Rock Creek Fish and Habitat Assessment for the Prioritization of Restoration and Protection

2008 Annual Report

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The Confederated Tribes and Bands of

The Yakama Nation

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Introduction

This report describes the results of the collection of baseline data for salmonids fish populations and habitat in the Rock Creek subbasin in south-eastern Washington. This is the first combined fish and habitat study approach taken for the Rock Creek subbasin. Overall the project goals include characterizing the baseline conditions of the Rock Creek watershed and fish habitat to prioritize sites for future restoration projects. Environmental and biological attribute data were collected throughout the watershed ranging from the headwaters originating in the Simcoe Mountains to the confluence with the Columbia River. Data collection, evaluation and input into the Ecosystem Diagnostic and Treatment (EDT) model is a continuous process. The EDT model assisted in the watershed analysis to determine the appropriate sites for future restoration activities. The Rock Creek Fish and Habitat Project is an important stepping stone in understanding the current conditions of the watershed in relation to historic conditions. The project also addresses many of the information gaps needed for the Rock Creek Steelhead Recovery Plan and the Rock Creek Subbasin Plan.

Description of Project Area – Rock Creek subbasin

The Rock Creek subbasin encompasses an area of approximately 223 square miles of southeastern Washington. Rock Creek joins the Columbia River at river mile (RM) 230, approximately 12 miles upstream of John Day Dam. The headwaters of Rock Creek originate in the Simcoe Mountains and flow in a southerly to southeasterly direction to the Columbia River. Elevations range from 200 feet at the confluence of Rock Creek and the Columbia River to over 3200 feet in the Simcoe Mountains. Major tributaries of Rock Creek include Quartz Creek, Badger Gulch, Luna Gulch, Harrison Creek, and Squaw Creek.

The headwaters of Rock Creek and its tributaries are coniferous forest plateau; land use is managed forest, grazing, and some rural residential. From the plateau, the stream enters steep-walled canyons where the channel becomes confined. Land cover converges from conifer forest to mixed conifer – deciduous forest in the canyon, transitioning to shrub-steppe in the uplands where land use is primarily grazing. Downstream of the canyons, streams enter alluvial valleys where channels converge from moderately confined to unconfined channels. The predominant land use activity is cattle grazing within the alluvial valley and on the adjacent terrace slopes.

Rock Creek currently supports fall Chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), summer steelhead (*O. mykiss*), resident rainbow trout (*O. mykiss*), and other native and introduced fish species throughout much of its watershed. Steelhead in the drainage are part of the Middle Columbia River steelhead Distinct Population Segment (DPS), which are listed as threatened under the Endangered Species Act (ESA). The fish population was originally listed at threatened as part of the Middle Columbia River steelhead Evolutionarily Significant Unit (ESU) on March 25, 1999. The lowest 2.5 river miles of Rock Creek contain fundamental spawning habitat for coho and fall chinook populations during the fall and winter months. Juvenile steelhead, coho, fall chinook, and resident rainbow trout rear in Rock Creek and its tributaries throughout the year.

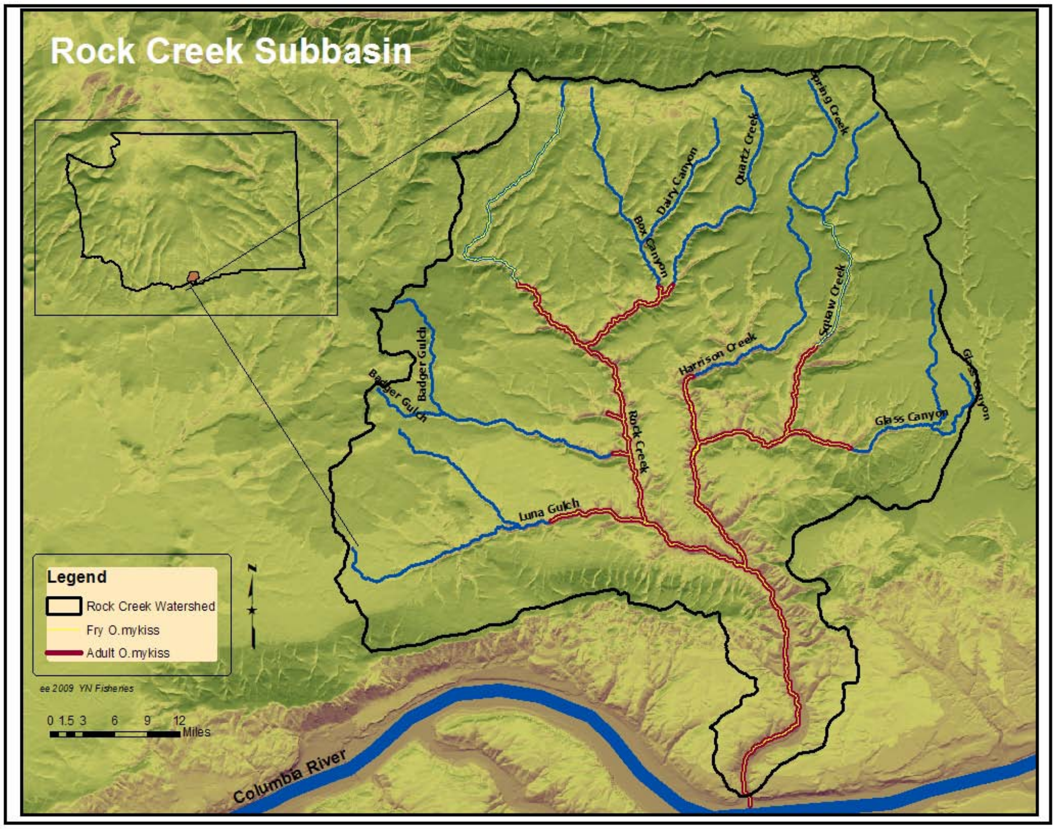

Figure 1. Rock Creek Subbasin in southeastern Washington.

Acknowledgements

We would like to take this opportunity to thank all those who have contributed to the success of this project. Those individuals and organizations that helped contribute in some way to the project.

- A special thanks to *private landowners* cooperation
- Bronsco Jim Jr., Sandy Pinkham, Rodger Begay, Roger Stahi, Jeremy Takala and Matthew Willett (YN Technicians)
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- Mike Babcock provided assistance with data management (YN Data Systems Manager)
- Andrew P. Matala, Lori Maxwell, Jeff Stephenson, and Shawn Narum (CRITFC Geneticists)
- Ken Luhan (USFWS Microbiologist)

1. Monitoring & Evaluation

Overall Objective: Gather baseline environmental and biological data throughout the subbasin to understand the current conditions of native salmonids and their associated habitat conditions. This fish and habitat assessment is the first to be conducted throughout the entire Rock Creek subbasin. Monitoring and evaluation allows for continuous evaluation of fish and habitat conditions and for identification for possible restoration project opportunities.

Task 1.a Spawning ground surveys (redd counts) and scale collection

Objective: Redd counts and spawner surveys were employed to monitor spatial and temporal redd distribution of fall Chinook, coho, and steelhead, and collect biological data from carcasses. Spawning ground surveys provide a means of monitoring annual adult escapement as well as spawner distribution.

Methods: Regular foot and one-man pontoon surveys were conducted within the known geographic range for each species. Individual redds were counted and their locations recorded using handheld Global Positioning System (GPS) units. Counts of live fish and carcasses were also recorded. Carcasses were examined for sex determination, egg/milt retention (percent spawned), and presence of Coded Wire Tags (CWT) or external experimental marks. Attempts were made to cover the entire known spawning range of each species. Stream reaches were surveyed multiple times during the spawning seasons, with most reaches receiving at least 2-3 passes.

Fall Chinook surveys were conducted from mid-October through mid-December; coho surveys were conducted from late October through late February; steelhead surveys began in late February and continued through early June.

Results: Spawner survey results are discussed below. Figures 2 and 3 exhibit the observed 2007-08 and 2008-09 spawning distribution for fall Chinook, coho, and steelhead, respectively. A tabular summary of spawning ground survey results by species is presented in Appendix A.

Fall Chinook

Fall Chinook surveys were conducted beginning in early November through late December, covering approximately 2.5 river miles during the 2007 and 2008 spawning seasons. Fall Chinook spawning occurs between RM 0 and RM 2.5. The majority of observed spawning occurs adjacent to the Rock Creek Lake (Army Corps Park) near the mouth of Rock Creek. For both 2007 and 2008 spawning seasons two live adults and two redds were observed and recorded. Two carcasses were found within the spawning reach during the 2007 spawning season and no carcasses during the 2008 spawning season.

Coho

Coho surveys were conducted between November and January, covering nearly 2.5 river miles. Coho spawning usually occurs between RM 0 and RM 2.5. The majority of observed spawning occurs from RM 0 to RM 1. No coho redds were located for both spawning seasons and one live adult was located during the 2007-08 spawning season. No carcasses were located within the spawning reach. During the 2008 spawning season there was limited instream flow which precluded coho salmon from migrating upstream past RM .5 to spawn.

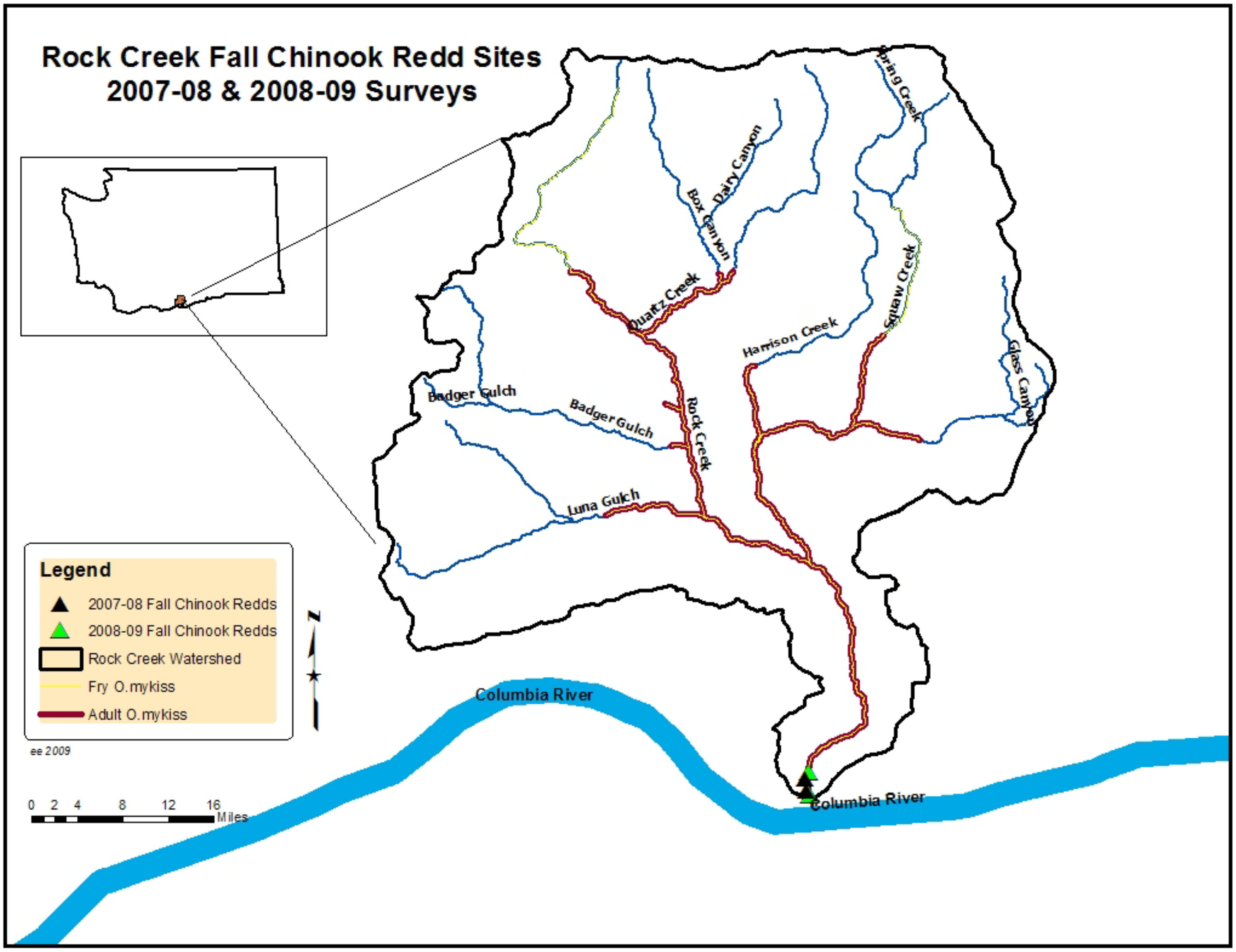

Figure 2. Rock Creek fall Chinook and coho 2007-08 & 2008-09 Redd distribution map.

Steelhead

Steelhead surveys were conducted between February and March, covering approximately 14 miles with between 2 – 3 passes at each survey reach. High spring flows and turbidity limit the timing and safe access to survey reaches. Steelhead spawning is widespread throughout much of the Rock Creek subbasin. A total of 75 redds were located and a total of 58 live adults were enumerated during the 2007-08 spawning season. A total of 45 redds were located and a total of 37 live adults were enumerated during the 2008-09 spawning season. The majority of observed and documented steelhead redds were located in the mainstem Rock Creek from RM 1- RM 9 and in Squaw Creek.

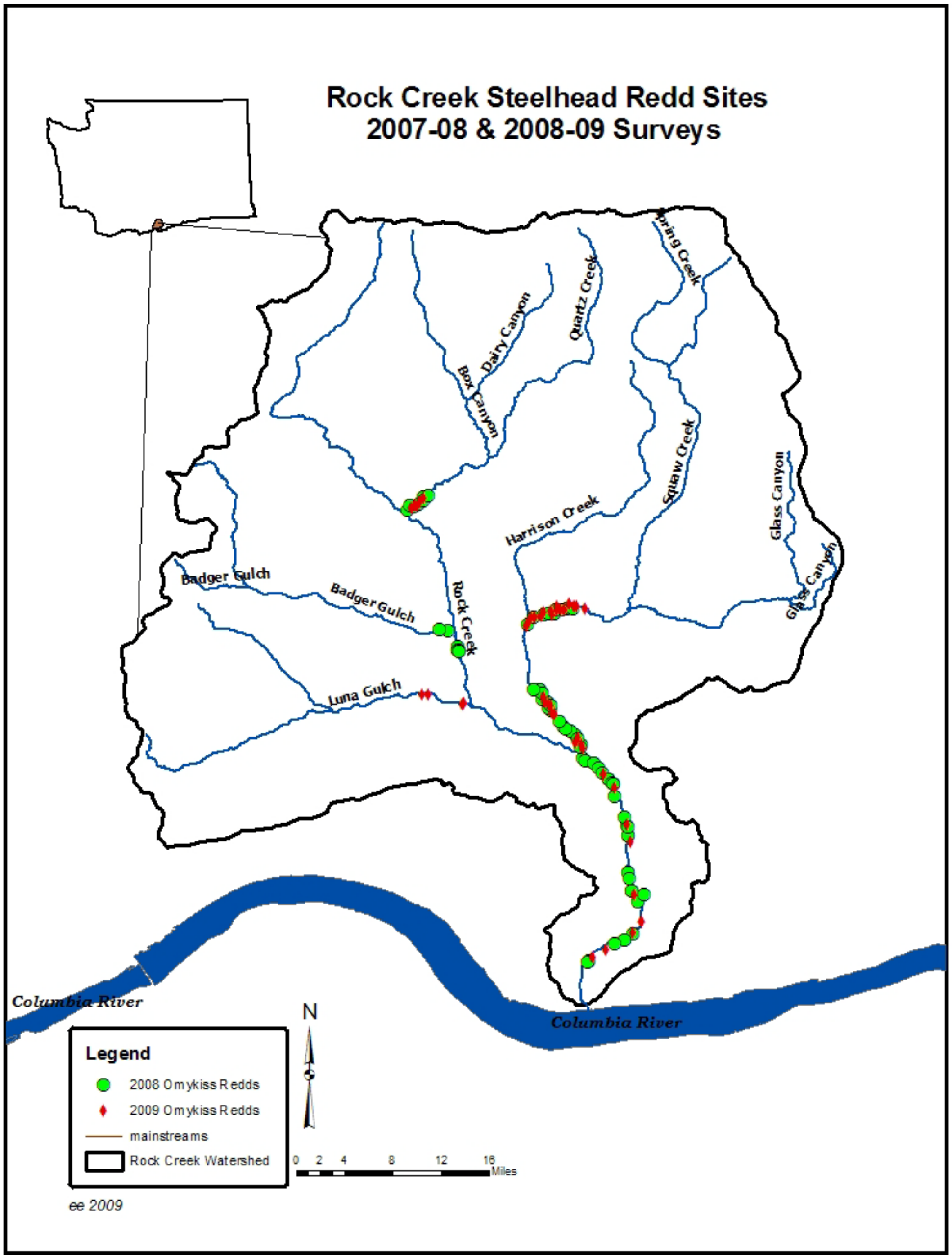

Figure 3. Rock Creek Steelhead 2007-08 & 2008-09 Redd distribution map.

