Supplemental Biological Data Collection, Middle Trinity River
Priority Instream Flow Study

Final Report

Prepared by:
Trinity River Authority of Texas and Texas Parks and Wildlife Department

Under Texas Parks and Wildlife Department Interlocal Contract No. 1148321527 and Texas Water Development Board Research and Planning Funds (TWDB Contract No. 1248311360)

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tra
Trinity River Authority of Texas

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Final Report

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Executive Summary

The 77th Texas Legislature passed Senate Bill 2 (SB 2) in 2001 which created the Texas Instream Flow Program (TIFP). This program is administered jointly by the Texas Commission on Environmental Quality (TCEQ), Texas Parks and Wildlife Department (TPWD), and Texas Water Development Board (TWDB). The Program's charge is to determine how much water rivers need to maintain a sound ecological environment. The middle Trinity River was identified by the TIFP as a priority subbasin in the Texas Instream Flow Studies: Programmatic Work Plan (TPWD, TCEQ & TWDB, 2002).

In late 2012, the TIFP and Trinity River Authority of Texas (TRA) began working on the reconnaissance and information evaluation phase of the project. A large biological data gap was identified and this Supplemental Biological Data Collection Study was initiated to obtain recent biological data for the study area. The TIFP and TRA sampled six sites twice in the middle Trinity River subbasin between August and November of 2012.

Standard TCEQ Surface Water Quality Monitoring (SWQM) biological field sampling methods were used although sampling events for each were segregated by identified mesohabitat types (i.e., riffle, run, pool, backwater). Results showed high species richness along the middle Trinity River study area with 36 species of fish, 58 taxa of benthic macroinvertebrates, and 15 species of mussels identified during the study. Additional data and spatial analysis is underway in order to provide information to TIFP and basin stakeholders.

This study was funded, in part, by TPWD Interlocal Contract No. 425702 to TRA, Texas Water Development Board Research and Planning Fund Contract No. 1248311360 to TPWD, and by the US Fish and Wildlife Service through Federal Aid in Sport Fish Restoration Program grant F-139-T to TPWD.

Introduction

In 2001, the Texas Legislature passed Senate Bill 2 (SB 2) which directed the Texas Parks and Wildlife Department (TPWD), the Texas Commission on Environmental Quality (TCEQ), and the Texas Water Development Board (TWDB), later referred to jointly as the Texas Instream Flow Program (TIFP), to work with area stakeholders to design and conduct studies to determine flow conditions needed in Texas' rivers to support a *"sound ecological environment."* Because of potential water development projects, reuse projects, water rights permitting issues, and other factors, the middle Trinity River was identified as one of six priority subbasins (TWDB, 2008).

Lotic systems have a natural level of variability (Richter, Mathews, Harrison, and Wigington, 2003) and studies undertaken to understand and explain river ecosystems have an inherent level of uncertainty (TIFP, 2008). Instream flow studies attempt to integrate information regarding a system's hydrology and hydraulics, geomorphology, biology, and water quality on a mesohabitat scale in order to determine a range of flows that will promote a *"sound ecological environment"* (TIFP, 2008)

The TIFP identified eight steps for instream flow studies in Texas (Figure 1). The first step in the process is Reconnaissance and Information Evaluation. Reconnaissance level studies of systems are paramount first steps in understanding stream ecosystems (Maddock, 1999). TRA completed an extensive field reconnaissance survey in 2011 and installed a series of long term channel morphology monitoring sites along the middle Trinity River in 2012 (TRA & RPS Espey, 2011) (TRA & RPS Espey Consultants Inc., 2013). Previous environmental flow work in the Trinity River basin identified and assembled existing data during the Senate Bill 3 (SB 3) process in 2009 (EIH, 2009). Environmental flow standards applicable to the middle Trinity River were adopted by TCEQ in 2011 and are shown in Appendix A.

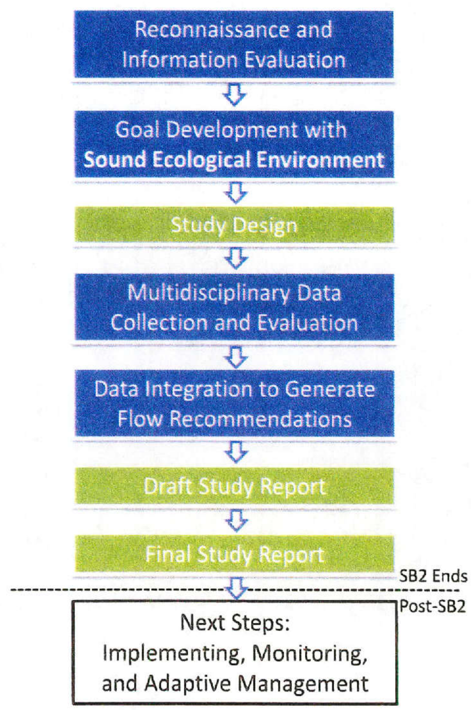

Figure 1. TIFP environmental flow study process.

Benthic organisms are appropriate indicators of ecosystem health (Dewson, James, & Death, 2007) and benthic analysis at the mesohabitat scale is appropriate (Rabeni, Doisy, & Galat, 2002). Aquatic macroinvertebrates are good indicators of stream quality because they are affected by the *"physical, chemical, and biological conditions of the stream"* (Barbour, Gerritsen, Snyder, and Stribling, 1999).

The goal of this project was to conduct biological collections of fish and benthic organisms (invertebrates and mussels) in order to fill both spatial and temporal data gaps. This work was conducted cooperatively by TRA and TIFP agencies. The contract scope, comments to draft report, and comment response, are shown in Appendix B.

Study Scope

Study Area Description

The middle Trinity River study area (Figure 2) was determined to be the 211 river miles stretching from the confluence of the East Fork Trinity River (river mile 432) downstream to the headwaters of Lake Livingston (river mile 221) located at the 131 ft (40 m) elevation contour. The middle Trinity River includes the lower 51 river miles within TCEQ Segment 0805 (Upper Trinity River) and all of Segment 0804 (Trinity River Above Lake Livingston). An additional sampling site was included further downstream within the 63 river mile riverine headwaters of Lake Livingston to determine if there was a need to extend the study area downstream.

The immediate middle Trinity River watershed covers 6,444 mi^2 (16,690 km^2). Including the 7,840 mi^2 (20,305 km^2) of watershed upstream, the total contributing watershed influencing the middle Trinity River is 14,284 mi^2 (36,995 km^2). A watershed map is shown in Appendix B. The immediate watershed is mostly rural and the river is hard to access due to limited crossings, high, steep river banks, and private landownership. Much of the watershed upstream of the immediate middle Trinity River is highly urbanized and contains the Dallas/Fort Worth (DFW) area. Within a 0.5 mile (0.8 km) buffer of the middle Trinity River mainstem (Figure 3), 30.4% of the land cover is wetland with only 1.2% classified as developed or barren.

