MONITORING OF RIPARIAN AND STREAM HABITAT AND BIOTIC COMMUNITIES IN THE WICHITA RIVER BASIN, TEXAS IN 2007: BASELINE MONITORING OF REFUGIA POOLS

Gene R. Wilde
Department of Biological Sciences
Texas Tech University
Lubbock, TX 79409

December 12, 2008

Final Report Submitted to:

Weston Solutions, Inc. and U.S. Army Corps of Engineers, Tulsa District

TABLE OF CONTENTS

Page

LIST OF TABLES

Table Page

LIST OF FIGURES

STUDY OBJECTIVES

Overall this study consists of five major tasks that include (1) a faunal survey of chloride collection areas (Areas VII, VIII, and X) in the North Wichita River, the Middle Fork of the Wichita River, and South Wichita River; (2) collection of contemporary data on the community structure of fish in the Wichita River and its major tributaries (North Wichita River, the Middle Fork of the Wichita River, and South Wichita River); (3) the identification of locations of refugia pools in the North Wichita River and South Wichita River; (4) refugia pool baseline habitat monitoring in the North Wichita River and South Wichita River; and (5) updated physical and chemical profiles of the Wichita River. Tasks 1 and 3 were completed during 2005 and are reported in Wilde and Gaines (2006). Tasks 2, 4, and 5 were undertaken in 2005-2006 (Wilde and Gaines 2006) and tasks 2 and 5 were again undertaken in 2007 (Wilde et al. 2008). However, baseline habitat monitoring of refugia pools (Task 4) was not possible during 2007 due to above average precipitation resulting in continuous flow in all portions of the Wichita River. Baseline monitoring of pool refugia within the Wichita River drainage basin was conducted during summer 2008. Six pool refugia on the South Fork Wichita River were monitored for a three week period during which the river ceased to flow. Three pools on the Wichita River upstream from Lake Kemp were sampled once. A total of 1085 fishes, representing 13 species, were collected from refugia. There was no evident change in water quality or fish assemblage composition or abundance during the period of sampling. This information will be used to assess potential affects of the Red River Chloride Control Project, Wichita River Only Portion on aquatic communities within the Wichita River drainage.

ACKNOWLEDGMENTS

A number of persons have contributed considerably to this project. I wish to thank Loretta Turner and Jim Randolph (Weston Solutions, Inc.) and Steve Nolen and Tony Clyde (U.S. Army Corps of Engineers, Tulsa District) for logistical and technical support, and (Jim Randolph and Tony Clyde) for help in the field. Bailey Gaines, Bart Durham, Aaron Urbanczyk, Doug Knabe, Michael Laman, and Coy Sanchez for assistance in the field and lab. I thank the landowners who granted me access to their property, including Rocky Mongrain (Bateman Ranch), Ruth Lowrance (Lowrance Ranch), and Wes Lupton (Burgess Y Ranch). I acknowledge Dennis Duke (U.S. Army Corps of Engineers, Truscott) for assistance in locating and contacting landowners. I gratefully acknowledge Weston Solutions, Inc. for supporting this study. Finally, I thank Loretta Turner (Weston Solutions, Inc.) for logistical and other support.

SUMMARY

In 2005, we established 17 permanent sampling sites in the Wichita River and its major tributaries. The sites were marked with permanent monuments, for which GPS coordinates were recorded, to allow long-term sampling and monitoring of the fish assemblage and stream characteristics at fixed locations. We sampled fish assemblages at these sites during spring, summer, and fall 2007 and assessed stream channel/ riparian habitat characteristics at each site. Twenty-eight species of fish and one hybrid combination were collected. Red River pupfish was the most commonly collected species and represented 42% of fishes collected. Other common fishes included plains killifish (16% of fishes collected) red shiner (11%), plains minnow (9.7%), Red River shiner (3%), shoal chub (3%), and western mosquitofish (2%). Collectively these seven species represented 86% of the fishes collected. Across all sites, the species richness and relative abundance were similar to that observed during the first year of this study. Most measures of stream size and vegetative cover decreased from the lower Wichita River upstream to the upper reaches of the North Wichita River, Middle Fork of the Wichita River, and South Wichita River. Because the summer and fall of 2007 were unusually wet, the river channel did not dry, which precluded sampling of stream refugia.

