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

Final Report

Prepared by:
Guadalupe-Blanco River Authority of Texas and Texas Parks and Wildlife Department

Under Texas Parks and Wildlife Department Interlocal Contract No. 435047 and Texas Water Development Board Research and Planning Fund Contract No. 1248311360

September 2014

GBRA

TEXAS PARKS & WILDLIFE

Life's better outside.

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

Final Report

Prepared by:
Guadalupe-Blanco River Authority of Texas and Texas Parks and Wildlife Department

Under Texas Parks and Wildlife Department Interlocal Contract No. 435047 and Texas Water Development Board Research and Planning Fund Contract No. 1248311360

September 2014

GBRA

TEXAS PARKS & WILDLIFE
Life's better outside.®

THIS PAGE INTENTIONALLY LEFT BLANK

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

Final Report

Table of Contents

List of Tables

List of Figures

PAGE INTENTIONALLY LEFT BLANK

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 lower Guadalupe River was identified by the program as a priority subbasin in the Texas Instream Flow Studies: Programmatic Work Plan (TIFP, 2002).

In early 2013, the TIFP and Guadalupe-Blanco River Authority (GBRA) 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 GBRA sampled five sites twice in the lower Guadalupe River between May and August of 2013.

Standard TCEQ Surface Water Quality Monitoring 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 in the lower Guadalupe River study area with 46 species of fish, 61 taxa of benthic macroinvertebrates, and 10 species of mussels collected during the study. Additional data analysis is underway in order to provide information to study partners and basin stakeholders.

This study was funded, in part, by TPWD Interlocal Contract No. 435047 to GBRA, TWDB Research and Planning Fund Contract No. 1248311360 to TPWD, and 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 lower Guadalupe River was identified as one of six priority subbasins (TWDB, 2008).

Lotic systems have a natural level of variability (Richter, Mathews, Harrison, & 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 (2008) 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. The goal of this project was to conduct baseline 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 Guadalupe-Blanco River Authority (GBRA) and TIFP agencies. The contract scope, comments on draft report, and response are provided in Appendix A.

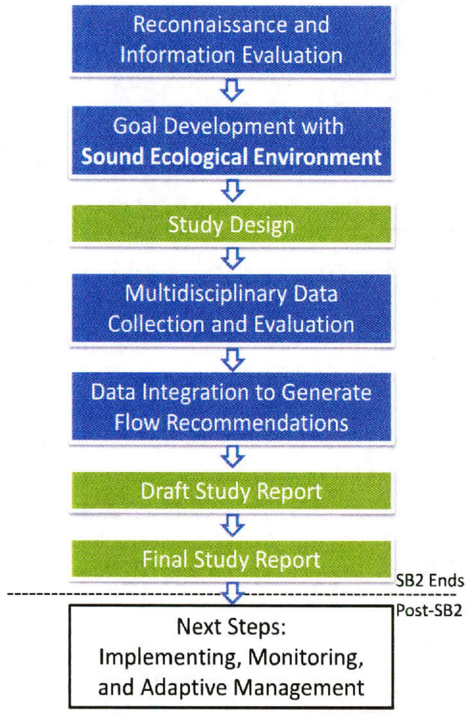

Figure 1. TIFP instream flow study process.

Study Scope

Study Area Description

The lower Guadalupe River study area (Figure 2) was determined to be the 230 river miles stretching from Seguin, TX (river mile 241) to the confluence with the San Antonio River (river mile 11).

Site Selection

Five sampling locations (Figure 2; 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

Site Numbers mentioned in this report are derived from a two-digit basin code (e.g. 18) and three-digit river mile designation (056 equals river mile 56), are specific to this study, and do not have additional meaning.

Sampling Schedule

Because of the lack of recent biological data within the lower Guadalupe River, each of the five sites were sampled twice in 2013 (Table 1). The intent was to sample each site twice in the TCEQ designated index period (March 15 – October 15), with one sampling event at each site occurring within the critical period (July 1 – Sept 30).

