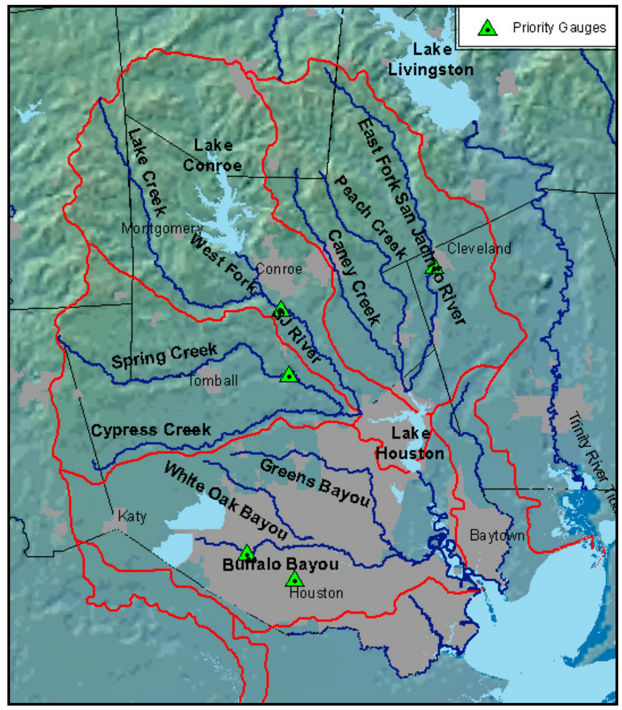
SAN JACINTO RIVER BASIN SB3 ECOLOGICAL OVERLAY
Final Report



SB3 Science Advisory Committee to the Environmental Flows Advisory Group

Texas Water Development Board

San Jacinto River Authority

September 21, 2009

Project No. 8069.01

Espey Consultants, Inc.

SAN JACINTO RIVER BASIN SB3 ECOLOGICAL OVERLAY

FINAL REPORT– September 21, 2009

Prepared for:

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1.0 EXECUTIVE SUMMARY

Development of environmental flow guidelines should involve characterization of indicators or ecological processes that respond to changes in flow or flow regime. In an accelerated process where detailed studies are not yet available, the guideline development process necessarily relies upon existing information and existing studies. Indeed, the Senate Bill 3 (SB3) effort is underway exactly because detailed studies have not been completed to evaluate the specific effects of changes to flow regime on many of the river and bay systems in Texas. Therefore, only limited amounts of information are available to identify particular flow rates or flow patterns for specific beneficial ecological processes. The main challenge is attempting to use small point data sets to characterize the natural spatial and temporal variability of water bodies.

This ecological overlay project aims to extract data or information from existing studies that may provide some guidance or may inform development of preliminary flow guidelines, until such time as more detailed studies or information are available. An initial effort to statistically characterize hydrology and flow regime is recently completed (Crespo 2009); later iterations of that hydrology project may be informed by this ecological overlay project to the degree of confidence attributed to the existing information. Ultimately over the long term, detailed site-specific data throughout a system is necessary to characterize habitat or ecological response to changes in flow regime.

Information discovered and presented in this report concentrating on the San Jacinto River basin includes a discussion of focal fish and mussel species (TPWD 1982), a characterization of least-impacted reaches (Moring 2001), status of biota (USGS 2002), nitrogen budgets (Longley et al. 2001), hydrology assessments and water quality assessments. The majority of information was discovered on the West Fork San Jacinto River (SJR) with some information on the East Fork SJR, the SJR below Lake Houston, and other tributaries in lesser amounts.

Coordination with Trinity-San Jacinto Bay-Basin Expert Science Team (TSJ-BBEST) instream flow subcommittee led to identification of priority stream flow gauges; hydrology and water quality information discovery is concentrated near these priority locations. Input from Texas Parks and Wildlife Department (TPWD) on focal freshwater fish and mussel species was considered, as was information on threatened and endangered species. Opinions have been provided by external mussel researchers and by TSJ-BBEST members. This project was developed in coordination with the parallel ecological overlay project in-progress for the Trinity River basin. TSJ-BBEST bay and estuary Salinity-Ecology Workshops have been ongoing and are summarized in minutes contained in a separate report (EC-TES 2009).

Focal instream biological components, including overbank flows, flow pulses, baseflows and seasonality, have been evaluated using habitat requirements of focal species. A matrix of geographic occurrence has been developed for fish and mussel species (Appendix B). Based upon requirements of a select few focal fish species, overbank flows appear beneficial to spotted gar, flow pulses may impact fry of largemouth bass (high velocity) and pallid shiner (high turbidity), and baseflows are beneficial to a number of species that exhibit utilization patterns of shallow riffle habitats including freckled madtom, flathead catfish young of year and dusky darter. Subsistence flow levels may be informed intolerance of largemouth bass to salinity and intolerance of freshwater drum to high temperatures. Spawning of the seven focal fish species is generally between April and June; the largemouth bass spawn earlier, December through March. Despite indication that these flow components may impact or benefit focal species, no site-specific analysis has been discovered to support identification of quantitative flow values for priority locations.

Biology and freshwater fish assemblages have been assessed for a variety of purposes through time; management measures to improve the fisheries have not been recommended because of satisfactory conditions (TPWD 1986). The USGS evaluated biotic integrity at a number of sites throughout the basin on small and large streams. Six stream sites on the San Jacinto and one on the Trinity were identified as least-impacted and several sites with highly urbanized watersheds are more impacted (Moring 2001). Use of characteristics at the least-impacted sites could improve assessments in the future, but assignment of flow values based upon these findings is challenging.

The five priority gauges identified by the TSJ-BBEST are West Fork San Jacinto River near Conroe; Spring Creek near Spring; East Fork San Jacinto River near Cleveland; Buffalo Bayou at Piney Point and Brays Bayou at Houston. All locations show increase in annual minimum flows, the result of area development including effluent discharges and water management.

One sediment transport analysis is available for the West Fork San Jacinto River (Herrera 1999) that may be useful in future modeling or development of a fluvial sediment overlay (SAC 2009b).

Water quality information gathered near these locations included SWQM data and reports of water quality surveys leading to waste load allocations. Based upon inspection of the data, dissolved oxygen (DO) does not exhibit a discernible relationship with flow; additional analysis or modeling is necessary to develop relationships with flow, flow pulses, temperature or loading. Limited analysis was discovered to characterize sediment and nutrient loading to the bay.

This report represents a draft deliverable to the SB3 Science Advisory Committee (SAC) submitted for review. A presentation of these findings will occur at the September 9, 2009, SAC meeting in Austin, as well as at the September 10, 2009, TSJ-BBEST meeting in Austin. Comments on this draft will be received by the San Jacinto River Authority and Espey Consultants, Inc., until September 14, 2009. The final report will be issued September 21, 2009.

2.0 BACKGROUND

2.1 SCOPE OF WORK

This project aims to provide, in a short timeframe, a compilation of information to guide in development of ecological overlays which may be used by the Trinity-San Jacinto Bay-Basin Expert Science Team (TSJ-BBEST) in support of environmental flow analyses. The focus area of this work is the San Jacinto River (SJR) basin. This work may also be used as a first step in discussion of how ecological overlays may be approached as other basins begin the Senate Bill 3 (SB3) process.

Specific work items include summary of relationships developed and reported in works by others. Relationships of interest include those between flow and biological variables, geomorphologic parameters, water quality or nutrient/sediment loadings. The generic term "flow" encompasses a variety of concepts including river flow regime, flow velocity and freshwater inflow to the bay. The scope of work is provided as Appendix A.

Consultation with members of the TSJ-BBEST, with the Trinity River overlay team, with state agency staff involved in the Texas Instream Flow Program (TIFP) and other experts is a goal of this project. As a result of coordination with the TSJ-BBEST, work is focused on areas near priority gauges identified by the TSJ-BBEST Instream Flow subcommittee (Table 1 and Figure 2). A complete table of gauges in the SJR basin, with notation of beginning and end dates, is provided in Appendix E.

Table 1 – Priority Gages

Station ID	Name	Period of Record
08068000	W. Fork San Jacinto near Conroe, TX	(1926-28) 1939-2009
08068500	E. Fork San Jacinto near Cleveland, TX	1939-2009
08070000	Spring Creek near Spring, TX	1939-2009
08075000	Brays Bayou near at Houston, TX	1936-2009
08073700	Buffalo Bayou at Piney Point, TX	1963-2009

Relevant publications were discovered for this project by searching resources including the recently-developed San Jacinto River Instream Flow Literature Catalogue (TCEQ contract number 582-9-89819). The resulting reports were reviewed for pertinent information. Additional material was gathered through electronic data searches, and communicating with State agency staff involved with the Texas Instream Flow Program. Literature sources are cited where relevant in this report; a companion archive of relevant electronic reports is distributed with the final report.

2.2 BASIN SETTING

The San Jacinto River Basin (Figure 1 and Figure 2) comprises 3,962 total square miles spanning two distinct zones divided by Lake Houston. The watershed upstream of Lake Houston comprises 2,837 square miles and includes major subwatersheds of Spring Creek, West Fork SJR and East Fork SJR. The upper watershed is within the Piney Woods Ecoregion (Figure 3) and area geology is characterized as Pliocene or Miocene (Figure 4). Three priority gauges fall near the geological division between the Pliocene zone and more recent Quatenary zone (Figure 4).

The watershed downstream of Lake Houston comprises 1,125 square miles and includes Brays Bayou, Buffalo Bayou, White Oak Bayou and Greens Bayou as well as the lower reach of the San Jacinto River downstream of Lake Houston to Galveston Bay. The lower watershed is in the Gulf Coastal Prairie ecoregion and Quaternary geological zone. Both land use land cover (Figure 5 and Table 2) and soils

(Figure 6) characteristics of the upper watershed are more diverse than the largely urban and developed area in the lower watershed.

By comparison to the lower Trinity River basin, limited wetlands are exhibited in this basin (Figure 7). Some freshwater emergent wetlands are evident along the upper Cypress Creek and a narrow band of freshwater emergent and forested/shrub wetlands are evident along the Lake Creek corridor. Additional analysis of connectivity to determine what pulse or overbank flow values benefit inundation of these wetlands is recommended if flow guidelines are considered for these areas.

Table 2 - Land Use Land Cover distribution by sub-basin (Homer et al. 2004)

	Spring Creek	West Fork SJR	East Fork SJR	Lower-SJR
Water	0.5%	4.8%	0.5%	2.2%
Developed	24.8%	14.6%	10.9%	65.4%
Barren	0.5%	0.4%	0.1%	0.5%
Forest	23.6%	32.1%	44.0%	7.3%
Shrub/Grass	11.1%	13.5%	18.2%	4.1%
Agricultural	31.0%	20.0%	8.3%	13.3%
Wetlands	8.5%	14.6%	17.9%	7.1%
Total Area (sq. mi.)	755	1,080	1,002	1,125

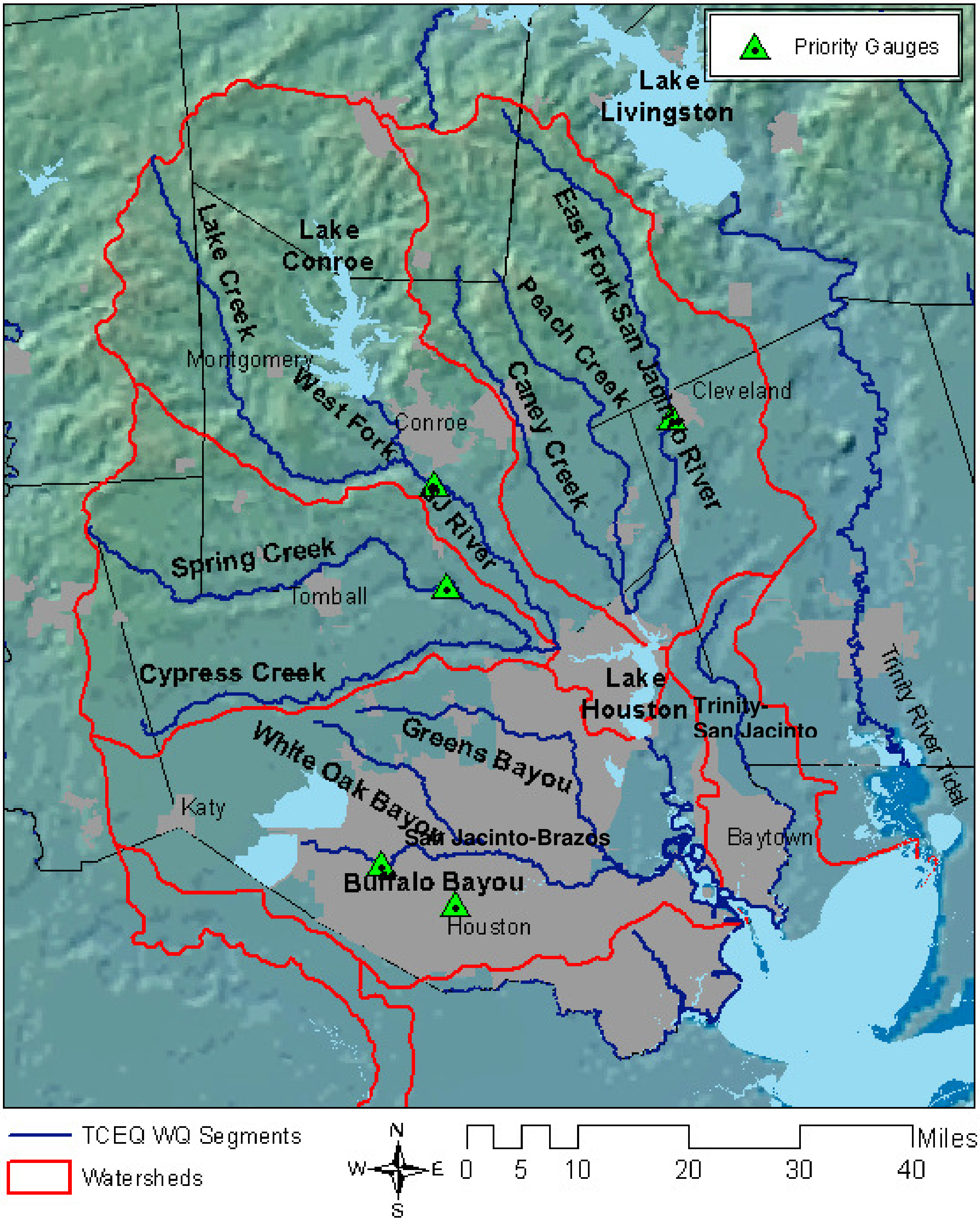

Figure 1 - San Jacinto River and Coastal Basins over terrain map

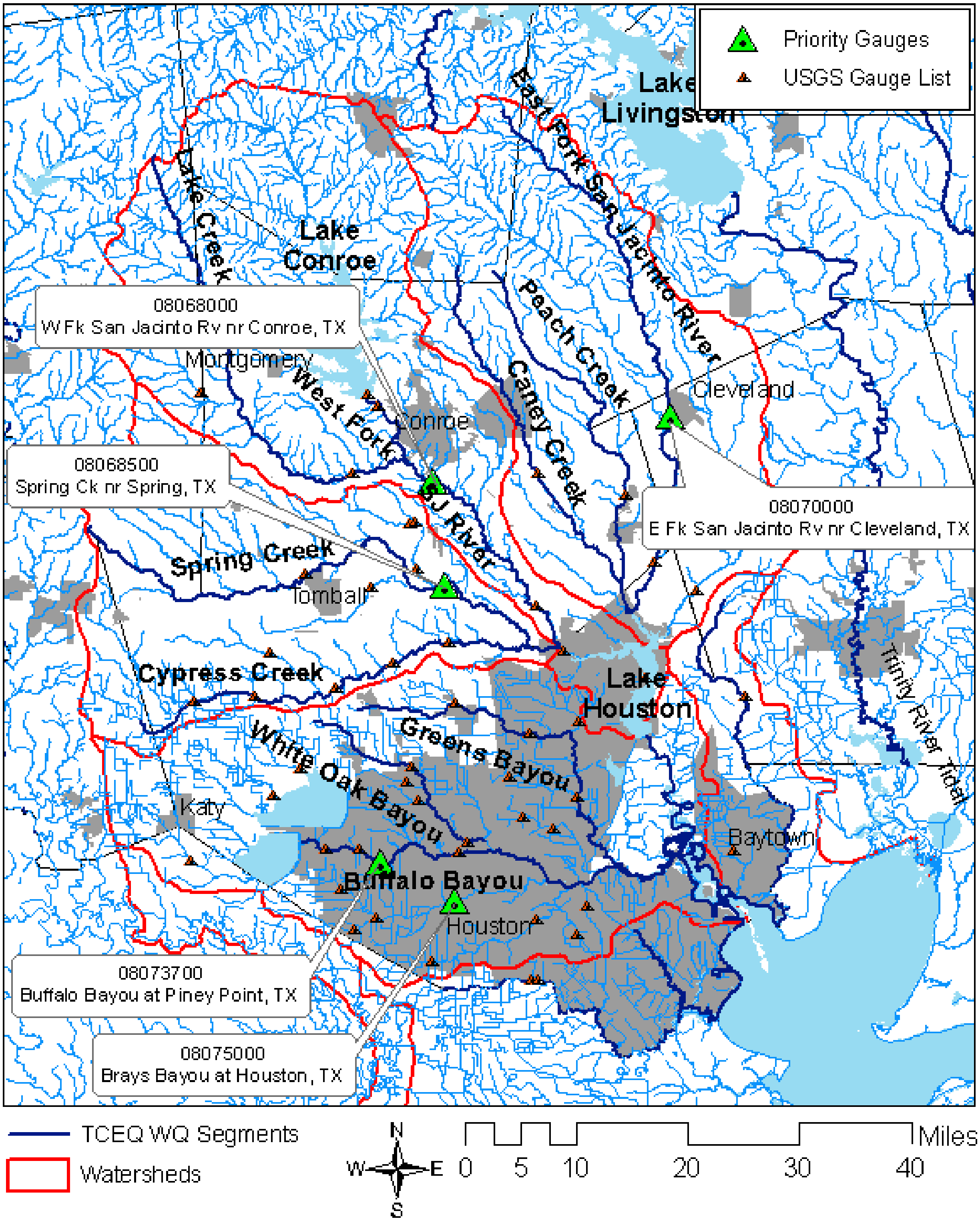

Figure 2 - Historical and current USGS gauges, BBEST Priority gauges emphasized, NHD stream lines shown

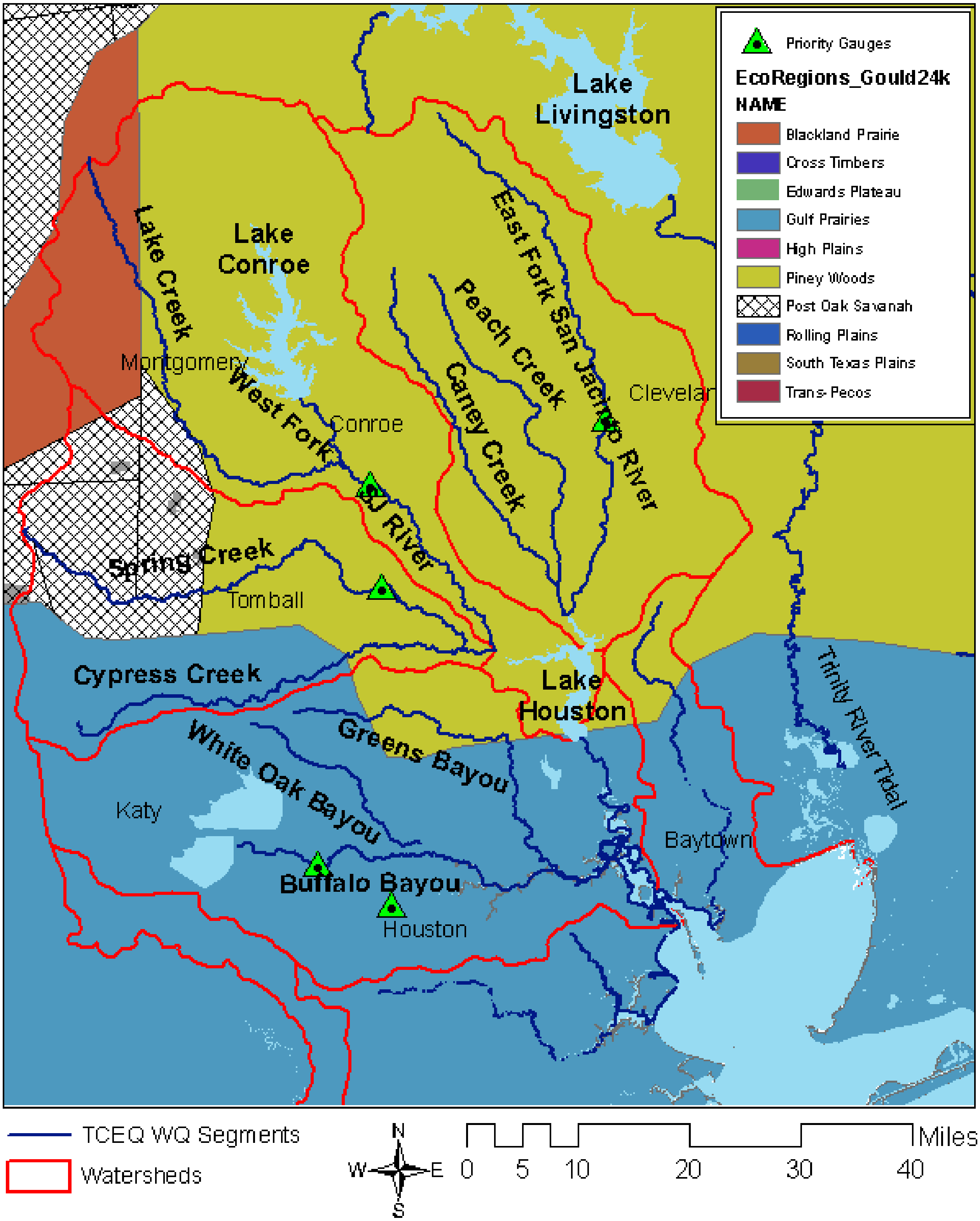

Figure 3 - Ecoregions (TPWD, Gould 24k)

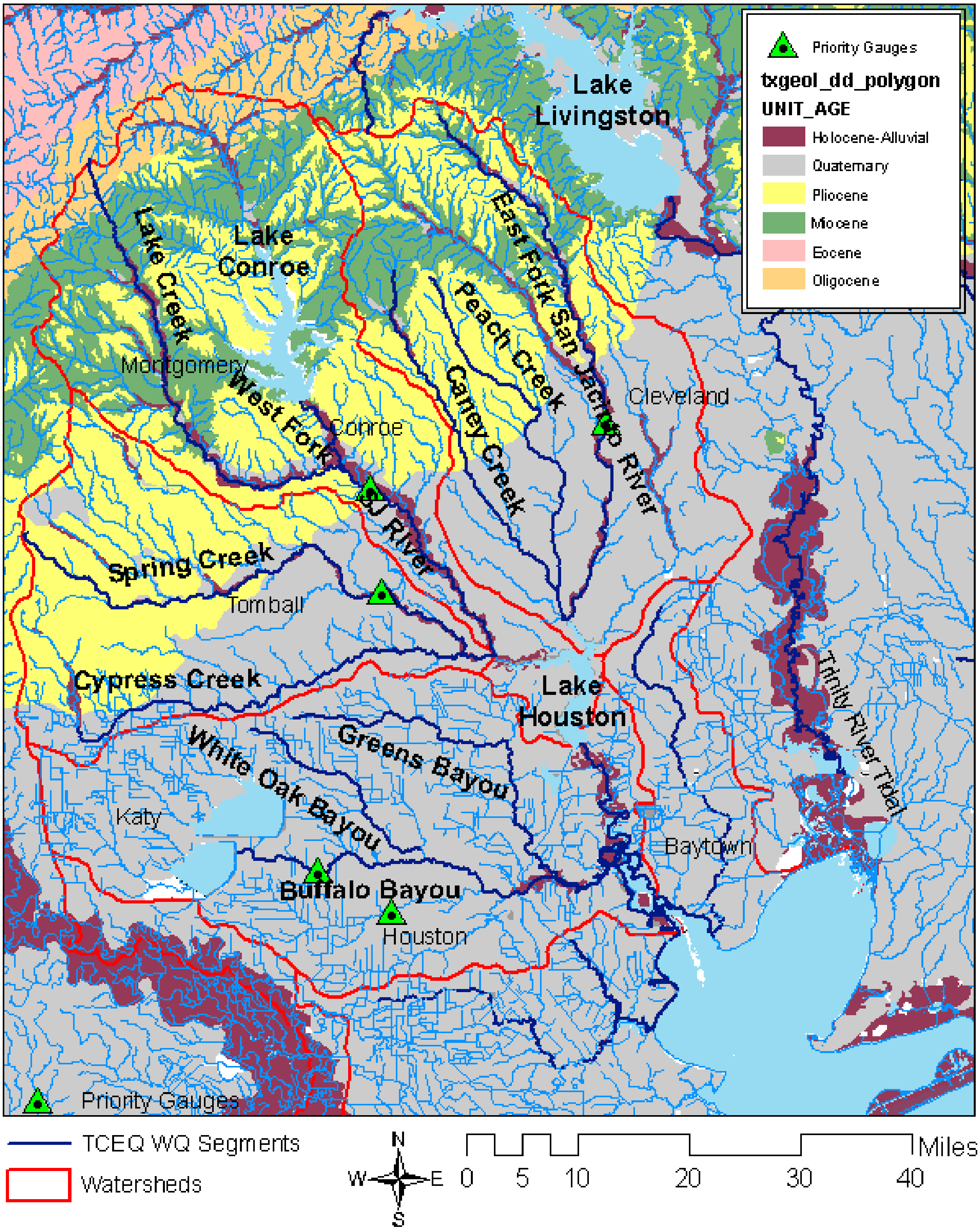

Figure 4 – Geology (USGS, GAT)