1.0 INTRODUCTION

Many of the larger streams and rivers within the Wichita River drainage basin have high concentrations of naturally occurring brines, which are composed primarily of sodium chloride with a high sulfate concentration (USACE 1972). These brines, of ancient marine origin, enter the surface waters of the Wichita River drainage basin either by dissolution of subsurface deposits or in spring inflows. Chloride concentrations in springs and seeps within the drainage range from 5,000 to 30,000 mg/l, but chloride concentrations in deep aquifers may exceed 100,000 mg/l (Garza 1983). Chloride concentrations in localized springs can be as high as 170,000 mg/l (Lewis and Dalquest 1957).

The U.S. Army Corps of Engineers, Tulsa District, has begun construction of a number of chloride control facilities to intercept and dispose of these saline inflows to the Wichita River and its tributaries (USACE 2002). Construction and operation of the Wichita River portion of the authorized Red River Chloride Control Project will intercept naturally occurring brines using a combination of dikes and inflatable weirs and will pump these brines to the Truscott brine disposal lake. Operation of these control structures is expected to considerably reduce salinity in the Wichita River and affected tributaries (e.g., Baldys et al. 1996).

The Red River Chloride Control Project, Wichita River Only Portion will comprise three chloride control structures within the Wichita River basin: the Y Ranch low flow dam (North Wichita River), the Lowrance low flow dam (Middle Fork of the Wichita River), and the Bateman low flow dam (South Wichita River). Construction of the Bateman Collection Dam, pumping facility, and pipeline (Area VIII) began in 1976

and the facility became operational in 1987. The Lowrance low flow dam and pump station have been constructed, but have never been operated. Construction has not yet begun on the Y Ranch collection facility, pumping station, or pipeline.

Hydrologic models indicate that reductions in base flows associated with chloride control projects would increase the number of days, in an average year, that no-flow conditions occur in most reaches of the river. During periods of no flow, fishes would be restricted to various refugia including pools and backwaters. An increase in the duration and intensity of competitive and, especially, predator-prey interactions in these restricted habitats may affect the composition and structure of local fish assemblages. Prolonged restriction of fishes to pools may increase their exposure to high water temperatures and low dissolved oxygen concentrations common in isolated pools, potentially resulting in changes in the structure and composition of local assemblages (Matthews 1998; Ostrand and Wilde 2002, 2004).

The purpose of this five-year study is to provide detailed information about the Wichita River habitat and fish assemblage. The overall study consists of five major tasks that included (1) a faunal survey of chloride collection areas (Areas VII, VIII, and X) in the North Wichita River, the Middle Fork of the Wichita River, and South Wichita River; (2) collection of contemporary data on the community structure of fish in the Wichita River and its major tributaries (North Wichita River, the Middle Fork of the Wichita River, and South Wichita River); (3) the identification of locations of refugia pools in the North Wichita River and South Wichita River; (4) refugia pool baseline habitat monitoring in the North Wichita River and South Wichita River; and (5) updated physical and chemical profiles of the Wichita River. Tasks 1 and 3 were completed during the first and second years of this study and are reported in Wilde and Gaines (2006) and Wilde et

al. (2008), respectively. Baseline habitat monitoring of refugia pools (Task 4) was not possible during 2007 due to above average precipitation resulting in continuous flow in all portions of the Wichita River. However, baseline habitat monitoring of refugia pools was conducted in July and August 2008. This report describes the results of that monitoring.

