Monitoring coal-bed methane development effects on surface-water quality of the Tongue and Powder Rivers

A study funded through the Montana DNRC RDGP

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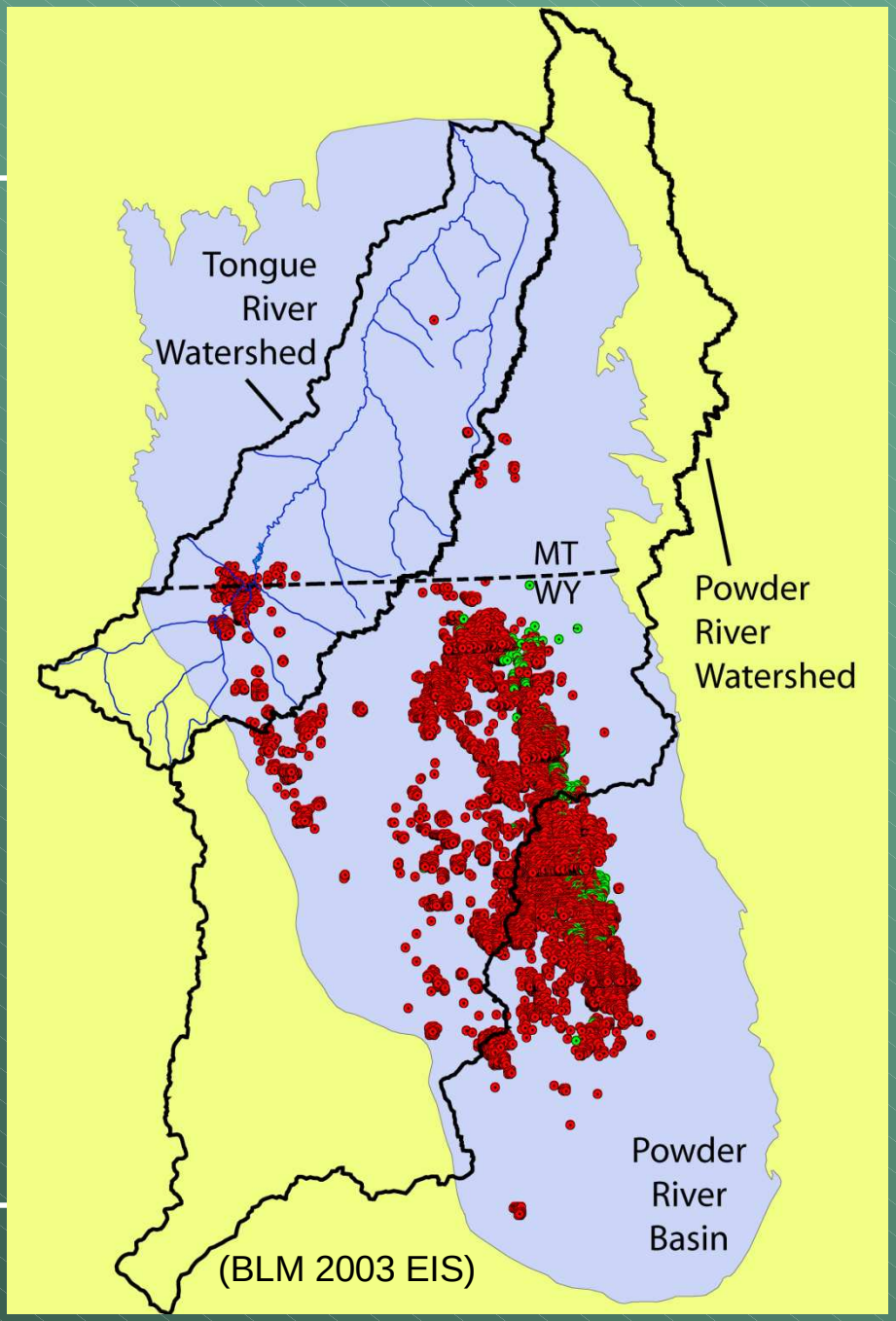
General Background

- In the late 1990's coal-bed methane production (primarily in Wyoming) developed rapidly
- Discharge of CBM production water has potential to affect surface-water quality
- Soils could be affected if sodium concentrations in irrigation water increase



- Well completed before 1997
- Well completed after 1997

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Need for Trends Analysis

- CBM impacts on receiving streams are difficult to distinguish from water-quality effects of natural climatic and streamflow variability
- Rigorous statistical analyses developed by USGS researchers (S-ESTREND and QWTREND) provide tools for addressing this issue

CBM discharge to Tongue River near State Line

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Study Objectives

- Evaluate available data sets for suitability for trends analysis
- Perform trends analyses on various constituents (primarily major ions) to determine significant temporal patterns
- Evaluate significant temporal and spatial patterns with respect to CBM development and other land-use patterns

