE, per year (black squares).

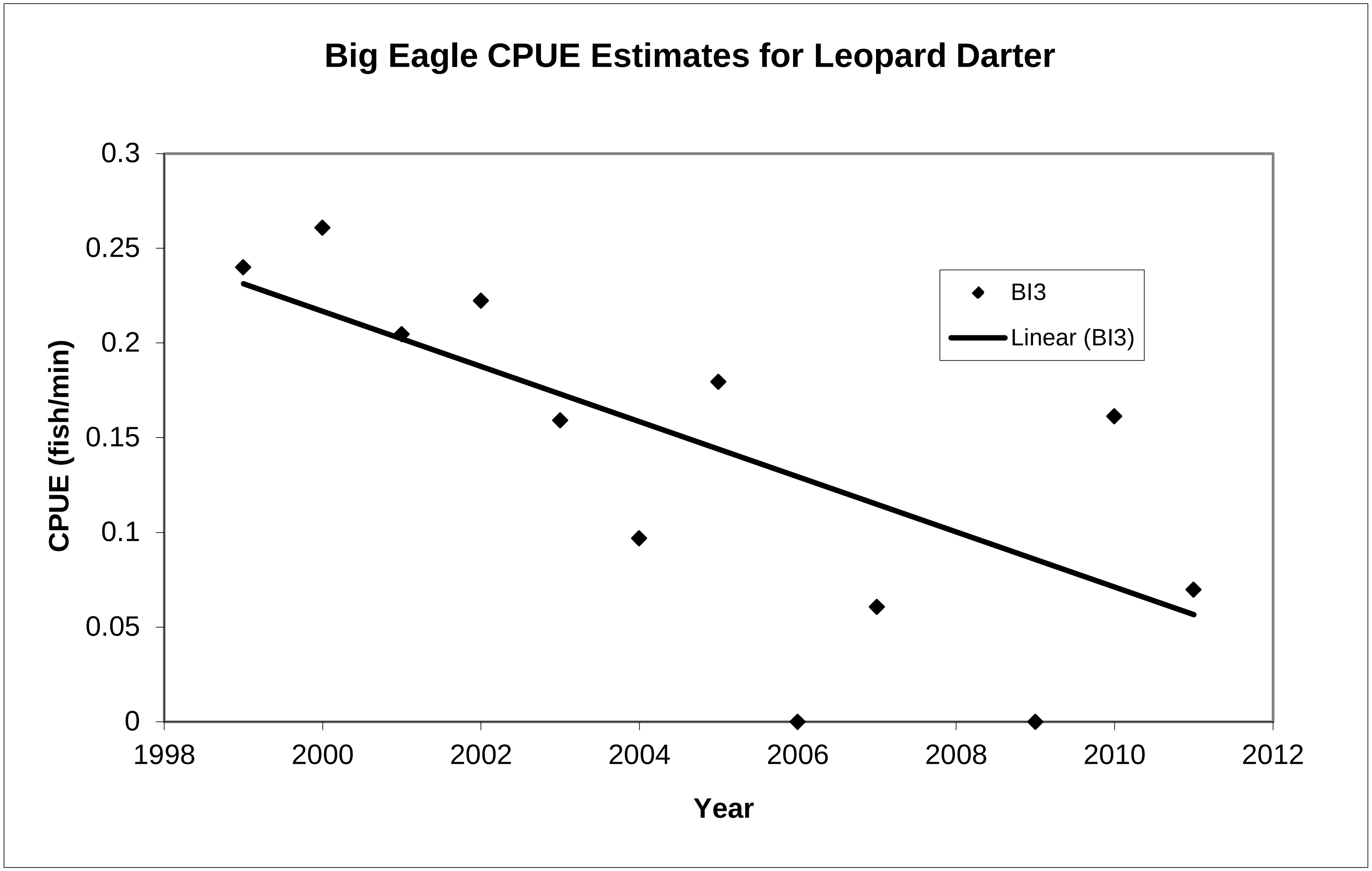


Figure 7. Big Eagle Creek catch per unit effort (CPUE) estimates at one permanent monitoring site for the leopard darter. Linear trend line calculation is based on CPUE, per year.