2.0 STUDY AREA

The Wichita River drains approximately 8,909 km^2 of arid and semi-arid grasslands in north-central Texas. The river rises in intermittent streams and springs on the east slope of the Llano Estacado and flows generally east and northeast for approximately 402 km before discharging into the Red River. The Wichita River has three main forks: the North Wichita River, the Middle Fork of the Wichita River, and the South Wichita River. The North Wichita River rises 10 km east of East Afton in northeast Dickens County and flows east and southeast about 160 km before joining the South Wichita River 24 km northwest of Seymour, in northeast Knox County, to form the Wichita River proper. The Middle Fork of the Wichita River rises near U.S. Highway 83, north of Fourmile Hill in north central King County, and flows northeast 56 km where it joins the North Wichita River, 10 km southwest of Foard City. The South Wichita River rises 16 km east of Dickens in east central Dickens County and flows east for 176 km before joining the North Wichita River. A map of the study area, in north-central Texas is presented as Figure 1.

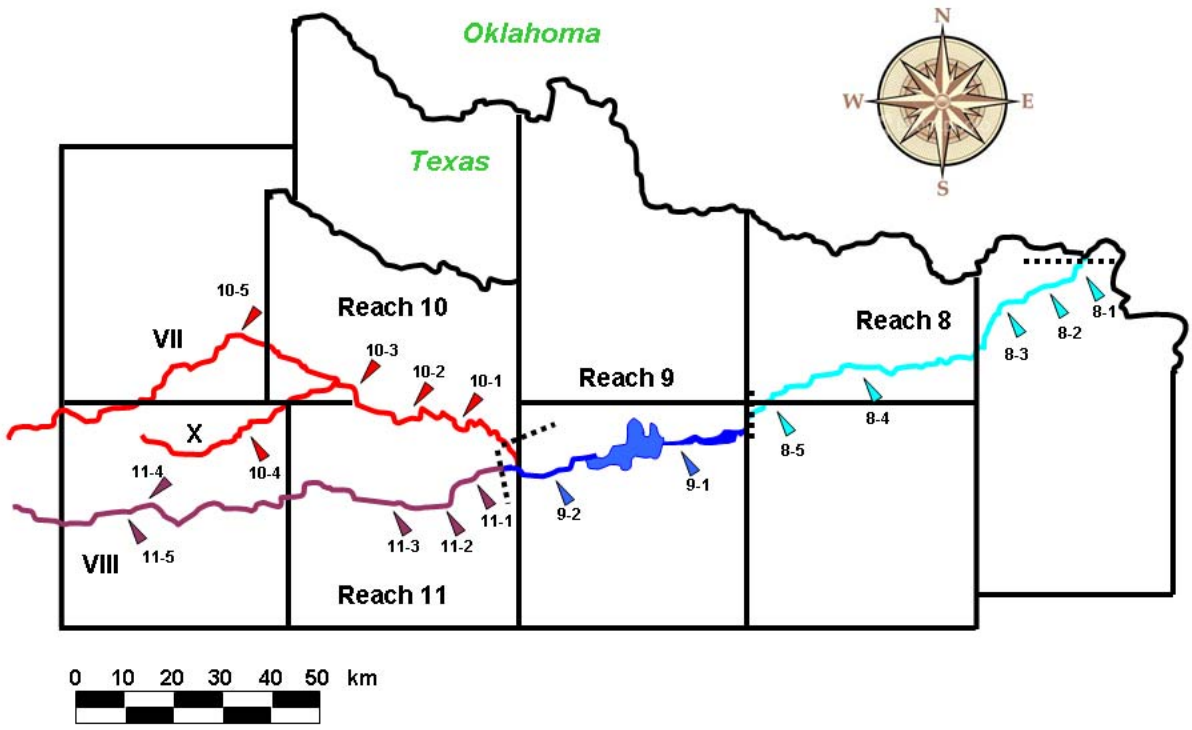

Figure 1. Map of the Wichita River (Reaches 8 and 9) study area including the North Wichita River (Reach 10), Middle Fork of the Wichita River (Reach 10), and South Wichita River (Reach 11). Reach boundaries are denoted by dashed lines and sampling sites are indicated by arrows. Hyphenated numbers indicate sampling sites within each reach. Salt spring and seep areas are labeled with Roman numerals denoting areas VII, VIII, and X.