Due largely to population growth in the watershed upstream, base flows in the middle Trinity River have increased significantly since 1970. Using an average of the 0-50th percentile flows at the USGS gage at Oakwood, located near the middle of the study area, base flows have increased 112% between the periods 1942-1969 to 1970-2012 (Figure 4). There is limited groundwater interaction in the middle Trinity River and during periods of low flow, over 95% of the water in the middle Trinity River is treated effluent from the DFW area (TRA, 2012). During a 2011 longitudinal reconnaissance of this reach, the middle Trinity River became a losing river system (TRA & RPS Espey, 2011).

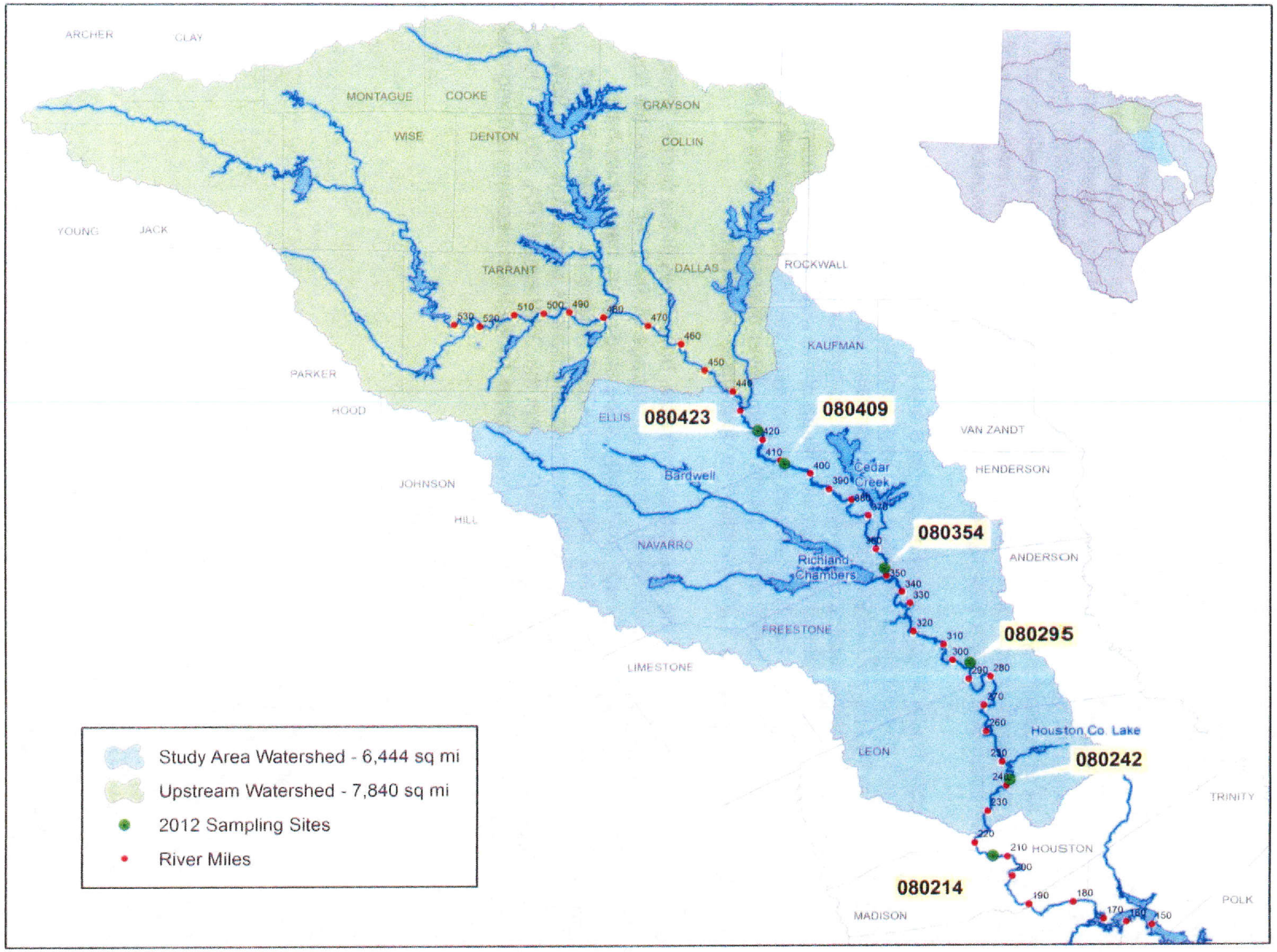

Figure 2. Middle Trinity River study area map.

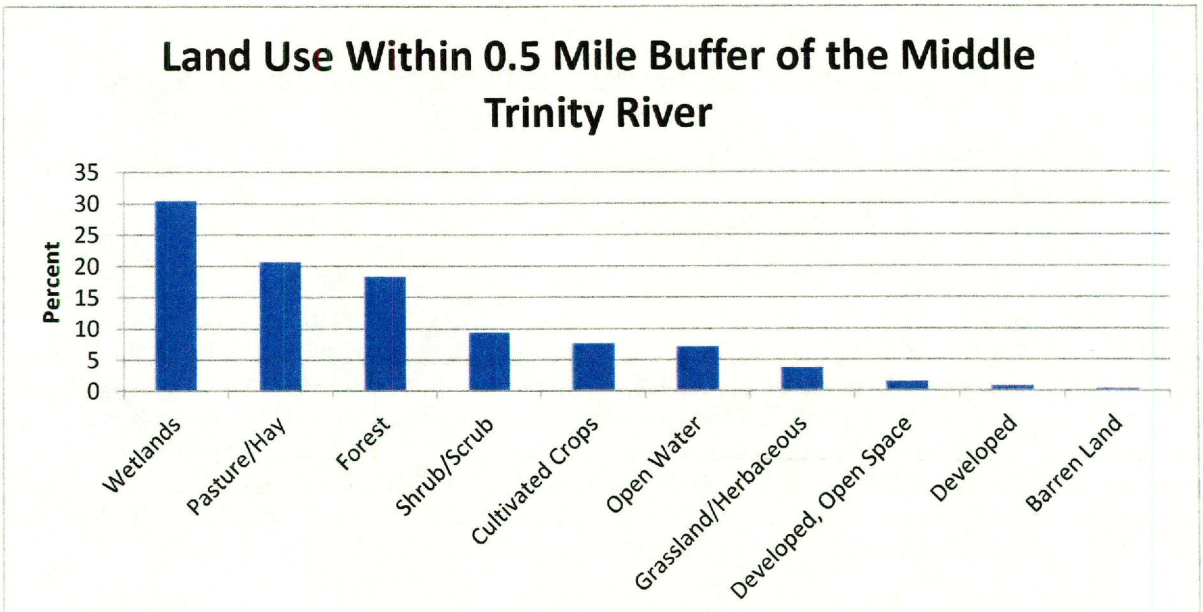

Figure 3. Land use from the National Land Cover Dataset 2006 within a 0.5 mile buffer of the middle Trinity River (USGS, 2011).