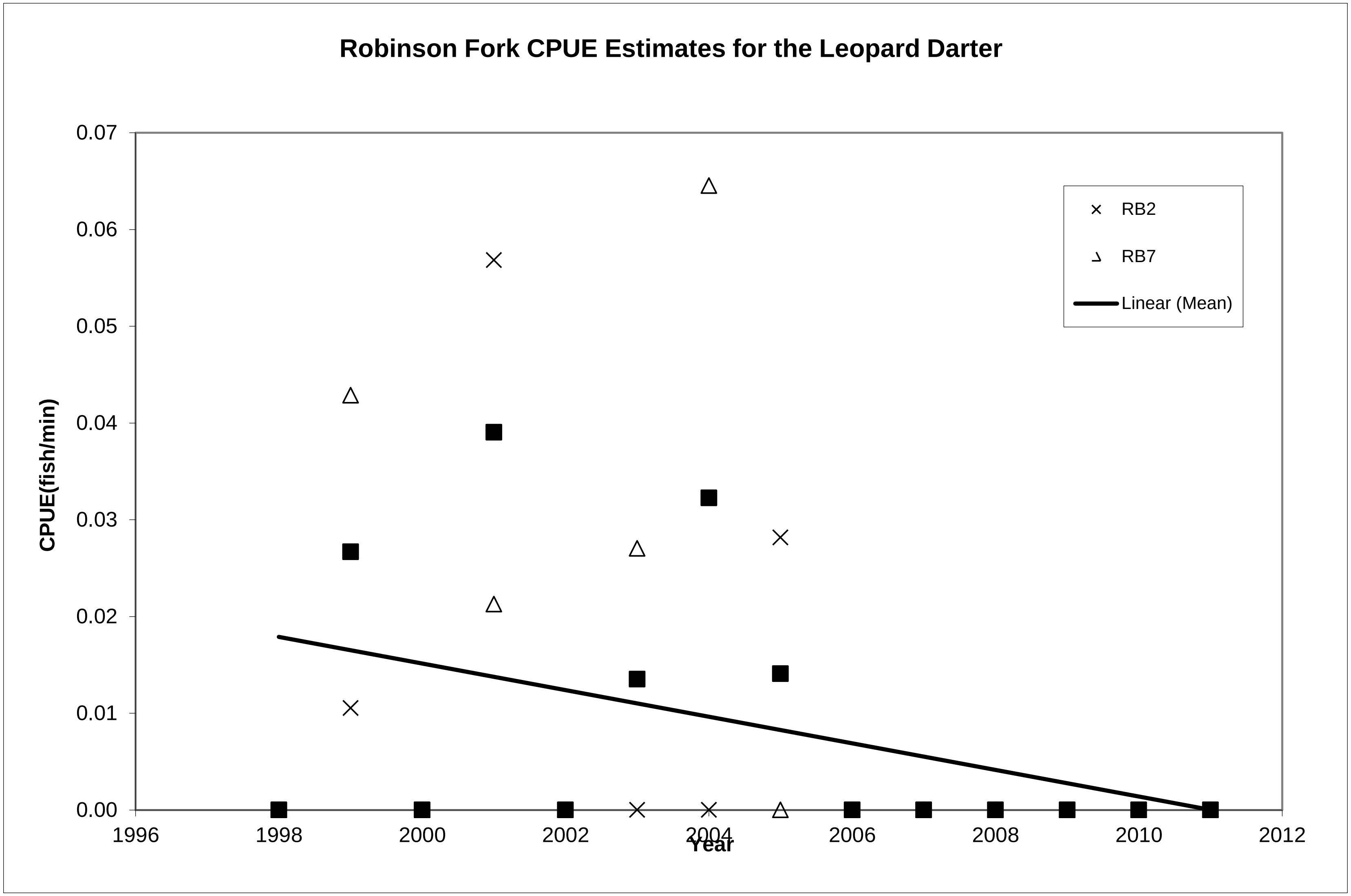


Figure 8. Robinson Fork catch per unit effort (CPUE) estimates at two permanent monitoring sites for the leopard darter. Linear trend line is calculated based on the mean CPUE, per year (black squares).

