Potlatch River Monitoring Report
2006-2008

Developed for:

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

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Technical Results Summary KPC-PR-08

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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

Introduction

The Idaho Association of Soil Conservation Districts (IASCD) collected water quality data from the Potlatch River and several of its tributaries from April 2006 through March 2008. This monitoring project was initiated to evaluate water quality in the Potlatch River watershed.

This report reviews monitoring results for the following parameters:

- -Total Phosphorus (TP)
- -Orthophosphorus (OP)
- -Bacteria (*Escherichia coli)*
- -Nitrogen Components—NO_2+NO_3, NH_3
- -Suspended Sediment Concentration (SSC)
- -Instantaneous Water Temperature
- -Turbidity
- -Dissolved Oxygen (DO)
- -Percent (%) Saturation
- -Total Dissolved Solids (TDS)
- -Specific Conductance

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.

Potlatch River Subbasin

The Potlatch River subbasin is part of the 4th field hydrologic unit code (HUC) # 17060306. The Potlatch River is approximately 56 miles long, and drains roughly 380,400 acres in Latah County, Clearwater County and Nez Perce County, Idaho. The upper Potlatch River is divided into two distinct forks, the East Fork and West Fork. The East Fork's headwaters are found in the northwest corner of Clearwater County, and the stream flows southwest to its confluence with the West Fork just north of Bovill, Idaho. The West Fork's headwaters begin in the northeast corner of Latah County and the stream flows southeast to its confluence with the East Fork.

Elevations in the subbasin range from approximately 5,000 feet at the headwaters to approximately 800 feet at the confluence with the Clearwater River. Land uses consist of non irrigated cropland (38%), pastureland (<1%), rangeland (4%), forestland (57%), and urban areas (<1%). Bovill, Troy, Deary, Kendrick and Juliaetta are the primary communities found within the watershed, and have a combined population of approximately 2,500 people.

Major tributaries to the Potlatch River include Little Potlatch Creek, Middle Potlatch Creek, Big Bear Creek, Pine Creek, Cedar Creek, Corral Creek, and the East and West Forks of the Potlatch River.

Climate

Climate in the Potlatch River basin is characterized by cool, moist winters and warm dry summers. Air temperatures in the basin typically decrease as elevation increases.

Average annual precipitation ranges from 15-20 inches in lower elevations to 50-60 inches in the higher elevations found near the headwaters. Over 85% of the annual precipitation occurs during late fall, winter and spring.

Fisheries

An extensive fisheries survey conducted by the Idaho Fish and Game (IDFG) in the Potlatch River watershed documented the following species (Shriever & Nelson, 1999):

- Rainbow Trout
- Steelhead Trout
- Coho Salmon
- Cutthroat Trout
- Brook Trout
- Rainbow/Cutthroat Trout Hybrid
- Largemouth Bass
- Bluegill and Pumpkinseed Sunfish
- Dace
- Sculpin
- Redside Shiner
- Bullhead
- Sucker
- Chiselmouth Chub
- Northern Pike Minnow

Table 1. General spawning and incubation periods for salmonids found in the Potlatch River and its tributaries.

	Spawning and Incubation Periods in the Potlatch River Watershed											
Salmonid Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Steelhead/Rainbow Trout		✓	✓	✓	✓							
Cutthroat Trout				✓	✓	✓						
Brook Trout									✓	✓	✓	
Coho Salmon										✓	✓	✓

Background

Water quality monitoring was previously conducted by the Idaho Department of Environmental Quality (IDEQ) from December, 2001 to October, 2002 on the main stem Potlatch River, West Fork Potlatch River, East Fork Potlatch River, Moose Creek, Big Bear Creek, West Fork Little Bear Creek, Boulder Creek, Cedar Creek, Corral Creek, Middle Potlatch Creek, Pine Creek, and Ruby Creek. This IASCD monitoring project revisited many of those same sites and, when possible, comparative analysis of these two data sets was performed.

The Potlatch River Total Maximum Daily Load (TMDL) was approved in September of 2008 by the Environmental Protection Agency (EPA). The Potlatch River Watershed Advisory Group (WAG) and supporting agencies will now work to create a TMDL implementation plan. This plan will provide the framework necessary to implement best management practices (BMPs) aimed at improving water quality through practices such as riparian restoration, bank stabilization, animal waste systems, grassed waterways, conservation cropping and tillage practices, and livestock exclusion.

Table 2 lists the pollutants of concern for specific stream segments found in section five of DEQ’s 2008 Integrated Report. The West Fork of Little Bear Creek, Hog Meadow Creek, and Little Boulder Creek were also monitored during this project, but are not listed in the Integrated Report.

Table 2. 2008 Integrated Report, Section 5 Waters

STREAM NAME	SEGMENT	POLLUTANTS
Potlatch River	Big Bear Cr. to Clearwater R.	SED, TEMP
Potlatch River	Moose Cr. to Big Bear Cr.	TEMP
Potlatch River	Headwaters to Moose Cr.	TEMP, BAC
Big Bear Creek	Headwaters to Mouth.	BAC, TEMP
Boulder Creek	Pig Cr. to Potlatch R.	BAC, TEMP
Cedar Creek	Leopold Cr. to Potlatch R.	SED, TEMP
Corral Creek	Headwaters to Potlatch R.	TEMP
Middle Potlatch Creek	Headwaters to Potlatch R.	BAC, SED, TEMP
Pine Creek	Headwaters to Potlatch R.	BAC, NUT, O/G, DO, SED, TEMP, NH3

BAC = Bacteria, DO = Dissolved Oxygen, NH3 = Ammonia, NUT = Nutrients, O/G = Oil and Grease, ORG = Organics, PST = Pesticides, SED = Sediment, TEMP = Temperature, * = Biological impairment, but no specific pollutant has been identified.

Targets

- Although there is no numeric standard in place for NO_2+NO_3, some literature claims that numbers above 0.30 mg/L could cause excessive plant growth and possible eutrophication (Cline, 1973 & Golterman, 1975). For the analysis in this report, 0.30 mg/L was used as the water quality target.

- The Environmental Protection Agency (EPA) developed a national guideline of 0.1 mg/L total phosphorus (TP) for streams (EPA 1986). It was also the target used by IDEQ in the Potlatch River TMDL. This target was also used in the evaluation of this data.

- Literature suggests that suspended sediment concentration (SSC) levels below 25 mg/L are ideal for the protection of fisheries and at this level there are no harmful effects on fish or fisheries (DFO, 2000).

- The Idaho Administrative Procedures Act (IDAPA), section 58.01.02.250, contains the Surface Water Quality Criteria for Aquatic Life Use. Criteria for dissolved oxygen (DO), total ammonia nitrogen (TAN), temperature, bacteria and pH are found there and were used in the evaluation of this data.

Table 3 lists the targets that were used in the evaluation of this data.

Table 3. Pollutant targets used to measure exceedances.

Pollutant of Concern	Pollutant Targets
Temperature	13 ^{o}C instantaneous; 9 ^{o}C daily average during Salmonid spawning period (September-June). 22 ^{o}C instantaneous; 19 ^{o}C daily average in July and August.
Total Phosphorus	0.1 mg/L
Suspended Sediment Concentration	25 mg/L
NO_2+NO_3	0.3 mg/L
Dissolved Oxygen	6.0 mg/L
pH	6.5 - 9.0
Bacteria	406 *E.coli* organisms/100 mL for primary contact recreation; 576 *E.coli* organisms/100 mL for secondary contact recreation.

Monitoring Site Descriptions

These sites are shown on the map in Figure 1.

POT-1 Mouth of Potlatch River (near confluence with Clearwater River)

POT-2 Middle Potlatch Creek (at mouth)

POT-3 Big Bear Creek (at mouth)

POT-4 Pine Creek (near mouth)

POT-5 Cedar Creek (at mouth)

POT-6 Boulder Creek (at the Linden road crossing, upstream from mouth)

POT-7 Little Boulder Creek (near mouth, at Little Boulder Creek campground)

POT-8 Potlatch River (at Little Boulder Creek campground)

POT-9 Hog Meadow Creek (near mouth, at Little Boulder Creek campground)

POT-10 West Fork Potlatch River (above Feather Creek)

POT-11 Potlatch River (below highway 9 bridge, near Bovill)

POT-12 Corral Creek (below highway 9 bridge, near Helmer)

POT-13 Big Bear Creek (above highway 9, at road below confluence of WF Bear Creek and Big Bear Creek)

POT-14 Big Bear Creek (below highway 9, near forest/ canyon boundary)

POT-15 West Fork Little Bear Creek (above City of Troy and old dam)

POT-16	West Fork Little Bear Creek (below City of Troy WWTP)
POT-17	Middle Potlatch Creek (on Spence Road, near forest/canyon boundary)

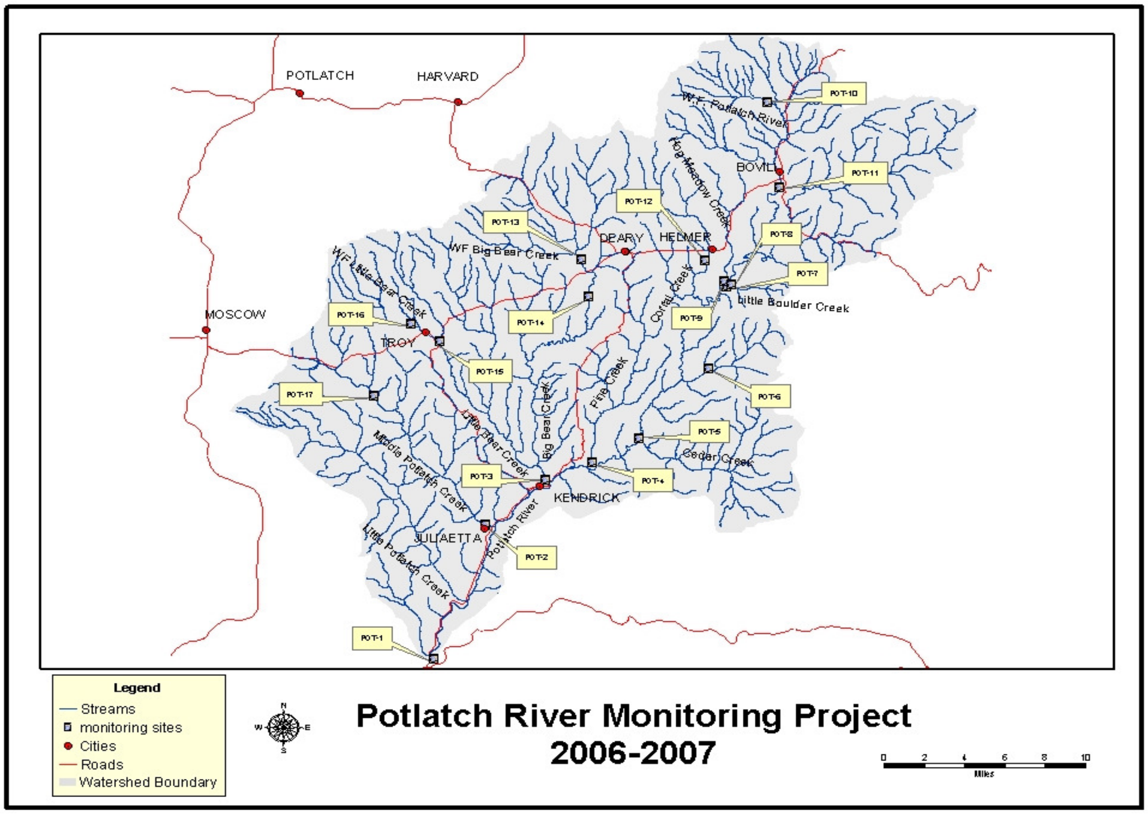


Figure 1. Potlatch River watershed and IASCD monitoring sites.

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). A number of streams in this study are listed as water quality limited in Idaho's 2008 Integrated §303(d)/ §305(b) 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, NH_3, 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 4. 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 4. Water Quality Parameters

Parameters	Sample Size	Preservation	Holding Time	Method
Suspended Sediment Concentration (SSC)	1L	Cool 4°C	7 Days	ASTM 3977-97
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 5.

Table 5. 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^{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 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.

Data Analysis

Analysis of the data was done, and descriptive statistics such as maximum, minimum, median, and mean values for each parameter measured were determined. These descriptive statistics are presented per subwatershed.

Box plots were used, when warranted, to graphically illustrate the differences between the 2002 and 2008 data sets. Box plots graph data as a box representing statistical values. The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers above and below the box indicate the 90th and 10th percentiles. Outlying points are also shown in most of the graphs.

Results and Discussion

Pollutants of Concern and Applicable Criterion/Standards

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.

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 following:

-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 for Idaho streams states that water temperatures must be twenty-two degrees Celsius or less with a maximum daily average of no greater than nineteen degrees Celsius. All of the waterbodies monitored during this project are also listed for Salmonid Spawning (SS), which means that water temperatures must be13 ^{o}C or less with a maximum daily average no greater than 9 ^{o}C during salmonid spawning and incubation periods.

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 the ability of water to 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 surface water standards or criteria exist that set limits on SC or TDS.

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 Hydrogen Ion Concentration (pH) values must fall within the range of 6.5 and 9.0 (IDAPA 58.01.02.250.01.a).

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. 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).

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." (DEQ IDAPA 58.01.02). 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.

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.

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.

Phosphorus sources exist in both inorganic and organic forms. Some important sources of TP include commercial fertilizers and manure, land application of biosolids, wastewater treatment plants (WWTP), livestock grazing, non-agricultural fertilization, and septic systems. Over time, excess phosphorus input causes a phosphorus surplus, which accumulates in soil and is mobilized when erosion occurs.

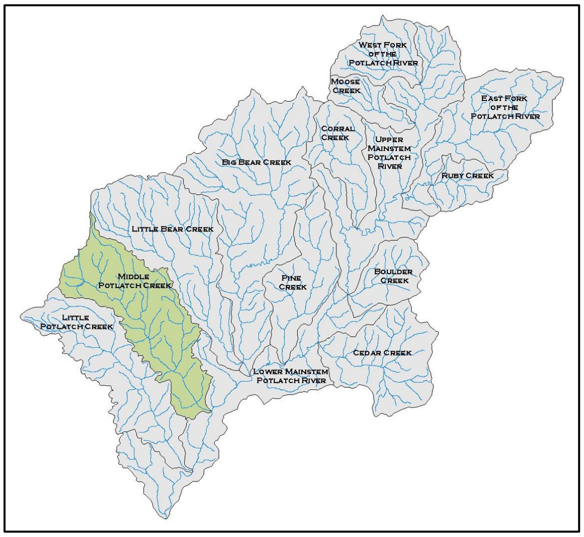
Bacteria (*E. coli*)

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); however, a single exceedance over the criterion does not constitute a violation of water quality standards (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 that were collected will allow for identification of streams where follow up monitoring should occur.

