

Statistical Assessment of Benthic Macroinvertebrate and Flow Data

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Team

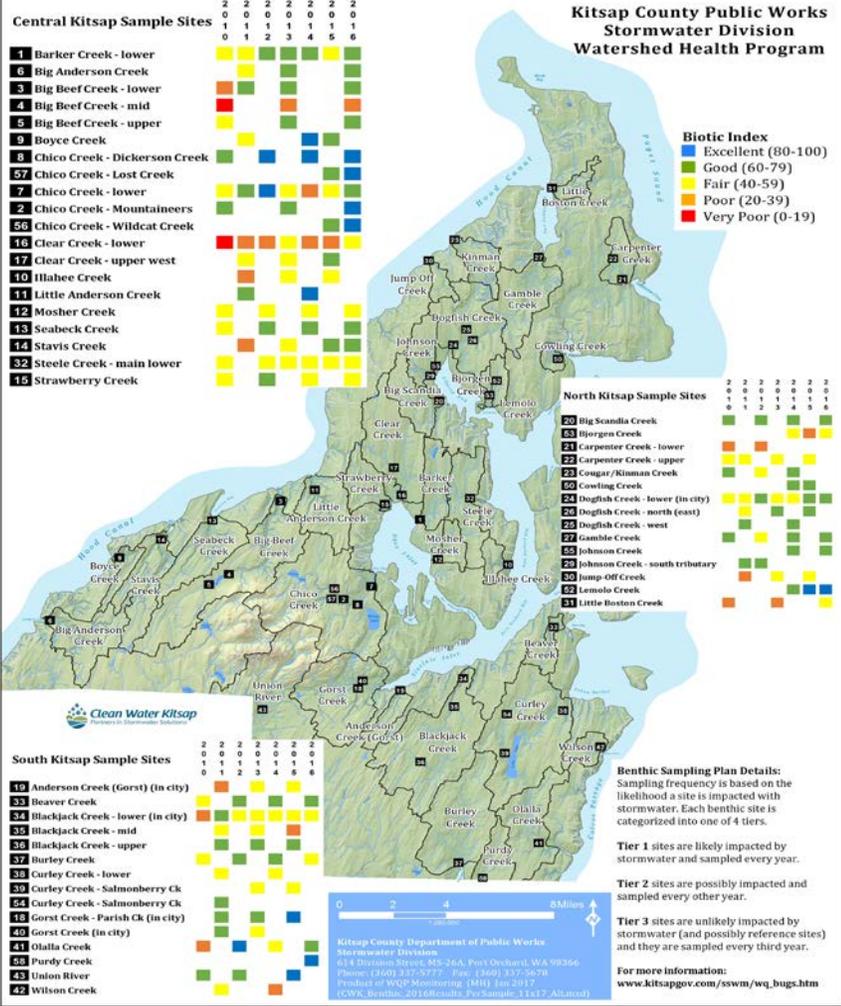
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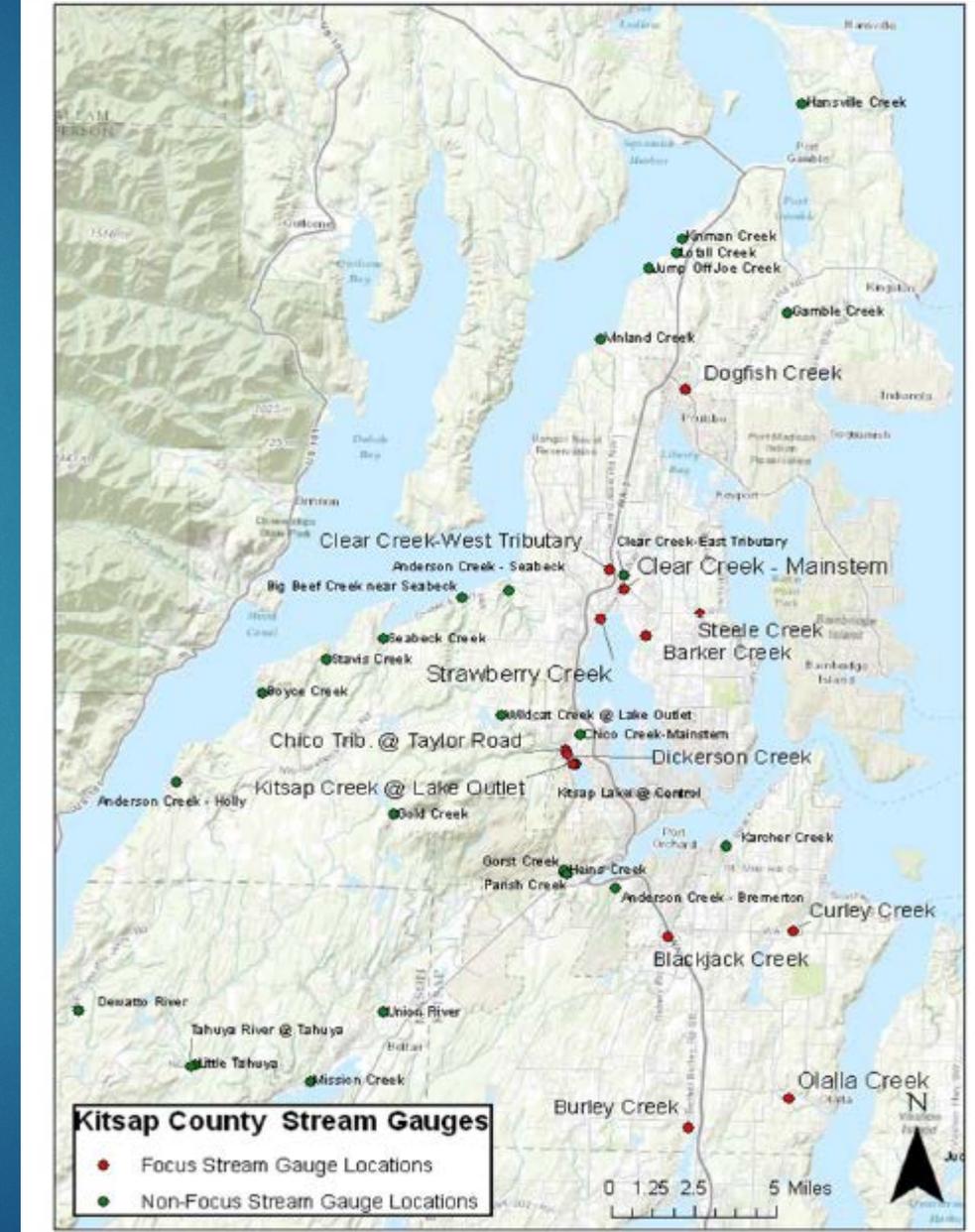
Clean Water Kitsap
Partners in Stormwater Solutions