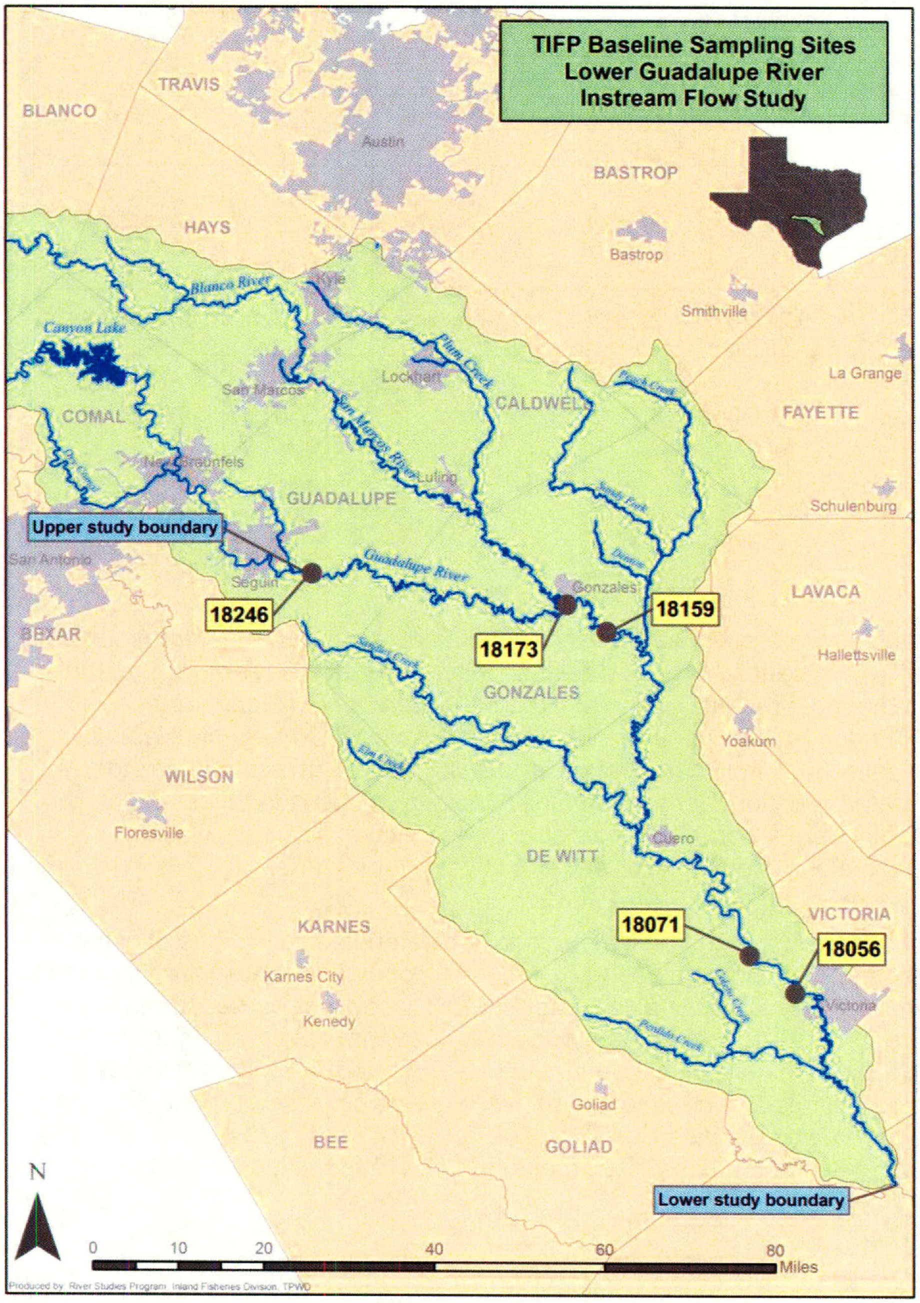

Figure 2. Lower Guadalupe River study area.

Table 1. Sample site locations and dates.

Site No.	Location Description	Sample Date 1	Sample Date 2	County	Latitude	Longitude
18056	Guadalupe River at Victoria Riverside Park, Victoria	5/24/2013	8/12/2013	Victoria	28.82269	-97.02216
18071	Guadalupe River at FM 447, SW of Nursery	5/23/2013	8/13/2013	Victoria	28.89212	-97.13617
18159	Guadalupe River 14 river miles downstream of US 183, Gonzales	6/24/2013	8/14/2013	Gonzales	29.42872	-97.38373
18173	Guadalupe River at US 183, Gonzales	5/22/2013	8/15/2013	Gonzales	29.48528	-97.44594
18246	Guadalupe River 1.5 miles downstream of FM 466, S of Seguin	5/21/2013	8/16/2013	Guadalupe	29.53668	-97.91331

Methodology

All available mesohabitat types were sampled for fish, benthic macroinvertebrates, and mussels (see Appendix A – Exhibit A). 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 included boat electrofishing as well as seining. Protocols for benthic macroinvertebrate collection methods included kicknet sampling in riffles and/or sample collection from woody debris, rocks, or other structures. Mussel sampling was comprised of timed searches along the shoreline and within the river channel.

Though sampling duration followed that outlined in the above references, collections of fish 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. 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 GBRA identified benthic macroinvertebrates.

Results

Results of the data collection efforts are presented in the following tables and spreadsheets including habitat, fish, benthic macroinvertebrate, and mussel data from each sampling event are provided in an electronic format.