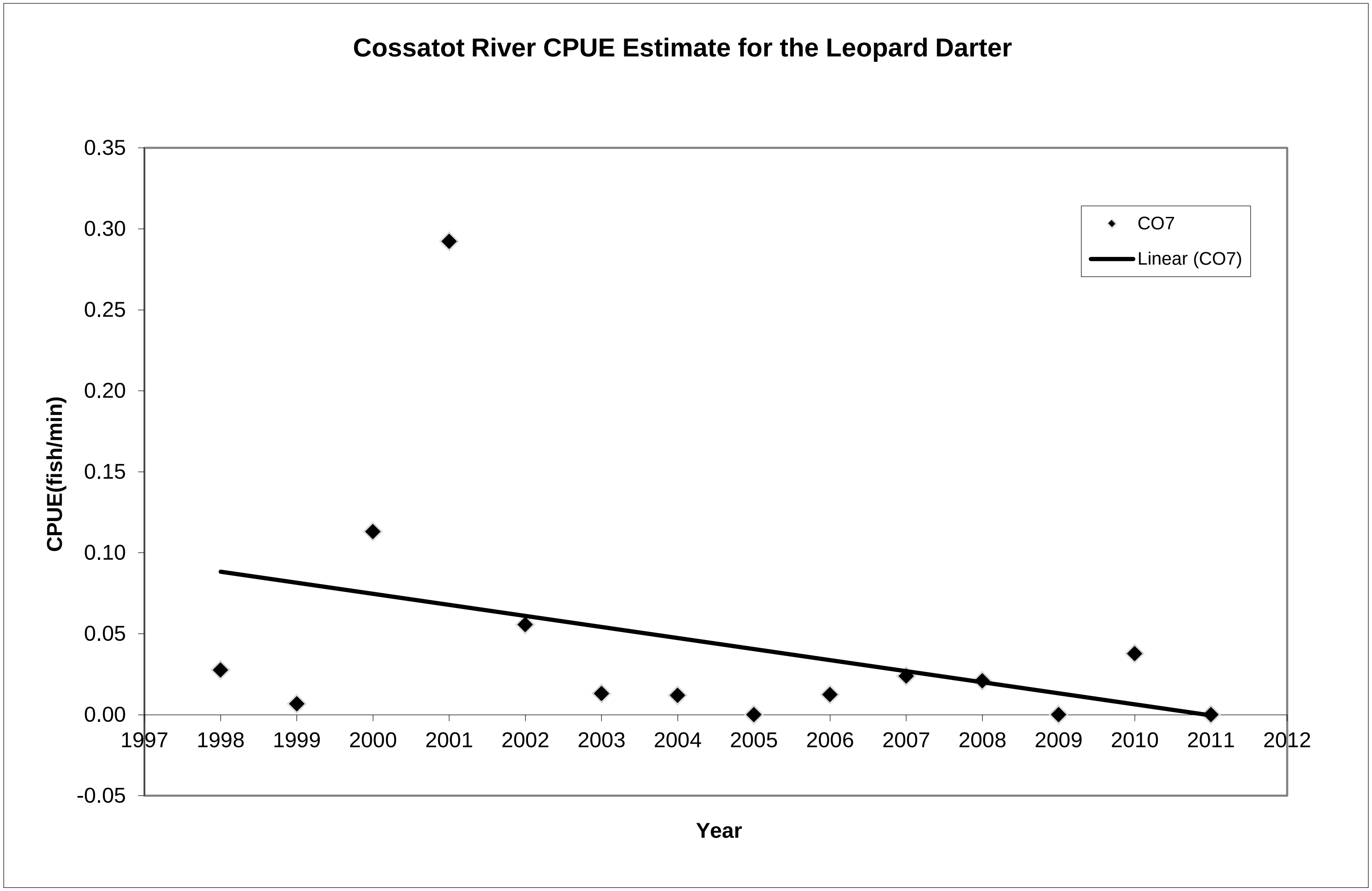


Figure 9. Cossatot River catch per unit effort (CPUE) estimates at one permanent monitoring site for the leopard darter. Linear trend line calculation is based CPUE, per year.

### 2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

#### 2.3.2.1 List Factor A: Present or threatened destruction, modification or curtailment of its habitat or range:

*Impoundments*

Habitat loss and degradation is the principal factor affecting survival of the leopard darter. The single most important factor resulting in leopard darter habitat destruction has been the development and operation of impoundments. Six major reservoirs, impounding all but one major stream (Glover River) in the Little River Basin, have significantly reduced the distribution and abundance of the leopard darter. Historically, viable leopard darter populations inhabited reaches in the lower Mountain Fork, lower Cossatot and lower reaches of the Little River (Eley et al. 1975). These populations were extirpated following construction of Broken Bow, Gillham, and Pine Creek Reservoirs, respectively. Although currently deauthorized, Lukfata Reservoir is still considered a potential threat to the species because it continues to be considered in future water planning efforts (as described in the Oklahoma Comprehensive Water Plan) as a potential option to address future water demands.

Dams eliminate and alter river flow within impounded areas, trap silt leading to increased sediment deposition, alter water quality, change hydrology and channel geomorphology, decrease habitat heterogeneity, affect normal flood patterns, and block upstream and downstream movement of fishes (Eley et al. 1975, Hubbs and Pigg 1976, Robison 1978; Cross and Collins 1995; Tiemann et al. 2004; Gillette et al. 2005). Within impounded waters, decline of stream fishes has been attributed to direct loss of supporting habitat, sedimentation, decreased dissolved oxygen, temperature levels, and alteration in resident fish populations (Cross and Collins 1995). Downstream of dams, declines in some species are associated with changes and fluctuation in flow regime, channel scouring and bank erosion, reduced dissolved oxygen levels and water temperatures, and changes in resident fish assemblages (Wildhaber et al. 2000; Bryan et al. 2010).

Dam construction has a secondary effect of fragmenting the ranges of fish species by leaving habitats and populations isolated upstream or between structures as well as creating extensive areas of deep uninhabitable, impounded waters. These isolated populations are unable to naturally recolonize suitable habitat from downstream which can isolate populations affecting gene flow and the species' population genetics (Allendorf and Luikart 2007); and contribute to becoming more prone to further extirpation from stochastic events, such as severe drought, accidental chemical spills, or unauthorized discharges.

These dams, by segmenting the species' riverine habitat, may impact the genetic variability in the species. Loss of genetic diversity in fragmented populations can impact species fitness, including fecundity and recruitment over time (Allendorf and Luikart 2007). As discussed in *Population Dynamics* section above, recent genetics research on the leopard darter suggests that the effective population size has significantly decreased following the construction of impoundments approximately 40 years ago (Echelle et al. 2010).

*Agriculture*

Water quality deterioration due to agricultural and industrial activities was identified as a major threat to the survival of the leopard darter (Jones 1984). Agricultural and industrial contaminants enter the environment through point and nonpoint discharges including spills, industrial and municipal effluents, and residential and agricultural runoff. These sources contribute organic compounds, heavy metals, nutrients, pesticides, and a wide variety of newly emerging contaminants such as pharmaceuticals to the aquatic environment. As a result, water and sediment quality can be degraded to levels that leopard darters could be impacted. In 1976, a chemical spill eliminated leopard darters from about 19 km of the upper Mountain Fork River in Arkansas (Robison 1978).

