



Cypress Basin Bioassessment
Marion and Harrison Counties, Texas

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Cypress Basin Bioassessment: Harrison and Marion Counties, Texas

EXECUTIVE SUMMARY

Four bioassessment and 10 supplemental fish collection sites were sampled in Marion and Harrison counties, Texas in the fall of 2014. Bioassessment sites (two sites on Big Cypress Bayou, one site on Black Cypress Bayou, and one site on Little Cypress Bayou) were selected to collect fish, aquatic macroinvertebrate, freshwater mussel, riparian, and instream habitat data in an effort to support the science needs of the Cypress Environmental Flows Project and recreational initiatives such as Texas Parks and Wildlife Department's Texas Paddling Trails and River Access and Conservation Area programs. The ten additional fish collections sites were selected to supplement statewide fish data needs as determined by the online database, the Fishes of Texas Project.

Overall 56 species of fish, 19 species of mussels, and 37 taxa of aquatic macroinvertebrates were collected from the Cypress Basin, including three fish species and one mussel species of greatest conservation need. The overall fish community was characterized by high species richness, diversity among trophic positions, and a low percentage of non-native species. All four bioassessment sites ranked as exceptional for the fish aquatic life use score. Of the lotic supplemental fish collection sites, species richness ranged from 9 to 30 species. There were some notable differences between main stem and tributary fish collections, with 20 additional species collected from tributaries. Conversely, five species collected on the main stem were absent from tributary samples. Only two non-native fish species were collected during this study.

Mussel species richness and catch-per-unit effort at the two bioassessment sites on Big Cypress Bayou were high. While catch rates were much lower on the Little and Black Cypress bayous, species richness was high and included one state threatened species, Texas Pigtoe.

Big Cypress Bayou scored as intermediate for aquatic invertebrate aquatic life use. Similar aquatic invertebrate communities were collected from both sites on Big Cypress Bayou; however, catch rates were lower on the upstream site, possibly due to a lower diversity of habitats.

The two bioassessment sites on Big Cypress Bayou were assessed for riparian community health and both sites were found to have a riparian area in good functioning condition as indicated by the diverse mixture of appropriate riparian species, high plant vigor, and presence of multiple age classes.

The four bioassessment sites were evaluated for overall stream health using a modified stream visual assessment protocol (SVAP2). The two sites on Big Cypress Bayou and the site on Little Cypress Bayou both ranked as having good stream health and the site on Black Cypress Bayou ranked as fair. Water quality data collected during this study met Texas Commission on Environmental Quality standards established for each stream segment.

This study found rich communities of fish, mussels, and riparian plants and trees at the four bioassessment sites. While the invertebrate community scores indicate some level of impairment, the low scores could also be indicative of a non-regionalized scoring system or lower than recommended sample size. Overall the Cypress Basin aquatic and riparian communities appear to be healthy. The recommendation is to continue biological and habitat monitoring at the four bioassessment sites to quantify how flow-ecology relationships in the Big Cypress and its major tributaries continue to respond to flow releases from Lake O' the Pines.

INTRODUCTION

Study Background

The objectives of this study were to support riverine science needs of the Cypress Environmental Flows Project, Texas Parks and Wildlife Department's (TPWD) recreational initiatives, and statewide fish data needs with a focus on species of greatest conservation need (SGCN). The Cypress Environmental Flows Project was initiated in 2004 by The Nature Conservancy (TNC) and the Caddo Lake Institute (CLI) in partnership with the Northeast Texas Municipal Water District (NETMWD), the U.S. Army Corps of Engineers (USACOE), TPWD, and others (CLI 2015) in an effort to identify and implement environmental flows for Big Cypress, Black Cypress and Little Cypress bayous and Caddo Lake. Objectives of the Flows Project are to ensure adequate instream flows to sustain the ecological, recreational, and economic value of Caddo Lake, its watershed, and the larger Cypress Basin (CLI 2015). As part of the Flows Project, flow regime recommendations (CLI 2010) were developed using a building block paradigm whereby conservation objectives are linked to specific flow components. These recommendations led to a five-year agreement by NETMWD and USACOE to modify releases of water from Lake O' the Pines beginning in 2011 (CLI 2015). Studies are underway to assess abiotic and biotic responses to the recommended flow regime. This study will provide important information for assessing the adequacy of the recommended flow regime and the need for future adjustments.

One of the objectives of the Flows Project is to implement flows needed to support recreation on Big Cypress Bayou and Caddo Lake (CLI 2015). This objective is shared by TPWD, specifically relating to two programs: the Texas Paddling Trails and the River Access and Conservation Area Programs. Currently paddling trails in the Cypress Basin are limited to the Caddo Lake area (TPWD 2016a) and there are no leased public access sites (TPWD 2016b); however, there is interest from TPWD, local partners, and area recreationalists to provide more public access between Lake O' the Pines and Caddo Lake for fishing and kayaking (Appendix A). Data collected to support the Flows Project would also provide valuable information for future paddling trails and leased fishing access sites.

Study Area

The Cypress Basin, part of the Red River Basin, is located in northeast Texas and northwest Louisiana. The basin encompasses 728,305 ha (2,812 mi²) and is dominated by pine and oak forests (TCEQ 2002). Paper and steel manufacturing, livestock production, and oil and gas production are the primary drivers of the economy within the basin (TCEQ 2002; USACOE 1995). The primary stream in the basin, Big Cypress Creek, originates in Hopkins County, TX and flows 97 km before it becomes Big Cypress Bayou downstream of Lake O' the Pines. Big Cypress Bayou then flows approximately 66 km before reaching Caddo Lake which spans the border between Texas and Louisiana. Little and Black Cypress bayous are the major tributaries of Big Cypress Bayou.

The Cypress Basin is known for its high diversity of river habitats, freshwater fish, and freshwater mussels (USFWS 1985; Braun and Moring 2013). Black Cypress Bayou was nominated as a least-impacted reference stream candidate by the Texas Commission on Environmental Quality (TCEQ) in 2005 based on high to exceptional scores for water quality, instream habitat, and fish community data (TCEQ 2005).

The basin does exhibit some water quality deficiencies in the form of low dissolved oxygen; however, this is something often characteristic of East Texas streams due to a combination of high allochthonous inputs and low flows (TCEQ 2002).

There are eight major reservoirs within the Cypress Basin which supply municipal and industrial water, as well as provide recreational opportunities, power plant cooling, and some flood control capacity (USACOE 1995). Lake O' the Pines, which impounds Big Cypress Bayou, was constructed in 1957 and is jointly owned and operated by USACOE and NETMWD. The reservoir holds approximately 254,900 acre-feet of water at conservation pool, but has a flood control capacity of 587,200 acre-feet (USACOE 1995). The primary purposes of Lake O' the Pines are municipal and industrial water supply, recreation, and flood control. Currently flow releases from Lake O' the Pines into Big Cypress Bayou follow the voluntary agreement outlined in the Flows Project recommendation report (CLI 2010).

Survey and Management History

Biological Surveys: Big Cypress Bayou, its tributaries, Caddo Lake and other reservoirs in the Cypress Basin are well-studied systems. Numerous studies on hydrology, geomorphology, water quality, and biological communities have been conducted. In the last 60 years, over 50 biological studies have been conducted in the basin focusing on fish communities, aquatic macroinvertebrate communities, and riparian and wetland vegetation (Winemiller et al. 2005). Historically, 71 fish species (Winemiller et al. 2005) and 34 freshwater mussel species (TPWD 2008) have been collected from the basin including several imperiled species. No comprehensive lists of historical benthic macroinvertebrate taxa or riparian plant species are available.

In support of the Flows Project, the United States Geological Survey (USGS) conducted a baseline assessment of instream aquatic habitats, fish communities, and freshwater mussels in Big, Little, and Black Cypress bayous during 2010 and 2011 (Braun and Moring 2013). During that study, 34 species of fish were collected from one site on Big Cypress Bayou. Fewer fish species were found at the sites on Little and Black Cypress bayous which had 33 and 26 species respectively. Fifteen species of mussels and 182 individuals were collected across three sites on Big and Black Cypress bayous, with Big Cypress Bayou being the most species rich with 13 species of freshwater mussel collected from one site (Braun and Moring 2013).

Imperiled Species: Historical fish collections from the Cypress Basin contain seven species currently identified by TPWD (2012) as SGCN: Blackspot Shiner *Notropis atrocaudalis*, Ironcolor Shiner *Notropis chalybaeus*, Taillight Shiner *Notropis maculatus*, Bluehead Shiner *Pteronotropis hubbsi*, Blackside Darter *Percina maculata*, Creek Chubsucker *Erimyzon oblongus* (now known as Western Creek Chubsucker *Erimyzon claviformis* in Texas), and Paddlefish *Polyodon spathula* (Braun and Moring 2013; Hendrickson and Cohen 2015; TPWD 2012; Winemiller et al. 2005). Bluehead Shiner, Blackside Darter, Creek Chubsucker, and Paddlefish are concurrently listed as state threatened in Texas (TPWD 2012). In 2010 and 2011, Braun and Moring (2013) collected nine Ironcolor Shiners and 14 Blackside Darters from Little Cypress Bayou and 13 Taillight Shiners from Big Cypress Bayou.

Historically four species of freshwater mussels concurrently listed as state threatened and SGCN have been collected from the Cypress Basin: Louisiana Pigtoe *Pleurobema riddellii*, Texas Pigtoe *Fusconaia askewi*, Sandbank Pocketbook *Lampsilis satura*, and Southern Hickorynut *Obovaria jacksoniana*. Braun and Moring (2013) found no state listed or SGCN mussel species during their 2010 surveys in Big Cypress and Black Cypress bayous.

Sport fish Harvest Regulations: Sport fishes in Big, Little, and Black Cypress bayous are all managed under the statewide freshwater fishing regulations (TPWD 2015a).

Sport fish Surveys: Surveys targeting sport fish species were conducted in 1995 (boat electrofishing and hoop netting) and 2001 (bass-only boat electrofishing) in Big Cypress Bayou downstream of Jefferson, TX. Largemouth Bass *Micropterus salmoides* were abundant, but the size structure of the population was poor. Few fish exceeded the 14-inch minimum harvest length limit, especially those collected during the 2001 survey. The population of Spotted Bass *Micropterus punctulatus* also exhibited poor size structure. Channel Catfish *Ictalurus punctatus* were present in low numbers during the 1995 survey. Data from 1995 and 2001 surveys are found in Appendix B. No surveys specifically targeting sport fish species have been conducted since 2001.

Fish Stockings: Two species of fish have historically been stocked in Big Cypress Bayou: the Florida subspecies of Largemouth Bass *M. salmoides floridanus* (FLMB) and Paddlefish (CLI 2015; TPWD 2015b). In the past two decades, TPWD has stocked over 305,000 FLMB fingerlings in Big Cypress Bayou in an effort to enhance fishing in the area (Table 1), but stockings of this species have not occurred since 2003. Additionally from 1981 to 2015, TPWD stocked over 8.5 million FLMB fingerlings and fry in Caddo Lake, which have the potential to migrate into Big Cypress Bayou.

TABLE 1.—Stockings of Paddlefish and Florida Largemouth Bass (FLMB) in Big Cypress Bayou (TPWD 2015a).

Date	Species Stocked	Site	Number Stocked
June 1993	Paddlefish	Big Cypress at CR 2231	5,330
July 1993	Paddlefish	Big Cypress at boat ramp and CR 2231	5,666
June 1994	Paddlefish	Big Cypress unspecified	4,480
July 1994	Paddlefish	Big Cypress at Caddo Lake State Park	750
June 1995	Paddlefish	Big Cypress at Hwy 259 boat ramp	4,710
June 1997	Paddlefish	Big Cypress at 997 bridge and unspecified	12,644
June 1998	Paddlefish	Big Cypress at 259 boat ramp, unspecified	14,634
May 1999	FLMB	Big Cypress at Thompson Crossing	100,023
June 2000	FLMB	Big Cypress unspecified	103,700
June 2000	Paddlefish	Big Cypress at CR 2231	4,719
May 2003	FLMB	Big Cypress unspecified	101,317
March 2014	Paddlefish	Big Cypress at Caddo Lake State Park	47
Sept 2014	Paddlefish	Big Cypress at Caddo Lake State Park	2,005

Paddlefish were stocked during the 1990's and in 2014 in an effort to restore the state threatened species to Big Cypress Bayou and Caddo Lake (Table 1; Diaz et al. 2015; TPWD 2015b). From 1992–2000 TPWD stocked approximately 53,000 Paddlefish fingerlings at various locations in Big Cypress Bayou and 26,684 fingerlings in Caddo Lake. Concurrent stockings in four other Texas river basins (Trinity, Sabine, Neches, and Angelina) failed to establish reproducing populations of Paddlefish. This was attributed to loss of fish downstream through dams and a lack of suitable spawning habitat (Betsill 1999). Anecdotal evidence suggests the 1990's Cypress Basin stockings were also unsuccessful and by the late 2000's it was suspected that few, if any, Paddlefish remained in the system (Bob Betsill, TPWD, personal communication).

In 2008 USACOE constructed cobble shoals in Big Cypress Bayou to serve as potential spawning sites for Paddlefish and provide benefits to other aquatic species (CLI 2015). In 2011 a voluntary flow agreement was put in place to, among other things, provide adequate streamflow for spawning, survival, and recruitment of Paddlefish. In March 2014, 47 tagged juvenile Paddlefish were released into Big Cypress Bayou as a test population to see if the river would support Paddlefish (Diaz et al. 2015). These fish were monitored for movement, growth, and survival. After this test population was deemed a success due to high retention and growth rates, 2,005 additional juvenile Paddlefish were released in September 2014 (TPWD 2015b). Monitoring of the 2014 stocked Paddlefish is ongoing.

