RELATIVE INFLUENCE OF PHYSICAL AND ANTHROPOGENIC VARIABLES

ON INSTREAM HABITAT IN SILVER CREEK, IDAHO

by

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ABSTRACT

The Silver Creek watershed is a spring creek ecosystem. Spring creeks are a unique, understudied component of stream habitat in the Northern Rocky Mountains. Spring creeks are unique because they have relatively constant temperatures, abundant macrophytes, and high levels of dissolved oxygen. With changing land management and increased suburban and exurban development across the West, spring creeks are becoming more recognized for their outstanding resource potential. However, little is known about these ecosystems. The goal of this study was to determine whether natural or anthropogenic variables are more strongly associated with instream habitat quality in Silver Creek while characterizing its natural, instream, and anthropogenic variables. Ten instream variables commonly used to assess runoff-dominated streams, seven natural variables, and fourteen anthropogenic variables were identified and sampled at eighteen locations within the Silver Creek watershed. Trends indicate that higher elevation (tributary) stream channels have lower slopes, are more narrow, more shallow, contain less sediment, and are bordered by a higher percentage of riparian lands than lower elevation (main stem) stream channels. Spearman rank correlation coefficients (R-values) and p-values were evaluated with 27% (19 of 70) of correlations significant at all sample locations in the natural and instream variables data set. Natural variables with the most correlations observed in relation to instream habitat variables were elevation, watershed area, and stream slope. Spearman rank correlation coefficients (R-values) and p-values were evaluated with 3% (5 of 150) of correlations significant at all sample locations in the anthropogenic and instream data set. Anthropogenic variables with the most correlations observed between instream habitat variables were percent developed acres, percent total riparian acres, and structure density. Overall, natural variables influence instream habitat more than anthropogenic variables. Correlations showed that as elevation increases, watershed area decreases, and width, average depth, maximum depth, and sediment depth all decrease. Future studies of Silver Creek should increase sample size, which would help to more adequately capture the habitat of the Silver Creek watershed and increase the potential for stronger, more discernible correlations.

INTRODUCTION

Spring creeks, or spring-dominated streams, are groundwater fed streams that do not receive major hydrological input directly from snowmelt or runoff (Whiting and Stamm 1995, Whiting and Moog 2001, Griffiths et al., 2008). Where some research exists regarding the science and management of spring creeks ecosystems, the substance, availability, and comprehensiveness of the resultant publications is lacking.

Runoff-dominated streams have been thoroughly studied to document dominant driving variables for ecosystem function. These variables are widely used in stream and riparian assessment techniques. Table 1 lists the primary variables of runoff-dominated stream ecosystems (Hynes 1970, Kauffman and Krueger 1984, Platts et al., 1987, Newton et. al., 1998, Winward 2000, Kaufmann 2002, USDA 2004). The variables are characterized as natural, anthropogenic, or instream. By measuring and analyzing these variables, relationships can be identified that can drive management decisions regarding the function of ecological sustainability of spring creek ecosystems.

Because the driving variables and standardized methodologies important to spring creek ecosystems have not been identified, land resource managers must rely on indices for runoff dominated streams to make management decisions about ecological sustainability. Although runoff dominated indices have been widely used in spring creek ecosystems, they have not been evaluated to determine their objectivity when applied to these ecosystems.

Table 1. Commonly used variables for assessment of runoff driven stream ecosystems.

Natural Variables	**Anthropogenic Variables**	**Instream Variables**
Elevation	% Annual Crops	Width
K-Factor (Soil Texture)	% Permanent Crops	Average Depth
Catchment Slope	% Developed	Maximum Depth
Stream Slope	% Riparian	Sediment Depth
	% Range	W:D Ratio
	Road Density	
	Structure Density	

Additionally, spring creeks present unique management challenges because of the lack of understanding of their structure and function. The unique geomorphic, hydrologic and ecological characteristics of spring creeks suggest the need for documentation and standardized evaluation to improve understanding of their structure and function for management purposes (Teal 1957, Hynes 1970, The Nature Conservancy 1975, Decker-Hess 1989, Schlosser 1991, Perrigo 2006). The goal of this study was to determine whether natural or anthropogenic variables were more strongly associated with instream habitat quality in Silver Creek while characterizing its natural, instream, and anthropogenic variables. . This information is needed to understand if variables used to assess the habitat quality of runoff driven streams are indicative of anthropogenic impacts that may cause stresses in spring creek ecosystems.

LITERATURE REVIEW

Spring Creek Overview

Spring creeks are characteristically short in length with low gradients. In the Northern Rocky Mountains, they typically emerge from subsurface limestone or basalt bedrock outcroppings and coalesce in lower elevation valley bottoms. Most spring creeks have high sinuosity, rectangular cross-sectional shape, weakly developed bars, a poorly defined thalweg, and little lateral channel migration (Whiting and Stamm 1995, Whiting and Moog 2001, Griffiths et al., 2008). They are known for their cool, clean, and nutrient rich waters (Decker-Hess 1989, Lawson 2003, Aasheim-Anderson 2004). Spring creeks have unique hydrologic regimes and possess natural chemical and physical properties (Glaizer 1991) such as consistent temperatures (Decker-Hess 1989, Lawson 2003, Aasheim-Anderson 2004, Reiser et al., 2004), elevated pH and alkalinity (Minckley 1962), high dissolved oxygen content, and abundant macroinvertebrates (Boussu 1954, Chapman 1966, Bilby 1984, Hubbs 1995).

Trout flourish in spring creeks because of the high water quality, abundant macroinvertebrates, clean substrates, and in-stream cover (Holton 1953, Bisson et al., 1988, Trotter and Bisson 1988, Sloat 2001). Trout migrate long distances to spring creeks to spawn because of stable conditions, thereby contributing recruitment over a large geographic area (Wilkinson 1996). Spring creeks support stable trout production throughout the year, allowing total biomass and growth to exceed that of runoff-dominated stream ecosystems (Minkley 1962, Aasheim-Anderson 1994).

Many factors have influenced the current state of spring creeks within the Northern Rocky Mountains, but the greatest has been one of human decisions regarding land, livestock, and agricultural management. It has been argued that these important fisheries systems are more physically and biologically affected by dominant agricultural land uses over the last century than by pre-settlement topographic and geologic variables (Manuel et al., 1979, Decker-Hess 1989, Liknes and Graham 1993, Lawson 2003, Perrigo 2006). Degradation, more or less continual since homestead time, has resulted from removal of riparian vegetation and subsequent exposure of barren, fragile stream banks to livestock.

Lack of both knowledge and land stewardship have led to mismanagement of livestock within riparian corridors. Heavy grazing in riparian areas has resulted in trampling of stream banks, loss of woody and herbaceous riparian vegetation, bank erosion, channel widening, and increased sediment and solar radiation inputs into streams (Gunderson 1966, Decker-Hess 1989, Allen-Diaz and Jackson 2000). Agricultural practices (tilling and grazing) throughout the West have caused adverse affects to channel structure, increased sediment loading to surface water, and covering of spawning gravels within the stream channel (Platts 1982, Kauffman and Krueger 1984, Thurow et al., 1988, Armour et al., 1994, Belsky et al., 1999).

Sediments tend to accumulate in spring creek ecosystems and are not flushed out as they would be in a runoff-dominated ecosystem because of the lack of high flows (Tilly 1968, Reiser et al., 2004, Perrigo 2006, Cuhaciyan personal communication). Without flood events to reset channels by flushing sediments and redistributing materials spring creeks are unable to completely restore themselves. Consequently, restoration requires professionally directed input of materials, energy, and labor. Habitat assessment protocols are commonly used in to help determine and monitor stream ecosystem health.

Habitat Assessment Techniques

Stream and riparian habitat assessment protocols are commonly used to document and assess stream ecosystem health as a precursor to restoration. Although many versions of these protocols exist, they were created for the assessment of runoff–dominated stream ecosystems and perhaps do not properly assess the spring creek environment. Two widely used techniques for stream assessment are the Environmental Monitoring and Assessment Program (EMAP), developed by the Environmental Protection Agency (EPA), and the Stream Visual Assessment Protocols (SVAP), developed by the Natural Resources Conservation Service (NRCS). Both assessment protocols were created based on the fundamentals described by Karr (1986), to assess and evaluate the aquatic condition of streams based on five factors (chemical variables, biotic factors, energy source, flow regime, and habitat structure) thought to influence stream integrity (Newton et al., 1998, Kaufmann 2002). Riparian assessment protocols are commonly used in conjunction with, or in place of stream assessment tools because they typically contain a stream component. Riparian assessment protocols are intended to rapidly assess the sustainability and functionality of the riparian corridor. Commonly used techniques for riparian assessments are the Riparian Assessment Method (RAM), developed by the NRCS and others developed by the U.S. Forest Service (Platts et al., 1987, Winward 2000). For the purpose of this study, the habitat structure portion of EMAP and SVAP was investigated, along with riparian components from RAM, Platts et al., 1987, and Winward 2000.

METHODS

Study Area

Silver Creek, near Picabo, Idaho is a highly productive spring creek ecosystem that supports an abundance of fish and wildlife. It is one the best examples of a high desert, cold spring ecosystem in the western United States (Hauck 1947, Brockway and Kalhown 1994, Gillilan and Lovell 1997, Perrigo 2006, and Gillilan et al., 2007). The Silver Creek watershed contains nine spring creeks (Chaney, Stalker, Mud, Grove, Loving, Cain, Patton, Wilson, and Silver Creeks) in a valley where land use is predominantly agriculture. Because land use varies among the nine sub-basins, the Silver Creek watershed provides a unique opportunity to study the relationship between pre-settlement geologic and topographic variables, recent land use, and riparian quality. Moreover, because of its high quality fishery and scenic, wildlife rich location, there is public demand to maintain the integrity of the Silver Creek ecosystem.

The Silver Creek watershed is located in Blaine County in central Idaho (Figure 1), approximately 15 miles southeast of Bellevue, and four miles west of Picabo (43°18’44.33”N, 114°04’17.01 W). This portion of the upper Wood River Valley, referred to as the Bellevue Triangle (Figure 2), is surrounded by the Pioneer Mountains to the northeast, the Smokey Mountains to the west, and the Picabo Hills to the south. The Silver Creek watershed is approximately 68,000 acres, or 275 square kilometers, with the majority of land used for agriculture to support alfalfa, barley, potatoes, and pasture (USDA 1996). Land ownership in the watershed is 64% private, 30% federal, and 6% state (USDA 1996). In this study we examined private and state owned stream segments within the Silver Creek watershed, both on the Nature Conservancy's Silver Creek Preserve and adjacent easement properties.

The Nature Conservancy's Silver Creek Preserve has played a pivotal role within the watershed. The Silver Creek Preserve was established in 1976 with the purchase of 479 acres of hunting and fishing property from the Sun Valley Company. Today, the preserve encompasses over 880 acres, with another 9,500 acres of bordering lands held in conservation easements. The long term goal of the Silver Creek Preserve is to maintain and enhance Silver Creek's aquatic and riparian ecosystems by preserving water quality and quantity, restoring and preserving natural habitats and rare species, and increasing the extent of protected lands (Todd 1997).

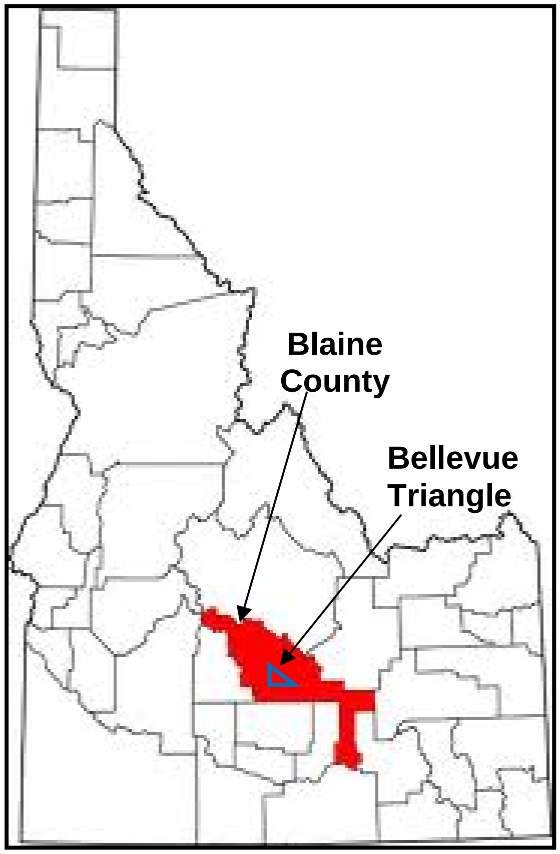

Figure 1. Blaine County, Idaho and the location of the Bellevue Triangle where the study was conducted.

Although the long term goal of the Silver Creek Preserve is to restore and preserve the natural habitat of the watershed, it does not seek to weaken or destroy the agricultural heritage of the area. Many restoration projects have occurred throughout the Silver Creek watershed, both on tributaries and the main stem of Silver Creek.

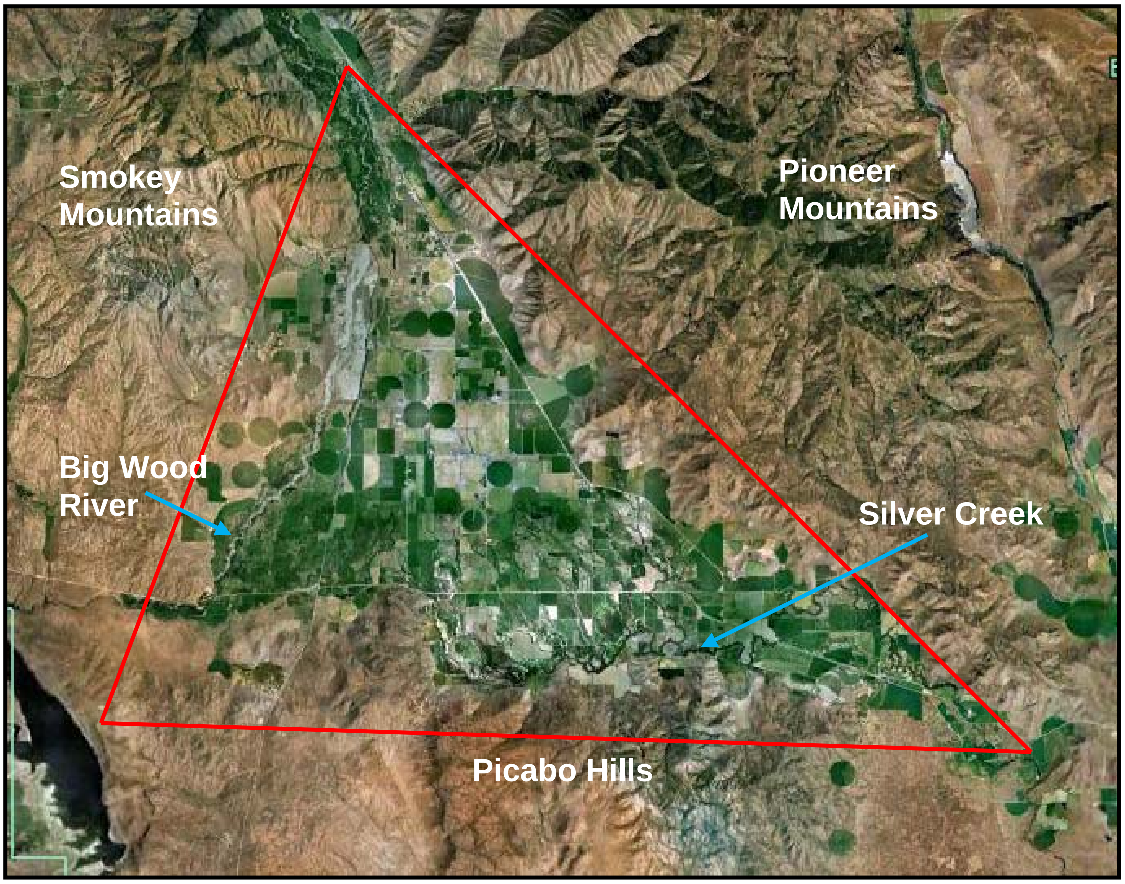

Figure 2. The Bellevue Triangle and Silver Creek watershed. The Pioneer Mountains to the east, the Smokey Mountains to the west, and the Picabo Hills to the south. Silver Creek flows to the Southeast and the Big Wood River flows to the Southwest.

Geology, Hydrology, and Soils.

The geologic setting of the Bellevue Triangle is key to understanding the hydrology of the Silver Creek watershed. The Bellevue Triangle region is underlain by Tertiary valley fill deposited by the ancestral Big Wood River flowing southeast across the valley and exiting south of Silver Creek, near Picabo (Castelin and Chapman 1972). In the early Pleistocene, basalt flows blocked the river channel, and formed a lake. Lake formation resulted in deposition of coarse-grained sediments in the north portion of the valley, at the inlet where high velocity flows took place and fine-grained sediments on the south portion, at the outlet where low velocity flows took place (Moreland 1977). As the elevation of the lake increased, the stream channel cut an outflow to the southwest. Several more lava flows occurred, altering the flow of the Big Wood River from southeast to southwest, which resulted in additional depositions on the valley floor (Moreland 1977). Concurrent with basalt flows, glaciation occurred in the upper valleys feeding the Big Wood River. With glaciers advancing and retreating, large amounts of coarse-grained materials were deposited throughout the valley floor, with heavier accumulations in the north valley (Castelin and Chapman 1972). This sequence of events created deposits of alternate layers of coarse and fine-grained sediments that comprise the current aquifer system (USDA 1996). Today, the Big Wood River flows to the southwest and Silver Creek flows to the southeast (Figure 2). Silver Creek and many of its tributaries flow through the ancestral channels of the Big Wood River.