3.0 METHODS

3.1 Refugia Pool Baseline Habitat Monitoring in the North Wichita River (Reach 10) and South Wichita River (Reach 11)

During the summer of 2007, refugia were not present and, hence, were not sampled. This decision was made in consultation with Weston Solutions, Inc. and U.S. Army Corps of Engineers, Tulsa District, personnel assigned to this project.

In late July-early August, a number of locations on the South Wichita River were dry and refugia were sampled. However, flow was continuous in the North Wichita River and the Middle Fork of the Wichita River; therefore, refugia could not be sampled in these rivers. In July through early August 2008, refugia were surveyed at two locations in the South Wichita River (Reach 11), downstream from the Bateman low flow dam, and at one location on the Wichita River upstream from Lake Kemp. These sites were chosen based on the presence and size of refugia as determined from the aerial videos, accessibility, and their proximity to riparian habitat and fish assemblage sampling sites. During the initial survey of refugia, all pools within a distance of 1.6 km upstream and downstream from the access point were sampled, photographed, and their GPS coordinates were recorded. Refugium habitat measurements included pool area, mean depth, maximum depth, and substrate type. Pool area, mean depth and maximum depth were measured at the upper, middle, and lower end of each pool and then were averaged for each pool. Substrate type was assessed at three locations within each pool and a composite estimate was recorded. Temperature and dissolved oxygen measurements were made at 10 cm depth intervals.

Based on a review of the habitat measurements, including temperature and dissolved oxygen profiles, only pools longer than 10 m in length were chosen for long-

term monitoring, at two-week intervals. At each of the three sampling locations, three pools were selected at random for long-term monitoring during the period of no flow.

On each sampling date, temperature and dissolved oxygen profiles were recorded twice daily, in the evening and as early as possible in the morning, from the surface to the maximum depth in 10-cm intervals. In addition to temperature and dissolved oxygen profiles, air temperature, pH, turbidity, current velocity, and conductivity also were measured and recorded. Also on each sampling date, the fish assemblage in each pool was sampled to assess any compositional changes resulting from, or associated with, physical and chemical changes in pool habitats. Fish sampling followed the methods recommended by Moulton et al. (2002).

4.0 Results

4.1 Refugia Pool Baseline Habitat Monitoring in the North Wichita River (Reach 10) and South Wichita River (Reach 11)

Because the river was wet throughout the summer of 2007, baseline habitat monitoring of pools was not conducted. Portions of the South Wichita River began to dry in late July 2008. An initial survey of refugia was conducted at two locations (areas 11-1 and 11-3) on the South Wichita River on 22-23 July 2008. Area 9-1 on the Wichita River upstream from Lake Kemp became dry in early August 2008 and was sampled in that montht. Three refugia from each site were chosen at random for time series monitoring. These sites were: (Site 11-3) South Fork Wichita River at County Road 3065, north of Vera; (Site 11-3) South Fork Wichita River at Highway 6, north of Benjamin, Highway 6 and (Site 9-1) Wichita River at State Highway 1919. Rains in mid August resulted in

resumed flows at all sites, therefore, sites 11-1 and 11-3 were sampled on two dates and site 9-1 was sampled only once.

Time-series sampling of refugia in the South Wichita River showed little change in the species richness, abundance, and composition of fishes through time (Table 1). Across all sites, a total of 1085 fishes representing 13 species were collected from the sampled refugia (Table 2). The most common fish in the sampled refugia were red shiner (27.1%), Red River shiner (27.0%), plains killifish (15.4%, shoal chub (12.4%), and plains minnow (8.0%). These six species generally represented the majority of the fish in each sample. Other species collected from the sampled refugia included bullhead minnow, fathead minnow, river carpsucker, Red River pupfish, Western mosquitofish, largemouth bass, green sunfish, and orangespotted sunfish, which collectively accounted for only 10% of fishes sampled.

