BONNEVILLE POWER ADMINISTRATION

Assess Current and Potential Salmonid Production in Rattlesnake Creek Associated with Restoration Efforts

Underwood Conservation District

Annual Report 2004 - 2005 September 2005 DOE/BP-00006301-4

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Bonneville Power Administration
P.O. Box 3621
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Assess Current and Potential Salmonid Production in Rattlesnake Creek Associated with Restoration Efforts.

2004-2005 Annual Report
for the period
July 1 2004 to June 30 2005

August 2005

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Project Number: 200102500

2004-2005 Annual Report
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Introduction

This project addresses existing habitat conditions, fish population status, and restoration priority sites within the Rattlesnake Creek watershed, a tributary of the White Salmon River. Our partners in this project are the United States Geological Survey (USGS) and the Yakama Nation (YN). Underwood Conservation District (UCD) is involved in the project via accomplishment of water quality monitoring, sampling for stable isotopes, and characterization of the watershed geomorphology. These work items are part of an effort to characterize the fish populations and stream and riparian habitat conditions in Rattlesnake Creek, to help guide habitat and fish restoration work.

Water chemistry and temperature information is being collected both on Rattlesnake Creek, and on other tributaries and the main stem of the White Salmon River. Information on the entire system enables us to compare results obtained from Rattlesnake Creek with the rest of the White Salmon system. Water chemistry and temperature data have been collected in a manner that is comparable with data gathered in previous years. The results from data gathered in the 2004-2005 performance period are reported.

Additional work being conducted as part of this study includes; an estimate of salmonid population abundance (YN and USGS); a determination of fish species composition, distribution, and life history (YN and USGS); and a determination of existing kinds, distribution, and severity of fish diseases (YN and USGS).

The overall objective is to utilize the above information to prioritize restoration efforts in Rattlesnake Creek.

Objective 1: Characterize stream and riparian habitat conditions in the Rattlesnake Creek drainage

This study is intended to establish Rattlesnake Creek baseline conditions prior to the anticipated development of removal of Condit Dam, or establishment of fish passage around that dam in 2006. This baseline information, along with water quality monitoring accomplished in the early to mid 1990s, will help in development of future watershed restoration strategies and evaluation of the projects accomplished. The baseline conditions can be compared with conditions following restoration activities, to assess project effectiveness.

<u>Task 1a:</u> Measure water quality, water quantity, stream habitat, and riparian conditions (UCD, YN, USGS)

Within the White Salmon River basin, UCD has established 19 sites to monitor various water quality parameters (Map 1). 8 sites are monitored for continuous water temperature, general water chemistry (pH, conductivity, turbidity, dissolved oxygen, and temperature), and advanced laboratory water chemistry (total phosphorus (TP), nitrate (NO3) and nitrite (NO2) as nitrogen, and total suspended solids (TSS)). 6 sites are monitored for continuous temperature and general water chemistry. 2 sites are only monitored for continuous temperature, and 3 sites only general chemistry. Five rounds of water chemistry sampling were conducted in the White Salmon basin during the 2004-2005 performance period. 17 out of the 19 sites were tested for the routine water chemistry parameters of pH, conductivity, turbidity, dissolved oxygen, and temperature. Four of the sample rounds were conducted quarterly throughout the year. A fifth round of water chemistry sampling was conducted in September 2004, during the period of low water flow.

Map 1
White Salmon River Watershed Water Quality Monitoring Sites

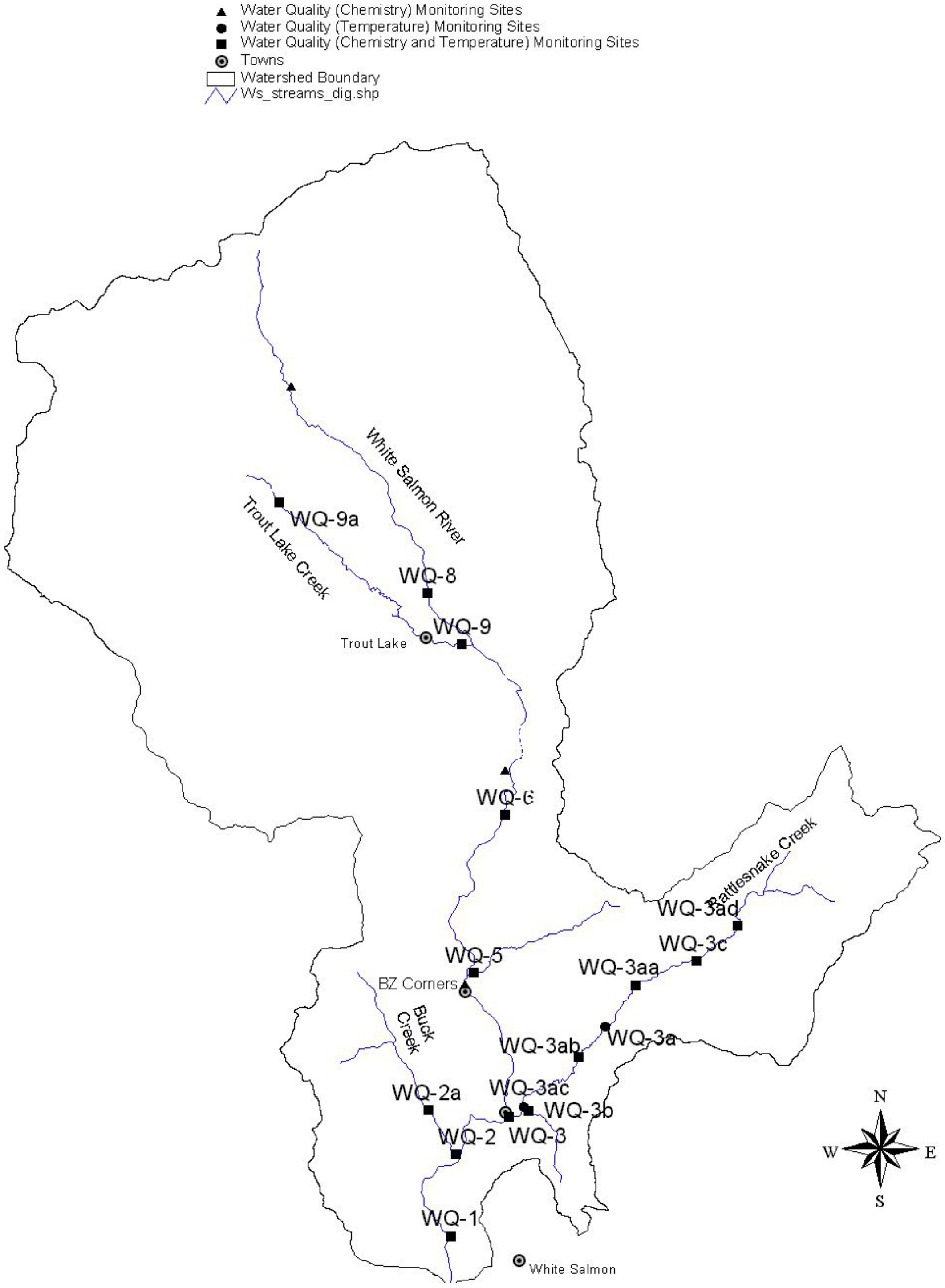


Table 1. Site locations and analysis carried out at each location.

Site ID	Site Description	Distance from mouth of White Salmon km	General water chemistry (pH,Conductivity , DO, temp)	Laboratory Analyses. Nitrate + Nitrite as Nitrogen ,T. Phos. and TSS	Continuous Temperature
1	White Salmon at base (USFWS)	2.50	●	●	●
2	Buck Creek at base (Big Buck Rd)	8.35	●		●
2a	Buck Creek at DNR boundary	11.62	●		●
3	Rattlesnake Creek at base	12.50	●	●	●
3b	Indian Creek at base	13.25	●	●	●
3ac	Rattlesnake Creek above INC	13.27			●
3ab	Rattlesnake Creek (at base of alluvial reach)	18.10	●	●	●
3a	Rattlesnake Creek at DNR	20.27			●
3aa	Rattlesnake Creek below upper canyon	23.8	●	●	●
3c	Mill Creek	26.52	●	●	●
3ad	Rattlesnake Creek upper canyon	29.40	●	●	●
4	White Salmon River at BZ boat launch	20.13	●		
5	Gilmer Creek (above falls)	21.38	●	●	●
6	White Salmon River (below Trout lake valley)	31.5	●		●
7	Trout Lake Water Co. Ditch (Sunnyside Rd)	57.01	●		
8	White Salmon River (upper)	67.00	●		●
9	Trout Lake Creek at base (Old Creamery Rd)	63.88	●		●
9a	Trout Lake Creek at 8810 rd	77.26	●		●
10	Cascade Creek	81.38	●		

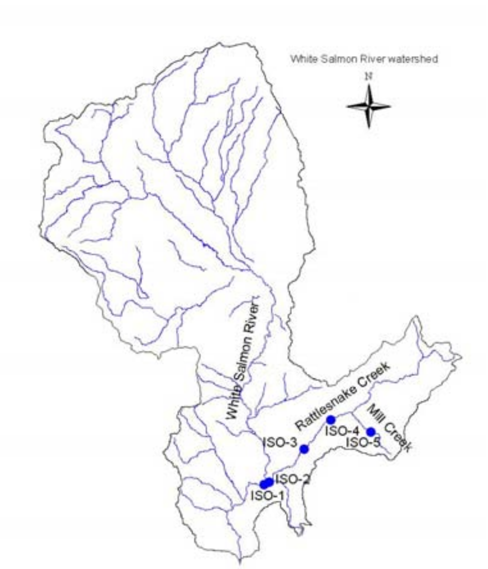
Continuous water temperature data is being collected at 16 of the 19 sites. Stream temperature information is collected using Onset Stowaway Temperature Loggers. The loggers are located at 8 stations throughout the main White Salmon watershed, and 8 stations in Rattlesnake Creek (sub basin of the White Salmon River) The loggers have been recording data year-round (1st deployed in spring 2001). Water temperature results are summarized graphically in this report.

In spring of 2004, data loggers were brought into the office, and temperature data from the previous year was downloaded onto computers. Logger accuracy was checked against a National Institute of Standards and Technology (NIST) thermometer, and reinstalled. In September 2004, loggers were again downloaded, and reinstalled for the winter. Water chemistry and temperature data are summarized in Appendix A

A permanent stream monitoring station was installed on lower Rattlesnake Creek in spring 2003 by River Measurement, LLC. Located near the base of Rattlesnake Creek, this gage will enable monitoring of discharge in the basin. Following installation, River Measurement began (and is continuing within Performance Period 2004-2005) involving site visits to take current-meter discharge measurements and to download data from the monitoring station. River Measurement is also documenting stream and channel conditions that affect the stage-discharge rating, and comparing staff gage readings to the monitoring station information to ensure the instrument is working properly. This station allows continuous monitoring of stream levels throughout the year. A curve showing temperature and discharge information for the 2004 Water Year is shown in Appendix B.