Unlike most spring creeks, which emanate from limestone or basalt materials, the springs that feed Silver Creek and the surrounding tributaries are derived from groundwater flows sourced from the Big Wood aquifer, precipitation, and snowmelt. Groundwater generally flows southeast along an ancestral topographic gradient across the Bellevue Triangle, to the Picabo Hills. Restricted by topographic barriers to the south, water is pushed to the surface where it encounters the nearly impermeable deposits of fine-grained sediments overlying Tertiary valley fill (Moreland 1977). This combination of geology and hydrology results in the formation of multiple spring fed streams north of the Picabo Hills. The springs eventually coalesce to form Silver Creek, which flows east along the Picabo Hills.

Three main soil complexes are located in the Bellevue Triangle area. They are the Little Wood-Balaam-Adamson (LWBA) complex, Picabo-Hapur-Bickett (PHB) complex, and Friedman-Elksel-Starhope (FES) complex. The PHB complex soils are the most common soils throughout the area and are mainly located in central and southern portions of the Bellevue Triangle. These predominantly agricultural soils are comprised of mixed alluvium (ranging in size from 2-264 mm), creating somewhat poorly drained loams and silt loams, with a K-factor of 0.37. They are found on 0-2% slopes of active stream terraces. The FES complex formed in deep volcanic residuum and colluvium, resulting in coarse-grained sandy to sandy loam soils, with a K-factor of 0.37, on 4-60% slopes. These soils are mainly found in the southeastern corner of the Bellevue Triangle on the mountain sides and foothills that are predominantly range and agricultural lands. The LBA complex is found in the northern portions of the study area, near Bellevue. These soils are deep, well drained loams and silt loams, with a K-factor of 0.28, formed on alluvial slopes from 0-4%. Soils of the LBA complex are primarily used for agriculture.

The K-factor is a variable in the Universal Soil Loss equation. It measures the inherent erodibility of a given soil under standard conditions and is a measurement of detachment and transport by rainfall and runoff (Wischmeier and Smith 1978, Brady and Weil 2008). Soils with a higher K-factor are more susceptible to erosion. The K-factor value of the LBA complex is least susceptible to erosion, and the K-factor values of FES and PHB are more susceptible to erosion. The loam and silt loam soil textures and K-factors of soils within the Bellevue Triangle region indicate they are moderately susceptible to erosion.

Land Use.

Land use within the Silver Creek watershed has changed over the last century. The earliest European culture documentation of the Silver Creek watershed is from Winfred Scott Ebey, who on August 11, 1854, drove his wagons “over some low hills to a camp on Silver Creek and noted “this beautiful clear stream 25 feet wide, 2 feet deep and so full of trout that they can hardly swim” (Dykes and Doyle 1998). In the late 1880’s with the aid of government funding, irrigation agriculture and livestock grazing were introduced, vastly changing the landscape of the Bellevue Triangle. Sheep and cattle devastated native plant communities and trampled and destabilized stream banks. Much of the landscape was converted from grasslands and riparian zones to agricultural fields, and irrigation canals were dug across the valley (Brockway and Kalhown 1994, Anderson et al. 1996). The result of this disturbance was increased surface run off, reduced bank stability, and channel sedimentation.

A comparison of aerial photographs from 1946 and 2009 (Figure 3) shows a slight increase in agricultural lands, removal and straightening of stream channels, and suburban and exurban development. The increase in human expansion coincides with a decrease in riparian habitat. These human actions disrupt the flow of water and encourage accumulation of sediment, frequently leading to degradation of streams and associated ecology (Ligon et al. 1995, Allan 2004).

Since the mid-1970's, management activities within the Silver Creek watershed have included riparian fencing, native vegetation restoration, channel narrowing, and bank stabilization. Today, management practices within the watershed continue to shift towards restoration and rehabilitation of the stream corridor, while agriculture persists as the dominant land use. Restoration activities within the watershed have helped to increase riparian cover and narrow the stream channel. The majority of flood irrigation practices have been replaced by sprinkler irrigation which helps to reduce sediment loading from overland flow. Although not monitored or documented, these efforts have likely improved the quality and quantity of riparian habitat, the integrity of stream banks, and the overall aquatic ecosystem within the Silver Creek watershed.

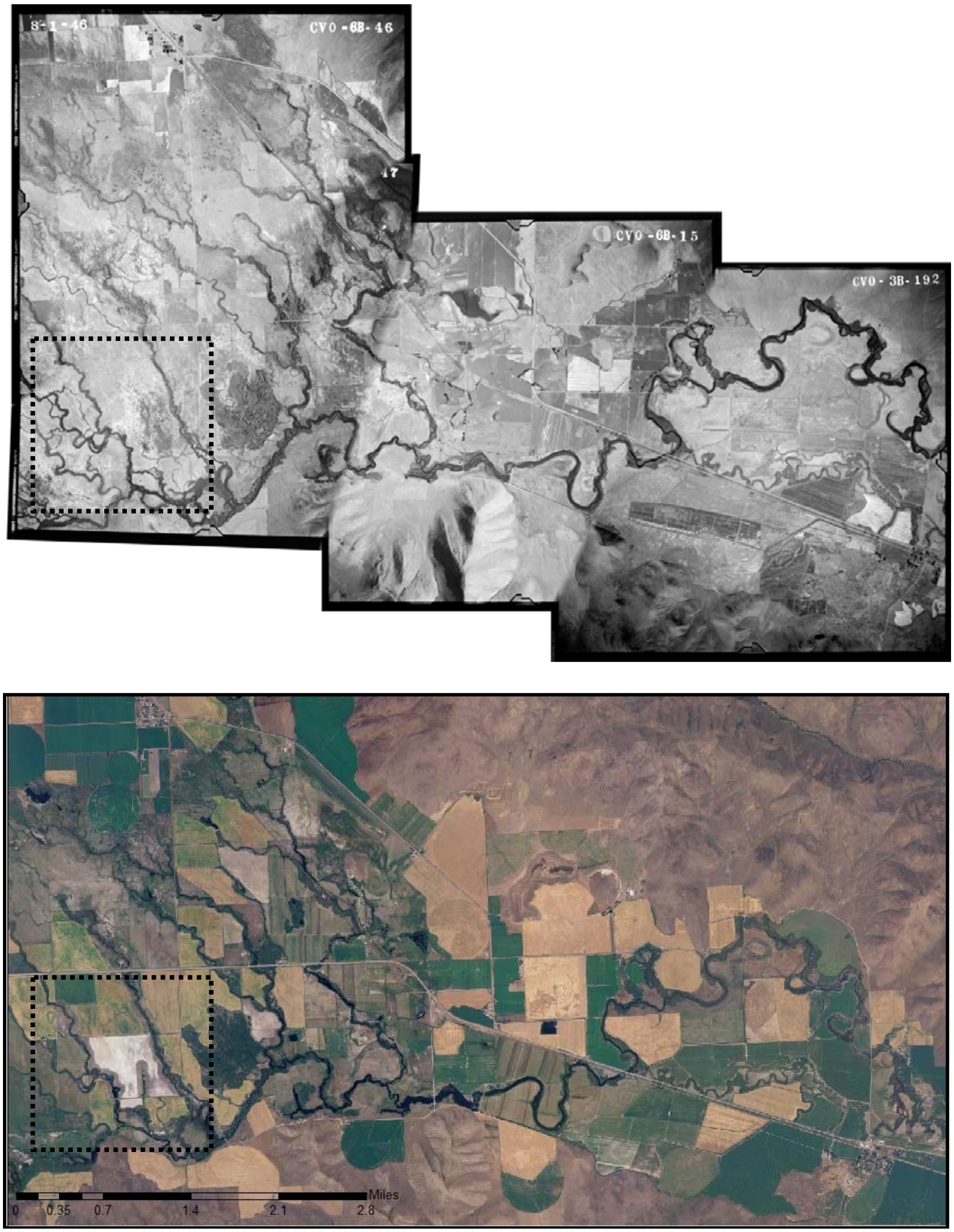

Figure 3. Aerial images of the Silver Creek watershed from 1946 and 2009. The dashed boxes show channel straightening, reduced riparian areas, and increased agricultural activities.

Sample Methods

The Silver Creek watershed was used for investigation of spring creek ecosystems because it represents a unique opportunity to study multiple streams within one watershed. Eighteen locations were selected within the watershed for sampling. Ten sites were located on tributaries and eight were on Silver Creek (Figure 4). Six sites were located within the Silver Creek Preserve at previously established monitoring locations. Ten sites were located on private property, six of these on tributaries and four on Silver Creek. Two sites were located on Silver Creek at Idaho Department of Fish and Game public access sites. Sampling locations were selected based on 1) previously established monitoring location, 2) stream access, and 3) areas of good and poor stream and riparian habitat quality (personal communication with Silver Creek Preserve Manager, Dayna Gross).

Each sample location consisted of three stream cross sections. Cross sections were spaced approximately three times the width of the main (middle) cross section from each other. The main channel cross section was surveyed by Alpine Enterprises of Ketchum, Idaho using Trimble survey grade GPS equipment. The channel cross sections were then mapped (Figure 4) and drawn (Appendix A) to depict stream channel morphology. Maps of the site were created with Arc MAP version 9.3.1 using aerial photographs and the Idaho Department of Water Resources watershed boundaries.

Figure 4. Sample locations of habitat variables in the Silver Creek watershed, near Picabo, Idaho. The main stem of Silver Creek is highlighted in white, with green triangles representing sample locations, and a dashed yellow line representing the boundaries of the Silver Creek Preserve.

Instream Variables

Based on parameters in the EMAP, SVAP, and RAM protocols, plus others gleaned from the literature review, ten numerically measureable instream variables were chosen for description and assessment of spring creek ecosystems. Instream variables measured included width, average depth, maximum depth, sediment thickness, instream vegetation thickness, width to depth ratio, depth to sediment depth ratio, and % instream vegetation, sediment, and gravel.

Instream variables were sampled at all three cross sections. Measurements for channel width and average and maximum depth were done on the main cross section using survey grade GPS equipment and conducted by Alpine Enterprises. A stadia rod, sag tape, bank pins and permanent wooden stakes were used to measure vegetation thickness and sediment depth at all cross sections. This equipment was also used to measure channel width and average and maximum depth at the remaining cross section locations. Vegetation thickness was measured from the top of instream vegetation to the sediment or gravel interface. Depth point samples were taken at intervals across the stream channel and averaged (Kershner et al., 2004). An ocular assessment of channel materials (vegetation, sediment, or gravels) was recorded at the same intervals as depth point samples. Total number of observations for sediment, vegetation, and gravel across the measured sample cross section were added and the percent of each calculated. Riparian widths were derived from aerial photographs using Arc MAP.

Anthropogenic Variables

Anthropogenic variables were land use categories described in the literature thought to influence or create stress within the aquatic environment. The primary anthropogenic variables in the Silver Creek watershed were agricultural and residential land uses. A land use map (Figure 5) of the Silver Creek watershed was created using ArcMAP to determine the extent of land use types. The six major land use categories identified were: annual agriculture (tilled crops), permanent agriculture (hay fields), developed areas, rangelands, riparian, and other. Riparian areas were further assessed and categorized based on quality (evaluated as excellent, good, or poor stand diversity) and quantity (density) of vegetation using 2009 aerial imagery. Quality of riparian vegetation was determined by the canopy cover and the width of the riparian corridor. Structure, irrigation pivot, and road densities were calculated using aerial photographs. The total influence of agriculture and human activities was calculated. Sub-watershed boundaries were drawn for all sample locations and percent land use was calculated for each of the eighteen sub-watersheds.

Natural Variables

Natural variables were identified as those variables within the ecosystem that are inherent and not changed by anthropogenic influences. These variables were measured to assess the variability within the landscape and their influence on instream variables within the ecosystem. Natural variables measured included average stream channel elevation, watershed area, reach-scale stream slope, catchment slope, and proximal slope, sinuosity, and K-factor. Elevations were determined by averaging elevations at individual channel cross section surveys. Watershed area was calculated using sub-watershed boundaries drawn in ArcMAP. Proximal stream slope was calculated by averaging 100 feet upstream and downstream of the surveyed stream cross section. Reach-scale stream slope was calculated using the highest and lowest points within the sub-basin watershed. Catchment slope was calculated using the entire stream length of sub-basin watersheds. K-factors were obtained from the Soil Survey of Blaine County as accessed by the NRCS Web Soil Survey.

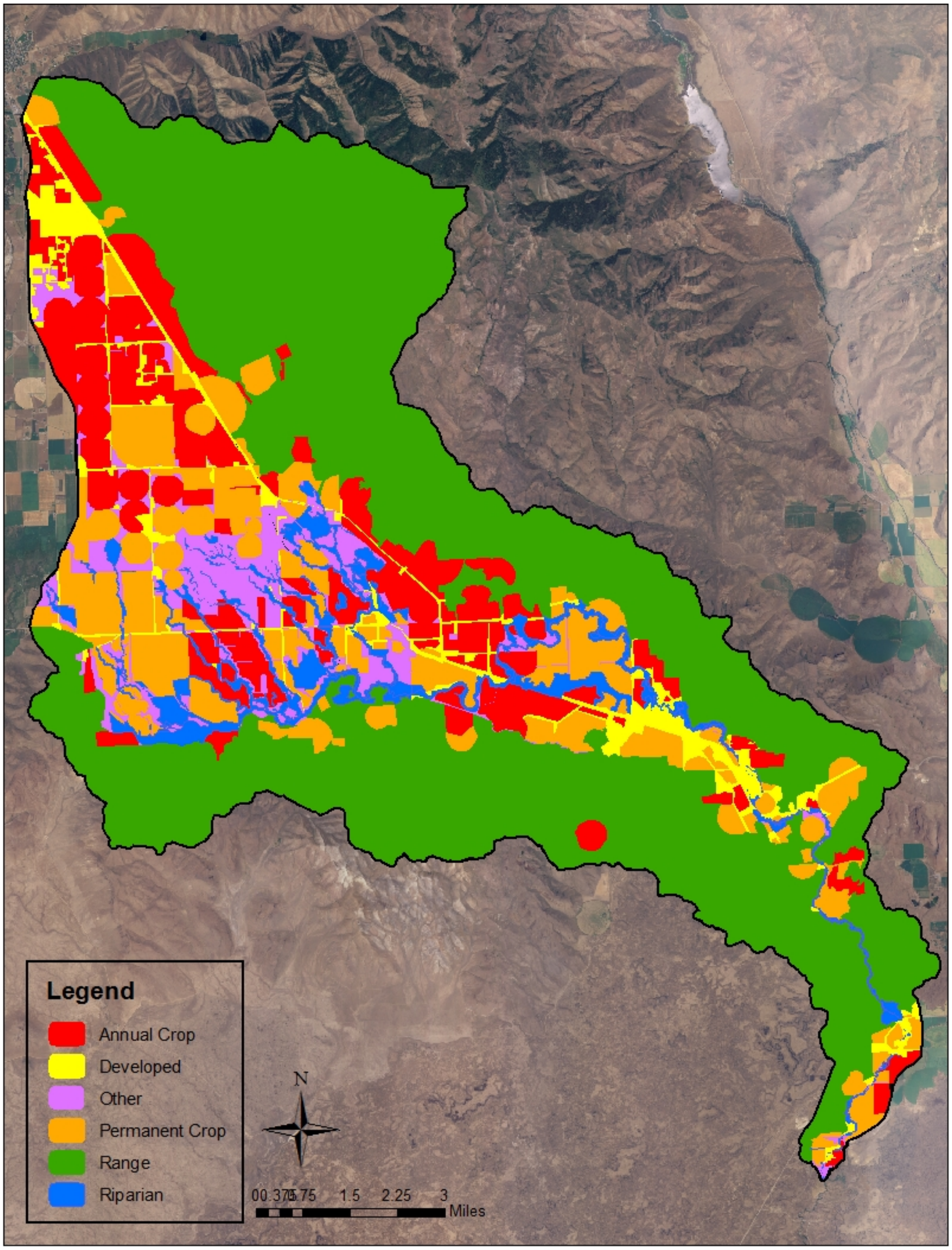

Figure 5. Land use map of the Silver Creek watershed.

Statistical Analysis

Spearman rank correlations for means of natural, anthropogenic, and instream variables were calculated using Statistica version 10.0 (StatSoft 2011). Spearman rank correlations were conducted in three ways. First, all sample areas were evaluated together. Then, in the second and third evaluations, the tributary and main stem sample locations were separated and evaluated. These three groups were then compared to determine if there were trends in the relationships between instream variables and natural and anthropogenic variables relationships. Correlations were evaluated using a p-value of 0.05.

RESULTS

Natural Variables and Instream Habitat

Natural and instream variable observations demonstrated that higher elevation (tributary) stream channels have smaller watershed areas (7,335 acres, versus 46,749 acres), lower stream slopes (0.12%, versus 0.16%), less sinuosity (1.54, versus 2.31), and higher K-factors (0.34 versus 0.11) than lower elevation (main stem) stream channels (Table 2). It was also demonstrated that average width (42 feet, versus 81.4 feet.), average depth (1.3 feet, versus 2.6 feet), and average sediment depth (0.5 feet, versus 0.9 feet) were lower in tributary samples than in main stem samples (Table 2).

