**Leopard Darter**
***(Percina pantherina)***

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

*Photo by D. Fenner, U.S. Fish and Wildlife Service*

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

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# 5-YEAR REVIEW

## Leopard Darter *(Percina pantherina)*

## 1.0 GENERAL INFORMATION

### 1.1 Listing History

**Species:** species, Leopard darter *(Percina pantherina)*
**Date listed:** January 27, 1978
**FR citation(s):** 43 FR 3711
**Classification:** Threatened

**Critical habitat/4(d) rule/Experimental population designation/Similarity of appearance listing:** In the final rule listing for the leopard darter, the U.S. Fish and Wildlife Service (Service) designated critical habitat for the species and provided a 4(d) rule to allow take for direct taking of the darter through the requirement of state collecting permits.

### 1.2 Methodology used to complete the review:

The Service most recently evaluated the biology and status of the darter in our August 21, 2012 5-year review. Outreach for this 5-year review consisted of a Federal Register Notice (87 FR 5834) 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. No new information as a part of the notice was provided to the Service.

### 1.3 FR Notice citation announcing the species is under active review:

87 FR 5834, "Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 35 Species in the Southwest," February 2, 2022.

## 2.0 REVIEW ANALYSIS

Section 4 of the Act (16 U.S.C. 1533) and its implementing regulations (50 CFR part 424) set forth the procedures for determining whether a species meets the definition of "endangered species" or "threatened species." The Act defines an "endangered species" as a species that is "in danger of extinction throughout all or a significant portion of its range," and a "threatened species" as a species that is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The Act requires that we determine whether a species meets the definition of "endangered species" or "threatened species" due to any of the five factors described below.

Section 4(a) of the Act describes five factors that may lead to endangered or threatened status for a species. These include: A) the present or threatened destruction, modification, or curtailment of its habitat or range; B) overutilization for commercial, recreational, scientific, or educational purposes; C) disease or predation; D) the inadequacy of existing regulatory mechanisms; or E) other natural or manmade factors affecting its continued existence.

The identification of any threat(s) does not necessarily mean that the species meets the statutory definition of an "endangered species" or a "threatened species." In assessing whether a species meets either definition, we must evaluate all identified threats by considering the expected response of the species, and the effects of the threats—in light of those actions and conditions that will ameliorate the threats—on an individual, population, and species level. We evaluate each threat and its expected effects on the species, then analyze the cumulative effect of all of the threats on the species as a whole. We also consider the cumulative effect of the threats in light of those actions and conditions that will have positive effects on the species—such as any existing regulatory mechanisms or conservation efforts. The Service recommends whether the species meets the definition of an "endangered species" or a "threatened species" only after conducting this cumulative analysis and describing the expected effect on the species now and in the foreseeable future.

## 2.1 Distinct Population Segment (DPS) policy (1996):

The DPS Policy does not apply to the Leopard darter.

## 2.2 Updated Information and Current Species Status

### 2.2.1 Biology and Habitat

An account of the biology and habitat of the leopard darter is found in the 2012 5-Year review (USFWS 2012). More recent and detailed accounts are provided in a September 17, 2020 biological opinion assessing the effects of a transportation project on the species (USFWS 2020) and the Service's June 22, 2023 Controlled Propagation, Translocation, Augmentation and Reintroduction Plan for the Threatened Leopard Darter *Percina Pantherina* (Service 2023). Information in those documents is included herein by reference with additional updated information on the species' current known distribution provided below.

Status and Distribution Update

The leopard darter is endemic to the Little River Basin in southeastern Oklahoma and southwestern Arkansas (Appendix A, Figure 1). The species currently occupies portions of the Little River upstream of Pine Creek Reservoir, Glover River upstream of the confluence with the Little River, the Mountain Fork River upstream of Broken Bow Reservoir and the Cossatot River upstream of Gillham Reservoir, albeit in relatively low numbers. Populations also have been found in some of the larger tributaries of these rivers and in limited reaches of the Little River downstream of Pine Creek Reservoir, when conditions are suitable. The population in the Robinson Fork of the Rolling Fork River in Arkansas is potentially extirpated; during annual snorkel surveys conducted since 1998, the leopard darter has not been observed in the Robinson Fork since 2005 (Appendix A, Figures 14 & 15; Table 3).

*Permanent Monitoring Site Results – Long Term Assessment*

Since 1998, the Oklahoma Ecological Services Field Office in cooperation with the Oklahoma Fish and Wildlife Conservation Office, Ouachita National Forest, and Oklahoma Department of Wildlife Conservation has established a monitoring team (team) to conduct annual monitoring of the species at 15 permanent sites encompassing each of the major Little River Basin tributaries (Appendix A, Figure 1). These surveys are primarily intended to monitor leopard darter populations and assess annual fluctuations in distribution and abundance of the species. Surveys are conducted entirely by underwater observation (snorkeling). At each site, swimming transects have been assigned to each snorkeler 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.

Annual team surveys indicate considerable inter-annual variation (Appendix A, Figures 2 through 16), ranging from 0 – 43.0 leopard darters observed per hour. Over the 25-year survey period (1998-2023) the average number of leopard darters observed per hour was highest in the Glover River, averaging 9.4 darters/hour with a range of 0 – 37.1 darters/hour, followed by the Little River (average of 7.5; range 0 – 36.5), and Mountain Fork (average of 6.4; range 0 – 22.0). Observations over the 25-year period in the Robison Fork and Cossatot Rivers were much lower than the other three tributaries, with a mean of 0.3 in the Robison Fork (range 0 – 3.9) and a mean of 1.5 darters/hour observed in the Cossatot River (range 0 – 17.5).

Temporal trends of our leopard darter counts, as provided in this review, were assessed with the nonparametric Mann-Kendall test (Kendall 1938 and Thompson *et al.* 1998) using MAKESENS software (Salmi *et al.* 2002). The coefficient of variation (CV) was calculated to further evaluate those analyses lacking 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 performed in Ellison *et al.* (2003) we provide CV calculations to allow the reader to make a judgment as to why a significant trend was not detected (Appendix A, Tables 1& 2).

Over the 25-year survey period, our results indicate leopard darters in the Little and Mountain Fork rivers (including Big Eagle Creek, a tributary of the Mountain Fork) remain stable, with no positive or negative trends detected at all eight permanent sites (Appendix A, Table 1). Leopard darters in the Glover River also remain stable, with no trends detected at three sites and a fourth site indicating a significantly positive trend, although surveys at this site began only 11 years ago (2013) as compared to a longer survey history at our other sites (Appendix A, Table 1). At our Robison Fork and Cossatot permanent sites, we observed significant negative trends at all three sites over the 25-year period (Appendix A, Table 1).

*Permanent Monitoring Site Results – Near Term (Current) Assessment*

More current trends were assessed by calculating similar statistics over the past 10 years (2014-2023) using our permanent site surveys (Appendix A, Table 2). Populations over the last 10 years appear to have remained stable in the Little and Glover rivers (eight sites with no trends detected), and stable to increasing at the Mountain Fork River sites with a significant positive trend at one site and no trend detected at three sites. Leopard darters have not been observed in the Robison Fork or Cossatot River in at least 10 years.

*Combined Results from Permanent and Rotational Sites*

A total of 341 surveys have been conducted by the Service and its partners at the 15 permanent monitoring sites since 1998. Most years the team, along with other less experienced surveyors, conducts surveys at additional 'rotational' sites. Rotational sites are those which the team intends to survey every 3-5 years. Between 1998 and 2023, the team conducted a total of 501 rotational surveys. At these rotational sites, leopard darters are counted but effort is not always timed due to larger team logistics and complexities in assisting newer surveyors that may not be familiar with the species. Therefore, the primary purpose of surveying rotational sites is to assess presence or absence of leopard darters at each site. At any site where a relatively new surveyor observed a leopard darter, that observation was confirmed by someone experienced with identifying the species.

For our presence/absence analysis in this review, we included both rotational and permanent monitoring sites, with results grouped by major tributary, by year (Appendix A, Table 3). Between 1998-2023 leopard darters were observed at an average of 80 percent of Glover River sites, followed by 79 percent of the Little River and 70 percent of the Mountain Fork River sites. Within these three tributaries, the percentage of sites where leopard darters were present in a given year ranged from 47 to 100 percent. This contrasts with results from the Robinson Fork and Cossatot Rivers, where only 35 percent (range 0 – 100 percent) of sites had leopard darters present in the Cossatot River and only 12 percent (range 0 – 50 percent) in the Robison Fork. It should be noted that in some years, sites selected for rotational surveys were not necessarily optimal habitat for the leopard darter, so caution should be taken when interpreting results. Additionally, there were many years where the team surveyed only a limited number of sites, possibly resulting in arbitrarily high or low presence/absence ratio. Again, interpreting these results should be taken with caution and are provided here for informational purposes.

*Additional Discussion on the Robinson Fork and Cossatot River*

In addition to annual monitoring surveys conducted by the team, there have been other targeted, and in some cases, more intensive surveys, including efforts in Arkansas by the Arkansas Game and Fish Commission (AGFC). The leopard darter has remained undetected in the Cossatot River since 2018, when three individuals were observed at one locale near the Cossatot River State Park (AGFC 2019). Known surveys targeting the leopard darter have been relatively limited since that time, with a total of four surveys conducted as part of the team's annual surveys (Appendix A, Figure 16). Fluker and Lee (2018) conducted traditional (seining) and environmental DNA (eDNA) surveys from 2016-2017 at eight sites in the Cossatot River and four sites in the Robinson Fork. They failed to detect leopard darters in their traditional surveys. The researchers did detect leopard darter eDNA at three sites below Gillham Reservoir, however potential contamination issues and their inability to replicate results, led the researchers to doubt the validity of their results.

The species has not been observed in the Robinson Fork since 2005, with a total of 46 surveys conducted by the team since that time (Appendix A, Figures 14 & 15, Table 3). Prior to these lapses, these populations were less predictably detected than those at most other team sites, but they had not gone undetected in consecutive years. Additionally, the Arkansas Game and Fish Commission failed to detect the leopard darter during an extensive 2019 survey effort of 16 sites throughout the Robinson Fork with a total of nearly 40 survey hours (AGFC 2020). Fluker and Lee (2018) did not detect leopard darters in their traditional and eDNA surveys, although due to issues mentioned above, the eDNA results should be used with caution.

The lapse in detecting the Robinson Fork and Cossatot River leopard darters involved focused efforts by experienced team observers at specific sites where the species was last observed. Prior to the present runs of 17 years of non-detection in the Robinson Fork as part of the team's efforts, the population went undetected in 38 percent (3) of 8 years (1998-2005). If this represents the chance of missing the population when it is present, then the probability of a 17-year run of non-detection is significant ($P = 0.38^{17} = < 0.0001$). The annual team repeatable monitoring of the Robinson Fork occurs at two locations. Thus, failure to detect the species in this system represents 34 attempts in the past 17 years (2005-2019, 2021-2023). The team's rotational surveys throughout the Little River drainage, included a total of 22 surveys across 9 additional sites in Robinson Creek between years 1994-2022. Leopard darters were not detected at any of those surveys, with the exception of one individual observed in 1999.

The annual team assessment in the Cossatot River is conducted at a location where the species was found during an intensive 1994-1995 survey focused on leopard darters (Robison 1996). This is the same segment where Zale *et al.* (1994) found the species to be most abundant in their 1986-1987 survey [17 individuals (Robison 1996) vs. 6 individuals and 1 individual (Zale *et al.* 1994) at two sites within the segment]. Leopard darters have not been observed as a part of the team's repeatable survey since 2010 (Appendix A, Figure 16). Prior to the present run of 13 consecutive years of non-detection (2010-2019, 2021-2023), the population went undetected in 15 percent (2) of 13 years (1998 - 2009). Using the above logic, the probability of a 12-year run of non-detection is again significant ($P = 0.15^{13} = <0.0001$). It should be noted that the more intense surveys in 2017 and 2018 (as mentioned above) yielded at least six leopard darters in years 2017 and 2018 (one leopard darter near the permanent survey site with the other five observed at sites further downstream), highlighting the importance of using caution before considering a population extirpated.

### 2.2.2 Threats Analysis (threats, conservation measures, and regulatory mechanisms):

A detailed review of the species' threats can be found in the 2012 5-year status review (USFWS 2012). The status of a species is determined from an assessment of factors specified in section 4 (a)(1) of the Act, including:

Factor A (the present or threatened destruction, modification, or curtailment of its habitat or range).
Factor B (overutilization for commercial, recreational, scientific, or educational purposes).
Factor C (disease or predation).
Factor D (the inadequacy of existing regulatory mechanisms).
Factor E (other natural or manmade factors affecting its continued existence).

