Resident Fish Stock Status Above Chief Joesph and Grand Coulee Dams

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Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams 2002 Annual Report

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Table of Contents

Executive Summary

In 1980, the United States Congress enacted the Northwest Power Planning and Conservation Act (PL 96-501, 1980), which established the Northwest Power and Conservation Council (NPCC), formerly the Northwest Power Planning Council. The NPCC was directed by Congress to develop a regional Power Plan and also the Columbia River Basin Fish and Wildlife Program (FWP) to restore or replace losses of fish caused by construction and operation of hydroelectric dams in the Columbia River Basin. In developing the FWP, Congress specifically directed NPCC to solicit recommendations for measures to be included in the Program from the region's fish and wildlife agencies and Indian tribes. All measures adopted by the Council were also required to be consistent with the management objectives of the agencies and tribes [Section 4.(h)(6)(A)], the legal rights of Indian tribes in the region [Section 4.(h)(6)(D)] and be based upon and supported by the best available scientific knowledge [Section 4.(h)(6)(B)]. The Resident Fish Stock Status above Chief Joseph and Grand Coulee Dams Project, also known as the Joint Stock Assessment Project (JSAP) specifically addresses NPPC Council measure 10.8B.26 of the 1994 program.

The Joint Stock Assessment Project is a management tool using ecosystem principles to manage artificial fish assemblages and native fish in altered environments existing in the Columbia River System above Chief Joseph and Grand Coulee Dams (Blocked Area). A three-phase approach of this project will enhance the fisheries resources of the Blocked Area by identifying data gaps, filling data gaps with research, and implementing management recommendations based on research results. The Blocked Area fisheries information is housed in a central location, allowing managers to view the entire system while making decisions, rather than basing management decisions on isolated portions of the system.

The JSAP is designed and guided jointly by fisheries managers in the Blocked Area. The initial year of the project (1997) identified the need for a central data storage and analysis facility, coordination with the StreamNet project, compilation of Blocked Area fisheries information, and a report on the ecological condition of the Spokane River System. These needs were addressed in 1998 by acquiring a central location with a data storage and analysis system, coordinating a pilot project with StreamNet, compiling fisheries distribution data throughout the

Blocked Area, identifying data gaps based on compiled information, and researching the ecological condition of the Spokane River.

In order to ensure that any additional information collected throughout the life of this project will be easily stored and manipulated by the central storage facility, it was necessary to develop standardized methodologies between the JSAP fisheries managers. Common collection and analytical methodologies were developed in 1999. In 1999, 2000, and 2001 the project began addressing some of the identified data gaps throughout the Blocked Area. Data collection of established projects and a variety of newly developed sampling projects are ongoing.

Projects developed and undertaken by JSAP fisheries managers include investigations of the Pend Orielle River and its tributaries, the Little Spokane River and its tributaries, and water bodies within and near the Spokane Indian Reservation. Migration patterns of adfluvial and reservoir fish in Box Canyon Reservoir and its tributaries, a baseline assessment of Boundary Reservoir and its tributaries, ecological assessment of mountain lakes in Pend Oreille County, and assessments of streams and lakes on the Spokane Indian Reservation were completed by 2001. Assessments of the Little Spokane River and its tributaries, tributaries to the Pend Oreille River, small lakes in Pend Oreille County, WA, and water bodies within and near the Spokane Indian Reservation were conducted in 2002. This work was done in accordance with the scope of work approved by Bonneville Power Administration (BPA).

Introduction

The area currently known as the Blocked Area was a highly productive, stable ecosystem prior to hydroelectric development (Scholz et al. 1985). This area contained healthy, native, self-sustaining populations of resident fish, wildlife, and anadromous fish. The native fish assemblage consisted of resident salmonids (trout, whitefish, char), anadromous salmonids (salmon, steelhead), catostomids (suckers), and cyprinids (minnows) very well adapted to pristine riverine conditions.

The amount of the anadromous fish resources was enormous throughout pre-dam history (Scholz et al. 1985, Osterman 1995, and Hewes 1973). Scholz et al. (1985) conservatively estimated the total salmon and steelhead escapement above the current Grand Coulee Dam location was between 1.1 million and 1.9 million fish annually. This estimate was calculated after Upper Columbia stocks targeted by lower river fisheries had been harvested, thus the anadromous fish production in the Upper Columbia was far greater than estimated escapements. This abundant resource supported the Upper Columbia ecosystem by transporting nutrients back to the Upper Columbia. The large nutrient transport by anadromous fish to the Upper Columbia played a functional role in supporting resident fish, wildlife, riparian communities, and human populations, thus making anadromous fish the keystone component (Willson and Halupka 1995; Cederholm et al. 1989; Kline et al. 1989; and Mills et al. 1993) in the Upper Columbia System. Anadromous fish provided 18,000,000 pounds annually to an Indian population of 50,000 individuals (Scholz et al. 1985).

The resident fish population was also very abundant in the Upper Columbia area (Scholz et al. 1985, Osterman 1995, and Bonga 1978). For example, in a U.S. Fish Commission Survey, Bean (1894) and Gilbert and Evermann (1895) noted that cutthroat trout and mountain whitefish were abundant in the Spokane River System. Gilbert and Evermann (1895) also noted that bull trout were abundant in the Pend Oreille River in an 1894 survey of that stream. To provide an idea of the numbers of resident trout found in these systems Lt. Abercrombie (U.S. Army) reported that a party of three anglers caught about 450 cutthroat trout in one afternoon fishing on the Spokane River near the City of Spokane Falls in August, 1877 (Scholz et al. 1985). Indian people harvested an estimated 153,000 resident fish accounting for 360,000 pounds of resident fish annually (Scholz et al. 1985).

The construction of Grand Coulee Dam eliminated over 1,140 linear miles of anadromous fish spawning and rearing habitat in the Upper Columbia River System (Scholz et al. 1985). In addition to the blockage and loss of habitat, dams and impoundments have created vast changes in the environment. Free-flowing rivers with rapids and gravel bars for spawning and incubation have been replaced with a series of reservoirs and impoundments. These severe habitat alterations have created habitat conditions more suitable for non-native species than for native species. This condition has allowed non-native species to thrive, effectively displacing native species.

The fish assemblage existing today in the Blocked Area is drastically different than pre-dam development. Anadromous fish, the keystone component of the Upper Columbia, are extinct due to the construction of Grand Coulee Dam. At least thirty-six (36) resident fish species are currently known to exist in the Blocked Area, the majority of which are not native. This largely non-native assemblage is, in part, the product of authorized and unauthorized introductions. Of the remaining native resident species, bull trout (*Salvelinus confluentus*) are listed as threatened under the Endangered Species Act (1973), and westslope cutthroat trout (*Oncorhynchus clarki lewisi*) are currently under court ordered status review for listing.

Westslope cutthroat trout were originally petitioned for listing in 1997. The U. S. Fish and Wildlife Service determined, in 2000, that listing was not warranted. The subspecies were found to inhabit 23,000 linear miles of stream habitat in 4275 tributaries, distributed among 12 major drainages and 62 watersheds throughout their historic range (U. S. Fish and Wildlife Service 2000). For the purpose of the status review, westslope cutthroat trout were evaluated on the basis of present stocks, regardless of their genetic characteristics. Westslope cutthroat are known to hybridize with other cutthroat subspecies and rainbow trout, and genetically pure westslope cutthroat are estimated to exist on only 2-4% of their historic range (McIntyre and Rieman 1995). Determining the distribution of genetically pure westslope cutthroat stocks and levels of introgression and hybridization is the focus of the current status review.

Dynamics of the current system have been developing over the last five decades, and have not reached equilibrium. Although recent research has began to focus on resident species, managers today are still unclear on ecological conditions of the system and distribution and range of many of the 36 known resident species.

Fish managers are charged with providing subsistence and recreational fisheries in the Blocked Area given historical expectations and current environmental conditions. This task is extremely unique in that nearly every variable throughout the system is artificial from the species assemblage, to the available habitats, to river level fluctuations. The JSAP has been designed to function as a tool for Blocked Area fish managers. This tool will focus on understanding the dynamics of fish and their habitats throughout the Blocked Area and recommend management action based on the best available science and the condition of the entire Blocked Area ecosystem. The JSAP allows managers to view the Blocked Area as a system by compiling previously collected data, organizing available data, identifying areas needing data, performing necessary research, and recommending management actions.

Information gathered by other projects has been provided to the JSAP for synthesis. Synthesized information consists of habitat information, fish distribution information, stocking histories, and results of enhancement monitoring and evaluations. Managers using synthesized information for recommendations depend on the JSAP to provide accurate and precise synthesis of available information. Likewise, the JSAP depends on quality data collection procedures used by individual projects. Thus, the symbiotic relationships between projects have positive synergistic effects on successful implementation of management actions in the Blocked Area by making the best available science available.

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Kalispel Tribe of Indians

Annual Report

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Table of Contents

List of Tables

List of Figures

Introduction

During field season 2002, the Kalispel Natural Resource Department (KNRD) conducted fish and habitat inventories of eight tributaries within the Pend Oreille River watershed. KNRD, in cooperation with Eastern Washington University Department of Biology, conducted fishery and productivity investigations of six lakes in Pend Oreille County, WA (Appendix 1). The focus of these inventories was a compilation of the baseline habitat conditions and status of resident fish stocks in the Pend Oreille River watershed in Pend Oreille County, WA.

The following report summarizes the results of data collection activities in the eight tributaries and six lakes (Figure 1 and Figure 2), with recommendations, habitat enhancement opportunities, and further research needs. A summary of database integration, GIS development, coordination, data sharing, and standardization activities appears in Appendix 2.

Study Area

Eight tributary streams and five lakes within the Lower Pend Oreille River watershed in Pend Oreille County, Washington were surveyed in 2002 (Figure 1 and Figure 2). Cusick, Trimble, and Bracket creeks flow into the Box Canyon Reservoir of the Pend Oreille River from the west (locations of each confluence were Township 34 North, Range 43 East, Section 13, Township 33 North, Range 43 East, Section 11, and Township 32 North, Range 44 East, Section 27, respectively). Drainage basin areas of these three streams are 2494 hectares (ha), 2662 ha, and 921 ha, respectively. Split Creek, a tributary to North Skookum Lake (Township 34 North, Range 44 East, Section 36), has a drainage basin area of 578 ha. Lodge, West Lodge, and an unnamed tributary to Bead Lake are located on the north end of Bead Lake (Township 33 North, Range 45 East, Section 34) and have a combined drainage basin area of 521 ha. Burnt Creek, a tributary to Marshall Lake (Township 32 North, Range 45 East, Section 24), has a drainage basin area of 455 ha.

Fishery and productivity investigations were conducted in North Skookum, South Skookum (Township 33 North, Range 44 East, Section 31), Conger (Township 33 North, Range 43 East, Section 4), Davis (Township 32 North, Range 44 East, Section 31), Mountain Meadows (Township 31 North, Range 44 East, Section 10), and Power Lakes (Township 32 North, Range 43 East, Section 28). Lakes ranged in size from 2.1 ha surface area with a maximum depth of 3 m in Conger Lake to 67 ha surface area and maximum depth of 44 m in Davis Lake (Appendix 1).

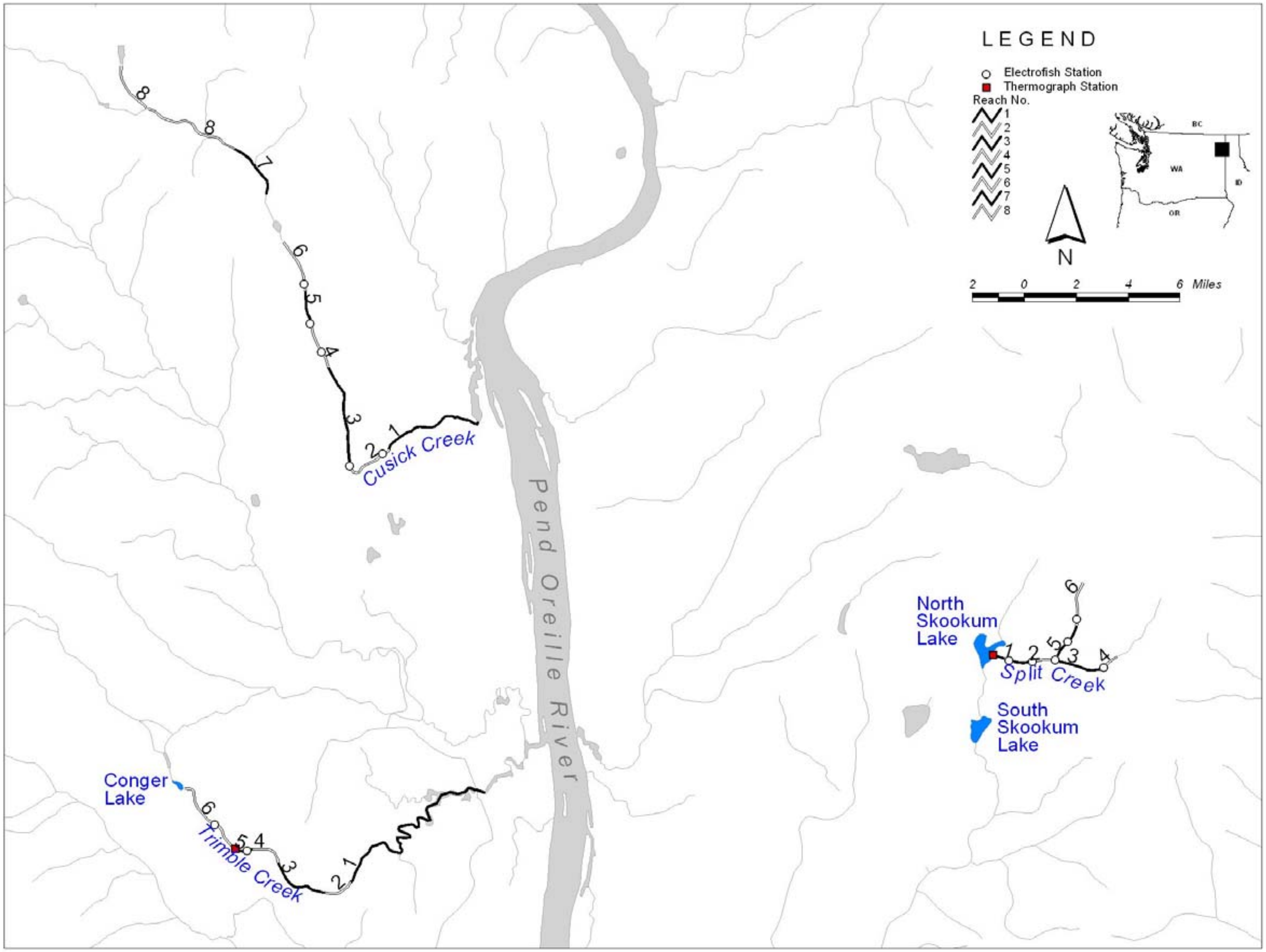

Figure 1. Map of northern portion of the study area showing lakes, stream reaches, electrofishing stations, and thermograph locations.

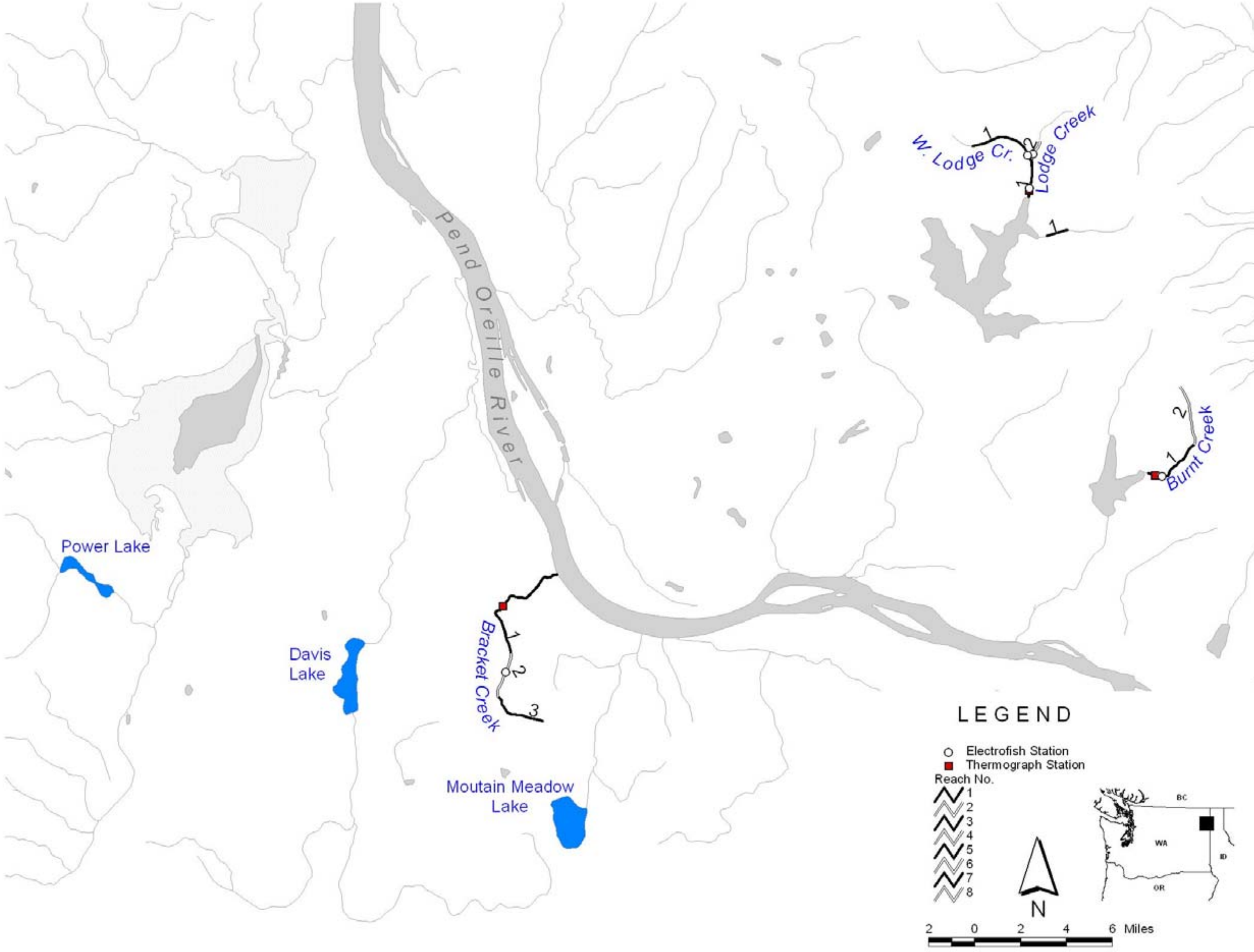

Figure 2. Map of southern portion of the study area showing lakes, stream reaches, electrofishing stations, and thermograph locations.

Methods

Stream Habitat Surveys

Each stream was stratified into homogeneous reaches. Reaches were defined as portions of streams with similar gradient and morphological characteristics. Rosgen's system (Rosgen 1994) was used to classify stream reaches. The Joint Stock Assessment Project (JSAP) stream habitat survey methodology (modified from Kalispel Natural Resource Department stream survey methodology, 1997; WDFW et al. 2002) consisted of two parts, reach variable measurements and transect measurements.

Reach variable measurements were those that were measured for the entire length of the reach and included air and water temperature, stream channel gradient, acting large woody debris (LWD), primary pools, and bank stability (Table 1). Primary pool and LWD counts were used to calculate mean densities per reach, as well as the entire stream. Densities were reported as the number of primary pools per kilometer (km) and the number of LWD per 100 meters (m). A primary pool was defined as a pool that was longer or wider than the mean wetted width of the stream. The length (0.1 m), width (0.1 m), maximum depth (centimeter; cm), and tailout depth (cm) were measured in each primary pool (KNRD 1997). The residual pool depth was calculated by summing the maximum and tailout depths and dividing by two.

Acting LWD consisted of any stable piece of organic debris with a diameter > 10 cm and a length > 1 m that intruded into the stream (KNRD 1997). Exposed root wads of live trees were not counted unless they intruded into the stream channel and provided habitat. Large debris dams causing one particular effect on the stream were counted as a single piece of LWD (KNRD 1997). Stream channel gradient was defined as the change in vertical elevation per unit horizontal distance of the channel (Platts et al. 1983; KNRD 1997). Gradient (%) was measured with a clinometer (Suunto Corp.™). Bank stability (%) was calculated by summing unstable bank measurements (m) and dividing by reach length, then subtracting from 100. Air and water temperatures were measured (˚C) at the beginning of each reach.

Table 1. Reach variables and method of collection.

Variables	**Method of Collection**
Air and Water Temperature	Thermometer reading in Celsius taken at the beginning of each reach.
Channel Type	A general classification of channel type based on channel morphology (see Rosgen 1994).
Gradient	Measured with a clinometer, at each transect.
Acting Large Woody Debris	Number of woody debris with a diameter >10cm and a length >1m in the stream.
Primary Pools	Count of number of pools with length or width greater than the avg. width of stream channel within each transect. Measure length (m), maximum depth (cm), and tailout depth (cm).
Bank Stability	Visual estimate of the length in meters of unstable bank per transect for possible sediment sources.

Transect measurements were oriented perpendicular to the stream flow; distance between transects was 60 m. The 60 m interval was measured with a hip chain while walking upstream. Transect parameters included habitat type, habitat width, wetted width, mean depth, maximum depth, percent composition of each dominant substrate type, and estimated percent embeddedness (Table 2). Mean values and standard deviations of each habitat parameter were calculated for each reach and stream.

Habitat types were divided into three categories, pool, riffle, and run. Pools were defined as portions of the stream with reduced current velocity and maximum depths two times greater than the tailout depth (WDFW et al. 2002). A riffle was a shallow rapid where the water flowed swiftly over completely or partially submerged obstructions to produce surface agitation (KNRD 1997). Runs were stream segments with intermediate characteristics between pools and riffles (Platts et al. 1983).

The wetted width of a stream was defined as the distance from the edge of the water on each shoreline, perpendicular to the flow of the stream. If the channel was braided, the wetted width of each braid was measured and summed to provide a total wetted width. Wetted width was measured to the nearest tenth of a meter.

Mean stream depth was determined by summing the depth measurements (cm) taken at ¼, ½, and ¾ the wetted width along the transect line and dividing them by four to account for the zero depth values at each shoreline (Platts et al. 1983). Maximum stream depths (cm) (Thalwag depth) were measured at each transect.

The dominant substrate type was determined for each habitat segment along the transect line (Table 3). The percent embeddedness, defined as the percentage of the surface area of larger substrate particles (gravel, cobble, rubble, and boulder) that were surrounded by fine particles (coarse sand and smaller; <0.6 cm) (Platts et al. 1983), of each substrate type was visually estimated along the transect line.

Table 2. Transect Variables and method of collection.

Variable	**Method of collection**
Habitat Type	Visually determine habitat types (i.e., pool, riffle, run).
Habitat Widths	Measure each specific habitat type in a transect to the nearest 0.1m.
Wetted Width	Sum of all habitat type widths along the transect line.
Mean Depth	Measure of depth at 1/4, 1/2, 3/4 across channel to the nearest cm.
Maximum Depth (Thalwag)	Maximum stream depth measured along each transect. The Thalwag is defined as the line connecting the deepest points along the streambed (Hunter 1991).
Dominant Substrate Size	Visually determine largest percentage of substrate for that habitat type (i.e., silt, sand, gravel, cobble, boulder, bedrock).
Substrate Embeddedness	Visual estimate of the percentage fine or coarse sediment surrounding larger substrates.

Table 3. Description of substrate classification used for stream habitat assessments (modified from KNRD 1997).

Substrate Type	Description
Bedrock	Large masses of solid rock
Boulder	>30.5 cm (>12.0 in.)
Rubble	15.2 - 30.5 cm (6.0 in. - 12.0 in.)
Cobble	7.6 - 15.2 cm (3.0 in. - 6.0 in.)
Gravel	0.6 - 7.6 cm (0.25 in. - 3.0 in.)
Sand	<0.6 cm (<0.25 in.)
Silt	Fine sediments with little grittiness.
Muck	Decomposed organic material, usually black in color.
Organic Debris	Undecomposed herbaceous material.

In addition to measuring transect and reach parameters, a summary was written for each reach. The purpose of this overview was to provide qualitative information on the general habitat conditions of the reach and describe any unique features, impacts, or attributes. Recorded in the reach overview were notable disturbances such as logging, erosion sources, livestock grazing impacts, road encroachment, etc. Road culverts were recorded and mapped on USGS topographic maps or GPS. The percentage of aquatic vegetation cover and overhead canopy cover were estimated. Potential limiting factors and enhancement opportunities were described. Fish passage barriers were recorded and mapped on USGS topographic maps or GPS.

Attributes of potential barriers were assessed relative to fish species and size present as well as stream size. Jump height, velocity, and water depth restrictions will limit passage of fish relative to their size. Barriers were identified as potential, temporal/seasonal, and definite (WDFW et al. 2002). Natural fish barriers were described as falls or chutes (Powers and Orsborn 1985). Falls were vertical overflow portions of the stream and chutes were defined as steep, sloping, open channels with high velocities (Orsborn and Powers 1985). Human-made barriers consisted of culverts and dams. A falls or culvert was determined to be a potential barrier if it had a vertical jump height > 0.9 m, which would prevent passage of most smaller resident species. Vertical jump heights > 3.4 m were considered definite barriers, which exceeded the maximum leaping height of the healthiest steelhead (610-792 mm TL) with a maximum burst speed of 8.1 m/s (26.5 ft/s) (Powers and Orsborn 1985). We assumed the swimming abilities of steelhead exceeded those of resident trout (McLellan and O'Connor 2003). A good takeoff pool is required for fish to leap any height, so a relatively low fall without a good take off pool may act as a total barrier (Powers and Orsborn 1985).

Stream flow, in cubic feet per second (cfs), was measured using methods similar to the midsection method developed by USGS (WDFW et al 2002). Discharge (Q; cfs) was measured with a Pygmy flow meter, and converted to m^3/s.

Stream temperatures (^oC) were monitored with Tidbit® temperature loggers (Onset Corp., MA) between 24 June and 7 October 2002. Temperatures were recorded hourly. The loggers were enclosed in camouflaged PVC tubes and attached to logs, rocks, or root wads on the stream bottom, out of direct sunlight. Loggers were placed at practical locations near the start of the first reach surveyed in each stream.

Stream Fish Sampling

Fish population data were collected using multiple pass depletion electrofishing sampling techniques (Murphy and Willis 1996, Heimbuch et al. 1997). Daytime sampling was conducted during the period from 26 August through 18 November 2002. One 100 m electrofishing station was established per reach, and selected to be representative of the reach. Block nets were set at the upstream and downstream boundaries to prevent immigration and emigration during the sampling period (Zippen 1958). Upon capture fish were transferred to 5-gallon holding containers of stream water until processed. Fish were anesthetized with Tricaine-S brand tricaine methanesulfonate (MS-222) (Western Chemical Inc., Ferndale, WA) prior to identification, measuring total length (TL) (mm), and weighing (g). All fish over 100 mm TL were weighed on an Ohaus electronic scale. Once fish were processed they were held in 5-gallon containers filled with stream water until fully recovered and returned to the stream.

Life history and population data were addressed by species composition, relative abundance, size (age class), and density (fish per 100 m^2). Population estimates were obtained using the MicroFish 2.2 Interactive Program, the interactive version of "Fisheries Population and Statistical Package" (Van Deventer and Platts 1986). The program uses the maximum likelihood population estimation model developed by Dr. Kenneth Burnham of North Carolina State University (Van Deventer and Platts 1985), and Zippin's (1958) removal-depletion strategy assumptions. Fish < 50 mm have been reported to pass through the mesh of blocknets (McLellan and O'Connor2003), and were excluded from the population estimates.

Fish densities were calculated by dividing the population estimate by the total sample area (100 m x mean stream width). This density was multiplied by 100 to yield number of fish per 100 m^2. For some species within stream reaches, Microfish 2.2 population estimates were not reliable due to low or variable capture probability, or non-descending removal pattern. In these cases actual capture numbers were used instead of population estimates to calculate densities.

A small fin tissue sample was extracted from cutthroat trout sampled in Burnt Creek. Samples were stored in absolute ethanol and sent to the WDFW Genetics Laboratory for microsatellite DNA analysis.

Lake Fish Sampling

In 2002, baseline fishery assessments were conducted in Conger, Davis, Mountain Meadows, Power, and North and South Skookum Lakes. The objectives of these sampling efforts were determination of species composition, relative abundance, and catch per unit effort (CPUE). The littoral zone was sampled with horizontal gillnets set in all lakes for a duration no longer than four hours. In addition, boat electrofishing and vertical gillnets were used in Davis Lake.

A total of four horizontal experimental monofilament gillnets, two floating and two sinking, were set in each lake except Mountain Meadows and Conger Lakes. Three gillnets were set in Mountain Meadows Lake and one was set in Conger Lake. Water depth limitations and abundant aquatic vegetation prevented full sampling of these lakes.

Horizontal gillnets were set perpendicular to shore at systematically selected sites. Systematic sampling was chosen over a simple random sampling strategy because the lakes, with the exception of Davis Lake, were typically small (< 16 hectares surface area), shallow (< 6 meters maximum depth), and had sunken timber and other obstacles along the shoreline. Nets measured 2.44 m by 60.96 m with four 15.24 m panels each with different square mesh sizes (1.27, 2.54, 3.81, and 5.08 cm, respectively). The smallest mesh size was set closest to shore.

Electrofishing of the littoral zone in Davis Lake was conducted with a Smith-Root 5.0 GPP electrofishing boat. The shoreline was divided into ten 400 m transects, of which 50% were randomly selected for sampling. Standardized 600-second electrofishing passes were conducted with pulsed DC current (30 pulses per second) with low voltage (50-500) and the range adjusted to induce taxis (3-6 amps). Electrofishing was conducted at night, beginning at dusk.

Pelagic sampling of Davis Lake was conducted with vertical gillnets. Four vertical monofilament gillnets (2.44 x 29.87 m), one net of each size (1.27, 2.54, 3.81, 5.08 cm square mesh), were set at the surface equally spaced along a transect running lengthwise (North-South) along the center of the lake. Nets were set for duration of four hours beginning at dusk.

Each fish collected was identified to species, measured (TL; mm) and weighed (grams). Catch-per-unit-effort (CPUE) by sampling gear was calculated for each species collected (number of fish per hour) and relative abundance (species composition) was calculated for each lake.

Relative weight (W_r) and condition factor (K_{TL}) indices were used to evaluate fish condition in all lakes. Relative weight was calculated as:

$$W_r = (W / W_s) \times 100$$

Where W is the weight (g) of an individual fish and W_s is the standard weight of a fish of the same length (Anderson and Neuman 1996). The W_s equations and minimum applicable total lengths were obtained from Anderson and Neuman (1996) and Bister et al. (2000). Fish of all lengths in good condition have a W_r of about 100 (Anderson and Neuman 1996).

Fulton-type condition factors were calculated as an index of how fish add weight in relation to increasing length (Anderson and Neuman 1996). Mean condition factor was calculated for all fish using the formula:

$$K_{TL} = (W / TL^3) \times 10^5$$

Where W is the weight (g) and TL is the total length (mm) of an individual fish. Condition factors were used to compare fish of the same species between water bodies.

Results

Cusick Creek

Seven reaches totaling 8.6 km were surveyed in Cusick Creek in 2002. The survey started at the Riley Creek Timber Company property line at elevation 652 m, and ended at the headwater beaver pond (elevation 841 m). Private land owners denied access to the lower 1701 m from the mouth to the survey start point. Timber harvest, heavy grazing, and residential development were commonly observed throughout the watershed. A summary of channel characteristics and habitat attributes recorded for Cusick Creek are presented in Table 4.

Mean wetted width of Cusick Creek was 2.1 m and depth was 15.0 cm with small gravel and sand the dominant substrates (32.8% and 32.1% of transects, respectively). Overall, substrate embeddedness was high in all but one reach (mean=86.4%). Embeddedness of small gravel, suitable for salmonid spawning, averaged 80.9%. Riffles were the dominant habitat type (51.3%), with runs recorded in 36.7% of transects. Mean channel gradient was 1.8% and ranged from 0.5% to 12.0%. Primary pool density averaged 12.9 pools/km; with mean length, maximum depth, and residual depths of 4.9 m, 51.5 cm, and 41.1 cm, respectively. Acting LWD was fairly common (14.1pieces/100 m). Discharge of Cusick Creek measured 0.013 m^3/sec on October 1, 2002. No temperature logger was placed in Cusick Creek, although stream temperatures recorded during the habitat survey in late autumn ranged from 4.0 °C to 6.5 °C.

Five 100 m electrofishing stations were sampled in Cusick Creek. Brook trout were captured in all stations, and observed in the reaches above Parker Lake not electrofished. One sculpin (*Cottus* sp.) was observed in reach 2, although none were collected while electrofishing. Two brown bullheads were captured in reach 6, just downstream of Parker Lake. Brook trout density ranged from 48.5/100 m^2 in reach 2 to 131.7/100 m^2 in reach 6 (Figure 3). Total lengths ranged from 45-200 mm TL with a mean of 90.5 mm TL (±30.6; n=1182) (Figure 4). Brook trout <100 mm accounted for 64.5% of the total capture.

Table 4. Channel characteristics and habitat attributes of Cusick Creek.

	Reach								
	1	2	3	4	5	6	7	8	Total
Length (m)	not	900	2400	420	600	1020	1080	2160	8580
No. Transects	surveyed	15	40	7	10	17	18	36	143
Mean Width (m)		2.7	2.5	2.8	2.5	2.3	1.7	1.5	2.1
Mean Depth (cm)		17.0	15.9	14.3	20.7	17.7	12.4	11.9	15
Gradient (%):									
Mean		5.7	1.0	0.9	1.0	0.6	1.3	2.3	1.8
Min.		2.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Max		12.0	3.5	1.0	1.5	2.0	4.5	7.5	12
Channel Type		A-3	C-4/C-5	C-5	B-3	C-5/C-6	C-5	B-4/C-5	
Temp (C):									
Air		N/A	6.0	6.0	8.0	9.0	9.0	13.5	
Stream		N/A	4.0	4.0	6.5	6.5	6.5	6.5	
Acting LWD (#/100 m)		13.1	11.7	11.0	12.3	17.6	15.4	16.2	14.1
Habitat Type:									
Pool (%)		33.5	8.6	7.7	0.0	0.0	19.4	13.6	11.9
Mean Pool Width		3.4	2.9	1.5			2.9	1.8	2.6
Riffle (%)		62.3	45.4	43.6	71.3	41.3	66.9	46.1	51.3
Mean Riffle Width		2.5	2.5	2.1	2.2	2.3	1.5	1.3	2.0
Run (%)		4.2	45.9	48.7	28.7	58.7	13.7	40.3	36.7
Mean Run Width		1.7	2.7	3.2	2.4	2.3	1.4	1.6	2.2
Substrate Embeddedness (%):									
Mean		60.7	90.3	85.6	77.7	97.6	92.8	87.3	86.4
Min.		10.0	40.0	50.0	40.0	90.0	70.0	30.0	10.0
Max.		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Substrate Composition:									
Boulder (%)		24.8	0.0	0.0	0.0	0.0	0.0	0.0	3.3
Cobble (%)		20.6	0.0	0.0	37.1	0.0	0.0	1.3	6.0
Gravel (%)		27.5	7.2	13.8	24.7	0.0	0.0	13.6	11.2
Small Gravel (%)		15.9	43.4	32.8	28.7	35.1	34.1	24.9	32.8
Sand (%)		0.0	30.5	45.6	0.0	30.5	65.9	52.2	32.1
Silt (%)		11.2	18.8	7.7	9.6	34.4	0.0	3.3	13.8
Organic Debris (%)		0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.8
Primary Pools:									
No.		24	24	6	6	8	15	28	111
Density (#/km)		26.7	10.0	14.3	10.0	7.8	13.9	13	12.9
Mean Length (m)		4.3	5.1	5.5	6.5	5.6	4.9	4.44	4.85
Mean Max. Depth (cm)		50.9	49.5	55.5	63.3	65.4	49.6	47.3	51.5
Mean Tailout Depth (cm)		9.1	10.9	7.8	9.2	16.6	9.7	10.4	10.4
Mean Residual Depth (cm)		41.8	38.6	47.7	54.2	48.8	39.9	36.9	41.1
Pool/Riffle Ratio		0.4:1	0.2:1	0.2:1	0.0:1	0.0:1	0.1:1	0.2:1	0.1:1

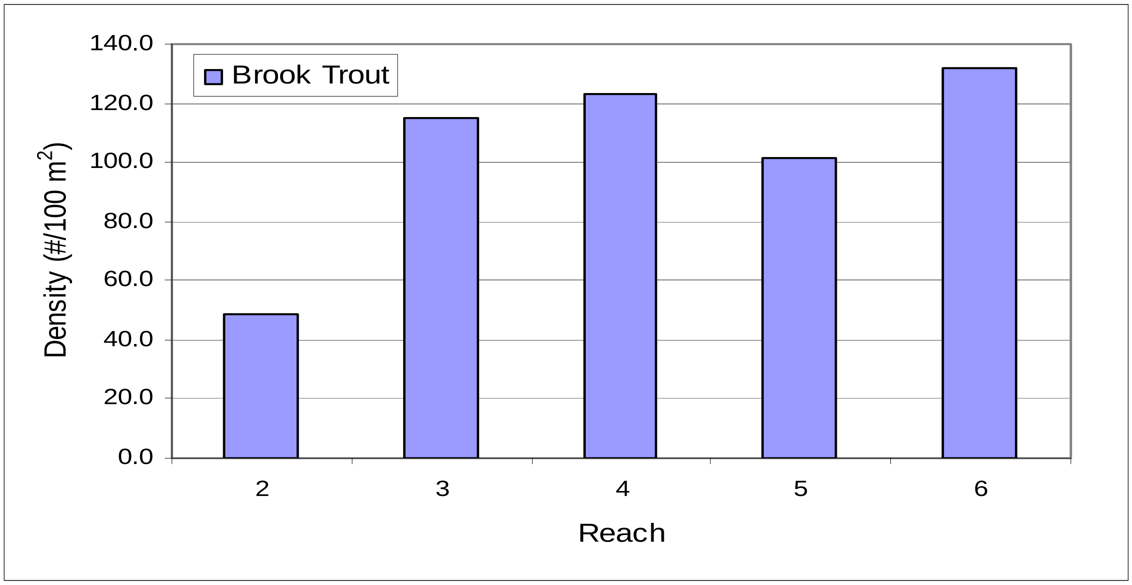

Figure 3. Estimated densities of brook trout sampled in Cusick Creek, by reach.

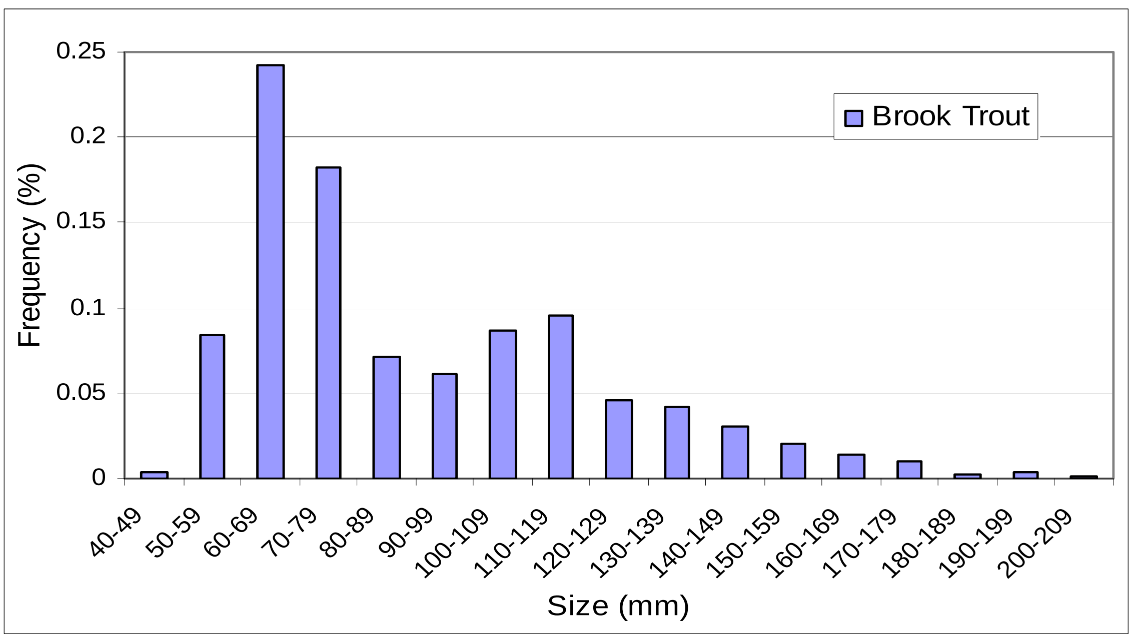

Figure 4. Length-frequency distribution of brook trout sampled in Cusick Creek.

Reach 1

No habitat assessment or fish sampling was conducted in reach one. Access was denied to the lower 1701 m of Cusick Creek by several private landowners with home sites located along the stream. Impacts from horse grazing and trampling were visible upstream of the Highway 20 culvert.

Reach 2

Reach two was classified as an A-3 channel that started at the Riley Creek Timber Company property line (elevation 652 m), and extended upstream 900 m to the double culvert under Riley Creek Road. Mean wetted width and depth were 2.7 m and 17.0 cm, respectively. Stream gradient was highest in reach 2 and ranged from 2.0% to 12.0% (X=5.7%). Boulders, cobbles, and gravels were evenly distributed throughout the reach (24.8%, 20.6%, and 27.5% of transects, respectively). Overall, substrate embeddedness was lower than any other reach surveyed in Cusick Creek (X=60.7%). Spawning sized gravels had an average embeddedness of 55.0%.

One potential fish passage barrier was recorded, a 1.2 m overhanging vertical fall, with take-off and landing pools blocked by debris. Riffle was the dominant habitat type, recorded in 62.3% of transects. Primary pool density was highest of any reach (26.7 pools/Km). Acting LWD density was fairly abundant (13.1 pieces/100 m). Backpack electrofishing resulted in the collection of 115 brook trout. Brook trout density, estimated at 48.5 fish/100 m^2, was the lowest of any reach in Cusick Creek.

Reach 3

Reach three included 2,400 m of C-4/C-5 type channel from Riley Creek Road to the USDA Forest Service boundary. The stream meandered through a narrow valley dominated by alder (*Alnus incana*), red-osier dogwood (*Cornus stolinifera*), and black hawthorne (*Cretageous douglasii*). Morphology and instream habitat differed significantly between reaches two and three. Mean stream width and depth were 2.5 m and 15.9 cm, respectively. Small gravel (43.4%) and sand (30.5%) were the dominant substrates, resulting in high mean embeddedness (90.3%). Mean gradient was 1.0% and ranged from 0.5-3.5%. Reach three had relatively low LWD density (11.7 pieces/100 m), resulting in low primary pool density (10.0 pools/Km). Run was the dominant habitat type in 45.9% of transects, with riffles accounting for 45.4% of transects. Impacts from cattle were severely degrading the stream in reach 3. Trampled banks, watering holes, and crossings were commonly observed and overall bank stability was 92.1%.

Brook trout was the only species collected electrofishing (n=252). Density was estimated at 115.2 fish/100 m^2.

Reach 4

Habitat conditions and stream morphology in reach four was similar to reach three. The reach started at the Forest Service boundary and extended 420 m through an open meadow to cedar forest edge. Mean stream width was 2.8 m and depth was 20.7 cm. Like reach 3, habitat was characterized by low gradient (0.9%), sand and small gravel substrates (45.6% and 32.8% of transects, respectively), and high embeddedness (mean=85.6%). LWD density was 11.0/100 m. Primary pool density was 14.3/Km.

Like reach three, cattle are impacting the stream in reach four. In 2002, the Forest Service completed a fencing project along the stream through the meadow. The purpose of the exclosure fence is to minimize impacts from ORV riders, campers, and cattle on the stream, and allow riparian vegetation to re-establish and stabilize stream banks.

Brook trout were the only species collected electrofishing (n=315) and density was estimated at 123.2/100 m^2.

Reach 5

Reach five extended 600 m through cedar forest ending at beaver ponds adjacent to the Cusick Creek game wintering area. The channel was classified as B-3, with cobble the dominant substrate in 37.1% of transects. Mean substrate embeddedness was 77.7%. Spawning sized gravels were recorded in 24.7% of transects and had an average embeddedness of 63.3%. The channel was more entrenched and water depths were greater than any other reach surveyed (mean=20.7 cm). Mean stream width was 2.5 m. Riffle was the dominant habitat type recorded in 71.3% of transects. Acting LWD was more abundant than previous reaches (12.3 pieces/100 m), although primary pool density remained low (10.0 pools/Km). Although at a low density, primary pools were, on average, longer, deeper, and contained less sediment than other reaches in Cusick Creek. Average length was 6.5 m, maximum depth averaged 63.3 cm, and residual pool depth averaged 54.2 cm. Unstable undercut banks were observed throughout the reach, and resulted in the lowest bank stability percentage of all reaches (88.9%, the same as reach six).

Two remnant dams and a bridge were present, and appear to have been used as a swimming hole. Beaver ponds above the forested section, which measured about 400 m long, were excluded from the assessment. Electrofishing in reach five resulted in the capture of 227 brook trout. No other species were captured or observed during the habitat survey. The estimated density of brook trout was 101.6/100 m^2.

Reach 6

Reach six measured 1,020 m from the game wintering area road to the outlet of Parker Lake. Habitat attributes and channel morphology were similar to reaches three and four. Channel type was C-5/C-6 with low gradient (0.6%) and small gravel and sand substrates (35.1% and 30.5%, respectively). Mean width was 2.3 m and mean depth was 17.7 cm. Reach 6 had the highest embeddedness recorded in Cusick Creek (mean=97.6%). Sand and silt were the dominant substrates in 30.5% and 34.4% of transects, respectively. A fair amount of LWD was recorded (17.6 pieces/100 m), often acting as sediment traps. Pool habitat was scarce. No pool habitat fell within transects, and primary pool density was low (7.8 pools/Km). Run was the dominant habitat type; 58.7% of transects were classified as run.

Cattle are severely impacting the stream in reach six. Bank stability was recorded at 88.9%. Cattle were observed in and along the stream during the survey. Brook trout and brown bullhead were collected in the reach six electrofishing station. Two bullhead measuring 185 mm and 105 mm are thought to have migrated downstream from Parker Lake. Two hundred sixty-nine brook trout were captured and density was estimated at 131.7 fish/100 m^2.

Reach 7

Reach seven measured 1,080 m from a second Forest Service exclosure fence (upstream of Parker Lake) to a gradient change just upstream of Forest Service Road #30. The channel was classified as C-5, with sand the dominant substrate in 65.9% of transects. Gradient ranged from 0.5-4.5% (mean=1.3%). Overall stream size was much smaller above the lake. Mean stream width measured 1.7 m and depth was 12.4 cm. Riffle was the dominant habitat type (66.9%). Moderate amounts of acting LWD were present (15.4 pieces/100 m) and created primary pools (13.9 pools/Km). As expected, primary pools were smaller than other reaches (mean length 4.9 m, maximum depth 49.6 cm, and residual depth 39.9) and pool habitat was recorded in 19.4% of transects.

The Forest Service completed the Parker Meadow fencing project in 1995. At the time of this survey, the channel was dry throughout the fenced portion. Stream flow stopped at the fence boundary, due to heavy ORV and cattle traffic around the fence that completely filled the channel. Several enhancement structures, notched channel-spanning logs, were present above Forest Service Road 030. The Forest Service placed structures in 1988-1989 and 1992-1993 (Karen Honeycutt, personal comm.) Although meant to create pool habitat, most of the structures were full of sand and sediment. Brook trout appeared abundant during the habitat assessment, although an early hard freeze prevented electrofishing.

Reach 8

Reach eight included 2,160 m of B-4/C-5 type channel that terminated at headwater beaver ponds. Mean stream width and depth was 1.5 m and 11.9 cm, respectively. Gradient averaged 2.3% and ranged from 0.5-7.5%. Riffle and run habitat occurred in 46.1% and 40.3% of transects, respectively. Sand was the dominant substrate in 52.2% of transects, with small gravel dominant in 24.9%. Mean substrate embeddedness was 87.3%, with spawning habitat averaging 69.0% embeddedness. Acting LWD was fairly common (16.2 pieces/100 m), contributing to 13.0 primary pools per Km. Pool quality was low, as evidenced by mean length, depth, and residual depth (4.4 m, 47.3 cm, and 36.9 cm, respectively).

Lower gradients were observed above the first 480 m, and beaver have created pool/wetland habitat in the headwaters. The upper half of the reach has been recently clear-cut. One Forest Service habitat enhancement structure (log placement) was observed near the beginning of the reach. Brook trout were observed throughout, although early season cold temperatures prevented sampling. A perennial tributary flowed into Cusick Creek approximately 70 m from the beaver pools. The tributary had a 25 m vertical fall located 20 m from the confluence.

Trimble Creek

Five reaches totaling 4,380 m were assessed in Trimble Creek between West Calispel Road (elevation 628 m) and Conger Lake (elevation 847 m). Residential development, roads, grazing, and logging were impacting the stream throughout. Overall, embeddedness was relatively high (mean=80.5%), and sand and silt comprised 38.1% of the substrate. Sicily Road runs parallel to the stream, and through steep valley segments erosion has washed sediments down slope into the channel. The mean of each channel characteristic and habitat attribute measured in Trimble Creek appears in Table 5.

Large woody debris density was relatively low (9.1 pieces/100 m). Riffle was the dominant habitat type in 68.5% of transects. Spawning sized gravel accounted for 11.8% of the substrate with mean embeddedness of 60.5%. Primary pool density ranged from 9.5 pools/Km to 28.3 pools/Km (mean=13.9 pools/Km). Gradient averaged 3.7%, and ranged from 0.5% to 16.0%.

Stream temperature was recorded hourly between 6 June and 7 October 2002 (Figure 5). Mean daily temperature was 10.29 °C (n=2496, SD=1.57). The maximum temperature recorded was 13.43 °C on 29 August. The minimum temperature, recorded on 2 October, was 5.0 °C. Discharge of Trimble Creek measured 0.01 m^3/sec. on September 9^{th}.

Two electrofishing stations were sampled in the Forest Service section of Trimble Creek. Access was denied to the lower watershed by private landowners. Brook trout was the only species collected, although one cutthroat trout was observed in reach 5 during the habitat assessment. Cutthroat trout were also present in a 1992 Forest Service electrofishing survey (USDA Forest Service, unpublished data). Brook trout densities were 69.2 fish/100 m^2 in reach 5 and 46.9 fish/100 m^2 in reach 6. Lengths ranged from 34-176 mm TL with a mean of 91.3 mm TL (±28.3; n=152) (Figure 6).

Table 5. Channel characteristics and habitat attributes of Trimble Creek.

	Reach						
	1	2	3	4	5	6	Total
Length (m)	not	840	1260	540	600	1140	4380
No. Transects	surveyed	14	21	9	10	19	73
Mean Width (m)		1.7	1.4	1.6	1.3	1.3	1.5
Mean Depth (cm)		16.4	9.4	10.3	11.2	10.1	11.3
Gradient (%):							
Mean		0.7	3.5	9.5	3.4	3.7	3.7
Min.		0.5	1.0	5.0	1.0	1.0	0.5
Max		2.0	7.0	16.0	5.5	6.5	16.0
Channel Type		E-5	A-4	A-3/Aa+3	A-4	B-4	
Temp (C):							
Air		23.0	24.0	18.0	18.0	19.0	
Stream		9.5	10.0	10.0	10.0	10.0	
Acting LWD (#/100 m)		2.5	9.1	9.8	11.7	9.6	9.1
Habitat Type:							
Pool (%)		12.2	8.7	14.7	16.0	15.4	12.8
Mean Pool Width		1.5	2.6	2.1	2.1	1.3	1.7
Riffle (%)		47.5	77.3	85.3	51.9	77.1	68.5
Mean Riffle Width		1.4	1.3	1.5	1.1	1.2	1.3
Run (%)		40.3	14.0	0.0	32.1	7.5	18.7
Mean Run Width		1.9	1.4	0.0	1.4	1.9	1.7
Substrate Embeddedness (%):							
Mean		98.7	65.9	70.6	89.5	82.8	80.5
Min.		95.0	20.0	25.0	75.0	30.0	20.0
Max.		100.0	100.0	100.0	100.0	100.0	100.0
Substrate Composition:							
Cobble (%)		0.0	24.7	76.2	11.5	7.1	20.3
Gravel (%)		0.0	27.1	0.0	7.6	13.8	11.8
Small Gravel (%)		22.3	20.7	0.0	56.5	50.2	29.7
Sand (%)		43.3	22.1	14.7	24.4	23.3	26.4
Silt (%)		34.5	5.4	9.1	0.0	5.5	11.7
Primary Pools:							
No.		8	15	10	17	11	61
Density (#/km)		9.5	11.9	18.5	28.3	9.6	13.9
Mean Length (m)		2.9	2.4	2.1	2.3	2.5	2.4
Mean Max. Depth (cm)		62.3	43.8	38.1	43.9	40.5	44.7
Mean Tailout Depth (cm)		10.0	7.1	6.9	10.4	5.8	8.1
Mean Residual Depth (cm)		52.3	36.7	31.2	33.5	34.6	36.6
Pool/Riffle Ratio		0.2:1	0.0:1	0.1:1	0.1:1	0.1:1	0.1:1

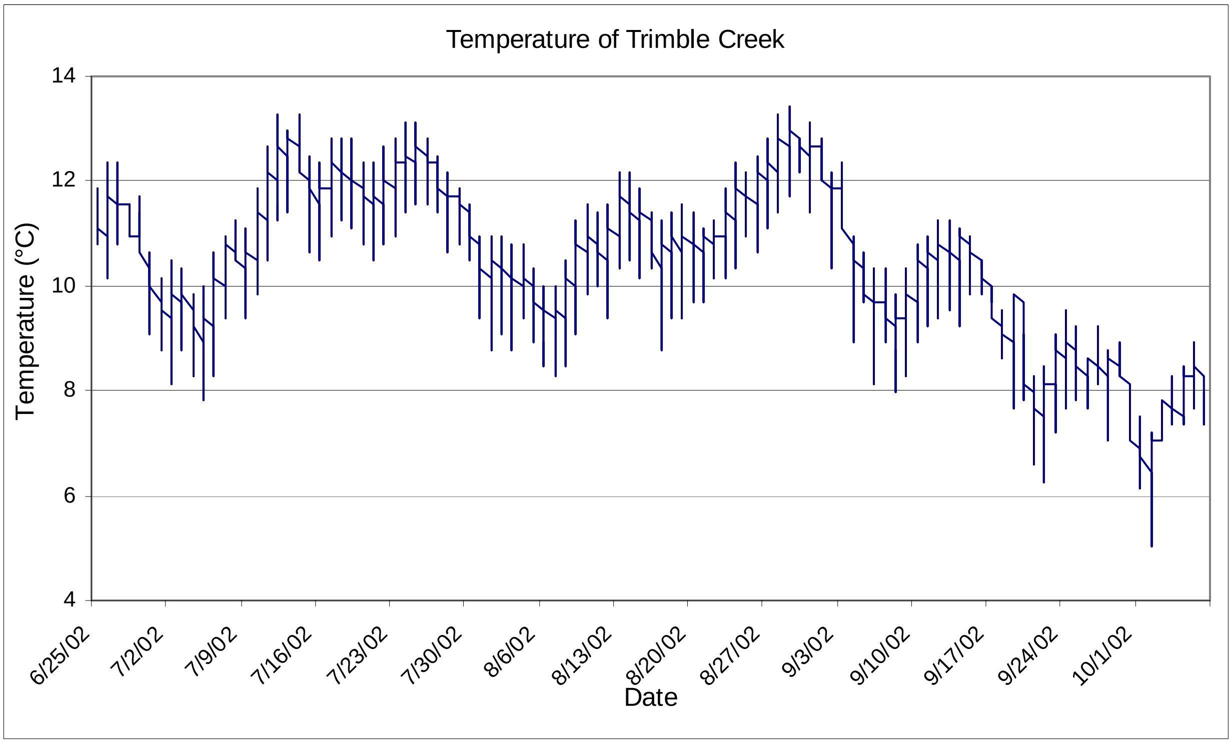

Figure 5. Stream temperatures recorded at Batey Bould ORV Park, Trimble Creek.

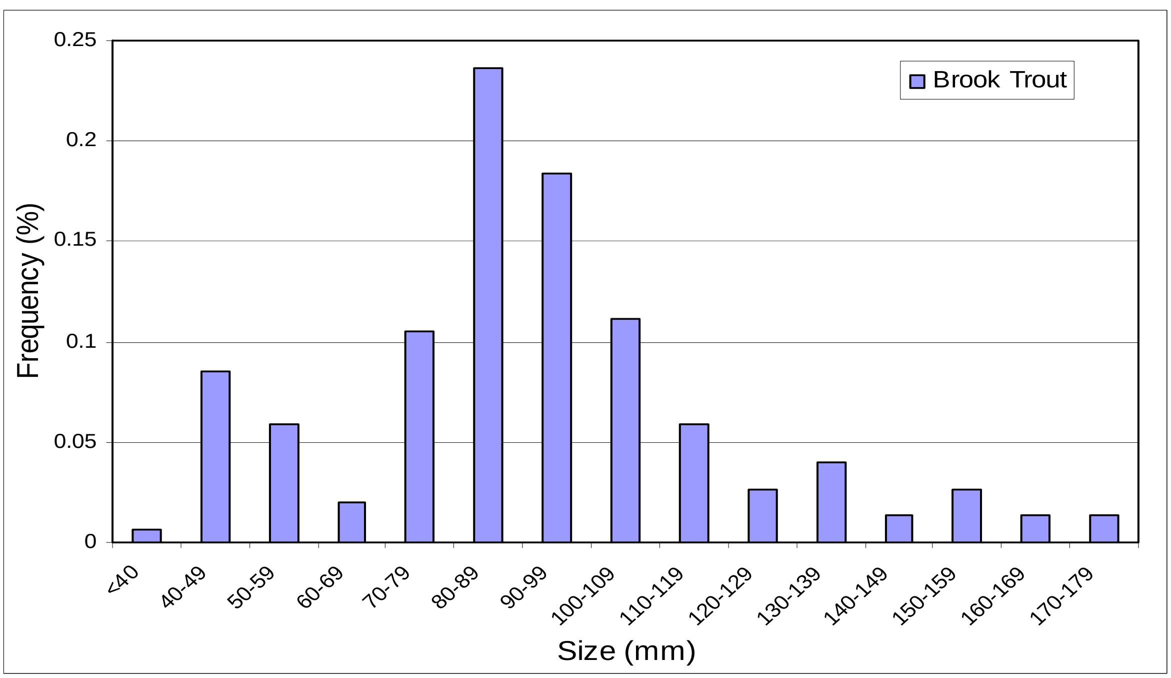

Figure 6. Length-frequency distribution of brook trout sampled in Trimble Creek.

Reach 1

No habitat assessment or fish sampling was conducted in reach one, known as Trimble Slough. The reach extended from the confluence with the Pend Oreille River to approximately 200 m downstream of the West Calispel Road culvert. Pumps operated by Pend Oreille Public Utility District maintain a constant water elevation in Trimble slough by pumping water from the Pend Oreille River into the slough. The slough is relatively wide (>20 m) and deep with several braided channels and fingers. Silt and mud are the dominant substrates. There is no riparian cover or LWD to speak of, except recently planted areas being rehabilitated by the Kalispel Tribe. Water temperatures in Trimble Slough routinely exceed 20 °C in summer. Cattle grazing and watering was impacting bank stability in Trimble Slough.

Reach 2

Reach two started at the West Calispel Road culvert and meandered 840 m through cow pasture to a cedar forest edge. Mean stream width was 1.7 m and depth was 16.4 cm. The channel was classified as C-5, with sand and silt the dominant substrates (43.4% and 34.5% of transects, respectively). The channel varied from deeply incised to broad and flooded meadow. Embeddedness (mean=98.7%) was highest and bank stability lowest (94.8%) of any reach measured above Trimble Slough. Mean gradient was 0.7%. Riffle was the dominant habitat type in 47.5% of transects. Large woody debris and primary pool densities were lower than any other reach (2.5 pieces/100 m and 8.0 pools/Km, respectively). Although infrequent, primary pools were deeper and longer than in upstream reaches. Meanders have created pool habitat with deep undercut banks, providing good wintering habitat. Mean maximum length, depth, and residual depths were 2.9 m, 62.3 cm, and 52.3 cm, respectively.

Reach 3

Reach three began at the forest edge and ended 1,260 m upstream at a private logging road culvert. Habitat conditions and channel characteristics were quite different above the meadow. Reach three was classified as an A-4 type channel. Gravel and small gravel were the dominant substrates (27.1% and 20.7% of transects, respectively). Mean embeddedness was 65.9%, and spawning gravels averaged 56.4% embedded. Gradient ranged from 1.0% to 7.0%, with a mean of 3.5%. Riffle was the dominant habitat type in 77.3% of transects. Pool habitat was lacking (8.7% of habitat transects, 11.9 primary pools/Km), as was acting LWD density (9.1 pieces/100 m).

Habitat disturbances observed in reach three included heavy logging and residential development. A small diversion dam and canal was present that appeared to be diverting ½ of the water to homes along the stream. Two road culverts and a corduroy bridge were observed in the reach. Brook trout were observed in reach three during the habitat assessment, but the reach was not electrofished at landowners request.

Reach 4

Reach four was classified as an A-3/Aa+3 channel type. The reach measured 540 m from the logging road culvert to a significant gradient change. Mean stream width was 1.6 m and depth was 10.3 cm. Gradient averaged 9.5%, ranging from 5.0-16.0%. Cobble was the dominant substrate (76.2% of transects), averaging 62.1% embedded. No spawning size gravels fell within transect lines. Reach four exhibited riffle-pool morphology, with riffles accounting for 85.3% of the habitat. Primary pools were abundant at 18.5 pools/Km and pool habitat occurred in 14.7% of transects. One potential passage barrier was noted, a 1.2 m vertical fall with a plunge pool.

Reach 5

Reach five included 600 m of A-4 type channel ending at the Sicily Road culvert at Batey Bould ORV Park. Mean stream widths and depths were 1.3 m and 11.2 cm, respectively. Mean gradient was 3.4% and ranged from 1.0-5.5%. Acting LWD and primary pool densities were higher than other reaches in Trimble Creek (11.7 pieces/100 m and 28.3 pools/Km, respectively). Riffle was the dominant habitat in 51.9% of transects. Small gravel was the dominant substrate, but high levels of sand and sediment contributed to the highest mean embeddedness (89.5%) of any reach in the upper watershed.

Four log enhancement structures were observed in reach five. Structures consisted of notched, channel spanning logs, similar to those found in Cusick Creek. Two were functioning as sediment traps, and two had been washed out. Eighty-two brook trout were collected in 100 m of electrofishing. The estimated density of brook trout was 69.2 fish/100 m^2.

Reach 6

Reach six measured 1,140 m and was classified as a B-4 type channel. The reach started at Batey Bould ORV Park and ended 300 m from the outlet of Conger Lake. The survey ended in a spring-fed, braided, bog with diminished flows. Mean stream width and depth was 1.3 m and 10.1 cm, respectively. Gradient ranged from 1.0-6.5%, with a mean of 3.7%. Riffle was the dominant habitat type in 77.1% of transects. Small gravel was the dominant substrate (50.2%) and average embeddedness was 82.8%. Densities of LWD and primary pools were both low (9.6 pieces/100 m and 9.6 pools/Km, respectively). Relative to stream size and flow, primary pools were of fairly high quality. Mean length, maximum depth, and tailout depths were 2.5 m, 40.5 cm, and 34.6 cm, respectively.

Three artificial log placements were encountered in reach six. One was functioning as a sediment trap; the others had been undercut. Sediment levels were high, likely the result of roads and logging. Clearcut logging was observed within 20 m of the stream. Very little water was flowing from the Conger Lake dam at the time of the survey. The earthen dam has a pipe outlet, which acts as a permanent upstream fish passage barrier. Fifty-six brook trout were collected in 100 meters of electrofishing. Density was estimated at 46.9 fish/100 m^2.

Bracket Creek

The stream assessment of Bracket Creek was limited to the upper portions of the watershed. Numerous private landowners limited access to the lower 2818 m of the stream. Bracket Creek from the confluence with the Pend Oreille River to the culvert under Turk Road is considered reach 1. At least 5 culverts were present in the reach. Two were identified as potential (likely definite) barriers to fish migration, including the culvert under Highway 20 and the adjacent railroad, and the culvert under Turk Road. This culvert is smooth concrete with low water depth, high velocity, and 0.7 m outfall drop. A dam and pipe outlet of a small pond directly upstream of Baker Lake Road is a definite barrier due to a fish screen at the outlet. Habitat in reach 1 ranged from low gradient alder and conifer stands, to a channelized, straightened ditch through hay pasture.

The Pend Oreille Conservation District has engaged landowners in a stream enhancement project near the intersection of Baker Lake Road and Turner Road. These enhancements include boulder and rip-rap placements, and riparian plantings to provide shade and cover. Channel characteristics and habitat attributes measured in Bracket Creek appear in Table 6.

The Bracket Creek survey began at the Turk Road culvert (elevation 683 m) and ended 1,620 m upstream at the headwater springs (elevation 792 m). The mean channel width was 1.5 m, and depth was 13.6 cm. Small gravel was the dominant substrate (27.5%), although sand and silt combined accounted for 42.2% of the substrate. Mean embeddedness was high, averaging 78.3%. Gradient ranged from 0.5% to 11.0%, with a mean of 4.9%. Riffle was the dominant habitat type in 63.4% of transects. Acting LWD and primary pool densities were 11.7 pieces/100 m and 14.8 pools/Km, respectively.

Discharge of Bracket Creek measured 0.01 m^3/sec. on September 9^{th} 2002. Stream temperature was measured hourly between 25 June and 7 October 2002 (Figure 7). Mean daily temperature was 14.9 °C (n=2497, SD=3.0). The maximum temperature recorded was 20.6 °C on 26 July. The minimum temperature, recorded on 2 October, was 6.8 °C.

Table 6. Channel characteristics and habitat attributes of Bracket Creek.

	Reach			
	1	**2**	**3**	**Total**
Length (m)	not	1080	540	1620
No. Transects	surveyed	18	9	27
Mean Width (m)		1.4	1.6	1.5
Mean Depth (cm)		13.5	13.8	13.6
Gradient (%):				
Mean		6.2	2.4	4.9
Min.		2.5	0.5	0.5
Max		11.0	5.5	11.0
Channel Type		A-4	B-6	
Temp (C):				
Air		9.0	9.0	9.0
Stream		8.0	8.0	8.0
Acting LWD (#/100 m)		12.8	9.4	11.7
Habitat Type:				
Pool (%)		12.0	0.0	7.6
Mean Pool Width		1.5		1.5
Riffle (%)		66.7	57.6	63.4
Mean Riffle Width		1.4	1.7	1.5
Run (%)		21.3	42.4	29.0
Mean Run Width		1.3	1.5	1.4
Substrate Embeddedness (%):				
Mean		68.0	95.6	78.3
Min.		15.0	80.0	15.0
Max.		100.0	100.0	100.0
Substrate Composition:				
Gravel (%)		28.1	0.0	17.8
Small Gravel (%)		25.7	30.6	27.5
Sand (%)		20.1	16.7	18.8
Silt (%)		6.4	52.8	23.4
Organic Debris (%)		19.7	0.0	12.5
Primary Pools:				
No.		19	5	24
Density (#/km)		17.6	9.3	14.8
Mean Length (m)		2.4	2.6	2.5
Mean Max. Depth (cm)		44.3	36.8	42.7
Mean Tailout Depth (cm)		8.4	5.0	7.7
Mean Residual Depth (cm)		35.8	31.8	35.0
Pool/Riffle Ratio		0.1:1	0.0:1	0.1:1

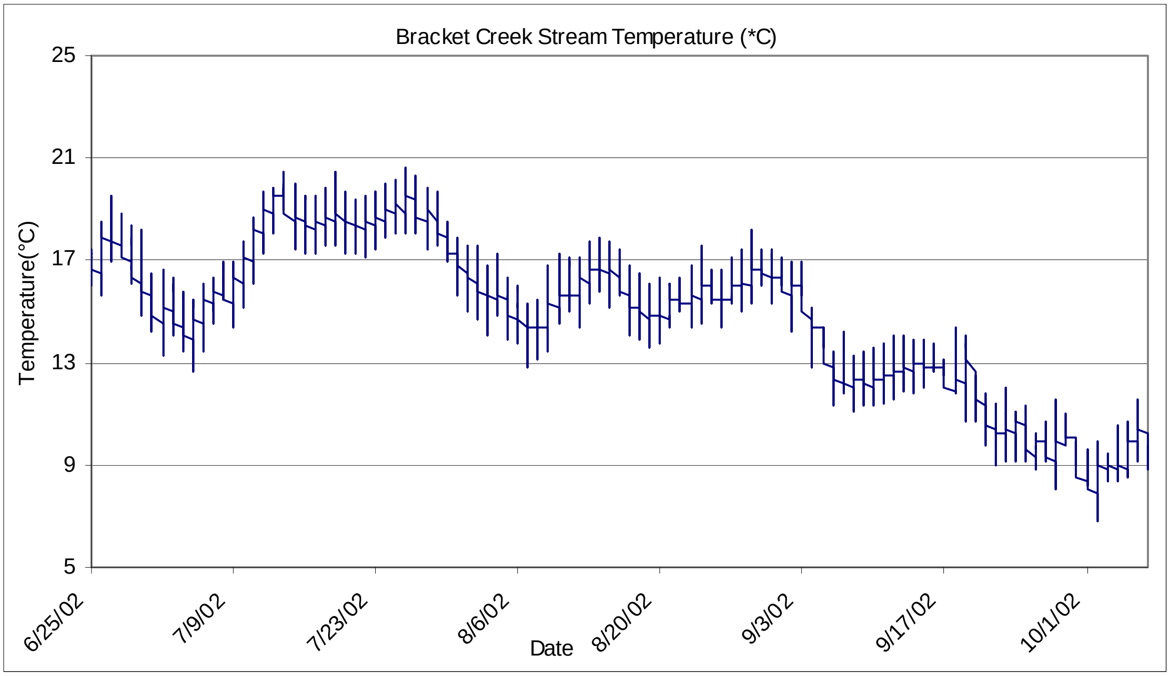

Figure 7. Stream temperatures recorded in Bracket Creek, 2002.

Reach 2

Reach two was classified as an A-4 type channel and measured 1,080 m. The reach began at the concrete culvert under Turk Road and ended at a private dam culvert. The outlet to the pond created by this dam was a small, high gradient culvert under a driveway, which was a permanent passage barrier. Gradient in reach 2 averaged 6.2%, and gravel and small gravel were the dominant substrates (28.1% and 25.7% of transects, respectively). Average embeddedness was 68.0%, with spawning sized gravels measuring 31% embedded. Moderate amounts of LWD were recorded (12.8/100 m), contributing to a moderately high primary pool density (17.6 primary pools/Km).

One 100-meter electrofishing station was established in reach 2 of Bracket Creek. Brook trout was the only species collected (n=51). Mean TL was 98.7 mm (SD=36.1), the smallest fish measured 43 mm TL and the longest was 197 mm TL (Figure 8). Density was estimated at 38.6 fish/100 m^2.

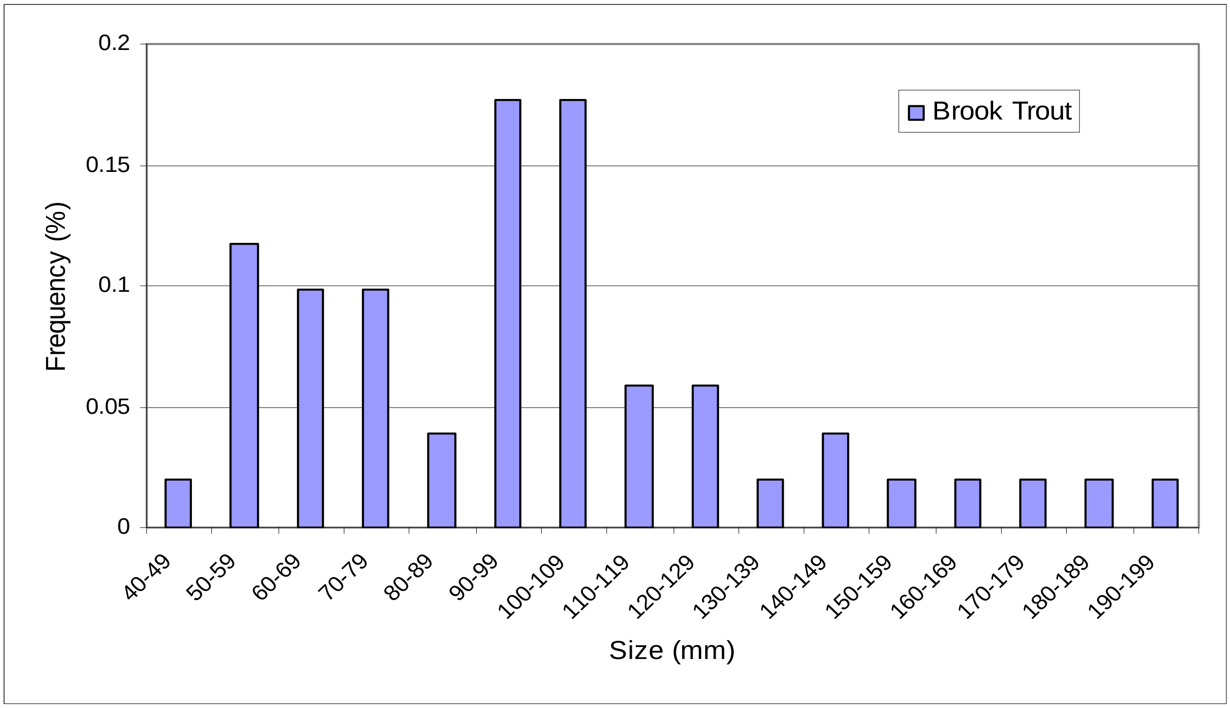

Figure 8. Length-frequency distribution of brook trout sampled in Bracket Creek.

Reach 3

Reach three was 540 m in length, classified as a B-6 type channel, located between the pond and the headwater springs. Mean stream width and depth were 1.6 m and 13.8 cm, respectively. Silt and organic material (peat) accounted for 52.8% of the substrate, resulting in high average embeddedness (95.6%). Riffle was the dominant habitat type (57.6%). Densities of primary pools and acting LWD were low, 9.3 pools/Km and 9.4 pieces/100 m, respectively. Bank stability was also low in reach three (87.5%).

Although brook trout were observed directly upstream of the pond, no electrofishing was conducted in reach three due to reduced water depths and intermittent flows upstream. Limiting factors in the reach include intermittent flow, high substrate embeddedness, lack of primary pools and LWD, and human-made passage barriers.

Split Creek

Split creek, a tributary to North Skookum Lake, was divided into seven reaches. The survey started at the inlet to the lake (elevation 1088 m) and ended 4.2 Km upstream when the stream became intermittent (elevation 1280 m). Logging activity and associated road building appear to be the major disturbances in the watershed. The upper reaches flow through clearcuts dominated by regenerating alder. Farther downstream, cedar is the dominant species with some very large trees (>1.5 m diameter at breast height). Natural barriers in reaches two and three permanently prevent fish passage. The mean of each channel characteristic and habitat attribute was calculated and appear in Table 7.

Mean stream width was 2.1 m and depth was 14.9 cm. Gradient of Split Creek averaged 9.1%, ranging from 1.0% to 23.5%. Acting LWD and primary pools were both abundant (19.3 pieces/100 m and 20.7 pools/Km, respectively). Overall, cobble was the dominant substrate (34.9%) and embeddedness estimates were relatively low (mean=45.9%). Spawning sized gravels were abundant (13.8%) and embeddedness averaged 43.3%. Riffle was the dominant habitat type (64.1%), although the first two reaches were dominated by pool and run habitat.

Stream temperature was recorded hourly between 25 June and 7 October 2002 (Figure 9). Mean daily temperature was 8.82 °C (n=2499, SD=1.9). The maximum temperature recorded was 12.7 °C on 13 July, 24 July, and 25 July. The minimum temperature, recorded on 2 October, was 3.2 °C. Discharge of Split Creek measured 0.02 m^3/sec. On September 9th.

Six 100-meter electrofishing stations resulted in the capture of 209 fish. Two largescale suckers (*Catostomus macrochirus*), measuring 75 mm and 85 mm TL, respectively, were collected in reach 1. Brook trout was the only other species collected. No fish were encountered in reaches 3,4,5,or 6, which were above the passage barriers. Brook trout density was 38.9/100 m^2 in reach 1 and 32.6/100 m^2 in reach 2 (Figure 10).

Lengths ranged from 30-250 mm TL with a mean of 107.5 mm TL (±44.4; n=207) (Figure 11).

Table 7. Channel characteristics and habitat attributes of Split Creek.