Spearman rank correlations of natural variables versus instream habitat variables produced 19 of 70 possible (27%) significant correlations, when all samples including main stem and tributary sites were evaluated together (Table 3). Main stem samples had 7 of 70 (10%) significant correlations and tributary samples had 4 of 70 (6%) significant correlations (Table 3). The natural variables in order from the highest to the lowest correlations with instream variables were: elevation (6 significant correlations); watershed area, stream slope, and proximal slope (5 significant correlations each); sinuosity (4 significant correlations); K-factor (3 significant correlations); and catchment slope (1 significant correlation). The instream variables in order from the highest to the lowest correlation with natural variables were: average depth (8 significant correlations); sediment depth (6 significant correlations); % gravel (4 significant correlations); width and maximum depth (3 significant correlations each); depth to sediment depth ratio and vegetation thickness (2 significant correlations each); and % sediment (1 significant correlations). Significant rank correlations (R-values) for natural and instream variables were low to moderate across the sample sets (Table 3). Negative correlations indicate an increase in values for natural variables and a decrease in values for instream variables (i.e., the variables move in opposite directions of one another). Positive correlations indicate an increase in value for natural variables and instream variables (i.e., the variables move in the same direction as one another).

Table 2. Averages and standard deviations for instream and natural habitat variables observed in Silver Creek. Standard deviations were only calculated for instream variables. Compete results can be found in Appendix C.

			Instream Variables								Natural Variables				
Location	Stream Type	Site ID	Average Width		Average Depth		Average W:D Ratio		Average Sediment Depth		Elevation	Watershed Area	Sinuosity	Stream Slope	K-Factor
			(ft)	st dev	(ft)	st dev		st dev	(ft)	st dev	(ft)	Acres			
Siver Creek	main	R1	35.67	4.77	3.25	0.49	10.98	2.83	0.98	0.72	4827.35	55568.77	1.80	0.22	0.02
Silver Creek	main	N2D	97.32	26.18	2.37	0.48	41.15	14.98	0.71	0.66	4859.08	35155.80	3.23	0.09	0.02
Siver Creek	main	D3D	89.72	36.51	2.52	0.40	35.60	13.67	0.51	0.38	4857.41	43694.72	1.82	0.20	0.02
Siver Creek	main	D4D	124.23	26.28	2.58	0.24	48.15	15.18	1.39	0.31	4848.70	46836.74	4.86	0.13	0.37
Silver Creek	main	D5D	68.13	1.63	2.17	0.36	31.33	5.67	0.90	0.46	4848.58	47599.89	1.53	0.10	0.37
Siver Creek	main	D6D	57.39	3.46	2.33	0.40	24.63	5.30	0.70	0.15	4842.58	47656.81	1.59	0.15	0.02
Silver Creek	main	D7D	104.65	14.53	2.50	0.53	41.89	3.97	0.68	0.31	4837.19	48265.30	1.65	0.12	0.02
Silver Creek	main	D8D	74.42	12.32	2.95	0.27	25.19	6.67	0.93	0.20	4836.16	49217.70	1.99	0.26	0.02
AVERAGE	average		81.44	28.26	2.58	0.35	31.52	11.94	0.85	0.27	4844.63	46749.47	2.31	0.16	0.11
Chaney Creek	tributary	R2	18.21	4.62	0.94	0.04	19.38	5.05	0.00	0.00	4875.22	510.74	1.39	0.05	0.37
Loving Creek	tributary	N1D	41.97	17.90	1.58	0.36	26.63	6.25	0.70	0.47	4858.03	6644.39	1.41	0.28	0.37
Grove Creek	tributary	N3D	76.49	6.78	1.03	0.22	74.53	22.25	0.68	0.60	4863.52	22374.87	3.14	0.05	0.37
Grove Creek	tributary	N4D	10.57	3.37	0.89	0.32	11.90	4.86	0.00	0.00	4895.59	14684.55	1.39	0.09	0.37
Wison Creek	tributary	N5D	39.53	17.73	1.25	0.23	31.54	15.85	0.59	0.28	4889.21	202.66	1.43	0.23	0.37
Stalker Creek	tributary	N6D	33.00	5.37	1.12	0.20	29.46	0.70	0.76	0.67	4866.74	10758.05	1.37	0.18	0.02
Stalker Creek	tributary	N7D	66.57	3.66	2.45	0.86	27.17	8.42	0.83	1.10	4871.33	8758.26	0.77	0.13	0.37
Mud Creek	tributary	N8D	19.70	1.53	1.97	0.25	10.01	1.68	0.66	0.13	4872.26	887.92	1.44	0.06	0.37
Grove Creek	tributary	D1D	48.09	14.50	0.31	0.06	156.85	12.73	0.00	0.15	4895.90	130.78	1.57	0.00	0.37
Loving Creek	tributary	D2D	65.67	10.66	1.23	0.04	53.43	35.64	0.83	0.00	4857.63	8400.48	1.53	0.13	0.37
AVERAGE	average		41.98	22.43	1.28	0.60	32.91	44.09	0.51	0.36	4874.54	7335.27	1.54	0.12	0.34

Table 3. Spearman rank correlations and p-values (R, p) for natural and instream variables at all, mains, and tributary sample locations. Instream variables are vertical, natural are horizontal. Significant correlations are **bold**.

	Elevation						K-Factor						Sinuosity					
	ALL		MAINS		TRIBUTARIES		ALL		MAINS		TRIBUTARIES		ALL		MAINS		TRIBUTARIES	
	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value
Width	**-0.529**	**0.024**	0.524	0.183	-0.491	0.150	-0.275	0.270	0.252	0.547	0.174	0.631	**0.734**	**0.001**	0.595	0.120	0.394	0.260
Average Depth	**-0.800**	**0.0001**	-0.476	0.233	-0.479	0.162	**-0.560**	**0.016**	-0.252	0.547	0.058	0.873	**0.513**	**0.030**	0.548	0.160	-0.285	0.425
Maximum Depth	**-0.690**	**0.002**	-0.405	0.320	-0.612	0.060	-0.340	0.167	-0.126	0.766	0.058	0.873	0.220	0.381	**-0.714**	**0.047**	-0.115	0.751
Sediment Depth	**-0.684**	**0.002**	-0.310	0.456	**-0.804**	**0.005**	-0.231	0.356	0.504	0.203	-0.294	0.410	0.313	0.205	0.381	0.352	-0.227	0.528
W:D Ratio	0.042	0.868	0.595	0.120	-0.115	0.751	0.121	0.633	0.378	0.356	-0.058	0.873	0.428	0.076	0.476	0.233	0.539	0.108
D:S Depth	**-0.696**	**0.001**	-0.048	0.911	-0.423	0.223	**-0.671**	**0.002**	**-0.756**	**0.030**	0.176	0.626	0.440	0.068	-0.310	0.456	-0.018	0.960
Vegetation Thickness	-0.157	0.535	0.635	0.091	-0.498	0.143	0.243	0.331	0.634	0.092	0.466	0.175	0.038	0.880	-0.096	0.821	0.067	0.854
% Instream Vegetation	-0.361	0.141	-0.167	0.693	0.067	0.853	-0.188	0.456	0.000	1.000	0.411	0.238	0.126	0.620	-0.381	0.352	-0.178	0.623
% Instream Gravels	0.439	0.069	0.000	1.000	0.527	0.117	-0.055	0.829	-0.504	0.203	-0.290	0.416	-0.232	0.354	-0.262	0.531	-0.091	0.803
% Instream Sediment	-0.202	0.422	0.095	0.823	-0.583	0.077	0.055	0.828	0.252	0.547	-0.176	0.626	0.251	0.314	**0.786**	**0.021**	0.301	0.399

	Stream Slope						Watershed Area					
	ALL		MAINS		TRIBUTARIES		ALL		MAINS		TRIBUTARIES	
	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value
Width	0.067	0.791	-0.429	0.289	0.030	0.934	**0.501**	**0.034**	-0.524	0.183	0.176	0.627
Average Depth	**0.536**	**0.022**	**0.738**	**0.037**	0.576	0.082	**0.748**	**0.0004**	0.476	0.233	0.018	0.960
Maximum Depth	0.309	0.213	-0.119	0.779	0.552	0.098	**0.542**	**0.020**	0.405	0.320	0.055	0.881
Sediment Depth	0.440	0.068	0.190	0.651	0.546	0.102	**0.590**	**0.010**	0.310	0.456	0.423	0.223
W:D Ratio	-0.212	0.399	-0.571	0.139	-0.103	0.777	-0.110	0.663	-0.595	0.120	-0.079	0.829
D:S Depth	0.400	0.100	0.190	0.651	0.436	0.208	**0.648**	**0.004**	0.048	0.911	0.031	0.933
Vegetation Thickness	0.023	0.928	**-0.946**	**0.0004**	0.365	0.300	-0.030	0.906	-0.635	0.091	-0.134	0.713
% Instream Vegetation	0.232	0.353	-0.095	0.823	0.374	0.287	0.340	0.167	0.167	0.693	-0.129	0.723
% Instream Gravels	**-0.564**	**0.015**	0.119	0.779	**-0.758**	**0.011**	-0.209	0.404	0.000	1.000	-0.006	0.987
% Instream Sediment	0.353	0.151	0.143	0.736	0.472	0.168	0.042	0.867	-0.095	0.823	0.202	0.575

	Catchment Slope						Proximal Slope					
	ALL		MAINS		TRIBUTARIES		ALL		MAINS		TRIBUTARIES	
	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value
Width	-0.407	0.094	-0.491	0.217	-0.321	0.365	0.067	0.791	-0.429	0.289	0.030	0.934
Average Depth	-0.169	0.502	0.108	0.799	-0.455	0.187	**0.536**	**0.022**	**0.738**	**0.037**	0.576	0.082
Maximum Depth	-0.148	0.559	0.359	0.382	-0.515	0.128	0.309	0.213	-0.119	0.779	0.552	0.098
Sediment Depth	-0.187	0.457	0.395	0.333	**-0.791**	**0.006**	0.440	0.068	0.190	0.651	0.546	0.102
W:D Ratio	-0.229	0.360	-0.371	0.365	0.055	0.881	-0.212	0.399	-0.571	0.139	-0.103	0.777
D:S Depth	-0.221	0.377	-0.228	0.588	-0.313	0.379	0.023	0.928	0.190	0.651	0.436	0.208
Vegetation Thickness	-0.344	0.163	0.012	0.977	-0.426	0.220	**-0.564**	**0.015**	**-0.946**	**0.0004**	0.365	0.300
% Instream Vegetation	-0.262	0.294	-0.563	0.146	0.031	0.933	0.232	0.353	-0.095	0.823	0.374	0.287
% Instream Gravels	0.327	0.185	0.419	0.301	0.418	0.229	**-0.564**	**0.015**	0.119	0.779	**-0.758**	**0.011**
% Instream Sediment	-0.098	0.698	0.359	0.382	-0.325	0.359	0.353	0.151	0.143	0.736	0.472	0.168

Anthropogenic Variables and Instream Habitat

Anthropogenic and instream variable observations demonstrated that overall percentages for permanent crops (16.2% versus, 15.6%), annual crops (18.7%, versus 17.2%), and developed areas (3.5%, versus 2.7%) were not considerably higher in lower elevation (main stem) compared to higher elevation (tributary) samples (Table 4). Tributary had greater percentage of total riparian acreage (7.2%, versus 4.8%) and greater road density (0.8, versus 0.4) than main stem sample locations (Table 4).

Spearman rank correlations of anthropogenic variables versus instream variables produced 5 of 150 (3.3%) significant correlations, when all samples were evaluated together. Main stem samples had 7 of 150 (5%) significant correlations and tributary samples had 4 of 150 (3%) significant correlations (Table 5). The anthropogenic variables in order from the highest to the lowest correlations with instream variables were: % developed (5 significant correlations), % total riparian vegetation area and structure density (3 significant correlations each); % riparian poor, % all agriculture, and pivot and road densities (1 significant correlation each). The instream variables in order from the highest to the lowest correlation with anthropogenic variables were: width and width to depth ratio (5 significant correlations); average depth (2 significant correlations); maximum depth, sediment depth, vegetation thickness, and % gravel (1 significant correlation); and depth to sediment depth ratio, % vegetation, and % sediment (0 significant correlations). Significant rank correlation coefficients (R-values) were generally low across the sample sets (Table 5). Negative correlations indicate an increase in values for anthropogenic variables and a decrease in values for instream variables (i.e., the variables move in opposite directions of one another). Positive correlations indicate an increase in value for anthropogenic variables and instream variables (i.e., the variables move in the same direction as one another).

Table 4. Averages calculated for anthropogenic variables in Silver Creek. Compete results can be found in Appendix C.

			Anthropogenic Variables						
Location	Stream Type	Site ID	Permanent Crop	Annual Crop	Total Riparian	Developed	Range	Structure Density	Road Density
			% Acreage	% Acreage	% Acreage	% Acreage	% Acreage		
Siver Creek	main	R1	16.53	18.08	5.28	3.54	50.29	0.01	0.43
Silver Creek	main	N2D	17.57	18.20	4.27	5.33	47.23	0.01	0.35
Siver Creek	main	D3D	16.01	19.31	4.78	3.37	48.85	0.02	0.39
Siver Creek	main	D4D	15.89	18.36	4.72	3.21	50.63	0.01	0.39
Silver Creek	main	D5D	15.88	18.86	4.65	3.23	50.30	0.01	0.40
Siver Creek	main	D6D	15.87	18.84	4.68	3.23	50.31	0.01	0.40
Silver Creek	main	D7D	15.96	19.21	4.70	3.20	49.87	0.01	0.41
Silver Creek	main	D8D	15.85	19.07	4.94	3.18	49.93	0.01	0.41
AVERAGE	average		16.19	18.74	4.75	3.54	49.68	0.01	0.40
Chaney Creek	tributary	R2	39.26	36.22	9.66	0.46	0.00	0.00	0.92
Loving Creek	tributary	N1D	11.37	21.03	8.02	2.45	47.13	0.02	0.52
Grove Creek	tributary	N3D	12.53	23.03	1.07	4.58	54.36	0.02	0.32
Grove Creek	tributary	N4D	7.84	8.18	0.01	0.79	82.83	0.00	0.31
Wison Creek	tributary	N5D	0.00	10.63	10.50	1.93	0.00	0.04	0.61
Stalker Creek	tributary	N6D	29.23	11.08	9.19	1.16	36.63	0.01	0.73
Stalker Creek	tributary	N7D	33.16	10.38	9.11	0.97	36.72	0.01	0.67
Mud Creek	tributary	N8D	12.31	26.89	13.34	2.36	0.00	0.01	1.24
Grove Creek	tributary	D1D	0.00	0.00	5.00	9.64	0.00	0.22	2.49
Loving Creek	tributary	D2D	9.87	24.24	6.46	2.79	48.38	0.02	0.52
AVERAGE	average		15.56	17.17	7.23	2.71	30.60	0.03	0.83

Table 5. Spearman rank correlations and p-values (R, p) for anthropogenic and instream variables at all, mains, and tributary sample locations. Instream variables are vertical, anthropogenic horizontal. Significant correlations are **bold**.

	% Permanent Crops						% Annual Crops						% Developed					
	ALL		MAINS		TRIBUTARIES		ALL		MAINS		TRIBUTARIES		ALL		MAINS		TRIBUTARIES	
	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value
Width	0.185	0.463	0.167	0.693	0.018	0.960	0.096	0.705	0.262	0.531	-0.115	0.751	**0.571**	**0.013**	-0.310	0.456	**0.648**	**0.043**
Average Depth	0.414	0.088	0.143	0.736	0.261	0.466	0.034	0.893	-0.167	0.693	0.248	0.489	0.273	0.272	-0.119	0.779	-0.079	0.829
Maximum Depth	0.310	0.211	0.333	0.420	0.152	0.675	0.121	0.633	-0.119	0.779	0.345	0.328	0.218	0.385	0.286	0.493	0.030	0.934
Sediment Depth	0.315	0.204	-0.143	0.736	0.363	0.302	-0.061	0.810	-0.667	0.071	0.129	0.723	0.173	0.493	-0.143	0.736	0.129	0.723
W:D Ratio	-0.188	0.455	0.214	0.610	-0.328	0.354	-0.065	0.798	0.238	0.570	-0.309	0.385	**0.501**	**0.034**	-0.238	0.570	**0.697**	**0.025**
D:S Depth	0.301	0.225	0.310	0.456	0.148	0.684	0.148	0.558	0.452	0.260	0.227	0.528	0.382	0.118	0.262	0.531	0.141	0.697
Vegetation Thickness	0.098	0.700	0.120	0.778	0.037	0.920	0.148	0.557	-0.108	0.799	0.146	0.688	0.105	0.679	0.096	0.821	0.286	0.424
% Instream Vegetation	-0.068	0.789	-0.667	0.071	-0.080	0.826	0.246	0.325	0.524	0.183	0.104	0.774	-0.031	0.902	-0.619	0.102	-0.264	0.461
% Instream Gravels	0.281	0.259	0.619	0.102	0.225	0.532	-0.240	0.336	-0.214	0.610	-0.212	0.556	0.053	0.836	**0.786**	**0.021**	-0.164	0.651
% Instream Sediment	-0.010	0.967	0.405	0.320	-0.086	0.813	0.092	0.716	-0.571	0.139	0.288	0.419	0.073	0.772	0.214	0.610	0.337	0.340