Agricultural activity within the basin, primarily poultry and swine feeding operations, also has been increasing over the past several years. Waste disposal from these operations typically involves land application. Generally, proper disposal of wastes from these facilities poses little threat to leopard darters. However, appropriate disposal of these wastes is lightly regulated and an application rate for southeastern Oklahoma has not been established.

Studies have documented the potential for serious water quality degradation if runoff from fields treated with swine and poultry manure is allowed to enter eastern Oklahoma streams (Sharpley et al. 1990). Nutrients, such as nitrogen and phosphorus, primarily occur in runoff from livestock farms, feedlots, heavily fertilized row crops and pastures (Peterjohn and Correll 1984). Nutrient over-enrichment can result in an increase in primary productivity, and the associated algae respiration depletes dissolved oxygen levels. Over-enriched conditions are exacerbated by low flow conditions, which may alter physiological processes. Since 1992, Service biologists conducting leopard darter surveys have noted increased abundance of filamentous algae at multiple sites. This algal growth is likely the result of increased nutrient input within these reaches. However, the exact source of these nutrients is unknown and additional research is needed.

*Logging*

Logging has been a major economic activity in the Little River Basin since the early 1960's. The ensuing intensive commercial harvest (clear-cutting) of forest products has significantly altered the terrestrial environment of the basin. Terrestrial perturbations, primarily logging and associated road building that result in increased stream sediment load, effects to water quality, and barriers to fish passage, were thought to have caused a decline in the endemic fish fauna of southeastern Oklahoma (Rutherford et al. 1987) and may particularly affect small, short lived species (Rutherford et al. 1992). The leopard darter, with its short life span and restricted distribution is potentially vulnerable to the effects of land use alteration. The leopard darter recovery plan identified logging as a major threat to the survival of the species (Jones 1984).

*Roads*

The effect of road construction, while not exclusively associated with timber extraction, is a related activity that can significantly influence fish populations. The upper Little River Basin typically has a high density (for example, 2.0 $km/km^2$ in the U.S. Forest Service's Broken Bow Unit) of unimproved roads providing access to thousands of hectares of pine plantations. Once revegetated, rates of erosion and sediment yield from pine plantations likely decline. However, erosion from logging roads declines only if traffic levels decrease following cessation of logging activity. Average sediment yield from roads in the Ouachita Mountains varies from about 0.085 to 0.044 metric tons/acre/year (Miller et al. 1985, Scoles et al. 1995). Miller et al. (1985) expressed concern that the number of stream crossings may have a greater influence on sediment delivery to streams than the actual area of roads.

In addition, road crossings also may obstruct movements of many stream fishes (Warren and Pardew 1998). Poor crossing design, primarily improper size, number, or placement of culverts, can lead to excessive current velocities within culverts, scour pools with cascades downstream of the culvert, and elevated hydraulic head at culvert inlets. These barriers, combined with a lack of water velocity refugia, significantly influence movements by stream fishes. Recent investigations have shown that most existing crossings in the Little River Basin are a barrier to leopard darter movement (Toepfer et al. 1999 and Schaefer et al. 2003). The long term effects of low water crossings are not known. Temporarily, they are known to restrict access to spawning areas and hinder re-colonization following periods of extended drought. Additional research on leopard darter movements and effects from low water crossings is needed.

*Gravel Mining*

Studies (Forshage and Carter 1973, Lyttle 1993) have documented reductions or eliminations of darter species in fish communities impacted by gravel dredging/removal operations. However, water quality degradation associated with commercial gravel dredging/removal operations does not appear to have a major impact on leopard darters at current activity levels. In 1994, the Corps granted a permit under Section 404 of the Clean Water Act authorizing the commercial removal of gravel from the Glover River. The Service's opinion on this project estimated that one leopard darter and an area of habitat encompassing 60 $m^2$ would be degraded annually as a result of the action.

*Water Quantity*

Proposed water sales could be detrimental to leopard darter populations. In 1999, the Oklahoma Legislature adopted HCR 1066 which directed the Water Resources Board (OWRB) to prepare a Kiamichi River Basin Water Resources Development Plan. The development of this legislation was influenced by an outstanding payment situation involving Sardis Reservoir and recent inquiries from north Texas entities to purchase water from Oklahoma. The OWRB, in cooperation with representatives of the Choctaw and Chickasaw Nations, developed the Kiamichi River Basin plan which, in part, invited comment from the public on the transfer of water outside of the basin. As a follow up to HCR 1066, in May 2000, the Legislature adopted HCR 1109 which directed the OWRB to coordinate with the Corps to study southeast Oklahoma's water resources and bring proposals for the development of those waters to the Legislature. As a result, the North Texas Water Agency (NTWA), Oklahoma City Water Utilities Trust (OCWUT) and the Central Oklahoma Water Authority (COWA) submitted proposals for consideration. Further discussions and negotiations were conducted with the NTWA and OCWUT. The COWA proposal was rejected, however the NTWA and OCWUT proposal are still under consideration. Also, as a result of HCR 1109, the State and two Tribes signed an MOU in October 2000 that established a timeline for negotiating and developing a draft compact related to water development among the three governments.

