Tributaries of the St. Maries River Monitoring Report 2003

A Water Quality Sampling Project for the 303 (d) listed Tributaries of the St. Maries River

Developed for:

Benewah Soil and Water Conservation District
Idaho Soil Conservation Commission
Idaho State Department of Agriculture
Idaho Department of Environmental Quality

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Acknowledgements

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Introduction

The Idaho Association of Soil Conservation Districts (IASCD) collected water quality data from several tributaries to the St. Maries River from November 2002 through November 2003.

This monitoring project was initiated to provide background data on the State of Idaho's §303 (d) listed tributaries of the St. Maries River. The Total Maximum Daily Load (TMDL) for the St. Maries River Watershed was completed in July of 2003. In addition to providing baseline data, the data collected in this study will also enable managers to determine where loads are entering the streams to allow for prioritization for the implementation of Best Management Practices (BMPs). In the end, continued monitoring at these sites will provide long-term data with to evaluate the condition of the streams both pre and post implementation of BMPs.

This report reviews monitoring results for the following parameters:

-Total Phosphorus (TP)
-Bacteria (*Escherichia coli)*
-Nitrogen Components—NO_2, NO_3, NH_3
-Total Suspended Solids (TSS)
-Instantaneous Water Temperature
-Turbidity
-Dissolved Oxygen (DO)
-Percent (%) Saturation
-Total Dissolved Solids (TDS)

The University of Idaho Analytical Science Laboratory (UIASL) conducted all inorganic parameter testing. The State of Idaho Health and Welfare Laboratory in Coeur d' Alene and Anatek Labs, Inc. performed bacteria analysis. Ken Clark or Cary Myler, formerly of the IASCD, performed all other measurements.

St. Maries River Subbasin

The St. Maries River Subbasin, fourth field hydrologic unit code (HUC) #17010304, drains approximately 307,840 acres in Latah, Benewah, Shoshone, and Clearwater Counties in Idaho. The headwaters of the St. Maries River are derived from two forks, the Middle Fork and West Fork. These segments originate in the southwestern corner of Shoshone County and flow northwesterly, where they meet near the town of Clarkia.

The tributaries to the St. Maries River tend to flow through steep V-shaped valleys until reaching the valley bottom, where they become lower gradient, meandering channels. The uplands are forested, while the valley bottoms are used primarily for agriculture and grazing.

Monitoring Site Descriptions

Ten monitoring sites were selected throughout the subbasin in November of 2002 (Figure 1). For comparison, monitoring sites were placed in both the upper and lower reaches on the larger tributaries to the St. Maries River. Site locations are defined by name and legal description in Table 1.

Table 1. Monitoring Sites in the St. Maries River Subbasin

Site ID	Site Name	Legal Description
SM-1	MF St. Maries River (upper)	R2E, T42N, NW Sec 11
SM-2	MF St. Maries River (lower)	R2E, T42N, SW Sec 5
SM-3	St. Maries River (lower)	R2E, T42N, SW Sec 6
SM-4	WF St. Maries River (upper)	R1E, T42N, SW Sec 26
SM-5	Little Carpenter Creek	R1E, T43N, SW Sec 7
SM-6	Tyson Creek	R1W, T44N, NW Sec 26
SM-7	Renfro Creek	R1W, T44N, NE Sec 22
SM-8	Santa Creek (lower)	R2W, T44N, SW Sec 31
SM-9	Santa Creek (upper)	R3W, T44N, SW Sec 36
SM-10	Charlie Creek	R2W, T44N, NE Sec 33

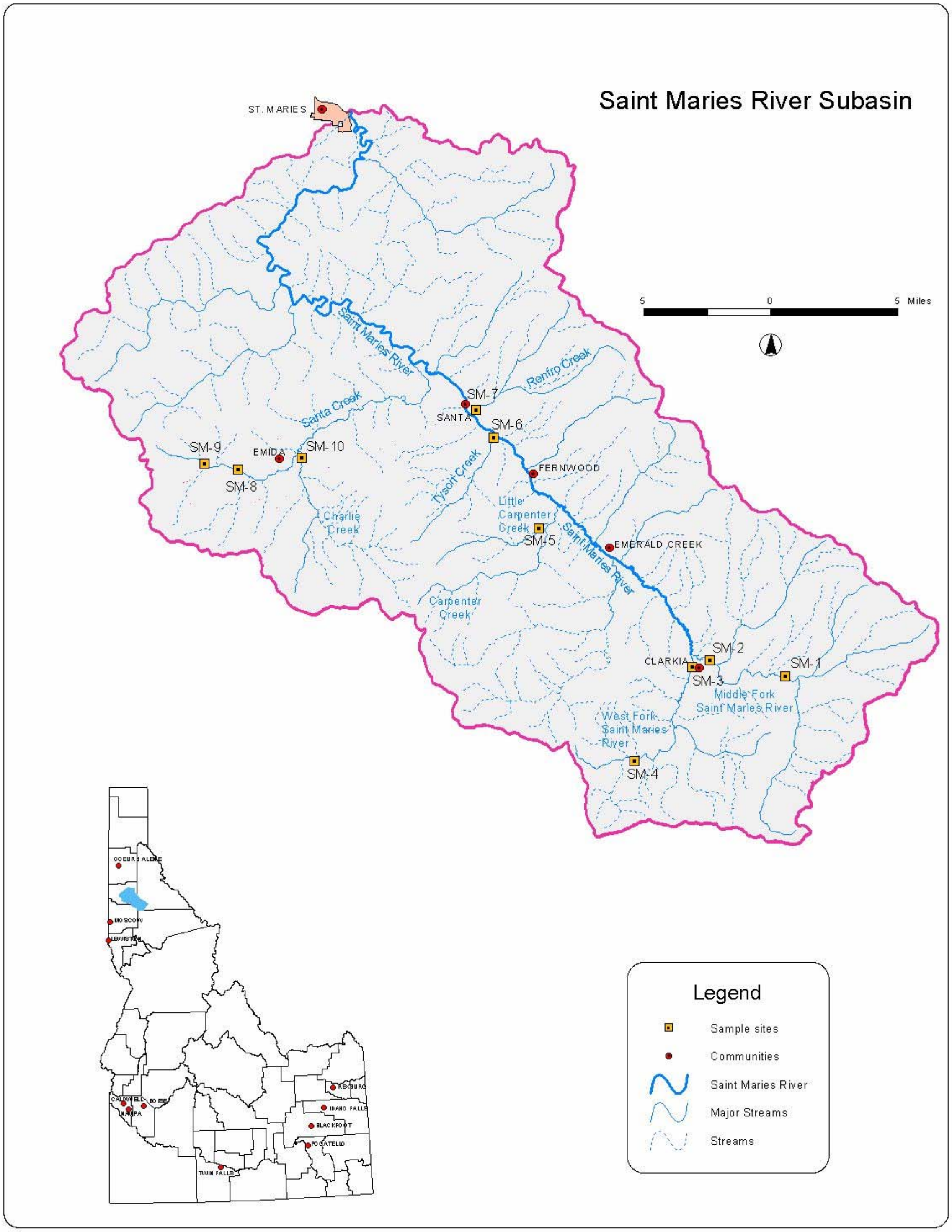


Figure 1. St. Maries River Watershed HUC 17010304 with IASCD monitoring sites

Methods and Materials

Water Quality

Water Quality Limited Segments

The Clean Water Act (CWA) requires restoration and maintenance of the chemical physical, and biological integrity of the nation's water (Public Law 92-500 Federal Water Pollution Control Act Amendments of 1972). Section §303 (d) of the CWA establishes requirements for states to identify and prioritize waterbodies that are water quality limited (do not meet water quality standards). All of the streams in this study are listed as water quality limited on Idaho's §303 (d) list.

Table 2 identifies the streams that were sampled, along with the pollutants of concern, as detailed in the §303 (d) list. Sediment was the pollutant of concern that all of the streams had in common.

Table 2. 303(d) listed waterbodies sampled.

Waterbody	Segment Number	1998 § 303(d) Boundaries	Pollutants of Concern
West Fork St. Maries	3581	Headwaters to St. Maries River	Sediment and temperature
Middle Fork St. Maries	3594	Headwaters to St. Maries River	Habitat alteration, sediment, and temperature
Santa Creek	3585	Headwaters to St. Maries River	Dissolved oxygen, habitat alteration nutrients, sediment, and temperature
Charlie Creek	3587	Headwaters to Santa Creek	Habitat alteration and sediment
Renfro Creek	3588	Headwaters to Davis Creek	Sediment
Tyson Creek	3589	North Fork Tyson Creek to St. Maries River	Habitat Alteration and sediment
Carpenter Creek	3591	Headwaters to St. Maries River	Habitat alteration and sediment

Sampling Protocols

Approximately 4 liters of stream water was collected at each site, using a DH-81 depth-integrating suspended-sediment sampler. The samples were collected and transferred into a 2.5-gallon polyethylene churn sample splitter. The polyethylene churn splitter was thoroughly rinsed with ambient water at each location prior to sample collection. The resultant composite sample was thoroughly homogenized before filling the appropriate sample containers. Water samples requiring preservation (NO_2+NO_3, NH_3, and TP) were transferred into preserved (H_2SO_4 pH <2) 500 mL sample containers. Water quality samples (TSS, NO_2+NO_3, NH_3, and TP) were then analyzed at the UIASL in Moscow, Idaho.

Bacteriological samples (total coliform and *E. coli*) were collected directly from the thalweg into sterile sample containers. The samples were shipped to the State of Idaho Health and Welfare Laboratory in Coeur d' Alene or Anatek Labs, Inc. in Moscow for analysis. Most probable number (MPN) multiple tube fermentation was used to determine fecal coliform and *E. coli* levels in the water sample.

A list of parameters, sample sizes, preservation, holding times, and analytical methods are displayed in Table 3. All sample containers were labeled with waterproof markers with the following information: station location, sample identification, date of collection, and time of collection. Samples were placed on ice and transported to the laboratory the same day as collection. Chain-of-custody forms accompanied each sample shipment.