	% Riparian Poor						% Riparian Good						% Riparian Excellent					
	ALL		MAINS		TRIBUTARIES		ALL		MAINS		TRIBUTARIES		ALL		MAINS		TRIBUTARIES	
	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value
Width	0.095	0.708	-0.643	0.086	0.413	0.235	0.114	0.652	0.048	0.911	0.038	0.918	0.068	0.788	0.643	0.086	-0.091	0.802
Average Depth	0.262	0.293	0.429	0.289	0.267	0.455	0.161	0.524	-0.286	0.493	-0.006	0.986	0.002	0.994	0.000	1.000	0.243	0.498
Maximum Depth	0.332	0.178	0.357	0.385	0.304	0.393	0.346	0.159	0.143	0.736	0.175	0.629	-0.178	0.481	**-0.714**	**0.047**	0.146	0.688
Sediment Depth	0.260	0.298	0.333	0.420	0.314	0.377	0.351	0.153	-0.262	0.531	0.468	0.172	-0.119	0.638	-0.262	0.531	-0.055	0.879
W:D Ratio	0.039	0.877	**-0.714**	**0.047**	0.280	0.434	0.003	0.990	0.167	0.693	-0.075	0.837	-0.021	0.935	0.571	0.139	-0.140	0.700
D:S Depth	0.289	0.245	0.024	0.955	0.351	0.320	0.028	0.912	0.119	0.779	-0.152	0.675	0.051	0.842	0.000	1.000	0.252	0.482
Vegetation Thickness	0.148	0.558	-0.659	0.076	0.485	0.156	0.136	0.592	0.204	0.629	-0.056	0.877	-0.011	0.966	0.180	0.670	-0.027	0.940
% Instream Vegetation	0.104	0.682	0.143	0.736	-0.142	0.697	-0.101	0.691	-0.119	0.779	-0.209	0.562	0.076	0.764	0.119	0.779	0.197	0.586
% Instream Gravels	-0.284	0.254	0.048	0.911	-0.140	0.700	0.031	0.902	0.095	0.823	-0.100	0.783	-0.008	0.974	-0.286	0.493	-0.085	0.815
% Instream Sediment	0.113	0.656	-0.119	0.779	0.117	0.748	0.071	0.780	-0.262	0.531	0.127	0.727	0.202	0.422	0.238	0.570	0.289	0.418

	Riparian Width						% Riparian					
	ALL		MAINS		TRIBUTARIES		ALL		MAINS		TRIBUTARIES	
	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value
Width	-0.257	0.303	-0.548	0.160	-0.152	0.676	**-0.498**	**0.035**	-0.238	0.570	-0.309	0.385
Average Depth	0.127	0.616	0.167	0.693	0.309	0.385	-0.092	0.717	**0.905**	**0.002**	0.564	0.090
Maximum Depth	0.174	0.489	0.190	0.651	0.358	0.310	-0.055	0.829	0.024	0.955	0.442	0.200
Sediment Depth	0.317	0.199	0.429	0.289	0.190	0.599	-0.080	0.753	0.310	0.456	0.080	0.827
W:D Ratio	-0.391	0.109	-0.571	0.139	-0.261	0.467	-0.296	0.233	-0.357	0.385	-0.382	0.276
D:S Depth	0.098	0.698	-0.262	0.531	0.190	0.599	-0.158	0.531	0.143	0.736	0.472	0.168
Vegetation Thickness	-0.037	0.883	-0.144	0.734	0.243	0.498	-0.082	0.746	**-0.874**	**0.005**	0.201	0.578
% Instream Vegetation	0.054	0.832	0.048	0.911	0.166	0.647	-0.200	0.426	-0.310	0.456	0.350	0.322
% Instream Gravels	-0.197	0.433	0.119	0.779	-0.333	0.347	-0.082	0.748	0.143	0.736	-0.248	0.489
% Instream Sediment	0.224	0.371	0.262	0.531	0.190	0.599	0.262	0.294	0.381	0.352	0.215	0.551

Table 5 (continued). Spearman rank correlations and p-values (R, p) for anthropogenic and instream variables at all, mains, and tributary sample locations. Significant correlations are **bold**.

	Structure Density						Pivot Density						Road Density					
	ALL		MAINS		TRIBUTARIES		ALL		MAINS		TRIBUTARIES		ALL		MAINS		TRIBUTARIES	
	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value
Width	0.385	0.115	0.238	0.570	**0.636**	**0.048**	0.162	0.520	-0.119	0.779	-0.067	0.854	**-0.499**	**0.035**	-0.491	0.217	-0.139	0.701
Average Depth	-0.071	0.779	-0.143	0.736	0.006	0.987	0.331	0.179	**0.762**	**0.028**	0.152	0.675	-0.271	0.278	0.443	0.272	0.006	0.987
Maximum Depth	0.057	0.823	-0.071	0.867	0.091	0.803	0.159	0.529	-0.048	0.911	0.225	0.532	-0.132	0.601	0.479	0.230	-0.055	0.881
Sediment Depth	-0.011	0.964	-0.024	0.955	0.018	0.960	0.145	0.566	0.238	0.570	0.178	0.622	-0.157	0.533	0.263	0.528	-0.178	0.623
W:D Ratio	**0.701**	**0.001**	0.357	0.385	**0.770**	**0.009**	-0.204	0.416	-0.238	0.570	-0.328	0.354	-0.158	0.531	-0.551	0.157	0.018	0.960
D:S Depth	-0.011	0.964	-0.095	0.823	0.190	0.599	0.303	0.221	0.095	0.823	0.135	0.709	-0.280	0.260	0.096	0.821	-0.018	0.960
Vegetation Thickness	0.280	0.260	0.395	0.333	0.347	0.327	-0.180	0.476	-0.587	0.126	0.012	0.973	-0.113	0.656	-0.596	0.119	-0.055	0.881
% Instream Vegetation	-0.147	0.560	-0.548	0.160	-0.153	0.672	0.073	0.773	-0.238	0.570	-0.092	0.800	-0.270	0.279	0.144	0.734	-0.227	0.528
% Instream Gravels	-0.255	0.307	0.238	0.570	-0.248	0.489	0.045	0.858	0.190	0.651	0.135	0.709	0.128	0.613	0.036	0.933	0.430	0.214
% Instream Sediment	0.334	0.176	0.333	0.420	0.411	0.238	0.159	0.528	0.190	0.651	0.103	0.776	0.006	0.980	-0.132	0.756	-0.227	0.528

	% All Human						% All Agriculture					
	ALL		MAINS		TRIBUTARIES		ALL		MAINS		TRIBUTARIES	
	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value
Width	0.030	0.906	0.119	0.779	-0.067	0.855	0.071	0.779	0.262	0.531	-0.055	0.881
Average Depth	0.191	0.448	0.048	0.911	0.382	0.276	0.150	0.553	-0.286	0.493	0.333	0.347
Maximum Depth	0.123	0.627	0.143	0.736	0.321	0.365	0.073	0.773	-0.143	0.736	0.285	0.425
Sediment Depth	0.082	0.747	-0.548	0.160	0.350	0.322	0.073	0.772	**-0.714**	**0.047**	0.387	0.270
W:D Ratio	-0.265	0.287	0.095	0.823	-0.455	0.187	-0.218	0.385	0.238	0.570	-0.394	0.260
D:S Depth	0.235	0.348	0.571	0.139	0.264	0.461	0.206	0.413	0.476	0.233	0.190	0.599
Vegetation Thickness	0.010	0.967	-0.084	0.844	0.128	0.725	0.043	0.867	0.132	0.756	0.061	0.868
% Instream Vegetation	0.000	1.000	-0.071	0.867	0.006	0.987	0.060	0.813	0.333	0.420	-0.080	0.827
% Instream Gravels	0.290	0.243	0.429	0.289	0.127	0.726	0.261	0.295	0.095	0.823	0.176	0.627
% Instream Sediment	0.036	0.887	0.000	1.000	-0.006	0.987	-0.024	0.925	-0.286	0.493	0.006	0.987

	% Range						% Other					
	ALL		MAINS		TRIBUTARIES		ALL		MAINS		TRIBUTARIES	
	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value	R	p-value
Width	0.376	0.125	-0.190	0.651	0.250	0.486	-0.319	0.197	0.500	0.207	-0.176	0.627
Average Depth	0.294	0.237	-0.024	0.955	-0.094	0.797	-0.368	0.132	-0.429	0.289	0.018	0.960
Maximum Depth	0.207	0.409	0.024	0.955	0.025	0.945	-0.251	0.316	-0.381	0.352	-0.103	0.777
Sediment Depth	0.364	0.138	0.571	0.139	0.317	0.373	-0.342	0.164	-0.381	0.352	-0.350	0.322
W:D Ratio	0.043	0.867	-0.143	0.736	0.038	0.918	0.094	0.711	0.571	0.139	0.115	0.751
D:S Depth	0.186	0.460	-0.524	0.183	-0.076	0.835	-0.303	0.222	0.048	0.911	0.043	0.906
Vegetation Thickness	-0.014	0.957	0.084	0.844	0.025	0.945	0.150	0.551	0.539	0.168	-0.024	0.947
% Instream Vegetation	0.140	0.579	-0.095	0.823	-0.057	0.876	-0.192	0.446	-0.190	0.651	0.043	0.906
% Instream Gravels	-0.093	0.713	-0.262	0.531	-0.188	0.604	0.040	0.874	0.048	0.911	0.139	0.701
% Instream Sediment	0.021	0.935	0.048	0.911	0.127	0.727	0.024	0.925	0.048	0.911	-0.117	0.748

Thorough research was conducted on stream and riparian assessment parameters prior to determining the suite of predictor variables to be sampled in this study. However, most information pertaining to stream and riparian sampling is based on run-off driven ecosystems. Multiple authors (Whiting and Stamm 1995, Whiting and Moog 2001, and Griffiths et. al., 2008) have stated that runoff-dominated and spring fed ecosystems are distinct ecosystems and driving factors within runoff-dominated ecosystems might not be adequate for evaluation of the spring creek habitat. Table 6 lists the natural, anthropogenic, and instream variables that are most commonly found in stream and riparian assessment protocols (Hynes 1970, Kauffman and Krueger 1984, Platts et al., 1987, Newton et. al., 1998, Winward 2000, Kaufmann 2002, USDA 2004), which were identified in this study as predictor variables for the Silver Creek watershed.

Table 6. Runoff based diagnostic variables for instream, anthropogenic, and natural parameters that were predictive indicators in Silver Creek.

Natural Variables	**Anthropogenic Variables**	**Instream Variables**
Elevation	% Annual Crops	Width
K-Factor (Soil Texture)	% Permanent Crops	Average Depth
Stream Slope	% Developed	Sediment Depth
Watershed Area	% Riparian	

These results indicate that there are some similarities between spring fed and runoff dominated streams. However, evidence is not strong enough to draw definitive conclusions as to the relationships between natural, anthropogenic, and instream variables in the Silver Creek watershed and further studies should be conducted to verify this information.

DISCUSSION

Natural variables were more strongly associated with instream habitat conditions than anthropogenic variables. The natural variables most strongly related to instream variables were watershed area and elevation suggesting that natural natural variables were more important than anthropogenic stressors in explaining instream habitat conditions in Silver Creek. This seems reasonable because it is known that strong gradients in stream habitats are associated with watershed area and elevations (Chapman 1966, Gunderson 1966, Hynes 1970, Bisson, Sullivan, and Nielsen 1988, Kauffman 2002, and Allan 2004). For example, as elevation increases, watershed area decreases, and width, average depth, maximum depth, and sediment depth all decrease. Channel dimension variables such as depth and width decrease because there is less stream discharge. Interestingly, the phenomena described above would also be predicted for a runoff-dominated watershed, but occurred in this study despite the spring-fed nature of Silver Creek.

The anthropogenic variables most strongly related to instream variables were percent developed acres, percent total riparian acres, and structure density. An increase in developed lands, whether for residential or agricultural purposes, resulting in decreased riparian acres, leads to increased runoff and overland flow, resulting in eroding banks and widening of the stream channel. Historically, the main stem of Silver was 25 feet wide and 2 feet deep, whereas today it averages 81 feet wide and 2.6 feet deep (Dykes and Doyle 1998). It is unclear if this relationship in Silver Creek is due to increased development or decreased riparian acreage. Furthermore, there were not significant correlations between total percent agricultural acreages and total percent human impacted acreages with instream variables. The relatively low percentage of significant correlations between anthropogenic and instream variables suggest that either: 1) there is little influence by human activities; 2) this study has overlooked other indicators of human influence; or 3) that natural variables are so dominant that the magnitude of human influences is not detectable.

Primary factors influencing correlations were sample size and diversity. A greater number of correlations were observed where there was: 1) a larger sample size, and 2) a greater range of variability among sampled variables. Using variability across the site (all samples) demonstrated correlations that were not visible when observing only a small scale (main stem and tributaries individually).

Topographic and hydrologic variables within the ecosystem may be strong enough to mask the affect of anthropogenic stress. The Silver Creek watershed was chosen for this study because of the large contiguous sampling area with a number of individual tributaries to provide replication. An increased knowledge of natural processes acting on the whole Silver Creek watershed would improve the design and implementations of future studies. More expansive investigations of groundwater and surface water interactions within the watershed could provide vital information to more strongly identify the parameters controlling Silver Creek.

CONCLUSIONS

Results show that natural site variables have stronger influence on instream variable than do anthropogenic variables. However, there were insufficient correlations between selected natural, anthropogenic and instream variables to recommend EMAP, SVAP, and RAM as viable assessment tools for Silver Creek. Prior to conducting further analysis and sampling on Silver Creek, a more in-depth look at natural landscape drivers and keynote habitat parameters should be taken. Future studies of Silver Creek should increase sample size on both tributaries and the main-stem. This would help to more adequately capture the habitat of the Silver Creek watershed and increase the potential for stronger and more discernible correlations. Furthermore, a time series analysis and model of sediment accumulation and transport would be particularly beneficial to enhance understanding of the watershed, as it is unclear where the source of sediment is and what affects it is having on ecosystem heath.

In order to benefit spring creek ecosystems as a whole, a comparison study should be conducted to further understand the characteristics of spring creek ecosystems and how they differ from runoff-dominated ecosystems. A study that includes multiple examples of spring and runoff-dominated streams would perhaps lead to better inference regarding general differences between the two ecosystems and help to identify the driving factors controlling spring creeks.

Spring creeks are unique ecosystems and there is a lack of understanding of their structure and function within the landscape. Although spring creeks have been extensively researched in regards to salmonid habitat, there is little research that examines the ecosystem as a whole. The knowledge and understanding of spring creeks continues to build with every piece of data that is collected, including the information contained within this study. Although this study and others may not produce abundant correlations or identify major trends in the Silver Creek watershed, it does suggest the need for a radically different assessment protocol. This knowledge will help to build a framework for future research on assessment parameters for spring creek ecosystems.

LITERATURE CITED

Aasheim-Anderson, R. 2004. Occurrence and seasonal dynamics of the whirling disease parasite, *myxobolus cerebralis*, in Montana spring creeks. Masters Thesis. Montana State University, Bozeman.

Allan, J. D. 2004. Landscapes to riverscapes: the influence of land use on stream ecology. Annual Review of Ecology, Evolution, and Systematics. 35: 257-284.

Allen-Diaz, B. and R.D. Jackson. 2000. Grazing effects on spring ecosystem vegetation of California's hardwood rangelands. Journal of Range Management. 53: 215-220.

Anderson, J. E., Ruppel, K. T., Glennon, J. M., Holte, K. E., and Rope, R. C. 1996. Plant communities, ethnoecolgy, and flora of the Idaho National Engineering Lab. Idaho Falls, Idaho. National Research Foundation.

Armour, C., Duff, D., and Elmore, W. 1994. The effects of livestock grazing on western riparian and stream ecosystems. Fisheries. 19(9): 9-12.

Belsky, A. J., Matzke, A., and Uselman, S. 1999. Survey of livestock influences on stream and riparian ecosystems in the western United States. Journal of Soil and Water Conservation. 54: 419-431.

Bilby, R.E. 1984. Characteristics and frequency of cool-water areas in a western Washington stream. Journal of Freshwater Ecology. 2: 593-602.

Bisson, P.A., K. Sullivan and J.L. Nielsen. 1988. Channel Hydraulics, habitat use, and body form of juvenile coho salmon, steelhead, and cutthroat trout in streams. Transactions of the American Fisheries Society. 117: 262-273.

Boussu, M.F. 1954. Relationship between trout populations and cover in a small stream. Journal of Wildlife Management. 18(2): 229-239.

Brady, N. C. and Weil, R. R. 2008. The Nature and Properties of Soils. 14th ed. Prentice Hall, Upper Saddle River, New Jersey.

Brockway, C. E. and Kalhown, M. A. 1994. Hydrological evaluation of the Big Wood River and Silver Creek watersheds phase 1. University of Idaho, Moscow.

Castelin, P. M. and Chapman, S. L. 1972. Water resources of the Big Wood River-Silver Creek area, Blaine County, ID. Water Bulletin (28) - Idaho Department of Water Administration.

Chapman, D.W., 1966. Food and space as regulators of salmonid populations in streams. The American Naturalist. 100: 345-357.

Cuhaciyan, C. O. 2008. Postdoctoral Researcher, USDA Forest Service, Boise Aquatic Sciences Lab and University of Idaho, Center for Ecohydraulic Research, Boise, Idaho.

Deker-Hess, J. 1989. An inventory of spring creeks in Montana. American Fisheries Society/Montana Department of Fish, Wildlife and Parks, Helena, MT.

Dykes, F. W. and Doyle, S. B. 1998. The 1854 Oregon Trail Diary of Winfield Scott Eby. Oregon-California Trails Association, Independence, Missouri.

Gillilan Associates, Inc. 2007. Kilpatrick pond and dam restoration feasibility study-final report. Bozeman, MT. Gillilan Associates, Inc.

Gillilan, S. and Lovell, J. 1997. Kilpatrick pond enhancement project. Bozeman, MT. Confluence Consulting, Inc.

Glaizer, D.S. 1991. The fauna of North American temperate cold springs: patterns and hypotheses. Freshwater Biology. 26: 527-542.

Griffiths, R. E., Anderson, D. E. and Springer, A. E. 2008. The morphology and hydrology of small spring-dominated channels. Geomorphology 102(3-4): 551-521.

Gunderson, D.R. 1966. Stream morphology and fish populations in relation to floodplain use. Master's Thesis. Montana State University, Bozeman.

Hauck, F. R. 1947, Preliminary Observations on Silver Creek and it's Headwater Tributaries with Notes on Population Studies and Some Fishing Results, Idaho Fish and Game Department.

Holton, G.D. 1953. A trout population study on a small creek in Gallatin County, Montana. Journal of Wildlife Management. 17 (1): 62-82.