<u>Task 1c:</u> Determine background levels of stable carbon and nitrogen isotopes in the Rattlesnake Creek drainage. (UCD, USGS)

UCD has continued to collect vegetation and invertebrate animal samples, and to derive the stable isotope ratios of carbon and nitrogen in those samples. The ratios of stable isotopes for these elements from marine-derived nutrients (brought into the system by migrating salmonids) are different than from terrestrial sources. Therefore, the ratios can serve as a "signature" indicating the presence of marine-derived nutrients. Since Condit Dam currently blocks anadromous salmonids from most of the White Salmon River system, our current work serves as a "baseline" from which we'll be able to see differences once the Condit Dam passage problem is solved.



Two rounds of field sampling were conducted by UCD and USGS staff in the 2004-2005 performance period. Field samples were collected in October 2004 and in June 2005. The samples were collected at five sites in the Rattlesnake Creek drainage (see map at right). Samples consist of terrestrial and aquatic plant materials, macroinvertebrates, and fish. Water quality parameters were also taken at each site on the day of collection (pH, conductivity, turbidity, dissolved oxygen, temperature, total Phosphorus, Nitrate + Nitrite, and Total suspended sediment). Between July 2004 and June 2005, two sets of samples were processed by UCD staff at the USGS facilities in Cook WA., those collected in June 2004 (the previous performance period) and those collected in October 2004. Samples collected in June 2005 will be processed in the next performance period. Once processed the samples are sent for isotope ratio analysis by an outside contractor (University of California, Davis).

The UCD report to BPA from our July 2003-June 2004 Performance Period included a detailed summary of results to that point in time. We lost our experienced person in this work, and are still processing some field information that was delayed, and have not been able to construct a similar report for this performance period. With the assistance of the USGS Columbia River Research Laboratory, we will complete a report for the entire life of the project in Performance Period July 2005-June 2006, our final project report.

Budget Summary

Expenditures by Category:

Underwood Conservation District
Rattlesnake Creek Project
BPA Project No. 2001-025-00
Contract 00006301
July 1, 2004- June 30, 2005

Category	**Expended**	**Unexpended**
Personnel:	27,174.07	480.93
Supplies:	585.96	414.04
Overhead:	3,828.70	(280.70)
Travel:	573.60	126.40
Subcontractors:	13,663.93	1,206.07
Other:		
Total:	45,826.26	1,946.74

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Connolly, P.J., 2003 (in print) – Assess current and potential salmonid production in Rattlesnake Creek associated with restoration efforts. 2002 Annual Report by US Geological Survey Western Fisheries Research Center, Columbia River Research Laboratory.

Meehan, W. R., editor. 1991. Influences of forest and rangeland management on salmonid fishes and their habits. American Fisheries Society Special Publication 19.

Stampfli, 1994 White Salmon River Watershed, Basin water quality investigation report. Underwood Conservation District.

Web site references

EPA ref 1 US Environmental Protection Agency, Monitoring and assessing water quality 5.3 temperature from web site http://www.epa.gov/volunteer/stream/vms53.html

EPA ref 2 Environmental Protection Agency, Monitoring and assessing water quality 5.4 temperature from web site http://www.epa.gov/volunteer/stream/vms54.html

US EPA ref 3 Environmental Protection Agency, Monitoring and assessing water quality 5.2 dissolved oxygen from web site http://www.epa.gov/volunteer/stream/vms52.html

EPA ref 4 Environmental Protection Agency, Monitoring and assessing water quality 5.5 turbidity from web site http://www.epa.gov/volunteer/stream/vms55.html

EPA ref 5 Environmental Protection Agency, Monitoring and assessing water quality 5.9 conductivity from web site http://www.epa.gov/volunteer/stream/vms59.html

EPA ref 6 Environmental Protection Agency, Monitoring and assessing water quality 5.6 Phosphorus from web site http://www.epa.gov/volunteer/stream/vms56.html

EPA ref 7 Environmental Protection Agency, Monitoring and assessing water quality 5.7 Nitrates from web site http://www.epa.gov/volunteer/stream/vms57.html

USGS ref1 USGS Water resources (http://water.usgs.gov/monitoring_day/measurements.html)

Appendix A:
Water Quality Results for the period July 1, 2004 to June 30, 2005

Sampling for water chemistry took place on five separate occasions during the performance period (see Table 1). The two September samplings were low "base" flows. The January 31, 2003 sample was a flush flow event, taken during a winter storm. During winter sample collection, some sites in Rattlesnake Creek were not sampled due to lack of winter access.

Table 1 Sampling Schedule.

Date	Type of Flow
July 13-14, 2004	Summer
September 13-14 2004	Base flow
October 18-19 2004	Fall
January 5-6 2005	Winter
April 5-6, 2005	Spring

General Water Chemistry

General indicators of stream health commonly used by the US Environmental Protection Agency (EPA) and Washington Department of Ecology (DOE) include temperature, pH, turbidity, conductivity, and dissolved oxygen (DO). Similar to a doctor assessing pulse and blood pressure in a patient, these are basic parameters that may indicate problems that require more in-depth analysis. Continuous temperature and advanced chemistry will be approached later in this report.

pH

pH is a measure of how acidic or basic a water body is. The pH can directly affect the survival of aquatic organisms. Pure water is neutral, with a pH of 7.0. pH readings below 7.0 indicate acidic conditions. Waters with pH less than 4.0 generally have no vertebrate life forms in them. pH readings above 7.0 indicate basic conditions. 'pH affects many chemical and biological processes in water. For example, different organisms flourish within different ranges of pH. The largest variety of aquatic organisms prefer a range of 6.5 – 8.0. pH outside this range reduces the diversity in the stream because it stresses the physiological systems of most organisms and can reduce reproduction. Low pH can also allow toxic elements and compounds to become mobile and "available" for uptake by aquatic plants and animals. This can produce conditions that are toxic to aquatic life, particularly to sensitive species like rainbow trout. Changes in acidity can be caused by atmospheric deposition (acid rain), surrounding rock, and certain wastewater discharges.' (EPA ref 2)

pH values in the watershed indicate healthy conditions. Of 293 pH measures, only 2 exceeded the upper state standard of 8.5, with 1 other exceeding the lower standard of 6.5. The highest reading, 9.92 on Trout Lake Creek in September, 2001, coincided with very high stream temperatures in a shallow portion of the stream, which may have affected the result. The highest result recorded during 2004-5 was 8.12 in September 2004, on Indian Creek.

pH is summarized by site in Table 2 and Table 3. While samples are not large enough for the means to be significant, they do indicate a lower pH in the White Salmon River, with higher pH values in tributaries. Tributaries at lower elevations also appear to have slightly higher pH values than tributaries at higher elevations, possibly due to warmer water temperatures.

Table 2: pH by White Salmon River Sites, 2001- April 2005

Station ID	Stream	Ave ph	Max	Min	Count
WQ-1	White Salmon	7.53	7.92	7.09	18
WQ-10	Cascade Creek	7.29	7.67	6.36	14
WQ-2	Buck Creek	7.70	7.99	7.36	18
WQ-2a	Buck Creek	7.77	8.01	7.24	17
WQ-3	Rattlesnake Creek	7.86	8.19	7.11	18
WQ-3aa	Rattlesnake Creek	7.87	8.7	7.09	19
WQ-3ab	Rattlesnake Creek	7.79	8.18	7.24	18
WQ-3ad	Rattlesnake Creek	7.84	8.06	7.41	16
WQ-3b	Indian Creek	7.90	8.22	7.28	19
WQ-3c	Mill Creek	7.78	8.18	7.26	15
WQ-4	White Salmon	7.43	7.65	7.16	16
WQ-5	Gilmer Creek	7.71	8.01	7.05	18
WQ-6	White Salmon	7.47	7.87	7.01	17
WQ-7a	TLWC Ditch	7.44	7.72	7.1	16
WQ-8	White Salmon	7.33	7.68	7.01	18
WQ-9	Trout Lake Creek	7.64	9.92	6.97	18
WQ-9a	Trout Lake Creek	7.43	7.78	7.04	18

Table 3. Average, maximum, and minimum pH

Stream	Ave ph	Max	Min	Count
Buck Creek	7.73	8.01	7.24	35
Cascade Creek	7.29	7.67	6.36	14
Gilmer Creek	7.71	8.01	7.05	18
Indian Creek	7.90	8.22	7.28	19
Mill Creek	7.78	8.18	7.26	15
Rattlesnake Creek	7.84	8.7	7.09	71
TLWC Ditch	7.44	7.72	7.1	16
Trout Lake Creek	7.53	9.92	6.97	36
White Salmon	7.44	7.92	7.01	69

Rattlesnake Creek and Indian Creek still show the highest mean pH values. Several sites on Rattlesnake Creek were not accessible in winter, thus have fewer samples.

Although Rattlesnake Creek shows higher pH readings than the rest of the White Salmon, it is still within levels preferred by aquatic organisms.

pH also continued to show seasonal variations as might be expected (Figure 1). During flush flows and winter periods, overall pH was lower. During low flows, it appears a bit higher.

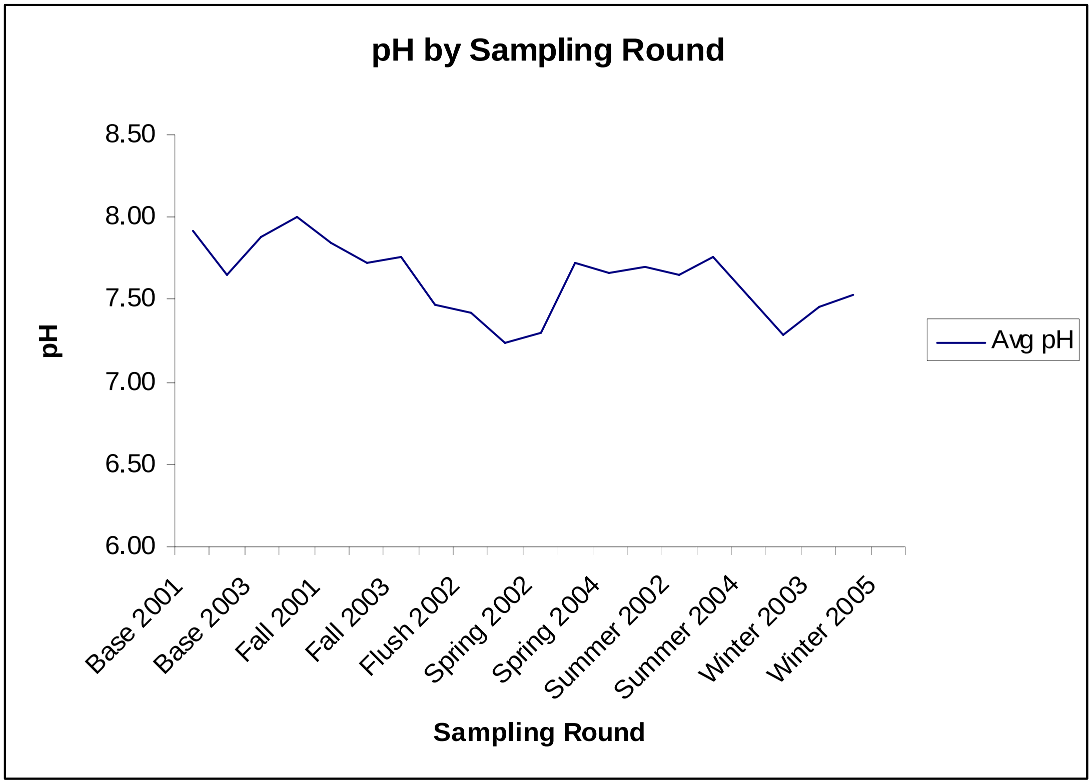


Figure 1, pH by Sampling Round

Data from the mid-1990s show similar results. pH values throughout the White Salmon were around neutral, with average site values ranging from 6.95 to 7.64. Rattlesnake Creek (measured only at the base in the mid-1990s) showed a maximum value of 7.77. None of the earlier data indicate pH levels that are out of the range most desirable for aquatic organisms.