In 2002, the Oklahoma legislature imposed a three-year moratorium on out-of-state water sales which was intended to "provide for the conservation, preservation, protection, and optimum development and utilization" of Oklahoma's water resources. The Oklahoma legislature extended the moratorium on out-of-state water sale in 2004 for another 5 years, "or until such time as the State of Oklahoma conducts and completes a comprehensive scientific hydrological study of the water resources of this state". Various hydrological studies have been underway; however, until such studies are completed, a comprehensive examination of their results will not be possible.

The extent of the proposed water sales and their effects on the leopard darter are unknown. To our knowledge, no water withdrawals are proposed directly from areas occupied by the leopard darter, however water withdrawals from basins that are occupied by the leopard darter could indirectly affect the species by shifting current demands and forcing reservoirs to change their operations which could potentially inundate additional areas upstream.

#### 2.3.2.2 Listing Factor B: Overutilization for commercial, recreational, scientific, or educational purposes.

There is no evidence to suggest that overutilization is a current threat to the leopard darter.

### 2.3.2.3 Listing Factor C: Disease and predation:

In 1996, there was an apparent isolated outbreak of fungus on leopard darters in West Fork Glover River (C. Toepfer, Oklahoma State University, 1996, pers. comm., Toepfer 1997). Toepfer reported observing 14 individuals to be infected with a white, lumpy fungus that apparently first appears as white spots on or near the dorsal fin. Later stages of infection appear to be marked by scattered white spots over the entire body. Those in advanced stages of infection generally also exhibit large white patches on the opercle. He suspected the infection could be related to lack of streamflow and poor water quality resulting from the ongoing drought. No such outbreak has been observed since that occurrence.

James et al. (1991) reported occasionally observing parasitic copepods (*Lernaea* sp.) attached to the base of either the dorsal or pectoral fins of leopard darters. Small leaches were also infrequently observed attached to either the pectoral or caudal fins. Of the 835 leopard darter individuals captured during 1985-1988, only 30 parasitized individuals were observed; with over 93 percent of the observances occurring during the summer. Page (1983) lists a number of organisms generally known to parasitize various darter species, many of which also are likely to infect leopard darters.

No specific information on predation exists, although a number of potential predators occur throughout the leopard darters range. Page (1983) lists 19 known predators of darters, of which 10 occur within the leopard darter’s range. James and Maughan (1989) noted channel darter feeding on leopard darter eggs. During periods of drought when water temperatures rise above 30 degrees Celsius, the leopard darter likely moves to deeper water for thermal refuge, where they encounter less cover habitat, leaving them more vulnerable to predators.

### 2.3.2.4 Listing Factor D: Inadequacy of existing regulatory mechanisms:

*Clean Water Act*

The objective of the Federal Water Pollution Control Act, commonly referred to as the Clean Water Act (CWA) (33 U.S.C. 1251 *et seq.*), is to restore and maintain the chemical, physical, and biological integrity of the nation's waters by preventing point and nonpoint pollution sources and a stated goal that “…wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983.” States are responsible for setting and implementing water quality standards that align with the requirements of the CWA. Overall, implementation of the CWA could benefit the leopard darter through the point and nonpoint programs.

Nonpoint source pollution comes from many diffuse sources, unlike pollution from industrial and sewage treatment plants. Nonpoint source pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it transports natural and human-made pollutants to lakes, rivers, wetlands, coastal waters and ground waters. States report that nonpoint source pollution is the leading remaining cause of water quality problems. The effects of nonpoint source pollutants on specific waters vary and may not always be fully assessed. However, these pollutants have harmful effects on fisheries and wildlife (http://www.epa.gov/owow_keep/NPS/whatis.html).

Sources of nonpoint source (NPS) pollution within the watersheds occupied by leopard darter include timber clear-cutting, clearing of riparian vegetation, urbanization, road construction, and other practices that allow bare earth to enter streams. Currently, the CWA may not adequately protect leopard darter habitat from nonpoint-source pollution. The Service has no information concerning the implementation of the CWA regarding nonpoint source pollution specific to protection of leopard darter. Insufficient implementation is likely a threat to leopard darter given that water quality has continued to degrade.

Point-source discharges within the range of the leopard darter have been reduced since the enactment of the CWA. Despite some reductions in point source discharges, adequate protection may not be provided by the CWA for filter-feeding organisms that can be affected by extremely low levels of contaminants.

The leopard darter is threatened due to the effects of habitat destruction, poor water quality, contaminants, and other factors. However, there is no specific information known about the sensitivity of the leopard darter to common point source pollutants like industrial and municipal pollutants and very little information on other *Percina* species. Because there is very little information known about water quality parameters necessary to fully protect leopard darter, it is difficult to determine whether the CWA is adequately addressing the threats to this species. However, given that a goal of the CWA is to establish water quality standards that protect fish and given that there are documented declines of this fish species in some drainages where water quality has declined, we conclude that the CWA has been insufficient to significantly reduce or remove the threats to the leopard darter.

#### 2.3.2.5 Listing Factor E: Other natural or manmade factors affecting its continued existence:

Our analyses under the Endangered Species Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). The term "climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a).

Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has been faster since the 1950s. Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions. (For these and other examples, see IPCC 2007a; and Solomon et al. 2007). Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-20th century cannot be explained by natural variability in climate, and is "very likely" (defined by the IPCC as 90 percent or higher probability) due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities, particularly carbon dioxide emissions from use of fossil fuels (IPCC 2007a, pp. 5-6 and figures SPM.3 and SPM.4; Solomon et al. 2007). Further confirmation of the role of GHGs comes from analyses by Huber and Knutti (2011), who concluded it is extremely likely that approximately 75 percent of global warming since 1950 has been caused by human activities.

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (e.g., Meehl et al. 2007; Ganguly et al. 2009; Prinn et al. 2011). All combinations of models and emissions scenarios yield very similar projections of increases in the most common measure of climate change, average global surface temperature (commonly known as global warming), until about 2030. Although projections of the magnitude and rate of warming differ after about 2030, the overall trajectory of all the projections is one of increased global warming through the end of this century, even for the projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced substantially by the extent of GHG emissions (IPCC 2007a; Meehl et al. 2007; Ganguly et al. 2009; Prinn et al. 2011). (See IPCC 2007b for a summary of other global projections of climate-related changes, such as frequency of heat waves and changes in precipitation. Also see IPCC 2011 for a summary of observations and projections of extreme climate events.)

Various changes in climate may have direct or indirect effects on species. These effects may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007a,b). Identifying likely effects often involves aspects of climate change vulnerability analysis. Vulnerability refers to the degree to which a species (or system) is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the type, magnitude, and rate of climate change and variation to which a species is exposed, its sensitivity, and its adaptive capacity (IPCC 2007a; see also Glick et al. 2011). There is no single method for conducting such analyses that applies to all situations (Glick et al. 2011). We use our expert judgment and appropriate analytical approaches to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

Although many species already listed as endangered or threatened may be particularly vulnerable to negative effects related to changes in climate, we also recognize that, for some listed species, the likely effects may be positive or neutral. In any case, the identification of effective recovery strategies and actions for recovery plans, as well as assessment of their results in 5-year reviews, should include consideration of climate-related changes and interactions of climate and other variables. These analyses also may contribute to evaluating whether an endangered species can be reclassified as threatened, or whether a threatened species can be delisted.

The timing and magnitude of the effects from climate change on watersheds occupied by the leopard darter is largely unknown. Ficke et al. (2007) described the general potential effects of climate change on freshwater fish populations worldwide. Overall, the distribution of fish species is expected to change, including range shifts and local extirpations. More specifically, increasing temperature and droughts could affect the leopard darter's ability to reproduce by limiting available habitat and potentially reaching water temperatures not tolerable for leopard darter reproduction (although specific thermal tolerance levels have not been determined). An increase of extreme climatological events and temperature could exacerbate water quality issues within the basin. Increased flooding could affect sedimentation and stream hydrology/morphology. Increased water demands could limit available habitat, affect hydrology and morphology of streams, affect water temperatures, and cause detrimental changes to water quality.

## 2.4 Synthesis

In 1978, the leopard darter was federally listed under the ESA as threatened. Critical habitat was also designated at the time, including portions of Black Fork Creek and the Glover, Little, and Mountain Fork Rivers. At the time of listing, four populations were known (Cossatot, Glover, Little, and Mountain Fork Rivers), all of which continue to persist in relatively low abundances, particularly when compared to population estimates for other short-lived darter species. The species has disappeared in the Cossatot downstream of Gillham dam, as predicted in the 1978 listing and more recent monitoring surveys suggest that, within the last 13 years leopard darter populations are stable to declining.

The species was listed primarily due to the loss of habitat through construction of reservoirs, which have eliminated numerous river miles within the Little River Basin and has altered flow dynamics, water quality, and habitat availability downstream of reservoirs where viable populations have disappeared. Although no new reservoirs have been constructed since the species was listed, current and future water demands may drive the desire for more to be constructed. One in particular, Lukfata Reservoir, was authorized for construction, but was never funded and in 2002 the reservoir was deauthorized by congress.

Impacts to water quality from agriculture, industry, gravel mining, and road construction were also identified as threats to the species. Poultry operations have recently increased within the watershed and clear cutting and gravel mining continues to occur. Roads and low water crossings are potentially a significant threat to the leopard darter, and additional research on the effects of increased sedimentation and low water crossing barriers is needed. More recently identified threats such as climate change and increased water demands further exacerbate potential impacts to the species.

Significant information on the leopard darter's status, life history, and genetics has been gathered since listing. The species is known to occur in some larger tributaries of the Glover, Little, and Mountain Fork Rivers, however their status in some of these tributaries has declined in recent years. Population size fluctuates from year to year, likely driven by precipitation, or lack thereof, and temperature. The species lives an average of 18 months, and most individuals spawn only once in their lifetime, leaving the species even more vulnerable to existing threats. Recent population genetics research suggests that the effective population size of the species is extremely low and has declined precipitously, suggesting that artificial immigration (moving individuals between drainages) may be necessary. A sufficiently large effective population size is essential to adapt to environmental change and maintain long-term population viability. These populations may be experiencing a bottleneck effect due to the small effective population size. Without genetic interchange, small, isolated populations could be slowly expiring, a phenomenon termed the extinction debt (Tillman et al. 1994). Even given the absence of existing or new anthropogenic threats, disjunct populations may be lost as a result of current below-threshold effective population size. Additionally, evidence indicates that general habitat degradation continues to decrease habitat patch size, further contributing to the decline of leopard darter populations. Fragmentation and isolation of small remaining populations of leopard darter are current and ongoing threats throughout its range and will continue into the future. Further, stochastic events may play a magnified role in population extirpation when small, isolated populations are involved.

