Threemile and Butcher Creeks Water Quality Monitoring Report 2005-2006

Developed for:

Idaho Soil and Water Conservation District
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Introduction

The Idaho Association of Soil Conservation Districts (IASCD) collected water quality data from Threemile Creek and Butcher Creek from April, 2005 through March, 2006.

This monitoring program was intended to provide background data on Threemile and Butcher Creeks. This monitoring project, along with previous efforts by the Idaho Department of Environmental Quality (DEQ) and the Nez Perce Tribe (NPT) will enable managers to determine where pollutant loads are entering the stream to allow prioritization for the implementation of Best Management Practices (BMPs).

This report reviews monitoring results for the following parameters:

-Total Phosphorus (TP)
-Orthophosphorus (OP)
-Bacteria (*Escherichia coli)*
-Nitrogen Compounds—NO_2+ NO_3, Total Ammonia Nitrogen (TAN)
-Suspended Sediment Concentration (SSC)
-Instantaneous Water Temperature
-Turbidity
-Dissolved Oxygen (DO)
-Percent (%) Saturation
-Total Dissolved Solids (TDS) and Conductivity
-pH

The University of Idaho Analytical Science Laboratory (UIASL) conducted all inorganic parameter testing and Anatek Labs, Inc. performed bacteria analysis. Ken Clark (IASCD Moscow) performed all other measurements.

Threemile/ Butcher Creek Subbasin

The Butcher Creek and Threemile Creek subbasins collectively drain approximately 36,169 acres in Idaho County, Idaho. Butcher Creek is a second order tributary and Threemile Creek is a third order tributary of the South Fork of the Clearwater River (SF CWR). Annual peak flows in these streams are often a result of rain-on-snow events or heavy spring rains, and can occur from midwinter to early spring. Annual precipitation in the area typically ranges from 20-30 inches.

Threemile Creek's forested headwaters originate, at approximately 5,000 feet, four miles south of Grangeville and flow approximately 16 miles to its confluence with the SF CWR at river mile 7.6. The watershed is approximately 24,966 acres in size and 99% privately owned (< 0.5% owned by the Bureau of Land Management (BLM 1999)). The lower five miles flow through the NPT Reservation.

Dryland farming and livestock grazing dominate the land use in the upper reaches of Threemile Creek. The creek then enters the City of Grangeville, where it receives effluent discharge from the waste water treatment plant (WWTP), as well as storm water runoff. Additional dryland farms are situated along the stream for approximately 4 miles north of Grangeville before it flows through a steep canyon for approximately 8 miles and into the SF CWR.

Agricultural activities, livestock grazing, and sewage effluent have left the Threemile Creek drainage in relatively poor condition. Logging and roads in the canyon reaches have also resulted in localized adverse effects to the stream (BLM 1999).

Butcher Creek's forested headwaters originate one mile south of Mt. Idaho, at approximately 5,000 feet. The stream flows 11.9 miles to its confluence with the SF CWR at river mile 11.7 and drains an area of approximately 11,203 acres. The watershed is 98% privately owned, 2% state-owned, and less than 0.001% BLM-owned (BLM 1999). The lower 1.8 miles of Butcher Creek flows within the NPT Reservation boundary.

Land use in the headwaters of Butcher Creek is comprised of some agriculture and timber extraction, but is becoming more of a suburban area with the number of ranchettes and residences growing yearly. The stream flows through a moderately steep canyon from the town of Mt. Idaho to the mouth. Cattle grazing occurs over the entire length of the creek, but is most common in the uppermost and lower reaches.

Both Threemile and Butcher Creek provide spawning and juvenile rearing habitat for steelhead and Chinook salmon, although the Chinook are found in low numbers (IDEQ, 2003).

The Idaho Water Quality Standards designate salmonid spawning, cold-water biota, and secondary contact recreation as the beneficial uses for both creeks, although Butcher is

only listed for salmonid spawning from its mouth to an unnamed tributary found 4.5 miles from the mouth (IDAPA 58.01.02.120.07).

Monitoring Site Descriptions

Ten monitoring sites were selected for this project, in order to assess the effects of different land uses on water quality in the watersheds. Below is a general description of site locations; these sites are also illustrated graphically in Figure 1.

TM-1: Located near the headwaters of Threemile creek.

TM-2: Located on Threemile creek near the southern boundary of Grangeville.

TM-3: Located at the mouth of unnamed tributary to Threemile creek, in Grangeville.

TM-4: Located near the mouth of unnamed tributary to Threemile creek, just north of Grangeville.

TM-5: Located on Threemile creek, just north of the Grangeville WWTP.

TM-6: Located on Threemile creek, north of Grangeville just downstream of Butcher Creek road, and just before the stream enters the canyon.

TM-7: Located near the mouth of Threemile creek.

BC-1: Located on Butcher Creek, near the town of Mount Idaho, below where the two headwater tributaries meet.

BC-2: Located on Butcher Creek near the highway 13 crossing.

BC-3: Located on small tributary to Butcher creek, along Butcher Creek road. .

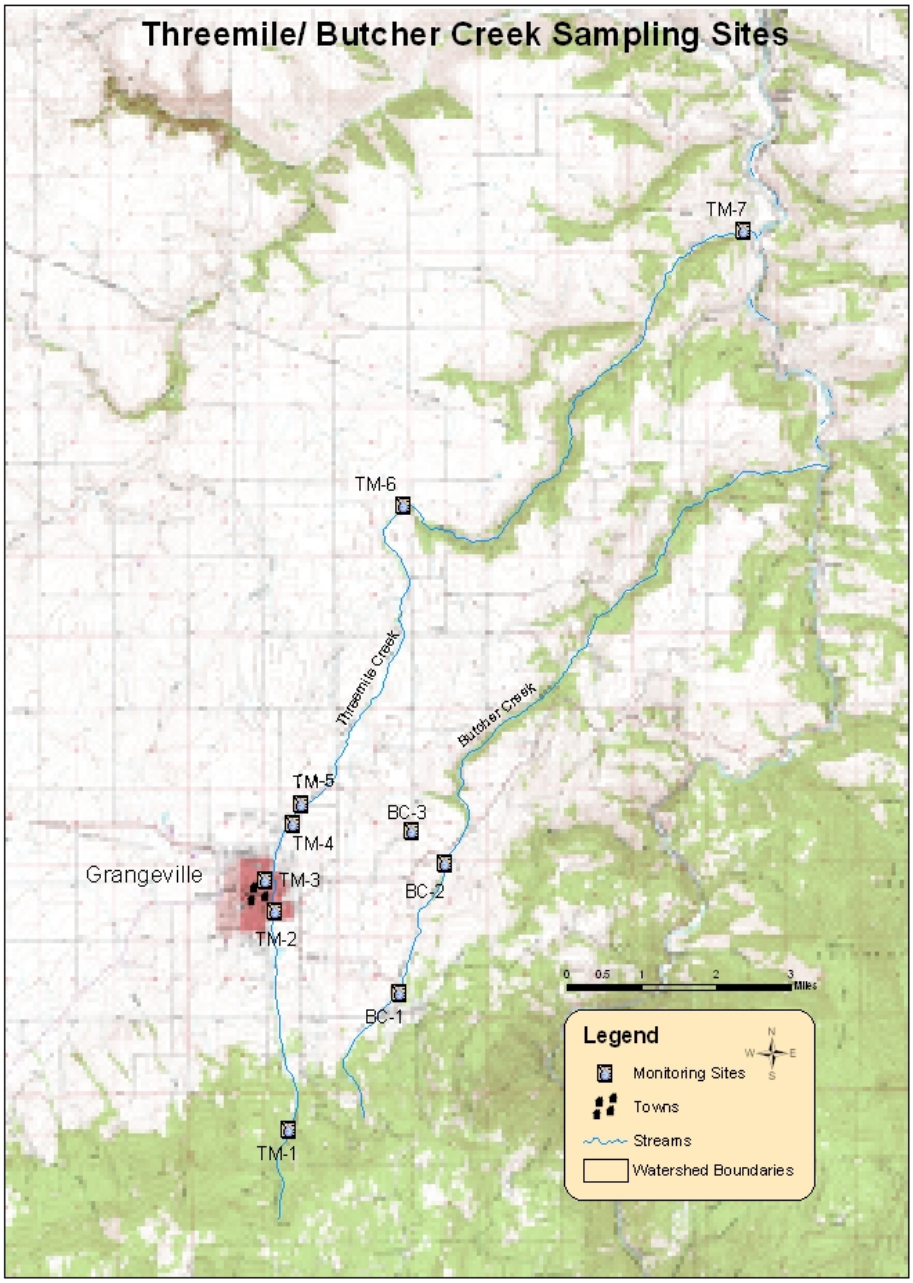


Figure 1. Three Mile/ Butcher Creek watershed IASCD monitoring sites.

Methods and Materials

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 (i.e. do not meet water quality standards). Both streams in this study are listed as water quality limited in Idaho's §303(d)/ §305(b) Integrated Report.

Sampling Protocols

Approximately four liters of stream water were 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 splitter. The polyethylene churn splitter was 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, TAN, and TP) were transferred into preserved (H_2SO_4 pH <2) 500 mL sample containers. Water quality samples (SSC, NO_2+NO_3, TAN, and TP) were then analyzed at the UIASL in Moscow, Idaho.

Bacteriological samples (*E. coli*) were collected directly from the thalweg into sterile sample containers. The samples were delivered to Anatek Labs, Inc. in Moscow for analysis. Most probable number (MPN) multiple tube fermentation was used to determine *E. coli* levels in the water sample.

A list of parameters, sample sizes, preservation, holding times, and analytical methods are displayed in Table 1. 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 1. Water Quality Parameters

Parameters	Sample Size	Preservation	Holding Time	Method
Suspended Sediment Concentration (SSC)	1L	Cool 4°C	7 Days	ASTM 3977-97
Nitrogen Compounds: 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 Orthophosphorus	100 mL	Cool 4°C, H_2SO_4 pH < 2	28 Days	EPA 365.4 EPA 365.2
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 2.

Table 2. Field Measurements

Parameters	Instrument	Calibration
Dissolved Oxygen	YSI Model 55	Ambient air calibration
Temperature	YSI Model 55	Centigrade thermometer
Conductance & TDS	Orion Model 115	Specific Conductance (25°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 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. 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 EPA. A method validation process, including precision and accuracy performance evaluations and method detection limit studies, is an element 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 duplicate 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 were reviewed in the Moscow field office and then submitted to the Idaho State Department of Agriculture (ISDA) in Boise for further review. These reviews ensure that all necessary observations, measurements, and analytical results were properly recorded. The analytical results were evaluated for completeness and accuracy. Any suspected errors were investigated and resolved, if possible. The data were then stored electronically and made available to any interested entity upon request.