Dissolved Oxygen

Dissolved oxygen is a measure of the amount of oxygen dissolved in water. It is important for determining whether the water body can support organisms which require oxygen – aerobic organisms – such as fish and zooplankton. High dissolved oxygen levels are better. Generally, levels greater than 5-6 mg/L can support diverse forms of aquatic life (USGS ref 1).

Dissolved oxygen (DO) is both produced and consumed in the stream system. Oxygen is acquired from the atmosphere and from plants as a result of photosynthesis. Running water dissolves more oxygen than still water as the turbulence at the water surface traps more air. Aquatic animal respiration, decomposition, and various chemical reactions consume oxygen.

‘Oxygen is measured in its dissolved form as DO. If more oxygen is consumed than is produced, DO levels decline and some sensitive animals may move away, weaken, or die.’ (EPA ref 3).

‘DO levels fluctuate seasonally and over a 24-hour period. They vary with water temperature and altitude. Cold water holds more oxygen than warm water, and water holds less oxygen at higher altitudes. Aquatic animals are most vulnerable to lowered DO levels in the early morning on hot summer days when stream flows are low. Water temperatures are high, and aquatic plants have not been producing oxygen since sunset.’ (EPA ref 3).

The results shown in Tables 4 and 5 indicate that while DO fluctuates by up to 5mg/L at some sites over the course of the project period, the amount of oxygen dissolved in the waters is above the minimum State standard. Site 9, Trout Lake Creek (Old Creamery Rd) has one reading below the Class A Standard of 8.0 mg/L . This may be attributed to poor flow, as the sample was taken in slow moving water. Later samples were taken from a more representative flow for the creek, which is in a fast moving channel (see also the high pH reading at this site on the same date.

As might be expected, streams that were cooler (White Salmon River, Cascade Creek) showed generally higher levels of dissolved oxygen than warmer streams, such as Rattlesnake Creek. DO also showed a tendency to be lower in summers and higher in winter (Figure 2).

Table 4. Dissolved oxygen levels, 2001- April 2005, by sampling site

Station ID	Stream	Ave DO	Max DO	Min DO	Count
WQ-1	White Salmon	12.04	13.43	10.17	20
WQ-10	Cascade Creek	12.06	13.41	10.91	15
WQ-2	Buck Creek	11.44	13.28	9.25	21
WQ-2a	Buck Creek	11.77	14.21	9.44	19
WQ-3	Rattlesnake Creek	11.28	14.35	9.56	21
WQ-3aa	Rattlesnake Creek	11.40	14.02	9.76	19
WQ-3ab	Rattlesnake Creek	10.94	13.76	8.69	19
WQ-3ad	Rattlesnake Creek	11.00	13.83	9.35	15
WQ-3b	Indian Creek	10.85	14.22	8.06	20
WQ-3c	Mill Creek	10.76	13	8.9	14
WQ-4	White Salmon	12.75	14.08	10.9	19
WQ-5	Gilmer Creek	11.37	12.88	10.21	21
WQ-6	White Salmon	11.97	13.95	8.77	19
WQ-7a	TLWC Ditch	11.68	14.33	8.33	19
WQ-8	White Salmon	12.32	14.54	9.92	21
WQ-9	Trout Lake Creek	11.74	14.76	7.77	21
WQ-9a	Trout Lake Creek	11.99	14.79	8.75	20

Table 5. Dissolved oxygen, 2001- April 2005, by stream

Stream	Ave DO mg/L	Max DO mg/L	Min DO mg/L	Count
Buck Creek	11.60	14.21	9.25	40
Cascade Creek	12.06	13.41	10.91	15
Gilmer Creek	11.37	12.88	10.21	21
Indian Creek	10.85	14.22	8.06	20
Mill Creek	10.76	13	8.9	14
Rattlesnake Creek	11.17	14.35	8.69	74
TLWC Ditch	11.68	14.33	8.33	19
Trout Lake Creek	11.86	14.79	7.77	41
White Salmon	12.27	14.54	8.77	79

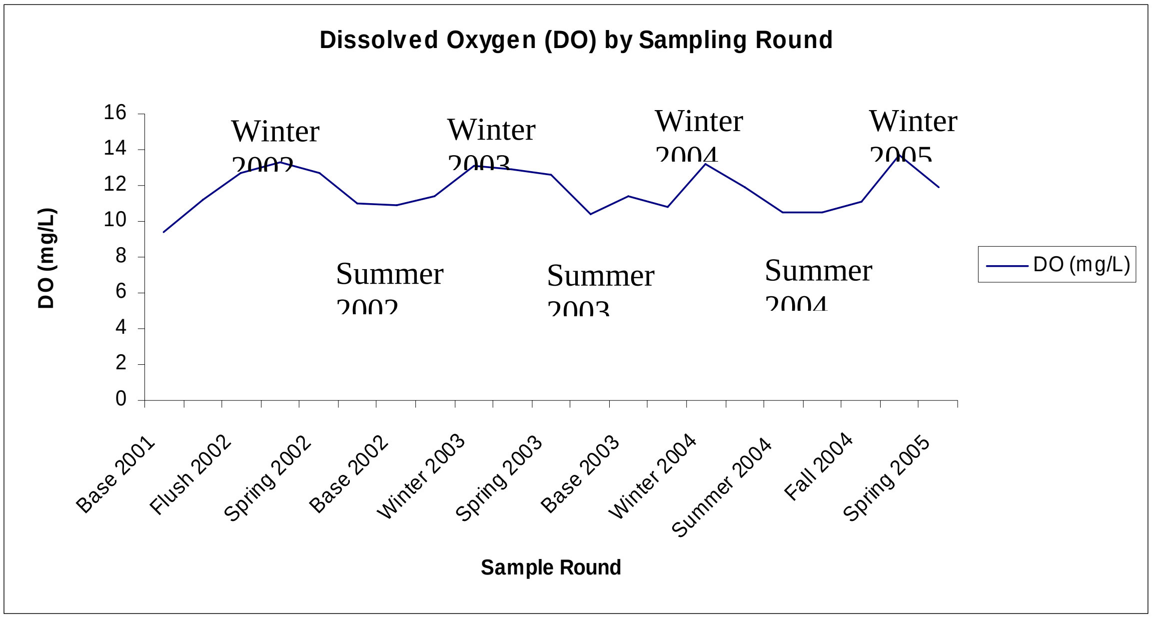


Figure 2. Dissolved Oxygen (DO) levels by sampling round, average for all locations.

Dissolved oxygen levels continue to look good for support of aquatic species, as we have noted in previous reports.

Turbidity

Turbidity is a measure of the clarity of the water. The amount of debris, soil particles, or plankton in the water affects the amount of sunlight that reaches aquatic plants. High turbidity will reduce the amount of light passing through the water column and reduce the plant's ability for photosynthesis, and so reduce the amount of available oxygen in the water.

'Higher turbidity increases water temperatures because suspended particles absorb more heat. This in turn, reduces the concentration of dissolves oxygen (DO) because warm water holds less DO than cold.' (EPA ref 4). 'Suspended materials can clog fish gills, reducing resistance to disease in fish, lowering growth rates, and affecting egg and larval development. As the particles settle, they can blanket the stream bottom, especially in slower waters, and smother fish eggs and benthic macroinvertebrates. Sources of turbidity include; soil erosion, waste discharge, urban runoff, eroding stream banks, excessive algal growth' (EPA ref 4).

'Regular monitoring of turbidity can help detect trends that might indicate increasing erosion in developing watersheds. However, turbidity is closely related to stream flow and velocity and should be correlated with these factors. Comparisons of the change in turbidity over time therefore should be made at the same point at the same flow. Turbidity is not a measurement of the amount of suspended solids present or the rate of sedimentation of a stream since it measures only the amount of light that is scattered by suspended particles.' (EPA ref 4).

Turbidity is closely related to streamflow, and may be particularly high during storm events. The 3 highest turbidity readings recorded in the past 4 years all occurred in January 2003, when we sampled during a high stormflow.

Table 6. Turbidity (NTU) by sampling site, 2001-2005

Station ID	Stream	Ave	Max	Min	Count
WQ-1	White Salmon	12.67	165	0.92	19
WQ-2	Buck Creek	5.88	98	0.47	21
WQ-2a	Buck Creek	0.97	2.59	0.3	19
WQ-3	Rattlesnake Creek	6.74	54	0.59	20
WQ-3aa	Rattlesnake Creek	3.46	15.6	0.46	20
WQ-3ab	Rattlesnake Creek	3.77	16.1	0.62	19
WQ-3ad	Rattlesnake Creek	2.19	9.95	0.49	16
WQ-3b	Indian Creek	3.80	13.1	0.79	20
WQ-3c	Mill Creek	3.29	12.8	0.71	15
WQ-4	White Salmon	5.26	40.9	0.98	18
WQ-5	Gilmer Creek	16.19	190	0.58	20
WQ-6	White Salmon	24.42	224	1.15	18
WQ-7a	TLWC Ditch	17.61	125	1.15	19
WQ-8	White Salmon	30.61	377	1.14	21
WQ-9	Trout Lake Creek	11.61	204	0.65	21
WQ-9a	Trout Lake Creek	0.94	8.28	0.27	20
WQ-10	Cascade Creek	22.04	105	1.82	15

Conductivity

Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Organic compounds like oil, phenol, alcohol, and sugar do not conduct electrical current very well and therefore have low conductivity when in water. Conductivity is also affected by temperature; the warmer the water, the higher the conductivity. For this reason, conductivity is reported at 25 degrees Celsius (25C). Conductivity in streams and rivers is affected primarily by the geology of the area through which the water flows. Streams than run through areas with clay soils tend to have higher conductivity because of the presence of materials that ionize when washed into the water. Ground water inflows can have the same effects depending on the bedrock they flow through.

The conductivity of rivers in the United States generally ranges from 50 to 1500 µs/cm. Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 µs /cm. Conductivity outside this range could indicate that the water is not suitable for certain species of fish or macroinvertebrates.' (EPA ref 5)

Conductivity is useful as a general measure of stream water quality. Each stream tends to have a relatively constant range of conductivity that, once established, may be used as a baseline for comparison with regular conductivity measurements. Significant changes in conductivity could then be an indicator that a discharge or some other source of pollution has entered a stream (EPA ref. 5).