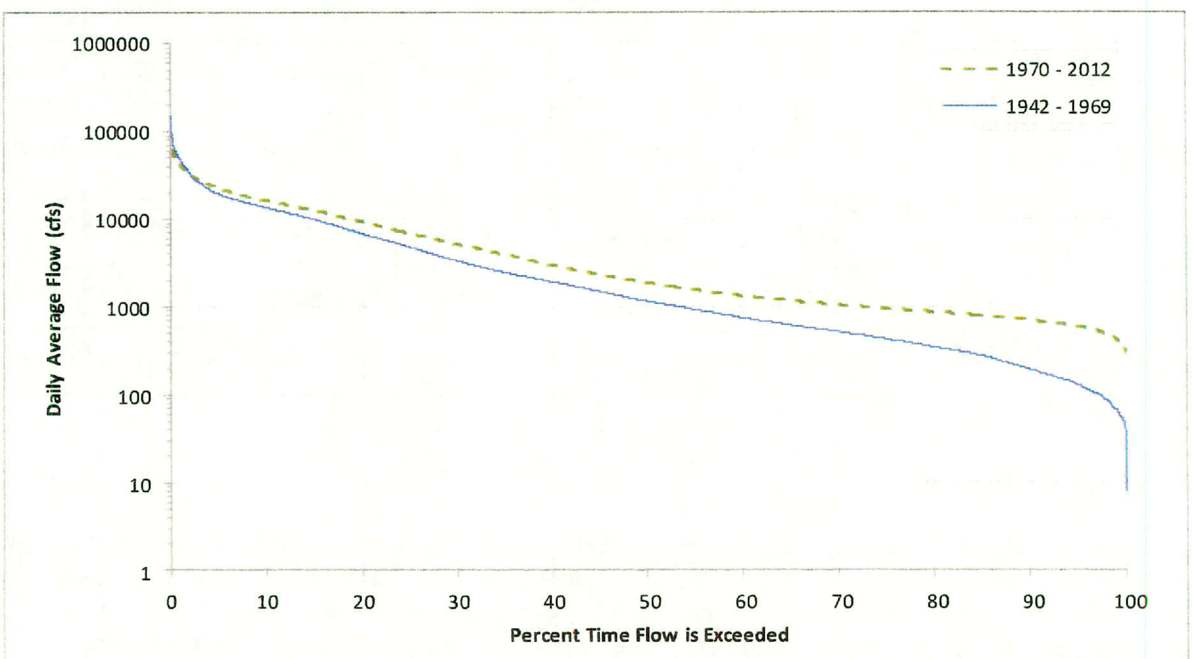

Figure 4. Flow exceedance curve for USGS gage 08065000, Trinity River near Oakwood, for periods 1942-1969 and 1970-2012.

Site Selection

Six sampling locations (Table 1) for supplemental biological sample collection were selected based upon:

1. Historical biological data collection sites
2. Reach segmentation
3. Availability of varied mesohabitat types
4. Instream structures and controls
5. Spatial distribution
6. Data gaps

In addition to TCEQ segmentation designations, reach segmentation also considered the 2011 Longitudinal Survey which took into account aerial photo analysis, field observations, and extensive empirical channel and mesohabitat data (TRA & RPS Espey, 2011). Minimal biological data has been collected since an extensive effort by TPWD in the late 1980s (Kleinsasser & Linam, 1990). A map of the 2012 sampling locations is shown in Figure 2. Site Numbers mentioned in this report are derived from a two-digit basin code (e.g. 08) and four-digit river mile designation (0214 equals river mile 214).

Table 1. Sample site locations and dates.

Site No.	Location Description	Sample Date 1	Sample Date 2	County1	County2	Latitude	Longitude
080214	Trinity River upstream of SH 21	8/14/2012	10/17/2012	Madison	Houston	31.080009	95.719439
080242	Trinity River downstream of SH 7	8/15/2012	10/16/2012	Leon	Houston	31.319278	95.667159
080295	Trinity River upstream of US 79/84	8/16/2012	10/29/2012	Freestone	Anderson	31.689245	95.790823
080354	Trinity River upstream of US 287	9/11/2012	10/30/2012	Freestone	Anderson	31.988122	96.056724
080409	Trinity River upstream of FM 85	9/12/2012	10/31/2012	Navarro	Henderson	32.31943	96.369236
080423	Trinity River at SH 34	9/13/2012	11/1/2012	Ellis	Kaufman	32.423932	96.452315

Sampling Schedule

Because of the lack of existing, recent biological data within the middle Trinity River, each of the six sites were sampled twice in 2012. The intent was to sample each site twice in the TCEQ designated index period (March 15 – October 15), with one sample event at each site being within the critical period (July 1 – Sept 30). Weather conditions necessitated that sampling be pushed outside of these dates in order to ensure an adequate recovery period after high flow pulses. TRA and TIFP staff agreed that the conditions were still appropriate for supplemental biological data collection intended to fill data gaps and characterize the biology of the middle Trinity River.

Methodology

All available mesohabitat types were sampled for fish, benthic macroinvertebrates, and mussels. Multi-agency crews were present during each sampling event and were typically split into four general crews:

1. Seine, hoop net, gill net, and mussel
2. Benthic macroinvertebrates
3. Habitat
4. Boat electrofisher

When needed, resources and tasks were redistributed to ensure timely sample completion.

In general, fish and benthic macroinvertebrate sampling methods followed those outlined in the most recent version of *Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collection and Analyzing Biological Community Habitat Data* (TCEQ, 2007). Fish collections were primarily conducted by boat electrofishing with a Smith Root 7.5 GPP electrofisher and seining with 4.5 m long seines comprised of 3.1 mm mesh. Sampling was augmented with hoop nets and experimental gill nets to effectively sample all habitats. Protocols for benthic macroinvertebrate collection methods included kicknet sampling and/or sample collection from woody debris, rocks, or other structures. Mussel sampling was comprised of time searches along the shoreline and within the river channel.

Though sampling duration followed that outlined in the above references, collections of both fish and benthic macroinvertebrates were segregated by identified mesohabitat types (e.g., riffle, run, pool, backwater). Within each discrete mesohabitat sample, a global positioning system (GPS) receiver recorded a minimum of one location. A measurement of depth, dominant substrate, instream cover, and current velocity was taken at each point where a GPS coordinate was collected. A photograph was taken of each area sampled.