**Benthic Macroinvertebrate Monitoring for Stream Health
2010 - 2016 Results**



Flow Monitoring Program

- ▶ Storm Basin Flow
- ▶ Stream Flow
- ▶ Rain Gauges
- ▶ Benthic monitoring program



Project Goals



MACROINVERTEBRATE ANALYSIS

- ▶ Evaluate whether there is an individual macroinvertebrate metric(s) that may perform better as early indicators for trend detection
- ▶ Assess whether there are long-term trends in macroinvertebrate data
- ▶ Assess whether there are short-term trends in macroinvertebrate data

FLOW DATA

- ▶ Evaluate how much of the observed variation can be explained by precipitation



Macroinvertebrate Analysis

Question 1: Is there a metric that is better for early trend detection?

B-IBI -- It's Just Another Index



Time Frame: 1 Year

Chart Display:

Chart Type: OHLC E

Indicators: Splits Moving

Moving Average: None 20 Day 50 Day 200 Day

Lower Studies: Volume MACD RSI

Compare To (10 Max.)

Index: None

Symbols:



What Does It Mean When the NASDAQ Is Down?

Evaluation of Individual Metrics

Data Culling

Select Sites with 5 or more consecutive years of data (26 of 123 sites)

Apply Statistic

Pearson's R and Kendall's tau correlations

Evaluate

Which Metrics displayed the Most Trends

Pearsons R Results

Comparison of Individual Metrics Using Pearson's R Correlation						
Site	BIBI	Taxa Richness	Ephemeroptera Richness	Clinger Richness	Percent Predator	Percent Tolerant
	R	R	R	R	R	R
Mountaineers/Chico Creek	-0.884	-0.851	-0.653	-0.844	0.194	-0.070
Chico Creek	-0.450	0.226	0.147	0.158	-0.683	-0.774
Lower Curley Creek	0.520	-0.844	0.657	-0.670	0.649	0.223
Clear Creek	-0.519	-0.295	-0.612	-0.593	0.127	0.550
Harding Creek	0.593	0.512	0.639	-0.109	0.907	0.174
Lower Barker Creek	0.601	0.401	0.639	-0.046	-0.643	0.259
Lower Chico Creek	-0.560	-0.023	-0.817	-0.485	-0.754	-0.678
Lower Clear Creek	0.684	0.809	-0.137	0.776	0.667	0.646
Illahsee Creek	0.856	0.413	0.832	0.817	0.731	0.431
Kitsap Creek	-0.529	NA	-0.268	-0.530	-0.655	-0.759
Upper Carpenter Creek	0.873	0.778	-0.414	0.781	0.382	0.343
Lower Main Dogfish Creek	0.586	0.471	0.982	0.919	-0.874	0.422
Blackjack Creek	0.346	0.321	0.487	0.363	-0.826	0.436
Gamble Creek	0.664	0.398	0.707	0.354	0.589	0.915
Big Anderson Creek	0.445	0.236	-0.707	0.343	0.847	-0.050
Lower Carpenter Creek	0.766	0.707	0.707	0.805	0.538	0.630

Light shading indicates significance at <0.10 and darker shading indicates significance at <0.050.

Pearsons vs Kendall tau

Comparison of Individual Metrics Using Pearson's R Correlation						
Site	BIBI	Taxa Richness	Ephemeroptera Richness	Clinger Richness	Percent Predator	Percent Tolerant
	R	R	R	R	R	R
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Were trends detected? Yes

At 7 to 8 (out of 16) sites, two or more metrics indicated a long term trend

At 4 to 5 sites at least 3 metrics indicated a trend

Was the trend direction consistent?