Water Quality: The Cypress Basin is comprised of 10 TCEQ designated stream segments (TCEQ 2014a). This study focuses on three of those segments: Big Cypress Bayou between Lake O' the Pines and Caddo Lake (segment 0402), Little Cypress Bayou (0409), and Black Cypress Bayou (0410). Each of these segments has historically demonstrated low dissolved oxygen for at least a portion of their reach (TCEQ 2012a). Additionally, Big Cypress and Black Cypress bayous have historically had documented water quality concerns over heavy metals such as mercury, arsenic, barium, chromium, manganese, selenium, and zinc in sediments. Mercury in particular has been listed as a chemical of concern that has led to a fish consumption advisory for Big Cypress Bayou and Caddo Lake in Marion and Harrison counties, TX (TPWD 2015c).

Recreational Access and Use: Creel surveys conducted in 1999 and 2001 on Big Cypress Bayou at the Lake O' the Pines spillway and downstream of Jefferson, TX (TPWD Inland Fisheries Division, unpublished data; Appendix A) show a significant amount of fishing effort was expended by anglers targeting sport fish species. Anglers primarily targeted Channel Catfish and Largemouth Bass, with other notable target species including sunfishes, crappies, and Flathead Catfish *Pylodictis olivaris*. While Big Cypress Bayou downstream of Lake O' the Pines does not offer extensive public bank fishing opportunities, it does have several public access points for boats and kayaks. There are five public boat ramps on Big Cypress Bayou downstream of Lake O' the Pines: Lake O' the Pines spillway, in the City of Jefferson, TX, Thompson Camp, upstream of Caddo Lake State Park, and at Caddo Lake State Park. Big Cypress Bayou also has five established paddling trails just upstream of and adjoining Caddo Lake State Park totaling over 32 km (TPWD 2016a). A paddling trail application has been submitted for Big Cypress Bayou upstream of Jefferson, TX, near one of the sites for this study, but is currently awaiting a finalized agreement. Due to their smaller sizes, Little and Black bayous do not offer any designated public river access or paddling trails. As there are no public parks along either of these tributaries, the only public access to these streams is at highway bridge crossings.

STUDY SITES

Sampling effort varied among 14 sites within the Cypress Basin (Figure 1; Table 2). The most comprehensive efforts took place at four aquatic bioassessment sites located on Big Cypress, Little Cypress, and Black Cypress bayous. At each of these sites fish surveys, mussel surveys, and stream health assessments were conducted. Additionally, at the two sites on Big Cypress Bayou, benthic macroinvertebrates were sampled and the riparian community was assessed. These four sites were selected to mirror sites in the USGS Cypress Basin baseline study (Braun and Moring 2013). However, to facilitate future monitoring efforts, the sites on Little and Black Cypress bayous were shifted approximately 2.4 km upstream and approximately 0.8 km downstream respectively from the USGS baseline study sites. Fish data was collected at 10 additional sites throughout the Cypress Basin (Figure 1; Table 2) where fish assemblage data was either lacking or outdated based on historical data in the Fishes of Texas database (Hendrickson and Cohen 2015).

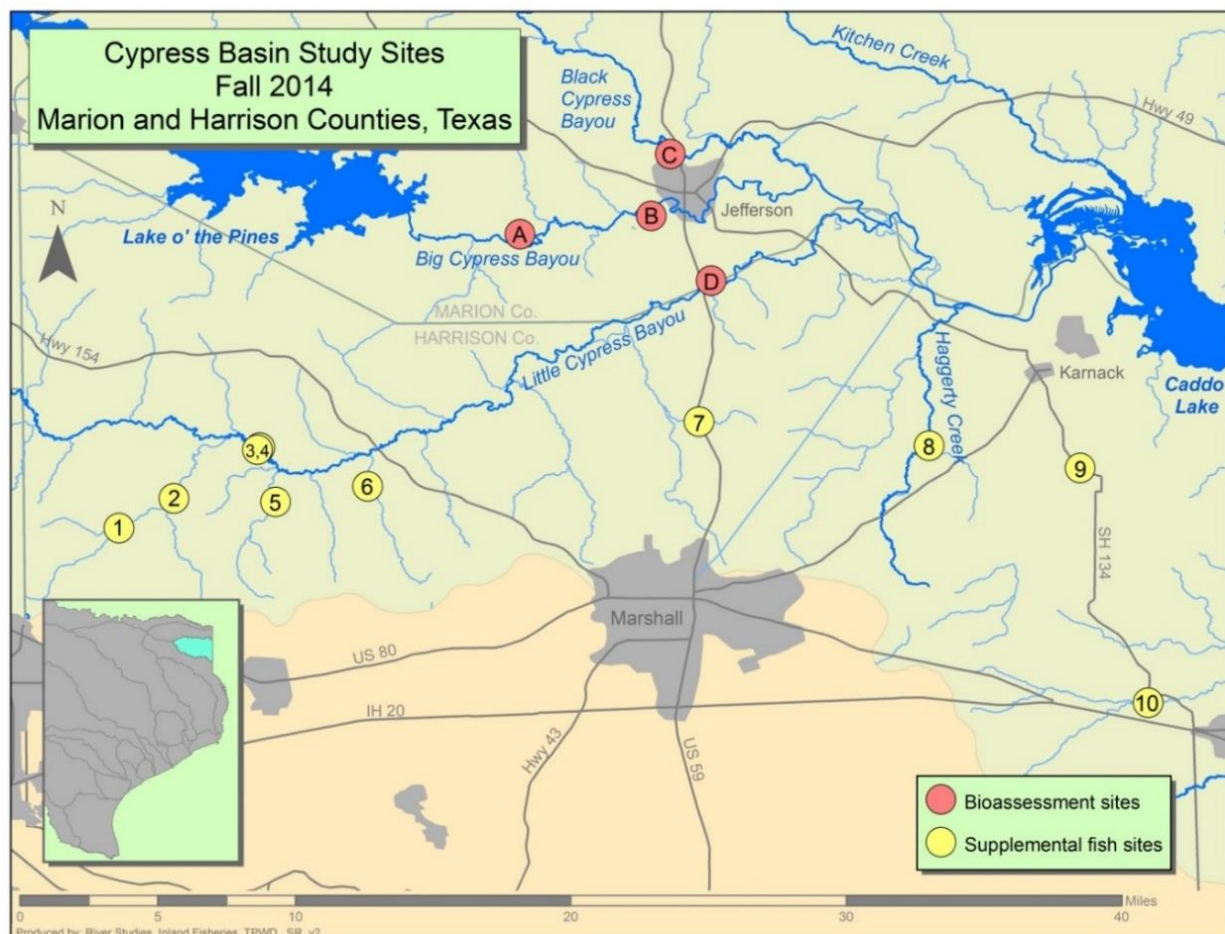


FIGURE 1.—Locations of Cypress Basin study sites in Marion and Harrison counties, TX. See Table 2 for site location information.

TABLE 2.—Cypress Basin study site locations and the type of data collected at each site during the fall of 2014 in Marion and Harrison counties, TX. Sites designated with letters represent bioassessment sites and sites designated with numbers represent supplemental fish collection sites.

Site	Location	Date	Fish	Mussels	Stream Health	Riparian	Macro-Inverts.
A	Big Cypress near French Creek	9/11/2014	x	x	x	x	x
B	Big Cypress upstream of Jefferson, TX	9/10/2014	x	x	x	x	x
C	Black Cypress upstream of US 59	10/10/2014	x	x	x		
		10/29/2014		x			
D	Little Cypress downstream of US 59	10/11/2014	x	x	x		
		10/28/2014		x			
1	Moccasin Creek at FM 2208	10/11/2014	x				
2	Moccasin Creek at FM 449	10/11/2014	x				
3	Little Cypress at FM 450	10/11/2014	x				
4	Little Cypress oxbow at FM 450	10/11/2014	x				
5	Page Creek at FM 449	10/11/2014	x				
6	Caney Creek at Airlite Rd	10/11/2014	x				
7	Unnamed tributary of Grays Creek at US 59	10/10/2014	x				
8	Haggerty Creek at Rayburn Rd.	10/12/2014	x				
9	Harrison Bayou at SH 134	10/12/2014	x				
10	Paw Paw Bayou at Jonesville Cutoff Rd.	10/12/2014	x				

Big Cypress Bayou

Two sites were selected on Big Cypress Bayou in Marion County, TX (Figure 1): Site A near the confluence with French Creek and Site B immediately upstream of Jefferson, TX. Both sites were characterized by predominately sand and silt substrates, tannin stained water, large quantities of woody debris, overhanging riparian vegetation, and minimal aquatic macrophytes (Figure 2). Site A differed from Site B by the presence of deeper habitats and no riffles. Site B also contained man-made cobble and boulder shoals that were added to the reach as part of the Big Cypress Restoration Project.



FIGURE 2.—Habitats found on Big Cypress Bayou Site A near the confluence with French Creek (left) and Site B upstream of Jefferson, TX (right).

Black Cypress Bayou

Site C located on Black Cypress Bayou in Marion County, TX was downstream of US 59 (Figure 1). This reach of Black Cypress Bayou was dominated by deep pool habitats, sandy substrates, tannin stained water, sloughing banks, and moderate amounts of woody debris (Figure 3). This site had a lower diversity of mesohabitats compared to the other three bioassessment sites.



FIGURE 3.—Habitats found at Site C on Black Cypress Bayou near US 59 north of Jefferson, TX consisted of mostly deep pool habitats (left) with a few short sections of run (right).

Little Cypress Bayou

The study site on Little Cypress Bayou (Site D) was located in Marion County, TX upstream of US 59 (Figure 1). Little Cypress Bayou had a narrower channel than Big Cypress Bayou and high diversity of mesohabitats including runs, riffles, pools, and backwaters (Figure 4). The water was tannin-stained and the stream channel contained large amounts of leaf litter and some woody debris.

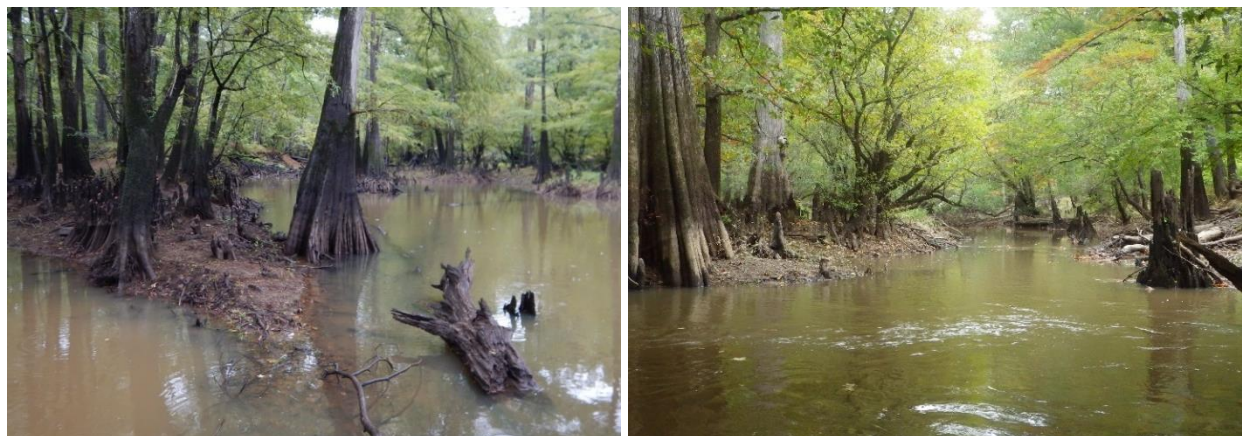


FIGURE 4.—Site D on Little Cypress Bayou at State Highway 59 south of Jefferson, TX contained a diversity of habitats including riffles, pools, backwaters (left), and runs (right).

Supplemental Fish Collection Sites

Ten supplemental fish collection sites were sampled (Sites 1-10; Figure 1; Table 2) in Harrison County, TX. These included sites on Little Cypress Bayou, an oxbow of Little Cypress Bayou, and on tributaries of Little Cypress Bayou (Moccasin Creek, Page Creek, Caney Creek, and an unnamed tributary of Grays Creek), Big Cypress Bayou (Haggerty Creek), Caddo Lake (Harrison Bayou), and Cross Lake in Louisiana (Paw Paw Bayou). These sites were sampled to serve the specific purpose of filling statewide fish data gaps, and as such, limited descriptive site information was recorded at the time of sampling. Photos of each site are included to give reference to site conditions where fish were collected (Figure 5).



FIGURE 5.—Supplemental fish collection sites 1-10, with the exception of Site 7, that were sampled October 10–12, 2014. Photos are labeled with the corresponding site numbers in Table 2.



FIGURE 5.—Continued.

WATER QUALITY AND QUANTITY

Methods: Water temperature, specific conductivity, dissolved oxygen, and pH were recorded in 15-min intervals for 19.5 h beginning the afternoon of September 10, 2014 in Big Cypress Bayou (Site B) using a YSI multi-parameter water quality data logger. The same unit was also deployed upstream at Site A for 1.5 h the morning of September 11, 2014. Total dissolved solids (TDS) concentrations were calculated by multiplying specific conductivity by 0.64 (Atekwana et al. 2004). Instantaneous measurements were recorded from Black Cypress (Site C) and Little Cypress (Site D) bayous during the afternoons of October 10 and 11, respectively. Data were verified using TCEQ quality assurance procedures (TCEQ 2014b). Means were calculated for each verified parameter and evaluated in context of the specific surface water quality standards established for each creek (TCEQ 2012b).

Stream discharge was measured at Site A and Site B on Big Cypress Bayou using a SonTek FlowTracker and following protocols outlined in Turnipseed and Sauer (2010).

Results and Discussion: All three stream segments sampled during this study are listed as impaired by TCEQ for not meeting established water quality standards (TCEQ 2012a). Big Cypress Bayou downstream of Lake O' the Pines (Segment 0402) is listed for low pH, depressed dissolved oxygen, and elevated mercury concentrations in edible tissue (TCEQ 2012a). Black Cypress (Segment 0410) and Little Cypress (Segment 0409) bayous are listed for elevated bacteria levels and depressed dissolved oxygen (TCEQ 2012a). TCEQ published an extensive evaluation of dissolved oxygen in Black Cypress Bayou (Crowe and Bayer 2005) and encouraged the adoption of site-specific seasonal criteria using a

dissolved oxygen regression equation based on water temperature, stream discharge, and watershed area. The premise behind the recommendation for site-specific dissolved oxygen criteria was that depressed dissolved oxygen concentrations in the stream are natural and should not result in an impaired listing. Similar explanations are likely for the low dissolved oxygen levels in Big Cypress and Little Cypress bayous given their habitat similarities with Black Cypress Bayou. Black Cypress Bayou is also documented to have elevated copper concentrations in the water and mercury concentrations in edible tissue.

