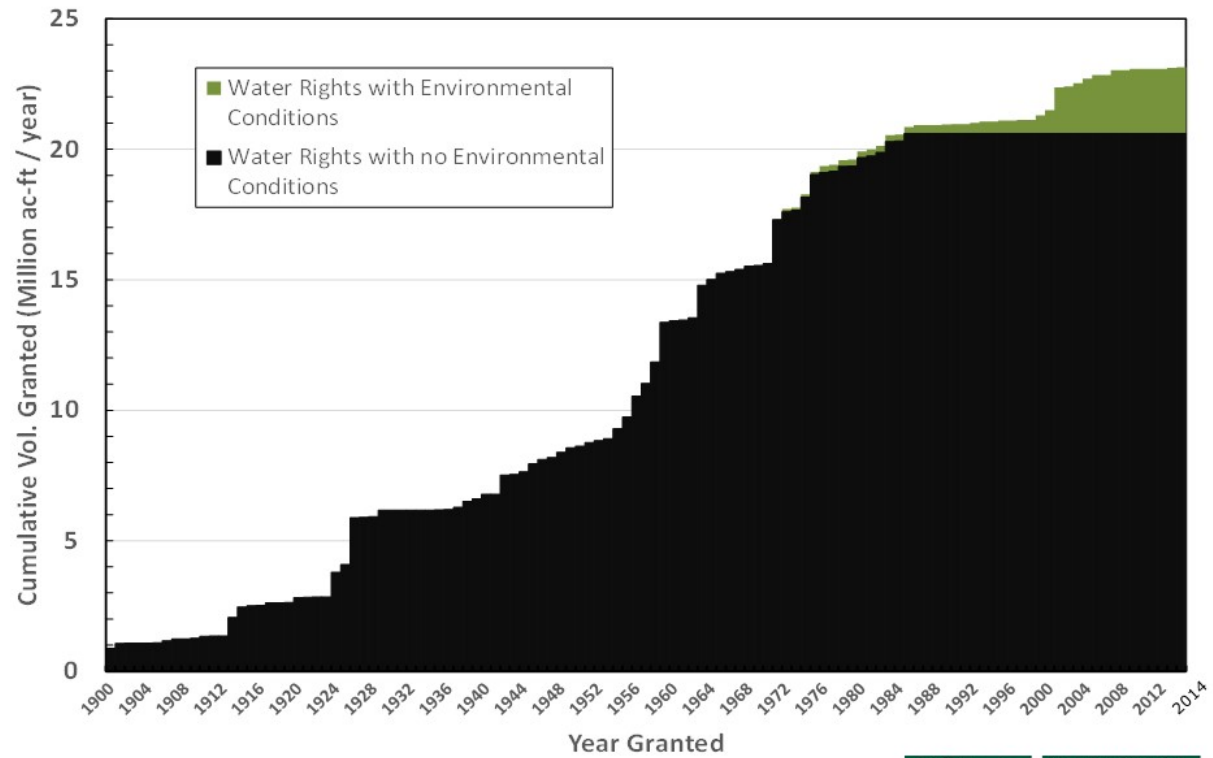# Water markets – how to use them to achieve environmental goals

Sharlene Leurig

Texas Water Research Network

May 31, 2019

Timeline of Texas Water Rights, 1900-2014

Legend:
- Water Rights with Environmental Conditions (green)
- Water Rights with no Environmental Conditions (black)

Y-axis: Cumulative Vol. Granted (Million ac-ft / year)
X-axis: Year Granted

Note: Only consumptive water rights included
Source: National Wildlife Federation analysis of data provided by the Texas Commission on Environmental Quality

NATIONAL WILDLIFE FEDERATION

Texas' Environmental Flow Standards

- Senate Bill 3 (SB 3): 80th Texas Legislature in 2007 created process of establishing environmental flows standards for all river basins

- SB 3 also called for voluntary strategies to meet environmental flow standards, especially in fully appropriated basins: "a variety of market approaches, both public and private, for filling the gap must be explored and pursued."
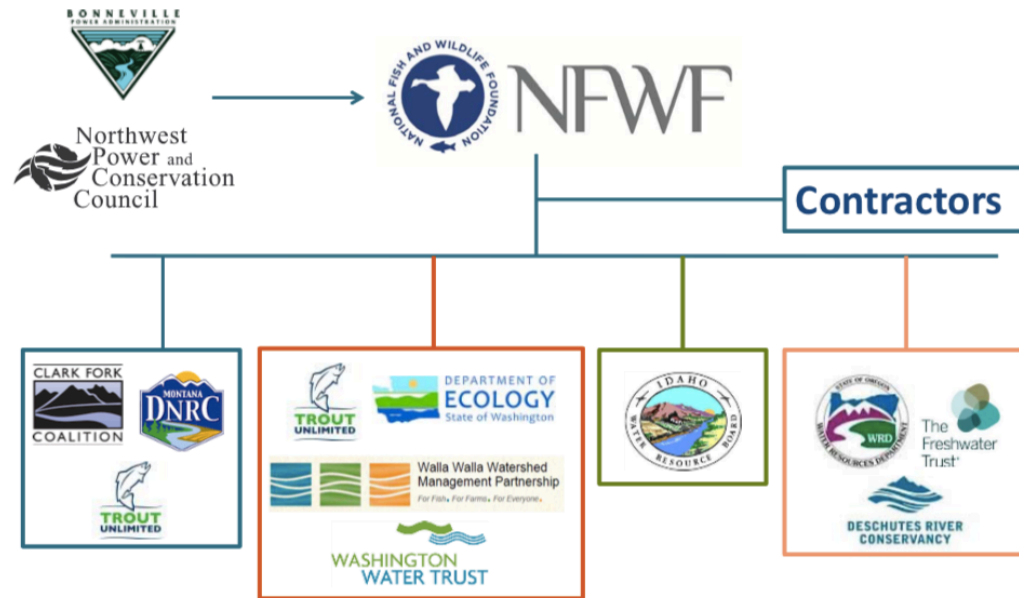
Over last 15 years, Columbia Basin Water Transactions Program has :