Table 3. Water Quality Parameters

Parameters	Sample Size	Preservation	Holding Time	Method
Non Filterable Residue (TSS)	1L	Cool 4°C	7 Days	EPA 160.2
Nitrogen Components: NO_3+NO_2 Ammonia	 60 mL 60 mL	Cool 4°C, H_2SO_4 pH < 2	28 Days	 EPA 353.2 EPA 350.1
Total Phosphorus	100 mL	Cool 4°C, H_2SO_4 pH < 2	28 Days	EPA 365.4
Escherichia coli	100 mL	Cool 4°C	30 Hours	MPN

Field Measurements

At each location, field parameters for dissolved oxygen, specific conductance, pH, temperature, turbidity, and total dissolved solids were measured. Calibration of all field equipment was in accordance with the manufacturer specifications. Field measurement parameters, equipment and calibration techniques are shown in Table 4.

Table 4. Field Measurements

Parameters	Instrument	Calibration
Dissolved Oxygen	YSI Model 55	Ambient air calibration
Temperature	YSI Model 55 StowAway temperature logger Model XTI 02	Centigrade thermometer Centigrade thermometer
Conductance & TDS	Orion Model 115	Specific Conductance (25^{o}C standard)
pH	Orion Model 210A	Standard buffer (7,10) bracketing for linearity
Turbidity	Hach Model 2100P	Formazin Primary Standard

All field measurements were recorded in a field notebook along with any pertinent observations about the site, including weather conditions, flow rates, personnel on site, and any problems observed that might affect water quality.

Flow Measurements

Flow measurements were collected at each site using a Marsh McBirney Flow Mate Model 2000 flow meter. The six-tenths depth method (0.6 of the total depth from the surface of the water surface) was used. A transect line was established at each monitoring station, across the width of the stream at an angle perpendicular to the flow, for the calculation of cross-sectional area. The discharge was computed by summing the products of the partial areas (partial sections) of the flow cross-sections and the average velocities for each of those sections. Stream discharge was reported as cubic feet per second (cfs).

Quality Assurance and Quality Control (QA/QC)

The UIASL utilizes methods approved and validated by the Environmental Protection Agency (EPA). A method validation process, including precision and accuracy performance evaluations and method detection limit studies, are required of UIASL Standard Methods. Method performance evaluations include quality control samples, analyzed with a batch to ensure sample data integrity. Internal laboratory spikes and duplicates are part of UIASL's quality assurance program. Laboratory QA/QC results generated from this project can be provided upon request.

QA/QC procedures from the field-sampling portion of this project included a split sample and a blank sample (one set per sampling day). The field blanks consisted of laboratory-grade deionized water, transported to the field and poured off into the appropriate sample containers. The blank sample was used to determine the integrity of the field teams handling of samples, the condition of the sample containers and deionized water supplied by the laboratory and the accuracy of the laboratory methods. Duplicate samples were obtained by filling two sets of sample containers with homogenized composite water from the same sampling site. The duplicate and blank samples were not identified as such to laboratory personnel to ensure laboratory precision.

Data Handling

All of the field data and analytical data generated from each survey was reviewed and submitted to ISDA for review. Each batch of data was reviewed to insure that all necessary observations, measurements, and analytical results have been properly recorded. The analytical results were evaluated for completeness and accuracy. Any suspected errors were investigated and resolved, if possible. The data was then stored electronically and made available to any interested entity upon request.

Results and Discussion

Analysis of the data was done, and maximum, minimum, median, and average values for each parameter measured was determined. The number of exceedances per year was calculated, based on the number sampling events whose respective values exceeded EPA or State of Idaho water quality standards and criteria.

Descriptive data is presented in Table 5.

Table 5. Maximum, minimum, median, and average values for each measured parameter at IASCD St. Maries Tributaries Monitoring locations. Number of exceedances per year equals the number of sampling events when each respective value exceeded EPA or State of Idaho water quality standards and criteria. Percent exceedance equals the percentage of sampling events when each respective value exceeded EPA or State of Idaho water quality standards and criteria.

SM-1	D.O. (mg/L)	% Sat (%)	Temp (°C)	Cond (µS/cm² @25°C)	TDS (mg/L)	pH (H^+)	Turbidity (NTU)	TSS (mg/L)	TP (mg/L)	Flow (cfs)	*Total-coli* (coli/100mL)	*E-coli* (coli/100mL)
Maximum	13.73	102.50%	21.00	58.90	29.00	8.30	26.20	9.00	0.038	212.57	2400.00	61.00
Minimum	7.20	73.60%	0.10	21.20	11.00	6.80	2.40	4.00	0.012	15.80	30.00	1.00
Average	10.81	88.58%	7.09	33.41	16.28	7.57	7.11	7.00	0.021	57.91	550.71	14.45
Median	10.94	88.55%	5.85	33.05	15.90	7.60	5.07	7.50	0.019	40.95	93.00	8.50
# exceedance	0.0		4.0			0.0	0.0		0.000			0.00
% exceedance	0.0%		16.7%			0.0%	0.0%		0.0%			0.0%

SM-2	D.O. (mg/L)	% Sat (%)	Temp (°C)	Cond (µS/cm² @25°C)	TDS (mg/L)	pH (H^+)	Turbidity (NTU)	TSS (mg/L)	TP (mg/L)	Flow (cfs)	*Total-coli* (coli/100mL)	*E-coli* (coli/100mL)
Maximum	13.50	102.70%	23.70	46.60	23.10	8.82	21.20	14.00	0.042	245.08	2400.00	290.00
Minimum	7.13	78.90%	0.10	22.00	11.00	6.90	2.52	4.00	0.010	20.37	41.00	1.00
Average	10.81	90.43%	8.23	38.57	19.04	7.65	6.73	6.80	0.020	91.71	619.18	74.28
Median	10.73	90.70%	6.25	40.60	19.95	7.65	4.87	6.00	0.018	66.94	150.00	12.00
# exceedance	0.0		7.0			0.0	0.0		0.000			0.00
% exceedance	0.0%		29.2%			0.0%	0.0%		0.0%			0.0%

SM-3	D.O. (mg/L)	% Sat (%)	Temp (°C)	Cond (µS/cm² @25°C)	TDS (mg/L)	pH (H^+)	Turbidity (NTU)	TSS (mg/L)	TP (mg/L)	Flow (cfs)	*Total-coli* (coli/100mL)	*E-coli* (coli/100mL)
Maximum	18.40	106.60%	23.10	66.80	33.00	8.10	32.50	30.00	0.069	177.49	2400.00	820.00
Minimum	7.61	78.60%	0.10	22.80	11.40	6.90	5.81	5.00	0.020	2.41	68.00	2.00
Average	10.79	89.19%	9.22	44.83	22.30	7.58	12.60	12.11	0.033	37.43	731.75	132.64
Median	10.46	89.55%	8.50	42.50	21.50	7.60	8.91	12.00	0.028	19.42	570.00	34.50
# exceedance	0.0		7.0			0.0	0.0		0.000			1.00
% exceedance	0.0%		31.8%			0.0%	0.0%		0.0%			5.0%

SM-4	D.O. (mg/L)	% Sat (%)	Temp (°C)	Cond (µS/cm² @25°C)	TDS (mg/L)	pH (H^+)	Turbidity (NTU)	TSS (mg/L)	TP (mg/L)	Flow (cfs)	*Total-coli* (coli/100mL)	*E-coli* (coli/100mL)
Maximum	13.19	100.30%	18.40	65.40	32.70	8.57	16.90	11.00	0.140	37.38	2000.00	110.00
Minimum	6.15	43.70%	0.10	31.10	16.00	6.70	2.87	4.00	0.010	0.62	40.00	2.00
Average	10.02	83.31%	7.78	49.61	24.35	7.60	7.67	7.75	0.028	6.79	543.08	15.01
Median	9.74	84.20%	7.80	53.40	26.40	7.70	6.63	8.00	0.021	2.19	190.00	5.00
# exceedance	0.0		5.0			0.0	0.0		1.000			0.00
% exceedance	0.0%		23.8%			0.0%	0.0%		1.0%			0.0%

SM-5	D.O. (mg/L)	% Sat (%)	Temp (°C)	Cond (µS/cm² @25°C)	TDS (mg/L)	pH (H^+)	Turbidity (NTU)	TSS (mg/L)	TP (mg/L)	Flow (cfs)	*Total-coli* (coli/100mL)	*E-coli* (coli/100mL)
Maximum	13.48	105.60%	22.70	48.30	23.90	8.79	163.00	210.00	0.290	29.54	17000.00	2400.00
Minimum	6.33	69.80%	0.10	21.10	11.00	7.10	7.11	4.00	0.023	0.35	190.00	2.00
Average	10.14	85.34%	9.20	36.72	17.96	7.89	25.01	24.27	0.065	5.33	2875.79	490.05
Median	10.84	83.90%	7.75	35.05	17.50	8.00	14.50	11.50	0.046	1.43	1700.00	150.00
# exceedance	0.00		7.00			0.00	2.00		3.000			5.00
% exceedance	0.0%		29.2%			0.0%	8.3%		13.0%			23.8%

SM-6	D.O. (mg/L)	% Sat (%)	Temp (°C)	Cond (µS/cm² @25°C)	TDS (mg/L)	pH (H^+)	Turbidity (NTU)	TSS (mg/L)	TP (mg/L)	Flow (cfs)	*Total-coli* (coli/100mL)	*E-coli* (coli/100mL)
Maximum	10.26	94.80%	22.20	106.70	53.40	8.40	20.10	7.00	0.070	6.40	2400.00	690.00
Minimum	7.54	71.30%	4.40	51.80	27.00	7.20	4.82	4.00	0.030	0.76	730.00	6.40
Average	8.50	84.57%	15.83	80.61	40.26	7.74	9.83	5.00	0.050	2.23	2018.00	138.66
Median	8.48	84.00%	17.40	75.50	38.30	7.65	7.26	4.50	0.050	1.57	2400.00	38.00
# exceedance	0.0		6.0			0.0	0.0		0.000			1.00
% exceedance	0.0%		66.7%			0.0%	0.0%		0.000			11.1%