The improvement of low water crossings that act as barriers to fish passage has been a primary focus of the Service in regards to leopard darter recovery. To date, over 100 river miles have been opened up to allow for improved passage through low water crossing structures. The Service continues to work with the U.S. Forest Service, logging industry, and county governments to improve fish passage throughout the Little River Basin.

No change in classification is warranted at this time. The four identified populations in the 1978 listing still persist. Within the last 13 years leopard darter populations appear to be stable to declining. Annual monitoring of the species over the next five years will be essential for assessing population trends and re-evaluating the species status. Population genetics results suggest that effective population size is extremely low and the development of a propagation and augmentation plan, in addition to an artificial immigration plan with close coordination among geneticists and resource managers will be needed to avoid further decline. If population trends decline significantly or if climate change or water demands further impact the Little River Basin, the leopard darter could become an endangered species.

# 3.0 RESULTS

## 3.1 Recommended Classification:

No change recommended – maintain as Threatened

## 3.2 New Recovery Priority Number

Recommend changing Recovery Priority Number from 11c to 2c:

Table 3. New recommended Recovery Priority Number using ranking system for determining Recovery Priority Numbers as established in 1983 (48 FR 43098, September 21, 1983 as corrected in 48 FR 51985, November 15, 1983).

| Degree of Threat | Recovery Potential | Taxonomy | Priority | Conflict |
|---|---|---|---|---|
| **High** | **High** | Monotypic Genus | 1 | 1C |
| | | **Species** | **2** | **2C** |
| | | Subspecies/DPS | 3 | 3C |
| | Low | Monotypic Genus | 4 | 4C |
| | | Species | 5 | 5C |
| | | Subspecies/DPS | 6 | 6C |
| Moderate | High | Monotypic Genus | 7 | 7C |
| | | Species | 8 | 8C |
| | | Subspecies/DPS | 9 | 9C |
| | Low | Monotypic Genus | 10 | 10C |
| | | Species | 11 | 11C |
| | | Subspecies/DPS | 12 | 12C |
| Low | High | Monotypic Genus | 13 | 13C |
| | | Species | 14 | 14C |
| | | Subspecies/DPS | 15 | 15C |
| | Low | Monotypic Genus | 16 | 16C |
| | | Species | 17 | 17C |
| | | Subspecies/DPS | 18 | 18C |

We recommend that the Recovery Priority Number be changed to 2c for the following reasons:

*Degree of threat* – Although the number of reservoirs has not changed since listing, our understanding of the degree of threat of existing reservoirs has increased, particularly in terms of the effect on genetic diversity and effective population size. As discovered by Echelle and Schwimm (2012, pers. comm.), leopard darter genetic diversity is low throughout the Little River Basin and effective population size is lower than reported for any other fish.

*Recovery potential* – Lukfata Reservoir has been deauthorized for construction, which meets one of three recovery tasks required for consideration of delisting. Although water demands will continue to increase in the drainage, including the potential reauthorization of Lukfata and authorization of other reservoirs within the Little River Basin, deauthorization of Lukfata was a significant step in limiting a significant threat to the species.

Although genetic diversity and effective population size is alarmingly low for leopard darters through the Little River Basin, a targeted recovery action of moving limited number of leopard darters between drainages and mimicking their historic patterns of migration (now not possible due to existing reservoirs) is possible. Because the leopard darter is an annual species, spawning at 12 to 18 months, positive effects of such movements could be observed within a relatively short amount of time. An artificial immigration plan will be developed and peer reviewed before such a plan is implemented.

## 4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

**Update the Recovery Plan**

- We recommend that the 1993 Draft Revised Recovery Plan be updated and finalized to include new information that we have learned since that time. The recovery plan should be revised to refine reclassification criteria, define measureable delisting criteria, and better address the five factor analysis.

**Continue Monitoring Program**

- The annual monitoring program has been essential to evaluating long term trends of the species. Continue to develop the program to ensure that data collected are statistically meaningful and allow for long term analysis of populations. Additional efforts should focus on the Robinson Fork of the Rolling Fork River where leopard darters have not been found since 2005 and Little River below Pine Creek Reservoir where two leopard darter individuals were collected in 2010.

**Additional Research**

- Examine leopard darter movements/migrations with implications for potential effects from low water crossings and reservoirs.
- Conduct molecular genetics (Environmental DNA) study to evaluate leopard darter status in the Robinson Fork of the Rolling Fork River and other drainages where the species has not been found.
- Conduct water quality assessment drainage wide with a focus on increased filamentous algae (nutrients).
- Further examine Service monitoring data. Evaluate potential causes of high annual fluctuations in counts, including effects from precipitation and temperature.
- Assess current logging practices and potential impacts to the Little River Basin.
- Conduct an instream flow study for the leopard darter
- Conduct a temperature tolerance study of leopard darter and other similar species within the drainage.