Results and Discussion

Analysis of the data was done, and descriptive statistics such as maximum, minimum, median, and mean values for each parameter measured were determined. The number of exceedances per year was calculated based on the number of sampling events whose respective values exceeded TMDL targets or State of Idaho water quality standards, whichever was more restrictive. These descriptive statistics are presented for each site in Table 3.

Table 3. Descriptive statistics for select parameters at Threemile/Butcher Creek IASDC monitoring sites.

TM-1	D.O.	% Sat	Temp	Cond	TDS	pH	Turbidity	NO2+NO3	TAN	OP	TP	SSC	*E-coli*
	(mg/L)	(%)	(°C)	(µS/cm²@25°C)	(mg/L)	(H^+)	(NTU)	(mg/L)	mg/L	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)
Maximum	13.34	92.60%	13.10	125.40	64.10	8.23	25.40	0.05	0.11	0.05	0.066	8.80	110.60
Minimum	9.19	81.20%	0.10	50.70	24.90	7.77	2.70	0.05	0.05	0.03	0.043	2.00	1.00
Mean	10.86	86.58%	6.08	94.02	47.67	8.00	8.45	0.05	0.05	0.04	0.055	4.33	25.42
Median	10.47	86.15%	6.00	94.85	47.50	7.99	7.62	0.05	0.05	0.04	0.055	2.00	16.05
# exceedance	0.0		0.0			0.0	0.0	0.0	0.0	0	0	0.0	0.00
% exceedance	0.0%		0.0%			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
TM-2	**D.O.**	**% Sat**	**Temp**	**Cond**	**TDS**	**pH**	**Turbidity**	**NO2+NO3**	**TAN**	**OP**	**TP**	**SSC**	***E-coli***
	(mg/L)	**(%)**	**(°C)**	**(µS/cm²@25°C)**	**(mg/L)**	**(H^+)**	**(NTU)**	**(mg/L)**	**mg/L**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(coli/100mL)**
Maximum	13.56	94.00%	20.70	196.00	99.00	8.51	54.60	0.64	0.50	0.1	0.2	54.00	2419.20
Minimum	7.50	82.50%	0.00	80.30	39.70	7.86	5.53	0.05	0.05	0.02	0.06	2.00	33.60
Mean	9.90	86.31%	10.32	126.40	62.94	8.07	20.36	0.12	0.10	0.05	0.1	17.11	752.58
Median	9.44	85.40%	9.85	128.15	63.80	8.05	22.00	0.05	0.05	0.05	0.1	14.00	410.60
# exceedance	0.0		4.0			0.0	0.0	1.0	0.0	0	7	0.0	7.00
% exceedance	0.0%		22.2%			0.0%	0.0%	5.6%	0.0%	0.0%	38.9%	0.0%	38.9%
TM-3	**D.O.**	**% Sat**	**Temp**	**Cond**	**TDS**	**pH**	**Turbidity**	**NO2+NO3**	**TAN**	**OP**	**TP**	**SSC**	***E-coli***
	(mg/L)	**(%)**	**(°C)**	**(µS/cm²@25°C)**	**(mg/L)**	**(H^+)**	**(NTU)**	**(mg/L)**	**mg/L**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(coli/100mL)**
Maximum	12.83	91.40%	18.10	327.00	163.00	8.77	114.00	0.87	0.24	0.31	0.99	42.00	2419.20
Minimum	5.49	58.30%	1.20	77.30	38.50	7.61	11.00	0.05	0.05	0.01	0.094	4.40	28.20
Mean	9.25	79.18%	9.36	166.92	83.89	7.87	46.95	0.34	0.08	0.08	0.232	14.82	852.88
Median	9.22	80.85%	8.95	123.75	61.90	7.85	48.60	0.24	0.05	0.06	0.16	10.50	727.00
# exceedance	1.0		2.0			0.0	5.0	6.0	0.0	2	10	0.0	7.00
% exceedance	7.1%		14.3%			0.0%	38.5%	42.9%	0.0%	14.3%	71.4%	0.0%	50.0%
TM-4	**D.O.**	**% Sat**	**Temp**	**Cond**	**TDS**	**pH**	**Turbidity**	**NO2+NO3**	**TAN**	**OP**	**TP**	**SSC**	***E-coli***
	(mg/L)	**(%)**	**(°C)**	**(µS/cm²@25°C)**	**(mg/L)**	**(H^+)**	**(NTU)**	**(mg/L)**	**mg/L**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(coli/100mL)**
Maximum	12.61	95.20%	17.50	409.00	205.00	8.62	67.40	0.61	0.21	0.11	0.24	21.00	2419.20
Minimum	8.46	82.40%	0.70	117.30	59.10	7.62	6.61	0.05	0.05	0.03	0.05	2.00	5.20
Mean	10.27	88.19%	8.92	207.44	104.80	8.00	38.21	0.23	0.06	0.06	0.136	9.74	292.77
	10.32	87.70%	7.80	167.70	85.20	7.92	35.50	0.21	0.05	0.06	0.12	8.60	96.00
# exceedance	0.0		3.0			0.0	2.0	2.0	0.0	1	8	0.0	1.00
% exceedance	0.0%		27.3%			0.0%	20.0%	18.2%	0.0%	9.1%	72.7%	0.0%	9.1%
TM-5	**D.O.**	**% Sat**	**Temp**	**Cond**	**TDS**	**pH**	**Turbidity**	**NO2+NO3**	**TAN**	**OP**	**TP**	**SSC**	***E-coli***
	(mg/L)	**(%)**	**(°C)**	**(µS/cm²@25°C)**	**(mg/L)**	**(H^+)**	**(NTU)**	**(mg/L)**	**mg/L**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(coli/100mL)**
Maximum	11.96	91.50%	21.50	680.00	347.00	8.08	77.40	14.00	8.60	2.4	2.4	140.00	2419.20
Minimum	3.40	38.60%	2.40	132.90	66.00	7.34	5.57	0.05	0.05	0.08	0.25	2.00	1.00
Mean	8.14	73.63%	12.39	283.24	139.65	7.74	26.82	4.00	0.95	0.58	0.758	20.92	827.46
Median	8.51	80.50%	11.90	262.50	125.00	7.76	16.10	3.20	0.42	0.34	0.43	11.00	411.30
# exceedance	5.00		5.00			0.00	1.00	17.00	0.00	17	18	1.00	6.00
% exceedance	27.8%		27.8%			0.0%	5.9%	94.4%	0.0%	94.4%	100.0%	5.6%	33.3%
TM-6	**D.O.**	**% Sat**	**Temp**	**Cond**	**TDS**	**pH**	**Turbidity**	**NO2+NO3**	**TAN**	**OP**	**TP**	**SSC**	***E-coli***
	(mg/L)	**(%)**	**(°C)**	**(µS/cm²@25°C)**	**(mg/L)**	**(H^+)**	**(NTU)**	**(mg/L)**	**mg/L**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(coli/100mL)**
Maximum	12.86	100.90%	23.50	868.00	443.00	9.27	182.00	6.80	2.10	0.98	1	110.00	2419.20
Minimum	7.64	82.20%	0.00	146.20	73.70	7.81	3.92	0.05	0.05	0.12	0.25	2.00	45.70
Mean	10.13	91.71%	11.64	301.62	154.02	8.61	36.87	3.33	0.17	0.4	0.508	22.14	695.13
Median	9.96	89.40%	11.10	290.50	147.50	8.58	13.20	3.30	0.05	0.28	0.465	6.30	497.90
# exceedance	0.0		7.0			0.0	5.0	16.0	0.0	18	18	2.0	8.00
% exceedance	0.0%		38.9%			0.0%	29.4%	88.9%	0.0%	100.0%	100.0%	11.8%	44.4%