Subwatershed Analysis

Middle Potlatch Creek (POT-2 and POT-17)



Middle Potlatch Creek originates approximately six miles southeast of Moscow, Idaho, on the eastern slope of Tomer Butte, and travels in a southeasterly direction toward Juliaetta, where it discharges into the Potlatch River. This creek is 18.5 miles long, and drains approximately 35,300 acres in the lower portions of the Potlatch River watershed.

A natural falls located at stream mile 8.0 acts as a migration barrier to anadromous fish (Johnson 1985). According to IDEQ, Middle Potlatch Creek is not supporting its beneficial uses, and is listed for sediment, temperature, and bacteria in Section 5 of the 2008 Integrated Report (IDEQ 2009).

Two monitoring stations were established on this creek, one near the mouth (POT-2) and one near the headwaters (POT-17). Data shows that nutrient levels are elevated, and exceedances of the temperature standards for spring salmonid spawning and summer cold water aquatic life are occurring. Elevated bacteria levels were also observed at the lower site.

Table 6 presents descriptive statistics for the MF Potlatch Creek mouth site (POT-2) and Table 7 presents descriptive statistics for the MF Potlatch Creek headwaters site (POT-17).

Table 6. Descriptive statistics for Middle Potlatch Creek monitoring site POT-2 (mouth), 2008.

POT-2	D.O.	Temp	pH	Turbidity	NO_2 +NO_3	NH_3	OP	TP	SSC	*E-coli*	Flow
	(mg/L)	(°C)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)	(cfs)
Maximum	14.66	22.20	9.16	40.20	12	0.11	0.19	0.24	24.00	1413.60	45.06
Minimum	6.90	0.50	7.40	3.79	0.21	0.05	0.07	0.089	2.00	4.10	0.09
Mean	10.16	11.29	8.18	15.15	2.1	0.05	0.11	0.148	8.05	185.17	9.12
Median	10.25	10.70	8.21	11.30	0.6	0.05	0.11	0.14	5.20	48.30	1.78
# exceedance	0.0	10.0	0.0		26	0	14	23	0.0	3.00	
% exceedance	0.0%	37.0%	0.0%		96.3%	0.0%	51.9%	85.2%	0.0%	12.5%	
# sampling events	26.0	27.0	24.0	26.0	27	27	27	27	27.0	24.00	

Table 7. Descriptive statistics for Middle Potlatch Creek monitoring site POT-17 (headwaters), 2008.

POT-17	D.O.	Temp	pH	Turbidity	$NO_2 + NO_3$	NH_3	OP	TP	SSC	*E-coli*	Flow
	(mg/L)	(°C)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)	(cfs)
Maximum	13.52	16.40	8.59	63.50	10	0.16	0.2	0.23	18.00	325.50	23.8
Minimum	8.36	0.00	7.30	2.70	0.05	0.05	0	0.037	2.00	8.60	0.59
Mean	11.48	7.78	7.95	24.03	2.81	0.06	0.08	0.113	7.28	98.32	8.01
Median	11.51	8.45	7.89	17.40	1.85	0.05	0.07	0.1	6.00	44.20	5.29
# exceedance	0.0	3.0	0.0		8	0	3	6	0.0	0.00	
% exceedance	0.0%	25.0%	0.0%		66.7%	0.0%	25.0%	50.0%	0.0%	0.0%	
# sampling events	12.0	12.0	10.0	11.0	12.0	12.0	12.0	12.0	12.0	6.0	

A statistical comparison of the data collected at monitoring stations POT-2 and POT-17, in 2002 and 2008, was conducted to identify any observable trends or changes in water quality at these sites. Table 8 contains some descriptive statistics for each data set at POT-2. Table 9 contains descriptive statistics for the data collected at POT-17.

Table 8. Middle Potlatch Creek data comparison at mouth (POT-2), 2002 and 2008.

Parameters	**Median**		**Minimum**		**Maximum**	
	2002	**2008**	**2002**	**2008**	**2002**	**2008**
pH	8.0	8.2	7.4	7.4	9.2	9.2
TP (mg/L)	0.14	0.14	0.09	0.09	0.24	0.24
E. coli (cfu/ 100mL)	2400.0	48.3	500.0	4.1	2400.0	1413.6
SSC (mg/L)	6.00	5.2	2.00	2.00	18.0	24.0
Turbidity (NTU)	17.4	11.30	2.7	3.79	63.5	40.2
NO_2+NO_3 (mg/L)	1.85	0.6	0.05	0.21	10.0	12.0
Temperature (°C)	9.0	10.7	0.3	0.5	22.1	22.2
Flow (cfs)	2.3	1.8	0.38	0.09	189.9	45.1

Most of the data collected during these two years were quite similar, with the differences in median levels being well within the range of normal variability. However, a statistically significant decrease of 98% in median *E. Coli* levels was noted at the mouth of Middle Potlatch Creek, from 2002 to 2008. There was also a 67.6% decrease in median levels of NO2+NO3 from 2002 to 2008, although levels were still elevated above the target criterion. The cause of these decreases is unknown at this time, but a decrease in livestock adjacent to the stream was noticed in 2008, and seems a likely reason for this reduction in nutrient and bacteria levels.

Table 9. Upper Middle Potlatch Creek data comparison (POT-17), 2002 and 2008.

Parameters	Median		Minimum		Maximum	
	2002	2008	2002	2008	2002	2008
pH	7.6	7.9	7.0	7.3	9.2	8.6
TP (mg/L)	0.1	0.1	0.05	0.04	0.44	0.23
E. coli (cfu/ 100mL)	28.5	44.2	0	8.6	370.0	325.5
SSC (mg/L)	6.5	6.0	2.0	2.0	160.0	18.0
Turbidity (NTU)	7.7	17.4	1.8	2.7	143.0	63.5
NO_2+NO_3 (mg/L)	1.35	1.85	0.05	.05	8.1	10.0
Temperature (°C)	8.95	8.45	0.1	0.0	21.0	16.4
Flow (cfs)	7.2	5.3	0.02	0.59	32.01	23.80

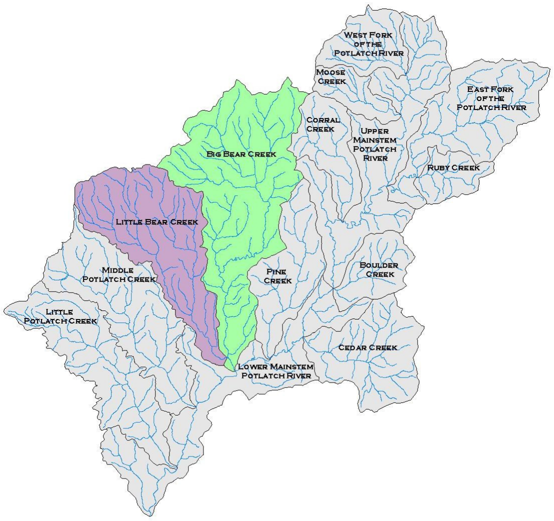
The data sets from 2002 and 2008 were very similar at POT-17 as well. A statistically significant difference in median values was not observed for any of the parameters measured during these two years.

2008 Middle Fork Potlatch Creek Summary:

- Nutrients are the main pollutant in this watershed, with TP exceeding the 0.1 mg/L target over 50% of the time at both monitoring sites, and nitrogen exceeding the 0.3 mg/L target 96.3% of the time at the mouth of the creek.
- DO levels met State of Idaho water quality criterion at both sites.
- A number of temperature exceedances were observed, with the instantaneous criterion being exceeded 37% of the time at the mouth (n=27).
- Sediment levels were within an optimal range.
- *E. coli* levels at POT-2 exceed the State of Idaho criterion for secondary contact recreation (576 cfu/ 100mL) 12.5% of the time, although levels have decreased from 2002 to 2008.

Bear Creek System:

Big Bear Creek (POT-3, POT-13 and POT-14)



Big Bear Creek is the largest subwatershed within the Potlatch River watershed, draining approximately 61,000 acres. It is approximately 21.7 miles long and originates roughly 6.2 miles northwest of Deary, Idaho. It travels in a southerly direction, before entering the Potlatch River near the town of Kendrick. According to IDEQ, Big Bear Creek is not supporting its beneficial uses, and is listed for temperature and bacteria in Section 5 of the 2008 Integrated Report (IDEQ 2009).

Three monitoring stations were established on Big Bear Creek, one near the mouth (POT-3), one below highway 9 near the forest/canyon boundary in upper Big Bear Creek (POT-14), and one above highway 9 just below the confluence of Big Bear Creek and the West Fork Big Bear Creek (POT-13).

A study by Bowersox et al, in 2005, found that some of the “highest overall fish densities present in electrofishing sites were found in large canyon streams such as the West Fork of Little Bear Creek, Little Bear Creek, Big Bear Creek, and Cedar Creek”. It should be noted that a fish migration barrier is located at stream km 9.0 of Big Bear Creek, so species composition was quite different above the barrier than below, with a much lower density of rainbow/steelhead trout being present above the barrier.

Tables 10, 11 and 12 present descriptive statistics for Big Bear Creek sites POT-13, POT-14 and POT-3, respectively.

Table 10. Descriptive statistics for Big Bear Creek monitoring site POT-13 (confluence of Big Bear and WF Big Bear), 2008.

POT-13	D.O.	Temp	pH	Turbidity	NO_2 +NO_3	NH_3	OP	TP	SSC	*E-coli*	Flow
	(mg/L)	(°C)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)	(cfs)
Maximum	13.29	24.10	8.97	43.70	0.43	0.05	0.04	0.11	12.00	1413.60	100.19
Minimum	4.58	0.00	6.59	5.44	0.05	0.05	0	0.036	2.00	14.50	0.11
Mean	9.77	9.98	7.41	17.66	0.11	0.05	0.02	0.066	4.34	257.96	16.57
Median	10.05	9.25	7.39	13.45	0.05	0.05	0.02	0.063	2.00	135.40	2.83
# exceedance	3.0	9.0	0.0		4	0	0	1	0.0	2.00	
% exceedance	11.5%	34.6%	0.0%		15.4%	0.0%	0.0%	3.8%	0.0%	10.0%	
# sampling events	26.0	26.0	22.0	26.0	26.0	26.0	26.0	26.0	25.0	20.0	

Table 11. Descriptive statistics for Big Bear Creek monitoring site POT-14 (forest/canyon boundary), 2008.

POT-14	D.O.	Temp	pH	Turbidity	NO_2 +NO_3	NH_3	OP	TP	SSC	*E-coli*	Flow
	(mg/L)	(°C)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)	(cfs)
Maximum	14.87	30.40	10.18	37.90	0.59	0.35	0.05	0.094	12.00	275.50	129.44
Minimum	7.60	0.00	6.95	4.85	0.05	0.05	0.01	0.037	2.00	12.10	0.12
Mean	11.28	12.95	8.32	14.43	0.1	0.06	0.02	0.063	5.01	78.04	16.38
Median	11.28	12.30	8.41	11.50	0.05	0.05	0.02	0.062	4.70	30.70	2.43
# exceedance	0.0	12.0	1.0		1	0	0	0	0.0	0.00	
% exceedance	0.0%	44.4%	4.3%		3.8%	0.0%	0.0%	0.0%	0.0%	0.0%	
# sampling events	27.0	27.0	23.0	27.0	26.0	26.0	26.0	26.0	26.0	22.0	

Table 12. Descriptive statistics for Big Bear Creek monitoring site POT-3 (mouth), 2008.

POT-3	D.O.	Temp	pH	Turbidity	NO_2 +NO_3	NH_3	OP	TP	SSC	*E-coli*	Flow
	(mg/L)	(°C)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)	(cfs)
Maximum	14.70	25.80	9.85	41.60	3.8	0.05	0.07	0.18	6.20	365.40	228.3
Minimum	8.30	1.40	7.32	2.47	0.05	0.05	0.02	0.045	2.00	1.00	0.14
Mean	10.50	14.42	8.58	9.63	0.5	0.05	0.05	0.076	2.50	57.40	27.08
Median	10.30	15.00	8.65	4.96	0.05	0.05	0.05	0.072	2.00	29.80	4.29
# exceedance	0.0	18.0	5.0		7	0	0	3	0.0	0.00	
% exceedance	0.0%	60.0%	17.9%		22.6%	0.0%	0.0%	9.7%	0.0%	0.0%	
# sampling events	30.0	30.0	28.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	

2008 Bear Creek Data Summary:

- Three DO violations (n=26) occurred at POT-13. Two occurred in late July, both in 2006 and 2007, while one occurred in September, 2006. At very low flows in the late summer/early fall, a large pool forms directly above this site due to channel constriction. In this warm, mostly stagnant water, oxygen levels are quickly depleted when bacteria consumes oxygen as organic matter decays. DO level rebounded lower in the watershed, however, and no violations were noted at the other two monitoring stations.
- pH levels were higher than the State of Idaho criterion five consecutive times (n=28) at the mouth, from July-September of 2007. No relationship between these high pH values and any of the other measured parameters could be shown; the cause of these elevated readings is unknown at this time.
- Turbidity and sediment levels were consistent throughout the Bear Creek drainage and were within an optimal range for aquatic life.
- While excessive nutrient loads do not appear to be a major problem in the watershed, three exceedances of the 0.1 mg/L TP target were documented at site POT-3 (n=31) and one exceedance was documented at POT-13 (n=26).
- The biggest problem in this catchment is water temperature. As one would expect, thermal loading increased from the upper site to the lower site, with 60% of the measurements at POT-3 exceeding the instantaneous temperature criteria.

Table 13. Bear Creek (mouth) data comparison (POT-3), 2002 and 2008.