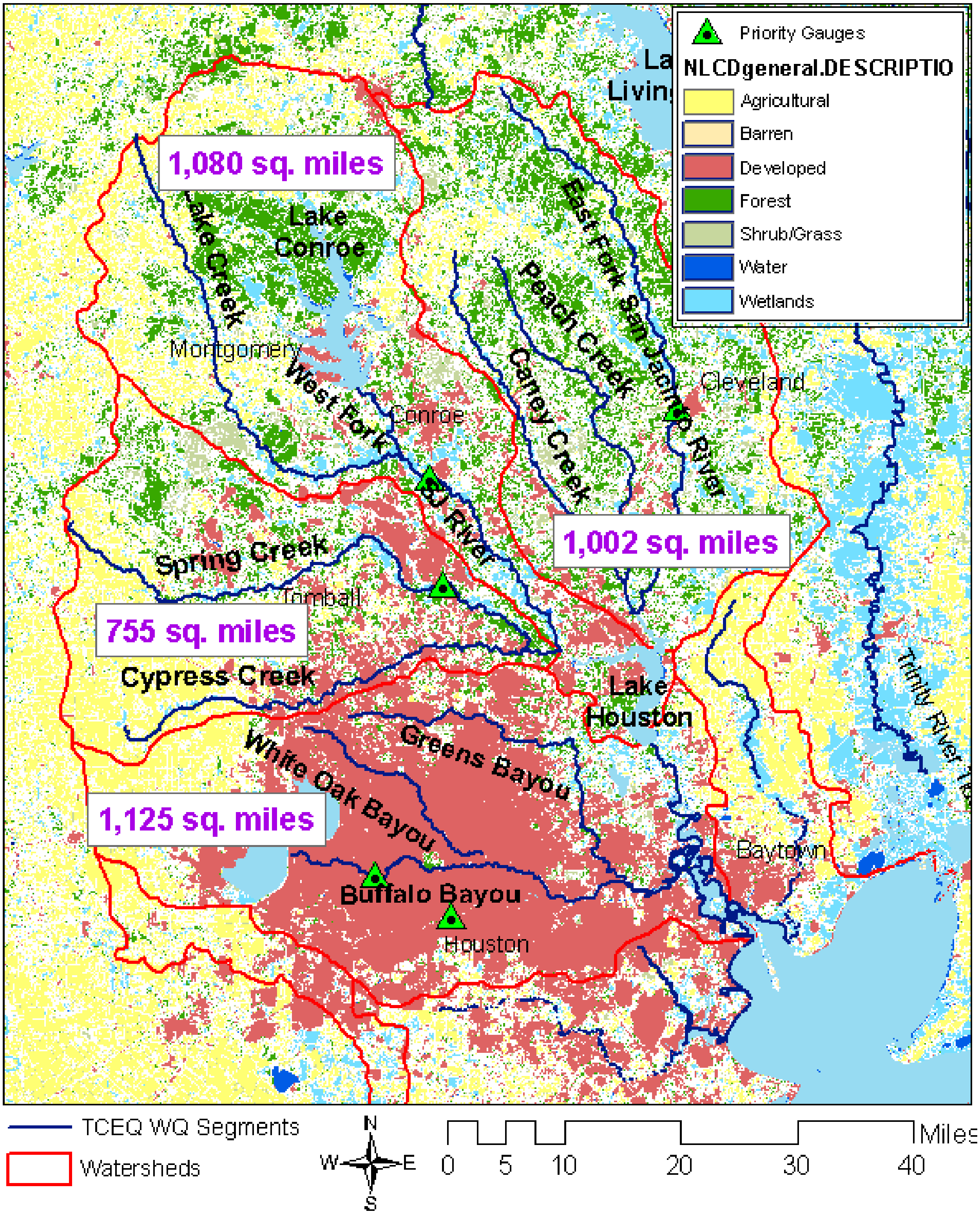

Figure 5 - Land Use Land Cover (NLCD 2001 – Homer et al. 2004)

Figure 6 - SSURGO soils areas (NRCS 2007)

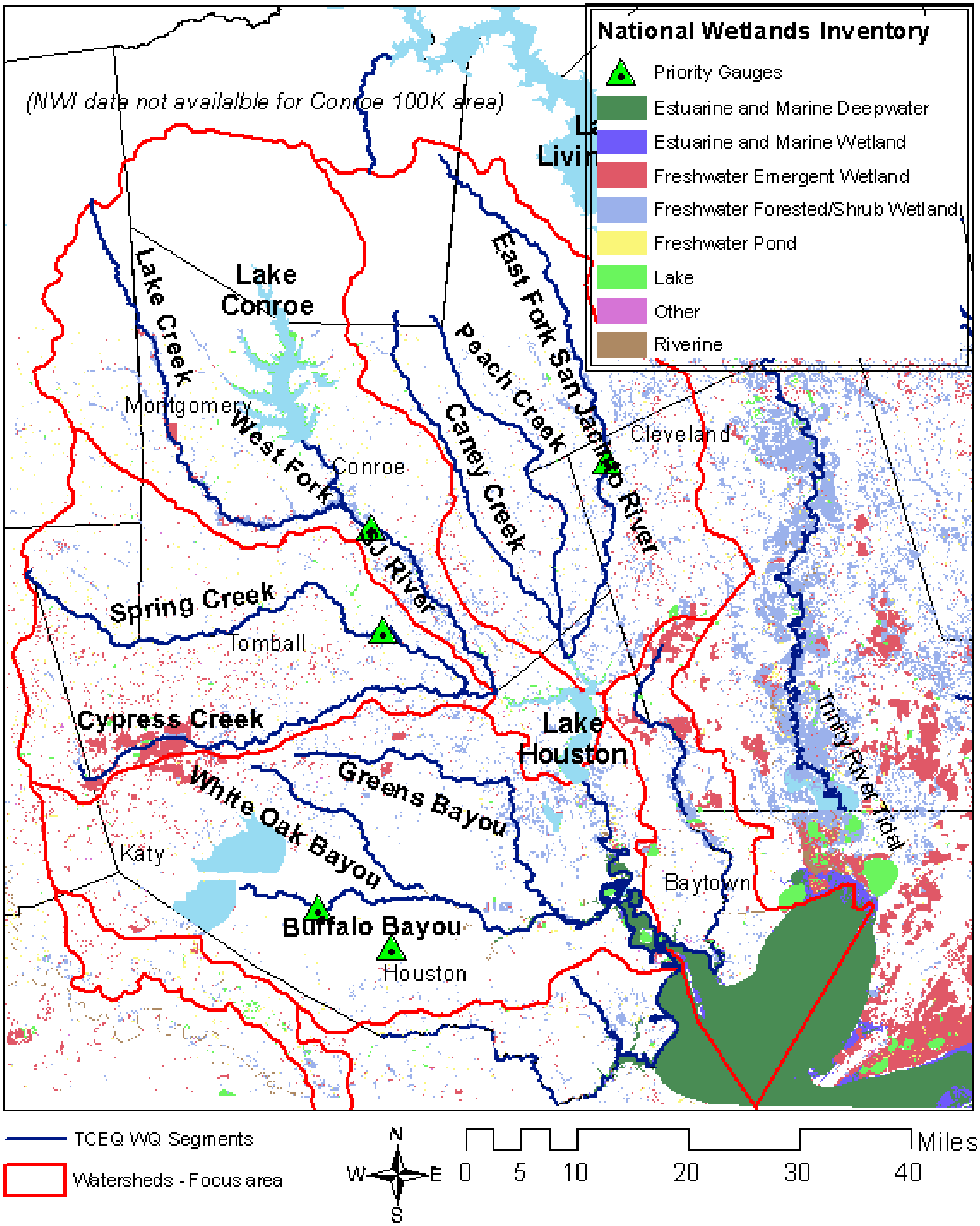

Figure 7 - National Wetlands Inventory (1992-94)

3.0 FOCAL FISH AND MUSSEL SPECIES AND FLOW COMPONENTS

Literature, data and expert opinion were used to generate fish and mussel occurrence matrices. The fish occurrence data includes a total of 117 species within 25 Families of fish. Mussel occurrence data reports a total of 3 Families of mussels with a total of 51 species plus one Macrobrachium shrimp. Spreadsheets summarizing occurrence include information from nine sources for fish and five sources for mussel data. The spreadsheets are provided electronically and contain occurrence data identified in this study. Some of the San Jacinto River Basin occurrence data include the actual number of specimens collected/observed, collection date, exact location (lat. and long.), water quality information and flow rate or velocity. Where available, this information is included. Other data sources identify relative abundance and others identify simple presence/absence. No effort has been made in this compilation effort to verify reported values using museum or voucher records. Information related to geographic distribution has been retained where possible. Condensed summary matrices (one each for fish and mussels) are provided in Appendix B.

The ultimate goal of this project is to develop ecological overlay information to support Senate Bill 3 environmental flow recommendations. The selected reports were reviewed for specific relationship information which included fish and mussel occurrences related to stream velocity, stream discharge, water quality, salinity, sediment loading, turbidity, etc. Where available, data specific to samples was incorporated as the "Relations" worksheet of the attached fish and mussel spreadsheet. Reference 3 (Moring et al. 1998) of this spreadsheet page contains site specific San Jacinto River Basin species, stream velocity, dissolved oxygen, and secchi disc data.

Concurrent with the development of the species occurrence lists, TPWD staff generated a TPWD Trinity – San Jacinto River Draft Focus Species List. In addition, the TPWD Rare and Endangered Species summaries were consulted for information related to the SJR basin. Limited review and comment has been provided by state agencies, university researchers, BBEST team members; additional information has been incorporated into a Modified TPWD Trinity-SJR Focus Species List (Appendix B), including incorporation of mussel information from Dr. Howells and Marsh May (TPWD) that includes data collected by Dr. Burlakova (formerly Stephen F. Austin University). Relevant species-specific information or characteristics for San Jacinto River basin species have been added to the list.

3.1.1 Focal freshwater fish species short list

A short list of focus species is here presented based upon information incorporated into the modified focal species list (Appendix B). Short list species are selected based on their occurrence in the SJR basin, tolerance limits, observed habitat requirements or other parameters discovered in the literature. Rationale is summarized below with information on how the species requirements can be related to flow. Two significant sources of information are (1) the Texas Freshwater Fishes website maintained by Dr. Tim Bonner at Texas State University (Hassan-Williams and Bonner 2009) and (2) the Fishes of Texas project overseen by Dr. Dean Hendrickson at University of Texas – Texas Natural History Collections (UT-TNHC 2009). Mapping and spatial distribution information derived from the UT-TNHC data is provisional and inclusion in this project report is subject to approval by UT staff. A map of all draft UT-TNHC data, divided into three time periods, is provided in Figure 8. Distribution of each short-list species is provided in Figure 9 through Figure 15. Additional spatial distribution information is provided in tabular form in Appendix C, based upon records contained in 10 literature and report references.

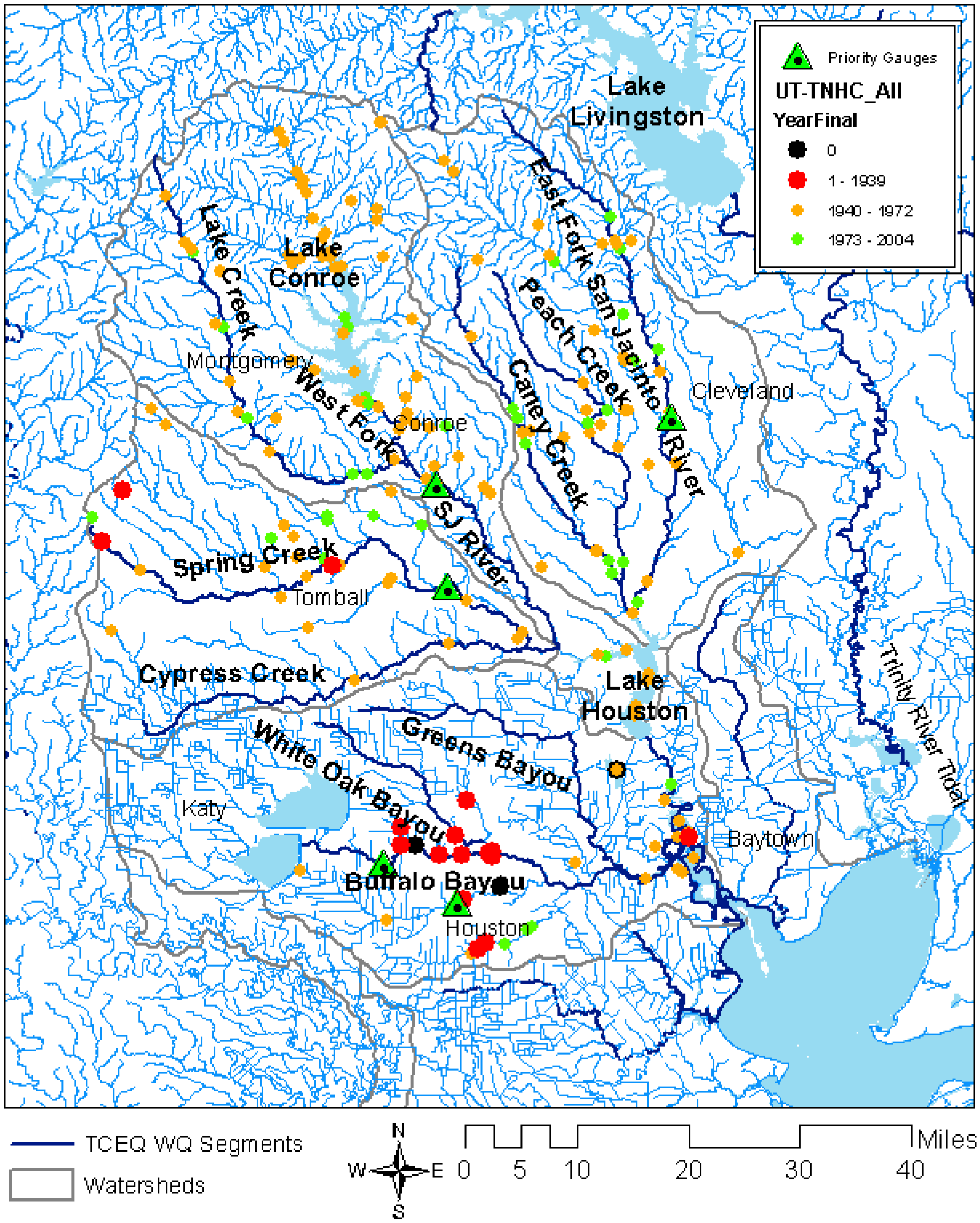

Figure 8 - DRAFT - UT-TNHC - Distribution of all records

Hybopsis amnis (pallid shiner)
- Limited recent occurrence data available
- Turbidity and siltation intolerance, adults <45 NTU; juveniles <85 NTU (Kwak 1991)
- Floodplain access is important for successful spawning or survival of young fish.
- Found in quiet waters over sand-silty bottoms, intolerant of heavy siltation and pollutants (Clemmer 1980).

Flow Component Relationship:

- Seasonality: In Texas, the data indicates May June spawning time. (Bonner)
- Flow Pulses: Potential that Turbidity tolerance may be affected by changes in pulse character

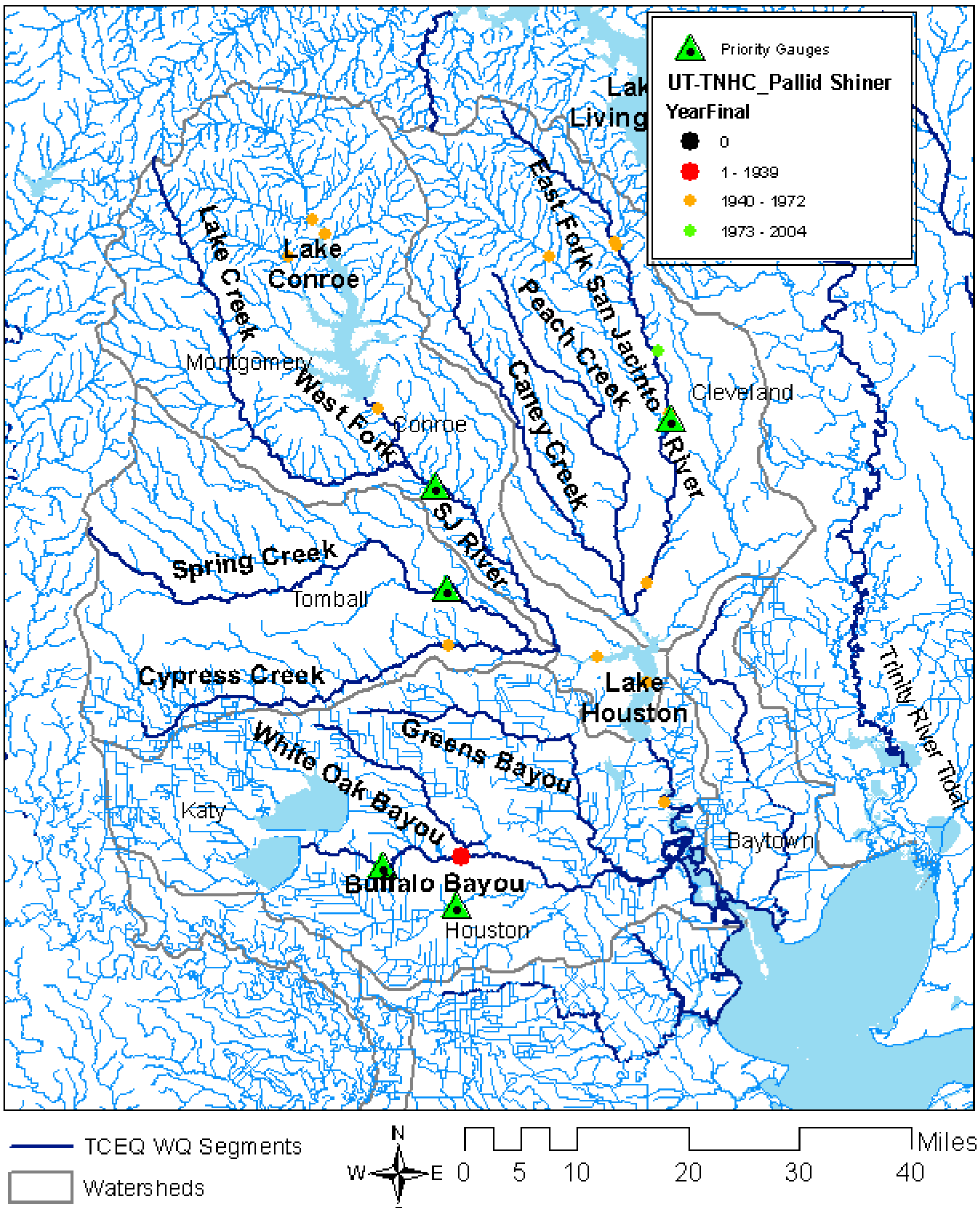

Figure 9 - DRAFT UT-THNC - Pallid shiner distribution

Noturus nocturnus (freckled madtom)
- Limited occurrence data available
- Fluvial specialist having a narrow range of habitat use.
- Inhabits clear to moderately turbid streams of medium to large size having permanent flow.
- Found in riffles over gravelly or rocky bottom (Rhode 1980; Urges 2003)

Flow Component Relationship:
- Seasonality: Spawning during summer months in southern Mississippi (Clark 1978)
- Baseflows: Maintenance of gravelly riffles

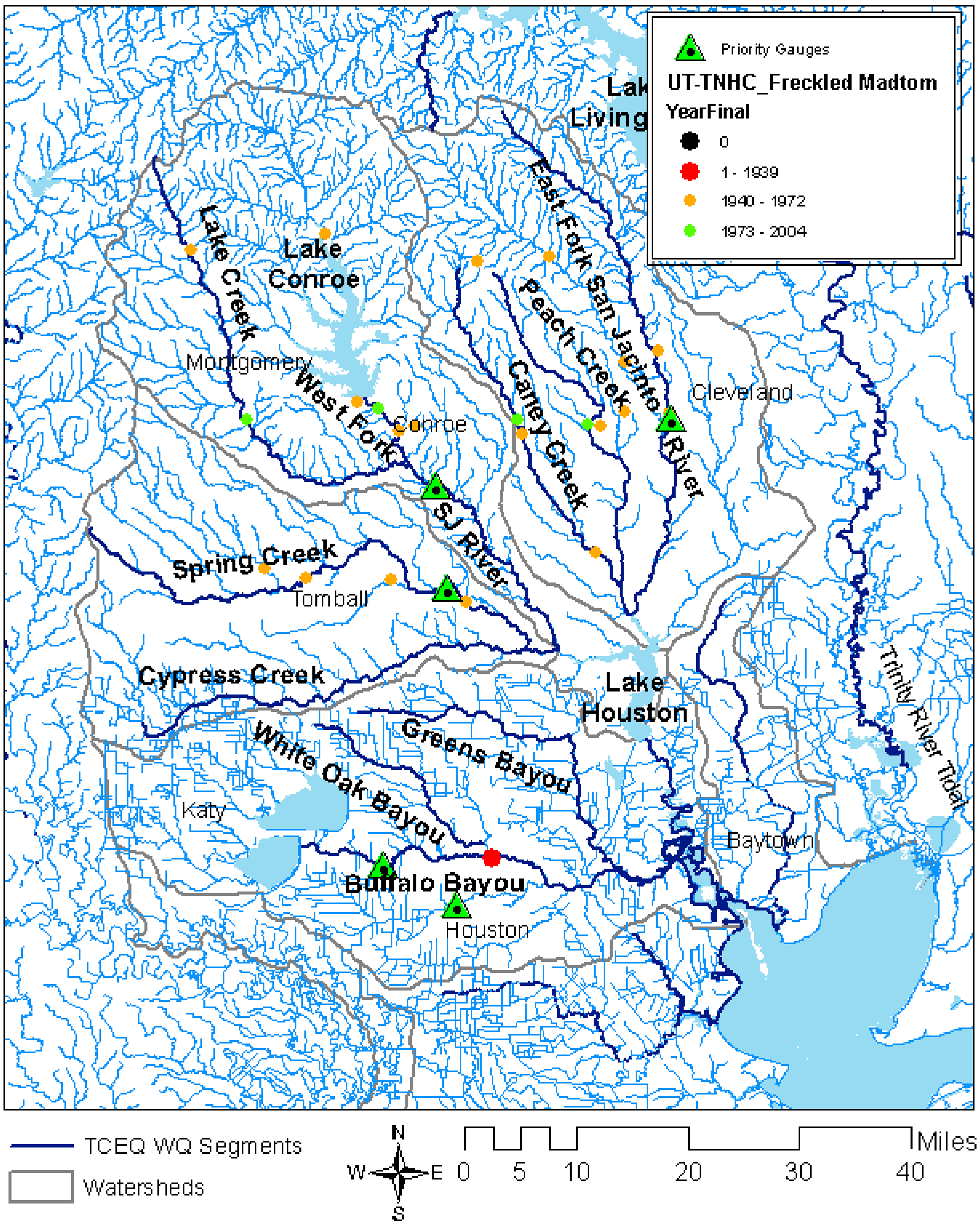

Figure 10 - DRAFT UT-TNHC - Freckled madtom distribution

Pylodictis olivaris (flathead catfish)
- Limited occurrence data available; museum vouchers pre-1973; upper watersheds.
- Host to glochidia of several species of mussels found in the SJR basin
- Young-of-the-year live in rubble bottomed riffles until between 2 and 4 inches in length (Minkley and Deacon 1959)

Flow Component Relationship:

Seasonality: Spawning season in Texas is late June and July (Hubbs et al. 1953; Munger and Deacon 1959)

Baseflows: Maintain rubble-bottom riffles in July through Fall.

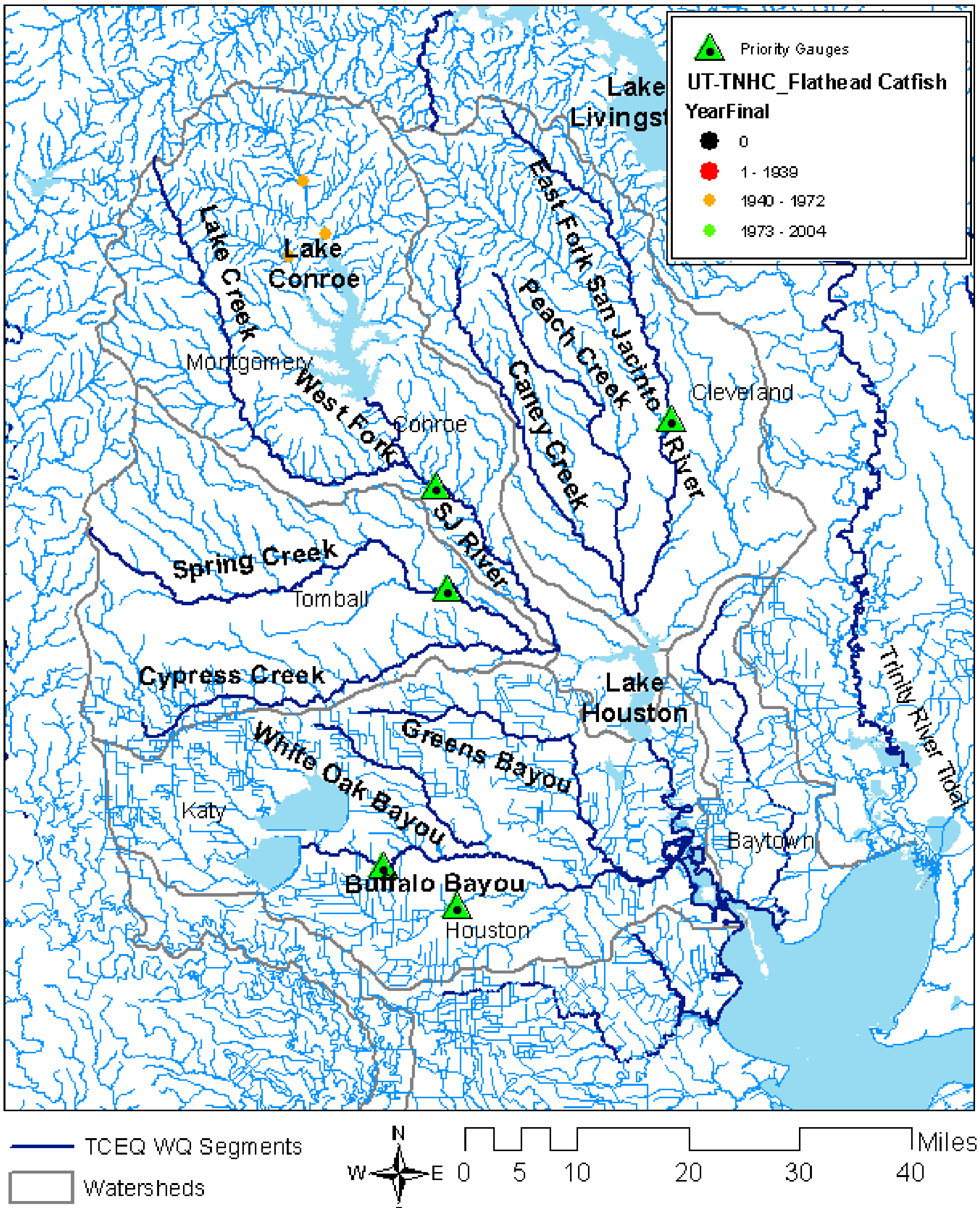

Figure 11 - DRAFT UT-TNHC - Flathead Catfish distribution

Aplodinotus grunniens (freshwater drum)
- Occurrence data available, observed in EFSJR and WFSJR
- Individuals have been observed to become distressed when water temperatures exceed 25.6°C, and when dissolved oxygen concentrations remain low over an extended period (Priegel 1967b).