- Completed >400 water transactions

- Restored >1 million AF

- Protected an additional 6.24 million AF of flow over next 100 years

- Watering over 1500 tributary stream miles

The Columbia River Basin— 15 Years of Success

Program Structure

Columbia Basin Water Transactions Program

Protected Flow in Acre Feet (2003-2017)

Pahsimeroi River, Idaho

What Do Transactions Look Like?

- Irrigation efficiencies
- Source Switch
- Crop Switch
- Dry Year Lease Options
- Outright Acquisitions

CBWTP

2017 KEY ACCOMPLISHMENTS*

34 **New** transactions

232 **Total** active transactions

472 Stream miles of habitat benefited by **new** streamflows

27,120 Acre-feet of **new** protected water instream

148 Cubic feet per second **new** protected water instream

213,265 Acre-feet of cumulatively protected streamflows for **life of transactions** funded in 2017

960 Cubic feet per second, **all** protected steamflows since 2003

*CBWTP and its partners develop and review water transactions carried out as part of the Columbia Basin Fish Accords with Idaho, the Confederated Tribes of the Colville Reservation and the Confederated Tribes of the Umatilla Indian Reservation. Outcome information is included here, and additional details can be found in the appendix at www.cbwtp.org.

CBWTP Flow Restoration Accounting Framework
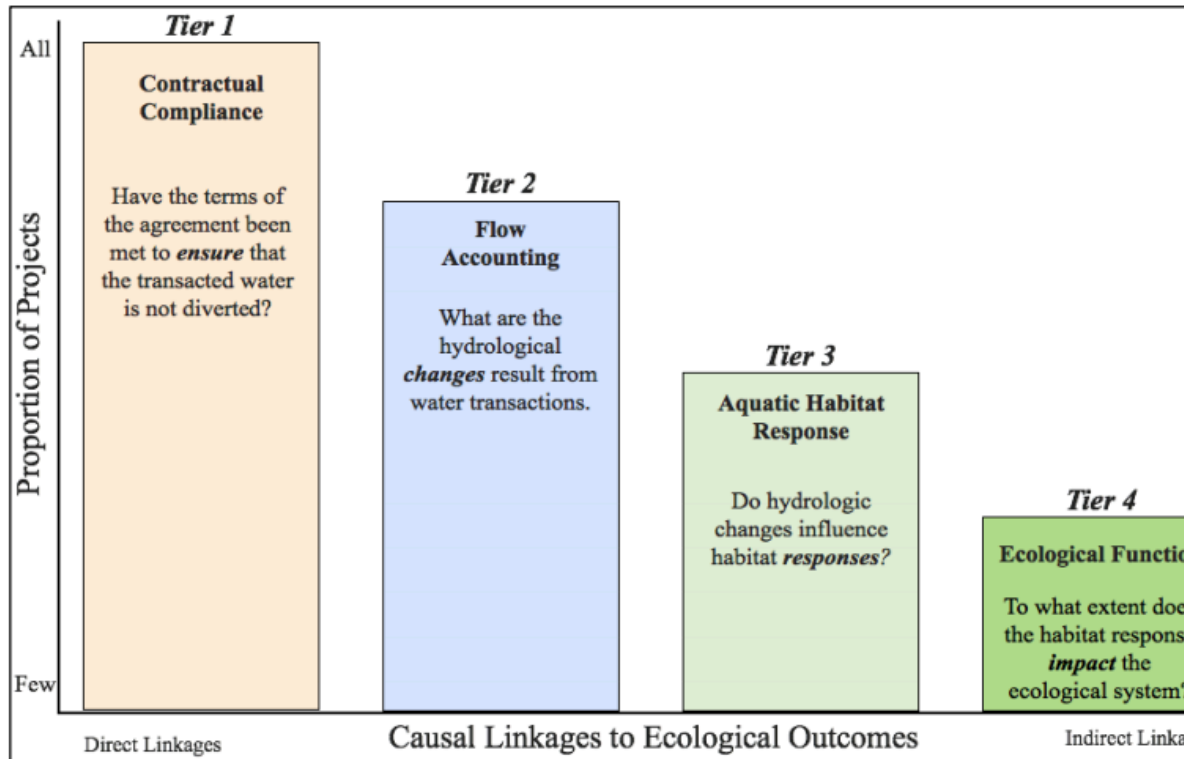
Filling a Critical Gap

- Build capacity and provide technical advice for environmental water transactors

- Recruit new and diverse transactors into the Texas environmental water markets space

- Develop new financing structures to streamline and scale environmental water transactions

- Steer philanthropic, corporate, state and federal investments into the environmental water market