Yes, with one exception

Was there consistency between the tests?

- ▶ 12 of 16 sites showed consistent trends; both statistics indicated a trend
- ▶ The 4 sites that were inconsistent were sites where only one metric indicated a trend

Which Metrics showed the most promise for trend detection?

Clinger (6 or 8/16)

Predator (6 or 7/16)

Ephemeroptera (4 or 5 /16)

Taxa Richness (3 or 4/16)

Percent Tolerant (3 or 4/16)

BIBI (3/16)



*At more than three-quarters of the sites where trends were observed a trend was not observed using BIBI.

Summary by Sites

- ▶ Mountaineers/Chico Creek : Four metrics (including B-IBI) indicated decreasing trends at this site = Likely deteriorating
- ▶ Lower Curley Creek : Three metrics indicated decreasing trends at this site = Probably deteriorating
- ▶ Illahee Creek : Four metrics (including B-IBI) indicated an increasing trend at this site = Likely Improving
- ▶ Upper Carpenter Creek : Three metrics (including B-IBI) indicated an increasing trend = Probably Improving
- ▶ Chico Creek: One or two metrics indicated an decreasing trend = Possible deteriorating

Macroinvertebrate Analysis

Question 2: Are there long term trends in the data?



Long Term Trend Assessment

Data Culling

Select Sites with data for two time periods (pre and post 2008) (11 of 123 sites)

Apply Statistic

Mann-Whitney Two-Sided U Test

Evaluate

- Are there Significant differences in time periods
- If so, use Whisker Box Plots to decide central tendency

Here Come the Flying Monkeys



Did Multiple Metrics Indicate a Trend?

Name	Taxa Richness		Plecoptera Richness		Trichoptera Richness		Long Lived Richness		Intolerant Richness		Percent Dominant	
	W	p-value	W	p-value	W	p-value	W	p-value	W	p-value	W	p-value
Mountaineers/Chico Creek	7.5	1.000	8.5	1.000	13	0.222	13	0.227	15	▼ 0.041	5.5	0.600
Lower Curley Creek	4.5	0.553	0	▲ 0.051	13	▼ 0.087	3	0.287	2	0.159	12	0.222
Boyce Creek	13	0.364	5.5	0.414	9	1.000	1.5	▲ 0.065	6	0.511	16	▼ 0.095
Illahee Creek	4	0.237	5.5	0.394	8	0.892	17	▼ 0.046	15	0.112	11	0.714
Upper West Fork Dogfish Creek	0	▲ 0.064	3	0.340	1	0.120	2	0.232	4	0.508	5	0.857
Blackjack Creek	17.5	1.000	19.5	0.864	6	▲ 0.058	18.5	1.000	19	0.930	32	▼ 0.026
Big Anderson Creek	10	0.457	5	0.544	13.5	▼ 0.075	9	0.654	9	0.648	10	0.500

Were the Trends Consistent?

Name	Taxa Richness		Plecoptera Richness		Trichoptera Richness		Long Lived Richness		Intolerant Richness		Percent Dominant	
	W	p-value	W	p-value	W	p-value	W	p-value	W	p-value	W	p-value
Mountaineers/Chico Creek	7.5	1.000	8.5	1.000	13	0.222	13	0.227	16	▼ 0.041	5.5	0.600
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Illahee Creek	4	0.237	5.5	0.394	8	0.892	17	▼ 0.046	15	0.112	11	0.714
Upper West Fork Dogfish Creek	0	▲ 0.064	3	0.340	1	0.120	2	0.232	4	0.508	5	0.857
Blackjack Creek	17.5	1.000	19.5	0.864	6	▲ 0.058	18.5	1.000	19	0.930	32	▼ 0.026
Big Anderson Creek	10	0.457	5	0.544	13.5	▼ 0.075	9	0.654	9	0.648	10	0.500

Macroinvertebrate Analysis

Question 3: Are there short-term trends?



Short Term Trend Assessment

Data Culling

Select only sites with data for 2010 to 2015 period (= 56 sites)
Eliminate all sites for which there is not at least 5 consecutive years of data (= 11 sites)

Apply Statistic

Pearson's R and Kendall's tau correlations

Evaluate

Were trends detected? If so, were they detected for multiple metrics? Were trends consistent between metrics?

Evaluate Results

Short -Term (2010-2015) Trends						
Station	n	Taxa Richness	Ephemeroptera Richness	Clinger Richness	Percent Dominant	Percent Predator
		R	R	R	R	R
Lower Barker Creek	6	0.401	0.639	-0.046	 0.740	-0.643
Lower Chico Creek	6	-0.023	 -0.817	-0.485	-0.661	 -0.754
Lower Clear Creek	6	 0.809	-0.137	0.776	0.015	0.667
Lower Main Dogfish	6	0.471	 0.982	 0.919	-0.280	 -0.874
Blackjack Creek	6	0.321	0.487	0.363	0.172	 -0.826

Light shading indicates significance at <0.10 and darker shading at <0.050. Negative values indicate decreasing trends.