Hubbs, C. 1995. Springs and spring runs as unique aquatic systems. Copeia 1995(4): 989-991.

Hynes, H.B.N. 1970. The ecology of running waters. University of Toronto Press, Canada.

Isaak, D.J, and Hubert, W.A. 1999. U.S. Geological Survey, Wyoming Cooperative Fish and Wildlife Research Unit. University of Wyoming, Laramiw, WY.

Jankovsky-Jones, M., S.K. Rust and R.K. Moseley. 1999. Riparian reference areas in Idaho: a catalog of plant associations and conservation sites. United States Department of Agriculture, Rocky Mountain Research Station. Ogden, Utah.

Karr, J.R., Fausch, K.D., Angermeier, P.L., Yant, P.R., and Schlosser, I.J. 1986. Assessing biological integrity in running waters- a method and its rationale. Illinois Natural History Survey. Special Publication 5. Champaign, Illinois.

Kaufmann, P.R. 2002. EMAP-Western pilot field operations manual for wadeable streams, section 7 (physical habitat characterization). Environmental Protection Agency. Corvallis, Oregon.

Kauffman, J. B. and Krueger, W. C. 1984. Livestock impacts on riparian ecosystem and streamside management implications – a review. Journal of Range Management. 37: 330-438.

Kershner, J.L., Archer, E.K., Coles-Ritchie, M., Cowley, E.R., Henderson, R.C., Kratz, K., Quimby, C.M., Turner, D.L., Ulmer, L.C., Vinson, M.R. 2004. Guide to effective monitoring of aquatic and riparian resources. General Technical Report RMRS-GTR-121. Fort Collins, CO: U.S. Department of Agriculture, Rocky Mountain Research Station. 57 p.

Lawson, M. 2003. Spring Creeks. Stackpole Books. Mechanicsburg, Pennsylvania.

Ligon, F. K., Dietrich, W. E., and Trush, W. J. 1995. Downstream ecological effects of dams. BioScience. 45(3): 183-192.

Liknes, G.A. and Graham, P.J. 1988. Effects of a century of human influence on the cutthroat trout of Yellowstone Lake. American Fisheries Society Symposium 4: 53-60.

Manuel, C. Y., Griffith, J. S., and Minshall, G. W. 1979. The sources and causes of sedimentation in Silver Creek, Blaine County, Idaho. Idaho State University.

Minckley, W.L. 1962. Ecology of a spring stream, Doe Run, Kentucky. Wildlife Monographs. 11: 1-124.

Moreland, J. A. 1977. Groundwater – Surface water relations in the Silver Creek area, Blaine County, Idaho. USGS, Boise, Idaho.

Perrigo, R. 2006. Historical Sedimentation and Sediment Transport Characteristics of Silver Creek, ID, USA. University of Western Austrailia.

Platts, W. C. 1982. Livestock and riparian-fishery interactions: what are the facts? Transactions of the North American Wildlife and Natural Resources Conference. USDA, Washington, DC.

Platts, W.S., Armor, C., Gordon, G.D, Bryant, M., Bufford, J.L., Cuplin, P, Jensen, S., Lienkaemper, G.W., Minshall, G. W., Monsen, S.B., Nelson, R.L. Sedell, J.R., and Tuhy J.S. 1987. Methods for evaluating Riparian Habitats with Application to Management, United States Department of Agriculture, Forest Service General Technical Report INT-221, Intermountain Research Station, Ogden, UT. 177 p.

Reiser, D.W., Chapin, D., DeVries, P., and Ramey, M. P. 2004. Flow regime and ecosystem interactions in spring-dominated streams; implications for selecting instream flow methods. Hydroécologic Appliquée. 14: 93-104.

Schlosser, J.J. 1991. Stream fish ecology: a landscape perspective. Bioscience. 41: 704-712.

Sloat, M.R. 2001. Status of westslope cutthroat trout in the Madison River basin: the influence of dispersal barriers and stream temperature. Masters Thesis. Montana State University, Bozeman.

StatSoft, Inc. (2011). STATISTICA (data analysis software system), version 10. www.statsoft.com.

Teal, J.M. 1957. Community metabolism in a temperate cold spring. Ecological Monographs. 27: 283-302.

The Nature Conservancy 1975, Idaho's Silver Creek: a conservation program for one of America's finest spring creeks, The Nature Conservancy, Hailey, Idaho.

The Nature Conservancy. 2005. Silver Creek fact sheet. The Nature Conservancy, Hailey, Idaho. Available: http://nature.org/wherewework/northamerica/states/idaho/files/silver_creek fact_sheet.pdf.

Thurow, R.F., C.E. Corsi and V.K. Moore. 1988. Status, ecology and management of Yellowstone cutthroat trout in the upper Snake River drainage, Idaho. American Fisheries Society Symposium 4:13-24.

Tilly, L.J. 1968. The structure and dynamics of cone spring. Ecological Monographs 38:169-197.

Todd, P. 1997, Silver Creek site conservation plan and five year plan, The Nature Conservancy, Hailey, ID

United State Department of Agriculture. 1996. Preliminary investigation report: Silver Creek watershed, Blaine County, Idaho. In cooperation with Natural Resource Conservation District and Blaine County Soil Conservation District.

Unite States Department of Agriculture-. 2004. Riparian Assessment – Using the NRCS Riparian Assessment Method. Natural Resources Conservation Service, Bozeman, MT, p. 43.

Newton, B., Pringle, C., Bjorkland, R. 1998. Stream visual assessment protocol. US Department of Agriculture. NWCC Technical Note 99 (1).

Whiting, P. J. and Stamm, J. F. 1995. The hydrology and form of spring-dominated channels. Geomorphology. 12:233-240.

Whiting, P. J. and Moog, D. B. 2001. The geometric, sedimentologic and hydrologic attributes of spring-dominated channels in volcanic areas. Geomorphology. 39:131-149.

Wilkinson, R.A. 1996. Fish community structure and brown trout predation in upper Silver Creek, Idaho. Master’s Thesis. Idaho State University, Pocatello.

Winward, A.H. 2000. Monitoring the Vegetation Resources in Riparian Areas. United States Department of Agriculture-Forest Service General Technical Report, RMRS-GTR-47. Intermountain Research Station. Ogden, UT, p. 50.

Wischmeier, W. H. and Smith, D. D. 1978. Predicting rainfall erosion losses- a guide to conservation planning. US Department of Agriculture-Agricultural Handbook No. 537

APPENDICES

APPENDIX A

CROSS SECTION DATA AND DRAWINGS FOR TRIBUTARY SAMPLE LOCATIONS

Table 7. Cross sectional survey data for Chaney Creek.

N (Y)	E (X)			Z (elevation)	Description
602341.196	1590062.97	0	0	4875.3128	Chaney
602341.118	1590062.94	0.08402744	0.84027436	4874.6146	EOW
602339.868	1590065.51	2.86362039	2.94764783	4873.304	GS
602337.2	1590068.5	4.00638057	6.9540284	4873.5884	GS
602333.917	1590072.24	4.97425042	11.9282788	4873.6575	GS
602332.186	1590075.75	3.91788372	15.8461625	4873.3676	GS
602330.914	1590077.06	1.82452512	17.6706877	4874.4874	EOW
602330.505	1590077.15	0.41809841	18.0887861	4875.1321	Chaney

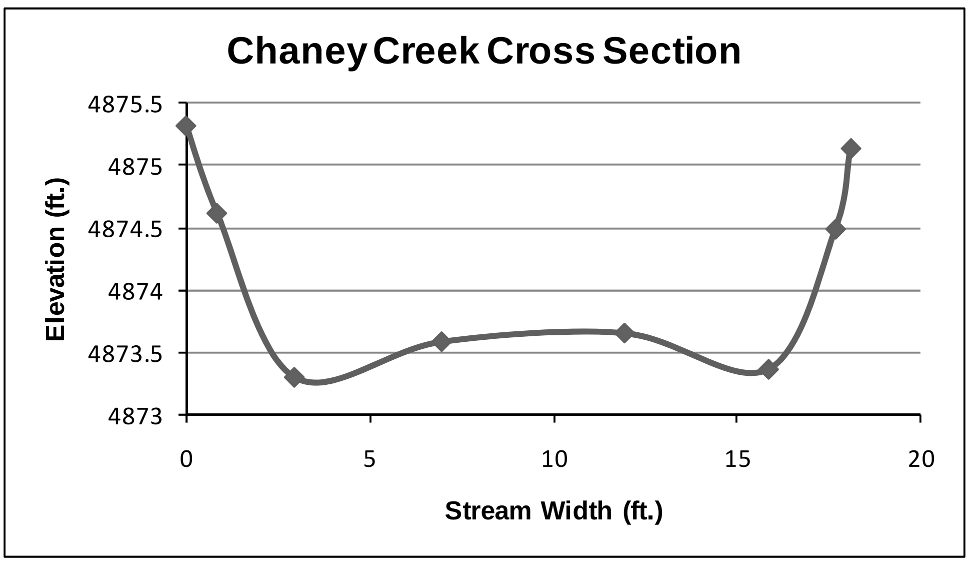

Figure 6. Cross sectional drawing of Chaney Creek.

Table 8. Cross sectional survey data for Stalker Creek at USGS gauge.

N (Y)	E (X)			Z (elevation)	Description
599775.222	1591750.61	0	0	4871.3304	USGS R
599776.438	1591750.49	1.22210944	1.22210944	4869.799	EOW
599776.813	1591750.67	0.41634402	1.63845346	4868.5455	BTM BNK R
599781.392	1591751.48	4.65139058	6.28984404	4867.9009	GS
599789.379	1591752.6	8.06491593	14.35476	4867.5414	GS
599795.747	1591753.76	6.47136125	20.8261212	4867.4041	GS
599801.474	1591754.93	5.8449854	26.6711066	4867.4099	GS
599807.714	1591755.55	6.27100415	32.9421108	4867.2755	GS
599815.595	1591755.64	7.88172304	40.8238338	4866.8812	GS
599817.637	1591755.12	2.10937679	42.9332106	4868.2317	GS
599822.615	1591755.15	4.97811543	47.911326	4868.3869	GS
599827.805	1591755.17	5.18984791	53.1011739	4867.8508	GS
599837.436	1591754.92	9.63425197	62.7354259	4868.8322	BTM BNK L
599837.919	1591754.9	0.48429504	63.219721	4869.746	EOW
599839.6	1591754.65	1.69865398	64.9183749	4870.8306	USGS L

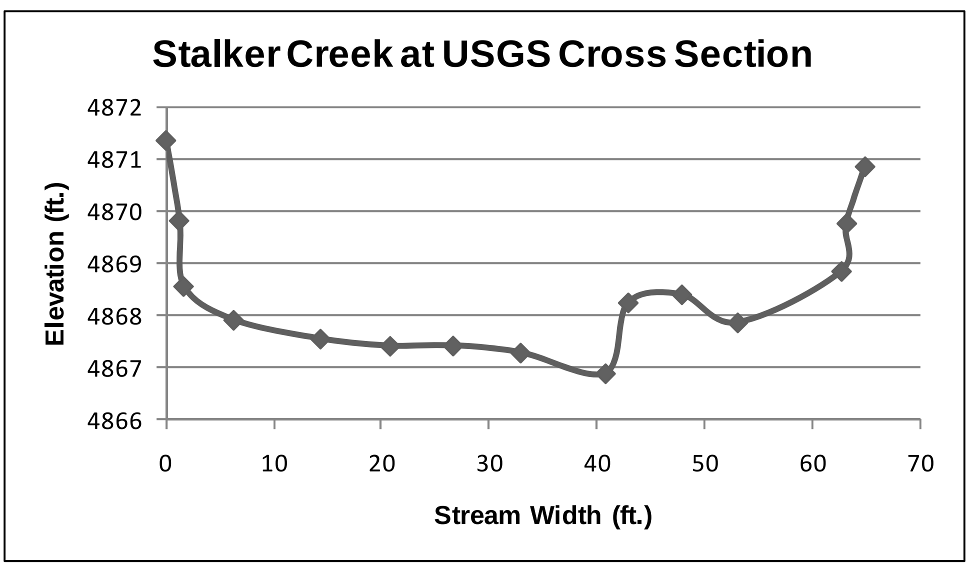

Figure 7. Cross sectional drawing of Stalker Creek at USGS gauge station.

Table 9. Cross sectional survey data for Mud Creek.

N (Y)	E (X)			Z (elevation)	Description
601875.155	1593263.49	0	0	4872.3795	MUD
601874.559	1593262.79	0.92432005	0.92432005	4871.0819	EOW
601874.051	1593261.55	1.33716758	2.26148763	4868.7913	GS
601871.653	1593257.36	4.82995069	7.09143832	4868.9628	GS
601870.191	1593254	3.66168154	10.7531199	4868.6139	GS
601868.064	1593251.14	3.56920106	14.3223209	4868.745	GS
601866.49	1593248.37	3.17913668	17.5014576	4869.0044	GS
601866.029	1593246.83	1.61147697	19.1129346	4871.1154	EOW
601865.957	1593246.39	0.44948782	19.5624224	4872.1389	MUD

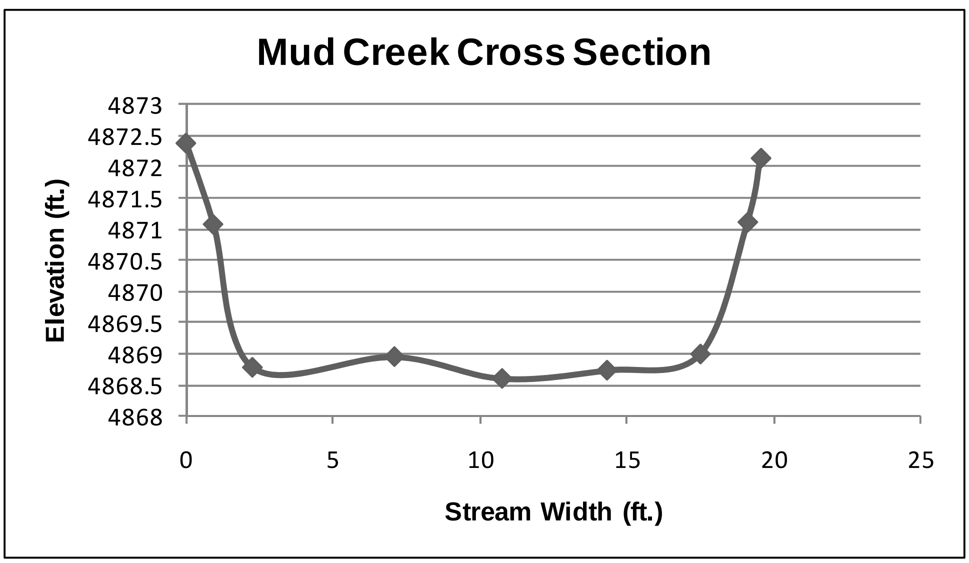

Figure 8. Cross sectional drawing of Mud Creek.

Table 10. Cross sectional survey data for Stalker Creek at TNC T1 monitoring site.

N (Y)	E (X)			Z (elevation)	Description
599657.531	1595907.21	0	0	4866.3844	T1 R
599658.127	1595906.67	0.81100831	0.81100831	4865.4688	EOW
599658.549	1595906.15	0.6678655	1.47887381	4863.8242	BTM BNK R
599660.757	1595900.76	5.81804623	7.29692004	4863.4923	GS
599662.804	1595895.92	5.26276305	12.5596831	4863.3432	GS
599665.397	1595890.98	5.57229304	18.1319761	4863.4681	GS
599667.856	1595886.41	5.1933726	23.3253487	4863.4045	GS
599672.596	1595878.3	9.39026128	32.71561	4863.1667	GS
599673.751	1595875.96	2.61661076	35.3322208	4863.5908	BTM BNK L
599673.861	1595875.4	0.56454026	35.896761	4865.579	EOW
599674.875	1595873.99	1.73653801	37.633299	4867.0897	T1 L

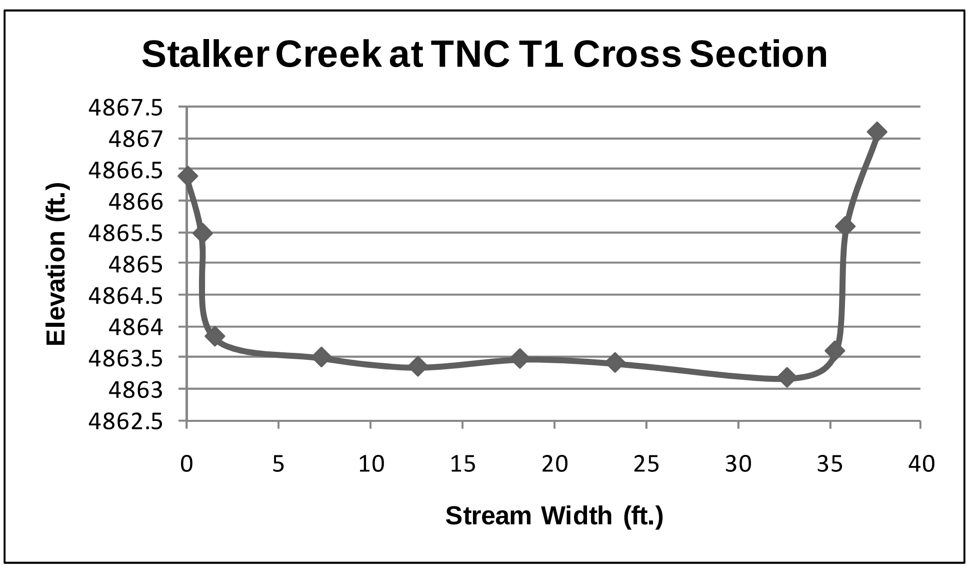

Figure 9. Cross sectional drawing of Stalker Creek at TNC T1 monitoring site.