Table 2. 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
18056	BE	backwater	2	2.1	2.5	2.9	0	0.05	0.1	2					
18056	BE	pool	1	--	3.8	--	--	0.47	--	1					
18056	BE	riffle	1	--	1.7	--	--	2.81	--			1			
18056	BE	run	9	1.2	3.28	5.9	0.02	1.07	3.29		1	6	1		
18056	S	backwater	2	2.0	2.2	2.4	0.18	0.195	0.21		1		1		
18056	S	pool	5	1.9	2.66	3.6	0.03	0.15	0.34	2	1		2		
18056	S	riffle	7	0.3	0.57	0.8	1.27	2.68	3.72			3	4		
18056	S	run	7	0.7	1.33	2.5	0.78	1.54	2.62		1	4	2		
18071	BE	backwater	1	7.0	7.0	7.0	0.055	0.055	0.055		1				
18071	BE	pool	5	2.2	3.74	6.4	0.02	0.16	0.355	4	1				
18071	BE	run	8	1.2	5.03	7.7	0.01	1.02	3.04	2	1	1	3	1	
18071	S	backwater	4	0.9	0.975	1.2	0.06	0.145	0.34	1	1		2		
18071	S	pool	2	0.7	1.05	1.4	0	0.07	0.14		2				
18071	S	riffle	4	0.4	0.6	1.0	0.63	1.76	2.84			1	2		1
18071	S	run	10	0.7	1.62	2.5	0.49	1.07	3.18		4	4	2		
18159	BE	backwater	1	2.7	2.7	2.7	0.09	0.09	0.09	1					
18159	BE	pool	4	2.1	4.0	5.3	0.28	0.54	0.97	1	1	2			
18159	BE	riffle	1	2.3	2.3	2.3	3.04	3.04	3.04			1			
18159	BE	run	6	1.8	2.58	4	0.06	0.80	2.89	2	2	1	1		
18159	S	backwater	5	1.0	1.86	2.5	0.01	0.18	0.41	1	2		2		
18159	S	pool	2	1.8	1.95	2.1	0.00	0.045	0.09		1		1		
18159	S	riffle	6	0.4	0.72	1.2	1.68	2.39	2.91			2	4		
18159	S	run	8	0.5	1.325	2.9	0.36	1.48	2.98		1	3	4		
18173	BE	backwater	4	3.1	3.775	4.5	0.015	0.07	0.12	3	1				
18173	BE	pool	3	3.7	4.93	5.8	0.005	0.02	0.03	3					
18173	BE	riffle	1	1.7	1.7	1.7	2.73	2.73	2.73			1			

Table 2. 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
18173	BE	run	6	1.7	3.3	8.7	0.16	1.29	3.61		1	3	2		
18173	S	backwater	6	0.8	1.57	2.5	0.01	0.12	0.23		2	4			
18173	S	pool	2	2.9	3.0	3.1	0.305	0.42	0.54			1	1		
18173	S	riffle	7	0.5	0.71	1.0	1.41	2.26	3.04			1	6		
18173	S	run	8	0.7	1.575	2.3	0.42	1.25	2.62			5	3		
18246	BE	backwater	2	5.8	7.9	10	0.01	0.02	0.03	1	1				
18246	BE	pool	1	4.5	4.5	4.5	0.785	0.785	0.785			1			
18246	BE	run	9	2.6	3.81	6.4	0.03	0.84	2.77	2	2	4	1		
18246	S	backwater	6	1.4	1.88	2.9	0.03	0.24	0.47	1	2	3			
18246	S	riffle	5	0.6	0.8	1.0	0.89	2.84	3.64			4	1		
18246	S	run	12	0.7	1.375	2.3	0.25	2.19	4.49			12			

Table 3. Fish species collected in the lower Guadalupe River baseline sampling during 2013.

Species	Common Name	18056	18071	18159	18173	18246
Agonostomus monticola	mountain mullet			X	X	
Anguilla rostrata	American eel	X				
Aplodinotus grunniens	freshwater drum	X	X	X	X	
Atractosteus spatula	alligator gar			X		
Campostoma anomalum	central stoneroller			X	X	X
Carpiodes carpio	river carpsucker	X				X
Cichlasoma cyanoguttatum	Rio Grande cichlid	X	X	X	X	X
Cyprinella lutrensis	red shiner	X	X	X	X	X
Cyprinella venusta	blacktail shiner				X	X
Cyprinus carpio	common carp					X
Dorosoma cepedianum	gizzard shad	X	X	X	X	X
Dorosoma petenense	threadfin shad		X		X	
Etheostoma chlorosoma	bluntnose darter			X		
Fundulus notatus	blackstripe topminnow				X	X
Gambusia affinis	western mosquitofish	X	X	X	X	X
Ictalurus punctatus	channel catfish	X	X	X	X	X
Ictiobus bubalus	smallmouth buffalo	X	X	X	X	X
Lepisosteus oculatus	spotted gar	X	X	X	X	
Lepisosteus osseus	longnose gar	X	X		X	
Lepomis auritus	redbreast sunfish					X
Lepomis cyanellus	green sunfish	X	X	X	X	X
Lepomis gulosus	warmouth	X	X		X	
Lepomis humilis	orangespotted sunfish	X				
Lepomis macrochirus	bluegill		X	X	X	X
Lepomis megalotis	longear sunfish	X	X	X	X	X
Lepomis microlophus	redear sunfish		X		X	
Lythrurus fumeus	ribbon shiner				X	
Macrhybopsis marconis	burrhead chub	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
Moxostoma congestum	gray redhorse	X	X	X	X	X
Mugil cephalus	striped mullet			X		
Notropis amabilis	Texas shiner		X			X
Notropis buchanani	ghost shiner	X	X	X	X	
Notropis volucellus	mimic shiner		X	X	X	X
Opsopoeodus emiliae	pugnose minnow	X				
Percina apristis	Guadalupe darter	X			X	
Percina carbonaria	Texas logperch		X	X	X	
Percina macrolepida	bigscale logperch				X	
Percina shumardi	river darter	X		X	X	
Pimephales vigilax	bullhead minnow	X	X	X	X	X
Poecilia formosa	Amazon molly	X	X	X	X	X
Poecilia latipinna	sailfin molly	X	X	X	X	X
Pomoxis annularis	white crappie		X			
Pylodictis olivaris	flathead catfish	X	X	X	X	X

Table 4. Mussel species found during baseline sampling on the lower Guadalupe River in 2013 and conservation status (TPWD 2012).