	Reach						
	1	2	3	4	5	6	Total
Length (m)	420	480	900	480	900	1020	4200
No. Transects	7	8	15	8	15	17	70.0
Mean Width (m)	3.6	3.1	2.4	1.4	2.0	1.1	2.1
Mean Depth (cm)	26.1	30.9	13.3	12.4	11.7	8.0	14.9
Gradient (%):							
Mean	1.8	11.8	5.8	11.5	7.9	14.0	9.1
Min.	1.0	5.5	2.5	6.0	5.0	5.5	1.0
Max	3.0	17.5	8.0	18.0	11.0	23.5	23.5
Channel Type	D-5/B-4	Aa+1/Aa+2	A-3	Aa+3	A-3/Aa+3	Aa+4	
Temp (C):							
Air	23.0	20.0	16.0	14.0	N/A	23.0	
Stream	10.0	9.0	8.0	8.0	N/A	8.5	
Acting LWD (#/100 m)	19.3	25.8	14.9	22.3	18.3	19.4	19.3
Habitat Type:							
Pool (%)	55.7	37.5	9.8	27.3	17.7	9.0	25.3
Mean PoolWidth	4.7	2.0	1.8	1.5	1.8	0.9	2.2
Riffle (%)	38.4	21.1	90.2	51.8	82.3	83.6	64.1
Mean Riffle Width	3.3	1.3	2.5	1.4	1.9	1.0	1.8
Run (%)	5.9	41.4	0.0	20.9	0.0	7.4	10.6
Mean Run Width	1.5	5.2		1.2		1.4	2.6
Substrate Embeddedness (%):							
Mean	75.0	36.3	30.7	45.0	52.8	47.4	45.9
Min.	25.0	0.0	10.0	25.0	20.0	0.0	0.0
Max.	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Substrate Composition:							
Bedrock (%)	0.0	27.9	0.0	0.0	0.0	25.4	8.1
Boulder (%)	0.0	12.7	4.9	0.0	5.7	11.6	6.1
Cobble (%)	16.9	33.5	48.0	75.3	38.1	10.6	34.9
Gravel (%)	0.0	5.6	12.8	11.8	32.4	22.8	13.8
Small Gravel (%)	50.2	0.0	28.6	12.9	10.0	23.3	21.9
Sand (%)	32.9	10.4	5.7	0.0	6.4	3.7	11.6
Silt (%)	0.0	10.0	0.0	0.0	7.4	0.0	3.2
Organic Debris (%)	0.0	0.0	0.0	0.0	0.0	2.6	0.3
Primary Pools:							
No.	13	18	17	12	16	11	87
Density (#/km)	31.0	37.5	18.9	25.0	17.8	10.8	20.7
Mean Length (m)	6.9	4.1	3.3	3.0	2.8	2.8	3.8
Mean Max. Depth (cm)	67.0	63.7	38.1	37.3	37.6	33.7	47.0
Mean Tailout Depth (cm)	17.1	11.3	8.1	3.1	3.5	3.5	8.0
Mean Residual Depth (cm)	49.9	52.3	30.0	34.3	34.1	30.3	39.0
Pool/Riffle Ratio	1.0:1	1.0:1	0.1:1	0.5:1	0.2:1	0.1:1	0.3:1

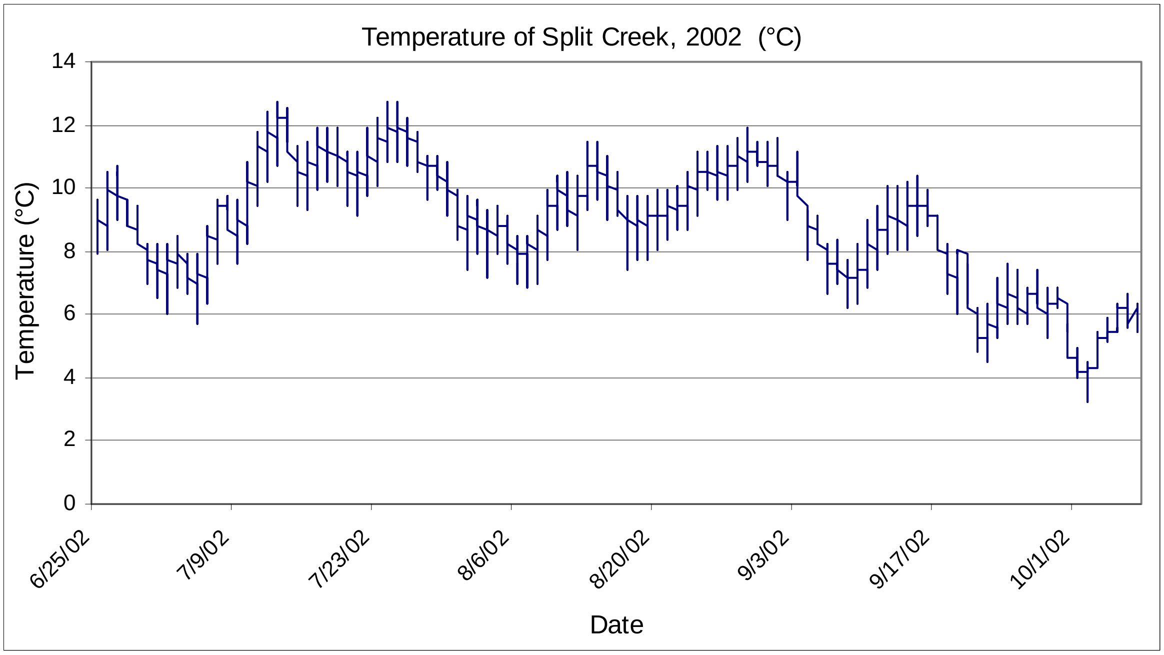

Figure 9. Stream temperatures recorded in Split Creek, 2002.

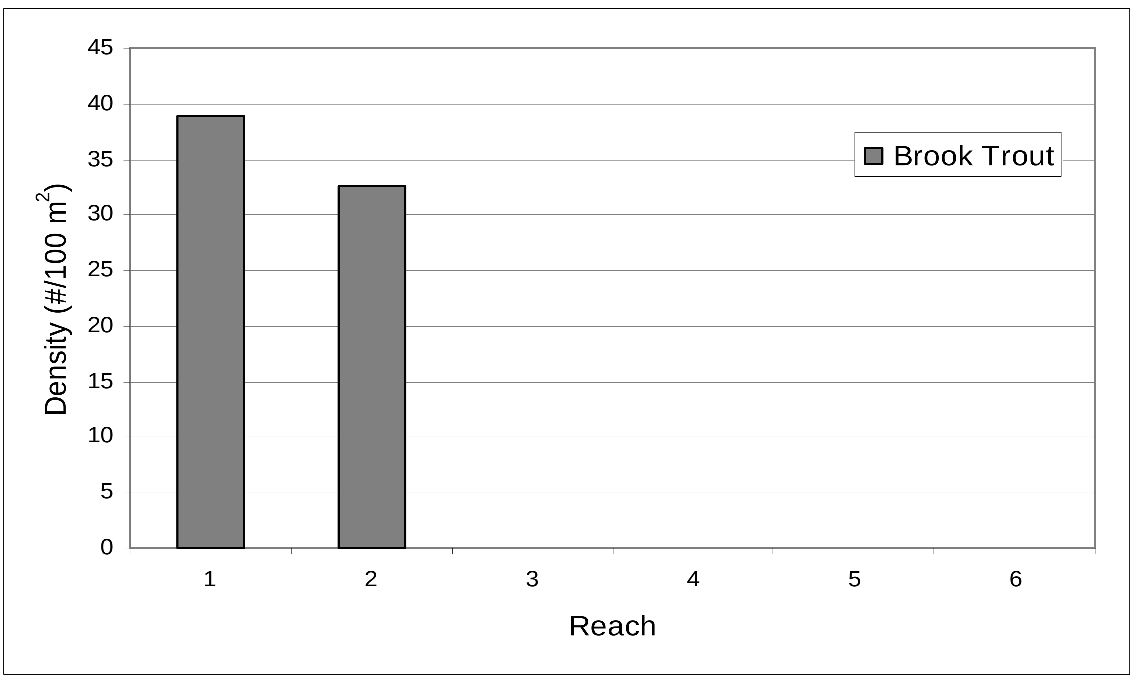

Figure 10. Estimated densities of brook trout sampled in Split Creek, by reach.

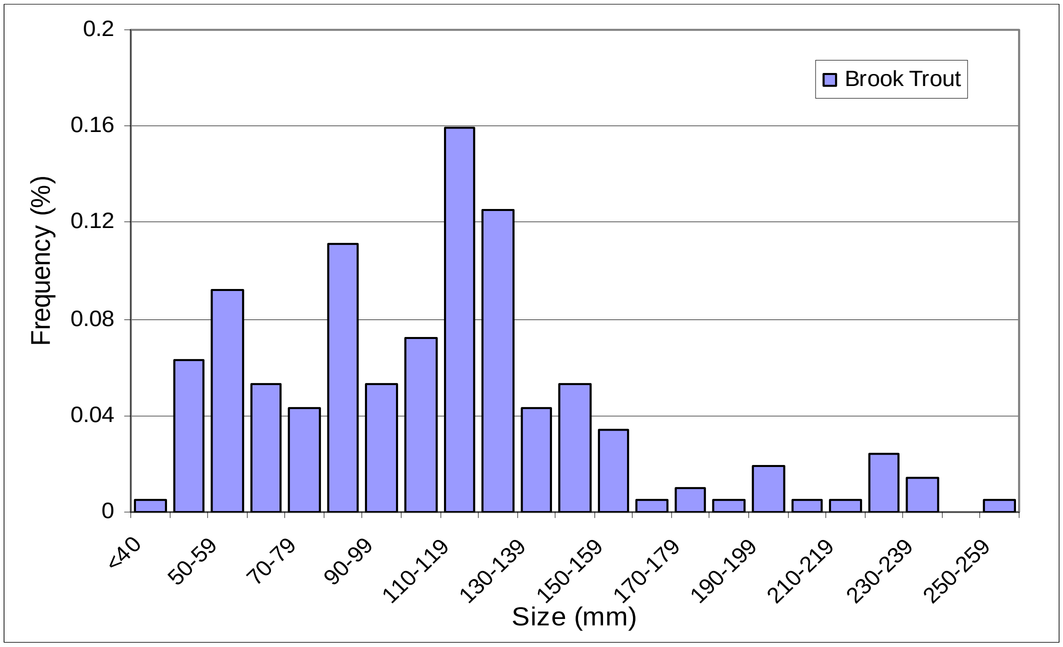

Figure 11. Length-frequency distribution of brook trout sampled in Split Creek.

Reach 1

Reach one started at the Forest Service Road # 128 culvert and extended 420 m to a significant change in gradient and substrate. The channel was classified as a D-4/5 channel, becoming B-4 near the end of the reach. Mean gradient measured 1.8%. Sand and small gravel were the dominant substrates (32.9% and 50.2 %, respectively) and embeddedness was the highest of any reach in Split Creek, averaging 75.0%. Large woody debris and primary pools were abundant (19.3 pieces/100 m and 31.0 pools/Km, respectively), and pool habitat occurred in 55.7% of transects. Large pools were present in braided channels above and below the road. Mean primary pool length, maximum depth, and residual depths were 6.9 m, 67.0 cm, and 49.9 cm, respectively.

The reach one electrofishing station was established above the braided channel. Two largescale suckers and 121 brook trout were collected. The estimated density of brook trout was 38.9 fish/100 m^2. Hundreds of fish over 200 mm were observed in large pools below the sample site, but it was impractical to sample the braided channels.

Reach 2

Reach two was comprised of 480 m of Aa+1/Aa+2 type channel ending at the confluence of the two tributaries forming Split Creek. A 200+ meter long series of steep chutes, cascades, and falls over bedrock substrate; 120 meters upstream from the start created permanent passage barriers. Chute gradients measured between 30% and 40%, although the average gradient measured at transects throughout the reach was 11.8%. The mean width was 3.1 m and the mean depth was 30.9 cm. Cobble was the dominant substrate in 33.5% of transects, and mean embeddedness was 36.3%. Run was the dominant habitat type (37.5%), a result of bedrock substrate present in 27.9% of transects. Densities of primary pools and acting LWD were highest in reach 2 (37.5 pools/Km and 25.8 pieces/100 m, respectively). Mean length of primary pools was 4.1 m, average maximum depth was 63.7 cm, and residual depth was 52.3 cm. Electrofishing occurred before the first passage barrier. Eighty-six brook trout were collected, and density was calculated at 32.6/100 m^2.

Reach 3

Reach three measured 900 m and was classified as an A-3 type channel. The reach ended at an unmarked tributary flowing into the east fork of Split Creek. Mean stream width and depths were 2.4 m and 13.3 cm, respectively. Average gradient was 5.8%. Acting LWD density was lower than other reaches surveyed, at 14.9 pieces/100m. Cobble was the dominant substrate (48.0% of transects). Mean embeddedness was lower than any other reach, averaging 30.7%. Riffle was the dominant habitat type recorded in 90.2% of transects.

As would be expected, water flow and depth were lower above the confluence of the two tributaries. Springs and seeps were common, and entered the stream from the right bank. Primary pools were generally smaller in length and depth (mean length 3.3 m, maximum depth 38.1, and residual depth 30.0). One potential barrier was identified, a 1.0 m fall over bedrock substrate. No fish were collected in 100 meters of electrofishing effort.

Reach 4

Reach four continued along the south fork of Split Creek from the unmarked tributary to an unmarked logging road crossing. By this point the stream had become intermittent. The channel was classified as an Aa+3, with average gradient of 11.5% and cobble substrate (75.3% of transects). Average substrate embeddedness was 45.0%. Mean stream width was 1.4 m and depth was 12.4 cm. Riffle was the dominant habitat type in 51.8% of transects. Pool habitat occurrence was 27.3%, and primary pools were abundant (25.0 pools/Km). Like reach three, pools were smaller in size and depth (3.0 m mean length, 37.3 cm mean maximum depth, and 34.3 cm mean residual depth). A 7.0 meter cascade over bedrock with 42.0% gradient was identified as a permanent barrier. No fish were encountered in the reach four sampling station.

Reach 5

Reach five started at the confluence of the two tributaries forming Split Creek, and followed the north fork to an unmarked logging road crossing. The reach was classified as an A-3 channel type, with cobble substrate and riffle habitat (38.1% and 82.3%, respectively). Mean gradient was 7.9%. Mean stream width was 2.0 m and depth was 11.7 cm. Overall substrate embeddedness averaged 52.8%, and spawning sized gravels, present in 32.4% of transects, were 47% embedded. Sand and sediment were observed more frequently in this reach, likely the result of past logging and road building along the stream. Pool habitat occurred in 17.7% of transects and primary pool density was 17.8 pools/Km. Mean length, maximum depth, and residual depths were 2.8 m, 37.6 cm, and 34.1 cm, respectively. Large woody debris density was 18.3 pieces/100 m. No fish were collected in the reach five sampling station.

Reach 6

Reach six measured 1,020 meters ending when the stream became intermittent above an unmarked logging road. The channel was classified as Aa+4 with gravel and small gravel the dominant substrates (46.1% of transects, collectively). Mean embeddedness was 47.4%. Gradient averaged 14.0%, and ranged from 5.5% to 23.5%. Mean stream width was 1.1 m and depth was 8.0 cm. Riffle was the dominant habitat type (83.6%). Acting LWD and primary pool densities were 19.4 pieces/100 m and 10.8 pools/Km, respectively. On average, primary pools were the smallest of any reach (mean length 2.8 m, maximum depth 33.7 cm, and residual depth 30.3 cm).

Several potential barriers were present in the reach. One culvert with an 11% pipe gradient, emptying onto bedrock was identified as a potential barrier. Seven falls ranging from 1.2 m to 2.0 m were also identified as potential barriers. No fish were collected in the reach six sampling station.

Tributaries to Bead Lake

Lodge Creek

Four tributaries to Bead Lake were investigated in 2002, including Lodge and West Lodge Creeks, a tributary of Lodge Creek. Lodge Creek is the largest perennial tributary to Bead Lake, and the only stream thought to be suitable for adfluvial salmonid migration. Two reaches were surveyed in Lodge and one reach in West Lodge. The survey started just upstream of the inlet to Bead Lake, south of the Forest Service Trail #127 (elevation 866 m). The confluence of Lodge and West Lodge is at elevation 902 m, the end of the Lodge Creek survey was at 988 m, and the end of the West Lodge Creek survey was at 1,109 m.

The mean of each channel characteristic and habitat attribute of Lodge and West Lodge Creeks were calculated and appear in Table 8. Lodge Creek averaged 1.5 m in width and 8.3 cm in depth. Gradient ranged from 2.5% to 16.0% (mean=8.9%). The dominant substrate was cobble (63.9%) and embeddedness averaged 45.0%. Embeddedness of spawning size gravels, which accounted for 14.4% of the substrate, averaged 55.0%. Riffle was the dominant habitat type in 48.3% of transects. Pool habitat was recorded in 32.6% of transects, and primary pool density was 12.9 pools/Km. Mean pool length, maximum depth, and residual depths were 2.5 m, 37.0 cm, and 33.2 cm, respectively.

Table 8. Channel characteristics and habitat attributes of Lodge Creek, West Lodge Creek, and an unnamed tributary to Bead Lake, 2002.

	Lodge Creek			West Lodge Creek	Bead Lake Trib
	1	2	Total	1	1
Length (m)	540	780	1320	1140	300
No. Transects	9	13	22	19	5
Mean Width (m)	1.7	1.3	1.5	1.4	1.1
Mean Depth (cm)	11.2	6.4	8.3	9.1	10.0
Gradient (%):					
Mean	5.2	11.4	8.9	11.0	5.0
Min.	2.5	8.0	2.5	7.0	4.0
Max	10.0	16.0	16.0	15.0	6.5
Channel Type	A-3	Aa+3		Aa+3	A-3
Temp (C):					
Air	21.0	24.0		16.0	17.5
Stream	9.5	10.0		10.0	9.0
Acting LWD (#/100 m)	12.0	15.1	13.9	13.3	10.0
Habitat Type:					
Pool (%)	3.2	60.4	32.6	16.6	56.4
Mean Pool Width	0.5	1.2	1.2	1.4	1.6
Riffle (%)	57.4	39.6	48.3	74.1	18.2
Mean Riffle Width	1.5	1.3	1.4	1.3	0.5
Run (%)	39.4	0.0	19.1	9.3	25.5
Mean Run Width	1.5		1.5	1.2	1.4
Substrate Embeddedness (%):					
Mean	37.3	51.5	45.0	68.3	37.5
Min.	10.0	25.0	10.0	10.0	10.0
Max.	100.0	100.0	100.0	100.0	100.0
Substrate Composition:					
Boulders (%)				16.9	
Cobble (%)	71.6	56.7	63.9	38.2	74.5
Gravel (%)	12.3	16.5	14.4	5.4	0
Small Gravel (%)	11.6	16.5	14.1	32.8	0
Silt (%)	4.5	10.4	7.5	6.6	25.5
Primary Pools:					
No.	5	12	17	22	11
Density (#/km)	9.3	15.4	12.9	19.3	36.7
Mean Length (m)	2.9	2.3	2.5	2.1	3.2
Mean Max. Depth (cm)	41.2	35.3	37.0	31.5	40.7
Mean Tailout Depth (cm)	4.8	3.4	3.8	3.2	6.4
Mean Residual Depth (cm)	36.4	31.8	33.2	28.3	34.4
Pool/Riffle Ratio	0.1:1	1.6:1	0.8:1	0.2:1	1.0:1

Stream temperature was measured hourly between 26 June and 7 October 2002 (Figure 12). Mean daily temperature was 9.9 °C (n=2476, SD=1.5). The maximum temperature recorded was 13.3 °C on 13 July. The minimum temperature, recorded on 2 October, was 5.1 °C. Discharge of Lodge Creek measured 0.009 m^3/sec. On September 9th.

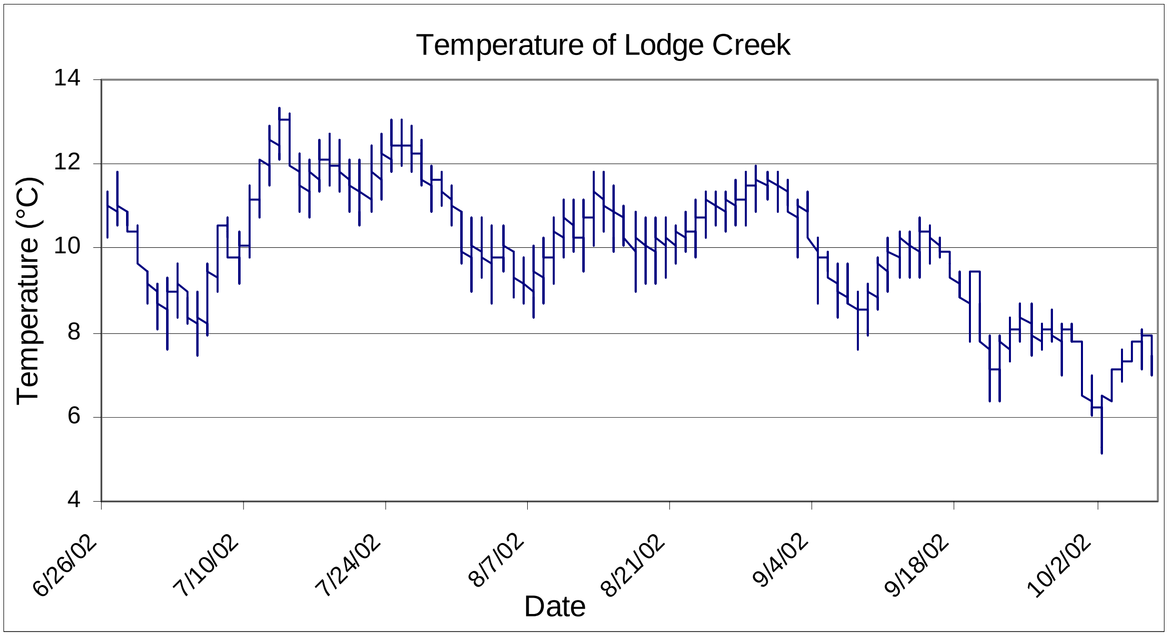

Figure 12. Stream temperatures recorded in Lodge Creek, 2002.

Two 100-meter electrofishing stations were established in Lodge Creek and one in West Lodge Creek. Brook trout was the only species collected; no fish were captured in reach 2 of Lodge Creek or reach 1 of West Lodge Creek. Brook trout lengths ranged from 52-224 mm TL with a mean of 101.5 mm TL (±33.0; n=53) (Figure 13). Density of brook trout in reach 1 was 48.8 fish/100 m^2.

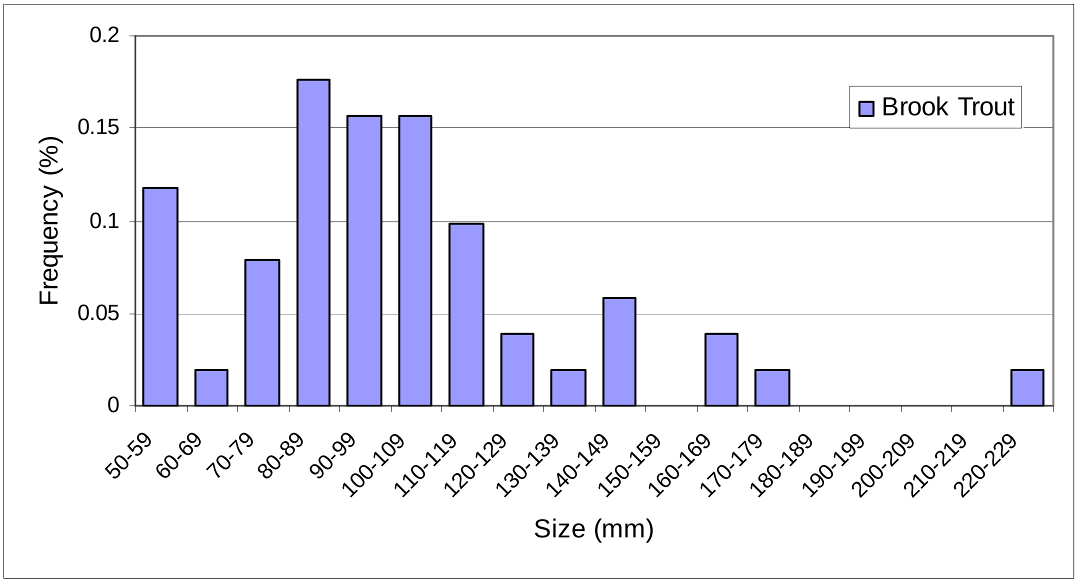

Figure 13. Length-frequency distribution of brook trout sampled in Lodge Creek.

Reach 1

Reach one measured 540 m from Bead Lake to the confluence of Lodge and West Lodge Creeks. The channel was classified as A-3, with cobble the dominant substrate (71.6%). Mean gradient was 5.2%, and ranged from 2.5-10.0%. Mean stream width was 1.7 m, and depth was 11.2 cm. Riffle and run habitats accounted for 57.4% and 39.4% of the habitats recorded at transects, respectively. Pool habitat was recorded in 3.2% of transects and primary pool density was low (9.3 pools/Km). Primary pool lengths averaged 2.9 m, maximum depth was 41.2 cm, and residual depth was 36.4 cm. Acting LWD density was also relatively low at 12.0 pieces/100 m. Overall, embeddedness in reach 1 (37.3%) was lower than the upper watershed, although embeddedness of spawning sized gravels averaged 80%, considered outside the threshold limit for salmonid spawning. Sediment loading in pools, attributed to logging practices, is impacting the stream in reach one.

Reach 2

Reach two started at the confluence of Lodge and West Lodge Creeks and extended 780 m upstream to springs and intermittent stream flows, just north of the point where Forest Service Trail #127 switches back and cuts uphill to the west. The stream is much smaller above the confluence as indicated by wetted width and depth (1.3 m and 6.4 cm, respectively). The channel was classified as Aa+3, with step pool morphology. Gradient averaged 11.4%, and cobble was the dominant substrate (56.7%). Overall, more silt was present in the reach contributing to higher mean embeddedness (mean=51.5%), although spawning sized gravels were within threshold limits for embeddedness (42.5%) and dominant in 16.5% of transects. Pool habitat was recorded in 60.4% of transects and primary pools were more abundant (15.4 pools/Km). Primary pools were generally smaller than in reach one (2.3 m mean length, 35.3 cm mean maximum depth, and 31.8 cm mean residual depth). Electrofishing of one 100-meter station resulted in no fish being collected, despite no passage barriers being identified.

West Lodge Creek

Reach one of West Lodge Creek measured 1,140 m from the confluence with Lodge Creek to the headwater springs south of Forest Service Road #3215. Stream habitat in West Lodge and reach two of Lodge Creek were very similar. The channel was classified as Aa+3 and cobble was the dominant substrate (38.2%). Average embeddedness was higher in West Lodge, averaging 68.3%. Acting LWD density was 13.3 pieces/100 m, and primary pools were more abundant (19.3 pools/Km). Unlike upper Lodge Creek, riffle was the dominant habitat type (74.1%). No fish were collected in 100 m of electrofishing effort.

Unnamed Tributaries to Bead Lake

Two unnamed tributaries to Bead Lake were investigated in 2002. The first tributary was dry at the time of the survey (19 August). The second tributary originated from a hillside spring 300 meters upstream of Forest Service Trail #127. There was no water in the channel above that point. It appeared that springtime flows from mountain run-off are very high in the narrow stream valley, as evidenced by large debris jams, boulder piles, deeply incised unstable banks, and deep plunge pools typical of high energy ephemeral systems. The reach from the lake to the spring measured 300 m and was classified as an A-3 type channel. Cobble was the dominant substrate (74.5%), with embeddedness averaging 37.5%. Mean stream width, depth, and gradient were 1.1 m, 10.0 cm, and 5.0%, respectively. Pool was the dominant habitat type (56.4% of transects) and primary pool density was high (36.7 pools/Km). Although large woody debris jams were present, LWD density was relatively low (10.0 pieces/100 m). Our protocol is to count debris jams causing one particular effect on the stream as a single piece of LWD (KNRD 1997). No fish sampling was conducted due to limited habitat availability and low flow.

Burnt Creek

Three reaches totaling 3.36 km were surveyed in Burnt Creek in 2002. The survey started at the inlet to Marshall Lake (elevation 841 m), and ended at the headwater springs just north of Forest Service Road #346 (elevation 1207 m). Past logging activities were the primary disturbance observed in the watershed. Reaches one and two were located on the mainstem Burnt Creek, and reach three was located on an unnamed, right-bank tributary. A summary of channel characteristics and habitat attributes recorded for Burnt Creek appears in Table 9.

Mean wetted width of Burnt Creek was 1.6 m and depth was 10.0 cm with cobble and small gravel the dominant substrates (30.0% and 25.3% of transects, respectively). Overall, substrate embeddedness was relatively low (mean=57.5%), although it increased farther up the watershed. Embeddedness of small gravel, suitable for salmonid spawning, averaged 78.3%. Riffle was the dominant habitat type (70.5%). Mean channel gradient was 13.3% and ranged from 0.1% to 35.0%. Primary pool density averaged 13.4 pools/Km, with mean length, maximum depth, and residual depths of 2.2 m, 36.3 cm, and 29.6 cm, respectively. Acting LWD was fairly common (15.8 pieces/100 m).

Stream temperature was measured hourly between 25 June and 7 October 2002 (Figure 14). Mean daily temperature was 10.37 °C (n=2,497, SD=1.89). The maximum temperature recorded was 14.6 °C on 13 July. The minimum temperature, recorded on 2 October, was 4.4 °C. Discharge of Burnt Creek measured 0.01 m^3/sec on September 9th, 2002.

One 100-meter electrofishing station was sampled in Burnt Creek. Cutthroat trout (presumably westslope cutthroat trout; from WDFW hatchery records, unpublished) was the only species collected. The mean length of fish collected was 58.4 mm TL (n=62, SD=36.7), and ranged from 31-151 mm TL (Figure 15). Fish sampling of the upper watershed was limited to minnow traps baited with salmon roe. Four traps were set in reach two for one night (60 total trap hours). No fish were captured using this gear, although one cutthroat trout was observed in a small pool in reach two during the habitat assessment. Fin tissue samples were taken from 28 fish and sent to the WDFW genetics laboratory in Olympia, Washington for analysis. This data was collected in conjunction with a separate BPA funded project entitled "Genetic Inventory of Bull Trout and Westslope Cutthroat Trout in the Pend Oreille Subbasin" and results will be reported in that projects annual report.

Table 9. Channel characteristics and habitat attributes of Burnt Creek, 2002.

	Reach			
	1	2	3	Total
Length (m)	1500	1080	780	3360
No. Transects	25	18	13	56
Mean Width (m)	2.2	1.1	1.3	1.6
Mean Depth (cm)	14.0	6.9	6.8	10.0
Gradient (%):				
Mean	8.1	19.3	15.1	13.3
Min.	0.5	10.0	5.5	0.5
Max	15.0	35.0	24.0	35.0
Channel Type	A-4/Aa+3	Aa+4	Aa+4	
Temp (C):				
Air	24.0	27.0	23.5	
Stream	11.0	10.0	10.0	
Acting LWD (#/100 m)	13.6	21.6	12.2	15.8
Habitat Type:				
Pool (%)	10.4	28.4	19.6	16.5
Mean Pool Width	1.9	1.1	1.6	1.4
Riffle (%)	73.6	64.2	67.5	70.5
Mean Riffle Width	2.1	0.9	1.2	1.5
Run (%)	15.2	7.4	12.9	13.1
Mean Run Width	2.1	1.4	1.1	1.7
Substrate Embeddedness (%):				
Mean	46.5	64.7	69.2	57.5
Min.	5.0	0.0	20.0	0.0
Max.	100.0	100.0	100.0	100.0
Substrate Composition:				
Boulder (%)	12.7	13.4	16.6	13.6
Cobble (%)	42.0	13.4	9.2	30.0
Gravel (%)	11.8	9.6	40.5	16.6
Small Gravel (%)	15.3	49.7	30.1	25.3
Sand (%)	5.2	0.0	0.0	3.1
Silt (%)	12.9	13.9	3.7	11.4
Primary Pools:				
No.	25	13	7	45
Density (#/km)	16.7	12.0	9.0	13.4
Mean Length (m)	2.6	1.9	1.1	2.2
Mean Max. Depth (cm)	44.8	25.5	25.7	36.3
Mean Tailout Depth (cm)	8.7	3.8	5.0	6.7
Mean Residual Depth (cm)	36.1	21.8	20.7	29.6
Pool/Riffle Ratio	0.1:1	0.3:1	0.2:1	0.2:1

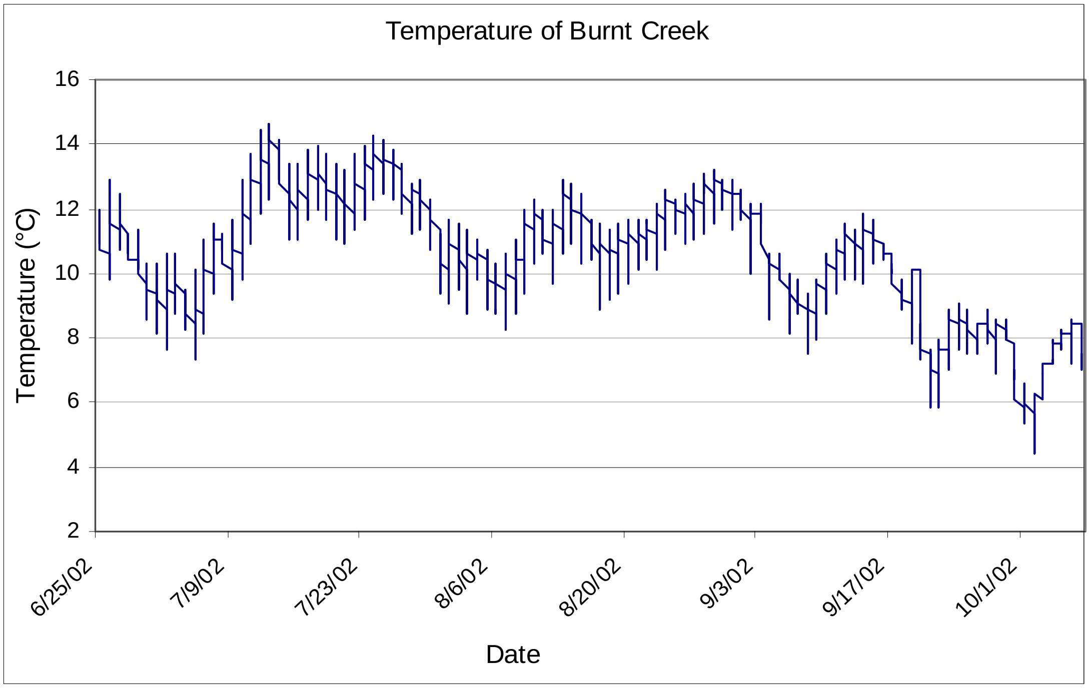

Figure 14. Hourly stream temperatures recorded in Burnt Creek, 2002.

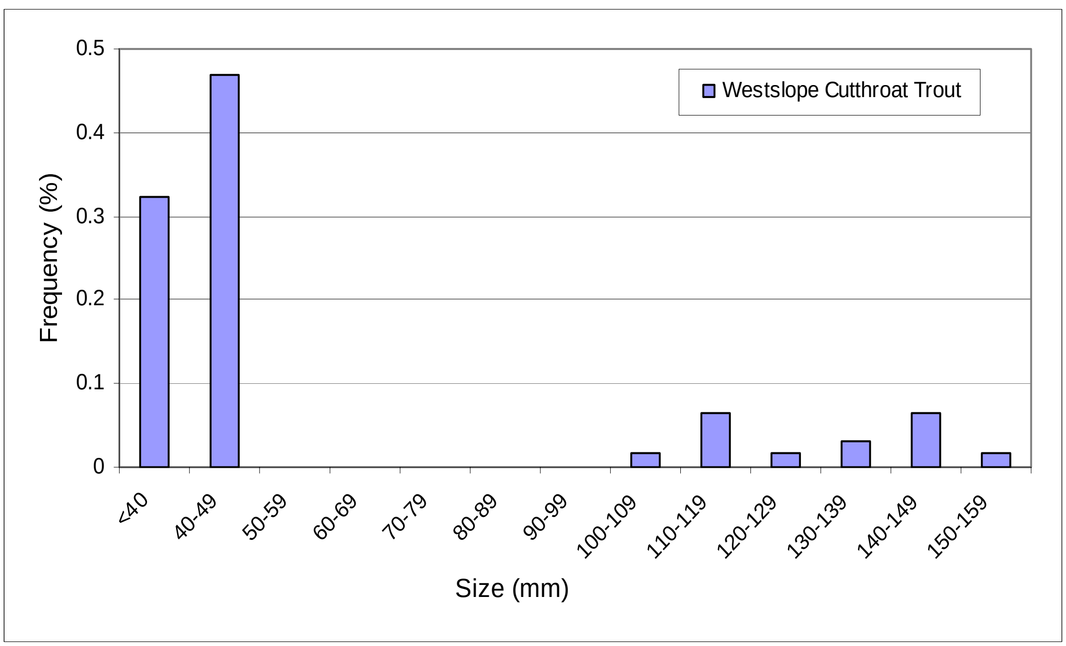

Figure 15. Length-frequency distribution of westslope cutthroat trout sampled in Burnt Creek.

Reach 1

Reach one was classified as an A-4/Aa+3 type channel that extended from the mouth of Burnt Creek to the confluence with an unnamed right-bank tributary 1500 m upstream. Mean stream width was 2.2 m, and depth was 14.0 cm. Gradient ranged from 0.5-15.0% (mean=8.1%). Cobble was the dominant substrate (42.0%), and embeddedness averaged 46.5%. Riffle was the dominant habitat type (73.6%) with pools and runs recorded in 10.4% and 15.2% of transects, respectively. Primary pool and LWD densities were 16.7 pools/Km and 13.6 pieces/100 m, respectively.

The estimated density of cutthroat trout >50 mm TL in reach one was 5.9 fish/100 m^2. An estimate of the true population size, including fish <50 mm TL (79% of the total take), would be much higher, but those fish were excluded from population estimate because they have been observed traveling through the mesh of blocknets (McLellan 2003).

Reach 2

Reach two measured 1080 m and was classified as an Aa+4 type channel. The survey ended at springs located north of Forest Service Road #346. The culvert under this road was identified as a definite barrier, with a gradient of 40% and high water velocity. Gradient in reach two ranged from 10.0-35.0%, and averaged 19.3%. Mean stream width and depth was 1.1 m and 6.9 cm, respectively. Riffle was the dominant habitat type (64.2%), and small gravel was the dominant substrate (49.7%). Substrate embeddedness was higher in reach two (64.7%). Acting LWD was abundant at 21.6 pieces/100 m. Pools accounted for 28.4% of the habitat, although primary pool density and mean sizes were low (12.0 pools/Km, mean length 1.9 m, maximum depth 25.5 cm, and residual depth 21.8 cm). No fish were collected in minnow traps placed throughout reach two, although one cutthroat trout was observed in reach two during the habitat assessment.

Reach 3

Reach three was the unnamed tributary that entered Burnt Creek at the top of reach one. Seven hundred-eighty meters were surveyed in the tributary. The channel was classified as Aa+4, with gravel and small gravel substrates in 40.5% and 30.1% of transects, respectively. Mean embeddedness was the highest of the three reaches (69.2%). Mean stream width was 1.3 m and depth was 6.8 cm. Like the other two reaches, riffle was the dominant habitat (67.5%). Pool habitat and primary pools were sparse, pools accounted for 19.6% of the habitat and primary pools density was 9.0 pools/Km. Reach three became intermittent after 300 m. It appears that low flow, abundant small woody debris accumulation in the stream, and increased sedimentation in the upper watershed may be limiting habitat quality in Burnt Creek.

Lake Fishery Assessments

Baseline fishery assessments were conducted in Conger, Davis, Mountain Meadows, Power, and North and South Skookum Lakes in 2002. There were 407 individuals representing 12 species of fish collected (Table 10). Catch-per-unit-effort (CPUE), relative abundance, and condition indices were calculated for each species and gear type within each lake. Brook trout and rainbow trout (*Oncorhynchus mykiss*) were the most abundant species (n=236, 58% relative abundance for brook trout and n=43, 10.6% relative abundance for rainbow trout).

Table 10. Common and scientific name, number collected, and total relative abundance of fish collected in five Pend Oreille County lakes, 2002.

Common Name	Scientific Name	Number Captured	Relative Abundance
Salmonidae			
Brook trout	*Salvelinus fontinalis*	236	58.0%
Rainbow trout	*Oncorhynchus mykiss*	43	10.6%
Kokanee	*Oncorhynchus nerka*	2	0.5%
Cyprinidae			
Northern pikeminnow	*Ptychocheilus oregonensis*	2	0.5%
Tench	*Tinca tinca*	3	0.7%
Catostomidae			
Largescale sucker	*Catostomus macrochirus*	2	0.5%
Centrarchidae			
Black crappie	*Poximus nigromaculatus*	9	2.2%
Blugill	*Lepomis macrochirus*	3	0.7%
Pumpkinseed	*Lepomis gibbosus*	24	5.9%
Largemouth bass	*Micropterus salmoides*	30	7.4%
Ictaluridae			
Brown bullhead	*Ictalurus nebulosus*	29	7.1%
Percidae			
Yellow perch	*Perca flavescens*	24	5.9%

Conger Lake

One horizontal floating gillnet was deployed in Conger Lake for a duration of four hours. Two species were collected: brown bullhead and rainbow trout. Rainbow trout was the most abundant species based on relative abundance (67%) and CPUE (1.5 fish/hour). Relative weight, condition factor, and mean size (range) were calculated for each species and appear in Table 11, although sample sizes were too small for accurate interpretation.

Table 11. Relative abundance, CPUE, mean total length (± SD), size range, mean relative weight (Wr, ± SD), and condition factor (K_{TL}, ± SD) of fish collected in Conger Lake, 2002.

Species	n	Relative Abundance (%)	CPUE (#/hour)	Mean TL mm (± SD)	Size Range (mm TL)	Mean Wr (± SD)	Mean K_{TL} (± SD)
Rainbow trout	6	67	1.5	158 (46)	115-215	86.4 (34.5)	1.1 (0.3)
Brown bullhead	3	33	0.75	156 (29)	123-172	103 (3.1)	1.5 (0.1)

Davis Lake

Nine species of fish were collected in Davis Lake. Catch-per-unit-effort, relative abundance, mean lengths, and condition indices were calculated and appear in Table 12. Largemouth bass was the most abundant species based on CPUE (34.8 fish/hour electrofishing) and relative abundance (33%, n=29), although no largemouth bass were collected gillnetting. The majority of the fish collected electrofishing in Davis Lake were located in two 400 m transects along the shallow southwest end of the lake. Water depth in three of five transects were too deep for effective sampling with this gear. Pumpkinseed had the second highest CPUE in the electrofishing surveys (21.6 fish/hour, 22% relative abundance, n=19).

Yellow perch was the most abundant species collected in littoral gillnets (0.33 fish/hour, 25% relative abundance, n=22), and were fairly well represented in electrofishing transects (19.2 fish/hour). Two individual kokanee were collected in pelagic gillnets. The fish were 225 mm TL and 242 mm TL, respectively, and captured at depths of 7.5 m and 12.5 m.

The mean relative weights (Wr) of largemouth bass, pumpkinseed, and yellow perch were 100.6 (SD=10.0), 86.1 (SD=25.5), and 76.9 (SD=7.2), respectively. Relative weights of pumpkinseed and yellow perch were below the national standard of 100. Relative weights of individual fish are presented in Figure 16.

Table 12. Relative abundance, CPUE, mean total length (± SD), size range, mean relative weight (Wr, ± SD), and condition factor (K_{TL}, ± SD) of fish collected in Davis Lake, 2002 (E-F; boat electrofishing, L-G; littoral gillnetting, P-G; pelagic gillnetting, nc; not calculable).

Species	n	Relative Abundance (%)	CPUE (#/hour)			Mean TL mm (± SD)	Size Range (mm TL)	Mean Wr (± SD)	Mean KTL (± SD)
			E-F	L-G	P-G				
Brown bullhead	2	2		0.11		187 (5.6)	183-191	112.8 (2)	1.64 (.03)
Black crappie	1	1		0.05		224 (nc)	224	49.7 (nc)	0.77 (nc)
Kokanee	2	2			0.13	233.5 (12.0)	225-242	nc	.87 (1)
Largemouth bass	29	33	34.8			174.3 (139.9)	21-466	100.6 (10)	1.50 (.25)
Largescale sucker	2	2	2.4			468.5 (23.3)	452-485	nc	.87 (.04)
Northern pikeminnow	2	2	1.2	0.05		305 (34.6)	281-330	nc	.72 (.07)
Pumpkinseed	19	22	21.6	0.05		111 (23)	67-164	86.1 (25.5)	1.74 (.52)
Tench	3	3	1.2	0.11		301.3 (99)	187-359	nc	1.45 (.11)
Yellow perch	22	25	19.2	0.33		114.6 (57.5)	37-222	76.9 (7.2)	.98 (.11)

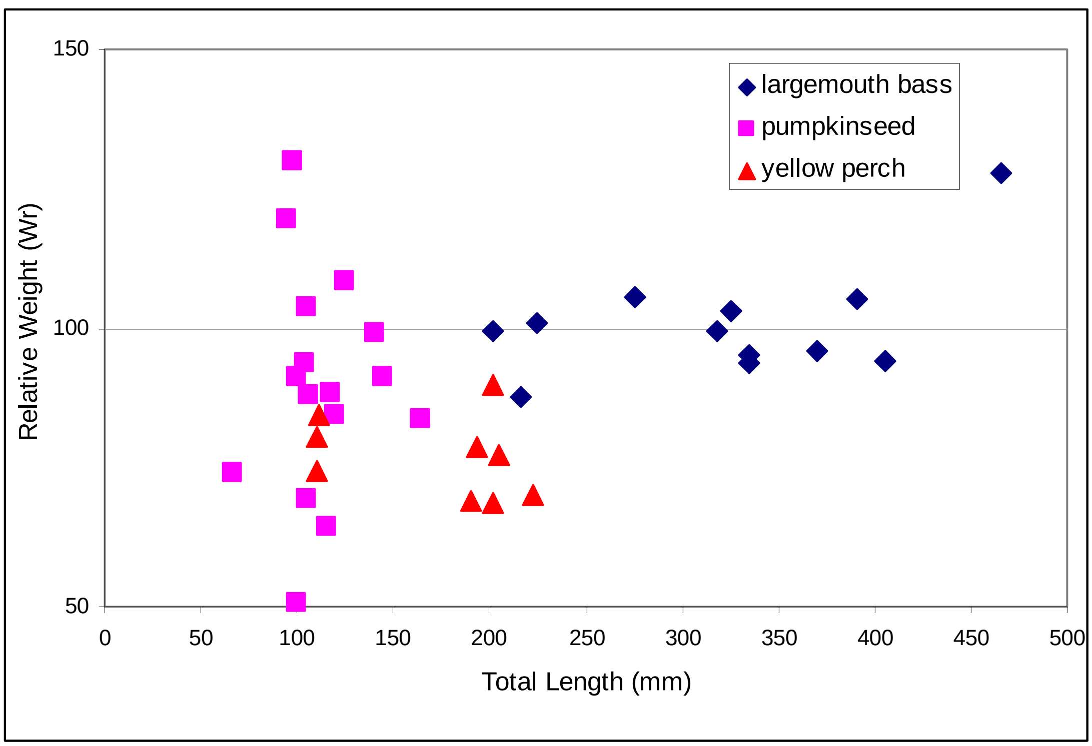

Figure 16. Relative weights of largemouth bass, pumpkinseed, and yellow perch collected in Davis Lake, 2002.

Mountain Meadow Lake

Three horizontal gillnets were set in the littoral zone of Mountain Meadow Lake for a total of 7.0 net hours. Five species of fish were collected, including (in declining order of abundance): black crappie, brown bullhead, pumpkinseed, yellow perch, and largemouth bass. Black crappie was the most abundant species collected based on relative abundance (47%) and CPUE (1.14 fish/hour) (Table 13). With the exception of brown bullhead, all species had mean relative weights below the national standard of 100 (Figure 17).

Table 13. Relative abundance, CPUE, mean total length (± SD), size range, mean relative weight (Wr, ± SD), and condition factor (K_{TL}, ± SD) of fish collected in Mountain Meadows Lake, 2002 (nc; not calculable).

Species	n	Relative Abundance (%)	CPUE (#/hour)	Mean TL mm (± SD)	Size Range (mm TL)	Mean Wr (± SD)	Mean K_{TL} (± SD)
Black crappie	8	47	1.14	217 (9.8)	199-230	87.5 (3.9)	1.35 (.05)
Brown bullhead	4	24	0.57	243 (29.8)	241-279	109 (11.3)	1.6 (.16)
Pumpkinseed	2	12	0.29	122 (17.1)	124-138	98.3 (17.1)	1.77 (.63)
Yellow perch	2	12	0.29	183 (111)	104-262	96.6 (nc)	1.16 (nc)
Largemouth bass	1	6	0.14	282 (nc)	282	91.1 (nc)	1.29 (nc)

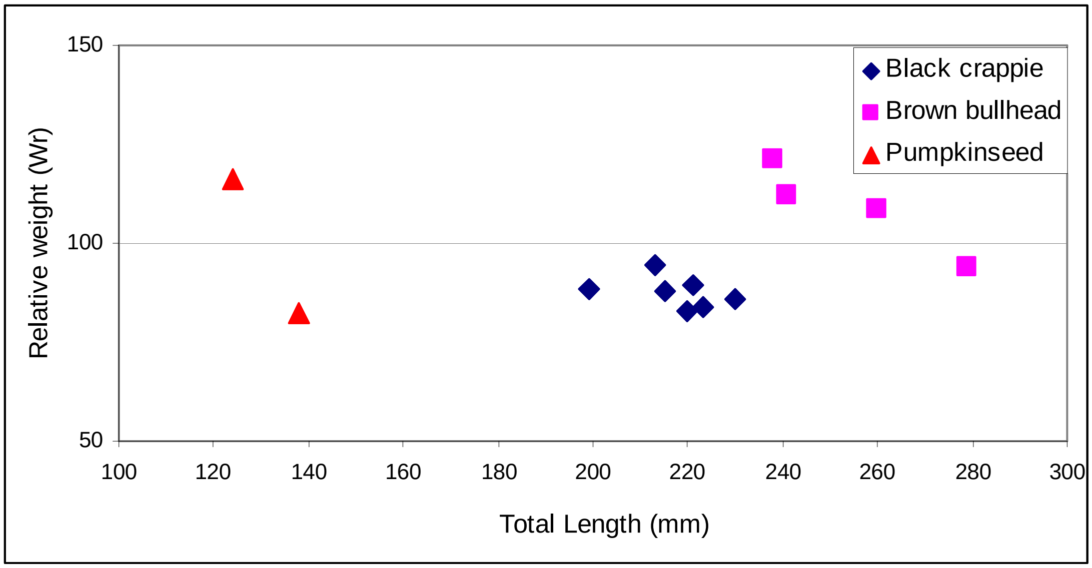

Figure 17. Relative weights of black crappie, brown bullhead, and pumpkinseed collected in Mountain Meadows Lake, 2002.

Power Lake

Four horizontal gillnets were placed in the littoral zone of Power Lake for a total of 10.0 net hours. Five species of fish were collected (in declining order of abundance): brown bullhead, rainbow trout, bluegill, pumpkinseed, and brook trout. Catch-per-unit-effort, relative abundance, mean lengths, and condition indices were calculated and appear in Table 14. Brown bullhead was the most abundant species based on CPUE, 2.0 fish/hour (n=20), and relative abundance of 57%. Net #1, located in shallow water near the inlet of Calispell Creek, contained 90% of the bullhead captured, and zero salmonids. Mean relative weights of all species except rainbow trout were above the national standard of 100 (Figure 18). Rainbow trout had an average relative weight of 80.5, and no fish had relative weight >100, indicating inter-intra specific competition for available food resources.

Table 14. Relative abundance, CPUE, mean total length (± SD), size range, mean relative weight (Wr, ± SD), and condition factor (K_{TL}, ± SD) of fish collected in Power Lake, 2002 (nc; not calculable).

Species	n	Relative Abundance (%)	CPUE (#/hour)	Mean TL mm (± SD)	Size Range (mm TL)	Mean Wr (± SD)	Mean KTL (± SD)
Brown bullhead	20	57	2.0	185.8 (22.5)	163-256	117.9 (21)	1.71 (.29)
Rainbow trout	8	23	0.8	246 (35)	216-316	80.5 (9.1)	.96 (.10)
Bluegill	3	9	0.3	118 (2.8)	116-120	108.2 (.4)	2.06 (.02)
Pumpkinseed	3	9	0.3	123 (3.6)	120-127	107.1 (2.2)	2.21 (.03)
Brook trout	1	3	0.1	224 (nc)	224	104.6 (nc)	1.09 (nc)

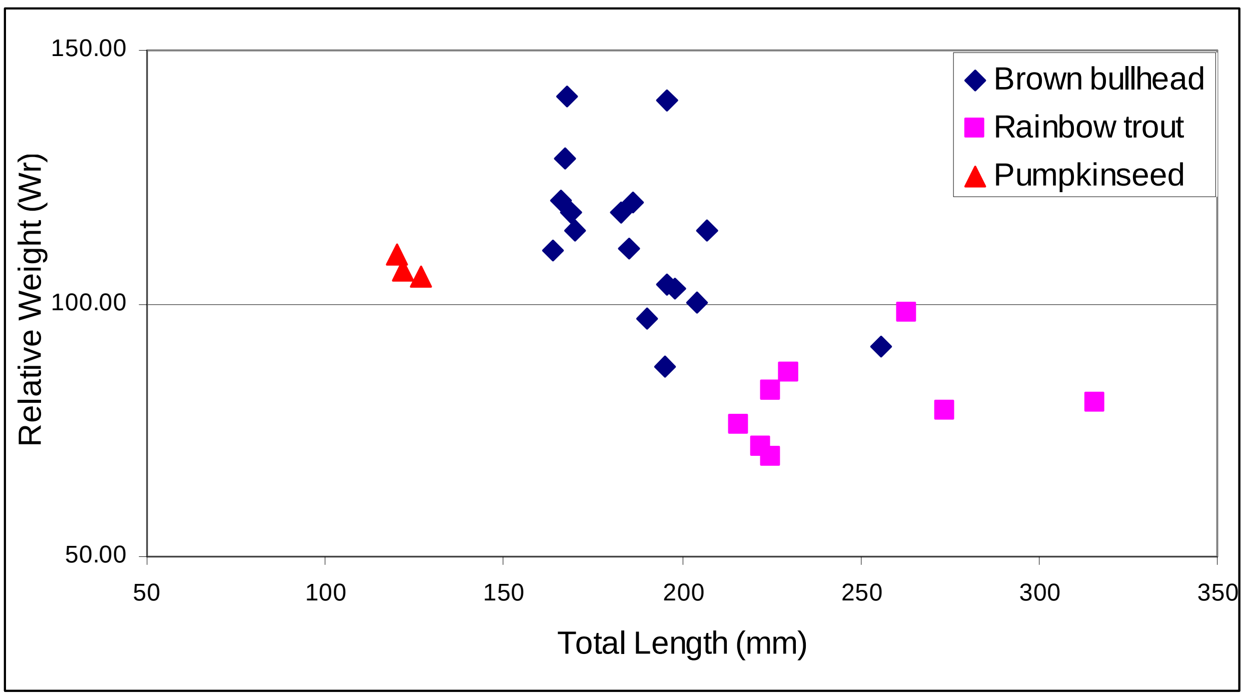

Figure 18. Relative weights of brown bullhead, rainbow trout, and pumpkinseed collected in Power Lake, 2002.

North Skookum Lake

Four horizontal gillnets were placed in the littoral zone of North Skookum Lake for a total of 12.75 net hours. Two species of fish were collected, brook trout and rainbow trout. Catch-per-unit-effort, relative abundance, mean lengths, and condition indices were calculated and appear in Table 15. Brook trout was the most abundant species based on a CPUE of 12.39 fish/hour (n=158), and relative abundance of 95%, compared to relative abundance of 5% (n=8) and CPUE of 0.63 fish/hour for rainbow trout. Mean relative weights of both species were slightly below the national standard of 100 (brook trout; 98.3, rainbow trout; 94.8) (Figure 19). Two distinct size/age classes of brook trout were present in the length-frequency distribution (Figure 20). One age class was centered on 115 mm and the other around 225 mm. No fish were collected between 140-199 mm.

Table 15. Relative abundance, CPUE, mean total length (± SD), size range, mean relative weight (Wr, ± SD), and condition factor (K_{TL}, ± SD) of fish collected in North Skookum Lake, 2002.

Species	n	Relative Abundance (%)	CPUE (#/hour)	Mean TL mm (± SD)	Size Range (mm TL)	Mean Wr (± SD)	Mean K_{TL} (± SD)
Brook trout	158	95	12.39	186.5 (56.3)	95-272	98.3 (12.2)	1.02 (.13)
Rainbow trout	8	5	0.63	259 (86.2)	120-412	94.8 (16.4)	1.13 (.20)

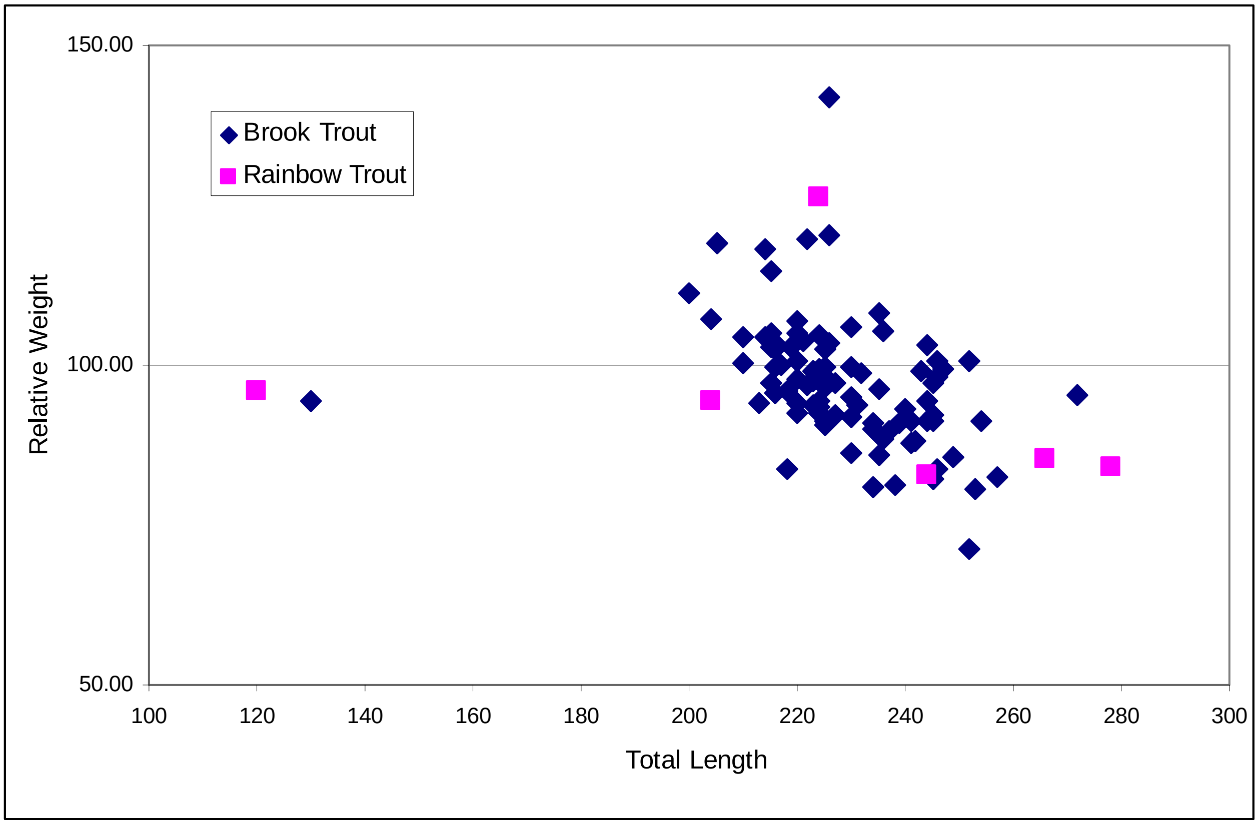

Figure 19. Relative weights of brook trout and rainbow trout collected in North Skookum Lake, 2002.

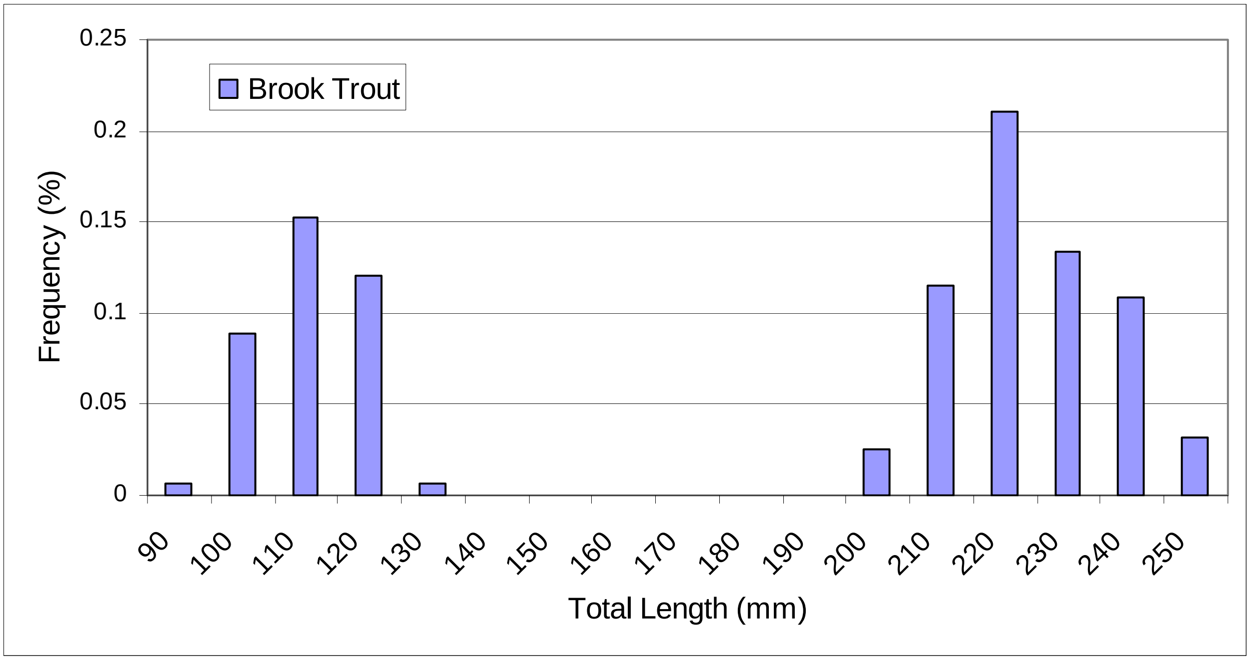

Figure 20. Length-frequency distribution of brook trout collected in North Skookum Lake, 2002.

South Skookum Lake

Four horizontal gillnets were placed in the littoral zone of South Skookum Lake for a total of 16.0 net hours. Two species of fish were collected, brook trout and rainbow trout. Catch-per-unit-effort, relative abundance, mean lengths, and condition indices were calculated and appear in Table 16. Brook trout was the most abundant species based on CPUE, 4.81 fish/hour (n=77), and relative abundance of 79%, compared to relative abundance of 21% (n=21) and CPUE of 1.31 fish/hour for rainbow trout. Mean relative weights of both species were slightly below the national standard of 100 (brook trout; 96.5, rainbow trout; 91.8) (Figure 21). Two distinct size/age classes of brook and rainbow trout were present in the length-frequency distribution (Figure 22). Similar to North Skookum Lake, the lengths between 130-180 mm were under-represented or absent.

Table 16. Relative abundance, CPUE, mean total length (± SD), size range, mean relative weight (Wr, ± SD), and condition factor (K_{TL}, ± SD) of fish collected in South Skookum Lake, 2002.

Species	n	Relative Abundance (%)	CPUE (#/hour)	Mean TL mm (± SD)	Size Range (mm TL)	Mean Wr (± SD)	Mean K_{TL} (± SD)
Brook trout	77	79	7.81	212 (56.3)	105-260	96.5 (19.1)	1.0 (.20)
Rainbow trout	21	21	1.31	241 (33.8)	131-296	91.8 (10.1)	1.1 (.12)

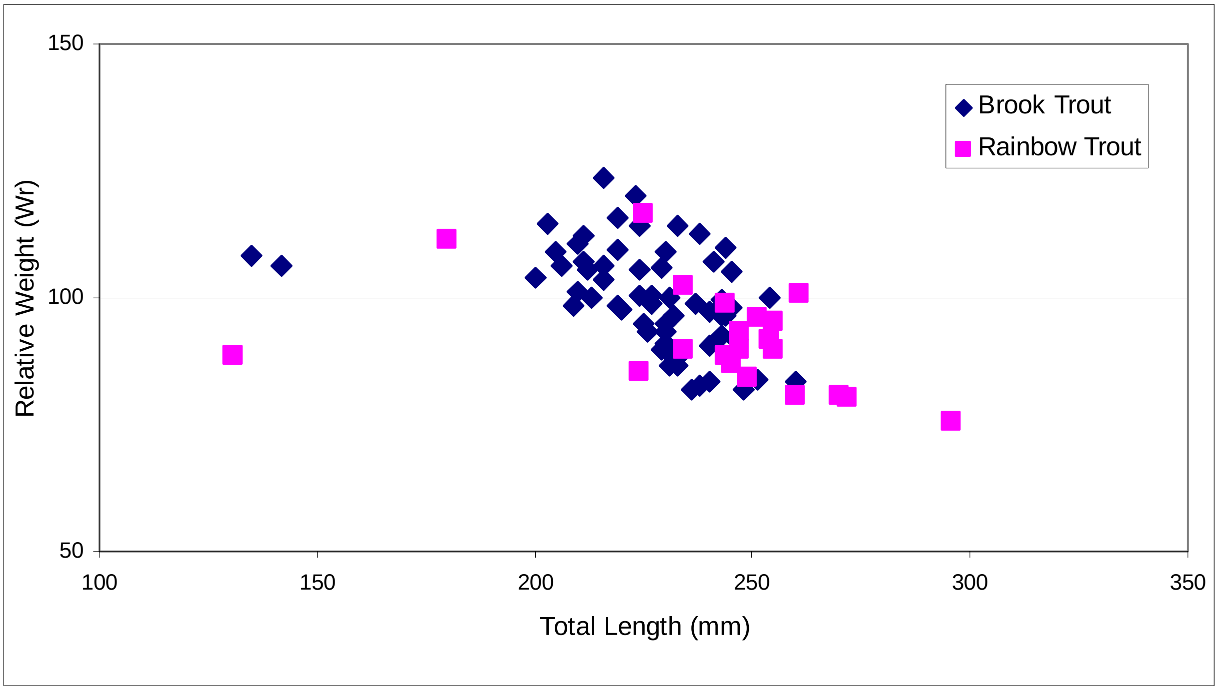

Figure 21. Relative weights of brook trout and rainbow trout collected in South Skookum Lake, 2002.

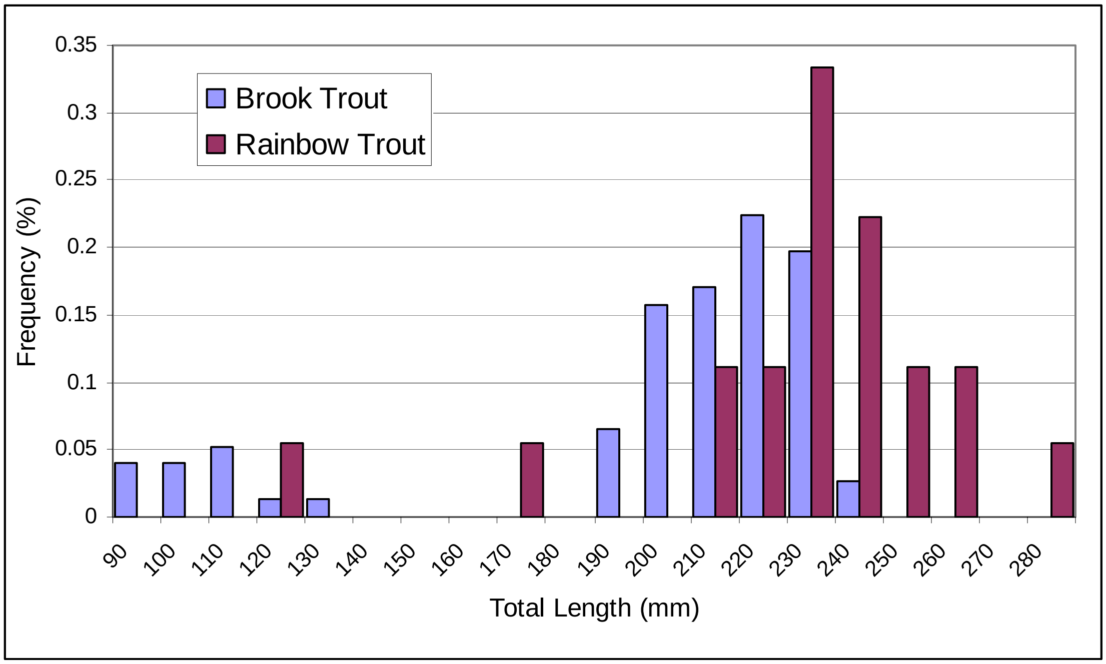

Figure 22. Length-frequency distribution of brook and rainbow trout collected in South Skookum Lake, 2002.

Discussion

Streams

Cusick Creek

The majority of streams that have been surveyed in the lower Pend Oreille River watershed, by this project and others, have been impacted by current and historic land use practices. Disturbances commonly documented include: logging, road construction and maintenance, residential development, livestock grazing, and agricultural development (Connor 2002, Andersen and Maroney 2000, 2001a, 2001b, Andersen and Olson 2002, McLellan 2001). Bracket and Cusick Creeks appear to have been impacted the heaviest by land use practices.

Livestock grazing on both public and private lands in the Cusick Creek watershed have caused bank instability and increased sediment delivery into the channel. Sand and/or silt were the dominant substrates in five of the seven reaches surveyed (45.9% overall composition, combined). Fine sediment limits salmonid reproduction, invertebrate production, species diversity, water quality, and stream depth (MacDonald et al. 1991, Beschta and Platts 1986, Hynes 1970). Although gravels were fairly common in Cusick Creek, spawning habitat was limited due to high embeddedness. Stream degradation is detrimental to native salmonids, it generally favors introduced salmonid species, which are more tolerant of lower quality habitat conditions.

Behnke (1979) described the distribution of native and non-native salmonids in the Smith River Drainage of Montana. In disturbed areas native westslope cutthroat trout were displaced by non-native brook trout. Only a small area in the headwaters of one stream, in pristine condition, was native cutthroat trout the dominant species. Similarly, no reaches surveyed in Cusick Creek contained cutthroat trout, but high densities of brook trout were encountered in nearly every reach.

Brook trout were stocked in Parker Lake between 1933 and 1992, and rainbow trout have been stocked annually since (WDFW unpublished hatchery records, Appendix

2). It appears that a self-reproducing population of brook trout is thriving in the lower reaches of Cusick Creek, as evidenced by fish densities (48.5-131.7 fish/100 m^2) and length-frequency distributions. There were two distinct age/size classes represented in the length-frequency distribution (age 0+ and age 1+). The gradual decline in frequency of fish greater than 120 mm TL indicates average survival of age 1+ fish.

Instream enhancement structures and riparian exclosure fences appear to have had marginal success improving fish habitat in Cusick Creek, although no data is known to have been collected to quantify the success of these enhancement efforts. These projects need to be monitored to evaluate success and guide future implementations. Moser and Colter (1997) monitored the effects of various enhancements in Clear Creek on the Fort Hall Reservation in Idaho, a low gradient, sinuous, spring creek characterized by silt substrate. They found that within two years of constructing a 2.5 Km exclosure fence bare streambank was reduced from a 30% frequency to less than 5%. The riparian zone showed regrowth of willows, dogwood and birch. Placement of rock wing dams and rootwads reduced surface fines and created clean gravels for spawning and invertebrate production. Wild trout populations were increased by 5-12 times and biomass by 3-4 times over pre-treatment conditions after seven years (Moser 1998).

Bracket Creek

Residential development, agriculture production, and passage barriers were impacting fish habitat quality in Bracket Creek. Private landowners limited access to the lower 1701 m of the stream. At least three permanent fish passage barriers were present in this reach. Upstream of the Baker Lake road culvert the channel has been straightened and entrenched for agriculture production. Stream temperature in Bracket Creek was the highest of any monitored in 2002, with maximum temperatures exceeding 20º C seven times in July, which may limit salmonid production.

Moderate quality habitat is limited to 1.1 Km of stream in the upper watershed between Turk Road and a private road culvert. Brook trout density was 38.6 fish/100 m^2, and the length-frequency distribution indicated two distinct size/age classes. There were fewer age 0^+ fish (<80 mm TL) compared to age 1^+ (70-120 mm TL), and the distribution was relatively consistent for fish between 120-200 mm TL indicating survival was high after the first year. No fish are known to have been planted in Bracket Creek at the time of this report, although a landowner indicated that two ponds along the stream, equipped with fish screens, had been stocked with rainbow trout.

Trimble Creek

Habitat in Trimble Creek ranged from a broad open-water slough, to meanders through agriculture and grazing land, to high gradient step-pool habitat. Summertime maximum stream temperature above the slough was 13.4 ºC. Logging and road construction appear to impact the upper watershed and contribute to sedimentation and high substrate embeddedness (62.1-89.5%). Substrate embeddedness greater than 20 percent decreases salmonid alevin emergence from the interstitial spaces by 30 to 40 percent (Hynes 1970). Localized roadbed sloughing appeared to contribute sediment to the channel in steep, narrow canyon sections of Sicily Road. Opportunities for habitat improvement exist to stabilize the roadbed (e.g. log crib and straw bale placements).

Placement of LWD and construction of wedge dams may also improve habitat in Trimble Creek, as large-woody debris and primary pool densities were relatively low (9.1 pieces/100 m and 13.9 pools/Km, respectively). Wedge dams will create sediment traps and calm water above, scour pools below, and possibly increase spawning gravel at the pool tailout (KNRD 1997). Artificial log structures were present in reaches five and six, although only three of seven were functioning properly. No known data has been collected on the success/failure of these structures and the effect they have had on fish populations. Structure design should be modified before any future implementation and monitored for effectiveness.

Brook trout was the only species captured in two 100-meter electrofishing stations in reaches five and six. In a survey conducted by the Forest Service in 1992, westslope cutthroat trout were collected (USFS unpublished data). Possible explanations for our findings (no cutthroat trout) are that westslope cutthroat trout were not recruited to our sampling gear, sampling effort was not adequate (spatially) to detect them, or they have been displaced by brook trout. Based on past electrofishing efforts, it is unlikely that westslope cutthroat were present in our sample stations and not detected. This and other projects (i.e. Kalispel Resident Fish Project) have routinely collected both species in stream reaches having sympatric populations.

It is also possible that our sampling effort was inadequate to detect westslope cutthroat trout. Hillman and Platts (1993) and Peterson et al. (2002) developed methods for detecting juvenile migratory bull trout (*Salvelinus confluentus*) and resident bull trout in streams small enough to employ block nets for sampling (approximately 5m or less wetted width). Although westslope cutthroat trout and bull trout exhibit different life history strategies and habitat usage, the methods described in Peterson et al. (2002) closely resemble our methodologies, and detection probabilities are assumed to be similar if the population size is small. Hillman and Platts (1993) suggested that 0.25 fish/100 m stream length be used as a density value for degree of rareness in a Poisson based formula. Under that assumption, nine 100 m stations would be required to detect at least 1 bull trout with 90% power (probability of detecting bull trout). I assume the density of westslope cutthroat trout to be higher than 0.25 fish/100 m, based on the Forest Service information from 1992. They sampled 45 m of stream near the Batey Bould ORV Park and captured 36 fish ranging in size from 25-200 mm TL corresponding to a density 80 fish/100 m (USFS, unpublished data). During our habitat assessment, field personnel noted one westslope cutthroat trout in a pool just upstream of the Batey Bould ORV Park, indicating they may, in fact, be present, but in much lower densities than in 1992.

Additionally, brook trout were absent from the 1992 survey of Trimble Creek (Tom Shuhda, pers. com.). Between 1984 and 1992 brook trout ranging in length from 69-100 mm were stocked in Conger Lake (WDFW hatchery records, appendix 2), possibly entraining downstream of the Conger Lake Dam. Interactions between brook and cutthroat trout have been well documented in the literature. Novinger and Rahel (1999) examined the competitive effects of brook trout on cutthroat trout in Colorado. Their findings indicated that age 0^+ brook trout had negative effects on growth and survival of age 0^+ cutthroat trout when held sympatrically in enclosures. Cummings (1987) studied the effects of competition between greenback cutthroat trout and brook trout in Colorado. In sympatry with brook trout, cutthroat trout juveniles occupied higher focal point velocities (water velocity at the fish's snout). After brook trout were removed, juvenile cutthroat trout (50-150mm) shifted to occupy significantly lower focal point velocities and distances to nearest cover, indicating brook trout excluded cutthroat trout from using more profitable stream positions, and had a competitive advantage. Of 202 stream reaches surveyed by the Kalispel Tribe between 1996 and 2001, only 70 (35%) contained cutthroat trout. Brook trout were present in over 50% of those 70 reaches, however, the eight highest cutthroat densities occurred in reaches containing no brook trout. This suggests interspecific competition may be impacting cutthroat trout in the Pend Oreille Watershed (Andersen and Maroney 2001). Additional sampling should be conducted in Trimble Creek to determine presence/absence of westslope cutthroat trout and implement management actions to preserve them.

Split Creek

Split Creek appeared to have the highest quality habitat, and the least human disturbance of the streams surveyed in 2002. Embeddedness was generally low (30.7-52.8%) in the upper watershed, and cobble and gravels were the dominant substrates (34.9% and 35.7%, respectively). Primary pool and LWD densities were both relatively high (20.7 pools/Km and 19.3 pieces/100 m, respectively). Mean temperature was 8.8 ºC and the maximum summertime temperature was 12.7 ºC.