Task 1.b Juvenile and resident salmonids population survey and scale collection/ analyses

Objective: Gather baseline information to determine juvenile anadromous and resident spatial distribution and relative abundance throughout the basin.

Methods: Fish presence, relative abundance, population size, length frequency, relative weights, and density were to be determined from backpack electrofishing data. A multiple pass removal depletion sampling strategy was to be used for fish collection. During multiple pass surveys, passes are completed until >50% reduction was achieved. Block nets were to be placed across the stream at the upstream and downstream ends of the survey reach prior to electrofishing. The 100m distance between the block nets was to be measured prior to installation of block nets. Electrofishing was to start from the downstream end and move upstream motion. Captured fish were to be transferred into a 5 gallon bucket holding stream water until processes. Fish were to be anesthetized with Tricane Methane Sulphonate (MS-222) prior to fish workup. Fish identification, weight, length, scales, and genetic sample was taken from sampled fish. All species noted during the population survey to get an understanding of fish biodiversity and distribution in the subbasin.

Results: An ESA Section 10 Take Permit for the capture, handle, and release of listed steelhead of Rock Creek was received on July 30, 2008, by National Marine Fisheries Service (NMFS). Rock Creek turns intermittent with subsurface flow in mid-June. Stream temperatures increased above the recommended NMFS electroshocking threshold to conduct electrofishing surveys. No juvenile population surveys were conducted this contract year; hence, PIT-tagging and scale collection was also postponed until next contract year.

Task 1.c Sediment Monitoring

Objective: The numbers generated from the Wolman pebble counts created a unique characterization of the composition of the streambed at one particular point in time at three observed spawning reaches. The composition of the streambed could represent characteristics of the stream such as effects of flooding, sedimentation, or other physical impacts to the stream. The Wolman pebble count method is a tried and tested method of measurement of sediment size on the bed surface. Information gathered from the surveys were incorporated into the EDT model and used to characterize preferred spawning gravels by salmon and steelhead adults.

Methods: Surface substrate was sampled at three selected spawning sites in the mainstem Rock Creek and Squaw Creek. Wolman pebble count methodologies were used to conduct the sampling. Each pebble count was a systematic method of sampling material on the surface of the streambed and was used to develop a particle size distribution. Each measured particle represents a portion of the streambed covered by particles of a certain size, and not the percent by volume or weight. The procedure requires an observer with a metric ruler or gravelometer to wade the stream and the second person is a note taker. Particles are tallied using size classes that are either grouped or further refined using Wentworth size classes. Basically, size doubles with each class or smaller class intervals based on ½ phi values. The latter classes are generally used when detailed particle size data are needed.

To conduct the Wolman count, personnel randomly select a transect perpendicular to the stream in the scour pool tail out or in a low-gradient riffle. At a minimum, one transect per habitat unit and/ or ten transects per stream segment are required. Starting at the bankfull stage mark, step along the transect and picks up the first particle your fingertip encountered when placed in front of their toe. Each particle was measured at the intermediate axis with a metric ruler. This axis is neither the longest nor the shortest of the three mutually perpendicular sides of each particle picked up. Also, embedded particles or those too large to be moved in place are recorded by measuring the smaller of the two exposed axes. For each transect, the particle counts for each size class are recorded on the Substrate Field Data Form.

Results:
This is the first year of monitoring and future pebble counts will be conducted at the same sites to make comparisons of year-to-year change in spawning habitat. Wolman Pebble Counts were conducted at three spawning riffle sites to document watershed-scale variability in supply of gravel and cobble in spawning habitats (Figure 4.). The first site is of particular interest for continuous monitoring due to the proposed Klickitat County bridge replacement project at the Bickleton Bridge crossing. The second site is near the Rock Creek confluence where there have been observed fall Chinook, coho, and steelhead spawning in recent years. The third site is located in Squaw Creek within primary steelhead spawning habitat. Data collected is represented in Appendix B.

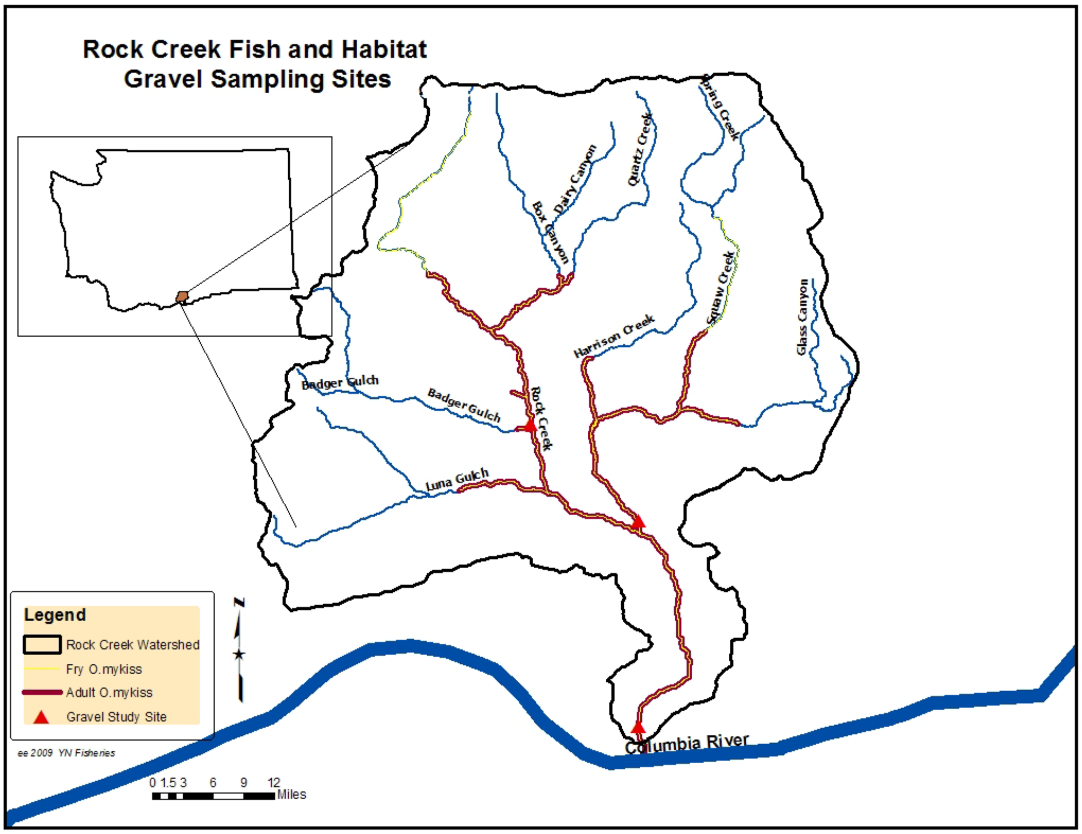

Figure 4. Spawning gravel sampling sites.

Task 1.d Temperature and water quality monitoring

Objective: Monitor stream temperature and water quality at selected sites on a seasonal basis to characterize the chemical and physical conditions of the subbasin at key locations.

Methods: Water temperature was monitored at ten sites throughout the mainstem Rock Creek and its tributaries (Squaw, Harrison, Luna Gulch, Badger Gulch, and Quartz creeks). Water temperature measurements were taken at 30-minute increments using Onset Corporation, Hobo temperature probes.

Air temperatures were monitored at three locations in the subbasin with the Hobo temperature probes. Basic water quality parameter measurements (pH, conductivity, dissolved oxygen, turbidity) were recorded seasonally at eight sites (3 – 10 times per year). Water quality measurements were taken using the YSI-85 water quality meter. Parameters collected included dissolved oxygen, conductivity, turbidity and pH.

Results: Summaries of water and air temperature data for each location are presented in Appendix C (Table C1). These summaries include (for each month during the reporting period): the number of days during which temperature was recorded; the number of times the daily minimum temperature was less than 0.5°C and 4.4°C; the number of times the daily average temperature was less than 0.5°C and 4.4°C; the number of times the daily maximum temperature was greater than 23°C and 24°C; the number of times the 7-day average daily maximum temperature was greater than 12°C, 16°C, 17.5°C, 18°C, and 22°C (the 7-day average daily maximum was calculated by averaging the daily maximum temperatures across the time period that started 3 days prior to and ended 3 days after a given day); the monthly 1-day maximum temperature (the highest instantaneous temperature recorded in a given month); the monthly 1-day maximum range (the largest daily range in temperature recorded during a given month); and the monthly average daily range (the average daily range in temperature recorded during a given month).

Accumulated water quality and temperature data was incorporated into the EDT model. Water quality measurements were conditional on the presence of actual instream flow. Rock Creek and its tributaries turn intermittent during the warmer summer months with ground water-fed pools distributed throughout the subbasin. Water quality was not recorded if there was no instream flow at the time of monthly site visit. The turbidity meter was not working functioning correctly; therefore, there were no continuous data recorded for this parameter. Water quality and temperature data was integrated into the EDT model and is located online on the Jones and Stokes EDT website http://edt.jonesandstokes.com/.

Task 1.g Habitat assessment

Objective: The purpose of habitat assessment is to characterize the present state and processes that create and maintain it so that appropriate restoration options and obstacles could be identified and prioritized.

Methods: Rock Creek and its tributaries were stratified into reaches using a USGS topographical map (1:24,000) and stream geomorphologic features. Habitat surveys were conducted on 20 stream reaches throughout the subbasin using EDT methodologies. Each habitat survey reach is similar in geomorphic characteristics throughout, such as pattern, slope, confinement, or sediment size. The information collected for each survey section included width measurements at wetted channel and high watermark; habitat type frequency and length; large woody debris and log jam counts; confinement; riparian function; and embeddedness observations. Habitat types were divided into seven categories: primary pool, large cobble riffle, small cobble riffle, pool tailout, glide, off-channel habitat, or side channel. Large wood debris information was also included in the habitat surveys such as enumeration of wood pieces in the stream channel and tally of logs in log jams. Riparian function attributes and condition were also documented for each surveyed stream reach.

Results: Habitat data was input into the Rock Creek EDT model and is available online on the Jones and Stokes EDT website http://edt.jonesandstokes.com/. Original habitat survey data is stored in the EDT Access database. The complete Rock Creek database is still in the developmental stages at this time. Habitat surveys will continue to be conducted annually and the data incorporated into the EDT model.

Rock Creek and its tributaries annually turn intermittent during the summer months (July through September) and is has been observed that ground water inputs keep cool water in pools throughout the subbasin. Juvenile salmonids and resident fish rear in the summer pools with accumulation where there is ground water contribution. Current hydrologic conditions of Rock Creek reflect upon previous land use practices such as road construction, diking, logging and riparian grazing. Historic road construction and logging in the head waters of Rock Creek altered the hydrological regime of the head waters of Rock Creek which continued downstream to the confluence. Rock Creek evolved from a rain-on-snow transitional flow regime to a flashy and/or early spring rain-on-snow system due to anthropogenic activities such as logging and road construction. Diking for roads and bridges restricted the natural channel migration process within the floodplain and created incised sections of the stream.

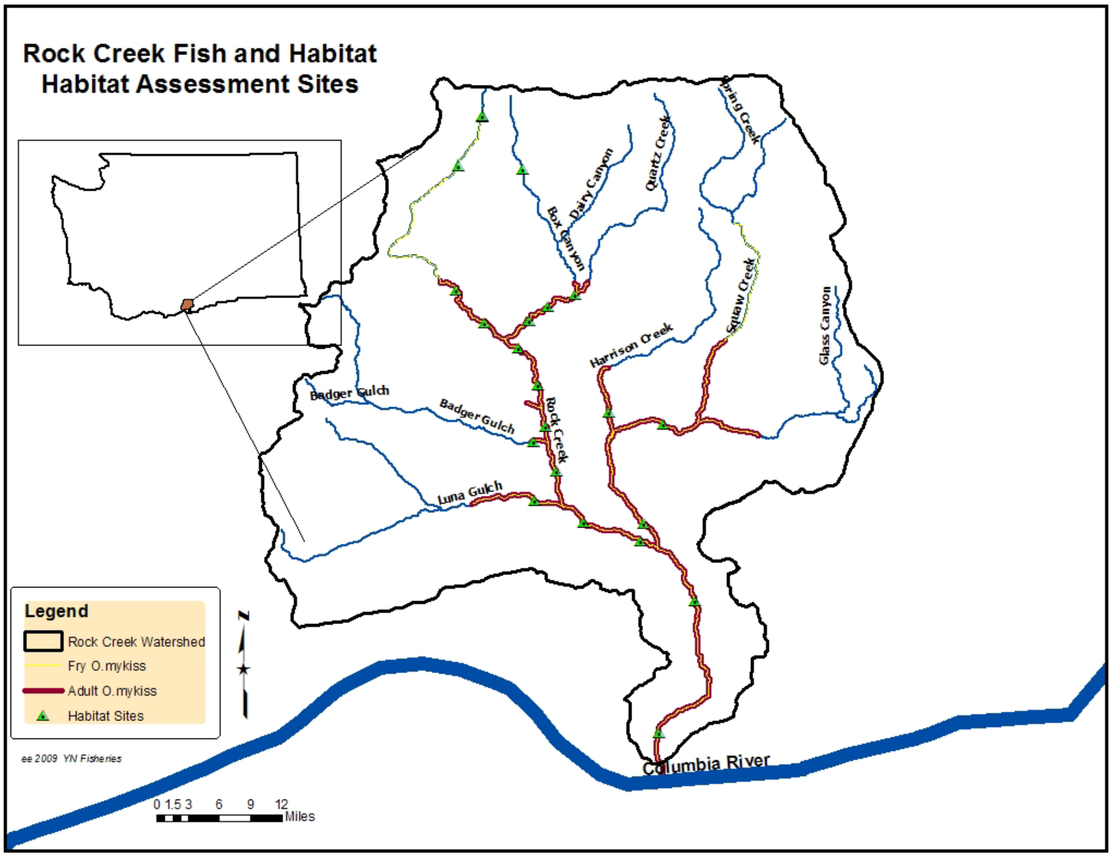

Figure 5. Rock Creek subbasin habitat assessment sites.

Task 1.h Juvenile steelhead PIT-tagging and United States Geological Survey (USGS) subcontract
Objective: Monitor juvenile steelhead movement within Rock Creek and its tributary streams. Additional benefits include monitoring movements through Columbia River dams and estimation of smolt-to-adult returns. Develop a sub-contract with USGS to construct two instream multiplexing PIT-tag units for two sites located in Rock Creek and Squaw Creek.

Methods: Juvenile steelhead were not PIT-tagged during this contract year since population surveys were not conducted this year.

Results: Two instream PIT-tag stations were constructed and are planned for installation for the purpose of researching juvenile and adult migration timing and rearing strategies of steelhead in Rock Creek.

Population surveys will be conducted in Rock Creek and Squaw Creek where a sample of juvenile steelhead will be PIT-tagged during the next contract year.

2. EDT Modeling

Overall Objective: Ecosystem Diagnostic and Treatment (EDT) model was utilized in this fish and habitat assessment to compare the historical and current habitat conditions of Rock Creek and its tributaries. The EDT model was applied to understand the effects of environmental attributes per life history stage of each species for the creation of protection and restoration measures pertaining to the Rock Creek Steelhead DPS Recovery Plan.

