



Brazos River Authority

Brazos River Authority Environmental Flow Program

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Background

Texas Instream Flow Program – 2001 (SB2; TCEQ, TPWD, TWDB)

How much water should flow in rivers for a sound ecological environment

Directed agencies to conduct studies and analyses to determine flow conditions

Environmental Flow Standards - 2007 (SB3; BBASC; BBEST)

Established criteria to maintain sound ecological environments

Recommended flow tiers – Subsistence, Low Base, Medium Base, High Base

TCEQ Adopts Environmental Flow Standards for Brazos Basin - 2014

Instream flow studies target each flow tier in the Brazos River Basin (BRA)

Utilize TIFP protocols to collect baseline ecosystem data – habitat, benthics, fish

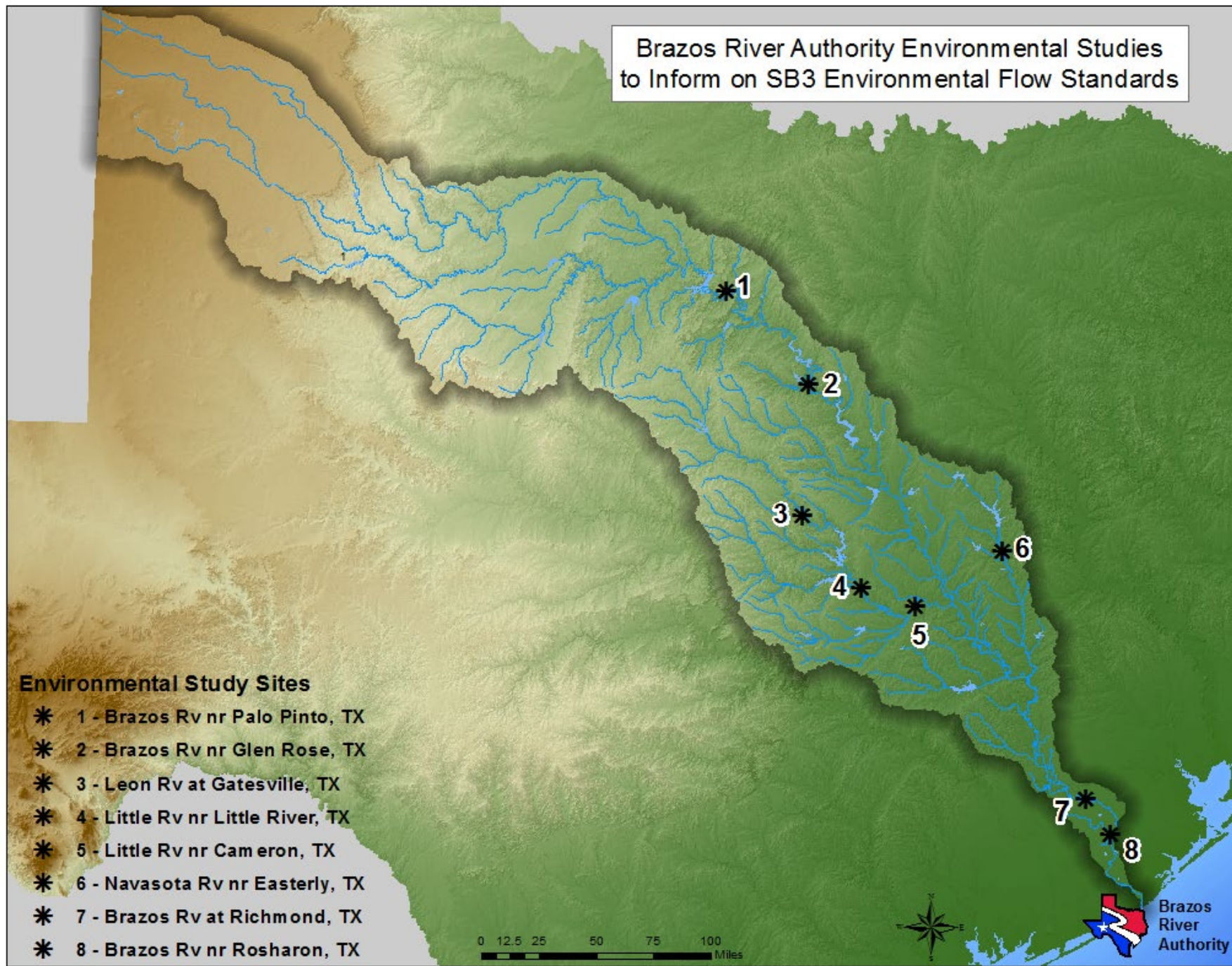


2014 TPWD MOU

- **BRA entered a MOU with TPWD in 2014 after e-flow standards were adopted for basin**
- **BRA commits to study 8 stream reaches with e-flow standards**
- **Goals**
 - **Generate baseline data for sites**
 - **Sample across range of adopted subsistence and base flows**
 - **15 instream events and 5 riparian/substrate/channel survey events per site**
 - **Create a methodology that can be repeated once baseline data sets are established to assess changes in water quality, biological assemblage, substrate, channel, etc.**



Brazos River Authority Environmental Studies
to Inform on SB3 Environmental Flow Standards





Site Selection Goals

- **Landowner access**
 - Has been difficult in some areas
 - Landowner attempts to be helpful
- **Undisturbed riparian zone on both sides of reach**
 - Not always attainable
- **Riffle**
- **Run**
- **Cut bank**



Components to be Studied at Each Site

- **Discharge, velocity, and depth point measurements**
- **Temperature, pH, Conductivity, and DO**
- **Fixed photography, instream cover, habitat identification and channel surveys**
- **Macroinvertebrates and mussels (where possible)**
- **Fish assemblages**
- **Riparian Tree Surveys**
- **Sediment composition**
- **Tree coring at some sites – started 2022**
 - Leon
 - Brazos at Rosharon



Progress

- **BRA implemented sampling in 2012 at 6 sites targeting each flow tier**
 - **In the process of establishing 2 new sites on the Little River**
 - **Landowner access is somewhat problematic**
- **66 events under this protocol**
- **Monitoring is ongoing**

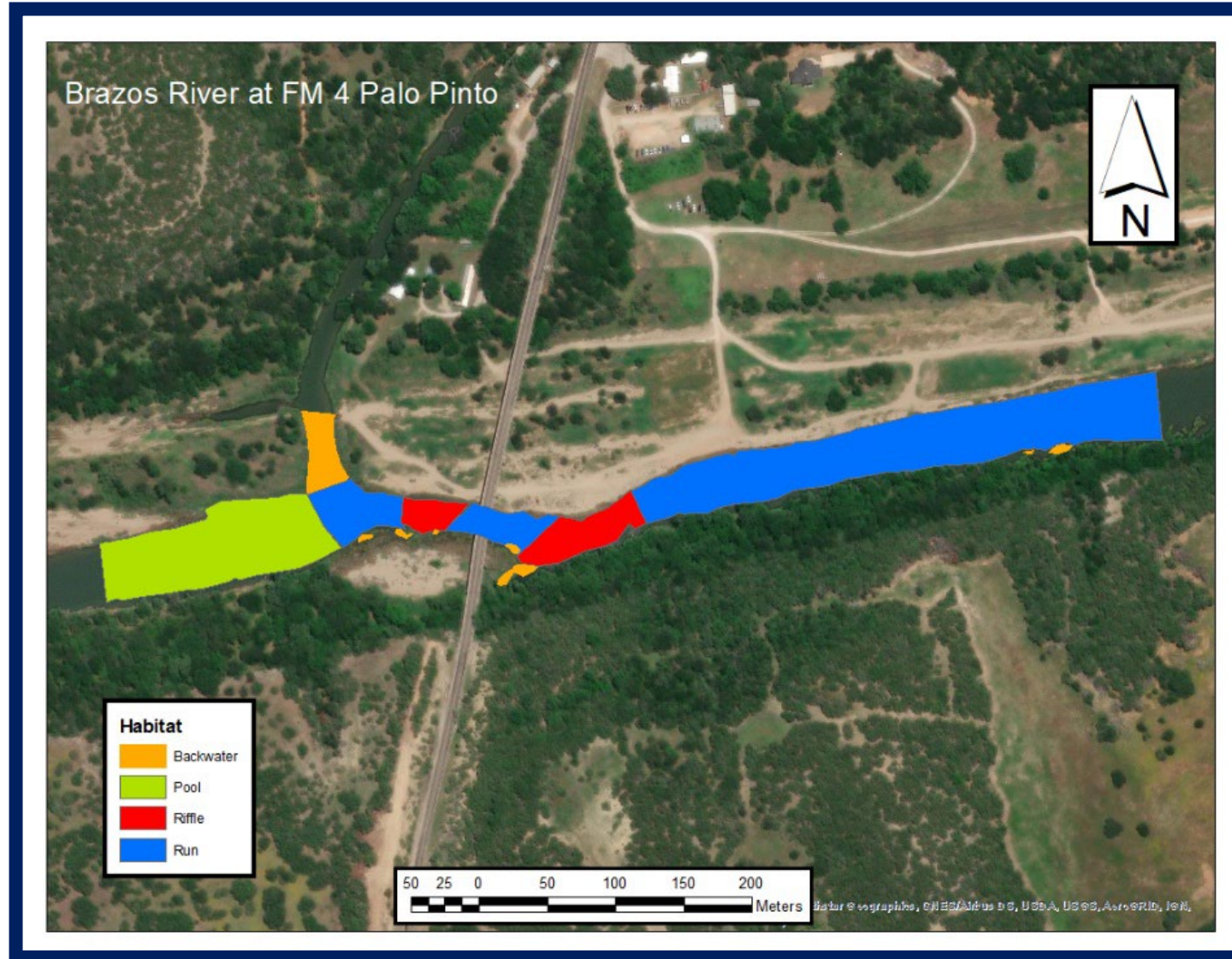


Biological Methods

- **Habitat**
 - GPS mapping of individual habitats
 - Water quality (YSI) and point velocity at equidistant points in each habitat
 - Instantaneous flow measurement (USGS or in-situ Flowtracker)
 - Post-processing: GIS maps
- **Fish**
 - Electrofishing, seining, and fish quantification by habitat
 - Post-processing: Regionalized fish IBI
- **Invertebrates**
 - Kicknet and snag sample collection for target of ~300 individuals
 - Post-processing: Benthic IBI
- **Mussels**
 - Hand sampling for 3 man-hours, identification and measuring



