Colorado Lavaca BBEST

March 30, 2011

Outline

- How did we get here?
  - Process to develop flow regime recommendations
- Where do we go now?
  - Implementation and balancing issues

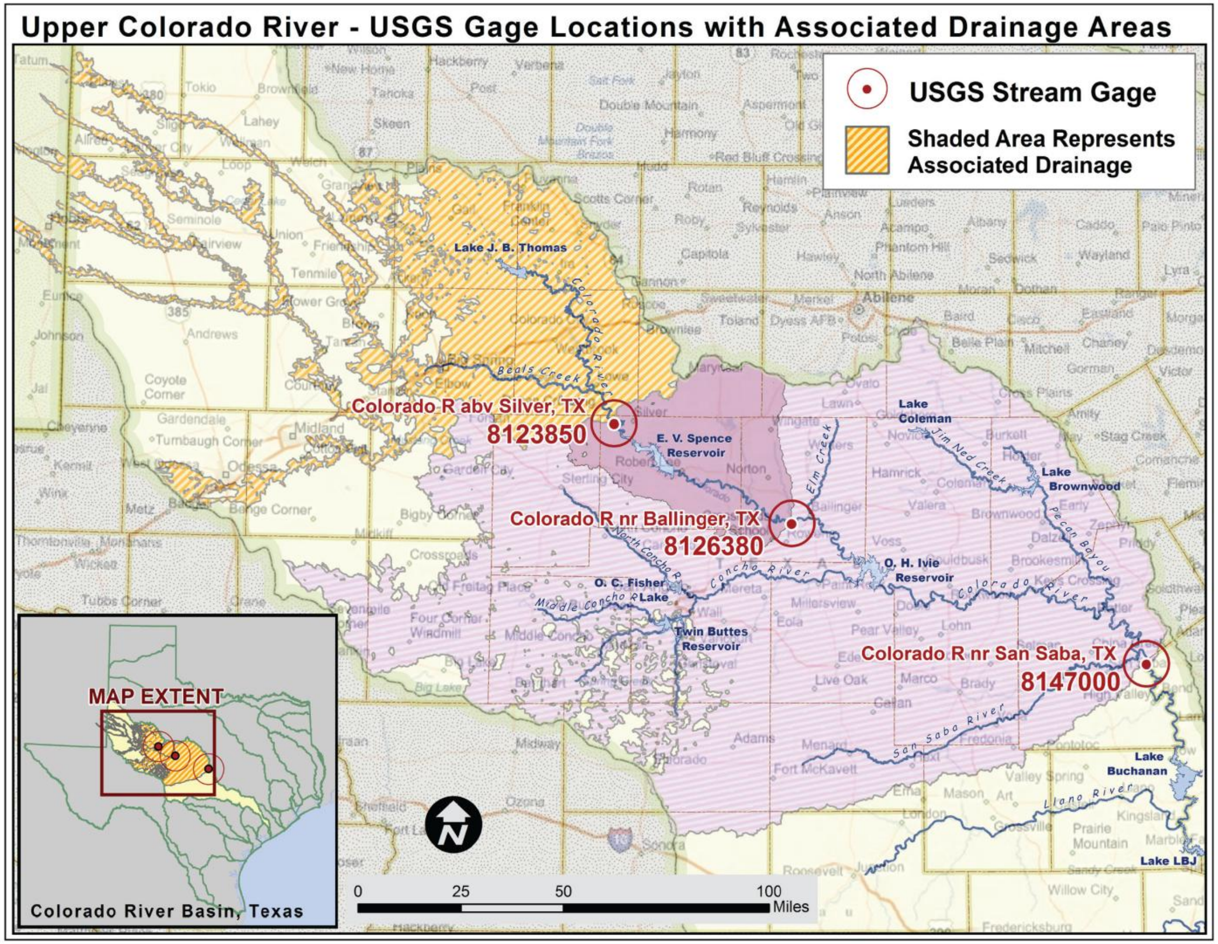
Regime Recommendations

- Flow Regime Components
- Geographic Scope
- Hydrology-based environmental flow regime (HEFR)
  - Period of Record
  - Inter-Annual Variability (seasons)
  - Hydrographic Separation
- Overlays
  - Aquatic Biology, Habitat, and Flow Relationships
  - Riparian Vegetation
  - Water Quality
  - Geomorphology