Species	Common name	Status
Amblema plicata	threeridge	
Cyrtonaias tampicoensis	Tampico pearlymussel	
Lampsilis hydiana	Louisiana fatmucket	
Lampsilis teres	yellow sandshell	
Megalonaias nervosa	washboard	
Quadrula aurea	golden orb	T, S2
Quadrula mitchelli	false spike	T, SH
Quadrula petrina	Texas pimpleback	T, S1
Toxolasma parvus	lilliput	
Tritogonia verrucosa	pistolgrip	

T = state threatened
S1 = critically imperiled
S2 = imperiled
SH = possibly extirpated

Table 5. Benthic macroinvertebrate taxa collected in the lower Guadalupe River subbasin.

Taxon	18246	18173	18159	18071	18056
Baetidae	X	X	X	X	X
Caenis sp.	X	X		X	
Camelobaetidius sp.	X	X	X	X	X
Isonychia sp	X	X	X	X	X
Leptohyphes sp.	X	X	X	X	X
Stenacron sp.		X			X
Stenonema sp.				X	X
Thraulodes sp.	X	X	X	X	X
Traverella sp.	X	X	X	X	X
Tricorythodes sp.	X	X	X	X	X
Neoperla sp.	X	X	X	X	X
Ceraclea sp.		X	X		
Cheumatopsyche sp.	X	X	X	X	X
Chimarra sp.	X				
Culoptila sp.		X	X	X	X
Helicopsyche sp.	X	X	X	X	
Hydropsyche sp.	X	X	X	X	X
Hydroptila sp.	X	X	X		
Nectopsyche sp.	X				
Oecetis sp.			X	X	X
Protoptila sp.	X		X	X	X
Smicridea sp.		X	X	X	
Corydalus sp.	X	X	X	X	X
Berosus sp. (larva)					X
Dubiraphia sp.	X				X
Helichus sp.	X	X	X		X
Helocharus sp.	X				
Heterelmis sp.	X		X	X	X
Hexacylloepus sp.	X	X	X	X	X
Hydrochus sp.			X		
Macrelmis sp.	X	X			
Microcylloepus sp.	X	X	X	X	X
Psephenus sp.	X				
Stenelmis sp.	X	X	X	X	X
Argia sp.	X	X	X		
Brechmorhoga sp.		X		X	
Erpetogomphus sp.		X	X	X	X
Perithemis sp.	X				
Ambrysus sp.	X		X		
Cryphocricos sp.		X	X		
Tricorixa sp.	X				
Rhagovelia sp.	X				
Chironomidae	X	X	X	X	X
Ceratopogonidae	X				X
Simulium sp.	X		X	X	

Table 5. Continued

Taxon	18246	18173	18159	18071	18056
Suragina sp.			X		
Tabanus sp.	X				
Hyallela azteca	X				X
Petrophila sp.	X	X	X	X	X
Amblema plicata					X
Corbicula fluminea	X	X	X	X	X
Melanoides sp.	X	X			X
Physella sp.	X	X	X		
Planorbella sp.	X				
Quadrula aurea		X		X	
Quadrula petrina		X			
Quadrula mitchelli			X		
Oligochaeta	X		X	X	X
Hirudinea	X				
Dugesia sp.	X	X			
Nematoda	X				

Discussion

Fish, benthic macroinvertebrate, and mussel data are summarized and discussed below. Additional data analysis is underway by the TIFP and GBRA in order to create the lower Guadalupe River Instream Flow Study Design in coopeartion with the stakeholder workgroup. Assemblage data from this study as well as historical biological data will be used to identify indicator species for the lower Guadalupe River Instream Flow Study and develop stratified random sampling designs for development of habitat utilization data.

Ichthyofauna

During the sampling in 2013, 46 fish species (Table 5) comprising more than 12,929 individuals were collected. Table 6 shows a comparison of fishery data between historical collections (Perkin and Bonner 2011) and 2013 baseline collections. Twenty four species from the historic assemblage were not collected in 2013. This may be due to several factors including limited effort compared to historic (two seasons in 2013 versus more than thirty years of collections) and 2013 sampling was conducted only in mainstem habitats whereas Perkin and Bonner (2011) compiled fish data from the Guadalupe River mainstem and its tributaries. Conversely, four species were collected during baseline sampling that were not reported in the historical record.