Although habitat quality and quantity was adequate to support native salmonids, only non-native brook trout were collected electrofishing. The uppermost extent of fish bearing water was 0.6 Km upstream of Forest Service Road #128. A series of impassable falls and chutes have prevented colonization by brook trout, and no fish were collected or observed above the passage barriers. It is not known whether westslope cutthroat trout ever inhabited split creek, as this was the first study of the watershed. Several other streams in the Pend Oreille Watershed, though, contain isolated resident populations above natural or man-made passage barriers (KNRD Resident Fish Project). Barriers have been used as a management tool for maintaining isolated populations of cutthroat trout or reintroducing them to waters where they have been extirpated. Harig et al. (2000) assessed the success of translocations of greenback cutthroat trout in Colorado. One of the factors associated with successful translocations was isolation from non-native salmonids above natural or man-made barriers. Forty-eight percent of the failed translocations were the result of being re-invaded by non-native salmonids, which occurred most often because of failed artificial barriers or incomplete removal of non-native fish. Split Creek may be a good candidate for translocation of native cutthroat trout, because of its permanent isolation from brook trout above the barriers.

Tributaries to Bead and Marshall Lakes

Lodge Creek is the largest tributary to Bead Lake, and coupled with West Lodge Creek (tributary to Lodge), the only streams likely to support a resident or adfluvial fish population. Moderate densities of brook trout were recorded in Lodge Creek (48.8 fish/100 m), although fish were absent from the upper reach of Lodge and West Lodge Creeks. Based on the length-frequency distribution, Lodge Creek appears to support a small reproducing population of extant brook trout. Age 0^+ (<70 mm) and age 1^+ (70-130 mm) fish accounted for 86% of the total capture.

The only documented plant of brook trout into Bead Lake was in 1937. Kokanee were planted in large numbers between 1941 and 1949. Stocking was discontinued from 1950 to 1965, when the lake was stocked with 77,601 lake trout (*Salvelinus namaycush*). A plant of 133,000 "Russian sockeye" was made in 1966 (1,500 fish of unknown size; WDFW unpublished hatchery records, Appendix 2). Planting was stopped in 1966 because the plants did not produce much of a fishery. Also, access was limited until recently. Currently there are "adequate" populations of burbot (*Lota lota*), lake trout, and kokanee in the lake (Jason McLellan pers. com.).

Burnt Creek is the only perennial tributary into Marshall Lake. The stream is characterized by high gradient, cobble substrate, narrow wetted width, and riffle habitat. Average stream temperature was 10.4 ºC, with a maximum of 14.6 ºC. Logging activity in the upper watershed caused replacement of the overstory conifer canopy with deciduous shrub canopy, possibly leading to higher recorded water temperatures.

Cutthroat trout was the only species collected while electrofishing in reach 1 of Burnt Creek. Prior to 1999, Marshall Lake was stocked with rainbow, brook, cutthroat, and kokanee. The lake was rehabilitated in 1999, and stocked with westslope cutthroat trout from Kings Lake in 2000, 2001, and 2002, and rainbow trout from the Spokane hatchery in 2000 (WDFW unpublished hatchery records, Appendix 2). Three size/age classes of cutthroat trout were present in the length-frequency distribution, although no fish measured between 50-100 mm TL.

Possible explanations for this size class being absent from the length-frequency distribution are poor survival of resident age 0^+ fish, rapid annual growth of age 0^+ fish, or migration of fish from the lake to the stream or vice versa. There appears to be adequate spawning habitat available in the stream, although if a resident breeding population of cutthroat trout were present in Burnt Creek, one would expect a more even distribution, unless mortality or migration is occurring. Genetic analysis of the fish sampled in the stream will help explain their origin.

Lake Fishery Assessments

Fishery assessments were conducted in conjunction with water quality, phytoplankton, zooplankton, and zoobenthos characterization for each water body. Both investigations were completed in 2002, in Conger, Davis, Mountain Meadows, and North and South Skookum Lakes. Power Lake was intended to be surveyed 2001, but low water due to dam repairs prevented fishery sampling. Results and discussion of water quality and invertebrate sampling conducted in 2002 appear in Appendix 1. With the exception of Mountain Meadows Lake, all the lakes have been stocked with game fish at some time by Washington Department of Fish and Wildlife. The only lake with adequate launch facilities for an electrofishing boat was Davis Lake, so CPUE and relative abundance estimates were limited to horizontal gillnetting in the rest of the lakes.

Brook trout were the most abundant species overall, based on relative abundance (58%) and CPUE, although nearly all were collected in North and South Skookum Lakes. Both lakes were stocked almost exclusively with brook trout until 1993, and have been stocked with rainbow trout from the Spokane and McCloud River hatcheries since (WDFW unpublished hatchery records, Appendix 2). The lakes had similar bathymetries, water quality, and plankton constituencies. Both lakes exhibited low levels of vertebrate planktivory, indicated by abundant large-bodied zooplankton, and could support increased sport fish stocking (Black et al. 2003, Appendix 1).

This is supported by the relatively high mean relative weights compared to coldwater, low productivity water bodies in Eastern Washington, indicating food resources are not limiting trout production in the Skookum Lakes. McLellan (2001) reported relative weights far below the national standard of 100 for rainbow trout in the Boundary Reservoir of the Pend Oreille River. Mean relative weights of rainbow and brook trout in this study were between 91.8 and 98.3 in the Skookum Lakes. The length-frequency distributions of brook trout in both lakes show large differences in the modes of the two size/age classes represented, with only few fish present between them. This may be indicative of weak year class recruitment, rapid growth rates, or not being captured by our gillnets.

It is unlikely that fish between 130-180 mm would not be captured by our sampling method, given that experimental gillnets are designed to be effective at capturing variable sizes of fish and we captured individuals both smaller and larger than this size class. More sampling, including electrofishing, and aging fish by scale or otolith analysis should be conducted to determine the size/age structure of trout in these lakes.

A biological investigation of Power Lake was conducted in 2001. Low lake level, due to dam repairs, prevented fishery sampling, which was postponed until 2002. In 2001, the lake was characterized as having unusually high productivity with high algal standing crop, dominated by inedible and toxic eubacteria (blue-green algae). Low levels of dissolved oxygen were present in deeper waters and benthic species composition was dominated by chironomids (associated with decomposing organic matter). Although much of the biovolume of phytoplankton was inedible, there was sufficient standing crop of edible taxa to produce high densities of large-bodied zooplankton (Black et al. 2003).

The lake was stocked with rainbow, brook, and cutthroat trout between 1933 and 1964. No plants were recorded between 1965 and 1993, when stocking of rainbow trout fry resumed and has continued through 2002 (WDFW unpublished hatchery records, Appendix 2). The low mean relative weight of rainbow trout (80.5) may indicate less than optimal habitat conditions in Power Lake for rainbow trout production, at least in a year following reservoir drawdown. More sampling should be conducted to determine the rainbow trout population structure, as the sample size in this study was small for accurate interpretation (n=8). Rainbow trout feed primarily on food associated with the bottom if adequate oxygen is available during summer when surface temperatures are high (Wydoski and Whitney 1979). The eutrophic condition and lack of dissolved oxygen in the hypolimnion may be limiting rainbow trout production in Power Lake.

Conger and Mountain Meadows Lakes were the shallowest lakes surveyed (both with 3 m maximum depths), and had diverse and abundant littoral macrophyte vegetation. Both lakes were polymictic (did not stratify) and not likely to exhibit limited dissolved oxygen availability (Black et al. 2003, Appendix 1).

No fish have been planted in Mountain Meadows Lake according to WDFW stocking records. The fish assemblage in the lake is dominated by warm-water species of unknown origin, although sample sizes were small for accurate interpretation of length-frequency and condition index data. Local fishermen indicated the lake had been a productive largemouth bass and black crappie fishery for some time and that heavy fishing pressure has recently depressed the fishery. Access to the lake is limited to the shore adjacent to Deeter Road with unimproved launches on this privately owned lake.

Similarly, no launch facility exists in Conger Lake. The lake generally receives light fishing pressure. Rainbow trout have been stocked annually in Conger Lake since 1993, with brook trout stocked between 1984-1992. Mean relative weight of rainbow trout was 86.4, indicating possible competition for food resources (although sample size was small; n=6). Black et al. (Appendix 1) noted 67% of algal standing crop was filamentous green algae, which has the potential to limit zooplankton abundance and composition. Further research is needed to assess the condition of rainbow trout in Conger Lake.

Davis Lake had the highest species richness recorded in the study (9 species). The stocking record includes kokanee, brook, cutthroat, lake, and rainbow trout (WDFW unpublished hatchery records, Appendix 2). Rainbow trout has been the only species stocked since 1957, with the exception of one plant of lake trout in 1983. The last kokanee plant into the lake was in 1949 and there appears to be a small reproducing population in the lake. Davis Lake appears to have heightened productivity, as indicated by lower dissolved oxygen concentrations in the hypolimnion, and 45% of the algal biovolume comprised of blue-green algae (eubacteria) (Black et al. 2003; Appendix 1). Davis was the deepest lake surveyed (44 m maximum depth) and the shore drops off steeply in much of the basin. This likely affected our electrofishing success, as only 2 of 5 randomly selected transects yielded any captures. A stratified sampling design may have increased our capture rates. Macrophyte diversity and density in Davis Lake was low, and Eurasian watermilfoil (*Myriophyllum spicatum*) was the dominant species. The Davis Lake Landowners association is currently working to secure grant funding to eradicate/control the watermilfoil population (Betty Perry, pers. com.).

Despite being the only species currently stocked in Davis Lake, no rainbow trout were captured in gillnets or electrofishing. Largemouth bass, yellow perch, and pumpkinseed were the most abundant species we collected. Relative weights of largemouth bass were 100.8, indicating good growth and health compared to the national standard. Relative weights of both yellow perch and pumpkinseed were low in comparison (76.9 and 86.1, respectively), indicating possible inter/intraspecific competition. Divens and Phillips (1999) found similar conditions in Jumpoff Joe Lake in Northeastern Washington, abundant pumpkinseed and stunted yellow perch, and inadequate densities of predatory gamefish (largemouth bass) to control their populations. The warmwater fish assemblage would benefit from increasing the number of predator fish in the lake by decreasing the density of panfish, in turn increasing their size and condition.

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Appendix 1

Biological Investigation of Five Pend Oreille River Drainage Lakes

prepared for

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Project Description

This study included summer and autumn assessment of the aquatic organisms of five lakes in the lower Pend Oreille River Drainage. Assessment included collection of replicate samples necessary for water quality, phytoplankton, zooplankton, and zoobenthos characterization of each water body. The five lakes included Conger, Davis, Mountain Meadows, and North and South Skookum Lakes, all of Pend Oreille Co., Washington.

Methods

Study Sites: The five water bodies included in this study were Conger, Davis, Mountain Meadows, and North and South Skookum Lakes. All lie within the Pend Oreille River drainage of northeast Washington State. Location and morphometric data are provided in Table 1. Mountain Meadows is an expansive shallow water body with a marsh perimeter surrounding 55 hectares of open water. Although expansive, the water depth does not exceed three meters (m). Davis Lake was the largest lake included in this survey, with 67 hectares of surface area and a maximum depth of 44 m. Conger Lake is a small pond with a surface area just over 2 hectares and a maximum depth that does not exceed three meters. North and South Skookum Lakes are typical of the small watershed mountain lakes in the Selkirk Mountain range of NE Washington. South Skookum Lake has 13 hectares of surface area and has a maximum depth of five meters. North Skookum Lake has 16 hectares of surface area and a maximum depth of six meters.

Water quality and phytoplankton: Temperature and dissolved oxygen concentration were collected surface to bottom in 2 m increments using a YSI Model 85 environmental meter. Water samples for determining total chlorophyll concentration (Chls A + B + C) were collected with an ARI student water bottle sampler at 2 m depth increments, then stored in amber bottles and on ice until analysis with Turner Designs Model 10-AU field fluorometer. Triplicate samples for phytoplankton identification and biovolume calculations were collected with the same sampling device from 5 meters of depth, preserved with Lugol's fixative, and stored in amber bottles until analysis. Algal species identification was conducted as per Prescott (1954). Algal biovolume was determined as per Wetzel and Likens (1991). All of the above collections occurred in the water column above the deepest location in each lake. Two replicate water samples were collected from a depth of 1 meter over the deepest part of each lake basin to determine nitrate and phosphate concentrations. Nutrient samples were processed using Hach spectrophotometric methods for nitrate and phosphate. All of the collections were made on each of 9 July, 26 August and 23 October, 2002, with the exception of water samples for algal biovolume determination which were not collected on 23 October.

Zooplankton: Three replicate zooplankton samples were collected from each water body on each of the three sample dates: 9 July, 26 August, and 23 October 2002. Each sample consisted of the contents of a single vertical tow taken with a 19 cm diameter, 153 um mesh, conical plankton net. In Davis Lake, one replicate tow was taken from a depth of ten meters to the surface, in each of the north, central and south basins of the lake. In Conger and both of the Skookum Lakes, three replicate samples were collected over the deep water location and each sample consisted of the contents of a single bottom to surface vertical haul. In Mountain Meadows Lake, three replicate bottom to surface vertical hauls were collected from three randomly chosen location near the center of the lake. Upon retrieval, all samples were concentrated onto a 153 um mesh sieve, submersed in 95% EtOH for 15 seconds to fix the animals, then transferred to sample bottles containing 70% EtOH for preservation and storage. Organisms were identified using the keys of Brooks (1959: branchiopoda), Wilson (1959: calanoida), and Yeatman (1959: cyclopoida). Density (individuals l^{-1}), biomass (dry weight ug l^{-1}), and body length (mm) were determined for each taxa. Biomass was estimated from body length using the length:weight regressions of Dumont et al (1975) and Bottrell et al (1976)**.**

Zoobenthos: Benthic invertebrate samples were collected using a 20 cm x 20 cm Eckman dredge along multiple replicate transects in each lake on 26 and 27 of August 2002. Samples were collected from each lake on 7 July and 26 August 2002. Two transects were sampled in Conger Lake and the Skookum Lakes, and along each, samples were collected at three separate locations representing shallow, intermediate and deep depths. Three transects were sampled in Davis and Mountain Meadows Lakes. In Davis Lake samples were collected at 2.5, 5, and 10 meters along each transect. In Mountain Meadows Lake, samples were collected at 1, 2, and 3.5 meters of depth along each transect. In all lakes, transect locations were chosen at random and spread equidistant around the perimeter of the lake. Retrieved dredge samples were rinsed on a 500 um sieve and stored in 70% EtOH for later analysis. Benthic animals were identified using the keys in Thorp and Covich (1991) and Merrit and Cummins (1996).

Macrophytes: Aquatic macrophyte composition and percent coverage were estimated in each lake on 9 and 10 September 2002. Sampling involved dropping a 1 m^2 quadrat at specific depths along randomly chosen transects, then snorkeling to estimate percent cover for each of the species within the quadrat. Example specimens of each species were returned to the laboratory for identification using the key of Muenscher (1959) and WA DOE (2001). Three transects were used in Conger Lake and macrophytes were assessed at 1, 2, and 3.5 m along each transect. Four transects were used in each of the Skookum Lakes and four depths were sampled out to approximately 5 m. Five transects were used in each of Davis and Mountain Meadows Lakes. In

Mountain Meadows Lake, three depths were sampled along each transect out to a depth of 3 or 3.5 meters, depending on the transect. In Davis Lake, 1, 2, 3.5, and 5 m depths were sampled along each of the five transects.

Results and Discussion

Temperature, dissolved oxygen, and chlorophyll profiles for each of the lakes on each of the three sample dates are presented in figures 1-6. All data indicates warm surface water conditions during July and August, an abundance of dissolved oxygen (values < 5 mg l^{-1}), and low chlorophyll densities (values < 5 ug l^{-1}) on all dates. Exceptions include the following: Dissolved oxygen in the hypolimnion of Davis Lake during late summer (27 August) indicates only about 50% of the surface water dissolved oxygen concentrations, indicating heightened productivity of this lake relative to the other four in the survey. However, although the hypolimnetic oxygen is lower than the epilimnion, late summer levels (when one would expect deep water DO levels to be at their lowest) are certainly adequate for aquatic life (> 4 mg l^{-1}). Additionally, North Skookum Lake exhibits a metalimnetic chlorophyll maximum, which is typical of low productivity lakes, and where the chlorophyll values exceed 10 ug l^{-1} at a depth of 4 m. Also of interest, the shallow lakes (Mountain Meadows and Conger) are both polymictic in that they do not thermally stratify. Thus, these water bodies are not likely to exhibit limited dissolved oxygen availablity except under the most extreme hypereutrophic conditions.

Epilimnetic nitrate and phosphate concentrations for each of the water bodies are presented in Table 2. In all lakes phosphate is the least abundant nutrient, and nitrate: phosphate ratios exceed 10:1 which suggests the lakes have low to intermediate productivity and that none are currently in a eutrophic state (Welch 1980).

Phytoplankton constituents within each water body are presented in Tables 3-7. Algal biovolume estimates for each lake are presented in Tables 8-12. All lakes show a high diversity of edible phytoplankton taxa, little algal standing crop, and few or no blue-green algae. Exceptions include Davis Lake, where on the 26 of August, blue green algae (eubacteria) represent 45% of the algal biovolume (Table 9). Conger Lake, on 9 July, included 4.336 mm^3 l^{-1} of algae of which over 67% was filamentous green algae (Tables 5 and 10), which has the potential to limit zooplankton composition and productivity.

Zooplankton constituents, density, biomass, and average length are presented for each lake in Figures 6-10. All lakes support a variety of branchiopod (cladoceran) and copepod taxa. Average lengths in each lake exceed 1 mm for many species, which suggests vertebrate planktivory is not an important regulatory force in any of the lake communities and that each water body could support a greater biomass of planktivorous fishes. Observations worthy of comment include the following: As a shallow, polymictic, and primarily littoral water body, Mountain Meadows Lake zooplankton (figure 6) does not include a species of Diaptomid copepod which prefer more pelagic open waters, and for the same reasons the lake does include two species of primarily littoral branchiopods, *Alona* and *Camptocercus*. In Conger Lake (figure 8), there exists low plankton diversity, abundance, and biomass associated with the 9 July blue-green algal bloom. Following the decline of blue-greens, on 27 August, zooplankton diversity, abundance, and biomass are greater than during the bloom of early July. In North Skookum Lake (figure 10), zooplankton composition is limited to two large-bodied species, *Daphnia schodleri* and a single species of *Diaptomus* (calanoid copepod). Although densities and biomass are adequate to support additional fish biomass, it is unusual for a water body of this size (16 hectares) to include just two species of crustacean zooplankton.

Tables 13-17 report the results of the benthic animal assessments of the five lakes surveyed. All of the lakes include a variety of insect, crustacean, and molluscan grazers and detritivores suggesting typical benthic component in the lake community. Exceptions include the following: Davis Lake includes portions of the lake bed which likely experience heavy deposition of decaying organic matter (e.g. transect #3, Table 14), which is indicated by the high densities of chironomids at all depths sampled.

Tables 18-22 report the macrophyte composition and coverage in each of the five lakes. As a primarily littoral aquatic environment, Mountain Meadows Lake possesses a variety of plant species with coverage that in most locations approaches 100 percent of the lakebed (Table 18). Conger, South Skookum, and North Skookum Lakes also possess several species of aquatic macrophyte though coverage is less extensive, and in many transect locations plants are absent (Tables 20-22, respectively). Davis Lake possess the least aquatic macrophyte diversity (only four species) of the five lakes surveyed (Table 19), and it does include eurasion watermilfoil

(*Myriophyllum spicatum*) as the most common species encountered with high percent coverage observed along transect number 3.

Conclusions: None of the lakes exhibit signs of excessive productivity or an unhealthy condition. Mountain Meadows Lake is an expansive open water marsh with no pelagic environment. Thus, the species composition is atypical of many of the lakes in Pend Oreille County, but not unusual for a water body with similar bathymetry. With the exception of Davis Lake, all of the lakes are fairly shallow (< 6 m) and are either polymictic or stratify with a low volume hypolimnion. Thus, they are not likely to experience low oxygen levels unless nutrient loading is dramatically increased. All of the lakes exhibit signs of low vertebrate planktivory pressure as indicated by high densities of large-bodied zooplankton (figures 6-10; Brooks and Dodson 1965, Zaret 1980) and could experience increased sport fish stocking (rainbow trout) without detrimental impacts. Davis Lake has been invaded by eurasian watermilfoil which is likely to increase in abundance through time.

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Table 1. Lake location, surface area, and maximum depth.

Lake	**Location (Township)**	**Surface Area (hectares)**	**Maximum Depth (m)**
Mountain Meadows	31 N R 44 E	55	3
Davis	31 N R 44 E 32 N R 44 E	67	44
Conger	33 N R 43 E	2.1	3
South Skookum	33 N R 44 E	13	5
North Skookum	34 N R 44 E	16	6

Table 2. Mean (+SE) nitrate and phosphate concentrations (mg l^{-1}) from each water body on each sample date, 2002. Means (and SE) were calculated from three sample replicates collected from one-meter depth from the center of each lake.

	9 July		**26 August**		**23 October**	
Lake	**N**	**P**	**N**	**P**	**N**	**P**
Mountain Meadows	4.06 (0.75)	0.02 (0.01)	1.83 (0.29)	0.13 (0.01)	3.5 (1.1)	0.16 (0.03)
Davis	4.3 (0.61)	0.07 (0.01)	1.9 (0.45)	0.11 (0.02)	2.6 (0.4)	0.22 (0.02)
Conger	4.87 (1.07)	0.02 (0.01)	1.87 (0.50)	0.08 (0.01)	1.35 (0.15)	0.17 (0.02)
South Skookum	4.4 (0.42)	0.09 (0.01)	1.9 (0.15)	0.06 (0.01)	1.75 (0.25)	0.15 (0.01)
North Skookum	4.0 (0.38)	0.09 (0.04)	0	0.19 (0.05)	1.0 (0.03)	0.23 (0.01)

Table 3. Phytoplankton identified from Mountain Meadows Lake in Pend Oreille Co., WA, 9 July and 28 August, 2002.

Division	**Class**	**Genus**
Chlorophyta	Chlorophyceae	*Chlamydomonas*
		Closterium
		Cosmarium
		Golenkinia
		Oocystis
		Roya
		Schroederia
		Tetraedron
		Ulothrix
Chrysophyta	Bacillariophyceae	*Cyclotella*
		Synedra
	Chrysophyceae	*Arachnochloris*
		Dinobryon
		Chrysococcus
		Mallomonas
		Ochromonas
Cryptophyta	Cryptophyceae	*Cryptomonas*
		Rhodomonas
Eubacteria	Cyanobacteria	*Aphanocapsa*
		Gloeocapsa
		Merismopedia
		Oscillatoria
Pyrrophyta	Dinophyceae	*Ceratium*

Table 4. Phytoplankton identified from Davis Lake in Pend Oreille Co., WA, 9 July and 27August, 2002.

Division	Class	Genus
Chlorophyta	Chlorophyceae	*Chlamydomonas*
		Cosmarium
		Golenkinia
		Nephrocytium
		Oocystis
		Quadrigula
		Schroederia
Chrysophyta	Bacillariophyceae	*Cyclotella*
		Melosira
		Stephanodiscus
		Synedra
	Chrysophyceae	*Dinobryon*
		Mallomonas
Cryptophyta	Cryptophyceae	*Cryptomonas*
		Rhodomonas
Eubacteria	Cyanobacteria	*Anabaena*
Pyrrophyta	Dinophyceae	*Gymnodinum*

Table 5. Phytoplankton identified from Conger Lake in Pend Oreille Co., WA, 9 July and 27August, 2002.

Division	**Class**	**Genus**
Chlorophyta	Chlorophyceae	*Carteria*
		Chlamydomonas
		Closterium
		Cosmarium
		Eudorina
		Gleocystis
		Golenkinia
		Oocystis
		Pandorina
		Roya
		Scenedesmus
		Schroederia
		Staurastrum
		Tetraedron
		Tetrallantos
Chrysophyta	Bacillariophyceae	*Asterionella*
		Cyclotella
		Melosira
	Chrysophyceae	*Arachnochloris*
		Dinobryon
		Mallomonas
		Ochromonas
Cryptophyta	Cryptophyceae	*Cryptomonas*
		Monomastrix
		Rhodomonas
Eubacteria	Cyanobacteria	*Anabaena*
		Aphanocapsa
		Chroococcus
		Gloeocapsa
		Merismopedia
Pyrrophyta	Dinophyceae	*Ceratium*
		Glenodinium

Table 6. Phytoplankton identified from South Skookum Lake in Pend Oreille Co., WA, 9 July and 26August, 2002.

Division	**Class**	**Genus**
Chlorophyta	Chlorophyceae	
		Chlamydomonas
		Chlorogonium
		Closterium
		Gleocystis
		Golenkinia
		Nephrocytium
		Oocystis
		Scenedesmus
		Schroederia
		Ulothrix
Chrysophyta	Bacillariophyceae	*Cyclotella*
		Stephanodiscus
		Synedra
	Chrysophyceae	*Gomphonema*
Cryptophyta	Cryptophyceae	*Cryptomonas*
		Monomastrix
		Rhodomonas
Eubacteria	Cyanobacteria	*Anabaena*
		Aphanizomenon
		Gloeocapsa
		Merismopedia

Table 7. Phytoplankton identified from North Skookum Lake in Pend Oreille Co., WA, 9 July and 26 August, 2002.

Division	Class	Genus
Chlorophyta	Chlorophyceae	*Ankistrodesmus*
		Chlamydomonas
		Gleocystis
		Scenedesmus
		Schroederia
Chrysophyta	Bacillariophyceae	*Anomoeoneis*
	Chrysophyceae	*Dinobryon*
		Mallomonas
Cryptophyta	Cryptophyceae	*Cryptomonas*
		Rhodomonas
Eubacteria	Cyanobacteria	*Anabaena*
		Aphanizomenon
		Gloeocapsa
Pyrrophyta	Dinophyceae	*Ceratium*

Table 8. Mean (+ SE) phytoplankton biovolume by algal division in Mountain Meadows Lake, Pend Oreille Co., Washington, 9 July and 26 August, 2002. Means (and SE) were calculated from three replicate samples collected from the center of the lake. Microplankton include very small unidentifiable algal cells which are likely in the division Chlorophyta. All values are $mm^3\ l^{-1}$.

Division	**9 July**	**26 August**
Microplankton	0.015 (0.007)	0.005 (0.001)
Chlorophyta	0.298 (0.005)	0.241 (0.065)
Chrysophyta	0.025 (0.009)	0.625 (0.048)
Cryptophyta	0.301 (0.109)	0.077 (0.029)
Eubacteria	0	0.015 (0.008)
Pyrrophyta	0.499 (0.498)	0

Table 9. Mean (+ SE) phytoplankton biovolume by algal division in Davis Lake, Pend Oreille Co., Washington, 9 July and 26 August, 2002. Means (and SE) were calculated from three replicate samples collected from the center of the lake. Microplankton include very small unidentifiable algal cells which are likely in the division Chlorophyta. All values are $mm^3\ l^{-1}$.

Division	**9 July**	**26 August**
Microplankton	0.058 (0.022)	0.018 (0.003)
Chlorophyta	0.114 (0.053)	0.029 (0.006)
Chrysophyta	0.398 (0.110)	0.229 (0.069)
Cryptophyta	0.127 (0.025)	0.074 (0.036)
Eubacteria	0	0.302 (0.048)
Pyrrophyta	0	0.019 (0.006)

Table 10. Mean (± SE) phytoplankton biovolume by algal division in Conger Lake, Pend Oreille Co., Washington, 9 July and 26 August, 2002. Means (and SE) were calculated from three replicate samples collected from the center of the lake. Microplankton include very small unidentifiable algal cells which are likely in the division Chlorophyta. All values are $mm^3\ l^{-1}$.

Division	9 July	26 August
Microplankton	0.024 (0.007)	0.079 (0.031)
Chlorophyta	0.899 (0.133)	0.283 (0.067)
Chrysophyta	0.390 (0.038)	0.260 (0.094)
Cryptophyta	0.056 (0.036)	0.180 (0.033)
Eubacteria	2.92 (0.422)	0.110 (0.092)
Pyrrophyta	0.047 (0.047)	0

Table 11. Mean (± SE) phytoplankton biovolume by algal division in South Skookum Lake, Pend Oreille Co., Washington, 9 July and 26 August, 2002. Means (and SE) were calculated from three replicate samples collected from the center of the lake. Microplankton include very small unidentifiable algal cells, which are likely in the division Chlorophyta. All values are $mm^3\ l^{-1}$.

Division	9 July	26 August
Microplankton	0.040 (0.012)	0.066 (0.005)
Chlorophyta	0.058 (0.015)	0.090 (0.054)
Chrysophyta	0.444 (0.130)	0.002 (0.001)
Cryptophyta	0.131 (0.024)	0.056 (0.017)
Eubacteria	0	0.072 (0.030)
Pyrrophyta	0	0

Table 12. Mean (± SE) phytoplankton biovolume by algal division in North Skookum Lake, Pend Oreille Co., Washington, 9 July and 26 August, 2002. Means (and SE) were calculated from three replicate samples collected from the center of the lake. Microplankton include very small unidentifiable algal cells which are likely in the division Chlorophyta. All values are mm^3 l^{-1}.

Division	**9 July**	**26 August**
Microplankton	0.023 (0.003)	0.007 (0.003)
Chlorophyta	0.021 (0.011)	0.033 (0.015)
Chrysophyta	0.022 (0.020)	0.018 (0.018)
Cryptophyta	0.160 (0.027)	0.001 (0.001)
Eubacteria	0.094 (0.022)	0.897 (0.284)
Pyrrophyta	0	0.218 (0.218)

Table 13. Mountain Meadows Lake benthic invertebrates collected 28 August, 2002 (Eckman Dredge).

Dredge Samples

Transect	**Depth (m)**	**Order**	**Family**	**Genus**	**Inds. m^{-2}**
1	1	Bivalvia	Sphaeriidae		25
		Diptera	Chironomidae		25
		Gastropoda	Planerbidae		100
		Trombidiformes			25
	2	Bivalvia	Sphaeriidae		75
		Diptera			25
		Diptera	Chironomidae		200
	3.5	Bivalvia	Sphaeriidae		75
		Diptera	Chaoboridae	Chaoborus	25
		Diptera	Chironomidae		150
		Gastropoda	Planerbidae		50
2	1	Bivalvia	Sphaeriidae		250
		Diptera			25
		Diptera	Chironomidae		425
		Diptera	Tabanidae		25
		Ephemeroptera	Caenidae	Caenis	75
		Gastropoda			25
		Gastropoda	Planorbidae		75
		Trichoptera	Polycenropodiae	Cernotina	500
	2	Bivalvia	Sphaeriidae		50
		Diptera	Chironomidae		75
		Diptera	Ceratopegonidae	Sphaeromias	25
		Gastropoda	Planorbidae		25
		Amphipoda	Talitridae	Hyalella	50
		Trichoptera	Polycentropodidae	Cernotina	25
	3.5	Bivalvia	Sphaeriidae		25
		Diptera	Chironomidae		75
		Diptera	Ceratopegonidae	Sphaeromias	25
3	1	Bivalvia	Sphaeriidae		25
		Diptera	Chironomidae		100
		Gastropoda	Physidae		25
		Odonata	Corduliidae	Epitheca	450
	2	Diptera	Chironomidae		125
		Hemiptera	Belostomatidae	Belostoma	25
	3.5	Bivalvia	Sphaeriidae		25
		Diptera	Chironomidae		200

Table 14. Davis Lake benthic invertebrates collected 27 August, 2002 (Eckman Dredge).

Dredge Samples

Transect	**Depth (m)**	**Order**	**Family**	**Genus**	**Inds. m^{-2}**
1	2.5	Diptera	Chironomidae		100
	5	Diptera	Chironomidae		250
		Amphipoda	Talitridae	Hyalella	75
		Trichoptera	Polycentropodidae	Cernotina	25
	10	Diptera	Chironomidae		900
2	2.5	Diptera	Chironomidae		50
		Odonata	Corduliidae	Epitheca	50
		Amphipoda	Talitridae	Hyalella	75
		Trichoptera	Polycentropodidae	Cernotina	25
	5	Diptera	Chironomidae		75
	10	Hirudinea			25
		Diptera	Chironomidae		450
		Oligochaeta			50
3	2.5	Diptera	Chironomidae		275
	5	Diptera	Chironomidae		150
	10	Diptera	Chironomidae		525
		Oligochaeta			150

Table 15. Conger Lake benthic invertebrates collected 26 August, 2002 (Eckman Dredge).

Dredge Samples

Transect	**Depth (m)**	**Order**	**Family**	**Genus**	**Inds. m^{-2}**
1	1	Diptera			25
		Diptera	Chironomidae		50
		Megaloptera	Sialidae	Sialis	25
	2	Diptera	Chironomidae		200
		Odonata	Coenagrionidae		25
	3.5	Diptera	Chironomidae		100
		Ephemeroptera	Caenidae	Caenis	25
		Amphipoda	Talidridae	Hyalella	25
		Trichoptera	Phryganeidae		25
2	1.5	Diptera	Chironomidae		50
		Megaloptera	Sialidae	Sialis	25
	2.5	Diptera	Chironomidae		325
		Megaloptera	Sialidae	Sialis	50
		Trichoptera	Phryganeidae		25
	4	Diptera	Chaoboridae	Chaoborus	300
		Diptera	Chironomidae		25

Table 16. South Skookum Lake benthic invertebrates collected 26 August 2002 (Eckman Dredge).

Dredge Samples

Transect	Depth (m)	Class	Order	Family	Genus	Inds. m^{-2}
1	1	Oligochaeta				100
			Gastropoda	Planerbidae		25
	2		Diptera	Chironomidae		100
			Odonata	Coenagrionidae		25
			Amphipoda	Talitridae	Hyalella	1200
	4.5		Diptera	Chaoboridae	Chaoborus	425
			Diptera	Chironomidae		450
			Diptera pupae			25
		Oligochaeta				50
			Amphipoda	Talitridae	Hyalella	25
2	1.5		Diptera	Chaboridae	Chaoborus	25
		Oligochaeta				25
	3.5	Nothing				
	5		Diptera	Chaoboridae	Chaoborus	775
			Diptera	Chironomidae		1025
			Diptera pupae			25
		Oligochaeta				75

Table 17. North Skookum Lake benthic invertebrates collected 26 August 2002 (Eckman Dredge).

Dredge Samples

Transect	Depth (m)	Class	Order	Family	Genus	Inds m^{-2}
1	1.5	Oligochaeta				75
			Diptera	Chironomidae		25
	3.5		Diptera	Chironomidae		25
	6.5		Diptera	Chaoboridae	Chaoborus	475
			Diptera	Chironomidae		275
		Oligochaeta				50
2	1.5		Diptera	Chironomidae		125
			Gastropoda	Planorbidae		25
			Amphipoda	Talidridae	Hyalella	25
	3		Diptera	Chironomidae		25
			Diptera	Chaoboridae	Chaoborus	25
			Oligochaeta			25
	6.5		Diptera	Chaoboridae	Chaoborus	300
			Diptera	Chironomidae		25

Table 18. Mountain Meadows Lake macrophytes and percent coverage estimated 9 September 2002.

Transect	Depth (m)	Species	% coverage
1	1	Chara spp.	95
		Potamogeton natans	5
	2	Potamogeton spp.	5
		Zannichellia palustris	5
	3	Zannichellia palustris	15
		Myriophyllum hippuroides	5
2	1	Potamogeton natans	30
		Zannichellia palustris	10
	2	Chara spp.	100
	3.5	Myriophyllum hippuroides	20
3	1	Chara spp.	100
	2	Chara spp.	100
		Potamogeton pectinatus	50 (above Chara)
	3	nothing	0
4	1	Chara spp.	100
		Potamogeton pectinatus	10 (above Chara)
	2	Zannichellia palustris	40
		Myriophyllum hippuroides	40
	3	Myriophyllum hippuroides	50
5	1	Zannichellia palustris	88
		Potamogeton pectinatus	10
		Potamogeton natans	2
	2	Zannichellia palustris	85
		Elodea canadensis	5
	3	Zannichellia palustris	25
		Myriophyllum hippuroides	25

Table 19. Davis Lake macrophytes and percent coverage estimated 9 September 2002.

Transect	Depth (m)	Species	% coverage
1	1	Myriophyllum spicatum	5
	2	Elodea canadensis	20
		Myriophyllum spicatum	15
	3.5	Myriophyllum spicatum	5
	5	nothing	0
2	1	nothing	0
	2	Brasenia schreberi	15
	3.5	Elodea canadensis	1
	5	nothing	0
3	1	Potamogeton illinoensis	70
		Myriophyllum spicatum	30
	2	Myriophyllum spicatum	90
	3.5	Elodea canadensis	90
	5	Elodea canadensis	5
4	Nothing		
5	Nothing		

Table 20. Conger Lake macrophytes and percent coverage estimated 9 September 2002.

Macrophytes Transect	Depth (m)	Species	% coverage
1	1	nothing	0
	2	unknown (c)	1
	3.5	unknown (c)	2
		unknown (c)	5
2	1	Potamogeton pusillus	80
		unknown (c)	1
	2	Nuphar polysepala	5
	3.5	Chara spp.	5
		unknown (c)	5
3	1	unknown (c)	1
	2	nothing	0
	3.5	unknown (c)	5
		Fontinalis antipyretica	5

(c)- short broad leaf plant 1.5-3.0cm x 1.0-1.5cm

Table 21. South Skookum Lake macrophytes and percent coverage estimated 9 September 2002.

Macrophytes Transect	Depth (m)	Species	% coverage
1	1	Potamogeton epihydrus	1
	2	nothing	0
	3.5	Elodea canadensis	1
	5	unknown (b)	1
2	1	Potamogeton epihydrus	40
	2	Potamogeton pusillus	80
	3.5	Potamogeton pusillus	5
	5	nothing	0
3	1	Isoetes spp.	50
	2	Elodea canadensis	1
	3.5	Elodea canadensis	1
	5	Chara spp.	5
4	1	Elodea canadensis	1
	2	nothing	0
	3.5	Elodea canadensis	1
	5	nothing	0

(b)- green leaf, rooted: 1.5cm x 6cm

Table 22. North Skookum Lake macrophytes and percent coverage estimated 9 September 2002.

Macrophytes Transect	Depth (m)	Species	% coverage
1	1	unknown (a)	1
	2	nothing	0
	3	Chara spp.	40
	4.5	Chara spp.	20
		Elodea canadensis	10
2	1	Potamogeton pusillus	25
		Elodea canadensis	25
	2	nothing	0
	3.5	Chara spp.	50
	5	nothing	0
3	1	algae	20
	2	unknown (a)	1
	3.5	unknown (a)	1
	5	nothing	
4	1	Chara spp.	75
		Elodea canadensis	25
	2	Chara spp.	90
		Elodea canadensis	10
	3.5	unknown (a)	2
	5	nothing	0

(a)- Short broad leaf plant 1.5- 3.0cm long x 1-1.5cm wide.

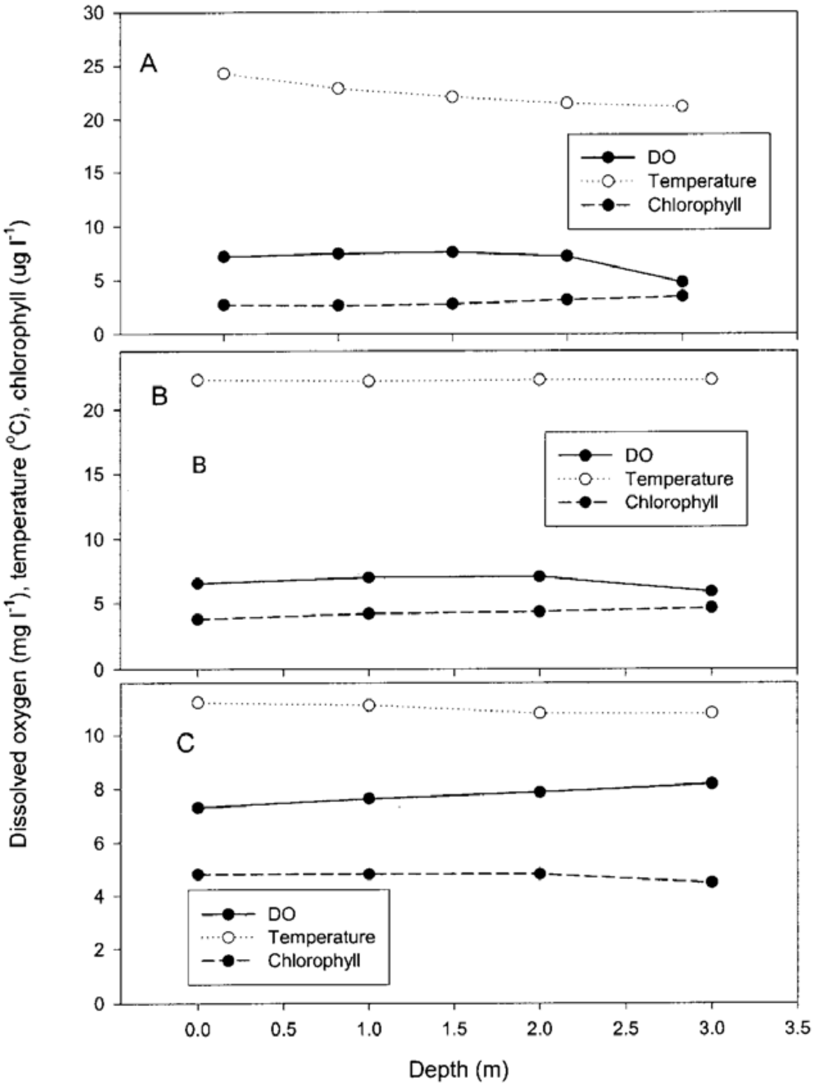

Figure 1. Dissolved oxygen, temperature, and chlorophyll profiles for Mountain Meadows Lake, 9 July (A) 27 August (B), 23 October (C), 2002.

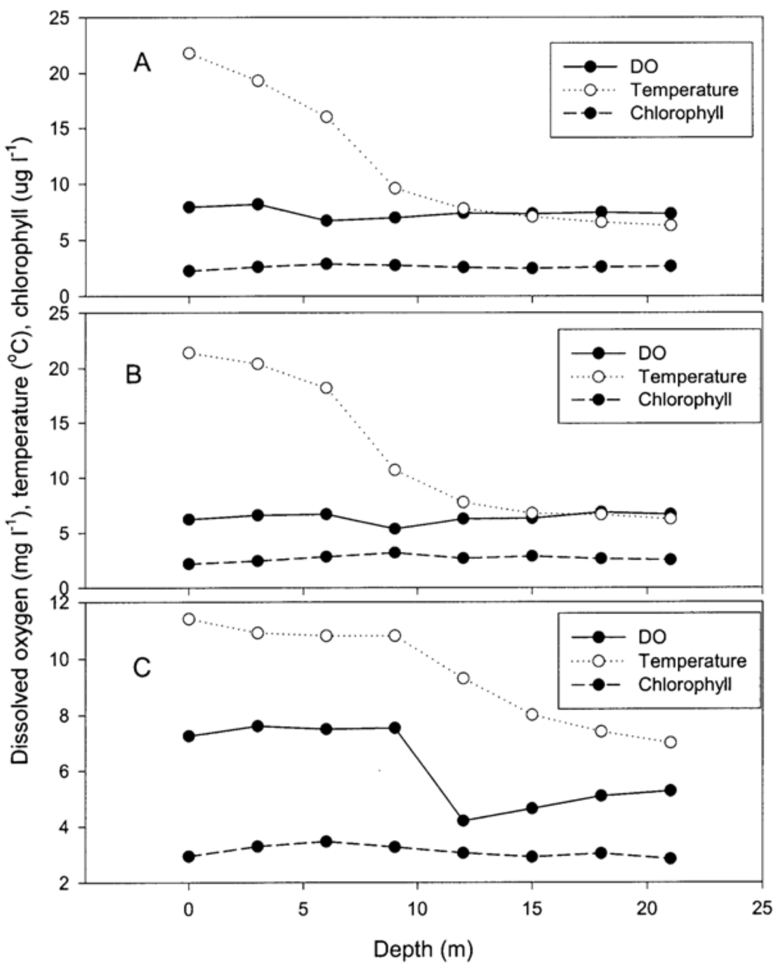

Figure 2. Dissolved oxygen, temperature, and chlorophyll profiles for Davis Lake, 9 July (A) 27 August (B), 23 October (C), 2002.

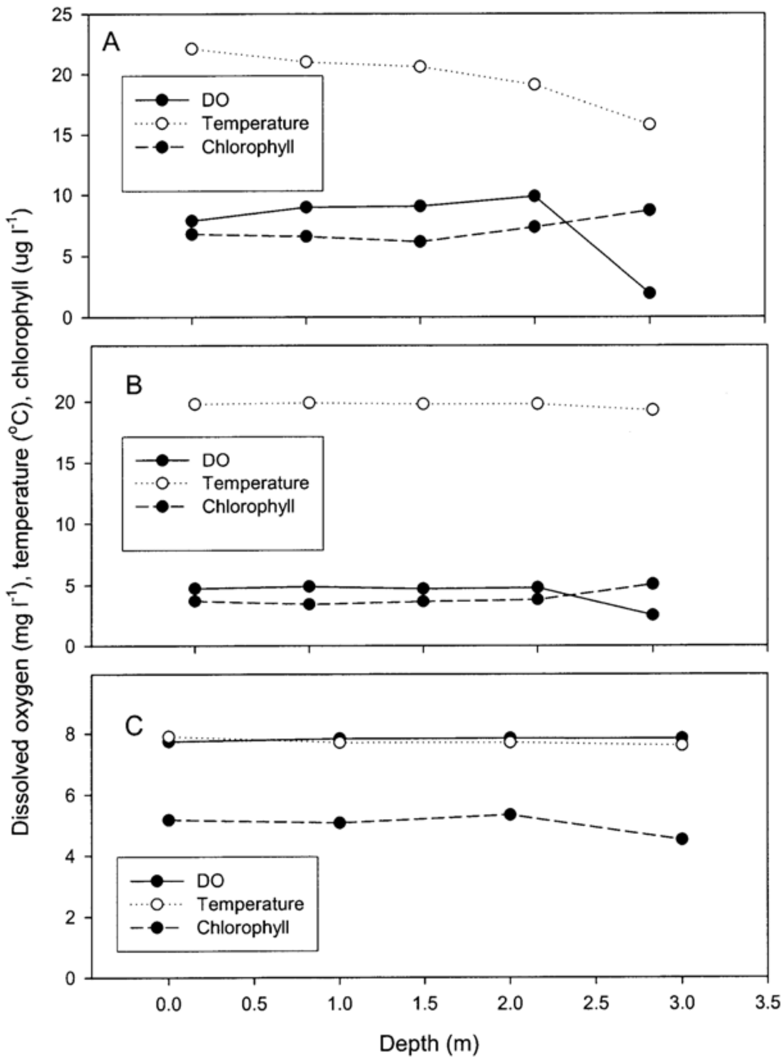

Figure 3. Dissolved oxygen, temperature, and chlorophyll profiles for Conger Lake, 9 July (A) 27 August (B), 23 October (C), 2002.

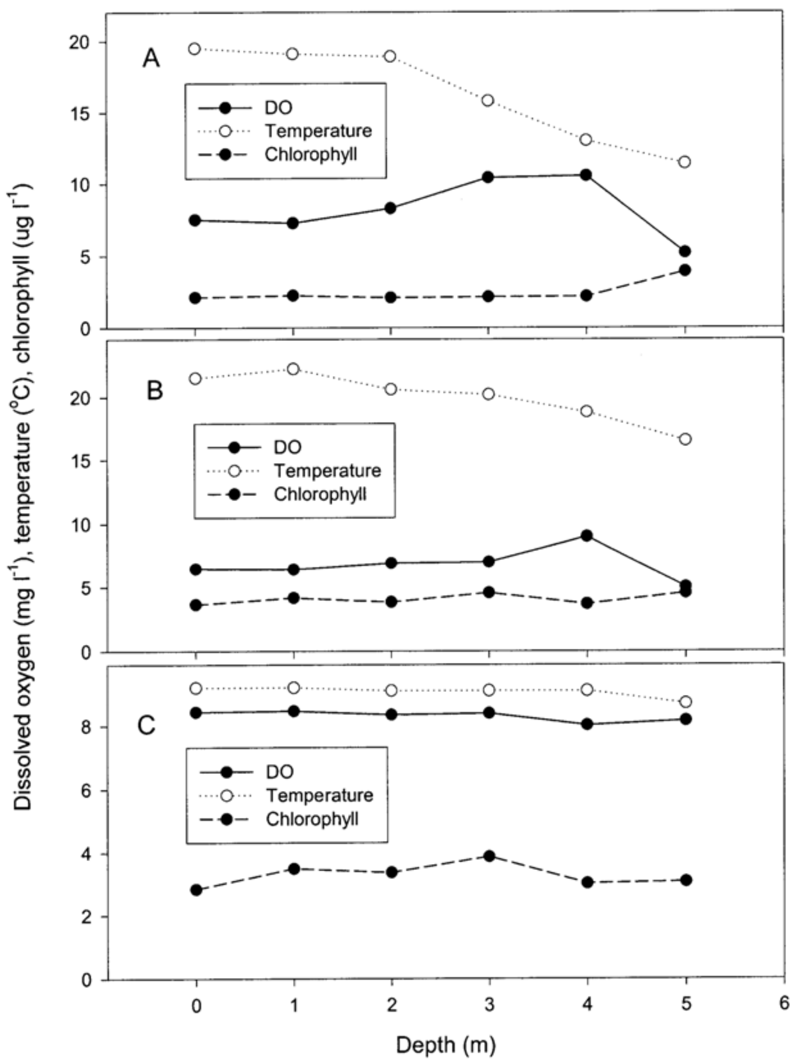

Figure 4. Dissolved oxygen, temperature, and chlorophyll profiles for South Skookum Lake, 9 July (A) 27 August (B), 23 October (C), 2002.

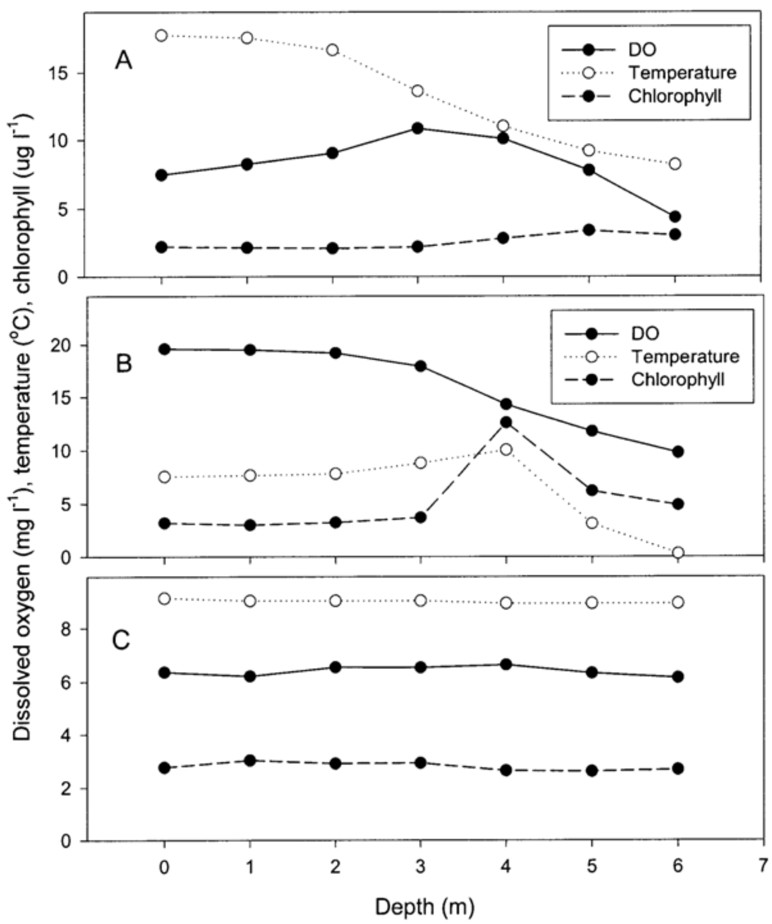

Figure 5. Dissolved oxygen, temperature, and chlorophyll profiles for North Skookum Lake, 9 July (A) 27 August (B), 23 October (C), 2002.

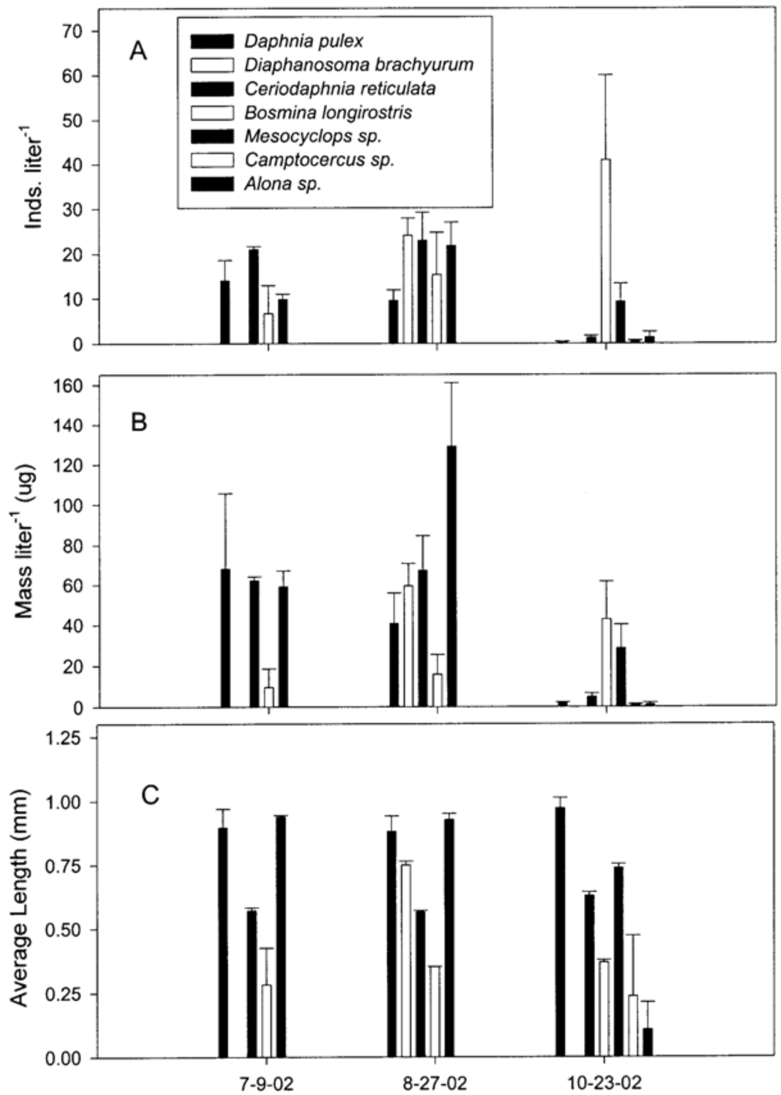

Figure 6. Mean (&SE) zooplankton density (A), biomass (B), and average length (C) of zooplankton collected from Mountain Meadows Lake during 2002.

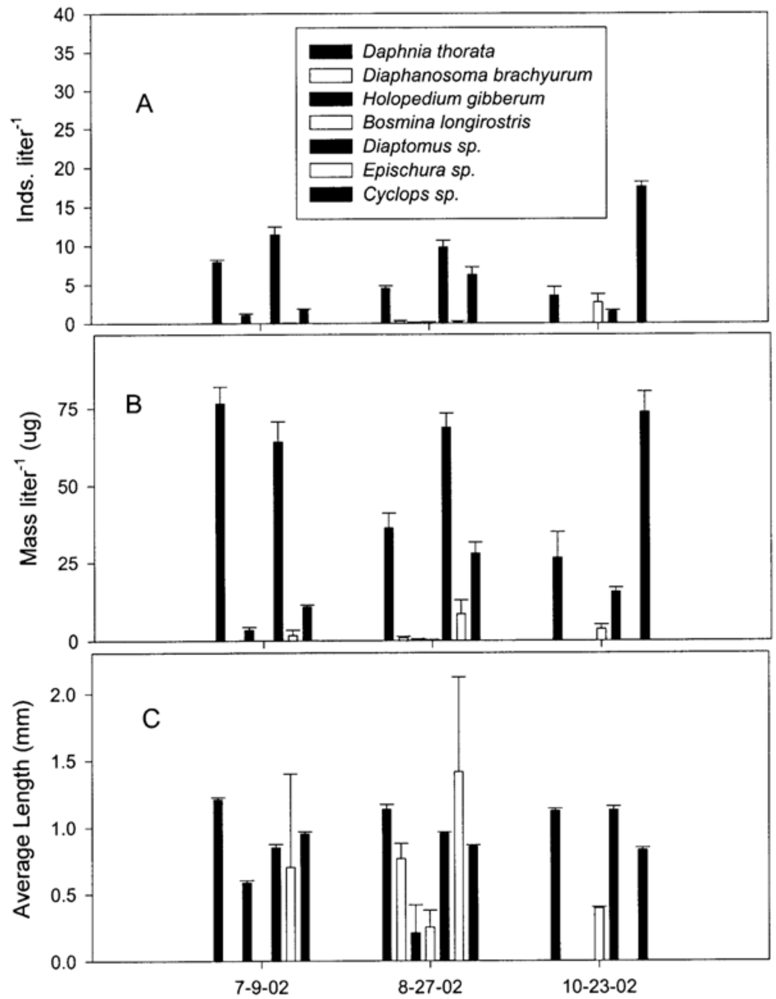

Figure 7. Mean (&SE) zooplankton density (A), biomass (B), and average length (C) of zooplankton collected from Davis Lake during 2002.

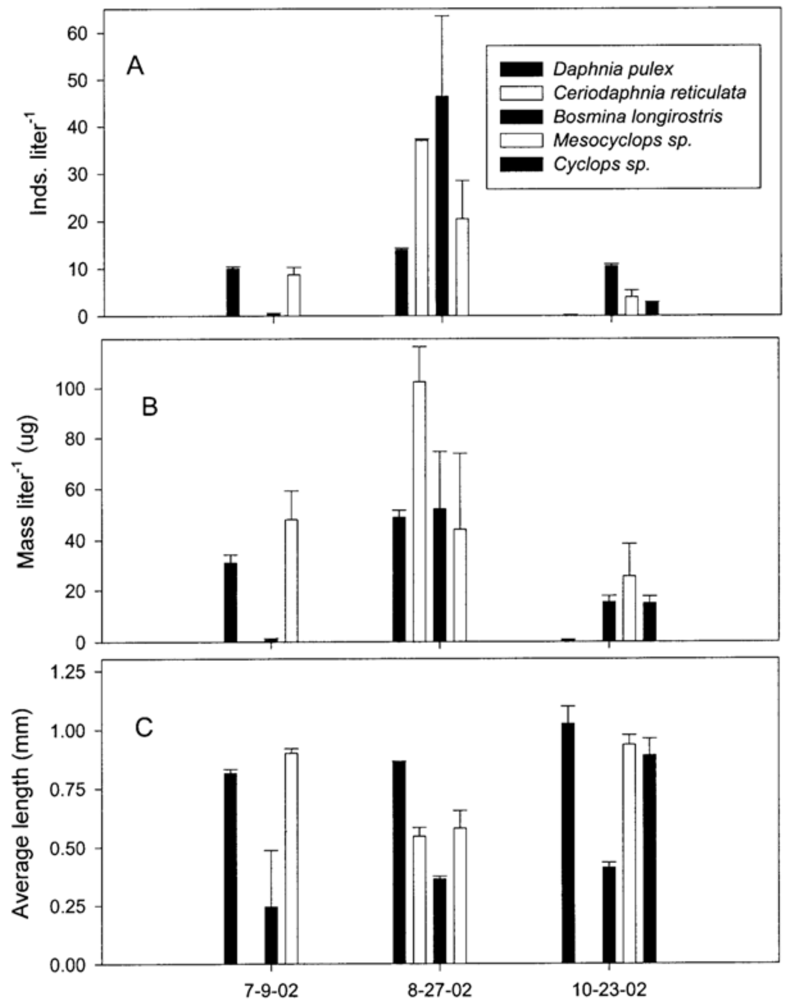

Figure 8. Mean (&SE) zooplankton density (A), biomass (B), and average length (C) of zooplankton collected from Conger Lake during 2002.

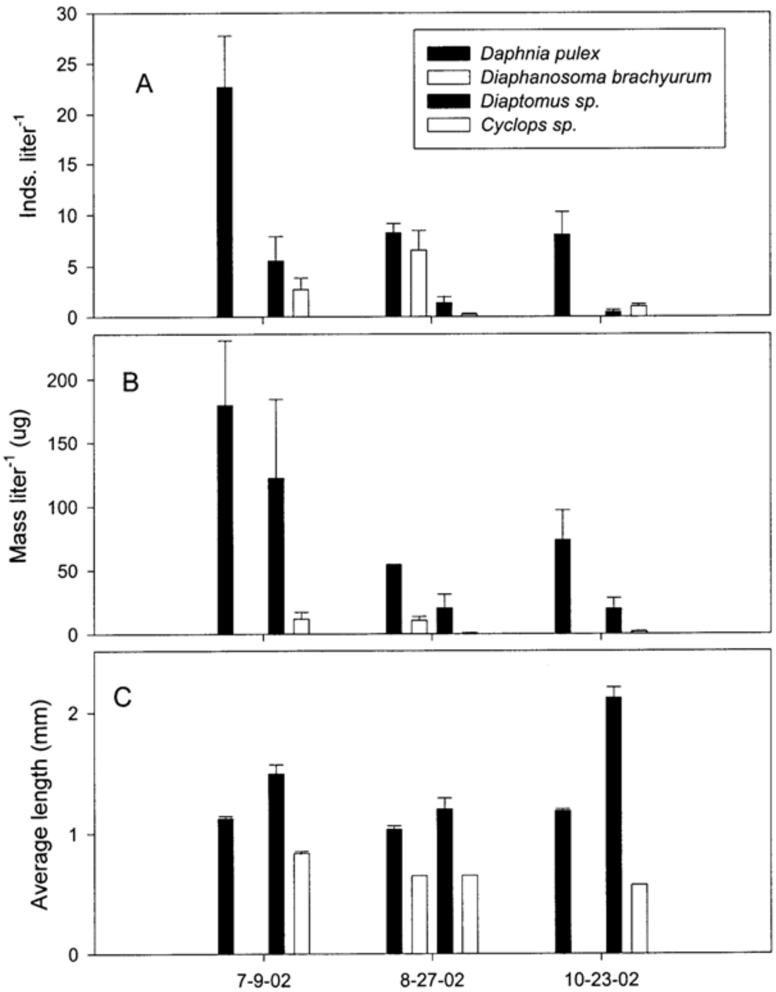

Figure 9. Mean (&SE) zooplankton density (A), biomass (B), and average length (C) of zooplankton collected from South Skookum Lake during 2002.

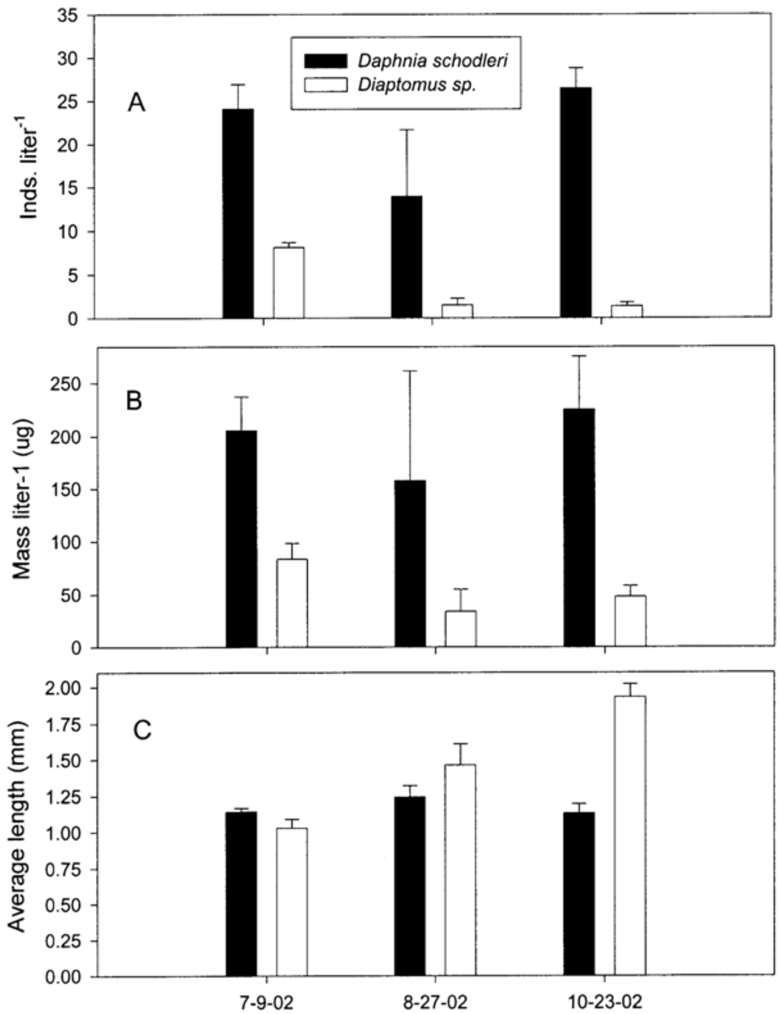

Figure 10. Mean (&SE) zooplankton density (A), biomass (B), and average length (C) of zooplankton collected from North Skookum Lake during 2002.

Appendix 2

Planting records for lakes surveyed in 2002.

Location	Year	Spp.	# Planted	Class	#perPound	MeanLength	Stock
BEAD	1933	K	216287				
BEAD	1933	LT	7500				
BEAD	1933	LT	3900				
BEAD	1933	LT	8640				
BEAD	1933	SH	43523				
BEAD	1934	K	175000				
BEAD	1934	RB	53000				
BEAD	1934	RB	100000				
BEAD	1934	SH	12393				
BEAD	1935	K	140000				
BEAD	1935	K	60000				
BEAD	1935	K	56000				
BEAD	1935	K	23420				
BEAD	1935	SH	20330				
BEAD	1936	K	150000				
BEAD	1936	LT	19525				
BEAD	1936	LT	11055				
BEAD	1936	SH	28000				
BEAD	1937	EB	1500				
BEAD	1937	K	99615				
BEAD	1937	RB	1500				
BEAD	1938	CT	98000				
BEAD	1938	CT	102700				
BEAD	1938	K	150000				
BEAD	1938	K	77108				
BEAD	1938	LT	2574				
BEAD	1938	LT	12400				
BEAD	1938	LT	4000				
BEAD	1938	LT	4000				
BEAD	1938	LT	2600				
BEAD	1938	LT	2600				
BEAD	1938	LT	2000				
BEAD	1938	LT	3230				
BEAD	1938	LT	20500				
BEAD	1938	RB	3000				
BEAD	1938	SH	9000				
BEAD	1939	K	318580				
BEAD	1939	RB	5000				
BEAD	1939	RB	7555				
BEAD	1939	RB	7745				
BEAD	1940	K	299700				
BEAD	1940	RB	7464				
BEAD	1940	RB	7492				

Location	Year	Spp.	# Planted	Class	#perPound	MeanLength	Stock
BEAD	1941	K	828465				
BEAD	1941	K	147400				
BEAD	1942	K	229800				
BEAD	1943	K	850150				
BEAD	1943	K	100000				
BEAD	1943	K	98000				
BEAD	1944	K	99900				
BEAD	1944	K	99900				
BEAD	1944	K	99900				
BEAD	1944	K	99900				
BEAD	1944	K	99900				
BEAD	1944	K	99900				
BEAD	1944	K	99099				
BEAD	1944	K	99900				
BEAD	1944	K	99900				
BEAD	1944	K	144500				
BEAD	1945	K	249900				
BEAD	1945	K	373000				
BEAD	1945	K	374000				
BEAD	1945	K	183910				
BEAD	1945	RB	59990				
BEAD	1945	RB	59910				
BEAD	1946	K	149950				
BEAD	1946	K	199900				
BEAD	1946	K	399800				
BEAD	1946	K	178850				
BEAD	1947	K	323800				
BEAD	1947	K	237950				
BEAD	1947	K	12639				
BEAD	1947	K	8500				
BEAD	1947	K	33797				
BEAD	1947	K	22228				
BEAD	1947	K	7200				
BEAD	1947	K	5850				
BEAD	1947	K	17600				
BEAD	1947	K	9798				
BEAD	1948	K	15106				
BEAD	1948	K	33000				
BEAD	1948	K	27334				
BEAD	1948	K	244000				
BEAD	1949	K	36791				
BEAD	1949	K	35990				
BEAD	1949	K	64716				
BEAD	1965	LT	77601		86.7		
CONGER 1&2	1984	EB	1500	Non-Smolt		100	E. Brook-Ford (Owhi Lake)

Location	Year	Spp.	# Planted	Class	#perPound	MeanLength	Stock
CONGER 1&2	1985	EB	1080	Non-Smolt		90	E. Brook-Ford (Owhi Lake)
CONGER 1&2	1987	EB	960	Non-Smolt		80	Methow River
CONGER 1&2	1987	EB	960	Non-Smolt		80	Methow River
CONGER 1&2	1988	EB	1173	Non-Smolt		69	E. Brook-Ford (Owhi Lake)
CONGER 1&2	1988	EB	966	Non-Smolt		69	E. Brook-Ford (Owhi Lake)
CONGER 1&2	1989	EB	1892	Non-Smolt		86	Methow River
CONGER 1&2	1990	EB	1960	Non-Smolt		70	Methow River
CONGER 1&2	1991	EB	1995	Non-Smolt		70	E. Brook-Ford (Owhi Lake)
CONGER 1&2	1992	EB	2015	Non-Smolt		73	E. Brook-Ford (Owhi Lake)
CONGER 1&2	1993	RB	2016	Non-Smolt		56	Spokane-McCloud R. CA
CONGER 1&2	1994	RB	980	Non-Smolt		49	Spokane-McCloud R. CA
CONGER 1&2	1994	RB	980	Non-Smolt		49	Spokane-McCloud R. CA
CONGER 1&2	1995	RB	1008	Fry	72		Spokane
CONGER 1&2	1995	RB	1008	Fry	72		Spokane
CONGER 1&2	1996	RB	1003	Fry	76		Spokane
CONGER 1&2	1996	RB	1003	Fry	76		Spokane
CONGER 1&2	1997	RB	1185	Fry	93		Spokane
CONGER 1&2	1997	RB	1185	Fry	93		Spokane
CONGER 1&2	1998	RB	1204	Fry	73		Spokane
CONGER 1&2	1998	RB	1204	Fry	73		Spokane
CONGER 1&2	1999	RB	2700	Fry	100		Spokane
CONGER 1&2	2000	RB	2408	Fry	86		Spokane
CONGER 1&2	2001	RB	1200	Fry	78		Spokane
CONGER 1&2	2001	RB	1200	Fry	78		Spokane
CONGER 1&2	2002	RB	1196	Fry	61	20	Spokane
CONGER 1&2	2002	RB	1196	Fry	61	20	Spokane
DAVIS	1933	K	55000				
DAVIS	1934	K	50400				
DAVIS	1935	K	80000				
DAVIS	1935	K	20000				
DAVIS	1936	EB	10000				
DAVIS	1936	K	50000				
DAVIS	1939	RB	4956				
DAVIS	1940	K	99950				
DAVIS	1940	RB	4996				
DAVIS	1941	K	129700				
DAVIS	1941	K	30600				
DAVIS	1941	RB	11998				
DAVIS	1942	K	202000				
DAVIS	1942	RB	6750				
DAVIS	1943	K	100000				
DAVIS	1943	K	100000				
DAVIS	1943	RB	12000				
DAVIS	1943	RB	15990				
DAVIS	1944	K	152400				

Location	Year	Spp.	# Planted	Class	#perPound	MeanLength	Stock
DAVIS	1944	RB	15105				
DAVIS	1944	RB	28000				
DAVIS	1946	RB	10000				
DAVIS	1947	K	287950				
DAVIS	1947	RB	4508				
DAVIS	1947	RB	5720				
DAVIS	1947	RB	4650				
DAVIS	1947	RB	7751				
DAVIS	1948	RB	4433				
DAVIS	1948	RB	4784				
DAVIS	1948	RB	10850				
DAVIS	1949	CT	78297				
DAVIS	1949	CT	2880				
DAVIS	1949	K	73200				
DAVIS	1950	CT	88000				
DAVIS	1951	CT	85060		784		
DAVIS	1952	CT	21000		750		
DAVIS	1952	CT	28320		1180		
DAVIS	1952	CT	12950		700		
DAVIS	1952	CT	7250		580		
DAVIS	1953	CT	25000		625		
DAVIS	1953	CT	50400		600		
DAVIS	1954	CT	78848		704		
DAVIS	1954	CT	8100		450		
DAVIS	1955	CT	112000		1400		
DAVIS	1956	CT	840		1		
DAVIS	1957	RB	77500		250		
DAVIS	1958	RB	60200		165		
DAVIS	1959	RB	25000		125		
DAVIS	1960	RB	25200		120		
DAVIS	1961	RB	24950		40		
DAVIS	1964	RB	6970		1.7		
DAVIS	1965	RB	10023		6		
DAVIS	1966	RB	10010		6.5		
DAVIS	1967	RB	10070		6		
DAVIS	1968	RB	10122		7.5		
DAVIS	1969	RB	10010		6.5		
DAVIS	1970	RB	10000		5		
DAVIS	1971	RB	10078		2.8		
DAVIS	1972	RB	10000		4		
DAVIS	1973	RB	10800		4.5		
DAVIS	1973	RB	17985				
DAVIS	1974	RB	10100		5.5		
DAVIS	1975	RB	10000		4.6		
DAVIS	1976	RB	10024		4.6		

Location	Year	Spp.	# Planted	Class	#perPound	MeanLength	Stock
DAVIS	1977	RB	10001		4		
DAVIS	1978	RB	10028		4.6		
DAVIS	1979	RB	9800		4.8		
DAVIS	1980	RB	7200		4.5		
DAVIS	1981	RB	8030		5.5		
DAVIS	1982	RB	15030		6		
DAVIS	1982	RB	8250	Smolt		6	Spokane-McCloud R. CA
DAVIS	1982	RB	6780	Smolt		6	Spokane-McCloud R. CA
DAVIS	1983	LT	7200	Non-Smolt		40	Mackinaw-Jenny L. WY
DAVIS	1983	RB	10320	Smolt		6	Spokane-McCloud R. CA
DAVIS	1983	RB	4000	Smolt		3.2	Spokane-McCloud R. CA
DAVIS	1984	RB	5936	Smolt		5.3	Spokane-McCloud R. CA
DAVIS	1984	RB	9018	Smolt		5.4	Spokane-McCloud R. CA
DAVIS	1985	RB	5200	Smolt		5.2	Spokane-McCloud R. CA
DAVIS	1985	RB	4316	Smolt		5.2	Spokane-McCloud R. CA
DAVIS	1986	RB	5829	Smolt		5.8	Spokane-McCloud R. CA
DAVIS	1986	RB	4698	Smolt		5.8	Spokane-McCloud R. CA
DAVIS	1987	RB	4012	Smolt		3.4	Spokane-McCloud R. CA
DAVIS	1987	RB	5920	Smolt		3.7	Spokane-McCloud R. CA
DAVIS	1988	RB	4814	Smolt		5.8	Spokane-McCloud R. CA
DAVIS	1988	RB	5220	Smolt		5.8	Spokane-McCloud R. CA
DAVIS	1989	RB	5517	Smolt		5.9	Spokane-McCloud R. CA
DAVIS	1989	RB	4658	Smolt		6.8	Spokane-McCloud R. CA
DAVIS	1990	RB	10075	Smolt		6.5	Spokane-McCloud R. CA
DAVIS	1990	RB	6030	Smolt		4.5	Spokane-McCloud R. CA
DAVIS	1991	RB	9600	Smolt		6.4	Spokane-McCloud R. CA
DAVIS	1992	RB	4876	Smolt		4.6	Spokane-McCloud R. CA
DAVIS	1992	RB	5129	Smolt		4.6	Spokane-McCloud R. CA
DAVIS	1992	RB	130	Smolt		0.3	Spokane-McCloud R. CA
DAVIS	1993	RB	4580	Smolt		4	Spokane-McCloud R. CA
DAVIS	1993	RB	3116	Smolt		4.1	Spokane-McCloud R. CA
DAVIS	1994	RB	8484	Smolt		4.7	Spokane-McCloud R. CA
DAVIS	1994	RB	667	Smolt		2.9	Spokane-McCloud R. CA
DAVIS	1995	RB	8149	LEGALS	5.8		Spokane
DAVIS	1995	RB	30016	Fry	56		Spokane
DAVIS	1996	RB	5416	Fry	5.4		Spokane
DAVIS	1996	RB	4585	Fry	5		Spokane
DAVIS	1996	RB	14991	Fry	76		Spokane
DAVIS	1996	RB	15028	Fry	68		Spokane
DAVIS	1997	RB	10050	Fry	5		Spokane
DAVIS	1997	RB	30036	Fry	93		Spokane
DAVIS	1998	RB	14976	Fry	72		Spokane
DAVIS	1998	RB	15004	Fry	62		Spokane
DAVIS	1999	RB	30024	Fry	72		Spokane
DAVIS	2000	RB	22330	Fry	101.5		Spokane