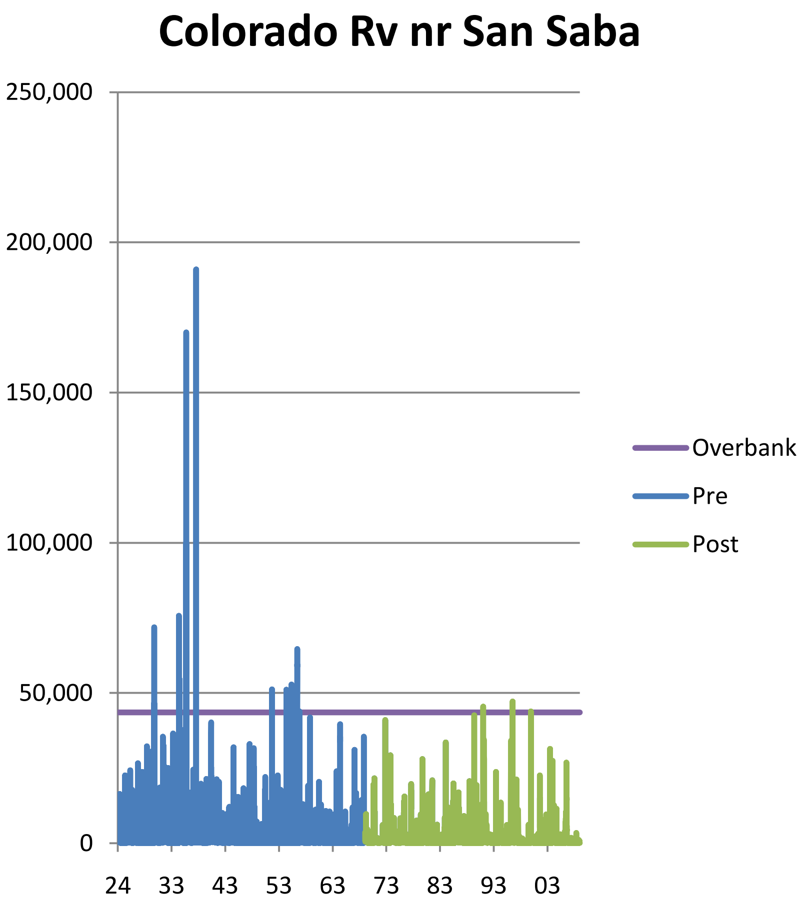
Flow Regime Components

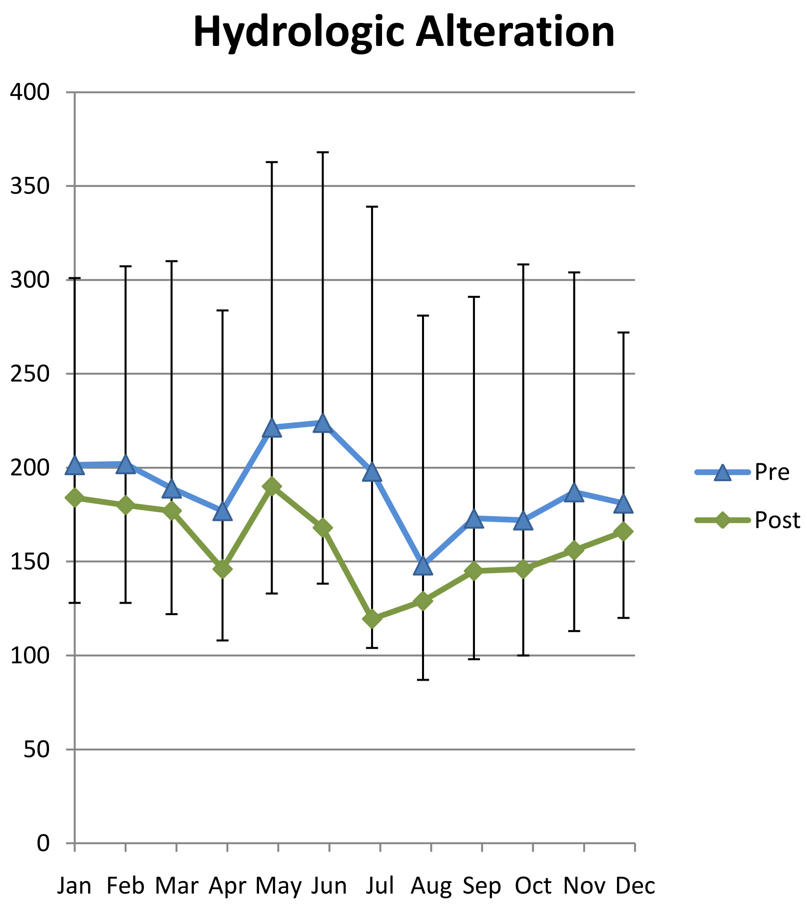
Component	Hydrology	Geomorphology	Biology	Water quality
No-flow periods	Flow ceases between perennial pools		Generally stressful for fish communities but may provide opportunities for certain macroinvertebrates, reptiles and amphibians to increase population sizes.	Temperatures rise and oxygen levels decrease. These conditions sometimes cause fish kills.
Subsistence flows	Infrequent, low flows	Increase deposition of fine and organic particles	Provide restricted aquatic habitat; limit connectivity	Elevate temperature and constituent concentrations Maintain adequate levels of dissolved oxygen
Base flows	Average flow conditions, including variability	Maintain soil moisture and groundwater table Maintain a diversity of habitats	Provide suitable aquatic habitat, Provide connectivity along channel corridor	Provide suitable in-channel water quality
High flow pulses	In-channel, short duration, high flows	Maintain channel and substrate characteristics; Prevent encroachment of riparian vegetation	Serve as recruitment events for organisms; Provide connectivity to near-channel water bodies	Restore in-channel water quality after prolonged low flow periods
Overbank flows	Infrequent, high flows that exceed the channel	Provide lateral channel movement and floodplain maintenance; Recharge floodplain water table; Form new habitats; Flush organic material into channel; Deposit nutrients in floodplain	Provide new life phase cues for organisms; Maintain diversity of riparian vegetation; Provide conditions for seedling development; Provide connectivity to floodplain	Restore water quality in floodplain water bodies
Channel Maintenance	For most streams, channel maintenance occurs mostly during pulse and overbank flows	Long-term maintenance of existing channel morphology	Maintains foundation for physical habitat features in stream	Water quality conditions like those during pulse and overbank flows

