How Low Should We Go?

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BUILDING STRONG®

Methods to determine low flow

- Hydrologic or Historic
- Hydraulic
- Habitat
- Holistic
- Water Quality
- Other

Hydrologic Methods

- Quick and easy
- Tennant (Montana Method)
  - 10% MAF (Mean Annual Flow)- minimum for fish
  - 30% MAF - adequate for fish
  - 60% MAF - good for fish
- 7Q10
- 90% Exceedence
- 95% Exceedence

Hydraulic Methods

- Based on cross sections
- More data required
- Often based on Manning's Equation
- Depth
- Width
- Wetted Area

Habitat Methods

- Two elements – hydraulic and fish habitat models
- IFIM – Instream Flow Incremental Methodology

  PHABSIM-physical habitat simulation

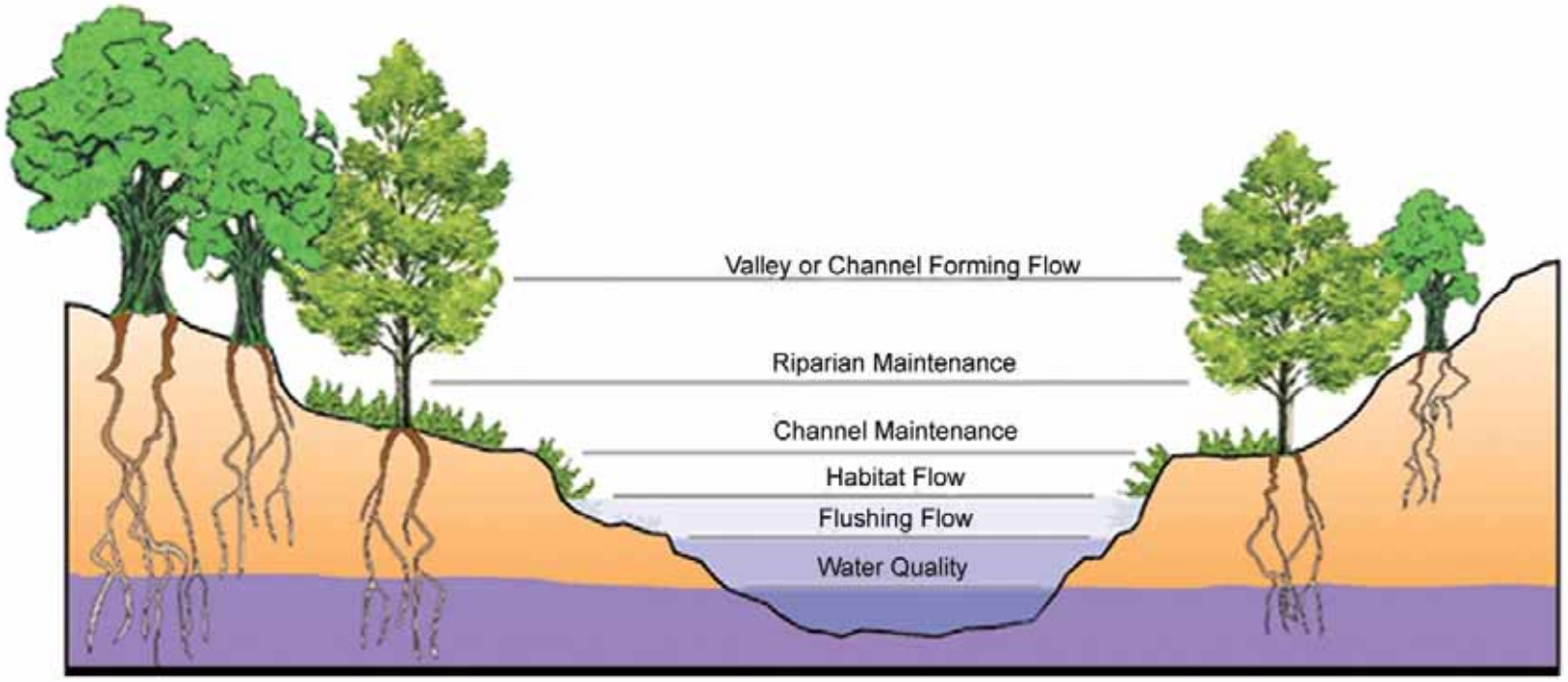
  RHABSIM-river habitat simulation

  RHYHABSIM-river hydraulic habitat simulation
- RCHARC – Riverine Community Habitat Assessment & Restoration Concept

Holistic Methods

- Arthington (1991) Holistic approach
  - Low flows
  - First major wet-season flood
  - Medium floods
  - Very large flood
- Range of Variability – 32 parameters
- Building Block Methodology- health of all components of riverine system- habitat integrity, social use, ecological importance, hydrology, hydraulics, geomorphology, water quality, vegetation, aquatic invertebrates, fish, and groundwater