Location	Year	Spp.	# Planted	Class	#perPound	MeanLength	Stock
DAVIS	2000	RB	2661	Fry	99.5		Spokane
DAVIS	2001	RB	40044	Fry	94		Spokane
DAVIS	2002	RB	40033	Fry	67	598	SPOK
MARSHALL	1933	RB	7040				
MARSHALL	1933	SH	25000				
MARSHALL	1934	RB	18955				
MARSHALL	1934	RB	50000				
MARSHALL	1934	RB	17890				
MARSHALL	1934	RB	50000				
MARSHALL	1934	SH	18000				
MARSHALL	1935	RB	30000				
MARSHALL	1935	SH	20000				
MARSHALL	1936	EB	3500				
MARSHALL	1936	EB	8000				
MARSHALL	1936	EB	11500				
MARSHALL	1936	RB	4500				
MARSHALL	1936	SH	25000				
MARSHALL	1937	EB	5000				
MARSHALL	1937	K	60000				
MARSHALL	1937	RB	10900				
MARSHALL	1937	RB	6000				
MARSHALL	1937	RB	2000				
MARSHALL	1938	K	86688				
MARSHALL	1938	RB	3000				
MARSHALL	1938	RB	2500				
MARSHALL	1939	K	63300				
MARSHALL	1939	K	187950				
MARSHALL	1939	RB	5000				
MARSHALL	1939	RB	4993				
MARSHALL	1939	RB	25100				
MARSHALL	1940	K	99884				
MARSHALL	1940	RB	4975				
MARSHALL	1940	RB	421				
MARSHALL	1940	RB	9974				
MARSHALL	1941	K	90700				
MARSHALL	1941	K	61200				
MARSHALL	1941	K	44900				
MARSHALL	1941	RB	6900				
MARSHALL	1942	K	306400				
MARSHALL	1942	RB	6210				
MARSHALL	1943	RB	16000				
MARSHALL	1943	RB	15975				
MARSHALL	1944	K	152500				
MARSHALL	1944	RB	29600				
MARSHALL	1945	K	90700				

Location	Year	Spp.	# Planted	Class	#perPound	MeanLength	Stock
MARSHALL	1945	K	92009				
MARSHALL	1945	RB	15100				
MARSHALL	1946	K	149900				
MARSHALL	1946	K	99901				
MARSHALL	1946	RB	6600				
MARSHALL	1946	RB	8400				
MARSHALL	1947	K	287950				
MARSHALL	1947	RB	13648				
MARSHALL	1948	K	244000				
MARSHALL	1948	RB	6010				
MARSHALL	1948	RB	8030				
MARSHALL	1953	CT	99880		500		
MARSHALL	1954	CT	99720		554		
MARSHALL	1955	CT	129600		1200		
MARSHALL	1956	CT	102425		1205		
MARSHALL	1957	CT	8400		1200		
MARSHALL	1958	CT	75600		275		
MARSHALL	1960	CT	50397		420		
MARSHALL	1961	CT	74925		600		
MARSHALL	1963	CT	40040		280		
MARSHALL	1964	CT	41240		275		
MARSHALL	1965	CT	40150		300		
MARSHALL	1966	CT	35000		200		
MARSHALL	1967	CT	34932		284		
MARSHALL	1968	CT	35000		250		
MARSHALL	1969	CT	35185		275		
MARSHALL	1970	CT	35100		270		
MARSHALL	1972	CT	35850		55		
MARSHALL	1973	CT	20000		30		
MARSHALL	1974	CT	20040		24		
MARSHALL	1975	CT	20020		26		
MARSHALL	1976	CT	30000		30		
MARSHALL	1977	CT	30080		47		
MARSHALL	1978	CT	24075		46		
MARSHALL	1979	CT	20475		65		
MARSHALL	1980	CT	30015		45		
MARSHALL	1981	CT	30010		28.5		
MARSHALL	1983	WC	30000	Non-Smolt		30	Intermontaine-Twin Lakes
MARSHALL	1984	WC	30000	Non-Smolt		30	Westslope-Kings Lake
MARSHALL	1985	WC	30000	Non-Smolt		25	Westslope-Ford
MARSHALL	1985	WC	40000	Non-Smolt		250	Westslope-Kings Lake
MARSHALL	1986	WC	22000	Non-Smolt		220	Westslope-Kings Lake
MARSHALL	1986	WC	25740	Non-Smolt		234	Westslope-Kings Lake
MARSHALL	1987	WC	47104	Non-Smolt		256	Westslope-Kings Lake
MARSHALL	1988	WC	40090	Non-Smolt		190	Westslope-Kings Lake

Location	Year	Spp.	# Planted	Class	#perPound	MeanLength	Stock
MARSHALL	1989	WC	40000	Non-Smolt		250	Westslope-Kings Lake
MARSHALL	1990	WC	40014	Non-Smolt		228	Westslope-Kings Lake
MARSHALL	1991	AG	2760	Non-Smolt		40	Rogers Lake-Montana
MARSHALL	1991	AG	1827	Non-Smolt		87	Rogers Lake-Montana
MARSHALL	1992	WC	20125	Non-Smolt		35	Westslope-Kings Lake
MARSHALL	1993	WC	25760	Non-Smolt		23	Westslope-Kings Lake
MARSHALL	1993	WC	21291	Non-Smolt		28.2	Westslope-Kings Lake
MARSHALL	1994	WC	22620	Non-Smolt		29	Westslope-Kings Lake
MARSHALL	1994	WC	27405	Non-Smolt		29	Intermontaine-Twin Lakes
MARSHALL	1994	WC	39984	Non-Smolt		224	Westslope-Kings Lake
MARSHALL	1995	CT	17920	Fry	28		King
MARSHALL	1995	CT	24337	Fry	16.5		King
MARSHALL	1996	RB	15050	Fry	86		Spokane
MARSHALL	1997	CT	17820	Fry	81		WAPA
MARSHALL	1997	CT	10004	Fry	16.4		King
MARSHALL	1997	CT	26085	Fry	185		King
MARSHALL	1997	CT	26048	Fry	176		Twin
MARSHALL	1998	CT	20013	Fry	21		Twin
MARSHALL	1998	CT	60065	Fry	205		King
MARSHALL	2000	CT	4944	Fry	24		King
MARSHALL	2000	CT	25050	Fry	30		King
MARSHALL	2000	CT	36486	Fry	179		King
MARSHALL	2000	RB	30073	Legals	5.3		Spokane
MARSHALL	2001	CT	35076		148		King
MARSHALL	2002	WC	35156	Fry	188	187	King
N SKOOKUM	1933	EB	7500				
N SKOOKUM	1933	EB	7500				
N SKOOKUM	1934	EB	15000				
N SKOOKUM	1934	EB	3000				
N SKOOKUM	1935	EB	30000				
N SKOOKUM	1936	EB	25000				
N SKOOKUM	1937	EB	10000				
N SKOOKUM	1937	EB	16000				
N SKOOKUM	1938	EB	50000				
N SKOOKUM	1938	EB	10000				
N SKOOKUM	1938	EB	8000				
N SKOOKUM	1939	EB	7800				
N SKOOKUM	1939	EB	31700				
N SKOOKUM	1940	EB	75125				
N SKOOKUM	1940	EB	4993				
N SKOOKUM	1942	EB	18100				
N SKOOKUM	1942	EB	17900				
N SKOOKUM	1943	EB	14980				
N SKOOKUM	1943	EB	14980				
N SKOOKUM	1948	EB	18930				

Location	Year	Spp.	# Planted	Class	#perPound	MeanLength	Stock
N SKOOKUM	1949	EB	11700				
N SKOOKUM	1949	EB	15300				
N SKOOKUM	1950	EB	25800				
N SKOOKUM	1951	EB	20000		1000		
N SKOOKUM	1952	EB	20820		1735		
N SKOOKUM	1953	EB	21000		1500		
N SKOOKUM	1954	EB	20150		650		
N SKOOKUM	1955	EB	20400		600		
N SKOOKUM	1956	EB	20000		768		
N SKOOKUM	1957	EB	15036		716		
N SKOOKUM	1958	EB	19995		500		
N SKOOKUM	1959	EB	20225		286		
N SKOOKUM	1961	EB	13432		460		
N SKOOKUM	1962	EB	12797		400		
N SKOOKUM	1963	EB	10080		140		
N SKOOKUM	1964	EB	10205		157		
N SKOOKUM	1965	EB	10400		130		
N SKOOKUM	1966	EB	10120		220		
N SKOOKUM	1967	EB	10350		115		
N SKOOKUM	1969	EB	10000		200		
N SKOOKUM	1970	EB	10175		185		
N SKOOKUM	1973	EB	5040		140		
N SKOOKUM	1974	EB	5146		166		
N SKOOKUM	1975	EB	5040		120		
N SKOOKUM	1976	EB	5100		150		
N SKOOKUM	1979	EB	5000		125		
N SKOOKUM	1980	EB	5074		86		
N SKOOKUM	1981	EB	5000		125		
N SKOOKUM	1982	EB	5096	Non-Smolt		98	E. Brook-Ford (Owhi Lake)
N SKOOKUM	1982	EB	5096		98		
N SKOOKUM	1983	EB	5000	Non-Smolt		100	E. Brook-Ford (Owhi Lake)
N SKOOKUM	1986	EB	3002	Smolt		3.8	E. Brook-Ford (Owhi Lake)
N SKOOKUM	1986	EB	5040	Non-Smolt		120	E. Brook-Ford (Owhi Lake)
N SKOOKUM	1987	EB	5000	Non-Smolt		100	Methow River
N SKOOKUM	1988	EB	4067	Non-Smolt		83	Methow River
N SKOOKUM	1989	EB	4059	Non-Smolt		99	Methow River
N SKOOKUM	1990	EB	8000	Non-Smolt		80	Methow River
N SKOOKUM	1991	EB	7980	Non-Smolt		105	E. Brook-Ford (Owhi Lake)
N SKOOKUM	1992	EB	6000	Non-Smolt		75	E. Brook-Ford (Owhi Lake)
N SKOOKUM	1993	EB	6072	Non-Smolt		88	E. Brook-Ford (Owhi Lake)
N SKOOKUM	1994	RB	5992	Non-Smolt		56	Spokane-McCloud R. CA
N SKOOKUM	1995	RB	6006	Fry	78		Spokane
N SKOOKUM	1996	RB	5899	Fry	93		Spokane
N SKOOKUM	1997	RB	6006	Fry	91		Spokane
N SKOOKUM	1998	RB	6006	Fry	77		Spokane

Location	Year	Spp.	# Planted	Class	#perPound	MeanLength	Stock
N SKOOKUM	1999	RB	6000	Fry	75		Spokane
N SKOOKUM	2000	RB	4002	Fry	87		Spokane
N SKOOKUM	2001	RB	5015	Fry	59		Spokane
N SKOOKUM	2002	RB	3023	Fry	65	47	Spokane
PARKER	1933	EB	50000				
PARKER	1933	EB	10000				
PARKER	1934	EB	50000				
PARKER	1934	EB	15000				
PARKER	1935	EB	25000				
PARKER	1936	EB	4000				
PARKER	1936	EB	8500				
PARKER	1936	EB	15000				
PARKER	1938	RB	1000				
PARKER	1939	RB	1500				
PARKER	1940	EB	4995				
PARKER	1940	RB	1496				
PARKER	1941	RB	5985				
PARKER	1942	RB	2875				
PARKER	1943	EB	14980				
PARKER	1947	RB	24500				
PARKER	1949	EB	24000				
PARKER	1950	EB	20400				
PARKER	1951	EB	19475		2050		
PARKER	1952	EB	15120		2520		
PARKER	1953	EB	20566		1582		
PARKER	1974	EB	4140		180		
PARKER	1974	EB	4140		180		
PARKER	1975	EB	1015		145		
PARKER	1975	EB	1015		145		
PARKER	1976	EB	1200		120		
PARKER	1977	EB	1400		140		
PARKER	1979	EB	560		70		
PARKER	1980	EB	1425		95		
PARKER	1981	EB	2250		150		
PARKER	1984	EB	1500	Non-Smolt		100	E. Brook-Ford (Owhi Lake)
PARKER	1985	EB	1800	Non-Smolt		90	E. Brook-Ford (Owhi Lake)
PARKER	1986	EB	1000	Non-Smolt		100	E. Brook-Ford (Owhi Lake)
PARKER	1987	EB	1040	Non-Smolt		80	Methow River
PARKER	1988	EB	897	Non-Smolt		69	E. Brook-Ford (Owhi Lake)
PARKER	1988	EB	1242	Non-Smolt		69	E. Brook-Ford (Owhi Lake)
PARKER	1989	EB	1290	Non-Smolt		86	Methow River
PARKER	1990	EB	980	Non-Smolt		70	Methow River
PARKER	1991	EB	980	Non-Smolt		70	E. Brook-Ford (Owhi Lake)
PARKER	1992	EB	1497	Non-Smolt		73	E. Brook-Ford (Owhi Lake)
PARKER	1993	RB	1512	Non-Smolt		56	Spokane-McCloud R. CA

Location	Year	Spp.	# Planted	Class	#perPound	MeanLength	Stock
PARKER	1994	RB	1499	Non-Smolt		49	Spokane-McCloud R. CA
PARKER	1995	RB	1512	Fry	72		Spokane
PARKER	1996	RB	1520	Fry	76		Spokane
PARKER	1997	RB	1627	Fry	93		Spokane
PARKER	1998	RB	1496	Fry	73		Spokane
PARKER	2001	RB	1000	Fry	78		Spokane
PARKER	2002	RB	994	Fry	61	16	Spokane
POWER	1933	CT	40000				
POWER	1933	EB	18000				
POWER	1934	EB	25000				
POWER	1934	EB	6000				
POWER	1934	RB	40000				
POWER	1934	RB	35000				
POWER	1935	EB	50000				
POWER	1935	RB	22600				
POWER	1936	EB	25000				
POWER	1936	EB	9000				
POWER	1937	EB	15000				
POWER	1938	RB	6109				
POWER	1939	RB	1248				
POWER	1939	RB	10480				
POWER	1940	EB	10313				
POWER	1940	EB	4990				
POWER	1940	RB	7025				
POWER	1941	RB	8279				
POWER	1942	RB	6720				
POWER	1943	RB	14400				
POWER	1944	RB	18000				
POWER	1945	RB	18540				
POWER	1946	RB	15000				
POWER	1947	RB	13182				
POWER	1948	RB	13975				
POWER	1949	RB	9665				
POWER	1949	RB	4800				
POWER	1949	RB	32950				
POWER	1951	RB	62400		2400		
POWER	1952	RB	19750		1000		
POWER	1952	RB	30550		1300		
POWER	1953	RB	49824		692		
POWER	1954	RB	50440		776		
POWER	1955	RB	20732		292		
POWER	1955	RB	29520		328		
POWER	1956	RB	50000		400		
POWER	1957	RB	15272		664		
POWER	1958	EB	19995		460		

Location	Year	Spp.	# Planted	Class	#perPound	MeanLength	Stock
POWER	1959	EB	20000		400		
POWER	1961	RB	19993		160		
POWER	1962	RB	15985		200		
POWER	1963	RB	7800		195		
POWER	1963	RB	7140		210		
POWER	1964	RB	8400		210		
POWER	1993	RB	4984	Non-Smolt		56	Spokane-McCloud R. CA
POWER	1994	RB	5100	Non-Smolt		60	Spokane-McCloud R. CA
POWER	1995	RB	4968	Fry	72		Spokane
POWER	1996	RB	5016	Fry	76		Spokane
POWER	1997	RB	5076	Fry	94		Spokane
POWER	1998	RB	5000	Fry	73		Spokane
POWER	1999	RB	5400	Fry	100		Spokane
POWER	2000	RB	5074	Fry	86		Spokane
POWER	2001	RB	5000	Fry	78		Spokane
POWER	2002	RB	5002	Fry	61	82	Spokane
SKOOKUM	1936	EB	3500				
SKOOKUM	1936	EB	8000				
SKOOKUM	1936	EB	15000				
SKOOKUM	1939	EB	7800				
SKOOKUM	1977	EB	5040		120		
SKOOKUM	1978	EB	5100		102		
S SKOOKUM	1933	EB	7500				
S SKOOKUM	1933	EB	7500				
S SKOOKUM	1934	EB	15000				
S SKOOKUM	1934	EB	3000				
S SKOOKUM	1935	EB	30000				
S SKOOKUM	1936	EB	25000				
S SKOOKUM	1936	EB	12000				
S SKOOKUM	1937	EB	6942				
S SKOOKUM	1937	EB	6500				
S SKOOKUM	1937	EB	9500				
S SKOOKUM	1938	EB	60000				
S SKOOKUM	1938	EB	6091				
S SKOOKUM	1939	EB	7500				
S SKOOKUM	1939	EB	31140				
S SKOOKUM	1940	EB	71972				
S SKOOKUM	1940	EB	4995				
S SKOOKUM	1942	EB	16300				
S SKOOKUM	1942	EB	15475				
S SKOOKUM	1943	EB	16385				
S SKOOKUM	1943	EB	15090				
S SKOOKUM	1944	EB	48300				
S SKOOKUM	1948	EB	24740				
S SKOOKUM	1949	EB	14180				

Location	Year	Spp.	# Planted	Class	#perPound	MeanLength	Stock
S SKOOKUM	1949	EB	13665				
S SKOOKUM	1950	EB	39500				
S SKOOKUM	1951	EB	40000		1000		
S SKOOKUM	1952	EB	40772		1735		
S SKOOKUM	1953	EB	39000		1500		
S SKOOKUM	1954	EB	25350		650		
S SKOOKUM	1955	EB	25200		600		
S SKOOKUM	1956	EB	30600		680		
S SKOOKUM	1957	EB	20048		716		
S SKOOKUM	1958	EB	20000		400		
S SKOOKUM	1959	EB	20992		300		
S SKOOKUM	1961	EB	13436		460		
S SKOOKUM	1962	EB	12795		400		
S SKOOKUM	1963	EB	10080		140		
S SKOOKUM	1964	EB	10205		157		
S SKOOKUM	1965	EB	10400		130		
S SKOOKUM	1966	EB	10120		220		
S SKOOKUM	1967	EB	10360		115		
S SKOOKUM	1969	EB	10000		200		
S SKOOKUM	1970	EB	10175		185		
S SKOOKUM	1973	EB	5040		140		
S SKOOKUM	1974	EB	5146		166		
S SKOOKUM	1975	EB	5100		150		
S SKOOKUM	1976	EB	5120		160		
S SKOOKUM	1977	EB	5040		120		
S SKOOKUM	1978	EB	5100		102		
S SKOOKUM	1979	EB	5000		125		
S SKOOKUM	1980	EB	5074		86		
S SKOOKUM	1981	EB	5000		125		
S SKOOKUM	1982	EB	5096	Non-Smolt		98	E. Brook-Ford (Owhi Lake)
S SKOOKUM	1983	EB	5000	Non-Smolt		100	E. Brook-Ford (Owhi Lake)
S SKOOKUM	1986	EB	3002	Smolt		3.8	E. Brook-Ford (Owhi Lake)
S SKOOKUM	1986	EB	5040	Non-Smolt		120	E. Brook-Ford (Owhi Lake)
S SKOOKUM	1987	EB	5000	Non-Smolt		100	Methow River
S SKOOKUM	1988	EB	4067	Non-Smolt		83	Methow River
S SKOOKUM	1989	EB	4059	Non-Smolt		99	Methow River
S SKOOKUM	1990	EB	8000	Non-Smolt		80	Methow River
S SKOOKUM	1991	EB	7980	Non-Smolt		105	E. Brook-Ford (Owhi Lake)
S SKOOKUM	1992	EB	8025	Non-Smolt		75	E. Brook-Ford (Owhi Lake)
S SKOOKUM	1993	RB	8024	Non-Smolt		59	Spokane-McCloud R. CA
S SKOOKUM	1994	RB	8008	Non-Smolt		56	Spokane-McCloud R. CA
S SKOOKUM	1995	RB	8034	Fry	78		Spokane
S SKOOKUM	1996	RB	7905	Fry	93		Spokane
S SKOOKUM	1997	RB	8008	Fry	91		Spokane
S SKOOKUM	1998	RB	8008	Fry	77		Spokane

Location	Year	Spp.	# Planted	Class	#perPound	MeanLength	Stock
S SKOOKUM	1999	RB	8025	Fry	75		Spokane
S SKOOKUM	2000	RB	4002	Fry	87		Spokane
S SKOOKUM	2001	RB	6018	Fry	59		Spokane
S SKOOKUM	2002	RB	4004	Fry	65	62	Spokane

Appendix 3

Joint Stock Assessment Project
2002 Report on Activities
Conducted by
Jim LeMieux
Kalispel GIS Administrator

Summary

GIS and related support for the JSAP has made significant progress in the overall goal of providing a single-source location for Resident fish data in the blocked area of Washington State. These include advances in data management, map production, and GIS administration.

<u>Database management</u>
The framework for all JSAP and non-JSAP collected fish and habitat data consists of several MS Access 2000 databases. Management tasks included the update of existing databases and the addition of new data tables. The core data sources to date include:

- Colville National Forest Fish and Habitat database.
- Kalispel Natural Resource Department Habitat database (by year).
- Kalispel Natural Resource Department Fish database.
- Spokane Tribe Fish and Habitat database.
- Washington Department of Fish and Wildlife Fish and Habitat database.
- Washington Department of Fish and Wildlife Salmonid Stock Inventory (SaSI) database.
- Washington Department of Fish and Wildlife Stream, Lake and Fish database (SLFD).
- Master geocode event tables.

The desperate nature of the JSAP data sources facilitated the need to unify these data in a way that preserved the integrity of each survey while providing a comparative analysis capability. To this end, the Kalispel Tribe in the first quarter of FY 2002 contracted with Cevian Technologies of Mount Vernon, WA to develop a unified database management system (UDB). The UDB was completed at the end of December 2002 and currently resides on a computer server in the Spokane office of the Kalispel Natural Resource Department. This required the purchase of MS SQL server 2000 software to house and run the UDB. This is a major milestone in the goal of becoming a data clearinghouse for JSAP data. Future possibilities include the development of a Web-based data portal for both spatial and non-spatial data including a geo-filtering capability.

<u>Map production</u>
Numerous hard copy and electronic maps were produced for the various participants in the JSAP. These included paper maps for field surveys and soft copy maps for report generation.

<u>GIS Administration</u>
The administration of GIS software and related hardware was a housekeeping chore necessary to stay efficient and up to date with the latest GIS technology. In the first quarter of FY 2002 the GIS program upgraded to the Arc 8.1 family of software. This was a major software release and required

some self-training to get up to speed with the new technology. Included with the upgrade was a set of Federal Geographic Data Committee (FGDC) compliant metadata tools. All federally funded GIS projects are required to meet FGDC standards. We are nearing our goal to make all of our GIS spatial data FGDC compliant by second quarter of FY 2003. No new GIS hardware was purchased in FY 2002. Some minor hardware server upgrades are planned for FY 2003, however, the ultimate hardware needs will be dependent on the agreed upon what functionality a web-based database should have.

Significant tasks:

- Wrote RFP and subsequent contract for the development of a unified Joint Stock Assessment database compiled from the data collected through the JSAP and pre-existing public data.
- Coordinated with Cevian Technologies in the development of a unified database including several phone conferences and in-person meetings.
- Purchased and installed MS SQL Server 2000 software on the Kalispel Natural Resource Department Spokane office server for use as the RDBMS for the future unified database.
- Built several survey maps of Nine Mile Reservoir and Little Spokane River watershed for WDFW (J. McLellan).
- Built a survey transect map of Moses Lake for WDFW (D. Burgess).
- Build a survey transect map of Banks Lake for WDFW (C. Baldwin).
- Imported and Geocoded fish and habitat data for the 2001 KNRD fish and habitat surveys.
- Imported and Geocoded fish and habitat data for the 2001 WDFW fish and habitat survey (J. McLellan).
- Built survey maps for KNRD (J. Connor) 2001 JSAP annual report.

2002 WDFW Annual Report for the Project
RESIDENT FISH STOCK STATUS
ABOVE CHIEF JOSEPH AND GRAND COULEE DAMS

Part I. Baseline Assessment of Fish Species Distribution and Densities
In the Little Spokane River Drainage, Year 2,
And
The Spokane River between Spokane Falls and Nine Mile Falls Dam.

Part II. Coordination, Data Standards Development,
and Data Sharing Activities

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600 Capitol Way North
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June 2003

2002 WDFW Annual Report for the Project
RESIDENT FISH STOCK STATUS
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June 2003

Abstract

Limited baseline fish distribution or instream habitat data had been collected on the middle Spokane River or free flowing portions of the Little Spokane River drainage. The objectives of this study were to determine: 1) baseline fish distribution and densities in the middle Spokane River, 2) age, growth, and condition of sport fish in the middle Spokane River, 3) baseline habitat conditions and fish distribution and density in five tributaries of the Little Spokane River, as part of a multi-year effort to survey the entire drainage, and 4) characterize the genetic structure of the wild rainbow trout populations in the middle Spokane River and tributaries of the Little Spokane River.

The middle Spokane River was stratified into two sections: the free-flowing stretch, between Monroe Street Dam and the upper extent of the impoundment from Nine Mile Dam at RKM 102.8, and the Nine Mile Reservoir. Fish were sampled in the upper portion of the free-flowing section in the summer of 2002, with a drift boat electrofisher. Fish sampling in the reservoir was conducted in the summer and fall of 2002, with a boat electrofisher and horizontal gill nets. Scale samples were collected from wild sport fish for age and growth analysis. Seven and 16 species of fish were collected in the free-flowing and reservoir sections, respectively. Bridgelip suckers had the highest catch-per-unit-effort (CPUE) in the free-flowing section and in Nine Mile Reservoir gill nets. Redside shiners had the highest electrofishing CPUE in the reservoir. Rainbow trout and mountain whitefish had the highest sport fish abundance in the free-flowing stretch and rainbow trout were the most abundant in the reservoir. Ages of wild rainbow trout ranged from 1 to 3 in the free-flowing section and 0 to 4 in the reservoir. Growth of free-flowing and reservoir rainbow trout was good and condition (K_{TL}) was average when compared to other populations.

Little Spokane River tributaries surveyed were Beaver, Dragoon, Little Deer, Spring, and West Branch Dragoon Creeks. Habitat parameters were measured at each fish survey site. Fish were collected by multiple-pass backpack electrofishing. Dragoon Creek was the largest stream surveyed based on mean wetted and bankfull widths. Little Deer Creek was the smallest stream based on mean wetted width and mean depth. The greatest diversity of fish was in the Dragoon Creek (13 species) and the lowest was in Little Deer Creek (2 species). With the exception of

Dragoon Creek, angling opportunities were limited due to the lack of stock and legal length trout and limited access.

The results of the DNA analysis indicated that each of the 11 populations examined to date (those in this report, as well as the 2001 collections) comprised distinct subpopulations (Hypothesis 1: rejected). The second hypothesis, that the populations are indistinguishable from one or more hatchery strains, was also rejected. Hypothesis 3, that the populations were the redband subspecies and not the coastal subspecies was accepted for Phalon Lake, and Deadman (Kettle River tributary), Little Deer, Deer, and Otter Creeks. However, Hypothesis 3 was rejected for the Spokane Hatchery stock, as well as Buck, upper Dragoon, lower Dragoon, and West Branch Dragoon Creeks. The data on the Spokane River sample was too limited to allow for accurate assignment.

Acknowledgements

We thank the Kalispel Tribe for administration of the Joint Stock Assessment Project, in particular Jason Connor and Joe Maroney. We gratefully acknowledge John Whalen (WDFW) for advice and guidance in all aspects of the project design and implementation. We thank Jim Lemieux for generating maps and watershed statistics and the following individuals for their assistance with field collections: Leslie King, Bret Nine, Heather Woller, Casey Baldwin, and Chris Donley (WDFW); Holly McLellan (Eastern Washington University), and volunteer Pat Davis. We also thank Jim Shaklee, Sewall Young, and Janet Loxterman (WDFW Genetics Lab) for conducting microsatellite DNA analysis. We thank Chris Donley and John Whalen (WDFW), as well as Holly McLellan and Dr. Al Scholz (EWU) for reviewing this report.

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Table of Contents

List of Tables

List of Figures

Introduction

Project Background

The Joint Stock Assessment Project (JSAP), developed in 1997, is a cooperative project of the Washington Department of Fish and Wildlife (WDFW), Kalispel Tribe of Indians (KNRD), Spokane Tribe of Indians, and Colville Confederated Tribes. The objective of the JSAP is to assess fish stocks and associated habitats, and generate a management plan(s) for protection, mitigation, and enhancement of resident fish in the blocked area watersheds above Chief Joseph and Grand Coulee Dams. In order to identify data gaps and effectively house stock assessment data, the participants developed a central database of fisheries related data for the blocked area that is accessible to all blocked area managers. Initial development of the database involved collecting all existing data. Using the historical database, data gaps were identified and new investigations were initiated to fill those gaps.

The Little Spokane River drainage was identified as a high priority watershed for 2001-2003. In addition, the Spokane River between Spokane Falls and Nine Mile Dam, which we call the middle Spokane River, was identified as a priority in 2002. This document describes survey results for the middle Spokane River and the second year of sampling in the Little Spokane River drainage.

History of the Spokane and Little Spokane Rivers

When the first Europeans arrived in the region, the fish communities of the Spokane and Little Spokane River systems were comprised of chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), steelhead (*O. mykiss*), resident trout (*O.* spp.), whitefish (*Prosopium* spp.), and suckers (*Catostomus* spp.) (Scholz et al. 1985). There was reportedly a small run of sockeye salmon (*O. nerka*) that migrated up the Little Spokane River to Chain Lake (WDFW Region 1 lake management file, 1956). Prior to the construction of Little Falls Dam in 1911, the fish resources in the Spokane River system provided a subsistence fishery for local Native American tribes and a nationally recognized sport fishery for the early white settlers (Scholz et al. 1985).

The species composition of the Spokane River and its tributaries began to change following the completion of Little Falls Dam, which prevented salmon and steelhead from returning to the system. There were also numerous introductions of non-indigenous fish species, which further changed the species composition (WDFW, unpublished hatchery records, A. Scholz, EWU, personal communication). Human impacts, such as timber harvest, agriculture, and commercial and residential development, are assumed to have had negative impacts on the remaining fish populations. However, prior to 2001 little instream habitat or fish data had been collected on the middle Spokane River or Little Spokane River systems.

The most substantial fisheries related work on the Spokane River was completed on the upper stretches near the Idaho/Washington border (Bailey and Saltes 1982; Bennett and Underwood 1988; Underwood and Bennett 1992; Johnson 1997), Long Lake (Pfeiffer 1985; Bennett and Hatch 1989; Bennett and Hatch 1991; Osborne et al. 2003), and the Spokane Arm of Lake Roosevelt (e.g. Peone et al. 1990; Griffith and Scholz 1990; McLellan 1998; Cichosz et al. 1999).

Previous fisheries related work on the middle Spokane River consisted of three fish species composition studies, as well as various single occasion fish collections, and five years of creel survey. The first survey consisted of two gill net sets (2 hours each) in Nine Mile Reservoir, as well as at least one beach seine haul in the Spokane River near the mouth of Latah Creek (Pfeiffer 1985). Twenty-eight fish were captured in the Nine Mile Reservoir: 14 northern pikeminnow (*Ptychocheilus oregonensis*) and 14 unidentified suckers. The seine haul below Latah Creek yielded 250 unidentified sucker fry, 50 northern pikeminnow fry, and five redside shiners (*Richardsonius balteatus*).

A more substantial survey of the middle Spokane River was conducted in 1987. This study involved macroinvertebrate, zooplankton, and fish abundance indices, age and growth an diet collections, as well as an evaluation of habitat conditions (Kleist 1987). Fish collection in the river above Nine Mile Reservoir was primarily limited to hook-and-line sampling, with the exception of boat electrofishing in the riffle at the river-reservoir interface. Boat electrofishing and gill netting were used in the reservoir. Fish captured in the free-flowing section included rainbow trout, brown trout (*Salmo trutta*), cutthroat trout (*O. clarki*), northern pikeminnow, and redside shiners. Kleist (1987) captured bridgelip suckers (*C. columbianus*), northern pikeminnow, brown trout, chiselmouth (*Acrocheilus alutaceus*), longnose dace (*Rhinicthys cataractae*), redside shiners, and yellow perch (*Perca flavescens*) in Nine Mile Reservoir. Mountain whitefish (*Prosopium williamsoni*) and rainbow trout were captured in the riffle at the river-reservoir interface (Kleist 1987).

A third study was conducted by Washington Water Power Company (now Avista Utilities; hereafter referred to as Avista) between 1990 and 1992. A description of the work was submitted to the Federal Energy Regulatory Commission (FERC) (Smith and Johnson 1992; Smith 1993). The data presented in this report was compiled from Smith and Johnson (1992) and WDFW Scientific Collection Permit Reports (Smith 1992; Johnson 1993). The methods used included boat electrofishing, snorkeling, gill netting, and trap netting; however, the reports did not specify effort or, in some instances, gear types used for collections.

Smith and Johnson (1992) reported that northern pikeminnow, bridgelip suckers, largescale suckers (*C. macrocheilus*), longnose dace, redside shiners, chiselmouth, yellow perch, tench (*Tinca tinca*), bullhead (*Ameiurus* spp.), mountain whitefish, brown trout, rainbow trout, cutthroat trout, kokanee (*O. nerka*), chinook salmon, and northern pike (*Esox lucius*) were present in the reservoir, but did not specifically indicate that they were captured during the study. Tables of fish captured by Smith and Johnson (1992) only included bullhead, northern pikeminnow, largescale sucker, tench, chiselmouth, mountain whitefish, brown trout, and rainbow trout.

The results in the FERC Report (Smith and Johnson 1992) were different than those reported in the Scientific Collection Permit Reports (Smith 1992; Johnson 1993). According to Scientific Collection Permit Reports, longnose suckers (*C. catostomus*), bridgelip suckers, mountain whitefish, rainbow trout, brown trout, kokanee, and northern pikeminnow in Nine Mile Reservoir and longnose suckers, bridgelip suckers, unidentified suckers, mountain whitefish, rainbow trout, brown trout, and northern pikeminnow were collected near the Spokane Rifle Club rapid (RKM 103.3) and unidentified suckers, mountain whitefish, rainbow trout, brown trout, white sturgeon (*Acipenser transmontanus*), and chiselmouth were collected near T.J. Meenach Bridge. A WDFW biologist (R. Peck), who was present on one of the sampling trips, recorded data in his field notebook that was not included in the Scientific Collection Permit Reports. They electrofished between the two rapids at the Spokane Rifle Club on October 6, 1992 and captured rainbow trout, mountain whitefish, suckers (bridgelip and largescale), and northern pikeminnow. They also electrofished approximately one mile downstream from the Spokane Rifle Club and collected one brown trout, one chinook salmon, and largescale suckers.

Additional fish sampling, between Monroe St. and Nine Mile Dams, was conducted between 1986 and 1998 that provided some fish presence information. Peden (1987) reported collecting chiselmouth, northern pikeminnow, longnose dace, speckled dace (*R. osculus*), redside shiners, suckers, and Umatilla dace (*R.* spp.) in the free-flowing section near the mouth of Latah Creek. In 1994, Avista personnel captured mountain whitefish and rainbow trout in the middle Spokane River (Johnson 1994). As part of a S.S. Geological Survey study, Maret (1999) collected rainbow trout, bridgelip suckers, largescale suckers, redside shiners, mountain whitefish, and northern pikeminnow in the middle Spokane River in 1998.

Avista personnel conducted creel surveys of the middle Spokane River in 1989 and 1992 (Smith et al. 1993) and 1996, 1997, and 1999 (Avista 2000). In 1989, the only catch data reported was related to trout (brown and rainbow trout) (Avista, unpublished data). Anglers fishing between T.J. Meenach Bridge and Nine Mile Dam caught rainbow trout and mountain whitefish in 1992 (Smith et al. 1993), 1996, 1997, and 1999 (Avista 2000). Anglers also caught one brown trout in 1999 (Avista 2000). The majority of anglers in 1989 and 1992 were using bait, followed by lures, and flies (Avista, unpublished data; Smith et al. 1993). Fly fisherman were the most common angler type encountered between in 1996, 1997, and 1999 (Avista 2000), which was to be expected following regulation changes to selective gear rules in the mid 1990's. However, anglers using bait in 1996-1999 were common, indicating noncompliance with the regulations (Avista 2000).

Prior to 2001, there had been little instream habitat or fish distribution data collected on the Little Spokane River or its tributaries. The only habitat information consisted of standardized stream assessment surveys (3 sites) conducted by the Washington Department of Ecology (WDOE) and temperature monitoring conducted by the Spokane County Conservation District (SCCD). The majority of the fish surveys in the Little Spokane River system occurred on the lakes (Zook 1978; Mongillo and Hallock 1995; Hallock and Mongillo 1998; Polacek and Baldwin 1999; Phillips and Divens 2000; Divens et al. 2001; 2002a; 2002b). The fish population data collected on the free flowing portions of the drainage consisted of work on the lower 27.0 km of the Little Spokane River, with the exception of various single site electrofishing surveys conducted on the upper Little Spokane River and eleven of its tributaries. All of the previous instream habitat and fish survey work in the Little Spokane River drainage was summarized in McLellan (2003).

In 2001, the WDFW Joint Stock Assessment Project completed standardized surveys of nine tributaries of the Little Spokane River (McLellan 2003). Fish distribution data from those surveys were included with the previous data to develop a table of known fish occurrences in the Little Spokane River drainage, as of the spring of 2002 (Table 1).

Spokane and Little Spokane River Stocking Histories

Fish have been planted in the Spokane and Little Spokane River basins over the last 110 years. Several species of fish were planted, including rainbow trout, brown trout, cutthroat trout, eastern brook trout (*Salvelinus fontinalis*), lake trout (*S. namaycush*), steelhead, kokanee, bass (*Micropterus* spp.), crappie (*Pomoxis* spp.), yellow perch, and catfish (*Ameiurus* spp.) (WDFW, unpublished hatchery records; A. Scholz, EWU, personal communication). The unpublished WDFW plant records for the Spokane River from 1933 through 2002 are provided in Appendix A. The current stocking regime for the middle Spokane River is 4,000 rainbow trout (primarily Spokane Hatchery stock). An additional 2,000 brown trout were planted in Nine Mile Reservoir in 2002.

The unpublished WDFW plant records for the Little Spokane River drainage from 1933 through 2001 were provided in McLellan (2003). The stocking regime for the Little Spokane River drainage in 2002 included approximately 1,500 rainbow trout in the Little Spokane River, 5,000 brown trout and 38,300 rainbow trout in Diamond Lake, 37,200 eastern brook trout and 7,500 rainbow trout in Sacheen Lake, 7,500 rainbow trout in Horseshoe Lake, 3,000 rainbow trout in Fan Lake, and 5,000 brown trout in Eloika Lake.

Table 1. Updated list of fish species reported to occur within the Little Spokane River system.

Common Name	Species Name	Location	Source
Salmonidae			
Brown Trout	*Salmo trutta*	Dry Creek	McLellan (2003)
		Eloika Lake	Divens et al. (2001)
		Little Spokane River	Hartung and Meier (1980); EWU, unpubl. data 2001
		Otter Creek	McLellan (2003)
		Sacheen Lake	WDFW, unpubl. data 2000
		W. Branch Little Spokane River	EWU, unpubl. data 1999; McLellan (2003)
		Wethey Creek	WDFW, unpubl. data 2002
Eastern Brook Trout	*Salvelinus fontinalis*	Bear Creek	McLellan (2003)
		Beaver Creek[1]	McLellan (2003)
		Buck Creek	EWU, unpubl. data 2000; McLellan (2003)
		Deer Creek	WDFW, unpubl. data 1978; EWU, unpubl. data 1999; McLellan (2003)
		Dragoon Creek	EWU, unpubl. data 2001
		Dry Creek	McLellan (2003)
		Heel Creek	McLellan (2003)
		Little Deer Creek	EWU, unpubl. data 1999
		Little Spokane River	EWU, unpubl. data 1999
		Mud Creek	Lines (1982)
		Otter Creek	WDFW, unpubl. data 1974; McLellan (2003)
		Sacheen Lake	Divens et al. (2002b)
		S. Fork Deadman Creek	EWU, unpubl. data 1999
		Spring Heel Creek	McLellan (2003)
		Trout Lake	WDFW, unpubl. data 1993
		Wethey Creek	WDFW, unpubl. data 2002
Lake Trout	*Salvelinus namaycush*	Horseshoe Lake	WDFW, unpubl. data 1993, 1995, 1997
Kokanee	*Oncorhynchus nerka*	Buck Creek	EWU, unpubl. data 2000
		Chain Lake	WDFW, unpubl. data 1993; Polacek and Baldwin (1999)
		Horseshoe Lake	WDFW, unpubl. data 1993, 1995, 1997
		Little Spokane River	EWU, unpubl. data 2000
Rainbow Trout	*Oncorhynchus mykiss*	Bear Creek	McLellan (2003)
		Beaver Creek[1]	McLellan (2003)
		Buck Creek	EWU, unpubl. data 2000; McLellan (2003)
		Chain Lake	Polacek and Baldwin (1999)

Common Name	Species Name	Location	Source
		Dartford Creek	WDFW, unpubl. data 1986, 1992
		Deadman Creek	EWU, unpubl. data 1999
		Deer Creek	EWU, unpubl. data 1999; McLellan (2003)
		Diamond Lake	Phillips and Divens (2000)
		Dragoon Creek	EWU, unpubl. data 2001
		Dry Creek	McLellan (2003)
		Eloika Lake	Divens et al. (2001)
		Fan Lake	Divens et al. (2002a)
		Horseshoe Lake	WDFW, unpubl. data 1993
		Little Deep Creek	EWU, unpubl. data 1999
		Little Deer Creek	EWU, unpubl. data 1999
		Little Spokane River	Hartung and Meier (1980, 1995); Peden (1987); Pfeiffer (1988); EWU, unpubl. data 1999, 2001
		Otter Creek	WDFW, unpubl. data 1974; McLellan (2003)
		Trout Lake	WDFW, unpubl. data 1993
		WB Little Spokane River	McLellan (2003)
		Wethey Creek	WDFW, unpubl. data 2002
Mountain Whitefish	*Prosopium williamsoni*	Bear Creek	McLellan (2003)
		Chain Lake	WDFW, unpubl. data 1993; Polacek and Baldwin (1999)
		Dry Creek	McLellan (2003)
		Horseshoe Lake	WDFW, unpubl. data 1993
		Little Spokane River	Hartung and Meier (1980, 1995); Pfeiffer (1988); EWU, unpubl. data 2001
		Otter Creek	McLellan (2003)
		WB Little Spokane River	McLellan (2003)
		Wethey Creek	WDFW, unpubl. data 2002
Pygmy Whitefish	*Prosopium coulteri*	Horseshoe Lake	Mongillo and Hallock (1995); Hallock and Mongillo (1998)
		Little Spokane River	Hartung and Meier (1980)
Esocidae			
Grass Pickerel	*Esox americanus vermiculatus*	Buck Creek	EWU, unpubl. data 2000
		Eloika Lake	Zook (1978); Divens et al. (2001)
		Fan Lake	Divens et al. (2002a)
		Little Spokane River	Hartung and Meier (1980, 1995)
		WB Little Spokane River	McLellan (2003)
Cyprinidae			
Carp	*Cyprinus carpio*	Little Spokane River	Hartung and Meier (1980)

Common Name	Species Name	Location	Source
Chiselmouth	*Acrocheilus alutaceus*	Chain Lake	WDFW, unpubl. data 1993; Polacek and Baldwin (1999)
		Little Spokane River	Hartung and Meier (1980, 1995); Peden (1987); Pfeiffer (1988); EWU, unpubl. data 1999, 2001
Longnose Dace	*Rhinichthys cataractae*	Bear Creek	McLellan (2003)
		Deadman Creek	EWU, unpubl. data 1999
		Deer Creek	McLellan (2003)
		Dry Creek	McLellan (2003)
		Little Deep Creek	EWU, unpubl. data 1999
		Little Spokane River	Hartung and Meier (1980, 1995); Peden (1987); EWU, unpubl. data 2001
		WB Little Spokane River	McLellan (2003)
Northern Pikeminnow	*Ptychocheilus oregonensis*	Chain Lake	WDFW, unpubl. data 1993; Polacek and Baldwin (1999)
		Dragoon Creek	Lines (1982); EWU, unpubl. data 2001
		Dry Creek	McLellan (2003)
		Little Spokane River	Hartung and Meier (1980, 1995); Pfeiffer (1988); EWU, unpubl. data 1999, 2001
Redside Shiner	*Richardsonius balteatus*	Chain Lake	Polacek and Baldwin (1999)
		Deadman Creek	EWU, unpubl. data 1999
		Dragoon Creek	Lines (1982)
		Little Deep Creek	EWU, unpubl. data 1999
		Little Spokane River	Hartung and Meier (1980; 1995); Peden (1987); Pfeiffer (1988); EWU, unpubl. data 1999, 2001
Speckled Dace	*Rhinichthys osculus*	Bear Creek	McLellan (2003)
		Deadman Creek	EWU, unpubl. data 1999
		Dragoon Creek	EWU, unpubl. data 2001
		Little Deep Creek	EWU, unpubl. data 1999
		Little Spokane River	EWU, unpubl. data 1999
		Otter Creek	McLellan (2003)
Tench	*Tinca tinca*	Chain Lake	WDFW, unpubl. data 1993; Polacek and Baldwin (1999)
		Eloika Lake	Zook (1978); Divens et al. (2001)
		Fan Lake	Divens et al. (2002a)
		Little Spokane River	Hartung and Meier (1980)
		Sacheen Lake	Divens et al. (2002b)
		Trout Lake	WDFW, unpubl. data 1993
		W. Branch Little Spokane River	EWU, unpubl. data 1999; McLellan (2003)
Catostomidae			

Common Name	Species Name	Location	Source
Bridgelip Sucker	*Catostomus columbianus*	Bear Creek	McLellan (2003)
		Deadman Creek	EWU, unpubl. data 1999
		Dragoon Creek	EWU, unpubl. data 2001
		Little Deep Creek	EWU, unpubl. data 1999
		Little Spokane River	Hartung and Meier (1980, 1995); EWU, unpubl. data 2001
Largescale Sucker	*Catostomus macrocheilus*	Chain Lake	WDFW, unpubl. data 1993; Polacek and Baldwin (1999)
		Little Spokane River	Hartung and Meier (1980, 1995); Peden (1987); Pfeiffer (1988); EWU, unpubl. data 2001
Longnose Sucker	*Catostomus catostomus*	Horseshoe Lake	WDFW, unpubl. data 1993
		Little Spokane River	Hartung and Meier (1980)
		Little Spokane River	Pfeiffer (1988)
		Trout Lake	WDFW, unpubl. data 1993
White Sucker	*Catostomus commersi*	Little Spokane River	Hartung and Meier (1995)
Centrarchidae			
Black Crappie	*Pomoxis nigromaculatus*	Chain Lakes	WDFW, unpubl. data 1993
		Diamond Lake	Phillips and Divens (2000)
		Eloika Lake	Zook (1978); Divens et al. (2001)
		Fan Lake	Divens et al. (2002a)
		Little Spokane River	Hartung and Meier (1980)
		Sacheen Lake	Divens et al. (2002b)
Bluegill	*Lepomis macrochirus*	Horseshoe Lake	WDFW, unpubl. data 1995
		Little Spokane River	Hartung and Meier (1980)
		W. Branch Little Spokane River	EWU, unpubl. data 1999; McLellan (2003)
Green Sunfish	*Lepomis cyanellus*	Bear Creek	McLellan (2003)
		Diamond Lake	Phillips and Divens (2000)
		Eloika Lake	Zook (1978); Divens et al. (2001)
		Fan Lake	Divens et al. (2002a)
		Horseshoe Lake	WDFW, unpubl. data 1995
		Sacheen Lake	Divens et al. (2002b)
		Trout Lake	WDFW, unpubl. data 1993
Largemouth Bass	*Micropterus salmoides*	Diamond Lake	Phillips and Divens (2000)
		Dry Creek	McLellan (2003)
		Eloika Lake	Zook (1978); Divens et al. (2001)
		Fan Lake	Divens et al. (2002a)
		Little Spokane River	Hartung and Meier (1980); Pfeiffer (1988)
		Sacheen Lake	Divens et al. (2002b)

Common Name	Species Name	Location	Source
		Spring Heel Creek	McLellan (2003)
		Trout Lake	WDFW, unpubl. data 1993
		W. Branch Little Spokane River	EWU, unpubl. data 1999; McLellan (2003)
Pumpkinseed	*Lepomis gibbosus*	Diamond Lake	Phillips and Divens (2000)
		Eloika Lake	Zook (1978); Divens et al. (2001)
		Fan Lake	Divens et al. (2002a)
		Horseshoe Lake	WDFW, unpubl. data 1993
		Little Spokane River	Hartung and Meier (1980, 1995)
		Sacheen Lake	Divens et al. (2002b)
		W. Branch Little Spokane River	EWU, unpubl. data 1999; McLellan (2003)
Smallmouth Bass	*Micropterus dolomieui*	Eloika Lake	Zook (1978)
Percidae			
Yellow Perch	*Perca flavescens*	Chain Lake	WDFW, unpubl. data 1993; Polacek and Baldwin (1999)
		Diamond Lake	Phillips and Divens (2000)
		Eloika Lake	Zook (1978); Divens et al. (2001)
		Fan Lake	Divens et al. (2002a)
		Horseshoe Lake	WDFW, unpubl. data 1993, 1995
		Little Spokane River	Hartung and Meier (1980)
		Sacheen Lake	Divens et al. (2001)
		Trout Lake	WDFW, unpubl. data 1993
		W. Branch Little Spokane River	EWU, unpubl. data 1999; McLellan (2003)
Ameiurus			
Black Bullhead	*Ameiurus melas*	Eloika Lake	Divens et al. (2001)
Brown Bullhead	*Ameiurus nebulosus*	Diamond Lake	Phillips and Divens (2000)
		Eloika Lake	Divens et al. (2001)
		Little Spokane River	Hartung and Meier (1980); EWU, unpubl. data 1999
		Sacheen Lake	Divens et al. (2002b)
		Trout Lake	WDFW, unpubl. data 1993
Yellow Bullhead	*Ameiurus natalis*	Eloika Lake	Zook (1978); Divens et al. (2001)
		Fan Lake	Divens et al. (2002a)
		Horseshoe Lake	WDFW, unpubl. data 1995
		Spring Heel Creek	McLellan (2003)
		W. Branch Little Spokane River	EWU, unpubl. data 1999; McLellan (2003)
Cottidae			
Sculpin spp.	*Cottus* spp.	Buck Creek	EWU, unpubl. data 2000
		Dragoon Creek	Lines (1982); EWU, unpubl. data 2001

Common Name	Species Name	Location	Source
		Little Spokane River	EWU, unpubl. data 1999
		Wethey Creek	WDFW, unpubl. data 2002
Mottled Sculpin	*Cottus bairdi*	Deer Creek	McLellan (2003)
		Dry Creek	McLellan (2003)
		Little Spokane River	Hartung and Meier (1980, 1995); Peden (1987)
		Otter Creek	McLellan (2003)
		WB Little Spokane River	McLellan (2003)
Slimy Sculpin	*Cottus cognatus*	Bear Creek	McLellan (2003)
		Buck Creek	McLellan (2003)
Torrent Sculpin	*Cottus rotheus*	Dry Creek	McLellan (2003)

[1]Beaver Creek; tributary to the West Branch Little Spokane River

Study Area

Spokane River

The Spokane River originates at the outlet of Lake Coeur d'Alene, Idaho and flows west through the city of Spokane, Washington. Just west of Spokane, it bends and flows north to Tum Tum, Washington, where it bends west and flows to its confluence with the Columbia River. Seven hydropower projects have been constructed on the Spokane River between Lake Coeur d'Alene and the Columbia River. The dams, in order from most upstream, are Post Falls, Upriver, Upper Falls, Monroe Street, Nine Mile, Long Lake, and Little Falls.

The focus of this study was the 25.6 km section between the Monroe Street and Nine Mile Dams. The 25-year mean daily discharge of the middle Spokane River measured below Monroe Street Dam, at river kilometer (RKM) 117.2, was 172.7 m^3/s [6,098.9 cubic feet/sec (cfs)] (USGS, Spokane, unpublished data). The mean daily discharge during water year (WY) 2002 (Oct. 1, 2001 to Sep. 30, 2002) was 223.9 m^3/s (7,907.6 cfs) (USGS, Spokane, unpublished data). The only notable tributaries of the middle Spokane River are Latah Creek at RKM 116.5 and Deep Creek at RKM 95.0. Between 1976 and 2002, Latah Creek contributed an average of 3.5% (6.0 m^3/s; 211.6 cfs) to the mean daily discharge of the middle Spokane River (USGS, Spokane, unpublished data). During WY 2002, Latah Creek contributed an average of 2.9% (6.5 m^3/s; 228.5 cfs) of the mean daily discharge of the middle Spokane River (USGS, Spokane, unpublished data). Deep Creek is an intermittent stream that is not monitored for discharge. The Spokane Advanced Wastewater Treatment Plant (RKM 108.3) also contributed an average of 1.7 m^3/s (60.9 cfs) of water to the discharge of the middle Spokane River in 2002 (Mike Castor, Spokane Advanced Wastewater Treatment Plant, personal communication). There are also locations of groundwater inflow near T.J. Meenach Bridge and Plese Flats.

The middle Spokane River has two distinct sections: free-flowing river and reservoir. The free-flowing section occurs between the Monroe Street Dam (RKM 119.1) and the bottom of the riffle at RKM 102.8, near the Spokane Rifle Club. The riverine section was characterized as having pool-riffle-run sequences, characteristic of lotic systems (Kleist 1987).

Nine Mile Reservoir was formed with the construction of Nine Mile Dam between 1906 and 1908 (Woodworth 1988). The reservoir extends 9.3 km to the bottom of the riffle at RKM 102.8 at the full pool elevation of 490.1 m (1,608 ft) above mean sea level (MSL). At full pool, Nine Mile Reservoir has a surface area of 170 hectares (420 acres) (Woodworth 1988) and a volume of 7.59 x 10^6 m^3 (6,150 acre-ft) (Tim Vore, Avista Utilities, personal communication). Nine Mile Dam operates as a run-of-the-river facility (Woodworth 1988).

The middle Spokane River is open to fishing year-round and is divided into two fish management areas. The river between Monroe Street Dam and the Seven Mile Road Bridge is managed as a selective trout fishery. Angling gear is limited to unscented artificial flies or lures with a single barbless hook and anglers are not allowed to fish from any floating device equipped with a motor. The daily bag limit for trout is one with a minimum length of 208 mm (8 inches). Only hatchery rainbow trout can be retained. Hatchery rainbow trout are marked with a clipped adipose fin. The other game fish are managed with general statewide bag limits and minimum size restrictions.

Nine Mile Reservoir, below the Seven Mile Road Bridge, has a harvest oriented management strategy. There are no gear restrictions, so bait, barbed hooks, and motorized boats can be used. The daily bag limit for all trout is five with a minimum length of 208 mm (8 inches). The other game fish are managed with general statewide bag limits and minimum size restrictions.

Little Spokane River

The Little Spokane River is located in eastern Washington, north of the city of Spokane. It has two main branches, the east (hereafter referred to as the Little Spokane River) and the west. The headwaters of both branches occur in Pend Oreille County, southeast of Newport, WA. McLellan (2003) provided a detailed description of the Little Spokane River system.

Five tributaries of the Little Spokane River were surveyed in 2002: Beaver, Dragoon, Little Deer, Spring, and West Branch Dragoon Creeks (Table 2). All of the streams surveyed, with the exception of Little Deer Creek, were within the Dragoon Creek watershed. Dragoon Creek drains 45,609 ha (112,615 acres) of forest, agricultural, and residential land (Lundgren 1998). The headwaters of Dragoon Creek are in the mountains south of Deer Lake in Stevens County. Dragoon Creek flows 41.0 km southeast into Spokane County, eventually reaching the Little Spokane River at RKM 34.2. Beaver Creek originates in the mountains south of Loon Lake, Stevens County and flows in a southerly direction until it meets Dragoon Creek at RKM 20.0. Spring Creek arises from a spring north of the city of Deer Park and its confluence with Dragoon Creek occurs at RKM 22.8. The headwaters of the West Branch Dragoon Creek are in the Huckleberry Mountains northwest of Spokane in Stevens County. The confluence of the West Branch Dragoon and Dragoon Creeks is at RKM 16.1.

Little Deer Creek, the largest tributary of Deer Creek, originates on the western slopes of Mount Spokane. Little Deer Creek flows in a southwesterly direction to its confluence with the Deer Creek (RKM 8.9).

All of the streams surveyed in 2002 were managed under the Statewide General Freshwater Regulations. The statewide regulations permitted angling from June 1st through October 31st. Harvest regulations were two trout, 208 mm (8 in.) or longer, except eastern brook trout, which had a bag limit of 5, with no minimum size. However, anglers were allowed to harvest 5 trout total, of which only two could be species other than eastern brook trout.   General statewide bag limits and minimum size restrictions applied to all other game fish species, which were the same as described for the middle Spokane River.

Table 2. Characteristics of the tributaries surveyed in 2002. Elevations are in meters above mean sea level.

Stream	Order	Length (Km)	Headwater Elevation (m)	Mouth Elevation (m)
Beaver Creek	3	13.0	731	636
Dragoon Creek	5	41.0	770	512
Little Deer Creek	3	10.2	1,463	604
Spring Creek	2	2.7	649	639
W.B. Dragoon Creek	4	18.5	704	611

Study Objectives

The objectives of the 2002 study were as follows:

- Determine the fish species present in the middle Spokane River.
- Estimate relative abundances and catch-per-unit effort as indices of abundance for each fish species in the middle Spokane River.
- Determine the age structure and growth of the wild sport fish populations in the middle Spokane River.
- Calculate indices of condition for game fish in the middle Spokane River.

- Quantify instream habitat at fish sample sites in Beaver, Dragoon, Little Deer, Spring, and West Branch Dragoon Creeks.
- Determine the fish species present in Beaver, Dragoon, Little Deer, Spring, and West Branch Dragoon Creeks.
- Estimate relative abundances, population sizes, and densities of each fish species in Beaver, Dragoon, Little Deer, Spring, and West Branch Dragoon Creeks.
- Characterize the population structure of wild rainbow trout in the Spokane River and Little Spokane River tributaries, using microsatellite DNA techniques.

Methods

Spokane River

The free-flowing stretch of the Spokane River, between Spokane Falls and T.J. Meenach Bridge, was sampled on July 31, 2002. Sampling was conducted during the day using a drift boat mounted with a Smith-Root 2.5 GPP electrofishing unit. Electrofishing settings were: voltage = low (50-500), percent = 50, pulse rate = 60 pulses/second Direct Current (DC), and amperage = 1.5 to 2.0. Discharge was 48.7 m^3/s (1,720 cfs) during the survey (USGS, Spokane, unpublished data). The river was divided linearly in to six segments (Figure 1). Randomly selected shorelines were sampled, but occasionally sampling was limited to the navigable portions of the channel. The first segment was on the north side of the river and started at Peaceful Valley (RKM 117.9) and ended at the USGS gaging station (RKM 117.2). The second segment was on the south shoreline and began just downstream of the old railroad trestle (RKM 116.7) and ended at RKM 115.9, in the middle of the bend below the mouth of Latah Creek. Segment three was on the west shoreline and started at the end of segment two and ended at RKM 115.1. The fourth segment started at the end of segment three and continued to RKM 114.4 and was on the east shoreline. The fifth segment was on the west shoreline, which started at the end of segment four and continued to RKM 113.6, the water main downstream of the old Natatorium Park site. The sixth segment was on the east shoreline and started at the end of segment five and extended to RKM 105.7, the county park at T.J. Meenach Bridge.

Nine Mile Reservoir was sampled between August 19 and 20 (summer) and October 13-14 (fall), 2002. Nine shoreline transects (400 m) were electrofished per season (Figure 2). Electrofishing was conducted with a 5.0 GPP Smith-Root electrofishing boat. Electrofishing settings were: voltage = low (50-500), percent = 40, pulse rate = 60 pulses/second Direct Current (DC), and amperage = 3.5 to 5.0. Each transect was randomly selected and all electrofishing was conducted at night, beginning at dusk. Horizontal experimental monofilament gill nets (2.4 x 61.0 m; four 15.2 meter panels with square mesh sizes 1.3, 2.5, 3.8, and 5.1 cm) were set at eight randomly selected shoreline sites per season (Figure 2). The nets were set perpendicular to the shore, with the smallest mesh size closest to the shore. Five horizontal gill nets were set in the pelagic zone per season at randomly selected sites (Figure 2). Nets were either set at the surface or on the bottom. Net depth (surface or bottom) was randomly determined with a coin toss. Data from surface and bottom nets were

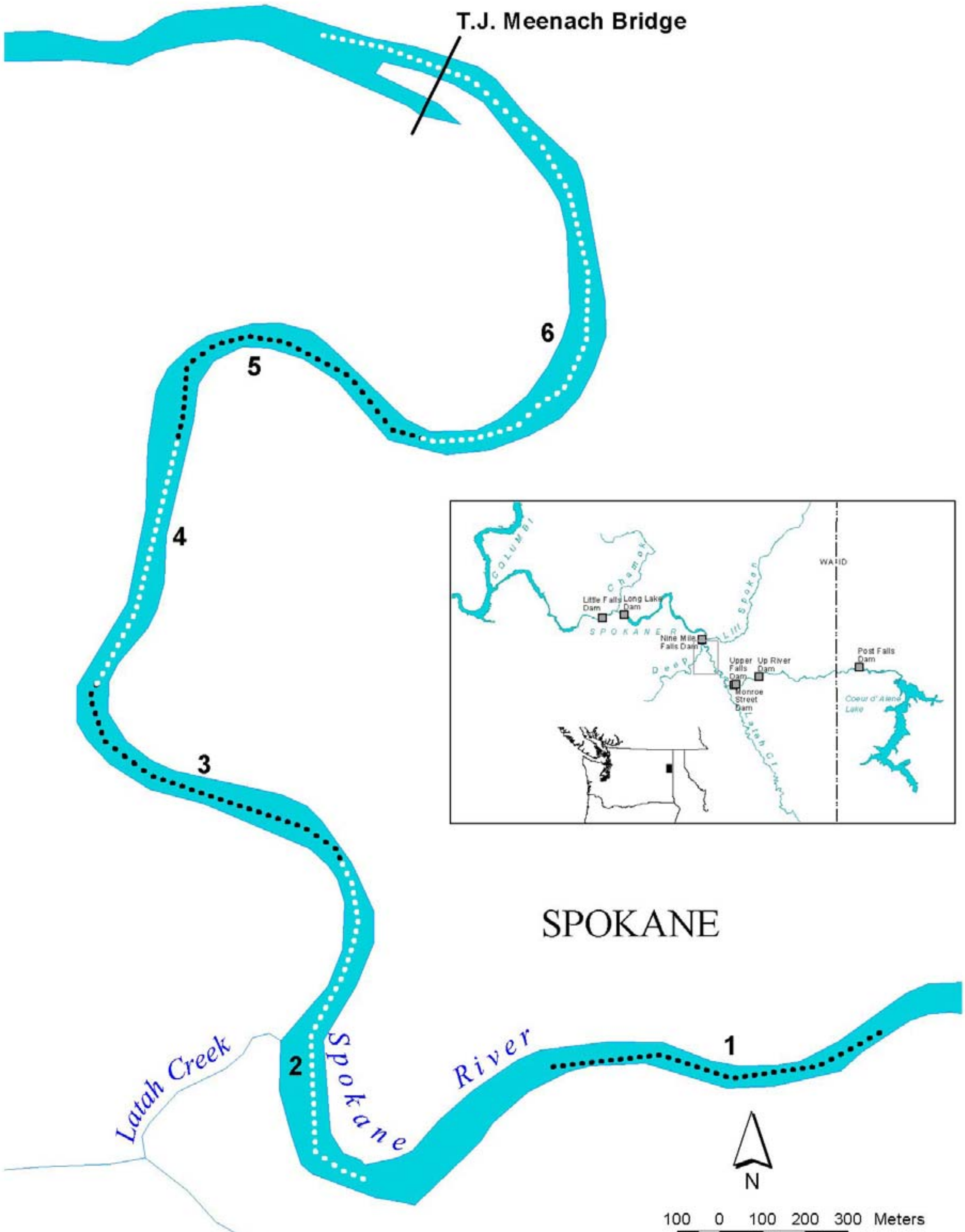

Figure 1. Electrofishing transects in the free-flowing Spokane River. Dotted lines indicate transects. Line colors alternate between transects.

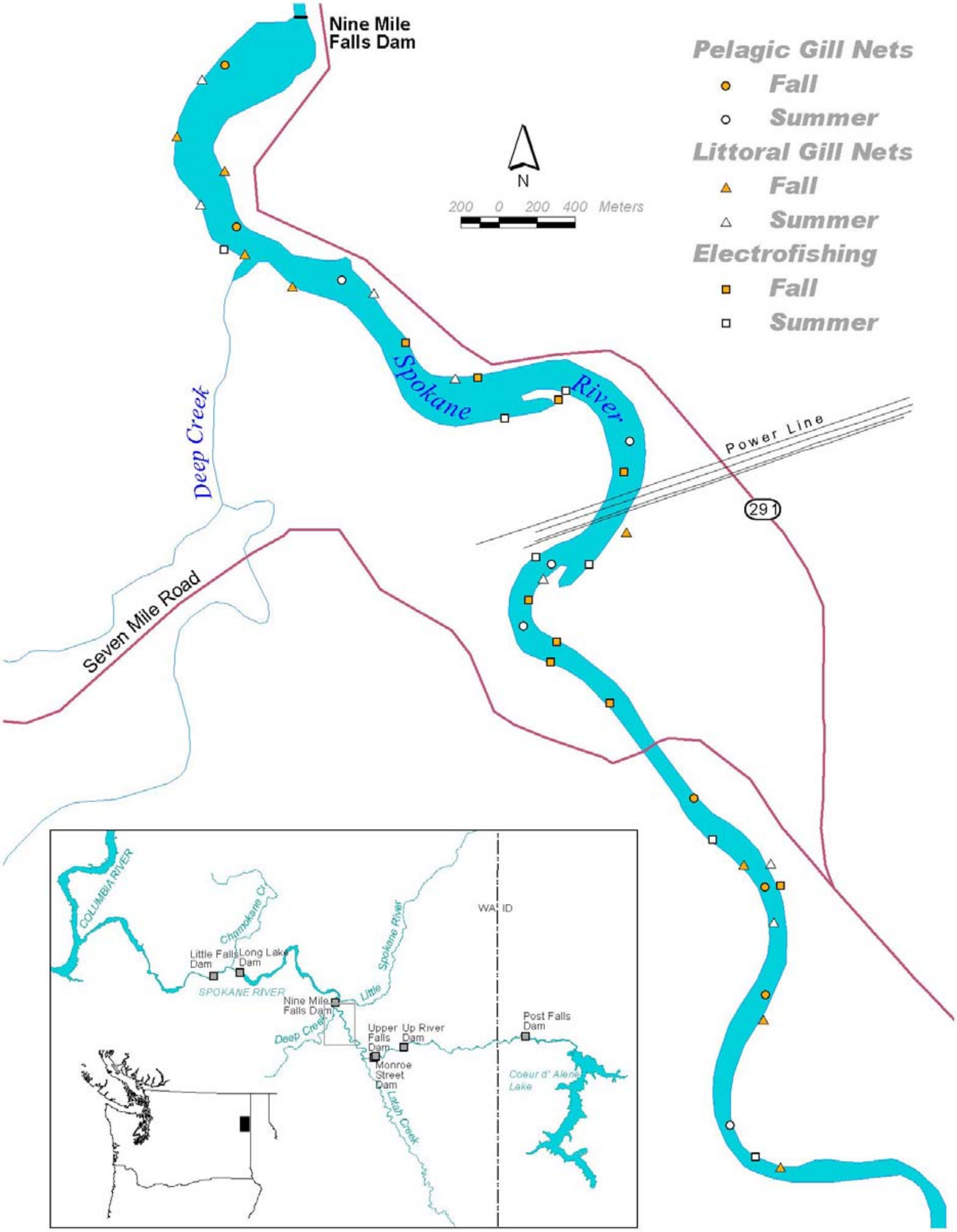

Figure 2. Fish sample sites on Nine Mile Reservoir. Electrofishing symbols represent transect starting locations, which were fished in and upstream direction.

pooled during analysis, because most of the nets covered the entire water column. All nets were soaked over night (12-20 hours).

Each fish collected was identified to species, measured (total length, TL; mm), and recorded. A subsample of the sculpins collected were fixed and preserved in 95% ethanol for species identification. Sculpins were keyed using Hallock (2003). Scale samples and weights (g) were obtained from all game fish. Catch-per-unit-effort (CPUE) by sampling method was determined for each fish species collected (number of fish/hour electrofishing, number of fish/littoral gill net night, and number of fish/pelagic gill net night). The CPUE for each fish species was calculated using all fish, including age 0 fish, as indices of relative density. Randomly chosen sample sections can contribute to high variability among samples, therefore, 80 percent confidence intervals (CI) were calculated for each mean CPUE by species and by sampling method. Species composition by number (relative abundance) was calculated from fish collected using boat electrofishing, littoral gill netting, and pelagic gill netting.

Proportional stock density (PSD) was calculated for each sport fish species collected in the Spokane River and Nine Mile Reservoir. The PSD's were calculated by dividing the number of fish ≥ the minimum quality length by the number of fish ≥ the minimum stock length, and multiplying by 100 (Anderson and Neuman 1996). Stock length was defined as the minimum length of fish with recreational value (20-26% of world record) and quality length was defined as the minimum size of fish that anglers would like to catch (36-41% of world record; Gabelhouse 1984). Relative stock densities were calculated to provide a proportion of stock length fish that were longer than quality length fish, relative to the world record. The three categories used for RSD were preferred, memorable, and trophy (Gabelhouse 1984). Preferred length was the minimum length of fish anglers would prefer to catch (45-55% of world record). Memorable length was the minimum length of fish anglers would remember catching (59-64% of world record). Trophy length was the minimum length of fish worthy of acknowledgement (74-80% of world record). RSD's were calculated by dividing the number of fish ≥ a specific length by the number of fish ≥ the minimum stock length, and multiplying by 100 (Anderson and Neuman 1996). Stock, quality, preferred, memorable, and trophy lengths were provided for fish collected (Table 3). Eighty percent confidence intervals were calculated, assuming a normal distribution, as an indication of precision.

Age and growth was evaluated from scale samples that were obtained from all wild sport fish collected. Scale samples were sent to the WDFW Fish Aging Lab in Olympia for analysis. The direct proportional method was used to back-calculate the total length at the formation of each annulus of salmonids, and the Fraser-Lee method was used for warmwater fish (Devries and Frie 1996). The back-calculation equation was,

$$L_i = \left(\frac{L_c - a}{S_c} \right) S_i + a$$

where, L_i was the back-calculated TL of the fish at the formation of the i^{th} annulus, L_c was the TL of the fish at capture, S_c was the length from the focus to the outermost edge of the scale at capture, S_i was the length from focus of the scale to the outer edge of the i^{th} annulus, and a was the y-intercept of the body length-scale length regression line. The direct proportional method assumed the intercept value, a, was equal to 0. When the Fraser-Lee method was employed, Carlander's (1982) standard intercept values were used.

The relative weight (W_r) index was used to evaluate the condition of sport fish collected in the middle Spokane River. The index was calculated as,

$$W_r = \frac{W}{W_s} x100$$

where, W is the weight (g) of an individual fish and W_s is the standard weight of a fish of the same length calculated with the standard weight (W_s) equation (Murphy and Willis 1991). The W_s equations were obtained from Andersen and Neuman (1996) and Bister et al. (2000). When available, the lotic W_s equation was used. A W_r value of 100 generally indicates that a fish is in good condition (Anderson and Gutreuter 1983).

In addition to relative weights, condition factors (K_{TL}) were calculated as an index of how fish add weight in relation to increasing length (Anderson and Neuman 1996). Mean condition factor was calculated for all game fish age 1 or older and $\geq$100 mm TL using the formula,

$$K_{TL} = \left(\frac{W}{TL^3} \right) \times 10^5$$

where, W is the weight (g) and TL is the total length (mm) of an individual fish.

Table 3. Length categories used for PSD and RSD calculations. The lengths listed represent total lengths (mm; Anderson and Neuman 1996). Numbers in parentheses are the percent of the world record (Gabelhouse 1984).

Species	Standard Length Categories				
	Stock (20-26)	**Quality (36-41)**	**Preferred (45-55)**	**Memorable (59-64)**	**Trophy (74-80)**
Brown trout	150	230	300	380	460
Chinook salmon	280	460	610	760	940
Rainbow trout	250	400	500	650	800
Black crappie	130	200	250	300	380
Pumpkinseed	80	150	200	250	300
Largemouth bass	200	300	380	510	630

Little Spokane River/Tributaries

Habitat Surveys

Each stream was stratified into reaches using a USGS topographic map (1:24,000 scale) (Figure 3; Appendix B). Reaches were defined as portions of streams with similar gradient between confluences with tributaries and road crossings. Each reach was divided into 100 m survey sections that were numbered consecutively moving upstream from the mouth. We randomly selected 10% of the survey sections in each reach to be sampled for habitat and fish distribution (Figure 4; Appendix C). Platts et al. (1983) recommended sampling 10% of a stream’s length for baseline surveys of habitat and fish distribution.

Stream habitat surveys were always completed following fish sampling. Habitat surveys consisted of two parts, the survey section measurements and transect measurements. Survey section measurements were those that were measured for the entire length of the 100 m survey section, and included counts of the total numbers of primary pools (PP) and acting large woody debris (LWD), as well as measurements of stream channel gradient (%) and water and air temperatures (°C). Total numbers of PP’s and LWD were used to estimate their mean densities per reach, as well as the entire stream. Densities were calculated as the number of PP per km and the number of LWD per 100 m. A PP was defined as a pool that was longer or wider than the mean wetted width of the survey section. The length (0.1 m), width (0.1 m), maximum depth (cm), and tailout depth (cm) were measured in each primary pool that occurred within each survey section (KNRD 1997). The residual pool depth was calculated by summing the maximum and tailout depths and dividing by two (KNRD 1997). Acting LWD were considered any piece of organic debris with a diameter > 10 cm and a length > 1 m that intruded into the stream (KNRD 1997). Exposed root wads of live trees were only counted if they were intruding the stream. Large debris dams causing one particular effect on the stream were counted as a single piece of LWD (KNRD 1997). Stream channel gradient was defined as the change in vertical elevation per unit horizontal distance of the channel (Platts et al. 1983; KNRD 1997). Gradient was measured with a clinometer (Suunto Corp.). Water temperatures were measured in the middle of the thalweg. Air temperatures were measured away from the water's surface and out of direct sunlight. Mean values and standard deviations of each parameter were calculated for each reach and stream.

Transect measurements consisted of those that were measured along a line that was perpendicular to the stream flow. The number of transects sampled was determined using a modified version of the protocol described by Simonson et al. (1994). Simonson et al. (1994) reported that estimates spaced two mean stream widths apart within a survey section 35 mean stream widths long were within 5% of the true value 95% of the time. The first transect occurred at the downstream end of the fish survey section and subsequent transects were measured in an upstream direction. The spacing of the subsequent transects was based on a visual estimate of the mean stream (wetted) width of the survey section. If the mean stream width was < 5 m, transects were spaced two times the mean stream width apart and the total number of transects was determined by how many occurred in a distance of 35 times the mean stream width or 100 meters, which ever was shorter. If the mean stream width was ≥ 5 m, transects were spaced every 10 m for 100 m. Unlike the protocol suggested by Simonson et al. (1994), the habitat transects were limited to the 100 m survey sections due to the large number of private landowners and the reduced precision was considered acceptable for the baseline survey.

Habitat parameters were measured or visually estimated along each transect. Parameters included habitat type, habitat width, wetted width, bankfull width, mean depth, maximum depth, percent composition of each substrate type, and percent embeddedness. Mean values and standard deviations of each habitat parameter were calculated for each reach and stream.

Habitat types were divided into three categories: pool, riffle, and run. Pools were defined as portions of the stream with reduced current velocity and usually deeper than a riffle (KNRD

1997). A riffle was a shallow rapid where the water flowed swiftly over completely or partially submerged obstructions to produce surface agitation (KNRD 1997). Runs were stream segments with intermediate characteristics between pools and riffles (Platts et al. 1983).

The wetted width of a stream was defined as the distance from the edge of the water on each shoreline, perpendicular to the flow of the stream. If the channel was braided, the wetted width of each braid was measured and summed to provide a total wetted width. Wetted width was measured to the nearest tenth of a meter. If a transect had two segments of a similar habitat type, their widths were summed to provide a single width for that habitat type.

The bankfull (or channel) width was defined as the cross section of the stream valley containing the stream that was distinct from the surrounding area due to breaks in the general slope of the land, lack of terrestrial vegetation, and changes in the composition of the substrate material (Platts et al. 1983). The bankfull width contained the stream bottom and stream bank and a bankfull flow fills the channel with water to the point just prior to its spreading onto the flood plain (Platts et al. 1983). The bankfull width was measured to the nearest tenth of a meter.

Mean stream depth was determined from summing the depth measurements (cm) taken at ¼, ½, and ¾ the wetted width along the transect line and dividing them by four to account for the zero depth values at each shoreline (Platts et al. 1983). Maximum stream depths (cm) were measured at each transect. The maximum depths provide the thalweg depth, or the line connecting the deepest points along the streambed (KNRD 1997).

The percent composition of each substrate type along each transect line was estimated visually (Table 4). The percent embeddedness was visually estimated along the transect line. Embeddedness was defined as the percentage of the surface area of larger substrate particles (cobble, rubble, and boulder) that were surrounded by fine particles (sand and smaller) (Platts et al. 1983).

Definite and potential, natural and human-made fish barriers were identified on each stream surveyed. Natural fish barriers were described as falls or chutes. Falls were vertical overflow portions of the stream (Powers and Orsborn 1985). Chutes were defined as steep, sloping, open channels with high velocities (Powers and Orsborn 1985). Human-made barriers consisted of culverts and dams. A falls or culvert was determined to be a definite barrier if it had a vertical height of 3.4 m (11.0 ft), which exceeded the maximum leaping height of the healthiest steelhead (610-792 mm TL) with a maximum burst speed of 8.1 m/s (26.5 ft/s) (Powers and

Orsborn 1985). We assumed the swimming abilities of steelhead exceeded those of resident trout. A good takeoff pool is required for fish to leap any height, so a relatively low fall without a good take off pool may act as a total barrier (Powers and Orsborn 1985). Waterfalls with vertical heights ≥ 1.5 m, without a plunge pool were considered a potential barrier. Culverts with a vertical height of ≥ 2.5 m were reported as potential barriers because they lacked landing pools. The lack of good landing pools reduces the chance of passage (Powers and Orsborn 1985). A chute was considered a potential barrier if it had a smooth bedrock substrate and a slope ≥ 25% and a length ≥ 15.0 m. Brook trout were found to ascend a 14.5 m long chute with 22% slope (Adams et al. 2000).