SM-7	D.O. (mg/L)	%Sat (%)	Temp (^oC)	Cond (µS/cm^2@25^oC)	TDS (mg/L)	pH (H^+)	Turbidity (NTU)	TSS (mg/L)	TP (mg/L)	Flow (cfs)	*Total-coli* (coli/100mL)	*E-coli* (coli/100mL)
Maximum	14.72	89.80%	20.70	139.00	78.60	8.40	33.50	11.00	0.080	48.36	2400.00	270.00
Minimum	6.44	71.60%	0.00	64.80	33.00	7.10	3.36	4.00	0.010	3.56	14.00	1.00
Average	10.75	90.86%	8.96	88.70	45.00	7.76	10.88	6.30	0.040	12.11	733.37	60.92
Median	10.52	91.10%	8.15	86.80	42.00	7.85	6.27	5.50	0.030	6.36	490.00	16.40
# exceedance	0.0		8.0			0.0	0.0		0.000			0.00
% exceedance	0.0%		33.3%			0.0%	0.0%		0.0%			0.0%

SM-8	D.O. (mg/L)	%Sat (%)	Temp (^oC)	Cond (µS/cm^2@25^oC)	TDS (mg/L)	pH (H^+)	Turbidity (NTU)	TSS (mg/L)	TP (mg/L)	Flow (cfs)	*Total-coli* (coli/100mL)	*E-coli* (coli/100mL)
Maximum	14.64	115.00	27.30	76.20	35.40	8.60	119.00	160.00	0.240	58.37	4600.00	2400.00
Minimum	7.31	79.60	0.10	35.80	19.00	6.50	5.37	5.00	0.030	0.68	13.00	5.00
Average	10.53	92.79	10.77	54.27	26.84	7.35	21.97	24.05	0.060	10.53	1762.26	534.28
Median	10.59	89.65	12.20	52.80	26.45	7.10	13.00	11.00	0.050	2.26	2000.00	200.50
# exceedance	0.0		12.0			0.0	2.0		2.000			7.00
% exceedance	0.0%		50.0%			0.0%	8.3%		8.3%			33.3%

SM-9	D.O. (mg/L)	%Sat (%)	Temp (^oC)	Cond (µS/cm^2@25^oC)	TDS (mg/L)	pH (H^+)	Turbidity (NTU)	TSS (mg/L)	TP (mg/L)	Flow (cfs)	*Total-coli* (coli/100mL)	*E-coli* (coli/100mL)
Maximum	14.23	106.60%	17.40	79.30	38.00	8.50	54.50	28.00	0.260	40.20	2400.00	2400.00
Minimum	6.88	71.50%	0.10	32.60	16.00	6.90	4.80	4.00	0.010	0.91	17.00	6.00
Average	10.50	87.02%	8.21	45.54	22.02	7.52	13.06	8.50	0.050	6.87	1374.16	355.64
Median	10.47	85.20%	7.90	44.60	22.00	7.40	10.20	6.50	0.030	1.94	1600.00	150.00
# exceedance	0.0		7.0			0.0	0.0		2.000			4.00
% exceedance	0.0%		30.4%			0.0%	0.0%		8.7%			20.0%

SM-10	D.O. (mg/L)	%Sat (%)	Temp (^oC)	Cond (µS/cm^2@25^oC)	TDS (mg/L)	pH (H^+)	Turbidity (NTU)	TSS (mg/L)	TP (mg/L)	Flow (cfs)	*Total-coli* (coli/100mL)	*E-coli* (coli/100mL)
Maximum	14.33	106.40%	21.20	48.40	49.00	8.10	23.70	22.00	0.068	113.14	2400.00	2400.00
Minimum	6.97	79.60%	0.10	26.40	13.00	6.31	4.03	4.00	0.012	1.94	4.00	3.00
Average	10.59	93.38%	10.08	35.20	18.51	7.43	9.83	10.25	0.036	22.46	1292.32	511.58
Median	10.86	93.45%	9.20	35.90	17.00	7.45	6.98	7.50	0.034	8.39	580.00	78.00
# exceedance	0.0		11.0			1.0	0.0		0.000			5.00
% exceedance	0.0%		45.8%			4.5%	0.0%		0.0%			23.8%

Parameters

Dissolved Oxygen

Dissolved Oxygen (DO) is found in microscopic bubbles of oxygen that are mixed in the water and occur between water molecules. DO is a very important indicator of a water body's ability to support aquatic life. Fish "breathe" by absorbing dissolved oxygen through their gills. Oxygen enters the water by absorption directly from the atmosphere or via photosynthesis by aquatic plant and algae. Oxygen is removed from the water by respiration and decomposition of organic matter.

The State of Idaho standard for DO states that dissolved oxygen must exceed 6.0 mg/L for cold water biota at all times. None of the sites sampled dropped below the 6.0 mg/L threshold.

Water Temperature

Water temperature is a very important indicator for overall water quality. Many of the physical, biological and chemical characteristics of a river are directly affected by temperature. For example, temperature influences the:

- -amount of oxygen that can be dissolved in water.
- -photosynthetic rate of algae and larger aquatic plants.
- -metabolic rates of aquatic organisms.
- -sensitivity of organisms to toxic wastes, parasites and diseases.

Cool water can hold more oxygen than warm water, because gases are more easily dissolved in cool water. The reduction of oxygen solubility at high water temperatures can compound the stress on fish caused by marginal dissolved oxygen concentrations.

The State of Idaho water quality standard for temperature support of cold-water biota is a water temperature of 22^{o} C or less with a daily average no greater than 19 ^{o} C. The State of Idaho water quality standard for temperature support of salmonid spawning states that the temperature must be equal to or less than 13^{o}C with a maximum daily average of no greater than 9^{o}C. All of the streams sampled, with the exception of Little Carpenter Creek, are listed for salmonid spawning and must therefore meet the more stringent criteria. Since Little Carpenter Creek is a direct tributary to Carpenter Creek, which is listed for salmonid spawning, the 13^{o}C criteria will be used for assessment.

The State of Idaho DEQ lists the summer period of June 21st through September 21st as a "period of interest" on which to gauge the frequency of temperature exceedence for cold-water aquatic life criteria. "Critical periods" for water temperature are defined by the DEQ as follows: for cold water aquatic life the critical time period is from July 15th through August 15th, the time period when most streams reach their highest temperature of the year (DEQ, WBAG).

The Saint Maries Subbasin TMDL identified the critical time period for temperature during the "low discharge conditions in August and early September". It was also noted "temperature assessments…indicate significant exceedences of the state salmonid spawning standards" (DEQ, 2003).

All sites exceeded the salmonid spawning instantaneous criteria of 13^{o} C during these critical months. Figure 2 graphically illustrates the instantaneous water temperature measurements for all sites. The dotted red line represents the 13^{o} C salmonid spawning temperature criteria.

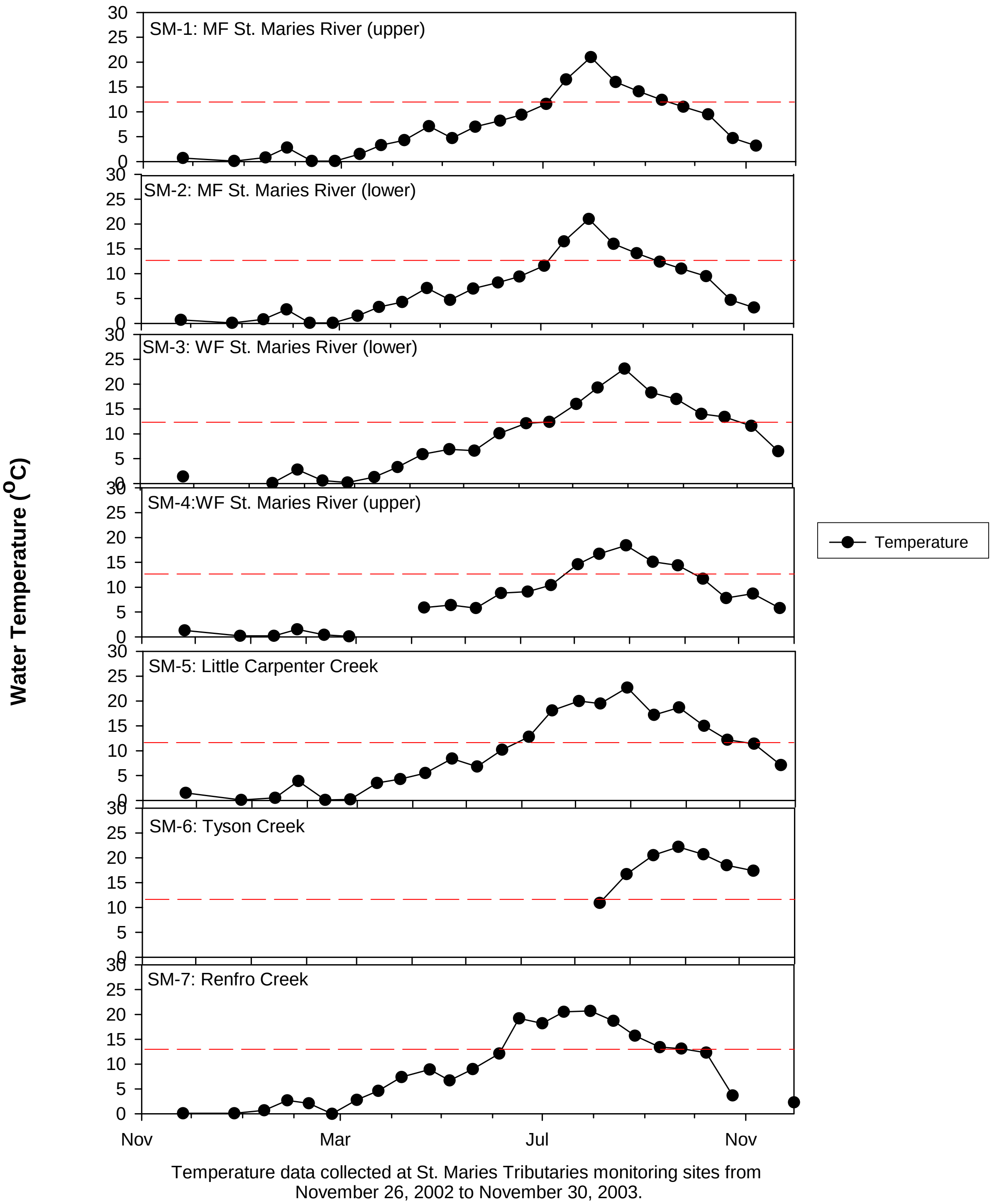
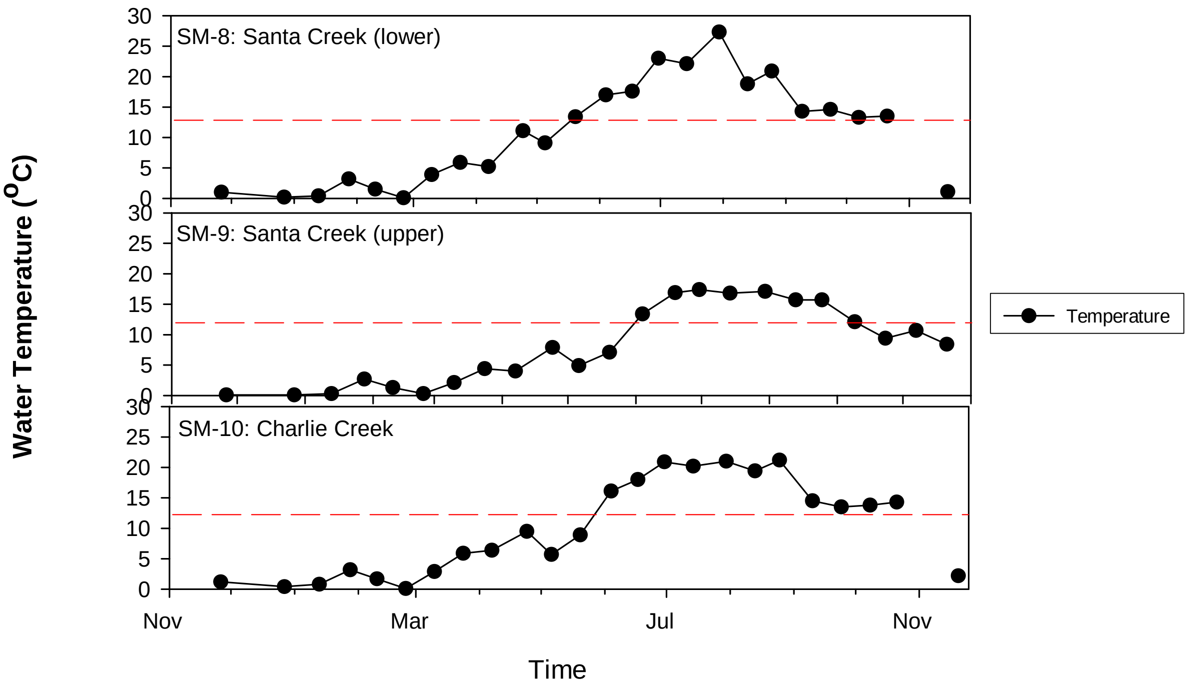