Holistic methods – flow effects



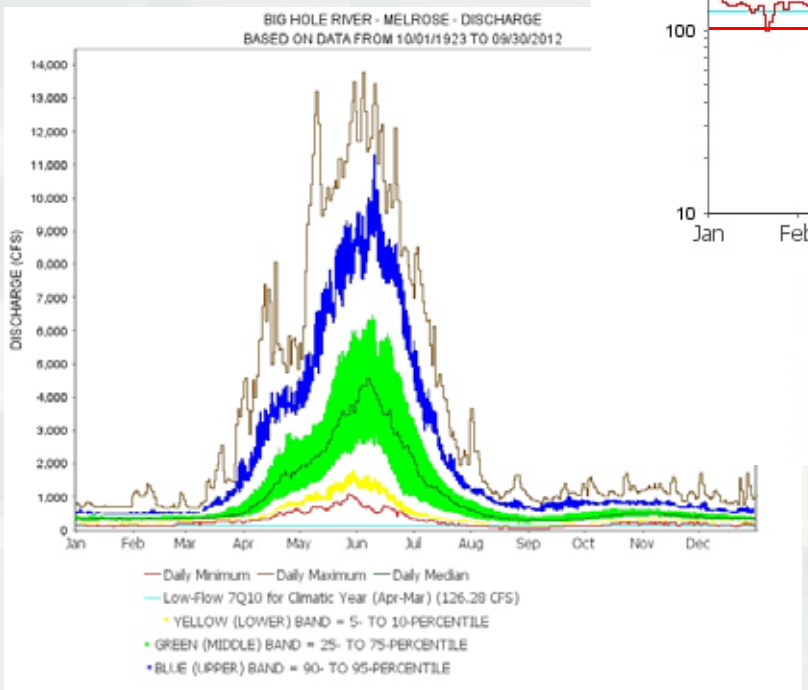
Water Quality Methods

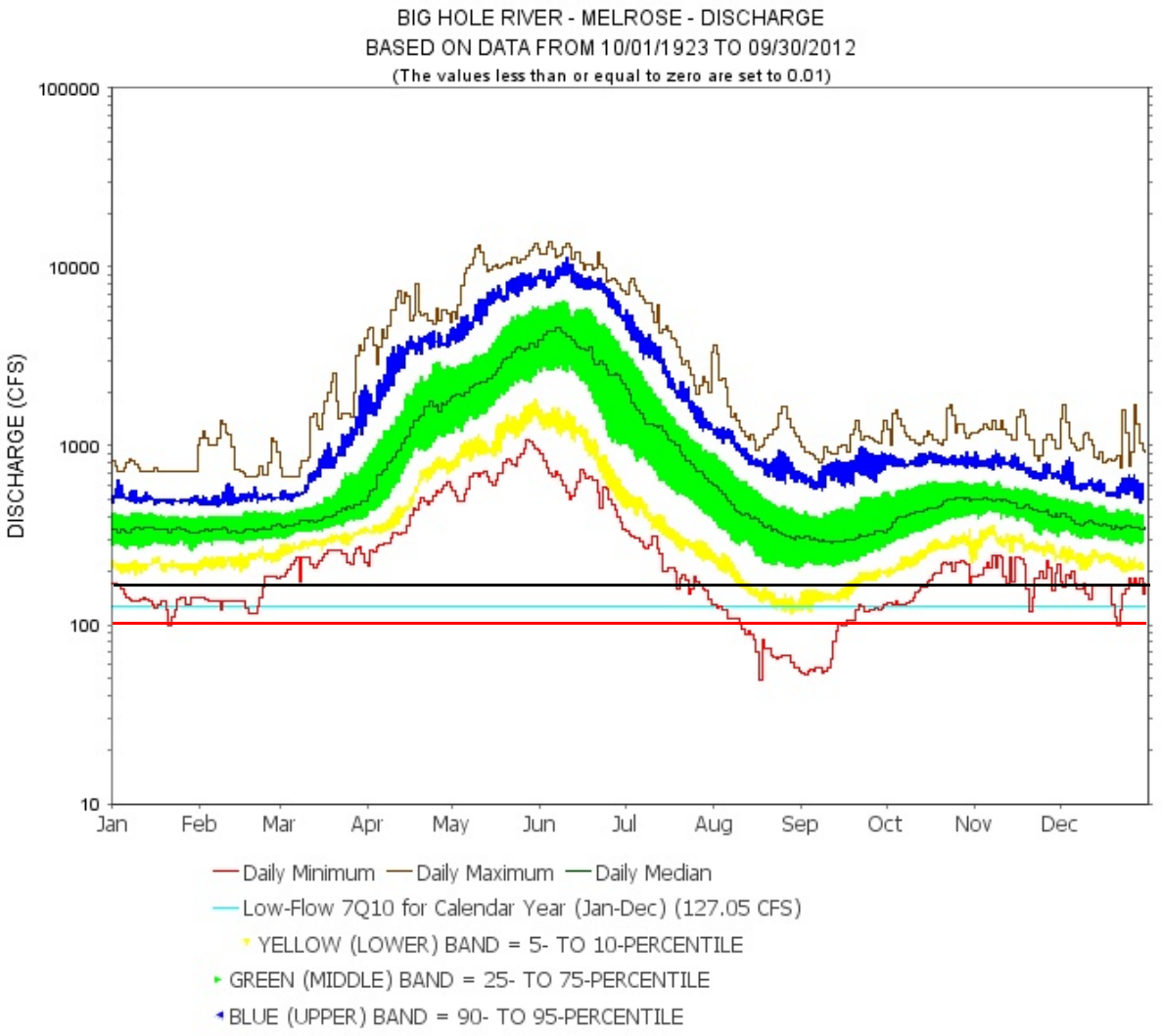
- Temperature - maximum
- Dissolved oxygen – minimum
- Total dissolved solids

Other Methods

- Float a boat
- 0.5 cfs/ square mile of drainage area
- Minimum depth for a fish to swim upstream