Colorado River near San Saba



Period of Record



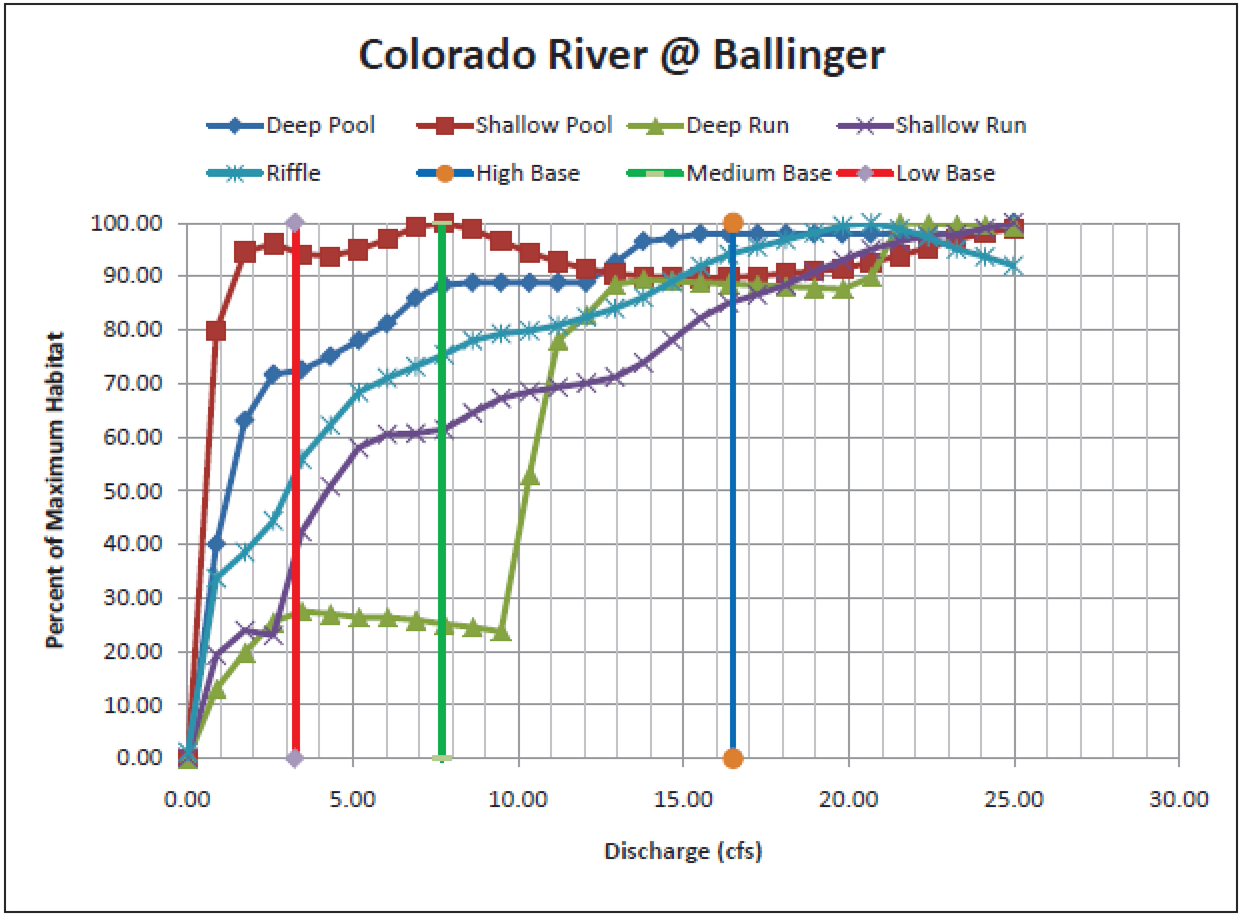


Hydrographic Separation

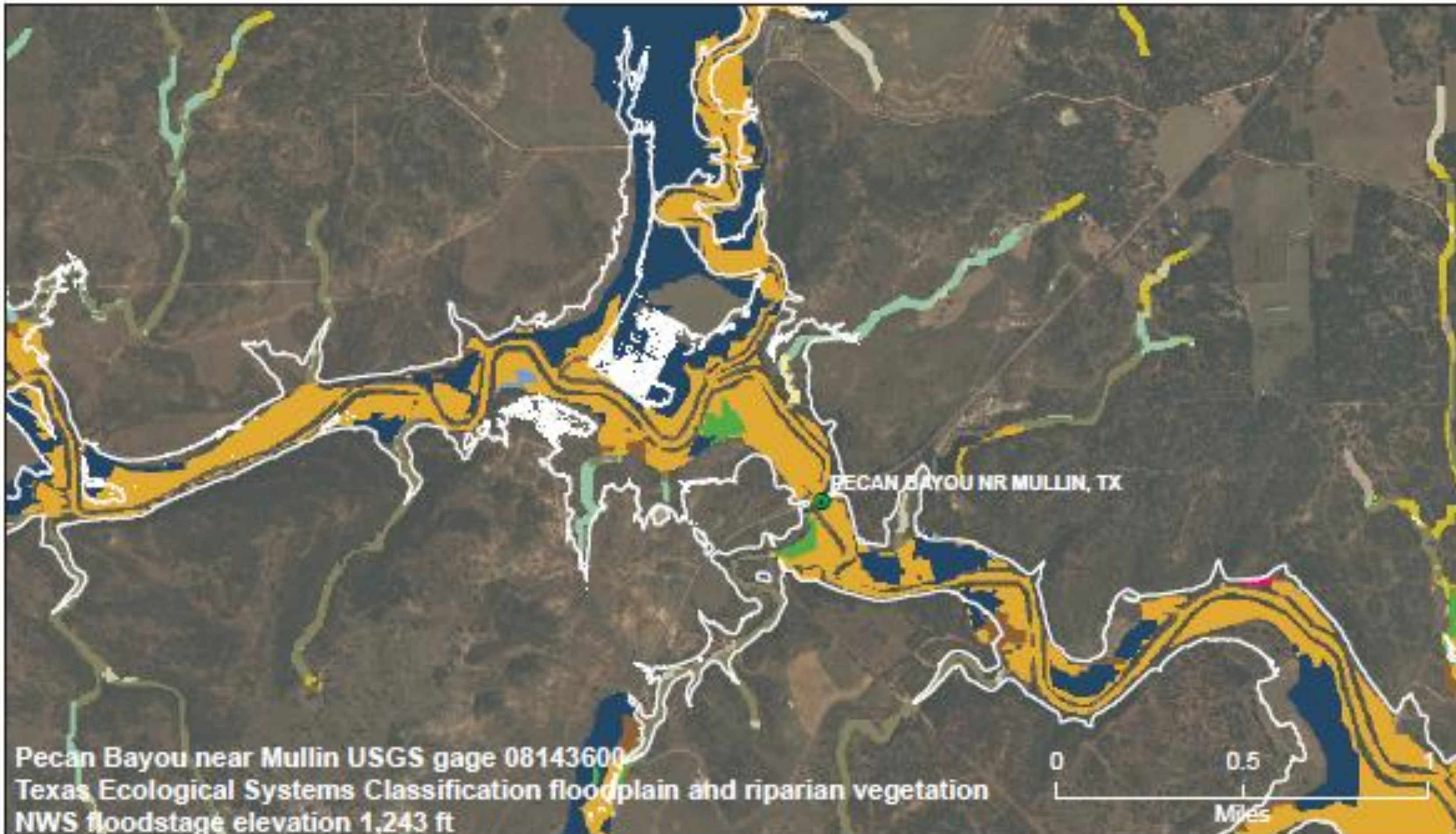
Name	Winter	Spring	Summer	Fall
Colorado Rv abv Silver	15	31	20	28
Colorado Rv nr Ballinger	25	56	39	50
Elm Ck at Ballinger	11	17	3	7
S Concho Rv at Christoval	45	45	45	45
Concho Rv at Paint Rock	52	49	28	49
Pecan Bayou nr Mullin	22	117	18	23
San Saba Rv at San Saba	146	178	88	123
Colorado Rv nr San Saba	344	825	355	506
Llano Rv at Llano	272	318	191	267
Pedernales Rv nr Johnson City	136	190	100	90
Colorado Rv at Austin	1,370	2,750	1,493	2,000
Onion Ck nr Driftwood	75	77	18	14
Colorado Rv at Bastrop	1,416	2,847	1,545	2,070
Colorado Rv at Columbus	2,705	4,540	1,968	3,030
Colorado Rv at Wharton	2,793	4,595	1,984	3,056
Colorado Rv nr Bay City	2,760	3,430	1,460	1,930
Lavaca Rv nr Edna	160	188	79	109
Navidad Rv at Strane Pk nr Edna	155	161	152	169
Sandy Ck nr Ganado	81	80	72	95
W Mustang Ck nr Ganado	47	52	56	62
E Mustang Ck nr Louise	13	14	15	16
Tres Palacios Rv nr Midfield	34	39	38	39
Garcitas Ck nr Inez	14	15	6	10

High Flow Pulses	Qp: 39,600 cfs with Average Frequency 1 per 5 years Regressed Volume is 163,228 to 553,287 (300,520) Regressed Duration is 6 to 31 (14)			
	Qp: 30,400 cfs with Average Frequency 1 per 2 years Regressed Volume is 120,703 to 408,898 (222,160) Regressed Duration is 6 to 28 (13)			
	Qp: 18,900 cfs with Average Frequency 1 per year Regressed Volume is 70,153 to 237,437 (129,062) Regressed Duration is 5 to 23 (10)			
	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 5,223 to 23,446 (11,066) Regressed Duration is 2 to 15 (6)	Qp: 11,200 cfs with Average Frequency 1 per season Regressed Volume is 43,413 to 113,422 (70,171) Regressed Duration is 4 to 13 (7)	Qp: 1,430 cfs with Average Frequency 1 per season Regressed Volume is 3,587 to 11,788 (6,502) Regressed Duration is 2 to	Qp: 3,760 cfs with Average Frequency 1 per season Regressed Volume is 10,803 to 34,218 (19,226) Regressed Duration is 2 to
	Qp: 522 cfs with Average Frequency 2 per season Regressed Volume is 1,470 to 6,617 (3,119) Regressed Duration is 1 to 9 (4)	Qp: 5,830 cfs with Average Frequency 2 per season Regressed Volume is 19,345 to 50,489 (31,252) Regressed Duration is 3 to 9 (5)	Qp: 511 cfs with Average Frequency 2 per season Regressed Volume is 1,060 to 3,493 (1,925) Regressed Duration is 1 to 4 (2)	Qp: 887 cfs with Average Frequency 2 per season Regressed Volume is 1,982 to 6,296 (3,533) Regressed Duration is 1 to 6 (3)
Base Flows (cfs)	210(43.0%)	356(42.2%)	198(37.6%)	226(40.4%)
	148(61.2%)	190(59.6%)	117(50.2%)	143(55.8%)
	99(78.8%)	115(77.1%)	72(62.8%)	91(71.4%)
Subsistence Flows (cfs)	54(95.0%)	42(95.0%)	7.7(95.0%)	22(95.3%)
	Nov, Dec, Jan, Feb	Mar, Apr, May, Jun	Jul, Aug	Sep, Oct
	Winter	Spring	Summer	Fall