A summary of the 2012 threat assessment is provided below.

Habitat loss and degradation is the principal factor affecting survival of the leopard darter (Factor A). 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.

Water quality deterioration due to agricultural and industrial activities was identified as a major threat to the survival of the leopard darter (Jones 1984) (Factor A). 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, disposal of these wastes is lightly regulated and an appropriate application rate for southeastern Oklahoma has not been established.

Logging and road development also has affected water quality and habitat throughout the leopard darter's range (Factor A). The effect of road construction, while not exclusively associated with timber extraction, is a related activity that can significantly influence fish populations through increased sedimentation and impacts to fish passage at road crossings. Gravel mining also may be affecting water quality and habitat, although we have not observed significant new actions since the 2012 review.

Water demands and proposed water sales could be detrimental to leopard darter populations (Factor A). 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.

There is no evidence to suggest overutilization is a current threat to the leopard darter (Factor B).

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) (Factor C). 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 (Factor C). No specific information on predation exists, although a number of potential predators occur throughout the leopard darters range (Factor C). 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.

Regulatory mechanisms for water quality criteria are in place, including the Clean Water Act (CWA) and state designations including High Quality Waters and Outstanding Resource Waters, however their effectiveness at improving and maintaining water quality are uncertain and warrant additional evaluation (Factor D).

The timing and magnitude of the effects from climate change on watersheds occupied by the leopard darter is largely unknown (Factor E). 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 in 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.

Information that has been updated since the 2012 5-year review is provided below.

*Conservation Genetics (Factors A and E)*

The leopard darter is particularly susceptible to genetic losses and local extirpation via stochastic environmental fluctuation. The species has a short breeding season (mid-March to mid-May), requires riffle habitat (therefore flowing water) for spawning (James *et al.* 1991; Toepfer 1997), and does not occur in reservoirs, which otherwise could serve as refuges during harsh conditions (e.g., droughts). Further, the short lifespan (18 months) makes the size of the breeding population strongly dependent on recruitment in the immediately preceding year (James *et al.* 1991).

Reservoir construction and habitat degradation have fragmented the range of the leopard darter. Populations are now isolated to four major tributaries of the Little River in southeastern Oklahoma (OK) and southwestern Arkansas (AR) (Appendix A, Figure 1). A 2012 genetic study revealed remarkably small effective population sizes ($N_e$) in these populations (Schwemm 2013). In particular, an $N_e$ of five was determined for the Cossatot River in AR, suggesting that this population may be nearing extirpation. Populations in the Cossatot and Robison Fork were considered "vulnerable to catastrophic extirpation" because of their restricted distributions (Zale *et al.* 1994). Artificial gene flow among these populations was suggested in Schwemm (2013) as a means of compensating for low $N_e$.

Development of a Controlled Propagation, Translocation, Augmentation, and Reintroduction (PTAR) Plan began in 2016, focusing on translocation of adult fish among tributaries. Based on potential effects to source populations, the Service paused plan development to explore other alternatives, such as translocation of larval darters. After three marginally successful field seasons, focus shifted to re-assessing controlled propagation as a means of supporting augmentation. Two facilities, the Service's Tishomingo, OK NFH and Conservation Fisheries, Inc. (a private non-profit located in Tennessee) are attempting to spawn the leopard darter, with limited success. Additional refinement to propagation techniques may soon produce enough leopard darters for reintroduction or augmentation in the wild. As such, the Service in partnership with the Arkansas Game and Fish Commission and Oklahoma Department of Wildlife Conservation completed development of the PTAR for the leopard darter on June 22, 2023 (USFWS 2023).

*Climate Change (Factors A and E)*

Ongoing climate change is another factor potentially affecting aquatic organisms, including fish. Because the leopard darter generally spawns only once in its lifetime, fluctuations in population numbers from year to year can vary significantly (Appendix A, Figures 2-16). Given this sensitivity, climatological conditions such as precipitation and temperature could have significant effects on population numbers of leopard darter. If drought-like conditions occur over multiple years to the extent that suitable spawning temperatures become limited, leopard darter populations could be at risk for decline.

Kloesel *et al*. (2018) asserted that, in the Southern Great Plains, both aquatic and terrestrial ecosystems are being affected directly and indirectly by climate change. The broad effects of climate change have been well-documented, and such effects are expected to occur across the entire United States (Portmann *et al.* 2009). Altered precipitation patterns are predicted to occur in some areas, with heavy rainfall increasing in duration and intensity. As climate changes, increased precipitation events are expected to produce more frequent high flows in rivers and streams, flows of greater magnitude, and flooding (Solomon *et al*. 2007, U.S. Global Change Research Program 2017). Assuming the timing of these flows is not significantly modified, spawning by stream fishes may be enhanced or at least not adversely impacted. But in some instances, higher flows may transport small fish over longer distances or cause them to be deposited into unsuitable habitats, such as in the headwaters of downstream reservoirs, where they have reduced possibility of returning upstream. Conversely, the ranges of some species may expand in streams with extensive free-flowing reaches.

More likely to be critical for leopard darters are declining stream flows and drought. Heat waves and chronic, long-duration hydrological drought are increasing in frequency and duration (U.S. Global Change Research Program 2017). Annual average temperatures and drought have been increasing since the early 20th century and these trends are expected to continue throughout the 21st century (Kloesel *et al*. 2018), adversely impacting both terrestrial and aquatic ecosystems and biodiversity (Kaushal *et al*. 2010). Warmer air temperatures during drought may lead to increased evapotranspiration and drier soils (Dong *et al.* 2011, Flanagan *et al*. 2017, Herceg *et al.* 2019), which vegetation in the riparian zone may help to regulate (Wondzell *et al.* 2019). Solar radiation during the growing season, combined with the higher aridity associated with decreased precipitation may contribute to further soil desiccation (Dong *et al*. 2011, Flanagan *et al.* 2017). Reduced soil moisture may be particularly problematic in riparian zones where elevated soil moisture exerts a substantial influence over the composition, structure and health of vegetative communities. Riparian areas contribute to bank stability and help to reduce erosion and sedimentation in streams (Oklahoma Cooperative Extension Service 1998). Shade provided by overhanging vegetation helps moderate stream temperatures and reduces algal production (Oklahoma Cooperative Extension Service 1998). Riparian areas also function to provide dissolved carbon compounds and particulate organic matter to streams (Welsch 1991). When droughts alter soil moisture and contribute to reduced stream flows, degradation of the riparian zone may occur. Degradation will ultimately impact the ability of riparian zones to maintain current stream conditions over time and in some instances, altered conditions may even favor establishment of non-native, drought tolerant species (Garssen *et al*. 2014). As water temperatures rise in response to reduced vegetative vigor in riparian zones, water quality will be directly affected (Spooner *et al.* 2005, Strayer 2008). Higher water temperatures often lead to lower dissolved oxygen and may reduce the amount of suitable habitat for fish and other aquatic organisms (Dahlke *et al.* 2020, Spooner *et al.* 2005, Strayer 2008). Although not addressing loss of stream connectivity, restoring disturbed riparian vegetation may help to minimize the effects of increasing air temperatures on water temperature (Wondzell *et al.* 2019).

Water temperature exerts a considerable influence over community structure and temporal succession in most aquatic organisms (Burton and Likens 1973). Fish species vary in sensitivity and tolerance to temperature fluctuation, but generally can survive only within a limited thermal range (Dahlke *et al.* 2020). Adult leopard darters are more tolerant to warmer water temperatures than at other points in their life history, but for this annual species, seasonal cues such as increasing water temperature may affect its ability to persist. Thermal tolerance varies from one stage of life history to another for most fishes, and affects the timing of life cycle events

(Dahlke *et al*. 2020). Like other fishes in the Percidae family which have a limited tolerance of water temperatures range (Dahlke *et al*. 2020), leopard darters migrate between 50°F (10°C) to 53°F (12°C) (James 1988, James and Maughan 1989), spawn at 53°F (12°C) to 63°F (17°C) (James 1988), and eggs hatch at 68°F (20°C) (James 1989). Connectivity between occupied habitats likely remained more prevalent in previous decades than current conditions, allowing populations to recover. During periods of drought when water temperatures rise above 86°F (30°C), leopard darters move into deeper and more isolated water for thermal refuge (Service 2012) likely resulting in reduced connectivity between individuals or local groupings. Southeastern Oklahoma experienced severe drought conditions in both 2006 (McLeman *et al*. 2008) and the summer of 2011, with low discharge and reduced water depths in the Little River (Atkinson *et al.* 2014; Irmscher and Vaughn 2015, Capps *et al.*2015) and Kiamichi River (Galbraith *et al.* 2010) in Oklahoma.

The response of both terrestrial and aquatic species to climate change is complex, variable and is often difficult to predict with certainty. However, several responses, many of them negative, are likely. Certain species may be able to adapt to extreme droughts, floods of unprecedented magnitude or frequency, and severe temperatures brought about by climate change, while other species cannot, resulting in impacts to terrestrial and aquatic ecosystems (Kloesel *et al*. 2018, Falk *et al.* 2019). As flows decline in drought conditions, aquatic habitats used by fish are altered, reduced, and could eventually cease to exist. Freshwater ecosystems which are already stressed by a variety of anthropogenic factors may be particularly sensitive to the effects of climate change (Burton and Likens 1973, Webb and Walling 1988, Wright *et al.* 1999, Kaushal *et al.* 2008), as these co-occurring stressors to fish populations and their habitats act synergistically (Mantyka-Pringle *et al*. 2014). For example, groundwater pumping, reservoir withdrawals, and excessive appropriation may contribute to rates of extraction that exceed recharge rates or stored reserves, which may then be confounded by drought, resulting in prolonged low flow conditions (Mashburn *et al.* 2019).

A more thorough analysis is needed of the correlation between climatological conditions and leopard darter reproduction and survival, including seasonal effects, and the impact of indirect effects related to climatological changes. Such analysis will assist with future recovery planning and conservation efforts.

### 2.3 Synthesis:

In 1978, the leopard darter was federally listed under the Act 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, although the Cossatot River population continues to be in decline. The species has disappeared in the Cossatot downstream of Gillham Reservoir, as predicted in the 1978 listing. Monitoring results from 1998 to 2023 indicate populations in the Little, Glover and

Mountain Fork are stable. The species may now be extirpated from the smaller Robison Fork Creek, however continued ongoing surveys within that drainage are needed.

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, or for direct withdrawals to occur from existing rivers. One reservoir, Lukfata Reservoir, was authorized for construction, but was never funded and in 2002 the reservoir was deauthorized by congress.

Genetics of the leopard darter has likely been altered as a result of reservoir construction. This is most apparent in the Cossatot River, where the effective population size low and targeted surveys have yielded a limited number of observations in the past 10 years. The Cossatot River population likely requires augmentation in the near future to sustain the population.

Impacts to water quality from agriculture, industry, gravel mining, and road construction continue to act as a stressor on the species. Poultry operations continue to operate within the watershed, as well as timber extraction and gravel mining. Roads and related sediment run-off and low water crossings that affect the darter's ability to move upstream are potentially significant threats to the leopard darter. More recently identified threats such as climate change and increased water demands further exacerbate potential impacts to the species.

Recovery actions such as the implementation of the Controlled Propagation, Translocation, Augmentation, and Reintroduction Plan for the Leopard Darter and road and crossing improvements and could yield significant conservation for the species.

After reviewing the best available scientific information, we conclude that the leopard darter remains a threatened species. The evaluation of threats affecting the species under the factors in 4(a)(1) of the Act and analysis of the status of the species in our 2012 5-year review (USFWS 2012) remains an accurate reflection of the species' status as threatened.

## 3.0 RESULTS

### 3.1 Recommended Classification:

No change is needed; remain Threatened.

### 3.2 New Recovery Priority Number:

No change recommended.

### 3.3 Listing and Reclassification Priority Number:

Not applicable.

