TRINITY RIVER AUTHORITY

Trinity River Reconnaissance Survey 2011

DRAFT -Data Review, Summary, and Analysis

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1.0 Overview

1.1 Background

In 2008, as part of the Senate Bill 3 process designed to create environmental flow recommendations in the Trinity River basin and Galveston Bay, large data gaps were identified pertaining to the on-the-ground conditions of the Trinity River. Additionally, a lack of connection existed between the people involved in the recommendation process and the river. Existing data were generally restricted to bridge crossings and other incongruent sites. There had been no systematic longitudinal survey of the Trinity River completed in decades.

In 2009, Trinity River Authority (TRA) staff traveled two sections of the Trinity River, one near State Highway 287 and a second near US 79/84. During these trips, staff collected field notes, bank heights, channel widths, and georeferenced photographs. In 2010, a more in-depth study was completed along two sections of the Trinity River. TRA staff worked from US 287 to State Highway 7 (105 river miles) and from the Lake Livingston dam to Trinity Bay near Anahuac, TX (117 river miles). Data collected included bank angles and heights, channel widths, flows, georeferenced photographs, field notes, mesohabitat types, soil samples, river bathymetry, instream cover, and floodplain connectivity. Both the 2009 and 2010 surveys provided valuable measurements of the channel and, more importantly, re-established TRA's connection and understanding of the river system from a field perspective across a longitudinal study area.

The 2011 Trinity River Reconnaissance Survey (TRRS) was conceptualized and planned using baseline knowledge from the 2009 and 2010 studies. The 2011 TRRSrepresents the most comprehensive and systematic longitudinal survey completed on the river in over 50 years. The objective was to collect quantitative datasets characteristic of the Trinity River and to begin the establishment of a field program to monitor river status and changes over the long term. This project was funded through the TRA by the Texas Commission on Environmental Quality (TCEQ) Clean Rivers Program (CRP). Espey Consultants, Inc. (RPS Espey) was hired to assist TRA with this project.

Project goals were as follows:

- Determine the relative abundance of instream mesohabitats (e.g. riffles, runs, pools, and etc.) on the Trinity River at a coarse scale;
- Identify potential reaches for future, detailed biological, geomorphological, water quality, habitat, and flow studies, and
- Identify representative channel locations to be used for long-term channel monitoring.

The focus of the 2011 field effort was to characterize low base-flow steady state conditions. The summer 2011 study timeframe exhibited conditions consistent with that objective. Trinity River flows were near the lowest that have been experienced in recent history, though flows remained considerably higher compared to historical (i.e., pre-1960) low flows. Summer 2011 flow conditions were as low as could be anticipated under current water use patterns (i.e. reservoir release, return flow and diversion).

The systematic data collected June through August 2011 includes:

- Georeferenced photographs taken at every river mile (as designated in Trinity River Miles – 1997) (Trinity River Authority, 1997);
- Additional georeferenced photographs throughout each reach;
- Georeferenced mesohabitat classification throughout each reach;
- Cross-sections every two 1997 RM (below and between vegetation lines);
- Continuous longitudinal depth profile throughout each reach;
- Flow measurements within each reach;
- Localized bank stability assessments;
- Measurement of mesohabitat characteristics (water quality, water surface slope, velocity, cross-sections and sediment samples) in selected reaches (B2, B3, B4); and
- Preliminary fish data collection by electroshock and seine.

Initial river mile (RM) designations were based on an internal TRA document, Trinity River Miles, 1997. A new RM system was created based on the results from this study. RMs listed in this document reference the new river mile system (Trinity River Miles, 2012). In some instances it was not practical to change the original RM designations. In this case, the river miles are designated with the year, e.g. (RM XX-1997).

In addition to TRA and RPS Espey staff, state agency personnel participated in data collection activities in select areas. Texas Water Development Board (TWDB) staff collected cross-section and longitudinal depth lines totaling 153 river miles, thus allowing TRA and RPS Espey to collect additional habitat-specific data within those miles. Texas Commission on Environmental Quality (TCEQ) staff participated in mesohabitat data collection in 59 river miles and also conducted a limited number of seine and backpack electroshocking activities; these represent the first fish samples collected on the main stem Trinity River in many years.

Two major river study areas made up of ten segments were identified during the planning stages; these areas and segments have been revised as result of the 2011 study into a second-generation segmentation. While some data descriptions will reference the initial segmentation, subsequent and future work, including data analysis presented in this report, reference the revised segmentation. The second-generation "2012" segmentation is divided into four areas with distinct characteristics and are comprised of 13 segments.

1.2 Study Extent

The geographic extent of interest for this study is approximately 290 river miles of the main stem Trinity River between the headwaters of Lake Livingston and Fort Worth, Texas. The lower bound is the 131 foot elevation contour at the headwaters of Lake Livingston and the upper bound is the lowermost low weir dam near Handley-Ederville Road in Fort Worth (Figure 1-1). Initially, the upper boundary was selected as Beach Street in Fort Worth, but was adjusted 7.5 RM downstream to avoid existing impoundments (in-channel weirs) upstream through Fort Worth.

This geographic extent coincides with other efforts ongoing within the basin, including Senate Bill 3 (SB3) environmental flow assessments and Senate Bill 2 (SB2), the Texas Instream Flow Program (TIFP) studies on the Middle Trinity River, currently under way and scheduled to be completed by 2016.

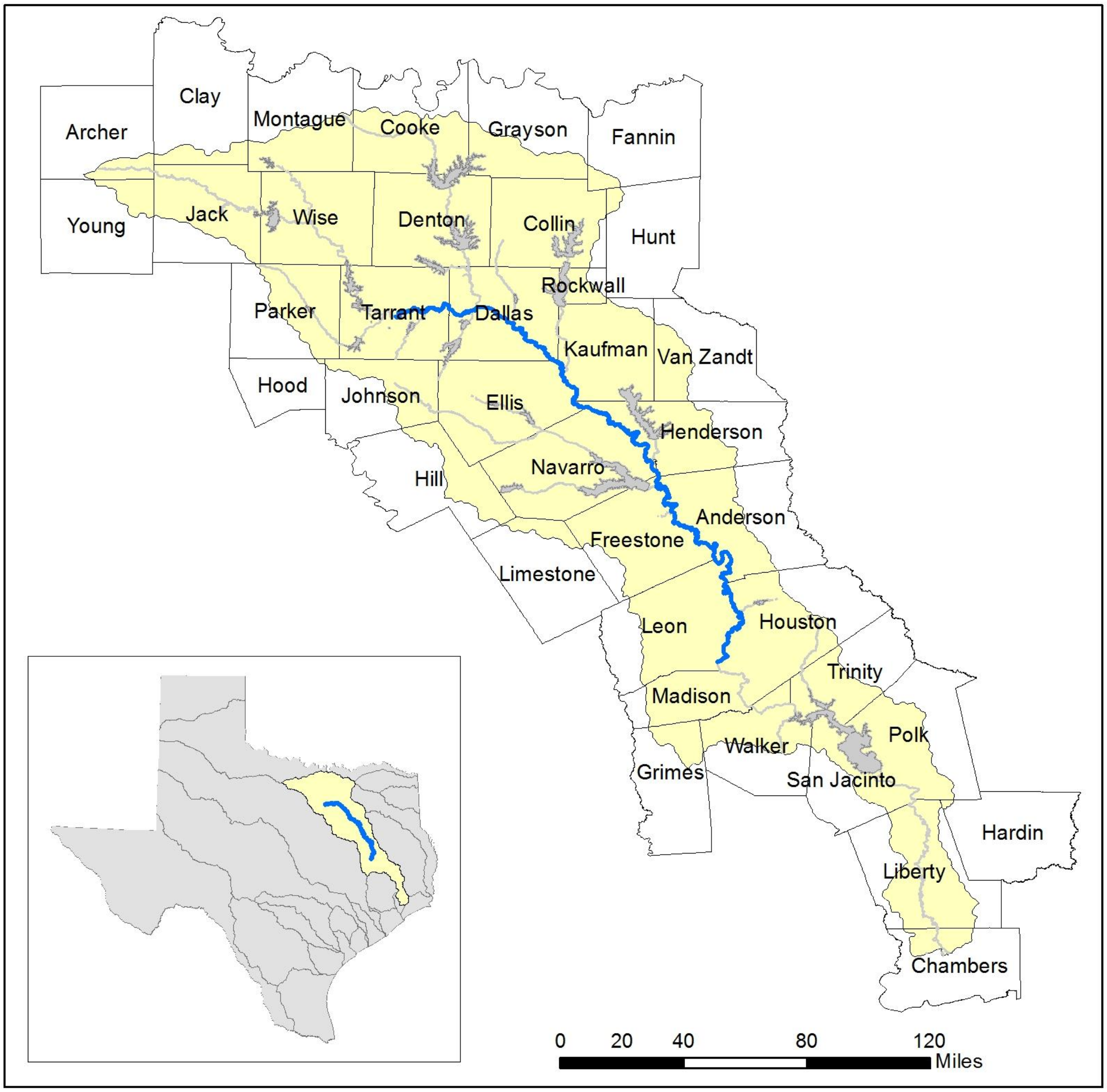


Figure 1-1 Map of the Approximant 290 River Mile Study Area.

1.3 Initial Segmentation

During the study scoping and planning process, the overall study extent was sub-divided into initial, preliminary areas and reaches with the intent of identifying reaches that exhibit relatively homogeneous or internally-consistent characteristics. Having this type of segmentation allows for comparison between reaches and identification of appropriate future studies to better identify and characterize active processes for each reach.

The overall study extent was initially divided into two major areas (Figure 1-2):

- Initial Study Area A – Confluence of East Fork Trinity River upstream to Beech Street in Fort Worth, TX
- Initial Study Area B – Headwaters of Lake Livingston upstream to confluence of East Fork Trinity River

Initial Study Area A represents reaches where the river has been impacted by urbanization and where some reaches have been affected by flow augmentation (return flows totaling 500-700 cfs), channelization, levees, armoring and a total of four relict navigational lock and dam structures that remain instream.

Initial Study Area B represents “Middle Trinity” reaches where the river approaches the coastal plain and where fluvial geomorphologic processes have the most freedom to dominate overall river planform, cross-section and habitats. This area is not unimpacted; many reaches have been channelized and leveed and two relict lock and dam structures remaining instream.

Three major regional-scale characteristics were used to further sub-divide each area into reaches:

- Flow changes (return flows and confluences)
- Ecoregions (Natural regions of Texas, TPWD)
- Geology (UT BET Geologic Atlas of Texas)

Five initial reaches in Study Area A were primarily delineated by major changes in base flow, specifically, contribution of four major waste water treatment plan discharges: Fort Worth Village Creek, TRA Central, Dallas Central and Dallas Southside. The upper boundary at Beech Street in Fort Worth, TX, was chosen as the upstream end of Study Area A (later shifted approximately 7 river miles downstream to Handly-Ederville Road in Fort Worth, TX) because it is the location of the first gauge downstream of major reservoir projects and flow management structures (e.g., Eagle Mountain Lake, Lake Worth, Benbrook Lake, etc.). The downstream boundary of Area A was chosen as the confluence with the East Fork Trinity River.

Five initial reaches in Study Area B were delineated in consideration of ecoregion, geology and a longitudinal field reconnaissance in 2010 during which TRA staff traveled over 60% of the area by boat. Primary reach boundaries were driven by location of tributary or inflow confluence.

Data and information acquired during this study resulted in a second generation river segmentation based on field observations and quantative channel data (see section 3.0). Data analysis and discussion in this report and future studies will use the second-generation segmentation (see 3.0 Revised areas and segmentation (Seg 2012)). Old segmentation designations may be used for dataset descriptions to ensure consistency with field notes or references specific to the mechanics and execution of the 2011 survey. In most cases, old segmentation has been converted to the new 2012 segmentation nomenclature. Initial and new segmentation will be noted as “Segments, Init” and “Segments, 2012”, respectively. Again, the second-generation, 2012 segmentation will be used for future work.

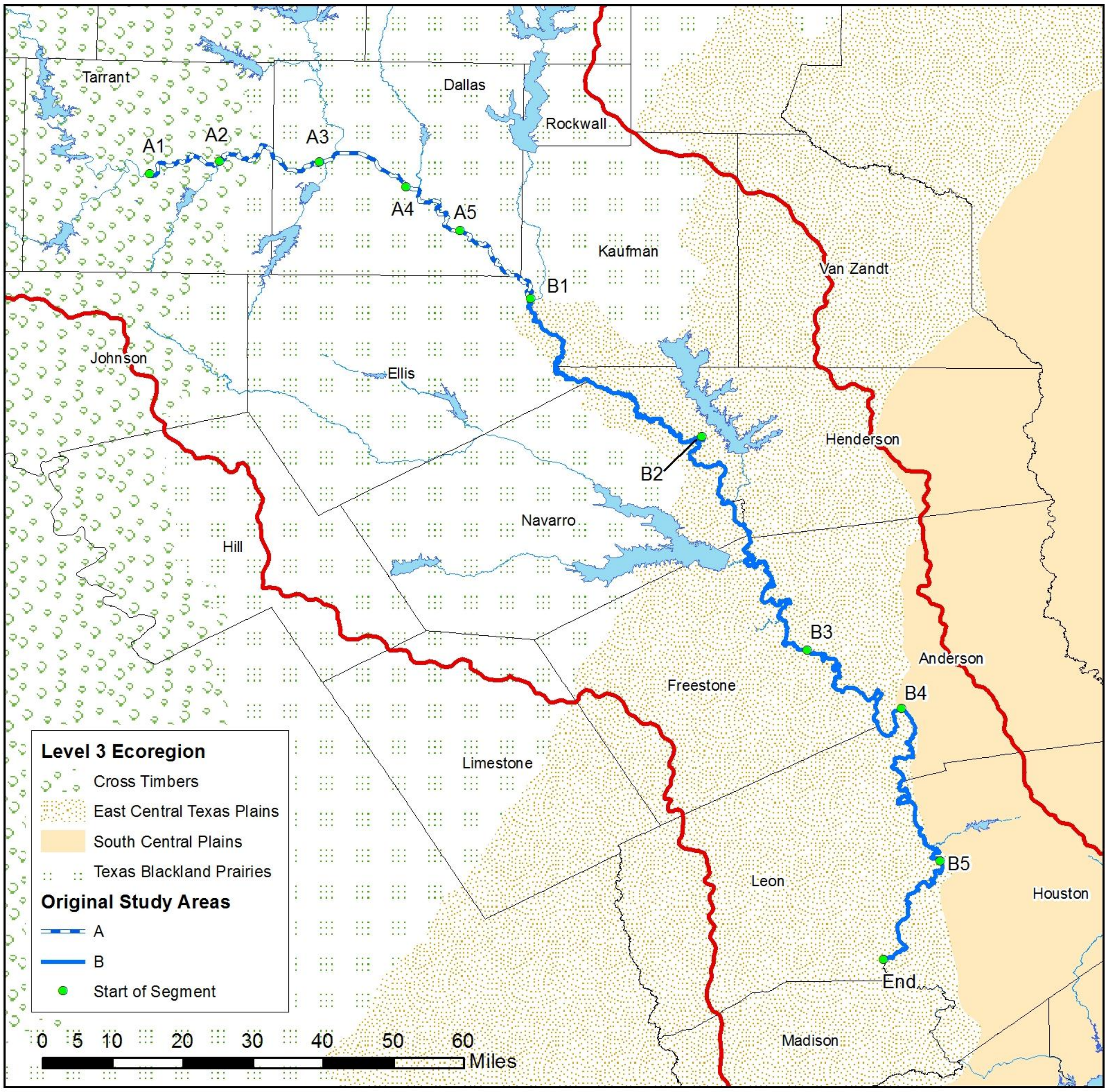


Figure 1-2. Map Depicting Original Study Areas and Segments with EPA Level 3 Ecoregions.