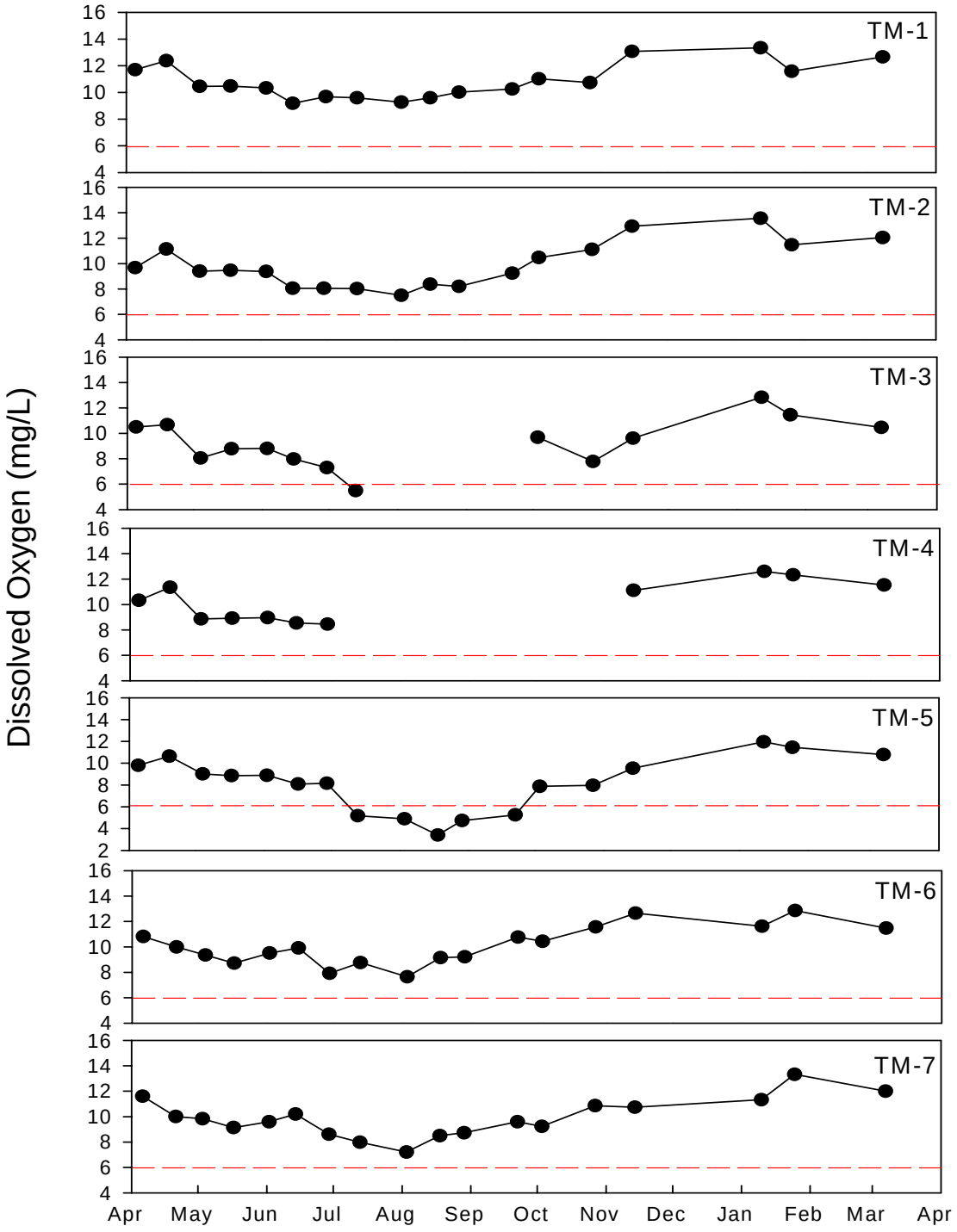
TM-7	D.O.	% Sat	Temp	Cond	TDS	pH	Turbidity	NO2+NO3	TAN	OP	TP	SSC	*E-coli*
	(mg/L)	(%)	(°C)	(µS/cm²@25°C)	(mg/L)	(H^+)	(NTU)	(mg/L)	mg/L	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)
Maximum	13.32	101.20%	21.70	369.00	190.00	8.80	223.00	8.20	1.90	0.3	0.65	170.00	1553.10
Minimum	7.21	85.20%	3.30	128.00	64.10	7.46	2.20	0.05	0.05	0.22	0.25	2.00	3.10
Mean	9.92	92.78%	12.99	257.22	132.61	8.37	29.52	2.30	0.16	0.26	0.323	14.20	218.42
Median	9.72	92.25%	12.65	252.00	132.50	8.34	12.00	1.18	0.05	0.26	0.285	2.00	47.40
# exceedance	0.0		7.0			0.0	1.0	12.0	0.0	0	7	1.0	2.00
% exceedance	0.0%		38.9%			0.0%	5.9%	66.7%	0.0%	0.0%	38.9%	5.6%	11.1%
BC-1	D.O.	% Sat	Temp	Cond	TDS	pH	Turbidity	NO2+NO3	TAN	OP	TP	SSC	*E-coli*
	(mg/L)	(%)	(°C)	(µS/cm²@25°C)	(mg/L)	(H^+)	(NTU)	(mg/L)	mg/L	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)
Maximum	12.71	90.30%	25.50	135.40	67.80	8.15	53.70	0.53	0.12	0.08	0.16	23.00	2419.20
Minimum	6.68	78.60%	0.30	66.20	33.20	7.71	6.40	0.05	0.05	0.03	0.077	2.00	33.60
Mean	9.41	84.91%	11.91	100.66	49.56	7.93	28.34	0.16	0.05	0.05	0.12	9.47	788.00
Median	9.42	84.75%	11.50	104.95	50.40	7.92	28.50	0.05	0.05	0.05	0.12	9.60	378.40
# exceedance	0.0		5.0			0.0	0.0	4.0	0.0	0	11	0.0	6.00
% exceedance	0.0%		31.3%			0.0%	0.0%	25.0%	0.0%	0.0%	68.8%	0.0%	37.5%
BC-2	D.O.	% Sat	Temp	Cond	TDS	pH	Turbidity	NO2+NO3	TAN	OP	TP	SSC	*E-coli*
	(mg/L)	(%)	(°C)	(µS/cm²@25°C)	(mg/L)	(H^+)	(NTU)	(mg/L)	mg/L	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)
Maximum	13.05	86.70%	22.60	198.40	99.20	8.21	53.80	0.90	0.11	0.08	0.18	19.00	2419.20
Minimum	6.76	77.70%	0.00	75.00	37.80	7.78	13.10	0.05	0.05	0.03	0.088	2.00	27.50
Mean	9.55	74.59%	11.68	115.17	57.75	7.97	35.22	0.25	0.05	0.06	0.133	12.84	573.51
Median	8.90	85.00%	13.00	106.20	52.90	7.94	37.90	0.11	0.05	0.06	0.13	12.00	313.00
# exceedance	0.0		6.0			0.0	0.0	4.0	0.0	0	11	0.0	4.00
% exceedance	0.0%		46.2%			0.0%	0.0%	30.8%	0.0%	0.0%	84.6%	0.0%	30.8%
BC-3	D.O.	% Sat	Temp	Cond	TDS	pH	Turbidity	NO2+NO3	TAN	OP	TP	SSC	*E-coli*
	(mg/L)	(%)	(°C)	(µS/cm²@25°C)	(mg/L)	(H^+)	(NTU)	(mg/L)	mg/L	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)
Maximum	9.26	88.20%	14.90	262.00	134.00	8.10	81.60	4.40	1.10	0.07	0.26	33.00	2419.20
Minimum	6.82	65.50%	12.10	171.60	85.50	7.65	24.90	0.05	0.05	0.05	0.12	8.40	360.90
Mean	8.33	80.64%	13.82	222.88	112.68	7.88	61.34	2.16	0.26	0.06	0.174	17.88	813.76
Median	8.42	82.50%	14.20	246.00	124.00	7.87	69.00	1.80	0.05	0.06	0.16	15.00	410.60
# exceedance	0.0		4.0			0.0	3.0	4.0	0.0	0	5	0.0	1.00
% exceedance	0.0%		80.0%			0.0%	60.0%	80.0%	0.0%	0.0%	100.0%	0.0%	20.0%

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. DO levels dropped below the criterion once at TM-3, which is a small tributary to Threemile located in Grangeville, and five times at TM-5, which is located on Threemile Creek, directly below the Grangeville WWTP (Figure 2).


Dissolved Oxygen (mg/L)
TM-1
TM-2
TM-3
TM-4
TM-5
TM-6
TM-7
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr

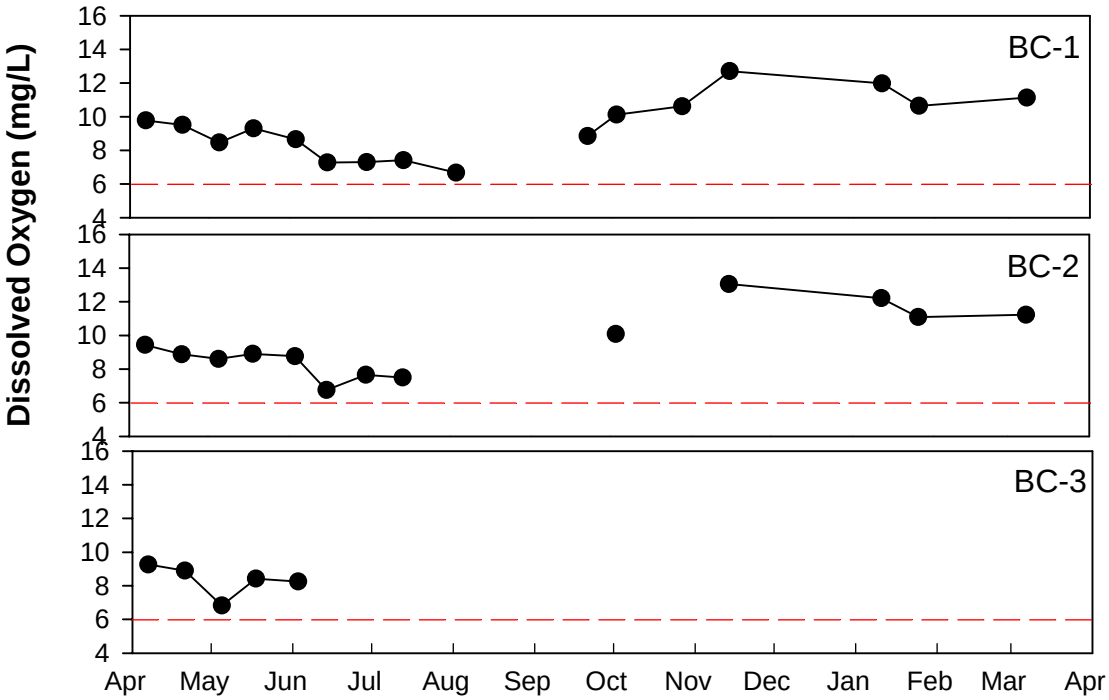


Figure 2. Dissolved Oxygen concentrations for Three Mile and Butcher Creeks. The dashed red line represents the 6.0 mg/L water quality criterion.

Water Temperature

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

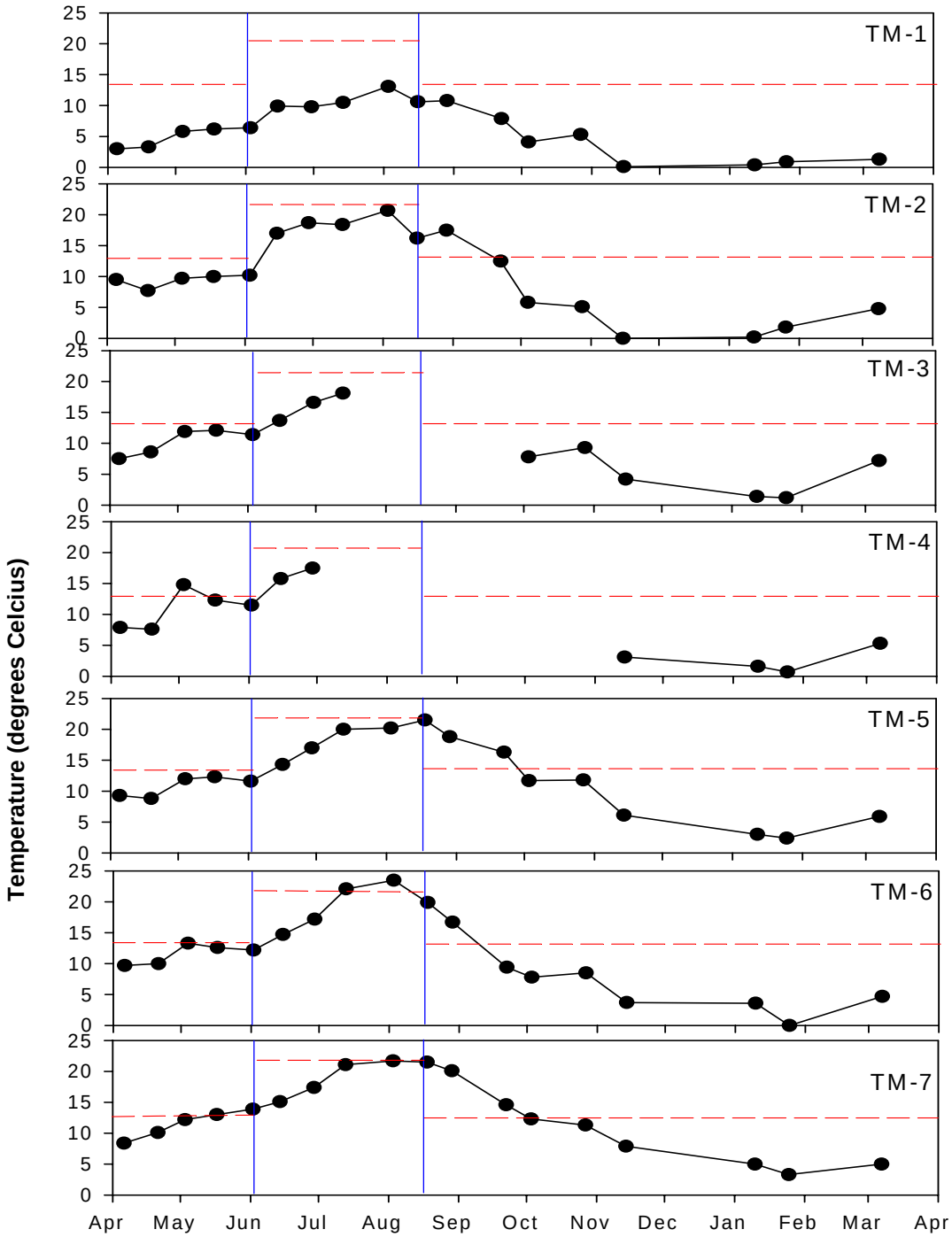
-amount of oxygen that can be dissolved in water.
-photosynthetic rate of algae and larger aquatic plants.
-metabolic rates of aquatic organisms.
-sensitivity of organisms to toxic wastes, parasites and diseases.