## 4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

We will work with our partners to implement the following recommended actions during the next five-year review period:

- Continue to support propagation efforts so that the PTAR plan to reintroduce or augment populations can be implemented.
    - Augment the Cossatot River population based in guidance in the Controlled PTAR for the Leopard Darter. This could be from hatchery propagated fish or through direct translocation of juveniles or adults from one tributary to the Cossatot River.
- Research and identify leopard darter sub-populations within each major tributary to allow partners to better implement the Controlled PTAR plan. See the PTAR plan for additional discussion on what information is needed.
- Continue to assess the possibly of capturing larval leopard darters to be used for augmentation or reintroductions. If successful, this approach could yield significant numbers to augment or reintroduce, including potentially high genetic diversity, while having minimal impact to the source population (as compared to removing adults for propagation work or direct translocation).
- Continue to identify priority fish passage projects and seek out partnerships and funding to improve crossings.
- Conduct additional research on the effects of run-off and increased sedimentation in the Little River Watershed.
- Conduct a thorough analysis of the team’s long term monitoring data set to identify drivers of occupancy and abundance of darters in the Little River watershed.
- Conduct research on leopard darter movement to better to aid in decision making when determining fish passage projects.
- Conduct a more thorough assessment of existing regulatory mechanisms in the Little River basin and if they are providing adequate protections for the leopard darter.

## 5.0 REFERENCES

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U.S. FISH AND WILDLIFE SERVICE

**5-YEAR REVIEW of the Leopard Darter (*Percina Pantherina*)**

**Current Classification**: Threatened

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

No change needed.

**Appropriate Listing/Reclassification Priority Number, if applicable**: Not applicable.

**FIELD OFFICE APPROVAL**:

**Field Supervisor, Fish and Wildlife Service, Oklahoma Ecological Services Office**

Approve KENNETH COLLINS Digitally signed by KENNETH COLLINS Date: 2023.08.30 15:14:45 -05'00' ________________________________________

**Appendix A – Leopard Darter 5-Year Review**

August 30, 2023

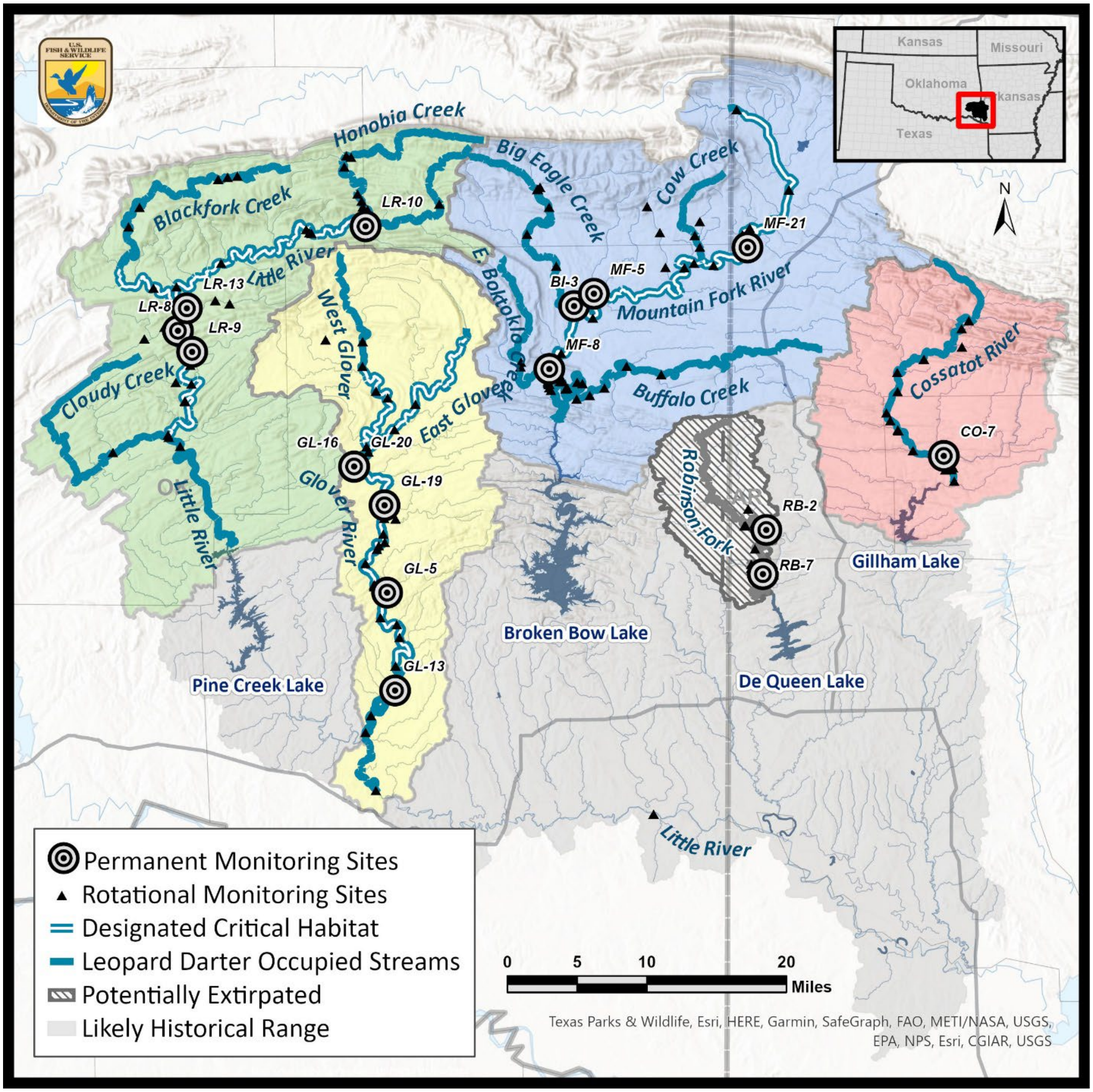


Figure 1. Historical, likely extirpated, and current known distribution of the leopard darter, designated critical habitat, and Service monitoring sites from 1998-2023.

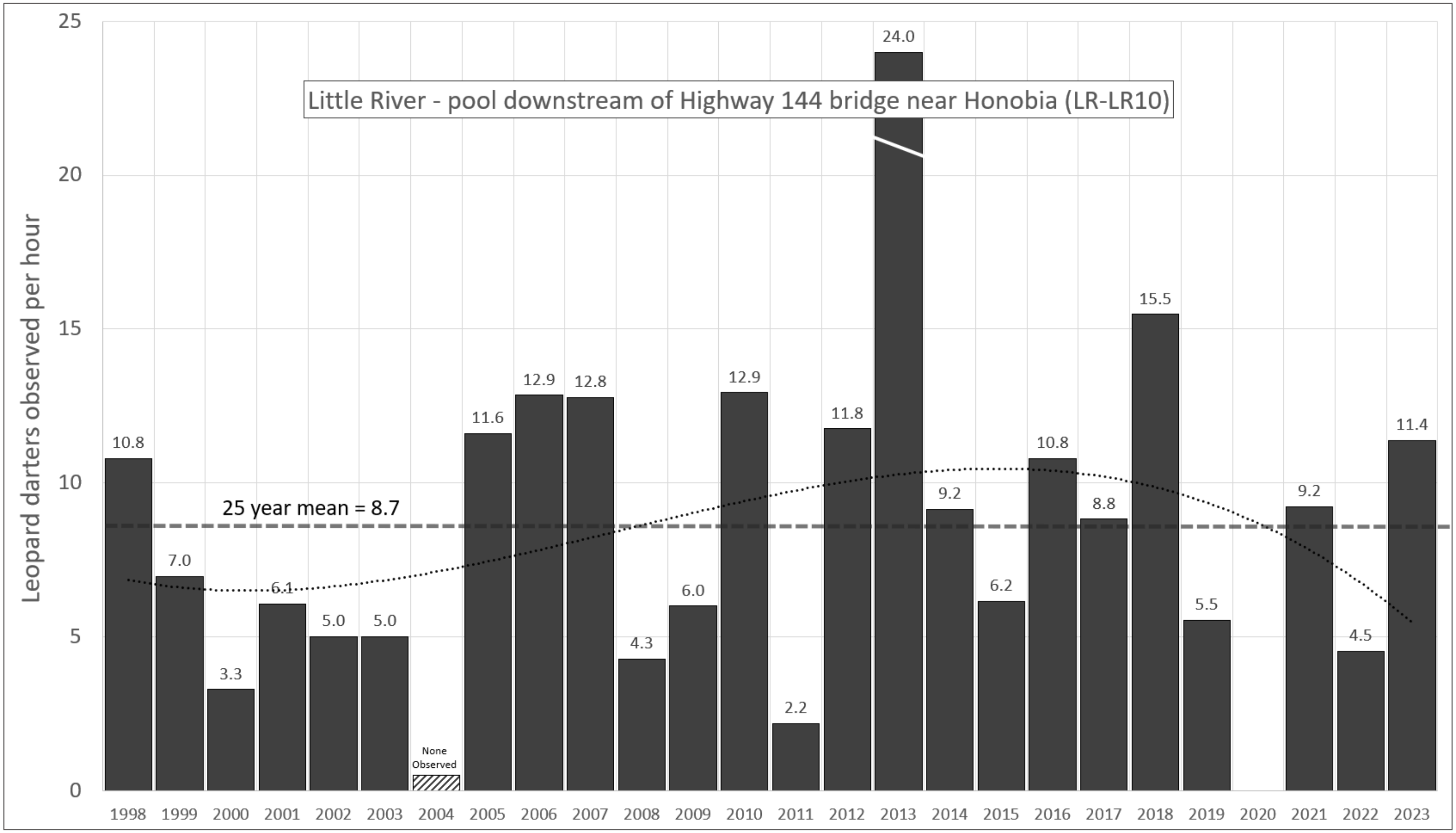


Figure 2. U.S. Fish and Wildlife Service permanent leopard darter site monitoring results (1998-2023). Permanent site description: pool downstream of State Highway 144 bridge near Honobia, OK (LR-10; 34.5311, -94.9356).

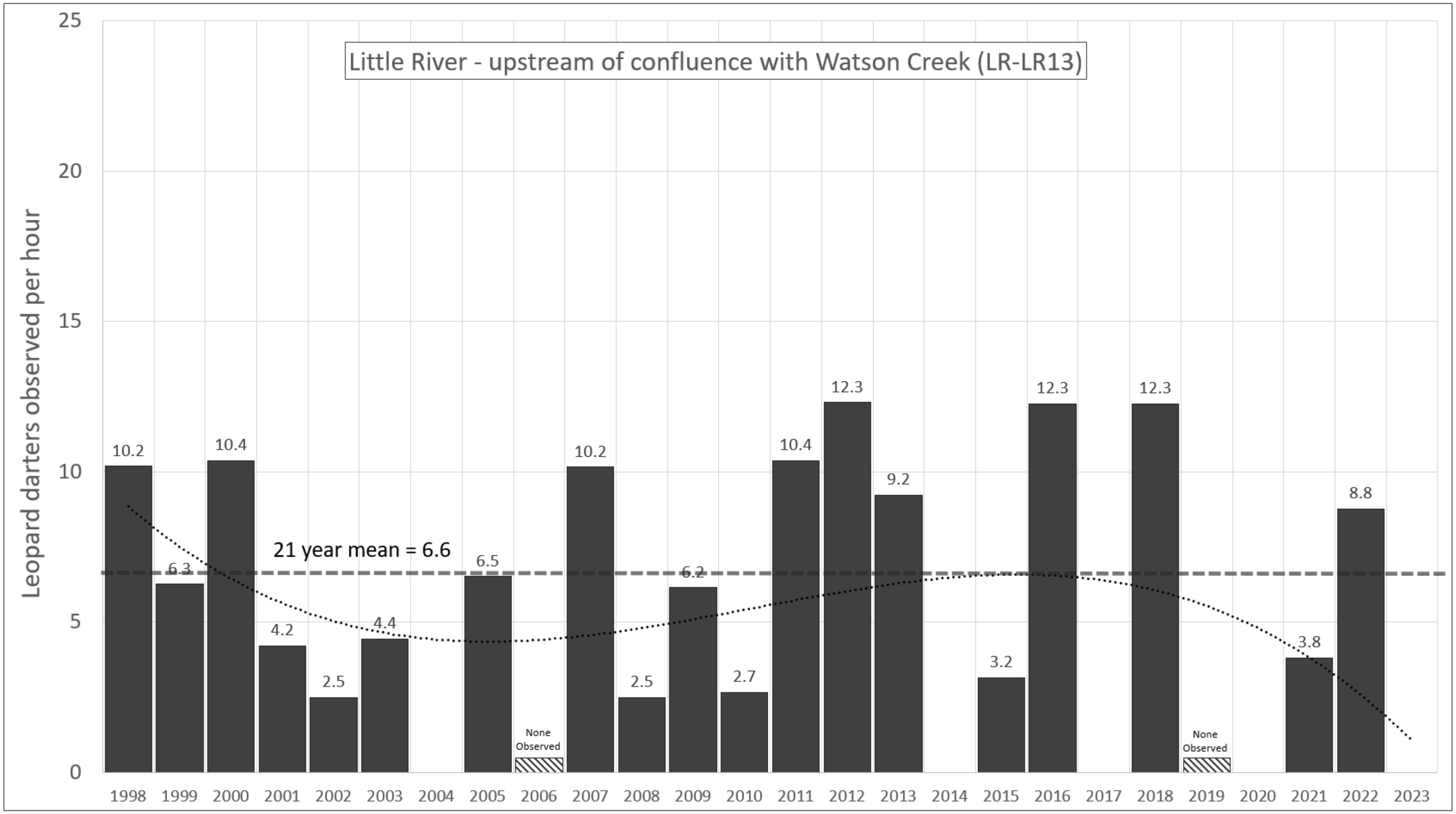


Figure 3. U.S. Fish and Wildlife Service permanent leopard darter site monitoring results (1998-2023). Permanent site description: Little River pool upstream of confluence with Watson Creek (LR-13; 34.4519, -95.1728).