Conductivity levels are generally low, but do vary substantially from site to site (Table 7) and from stream to stream (Table 8). Indian Creek, Rattlesnake Creek, Gilmer Creek and Mill Creek show the highest conductivity levels.

Table 7. Conductivity (µS/cm), 2001-2005, by sampling site

Station ID	Stream	Ave Conductivity	Max Conductivity	Min Conductivity	Count
WQ-1	White Salmon	60.02	73.2	34.5	20
WQ-2	Buck Creek	71.48	96	34.8	21
WQ-2a	Buck Creek	70.32	89.4	43.4	19
WQ-3	Rattlesnake Creek	122.08	193.3	51.8	21
WQ-3aa	Rattlesnake Creek	114.60	175.8	6.5	20
WQ-3ab	Rattlesnake Creek	118.12	174.3	54.6	19
WQ-3ad	Rattlesnake Creek	132.46	192.5	52.9	16
WQ-3b	Indian Creek	148.52	210	60.2	20
WQ-3c	Mill Creek	109.77	148.8	58.8	15
WQ-4	White Salmon	57.18	69.9	34	19
WQ-5	Gilmer Creek	119.69	171.5	59.8	21
WQ-6	White Salmon	52.28	76.8	23.5	19
WQ-7	TLWC Ditch	47.22	76.2	26	6
WQ-8	White Salmon	56.58	77.3	23.1	21
WQ-9	Trout Lake Creek	43.22	60.2	22	21
WQ-9a	Trout Lake Creek	39.01	52.4	19	20
WQ-10	Cascade Creek	93.67	115.9	67.3	15

Table 8. Conductivity (µS/cm), 2001- April 2005, by stream.

Stream	Ave	Max	Min	Count
Buck Creek	70.93	96	34.8	40
Cascade Creek	93.67	115.9	67.3	15
Gilmer Creek	119.69	171.5	59.8	20
Indian Creek	148.52	210	60.2	20
Mill Creek	109.77	148.8	58.8	15
Rattlesnake Creek	121.31	193.3	6.5	75
TLWC Ditch	50.07	76.2	13.5	19
Trout Lake Creek	41.17	60.2	19	41
White Salmon	56.56	77.3	23.1	76

Advanced Laboratory Analysis.

For this study UCD was able to send collected samples to a certified laboratory for analysis. The Laboratory used was Columbia Analytical Services (CAS).

Columbia Analytical Services
1317 South 13th Avenue,
Kelso, WA 98626

CAS provided UCD with prepared sample bottles and coolers. Analysis was conducted using EPA standard methods for nitrate and nitrite as nitrogen (EPA Method 353.2), and Total phosphorus (EPA Method 365.3). Only five (5) sites on Rattlesnake Creek were assessed for phosphorus and nitrates. Gilmer Creek was assessed only twice during the sample period.

Phosphorus

Both phosphorus and nitrogen are essential nutrients for the plants and animals that make up the aquatic food web. Since phosphorus is the nutrient in short supply in most waters, even a modest increase in phosphorus can, under the right conditions, set off a whole chain of undesirable events in a stream including accelerated plant growth, algae blooms, low dissolved oxygen, and the death of certain fish, invertebrates, and other aquatic animals.

There are many sources of phosphorus, both natural and human. These include soil and rocks, wastewater treatment plants, runoff from fertilized lawns and cropland, failing septic systems, runoff from animal manure storage areas, disturbed land areas, drained wetlands, water treatment, and commercial cleaning preparations.

Phosphorus has a complicated story. Pure “elemental” Phosphorus (P) is rare. In nature, phosphorus usually exists as part of a phosphate molecule (PO4). Phosphorus in aquatic systems occurs as organic phosphate and inorganic phosphate. Organic Phosphate consists of a phosphate molecule associated with a carbon-based molecule, as in plant or animal tissue. Phosphate that is not associated with organic material is inorganic. Inorganic phosphorus is the form required by plants. Animals can use either organic or inorganic phosphate.…Monitoring phosphorus is challenging because it involves measuring very low concentrations down to 0.01 milligrams per liter (mg/L) or even lower. Even such very low concentrations of phosphorus can have a dramatic impact on streams.' (EPA ref 6).

The test for total phosphorus measures all forms of phosphorus in the sample (orthophosphate , condensed phosphate and organic phosphate). The sample is not filtered and therefore measures both dissolved and suspended orthophosphate. The minimum reporting limit (MRL) used by CAS was 0.01mg/L. and the minimum detection limit (MDL) was 0.009mg/L.

Phosphorus levels in 2001-spring 2005 samples were low, averaging .054 in 107 detectable samples. Gilmer Creek is slightly higher than the White Salmon River and Rattlesnake Creek. A 1992-1994 report on the White Salmon River (Stampfli, 1994) showed Phosphorus levels in the same range.

Table 9. Phosphorus, 2001- April 2005, by sampling site

Station ID	Stream	Ave. Phosphorus
WQ-1	White Salmon	0.06
WQ-3	Rattlesnake Creek	0.06
WQ-3aa	Rattlesnake Creek	0.04
WQ-3ab	Rattlesnake Creek	0.05
WQ-3ad	Rattlesnake Creek	0.03
WQ-3b	Indian Creek	0.07
WQ-3c	Mill Creek	0.04
WQ-5	Gilmer Creek	0.07

Nitrate and Nitrite Nitrogen

Nitrogen is found in several different forms in nature including ammonia (NH3), nitrate (NO3), and nitrite (NO2). Plants require nitrate, but like phosphorus too much nitrate can cause water quality problems. If both nitrate and phosphorus increase together they can accelerate plant growth and alter the types of plants and animals in the stream. Such increases can affect dissolved oxygen, temperature, and other indicators. Excess nitrates can decrease dissolved oxygen and become toxic to warm-blooded animals at concentrations in excess of 10mg/L under certain conditions. *Natural levels of nitrates in surface waters are typically less than 1mg/L.*

Nitrate sources include wastewater plants, fertilizer runoff from lawns and crops, failing septic systems, and runoff from animal manure storage areas. Nitrates dissolve in water more readily, and enter the streams faster than phosphorus (they do not attach themselves to soil particles as phosphorus does). Therefore, nitrates are better indicators of possible pollution from sewage during dry weather.

This study is assessing nitrate and nitrite as nitrogen. It is possible that low nitrate readings may be an indication of a stream affected by a high input of nitrogen rich organic matter. The decomposition of organic matter decreases DO levels, which in turn slows down the rate of oxidization of ammonia to nitrite, and then to nitrate. Therefore, just a nitrate reading may not be the best indicator.

CAS analyzed the samples using EPA Method 353.2. This procedure is applicable to determining Nitrate/Nitrite concentrations greater than 0.02mg/L in water. The MRL for this method was 0.2mg/L and the MDL was 0.007mg/L.

The nitrate and nitrite nitrogen results for this project period were nearly all below the MRL of the test used (EPA 353.2). Only five sites, Gilmer Creek (13 samples), the base of Rattlesnake Creek (2 samples), and 3 other Rattlesnake Creek sites (1 sample each) showed results above the MRL. Nine samples were higher than the typical value of 1mg/L for surface waters, all occurring on Gilmer Creek. Similar results were obtained in sampling during the early 1990s. Most sites had occasional positive samples of nitrogen, with the rest being below reporting limits.

Table 10. Nitrate/Nitrite, detectable measurements by sampling site, 2001- April 2005.

Station ID	Stream	Nitrate +Nitrite as nitrogen (mg/L)	DATE
WQ-1	White Salmon	.1	05-Apr-05
WQ-3	Rattlesnake Creek	0.06	05-Apr-05
WQ-3	Rattlesnake Creek	0.20	23-Jul-03
WQ-3	Rattlesnake Creek	0.3	07-Jan-03
WQ-3aa	Rattlesnake Creek	0.2	08-Jan-02
WQ-3aa	Rattlesnake Creek	0.3	19-Oct-04
WQ-3ab	Rattlesnake Creek	0.3	08-Jan-03
WQ-3ad	Rattlesnake Creek	0.2	08-Jan-03
WQ-5	Gilmer Creek	0.4	31-Jan-03
WQ-5	Gilmer Creek	1.1	07-Jan-03
WQ-5	Gilmer Creek	1.9	01-Apr-03
WQ-5	Gilmer Creek	1.90	21-Jan-04
WQ-5	Gilmer Creek	1.93	05-Apr-05
WQ-5	Gilmer Creek	3.1	12-Apr-04
WQ-5	Gilmer Creek	4.1	12-Sep-01
WQ-5	Gilmer Creek	4.1	13-Jul-04
WQ-5	Gilmer Creek	4.20	04-Jan-05
WQ-5	Gilmer Creek	4.5	10-Sep-02
WQ-5	Gilmer Creek	5.5	18-Oct-04
WQ-5	Gilmer Creek	6.0	23-Jul-03
WQ-5	Gilmer Creek	6.3	03-Apr-02
WQ-5	Gilmer Creek	7	16-Sep-03
WQ-5	Gilmer Creek	8	03-Oct-02
WQ-5	Gilmer Creek	8	20-Oct-03
WQ-5	Gilmer Creek	8.2	13-Sep-04

Temperature

The temperature of water in a stream can adversely affect the biological and chemical processes that take place in the water body. 'Aquatic organisms from microbes to fish are dependent on certain temperature ranges for their optimal health. Optimal temperatures for fish depend on the species: some survive best in colder water, whereas others prefer warmer water. Benthic macroinvertebrates are also sensitive to temperature and will move in the stream to find their optimal temperature. If temperatures are outside this optimal range for a prolonged period of time, organisms are stressed and can die.' (EPA ref 1).

For fish there are two kinds of limiting temperatures the maximum temperature for short exposures and a weekly average temperature that varies according to the time of year and the life cycle stage of the fish species. Reproductive stages (spawning and embryo development) are the most sensitive stages.' (EPA ref 1) See table 11 for temperature criteria for salmonid fishes found in the Columbia River region.

Table 11. Lethal temperatures for selected salmonid species (Bjornn and Reiser 1991).

Species	Lower Lethal temp. °C	Upper Lethal temp. °C	Preferred Range °C
Coho Salmon	1.7	28.8	12-14
Chinook Salmon	0.8	26.2	12-14
Steelhead	0.0	23.9	10-13
Rainbow Trout	-	29.4	-
Cutthroat trout	0.6	22.8	-

'Temperature affects the oxygen content of the water (oxygen levels become lower as temperature increases); the rate of photosynthesis by aquatic plants; the metabolic rates of aquatic organisms; and the sensitivity of organisms to toxic wastes, parasites, and diseases.' (EPA ref 1) As temperature increases the organisms use up more oxygen as respiration increases while they adjust to cope with the rising temperature.

Factors affecting stream water temperatures include the weather, the amount of vegetation providing shade along the stream bank, groundwater inflows, the volume of water, the depth of the water, impoundments (barriers such as dams that restrict the flow), and the turbidity of the water. Wide shallow streams with slow flows are more likely to have increased temperatures as more of the water body is exposed to sunlight for a longer period of time compared to water in a narrow, deep channel with a rapid flow. 'Stream temperatures can be altered by removal of stream bank vegetation, withdrawal and return of water for irrigation, release of water from deep reservoirs, and cooling of nuclear power plants.' (Bjornn and Reiser, 1991).