Parameters	Median		Minimum		Maximum	
	2002	2008	2002	2008	2002	2008
pH	7.6	8.6	7.0	7.3	9.2	9.9
TP (mg/L)	0.07	0.07	0.02	0.05	0.23	0.18
E. coli (cfu/ 100mL)	23.0	31.8	0.5	0.5	580.0	365.4
SSC (mg/L)	2.0	2.0	2.0	2.0	50.0	6.2
Turbidity (NTU)	3.6	5.0	1.85	2.47	40.7	41.6
NO_2+NO_3 (mg/L)	0.05	0.05	0.05	0.05	4.4	3.8
Temperature (°C)	10.9	15.0	0.0	1.4	24.0	25.8
Flow (cfs)	19.0	5.3	0.6	0.1	260.0	247.8

All measured parameters were quite similar during both sampling periods, with the difference between mean and median values during the two periods being statistically insignificant.

West Fork of Little Bear Creek (POT-16)

The Little Bear Creek subwatershed drains approximately 39,745 acres. It's confluence with Big Bear Creek is located roughly one mile above the mouth of Big Bear Creek. The West Fork Little Bear Creek is approximately 11.8 miles long, originating roughly five miles northwest of Troy, Idaho. The stream flows southeast, through the town of Troy and down a narrow canyon, before entering Little Bear Creek.

In the Bowersox et al study, the West Fork of Little Bear Creek had the highest rainbow/steelhead trout density of all sampled streams in the Potlatch River watershed, with a mean density of 13.2 fish/100 m^2 (2005).

Two monitoring stations were established on the West Fork of Little Bear Creek. The upper site was located upstream of the City of Troy, just above an old dam that acts as a fish migration barrier (POT-15). The lower site was located below the City of Troy and its waste water treatment plant, in the WF Little Bear canyon (POT-16).

Although the West Fork of Little Bear Creek is not currently listed on the 303(d) list for being water quality impaired, the IDEQ concluded from their monitoring efforts in 2002 that the stream is in fact water quality limited due to high levels of nitrate measured below the City of Troy WWTP. A TMDL was developed by IDEQ for total inorganic nitrogen (TIN) in this stream. Data collected in 2008 affirmed that water quality standards for nutrients are being exceeded in the West Fork of Little Bear, as are temperature standards for spring salmonid spawning and summer cold water aquatic life, and bacteria at the lower site.

Tables 14 and 15 present descriptive statistics for the West Fork Big Bear Creek sites POT-15 and POT-16, respectively.

Table 14. Descriptive statistics for West Fork Little Bear Creek monitoring site POT-15 (above City of Troy and old dam), 2008.

POT-15	D.O.	Temp	pH	Turbidity	$NO_2 + NO_3$	NH_3	OP	TP	SSC	*E-coli*	Flow
	(mg/L)	(°C)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)	(cfs)
Maximum	14.02	18.60	7.54	48.40	0.23	0.05	0.05	0.11	24.00	104.30	28.66
Minimum	8.07	0.10	6.75	6.99	0.05	0.05	0.02	0.061	2.00	5.20	0.14
Mean	10.36	9.54	7.22	17.05	0.08	0.05	0.03	0.079	5.28	52.27	7.51
Median	10.28	10.60	7.21	14.80	0.05	0.05	0.03	0.077	2.00	45.35	2.52
# exceedance	0.0	5.0	0.0		0	0	0	1	0.0	0.00	
% exceedance	0.0%	35.7%	0.0%		0.0%	0.0%	0.0%	7.1%	0.0%	0.0%	
# sampling events	14.0	14.0	11.0	13.0	14.0	14.0	14.0	14.0	14.0	12.0	

Table 15. Descriptive statistics for West Fork Little Bear Creek monitoring site POT-16 (below City of Troy WWTP), 2008.

POT-16	D.O.	Temp	pH	Turbidity	$NO_2 + NO_3$	NH_3	OP	TP	SSC	*E-coli*	Flow
	(mg/L)	(°C)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)	(cfs)
Maximum	13.95	23.30	8.05	38.60	19	14	3.6	3.9	30.00	1986.30	66.79
Minimum	2.32	0.60	6.84	5.88	0.05	0.05	0.04	0.08	2.00	2.00	0.13
Mean	7.26	12.78	7.32	16.77	5.2	3.08	1.19	1.514	8.34	172.13	8.19
Median	6.72	13.95	7.30	15.20	1.9	0.69	0.43	0.51	7.20	33.65	1.82
# exceedance	14.0	16.0	0.0		22	0	20	26	1.0	2.00	
% exceedance	46.7%	53.3%	0.0%		75.9%	0.0%	69.0%	89.7%	3.4%	7.7%	
# sampling events	30.0	30.0	27.0	29.0	29.0	29.0	29.0	29.0	29.0	26.0	

D.O. violations were not observed at the upper site (POT-15). It should be noted that this stream segment went dry in mid-June during both monitoring years, before high water temperatures and low flow conditions would likely influence D.O. levels. Fourteen D.O. violations were observed at POT-16 during the summer months (n=30). A strong correlation between nutrient and DO levels indicates that nutrients and high temperatures are likely causes for the low DO numbers. A graphic comparison between data sets from POT-15 and POT-16 is shown in Figure 3.

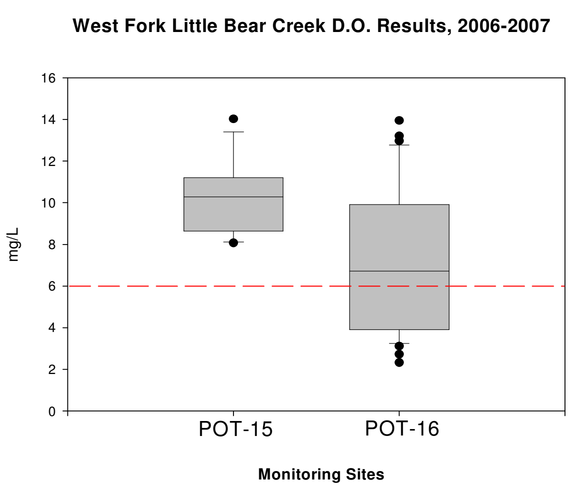


Figure 2. Comparison of WF Little Bear Creek dissolved oxygen data. The dashed red line indicates the applicable 6.0 mg/L criterion.

The annual mean ratio of total inorganic nitrogen (TIN) to orthophosphate (OP) in the West Fork of Little Bear was 6.7:1. TIN to OP ratios less than 7.0 are indicative of a nitrogen-limited system. Every other stream sampled during this project was found to be a phosphorus-limited system. One likely source of this nitrogen loading is the City of Troy WWTP, located a short distance upstream from this monitoring site.

Phosphorus levels were also quite high during the summer baseflow conditions; with close to 90% of the samples taken exceeding the TP target of 0.1 mg/L. Excessive aquatic vegetation was common in the stream.

2008 West Fork Little Bear Creek Data Summary:

- Turbidity and sediment levels were fairly consistent in the West Fork of Little Bear Creek and, aside from a single SSC reading of 30.0 mg/L, were within an optimal range for aquatic life.
- While excessive nutrient loads do not appear to be a problem in the upper watershed, it is the primary issue below the City of Troy WWTP, with 89.7% of the samples exceeding the 0.1 mg/L TP target (n=29), and 75.9% of the samples exceeding the 0.3 mg/L NO_2+NO_3 target (n=29) at site POT-16.
- No DO exceedances (n=14) occurred at the upper site, POT-15. Fourteen exceedances (n=30) were documented at site POT-16, located below the City of Troy WWTP. Elevated nutrient levels and high stream temperatures seem the most likely cause for the low DO levels at site POT-16.
- A number of temperature exceedances were observed, with the instantaneous criterion being exceeded over 50% of the time at POT-16 (n=30).

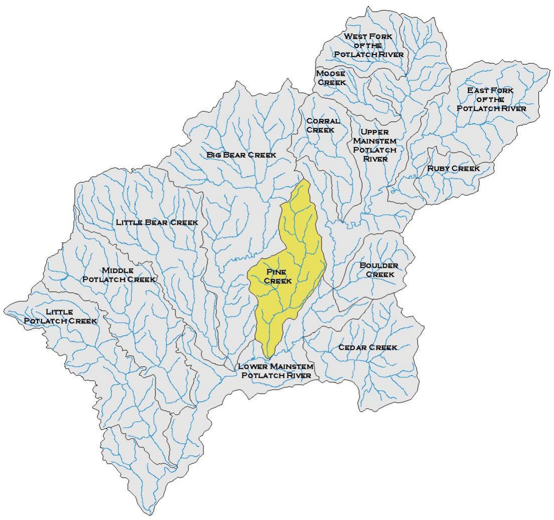
A comparison of the data collected at monitoring site POT-16, in 2002 and 2008, was conducted to identify any observable trends or changes in water quality at the site. Table 16 contains some descriptive statistics for each data set.

Table 16. West Fork of Little Bear Creek data comparison (POT-16), 2002 and 2008

Parameters	**Median**		**Minimum**		**Maximum**	
	2002	**2008**	**2002**	**2008**	**2002**	**2008**
DO (mg/L)	10.3	6.7	5.04	2.32	20.0	14.0
pH	7.5	7.3	6.7	6.8	8.1	8.0
TP (mg/L)	0.23	0.51	0.07	0.08	3.8	3.9
E. coli (cfu/ 100mL)	32.3	33.7	0.00	2.00	2400.0	1986.3
SSC (mg/L)	11.5	7.2	2.0	2.0	140.0	30.0
Turbidity (NTU)	11.6	15.2	3.11	5.88	203.0	38.6
NO_2+NO_3 (mg/L)	1.04	1.9	0.05	0.05	19.0	19.0
NH_3 (mg/L)	0.08	0.83	0.05	0.05	3.8	14.0
Temperature (°C)	6.65	13.95	0.1	0.6	22.8	23.3
Flow (cfs)	1.00	1.82	0.03	0.13	50.74	66.79

The median DO level decreased 35% from 2002 to 2008, and there was a statistically significant difference in mean DO levels as well. Median NO_2+NO_3 levels were 83% higher in 2008 than in 2002; median TP levels were 122% higher in 2008 than in 2002; and there was a statistically significant change in median ammonia levels, with a 938% increase in median levels from 2002 to 2008.

Pine Creek (POT-4)



The Pine Creek subwatershed drains approximately 20,600 acres. Pine Creek is approximately 14.2 miles long, originating near Deary, Idaho, and flowing south, with the upper reaches flowing through open prairie and the mid and lower reaches flowing primarily through canyon land.

According to IDEQ, Pine Creek is not supporting its beneficial uses, and is listed for sediment, temperature, and nutrients in Section 5 of the 2008 Integrated Report (IDEQ 2009).

One monitoring station was established on Pine Creek, near its confluence with the Potlatch River (POT-4).

Table 17 presents descriptive statistics for Pine Creek site POT-4.

Table 17. Descriptive statistics for Pine Creek monitoring site POT-4. (near mouth), 2008.

POT-4	D.O.	Temp	pH	Turbidity	NO_2 +NO_3	NH_3	OP	TP	SSC	*E-coli*	Flow
	(mg/L)	(°C)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)	(cfs)
Maximum	13.09	19.80	8.44	43.20	4.7	0.2	0.08	0.17	5.20	135.40	48.73
Minimum	6.28	2.40	7.15	3.52	0.05	0.05	0.04	0.069	2.00	1.00	0.09
Mean	9.50	10.38	7.58	14.37	0.99	0.06	0.06	0.103	2.52	30.13	10.74
Median	9.26	12.05	7.52	11.25	0.34	0.05	0.06	0.097	2.00	16.00	3.17
# exceedance	0.0	8.0	0.0		10	0	0	8	0.0	0.00	
% exceedance	0.0%	40.0%	0.0%		50.0%	0.0%	0.0%	40.0%	0.0%	0.0%	
# sampling events	20.0	20.0	17.0	20.0	20.0	20.0	20.0	20.0	20.0	16.0	

Nitrogen levels exceeded the target criterion 50% of the time (n=20), and total phosphorus levels also exceeded the 0.1 mg/L target 40% of the time (N=20). Temperature levels also exceeded State of Idaho criteria 40% of the time during this study (n=20). It should be noted that flow in this stream was too minimal from late June to early September, in both sampling years, to collect unbiased samples. Therefore, monitoring was suspended during this time period. Large, mostly stagnant pools remained throughout the watershed, however, and provided refugia for populations of fish throughout the summer months.

Figures 4, 5, and 6 show NO_2+NO_3, TP and instantaneous temperature measurements, respectively.

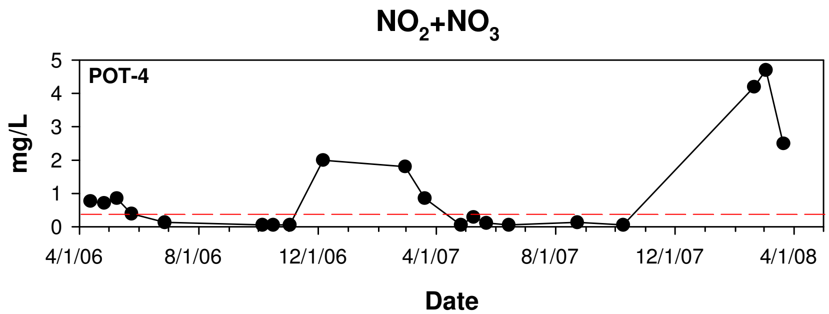


Figure 3. NO_2+NO_3 levels for Pine Creek (POT-4), 2006-2008. The dashed red line indicates the applicable 0.3 mg/L target criterion.

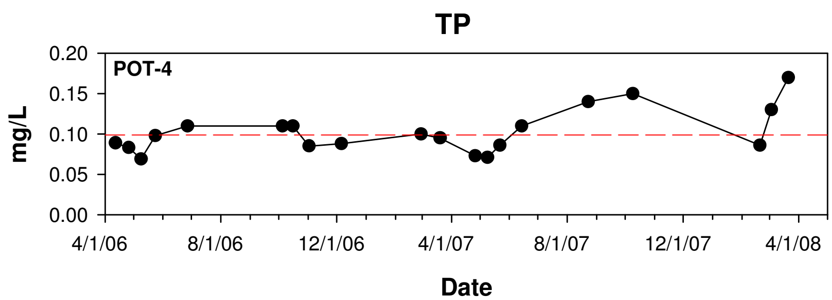


Figure 4. TP levels for Pine Creek (POT-4), 2006-2008. The dashed red line indicates the applicable 0.1 mg/L criterion.