Across all sites and refugia, 610 fish (68 per sample) were collected on the first date that refugia were sampled, 492 fish (88 per sample) were collected on the second date. There was no systematic change in either fish abundance and composition or water quality during the period of sampling.

5.0 DISCUSSION

The role of dry-season refugia in maintenance of stream fish populations has not been extensively studied. The importance of such refugia in the Wichita River is increased because operation of chloride control projects within the upper basin is expected to increase the frequency and duration of periods in which the river is dry. Previous studies of fishes confined to dry-season pools have generally implicated changing physical and

Table 1. Fish assemblages and habitat conditions in South Wichita River refugia sampled in summer 2008.

Date	Site	Pool	Time	Maximum depth (cm)	Area (m2)	Water temperature (^{O}C)	Dissolved oxygen (mg/l)	Conductivity (mS/cm)	Plains killifish (%)	Plains minnow (%)	Red shiner (%)	Red River shiner (%)	Red River pupfish (%)	Shoal Chub (%)	Other species (%)	Total fish Collected (N)
7/22/2008	11.1	U1	17:20	29	165.2	33.3	9.9	10.1		9.1	22.7	45.5		9.1	13.6	22
7/22/2008	11.1	U2	17:30	32	133.0	31.7	9.7	17.2	3.8	11.5	38.5	23.1		11.5	11.5	26
7/22/2008	11.1	D1	16:45	21	185.2	35.1	12.3	9.4	22.7	1.2	2.9	41.9	0.6	11.0	19.8	172
7/23/2008	11.1	U2	7:02	30	147.9	24.5	6.6	14.8								
7/23/2008	11.1	U1	7:10	30	169.9	24.4	3.3	8.2								
7/23/2008	11.1	D1	6:50	34	155.1	23.0	5.0	6.6								
7/23/2008	11.3	D2	20:15	14	84.2	28.9	8.5	12.6	40.0		60.0					10
7/23/2008	11.3	D1	19:45	24	115.6	33.0	11.9	15.5			98.2				1.8	56
7/23/2008	11.3	U1	18:40	49	416.8	33.5	12.3	12.1	17.6	10.6	18.2	24.7	0.6	26.5	1.8	170
7/24/2008	11.3	D1	7:10	24	86.5	23.9	4.9	11.3								
7/24/2008	11.3	D2	7:20	22	72.9	23.8	5.7	11.4								
7/24/2008	11.3	U1	8:00	48	456.9	24.9	5.8	9.4								
8/5/2008	11.1	D1	16:45	32	183.7	36.5	13.8	9.8	24.2	6.5	3.7	49.8	1.9	13.0	0.9	215
8/5/2008	11.1	U1	17:17	22	123.3	35.1	12.3	12.8	19.4	9.0	35.8	10.4		6.0	19.4	67
8/5/2008	11.1	U2	17:30	29	96.3	33.0	11.3	18.6	8.0	4.0	68.0	4.0	12.0		4.0	25
8/6/2008	11.1	D1	7:00	33	153.8	23.1	4.4	7.9								
8/6/2008	11.1	U1	7:05	26	114.8	23.3	5.5	10.4								
8/6/2008	11.1	U2	7:15	27	85.8	23.2	6.1	15.4								
8/5/2008	11.3	D1	18:40	7	5.0	35.5	11.7	25.3	7.1	0.0	57.1		14.3		21.4	14
8/5/2008	11.3	D2	18:53	18	21.0	29.8	9.7	17.1	20.0	0.0	30.0	40.0	10.0		0.0	10
8/5/2008	11.3	U1	19:30	41	255.4	32.4	11.3	13.4	14.3	21.1	11.2	18.6	8.1	18.0	8.7	161
8/6/2008	11.3	D1	8:15	8	11.3	22.8	3.4	15.5								
8/6/2008	11.3	D2	8:25	16	38.6	22.2	4.5	14.6								
8/6/2008	11.3	U1	9:00	40	233.0	24.3	5.2	11.6								
8/6/2008	9.2	U1	18:00	52	1791.8	31.4	12.6	16.8		4.8	73.8	14.3		3.6	3.6	84
8/6/2008	9.2	D1	18:50	46	452.0	30.0	10.6	18.1		5.7	79.2	3.8		3.8	7.5	53
8/6/2008	9.2	D2	19:10	40	212.0	29.4	10.3	18.2			58.8	17.6		17.6	5.9	17
8/7/2008	9.2	U1	7:05	48	1713.4	25.9	6.7	15.7								
8/7/2008	9.2	D1	7:30	46	344.0	25.5	6.5	16.8								
8/7/2008	9.2	D2	7:45	40	231.5	25.4	6.6	16.9								