Flow Component Relationship:

- Seasonality: Spawning season during May and June
- Baseflows: Maintain summer temperatures and DO

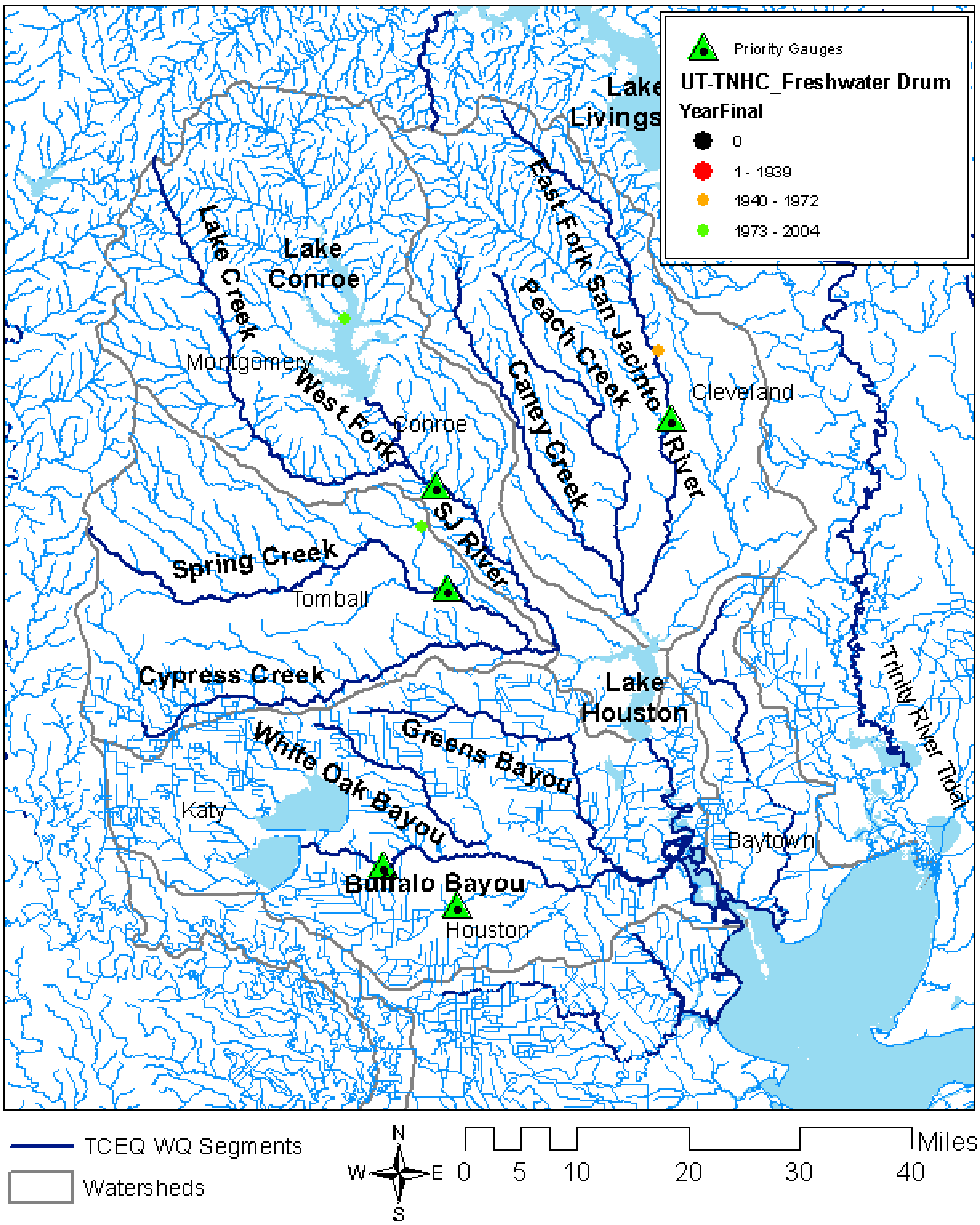

Figure 12 - DRAFT UT-TNHC – Freshwater drum distribution

Micropterus salmoides (largemouth bass)
- Occurrence data available, widespread
- Fry cannot survive for extended periods in salinities >6 ppt and embryo >10.5ppt (Stuber et al. 1982)
- Optimal current velocities for fry are < 4 cm/sec (Hardin and Bovee 1978), and fry cannot tolerate current velocities > 27 cm/sec (Macleod 1967; Laurence 1972).

Flow Component Relationship:

- Seasonality: Spawning season late winter to early spring with water temperatures 16-22` C
- Baseflows: Maintain salinity above 6 through summer for fry.

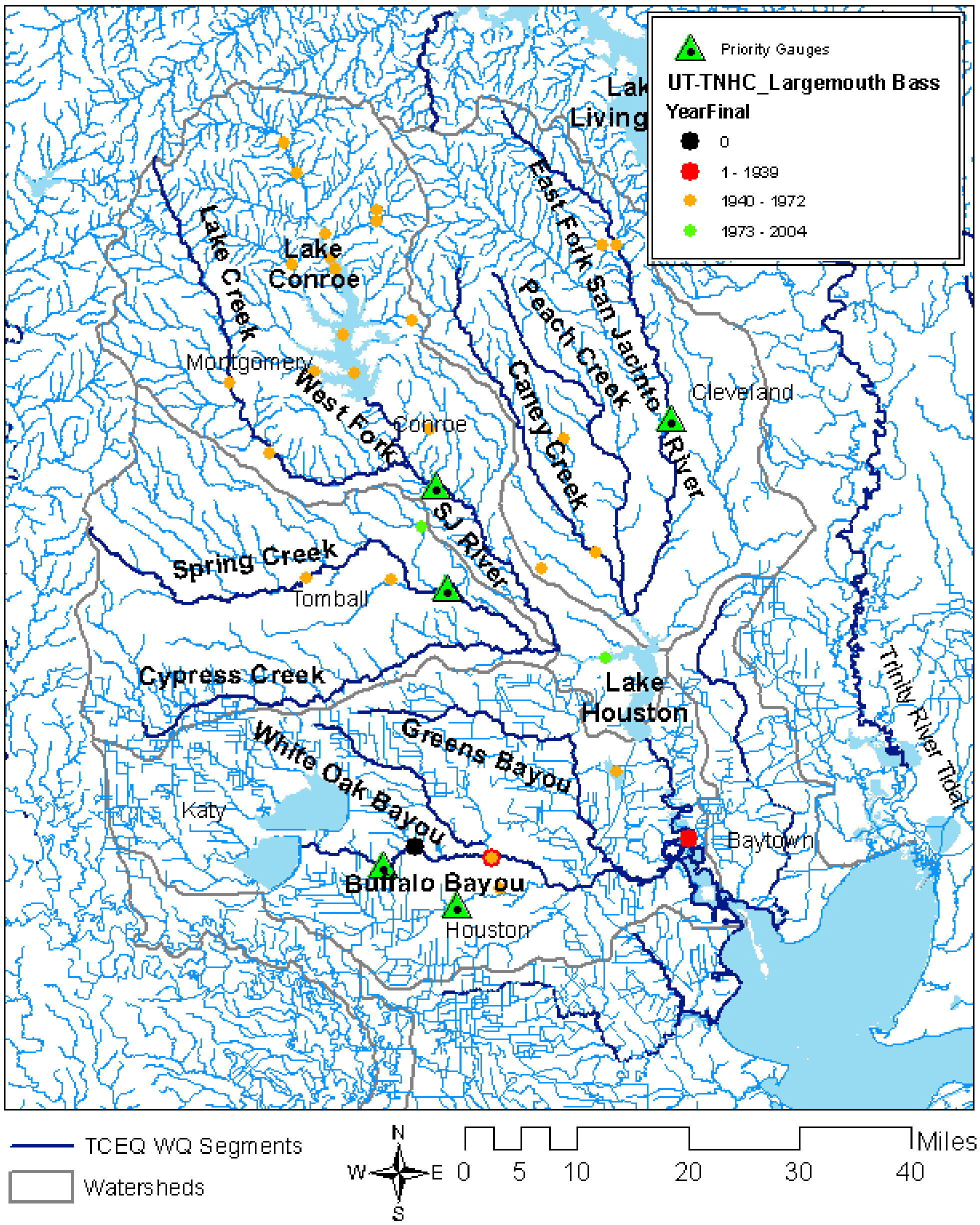

Figure 13 - DRAFT UT-TNHC - Largemouth bass distribution

Percina sciera (dusky darter)
- Occurrence data available, observed in EFSJR and WFSJR
- Herbert and Gelwick (2003) found this fluvial specialist associated with the free-flowing East Fork SJR
- Most common over gravel or gravel and sand raceways; occupying midwater stratum; often found in current in accumulations of branches and leaves (Page and Smith 1970; Page 1980; Page 1983).
- Rock and gravel spawners (Page and Smith 1970; Simon 1999).

Flow Component Relationship:

- Seasonality: Spawning season in the Colorado River near Austin is from February through June over gravelly substrates (Hubbs 1961).
- Baseflows: Spawn in gravel riffles at depths of 30-90 cm (Page and Smith 1970; Page 1983). Spawning and mesohabitat requirements indicate a preference for shallow riffles.

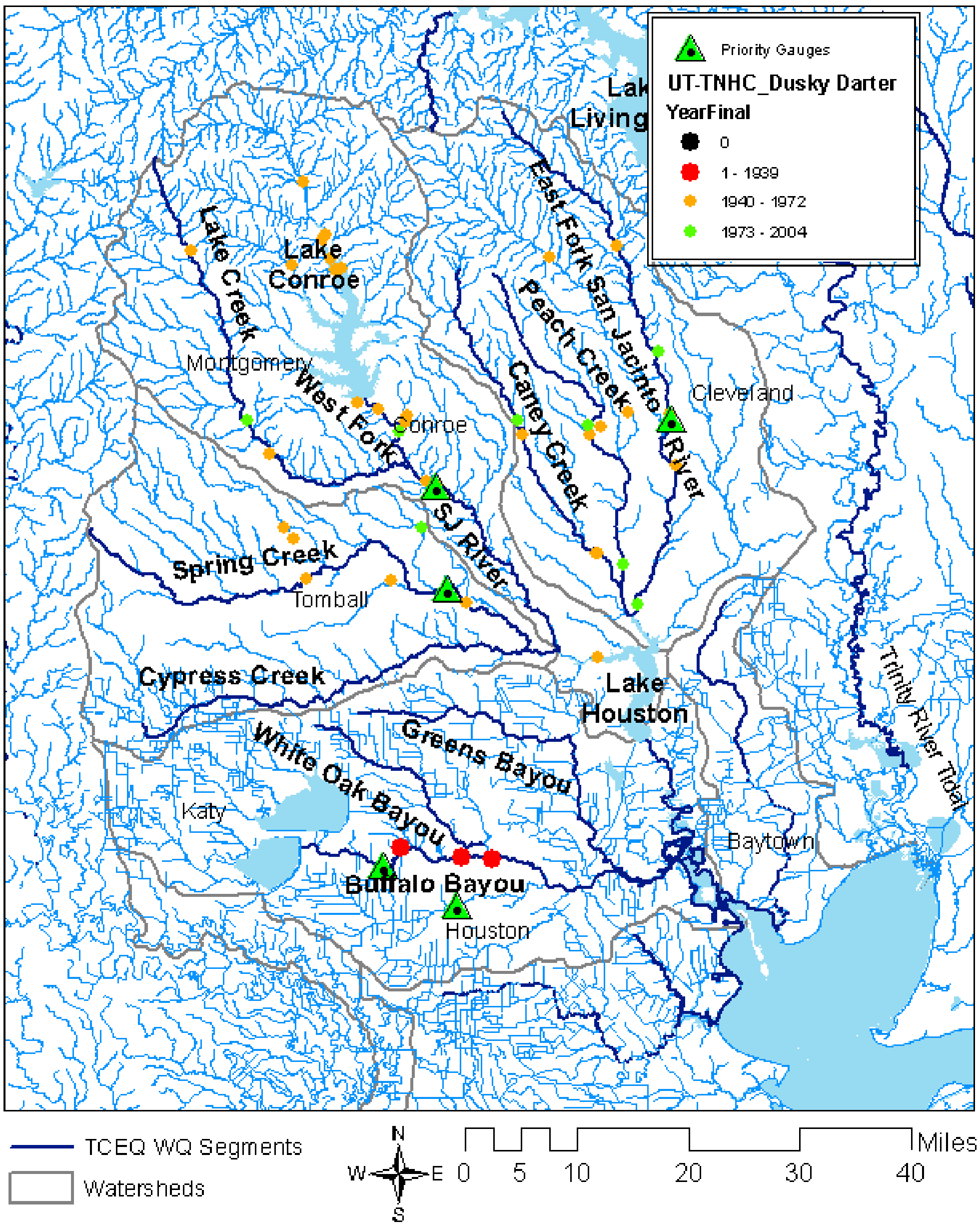

Figure 14 - DRAFT UT-TNHC - Dusky darter distribution

Lepisosteus oculatus (spotted gar)
- Robertson et al 2008, and Winemiller et al 2000, found Spotted gar to be more abundant in proximity to floodplain habitats (oxbows).
- The nature of oxbow formation and succession requires sufficient flow to connect the river with the floodplain habitats to allow access of spotted gar to these habitats.
- Spotted gars prefer backwater/floodplain habitats for reproduction. They spawn in submerged living/dead plants (Lee et al 1980), and prefer the slack waters found in backwater and floodplain habitats.

Flow Component Relationship:

- Seasonality: Literature indicates spring spawning in quiet, weedy backwaters.
- Flow Pulses: Spring flow pulses to allow access to backwaters

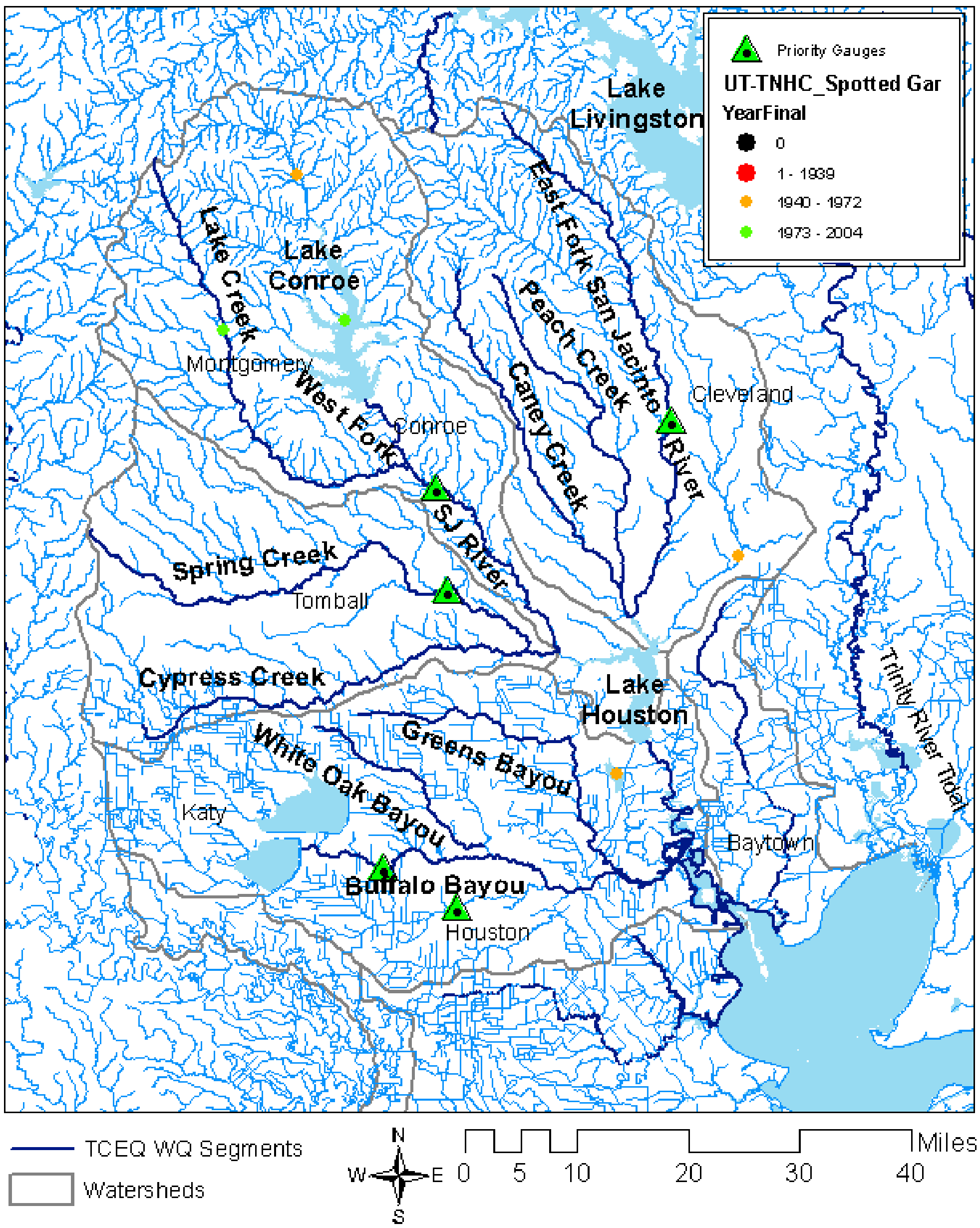

Figure 15 - DRAFT UT-TNHC - Spotted Gar distribution

3.1.2 Focal mussel and invertebrate species short list

Mussel and invertebrate species identified by TPWD and by USFWS are provided below. Spatial distribution information is limited and is provided in tabular form in Appendix B.

Fusconaia askewi (Texas pigtoe)
- found in sand and gravel substrate (Ansley 1998)

Tritogonia verruscosa (Pistolgrip)
- typical of oxygen rich riffles and runs

Lampsilis teres (Yellow sandshell)
- intolerant of drought and dewatering; actively follow flood flow onto land, then retreat back as flows return to channel
- found in sand and gravel substrate (Ansley 1998)
- glochidia hosts include green sunfish, warmouth, and largemouth bass

Quadrula apiculata (Southern mapleleaf)
- generalist but sensitive to dewatering (USFWS, Cherrish Stevens/Dr. Howells, personal communication 2009).
- found in sand and gravel substrate (Ansley 1998)

Macrobrachium ohione (Ohio shrimp)
– inhabits main stem rivers; migratory species

3.2 INSTREAM FLOW COMPONENTS

Statistical approaches to describe instream flow regime using historical gauge records have been summarized (SAC 2009a) and subsequently discussed throughout this evolving SB3 process. Among participants in the process, a degree of uncertainty exists on the meaning of flow components, and a greater degree of uncertainty exists on the use or application of flow regime statistics in development of environmental flow guidelines.

A useful set of initial steps in the flow guideline development process may be for each group to concisely and clearly identify (step 1) which flow components are relevant to each priority stream segment; (step 2) levels of data, analyses and/or expert judgment acceptable in characterization in each flow component; (step 3) clear purposes or goals for each flow component; and (step 4) an indication of when and/or how often each flow component is relevant.

A wide range of purposes, ecological roles and evaluation approaches are proposed for four flow components (SAC 2009c-Table 1, SAC 2009a). Description excerpts from the Hydrologic Methods document (SAC 2009a) for each regime component are provided in Figure 16 (organized per the graphic matrix framework from SAC 2009a).

Overbank Flows	Overbank flows are infrequent, high magnitude flow events that produce water levels that exceed channel banks and result in water entering the floodplain. A primary objective is to maintain riparian areas associated with riverine systems, eg, transport sediments and nutrients to riparian arease, recharge floodplain aquifers, and provide suitable conditions for seedlings.											
High Flow Pulses	High flow pulses are short duration, high magnitude (but still within channel) flow events that occur during or immediately following reainfall events. They serve to maintain important physical habitat features and connectivity along a stream channel.											
Base Flows (cfs)	Base flows represent the range of "average" or "normal" flow conditions in the absense of significant precipitation or runoff events. Base flows provide instream habitat conditions needed to maintain the diversity of biological communities in streams and rivers.											
Subsistence Flows (cfs)	Subsistence flows are low flows that occur during times of drought or under very dry conditions											
	Dec	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**
	Winter			**Spring**			**Summer**					

Figure 16 – SAC 2009a, NRC 2005 and TIFP 2008 descriptions of flow components

3.2.1 San Jacinto River Basin flow components

Only limited quantitative data or analysis was discovered to identify appropriate instream flow values on the basis of fish or mussel habitat utilization. The data and analyses discovered and evaluated to date are lacking sufficient detail to characterize specific flow rates or flow ranges that provide specific habitat conditions. In addition, quantitative measures defining bounds of habitat conditions (e.g., range of suitable velocities) are not quantified for all species and/or guilds, so consideration of the inter-relation of habitat suitability amongst the full population is not able to be evaluated. Finally, relationships are not available to characterize how habitat conditions change with changing flow. All of these factors should be evaluated quantitatively in the future to increase confidence in any flow guideline or recommendation.

Given the limitations noted above, evaluation of focal species provides only limited information suitable for informing development of flow guidelines. Some focal species have life cycle or habitat utilization characteristics that speak to instream flow components (Table 3). Given a wide range of turbidity in the San Jacinto basin (where limited data is available in the SWQM database) from zero to 200 NTU with 65% of records exceeding 45 NTU, turbidity needs of the pallid shiner require additional basin-specific study. Similarly, temperature needs of the freshwater drum require basin-specific studies; that 33% of temperature measurements near priority San Jacinto basin priority gauges are above 25.6 degrees C.

A potential basin-specific purpose matrix for watercourses in the San Jacinto River basin (Figure 17) is presented with goals (step 3) and timing (step 4) of flow components based upon the focal fish species. With additional data or analysis, an individual matrix could be developed for each priority reach (step 1) and specific flow rates or ranges could be developed to identify critical thresholds.

Potential flow components should be evaluated by the TSJ-BBEST in consideration of the level of quantitative data available to support each flow component (step 2).

Table 3 – Potential flow components and focal species

<u>Flow Components</u>

Overbank flows

Spotted gar – spring overbank habitats may be beneficial for spawning

Flow pulses

Pallid shiner – turbidity intolerance >45 NTU (adults) and >85 NTU (juveniles)

Largemouth bass – fry are intolerant to velocity >27cm/s

Base flows

Freckled madtom – habitat utilization is largely gravelly riffles

Flathead catfish – young of year require rubble-bottom riffles July – Fall

Dusky darter – spawn over gravel riffles 30-90cm deep February through June

Subsistence flows

Freshwater drum – intolerant of temp. >25.6`C and extended periods of low DO

Largemouth bass – salinity intolerant > 12ppt

<u>Seasonality</u>

Maintenance of spawning habitats important between **April** and **June** for most species.

Bass spawn earlier – late winter to early spring at temperatures between 16 and 22`C

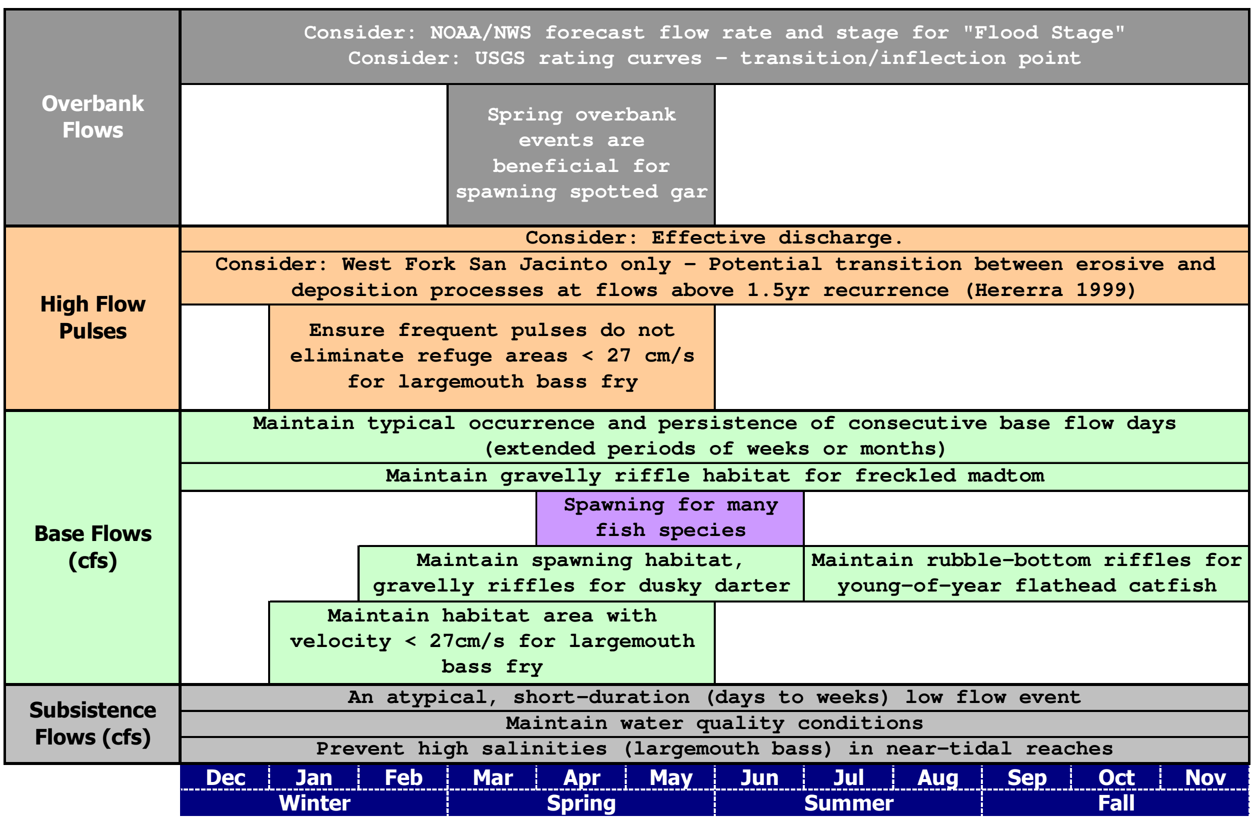

Figure 17 – San Jacinto River - potential flow component purpose matrix, based upon focal species

4.0 OVERLAY INFORMATION

This section presents a concise review of information within the San Jacinto River basin related to ecological condition, hydrology, water quality, physical processes and nutrient/sediment loading to the bay.