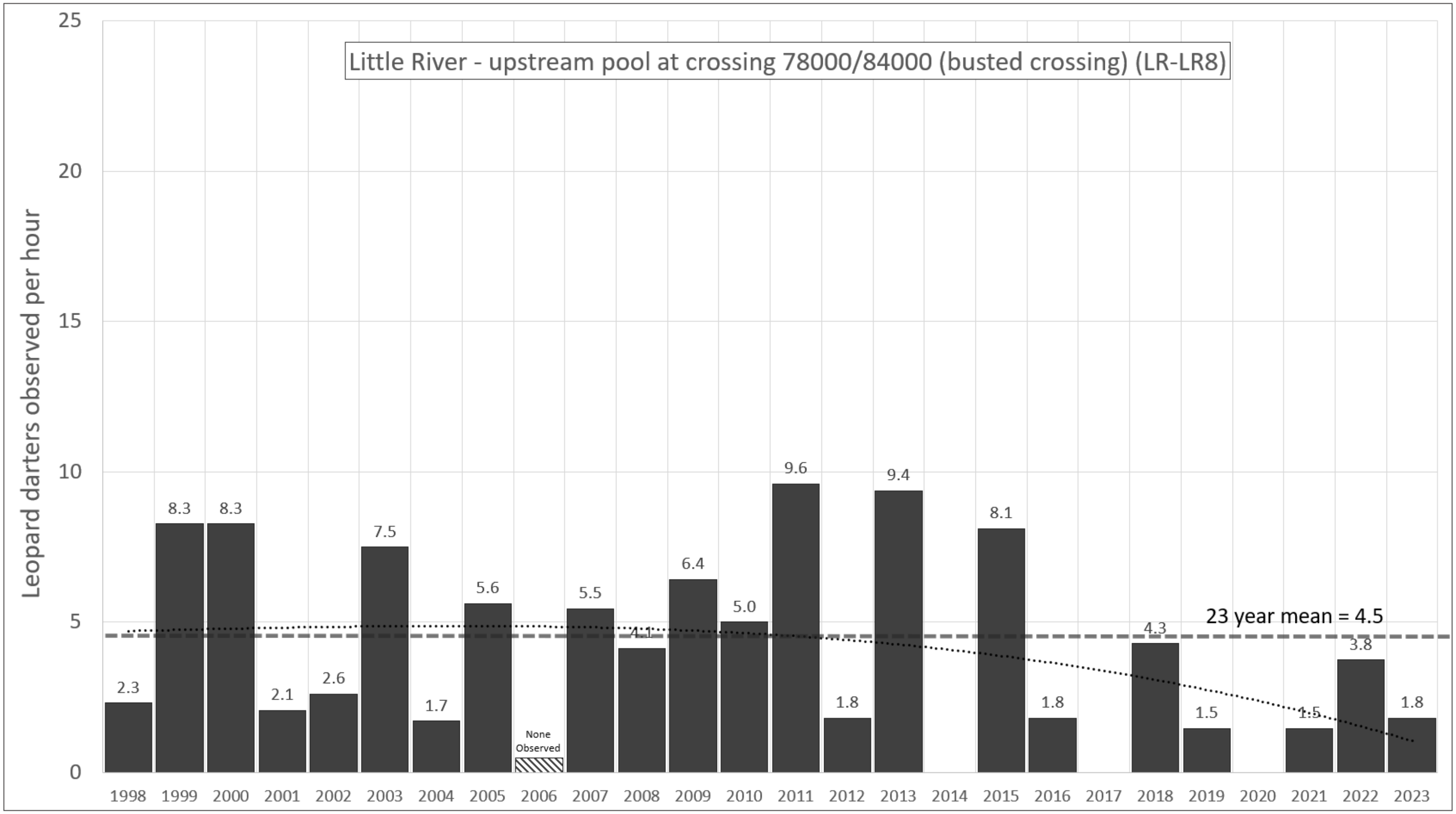


Figure 4. U.S. Fish and Wildlife Service permanent leopard darter site monitoring results (1998-2023). Permanent site description: Little River pool upstream of crossing 78000/84000 'busted crossing' (LR-8; 34.4297, -95.185).

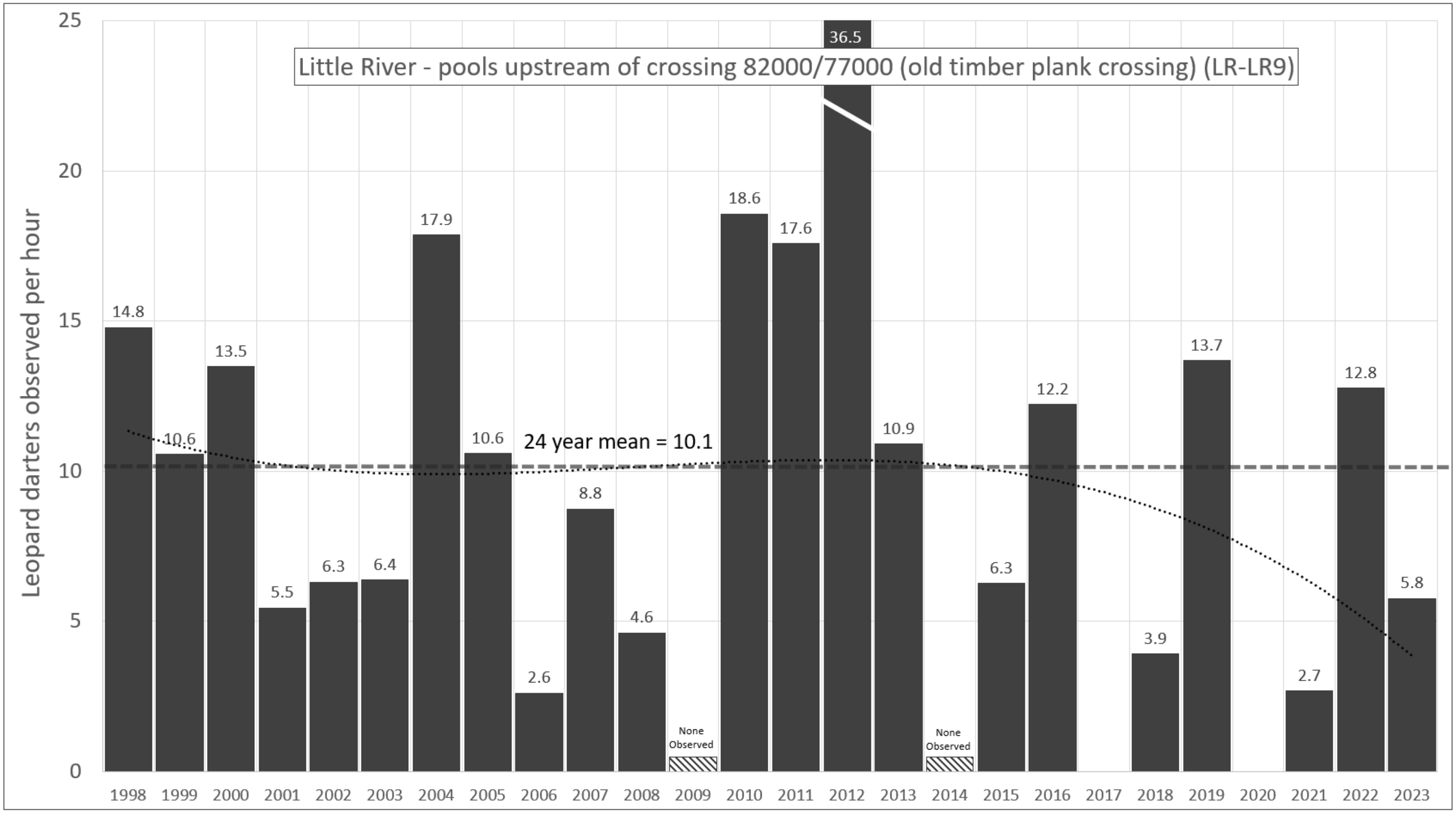

Figure 5. U.S. Fish and Wildlife Service permanent leopard darter site monitoring results (1998-2023). Permanent site description: Little River pools upstream of 82000/77000 'old timber plan crossing' (LR-9; 34.4089, -95.1664).

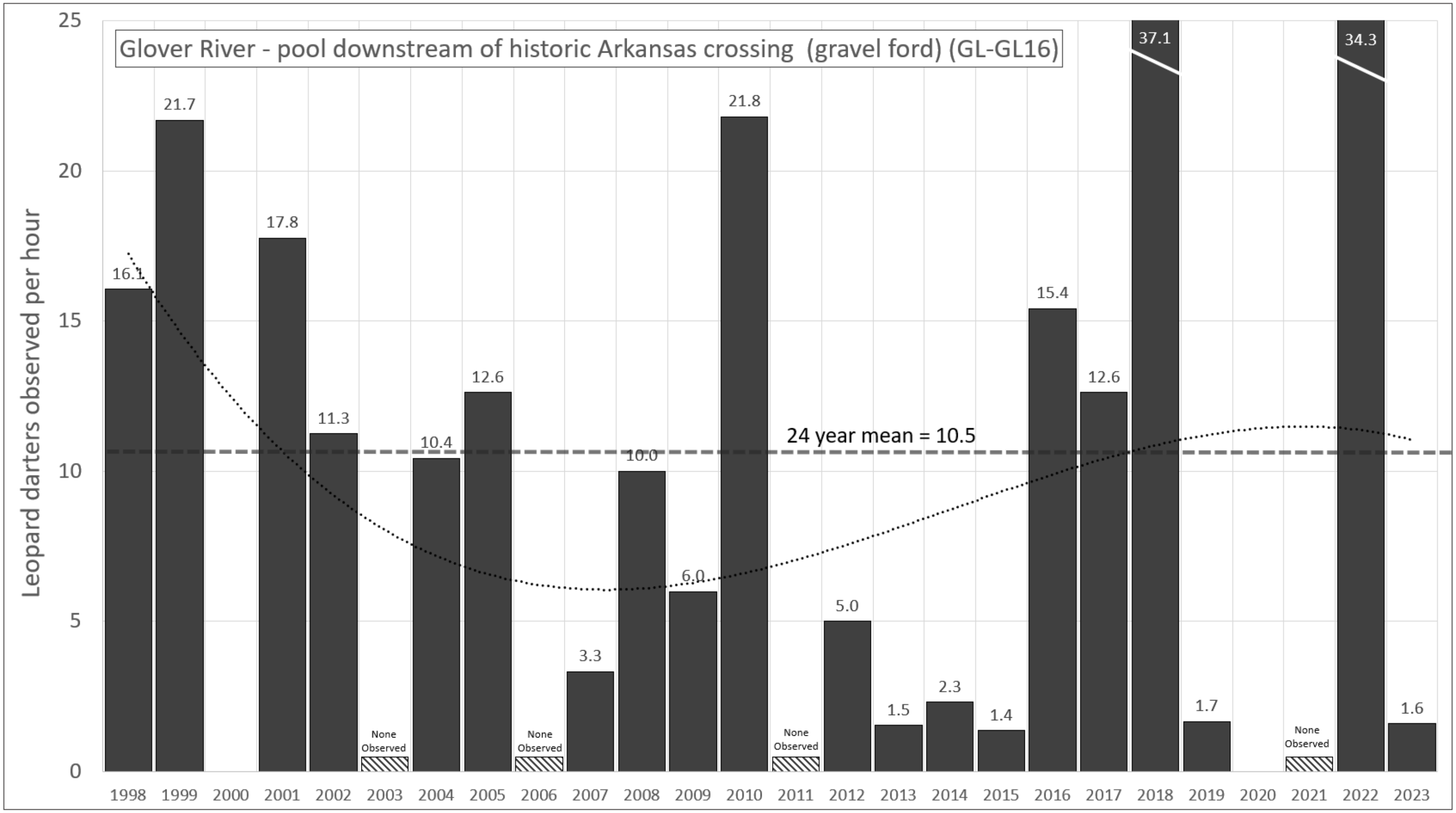


Figure 6. U.S. Fish and Wildlife Service permanent leopard darter site monitoring results (1998-2023). Permanent site description: Glover River pool downstream of historic Arkansas crossing 'gravel ford' (GL-16; 34.2939, -94.9542).