Water temperature, dissolved oxygen, and pH met their designated TCEQ water quality standards during this study for Big Cypress Bayou (Table 3) and Little Cypress Bayou (Table 4). No standards exist for Black Cypress Bayou; however, proposed standards are currently being reviewed by the Environmental Protection Agency and are similar to those reported for Little Cypress Bayou (Water Monitoring Solutions 2013). While no standard exists for specific conductivity, it can be used as a means of indirectly measuring TDS. Based upon specific conductivity, TDS was also within established standards for Big Cypress and Little Cypress bayous (Tables 3 and 4). Bacteria and metals were not evaluated during this study.

TABLE 3.—Water quality summary data from Site A on Big Cypress Bayou, September 10–11, 2014. TCEQ water quality standards for Segment 0402: Big Cypress Bayou between Lake O’ the Pines and Caddo Lake (TCEQ 2014a) are reported for comparison.

	Temperature (°C)	Specific Conductivity (μ S/cm)	Total Dissolved Solids (mg/L)	Dissolved Oxygen (mg/L)	pH
Mean	28.4	192	123	6.9	7.0
Minimum	27.8	191	122	4.0	6.6
Maximum	28.8	199	127	9.2	7.2
TCEQ Standard	≤ 33.9	N/A	≤ 300	24 hr avg: ≥ 5 24 hr min: ≥ 3	6-8.5

TABLE 4.—Water quality summary based upon instantaneous measurements collected from Black Cypress Bayou on October 10, 2014, and from Little Cypress Bayou on October 11, 2014. TCEQ water quality standards for Segment 0409: Little Cypress (TCEQ 2014a) are reported for comparison. No standards exist for Black Cypress Bayou.

	Temperature (°C)	Specific Conductivity (μ S/cm)	Total Dissolved Solids (mg/L)	Dissolved Oxygen (mg/L)	pH
Black Cypress Bayou	23.6	65	42	4.6	6.1
Little Cypress Bayou	22.4	165	106	3.3	6.6
TCEQ Standard	≤ 32.2	-	≤ 300	Grab min: ≥ 3	5.5-8.5

Stream discharge at the time of sampling was typical of historical conditions during September. Measured discharge at Site B on Big Cypress Bayou was 1.13 m³/s (40 ft³/s) on September 9, 2014, as compared to a measurement of 1.39 m³/s (49 ft³/s) recorded approximately 17 km upstream at USGS gage 07346000 Big Cypress Bayou near Jefferson. The mean discharge from the USGS gage for the period of record (1957–2014) on September 9 is 1.56 m³/s (55 ft³/s). Measured discharge at Site A on Big Cypress Bayou was 1.19 m³/s (42 ft³/s) on September 11, 2014, as compared to the measurement of 1.42 m³/s (50 ft³/s) at the USGS gage approximately 8 km upstream. Mean discharge for the period of record (1957–2014) for September 11 is 1.47 m³/s (52 ft³/s). These flows are slightly higher than the recommended baseflow of 1.13 m³/s (40 ft³/s) for an average or wet year (CLI 2010) which were set to maintain fish habitat and provide connectivity to backwaters and oxbows.

FISH ASSEMBLAGE

Bioassessment Sites (Sites A-D)

Methods: Fish were collected from bioassessment sites on Big Cypress Bayou on September 10–11, 2014, Little Cypress Bayou on October 11, 2014, and Black Cypress Bayou on October 10, 2014 (Table 2). Backpack electrofishers and seines were employed at all wadable, lotic sites. In addition, a boat electrofisher was used to sample deep habitats at both sites on Big Cypress Bayou (sites A and B) and a gill net was deployed at the Black Cypress Bayou site (Site C). Boat electrofishing was also conducted in an oxbow lake adjacent to Site B on Big Cypress Bayou.

Sampling techniques were selected based on effectiveness at capturing fish at each particular sampling area given the depth, velocity, substrate, and cover present. Expanding upon TCEQ sampling protocols (2014b), a minimum sampling effort of 10 seine hauls and 15 minutes of electrofishing effort was established for each site; however, additional sampling continued if needed until all habitats had been effectively sampled and new species were not collected.

Fish from each sample (i.e. electrofishing transect or seine haul) were kept separate and habitat data was recorded at the location of each sample. This habitat data included measurements of depth, velocity, substrate, and instream cover. While habitat data was not incorporated into this report, it will be available for future analysis of fish-habitat associations.

Once captured, large fish were identified to species, measured, photographed, and released. Smaller specimens were fixed in a 10% solution of formalin for later identification and enumeration in the laboratory. All fish were examined for external deformities, disease, lesions, tumors, and skeletal abnormalities. Vouchered specimens will be permanently housed at the University of Texas Biodiversity Collections Facility in Austin, Texas. This data will also be available online through the Fishes of Texas Project (Hendrickson and Cohen 2015).

Regionalized Index of Biotic Integrity (IBI) metrics developed for the South Central and Southern Humid, Mixed Land Use Region (Linam et al. 2002) were calculated for the four bioassessment sites. The IBI provides a means of generally assessing fish assemblage degradation due to water quality. Results are reported as an aquatic life use and possible rankings include exceptional, high, intermediate, and limited.

Results and Discussion: Forty-seven fish species and 1,356 individuals were collected across the four bioassessment sites (Table 5). Sites A and D each yielded 32 species, while 28 species were identified from Sites B and C. The number of species captured at both sites on Big Cypress Bayou during this study was slightly lower than the most recently available fish surveys on Big Cypress Bayou, the 2010-2011 USGS study, which found 37 species at Site B over both years (Braun and Moring 2013). USGS did not collect fish at Site A. Twenty-eight species were collected during this study at Site C on Black Cypress Bayou, in comparison to 26 collected in 2010 by USGS. This study also collected 32 species on Little Cypress Bayou in comparison to 33 species collected in 2010 by USGS.

Nine native cyprinid species were collected from the four bioassessment sites. Ribbon Shiner *Lythrurus fumeus* was found at each bioassessment site and was the most abundant cyprinid collected (Table 5; Figure 6). This species has been previously characterized as a habitat generalist (Snelson 1973; Herbert and Gelwick 2003). Weed Shiner *Notropis texanus*, which was collected at all bioassessment sites except Little Cypress Bayou, has been hypothesized to be a floodplain specialist. Ross and Baker (1983) suggested that Weed Shiner regularly utilize floodplain habitats when available and increases in inundation of the floodplain were correlated with high annual abundances of the species. Weed Shiner is a potentially valuable indicator of the success of the implemented flow regime in Big Cypress Bayou.

Several cyprinids were only collected from one site including Cypress Minnow *Hybognathus hayi* and Golden Shiner *Notemigonus crysoleucas* collected from Little Cypress Bayou and Pallid Shiner *Hybopsis amnis* collected from Site B on Big Cypress Bayou. Kwak (1991) suggests there is a correlation between Pallid Shiner abundance and stream discharge and he hypothesized that floodplain inundation may be important to reproduction and survival of juveniles. Monitoring biotic responses of this species may also serve as an indicator of the success of the implemented flow regime.

Spotted Sucker *Minytrema melanops* was the only catostomid collected and was present at all bioassessment stations. Four catfish species were collected, two of which were found in all three streams: Yellow Bullhead *Ameiurus natalis* and Freckled Madtom *Noturus nocturnus*. Channel Catfish and Tadpole Madtom *N. gyrinus* were not collected from Black Cypress Bayou; however, both have been reported in previous collections (Crowe and Bayer 2005). Freckled and Tadpole madtoms have both been listed as intolerant species and their presence across the four sites is an indicator of high quality and stable habitat conditions (Linam and Kleinsasser 1998).

Twelve centrarchid species were collected with Longear Sunfish *Lepomis megalotis* being the most abundant (Figure 6). Most species were found across several sample sites; however, a few were only captured at one. The non-native Redbreast Sunfish *Lepomis auritus* was only collected from Big Cypress Bayou. Black Crappie *Pomoxis nigromaculatus* was only collected in Little Cypress Bayou and Bantam Sunfish *Lepomis symmetricus* was unique to the oxbow lake near Site B.



FIGURE 6.—The most abundant species collected across the four bioassessment sites shown from left to right are Longear Sunfish, Ribbon Shiner, Blacktail Shiner, and Bullhead Minnow. The first two species were collected from all four sites, while the latter two were only collected from the mainstem Big Cypress Bayou sites.

TABLE 5.—Abundance of fish collected by species for all gear types combined by site from Big Cypress, Little Cypress, and Black Cypress bayous, Marion County, Texas. Sites: A. Big Cypress Bayou near French Creek (9/11/2014), B. Big Cypress Bayou upstream of Jefferson (9/10/2014), C. Black Cypress Bayou at US 59 (10/10/2014), D. Little Cypress Bayou at US 59 (10/11/2014), Oxbow. oxbow lake adjacent to Site B (9/10/2014).

Family	Scientific name	Common name	Site A	Site B	Site C	Site D	Oxbow
Lepisosteidae	<i>Lepisosteus oculatus</i>	Spotted Gar	3			1	4
	<i>Lepisosteus osseus</i>	Longnose Gar	1				
Amiidae	<i>Amia calva</i>	Bowfin			1		4
Clupeidae	<i>Dorosoma cepedianum</i>	Gizzard Shad	9	13			
Cyprinidae	<i>Cyprinella venusta</i>	Blacktail Shiner	7	96			
	<i>Cyprinus carpio</i>	Common Carp	1				
	<i>Hybognathus hayi</i>	Cypress Minnow				2	
	<i>Hybopsis amnis</i>	Pallid Shiner		2			
	<i>Luxilus chrysocephalus</i>	Striped Shiner			1	4	
	<i>Lythrurus fumeus</i>	Ribbon Shiner	7	75	37	21	
	<i>Notemigonus crysoleucas</i>	Golden Shiner				2	
	<i>Notropis texanus</i>	Weed Shiner	1	21	22		
	<i>Opsopoeodus emiliae</i>	Pugnose Minnow		1	2		
	<i>Pimephales vigilax</i>	Bullhead Minnow	1	95			
	Catostomidae	<i>Minytrema melanops</i>	Spotted Sucker	3	19	3	10
Ictaluridae	<i>Ameiurus natalis</i>	Yellow Bullhead	1		1	4	
	<i>Ictalurus punctatus</i>	Channel Catfish	1	1		4	
	<i>Noturus gyrinus</i> ¹	Tadpole Madtom	1	2		4	
	<i>Noturus nocturnus</i> ¹	Freckled Madtom	3	3	23	55	
Esocidae	<i>Esox americanus</i>	Redfin Pickerel	1		1	5	
Aphredoderidae	<i>Aphredoderus sayanus</i>	Pirate Perch	8	2	14	42	1
Atherinopsidae	<i>Labidesthes sicculus</i> ¹	Brook Silverside	44	16	26	8	
Fundulidae	<i>Fundulus notatus</i>	Blackstripe Topminnow	21	1	39	20	
Poeciliidae	<i>Gambusia affinis</i>	Western Mosquitofish	17	5	10	40	20
Centrarchidae	<i>Centrarchus macropterus</i>	Flier			2	1	
	<i>Lepomis auritus</i>	Redbreast Sunfish	2	2			
	<i>Lepomis cyanellus</i>	Green Sunfish		1	2	1	
	<i>Lepomis gulosus</i>	Warmouth		1	1	11	
	<i>Lepomis macrochirus</i>	Bluegill	7	7	14	17	
	<i>Lepomis megalotis</i>	Longear Sunfish	44	53	9	37	
	<i>Lepomis microlophus</i>	Redear Sunfish	5	7	2	1	
	<i>Lepomis miniatus</i>	Redspotted Sunfish	8	5	3	5	
	<i>Lepomis</i> sp. (unknown)	Juvenile sunfish species			9	7	
	<i>Lepomis symmetricus</i>	Bantam Sunfish					6
	<i>Micropterus punctulatus</i>	Spotted Bass	6	3	1		
	<i>Micropterus salmoides</i>	Largemouth Bass	3	1	3	2	
	<i>Pomoxis nigromaculatus</i>	Black Crappie				2	
Percidae	<i>Ammocrypta vivax</i>	Scaly Sand Darter	1				
	<i>Etheostoma artesia</i>	Redspot Darter			2	17	
	<i>Etheostoma asprigene</i>	Mud Darter			4	9	
	<i>Etheostoma chlorosoma</i>	Bluntnose Darter				3	
	<i>Etheostoma gracile</i>	Slough Darter	7		5	19	
	<i>Etheostoma histrio</i>	Harlequin Darter	5	4	1	3	
	<i>Etheostoma proeliare</i> ¹	Cypress Darter			3	18	
	<i>Percina caprodes</i> ¹	Logperch	9	13		3	
	<i>Percina maculata</i> ¹	Blackside Darter	1	1			
	<i>Percina sciera</i> ¹	Dusky Darter	7	12	1	3	
Sciaenidae	<i>Aplodinotus grunniens</i>	Freshwater Drum	1				
Number of species collected			32	28	28	32	5
Number of individuals collected			236	462	242	381	35

1-Intolerant species (Linam and Kleinsasser 1998)

Ten species of darters were collected. Harlequin Darter *Etheostoma histrio* and Dusky Darter *Percina sciera* were collected from all four bioassessment sites. Bluntnose Darter *Etheostoma chlorosoma* was only collected from Little Cypress Bayou while Blackside Darter and Scaly Sand Darter *Ammocrypta vivax* were only found in Big Cypress Bayou. Four of the darter species collected (Cypress Darter *Etheostoma proeliare*, Blackside Darter, Logperch *Percina caprodes*, and Dusky Darter) have been classified as intolerant taxa and are important indicators of stream health (Linam and Kleinsasser 1998).