Figure 2. Instantaneous Water Temperature



Temperature data collected at St. Maries Tributaries monitoring sites from November 26, 2002 to November 30, 2003.

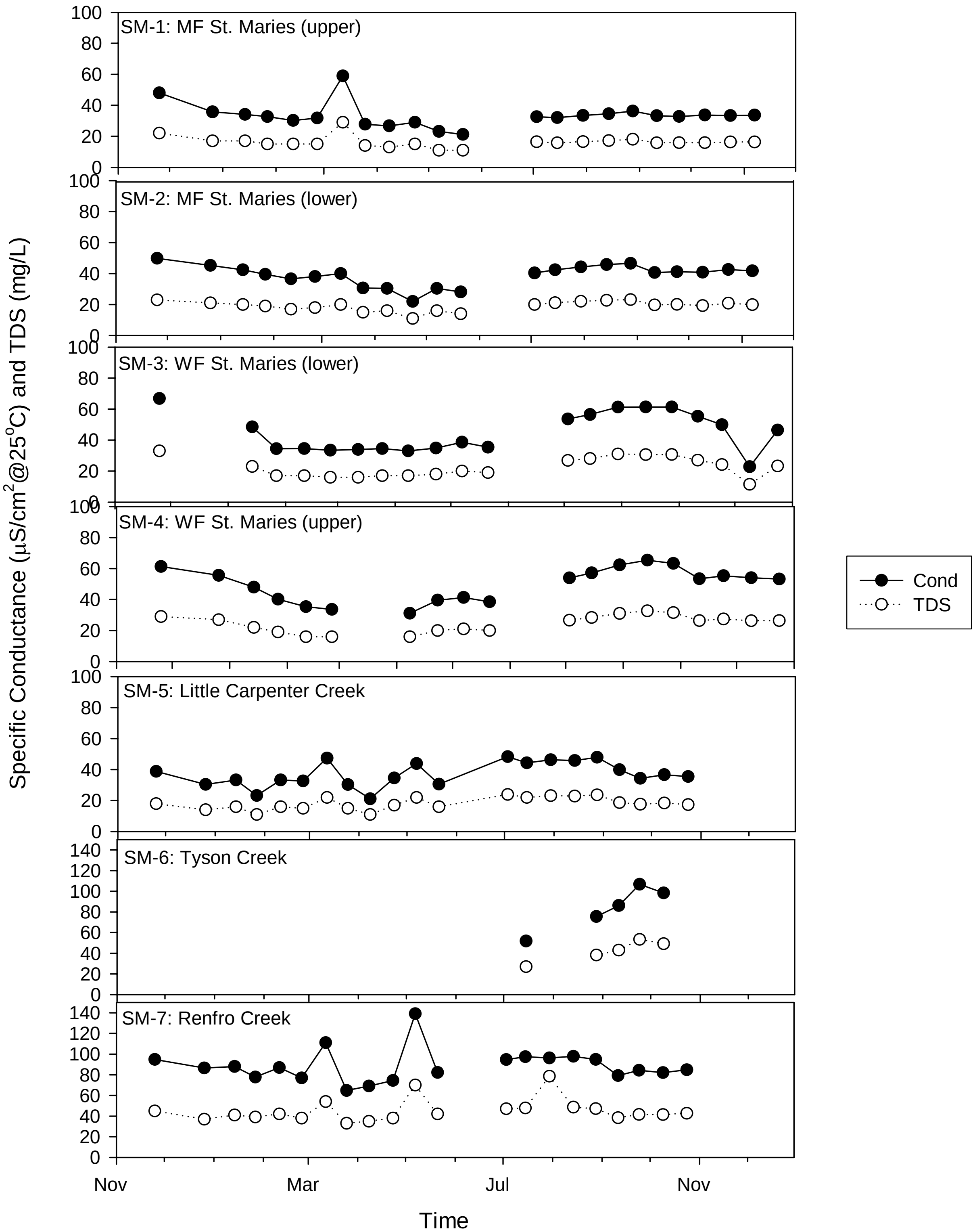
Figure 2. Instantaneous Water Temperature

Specific Conductance and Total Dissolved Solids

Total Dissolved Solids (TDS) is a measure of the total amount of minerals, salts, organic matter, and nutrients dissolved in water. Specific Conductance (SC) is a measure of how well water can conduct an electrical current. Conductivity increases with increasing concentrations and mobility of dissolved ions. These ions, which come from the breakdown of compounds, conduct electricity because they are negatively or positively charged when dissolved in water. Therefore, SC is an indirect measure of the presence of dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron, and can be used as an indicator of water pollution.

No standards or criteria exist that set limits on SC or TDS.

Figure 3 shows the levels of SC and TDS found at all sites throughout the sampling period.



Conductivity and TDS data collected at St. Maries Tributaries monitoring sites from November 26, 2002 to November 30, 2003.

Figure 3. Specific Conductivity and Total Dissolved Solids

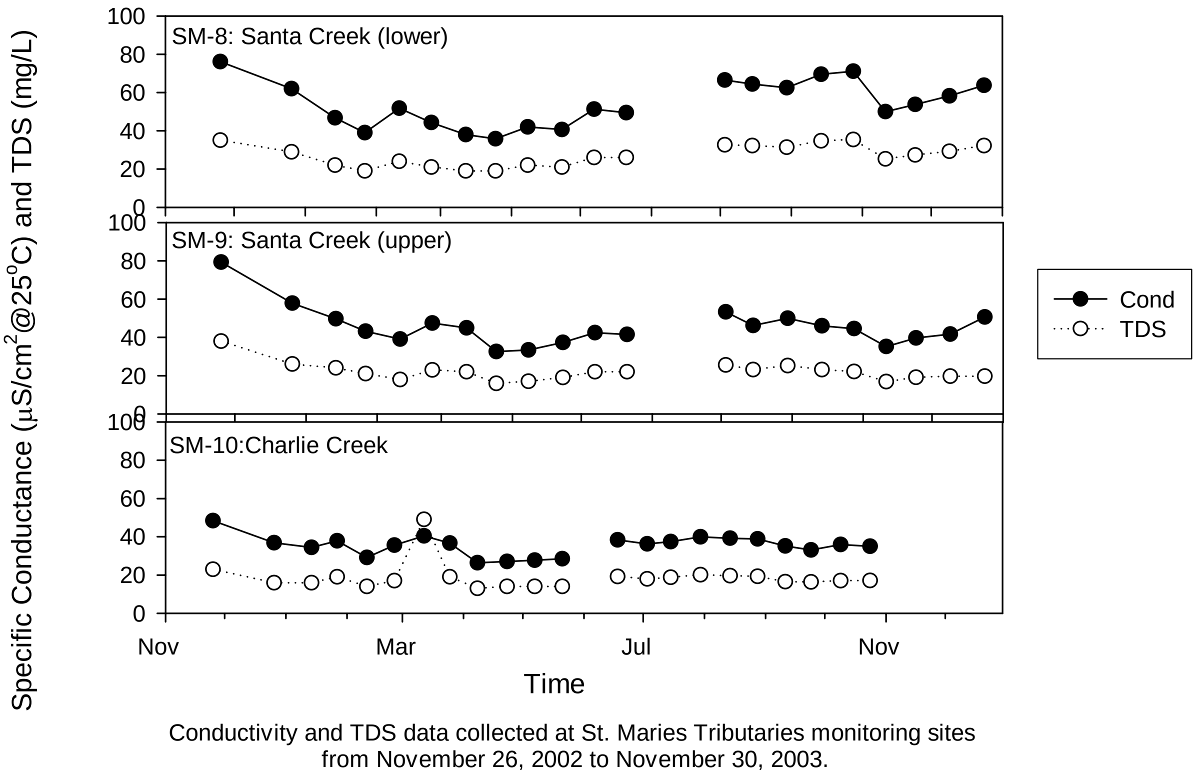


Figure 3. Specific Conductivity and Total Dissolved Solids

pH

pH represents the effective concentration (activity) of hydrogen ions (H^+) in water. The activity of hydrogen ions can be expressed most conveniently in logarithmic units. pH is defined as the negative logarithm of the activity of H^+ ions:

- pH = -log [H^+],
- where [H^+] is the concentration of H^+ ions in moles per liter.