Table 2. Fish species collected in Wichita River pool refugia (all sites combined) sampled in summer 2008.

Species	Number
Red shiner *Cyprinella lutrensis*	294
Red River shiner *Notropis bairdi*	293
Plains killifish *Fundulus zebrinus*	167
Shoal chub M*acrhybopsis hyostoma*	135
Plains minnow *Hybognathus placitus*	87
Bullhead minnow *Pimephales vigilax*	37
Red River pupfish *Cyprinodon rubrofluviatilis*	25
Fathead minnow *Pimephales promelas*	14
Green sunfish *Lepomis cyanellus*	10
Orangespotted sunfish *Lepomis humilus*	9
River carpsucker *Carpiodes carpio*	7
Western mosquitofish *Gambusia affinis*	6
Largemouth bass *Micropterus salmoides*	1

chemical conditions as the mechanism for changes in species composition (Capone and Kushlan 1991; Ostrand and Wilde 2002, 2004). Wilde and Gaines. (2006) reported rapid changes in the species composition and abundance of fishes in Wichita River refugia pools over a six week period. Although they observed no systematic changes in water chemistry, they observed transient periods of low dissolved oxygen concentrations and speculated these were responsible for the observed changes in fish assemblages. In the present study, a small number of refugia were sampled for a one- to three-week period, during which time the fish assemblages changed very little. The observation period of this study was shorted than that of Wilde and Gaines (2006); however, dissolved oxygen concentrations remained relatively high during all sampling events in 2008.

Because predatory (e.g., largemouth bass and ictalurids) and nonpredatory (primarily cyprinodontids and minnows) fishes will be confined in refugia pools, some concerns have been raised about predatory impacts on smaller fishes, particularly the Red River pupfish. However, the present results and those of other studies of the Wichita River (Lewis and Dalquest 1957; Echelle et al. 1995; Wilde et al. 1996; Gelwick et al. 2000) indicate that predatory fishes are not common in the upper Wichita River and its tributaries. Results of this survey shows that predatory fishes present in the upper Wichita River are smaller individuals. Therefore, predation may not be a problem in these refugia. Further, predatory species were present in low numbers in the sampled refugia and were among the first fish to disappear from these habitats in 2006 when sampling occurred over a six-week period (Wilde et al. 2006).

An aerial survey of the Wichita River and its main tributaries, upstream from Wichita Falls, conducted in March 2006 suggests that dry-season refugia will be common in most reaches of the river (Wilde and Gaines. 2006). The survey was conducted during a

time in which the river channel was not dry. However, the Wichita River and its main tributaries were fairly clear and it is possible to discern areas within the river channel that appear to be deep enough to provide refuge during most dry periods. In general, these areas were located along hills and escarpments along which the river has scoured deep holes.