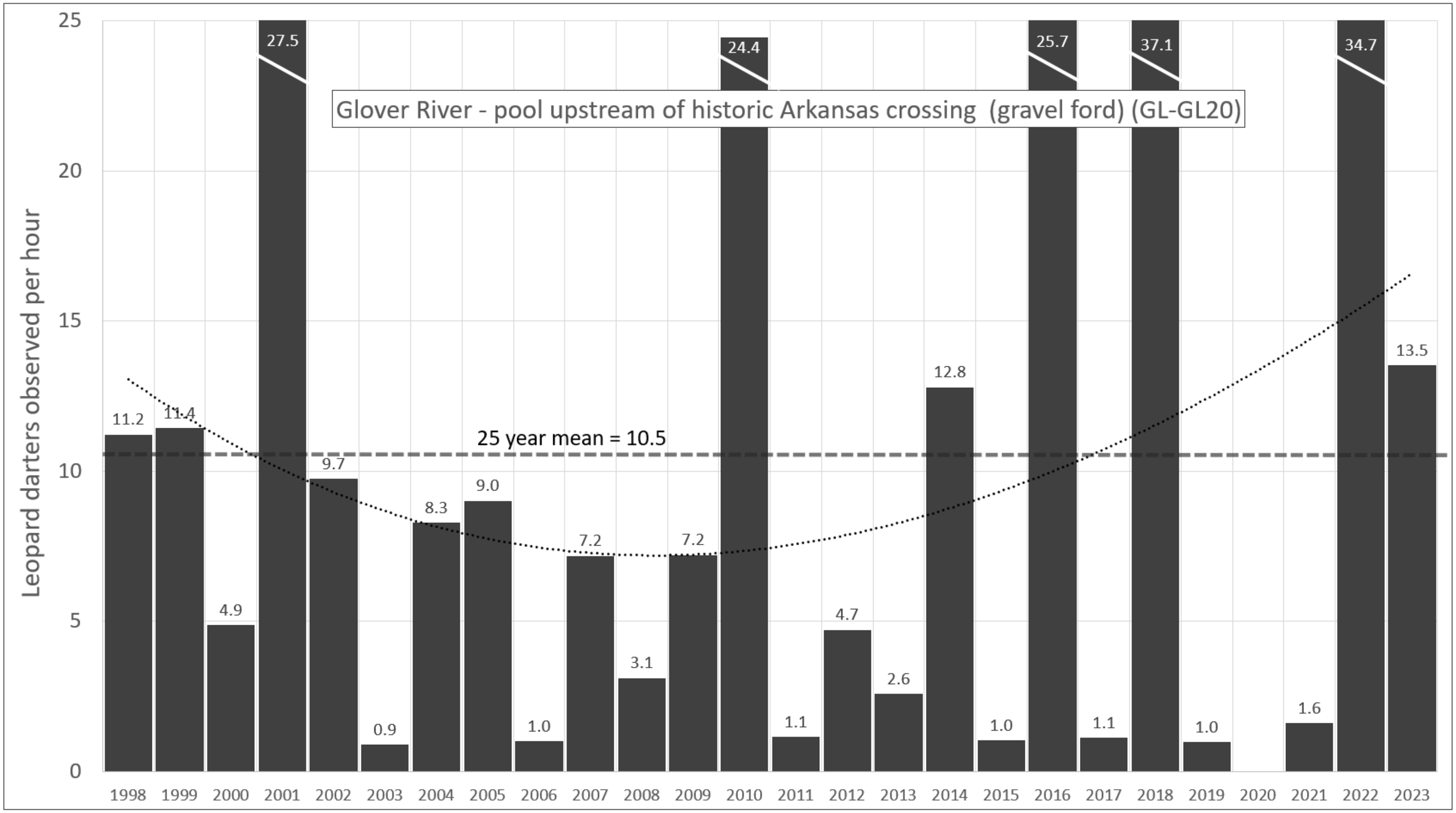


Figure 7. U.S. Fish and Wildlife Service permanent leopard darter site monitoring results (1998-2023). Permanent site description: Glover River pool upstream of historic Arkansas crossing 'gravel ford' (GL-20; 34.2942, -94.9542).

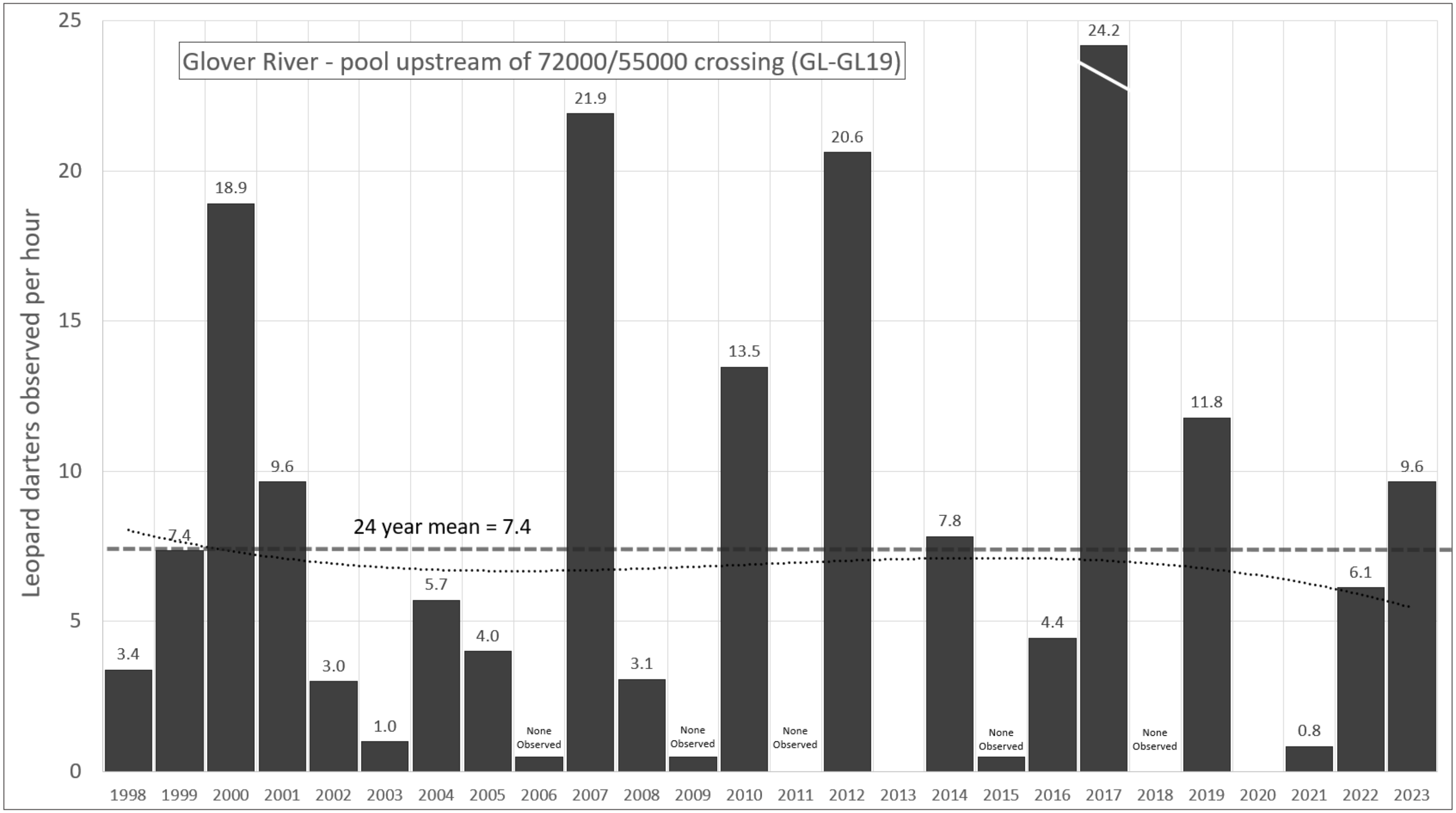

Figure 8. U.S. Fish and Wildlife Service permanent leopard darter site monitoring results (1998-2023). Permanent site description: Glover River pool upstream of 72000/55000 crossing (GL-19; 34.2556, -94.9147).

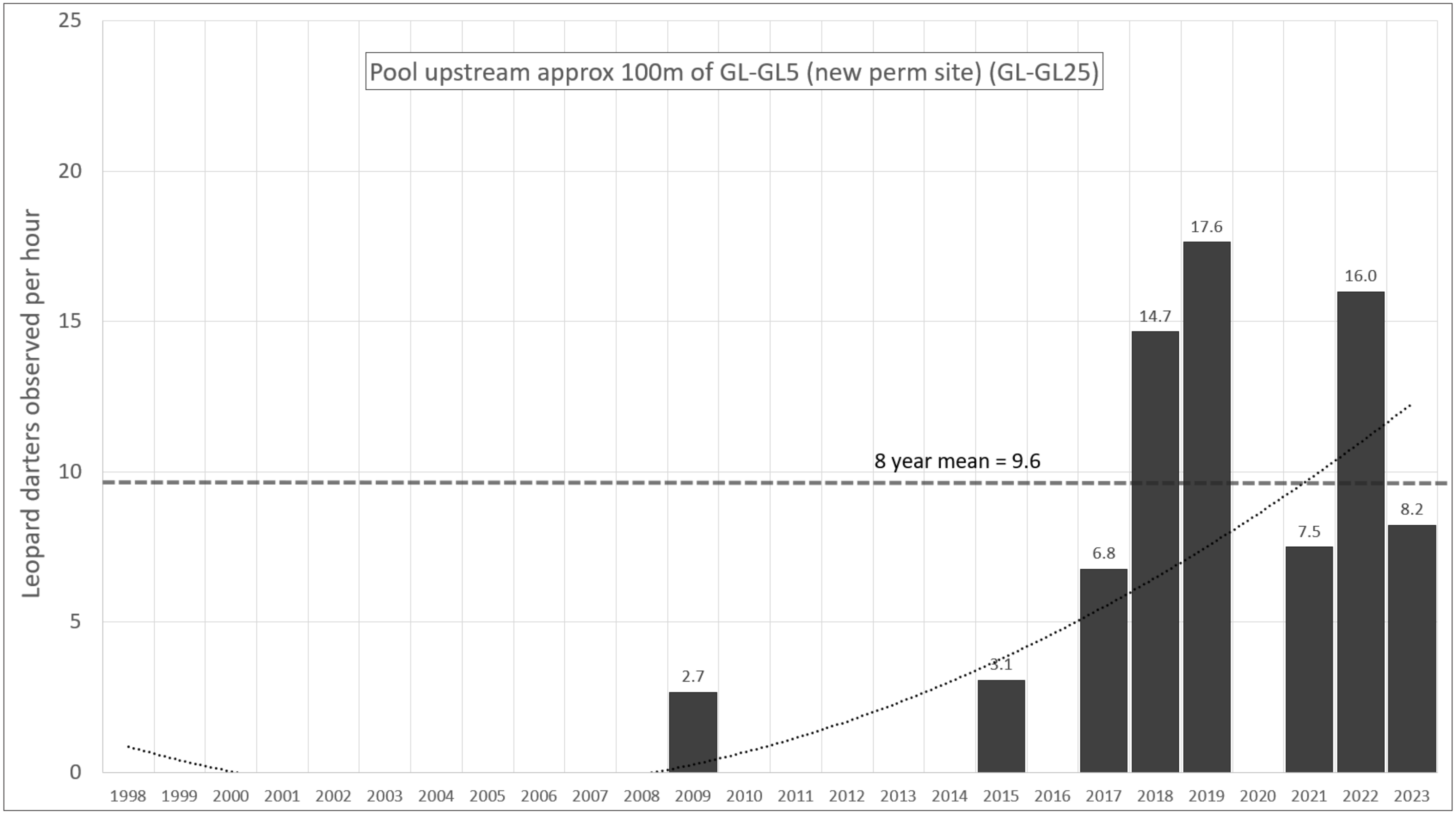


Figure 9. U.S. Fish and Wildlife Service permanent leopard darter site monitoring results (1998-2023). Permanent site description: Glover River pool approximately 100 meters upstream of 53000 crossing (GL-25; 34.1705, -94.9145).