4.1 BIOLOGY

Three companion reports discovered describe data collection and site characterization leading to a waste load allocation study for the West Fork San Jacinto River between Lake Conroe and the headwaters of Lake Houston (TWC 1986). Stream substrate was fine sand throughout the reach and flow steadily increases downstream as a result of significant effluent discharges (TDWR 1981, Twidwell 1983). Stream velocities ranged from 0.5 feet per second (fps) in the upper reaches to 1 fps in the middle reaches under normal flow conditions throughout the reach with flow ranging from 7 cfs to 100 cfs (TDWR 1981). Similar velocity patterns (0.34 fps to 0.45 fps) were observed for lower flow conditions (7 cfs to 47 cfs) during a later study (Twidwell 1983). Macrobenthic data indicated little utilization of predominantly sandy substrate conditions; however, areas with gravelly riffles suitable for sampling macrobenthos indicated high diversity indicative of clean water conditions during December 1979 (TDWR 1981).

During 1984, the West Fork San Jacinto River downstream of Lake Conroe to the headwaters of Lake Houston were surveyed and assessed for water quality, fish habitat, fish communities, recreational fishing and harvest. Changes to management practices for the period 1985-1989 were not recommended because no pollution problems were found; fish habitat appeared to be adequate for the existing resource; and fish community appeared to be in relatively good condition (TPWD 1986). The total species collected in this reach was 48, whereas a study completed in 1967-68 that included this reach and smaller tributaries collected 59 species of fish (TPWD 1986).

The San Jacinto River from Lake Houston downstream to the Houston Ship channel was sampled for the period during February 1971 and August 1971, following a period where no releases had been made from Lake Houston since November 1970 (TPWD 1972). Freshwater flow consisted of small amounts from dam seepage and from tributary Gum Gully. Low DO (1.2 – 4 mg/L) was observed near the confluence with the ship channel during February 1971. Low DO (1.2 mg/L) and high chlorides (185 mg/L) were observed in August associated with a fish kill at Station 3 near the Houston Ship Channel. All other areas indicated conditions suitable for the fish population (TPWD 1972).

Descriptions from 1997-1998 field studies throughout the basin characterize the water courses as meandering channels with common riffles/pool near bends and runs in straight sections (Moring 2001). Velocity, depth, substrate type and distribution data was measured in the field during the same study. Based upon a multivariate structural and riparian, channel and environmental (RCE) indices and biotic indices developed from field data, seven least-impacted reference reaches were identified: Big Creek (Trinity River basin tributary with similar characteristics to SJR basin watercourses), Branch Creek, three reaches on the East Fork San Jacinto River, Luce Bayou and Caney Creek near Willis (Moring 2001) (Figure 19).

Bayou reaches with urbanized watersheds and little riparian or forest cover exhibited lower (less desirable) stream-habitat integrity and biotic indices (Moring et al. 2001). A statistically significant multiple regression equation was developed ($r = 0.69$, $F(3,27)=8.04$, $p=0.0006$) to relate population density, percent of forest land use and two index measures (Figure 18).

$$\bar{Y}\ (\text{biological integrity}) = 5.73 + 0.065\ (\text{RCE maximum}) + 6.32\ (\text{percent forest land use}) - 0.002\ (\text{people per square mile})$$

Figure 18 - Multiple regression predictor of biotic integrity (Moring et al. 2001)

DO was measured May 17-July 18, 2000 and found to be low (median 3.83 mg/L) on the Spring Creek 303D listed site (USGS 2002) but not low at the reference sites. The biological integrity score (based upon benthic macroinvertebrate collections) at the Spring Creek site (15) was above median (14) compared to other reference sites; in the earlier study (Moring 2001) the score was 17 at both sites potentially reflecting seasonal or annual variability in abundance. The number of fish species collected at the site (12) was above-median (16). The and RCE indices were not much lower at Spring Creek site compared to other reference sites in the basin with much higher DO.

In summary, the ecology of the San Jacinto River basin upstream of Lake Houston appears to be in good condition. Some areas (e.g., Cypress Creek) may be experiencing impacts by development, management or effluent flows as exhibited in DO, lead and/or bacteria measurements, but assessments of ecological condition indicate few, if any, long-term problems. Discovery of more detailed, more recent studies may provide better information.

Information discovered to assess the ecological condition indicated more-impacted watercourses in the lower San Jacinto River basin, including the below-Lake Houston reach of the San Jacinto River and the Bayou watercourses in highly developed metropolitan areas within and surrounding the City of Houston. Buffalo Bayou, White Oak Bayou, Greens Bayou and Cypress Creek exhibited relatively lower ecological condition than upper watershed watercourses that are less impacted.

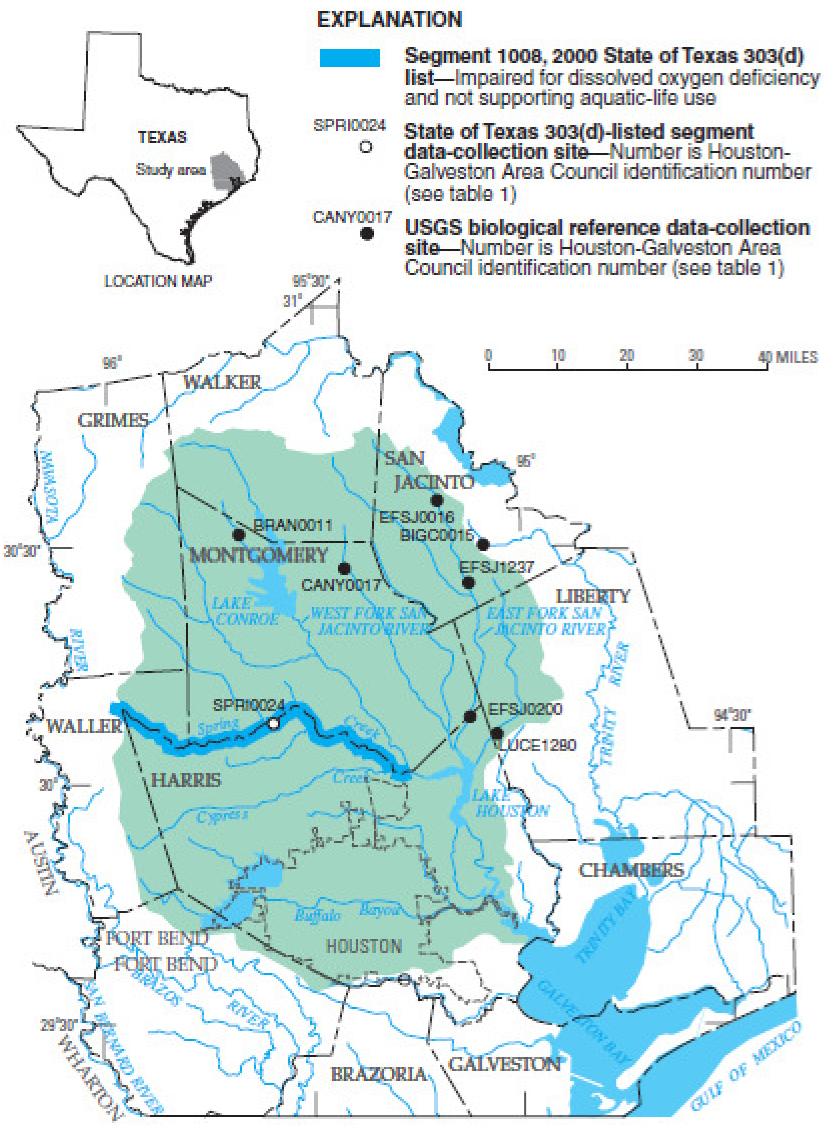

Figure 1. San Jacinto River Basin and data-collection sites.

Figure 19 - Least-impacted reference sites and listed Spring Creek site (USGS 2002)

4.2 HYDROLOGY AND HYDRAULICS

A detailed hydrological analysis for priority gauges in the Trinity and San Jacinto Rivers watershed is examined in (Crespo 2009); no review of that coincident work has been made in this project.

At priority gauges, 7Q2 from TCEQ (TCEQ 2009) are provided in Table 4. While these values are typically used for purposes associated with water quality permitting, they are, by definition hydrological statistics, indicative of the seven-day low flow event with recurrence interval of two years based upon the period analyzed and are useful for comparing to historical 7-day minimum flows.

Table 4 - TCEQ 7Q2 values for SJR basin gauges

Segment	Site Code	Site Name	Start Year	End Year	7Q2 (ft3/s)
902	08067500	Cedar Bayou nr Crosby, TX	1972	1996	0.3
1003	08070200	E Fk San Jacinto Rv nr New Caney, TX	1984	1996	22.6
1003	**08070000**	**E Fk San Jacinto Rv nr Cleveland, TX**	**1973**	**1996**	**18.2**
1004	08068090	W Fk San Jacinto Rv abv Lk Houston nr Porter, TX	1984	1996	26.6
1004	**08068000**	**W Fk San Jacinto Rv nr Conroe, TX**	**1974**	**1996**	**20.3**
1004	08067650	W Fk San Jacinto Rv bl Lk Conroe nr Conroe, TX	1975	1989	0.1*
1004	08067610	Lk Conroe Outflow Weir nr Conroe, TX	1974	1989	0.1*
1008	**08068500**	**Spring Ck nr Spring, TX**	**1975**	**1996**	**15.4**
1009	08069000	Cypress Ck nr Westfield, TX	1979	1996	17.6
1009	08068800	Cypress Ck at Grant Rd nr Cypress, TX	1983	1996	1.2
1009	08068740	Cypress Ck at House-Hahl Rd nr Cypress, TX	1976	1996	0.2
1009	08068720	Cypress Ck at Katy-Hockley Rd nr Hockley, TX	1976	1996	0.1*
1010	08070500	Caney Ck nr Splendora, TX	1973	1996	14.2
1011	08071000	Peach Ck at Splendora, TX	1960	1977	7.2
1014	08074000	Buffalo Bayou at Houston, TX	1962	1975	25.4
1014	**08073700**	**Buffalo Bayou at Piney Point, TX**	**1985**	**1996**	**50.6**
1014	08073600	Buffalo Bayou at W Belt Dr, Houston, TX	1980	1996	43.3
1014	08073500	Buffalo Bayou nr Addicks, TX	1980	1996	23
1015	08067900	Lake Ck nr Conroe, TX	1969	1989	2.8
1016	08076000	Greens Bayou nr Houston, TX	1980	1996	20.7
1016	08075900	Greens Bayou nr US Hwy 75 nr Houston, TX	1981	1996	11.8
1017	08074500	Whiteoak Bayou at Houston, TX	1980	1996	29.1
1102	08077000	Clear Ck nr Pearland, TX	1963	1992	0.5
1108	08078000	Chocolate Bayou nr Alvin, TX	1966	1996	1.5

Using all available gauge records for the entire period of record, the 7-consecutive-day minimum flow (Min 7Q) for each year is depicted at each priority gauge. Minimum annual seven-consecutive-day (Min7Q) flows in the West Fork SJR at Conroe have changed over time, although have remained somewhat consistent for the post-Lake Conroe (post-1972) period (Figure 20). Min7Q flows in Spring Creek have exhibited a gradual rise coincident with increased development and increased wastewater effluent discharges (Figure 21). At the East Fork SJR near Cleveland site, a more erratic pattern is evident where the 1950-1970 period is generally lower than the recent period (Figure 22). Min7Q for both Buffalo Bayou (Figure 23) and Brays Bayou (Figure 24) has exhibited a dramatic rise since the beginning of gauge records.

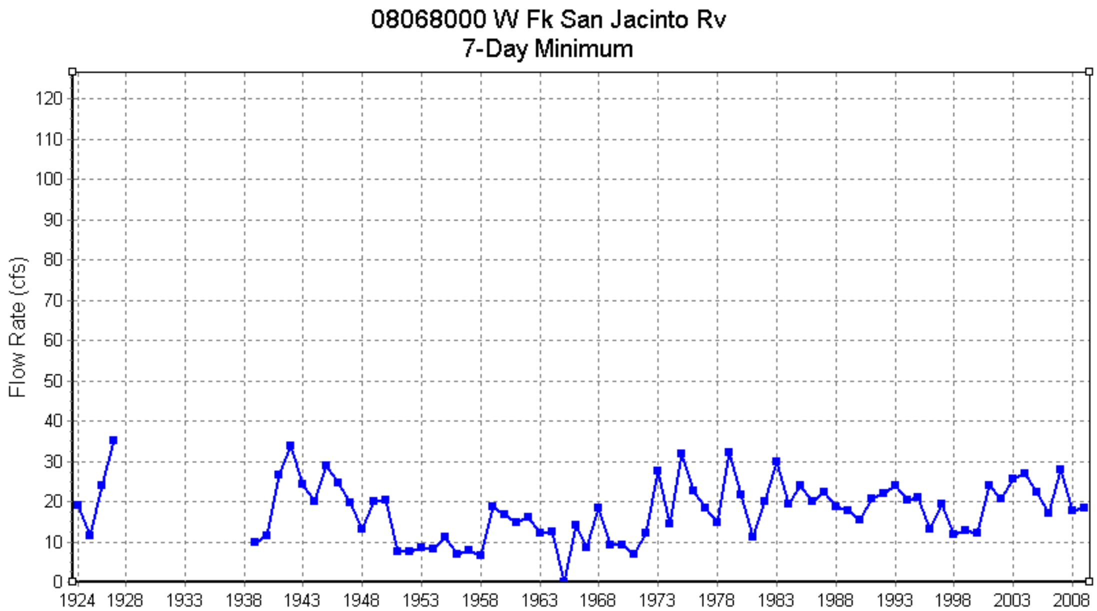

Figure 20 - Min 7Q, W Frk SJR near Conroe

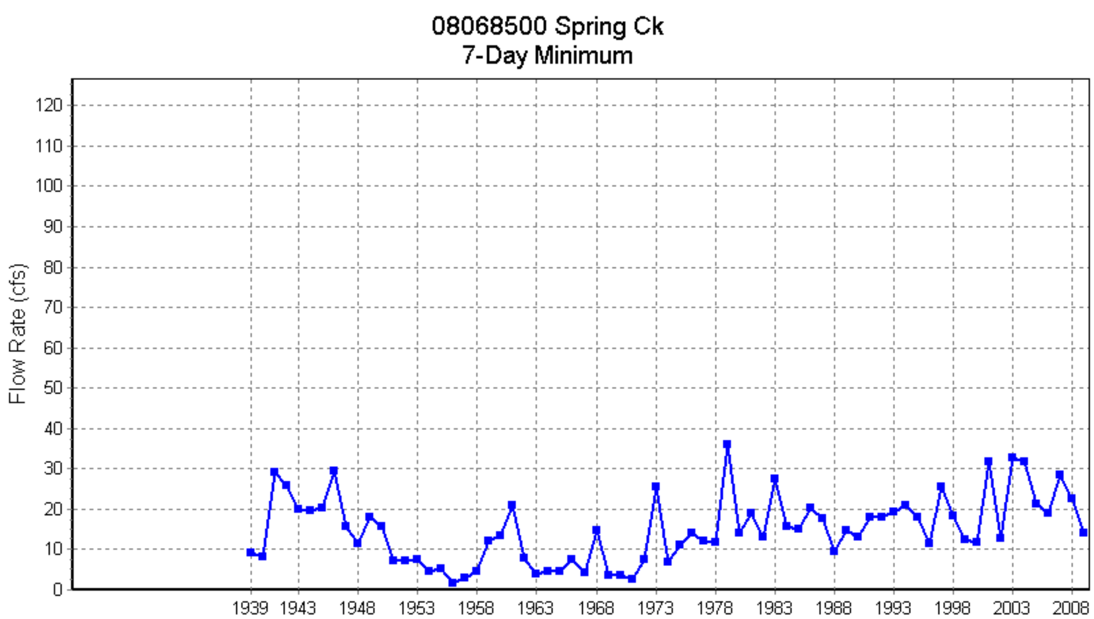

Figure 21 - Min 7Q for Spring Creek near Spring

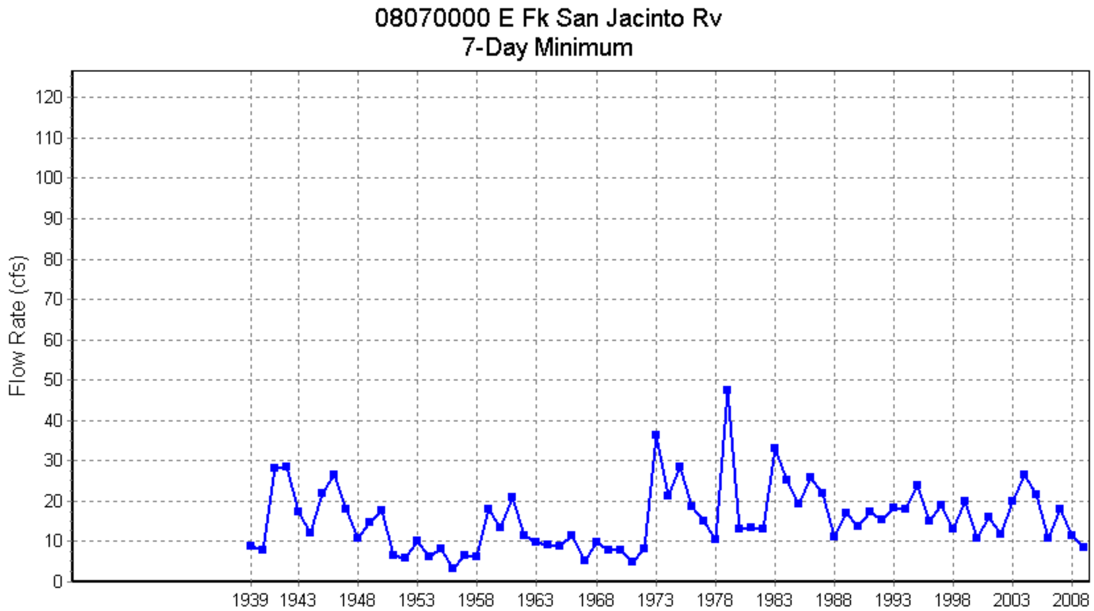

Figure 22 - Min 7Q for E Frk SJR near Cleveland

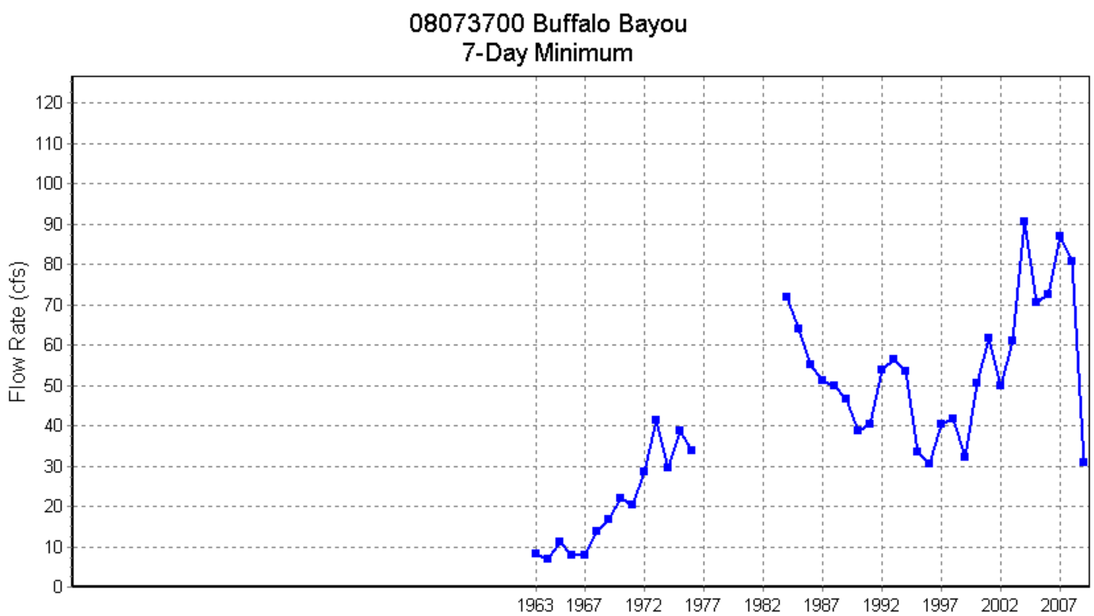

Figure 23 - Min 7Q for Buffalo Bayou at Piney Point

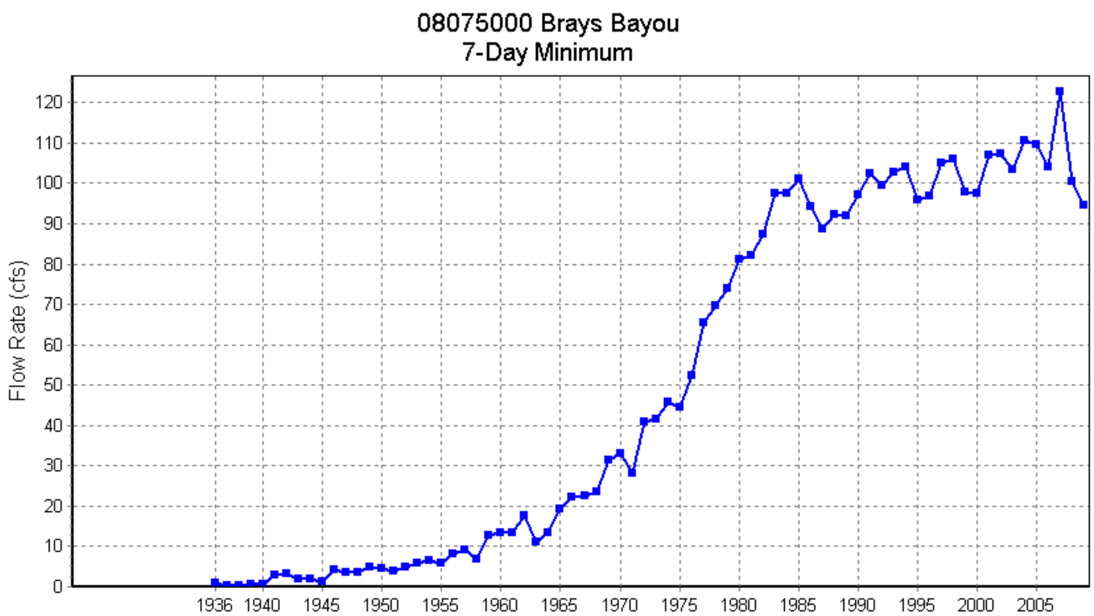

Figure 24 - Min 7Q for Brays Bayou at Houston

4.3 PHYSICAL PROCESSES

Numerous estimates of suspended sediment load have been located; however, quantitative data on bedload have not been discovered. One estimate of the percentage of total load attributable to the bedload component is 20-25% (USDA 1952).

For one site on the W. Fork San Jacinto River just upstream of the headwaters of Lake Houston, investigations of the Hallet point bar indicate a transition in sediment transport regime from erosive processes below the 1.5 year recurrence interval flow to depositional processes above the 1.5 year flow (Herrera 1999). The erosive processes below the 1.5 year flow establish the overall morphology of the bar (Herrera 1999). The 1.5 year flows was identified as 5,200 cfs before Lake Conroe was completed (1973) to 8,000 cfs for the period following completion. For the entire period of record at the W Frk SJR at Conroe gauge, the 1.5 year flow is 7,000 cfs. Based upon cross-section surveys, this flow is lower than a bank-full condition at this particular site that occurs approximately once per four years with magnitude near 18,000 cfs (Herrera 1999).

Information benefitting a sediment transport analysis such as proposed in the Fluvial Sediment overlay (SAC 2009b) is contained in Herrera 1999. Data and information includes sinuosity (1.3), width-depth ration (35), slope (0.0009), qualitative grain-size (descriptions but no sieve analyses), cross-section measurements and mapping of morphology changes for a series of flood events for the particular study site and immediately surrounding areas (Herrera 1999).

The annual average suspended sediment load of the East Fork San Jacinto River is 17 ac-ft per year, ranging from 0 ac-ft in 1971 to 41 ac-ft in 1975, based upon 29 years of record 1953 through 1982 (Quincy 1988).

Additional sediment data:

Sediment load for W. Fork San Jacinto:
SJRA 1981 - LP 168: 363,200 lb/day TSS in 1980
504,800 lb/day TSS (projected year 2000)

Sediment load for E. Fork San Jacinto:
SJRA 1981 - LP 168: 189,800 lb/day TSS in 1980
211,400 lb/day TSS (projected yr 2000)

TDWR 1981: 0.037 ac-ft sediment / square mile annual contribution captured by Lake Houston

TWDB daily suspended sediment data (1964-1989); Texas sampler

Sediment transport for the Trinity
Extensive work has been completed with TWDB funding by Slattery and Phillips.
http://www.twdb.state.tx.us/RWPG/rpgm_rpts/IndividualReportPages/2002483440_LowerTrinity.asp

Suspended sediment load estimates are provided for the Trinity River near Rosser, Crocket and Romayor, and Chambers Creek and Long King Creek in Quincy (1988).

4.4 WATER QUALITY

TCEQ water quality data downloaded from the SWQM reporting system was obtained near each priority gauge. Dissolved Oxygen (DO in mg/L) was linked to USGS streamflow (cfs) records at each station (Figure 25 through Figure 29). Select records indicate occurrences where DO drops below 4 mg/L at each of the gauges; however, these low-DO occurrences occur across a range of flow rates so relationships are not apparent based upon data alone. Additional analysis is required to diagnose reasons for low DO periods, including temperature (seasonality), consistent loading (e.g., from a wastewater treatment plant), irregular loading condition (short-term response to a flow pulse or to a large effluent discharge) or time of day (considering diurnal photosynthesis/respiration cycle).