Benthic Macroinvertebrates

In the five study reaches sampled in the spring and summer of 2013, approximately 61 taxa were identified (Chironomidae were enumerated at family level) (Table 5). A comparison of historic benthic macroinvertebrate collections with collections made for this study is found in Table 7. Further analysis of benthic macroinvertebrate data is ongoing to evaluate site specific benthic macroinvertebrate metrics for calculating benthic macroinvertebrate community health, or assign each study reach a benthic macroinvertebrate Aquatic Life Use (TCEQ, 2007).

Mussels

During timed searches at each sampling site, 10 species (live) of mussels were collected (Table 4), including three state-threatened species (TPWD 2012). Catch per unit effort (total mussels/hour) ranged from 1.75 (Site 18246) to 56.8 (Site 18159). No apparent longitudinal trend in mussel abundance was observed. A comparison of historical and current mussel occurrence is presented in Table 8.

Table 6. Fish species collected in the lower Guadalupe River from 1950 to 2000 (Perkin and Bonner 2011) and during baseline TIFP sampling in 2013.

Species	Common Name	Historic	2013 Baseline
Atractosteus spatula	alligator gar		X
Lepisosteus oculatus	spotted gar	X	X
Lepisosteus osseus	longnose gar	X	X
Anguilla rostrata	American eel	X	X
Dorosoma cepedianum	gizzard shad	X	X
Dorosoma petenense	threadfin shad	X	X
Campostoma anomalum	central stoneroller	X	X
Cyprinella lutrensis	red shiner	X	X
Cyprinella venusta	blacktail shiner	X	X
Cyprinus carpio	common carp	X	X
Dionda nigrotaeniata	Guadalupe roundnose minnow	X	
Lythrurus fumeus	ribbon shiner		X
Macrhybopsis marconis	burrhead chub	X	X
Notropis amabilis	Texas shiner	X	X
Notropis buchanani	ghost shiner	X	X
Notropis stramineus	sand shiner	X	
Notropis volucellus	mimic shiner	X	X
Opsopoeodus emiliae	pugnose minnow	X	X
Pimephales promelas	fathead minnow	X	
Pimephales vigilax	bullhead minnow	X	X
Carpiodes carpio	river carpsucker	X	X
Erimyzon oblongus	creek chubsucker	X	
Erimyzon sucetta	lake chubsucker	X	
Ictiobus bubalus	smallmouth buffalo	X	X
Minytrema melanops	spotted sucker	X	
Moxostoma congestum	gray redhorse	X	X
Astyanax mexicanus	Mexican tetra	X	
Ameiurus melas	black bullhead	X	
Ameiurus natalis	yellow bullhead	X	
Ictalurus lupus	headwater catfish	X	
Ictalurus punctatus	channel catfish	X	X
Noturus gyrinus	tadpole madtom	X	
Pylodictis olivaris	flathead catfish	X	X
Oncorhynchus mykiss	rainbow trout	X	
Salmo trutta	brown trout	X	
Fundulus notatus	blackstripe topminnow	X	X
Gambusia affinis	western mosquitofish	X	X

Table 6 continued.

Species	Common Name	Historic	2013 Baseline
Gambusia geiseri	largespring gambusia	X	
Poecilia latipinna	sailfin molly	X	X
Poecilia formosa	Amazon molly		X
Menidia beryllina	inland silverside	X	X
Morone saxatilis	striped bass	X	
Ambloplites rupestris	rock bass	X	
Lepomis auritus	redbreast sunfish	X	X
Lepomis cyanellus	green sunfish	X	X
Lepomis gulosus	warmouth	X	X
Lepomis humilis	orangespotted sunfish	X	X
Lepomis macrochirus	bluegill	X	X
Lepomis megalotis	longear sunfish	X	X
Lepomis microlophus	redear sunfish	X	X
Lepomis miniatus	redspotted sunfish	X	
Micropterus dolomieu	smallmouth bass	X	
Micropterus punctulatus	spotted bass	X	X
Micropterus salmoides	largemouth bass	X	X
Micropterus treculii	Guadalupe bass	X	
Pomoxis annularis	white crappie	X	X
Pomoxis nigromaculatus	black crappie	X	
Etheostoma chlorosoma	bluntnose darter	X	X
Etheostoma gracile	slough darter	X	
Etheostoma lepidum	greenthroat darter	X	
Etheostoma spectabile	orangethroat darter	X	
Percina carbonaria	Texas logperch	X	X
Percina macrolepida	bigscale logperch	X	X
Percina apristis	Guadalupe darter	X	X
Percina shumardi	river darter	X	X
Aplodinotus grunniens	freshwater drum		X
Cichlasoma cyanoguttatum	Rio Grande cichlid	X	X
Agonostomus monticola	mountain mullet	X	X
Mugil cephalus	striped mullet	X	X
Mugil curema	white mullet	X	
Achirus lineatus	lined sole	X	

Table 7. Benthic macroinvertebrate taxa collected in historic sampling as well as baseline TIFP sampling from 2013.