Stream temperatures (^{o}C) were recorded with Tidbit® temperature loggers (Onset Corp., MA) between June 6 and November 24, 2002. The temperature-logging interval was every two hours. The loggers were fixed with identification tags and were attached to logs or root wads near the stream bottom, out of direct sunlight. Loggers were placed near the mouth of all of the streams monitored (Figure 5). An additional logger was also set in the upper reaches of Deadman Creek. Dragoon Creek had additional loggers placed in the middle and upper reaches. The Little Spokane River had five additional loggers spaced out between the lower and upper reaches. They were placed at the Indian Painted Rocks USGS gaging station, Wandermere USGS gaging station, Chattaroy, Elk, and Scotia (Figure 5). Mean temperatures and standard deviations were calculated for the complete recording period in 2002 (June 6 – November 24) and for the period from June 6 to October 28, which was the same time period as the 2001 temperature data for comparisons.

Table 4. Description of substrate classification used for stream habitat assessments (modified from KNRD 1997).

Substrate Type	**Description**
Bedrock	Large masses of solid rock
Boulder	>30.5 cm (>12.0 in.)
Rubble	15.2 - 30.5 cm (6.0 in. - 12.0 in.)
Cobble	7.6 - 15.2 cm (3.0 in. - 6.0 in.)
Gravel	0.6 - 7.6 cm (0.25 in. - 3.0 in.)
Sand	<0.6 cm (<0.25 in.)
Silt	Fine sediments with little grittiness.
Muck	Decomposed organic material, usually black in color.
Organic Debris	Undecomposed herbaceous material.

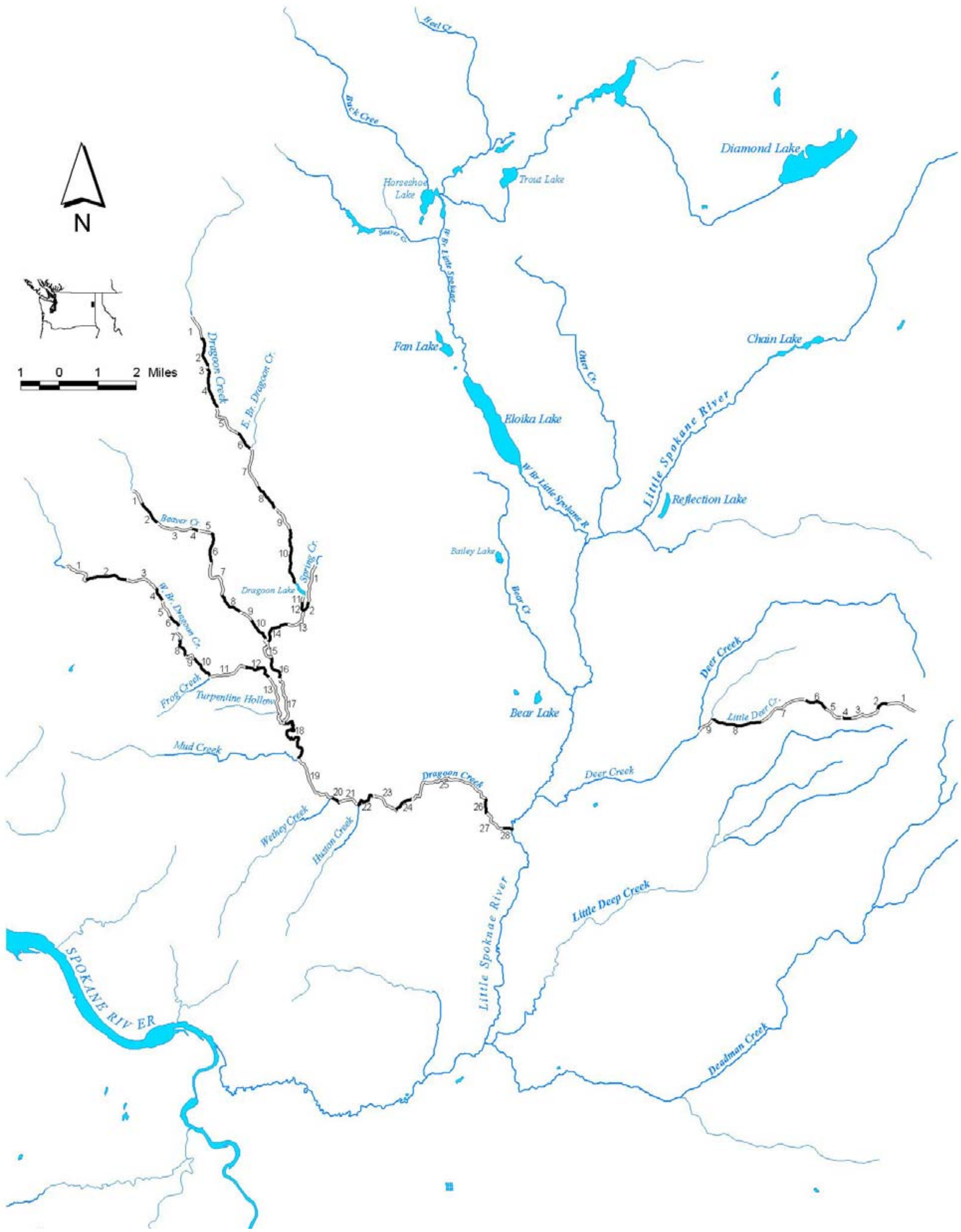

Figure 3. Habitat and fish stratified sampling reaches on Beaver, Dragoon, West Branch Dragoon, Little Deer, and Spring Creeks.

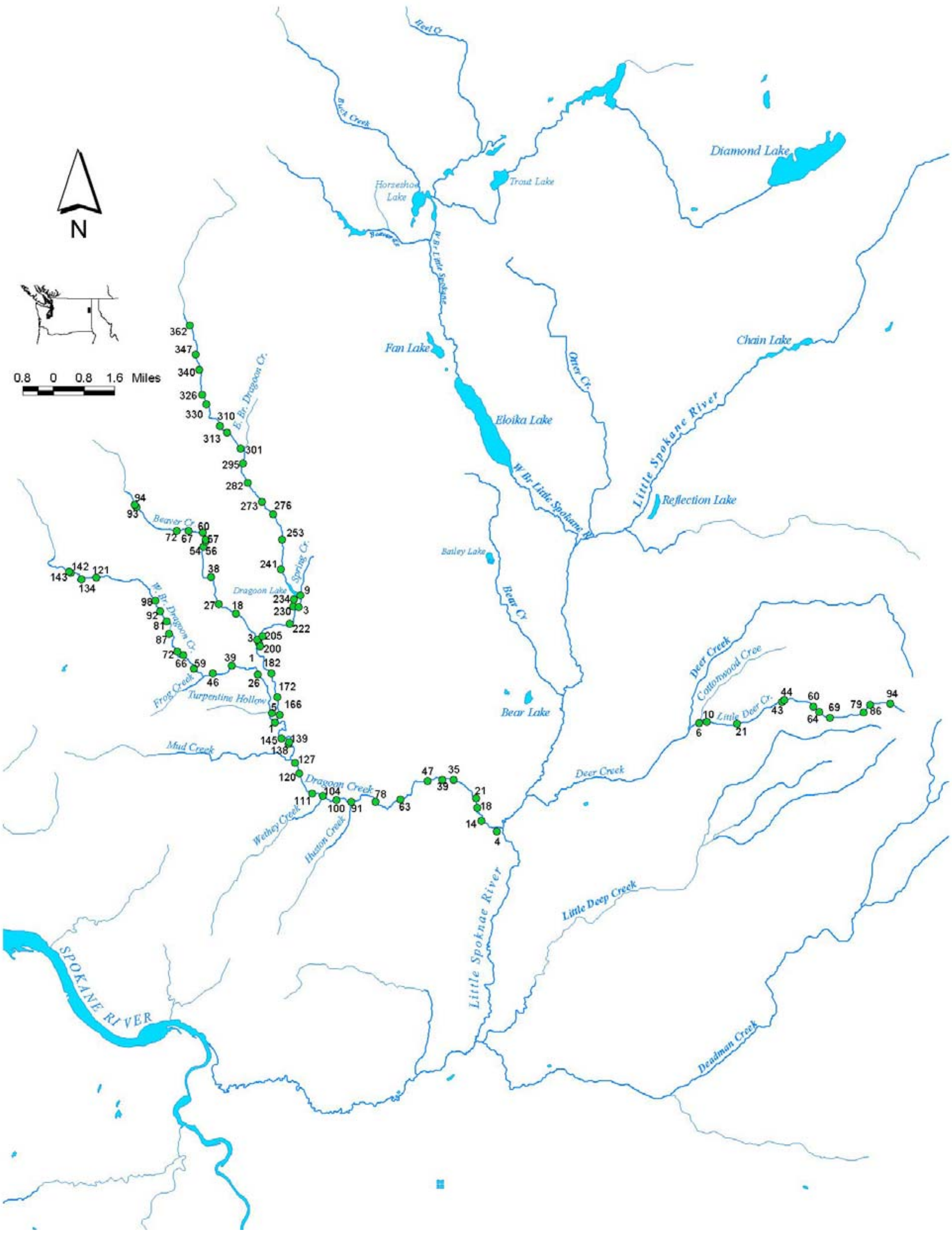

Figure 4. Randomly selected habitat and fish sample sites on Beaver, Dragoon, West Branch Dragoon, Little Deer, and Spring Creeks.

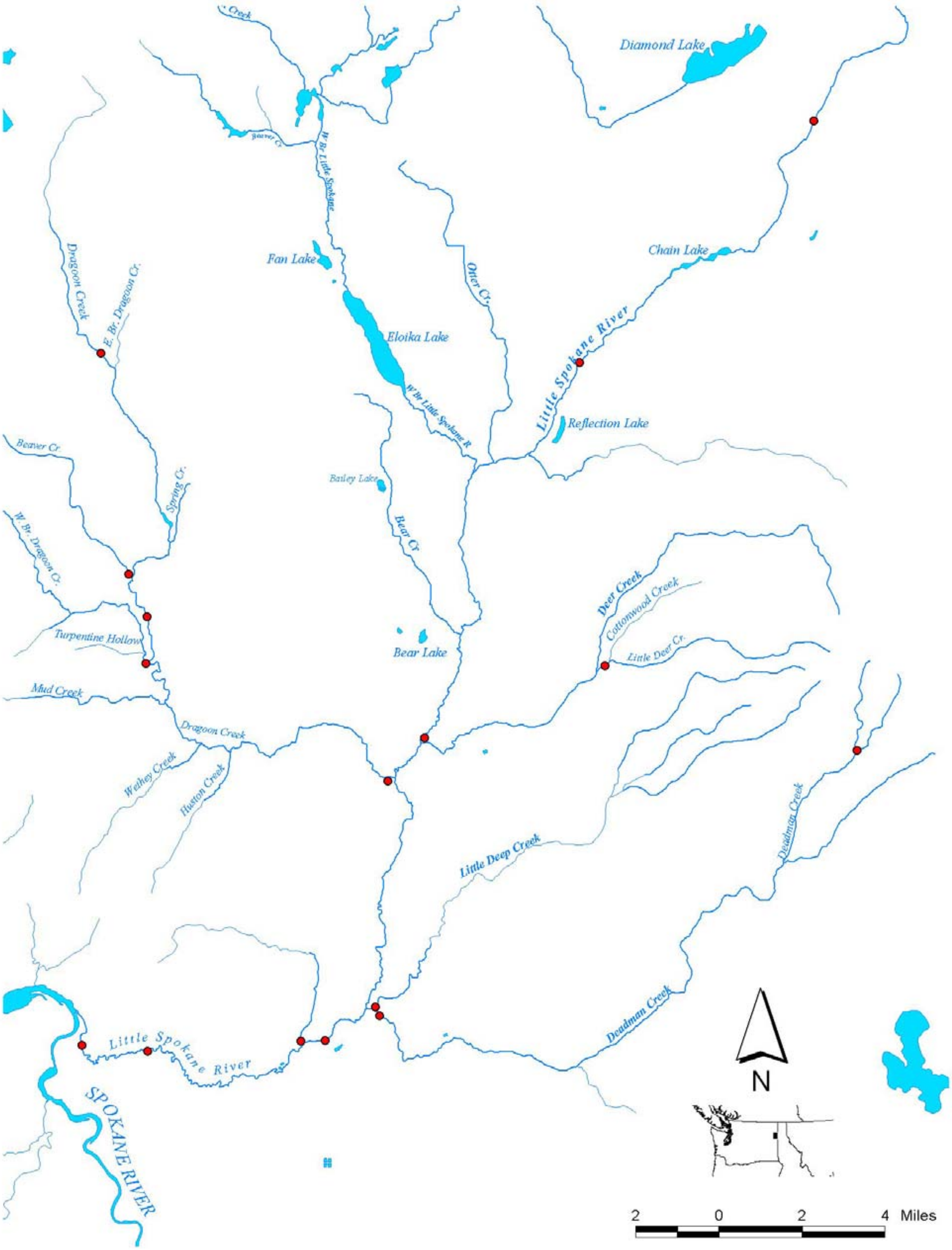

Figure 5. Locations of thermographs in the Little Spokane River drainage, 2002.

Fish Surveys

Fish presence, relative abundance, population size, and density were determined from backpack electrofishing data collected at each survey section. A multiple-pass removal-depletion sampling strategy was used for fish collection (White et al. 1982; Platts et al. 1983). Two passes were completed, unless a 50% depletion of salmonids was not achieved. Additional passes were completed until a 50% reduction was achieved. Block nets (1.22 m x 15.24 m; 0.64 cm mesh) were placed across the stream at the downstream and upstream ends of the survey section prior to electrofishing. The 100 m distance between the block nets was measured with a hip chain, while walking parallel to the stream on the bank. Electrofishing was conducted beginning at the downstream end, moving upstream, while attempting to electrofish the stream consistently on each pass. All fish collected on each pass were identified, counted, measured to the nearest mm total length (TL), and released outside of the blocked survey section. Sculpins from what appeared to be different species were collected from each stream for identification. The sculpins were fixed in 95% ethanol and keyed using Hallock (2003).

Relative abundances of fish in each stream were calculated by dividing the total number of fish of a particular species caught by the total number of all species caught, and multiplying it by 100. Length-frequency distributions were developed for each game fish species collected in each stream, when 25 or more individuals were collected.

In order to assess harvest potential, the proportion of the populations of eastern brook trout that were of stock length and brown and rainbow trout that were of legal length for harvest were calculated. Stock length for lotic eastern brook trout was 130 mm TL (Anderson and Neumann 1996).

Population estimates were calculated for each species of fish at each survey section using the CAPTURE model Zippin M_b (Otis et al. 1978; White et al. 1982). Fish < 50 mm TL were excluded because they were observed passing through the mesh of the block nets. Densities (number of fish/100 m^2) were calculated by dividing the population estimate in a survey section, by the surface area (m^2) of the survey site, which was multiplied by 100. The surface area of the survey section was determined by multiplying the mean wetted width (m) of the survey section by it's the length (m).

Population Characterization with DNA Analysis

Tissue samples were collected from wild rainbow trout populations for microsatellite DNA analysis. When sampling the stream populations, tissue was obtained from a maximum of 10 individuals per site, at alternating sites beginning near the headwaters. When insufficient sample sizes were obtained in upstream sites, more than 10 fish were sampled at some lower sites or fish were sampled from consecutive sites. Tissue samples were collected from all wild rainbow trout captured in the Spokane River.

Tissue was obtained by clipping the left ventral fin. Each sample was preserved in absolute ethanol and assigned a unique identification code that was printed on waterproof paper and placed in the sample vial. The WDFW Genetics Laboratory conducted the microsatellite DNA analysis and statistical tests (see Appendix L). Three hypotheses were tested: 1) the rainbow trout in sampled streams comprise one single, interbreeding population, 2) the rainbow trout in the sampled streams are genetically indistinguishable from one or more hatchery strain (Spokane Hatchery stock or Phalon Lake conservation stock), and 3) the rainbow trout in the sampled streams are interior redband strain (represented by Phalon Lake stock) not coastal strain (*O. mykiss irideus*, represented by Spokane Hatchery stock).

Results

Spokane River

There were seven and 16 species of fish collected in the free-flowing Spokane River and Nine Mile Reservoir, respectively (Table 5). Catch-per-unit-effort (CPUE) and relative abundance were calculated for each species, gear type, and season (Tables 6, 7, and 8; Appendix C). Bridgelip suckers were the most abundant species in the free-flowing section, based on CPUE (158.5 fish/hr) and relative abundance (64.9%; n=155) (Table 6). Mountain whitefish were the most abundant sport fish species in the free-flowing section, based on CPUE (30.9 fish/hr; SD=12.0); however, rainbow trout and mountain whitefish had the same relative abundance (11.7%; n=28) (Table 6). Twenty-five (89.2%) of the rainbow trout were wild.

Redside shiners had the highest CPUE in Nine Mile Reservoir boat electrofishing surveys (31.6 fish/hr), but bridgelip suckers had the highest CPUE in littoral and pelagic gill nets (12.1 and 19.4 fish/night, respectively) (Table 7). Rainbow trout were the most abundant sport fish, based on CPUE in all gear types (8.0 fish/hr; 3.4 and 2.8 fish/night) (Table 7). Bridgelip suckers had the highest relative abundance in the reservoir (34.6%; n=455) (Table 8). Rainbow trout were the dominant sport fish in the reservoir as indicated by the relative abundance (8.0%; n=106) (Table 8). Two (40.0%) of the brown trout and 24 (22.9%) of the rainbow trout captured in the reservoir were wild. Three sculpins were preserved for identification. All three were identified as torrent sculpins (*Cottus rhotheus*).

Proportional stock densities (PSD) and relative stock densities (RSD) were calculated for each game fish species collected in the free-flowing and reservoir sections (Table 9). Sample sizes were too small for interpretation.

Ages of wild rainbow trout collected in the free-flowing and reservoir sections ranged from 1 to 3 and 0 to 4, respectively. Mean back-calculated total lengths at the formation of each annulus were calculated for wild rainbow trout collected in both the free-flowing and reservoir sections (Tables 10 and 11). Mountain whitefish from the free-flowing stretch ranged in age from 2 to 4 and mountain whitefish collected in the reservoir were from age 0 to 5. Mean back-calculated total lengths at the formation of each annulus were calculated for mountain whitefish collected in the free-flowing Spokane River (Table 12). Mean back-calculated total lengths were also calculated for the sport fish species that had small sizes (Table 13).

The mean W_r of rainbow trout collected in the Spokane River was 88 (SD=11). The mean and individual W_r values, except one, of rainbow trout from the free-flowing section were below the national standard (100) (Figure 6). The mean W_r of the mountain whitefish from the free-flowing stretch was 80 (SD=13). Similar to the rainbow trout, all of the individual mountain whitefish W_r values were below national standard (Figure 6). In Nine Mile Reservoir, the rainbow trout mean W_r was 87 (SD=9), which was below the national standard, as were all of the individual W_r values, except for one (Figure 7). Mean total length, weight, W_r, and K_{TL} was calculated for each sport fish species collected in the free-flowing and reservoir sections (Table 14).

Table 5. Common and scientific names of fish species captured in the free-flowing Spokane River and Nine Mile Reservoir, 2002.

Common Name	**Species Name**	**Free-Flowing**	**Reservoir**
Salmonidae			
Brown trout	*Salmo trutta* Linnaeus		X
Chinook salmon	*Oncorhynchus tshawytscha* (Walbaum)		X
Rainbow trout	*Oncorhynchus mykiss* (Walbaum)	X	X
Mountain whitefish	*Prosopium williamsoni* (Girard)	X	X
Cyprinidae			
Chiselmouth	*Acrocheilus alutaceus* Agassiz and Pickering		X
Longnose dace	*Rhinichthys cataractae* (Valenciennes)	X	
Northern pikeminnow	*Ptychocheilus oregonensis* (Richardson)	X	X
Redside shiner	*Richardsonius balteatus* (Richardson)	X	X
Tench	*Tinca tinca* (Linnaeus)		
Catostomidae			
Bridgelip sucker	*Catostomus columbianus* (Eigenmann and Eigenmann)	X	X
Largescale sucker	*Catostomus macrocheilus* (Girard)	X	X
Centrarchidae			
Black crappie	*Poxomis nigromaculatus* (Lesueur)		X
Pumpkinseed	*Lepomis gibbosus* (Linnaeus)		X
Largemouth bass	*Micropterus salmoides* (Lacepede)		X
Ameiurus			
Brown bullhead	*Ameiurus nebulosus* (Lesueur)		X
Percidae			
Yellow perch	*Perca flavescens* (Mitchill)		X
Cottidae			
Sculpin spp.	*Cottus* spp.		X

Table 6. Catch-per-unit-effort (CPUE; ± 80% CI), relative abundance, and size range of fish collected in the free-flowing section of the Spokane River in 2002 (total effort = 0.98 hours; 6 sites).

Species	n	Relative Abundance (%)	CPUE (#/hour)	Size Range (mm)
Rainbow trout	28	11.7	28.3 (± 5.5)	197-410
Mountain whitefish	28	11.7	30.9 (± 12.0)	236-381
Longnose dace	2	0.8	2.0 (± 2.6)	69-90
Northern pikeminnow	1	0.4	1.0 (± 1.3)	417
Redside shiner	2	0.8	1.8 (± 1.5)	99-109
Bridgelip sucker	155	64.9	158.5 (± 17.3)	105-461
Largescale sucker	23	9.6	24.3 (± 8.7)	310-524

Table 7. Catch-per-unit-effort (CPUE; ± 80% CI) of fish collected in Nine Mile Reservoir in 2002 (total electrofishing effort = 3.02 hours).

	Gear Type		
Species	Electrofishing #/ hour (n=18 sites)	Littoral Gill Netting #/GN night (n=16)	Pelagic Gill Netting #/GN night (n=10)
Brown trout	0.3 (± 0.4)	0.2 (± 0.1)	0.1 (± 0.1)
Rainbow trout	8.0 (± 2.9)	3.4 (± 1.0)	2.8 (± 1.2)
Chinook salmon	0	0.1 (± 0.1)	0
Mountain whitefish	2.7 (± 1.6)	0.1 (± 0.2)	0.2 (± 0.2)
Sculpin	7.8 (± 4.8)	0	0
Chiselmouth	2.3 (± 1.5)	0.4 (± 0.3)	0.4 (± 0.3)
Northern pikeminnow	27.9 (± 10.5)	4.8 (± 1.2)	1.8 (± 0.7)
Redside shiner	31.6 (± 14.8)	1.8 (± 0.9)	0.1 (± 0.1)
Tench	0.7 (± 0.9)	0	0
Bridgelip sucker	28.0 (± 12.9)	12.1 (± 6.8)	19.4 (± 12.6)
Largescale sucker	28.0 (± 9.3)	9.8 (± 3.0)	8.0 (± 2.0)
Black crappie	0.7 (± 0.9)	0	0
Pumpkinseed	3.0 (± 3.4)	0	0
Largemouth bass	3.0 (± 3.1)	0	0
Yellow perch	1.3 (± 1.3)	0	0
Brown bullhead	0.3 (± 0.4)	0	0

Table 8. Annual relative abundance, mean total length (±SD), and size range of fish collected in Nine Mile Reservoir in 2002.

Species	n	Relative Abundance (%)	Mean Total Length (mm)	Size Range (mm)
Brown trout	5	0.4	323 (± 90)	250-436
Rainbow trout	106	8.2	322 (± 78)	83-493
Chinook salmon	1	0.1	368	368
Mountain whitefish	12	0.9	259 (± 77)	113-368
Sculpin	24	1.9	95 (± 13)	71-119
Chiselmouth	18	1.4	169 (± 78)	76-325
Northern pikeminnow	179	13.9	202 (± 140)	54-558
Redside shiner	125	9.7	80 (± 22)	47-132
Tench	2	0.2	249 (± 163)	134-364
Bridgelip sucker	472	36.6	323 (± 84)	72-449
Largescale sucker	321	24.9	399 (± 106)	75-590
Black crappie	2	0.2	143 (± 15)	132-153
Pumpkinseed	9	0.7	104 (± 17)	62-117
Largemouth bass	9	0.7	178 (± 72)	137-366
Yellow perch	4	0.3	110 (± 7)	100-115
Brown bullhead	1	0.1	287	287

Table 9. Annual PSD and RSD values (± 80% CI) of sport fish collected in the free-flowing Spokane River and Nine Mile Reservoir in 2002.

Species	# Stock Length	PSD	RSD-P	RSD-M	RSD-T
Spokane River					
Electrofishing					
Rainbow trout	21	10 (± 8)	0	0	0
Nine Mile Reservoir					
Electrofishing					
Brown trout	1	100 (± 0)	0	0	0
Rainbow trout	16	19 (± 13)	0	0	0
Black crappie	2	0	0	0	0
Pumpkinseed	8	0	0	0	0
Largemouth bass	1	100 (± 0)	0	0	0
Littoral Gill Netting					
Brown trout	3	100 (± 0)	67 (± 35)	67 (± 35)	0
Rainbow trout	52	15 (± 6)	0	0	0
Chinook salmon	1	0	0	0	0
Pelagic Gill Netting					
Brown trout	1	100 (± 0)	0	0	0
Rainbow trout	28	7 (± 6)	0	0	0

Table 10. Mean back-calculated total lengths (± standard deviation) at the formation of each annulus for wild rainbow trout collected in the free-flowing section of the middle Spokane River during 2002.

		Mean Total Length at the Formation of Each Annulus		
Cohort	**n**	**1**	**2**	**3**
2001	6	119 (± 11)		
2000	7	124 (± 62)	294 (± 27)	
1999	11	110 (± 19)	266 (± 30)	342 (± 39)
Grand Mean	24	116 (± 35)	277 (± 32)	342 (± 39)
Mean Annual Growth		116 (± 35)	161 (± 29)	77 (± 24)

Table 11. Mean back-calculated total lengths (± standard deviation) at the formation of each annulus for wild rainbow trout collected in Nine Mile Reservoir during 2002.

		Mean Total Length at the Formation of Each Annulus			
Cohort	**n**	**1**	**2**	**3**	**4**
2001	6	119 (± 57)			
2000	3	122 (± 14)	253 (± 66)		
1999	7	102 (± 15)	277 (± 32)	357 (± 41)	
1998	4	100 (± 18)	261 (± 37)	336 (± 20)	402 (± 17)
Grand Mean	20	110 (± 33)	267 (± 39)	349 (± 35)	402 (± 17)
Mean Annual Growth		110 (± 33)	161 (± 38)	78 (± 24)	67 (± 30)

Table 12. Mean back-calculated total lengths (± standard deviation) at the formation of each annulus for mountain whitefish collected in the free-flowing section of the middle Spokane River during 2002.

		Mean Total Length at the Formation of Each Annulus			
Cohort	**n**	**1**	**2**	**3**	**4**
2001	0	-			
2000	2	182 (± 12)	258 (± 38)		
1999	15	174 (± 22)	277 (± 20)	314 (± 18)	
1998	7	177 (± 16)	287 (± 20)	320 (± 18)	345 (± 14)
Grand Mean	24	175 (± 20)	278 (± 21)	316 (± 18)	345 (± 14)
Mean Annual Growth		175 (± 20)	103 (± 23)	36 (± 8)	25 (± 6)

Table 12A. Mean back-calculated total lengths (mm) at the formation of each annulus (± standard deviation) of sport fish that had small sample sizes, collected in Nine Mile Reservoir during 2002.

		Mean Total Length at the Formation of Each Annulus				
Species	**n**	**1**	**2**	**3**	**4**	**5**
Brown trout[1]	1	71	147	369		
Chinook salmon	1	208	316			
Mountain whitefish	9	164 (± 18)	253 (± 20)	304 (± 5)	328 (± 2)	352
Black Crappie	2	85 (± 13)				
Pumpkinseed	7	45 (± 4)	91 (± 8)			
Largemouth Bass	9	67 (± 4)	164	285	328	350
Yellow perch	4	66 (± 7)				

[1]Identified as wild due to lack of deformed dorsal fin, which was characteristic of catchable size hatchery trout.

Table 13. Mean total length (TL), weight, relative weight (W_r), and condition factor (K_{TL}) of all sport fish species collected in the free-flowing Spokane River and Nine Mile Reservoir in 2002.

Species	n	TL (mm)	Weight (g)	W_r	K_{TL}
Spokane River					
Rainbow trout	26	313 (± 65)	324 (± 71)	88 (± 11)	0.96 (± 0.11)
Mountain whitefish	24	330 (± 28)	291 (± 69)	80 (± 13)	0.80 (± 0.13)
Nine Mile Reservoir					
Brown trout	4	341 (± 93)	473 (± 370)	90 (± 16)	0.97 (± 0.16)
Chinook salmon	1	368	520	86	1.04
Rainbow trout	101	334 (± 60)	382 (± 189)	87 (± 9)	0.95 (± 0.09)
Mountain whitefish	11	272 (± 65)	223 (± 149)	92 (± 9)	0.93 (± 0.09)
Black crappie	2	143 (± 15)	47 (± 17)	119 (± 2)	1.58 (± 0.09)
Pumpkinseed	7	110 (± 6)	30 (± 5)	112 (± 7)	2.25 (± 0.13)
Largemouth bass	6	196 (± 84)	162 (± 256)	105 (± 8)	1.37 (± 0.07)
Yellow perch	4	110 (± 7)	15 (± 2)	94 (± 5)	1.13 (± 0.04)
Brown bullhead	1	287	352	98	1.49

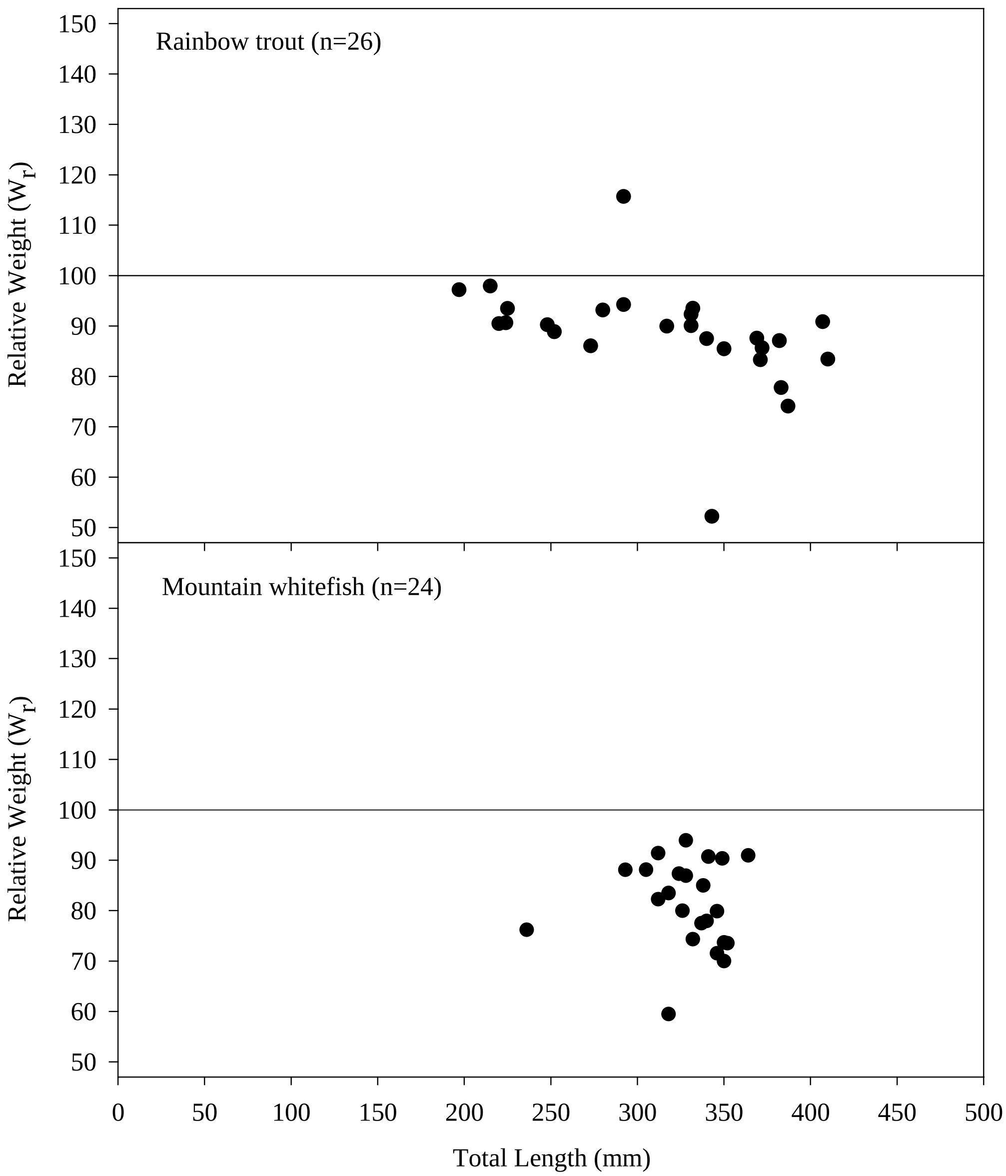

Figure 6. Relative weights of rainbow trout and mountain whitefish collected in the free-flowing Spokane River in July 2002. The national standard of 100 generally indicates good condition.

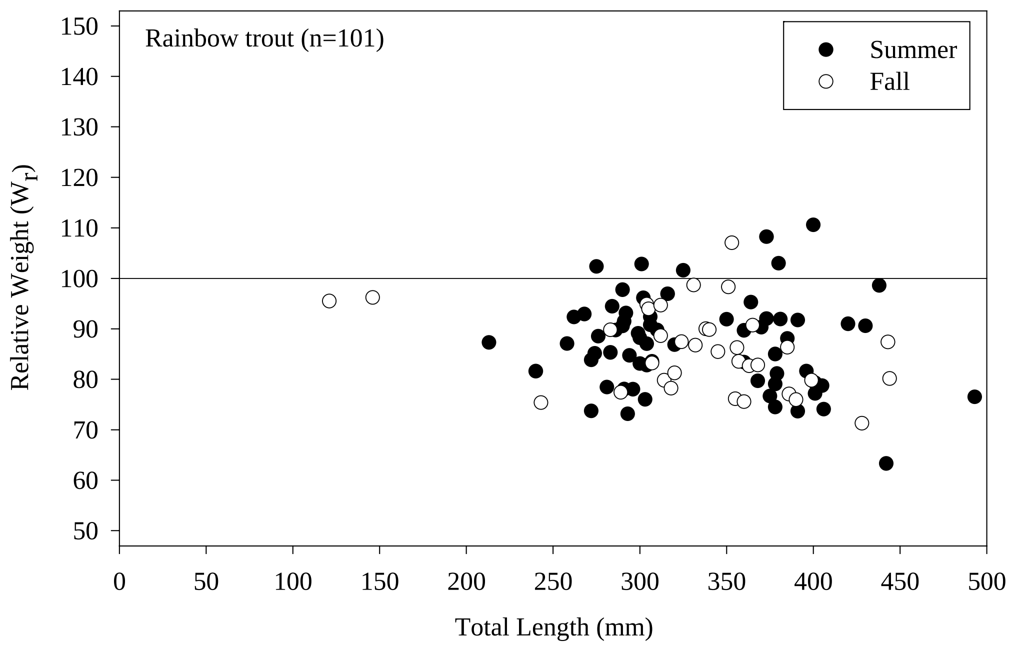

Figure 7. Relative weights of rainbow trout collected in Nine Mile Reservoir in 2002. The national standard of 100 generally indicates good condition.

Little Spokane River

Beaver Creek

Beaver Creek was divided into 11 reaches that were sampled between July 29 and August 12 (Figure 3; Appendix D). A total of 13 sites were surveyed (Figure 4; Appendix E). The mean and standard deviation (SD) of each habitat parameter was calculated for the stream, as well as each reach (Table 15; Appendix F). The mean wetted width of Beaver Creek was 1.7 m (SD=1.1) and the mean depth was 21 cm (SD=12) (Table 15). The dominant habitat and substrate types were run (93%) and muck (51%), respectively (Table 15).

Daily average, maximum, and minimum temperatures of Beaver Creek were determined (Figure 8). Mean temperature was 10.02 (SD=5.10) °C, with a maximum of 18.58 °C on July 14 and a minimum of -0.19 °C on October 25-27, 30, and 31. The mean temperature of Beaver Creek between June 6 and October 28, the same time period monitored in 2001, was 11.53 (SD=3.96) °C.

Seven species of fish were collected in Beaver Creek: brown trout, eastern brook trout, rainbow trout, sculpins, speckled dace, redside shiners, and bridgelip suckers (n=748) (Table 16). Four sculpins, collected at site 93 (Reach 2), were were identified as mottled sculpins (*Cottus bairdi*). Speckled dace were the most abundant species in Beaver Creek, based on relative abundance (49.5%; n=370) (Table 16). Eastern brook trout were the most abundant sport fish (27.7%; n=207) (Table 16). The percentage of the eastern brook trout population that was of stock length was 41.5% (n=86) (Figure 9). One of the two brown trout and none of the seven rainbow trout collected were of legal length for harvest.

Population estimates, their corresponding standard errors and 95% confidence intervals, as well as densities were calculated for brown trout, eastern brook trout, redside shiners, speckled dace, bridgelip suckers, and sculpins (Table 17).

Table 14. Mean values (± SD) of habitat parameters measured and counted in Beaver Creek.

Sample Sizes		**Riffle Habitat**	
No. Reaches	11	No. Riffles	11
No. Sections	13	Riffle Width (m)	1.9 (± 0.7)
No. Transects	198	Riffle Occurrence (%)	5
		Pool Habitat	
Transect Measurements		No. Pools	4
Wetted Width (m)	1.7 (± 1.1)	Pool Width (m)	6.2 (± 4.1)
Bankfull Width (m)	3.5 (± 1.5)	Pool Occurrence (%)	2
Depth (cm)	21 (± 12)	**Run Habitat**	
Maximum Depth (cm)	38 (± 21)	No. Runs	183
		Run Width (m)	1.6 (± 0.7)
Survey Section Measurements		Run Occurrence (%)	93
Gradient (%)	1.0 (± 0.1)		
Water Temperature (^{o}C)	11.5 (± 1.4)	**Substrate Composition (%)**	
Air Temperature (^{o}C)	22.7 (± 4.4)	Organic	8 (± 17)
No. LWD/100 m	17 (± 12)	Muck	51 (± 39)
No. PP/km	4 (± 9)	Silt	16 (± 23)
		Sand	19 (± 30)
Primary Pools (PP)		Gravel	3 (± 10)
No. PP	5	Cobble	2 (± 10)
PP Width (m)	6 (± 3.4)	Rubble	0 (± 1)
PP Length (m)	6.6 (± 1.5)	Boulder	0 (± 0)
PP Max. Depth (cm)	94 (± 29)	Bedrock	0 (± 0)
PP Residual Depth (cm)	65.6 (± 26.3)	Embeddedness (%)	96 (± 13)

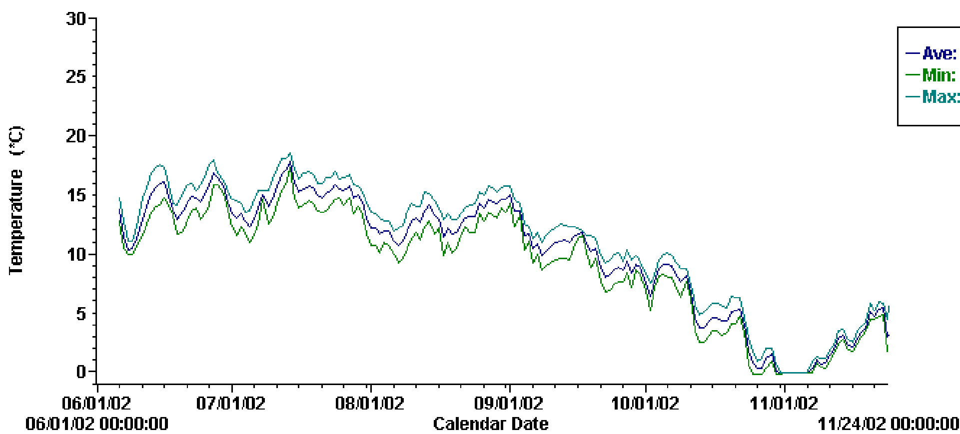

Figure 8. Mean, minimum, and maximum daily temperatures recorded on Beaver Creek.

Table 15. Relative abundances (R.A.), mean total lengths (TL; ± SD), and size ranges of each species of fish collected in Beaver Creek.

Reach	n	R. A. (%)	Mean TL (mm)	TL Range (mm)
1				
Eastern brook trout	20	83.3	143 (± 39)	77-219
Sculpin spp.	4	16.7	51 (± 10)	41-65
2				
Eastern brook trout	96	89.7	84 (± 37)	43-216
Sculpin spp.	11	10.3	58 (± 14)	39-82
3				
Eastern brook trout	2	66.7	96 (± 9)	89-102
Sculpin spp.	4	33.3	56 (± 3)	53-60
4				
Eastern brook trout	10	47.6	168 (± 35)	103-224
Speckled dace	10	47.6	74 (± 5)	64-81
Sculpin spp.	1	4.8	70	70
5				
Eastern brook trout	20	16.5	165 (± 26)	89-209
Speckled dace	100	82.6	44 (± 5)	29-66
Sculpin spp.	1	0.8	73	73
6				
Brown trout	2	1.3	211 (± 7)	206-216
Eastern brook trout	3	1.9	186 (± 24)	160-206
Redside shiner	9	5.6	87 (± 20)	37-102
Speckled dace	145	90.6	59 (± 20)	24-104
Bridgelip sucker	1	0.6	152	152
7				
Eastern brook trout	7	7.1	213 (± 31)	185-263
Redside shiner	4	4.1	88 (± 7)	79-95
Speckled dace	78	79.6	58 (± 15)	30-89
Bridgelip sucker	7	7.1	121 (± 40)	44-172
Sculpin spp.	2	2.0	61 (± 35)	36-86
8				
Eastern brook trout	3	2.9	212 (± 33)	177-241
Rainbow trout	7	6.7	54 (± 5)	46-59
Redside shiner	21	20.0	76 (± 32)	40-145
Speckled dace	35	33.3	61(± 16)	30-94
Bridgelip sucker	20	19.0	124 (± 30)	82-190
Sculpin spp.	19	18.1	67 (± 15)	26-89
9				
Eastern brook trout	7	50.0	179 (± 64)	88-296
Speckled dace	2	14.3	77 (± 7)	72-82
Sculpin spp.	5	35.7	68 (± 10)	55-82
10				
Eastern brook trout	13	26.0	102 (± 33)	73-165
Sculpin spp.	37	74.0	65 (± 15)	26-97
11				
Eastern brook trout	26	61.9	116 (± 38)	68-206
Sculpin spp.	16	38.1	68 (± 20)	54-137

Table 15. Continued

Reach	n	R. A. (%)	Mean TL (mm)	TL Range (mm)
Total				
Brown trout	2	0.3	211 (± 7)	206-216
Eastern brook trout	207	27.7	118 (± 54)	43-296
Rainbow trout	7	0.9	54 (± 5)	46-59
Redside shiner	34	4.5	80 (± 28)	37-145
Speckled dace	370	49.5	55 (± 17)	24-104
Bridgelip sucker	28	3.7	124 (± 32)	44-190
Sculpin spp.	100	13.4	64 (± 16)	26-137

Table 16. Population estimates (N), their corresponding standard errors (SE) and 95% confidence intervals, and density estimates for each species of fish collected at each site in Beaver Creek.

Reach	Site	N	SE	Lower 95% CI	Upper 95% CI	Density (#/100 m^2)
Brown trout						
6	54	1	0.0000	1	1	1
6	57	1	0.0000	1	1	1
Eastern brook trout						
1	94	22	3.2499	21	38	12
2	93	10	10.8764	92	139	7
3	72	2	0.0000	2	2	2
4	67	10	1.2001	10	10	5
5	60	20	0.7649	20	20	13
6	54	3	0.0000	3	3	3
7	38	7	0.9476	7	7	4
8	27	3	0.0000	3	3	1
9	18	7	0.9476	7	7	4
10	3	14	2.0456	14	26	7
11	1	30	4.6238	27	51	14
Redside shiner						
6	54	1	0.0000	1	1	1
6	57	3	0.7454	3	3	2
Speckled dace						
4	67	12	3.8494	11	34	6
6	54	51	36.2371	30	231	53
6	56	41	17.8307	29	123	33
6	57	88	81.3179	43	500	60
7	38	75	15.0238	62	131	46
9	18	2	0.0000	2	2	1
Bridgelip sucker						
6	57	1	0.0000	1	1	1
8	27	22	3.2499	21	38	10
Sculpin						
4	67	1	0.0000	1	1	0
5	60	1	0.0000	1	1	1
7	38	1	0.0000	1	1	1
10	3	85	123.4578	34	788	45
11	1	17	2.8644	17	33	8

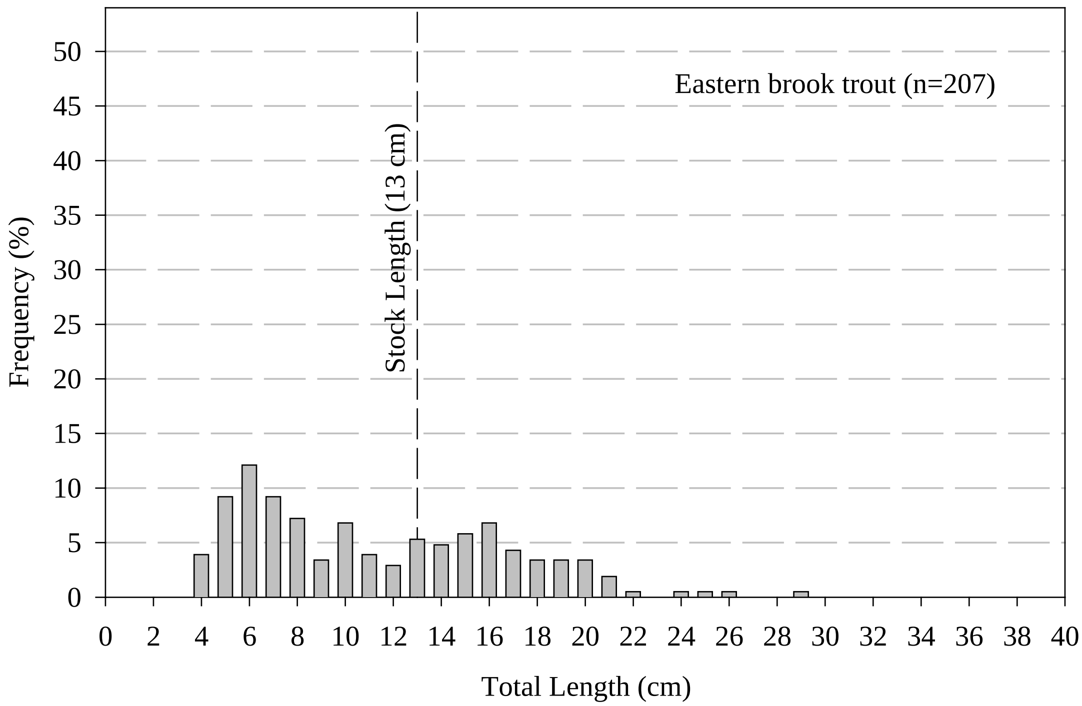

Figure 9. Length-frequency distribution of eastern brook trout collected in Beaver Creek.

Dragoon Creek

Dragoon Creek was divided into 28 reaches that were sampled between June 6 and July 17 (Figure 3; Appendix D). A total of 40 sites were surveyed (Figure 4; Appendix E). The mean of each habitat parameter was calculated for the stream, as well as each reach (Table 18; Appendix G). The mean wetted width was 4.9 m (SD=2.5) and the mean depth was 33 cm (SD=18) (Table 18). The dominant habitat and substrate types were run (57%) and sand (43%), respectively (Table 18).

Dragoon Creek Dam, located on the northwest edge of the city of Deer Park, was identified as a potential seasonal fish passage barrier. The dam (5.5 m tall) was built in 1913 to create a reservoir for holding logs at a mill (D. Johnson, Washington Department of Ecology, personal communication) and was historically a fish passage barrier. The dam was opened and the reservoir was drained between 1981 and 1983. When examined during this survey the reservoir was empty and the dam outlet was open and appeared to allow for fish passage.

However, the dam outlet is 61.0 cm x 61.0 cm (2 ft. x 2 ft.) and not adequate to allow complete discharge, so the reservoir refills during high flow events (D. Johnson, Washington Department of Ecology, personal communication). During these events, the velocity of the water passing through the outlet likely prevents fish passage.

Daily average, maximum, and minimum temperatures were determined for sites in lower, middle, and upper Dragoon Creek (Figures 10 through 12). Mean temperature at lower Dragoon Creek was 11.74 (SD=6.00) °C, with a maximum of 22.97 °C on July 12 and a minimum of –0.12 °C on October 26, 27, and 30. The mean temperature at middle Dragoon Creek was 10.36 (SD=4.92) °C, with a maximum of 18.58 °C on July 14 and a minimum of 0.05 °C on October 31-November 5. The mean temperature of upper Dragoon Creek was 10.19 (SD=5.59) °C, with a maximum of 21.18 °C on July 12 and a minimum of 0.05 °C on November 2-9. The mean temperature at upper Dragoon Creek between June 6 and October 28, the same time period monitored in 2001, was 11.81 (SD=4.46) °C.

Thirteen species of fish were collected in Dragoon Creek: brown trout, eastern brook trout, rainbow trout, mountain whitefish, brown bullhead, chiselmouth, longnose dace, northern pikeminnow, redside shiners, speckled dace, bridgelip suckers, largescale suckers, and sculpins (n=4,475) (Table 19). A total of 16 sculpins were collected from sites 340, 200, 120, and 21 (Reaches 3, 15, 19, and 25, respectively) and preserved for identification. The two from site 340 were identified as mottled sculpins. Three of the four at site 200 were mottled sculpins and the fourth was a torrent sculpin. Of the five samples from site 120, four were mottled sculpins and the fifth was a torrent sculpin. Three of the five sculpins preserved from site 21 were torrent sculpins and the other two were mottled sculpins.

Sculpins were the most abundant fish species in Dragoon Creek, based on relative abundance (41.2%; n=1,845) (Table 19). Eastern brook trout were the most abundant sport fish species, based on relative abundance (14.6%; n=653) (Table 19). The percentage of the eastern brook trout population that was of stock length was 52% (n=339) (Figure 13). The percentages of the brown and rainbow trout populations that were of legal length for harvest were 17.8% (n=18) and 20.1% (n=38), respectively (Figures 13 and 14).

Population estimates, their corresponding standard errors and 95% confidence intervals, and densities were calculated for brown trout, eastern brook trout, rainbow trout, mountain whitefish, chiselmouth, longnose dace, northern pikeminnow, redside shiners, speckled dace, bridgelip suckers, largescale suckers, and sculpins (Table 20).

Table 17. Mean values (± SD) of habitat parameters measured and counted in Dragoon Creek.

Sample Sizes		**Riffle Habitat**	
No. Reaches	27	No. Riffles	123
No. Sections	40	Riffle Width (m)	4.9 (± 2.5)
No. Transects	492	Riffle Occurrence (%)	24
		Pool Habitat	
Transect Measurements		No. Pools	98
Wetted Width (m)	4.9 (± 2.5)	Pool Width (m)	4.8 (± 2.6)
Bankfull Width (m)	8.7 (± 4.5)	Pool Occurrence (%)	19
Depth (cm)	33 (± 18)	**Run Habitat**	
Maximum Depth (cm)	59 (± 27)	No. Runs	290
		Run Width (m)	4.5 (± 2.4)
Survey Section Measurements		Run Occurrence (%)	57
Gradient (%)	1.3 (± 0.3)		
Water Temperature (^{o}C)	14.1 (± 2.5)	**Substrate Composition (%)**	
Air Temperature (^{o}C)	22.2 (± 6.5)	Organic	4 (± 10)
No. LWD/100 m	14 (± 15)	Muck	6 (± 19)
No. PP/km	18 (± 15)	Silt	16 (± 25)
		Sand	43 (± 32)
Primary Pools (PP)		Gravel	9 (± 15)
No. PP	71	Cobble	14 (± 22)
PP Width (m)	5.7 (± 2.7)	Rubble	4 (± 9)
PP Length (m)	8.5 (± 4.8)	Boulder	2 (± 9)
PP Max. Depth (cm)	94 (± 34)	Bedrock	2 (± 11)
PP Residual Depth (cm)	67 (± 26)	Embeddedness (%)	78 (± 27)

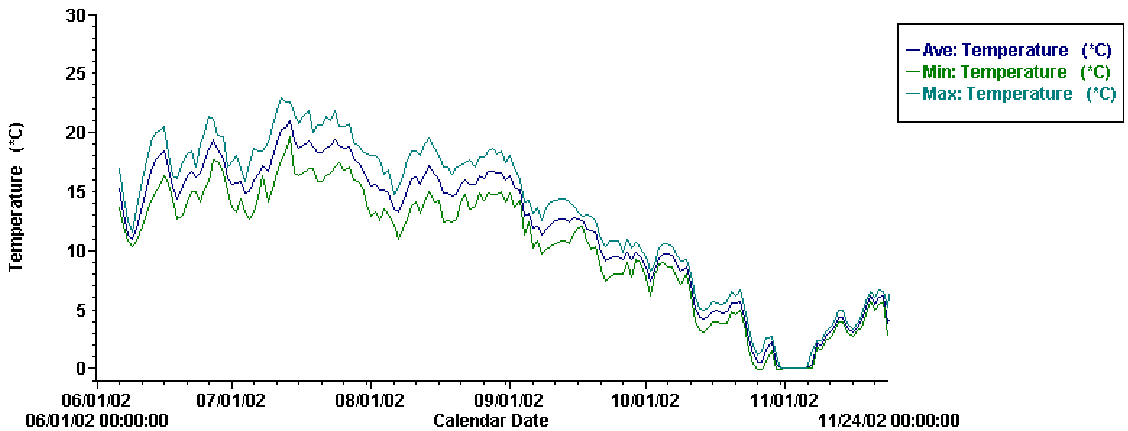

Figure 10. Mean, minimum, and maximum daily temperatures recorded on lower Dragoon Creek.

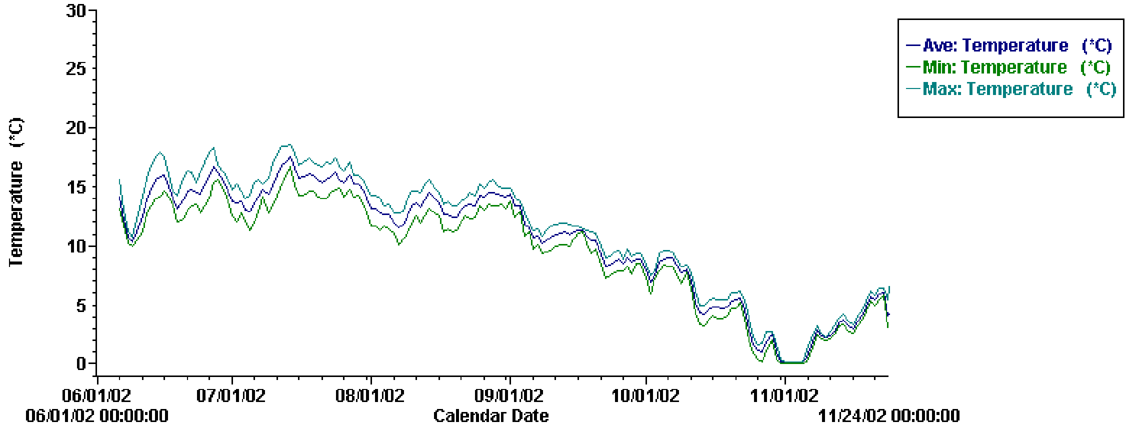

Figure 11. Mean, minimum, and maximum daily temperatures recorded on middle Dragoon Creek.

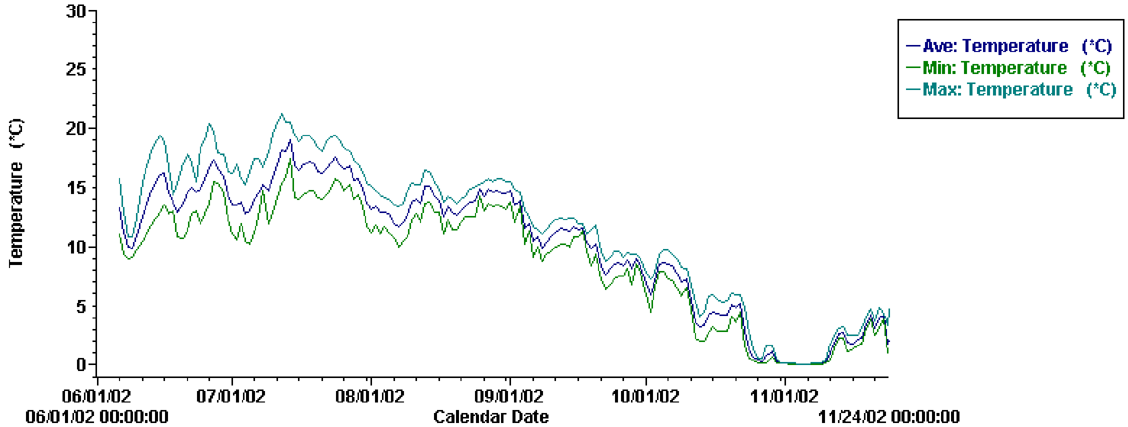

Figure 12. Mean, minimum, and maximum daily temperatures recorded on upper Dragoon Creek.

Table 18. Relative abundances (R.A.), mean total length (TL; ± SD), and size range of each species of fish collected in Dragoon Creek.

Reach	n	R. A. (%)	Mean TL (mm)	TL Range (mm)
1				
Eastern brook trout	17	56.7	140 (± 32)	90-202
Rainbow trout	2	6.7	147 (± 37)	121-173
Sculpin spp.	11	36.7	57 (± 16)	36-80
2				
Eastern brook trout	11	18.6	100 (± 9)	90-121
Rainbow trout	1	1.7	104	104
Sculpin spp.	47	79.7	60 (± 15)	40-84
3				
Eastern brook trout	67	72.8	124 (± 32)	82-208
Rainbow trout	7	7.6	125 (± 29)	70-162
Sculpin spp.	18	19.6	62 (± 13)	42-86
4				
Eastern brook trout	85	78.0	126 (± 38)	49-220
Rainbow trout	2	1.8	172 (± 17)	160-184
Sculpin spp.	22	22.2	72 (± 15)	45-110
5				
Eastern brook trout	45	51.1	122 (± 35)	37-200
Rainbow trout	5	5.7	154 (± 38)	98-194
Redside shiner	4	4.5	90 (± 10)	81-102
Speckled dace	18	20.5	50 (± 11)	35-72
Bridgelip sucker	2	2.3	121 (± 17)	109-133
Sculpin spp.	14	15.9	80 (± 8)	63-91
6				
Eastern brook trout	51	56.7	101 (± 53)	44-183
Rainbow trout	9	10.0	154 (± 34)	112-201
Brown bullhead	1	1.1	145	145
Sculpin spp.	29	32.2	75 (± 21)	52-167
7				
Eastern brook trout	89	34.6	96 (± 54)	42-236
Rainbow trout	2	0.8	162 (± 24)	145-179
Redside shiner	81	31.5	66 (± 14)	44-107
Speckled dace	18	7.0	65 (± 13)	38-86
Bridgelip sucker	7	2.7	104(± 44)	63-173
Sculpin spp.	60	23.3	74 (± 12)	51-104
8				
Eastern brook trout	21	35.6	126 (± 70)	52-238
Rainbow trout	2	3.4	155 (± 45)	123-187
Redside shiner	2	3.4	75 (± 35)	50-100
Sculpin spp.	34	57.6	71 (± 10)	41-88
9				
Rainbow trout	1	1.8	178	178
Redside shiner	5	8.9	94 (± 12)	78-106
Speckled dace	1	1.8	66	66
Sculpin spp.	49	87.5	62 (± 11)	43-94
10				
Eastern brook trout	1	0.6	156	156
Redside shiner	45	25.6	70 (± 18)	43-110

Table 18. Continued.

Reach	n	R. A. (%)	Mean TL (mm)	TL Range (mm)
Speckled dace	37	21.0	52 (± 15)	27-89
Bridgelip sucker	7	4.0	103 (± 39)	59-181
Sculpin spp.	86	48.9	69 (± 12)	48-94
11				
Eastern brook trout	7	3.0	162 (± 35)	123-229
Rainbow trout	1	0.4	142	142
Longnose dace	1	0.4	73	73
Northern pikeminnow	6	2.6	81 (± 27)	63-136
Redside shiner	119	50.9	72 (± 21)	23-112
Speckled dace	77	32.9	63 (± 14)	32-102
Bridgelip sucker	5	2.1	100 (± 36)	76-164
Sculpin spp.	18	7.7	73 (± 11)	59-93
12				
Eastern brook trout	9	4.1	170 (± 33)	140-250
Redside shiner	51	23.0	78 (± 17)	44-118
Speckled dace	133	59.9	58 (± 12)	32-92
Bridgelip sucker	4	1.8	72 (± 15)	55-90
Sculpin spp.	25	11.3	65 (± 11)	41-94
13				
Brown trout	3	1.4	169 (± 65)	114-240
Eastern brook trout	72	34.0	119 (± 47)	46-243
Rainbow trout	6	2.8	185 (± 41)	134-252
Mountain whitefish	1	0.5	183	183
Redside shiner	2	0.9	50 (± 1)	49-50
Sculpin spp.	128	60.4	61 (± 14)	41-98
14				
Brown trout	8	5.0	164 (± 31)	142-240
Eastern brook trout	47	29.2	144 (± 37)	52-248
Rainbow trout	7	4.3	175 (± 27)	139-209
Mountain whitefish	6	3.7	201 (± 6)	194-210
Sculpin spp.	93	57.8	63 (± 18)	40-124
15				
Brown trout	8	5.4	142 (± 59)	62-240
Eastern brook trout	32	21.5	173 (± 55)	80-295
Rainbow trout	9	6.0	154 (± 64)	49-227
Mountain whitefish	1	0.7	211	211
Longnose dace	2	1.3	96 (± 15)	85-106
Redside shiner	39	26.2	83 (± 17)	40-112
Bridgelip sucker	3	2.0	96 (± 9)	87-104
Sculpin spp.	55	36.9	71 (± 20)	26-117
16				
Brown trout	4	4.3	161 (± 29)	139-202
Eastern brook trout	22	23.7	113 (± 58)	51-236
Rainbow trout	5	5.4	189 (± 72)	135-315
Mountain whitefish	3	3.2	203 (± 7)	195-209
Redside shiner	3	3.2	75 (± 20)	60-98
Speckled dace	20	21.5	63 (± 14)	38-88
Sculpin spp.	36	38.7	75 (± 17)	52-112
17				
Brown trout	8	3.2	174 (± 15)	147-195

Table 18. Continued.

Reach	n	R. A. (%)	Mean TL (mm)	TL Range (mm)
Eastern brook trout	35	14.0	160 (± 50)	60-239
Rainbow trout	15	6.0	172 (± 39)	130-281
Mountain whitefish	8	3.2	202 (± 5)	193-208
Longnose dace	4	1.6	83 (± 17)	60-101
Redside shiner	71	28.4	67 (± 17)	42-124
Speckled dace	13	5.2	44 (± 11)	34-67
Bridgelip sucker	9	3.6	81 (± 27)	42-123
Sculpin spp.	87	34.8	75 (± 13)	51-118
18				
Brown trout	17	4.3	159 (± 49)	61-220
Eastern brook trout	20	5.1	176 (± 47)	58-254
Rainbow trout	17	4.3	187 (± 44)	141-270
Mountain whitefish	5	1.3	180 (± 53)	86-212
Chiselmouth	7	1.8	91 (± 18)	77-119
Longnose dace	19	4.8	68 (± 10)	52-82
Northern pikeminnow	1	0.3	149	149
Redside shiner	111	28.1	81 (± 20)	31-114
Speckled dace	63	15.9	62 (± 14)	40-90
Bridgelip sucker	17	4.3	80 (± 32)	47-155
Sculpin spp.	118	29.9	72 (± 12)	49-120
19				
Brown trout	24	6.4	152 (± 60)	63-331
Eastern brook trout	13	3.5	166 (± 51)	80-222
Rainbow trout	14	3.8	186 (± 70)	46-326
Mountain whitefish	11	2.9	135 (± 42)	107-206
Longnose dace	31	8.3	68 (± 13)	48-93
Northern pikeminnow	1	0.3	75	75
Redside shiner	57	15.3	87 (± 18)	40-120
Speckled dace	80	21.4	60 (± 14)	30-105
Bridgelip sucker	38	10.2	75 (± 36)	43-173
Sculpin spp.	104	27.9	63 (± 12)	28-96
20				
Brown trout	2	6.1	242 (± 137)	145-339
Eastern brook trout	7	21.2	162 (± 18)	137-189
Longnose dace	1	3.0	58	58
Speckled dace	22	66.7	62 (± 14)	44-93
Sculpin spp.	1	3.0	80	80
21				
Brown trout	10	18.9	136 (± 44)	69-193
Rainbow trout	3	5.7	154 (± 15)	138-167
Redside shiner	3	5.7	65 (± 7)	59-72
Speckled dace	8	15.1	56 (± 12)	37-77
Bridgelip sucker	4	7.5	94 (± 45)	59-155
Sculpin spp.	25	47.2	70 (± 11)	53-95
22				
Brown trout	4	3.8	206 (± 75)	150-317
Rainbow trout	7	6.7	188 (± 44)	135-251
Mountain whitefish	5	4.8	243 (± 61)	178-332
Chiselmouth	6	5.8	198 (± 71)	77-262
Longnose dace	6	5.8	66 (± 13)	54-91

Table 18. Continued.

Reach	n	R. A. (%)	Mean TL (mm)	TL Range (mm)
Redside shiner	10	9.6	86 (± 20)	64-129
Speckled dace	7	6.7	68 (± 8)	60-83
Bridgelip sucker	10	9.6	110 (± 27)	72-152
Sculpin spp.	49	47.1	65 (± 18)	32-124
23				
Brown trout	6	8.1	239 (± 113)	77-371
Rainbow trout	6	8.1	199 (± 130)	59-357
Longnose dace	5	6.8	72 (± 10)	60-87
Redside shiner	5	6.8	52 (± 39)	19-119
Speckled dace	5	6.8	62 (± 6)	57-70
Bridgelip sucker	1	1.4	54	54
Sculpin spp.	46	62.2	68 (± 9)	51-93
24				
Brown trout	4	4.9	239 (± 59)	204-328
Rainbow trout	3	3.7	300 (± 59)	238-355
Mountain whitefish	3	3.7	345 (± 49)	289-376
Chiselmouth	1	1.2	270	270
Longnose dace	1	1.2	77	77
Redside shiner	23	28.0	61 (± 27)	34-120
Speckled dace	10	12.2	69 (± 8)	60-83
Bridgelip sucker	15	18.3	111 (± 82)	49-242
Sculpin spp.	22	26.8	79 (± 13)	62-115
25				
Brown trout	3	0.6	207 (± 8)	197-212
Eastern brook trout	2	0.4	216 (± 34)	192-240
Rainbow trout	33	6.7	190 (± 56)	62-338
Mountain whitefish	8	1.6	216 (± 6)	205-223
Longnose dace	46	9.4	103 (± 23)	60-142
Redside shiner	18	3.7	39 (± 23)	24-104
Bridgelip sucker	11	2.2	150 (± 29)	83-185
Sculpin spp.	368	75.3	74 (± 21)	24-154
26				
Rainbow trout	1	1.3	129	129
Mountain whitefish	4	5.0	207 (± 3)	204-211
Longnose dace	6	7.5	86 (± 19)	69-122
Redside shiner	1	1.3	87	87
Sculpin spp.	68	85.0	73 (± 17)	47-147
27				
Rainbow trout	15	8.1	204 (± 69)	110-340
Mountain whitefish	5	2.7	128 (± 39)	109-199
Longnose dace	31	16.8	85 (± 16)	66-126
Bridgelip sucker	6	3.2	158 (± 23)	135-198
Sculpin spp.	128	69.2	73 (± 19)	27-145
28				
Rainbow trout	16	5.9	168 (± 31)	121-248
Mountain whitefish	20	7.4	102 (± 5)	91-111
Chiselmouth	5	1.9	81 (± 14)	65-100
Longnose dace	11	4.1	83 (± 13)	69-107
Northern pikeminnow	12	4.4	379 (± 66)	295-515
Redside shiner	22	8.1	87 (± 16)	59-127

Table 18. Continued.

Reach	n	R. A. (%)	Mean TL (mm)	TL Range (mm)
Speckled dace	1	0.4	67	67
Bridgelip sucker	70	25.9	104 (± 51)	64-365
Largescale sucker	9	3.3	445 (± 38)	383-500
Sculpin spp.	104	38.5	70 (± 20)	24-135
Total				
Brown trout	101	2.3	168 (± 62)	61-371
Eastern brook trout	653	14.6	127 (± 51)	37-295
Rainbow trout	189	4.2	179 (± 57)	46-357
Mountain whitefish	80	1.8	171 (± 65)	86-376
Brown bullhead	1	<0.1	145	145
Chiselmouth	19	0.4	132 (± 74)	65-270
Longnose dace	164	3.7	83 (± 22)	48-142
Northern pikeminnow	20	0.4	263 (± 156)	63-515
Redside shiner	672	15.0	74 (± 21)	19-129
Speckled dace	513	11.5	59 (± 14)	27-105
Bridgelip sucker	209	4.7	99 (± 49)	42-365
Largescale sucker	9	0.2	445 (± 38)	383-500
Sculpin spp.	1,845	41.2	70 (± 17)	24-167

Table 19. Population estimates (N), their corresponding standard error (SE) and 95% confidence intervals, and density estimates for each species of fish collected at each site in Dragoon Creek.

Reach	Site	N	SE	Lower 95% CI	Upper 95% CI	Density (#/100 m^2)
Brown trout						
13	222	3	0.0000	3	3	1
14	205	8	0.3953	8	8	2
15	200	8	0.8660	8	8	2
16	182	4	0.0000	4	4	1
17	166	2	0.0000	2	2	<1
17	172	6	1.0541	6	6	1
18	138	5	1.2000	5	5	1
19	111	16	4.9589	14	42	2
19	127	10	1.2001	10	10	1
20	104	2	0.0000	2	2	<1
21	100	12	3.8494	11	34	1
22	91	4	0.0000	4	4	1
23	78	6	0.0000	6	6	1
Eastern brook trout						
1	362	24	10.6245	18	77	10
2	347	12	2.9527	12	29	5
3	340	131	58.6747	81	362	56
4	326	75	20.0350	57	150	24
4	330	55	25.5533	37	167	22
5	310	35	6.2807	31	61	12
5	313	13	2.4079	13	27	4
6	301	48	5.1859	45	69	19
7	282	131	38.5465	95	271	38
7	295	3	0.0000	3	3	1
8	273	23	2.9356	22	38	7

Table 19. Continued.

Reach	Site	N	SE	Lower 95% CI	Upper 95% CI	Density (#/100 m^2)
11	234	8	2.5152	8	23	2
12	230	9	1.3752	9	18	2
13	222	94	17.1221	77	153	24
14	205	60	11.3159	50	103	17
15	200	33	2.1546	33	44	7
16	182	22	0.9949	22	22	4
17	166	15	1.5924	15	25	3
17	172	22	3.2499	21	38	5
18	138	5	0.5292	5	5	1
18	145	5	0.7873	5	5	1
20	104	8	2.5125	8	23	1
25	21	1	0.0000	1	1	<1
25	35	1	0.0000	1	1	<1
Rainbow trout						
2	347	1	0.0000	1	1	<1
5	310	2	0.0000	2	2	1
5	313	3	0.0000	3	3	1
6	301	9	1.4304	9	18	4
7	282	2	0.0000	2	2	1
8	273	2	0.0000	2	2	1
9	276	1	0.0000	1	1	<1
11	234	1	0.0000	1	1	<1
13	222	6	1.0024	6	6	2
14	205	7	0.4286	7	7	2
15	200	7	0.4286	7	7	1
16	182	5	0.5292	5	5	1
17	166	8	2.5125	8	23	2
17	172	8	1.8101	8	20	2
18	138	2	0.0000	2	2	<1
18	139	8	2.5125	8	23	1
18	145	8	0.7687	8	8	1
19	111	12	0.0000	12	12	2
19	127	1	0.0000	1	1	<1
21	100	3	0.7454	3	3	<1
22	91	7	0.9476	7	7	1
23	78	6	1.0541	6	6	1
25	35	9	1.4304	9	18	1
25	47	6	0.4714	6	6	1
26	18	1	0.0000	1	1	<1
27	14	15	0.9165	15	15	2
28	4	17	2.8644	17	33	2
Mountain whitefish						
17	172	6	0.0000	6	6	1
18	138	1	0.0000	1	1	<1
18	139	3	0.7454	3	3	1
18	145	1	0.0000	1	1	<1
19	111	3	0.0000	3	3	<1
19	120	8	0.0000	8	8	1
25	21	1	0.0000	1	1	<1
25	35	6	1.0541	6	6	1
26	18	4	0.6124	4	4	1
27	14	5	1.2000	5	5	1

Table 19. Continued.

Reach	Site	N	SE	Lower 95% CI	Upper 95% CI	Density (#/100 m^2)
28	4	28	11.0931	21	81	3
Chiselmouth						
28	4	5	1.2000	5	5	1
Longnose dace						
11	234	1	0.0000	1	1	<1
15	200	2	0.0000	2	2	<1
18	145	16	3.4893	15	34	2
19	111	39	10.8335	32	86	6
20	104	1	0.0000	1	1	<1
22	91	6	0.0000	6	6	1
23	78	5	1.2000	5	5	1
Northern pikeminnow						
11	234	6	0.4714	6	6	1
19	127	1	0.0000	1	1	<1
28	4	13	2.4079	13	27	2
Redside shiner						
7	295	73	0.0000	73	73	18
8	273	1	0.0000	1	1	<1
9	276	5	1.2000	5	5	2
10	241	28	7.5506	23	63	8
10	253	21	3.6505	20	39	6
11	234	108	7.1630	101	132	26
12	230	51	3.3865	49	65	14
15	200	58	24.0128	41	162	12
16	182	3	0.7454	3	3	1
17	166	62	1.3093	62	69	13
17	172	5	1.2000	5	5	1
18	138	2	0.0000	2	2	<1
18	139	40	8.5468	34	76	7
18	145	82	7.1115	75	106	12
19	111	8	0.8660	8	8	1
19	120	13	2.4079	13	27	2
19	127	35	1.4188	35	43	5
21	100	3	0.7454	3	3	<1
22	91	10	0.3464	10	10	1
24	63	9	1.3752	9	18	1
25	39	3	0.0000	3	3	<1
28	4	22	0.4636	22	22	3
Speckled dace						
5	313	7	0.9476	7	7	2
7	295	15	0.0000	15	15	4
9	276	1	0.0000	1	1	<1
10	241	19	7.5035	16	58	5
10	253	1	0.0000	1	1	<1
11	234	88	18.3997	71	155	21
12	230	191	69.6594	69	442	51
16	182	16	0.8795	16	16	3
18	138	44	29.6750	28	191	9
18	139	13	2.4079	13	27	2
19	120	57	30.2453	37	195	7
19	127	20	4.8906	18	44	3
20	104	17	0.5391	17	17	2
21	100	6	0.4714	6	6	1

Table 19. Continued.