Big Cypress Bayou rated as having an exceptional aquatic life use based upon the regionalized IBI (Tables 6 and 7). Brook Silverside *Labidesthes sicculus* and Longear Sunfish were the two most abundant species at Site A, comprising 19% of the catch each; whereas, Blacktail Shiner *Cyprinella venusta* and Bullhead Minnow *Pimephales vigilax* were the most abundant species downstream at Site B, each making up a total of 21% of the fish collected. A high number of intolerant taxa, including the abundant Brook Silverside, contributed to the exceptional aquatic life use scores at each site.

TABLE 6.—Index of Biotic Integrity results for Big Cypress Bayou, Site A (Marion County, Texas).

Collector: Robertson et al.			September-14		Ecoregions 33 & 35	
Metric Category	Intermediate Totals for Metrics		Metric Name	Raw Value	IBI Score	
	Drainage Basin Size (km ²)	3800				
Species Richness and Composition	Number of Fish Species	32	Number of Fish Species	32	5	
	Number of Native Cyprinid Species	4	Number of Native Cyprinid Species	4	3	
	Number of Benthic Invertivore Species	9	Number of Benthic Invertivore Species	9	5	
	Number of Sunfish Species	5	Number of Sunfish Species	5	5	
	Number of Intolerant Species	6	Number of Intolerant Species	6	5	
	Number of Individuals as Tolerants ^a	23	% of Individuals as Tolerant Species ^a	9.7	5	
Trophic Composition	Number of Individuals as Omnivores	12	% of Individuals as Omnivores	5.1	5	
	Number of Individuals as Invertivores	210	% of Individuals as Invertivores	89.0	5	
	Number of Individuals as Piscivores	14	% of Individuals as Piscivores	5.9	3	
Fish Abundance and Condition	Number of Individuals (Seine)	90	Number of Individuals in Sample		2	
	Number of Individuals (Shock)	146	Number of Individuals/seine haul	7.5	1	
	Number of Individuals in Sample	236	Number of Individuals/min electrofishing	3.95	3	
	# of Individuals as Non-native species	3	% of Individuals as Non-native Species	1.3	5	
	# of Individuals With Disease/Anomaly	0	% of Individuals With Disease/Anomaly	0.0	5	
				Index of Biotic Integrity Numeric Score:		53
				Aquatic Life Use:		Exceptional
This data should be incorporated with water quality, habitat, and other available biological data to assign an overall stream score.						

^a Excluding Western Mosquitofish

TABLE 7.—Index of Biotic Integrity results for Big Cypress Bayou, Site B (Marion County, Texas).

Collector: Robertson et al.			September-14		Ecoregions 33 & 35	
Metric Category	Intermediate Totals for Metrics		Metric Name	Raw Value	IBI Score	
	Drainage Basin Size (km ²)	3800				
Species Richness and Composition	Number of Fish Species	28	Number of Fish Species	28	5	
	Number of Native Cyprinid Species	6	Number of Native Cyprinid Species	6	5	
	Number of Benthic Invertivore Species	7	Number of Benthic Invertivore Species	7	5	
	Number of Sunfish Species	7	Number of Sunfish Species	7	5	
	Number of Intolerant Species	6	Number of Intolerant Species	6	5	
	Number of Individuals as Tolerants ^a	23	% of Individuals as Tolerant Species ^a	5.0	5	
Trophic Composition	Number of Individuals as Omnivores	14	% of Individuals as Omnivores	3.0	5	
	Number of Individuals as Invertivores	442	% of Individuals as Invertivores	95.7	5	
	Number of Individuals as Piscivores	6	% of Individuals as Piscivores	1.3	1	
Fish Abundance and Condition	Number of Individuals (Seine)	297	Number of Individuals in Sample		3	
	Number of Individuals (Shock)	165	Number of Individuals/seine haul	21.2	3	
	Number of Individuals in Sample	462	Number of Individuals/min electrofishing	7.08	3	
	# of Individuals as Non-native species	2	% of Individuals as Non-native Species	0.4	5	
	# of Individuals With Disease/Anomaly	2	% of Individuals With Disease/Anomaly	0.4	5	
				Index of Biotic Integrity Numeric Score:		54
				Aquatic Life Use:		Exceptional
This data should be incorporated with water quality, habitat, and other available biological data to assign an overall stream score.						

^a Excluding Western Mosquitofish

Black Cypress Bayou received an exceptional aquatic life use rating (Table 8). The most numerous species collected were Blackstripe Topminnow *Fundulus notatus* and Ribbon Shiner which comprised 16% and 15% of the catch respectively. Black Cypress Bayou had high species richness, no non-native species, and no fish collected with disease or anomalies, all of which contributed to the exceptional aquatic life use score.

TABLE 8.—Index of Biotic Integrity results for Black Cypress Bayou at US 59, Site C (Marion County, Texas).

Collector: University of Texas			October-14		Ecoregions 33 & 35	
Metric Category	Intermediate Totals for Metrics		Metric Name	Raw Value	IBI Score	
	Drainage Basin Size (km ²)	945				
Species Richness and Composition	Number of Fish Species	28	Number of Fish Species	28	5	
	Number of Native Cyprinid Species	4	Number of Native Cyprinid Species	4	3	
	Number of Benthic Invertivore Species	8	Number of Benthic Invertivore Species	8	5	
	Number of Sunfish Species	7	Number of Sunfish Species	7	5	
	Number of Intolerant Species	4	Number of Intolerant Species	4	5	
	Number of Individuals as Tolerants ^a	18	% of Individuals as Tolerant Species ^a	7.4	5	
Trophic Composition	Number of Individuals as Omnivores	1	% of Individuals as Omnivores	0.4	5	
	Number of Individuals as Invertivores	233	% of Individuals as Invertivores	95.9	5	
	Number of Individuals as Piscivores	9	% of Individuals as Piscivores	3.7	1	
Fish Abundance and Condition	Number of Individuals (Seine)	141	Number of Individuals in Sample		3	
	Number of Individuals (Shock)	93	Number of Individuals/seine haul	14.1	3	
	Number of Individuals in Sample	243	Number of Individuals/min electrofishing	5.92	3	
	# of Individuals as Non-native species	0	% of Individuals as Non-native Species	0.0	5	
	# of Individuals With Disease/Anomaly	0	% of Individuals With Disease/Anomaly	0.0	5	
				Index of Biotic Integrity Numeric Score:		52
				Aquatic Life Use:		Exceptional
This data should be incorporated with water quality, habitat, and other available biological data to assign an overall stream score.						

^a Excluding Western Mosquitofish

Little Cypress Bayou also rated as having an exceptional aquatic life use (Table 9). No particular fish species dominated the Little Cypress Bayou fish assemblage; however, the most numerous species were Freckled Madtom and Pirate Perch *Aphredoderus sayanus* which comprised 14% and 11% of the catch respectively. Little Cypress Bayou also had high species richness, no non-native species, and no fish collected with diseases or anomalies.

TABLE 9.—Index of Biotic Integrity results for Little Cypress Bayou at US 59, Site D (Marion County, Texas).

Collector: University of Texas			October-14		Ecoregions 33 & 35	
Metric Category	Intermediate Totals for Metrics		Metric Name	Raw Value	IBI Score	
	Drainage Basin Size (km ²)	1748				
Species Richness and Composition	Number of Fish Species	32	Number of Fish Species	32	5	
	Number of Native Cyprinid Species	4	Number of Native Cyprinid Species	4	3	
	Number of Benthic Invertivore Species	11	Number of Benthic Invertivore Species	11	5	
	Number of Sunfish Species	8	Number of Sunfish Species	8	5	
	Number of Intolerant Species	6	Number of Intolerant Species	6	5	
	Number of Individuals as Tolerants ^a	36	% of Individuals as Tolerant Species ^a	9.4	5	
Trophic Composition	Number of Individuals as Omnivores	10	% of Individuals as Omnivores	2.6	5	
	Number of Individuals as Invertivores	349	% of Individuals as Invertivores	91.6	5	
	Number of Individuals as Piscivores	22	% of Individuals as Piscivores	5.8	3	
Fish Abundance and Condition	Number of Individuals (Seine)	170	Number of Individuals in Sample		4	
	Number of Individuals (Shock)	211	Number of Individuals/seine haul	15.5	3	
	Number of Individuals in Sample	381	Number of Individuals/min electrofishing	11.72	5	
	# of Individuals as Non-native species	0	% of Individuals as Non-native Species	0.0	5	
	# of Individuals With Disease/Anomaly	0	% of Individuals With Disease/Anomaly	0.0	5	
				Index of Biotic Integrity Numeric Score:		55
				Aquatic Life Use:		Exceptional
This data should be incorporated with water quality, habitat, and other available biological data to assign an overall stream score.						

^a Excluding Western Mosquitofish

Supplemental Fish Collection Sites (Sites 1-10)

Methods: Fish were collected from ten supplemental sites throughout the Cypress Basin October 10-12, 2014 using a combination of seining and backpack electrofishing techniques (Table 2; Figure 1). Effort was expended until all available mesohabitats were sampled and no new species were collected. Fish were identified, measured, and released or preserved in 10% formalin and taken back to the laboratory for identification. Species that were released were vouchered via photograph prior to release. All vouchered specimens will be permanently housed at the University of Texas Biodiversity Collections facility in Austin, Texas. This data will also be available online through the Fishes of Texas Project (Hendrickson and Cohen 2015).

Results and Discussion: Across ten sites, a total of 1,745 individuals were collected representing 44 species (Table 10). The most species rich site was Site 3, Little Cypress Bayou at FM 450, which had 30 species including one state threatened species, Blackside Darter. The least diverse site, Site 4, was the oxbow adjacent to Site 3. The least species rich lotic sites were sites 6 and 7, Caney Creek and the unnamed tributary of Gray's Creek, which each had nine species.

The most numerous and widespread species collected during supplemental sampling was the Western Mosquitofish *Gambusia affinis* (Table 10; Figure 7). This was also the only species that occurred across all 10 sites. Bluegill *Lepomis macrochirus* was the second most widespread species, occurring at nine sites. Both of these species are considered to be tolerant of disturbance events and habitat degradation and are widely distributed throughout Texas (Linam and Kleinsasser 1998; Thomas et al. 2007). Ribbon Shiner was the second most abundant fish collected from supplemental sites; however, it only occurred at five sites.

Eight species of darters were collected from the supplemental sites. Four of these species are considered intolerant (Blackside Darter, Dusky Darter, Cypress Darter, and Goldstripe Darter *Etheostoma parvipinne*) and are indicators of stable, high quality habitat (Linam and Kleinsasser 1998).

Additionally, 12 cyprinid species were collected from supplemental sites including the SGCN Blackspot Shiner which is classified as a fluvial specialist (Herbert and Gelwick 2003). A fluvial specialist is a species that selects lotic macrohabitats such as runs and riffles and requires flowing water to complete some aspect of its life history. Other fluvial specialists collected during this study include the Western Creek Chubsucker, Freckled Madtom, Dusky Darter, and Goldstripe Darter. The occurrence of these species indicates the presence of functioning lotic habitats.



FIGURE 7.—Widespread and abundant fish species collected during the supplemental sampling shown from left to right are Western Mosquitofish, Blackstripe Topminnow, Bluegill, and Pirate Perch.

TABLE 10.—Abundance of fish collected by species for all gear types from sites throughout Cypress Basin October 10-12, 2014 in Harrison County, Texas. Sites: 1. Moccasin Creek at FM2208 (10/11/2014), 2. Moccasin Creek at FM 449 (10/11/2014), 3. Little Cypress at FM 450 (10/11/2014), 4. Little Cypress oxbow at FM 450 (10/11/2014), 5. Page Creek at FM 449 (10/11/2014), 6. Caney Creek at Airlite Rd. (10/11/2014), 7. Unnamed tributary of Grays Creek at US 59 (10/10/2014), 8. Haggerty Creek at Rayburn Rd. (10/12/2014), 9. Harrison Bayou at SH 134 (10/10/2014), 10. Paw Paw Bayou at Jonesville Cutoff Rd. (10/12/2014).