The State of Idaho surface water quality criteria for Aquatic Life Use designations states that the Hydrogen Ion Concentration (pH) values must fall within the range of 6.5 and 9.5 (Sec. 250-WQS). SM-10 fell below the criteria once during the sampling period.

Turbidity and Total Suspended Solids

Total suspended solids (TSS) include both sediment and organic material suspended in water. TSS can cause problems for fish by clogging gills and for aquatic plants by limiting growth because of reduced light penetration. In addition, TSS provides a medium for the accumulation and transport of other constituents such as phosphorus and bacteria.

The sediment standard in Idaho is a narrative standard that states sediment shall not exceed, "…in the absence of specific sediment criteria, quantities which impair designated beneficial uses." The State of Idaho water quality standard for Turbidity states that measurements shall not exceed background turbidity by more than 50 NTU instantaneously or more than 25 NTU for more than ten consecutive days.

A comparison between turbidity (lack of water clarity due to particulate matter in the water column), TSS concentration, and discharge is presented in Figure 4. In addition, simple regression analysis was done to compare TSS and Turbidity values in streams where sediment appeared to be an issue. In most cases, the R^2 values were close to or greater than 0.90, indicating a strong correlation between TSS and Turbidity. In the future, it may be possible to use turbidity as a surrogate for TSS in order to save both time and money.

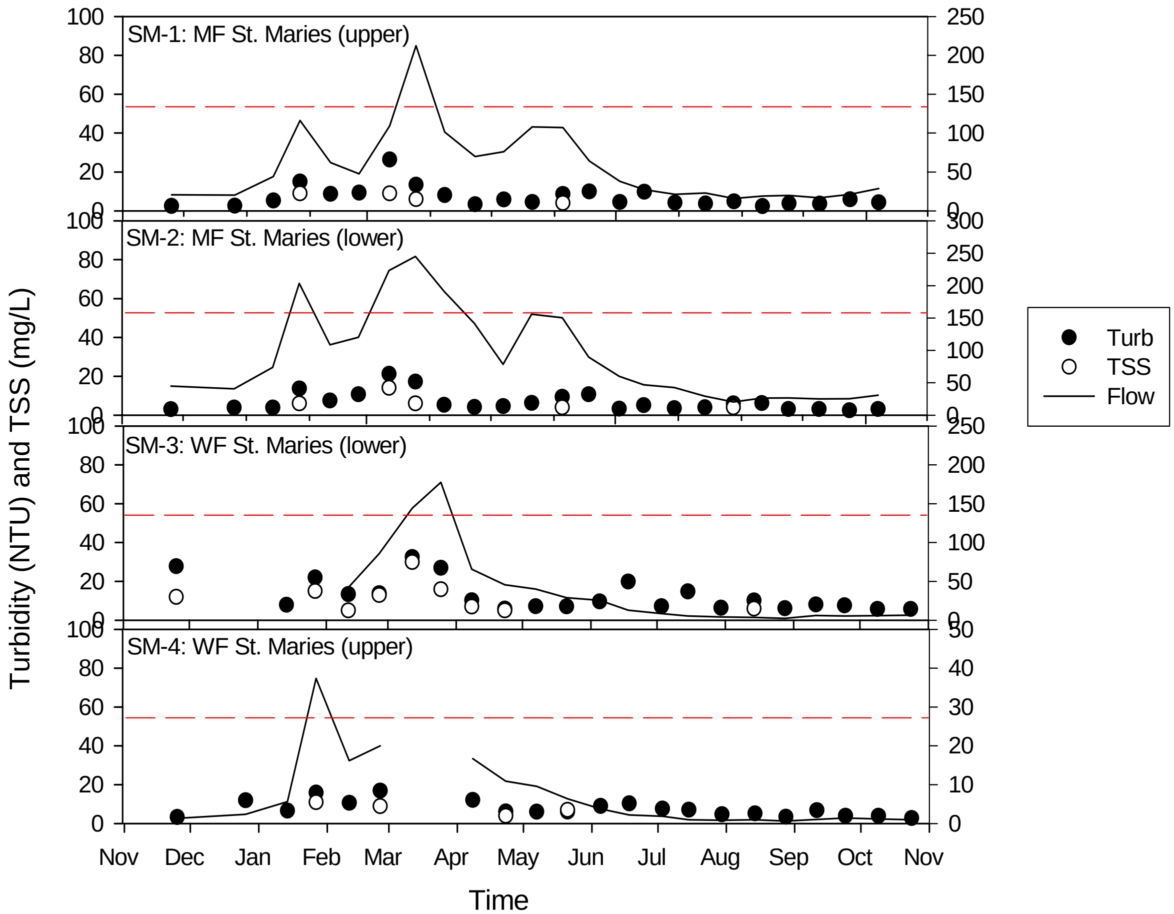
TSS and turbidity appear to be associated with increases in stream flow during spring runoff. However, increases in TSS and turbidity during the rest of the year do not appear to be a function of stream discharge. Instead, these increases are likely the result of land use practices in the watershed (i.e. grazing, road building/maintenance, forestry activities, and recreation).

A baseline background number has not been identified by the IDEQ for the St. Maries watershed so, for the sake of analysis, the average of all turbidity measurements taken at SM-1 (MF St. Maries) was used as the background value. The average turbidity at SM-1 was found to be 7 NTU and the dashed red line in Figure 4 represents the 57 NTU instantaneous threshold for turbidity being used in the examination of this data.

Analysis of TSS data gathered by IASCD led to large differences in total sediment load estimates than those presented by IDEQ in the St. Maries TMDL. The data clearly show that Santa Creek should be a top priority for agricultural BMP implementation. An estimated 468 tons/yr. of sediment entered Santa Creek during 2002-2003, from a one-mile stretch between monitoring stations. The IDEQ estimate of 2,899 tons/yr. is for the entire Santa Creek drainage. The TMDL allocated 272 tons/yr. (16.7%) as the agricultural contribution to the total estimate of sediment entering Santa Creek; monitoring data show that the true contribution from agricultural land is likely much higher. Future monitoring efforts will help to further clear up the discrepancy between respective sediment estimation totals in the West Fork and Middle Fork St. Maries drainages. Table 6 compares the TMDL actual load estimation with the load estimation generated from IASCD monitoring data.

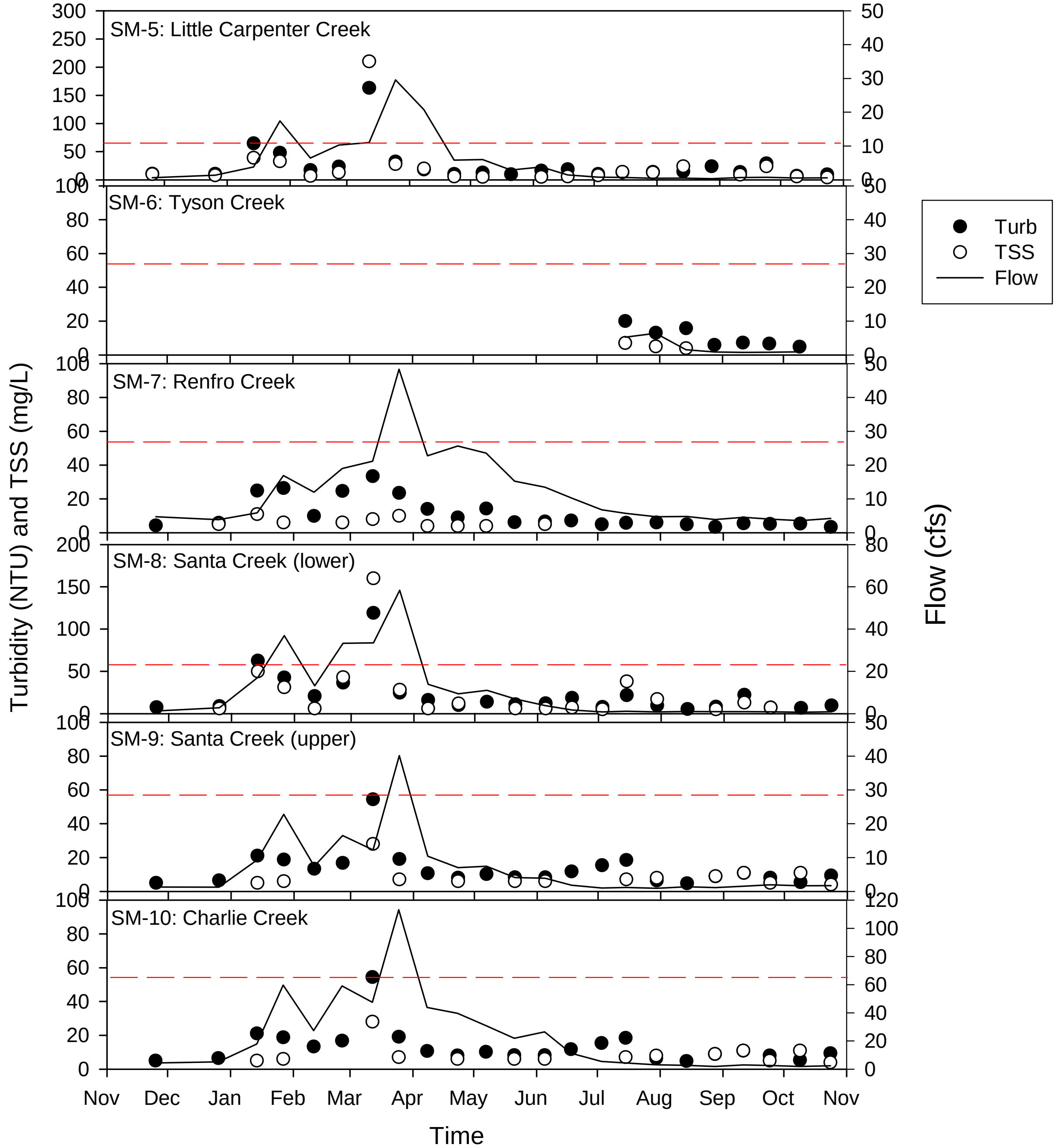
Table 6. Sediment load estimate comparisons