Reach	Site	N	SE	Lower 95% CI	Upper 95% CI	Density (#/100 m^2)
22	91	8	2.5125	8	23	1
24	63	10	1.1135	10	10	2
28	4	1	0.0000	1	1	<1
Bridgelip sucker						
5	310	1	0.0000	1	1	<1
5	313	1	0.0000	1	1	<1
7	282	1	0.0000	1	1	<1
7	295	6	0.0000	6	6	2
10	241	6	0.0000	6	6	2
10	253	1	0.0000	1	1	<1
11	234	5	0.5292	5	5	1
17	166	8	0.8660	8	8	2
18	138	6	1.0541	6	6	1
18	139	5	1.2000	5	5	1
19	120	6	1.0541	6	6	1
19	127	32	8.2660	26	69	4
22	91	12	3.8494	11	34	2
23	78	1	0.0000	1	1	<1
24	63	13	0.8750	13	13	2
25	21	1	0.0000	1	1	<1
25	35	12	3.8494	11	34	2
28	4	96	19.0160	78	163	12
Largescale sucker						
28	4	9	0.0000	9	9	1
Sculpin						
1	362	7	0.4286	7	7	3
2	347	35	4.4855	32	54	14
3	340	16	4.5372	14	39	7
4	326	11	1.0198	11	11	4
4	330	10	0.8594	10	10	4
5	313	4	0.0000	4	4	1
6	301	40	12.4924	31	95	16
7	282	84	19.5013	66	156	25
8	273	57	30.2453	37	195	17
9	276	104	87.1352	52	528	37
10	241	8	1.8101	8	20	2
10	253	120	40.6944	84	274	35
12	230	27	3.5737	25	43	7
13	222	116	17.7533	97	174	30
15	200	242	512.3658	63	3328	51
16	182	37	1.8299	37	46	7
17	172	44	9.1564	37	82	9
18	139	22	1.7585	22	32	4
18	145	95	83.3715	46	504	13
19	111	80	16.5222	65	141	12
21	100	44	29.6750	28	191	5
22	91	132	176.1343	50	1096	18
24	63	29	8.6551	24	68	5
25	21	302	38.1026	252	409	45
25	35	90	10.8907	79	127	12
26	18	81	11.0082	71	120	12
27	14	257	108.6625	156	659	36
28	4	312	283.3798	127	1634	38

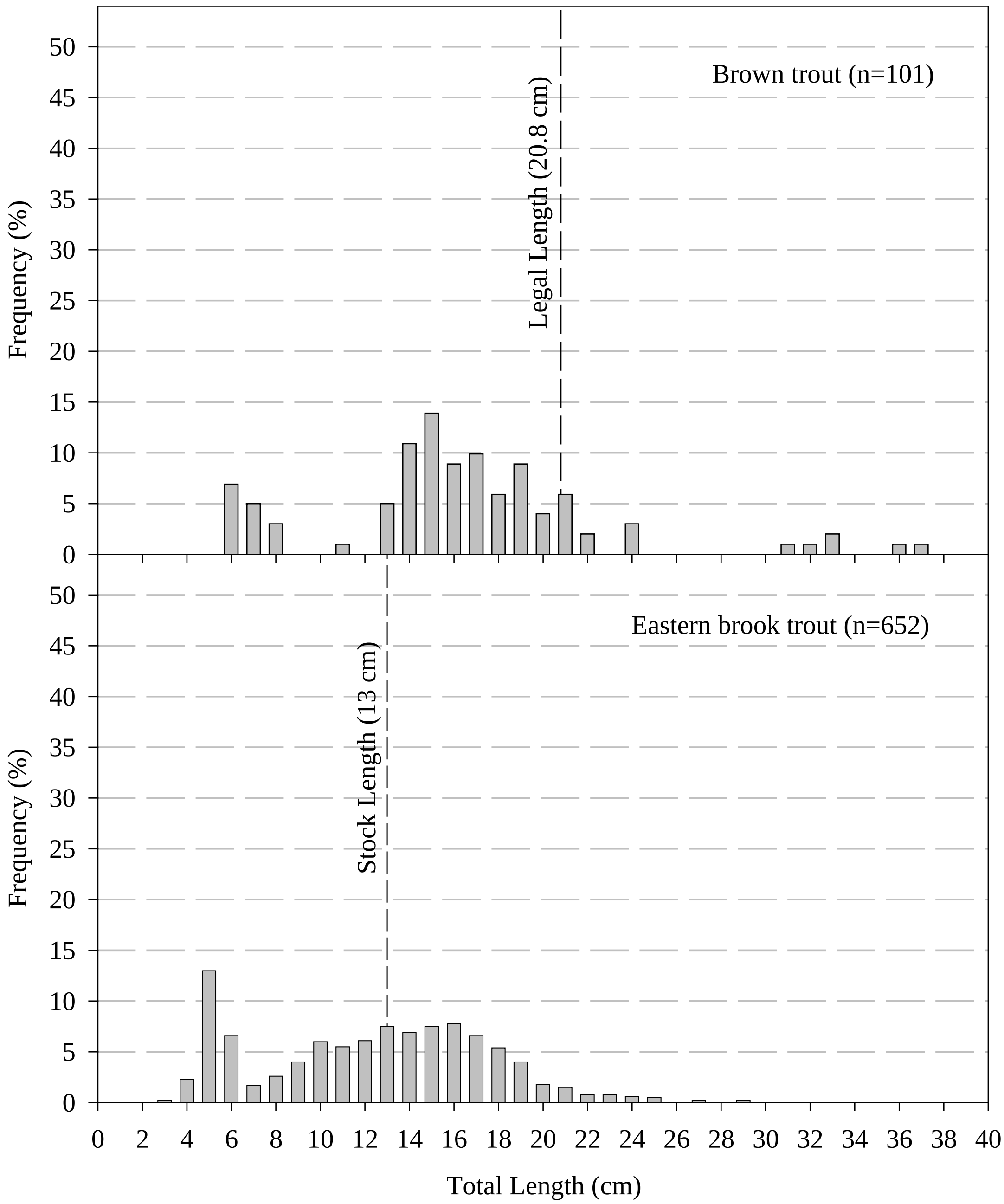

Figure 13. Length-frequency distributions of brown and eastern brook trout collected in Dragoon Creek.

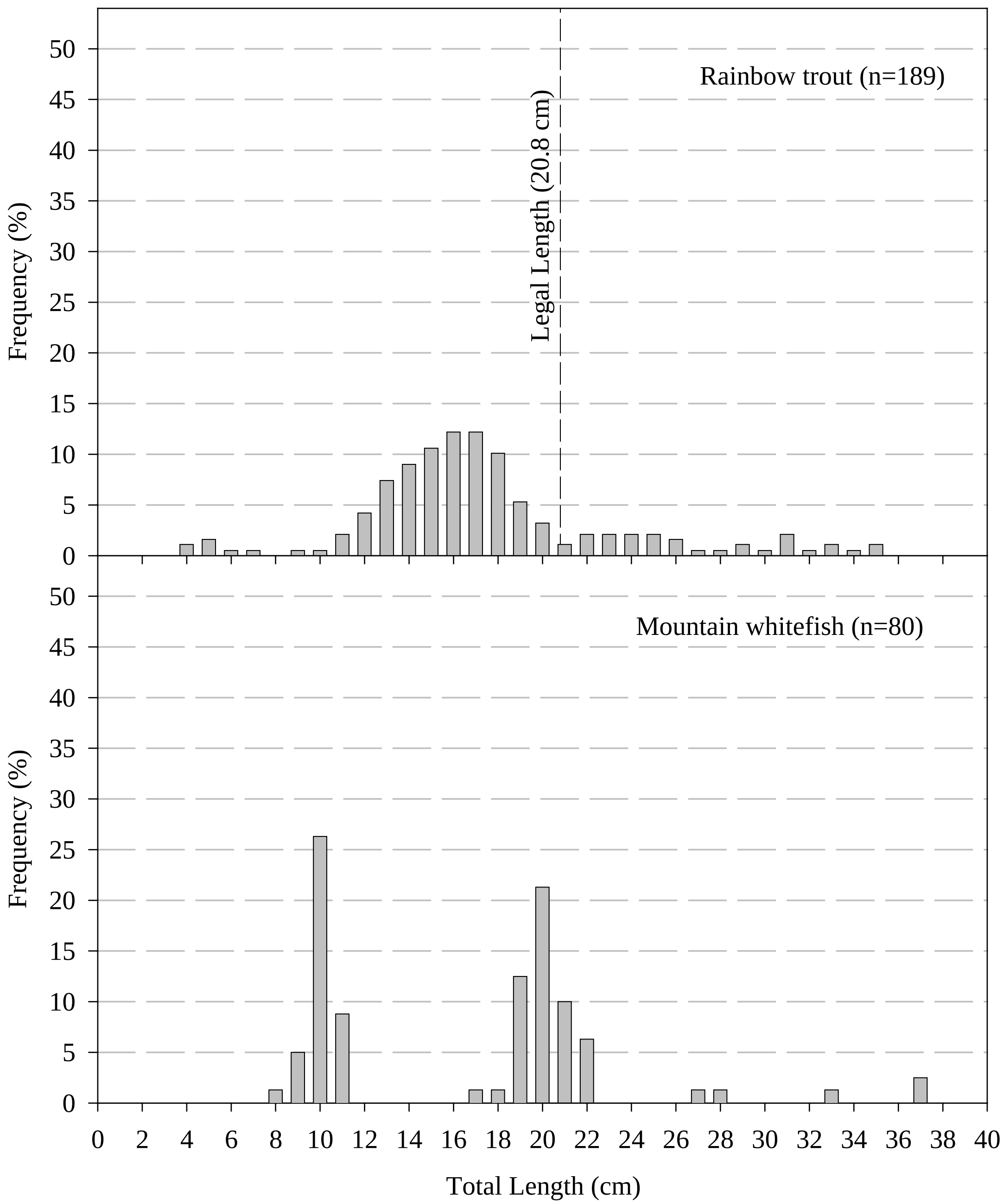

Figure 14. Length-frequency distributions of rainbow trout and mountain whitefish collected in Dragoon Creek.

Little Deer Creek

Little Deer Creek was divided into 9 reaches that were sampled between September 16 and 25 (Figure 3; Appendix D). A total of 11 sites were surveyed (Figure 4; Appendix E). The mean of each habitat parameter was calculated for the stream, as well as each reach (Table 21; Appendix H). The mean wetted width was 1.2 m (SD=0.5) and the mean depth was 6 cm (SD=3) (Table 21). The dominant habitat and substrate types were riffle (79%) and gravel (30%), respectively (Table 21).

The culvert at the bend where Tallman Road turns into Blanchard Creek Road was identified as a definite fish passage barrier. The culvert was under the private road coming off the southern portion of the bend. The vertical height to the mouth was 25 cm and the gradient of the culvert was 4%. The take off pool was 1.2 m wide, 1.0 m long, and 22 cm deep. The base of the upper end of the culvert was up against a large rock, which spanned the entire width of the opening. The rock sloped away from the culvert at a gradient of approximately 70% and there was an opening of approximately 40 cm between the upper lip of the culvert and the rock. A vertical leap of 64 cm would be required to clear the rock. There was woody debris covering the opening between the culvert lip and the rock, increasing the difficulty of passage.

Daily average, maximum, and minimum temperatures of Little Deer Creek were determined (Figure 15). The mean temperature was 9.03 (SD=5.19) °C, with a maximum of 19.10 °C on July 13-14 and a minimum of –0.22 °C on October 28, 29, and November 1, 2, and 4-6.

Eastern brook and rainbow trout were the only two species of fish collected (n=769) (Table 22). Rainbow trout were the most abundant species, based on relative abundance (91.9%; n=707) (Table 22). The percentage of the eastern brook trout population that was of stock length was 29.0% (n=18) (Figure 16). There were no rainbow trout of legal length for harvest (Figure 16).

Population estimates, their corresponding standard errors and 95% confidence intervals, and densities were calculated for eastern brook and rainbow trout (Table 23).

Table 20. Mean values (± SD) of habitat parameters measured and counted in Little Deer Creek.

Sample Sizes		**Riffle Habitat**	
No. Reaches	9	No. Riffles	149
No. Sections	11	Riffle Width (m)	1.1 (± 0.4)
No. Transects	187	Riffle Occurrence (%)	79
		Pool Habitat	
Transect Measurements		No. Pools	28
Wetted Width (m)	1.2 (± 0.5)	Pool Width (m)	1.6 (± 0.6)
Bankfull Width (m)	3.4 (± 1.3)	Pool Occurrence (%)	15
Depth (cm)	6 (± 3)	**Run Habitat**	
Maximum Depth (cm)	12 (± 6)	No. Runs	12
		Run Width (m)	1.5 (± 0.4)
Survey Section Measurements		Run Occurrence (%)	6
Gradient (%)	4 (± 2.9)		
Water Temperature (^{o}C)	10.1 (± 1.4)	**Substrate Composition (%)**	
Air Temperature (^{o}C)	12.5 (± 2.9)	Organic	1 (± 3)
No. LWD/100 m	22 (± 13)	Muck	0 (± 0)
No. PP/km	12 (± 11)	Silt	7 (± 17)
		Sand	27 (± 23)
Primary Pools (PP)		Gravel	30 (± 25)
No. PP	13	Cobble	18 (± 20)
PP Width (m)	2.1 (± 0.4)	Rubble	10 (± 15)
PP Length (m)	2.7 (± 0.7)	Boulder	5 (± 13)
PP Max. Depth (cm)	32 (± 10)	Bedrock	0 (± 7)
PP Residual Depth (cm)	21 (± 5)	Embeddedness (%)	49 (± 25)

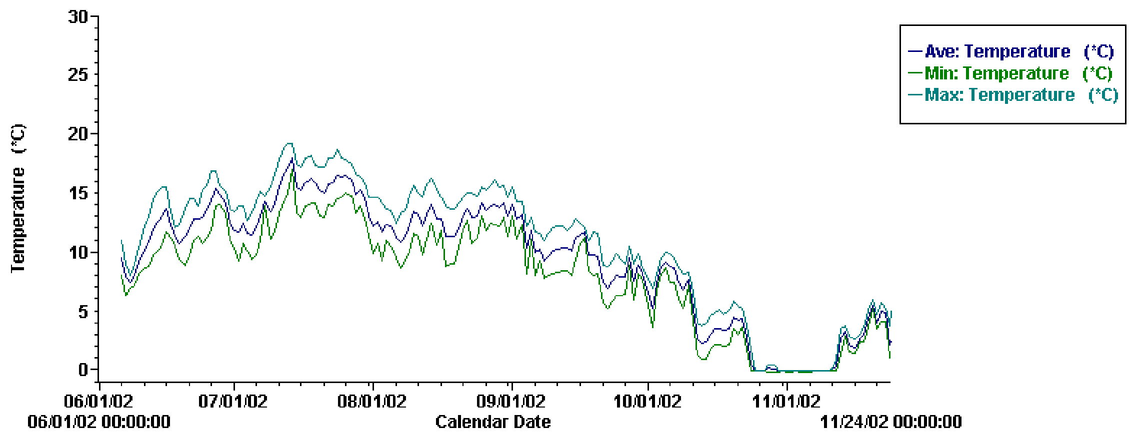

Figure 15. Mean, minimum, and maximum daily temperatures recorded on Little Deer Creek.

Table 21. Relative abundances (R.A.), mean total lengths (TL; ± SD), and size ranges of each species of fish collected in Little Deer Creek.

Reach	n	R. A. (%)	Mean TL (mm)	TL Range (mm)
1				
No Fish				
2				
No Fish				
3				
Rainbow trout	17	100.0	93 (± 16)	78-137
4				
Eastern brook trout	6	8.1	164 (± 17)	141-192
Rainbow trout	68	91.9	96 (± 36)	36-174
5				
Eastern brook trout	5	50.0	103 (± 25)	64-134
Rainbow trout	5	50.0	92 (± 26)	69-137
6				
Eastern brook trout	24	6.9	108 (± 37)	42-177
Rainbow trout	322	93.1	57 (± 17)	30-130
7				
Eastern brook trout	8	14.3	84 (± 18)	71-127
Rainbow trout	48	85.7	59 (± 15)	43-128
8				
Eastern brook trout	19	7.1	100 (± 32)	61-149
Rainbow trout	247	92.9	60 (± 24)	31-174
9				
Eastern brook trout	24	7.0	108 (± 37)	42-177
Rainbow trout	318	93.0	57 (± 17)	30-130
Total				
Eastern brook trout	62	8.1	107 (± 36)	42-192
Rainbow trout	707	91.9	63 (± 25)	30-174

Table 22. Population estimates (N), their corresponding standard error (SE) and 95% confidence intervals, and density estimates for each species of fish collected at each site in Little Deer Creek.

Reach	Site	N	SE	Lower 95% CI	Upper 95% CI	Density (#/100 m^2)
Eastern brook trout						
4	69	6	1.0541	6	6	5
5	64	5	0.5292	5	5	5
7	43	6	0.4714	6	6	5
7	44	2	0.0000	2	2	2
8	10	16	0.2652	16	16	11
8	21	3	0.7454	3	3	2
9	6	23	0.9683	23	23	14
Rainbow trout						
3	79	17	0.5391	17	17	13
4	69	59	1.7005	59	67	50
5	64	5	0.0000	5	5	5
6	60	4	0.6124	4	4	3
7	43	16	3.9691	15	37	14
7	44	24	0.9428	24	24	25
8	10	142	11.8203	129	178	94
8	21	40	8.5468	34	76	29
9	6	210	7.8136	201	234	131

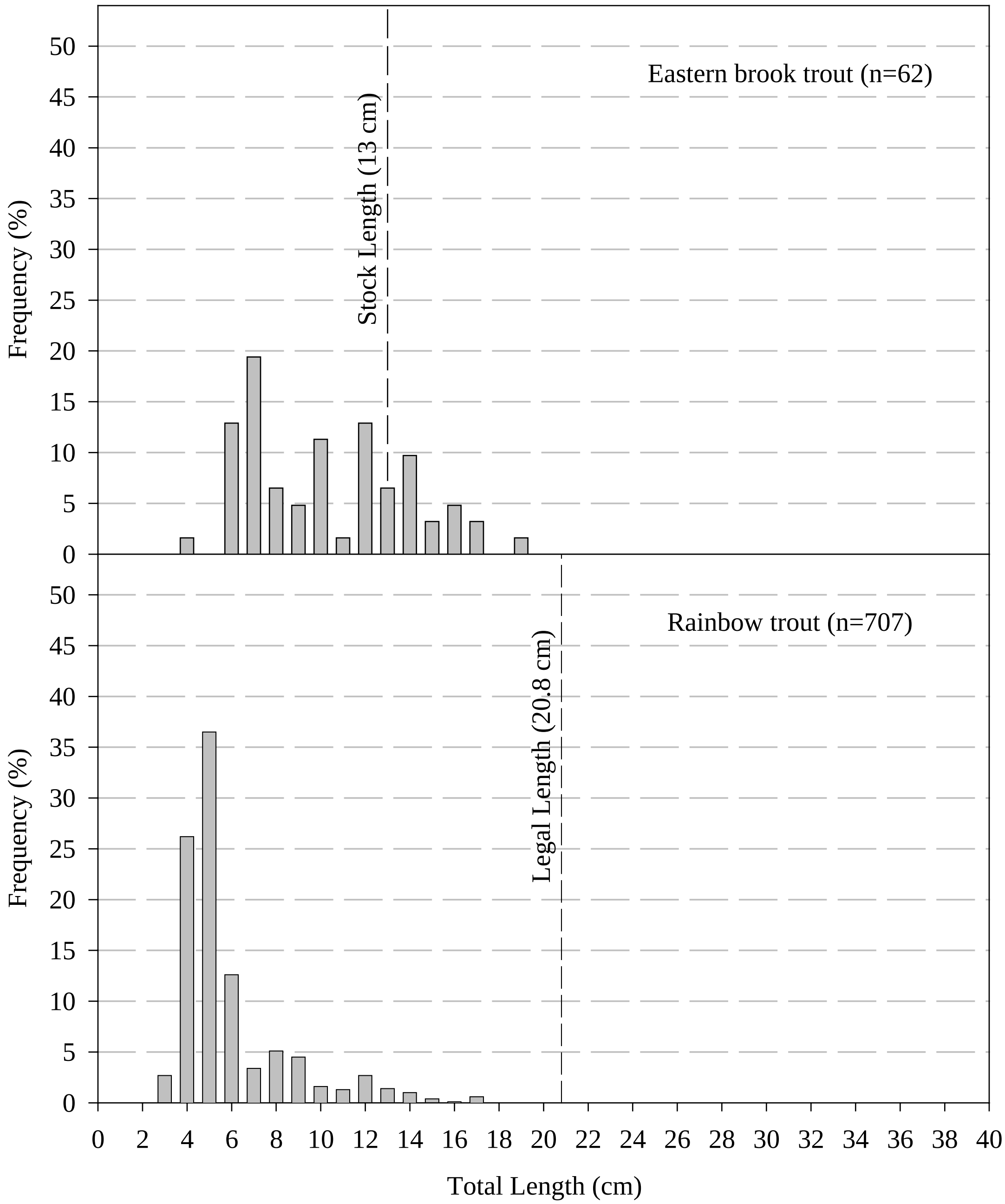

Figure 16. Length-frequency distributions of eastern brook and rainbow trout Little Deer Creek.

Spring Creek

Spring Creek was divided into 2 reaches that were sampled on July 18 (Figure 3; Appendix D). Two sites were surveyed (Figure 4; Appendix E). The mean of each habitat parameter was calculated for the stream, as well as each reach (Table 24; Appendix I). The mean wetted width was 3.8 m (SD=0.9) and the mean depth was 33 cm (SD=11) (Table 24). The dominant habitat and substrate types were run (100%) and sand (46%), respectively (Table 24).

Brown trout, eastern brook trout, rainbow trout, and sculpins were collected (n=273) (Table 25). Four sculpins, collected at site 3 (Reach 2), were preserved for identification. All were identified as mottled sculpins. Brook trout were the most abundant fish species, based on relative abundance (82.8%; n=226) (Table 25). The percentage of the brook trout population that was of stock length was 43.8% (n=98) (Figure 17).

Population estimates, their corresponding standard errors and 95% confidence intervals, and densities were calculated for brown trout, brook trout, rainbow trout, and sculpins (Table 26).

Table 23. Mean values (± SD) of habitat parameters measured and counted in Spring Creek.

Sample Sizes		**Riffle Habitat**	
No. Reaches	2	No. Riffles	0
No. Sections	2	Riffle Width (m)	-
No. Transects	27	Riffle Occurrence (%)	0
		Pool Habitat	
Transect Measurements		No. Pools	0
Wetted Width (m)	3.8 (± 0.9)	Pool Width (m)	-
Bankfull Width (m)	5.1 (± 1.2)	Pool Occurrence (%)	0
Depth (cm)	33 (± 11)	**Run Habitat**	
Maximum Depth (cm)	57 (± 19)	No. Runs	27
		Run Width (m)	3.8 (± 0.9)
Survey Section Measurements		Run Occurrence (%)	100
Gradient (%)	1.0 (± 0.0)		
Water Temperature (^{o}C)	10.0 (± 0.0)	**Substrate Composition (%)**	
Air Temperature (^{o}C)	21.0 (± 2.8)	Organic	14 (± 11)
No. LWD/100 m	8 (± 5)	Muck	19 (± 22)
No. PP/km	0 (± 0)	Silt	20 (± 18)
		Sand	46 (± 38)
Primary Pools (PP)		Gravel	0 (± 0)
No. PP	0	Cobble	0 (± 0)
PP Width (m)	-	Rubble	0 (± 0)
PP Length (m)	-	Boulder	0 (± 0)
PP Max. Depth (cm)	-	Bedrock	0 (± 0)
PP Residual Depth (cm)	-	Embeddedness (%)	100 (± 0)

Table 24. Relative abundances (R.A.), mean total lengths (TL; ± SD), and size ranges of each species of fish collected in Spring Creek.

Reach	n	R. A. (%)	Mean TL (mm)	TL Range (mm)
1				
Brown trout	1	0.8	180	180
Eastern brook trout	114	85.7	129 (± 38)	71-217
Rainbow trout	4	3.0	147 (± 15)	133-168
Sculpin spp.	14	10.5	81 (± 13)	62-102
2				
Eastern brook trout	112	80.0	100 (± 37)	57-204
Sculpin spp.	28	20.0	68 (± 13)	47-107
Total				
Brown trout	1	0.4	180	180
Eastern brook trout	226	82.8	115 (± 40)	57-217
Rainbow trout	4	1.5	147 (± 15)	133-168
Sculpin spp.	42	15.4	72 (± 14)	47-107

Table 25. Population estimates (N), their corresponding standard error (SE) and 95% confidence intervals, and density estimates for each species of fish collected at each site in Spring Creek.

Reach	Site	N	SE	Lower 95% CI	Upper 95% CI	Density (#/100 m^2)
Brown trout						
1	9	1	0.0000	1	1	<1
Eastern brook trout						
1	9	132	10.1361	121	164	40
2	3	120	4.9578	115	136	29
Rainbow trout						
1	9	4	0.0000	4	4	1
Sculpin						
1	9	20	10.1883	15	73	6
2	3	41	17.8307	29	123	10

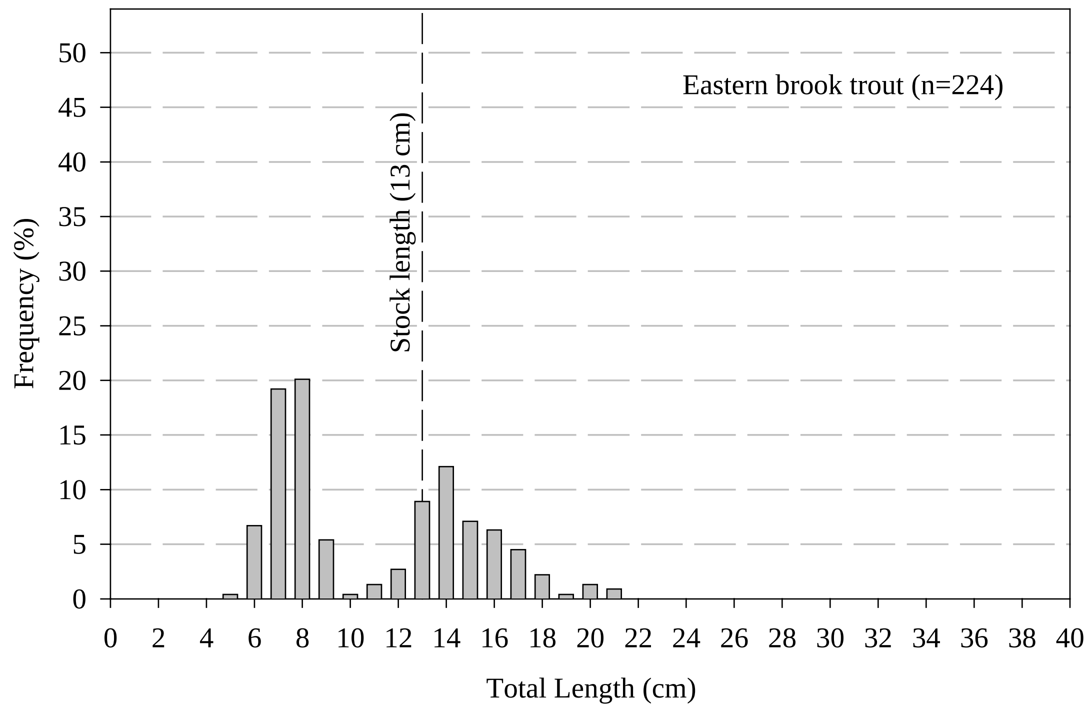

Figure 17. Length-frequency distribution of eastern brook trout in Spring Creek.

West Branch Dragoon Creek

West Branch Dragoon Creek was divided into 13 reaches that were sampled between August 26 and September 12 (Figure 3; Appendix D). A total of 16 sites were surveyed (Figure 3; Appendix E). The mean of each habitat parameter was calculated for the stream, as well as each reach (Table 27; Appendix J). The mean wetted width was 2.3 m (SD=1.5) and the mean depth was 25 cm (SD=17) (Table 27). The dominant habitat and substrate types were run (76%) and sand (39%), respectively (Table 27).

Daily average, maximum, and minimum temperatures of West Branch Dragoon Creek were determined (Figure 18). The mean temperature was 10.73 (SD=5.50) °C, with a maximum of 20.49 °C on July 12 and a minimum of –0.06 °C on October 26, 27, 30, 31 and November 1-5. The mean temperature of West Branch Dragoon Creek between June 6 and October 28, the same time period monitored in 2001, was 12.31 (SD=4.39) °C.

Nine species of fish were collected in the West Branch Dragoon Creek: brown trout, brook trout, rainbow trout, chiselmouth, longnose dace, redside shiner, speckled dace, bridgelip sucker, and sculpin (n=2,197) (Table 28). Seven sculpins, three from site 66 (Reach 9), and four from site 1 (Reach 14), were preserved for identification. All three from site 66 were identified as mottled sculpins. Three of the four from site 1 were identified as torrent sculpins and the fourth was a mottled sculpin. Speckled dace were the most abundant fish species, based on relative abundance (33.6%; n=739) (Table 28). Eastern brook trout were the most abundant sport fish species, based on relative abundance (8.2%; n=180) (Table 28). The percentage of the eastern brook trout population that was of stock length was 57.2% (n=103) (Figure 19). The percentages of brown and rainbow trout populations that were of legal length for harvest was 80.0% (n=4) and 1.9% (n=3), respectively.

Population estimates, their corresponding standard errors and 95% confidence intervals, and densities were calculated for brown trout, brook trout, rainbow trout, chiselmouth, longnose dace, redside shiner, speckled dace, bridgelip sucker, and sculpin (Table 29).

Table 26. Mean values (± SD) of habitat parameters measured and counted in West Branch Dragoon Creek.

Sample Sizes		**Riffle Habitat**	
No. Reaches	13	No. Riffles	36
No. Sections	16	Riffle Width (m)	2.4 (± 1.4)
No. Transects	236	Riffle Occurrence (%)	15
		Pool Habitat	
Transect Measurements		No. Pools	21
Wetted Width (m)	2.3 (± 1.5)	Pool Width (m)	3.8 (± 1.8)
Bankfull Width (m)	4.6 (± 2.2)	Pool Occurrence (%)	9
Depth (cm)	25 (± 17)	**Run Habitat**	
Maximum Depth (cm)	42 (± 27)	No. Runs	181
		Run Width (m)	2.1 (± 1.3)
Survey Section Measurements		Run Occurrence (%)	76
Gradient (%)	1.1 (± 0.2)		
Water Temperature (^{o}C)	11.6 (± 1.7)	**Substrate Composition (%)**	
Air Temperature (^{o}C)	21.9 (± 4.3)	Organic	5 (± 15)
No. LWD/100 m	15 (± 11)	Muck	10 (± 23)
No. PP/km	12 (± 13)	Silt	32 (± 31)
		Sand	39 (± 37)
Primary Pools (PP)		Gravel	4 (± 11)
No. PP	19	Cobble	8 (± 18)
PP Width (m)	4.6 (± 1.5)	Rubble	1 (± 4)
PP Length (m)	7.4 (± 2.8)	Boulder	0 (± 2)
PP Max. Depth (cm)	85 (± 27)	Bedrock	0 (± 0)
PP Residual Depth (cm)	63 (± 20)	Embeddedness (%)	90 (± 19)

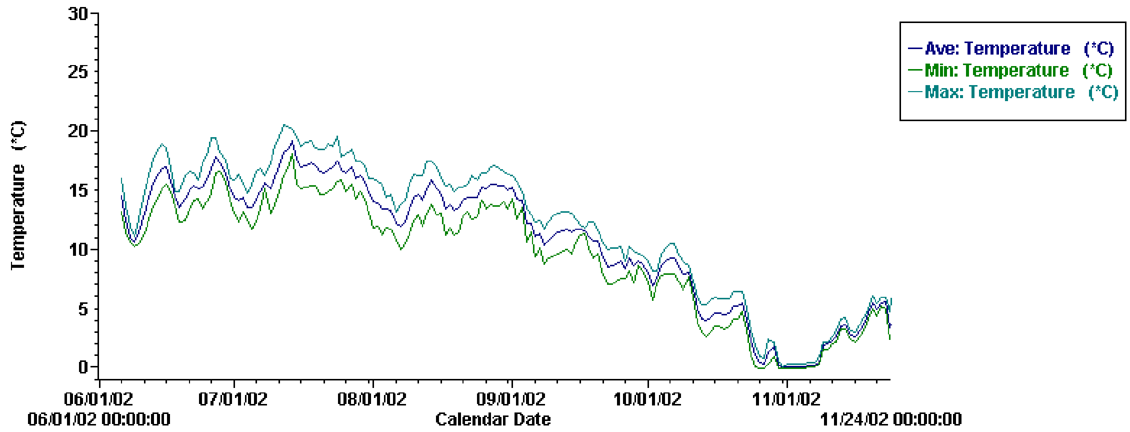

Figure 18. Mean, minimum, and maximum daily temperatures recorded on West Branch Dragoon Creek.

Table 27. Relative abundances (R.A.), mean total lengths (TL; ± SD), and size ranges of each species of fish collected in West Branch Dragoon Creek.

Reach	n	R. A. (%)	Mean TL (mm)	TL Range (mm)
1				
Eastern brook trout	7	25.0	140 (± 25)	115-185
Speckled dace	21	75.0	64 (± 7)	47-83
2				
Eastern brook trout	137	56.1	134 (± 32)	61-208
Speckled dace	107	43.9	61 (± 8)	46-86
3				
Not Sampled				
4				
Eastern brook trout	7	3.3	193 (±30)	149-244
Redside shiner	117	54.9	72 (± 19)	22-114
Speckled dace	76	35.7	56 (± 11)	29-80
Bridgelip sucker	13	6.1	112 (± 36)	62-154
5				
Eastern brook trout	2	0.7	202 (± 36)	176-227
Redside shiner	77	27.0	68 (± 21)	27-111
Speckled dace	139	48.8	54 (± 14)	26-89
Bridgelip sucker	67	23.5	81 (± 43)	26-154
6				
Redside shiner	66	50.8	76 (± 18)	28-116
Speckled dace	57	43.8	62 (± 9)	35-88
Bridgelip sucker	7	5.4	100 (± 30)	68-163
7				
Redside shiner	70	22.0	79 (± 20)	27-122
Speckled dace	198	62.3	51 (± 10)	29-80
Bridgelip sucker	50	15.7	63 (± 37)	33-158
8				
Speckled dace	61	100.0	58 (± 13)	31-86
9				
Rainbow trout	1	11.1	197	197

Table 27. Continued.

Reach	n	R. A. (%)	Mean TL (mm)	TL Range (mm)
Chiselmouth	1	11.1	NL	-
Redside shiner	1	11.1	90	90
Speckled dace	3	33.3	59 (± 7)	52-65
Sculpin spp.	3	33.3	73 (± 18)	57-93
10				
Brown trout	1	0.8	234	234
Eastern brook trout	1	0.8	109	109
Rainbow trout	35	26.5	76 (± 9)	55-92
Redside shiner	3	2.3	70 (± 1)	69-71
Speckled dace	34	25.8	66 (± 11)	40-89
Sculpin spp.	58	43.9	75 (± 14)	59-123
11				
Brown trout	1	0.9	92	92
Eastern brook trout	1	0.9	218	218
Rainbow trout	18	16.8	108 (± 59)	62-257
Speckled dace	25	23.4	51 (± 11)	32-77
Sculpin spp.	62	57.9	73 (± 19)	32-121
12				
Brown trout	2	2.0	232 (± 4)	229-234
Rainbow trout	25	24.5	103 (± 28)	69-177
Longnose dace	2	2.0	88 (± 4)	85-91
Redside shiner	26	25.5	74 (± 7)	60-89
Speckled dace	13	12.7	35 (± 3)	30-42
Bridgelip sucker	1	1.0	161	161
Sculpin spp.	33	32.4	67 (± 20)	35-124
13				
Eastern brook trout	4	2.3	158 (± 54)	106-222
Rainbow trout	38	22.0	115 (± 49)	63-264
Longnose dace	2	1.2	85 (± 13)	76-94
Bridgelip sucker	1	0.6	115	115
Sculpin spp.	128	74.0	70 (± 18)	35-125
14				
Brown trout	1	0.3	210	210
Eastern brook trout	21	5.3	180 (± 57)	110-275
Rainbow trout	37	9.4	95 (± 33)	65-204
Longnose dace	2	0.5	87 (± 13)	77-96
Redside shiner	231	58.5	74 (± 18)	33-129
Speckled dace	5	1.3	60 (± 11)	41-71
Bridgelip sucker	18	4.6	89 (± 27)	34-145
Sculpin spp.	80	20.3	74 (± 23)	32-143
Total				
Brown trout	5	0.2	200 (± 61)	92-234
Eastern brook trout	180	8.2	143 (± 40)	61-275
Rainbow trout	154	7.0	99 (± 40)	55-264
Chiselmouth	1	<0.1	NL	-
Longnose dace	6	0.3	87 (± 9)	76-96
Redside shiner	591	26.9	74 (± 19)	22-129
Speckled dace	739	33.6	56 (± 12)	26-89
Bridgelip sucker	157	7.1	80 (± 41)	26-163
Sculpin spp.	364	16.6	72 (± 19)	32-143

Table 28. Population estimates (N), their corresponding standard error (SE) and 95% confidence intervals, and density estimates for each species of fish collected at each site in West Branch Dragoon West Branch Dragoon Creek.

Reach	Site	N	SE	Lower 95% CI	Upper 95% CI	Density (#/100 m^2)
Brown trout						
10	59	1	0.0000	1	1	<1
11	39	1	0.0000	1	1	<1
14	1	1	0.0000	1	1	<1
Eastern brook trout						
1	142	2	0.0000	2	2	2
1	143	5	0.0000	2	2	4
2	121	40	3.6566	38	55	35
2	134	107	4.9139	103	124	96
5	92	2	0.0000	2	2	1
13	5	4	0.6124	4	4	1
14	1	21	1.3550	21	30	4
Rainbow trout						
9	66	1	0.0000	1	1	<1
10	59	39	4.2214	36	56	16
11	39	15	0.5812	15	15	4
11	46	3	0.7454	3	3	1
12	26	29	5.1111	26	52	6
13	5	40	3.0124	39	54	8
14	1	50	12.3670	40	99	10
Chiselmouth						
9	66	1	0.0000	1	1	<1
Longnose dace						
13	5	2	0.0000	2	2	<1
14	1	2	0.3844	2	2	<1
Redside shiner						
4	98	145	23.7106	118	220	68
5	92	77	10.0698	68	113	58
6	87	71	6.1772	65	93	28
7	81	69	5.3889	64	88	26
9	66	1	0.0000	1	1	<1
12	26	32	7.2284	27	64	7
14	1	223	4.5108	218	236	44
Speckled dace						
1	143	19	2.2686	19	31	17
4	98	51	3.0201	49	63	24
5	92	173	75.9564	107	468	130
6	87	56	3.5821	53	70	22
7	81	126	13.4422	111	169	48
8	72	59	13.3324	49	112	31
9	66	3	0.7454	3	3	1
11	39	3	0.7454	3	3	1
Bridgelip sucker						
4	98	22	16.4838	14	110	10
5	92	67	26.8063	47	180	50
7	81	16	3.9691	15	37	6
Sculpin						
9	66	3	0.7454	3	3	1
11	39	40	12.4924	31	95	11

Table 28. Continued.

Reach	**Site**	**N**	**SE**	**Lower 95% CI**	**Upper 95% CI**	**Density (#/100 m^2)**
11	46	44	29.6750	28	191	18
13	5	170	45.2502	124	326	36

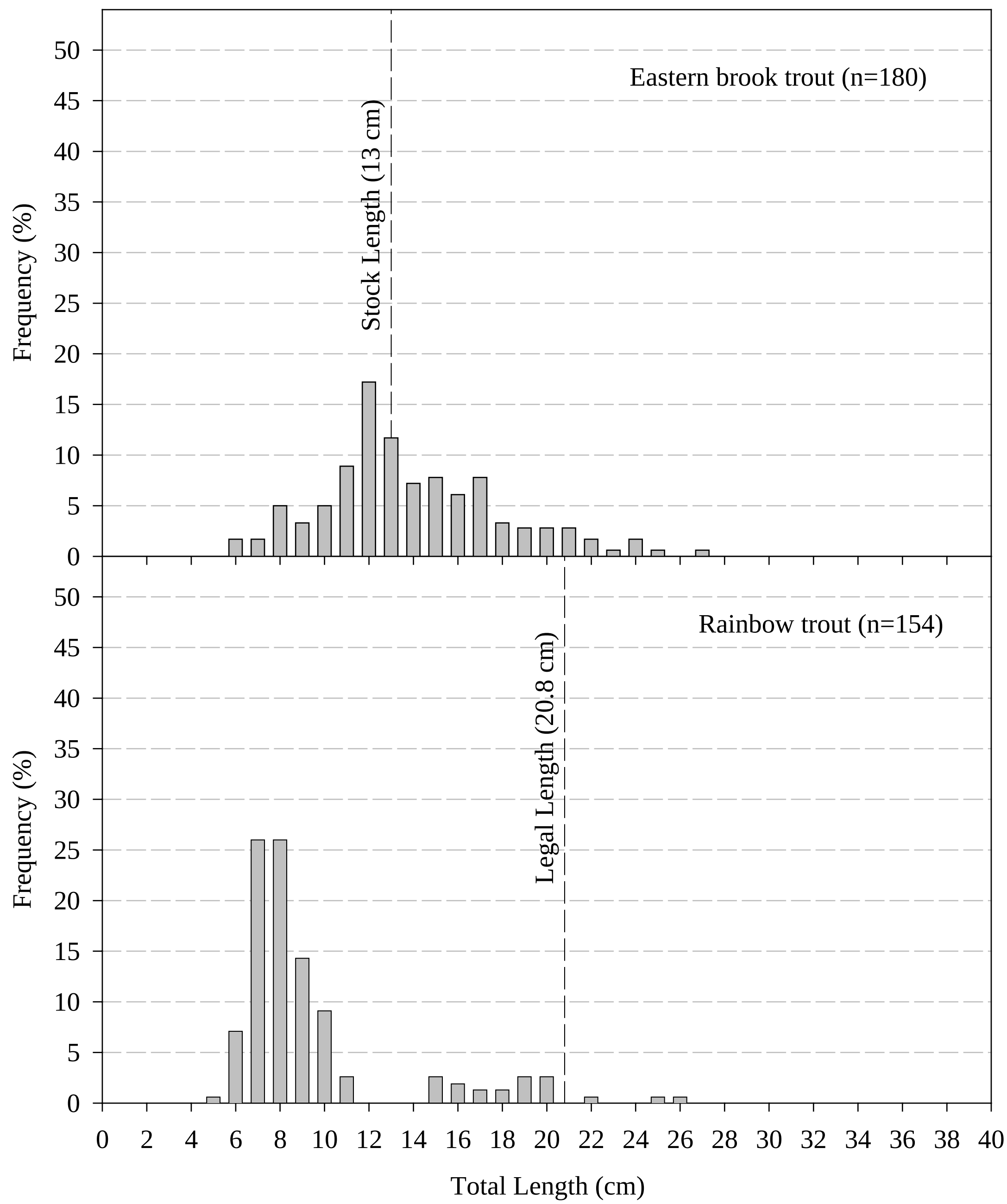

Figure 19. Length-frequency distributions of eastern brook and rainbow trout in the West Branch Dragoon Creek.

Other Streams

Daily average, maximum, and minimum temperatures of Dartford, lower and upper Deadman, and Little Deep Creeks, the Little Spokane River at its mouth, Indian Painted Rocks, Wandermere, Elk, and Scotia were determined (Figures 20 through 28). The thermograph set at Chattaroy was not recovered. The mean temperature of Dartford Creek was 10.57 (SD=3.40) °C, with a maximum of 16.73 °C on July 12 and a minimum of 0.69 °C on November 1. The mean temperature between June 6 and October 28, the same time period monitored in 2001, was 11.51 (SD=2.70) °C.

The mean temperature of lower Deadman Creek was 11.55 (SD=4.23) °C, with a maximum of 20.96 °C on July 12 and a minimum of –0.12 °C on October 26, 27, and 30. The mean temperature of upper Deadman Creek was 7.63 (SD=3.82) °C, with a maximum of 15.79 °C on July 13 and a minimum of –0.46 °C on October 29-31.

The mean temperature of Little Deep Creek was 10.76 (SD=4.57) °C, with a maximum of 20.49 °C on June 26 and a minimum of –0.16 °C on November 1. The mean temperature between June 6 and October 28, the same time period monitored in 2001, was 12.05 (SD=3.70) °C.

The mean temperature of the Little Spokane River at its mouth was 12.33 (SD=3.35) °C, with a maximum of 19.24 °C on July 12 and a minimum of 4.88 °C on November 1-3. The mean temperature at the mouth between June 6 and October 28, the same time period monitored in 2001, was 13.29 (SD=2.70) °C. The mean temperature of the Little Spokane River at the Indian Painted Rocks was 12.08 (SD=3.13) °C, with a maximum of 18.73 °C on July 12 and a minimum of 3.13 °C on November 1-2. The mean temperature of the Little Spokane River at Wandermere was 13.10 (SD=4.86) °C, with a maximum of 22.38 °C on July 13 and a minimum of 2.80 °C on October 31. The mean temperature at Wandermere between June 6 and October 28, the same time period monitored in 2001, was 14.5 (SD=3.88) °C. The mean temperature of the Little Spokane River at Elk was 13.90 (SD=6.25) °C, with a maximum of 25.79 °C on July 12 and a minimum of 0.74 °C on November 1. The mean temperature at Elk between June 6 and October 28, the same time period monitored in 2001, was 15.83 (SD=4.73) °C. The mean temperature of the Little Spokane River at Scotia was 10.66 (SD=4.41) °C, with a maximum of 21.19 °C on July 12 and a minimum of 0.09 °C on November 1.

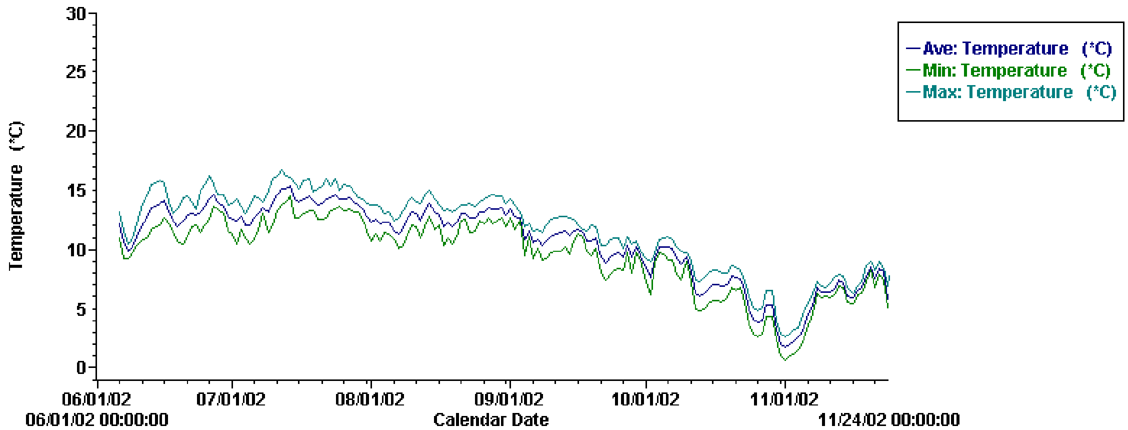

Figure 20. Mean, minimum, and maximum daily temperatures recorded on Dartford Creek.

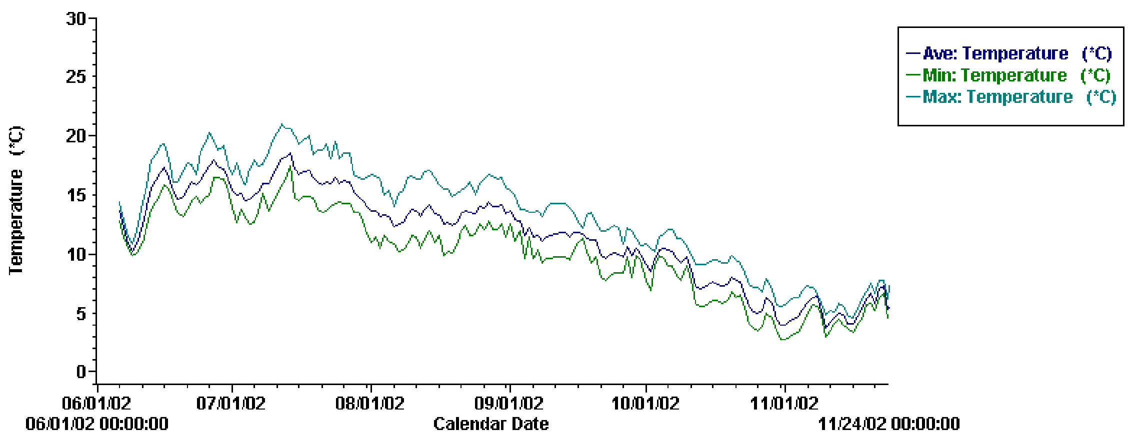

Figure 21. Mean, minimum, and maximum daily temperatures recorded on lower Deadman Creek.

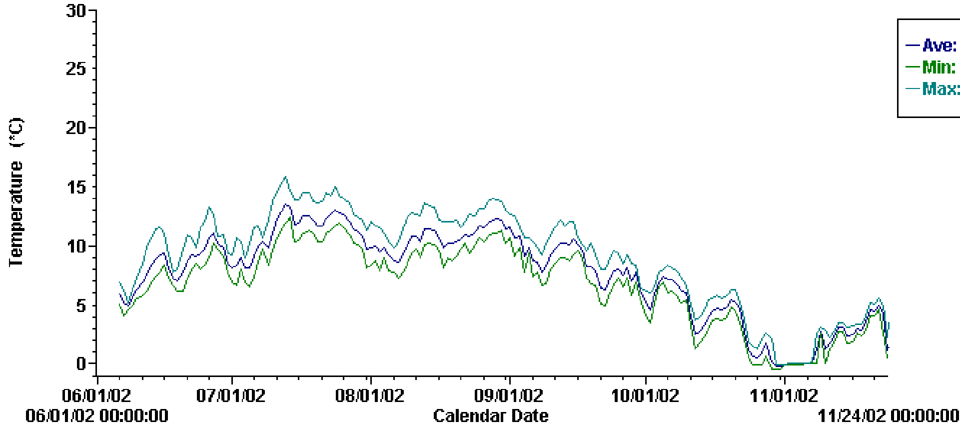

Figure 22. Mean, minimum, and maximum daily temperatures recorded on upper Deadman Creek.

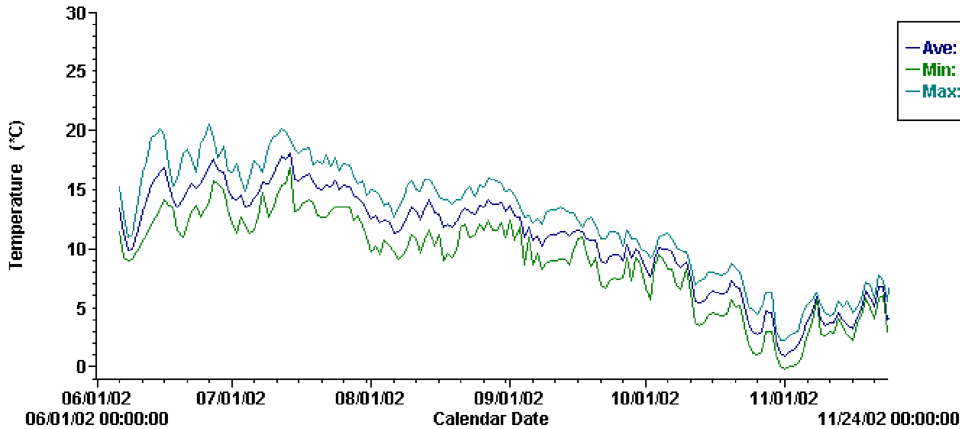

Figure 23. Mean, minimum, and maximum daily temperatures recorded on Little Deep Creek.

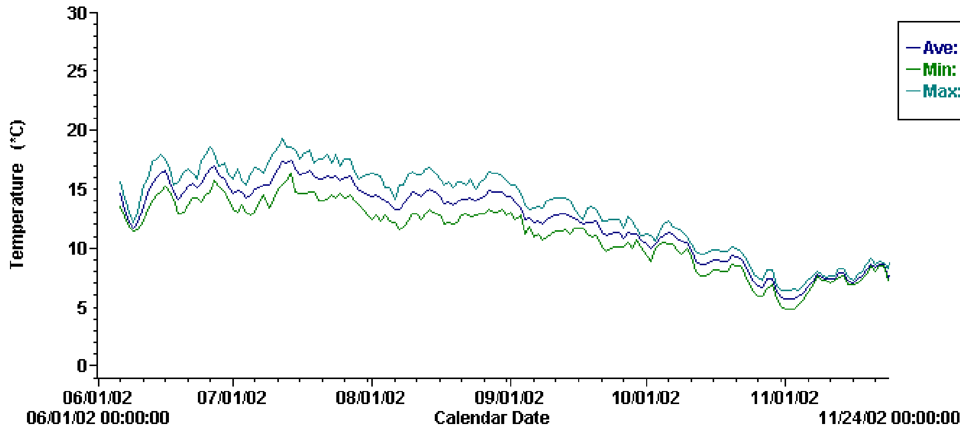

Figure 24. Mean, minimum, and maximum daily temperatures recorded on the Little Spokane River at the mouth.

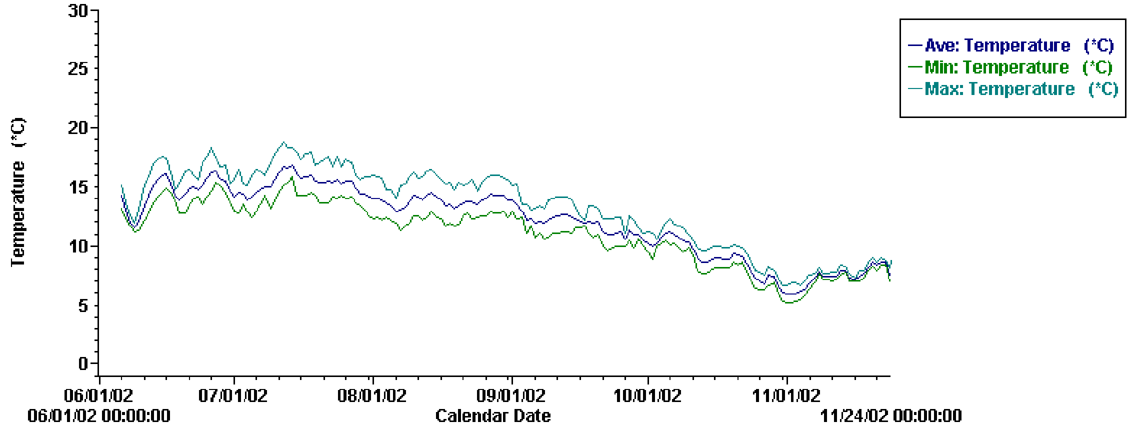

Figure 25. Mean, minimum, and maximum daily temperatures recorded on the Little Spokane River at Indian Painted Rocks.

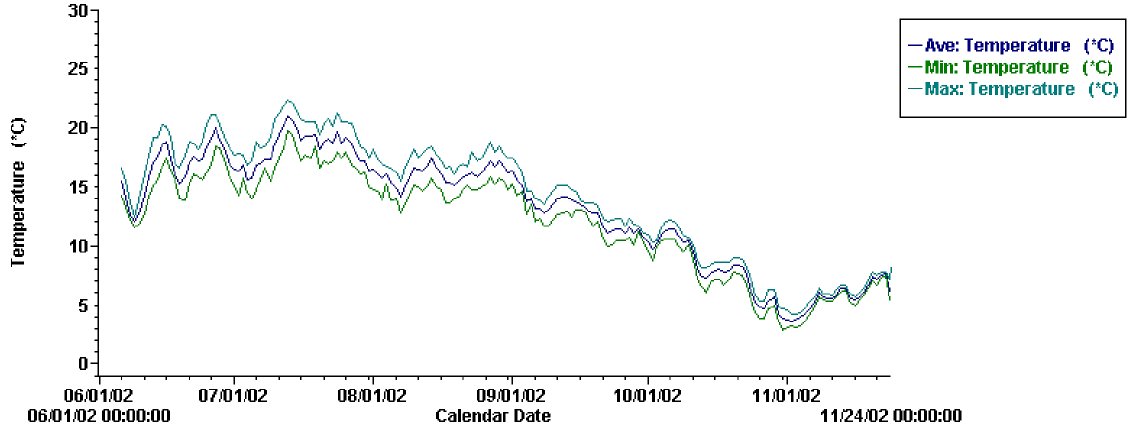

Figure 26. Mean, minimum, and maximum daily temperatures recorded on the Little Spokane River at Wandermere.

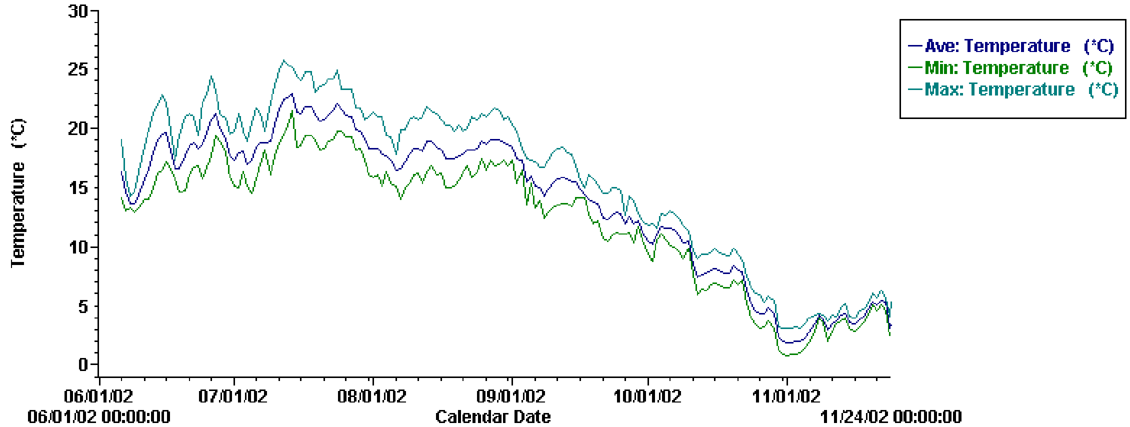

Figure 27. Mean, minimum, and maximum daily temperatures recorded on the Little Spokane River at Elk.

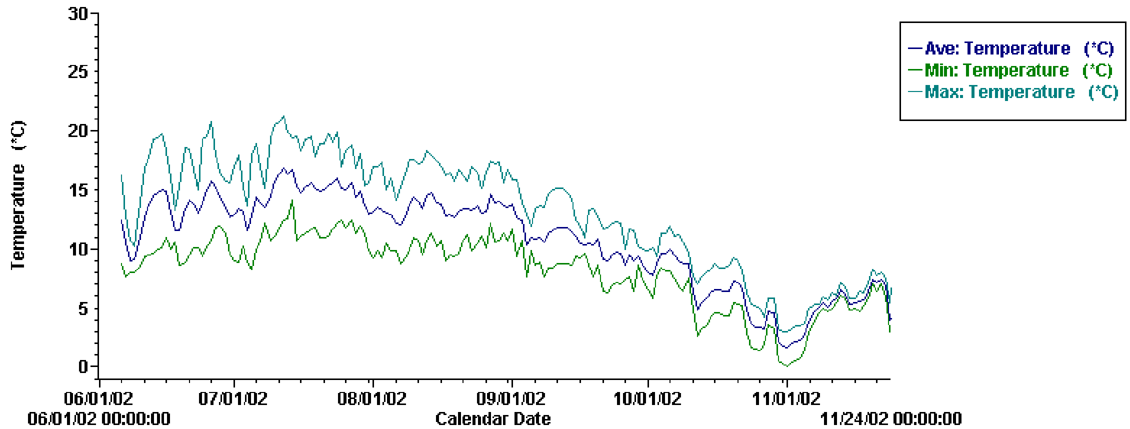

Figure 28. Mean, minimum, and maximum daily temperatures recorded on the Little Spokane River at Scotia.

Population Characterization with DNA Analysis

The rainbow trout populations in Dragoon Creek, Little Deer Creek, West Branch Dragoon Creek, and the middle Spokane River were sampled for microsatellite DNA analysis. Fin tissue samples were collected from 47 wild rainbow trout captured in the middle Spokane River. Twenty-five of the fish were from the free-flowing section and 22 were from Nine Mile Reservoir. Fin tissue samples were collected from a total of 150 individuals from Dragoon Creek. The samples were divided into two collections: upper (50 samples), which were from sites upstream of RKM 19 (site 190), and lower (100 samples), which were from sites downstream of RKM 19. Samples were obtained from fish (mean TL=185 mm; SD=53) at all of the sites sampled except 63, 104, 120, 241, 253, and 295. Fin tissue samples were collected from a total of 50 individuals (mean TL=119 mm; SD=29) from sites 9, 10, 21, 43, 44, 64, 69, and 79 on Little Deer Creek. Fin tissue samples were collected from a total of 50 individuals (mean TL=150 mm; SD=50) from sites 1, 5, 7, 26, 39, 46, 59, and 66 on West Branch Dragoon Creek.

The DNA results are summarized briefly here, but for a more detailed report see Appendix L. The results of the DNA analysis indicated that each of the 11 populations examined to date (those in this report, as well as the 2001 collections) comprised distinct subpopulations (Hypothesis 1: rejected). The second hypothesis, that the populations are indistinguishable from one or more hatchery strains, was also rejected. Hypothesis 3, that the populations were the redband subspecies and not the coastal subspecies was accepted for Phalon

Lake, and Deadman (Kettle River tributary), Little Deer, Deer, and Otter Creeks. However, Hypothesis 3 was rejected for the Spokane Hatchery stock, as well as Buck, upper Dragoon, lower Dragoon, and West Branch Dragoon Creeks. The data on the Spokane River sample was too limited to allow for accurate assignment.

The consensus neighbor-joining tree showed the likely relationships between the subpopulations that were examined (Appendix L). Buck Creek and Spokane Hatchery stock were closely related suggesting a strong coastal influence in the Buck Creek population (Appendix L). Little Deer, Deer, and Otter Creeks more closely related to the redband reference populations (Phalon Lake and Deadman Creek) than the coastal reference population (Spokane Hatchery stock), suggesting they were interior redband rainbow trout. The Dragoon Creek subpopulations were more closely related to the coastal group than the redband group, suggesting substantial coastal influence. The Spokane River group did not fit well with any of the other groups, suggesting the influence of several subpopulations.

Discussion

Spokane River

The fish species composition was less diverse in the free-flowing portion of the middle Spokane River when compared to Nine Mile Reservoir. There were seven species of fish collected in the riverine section while 16 species were collected in the reservoir. All of the species captured in the river were also captured in reservoir, with the exception of longnose dace. The dominant species were relatively similar in both sections. Bridgelip suckers had the highest boat electrofishing CPUE in the free-flowing section, gill net CPUE's in the reservoir, and relative abundance in both sections. Rainbow trout had the highest CPUE (all gear types) and relative abundance of the sport fish collected in the reservoir. Rainbow trout also had the highest relative abundance in the free-flowing section, tied with mountain whitefish; however, mountain whitefish had a higher CPUE. Redside shiners had a low CPUE in the riverine section, but had the highest boat electrofishing CPUE in the reservoir.

The species composition in the free-flowing stretch of the middle Spokane River in 2002 was different than those described in most previous studies. Unlike the survey by Pfeiffer (1985), few juvenile fish were collected in 2002. Kleist (1987) collected five species of fish in the riverine stretch, which was similar to the seven captured in 2002. However, unlike this study, Kleist (1987) captured brown trout and cutthroat trout, but no bridgelip suckers or longnose dace and rainbow trout were captured three times more often than non-game species. Peden (1987) captured several species of fish near the mouth of Latah Creek that were not observed in 2002, including: chiselmouth, speckled dace, Umatilla dace, and redside shiners. Johnson (1993) reported suckers were the most abundant fish collected and rainbow trout and mountain whitefish were relatively abundant near TJ Meenach Bridge, similar to this study, but they also captured brown trout, white sturgeon, and chiselmouth, which were not collected in 2002. Unlike the other studies, Maret (1999) collected all of the species observed in 2002, except longnose dace, and the relative abundance values were also relatively similar.

The lack of brown trout in the 2002 survey may have been the result of discontinued stocking by WDFW in 1994 (WDFW, unpublished hatchery records). Brown trout were planted in the middle Spokane River in 2002, but the stocking location was 4.3 km downstream of the lowest riverine survey site. The single cutthroat trout in 1987 was likely entrained from Lake Coeur d'Alene. Mountain whitefish were captured in the last riffle of the free-flowing section by boat electrofishing, but not in the hook-and-line surveys (Kleist 1987). The fact that they were present in relatively high numbers in the stretch above T.J. Meenach Bridge suggested that the previous hook-and-line surveys were not selective for mountain whitefish. The differences between all of the surveys were likely the result of sampling bias or random chance. Results obtained by seining were likely biased toward collecting small fish near shore and angling was biased towards larger fish (dependent on hook size) that were attracted to the specific flies, lures, or bait used. Boat electrofishing was biased towards larger fish than seining and habitats where the boat could access. Backpack electrofishing, the method used by Peden (1987), would have been limited to wadeable areas, which may not have been occupied by the same species or in the same densities as non-wadeable areas. Due to the small amount of effort expended in the free-flowing river it would be expected that species present in low densities would only be captured occasionally.

The species composition and densities of fish in Nine Mile Reservoir in 2002 were different than was described in previous studies. There were 16 species of fish collected in 2002 compared to two in 1985, nine in 1987, and eight in 1990-1992 (Pfeiffer 1985; Kleist 1987; Smith 1992; Johnson 1993). Species captured in 2002 that were not present in previous studies were black crappie, pumpkinseed, largemouth bass, and sculpins. Longnose suckers and kokanee were reportedly collected in 1990-1992 (Smith 1992). Cutthroat trout and northern pike were reported to occur in the reservoir (Smith and Johnson 1992); however, none of the previous investigators recorded collecting either of these species in the reservoir. Cutthroat trout have been collected in the free-flowing stretch below Monroe Street Dam (Kleist 1987) and northern pike inhabit Lake Coeur d'Alene, so it is possible that individuals of these species may occasionally entrain in to Nine Mile Reservoir.

The species composition observed in the reservoir in 1985 was 50% unidentified suckers and 50% northern pikeminnow (Pfeiffer 1985). The 1985 survey was not representative due to limited effort, which consisted of two gill net sets (2 hours each). A better representation of the reservoir was obtained in 1987, when nine species of fish were collected (Kleist 1987). Similar to our results in 2002, Kleist (1987) reported that bridgelip suckers had the highest relative abundance. Unlike our results, redside shiners and rainbow trout had low relative abundances and CPUE's (Kleist 1987). Differences in the species composition may have been related to effort. Kleist (1987) expended twice the electrofishing effort (6.0 hours) than was completed in

2002 (3.0 hours). However, gill net effort in 1987 was 5.0 hours (Kleist 1987), compared to 278.3 hours for littoral gill nets and 195.0 hours for pelagic gill nets in 2002. The observed differences may have also been the result of actual changes in the species composition. Redside shiners were most abundant in 2002 electrofishing surveys, so if they were present in equal densities in 1987 similar results would have been expected.

The differences in CPUE and relative abundance between the 1991-1992 and the 2002 studies could not be evaluated because effort and catch by gear type were not provided. However, the species composition (species captured) in 1991-1992 was similar to that observed by Kleist (1987), suggesting that there were differences in sampling strategies compared to 2002 or the species composition has changed. Smith (1992) and Johnson (1993) reported catching a kokanee and longnose suckers in the reservoir, which were not observed in 2002. The kokanee was likely entrained from Lake Coeur d'Alene and their densities in the reservoir were so low that they were not collected in 2002 due to random chance. The longnose suckers were likely misidentified largescale suckers. The 1991-1992 study was the only report of longnose suckers in Nine Mile Reservoir (Smith 1992; Johnson 1993). They reported collecting several hundred individuals, so it was unlikely that other investigators before or after them missed them in their collections. In addition they did not report collecting any largescale suckers, which had relatively high densities in this and other surveys (Kleist 1987; Maret 1999).

Few brown trout were captured in the reservoir despite a plant of 2,000 catchable size fish (208 to 305 mm; 8 to 12 inch) in the spring of 2002. Three of the five brown trout captured were identified as hatchery fish due to the presence of deformed dorsal fins and their sizes (250-272 mm TL). The hatchery brown trout catch may have been low because they may not have recruited to the sampling gear or they may have left the population due to predation, entrainment, or emigration to the free-flowing section. Predators, such as northern pikeminnow, were present in the reservoir, but their impacts on stocked fish have not been quantified. Predators in other systems have been documented preying on stocked salmonids at the release site. Walleye were observed eating recently planted rainbow trout and kokanee in the Spokane River Arm of Lake Roosevelt (EWU, unpublished data). Walleye preyed on hatchery kokanee and rainbow trout at the time of their release from a Lake Roosevelt associated hatchery (Baldwin et al., in press). With relatively short retention times, it was conceivable that many fish may have been "flushed out" of the Nine Mile Reservoir. Entrainment losses from Nine Mile Reservoir have not been quantified. The assessment of the riverine section was limited to a single day and small percentage of the river, but no brown trout were collected in the stretch surveyed. Research should be conducted to evaluate the success of hatchery trout plants in Nine Mile Reservoir.

The presence of multiple age classes of wild rainbow trout suggests that some natural reproduction is occurring in the middle Spokane River system. Kleist (1987) concluded that spawning habitat in the Spokane River was limited and recruitment was low. Tributary spawning was not considered in the 1987 study. The Coeur d'Alene Tribe has observed large (approx. 500 mm TL) rainbow trout in the headwaters of Latah Creek (R. Peters, Coeur d'Alene Tribe, personal communication). These fish were thought to have migrated up from the Spokane River to spawn, although no spawning activity was observed.

The wild rainbow trout in the middle Spokane River may have also originated from fish entrained from the upper river. Entrainment has not been documented for rainbow trout, but it has with other species of salmonids. Jaw tagged brown trout from the upper river (Idaho) have been captured below Long Lake and Little Falls Dams (EWU, unpublished data). Chinook and kokanee salmon presumably from Lake Coeur d'Alene have been collected in Nine Mile Reservoir (Smith 1992; WDFW unpublished data; this study), Lake Spokane Reservoir (Osborne et al. 2003), Little Falls Reservoir, and the Spokane Arm of Lake Roosevelt (EWU, unpublished data). Preliminary microsatellite DNA analysis results indicated the rainbow trout population in the middle Spokane River is comprised of individuals representing multiple stocks (Appendix L). Additional research should be conducted to determine the origin(s) of the wild rainbow trout in the middle Spokane River.

Growth of free-flowing middle Spokane River and Nine Mile Reservoir rainbow trout was good when compared to rainbow trout from other northwest rivers and reservoirs (Table 30). First year growth appeared to be moderate, but growth in subsequent years was relatively high and comparable to rivers generally considered high quality trout streams, such as the Madison River. Condition factors (K_{TL}) of rainbow trout from the middle Spokane River were average when compared to those from other northwest rainbow trout populations (Table 32).

Mountain whitefish growth in the free-flowing stretch of the middle Spokane River was high when compared to other northwest populations (Table 31). The oldest mountain whitefish collected in the Spokane River was age 5, unlike the other northwest populations that have individuals from age 6 to age 8 (Table 31). The condition factor of mountain whitefish in the Spokane River was between those reported for Pend Oreille River reservoirs (Table 33).

Table 29. Comparison of mean back-calculated total lengths (mm) of rainbow trout in northwest rivers and reservoirs.

		Mean Total Length (mm) at Each Annulus						
Location	**n**	**1**	**2**	**3**	**4**	**5**	**6**	**Source**
Missouri River, MT	478	81	201	282	343	404	421	Carlander (1969)
Madison River, WY	125	127	244	356	417			Carlander (1969)
Snake River, ID	80	130	257	353	462	495		Carlander (1969)
Lake Roosevelt, WA 1997	35	136	248	332	367			Cichosz et al. (1999)
Box Canyon Reservoir, WA 1988-90	29	96	156	256	369	538	817	Ashe and Scholz (1992)
Boundary Reservoir, WA 2000	15	91	186	291	391	526	614	McLellan (2001)
Spokane River, WA/ID 1985[1]	189	165	262	329	379	404		Underwood and Bennett (1992)
Spokane River, WA/ID 1986[1]	84	149	238	328	397			Underwood and Bennett (1992)
Spokane River/Nine Mile Reservoir, WA 1987	36	123	219	318	397			Kleist (1987)
Spokane River, WA 2002	24	116	277	342				Current study
Nine Mile Reservoir, WA 2002	20	110	267	349	402			Current study

[1]Converted from fork length (FL) using the equation TL=1.071FL (Carlander 1969).

Table 30. Comparison of mean back-calculated total lengths (mm) of mountain whitefish in northwest rivers and reservoirs.

		Mean Total Length (mm) at Each Annulus								
Location	**n**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Source**
Montana Reservoirs	232	86	183	246	290	312	335	351	371	Carlander (1969)
Montana Rivers	1,212	86	180	246	292	328	353	368	419	Carlander (1969)
Madison River, WY	36	130	226	305	348	388	429			Carlander (1969)
Box Canyon Reservoir, WA 1988-90	1,540	149	206	250	285	341	381	413	435	Ashe and Scholz (1992)
Boundary Reservoir, WA 2000	35	75	177	248	278	317	324	343		McLellan (2001)
Spokane River, WA 2002	24	175	278	316	345					Current study
Nine Mile Reservoir, WA 2002	11	164	253	304	328	352				Current study

Table 31. Comparison of rainbow trout condition factors (K_{TL}) from northwest rivers and reservoirs.

Location	n	K_{TL}	Source
Deer Lake, WA 1985	32	1.08	Scholz et al. (1988)
Loon Lake, WA 1985	15	0.93	Scholz et al. (1988)
Box Canyon Reservoir, WA 1988-90	29	0.93	Ashe and Scholz (1992)
Lake Roosevelt, WA 1997	35	1.22	Cichosz et al. (1999)
Rock Lake, WA 1999	266	0.98	McLellan (2000)
Boundary Reservoir, WA 2000	15	0.95	McLellan (2001)
Spokane River, WA 2002	26	0.96	Current study
Nine Mile Reservoir, WA 2002	101	0.95	Current study

Table 32. Comparison of mountain whitefish condition factors (K_{TL}) from northwest rivers and reservoirs.

Location	n	K_{TL}	Source
Box Canyon Reservoir, WA 1988-90 (weighted mean)	-	0.76	Ashe and Scholz (1992)
Boundary Reservoir, WA 2000	35	0.83	McLellan (2001)
Spokane River, WA 2002	24	0.80	Current study

Little Spokane River

Beaver Creek

Beaver Creek was the second smallest stream surveyed according to wetted width, bankfull width, and mean depth. The dominant substrate in Beaver Creek was muck (51%), unlike the rest of the streams surveyed in the Dragoon Creek system, which were dominated by sand. Beaver Creek was a low gradient (1%), low velocity stream that primarily flowed through active agricultural lands. Agricultural activities likely increased the amount of fine sediments (sand sized particles and smaller) in the stream above natural levels (Marcus et al. 1990, and references within). Large amounts of fine substrates (sand and smaller) may limit trout growth, over-winter survival, and reproduction by filling the interstitial spaces between larger substrate particles, subsequently decreasing macroinvertebrate production and prey availability (Alexander and Hansen 1986), winter concealment cover for juveniles (Griffith and Smith 1993; Meyer and Griffith 1997), and embryo survival (Tappel and Bjornn 1983; Phillips et al. 1975).

The maximum summer temperature of Beaver Creek (18.58 ^{o}C) exceeded the maximum for Class A coldwater streams (18 ^{o}C), as described in the Washington Administrative Code (WAC) Chapter 173-201A. However, all of the summer maximum temperatures recorded were within the preferred ranges of brown, eastern brook, and rainbow trout (15 to 21 ^{o}C) (Coutant 1977). The mean temperature between June 6 and October 28, 2002 was 0.50 ^{o}C cooler than during the same time period in 2001. The summer maximum temperatures were almost identical (0.07 ^{o}C warmer in 2002), but the minimum fall temperature was 4.17 ^{o}C cooler in 2002. The lower minimum was the result of a record cold snap during the last two weeks of October 2002.

Despite no record of brown trout ever being stocked directly in to Beaver Creek, two brown trout were collected in the stream. A wild population of brown trout currently exists in Dragoon Creek, so it was likely that those in Beaver Creek emigrated from Dragoon Creek.

Eastern brook trout were planted in Beaver Creek in 1941, 1944, and 1945 and rainbow trout were planted in 1944 and 1946 by WDFW (WDFW, unpublished hatchery records). Brook trout were present throughout Beaver Creek, but only seven juvenile rainbow trout were collected in Reach 8. Rainbow trout likely failed to establish a population due to habitat conditions, either directly from unsuitability or indirectly through interspecific competition. Brook trout were found to dominate rainbow trout in slow flow habitats (Cunjak and Green 1984), which were typical of Beaver Creek. Magoulick and Wilzbach (1998) reported that brook trout were more aggressive, captured more prey, and grew better than rainbow trout regardless of temperature or macrohabitat.

There appeared to be multiple size/age classes of brook trout in Beaver Creek. The largest size class was between 4 and 9 cm, which likely represented mostly age 0 fish, with a few age 1 fish. A second size class, between 9 and 12 cm, was likely mostly comprised of age 1 and a few age 2 fish. The lack of distinct size classes after 12 cm, likely represented multiple ages. Brook trout growth appeared to be slow, as indicated by the lack of distinct size classes. The relatively gradual decline in frequency of fish after each size class, particularly after the second size class, suggested that survival of brook trout of all ages was high. Survival may have been lower than indicated by the length-frequency distribution, because the proportions of fish of each age may not have been represented equally in each size class. Otolith analysis is needed to determine the age structure and growth and survival rates of the population.

Angler opportunities were limited on Beaver Creek, due to few access opportunities and low densities of legal size brown and rainbow trout. All of the land adjacent to the stream was privately owned and many landowners, although not directly asked, expressed that they did not permit access to anglers. Brown trout and rainbow trout densities were too low to provide angling opportunities. The proportion of brook trout that were of stock length was relatively high (41.5%), indicating that, provided some access, the angling value of the stream could be decent. However, the stock length for lotic brook trout is 130 mm (5.1 inches), which is 78 mm (2.9 inches) shorter than the minimum legal size for other trout and 70 mm shorter than the stock length for lentic brook trout (200 mm). The proportion of the brook trout population that was 200 mm or longer was 7.7%.

The proportion of the brook trout population that was 200 mm or longer in Beaver Creek was higher than any of the streams surveyed in 2001 (McLellan 2003). The higher proportion of large fish may have been the result of timing. Gravid brook trout have been observed in the Little Spokane River between mid-September and mid-October, so it was possible that adults from Dragoon Creek were beginning to move into Beaver Creek for spawning. However, none of the fish collected in Beaver Creek appeared to be gravid. It is unknown if some of the brook trout in Beaver Creek exhibit a fluvial life history strategy.

Dragoon Creek

Dragoon Creek was the largest stream surveyed based on wetted width, bankfull width, and mean depth (33 cm; tied with Spring Creek). The maximum summer temperatures of lower, middle, and upper Dragoon Creek (22.97, 18.58, and 21.18 ^{o}C, respectively) exceeded the maximum for Class A coldwater streams (18 ^{o}C), as described in the Washington Administrative Code (WAC) Chapter 173-201A. However, the summer maximum temperature recorded at the middle Dragoon Creek site was within the preferred ranges of brown, eastern brook, and rainbow trout (15 to 21 ^{o}C) (Coutant 1977). The lower water temperatures at the middle Dragoon Creek site were likely the result of cold-water inflow from Spring and Beaver Creeks. Both streams flowed in to Dragoon Creek within 10 km (upstream) of the middle Dragoon Creek site. The maximum summer temperature recorded in Beaver Creek was 18.58 ^{o}C. Temperatures were not monitored on Spring Creek with a thermograph, but the temperature of Spring Creek measured on July 18 with a hand held thermometer was 10.00 ^{o}C.