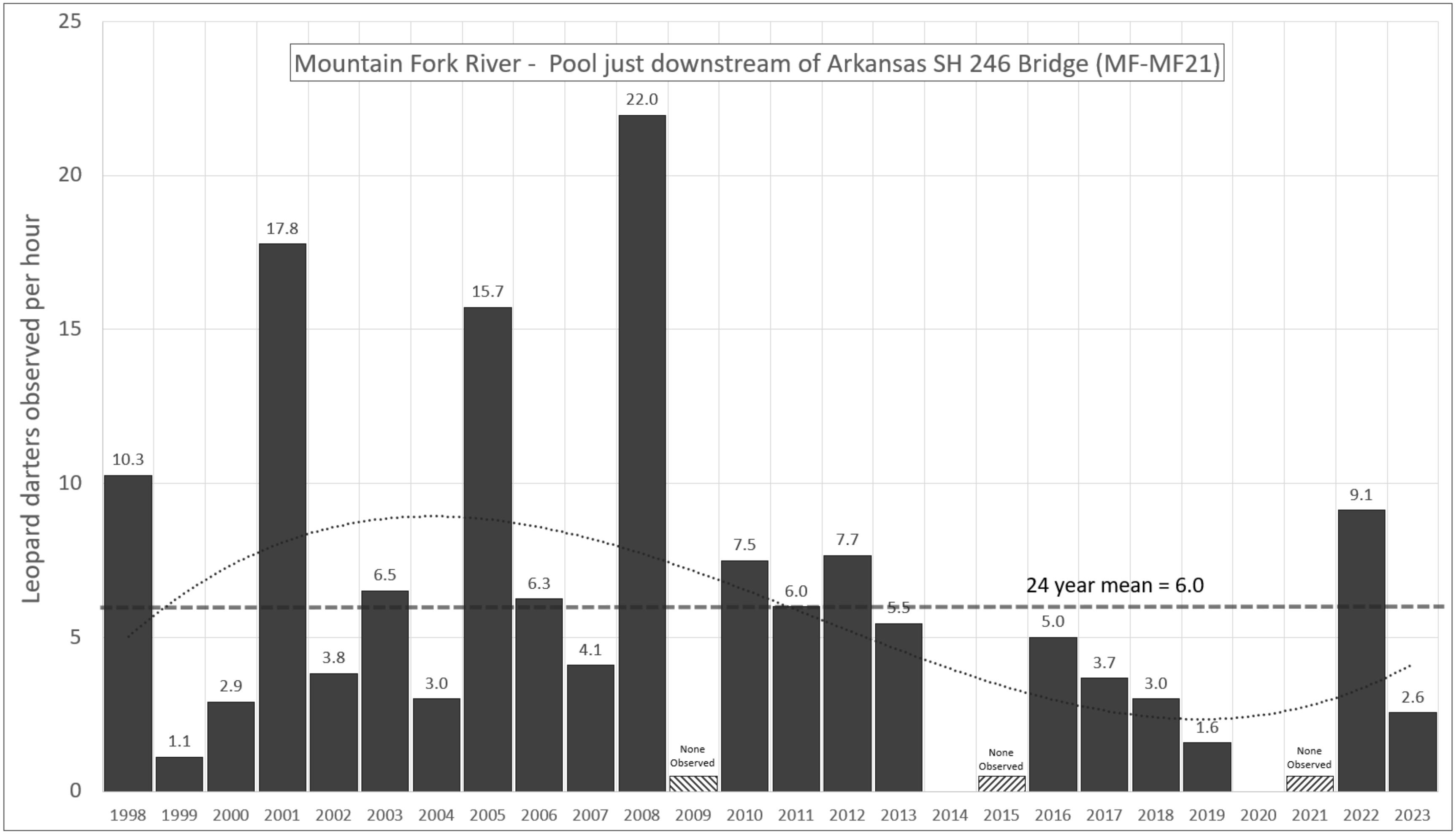

Figure 10. U.S. Fish and Wildlife Service permanent leopard darter site monitoring results (1998-2023). Permanent site description: Mountain Fork River pool just downstream of Arkansas State Highway 246 bridge (MF-21; 34.505, -94.4306).

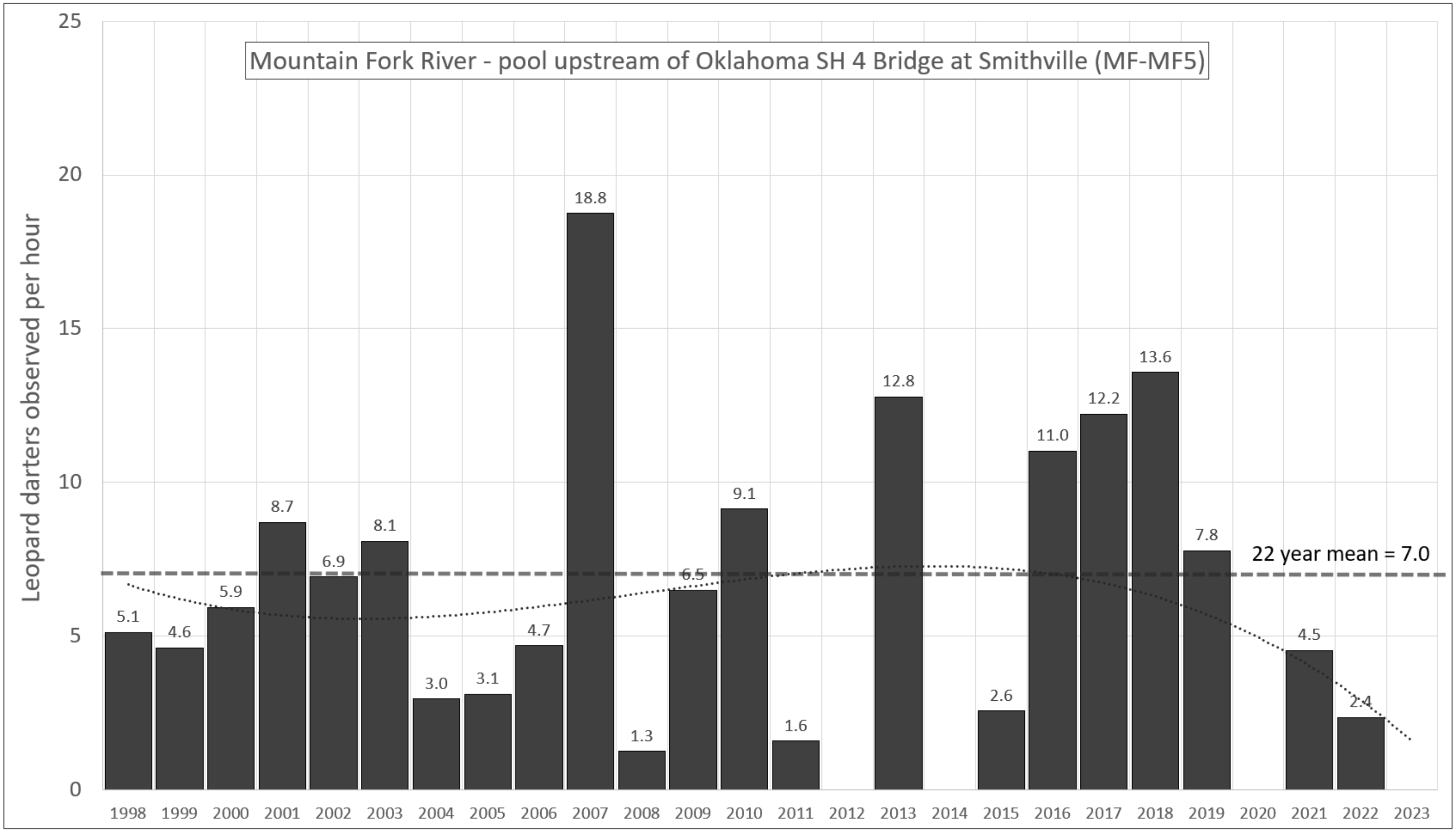


Figure 11. U.S. Fish and Wildlife Service permanent leopard darter site monitoring results (1998-2023). Permanent site description: Mountain Fork River pool upstream of Oklahoma State Highway 4 bridge at Smithville (MF-5; 34.4617, -94.6344).

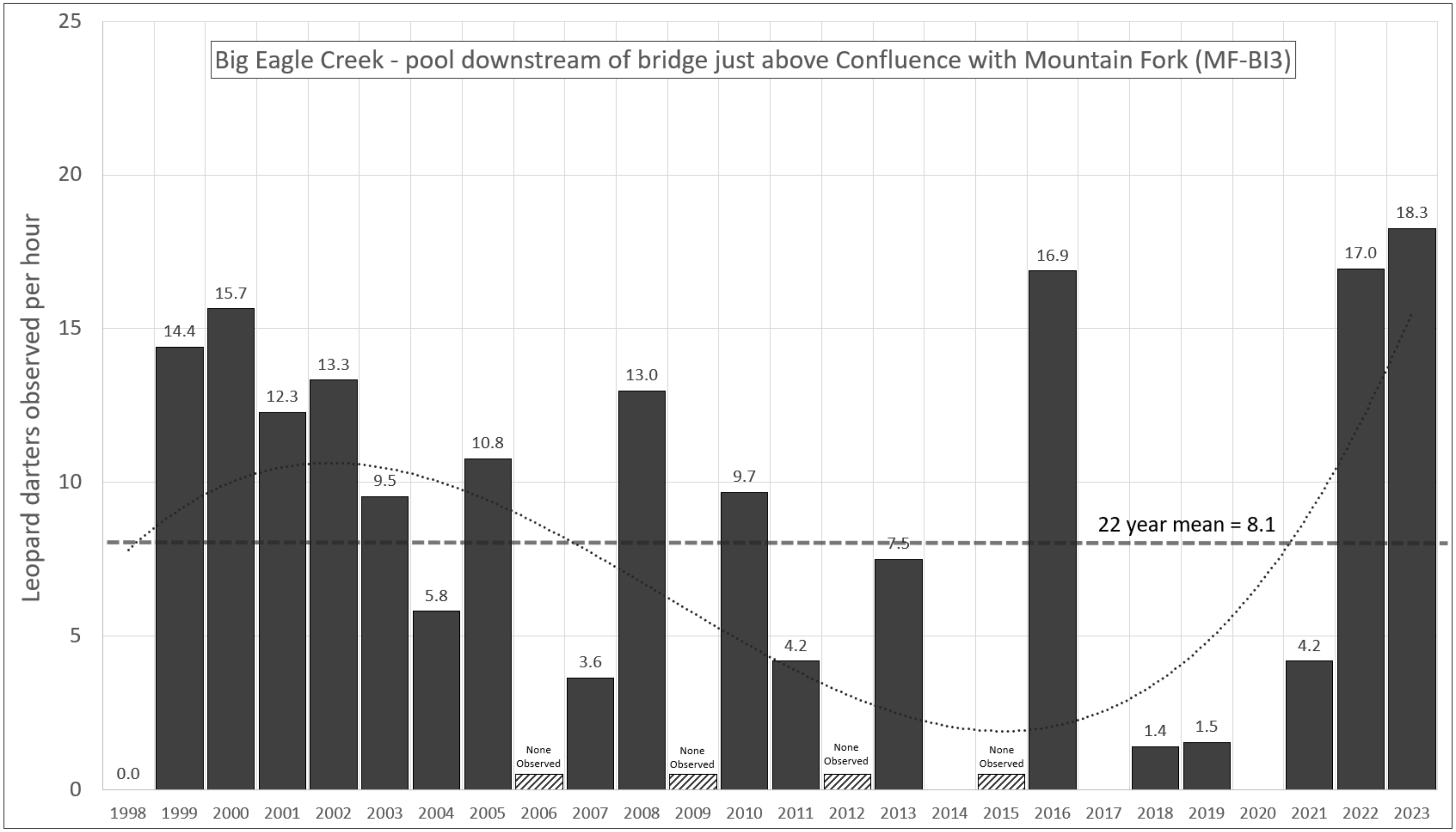


Figure 12. U.S. Fish and Wildlife Service permanent leopard darter site monitoring results (1998-2023). Permanent site description: Big Eagle Creek pool downstream of bridge just above confluence with Mountain Fork River (BI-3; 34.4497, -94.6608).