Stream Name	Sediment Load Estimation for 2002-2003 (tons/yr)	TMDL Estimated Existing Load (tons/yr)
West Fork St. Maries	450	1,484
Middle Fork St. Maries	358	1,610
Charlie Creek	191	n/a
Renfro Creek	57	n/a
Little Carpenter Creek	179	n/a
Santa Creek	468 (on a 1-mile stretch of agricultural land)	2,899



Turbidity, TSS, and Flow data collected at St. Maries Tributaries monitoring sites from November 26, 2002 to November 30, 2003.

Figure 4. Turbidity, TSS, and Discharge



Turbidity, TSS, and Flow data collected at St. Maries Tributaries monitoring sites from November 26, 2002 to November 30, 2003.

Figure 4. Turbidity, TSS, and Discharge

Nitrate+Nitrite (NO_3+NO_2) and Ammonia (NH_3)

Excessive concentrations of nitrate and/or nitrite can be harmful to humans and wildlife. Although there is no aquatic numeric standard in place, numbers above 0.30 mg/L can cause excessive plant growth and possible eutrophication (Cline, 1973 & Golterman, 1975).

Idaho administrative code employs a narrative standard for nutrients, which states that "surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses" (DEQ IDAPA 58.01.02).

High concentrations of nitrate and/or nitrite can also produce "brown blood disease" in fish. Nitrite enters the bloodstream through the gills and turns the blood a chocolate-brown color. As in humans, nitrite reacts with hemoglobin to form methemoglobin. Brown blood cannot carry sufficient amounts of oxygen, and affected fish can suffocate despite adequate oxygen concentration in the water. This accounts for the gasping behavior often observed in fish with brown blood disease, even when oxygen levels are relatively high (Mississippi State University, 1998).

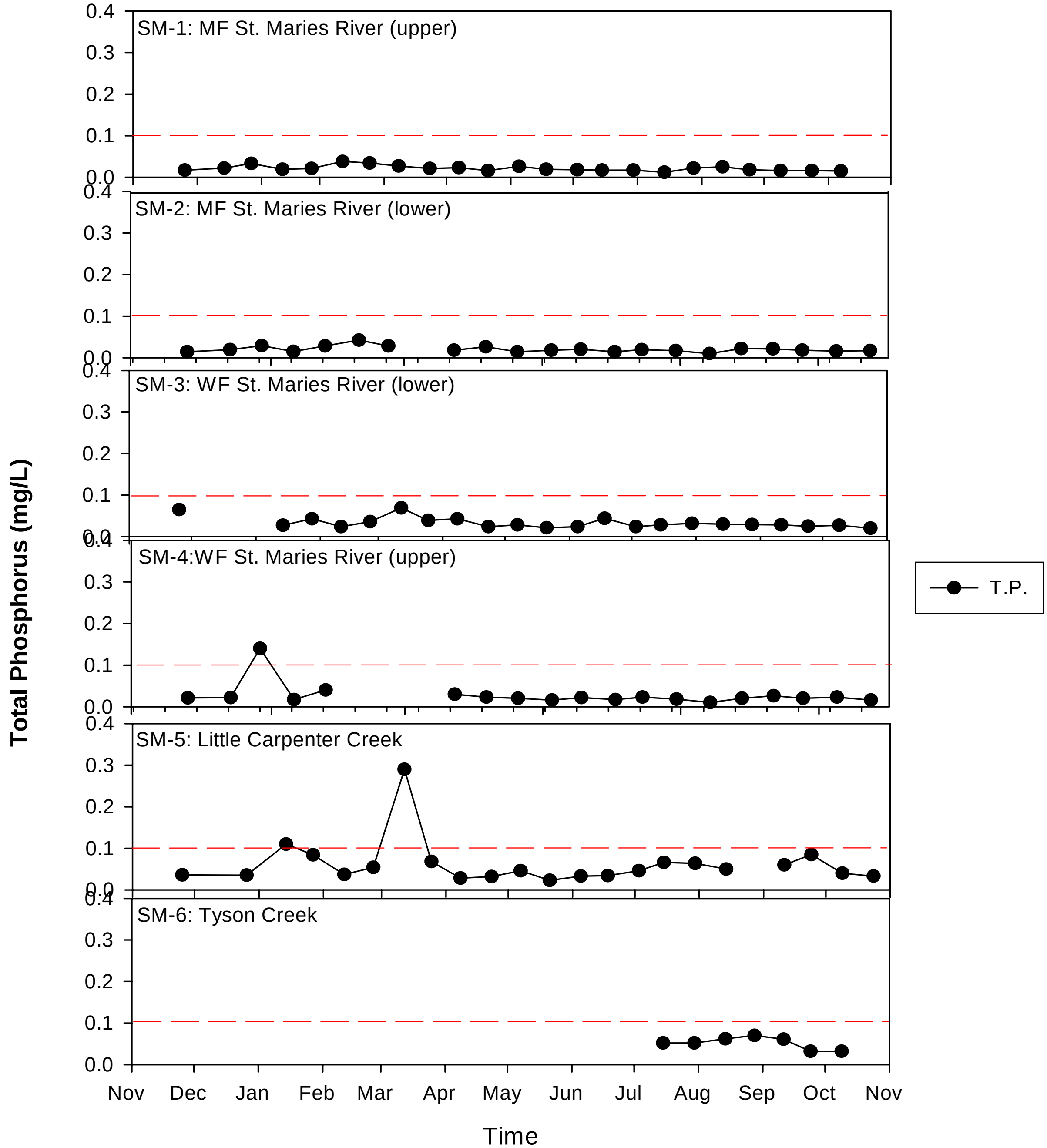
Ammonia is the least stable form of nitrogen in water. Ammonia is easily transformed to nitrate in waters that contain oxygen and can be transformed to nitrogen gas in waters that are low in oxygen. Ammonia concentrations can affect hatching and growth rates of fish; changes in tissues of gills, liver, and kidneys may occur during structural development.

Aside from a solitary ammonia reading of 0.015 mg/L in Santa Creek during mid-September, nitrogen levels were below the laboratory minimum detection limit at all sites for the duration of the monitoring project.

Total Phosphorus

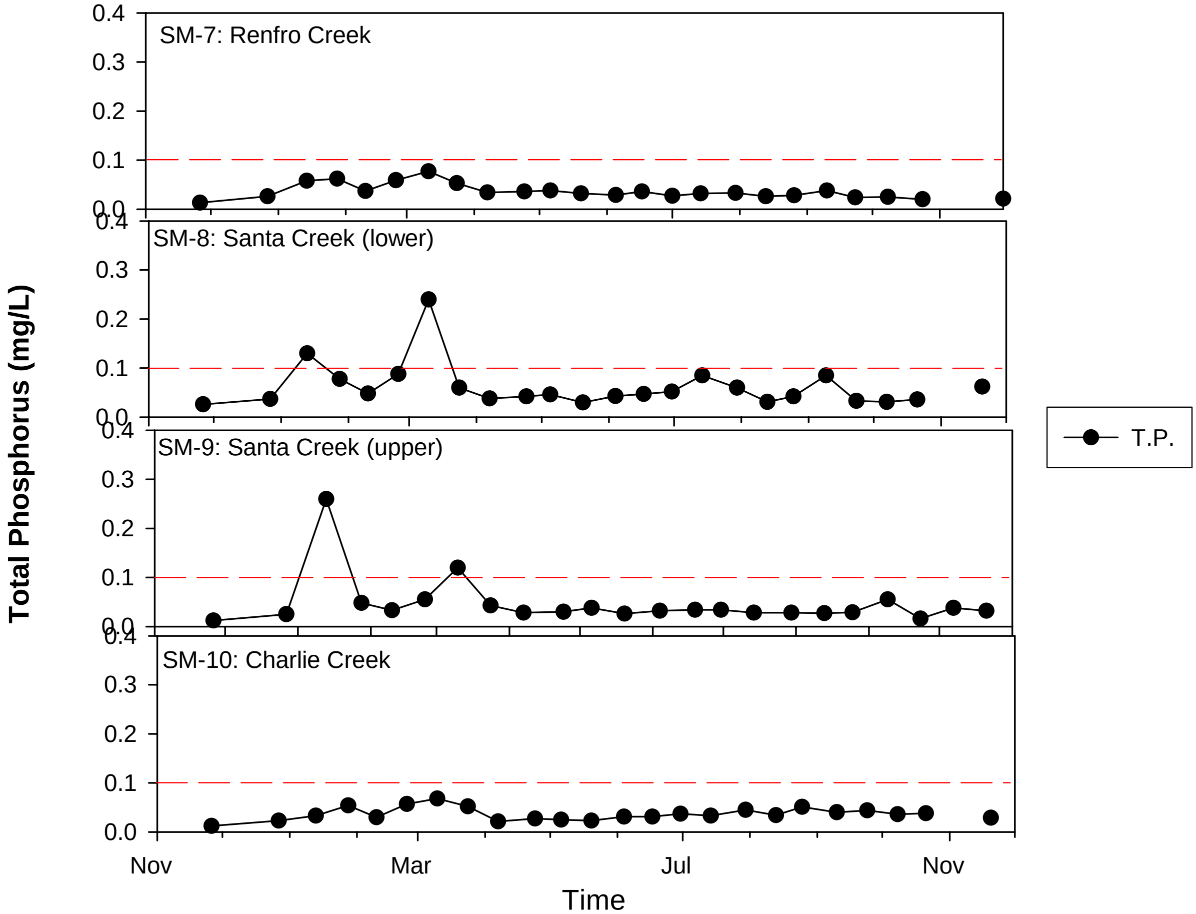
Total phosphorus (TP) is a measure of all the forms of phosphorus, dissolved or particulate, that is found in a sample. In freshwater lakes and rivers, phosphorus is often found to be the growth-limiting nutrient, because it occurs in the least amount relative to the needs of plants. If excessive amounts of phosphorus and nitrogen are added to the water, algae and aquatic plants can be produced in large quantities. When these algae die, bacteria decompose them, and use up oxygen. As a result, dissolved oxygen concentrations can drop too low for fish to breathe; leading to fish kills. The loss of oxygen in the bottom waters can free phosphorus previously trapped in the sediments, further increasing the available phosphorus.