1.4 Field Work Timeline

Field work was completed between June 6, 2011 and August 10, 2011. A total of seven trips were made each lasting between one and five days depending on logistics and access. Trip 1 converted into a field data collection methods testing trip and data goals were adjusted based on feasibility and time constraints. Because data from Trip 1 was not consistent with the remainder of the study, the same reach was redone at the end and is designated Trip 7. The only data from Trip 1 used in analysis was a single characteristic mesohabitat slope and velocity measurement.

The trips were not completed in any spatial order, but were planned in consideration of access conditions, field staff scheduling, and flow conditions. A table of field work and field crew is summarized in Table 1.

Table 1-1. Table of field work segments, dates, and personnel.

Segments, Init		**Segments, 2012**		**Trip - day**	**Date**	**Notes**	**Crew**
	RM-1997		**RM-2011**				
A1	523-517			Not visited		Beach – Dam3	n/a
	517-508	A1	511.8-503.3	Trip 3 – day 4	2011-07-01	Dam3 – V Crk	WM TO
A2	508-504	A2	503.3-499	Trip 3 – day 4	2011-07-01	V Crk – Collns	WM TO
	504-491		499-486	Trip 3 – day 3	2011-06-30	Collns – Bltline	WM TO
	491-486		486-480.9	Trip 3 – day 2	2011-06-29	Beltline - TRA	WM TO
A3	486-479	A3	480.9-474	Trip 3 – day 2	2011-06-29	TRA - Sylvan	WM TO
	479-472		474-466.8	Trip 3 – day 1	2011-06-28	Sylvan – DalC	WM TO
A4	472-468	A4	466.8-463	Trip 3 – day 1	2011-06-28	DalC – Loop12	WM TO
	468-465		463-459.9	Trip 4 – day 1	2011-07-05	Loop12–Lock1	WM TO
	465-458	B1	459.9-453	Trip 5 – day 2	2011-07-13	Lock1 – DalS	WM TO
A5	458-457		453-452	Trip 5 – day 2	2011-07-13	DalS – Lock2	WM TO
	457-449		452-443.8	Trip 5 – day 2	2011-07-13	Lock2 - Lock3	WM TO
	449-439	B2	443.8-433.1	Trip 5 – day 4	2011-07-15	Lock3 - Lock4	WM TO
	439-438	B3	433.1-*425.5*	Trip 5 – day 1	2011-07-12	Lock 4-E Fork	WM TO
B1	438-430	B4	*425.5*-424	Trip 5 – day 1	2011-07-12	E Fork - SH34	WM TO
	430-413		424-410.8	Trip 5 – day 3	2011-07-14	SH34 - L.Falls	WM TO
	413-396	C1	410.8-393	Trip 6 – day 1	2011-08-03	L.Falls - 396	WM TO DF MV DG KG
	396-383		393-381.4	Trip 6 – day 2	2011-08-04	396 - Spillway	WM TO DF MV DG KG
B2	383-366	C2	381.4-364	Trip 6 – day 2	2011-08-04	Spillway - 366	WM TO DF MV DG KG TS
	366-354		364-352	Trip 6 – day 3	2011-08-05	366 - US287	WM TO DF MV DG KG TS
	354-336		352-334	Trip 2 – day 1	2011-06-13	US287 - 336	WM TO DF MV
	336-320		334-316.6	Trip 2 – day 2	2011-06-14	336 - Ctf. Crk	WM TO DF MV
B3	320-306	C3	316.6-303	Trip 2 – day 2	2011-06-14	Ctf. Crk - 306	WM TO DF MV
	306-284		303-280.9	Trip 2 – day 3	2011-06-15	306 – L.Starr	WM TO DF MV
B4	284-262	C4	280.9-259	Trip 2 – day 4	2011-06-16	L.Starr - 262	WM TO DF MV
	262-247		259-244.5	Trip 2 – day 5	2011-06-17	262 - Lock6	WM TO DF MV
B5	247-224	D1	244.5-221.2	Trip 1 – day 1	2011-06-06	Lock6 - Lk Liv	WM TO GC
LL	*224-215*	*LL*	*221.2-212*	*Trip 1 – day 1*	*2011-06-06*	*To exit SH21*	*WM TO GC*
B5	247-224	D1	244.5-221.2	Trip 7 – day 1	2011-08-10	Lock6 - Lk Liv	WM GC AK
LL	*224-215*	*LL*	*221.2-212*	*Trip 7 – day 1*	*2011-08-10*	*To exit SH21*	*WM GC AK*

Webster Mangham (TRA) - WM
Tim Osting (Espey Consultants, Inc.) - TO
David Flores (TWDB) - DF
Mike Viellieux (TWDB) - MV
Dakus Geeslin (TCEQ) - DG
Kyle Garmany (TCEQ) - KG
Tony Smith (Espey Consultants, Inc.) - TS
Glenn Clingenpeel (TRA) - GC
Angela Kilpatrick (TRA) - AK

1.5 Purpose

An underlying objective of the 2011 Trinity River survey was to create one consistent dataset spanning the entire 290 river mile study area. Data were collected in a systematic way in order to provide:

- meso-scale habitat characterization
- logical, scientifically defensible segmentation
- a planning tool for future studies
- study site identification
- study type identification

The datasets will also be useful for future studies including:

- flood model development
- water quality model development
- SB2 site selection
- channel stability studies

1.6 Dataset Description, Collection Methods, Quality Assurance, and Google Earth™

The quality of the dataset was paramount regardless of field conditions or the level of effort needed to collect or verify measurements. All field data were quality assured (QA) as required in the field, during post processing, or both. Field and QA efforts resulted in a highly robust and reliable dataset.

Field data were collected using English units to coincide with typically recorded hydrology measurements (cfs, fps, feet, acre-feet, tons, etc.) and TRA's historical use of river miles developed in 1997 from TCEQ segment line CAD files (RM 1997). Geospatial data was collected in WGS-84 due to the geography of the basin and the varied GPS equipment involved. Units may be converted for reporting and/or modeling efforts as required. Individual studies or modeling efforts may utilize units as appropriate, but results in the archive datasets will remain in English units.

Each data parameter is discussed further below.

1.6.1 Photography

Over 4,700 high resolution georeferenced photographs were taken along the study extent using two different camera/GPS methods:

- Cannon™ EX-H20G camera
  - 14.1 megapixel
  - 24 mm lens
  - GPS accuracy ±10m (SPS, non-WAAS)
  - GPS Datum WGS-84
  - Tags photograph instantly
- Nikon™ D500 Digital SLR with JOBO™ GPS hot shoe attachment
  - 12.9 megapixel
  - 18-55 mm lens
  - GPS accuracy +/- 10m

- GPS Datum WGS-84
- Tags photograph during post processing of images

A consistent photograph series was taken at each RM-1997: in order -- upstream, downstream, left bank, right bank. Additional photographs were taken at bridge crossing, major tributary confluences, and other points of interest. Because the photographs will be available for public download, any images making field personnel recognizable were removed. In a few instances, this required one or more of the RM-1997 series photographs to be removed.

Due to the entrenched nature of the Trinity River system, satellite reception for GPS was occasionally interrupted. GPS equipment automatically divided the photographs taken during these times into two groups based on time. It codes the first half of the photographs at the last known GPS position and the second half at the location where satellite reception was reacquired. When possible, photographs were adjusted manually during post processing to a more accurate location.

Photographs were added to ExpertGPS™ and exported as KMZ. The conversion automatically compresses the image from approximately 2-3MB to 10-90kB resulting in reduced resolution. While the loss in clarity is noticeable, it is necessary to ensure the KMZ file size is manageable.

1.6.2 Cross-sections below vegetation line

At each even RM-1997 (i.e., once every two miles), cross-section measurements were collected of the instream channel, below the wetted width. This cross-section set is considered a random sampling of cross-section types in the study area since each measurement was collected at a uniform spacing.

Dominant bank process and stability was characterized as well as dominant surficial bank material near the water line. A total of 146 cross-sections were measured (Table 1-2). In a few cases, the RM-1997 river mile map based locations did not lie on the actual channel. In these cases, cross-sections were measured approximately two actual river miles apart to ensure consistency for the dataset.

Bathymetric cross-sections were measured using either a Sontek RiverSurveyor® M9 acoustic Doppler profiler (ADP), a wading rod with Marsh-McBirney Flo-Mate® Model 2000 portable flow meter and tape measure, or a combination of both.

The following bathymetric data were recorded on field sheets (Figure 1-3):

- Area
- Width
- Flow (Q)
- Average Velocity ($\bar{v}$)

Each cross-section was post processed and individually QAd using RiverSurveyor® Live. Cross-sectional area and wetted width values are considered to be representative of the cross-section; by-area and by-segment summaries are provided for respective metrics in Table 1-3,

Table 1-4, and Table 1-5. Flow values and average velocity should be viewed with caution because sites were pre-determined at even RM-1997, not locations conducive for measuring flow or velocity. For example, deep, slow moving pools presented a problem with keeping the ratio of boat to water speed at 1:1 or below. After post processing, the cross-sections were added to a GIS and the mesohabitat value was added based on the mesohabitat marked in the field on a handheld Trimble © unit.

Table 1-2. Cross-sectional count by segment (2012) and by mesohabitat.

Segment, 2012	Count of cross-secs Total (N)	Count of cross-secs, by mesohabitat type Bifurcated (N)	Pool (N)	Riffle (N)	Run (N)
A1	4	-	4	-	-
A2	11	-	3	2	6
A3	7	-	-	-	7
A4	4	-	-	-	4
*A_summary**	*26*	*-*	*7*	*2*	*17*
B1	8	-	3	-	5
B2	6	-	3	-	3
B3	4	-	2	-	2
B4	8	-	2	-	6
*B_summary**	*26*	*-*	*10*	*-*	*16*
C1	15	-	9	-	6
C2	32	1	9	-	22
C3	17	-	2	-	15
C4	19	1	4	-	14
*C_summary**	*83*	*2*	*24*	*-*	*57*
D1	11	-	5	-	6
Grand_Summary	*Total* **146**	*Total* **2**	*Total* **46**	*Total* **2**	*Total* **96**

*Summary row count is number of samples inside each category; summary row average is average of all samples.

Table 1-3. Cross-sectional area by segment (2012) and by mesohabitat.

Segment, 2012	Wet cross-sect. area N count	Wet cross-sect. area Average (sq_ft)	Wet cross-sect. area, by mesohabitat type: Bifurcated (sq_ft)	Pool (sq_ft)	Riffle (sq_ft)	Run (sq_ft)
A1	4	203		203		
A2	11	280		471	81	250
A3	7	563				563
A4	4	579				579
*A_summary**	*26*	*390*				
B1	8	872		1,209		670
B2	6	1,160		1,852		467
B3	4	1,306		1,434		1,178
B4	8	990		2,241		573
*B_summary**	*26*	*1,041*				
C1	15	576		678		423
C2	32	567	1,554	547		531
C3	17	558		379		583
C4	19	1,064	894	1,712		891
*C_summary**	*83*	*681*				
D1	11	1,013		1,438		658
Grand_Summary	*Total* **146**	*Average* **718**	*Average* **1,224**	*Average* **969**	*Average* **81**	*Average* **601**

*Summary row count is number of samples inside each category; summary row average is average of all samples.

Table 1-4. Cross-sectional wetted width by segment (2012) and by mesohabitat.

Segment, 2012	Wetted width N count	Wetted width Average (ft)	Wetted width, by mesohabitat type Bifurcated (ft)	Pool (ft)	Riffle (ft)	Run (ft)
A1	4	70		70		
A2	11	87		92	71	90
A3	7	103				103
A4	4	90				90
*A_summary**	*26*	*89*				
B1	8	127		154		112
B2	6	157		179		135
B3	4	146		139		153
B4	8	137		183		121
*B_summary**	*26*	*140*				
C1	15	107		110		101
C2	32	117	181	113		116
C3	17	113		116		113
C4	19	160	171	186		151
*C_summary**	*83*	*124*				
D1	11	181	-	162		196
	Total	*Average*	*Average*	*Average*	*Average*	*Average*
Grand_Summary	**146**	**125**	**176**	**130**	**71**	**122**

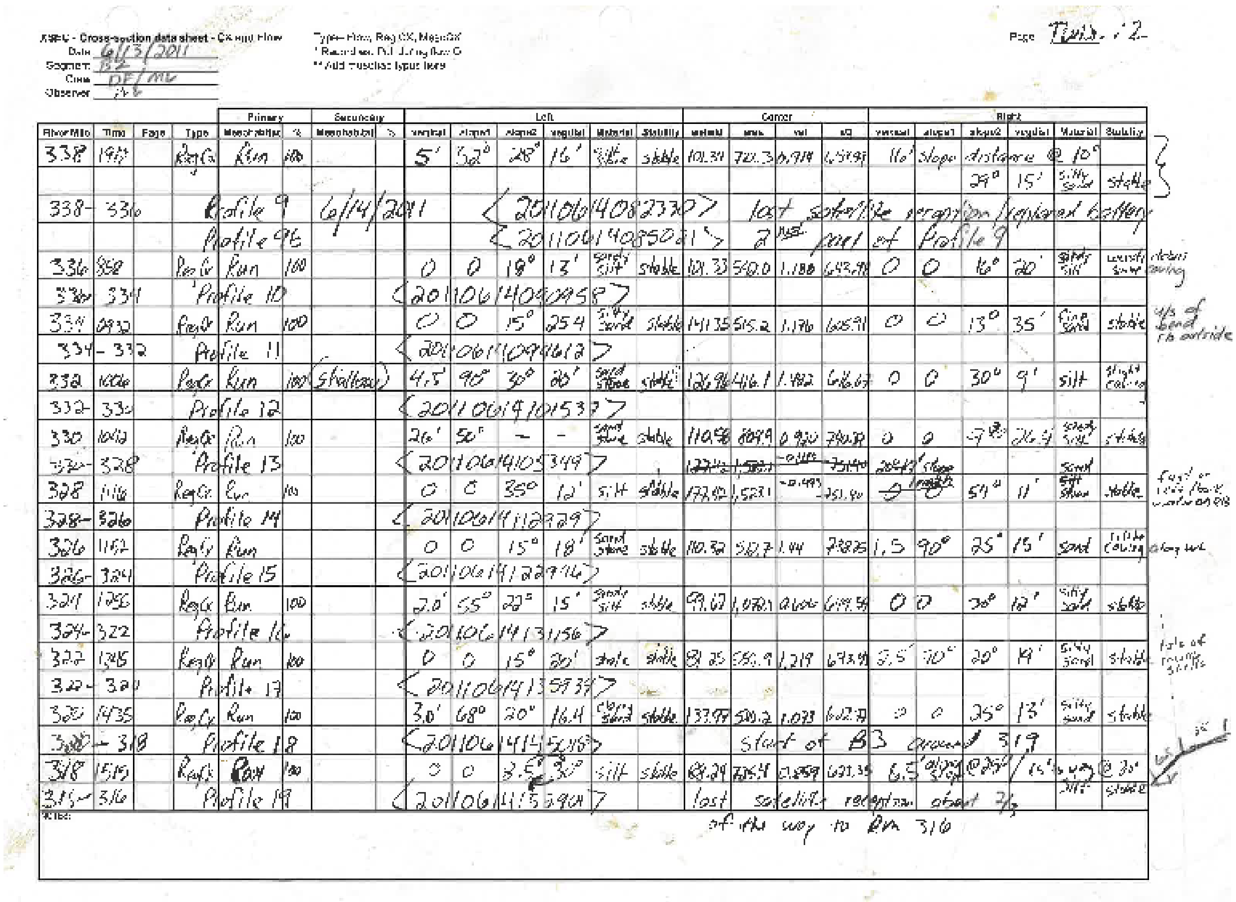
*Summary row count is number of samples inside each category; summary row average is average of all samples.