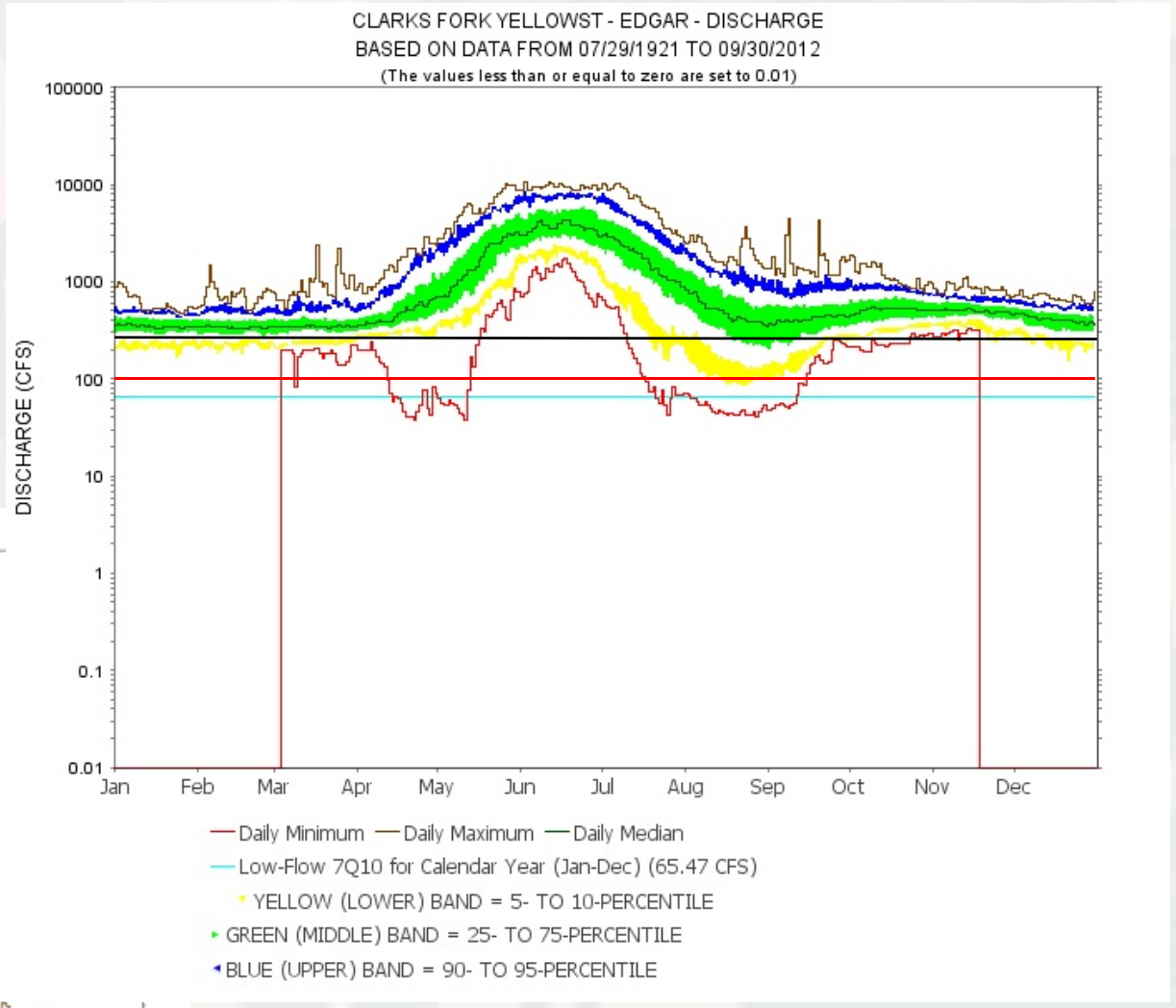
Big Hole River at Melrose, 1923 to 2012

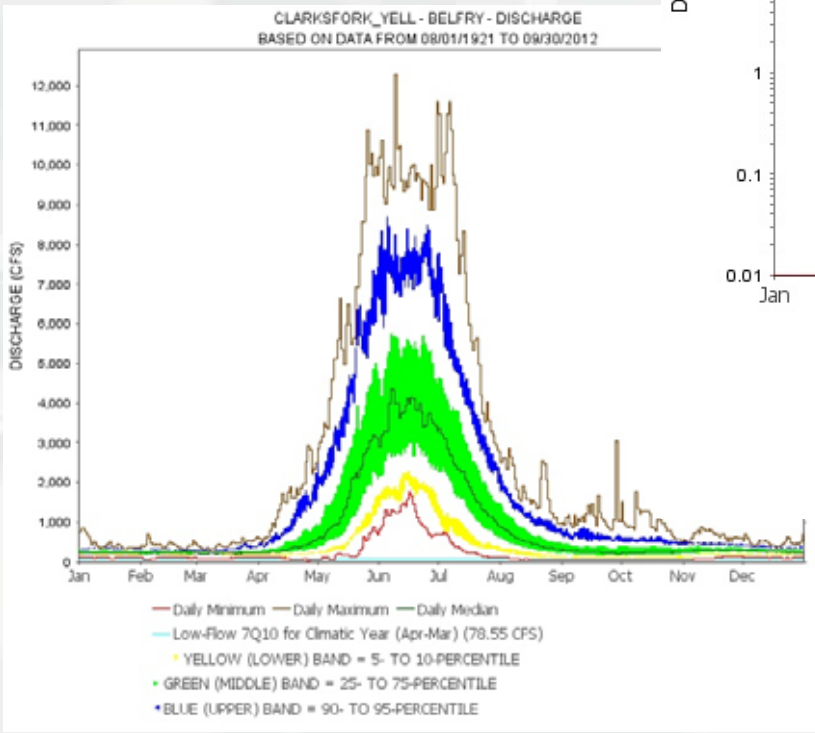




	cfs	cfs/sqmi	% Dur	cfs	cfs/sqmi
Mean	1106	0.45	10%	255	0.10
Median	470	0.19	25%	330	0.13
Minimum	49	0.02	75%	1030	0.42
Maximum	13800	5.57	90%	2920	1.18
7Q10	126	0.05	Tennant	331.8	0.13

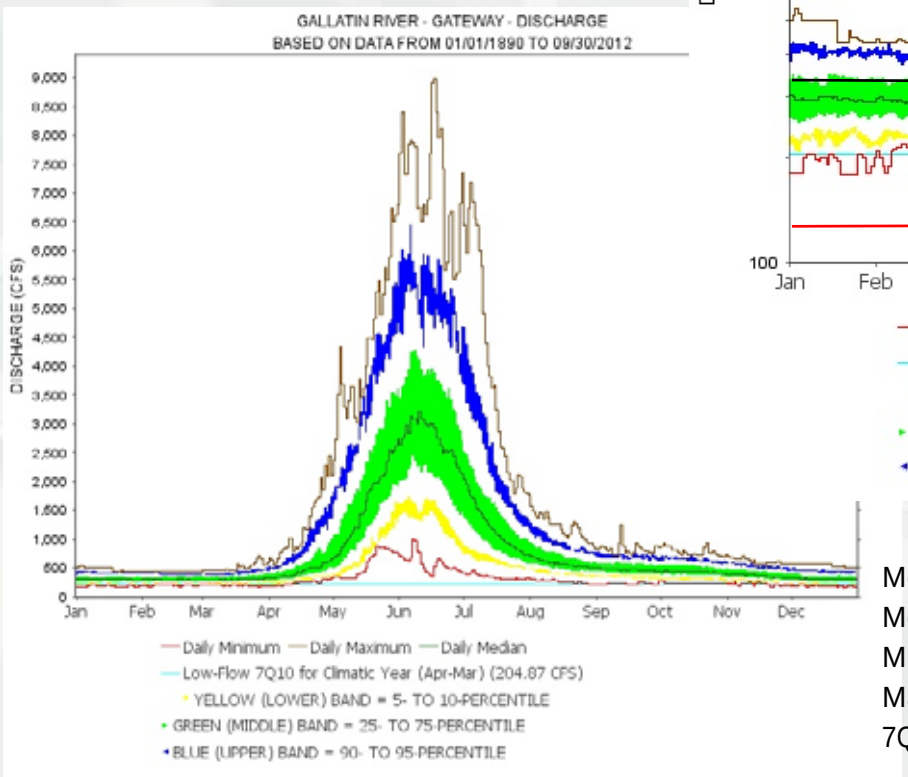
Clarksfork of Yellowstone River at Belfry, MT 1921 to 2012