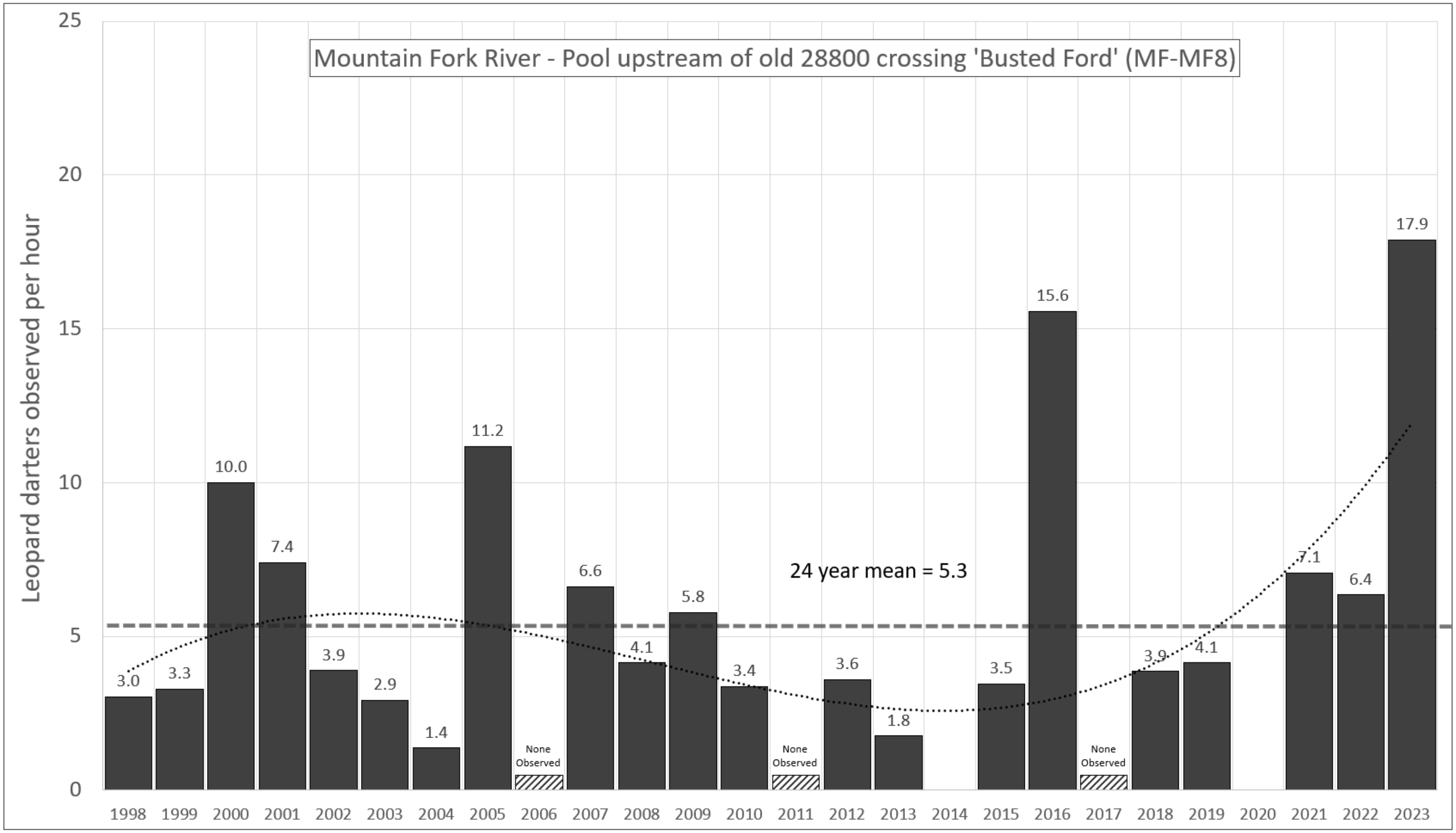

Figure 13. U.S. Fish and Wildlife Service permanent leopard darter site monitoring results (1998-2023). Permanent site description: Mountain Fork River pool upstream of old 28000 crossing 'busted ford' (MF-8; 34.3881, -94.6947).

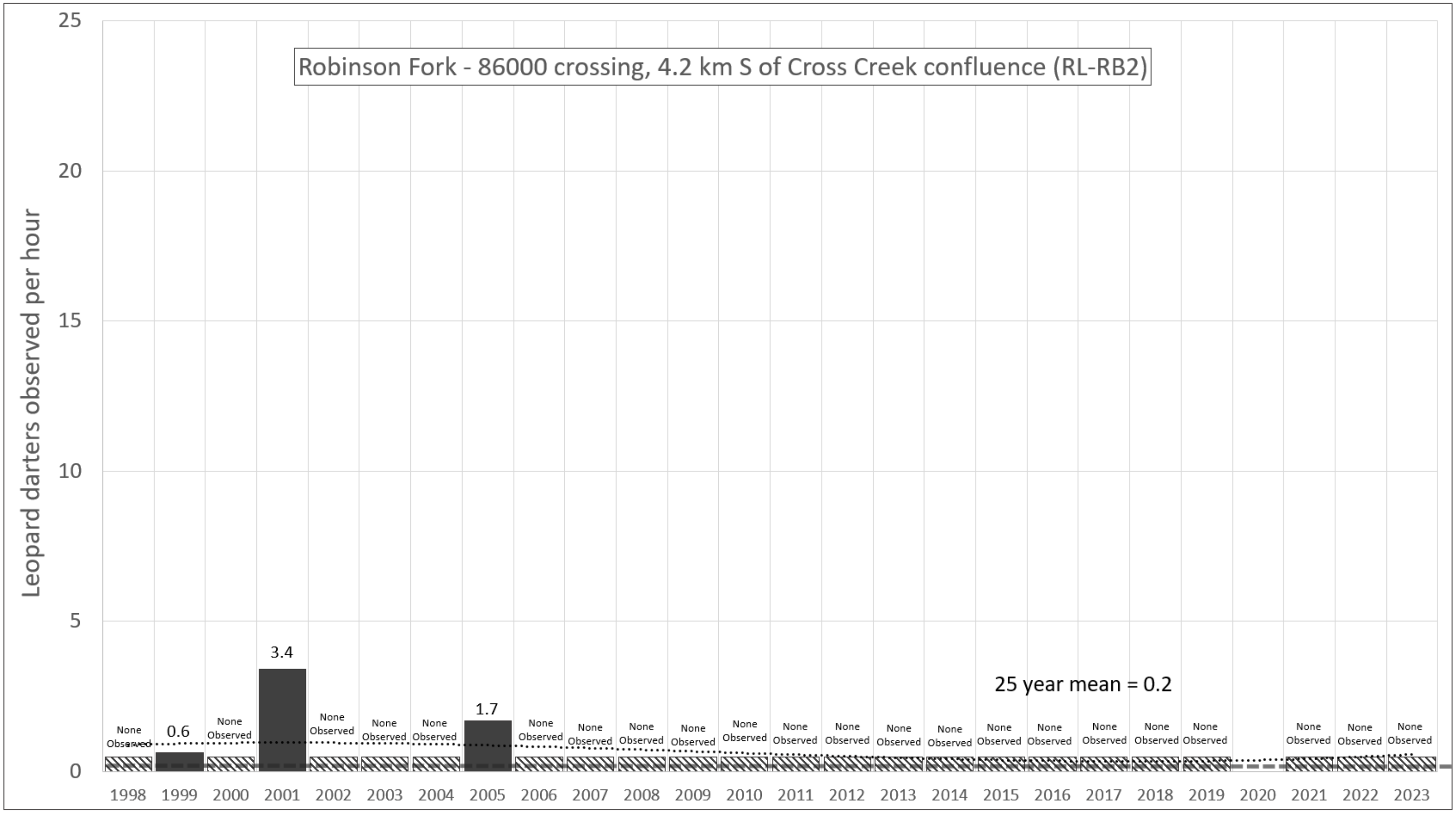


Figure 14. U.S. Fish and Wildlife Service permanent leopard darter site monitoring results (1998-2023). Permanent site description: Robinson Fork pool upstream of 86000 crossing, 4.2 km south of Cross Creek confluence (RB-2; 34.2258, -94.4119)

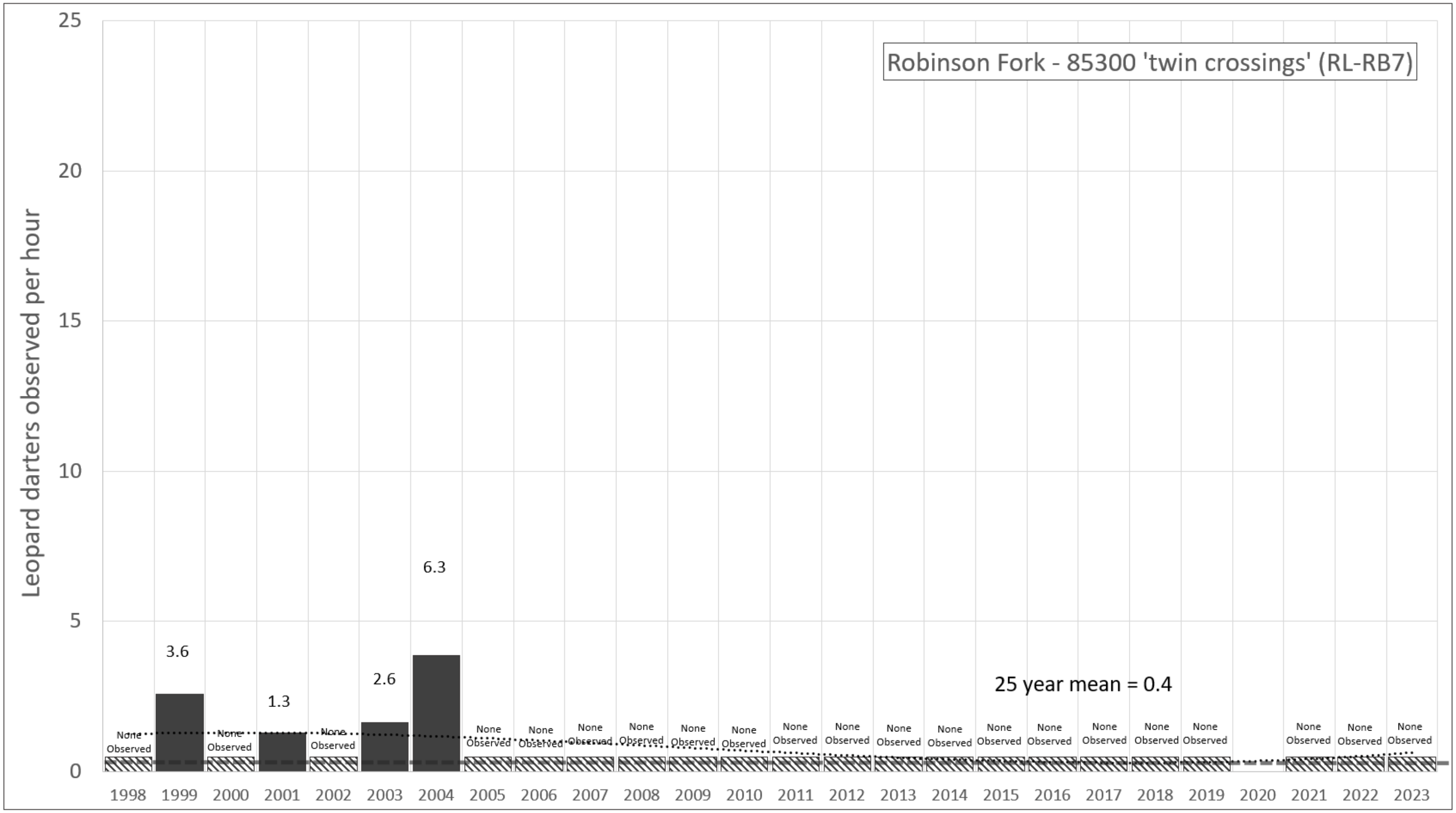


Figure 15. U.S. Fish and Wildlife Service permanent leopard darter site monitoring results (1998-2023). Permanent site description: Robinson Fork pools downstream of 85300 'twin crossings' (RB-7; 34.1822, -94.4172).