Two intensive surveys in 79 (winter good conditions, TDWR 1981) and 81 (summer poor conditions, Twidwell 1983) were conducted and used to develop a QualTX model and Waste Load Allocation for West Fork San Jacinto River (TWC 1986). Data including channel characteristics, loading, travel time, stream velocity and water quality data are included in these reports. For warm summer conditions (July 1982) and lower flow conditions (7 cfs to 47 cfs), the follow up study (Twidwell 1983) discovered areas with dissolved oxygen (DO) sag for approximately 10 miles downstream of the major treatment discharge (Twidwell 1983); construction of a new WWTP plant was anticipated to significantly improve water quality conditions and DO near the Conroe stream gauging station indicate significantly higher DO values in the 1990s (Figure 25). Low DO events have been measured in the 2000s (Figure 25); detailed investigation of these events may yield information on causes or relationships with flow.

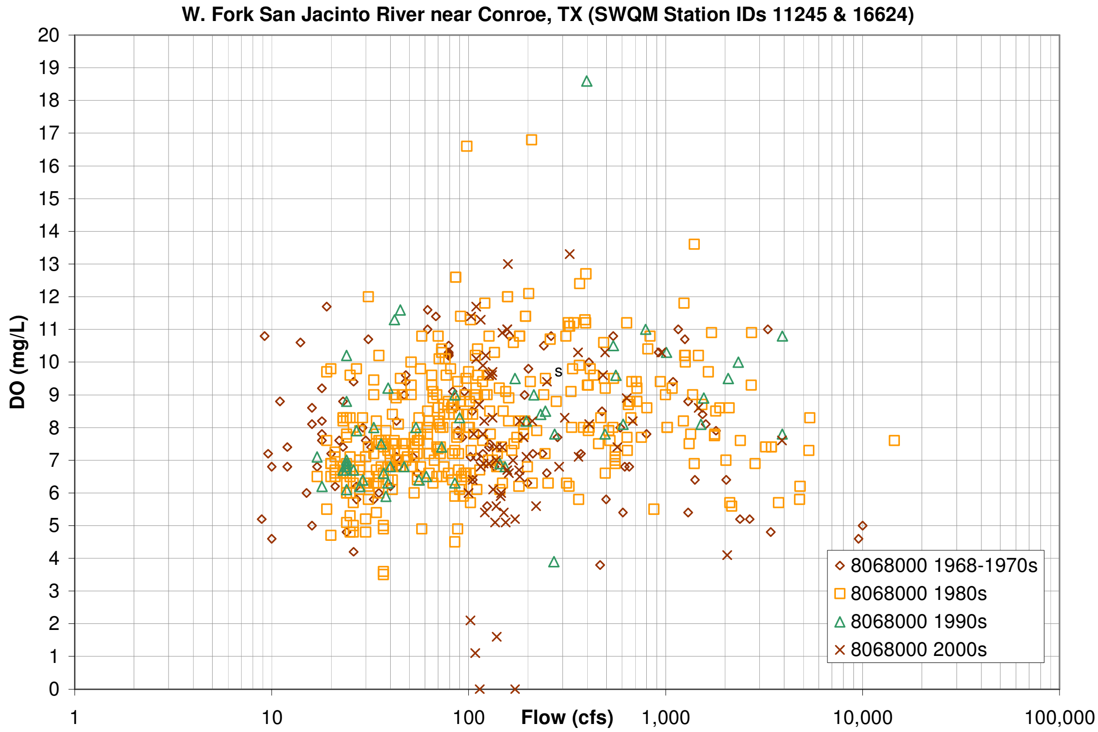

Figure 25 - SWQM DO (mg/L) vs USGS Flow (cfs) for W Frk SJR near Conroe

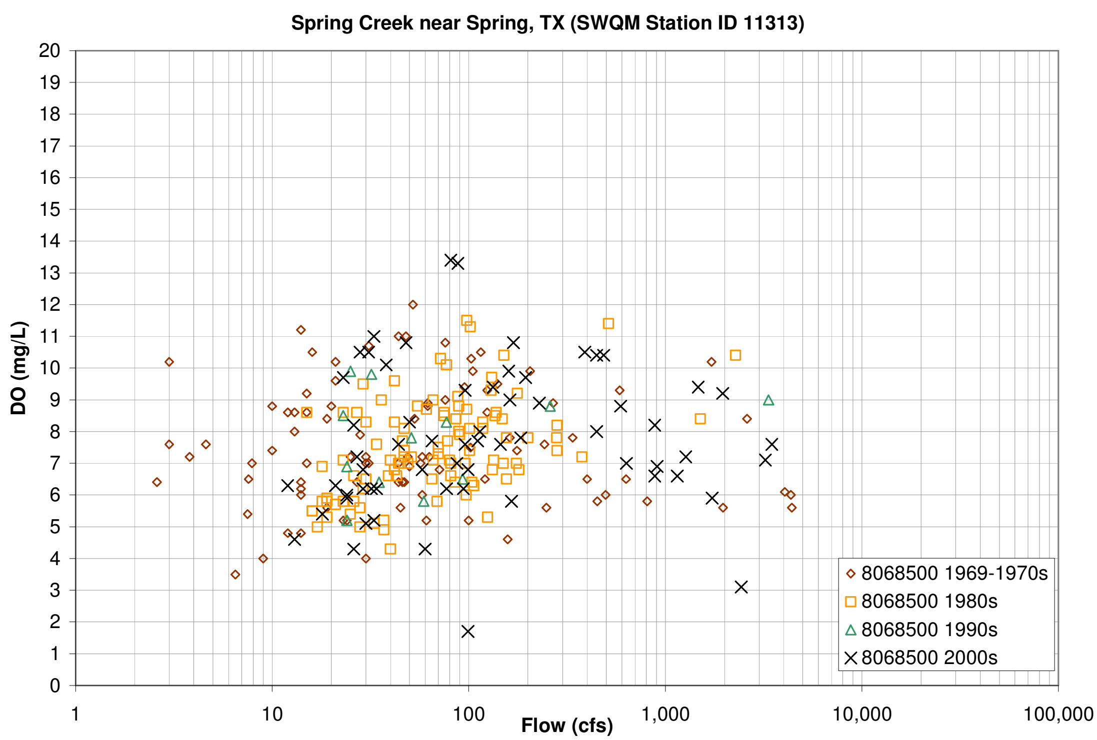

Figure 26 - SWQM DO (mg/L) vs USGS Flow (cfs) for Spring Creek near Spring

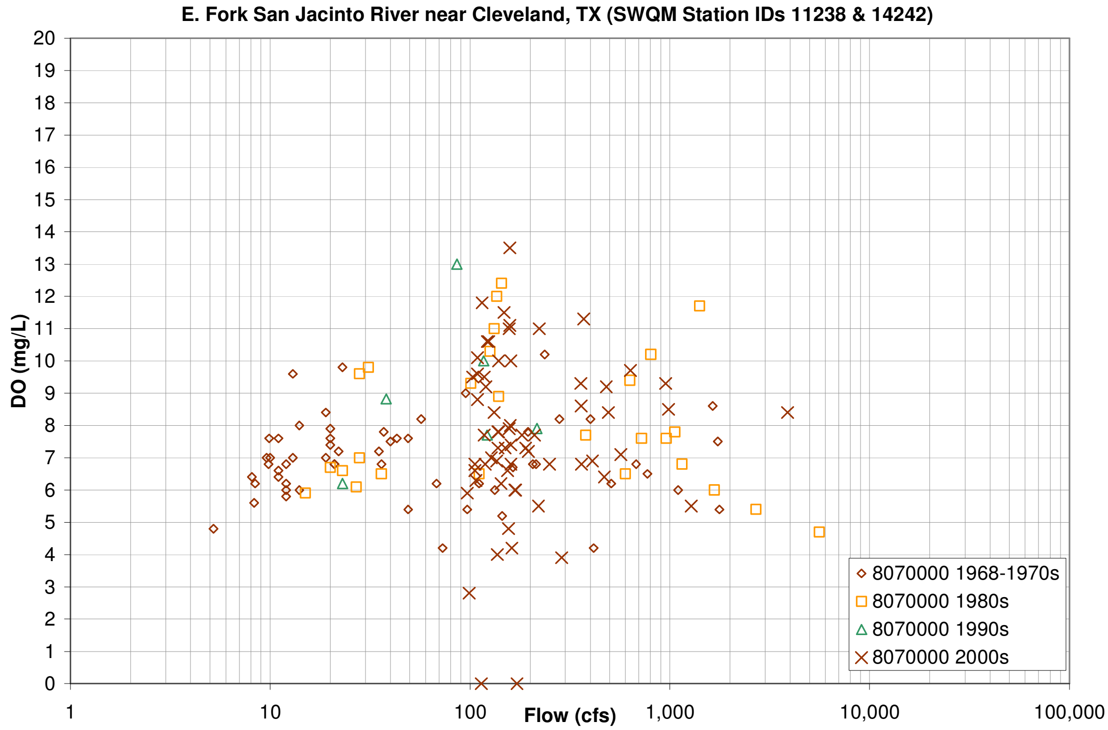

Figure 27 - SWQM DO (mg/L) vs USGS Flow (cfs) for E Frk SJR nr Conroe

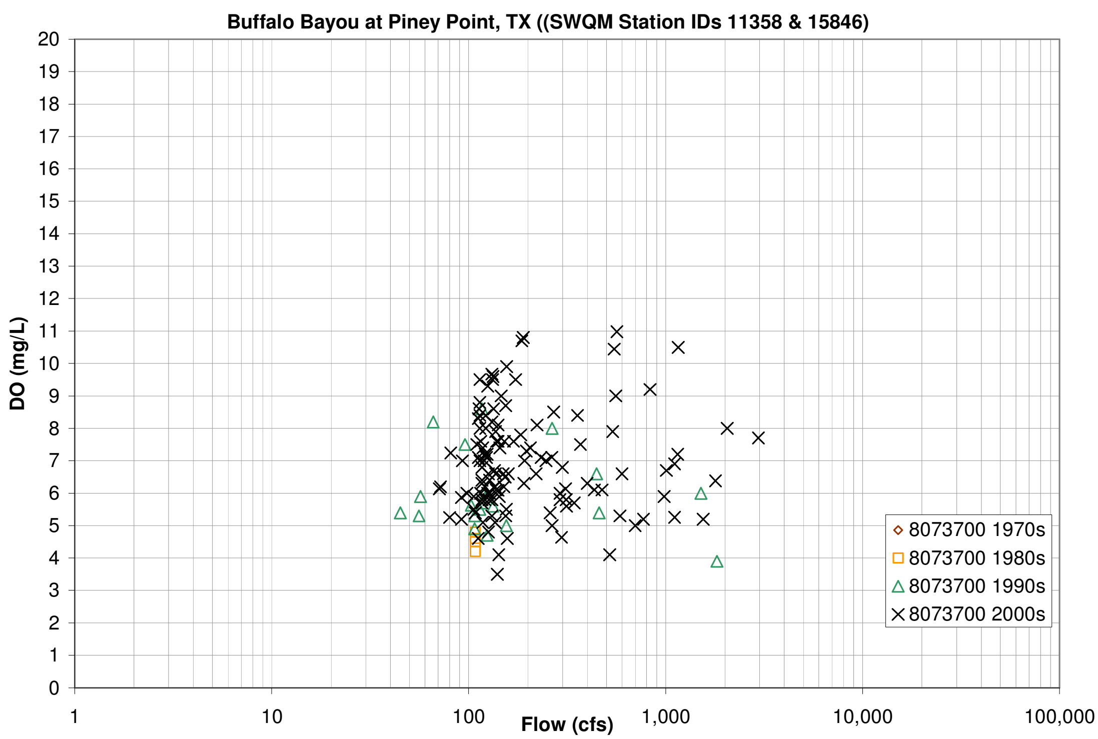

Figure 28 - SWQM DO (mg/L) vs USGS Flow (cfs) for Buffalo Bayou at Piney Point

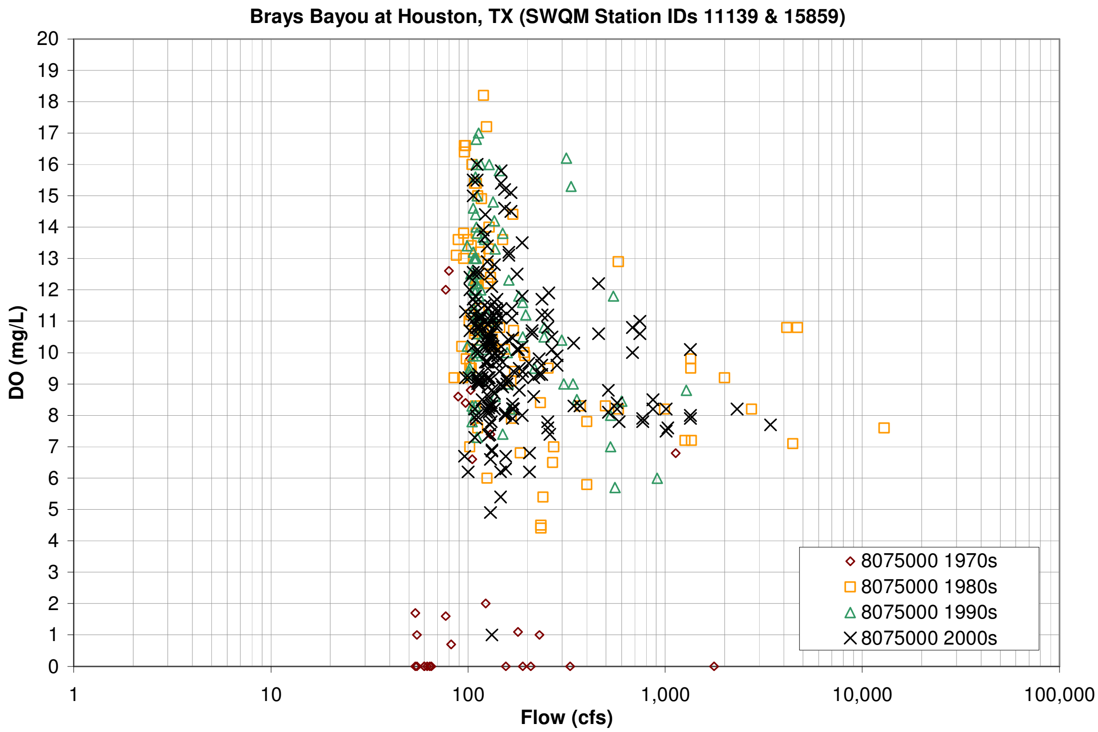

Figure 29 - SWQM DO (mg/L) vs USGS Flow (cfs) for Brays Bayou at Houston

4.5 SEDIMENT AND NUTRIENT LOADING TO THE BAY

To date, no relationships have been discovered between nutrient or sediment loadings to Galveston Bay with freshwater inflow from the San Jacinto River basin. Quantitative values to begin to develop such loading estimates have been compiled and may be used as a starting place for other future projects that may develop loading estimates.

Relevant data estimates reported in existing reports are noted below.

4.5.1 Bay Sediment

<u>Bay Volume:</u>
Estimates of the volume of Galveston bay indicate a fluctuation in volume through the last century. USDA 1952 (see appendix, page 125) describes a 10% net decrease in bay volume from 1898 (1,895,000 ac-ft) to 1937 (1,644,000 ac-ft) because of decreased depths in the delta areas. For a more recent period, Longley et al. (1994) estimate that bay depth has increased between 0 and 1.5 feet for the period 1968 to 1977 based upon NOAA soundings; the cause of deepening is hypothesized to be related to subsidence.

<u>Sediment delivery:</u>
USDA 1952 (see appendix, page 125) provides estimates of suspended sediment load at Romayor (4,396 ac-ft/year) and Huffman (657 ac-ft/year) calculated from 4-year record to 1948; bedload material is hypothesized to be 20-25% of suspended material. With volume of sediment not measured (bedload) assumed to be 25% of suspended material, total annual sediment load to Galveston Bay is 6,300 ac-ft/year for the period analyzed.

Longley et al. (1994) estimate TSS load passing Romayor for the period 1969-86 to be 526 acft/yr; this is much less than for the period 1936-71 is 2,573 acft/yr. Suspended sediment load contributed by the San Jacinto basin below Lake Houston, including Buffalo Bayou is 220.9 acft based on data from 1979. Since completion of Lake Houston in 1953, there is a significant reduction in the amount of sediment delivered from the SJR (Longley et al. 1994).

Additional sediment data:

SJRA 1981 – LP168

- Cedar Bayou
  - 156,200 lb/day TSS in 1980
  - 156,200 lb/day TSS (projected yr 2000)
- Chocolate Bayou above tidal
  - 10,000 lb/day TSS in 1980
  - 10,000 lb/day TSS (projected yr 2000)
- Chocolate Bayou, below tidal
  - 81,400 lb/day TSS in 1980
  - 127,400 lb/day TSS (projected yr 2000)
- Chocolate Bay
  - 90,000 lb/day TSS in 1980
  - 132,200 lb/day TSS (projected yr 2000)
- Moses Lake
  - 65,800 lb/day TSS in 1980
  - 77,000 lb/day TSS (projected yr 2000)
- Trinity Bay
  - 141,400 lb/day TSS in 1980
  - 146,600 lb/day TSS (projected yr 2000)

4.5.2 Bay Nutrients

Nutrient loadings based upon 1970-1977 datasets are provided in LP113 (TDWR 1981, see Section 6). Loadings are provided for inorganic Nitrogen, organic nitrogen, total phosphorus and TOC, by station by month (min and max) (see p212 in the PDF).

Longley et al. (1994) includes calculations of major nutrient loadings for 1977-1987 period data.

Longley et al. (2001) (Appendix to the Analysis of Freshwater Inflows) notes a trend of decreasing nutrients, likely from increasing treatment of waste water flows (Table 5).

Table 5 - Annual total nitrogen budget in Galveston Bay 1988-1990 (Longley et al. 2001)

Annual total nitrogen budget for the Galveston Bay system, 10^6 g /y TN.

	1988	*1989*	*1990*
Inputs from Freshwater Inflows			
Gaged streamflow	8360	25900	35090
Ungaged runoff	3320	9590	5890
Wastewater	7250	7290	7570
Direct rain	570	760	700
Total	19500	43550	49250
Nitrogen Fixation	560	560	560
Inputs from Entrained Tides	2330	2440	2240
Total Inputs	22390	46550	52050
Outflows			
Net water balance outflow	-3090	-14610	-14530
Entrainment outward	-22320	-27770	-24060
Total Outflows	-25420	-42380	-38590
Transport Balance	-3590	3610	12900
Denitrification	-3680	-3680	-3680
Sediment Burial	-690	-2280	-2620
Fisheries, Fish migration	-770	-1070	-1430
Total Losses	-30560	-49410	-46320
Water Column Storage	170	270	-360
Remainder	-8000	-2590	5370

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Appendix A – Scope of Work

Exhibit A

Scope of Work

Development of Ecological Overlay Information and Data for Support of Senate Bill 3 Environmental Flow Recommendations

The Senate Bill 3 (SB3) Science Advisory Committee (SAC) requests the compilation of information to guide in the development of an ecological overlay which can be used to support environmental flow recommendations. In an effort to evaluate the availability of useful information, the contractor will review existing data and literature developed under previous studies for the San Jacinto River basin and Galveston Bay, and will summarize aquatic, biological, riparian, and river flow relationships for the areas mentioned above, concentrating on the San Jacinto River basin.

Work items:

1) Summarize relationship of behavioral, physiological, or demographic variables for focal aquatic and riparian biological components (*e.g.*, species, communities, guilds) to short-term or long-term variation in flow velocity or flow regime.
2) Summarize relationship of geomorphologic parameters to flow velocity or flow regime.
3) Summarize relationship of parameters of water quality to flow velocity or flow regime.
4) Summarize relationship of nutrient and sediment loadings to freshwater inflow regimes to the bay.
5) Develop a matrix representing the geographic occurrence of for fish and mollusk species throughout the San Jacinto River based upon existing literature and consultation with known experts working in this area. This is to be a qualitative effort, simply presence /absence. The matrix need not be a quantitative estimate of population numbers, but rather a geographic checklist of species occurrences.
6) Coordinate development of focal biological components with staff of state agencies involved in the Texas Instream Flow Program (http://www.twdb.state.tx.us/InstreamFlows/index.html). Information sources are currently under development as part of state agency efforts under Senate Bill 2, and are anticipated to be made available to the contractor.
7) Consult with members of the Trinity and San Jacinto Bay and Basin Science Team (BBEST) to provide additional guidance with regard to focal biological resources, geomorphologic parameters, and water quality parameters that are likely to be sensitive to flow variation or serve as valuable indicators of the overall status of the aquatic and riparian ecosystems. The contractor may also suggest additional indicators during the review.
8) Utilize a prioritized list of items (questions), which will be provided by the SAC following consultation with the Trinity and San Jacinto BBEST, to facilitate the review process.

9) Coordinate with the Trinity River Authority to equitably divide tasks outlined in the scope of work and to develop a final summary report.
10) Attend SAC and Trinity and San Jacinto BBEST meetings in August 2009 to report on status and progress of tasks.
11) Reports of progress covered at SAC and BBEST meetings, including draft results, should be distributed electronically as appropriate between meetings.

Deliverables:

1) Summary report that includes graphical representations and/or tabular information revealing key relationships between flow variation and the ecological indicators. The report should include the requested species occurrence matrix. The report and project deliverables should be developed in coordination with the Trinity River Authority to facilitate use of the information by the Trinity and San Jacinto BBEST.
2) Graphical and tabular data shall be delivered in an appropriate digital format, *e.g.*, spreadsheet files, ASCII files, etc., and all relevant source documents will be scanned and delivered with the summary report.
3) The final version of the summary report, in electronic format, will be completed no later than September 21, 2009.

Appendix B – Species Lists

CONDENSED LIST OF FISH AND MUSSEL SPECIES OCCURRENCE

Species List - Fish
San Jacinto River

			Ref. 1 TSU	Ref. 2 1997 % Abundance		Reference 3 USGS 1997-98 # Collected									Ref. 4 1998	Ref. 5 TPWD Rare		Ref. 6 1996	Ref. 7 2000	Ref. 8 69-72	Ref.9 UT - TNHC		
Scientific Name	**Common Name**	TPWD draft focal species list 2009-08-12	San Jacinto River Basin	W. Fork San Jacinto River	E. Fork San Jacinto River	E. Fork San Jacinto River	W. Fork San Jacinto River	Garners Bayou	Greens Bayou	Buffalo Bayou	Cedar Bayou	Dickenson Bayou	White Oak Bayou	Luce Bayou	Upper Basin	Upper SJR Basin	Harris County	Lower San Jacinto Riber Basin	Upper San Jacinto River Basin	San Jacinto - Lake Houston Subbasin	San Jacinto River Basin pre-1940	San Jacinto River Basin 1940-1972	San Jacinto River Basin 1973+
Lepisosteidae																							
Atractosteus spatula	alligator gar		X																				
Lepisosteus oculatus	spotted gar	X	X			8	13	1	13	25	2	2			1			4		X		X	X
Lepisosteus osseus	longnose gar		X			2	1			14										X			
Lepisosteus platostomus	shortnose gar						13													X			
Petromyzontidae																							
Ichthyomyzon castaneus	chestnut lamprey																						X
Ichthyomyxon gagei	southern brook lamprey		X	0	8.5															X		X	X
Amiidae																							
Amia calva	bowfin		X		<0.1					2													X
Anguillidae																							
Anguilla rostrata	American eel		X													X	X						
Clupeidae																							
Alosa chrysochloris	skipjack herring		X																				
Brevoortia patronus	gulf menhaden																				X		
Dorosoma cepedianum	gizzard shad		X			17	186	2	3	658					5			3	1	X		X	X
Dorosoma petenense	threadfin shad		X				8			1								496		X			X
Engraulidae																							
Anchoa mitchilli	bay anchovy																	10					X
Cyprinidae																							
Carassius auratus	goldfish		X																				
Ctenopharyngodon idella	grass carp		X				2			3								3					X
Cyprinella lutrensis	red shiner		X	0.6	0.1	9	472	25	355	6	19		60								X	X	X
Cyprinella venusta	blacktail shiner		X	3.9	1.4	234	665				3			6	82			1	5			X	X
Cyprinus carpio	common carp		X				5		5	10			1					4		X			X
Hybognathus nuchalis	Mississippi silvery minnow		X																			X	
Hybognathus placitus	plains minnow		X																				
Hybopsis amnis	pallid shiner	X	X				1															X	X
Luxilus chrysocephalus	striped shiner		X																	X			

Species List - Fish San Jacinto River			**Ref. 1** TSU	**Ref. 2** 1997 **% Abundance**		**Reference 3** USGS 1997-98 **# Collected**									**Ref. 4** 1998	**Ref. 5** TPWD Rare		**Ref. 6** 1996	**Ref. 7** 2000	**Ref. 8** 69-72	**Ref.9** UT - TNHC		
Scientific Name	**Common Name**	**TPWD draft focal species list 2009-08-12**	**San Jacinto River Basin**	**W. Fork San Jacinto River**	**E. Fork San Jacinto River**	**E. Fork San Jacinto River**	**W. Fork San Jacinto River**	**Garners Bayou**	**Greens Bayou**	**Buffalo Bayou**	**Cedar Bayou**	**Dickenson Bayou**	**White Oak Bayou**	**Luce Bayou**	**Upper Basin**	**Upper SJR Basin**	**Harris County**	**Lower San Jacinto Riber Basin**	**Upper San Jacinto River Basin**	**San Jacinto - Lake Houston Subbasin**	**San Jacinto River Basin pre-1940**	**San Jacinto River Basin 1940-1972**	**San Jacinto River Basin 1973+**
Lythrurus fumeus	ribbon shiner	X	X	9.2	4.3														13	X		X	X
Lythrurus umbratilis	redfin shiner		X	1.3	4.3														1	X		X	X
Macrhybopsis aestivalis	speckled chub						1																
Macrhybopsis hyostoma	shoal chub		X																				
Notemigonus crysoleucas	golden shiner		X	0.4	0.1															X		X	X
Notropis amabilis	Texas shiner		X																	X			
Notropis atherinoides	emerald shiner																		8	x			X
Notropis atrocaudalis	blackspot shiner	X	X	3.9	4.9		4												33	X		X	X
Notropis blennius	river shiner					1																	
Notropis buchanani	ghost shiner		X																	X			
Notropis potteri	chub shiner		X																			X	
Notropis sabinae	Sabine shiner		X																	X			X
Notropis shumardi	silverband shiner		X																				
Notropis stramineus	sand shiner						8								10								
Notropis texanus	weed shiner		X																				
Notropis volucellus	mimic shiner		X	<0.1	0															X		X	X
Opsopoeodus emiliae	pugnose minnow		X	0.1	0.1	1	2													X	X	X	X
Phenacobius mirabilis	suckermouth minnow																			X			
Pimephales promelas	fathead minnow		X				1				3											X	
Pimephales vigilax	bullhead minnow		X	2.9	<0.1	85	851	52	117	207	29		365		96				53	X		X	X
Semotilus atromaculatus	creek chub		X																				
Catostomidae																							
Carpiodes carpio	river carpsucker		X			2	33													X		X	X
Cycleptus elongatus	blue sucker		X													XT							
Erimyzon oblongus	creek chubsucker	X	X	0.7 (I)	1.5 (I)											X T	X T		2	X		X	
Erimyzon sucetta	lake chubsucker		X	0.2	0															X		X	X
Ictiobus bubalus	smallmouth buffalo		X			1				5								6		X		X	