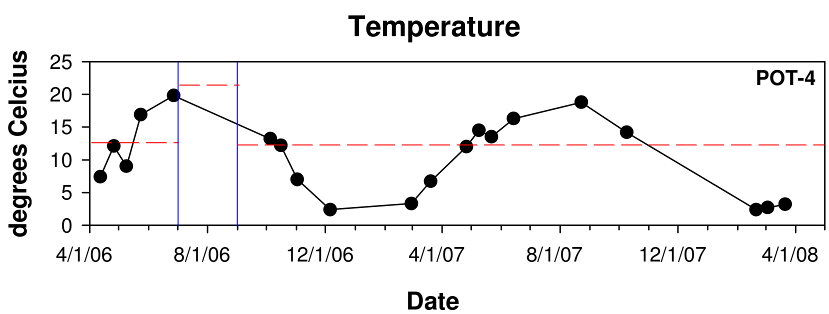


Figure 5. Instantaneous temperature readings for Pine Creek (POT-4), 2006-2008. The blue line delineates the period of the year deemed critical to salmonid spawning and incubation (September 1st – June 1^{st}). The dashed red lines represent the 13^{o} C and 22^{o} C targets, as they apply.

2008 Pine Creek Data Summary:

- Turbidity and sediment levels were very low in Pine Creek, and were well within an optimal range for aquatic life.
- Excessive nutrient loads were documented in Pine Creek, with nitrogen levels exceeding the 0.3 mg/L target criterion 50% of the time (n=20), and total phosphorus levels exceeding the 0.1 mg/L target 40% of the time (N=20).
- No violations of the 6.0 mg/L DO criterion was observed in Pine Creek (n=20), although during the summer months, when monitoring was suspended due to lack of flow, many of the remaining pools had DO levels below 6.0 mg/L.

- A number of temperature exceedances were observed, with the instantaneous criterion being exceeded 40% of the time (n=20).

A comparison of the data collected at monitoring site POT-4, in 2002 and 2008, was conducted to identify any observable trends or changes in water quality at the site. Table 18 contains some descriptive statistics for each data set.

Table 18. Pine Creek data comparison (POT-4), 2002 and 2008

Parameters	Median		Minimum		Maximum	
	2002	**2008**	**2002**	**2008**	**2002**	**2008**
DO (mg/L)	9.2	9.5	5.5	6.3	20.0	13.1
pH	7.6	7.5	7.0	7.15	8.9	8.4
TP (mg/L)	0.11	0.10	0.05	0.07	0.21	0.17
E. coli (cfu/ 100mL)	15.0	16.0	0.00	0.50	870.0	135.0
SSC (mg/L)	2.0	2.0	2.0	2.0	26.0	5.2
Turbidity (NTU)	3.8	11.3	2.2	3.5	46.6	43.2
NO_2+NO_3 (mg/L)	0.14	0.34	0.05	0.05	4.3	4.7
Temperature (°C)	11.2	12.1	0.19	2.4	21.0	19.8
Flow (cfs)	1.7	3.2	0.02	0.09	148.2	48.7

All measured parameters were quite similar during both sampling periods, with the difference between mean and median values during the two periods being statistically insignificant.

Cedar Creek (POT-5)

The Cedar Creek subwatershed drains approximately 25,200 acres. Cedar Creek is roughly 9.6 miles long, originating approximately four miles northeast of Southwick, Idaho, on the northern slope of Teakean Butte. It travels westward, through the forested hills and grasslands north and east of the community of Southwick.

According to IDEQ (2008), aquatic life beneficial uses are not being fully supported in Cedar Creek.

Cedar Creek from Leopold Creek to its mouth is listed for sediment and temperature.

Both Cedar Creek and Little Boulder Creek had the highest rainbow/steelhead trout densities outside of the Little Bear Creek drainage with 8.0 and 4.7 fish/100m^2 respectively. When rainbow/steelhead trout densities were separated into age classes, age-1 rainbow/steelhead trout densities were highest in Cedar Creek (Bowersox et al. 2005).

One monitoring station was established on Cedar Creek, near its confluence with the Potlatch River (POT-5).

Table 19 presents descriptive statistics for Cedar Creek site POT-5.

Table 19. Descriptive statistics for Cedar Creek monitoring site POT-5 (near mouth), 2008.

POT-5	D.O.	Temp	pH	Turbidity	NO_2+NO_3	NH_3	OP	TP	SSC	*E-coli*	Flow
	(mg/L)	(°C)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)	(cfs)
Maximum	13.53	23.90	9.84	1000.00	5.5	0.12	0.08	1.6	970.00	1119.90	233.02
Minimum	8.31	0.10	6.97	3.24	0.05	0.05	0.02	0.037	2.00	1.00	0.33
Mean	10.50	11.95	8.35	48.05	0.92	0.05	0.04	0.128	36.94	81.65	15.97
Median	10.17	10.70	8.47	8.02	0.05	0.05	0.04	0.077	2.00	32.70	1.87
# exceedance	0.0	13.0	1.0		11	0	0	4	2.0	1.00	
% exceedance	0.0%	41.9%	3.6%		35.5%	0.0%	0.0%	12.9%	6.5%	3.8%	
# sampling events	31.0	31.0	28.0	31.0	31.0	31.0	31.0	31.0	31.0	26.0	

Nitrogen levels exceeded the 0.3 mg/L target criterion 35.5% of the time (n=31), and total phosphorus levels also exceeded the 0.1 mg/L target 12.9% of the time (N=31). Temperature levels exceeded State of Idaho criteria 41.9% of the time during this study (n=31). There was a major rain event in May of 2006, which caused widespread erosion in the upper reaches of the watershed, and subsequent deposition of sediment into the Potlatch River. The precipitation lasted for several days and the Potlatch River below Cedar Creek was noticeably turbid for approximately a week. This one week event was the cause of the extremely elevated sediment, turbidity and TP maximum levels seen in Table 19.

Figures 7, 8, and 9 show NO_2+NO_3, TP and instantaneous temperature measurements, respectively.

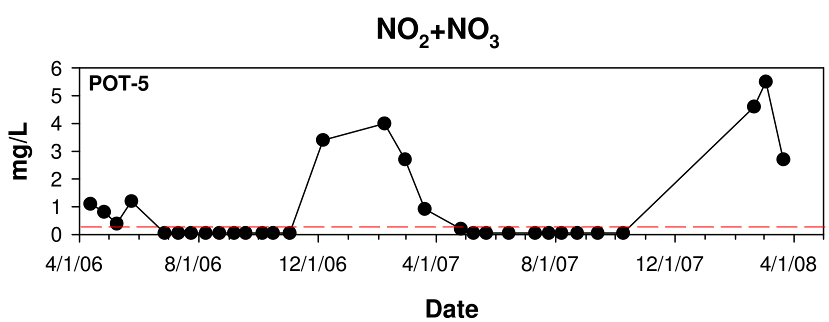


Figure 6. NO_2+NO_3 levels for Cedar Creek (POT-5), 2006-2008. The dashed red line indicates the applicable 0.3 mg/L target criterion.

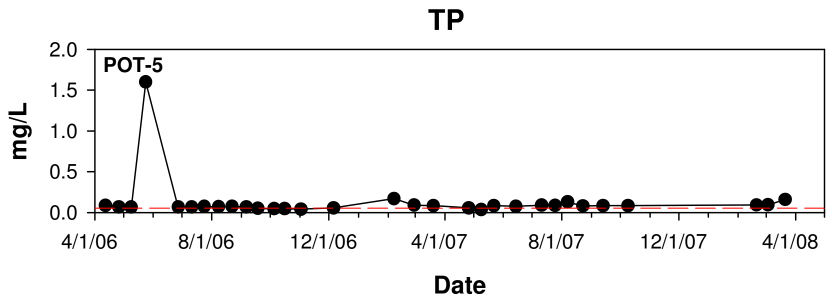


Figure 7. TP levels for Cedar Creek (POT-5), 2006-2008. The dashed red line indicates the applicable 0.1 mg/L criterion.

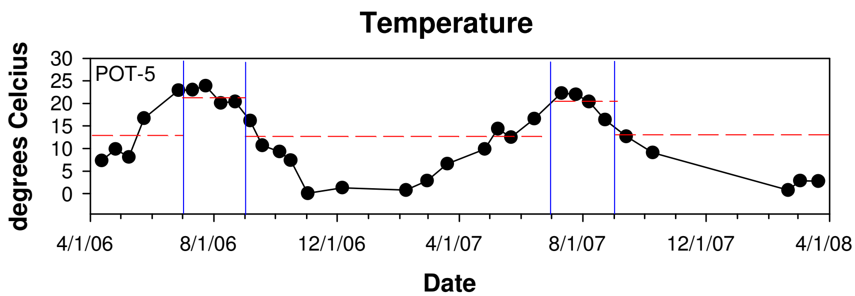


Figure 8. Instantaneous temperature readings for Cedar Creek (POT-5), 2006-2008. The blue line delineates the period of the year deemed critical to salmonid spawning and incubation (September 1st – June 1st). The dashed red lines represent the 13° C and 22° C targets, as they apply.

2008 Cedar Creek Data Summary:

- One major rain event occurred in May, 2006 and caused widespread erosion in the watershed, which led to extreme elevations in sediment, TP and turbidity levels for approximately one week. Another rain on snow event in February, 2007 caused levels of the same parameters to be elevated once again. In both cases, a large plume of extremely turbid water flowed from Cedar Creek into the Potlatch River and noticeably increased turbidity levels in the Potlatch River, from the Cedar Creek confluence to the mouth. Aside from these localized events, turbidity and sediment levels were typically very low in Cedar Creek, and were well within an optimal range for aquatic life.
- Excessive nutrient loads were documented in Cedar Creek, with nitrogen levels exceeding the 0.3 mg/L target criterion 35.5% of the time (n=31), and total phosphorus levels exceeding the 0.1 mg/L target 12.9% of the time (N=31).
- No violation of the 6.0 mg/L DO criterion was observed in Cedar Creek (n=31).
- A number of temperature exceedances were observed, with the instantaneous criterion being exceeded 41.9% of the time (n=31).

A comparison of the data collected at monitoring site POT-5, in 2002 and 2008, was conducted to identify any observable trends or changes in water quality at the site. Table 20 contains some descriptive statistics for each data set.

Table 20. Cedar Creek data comparison (POT-5), 2002 and 2008.

Parameters	Median		Minimum		Maximum	
	2002	2008	2002	2008	2002	2008
DO (mg/L)	11.6	10.5	8.8	8.3	18.0	13.5
pH	8.2	8.5	7.4	7.0	8.9	9.8
TP (mg/L)	0.07	0.08	0.03	0.04	0.57	1.6
E. coli (cfu/ 100mL)	29.0	32.7	0.5	0.5	1100.0	1120.0
SSC (mg/L)	2.0	2.0	2.0	2.0	260.0	970.0
Turbidity (NTU)	4.9	8.0	1.5	3.2	69.2	1000.0
NO_2+NO_3 (mg/L)	0.05	0.05	0.05	0.05	4.3	5.5
Temperature (°C)	7.1	10.7	0.23	0.1	23.8	23.9
Flow (cfs)	3.47	1.87	0.18	0.33	245.0	233.0

All measured parameters were quite similar during both sampling periods, with the difference between median values for all parameters except turbidity being statistically insignificant.

Boulder Creek System:

Boulder Creek (POT-6)

The Boulder Creek subwatershed, including Little Boulder Creek, drains approximately 11,280 acres. Boulder Creek is approximately 7.3 miles long, originating roughly 8.6 miles northeast of Southwick, Idaho. The stream travels in a southwesterly direction, and the watershed is almost entirely forested. Land use activities include timber harvest and road systems. A falls located approximately 1.2 miles upstream from the mouth may act as a migration barrier to anadromous fish, and natural/wild rainbow/steelhead trout were found only below this barrier (Schriever 1999).

Boulder Creek, from Pig Creek to its mouth, is listed for bacteria and temperature. According to IDEQ (2008), aquatic life beneficial uses are not being fully supported in Boulder Creek.

One monitoring station was established on Boulder Creek, at the Linden road crossing (POT-6). Table 21 presents descriptive statistics for Boulder Creek site POT-6.

Table 21. Descriptive statistics for Boulder Creek monitoring site POT-6, 2008.

POT-6	D.O.	Temp	pH	Turbidity	$NO_2 + NO_3$	NH_3	OP	TP	SSC	*E-coli*	Flow
	(mg/L)	(°C)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)	(cfs)
Maximum	11.34	20.50	8.23	29.90	0.18	0.05	0.04	0.2	23.00	1732.90	21.14
Minimum	7.93	5.10	7.20	4.27	0.05	0.05	0.01	0.026	2.00	7.40	0.13
Mean	9.58	12.33	7.80	10.39	0.06	0.05	0.02	0.053	3.51	165.65	3.39
Median	9.77	11.30	7.75	7.15	0.05	0.05	0.02	0.048	2.00	47.25	0.68
# exceedance	0.0	9.0	0.0		0	0	0	1	0.0	2.00	
% exceedance	0.0%	39.1%	0.0%		0.0%	0.0%	0.0%	4.5%	0.0%	9.1%	
# sampling events	23.0	23.0	21.0	23.0	22.0	22.0	22.0	22.0	22.0	22.0	

One exceedance of the 0.1 mg/L TP target was observed. Temperature exceedances occurred 39.1% of the time. Two exceedances of the 576 organisms/100mL *E. coli* standard for secondary contact recreation were observed.

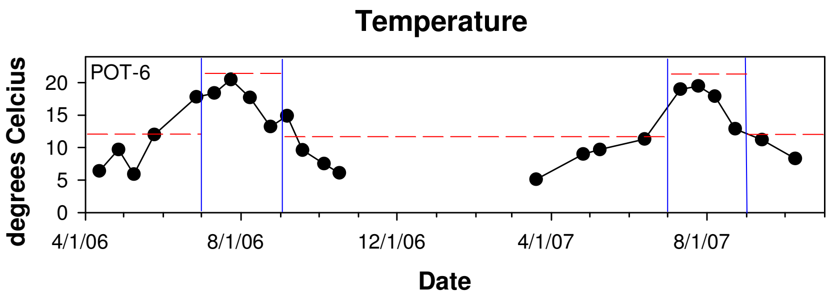


Figure 9. Instantaneous temperature readings for Boulder Creek (POT-6), 2006-2008. The blue line delineates the period of the year deemed critical to salmonid spawning and incubation (September 1st – June 1st). The dashed red lines represent the 13° C and 22° C targets, as they apply.