A minimum of one streamflow discharge measurement was completed at each site using a SonTek RiverSurveyor® M9 and standard USGS methods for boat mounted acoustic Doppler current profilers (Mueller & Wagner, 2009) or standard SWQM wadeable stream methods described in the TCEQ *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods* (2012). When available and appropriate, data from a USGS stream gage was recorded in lieu of field measurements.

Fishes and benthic macroinvertebrates collected in the field were identified following the requirements outlined in TCEQ (2007). TPWD provided quality assurance for identification of fish and mussel specimens and TCEQ identified benthic macroinvertebrates.

Results

Streamflow discharge measurements are reported in Table 2. Additionally, median flows from the middle Trinity River USGS gages are shown in Table 3.

Table 2. Flow results from 2012 supplemental biological data collection along the middle Trinity River.

Site	Date	Q (cfs)	Source**
080214	8/14/2012	707	M9
080214	10/17/20102	975	M9
080242	8/15/2012	722	USGS Gage 08065350 - Provisional
080242	10/16/2012	1010	USGS Gage 08065350 - Provisional
080295	8/16/2012	653	USGS Gage 08065000 - Provisional
080295	10/29/2012	811	USGS Gage 08065000 - Provisional
080354	9/11/2012	616	M9
080354	10/30/2012	669	M9
080409	9/12/2012	634	M9
080409	10/31/2012	671	M9
080423	9/13/2012	618	USGS Gage 08062500 - Provisional
080423	11/1/2012	949	USGS Gage 08062500 - Provisional
**M9 data is instantaneous; USGS gage data was selected near the middle of the workday.			

Table 3. Period of record USGS median flow (cfs) values for each biological data collection site.

Site	USGS Gage Number	USGS Gage Name	USGS Median ** Q (cfs)	Earliest Record
080214	na	na	na	na
080242	8065350	Trinity River near Crockett	2,270	1964
080295	8065000	Trinity River near Oakwood	1,520	1924
080354	na	na	na	na
080409	8062500	Trinity River near Rosser	1,000	1924a
080423	8062500	Trinity River near Rosser	1,000	1924a

** Median flows calculated for period from earliest record to 2012 except as noted.
a Ungaged from 1925 to 1938

Data for habitat (Table 4), fish (Table 5), mussels (Table 6), and benthic macroinvertebrates (Table 7) are reported in the following pages. Raw data (including all sampling methods) and georeferenced photographs are included in the accompanying electronic media.

Table 4. Summary of depth, velocity, and dominant substrate types by site, sample-collection method (BE=boat electrofishing; S=seine), and habitat.

Site_id	Method	Habitat	Number of samples	Depth (ft)			Velocity (ft/s)			Number of samples					
				Min	Mean	Max	Min	Mean	Max	Silt / Clay	Sand	Gravel	Rubble / Cobble	Boulder	Bedrock
80214	BE	backwater	2	2.9	3.0	3.1	0.22	0.28	0.34	2	0	0	0	0	0
80214	BE	pool	7	3.9	6.5	8.7	0.21	0.42	0.62	5	1	0	0	0	1
80214	BE	run	11	1.4	4.7	8.5	0.44	0.76	1.01	2	6	2	1	0	0
80214	S	backwater	4	0.3	0.9	1.6	0.00	0.05	0.13	2	2	0	0	0	0
80214	S	pool	5	1.4	2.0	2.5	0.00	0.06	0.13	4	1	0	0	0	0
80214	S	run	11	0.4	1.3	1.9	0.16	0.48	1.97	3	8	0	0	0	0
80242	BE	backwater	4	2.4	4.8	8.8	0.27	0.54	0.86	4	0	0	0	0	0
80242	BE	pool	1	--	5.3	--	--	0.34	--	1	0	0	0	0	0
80242	BE	run	17	1.7	4.4	7.4	0.72	1.46	2.23	1	8	6	2	0	0
80242	S	backwater	4	0.5	1.2	1.6	0.09	0.21	0.30	0	2	2	0	0	0
80242	S	pool	1	--	2.3	--	--	0.16	--	1	0	0	0	0	0
80242	S	riffle	5	0.2	0.8	1.4	0.59	1.65	2.10	0	1	4	0	0	0
80242	S	run	11	0.1	1.3	2.4	0.15	0.67	1.67	1	9	1	0	0	0
80295	BE	backwater	3	3.7	5.0	6.2	0.51	2.45	3.53	3	0	0	0	0	0
80295	BE	riffle	2	2.1	3.3	4.6	2.41	2.69	2.96	0	0	0	2	0	0
80295	BE	run	14	1.5	4.4	7.6	0.54	2.02	4.88	4	4	2	4	0	0
80295	S	backwater	5	0.9	1.4	1.9	0.04	0.11	0.26	2	1	1	1	0	0
80295	S	riffle	5	0.2	0.7	1.1	0.56	1.39	1.97	0	0	1	4	0	0
80295	S	run	14	0.9	1.6	2.3	0.02	0.86	2.26	1	6	2	5	0	0
80354	BE	backwater	4	3.3	5.5	7.9	0.24	0.31	0.34	4	0	0	0	0	0
80354	BE	run	23	1.7	5.5	11.8	0.75	1.38	2.23	12	7	3	1	0	0
80354	S	backwater	4	0.8	1.7	2.4	0.01	0.02	0.04	2	1	1	0	0	0
80354	S	pool	1	--	0.5	--	--	0.34	--	0	1	0	0	0	0
80354	S	riffle	1	1.3	1.3	1.3	--	1.79	--	0	0	1	0	0	0
80354	S	run	14	0.6	1.2	2.4	0.35	0.92	1.36	1	9	4	0	0	0
80409	BE	backwater	2	3.5	4.2	5.0	0.33	0.49	0.64	2	0	0	0	0	0

Continued on next page.

Table 4. Continued.