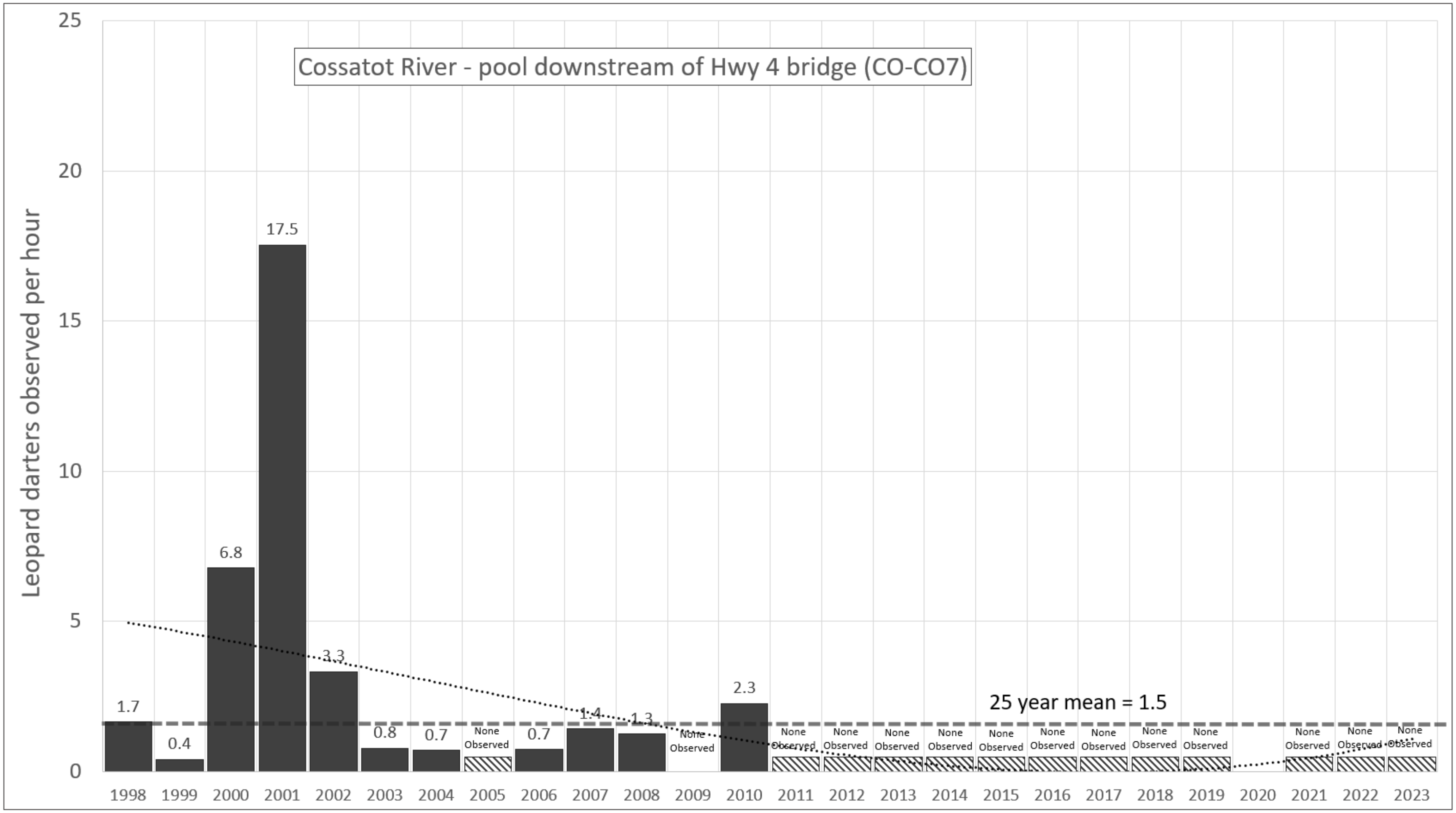


Figure 16. U.S. Fish and Wildlife Service permanent leopard darter site monitoring results (1998-2023). Permanent site description: Cossatot River pool downstream of Arkansas State Highway 4 bridge (CO-7, 34.2958, -94.1761).

Table 1. Mann-Kendall test results of <u>long-term trends (1998-2023)</u> for 16 permannt monitoring sites for leopard darter. Coefficient of variation calculated for sites with no significant trend to determine if high variability (>50%) may explain failure to reject null hypothesis (no trend). *Mann-Kendall test result.

| **Site ID** | **Total Surveys** | **Long-Term Trend** | **Probability value*** | **Coefficient of variation (CV)** |
|---|---|---|---|---|
| LR-10 | 25 | No Trend Detected | 0.35 | 59.6% |
| LR-13 | 21 | No Trend Detected | 0.759 | 60.2% |
| LR-8 | 23 | No Trend Detected | 0.222 | 64.3% |
| LR-9 | 24 | No Trend Detected | 0.534 | 77.5% |
| GL-20 | 25 | No Trend Detected | 0.815 | 100.3% |
| GL-16 | 24 | No Trend Detected | 0.331 | 98.5% |
| GL-19 | 24 | No Trend Detected | 0.98 | 101.2% |
| GL-25 | 8 | **Increasing** | **0.048** | |
| MF-21 | 24 | No Trend Detected | 0.148 | 91.3% |
| MF-5 | 22 | No Trend Detected | 0.672 | 70.3% |
| BI-3 | 22 | No Trend Detected | 0.421 | 76.9% |
| MF-8 | 24 | No Trend Detected | 0.635 | 86.0% |
| RB-2 | 25 | **Decreasing** | **0.014** | |
| RB-7 | 25 | **Decreasing** | **0.008** | |
| CO-7 | 25 | **Decreasing** | **<0.001** | |

Table 2. Mann-Kendall test results of trends in the last 10 years (2014-2023) monitoring sites for leopard darter. Coefficient of variation calculated for sites with no significant trend to determine if high variability (>50%) may explain failure to reject null hypothesis (no trend). *Mann-Kendall test result.

| **Site ID** | **Total Surveys** | **Trend - Last 10 Years (2014-2023)** | **Probability value*** | **Coefficient of variation (CV)** |
|---|---|---|---|---|
| LR-10 | 9 | No Trend Detected | 1 | 34.5% |
| LR-13 | 6 | No Trend Detected | 1 | 74.3% |
| LR-8 | 7 | No Trend Detected | 0.282 | 72.0% |
| LR-9 | 8 | No Trend Detected | 0.445 | 70.3% |
| GL-20 | 9 | No Trend Detected | 0.532 | 101.6% |
| GL-16 | 9 | No Trend Detected | 0.834 | 117.9% |
| GL-19 | 9 | No Trend Detected | 0.595 | 107.7% |
| GL-25 | 7 | No Trend Detected | 0.176 | 51.7% |
| MF-21 | 8 | No Trend Detected | 0.899 | 87.6% |
| MF-5 | 7 | No Trend Detected | 0.452 | 69.4% |
| BI-3 | 7 | **Increasing** | **0.019** | 99.0% |
| MF-8 | 8 | No Trend Detected | 0.134 | 85.4% |
| RB-2 | 9 | N/A - leopard darters not observed | | |
| RB-7 | 9 | N/A - leopard darters not observed | | |
| CO-7 | 9 | N/A - leopard darters not observed | | |

Table 3. U.S. Fish and Wildlife Combined permanent and rotational monitoring sites, by year: Total number of sites surveyed by each major tributary, total number of sites where leopard darters were observed (present), and the percentage of sites where leopard darters were observed. *Note that in 2017 and 2018, additional intensive surveys at numerous sites were conducted on the Cossatot River, which are not included in these results. Table 3 is broken into three sections for Section 508 compliance.

Total number of sites surveyed per major tributary.

| Total # Sites | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Little | 14 | 16 | 10 | 18 | 17 | 11 | 6 | 20 | 6 | 15 | 5 | 5 | 9 | 11 | 8 | 6 | 2 | 7 | 4 | 2 | 16 | 8 | 5 | 4 | 3 |
| Glover | 9 | 7 | 13 | 8 | 14 | 5 | 9 | 10 | 13 | 8 | 5 | 6 | 10 | 8 | 6 | 7 | 6 | 9 | 6 | 5 | 6 | 12 | 8 | 5 | 8 |
| Mountain Fork | 7 | 20 | 17 | 10 | 11 | 9 | 13 | 9 | 23 | 9 | 17 | 4 | 4 | 13 | 6 | 12 | 1 | 9 | 13 | 3 | 6 | 9 | 8 | 14 | 12 |
| Robinson Fork | 2 | 6 | 2 | 4 | 4 | 2 | 3 | 2 | 2 | 5 | 2 | 2 | 3 | 2 | 5 | 2 | 6 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| Cossatot | 5 | 5 | 10 | 6 | 3 | 1 | 4 | 1 | 1 | 3 | 1 | 1 | 7 | 1 | 4 | 1 | 2 | 3 | 18 | 3* | 1* | 1 | 1 | 1 | 1 |

Total number of sites where Leopard darters were observed (present) by major tributary.

| # Sites Present | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Little | 11 | 13 | 10 | 14 | 12 | 7 | 5 | 15 | 3 | 7 | 5 | 4 | 9 | 8 | 6 | 5 | 1 | 6 | 4 | 2 | 10 | 5 | 5 | 4 | 3 |
| Glover | 8 | 7 | 9 | 7 | 9 | 3 | 8 | 8 | 7 | 6 | 5 | 4 | 8 | 4 | 5 | 6 | 5 | 7 | 6 | 5 | 5 | 9 | 6 | 5 | 8 |
| Mountain Fork | 6 | 11 | 14 | 10 | 9 | 7 | 11 | 9 | 13 | 8 | 10 | 2 | 4 | 12 | 4 | 9 | 0 | 2 | 10 | 2 | 5 | 8 | 5 | 12 | 11 |
| Robinson Fork | 0 | 3 | 0 | 2 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cossatot | 2 | 1 | 4 | 5 | 2 | 1 | 2 | 0 | 1 | 1 | 1 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0* | 0* | 0 | 0 | 0 | 0 |

Percentage of sites where Leopard darters were observed by major tributary.

| Percent Present | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2021 | 2022 | 2023 | MEAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Little | 0.79 | 0.81 | 1.00 | 0.78 | 0.71 | 0.64 | 0.83 | 0.75 | 0.50 | 0.47 | 1.00 | 0.80 | 1.00 | 0.73 | 0.75 | 0.83 | 0.50 | 0.86 | 1.00 | 1.00 | 0.63 | 0.63 | 1.00 | 1.00 | 1.00 | 0.79 |
| Glover | 0.89 | 1.00 | 0.69 | 0.88 | 0.64 | 0.60 | 0.89 | 0.80 | 0.54 | 0.75 | 1.00 | 0.67 | 0.80 | 0.50 | 0.83 | 0.86 | 0.83 | 0.78 | 1.00 | 1.00 | 0.83 | 0.75 | 0.75 | 1.00 | 1.00 | 0.80 |
| Mountain Fork | 0.86 | 0.55 | 0.82 | 1.00 | 0.82 | 0.78 | 0.85 | 1.00 | 0.57 | 0.89 | 0.59 | 0.50 | 1.00 | 0.92 | 0.67 | 0.75 | 0 | 0.22 | 0.77 | 0.67 | 0.83 | 0.89 | 0.63 | 0.86 | 0.92 | 0.71 |
| Robinson Fork | 0 | 0.50 | 0 | 0.50 | 0 | 0.50 | 0.33 | 0.50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.12 |
| Cossatot | 0.40 | 0.20 | 0.40 | 0.83 | 0.67 | 1.00 | 0.50 | 0 | 1.00 | 0.33 | 1.00 | 0 | 0.43 | 0 | 0.25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.35 |