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 cold water aquatic life (CWAL) criteria of 19 ^{o}C daily average and 22 ^{o}C as a daily maximum apply to Threemile and Butcher Creeks year-round. In addition, more restrictive salmonid spawning criteria of 9 ^{o}C daily average and 13 ^{o}C daily maximum apply to both creeks from August 15th – June 1st, to account for the spawning and incubation periods for Spring/Summer Chinook (August 15- April 30) and

Steelhead/Rainbow Trout (February 1st – June 1st). The less restrictive 22 °C criterion applies from June 2nd – August 14th (DEQ, 2003, Tables 41 and 42).

Exceedances of the temperature criteria occurred at every site, except TM-1, which is near the headwaters of Three-Mile Creek. Figure 3 shows the instantaneous water temperature measurements for each site. The dashed red line represents the 13° C salmonid spawning temperature criteria or the 22° C CWAL criteria, as applicable.



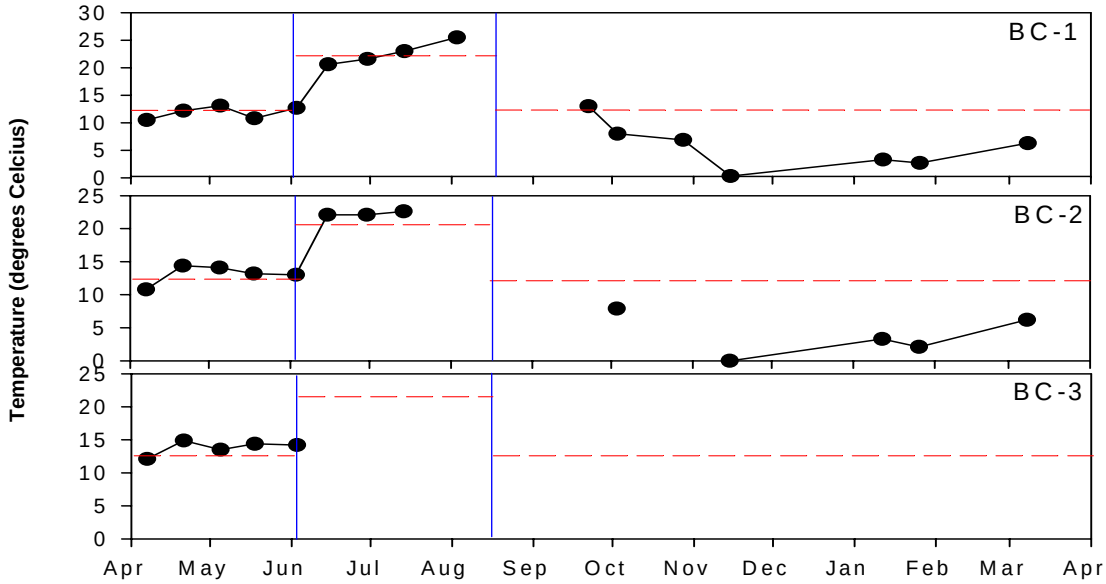


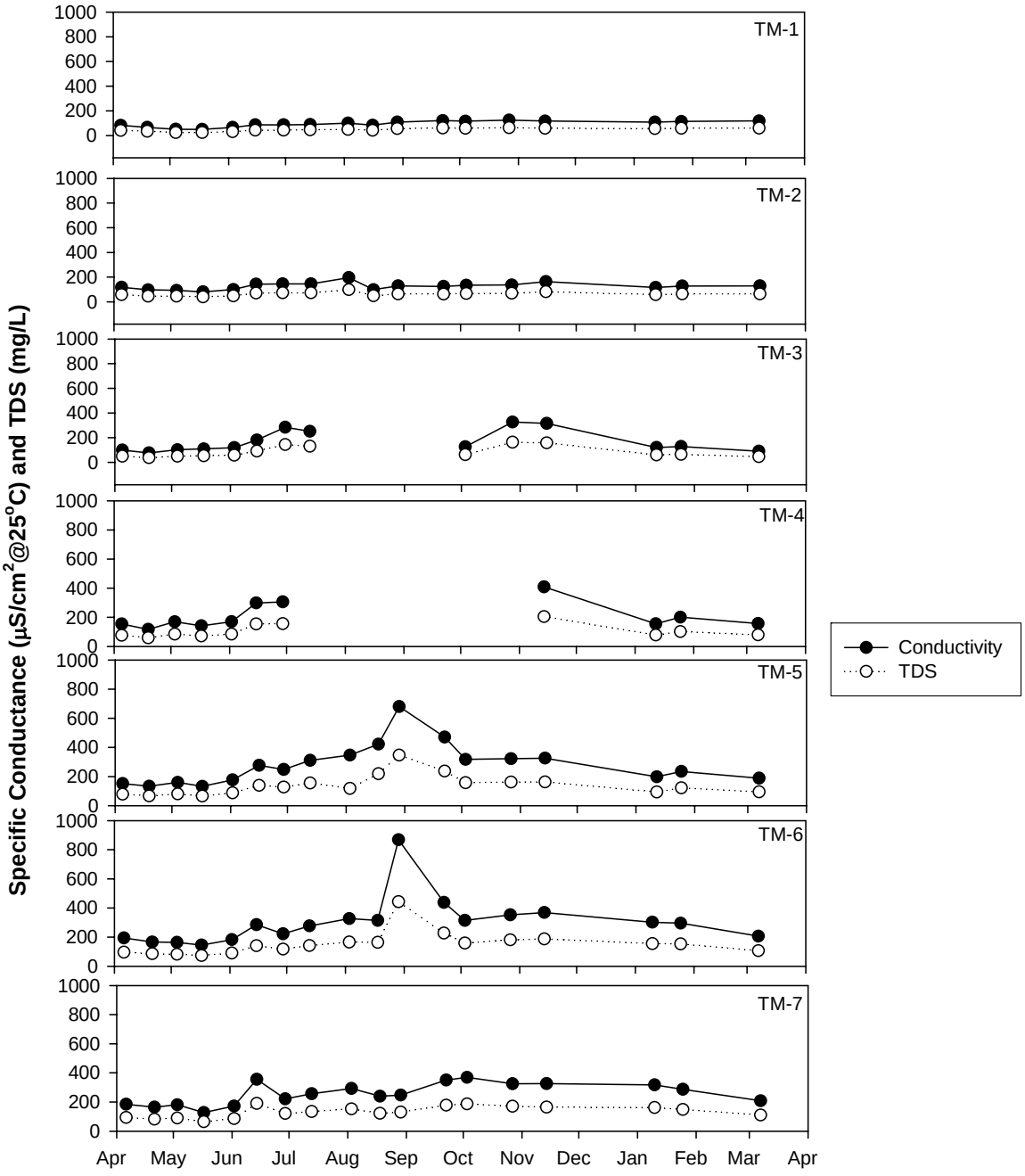
Figure 3. Instantaneous water temperature for Threemile and Butcher Creeks. The blue line delineates the period of the year deemed critical to salmonid spawning and incubation (August 15th – June 1st). The dashed red lines represent the 13° C and 22° C targets, as they apply.

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


Specific Conductance (µS/cm²@25°C) and TDS (mg/L)
TM-1
TM-2
TM-3
TM-4
TM-5
TM-6
TM-7
0
200
400
600
800
1000
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
Conductivity
TDS

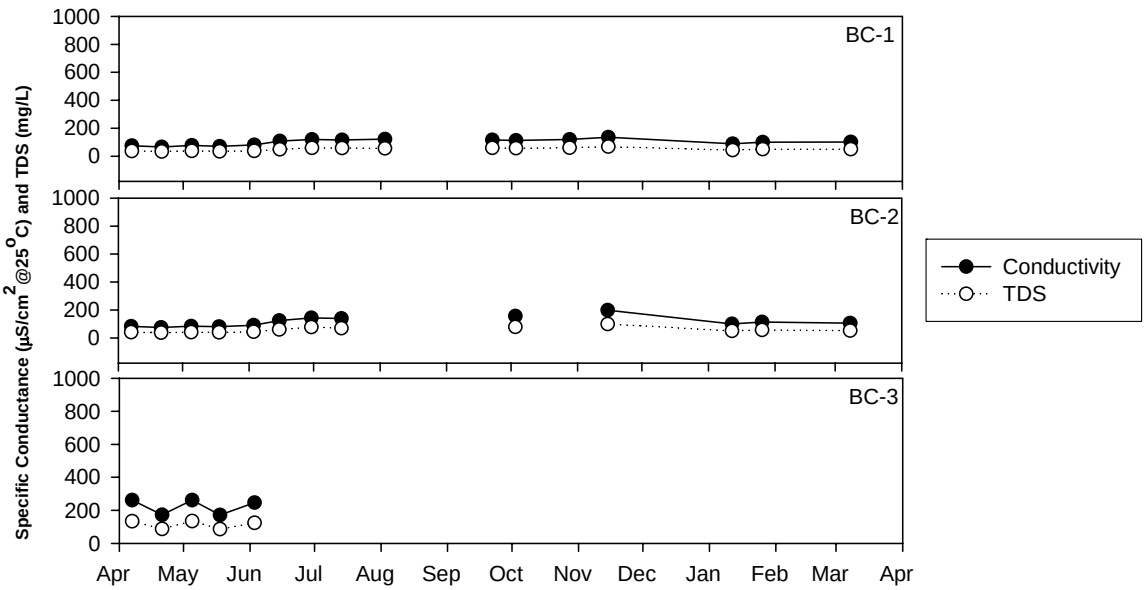


Figure 4. Specific Conductivity and Total Dissolved Solids levels for Three Mile and Butcher Creeks.

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 (IDAPA 58.01.02.250.01.a). No samples during this monitoring period were outside of this range.