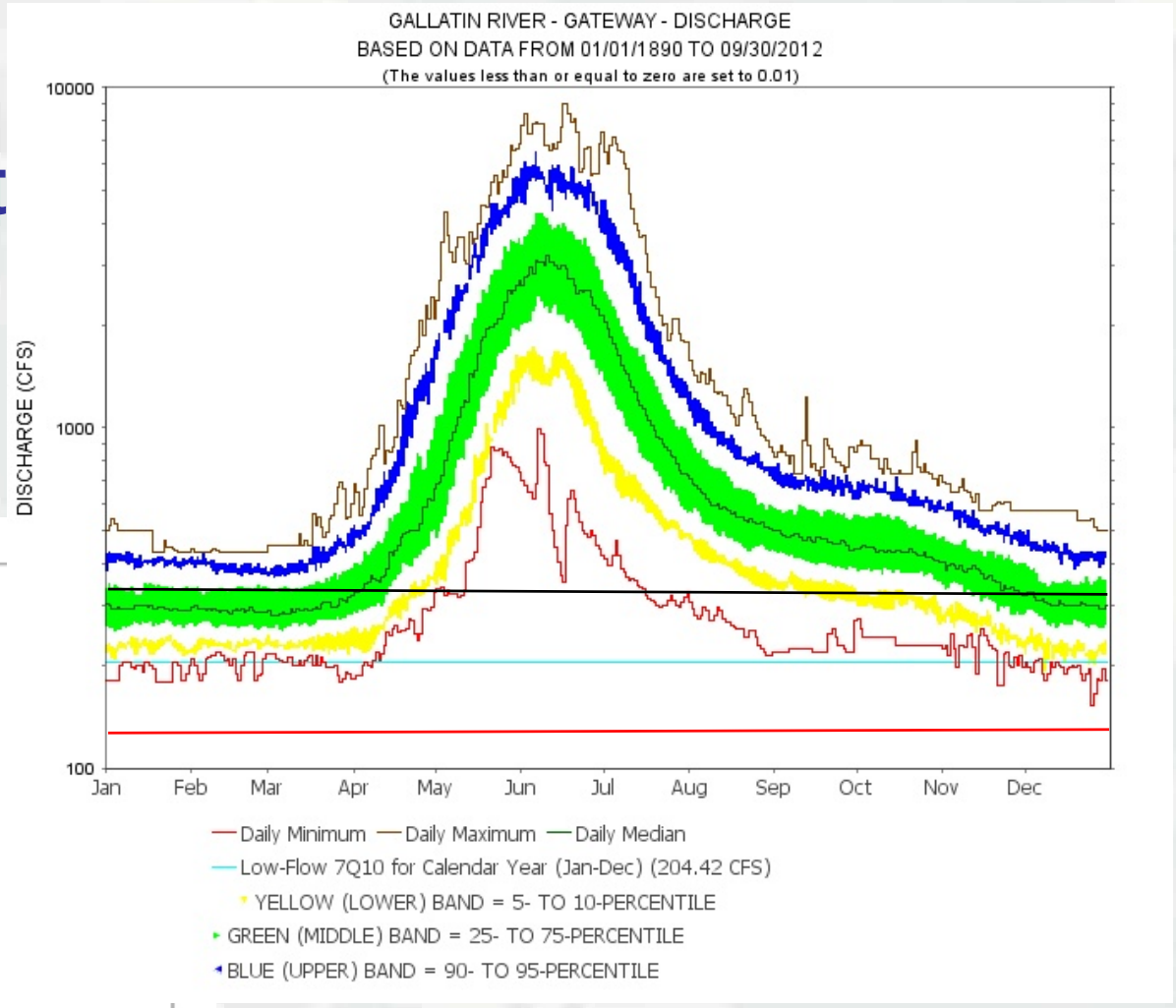




	cfs	cfs/sqmi	% Dur	cfs	cfs/sqmi
Mean	925	0.80	10%	170	0.15
Median	297	0.26	25%	220	0.19
Minimum	33	0.03	75%	793	0.69
Maximum	12300	10.66	90%	2840	2.46
7Q10	78.55	0.07	Tennant	277.5	0.24