Site_id	Method	Habitat	Number of samples	Depth (ft)			Velocity (ft/s)			Number of samples					
				Min	Mean	Max	Min	Mean	Max	Silt / Clay	Sand	Gravel	Rubble / Cobble	Boulder	Bedrock
80409	BE	falls	1	--	4.1	--	--	1.18	--	0	1	0	0	0	0
80409	BE	plunge pool	1	--	4.3	--	--	1.22	--	0	0	0	0	1	0
80409	BE	pool	2	6.8	6.9	7.0	0.38	0.41	0.44	2	0	0	0	0	0
80409	BE	rapid	2	3.8	4.0	4.2	3.48	3.87	4.27	0	0	0	0	0	2
80409	BE	run	15	2.4	4.6	9.2	0.81	1.93	3.85	7	4	4	0	0	0
80409	S	backwater	5	1.0	1.7	3.6	0.06	0.14	0.26	3	0	1	1	0	0
80409	S	pool	2	1.3	1.9	2.4	0.07	0.16	0.24	2	0	0	0	0	0
80409	S	riffle	2	0.2	0.5	0.7	1.97	2.51	3.05	0	0	1	1	0	0
80409	S	run	14	0.5	1.6	2.7	0.07	0.98	2.43	7	2	2	3	0	0
80423	BE	backwater	3	4.2	5.7	8.4	0.08	0.35	0.49	3	0	0	0	0	0
80423	BE	falls	3	5.6	6.3	7.7	1.00	1.18	1.43	0	0	1	0	0	2
80423	BE	pool	3	5.6	7.6	11.6	0.27	0.38	0.50	3	0	0	0	0	0
80423	BE	riffle	1	--	1.5	--	--	1.65	--	0	0	0	1	0	0
80423	BE	run	9	1.9	5.2	9.0	0.19	1.41	2.34	3	3	0	1	1	1
80423	S	backwater	5	0.9	1.6	3.1	0.03	0.12	0.20	2	3	0	0	0	0
80423	S	pool	1	--	3.6	--	--	0.06	--	0	1	0	0	0	0
80423	S	riffle	3	0.4	0.6	0.8	0.46	2.11	3.93	1	0	0	2	0	0
80423	S	run	10	0.8	1.7	3.3	0.08	1.09	3.97	2	4	1	2	0	1

Table 5. Fish species collected in the middle Trinity River subbasin during 2012.

Species	Common Name	080214	080242	080295	080354	080409	080423
Ameiurus natalis	yellow bullhead	X					
Aplodinotus grunniens	freshwater drum	X	X	X	X	X	X
Atractosteus spatula	alligator gar		X		X	X	X
Carpiodes carpio	river carpsucker		X	X			X
Cyprinella lutrensis	red shiner	X	X	X	X	X	X
Cyprinella venusta	blacktail shiner		X	X	X		
Cyprinus carpio	common carp	X		X	X		
Dorosoma cepedianum	gizzard shad	X	X	X	X		X
Dorosoma petenense	threadfin shad	X	X	X	X		X
Etheostoma chlorosoma	bluntnose darter				X	X	
Etheostoma gracile	slough darter	X			X	X	
Fundulus notatus	blackstripe topminnow						X
Gambusia affinis	western mosquitofish	X	X	X	X	X	X
Ictalurus furcatus	blue catfish	X	X	X	X	X	X
Ictalurus punctatus	channel catfish	X	X	X	X	X	X
Ictiobus bubalus	smallmouth buffalo	X	X	X	X	X	X
Lepisosteus oculatus	spotted gar	X	X	X	X	X	X
Lepisosteus osseus	longnose gar	X	X	X	X	X	X
Lepomis cyanellus	green sunfish	X	X	X			X
Lepomis gulosus	warmouth	X					
Lepomis humilis	orangespotted sunfish	X	X	X		X	X
Lepomis macrochirus	bluegill	X		X	X		X
Lepomis megalotis	longear sunfish	X	X	X	X	X	X
Menidia beryllina	inland silverside	X	X	X		X	
Micropterus punctulatus	spotted bass	X	X	X		X	X
Micropterus salmoides	largemouth bass	X	X			X	X
Morone chrysops	white bass	X	X	X			
Notropis buchanani	ghost shiner	X	X	X	X	X	X
Notropis shumardi	silverband shiner	X	X				
Notropis texanus	weed shiner		X	X			
Noturus nocturnus	freckled madtom	X	X	X	X	X	X
Percina macrolepida	bigscale logperch			X		X	X
Percina sciera	dusky darter		X	X		X	
Pimephales vigilax	bullhead minnow	X	X	X	X	X	X
Pomoxis annularis	white crappie	X	X	X	X		X
Pylodictis olivaris	flathead catfish	X	X	X	X	X	X

Table 6. Mussel species found in the Trinity River subbasin in 2012.

Species	Common name	Status
Truncilla donaciformis	fawnsfoot	TCAP
Pyganodon grandis	giant floater	
Leptodea fragilis	fragile papershell	
Potamilus amphichaenus	Texas heelsplitter	1,3 (TWAP-SC)
Fusconaia askewi	Texas pigtoe	1,2,3 (TWAP-SC)
Obliquaria reflexa	threehorn wartyback	
Quadrula mortoni	western pimpleback	
Quadrula nobilis	Gulf mapleleaf	
Amblema plicata	threeridge	
Arcidens confragosus	rock pocketbook	(TWAP-SC)
Megalonaias nervosa	washboard	
Plectomerus dombevanus	bankclimber	
Tritogonia verrucosa	pistolgrip	
Potamilus purpuratus	bleufer	
Lampsilis teres	yellow sandshell	

TWAP-SGCN = Texas Conservation Action Plan-Species of Greatest Conservation Need (TPWD, 2010)
1 = State Rank (S1) – Critically imperiled, extremely rare, very vulnerable to extirpation, 5 or fewer occurrences
2 = State Rank (S2) – Imperiled in state, very rare, vulnerable to extirpation, 6 to 20 occurrences
3 = State Threatened

Table 7. Benthic macroinvertebrates collected in the middle Trinity River subbasin in 2012.

Taxon	80214	80242	80295	80354	80409	80423
Baetis sp.	X	X	X	X	X	X
Camelobaetidius sp.		X	X	X	X	X
Fallceon sp.	X	X			X	X
Paracloeodes sp.	X					
Pseudocloeon sp.		X	X	X	X	X
Campsurus sp.				X		
Pentagenia vittegera	X					
Caenis sp.	X	X	X	X	X	X
Isonychia sp.	X	X	X	X	X	X
Maccaffertium sp.	X	X	X	X	X	X
Stenonema sp.			X	X	X	
Asioplax sp.	X	X	X	X	X	X
Tricorythodes sp.	X	X	X	X	X	X
Traverella sp.		X	X	X	X	
Choroterpes sp.			X			
Neoperla sp.		X	X	X		
Cheumatopsyche sp.	X	X	X	X	X	X
Hydropsyche sp.	X	X	X	X	X	X
Potamyia flava	X		X			
Hydroptila sp.					X	X
Mayatrichia sp.			X			
Neotrichia		X	X			X
Nectopsyche sp.		X	X	X	X	X
Neureclipsis sp.	X					X
Cyrnellus sp.	X	X				
Corydalus cornutus		X	X	X		
Chauliodes sp.			X			
Petrophila sp.		X		X	X	X
Dubiraphia sp.			X	X		
Heterelmis sp.	X	X	X	X	X	
Stenelmis sp.	X	X	X	X	X	X
Helichus sp.			X	X		
Dineutus sp.				X		
Berosus sp. (larva)			X			
Desmopachria sp.				X		
Argia sp.	X		X		X	X
Enallagma sp.						X
Hetaerina sp.						X
Dromogomphus sp.			X			
Erpetogomphus sp.	X					
Stylurus sp.					X	
Rhagovelia sp.						X
Chironomidae	X	X	X	X	X	X
Atrichopogon sp.	X					
Bezzia sp.	X		X			

Continued on next page.