Additional cross-section information (bank angles and heights) was collected to extend wetted cross-section out of the water up to the level where vegetation began. This data was recorded on field sheets.

After QA, cross section locations and data were converted into KMZ as CX_2011.kmz.

1.6.3 Longitudinal depth profile

Continuous X, Y, and Z (latitude, longitude, and depth) data were collected in roughly the channel center along the entire 290 miles. Data were collected with a boat mounted Sontek RiverSurveyor® M9 ADP by TRA staff for the upper 137 RM-1997 and TWDB staff for the lower 153 RM-1997. Generally, each longitudinal profile is approximately two river miles (RM-1997) in length and the filenames and approximate starting and stopping river miles were recorded on field sheets (Figure 1-3). Profiles were stopped and restarted when conditions required (battery replacement, stopping to gather additional data, etc.).



XSEC - Cross-section data sheet - CX and Flow
Date 6/13/2011
Segment B2
Crew DF/MG

Type= Flow, Reg CX, MegaCX
** Add macrohab types here

Page Trip 2

River Mile	Time	Page	Type	Primary Macrohabitat	%	Secondary Macrohabitat	%	Left vertical	slope1	slope2	vegdist	Material	Stability	Center wetwid	area	vel	sQ	Right vertical	slope1	slope2	vegdist	Material	Stability	
338	1917		RegCx	Run	100			5'	52°	28°	16'	Silty clay	stable	101.31	722.3	0.914	659.91	16' slope distance @ 10°						
																				29°	15'	silty sand	stable	
338-336				Profile 9		6/14/2011		< 20110614082330 >						lost satellite reception / replaced battery										
				Profile 9b				< 20110614085021 >						2nd part of Profile 9										
336	858		RegCx	Run	100			0	0	19°	13'	sandy silt	stable	101.33	540.0	1.188	643.98	0	0	16°	20'	silty silt	woody debris	debris caving
336-334				Profile 10				< 20110614090958 >																
334	0932		RegCx	Run	100			0	0	15°	25.4	silty sand	stable	141.35	515.2	1.176	605.91	0	0	13°	35'	fine sand	stable	4/5 of bend to outside
334-332				Profile 11				< 20110614094612 >																
332	1006		RegCx	Run	100	(Shallow)		4.5'	90°	30°	20'	sandstone	stable	126.96	416.1	1.482	616.67	0	0	30°	9'	silt	slight caving	
332-330				Profile 12				< 20110614101537 >																
330	1012		RegCx	Run	100			26'	50°	–	–	sandstone	stable	110.98	809.9	0.920	740.82	0	0	57°	26.4	sandy silt	stable	
330-328				Profile 13				< 20110614105349 >																
328	1116		RegCx	Run	100			0	0	35°	12'	silt	stable	177.10	1,523.1	0.493	751.40	~~0~~ 0		57°	11'	sand silt shale	stable	
328-326				Profile 14				< 20110614112929 >																
326	1152		RegCx	Run				0	0	15°	18'	sandstone	stable	110.32	510.7	1.44	738.25	1.5	90°	25°	15'	sand	little caving	along wl
326-324				Profile 15				< 20110614122914 >																
324	1256		RegCx	Run	100			2.0'	55°	22°	15'	sandy silt	stable	99.67	1,070.1	0.606	619.54	0	0	30°	12'	silty sand	stable	
324-322				Profile 16				< 20110614131156 >																
322	1345		RegCx	Run	100			0	0	15°	20'	shale	stable	81.25	550.9	1.219	673.41	3.5'	70°	20°	19'	silty sand	stable	lots of roundish stuff
322-320				Profile 17				< 20110614135939 >																
320	1435		RegCx	Run	100			3.0'	68°	20°	16.4	clay/sand	stable	133.97	580.2	1.038	602.70	0	0	25°	13'	silty sand	stable	
320-318				Profile 18				< 20110614145018 >						start of B3 around 319										
318	1519		RegCx	Run	100			0	0	3.5'	30°	silt	stable	83.29	735.4	0.859	631.35	6.5'		@25° / 15'		veg @ 30'		
318-316				Profile 19				< 20110614155904 >						lost satellite reception about 2/3 of the way to RM 316							silt	stable		

Notes:

Figure 1-3. Field data sheet example showing longitudinal profile and cross-section field data.

Except for trips 3 and 4, GPS data were receiving real-time correction and the error is estimated at less than 1 meter. For trips 3 and 4, the real-time correction was not enabled and in places increased the positional error. During post processing, longitudinal profile data were added to GIS and lined up appropriately with satellite imagery (Figure 1-4), with some minor exceptions in the upper reaches of Study Area A (Trips 3 and 4). Additionally, satellite reception was lost and no data were recorded along approximately 2.1 river miles of initial Segment A2 (between RM-1997 504.0 to 503.5 and 487.4 to 485.8). Any data included in this report represents the best-possible data; therefore, data in areas identified above have been adjusted.

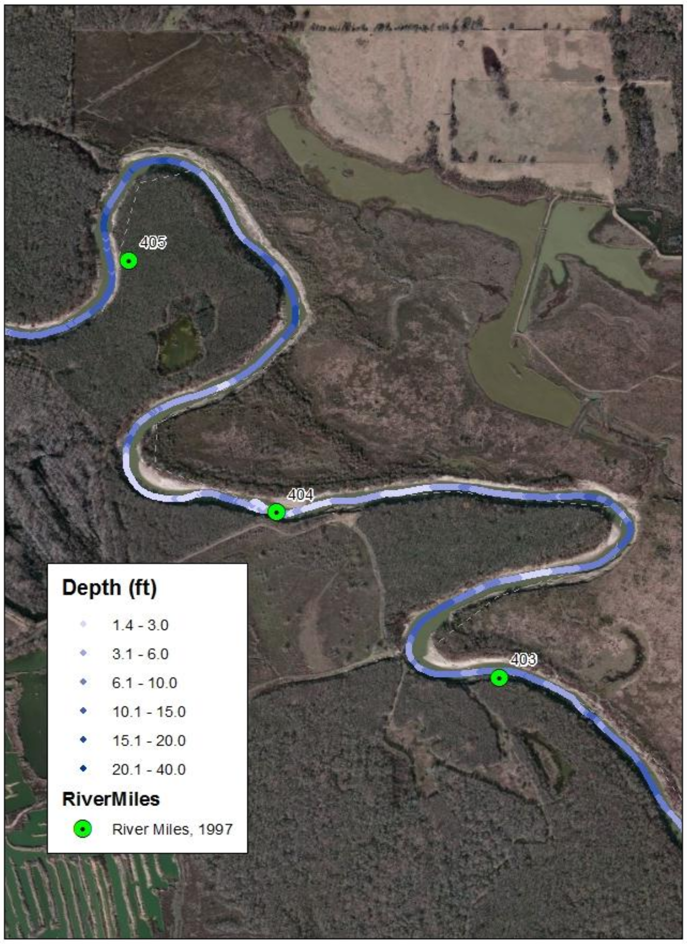


Figure 1-4 – Example of depth measurements along boat path

Over 238,000 individual X, Y, Z measurements were collected. Each point is based on time, not distance, so the spatial interval between the pings is not constant because of the changing boat speeds. On average, a depth measurement was taken every 6 feet. In order to better represent the profile, depth data were transformed into a curvilinear projection and matched to the mesohabitat line (see 1.6.4).

Error estimations for the depth measurements are more influenced by the changes in flow during the survey and field conditions than the ADP equipment. Because the study was not completed in river mile order or segment order, flows (and therefore depth) varied across time and space. USGS gage data were used to estimate the stage changes related to the different flow values observed during the study timeframe. Depth error resulting from changes in flow is estimated at ±0.2 feet for initial Study Area A (Seg 2012 Areas A and B) and ±0.4 feet in Study Area B (Seg 2012 Areas C and D).

In addition to depth data, the equipment recorded water velocity for each bin along the profile. Due to the changing boat speeds and high ratio of boat speed to water velocity, the water velocity values from longitudinal profiles are were not used for this assessment. Additional post-processing may be conducted in the future.

1.6.4 Mesohabitat visual characterization

Continual visual mesohabitat designations were recorded throughout the entire 290 mile study extent resulting in over 1,200 points. Visual indications include ripples on the water surface, turbulence, water flow patterns near debris, and speed of floating objects or foam. Data were recorded on a Trimble Geo-XH (post corrected accuracy < 5 cm) handheld data logger using a simplified data dictionary. Mesohabitats were marked if they were at least one channel width in length, smaller mesohabitats (e.g., left-side habitat different than right-side habitat) were marked "bifurcated". Five mesohabitat categories were used and are listed below along with field indicators:

- Backwater
    - Backwaters generally have negative or zero velocity
- Pool
    - No distinct "vee" around channel debris (Figure 1-5)
    - Generally < 0.5 fps as measured at the surface
- Run
    - Distinct "vee" around channel debris (Figure 1-6)
    - Generally > 1 fps as measured at the surface
- Riffle
    - Shallow, fast moving water
    - Turbulence on water surface
    - Visible water surface slope drop
    - Coarser substrate
    - Would serve as riffle habitat for fish
- Bifurcated
    - Habitat across channel cross-section is not homogeneous
    - Any combination of riffle, run, pool, backwater
    - Percent of each was estimated

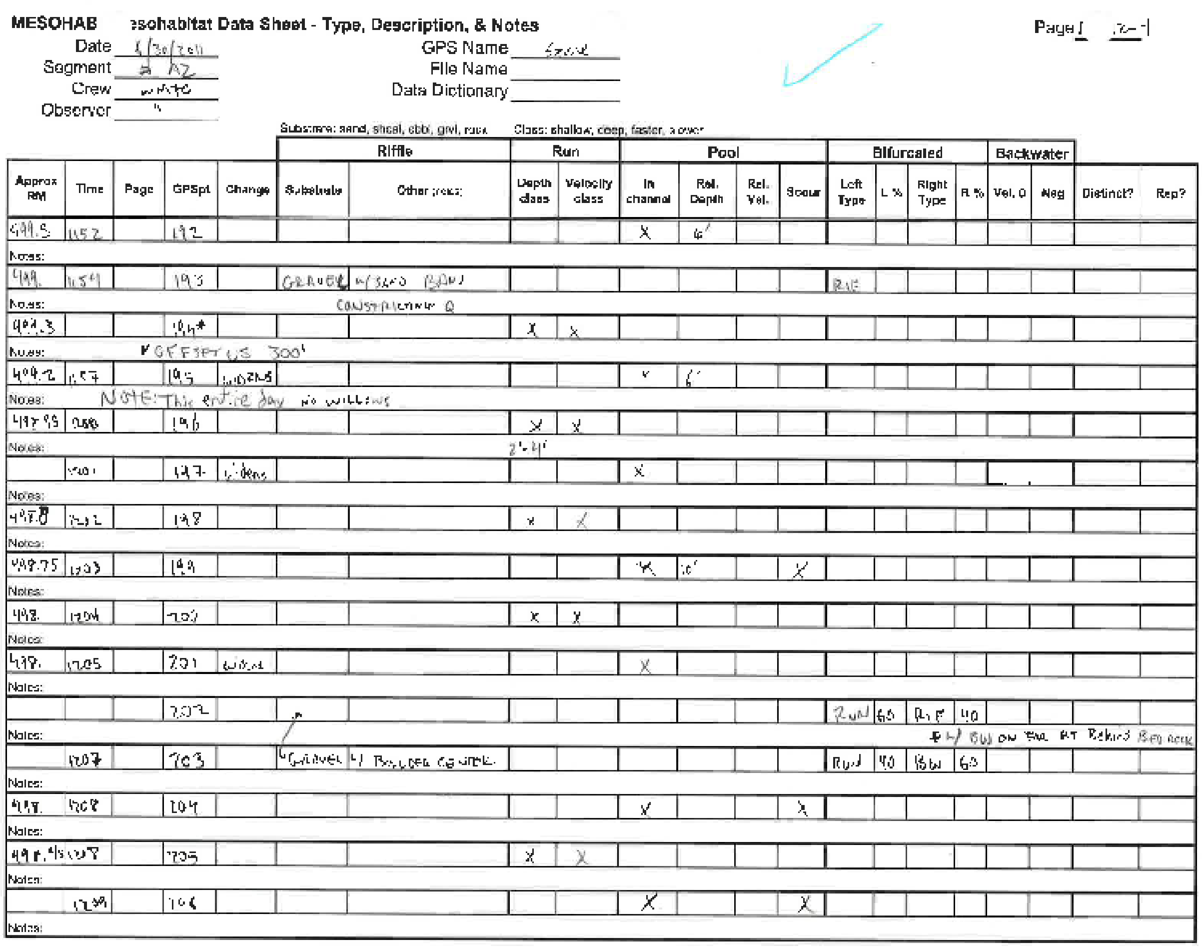
Figure 1-5. Photograph showing pool mesohabitat with lack of "vees" around woody debris, Study Area A.

Figure 1-6. Photograph showing run mesohabitat with "vees" around woody debris, Study Area A.

Field data sheets were completed at each mesohabitat location and included: approximate RM-1997 (estimated to tenths or hundredths), time, and notes (Figure 1-7). During post-processing, field data sheets were transposed into spreadsheets and mesohabitat points were downloaded through Pathfinder®. Field data and GPS data were combined based on GPS point ID.

The mesohabitat points were differentially corrected and added to GIS on top of NAIP 2010 1m imagery. The points were connected with polylines one by one at a 1:5,000 scale following the centerline of the channel as displayed in the imagery (Figure 1-8). This file represents the only large scale mesohabitat map ever completed on the Trinity River, and also likely the most accurate digital polyline of the main stem.

This feature class was exported to a KMZ file and is included in the data Appendix.



MESOHAB Mesohabitat Data Sheet - Type, Description, & Notes

Page 1 of 1

Date 6/30/2011
Segment
Crew
Observer

GPS Name
File Name
Data Dictionary

Substrate: sand, gravel, cobble, bldr, rock — Class: shallow, deep, faster, slower

					Riffle		Run		Pool				Bifurcated				Backwater			
Approx RM	Time	Page	GPSpt	Change	Substrate	Other notes	Depth class	Velocity class	In channel	Rel. Depth	Rel. Vel.	Scour	Left Type	L %	Right Type	R %	Vel. 0	Veg	Distinct?	Rep?
499.5	1152		192						X	6'										
Notes:																				
499.	1154		193		GRAVEL	w/ SAND BAND							R/E							
Notes:						CONSTRICTION Q														
499.3			194*				X	X												
Notes: *OFFSET US 300'																				
499.2	1157		195	widens					X	6'										
Notes: NOTE: This entire day no willows																				
498.95	1200		196				X	X												
Notes:							2'-4'													
	1201		197	widens					X											
Notes:																				
498.8	1202		198				X	X												
Notes:																				
498.75	1203		199						X	10'		X								
Notes:																				
498.	1204		200				X	X												
Notes:																				
498.	1205		201	widens					X											
Notes:																				
			202										Run	60	Rif	40				
Notes:															w/ BW on RL RT Behind Bar area					
	1207		203		Gravel	w/ Boulder cobble							Run	40	BW	60				
Notes:																				
498.	1208		204						X			X								
Notes:																				
497.45	1207		205				X	X												
Notes:																				
	1209		206						X			X								
Notes:																				

Figure 1-7. Mesohabitat field data sheet example (RM1997 and Initial Segments).