Task 2.a EDT Database and modeling
Objective: The projects goals include achieving baseline conditions for the Rock Creek watershed and habitat to prioritize sites for restoration. Data was collected, compiled, analyzed, and put into the EDT model. Historic watershed conditions were researched and incorporated into the EDT model. Watershed modeling assessed the Rock Creek watershed and field investigations were conducted to pinpoint the impact and magnitude of past land use activities, as well as restoration opportunities and benefits.

Methods: Environmental and biological attribute data was collected in fifteen reaches throughout the subbasin. Data was compiled, analyzed, and put into the EDT model. Historic watershed conditions (e.g. GLO maps, air photos, flow data) was researched and incorporated into the EDT model. All data was evaluated and incorporated into the Stream Reach Editor Access database. Model iterations and baseline reports were received from the Jones and Stokes EDT website http://edt.jonesandstokes.com/.

Results: Baseline reports were created from the online Jones and Stokes website. A baseline report for each species was conducted and broken into four sections. The first report compared each life history stage of each species to environmental attributes (e.g. channel stability, flow, food, harassment). The second report compared each EDT stream reach with environmental attributes for the creation of protection and restoration strategies (e.g. protection and restoration benefits). The third report gave a graphical view of each reach with percent change in abundance, productivity, and diversity index for both degradation and restoration of each reach. The fourth report represented a reach-by-reach analysis of overall restoration benefit and preservation benefit for each life history trajectory and productivity change. Overall result baseline reports for each species are included in Appendix D. All baseline reports will be used in the evaluation process of future restoration projects for Rock Creek and its tributaries. A list of key restoration and protection projects from the resultant EDT baseline reports was created for the Rock Creek subbasin. Middle Columbia Steelhead Recovery Plan and Rock Creek Subbasin Plan goals and objectives were also considered in the process of creating the priority list. Overall, EDT modeling assisted in subbasin and field investigations to further pinpoint the impact and magnitude of past activities, as well as feasible restoration opportunities and benefits.

Priority list for restoration and protection projects

1. *Restore riparian condition and function*
   Action: Restore and enhance natural riparian vegetative communities.
   Develop grazing strategies that promote riparian recovery.
   Eradicate invasive plant species from riparian areas.

2. *Restore floodplain function and channel migration processes*
   Action: Reconnect side channels.

Remove dikes.
Reconnect floodplain to channel.
Relocate or improve floodplain infrastructure and roads.

3. *Restore degraded upland processes*
   Action: Restore native upland plant communities.
   Implement Best Management Practices (BMPs) to forest, agriculture, and grazing practices that mimic natural runoff and sediment production.
   Implement road management actions to reduce erosion and fine sediment inputs.

4. *Improve degraded water quality, reduce summer water temperatures*
   Action: Restore natural functions and processes through actions identified in strategies above.
   Construct water and sediment control basins.

3. Ecological Interactions

Overall Objective: Establish a thorough baseline profile of fish pathogen presence in Rock Creek and its tributaries.

Task 3.a Pathogen Sampling

Objective: Determine fish pathogen presence and distribution throughout the subbasin for salmonids and other native fish populations.

Methods: A total of 114 fish were collected for pathogen sampling of Rock Creek juvenile steelhead/rainbow trout and other resident species [(bridgelip sucker (*Catostomus columbianus*), longnose dace (*Rhinichthys cataractae)*, redside shiner (*Richardsonius balteatus*)]. A sub-sample of fish captured during population studies and all fish incidentally killed during sampling for distribution and abundance were preserved and taken to the U.S. Fish and Wildlife Service's Lower Columbia River Fish Health Center (LCRFHC) for a pathogen analyses.

Results: The Rock Creek fish health report indicates the mainstem Rock Creek fish samples were in good health and no pathogens were detected. The juvenile steelhead pathogen analyses from Squaw Creek tested positive for *Renibacterium salmoniarum*, the causative bacteria for bacteria kidney disease (BKD). This does not mean the fish are heavily infected. The type of test, ELISA and PCR, are sensitive techniques and can pick up small amounts of bacteria. Also, the fish that were examined did not have any obvious kidney lesions or swelling. See Appendix E. for more detail.

4. Genetics

Overall objective: The purpose of genetic analyses of Rock Creek steelhead is to understand the genetic composition of the population and its relatedness to adjacent drainage population in the region. A key component of the Middle Columbia River Steelhead Distinct Population Segments (DPS) Recovery Plan includes a genetics assessment of steelhead in Rock Creek to determine whether the steelhead are a unique strain or a sub-population.

Task 4.a Genetic sample collection, data synthesis and analysis

Objective: Compare genetic samples collected from three sites for heterogeneity and population differences within the subbasin. Another objective of this study is to determine whether there is relatedness to other populations in the Middle Columbia region.

Methods: Samples were collected from a total of two sites in the mainstem and one site in Squaw Creek. A total of 52 genetic samples were collected from each site. A tissue sample (fin clip) from a sub-sample of juvenile steelhead captured during electrofishing was removed and preserved (95% ethanol) for genetic analyses. Samples were sent to CRITFC for the genetic analyses. The methods used to conduct the genetic comparison are included in Appendix F. CRITFC Rock Creek genetics report.

Results: Overall, a high level of variability was observed across the three Rock Creek collections. A Fishers exact test indicated significant population heterogeneity between the three collections and significant population differences regionally. A phylogenetic analysis across the entire Columbia River estuary to the upper Salmon River indicated that the Rock Creek collections appear to be most genetically similar to the Middle Columbia River populations. Detailed genetics report is included in Appendix F.

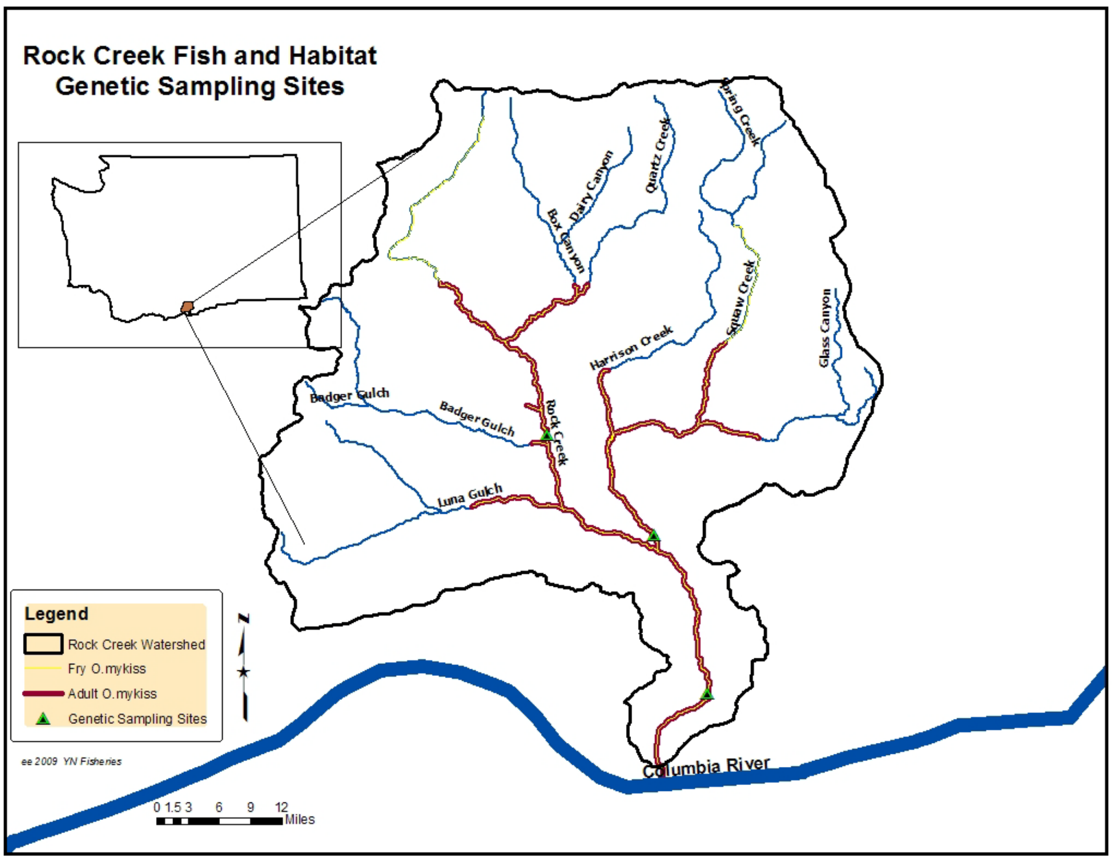

Figure 6. Genetic sample collection sites.

5. Native Tree Revegetation

Overall objective: Plant native trees and willows in Rock Creek riparian zones. Native trees include alder *(Alnus sinusata),* black cottonwood *(Populus trichocarpa),* ponderosa pine *(Pinus ponderosa),* red-osier dogwood *(Cornus stolonifera)*, and chokecherry *(Prunus virginiana).* All of the chosen trees/shrubs are native to the Rock Creek watershed and these tree plantings will increase the vegetation diversity of the area. The riparian plantings will aid in streambank protection, reduce bank erosion, decrease surface water temperatures through increased riparian cover and contribute to bank storage and late season base flows.

Task 5.a Tree Revegetation
Objective: Identify key sites for revegetation from an evaluation of orthophotos, topographic maps and site visits. Locate tree and willow stands for future cutting collections. Prepare planting sites prior to planting and plant trees.

Methods: Site visits were conducted throughout the subbasin to identify native trees and willows in various riparian zones of the creek. Large and healthy willow bunches were identified for future willow cuttings sites. Topographic maps were used to identify where springs and higher groundwater may be available to support tree plantings. Site preparation for tree planting was conducted prior to tree planting. Five fence enclosures were constructed to keep cattle out of the planting sites with one third of the trees planted within the enclosures. Planting areas were cleared of brush and other debris. Trees and willows were planted during the early spring months (late February and early March) when the soil was saturated to allow for root establishment and growth. Weed mats were tacked below the tree onto the earth with pins.

Results: 200 willow cuttings and 200 trees were planted along 2 river miles of Rock Creek. There was approximately 70% survival of total trees planted. Tree revegetation sites were chosen based on location to high ground water and soil saturation. The Rock Creek subbasin turns very dry through the summer months and efficient soil moisture is essential for the survival and growth of the trees. Hand watering each tree once a week during the summer sustained the trees until the fall rains.

Task 5.b Willow Nursery
Objective: Collect native willow cuttings from Rock Creek to plant in containers for future planting opportunities in Rock Creek. The objective is to plant native willows from Rock Creek at sites throughout the subbasin.

Methods: 200 willow cuttings were collected from three sites for growing containerized willows. Coyote willow, red-osier dogwood, and cottonwood cuttings were collected from large healthy bunches. Willows were taken back to office and soaked in water for a few weeks. A nursery was constructed for the planting pots and soil. Willows were placed in the containers and watered 2-3 times per week.

Results: 200 willows were planted with a 25% survival. The cottonwood and red-osier dogwood cuttings did not survive possibly due to unestablished root systems. The coyote willows did survive and are currently healthy with well-established root systems. Willows are watered 2-3 times per week during the warm summer months. During the spring of 2010, additional willow cutting will be collected and planted in the nursery for future revegetation purposes.

6. Appendices

Appenidix A. Spawner ground survey results for fall Chinook, coho and steelhead

Results of 2007-08 Fall Chinook spawning surveys in the Rock Creek Subbasin

Stream	Reach	Miles	# Passes	Reach Redds Totals	Redds /Mile	Live Observed			Morts		
						Floy Tag	No Floy	Unknown	Floy Tag	No Floy	Unknown
Mainstem	Rock Creek	2.5	2	2	0.80	0	0	2	0	2	0
	Mainstem T(	2.5		2	0.80	0.00	0.00	2.00	0.00	2.00	0.00

Results of 2008-09 Fall Chinook spawning surveys in the Rock Creek Subbasin

Stream	Reach	Miles	# Passes	Reach Redds Totals	Redds /Mile	Live Observed			Morts		
						Floy Tag	No Floy	Unknown	Floy Tag	No Floy	Unknown
Mainstem	Rock Creek	2.5	2	2	0.80	0	0	2	0	0	0
	Mainstem T(	2.5		2	0.80	0	0	2	0	0	0

Table A1. Fall Chinook survey tabular data.

Results of 2007-08 Coho spawning surveys in the Rock Creek Subbasin

Stream	Reach	Miles	# Passes	Reach Redds Totals	Redds /Mile	Live Observed			Morts		
						Floy Tag	No Floy	Unknown	Floy Tag	No Floy	Unknown
Mainstem	Rock Creek conflu. to gas line	2.5	2	0	0.00	0	0	0	0	0	0
	Mainstem Totals (surveyed reach)	2.5		0	0.00	0	0	0	0	0	0

Results of 2008-09 Coho spawning surveys in the Rock Creek Subbasin

Stream	Reach	Miles	# Passes	Reach Redds Totals	Redds /Mile	Live Observed			Morts		
						Floy Tag	No Floy	Unknown	Floy Tag	No Floy	Unknown
Mainstem	Rock Creek conflu. to gas line	2.5	2	0	0.00	0	0	1	0	0	0
	Mainstem Totals (surveyed reach)	2.5		0	0.00	0	0	1	0	0	0

Table A2. Coho spawner survey tabular data.

Stream	Reach	Miles	# Passes	Redds Totals	Redds /Mile	Live Observed Floy Tag	Live Observed No Floy	Live Observed Unknown	Morts Floy Tag	Morts No Floy	Morts Unknown
Mainstem	Rock Creek conflu. to gas line	2.5	3	31	12.40	0	19	0	0	1	0
	Rock Creek Luna conf. to Bick Br.	2.5	3	7	2.80	0	0	2	0	0	0
	Mainstem Totals (surveyed reaches)	5		38	15.20	0	19	21	0	1	0
Tributaries	Luna Gulch	1.5	3	1	0.67	0	1	0	0	0	0
	Squaw Creek at confluence	1.5	3	17	11.33	0	0	8	0	0	0
	Squaw Creek at Harrison conflu.	1.5	2	10	6.67	0	0	2	0	0	0
	Harrison Creek confluence	1	2	0	0.00	0	0	0	0	0	0
	Badger Gulch at confluence	0.5	2	2	4.00	0	0	0	0	0	0
	Quartz Creek at confluence	1.5	2	7	4.67	0	0	6	0	0	0
	Tributary Totals (surveyed reaches)	7.5		37	27.33	0	1	16	0	0	0
	Rock Creek subbasin Totals	**12.5**		**75**		**0**	**20**	**37**	**0**	**1**	**0**
	Mainstem Contribution %			*51*		~	*95*	*57*	~	*100*	~
	Tributary Contribution %			*49*		~	*5*	*43*	~	*0*	~

Results of 2008-09 Steelhead spawning surveys in the Rock Creek Subbasin

Stream	Reach	Miles	# Passes	Reach Redds Totals	Redds /Mile	Live Observed Floy Tag	Live Observed No Floy	Live Observed Unknown	Morts Floy Tag	Morts No Floy	Morts Unknown
Mainstem	Rock Creek conflu. to gas line	2.5	3	12	4.80	0	1	4	0	0	0
	Rock Creek Luna conf. to Bick Br.	2.5	3	0	0.00	0	0	2	0	0	0
	Mainstem Totals (surveyed reaches)	5		12	4.8	0	1	6	0	0	0
Tributaries	Luna Gulch	1.5	3	2	1.33	0	0	5	0	0	0
	Squaw Creek at confluence	1.5	3	10	6.67	0	0	12	0	0	0
	Squaw Creek at Harrison conflu.	1.5	2	16	10.67	0	0	9	0	0	0
	Harrison Creek confluence	1	2	0	0.00	0	0	0	0	0	0
	Badger Gulch at confluence	0.5	2	0	0.00	0	0	0	0	0	0
	Quartz Creek at confluence	1.5	2	5	3.33	0	0	4	0	0	0
	Tributary Totals (surveyed reaches)	7.5		33	22	0	0	30	0	0	0
	Rock Creek subbasin Totals	**12.5**		**45**		**0**	**1**	**36**	**0**	**0**	**0**
	Mainstem Contribution %			*36*		~	*100*	*17*	~	~	~
	Tributary Contribution %			*73*		~	*0*	*83*	~	~	~

Table A3. Steelhead spawner survey tabular data.