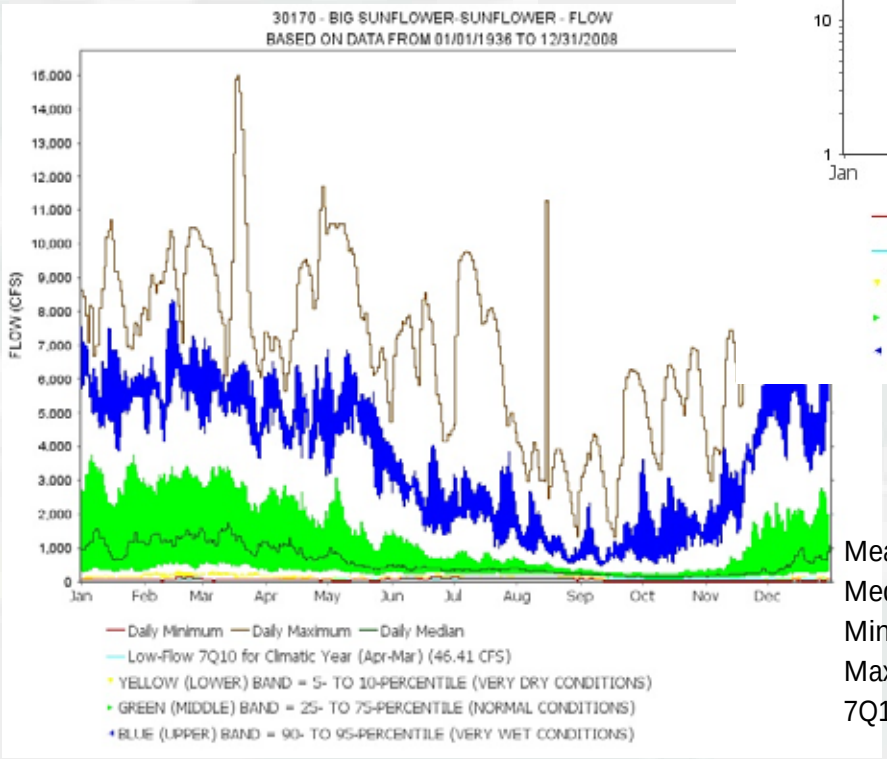
Gallatin River, at Gateway, MT 1890-2012

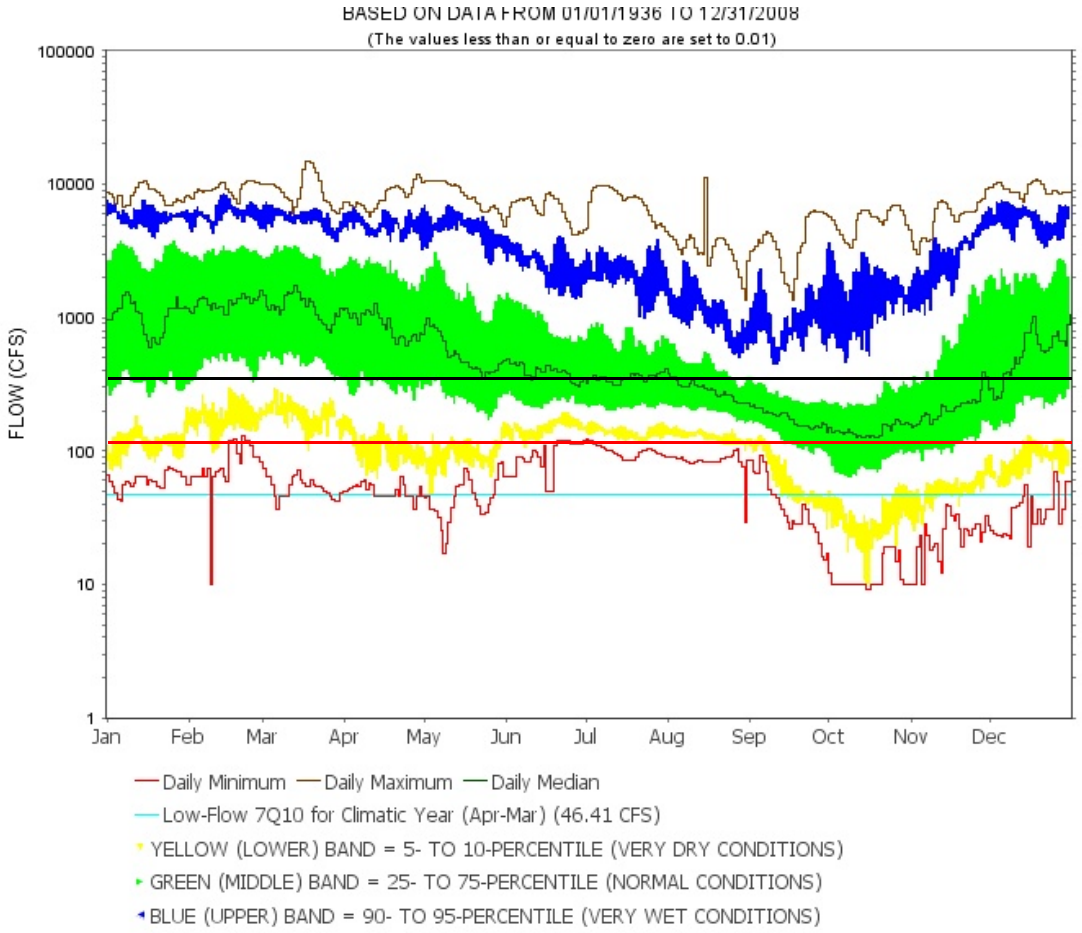




	cfs	cfs/sqmi	% Dur	cfs	cfs/sqmi
Mean	1192	1.44	10%	263	0.32
Median	414	0.50	25%	310	0.38
Minimum	153	0.19	75%	727	0.88
Maximum	8970	10.87	90%	2000	2.42
7Q10	204	0.25	Tennant	357.6	0.43