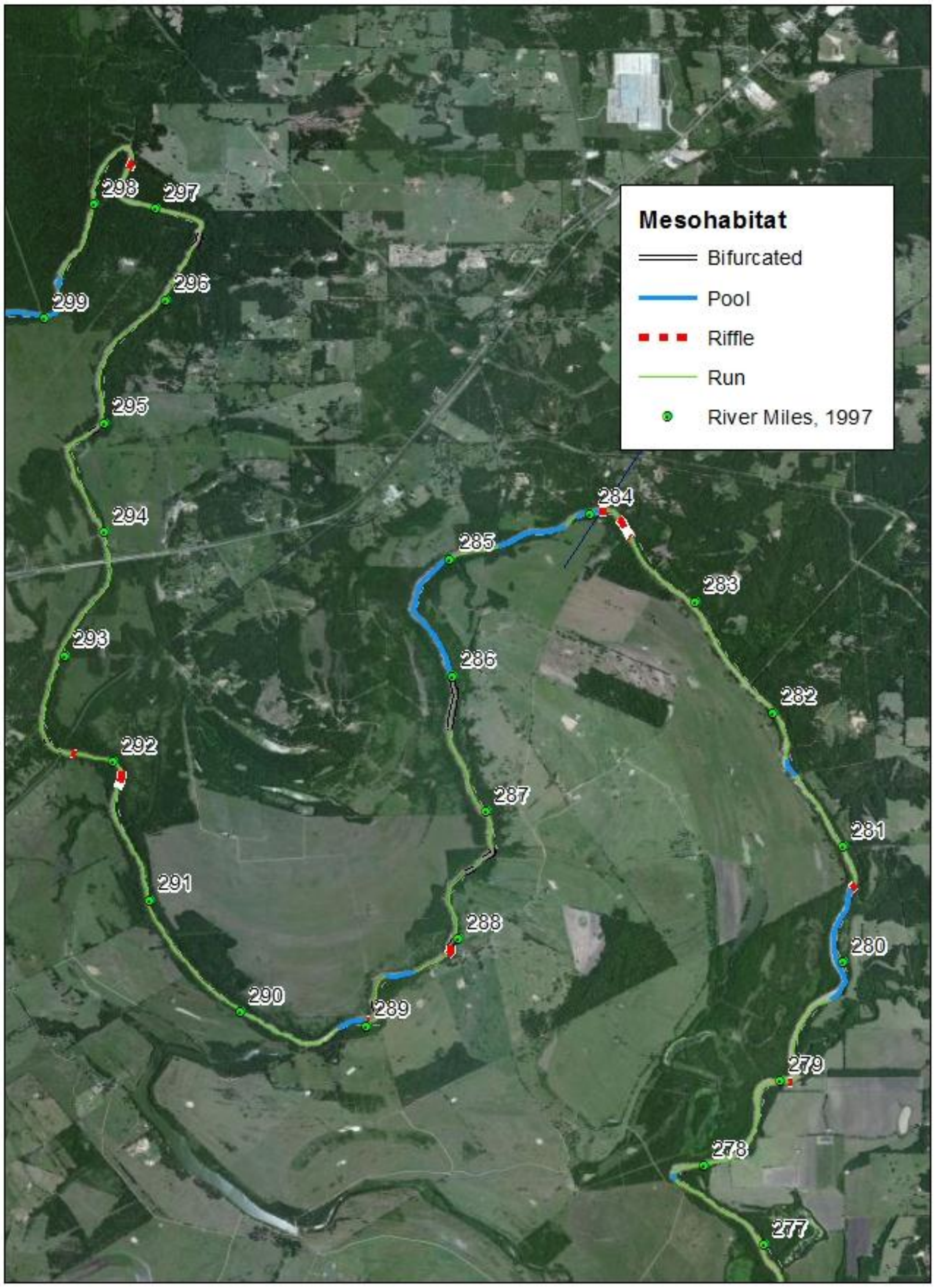


Figure 1-8. Mesohabitat lines near Oakwood, Texas.

1.6.5 Flow measurements

Flow (Q) is an important standalone aspect of river studies and paramount in the context of understanding other measured variables (depth, velocity, water quality, sediment transport, etc.). Flow measurements were measured during this study using United States Geological Survey (USGS) methods. Flow was measured using either a Sontek RiverSurveyor® M9 Acoustic Doppler Profiler (ADP), or wading rod with Marsh-McBirney Flo-Mate® Model 2000 portable flow meter. Each ADP measurement was post processed and quality assured with RiverSurveyor® Live and exported as a .KMZ file and included in the data appendix.

Twenty-five flow measurements were collected, with a goal of at least one flow measurement per day per segment (initial). After re-segmentation, flow locations were found to fall within each 2012 segment with the exception of 2012 B3 (see Section 3.0 for more information.) Multiple flow measurements were averaged if more than one was taken within each Seg 2012 (Table 1-5).

Table 1-5. Flow measurement summary.

Segment 2012	N	Average Flow (cfs)	Average Width (ft)	Average Area (ft²)	Average Velocity (fps)
A1	2	4.2	52.1	69.0	0.5
A2	2	147.1	69.8	79.5	1.4
A3	2	367.8	102.1	415.4	1.0
Downstream (DS) of all DFW area major discharges					
A4	2	605.1	83.3	579.9	1.1
B1	2	587.8	118.9	417.8	1.4
B2	1	668.6	117.3	808.1	0.8
B3	0				
B4	2	702.6	104.1	569.7	1.4
C1	1	718.6	87.4	516.1	1.4
C2	5	625.8	116.3	646.9	1.1
C3	3	587.9	129.8	772.5	0.8
C4	2	686.5	128.9	1024.7	0.8
D1	1	595.2	104.7	347.2	1.7
*DS Summary**	*19*	*634*	*113*	*653*	*1.12*
Grand Summary	25	523	104	541	1.08

(*) – DS Summary includes only A4-D1 (Seg 2012), downstream of all major DFW area major discharge inflows

1.6.6 Directed mesohabitat characterization – Area C

In order to provide more information for the TIFP study along the Middle Trinity River, water quality (Table 1-6), slope (Figure 1-9), sediment (Figure 1-10), and cross section data were gathered in one riffle, one run, and one pool in select segments. Mesohabitats were chosen if it appeared representative of that type of mesohabitat in that segment. Data were reviewed and are summarized in the data appendix.

Table 1-6. WQ data at characteristic mesohabitats.

Date_time	RM 2012	Seg 2012	Meso-habitat	N	WQ Dep (ft)	Vel. Range (fps)	Temp. (°C)	DO (mg/L)	Secchi Tube (ft)	pH	Sp.cond (uS/cm @25°C)
8/3/11 13:50	406.8	C1	pool	3	8.3		34.2	7.9	1.08	8.1	809.3
8/3/11 13:00	406.75	C1	run	1	1		34.3	8.5		8.1	803
8/4/11 14:05	384.3	C1	riffle	1	1	2.7-5.7	33.8	9.2	0.97	8.2	830
6/13/11 16:53	345.7	C2	riffle	1	1		31.4	8.4	1.34	8.2	765
6/14/11 14:05	319	C2	pool	1			31.2	8.4	1.18	8.5	752
6/14/11 15:45	318.9	C2	run	1	1		31.3	8.5	1.18	8.5	761
6/15/11 11:47	294.9	C3	run	1	3	4.4-4.9	30.7	8.2	1.51	8.8	752
6/15/11 14:22	294.6	C3	riffle	1			31.2	9.0	1.18	8.8	751
6/15/11 16:50	285.7	C3	run	2	3.5		32.1	11.1	1.40	9.0	740
6/15/11 17:20	284.7	C3	run	2	3.5		32.2	10.9	1.29	9.0	738.5
6/16/11 15:00	267.5	C4	run	1	1		32.2	11.5	2.04	9.1	746
6/16/11 17:42	263.7	C4	pool	2	3.5		32.3	11.3	1.83	9.1	710.5
6/17/11 9:00	258.2	C4	riffle	3	3		30.6	7.4	1.08	9.1	726.7
6/06/11 15:03	233	D1	run	1	1		31.35	11.5	0.43	8.6	490
6/06/11 16:00	232.5	D1	riffle	1	1		31.5	10.7	0.52	8.6	466

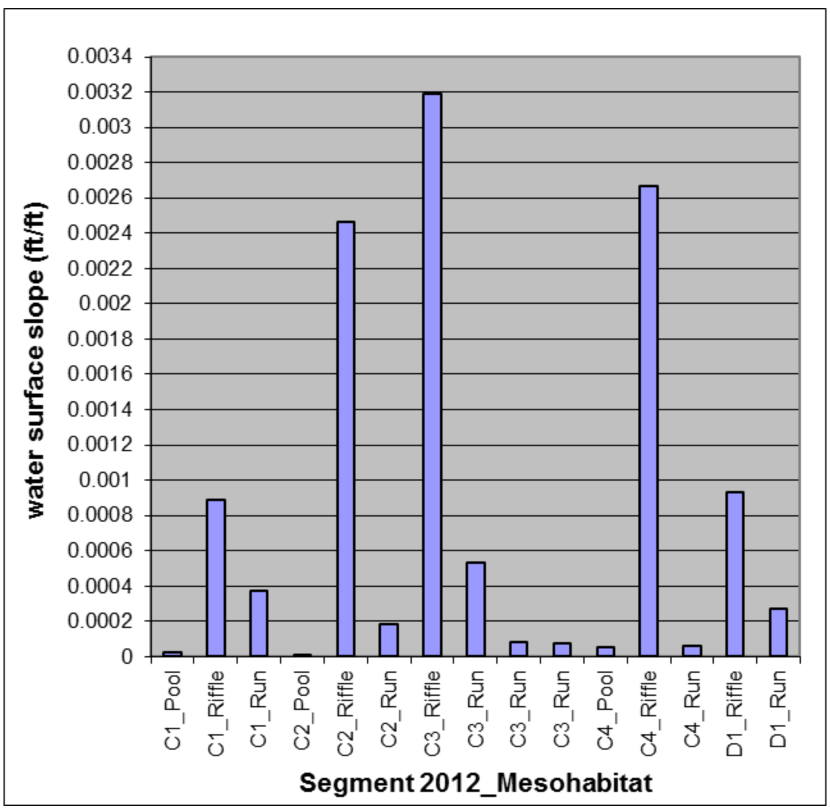


Figure 1-9. Water surface slope values from characteristic mesohabitats along the Middle Trinity River.

Figure 1-10. Photograph of sediment sample from the Trinity River.

1.6.7 Fish sampling

Limited electroshocking and seining within seg, old B2 and B3 by TCEQ field staff (C1 and C2 Seg 2012). Sites were selected at random based on time and site accessibility. In many places, water depth and velocity made fish sampling impossible without barge mounted shocking equipment. Mesohabitat types sampled included backwater, riffle, and run. Site location, velocity, and substrate were recorded and fish were either preserved or identified in the field and released. The species list and count is shown in Table 1-7.

Table 1-7. Species list of fish collected in the Trinity River, 2011.

Common Name	Scientific Name	Total
Red shiner	*Cyprinella lutrensis*	100
Ghost shiner	*Notropis buchanani*	4
Western mosquitofish	*Gambusia affinis*	11
Flathead catfish	*Pylodictis olivaris*	2
Channel catfish	*Ictalurus punctatus*	8
Freckled madtom	*Noturus nocturnus*	11
Spotted Bass	*Micropterus punctulatus*	1
Total		**137**

1.6.8 Google Earth

Data from the Longitudinal Survey are available in a Google Earth file format (.kmz). The data can be accessed from the Reports section of the Basin Planning web page located on the Trinity River Authority website (http://www.trinityra.org/default.asp?contentID=97). Google Earth .kmz files are an excellent tool for displaying large amounts in a spatial context, but these files are not appropriate for all uses. An explanation of data limitations and additional metadata are available in the Read Me file associated with the Google Earth download.

Google Earth Data Available:

Georeferenced Photographs
Longitudinal Profile Depth Measurements
Every 2-Mile Cross Sections
Intensive Mesohabitat Locations
Mesobahitat Designations
River Miles
Segment Divisions

2.0 Overview of Trinity Basin Conditions – Summer Survey, 2011

2.1 Weather and climate

The 3 month survey period (June to August 2011) represented hotter and drier conditions compared to typical summer conditions. Daily high air temperatures were between 95°F and 108°F with limited cloud cover. Antecedent rainfall was significantly below average; during the survey period one rainfall event in June provided 1" to 3" of rain (heaver in upstream in initial Area A than in Area B). Towards the end of trip 6 in initial reaches B2 and B3 (Seg 2012), many of the riparian areas exhibited fall colors as trees began to shed leaves as a result of the dry conditions. Extreme or exceptional drought conditions existed across the state, including most counties within the study area (Figure 2-1).

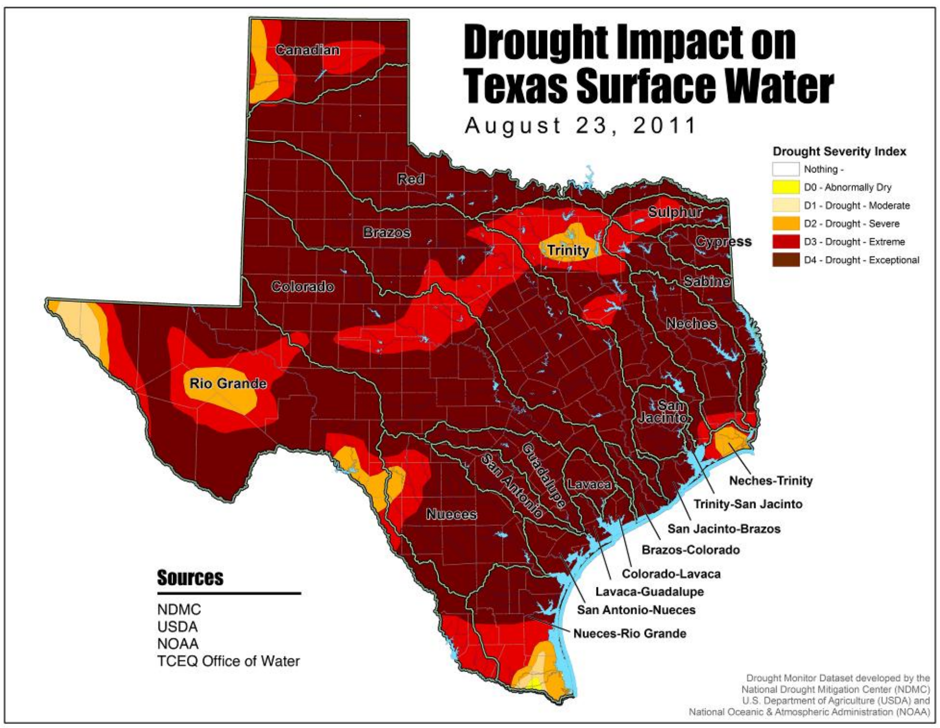


Figure 2-1. TCEQ Drought Impact on Texas Surface Water, Drought Severity Index (August 23, 2011).

2.2 Hydrology context – baseflows and pulses

The intent for this survey is to characterize the lowest base flow conditions feasible. These conditions were in fact exhibited during the survey period (Figure 2-2 and Figure 2-3). Considering typical return flows from the Dallas area into Area B are approximately 700cfs, the measured flows in Area B between approximately 550cfs and 900 cfs (Figure 2-3) during the study timeframe met the intent of the survey. Under historical conditions without the return flows, river flow would be anticipated to have been much lower in Area B, less than 100 cfs, for portions of the survey period.