Family	Scientific name	Common name	1	2	3	4	5	6	7	8	9	10	
Amiidae	<i>Amia calva</i>	Bowfin			1								
Clupeidae	<i>Dorosoma cepedianum</i>	Gizzard Shad			1								
Cyprinidae	<i>Cyprinella venusta</i>	Blacktail Shiner			6								
	<i>Hybognathus hayi</i>	Cypress Minnow		36	8								
	<i>Hybopsis amnis</i>	Pallid Shiner			2								
	<i>Luxilus chrysocephalus</i>	Striped Shiner					5						
	<i>Lythrurus fumeus</i>	Ribbon Shiner	3	63	175		1				25		
	<i>Lythrurus umbratilis</i>	Redfin Shiner			2		3	15		3	7		
	<i>Notemigonus crysoleucas</i>	Golden Shiner		25			24			1	4	11	
	<i>Notropis atrocaudalis</i>	Blackspot Shiner						5	3	2		8	
	<i>Notropis texanus</i>	Weed Shiner		1	65								
	<i>Opsopoeodus emiliae</i>	Pugnose Minnow		1	6								
	<i>Pimephales vigilax</i>	Bullhead Minnow			3								
	<i>Semotilus atromaculatus</i>	Creek Chub							1	9			
	Catostomidae	<i>Erimyzon claviformis</i>	Western Creek Chubsucker						1	2			
<i>Erimyzon sucetta</i>		Lake Chubsucker		1									
Ictaluridae	<i>Ameiurus melas</i>	Black Bullhead		61			1				1		
	<i>Ameiurus natalis</i>	Yellow Bullhead	1	17								1	
	<i>Ictalurus punctatus</i>	Channel Catfish			3								
	<i>Noturus gyrinus</i> ¹	Tadpole Madtom			3								
Esocidae	<i>Esox americanus</i>	Redfin Pickerel		9	4		6			1	5		
Aphredoderidae	<i>Aphredoderus sayanus</i>	Pirate Perch	1	13	10			4	2		5	2	
Atherinopsidae	<i>Labidesthes sicculus</i> ¹	Brook Silverside			6								
Fundulidae	<i>Fundulus notatus</i>	Blackstripe Topminnow	11	18	28		2	6				10	
Poeciliidae	<i>Gambusia affinis</i>	Western Mosquitofish	37	41	73	6	11	37	35	4	358	14	
Centrarchidae	<i>Centrarchus macropterus</i>	Flier			1		7			2	3	7	
	<i>Lepomis cyanellus</i>	Green Sunfish	14		3						3		
	<i>Lepomis gulosus</i>	Warmouth		1	4	3	2				17		
	<i>Lepomis macrochirus</i>	Bluegill	18	5	15	3	13		6	8	5	6	
	<i>Lepomis marginatus</i>	Dollar Sunfish					1		8				
	<i>Lepomis megalotis</i>	Longear Sunfish	1		12					1		5	
	<i>Lepomis microlophus</i>	Redear Sunfish	5	6	13		2			2	2	6	
	<i>Lepomis</i> sp. (unknown)	Sunfish species	1		2								1
	<i>Lepomis symmetricus</i>	Bantam Sunfish					25						
	<i>Micropterus salmoides</i>	Largemouth Bass		1	3	5				1			2
	<i>Pomoxis annularis</i>	White Crappie											1
	<i>Pomoxis nigromaculatus</i>	Black Crappie			2	3							
Percidae	<i>Etheostoma artesiae</i>	Redspot Darter								1			
	<i>Etheostoma asprigene</i>	Mud Darter			3								
	<i>Etheostoma chlorosoma</i>	Bluntnose Darter		3	17		7			1			
	<i>Etheostoma gracile</i>	Slough Darter		7	2		4	45			5	8	
	<i>Etheostoma parvipinne</i> ¹	Goldstripe Darter						2					
	<i>Etheostoma proeliare</i> ¹	Cypress Darter									1		
	<i>Percina maculata</i> ¹	Blackside Darter			5								
	<i>Percina sciera</i> ¹	Dusky Darter			1								
Number of species collected			9	18	30	6	15	9	9	10	14	13	
Number of individuals collected			92	309	479	45	89	116	67	25	441	82	

I-Intolerant species (Linam and Kleinsasser 1998)

Summary of Fish Collection Data

A total of 56 species were collected during this study, as compared to a total of 71 species historically captured throughout the Cypress Basin. While it is possible that some species have been extirpated from the basin, it is more likely that many of the species not collected during this study are those that utilize lentic habitats such as those in and around Caddo Lake or those that were too uncommon to encounter during the short sampling period of this study. A total of 36 species were collected from two sites on the main stem Big Cypress Bayou as compared to 51 species collected from all tributary sites (sites 1-10 and sites C and D). When compared to the main stem, tributary sites added 20 additional species (Bowfin *Amia calva*, Cypress Minnow, Striped Shiner *Luxilus chrysocephalus*, Redfin Shiner *Lythrurus umbratilis*, Golden Shiner, Blackspot Shiner, Creek Chub *Semotilus atromaculatus*, Western Creek Chubsucker, Lake Chubsucker *Erimyzon sucetta*, Black Bullhead *Ameiurus melas*, Flier *Centrarchus macropterus*, Dollar Sunfish *Lepomis marginatus*, Bantam Sunfish, Black Crappie, White Crappie *Pomoxis annularis*, Redspot Darter *Etheostoma artesiae*, Mud Darter *E. asprigene*, Bluntnose Darter, Goldstripe Darter, and Cypress Darter; Figure 8). Five species were unique to the main stem Big Cypress Bayou (Longnose Gar *Lepisosteus osseus*, Common Carp, Redbreast Sunfish, Scaly Sand Darter, Freshwater Drum *Aplodinotus grunniens*, and; Figure 9).

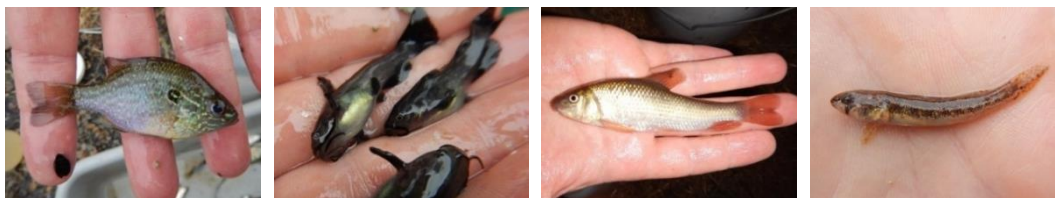


FIGURE 8.—Some fish species collected in the tributaries, but absent from main stem collections shown from left to right are Dollar Sunfish, Black Bullhead, Western Creek Chubsucker, and Goldstripe Darter.

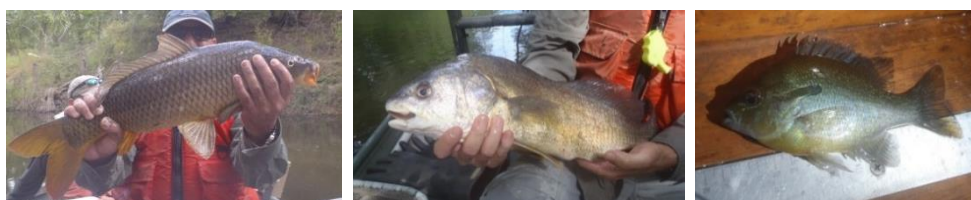


FIGURE 9.—Some of the species unique to the main stem Big Cypress Bayou collections shown from left to right are Common Carp, Freshwater Drum, and Redbreast Sunfish.

Overall, the portion of the Cypress Basin that was sampled during this study can be characterized by high species richness, diversity among trophic positions, low abundance of non-native species, the presence of several flow sensitive species, and the presence of several SGCN fish species. While a handful of species are widespread throughout the basin, there are some notable differences in fish assemblages among tributaries and between tributaries and the main stem including the absence of non-native species and a higher number of SGCN fish species in tributaries.

MUSSEL ASSEMBLAGE

Methods: Four sites were surveyed for mussels for this assessment during September and October 2014 (Table 2): two sites on Big Cypress Bayou (Sites A and B), one site on Black Cypress Bayou (Site C), and one site at Little Cypress Bayou (Site D). Mussels were surveyed for a minimum of two person-hours per site using timed snorkel surveys or tactile searches in all available mesohabitat types (Strayer and Smith 2003). All live mussels encountered during timed searches were enumerated and returned to the habitat in which they were found. Recently dead mussel shells that were encountered were noted.

Results and Discussion: A total of 5.25 person-hours of search time was conducted between the two sites on Big Cypress Bayou with a total of 277 live mussels comprising 14 species collected, two person-hours of search time was conducted at Little Cypress Bayou with a total of 13 live mussels comprising seven species collected, and 3.5 person-hours of search time was conducted at Black Cypress Bayou with a total of nine live mussels comprising three species collected (Table 11). Catch-per-unit-effort (CPUE) totals ranged from 2.57 mussels per hour at Black Cypress Bayou to 74.00 mussels per hour at Big Cypress Bayou, Site B. At Site A, 191 individuals of an unknown species were collected (Unknown Species A). These individuals were difficult to identify given the extent of the deterioration of the umbo (Figure 10), but they were either large Bankclimbers *Plectomerus dombeyanus* or Washboards *Megaloniais nervosa*. Genetic verification of the identity of these species is pending. One individual of a second unknown species was collected from Site A (Unknown species B). This individual was tannin-stained, making identification inconclusive. Several individuals from Site B were only identified to genus (Table 11). Due to tannin-staining and shell deterioration identification to the species level was inconclusive. All individuals that could not be identified to the species level in the field have been sent for genetic identification.



FIGURE 10.—Mussels collected from the bioassessment sites from left to right are Deertoe collected from Site A, state threatened Pigtoe collected from Site C, mussels collected during one time search on Site A, and Unknown species A with umbo deterioration collected from Site A.

Historically, 34 species of mussels are known from the Cypress Basin (TPWD 2008), of which 19 species were collected during this sampling event. A recent quantitative mussel survey by Braun and Mooring (2013) at both Big Cypress Bayou sites and near the Black Cypress Bayou site yielded 16 total species with only one species that was not collected during this survey, Pimpleback *Quadrula pustulosa*. Of the four state listed mussel species that occur in the Cypress Basin (Table 11), only Texas Pigtoe were collected at sites B and C during this study in low abundance.

It is difficult to utilize these results as a tool to assess the health of the Cypress Basin given there are no thorough historical mussel assemblage studies for comparison. While this rapid bioassessment of the mussel community was not designed to determine all species present at study sites, over half of the historical mussel species list was encountered with minimal search effort. Although habitat generalist species (e.g. Threeridge *Amblema plicata*, Yellow Sandshell *Lampsilis teres*, Southern Mapleleaf *Quadrula apiculata*) and lentic-adapted species (e.g. Fragile Papershell *Leptodea fragilis*, Giant Floater *Pyganodon grandis*, Paper Pondshell *Utterbackia imbecillis*) were present at study sites, lotic adapted habitat specialists were also present (e.g. Texas Pigtoe, Washboard, Pistolgrip *Quadrula verrucosa*, Deertoe *Truncilla truncata*) suggesting the presence of functioning lotic mesohabitats at those sites.

TABLE 11.—Historical species list of freshwater mussels from the Cypress Basin (TPWD 2008) with abundance of live individuals collected by species and CPUE in parentheses during timed search surveys, September and October 2014, Marion County, TX. DS denotes a recently dead shell was found during time searches. Sites: A. Big Cypress Bayou near French Creek (9/11/2014), B. Big Cypress Bayou upstream of Jefferson (9/10/2014), C. Black Cypress Bayou at US 59 (10/10/2014, 10/29/2014), D. Little Cypress Bayou at US 59 (10/28/2014).

Species	Common Name	Site A	Site B	Site C	Site D
<i>Amblema plicata</i>	Threeridge	3 (1.00)	3 (1.33)	DS	DS
<i>Arcidens confragosus</i>	Rock Pocketbook				
<i>Fusconaia askewi</i>	Texas Pigtoe		2 (0.89)	2 (0.57)	
<i>Fusconaia flava</i>	Wabash Pigtoe				
<i>Fusconaia</i> sp.	<i>Fusconaia</i> sp. unknown		2 (0.89)		
<i>Lampsilis cardium</i>	Plain Pocketbook				
<i>Lampsilis hydiana</i>	Louisiana Fatmucket		3 (1.33)	1 (0.29)	1 (0.50)
<i>Lampsilis satura</i>	Sandbank Pocketbook				
<i>Lampsilis teres</i>	Yellow Sandshell	4 (1.33)			DS
<i>Leptodea fragilis</i>	Fragile Papershell				1 (0.50)
<i>Ligumia subrostrata</i>	Pond Mussel				
<i>Megaloniais nervosa</i>	Washboard		1 (0.44)		
<i>Obliquaria reflexa</i>	Threehorn Wartyback		1 (0.44)		
<i>Obovaria jacksoniana</i>	Southern Hickorynut				
<i>Plectomerus dombeyanus</i>	Bankclimber	2 (0.67)	6 (2.67)		DS
<i>Pleurobema riddellii</i>	Louisiana Pigtoe				
<i>Potamilus ohioensis</i>	Pink Papershell				
<i>Potamilus purpuratus</i>	Bleufer	5 (1.67)	4 (1.78)	DS	DS
<i>Pyganodon grandis</i>	Giant Floater				1 (0.50)
<i>Quadrula apiculata</i>	Southern Mapleleaf		1 (0.44)		
<i>Quadrula mortoni</i>	Western Pimpleback	1 (0.33)	10 (4.44)	6 (1.71)	1 (0.50)
<i>Quadrula nobilis</i>	Gulf Mapleleaf				
<i>Quadrula nodulata</i>	Wartyback				
<i>Quadrula pustulosa</i>	Pimpleback				
<i>Quadrula quadrula</i>	Mapleleaf				
<i>Quadrula verrucosa</i>	Pistolgrip	7 (2.33)	2 (0.89)		DS
<i>Quadrula</i> sp.	<i>Quadrula</i> sp. unknown		1 (0.44)		
<i>Strophitus undulatus</i>	Creeper		6 (2.67)		
<i>Toxolasma parvus</i>	Lilliput				
<i>Toxolasma texasiensis</i>	Texas Lilliput			DS	2 (1.00)
<i>Truncilla donaciformis</i>	Fawnsfoot				
<i>Truncilla truncata</i>	Deertoe	8 (2.67)	12 (5.33)		
<i>Unioemerus declivis</i>	Tapered Pondhorn		1 (0.44)		
<i>Unioemerus tetralasmus</i>	Pondhorn				1 (0.50)
<i>Utterbackia imbecillis</i>	Paper Pondshell				6 (3.00)
<i>Villosa lienosa</i>	Little Spectaclecase				
Unknown species A	Unknown	191 (63.67)			
Unknown species B	Unknown	1 (0.33)			
Number of species collected		7	13	3	7
Number of individuals collected (CPUE)		222 (74.00)	55 (24.44)	9 (2.57)	13 (6.50)

BENTHIC MACROINVERTEBRATE ASSEMBLAGE

Methods: Aquatic benthic macroinvertebrates were collected from sites A and B on Big Cypress Bayou on September 11th and 12th respectively. Using a D-frame kick net following Rapid Bioassessment protocols in TCEQ's surface water quality monitoring procedures handbook (TCEQ 2014b), effort was made to collect a minimum of 175 macroinvertebrates per location. No snag sampling was conducted.

Macroinvertebrates were preserved in 70% ethanol and identified to the lowest possible taxonomic group. The macroinvertebrate community was assessed using a statewide benthic macroinvertebrate index of biological integrity (BIBI) which consists of scoring for 12 metrics (TCEQ 2014b). These metrics were scored and summed to determine the aquatic life use score. The macroinvertebrate community was also assessed using a draft regionalized BIBI for comparison. This data is included in Appendix C.