Habitat Mapping



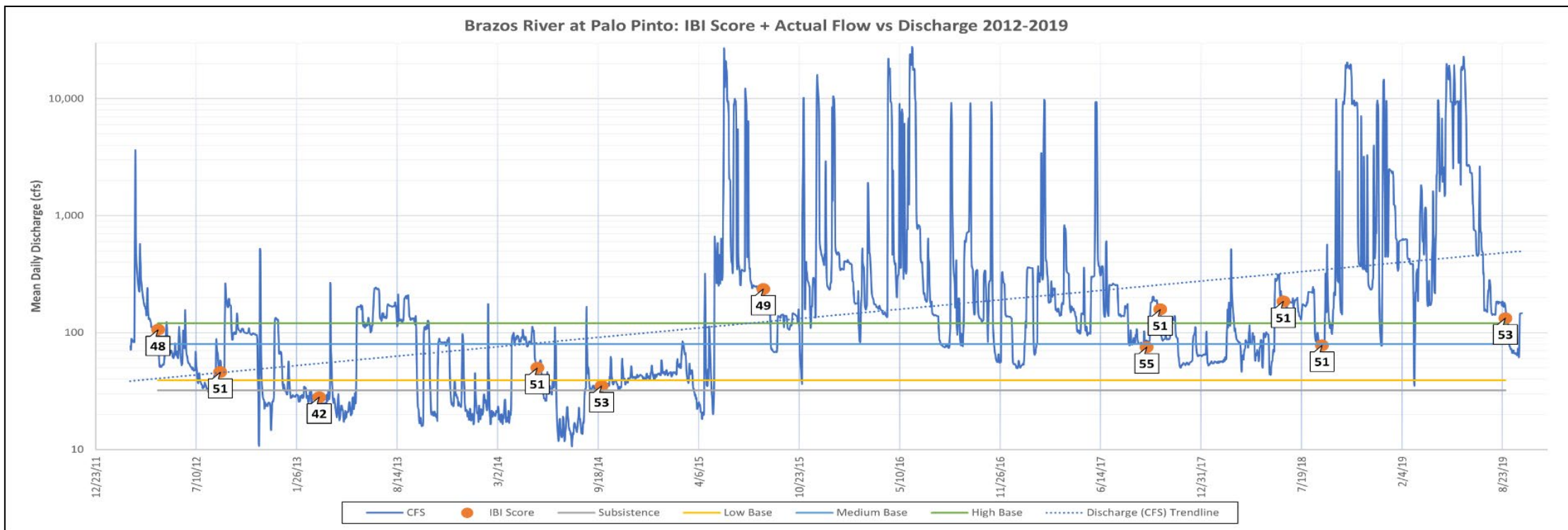


Events Summary- Fish

Site	Sampling Date	Flow Tier	Target Flow (cfs)	Actual Flow (cfs)	Fish Collection		
					# species	IBI score	ALU Rating
Brazos R. nr Palo Pinto (at FM 4)	25Apr12	high base	100-120	106	17	48	high
	27Aug12	low base	39-40	46	29	51	exceptional
	12Mar13	subsistence	17	28	22	42	high
	20May14	low base	39-40	50	22	51	exceptional
	25Sep14	low base	39-40	35	24	53	exceptional
	13Aug15	> high base	> 120	236	21	49	exceptional
	14Sep17	medium base	61-75	75	26	55	exceptional
	11Oct17	> high base	> 120	158	27	51	exceptional
	13Jun18	>high base	> 120	185	25	51	exceptional
	29Aug18	medium base	61-75	78	27	51	exceptional
29Aug19	> high base	> 120	133	25	53	exceptional	
Leon R. nr Gatesville (at FM 1829)	01Aug19	> high base	> 54	59.6	18	45	high
	10Oct19	medium base	12-24	24.7	18	45	high
	16Mar22	medium base	12-24	13.3	16	45	high
	26Jul23	subsistence	1	>0.01	16	49	exceptional
	08Jul24	high base	27-54	33.2	20	38	intermediate
Navasota R. nr Easterly (at OSR)	22Jul15	high base	16-29	24	29	56	exceptional
	11Feb16	> high base	> 29	101	15	48	high
	14Jul16	> high base	> 29	46	27	50	high
	27Sep17	medium base	8-19	12.7	23	50	high
	8-9May18	> high base	> 29	44	20	50	high
	26Jul18	low base	3-10	6.7	29	56	exceptional
	15Aug19	high base	16-29	26.7	27	54	exceptional
	26Sep19	high base	16-29	18.7	29	60	exceptional
22Aug24	high base	16-29	28.4	30	58	exceptional	
Brazos R. nr Richmond (at FM 723 N of Rosenberg)	21Aug13	subsistence	550	425	22	43	high
	15Apr14	subsistence	550	~700	16	40	high
	14Jul14	low base	930-1,190	801	17	45	high
	18-19Oct16	high base	2,190-3,980	~2200	16	47	high
	16Nov17	medium base	1,330-2,140	~1700	23	45	high
	16Oct19	low base	930-1,190	~1000	13	45	high
	10Dec21	low base	930-1,190	~1100	9	41	high
	12Sep22	low base	930-1,190	~1200	19	45	high
Brazos R. nr Rosharon (8.4 km upstr. FM 1462)	29Apr14	subsistence	430	492	20	41	high
	13Aug14	low base	430	770	20	39	high
	17Sep15	medium base	1,420-2,570	2544	16	30	intermediate
	12Sep19	medium base	1,420-2,570	1769	19	37	high
	17Aug22	subsistence	430	295	21	36	intermediate