Appendix B. Sediment Data

Class Name	Particle Size Class (mm)	Rock Creek Park # of particle	Bickleton Bridge # of particle	Squaw Creek # of particle
Sand	<2	14	14	13
VF Gravel	2 - 2.8	13	6	3
VF Gravel	2.8 - 4	2	1	0
Fine Gravel	4 - 5.6	2	0	0
Fine Gravel	5.6 - 8	0	0	0
Med. Gravel	8 - 11.3	2	0	2
Med. Gravel	11.3 - 16	1	0	1
Coarse Gravel	16 - 22.6	0	0	2
Coarse Gravel	22.6 - 32	4	3	6
VC Gravel	32 - 45.3	10	7	12
VC Gravel	45.3 - 64	20	12	11
Sm. Cobble	64 - 90.5	23	17	24
Sm. Cobble	90.5 - 128	6	13	8
Lg. Cobble	128 - 181	2	11	12
Lg. Cobble	181 - 256	1	7	2
Sm. Boulder	256 - 362	0	3	2
Sm. Boulder	362 - 512	0	4	1
Med. Boulder	512 - 1024	0	2	1
Lg. Boulder	1024 - 2048	0	0	0
VL Boulder	2048 - 4096	0	0	0
Bedrock	>4096	0	0	0

Table B1. Sediment data from three spawning sites in Rock Creek and Squaw Creek.

Appendix C. Rock Creek Subbasin Air and Water Temperature Sites and Reports

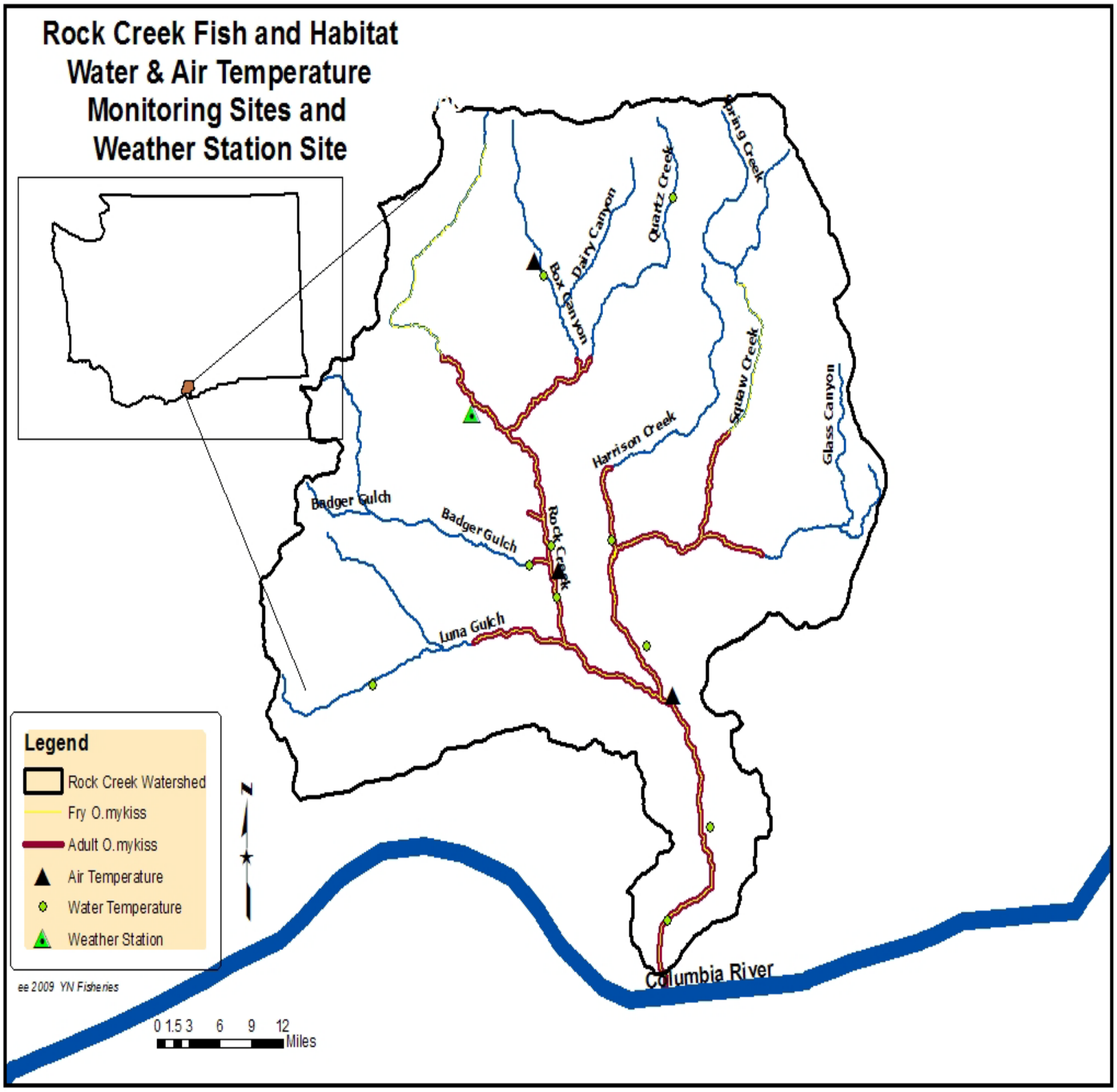

Figure C1. Rock Creek water & air monitoring sites and weather station site.

Table C1. Rock Creek water and air temperature reports.

Monthly Temperature Summaries (degrees C)

Badger Gulch Water Temperature ˚C

2007	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
February	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
March	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
April	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
May	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
June	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
July	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
August	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	1	0	0	0	0	0	0	0	0	0	0	0	8.2	0.9	0.9
November	30	0	0	0	0	0	0	0	0	0	0	0	10.2	1.4	0.9
December	31	0	30	0	28	0	0	0	0	0	0	0	5.9	3.6	1.2

Badger Gulch Water Temperature ˚C

2008	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	31	8	31	6	31	0	0	0	0	0	0	0	3.4	1.6	0.8
February	29	0	28	0	24	0	0	0	0	0	0	0	7.3	3.3	2.0
March	31	0	16	0	4	0	0	0	0	0	0	0	9.3	4.7	3.1
April	13	0	4	0	0	0	0	0	0	0	0	0	12.4	5.1	4.1
May	5	0	0	0	0	0	0	5	0	0	0	0	14.1	2.6	1.4
June	30	0	0	0	0	0	0	30	6	3	2	0	19.7	3.3	2.4
July	31	0	0	0	0	0	0	31	31	31	31	0	20.5	5.1	2.7
August	31	0	0	0	0	4	3	31	30	23	22	5	25.7	6.4	2.8
September	30	0	0	0	0	0	0	30	12	0	0	0	16.8	2.7	1.4
October	22	0	0	0	0	0	0	7	0	0	0	0	14.1	2.0	0.9
November	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
December	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--

Bickleton Bridge Water Temperature ˚C

2007	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
February	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
March	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
April	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
May	6	0	0	0	0	0	0	6	4	1	0	0	18.1	4.5	4.0
June	30	0	0	0	0	0	0	30	25	7	5	0	20.8	4.7	3.2
July	31	0	0	0	0	0	0	31	31	31	31	0	22.5	4.7	3.2
August	31	0	0	0	0	0	0	31	31	31	31	0	21.3	3.6	3.0
September	30	0	0	0	0	0	0	30	22	16	15	0	20.2	3.6	2.7
October	31	0	0	0	0	0	0	16	0	0	0	0	14.1	2.7	1.9
November	30	0	10	0	9	0	0	0	0	0	0	0	10.6	2.7	1.5
December	31	0	30	0	26	0	0	0	0	0	0	0	5.3	1.9	1.1

Bickleton Bridge Water Temperature ˚C

2008	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	8	31	5	31	0	0	0	0	0	0	0	4.5	1.6	1.0
February	29	0	28	0	22	0	0	0	0	0	0	0	6.7	2.7	1.9
March	31	0	25	0	9	0	0	0	0	0	0	0	8.0	4.2	2.6
April	30	0	19	0	1	0	0	0	0	0	0	0	12.3	5.7	4.0
May	31	0	0	0	0	0	0	19	3	0	0	0	18.4	5.9	3.5
June	30	0	0	0	0	0	0	30	15	6	5	0	22.0	4.9	3.6
July	23	0	0	0	0	0	0	23	23	23	23	0	22.1	4.6	3.5
August	31	0	0	0	0	0	0	31	31	31	31	0	21.8	4.3	3.0
September	30	0	0	0	0	0	0	30	22	11	0	0	18.3	3.4	2.8
October	31	0	0	0	0	0	0	12	0	0	0	0	16.0	3.3	2.1
November	30	0	2	0	0	0	0	0	0	0	0	0	12.7	3.7	1.7
December	31	0	21	0	18	0	0	0	0	0	0	0	9.2	2.7	1.1

NOTE: All Temperatures and Ranges in degrees C, -- Indicates No Available Data.

Bickleton Bridge Watter Temperature ˚C

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	2	31	1	29	0	0	0	0	0	0	0	5.8	3.0	1.1
February	28	0	28	0	26	0	0	0	0	0	0	0	5.9	2.9	1.7
March	31	1	25	0	14	0	0	0	0	0	0	0	8.3	4.0	2.4
April	22	0	6	0	1	0	0	1	0	0	0	0	13.2	5.3	3.8
May	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
June	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
July	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
August	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
November	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
December	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--

Bickleton Bridge Air Temperature ˚C

2008	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
February	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
March	6	5	6	1	5	1	1	6	0	0	0	0	25.2	24.5	15.2
April	30	21	28	0	3	6	5	30	18	14	14	1	28.2	25.9	17.9
May	31	4	7	0	0	12	10	31	31	31	31	15	38.2	26.9	15.8
June	30	0	2	0	0	20	17	30	30	30	30	20	37.3	22.6	16.4
July	31	0	0	0	0	31	31	31	31	31	31	31	35.3	23.8	17.4
August	31	0	0	0	0	25	24	31	31	31	31	31	37.5	22.9	15.9
September	30	0	2	0	0	21	20	30	30	30	30	24	31.5	24.2	17.8
October	31	13	21	0	0	2	1	31	24	15	9	1	25.1	20.9	14.5
November	30	14	24	2	11	0	0	12	0	0	0	0	18.1	15.5	9.6
December	31	26	31	15	26	0	0	0	0	0	0	0	16.9	18.3	8.0

NOTE: All Temperatures and Ranges in degrees C, -- Indicates No Available Data.

Bickleton Bridge Air Temperature ˚C

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	26	30	16	26	0	0	0	0	0	0	0	17.3	17.0	6.9
February	28	23	28	6	26	0	0	0	0	0	0	0	15.0	17.6	8.8
March	31	20	30	3	11	0	0	14	0	0	0	0	19.6	18.2	11.6
April	22	6	15	0	1	5	5	22	17	13	12	6	32.2	25.9	17.0
May	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
June	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
July	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
August	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
November	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
December	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--

Box Canyon Road Air Temperature ˚C

2008	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
February	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
March	6	6	6	5	6	1	1	0	0	0	0	0	24.7	27.5	13.5
April	30	28	30	4	21	0	0	13	0	0	0	0	22.3	22.4	14.2
May	31	9	17	0	1	5	5	31	21	16	14	5	31.8	22.9	14.7
June	30	4	20	0	0	10	8	30	23	21	20	16	34.9	23.8	17.4
July	31	0	8	0	0	24	22	31	31	31	31	31	31.6	24.1	18.8
August	31	2	6	0	0	18	18	31	31	31	31	25	37.9	23.5	17.2
September	30	4	16	0	0	20	16	30	30	29	27	20	30.5	24.2	19.6
October	31	21	26	0	11	1	1	27	15	8	6	0	26.8	23.4	15.8
November	30	20	27	6	15	0	0	4	0	0	0	0	15.8	17.1	9.7
December	31	31	31	24	28	0	0	0	0	0	0	0	14.0	17.0	8.8

NOTE: All Temperatures and Ranges in degrees C, -- Indicates No Available Data.

Box Canyon Road Air Temperature ˚C

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	30	30	23	30	0	0	0	0	0	0	0	12.2	18.2	7.7
February	28	28	28	22	28	0	0	0	0	0	0	0	12.3	17.9	9.5
March	31	31	31	12	30	0	0	0	0	0	0	0	14.6	16.5	9.8
April	24	18	23	1	9	2	2	16	6	6	5	0	26.3	24.0	15.4
May	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
June	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
July	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
August	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
November	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
December	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--

Box Canyon Road Water Temperature ˚C

2008	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
February	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
March	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
April	15	0	15	0	6	0	0	0	0	0	0	0	10.1	6.4	4.4
May	31	0	7	0	0	0	0	18	0	0	0	0	16.1	7.9	5.2
June	30	0	0	0	0	0	0	30	7	4	3	0	19.3	7.3	5.9
July	31	0	0	0	0	0	0	31	21	15	13	0	19.3	6.1	3.8
August	16	0	0	0	0	0	0	16	3	0	0	0	17.0	2.8	1.7
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
November	11	0	7	0	5	0	0	0	0	0	0	0	7.1	2.6	2.1
December	31	10	31	4	26	0	0	0	0	0	0	0	6.8	3.3	1.5

NOTE: All Temperatures and Ranges in degrees C,   -- Indicates No Available Data.

Box Canyon Road Water Temperature ˚C

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	6	31	2	31	0	0	0	0	0	0	0	4.1	2.2	1.0
February	28	8	28	1	28	0	0	0	0	0	0	0	3.6	2.7	1.7
March	31	5	31	0	31	0	0	0	0	0	0	0	6.2	4.0	2.3
April	24	0	20	0	6	0	0	0	0	0	0	0	11.7	6.8	4.2
May	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
June	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
July	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
August	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
November	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
December	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--

Hwy 8 Bridge Water Temperature ˚C

2007	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
February	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
March	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
April	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
May	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
June	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
July	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
August	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	1	0	0	0	0	0	0	1	0	0	0	0	14.8	0.6	0.6
November	30	0	0	0	0	0	0	18	0	0	0	0	16.3	2.5	1.3
December	31	0	18	0	10	0	0	0	0	0	0	0	9.0	3.9	1.3

NOTE: All Temperatures and Ranges in degrees C, -- Indicates No Available Data.

Hwy 8 Bridge Water Temperature ˚C

2008	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	6	31	0	27	0	0	0	0	0	0	0	5.6	2.9	1.5
February	29	0	24	0	14	0	0	0	0	0	0	0	8.0	3.3	2.3
March	31	0	12	0	0	0	0	0	0	0	0	0	10.0	5.9	3.3
April	13	0	3	0	0	0	0	3	0	0	0	0	13.5	6.5	5.4
May	5	0	0	0	0	0	0	5	5	5	5	0	19.7	7.0	4.1
June	30	0	0	0	0	0	0	30	30	30	27	1	22.7	7.8	5.9
July	31	0	0	0	0	7	4	31	31	31	31	17	26.1	13.0	6.2
August	31	0	0	0	0	21	16	31	31	31	31	31	29.9	14.1	8.9
September	30	0	0	0	0	17	17	30	30	30	30	21	30.3	16.9	12.2
October	22	0	0	0	0	1	0	22	15	5	5	0	23.2	11.4	6.7
November	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
December	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--

Longhouse Water Temperature ˚C

2007	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
February	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
March	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
April	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
May	8	0	0	0	0	3	2	8	8	8	8	7	27.1	10.4	6.6
June	30	0	0	0	0	9	3	30	30	30	30	20	25.3	8.2	6.2
July	31	0	0	0	0	31	29	31	31	31	31	31	30.6	11.3	8.0
August	31	0	0	0	0	29	26	31	31	31	31	31	32.3	15.7	9.9
September	30	0	0	0	0	15	15	30	29	26	24	15	29.5	16.3	9.6
October	31	0	0	0	0	0	0	27	0	0	0	0	17.7	7.5	3.9
November	30	0	0	0	0	0	0	3	0	0	0	0	13.6	3.6	1.7
December	31	0	14	0	5	0	0	0	0	0	0	0	9.2	3.7	1.3

NOTE: All Temperatures and Ranges in degrees C, -- Indicates No Available Data.