Results and Discussion: A total of 203 benthic macroinvertebrates representing 11 orders and 30 families (Table 12) were collected and identified from Big Cypress Bayou. Due to a low sample size at Site A, no BIBI was calculated. While Site B abundance was slightly less than the minimum number recommended to calculate the statewide BIBI (140 individuals; Bill Harrison, TCEQ, personal communication), we report the BIBI results and aquatic life use in Table 13. For Site B, an overall aquatic life use score of 25 was calculated, placing it in the intermediate category (Table 13). It should be noted when interpreting these results that this intermediate aquatic life use score was calculated based on the statewide BIBI criteria rather than a regionalized index, no snag sampling was conducted, and the total sample size was slightly less than recommended.

The dominant macroinvertebrate taxa present at Site B were mayflies (Order Ephemeroptera), beetles (Order Coleoptera), and true bugs (Order Hemiptera), making up 35.7%, 18.3%, and 16.7% of the total catch, respectively. The lack of stoneflies and riffle beetles, and few caddisflies limited the BIBI score; however, the presence of a high relative proportion of mayflies is an indicator of good water quality and habitat. Additionally, many of the mayfly families present typically utilize lotic habitats and are indicators of functioning riffle and run mesohabitats (Merritt et al. 2008).

When compared to the draft regionalized BIBI for ecoregions 33 and 35 (Appendix C), the statewide BIBI total score was lower. The regionalized BIBI resulted in a score of 33, placing the invertebrate community at Site B in the High aquatic life use category. While over half of the statewide metrics received low scores of 1 or 2, the lowest metric scored in the regionalized BIBI was % Dominant functional group, which received a score of 2. While the scoring criteria for the regionalized BIBI is still in draft form, it supports that the invertebrate community is healthy and functioning when compared to other similar systems within its ecoregion.

TABLE 12.—Abundance of aquatic benthic macroinvertebrates with their associated trophic guilds collected from Big Cypress Bayou at sites A and B, September 2014. Trophic guilds are abbreviated as collector gatherer (CG), filtering collector (FC), predator (P), scraper (SCR), and shredder (SHR). Life stages are abbreviated as adult (A) and larvae (L). Sites: A. Big Cypress Bayou near French Creek (9/11/2014), B. Big Cypress Bayou upstream of Jefferson (9/10/2014)

Order	Family	Genus	Trophic	Life Stage	Site A	Site B
Amphipoda	Gammaridae	<i>Gammarus</i>	CG/SHR		2	5
Coleoptera	Gyrinidae	<i>Dineutus</i>	P	A		3
		<i>Gyrinus</i>	P	A		16
	Haliplidae	<i>Peltodytes</i>	SHR/P	A	7	1
	Hydrochidae	<i>Hydrochus</i>	SHR	A		1
	Hydrophilidae	<i>Berosus</i>	CG	A		1
		<i>Berosus</i>	P	L		1
Decapoda	Palaemonidae	Freshwater	CG		15	
Diptera	Ceratopogonidae		P/CG		2	2
	Chironomidae		P/CG/FC		16	15
	Culicidae		FC/CG		2	
	Simuliidae	<i>Simulium</i>	FC			1
Ephemeroptera	Baetidae	<i>Acerpenna</i>	SCR/CG			7
		<i>Baetis</i>	SCR/CG			2
		<i>Paracloeodes</i>	SCR/CG			2
		<i>Procloeon</i>	SCR/CG			1
		<i>Pseudocloeon</i>	SCR/CG			5
	Caenidae	<i>Caenis</i>	SCR/CG		3	6
	Ephemeridae	<i>Hexagenia</i>	CG		4	6
	Heptageniidae	<i>Maccaffertium</i>	SCR/CG		1	1
		<i>Stenacron</i>	SCR/CG			1
	Oligoneuriidae	<i>Isonychia</i>	FC			1
	Tricorythidae	<i>Tricorythodes</i>	CG		5	13
Hemiptera	Belostomatidae	<i>Belostoma</i>	P		2	
	Gerridae	<i>Rheumatobates</i>	P		1	2
		<i>Trepobates</i>	P		2	2
		<i>Limnocoris</i>	P			1
	Nepidae	<i>Ranatra</i>	P		2	4
	Notonectidae	<i>Notonecta</i>	P			1
	Veliidae	<i>Rhagovelia</i>	P			11
Hirudinea	Hirudinea	Leech	P		1	
Megaloptera	Corydalidae	<i>Corydalus</i>	P		1	
Odonata	Aeschnidae	<i>Basiaeschna</i>	P		1	
	Coenagrionidae	<i>Argia</i>	P			1
	Gomphidae	<i>Dromogomphus</i>	P		1	2
	Macromiidae	<i>Macromia</i>	P		2	10
Trichoptera	Leptoceridae	<i>Nectopsyche</i>	SHR/CG/P		3	1
Trombidiformes*	Hydracarina	Water mite	P		4	
Number of taxa collected					21	30
Number of individuals collected					77	126

*Lowest taxonomic identification available if Order was not determined

TABLE 13.—Benthic Index of Biotic Integrity metrics and scores for kick-net samples collected using the rapid bioassessment protocol for benthic macroinvertebrates at Big Cypress Bayou, Site B, September 10, 2014, Marion County, TX. Metrics are scored from low to high quality on a scale of 1-4 (see Table B.11 in TCEQ 2014b).

Metric	Total	Score
Taxa richness	31	4
EPT taxa abundance	12	4
Biotic index (HBI)	5.15	2
% Chironomidae	11.90	2
% Dominant taxon	12.70	4
% Dominant FFG	48.28	2
% Predators	48.28	1
Ratio of intolerant: tolerant taxa	0.83	1
% of total Trichoptera as Hydropsychidae	0	1
# of non-insect taxa	1	1
% Collector-gatherers	32.80	2
% of total number as Elmidae	0	1
Total Score		25
Aquatic Life Use		Intermediate

RIPARIAN ASSEMBLAGE

Methods: A qualitative visual assessment of the riparian area was conducted at Site A and Site B on Big Cypress Bayou to obtain a basic understanding of the overall functioning condition of the riparian area. These surveys were conducted at Site A on September 11, 2014 and at Site B on September 10, 2014. Dominant species present, age class distribution, and vigor of the plants within the riparian corridor were noted during this qualitative assessment. Non-native plant species were also recorded.

Results and Discussion: At Site A, common tree species observed within the riparian area included: bald cypress *Taxodium distichum*, common persimmon *Diospyros virginiana*, black walnut *Juglans nigra*, red maple *Acer rubrum*, white oak *Quercus alba*, water oak *Quercus nigra*, black oak *Quercus vetulina*, sweetgum *Liquidambar styraciflua*, and American elm *Ulmus americana*. Common herbaceous and shrub species observed included: pluchea *Pluchea odorata*, greenbrier *Smilax* sp., primrose sp., *Ludwegia* sp., American beautyberry *Callicarpa americana*, bog hemp *Boehmeria cylindrica*, trumpet creeper *Campsis radicans*, silver bluestem *Bothriochloa sacchariodes*, spiderwort *Tradescantia* sp., balloon vine *Cardiospermum halicacabum*, Virginia creeper *Parthenocissus quinquefolia*, Virginia wildrye *Elymus virginicus*, globe flatsedge *Cyperus echinatus*, inland sea oats *Chasmanthium latifolium*, dwarf palmetto *Sabal minor*, blue mistflower *Conoclinium coelistinum*, Cardinal flower *Lobelia cardinalis*, morning glory *Ipomoea* sp., grape *Vitis* sp., and Saint John's wort *Hypericum perforatum*. Non-native species noted during the qualitative assessment for Site A included alligator weed *Alternanthera philoxeroides*, King Ranch bluestem *Bothriochloa ischaemum*, and Johnson grass *Sorghum halepense*. Overall, the riparian area was in good functioning condition as indicated by the diverse mixture of appropriate riparian species, high plant vigor, and presence of multiple age classes.

At Site B, common tree species observed included: Southern red oak *Quercus falcata*, water oak, red maple, blackgum *Nyssa sylvatica*, bald cypress, American hornbeam *Carpinus caroliniana*, black oak, and sweetgum. Common shrubs and herbaceous species included: sassafras *Sassafras albidum*, bog hemp, inland sea oats, blue mistflower, grape, poison ivy *Toxicodendron radicans*, wisteria *Wisteria* sp., balloon vine, pluchea, cardinal flower, marsh-elder *Iva* sp., and greenbrier. Non-native species found during the qualitative assessment for Site B were Chinese tallow tree (*Triadica sebifera*), Chinaberry (*Melia azedarach*), and coastal Bermuda grass (*Cynodon dactylon*). The riparian area of Site B was also found to be in good overall functioning condition as indicated by the diverse mixture of appropriate riparian species, high plant vigor, and presence of multiple age classes. It was noted that the riparian area becomes very narrow when compared to the rest of the study site at the upstream end of Site B. There is heavy grazing/mowing pressure within 3-5 meters of the riparian zone at this point, which is causing sheet flow off of the pasture into the riparian area, creating an erosion zone and sloughing bank. This is then in turn creating an erosional eddy around a large bald cypress tree at the upper end of the study reach. Allowing for higher vegetation growth further back from the riparian area will help slow down the sheet flow into the riparian zone and can help to reduce future erosion in this area.

STREAM HEALTH

Methods: To obtain a snapshot of riparian habitat and overall stream condition at each site, a modified Stream Visual Assessment Protocol (SVAP2 see TPWD 2015d) was conducted on Sites A, B, C, and D in September and October 2014 (Table 2). The modified SVAP2 is based on the SVAP protocol created by the Natural Resources Conservation Service (NRCS 1998), but includes updates to make it more relevant to Texas streams. This protocol allows for a basic level of ecological assessment to qualitatively evaluate the condition of aquatic ecosystems associated with wadeable streams. The modified SVAP2 utilizes scores from thirteen major scoring elements including: channel condition, hydrological alteration, bank stability, riparian area quantity, riparian area quality, water appearance, nutrient enrichment, barriers to aquatic species movement, stream habitat complexity, pools, aquatic invertebrate community, riffle embeddedness, and salinity. After scoring each element, scores are summed and divided by the number of elements to provide an overall SVAP2 score. Scores are graded as follows: 1-2.9 = Severely Degraded, 3-4.9 = Poor, 5 to 6.9 = Fair, 7 to 8.9 = Good, 9 to 10 = Excellent. It is important to note that these scores are based on characteristics of a particular stream reach and are not making a statement on the health of the entire stream. The utility in this protocol is that a discrete stream reach can be monitored over time to determine if the general health of the ecosystem is improving, declining, or maintaining.

Results and Discussion: Overall stream health for Site A rated as “Good” (SVAP2 Score= 8.5, Table 14A), Site B rated as “Good” (SVAP2 Score=8, Table 14B), Site C rated as “Fair” (SVAP2 Score=6.95, Table 15A), and Site D rated as “Good” (SVAP2 score = 7.55, Table 15B). These values can be used as general statements about the state of the stream environment at each site. Sites A, B, and D are functioning well as is shown by the scores falling into the good category. Site A and B had low scores for hydrologic alteration due to operations of Lake O’ the Pines which has reduced the occurrence of bankfull flows (Winemiller et al. 2005); downstream releases are limited to 85 m³/s (3000 ft³/s).

TABLE 14.—Element scores from the Stream Visual Assessment Protocol (SVAP2) conducted on Big Cypress Bayou in September 2014 at A. Site A on Big Cypress Bayou near the confluence with French Creek (9/11/2014) and B. Site B on Big Cypress Bayou upstream of Jefferson, TX (9/10/2014). Element scores are rated from 1 (severely degraded) to 10 (excellent). The average of the element scores is listed as the stream health score.

A.		B.	
Element	Score	Element	Score
Channel Condition	9	Channel Condition	7
Hydrologic Alteration	3	Hydrologic Alteration	3
Bank Condition	9	Bank Condition	8.5
Riparian Area Quantity	9	Riparian Area Quantity	7
Riparian Area Quality	8	Riparian Area Quality	7
Water Appearance	8	Water Appearance	9
Nutrient Enrichment	10	Nutrient Enrichment	8.5
Barriers to Movement	10	Barriers to Movement	10
Stream Habitat Complexity	9	Stream Habitat Complexity	9.5
Pools	8.5	Pools	10
Aquatic Invertebrate Community	9	Aquatic Invertebrate Community	7
Riffle Embeddedness	n/a	Riffle Embeddedness	7
Salinity	10	Salinity	10
Stream Health Score	8.5	Stream Health Score	8

TABLE 15.—Element scores from the Stream Visual Assessment Protocol (SVAP2) conducted in October 2014 at: A. Site C on Black Cypress Bayou near Jefferson, TX (10/10/2014) and B. Site D on Little Cypress Bayou near Jefferson, TX (10/11/2014). Element scores are rated from 1 (severely degraded) to 10 (excellent). The average of the element scores is listed as the stream health score.

A.		B.	
Element	Score	Element	Score
Channel Condition	6.5	Channel Condition	9
Hydrologic Alteration	6	Hydrologic Alteration	8
Bank Condition	5	Bank Condition	9
Riparian Area Quantity	8	Riparian Area Quantity	9
Riparian Area Quality	8	Riparian Area Quality	8
Water Appearance	3	Water Appearance	3
Nutrient Enrichment	10	Nutrient Enrichment	9
Barriers to Movement	10	Barriers to Movement	10
Stream Habitat Complexity	5	Stream Habitat Complexity	5
Pools	9	Pools	5
Aquatic Invertebrate Community	6	Aquatic Invertebrate Community	8
Riffle Embeddedness	n/a	Riffle Embeddedness	n/a
Salinity	no score	Salinity	no score
Stream Health Score	7	Stream Health Score	8

Site C had a score that fell into the fair category, meaning that while the stream ecosystem is in fair condition at this time, it is not functioning as well as the other sites and could potentially move into the poor condition category if conditions are not improved. In comparing the element scores for the four sites, the element that appears to have caused Site C to score lower than the other sites was bank condition, which scored as a 5 for Site C (Table 15A). A score of 5 on bank condition indicates that the banks are moderately unstable with very little protection of banks by roots, natural wood, vegetation, or rock; and/or that there is a factor contributing to bank instability such as recreational and/or livestock use; and/or that there is excessive bank erosion or active bank failures; and/or that there are fabricated structures covering more than half of the reach or the entire bank. Bank erosion at this site can be seen in the first photograph of Figure 3. By addressing factors that are causing the bank instability, this site could trend back to a better functioning condition.