Results – Palo Pinto

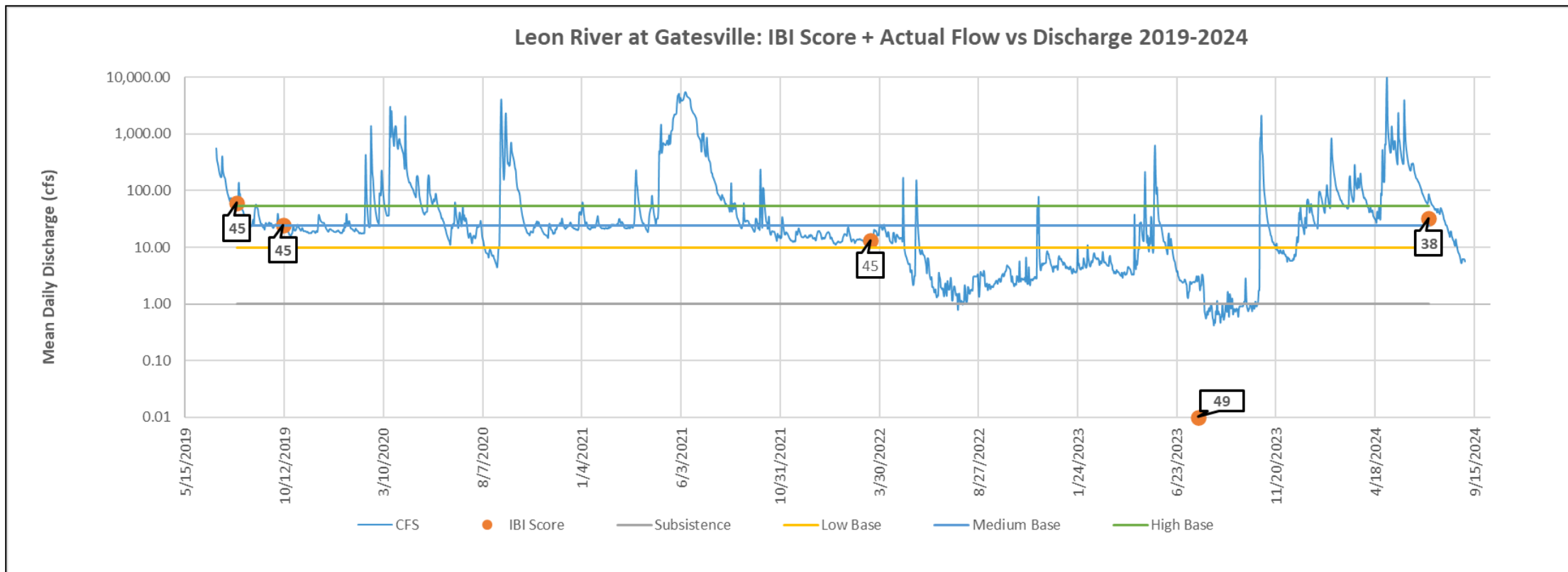


Ecoregion 27/29/32 IBI Scores

Exceptional	> 48
High	41 - 48
Intermediate	35 - 40
Limited	< 35



Results – Leon River

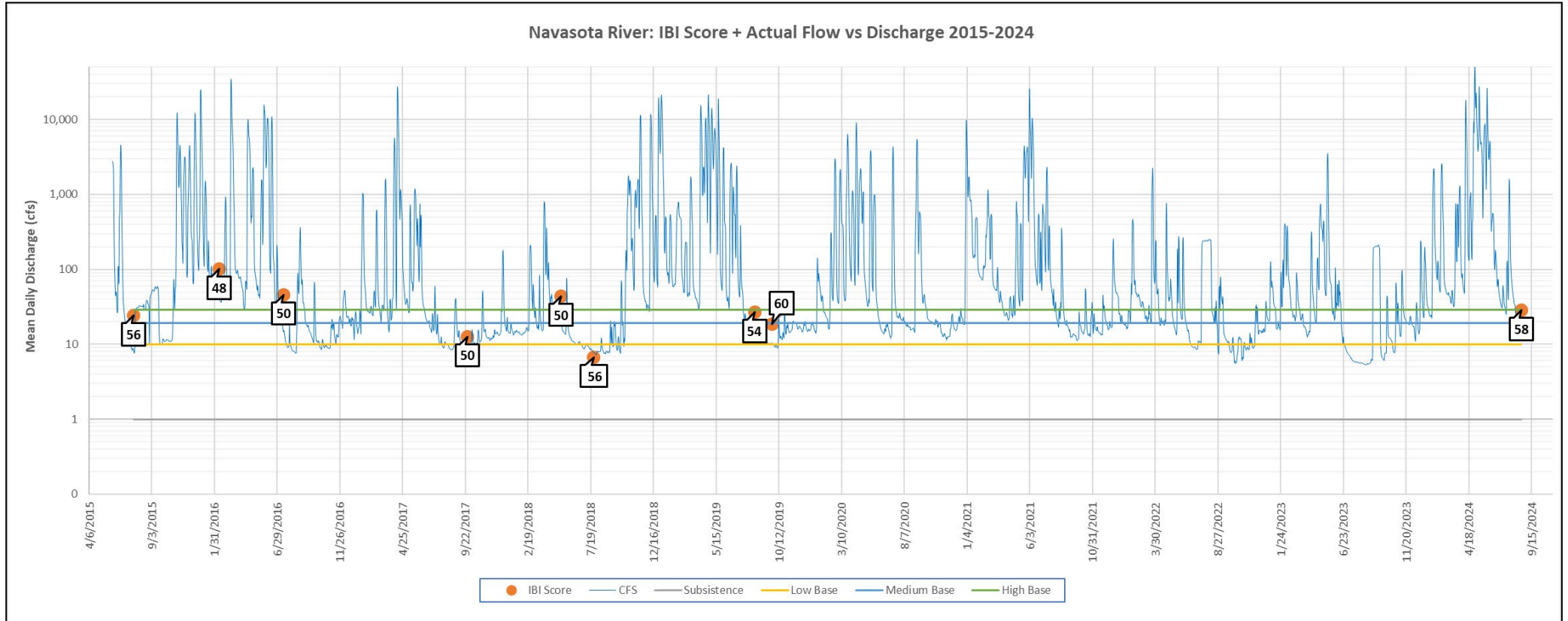


Ecoregion 27/29/32 IBI Scores

Exceptional	> 48
High	41 - 48
Intermediate	35 - 40
Limited	< 35



Results – Navasota River

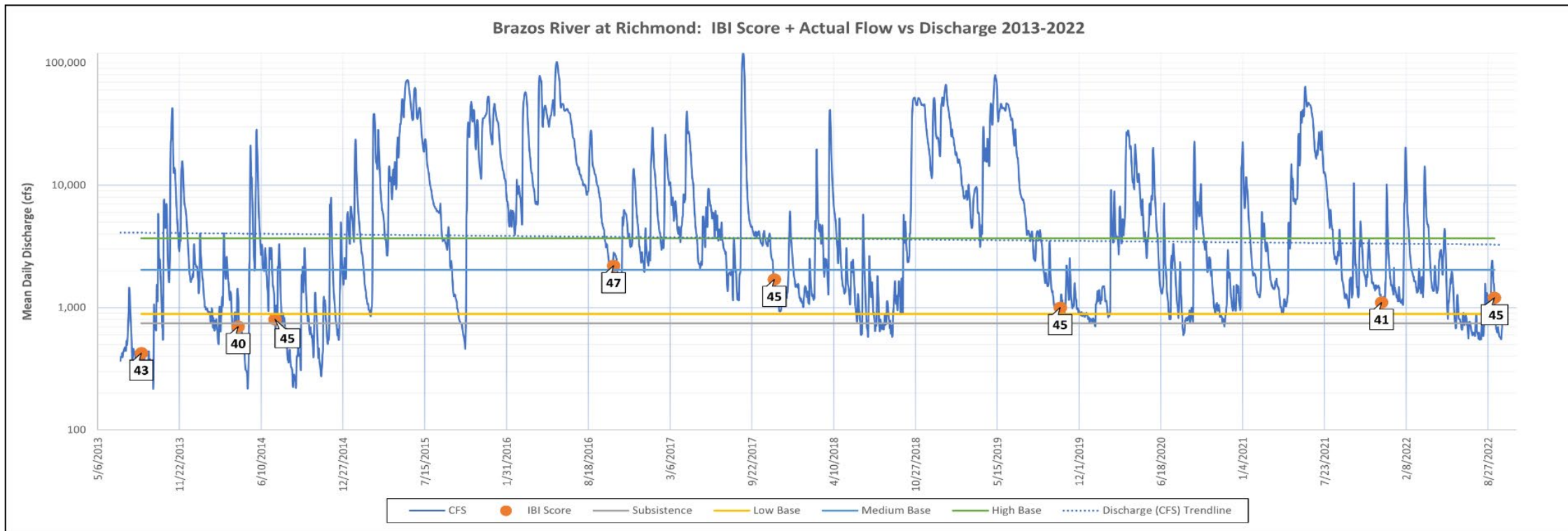


Ecoregion 33/35 IBI Scores

Exceptional	> 51
High	42 - 51
Intermediate	34 - 41
Limited	< 34



Results - Richmond

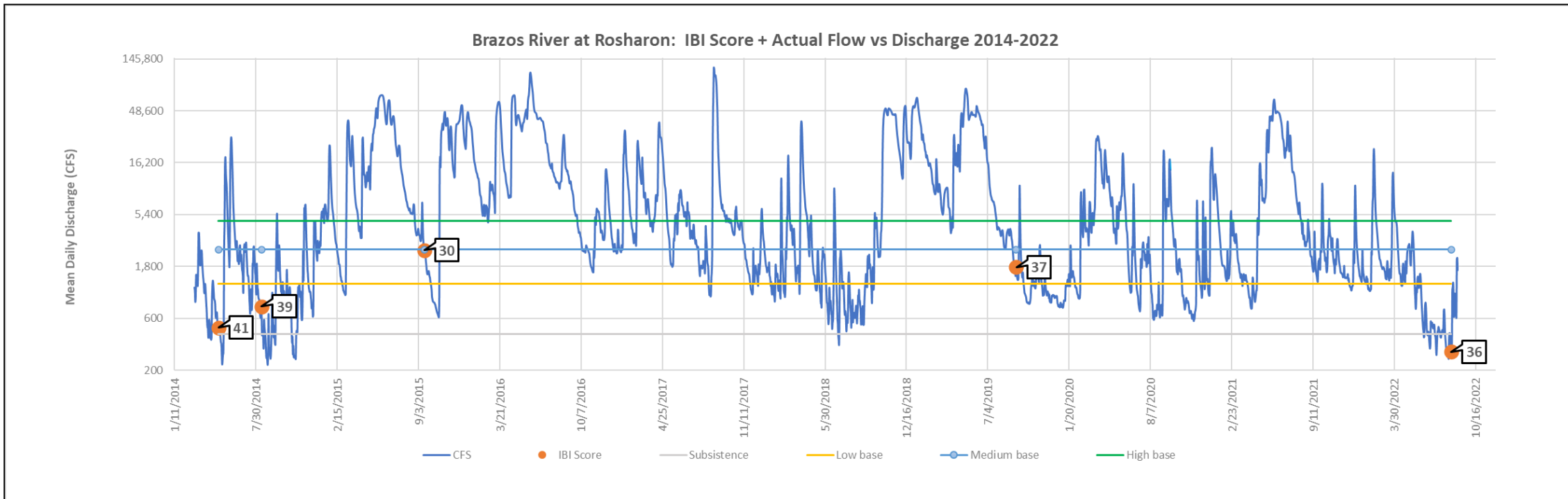


Ecoregion 34 IBI Scores

Exceptional	> 48
High	37 - 48
Intermediate	23 - 36
Limited	< 23



Results – Rosharon



Ecoregion 34 IBI Scores

Exceptional	> 48
High	37 - 48
Intermediate	23 - 36
Limited	< 23



Results – Fish

- **Highest species richness at Navasota R. and Brazos R. at Palo Pinto**
- **No T&E species observed**
- **2 TXNDD species**
 - **Alligator Gar:**
 - **Navasota River and Brazos River at Rosharon**
 - **Silverband Shiner:**
 - **Brazos River at Richmond and Rosharon**
- **Fish hosts to 2 federally-protected and 1 state-protected mussel species**
 - **Endangered – Balcones Spike (USFWS)**
 - **Red Shiner**
 - **Blacktail Shiner**
 - **Threatened – Texas Fawnsfoot (USFWS) and Brazos Heelsplitter (TPWD)**
 - **Freshwater Drum**