Longhouse Water Temperature ˚C

2008	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	31	6	31	0	26	0	0	0	0	0	0	0	5.8	2.8	1.5
February	29	0	24	0	13	0	0	0	0	0	0	0	8.0	3.2	2.3
March	31	0	12	0	0	0	0	0	0	0	0	0	10.0	5.7	3.3
April	30	0	2	0	0	0	0	12	0	0	0	0	16.0	6.6	5.1
May	31	0	0	0	0	0	0	31	19	13	10	0	21.1	6.9	4.7
June	30	0	0	0	0	3	2	30	30	28	23	4	25.0	6.9	5.2
July	23	0	0	0	0	23	20	23	23	23	23	23	27.7	10.3	7.1
August	31	0	0	0	0	30	28	31	31	31	31	31	33.8	13.4	9.8
September	30	0	0	0	0	20	19	30	30	30	30	20	29.1	15.8	12.2
October	31	0	0	0	0	0	0	30	15	6	5	0	20.5	8.9	5.4
November	30	0	0	0	0	0	0	7	0	0	0	0	14.4	2.9	1.8

Longhouse Water Temperature ˚C

2009	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	31	0	25	0	22	0	0	0	0	0	0	0	7.6	2.8	1.3
February	28	0	19	0	9	0	0	0	0	0	0	0	7.7	3.4	1.8
March	31	0	11	0	5	0	0	0	0	0	0	0	10.6	4.5	3.0
April	22	0	0	0	0	0	0	7	0	0	0	0	16.2	5.7	4.2
May	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
June	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
July	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
August	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
November	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
December	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--

NOTE: All Temperatures and Ranges in degrees C,   -- Indicates No Available Data.

Luna Gulch Water Temperature ˚C

2007	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
February	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
March	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
April	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
May	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
June	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
July	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
August	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
November	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
December	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--

Luna Gulch Water Temperature ˚C

2008	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
February	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
March	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
April	14	0	3	0	0	0	0	5	0	0	0	0	14.9	8.8	6.3
May	31	0	0	0	0	0	0	31	0	0	0	0	17.1	8.8	4.8
June	30	0	0	0	0	0	0	30	1	0	0	0	16.3	4.7	3.5
July	31	0	0	0	0	0	0	31	2	0	0	0	16.6	3.5	2.3
August	31	0	0	0	0	0	0	31	0	0	0	0	16.2	2.1	1.2
September	30	0	0	0	0	0	0	30	0	0	0	0	14.2	2.6	1.8
October	31	0	0	0	0	0	0	5	0	0	0	0	12.7	2.0	1.3
November	30	0	0	0	0	0	0	0	0	0	0	0	10.4	1.9	0.9
December	31	0	18	0	16	0	0	0	0	0	0	0	8.1	3.4	1.0

NOTE: All Temperatures and Ranges in degrees C, -- Indicates No Available Data.

Luna Gulch Water Temperature ˚C

2009	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	31	6	31	2	28	0	0	0	0	0	0	0	6.3	4.5	1.5
February	28	1	28	0	28	0	0	0	0	0	0	0	6.5	4.7	2.4
March	31	1	29	0	16	0	0	0	0	0	0	0	10.2	6.2	4.1
April	22	0	6	0	0	0	0	6	0	0	0	0	15.3	8.3	6.0
May	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
June	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
July	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
August	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
November	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
December	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--

Newell Road Air Temperature ˚C

2008	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
February	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
March	6	5	6	0	2	1	1	6	0	0	0	0	26.1	23.7	15.7
April	30	13	27	0	2	4	4	30	17	15	14	0	28.4	24.9	17.4
May	31	1	5	0	0	15	12	31	31	31	31	20	37.4	24.6	15.5
June	30	0	0	0	0	21	20	30	30	30	30	23	41.4	25.5	17.3
July	31	0	0	0	0	31	31	31	31	31	31	31	37.9	25.6	18.1
August	31	0	0	0	0	31	30	31	31	31	31	31	43.3	25.8	17.6
September	30	0	1	0	0	25	23	30	30	30	30	29	35.3	25.8	20.4
October	31	7	17	0	0	9	6	31	31	31	30	6	30.3	24.3	17.1
November	30	12	22	1	8	0	0	21	2	0	0	0	21.3	18.0	11.4
December	31	24	30	15	22	0	0	9	0	0	0	0	20.5	21.8	11.0

NOTE: All Temperatures and Ranges in degrees C, -- Indicates No Available Data.

Newell Road Air Temperature ˚C

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	25	29	16	24	0	0	4	0	0	0	0	21.6	20.7	9.1
February	28	23	28	2	23	0	0	1	0	0	0	0	18.9	21.1	11.9
March	31	21	30	1	9	1	1	25	13	7	5	0	24.0	23.1	16.4
April	22	7	14	0	0	12	10	22	22	21	21	13	35.7	30.2	21.1
May	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
June	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
July	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
August	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
November	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
December	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--

Quartz Creek Water Temperature ˚C

2008	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
February	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
March	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
April	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
May	25	0	2	0	0	0	0	6	0	0	0	0	14.4	6.6	4.4
June	30	0	0	0	0	0	0	20	0	0	0	0	15.3	6.3	4.9
July	31	0	0	0	0	0	0	31	0	0	0	0	16.4	7.2	4.9
August	27	0	0	0	0	0	0	27	26	11	9	0	22.9	9.5	6.6
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	27	0	7	0	0	0	0	0	0	0	0	0	12.7	6.5	4.0
November	22	0	0	0	0	0	0	0	0	0	0	0	10.9	4.6	2.2
December	31	0	12	0	11	0	0	0	0	0	0	0	7.4	0.7	0.4

NOTE: All Temperatures and Ranges in degrees C, -- Indicates No Available Data.

Quartz Creek Water Temperature ˚C

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	4	31	0	31	0	0	0	0	0	0	0	4.8	3.2	1.3
February	28	0	28	0	28	0	0	0	0	0	0	0	4.6	3.0	2.1
March	31	0	31	0	31	0	0	0	0	0	0	0	6.4	3.4	2.1
April	22	0	14	0	3	0	0	0	0	0	0	0	14.4	8.6	3.6
May	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
June	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
July	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
August	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
November	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
December	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--

Site 2 trees Water Temperature ˚C

2007	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
February	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
March	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
April	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
May	6	0	0	0	0	0	0	6	6	6	6	1	22.5	7.5	6.8
June	30	0	0	0	0	3	2	30	30	30	30	3	25.0	6.8	4.8
July	31	0	0	0	0	28	23	31	31	31	31	31	26.7	5.9	4.2
August	31	0	0	0	0	24	17	31	31	31	31	31	26.1	6.5	5.2
September	30	0	0	0	0	3	0	30	30	22	20	6	23.8	5.1	3.7
October	31	0	0	0	0	0	0	26	0	0	0	0	16.4	2.7	1.6
November	30	0	0	0	0	0	0	0	0	0	0	0	12.1	2.6	1.5
December	31	0	21	0	14	0	0	0	0	0	0	0	8.7	3.8	1.3

NOTE: All Temperatures and Ranges in degrees C, -- Indicates No Available Data.

Site 2 Trees Water Temperature ˚C

2008	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	6	31	5	30	0	0	0	0	0	0	0	5.4	2.9	1.4
February	29	0	24	0	15	0	0	0	0	0	0	0	7.6	3.1	2.2
March	31	0	13	0	0	0	0	0	0	0	0	0	9.3	5.1	3.0
April	30	0	3	0	0	0	0	6	0	0	0	0	15.3	6.8	4.9
May	31	0	0	0	0	0	0	31	18	12	8	0	21.1	7.6	5.0
June	30	0	0	0	0	3	3	30	30	27	23	5	25.3	8.2	6.0
July	21	0	0	0	0	12	3	21	21	21	21	21	25.2	5.3	3.8
August	19	0	0	0	0	15	9	19	19	19	19	19	26.7	6.4	4.6
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	23	0	0	0	0	1	1	15	3	0	0	0	24.6	8.3	2.4
November	30	0	0	0	0	0	0	2	0	0	0	0	13.9	2.9	1.5
December	31	4	16	1	14	0	0	0	0	0	0	0	10.6	2.9	1.6

Site 2 Trees Water Temperature ˚C

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	2	26	0	24	0	0	0	0	0	0	0	7.1	3.6	1.3
February	28	0	23	0	13	0	0	0	0	0	0	0	7.4	3.3	1.9
March	31	0	16	0	6	0	0	0	0	0	0	0	9.9	4.3	2.9
April	22	0	1	0	0	0	0	6	0	0	0	0	16.3	6.5	4.7
May	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
June	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
July	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
August	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
November	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
December	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--

NOTE: All Temperatures and Ranges in degrees C, -- Indicates No Available Data.

Squaw Creek 1 Water Temperature ˚C

2008	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
February	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
March	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
April	14	0	3	0	0	0	0	0	0	0	0	0	12.9	6.0	4.6
May	31	0	0	0	0	0	0	21	0	0	0	0	16.4	5.9	3.5
June	30	0	0	0	0	0	0	30	6	3	1	0	19.2	4.3	3.2
July	31	0	0	0	0	0	0	31	31	31	31	0	20.3	5.6	4.2
August	31	0	0	0	0	0	0	31	31	24	16	0	20.3	4.4	2.8
September	2	0	0	0	0	0	0	2	2	0	0	0	16.0	3.5	3.4
October	9	0	0	0	0	0	0	0	0	0	0	0	9.6	2.4	1.8
November	30	0	0	0	0	0	0	0	0	0	0	0	11.3	2.6	1.3
December	31	7	19	1	18	0	0	0	0	0	0	0	8.1	2.3	1.3

Squaw Creek 1 Water Temperature ˚C

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	2	31	2	30	0	0	0	0	0	0	0	5.5	3.6	1.3
February	28	0	28	0	28	0	0	0	0	0	0	0	5.1	3.5	1.6
March	31	0	29	0	18	0	0	0	0	0	0	0	8.1	4.5	2.9
April	22	0	5	0	1	0	0	4	0	0	0	0	13.9	6.2	4.7
May	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
June	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
July	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
August	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
November	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
December	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--

NOTE: All Temperatures and Ranges in degrees C, -- Indicates No Available Data.

Squaw Creek 2 Water Temperature ˚C

2008	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
February	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
March	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
April	14	0	0	0	0	0	0	3	0	0	0	0	13.6	6.4	4.5
May	31	0	0	0	0	0	0	31	3	0	0	0	18.0	7.2	4.8
June	10	0	0	0	0	0	0	10	0	0	0	0	16.1	6.8	4.7
July	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
August	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
November	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
December	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--

Squaw Creek 2 Water Temperature ˚C

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
February	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
March	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
April	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
May	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
June	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
July	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
August	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
September	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
October	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
November	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--
December	0	--	0	0	0	0	0	0	0	0	0	0	--	--	--

NOTE: All Temperatures and Ranges in degrees C,   -- Indicates No Available Data.

Appendix D. EDT Results

Rock Creek Fall Chinook
Protection and Restoration Strategic Priority Summary

Geographic area	Protection benefit	Restoration benefit	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
	Geographic area priority		Attribute class priority for restoration															
Luna		◦	•				•	●	●	•					•			●
Rock Below Squaw	○	○	●				•	●	●		•			•	•			●
Rock Between Squaw and Luna	○	○	•				●	●	•						•	•		●
Squaw Cr	◦		•				•	●	●		●					•		●

1/ "Channel stability" applies to freshwater areas only.

Key to strategic priority (corresponding Benefit Category letter also shown)

A		B		C		D & E	
○ / ●	High	○ / ●	Medium	◦ / •	Low		Indirect or General

Table D1. Rock Creek fall Chinook protection and restoration summary.

Rock Creek Fall Chinook
Life Stage Summary Across All Geographic Areas

Relevant months	Productivity change (%)	Life Stage Rank	Channel stability	Chemicals	Competition (w/ hatc	Competition (other sp	Flow	Food	Habitat diversity	Harassment/poachin	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
			Change in attribute impact on survival															
									●	•						•		●
Spawning	100.0%	0	●												●			●
Egg incubation	100.0%	0	•			•	●	●	●					•				◦
Fry colonization	100.0%	0						●	•					•				○
0-age active rearing	57.9%	0																
0-age migrant	0.0%	0																
0-age inactive	0.0%	0																
1-age active rearing	0.0%	0																
1-age migrant	0.0%	0																
1-age transient rearing	0.0%	0																
2+-age transient rearing	0.0%	0					●		•		•							●
Prespawning migrant	100.0%	0					•		●	•								●

1/ Ranking based on effect over entire geographic 2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width. NA = Not applicab

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

	Loss	Gain
None		
Small	•	◦
Moderate	●	○
High	●	○
Extreme	●	○

Table D2. Rock Creek fall Chinook life stage summary across all geographic areas.

Rock Creek (YN) Fall Chinook

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection Category/ran		Restoration Category/ra	
Luna	0	0	0	0
Rock Below Squaw	0	0	0	0
Rock Between Squaw and Luna	0	0	0	0
Squaw Cr	0	0	0	0

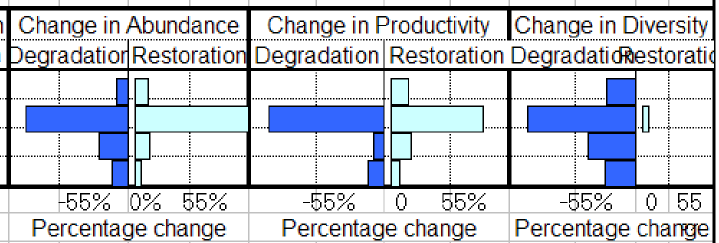

Table D3. Rock Creek fall Chinook areas for protection and restoration measures.

Rock Creek Coho

Protection and Restoration Strategic Priority Summary

Geographic area	Protection benefit	Restoration benefit	Channel stability	Chemicals	Competition (w/ ha	Competition (other	Flow	Food	Habitat diversity	Harassment/poachi	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Badger Gulch			•					●	•						●	●		●
Luna		◯	•				•	●	●	•					•			●
Quartz		∘	●				•	●	•						●	⬤		●
Rock Above Quartz			•					•	●						●			•
Rock Below Squaw	∘	○	●		•		•	●	●					•	•	●		●
Rock Between Badger and Unnamed			•				•	●	•						●	•		●
Rock Between Luna and Badger			●		•		•	⬤	●							●		●
Rock Between Squaw and Luna	○		•				•	●	•						•	●		●
Rock Between Unnamed and Quartz			•				•	●	•						●	•		●
Squaw Cr	◯	∘	•				•	●	•		●				•	●		●
Unnamed Trib			•				•	●	•						●	●		⬤

1/ "Channel stability" applies to freshwater areas only.

Key to strategic priority (corresponding Benefit Category letter also shown)

A		B		C		D & E	
◯ ⬤	High	○ ●	Medium	∘ •	Low		Indirect or General

Table D4. Rock Creek coho protection and restoration summary.

Rock Creek Coho Life Stage Summary Across All Geographic Areas																	
		Change in attribute impact on survival															
Relevant months	**Productivity change (%)**	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
0	0.0%							●	•					•			⬤
Spawning	100.0%	⬤												⬤			●
Egg incubation	100.0%	•			•	●	⬤	●						•			•
Fry colonization	100.0%	•		•	•	•	⬤	●				•	•	•	⬤		⬤
0-age active rearing	100.0%							●									⬤
0-age migrant	100.0%	•				•	⬤	○									
0-age inactive	98.6%	•		•		•	⬤	●									○
1-age active rearing	98.6%							•					•				∘
1-age migrant	98.6%																
1-age transient rearing	0.0%																
2+-age transient rearing	0.0%																⬤
Prespawning migrant	100.0%					•		●									●

1/ Ranking based on effect over entire geogr 2/ Value shown is for overall population performance

Notes: Changes in key habitat can be caused by either a change in percent key habitat or NA = Not applic

Potential % changes in performance measures for reaches upstream of dams were computed wit allowed at dams (though reservoir effects still in place).

KEY	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⬤	◯
Extreme	⬤	◯

Table D5. Rock Creek coho life stage summary across all geographic areas.