IMPERILED SPECIES

One state threatened fish species, Blackside Darter, was collected from both sites on Big Cypress Bayou and Site 3 on Little Cypress Bayou. Only one individual was collected per site at each of the Big Cypress sites; however, low abundances are typical of Blackside Darter populations (Page 1983) and are not necessarily a cause for concern. While this species is restricted to the northeastern corner of Texas, it is fairly widespread within the United States. Braun and Moring (2013) found one individual in Little Cypress Bayou and historical data has shown previous collections from Black Cypress Bayou (Hendrickson and Cohen 2015). It is likely that this species still inhabits all three streams; however, due to low abundances it is not detected in every sampling event.

Supplemental fish collections captured two additional SGCN species: Blackspot Shiner and Western Creek Chubsucker. The Blackspot Shiner can be found across the western gulf slope drainages. In Texas, it is limited to the eastern portions of the state from the Brazos River north to the Red River. This species has been listed as having stable populations; however, it is uncommon within its distribution (TPWD 2012; Warren et al. 2000). This species has been reported to be most abundant in headwater sections of streams (TPWD 2012). During this study, the Blackspot Shiner was collected from four sites at low abundances. The Western Creek Chubsucker was collected from two sites, also in low abundances. This species is widespread throughout the United States, but is restricted to the eastern portion of the state and is listed as state threatened in Texas (TPWD 2012).

Four of the seven SGCN species reported from the Cypress Basin were not collected during this study: Paddlefish, Bluehead Shiner, Ironcolor Shiner, and Taillight Shiner. Braun and Moring (2013) collected the latter two species in low numbers during their 2010–2011 surveys of Big Cypress and Little Cypress bayous; however, they did not collect Paddlefish or Bluehead Shiners. Bluehead Shiner was collected within Site B in 1992 and in close proximity to Site C on Black Cypress Bayou (approximately 3 km downstream) and Site D on Little Cypress Bayou (approximately 8 km downstream) in 1987 by N. H. Douglas, *et al.* (Hendrickson and Cohen 2015). Bluehead Shiner prefer slow moving habitats including oxbows and backwaters (Thomas et al. 2007). Targeted sampling of these types of habitats could be useful in determining if this species still persists in the basin and in what abundances.

At the time of this study, 47 tagged juvenile Paddlefishes had been in the system for six months and an additional 2,005 juvenile Paddlefishes had been released during the month of September 2014 (Diaz et al. 2015). Radio tracking data revealed that the majority of Paddlefish spent their time immediately downstream of the Lake O' the Pines spillway or near Caddo Lake (Diaz et al. 2015). While tracking data indicates that Paddlefish passed through sites A and B, there have been no documented occasions of Paddlefish within these sites. It is possible that Paddlefish were not collected during this study due to their relatively low abundance and gear selectivity. Gill nets were not used in an effort to minimize potentially negative impacts on recently stocked Paddlefish.

One state threatened mussel species, Texas Pigtoe, was collected from Big and Black Cypress bayous. Texas Pigtoe occur in East Texas and can be found in a diversity of habitats. Little is currently known about the life history of this species. Braun and Moring (2013) collected one mussel that was identified as *Fusconaia* sp. It is possible this was a Texas Pigtoe; however, they can be very hard to morphologically distinguish from the Triangle Pigtoe *F. lananensis*. A subset of the Texas Pigtoe specimens collected during this study have been sent for genetic verification.

RECREATIONAL ACCESS

There are several public access points on Big Cypress Bayou between Lake O' the Pines and Caddo Lake (Figure 11). These points vary from concrete boat ramps to smaller kayak access points. Sites also vary in the access fee charged and amenities (Table 16). Most public access on this stretch of Big Cypress Bayou is concentrated on the downstream end near the upper end of Caddo Lake. Caddo Lake State Park and Wildlife Management Area offer the most expansive bank fishing areas; however, it should be noted these stretches of Big Cypress Bayou are heavily influenced by the lake and do not have much streamflow in contrast to the upper reaches downstream of Lake O' the Pines. Additional access is available at bridge crossings along the right-of-way; however, these sites have limited parking and launching facilities so they were not included in this report.

Based on the 1999 and 2001 TPWD creel surveys, it is evident that fishing is a popular recreational activity on Big Cypress Bayou downstream of Lake O' the Pines; however, this is somewhat limited by access availability. During these surveys recreational users voiced support for TPWD acquiring new access sites on Big Cypress Bayou (Appendix A). Big Cypress Bayou from Lake O' the Pines to Jefferson, TX has no access points or road crossings and could benefit from a TPWD leased access site to increase accessibility and decrease the distance traveled by paddlers launching at the Lake O' the Pines tailrace. Access to Little and Black Cypress bayous near Jefferson, TX is limited to bridge crossings. While access along the right-of-way is available at some crossing, those sites are not included in this report.

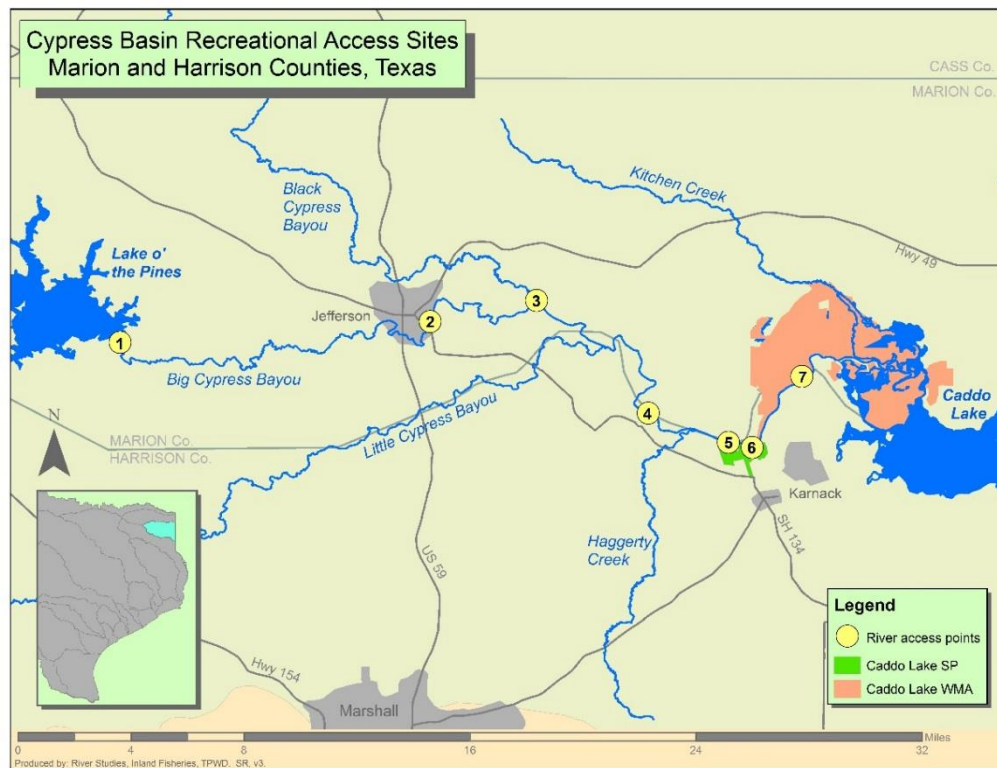


FIGURE 11.—Cypress Basin public recreational access locations in Marion and Harrison counties, Texas. See Table 16 for site information.

TABLE 16.—Big Cypress Bayou public access locations between Lake O' the Pines and Caddo Lake.

Number	Location Name	GPS Coordinates	Fee Charged	Use	Controlling Authority	Comments
1	Lake O' the Pines outflow	Lat: 32.747953 Long: -94.499618	\$3/car	boat, kayak, bank fishing	USACOE	bank fishing
2	Jefferson Ramp	Lat: 32.758303 Long: -94.340762	free	boat, kayak	TPWD	
3	Thompson Camp	Lat: 32.768982 Long: -94.28927	free	boat, kayak	Marion Co.	unimproved ramp
4	Backwater Jacks	Lat: 32.711360 Long: -94.229060	\$3/car*	boat, kayak	Private	camping
5	Harrison County Ramp	Lat: 32.696328 Long: -94.187965	free	boat, kayak	Harrison County	
6	Caddo Lake State Park	Lat: 32.692000 Long: -94.180000	\$3/person**	boat, kayak, bank fishing	TPWD	camping
7	Caddo Lake WMA	Lat: 32.736719 Long: -94.122485	\$12/person***	kayak, bank fishing	TPWD	primitive camping

* Free to guests

** 12 and under free

***This fee covers an annual Limited Public Use Permit

SPORT FISHING OPPORTUNITIES

Many species collected during this study have potential to provide recreational fishing opportunities across the Cypress Basin. In particular, Largemouth Bass and Channel Catfish, both collected during this study, were identified as important target species for anglers in 1999 and 2001 (Appendix A). Although these species were collected in low numbers during this study, they were collected across bioassessment sites. Gear bias may have played a role in the low numbers of bass and catfish collected. Future sampling events at these sites should include additional boat electrofishing effort and gear types such as gill nets, hoop nets, and hook and line sampling to better quantify sport fish populations.

Boat electrofishing surveys conducted by TPWD Fisheries Management staff on Big Cypress Bayou downstream of Jefferson, TX in 1995 and 2001 documented a CPUE of 46.5/hour and 45.9/hour respectively for Largemouth Bass with a wide distribution of lengths; however, most fish collected were below the minimum length limit of 14 inches (Appendix D). The number of legal length Largemouth Bass dropped from a CPUE of 7.5/hour in 1995 to 0.7/hour in 2001 with similar sampling effort expended at each survey. No Largemouth Bass greater than 14 inches were collected from Big Cypress Bayou during these surveys; however, Largemouth Bass were not specifically targeted.

Additional electrofishing surveys should be conducted to enhance understanding of the Largemouth Bass population in Big Cypress Bayou before any additional enhancement or management actions are recommended.

Despite stockings of the Florida subspecies of Largemouth Bass in 1999 and 2000 genetics data collected during the 2001 electrofishing survey (N = 51) indicated only 17.7% of the alleles originated from the Florida sub-species and no pure Florida bass were collected. Influence from these stocking may not have been completely manifested in 2001 as many of the stocked fish may not have been sexually mature. Targeted sampling should be conducted to gather additional population, growth, genetics, and angler utilization information for Largemouth Bass.

Although not specifically named in creel surveys, Spotted Bass are also likely targeted when angling for Largemouth Bass. During this study Spotted Bass were collected in abundances similar to Largemouth Bass and were found at three of the four bioassessment sites. TPWD electrofishing surveys documented a drop in boat electrofishing CPUE for Spotted Bass from 19.5/hour in 1995 to 2.8/hour in 2001 (Appendix D). There is no minimum harvest length limit for Spotted Bass, which may make it a desirable target species for anglers. Spotted Bass collected during this survey on Big Cypress Bayou ranged from 2 to 12 inches in length.

The other popular sport fish targeted by anglers was Channel Catfish (Appendix A). Hoop net surveys conducted in 1995 by TPWD collected only two Channel Catfish; however, both were over the minimum harvest length limit of 12 inches. The 2014 bioassessment collected only two Channel Catfish from Big Cypress Bayou and four from Black Cypress Bayou. Channel Catfish collected from Big Cypress Bayou during this survey were small, measuring only 1 and 6 inches; however, no targeted sampling was conducted for this species. Future surveys should include hoop and gill net surveys in order to better quantify Channel Catfish populations.

Additional fishing opportunities in the basin include eight species of sunfish and two species of crappie (Tables 5 and 10). Bluegill and Longear Sunfish were both abundant and widely distributed throughout the basin and Bluegill in particular was mentioned in TPWD creel surveys as a targeted species for anglers (Appendix A).

SUMMARY AND RECOMMENDATIONS

Big Cypress Bayou

Thirty-six species of fish, 14 species of freshwater mussels, and 37 taxa of aquatic macroinvertebrates were collected from two sites on Big Cypress Bayou. Both sites were classified as having excellent aquatic life use for the fish community based on the regionalized Index of Biotic Integrity. The downstream Big Cypress Bayou site had an intermediate aquatic life use for macroinvertebrates due to a lack of stoneflies and riffle beetles, and minimal numbers of caddisflies. Water quality data collected during this study met established water quality standards for Big Cypress Bayou. The riparian community had good diversity and recruitment at both sites.

Overall, stream health was categorized by the SVAP2 as good for both sites and all metrics, except hydrologic alteration which scored below average. Both sites scored high due to no barriers for aquatic species movement (between Caddo Lake and Lake O' the Pines dam) and low nutrient enrichment.

Black Cypress Bayou

Twenty-eight species of fish and three species of mussels were collected from one site on Black Cypress Bayou, including one state threatened mussel species, Texas Pigtoe. The site rated as having an excellent aquatic life use based upon the fish community regionalized Index of Biotic Integrity. While there are no established water quality standards for Black Cypress Bayou, a point water quality measurement met those proposed for this stream segment. This site received the lowest stream health score of the four bioassessment sites and fell into the fair category based on SVAP2 criteria. While overall Black Cypress Bayou has been recognized for its natural condition (TCEQ 2005), the site sampled during this study had moderate bank stability due to sloughing banks and moderate instream habitat complexity which brought down the overall score. This site consisted of mostly deep pool habitats, which was also a potential factor for the low mussel catch rates in comparison to other sites. This site scored high due to lack of barriers to aquatic species, low nutrient enrichment, and a high proportion of pools.