Turbidity and Suspended Sediment Concentration

Suspended sediment concentration (SSC) includes both sediment and organic material suspended in water. Suspended sediment can cause problems for fish by clogging gills. In addition, excessive sediment provides a medium for the accumulation and transport of other constituents such as phosphorus and bacteria.

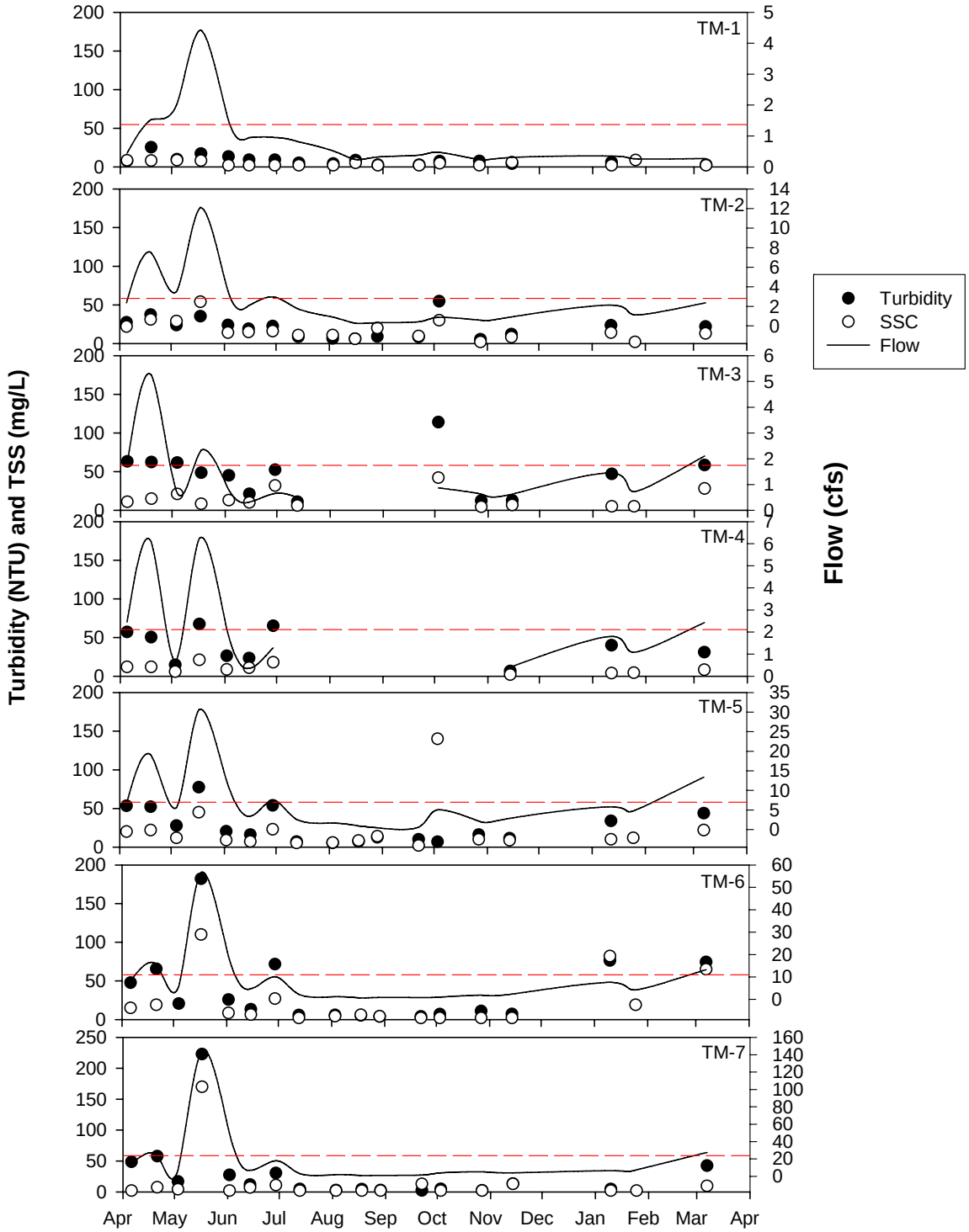
The sediment standard in Idaho is a narrative standard that states sediment shall not exceed, "…in the absence of specific sediment criteria, quantities which impair designated beneficial uses." The State of Idaho water quality standard for Turbidity states that measurements shall not exceed background 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), SSC concentration, and discharge is presented in Figure 5. In addition, simple correlation analysis was done to compare SSC and Turbidity. In general, there was no significant correlation between the two parameters in the upper Threemile Creek watershed. However, in the lower part of the watershed, TM-6 and TM-7 both had correlation coefficients greater than 0.90, indicating a strong correlation between SSC and turbidity at those sites. In the future, it may be possible to use turbidity as a surrogate for SSC at the mouth of Threemile Creek, in order to save both time and money.

SSC and turbidity appear to be associated with increases in stream flow during spring runoff. However, increases in SSC 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 for turbidity has not been identified by the DEQ for the Threemile/ Butcher Creeks watershed so, for the sake of this analysis, the average of all turbidity measurements taken at the upper monitoring site on Threemile Creek (TM-1) was used as the background value. The average turbidity at TM-1 was found to be 8.45 NTU and the dashed red line in Figure 5 represents the 58.45 NTU instantaneous threshold for turbidity being used in the examination of this data.

The average SSC level in the Threemile/Butcher Creeks watershed was 14.345 mg/L. Literature suggests that levels below 25 mg/L are ideal for the protection of fisheries and produce no harmful effects on fish or fisheries (DFO, 2000).


TM-1
TM-2
TM-3
TM-4
TM-5
TM-6
TM-7
Turbidity (NTU) and TSS (mg/L)
Flow (cfs)
Turbidity
SSC
Flow
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr

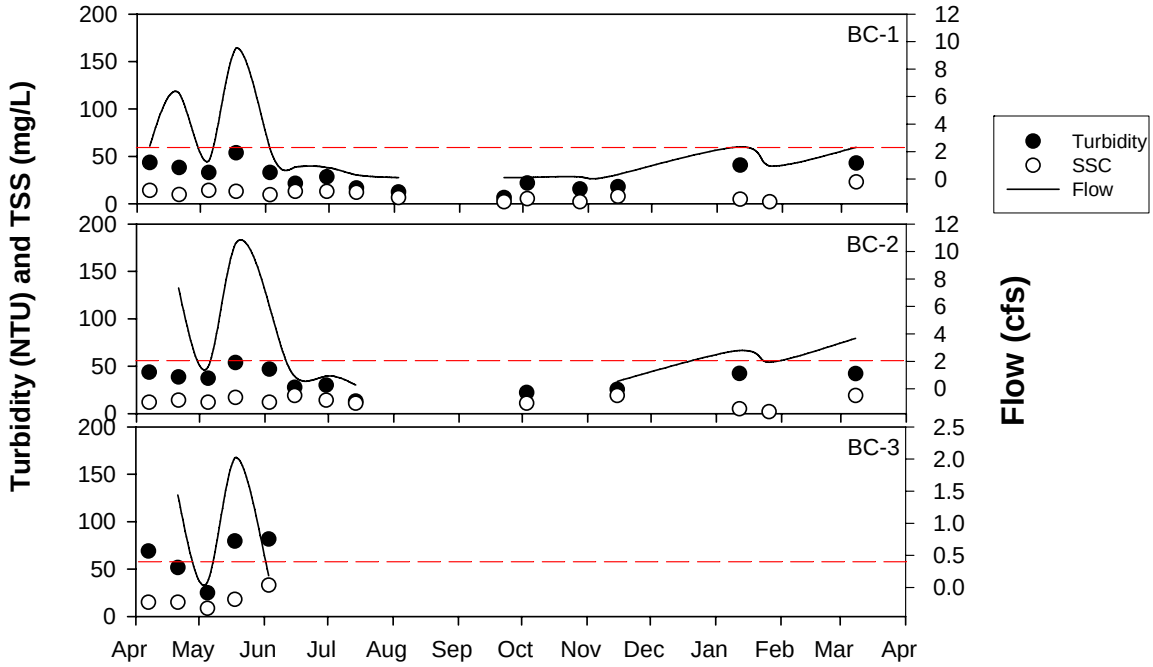


Figure 5. Turbidity, SSC and Discharge rates for Three Mile and Butcher Creeks.

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

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 concentrations can affect hatching and growth rates of fish; changes in tissues of gills, liver, and kidneys may occur during structural development.

NO_3+NO_2 and ammonia levels were relatively low in the upper portion of the Threemile Creek watershed, but increased dramatically at the monitoring site located below Grangeville's waste water treatment plant (WWTP). Median NO_3+NO_2 levels at TM-2, located near the southern edge of Grangeville, were 0.05 mg/L. Median NO_3+NO_2 levels at TM-5, located north of Grangeville and just downstream of the WWTP, were 3.2 mg/L. This is an increase of 6,300 percent in median concentrations, which is a statistically significant change in conditions (P = <0.001). Median NO_3+NO_2 levels remained quite high at TM-6, but were slightly lower at the mouth of Threemile Creek (TM-7).