Rock Creek Steelhead Protection and Restoration Strategic Priority Summary																		
Geographic area priority			**Attribute class priority for restoration**															
Geographic area	**Protection benefit**	**Restoration benefit**	***Channel stability***	***Chemicals***	***Competition (w/ ha***	***Competition (other***	***Flow***	***Food***	***Habitat diversity***	***Harassment/poachi***	***Obstructions***	***Oxygen***	***Pathogens***	***Predation***	***Sediment load***	***Temperature***	***Withdrawals***	***Key habitat quantity***
Badger Gulch							•	•	•				•		●	●		●
Luna	∘	○	•				•	●	•	•	⬤	•			•			●
Quartz		○					•	●	•		●		•		●	⬤		●
Rock Above Quartz	∘							•			•				⬤			•
Rock Below Squaw	◯	◯	•		•		•	•	●				•	•	●	●		●
Rock Between Badger and Unnamed							•	•	•						●	•		●
Rock Between Luna and Badger			•		•		●	⬤	●				•			●		⬤
Rock Between Squaw and Luna		∘	•				•	•	•		●		•		•	●		⬤
Rock Between Unnamed and Quartz							•	●	•		●				●	⬤		●
Squaw Cr	○	○	•				•	•	•		⬤		•		•	•		●
Unnamed Trib			•				•	●	●		⬤		•		●	●		⬤

1/ "Channel stability" applies to freshwater areas only.

Key to strategic priority (corresponding Benefit Category letter also shown)

A		B		C		D & E	
◯ ⬤	High	○ ●	Medium	∘ •	Low		Indirect or General

Table D6. Rock Creek steelhead protection and restoration summary.

Rock Creek Steelhead

Life Stage Summary Across All Geographic Areas

Relevant months	Productivity change (%)	Channel stability	Chemicals	Competition (w/ hatc	Competition (other sp	Flow	Food	Habitat diversity	Harassment/poachin	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
		Change in attribute impact on survival															
#REF!	#REF!							●	•					•	•		●
Spawning	100.0%	●												⬤	⬤		●
Egg incubation	100.0%	•				●	⬤	●		●			•		●		●
Fry colonization	100.0%	•		•		●	⬤	●				●	•	•	●		⬤
0-age active rearing	100.0%	•				•	⬤	●									●
0,1-age inactive	108.0%							•					•				∘
1-age migrant	98.8%					•	⬤	●							•		●
1-age active rearing	100.0%					•		●									●
2+-age active rearing	8.0%							•					•				○
2+-age migrant	8.0%																
2+-age transient rearing	0.0%																∘
Prespawning migrant	100.0%																○

1/ Ranking based on effect over entire geographic area.
Notes: Changes in key habitat can be caused by either a change in percent key h; NA = Not applica
Potential % changes in performance measures for reaches upstream of dams were comput
allowed at dams (though reservoir effects still in place).

KEY	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⬤	◯
Extreme	⬤	◯

Table D7. Rock Creek steelhead life stage summary across all geographic areas.

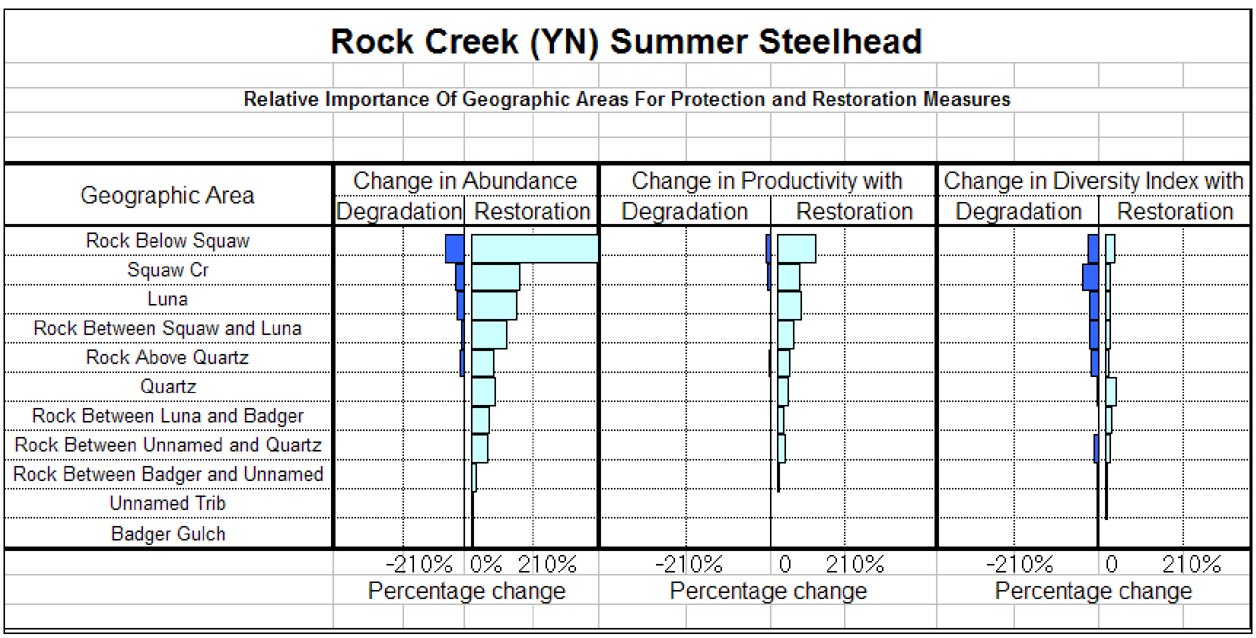

Table D8. Rock Creek steelhead areas for protection and restoration measures.

Appendix E. Pathogen Results

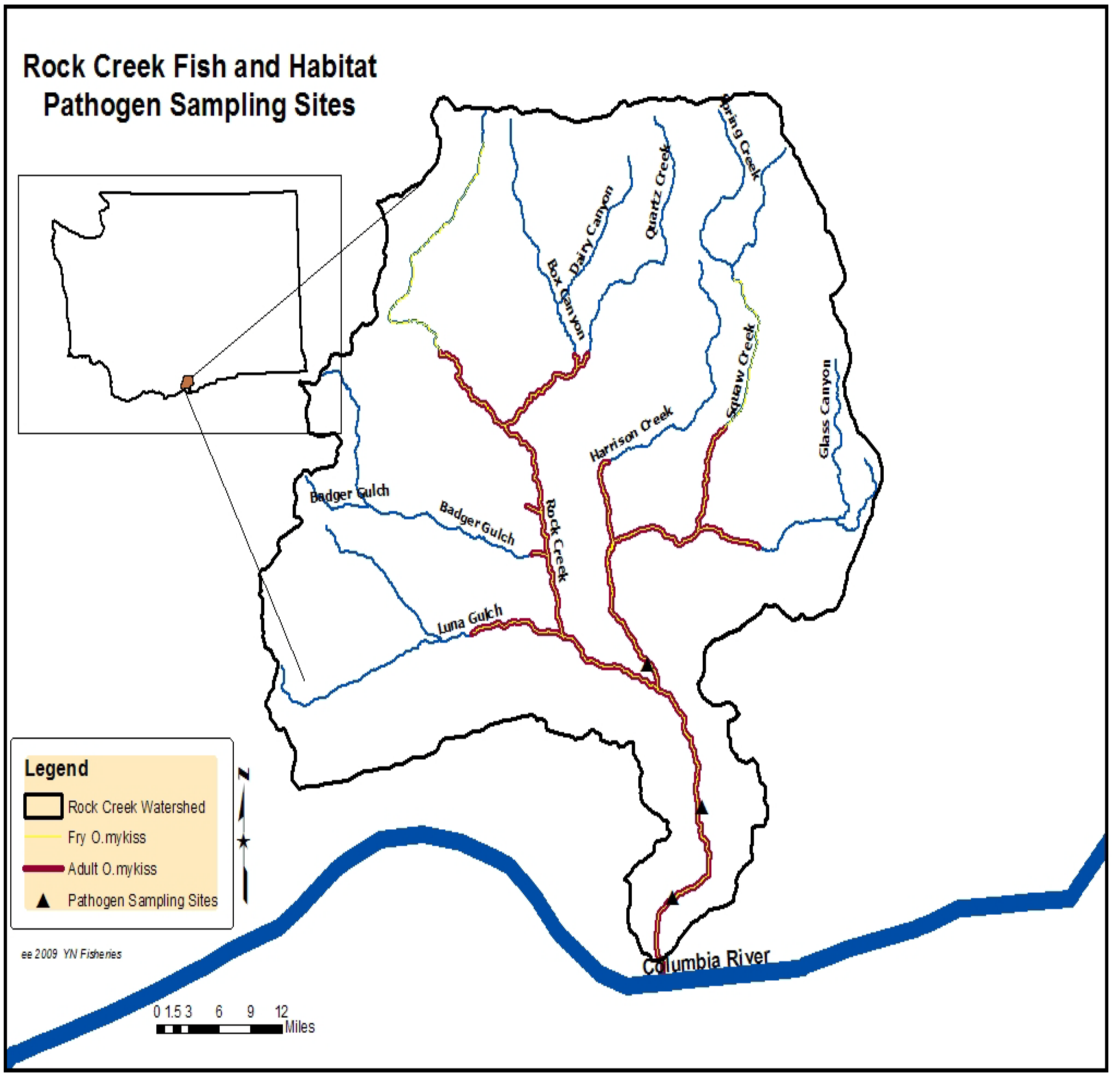

Figure E1. Rock Creek fish pathogen sampling sites.

U.S. FISH & WILDLIFE SERVICE
LOWER COLUMBIA RIVER FISH HEALTH CENTER
201 Oklahoma Road
Willard, WA 98605
Phone: 509-538-2400
Fax: 509-538-2404

FISH HEALTH REPORT 2009

FISH SOURCE	FISH EXAMINED
Location: Squaw Creek **County**: Klickitat **Contact Person:** Elaine Espirito **Affiliation:** YIN **Phone:** (509) 369-3570	**Species:** Redside shiners **Age:** Juvenile/Adult **CHN:** W09-006 **Number of fish:** 11 **Date Sampled:** 11/13/2008

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	11	not detected	EPC and CHSE-214 cells
IHNV	11	not detected	EPC and CHSE-214 cells
VHS	11	not detected	EPC and CHSE-214 cells
SVCV	11	not detected	EPC and FHM cells
AS	11	not detected	BHIA medium
YR	11	not detected	BHIA medium
ESC	11	not detected	BHIA medium
BCD	11	not detected	TYES medium
CD	11	not detected	TYES medium
RS	-	not tested	ELISA
WD	-	not tested	Pepsin/Trypsin Digest
Comments			

Table E1. Squaw Creek redside shiners pathogen results.

FISH SOURCE	FISH EXAMINED
Location: Rock Creek **County**: Klickitat **Contact Person:** Elaine Espirito **Affiliation:** YIN **Phone:** (509) 369-3570	**Species:** Steelhead **Age:** Juvenile **CHN:** W09-007 **Number of fish:** 2 **Date Sampled:** 11/13/2008

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	2	not detected	EPC and CHSE-214 cells
IHNV	2	not detected	EPC and CHSE-214 cells
VHS	2	not detected	EPC and CHSE-214 cells
SVCV	-	not tested	EPC and FHM cells
AS	2	not detected	BHIA medium
YR	2	not detected	BHIA medium
ESC	2	not detected	BHIA medium
BCD	2	not detected	TYES medium
CD	2	not detected	TYES medium
RS	-	not tested	ELISA
WD	2	not detected	Pepsin/Trypsin Digest and PCR

Table E2. Rock Creek juvenile steelhead pathogen results.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral HemorrhagicSepticemia Virus, **SVCV** Spring Viremia of Carp Virus, **AS** Furunculosis (*Aeromonas salmonicida)*, **YR** Enteric Redmouth (*Yersinia ruckeri),* **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri)*, **BCD** Coldwater Disease (*Flavobacterium psychrophilum)*, **CD** Columnaris (*Flavobacterium columnare),* **RS** BKD (*Renibacterium salmoninarum*), **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

FISH SOURCE	FISH EXAMINED
Location: Rock Creek **County**: Klickitat **Contact Person:** Elaine Espirito **Affiliation:** YIN **Phone:** (509) 369-3570	**Species:** Redside shiner **Age:** Juvenile/ Adult **CHN:** W09-008 **Number of fish:** 8 **Date Sampled:** 11/13/2008

DISEASE AGENT [1]	**SAMPLE SIZE**	**RESULTS**	**COMMENTS**
IPNV	8	not detected	EPC and CHSE-214 cells
IHNV	8	not detected	EPC and CHSE-214 cells
VHS	8	not detected	EPC and CHSE-214 cells
SVCV	8	not detected	EPC and FHM cells
AS	8	not detected	BHIA medium
YR	8	not detected	BHIA medium
ESC	8	not detected	BHIA medium
BCD	8	not detected	TYES medium
CD	8	not detected	TYES medium
RS	-	not tested	ELISA
WD	-	not tested	Pepsin/Trypsin Digest

Comments	Highway 8 Bridge.

Table E3. Rock Creek redside shiner pathogen results.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral HemorrhagicSepticemia Virus, **SVCV** Spring Viremia of Carp Virus, **AS** Furunculosis (*Aeromonas salmonicida)*, **YR** Enteric Redmouth (*Yersinia ruckeri),* **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **BCD** Coldwater Disease (*Flavobacterium psychrophilum),* **CD** Columnaris (*Flavobacterium columnare),* **RS** BKD (*Renibacterium salmoninarum*), **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

FISH SOURCE	FISH EXAMINED
Location: Rock Creek **County**: Klickitat **Contact Person:** Elaine Espirito **Affiliation:** YIN **Phone:** (509) 369-3570	**Species:** Redside shiner **Age:** Juvenile/ Adult **CHN:** W09-009 **Number of fish:** 5 **Date Sampled:** 11/13/2008

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	5	not detected	EPC and CHSE-214 cells
IHNV	5	not detected	EPC and CHSE-214 cells
VHS	5	not detected	EPC and CHSE-214 cells
SVCV	5	not detected	EPC and FHM cells
AS	5	not detected	BHIA medium
YR	5	not detected	BHIA medium
ESC	5	not detected	BHIA medium
BCD	5	not detected	TYES medium
CD	5	not detected	TYES medium
RS	-	not tested	ELISA
WD	-	not tested	Pepsin/Trypsin Digest

Comments	Mainstem.

Table E4. Rock Creek redside shiner pathogen results.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral HemorrhagicSepticemia Virus, **SVCV** Spring Viremia of Carp Virus, **AS** Furunculosis (*Aeromonas salmonicida)*, **YR** Enteric Redmouth (*Yersinia ruckeri),* **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri)*, **BCD** Coldwater Disease (*Flavobacterium psychrophilum)*, **CD** Columnaris (*Flavobacterium columnare)*, **RS** BKD (*Renibacterium salmoninarum*), **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

FISH SOURCE	FISH EXAMINED
Location: Rock Creek **County**: Klickitat **Contact Person:** Elaine Espirito **Affiliation:** YIN **Phone:** (509) 369-3570	**Species:** Longnose dace **Age:** Juvenile/ Adult **CHN:** W09-010 **Number of fish:** 23 **Date Sampled:** 11/13/2008

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	23	not detected	EPC and CHSE-214 cells
IHNV	23	not detected	EPC and CHSE-214 cells
VHS	23	not detected	EPC and CHSE-214 cells
SVCV	23	not detected	EPC and FHM cells
AS	23	not detected	BHIA medium
YR	23	not detected	BHIA medium
ESC	23	not detected	BHIA medium
BCD	23	not detected	TYES medium
CD	23	not detected	TYES medium
RS	-	not tested	ELISA
WD	-	not tested	Pepsin/Trypsin Digest

Comments	Highway 8 Bridge.