The EPA Gold Book criterion for total phosphorus concentrations is 0.10 mg/L for streams or rivers not discharging directly into lakes or reservoirs. Sites SM-4, 5,8, & 9 all exceeded the 0.10 mg/L threshold during the monitoring period. Highest phosphorus rates were observed during spring runoff, when soil becomes highly mobile within stream systems and carries the phosphorus load with it. The dashed red line in Figure 5 represents the 0.10 mg/L threshold for total phosphorus.



Total phosphorus data collected at St. Maries Tributaries monitoring sites from November 26, 2002 to November 30, 2003.

Figure 5. Total Phosphorus



Total phosphorus data collected at St. Maries Tributaries monitoring sites from November 26, 2002 to November 30, 2003.

Figure 5. Total Phosphorus

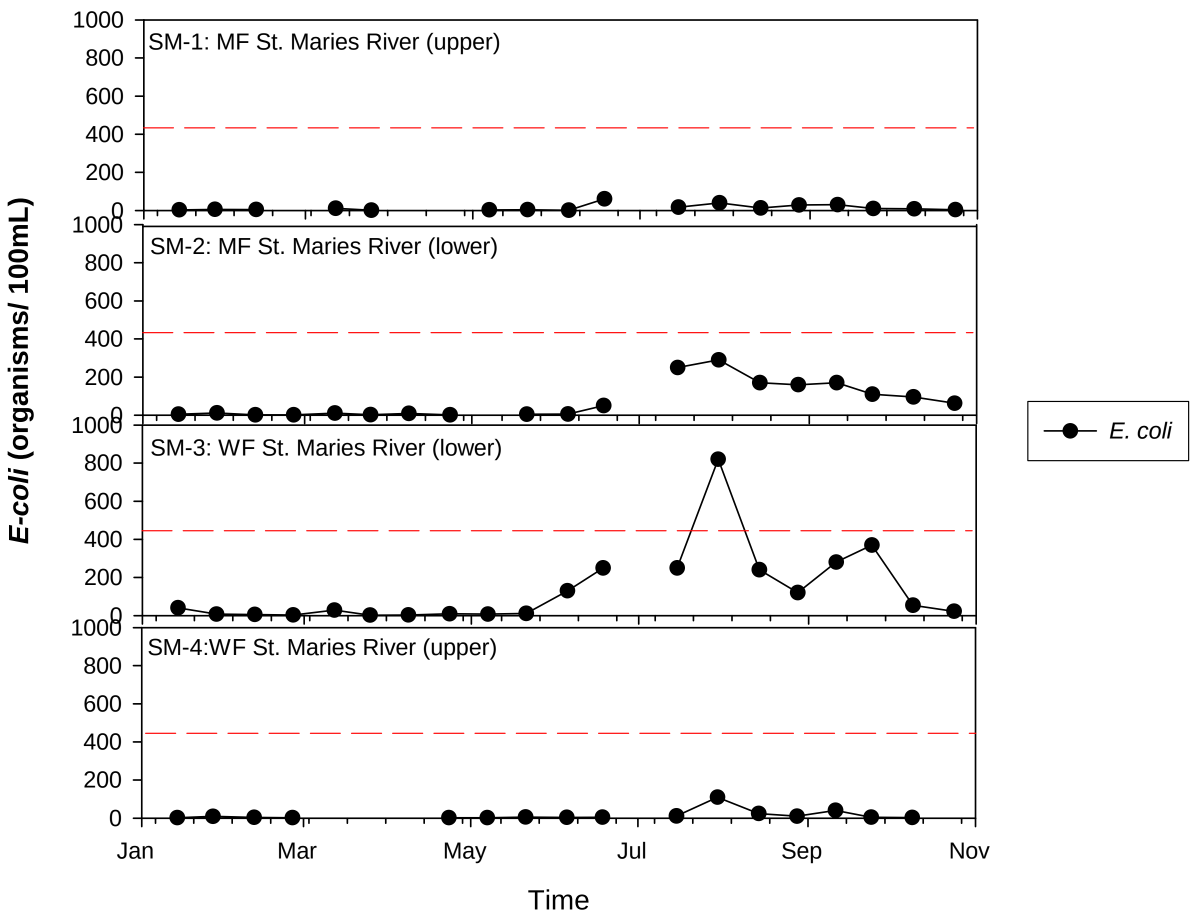
Bacteria (*Escherichia coli*)

The coliform bacteria group consists of several genera of bacteria belonging to the family *enterobacteriaceae*. These mostly harmless bacteria live in soil, water, and the digestive system of animals. *Escherichia coli* (*E. coli)* is a type of fecal coliform bacteria commonly found in the intestines of animals and humans. The presence of *E. coli* in water is a strong indication of recent sewage or animal waste contamination.

The standard for *E. coli* is that concentrations should not exceed 126 organisms/100 mL, which should be based on the geometric mean (5 samples collected over a 30 day period). The *E. coli* standard for primary contact is not to exceed 406 organisms/100 mL at any time and not to exceed 576 organisms/100 mL at any time for secondary contact. The dashed red line in Figure 6 indicates the 406 or 576 organism/100mL instantaneous recommendation, as applies.

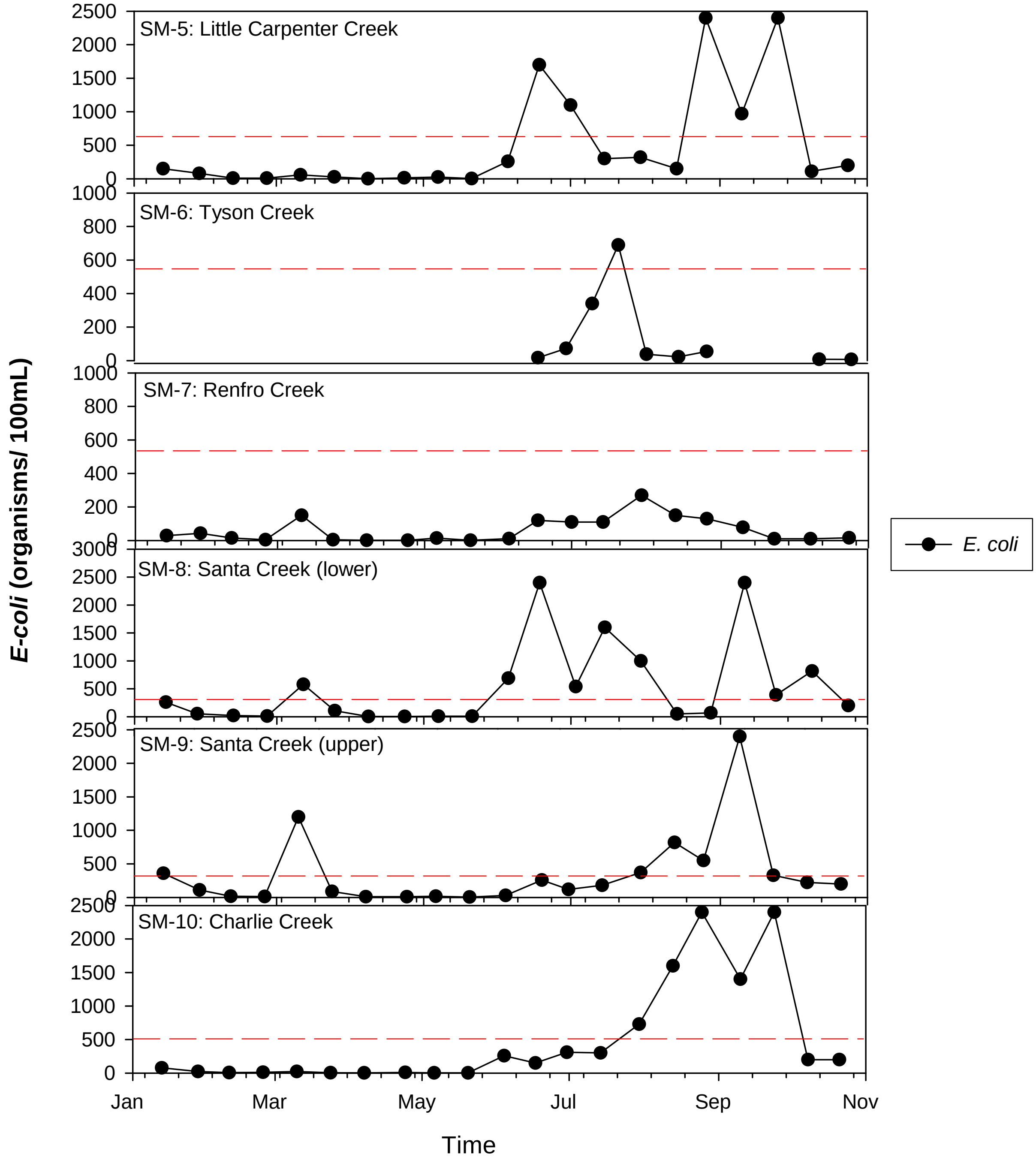
The West Fork and Middle Fork of the St. Maries River, along with Santa Creek are listed for primary contact recreation. All of the other streams monitored are listed for secondary contact recreation.