**Outreach**

- Foster a working relationship with forestry and other agricultural private sector companies, landowners, and county governments to address and minimize potential impacts.

**Outreach (continued)**

- Develop standard best management practices and potentially a Habitat Conservation Plan or Safe Harbor Agreement involving forestry and agricultural operations and fish passage projects.

**Propagation and Reintroduction Plan**

- Work with National Fish Hatcheries to develop a captive rearing program for the leopard darter. Possible locations for reintroduction (where the species may no longer occur) could be the Robinson Fork River in Arkansas after further population monitoring of that system.

**Artificial Immigration Plan**

- Work with conservation geneticists to develop an artificial immigration plan targeted at promoting natural immigration and improving genetic diversity and effective population size of the leopard darter.

## 5.0 REFERENCES


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**U.S. FISH AND WILDLIFE SERVICE**
**5-YEAR REVIEW of leopard darter (*Percina pantherina*)**

**Current Classification**: Threatened

**Recommendation resulting from the 5-Year Review:**

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change needed

**Appropriate Listing/Reclassification Priority Number, if applicable:** NA

**Review Conducted By**: Daniel Fenner, Oklahoma Ecological Services Field Office.

**FIELD OFFICE APPROVAL:**

**Lead Field Supervisor, U. S. Fish and Wildlife Service, Oklahoma Ecological Services Field Office**

Approve Dixie Porter Date 8-21-12

**REGIONAL OFFICE APPROVAL:**

Acting **Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 2**

Approve Susan Jacobsen Date Aug 31, 2012

for **Cooperating Regional Director, U.S. Fish and Wildlife Service, Region 4**

_X_ Concur _____ Do Not Concur

Signature __________ Date 9/30/12

# APPENDIX A

USDA United States Department of Agriculture | Forest Service | Ouachita National Forest | P.O. Box 1270 Hot Springs, AR 71902

File Code: 2670

Date: May 30, 2006

Field Supervisor
Attention: 5-Year Review
U.S. Fish and Wildlife Service
Oklahoma Ecological Services Field Office
9014 East 21st Street
Tulsa, Oklahoma 74129

Dear Mr. Brabander:

The Ouachita National Forest has participated in joint leopard darter (federally listed as threatened) surveys with the staff of the Oklahoma Ecological Services Field Office since 1992. All jointly collected data and data that we have collected independently have been furnished to your biologists with leopard darter responsibilities. Additionally, we have concluded several Biological Consultations with your office.

Our assessment of the status of the threatened leopard darter is that its existence across its historic range is not secure but does not rise to the threshold of endangered. This conclusion is based upon:

- Finding leopard darters only three out of eight years at either of the two Robinson Fork permanent monitoring sites and then only one or two individuals.
- Finding leopard darters in only six of eight years at the one Cossatot River permanent monitoring site and when found, in very low numbers in all of but one of those years.
- The Cossatot River population occupies only a very small range within the Cossatot River and the plans to expand the population upstream into the river's headwaters within the Ouachita National Forest has not been initiated. As this population is so small, artificial propagation will be essential to expand the population through introductions into suitable habitats upstream. Neither the culture techniques nor introduction techniques have been developed.
- The Buffalo Creek population is completely isolated from its parent leopard darter population in the Mountain Fork River due to the backwaters of Broken Bow Reservoir. While we have not been able to secure funding for a genetics analysis of this population, we suspect its genetic viability to be threatened due to its small population size and the disconnect from the population in the Mountain Fork River.
- Lukfata Reservoir, a Congressionally-authorized but un-built US Army Corps of Engineers reservoir has not been deauthorized, a recovery plan delisting criterion. The US Forest Service/Ouachita National Forest has recommended the Glover River be listed as Scenic under the Wild and Scenic Rivers Act which would preclude damming. However, an attempt to pass the legislation did not make it to the floor of Congress before the session ended and it has not been submitted in

the current Congressional session. It is thought it might be resubmitted in the next Congress.

- Approximately 13 reservoir construction proposals have been made for impounding rivers and streams of Southeast Oklahoma in a scheme to sell potable water to Texas cities. Many of these dams are proposed for streams and rivers containing critically important leopard darter populations. Impoundments eliminate leopard darter habitat within the lake's basin as well as downstream and fragment habitat and populations.
- Habitats of the leopard darter are further fragmented by forest road crossings and crossing designs currently in use have not been proven to pass leopard darters.

With 14 to 16 miles of Critical Habitat of the leopard darter within National Forest System Lands, the Forest Service is committed to the restoration of this species to non-threatened status. The Ouachita National Forest has spent considerable time and effort on monitoring, habitat protection and restoration as well as funding research on various life history/culture aspects of the species. It appears to us delisting from threatened is premature at this point. Neither is elevating its status to endangered warranted at this time.

Sincerely,

Richard L. Rosemier

RICHARD L. ROSEMIER
Acting Forest Supervisor

cc: Regional Forester
George Bukenhofer, Regional Office, T&E Program Manager
Richard Standage, Ouachita NF, Aquatic T&E Program Manager
Daniel Fenner, FWS biologist, Tulsa