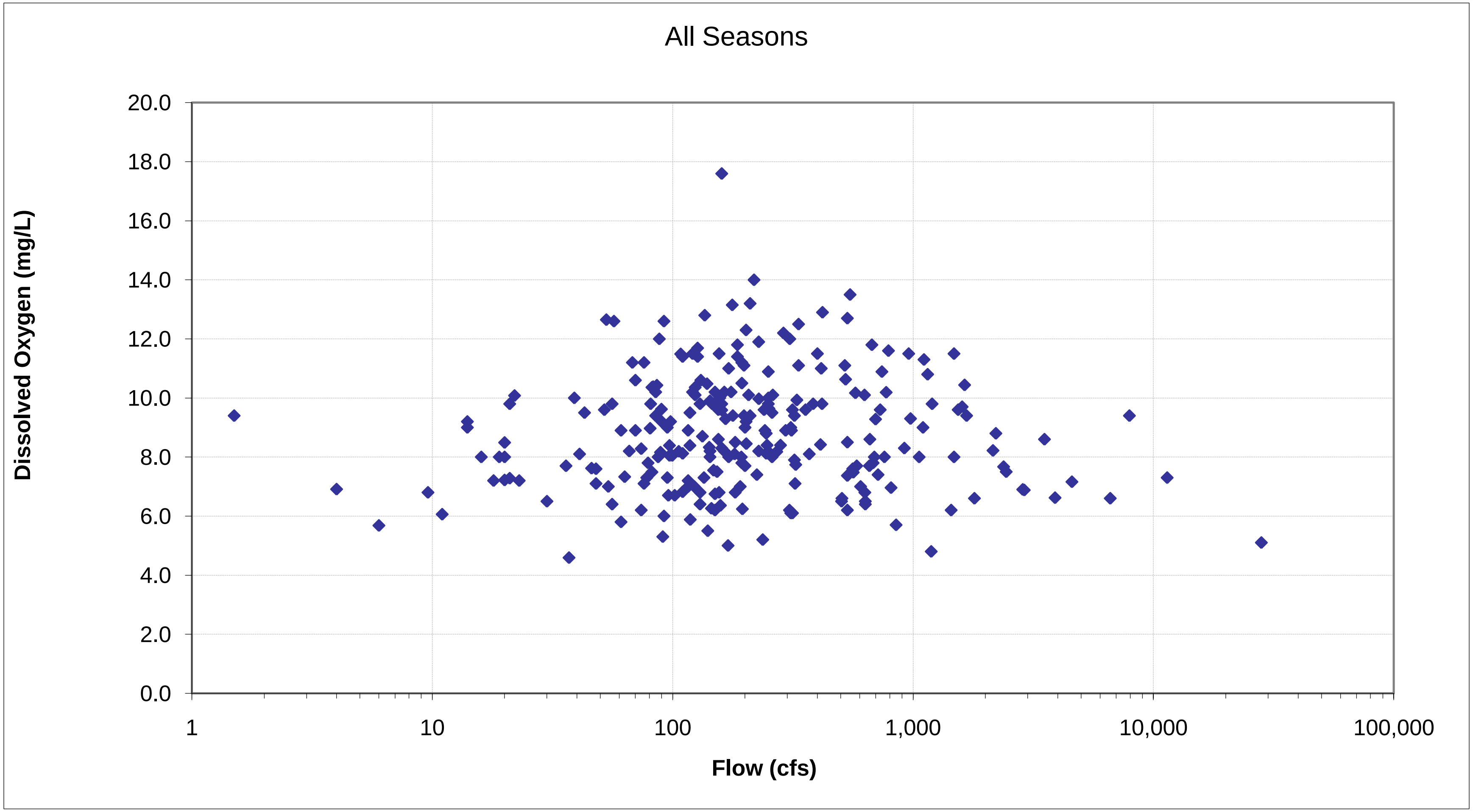
Aquatic Biology, Habitat, and Flow Relationships