More Flying Monkeys



More Evaluation

Short -Term (2010-2015) Trends						
Station	n	Taxa Richness	Ephemeroptera Richness	Clinger Richness	Percent Dominant	Percent Predator
		R	R	R	R	R
Lower Barker Creek	6	0.401	0.639	-0.046	▲ 0.740	-0.643
Lower Chico Creek	6	-0.023	▼ -0.817	-0.485	-0.661	▼ -0.754
Lower Clear Creek	6	▲ 0.809	-0.137	-0.776	0.015	0.667
Lower Main Dogfish	6	0.471	▲ 0.982	▲ 0.919	-0.280	▼ -0.874
Blackjack Creek	6	0.321	0.487	0.363	0.172	▼ -0.826

Light shading indicates significance at <0.10 and darker shading at <0.050. Negative values indicate decreasing trends.

Flow Data Analysis

Are there trends in flow that can not be attributed to precipitation?



Evaluation of Stream Flow Data

Data Handling

Select Sites with both stream flow and precipitation data = 10 sites

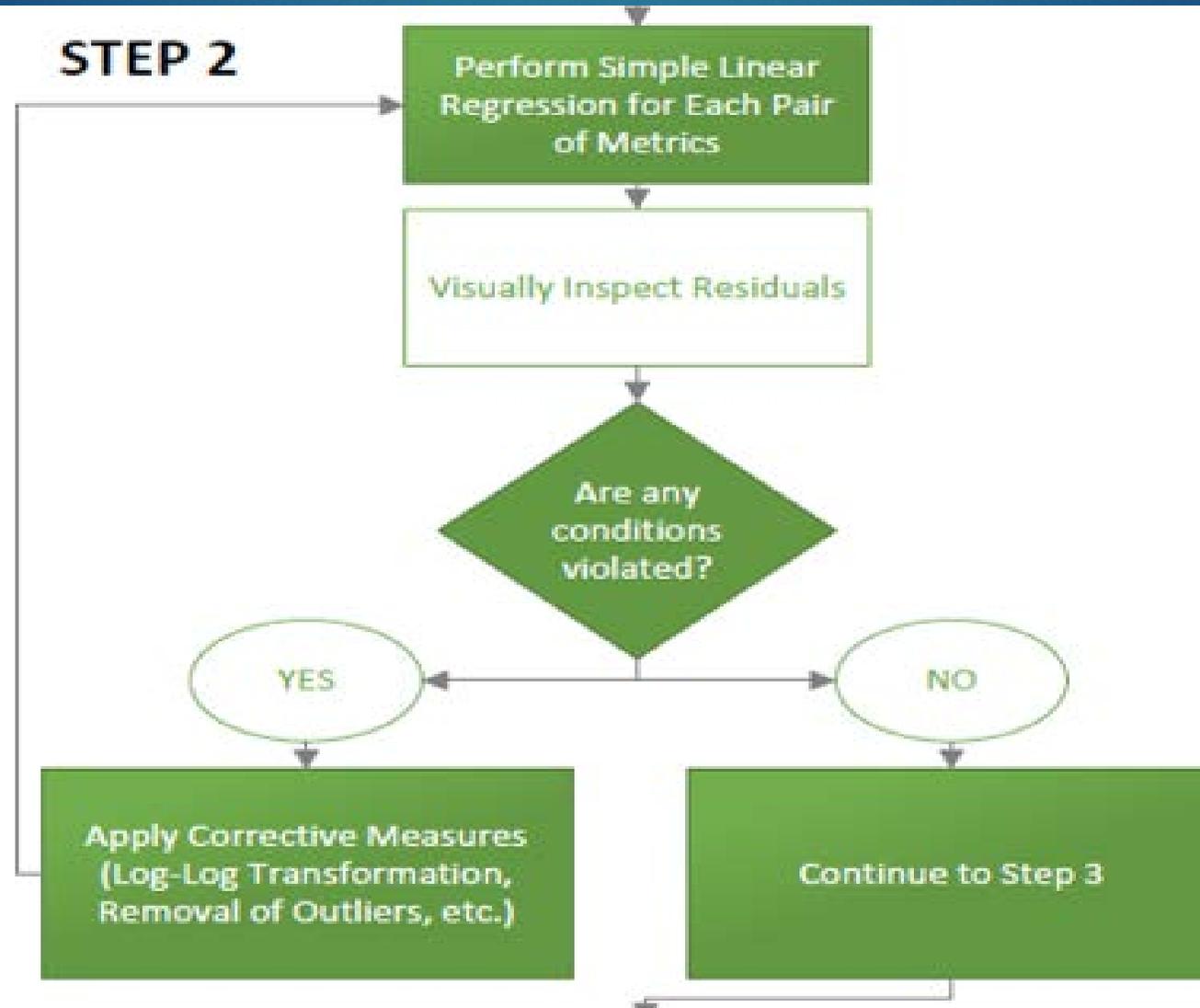
Use 'storm chunker' to desegregate annual record into discrete storms