We collect temperature information via two methods in this study. One method collected temperature information, using a hand held digital thermometer, while collecting the general water chemistry data (pH, DO, etc.). This temperature data determines the temperature at the same time at which the other variables are collected. This allows for the correlation of temperature to the other variables that may be influenced by temperature (e.g. DO). The data also gives us a snapshot in time of temperature information.

The second method used continuous-reading temperature loggers. The equipment used were Onset® Stowaway® temperature loggers. The loggers were programmed to record the temperature at 2-hour intervals throughout the time they were in the stream. The data was downloaded into a computer, and a detailed record of stream temperatures was produced. Water temperatures are always recorded as degrees Celsius (^{o}C). Data are shared with USGS partners at the Columbia River Research Laboratory.

Temperature data collected during Water Chemistry Sampling

Water temperature is collected at the time of water chemistry sampling, in case it would prove of value in evaluating conditions during sampling. Since these temperature data were collected mainly as an associate of other water chemistry information, and represent only a snapshot of temperature at the time of sampling, not a lot more can be assumed from the information by itself. The data collected using continuous temperature monitoring equipment will be better suited for reporting downstream trends.

Temperature data collected via continuous temperature loggers

Following are graphs and information showing 2004 data from each site. Daily maximum and daily minimum temperatures are shown for the entire calendar year if available. Y axes for all graphs are the same, allowing visual comparison of sites.

Temperature patterns are similar to previous years. The White Salmon River is relatively cool, in large part due to its size and headwaters in the relatively high elevations of the Gifford Pinchot National Forest. Tributaries are warmer, particularly Rattlesnake Creek, Trout Lake Creek, and Indian Creek, which both exceeded 20 degrees C for extended periods of time.

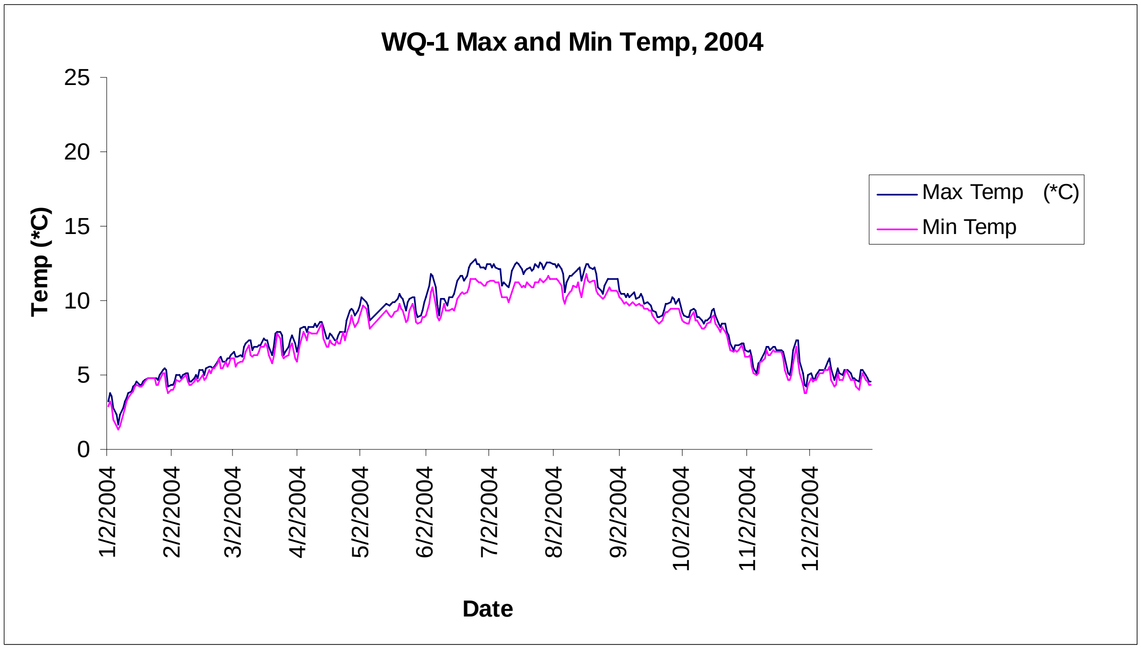


Figure 3. Daily minimum and maximum temperatures at White Salmon River near the base (WQ-1) during 2004. This site remains cool throughout the year.

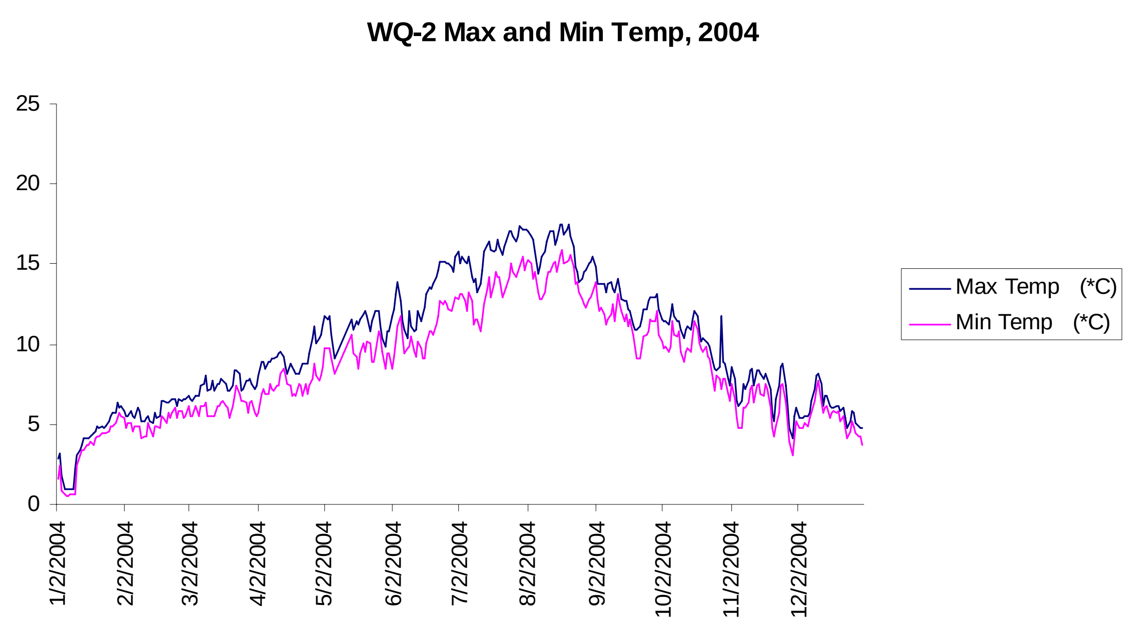


Figure 4. Daily minimum and maximum temperatures lower Buck Creek, WQ-2, during 2004.

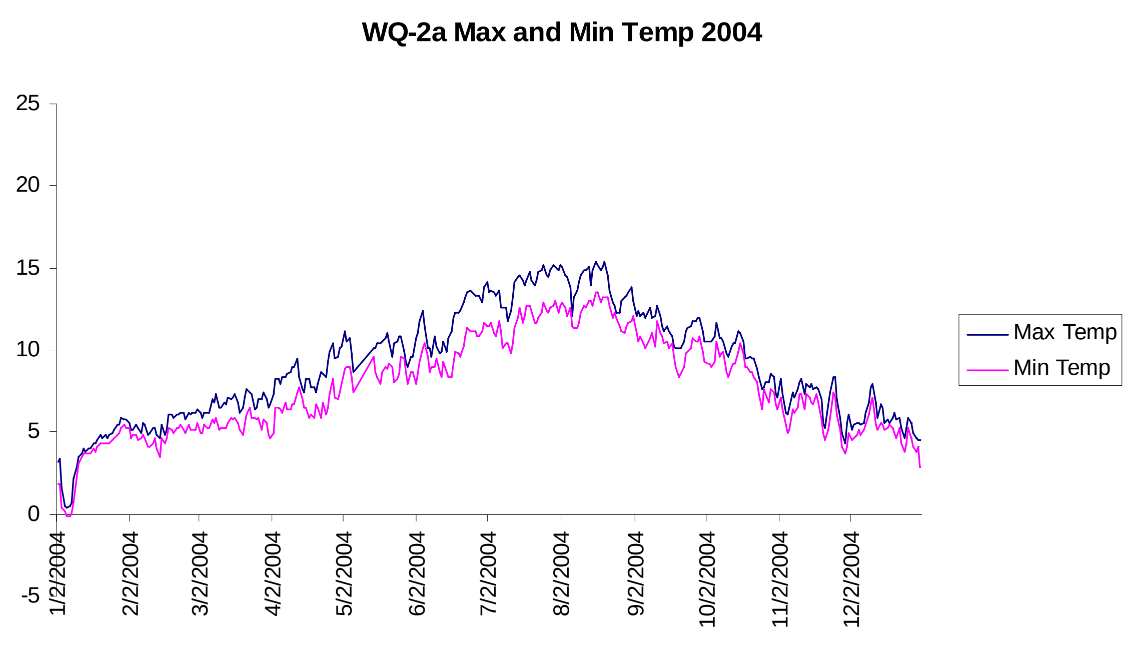


Figure 5. Daily minimum and maximum temperatures upper Buck Creek, WQ-2a, during 2004.

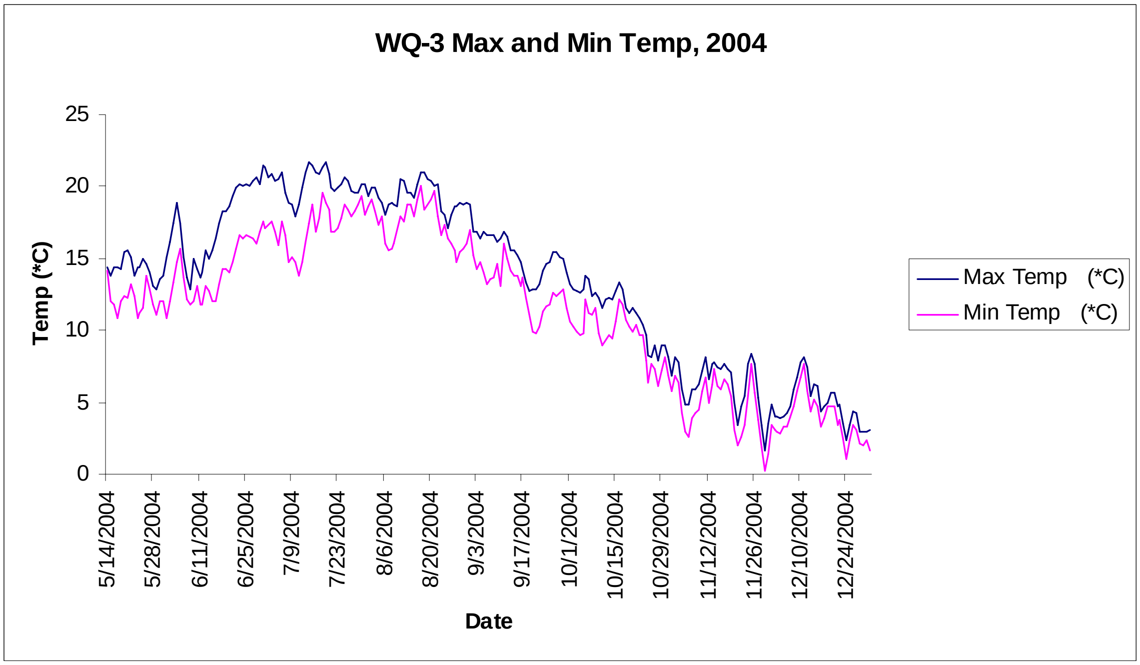


Figure 6. Daily minimum and maximum temperatures for Rattlesnake Creek (base), WQ-3, during 2004. The logger was lost during winter 2004, so we do not have data before May. During summer, WQ-3 exceeded 20 degrees C on 25 days.