- Define near- and long-term goals for freshwater flow protection

- Provide trusted evaluation of environmental water project benefits

- Develop monitoring frameworks to ensure water delivery and ecological benefit

TEXAS WATER TRADE

Texas is different

- While ag dominates flows in some regions, urban and industrial demand dominate in others
- Water rights have been highly consolidated in some basins
- We are on the precipice of significant Endangered Species drivers but it is not a current forcing factor in many basins
- Texas experiences tremendous hydrological volatility and ecological needs beyond stream connectivity
- Federal presence is more attenuated

TEXAS WATER TRADE

Defining Goals and Standards

- Selecting Priority Geographies
- Setting Our Flow Restoration and Protection Goals
- Selecting Qualifying Transactions
- Setting Performance Expectations for Qualifying Transactions
- Monitoring Outcomes

TEXAS WATER TRADE

Selecting Geographies + Restoration Targets

1. To what degree are Texas rivers being depleted?
    - How much water is being diverted?
    - What proportion of flow is that?
2. Which rivers are most affected?
    - How frequently are they falling short of pre-development norms?
3. What water uses are driving this depletion?
    - What are the permitted uses?
    - Who are the types of users?
4. What is a realistic goal for restoration or protection?

TEXAS WATER TRADE

Gauges for Initial Screen
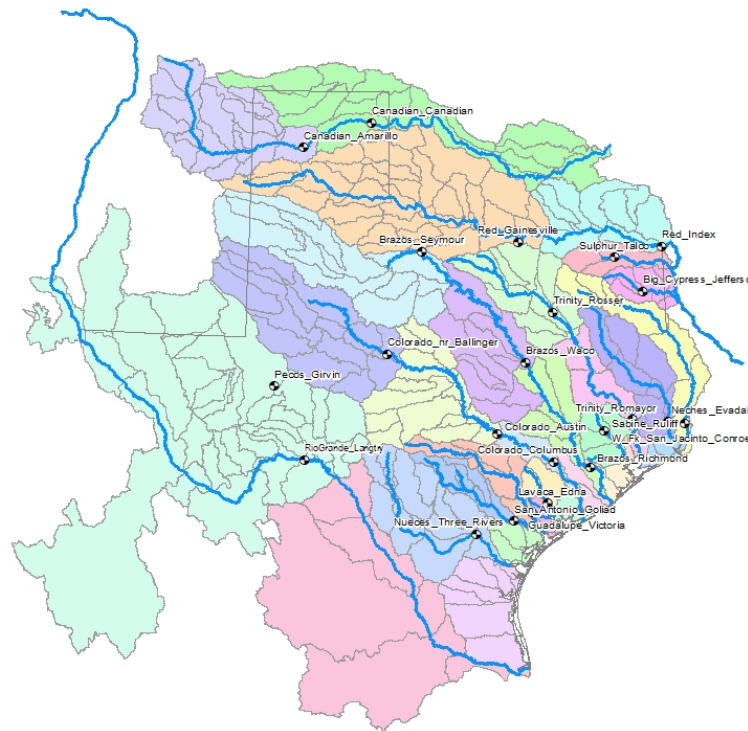
watersheds
- 1.1, Upper Canadian
- 1.2, Lower Canadian
- 2.1, Upper Red
- 2.2, Middle Red
- 3, Sulphur
- 4, Cypress
- 5, Sabine
- 6, Neches
- 7, Neches-Trinity
- 8.1, Upper Trinity
- 8.1, Lower Trinity
- 9, Trinity-San Jacinto
- 10, San Jacinto
- 11, San Jacinto-Brazos
- 12.1, Upper Brazos
- 12.2, Middle Brazos
- 12.3, Lower Brazos
- 13, Brazos-Colorado
- 14.1, Upper Colorado
- 14.2, Middle Colorado
- 14.3, Lower Colorado
- 15, Colorado-Lavaca
- 16, Lavaca
- 17, Lavaca-Guadalupe
- 18, Guadalupe
- 19, San Antonio
- 20, San Antonio-Nueces
- 21, Nueces
- 22, Nueces-Rio Grande
- 23.2, Middle Rio Grande
- 23.3, Lower Rio Grande

Analysis provided by Trungale Engineering

Historical period of record - filters

- Initial filter 20+ years of pre-regulation flow data.

- Pre-regulation means that < 20% of the upstream drainage is controlled by reservoir regulation.

- Secondary filter included 10+ year with the condition that Palmer Drought Index for this period not be significantly different than the longer term 100+ year record.

- Final filter site by site review of flow data to determine whether flows had been significantly impacted.