Table 7. Continued

Taxon	80214	80242	80295	80354	80409	80423
Sphaeromias sp.	X					
Simulium sp.		X	X	X	X	X
Limnophora sp.						X
Hyallela azteca	X					X
Collembola						X
Ostracoda	X					
Corbicula fluminea		X	X	X	X	X
Sphaerium sp.			X			
Physella sp.			X			X
Ferrisia sp.			X			
Hydracarina sp.						X
Oligochaeta	X	X	X		X	X
Dugesia sp.						X

Discussion

Habitat, fish, and benthic invertebrate data are summarized and discussed below. Additional data analysis is underway by the TIFP and TRA in order to create the middle Trinity River Study Design in collaboration with the stakeholder workgroup. Habitat and fish assemblage data from this study will be used to determine appropriate indicator species for the middle Trinity River instream flow study and develop stratified random sampling designs for collection of habitat utilization data.

Habitat

Sampling events took place during a range of base flow conditions and were below the period of record median flow. Even at these lower end flows, sampling crews had difficulty in some locations due to water depth (too deep) and high velocities. In some instances, substrate notation was complicated by the type of substrate. For example, some substrate samples were 100% compacted, spherical clay balls. These were recorded as clay due to type, though their structure and size fit into the large sand to gravel category.

Large woody debris is prevalent in many locations along the middle Trinity River and serves as instream cover and as a nutrient source.

Fisheries

Collection methods included boat electrofishing and seining in as many habitat types as possible. Additionally, hoop and gill nets were utilized to supplement collections. A total of 36 species comprising more than 58,000 individuals was collected. Several lotic-adapted species that were distributionally limited (e.g., dusky darter), uncommon (e.g., freckled madtom), or absent (e.g., bigscale logperch) in the 1970s and 1980s were observed more broadly. Table 8 shows a comparison of fishery data between historical collections and 2012 (Perkin & Bonner, in revision) (Kleinsasser & Linam, 1990) (TPWD, 1974). Eighteen species from the historic assemblage were not collected in 2012. This may be due to several factors including limited effort compared to historic (two seasons in 2012 versus more than thirty years of collections) and 2012 sampling was conducted only in mainstem habitats.

Previous studies had suggested longitudinal zonation of fish assemblages, likely related to water quality issues. Preliminary analysis of the baseline fish data demonstrated fewer longitudinal trends, with the upper four sites grouping together and the lower two clustering.

Benthic Macroinvertebrates

In the six study reaches sampled in the summer and fall of 2012, approximately 54 taxa were identified (Chironomidae enumerated at family level) based on the analysis of over 5,000 individuals. Two primary sampling techniques were used. Snags, in form of woody debris and submerged tree limbs, were sampled in areas exposed to current. Kicknet samples were collected in shallow riffles and runs.

Several sensitive benthic macroinvertebrate taxa were collected that were not noted in Dickson, et al. (1989). In general, sensitive benthic macroinvertebrate taxa were distributed across all six study reaches. Table 9 shows a comparison of benthic macroinvertebrate data between historical collections(Dickson et al., 1989) (Davis, 1989) and 2012 sampling.

The sample reach located around State Highway 21 (Site ID 80214) is different from upstream reaches. This is primarily related to the predominance of sandy substrates and lack of cobble/gravel riffles that were present in each of the other reaches.

Mussels

Timed searches were used at all six collection sites during baseline sampling in 2012. In that effort, 15 species (live) were collected (Table 6), including two state threatened species, Texas heelsplitter and Texas pigtoe (Texas Mussel Watch, 2008). Catch per unit effort (total mussels/hour) ranged from 4.5 to 29.2, which are relatively high values. No apparent longitudinal trend in mussel abundance was observed. The highest diversity and abundance of mussels was in a reach with large riffles. Table 10 shows a comparison of mussel data between historical collections and 2012. Invasive zebra mussels (*Dreissena polymorpha*) have been found upstream of the study area, but were not observed during this extensive sampling effort.

Table 8. Fish species collected in the middle Trinity River from 1970s to 2000s (Perkin & Bonner, in revision) and during baseline TIFP sampling in 2012.

Species	Common name	Historic	2012 Baseline
Ameiurus melas	black bullhead	X	
Ameiurus natalis	yellow bullhead	X	X
Amia calva	bowfin	X	
Aplodinotus grunniens	freshwater drum	X	X
Atractosteus spatula	alligator gar	X	X
Campostoma anomalum	central stoneroller	X	
Carpiodes carpio	river carpsucker	X	X
Ctenopharyngodon idella	grass carp	X	
Cyprinella lutrensis	red shiner	X	X
Cyprinella venusta	blacktail shiner	X	X
Cyprinus carpio	common carp	X	X
Dorosoma cepedianum	gizzard shad	X	X
Dorosoma petenense	threadfin shad	X	X
Etheostoma chlorosoma	bluntnose darter	X	X
Etheostoma gracile	slough darter	X	X
Etheostoma proeliare	cypress darter	X	
Fundulus notatus	blackstripe topminnow	X	X
Gambusia affinis	western mosquitofish	X	X
Ictalurus furcatus	blue catfish	X	X
Ictalurus punctatus	channel catfish	X	X
Ictiobus bubalus	smallmouth buffalo	X	X
Labidesthes sicculus	brook silverside	X	
Lepisosteus oculatus	spotted gar	X	X
Lepisosteus osseus	longnose gar	X	X
Lepomis auritus	redbreast sunfish	X	
Lepomis cyanellus	green sunfish	X	X
Lepomis gulosus	warmouth	X	X
Lepomis humilis	orangespotted sunfish	X	X
Lepomis macrochirus	bluegill	X	X
Lepomis marginatus	dollar sunfish	X	
Lepomis megalotis	longear sunfish	X	X
Lepomis microlophus	redear sunfish	X	
Lepomis miniatus	redspotted sunfish	X	
Lythrurus fumeus	ribbon shiner	X	
Lythrurus umbratilis	redfin shiner	X	
Menidia beryllina	inland silverside	X	X
Micropterus punctulatus	spotted bass	X	X
Micropterus salmoides	largemouth bass	X	X
Minytrema melanops	spotted sucker	X	
Morone chrysops	white bass	X	X
Morone mississippiensis	yellow bass	X	
Morone saxatilis	striped bass	X	

Table 8. Continued

Species	Common name	Historic	2012 Baseline
Notemigonus crysoleucas	golden shiner	X	
Notropis buchanani	ghost shiner	X	X
Notropis shumardi	silverband shiner	X	X
Notropis texanus	weed shiner	X	X
Notropis volucellus	mimic shiner	X	X
Noturus gyrinus	tadpole madtom	X	
Noturus nocturnus	freckled madtom	X	X
Opsopoeodus emiliae	pugnose minnow	X	X
Percina macrolepida	bigscale logperch	X	X
Percina sciera	dusky darter	X	X
Pimephales vigilax	bullhead minnow	X	X
Pomoxis annularis	white crappie	X	X
Pomoxis nigromaculatus	black crappie	X	
Pylodictis olivaris	flathead catfish	X	X

Table 9. Benthic macroinvertebrate taxa collected in historic sampling as well as baseline TIFP sampling in 2012.