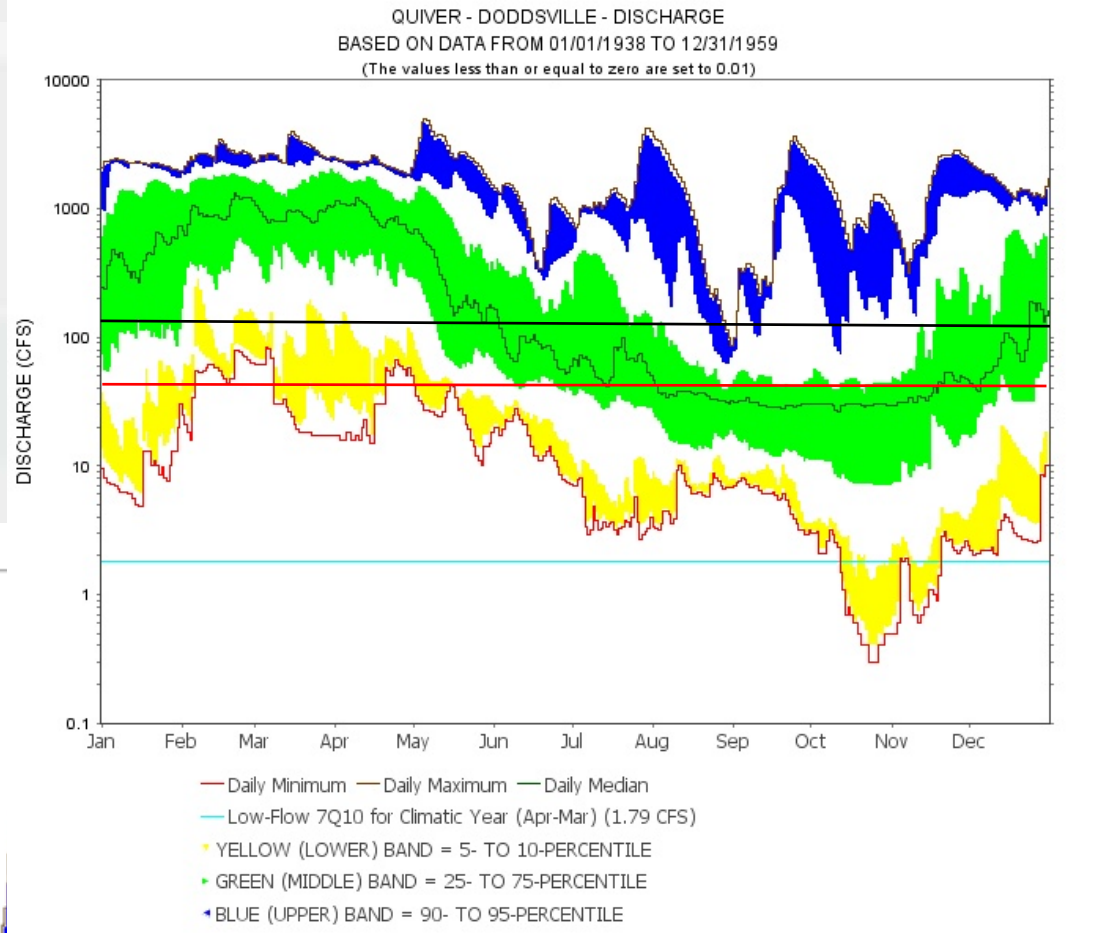
Big Sunflower at Sunflower, 1936-2008

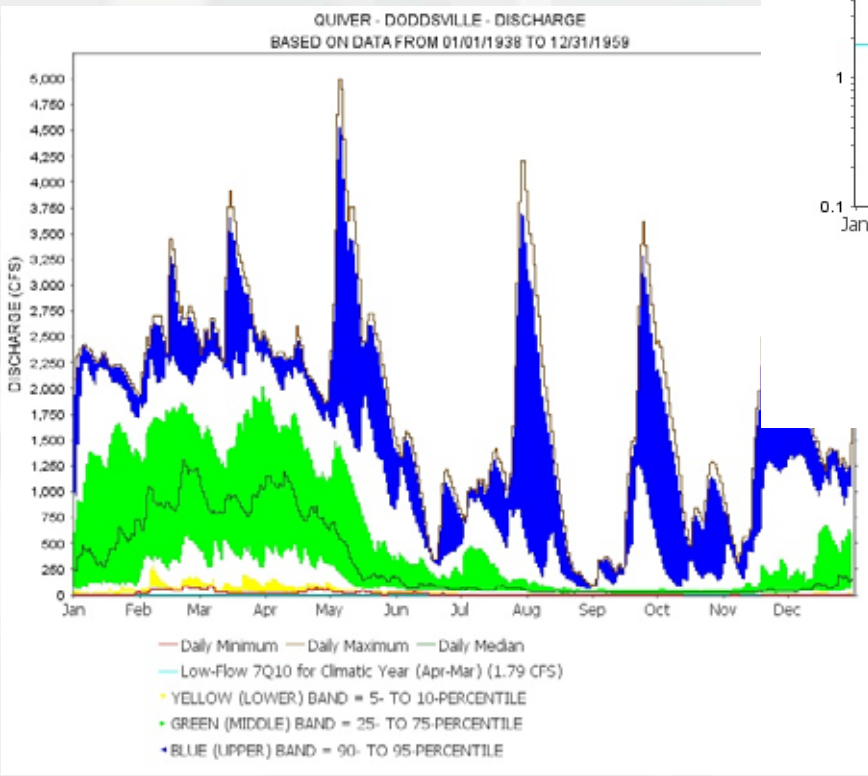




	cfs	cfs/sqmi	% Dur	cfs	cfs/sqmi
Mean	1071	1.40	10%	118	0.15
Median	386	0.50	25%	190	0.25
Minimum	10	0.01	75%	1260	1.64
Maximum	15000	19.56	90%	3140	4.09
7Q10	46.41	0.06	Tennant	321.3	0.42