Observations

- **All but 2 sites (not represented here) exhibited ALU scores of “high” or “exceptional” across 5 hydrological targets (subsistence, low base, medium base, high base, and greater than high base)**
 - **Exceptions**
 - **Brazos River near Glen Rose - “intermediate” at one low base sampling event**
 - **Brazos River near Rosharon - “intermediate” at one subsistence and one medium base**
- **The fish community IBI results of 11 years of sampling at sites on the mainstem Brazos River and three of its major tributaries indicate overall sound fish environments across recommended flow tiers and highlight the resiliency of fish communities in ever-changing habitats.**



Mussels

Site	Date	Time	Method	Quadrat Number	Collectors	Taxon	Number of Individuals	Kept / Released	Comment
Navasota R. at OSR	7/20/2015	1215-1315	Time Search	na	JG/MB	Lousiana fatmucket	5	R	
Navasota R. at OSR	7/20/2015	1215-1315	Time Search	na	JG/MB	Smooth pimpleback	39	R	
Navasota R. at OSR	7/20/2015	1215-1315	Time Search	na	JG/MB	Threeridge	19*	R	* Stopped counting after 19 as it was the dominant species in the area and would be documented in quadrat samples.
Navasota R. at OSR	7/20/2015	1215-1315	Time Search	na	JG/MB	Fragile papershell	1	R	
Navasota R. at OSR	7/20/2015	1215-1315	Time Search	na	JG/MB	Southern mapleleaf	4	R	
Navasota R. at OSR	7/20/2015	1215-1315	Time Search	na	JG/MB	Pistolgrip	2	R	
Navasota R. at OSR	7/20/2015	1215-1315	Time Search	na	JG/MB	Yellow sandshell	1	R	
Navasota R. at OSR	7/20/2015	1215-1315	Time Search	na	JG/MB	Washboard	3	R	
Navasota R. at OSR	7/20/2015	1346	0.25m ² Quadrat	1	JG	Threeridge	2	R	
Navasota R. at OSR	7/20/2015	1346	0.25m ² Quadrat	1	JG	Smooth pimpleback	1	R	
Navasota R. at OSR	7/20/2015	1351	0.25m ² Quadrat	2	JG	Smooth pimpleback	2	R	Many Corbicula collected as well.
Navasota R. at OSR	7/20/2015	1354	0.25m ² Quadrat	3	JG	Threeridge	2	R	
Navasota R. at OSR	7/20/2015	1354	0.25m ² Quadrat	3	JG	Smooth pimpleback	1	R	
Navasota R. at OSR	7/20/2015	1400	0.25m ² Quadrat	4	JG	Threeridge	2	R	
Navasota R. at OSR	7/20/2015	1400	0.25m ² Quadrat	4	JG	Smooth pimpleback	2	R	
Navasota R. at OSR	7/20/2015	1400	0.25m ² Quadrat	4	JG	Southern mapleleaf	1	R	
Navasota R. at OSR	7/20/2015	1406	0.25m ² Quadrat	5	JG	Threeridge	9	R	
Navasota R. at OSR	7/20/2015	1406	0.25m ² Quadrat	5	JG	Smooth pimpleback	3	R	
Navasota R. at OSR	7/20/2015	1406	0.25m ² Quadrat	5	JG	Southern mapleleaf	1	R	
Navasota R. at OSR	7/20/2015	1411	0.25m ² Quadrat	6	JG	Threeridge	1	R	
Navasota R. at OSR	7/20/2015	1414	0.25m ² Quadrat	7	JG	Smooth pimpleback	2	R	
Navasota R. at OSR	7/20/2015	-	0.25m ² Quadrat	8	JG	none	0	na	
Navasota R. at OSR	7/20/2015	-	0.25m ² Quadrat	9	JG	none	0	na	
Navasota R. at OSR	7/20/2015	-	0.25m ² Quadrat	10	JG	none	0	na	
Navasota R. at OSR	7/20/2015	1427	0.25m ² Quadrat	11	JG	Smooth pimpleback	1	R	
Navasota R. at OSR	7/20/2015	-	0.25m ² Quadrat	12	JG	none	0	na	
Navasota R. at OSR	7/20/2015	-	0.25m ² Quadrat	13	JG	none	0	na	
Navasota R. at OSR	7/20/2015	-	0.25m ² Quadrat	14	JG	none	0	na	
Navasota R. at OSR	7/20/2015	-	0.25m ² Quadrat	15	JG	none	0	na	
Threeridge/m ²	4.3								
Smooth pimpleback/m ²	3.2								
Southern mapleleaf/m ²	0.8								





Events Summary- Macroinverts

Site	Sampling Date	Flow Tier	Target Flow (cfs)	Actual Flow (cfs)	Invertebrates		
					# species	IBI Score	ALU Rating
Brazos R. nr Palo Pinto (at FM 4)	25-Apr-12	high base	100-120	106	16	27	intermediate
	27-Aug-12	low base	39-40	46	---	---	---
	12-Mar-13	subsistence	17	28	14	25	intermediate
	20-May-14	low base	39-40	50	18	28	intermediate
	25-Sep-14	low base	39-40	35	16	27	intermediate
	13-Aug-15	> high base	> 120	236	11	21	limited
	14-Sep-17	medium base	61-75	75	22	32	high
	11-Oct-17	> high base	> 120	158	20	35	high
	13-Jun-18	>high base	> 120	185	26	37	exceptional
	29-Aug-18	medium base	61-75	78	18	26	intermediate
29-Aug-19	> high base	> 120	133	17	33	high	
Leon R. nr Gatesville (at FM 1829)	01Aug19	> high base	> 54	59.6	18	33	high
	10Oct19	medium base	12-24	24.7	19	31	high
	16Mar22	medium base	12-24	13.3	20	27	intermediate
	26Jul23	subsistence	1	>0.01	24	26	intermediate
	08Jul24	high base	27-54	33.2	Awaiting data		
Navasota R. nr Easterly (at OSR)	22-Jul-15	high base	16-29	24	21	33	high
	11-Feb-16	> high base	> 29	101	24	32	high
	14-Jul-16	> high base	> 29	46	21	30	high
	27-Sep-17	medium base	8-19	12.7	35	31	high
	8-9May18	> high base	> 29	44	24	32	high
	26-Jul-18	low base	3-10	6.7	33	32	high
	15-Aug-19	high base	16-29	26.7	20	35	high
	26-Sep-19	high base	16-29	18.7	25	27	intermediate
22Aug24	high base	16-29	28.4	Awaiting data			
Brazos R. nr Richmond (at FM 723 N of Rosenberg)	21-Aug-13	subsistence	550	425	---	---	---
	15-Apr-14	subsistence	550	~700	30	25	intermediate
	14-Jul-14	low base	930-1,190	801	22	27	intermediate
	18-19Oct16	high base	2,190-3,980	~2200	19	29	high
	16-Nov-17	medium base	1,330-2,140	~1700	15	28	intermediate
	16-Oct-19	low base	930-1,190	~1000	10	16	limited
	10-Dec-21	low base	930-1,190	~1100	15	22	intermediate
	12-Sep-22	low base	930-1,190	~1200	13	21	limited
Brazos R. nr Rosharon (8.4 km upstr. FM 1462)	29Apr14	subsistence	430	492	14	21	limited
	13Aug14	low base	430	770	9	21	limited
	17Sep15	medium base	1,420-2,570	2544	10	22	intermediate
	12Sep19	medium base	1,420-2,570	1769	10	25	intermediate
	17Aug22	subsistence	430	295	7	19	limited



Macroinvertebrates

SPECIES LIST - BENTHIC MACROINVERTEBRATES						
Date	9/15/15					
Site	Brazos R. near Rosharon					
TCEQ ID	16355					
STORET	Phylum	Class	Order	Family	Genus	Sample
92491	Arthropoda	Insecta	Diptera	Chironomidae		103
92596	Arthropoda	Insecta	Diptera	Simuliidae	<i>Simulium</i>	2
91646	Arthropoda	Insecta	Ephemeroptera	Baetidae	<i>Baetis</i>	36
91600	Arthropoda	Insecta	Ephemeroptera	Caenidae	<i>Caenis</i>	19
91510	Arthropoda	Insecta	Ephemeroptera	Heptageniidae	<i>Maccaffertium</i>	10
91590	Arthropoda	Insecta	Ephemeroptera	Isonychidae	<i>Isonychia</i>	1
91552	Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae	<i>Traverella</i>	4
92296	Arthropoda	Insecta	Trichoptera	Hydropsychidae	<i>Hydropsyche</i>	94
92330	Arthropoda	Insecta	Trichoptera	Hydroptilidae	<i>Neotrichia</i>	1
92304	Arthropoda	Insecta	Trichoptera	Leptoceridae	<i>Nectopsyche</i>	2