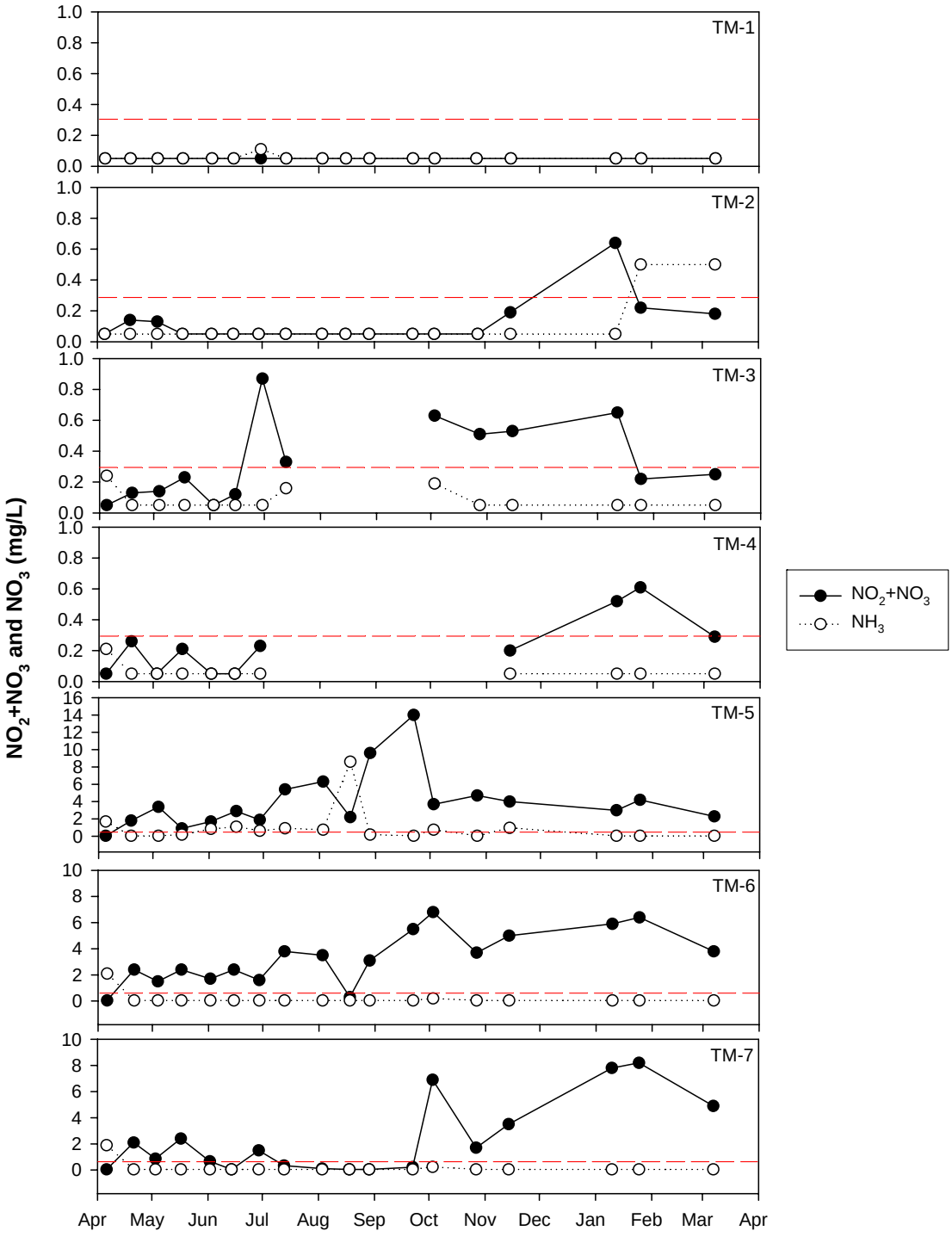
Exceedances of the 0.30 mg/L guidance criterion also occurred at sites BC-1 and BC-2, on the main stem of Butcher Creek, although the median levels were much lower than those observed in the lower reaches of Threemile Creek (0.05 mg/L for both sites). BC-3 had elevated NO_3+NO_2 levels as well, with the median being 1.80 mg/L. This site was located on a small tributary to Butcher Creek, directly below a small cattle operation, which was the likely cause of the elevated NO_3+NO_2 levels.

Ammonia levels were also elevated at sites TM-2, TM-5, TM-6, and TM-7, with the highest median concentration occurring at TM-5, located just downstream of the Grangeville WWTP. The maximum ammonia measurement was 8.6 mg/L and was also collected at TM-5. The State of Idaho's acute criterion for ammonia is dependent upon the pH of the water body, and the allowable level of ammonia is calculated using the following equation:

$$CMC = \frac{0.275}{1+10^{7.204-pH}} + \frac{39.0}{1+10^{pH-7.204}}$$

All ammonia data were evaluated using this equation, and no violations of the criterion were observed, although ammonia levels were quite high in several cases.

Figure 6 shows the levels of NO_3+NO_2 and ammonia, and the dashed red line indicates the 0.3 mg/L guidance criterion for NO_3+NO_2.


TM-1
TM-2
TM-3
TM-4
TM-5
TM-6
TM-7
NO_2+NO_3 and NO_3 (mg/L)
NO_2+NO_3
NH_3
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr

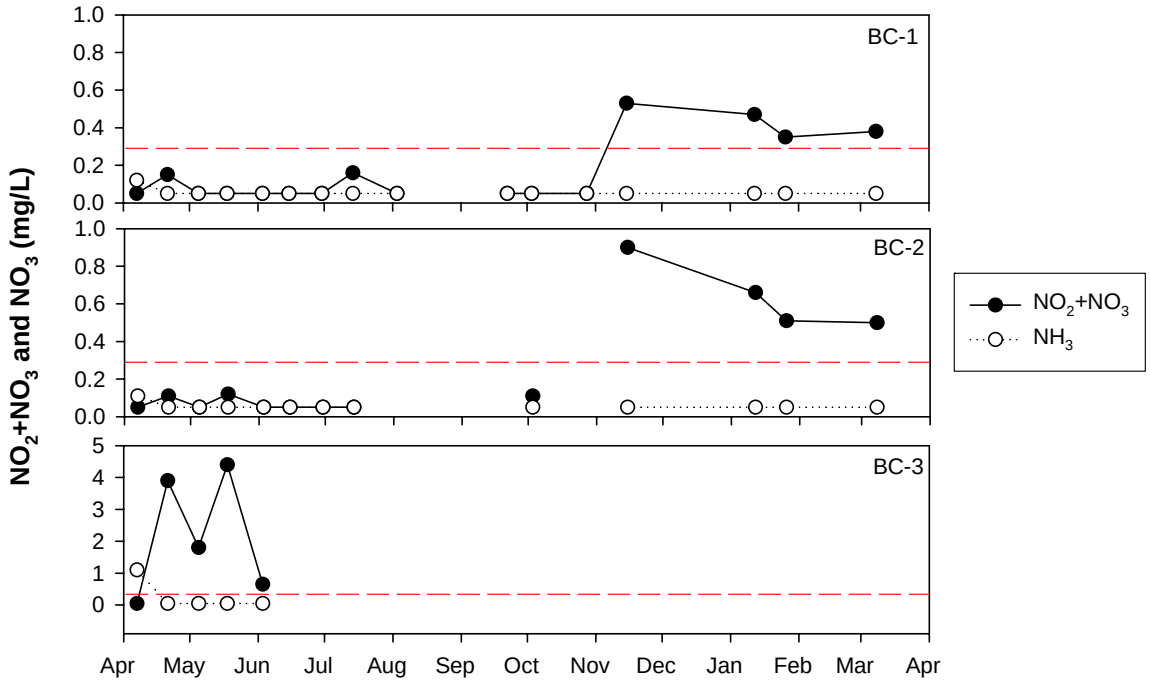


Figure 6. NO_2+NO_3 and NH_3 levels for Three Mile and Butcher Creeks, 2005-2006. The dashed red line indicates the 0.3 mg/L guidance criterion for NO_3+NO_2.

Phosphorus

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 Department of Environmental Quality (DEQ) has set a Total Phosphorus (TP) target of 0.08 mg/L for the segment of Threemile Creek upstream of the WWTP outfall. A TP target of 0.1 mg/L was selected for the segment beginning downstream of the WWTP and ending at the "Big Barn" site where the stream drops into the canyon. This target is based on the EPA "Goldbook" (1986) and reflects a slight increase from the upstream target due to natural enrichment anticipated with the change in soil type and the distance downstream from headwater areas. A TP target of 0.3 mg/L was selected for the mouth. Monitoring has demonstrated that the TP concentration at the mouth does not vary

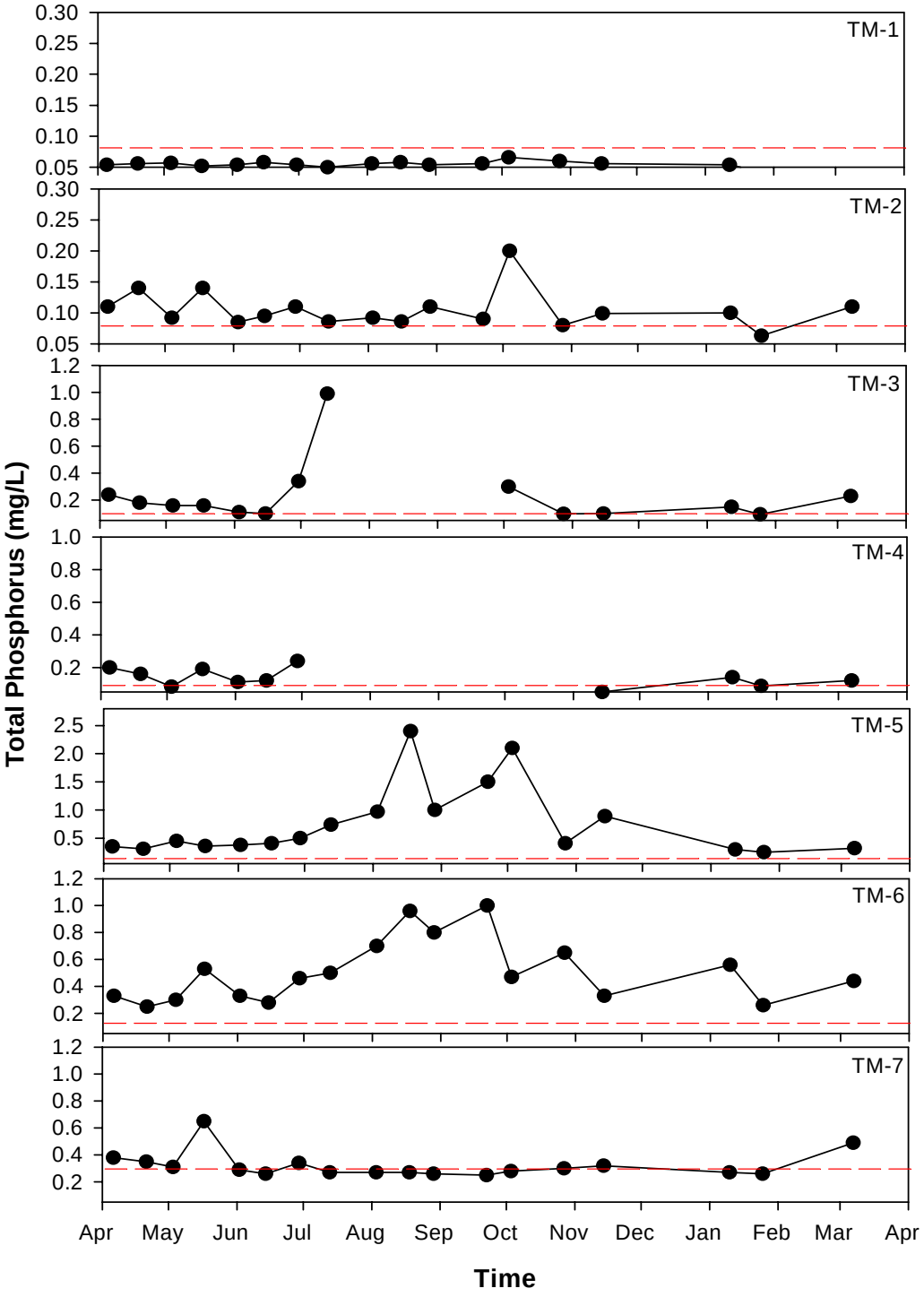
substantially with flow, seasons, or WWTP influence and is consistently near 0.3 mg/L. (DEQ, 2003). A TP target of 0.1 mg/L will be used for the sites on Butcher Creek.