Analysis provided by Trungale Engineering

Period of Analysis

subbasin_nu	subbasin_na	station	station_nm	Pre Start	Pre End	Pre Yrs
1.1	Upper Canadian	7227500	Canadian Rv nr Amarillo, TX	1939	1962	24
1.2	Lower Canadian	7228000	Canadian Rv nr Canadian, TX	1939	1962	24
2.1	Upper Red	7316000	Red River near Gainesville, TX	1937	2018	82
2.2	Middle Red	7337000	Red River at Index, AR	1937	1942	6
3	Sulphur	7343200	Sulphur Rv nr Talco, TX	1957	1990	34
4	Cypress	7346000	Big Cypress Bayou nr Jefferson, TX	1925	1956	32
5	Sabine	8030500	Sabine Rv nr Ruliff, TX	1925	1965	41
6	Neches	8041000	Neches Rv at Evadale, TX	1922	1950	29
8.1	Upper Trinity	8062500	Trinity Rv nr Rosser, TX	1939	1952	14
8.1	Lower Trinity	8066500	Trinity Rv at Romayor, TX	1925	1967	43
10	San Jacinto	8068000	W Fk San Jacinto Rv nr Conroe, TX	1940	1972	33
12.1	Upper Brazos	8082500	Brazos Rv at Seymour, TX	1924	1976	53
12.2	Middle Brazos	8096500	Brazos Rv at Waco, TX	1899	1940	42
12.3	Lower Brazos	8114000	Brazos Rv at Richmond, TX	1923	1950	28
14.1	Upper Colorado	8126380	Colorado Rv nr Ballinger, TX	1908	1951	44
14.2	Middle Colorado	8158000	Colorado Rv at Austin, TX	1899	1936	38
14.3	Lower Colorado	8161000	Colorado Rv at Columbus, TX	1917	1936	20
16	Lavaca	8164000	Lavaca Rv nr Edna, TX	1939	2018	80
18	Guadalupe	8176500	Guadalupe Rv at Victoria, TX	1935	1963	29
19	San Antonio	8188500	San Antonio Rv at Goliad, TX	1940	1973	34
21	Nueces	8210000	Nueces Rv nr Three Rivers, TX	1916	1981	66
23.2	Middle Rio Grande	8446500	Pecos Rv nr Girvin, TX	1940	1964	25
23.2	Middle Rio Grande	8377200	Rio_Grande_Langtry	1962	2018	57
23.3	Lower Rio Grande	8475000	Rio_Grande_Brownsville	1934	1952	19

Analysis provided by Trungale Engineering

	Dec / Jan / Feb (Winter)	Mar / Apr / May (Spring)	Jun / Jul / Aug (Summer)	Sep / Oct / Nov (Fall)
High Flow Pulses	Qp: 48,000 cfs with Average Frequency 1 per 5 years — Regressed Volume is 248,875 to 665,947 (407,108) — Regressed Duration is 7 to 23 (13)			
	Qp: 38,400 cfs with Average Frequency 1 per 2 years — Regressed Volume is 188,235 to 503,293 (307,794) — Regressed Duration is 6 to 20 (11)			
	Qp: 29,700 cfs with Average Frequency 1 per year — Regressed Volume is 136,470 to 364,609 (223,066) — Regressed Duration is 5 to 17 (10)			
	Qp: 2,200 cfs with Average Frequency 1 per season — Regressed Volume is 5,813 to 21,724 (11,238) — Regressed Duration is 1 to 5 (3)	Qp: 2,350 cfs with Average Frequency 1 per season — Regressed Volume is 6,069 to 15,936 (9,835) — Regressed Duration is 1 to 4 (2)	Qp: 2,260 cfs with Average Frequency 1 per season — Regressed Volume is 5,392 to 12,920 (8,347) — Regressed Duration is 1 to 3 (2)	Qp: 2,400 cfs with Average Frequency 1 per season — Regressed Volume is 5,064 to 12,874 (8,075) — Regressed Duration is 1 to 3 (2)
		Qp: 2,350 cfs with Average Frequency 2 per season — Regressed Volume is 6,069 to 15,936 (9,835) — Regressed Duration is 1 to 4 (2)	Qp: 2,260 cfs with Average Frequency 2 per season — Regressed Volume is 5,392 to 12,920 (8,347) — Regressed Duration is 1 to 3 (2)	Qp: 2,400 cfs with Average Frequency 2 per season — Regressed Volume is 5,064 to 12,874 (8,075) — Regressed Duration is 1 to 3 (2)
Base Flows (cfs)	782 (35.3%)	1100 (48.6%)	1100 (41.9%)	940 (42.1%)
	480 (55.6%)	670 (64.1%)	651 (57.1%)	498 (57.9%)
	322 (76.1%)	335 (80.1%)	370 (73.0%)	320 (73.9%)
Subsistence Flows (cfs)	195 (95.1%)	183 (95.7%)	97 (95.1%)	128 (95.2%)

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

Base Flow Levels
- High (75th %ile)
- Medium (50th %ile)
- Low (25th %ile)

Pulse volumes are in units of acre-feet and durations are in days.

Period of record used : 1/1/1899 to 12/31/1936.

Q95 calculation used for subsistence flows. Annual Q95 value is 152 cfs. Water C
User did not input bankfull; all episodic events are labeled as high flow pulses.

Colorado_Austin

Attainment Frequency Calculation

								-25%	High Impact
								-10%	Moderate Impact
								0%	Negligable Impact
								10%	Too Much