Macroinvertebrates

Qualitative Benthic IBI		
Date	9/15/15	
Site	Brazos R. near Rosharon	
TCEQ ID	16355	
Metric	Value	Score
Taxa Richness	10	2
EPT Index	8	3
HBI	5.28	1
% Chironomidae	37.87	1
% Dominant Taxon	37.87	2
% Dominant FFG	49.75	2
% Predators	12.87	4
Intolerant : Tolerant	1.22	1
% Total Trichoptera as Hydropsychidae	96.91	1
Number of Non-Insect Taxa	0	1
% CG	24.82	3
% n as Elmidae	0.00	1
AQUATIC LIFE USE SCORE	22	
AQUATIC LIFE USE RATING	Intermediate	
Kicknet (Qualitative) Scoring Criteria		
Exceptional		>36
High		29 - 36
Intermediate		22 - 28
Limited		<22

Benthic MetaData		
Date	9/15/15	
Site	Brazos R. near Rosharon	
TCEQ ID	16355	
Description	STORET	Value
Data reporting units	89899	1
Kicknet effort (min)	89904	5
Kicknet effort (sq m)	89903	1
Snag area sampled (sq m)	89975	0.3
Snag sampling effort (min)	89905	15
Net mesh size (cm)	89946	0.06
Benthic sampler	89950	3
% Undercut bank	89921	0
% Overhanging brush	89922	0
% Gravel substrate	89923	5
% Sand substrate	89924	30
% Soft bottom	89925	2
% Macrophyte bed	89926	0
% Snags and brush	89927	63
% Bedrock	89928	0
Stream order	84161	9
Ecoregion	89961	34
Total n for sample	89906	272



Channel Surveys

- Monitor change in channel over time and impacts of High Flow Pulses
- Three transects surveyed per site
 - Also used for riparian and sediment





Charts and Analysis Developed using Channel Survey Data

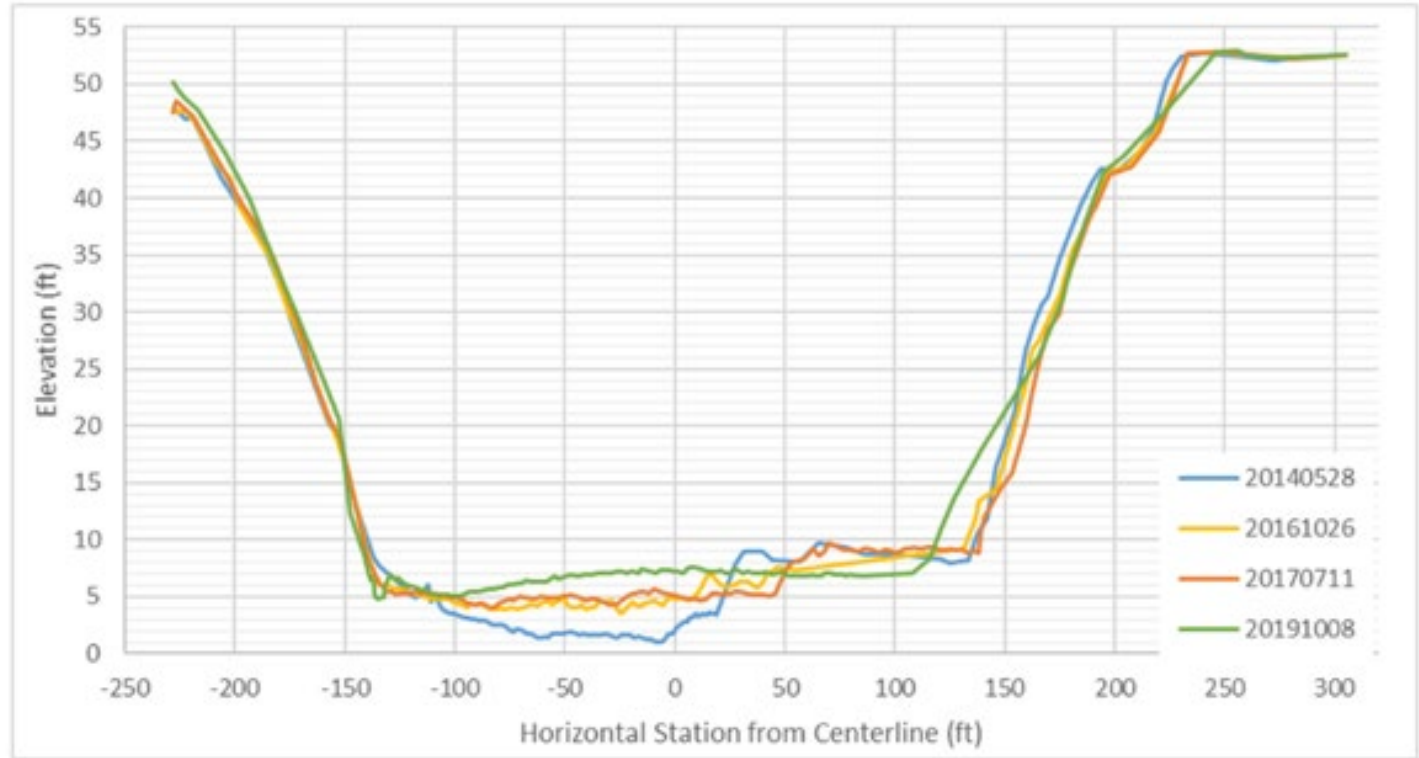


Figure 4.3B: Rosharon upstream cross section for survey years 2014, 2016, 2017 and 2019.

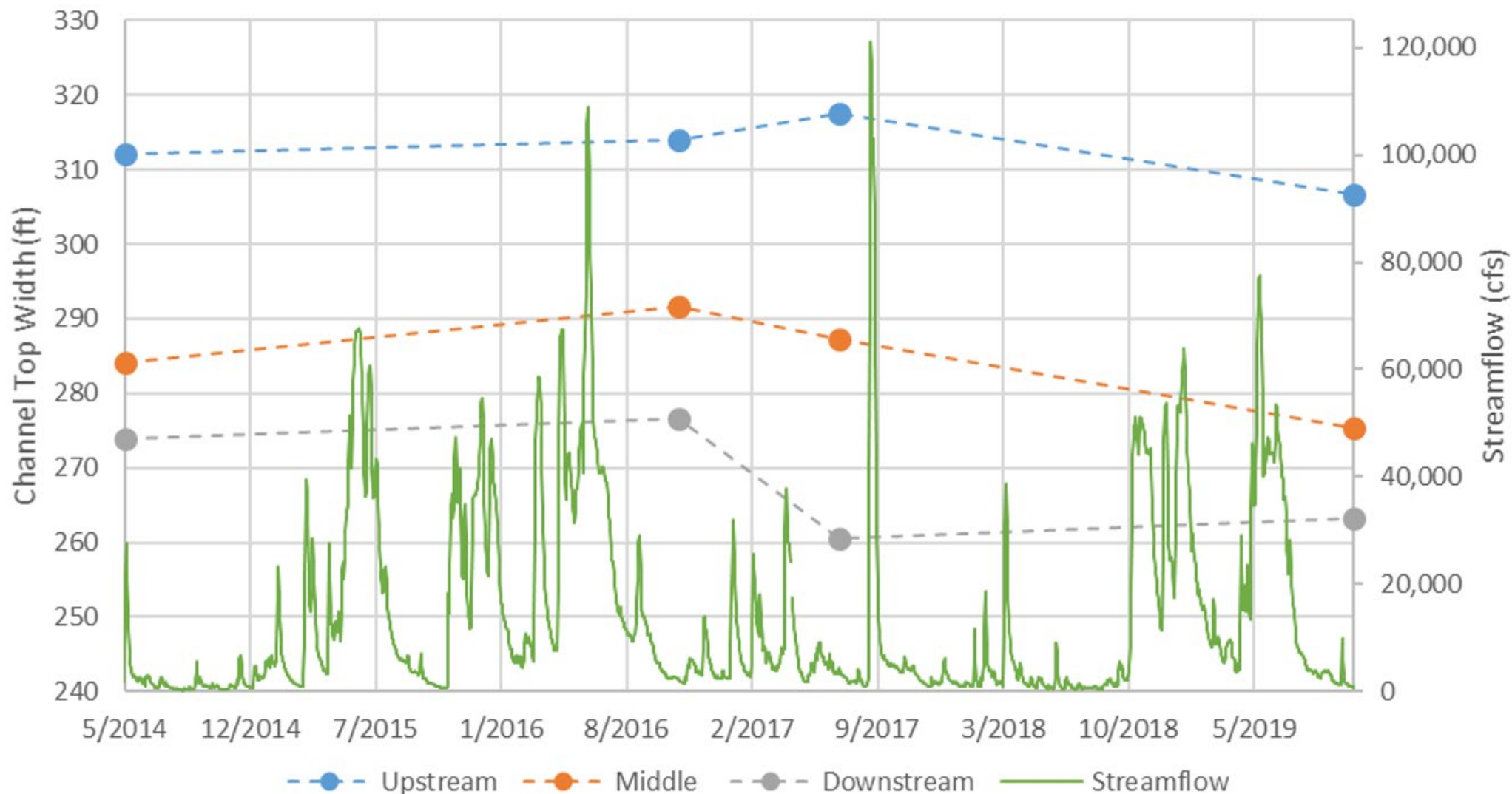


Figure 4.2F: Yearly changes in wetted top width for each Rosharon cross section, along with streamflow. Each cross-section point corresponds to a survey event. Top width is measured at a streamflow of 13,600 cfs and referenced from HEC-RAS model results.