The only site with no exceedances of the recommended criterion was located at the headwaters of Threemile Creek. TM-2, located just upstream of Grangeville, had a median concentration of 0.1 mg/L and exceeded the 0.08 mg/L target 38.9% of the time (n=18). All sites located in and below the City of Grangeville had very high levels of phosphorus present. Both sites TM-5 (below the WWTP) and TM-6 (directly above the canyon) exceeded the target criterion 100% of the time (n=18). TM-7, at the mouth of Threemile Creek, only exceeded the criteria 38.9% of the time, but that was due to the higher target of 0.3 mg/L set by the DEQ in the TMDL. When evaluated at the 0.1 mg/L target, TM-7 exceeded that number 100% of the time.

The average ratio of orthophosphorus to total phosphorus was 0.56 in Threemile Creek, indicating that a sizeable portion of the total phosphorus load is in soluble form and can be readily taken up by aquatic vegetation. This high level of phosphorus is potentially contributing to excessive growth of algae and other aquatic plants that can cause destruction of habitat and depletion of dissolved oxygen, which usually results in the disappearance of intolerant aquatic insect species and fish. OP to TP ratios increased as one moved downstream, with the highest average ratio being found at the mouth of Threemile Creek (0.91).

Phosphorus levels were also quite high throughout Butcher Creek, exceeding the 0.1 mg/L criterion an equal number of times at both the upstream and downstream monitoring points.

Figure 7 shows the levels of TP, and the dashed red line indicates the appropriate criterion for each site.


TM-1
TM-2
TM-3
TM-4
TM-5
TM-6
TM-7
Total Phosphorus (mg/L)
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
Time

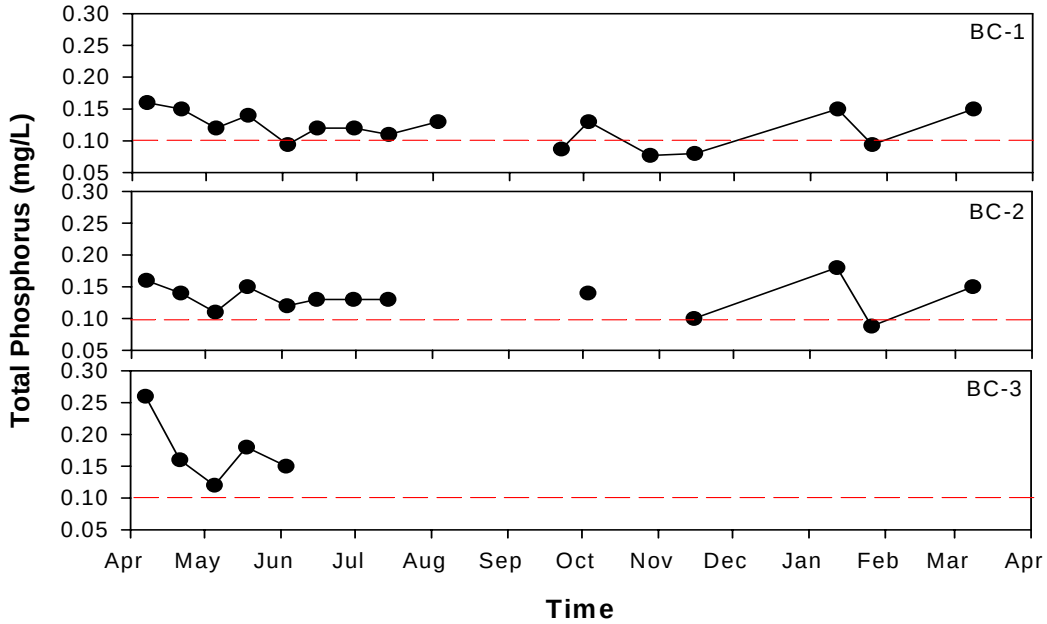


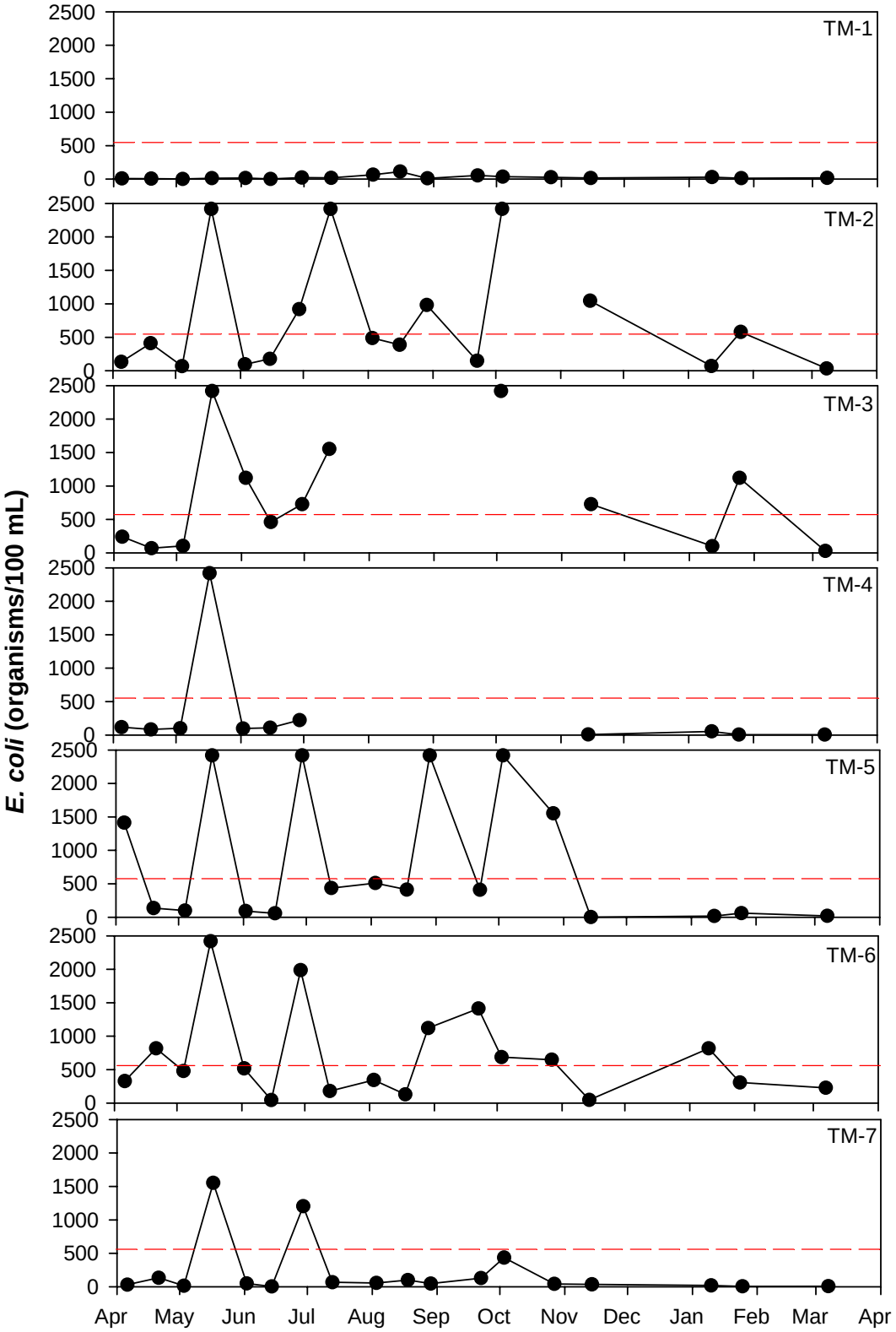
Figure 7. TP levels for Threemile and Butcher Creeks, 2005-2006.

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 *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 (IDAPA 58.01.02.251.02.a). Both Threemile and Butcher Creeks are listed for secondary contact recreation, so the dashed red line in Figure 8 indicates the 576 organism/100mL instantaneous criterion. A single exceedance over the criterion does not constitute a violation of water quality standards, however (IDAPA 58.01.02.080.03). Five samples must be taken within a 30-day period to assess against the geometric mean criterion of 126 cfu/100 ml to determine a violation. An assessment of the geometric mean criterion was not conducted during this study due to time considerations and limited resources. However, the instantaneous measurements will allow for identification of streams where follow up monitoring should occur.

With the exception of TM-1, located near the headwaters of Threemile Creek, every site exceeded the state criterion at least once during this monitoring project. TM-6 had the largest number of *E. coli* exceedances, with 44.4% of the samples being greater than the instantaneous allowable limit of 576 organisms/ 100mL.


E. coli (organisms/100 mL)
TM-1
TM-2
TM-3
TM-4
TM-5
TM-6
TM-7
2500
2000
1500
1000
500
0
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr

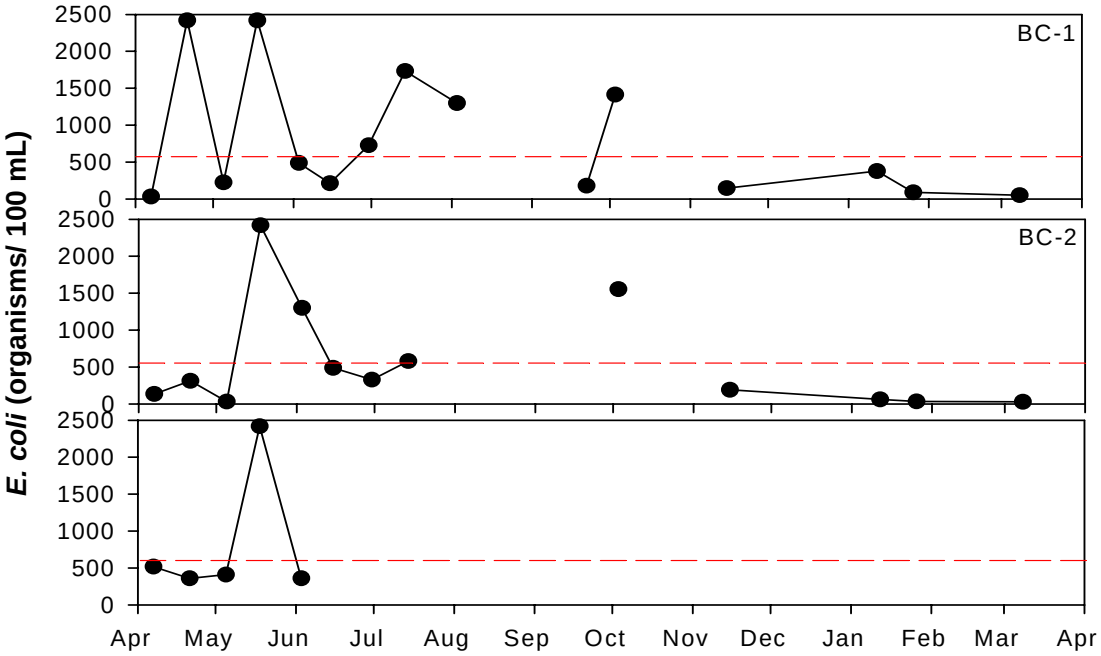


Figure 8. *E. coli* levels for Three Mile and Butcher Creeks, 2005-2006.