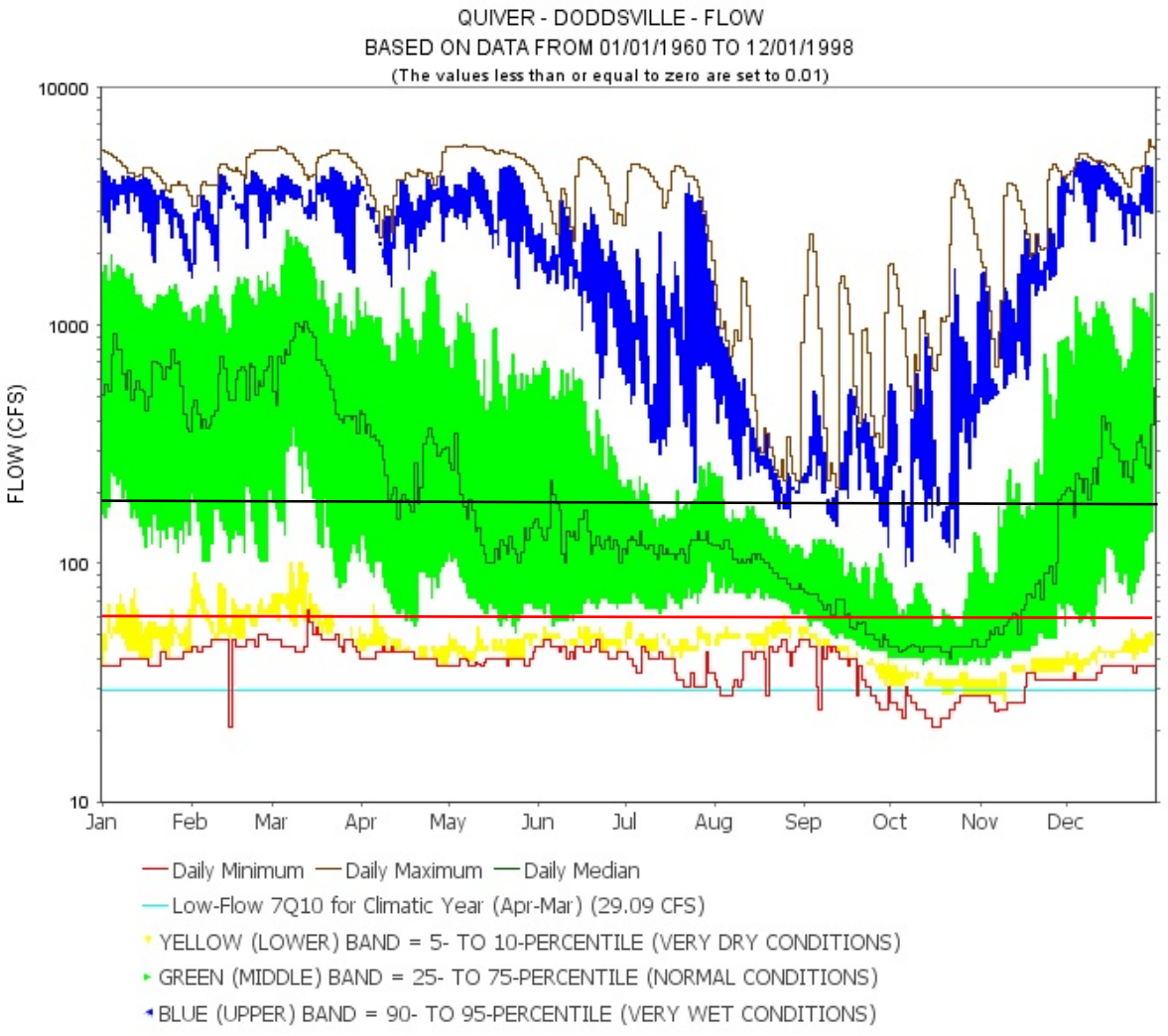
Quiver River at Doddsville, 1938-1958

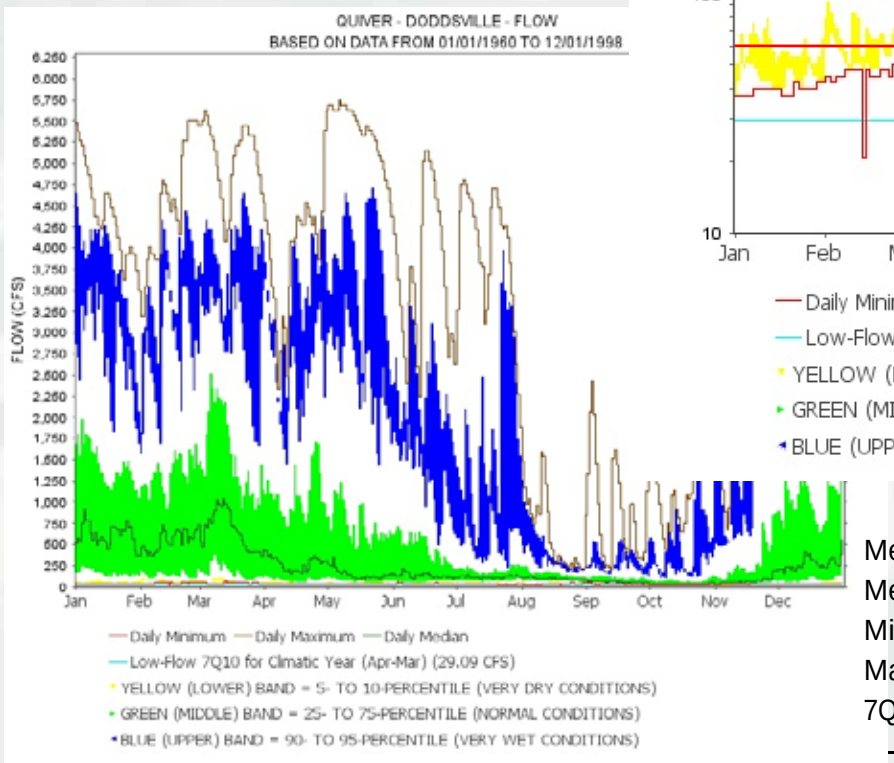




	cfs	cfs/sqmi	% Dur	cfs	cfs/sqmi
Mean	477	1.63	10%	6.8	0.02
Median	94	0.32	25%	15	0.05
Minimum	0.3	0.001	75%	771	2.64
Maximum	3920	13.42	90%	1550	5.31
7Q10	1.79	0.01	Tennant	143.1	0.49