ESTREND OVERVIEW

- Non-parametric test for significant monotonic temporal trends in flow-adjusted constituent concentrations
- Flow-adjusted constituent concentrations are the residuals from a regression analysis of concentration with discharge for discrete samples
- Non-parametric Seasonal Kendall Test is applied to the residuals

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QWTREND OVERVIEW

- Uses a PARMA model to detect significant temporal trends in flow-adjusted constituent concentrations
- Detailed parametric analysis of correlative structure of continuous streamflow record and discrete water-quality data; concentrations flow adjusted
- 5-yr record of discharge required
- Residuals are examined for apparent trends, trends are inserted into the analysis and tested for significance
- Allows for analysis of multiple trends and types of trends in a single dataset

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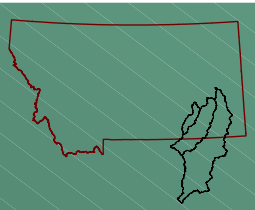
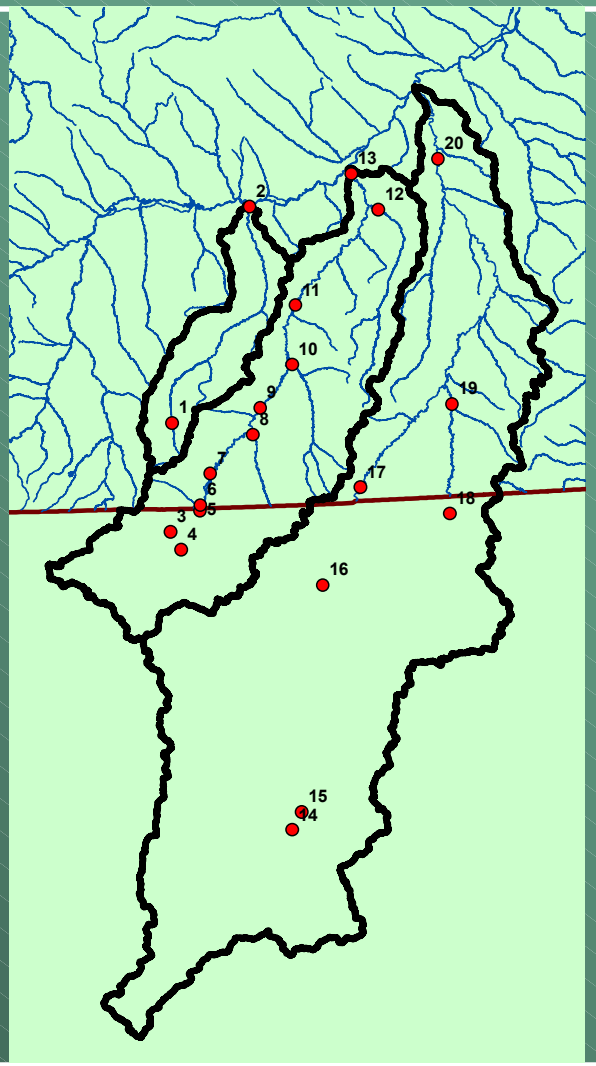
EXPLORATORY DATA ANALYSIS



Currently, 20 stations with data that satisfy requirements for using ESTREND or QWTREND (or both) for at least one constituent of primary interest

Map number	Station identification number	Station name	Trends analysis[1]
1	06295113	Rosebud Creek at Reservation boundary near Kirby, MT	ESTREND, QWTREND
2	06296003	Rosebud Creek at mouth, near Rosebud, MT	ESTREND, QWTREND
3	06299980	Tongue River at Monarch, WY	ESTREND, QWTREND
4	06305500	Goose Creek below Sheridan, WY	ESTREND, QWTREND
5	06306250	Prairie Dog Creek near Acme, WY	ESTREND
6	06306300	Tongue River at State Line, near Decker, MT	ESTREND, QWTREND
7	06307500	Tongue River below Dam, near Decker, MT	ESTREND, QWTREND
8	06307600	Hanging Woman Creek near Birney, MT	ESTREND, QWTREND
9	06307616	Tongue River near Birney, MT	ESTREND, QWTREND
10	06307740	Otter Creek at Ashland, MT	ESTREND, QWTREND
11	06307830	Tongue R at Brandenberg Bridge, MT	ESTREND, QWTREND
12	06308400	Pumpkin Creek near Miles City, MT	ESTREND, QWTREND
13	06308500	Tongue River at Miles City, MT	ESTREND, QWTREND
14	06313400	Salt Creek near Sussex, WY	ESTREND, QWTREND
15	06313500	Powder River at Sussex, WY	ESTREND, QWTREND
16	06317000	Powder River at Arvada, WY	ESTREND, QWTREND
17	06324500	Powder River at Moorhead, MT	ESTREND, QWTREND
18	06324970	Little Powder River above Dry Creek near Weston, WY	ESTREND, QWTREND
19	06325500	Little Powder River near Broadus, MT	ESTREND
20	06326500	Powder River near Locate, MT	ESTREND, QWTREND