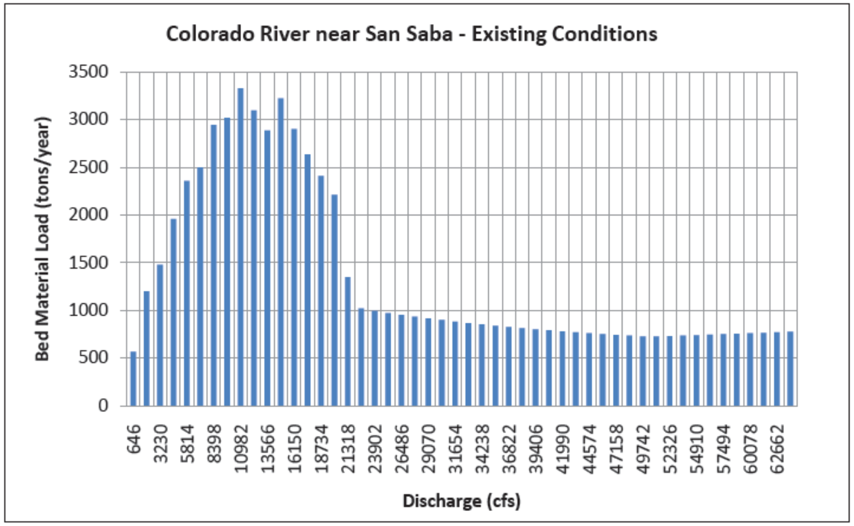
Riparian Vegetation

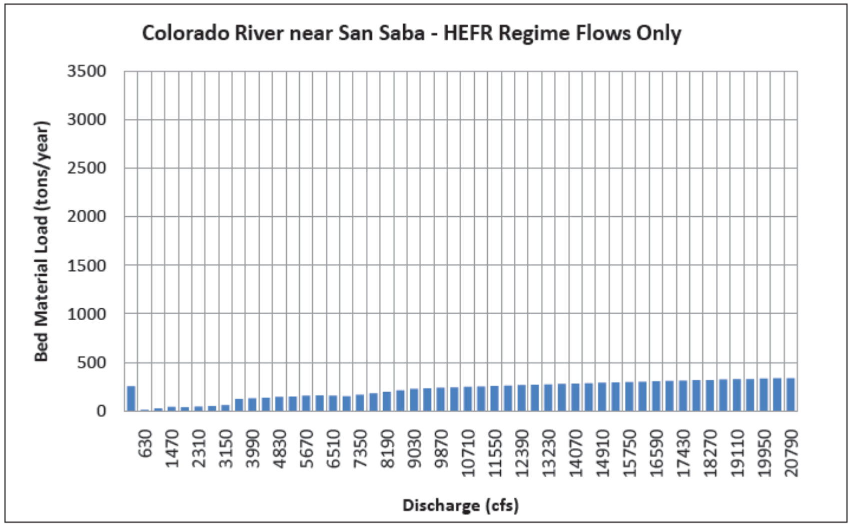


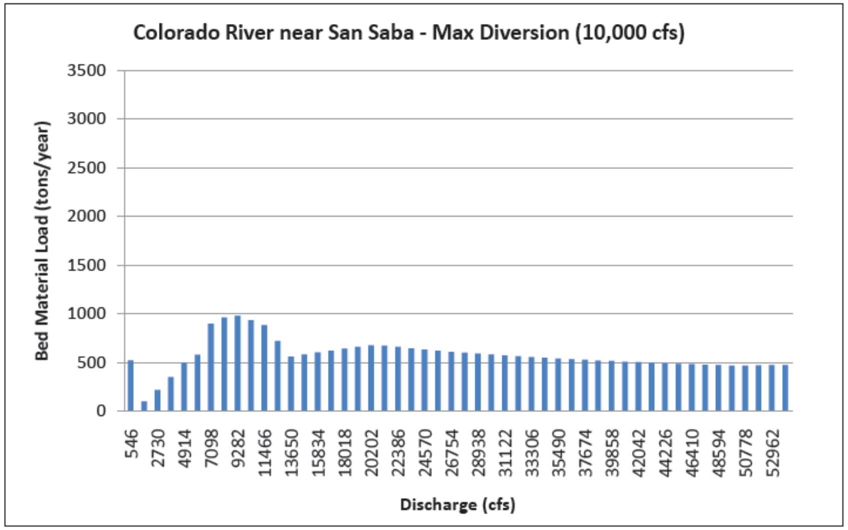
Water Quality

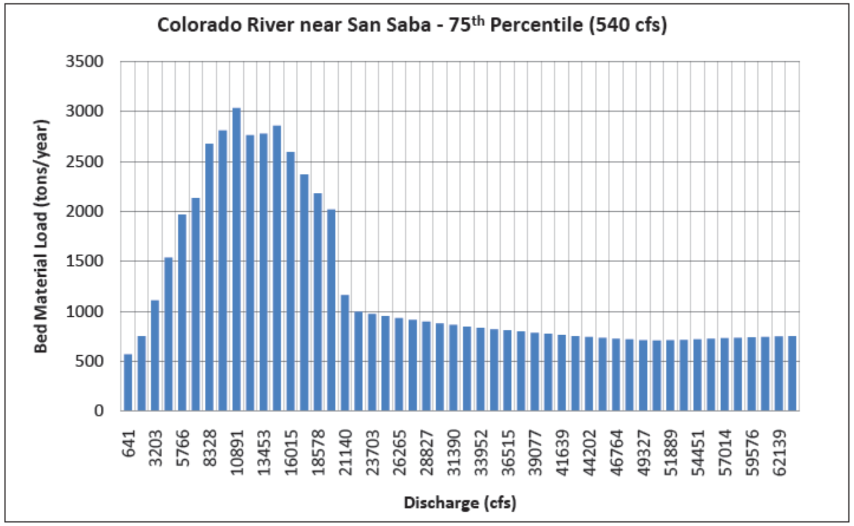


Geomorphology









Colorado River near San Saba,USGS Gage 08147000, Recommended Environmental Flow Regime

	Winter	Spring	Summer	Fall
No-flow periods 1923-2009	0 periods Max duration: 0 days	0 periods Max duration: 0 days	4 periods Max duration: 24 days	0 periods Max duration: 0 days
Subsistence	50 cfs	50 cfs	30 cfs	30 cfs
Base Low	95 cfs	120 cfs	72 cfs	95 cfs
Base Medium	150 cfs	190 cfs	120 cfs	150 cfs
Base High	210 cfs	360 cfs	210 cfs	210 cfs
2 Pulses per season	Trigger: 520 cfs Volume: 3,100 af Duration: 9 days	Trigger: 5,800 cfs Volume: 31,300 af Duration: 9 days	Trigger: 510 cfs Volume: 1,900 af Duration: 4 days	Trigger: 890 cfs Volume: 3,500 af Duration: 6 days
1 Pulse per season	Trigger: 1,600 cfs Volume: 11,100 af Duration: 15 days	Trigger: 11,000 cfs Volume: 70,200 af Duration: 13 days	Trigger: 1,400 cfs Volume: 6,500 af Duration: 7 days	Trigger: 3,800 cfs Volume: 19,200 af Duration: 12 days
1 Pulse per year	Trigger: 18,900 cfs Volume: 129,100 af Duration: 23 days			
1 Pulse per 2 years	Trigger: 30,400 cfs Volume: 222,200 af Duration: 28 days			
1 Pulse per 5 years	Trigger: 39,600 cfs Volume: 300,500 af Duration: 31 days			
Channel Maintenance Flow	A quantity of flow in addition to flows provided by subsistence, base, pulse and overbank flows proposed here would be needed to maintain channel morphology. Analysis by the BBEST at 3 sites across the basins (upper Colorado, lower Colorado, and Lavaca) and within the bounds of the analysis in this report indicates a range of average annual flows on the order of 77-93% of the average annual flow from 1940-1998 with the variability characteristic of the period of record maintains existing channel morphology. The specific flow needed to maintain the channel and its ecological functions will need to be determined on a project and site-specific basis.			
Long-term Engagement Frequencies	Base-high 25%, Base-medium 50%, Base-low 25%, Subsistence 100%, and Pulses 100%. The goal of the engagement frequencies is to produce an instream flow regime that mimics natural patterns by providing the target base flows at frequencies which closely approximate historical occurrences.			

cfs = cubic feet per second

af = acre-feet

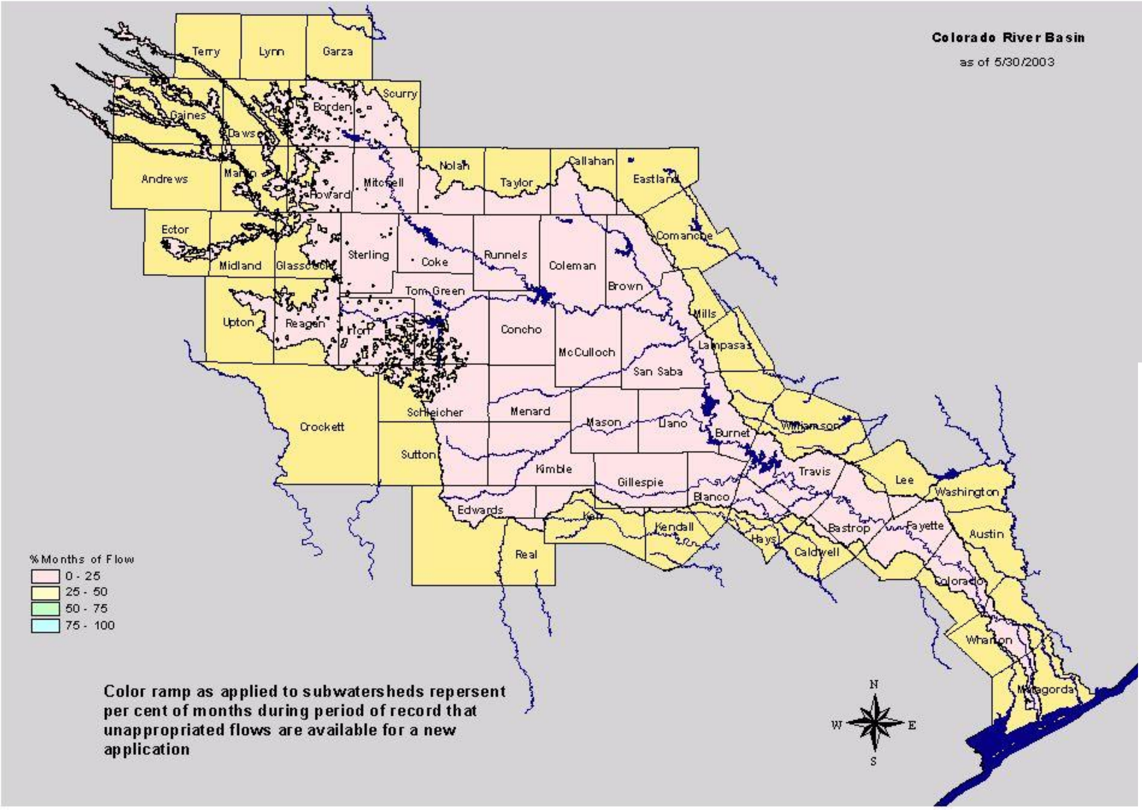
Next?