station	station_na	Pre Start	Pre End	PY10 Start	PY10 End	Avg_Spr_Mag	Avg_Spr_Freq	Avg_Spr_Freq	Avg Spr
7227500	Canadian Rv nr Amarillo, TX	1939	1962	2008	2017	12	56	53	-7%
7228000	Canadian Rv nr Canadian, TX	1939	1962	2008	2017	5	58	100	71%
7316000	Red River near Gainesville, TX	1937	1982	2008	2017	580	64	56	-13%
7337000	Red River at Index, AR	1937	1942	2008	2017	5,700	70	64	-9%
7343200	Sulphur Rv nr Talco, TX	1956	1990	2008	2017	65	68	76	10%
7346000	Big Cypress Bayou nr Jefferson, TX	1925	1956	2008	2017	274	75	60	-21%
8030500	Sabine Rv nr Ruliff, TX	1925	1965	2008	2017	5,700	72	54	-25%
8041000	Neches Rv at Evadale, TX	1922	1950	2008	2017	4,920	74	46	-37%
8062500	Trinity Rv nr Rosser, TX	1924	1950	2008	2017	833	77	84	9%
8066500	Trinity Rv at Romayor, TX	1925	1967	2008	2017	2,475	71	69	-2%
8068000	W Fk San Jacinto Rv nr Conroe, TX	1940	1972	2008	2017	79	69	50	-27%
8082500	Brazos Rv at Seymour, TX	1924	1976	2008	2017	18	59	69	18%
8096500	Brazos Rv at Waco, TX	1899	1940	2008	2017	512	63	49	-23%
8114000	Brazos Rv at Richmond, TX	1923	1950	2008	2017	3,390	69	55	-19%
8126380	Colorado Rv nr Ballinger, TX	1908	1951	2008	2017	16	62	14	-78%
8158000	Colorado Rv at Austin, TX	1899	1936	2008	2017	670	64	43	-33%
8161000	Colorado Rv at Columbus, TX	1916	1936	2008	2017	1,230	64	49	-23%
8164000	Lavaca Rv nr Edna, TX	1939	2017	2008	2017	48	66	50	-24%
8176500	Guadalupe Rv at Victoria, TX	1934	1963	2008	2017	715	67	57	-14%
8188500	San Antonio Rv at Goliad, TX	1940	1973	2008	2017	248	62	76	24%
8210000	Nueces Rv nr Three Rivers, TX	1916	1981	2008	2017	42	61	63	2%
8377200	Rio Grande at Foster Rh nr Langtry, TX	1962	2017	2008	2017	505	51	16	-69%
8446500	Pecos Rv nr Girvin, TX	1939	1964	2008	2017	32	57	19	-66%
8475000	Rio Grande nr Brownsville, TX	1934	1952	2008	2017	984	51	8	-84%
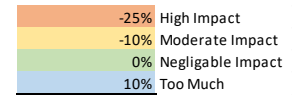
Analysis provided by Trungale Engineering