Species List - Fish San Jacinto River			Ref. 1 TSU	Ref. 2 1997 % Abundance		Reference 3 USGS 1997-98 # Collected									Ref. 4 1998	Ref. 5 TPWD Rare		Ref. 6 1996	Ref. 7 2000	Ref. 8 69-72	Ref.9 UT - TNHC		
		TPWD draft focal species list 2009-08-12	San Jacinto River Basin	W. Fork San Jacinto River	E. Fork San Jacinto River	E. Fork San Jacinto River	W. Fork San Jacinto River	Garners Bayou	Greens Bayou	Buffalo Bayou	Cedar Bayou	Dickenson Bayou	White Oak Bayou	Luce Bayou	Upper Basin	Upper SJR Basin	Harris County	Lower San Jacinto Riber Basin	Upper San Jacinto River Basin	San Jacinto - Lake Houston Subbasin	San Jacinto River Basin pre-1940	San Jacinto River Basin 1940-1972	San Jacinto River Basin 1973+
Scientific Name	**Common Name**																						
Minytrema melanops	spotted sucker		X	0.2	0.5		3				2									X		X	X
Moxostoma congestum	gray redhorse		X																				
Moxostoma poecilurum	blacktail redhorse	X	X	0	<0.1	43	11								9					X		X	X
Ictaluridae																							
Ameiurus melas	black bullhead		X	0.2	0.1		3												1	X		X	
Ameiurus natalis	yellow bullhead		X	1.6	3.6	4	6	3	1	4	4		2						38	X		X	X
Ictalurus furcatus	blue catfish		X			1				14								4		X			X
Ictalurus punctatus	channel catfish		X	<0.1	0.1	14	51		2	39	15				2			2		X		X	X
Noturus gyrinus	tadpole madtom		X	<0.1	0	6	33			1			2	1	2					X		X	X
Noturus nocturnus	freckled madtom	X	X	0.4	1.3	1	2								1					X		X	X
Pylodictis olivaris	flathead catfish	X	X			1	4				1							2		X		X	
Loricariidae																							
Pterygoplichthys disjunctivus	vermiculated sailfin catfish (I)																						X
Pterygoplichthys multiradiatus	plecostomus																						X
Esocidae																							
Esox americanus	redfin/grass pickerel		X	0.2	0.9	6	4							1					1	X		X	X
Salmonidae																							
Oncorhynchus mykiss	rainbow trout		X																				
Aphredoderidae																							
Aphredoderus sayanus	pirate perch		X	4.9	6.3	38	66			1				4	4			1	6			X	X
Mugilidae																							
Mugil curema	white mullet *																						X
Mugil cephalus	striped mullet		X					2	51	12	5							59			X	X	X
Atherinopsidae																							
Labidesthes sicculus	brook silverside		X				7								1			1	1 (I)	X		X	X
Menidia beryllina	inland silverside		X															7		X	X	X	X

Species List - Fish San Jacinto River			**Ref. 1** TSU	**Ref. 2** 1997 **% Abundance**		**Reference 3** USGS 1997-98 **# Collected**									**Ref. 4** 1998	**Ref. 5** **TPWD Rare**		**Ref. 6** 1996	**Ref. 7** 2000	**Ref. 8** 69-72	**Ref.9** UT - TNHC		
Scientific Name	**Common Name**	**TPWD draft focal species list 2009-08-12**	**San Jacinto River Basin**	**W. Fork San Jacinto River**	**E. Fork San Jacinto River**	**E. Fork San Jacinto River**	**W. Fork San Jacinto River**	**Garners Bayou**	**Greens Bayou**	**Buffalo Bayou**	**Cedar Bayou**	**Dickenson Bayou**	**White Oak Bayou**	**Luce Bayou**	**Upper Basin**	**Upper SJR Basin**	**Harris County**	**Lower San Jacinto Riber Basin**	**Upper San Jacinto River Basin**	**San Jacinto - Lake Houston Subbasin**	**San Jacinto River Basin pre-1940**	**San Jacinto River Basin 1940-1972**	**San Jacinto River Basin 1973+**
Fundulidae																							
Adinia xenica	diamond killifish																					X	
Fundulus chrysotus	golden topminnow		X	<0.1	0		2												6	X		X	X
Fundulus blairae	western starhead topminnow		X																				X
Fundulus dispar	starhead topminnow																					X	X
Fundulus grandis	Gulf killifish		X															1		X	X	X	X
Fundulus notti	starhead topminnow																			X			
Fundulus notatus	blackstripe topminnow		X			62	100				1			1	9				34	X		X	X
Fundulus olivaceus	blackspotted topminnow		X	10.2	8.8															X		X	X
Fundulus pulvereus	bayou topminnow																					X	
Lucania parva	rainwater killifish		X																			X	
Poeciliidae																							
Gambusia affinis	western mosquitofish		X	37.7	33.4										12				296	X		X	X
Gambusia sp	mosquitofish					15	222	34	14	2	31	3	44	8									
Poecilia latipinna	sailfin molly		X				4	26	15				25									X	X
Cyprinodontidae																							
Cyprinodon variegatus	sheepshead minnow		X																	X		X	X
Moronidae																							
Morone chrysops	white bass		X				1											12		X			
Morone mississippiensis	yellow bass		X															1		X		X	
Morone saxatilis	striped bass		X				4																
Centrarchidae																							
Centrarchus macropterus	flier		X																	X		X	
Lepomis auritus	redbreast sunfish		X			7	25	4															
Lepomis cyanellus	green sunfish		X	0.8	1	11	104	10	5	4	2	4	34		2				3	X		X	X
Lepomis gulosus	warmouth		X	1.4	1.4	26	66	2		8	11	1	1	3	3				8	X		X	X
Lepomis humilis	orangespotted sunfish		X			4	15			203	1												

Species List - Fish San Jacinto River			Ref. 1 TSU	Ref. 2 1997 % Abundance		Reference 3 USGS 1997-98 # Collected									Ref. 4 1998	Ref. 5 TPWD Rare		Ref. 6 1996	Ref. 7 2000	Ref. 8 69-72	Ref.9 UT - TNHC		
		TPWD draft focal species list 2009-08-12	San Jacinto River Basin	W. Fork San Jacinto River	E. Fork San Jacinto River	E. Fork San Jacinto River	W. Fork San Jacinto River	Garners Bayou	Greens Bayou	Buffalo Bayou	Cedar Bayou	Dickenson Bayou	White Oak Bayou	Luce Bayou	Upper Basin	Upper SJR Basin	Harris County	Lower San Jacinto Riber Basin	Upper San Jacinto River Basin	San Jacinto - Lake Houston Subbasin	San Jacinto River Basin pre-1940	San Jacinto River Basin 1940-1972	San Jacinto River Basin 1973+
Scientific Name	**Common Name**																						
Lepomis macrochirus	bluegill		X	2.5	1.5	74	356	6	8	29	40		6	1	32			41	35	X		X	X
Lepomis marginatus	dollar sunfish		X	1	0.2	5													6	X		X	X
Lepomis megalotis	longear sunfish	X	X	9.1	6.8	344	1170	8	76	42	100	2	64	9	172			21	89	X		X	X
Lepomis microlophus	redear sunfish		X	<0.1	0		6								3					X		X	X
Lepomis miniatus	redspotted sunfish.		X																			X	X
Lepomis punctatus	spotted sunfish			2.2	2.6	5	6				2				1				11	X			
Lepomis symmetricus	bantam sunfish		X																	X		X	
Micropterus punctulatus	spotted bass		X	<0.1	<0.1		1													X		X	X
Micropterus salmoides	largemouth bass	X	X	0.8	0.3	20	163		12	14	4		23		15			30		X		X	X
Pomoxis annularis	white crappie		X	<0.1	0	2	34			3								15	1	X		X	X
Pomoxis nigromaculatus	black crappie		X			1												11		X		X	X
Percidae																							
Ammocrypta vivax	scaly sand darter		X																	X		X	X
Etheostoma chlorosoma	bluntnose darter		X	0.8	1		4													X		X	X
Etheostoma gracile	slough darter		X	0.6	0.8		1				2								1	X		X	X
Etheostoma parvipinne	goldstripe darter	X	X	1.4	0.4														6 (I)	X		X	
Etheostoma proeliare	cypress darter		X																			X	
Etheostoma spectabile	orangethroat darter		X																				
Percina caprodes	logperch																			X		X	X
Percina macrolepida	bigscale logperch		X				15															X	X
Percina maculata	blackside darter																						X
Percina sciera	dusky darter	X	X	0.3 (I)	1.2 (I)	38	46								20					X		X	X

Species List - Fish
San Jacinto River

Scientific Name	Common Name	TPWD draft focal species list 2009-08-12	Ref. 1 TSU: San Jacinto River Basin	Ref. 2 1997 % Abundance: W. Fork San Jacinto River	Ref. 2 1997 % Abundance: E. Fork San Jacinto River	Reference 3 USGS 1997-98 # Collected: E. Fork San Jacinto River	Reference 3: W. Fork San Jacinto River	Reference 3: Garners Bayou	Reference 3: Greens Bayou	Reference 3: Buffalo Bayou	Reference 3: Cedar Bayou	Reference 3: Dickenson Bayou	Reference 3: White Oak Bayou	Reference 3: Luce Bayou	Ref. 4 1998: Upper Basin	Ref. 5 TPWD Rare: Upper SJR Basin	Ref. 5: Harris County	Ref. 6 1996: Lower San Jacinto Riber Basin	Ref. 7 2000: Upper San Jacinto River Basin	Ref. 8 69-72: San Jacinto - Lake Houston Subbasin	Ref.9 UT - TNHC: San Jacinto River Basin pre-1940	Ref.9: San Jacinto River Basin 1940-1972	Ref.9: San Jacinto River Basin 1973+
Sciaenidae																							
Aplodinotus grunniens	freshwater drum	X	X	0	<0.1	8	18			1					1					X		X	X
Cynoscion nebulosus	spotted sea trout *																				X		
Leiostomus xanthurus	spot *																					X	X
Micropogonias undulatus	atlantic croaker																	1				X	
Elassomatidae																							
Elassoma zonatum	banded pygmy sunfish		X	0.4	2.6	1														X		X	X
Cichlidae																							
Cichlasoma cyanoguttatum	Rio Grande cichlid		X					9	7				8										X
Oreochromis aureus	blue tilapia (introduced)																						X
Eleotridae																							
Dormitator maculatus	pacific sleeper																					X	X

(1) Freshwater Fishes of the San Jacinto River Drainage
Texas Freshwater Fishes, Department of Biology,
Texas State University
(http://www.bio.txstate.edu/~tbonner/txfishes/)

(2) Spatial Variation of Headwater Fish Assemblages Explained by Hydrologic Variabiity
and Upstream Effects of Impoundment.
Matthew E. Herbert and Frances P. Gelwick. Copeia, 2003, pp. 273-284.
(I) Intolerant
During 1997, fishes were sampled quarterly as follows: 8 February to 2 March, 30 April to 3 June, 11 August to 22 August, and 5 Noverber to 23 November. Sampling periods were during seasonal baseflow to avoid short-term displacement of fishes furing spates (Paloumpis, 1958) and for greater efficiency and consistency of effort. For West Fork streams directly entering Lake Conroe, sites were sufficiently upstream such that flowing stream conditons were present throughout the site.
Study sites were on first to fourth order streams of the East (9 sites) and West Forks (12 sites) and were typical of sandy, coastal streams in the southeastern United States (Felley, 1992). All sites were within the Sam Houston National Forest,and land cover was predominantly loblolly pine (Pinus taeda).

(3) Fish, Benthic Macroinvertebrate, and Stream Habitat Data From the Houston-Galveston Area Council Service Area, Texas, 1997-98
Moring, Bruce, et al. 1998. USGS Report 98-658
(http://pubs.usgs.gov/of/1998/ofr98-658/)
West Fork SJR includes: Spring Cr., Lake Cr., Panther Cr., Sandy Cr., Willow Cr., Walnut Cr., Cypress Cr.
East Fork SJR includes: Caney Cr., Spring Branch Cr.

(4) A Study of Freshwater Mussels (Pelecypoda: Unionidae), Fish, and Associsted Ecological Factors in Lake Creek, Montgomery County, Texas
Stephen P. Ansley, 1998 Thesis, Southwest Texas State University

Site 1 - 1.5 km north of the junction of FM 1488 and FM 2978 at
N 30 09' 07.6" latitude and W 95 20' 49.4" longitude
Site 2 - 2.7 km north of the junction of FM 1488 and FM 149 at
N 30 09' 53.2" latitude and W 95 25' 18.7" longitude

(5) Texas Parks and Wildlife Dept. Annotated County Lists of Rare Species
Last Revision 5/4/2009 5:54:00 PM
http://gis.tpwd.state.tx.us/TpwEndangeredSpecies/DesktopDefault.aspx
X - Species Present
T - Species on the Texas Threatened List

(6) Fish Populations in the Major Tributaries of the Houston Ship Channel.
Segments 1001. 1006' 1007' 1013' 1017
Mark Luedke, June 1994. Texas Natural Resource Conservation Commission
The San Jacinto River was surveyed at two sites, Banana Bend and HWY 90. The Banana Bend and HWY 90 sites are 12.2 and 15.3 miles, respectively, upstream from the mouth of the San Jacinto River. Both sampling sites are in Segment 1001. Little or no water flows over the Lake Houston dam during critical low flow conditions, so the Jan Jacinto River above the dam has not been considered part of the Houston Ship Channel System (Kirkpatrick 1987). The average flow near the sites surveyed was not determined by the USGS because of tidal influences.

(7) The effects of Timber Harvesting on Stream Water Quality in the Sam Houston National Forest:
A Physicochemical, Benthic Macroinvertebrate, and Fish Analysis.
Charles Dewey Stoffels, Stephen F. Austin State University, August 2000
(I) - Intolerant

(8) A Study of Aquatic Quality and Soci-Economic Uses of San Jacinto River Watershed
Sam Houston State University. Huntsville, Texas 1973. Under NSF Grant GY-10760
The Study area was the San Jacinto Watershed, Lake Houston Subbasin from May 14, 1973 to August 3, 1973.

(9) DRAFT Hendrickson spreadsheet Trinity&SanJacinto_forGeorgeGuillen.xls

MUSSELS

Species List - Mollusks and Invertebrate San Jacinto River			Ref. 3 USGS 97-98										Ref. 4 1998	Ref. 5 Rare		Ref. 7 2000	Ref.10 TPWD	
Scientific Name	Common Name	TPWD draft focal species list 2009-08-12	Buffalo Bayou	Caney Creek	Cypress Creek	East Fork SJR	West Fork SJR	Lake Creek	East Sandy Creek	Luce Bayou	White Oak Bayou	Willow Creek	Upper Basin	Upper Basin	Harris Co.	Upper basin	San Jacinto River	Code
Unionidae																		
Amblema plicata	threeridge																X	
Anodonta suborbiculata	flat floater																*	
Arkansia wheeleri	Ouachita rock-pocketbook																	1-FE
Fusconaia lananensis	triangle pigtoe																X	2-SC
Glebula rotundata	round pearlshell																X	
Lampsilis bracteata	Texas fatmucket																	5-SC
Lampsilis hydiana	Louisiana fatmucket																X	
Lasmigona complanata	white heelsplitter																	SC
Leptodea fragilis	fragile papershell																X	
Ligumia subrostrata	pond mussel																X	
Megalonaias nervosa	washboard																X	
Obliquaria reflexa	threehorn wartyback																X	
Obovaria jacksoniana	southern hickorynut																X	5-SC
Pleurobema riddellii	Louisiana pigtoe)																X	2-SC
Popenaias popeii	Texas hornshell																	3,7-FC
Potamilus amphichaenus	Texas heelsplitter																	2-SC
Potamilus metnecktayi	Salina mucket																	2-SC
Potamilus ohiensis	pink papershell																X	
Potamilus purpuratus	bleufer																X	
Pyganodon grandis	giant floater																X	
Quadrula aurea (golden orb)	golden orb																	5-SC
Quadrula couchiana	Rio Grande monkeyface																	4-SC
Quadrula houstonensis	smooth pimpleback																	5-SC
Quadrula mortoni	western pimpleback																5-X	
Quadrula nobilis	gulf mapleleaf																O	
Quadrula nodulata	wartyback																	SC
Quadrula petrina	Texas pimpleback																	5-SC
Quadrula pustulosa	pimpleback																X	
Quincuncina mitchelli	false spike																	4-SC
Strophitus undulatus	creeper																O	SC
Toxolasma parvus	lilliput																X	
Toxolasma texasiensis	Texas lilliput																X	
Truncilla cognata	Mexican fawnsfoot																	2-SC
Truncilla macrodon	Texas fawnsfoot																	5-SC
Truncilla truncata	deertoe																X	
Uniomerus declivis	tapered pondhorn																X	
Uniomerus tetralasmus	pondhorn																X	
Utterbackia imbecillis	paper pondshell																X	
Arcidens confragosus	rock pocketbook	X												X	X		X	5-SC
Tritogonia verrucosa	pistolgrip													X	X		X	

Species List - Mollusks and Invertebrate San Jacinto River			Ref. 3 USGS 97-98										Ref. 4 1998	Ref. 5 Rare		Ref. 7 2000	Ref.10 TPWD	
Scientific Name	**Common Name**	**TPWD draft focal species list 2009-08-12**	**Buffalo Bayou**	**Caney Creek**	**Cypress Creek**	**East Fork SJR**	**West Fork SJR**	**Lake Creek**	**East Sandy Creek**	**Luce Bayou**	**White Oak Bayou**	**Willow Creek**	**Upper Basin**	**Upper Basin**	**Harris Co.**	**Upper basin**	**San Jacinto River**	**Code**
Truncilla donaciformis	fawnsfoot													X			X	SC
Villosa lienosa	little spectaclecase													X	X		X	
Lampsilis satura	sandbank pocketbook													X	X		X	2-SC
Fusconaia askewi	Texas pigtoe												2	X	X		X	2,3-SC
Fusconaia flava	Wabash pigtoe	X												X	X		X	
Plectomerus dombevanus	mudskipper, bankclimber												4				X	
Lampsilis teres	yellow sandshell	X											2				X	
Quadrula apiculata	southern mapleleaf												36				X	
Uniomerus sp.																X		
Corbiculidae																		
Corbicula sp																X		
Sphaeriidae (No Genus species in Ref. 3)			14	0	29	22	12	209	0	7	1	1						
Sphaerium fluminea.			14	29	0	0	0	1	4	0	0	1						
Sphaerium sp.																X		
INVERTEBRATE																		
Macrobrachium ohione	Ohio shrimp	X																

(3) Fish, Benthic Macroinvertebrate, and Stream Habitat Data From the Houston-Galveston Area Council Service Area, Texas, 1997-98
Moring, Bruce, et al. 1998. USGS Report 98-658

(4) A Study of Freshwater Mussels (Pelecypoda: Unionidae), Fish, and Associated Ecological Factors in Lake Creek, Montgomery County, Texas
Stephen P. Ansley, 1998 Thesis, Southwest Texas State University
COPYRIGHT 1998
Site 1 - 1.5 km north of the junction of FM 1488 and FM 2978 at
N 30 09' 07.6" latitude and W 95 20' 49.4" longitude

(5) Texas Parks and Wildlife Dept. Annotated County Lists of Rare Species
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http://gis.tpwd.state.tx.us/TpwEndangeredSpecies/DesktopDefault.aspx
X - Species Present
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(7) The Effects of Timber Harvesting on Stream Water Quality in the Sam Houston National Forest: A Physicochemical, Benthic Macroinvertebrate, and Fish Analysis.
Charles Dewey Stoffels, Stephen F. Austin State University, August 2000

10 TPWD (Marsha May), Texas Mussel Distribution Chart.
TWAP-SC = Species of Concern, TPWD Texas Wildlife Action Plan 2005
[1] Federal Endangered Species (FE)
[2] State Rank (S1) - Critically imperiled, extremely rare, very vulnerable to extirpation, 5 or fewer occurrences
[3] State Rank (S2) - Imperiled in state, very rare, vulnerable to extirpation, 6 to 20 occurrences
[4] State Rank (SH) - Of historical occurrence in state. May be rediscovered.
[5] State Rank (S?) - Not ranked to date
[7] Federal Candidate Species (FC)
* - Introduced

0 - Historical occurrence

Appendix C – Focus Species Lists

Draft List of Focus Species for Trinity and San Jacinto River Basins

This draft list was transmitted electronically from John Botros (TPWD) to Tim Osting (Espey Consultants, Inc.) on August 12, 2009. Highlighted notations were added, from the TSU/Bonner website, USGS and other references as noted.

MODIFIED Draft List of Focus Species for Trinity and San Jacinto River Basins

Trinity River Basin

Fishes

- *Polyodon spathula* (paddlefish) – species of concern; inhabits medium to large river systems usually in pool / backwater areas; uses gravel beds and swift water areas to spawn
    a. "Large river populations make extensive spawning migrations in the spring (Russell 1986; Paukert and Fisher 2000); their movement on these occasions associated with pools during high water."
    b. "only increased and prolonged river flow will attract fish onto the gravel beds; flow must be able to maintain a 3-5 m rise in the river for about 10-14 days (Russell 1986; Pitman 1992)".
    c. "Usually in swiftly flowing water over large gravel bars (Purkett 1961; 1963)."
- *Atractosteus spatula* (alligator gar) – species of concern; inhabits large river systems; dependent upon backwater / floodplain habitats for reproduction; piscivore
- *Notropis atrocaudalis* (blackspot shiner) – species of concern; inhabits small to moderate sized tributary streams
- *Notropis shumardi* (silverband shiner) - species of concern; flow sensitive species
- *Ictalurus furcatus* (blue catfish) – large river species with adults inhabiting the main river and juveniles being found in tributaries; sportfish
- *Morone chrysops* (white bass) – inhabits main stem river, migratory; sportfish
- *Lepomis megalotis* (longear sunfish) – inhabits both main stem and tributaries in pool and backwater areas; nest builder; invertivore
- *Micropterus salmoides* (largemouth bass) – inhabits both main stem and tributaries in pool and backwater areas; nest builder; piscivore; sportfish
- *Percina sciera* (dusky darter) – inhabits main stem and tributaries in run and riffle areas; flow sensitive; benthic invertivore
- *Aplodinotus grunniens* (freshwater drum) – large river species; mussel glochidia host species

Invertebrates

- *Lampsilis teres* (yellow sandshell) - intolerant of drought and dewatering; actively follow flood flow onto land, then retreat back as flows return to channel
- *Tritogonia verrucosa* (pistolgrip) – typical of oxygen rich riffles and runs
- *Fusconaia flava* (Wabash pigtoe) – especially intolerant of changing stream environments
- *Macrobrachium ohione* (Ohio shrimp) – inhabits main stem rivers; migratory species

San Jacinto River Basin

Fishes

- ***Lepisosteus oculatus*** (spotted gar) – ubiquitous in SJ basin; floodplain connectivity required for reproduction; piscivore
    a. BBEST recommended considering this as a focus species
    b. Limited habitat data exists coincident with catch data: velocity, secchi disc
    c. May be less tolerant of turbidity than other gar and tend to be more associated with aquatic vegetation (Lee and Wiley 1980; Pfliger 1997; Ross 2001).
    d. Spawn in shallow water among rooted aquatic vegetation (Lee and Wiley 1980; Tyler and Granger 1984; Love 2004).
    e. Spotted gar prefer shallow open waters, usually 3 - 5 m deep, as well as stagnant backwater. Spotted gars are rarely found in areas that do not include some form of brush covering. (Snedden, Kelso, and Rutherford, 1999)
- ***Lythrurus fumeus*** (ribbon shiner) – inhabits small and medium sized coastal plain streams; mesohabitats and substrate preferences variable
    a. Limited habitat data exists coincident with catch data: velocity, secchi disc
    b. Quiet pools or backwaters with weak flow preferred. Extremely tolerant of turbidity and other ecological factors characteristic of creeks and ditches flowing through agricultural areas (Snelson 1973).
    c. In the East and West Forks of the San Jacinto River, Texas, this species was associated with streams having higher and temporally less variable baseflow, but greater spatial variability of depth (Herbert and Gelwick 2003).
    d. Tolerant of turbidity and associated ecological factors characteristic of creeks flowing through agricultural areas. Prefers clear, vegetated pools with little current over sand (Smith, P. W. 1979. The fishes of Illinois. Univ. Illinois Press, Urbana. 314 pp).
- ***Hybopsis amnis*** (pallid shiner) – inhabits medium to larger streams; intolerant of excessive turbidity; year class strength linked to stream discharge
    a. BBEST recommended removing this species from consideration as focal
    b. Quiet waters over sand-silty bottoms, intolerant of heavy siltation and pollutants (Clemmer 1980).
    c. Turbidity limits and velocity limit information is available
    d. Floodplain access is important for successful spawning or survival of young fish (Kwak 1991).
- ***Notropis atrocaudalis*** (blackspot shiner) - species of concern; inhabits small to moderate sized tributary streams
    a. Limited habitat data exists coincident with catch data: velocity
    b. In runs and pools over all types of substrates, generally avoiding areas of backwater and swiftest currents. In Banita Creek, TX, N. atrocaudalis were found at mean depths ranging from 0.19 to 0.29 m, and mean current velocities ranging from 0.13 to 0.30 m/s (Bean et al., unpublished data).
- ***Erimyzon oblongus*** (creek chubsucker) - State threatened species; fluvial specialist; inhabits main stem and tributaries
    a. BBEST recommended removing this species from consideration as focal
    b. Limited habitat data exists coincident with catch data: velocity at location of spawning
    c. The creek chubsucker is highly sensitive to siltation and pollution. In Ohio, dead creek chubsuckers have been found with silt packed gills (Trautman 1981).
    d. Adult creek chubsuckers move upstream to spawn in the early spring. (Trautman 1981, Becker 1983).

   e. Populations apparently declining in streams subject to siltation (Wall and Gilbert 1980).
   f. Occupies small rivers and creeks often highly vegetated (Wall and Gilbert 1980).
   g. Infrequent occurrence; greater number of museum specimens pre-73.
- ***Moxostoma poecilurum*** (blacktail redhorse) - inhabits main stem and tributaries; sandy to rocky substrates
   a. Limited habitat data exists coincident with catch data: velocity, secchi disc, D.O.
   b. During frequent but brief periods of flooding, blacktail redhorses move onto the inundated floodplain (Slack 1996; Ross 2001). Tolerates brackish water; specimen collected from Escambia River, Florida where salinity was 4.5 ppt at the surface and 24.4 ppt near the bottom (Bailey et al. 1954).
   c. Specimens from Village Creek, Texas, captured in channel pools; however, none were collected in winter and spring due to high stream discharges. (Moriarty and Winemiller 1997).
- ***Noturus nocturnus*** (freckled madtom) – flow sensitive life cycle; medium to large sized systems
   a. BBEST recommended use of this as a focal species
   b. Limited habitat data exists coincident with catch data: velocity, secchi disc, D.O.
   c. Inhabits clear to moderately turbid streams of medium to larges size having permanent flow and low to moderate gradients (Rhode 1980).
   d. N. nocturnus is an intolerant species sensitive to environmental conditions and typically first to disappear following a disturbance; fluvial specialist having narrow range of habitat use.
   e. In South Sulpher River, Texas, species associated with higher velocities and with riffle-habitat types and shallower depths that occurred during the low flow range (Morgan 2002).
- ***Pylodictis olivaris*** (flathead catfish) – long lived species; strong ties to floodplain connectivity; sportfish
   a. BBEST recommended use of this as a focal species
   b. Limited habitat data exists coincident with catch data: velocity, secchi disc, D.O.
   c. No floodplain connectivity references/data found.
   d. Life cycle: Young-of-the-year live in rubble bottomed riffles until between 2 and 4 inches in length
   e. Poor overall health and certain environmental conditions such as drought or flood can reduce flatheads' ability to spawn. (TPWD)
   f. Pflieger (1975) stated that the flathead catfish inhabits a variety of streams types, but avoids streams with high gradients or intermittent flow. The term "high gradient" was not defined.
   g. Adults are usually found associated with submerged logs or other cover (Pflieger 1975; Smith 1979).
   h. In Texas, Gholson (1975) reported that flathead catfish were most abundant near rocks, shoals, log jams, brush tops, ledges, submerged trees, and other structures that afford cover and also are associated with current.
   i. HSI Models: Flathead Catfish. USFWS Biological Report 82(10.152) September 1987
- ***Lepomis megalotis*** (longear sunfish) - inhabits both main stem and tributaries in pool and backwater areas; nest builder; invertivore.
   a. Limited habitat data exists coincident with catch data: velocity, secchi disc, D.O.
   b. Spawning occurs in shallow water with gravel bottom, and little current (Bietz 1981; Hubbs and Cooper 1935; Hankinson 1919).
   c. Abundant in clear, small upland streams with rocky bottoms and permanent or semi-permanent flows (Robison and Buchanan 1988).