- Balancing water supply and river needs
  - Evaluate water supply projects to assess impact of e-flows on project yields
- BBEST support of BBASC recommendation report
- Implementation Issues
- Monitoring and adaptive management workplan
  - Validate and/or revise flow recommendations based on response of selected indicators of ecological health
- GSA BBASC path

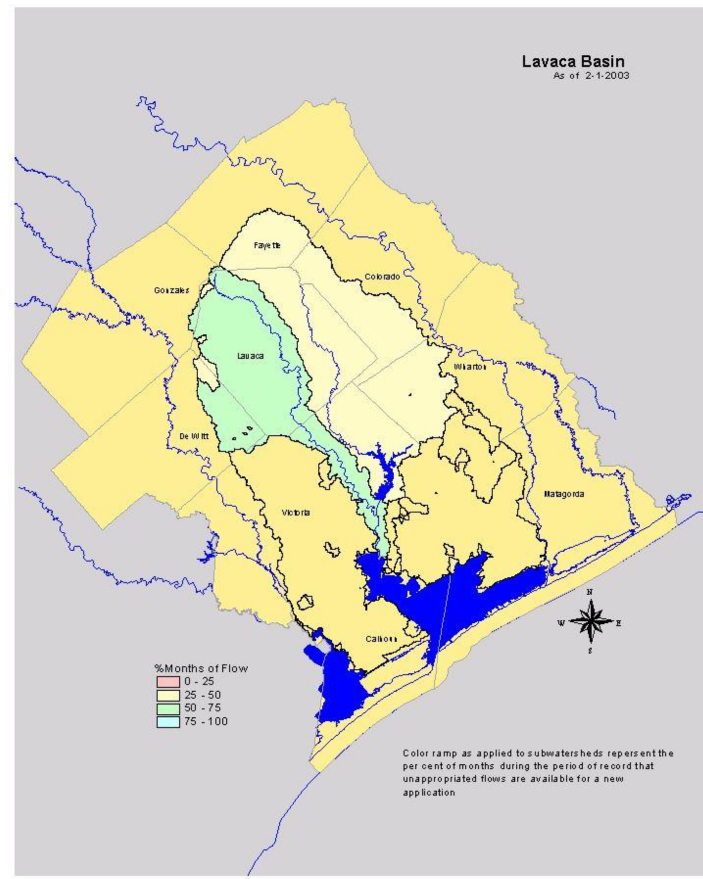
Attainment Frequencies

Base Flow Targets Percent Excedence										
	Gage (Historical)					FRAT (Infinate Infrustructure)				
Season	Subs	Dry	Avg	Wet		Subs	Dry	Avg	Wet	
Winter	96%	84%	65%	47%		96%	84%	49%	16%	
Spring	93%	78%	63%	45%		93%	78%	47%	22%	
Summer	85%	67%	53%	38%		85%	67%	45%	17%	
Fall	93%	74%	58%	46%		93%	74%	43%	15%	
All Months	93%	77%	61%	45%		93%	77%	46%	18%	
High Flow Targets Percent Excedence										
	Gage (Historical)					FRAT (Infinate Infrustructure)				
Season	2ps	1ps	p1y	p2y	p5y	2ps	1ps	p1y	p2y	p5y
Winter	44% (61%)	42%	53%	28%	18%	39% (65%)	47%	51%	21%	11%
Spring	35% (74%)	51%				30% (72%)	49%			
Summer	49% (81%)	51%				40% (77%)	53%			
Fall	44% (75%)	54%				37% (75%)	53%			

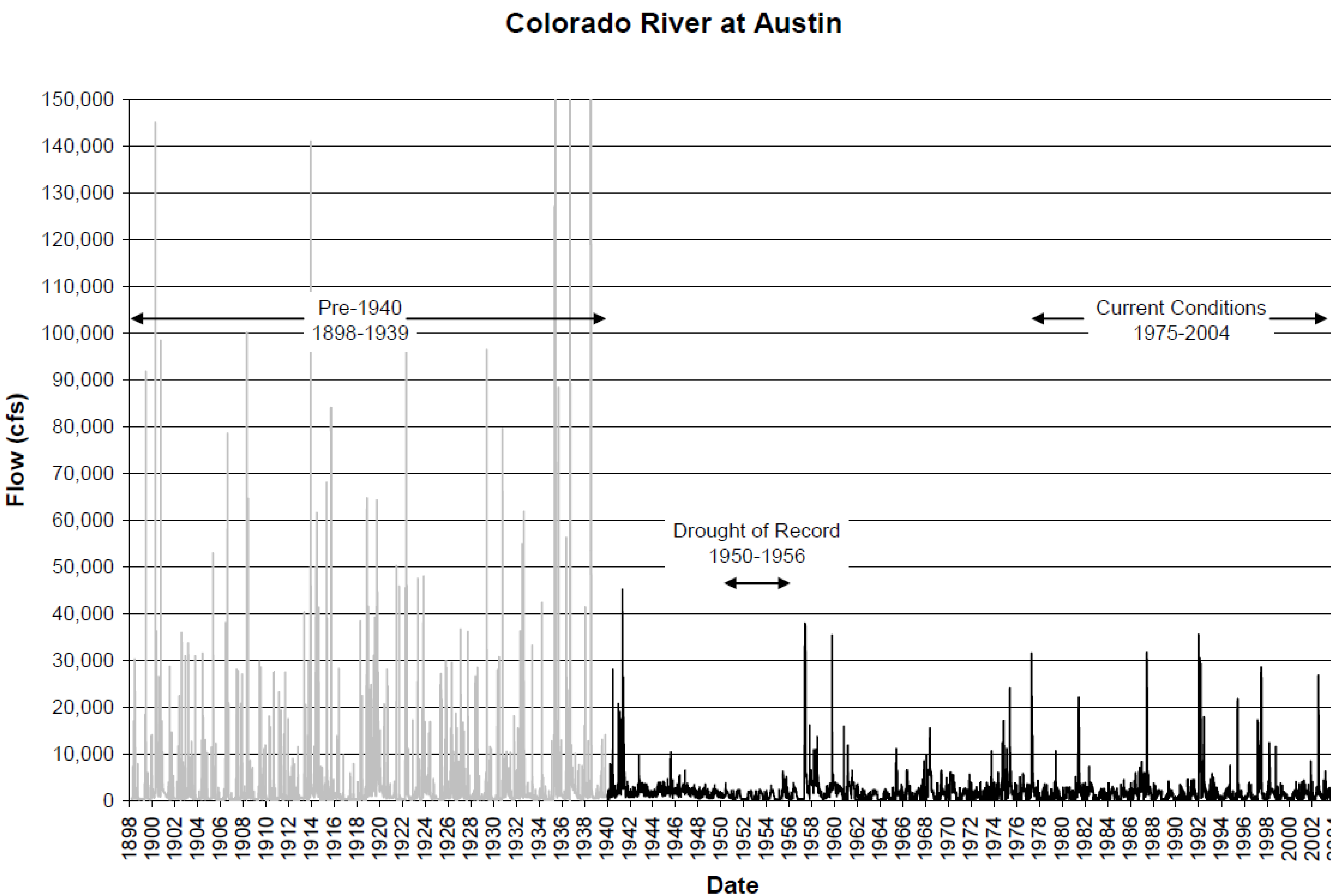
Water Availability Evaluation for New Perpetual Rights