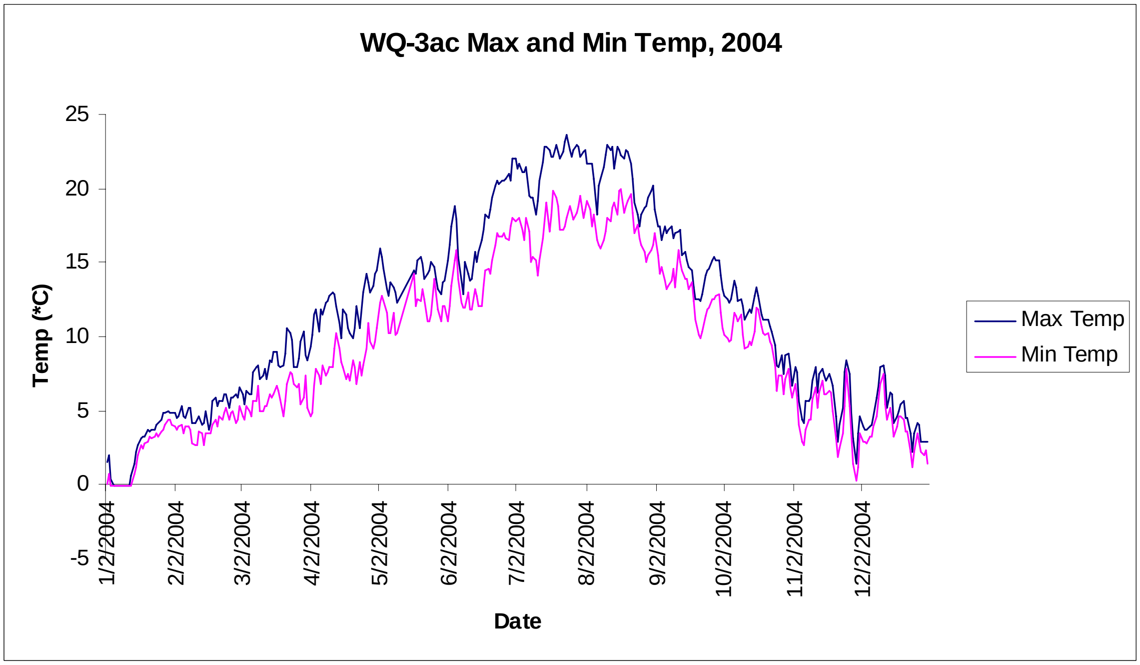


Figure 7. Daily minimum and maximum temperatures Rattlesnake Creek above Indian Creek, WQ-3ac, during 2004. During summer, WQ-3ac warmed quickly in mid-June, and remained quite warm until late August.

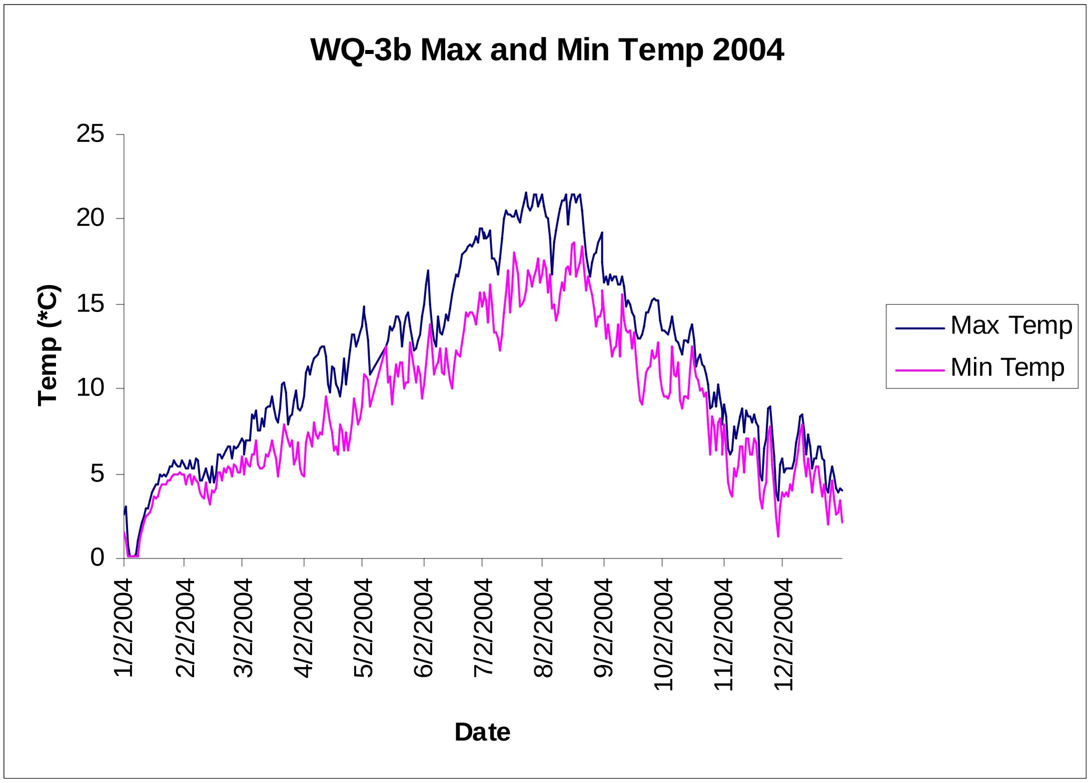


Figure 8. Daily minimum and maximum temperatures for Indian Creek (base), WQ-3b, during 2004.

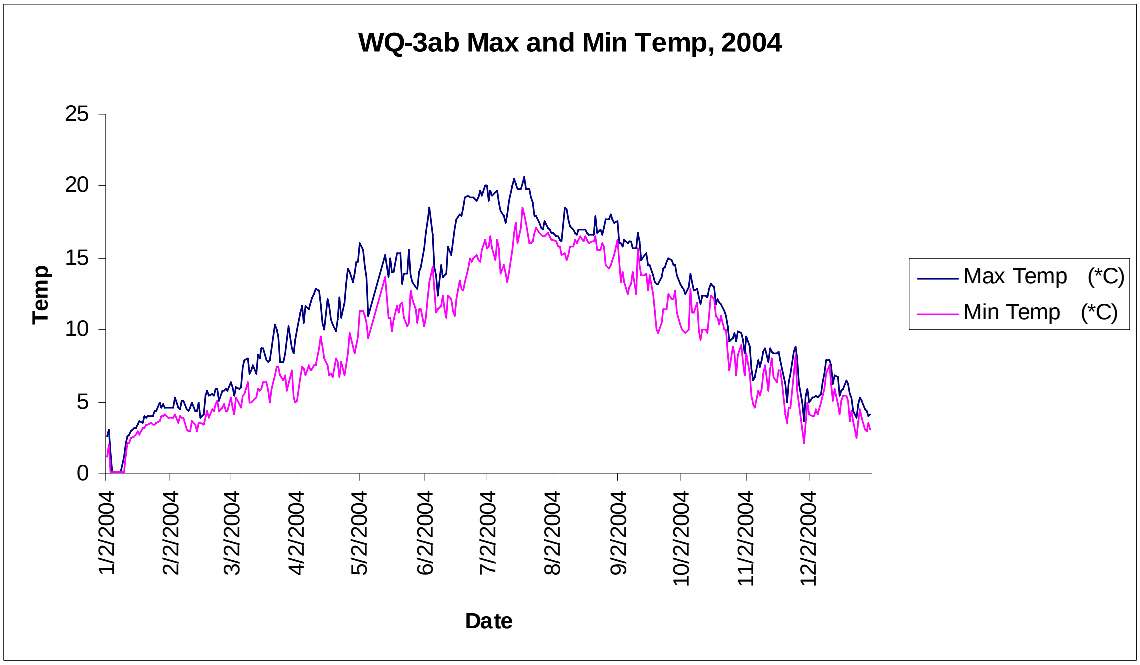


Figure 9. Daily minimum and maximum temperatures for Rattlesnake Creek (base of alluvial reach), WQ-3ab, during 2004.

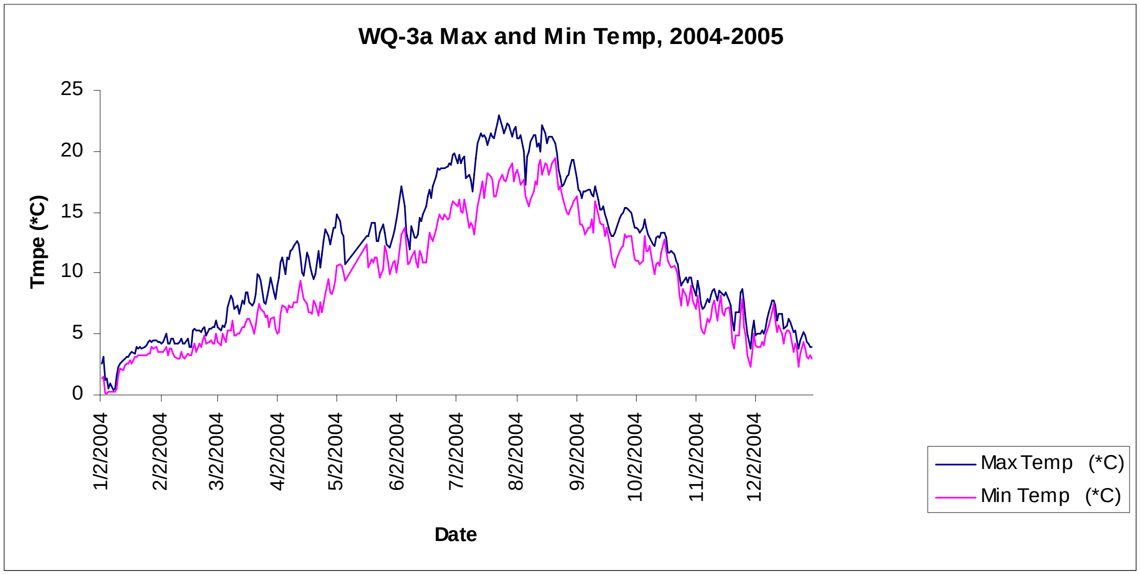


Figure 10. Daily minimum and maximum temperatures for Rattlesnake Creek (middle of alluvial reach), WQ-3a, during 2004.