2008 Boulder Creek Data Summary:

- Water quality was generally very good in Boulder Creek.
- One exceedance of the 0.1 mg/L TP target was observed in August of 2007. No other nutrient exceedances occurred.
- No violation of the 6.0 mg/L DO criterion was observed in Boulder Creek (n=23).
- Turbidity and sediment levels were very low in Boulder Creek, and were well within an optimal range for aquatic life.
- Nine temperature exceedances were observed, with the instantaneous criterion being exceeded 39.1% of the time (n=23).
- Two exceedances of the 576 organisms/100mL *E. coli* standard for secondary contact recreation were observed.

A comparison of the data collected at monitoring site POT-6, in 2002 and 2008, was conducted to identify any observable trends or changes in water quality at the site.

Table 22 contains some descriptive statistics for each data set.

Table 22. Boulder Creek data comparison (POT-6), 2002 and 2008.

Parameters	Median		Minimum		Maximum	
	2002	2008	2002	2008	2002	2008
DO (mg/L)	9.60	9.77	7.58	7.93	14.9	11.3
pH	7.90	7.75	7.40	7.20	8.30	8.23
TP (mg/L)	0.04	0.05	0.01	0.03	0.05	0.20
E. coli (cfu/ 100mL)	99.5	47.3	4.0	7.4	1400.0	1732.9
SSC (mg/L)	2.0	2.0	2.0	2.0	8.0	23.0
Turbidity (NTU)	4.75	7.15	1.90	4.27	12.6	29.9
NO_2+NO_3 (mg/L)	0.05	0.05	0.05	0.05	0.65	0.18
Temperature (°C)	11.8	11.3	1.50	5.10	20.1	20.5
Flow (cfs)	0.72	0.68	0.08	0.13	15.4	21.1

All measured parameters were quite similar during both sampling periods, with the difference between median values for all parameters except turbidity being statistically insignificant.

Little Boulder Creek (POT-7)

Little Boulder Creek also flows in a southwesterly direction, and the watershed is almost entirely forested. This tributary to the Potlatch River is approximately 5.9 miles long, originating four miles southwest of Helmer, Idaho, on the western slope of McGary Butte. Land use activities include timber harvest and road systems. Little Boulder Creek was found to have one of the highest densities of rainbow/steelhead in the Potlatch River catchment (Bowersox et al. 2005).

Little Boulder Creek is currently listed in section 3 of the IDEQ's 2008 Integrated Report, as "unassessed water". One monitoring station was established near the mouth of Little Boulder Creek (POT-7).

Table 23 presents descriptive statistics for Boulder Creek site POT-7.

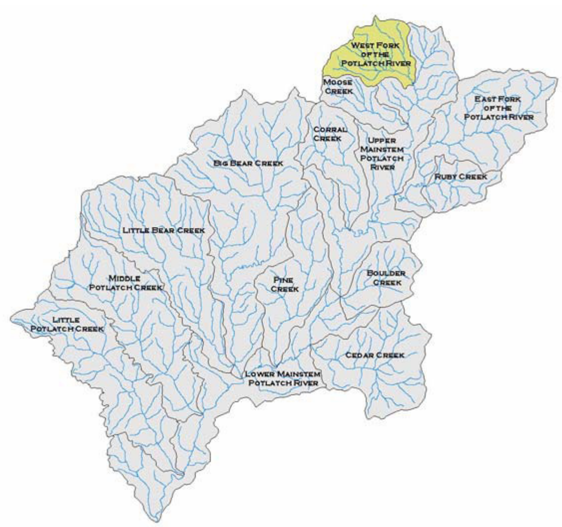
Table 23. Descriptive statistics for Little Boulder Creek monitoring site POT-7, 2008.

POT-7	D.O.	Temp	pH	Turbidity	NO_2 +NO_3	NH_3	OP	TP	SSC	*E-coli*	Flow
	(mg/L)	(°C)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)	(cfs)
Maximum	13.95	16.60	8.05	34.00	0.05	0.1	0.03	0.074	5.10	325.50	11.41
Minimum	7.89	0.00	6.93	3.98	0.05	0.05	0.01	0.028	2.00	11.00	0.13
Mean	11.19	7.04	7.41	18.43	0.05	0.05	0.02	0.047	32.74	68.55	2.72
Median	11.22	6.70	7.41	15.60	0.05	0.05	0.02	0.044	2.00	48.80	1.31
# exceedance	0.0	3.0	0.0		0	0	0	0	0.0	0.00	
% exceedance	0.0%	16.7%	0.0%		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
# sampling events	18.0	18.0	14.0	18.0	18.0	18.0	18.0	18.0	18.0	15.0	

2008 Little Boulder Creek Data Summary:

- Little Boulder Creek had the best water quality of any stream sampled, and would potentially make a very good reference/trend stream for comparative analysis with similar streams in similar ecoregions.
- No nutrient exceedances occurred.
- No violation of the 6.0 mg/L DO criterion was observed in Little Boulder Creek (n=18).
- Three temperature exceedances were observed, with the instantaneous criterion being exceeded 16.7% of the time (n=18).
- Turbidity and sediment levels were very low in Little Boulder Creek, and were well within an optimal range for aquatic life.

West Fork of the Potlatch River (POT-10)



The upper portion of the Potlatch River is divided into two main tributaries, the East Fork and West Fork. The West Fork originates in the northeast corner of Latah County and flows southeast to its confluence with the Potlatch River. The West Fork of the Potlatch River subwatershed drains approximately 12,500 acres, and is roughly seven miles long. It originates approximately 8.1 miles northeast of Bovill, Idaho.

The subwatershed is primarily forested, with interspersed meadows found throughout. Land use activities include forestry, livestock and road systems. The West Fork Potlatch River had the highest fish densities of all the streams sampled in the Potlatch River catchment (Bowersox et al. 2005).

The West Fork Potlatch River is listed for bacteria and temperature in Section 5 of the 2008 Integrated Report (IDEQ 2008). According to IDEQ (2008), aquatic life, primary contact recreation, and salmonid spawning beneficial uses are not being fully supported. IDEQ also stated that reconnaissance data indicate further monitoring, biological surveys, assessments, and implementation projects should occur in the West Fork Potlatch River (IDEQ 2009). One monitoring station was established on the West Fork Potlatch River, above its confluence with Feather Creek (POT-10).

Table 24 presents descriptive statistics for West Fork Potlatch River, site POT-10.

Table 24. Descriptive statistics for West Fork Potlatch River monitoring site POT-10, 2008.

POT-10	D.O.	Temp	pH	Turbidity	NO_2 +NO_3	NH_3	OP	TP	SSC	*E-coli*	Flow
	(mg/L)	(°C)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)	(cfs)
Maximum	13.43	21.70	8.60	12.80	0.05	0.05	0.06	0.18	11.00	2419.20	81.47
Minimum	5.16	0.10	6.72	3.55	0.05	0.05	0	0.018	2.00	1.00	0.14
Mean	8.46	11.24	7.28	6.15	0.05	0.05	0.02	0.057	2.86	164.77	8.61
Median	8.12	11.30	7.10	5.01	0.05	0.05	0.01	0.054	2.00	30.70	1.4
# exceedance	2.0	9.0	0.0		0	0	0	2	0.0	2.00	
% exceedance	8.0%	36.0%	0.0%		0.0%	0.0%	0.0%	8.3%	0.0%	4.3%	
# sampling events	25.0	25.0	21.0	25.0	24.0	24.0	24.0	24.0	24.0	23.0	

Total phosphorus levels exceeded the 0.1 mg/L target twice during this study (N=24). Temperature levels exceeded State of Idaho criteria 36.0% of the time during this study (n=25), and DO levels fell below the 6.0 mg/L criterion twice (n=25). Heavy beaver activity was observed directly upstream from the monitoring station in July of 2007, and decreases in DO were observed on subsequent visits. It seems likely that the stagnation of water behind the beaver dam was at least partially responsible for the drop in DO levels seen downstream. Figure 11 and Figure 12 show the inverse relationship between water temperatures and DO levels.

Heavy snow and ice made this site inaccessible from mid December, 2006 to April, 2007.

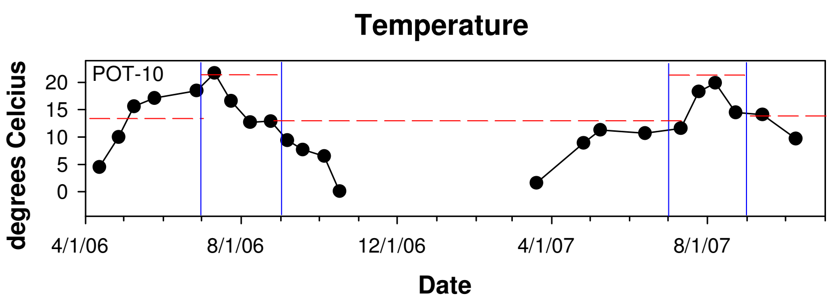


Figure 10. Instantaneous temperature readings for West Fork Potlatch River (POT-10), 2006-2008. The blue line delineates the period of the year deemed critical to salmonid spawning and incubation (September 1st – June 1st). The dashed red lines represent the 13° C and 22° C targets, as they apply.

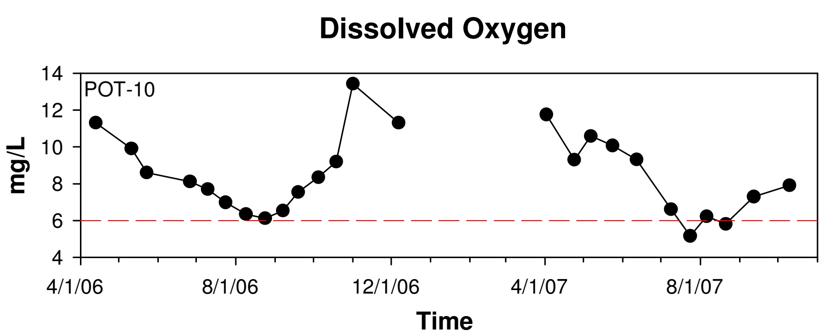


Figure 11. Dissolved oxygen concentrations for West Fork Potlatch River (POT-10), 2006-2008. The dashed red line indicates the 6.0 mg/L criterion for DO.

2008 West Fork Potlatch River Data Summary:

- Nutrient levels were generally low, with two samples exceeding the 0.1 mg/L target criterion for TP (n=24). No exceedances of nitrogen were observed.
- Temperature levels exceeded State of Idaho criteria 36.0% of the time (n=25).
- Two violations of the 6.0 mg/L DO criterion were observed (n=23).
- Turbidity and sediment levels were very low in West Fork Potlatch River, and were well within an optimal range for aquatic life.
- Two exceedances of the 406 organisms/100mL *E. coli* standard for primary contact recreation were observed (n=23).

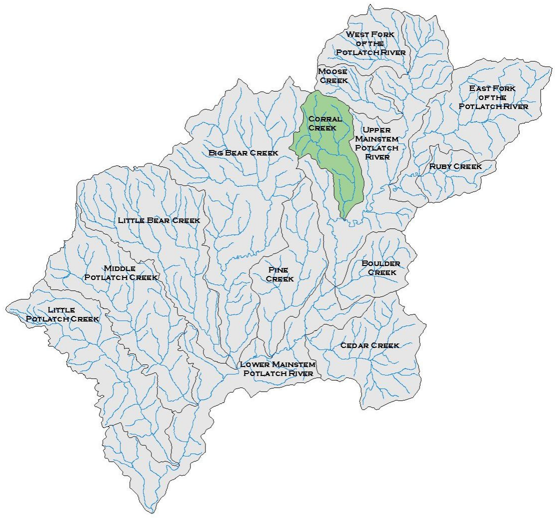
A comparison of the data collected at monitoring site POT-10, in 2002 and 2008, was conducted to identify any observable trends or changes in water quality at the site. Table 25 contains some descriptive statistics for each data set.

Table 25. West Fork Potlatch River data comparison (POT-10), 2002 and 2008.

Parameters	Median		Minimum		Maximum	
	2002	2008	2002	2008	2002	2008
DO (mg/L)	9.25	8.12	6.28	5.16	12.8	13.4
pH	7.55	7.19	7.0	6.72	8.2	8.6
TP (mg/L)	0.03	0.06	0.01	0.02	0.05	0.18
E. coli (cfu/ 100mL)	59.8	42.6	0.50	1.00	1299.7	2419.2
SSC (mg/L)	2.00	2.00	2.00	2.00	8.00	11.0
Turbidity (NTU)	2.67	5.01	1.55	3.55	5.35	12.8
NO_2+NO_3 (mg/L)	0.05	0.05	0.05	0.05	0.05	0.05
Temperature (°C)	12.8	12.2	1.50	0.10	20.0	21.7
Flow (cfs)	1.31	1.75	0.54	0.14	35.5	81.5

All measured parameters were quite similar during both sampling periods, with the difference between median values for all parameters being statistically insignificant.

Corral Creek (POT-12)



The Corral Creek subwatershed drains approximately 14,300 acres. It is roughly 11.4 miles long, originating approximately 5.9 miles northwest of Deary, Idaho. The subwatershed is primarily forested, with interspersed meadows found throughout. Land use activities include forestry, livestock and road systems.

Corral Creek is listed for temperature in Section 5 of the 2008 Integrated Report (IDEQ 2008). According to IDEQ (2008), aquatic life and salmonid spawning beneficial uses are not being fully supported in Corral Creek.

Extensive stream restoration is currently being implemented in this watershed. An entire section of the railroad grade just northwest of the town of Helmer, which had been identified as a migration barrier for steelhead, has already been removed and riparian vegetation has been established. Re-routing of the flow out of ditches and into historic sections of the stream channel, improvement of meadow hydrology, and riparian plantings further upstream are also under way.

One monitoring station was established on the Corral Creek, just below State Highway 8. Table 26 presents descriptive statistics for Corral Creek, site POT-12.