Table 11. Cross sectional survey data for Wilson Creek.

N (Y)	E (X)			Z (elevation)	Description
608584.774	1593543.35	0	0	4889.6609	WLSN
608583.858	1593542.26	1.42238055	1.42238055	4887.8556	EOW
608582.047	1593541.59	1.93029533	3.35267588	4887.219	GS
608576.425	1593537.1	7.19623876	10.5489146	4886.495	GS
608570.478	1593532.2	7.70690684	18.2558215	4886.2819	GS
608565.394	1593528.55	6.25781503	24.5136365	4885.8884	GS
608559.871	1593524.32	6.95459833	31.4682348	4886.0554	GS
608554.766	1593520.39	6.44533446	37.9135693	4886.2007	GS
608550.832	1593517.18	5.0793004	42.9928697	4886.7078	GS
608549.783	1593516.41	1.30030698	44.2931767	4887.8032	EOW
608549.609	1593516.27	0.22032678	44.5135035	4888.7622	WLSN

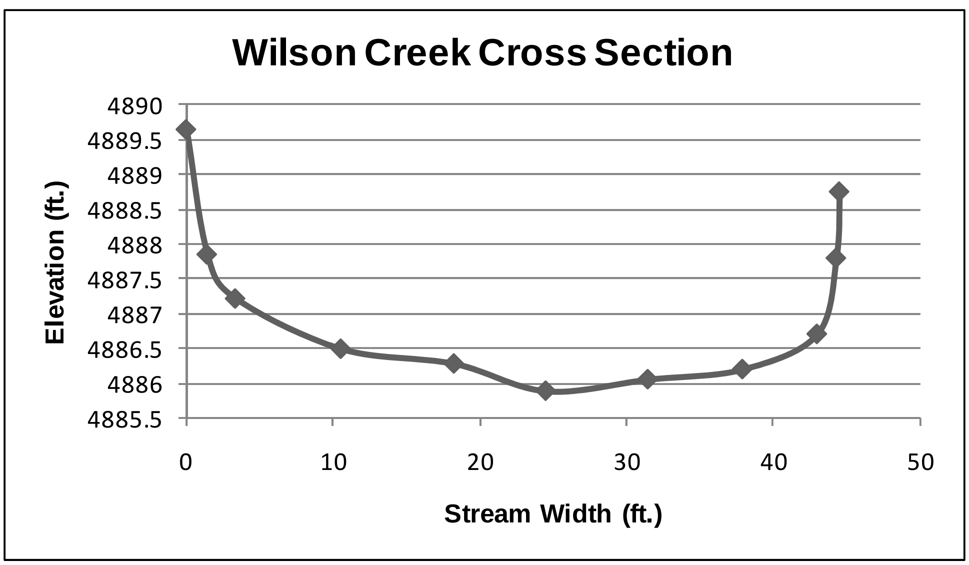

Figure 10. Cross sectional drawing of Wilson Creek.

Table 12. Cross sectional survey data for Upper Grove Creek.

N (Y)	E (X)			Z (elevation)	Description
610681.547	1593177.37	0	0	4895.3997	OG2
610683.04	1593177.92	1.58909744	1.58909744	4894.169	EOW
610683.952	1593178.17	0.94709543	2.53619287	4893.4963	GS
610687.706	1593179.86	4.11638179	6.65257466	4893.3523	GS
610689.33	1593180.75	1.84938313	8.50195779	4893.5118	GS
610691.444	1593181.6	2.28094918	10.782907	4893.4989	GS
610691.965	1593181.88	0.59104674	11.3739537	4894.1729	EOW
610692.928	1593182.49	1.140058	12.5140117	4895.772	OG2

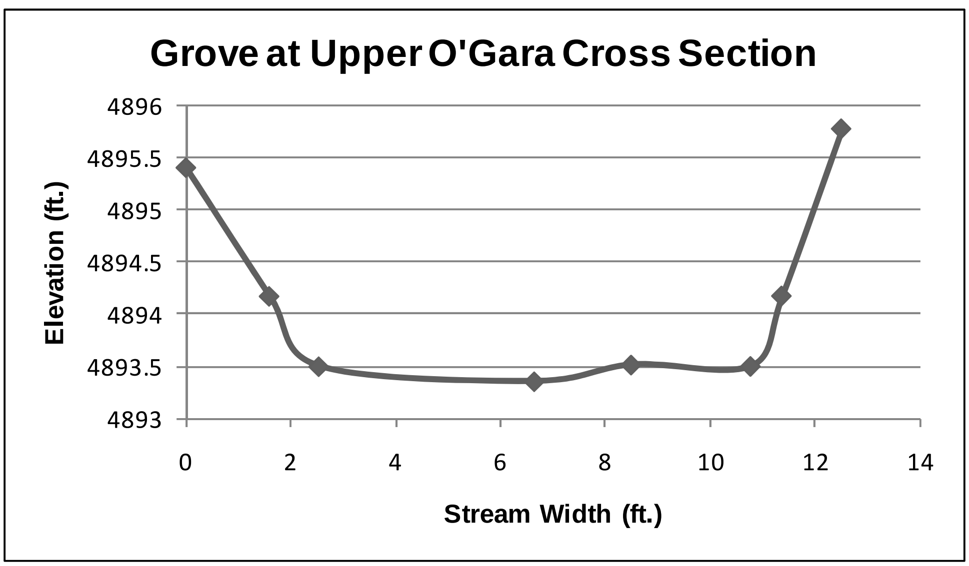

Figure 11. Cross sectional drawing of Upper Grove Creek at O’Gara’s.

Table 13. Cross sectional survey data for Lower Grove Creek.

N (Y)	E (X)			Z (elevation)	Description
611326.831	1593489.96	0	0	4895.9026	OG1
611327.849	1593491.36	1.72699157	1.72699157	4895.1534	EOW
611330.761	1593495.26	4.86582877	6.59282034	4894.6945	GS
611340.451	1593509.4	17.1469512	23.7397715	4894.555	GS
611348.194	1593521.01	13.9533176	37.6930892	4894.6759	GS
611349.862	1593524.98	4.3010105	41.9940997	4895.1982	EOW
611350.328	1593525.76	0.91572473	42.9098244	4895.8949	OG1

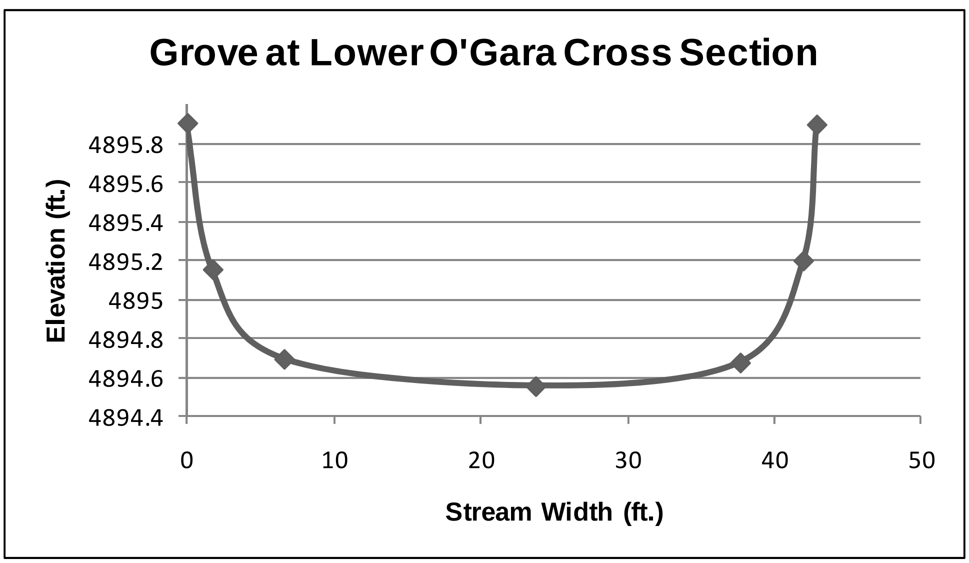

Figure 12. Cross sectional drawing of Lower Grove Creek at O’Gara’s.

Table 14. Cross sectional survey data for Grove Creek at TNC T5 monitoring site.

N (Y)	E (X)			Z (elevation)	Description
602694.908	1597463.63	0	0	4863.4195	T5 L (GS)
602694.29	1597463.48	0.63583897	0.63583897	4863.0123	EOW
602693.85	1597463.14	0.55408329	1.18992226	4861.9707	BTM BNK L
602689.187	1597458.88	6.31863792	7.50856019	4862.0621	GS
602683.801	1597454.44	6.97867172	14.4872319	4861.9481	GS
602676.662	1597447.99	9.61759072	24.1048226	4861.9512	GS
602670.415	1597441.47	9.03114018	33.1359628	4861.9291	GS
602663.731	1597435.96	8.66228498	41.7982478	4862.1033	GS
602656.06	1597428.21	10.9034383	52.701686	4862.1844	GS
602650.787	1597423.48	7.08859042	59.7902765	4861.8611	GS
602645.549	1597417.32	8.08406644	67.8743429	4862.0341	GS
602643.066	1597415.28	3.20983355	71.0841765	4862.7135	BTM BNK R
602642.224	1597414.13	1.425499	72.5096755	4863.1219	EOW
602641.826	1597414.15	0.39812567	72.9078011	4863.6224	T5 R (GS)

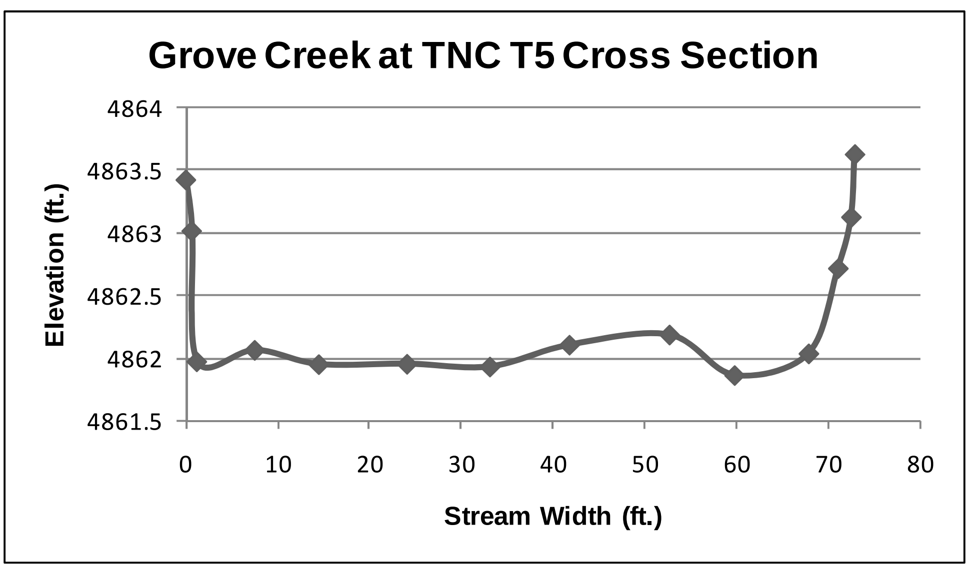

Figure 13. Cross sectional drawing of for Grove Creek at TNC T5 monitoring site.

Table 15. Cross sectional survey data for Loving Creek at Loving Creek Ranch.

N (Y)	E (X)			Z (elevation)	Description
602963.325	1602530.06	0	0	4858.5973	LCR
602960.918	1602529.78	2.42334594	2.42334594	4857.5591	EOW
602959.893	1602529.69	1.02935961	3.45270554	4856.0516	GS
602947.206	1602526.94	12.9810764	16.433782	4855.9692	GS
602933.241	1602522.63	14.613951	31.047733	4855.9792	GS
602920.821	1602519.8	12.7396989	43.7874319	4856.5311	GS
602919.156	1602520.04	1.6829583	45.4703902	4859.3944	LCR
602920.564	1602519.95	1.41173353	46.8821237	4857.4707	EOW

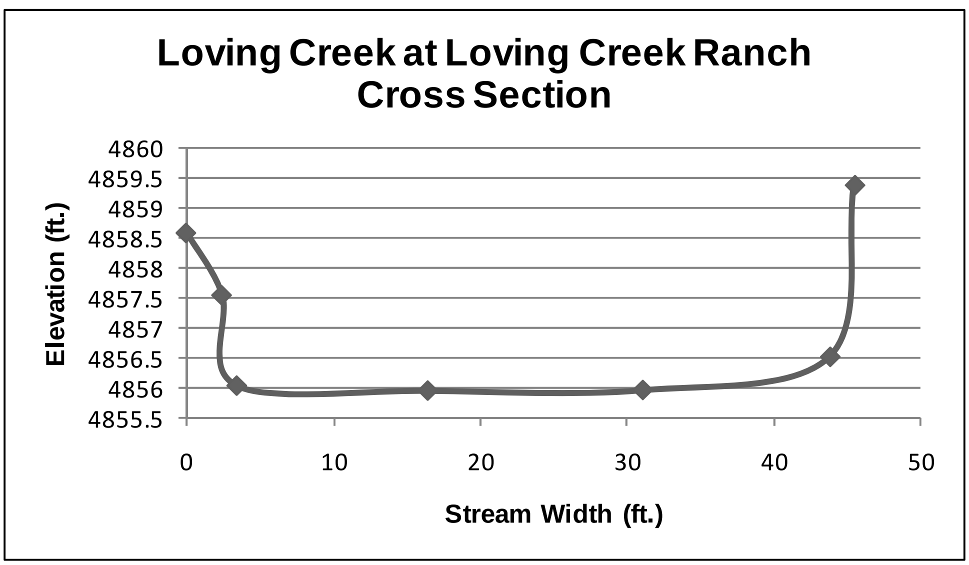

Figure 14. Cross sectional drawing of Loving Creek at Loving Creek Ranch.

Table 16. Cross sectional survey data for Loving Creek at TNC T4 monitoring site.

N (Y)	E (X)			Z (elevation)	Description
602388.61	1602980.97	0	0	4857.8892	T4 R
602388.336	1602980.96	0.2745277	0.2745277	4856.5969	EOW
602388.754	1602981.39	0.59603695	0.87056466	4855.1383	BTM BNK R
602390.167	1602988.55	7.29679876	8.16736341	4854.3623	GS
602392.195	1602995.07	6.83037921	14.9977426	4854.5693	GS
602394.968	1603003.56	8.93271532	23.9304579	4854.645	GS
602398.559	1603011.96	9.13735649	33.0678144	4854.5966	GS
602402.649	1603020.57	9.53137749	42.5991919	4854.3433	GS
602407.534	1603029.17	9.88835316	52.4875451	4854.3152	GS
602409.531	1603035.44	6.57973213	59.0672772	4854.4623	BTM BNK L
602411.748	1603038.62	3.8770054	62.9442826	4856.5152	EOW
602412.528	1603039.96	1.55233529	64.4966179	4857.3633	T4 L

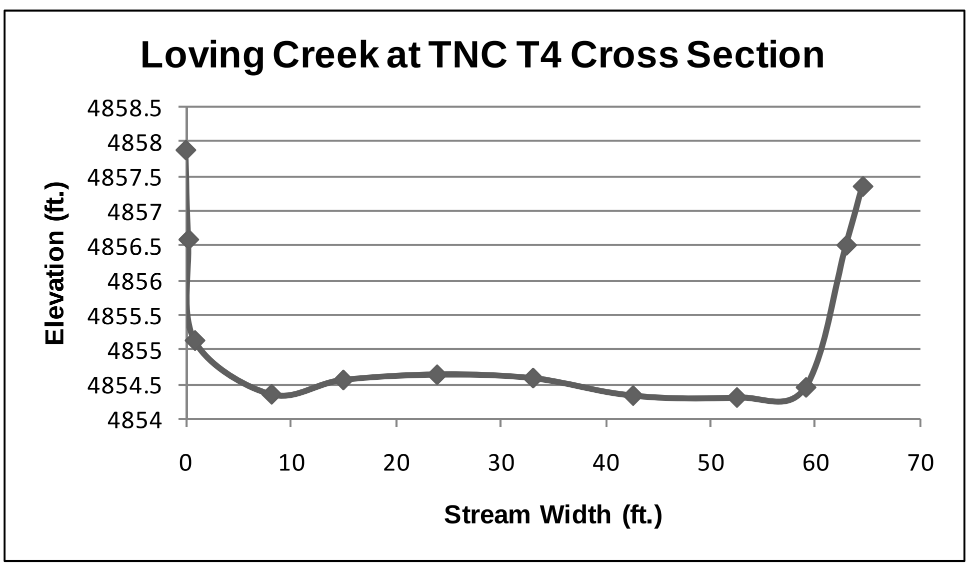

Figure 15. Cross sectional drawing of TNC T4 monitoring site.

APPENDIX B

CROSS SECTION DATA AND DRAWINGS FOR MAIN STEM SAMPLE LOCATIONS

Table 17. Cross sectional survey data for Silver Creek at TNC T2 monitoring site.