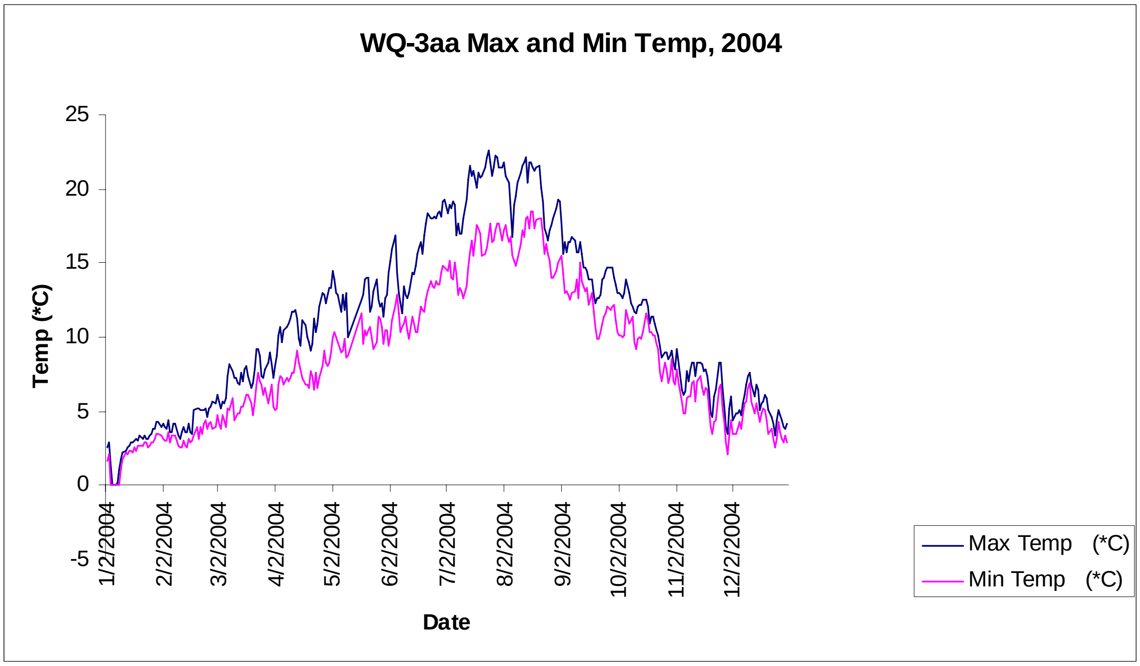


Figure 11. Daily minimum and maximum temperatures for Rattlesnake Creek (base of upper canyon), WQ-3aa, during 2004.

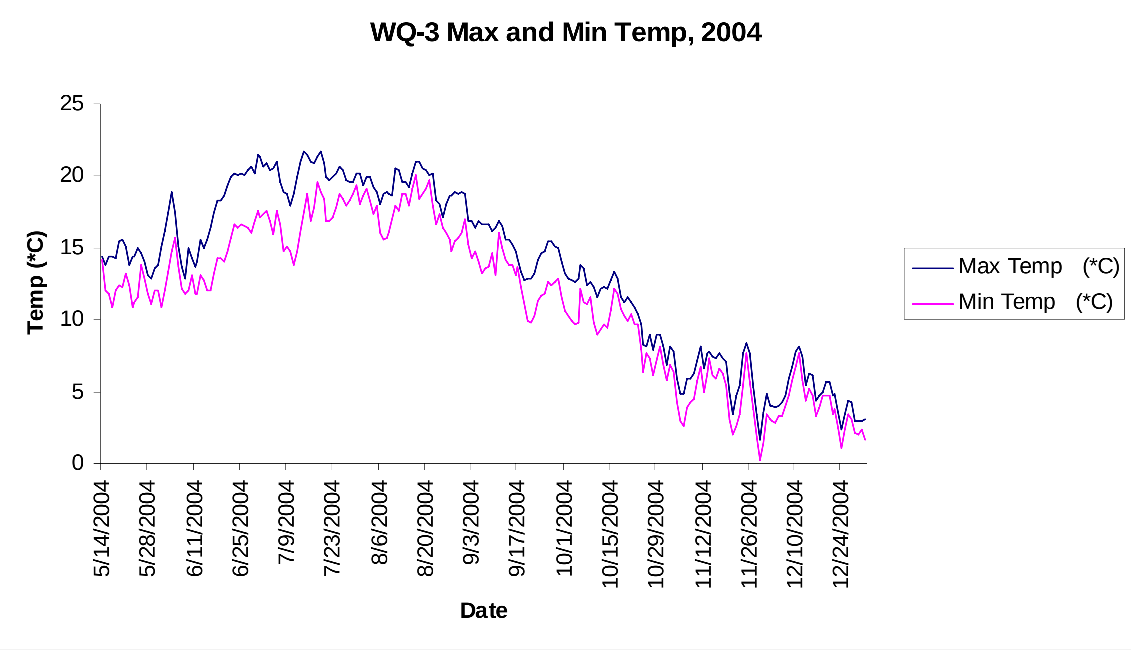
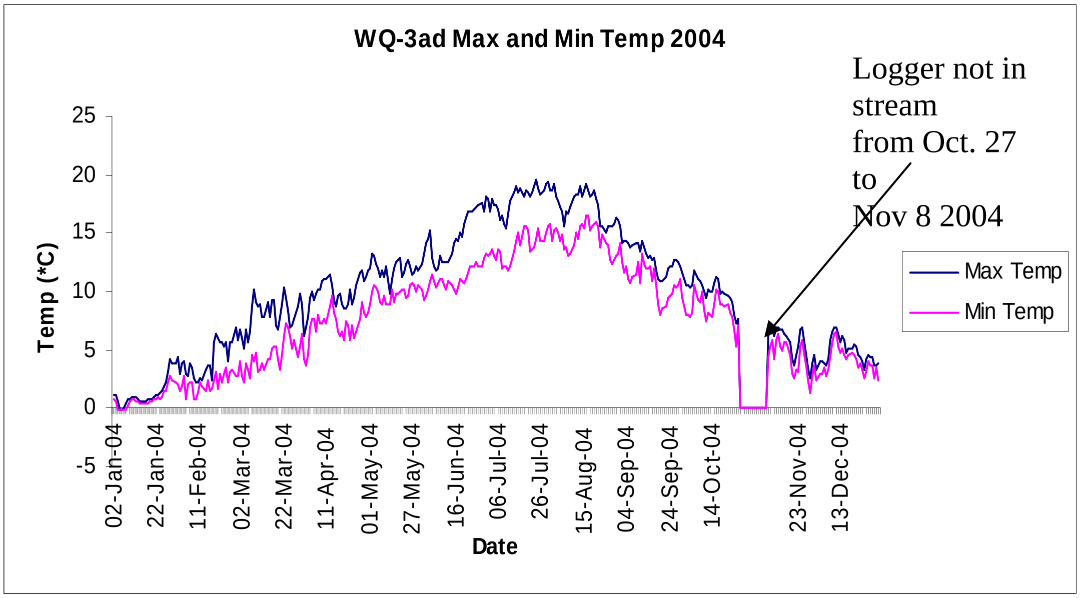


Figure 12. Daily minimum and maximum temperatures for Mill Creek (base), WQ-3c, during 2004.



Logger not in stream from Oct. 27 to Nov 8 2004

Figure 13 Daily minimum and maximum temperatures for Rattlesnake Creek (upper Canyon), WQ-3ad, during 2004. The logger was temporarily removed from the Stream in October 2004.

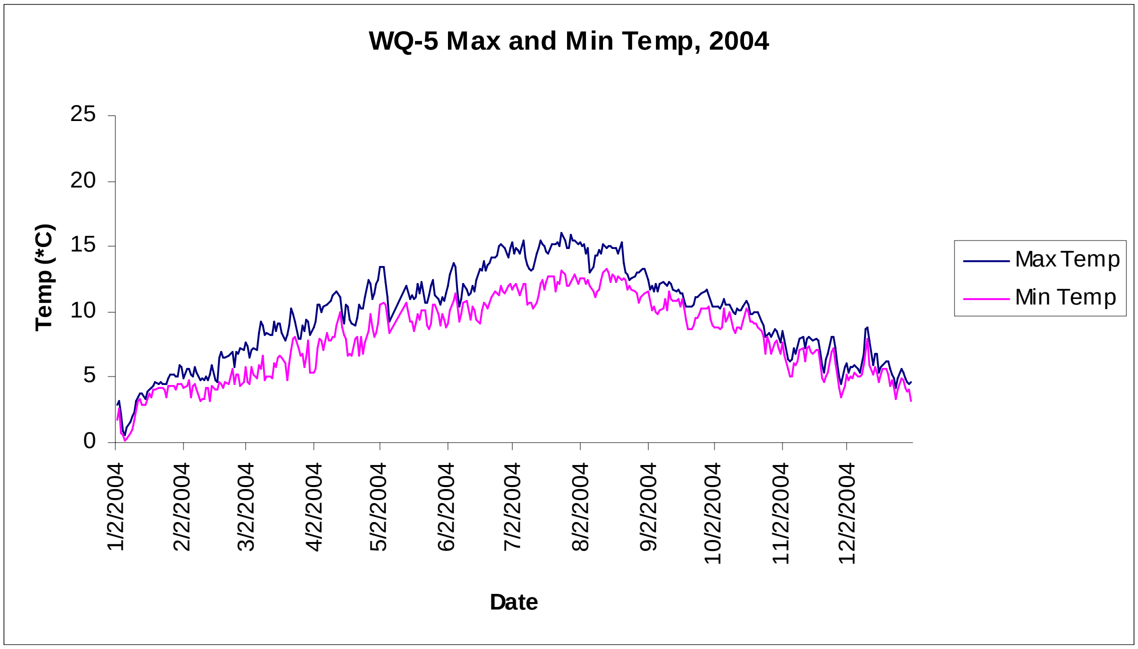


Figure 14. Daily minimum and maximum temperatures for Gilmer Creek, WQ-5, during 2004.