Table 26. Descriptive statistics for Corral Creek monitoring site POT-12, 2008.

POT-12	D.O. (mg/L)	Temp (°C)	pH (H^+)	Turbidity (NTU)	NO_2 +NO_3 (mg/L)	NH_3 (mg/L)	OP (mg/L)	TP (mg/L)	SSC (mg/L)	*E-coli* (coli/100mL)	Flow (cfs)
Maximum	13.47	22.90	7.50	42.10	0.15	0.05	0.05	0.064	10.00	1553.10	121
Minimum	8.02	0.00	6.75	8.08	0.05	0.05	0	0.032	2.00	21.10	0.24
Mean	10.45	9.91	7.11	21.62	0.06	0.05	0.01	0.047	4.91	295.84	17.02
Median	9.72	10.35	7.12	19.90	0.05	0.05	0.01	0.045	5.20	70.35	2.26
# exceedance	0.0	5.0	0.0		0	0	0	0	0.0	2.00	
% exceedance	0.0%	35.7%	0.0%		0.0%	0.0%	0.0%	0.0%	0.0%	16.7%	
# sampling events	14.0	14.0	10.0	15.0	15.0	15.0	15.0	15.0	14.0	12.0	

Temperature levels exceeded State of Idaho criteria 35.7% of the time during this study (n=14), but no subsequent effect on DO levels was observed. Two exceedances of the 576 organisms/100mL *E. coli* standard for secondary contact recreation were observed.

Corral Creek went dry in late June, during both monitoring seasons, and flow did not resume until rain on snow events in March accounted for a rapid rise in water levels. Figure 13 shows flow levels during this monitoring period, and Figure 14 shows instantaneous stream temperature levels.

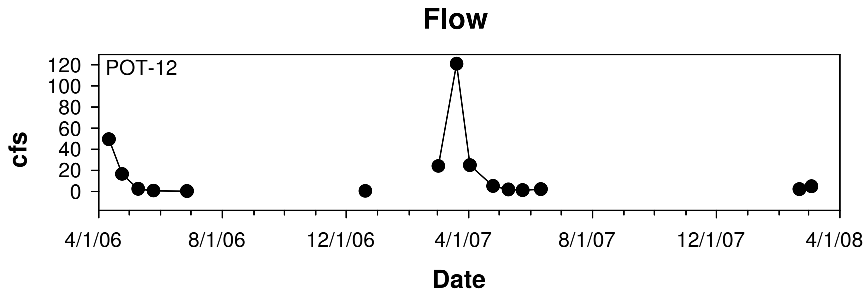


Figure 12. Flow rates for Corral Creek (POT-12), 2006-2008.

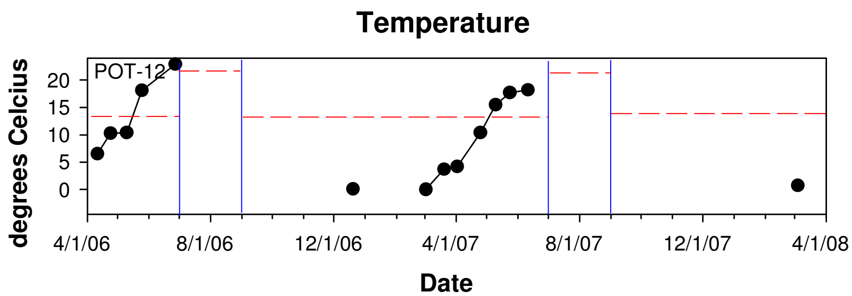


Figure 13. Instantaneous temperature readings for Corral Creek (POT-12), 2006-2008. The blue line delineates the period of the year deemed critical to salmonid spawning and incubation (September 1st – June 1st). The dashed red lines represent the 13° C and 22° C targets, as they apply.

2008 Corral Creek Data Summary:

- Nutrient levels were very low, with no samples exceeding either the 0.3 mg/L target criterion for nitrogen or the 0.1 mg/L target for TP (n=15).
- Temperature levels exceeded State of Idaho criteria 35.7% of the time (n=14).
- No violations of the 6.0 mg/L DO criterion were observed (n=14).
- Turbidity and sediment levels were very low in Corral Creek, and were well within an optimal range for aquatic life.
- Two exceedances of the 576 organisms/100mL *E. coli* standard for secondary contact recreation were observed (n=12).

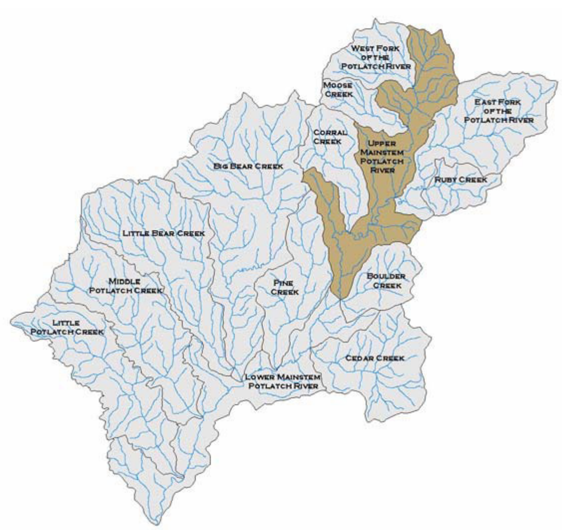
A comparison of the data collected at monitoring site POT-12 in 2002 and 2008, was conducted to identify any observable trends or changes in water quality at the site. Table 27 contains some descriptive statistics for each data set.

Table 27. Corral Creek data comparison (POT-12), 2002 and 2008.

Parameters	Median		Minimum		Maximum	
	2002	**2008**	**2002**	**2008**	**2002**	**2008**
DO (mg/L)	12.0	9.72	6.36	8.02	16.9	13.5
pH	7.20	7.12	6.40	6.75	7.70	7.50
TP (mg/L)	0.05	0.05	0.03	0.03	0.09	0.06
E. coli (cfu/ 100mL)	40.0	70.4	0.00	21.1	870.0	1553.1
SSC (mg/L)	2.00	2.00	2.00	2.00	24.0	10.0
Turbidity (NTU)	12.7	19.9	2.42	8.08	54.3	42.1
NO_2+NO_3 (mg/L)	0.05	0.05	0.05	0.05	0.16	0.15
Temperature (°C)	3.90	10.4	0.00	0.00	31.3	22.9
Flow (cfs)	16.9	2.26	0.35	0.24	173.7	121.0

All measured parameters were quite similar during both sampling periods, with the difference between median values for all parameters being statistically insignificant.

Upper Mainstem Potlatch River & Hog Meadow Creek (POT-8, POT-9, POT-11)



The upper mainstem of the Potlatch River subwatershed drains approximately 40,300 acres. The upper mainstem extends from the headwaters of the Potlatch River to its confluence with Big Bear Creek, near the town of Kendrick. The subwatershed is comprised of a mixture of forested lands, agricultural fields and meadows. Land use activities include forestry, livestock and road systems.

The Potlatch River, from its headwaters to Big Bear Creek is listed for temperature and bacteria in Section 5 of the 2008 Integrated Report (IDEQ 2008). According to IDEQ (2008), aquatic life, salmonid spawning, and primary contact recreation beneficial uses are not being fully supported in the upper portion of the Potlatch River subwatershed.

POT-11 (mainstem Potlatch River, at State Highway 8 crossing)

This monitoring station was established on the mainstem of the Potlatch River, just below State Highway 8, near the town of Bovill. Table 28 presents descriptive statistics for site POT-11.

Table 28. Descriptive statistics for Potlatch River monitoring site POT-11, 2008.

POT-11	D.O.	Temp	pH	Turbidity	NO_2 +NO_3	NH_3	OP	TP	SSC	*E-coli*	Flow
	(mg/L)	(°C)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)	(cfs)
Maximum	13.94	24.70	8.07	21.10	0.12	0.13	0.03	0.064	12.00	2419.20	81.47
Minimum	5.22	0.00	6.55	2.89	0.05	0.05	0	0.022	2.00	2.00	0.14
Mean	9.57	11.50	7.45	8.56	0.05	0.05	0.02	0.037	3.44	309.66	41.33
Median	9.41	12.00	7.52	8.14	0.05	0.05	0	0.034	2.00	117.80	15.54
# exceedance	2.0	15.0	0.0		0	0	0	0	0.0	7.00	
% exceedance	6.5%	48.4%	0.0%		0.0%	0.0%	0.0%	0.0%	0.0%	24.1%	
# sampling events	31.0	31.0	26.0	31.0	30.0	30.0	30.0	30.0	30.0	29.0	

Nutrient levels were very low, with no samples exceeding either the 0.3 mg/L target criterion for nitrogen or the 0.1 mg/L target for TP (n=30). Temperature levels exceeded State of Idaho criteria 48.4% of the time during this study (n=30), and two violations of the 6.0 mg/L criterion for DO were observed when temperatures were at their highest. Seven exceedances of the 406 organisms/100mL *E. coli* standard for primary contact recreation were observed. Seasonal cattle grazing occurred directly upstream from this monitoring station, and could have contributed to the increased levels of *E. coli* that were observed.

Figure 15 clearly shows the inverse relationship between stream temperatures and DO levels.

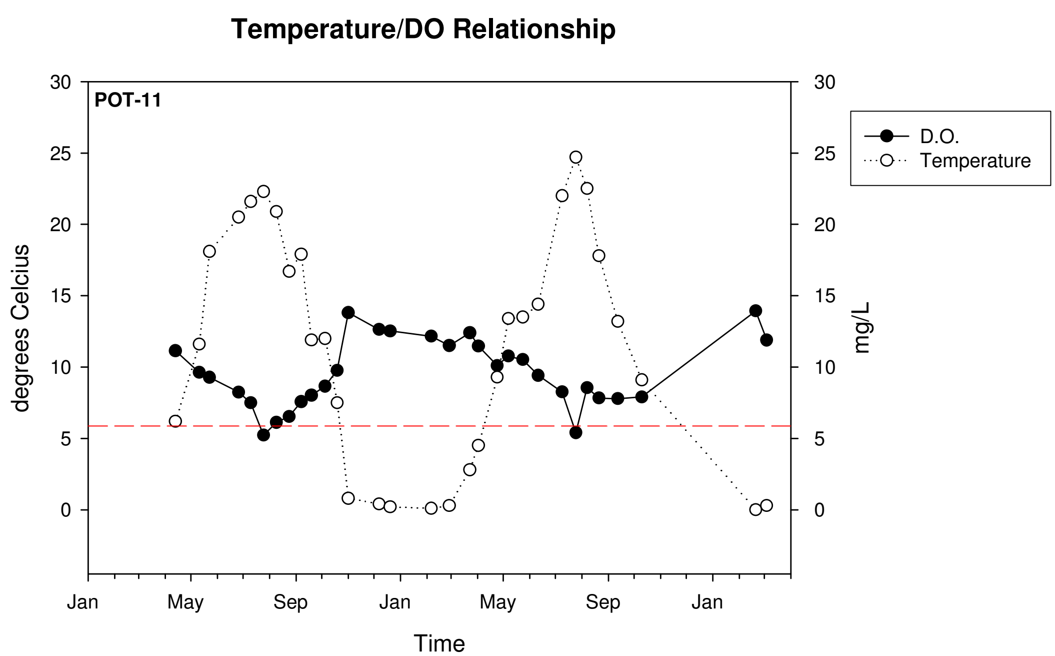


Figure 14. Instantaneous temperature readings and Dissolved Oxygen readings for POT-11, 2006-2008. The dashed red line represents the State of Idaho 6.0 mg/L criterion for dissolved oxygen concentration.

2008 POT-11 Summary:

- Nutrient levels were very low, with no samples exceeding either the 0.3 mg/L target criterion for nitrogen or the 0.1 mg/L target for TP (n=30).
- Temperature levels exceeded State of Idaho criteria 48.4% of the time (n=31).
- Two violations of the 6.0 mg/L DO criterion were observed (n=31).
- Turbidity and sediment levels were very low at this site, and were well within an optimal range for aquatic life.
- Seven exceedances of the 406 organisms/100mL *E. coli* standard for primary contact recreation were observed (n=29)

A comparison of the data collected at monitoring site POT-11 in 2002 and 2008, was conducted to identify any observable trends or changes in water quality at the site. Table 29 contains some descriptive statistics for each data set.

Table 29. Data comparison for POT-11, 2002 and 2008.

Parameters	**Median**		**Minimum**		**Maximum**	
	2002	**2008**	**2002**	**2008**	**2002**	**2008**
DO (mg/L)	10.4	9.4	6.9	5.2	20.0	13.9
pH	7.30	7.52	5.89	6.55	7.80	8.07
TP (mg/L)	0.03	0.03	0.02	0.02	0.06	0.06
E. coli (cfu/ 100mL)	46.0	117.8	0.00	2.00	2400.0	2400.0
SSC (mg/L)	2.00	2.00	2.00	2.00	21.0	12.0
Turbidity (NTU)	4.58	8.14	1.35	2.89	14.0	21.1
NO_2+NO_3 (mg/L)	0.05	0.05	0.05	0.05	0.05	0.12
Temperature (°C)	4.50	12.0	0.10	0.00	24.8	24.7
Flow (cfs)	24.6	41.3	1.32	0.14	88.7	363.6

The difference between median values for all parameters was statistically insignificant. Bacteria and high water temperatures are a continuing concern at this site.

POT-8 (mainstem Potlatch River, at Park Road Bridge)

This monitoring station was established on the mainstem of the Potlatch River, on Park Road, adjacent to the Little Boulder Creek Campground, approximately two miles south of Helmer, Idaho.

Table 30 presents descriptive statistics for site POT-8.

Table 30. Descriptive statistics for Potlatch River monitoring site POT-8, 2008.