Calculate peak storm flows, storm volumes and rainfall depths

Apply Statistics

Evaluate

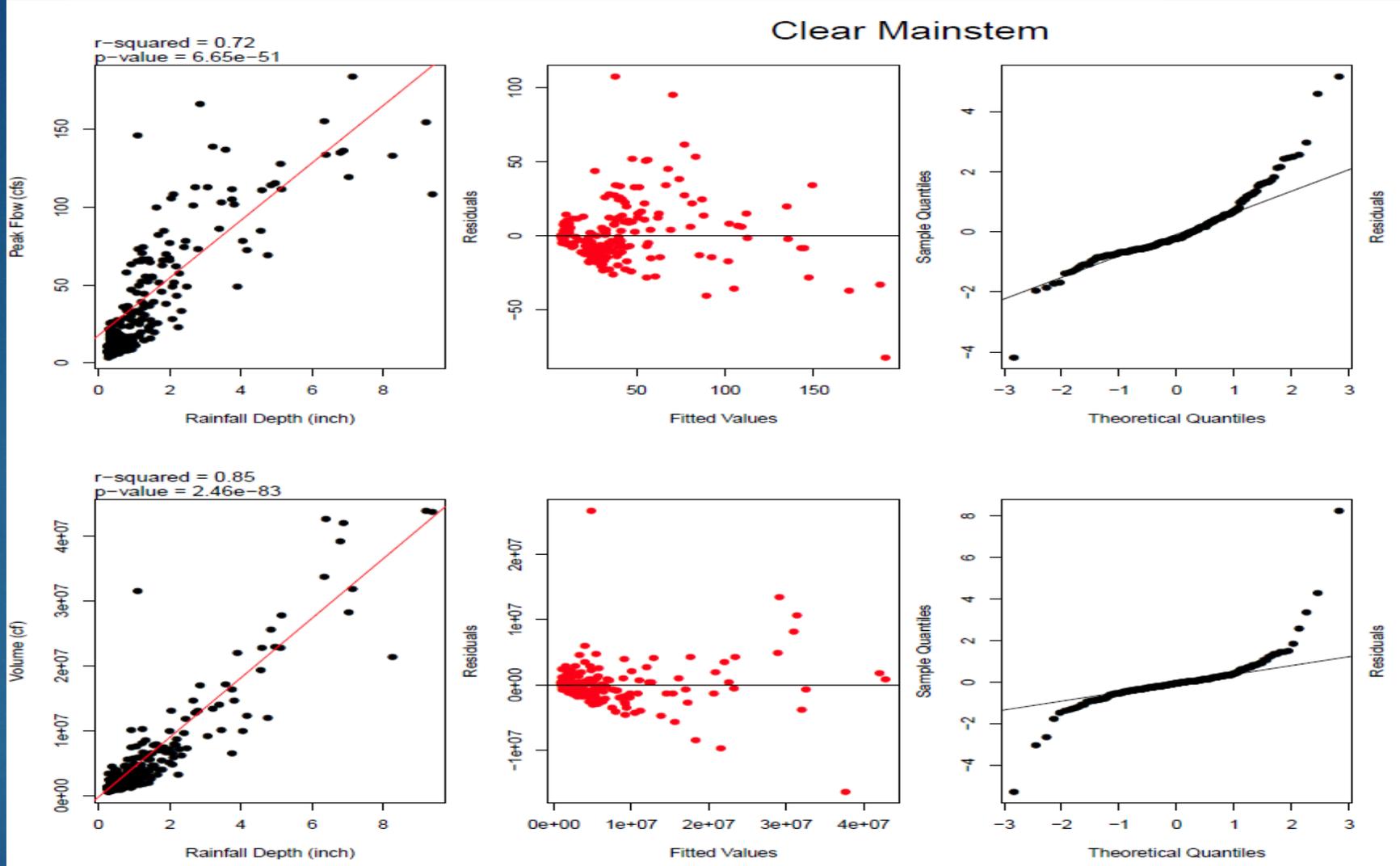
Apply Statistics



Linear Regression

Inspect Residuals

Log Transform if necessary