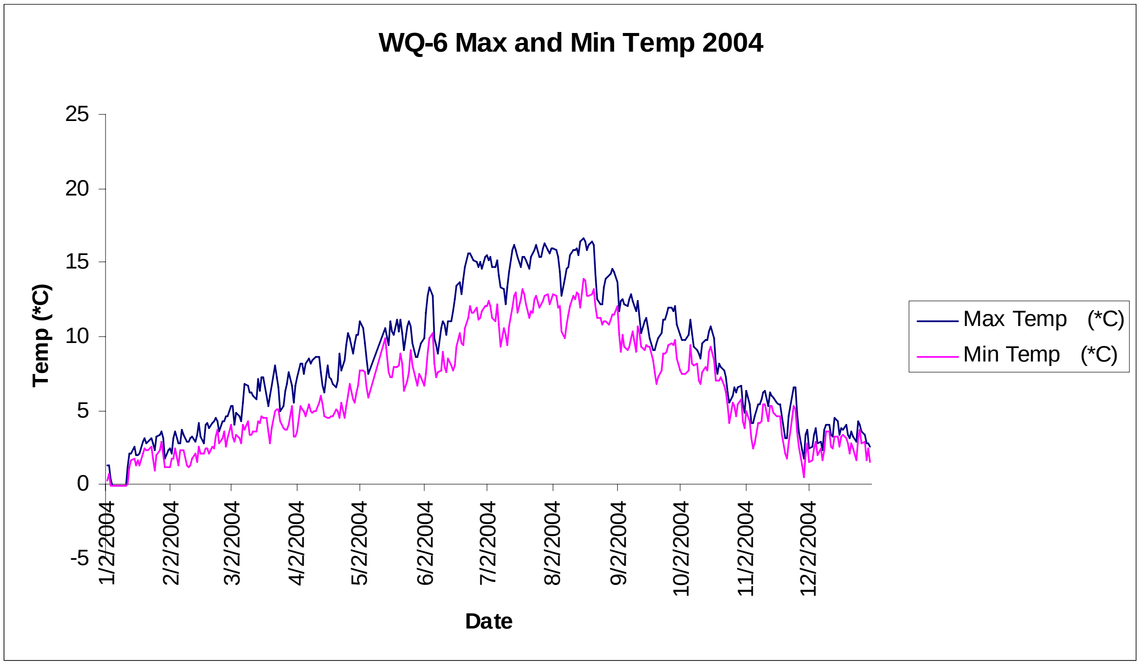


Figure 15. Daily minimum and maximum temperatures for the White Salmon River (below the Trout Lake Valley), WQ-6, during 2004.

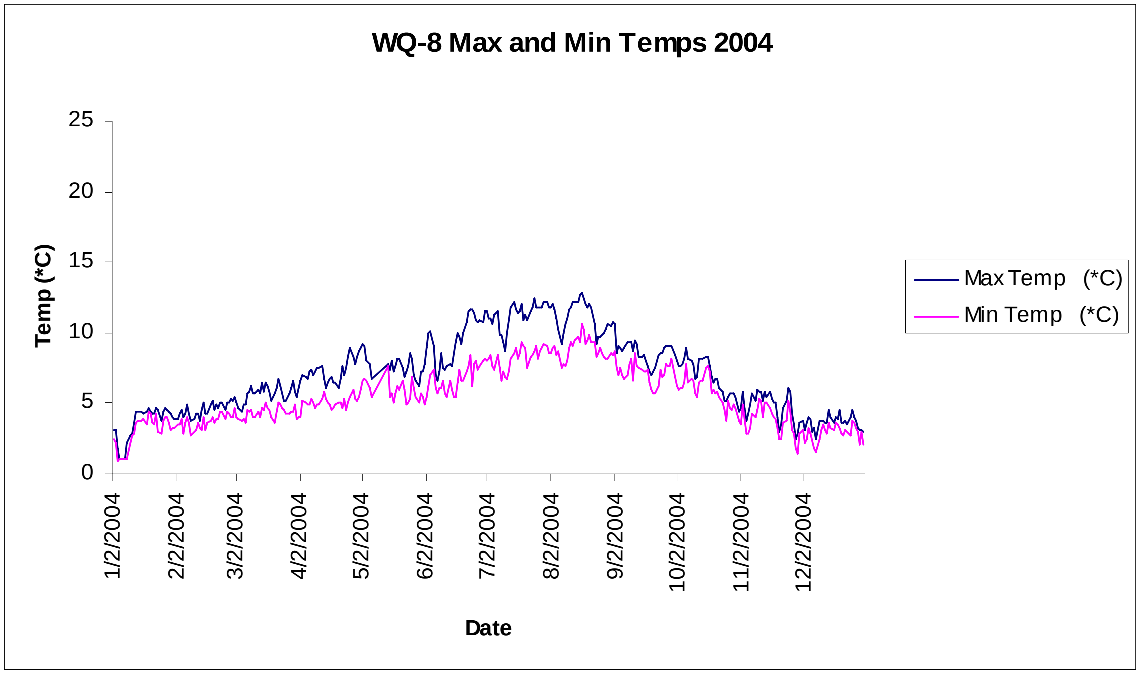


Figure 16. Daily minimum and maximum temperatures for the upper White Salmon River, WQ-8, during 2004.

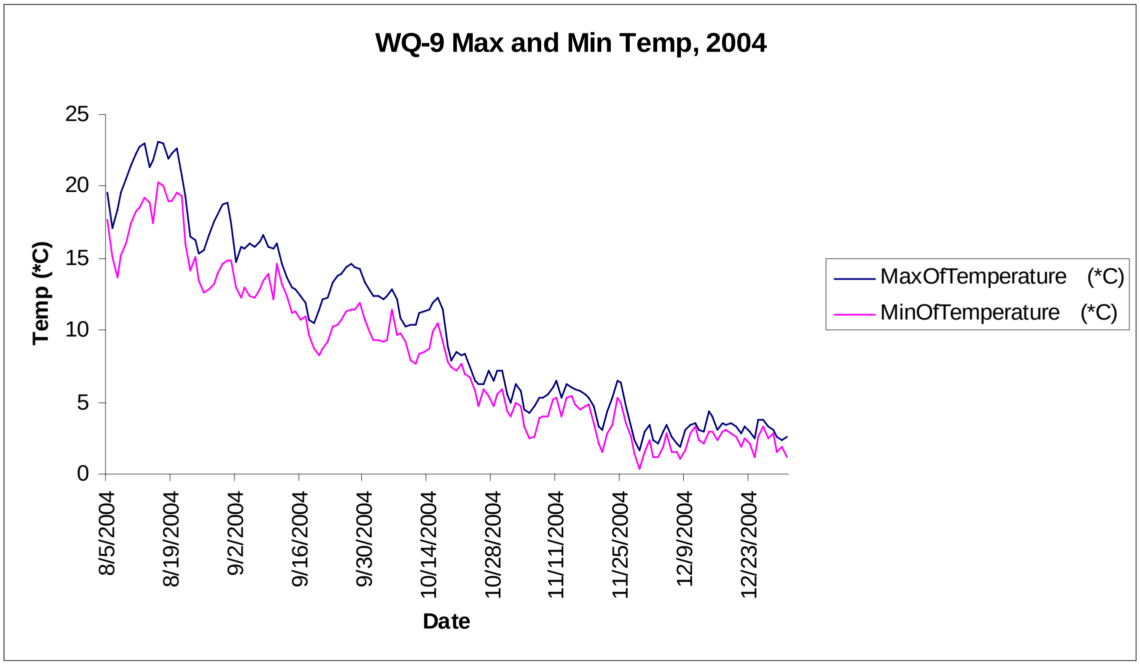


Figure 17. Daily minimum and maximum temperatures for the lower Trout Lake Creek, WQ-9, during 2004. We lost data before August 2004.

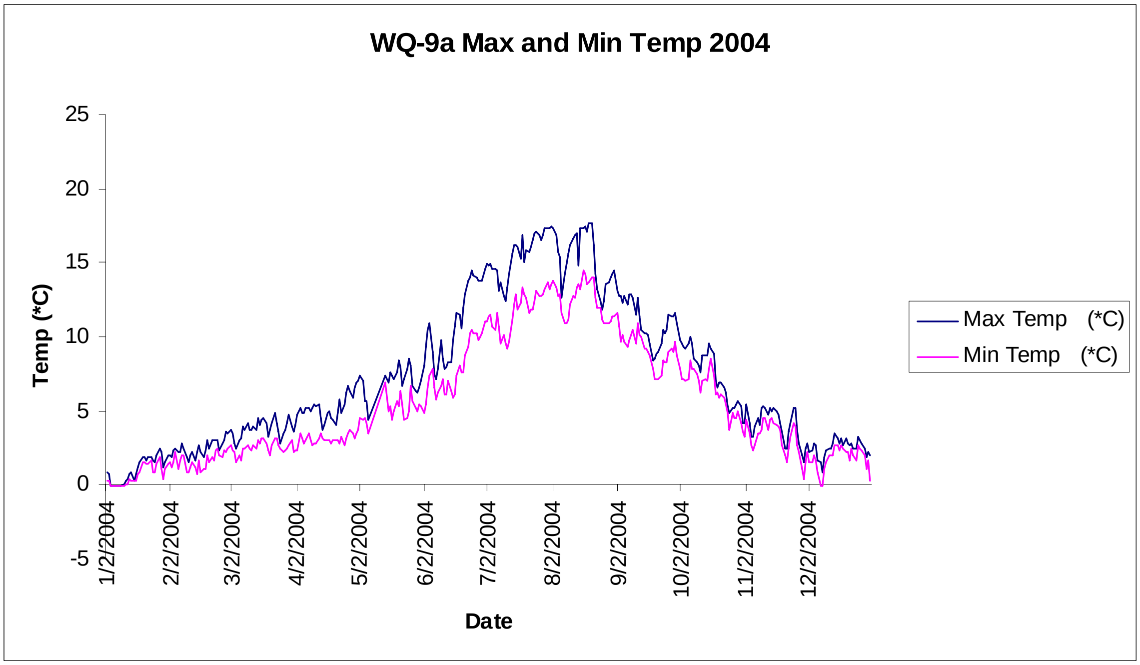


Figure 18. Daily minimum and maximum temperatures at upper Trout Lake Creek, WQ-9a, during 2004.

Summary

For data collected in 2001- April 2005:

- pH readings were all within the State standards of 6.5-8.5. One reading (Sept 2001) of 9.92 on Trout Lake Creek may be equipment error; there were no other values nearly as high recorded. In 2004, the highest pH measurement was 8.12 on Rattlesnake Creek. We continue to see lower pH values in the White Salmon river than in tributaries.
- Dissolved Oxygen levels appear to be adequate for support of aquatic species for in the entire White Salmon River watershed. Dissolved oxygen is higher during colder months when flows are higher than during warmer months when flows are low.
- Turbidity levels appear to be tied to flow levels and storm events. Averages for turbidity don't appear to be very meaningful.
- Conductivity levels are relatively low compared to the range within the US, but remain fairly consistent.
- Phosphorus levels remain low. Levels are slightly higher in Gilmer Creek.
- Nitrate and nitrite nitrogen results for this project period remain nearly all below the method reporting limit. From July 2004 through April 2005, only 8 samples mere above the method reporting limit. Five of those samples were from Gilmer Creek.
- Some correlation was observed between increased water temperatures and decreased DO. The continuous temperature loggers gave a much more detailed pattern of temperature and highlighted Rattlesnake Creek and Trout Lake Creek as particularly warm.

Appendix B: Water Quantity Data

Discharge and temperature for Rattlesnake Creek, for the Water Year 2004 (Sept. 2003 through August 2004) are shown below. Information is gathered from the Rattlesnake Gage, located on Rattlesnake Creek approximately .2 miles upstream from its confluence with the White Salmon River.

2004 data show a steadily increasing discharge during fall 2003 and early winter 2004, with a strong peak occurring in late January. Discharge remained high throughout much of February, before dropping steadily to a low of about .5 cfs in early August. As would be expected, some of the highest water temperatures occurred during times of lowest discharge.