6.0 LITERATURE CITED

Baldys, S., III, P. W. Bush, and C. C. Kidwell. 1996. Effects of low-flow diversions from the South Wichita River on downstream salinity of the South Wichita River, Lake Kemp, and the Wichita River, North Texas, October 1982-September 1992. U.S. Geological Survey Water-Resources Investigations Report 95-4288.

Capone, T. A., and J. A. Kushlan. 1991. Fish community structure in dry-season stream pools. Ecology 72:983-992.

Echelle, A. A., W. L. Fisher, and A. F. Echelle. 1995. Assessment of fish communities in relation to chloride control in the Wichita River and the distribution of pupfish in the Red River drainage. Report sent to U.S. Army Corps of Engineers, Tulsa District. Oklahoma State University, Stillwater, Oklahoma.

Garza, S. 1983. Projected effects of proposed chloride-control projects on shallow ground water—preliminary results for the Wichita River Basin, Texas. U.S. Geological Survey, Water-Resources Investigations Report 83-4026. Austin, Texas.

Gelwick, F. P., N. J. Dictson, and M. D. Zinn. 2000. Analysis of fish distribution in the Wichita River system and Red River tributaries from the Wichita River confluence to Lake Texoma as related to environmental variables in summer 1998 with stochastic models for distribution of two salt-tolerant species under conditions of estimated land use and concentration of total dissolved solids for five alternative plans by U.S. Army Corps of Engineers for control of saltwater

inflows to the Wichita river. Report submitted to U.S. Army Corps of Engineers, Tulsa District. Texas A&M University, College Station, Texas.

Lewis, L. D., and W. W. Dalquest. 1957. A fisheries survey of the Big Wichita River system. IF Report Series No. 2. Texas Parks and Wildlife Department, Austin, Texas.

Matthews, W. J. 1998. Patterns in freshwater fish ecology. Kluwer Academic Publishers, Norwell, Massachusetts.

Moulton II, S. R., J. G. Kennen, R. M. Goldstein, and J. A. Hambrook. 2002. Revised protocols for sampling algal, invertebrate, and fish communities as part of the national water-quality assessment program. United States Geological Survey Open-File Report 02-150.

Ostrand, K. G., and G. R. Wilde. 2002. Seasonal and spatial variation in a prairie stream-fish assemblage. Ecology of Freshwater Fish 11:137-149.

Ostrand, K. G., and G. R. Wilde. 2004. Changes in prairie stream fish assemblages restricted to isolated streambed pools. Transactions of the American Fisheries Society 133:1329-1338.

U.S. Army Corps of Engineers. 1972. Chloride-control. Part I, Arkansas-Red River basins, Oklahoma, Kansas, and Texas. Tulsa District, U.S. Army Corps of Engineers, Tulsa, Oklahoma.

U.S. Army Corps of Engineers. 2002. Supplement to final environmental statement for the authorized Red River chloride control project Wichita River only portion. Tulsa District, U.S. Army Corps of Engineers, Tulsa, Oklahoma.

Wilde, G. R., and B. Gaines. 2006. Identification of refugia habitat, faunal survey of collection areas, and monitoring of riparian and stream habitat and biotic communities in the Wichita River Basin, Texas. Report submitted to U.S. Army Corps of Engineers, Tulsa District. Texas Tech University, Lubbock, Texas.

Wilde, G. R., B. Gaines, and B. W. Durham. 2008. Monitoring of riparian and stream habitat and biotic communities in the Wichita River Basin, Texas in 2007. Report submitted to U.S. Army Corps of Engineers, Tulsa District. Texas Tech University, Lubbock, Texas.

Wilde, G. R., R. R. Weller, C. D. Smith, and R. Jimenez, Jr. 1996. Review and synthesis of existing fish collection records for the upper Red River Basin upstream from Lake Texoma. Report submitted to U.S. Army Corps of Engineers, Tulsa District. Texas Tech University, Lubbock, Texas.