Taxon	Historic	2013 Baseline
Baetidae	X	X
Brachycercus flavus	X	
Caenis sp.	X	X
Camelobaetidius sp.	X	X
Hexagenia sp.	X	
Isonychia sp	X	X
Leptohyphes sp.	X	X
Stenacron sp.		X
Stenonema sp.	X	X
Thraulodes sp.	X	X
Traverella sp.	X	X
Tricorythodes sp.	X	X
Tortopus sp.	X	
Neoperla sp.	X	X
Ceraclea sp.	X	X
Cheumatopsyche sp.	X	X
Chimarra sp.	X	X
Culoptila sp.		X
Helicopsyche sp.	X	X
Hydropsyche sp.	X	X
Hydroptila sp.	X	X
Mayatrichia sp.	X	
Nectopsyche sp.	X	X
Neotrichia sp.	X	
Ochrotrichia sp.	X	
Oecetis sp.	X	X
Polyplectropus santiago	X	
Potamyia flava	X	
Protoptila sp.	X	X
Smicridea sp.	X	X
Corydalus sp.	X	X
Climacia chapini	X	
Berosus sp. (larva)	X	X
Dineutes sp.	X	
Dubiraphia sp.	X	X
Helichus sp.	X	X
Helocharus sp.	X	X
Heterelmis sp.	X	X
Hexacylloepus sp.	X	X
Hydrochus sp.	X	X
Macrelmis sp.	X	X
Microcylloepus sp.	X	X
Neoelmis sp.	X	

Table 7 continued.

Psephenus sp.	X	X
Stenelmis sp.	X	X
Argia sp.	X	X
Brechmorhoga sp.	X	X
Erpetogomphus sp.	X	X
Erythemis sp.	X	
Gomphus sp.	X	
Hagenius brevistylus	X	
Macromia sp.	X	
Perithemis sp.		X
Phyllogomphoides sp.	X	
Ambrysus sp.	X	X
Cryphocricos sp.	X	X
Limnocoris lutzi	X	
Metrobates sp.	X	
Tricorixa sp.		X
Rhagovelia sp.		X
Bezzia/Palpomyia sp.	X	
Ceratopogonidae	X	X
Chironomidae	X	X
Culicoides sp.	X	
Forcipomyia sp.	X	
Hemerodromia sp.	X	
Hexatoma sp.	X	
Molophilus sp.	X	
Probezzia sp.	X	
Simulium sp.		X
Suragina sp.		X
Tabanus sp.	X	X
Hyallela azteca		X
Petrophila sp.	X	X
Amblema plicata		X
Corbicula fluminea	X	X
Hebetancylus excentricus	X	
Hydrobiidae	X	
Melanoides sp.	X	X
Physella sp.	X	X
Planorbella sp.		X
Quadrula aurea	X	X
Quadrula petrina		X
Quadrula mitchelli		X
Oligochaeta	X	X
Hirudinea	X	X
Dugesia sp.	X	X

Table 7 continued.

Crustacea	X	
Ostracoda	X	
Palaemonetes kadiakensis	X	
Spongillidae	X	
Nematoda		X

Table 8. Historic unionid mussel occurrences in the Guadalupe River basin (TPWD 2008) with recent collections during 2013 baseline sampling and current status (TPWD 2012).

Species	Common name	Historic	2013 Baseline	Status*
Toxolasma parvus	lilliput	X	X	
Toxolasma texasiensis	Texas lilliput	X		
Uniomerus tetralasmus	pondhorn	X		
Strophitus undulatus	creeper	X		
Pyganodon grandis	giant floater	X		
Utterbackia imbecillis	paper pondshell	X		
Quadrula apiculata	southern mapleleaf	X		
Quadrula aurea	golden orb	X	X	T, S2
Quadrula petrina	Texas pimpleback	X	X	T, S1
Quadrula mitchelli	false spike	X	X	T, SH
Cyrtonaias tampicoensis	Tampico pearlymussel	X	X	
Amblema plicata	threeridge	X	X	
Arcidens confragosus	rock pocketbook	X		
Megalonaias nervosa	washboard	X	X	
Tritogonia verrucosa	pistolgrip	X	X	
Glebula rotundata	round pearlyshell	X		
Lampsilis bracteata	Texas fatmucket	X		T, S1
Potamilus purpuratus	bleufer	X		
Lampsilis hydiana	Louisiana fatmucket	X	X	
Lampsilis teres	yellow sandshell	X	X	
Ligumia subrostrata	pond mussel	X		

*T = state threatened
S1 = critically imperiled
S2 = imperiled
SH = possibly extirpated

References

Perkin, J. S., and T.H. Bonner. 2011. Long term changes in flow regime and fish assemblage composition in the Guadalupe and San Marcos Rivers of Texas. River Research and Applications 27:566-579.

Richter, B. D., Mathews, R., Harrison, D. L., and Wigington, R. 2003. Ecologically Sustainable Water Management: Managing River Flows for Ecological Integrity. Ecological Applications, 13(1), 206-224.

[TCEQ] Texas Commision on Environmental Quality. 2007. Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collection and Analyzing Biological Assemblage and Habitat Data. Austin, Texas.

[TIFP] Texas Instream Flow Program. 2002. Texas Instream Flow Studies: Programmatic Work Plan. Austin: Texas Water Development Board.