Water Availability Evaluation for New Perpetual Rights



Slides to address specific questions



Colorado River at Austin
Flow (cfs)
150,000
140,000
130,000
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Pre-1940
1898-1939
Current Conditions
1975-2004
Drought of Record
1950-1956
1898
1900
1902
1904
1906
1908
1910
1912
1914
1916
1918
1920
1922
1924
1926
1928
1930
1932
1934
1936
1938
1940
1942
1944
1946
1948
1950
1952
1954
1956
1958
1960
1962
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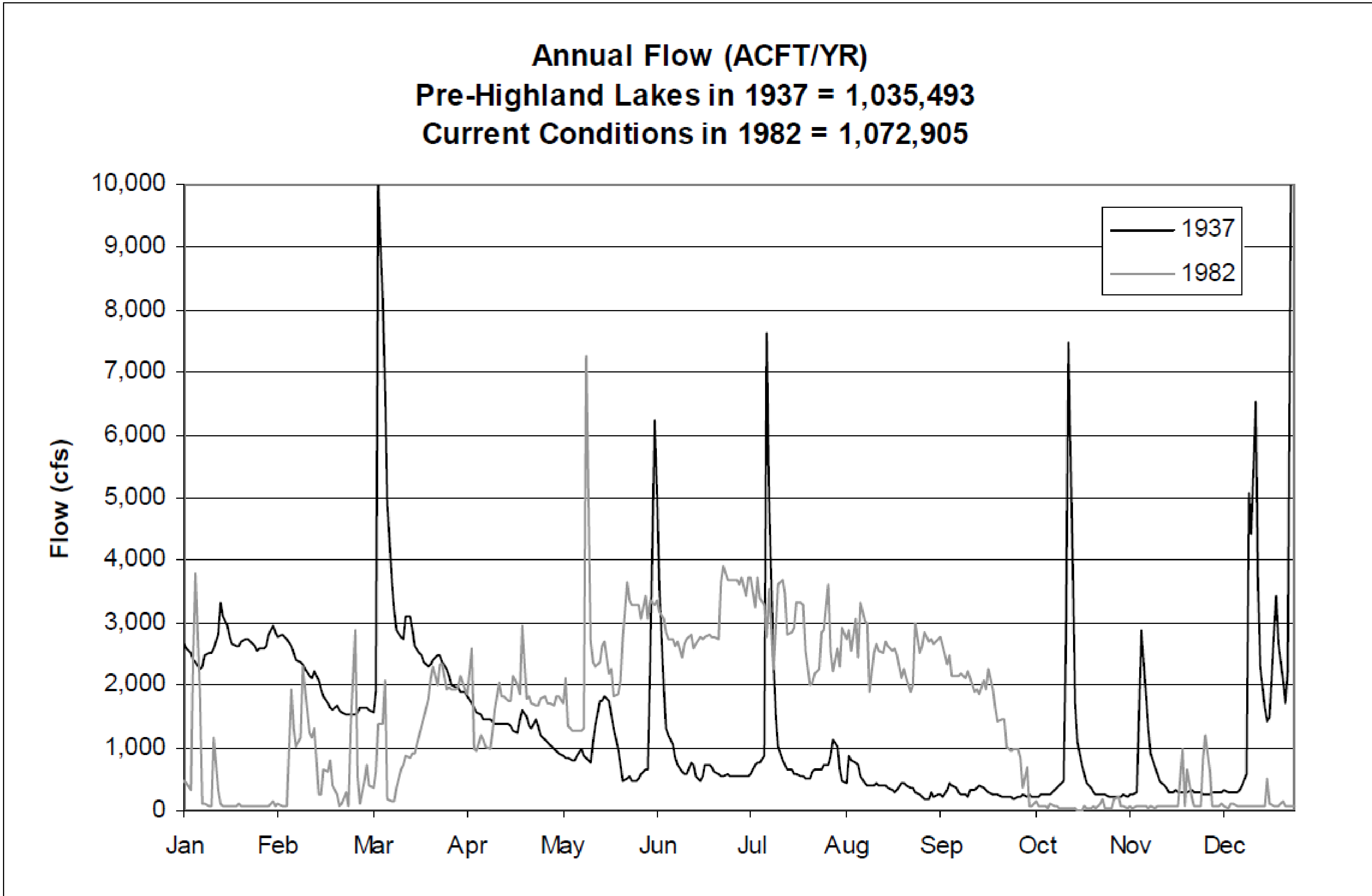
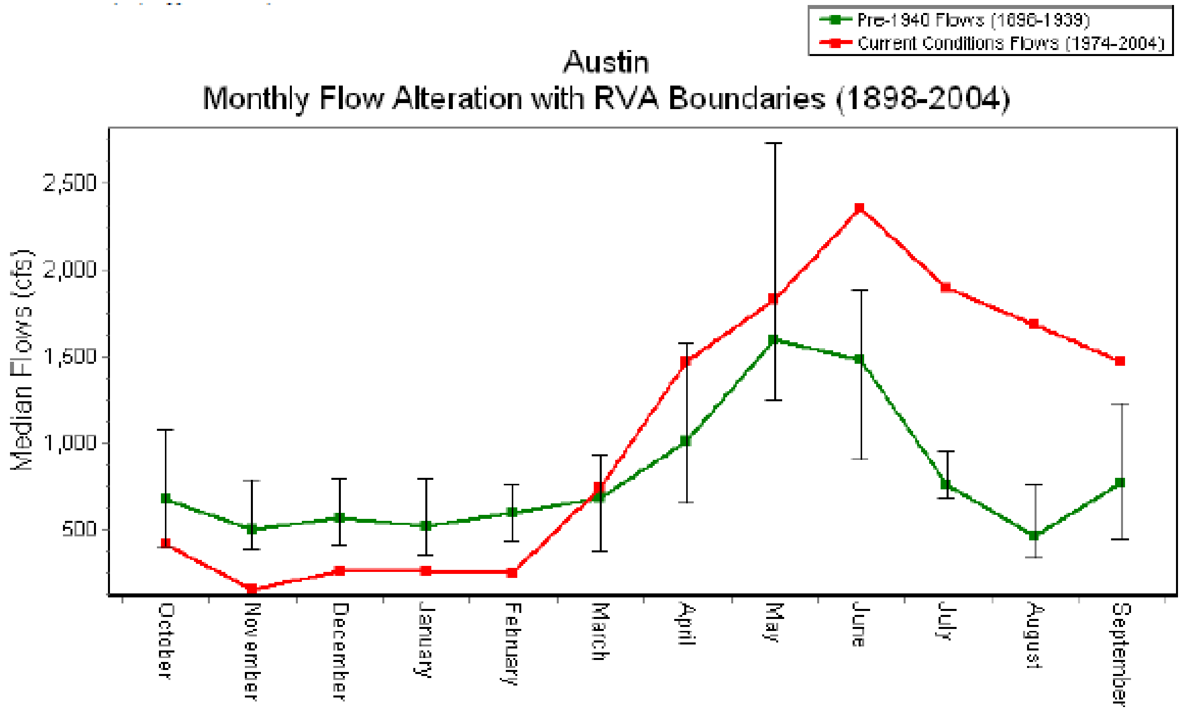
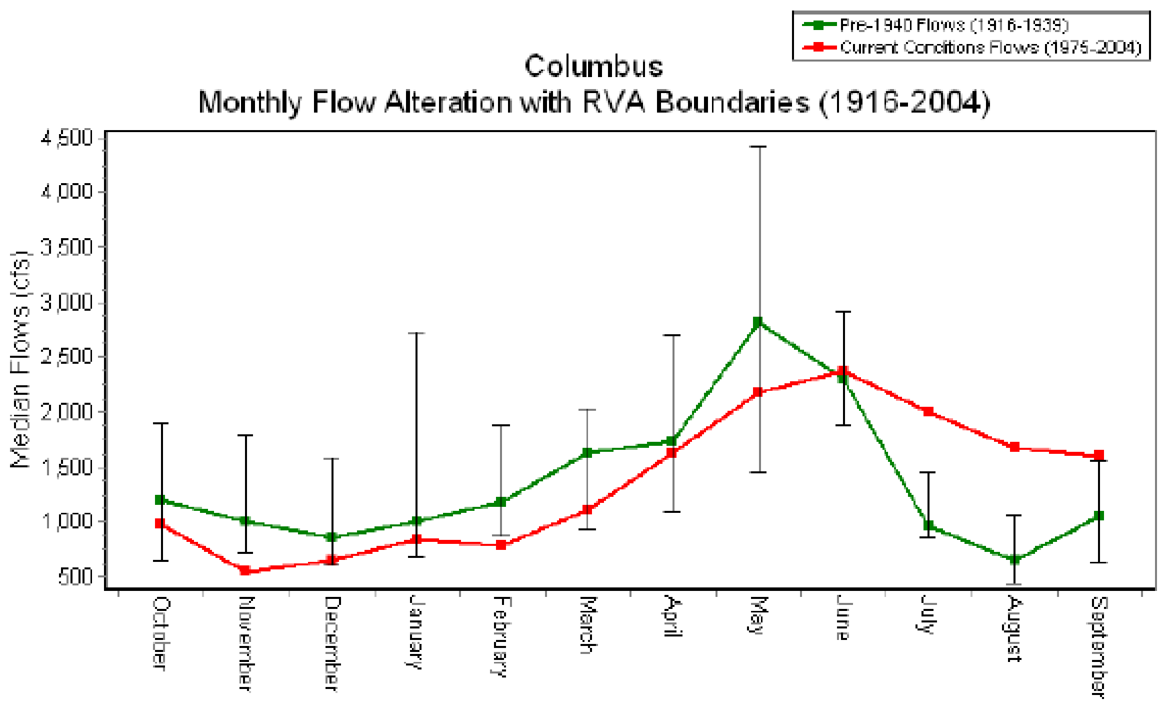
1998
2000
2002
2004
Date