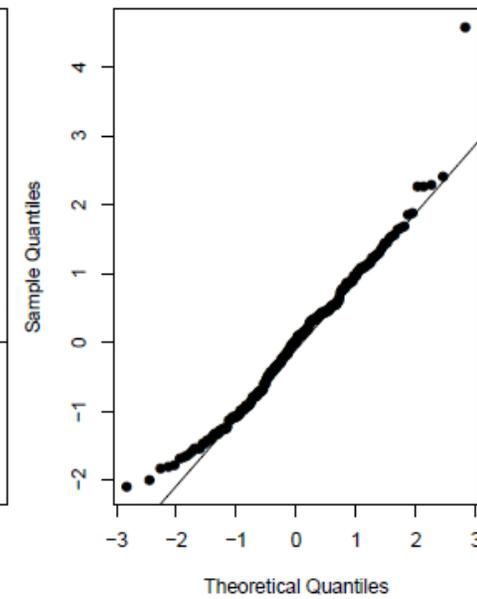
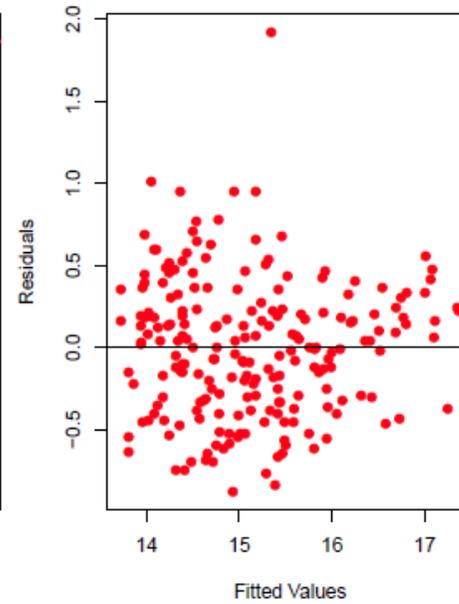
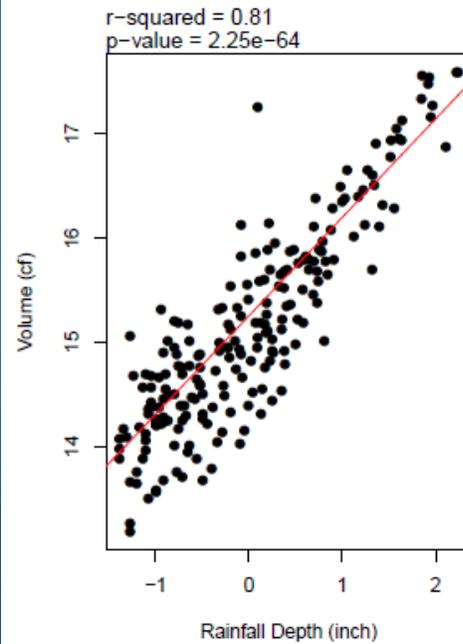
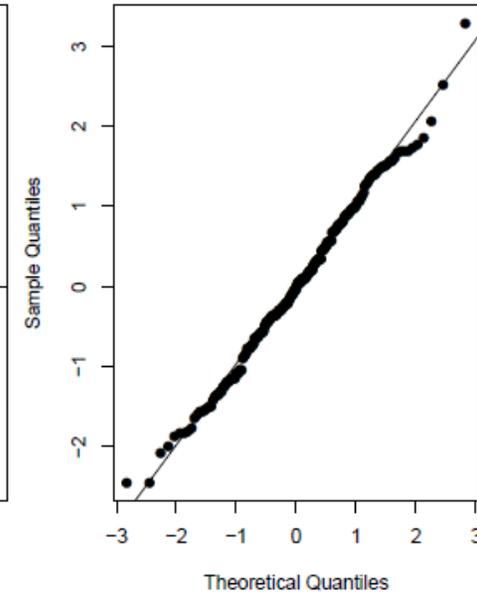
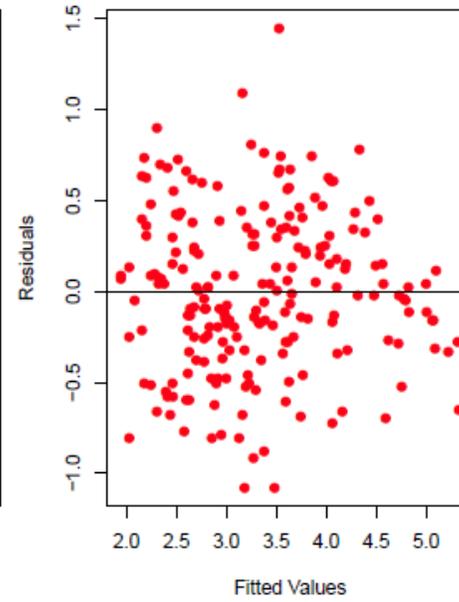
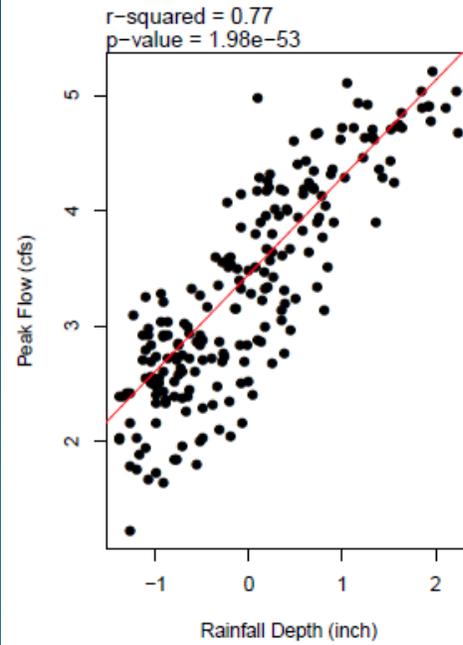