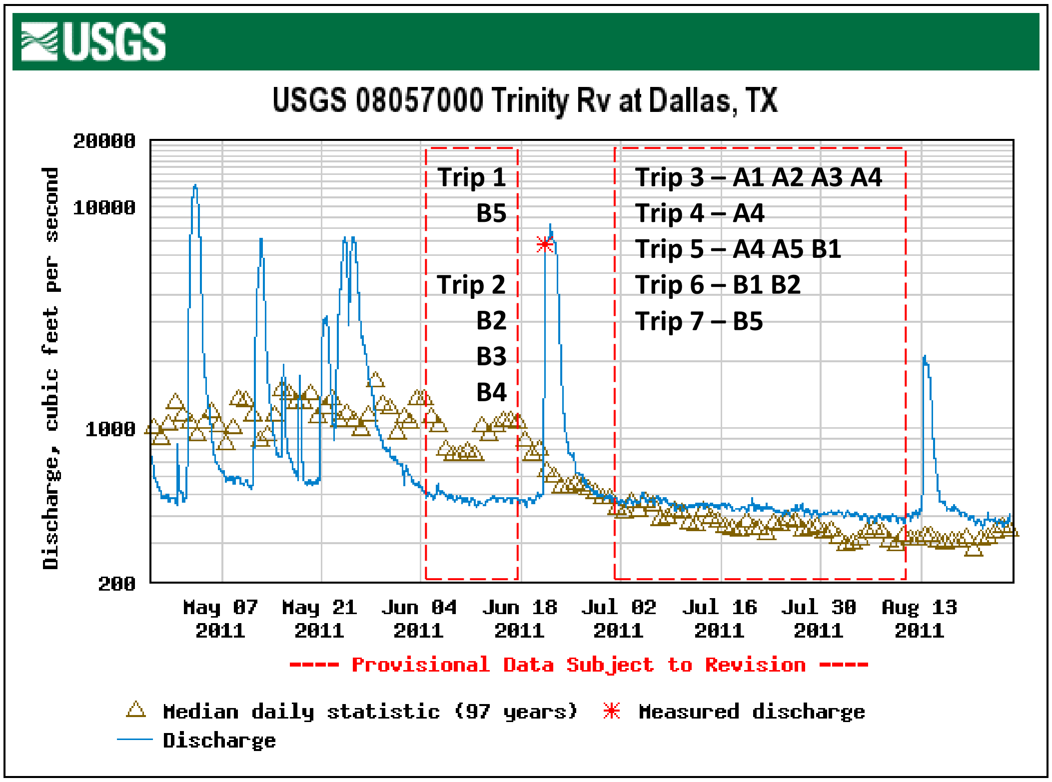


Figure 2-2. Survey period 120-day hydrograph –USGS 08057000 at Dallas (Initial Segs).

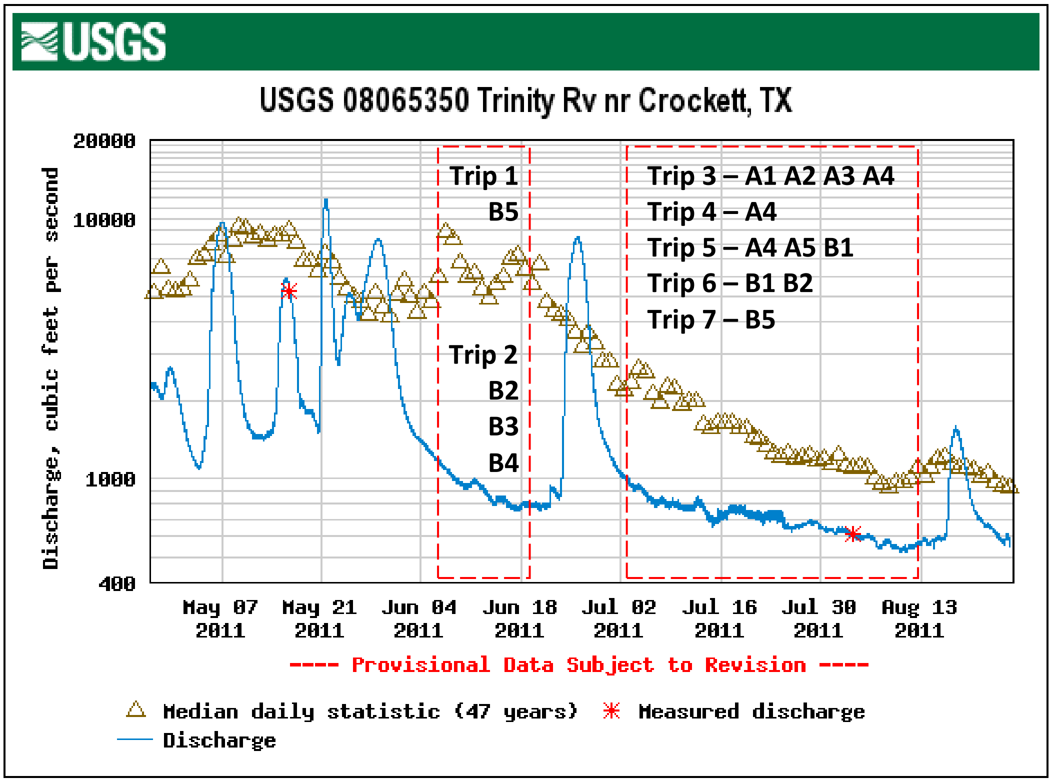


Figure 2-3. Survey period 120-day hydrograph –USGS 08065350 nr Crockett (Initial Segs).

The SB3 flow standards issued by TCEQ in 2011 were developed from pre-1960s historical conditions and are reflective of a period with much lower return flows. The flow standards exhibit much lower flows when compared to flow statistics derived from a more recent, current period (Table 2-1, "HEFR" column). Without return flows, the river flows near Oakwood may have been comparable to the SB3 subsistence or dry conditions (<160cfs); however, the actual measured flows (>600 cfs) during the survey period were higher than the wet condition in the TCEQ standards. Compared to current-period hydrology, the measured flows hover between subsistence and dry condition flow rates. In the middle of the survey period, one 8,000 to 9,000 cfs pulse occurred and would satisfy the flow standards; it is also higher than recent-period peak flow of a 2 per season pulse (Table 2-1).

Water level (gauge height) for selected gauges (Table 2-2) was tabulated for purposes of identifying order-of-magnitude water level changes in relation to flow changes. The gauge heights in Table 2-2 correspond to flow rates in the same position within Table 2-1.

Table 2-1. Characteristic Flow Rates.

		Flows (cfs)					
		TCEQ Standard (early period, approx. pre-1960s)				HEFR (1965-2011)	
Gage	**Season**	**Winter**	**Spring**	**Summer**	**Fall**	**Jan-Jun**	**Jul-Dec**
Beach	**1/yr**					5,190	
	1/season					4,290	2,190
	2/season					2,580	1,440
	Wet					61	37
	Avg					39	26
	Dry					28	20
	Subs.					8	8
Grand Prairie	**1/yr**					7,440	
	1/season					6,000	3,630
	2/season	300	1,200	300	300	4,150	2,550
	Wet					237	191
	Avg					187	158
	Dry	45	45	35	35	146	134
	Subs.	19	25	23	21	102	98
Dallas	**1/yr**					14,400	
	1/season					10,700	5,800
	2/season	700	4,000	1,000	1,000	5,800	4,140
	Wet					523	446
	Avg					429	366
	Dry	50	70	40	50	292	275
	Subs.	26	37	22	15	189	181
Oakwood	**1/yr**					20,800	
	1/season					16,600	9,540
	2/season	3,000	7,000	2,500	2,500	8,560	5,540
	Wet					1,260	920
	Avg					996	796
	Dry	340	450	250	260	786	658
	Subs.	120	160	75	100	465	442

NOTE: HEFR Wet/Avg/Dry are 75/50/25 percentile of baseflow-only time-series; subsistence is the median of the subset of baseflows lower than 10th percentile

Table 2-2. Gauge height associated with flows in previous table, based upon gauging station.

		Gage Height (ft.) associated with Flows, based upon rating					
		TCEQ Standard (early period, approx. pre-1960s)				HEFR (1965-2011)	
Gage	**Season**	**Winter**	**Spring**	**Summer**	**Fall**	**Jan-Jun**	**Jul-Dec**
Beach	**1/yr**					20.50	
	1/season					19.00	17.35
	2/season					18.25	16.52
	Wet					14.23	14.06
	Avg					14.07	13.96
	Dry					14.01	13.94
	Subs.					#N/A	#N/A
Grand Prairie	**1/yr**					17.96	
	1/season					15.60	11.16
	2/season	3.37	5.75	3.37	3.37	12.17	8.90
	Wet					3.13	2.94
	Avg					2.92	2.81
	Dry	#N/A	#N/A	#N/A	#N/A	2.76	2.70
	Subs.	#N/A	#N/A	#N/A	#N/A	2.55	2.53
Dallas	**1/yr**					33.00	
	1/season					30.30	24.09
	2/season	13.86	21.10	14.70	14.70	24.09	21.35
	Wet					13.29	13.00
	Avg					12.93	12.69
	Dry	10.75	10.99	10.61	10.75	12.39	12.31
	Subs.	10.37	10.57	10.30	10.12	11.88	11.83
Oakwood	**1/yr**					32.25	
	1/season					28.60	21.09
	2/season	11.16	17.79	10.09	10.09	19.86	15.64
	Wet					7.00	6.02
	Avg					6.25	5.62
	Dry	#N/A	#N/A	#N/A	#N/A	5.59	5.17
	Subs.	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

2.3 Hydrology context – Recent and Historical Flooding

Large flood events cause not only disturbance and changes to localized bank areas, but can also cause larger-scale adjustments affecting channel planform, widening and contribution of Large Woody Debris (LWD). Some channel areas were observed during the survey to be responding to recent or historical flood flow events.

To help understand the context and time scales of some features including cues identified during the site survey (e.g., tree growth patterns, disturbed banks, distribution of LWD), high-flow events are identified that may be used as reference points in time (Table 2-3).

Tropical storm Hermine in September 2010 resulted in significant localized rainfall and high peak flows in the Trinity River basin. During the summer of 2007 a larger flow event occurred within the basin. The most recent overbank events occurred in spring 1990 and winter 1991.

At the Trinity River at Dallas gauge, no peak flows higher than 1990 were recorded except before 1950. Larger peaks were recorded in 1949, 1942 and 1908 (82500, 111000 and 184000 cfs, respectively).
At the Crocket gauge, no peak flows higher than 1990 were recorded except before 1946. Larger flow peaks were recorded in 1890, 1908, 1942, 1944 and 1945 (180000, 164000, 153000, 111000 and 140000cfs, respectively).

Table 2-3. Annual peak flow records from selected USGS gauges.

Fall 2010 (1-year before survey)
08048543 W Fork at Beach Street, Fort Worth – Sept 8, 2010 – 22,900cfs peak flow
08057000 Trinity River at Dallas, TX – Sept 9, 2010 – 44,200cfs peak flow
08057410 Trinity River below Dallas, TX – Sept 8, 2010 – 38,100cfs peak flow
08065000 Trinity River nr Oakwood, TX – October 31, 2010 - 49,900cfs peak flow
Summer 2007 (4-years before survey)
08057000 Trinity River at Dallas, TX – June 28, 2007 – 38,700cfs
08065000 Trinity River nr Oakwood, TX – July 10, 2007 – 71,600cfs
08065350 Trinity River at Crocket, TX – July 12, 2007 – 67,500cfs
Spring 1990 and Winter 1991 (20 years before survey)
08048543 W Fork at Beach Street, Fort Worth – May 2, 1990 – 46,600cfs* :: Dec 20, 1991 – 36,100 cfs
08057000 Trinity River at Dallas, TX – May 3, 1990 – 82,300cfs :: Dec 21, 1991 – 62,200 cfs
08057410 Trinity River below Dallas, TX – May 4, 1990 – 87,000cfs* :: Dec 22, 1991 – 56,900cfs
08065000 Trinity River nr Oakwood, TX – May 7, 1990 – 107,000cfs* :: Dec 24, 1991 – 106,000cfs
08065350 Trinity River at Crocket, TX – May 10, 1990 – 109,000cfs :: Dec 26, 1991 – 109,000cfs
* = largest peak flow record for this gauge

3.0 Revised areas and segmentation (Seg 2012)

3.1 Rationale for revising segmentation

The purpose of segmentation in this study is to facilitate evaluation by grouping river reaches with similar characteristics. Based upon data and experience accumulated during the 2011 survey, the initial Trinity River mainstem segmentation was revised. Similar river reaches were grouped into segments and similar segments were grouped into similar areas. The resulting second-generation Trinity River mainstem segmentation (Seg 2012) is described in the subsequent section (Table 3-1).

Table 3-1. Second-generation segmentation (2012).

Area (2012)	Segment (2012)	Description	RM2012 Start	RM2012 End	RM2012 Length (mi)
A		**Urban Area**			
	A1	Handley-Ederville to VC	511.8	503.3	8.5
	A2	VC to 0.5mi UpS TRACRWS	503.3	480.9	22.4
	A3	0.5mi UpS TRACRWS to DAL Central	480.9	466.8	14.1
	A4	Dal Central to 250 meters up Lock 1	466.8	459.9	6.9
B		**Locks and Flood Control**			
	B1	250 meters up Lock 1 to Lock 3	459.9	443.8	16.1
	B2	Lock 3 to Lock 4	443.8	433.1	10.7
	B3	Lock 4 to Lock 5	433.1	425.5	7.6
	B4	Lock 5 to TR Falls	425.5	410.8	14.7
C		**Middle Trinity**			
	C1	TR Falls to Cedar Creek	410.8	381.4	29.4
	C2	Cedar Creek to Catfish Creek	381.4	316.6	64.8
	C3	Catfish Creek to Mack Creek	316.6	280.9	35.8
	C4	Mack Creek to Lock 6	280.9	244.5	36.4
D		**Coastal Plain**			
	D1	Lock 6 to Lk Livingston Pool	244.5	221.2	23.3
	Total_Survey		**511.8**	**221.2**	**290.6**

3.2 Second-generation areas and segments (Seg 2012)

3.2.1 Area A (Seg 2012) – Urban area

Area A (2012) is located at the upstream end of the study area within an area of dense urban development (cities including and surrounding Fort Worth and Dallas). The 2012 segmentation preserves major segment divisions at locations of major effluent discharge inflows.

The revised upstream end of segment A1 (2012) is located at the crossing of Handley-Ederville Road, which is just downstream of the most downstream (of three) low-water dams.

The upstream end of segment A2 (2012) is located at the outfall location of Fort Worth Village Creek Wastewater Treatment Plant (WWTP). This is no change from initial segmentation.

The upstream end of segment A3 (2012) is located where channelization begins, approximately 0.5 river miles upstream of the outfall location of TRA Central Regional WWTP. This channel in this segment has been modified by straightening and levees.

The upstream end of segment A4 (2012) is located at the outfall location of City of Dallas Central WWTP. This is no change from initial segmentation. This segment includes the USGS below Dallas gauge. The downstream end of segment A4 (2012) is located approximately 820 ft (250m) upstream of the most upstream Lock and Dam (Lock #1). This is downstream of Loop 12 and upstream of IH-20.

3.2.2 Area B (Seg 2012) – Locks and flood control

Area B (2012) is located downstream of the highly urbanized metropolitan area and encompasses a river area historically influenced by navigation and flood-control projects. A total of five lock and dam structures are included in this area, as well as some leveed reaches, some straightened reaches and the confluence with the East Fork Trinity River. Major segment divisions are located at lock structures.