N (Y)	E (X)			Z (elevation)	Description
600426.884	1600317.6	0	0	4858.8975	T2 R
600427.701	1600318.02	0.91908403	0.91908403	4857.8563	EOW
600427.913	1600317.72	0.36692912	1.28601315	4855.8114	BTM BNK R
600431.562	1600314.86	4.63625925	5.9222724	4855.6911	GS
600439.357	1600311.53	8.47564191	14.3979143	4855.2728	GS
600444.541	1600309.87	5.44390849	19.8418228	4854.936	GS
600447.666	1600307.17	4.13177285	23.9735957	4854.8923	GS
600455.172	1600305.08	7.79055092	31.7641466	4854.8601	GS
600464.439	1600302.11	9.73113221	41.4952788	4855.3206	GS
600471.74	1600299.18	7.86514596	49.3604247	4855.5759	GS
600473.756	1600297.47	2.64453652	52.0049613	4855.6672	GS
600482.354	1600294.43	9.1193572	61.1243184	4855.5973	GS
600486.224	1600291.99	4.57412986	65.6984483	4855.7448	BTM BNK L
600487.724	1600291.47	1.58838089	67.2868292	4857.8384	EOW
600488.373	1600291.12	0.73859749	68.0254267	4859.2668	T2 L

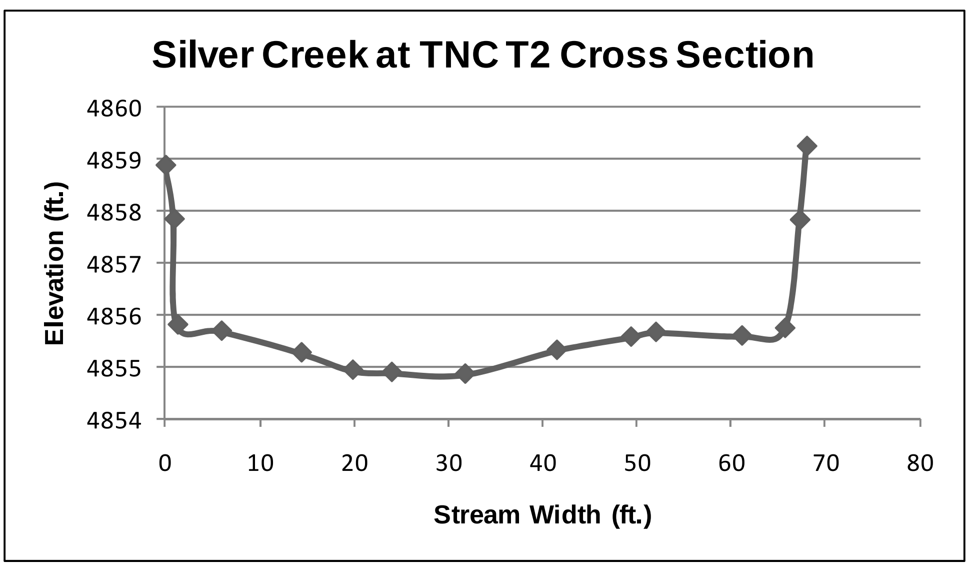

Figure 16. Cross sectional drawing of TNC T2 monitoring site.

Table 18. Cross sectional survey data for Silver Creek at TNC T3 monitoring site.

N (Y)	E (X)			Z (elevation)	Description
601138.14	1602452.13	0	0	4857.0093	T3 L
601137.567	1602449.57	2.61614233	2.61614233	4855.8307	EOW
601137.419	1602447.96	1.61641735	4.23255968	4853.7899	BTM BNK L
601133.757	1602441.41	7.50262104	11.7351807	4853.2543	GS
601132.569	1602432.69	8.80799852	20.5431792	4852.5334	GS
601130.122	1602425.94	7.1802986	27.7234778	4852.4612	GS
601123.948	1602417.31	10.6070093	38.3304872	4852.6178	GS
601122.986	1602409.01	8.36066429	46.6911514	4851.8453	GS
601118.657	1602400.38	9.65423161	56.3453831	4853.2328	GS
601119.96	1602387.46	12.9859465	69.3313295	4855.3057	BTM BNK R
601119.93	1602387.29	0.17122036	69.5025499	4855.7999	EOW
601118.908	1602385.76	1.83517504	71.3377249	4857.8063	T3 R

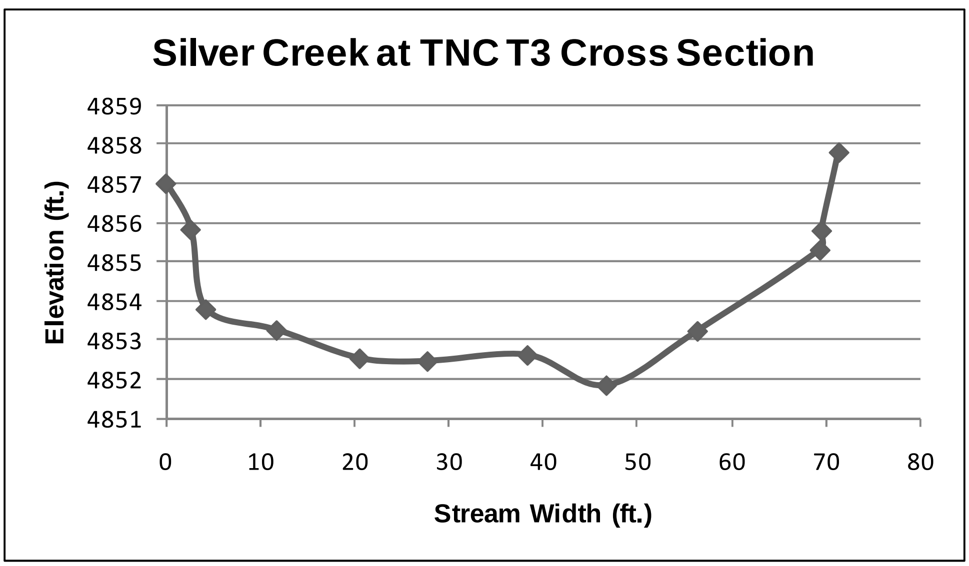

Figure 17. Cross sectional drawing of TNC T3 monitoring site.

Table 19. Cross sectional survey data for Silver Creek at Purdy's south of Highway 20.

N (Y)	E (X)			Z (elevation)	Description
599265.677	1609096.46	0	0	4848.9649	S20
599265.182	1609096.31	0.51560842	0.51560842	4848.227	EOW
599261.208	1609095.32	4.09511977	4.61072819	4846.4103	GS
599250.942	1609092.34	10.6913504	15.3020786	4845.2515	GS
599236.304	1609088.09	15.2429809	30.5450595	4845.053	GS
599221.823	1609084.45	14.9306006	45.4756601	4844.8927	GS
599201.605	1609077.24	21.4647088	66.9403689	4845.0722	GS
599181.727	1609073.35	20.2551807	87.1955497	4845.3983	GS
599165.353	1609071.01	16.5401758	103.735726	4845.4838	GS
599159.951	1609069.64	5.5746723	109.310398	4847.0487	GS
599149.715	1609073.13	10.8144511	120.124849	4847.7103	GS
599127.846	1609069.18	22.2219769	142.346826	4848.0112	EOW
599120.972	1609067.52	7.07244548	149.419271	4848.4327	S20

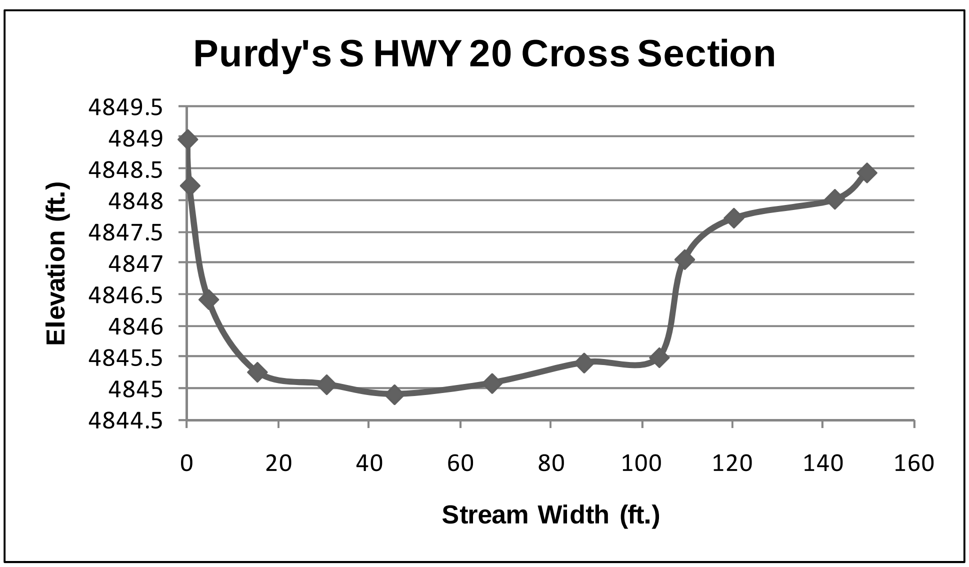

Figure 18. Cross sectional drawing of Purdy's south of Highway 20.

Table 20. Cross sectional survey data for Silver Creek at Purdy's north of Highway 20.

N (Y)	E (X)			Z (elevation)	Description
603375.418	1611551.04	0	0	4843.3871	N20
603375.06	1611550.47	0.68031335	0.68031335	4842.8471	EOW
603375.085	1611549.48	0.98172606	1.6620394	4840.5945	GS
603376.45	1611540.76	8.82532203	10.4873614	4840.6544	GS
603379.264	1611527.91	13.1576652	23.6450266	4840.3125	GS
603381.384	1611519.46	8.71166404	32.3566906	4839.7435	GS
603382.974	1611508.39	11.1876767	43.5443673	4840.4238	GS
603385.589	1611491.89	16.7034442	60.2478115	4840.692	GS
603387.598	1611483.41	8.71202632	68.9598378	4840.9671	GS
603387.848	1611482.5	0.94902949	69.9088673	4842.8994	EOW
603387.95	1611481.47	1.02797296	70.9368402	4843.7663	N20

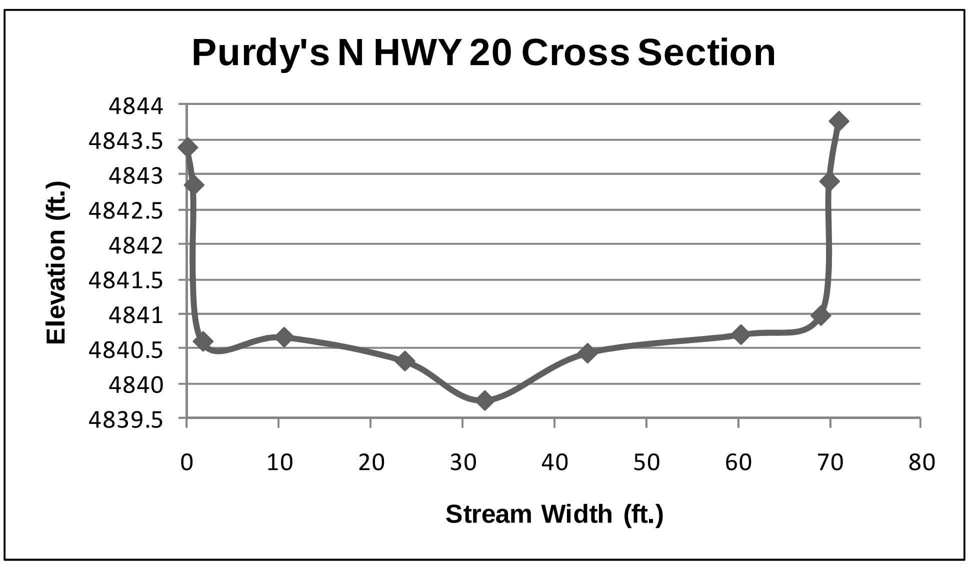

Figure 19. Cross sectional drawing of Purdy's north of Highway 20.

Table 21. Cross sectional survey data for Silver Creek at Martin's Bridge, IDFG Silver Creek West Access.

N (Y)	E (X)		Width	Z (elevation)	Description
604514.872	1611871.45	0	0	4842.8771	SCW
604510.617	1611872.62	4.41476766	4.41476766	4842.1608	EOW
604515.46	1611871.4	4.9963329	9.41110056	4841.5928	GS
604517.312	1611871.5	1.85508841	11.266189	4839.3913	GS
604542.155	1611857.16	28.6842961	39.950485	4839.4748	GS
604552.482	1611850.42	12.3315734	52.2820584	4839.4185	GS
604564.911	1611843.46	14.2466972	66.5287556	4839.8132	GS
604568.089	1611841.33	3.82653218	70.3552878	4843.081	SCW
604567.917	1611842.02	0.71259432	71.0678821	4842.2823	EOW

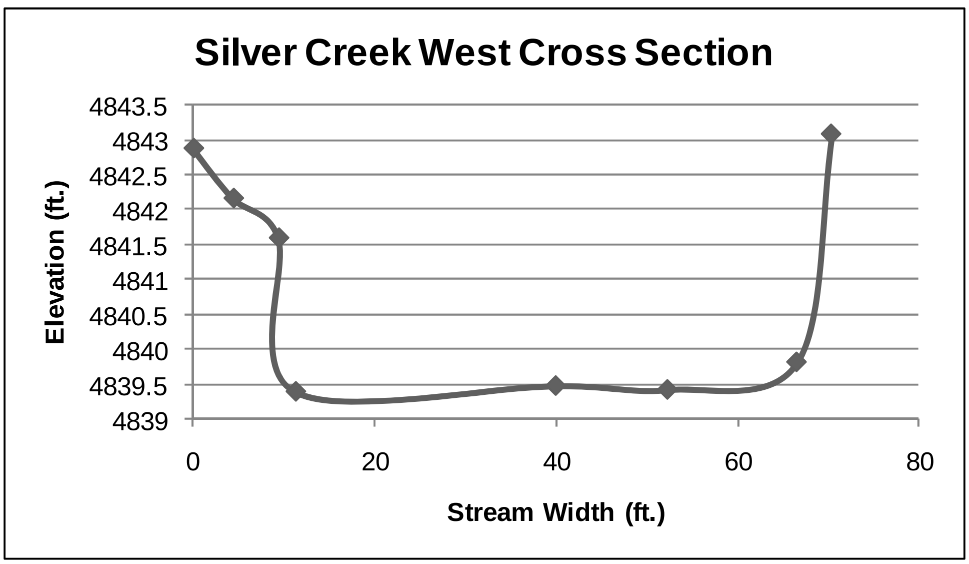

Figure 20. Cross sectional drawing of Martin's Bridge, IDFG Silver Creek West Access.

Table 22. Cross sectional survey data for Silver Creek at Point of Rocks, IDFG Silver Creek East Access.

N (Y)	E (X)			Z (elevation)	Description
606212.708	1616086.61	0	0	4837.4187	POR
606215.505	1616085.56	2.98694903	2.98694903	4836.9462	EOW
606211.115	1616087.16	4.67068797	7.65763701	4836.5628	GS
606208.224	1616089.41	3.66534085	11.3229779	4835.6473	GS
606197.622	1616093.42	11.3365724	22.6595503	4834.6309	GS
606179.149	1616104.47	21.5259042	44.1854545	4833.448	GS
606158.971	1616115.72	23.098907	67.2843615	4833.3533	GS
606141.913	1616126.51	20.1861033	87.4704648	4833.4845	GS
606135.396	1616130.54	7.66373552	95.1342003	4835.1556	GS
606133.323	1616131.99	2.52604342	97.6602437	4837.7859	POR
606131.206	1616134.36	3.18232127	100.842565	4836.9539	EOW

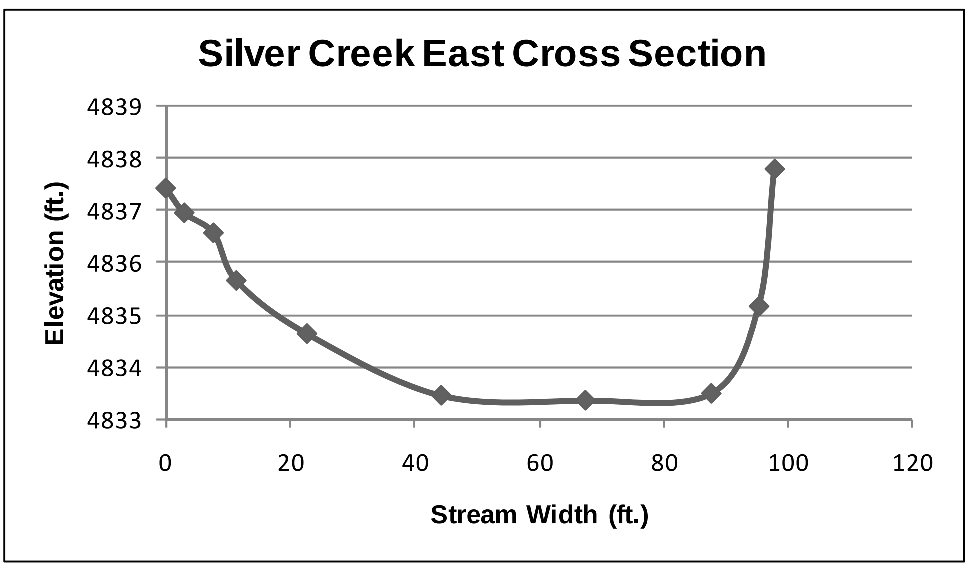

Figure 21. Cross sectional drawing of Point of Rocks, IDFG Silver Creek East Access.

Table 23. Cross sectional survey data for Silver Creek at French's downstream of bridge.