Annual Flow (ACFT/YR)
Pre-Highland Lakes in 1937 = 1,035,493
Current Conditions in 1982 = 1,072,905
Flow (cfs)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1937
1982


Pre-1940 Flows (1898-1939)
Current Conditions Flows (1974-2004)
Austin
Monthly Flow Alteration with RVA Boundaries (1898-2004)
Median Flows (cfs)
2,500
2,000
1,500
1,000
500
October
November
December
January
February
March
April
May
June
July
August
September


Pre-1940 Flows (1916-1939)
Current Conditions Flows (1975-2004)
Columbus
Monthly Flow Alteration with RVA Boundaries (1916-2004)
Median Flows (cfs)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
October
November
December
January
February
March
April
May
June
July
August
September

	FLOW REGIME	
Simulated Parameters	Existing (1975-2004)	Pre-1940 (Natural)
Habitat Diversity (see figures 4.8 – 4.16)	Less habitat diversity year round, particularly during summer irrigation releases	Habitat diversity present year round.
Larval / Juvenile Edge Habitat	Limited edge aquatic habitat during post-spawning months (May – July)	More simulated edge aquatic habitat than existing, but still reduced due to existing channel morphology.
Pre-Spawning migration – *Cycleptus elongatus*	Lower flows in Winter months reduce water depth thus causing more restriction to migration.	Higher flows in the Winter months cause greater water depths and thus, ease of migration.
Sediment Transport – Edge Habitat	Summer time base flows are high enough to provide constant sand transport, thus causing less edge aquatic habitat and adjacent riparian development.	Reduced summer time base flows mean greater potential for aquatic and riparian habitat diversity and river edge stabilization.
Sediment Transport - Deeper Habitats	More base flow sediment transport means more settling of materials in low-velocity habitats, thus reducing deep run/pool function.	Less sediment deposition into deep run/pools maintains this habitat function.
Sediment Transport - macroinvertebrate condition	More summertime base flow sediment transport causes continual disturbance, potentially affecting marcroinvertebrate communities in some areas.	Less summertime base flow sediment transport reduces continual disturbance, potentially benefiting macroinvertebrate communities in some areas.
Water Quality	Flow maintained at levels high enough to create high dissolved oxygen (>6.0 mg/L) even during the hot summer-time months.	Modeling demonstrates that lower summertime flows still produces good dissolved oxygen (>5.0 mg/L). Greater potential for occasional low DO events during summer.

Base Flow Targets Percent Excedence															
	Gage-All					Gage-early					Gage-late				
Season	Subs	Dry	Avg	Wet		Subs	Dry	Avg	Wet		Subs	Dry	Avg	Wet	
Winter	96%	80%	60%	43%		88%	70%	57%	43%		98%	77%	51%	32%	
Spring	93%	76%	60%	42%		90%	76%	65%	50%		94%	73%	54%	38%	
Summer	83%	63%	50%	36%		89%	73%	63%	49%		84%	50%	35%	26%	
Fall	92%	69%	54%	42%		91%	72%	60%	51%		90%	63%	40%	25%	
All Months	92%	74%	57%	41%		89%	73%	61%	48%		93%	68%	48%	32%	

High Flow Targets Percent Excedence															
	Gage-All					Gage-early					Gage-late				
Season	2ps	1ps	p1y	p2y	p5y	2ps	1ps	p1y	p2y	p5y	2ps	1ps	p1y	p2y	p5y
Winter	43% (60%)	40%	51%	27%	17%	68% (74%)	58%	63%	47%	32%	53% (58%)	47%	47%	21%	16%
Spring	31% (67%)	46%				74% (95%)	79%				11% (53%)	32%			
Summer	41% (76%)	47%				63% (95%)	74%				16% (63%)	32%			
Fall	40% (73%)	47%				53% (89%)	74%				32% (79%)	21%			