The upstream end of segment B1 (2012) is located approximately 820 ft (250m) upstream of Lock #1. The City of Dallas Southside discharge and Lock #2 are included in this segment. Bank failure downstream caused by downcutting below Lock #2 may in coming years threaten the integrity of Lock #2 as a flow control. In the future, the river may by-pass Lock #2 as erosion continues or as a significant flow event causes another sudden bank failure; this would cause impacts through time to upstream bed slope, planform and area landowners including the Dallas Southside WWTP.

The upstream end of segment B2 (2012) is located at Lock #3. This segment exhibited narrower, incised channels, and predominance of run mesohabitat, possibly indicative of increased slope.

The upstream end of segment B3 (2012) is located at Lock #4. The confluence with the East Fork Trinity River is included in this segment.

The upstream end of segment B4 (2012) is located at Lock #5. This segment includes significant levee, straightening and by-pass projects for flood control. The USGS Rosser gauge is located within this segment. The downstream end of this segment is located at Trinity Falls, a naturally-occurring outcrop of dense compacted clay. Trinity Falls comprises an eight to 10 foot drop in river bed elevation.

3.2.3 Area C (Seg 2012) – Middle Trinity

Area C (2012) comprises a long section of the Trinity River that has not experienced modification projects as significant as upstream areas.

The upstream end of segment C1 (2012) is located at Trinity Falls. The confluence of Richland-Chambers Creek is included in this segment.

The upstream end of segment C2 (2012) is located at the constructed spillway outfall of Cedar Creek Reservoir.

The upstream end of segment C3 (2012) is located at the confluence of Catfish Creek. This segment exhibits some evidence of riparian area clearing to the banks. The clearing activities have resulted in localized bank erosion/widening with associated shallowing near bank failure areas.

The upstream end of segment C4 (2012) is located at the confluence of Mack Creek. This segment exhibits evidence of channel migration and adjustments. Also included in this segment are Hurricane Shoals. Just downstream of the Shoals, the downstream end of the segment is located at Lock #6 and the USGS Crockett gauge.

3.2.4 Area D (Seg 2012) – Coastal Plain

Area D (2012) is homogeneous for the entire single-segment area. All reaches in this area exhibit similar bank material, bank slope and bank condition. Very little riparian area has been cleared to the banks, and little evidence of channel modification (levees, straightening, etc) was observed.

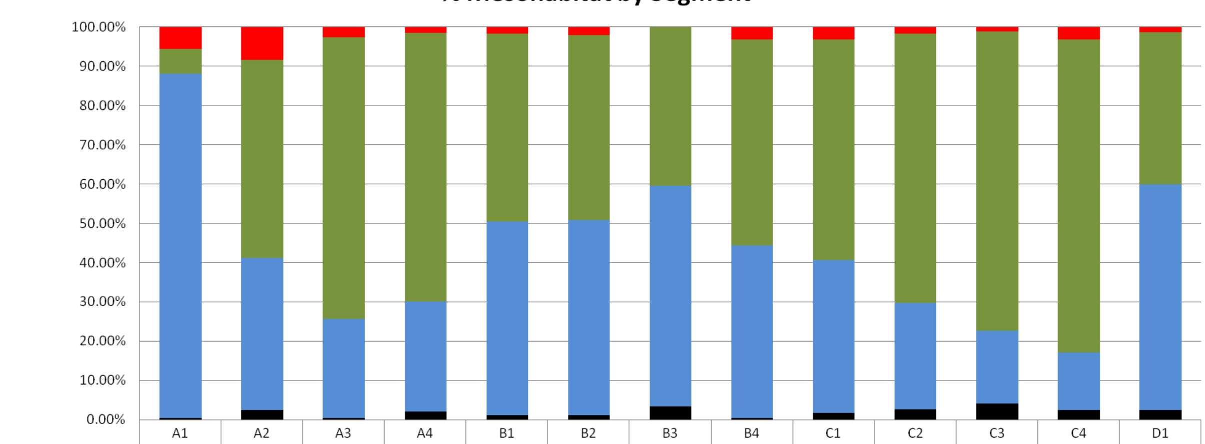
The upstream end of segment D1 (2012) is located at Lock #6 near the USGS Crockett gauge. The downstream end of the segment is located at elevation 131ft marking the headwaters of Lake Livingston.

4.0 Data analysis

4.1 Mesohabitats area and counts in each segment

Based upon the longitudinal mesohabitat characterization and the new river mile designations (RM2012), the overall makeup of mesohabitat type by segment reflects a preponderance of Run habitat in most segments (Figure 4-1 and Figure 4-3. Ratio of Pool area to Run area (Seg 2012) (negative means more Run).

). Exceptions where pool is the predominant mesohabitat are segment A1 where flow is low as a result of no baseflow augmentation from effluent discharges, segment B3 located between locks (constructed grade control) and segment D1 that lies in the Coastal Plain Of note is that segment D1 ends upstream of the lake's flood pool topographic contour line (131ft); backwater effects are NOT a factor contributing to deeper pools in this segment. Across all Area C segments, the combined bifurcated and riffle percentage is approximately 5%.



	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1
Flow Mean	4	147	368	605	588	669		703	719	626	588	687	595
Percent_Riffle	5.60%	8.40%	2.60%	1.46%	1.69%	2.13%	0.00%	3.11%	3.16%	1.71%	1.09%	3.21%	1.21%
Percent_Run	6.28%	50.50%	71.73%	68.56%	47.88%	46.96%	40.51%	52.63%	56.25%	68.56%	76.22%	79.79%	38.82%
Percent_Pool	87.82%	38.76%	25.37%	27.90%	49.27%	49.83%	56.17%	43.81%	38.84%	27.21%	18.64%	14.52%	57.56%
Percent_Bifurcated	0.30%	2.33%	0.30%	2.08%	1.17%	1.08%	3.31%	0.44%	1.74%	2.52%	4.06%	2.48%	2.41%
Length (RM)	8.5	22.4	14.1	6.9	16.1	10.7	7.6	14.7	29.4	64.8	35.8	36.4	23.3

Figure 4-1. Percent of mesohabitat (by length) for each segment.

To complement the summary of mesohabitat by area, the count of mesohabitats per mile within each segment gives an indication of distance between habitat changes (Figure 4-2). For example, segment A2 exhibited switching between short mesohabitats; with a total of approximately 8 mesohabitats per mile (0.5 bif. + 2.5 pool + 1.5 riffle + 3.5 run) this averages to mesohabitats between 600 and 700 feet long. Contrast this with segment C3 that exhibited long, continuous reaches of homogeneous mesohabitats; with a total of approximately 2.75 mesohabitats per mile (0.5 bif. + 0.5 pool + 0.25 riffle + 1.5 run) the average mesohabitat length is approximately 2,000 feet long.

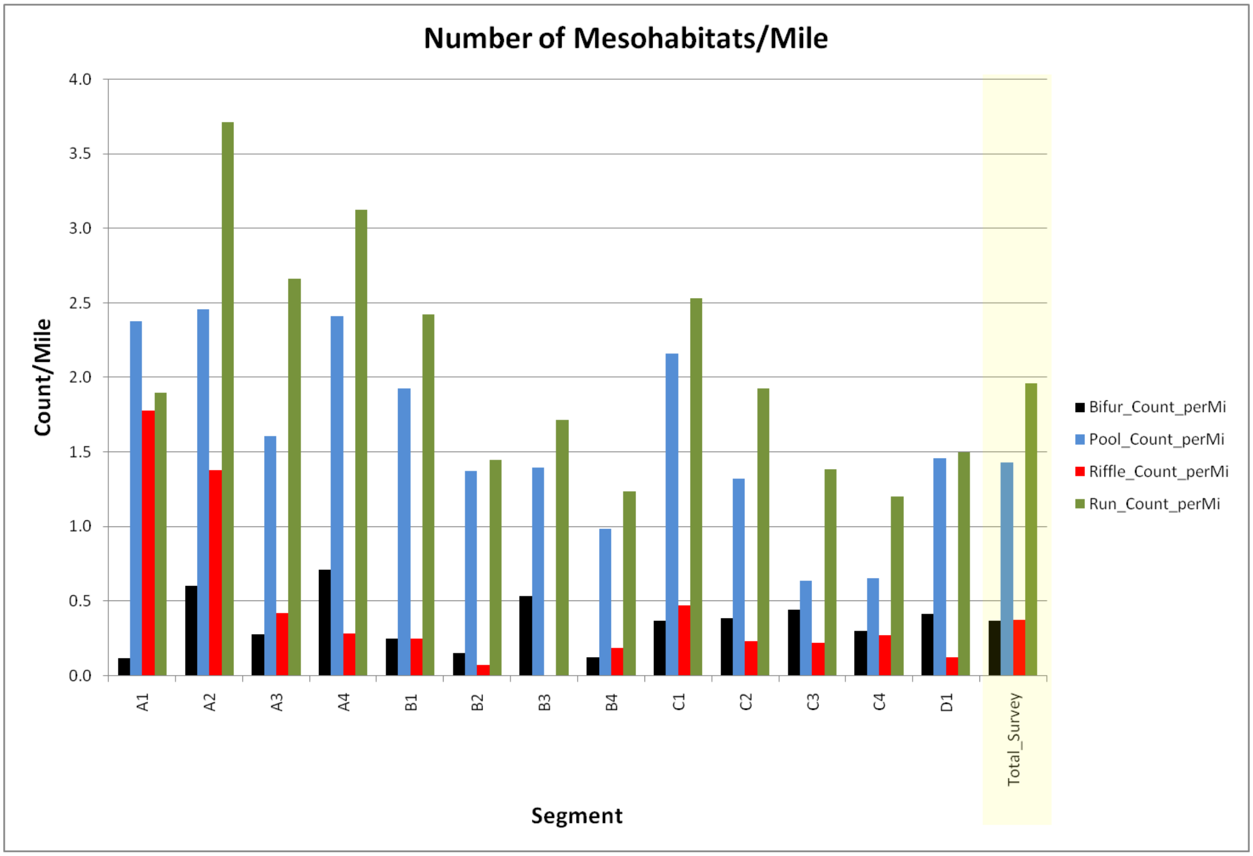


Figure 4-2. Number of mesohabitats per mile for each segment (Seg 2012).

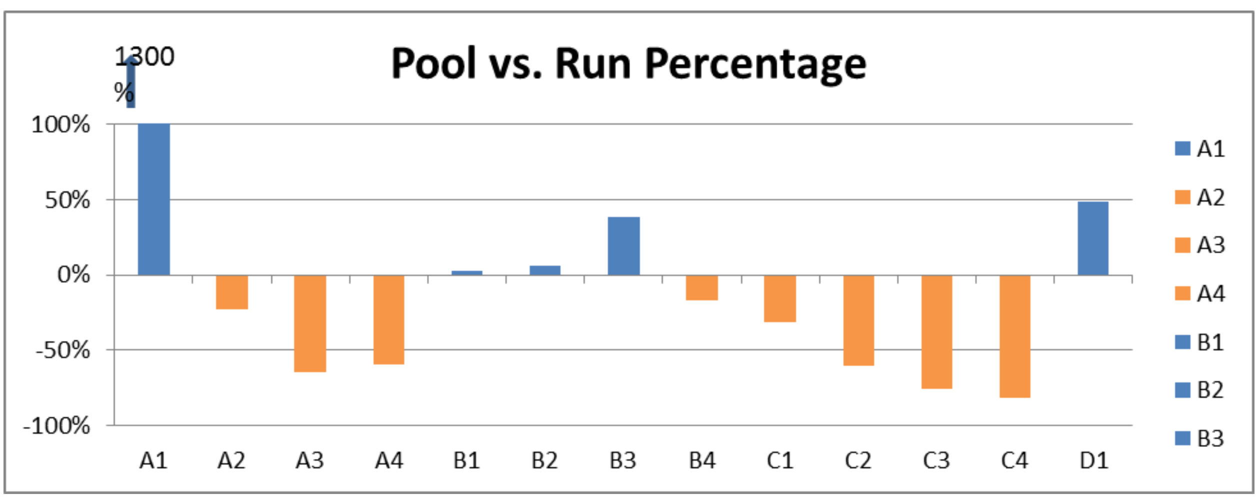


Figure 4-3. Ratio of Pool area to Run area (Seg 2012) (negative means more Run).

4.2 Depth

Mesohabitat reaches within each segment were associated with the longitudinal depth profile data. The dataset is essentially a long time-series of depth points collected over the entire 290 mile survey area where each depth point is associated with the type of mesohabitat from the reach (nearly 300,000 points with attributes x,y,z,mesohabitat).

The breakout is consistent with what might be expected: pools are deepest, riffles are shallowest and in the middle are runs and bifurcated (which are typically comprised of runs and riffles) (Figure 4-4).

Depth magnitude is representative of the lowest baseflow conditions in recent history, considering discharges from the DFW area. At USGS gauge locations, the fluctuation in water level during survey days was calculated as a surrogate estimate for depth error (Figure 4-4). The measured depths are considered within 0.4 feet of what could be expected under similar future low base flow conditions.

The average depth for riffles is shown on the order of 4 feet in areas A through D. This is an artifact of two factors: (1) choosing the deepest area of each riffle to navigate the boat and (2) the very short length of riffles (because of navigating fast-moving waters, the field crew typically marked the transition to between habitats as soon as safely practicable which may be several meters upstream or downstream of the actual transition). Therefore, the average depth for riffles may be skewed high considering the typical range depths evident at each riffle between inches deep and several feet deep.

For each segment, the overall range of depths is shown in Figure 4-5. The deepest of scour pools exceeded thirty feet. Average depths throughout Area C were very consistent at low baseflow conditions at approximately 7.5 feet.

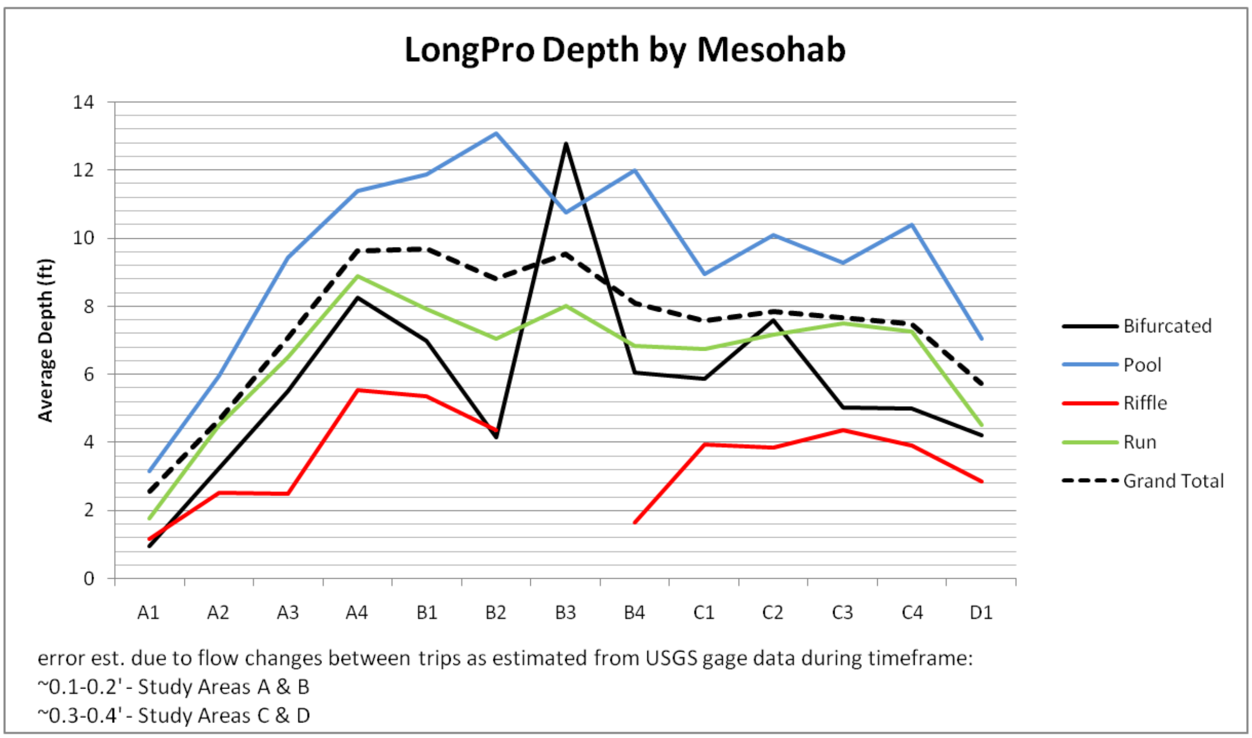


Figure 4-4. Average Depth of mesohabitats, for each segment (Seg 2012).