- ***Micropterus salmoides*** (largemouth bass) – inhabits both main stem and tributaries in pool and backwater areas; nest builder; piscivore; sportfish
    a. Limited habitat data exists coincident with catch data: velocity, secchi disc, D.O.
    b. Growth seems to be poor for fish in salinities of over 4 ppt (Peterson 1991); fish cannot survive for an extended period in salinities greater than 12 ppt (Meador and Kelso 1990).
- ***Etheostoma parvipinne*** (goldstripe darter) - inhabits both main stem and tributaries in run mesohabitats; flow sensitive
    a. Occurrence data available
    b. In Texas, occupies small first-order creeks (Hubbs et al 1991). Species prefers small streams and feeder streams of low to moderate gradient (Rohde 1980).
    c. With in the East Fork of the San Jacinto River, Texas, Herbert and Gelwick (2003) found species to be associated with shallow water and higher conductivities
    d. Smiley et al. (2006) sampled 14 first-order streams in north-central Mississippi (streams did not contain aquatic vegetation), and found that species abundance was positively correlated with increasing percentage canopy cover, increasing water temperature and decreasing dissolved oxygen levels, increasing percentage sand and decreasing percentage clay substrate.
    e. A population was documented by Abdul (1987) in a small cattle pond in east Texas that was characterized by low pH (mean 3.7, range 2.9-4.0) and no buffering capacity (0 alkalinity); Etheostoma parvipinne was the only fish species present in the stream pond, and Robbins et al. (2003) reported that a reproducing population was still present as of August 2000.
    f. Smiley et al. (2006) report common occurrence of species in small streams having sand substrates, shallow water depths, and slow water velocities.
- ***Percina sciera*** (dusky darter) – inhabits main stem and tributaries in run and riffle areas; flow sensitive; benthic invertivore
    a. Limited habitat data exists coincident with catch data: velocity, secchi disc, D.O.
    b. Considered pollution intolerant species (United States Environmental Protection Agency 1983; Kleinsasser and Linam 1987; Linam and Kleinsasser 1987a).
- ***Aplodinotus grunniens*** (freshwater drum) – large river species; mussel glochidia host species
    a. Limited habitat data exists coincident with catch data: velocity, secchi disc, D.O.
    b. Individuals have been observed to become distressed when water temperatures exceed 25.6°C, and when dissolved oxygen concentrations remain low over an extended period (Priegel 1967b).

<u>Invertebrates</u>

- *Lampsilis teres* (yellow sandshell) - intolerant of drought and dewatering; actively follow flood flow onto land, then retreat back as flows return to channel
- *Tritogonia verrucosa* (pistolgrip) – typical of oxygen rich riffles and runs
- *Fusconaia flava* (Wabash pigtoe) – especially intolerant of changing stream environments
- *Quadrula apiculata* (Southern mapleleaf) – generalist but sensitive to dewatering (USFWS, Cherrish Stevens/Dr. Howells, personal communication 2009).
- *Macrobrachium ohione* (Ohio shrimp) – inhabits main stem rivers; migratory species

Appendix D – Data sources

SUMMARY OF RELEVANT DATA SOURCES

SUMMARY OF RELEVANT DATA SOURCES

SAN JACINTO RIVER BASIN

San Jacinto River Authority – www.sjra.net

Objective 1.3: Existing Hydrologic Data Sets

USGS NWIS (National Water Information System) –
Daily-averaged stream flow records
(see spreadsheet for listing of all records in basin)
Real-time flow records
Peak flow

Streamflow
http://waterdata.usgs.gov/tx/nwis/current/?type=flow
Lakes
http://waterdata.usgs.gov/tx/nwis/current/?type=lake
Instantaneous Data Archive (IDA) - Historical 15-minute flow records
http://ida.water.usgs.gov/ida/index.cfm?ncd=48

USGS – National Hydrography Dataset (NHD), geospatial information
http://nhd.usgs.gov/data.html

NWS – Flood forecasting and flood magnitude (etc., overbank) notations
http://www.weather.gov/ahps/forecasts.php
http://ahps.srh.noaa.gov/ahps2/forecasts.php?wfo=hgx&view=1,1,1,1,1,1,1,1&toggles=10,7,8,2,9,15,6
Example: Forecast and Action Stage information for Spring Creek near Spring, TX
http://ahps.srh.noaa.gov/ahps2/hydrograph.php?wfo=hgx&gage=spnt2&view=1,1,1,1,1,1,1,1

TCOON – Galveston Bay tide data
http://lighthouse.tamucc.edu/TCOON/HomePage

TWDB - Coastal Hydrology (TxRR)
http://midgewater.twdb.state.tx.us/bays_estuaries/hydrologypage.html
GIS - http://www.twdb.state.tx.us/mapping/index.asp

Objective 1.5: Existing Biological Data

TSU – Texas Freshwater Fishes (Tim Bonner's Field Guide)
http://www.bio.txstate.edu/~tbonner/txfishes/
San Jacinto basin
http://www.bio.txstate.edu/~tbonner/txfishes/San%20Jacinto.htm

TPWD – Rare, Threatened and Endangered Species of Texas, by County
http://gis.tpwd.state.tx.us/TpwEndangeredSpecies/DesktopDefault.aspx
Ecologically Significant Stream Segements
http://www.tpwd.state.tx.us/landwater/water/environconcerns/water_quality/sigsegs/

EPA - Texas Ecoregions
http://www.epa.gov/wed/pages/ecoregions/tx_eco.htm

USFWS – Endangered Species: Listed, Proposed and Candidate Species
http://www.fws.gov/endangered/wildlife.html

EARDC – List of Reports and Studies (biology, WQ and spring flow)
http://www.eardc.txstate.edu/EARDC%20Reports-Studies.html

Objective 1.6: Existing Physical Processes Data

TWDB – Historical suspended sediment load (tons/day) data at station 08070000 E. Fork San Jacinto River near Cleveland, TX. (see spreadsheet)

TNRIS –
Digital Data - Aerial Photos, DRGs, Basin (HUC) boundaries,
http://www.tnris.org/datadownload/download.jsp
StratMap – Hypsography/DEMs (Topography)
http://www.tnris.org/StratMap.aspx?layer=122

UT BEG – GAT
http://www.beg.utexas.edu/mainweb/services/15minquads.htm

USGS – National Land Cover Database (NLCD)
http://www.mrlc.gov/

NOAA –Coastal Change Analysis Program (C-CAP)
http://www.csc.noaa.gov/crs/lca/gulfcoast.html

NRCS – SSURGO soils data
http://soils.usda.gov/survey/geography/ssurgo/

USACE – Galveston District Library
http://www.swg.usace.army.mil/Library/default.asp

Objective 1.7: Existing Water Quality Data

TCEQ – Stream segments and monitoring stations
GIS - http://www.tceq.state.tx.us/implementation/water/tmdl/atlas.html
Maps - http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/gi/gi-316/index.html
http://www.tceq.state.tx.us/files/basin18-20-GuadSanAntNuec.pdf_4447615.pdf
Surface Water Quality Monitoring System (SWQMS)
http://www.tceq.state.tx.us/compliance/monitoring/crp/data/samplequery.html

TWDB –
Estuarine Hydrographic Surveys (Galveston Bay)
http://midgewater.twdb.state.tx.us/bays_estuaries/surveypage.html
Estuary Monitoring Program – Datasonde Data
http://midgewater.twdb.state.tx.us/bays_estuaries/sondpage.html

USGS – Real-time water quality data for Texas
http://waterdata.usgs.gov/tx/nwis/current/?type=quality

Appendix E – USGS data

SUMMARY TABLE OF HISTORICAL AND CURRENT USGS GAUGING STATIONS IN THE SAN JACINTO AND COASTAL BASINS

USGS stream gaging stations in the San Jacinto and San Jacinto coastal basins

Site Code	Site Name	Value Count	Start Date	End Date	County	Latitude	Longitude
08075605	Berry Bayou at Nevada St, Houston, TX	814	10/01/2006	07/28/2009	Harris	29.65662003	-95.22910309
08075730	Vince Bayou at Pasadena, TX	13598	10/01/1971	07/28/2009	Harris	29.69467354	-95.21632385
08076700	Greens Bayou at Ley Rd, Houston, TX	1717	12/02/1971	07/28/2009	Harris	29.83716965	-95.23326874
08076997	Clear Ck at Mykawa St nr Pearland, TX	814	10/01/2006	07/28/2009	Harris	29.59689903	-95.29743958
08067500	Cedar Bayou nr Crosby, TX	9911	10/01/1971	07/28/2009	Liberty	29.97271919	-94.98576355
08067525	Goose Ck at Baytown, TX	814	10/01/2006	07/28/2009	Harris	29.77078247	-94.99964905
08067610	Lk Conroe Outflow Weir nr Conroe, TX	5113	10/01/1973	09/30/1989	Montgomery	30.35659599	-95.5605011
08067650	W Fk San Jacinto Rv bl Lk Conroe nr Conroe, TX	8817	10/18/1973	07/28/2009	Montgomery	30.34215355	-95.54299927
08067700	Caney Ck nr Dobbin, TX	914	04/01/1963	09/30/1965	Montgomery	30.35381889	-95.80995178
08067900	Lake Ck nr Conroe, TX	731	10/01/2002	09/30/2004	Montgomery	30.25354576	-95.57883453
08068000	W Fk San Jacinto Rv nr Conroe, TX	26578	05/01/1924	07/28/2009	Montgomery	30.24465752	-95.45716095
08068090	W Fk San Jacinto Rv abv Lk Houston nr Porter, TX	8986	05/01/1984	07/28/2009	Montgomery	30.08605194	-95.29993439
08068275	Spring Ck nr Tomball, TX	3370	10/01/1999	07/28/2009	Montgomery	30.1199398	-95.64605713
08068325	Willow Ck nr Tomball, TX	796	10/01/2006	07/28/2009	Harris	30.10549545	-95.54660797
08068390	Bear Br at Research Blvd, The Woodlands, TX	3618	01/27/1999	07/28/2009	Montgomery	30.19055557	-95.49111176
08068400	Panther Br at Gosling Rd, The Woodlands, TX	4379	08/01/1974	07/28/2009	Montgomery	30.19215965	-95.48382568
08068450	Panther Br nr Spring, TX	5015	04/01/1972	07/28/2009	Montgomery	30.13105011	-95.48133087
08068500	Spring Ck nr Spring, TX	25449	04/01/1939	07/28/2009	Montgomery	30.11049461	-95.43632507
08068720	Cypress Ck at Katy-Hockley Rd nr Hockley, TX	12073	06/01/1975	07/28/2009	Harris	29.95022392	-95.80828094
08068740	Cypress Ck at House-Hahl Rd nr Cypress, TX	12259	06/01/1975	07/28/2009	Harris	29.95911217	-95.71772766
08068780	Little Cypress Ck nr Cypress, TX	7889	05/01/1982	07/28/2009	Harris	30.01605415	-95.69744873
08068800	Cypress Ck at Grant Rd nr Cypress, TX	6293	10/01/1982	07/28/2009	Harris	29.97355652	-95.59855652
08068900	Cypress Ck at Stuebner-Airline Rd nr Westfield,	731	10/01/1987	09/30/1989	Harris	30.00661087	-95.5118866
08069000	Cypress Ck nr Westfield, TX	23551	07/01/1944	07/28/2009	Harris	30.03577614	-95.42882538
08069500	W Fk San Jacinto Rv nr Humble, TX	9496	10/01/1928	09/30/1954	Harris	30.02716446	-95.25798798
08070000	E Fk San Jacinto Rv nr Cleveland, TX	25439	05/01/1939	07/28/2009	Liberty	30.33659744	-95.10410309
08070200	E Fk San Jacinto Rv nr New Caney, TX	8986	05/01/1984	07/28/2009	Montgomery	30.14549255	-95.12437439
08070500	Caney Ck nr Splendora, TX	23733	01/01/1944	07/28/2009	Montgomery	30.25965881	-95.30243683
08071000	Peach Ck at Splendora, TX	15948	10/01/1943	07/28/2009	Montgomery	30.2327137	-95.1682663
08071280	Luce Bayou abv Lk Houston nr Huffman, TX	8975	05/01/1984	07/28/2009	Liberty	30.1096611	-95.05992889
08071500	San Jacinto Rv nr Huffman, TX	6209	10/01/1936	09/30/1953	Harris	29.99466324	-95.13354492

Site Code	Site Name	Value Count	Start Date	End Date	County	Latitude	Longitude
08072300	Buffalo Bayou nr Katy, TX	11498	07/01/1977	07/28/2009	Fort Bend	29.74328613	-95.8068924
08072730	Bear Ck nr Barker, TX	11498	07/01/1977	07/28/2009	Harris	29.83078194	-95.68688965
08072760	Langham Ck at W Little York Rd nr Addicks, TX	3766	07/01/1977	07/28/2009	Harris	29.86717033	-95.64661407
08073500	Buffalo Bayou nr Addicks, TX	23124	09/01/1945	07/28/2009	Harris	29.76189613	-95.60578156
08073600	Buffalo Bayou at W Belt Dr, Houston, TX	13628	09/01/1971	07/28/2009	Harris	29.7621727	-95.557724
08073700	Buffalo Bayou at Piney Point, TX	13463	10/01/1963	07/28/2009	Harris	29.74689674	-95.52355194
08074000	Buffalo Bayou at Houston, TX	15238	06/01/1936	07/28/2009	Harris	29.76022911	-95.40855408
08074020	Whiteoak Bayou at Alabonson Rd, Houston, TX	3326	10/01/1999	07/28/2009	Harris	29.87078094	-95.48049927
08074150	Cole Ck at Deihl Rd, Houston, TX	8191	05/01/1964	02/11/2004	Harris	29.85133743	-95.48799896
08074250	Brickhouse Gully at Costa Rica St, Houston, TX	6373	09/01/1964	02/11/2004	Harris	29.82800484	-95.46938324
08074500	Whiteoak Bayou at Houston, TX	26510	05/25/1936	07/28/2009	Harris	29.7752285	-95.39716339
08074760	Brays Bayou at Alief, TX	814	10/01/2006	07/28/2009	Harris	29.7091198	-95.58300018
08074800	Keegans Bayou at Roark Rd nr Houston, TX	6373	09/01/1964	02/11/2004	Harris	29.65662193	-95.56216431
08074810	Brays Bayou at Gessner Dr, Houston, TX	2640	10/01/2001	07/28/2009	Harris	29.6727314	-95.52827454
08075000	Brays Bayou at Houston, TX	26510	05/25/1936	07/28/2009	Harris	29.69717407	-95.41216278
08075400	Sims Bayou at Hiram Clarke St, Houston, TX	14090	08/18/1964	07/28/2009	Harris	29.61884308	-95.44605255
08075500	Sims Bayou at Houston, TX	15707	10/01/1952	09/01/2001	Harris	29.67439651	-95.28938293
08075763	Hunting Bayou at Hoffman St, Houston, TX	806	10/01/2006	07/28/2009	Harris	29.80883789	-95.31327057
08075770	Hunting Bayou at IH 610, Houston, TX	16306	05/01/1964	07/28/2009	Harris	29.79328156	-95.26799011
08075900	Greens Bayou nr US Hwy 75 nr Houston, TX	10569	08/03/1965	07/28/2009	Harris	29.9568882	-95.41799164
08076000	Greens Bayou nr Houston, TX	20537	10/01/1952	07/28/2009	Harris	29.91827774	-95.30687714
08076180	Garners Bayou nr Humble, TX	5780	02/25/1986	07/28/2009	Harris	29.93438911	-95.23410034
08076500	Halls Bayou at Houston, TX	17974	10/01/1952	07/28/2009	Harris	29.86189079	-95.33493805
08077000	Clear Ck nr Pearland, TX	15958	08/01/1944	09/04/1994	Brazoria	29.59745407	-95.28660583
08078000	Chocolate Bayou nr Alvin, TX	18189	03/01/1959	07/28/2009	Brazoria	29.36940384	-95.32077026

Appendix F – SAC/BBEST presentation

San Jacinto River Basin Ecological Overlay Drill-down

Tim Osting
Espey Consultants, Inc.
2009-09-09 (SAC)
2009-09-10 (BBEST)

1

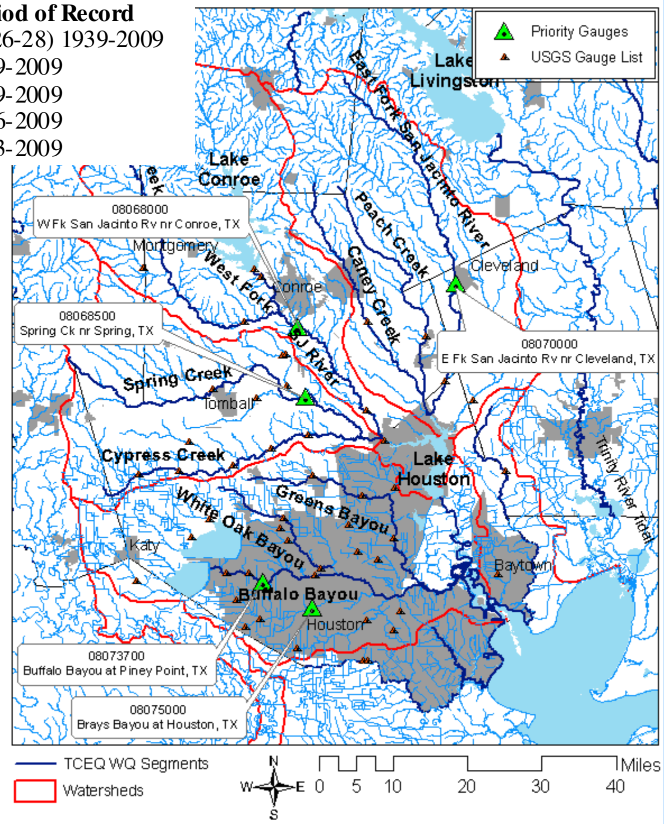
Deliverables

- Matrix of fish and mussel species
  - Focal components
- Report
  - Short list of focal fish and mussel species
  - Relationships between “flow” and…
    - …Focal species and biological components
    - …Physical processes
    - …Water quality
    - …Nutrient and sediment loading

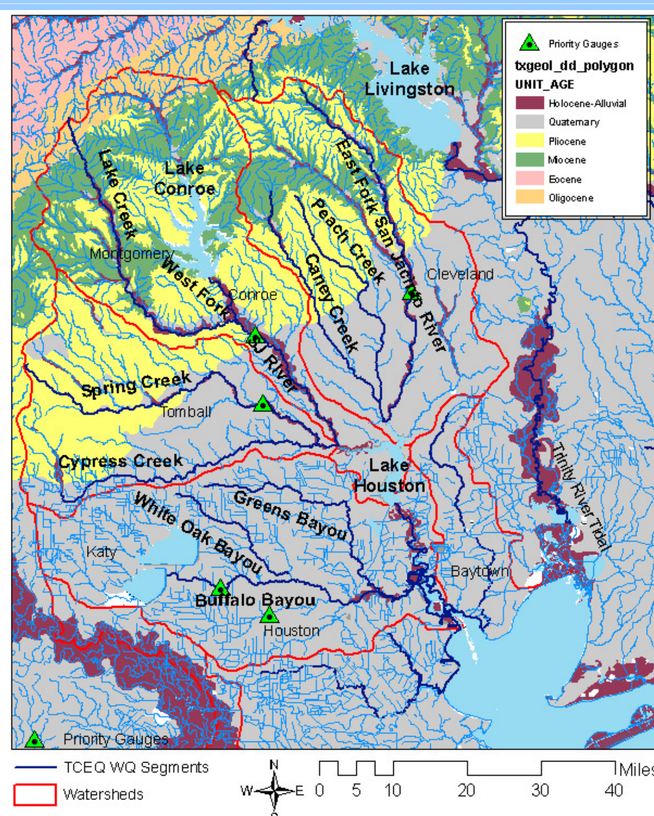
2

Name	Period of Record
W. Fork San Jacinto near Conroe, TX	(1926-28) 1939-2009
E. Fork San Jacinto near Cleveland, TX	1939-2009
Spring Creek near Spring, TX	1939-2009
Brays Bayou near at Houston, TX	1936-2009
Buffalo Bayou at Piney Point, TX	1963-2009

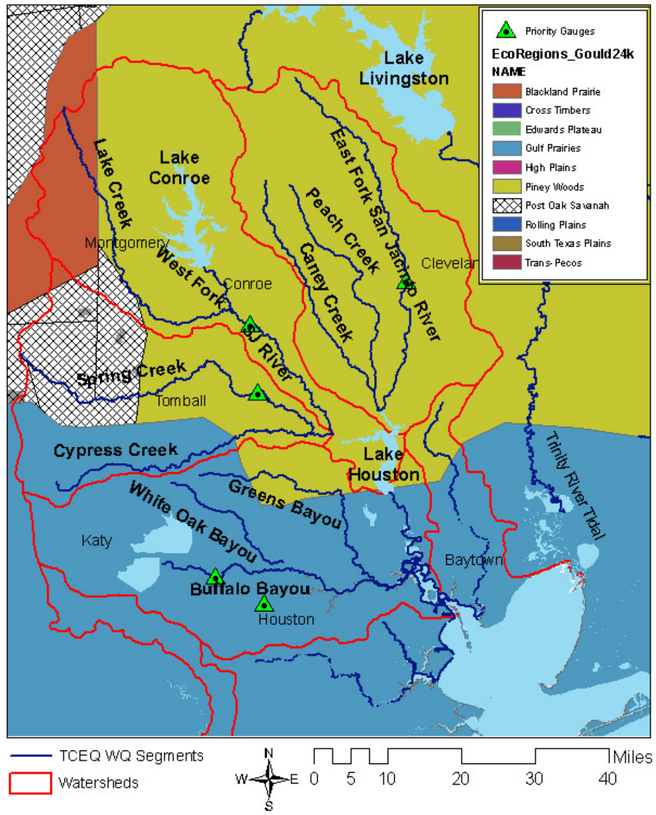
SJR – Priority gauges



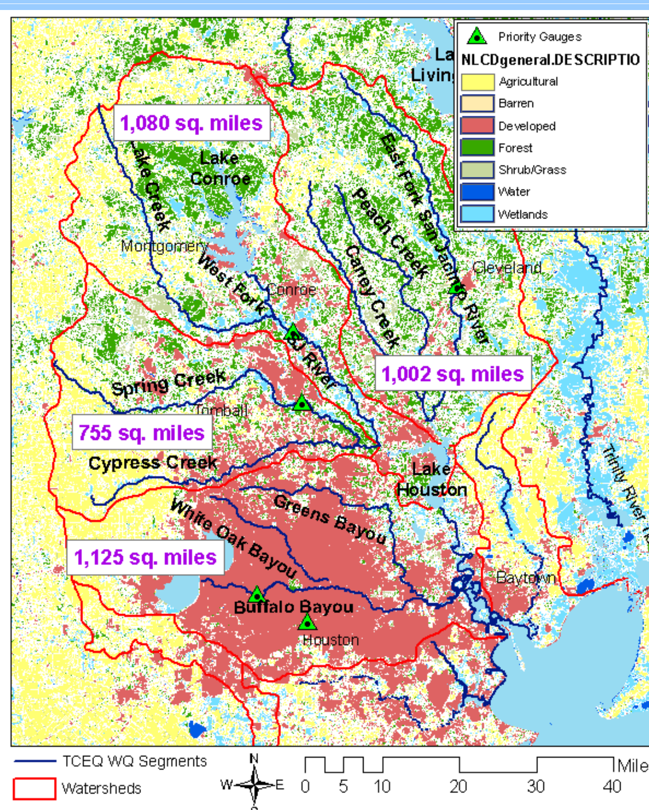
SJR – Geology



SJR – Ecoregions



SJR – Land Use Land Cover



SJR – Land Use Land Cover

	Spring Creek	West Fork SJR	East Fork SJR	Lower-SJR
Water	0.5%	4.8%	0.5%	2.2%
Developed	24.8%	14.6%	10.9%	65.4%
Barren	0.5%	0.4%	0.1%	0.5%
Forest	23.6%	32.1%	44.0%	7.3%
Shrub/Grass	11.1%	13.5%	18.2%	4.1%
Agricultural	31.0%	20.0%	8.3%	13.3%
Wetlands	8.5%	14.6%	17.9%	7.1%
Total Area (sq. mi.)	755	1,080	1,002	1,125