Table E5. Rock Creek longnose dace pathogen results.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral HemorrhagicSepticemia Virus, **SVCV** Spring Viremia of Carp Virus, **AS** Furunculosis (*Aeromonas salmonicida)*, **YR** Enteric Redmouth (*Yersinia ruckeri),* **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **BCD** Coldwater Disease (*Flavobacterium psychrophilum)*, **CD** Columnaris (*Flavobacterium columnare)*, **RS** BKD (*Renibacterium salmoninarum*), **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

FISH SOURCE	**FISH EXAMINED**
Location: Rock Creek **County**: Klickitat **Contact Person:** Elaine Espirito **Affiliation:** YIN **Phone:** (509) 369-3570	**Species:** Bridgelip sucker **Age:** Juvenile/ Adult **CHN:** W09-011 **Number of fish:** 7 **Date Sampled:** 11/13/2008

DISEASE AGENT [1]	**SAMPLE SIZE**	**RESULTS**	**COMMENTS**
IPNV	7	not detected	EPC and CHSE-214 cells
IHNV	7	not detected	EPC and CHSE-214 cells
VHS	7	not detected	EPC and CHSE-214 cells
SVCV	7	not detected	EPC and FHM cells
AS	7	not detected	BHIA medium
YR	7	not detected	BHIA medium
ESC	7	not detected	BHIA medium
BCD	7	not detected	TYES medium
CD	7	not detected	TYES medium
RS	-	not tested	ELISA
WD	-	not tested	Pepsin/Trypsin Digest

Comments	Highway 8 Bridge.

Table E6. Rock Creek bridgelip sucker pathogen results.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral HemorrhagicSepticemia Virus, **SVCV** Spring Viremia of Carp Virus, **AS** Furunculosis (*Aeromonas salmonicida)*, **YR** Enteric Redmouth (*Yersinia ruckeri),* **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **BCD** Coldwater Disease (*Flavobacterium psychrophilum),* **CD** Columnaris (*Flavobacterium columnare),* **RS** BKD (*Renibacterium salmoninarum*), **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

FISH SOURCE	FISH EXAMINED
Location: Rock Creek **County**: Klickitat **Contact Person:** Elaine Espirito **Affiliation:** YIN **Phone:** (509) 369-3570	**Species:** Steelhead **Age:** Juvenile **CHN:** W09-012 **Number of fish:** 24 **Date Sampled:** 11/21/2008

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	24	not detected	EPC and CHSE-214 cells
IHNV	24	not detected	EPC and CHSE-214 cells
VHS	24	not detected	EPC and CHSE-214 cells
SVCV	-	not tested	EPC and FHM cells
AS	24	not detected	BHIA medium
YR	24	not detected	BHIA medium
ESC	24	not detected	BHIA medium
BCD	24	not detected	TYES medium
CD	24	not detected	TYES medium
RS	1	not detected	ELISA
WD	24	not detected	Pepsin/Trypsin Digest
Comments	One fish with Black spot (*Neascus*) on the skin.		

Table E7. Rock Creek juvenile steelhead pathogen results.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral HemorrhagicSepticemia Virus, **SVCV** Spring Viremia of Carp Virus, **AS** Furunculosis (*Aeromonas salmonicida),* **YR** Enteric Redmouth (*Yersinia ruckeri),* **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **BCD** Coldwater Disease (*Flavobacterium psychrophilum),* **CD** Columnaris (*Flavobacterium columnare),* **RS** BKD (*Renibacterium salmoninarum*), **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta)*

Appendix F. Genetic Report

Evaluation of steelhead trout (*Oncorhynchus mykiss*) from Rock Creek in the middle Columbia River: Genetic comparison with populations among the SPAN Columbia River Basin dataset

Drafted by: Andrew P. Matala, Columbia River Inter-Tribal Fish Commission
Date submitted: June 2009

Objective/Background

This report summarizes a genetic evaluation of steelhead trout collected from Rock Creek and Squaw Creek (a tributary of Rock Creek) in the Middle Columbia River Basin. The watershed supports anadromous steelhead and resident O. mykiss. The stock is part of Mid-Columbia Evolutionarily Significant Unit (ESU) for steelhead, which has been listed as "threatened" under the Endangered Species Act (Busby *et al*. 1996); Rock Creek steelhead status is unknown (WDF and WDW, 1993). Rock Creek Summer Steelhead are wild origin and distinct from other mid-Columbia stocks based on geographic isolation of the spawning population (WDF and WDW, 1993). Adult fish enter the Columbia from May to November, and spawning occurs from February through April. Juvenile life histories information specific to this watershed remains largely undocumented (Lautz 2000). Steelhead are known to occur in Rock Creek up to a point 1/4 mile above the confluence with Quartz Creek and in Squaw Creek up to the confluence with Harrison Creek. In this evaluation, juvenile fish were characterized with a suite of standardized molecular markers to identify distinctions (and similarities) with collections from adjacent and regional populations throughout the Columbia River Basin.

Methods

The analyses were conducted with data collected across 13 standardized microsatellite loci (appendix 1) designated by the Stephen Phelps Allele Nomenclature (SPAN) consortium; SPAN is a multi-agency collaboration to collect and distribute standardized genetic data for steelhead trout, providing information for both small scale (subbasin) and large scale (Columbia Basin-wide) population studies. Multi-locus genotypes were compiled for n=34 juvenile O. mykiss sampled from a location in Rock Creek identified as Highway 8 Bridge, n=51 juvenile O. mykiss sampled from a location in Rock Creek identified as downstream of the Bickleton Rd. Crossing, and n=72 juvenile fish sampled from Squaw Creek; all other steelhead genetic data referenced in the report was accessed via the SPAN baseline.

All samples were polymerase chain reaction (PCR) amplified using optimized annealing temperatures. Fragment analysis of fluorescently labeled PCR products was conducted using an Applied Biosystems 3730 Genetic Analyzer and genotypes were scored and compiled using GeneMapper software. An un-rooted neighbor-joining (NJ) phylogram was constructed using PHYLIP version 3.68 (Felsenstein 1992) in a phylogentic analysis to display similarities among CTUIR and SPAN groups; similarities are observed as branch associations (clusters) in the genetic distance topology of the tree. The same analysis was repeated using SPAN collections limited to lower mid-Columbia River populations, including collections from the adjacent John Day and Klickitat Rivers, in order to evaluate Rock Creek collections on a condensed or regional geographic scale.

For all lower mid-Columbia groups the program GENEPOP (Raymond and Rousset 1995) was used to test Hardy-Weinburg equilibrium (HWE) expectations; deviations may indicate population admixtures. To estimate genetic diversity of each collection, unbiased heterozygosity (H_E) was calculated in GENEPOP, and the program FSTAT v2.9.3.2 (Goudet 1995) was used to estimate among-group differences in allelic richness (allelic diversity scaled to sample size; AR); tests were conducted using 1000 iterations and significance was evaluated using single-factor ANOVA. A matrix of pairwise F_{st}□ values for all pairs of regional populations was generated in GENEPOP; this is a measure of the proportion of total variation that can be attributed to differences among the groups. Among-group significance was tested using ARLEQUIN version 3.1 (Excoffier *et al.* 2005). Fishers exact test was performed in GENEPOP to test population homogeneity between Rock Creek groups and other lower mid-Columbia subbasin groups (e.g. John Day River). The program GenAlEx version 6.2 (Peakall and Smouse 2006) was used to conduct principle components analysis (PCA).

Results

A high level of variability was observed across the three Rock Creek collections. Average observed heterozygosity ranged from 0.775 in the Highway 8 Rock Creek collection to 0.780 in the Bickleton Rock Creek collection. Mean allelic richness ranged from 8.3 to 9.9, however the difference among collections was not significant (P=0.42). Allelic richness was also not significantly different between Rock Creek and John Day River collections; this comparison was made for reference to a regionally proximate population/s. A total of five HWE deviations were observed across all tests; this included three in the Squaw Creek collection and one each in the Rock Creek collections. This outcome may be the artifact of small sample sizes or alternatively indicates sampling of a small number of family groups (siblings) or an admixture of resident and anadromous populations (for example).

Fishers exact test indicated significant population heterogeneity between the three Rock Creek and collections (P<0.001) as well as significant population differences regionally. Similar result were observed overall for tests of among-group variation. However, pairwise Fst was not significant between the Rock Creek Bridge and Rock Creek Bickleton collections, indicating a potentially large amount of variation among individuals within each group (Table 1). Remaining comparisons with SPAN collections from the lower mid-Columbia region indicate significant differences comparable to observed differences in pairwise comparisons from throughout the region. This suggests Rock Creek collections were differentiated from other subbasins, similar to what was observed between most subbasin comparisons across the lower mid-Columbia region, and substantiates distinctness of summer steelhead in this watershed.

In phylogenetic analysis across the entire SPAN dataset (spanning the Columbia River estuary to the upper Salmon River), the Rock Creek collections appear to be most genetically similar to Middle Columbia River populations (e.g. John Day, Umatilla and Deschutes Rivers; Figure 1), yet cluster distinctly on their own branch in the phylogram topology. Within the lower mid-Columbia subbasins the Rock Creek collections are most distant from Umatilla and Klickitat River collections. The node in the radial tree topology that separates Rock Creek collections from all other populations in the data set is supported with 93% bootstrap support across 1000 replicate trees (Figure 2). Some genetic sub-structure may be evident among these three collections, where the two Rock Creek collections (Bridge and Bickleton) occupy a branch in the cluster that separates Squaw Creek at the node with 99% bootstrap support. A similar result can be seen in the PCA plot, where the Squaw Creek collection appears in closer proximity to John Day River collections than do the remaining two Rock Creek collections (Figure 3).

Discussion

These results indicate genetic similarity between collections of juvenile *O. mykiss* within the Rock Creek watershed (including the Squaw Creek Tributary), and a significant distinction from other populations or collections from out-of-basin in the Middle Columbia region. It is unclear based on this preliminary analysis how distinct this population is historically or if structure exists within Rock Creek that is temporally stable and/or spatially stratified. Population structure may exist within the Rock Creek watershed, but identifying how genetic variation is distributed will require greater sample sizes and an emphasis on temporally stratified sampling. The apparent clear distinction of this group among Columbia River Basin steelhead populations warrants further investigation and monitoring.

Acknowledgments
Contributing CRITFC staff are: Lori Maxwell, Jeff Stephenson and Shawn Narum

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Figure 1. Neighbor-Joining tree (phylogram) topology identifying the genetic distance relationship between Rock and Squaw Creek collections and the basin-wide SPAN populations.

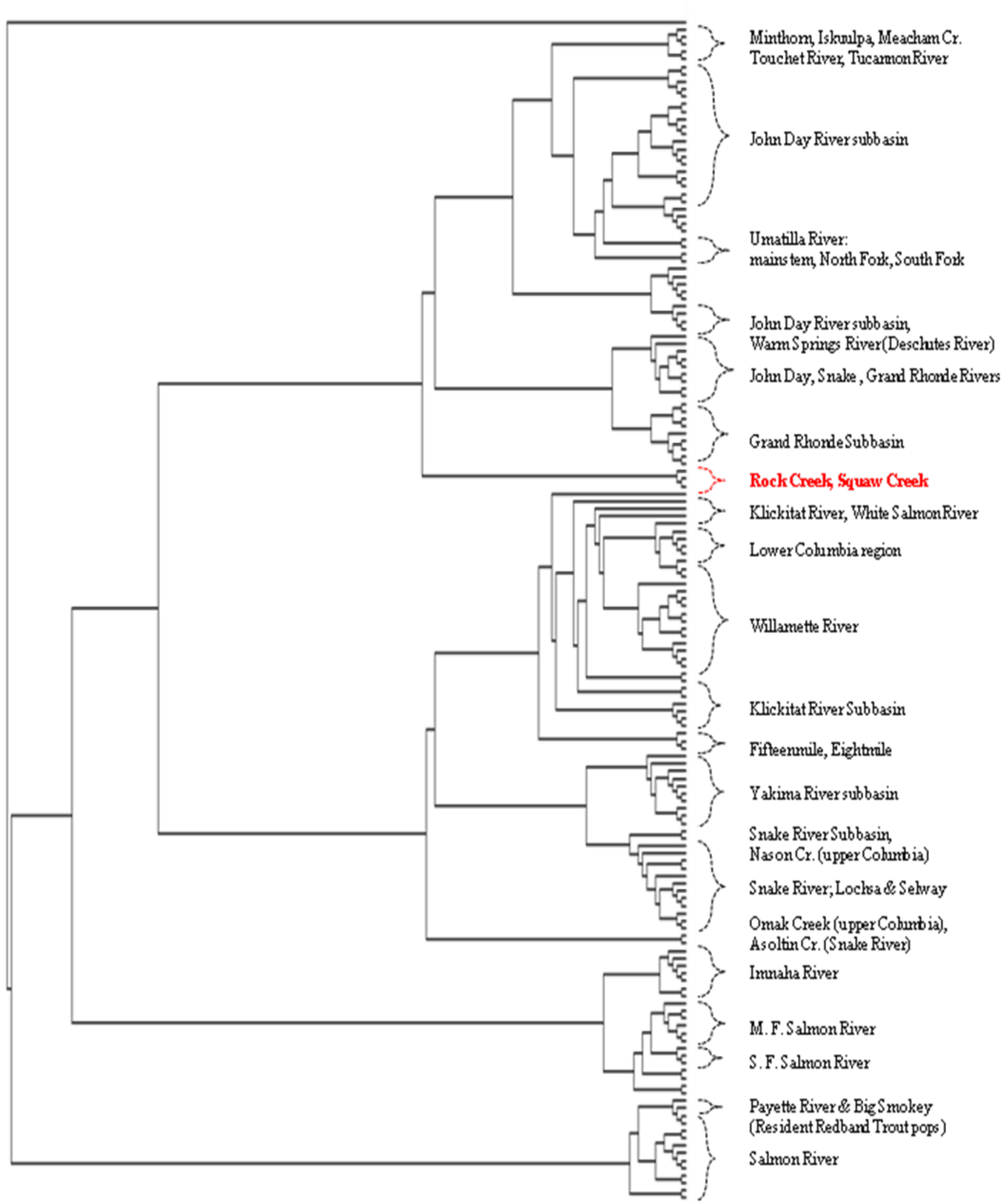


Figure 2. Neighbor-Joining (radial) tree topology identifying the genetic distance relationship between Rock and Squaw Creek collections and populations from SPAN in the lower mid-Columbia region. Bootstrap support consistent with greater than 50% consensus in the topology is shown at branch nodes.

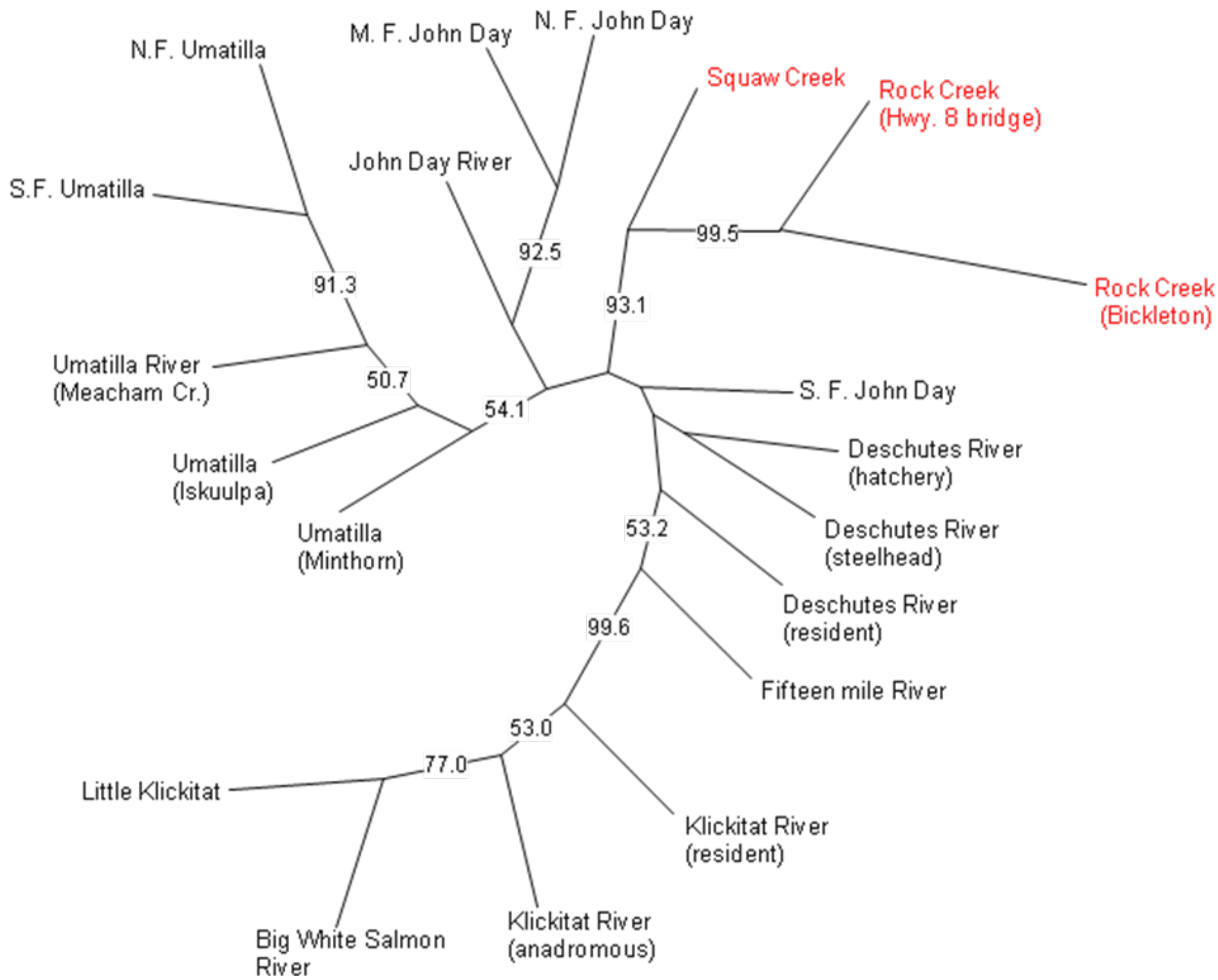


Figure 3. Principle Components Analysis (PCA) plot. Rock and Squaw Creek collections are indicated by yellow data points in the plot. Axes one through three represent or explain 39.5%, 22.4%, and 15.5% of the total variation respectively (axis three not shown).