Conclusions

The monitoring program for Threemile Creek and Butcher Creek was completed as planned. Protocols were followed, QA/QC standards were met, and specific information per parameter for each watershed was collected. Data collected from this monitoring project will be used as baseline data to better ascertain the current condition of the watershed, to help define critical areas within the watershed for placement of agricultural BMPs, and to evaluate changes in water quality over time.

Excessive stream temperatures were observed throughout Threemile Creek and Butcher Creek. 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. Suitable temperatures are 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. Both Threemile Creek and Butcher Creek are designated for salmonid spawning and therefore have relatively stringent temperature requirements associated with them. With the exception of the headwaters of Threemile Creek (TM-1), every site exceeded the temperature criteria during the course of this study.

Excessive nutrient levels are a likely cause for the low dissolved oxygen (DO) concentration seen at some sites. DO levels that were lower than the State criterion of 6.0 mg/L occurred once at TM-3, which is a small tributary to Threemile located in Grangeville, and five times at TM-5, which is located on Threemile Creek, directly below the Grangeville WWTP. Lowering nutrient levels within the creek could help to ensure that DO levels remain adequate throughout the summer months.

E. coli bacteria were also found to be a significant pollutant in portions of the watershed. Livestock are found in varying concentrations throughout the drainage 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.

While a few exceedances of the sediment criterion occurred, it doesn't seem to be a major problem in the watershed, nor does there appear to be a strong relationship between TP loading and sediment.

Threemile Creek

The uppermost site on Threemile Creek, TM-1, had no exceedances of state water quality criteria, and could reasonably be considered to represent natural background conditions in the watershed. At site TM-2, which is just upstream of Grangeville, several exceedances of both the temperature and total phosphorus criteria were observed.

A dramatic change in nutrient levels was evident as one moved downstream, below the City of Grangeville and its waste water treatment plant. Median NO_2+NO_3 levels increased by 6,300% and median TP levels increased 240% in the section of stream located between TM-2 (upstream of Grangeville) and TM-5 (downstream of Grangeville). Stormwater runoff and effluent discharge from the WWTP seem the most likely cause of these sudden increases. Although there is no aquatic numeric standard in place, numbers above 0.30 mg/L can cause excessive plant growth and possible eutrophication, so this value was used as a target for this analysis. (Cline, 1973 & Golterman, 1975). Only one exceedance of the 0.30 mg/L guidance criteria was measured above the City of Grangeville, while 17 (94.4%) of the samples directly below the WWTP exceeded the target. These elevated nutrient levels, along with low flows, are the probable cause of the low dissolved oxygen levels seen at this site. These water quality issues must be addressed by the municipality itself and create a significant challenge to achieving adequate water quality in the lower reaches of Threemile Creek.

The State of Idaho Criterion Maximum Concentration (CMC) for total ammonia nitrogen was not exceeded during this study, but there were several extremely high ammonia measurements below the City of Grangeville during this study and visual observations indicated that aquatic invertebrate and fish populations were noticeably absent from the stream directly below the Grangeville WWTP.

TM-6 is the last site on the Camas Prairie, and was located directly above the canyon that guides the stream down to the South Fork Clearwater River. Both TP and NO_2+NO_3 levels remained quite high at this site, although levels dropped slightly from those seen at TM-5. Turbidity and sediment (SSC) levels were also quite a bit higher at this site than any upstream.

TM-7 is located near the mouth of Threemile Creek. Nutrient levels were also elevated at this site, as were turbidity and SSC.

Butcher Creek

Butcher Creek also had significant nutrient problems that were noticeable even at the uppermost monitoring site (BC-1). Directly above the site are a number of houses and small "hobby farms", some with small ponds. It seems likely that the elevated nutrient levels seen at this site are caused by a combination of septic system drainage networks and animal waste runoff. *E. coli* levels were also relatively high at this site, giving further support to the hypothesis that animal waste and septic leachate are sources that contribute significantly to the water quality problems observed at this location.

Both TP and NO_2+NO_3 levels in Butcher Creek increase as one moves downstream. The middle section of Butcher Creek is actively grazed by both cattle and horses, and their impact on riparian vegetation and streambank stability is noticeable. Due to the lack of landowner cooperation, a monitoring site at the mouth of Butcher Creek was not established. Therefore, an assessment of water quality at the mouth and an estimated contribution of pollutant loading to the SF CWR could not be conducted. Efforts to establish a monitoring site at the mouth for future projects should be a priority.

Recommendations

Threemile Creek

The portion of Threemile Creek above the city of Grangeville has some water quality concerns, although not as pronounced as the rest of the stream. Conditions could likely be improved with some relatively simple management strategies. Cattle have open access to Threemile Creek in the reach directly upstream of Grangeville. Streambank stability and vegetative communities have been adversely affected by these livestock. Cattle exclusion and riparian plantings in this reach would likely help to lower both nutrient levels and water temperatures.

Land use practices downstream of Grangeville consist primarily of dryland agriculture and cattle grazing. Farming, grazing and other land use practices have reduced the density of riparian plant communities along the stream between TM-5 and TM-6. Re-establishing healthy and diverse herbaceous and woody plant communities of various

sizes and ages will create the structure needed to trap sediment, provide bank stability, and uptake some of the excess nutrients. Fencing cattle away from the creek would also help in riparian plant establishment and remove a direct source of nutrient loading.

While it will be very challenging to improve water quality in Threemile Creek without first addressing the influence of Grangeville's infrastructure, installing best management practices (BMPs) in areas impacted by agriculture will certainly help to improve the quality of the water that empties into the South Fork Clearwater River.

Butcher Creek

Livestock exclusion and the development of offsite watering facilities, in conjunction with riparian planting and restoration, is the best strategy for improving water quality in this watershed. Inspection and maintenance of septic systems in the upper watershed may also prove to be beneficial.

Based on the results of this monitoring project, stream inventory, and prioritization efforts, stakeholders should fund, devise, and construct high quality stream improvements designed to promote water quality enhancement.

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Mississippi State University. 1998. Information Sheet 1390.

Acronyms and Abbreviations

BLM	Bureau of Land Management
BMPs	Best Management Practices
C	Celcius
cfs	Cubic feet per second
cm	centimeter(s)
CWA	Clean Water Act
CWAL	Cold Water Aquatic Life
DEQ	Idaho Department of Environmental Quality
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
GIS	Geographical Information Systems
HUC	Hydrologic Unit Code
IASCD	Idaho Association of Soil Conservation Districts
ISDA	Idaho State Department of Agriculture
mg/L	milligrams per liter
NH_3	Ammonium
NO_2+NO_3	Nitrate-Nitrite
NRCS	Natural Resource Conservation Service
OP	Ortho Phosphorus
QA/QC	Quality assurance/quality control
SCC	Soil Conservation Commission
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSS	Total Suspended Solids
USFS	United States Forest Service
UIASL	University of Idaho Analytical Science Laboratory
WAG	Watershed Advisory Group

Glossary

§303(d)	Refers to section 303 subsection "d" of the Clean Water Act. 303(d) requires states to develop a list of waterbodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to U.S. Environmental Protection Agency approval.
Bedload	Material (generally sand-sized or larger sediment) that is carried along the streambed by rolling or bouncing.
Beneficial Use	Any of the various uses of water, including, but not limited to, aquatic biota, recreation, water supply, wildlife habitat, and aesthetics, which are recognized in water quality standards.
Best Management Practices (BMPs)	Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.
Catchment	Land area that contributes runoff (drains) to a given point in a stream or river. Synonymous with watershed and drainage or river basin.
Censored Data	Sample observations for which the complete distribution is not known. Censored data often appear in laboratory reports when the concentration being analyzed is lower than the detection limit or higher than the allowable range for a particular type of laboratory equipment or procedure.

Conductivity	The ability of an aqueous solution to carry electric current, expressed in micro (μ) mhos/cm at 25 °C. Conductivity is affected by dissolved solids and is used as an indirect measure of total dissolved solids in a water sample.
Criteria	In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. EPA develops criteria guidance; states establish criteria.
Cubic Feet per Second	A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, one cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day.
Discharge	The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).
Dissolved Oxygen	The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.
E. coli	Short for *Escherichia Coli*, *E. coli* are a group of bacteria that are a subspecies of coliform bacteria. Most *E. coli* are essential to the healthy life of all warm-blooded animals, including humans. Their presence is often indicative of fecal contamination.

Exceedance	A violation of the pollutant levels permitted by water quality criteria.
Mean	Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people.
Median	The middle number in a sequence of numbers. If there are an even number of numbers, the median is the average of the two middle numbers. For example, 4 is the median of 1, 2, 4, 14, 16; and 6 is the median of 1, 2, 5, 7, 9, 11.
Nonpoint Source	A dispersed source of pollutants, generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and non-irrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.
Nutrient	Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth.
pH	The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very alkaline (pH=14). A pH of 7 is neutral.

	Surface waters usually measure between pH 6 and 9.
Point Source	A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable "point" of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.
Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Riffle	A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness.
Sediments	Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.
Subbasin	A smaller watershed area delineated within a larger watershed, often for purposes of describing and managing localized conditions.
Surface Runoff	Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants in rivers, streams, and lakes. Surface runoff is also called overland flow.

Suspended Sediments	Fine material (usually sand size or smaller) that remains suspended by turbulence in the water column until deposited in areas of weaker current. These sediments cause turbidity and, when deposited, reduce living space within streambed gravels and can cover fish eggs or alevins.
Thalweg	The center of a stream's current, where most of the water flows.
Total Suspended Solids (TSS)	A measure of the suspended organic and inorganic solids in water. Measured in mg/L or ppm.
Tributary	A stream feeding into a larger stream or lake.
Turbidity	A measure of the extent to which light passing through water is scattered by fine suspended materials. The effect of turbidity depends on the size of the particles (the finer the particles, the greater the effect per unit weight) and the color of the particles.
Water Quality Limited	A label that describes waterbodies for which one or more water quality criterion is not met or beneficial uses are not fully supported. Water quality limited segments may or may not be on a §303(d) list.
Water Quality Standards	State-adopted and EPA-approved ambient standards for waterbodies. The standards prescribe the use of the waterbody and establish the water quality criteria that must be met to protect designated uses.

Watershed	1) All the land which contributes runoff to a common point in a drainage network, or to a lake outlet. Watersheds are infinitely nested, and any large watershed is composed of smaller "subwatersheds." 2) The whole geographic region which contributes water to a point of interest in a waterbody.