POT-8	D.O.	Temp	pH	Turbidity	NO_2 + NO_3	NH_3	OP	TP	SSC	*E-coli*	Flow
	(mg/L)	(°C)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)	(cfs)
Maximum	13.92	26.60	10.31	23.60	0.1	0.11	0.02	0.043	7.10	1046.20	726.61
Minimum	8.10	0.00	7.05	3.25	0.05	0.05	0	0.019	2.00	5.20	3.06
Mean	10.58	12.59	8.17	8.08	0.05	0.05	0.01	0.029	2.67	102.95	80.84
Median	10.29	13.90	8.16	6.06	0.05	0.05	0	0.028	2.00	26.90	22.41
# exceedance	0.0	15.0	3.0		0	0	0	0	0.0	2.00	
% exceedance	0.0%	51.7%	11.5%		0.0%	0.0%	0.0%	0.0%	0.0%	8.0%	
# sampling events	29.0	29.0	26.0	29.0	28.0	28.0	28.0	28.0	28.0	25.0	

Nutrient levels were very low, with no samples exceeding either the 0.3 mg/L target criterion for nitrogen or the 0.1 mg/L target for TP (n=28). Temperature levels exceeded State of Idaho criteria 51.7% of the time during this study (n=29). Two exceedances of the 406 organisms/100mL *E. coli* standard for primary contact recreation were observed. Three exceedances of the State of Idaho maximum pH value of 9.0 were observed in July and August of 2007.

Figure 16 shows instantaneous temperature measurements during this study.

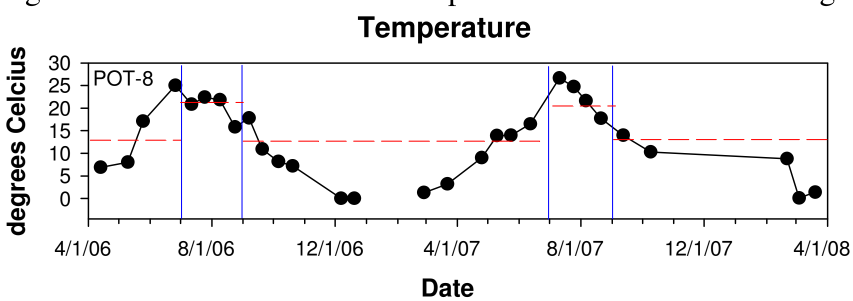


Figure 15. Instantaneous temperature readings for POT-8, 2006-2008. The blue line delineates the period of the year deemed critical to salmonid spawning and incubation (September 1st – June 1st). The dashed red lines represent the 13° C and 22° C targets, as they apply.

2008 POT-8 Summary:

- Nutrient levels were very low, with no samples exceeding either the 0.3 mg/L target criterion for nitrogen or the 0.1 mg/L target for TP (n=28).
- Temperature levels exceeded State of Idaho criteria 51.7% of the time (n=29). The river at this site is very wide and solar loading will continue to be an issue at this site.
- No violations of the 6.0 mg/L DO criterion were observed (n=29).
- Turbidity and sediment levels were very low at this site, and were well within an optimal range for aquatic life.
- Two exceedances of the 406 organisms/100mL *E. coli* standard for primary contact recreation were observed (n=29).
- Four exceedances of the maximum pH level of 9.0 were observed. There is no indication that nutrient levels were influencing pH levels, and no other human activity in the area was observed that would have led to an increase in pH levels.

A comparison of the data collected at monitoring site POT-8 in 2002 and 2008, was conducted to identify any observable trends or changes in water quality at the site. Table 31 contains some descriptive statistics for each data set.

Table 31. Data comparison for POT-8, 2002 and 2008.

Parameters	**Median**		**Minimum**		**Maximum**	
	2002	**2008**	**2002**	**2008**	**2002**	**2008**
DO (mg/L)	11.5	10.3	7.47	8.10	16.8	13.9
pH	7.63	8.16	6.98	7.05	8.90	10.3
TP (mg/L)	0.03	0.03	0.01	0.02	0.08	0.04
E. coli (cfu/ 100mL)	17.0	26.9	3.00	5.20	2400.0	1046.2
SSC (mg/L)	2.00	2.00	2.00	2.00	25.0	7.10
Turbidity (NTU)	3.72	6.06	1.20	3.25	24.9	23.6
NO_2+NO_3 (mg/L)	0.05	0.05	0.05	0.05	0.10	0.10
Temperature (°C)	4.40	13.9	0.00	0.00	24.8	26.6
Flow (cfs)	n/a	22.4	n/a	3.06	n/a	726.6

The difference between median values for all parameters was statistically insignificant. High stream temperatures are an ongoing problem at this site.

Hog Meadow Creek (POT-9)

This monitoring station was established at the mouth of Hog Meadow Creek, adjacent to the Little Boulder Creek Campground, approximately two miles south of Helmer, Idaho. Hog Meadow Creek is an intermittent creek that only had flow from March to May, during this study.

Table 32 presents descriptive statistics for site POT-9.

Table 32. Descriptive statistics for Potlatch River monitoring site POT-9, 2008.

POT-9	D.O.	Temp	pH	Turbidity	NO_2 +NO_3	NH_3	OP	TP	SSC	*E-coli*	Flow
	(mg/L)	(°C)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(coli/100mL)	(cfs)
Maximum	13.94	15.50	7.60	55.10	0.11	0.05	0.02	0.058	17.00	31.30	35.35
Minimum	8.01	0.00	6.60	12.70	0.05	0.05	0.01	0.033	2.00	2.00	0.92
Mean	11.33	5.65	7.26	25.89	0.06	0.05	0.02	0.048	4.89	16.97	9.63
Median	11.73	4.55	7.31	22.85	0.05	0.05	0.02	0.051	2.00	14.50	6.18
# exceedance	0.0	1.0	0.0		0	0	0	0	0.0	0.00	
% exceedance	0.0%	10.0%	0.0%		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
# sampling events	9.0	10.0	8.0	10.0	10.0	10.0	10.0	10.0	10.0	7.0	

2008 POT-9 Summary:

- Nutrient levels were very low, with no samples exceeding either the 0.3 mg/L target criterion for nitrogen or the 0.1 mg/L target for TP (n=10).
- Temperature levels exceeded State of Idaho criteria once during this study (n=10).
- No violations of the 6.0 mg/L DO criterion were observed (n=9).

- Turbidity and sediment levels were very low at this site, and were well within an optimal range for aquatic life.
- No exceedances of the 576 organisms/100mL *E. coli* standard for secondary contact recreation were observed (n=7).

No data was collected from this stream in 2002.

Lower Mainstem Potlatch River (POT-1)

The lower mainstem of the Potlatch River subwatershed drains approximately 38,000 acres. The lower mainstem extends from its confluence with Big Bear Creek to its confluence with the Clearwater River. The subwatershed is comprised of relatively dry canyon land, and the communities of Kendrick and Juliaetta are found along this reach. State Highway 3 borders this reach for its entire length.

The Potlatch River, from Big Bear Creek to its mouth is listed for temperature and sediment in Section 5 of the 2008 Integrated Report (IDEQ 2008). According to IDEQ (2008), aquatic life and salmonid spawning beneficial uses are not being fully supported in the lower portion of the Potlatch River subwatershed.

One monitoring station was established on the mainstem of the Potlatch River, near the USGS water-stage recorder, approximately one-half miles from its mouth.

Table 33 presents descriptive statistics for site POT-1.

Table 33. Descriptive statistics for Potlatch River monitoring site POT-1, 2008.

POT-1	D.O. (mg/L)	Temp (°C)	pH (H^+)	Turbidity (NTU)	NO_2 +NO_3 (mg/L)	NH_3 (mg/L)	OP (mg/L)	TP (mg/L)	SSC (mg/L)	*E-coli* (coli/100mL)	Flow (cfs)
Maximum	15.37	25.00	10.09	947.00	5	0.17	0.12	0.81	390.00	866.40	1490
Minimum	7.66	0.90	7.09	1.98	0.05	0.05	0.01	0.024	2.00	3.10	2.1
Mean	10.98	13.34	8.34	46.85	0.67	0.06	0.03	0.084	19.00	74.35	279.2
Median	11.13	12.65	8.25	5.11	0.05	0.05	0.02	0.042	2.00	20.00	57.5
# exceedance	0.0	13.0	2.0		9	0	1	5	2.0	2.00	
% exceedance	0.0%	46.4%	8.0%		32.1%	0.0%	3.6%	17.9%	7.1%	7.7%	
# sampling events	28.0	28.0	25.0	27.0	28	28	28	28	28.0	26.00	

Nitrogen levels exceeded the 0.3 mg/L target criterion 32.1% of the time during this study (n=28), and there was a fairly strong correlation between NO_2+NO_3 and flow (Figure 17). TP levels exceeded the 0.1 mg/L target 17.9% of the time (n=28). Temperature levels exceeded State of Idaho criteria 46.4% of the time during this study (n=28). Two exceedances of the 406 organisms/100mL *E. coli* standard for primary contact recreation were observed. Two exceedances of the State of Idaho maximum pH value of 9.0 were observed in July and August of 2007.

Turbidity and sediment were generally within acceptable levels for aquatic life, with the exception of a week-long event in late May of 2006, when heavy rains near Southwick resulted in a massive load of sediment being deposited from Cedar Creek into the Potlatch River. This one event accounts for the maximum values for turbidity, SSC and TP in Table 29.

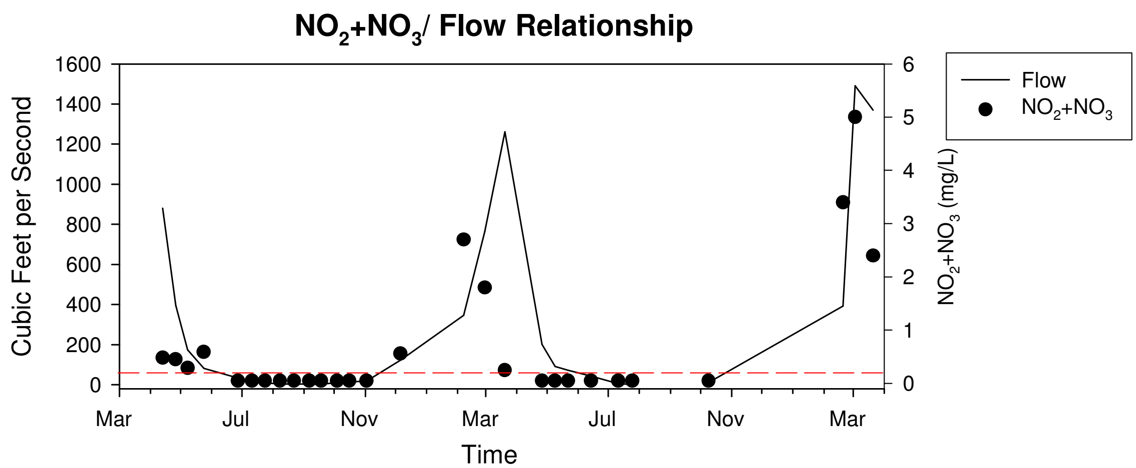


Figure 16. NO_2+NO_3 levels and Flow measurements for POT-1, 2006-2008. The dashed red line represents the 0.30 mg/L target criterion for nitrogen concentration.

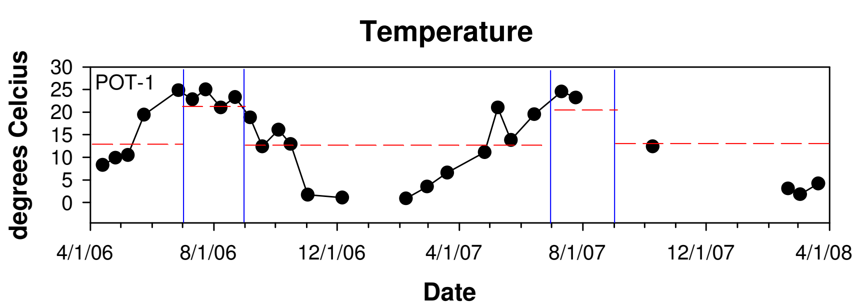


Figure 17. Instantaneous temperature readings for POT-1, 2006-2008. The blue lines delineate the period of the year deemed critical to salmonid spawning and incubation (September 1st – June 1st). The dashed red lines represent the 13° C and 22° C targets, as they apply.

2008 POT-1 Summary:

- Nitrogen levels exceeded the 0.3 mg/L target criterion 32.1% of the time during this study (n=28). Spikes in nitrogen levels occurred in February and March of both study years, and rainfall during that period may have mobilized nitrogen, laid down as fertilizer, from surrounding agricultural lands.
- TP levels exceeded the 0.1 mg/L target 17.9% of the time (n=28).
- Temperature levels exceeded State of Idaho criteria 46.4% of the time (n=28). The entire lower portion of the Potlatch River is quite wide and has relatively little shade, making solar loading a difficult problem to overcome.

- No violations of the 6.0 mg/L DO criterion were observed (n=29).
- Turbidity and sediment levels were generally very low at this site, aside from one event in May, 2006, when heavy rains caused a massive amount of sediment to be delivered from Cedar Creek into the Potlatch River.
- Two exceedances of the 406 organisms/100mL *E. coli* standard for primary contact recreation were observed (n=26).
- Two exceedances of the maximum pH level of 9.0 were observed.

No data was collected this far downstream by IDEQ in 2002, so a comparison of data sets for this site is not possible.

Conclusions

The monitoring program for the mainstem and tributaries of the Potlatch River was successfully carried out as planned. Protocols were followed, QA/QC standards were met, and specific information per parameter for each sub-watershed was collected.

Excessive stream temperature is a concern throughout the Potlatch River 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. Every site exceeded the temperature criteria multiple times during the course of this study.

Total phosphorus loading is also a persistent issue in certain subwatersheds. Pine Creek, West Fork Little Bear Creek, Middle Fork Potlatch Creek, and the site located furthest downstream on the mainstem Potlatch River (POT-1) all had a significant number of exceedances over the 0.1 mg/L target for TP. The average ratio of orthophosphorus to total phosphorus was 0.74 in Middle Potlatch Creek, 0.58 in Pine Creek, and 0.79 in the West Fork of Little Bear 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. Fourteen violations of the 6.0 mg/L standard for dissolved oxygen were documented at the West Fork of Little Bear Creek site (n=30). No violations of the DO criterion were observed in Pine Creek or Middle Fork Potlatch Creek during this study. DO violations were also noted in Big Bear Creek, West Fork Potlatch River and the mainstem of the Potlatch River near Bovill, however these violations do not appear to be linked to excessive nutrient loads.