Little Cypress Bayou

Overall 41 species fish were collected from two sites at Little Cypress Bayou, including 32 species collected at the bioassessment site (Site D) and one SGCN fish species, Blackside Darter. The bioassessment site rated as having an excellent aquatic life use based upon the fish community regionalized Index of Biotic Integrity. Seven species of mussels were collected from the bioassessment site on Little Cypress Bayou. The overall stream health score fell into the good category, with the lowest scores coming from moderate stream habitat complexity and a moderate proportion of pool habitats. This reach scored high due to the absence of barriers to fish passage, stable banks, a high quality riparian corridor, low nutrient enrichment, and an intact stream channel. Point water quality measurements for this site were within established standards for the stream segment.

Recommendations

All bioassessment sites contained large amounts of instream habitat in the form of large and small woody debris. The upstream site on Big Cypress Bayou (Site A) and the Black Cypress Bayou site (Site C) had lower mesohabitat complexity and contained no riffle habitats. This did not seem to affect fish species diversity at these sites and may be representative of the nature of these bayou systems. Site B ranked as having an intermediate aquatic invertebrate community. Periodic monitoring of the benthic macroinvertebrate community is recommended. Outside of specific objectives such as Paddlefish habitat restoration, no actions are recommended to modify instream habitat or mesohabitat complexity at this time.

The riparian corridor was primarily intact at all four sites and scored high to excellent for riparian quantity and quality. Most likely as a result of the riparian corridor, bank stability scored high for all sites with the exception of Black Cypress Bayou. The site at Black Cypress Bayou had one large sloughing bank that is likely the result of hydrologic alteration from the highway bridge or due to land use practices outside of the riparian corridor.

A similar erosional situation is occurring at one section of Site A on Big Cypress Bayou just upstream of Jefferson, TX. While a riparian corridor is intact the entire reach of the site, one section of the corridor is narrow and bordered by pastureland. Sheet flow off of this pasture is causing erosion and sloughing of the bank. Widening of the riparian corridor at both of these sites will help to slow down runoff into the streams and reduce erosion.

Two non-native fish species were collected from Big Cypress Bayou during this study. These species were collected in very low numbers and were not widely distributed throughout the basin. Several non-native riparian species were found at the sites on Big Cypress Bayou; however, the riparian community still contained a diverse, functioning system. It is recommended that the area be monitored for spread of these species.

Big Cypress Bayou offers recreational opportunities through paddling trails, fishing, and public access at properties such as Caddo Lake State Park and Caddo Lake Wildlife Management Area; however, most of these opportunities are concentrated in the bayou-like portions of the stream, near Caddo Lake. Based on interest from anglers (Appendix A) it is recommended that additional public access points be made available through the Texas Paddling Trails or the River Access and Conservation Area programs. In support of public recreation initiatives, it is recommended that future biological sampling include more directed effort to quantify sport fish populations including targeted boat electrofishing, gill net, hoop net, hook and line, and creel surveys.

In summary, this study found the four bioassessment sites had robust fish communities, good water quality, high mussel species richness and abundances, and moderate to good overall stream health scores. The supplemental fish collection sites added several additional fish species and filled data gaps for the basin. Further monitoring of the macroinvertebrate community may be warranted to understand the cause of the intermediate aquatic life use score at Site B. The primary recommendation for the Cypress Basin is to conduct additional biological monitoring at the four bioassessment sites every two to five years as needed to document changes in relation to the flow regime and to support science needs of the Cypress Environmental Flows Project and local river recreation initiatives.

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APPENDIX A

TPWD 1995 and 2001: Creel Survey Results from Big Cypress Bayou

ANGLER TARGET SPECIES.—Percent directed angler effort for all boat and bank anglers by species collected during a creel survey for Big Cypress Bayou, TX, July 1–September 30, 1999, and July 1–September 30, 2001. Hours of fishing effort directed toward each species are in parenthesis. This survey was conducted from the Hwy 43 bridge crossing to Jefferson, TX and at the Lake O’ the Pines spillway.

Species	1999	2001
Crappies	0.63 (93)	8.87 (1,636)
Panfishes	4.64 (678)	3.22 (595)
White Bass	7.87 (1,149)	
Hybrid Striped Bass	9.10 (1,323)	
Bluegill	9.10 (1,324)	
Largemouth Bass	18.00 (2,635)	31.09 (5,735)
Channel Catfish	25.32 (3,699)	12.87 (2,374)
Flathead Catfish		1.5 (277)
Any Species	25.36 (3,704)	41.04 (7,570)
Catfishes		0.66 (122)
Smallmouth Buffalo		0.72 (135)

ANGLER SATISFACTION.—Results of angler satisfaction surveys conducted on Big Cypress Bayou in 1999 and 2001. This survey was conducted from the Hwy 43 bridge crossing to Jefferson, TX and at the Lake O’ the Pines spillway. Standard deviations for Likert scores are in parentheses.

Statements	N	Mean score
Overall, how satisfied are you with the current fishing and recreation opportunities on the Big Cypress Bayou?*	164	3.5 (0.77)
Would you support Texas Parks and Wildlife using public dollars to lease areas on the Big Cypress Bayou for fishing and recreational access? **	78	3.9 (0.90)

*Mean scores were calculated from a 5-point Likert-type scale, with 5.0 = “Extremely satisfied” and 1.0 = “Not at all satisfied.”

**Mean scores were calculated from a 5-point Likert-type scale, with 5.0 = “Strongly support” and 1.0 = “Strongly oppose.”

APPENDIX B

TPWD 1995: Electrofishing Survey Results from Big Cypress Bayou

BIG CYPRESS BAYOU.—Catch rate (CPUE) and number (N) of all species collected boat electrofishing from Big Cypress Bayou downstream of Jefferson, TX, 1995.

Species	CPUE	N
Spotted Gar	18.00	24
Longnose Gar	1.50	2
Bowfin	1.50	2
Paddlefish	0.75	1
Gizzard Shad	133.50	178
Threadfin shad	51.00	68
Common Carp	15.00	20
Blacktail Shiner	6.00	8
Smallmouth Buffalo	2.25	3
Spotted Sucker	19.50	26
Yellow Bullhead	0.75	1
Channel Catfish	1.50	2
Flathead catfish	5.25	7
White Bass	0.75	1
Yellow Bass	1.50	2
Warmouth	6.00	8
Bluegill	65.25	87
Longear Sunfish	49.50	66
Redear Sunfish	35.25	47
Redspotted Sunfish	2.25	3
Spotted Bass	19.50	26
Largemouth Bass	46.50	62
Black Crappie	15.00	20
Freshwater Drum	12.00	16
Hybrid sunfish	1.50	2

APPENDIX C

Draft Regionalized Benthic Macroinvertebrate Index of Biotic Integrity

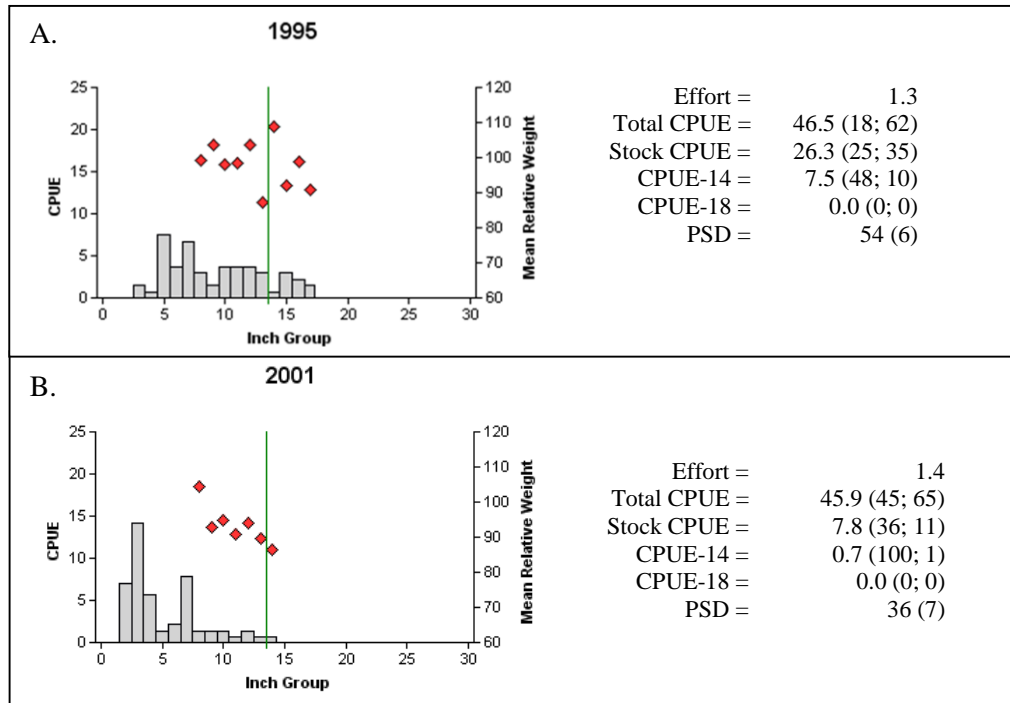
REGIONALIZED BENTHIC MACROINVERTEBRATE INDEX OF BIOTIC INTEGRITY (DRAFT).—Regionalized Benthic Index of Biotic Integrity metrics and scores for kick-net samples collected using the rapid bioassessment protocol for benthic macroinvertebrates at Big Cypress Bayou, Site B, September 10, 2014, Marion County, TX. Metrics are scored from low to high quality on a scale of 1–4.

Metric	Total	Score
RICHNESS AND COMPOSITION MEASURES		
Total number of taxa	31	4
Number of EPT taxa	12	3
% Diptera and non-insects	18.25	4
% Dominant taxon	12.03	4
FUNCTIONAL COMPOSITION		
% Dominant functional group	48.28	2
% Shredder	3.44	4
% Scraper	9.92	3
TOLERANCE MEASURES		
Hilsenhoff biotic index (HBI)	5.15	3
# of Intolerant taxa	23	3
% Tolerant organisms	4.76	3
Total Score		33
Aquatic Life Use		High

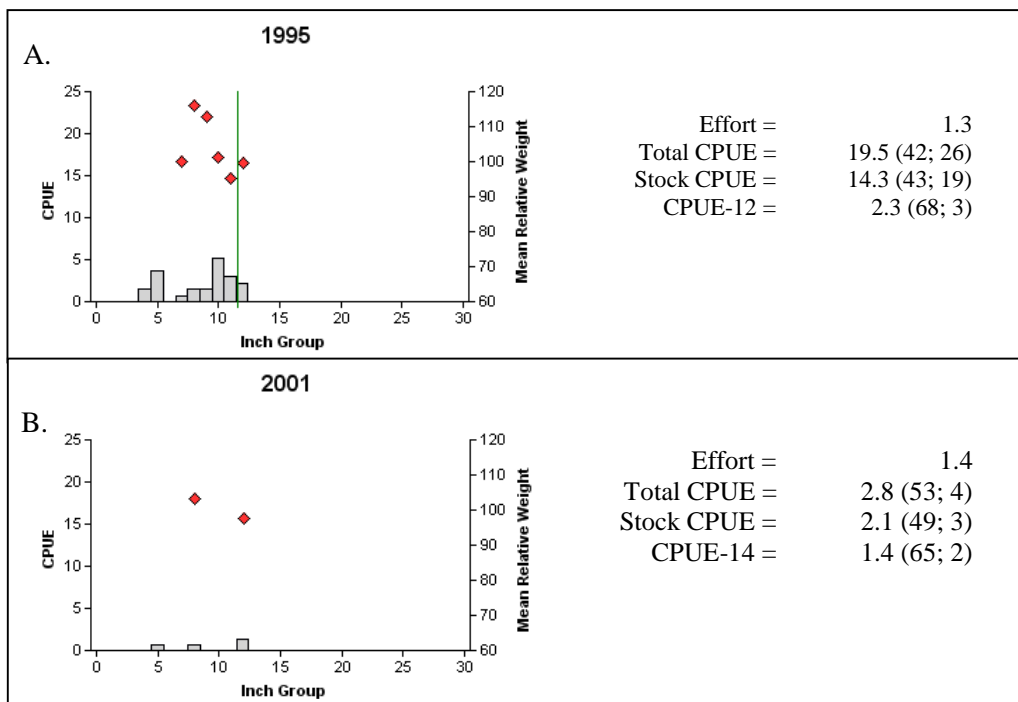
APPENDIX D

TPWD 1995 and 2001: Sport fish Survey Results from Big Cypress Bayou

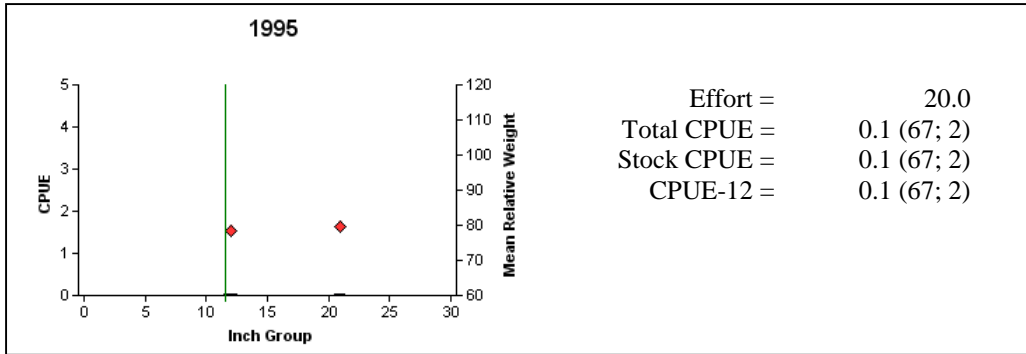
LARGEMOUTH BASS.—Number of Largemouth Bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Big Cypress Bayou downstream of Jefferson, TX: A. 1995 and B. 2001. Minimum length limit indicated by vertical line.



SPOTTED BASS.—Number of Spotted Bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Big Cypress Bayou downstream of Jefferson, TX: A. 1995 and B. 2001. Minimum length limit indicated by vertical line. On Sept. 1, 2001 the Spotted Bass minimum length limit changed from 12 inches to no minimum.



CHANNEL CATFISH.—Number of Channel Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for a hoop netting survey, Big Cypress Bayou downstream of Jefferson, TX, August 1995. Minimum length limit indicated by vertical line.





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