Taxon	Historic	2012 Baseline
Baetis sp.	X	X
Camelobaetidius sp.		X
Fallceon sp.		X
Paracloeodes sp.	X	X
Pseudocloeon sp.		X
Campsurus sp.		X
Hexagenia sp.	X	
Pentagenia vittegera		X
Tortopus sp.	X	
Caenis sp.	X	X
Isonychia sp.		X
Maccaffertium sp.		X
Stenacron sp.	X	
Stenonema sp.	X	X
Asioplax sp.		X
Tricorythodes sp.	X	X
Traverella sp.		X
Perlesta sp.		X
Cheumatopsyche sp.		X
Hydropsyche sp.		X
Potamyia sp.	X	X
Hydroptila sp.		X
Neotrichia		X
Nectopsyche sp.		X
Neureclipsis sp.		X
Cymellus sp.	X	X
Corydalus cornutus		X
Petrophila sp.		X
Dubiraphia sp.		X
Heterelmis sp.		X
Microcylloepus sp.		X
Stenelmis sp.		X
Helichus sp.		X
Helophorus sp.	X	
Dineutus sp.		X
Gyretes sp.	X	
Berosus sp. *(larva)*		X
Desmopachria sp.		X
Hydrochus sp.	X	
Tropisternus sp.	X	
Peltodytes sp.	X	
Dytiscus sp.	X	
Argia sp.		X

Taxon	Historic	2012 Baseline
Enallagma sp.		X
Hetaerina sp.		X
Lestes sp.	X	
Dromogomphus sp.		X
Erpetogomphus sp.		X
Stylurus sp.		X
Metrobates sp.	X	
Rhagovelia sp.		X
Rheumatobates sp.	X	
Trichocorixa sp.	X	
Hebrus sp.	X	
Chironomidae	X	X
Atrichopogon sp.		X
Bezzia sp.		X
Sphaeromias sp.		X
Simulium sp.		X
Limnophora sp		X
Dicranota sp.	X	
Erioptera sp.	X	
Syrphidae sp.	X	
Hyallela azteca		X
Collembola		X
Palaemonetes sp.	X	
Ostracoda	X	X
Sphaerium sp.	x	
Corbicula fluminea	X	X
Ferrisia rivularis	X	
Physella sp.	X	X
Gyraulus sp.	X	
Hydracarina sp.	X	X
Oligochaeta	X	X
Nematoda	X	
Dugesia sp.	X	X

Table 10. Historic unionid mussel occurrences in the Trinity River basin with recent collections during 2012 baseline sampling and current status.

Species	Common name	Historic	2012 Baseline	Status
Toxolasma parvus	lilliput	X		
Toxolasma texasiensis	Texas lilliput	X		
Truncilla donaciformis	fawnsfoot	X	X	(TWAP-SC)
Truncilla macrodon	Texas fawnsfoot	X		3,4 (TWAP-SC)
Uniomerus declivis	tapered pondhorn	X		
Uniomerus tetralasmus	pondhorn	X		
Villosa lienosa	little spectaclecase	X		
Pyganodon grandis	giant floater	X	X	
Utterbackia imbecillis	paper pondshell	X		
Lasmigona complanata	white heelsplitter	X		
Leptodea fragilis	fragile papershell	X	X	
Potamilus amphichaenus	Texas heelsplitter	X	X	1,3 (TWAP-SC)
Potamilus ohiensis	pink papershell	X		
Fusconaia askewi	Texas pigtoe	X	X	1,2,3 (TWAP-SC)
Fusconaia flava	Wabash pigtoe	X		
Fusconaia lananensis	triangle pigtoe	X		1,3
Obovaria jacksoniana	southern hickorynut	X		3 (TWAP-SC)
Obliquaria reflexa	threehorn wartyback	X	X	
Pleurobema riddellii	Louisiana pigtoe	X		1,3 (TWAP-SC)
Quadrula apiculata	southern mapleleaf	X		
Quadrula mortoni	western pimpleback	X	X	
Quadrula nobilis	gulf mapleleaf	X	X	
Truncilla truncate	deertoe	X		
Amblema plicata	threeridge	X	X	
Arcidens confragosus	rock pocketbook	X	X	(TWAP-SC)
Megalonaias nervosa	washboard	X	X	
Plectomerus dombevanus	bankclimber	X	X	
Tritogonia verrucosa	pistolgrip	X	X	
Glebula rotundata	round pearlyshell	X		
Lampsilis satura	sandbank pocketbook	X		1,3 (TWAP-SC)
Potamilus purpuratus	bleufer	X	X	
Lampsilis hydiana	Louisiana fatmucket	X		
Lampsilis teres	yellow sandshell	X	X	
Ligumia subrostrata	pond mussel	X		

TWAP-SC = Texas Wildlife Action Plan-Species of Concern (TPWD, 2005)
1 = State Rank (S1) – Critically imperiled, extremely rare, very vulnerable to extirpation, 5 or fewer occurrences
2 = State Rank (S2) – Imperiled in state, very rare, vulnerable to extirpation, 6 to 20 occurrences
3 = State Threatened
4 = Candidate Species under Federal Endangered Species Act

Recommendations for Additional Work

Instream flow reconnaissance and supplemental studies are, by nature, designed to be the basis for additional studies. As the instream flow study for the middle Trinity River subbasin moves forward, opportunities exist to expand the scientific knowledge base. The following additional studies are recommended:

- Substrate plays an important role in instream flow studies. Particle size studied in conjunction with other physical and hydraulic variables have been able to predict distribution and, in some cases, the density of macroinvertebrates (Gore, Layzer, & Mead, 2001) (Statner, Merigoux, & Leichtfried, 2005). Additional research should be done to determine the habitat function of the spherical clay balls identified during this study.
- Large woody debris is common throughout some portions of the middle Trinity River study area. The role, amount, and movement of large woody debris throughout this system needs to be better understood.
- The SWQM guidelines for stream sampling were designed for small, wadeable streams. Additional methods for biological and sediment sampling on large river systems should be continually tested and developed to ensure that mesohabitat specific sampling is representative.