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Matrix of fish and mussel species

- Fish and Mussel species matrix
  - Fish species – geographic occurrence
    - TSU – Hassan-Williams and Bonner website
    - Six other references
    - TPWD draft focal species
    - TPWD rare and threatened species
    - UT TNHC - Hendrickson
  - Mussel species – geographic occurrence
    - TPWD draft focal species
    - TPWD Marsha May (includes Burlakova's data)
    - Three other references
    - USFWS, Dr. Howells

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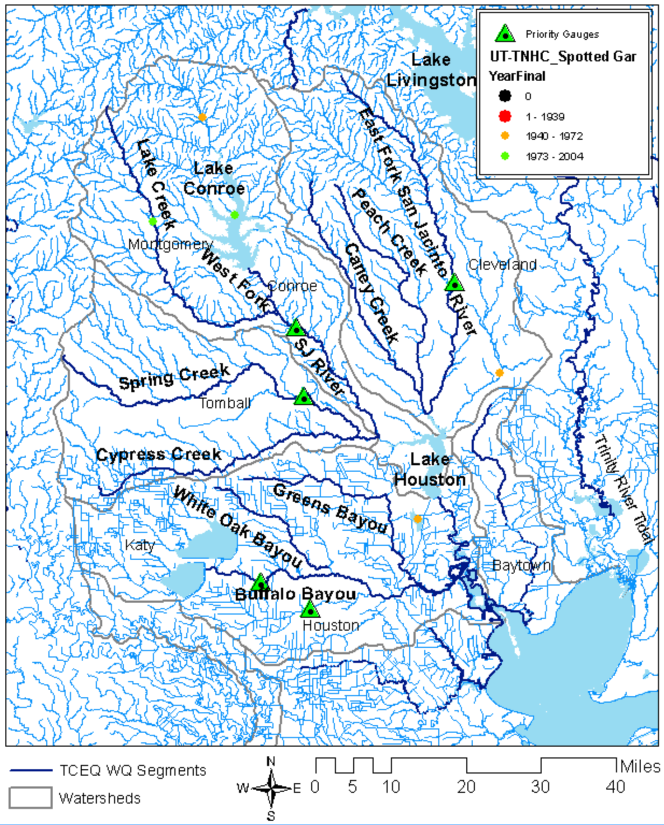
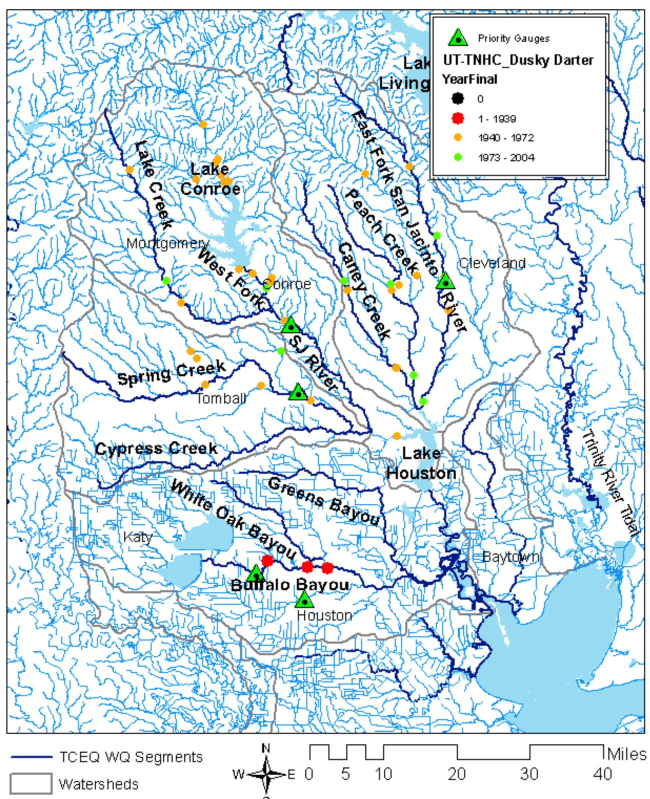
Spotted Gar (draft TNHC)



10

Dusky darter (draft TNHC)



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Focal mussel and invertebrate species

Species List - Mollusks and Invertebrate San Jacinto River			Ref. 3 USGS 97-98										Ref. 4 1998	Ref. 5 Rare		Ref. 7 2000	Ref.10 TPWD	
		TPWD draft focal species list 2009-08-12	Buffalo Bayou	Caney Creek	Cypress Creek	East Fork SJR	West Fork SJR	Lake Creek	East Sandy Creek	Luce Bayou	White Oak Bayou	Willow Creek	Upper Basin	Upper Basin	Harris Co.	Upper basin	San Jacinto River	Code
Scientific Name	**Common Name**																	
Tritogonia verrucosa	pistolgrip													X	X		X	
Fusconaia askewi	Texas pigtoe												2	X	X		X	2,3-SC
Lampsilis teres	yellow sandshell	X											2				X	
Quadrula apiculata	southern mapleleaf												36				X	
INVERTEBRATE																		
Macrobrachium ohione	Ohio shrimp	X																

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Focal component discussion

- **Challenges in using the focal species information**
  - **Considering available time-frame, resources and existing information**

- What is a focal biological component?
  - Focal species or guilds
  - Considers competing needs of guilds or species
  - Parameter sensitive to flow variation
  - Parameter indicating ecosystem status
  - Habitat condition affecting a focal species
  - A specific flow condition, in a specific location, during a specific time of year, affecting a focal species?
    - High flow pulse
    - Baseflow in August

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Flow components

Overbank Flows	Overbank flows are infrequent, high magnitude flow events that produce water levels that exceed channel banks and result in water entering the floodplain. A primary objective is to maintain riparian areas associated with riverine systems, eg, transport sediments and nutrients to riparian arease, recharge floodplain aquifers, and provide suitable conditions for seedlings.
High Flow Pulses	High flow pulses are short duration, high magnitude (but still within channel) flow events that occur during or immediately following reainfall events. They serve to maintain important physical habitat features and connectivity along a stream channel.
Base Flows (cfs)	Base flows represent the range of "average" or "normal" flow conditions in the absense of significant precipitation or runoff events. Base flows provide instream habitat conditions needed to maintain the diversity of biological communities in streams and rivers.
Subsistence Flows (cfs)	Subsistence flows are low flows that occur during times of drought or under very dry conditions

Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Winter			Spring			Summer					

From SAC 2009 Hydrologic methods report that cites TIFP 2008, NRC 2005

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Fish focal component summary

<u>Flow Components</u>
Overbank flows
Spotted gar – spring overbank habitats may be beneficial for spawning
Flow pulses
Pallid shiner – turbidity intolerance >45 NTU (adults) and >85 NTU (juveniles)
Largemouth bass – fry are intolerant to velocity >27cm/s
Base flows
Freckled madtom – habitat utilization is largely gravelly riffles
Flathead catfish – young of year require rubble-bottom riffles July – Fall
Dusky darter – spawn over gravel riffles 30-90cm deep February through June
Subsistence flows
Freshwater drum – intolerant of temp. >25.6`C and extended periods of low DO
Largemouth bass – salinity intolerant > 12ppt

<u>Seasonality</u>
Maintenance of spawning habitats important between **April** and **June** for most species.
Bass spawn earlier – late winter to early spring at temperatures between 16 and 22`C

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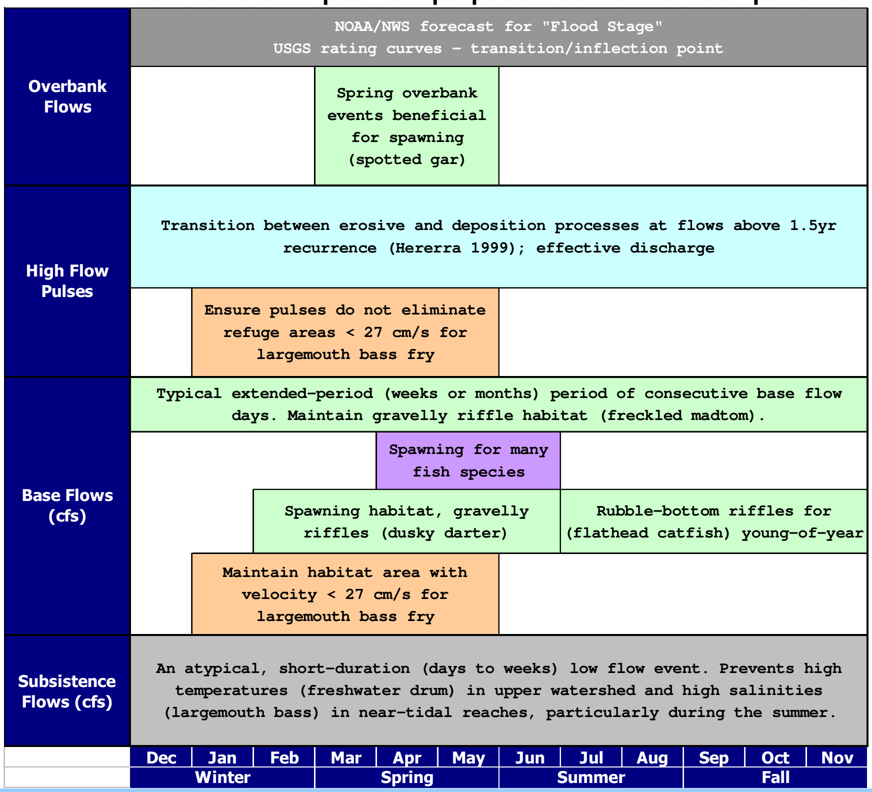
San Jacinto River basin - potential purpose matrix of flow components



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Flow component discussion

- General species information may support utility of flow components
- Site-specific information does not support choice of specific flow values

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Biology overlay

- TDWR 1981 and TDWR 1983
  - W Fork San Jacinto River
  - intensive surveys from winter 1979 and summer 1981
  - Stream substrate sand; some areas of gravel riffles
- TPWD 1986 – Fisheries status reports
  - Characterize the fisheries as in good condition
- USGS least-impacted sites/reaches

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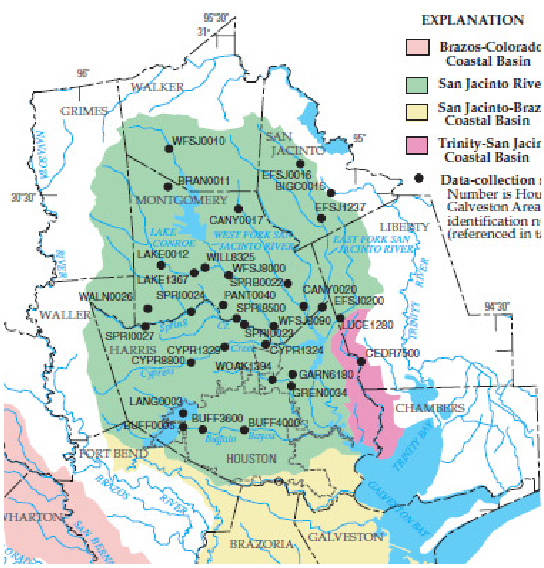
USGS-HGAC study



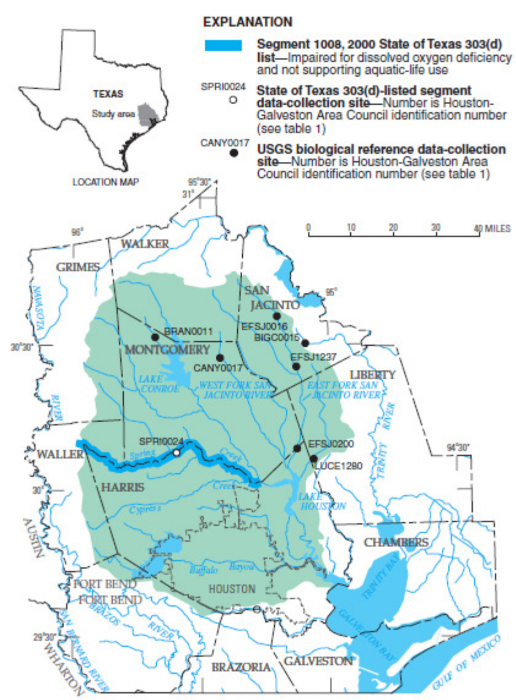


Figure 1. San Jacinto River Basin and data-collection sites.

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Hydrology overlay

Table 1 - TCEQ 7Q2 values for SJR basin gauges

Segment	Site Code	Site Name	Start Year	End Year	7Q2 (ft3/s)
902	08067500	Cedar Bayou nr Crosby, TX	1972	1996	0.3
1003	08070200	E Fk San Jacinto Rv nr New Caney, TX	1984	1996	22.6
1003	**08070000**	**E Fk San Jacinto Rv nr Cleveland, TX**	**1973**	**1996**	**18.2**
1004	08068090	W Fk San Jacinto Rv abv Lk Houston nr Porter, TX	1984	1996	26.6
1004	**08068000**	**W Fk San Jacinto Rv nr Conroe, TX**	**1974**	**1996**	**20.3**
1004	08067650	W Fk San Jacinto Rv bl Lk Conroe nr Conroe, TX	1975	1989	0.1*
1004	08067610	Lk Conroe Outflow Weir nr Conroe, TX	1974	1989	0.1*
1008	**08068500**	**Spring Ck nr Spring, TX**	**1975**	**1996**	**15.4**
1009	08069000	Cypress Ck nr Westfield, TX	1979	1996	17.6
1009	08068800	Cypress Ck at Grant Rd nr Cypress, TX	1983	1996	1.2
1009	08068740	Cypress Ck at House-Hahl Rd nr Cypress, TX	1976	1996	0.2
1009	08068720	Cypress Ck at Katy-Hockley Rd nr Hockley, TX	1976	1996	0.1*
1010	08070500	Caney Ck nr Splendora, TX	1973	1996	14.2
1011	08071000	Peach Ck at Splendora, TX	1960	1977	7.2
1014	08074000	Buffalo Bayou at Houston, TX	1962	1975	25.4
1014	**08073700**	**Buffalo Bayou at Piney Point, TX**	**1985**	**1996**	**50.6**
1014	08073600	Buffalo Bayou at W Belt Dr, Houston, TX	1980	1996	43.3
1014	08073500	Buffalo Bayou nr Addicks, TX	1980	1996	23
1015	08067900	Lake Ck nr Conroe, TX	1969	1989	2.8
1016	08076000	Greens Bayou nr Houston, TX	1980	1996	20.7
1016	08075900	Greens Bayou nr US Hwy 75 nr Houston, TX	1981	1996	11.8
1017	08074500	Whiteoak Bayou at Houston, TX	1980	1996	29.1
1102	08077000	Clear Ck nr Pearland, TX	1963	1992	0.5
1108	08078000	Chocolate Bayou nr Alvin, TX	1966	1996	1.5

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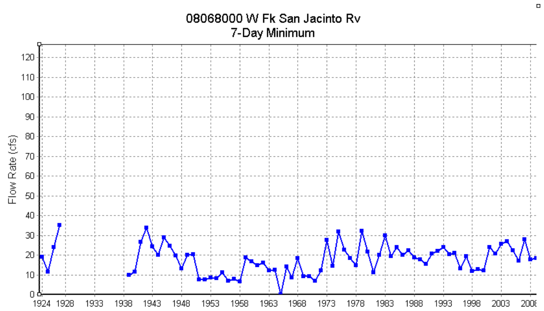
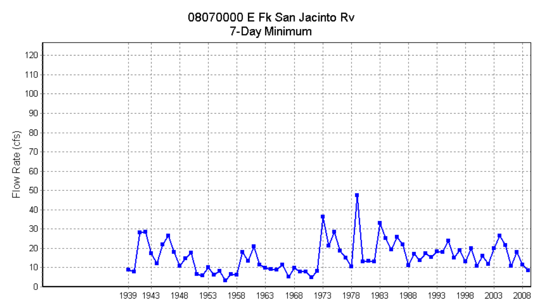
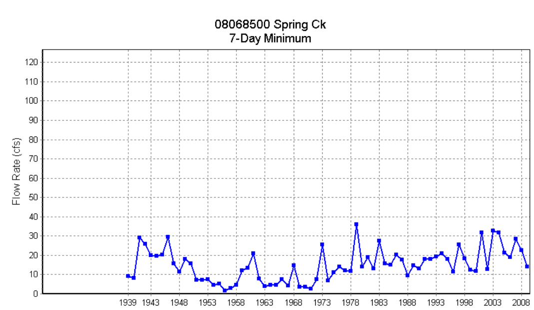
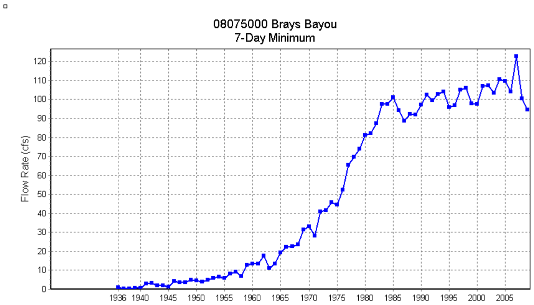
Hydrology overlay









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Physical Processes overlay

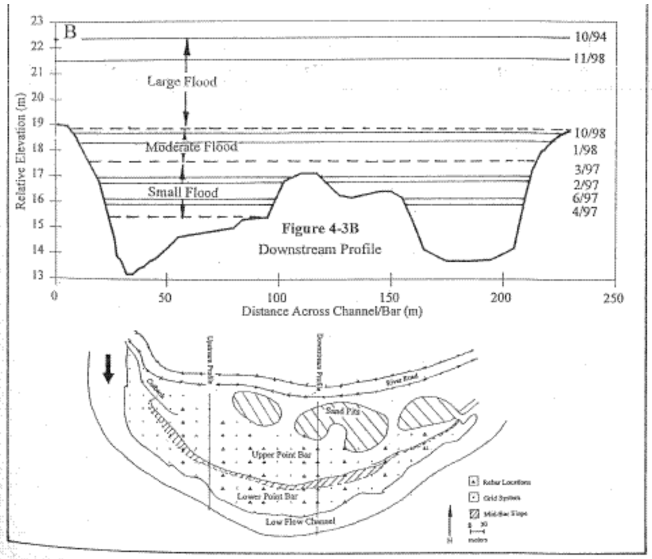

Figure 3-4: Upstream (A) and Downstream (B) Profiles across Hallett point bar showing high stage of five flood events.

Herrera, Roxana. 1999. Morphology and stratigraphy of a coarse-grained point bar on the West Fork San Jacinto River : Montgomery County, Texas. University of Houston, MS Thesis.

- 08068000 USGS West Fork SJR at Conroe
- Small flood <1.5 year Recurrence Interval (RI)
  - ~7,000 cfs
  - Erosion processes
- Medium flood 1.5 to 4 year RI
  - Deposition
- Large flood >4 year RI
  - 18,000 cfs
  - Deposition

Sinuosity=1.3; width:depth=35; slope=0.0009; grain-size (qualitative)

cross-section and mapping measurements following a number of flood events

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Physical processes overlay

- USDA 1952
  - Bedload component estimated at 20-25% of total sediment load
- SJRA 1981 (LP168)
  - Suspended sediment load estimated
    - E Fork SJR – 363,200 lb/day
    - W Fork SJR – 189,800 lb/day
- TDWR 1981
  - E Fork SJR – 0.037 ac-ft/sq. mile/year
  - Captured by Lake Houston

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Water quality overlay

- Intensive surveys:
  - Winter 1979
  - Summer 1981
- Cursory inspection of available TCEQ-SWQM data

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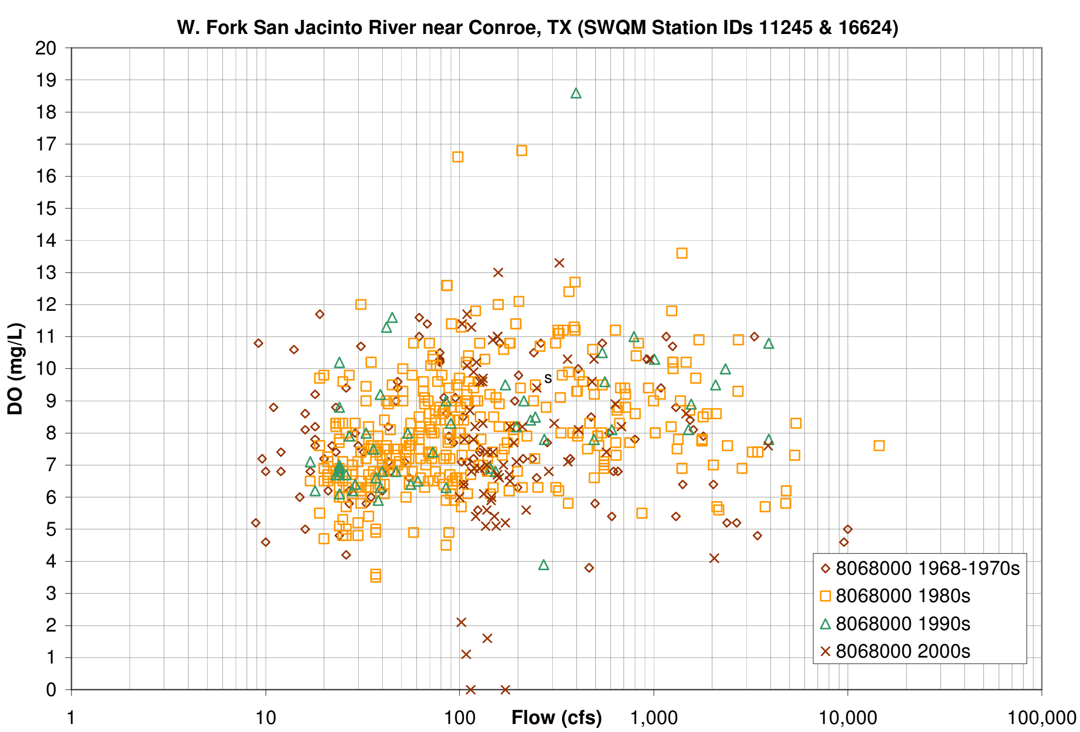

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Sediment and nutrient loading

- USDA 1952
  - Net 10% decrease in bay volume 1898-1937 because of decreased depths in delta areas
- Longley et al. 1994
  - Net increase in depth 1968-1977
  - Subsidence
  - Lake Houston completed 1953
- TDWR 1981 (LP113) – Nutrient loadings based upon 1970-1977 data
- Longley et al. 2001
  - Nutrient budget

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Questions

- Process
  - TWDB accepting comments
    - Jorge Izaguirre
    - Ruben Solis
  - September 14, 2009 - Final comments transmitted to SJRA-EC team
  - September 21, 2009 - Final report due
- tosting at espeyconsultants.com
- 512.326.5659

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Appendix G – TWDB comments

COMMENTS FROM TWDB AND SAC

Tim Osting

From: Jorge Izaguirre [Jorge.Izaguirre@twdb.state.tx.us]
Sent: Thursday, September 17, 2009 2:06 PM
To: Tim Osting; rkelling@sjra.net; Ruben Solis
Cc: Carla Guthrie; Mark Wentzel; Nolan Raphelt
Subject: Re: Fwd: RE: SB3 SAC San Jacinto River basin EcologicalOverlayDraft for distribution

Attachments: 20090904_SJR_Fish_Mussel_Matrix.xls; 20090904_SJR_EcoOverlay_DRAFTd.pdf; 0900010980_SJRA.pdf

20090904_SJR_Fish_Mussel_Matri... 20090904_SJR_EcoOverlay_DRAFTd... 0900010980_SJRA.pdf (1 MB)

Tim,

FYI (see email below).

Here are some comments:

From Carla Guthrie:
For Osting and SJRA draft report: Report looks outstanding given the time constraints on the project. Only comment is that the Executive Summary paragraph #4 uses TSF rather than TSJ for the Trinity-San Jacinto acronym.

From me:
Page 2:
3.0 Overlay .... has ERROR! BOOKMARK NOT DEFINED.

Also, as a reminder, please review section 2 of Exhibit C on the contract (attached 0900010980_SJRA.pdf). This section outlines the final deliverables.

Thanks,

Jorge

>>> Ruben Solis 9/17/2009 1:12 PM >>>
FYI - the SAC has no additional comments. - Ruben

>>> "rbrandes" <rbrandes@trcsolutions.com> 9/17/2009 1:11 PM >>>
Ruben, don't know of any comments so I guess go with it.
------Original Message------
From: Ruben Solis
To: Bob TR Brandes
Cc: Tim Osting
Subject: Fwd: RE: SB3 SAC San Jacinto River basin Ecological OverlayDraft for distribution
Sent: Sep 17, 2009 8:27 AM

Bob,

Bob Huston is out - wondering if we'll be getting any comments from the SAC on the San Jacinto River Basin Ecological Overlay draft report provided by Tim Osting. The final is due on Monday, and he's trying to wrap up his edits.

Thanks.

- Ruben

>>> "Tim Osting" <tosting@espeyconsultants.com> 9/16/2009 10:50 AM >>>

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Ruben,
I've not received a response from Mr. Huston except yesterday's auto-response below. Dr. Espey suggested possibly contacting Fred Manhart if you think it is necessary.

I've not received any specific comments from SAC. Except Weirsema discussed during the SAC meeting use of caution related to habitat suitability given regional differences; he used as an example temperature preferences developed from data in northern US states. To date, no comments affecting the final report have been provided to me.

Tim

-----Original Message-----
From: Robert Huston
Sent: Tuesday, September 15, 2009 10:51 AM
To: Tim Osting
Subject: Out of Office AutoReply: SB3 SAC San Jacinto River basin Ecological Overlay Draft for distribution

I am out of the office until Monday, September 21st. Should you need to contact me in case of emergency, please leave me a voice mail on my cell phone (512)913-4554. Thanks, Bob Huston

Sent via BlackBerry by AT&T

E C