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EXPLORATORY DATA ANALYSIS

Currently, 22 water-quality constituents or properties that satisfy requirements for using ESTREND or QWTREND (or both) for most or all stations

Water-quality constituent or property
Specific conductance
Hardness, water
Calcium
Magnesium
Potassium
Sodium Adsorption Ratio
Sodium, fraction of cations
Sodium
Alkalinity
Bicarbonate
Chloride
Fluoride
Silica
Sulfate
Dissolved solids, sum of constituents
Total nitrogen
Total Phosphorus
Boron
Iron
Manganese
Selenium
Suspended sediment

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Workplan

	FY09	FY10				FY11			
	4	1	2	3	4	1	2	3	4
Method Development	X	X	X						
Data Analysis									
ESTREND		X	X	X	X				
QWTREND		X	X	X	X				
Methods Comparison				X	X	X			
Report Generation									
Peer Review						X	X		
Center and Region Review								X	
Report Published									X

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Data Collection

- ***1.A.1.a Install specific conductance monitor at Prairie Dog Creek Near Acme, WY (station 06306250)***
- **The specific conductance monitor was installed in late June and began operation on June 26, 2009.**
- ***1.A.2.a Install specific conductance monitor Tongue River at Miles City, MT (station 06308500)***
- **The specific conductance monitor was installed in early July and began operation on July 7, 2009.**

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Data Collection

- Real-time SAR estimation was provided on the USGS web site for the three stations:
- Station 06306300 -- Tongue River at State Line near Decker, MT available at:
- http://nwis.waterdata.usgs.gov/mt/nwis/uv?cb_90856=on&format=gif_default&period=7&site_no=06306300
- Station 06307616 -- Tongue River at Birney Day School Bridge near Birney, MT available at:
- http://nwis.waterdata.usgs.gov/mt/nwis/uv?cb_90856=on&format=gif_default&period=7&site_no=06307616
- Station 06307990 -- Tongue River above T&Y diversion dam near Miles City, MT available at:
- http://nwis.waterdata.usgs.gov/mt/nwis/uv?cb_90856=on&format=gif_default&period=7&site_no=06307990

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Synoptic Sampling

- ***1.B Conduct Tongue River synoptic sampling***

- **The purpose of the synoptic sampling was to evaluate effects of coal-bed methane production on water quality and periphyton.**

- **During the period September 14 through 16, synoptic samples were collected at 15 sites and analyzed for selected major ions and nutrients. Samples for 7 of the stations were collected for analysis of periphyton biomass, periphyton chlorophyll-a and pheophytin-a concentrations, and periphyton taxonomy.**

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Synoptic Sample

Summary of synoptic water-quality samples collected September 2009

Station Name	USGS Station Number	Sampling date (YYYYMMDD)	Sampling time
Tongue River near Acme WY[1]	06306000	20090914	1030
Ash Creek at mouth nr Acme, WY	445700106563101	20090914	1400
Youngs Creek at mouth, near Decker, MT	445817106544601	20090914	1615
Tongue R dwnstr from Youngs Cr nr Acme WY[1]	445828106543601	20090914	1730
Tongue River bl Youngs Cr nr Acme WY[1]	06306020	20090915	0930
CBM Permit MT-0030457-008 nr Decker, MT	445955106524801	20090915	1020
Tongue R below Youngs Creek near Decker MT	445957106524701	20090915	1130
Tongue R below Youngs Creek near Decker MT	445957106524701	20090915	1130
CBM permit MT 0030457 014	445953106505601	20090915	1545
Tongue R upstr from Prairie Dog Creek nr Acme WY[1]	445935106505401	20090915	1600
Tongue R dwnstr from Prairie Dog Cr nr Acme WY[1]	445938106490801	20090915	1815
CBM Permit MT 0030457 012	445949106492901	20090915	1840
Tongue River upst from Badger Cr nr Decker MT[1]	450047106490101	20090916	1230
Prairie Dog Creek near Acme, WY	06306250	20090917	1030
Tongue River at State Line nr Decker MT[1]	06306300	20090917	0945

[1]Periphyton biomass, periphyton chlorophyll-a and pheophytin-a concentrations, and periphyton taxonomy analyses performed for indicated stations.

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QUESTIONS?

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