NO_2+NO_3 levels were elevated in Cedar, Middle Fork Potlatch, West Fork Little Bear and Pine Creeks. 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, so this value was used as a target for this analysis. (Cline, 1973 & Golterman, 1975). The data suggest that much of the nitrogen could be coming from agricultural fields in the upper Potlatch River watershed. In this watershed, nitrogen fertilizers are often applied in the fall, and seasonal spikes in nitrogen levels are seen in January through March as winter and spring rains wash residual nitrogen off of fields and into nearby waterways. Many of the subwatersheds in this study showed no nutrient impairment.

Ammonia levels were quite high at site POT-16, on the West Fork Little Bear Creek, below the City of Troy's waste water treatment plant (WWTP), although they were still below the State of Idaho's acute criterion for ammonia. It is likely that the relatively high ammonia concentrations found at POT-16 are attributable to the effluent inflow from the WWTP.

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. Bacteria levels were generally low throughout the watershed, although exceedances of the State of Idaho instantaneous criteria occurred at ten of the sixteen monitoring sites. Middle Potlatch Creek (POT-2) and the mainstem of the Potlatch River near Bovill (POT-11) had highest number of exceedances during this project. The presence of livestock was noticeable at both of these locations, and is a likely cause of the elevated bacteria levels.

Suspended Sediment Concentration (SSC) includes both sediment and organic material suspended in water. Excessive sediment levels can cause problems for fish by clogging gills and for aquatic plants by limiting growth because of reduced light penetration. In addition, sediment often provides a medium for the accumulation and transport of other constituents such as phosphorus and bacteria. Sediment, in itself, doesn't appear to be a significant problem in most of this watershed, however one major rain event occurred in May, 2006 that caused extreme elevations in sediment levels in Cedar Creek, and the Potlatch River below Cedar Creek. A similar event occurred the following year in February in the Cedar Creek watershed, and once again caused sediment levels to dramatically increase. In both cases, a large plume of extremely turbid water flowed from Cedar Creek into the Potlatch River and noticeably increased turbidity and SSC levels in the Potlatch River, from the Cedar Creek confluence to the mouth.

An abbreviated summary for each site follows.

2008 Middle Fork Potlatch Creek Summary (POT-2):

- Nutrients are the main pollutant in this watershed, with TP exceeding the 0.1 mg/L target over 50% of the time at both monitoring sites, and nitrogen exceeding the 0.3 mg/L target 96.3% of the time at the mouth of the creek.
- DO levels met State of Idaho water quality criterion at both sites.
- A number of temperature exceedances were observed, with the instantaneous criterion being exceeded 37% of the time at the mouth (n=27).

- Sediment levels were within an optimal range.
- *E. coli* levels at POT-2 exceed the State of Idaho criterion for secondary contact recreation (576 cfu/ 100mL) 12.5% of the time, although levels have decreased from 2002 to 2008.

2008 Big Bear Creek Data Summary (POT-3, POT-13, POT-14):

- Three DO violations (n=26) occurred at POT-13. Two occurred in late July, both in 2006 and 2007, while one occurred in September, 2006. At very low flows in the late summer/early fall, a large pool forms directly above this site due to channel constriction. In this warm, mostly stagnant water, oxygen levels are quickly depleted when bacteria consumes oxygen as organic matter decays. DO level rebounded lower in the watershed, however, and no violations were noted at the other two monitoring stations.
- pH levels were higher than the State of Idaho criterion five consecutive times (n=28) at the mouth, from July-September of 2007. No relationship between these high pH values and any of the other measured parameters could be shown; the cause of these elevated readings is unknown at this time.
- Turbidity and sediment levels were consistent throughout the Bear Creek drainage and were within an optimal range for aquatic life.
- While excessive nutrient loads do not appear to be a major problem in the watershed, three exceedances of the 0.1 mg/L TP target were documented at site POT-3 (n=31) and one exceedance was documented at POT-13 (n=26).
- The biggest problem in this catchment is water temperature. As one would expect, thermal loading increased from the upper site to the lower site, with 60% of the measurements at POT-3 exceeding the instantaneous temperature criterion.

2008 West Fork Little Bear Creek Data Summary (POT-15, POT-16):

- Turbidity and sediment levels were fairly consistent in the West Fork of Little Bear Creek and, aside from a single SSC reading of 30.0 mg/L, were within an optimal range for aquatic life.
- While excessive nutrient loads do not appear to be a problem in the upper watershed, it is the primary issue below the City of Troy WWTP, with 89.7% of the samples exceeding the 0.1 mg/L TP target (n=29), and 75.9% of the samples exceeding the 0.3 mg/L NO_2+NO_3 target (n=29) at site POT-16.
- No DO exceedances (n=14) occurred at the upper site, POT-15. Fourteen exceedances (n=30) were documented at site POT-16, located below the City of Troy WWTP. Elevated nutrient levels seem the most likely cause for the low DO levels at site POT-16.
- A number of temperature exceedances were observed, with the instantaneous criterion being exceeded over 50% of the time at POT-16 (n=30).

2008 Pine Creek Data Summary (POT-4):

- Turbidity and sediment levels were very low in Pine Creek, and were well within an optimal range for aquatic life.

- Excessive nutrient loads were documented in Pine Creek, with nitrogen levels exceeding the 0.3 mg/L target criterion 50% of the time (n=20), and total phosphorus levels exceeding the 0.1 mg/L target 40% of the time (N=20).
- No violations of the 6.0 mg/L DO criterion was observed in Pine Creek (n=20), although during the summer months, when monitoring was suspended due to lack of flow, many of the remaining pools had DO levels below 6.0 mg/L.
- A number of temperature exceedances were observed, with the instantaneous criterion being exceeded 40% of the time (n=20).

2008 Cedar Creek Data Summary (POT-5):

- One major rain event occurred in May, 2006 that caused extreme elevations in sediment, TP and turbidity levels for approximately two weeks. Another rain on snow event in February, 2007 caused levels of the same parameters to be elevated once again. In both cases, a large plume of extremely turbid water flowed from Cedar Creek into the Potlatch River and noticeably increased turbidity levels in the Potlatch River, from the Cedar Creek confluence to the mouth. Aside from these localized events, turbidity and sediment levels were typically very low in Cedar Creek, and were well within an optimal range for aquatic life.
- Excessive nutrient loads were documented in Cedar Creek, with nitrogen levels exceeding the 0.3 mg/L target criterion 35.5% of the time (n=31), and total phosphorus levels exceeding the 0.1 mg/L target 12.9% of the time (N=31).
- No violation of the 6.0 mg/L DO criterion was observed in Cedar Creek (n=31.
- A number of temperature exceedances were observed, with the instantaneous criterion being exceeded 41.9% of the time (n=31).

2008 Boulder Creek Data Summary (POT-6):

- Water quality was generally very good in Boulder Creek.
- One exceedance of the 0.1 mg/L TP target was observed in August of 2007. No other nutrient exceedances occurred.
- No violation of the 6.0 mg/L DO criterion was observed in Boulder Creek (n=23).
- Turbidity and sediment levels were very low in Boulder Creek, and were well within an optimal range for aquatic life.
- Nine temperature exceedances were observed, with the instantaneous criterion being exceeded 39.1% of the time (n=23).

2008 Little Boulder Creek Data Summary (POT-7):

- Water quality was excellent in Little Boulder Creek.
- No nutrient exceedances occurred.
- No violation of the 6.0 mg/L DO criterion was observed in Little Boulder Creek (n=18).
- Three temperature exceedances were observed, with the instantaneous criterion being exceeded 16.7% of the time (n=18).
- Turbidity and sediment levels were very low in Little Boulder Creek, and were well within an optimal range for aquatic life.

2008 West Fork Potlatch River Data Summary (POT-10):

- Nutrient levels were generally low, with two samples exceeding the 0.1 mg/L target criterion for TP (n=24). No exceedances of nitrogen were observed.
- Temperature levels exceeded State of Idaho criteria 36.0% of the time (n=25).
- Two violations of the 6.0 mg/L DO criterion were observed (n=23).
- Turbidity and sediment levels were very low in West Fork Potlatch River, and were well within an optimal range for aquatic life.
- Two exceedances of the 406 organisms/100mL *E. coli* standard for primary contact recreation were observed (n=23).

2008 Corral Creek Data Summary (POT-12):

- Nutrient levels were very low, with no samples exceeding either the 0.3 mg/L target criterion for nitrogen or the 0.1 mg/L target for TP (n=15).
- Temperature levels exceeded State of Idaho criteria 35.7% of the time (n=14).
- No violations of the 6.0 mg/L DO criterion were observed (n=14).
- Turbidity and sediment levels were very low in Corral Creek, and were well within an optimal range for aquatic life.
- Two exceedances of the 576 organisms/100mL *E. coli* standard for secondary contact recreation were observed (n=12).

2008 Potlatch River Upper Mainstem Summary (POT-11):

- Nutrient levels were very low, with no samples exceeding either the 0.3 mg/L target criterion for nitrogen or the 0.1 mg/L target for TP (n=30).
- Temperature levels exceeded State of Idaho criteria 48.4% of the time (n=31).
- Two violations of the 6.0 mg/L DO criterion were observed (n=31).
- Turbidity and sediment levels were very low at this site, and were well within an optimal range for aquatic life.
- Seven exceedances of the 406 organisms/100mL *E. coli* standard for primary contact recreation were observed (n=29).

2008 Potlatch River Upper Mainstem Summary (POT-8):

- Nutrient levels were very low, with no samples exceeding either the 0.3 mg/L target criterion for nitrogen or the 0.1 mg/L target for TP (n=28).
- Temperature levels exceeded State of Idaho criteria 51.7% of the time (n=29). The river at this site is very wide and solar loading will continue to be an issue at this site.
- No violations of the 6.0 mg/L DO criterion were observed (n=29).
- Turbidity and sediment levels were very low at this site, and were well within an optimal range for aquatic life.
- Two exceedances of the 406 organisms/100mL *E. coli* standard for primary contact recreation were observed (n=29).
- Four exceedances of the maximum pH level of 9.0 were observed. There is no indication that nutrient levels were influencing pH levels, and no other human activity in the area was observed that would have led to an increase in pH levels.

This is likely either a natural phenomenon or the pH meter used in this study was malfunctioning.

2008 Hog Meadow Creek Summary (POT-9):

- Nutrient levels were very low, with no samples exceeding either the 0.3 mg/L target criterion for nitrogen or the 0.1 mg/L target for TP (n=10).
- Temperature levels exceeded State of Idaho criteria once during this study (n=10).
- No violations of the 6.0 mg/L DO criterion were observed (n=9).
- Turbidity and sediment levels were very low at this site, and were well within an optimal range for aquatic life.
- No exceedances of the 576 organisms/100mL *E. coli* standard for secondary contact recreation were observed (n=7).

2008 Potlatch River Lower Mainstem Summary (POT-1):

- Nitrogen levels exceeded the 0.3 mg/L target criterion 32.1% of the time during this study (n=28). Spikes in nitrogen levels occurred in February and March of both study years, and rainfall during that period may have mobilized nitrogen, laid down as fertilizer, from surrounding agricultural lands.
- Temperature levels exceeded State of Idaho criteria 46.4% of the time (n=28). The entire lower portion of the Potlatch River is quite wide and has relatively little shade, making solar loading a difficult problem to overcome.
- No violations of the 6.0 mg/L DO criterion were observed (n=29).
- Turbidity and sediment levels were generally very low at this site, aside from one event in May, 2006, when heavy rains caused a massive amount of sediment to be delivered from Cedar Creek into the Potlatch River.
- Two exceedances of the 406 organisms/100mL *E. coli* standard for primary contact recreation were observed (n=26).
- Two exceedances of the maximum pH level of 9.0 were observed.

Recommendations

Nutrients are the major pollutant in this watershed, with Pine Creek, West Fork Little Bear Creek, Cedar Creek and Middle Potlatch Creek being the most impacted subwatersheds in the Potlatch River catchment. Steps should be taken to reduce the overall quantity of nitrogen and phosphorus entering the Potlatch River from these tributaries. Nutrient management plans should be developed by landowners in the watershed, with assistance from the Natural Resource Conservation Service (NRCS) and local soil and water conservation districts, so that producers have a tool to increase net returns while protecting water quality. Producers in this watershed often apply nitrogen fertilizer as anhydrous ammonia in the fall. Winter and spring rains wash much of this soluble fertilizer into these streams. Nitrogen does not accumulate in the soil, so the high nitrate levels observed in this study are a result of seasonal applications. Therefore, changes in application timing and rates could very well contribute to an immediate benefit to water quality in this catchment.

Although SSC levels were generally quite low in the Potlatch River watershed, erosion is evident in many areas, both in-stream and in adjacent farmland, and treatment should be applied to areas undergoing the most severe erosion. In particular, priority should be given to the Cedar Creek subwatershed, where the lack of substantial riparian vegetation in the upper portion of the catchment results in heavy seasonal sediment loads being delivered to the stream channel annually and subsequently flushed down into the Potlatch River. The re-vegetation of stream banks along Cedar Creek would help to reduce sediment transport, as healthy riparian vegetation is effective in reducing bank erosion. Riparian vegetation will also filter sediment being transported in surface water runoff. Some Best Management Practices (BMPs) that should be explored for this subwatershed are crop rotations, filter strips, grassed waterways and residue management strategies, such as no till farming practices. Surveys should also be done in the lower portion of the Cedar Creek subwatershed to evaluate the quantity of sediment being delivered to the stream due to mass wasting in the steep canyon land that typifies the lower reach.

Excessive stream temperature is a widespread and difficult problem to overcome, and should be addressed by re-establishing natural full potential canopy shade along streams. Reducing sediment loads within critical reaches will also assist in reducing stream temperatures, since suspended particles tend to absorb more heat.

Some specific BMPs that would help to improve overall water quality in the Potlatch River drainage are: tree and shrub plantings, grassed waterways, stream bank stabilization, conservation cropping and tillage practices, protected riparian zones, and detailed nutrient management plans developed by landowners and local conservation districts. In addition, loss of connectivity between many of these streams and their floodplains and associated wetlands has resulted in a loss of both terrestrial and aquatic biodiversity, as well as land and water productivity.

Based on the collected data from this study, the most severely water quality limited streams in this watershed are: Pine Creek, West Fork Little Bear Creek, Middle Fork Potlatch Creek and Cedar Creek. Giving priority to restoration efforts in these streams would have the greatest positive impact on water quality in the Potlatch River itself.

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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.
DFO	Department of Fisheries and Oceans, Canada.
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.
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 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	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