The mean temperature of upper Dragoon Creek (the only area monitored in 2001) between June 6 and October 28, 2002 was 0.30 ^{o}C cooler than during the same time period in 2001. The summer maximum and fall minimum temperatures were 3.86 and 2.91 ^{o}C cooler in 2002, respectively. The difference in the maximum may have been the result of different sites in each of the years. The 2001 site was 5.8 km downstream of the 2002 site. At the 2001 location, the thermograph was placed in a deep pool upstream of a culvert where the velocity was low, which may have reached higher temperatures at the depth of the thermograph. The thermograph at the 2002 site was placed in the thalweg near the stream bottom, where velocities were relatively high to ensure mixing. The temperature data from the 2002 site was probably more representative of the average conditions in the upper reaches of the stream. The lower minimum was the result of a record cold snap during the last two weeks of October 2002.

Dragoon Creek was stocked with over a half million brown, brook, cutthroat, and rainbow trout between 1934 and 1989 (WDFW, unpublished hatchery records). The brown trout and brook populations most likely originated from those plants or previous plants from U.S. Fish Commission or county sponsored stocking programs (A. Scholz, EWU, personal communication).

No cutthroat trout were collected in Dragoon Creek, despite being planted in 1936 and 1937. The failure to establish a cutthroat trout population was likely a result of poor habitat conditions and competition with other species.

More rainbow trout were planted in Dragoon Creek than the rest of the species combined (WDFW, unpublished hatchery records). All of the stocking events, with the exception of 350 fish in 1983, occurred prior to 1953 (WDFW, unpublished hatchery records). The origin and genetic composition of the current population is in question. Historically, steelhead migrated up the Little Spokane River to spawn (Scholz et al. 1985), but it is unclear as to which, if any, of the tributaries they used for spawning, with the exception of Deer Creek (A. Scholz, EWU, personal communication). There were no known historic barriers to fish movements in Dragoon Creek, so it was assumed that steelhead were historically present. Thus, the rainbow trout in Dragoon Creek were thought to possibly be native redband rainbow trout, but substantial introgression by coastal rainbow trout was suggested by the microsatellite DNA analysis (Appendix L).

The distribution of brown trout was limited to Reach 13 and below. The reasons for the lack of brown trout upstream were unknown, but may have been related to the old Dragoon Creek Dam and/or habitat conditions. Prior to it's opening, the Dragoon Creek Dam blocked fish passage and limited their distribution to lower reaches. Since then brown trout apparently have not expanded upstream of the dam. Water temperatures and habitat upstream of the mouth of Spring Creek were not considered favorable for brown trout. The stream was narrow, maximum summer temperatures exceeded 21 °C, and fines generally dominated the substrate. Maximum summer temperatures below the mouth of Spring Creek did not exceed 21 °C, the stream was wider, and the substrate was generally larger. Garrett and Bennett (1995) reported brown trout in the Pend Oreille River, Washington avoiding water temperatures ≥ 19 °C. However, brook trout, which are thought to prefer lower temperatures were widely distributed upstream of the dam.

Eastern brook trout were present throughout the stream (with the exception of a few reaches). Densities were generally high upstream of Reach 18 (up to 56 fish/100 m^2) and relatively low from Reach 18 downstream (≤ 1 fish/100 m^2). Rainbow trout, like brook trout, were present (with the exception of a few reaches) throughout the stream. Densities of rainbow trout were low (≤ 2 fish/100 m^2, except 4 fish/100 m^2 in Reach 6).

The dominance of brook trout or brown and rainbow trout, based on densities, was such that brook trout were most abundant in the upper 17 reaches, with the exception of Reach 9, where one rainbow trout and one brook trout were caught, respectively. Reach 18 was an intermediate zone, where the densities of brook, brown, and rainbow trout were approximately equal. From Reach 19 down to the mouth, brown and rainbow trout were the dominant trout species. The distribution was consistent with that observed in other streams with sympatric populations of brook trout and brown and/or rainbow trout. Bozek and Hubert (1992) observed the same general distribution in Wyoming streams and classified brook trout as high elevation, low gradient, narrow stream species and classified brown and rainbow trout as low elevation, low gradient, wide stream species. In southern Appalachian streams, introduced rainbow trout occupied low reaches and confined brook trout to upper reaches, with a small zone of sympatry in intermediate reaches (Larson and Moore 1985; Larson et al. 1995). The reasons for the observed trend in distribution is unknown, but may be related to selective advantages in different habitats.

Brown trout and rainbow trout apparently have a competitive advantage in lower stream reaches. Fausch and White (1981) reported a change in daytime resting habitat use to more advantageous positions by brook trout after the removal of brown trout, indicating competitive dominance by brown trout. In laboratory streams, wild brook trout changed microhabitat position, lost weight, and developed fungal infections (*Saprolegnia* spp.) in the presence of hatchery brown trout (Dewald and Wilzbach 1992).

The displacement of brook trout in the Appalachian streams indicated a competitive dominance by rainbow trout (Larson and Moore 1985). Ironically, laboratory experiments suggested that brook trout dominate rainbow trout in low flow habitats (Cunjak and Green 1984), which are typically more characteristic of lower reaches, and regardless of temperature or macrohabitat (Magoulick and Wilzbach 1998). Cunjak and Green (1986) reported juvenile brook trout dominated rainbow trout at 8 and 13 °C and at 19 °C no species established dominance. Fausch (1988) cautioned about the interpretation of experiments designed to evaluate competition between salmonids, referring specifically to the work of Cunjak and Green (1984; 1986). Nonetheless, the laboratory experiments and field studies together indicate that the relationship between competitive interactions and habitat conditions is more complex than one or two factors.

Several factors have been suggested to influence the competitive interactions of brook, brown, and rainbow trout. Brook trout have been suggested to have a competitive advantage at higher elevations, in colder water temperatures, higher gradients, and narrower streams (Larson and Moore 1985; Cunjak and Green 1986; Bozek and Hubert 1992; Larscheid and Hubert 1992; Larson et al. 1995). Although not tested for statistical significance, the only measured habitat feature that appeared to be related to the dominance of brook, brown, or rainbow trout in Dragoon Creek was wetted width. Brown and rainbow trout were more abundant in reaches that were substantially wider (1.2–4.5 m) than those dominated by brook trout. Bozek and Hubert (1992) found brook trout in significantly narrower stream reaches than rainbow trout.

The reasons for the limited distribution of mountain whitefish were unknown, but may have also been related to the old Dragoon Creek Dam and/or habitat conditions, particularly temperature. Mountain whitefish generally occupy streams with mean temperatures ranging from 9 to 11 ^{o}C (Wydoski and Whitney 1979).

There were several size classes of brown trout, but they were not easily interpreted to specific age classes. The first size class was assumed to represent age 0 fish. The number of fish in the second size class was greater than in the first, which suggested that our sampling was biased towards larger brown trout, there was a weak year class, or there were multiple life history strategies in the population. We do not believe that our sampling method was biased towards larger brown trout, due to our demonstrated success at collecting large numbers of small fish (both salmonids and non-salmonids). Sample site selection may have randomly excluded age 0 brown trout rearing areas. There may have been a weak year class in 2002, but this remains unknown without multiple years of data. The most likely explanation for the low number age 0 brown trout may be the existence of a fluvial aspect of the population, where adult brown trout migrate from Dragoon Creek and/or the Little Spokane River to smaller tributaries for spawning and rearing. Juvenile brown trout were collected in Wethey Creek, a tributary of Dragoon Creek, in the spring of 2002 (WDFW, unpublished data). The life history strategies of brown trout in Dragoon Creek should be determined to allow for improved management. Otolith analysis is needed to determine the age structure and growth and survival rates of the brown trout population.

There was one apparent size/age class of brook trout in Dragoon Creek. The first and largest size class was between 3 and 7 cm, which likely represented mostly age 0 fish. The length distribution after 7 cm, likely contained multiple ages. Brook trout growth appeared to be slow, indicated by the lack of distinct size classes. The relatively gradual decline in frequency of fish after each size class, suggested that survival of brook trout of all ages was high. Survival may have been lower than indicated by the length-frequency distribution, because the proportions of fish of each age may not have been represented equally in each size class. Otolith analysis is needed to determine the age structure and growth and survival rates of the brook trout population.

The rainbow trout length frequency distribution had two distinct size/age classes. There were few age 0 fish, represented by the first size class (4 to 7 cm), collected compared to age 1 fish. The number of fish after age 1 declined sharply, with densities of older fish remaining relatively constant, but low. As with brown trout, the low numbers of age 0 fish observed may have been the result of sampling bias, poor year class strength, or a fluvial life history strategy. The relatively large decline in numbers between age 1 and 2 (high mortality) may be the result of angler harvest. Based on the length frequency distribution, rainbow trout reach legal harvest length (208 cm) between ages 1 and 2. Angler pressure on Dragoon Creek was not quantified, but anglers were observed on several occasions. However, the survival rate for fish longer than 208 cm appears to be high. Survival may have been lower than indicated by the length-frequency distribution, because the proportions of fish of each age may not have been represented equally in each size class. The life history strategies of rainbow trout in Dragoon Creek should be determined to allow for improved management. Otolith analysis is needed to determine the age structure and growth and survival rates of the population.

Mountain whitefish exhibited two distinct size/age classes. The relatively small decrease in the numbers of fish between the first two size classes suggested that survival was high. The virtual disappearance of whitefish after the second size class suggested low survival, or possibly out migration (fluvial life history strategy). The large gap between the first two size classes indicated good growth. Survival may have been lower than indicated by the length-frequency distribution, because the proportions of fish of each age may not have been represented equally in each size class. The life history strategies of mountain whitefish in Dragoon Creek should be determined to allow for improved management. Otolith analysis is needed to determine the age structure and growth and survival rates of the population.

Dragoon Creek provides some angler opportunity, due to access opportunities and relatively high proportions of stock and legal size trout. The majority of the land adjacent to the stream was privately owned and several landowners, although not directly asked, expressed that they did not permit access to anglers. However, the Washington Department of Natural Resources operates a park and campground on Dragoon Creek, where anglers can access the stream. In addition, some landowners indicated that they have granted anglers access to the stream. The proportion of brook trout that were of stock length was relatively high (52.0%), but only 6.3% of the brook trout population was 200 mm or longer. Despite relatively low densities (typically $\leq$ 2 fish/100 m^2), the proportions of the brown and rainbow trout populations that were of legal length for harvest were relatively high (17.8 and 20.1%, respectively). There were brown and rainbow trout that exceeded (355 mm; 13.8 inches).

Four previous single site electrofishing surveys of Dragoon Creek identified seven species of fish: brook trout, rainbow trout, sculpin, northern pikeminnow, redside shiner, speckled dace, and bridgelip sucker (EWU, unpublished data; Lines 1982). Thirteen species were collected in 2002. The high number of species collected in 2002 was related to sample size. There were 40 sites distributed along the entire length of the stream in 2002, whereas all of the previous surveys occurred at a total of four sites.

Little Deer Creek

Little Deer Creek was the smallest (wetted width=1.2 m), shallowest (mean depth=6 cm), and steepest (gradient=4.0%) stream surveyed in 2002. Of the streams surveyed in 2002, Little Deep Creek had the highest density of LWD, largest dominant substrate (gravel versus sand/muck), and lowest embeddedness (49% versus ≥ 78%). The maximum summer temperature of Little Deer Creek (19.10 ^{o}C) exceeded the maximum for Class A coldwater streams (18 ^{o}C), as described in the WAC Chapter 173-201A. However, the summer maximum temperatures recorded were within the preferred ranges of brown, eastern brook, and rainbow trout (15 to 21 ^{o}C) (Coutant 1977).

No fish were collected in Reaches 1 or 2, possibly due to a culvert that was identified as a fish passage barrier located at the upper end of Reach 3. Rainbow trout had higher densities than brook trout in all reaches, except Reach 5, where they had equal numbers. There were no WDFW stocking records for Little Deer Creek. The brook trout were likely established from fish that emigrated from Deer Creek.

There appeared to be several size/age classes in the length-frequency distribution of eastern brook trout. The relatively uniform and moderate slope of the line between the peak sizes suggested that annual survival between year classes was relatively constant and moderate. Survival may have been lower than indicated by the length-frequency distribution, because the proportions of fish of each age may not have been represented equally in each size class. Growth appeared to be relatively slow, as indicated by the lack of distinct size classes after the first one. Otolith analysis is needed to determine the age structure, survival rates, and growth rates of the population.

The origin of the rainbow trout population in Little Deer Creek was unknown. However, they are likely native interior redband rainbow trout that are related to rainbow trout in Deer Creek. Microsatellite DNA analysis indicated that the rainbow trout population in Deer Creek was comprised of interior redband rainbow trout with little or no indication of coastal rainbow trout influence (McLellan 2003). Rainbow trout from Little Deer Creek were observed with morphological characteristics thought to be consistent with interior redband rainbow trout (A. Scholz, EWU, personal communication). Microsatellite DNA analysis indicated that the rainbow trout subpopulation in Little Deer Creek was likely native interior redband rainbow trout (Appendix L). The subpopulations of redband trout in Deer and Little Deer Creeks were the most closely related subpopulations of those examined to date (Appendix L).

There appeared to be three size/age classes of rainbow trout, although only the first one was distinct. The steep decline in the number of fish between the first and second size classes suggested that first year survival was low. Survival rates were higher for subsequent size/age classes. Growth appeared to be relatively slow, as indicated by the small size of age 2 fish (7-9 cm TL) and the lack of distinct size classes. Otoliths need to be analyzed to determine age, growth, and survival characteristics.

Eastern Washington University conducted a single electrofishing survey on Little Deer Creek in 1999 (EWU, unpublished data). Similar to the 2002 study, they only collected brook and rainbow trout. They also found brook trout in lower densities than rainbow trout.

Angler opportunities were essentially nonexistent on Little Deer Creek, due to few access opportunities and the lack of legal size trout. All of the land adjacent to the stream was privately owned and many landowners, although not directly asked, expressed that they did not permit access to anglers. The proportion of brook trout that were of stock length was relatively high (29.0%), indicating that the stream may have some angling value. There were no brook trout 200 mm or longer. There were no legal size rainbow trout collected in Little Deer Creek.

Spring Creek

Spring Creek was the largest tributary of Dragoon Creek surveyed based on wetted and bankfull widths. Spring Creek also had the greatest mean depth (tied with Dragoon Creek). Spring Creek had the lowest densities of LWD and primary pools.

Spring Creek was stocked with eastern brook trout in 1941 and 1944 and rainbow trout in four years between 1951 and 1956 (WDFW, unpublished hatchery records). Both species were still present in 2002, but rainbow trout densities were low. Brook trout had the highest densities of all of the fish collected in the stream. Similar to Beaver Creek, habitat conditions, either directly from suitability or indirectly through interspecific competition, may have contributed to the apparent domination of brook trout over rainbow trout.

There were two distinct size/age classes in the length frequency distribution of brook trout collected in Spring Creek. The first size class had the highest number of fish. First year survival appeared to be moderate, as indicated by the moderate decrease in numbers between the peaks of the first two size classes. However, survival may have been lower than indicated by the length-frequency distribution, because the proportions of fish of each age may not have been represented equally in each size class. The relatively wide gap between the first and second size classes suggested that first year growth was good. The lack of subsequent size classes suggested growth was slow, or that fish were leaving the population (immigration or mortality). Otoliths need to be analyzed to determine age, growth, and survival characteristics.

Angler opportunities were limited on Spring Creek, due to few access opportunities and low densities of stock and legal size trout. All of the land adjacent to the stream was privately owned, with the exception of a Deer Park city park, and it was unknown if any landowners were would grant access to anglers. The park only provided access to 100 m of the stream. The proportion of brook trout that were of stock length was relatively high (43.8%), indicating that the stream had some angling value. There were no brook trout 200 mm or longer and no legal size brown or rainbow trout collected in Spring Creek.

West Branch Dragoon Creek

West Branch Dragoon Creek was the second largest tributary of Dragoon Creek surveyed based on wetted and bankfull widths, but it was the longest. Similar to the other streams in the Dragoon Creek drainage that were surveyed in 2002, the West Branch Dragoon Creek was dominated by sand (39%) and had relatively high embeddedness (90%). The gradient of West Branch Dragoon Creek was low (1.1%).

No fish passage barriers were identified, but a possible barrier used to exist at the break between Reaches 6 and 7. A dam was constructed at the site circa 1954, with the purpose of holding water for irrigation during low flow periods (Biggs 1954). The dam has since washed out and does not act as a fish passage barrier. According to local residents the dam washed out some time around 1992. It is unknown if the dam acted as a complete fish passage barrier, but based on what remains of the dam it appears it was.

The maximum summer temperature of West Branch Dragoon Creek (20.49 ^{o}C) exceeded the maximum for Class A coldwater streams (18 ^{o}C), as described in the WAC Chapter 173-

201A. However, the summer maximum temperatures recorded were within the preferred ranges of brown, eastern brook, and rainbow trout (15 to 21 ^{o}C) (Coutant 1977). The mean temperature between June 6 and October 28, 2002 was 0.51 ^{o}C cooler than during the same time period in 2001. The summer maximum and fall minimum temperatures were 0.47 and 4.51 ^{o}C cooler in 2002, respectively. The lower minimum was the result of a record cold snap during the last two weeks of October 2002.

According to WDFW stocking records, no fish have been planted in the West Branch Dragoon Creek (WDFW, unpublished stocking records). All of the trout populations collected in West Branch Dragoon Creek potentially originated from fish that emigrated from Dragoon Creek. Some may have been established prior to 1933 from undocumented plants of fish provided by U.S. Fish Commission or county sponsored stocking programs (A. Scholz, EWU, personal communication).

The origin of the rainbow trout population in West Branch Dragoon Creek was of particular interest, because they were potentially native redband rainbow trout based on the historical occurrence of steelhead in the drainage. However, the probable mixing of fish between the West Branch Dragoon Creek and the rest of the streams in the Dragoon system, many of which have had substantial numbers of rainbow trout plants, suggests that there may have been substantial influence by hatchery fish of coastal origin. Microsatellite DNA analysis of tissue samples from West Branch Dragoon Creek indicated that the West Branch and Dragoon Creek rainbow trout populations were relatively closely related, but were genetically distinct subpopulations indicating little interbreeding. However, the DNA analysis also suggested there was a substantial coastal rainbow trout influence in the population.

Speckled dace and redside shiners dominated the species composition in West Branch Dragoon Creek. Trout distributions were limited to the upper (1 and 2) and lower (9-14) reaches, with the exception of one brook trout that was captured in Reach 5. Eastern brook trout had the highest densities in Reaches 1 and 2. Rainbow trout had higher densities than brown and brook trout in Reaches 10-14. The distributions did not appear to be related to measured habitat conditions.

The length-frequency distribution of brook trout had no distinct size/age classes, which indicated that annual survival was high and growth rates were low. Analysis of otoliths needs to be conducted to determine the age structure, as well as survival and growth rates.

The rainbow trout length-frequency distribution had two distinct size/age classes. The first age class was much larger than the second; suggesting first year mortality was high or fish were leaving the population after age 0. The relatively sharp decline in rainbow trout in West Branch Dragoon after age 0 coupled with the low number of age 0 fish in Dragoon Creek supports the idea that there were rainbow trout exhibiting a fluvial life history pattern. We hypothesize that adult rainbow trout from Dragoon Creek migrate into West Branch Dragoon to spawn. The offspring hatch and rear for their first year in West Branch Dragoon and then migrate into Dragoon Creek were they live the rest of their lives, eventually returning the West Branch Dragoon to spawn each spring. Preliminary microsatellite DNA analysis indicated that there was little inbreeding between the West Branch Dragoon and Dragoon Creek rainbow populations, providing evidence against the fluvial life history hypothesis. However, the sampling methodology (collecting adults) and the possibility of a mixed stock population in Dragoon Creek may have hidden the fluvial life history strategy, so other methods of determining life histories and more DNA analysis is needed. The relatively wide gap between the first two size classes indicated that first year growth was good. Analysis of otoliths needs to be conducted to determine the age structure, as well as survival and growth rates.

Similar to Beaver, Little Deer, and Spring Creeks, angler opportunities were limited due to few access opportunities and low densities of stock and legal size trout. All of the land adjacent to the stream was privately owned and several landowners encountered during this study, although not asked, expressed that they did not grant access to anglers. Like the other streams surveyed, the proportion of brook trout that were of stock length was relatively high (57.2%). However, only 10.6% of the brook trout were 200 mm or longer. Four of the five brown trout collected were legal size; however, densities were too low to provide good fishing. The proportion of the rainbow trout population that was of legal length was 1.9%.

Other Streams

The summer maximum temperatures of lower Deadman Creek, Little Deep Creek, and the Little Spokane River exceeded the WAC maximum for Class A coldwater streams (18 ^{o}C). Dartford Creek and upper Deadman Creek were the only streams monitored that did not exceed 17^{o}C.

The maximum temperatures of lower Deadman Creek, Little Deep Creek, and the Little Spokane River, at its mouth and the Indian Painted Rocks, were within the preferred ranges of brown, eastern brook, and rainbow trout (15 to 21 ^{o}C) (Coutant 1977). Maximum temperatures exceeded the upper avoidance levels reported for adult brown, brook, and rainbow trout (19, 20, and 20 ^{o}C, respectively) in the Little Spokane River upstream of Wandermere (Coutant 1977; Garrett and Bennett 1995). Maximum temperatures in the Little Spokane River at Elk exceeded 20.0 ^{o}C on 65 days in 2002, which was similar to 2001 when they exceeded 20.0 ^{o}C on 59 days. The maximum temperature of the Little Spokane River at Scotia exceeded 20.0 ^{o}C on four days and exceeded 21.0 ^{o}C on one day. Summer maximum temperatures may limit salmonid production in the Little Spokane River, between Wandermere and Chain Lake.

Mean and maximum water temperatures in the Little Spokane River increased between Scotia and Elk and then declined at successive downstream monitoring sites to the Indian Painted Rocks. Mean and maximum water temperatures increased again between the Indian Painted Rocks and the mouth. Mean water temperatures at Scotia, Elk, Wandermere, Indian Painted Rocks and the mouth were 10.66, 13.9, 13.10, 12.08, and 12.33 ^{o}C, respectively. The increase in temperature between Scotia and Elk was likely the result of warm surface waters from Chain Lake flowing down the Little Spokane River. As Chain Lake stratified and its surface water heated, the colder, more dense water flowing in from the Little Spokane River would sink, thus the shallow outflow of the lake would be comprised of the warmer, less dense surface waters. The decreasing temperatures between Elk and the Indian Painted Rocks were likely the result of cold groundwater inflow that reportedly occurs near Wandermere (Hartung and Meier 1980; 1995).

The mean temperature of Dartford Creek between June 6 and October 28, 2002 was virtually the same (0.09 ^{o}C cooler) as it was during the same time period in 2001. The summer maximum and fall minimum temperatures were 0.47 and 5.14 ^{o}C cooler in 2002, respectively. The lower minimum was the result of a record cold snap during the last two weeks of October 2002.

The mean temperature of Little Deep Creek between June 6 and October 28, 2002 was 0.31 ^{o}C warmer than during the same time period in 2001. The summer maximum was 2.48 ^{o}C warmer and the fall minimum temperatures were 5.10 ^{o}C cooler in 2002. The lower minimum was the result of a record cold snap during the last two weeks of October 2002.

The mean temperature of Little Spokane River at Elk between June 6 and October 28, 2002 was virtually the same (0.03 ^{o}C cooler) as it was during the same time period in 2001. The summer maximum was 0.31 ^{o}C warmer and the fall minimum temperatures were 5.24 ^{o}C cooler in 2002. The lower minimum was the result of a record cold snap during the last two weeks of October 2002.

The mean temperature of Little Spokane River at Wandermere between June 6 and October 28, 2002 was virtually the same (0.13 ^{o}C cooler) as it was during the same time period in 2001. The summer maximum was 1.04 ^{o}C warmer and the fall minimum temperatures were 4.84 ^{o}C cooler in 2002. The lower minimum was the result of a record cold snap during the last two weeks of October 2002.

The mean temperature of Little Spokane River at its mouth between June 6 and October 28, 2002 was virtually the same (0.10 ^{o}C cooler) as it was during the same time period in 2001. The summer maximum was 0.81 ^{o}C warmer and the fall minimum temperatures were 3.40 ^{o}C cooler in 2002. The lower minimum was the result of a record cold snap during the last two weeks of October 2002.

Recommendations

- Increase the number of occasions and area of sampling in the free-flowing section of the middle Spokane River to get better estimates of species composition, distribution, and abundance.
- Increase the number of scale samples collected from wild game fish from the middle Spokane River for improved confidence in the age structure and growth rate estimates.
- Determine the origins and stock composition of the wild rainbow trout population in the middle Spokane River.
- Evaluate the success of middle Spokane River trout stocking programs with a statistically defensible creel survey.
- Re-evaluate stocking programs and management goals for the middle Spokane River once the DNA studies are complete.
- Complete fish and habitat surveys of the Little Spokane River drainage.
- Identify habitat restoration opportunities in the Little Spokane River system, particularly related to decreasing sediment loading, with statistically defensible evaluation plans.
- Identify the human-made fish migration barriers in the Little Spokane River system that should be removed or improved to restore fish passage.
- Collect otoliths from each salmonid population in the Little Spokane River system to determine age structures, growth rates, and survival rates.
- Identify the life history strategies of fish populations in the Little Spokane River system.
- Microsatellite DNA characterization of the rainbow trout populations in the Spokane and Little Spokane River systems that have not been evaluated to determine purity and distinction from other stocks.

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Appendices

Appendix A.

Table A1. Fish plants in the Spokane River by WDFW. Data from unpublished hatchery records. EB = eastern brook trout, RB = rainbow trout, BT = brown trout.

Location	Year	Species	# Planted	Size/Count	Unit	Stock
Spokane River	1934	EB	27,130			
Spokane River	1935	RB	49,515			
Spokane River	1936	RB	30,000			
Spokane River	1937	RB	3,750			
Spokane River	1938	RB	7,700			
Spokane River	1939	RB	9,980			
Spokane River	1940	RB	4,986			
Spokane River	1941	RB	16,958			
Spokane River	1943	RB	31,337			
Spokane River	1944	EB	9,970			
Spokane River	1944	RB	17,540			
Spokane River	1948	RB	5,759			
Spokane River	1949	RB	6,280			
Spokane River	1951	RB	6,300	6.0	No./Lb.	
Spokane River	1952	RB	4,500	4.5	No./Lb.	
Spokane River	1953	RB	17,663	62.0	No./Lb.	
Spokane River	1954	RB	9,410	4.5	No./Lb.	
Spokane River	1954	RB	4,255	0.8	No./Lb.	
Spokane River	1972	BT	2,135			
Spokane River	1973	BT	2,002	2.2	No./Lb.	
Spokane River	1974	RB	2,002	2.2	No./Lb.	
Spokane River	1976	RB	288,500	1300.0	No./Lb.	
Spokane River	1976	RB	107,640	585.0	No./Lb.	
Spokane River	1977	BT	2,310	21.0	No./Lb.	
Spokane River	1977	RB	2,000	4.0	No./Lb.	
Spokane River	1977	RB	301,280	90.0	No./Lb.	
Spokane River	1977	RB	25,000	200.0	No./Lb.	
Spokane River	1977	RB	19,680	82.0	No./Lb.	
Spokane River	1978	RB	60,060	110.0	No./Lb.	
Spokane River	1978	RB	135,218	104.0	No./Lb.	
Spokane River	1979	BT	5,040	21.0	No./Lb.	
Spokane River	1980	BT	5,024	32.0	No./Lb.	
Spokane River	1981	BT	5,040	12.6	No./Lb.	
Spokane River	1981	BT	5,040	12.6	No./Lb.	Mt. Shasta California
Spokane River	1982	BT	5,412	13.2	No./Lb.	Mt. Shasta California
Spokane River	1982	RB	470	2.0	No./Lb.	Spokane-McCloud R. CA
Spokane River	1983	BT	9,652	15.2	No./Lb.	Mt. Shasta California
Spokane River	1984	EB	2,520	3.5	No./Lb.	E. Brook-Ford (Owhi Lake)
Spokane River	1986	BT	8,058	5.1	No./Lb.	Ford (Mt. Shasta, CA)
Spokane River	1986	BT	7,920	2.0	No./Lb.	Ford (Mt. Shasta, CA)
Spokane River	1987	BT	3,010	3.5	No./Lb.	Ford (Mt. Shasta, CA)
Spokane River	1987	BT	4,060	2.0	No./Lb.	Ford (Mt. Shasta, CA)

Table A1. Continued.

Location	Year	Species	# Planted	Size/Count	Unit	Stock
Spokane River	1987	RB	2,280	4.0	No./Lb.	Spokane-McCloud R. CA
Spokane River	1987	RB	3,410	2.0	No./Lb.	Spokane-McCloud R. CA
Spokane River	1988	BT	1,470	2.0	No./Lb.	Ford (Mt. Shasta, CA)
Spokane River	1988	RB	500	5.0	No./Lb.	
Spokane River	1988	RB	3,200	4.0	No./Lb.	Spokane-McCloud R. CA
Spokane River	1989	BT	7,052	3.5	No./Lb.	Ford (Mt. Shasta, CA)
Spokane River	1989	RB	1,900	2.0	No./Lb.	Spokane-McCloud R. CA
Spokane River	1990	RB	2,400	3.0	No./Lb.	Spokane-McCloud R. CA
Spokane River	1991	RB	506	2.2	No./Lb.	Spokane-McCloud R. CA
Spokane River	1991	RB	2,291	2.9	No./Lb.	Spokane-McCloud R. CA
Spokane River	1991	RB	479	2.1	No./Lb.	Spokane-McCloud R. CA
Spokane River	1992	BT	27,216	68.9	No./Lb.	Ford (Mt. Shasta, CA)
Spokane River	1992	RB	1,002	3.0	No./Lb.	Spokane-McCloud R. CA
Spokane River	1992	RB	63,304	96.5	No./Lb.	Spokane-McCloud R. CA
Spokane River	1993	BT	4,865	3.5	No./Lb.	Ford (Mt. Shasta, CA)
Spokane River	1993	RB	1,552	3.2	No./Lb.	Spokane-McCloud R. CA
Spokane River	1993	RB	300	3.0	No./Lb.	Spokane-McCloud R. CA
Spokane River	1993	RB	200	3.0	No./Lb.	Spokane-McCloud R. CA
Spokane River	1993	RB	100	0.3	No./Lb.	Spokane-McCloud R. CA
Spokane River	1994	BT	612	3.6	No./Lb.	Ford (Mt. Shasta, CA)
Spokane River	1994	BT	5,049	3.3	No./Lb.	Ford (Mt. Shasta, CA)
Spokane River	1994	RB	1,000	2.0	No./Lb.	Spokane-McCloud R. CA
Spokane River	1997	RB	4,000	3.2	No./Lb.	Spokane-McCloud R. CA
Spokane River	1997	RB	10,248	11.2	No./Lb.	Phalon Lake
Spokane River	1997	RB	55,194	19.3	No./Lb.	Spokane-McCloud R. CA
Spokane River	1997	RB	10,008	18.0	No./Lb.	Spokane-McCloud R. CA
Spokane River	1998	RB	1,024	12.8	No./Lb.	Phalon Lake
Spokane River	1998	RB	4,107	3.1	No./Lb.	Spokane-McCloud R. CA
Spokane River	1999	RB	4,656	4.6	No./Lb.	Spokane-McCloud R. CA
Spokane River	2000	RB	4,000	3.9	No./Lb.	Spokane-McCloud R. CA
Spokane River	2000	RB	2,001	4.4	No./Lb.	Spokane-McCloud R. CA
Spokane River	2000	RB	6,046	2.9	No./Lb.	Spokane-McCloud R. CA
Spokane River	2001	RB	3,645	3.0	No./Lb.	Spokane-McCloud R. CA
Spokane River	2002	BT	2,000			
Spokane River	2002	RB	4,000			

Appendix B.

Table B1. Coordinates of the 2002 Spokane River electrofishing sample sections. Lat.=north latitude, Long.=west longitude, and DD=decimal degrees.

Section #	Start_Lat. (DD)	Start_Long. (DD)	End_Lat. (DD)	End_Long. (DD)
1	47.66010	117.43882	47.65954	117.44909
2	47.65658	117.45478	47.66374	117.45509
3	47.66374	117.45509	47.66739	117.46322
4	47.66739	117.46322	47.67224	117.46033
5	47.67224	117.46033	47.67238	117.45326
6	47.67238	117.45326	47.68109	117.45637

Table B2. Coordinates of the 2002 Nine Mile Reservoir sample sites. Sites with a P indicate a pelagic gill net set. Other gill net sites had littoral sets. Lat.=north latitude, Long.=west longitude, and DD=decimal degrees.

Site #	Lat. (DD)	Long. (DD)	Method	Season
9	47.76392	117.54959	Electrofishing	Summer
19	47.75608	117.52992	Electrofishing	Summer
23	47.75739	117.52565	Electrofishing	Summer
26	47.74924	117.52395	Electrofishing	Summer
29	47.74955	117.52767	Electrofishing	Summer
32	47.74560	117.52619	Electrofishing	Summer
39	47.73634	117.51521	Electrofishing	Summer
40	47.73422	117.51047	Electrofishing	Summer
46	47.72144	117.51208	Electrofishing	Summer
3	47.77190	117.55122	Gill net	Summer
5	47.76922	117.55295	Gill net	Summer
7	47.76605	117.55122	Gill net	Summer
12	47.76192	117.53909	Gill net	Summer
16	47.75793	117.53339	Gill net	Summer
28	47.74855	117.52716	Gill net	Summer
38	47.73524	117.51118	Gill net	Summer
41	47.73248	117.51093	Gill net	Summer
P5	47.76254	117.54133	Gill net	Summer
P10	47.75505	117.52117	Gill net	Summer
P12	47.74924	117.52655	Gill net	Summer
P13	47.74634	117.52849	Gill net	Summer
P21	47.72293	117.51386	Gill net	Summer
14	47.75959	117.53686	Electrofishing	Fall
16	47.75799	117.53182	Electrofishing	Fall
21	47.75698	117.52616	Electrofishing	Fall
24	47.75359	117.52158	Electrofishing	Fall
30	47.74754	117.52819	Electrofishing	Fall
32	47.74560	117.52619	Electrofishing	Fall
33	47.74465	117.52660	Electrofishing	Fall
35	47.74274	117.52247	Electrofishing	Fall
40	47.73422	117.51047	Electrofishing	Fall
5	47.76922	117.55295	Gill net	Fall
6	47.76763	117.54959	Gill net	Fall
9	47.76371	117.54816	Gill net	Fall

Table B2. Continued.

Site #	Lat. (DD)	Long. (DD)	Method	Season
11	47.76220	117.54480	Gill net	Fall
24	47.75078	117.52137	Gill net	Fall
39	47.73517	117.51302	Gill net	Fall
42	47.72789	117.51160	Gill net	Fall
46	47.72096	117.51034	Gill net	Fall
P1	47.77260	117.54958	Gill net	Fall
P3	47.76502	117.54872	Gill net	Fall
P16	47.73829	117.51652	Gill net	Fall
P18	47.73416	117.51154	Gill net	Fall
P20	47.72908	117.51146	Gill net	Fall

Appendix C.

Table C1. Catch-per-unit-effort (CPUE; ± 80% CI) of fish collected in Nine Mile Reservoir in the summer of 2002 (total electrofishing effort = 1.51 hours).

	Gear Type		
	Electrofishing	**Littoral Gill Netting**	**Pelagic Gill Netting**
Species	**#/ hour (n= 9 sites)**	**#/GN night (n=8)**	**#/GN night (n=5)**
Brown trout	0	0.3 (± 0.2)	0.2 (± 0.3)
Rainbow trout	7.3 (± 5.1)	4.1 (± 1.3)	5.2 (± 1.1)
Mountain whitefish	0.7 (± 0.9)	0.3 (± 0.3)	0
Sculpin	11.5 (± 9.1)	0	0
Chiselmouth	4.0 (± 2.9)	0.4 (± 0.3)	0.6 (± 0.5)
Northern pikeminnow	47.1 (± 16.6)	6.1 (± 1.9)	3.0 (± 0.8)
Redside shiner	57.9 (± 24.6)	1.8 (± 1.2)	0.2 (± 0.3)
Tench	1.3 (± 1.7)	0	0
Bridgelip sucker	32.7 (± 22.8)	23.6 (± 11.7)	34.4 (± 22.8)
Largescale sucker	28.7 (± 10.7)	17.0 (± 3.8)	12.2 (± 1.0)
Black crappie	1.3 (± 1.7)	0	0
Pumpkinseed	6.0 (± 6.8)	0	0
Largemouth bass	4.7 (± 6.0)	0	0
Yellow perch	2.0 (± 2.6)	0	0

Table C2. Catch-per-unit-effort (CPUE; ± 80% CI) of fish collected in Nine Mile Reservoir in the fall of 2002 (total electrofishing effort = 1.50 hours).

	Gear Type		
	Electrofishing	**Littoral Gill Netting**	**Pelagic Gill Netting**
Species	**#/ hour (n=9 sites)**	**#/GN night (n=8)**	**#/GN night (n=5)**
Brown trout	0.7 (± 0.9)	0.1 (± 0.2)	0
Rainbow trout	8.7 (± 3.2)	2.6 (± 1.7)	0.4 (± 0.3)
Chinook salmon	0	0.1 (± 0.2)	0
Mountain whitefish	4.7 (± 2.8)	0	0.4 (± 0.3)
Sculpin	4.0 (± 2.9)	0	0
Chiselmouth	0.7 (± 0.9)	0.5 (± 0.4)	0.2 (± 0.3)
Northern pikeminnow	8.7 (± 6.7)	3.5 (± 1.5)	0.6 (± 0.5)
Redside shiner	5.3 (± 6.8)	1.9 (± 1.4)	0
Bridgelip sucker	23.3 (± 13.3)	0.6 (± 0.5)	4.4 (± 3.1)
Largescale sucker	27.3 (± 16.0)	2.6 (± 1.1)	3.8 (± 1.7)
Largemouth bass	1.3 (± 1.7)	0	0
Yellow perch	0.7 (± 0.9)	0	0
Brown bullhead	0.7 (± 0.9)	0	0

Table C3. Relative abundance, mean total length (±SD), and size range of fish collected in Nine Mile Reservoir in the summer of 2002.

Species	n	Relative Abundance (%)	Mean Total Length (mm)	Size Range (mm)
Brown trout	3	0.3	320 (± 101)	252-436
Rainbow trout	70	6.9	319 (± 80)	83-493
Mountain whitefish	3	0.3	231 (± 115)	113-342
Sculpin	18	1.8	96 (± 15)	71-119
Chiselmouth	12	1.2	188 (± 89)	76-325
Northern pikeminnow	135	13.3	203 (± 144)	54-558
Redside shiner	102	10.0	76 (± 21)	47-125
Tench	2	0.2	249 (± 163)	134-364
Bridgelip sucker	410	40.4	333 (± 76)	72-449
Largescale sucker	240	23.6	419 (± 79)	75-590
Black crappie	2	0.2	143 (± 15)	132-153
Pumpkinseed	9	0.9	104 (± 17)	62-117
Largemouth bass	7	0.7	181 (± 82)	137-366
Yellow perch	3	0.3	109 (± 8)	100-115

Table C4. Relative abundance, mean total length (±SD), and size range of fish collected in Nine Mile Reservoir in the summer of 2002.

Species	n	Relative Abundance (%)	Mean Total Length (mm)	Size Range (mm)
Brown trout	2	0.7	327 (± 109)	250-404
Rainbow trout	36	13.1	328 (± 76)	106-444
Chinook salmon	1	0.4	368	368
Mountain whitefish	9	3.3	268 (± 67)	172-368
Sculpin	6	2.2	93 (± 9)	79-103
Chiselmouth	6	2.2	130 (± 19)	116-167
Northern pikeminnow	44	16.1	199 (± 128)	72-536
Redside shiner	23	8.4	102 (± 14)	65-132
Bridgelip sucker	62	22.6	260 (± 107)	93-440
Largescale sucker	81	29.6	337 (± 145)	98-573
Largemouth bass	2	0.7	166 (± 6)	161-170
Yellow perch	1	0.4	113	113
Brown bullhead	1	0.4	287	287

Table C5. Mean total length (TL), weight, relative weight (W_r), and condition factor (K_{TL}) of hatchery and wild sport fish species collected in Nine Mile Reservoir in the summer of 2002.

Species	**n**	**TL (mm)**	**Weight (g)**	**W_r**	**K_{TL}**
Brown trout	2	354 (± 116)	480 (± 443)	83 (± 10)	0.89 (± 0.09)
Rainbow trout	66	334 (± 58)	384 (± 198)	87 (± 9)	0.95 (± 0.10)
Mountain whitefish	2	290 (± 74)	271 (± 212)	97 (± 10)	0.97 (± 0.11)
Black crappie	2	143 (± 15)	47 (± 17)	119 (± 2)	1.58 (± 0.09)
Pumpkinseed	7	110 (± 6)	30 (± 5)	112 (± 7)	2.25 (± 0.13)
Largemouth bass	4	211 (± 104)	214 (± 314)	107 (± 10)	1.41 (± 0.05)
Yellow perch	3	109 (± 8)	15 (± 3)	94 (± 6)	1.14 (± 0.05)

Table C6. Mean total length (TL), weight, relative weight (W_r), and condition factor (K_{TL}) of hatchery and wild sport fish species collected in Nine Mile Reservoir in the fall of 2002.

Species	**n**	**TL (mm)**	**Weight (g)**	**W_r**	**K_{TL}**
Brown trout	2	327 (± 109)	467 (± 462)	97 (± 22)	1.05 (± 0.22)
Chinook salmon	1	368	520	86	1.04
Rainbow trout	35	334 (± 66)	380 (± 171)	86 (± 8)	0.94 (± 0.09)
Mountain whitefish	9	268 (± 67)	212 (± 146)	91 (± 9)	0.92 (± 0.09)
Largemouth bass	2	166 (± 6)	59 (± 6)	101 (± 3)	1.30 (± 0.03)
Yellow perch	1	113	16	91	1.11
Brown bullhead	1	287	352	98	1.49

Appendix D.

Table D1. Coordinates of the starting and ending locations and the lengths of the stream reaches surveyed in 2002. Lat.=north latitude; Long.=north longitude; DD=decimal degrees; S=start; E=end.

Stream	Reach	S_Lat. (DD)	S_Long. (DD)	E_Lat. (DD)	E_Long. (DD)	Length (m)
Beaver Creek	1	48.00225	117.58198	47.99696	117.57654	722
Beaver Creek	2	47.99696	117.57654	47.98983	117.56755	1,041
Beaver Creek	3	47.98983	117.56755	47.98804	117.54814	1,542
Beaver Creek	4	47.98804	117.54814	47.98714	117.54487	270
Beaver Creek	5	47.98714	117.54487	47.98611	117.53726	579
Beaver Creek	6	47.98611	117.53726	47.97507	117.53802	1,261
Beaver Creek	7	47.97507	117.53802	47.96294	117.53149	1,769
Beaver Creek	8	47.96294	117.53149	47.95649	117.52117	1,117
Beaver Creek	9	47.95649	117.52117	47.95363	117.51494	588
Beaver Creek	10	47.95363	117.51494	47.94646	117.50764	1,018
Beaver Creek	11	47.94646	117.50764	47.94550	117.50632	146
Dragoon Creek	1	48.06855	117.54962	48.05945	117.54394	1,051
Dragoon Creek	2	48.05945	117.54394	48.05383	117.54327	1,299
Dragoon Creek	3	48.05383	117.54327	48.04776	117.54066	80
Dragoon Creek	4	48.04776	117.54066	48.03318	117.53493	1,748
Dragoon Creek	5	48.03318	117.53493	48.02373	117.52307	1,603
Dragoon Creek	6	48.02373	117.52307	48.01818	117.51556	842
Dragoon Creek	7	48.01818	117.51556	48.00397	117.51164	1,724
Dragoon Creek	8	48.00397	117.51164	47.99569	117.50193	1,221
Dragoon Creek	9	47.99569	117.50193	47.98941	117.49482	1,131
Dragoon Creek	10	47.98941	117.49482	47.96822	117.49183	2,259
Dragoon Creek	11	47.96295	117.48636	47.96030	117.48713	310
Dragoon Creek	12	47.96030	117.48713	47.95779	117.48636	318
Dragoon Creek	13	47.95779	117.48636	47.95263	117.49612	1,206
Dragoon Creek	14	47.95263	117.49612	47.94543	117.50627	1,326
Dragoon Creek	15	47.94543	117.50627	47.93939	117.50366	1,016
Dragoon Creek	16	47.93939	117.50366	47.93199	117.49851	1,065
Dragoon Creek	17	47.93199	117.49851	47.91555	117.49732	2,076
Dragoon Creek	18	47.91555	117.49732	47.90203	117.48859	3,127
Dragoon Creek	19	47.90203	117.48859	47.88826	117.47037	2,480
Dragoon Creek	20	47.88826	117.47037	47.88599	117.46532	369
Dragoon Creek	21	47.88599	117.46532	47.88471	117.45537	900
Dragoon Creek	22	47.88471	117.45537	47.88808	117.44634	969
Dragoon Creek	23	47.88808	117.44634	47.88346	117.43343	1,227
Dragoon Creek	24	47.88346	117.43343	47.88728	117.42459	828
Dragoon Creek	25	47.88728	117.42459	47.88708	117.38399	4,095
Dragoon Creek	26	47.88708	117.38399	47.88168	117.38303	647
Dragoon Creek	27	47.88168	117.38303	47.87531	117.37361	1,098
Dragoon Creek	28	47.87531	117.37361	47.87424	117.36917	312
Little Deer Creek	1	47.92073	117.14464	47.92359	117.16124	1,334
Little Deer Creek	2	47.92359	117.16124	47.92101	117.16609	511
Little Deer Creek	3	47.92101	117.16609	47.91819	117.18161	1,294
Little Deer Creek	4	47.91819	117.18161	47.91819	117.18621	346
Little Deer Creek	5	47.91819	117.18621	47.92228	117.19484	824
Little Deer Creek	6	47.92228	117.19484	47.92518	117.20695	989

Table D1. Continued.

Stream	Reach	S_Lat. (DD)	S_Long. (DD)	E_Lat. (DD)	E_Long. (DD)	Length (m)
Little Deer Creek	7	47.92518	117.20695	47.91639	117.23165	2,199
Little Deer Creek	8	47.91639	117.23165	47.91707	117.25848	2,082
Little Deer Creek	9	47.91707	117.25848	47.91318	117.26508	656
Spring Creek	1	47.97479	117.47957	47.96030	117.48380	1,690
Spring Creek	2	47.96030	117.48380	47.95779	117.48641	376
WB Dragoon Creek	1	47.97376	117.61878	47.96869	117.60727	1,325
WB Dragoon Creek	2	47.96869	117.60727	47.96921	117.58786	1,776
WB Dragoon Creek	3	47.96921	117.58786	47.96531	117.56820	1,398
WB Dragoon Creek	4	47.96531	117.56820	47.96080	117.56473	596
WB Dragoon Creek	5	47.96080	117.56473	47.95494	117.56034	758
WB Dragoon Creek	6	47.95494	117.56034	47.95197	117.55600	466
WB Dragoon Creek	7	47.94949	117.55707	47.94597	117.55508	487
WB Dragoon Creek	8	47.94597	117.55508	47.94008	117.55166	785
WB Dragoon Creek	9	47.94008	117.55166	47.93908	117.54640	542
WB Dragoon Creek	10	47.93908	117.54640	47.93311	117.53751	1,055
WB Dragoon Creek	11	47.93311	117.53751	47.93615	117.51786	1,690
WB Dragoon Creek	12	47.93615	117.51786	47.93215	117.50510	1,334
WB Dragoon Creek	13	47.93215	117.50510	47.91552	117.49732	2,238

Appendix E.

Table E1. Coordinates of the starting locations of the habitat and fish survey sections and the transect spacing distance for the habitat surveys. Lat.=north latitude; Long.=north longitude; DD=decimal degrees.

Stream	Reach	Section	Lat. (DD)	Long. (DD)	Transect Interval (m)
Beaver Creek	11	1	47.94543	117.50642	6
Beaver Creek	10	3	47.94677	117.50754	6
Beaver Creek	9	18	47.95649	117.51954	6
Beaver Creek	8	27	47.96008	117.52929	3
Beaver Creek	7	38	47.97018	117.53343	6
Beaver Creek	6	54	47.98159	117.53787	3
Beaver Creek	6	56	47.98366	117.53669	3
Beaver Creek	6	57	47.98435	117.53674	4.5
Beaver Creek	5	60	47.98707	117.53838	3
Beaver Creek	4	67	47.98762	117.54645	3
Beaver Creek	3	72	47.98759	117.55314	2
Beaver Creek	2	93	47.99638	117.57572	4
Beaver Creek	1	94	47.99724	117.57664	4
Dragoon Creek	28	4	47.87497	117.37252	10
Dragoon Creek	27	14	47.87899	117.38130	10
Dragoon Creek	26	18	47.88399	117.38354	10
Dragoon Creek	25	21	47.88743	117.38409	10
Dragoon Creek	25	35	47.89439	117.39688	10
Dragoon Creek	25	39	47.89425	117.40311	10
Dragoon Creek	25	47	47.89374	117.41158	10
Dragoon Creek	24	63	47.88693	117.42684	10
Dragoon Creek	23	78	47.88594	117.44057	10
Dragoon Creek	22	91	47.88595	117.45419	10
Dragoon Creek	21	100	47.88657	117.46236	10
Dragoon Creek	20	104	47.88805	117.47001	10
Dragoon Creek	19	111	47.88885	117.47624	10
Dragoon Creek	19	120	47.89649	117.48353	10
Dragoon Creek	19	127	47.90037	117.48568	10
Dragoon Creek	18	138	47.90750	117.48941	10
Dragoon Creek	18	139	47.90832	117.48920	10
Dragoon Creek	18	145	47.90956	117.49339	10
Dragoon Creek	17	166	47.91854	117.49447	8
Dragoon Creek	17	172	47.92515	117.49595	10
Dragoon Creek	16	182	47.93406	117.49927	10
Dragoon Creek	15	200	47.94439	117.50565	8
Dragoon Creek	14	205	47.94819	117.50463	8
Dragoon Creek	13	222	47.95287	117.48927	8
Dragoon Creek	12	230	47.95927	117.48743	7
Dragoon Creek	11	234	47.96209	117.48702	6
Dragoon Creek	10	241	47.97331	117.49429	6
Dragoon Creek	10	253	47.98459	117.49399	6
Dragoon Creek	8	273	47.99869	117.50536	7
Dragoon Creek	9	276	47.99408	117.49911	6
Dragoon Creek	7	282	48.00585	117.51321	8
Dragoon Creek	7	295	48.01307	117.51605	10

Table E1. Continued.

Stream	Reach	Section	Lat. (DD)	Long. (DD)	Transect Interval (m)
Dragoon Creek	6	301	48.01866	117.51750	5
Dragoon Creek	5	310	48.02469	117.52531	4
Dragoon Creek	5	313	48.02719	117.52917	7
Dragoon Creek	4	326	48.03540	117.53690	6
Dragoon Creek	4	330	48.03902	117.53919	6
Dragoon Creek	3	340	48.04817	117.54092	6
Dragoon Creek	2	347	48.05400	117.54317	5
Dragoon Creek	1	362	48.06499	117.54665	5
Little Deer Creek	9	6	47.91600	117.25935	3
Little Deer Creek	8	10	47.91658	117.25496	3
Little Deer Creek	8	21	47.91588	117.23834	3
Little Deer Creek	7	43	47.92429	117.21292	3
Little Deer Creek	7	44	47.92493	117.21160	3
Little Deer Creek	6	60	47.92256	117.19536	3
Little Deer Creek	5	64	47.92042	117.19208	3
Little Deer Creek	4	69	47.91815	117.18626	3
Little Deer Creek	3	79	47.92023	117.16736	3
Little Deer Creek	2	86	47.92318	117.16364	3
Little Deer Creek	1	94	47.92370	117.15215	3
Spring Creek	2	3	47.95903	117.48432	5
Spring Creek	1	9	47.96357	117.48335	10
WB Dragoon Creek	14	1	47.91552	117.49732	10
WB Dragoon Creek	13	5	47.91903	117.49896	10
WB Dragoon Creek	12	26	47.93367	117.50699	10
WB Dragoon Creek	11	39	47.93677	117.52159	6
WB Dragoon Creek	11	46	47.93387	117.53225	8
WB Dragoon Creek	10	59	47.93567	117.54277	6
WB Dragoon Creek	9	66	47.94073	117.54875	8
WB Dragoon Creek	8	72	47.94201	117.55227	5
WB Dragoon Creek	7	81	47.94883	117.55687	5
WB Dragoon Creek	6	87	47.95335	117.55830	6
WB Dragoon Creek	5	92	47.95714	117.56202	3
WB Dragoon Creek	4	98	47.96111	117.56468	5
WB Dragoon Creek	2	121	47.96976	117.59808	2
WB Dragoon Creek	2	134	47.96896	117.60630	3
WB Dragoon Creek	1	142	47.97155	117.61213	2
WB Dragoon Creek	1	143	47.97183	117.61336	2

Appendix F.

Table F1. Mean values (± SD) of habitat parameters measured along transects on Beaver Creek.

Reach	No. Sections	No. Transects	Wet Width (m)	Bankfull Width (m)	Mean Depth (cm)	Mean Max. Depth (cm)
1	1	17	1.8 (± 0.4)	3.7 (± 0.9)	16 (± 4)	28 (± 7)
2	1	17	1.5 (± 0.5)	2.5 (± 0.5)	11 (± 4)	19 (± 6)
3	1	17	1.2 (± 0.5)	2.3 (± 0.7)	17 (± 5)	30 (± 7)
4	1	17	2.2 (± 0.9)	4.1 (± 0.8)	33 (± 10)	69 (± 12)
5	1	17	1.5 (± 0.3)	3.1 (± 0.9)	13 (± 4)	24 (± 6)
6	3	43	1.2 (± 0.4)	4.0 (± 1.7)	22 (± 9)	36 (± 12)
7	1	14	1.6 (± 0.6)	3.2 (± 0.6)	26 (± 11)	41 (± 16)
8	1	17	3.4 (± 2.6)	4.7 (± 3.0)	35 (± 20)	64 (± 32)
9	1	13	1.8 (± 0.5)	3.6 (± 0.9)	24 (± 14)	42 (± 25)
10	1	13	1.9 (± 0.5)	3.1 (± 0.6)	16 (± 8)	28 (± 12)
11	1	13	2.1 (± 0.6)	3.3 (± 0.6)	22 (± 7)	38 (± 10)
Total	**13**	**198**	**1.7 (± 1.1)**	**3.5 (± 1.5)**	**21 (± 12)**	**38 (± 21)**

Table F2. Mean values (± SD) of habitat parameters measured and counted at each survey section on Beaver Creek.

Reach	No. Sections	Gradient (%)	Water Temp. (°C)	Air Temp. (°C)	No. LWD/100 m	No. PP/km
1	1	1.0	10.0	23.0	42	0
2	1	1.0	11.0	24.0	18	0
3	1	1.0	12.5	30.0	18	0
4	1	1.0	10.5	21.0	20	0
5	1	1.0	13.0	27.0	0	10
6	3	1.0 (± 0.0)	12.3 (± 0.3)	21.7 (± 3.5)	7 (± 6)	0 (± 0)
7	1	1.0	10.0	17.0	8	0
8	1	1.0	14.0	25.0	4	30
9	1	1.5	11.0	23.0	27	0
10	1	1.0	9.0	14.0	29	0
11	1	1.0	11.0	26.0	27	10
Total	**13**	**1.0 (± 0.1)**	**11.5 (± 1.4)**	**22.7 (± 4.4)**	**17 (± 12)**	**4 (± 9)**

Table F3. Mean wetted widths, lengths, maximum depths, and residual depths (± SD) of primary pools on Beaver Creek.

Reach	n	Mean Width (m)	Mean Length (m)	Mean Max. Depth (cm)	Mean Residual Depth (cm)
1	0	-	-	-	-
2	0	-	-	-	-
3	0	-	-	-	-
4	0	-	-	-	-
5	1	4.8	7.0	89	70
6	0	-	-	-	-
7	0	-	-	-	-
8	3	7.1 (± 4.3)	6.7 (± 2.1)	108 (± 28)	74 (± 29)
9	0	-	-	-	-
10	0	-	-	-	-
11	1	4.0	6.0	58	37
Total	**5**	**6.0 (± 3.4)**	**6.6 (± 1.5)**	**94 (± 29)**	**66 (± 26)**

Table F4. Mean width (± SD) and percent occurrence of each habitat type observed on Beaver Creek.

Reach	Riffle			Run			Pool		
	n	Width (m)	Occurrence (%)	n	Width (m)	Occurrence (%)	n	Width (m)	Occurrence (%)
1	0	-	0	17	1.8 (± 0.4)	100	0	-	0
2	1	2.5	6	16	1.4 (± 0.4)	94	0	-	0
3	1	0.8	6	16	1.2 (± 0.5)	94	0	-	0
4	0	-	0	17	2.2 (± 0.9)	100	0	-	0
5	1	0.9	6	16	1.5 (± 0.3)	94	0	-	0
6	0	-	0	43	1.2 (± 0.4)	100	0	-	0
7	0	-	0	14	1.6 (± 0.6)	100	0	-	0
8	1	1.8	6	12	2.6 (± 1.1)	70	4	6.2 (± 4.1)	24
9	0	-	0	13	1.8 (± 0.5)	100	0	-	0
10	6	2.1 (± 0.5)	46	7	1.7 (± 0.4)	54	0	-	0
11	1	1.7	8	12	2.2 (± 0.7)	92	0	-	0
Total	**11**	**1.9 (± 0.7)**	**5**	**183**	**1.6 (± 0.7)**	**93**	**4**	**6.2 (± 4.1)**	**2**

Table F5. Mean substrate embeddedness and percent composition of each substrate type (± SD) observed on Beaver Creek.

			Mean Composition (%) of Each Substrate Type								
Reach	**n**	**Embeddedness (%)**	**Organic**	**Muck**	**Silt**	**Sand**	**Gravel**	**Cobble**	**Rubble**	**Boulder**	**Bedrock**
1	17	100 (± 0)	50 (± 22)	49 (± 21)	0 (± 1)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
2	17	95 (± 19)	2 (± 5)	63 (± 47)	13 (± 26)	11 (± 22)	11 (± 23)	0 (± 1)	0 (± 0)	6 (± 13)	0 (± 0)
3	17	100 (± 0)	2 (± 4)	72 (± 14)	26 (± 16)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
4	17	100 (± 0)	0 (± 0)	68 (± 32)	21 (± 20)	0 (± 0)	0 (± 0)	11 (± 32)	0 (± 0)	0 (± 0)	0 (± 0)
5	17	100 (± 0)	9 (± 12)	85 (± 25)	6 (± 24)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	2 (± 7)	0 (± 0)
6	43	100 (± 2)	9 (± 11)	47 (± 34)	26 (± 22)	18 (± 25)	0 (± 0)	0 (± 0)	0 (± 1)	0 (± 0)	0 (± 0)
7	14	88 (± 22)	9 (± 24)	37 (± 44)	5 (± 8)	39 (± 37)	8 (± 18)	1 (± 3)	0 (± 0)	0 (± 0)	0 (± 0)
8	17	100 (± 0)	0 (± 0)	82 (± 39)	18 (± 39)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
9	13	91 (± 19)	0 (± 0)	35 (± 33)	28 (± 21)	29 (± 27)	6 (± 10)	2 (± 4)	0 (± 0)	0 (± 0)	0 (± 0)
10	13	68 (± 19)	0 (± 0)	0 (± 0)	3 (± 6)	72 (± 18)	10 (± 13)	14 (± 11)	2 (± 3)	0 (± 0)	0 (± 0)
11	13	97 (±12)	0 (± 0)	5 (± 5)	19 (± 6)	73 (± 8)	1 (± 2)	1 (± 4)	0 (± 1)	0 (± 0)	0 (± 0)
Total	**198**	**96 (± 13)**	**8 (± 17)**	**51 (± 39)**	**16 (± 23)**	**19 (± 30)**	**3 (± 10)**	**2 (± 10)**	**0 (± 1)**	**0 (± 0)**	**0 (± 0)**

Appendix G.

Table G1. Mean values (± SD) of habitat parameters measured along transects on Dragoon Creek.

Reach	No. Sections	No. Transects	Wet Width (m)	Bankfull Width (m)	Mean Depth (cm)	Mean Max. Depth (cm)
1	1	17	2.5 (± 0.9)	4.7 (± 1.3)	19 (± 9)	35 (± 16)
2	1	17	2.4 (± 0.6)	3.6 (± 0.8)	17 (± 11)	36 (± 16)
3	1	16	2.4 (± 0.6)	3.8 (± 0.9)	21 (± 14)	42 (± 21)
4	2	33	2.8 (± 0.8)	4.3 (± 1.1)	31 (± 13)	53 (± 19)
5	2	31	3.2 (± 1.1)	5.8 (± 1.8)	24 (± 12)	44 (± 22)
6	1	17	2.5 (± 0.8)	4.6 (± 1.2)	26 (± 11)	43 (± 17)
7	2	23	3.7 (± 1.3)	6.6 (± 1.7)	34 (± 16)	61 (± 26)
8	1	12	3.3 (± 0.7)	5.1 (± 0.8)	38 (± 12)	60 (± 20)
9	1	16	2.8 (± 0.8)	5.1 (± 1.2)	33 (± 14)	53 (± 22)
10	2	32	3.5 (± 0.7)	7.1 (± 2.3)	29 (± 12)	50 (± 18)
11	1	14	4.6 (± 1.5)	8.0 (± 1.8)	33 (± 20)	68 (± 28)
12	1	15	3.7 (± 2)	17.5 (± 6.1)	40 (± 12)	72 (± 14)
13	1	13	3.9 (± 1.3)	7.1 (± 2.0)	45 (± 24)	84 (± 24)
14	1	12	3.6 (± 0.8)	10.3 (± 1.5)	38 (± 19)	64 (± 23)
15	1	12	4.8 (± 1.8)	12.9 (± 2.4)	26 (± 12)	43 (± 17)
16	1	10	5.1 (± 0.8)	7.8 (± 0.7)	37 (± 13)	58 (± 21)
17	2	22	4.9 (± 1.8)	8.4 (± 2.1)	32 (± 16)	57 (± 24)
18	3	30	5.9 (± 1.6)	10.1 (± 2.6)	31 (± 15)	57 (± 23)
19	3	30	7.5 (± 2.1)	13.5 (± 4.3)	41 (± 20)	79 (± 27)
20	1	10	7.8 (± 0.6)	10.5 (± 1.2)	57 (± 13)	113 (± 33)
21	1	10	9.6 (± 1.2)	11.6 (± 1.9)	56 (± 21)	96 (± 37)
22	1	10	7.5 (± 2.3)	10.6 (± 2.9)	35 (± 12)	64 (± 19)
23	1	10	8.2 (± 1.7)	17.6 (± 5.4)	33 (± 14)	53 (± 20)
24	1	10	6.4 (± 0.5)	7.4 (± 0.5)	62 (± 10)	96 (± 16)
25	4	40	7.7 (± 1.5)	11.9 (± 2.8)	38 (± 22)	65 (± 26)
26	1	10	6.7 (± 1.9)	11.0 (± 1.6)	29 (± 15)	55 (± 23)
27	1	10	7.1 (± 1.2)	13.3 (± 2.1)	22 (± 7)	46 (± 14)
28	1	10	8.3 (± 1.9)	16.1 (± 2)	27 (± 10)	50 (± 22)
Total	**40**	**492**	**4.9 (± 2.5)**	**8.7 (± 4.5)**	**33 (± 18)**	**59 (± 27)**

Table G2. Mean values (± SD) of habitat parameters measured and counted at each survey section on Dragoon Creek.

Reach	No. Sections	Gradient (%)	Water Temp. (°C)	Air Temp. (°C)	No. LWD/100 m	No. PP/km
1	1	1.5	10.0	14.0	26	70
2	1	1.5	11.5	15.0	21	30
3	1	1.5	9.0	15.0	42	30
4	2	1.5 (± 0.7)	10.5 (± 0.7)	14.5 (± 0.7)	33 (± 6)	30 (± 14)
5	2	1.0 (± 0.0)	14.5 (± 2.1)	21.8 (± 4.6)	17 (± 13)	35 (± 7)
6	1	1.0	10.5	21.0	30	30
7	2	1.5 (± 0.0)	12.8 (± 0.4)	22.8 (± 5.3)	24 (± 22)	25 (± 21)
8	1	1.0	15.0	27.0	26	10
9	1	1.0	14.0	16.0	24	30
10	2	1.0 (± 0.0)	12.0	15.0	19 (± 7)	10 (± 0)
11	1	1.0	15.0	19.0	63	20
12	1	1.0	13.0	24.0	4	0
13	1	1.0	11.0	14.0	10	30
14	1	1.0	12.0	18.0	2	0
15	1	1.0	14.0	25.0	2	10
16	1	2.0	14.0	25.0	4	10
17	2	1.3 (± 0.4)	15.5 (± 2.8)	24.3 (± 4.6)	10 (± 1)	20 (± 0)
18	3	1.7 (± 0.3)	16.5 (± 0.5)	30.8 (± 4.8)	4 (± 4)	17 (± 15)
19	3	1.3 (± 0.3)	15.2 (± 1.9)	24.3 (± 8.0)	3 (± 3)	17 (± 12)
20	1	1.0	13.0	20.0	1	10
21	1	1.0	13.0	20.5	24	10
22	1	1.0	15.5	25.5	8	20
23	1	1.5	13.5	18.0	0	10
24	1	1.0	16.0	33.5	0	0
25	4	1.6 (± 0.3)	15.3 (± 0.9)	18.8 (± 2.9)	7 (± 7)	8 (± 5)
26	1	1.5	19.5	34.0	1	10
27	1	1.0	16.0	24.0	4	10
28	1	1.0	20.0	37.0	2	0
Total	**40**	**1.3 (± 0.3)**	**14.1 (± 2.5)**	**22.2 (± 6.5)**	**14 (± 15)**	**18 (± 15)**

Table G3. Mean wetted widths, lengths, maximum depths, and residual depths (± SD) of primary pools on Dragoon Creek.

Reach	n	Mean Width (m)	Mean Length (m)	Mean Max. Depth (cm)	Mean Residual Depth (cm)
1	7	3.7 (± 0.4)	4.2 (± 1.3)	50 (± 8)	33 (± 4)
2	3	2.8 (± 0.7)	5.3 (± 1.5)	62 (± 6)	42 (± 3)
3	3	3.4 (± 0.4)	5.0 (± 0.3)	73 (± 11)	55 (± 12)
4	6	3.2 (± 0.7)	5.4 (± 0.9)	77 (± 14)	55 (± 15)
5	7	3.7 (± 0.9)	7.6 (± 2.1)	76 (± 17)	57 (± 15)
6	3	3.6 (± 0.9)	5.8 (± 2.9)	74 (± 17)	49 (± 7)
7	5	5.9 (± 1.9)	8.5 (± 3)	104 (± 15)	69 (± 24)
8	1	4.0	3.3	56	50
9	3	3.9 (± 1.3)	6.7 (± 1.8)	88 (± 46)	67 (± 25)
10	2	5.1 (± 0.3)	7.2 (± 3.3)	106 (± 20)	75 (± 14)
11	2	5.3 (± 1.1)	9.1 (± 6.6)	118 (± 4)	89 (± 10)
12	0	-	-	-	-
13	3	5.4 (± 0.2)	8.4 (± 5.1)	122 (± 25)	84 (± 23)
14	0	-	-	-	-
15	1	9.2	19.3	110	79
16	1	6.4	7.4	100	75
17	4	8.6 (± 2.6)	11.2 (± 2.9)	103 (± 15)	79 (± 8)
18	5	8.0 (± 2.1)	7.7 (± 1.7)	97 (± 13)	70 (± 8)
19	5	9.7 (± 2.3)	13.9 (± 3.9)	120 (± 32)	93 (± 15)
20	1	8.5	19.7	180	117
21	1	11.0	17.2	225	175
22	2	10.0 (± 0.4)	10.5 (± 0.6)	125 (± 7)	87 (± 7)
23	1	9.0	11.8	93	72
24	0	-	-	-	-
25	3	7.6 (± 2.7)	10.0 (± 1.1)	120 (± 23)	87 (± 18)
26	1	6.3	29.0	140	89
27	1	6.8	11.6	120	78
28	0	-	-	-	-
Total	**71**	**5.7 (± 2.7)**	**8.5 (± 4.8)**	**94 (± 34)**	**68 (± 26)**

Table G4. Mean width (± SD) and percent occurrence of each habitat type observed on Dragoon Creek.

Reach	Riffle			Run			Pool		
	n	**Width (m)**	**Occurrence (%)**	**n**	**Width (m)**	**Occurrence (%)**	**n**	**Width (m)**	**Occurrence (%)**
1	4	1.4 (± 0.3)	24	5	2.3 (± 0.5)	29	8	3.2 (± 0.7)	47
2	5	2.3 (± 0.5)	28	8	2.4 (± 0.7)	44	5	2.2 (± 0.7)	28
3	6	1.8 (± 0.9)	33	10	2.6 (± 0.5)	56	2	0.7 (± 0.1)	11
4	2	2.0 (± 0.2)	6	23	2.7 (± 0.7)	70	8	3.0 (± 0.8)	24
5	5	2.5 (± 0.8)	16	18	3.2 (± 1.1)	56	9	3.3 (± 1.0)	28
6	2	3.3 (± 0.1)	12	10	2.1 (± 0.5)	59	5	3 (± 1.0)	29
7	4	3.5 (± 0.6)	17	13	3.6 (± 1.3)	57	6	3.9 (± 1.8)	26
8	1	3.8	8	10	3.2 (± 0.8)	84	1	4	8
9	0	-	0	13	2.6 (± 0.4)	81	3	3.9 (± 1.3)	19
10	5	3.8 (± 0.6)	15	25	3.3 (± 0.7)	76	3	3.7 (± 1.7)	9
11	3	3.7 (± 1.6)	19	8	3.8 (± 1.4)	50	5	4.6 (± 1.6)	31
12	0	-	0	15	3.7 (± 2.0)	100	0	-	0
13	3	2.7 (± 2.7)	20	9	3.0 (± 0.7)	60	3	4.9 (± 0.8)	20
14	2	2.8 (± 0.2)	15	11	3.5 (± 1.0)	85	0	-	0
15	8	3.9 (± 0.8)	67	3	5.7(± 1.6)	25	1	9.2	8
16	2	5.3 (± 0.8)	20	7	5.0 (± 0.8)	70	1	5.3	10
17	8	3.6 (± 0.7)	35	10	4.3 (± 1.2)	43	5	7.0 (± 1.1)	22
18	13	4.7 (± 1.6)	39	12	5.6 (± 1.2)	37	8	6.1 (± 2.6)	24
19	4	5.0 (± 2.8)	12	20	6.9 (± 2.0)	61	9	7.4 (± 3.6)	27
20	0	-	0	8	7.7 (± 0.6)	80	2	8.3 (± 0.4)	20
21	1	12.3	10	7	9.3 (± 0.6)	70	2	9.4(± 1.5)	20
22	2	7.4 (± 4.3)	20	6	7.9 (± 1.7)	60	2	6.7 (± 3.5)	20
23	3	6.9 (± 0.6)	30	6	8.7 (± 2.0)	60	1	9.0	10
24	0	-	0	10	6.4 (± 0.5)	100	0	-	0
25	17	7.5 (± 1.5)	40	20	7.6 (± 1.3)	48	5	5.5 (± 3.4)	12
26	7	7.1 (± 2.1)	70	0	-	0	3	5.9 (± 1.0)	30
27	9	7.1 (± 1.3)	90	0	-	0	1	6.9	10
28	7	7.6 (± 1.8)	70	3	10.0 (± 0.7)	30	0	-	0
Total	**123**	**4.9 (± 2.5)**	**24**	**290**	**4.5 (± 2.4)**	**57**	**98**	**4.8 (± 2.6)**	**19**

Table G5. Mean substrate embeddedness and percent composition of each substrate type (± SD) observed on Dragoon Creek.

			Mean Composition (%) of Each Substrate Type								
Reach	**n**	**Embeddedness (%)**	**Organic**	**Muck**	**Silt**	**Sand**	**Gravel**	**Cobble**	**Rubble**	**Boulder**	**Bedrock**
1	17	76 (± 20)	0 (± 0)	1 (± 2)	9 (± 16)	62 (± 19)	26 (± 18)	3 (± 4)	1 (± 2)	0 (± 0)	0 (± 0)
2	17	100 (± 0)	1 (± 5)	0 (± 0)	3 (± 6)	72 (± 14)	23 (± 15)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
3	16	97 (± 10)	1 (± 3)	1 (± 3)	20 (± 26)	71 (± 27)	6 (± 7)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
4	32	100 (± 0)	1 (± 3)	6 (± 12)	12 (± 10)	80 (± 16)	0 (± 2)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
5	31	98 (± 6)	2 (± 4)	2 (± 4)	28 (± 30)	49 (± 30)	19 (± 29)	0 (± 1)	0 (± 0)	0 (± 1)	0 (± 0)
6	17	99 (± 5)	5 (± 7)	3 (± 6)	7 (± 8)	84 (± 12)	0 (± 0)	1 (± 3)	0 (± 1)	0 (± 0)	0 (± 0)
7	23	100 (± 0)	1 (± 2)	6 (± 9)	25 (± 23)	67 (± 26)	2 (± 6)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
8	12	100 (± 0)	2 (± 6)	13 (± 31)	52 (± 40)	33 (± 40)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
9	16	100 (± 0)	0 (± 1)	38 (± 46)	51 (± 40)	11 (± 19)	0 (± 1)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
10	32	91 (± 13)	5 (± 10)	3 (± 14)	54 (± 27)	28 (± 27)	8 (± 16)	1 (± 2)	0 (± 1)	0 (± 2)	0 (± 0)
11	14	92 (± 19)	19 (± 22)	17 (± 34)	41 (± 34)	13 (± 21)	7 (± 15)	2 (± 6)	0 (± 0)	0 (± 0)	1 (± 3)
12	15	100 (± 0)	15 (± 11)	68 (± 34)	8 (± 24)	9 (± 25)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
13	13	90 (± 12)	3 (± 6)	5 (± 11)	13 (± 21)	68 (± 32)	4 (± 8)	6 (± 14)	0 (± 1)	0 (± 0)	0 (± 0)
14	12	73 (± 11)	3 (± 5)	0 (± 0)	4 (± 9)	21 (± 12)	5 (± 5)	58 (± 13)	10 (± 8)	0 (± 1)	0 (± 0)
15	12	37 (± 29)	2 (± 3)	1 (± 3)	9 (± 20)	10 (± 6)	12 (± 15)	30 (± 27)	15 (± 23)	3 (± 6)	20 (± 37)
16	10	51 (± 15)	0 (± 0)	2 (± 2)	1 (± 2)	22 (± 18)	13 (± 18)	59 (± 23)	5 (± 6)	0 (± 0)	0 (± 0)
17	22	64 (± 16)	1 (± 3)	1 (± 5)	5 (± 7)	42 (± 22)	22 (± 22)	25 (± 25)	3 (± 5)	1 (± 2)	0 (± 0)
18	30	62 (± 24)	2 (± 5)	0 (± 0)	4 (± 7)	37 (± 26)	19 (± 19)	33 (± 24)	1 (± 3)	0 (± 1)	4 (± 15)
19	30	70 (± 28)	11 (± 20)	2 (± 6)	16 (± 23)	30 (± 26)	5 (± 7)	20 (± 20)	6 (± 8)	1 (± 2)	9 (± 26)
20	10	98 (± 4)	23 (± 12)	13 (± 11)	7 (± 8)	56 (± 18)	2 (± 2)	1 (± 2)	0 (± 0)	0 (± 0)	0 (± 0)
21	10	83 (± 34)	15 (± 18)	2 (± 3)	5 (± 2)	53 (± 29)	6 (± 8)	9 (± 18)	0 (± 0)	0 (± 0)	7 (± 22)
22	10	54 (± 29)	3 (± 5)	0 (± 0)	3 (± 4)	37 (± 26)	5 (± 7)	35 (± 28)	10 (± 10)	3 (± 3)	7 (± 16)
23	10	75 (± 16)	2 (± 3)	1 (± 2)	6 (± 9)	39 (± 21)	6 (± 5)	29 (± 21)	16 (± 15)	3 (± 4)	0 (± 0)
24	10	70 (± 19)	24 (± 21)	1 (± 2)	1 (± 2)	59 (± 22)	3 (± 4)	13 (± 11)	1 (± 2)	0 (± 0)	0 (± 0)
25	40	59 (± 23)	2 (± 4)	0 (± 1)	4 (± 7)	34 (± 26)	8 (± 11)	23 (± 24)	13 (± 10)	17 (± 20)	0 (± 0)
26	10	28 (± 28)	0 (± 0)	0 (± 0)	0 (± 0)	26 (± 29)	5 (± 7)	16 (± 20)	14 (± 25)	19 (± 22)	11 (± 17)
27	10	44 (± 8)	0 (± 0)	0 (± 0)	0 (± 0)	20 (± 22)	6 (± 6)	43 (± 21)	22 (± 16)	10 (± 8)	0 (± 0)
28	10	51 (± 14)	0 (± 0)	0 (± 0)	0 (± 0)	30 (± 28)	8 (± 9)	32 (± 15)	22 (± 9)	9 (± 4)	0 (± 0)
Total	**491**	**78 (± 27)**	**4 (± 10)**	**6 (± 19)**	**16 (± 25)**	**43 (± 32)**	**9 (± 15)**	**14 (± 22)**	**4 (± 9)**	**2 (± 9)**	**2 (± 11)**

Appendix H.