Attainment Frequency Summary

-25%	High Impact	
-10%	Moderate Impact	
0%	Negligable Impact	
10%	Too Much	

station	station_na	Subs Win	Subs Spr	Subs Sum	Subs Fall	Dry Win	Dry Spr	Dry Sum	Dry Fall	Avg Win	Avg Spr	Avg Sum	Avg Fall	Wet Win	Wet Spr	Wet Sum	Wet Fall	Subs	Dry	Avg	Wet	Win	Spr	Sum	Fall	All
7227500	Canadian Rv nr Amarillo, TX	-8%	-6%	-17%	-5%	-16%	-11%	-22%	-11%	-24%	-7%	-34%	-11%	-52%	-14%	-46%	-15%	-9%	-15%	-19%	-32%	-25%	-9%	-30%	-11%	-19%
7228000	Canadian Rv nr Canadian, TX	5%	18%	24%	25%	25%	29%	26%	25%	23%	71%	22%	67%	-69%	130%	-81%	63%	18%	26%	46%	11%	-4%	62%	-2%	45%	25%
7316000	Red River near Gainesville, TX	-20%	-8%	-17%	-25%	-15%	-22%	-19%	-14%	-42%	-13%	-18%	-16%	-29%	-3%	-28%	-27%	-18%	-17%	-22%	-22%	-27%	-12%	-20%	-20%	-20%
7337000	Red River at Index, AR	4%	4%	-16%	4%	3%	-9%	-15%	-1%	-28%	-9%	0%	3%	-20%	-4%	-16%	-44%	-1%	-6%	-8%	-21%	-10%	-4%	-12%	-9%	-9%
7343200	Sulphur Rv nr Talco, TX	2%	1%	8%	9%	4%	2%	16%	14%	-10%	10%	18%	-4%	-6%	14%	-13%	-40%	5%	9%	4%	-11%	-2%	7%	7%	-5%	2%
7346000	Big Cypress Bayou nr Jefferson, TX	-11%	-23%	5%	9%	-34%	-19%	44%	61%	-44%	-21%	35%	96%	-49%	-30%	16%	10%	-5%	13%	17%	-13%	-35%	-23%	25%	44%	3%
8030500	Sabine Rv nr Ruliff, TX	-17%	-22%	5%	5%	-31%	-24%	6%	16%	-34%	-25%	32%	13%	-30%	-21%	44%	57%	-7%	-8%	-4%	12%	-28%	-23%	22%	23%	-2%
8041000	Neches Rv at Evadale, TX	-9%	-13%	5%	5%	-16%	-25%	38%	60%	-45%	-37%	62%	117%	-56%	-53%	28%	173%	-3%	14%	24%	23%	-32%	-32%	33%	89%	15%
8062500	Trinity Rv nr Rosser, TX	0%	0%	3%	5%	25%	11%	23%	33%	52%	9%	55%	68%	14%	-8%	60%	97%	2%	23%	46%	41%	23%	3%	35%	51%	28%
8066500	Trinity Rv at Romayor, TX	6%	5%	5%	5%	14%	-5%	40%	54%	-18%	-2%	25%	64%	-25%	-3%	-1%	-12%	5%	26%	17%	-10%	-6%	-2%	17%	28%	9%
8068000	W Fk San Jacinto Rv nr Conroe, TX	4%	-16%	3%	5%	-6%	-25%	13%	35%	-26%	-27%	15%	47%	-35%	-28%	5%	51%	-1%	4%	2%	-2%	-16%	-24%	9%	34%	1%
8082500	Brazos Rv at Seymour, TX	4%	0%	6%	7%	8%	6%	8%	11%	31%	18%	10%	3%	58%	-1%	3%	-10%	4%	8%	15%	12%	25%	6%	7%	3%	10%
8096500	Brazos Rv at Waco, TX	5%	5%	3%	1%	-13%	-17%	-8%	-15%	-23%	-23%	-26%	-22%	-28%	-13%	-39%	-26%	3%	-13%	-23%	-26%	-15%	-12%	-18%	-15%	-15%
8114000	Brazos Rv at Richmond, TX	-9%	-21%	-7%	-13%	-20%	-22%	-28%	-12%	-25%	-19%	-27%	-1%	-30%	-16%	-22%	-2%	-12%	-20%	-18%	-18%	-21%	-19%	-21%	-7%	-17%
8126380	Colorado Rv nr Ballinger, TX	-58%	-54%	-68%	-68%	-63%	-68%	-84%	-87%	-63%	-78%	-93%	-90%	-88%	-86%	-95%	-94%	-62%	-75%	-81%	-91%	-68%	-72%	-85%	-85%	-77%
8158000	Colorado Rv at Austin, TX	-46%	-11%	5%	-6%	-71%	-16%	-1%	-44%	-79%	-33%	-4%	-51%	-79%	-39%	0%	-66%	-14%	-33%	-42%	-46%	-69%	-25%	0%	-42%	-34%
8161000	Colorado Rv at Columbus, TX	-16%	-1%	2%	1%	-24%	-10%	-5%	-15%	-41%	-23%	11%	-20%	-46%	-47%	-29%	-60%	-4%	-13%	-18%	-45%	-32%	-20%	-5%	-24%	-20%
8164000	Lavaca Rv nr Edna, TX	-12%	-1%	-12%	-13%	-30%	-19%	-45%	-40%	-48%	-24%	-32%	-10%	-7%	-13%	-26%	-5%	-5%	-12%	-34%	-37%	-44%	-32%	-21%	-39%	-31%
8176500	Guadalupe Rv at Victoria, TX	5%	4%	5%	5%	-23%	-17%	-20%	-16%	-14%	-14%	-32%	-10%	-7%	-13%	-26%	-5%	5%	-19%	-17%	-13%	-10%	-10%	-18%	-6%	-11%
8188500	San Antonio Rv at Goliad, TX	5%	5%	5%	3%	29%	24%	3%	14%	32%	24%	7%	17%	34%	36%	13%	21%	5%	18%	20%	26%	25%	22%	7%	14%	17%
8210000	Nueces Rv nr Three Rivers, TX	6%	5%	14%	9%	32%	26%	38%	31%	59%	2%	-15%	-19%	-13%	-28%	-54%	-38%	8%	32%	7%	-33%	21%	1%	-4%	-4%	3%
8377200	Rio Grande at Foster Rh nr Langtry, TX	-14%	-8%	-8%	-5%	-48%	-55%	-25%	-13%	-56%	-69%	-36%	-9%	-61%	-80%	-44%	-5%	-9%	-35%	-43%	-48%	-45%	-53%	-28%	-8%	-34%
8446500	Pecos Rv nr Girvin, TX	-33%	-28%	-33%	-14%	-51%	-52%	-40%	-25%	-57%	-66%	-54%	-31%	-60%	-68%	-64%	-27%	-27%	-42%	-52%	-55%	-51%	-54%	-48%	-24%	-44%
8475000	Rio Grande nr Brownsville, TX	7%	11%	5%	5%	-90%	-27%	-31%	-67%	-96%	-84%	-74%	-82%	-97%	-91%	-82%	-80%	7%	-54%	-84%	-88%	-69%	-48%	-45%	-56%	-55%