The West Fork St. Maries River (SM-3), Little Carpenter Creek (SM-5), Tyson Creek (SM-6), Santa Creek (SM-8 & 9), and Charlie Creek (SM-10) all exceeded their associated contact criteria. All of these streams had cattle directly accessing them in areas adjacent to or directly at the monitoring sites. In addition to this obvious source of bacterial contamination, there are farmhouses and suburban residences near these streams and possible contamination from faulty septic systems must not be overlooked.



E. Coli data collected at St. Maries Tributarie monitoring sites
from November 26, 2002 to November 30, 2003.

Figure 6. *E. coli* Bacteria



E. Coli data collected at St. Maries Tributarie monitoring sites
from November 26, 2002 to November 30, 2003.

Figure 6. *E. coli* Bacteria

Water Quality Exceedances Summary

The most significant problems facing the St. Maries watershed appear to be high water temperature, soil erosion (both in-channel and runoff), and bacteriological contamination. An elevated level of phosphorus is also seen at a few sites, although it doesn't appear to be affecting DO levels. In order to better visualize individual sites as part of a system, as well as for the sake of simplification, waterbody exceedances are listed by stream rather than site, in Table 7.

Table 7. Mean percent exceedances over target levels.

Waterbody	**ID #**	**Parameters of Concern-Mean % Exceedance**		
		Temperature	Total Phosphorus	E. coli
Middle Fork St. Maries	SM 1-2	22.92 %	0.0 %	0.0 %
West Fork St. Maries	SM 3-4	27.91%	0.0 %	2.78 %
Little Carpenter Creek	SM 5	29.17 %	13.04 %	23.81 %
Tyson Creek	SM 6	66.67 %	0.0 %	11.11 %
Renfro Creek	SM 7	33.33 %	0.0 %	0.0 %
Santa Creek	SM 8-9	40.43 %	8.51 %	26.83 %
Charlie Creek	SM 10	45.83 %	0.0 %	23.81 %

Conclusions

The monitoring program for the tributaries of the St. Maries River was successfully carried out as planned. Protocols were followed, QA/QC standards were met, and specific information per parameter for each subwatershed was collected. The data collected during this reconnaissance-monitoring project will be used as baseline data to better ascertain the current condition of the watershed and to help define critical areas within the watershed for placement of agricultural BMPs.

Sediment, phosphorus, and pathogens are the primary pollutants within the St. Maries River subbasin. Water temperature standards were also violated at every monitoring location, making high water temperature a principal concern as well.

Erosion and the resultant sedimentation of streams is one of the key concerns in the St. Maries watershed. While some sediment in streams is natural, excessive loads of sediment can have negative effects on stream ecosystems. Some effects of erosion and sediment deposition include loss of agricultural soils, decreased water-retention capacity of forestlands, and increased flood frequency. Also of concern is the effect sedimentation can have on biotic communities, including the reduction of fish diversity and other animal communities, and the overall lowering of productivity in aquatic populations. Erosion and re-suspension of sediment can also contribute significant portions of the overall phosphorus load of streams that drain both agricultural and non-agricultural areas.

Excessive stream temperature is another major issue in this watershed. Aquatic organisms from microbes to fish are dependent on certain temperature ranges for their optimal health. Aquatic insects are sensitive to temperature and will move in a stream to find their optimal temperature. Temperature is also critical for fish spawning and embryo development. If stream temperatures are outside of optimal levels for prolonged periods of time, organisms become stressed and may die or be unable to reproduce. Higher turbidity increases water temperatures because the suspended particles absorb more heat.

Bacteria were also found to be a significant pollutant in portions of the watershed. As indicated before, livestock are found in varying concentrations throughout the region and have noticeably impacted many of the sampling sites. They are the most probable source of the bacterial contamination, although wildlife and faulty septic systems may also be contributing factors.

E. coli DNA testing may be an option one could pursue if there is some debate regarding the source of the excess bacteria in these systems. This method would entail developing a library of DNA fingerprints of *E. coli* strains isolated from various potential sources and comparing these fingerprints with the fingerprints of samples collected in streams. A relative percentage of source species could then be developed, and proper management strategies could be devised.

Recommendations

Significant erosion is currently evident in a number of streams, and treatment should be prioritized to streams that are already undergoing the most severe erosion. Based on visual assessments, TSS rates, and turbidity levels, Santa Creek, Little Carpenter Creek, and Charlie Creek seem to have the highest rates of bank erosion. Bacteria levels on these streams were significantly higher than in the other streams sampled, likely from cattle accessing the stream.

The re-vegetation of riverbanks throughout the St. Maries watershed will go a long way toward reducing sediment transport, as healthy riparian vegetation is effective in reducing bank erosion. Riparian vegetation will also filter sediment being transported in surface water runoff.

Excessive stream temperature is another difficult problem to overcome, and can likely be addressed by re-establishing natural full potential canopy shade. Reducing sediment loads within critical reaches will assist in reducing stream temperatures as well.

Fencing cattle away from creeks and developing off-stream watering facilities is apt to be the most cost-effective method to reduce bacteria levels and sedimentation in problem areas. In many cases, this is the simplest and most effective BMP to implement in impacted watersheds.

Implementation of targeted stream improvements to reduce sediment loads, lower temperatures, and lower bacteria levels will be important. Based on stream inventory and prioritization efforts, stakeholders (IASCD, ISDA, SCC, USFS, IDL, and private land owners) should fund, devise, and construct high quality stream improvements designed to promote water quality enhancement.

This water quality monitoring was conducted in order to give adequate definition to water quality problems in the region and to help land managers identify problem areas and direct their conservation efforts accordingly. Now that the pollutants of concern have been identified and quantified, BMPs can be put in place to help mitigate them. It is recommended that further monitoring be conducted in order to evaluate the overall effectiveness of BMPs put on the ground.

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Appendix A
Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC)

The QA/QC procedures for this project are outlined prior to monitoring in the "St. Maries Monitoring Program 2002-2003." (Myler,2002)

The University of Idaho Analytical Science Laboratory (UIASL) conducted all inorganic parameter testing. The State of Idaho Health and Welfare Laboratory in Coeur d' Alene and Anatek Labs, Inc. performed bacteria analysis. All laboratories use EPA approved and validated methodology.

Duplicate samples and blank samples were submitted as part of the field QA/QC procedures. The blanks consisted of laboratory grade deionized water, poured off into properly prepared sample containers in the field. There were no constituents detected (above the laboratory's minimum detection limit) for any of the blank samples submitted during this project.

The duplicate samples consisted of sample containers filled in the field with the same composite water used for the lower Santa Creek site (SM-8). Duplicate samples were not identified as such for analysis by the laboratory, but rather entered the facility as blind duplicates. The duplicate samples were used to determine laboratory precision.

Precision is defined as the closeness of repeated measures to the same value. Relative percent difference (RPD) is the normal measure of precision when calculated from duplicate samples, and is calculated using the following equation:

$$RPD = \frac{(C_1-C_2)*100\%}{(C_1+C_2)/2}$$

RPD = relative percent difference
C_1 = Larger of the two samples
C2 = Smaller of the two samples

Date	SM-8 TSS	Duplicate TSS	RPD	SM-8 TP	Duplicate TP	RPD	SM-8 *E. coli*	Duplicate *E. coli*	RPD
11/26/02	<4.0	<4.0	0.00	0.026	0.021	21.277			
12/27/02	6	6	0.00	0.037	0.036	2.740			
1/13/03	50	39	24.72	0.130	0.130	0.00	260.0	57.0	128.076
1/28/03	31	30	3.28	0.078	0.079	1.274			
2/11/03	6	5	18.18	0.048	0.048	0.00	23.0	26.0	12.245
2/24/03	43	36	17.72	0.088	0.081	8.284	11.0	22.0	66.667
3/10/03	160	150	6.45	0.240	0.250	4.082	580.0	440.0	27.451
3/24/03	28	29	3.51	0.060	0.064	6.452	108.0	96.0	11.765
4/7/03	6	6	0.00	0.038	0.038	0.00	5.0	7.0	33.333
4/24/03	12	<4.0	142.86	0.042	0.041	2.410	5.0	13.0	88.889

Date	SM-8 TSS	Duplicate TSS	RPD	SM-8 TP	Duplicate TP	RPD	SM-8 *E. coli*	Duplicate *E. coli*	RPD
5/5/03	<4.0	6	100	0.046	0.051	10.309	8.0	13.0	47.619
5/22/03	6	4	40	0.030	0.033	9.524	9.0	9.0	0
6/4/03	6	6	0	0.043	0.043	0.00	690.0	920.0	28.571
6/17/03	7	9	25	0.047	0.047	0.00	>2400.0	>2400.0	0
6/30/03	5	6	18.18	0.052	0.051	1.942	540.0	63.0	158.209
7/14/03	38	36	5.41	0.085	0.085	0.00	1600.0	2400.0	40.0
7/30/03	17	13	26.67	0.060	0.055	8.696	1000.0	910.0	9.424
8/14/03	<4.0	5	0.00	0.031	0030	3.279	50.0	40.0	22.222
8/26/03	5	6	18.18	0.042	0.036	15.385	70.0	90.0	25.0
9/9/03	13	14	7.41	0.085	0.091	6.818	>2400.0	>2400.0	0
9/24/03	7	6	15.38	0.033	0.030	9.524			
10/7/03	<4.0	<4.0	0.00	0.031	0.031	0.00	816.4	1203.3	38.313
10/21/03	<4.0	<4.0	0.00	0.036	0.038	5.405	>200.5	>200.5	0
11/25/03	11	9	20.00	0.062	0.062	0.00			

Precision was very good for TSS and TP and fairly good for *E. coli* bacteria. The higher level of variation in the *E. coli* samples is likely due to the fact that bacteria is taken as a grab sample, rather than composited and homogenized as TSS and TP are.