N (Y)	E (X)			Z (elevation)	Description
607617.671	1617979.4	0	0	4836.6843	FR
607626.022	1617984.45	9.7594505	9.7594505	4835.8006	EOW
607614.326	1617977.6	13.557727	23.3171775	4833.2319	GS
607597.359	1617972.37	17.7527055	41.069883	4832.3771	GS
607582.533	1617965.45	16.3648239	57.4347069	4831.898	GS
607564.581	1617957.65	19.5700709	77.0047778	4832.1794	GS
607548.517	1617951.29	17.2777208	94.2824986	4833.5214	GS
607546.359	1617950.05	2.48852835	96.7710269	4836.6514	FR
607546.928	1617949.99	0.57284173	97.3438686	4835.6431	EOW

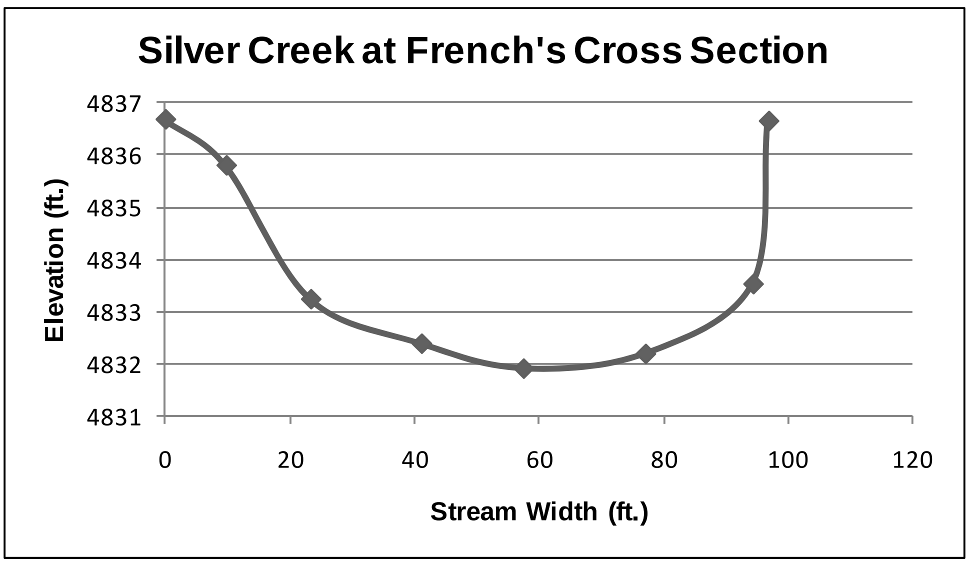

Figure 22. Cross sectional drawing of French's downstream of bridge.

Table 24. Cross sectional survey data for Silver Creek at Swanson’s.

N (Y)	E (X)			Z (elevation)	Description
596949.88	1628050.27	2.01793036	2.01793036	4827.3492	REF
596949.973	1628052.28			4825.5742	EOW
			0	4827.3492	
			1.2	4825.5742	
			2.5	4824.1078	
			5	4823.5037	
			11	4821.962	
			15	4822.5453	
			20	4823.7953	
			25	4823.024	
			30.4166	4822.2537	
			33.32	4824.523	
			33.62	4826.462	

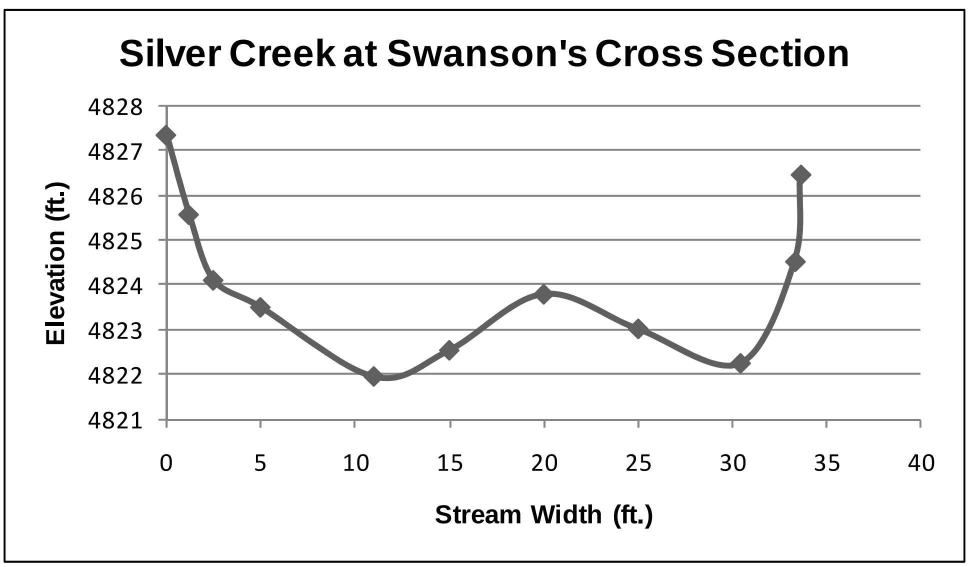

Figure 23. Cross sectional drawing of Silver Creek at Swanson’s.

APPENDIX C

ALL DATA AVERAGES

Table 25. Data averages and standard deviations for natural variables.

Location	Stream Type	Site ID	Elevation	Watershed Area	Sinuosity	K-factor	Stream slope	Catchment slope	Proximal Catchment slope
			(ft)						
Siver Creek	main	R1	4827.35	55568.77	1.80	0.02	0.22	0.01	0.44
Silver Creek	main	N2D	4859.08	35155.80	3.23	0.02	0.09	0.00	0.18
Siver Creek	main	D3D	4857.41	43694.72	1.82	0.02	0.20	0.00	0.40
Siver Creek	main	D4D	4848.70	46836.74	4.86	0.37	0.13	0.00	0.27
Silver Creek	main	D5D	4848.58	47599.89	1.53	0.37	0.10	0.00	0.19
Siver Creek	main	D6D	4842.58	47656.81	1.59	0.02	0.15	0.00	0.30
Silver Creek	main	D7D	4837.19	48265.30	1.65	0.02	0.12	0.00	0.23
Silver Creek	main	D8D	4836.16	49217.70	1.99	0.02	0.26	0.00	0.52
Average	main		4844.63	46749.47	2.31	0.11	0.16	0.00	0.32
Standard Dev	main		10.92	5750.39	1.16	0.16	0.06	0.00	0.12
Chaney Creek	tributary	R2	4875.22	510.74	1.39	0.37	0.05	0.00	0.09
Loving Creek	tributary	N1D	4858.03	6644.39	1.41	0.37	0.28	0.00	0.56
Grove Creek	tributary	N3D	4863.52	22374.87	3.14	0.37	0.05	0.00	0.10
Grove Creek	tributary	N4D	4895.59	14684.55	1.39	0.37	0.09	0.00	0.19
Wison Creek	tributary	N5D	4889.21	202.66	1.43	0.37	0.23	0.00	0.45
Stalker Creek	tributary	N6D	4866.74	10758.05	1.37	0.02	0.18	0.00	0.35
Stalker Creek	tributary	N7D	4871.33	8758.26	0.77	0.37	0.13	0.00	0.25
Mud Creek	tributary	N8D	4872.26	887.92	1.44	0.37	0.06	0.00	0.12
Grove Creek	tributary	D1D	4895.90	130.78	1.57	0.37	0.00	0.00	0.00
Loving Creek	tributary	D2D	4857.63	8400.48	1.53	0.37	0.13	0.00	0.26
Average	tributary		4874.54	7335.27	1.54	0.34	0.12	0.00	0.24
Standard Dev	tributary		14.42	7352.06	0.60	0.11	0.09	0.00	0.26

Table 26. Data averages and standard deviations for anthropogenic variables.

Location	Stream Type	Site ID	Riparian Width	Perm Crop	Annual Crop	Total Riparian	Riparian Poor	Riparian Good	Riparian Excellent
				%	%	%	%	%	%
Siver Creek	main	R1	340.99	16.53	18.08	5.28	29.94	26.89	43.21
Silver Creek	main	N2D	229.03	17.57	18.20	4.27	17.16	21.00	61.84
Siver Creek	main	D3D	12.67	16.01	19.31	4.78	21.81	28.77	49.43
Siver Creek	main	D4D	28.16	15.89	18.36	4.72	23.46	28.01	48.52
Silver Creek	main	D5D	150.85	15.88	18.86	4.65	23.52	28.08	48.43
Siver Creek	main	D6D	148.82	15.87	18.84	4.68	23.84	27.96	48.19
Silver Creek	main	D7D	69.86	15.96	19.21	4.70	23.84	27.70	48.45
Silver Creek	main	D8D	207.20	15.85	19.07	4.94	23.96	26.85	49.19
Average	main		148.45	16.19	18.74	4.75	23.44	26.91	49.66
Standard Dev	main		110.91	0.60	0.47	0.28	3.48	2.47	5.30
Chaney Creek	tributary	R2	266.06	39.26	36.22	9.66	0.00	0.00	99.99
Loving Creek	tributary	N1D	211.49	11.37	21.03	8.02	27.65	26.75	45.60
Grove Creek	tributary	N3D	97.23	12.53	23.03	1.07	12.12	0.53	87.21
Grove Creek	tributary	N4D	11.06	7.84	8.18	0.01	0.00	100.00	0.00
Wison Creek	tributary	N5D	123.00	0.00	10.63	10.50	9.44	0.00	90.58
Stalker Creek	tributary	N6D	150.22	29.23	11.08	9.19	12.62	34.85	52.53
Stalker Creek	tributary	N7D	75.28	33.16	10.38	9.11	14.50	34.46	51.04
Mud Creek	tributary	N8D	173.98	12.31	26.89	13.34	45.75	0.00	54.25
Grove Creek	tributary	D1D	29.78	0.00	0.00	5.00	100.06	0.00	0.00
Loving Creek	tributary	D2D	180.94	9.87	24.24	6.46	35.49	51.03	13.48
Average	tributary		131.90	15.56	17.17	7.23	25.76	24.76	49.47
Standard Dev	tributary		80.53	13.63	10.84	4.18	30.00	32.64	36.37

Table 27 (Continued). Data averages and standard deviations for anthropogenic variables.

Location	Stream Type	Site ID	Developed	Other	Range	All Ag	All Human	Structure Density	Road Density	Pivot Density
			%	%	%	%	%			
Siver Creek	main	R1	3.54	6.29	50.29	34.61	38.15	0.01	0.43	0.00
Silver Creek	main	N2D	5.33	7.40	47.23	35.77	41.10	0.01	0.35	0.00
Siver Creek	main	D3D	3.37	7.68	48.85	35.32	38.69	0.02	0.39	0.00
Siver Creek	main	D4D	3.21	7.19	50.63	34.24	37.46	0.01	0.39	0.00
Silver Creek	main	D5D	3.23	7.08	50.30	34.74	37.97	0.01	0.40	0.00
Siver Creek	main	D6D	3.23	7.08	50.31	34.71	37.94	0.01	0.40	0.00
Silver Creek	main	D7D	3.20	7.07	49.87	35.17	38.37	0.01	0.41	0.00
Silver Creek	main	D8D	3.18	7.03	49.93	34.92	38.10	0.01	0.41	0.00
Chaney Creek	tributary	R2	0.46	14.43	0.00	75.48	75.94	0.00	0.92	0.00
Average	main		3.19	7.91	44.16	39.44	42.63	0.01	0.46	0.00
Standard Dev	main		1.23	2.47	16.59	13.52	12.53	0.00	0.17	0.00
Loving Creek	tributary	N1D	2.45	10.00	47.13	32.40	34.85	0.02	0.52	0.00
Grove Creek	tributary	N3D	4.58	4.42	54.36	35.57	40.15	0.02	0.32	0.00
Grove Creek	tributary	N4D	0.79	0.35	82.83	16.02	16.81	0.00	0.31	0.00
Wison Creek	tributary	N5D	1.93	76.76	0.00	10.63	12.57	0.04	0.61	0.00
Stalker Creek	tributary	N6D	1.16	12.70	36.63	40.31	41.47	0.01	0.73	0.00
Stalker Creek	tributary	N7D	0.97	9.66	36.72	43.54	44.51	0.01	0.67	0.00
Mud Creek	tributary	N8D	2.36	45.08	0.00	39.20	41.56	0.01	1.24	0.00
Grove Creek	tributary	D1D	9.64	85.17	0.00	0.00	9.64	0.22	2.49	0.00
Loving Creek	tributary	D2D	2.79	8.27	48.38	34.10	36.89	0.02	0.52	0.00
Average	tributary		2.96	28.05	34.01	27.98	30.94	0.04	0.82	0.00
Standard Dev	tributary		2.76	32.68	28.85	15.25	13.85	0.07	0.68	0.00

Table 28. Data averages and standard deviations for instream variables.

Location	Stream Type	Site ID	Width		Average Depth		Maximum Depth		Width : Depth Ratio		Sediment Depth	
			average (ft)	stnd dev	average (ft)	stnd dev	average (ft)	stnd dev	average	stnd dev	average (ft)	stnd dev
Siver Creek	main	R1	35.67	4.766	3.25	0.49	4.15	0.74	10.98	2.829	0.98	0.716
Silver Creek	main	N2D	97.32	26.178	2.37	0.48	2.92	0.47	41.15	14.979	0.71	0.663
Siver Creek	main	D3D	89.72	36.513	2.52	0.40	3.15	0.90	35.60	13.671	0.51	0.384
Siver Creek	main	D4D	124.23	26.284	2.58	0.24	2.67	0.15	48.15	15.181	1.39	0.312
Silver Creek	main	D5D	68.13	1.625	2.17	0.36	3.27	0.39	31.33	5.670	0.90	0.462
Siver Creek	main	D6D	57.39	3.459	2.33	0.40	3.23	0.23	24.63	5.299	0.70	0.146
Silver Creek	main	D7D	104.65	14.534	2.50	0.53	4.12	0.42	41.89	3.971	0.68	0.310
Silver Creek	main	D8D	74.42	12.318	2.95	0.27	1.78	0.78	25.19	6.669	0.93	0.196
Average	average		**81.44**	15.71	**2.58**	0.40	**3.16**	0.51	**32.36**	8.53	**0.85**	0.40
Chaney Creek	tributary	R2	18.21	4.623	0.94	0.04	1.26	0.29	19.38	5.047	0.00	0.000
Loving Creek	tributary	N1D	41.97	17.900	1.58	0.36	1.98	0.18	26.63	6.248	0.70	0.466
Grove Creek	tributary	N3D	76.49	6.780	1.03	0.22	1.33	0.20	74.53	22.251	0.68	0.603
Grove Creek	tributary	N4D	10.57	3.371	0.89	0.32	1.12	0.36	11.90	4.858	0.00	0.000
Wison Creek	tributary	N5D	39.53	17.728	1.25	0.23	2.13	0.94	31.54	15.851	0.59	0.282
Stalker Creek	tributary	N6D	33.00	5.372	1.12	0.20	1.62	0.14	29.46	0.696	0.76	0.667
Stalker Creek	tributary	N7D	66.57	3.655	2.45	0.86	3.24	0.72	27.17	8.419	0.83	1.100
Mud Creek	tributary	N8D	19.70	1.530	1.97	0.25	2.60	0.88	10.01	1.676	0.66	0.131
Grove Creek	tributary	D1D	48.09	14.497	0.31	0.06	0.47	0.24	156.85	12.730	0.00	0.152
Loving Creek	tributary	D2D	65.67	10.659	1.23	0.04	3.35	0.10	53.43	35.638	0.83	0.000
Average	average		**41.98**	8.61	**1.28**	0.26	**1.91**	0.41	**44.09**	11.34	**0.51**	0.34

Table 29 (Continued). Data averages and standard deviations for instream variables.

Location	Stream Type	Site ID	D : Sed Depth		Veg thick		Percent Vegeation		Percent Gravels		Percent Sediment	
			average	stnd dev	average (ft)	stnd dev	average %	stnd dev	average %	stnd dev	average %	stnd dev
Siver Creek	main	R1	3.31	0.422	0.00	0.000	0.00	0.000	48.00	24.644	52.00	24.644
Silver Creek	main	N2D	3.31	1.316	0.62	0.435	43.94	7.598	31.82	16.311	24.24	23.535
Siver Creek	main	D3D	4.99	1.959	0.44	0.311	42.50	11.986	38.75	11.878	18.75	3.617
Siver Creek	main	D4D	1.86	0.262	0.53	0.070	34.85	3.245	12.12	3.883	53.03	5.209
Silver Creek	main	D5D	2.42	1.697	0.69	0.162	75.00	10.846	12.50	5.494	12.50	12.509
Siver Creek	main	D6D	3.31	0.383	0.47	0.279	56.82	7.217	34.09	1.033	9.09	8.250
Silver Creek	main	D7D	3.65	1.178	0.49	0.165	72.73	15.891	18.18	21.311	9.09	9.553
Silver Creek	main	D8D	3.19	0.577	0.00	0.124	76.92	9.547	1.92	3.307	21.15	6.292
Average	average		**3.25**	0.97	**0.40**	0.19	**50.34**	8.29	**24.67**	10.98	**24.98**	11.70
Chaney Creek	tributary	R2	0.00	0.000	0.05	0.282	13.33	12.583	86.67	12.583	0.00	0.000
Loving Creek	tributary	N1D	2.24	1.801	0.75	0.198	71.11	1.627	6.66	12.238	22.22	10.999
Grove Creek	tributary	N3D	1.50	0.590	0.15	0.218	10.20	8.145	57.14	41.449	32.65	42.544
Grove Creek	tributary	N4D	0.00	0.000	0.00	0.000	40.65	0.000	59.38	0.000	0.00	0.000
Wison Creek	tributary	N5D	2.13	0.698	0.15	0.089	41.38	11.666	10.34	15.486	48.28	25.014
Stalker Creek	tributary	N6D	1.47	0.652	0.00	0.000	0.00	0.000	68.75	25.220	31.25	25.220
Stalker Creek	tributary	N7D	2.94	2.826	0.96	0.846	39.58	14.402	37.50	25.214	22.92	16.722
Mud Creek	tributary	N8D	2.97	0.774	0.34	0.079	58.33	14.434	16.67	7.217	25.00	12.500
Grove Creek	tributary	D1D	0.00	0.251	0.07	0.000	0.00	0.000	100.00	14.260	0.00	14.260
Loving Creek	tributary	D2D	1.48	0.000	0.53	0.060	0.00	17.472	15.09	17.472	84.91	0.000
Average	average		**1.47**	0.906	**0.30**	0.255	**27.459**	6.985	**45.82**	11.400	**26.72**	13.595