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Appendix A. SB 3 flow standards within the middle Trinity River

Location	Season	Subsistence Flow (cfs)	Base Flow (cfs)	Pulse Flow
USGS Gage: 08049500 West Fork Trinity River near Grand Prairie	Winter	19	45	Trigger: 300 cfs Volume: 3,500 af Duration: 4 days
	Spring	25	45	Trigger: 1,200 cfs Volume: 8,000 af Duration: 8 days
	Summer	23	35	Trigger: 300 cfs Volume: 1,800 af Duration: 3 days
	Fall	21	35	Trigger: 300 cfs Volume: 1,800 af Duration: 3 days
USGS Gage: 08057000 Trinity River at Dallas	Winter	26	50	Trigger: 700 cfs Volume: 3,500 af Duration: 3 days
	Spring	37	70	Trigger: 4,000 cfs Volume: 40,000 af Duration: 9 days
	Summer	22	40	Trigger: 1,000 cfs Volume: 8,500 af Duration: 5 days
	Fall	15	50	Trigger: 1,000 cfs Volume: 8,500 af Duration: 5 days
USGS Gage: 08065000 Trinity River near Oakwood	Winter	120	340	Trigger: 3,000 cfs Volume: 18,000 af Duration: 5 days
	Spring	160	450	Trigger: 7,000 cfs Volume: 130,000 af Duration: 11 days
	Summer	250	250	Trigger: 2,500 cfs Volume: 23,000 af Duration: 5 days
	Fall	100	260	Trigger: 2,500 cfs Volume: 23,000 af Duration: 5 days

Adapted from (Tex. Admin. Code tit. 30 § 298.225)

Appendix B. Scope of Work and Comments

Supplement Existing Biological data in the middle Trinity River Study Area

Background: A preliminary evaluation of existing biological data in the middle Trinity River indicates temporal and spatial gaps in historical collections that should be supplemented to allow a more thorough understanding of the system and its biology. The goal of the project is to conduct new biological collections that would facilitate a better understanding of biological assemblages and aid in scoping an instream flow study.

Task 1: Identify sampling locations, conduct reconnaissance, and secure access.
Through coordination between the Trinity River Authority (Authority), Texas Parks and Wildlife Department (TPWD), Texas Water Development Board (TWDB), and Texas Commission on Environmental Quality (TCEQ), a minimum of five appropriate sampling locations will be developed to fill baseline biological data needs within the middle Trinity River study area. Among the considerations for selection of sample sites are:

- Geographic gaps in the historic data;
- Representativeness of the reach;
- A lack of recent collections (e.g., post 1995); and
- Overall geographic coverage, especially as it relates to areas where instream flow study sites may be located.

The Authority will identify adjacent landowners through appraisal district records or other means and initiate contacts if access to their property is required, securing it through written permission.

Task 2: Collect biological assemblages and associated data

In general, sampling methods for biological assemblages will follow those outlined in the most recent version of *Surface Water Quality Monitoring Procedures, Vol 2: Methods for Collection and Analyzing Biological Community Habitat Data*. Fish collections will include boat and backpack electrofishing as well as seining and may be augmented by other methods to effectively sample all habitats. See *Appendix A: Fish Sampling Guidelines*. Protocols for benthic macroinvertibrate collection methods will include kicknet sampling and/or sample collection from woody debris, rocks, or other structures as available and may be augmented by other methods to effectively sample all habitats. See *Appendix B: Benthic Sampling Guidelines.*

Though sampling duration will follow that outlined in the above reference, collections of both fish and benthic macroinvertebrates will be segregated by identified mesohabitat types (e.g., riffle, run, pool, backwater). Within each discrete mesohabitat sample, a global positioning system (GPS) receiver will be used to record a minimum of one location (datum-WGS84; units=decimal degrees; reception-3D). A measurement will be made of habitat depth, dominant substrate, and current velocity at each point where a GPS coordinate is collected. A photograph will be taken depicting the area sampled.

A minimum of one flow measurement will be completed at each site using standard USGS methods for boat mounted acoustic Doppler current profilers (Mueller and Wagner, 2009) or standard SWQM wadeable stream methods described in the TCEQ *Surface Water Quality Monitoring Procedures, Vol 1: Physical and Chemical Monitoring Methods*. When available and appropriate, data from a USGS stream gage data may be recorded in lieu of field measurements.

The intent is to sample each site twice during the index period (e.g., TCEQ), with one of those during the critical period.

Sampling will be conducted in consultation and collaboration with the Authority, TPWD, TWDB, TCEQ Resource Protection Team, and TCEQ Surface Water Quality Monitoring Team and a representative from each agency will be notified in advance of field sampling events to allow for participation. TPWD will provide technical assistance and gear associated with field sampling.

Task 3: Identify fishes and benthic macroinvertebrates, prepare species lists, and report data

Fishes and benthic macroinvertebrates collected in the field will be identified following the requirements outlined in TCEQ (2005). TPWD will provide quality assurance for identification of fish specimens. TCEQ SWQM will provide assistance in identification of benthic macroinvertebrates. Fish and benthic macroinvertebrate assemblage enumeration, location, and habitat information will be reported in Microsoft Excel format. Photographs will be submitted in a suitable electronic format and georeferenced.

Deliverables:

A report containing all the details of work for the above mentioned tasks and the methodologies used will be delivered to TPWD. The report will also contain results, conclusions and recommendations for further work.

Attachment I

Supplemental Biological Data Collection,
Middle Trinity River Priority Instream Flow Study
&
Supplemental Biological Data Collection,
Lower Guadalupe River Priority Instream Flow Study

Draft-final report to the Texas Water Development Board

TWDB Contract number 1248311360

The objective of this project, as stated in the scope of work, was to "conduct reconnaissance and collect baseline biological data" for the middle Trinity and lower Guadalupe Rivers. This objective seems to have been carried out and documented quite well. After review, reviewers identified a small number of required and suggested changes.

REQUIRED CHANGES

Draft Final Report Comments:

1. On page 3 of the Guadalupe report, the statement is made "The Lower Guadalupe River study area (Figure2) was determined to be the 288 river miles stretching from downstream of Canyon Lake Dam (river mile 299) to the GBRA saltwater barrier (river mile 10)." This is an incorrect statement. The study area as agreed to by study partners would more accurately be described as the Guadalupe River from Seguin (river mile 241) to the confluence with the San Antonio River (river mile 11). Please make necessary changes to reflect this description of the study area.
2. On page 3 of the Trinity report, 2nd paragraph, contains the phrase "**Error! Reference source not found.**" This appears to be a typo. Please remove.

SUGGESTED CHANGES

3. Please consider designating study area boundaries (on Figure 2 on page 4 of the Guadalupe report).
4. Some reviewers confused the 5 digit Site Numbers (on page 5 of the Guadalupe report and page 6 of the Trinity report) with SWQMIS Site ID numbers. Please consider adding a statement that Site Numbers mentioned in the reports are specific to these studies and do not have any additional meaning.

All of the above comments were fully addressed in this report.