[TIFP] Texas Instream Flow Program. 2008. Texas Instream Flow Studies: Technical Overview. Report No. 369. Austin: Texas Water Development Board.

[TPWD] Texas Parks and Wildlife Department. 2008. Texas Mussel Watch: Freshwater mussels Texas distribution chart. Austin, Texas.

[TPWD] Texas Parks and Wildlife Department. 2012. Texas Conservation Action Plan 2012-2016. Austin, Texas.

Appendix A. Scope of Work and Comments

Supplement Existing Biological data in the Lower Guadalupe River Study Area

Background: The goal of the project is to conduct new biological collections that would facilitate a better understanding of biological assemblages and their distributions and aid in scoping an instream flow study.

Task 1: Identify sampling locations, conduct reconnaissance, and secure access.
Through coordination between the Guadalupe-Blanco River Authority (GBRA), 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 Lower Guadalupe River study area. Among the considerations for selection of sample sites are:

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

GBRA 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 *Exhibit A: Fish Sampling Guidelines.*
Though sampling duration will follow that outlined in the above reference, collections of fish 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 discharge 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 GBRA, TPWD, TWDB, and TCEQ Resource Protection 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, prepare species lists, and report data

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

Exhibit A: Fish Sampling Guidelines

General guidelines:

The goal in fish sampling is to collect a representative sample of the species present in their relative abundances. All available habitats and combinations of habitats should be sampled. Beyond the minimum efforts outlined below, sampling should always continue until no additional species are collected.

In most streams, fish will be collected using multiple gear types—seines and electrofishers. Hoop and gill nets may be used to augment seine and electrofishing samples. Electrofisher capabilities vary by manufacturer and model. Each model is effective under certain specific conductance ranges. For example, the Smith Root Type 12 model backpack electrofisher is most effective at specific conductance levels less than 1,000 µS/cm, though it is rated to 1,600 µS/cm. The ring anode may be wrapped with electrical tape "candy-cane style" to reduce surface area in higher conductivities. Both electrofishing and seining are required. If unable to employ multiple gear types, indicate the reason and increase effort with the gear employed. For instance, if seining is not possible because of an abundance of heavy debris (though it should be noted that some seining is usually possible), indicate the reason and increase electrofishing effort. If electrofishing is not possible, then you should increase seining effort.

Use a backpack electrofisher in wadeable streams and wadeable areas of larger rivers that may not be sampled effectively with other methods. After reaching the stream, the unit will be powered up and controls set for ambient stream conditions. The frequency will initially be set at 60 Hz at 6 ms (setting I5 on the newer Smith-Root backpacks) and the voltage at 100 volts. The sampling team will engage the unit and check the output. Since the goal is to generate maximum output for the water conditions, the electrofisher is then disengaged and the voltage adjusted up to the next setting. The unit is powered up again and the output tested again. This procedure is repeated until the voltage is maximized (the electrofisher will reset when the output is beyond specifications). In general, lower voltages are used in high conductivity waters and higher voltages in low conductivity waters. Smith-Root provides general recommendations for voltage in waters of differing specific conductance—100 to 300 volts for specific conductance of 400 to 1,600 µS/cm, 400 to 700 volts for 200 to 400 µS/cm, and 800 to 1,100 volts for <200 µS/cm.

Once the controls are adjusted, the sampling team will reset the timer using a magnet. The collector carrying the backpack will wade in an upstream direction to eliminate the effects of turbidity caused by disturbing bottom sediment. Current should be discontinuously applied in short bursts since fishes on the perimeter of the field may be directed into habitat where they would not normally occur or may move out of the area and will not be susceptible to collection. For example, electrical current could be applied along the length of an undercut bank and then turned off until another discrete habitat type is encountered. The netters should follow and attempt to capture all stunned fishes. Wearing polarized sunglasses facilitates spotting organisms. In particularly turbid water, a small seine can be pulled behind the electrofisher since stunned fishes will often be difficult to observe.

All available habitat and cover types within the reach should be sampled. Actual shocking (trigger) time as recorded by the backpack timer should not be less than 900 seconds. Shocking should always continue as long as additional species are being collected. All species observed but not captured should be noted (along with an estimated total length) as such.

In larger streams, use boat-mounted electrofishers. The minimum sampling effort is 900 seconds of actual shock time. Guidelines should follow those for backpack fishing (e.g., sample all habitats within a reach and continue sampling until no new species are collected). When sampling in streams and rivers, boat-mounted electrofishers may be employed productively moving downstream with the flow. If the boat speed is slightly slower than the flow, it increases the chances that fishes will float to the surface and stay close enough to the boat for capture.