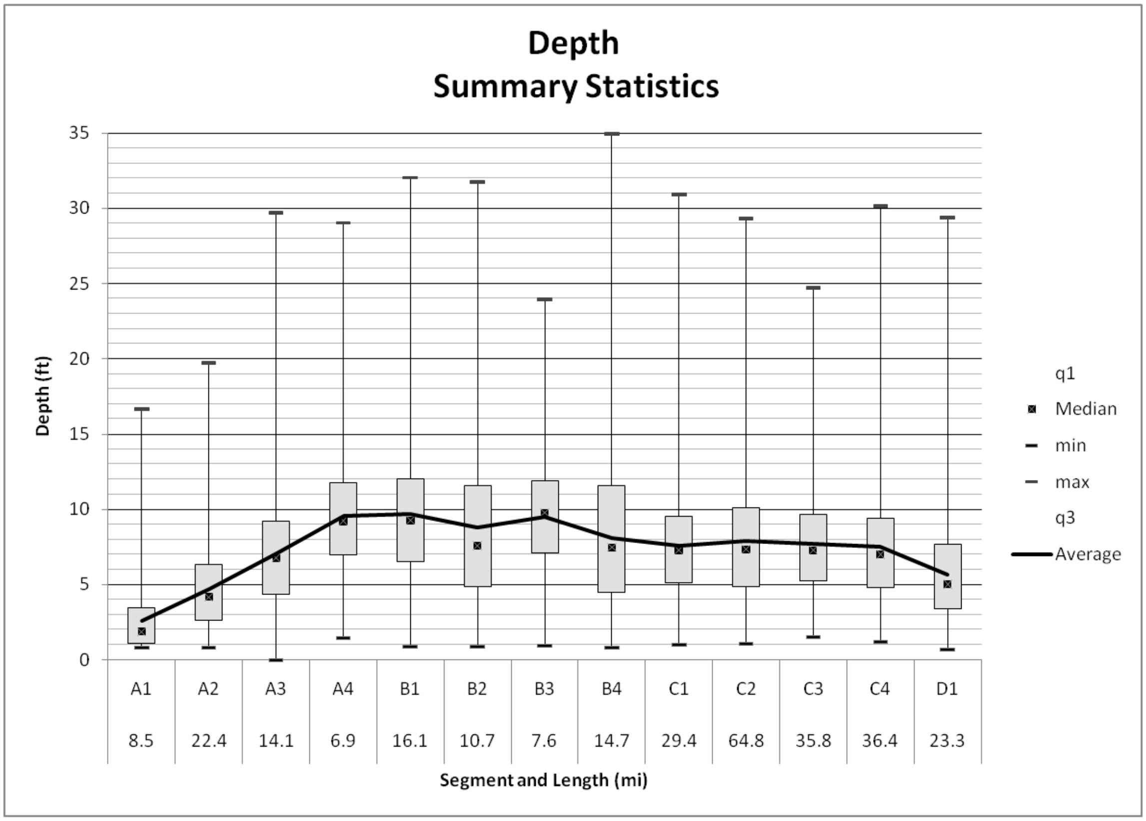


Figure 4-5. Depth characteristics for each segment (Seg 2012).

4.3 Cross-sections

Based upon wetted cross-section data collected every two miles, average cross-sectional area in each 2012 study area (Figure 4-6 and Figure 4-8) illustrate differences in the lock segments, the middle Trinity (area C) and Area D. Of areas B, C and D representing the middle Trinity, Area C has the lowest average cross-sectional area, near 650 ft^2.

The longitudinal distribution of cross-sectional area and wetted width (Figure 4-7) illustrates the irregularity of Area B and the homogeneity of Area C (2012). Wetted width in Area C is approximately 120 feet. The increase near the interface between Area C and Area D is a result of a significant natural grade control at Hurricane Shoals, located just upstream of Lock #6 near the Crockett gauge.

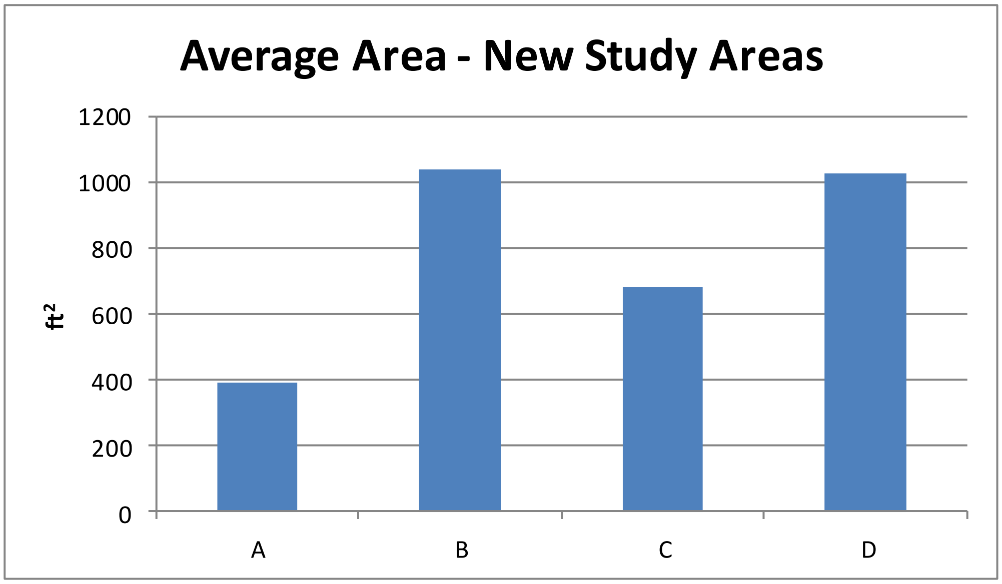


Figure 4-6. Average cross-sectional area of mesohabitats, for each segment (Seg 2012).

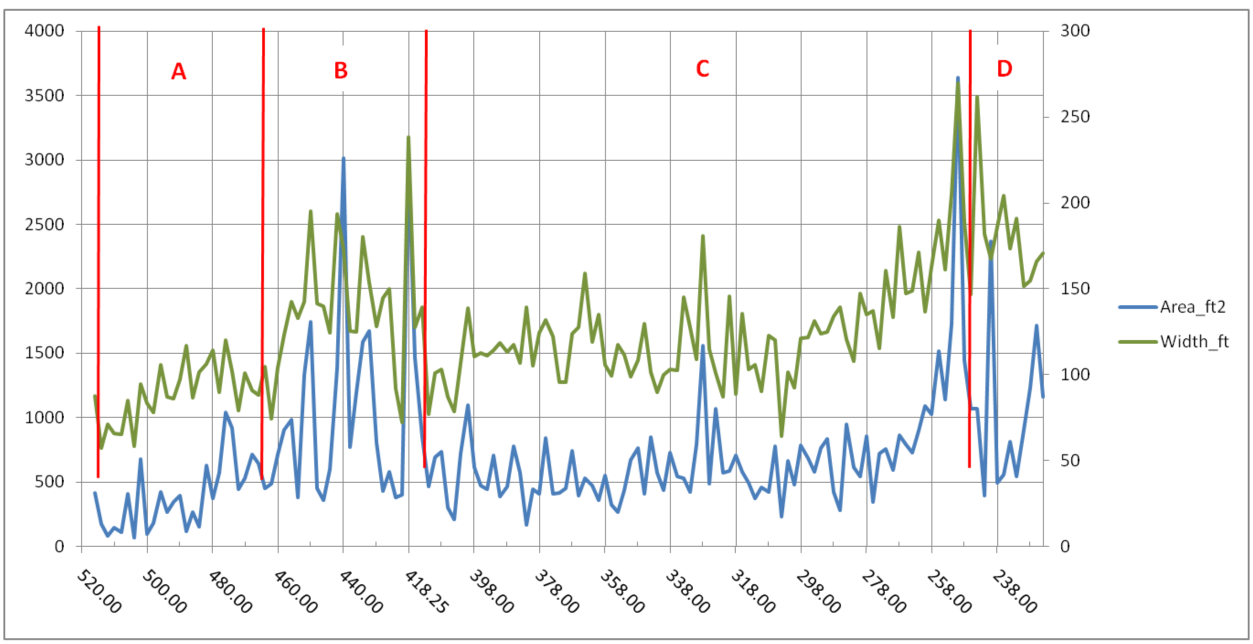
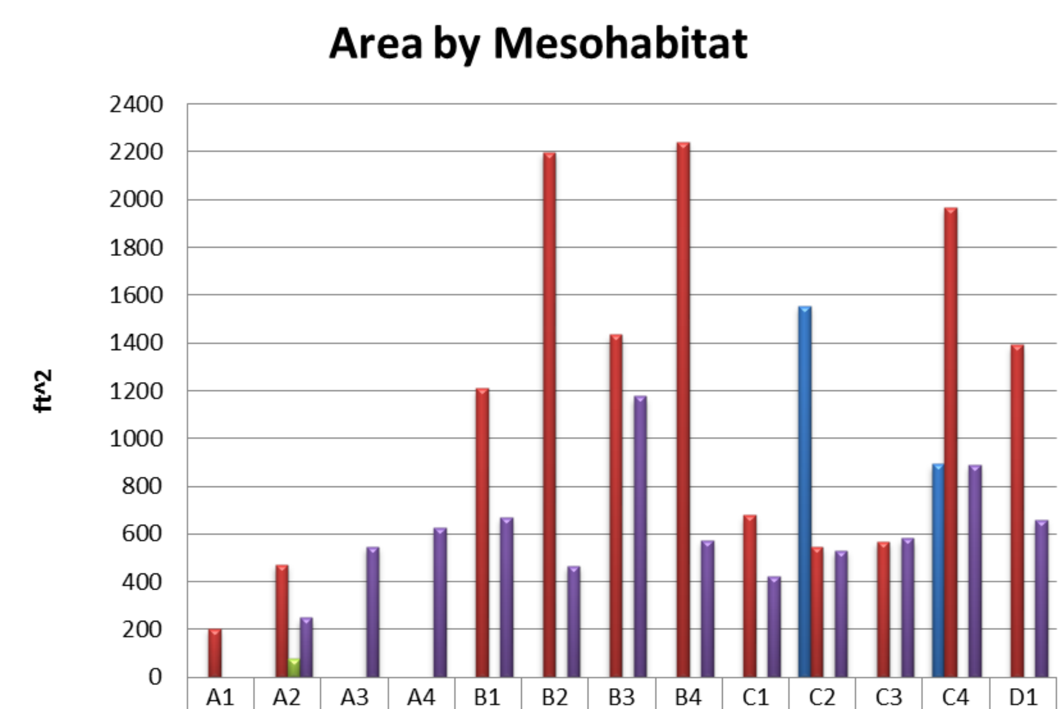


Figure 4-7. Average cross-sectional area and wetted width from cross-section measurements (Seg 2012).



	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1
Bifurcated										1554		893.9	
Pool	202.7	471.2			1209	2199	1434	2241	677.9	546.8	567.5	1968	1391
Riffle		80.72											
Run		250.5	547.8	625.2	670.1	466.9	1178	572.6	423.4	530.8	582.9	890.5	658.4

Figure 4-8. Average cross-sectional area from cross-section measurements, by mesohabitat (Seg 2012).

4.4 Comparison to Phillips (2008) geomorphic office-based analysis

Phillips conducted an office-based geomorphic assessment for the Texas Water Development Board in 2008. While a careful, thorough analysis has not yet been conducted to compare the Phillips findings to the 2011 survey, a number of parallel findings are here noted.

A significant grade control and shift in characteristics of run habitat was noted in the vicinity of Yard, TX (RM328-2012). This corresponds to a change in slope and geologic influence noted by Phillips (see river km 175 on Figure 4-9).

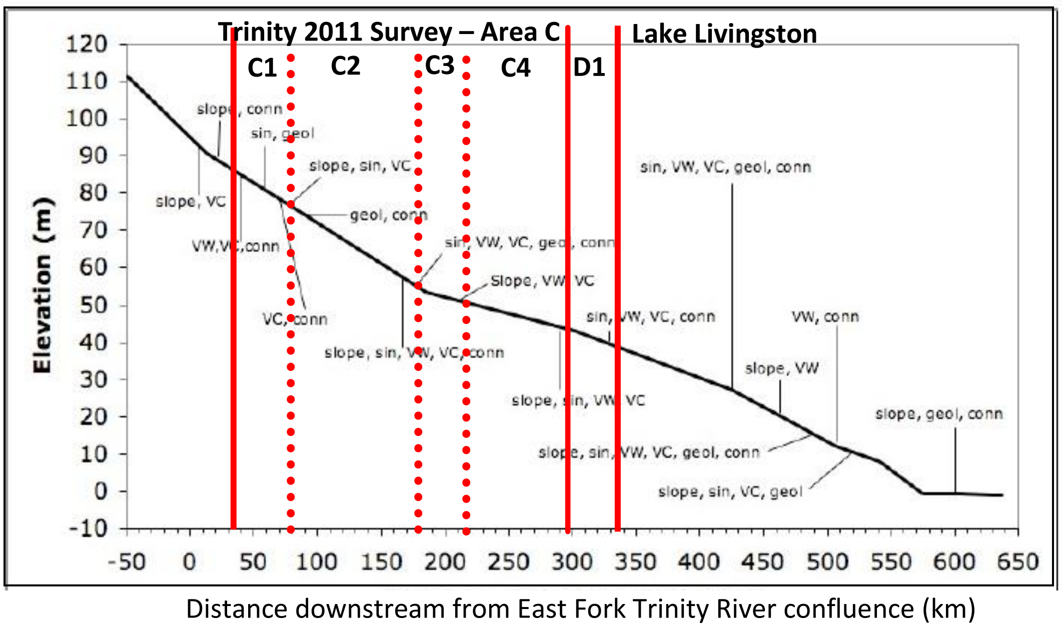


Figure 4-9. Preliminary Area C (2012) reaches over Phillips (2008) geomorphic process transitions.

5.0 Prioritizing Areas for Long-term Study

5.1 Objectives

From a broad perspective, choice of river study sites should be consistent with study objectives. Desirable study site characteristics for a suspended sediment sampling study (where specific location is not as important allowing access drives site selection) are not necessarily the same as desirable characteristics for a study of reach-representative instream aquatic habitat (where bounds of a local study site should encompass a representative range of habitats existing in a longer segment).

The Trinity River Long-term Study (TRA, in preparation) has three primary objectives that will be used to inform study site selection:

- To understand the current status of the Trinity River, using the 2011 to 2015 period as baseline
- To understand what processes are active in the river at broad scale, and what localized effects are active resulting from urban, rural and riparian activities
- To understand, through time (e.g., after 20 years), what have been the most influential factors of change (e.g., climate, flow patterns, structures, land use, water quality, etc.).