Analysis provided by Trungale Engineering

Upstream Water RIghts
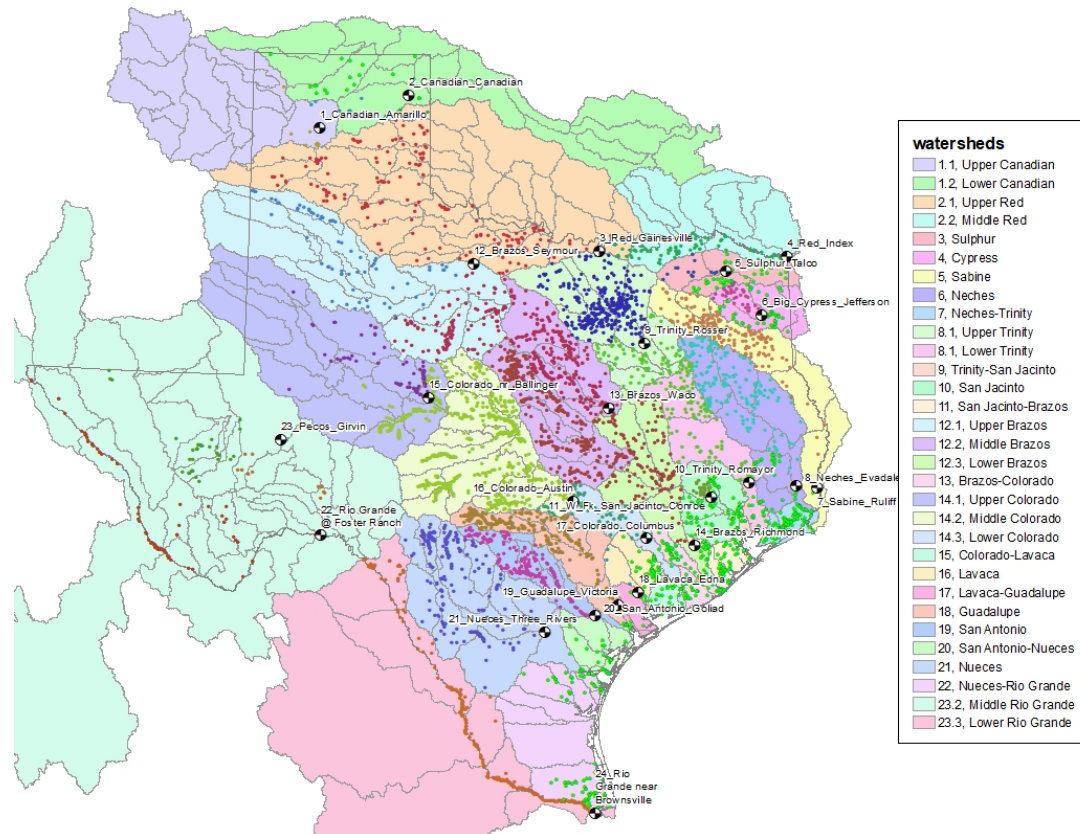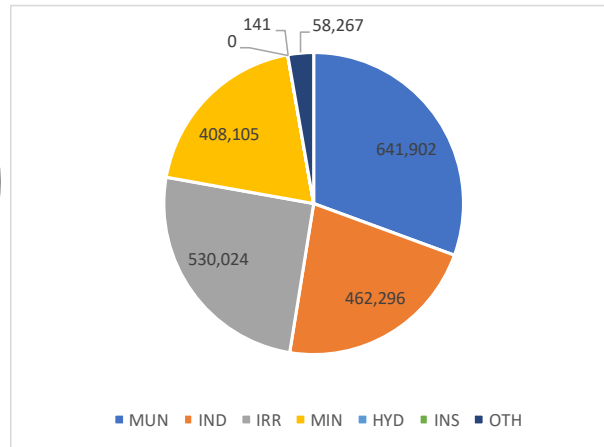

Analysis provided by Trungale Engineering

Water Use Types for Each Basin

	gage	MUN	IND	IRR	MIN	HYD	INS	OTH	TOT	MAF	%PER/MAF
1	Canadian_Amarillo	0	0	349	30	0	0	0	379	173,595	0%
2	Canadian_Canadian	100,000	51,953	1,251	30	0	0	77	153,311	184,482	83%
3	Red_Gainesville	127,518	106,160	82,676	24,250	0	0	44,755	385,360	2232185	17%
4	Red_Index	349,398	307,791	197,151	52,984	0	2,758	107,260	1,017,341	9,300,761	11%
5	Sulphur_Talco	144,244	35,787	48,276	0	0	0	35,055	263,361	935,871	28%
6	Big_Cypress_Jefferson	55,377	177,719	10,928	11,043	0	0	78,963	334,029	453,877	74%
7	Sabine_Ruliff	309,153	420,757	242,500	238,177	0	0	266,020	1,476,608	5,950,089	25%
8	Neches_Evadale	349,068	60,063	11,537	7,915	0	0	43,588	472,170	4,336,010	11%
9	Trinity_Rosser	937,453	674,464	411,055	69,107	172,737	0	472,752	2,737,569	2,319,360	118%
10	Trinity_Romayor	1,338,458	1,258,561	774,540	72,390	172,737	0	697,379	4,314,064	5,763,931	75%
11	W_Fk_San_Jacinto_Con	18,534	35,201	18,820	16,667	0	0	16,887	106,108	372,496	28%
12	Brazos_Seymour	31,395	10,879	32,677	12,785	0	0	20,146	107,883	231,854	47%
13	Brazos_Waco	240,108	146,815	143,708	72,508	32,964	0	136,688	772,790	1,693,189	46%
14	Brazos_Richmond	673,747	2,206,996	549,065	176,521	32,964	0	871,308	4,510,601	5,406,385	83%
15	Colorado_nr_Ballinger	61,965	15,950	18,093	12,264	0	0	24,418	132,690	151,364	88%
16	Colorado_Austin	641,902	462,296	530,024	408,105	0	141	58,267	2,100,735	1,505,455	140%
17	Colorado_Columbus	947,938	500,266	543,137	409,727	6,000	141	81,081	2,488,289	2,162,534	115%
18	Lavaca_Edna	0	0	1,833	0	0	0	0	1,833	264,714	1%
19	Guadalupe_Victoria	67,154	317,188	54,950	871	4,546,817	32,201	834,992	5,854,173	1,400,224	418%
20	San_Antonio_Goliad	25,765	36,253	100,922	6,269	0	192	27,900	197,301	556,183	35%
21	Nueces_Three_Rivers	29,836	28,768	98,489	28,090	0	0	30,223	215,406	526,050	41%
22	Rio_Grande_Foster_Rar	89,433	82,028	144,854	81,850	0	2,154	89,514	489,832	1,002,288	49%
23	Pecos_Girvin	644	0	245,672	146,250	0	0	244	392,809	44,980	873%
24	Rio_Grande_Brownsvill	385,951	146,297	1,930,372	406,734	3,185,966	12,945	719,767	6,788,033	1,043,957	650%