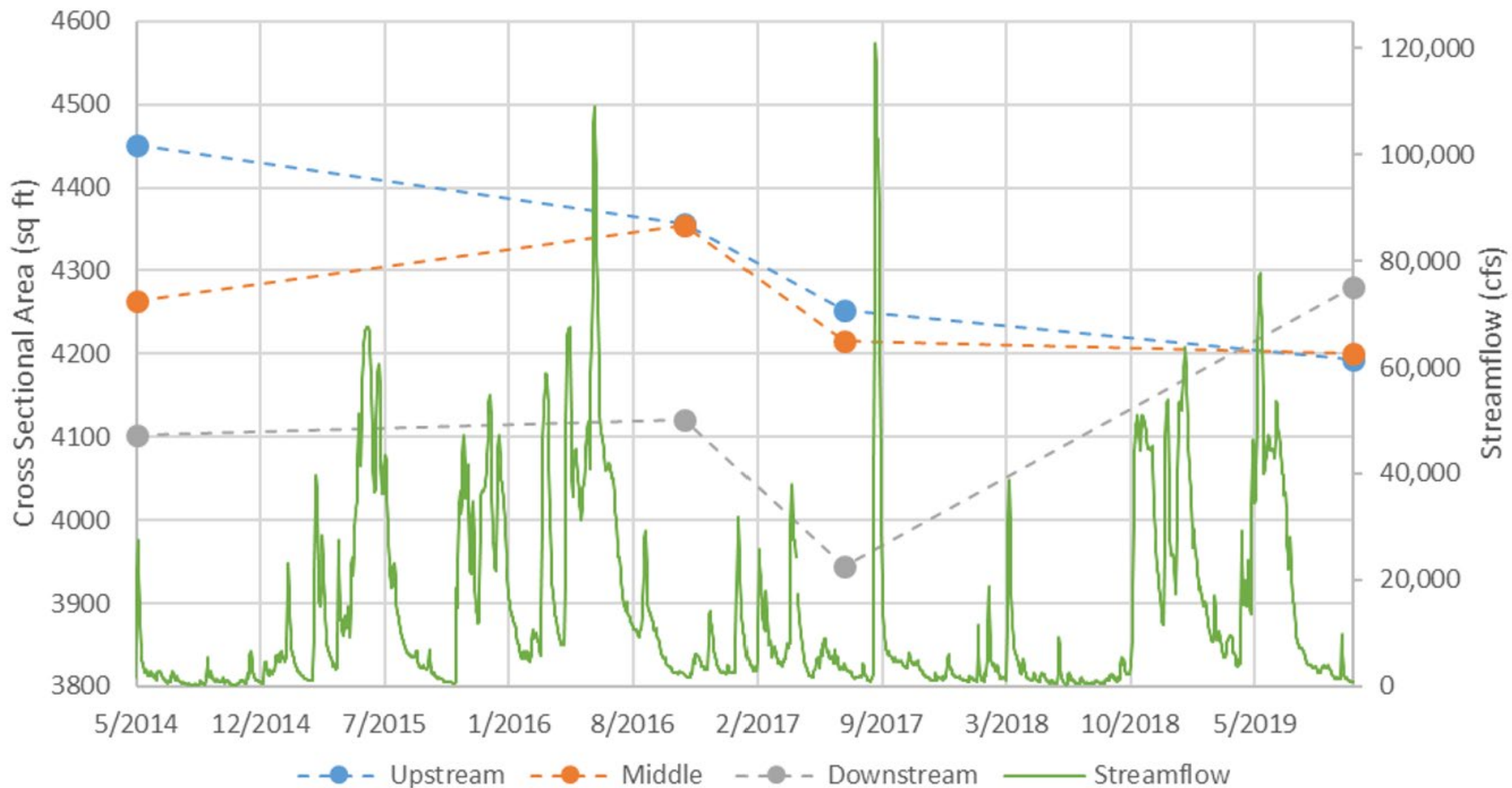


Figure 4.2E: Yearly changes in cross sectional area for each Rosharon cross section, along with streamflow. Each cross-section point corresponds to a survey event. Cross sectional area is measured at a streamflow of 13,600 cfs and referenced from HEC-RAS model results.



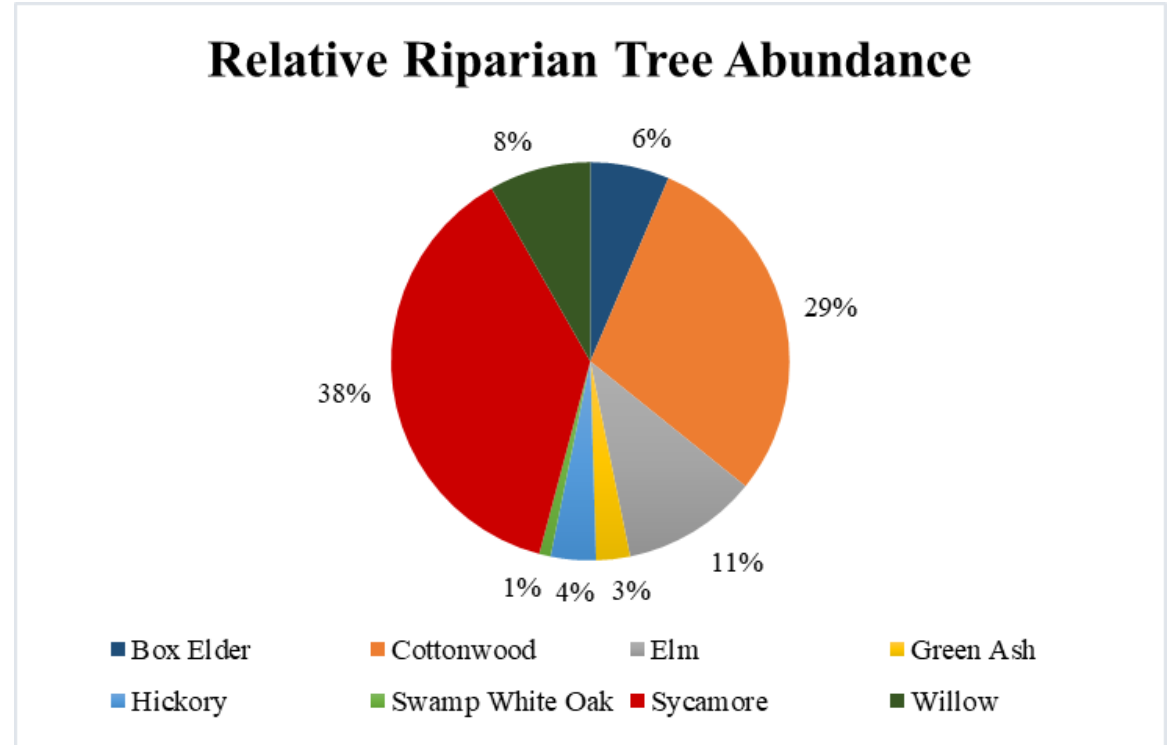
Riparian Sampling

- Identify trees, saplings and seedlings
- Three transects per site
- Started Tree Coring in 2022
 - Rosharon
 - Leon River at Gatesville in