Clearly, this is a broad set of objectives spanning many river science disciplines including biology, hydrology, geomorphology and water quality. Also clearly, the four river areas identified in the 2011 reconnaissance survey encompass nearly 300 river miles meandering through different ecoregions, geologies, in-channel structures and population centers. Because of their unique characteristics, the objectives noted above will be considered for each study area.

The Trinity River Long-Term Study is intended to be a semi-opportunistic study. Resources are anticipated to be dedicated to this study through time; however, the larger vision is for this study to serve as a guidepost and clearinghouse for all studies conducted in the basin. Where studies conducted for other programs can fulfill or inform on the larger Long-Term objectives, those studies would have the opportunity to be tweaked to maximize their utility, or should be tracked to incorporate their results into Long-Term study summaries.

5.2 Rationale for choice of study areas

To balance research needs with available resources, the following is a priority list for study areas and study segments:

1. **Study Area C – Middle Trinity** – Two main factors contribute to high priority placed on this study area. (1) This area encompasses a large geographic area exhibiting limited influence (when compared to other study areas) from external factors. The primary influence is increased baseflow from upstream sources. (2) There is current interest in this area by other programs (TIFP), to the level of initiating related studies.
2. **Study Area A – Urban area** – This highly-influenced study area spanning the Fort Worth and Dallas metroplex receives four large discharges and exhibits a range of in-channel conditions

from lightly impacted to highly modified for flood control. Because of the wide range of influences; the opportunities for recreation and public visibility; the potential for future influences and change; and the proximity to less-influenced headwater streams, this study area is a good candidate for long-term study.

3. **Study Area D – Coastal Plain** – Like study area C, this study area D is lightly influenced. The single segment identified within this area is highly homogeneous along its length based upon instream mesohabitat, bank materials and intact riparian areas. Area D exhibits a predominance of pool mesohabitats in contrast to Area C which is predominantly run mesohabitat.
4. **Study Area B – Locks and Flood Control** – This study area is highly influenced by a number of factors including five relic, non-functioning lock and dam structures and flood control bypass channels. The river channel in this area is complex and it's current condition represents continued adjustment in response to 100-year old in-channel grade control structures, 40 to 50 year old flood control activities, and recent high flow flood events (e.g., Tropical Storm Hermine in 2010, larger flows in 2007 and highest-recorded flows in 1991).
5. **Study Area F (Lake Livingston dam downstream to Wallisville)** – While this area was not covered in the 2011 study, data analysis of the recently-completed 2013 reconnaissance mission (or further evaluation of a previous reconnaissance mission (2010)) may identify this as an important area to monitor.

The above prioritization represents current information and knowledge. As studies are completed and new information becomes available, the priorities will be refined through time.

Detail is included in following sections to describe choice of priority reaches inside each study area. Focus and increased level of detail is included for the high-priority areas C and A; additional detail will be added after further evaluation to support study segment selection for areas B, D and F.

5.2.1 Priority 1: Area C – Middle Trinity

Specific study sites should be chosen according to the purpose of the study.

The following table (Table 5-1) includes categories of consideration identified based upon field notes and information gained during the 2011 survey. Other specific considerations will be identified as studies are scoped. Candidate study reaches are identified for each category.

Prioritization of segments within study area C is as follows:

1. **C1 and C2**– The two segments are similar based upon predominance of run habitat (approximately 60-65% run, Figure 4-1) and upon number of pools and runs per mile (Figure 4-2). These segments represent the most stable, comparatively un-impacted reaches, representative of a modern-day Trinity River.
2. **C3** – C3 is similar to C1 and C2 with main exception of some areas of widening (shallowing and in-channel bars) in bends adjacent to riparian area disturbance. The widening is a result of bank failure.
3. **C4** – Geometric characteristics have some similarity to other C segments as well as to D1. Recent channel adjustments are observed in this section. Influence of natural grade control caused by Hurricane Shoals, just upstream of the lock near the downstream boundary, is evident in the downward trend of increasing pools and increasing depth (Figure 4-7 and Figure 4-8).

Table 5-1. Area C – Selected study site considerations and candidate reaches (2012 RMs).

Consideration: Unique or notable reaches.

- C1 – RM410.8 - Near Trinity Falls
- C2 - RM381.5 - Near reservoir outlet Cedar Creek
- C2 - RM349 - Near reservoir outlet Richland Chambers
- C2 – RM 328 – Near Yard –high bluff river left and riffle grade control
- C2 - downstream of Yard (narrow channel with willows leaning in)
- C2 - Downstream of Bluff, just downstream of old prison bridge abutments (channel/floodplain interaction and active adjustment of low-flow channel)
- C3 - one of the Run C - mid-channel bars
- C4 - Channel adjustment areas
- C4 - Hurricane Shoals
- Include a couple riffle areas since they are less common than runs or pools.

Consideration: Encompass a RANGE OF CONDITIONS.

- C1 – RM 410.8 - Near the falls
- C1 - Pool (shallower pools than C4 pools)
- C2 - Run A – stable
- C2 – RM 345 to RM 329 – no riffle or bifurcated habitats; long runs and pools
- C2 - Run B - steep, less stable
- C3 - Run C – some areas not stable, mid-channel bars, altered riparian area
- C3 and C4 – more big gar observed rolling in pools compared to upstream areas
- C4 – Pool (deeper than C1 pools)

Consideration: LONG-TERM STABILITY

- C1 - Riffle downstream of falls
- C1 - Riffle upstream of Cedar Creek outfall
- C2 - Run A with intact riparian area
- C3 – In highly sinuous portion between RM 294 and/or 308
- C4 – Meander bend at RM 281

Consideration: Instream mesohabitats

These are locations where directed mesohabitat sampling was conducted in 2011. These mesohabitats were chosen by the field crew because they appeared similar to the predominance of that type of habitat in the segment; therefore, these locations are considered generally “representative” and candidate study sites.

- C1 – RM 406.8 - pool
- C1 – RM 406.75 - run
- C1 – RM 384.3 - riffle – upstream of Cedar Creek outfall
- C2 – RM 345.7 – riffle
- C2 – RM 319 - pool
- C2 – RM 318.9 - run
- C3 – RM 294.9 - run
- C3 – RM 294.6 – riffle
- C3 – RM 285.7 - run
- C3 – RM 284.7 - run
- C4 – RM 267.5 - run

Candidate study reaches within priority study segments is as follows:

1. **C1 and C2** – Targets are for 60-65% run and 5% combined riffle/bifurcated. Excluding short riffles and bifurcated mesohabitats, run and pool mesohabitats should be between approximately 1,100 to 1,920 feet long (between 4.75 and 2.75 per mile).
    a. C1 – RM346 to RM328 (Figure 5-1) – upstream of Yard for intact riparian areas; this would be a good area to estimate channel widening and migration because of the lack of intermediate grade controls
    b. C1 - RM383 to RM387 (Figure 5-2) – Upstream of Cedar Creek outfall for habitat diversity
2. **C3** – A main objective for study in C3 should be to evaluate widening considering increased baseflows and riparian clearing. Target is 75-80% run and 5% combined riffle/bifurcated. Excluding bifurcated and riffle mesohabitats, run and pool mesohabitats can be approximately 2,600 feet long (2 per mile), longer than C1/C2 segments.

Additional office-based and field reconnaissance should be conducted to verify reasonable access to the sites, and to identify exact upstream and downstream boundaries.

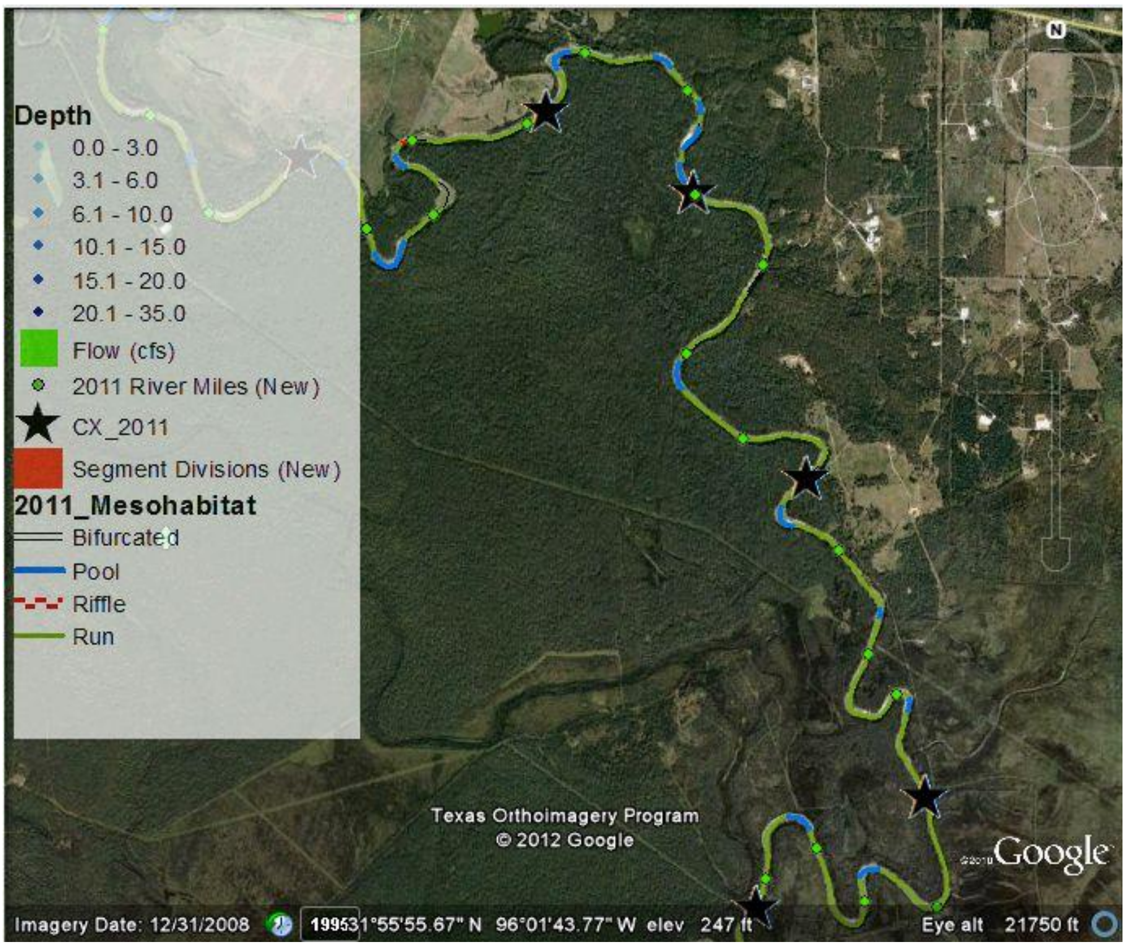


Figure 5-1. Candidate study reach – C1 – RM346-RM328.

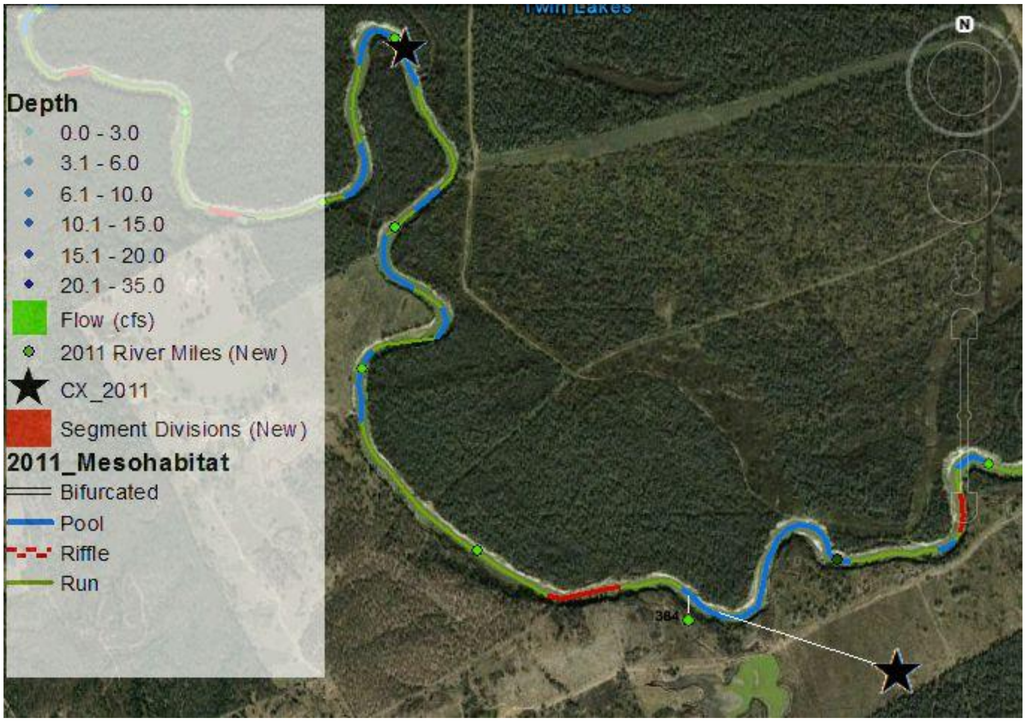


Figure 5-2. Candidate study reach – C1 – RM383 to RM387.

5.2.2 Priority 2: Area A – Urban areas

Prioritization of segments within study area A is as follows:

1. **A1 and A2** – Upstream of Elm Fork, limited channel/floodplain alteration was observed. This reach was primarily influenced by upstream flow management. Segments A1 and A2 are separated by a large municipal discharge (Village Creek WWTP)
2. **A4** – This area transitions out of the A3 flood control area.
3. **A3** – A3 is heavily modified for flood control (channelized, leveed, improvement projects in-progress) so is lower priority for baseline study.

5.2.3 Priority 3: Area D – Coastal Plain

Study area D appeared to include the most stable, un-influenced reaches observed during the 2011 survey. Notable are the largely intact riparian areas and stable, homogeneous banks.

A specific study site has not been identified at this time in study area D.

At RM233 (2012), a benchmark reference point was placed in a tree adjacent to a bifurcated riffle complex. A study reach surrounding this benchmark (from RM235 to RM230) may be suitable for instream flows assessment considering a range of run and pool mesohabitats with the bifurcated riffle in the center. During the 2011 survey, directed mesohabitat data (sediment, water quality, slope, etc.) was measured near the benchmark in a Run mesohabitat area and in a bifurcated Riffle-Run complex mesohabitat; the field crew considered these areas characteristic of other similar habitats in this study reach D1.

5.2.4 Priority 4: Area B – Locks and flood control

Prioritization of reaches within study area C is as follows:

1. **B1** – Considering the pending breach of river around Lock 2, study of the current baseline in this reach upstream of Lock 2 will enable quantification of changes using before and after datasets.
2. **B3** – This reach is steep and exhibits primarily run mesohabitat. Lock 4 at the downstream end may be in danger of breach, so to study this reach in advance to establish the current baseline will provide before and after datasets.
3. **B4** – This reach exhibits a wide range of conditions and could be further subdivided.
    a. One study could be evolution of reach between upper and lower falls considering the constructed channel bypass and levee system.
4. **B2** - add

5.2.5 Priority 5: (Tentative) Area F – Downstream of Lake Livingston

This area has not yet been evaluated in sufficient detail to allow for study site selection or prioritization.

6.0 References

Phillips, J.D. 2008. Geomorphic controls and transition zones in the lower Sabine River. Hydrological Processes 22: 2424-2437.

TRA Publications to be entered here for FINAL.