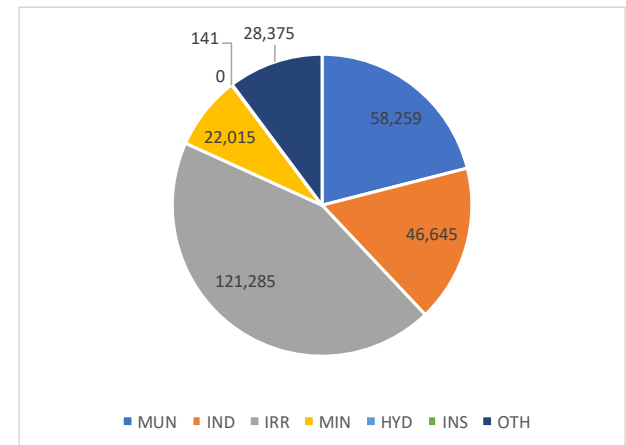Analysis provided by Trungale Engineering

Uses by Owner Types

Permits held by Institutions

All Water Right Permits
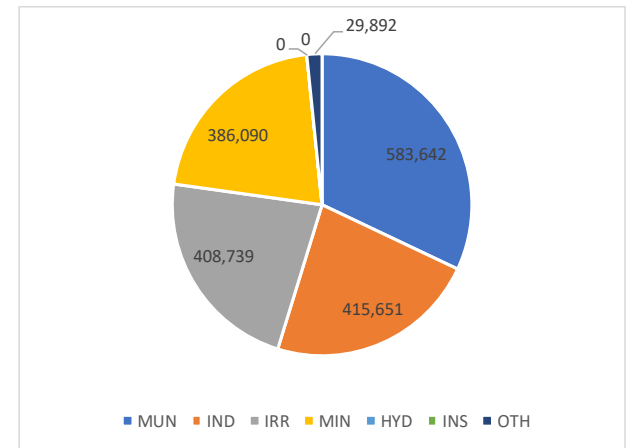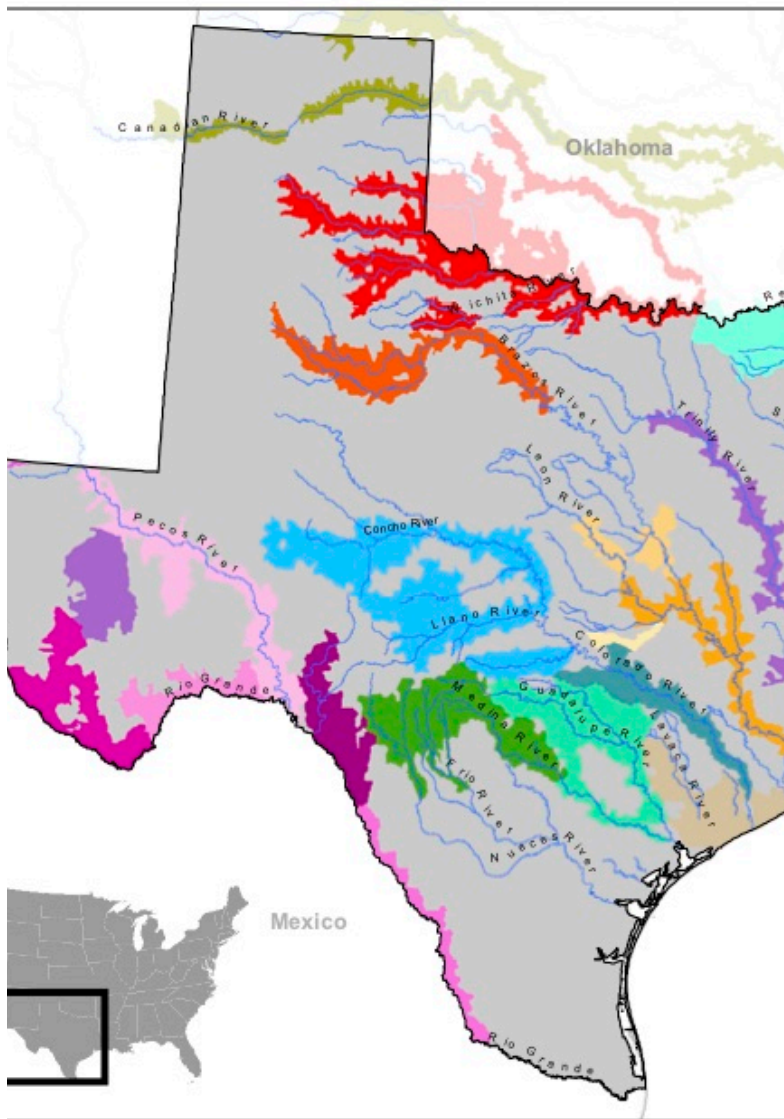
Permits held by Individuals

Analysis provided by Trungale Engineering

Next Steps

Zero in on basins failing to meet attainment frequencies for subsistence flows	Compare to TPWD's Native Fish Conservation Areas + Mussels Presence
Estimate volumetric deficits	Model strategies at site specific locations

Thank You

Sharlene Leurig
Chief Executive Officer
leurig@texaswatertrade.org