Log-log
transformation

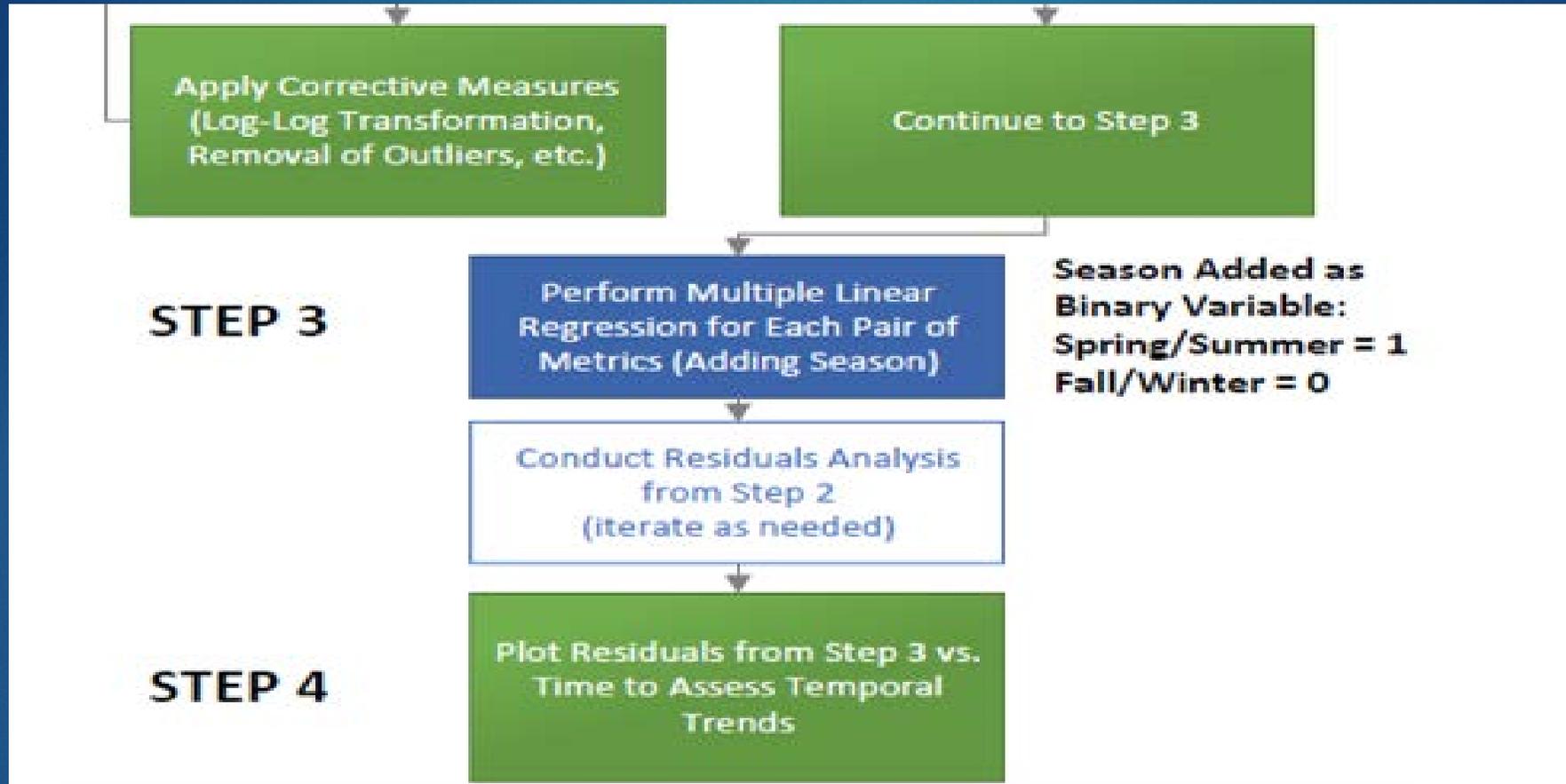
Redo Linear
Regression

Re-Inspect
Residuals

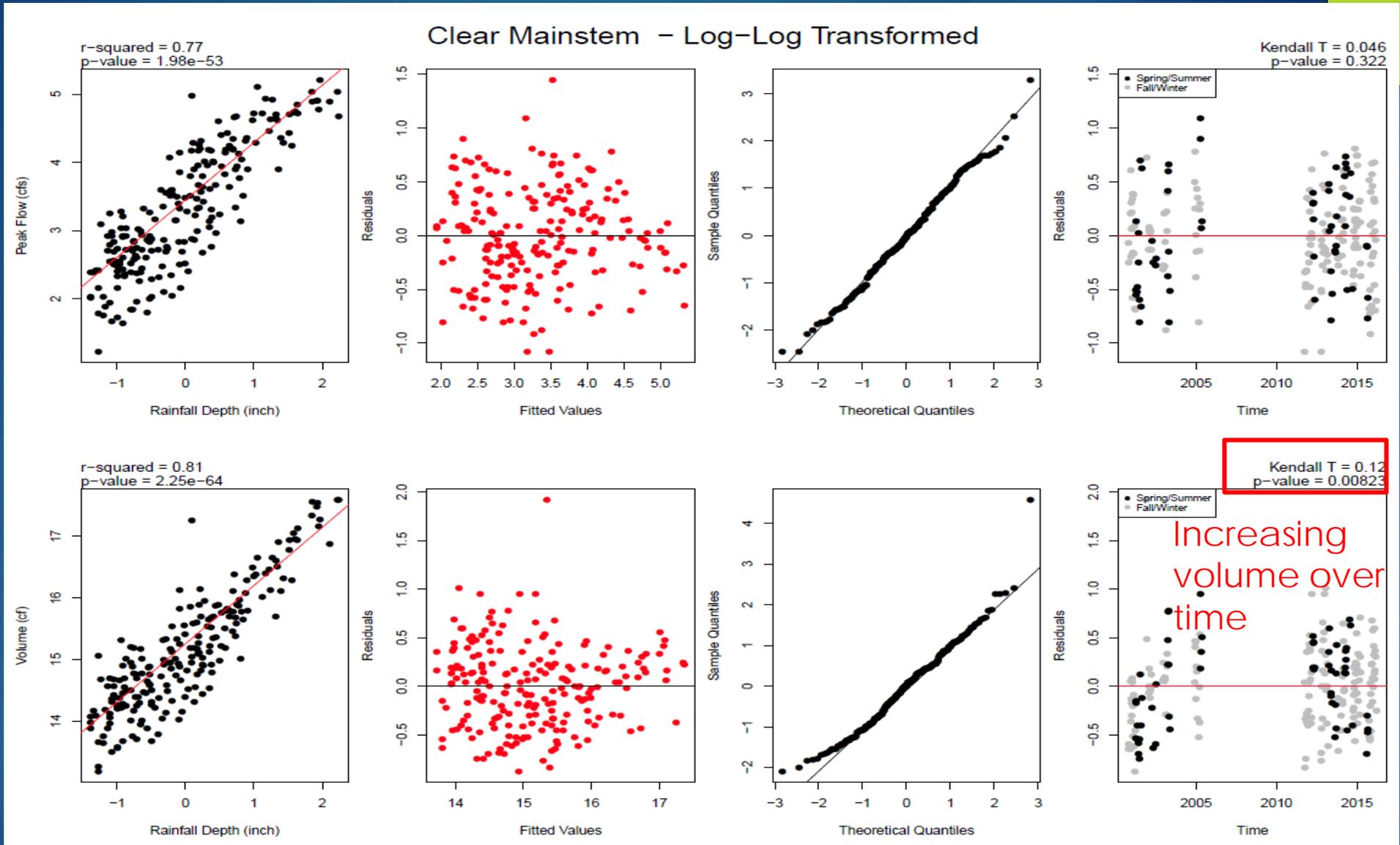
Clear Mainstem - Log-Log Transformed



Apply Statistics



Step 3.
Multiple
Regression
on Residuals
over Time
(including
season)





Summary of Temporal Trends.

Site Name	Metrics	Trend	Kendall's Tau Statistic	P-Value
Barker Creek	Storm Peak Flow	---	0.064	0.245383
Barker Creek	Storm Volume	---	-0.042	0.446647
Blackjack Creek	Storm Peak Flow	---	-0.047	0.169824
Blackjack Creek	Storm Volume	▼	-0.116	0.018632
Burley Creek	Storm Peak Flow	▼	-0.239	6.91E-06
Burley Creek	Storm Volume	▼	-0.212	9.85E-05
Chico Creek at Taylor Road	Storm Peak Flow	---	0.099	0.081914
Chico Creek at Taylor Road	Storm Volume	---	0.055	0.256942
Clear Creek (Mainstem)	Storm Peak Flow	---	0.054	0.322172
Clear Creek (Mainstem)	Storm Volume	▲	0.131	0.008235
Clear Creek (West tributary)	Storm Peak Flow	▲	0.113	0.024125
Clear Creek (West tributary)	Storm Volume	▲	0.114	0.03835
Curley Creek	Storm Peak Flow	▲	0.096	0.042329
Curley Creek	Storm Volume	---	0.089	0.06513
Dogfish Creek	Storm Peak Flow	---	0.079	0.118783
Dogfish Creek	Storm Volume	---	0.009	0.70475
<u>Qllala</u> Creek	Storm Peak Flow	---	0.050	0.153265
<u>Qllala</u> Creek	Storm Volume	---	0.073	0.16898
Steele Creek	Storm Peak Flow	---	-0.019	0.736591
Steele Creek	Storm Volume	---	-0.076	0.257378

Trends at 0.05 significance level



How do Trends Compare

SITES WHERE GENERAL TRENDS WERE OBSERVED

SITE	Benthic Trends	Flow Trend	Restoration Activity
Moutaineers/Chico Creek	Four metrics ▼	None Detected	
Lower Curley Creek	Three metrics ▼	None Detected	
Illahee Creek	Four metrics ▲	----	LWD Placement (2013)
Upper Carpenter Creek	Three metrics ▲	----	
Chico Creek	1-2 metrics ▼	None Detected	



Summary

- ▶ There may be a few macroinvertebrate metrics that are more sensitive to change and can serve as early indicators of trends; **more data sets should be evaluated** using this same methodology.
- ▶ Long and short term macroinvertebrate assessments were not compelling; few sites where multiple metrics indicated a trend and inconsistencies.
- ▶ After controlling for rainfall/runoff responses there were significant trends in flow at some sites; inferring that other variables such as land use or topographic complexity are impacting flow.