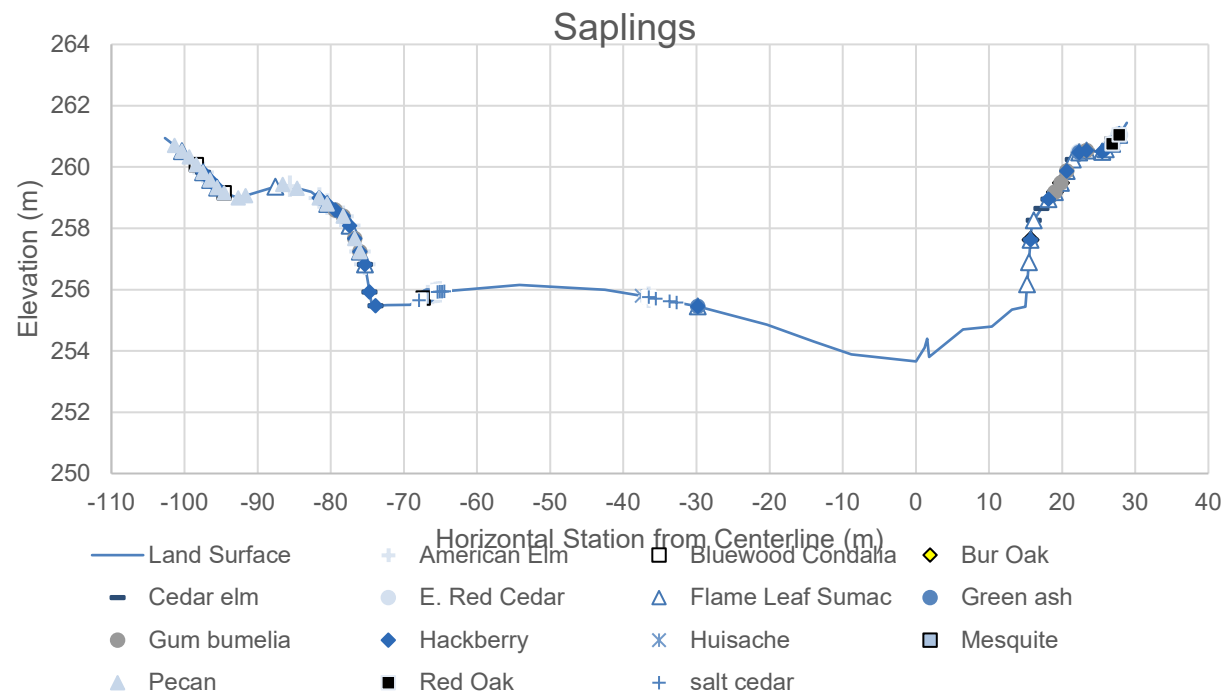
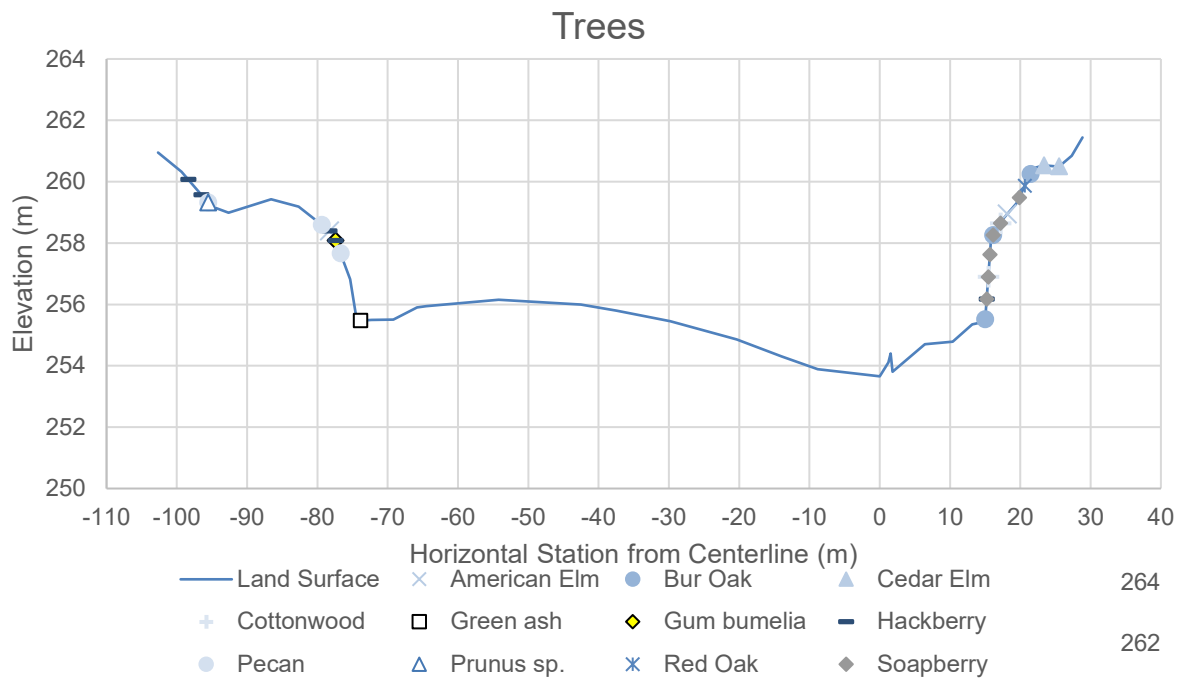


Charts and Analysis Developed using Riparian Data



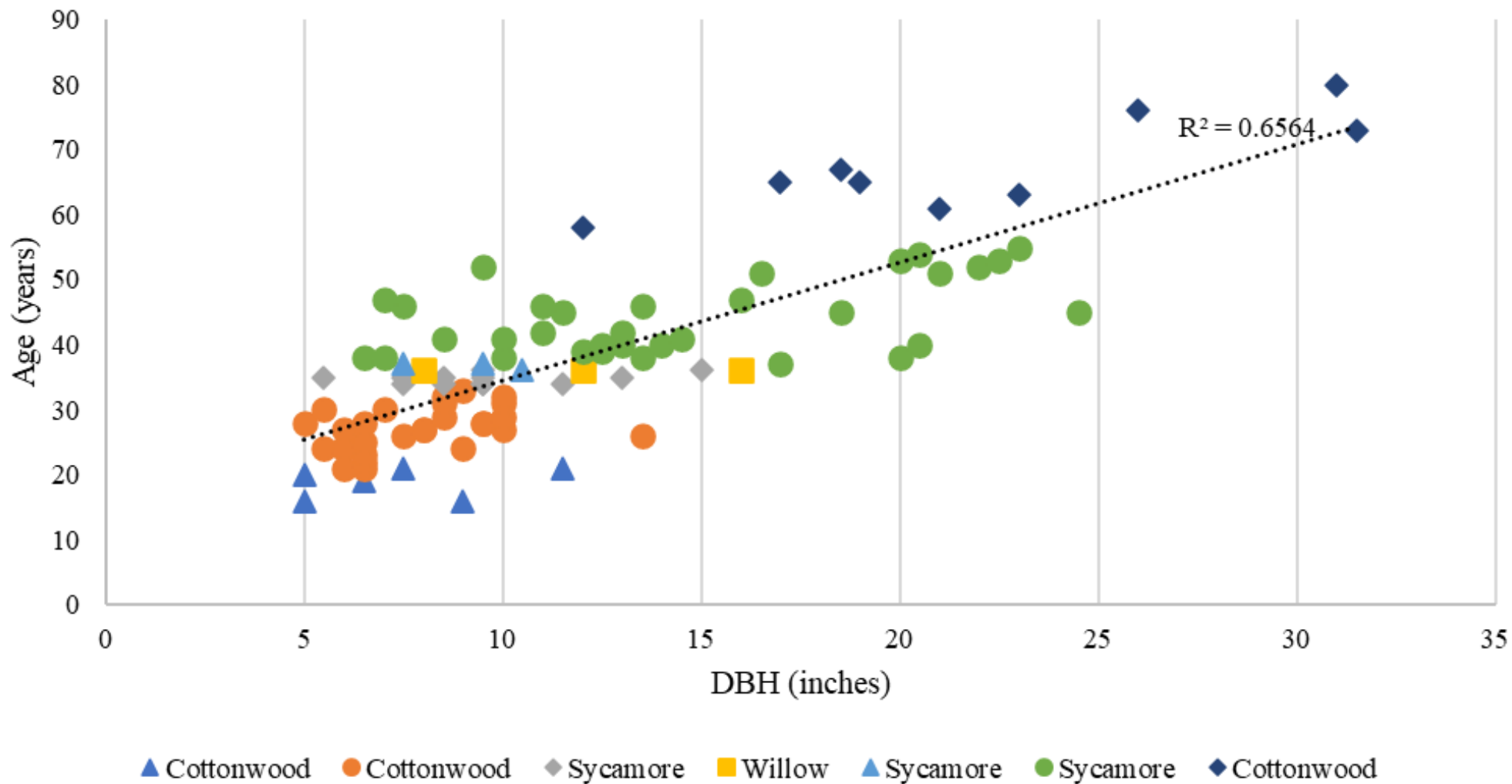


Palo Pinto Riparian Transect and Survey Downstream Cross Section - 2014





Rosharon - Riparian Tree Age vs DBH





Sediment Sampling

- Identifying discrete bed sediment grainsize distribution
- Three Transects per Site
- 3-5 samples per site