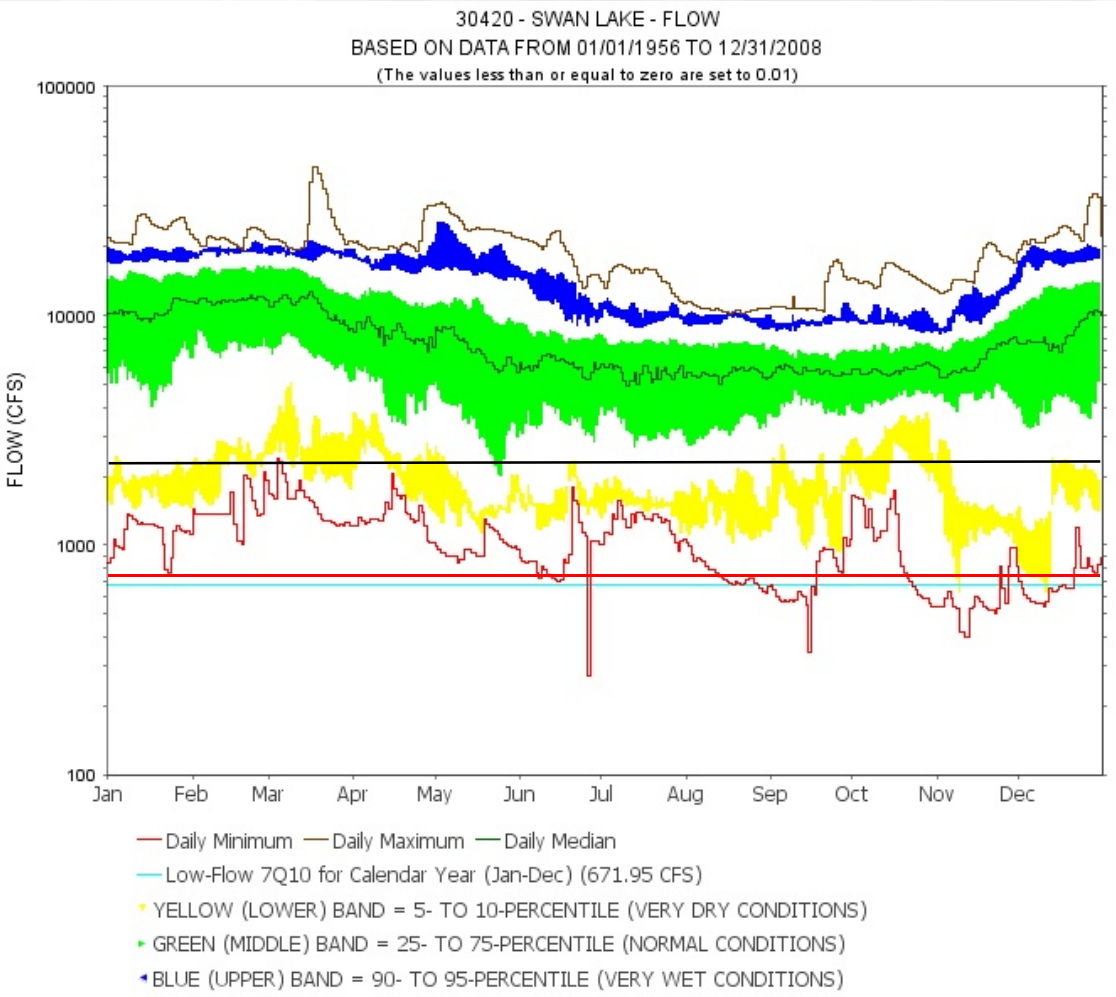
Quiver River at Doddsville, 1960-1998

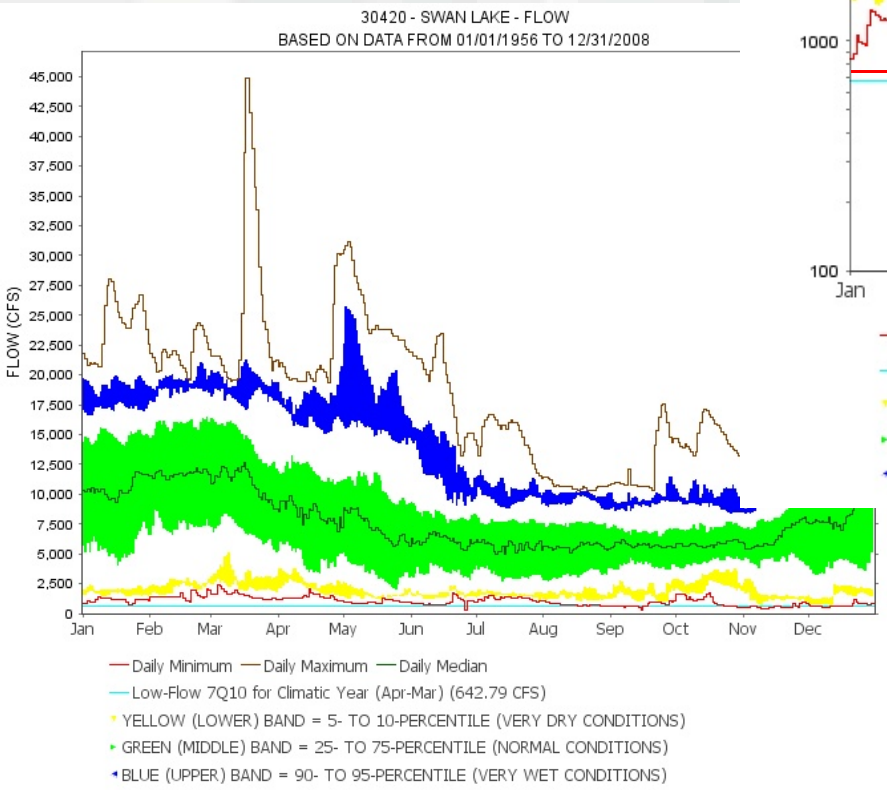




	cfs	cfs/sqmi	% Dur	cfs	cfs/sqmi
Mean	582	1.99	10%	45	0.15
Median	136	0.47	25%	63.8	0.22
Minimum	20.6	0.07	75%	570	1.95
Maximum	6000	20.55	90%	1731	5.93
7Q10	29	0.10	Tennant	174.6	0.60

Tallahatchie River at Swan Lake, 1956 to 2008





	cfs	cfs/sqmi	% Dur	cfs	cfs/sqmi
Mean	7688	1.50	10%	2040	0.40
Median	6910	1.35	25%	4080	0.80
Minimum	270	0.05	75%	10300	2.01
Maximum	34000	6.63	90%	14700	2.87
7Q10	642.79	0.13	Tennant	2306.4	0.45

Conclusions

- Tennant method works for Montana mountain streams
- Tennant method does not work well for Mississippi Delta streams
- Massachusetts Method (.5 cfs/sq mi) does work in either Montana or Mississippi
- Methods to determine adequate low flows should be developed regionally