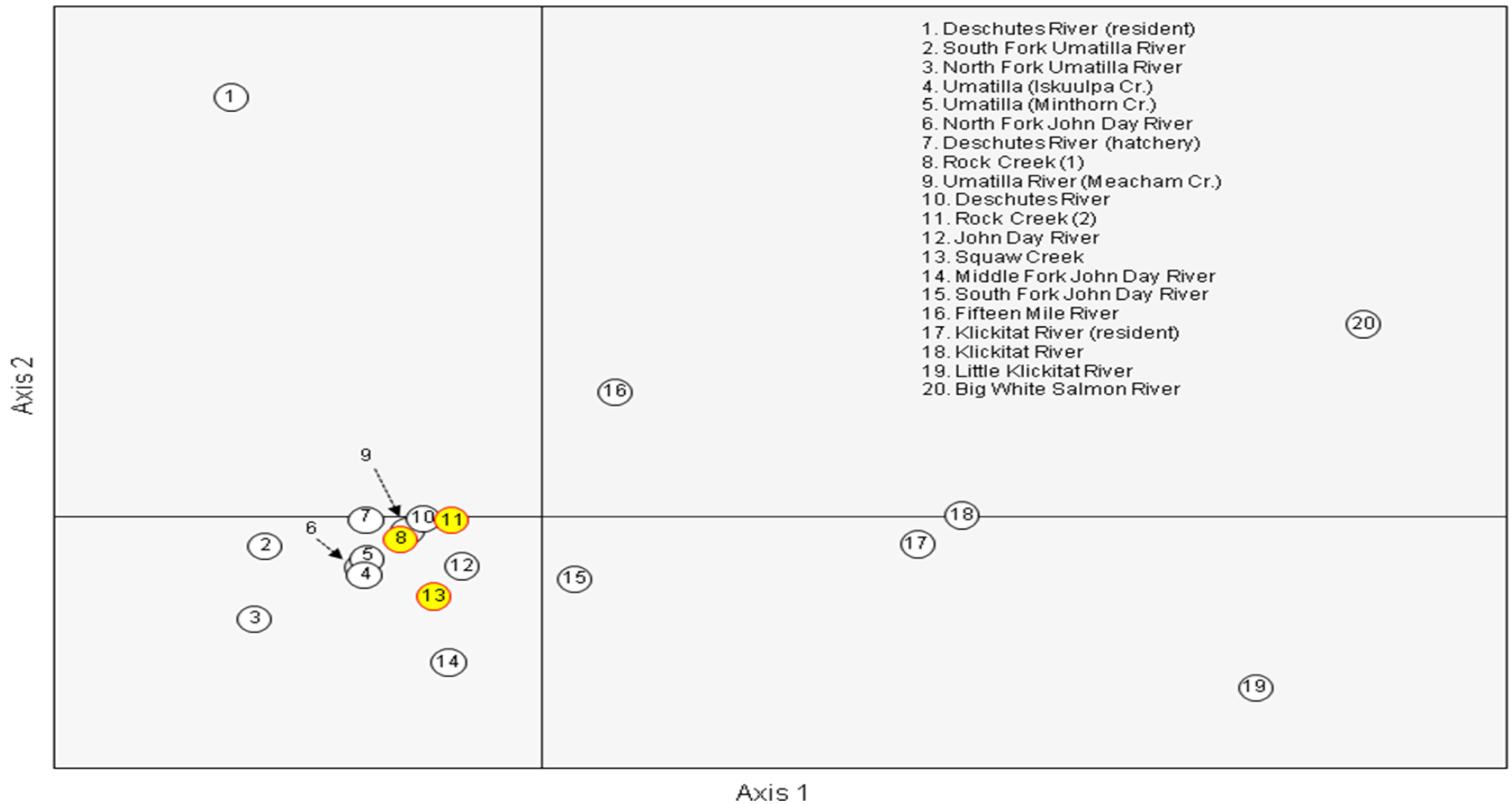


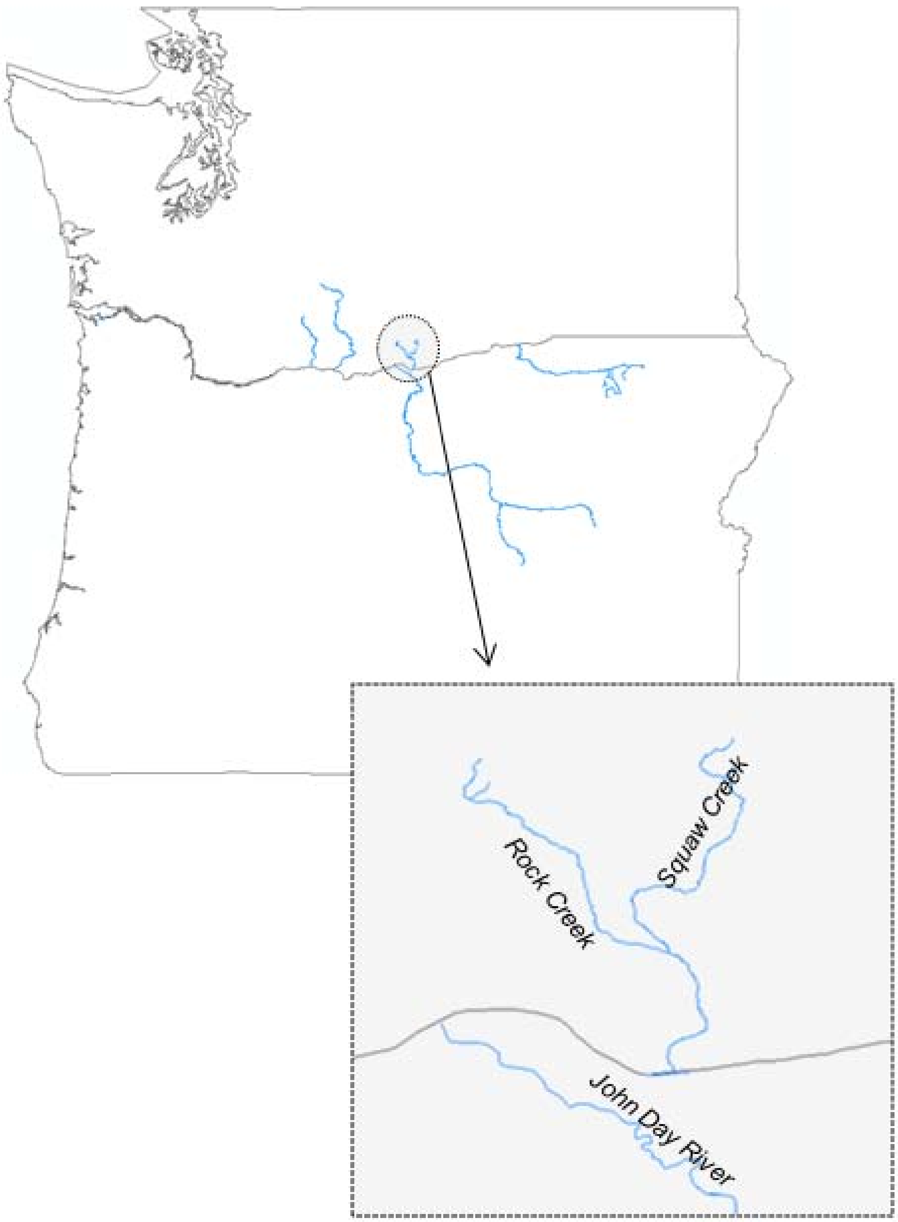
Table 1. Pairwise F_{st} (among-group variation) results for Rock/Squaw Creek collections, and comparisons with lower mid-Columbia populations from the SPAN baseline. The lower half matrix provides the F_{st} value, and the upper half matrix gives the corresponding *P*-value. Nearly all comparisons were significant (α=0.01); the exceptions (no significant among-group variation) are indicated by bold italics. Population designations are: 1 – Iskuulpa, 2 – Minthorn, 3 - Rock Creek (hwy. 8 bridge), 4 - Squaw Creek, 5 - Rock Creek (Bickleton), 6 - Big White Salmon River, 7 - Deschutes [hatchery], 8 – Deschutes, 9 - Deschutes [resident], 10 - Fifteen-Mile River, 11 – Klickitat, 12 - Klickitat [resident], 13 - Little Klickitat, 14 - John Day, 15 - M.F. John Day, 16 - N.F. John Day, 17 - S.F. John Day, 18 - N. F. Umatilla, 19 - S. F. Umatilla and 20 - Meacham Cr.

population	1	2	**3**	**4**	**5**	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	---	***0.234***	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	***0.550***
2	***0.001***	---	***0.054***	0.000	0.000	0.000	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	***0.928***
Rock(Hwy 8)	0.011	***0.003***	---	0.000	***0.036***	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	***0.054***
Squaw Creek	0.010	0.005	0.007	---	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009
Rock (Bickleton)	0.014	0.010	***0.005***	0.010	---	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.055	0.052	0.048	0.058	0.050	---	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.012	0.008	0.014	0.011	0.016	0.051	---	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.005	0.003	0.008	0.008	0.008	0.047	0.005	---	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	***0.117***
9	0.068	0.068	0.085	0.064	0.074	0.113	0.077	0.064	---	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.017	0.013	0.019	0.019	0.018	0.031	0.013	0.010	0.065	---	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.028	0.027	0.031	0.027	0.033	0.035	0.030	0.022	0.086	0.022	---	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.033	0.030	0.034	0.029	0.038	0.050	0.033	0.029	0.089	0.032	0.019	---	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.044	0.045	0.048	0.045	0.048	0.047	0.058	0.044	0.126	0.047	0.024	0.030	---	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.006	0.005	0.009	0.013	0.015	0.049	0.010	0.005	0.072	0.012	0.022	0.027	0.043	---	0.000	0.000	0.000	0.000	0.000	0.000
15	0.015	0.013	0.015	0.016	0.026	0.060	0.019	0.014	0.089	0.024	0.030	0.032	0.044	0.010	---	0.000	0.000	0.000	0.000	0.000
16	0.004	0.004	0.012	0.009	0.017	0.057	0.012	0.007	0.067	0.016	0.029	0.030	0.046	0.007	0.009	---	0.000	0.000	0.000	***0.036***
17	0.011	0.013	0.022	0.020	0.024	0.047	0.017	0.011	0.094	0.019	0.024	0.034	0.045	0.020	0.029	0.014	---	0.000	0.000	0.000
18	0.011	0.010	0.013	0.020	0.024	0.070	0.026	0.018	0.084	0.033	0.040	0.045	0.062	0.016	0.023	0.013	0.017	---	***0.054***	0.000
19	0.007	0.005	0.011	0.021	0.020	0.061	0.014	0.011	0.073	0.019	0.038	0.040	0.063	0.009	0.020	0.011	0.020	***0.005***	---	0.000
20	***0.000***	***0.002***	***0.003***	0.005	0.009	0.049	0.007	***0.002***	0.062	0.010	0.019	0.025	0.046	0.005	0.010	***0.003***	0.010	0.011	0.005	---

Appendix 1. Thirteen SPAN loci. The symbol (*) designates a GenBank accession number.

Locus	Cite/Source
Ots3	Banks *et al.* 1999
Ots4	Banks *et al.* 1999
Ots100	Banks *et al.* 1999
Omy7iNRA	Nichols *et al.* 2003
Ogo4	Olsen *et al.* 1998
Oki23	Smith *et al.* 1998
Ssa289	McConnell 1995
Ssa407	Cairney *et al.* 2000
Ssa408	Cairney *et al.* 2000
Omy1011UW	Spies *et al.* 2005
One14	Scribner *et al.* 1996
Oke4	AF330221*

Appendix 2. I do not have confirmation of the collection sites which are not accurately depicted on this map of the study area.



Appendix G. Native tree revegetation site

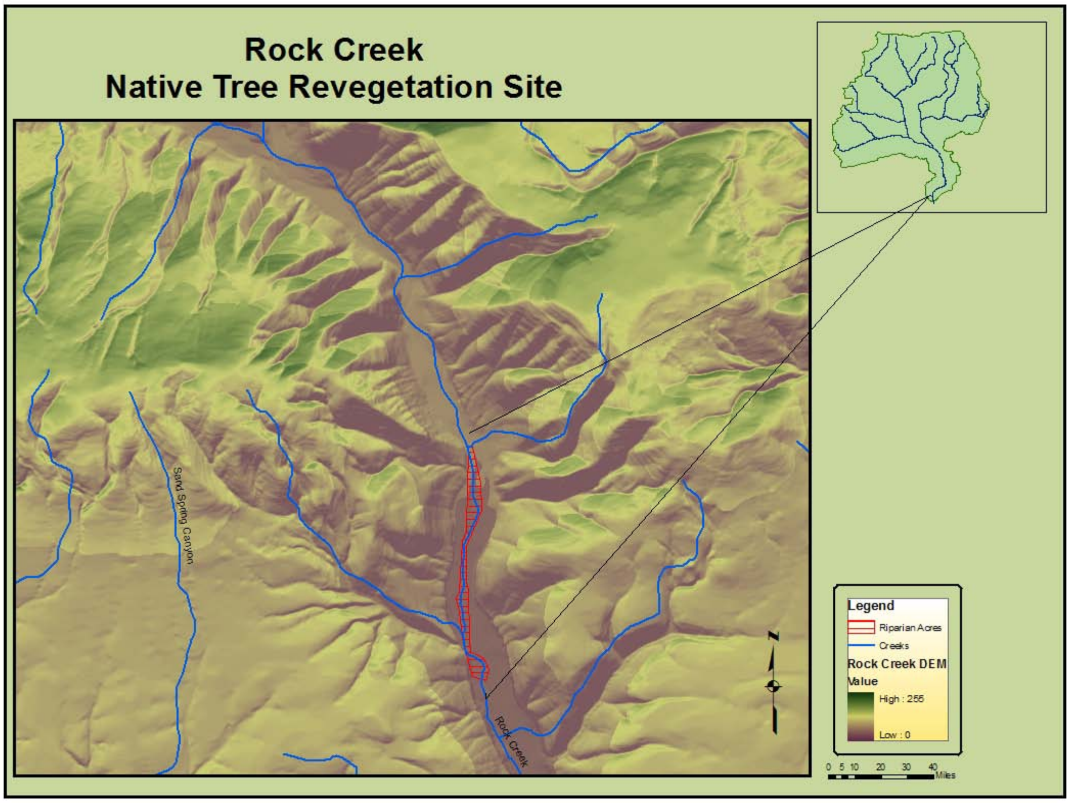


Figure G1. Rock Creek tree and willow planting site.

Figure G2. Rock Creek Ponderosa Pine tree at tree planting site.

Figure G3. Rock Creek willow and tree nursery located at the Goldendale field office.

Appendix H. References

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