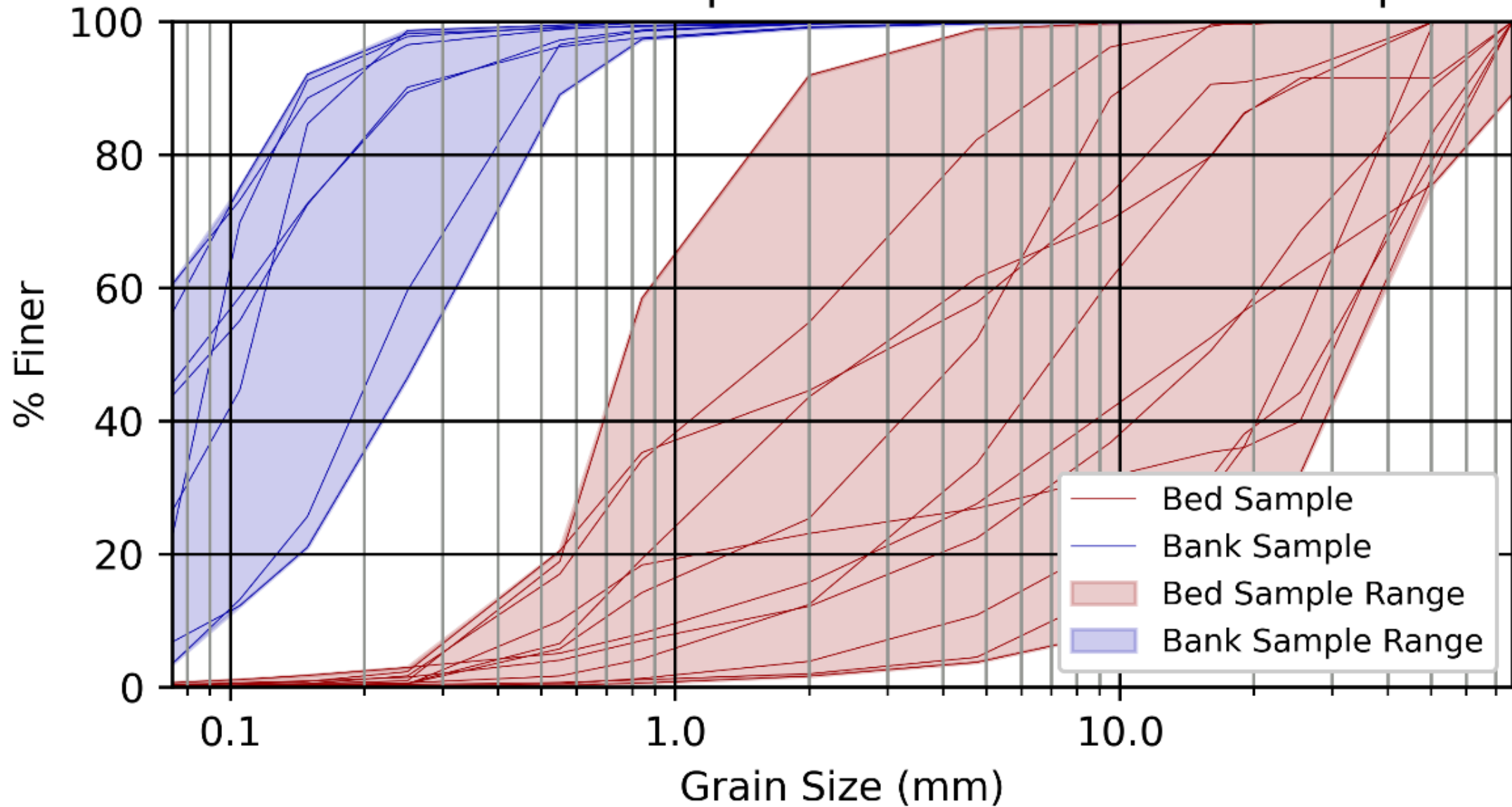


Charts and Analysis Developed using Sediment Data

Site	Metric	AVERAGE	COUNT	STDEV.S	MEDIAN
PaloPinto_banks	D85 (mm)	4.41	29.00	12.49	0.36
	D50 (mm)	2.69	24.00	7.49	0.23
	% Passing #200	23.85	29.00	21.99	24.11
PaloPinto_channel	D85 (mm)	36.37	44.00	21.39	41.63
	D50 (mm)	16.23	44.00	13.31	13.30
	% Passing #200	0.54	44.00	1.63	0.14
Site	Metric	AVERAGE	COUNT	STDEV.S	MEDIAN
Navasota_banks	D85 (mm)	0.23	27.00	0.13	0.22
	D50 (mm)	0.14	18.00	0.04	0.15
	% Passing #200	44.70	30.00	27.46	42.58
Navasota_channel	D85 (mm)	0.47	45.00	0.54	0.39
	D50 (mm)	0.15	38.00	0.06	0.14
	% Passing #200	36.06	45.00	16.83	36.78
Site	Metric	AVERAGE	COUNT	STDEV.S	MEDIAN
Richmond_banks	D85 (mm)	0.23	29.00	0.29	0.13
	D50 (mm)	0.16	15.00	0.12	0.10
	% Passing #200	52.68	30.00	25.19	50.35
Richmond_T234	D85 (mm)	2.57	37.00	2.89	0.79
	D50 (mm)	0.67	36.00	0.67	0.44
	% Passing #200	7.36	38.00	18.34	0.24
Site	Metric	AVERAGE	COUNT	STDEV.S	MEDIAN
Rosharon_banks	D85 (mm)	0.14	24.00	0.05	0.11
	D50 (mm)	0.12	7.00	0.03	0.13
	% Passing #200	63.37	30.00	24.79	70.62
Rosharon_Channel	D85 (mm)	1.85	38.00	2.07	0.81
	D50 (mm)	0.58	35.00	0.30	0.49
	% Passing #200	6.06	38.00	16.50	0.31

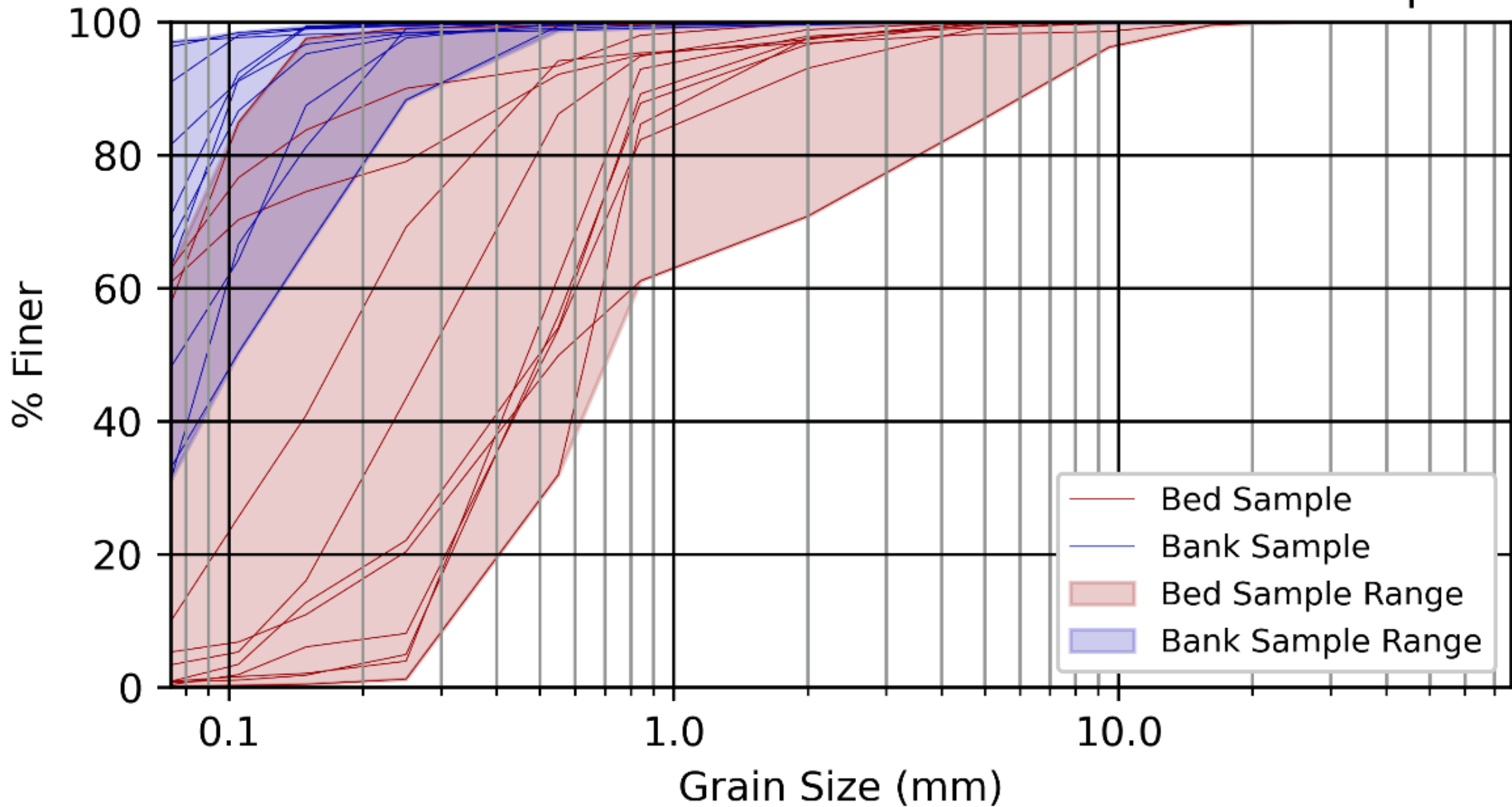


Brazos Palo Pinto - Upstream Bed and Bank Samples





Brazos Rosharon - Downstream Bed and Bank Samples





Annual Environmental Flows Achievement Report

- **Summary of the BRA's WMP Water Accounting Plan**
- **Submitted to TCEQ Annually**

Measurement Point	Season	Hydrologic Condition	Total Number of Days Baseflow not Met	Total Number of Days Subsistence not Met	Did water storage or diversion under the WMP occur in applicable reach on any days not meeting criteria?
USGS 08088000 Brazos River near South Bend	Winter	Wet	56	0	No
	Spring	Average	0	0	No
	Summer	Average	45	0	No
USGS 08114000 Brazos River near Richmond	Winter	Average	100	0	No
	Spring	Average	14	0	No
	Summer	Average	62	7	No



Annual Environmental Flows Achievement Report

- **Sample Charts: Nov 2019 through Oct 2020 period is consistent with SB3 seasons**

Measurement Point	Season	Were SB3 HFP Standards met?	During HFP did WMP water use occur at a rate greater than diversion rate trigger levels? ¹	Did WMP water use occur during HFP after all HFP criteria were met?	Total WMP water storage or diversion within applicable reaches during season (acre-ft)
USGS 08088000 Brazos River near South Bend	Winter	No pulse req'd	not applicable=n/a	n/a	278.6
	Spring	Yes	No	No	0.0
	Summer	No	No	No	0.0
USGS 08114000 Brazos River near Richmond	Winter	No	No	No	0.0
	Spring	Yes	No	No	0.0
	Summer	Yes	No	No	122.8



Other BRA Work

- **Routine Water Quality Sampling under the Texas Clean Rivers Program at all sites with E-flow Standards**
- **Freshwater Mussel Monitoring – BRA CCAA**
 - **Data Gap Surveys**
 - **Long-term Monitoring of Key Mussel Populations**
 - **Habitat quantification tool**
 - **Physiological Tolerance Studies**
- **Brazos Watersnake Study**





Future Work

- **Continue monitoring all sites to fill in data gaps**
- **Commence sampling at 2 new Little River sites**
- **More in-depth analyses on:**
 - **Fish community data**
 - **GIS analyses of organismal and habitat data per site**
- **Periodic sampling of sites with established baseline data sets**



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- AquaStrategies
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Questions?