A seining crew consists of a minimum of two persons, but is more effective with three. Several different seines will be used, depending on the habitats. Deep pools may be sampled with a 30' x 6' x 1/4" mesh seine, whereas riffles, runs, and small pools will be sampled using a 15' x 6' x 3/16" or a 6' x 6' x 3/16" mesh seine. A minimum of 10 effective seine hauls should be attempted. In order for a seine haul to be considered effective, the collectors should evaluate whether the haul was negatively affected in any way. If the samplers hang the seine on woody debris or lift the net in a manner that may allow escapement, then they will decide whether the haul should be considered ineffective and not counted as viable. Capturing no fish would not necessarily constitute an ineffective haul. Seining can be conducted in either an upstream or downstream direction depending on current velocity and habitat. The number of effective seine hauls and an estimate of the distance will be recorded. As in backpack electrofishing, sampling will continue until no new species additions are noted. Two seine hauls should be taken beyond the last one in which a new species is collected (e.g., if on haul #10, a new species is observed, then two more hauls are required. If an additional species is collected on haul #12, then two more hauls would be added.) A riffle kick may be effective in shallow, fast water. This requires two samplers positioning the seine on the downstream end of a riffle while a third collector disturbs the riffle substrate as he moves toward the stationary seine, resulting in the dislodgement of fish into the stationary seine.

Hoop nets will be 12 feet long with 1-inch square mesh in front and back, with 7 fiberglass hoops tapering from 3 feet. They are most effective when set near instream structure and in deep water. Nets will be set adjacent to the bank in flowing water of sufficient depth to cover the largest hoop. In general, this would constitute a slow run with adjacent or downstream structure. When placing the net, the cod end should always be secured with a zip tie so that fish cannot escape. The cod end will be anchored upstream and the open end facing downstream with the net fully extended.

Gill nets may also be used as an additional sampling method and will be 125 feet in length, eight feet deep, with five 25-foot panels of 1.0, 1.5, 2.0, 2.5, and 3.0 inch square monofilament mesh, and a float line on top and lead line on the bottom. They fish most effectively when set in water of little or no current, often on the inside bend of a river downstream from a point bar out of the swiftest flow. Generally, the small mesh end of the net will be set against the shore, with the remainder of the net placed at a 30 degree angle downstream. The shallow end may be tied to structure or anchored. The deep end will be anchored with a suitable identifying float.

Both hoop and gill nets should be fished for 12 to 24 hours including an overnight period. The nets will be identified with a departmental tag including the telephone number and a contact. The time for deployment and pickup should be recorded along with the mesohabitat in which the net was set and estimates of instream cover and substrate if possible. Depth and velocity are not required.

Fish that are too large for sample containers should be positively identified, measured on a portable measuring board (total length), checked for disease or anomaly, photographed for vouchering, and released. Record data in field book or sampling form for each sampling event (e.g., seine haul or electrofishing effort).

A habitat team will work with the sampling team and record habitat data for each seine haul and electrofishing effort. Effort will be taken to avoid disturbing habitat not yet sampled and to avoid straying too close to fish sampling teams, especially while electrofishing. The two teams will need to work as one unit ensuring that complete data is collected for each sampling effort and that fish and containers are processed.

Fish Sampling Procedures:

- Layout site: Examine the area to be sampled. Locate a reach that is 40 times the mean wetted width of the stream. Ideally that would cover at least one full meander wavelength i.e., you may exceed the 40x if the scale of the stream dictates. Flag the ends of the site.
- Prior to sampling, evaluate the varying habitats represented and gear types necessary for sampling.
- Use multi-probe water quality instrument and record instantaneous data in field book or sampling form.
- Take a minimum of 10 seine hauls, but as noted above, continue to sample beyond the minimum if new species are collected.
- Limit seine hauls to discrete habitat types (don't mix pools and riffles) and to the extent possible lateral location in the stream channel (bank, mid-channel, etc.).
- For each seine haul, mark the start and finish with numbered pin flags (or floats) to facilitate later habitat measurement (S1start, S1finish).
- Write down the haul #, distance, length of seine, and habitat type (e.g., fast run) and lateral location (bank, mid-channel, etc.) in field book or sampling form.
- Place the fish from each haul in a plastic quart jar (or other appropriate size depending upon catch) that is already half full of 10 percent formalin. Number the jar (not the lid) with a sharpie (site number + S1, S2, etc.).
- Electrofish for a minimum of 900 seconds actual trigger time. Record trigger time.
- Sample discrete habitats and place the fish in a plastic quart jar. In effect, this might mean hitting a single riffle, single run, a pool with significant undercuts, etc. Record lateral location of effort (bank, mid-channel, etc.).
- Label the jars with E1, E2, etc. Take notes on the corresponding habitat type and lateral location.
- When the sampling is complete, prepare a normal fish sampling label to go inside each jar. Include the location, site number, date, S1, S2, etc. numbers on the label and the habitat type sampled.

Habitat Measurement Procedures:

- Measure distance of each sampling event using a measuring tape or range finder as appropriate.
- Characterize substrate conditions for the area sampled using a modified Wentworth scale (see field guide).
- Characterize instream cover using quartiles and codes (see field guide).

- Measure depth and current velocity at a location that best represents the type of habitat sampled or average hydraulic conditions.
- Record GPS coordinates at that location using point averaging, if available.
- Take photograph(s) ensuring that the habitat sampled is accurately depicted. Record the numbers on the photographs.

Pull pin flags (or floats) only after ensuring that all data is recorded and photographs taken.

Comments on Draft Report

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.