Table H1. Mean values (± SD) of habitat parameters measured along transects on Little Deer Creek.

Reach	No. Sections	No. Transects	Wet Width (m)	Bankfull Width (m)	Mean Depth (cm)	Mean Max. Depth (cm)
1	1	17	1.1 (± 0.5)	2.5 (± 0.9)	5 (± 2)	10 (± 5)
2	1	17	1.3 (± 0.5)	2.5 (± 0.6)	6 (± 3)	12 (± 4)
3	1	17	1.3 (± 0.4)	3.7 (± 1.1)	6 (± 3)	12 (± 6)
4	1	17	1.2 (± 0.6)	2.9 (± 1.5)	8 (± 5)	16 (± 9)
5	1	17	0.9 (± 0.4)	3.2 (± 1)	4 (± 2)	7 (± 3)
6	1	17	1.2 (± 0.5)	3.2 (± 0.9)	6 (± 3)	10 (± 6)
7	2	34	1.0 (± 0.4)	3.4 (± 1.3)	5 (± 2)	10 (± 4)
8	2	34	1.4 (± 0.4)	3.5 (± 0.8)	7 (± 3)	13 (± 7)
9	1	17	1.6 (± 0.4)	5.6 (± 1.2)	7 (± 4)	14 (± 6)
Total	**11**	**366**	**1.2 (± 0.5)**	**3.4 (± 1.3)**	**6 (± 3)**	**12 (± 6)**

Table H2. Mean values (± SD) of habitat parameters measured and counted at each survey section on Little Deer Creek.

Reach	No. Sections	Gradient (%)	Water Temp. (°C)	Air Temp. (°C)	No. LWD/100 m	No. PP/km
1	1	10.0	8.0	8.5	45	10
2	1	8.0	10.0	12.0	31	10
3	1	5.0	10.0	13.5	28	10
4	1	1.5	11.0	12.0	36	40
5	1	3.0	13.0	14.5	19	10
6	1	3.0	10.0	11.0	19	10
7	2	4.5 (± 0.7)	8.5 (± 0.7)	11.0 (± 2.1)	16 (± 19)	5 (± 7)
8	2	2.5 (± 1.4)	10.5 (± 0.7)	14.8 (± 6)	13 (± 7)	5 (± 7)
9	1	1.0	11.0	15.0	12	20
Total	**11**	**4.0 (± 2.9)**	**10.1 (± 1.4)**	**12.5 (± 2.9)**	**22 (± 13)**	**12 (± 11)**

Table H3. Mean wetted widths, lengths, maximum depths, and residual depths (± SD) of primary pools on Little Deer Creek.

Reach	n	Mean Width (m)	Mean Length (m)	Mean Max. Depth (cm)	Mean Residual Depth (cm)
1	1	2.7	2.7	35	22
2	1	2.1	1.8	23	15
3	1	1.6	4.0	30	20
4	4	1.9 (± 0.4)	2.3 (± 0.2)	39 (± 15)	25 (± 7)
5	1	1.9	2.2	35	22
6	1	2.1	2.2	33	21
7	1	2.6	2.1	22	13
8	1	2.5	3.5	29	19
9	2	2.5 (± 0.1)	3.6 (± 0.6)	27 (± 6)	19 (± 2)
Total	**13**	**2.1 (± 0.4)**	**2.7 (± 0.7)**	**32 (± 10)**	**21 (± 5)**

Table H4. Mean width (± SD) and percent occurrence of each habitat type observed on Little Deer Creek.

Reach	Riffle			Run			Pool		
	n	Width (m)	Occurrence (%)	n	Width (m)	Occurrence (%)	n	Width (m)	Occurrence (%)
1	14	1.0 (± 0.3)	82	0	-	0	3	1.5 (± 1)	18
2	14	1.3 (± 0.5)	82	0	-	0	3	1.5 (± 0.5)	18
3	13	1.3 (± 0.4)	76	0	-	0	4	1.3 (± 0.3)	24
4	13	0.9 (± 0.4)	72	2	1.2 (± 0.6)	11	3	1.9 (± 0.4)	17
5	15	0.8 (± 0.3)	88	0	-	0	2	1.5 (± 0.6)	12
6	16	1.1 (± 0.5)	94	0	-	0	1	2.1	6
7	27	1.0 (± 0.4)	79	3	1.2 (± 0.4)	9	4	1.6 (± 0.7)	12
8	24	1.4 (± 0.4)	70	5	1.6 (± 0.3)	15	5	1.6 (± 0.6)	15
9	13	1.4 (± 0.5)	72	2	1.9 (± 0.1)	11	3	1.6 (± 0.8)	17
Total	**149**	**1.1 (± 0.4)**	**79**	**12**	**1.5 (± 0.4)**	**6**	**28**	**1.6 (± 0.6)**	**15**

Table H5. Mean substrate embeddedness and percent composition of each substrate type (± SD) observed on Little Deer Creek.

			Mean Composition (%) of Each Substrate Type								
Reach	**n**	**Embeddedness (%)**	**Organic**	**Muck**	**Silt**	**Sand**	**Gravel**	**Cobble**	**Rubble**	**Boulder**	**Bedrock**
1	17	24 (± 16)	0 (± 0)	0 (± 0)	5 (± 19)	14 (± 18)	21 (± 17)	30 (± 25)	19 (± 19)	6 (± 12)	5 (± 22)
2	17	54 (± 12)	0 (± 0)	0 (± 0)	2 (± 4)	21 (± 17)	20 (± 23)	29 (± 26)	23 (± 16)	5 (± 6)	0 (± 0)
3	17	61 (± 19)	1 (± 2)	0 (± 0)	11 (± 24)	24 (± 23)	30 (± 26)	13 (± 16)	12 (± 15)	9 (± 18)	0 (± 0)
4	18	39 (± 42)	3 (± 7)	0 (± 0)	8 (± 24)	31 (± 28)	47 (± 31)	7 (± 15)	3 (± 13)	1 (± 5)	0 (± 0)
5	17	54 (± 15)	0 (± 0)	0 (± 1)	7 (± 16)	16 (± 10)	32 (± 20)	24 (± 15)	14 (± 20)	7 (± 16)	0 (± 0)
6	17	42 (± 22)	0 (± 1)	0 (± 0)	1 (± 4)	23 (± 24)	37 (± 29)	27 (± 24)	8 (± 11)	3 (± 6)	0 (± 0)
7	34	57 (± 17)	0 (± 2)	0 (± 0)	7 (± 11)	39 (± 27)	17 (± 15)	16 (± 18)	12 (± 17)	9 (± 19)	0 (± 0)
8	34	52 (± 30)	0 (± 0)	0 (± 0)	5 (± 8)	34 (± 17)	35 (± 20)	18 (± 13)	5 (± 7)	2 (± 8)	0 (± 0)
9	18	47 (± 30)	1 (± 3)	0 (± 0)	19 (± 26)	26 (± 24)	41 (± 30)	5 (± 8)	1 (± 3)	3 (± 12)	0 (± 0)
Total	**189**	**49 (± 25)**	**1 (± 3)**	**0 (± 0)**	**7 (± 17)**	**27 (± 23)**	**30 (± 25)**	**18 (± 20)**	**10 (± 15)**	**5 (± 13)**	**0 (± 7)**

Appendix I.

Table I1. Mean values (± SD) of habitat parameters measured along transects on Spring Creek.

Reach	No. Sections	No. Transects	Wet Width (m)	Bankfull Width (m)	Mean Depth (cm)	Mean Max. Depth (cm)
1	1	10	3.3 (± 0.5)	4.1 (± 0.5)	44 (± 8)	78 (± 10)
2	1	17	4.1 (± 0.9)	5.8 (± 1.1)	27 (± 6)	45 (± 10)
Total	**2**	**27**	**3.8 (± 0.9)**	**5.1 (± 1.2)**	**33 (± 11)**	**57 (± 19)**

Table I2. Mean values (± SD) of habitat parameters measured and counted at each survey section on Spring Creek.

Reach	No. Sections	Gradient (%)	Water Temp. (°C)	Air Temp. (°C)	No. LWD/100 m	No. PP/km
1	1	1.0	10.0	23.0	11	0
2	1	1.0	10.0	19.0	4	0
Total	**2**	**1.0 (± 0)**	**10.0 (± 0)**	**21.0 (± 2.8)**	**8 (± 5)**	**0 (± 0)**

Table I3. Mean width (± SD) and percent occurrence of each habitat type observed on Spring Creek.

Reach	Riffle			Run			Pool		
	n	Width (m)	Occurrence (%)	n	Width (m)	Occurrence (%)	n	Width (m)	Occurrence (%)
1	0	-	0	10	3.3 (± 0.5)	100	0	-	0
2	0	-	0	17	4.1 (± 0.9)	100	0	-	0
Total	**0**	**-**	**0**	**27**	**3.8 (± 0.9)**	**100**	**0**	**-**	**0**

Table I4. Mean substrate embeddedness and percent composition of each substrate type (± SD) observed on Spring Creek.

			Mean Composition (%) of Each Substrate Type								
Reach	n	Embeddedness (%)	Organic	Muck	Silt	Sand	Gravel	Cobble	Rubble	Boulder	Bedrock
1	10	100 (± 0)	24 (± 5)	44 (± 17)	32 (± 19)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
2	17	100 (± 0)	9 (± 9)	4 (± 6)	13 (± 13)	74 (± 14)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
Total	**27**	**100 (± 0)**	**14 (± 11)**	**19 (± 22)**	**20 (± 18)**	**46 (± 38)**	**0 (± 0)**	**0 (± 0)**	**0 (± 0)**	**0 (± 0)**	**0 (± 0)**

Appendix J.

Table J1. Mean values (± SD) of habitat parameters measured along transects on West Branch Dragoon Creek.

Reach	No. Sections	No. Transects	Wet Width (m)	Bankfull Width (m)	Mean Depth (cm)	Mean Max. Depth (cm)
1	2	34	1.0 (± 0.4)	2.4 (± 0.6)	8 (± 5)	14 (± 9)
2	2	34	1.1 (± 0.4)	3.9 (± 2.1)	18 (± 10)	30 (± 14)
4	1	17	2.1 (± 1.2)	4.2 (± 1.1)	38 (± 14)	62 (± 24)
5	1	17	1.3 (± 0.3)	3.7 (± 1.5)	22 (± 9)	39 (± 15)
6	1	16	2.7 (± 1.0)	5.4 (± 2.2)	22 (± 16)	39 (± 27)
7	1	17	2.6 (± 0.8)	6.6 (± 0.6)	18 (± 12)	29 (± 17)
8	1	17	1.9 (± 0.5)	3.2 (± 0.5)	17 (± 5)	31 (± 10)
9	1	12	2.6 (± 0.7)	3.6 (± 0.9)	51 (± 19)	78 (± 25)
10	1	16	2.4 (± 0.7)	5.6 (± 3.1)	41 (± 10)	62 (± 16)
11	2	26	3.2 (± 1.4)	4.8 (± 1.8)	40 (± 16)	64 (± 24)
12	1	10	4.6 (± 0.7)	7.5 (± 1.2)	33 (± 18)	58 (± 32)
13	1	10	4.7 (± 1.1)	7.8 (± 1.4)	17 (± 5)	31 (± 9)
14	1	10	5.1 (± 1.7)	7.3 (± 1.6)	33 (± 17)	64 (± 29)
Total	**16**	**236**	**2.3 (± 1.5)**	**4.6 (± 2.2)**	**25 (± 17)**	**42 (± 27)**

Table J2. Mean values (± SD) of habitat parameters measured and counted at each survey section on West Branch Dragoon Creek.

Reach	No. Sections	Gradient (%)	Water Temp. (°C)	Air Temp. (°C)	No. LWD/100 m	No. PP/km
1	2	1.0 (± 0)	10.8 (± 1.1)	19.5 (± 3.5)	16 (± 1)	0 (± 0)
2	2	1.0 (± 0)	9.5 (± 0.7)	27.5 (± 2.1)	6 (± 5)	10 (± 14)
4	1	1.0	12.0	17.5	20	50
5	1	1.0	14.0	24.0	6	10
6	1	1.0	14.5	23.5	43	10
7	1	1.0	12.0	14.0	5	20
8	1	1.0	13.0	23.5	15	10
9	1	1.0	11.0	23.5	10	10
10	1	1.0	10.5	23.0	17	10
11	2	1.0 (± 0)	10 (± 0)	16.8 (± 3.2)	4 (± 3)	5 (± 7)
12	1	1.0	12.0	26.0	17	0
13	1	1.5	14.0	25.5	16	20
14	1	1.5	12.0	22.0	33	20
Total	**16**	**1.1 (± 0.2)**	**11.6 (± 1.7)**	**21.9 (± 4.3)**	**15 (± 11)**	**12 (± 13)**

Table J3. Mean wetted widths, lengths, maximum depths, and residual depths (± SD) of primary pools on West Branch Dragoon Creek.

Reach	n	Mean Width (m)	Mean Length (m)	Mean Max. Depth (cm)	Mean Residual Depth (cm)
1	0	-	-	-	-
2	2	3.4 (± 1.4)	7.1 (± 1.8)	83 (± 14)	47 (± 8)
4	5	4.7 (± 0.8)	6.0 (± 1.8)	99 (± 26)	77 (± 19)
5	1	3.8	9.4	88	59
6	1	4.0	8.0	130	78
7	2	3.5 (± 1.0)	6.9 (± 0.5)	62 (± 20)	48 (± 16)
8	1	3.2	4.6	79	47
9	1	4.1	6.0	140	120
10	1	3.5	4.5	75	70
11	1	4.5	7.1	67	62
12	0	-	-	-	-
13	2	6.3 (± 0.3)	8.9 (± 1.3)	52 (± 8)	40 (± 7)
14	2	7.4 (± 1.7)	13.1 (± 4.2)	103 (± 43)	63 (± 19)
Total	**19**	**4.6 (± 1.5)**	**7.4 (± 2.8)**	**88 (± 29)**	**64 (± 22)**

Table J4. Mean width (± SD) and percent occurrence of each habitat type observed on West Branch Dragoon Creek.

Reach	Riffle			Run			Pool		
	n	Width (m)	Occurrence (%)	n	Width (m)	Occurrence (%)	n	Width (m)	Occurrence (%)
1	5	0.6 (± 0.2)	15	28	1.1 (± 0.4)	82	1	1.5	3
2	2	0.9 (± 0.1)	6	32	1.1 (± 0.4)	94	0	-	0
4	0	-	0	11	1.4 (± 0.4)	65	6	3.4 (± 1)	35
5	0	-	0	16	1.3 (± 0.3)	94	1	1.6	6
6	3	1.8 (± 0.4)	18	13	2.6 (± 0.9)	76	1	4.0	6
7	6	2.0 (± 0.4)	35	9	2.9 (± 0.7)	53	2	3.5 (± 1.0)	12
8	6	1.8 (± 0.6)	35	11	2.0 (± 0.5)	65	0	-	0
9	1	3.9	8	10	2.5 (± 0.6)	84	1	2.1	8
10	0	-	0	14	2.3 (± 0.7)	87	2	2.8 (± 1.0)	13
11	3	2.6 (± 0.3)	12	21	3.2 (± 1.5)	80	2	3.8 (± 1.0)	8
12	2	4.7 (± 0.4)	20	8	4.5 (± 0.8)	80	0	-	0
13	6	4.4 (± 0.9)	60	2	4.6 (± 1.3)	20	2	5.8 (± 1.0)	20
14	2	2.8 (± 0.4)	18	6	4.4 (± 0.9)	55	3	6.2 (± 2.4)	27
Total	**36**	**2.4 (± 1.4)**	**15**	**181**	**2.1 (± 1.3)**	**76**	**21**	**3.8 (± 1.8)**	**9**

Table J5. Mean substrate embeddedness and percent composition of each substrate type (± SD) observed on West Branch Dragoon Creek.

			Mean Composition (%) of Each Substrate Type								
Reach	**n**	**Embeddedness (%)**	**Organic**	**Muck**	**Silt**	**Sand**	**Gravel**	**Cobble**	**Rubble**	**Boulder**	**Bedrock**
1	34	97 (± 9)	0 (± 0)	2 (± 4)	17 (± 11)	80 (± 13)	0 (± 0)	0 (± 0)	1 (± 4)	0 (± 1)	0 (± 0)
2	34	100 (± 0)	1 (± 4)	5 (± 13)	13 (± 22)	81 (± 30)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
4	17	89 (± 21)	1 (± 3)	33 (± 38)	25 (± 24)	21 (± 25)	14 (± 24)	4 (± 12)	0 (± 1)	0 (± 0)	0 (± 0)
5	17	100 (± 0)	11 (± 7)	14 (± 18)	33 (± 27)	42 (± 32)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
6	16	91 (± 17)	10 (± 27)	13 (± 34)	44 (± 36)	18 (± 26)	7 (± 16)	6 (± 14)	1 (± 3)	0 (± 1)	0 (± 0)
7	17	57 (± 25)	5 (± 3)	5 (± 7)	35 (± 19)	8 (± 12)	10 (± 9)	30 (± 19)	6 (± 8)	1 (± 2)	0 (± 0)
8	17	100 (± 0)	9 (± 27)	32 (± 43)	26 (± 36)	32 (± 41)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
9	12	100 (± 0)	8 (± 17)	0 (± 0)	49 (± 39)	43 (± 36)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
10	16	98 (± 6)	6 (± 8)	1 (± 3)	75 (± 22)	14 (± 20)	2 (± 5)	2 (± 4)	1 (± 2)	0 (± 0)	0 (± 0)
11	26	81 (± 20)	3 (± 10)	11 (± 27)	36 (± 32)	25 (± 21)	7 (± 11)	15 (± 22)	1 (± 3)	1 (± 3)	0 (± 0)
12	10	84 (± 18)	35 (± 37)	5 (± 11)	25 (± 32)	15 (± 15)	2 (± 4)	15 (± 21)	3 (± 4)	1 (± 2)	0 (± 0)
13	10	52 (± 19)	0 (± 0)	0 (± 0)	18 (± 24)	8 (± 9)	7 (± 7)	57 (± 15)	8 (± 10)	3 (± 6)	0 (± 0)
14	10	86 (± 13)	1 (± 2)	4 (± 13)	54 (± 39)	17 (± 26)	11(± 19)	9 (± 8)	2 (± 3)	1 (± 2)	0 (± 0)
Total	**236**	**90 (± 19)**	**5 (± 15)**	**10 (± 23)**	**32 (± 31)**	**39 (± 37)**	**4 (± 11)**	**8 (± 18)**	**1 (± 4)**	**0 (± 2)**	**0 (± 0)**

Appendix K.

Table K1. Locations of thermographs set in the Little Spokane River drainage in 2002. Lat.=latitude, Long.=longitude, and DD=decimal degrees.

Stream	Location	Lat. (DD)	Long. (DD)
Beaver Creek	lower	47.94674	117.50749
Dartford Creek	lower	47.78440	117.41733
Deadman Creek	lower	47.79350	117.37654
Deadman Creek	upper	47.88647	117.13043
Dragoon Creek	lower	47.87513	117.37304
Dragoon Creek	middle	47.93189	117.49815
Dragoon Creek	upper	48.02359	117.52281
Little Deep Creek	lower	47.79656	117.37884
Little Deer Creek	lower	47.91565	117.26078
Little Spokane River	lower	47.78257	117.53023
Little Spokane River	Indian Painted Rocks	47.78072	117.49626
Little Spokane River	Wandermere	47.78464	117.40459
Little Spokane River	Chattaroy	47.89019	117.35413
Little Spokane River	Elk	48.02126	117.27453
Little Spokane River	Scotia	48.10552	117.15319
WB Dragoon Creek	lower	47.91572	117.49860

Appendix L.

Washington State Department of Fish and Wildlife
Fish Program, Science Division
Genetics Lab

8 May 2003

To: Jason McLellan

From: Janet Loxterman

Subject: Little Spokane River Rainbow Trout

We examined the geographic population structure of 11 populations of rainbow trout (*Oncorhynchus mykiss*) from the Little Spokane River. We used genetic diversity at 14 microsatellite loci (*One-102, One-114, Ots-100, Ots-103, One-108, One-101, Ots-3M, Ots-1, Omy-77, Omm-1070, Omm-1130, Omy-1011, Oki-10,* and *Omy-1001*) to assess population structure in the Little Spokane River using 11 collections - Buck Creek (01BU, n=50), Deer Creek (01BS, n=100), Otter Creek (01BQ, n=50), Phalon Lake [redband] rainbow trout (01BN, n=100), Spokane Hatchery [coastal] rainbow trout (00DF, n=100), Lower Dragoon Creek (02AN, n =100), WB Dragoon Creek (02AT, n = 50), Upper Dragoon Creek (02AU, n = 50), Little Deer Creek (02AX, n = 50), Spokane River (02HI = 47), and Deadman Creek (02MB, n = 100).

All 14 microsatellite loci were polymorphic ranging from seven (*Ots-103*) to 52 (*Omm-1130*) alleles per locus. Tests for deviations from Hardy-Weinberg expectations (GENEPOP 3.3) indicated that five microsatellite loci (*One-102, One-108, Ots-1, Omm-1070,* and *Omm-1130*) had a deficiency of heterozygous individuals (Table 1). However, only one locus (*One-108*) deviated in more than three subpopulations, most of the other deviations were in one or two subpopulations thus all loci were retained for the analyses. Linkage tests revealed significant disequilibrium in ten subpopulations (Table 2). Most subpopulations had only a few pairs of loci exhibiting disequilibrium, except for the Otter Creek subpopulation, which had 11 pairs of loci indicating significant linkage disequilibrium. Since most of the loci were in Hardy-Weinberg equilibrium in the Otter Creek subpopulation, the significant linkage is noteworthy but not a serious concern. Overall, like the tests for Hardy-Weinberg equilibrium, there was not a consistent pattern in the loci exhibiting linkage disequilibrium and thus all loci were retained for the analyses.

Heterozygosity estimates were similar among all subpopulations, ranging from 0.7110 (Spokane hatchery) to 0.8420 (Phalon Lake) (Table 3). Both heterozygosity and allelic richness estimates were highest in the Phalon Lake subpopulation (01BN), while the Spokane Hatchery population (00DF) exhibited the lowest estimate of allelic diversity (Table 3). These differences in genetic diversity, specifically allelic richness, may reflect the demographic history of these populations. Phalon Lake was recently derived from several collections, in addition, allozyme data have suggested potential introgression of cutthroat (*O. clarki*) genes into this population, both of which may contribute to the higher genetic diversity observed in this collection. Conversely, several generations of hatchery propagation in the Spokane Hatchery collection may explain the lower genetic diversity exhibited in this collection.

To assess population structure among these subpopulations, we computed several pairwise estimates of genetic differentiation between populations. Estimates of both genotypic population differentiation (GENEPOP 3.3) and F-statistics (ARLEQUIN) revealed significant levels of population structure and genetic differentiation between all population pairs (Tables 4 and 5). Both estimates use allele and genotype frequency data to assess differences between population pairs. These results indicate that these populations of rainbow trout are not randomly interbreeding and thus, represent distinct populations.

Further, the relationships among these distinct rainbow trout populations were examined by calculating Cavalli-Sforza and Edwards pairwise genetic distances (1000 replicates) between population pairs using MICROSAT. These genetic distances were then used to construct a neighbor-joining tree as implemented in PHYLIP. Similar to the population differentiation estimates, the neighbor-joining tree reveals strong support for these populations being genetically distinct. In the tree, the Buck Creek and Spokane Hatchery subpopulations form a cluster (100% bootstrap support); the Little Deer Creek and Deer Creek subpopulations form a group (98% bootstrap support) with Otter Creek (79% bootstrap support); the Phalon Lake subpopulation clustered with Deadman Creek (88% bootstrap support); Lower Dragoon and WB Dragoon Creeks form a group with Upper Dragoon Creek (99% bootstrap support). In addition, there is strong support for the Spokane Hatchery, Buck Creek, WB Dragoon Creek, Lower Dragoon Creek, and Upper Dragoon Creek group (100% bootstrap), while the remaining cluster is more loosely supported (63% bootstrap). The Spokane River subpopulation is weakly supported and does not cluster with any of the other subpopulations (Figure 1).

The relatively close relationship between the Buck Creek collection and the Spokane Hatchery strain may indicate that the *O. mykiss* in Buck Creek represent a population whose ancestry includes a substantial component of coastal rainbow hatchery genes. Similarly, the divergence of the Deer Creek/Little Deer Creek/Otter Creek cluster may indicate that these populations consist largely or entirely of native interior (redband) rainbow with little or no coastal rainbow (hatchery) influence. Further, while the Phalon Lake sample may exhibit some introgression of cutthroat genes, it forms a group with Deadman Creek, which is believed to represent a native strain, suggesting that Phalon Lake is largely a native rainbow subpopulation. This contention is also supported by the Phalon Lake/Deadman Creek group clustering more closely with the Deer Creek/Little Deer Creek/Otter Creek group rather than with the more hatchery influenced strains.

Overall, our results strongly support the contention that these rainbow trout subpopulations are genetically differentiated stocks with one group representing native interior *O. mykiss* and the other exhibiting more coastal *O. mykiss* influence. While these subpopulations represent different rainbow trout stocks, the neighbor-joining tree suggests that there is some geographic structure among the subpopulations. However, the significant levels of both genotypic and genetic differentiation indicate that there is little or no gene flow among these subpopulations of rainbow trout. Since these subpopulations are genetically distinct, any management or conservation plans involving these subpopulations should be consistent with these genetic differences.

Table 1. Probability values for Hardy-Weinberg tests (heterozygote deficiencies) for 14 microsatellite loci in 11populations of rainbow trout. Significant deviations are indicated in bold type.

	Population										
Locus	Lower Dragoon Creek	WB Dragoon Creek	Upper Dragoon Creek	Little Deer Creek	Spokane River	Deadman Creek	Spokane Hatchery	Phalon Lake	Otter Creek	Deer Creek	Buck Creek
One102	**0.0000**	0.9976	0.9416	0.3989	0.0088	**0.0000**	0.7200	0.0662	0.2707	0.0224	0.4298
One114	0.1768	0.4812	0.7897	0.4945	0.0258	0.0762	0.3190	0.2027	0.4541	0.2459	0.8914
Ots100	0.9951	0.7539	0.6071	0.3912	0.0754	0.3178	0.6114	0.0583	0.2075	0.0366	0.4901
Ots103	1.0000	0.5348	0.5997	1.0000	0.2768	1.0000	0.1236	0.5144	0.4599	0.0371	1.0000
One108	**0.0000**	0.0006	0.0043	**0.0000**	0.3155	0.1527	0.6666	**0.0000**	**0.0002**	**0.0000**	0.0036
One101	0.0817	0.1451	0.7871	0.3256	0.1916	0.9271	0.3997	0.4472	0.8556	0.1436	0.1577
Ots3M	0.2429	0.1985	0.5688	0.2067	0.7595	0.5062	0.5296	0.1872	0.0060	0.0659	0.4132
Ots1	**0.0000**	0.0642	0.7053	0.4419	0.3276	**0.0000**	0.6696	0.5300	0.1284	0.7338	0.8218
Omy77	0.0382	0.8411	0.0492	0.3435	0.4734	0.0946	0.0239	0.0485	0.3159	0.2172	0.1492
Omm1070	0.1449	**0.0000**	0.1671	0.0381	0.0109	**0.0000**	0.3058	0.1891	0.2988	0.0973	**0.0000**
Omm1130	0.0001	0.1084	0.0036	0.0465	0.0520	0.0265	0.8220	0.0132	0.0172	**0.0000**	1.0000
Omy1011	0.0782	0.7835	0.0857	0.8994	0.0592	0.3121	0.6806	0.7797	0.8639	0.7147	0.3940
Oki10	0.2533	0.8587	0.9467	0.5179	0.3886	0.8401	0.9658	0.7792	0.6370	0.2673	0.7088
Omy1001	0.0365	1.0000	0.7857	0.7682	0.0260	0.1134	0.9891	0.6718	0.1827	0.7842	0.3032

Table 2. Pairs of microsatellite loci exhibiting significant linkage disequilibrium in ten subpopulations of rainbow trout.

Population	Locus 1	Locus 2	P-value
Lower Dragoon Creek	Omy-77	Omy-1011	0.0000
Lower Dragoon Creek	One-114	Oki-10	0.0000
Lower Dragoon Creek	Ots-1	Omy-1001	0.0000
WB Dragoon Creek	One-102	Ome-108	0.0000
WB Dragoon Creek	Ots-100	One-101	0.0000
WB Dragoon Creek	One-102	Ots-3M	0.0000
WB Dragoon Creek	One-101	Omm-1130	0.0000
WB Dragoon Creek	One-101	Omy-1001	0.0000
WB Dragoon Creek	Ots-3M	Omy-1001	0.0000
Upper Dragoon Creek	Ots-100	One-108	0.0000
Little Deer Creek	One-114	Omy-77	0.0000
Little Deer Creek	One-114	Omy-1001	0.0000
Spokane River	Ots-103	Omy-1001	0.0000
Deadman Creek	One-108	Ots-1	0.0000
Deadman Creek	Omy-77	Omm-1130	0.0000
Deadman Creek	Ots-100	Oki-10	0.0000
Deadman Creek	Oki-10	Omy-1001	0.0000
Spokane Hatchery	Ots-1	Omy-1001	0.0000
Otter Creek	One-114	One-108	0.0000
Otter Creek	One-114	Omy-77	0.0000
Otter Creek	Ots-100	Omy-77	0.0000
Otter Creek	One-108	Omm-1070	0.0000
Otter Creek	Omy-77	Omm-1070	0.0000
Otter Creek	One-102	Omy-1001	0.0000
Otter Creek	Ots-1	Omy-1001	0.0000
Otter Creek	Omy-77	Omy-1001	0.0000
Otter Creek	Omm-1070	Omy-1001	0.0000
Otter Creek	Omm-1130	Omy-1001	0.0000
Otter Creek	Oki-10	Omy-1001	0.0000
Deer Creek	One-114	Ots-1	0.0000
Buck Creek	Omy-77	Omy-1001	0.0000

Table 3. Estimates of genetic diversity within 11 populations of rainbow trout including collection code, sample size (N), heterozygosity (Avg Het), and allelic richness (Ao).

Population	Collection Code	N	Avg Het	Ao
Lower Dragoon Creek	02AN	100	0.7920	11.8496
WB Dragoon Creek	02AT	50	0.7730	9.7441
Upper Dragoon Creek	02AU	50	0.7720	10.3878
Little Deer Creek	02AX	50	0.7210	10.5462
Spokane River	02HI	47	0.7630	10.7284
Deadman Creek	02MB	100	0.7760	11.8176
Spokane Hatchery	00DF	100	0.7110	6.4411
Phalon Lake	01BN	100	0.8420	13.7236
Otter Creek	01BQ	50	0.7590	9.5694
Deer Creek	01BS	100	0.7760	12.2064
Buck Creek	01BU	50	0.8020	11.4069

Table 4. Estimates of genotypic population differentiation between pairs of rainbow trout subpopulations. All comparisons are statistically significant at P < 0.001.

Population Pair	Chi2	df	P-value
WB Dragoon Creek & Lower Dragoon Creek	147.606	28	0.0000
Upper Dragoon Creek & Lower Dragoon Creek	Infinity	28	Highly sign.
Upper Dragoon Creek & WB Dragoon Creek	Infinity	28	Highly sign.
Little Deer Creek & Lower Dragoon Creek	Infinity	28	Highly sign.
Little Deer Creek & WB Dragoon Creek	Infinity	28	Highly sign.
Little Deer Creek & Upper Dragoon Creek	Infinity	28	Highly sign.
Spokane River & Lower Dragoon Creek	Infinity	28	Highly sign.
Spokane River & WB Dragoon Creek	Infinity	28	Highly sign.
Spokane River & Upper Dragoon Creek	Infinity	28	Highly sign.
Spokane River & Little Deer Creek	Infinity	28	Highly sign.
Deadman Creek & Lower Dragoon Creek	Infinity	28	Highly sign.
Deadman Creek & WB Dragoon Creek	Infinity	28	Highly sign.
Deadman Creek & Upper Dragoon Creek	Infinity	28	Highly sign.
Deadman Creek & Little Deer Creek	Infinity	28	Highly sign.
Deadman Creek & Spokane River	Infinity	28	Highly sign.
Spokane Hatchery & Lower Dragoon Creek	Infinity	28	Highly sign.
Spokane Hatchery & WB Dragoon Creek	Infinity	28	Highly sign.
Spokane Hatchery & Upper Dragoon Creek	Infinity	28	Highly sign.
Spokane Hatchery & Little Deer Creek	Infinity	28	Highly sign.
Spokane Hatchery & Spokane River	Infinity	28	Highly sign.
Spokane Hatchery & Deadman Creek	Infinity	28	Highly sign.
Phalon Lake & Lower Dragoon Creek	Infinity	28	Highly sign.
Phalon Lake & WB Dragoon Creek	Infinity	28	Highly sign.
Phalon Lake & Upper Dragoon Creek	Infinity	28	Highly sign.
Phalon Lake & Little Deer Creek	Infinity	28	Highly sign.
Phalon Lake & Spokane River	Infinity	28	Highly sign.
Phalon Lake & Deadman Creek	Infinity	28	Highly sign.
Phalon Lake & Spokane Hatchery	Infinity	28	Highly sign.
Otter Creek & Lower Dragoon Creek	Infinity	28	Highly sign.
Otter Creek & WB Dragoon Creek	Infinity	28	Highly sign.
Otter Creek & Upper Dragoon Creek	Infinity	28	Highly sign.
Otter Creek & Little Deer Creek	Infinity	28	Highly sign.
Otter Creek & Spokane River	Infinity	28	Highly sign.
Otter Creek & Deadman Creek	Infinity	28	Highly sign.
Otter Creek & Spokane Hatchery	Infinity	28	Highly sign.
Otter Creek & Phalon Lake	Infinity	28	Highly sign.
Deer Creek & Lower Dragoon Creek	Infinity	28	Highly sign.
Deer Creek & WB Dragoon Creek	Infinity	28	Highly sign.
Deer Creek & Upper Dragoon Creek	Infinity	28	Highly sign.
Deer Creek & Little Deer Creek	90.236	28	0.0000
Deer Creek & Spokane River	Infinity	28	Highly sign.
Deer Creek & Deadman Creek	Infinity	28	Highly sign.
Deer Creek & Spokane Hatchery	Infinity	28	Highly sign.
Deer Creek & Phalon Lake	Infinity	28	Highly sign.
Deer Creek & Otter Creek	Infinity	28	Highly sign.
Buck Creek & Lower Dragoon Creek	Infinity	28	Highly sign.
Buck Creek & WB Dragoon Creek	Infinity	28	Highly sign.
Buck Creek & Upper Dragoon Creek	Infinity	28	Highly sign.
Buck Creek & Little Deer Creek	Infinity	28	Highly sign.
Buck Creek & Spokane River	Infinity	28	Highly sign.
Buck Creek & Deadman Creek	Infinity	28	Highly sign.
Buck Creek & Spokane Hatchery	Infinity	28	Highly sign.
Buck Creek & Phalon Lake	Infinity	28	Highly sign.
Buck Creek & Otter Creek	Infinity	28	Highly sign.
Buck Creek & Deer Creek	Infinity	28	Highly sign.

Table 5. Pairwise estimates of genetic differentiation (Fst) among 11 subpopulations of rainbow trout. All estimates are statistically significant different from zero at P < 0.001.

	Lower Dragoon Creek	WB Dragoon Creek	Upper Dragoon Creek	Little Deer Creek	Spokane River	Deadman Creek	Spokane Hatchery	Phalon Lake	Otter Creek	Deer Creek	Buck Creek
Lower Dragoon Creek	---										
WB Dragoon Creek	0.01133	---									
Upper Dragoon Creek	0.03168	0.02860	---								
Little Deer Creek	0.03933	0.05715	0.05814	---							
Spokane River	0.06278	0.07654	0.07132	0.07000	---						
Deadman Creek	0.04537	0.05770	0.04834	0.04645	0.06025	---					
Spokane Hatchery	0.10750	0.11180	0.12681	0.16574	0.17187	0.15401	---				
Phalon Lake	0.03141	0.04352	0.05199	0.04828	0.05617	0.02651	0.11669	---			
Otter Creek	0.04312	0.05533	0.05543	0.05907	0.08061	0.06065	0.12349	0.05102	---		
Deer Creek	0.02629	0.04082	0.04748	0.00339	0.05863	0.02914	0.14446	0.03671	0.04413	---	
Buck Creek	0.03502	0.04640	0.05374	0.08468	0.07366	0.07365	0.08829	0.04131	0.05802	0.06381	---

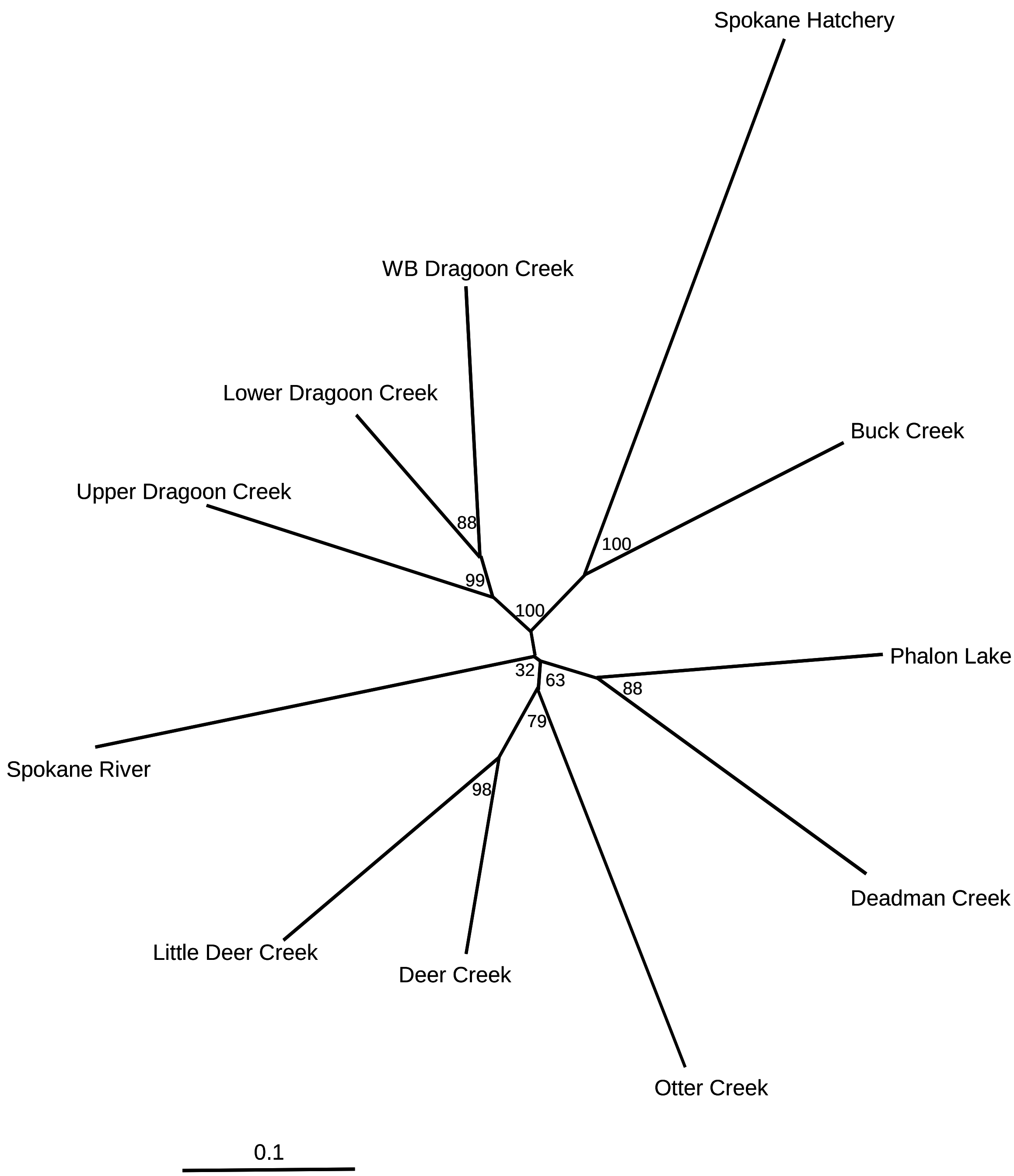

Figure 1. Consensus tree from 1000 neighbor-joining trees based on Cavalli-Sforza and Edwards pairwise genetic distances for 11 populations of rainbow trout. Numbers indicate bootstrap support.

2002 WDFW Annual Report for the Project
RESIDENT FISH STOCK STATUS
ABOVE CHIEF JOSEPH AND GRAND COULEE DAMS

Part II. Coordination, Data Standards Development, and Data Sharing Activities

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June 2003

Introduction

The Resident Fish Stock Status Project, also referred to as the Joint Stock Assessment Project (JSAP), was started in 1998 at the request of tribal and state fish management agencies in the Blocked Area (that part of the Columbia Basin above Chief Joseph and Grand Coulee Dams**).** The primary objective is to jointly perform stock assessment and generate a management plan for protection, mitigation, and enhancement of blocked area resident fish. To perform joint stock assessment, participants need a common database, and early reviews of available data identified both useful collections and major gaps in the biological data record for resident fish.

This project, then, has two main emphases. The "field research" part prioritizes identified data gaps, plans and conducts studies to gather needed baseline data, and provides the analysis required to fully address these gaps. The "data sharing" part of the project coordinates development of common data codes, formats, and standards for priority data categories, and facilitates sharing of these data among not only project participants but Columbia Basin interests at large via a direct connection with the Northwest Power and Conservation Council-funded StreamNet Project. Jason McLellan leads the field research, while Cynthia Burns and I provide coordination, data standards, and data sharing support.

The following summary covers activities from March 1, 2002 through February 28, 2003.

Coordination and Data Standards Development

There was a greater emphasis on data standards development and less on data sharing this year, as the planned work to convert JSAP format fish and habitat data to StreamNet formats hit unforeseen obstacles.

In Spring 2002 the StreamNet Steering Committee was directed to re-prioritize activities to align more closely with the needs of sub-basin planning efforts. As a result, StreamNet data exchange format activities in 2002 centered around hatchery returns, generalized fish distribution, and natural fish escapement, and no significant work on fish/habitat survey data was done. The decision was made to standardize the JSAP data among JSAP participants, using standard geo-spatial referencing, and to provide these data to StreamNet as what StreamNet calls a "Warehouse Dataset". Such data reside at the StreamNet Project headquarters and are accessible via download from the StreamNet Web site, but are not integrated into the query system.

At the same time, the JSAP Steering Committee approved a contract with Cevian, Inc. to design and build a flexible "Unified Database" that would provide standardization across both JSAP datasets and data collections from other entities in the Blocked Area (US Forest Service, etc.). We decided to participate closely in this work to ensure that the final database could extract data and submit it to StreamNet as a "Warehouse Dataset". Thus WDFW headquarters staff contributions to the JSAP Project this year were largely my coordination efforts in providing oversight to the Cevian database development effort.

On July 2, 2002 I met with the JSAP Steering Committee in Spokane to review Cevian's initial database assessment work. Cevian staff were there to respond to my written reactions to their work. In addition, I sent Cevian additional data dictionary and look-up table information supporting the WDFW Stream, Lake and Fish Database (SLFD).

In August, Cevian submitted Version 1 of the Unified Database Schema. I wrote and submitted a detailed review of the schema, questioning the complexity of the table relationships and requesting that further stepwise information be provided to explain how simple queries against this schema would be performed. Cevian complied, and some simplification resulted.

On November 7, 2002 JSAP Steering Committee met again in Spokane to review and provide feedback on the initial UDB data input tool. We also drafted a work plan to load the final application/database, test the system, and develop a process for annual updates (the contract calls for Cevian to only load data provided through the 2001 sampling season).

On December 17, I met with JSAP Data Manager Jim Lemieux and other JSAP participants in Spokane to load the initial input tool onto my laptop and learn the steps necessary to conduct initial system tests, including data loading and roll-back. There were some minor bugs in this first release, and a patched version was provided in January.

Further testing was postponed due to my involvement in other priorities at that time. I expect to return to UDB testing and annual update process development in March.

Data Sharing Activities

WDFW headquarters staff participated in a series of activities supporting compilation, standardization, and sharing of data relevant to the JSAP effort:

- Burns finalized conversions of Blocked Area warmwater fish sampling data to formats that align closely with the current formats used by WDFW JSAP staff.
- Burns began a comparison of these formats with current draft StreamNet Project data formats, which was postponed pending further StreamNet action on the formats.
- I provided Stream, Lake and Fish Database (SLFD) sampling data forms from the Crab Creek drainage to McLellan and Eastern Washington University professor Dr. Al Scholz.
- I provided a comprehensive historical fish stocking summary from Lincoln County to Dr. Scholz.
- Burns updated the JSAP Sampling Sites table with 2001 sites and converted the table from Paradox to Microsoft Access as part of WDFW's migration from Corel to Microsoft software products.
- I provided information to McLellan on obtaining accurate Longitude/Latitude coordinates for sampling sites using the TopoZone Web site.
- I provided copies of the StreamNet EventMapper tool along with instructions for using it to identify LLID codes for 1:100,000 resolution streams to McLellan.

- I received a “final” copy of the bull trout distribution and use data from the Pend Oreille (WRIA 62) Limiting Factors Analysis Technical Advisory Group. The TAG re-labeled some of the data categories and instituted some new categories. I analyzed the product and provided a cross-reference to allow WDFW GIS staff to incorporate these data into the new 1:24,000 resolution statewide fish distribution database under construction. The new bull trout data will be ready for dissemination and mapping in April 2003.

Resident Fish Stock Status above Chief Joseph And Grand Coulee Dams

Spokane Tribe of Indians

2002 Annual Report

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Project Number

199700400

This report contains preliminary data and conclusions that may be subject to change. This report may be cited in publications, but the manuscript status (Annual Report) must be noted.

Abstract

This report contains fish sampling, habitat, and temperature data on Ente' Creek (McCoy Marina), McCoy Creek, Orzada Creek, Sheep Creek, Tshimikain Creek, and Little Tshimikain Creek.

Ente' Creek is a spring fed creek draining into the Spokane Arm of Lake Roosevelt just south of McCoy's Marina. Reach 1 of Ente' Creek started at the confluence of the Spokane arm (water level 1240.4). Fish were sampled in reach 1, but none were sampled above the Lake Roosevelt full pool elevation of 1290. Lack of pool habitat and flow provide habitat for smaller salmonids during the summer but may provide for larger spring spawning during the spring. A fish barrier was observed 1,100 meters upstream from the mouth.

Reaches 1 through 4 of McCoy Creek were sampled for fish; no fish were sampled in any of the reaches. Through personnel communication (B.J. Kieffer and Keith Kieffer), rainbow trout were historically harvested from reach 1 during spring spawning runs and stickleback, and amphipods were present large numbers. Receding lake levels caused by the lack of spring recharge, and the absence of amphipods and minnows has led to a serious decline in the McCoy Lake fishery. Reaches 1 and 2 are fed by springs, which due to urban development and a series of low water years, do not receive enough flow to provide adequate fish habitat. Much of the McCoy Creek channel has been purchased through BPA mitigation dollars. The future project for McCoy Creek is to reconnect reaches 2 and 3 to reestablish flow and to provide spawning opportunity out of McCoy Lake.

Reach 1 of Orazada Creek started at the confluence of the Spokane arm (water level 1284.3), to the Ford Wellpinit Hwy. Habitat was predominately riffles and runs with very few substantial pools. The short distance before entering the Spokane Arm of Lake Roosevelt and dense riparian vegetation insures desirable stream temperatures. Salmonids were sampled near the beginning of reach 1. Similar to Ente' Creek this stream provides summer habitat for younger salmonids and may provide spawning

opportunity for larger salmonids in the spring. The culvert under the highway acts as fish barrier. Flow above the culvert is subsurface while the headwaters remain perennial.

Reach 1 of Sheep Creek started at the confluence of Little Tshimikain Creek to the end of reach 4 which is located at Drum Rd. Although fish were sampled throughout all the reaches, reach 1 had the most salmonids sampled which had a density of 42.45 fish/100m². Reaches 1 through 3 had similar gradients and provided adequate substrate for salmonids. The majority of the fish caught were speckled dace and redside shiners.

Habitat surveys on reaches 1 and 2 of Tshimikain Creek were done in 2002. Fish sampling and habitat surveys will be completed in 2003. The temperatures of Tshimikain Creek exceeded the water quality standards periodically.

Reaches 12 and 13 completed the mainstem habitat surveying on Little Tshimikain Creek. Fish sampling took place in reaches 8 through 13 of Little Tshimikain Creek. Reach 10 had the highest density of fish at 180.88 fish/100m² (predominately non-salmonids). Reach 9 of little Tshimikain Creek produced the most salmonids which had a density of 18.15 fish/100m². Little Tshimikain exceeds water temperature criteria and is influenced heavily by beavers and grazing which is compounded by the low gradient

ACKNOWLEDGEMENTS

We would like to take this opportunity to thank all those that have contributed to the success of the project. Those individuals and organizations that helped contribute in some way to the project are listed below in no particular order.

- Bonneville Power Administration (Funding)
- In memory of DJ Flett (Technician)
- Josh Flett (Technician)
- Lake Roosevelt Fisheries Evaluation Program (Technical and Logistical)
- Spokane Tribal GIS Program (GIS & Mapping)
- Kalispel Tribe (Administration, Funding & GIS)
- Spokane Tribal Wildlife Committee (Permitting)
- Spokane Tribal Hatchery (Technical & Stocking)

Table of Contents

List of Tables

List of Figures

Page

INTRODUCTION

1.1 *OBJECTIVES*

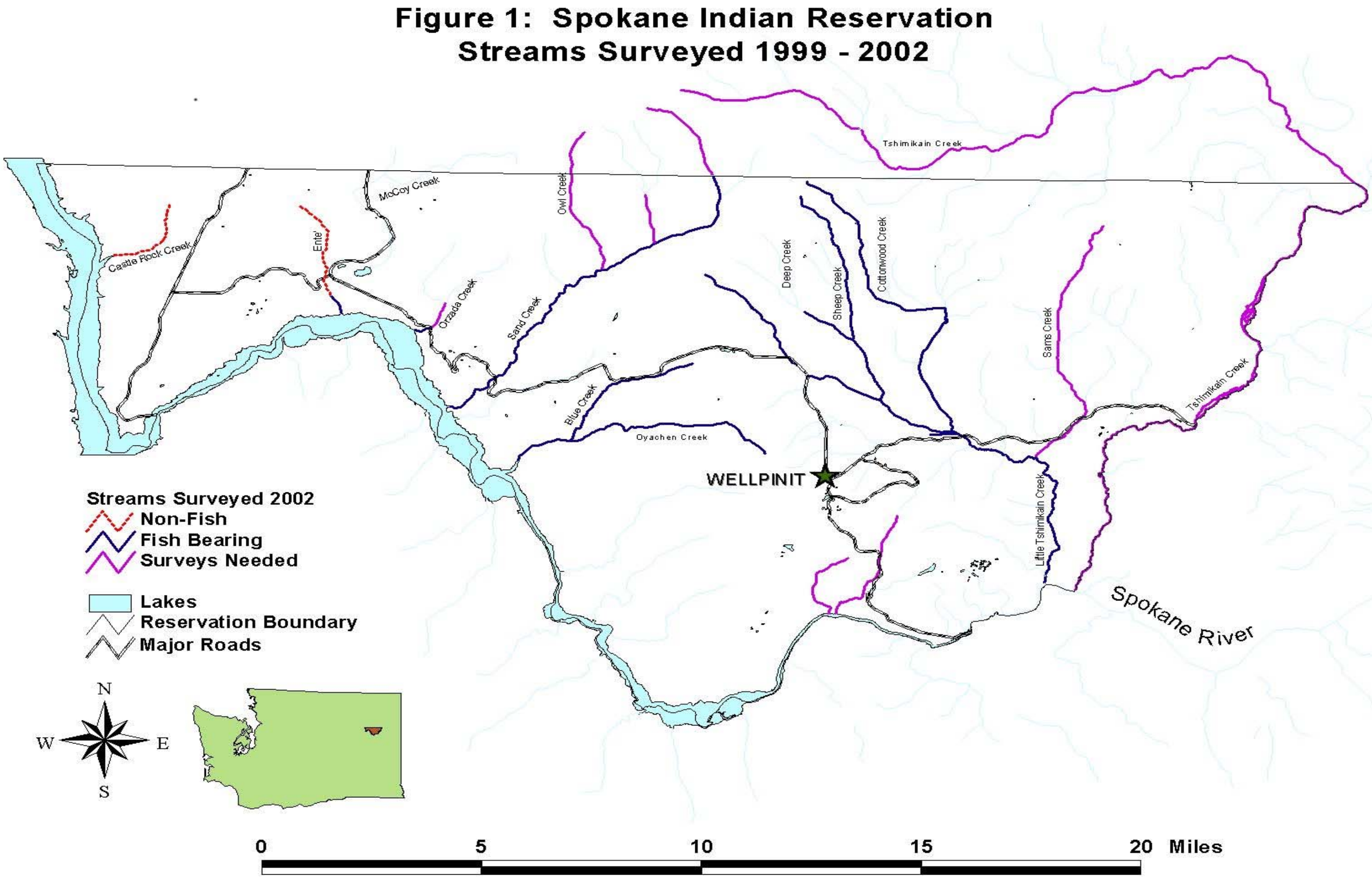
The Spokane Tribe is one of four organizations that are currently working under the “Resident Fish Stock Status above Chief Joseph and Grand Coulee Dams” project. Under this project, the Spokane Tribe will compile and analyze historical fish and fish habitat data on all water bodies within and near the Spokane Indian Reservation (SIR). Current baseline habitat and fisheries data will be collected on all fish bearing waters on or near the SIR. A comprehensive coverage of fish distribution and habitats will be kept in a central database and linked with Geographic Information System (GIS) coverage’s for all areas surveyed. Data collected by other projects such as Lake Roosevelt Monitoring and hatchery-stocking records will be gradually incorporated into the central database.

The first data collected by the Spokane Tribe Indians for this project is reported in the 1999 Annual Report, “Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams” project #199700400. Annual reports may contain only partial data on a stream or lake. Refer to prior and/or subsequent reports to obtain all data available that was collected under this project. This is the 4th annual report for this project.

1.2 DESCRIPTION OF STUDY AREA

Data collection activities in 2002 were concentrated within the Spokane Indian Reservation located in Stevens County Washington. The borders of the SIR are Franklin D Roosevelt Lake to the west, the Spokane River arm of Lake Roosevelt to the south, the 48° parallel to the north, and Tshimikain Creek to the west (Figure 1). The streams of focus for this report are Ente’ (McCoy Marina), McCoy Creek, Orzada Creek, Sheep Creek, Little Tshimikain Creek, and Tshimikain Creek. McCoy Creek flows into McCoy Lake, of which there is no outflow. Little Tshimikain and Tshimikain Creeks flow into the Spokane River in between Little Falls Dam, and Long Lake Dam. Sheep Creek is a tributary of Little Tshimikain Creek. Orzada and Ente’ Creek flow into the Spokane arm of Lake Roosevelt. The name Ente’ Creek has been designated by the Spokane Tribal

Figure 1 **Spokane Indian Reservation Boundary and Water Resources**



Culture and Language Dept (personnel communication, Paulene Flett 2002).

Methods

2.1 Stream Habitat Survey

The stream habitat methodology in 2002 has been changed from what it was in previous years. In 2002, 60-meter transects were measured instead of 90-meter transects. Further analyst indicated that 90-meter transects may misrepresent actual habitat data. Streams were measured by walking in the stream channel using a hip-chain. The information collected at each transect included: habitat identification (i.e. riffle, run, pool), wetted width to the nearest tenth of a meter, water depths at 0.25, 0.5, and 0.75 width to the nearest cm, substrate size (Table 1), and a visual estimate of substrate embeddedness. Channel gradients were obtained using a clinometer with percent scale. The number of primary pools and large woody debris (LWD) were recorded the entire length between transects. Primary pools were identified as those longer or wider than the average stream width. Primary pools also had a maximum depth of at least two times the tail-out depth. Large woody debris was tallied if it was at least a meter in length, and 10cm diameter. Bank full widths and depths were measured at representative sites within each reach.

The length of each reach averaged 24 transects (1,440 meters). Reach breaks were made at 24 transects or at significant changes in stream habitat. Data for each reach and stream was summarized. General observations were recorded into a field notebook.

Table 1 Substrate classifications according to Espinosa (1988)

Organic debris:	undecomposed sticks, leaves, logs, or other woody and herbaceous material
Muck:	decomposed organic material, usually black in color
Silt:	fine sediments with little grittiness
Sand:	< 0.25 inches in diameter
Small Gravel:	0.25 – 1 inches
Coarse Gravel:	1 – 3 inches
Cobble:	3 – 6 inches
Rubble:	6 – 12 inches
Boulders:	> 12 inches
Bedrock:	large masses of solid rock

2.2 Relative Fish Abundance

Within each reach delineated during the habitat survey, the minimum of one site was randomly selected to collect relative fisheries abundance. Fish were sampled using backpack electroshockers according to Reynolds (1996). Fish sample sites were selected not to bisect habitats. Transects included both pool and riffle habitats, and were a minimum of 30 meters in length.

Backpack electroshockers were used at all sites sampled in 2002. A Smith Root model VII, or a model XII were adjusted to the specific water depth and conductivity. A single pass was made on transects with a width only 2-4 times the width of the electro fishing wand. Multiple-pass electro fishing was performed in reaches that were greater than four times the width of the wand, and all transects where salmonids were captured. A single pass was used to determine fish presence in headwaters and above barriers. Fish presence was assumed to extend upstream unless proven otherwise by barriers, lack of flow, and electrofishing. Fish were identified using Wydoski (1979) as well as Simpson (1982).

Fish per 100/m² was calculated based on the length of the sample site as well as the average width. Standard deviation was calculated for those sites where the multiple-pass depletion method was used.

The following size/age classes for salmonid species (Table 2) were determined according to Clearwater National Forest guidelines (Epinosa 1988). The size classifications are general guidelines that were found applicable in other northeastern Washington streams; accepting that not all streams will fall under these guidelines.

Table 2 Size/age class of specific species according to Espinosa (1988)

Species	**Group**	**Size Range**
Rainbow Trout	age 0+	< 65 mm FL
Cutthroat Trout	age 1+	65-110 mm FL
	age 2+	111-150 mm FL
	age 3+	151-200 mm FL
	age 4+	201-305 mm FL
	BIG	> 305 mm FL
Bull Trout	age 0+	< 65 mm FL
Brown Trout	age 1+	65-115 mm FL
Brook Trout	age 2+	116-165 mm FL
	age 3+	166-210 mm FL
	age 4+	211-305 mm FL
	BIG	> 305 mm FL
Sculpin: Record total number of sculpin; by species if possible.		
Sucker: Record total number of suckers; by species if possible.		
Other: Record total number; by species if possible.		

2.3 Temperature Data Loggers

Temperature loggers were placed in the streams main flow and anchored with weights. The temperature data loggers that are used to obtain current stream flow temperatures for the year 2002 on the Spokane Tribe of Indians reservation, are made by Optic Stow Away Temp data loggers, and will record to the nearest ± 0.2 °C. The start dates for the temperature loggers was June 2002, and were collected by November 2002. The data loggers are programmed to take temperature every hour, which allowed maximum, minimum, and daily temperatures for each month. The Spokane Indian Reservation water quality standard has set a maximum seven-day average temperature of 18.50°C for aquatic safe conditions in the months of June 1 through September 1. From September 2, through October 1, and April 2 to the end of May the seven-day maximum average will not exceed 13.50 ºC. From October 2 to April 1, the seven day maximum average will not exceed 11ºC.

Results and Discussion

3.1 Ente' (McCoy Marina)

Reach 1 on Ente' (McCoy Marina) was surveyed in 2002 (Figure 2). The sampling of the fish (Table 10) began at the lake (elevation 1240.4) to the high water mark of 1290. Sampling continued from the high water mark up reach 1 (approximately 400m), though no fish were sampled above the high water mark. Above the ordinary high water mark the lack of primary pool habitat may explain the lack of fish in the upper portion of reach 1. Four rainbow trout (Salmo gairdneri), two brown trout (Salmo trutta), and three sculpin, family Cottidae, where sampled within reach 1. In reach 1 the average depth was 9.3 cm and the average wetted width is 1.6 meters. A total of 11 fish were sampled in reach 1, which had a density of 17.34 fish/100m². The six salmonids that were sampled had a density of 9.46 fish/100m². Out of the six salmonid species, 4 rainbows were considered age 2+, and the 2 brown trout were considered age 1+ (Espinosa A. 1988).

The habitat surveying on Ente' (Table 3) was completed using 90 meter transects, prior to the 2002 protocol change of 60 meter transects. The habitat survey on reach 1 had an average gradient of 4.4%, an average depth of 9.3 cm, and wetted width of 1.6 m. The majority of the substrate is consisted of gravel and sand with an embeddness of 53.7%. The majority of the stream habitat is riffle-run (100%). The average bank full width was 2.1m and the average bank full depth was 35.83cm.

Ente' (Table 3) had a maximum daily average for the month of June 12.27ºC, July 13.74ºC, August 12.54ºC, September 11.99ºC, and October 10.69ºC. The highest seven day maximum average from June to October was 15.48ºC in the month of July. Ente' was within the tribal water quality standards from June 4th to October 30th.

Figure 2 Reach 1 of Ente' Creek

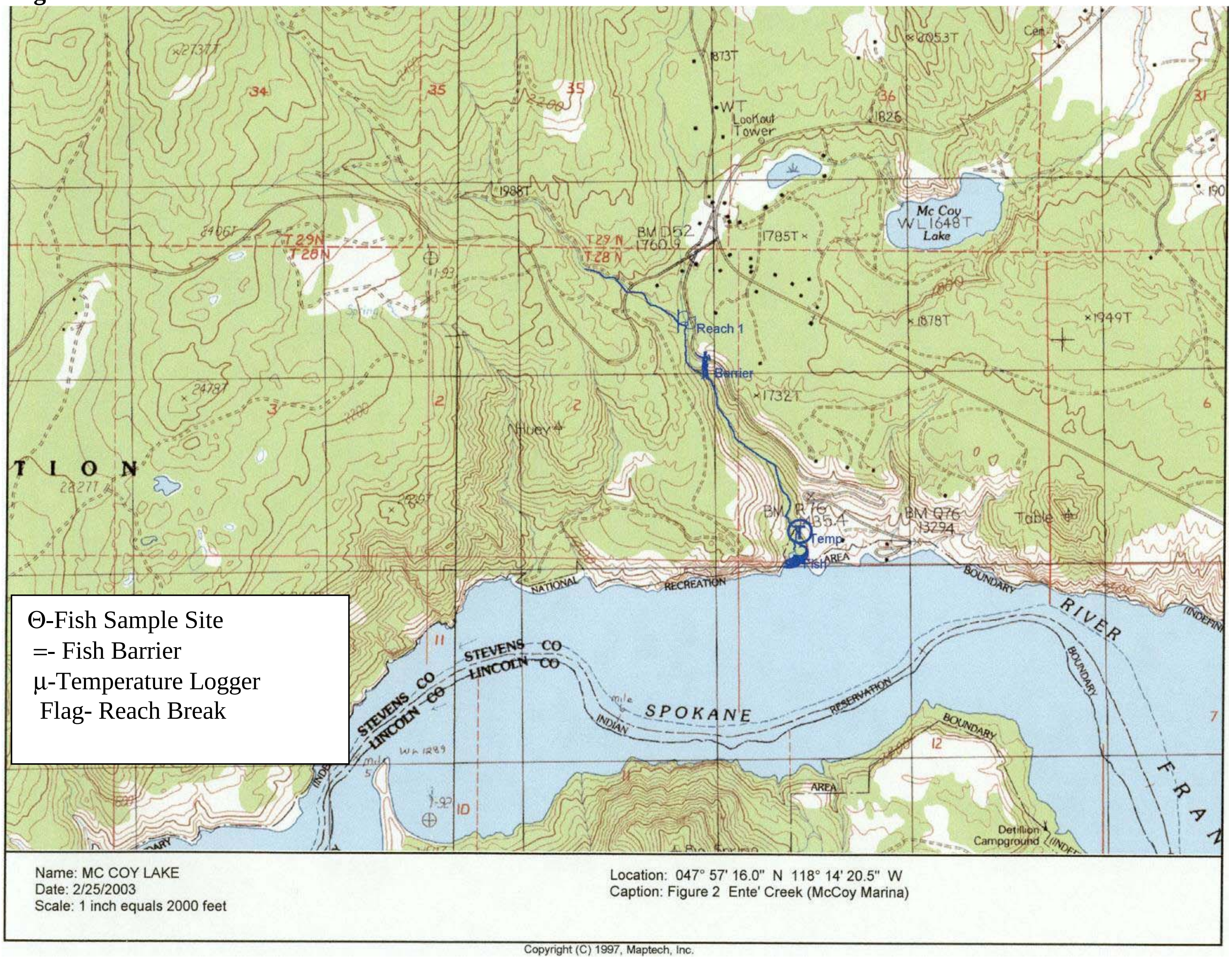


Table 3 Habitat and Temperature Data for Ente' Summer 2002

Habitat

Reach	**1**
Length (m)	1170
Mean Embeddedness	53.7
Min	10
Max	100
Pool-Riffle Ratio	0:1
LWD (#/100m)	70
Primary Pools (#/Km)	7.7
Mean Stream Width (m)	1.6
Mean Stream Depth (cm)	9.3
Mean Gradient (%)	4.4
Min	1
Max	9
Substrate (% Occurrence)	
Bedrock	0
Boulders	0
Rubble	0
Cobble	10.6
Gravel	40.6
Small Gravel	0
Sand	41.5
Silt	7.2
Muck	0
Habitat Types	
Pool (% Occurrence)	0
Mean Width (m)	0
Min Width (m)	0
Max Width (m)	0
Riffle (% Occurrence)	34.8
Mean Width (m)	1.4
Min Width (m)	0.8
Max Width (m)	2
Run (% Occurrence)	65.2
Mean Width (m)	1.4
Min Width (m)	0.7
Max Width (m)	2.5

Data Logger

June High	12.9
June Low	9.64
June avg.	**11.27**
June Daily Max avg.	**12.27**
July High	16.49
July Low	10.27
July avg.	**13.38**
July Daily Max avg.	**13.74**
August High	12.9
August Low	10.27
August avg.	**11.59**
August Daily Max avg.	**12.54**
September High	13.36
September Low	9.8
September avg.	**11.58**
September Daily Max avg.	**11.99**
October High	11.97
October Low	6.09
October avg.	**9.03**
October Daily Max avg.	**10.69**
Total avg. Temp	**11.37**
Highest Temp	**16.49**
Highest Date	**7/11/2002**
Lowest Temp	**6.09**
Lowest Date	**10/30/2002**
Logger Start Date	**6/4/2002**
Logger Finish Date	**10/30/2002**

3.2 McCoy Creek

Four reaches (1-4) were surveyed on McCoy Creek for habitat and fish in 2002 (Figure 3). The majority of the McCoy Creek drainage has been purchased through BPA mitigation dollars. Prior to 1950's, the stream was diverted for farming between reaches two and three and irrigation to the north (Figure 3). Historically, through personnel communication (B.J. Kieffer and Keith Kieffer, 2002), large rainbow trout ran up McCoy Creek from McCoy Lake. B.J and Keith explained how they would harvest the fish in large numbers out of reach 1 of McCoy Creek. The future project for McCoy Creek is to reconnect reaches 2 and 3, and to return flows back into the McCoy Lake. Habitat and fish surveys were completed to identify a baseline for the drainage. The sampling started at the confluence of McCoy Lake and McCoy Creek up to reach 4 of McCoy Creek. Two artificial ponds exist within reach 2 and fish are stocked in the upper of these, but neither was surveyed. Low flows in the spring time and no flow at the confluence (reach 1) at mid to late summer inhibit fish passage to upper reaches.

Water Quality and flow data were collected in reaches 1, 3, and 4 from January 2002, to August 2002 of McCoy Creek (Table 9).

Habitat surveys (Table 4.2) that were conducted on McCoy Creek started at the confluence of McCoy Lake and McCoy Creek, up to the reach 4 of McCoy Creek. The gradient for reach 1 was 4.0% with an average depth of 12.9cm, and an average wetted width of 1.7m. The majority of the substrate was silt (78%), and the average embeddness was 77.6%. The majority of the habitat types consisted of riffle-run (96.9%) habitat, with a small percentage of pool (3.1%) habitat. The bank full width was 1.2m and average bank full depth was 20cm. Because of a non participating land owner, 40m of reach 2 was unable to be surveyed. The gradient for reach 2 was 1.1%, with an average depth of 31.5cm, and an average wetted width of 4.9m. The predominant substrate was silt (100%) and the average embeddness was 100%. The habitat comprised of pools (86.1%), with a small percentage being riffle-run (13.9%). A channel has been dredged throughout reach 2 to confine the flows and reduce the size of the wetland. Reach 2 surveying began at the pond outlet at the Anderson Ranch. Reach 3 had a gradient of 4.1%, with an average depth of 9.9cm, and a wetted width of 1.1m. Average bank full widths and depths was 1.2m and 46.66cm respectively. The majority of the substrate consisted of sand 35.1%, and average embeddness was 63%. Riffles-run was the only habitat found in reach 3. Reach 4 had a gradient of 5.3% with an average depth of 11.8cm and a wetted width of 1.4m. The majority of the substrate was small gravel 40.4% and the average embeddness was 46.8%. The only habitat type for reach 4 was riffle-run.

The three temperature loggers that were placed in McCoy Creek (Table 4.3) are recognized as Lower (reach 1), Middle (reach 3), and Upper (reach 4). Lower McCoy Creek maximum daily average for the month of June was 17.62ºC. The highest seven day maximum average for June was 19.46ºC. Water quality standards were exceeded from June 9th to June 19th. Lower McCoy Creek was dewatered soon after June 25th. Middle McCoy Creek maximum daily average for the month of June was 17.14ºC, July 18.16ºC, August 19.0ºC, September 14.17ºC, and October 10.17ºC. The highest seven day maximum average from June to October was 19.98ºC in the month of August. Water quality standards were periodically exceeded from June 11th to September 1st. Water quality standards were exceeded from September 2nd to September 21st with a highest seven day average of 15.97ºC. Water quality standards were exceeded from October 2nd to October 12th with a highest seven day average of 12.83ºC. Upper McCoy Creek maximum daily average for the month of June was 15.40ºC, July 16.68ºC, August 15.05ºC, September 12.0ºC, and October 6.33ºC. The highest seven day maximum average from June to October was 18.20ºC. Upper McCoy Creek was within the water quality standards set by the Spokane Tribe of Indians from June 4th to October 30th. There are a series of springs above reach 4 that comprise the majority of the summer flows. Numerous houses have been built recently within McCoy Creek drainage and many are using the spring water as their domestic supply. The Department of Natural Resources is exploring ways to restore flows into McCoy Creek and McCoy Lake to restore fish runs out of the Lake.

Figure 3 Reaches 1-4 of McCoy Creek

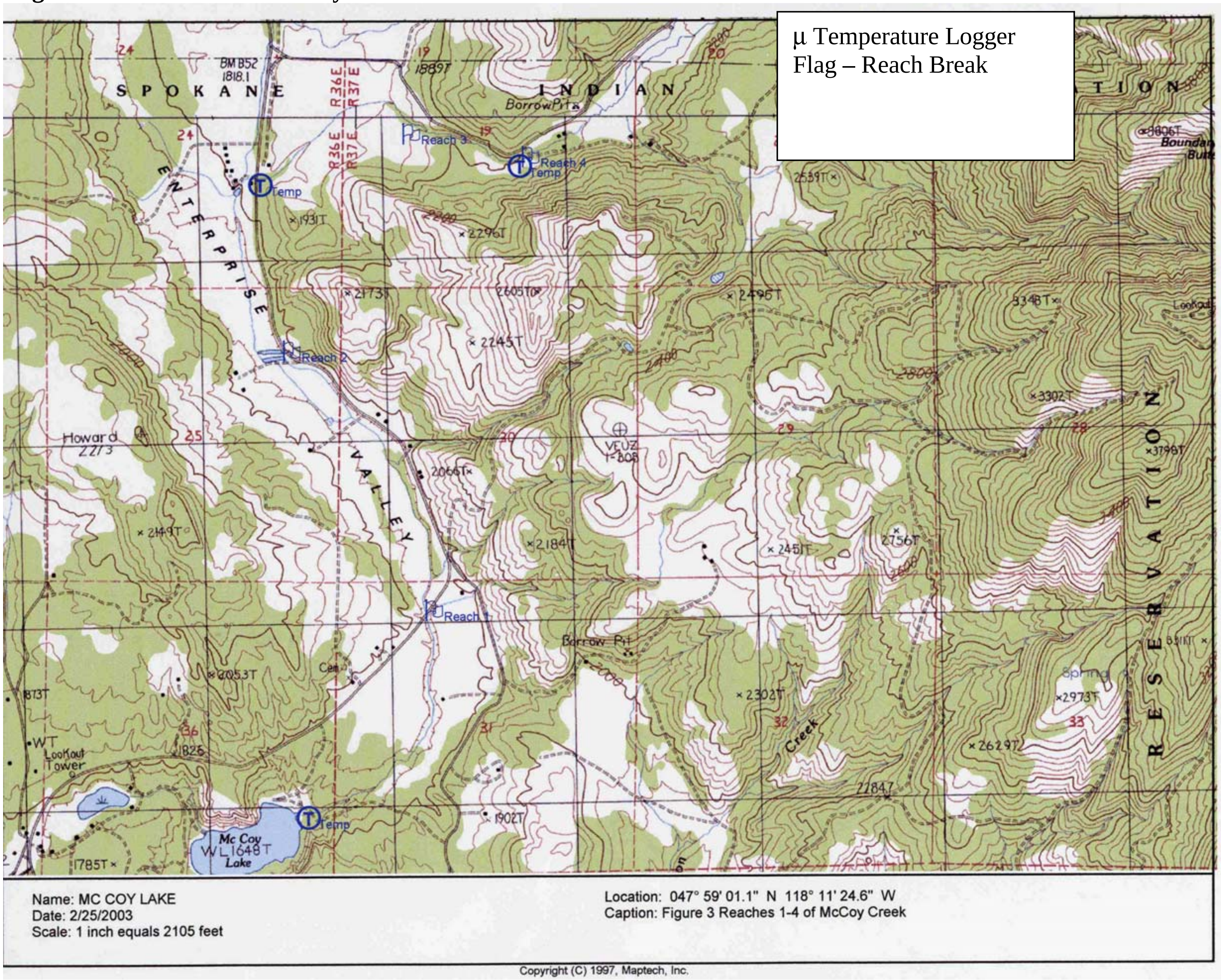


Table 4.1 Habitat Data for McCoy Creek, Summer 2002

Reach	1	2	3	4	Combined
Length (m)	1500	1320	1500	780	5100
Mean Emeddedness	77.6	100	63	46.8	74.4
Min	20	100	20	10	10
Max	100	100	100	100	100
Pool-Riffle Ratio	1:1	N/A	0:1	0:1	5:1
LWD (#/100m)	4.1	0.5	8.3	13.6	5.9
Primary Pools (#/Km)	1.3	3	7.3	5.1	4.1
Mean Stream Width (m)	1.7	4.9	1.1	1.4	2.3
Mean Stream Depth (cm)	12.9	31.5	9.9	11.8	16.7
Mean Gradient (%)	4	1.1	4.1	5.3	3.7
Min	1	1	2	2	1
Max	8	1.5	8	7	8
Substrate (% Occurrence)					
Bedrock	0	0	0	0	0
Boulders	0	0	0	0	0
Rubble	0	0	0	7.9	0.7
Cobble	0	0	26	8.4	4.5
Gravel	11.9	0	25.3	13.5	7.5
Small Gravel	4.9	0	13.7	40.4	6.7
Sand	5.2	0	35.1	29.8	8.9
Silt	78	100	0	0	71.6
Muck	0	0	0	0	0
Habitat Types					
Pool (% Occurrence)	3	86.1	0	0	47.6
Mean Width (m)	1.3	4.6	0	0	4.4
Min Width (m)	1.3	1.7	0	0	1.3
Max Width (m)	1.3	8.2	0	0	8.2
Riffle (% Occurrence)	19.9	0	70.5	86.5	22.5
Mean Width (m)	1.1	0	1.2	1.4	1.2
Min Width (m)	0.6	0	0.8	0.9	0.6
Max Width (m)	1.9	0	1.7	2.5	2.5
Run (% Occurrence)	77	13.9	29.5	13.5	29.9
Mean Width (m)	2.1	7.5	1.1	1.2	2.1
Min Width (m)	0.7	5.2	0.7	1.2	0.7
Max Width (m)	4.2	9.7	1.4	1.2	9.7

Table 4.2 Temperature Data for McCoy Creek, Summer 2002

Data Logger	**Lower (Mc-1)**	**Middle (Mc-3)**	**Upper (Mc-4)**
June High	20.98	20.07	18.11
June Low	7.77	6.92	7.04
June avg.	**14.38**	**13.5**	**12.58**
June Daily Max avg.	**17.62**	**17.14**	**15.4**
July High	0	19.91	19.08
July Low	0	8.46	8.89
July avg.	**0**	**14.19**	**13.99**
July Daily Max avg.	**0**	**18.16**	**16.68**
August High	0	20.89	16.67
August Low	0	8.31	9.97
August avg.	**0**	**14.6**	**13.32**
August Daily Max avg.	**0**	**19**	**15.05**
September High	0	17.97	16.04
September Low	0	5.83	6.73
September avg.	**0**	**11.9**	**11.39**
September Daily Max avg.	**0**	**14.17**	**12**
October High	0	13.56	10.44
October Low	0	0.33	0.61
October avg.	**0**	**6.95**	**5.53**
October Daily Max avg.	**0**	**10.17**	**6.33**
Total avg. Temp	**14.38**	**12.23**	**11.36**
Highest Temp	**20.98**	**20.89**	**19.08**
Highest Date	**6/15/2002**	**8/13/2002**	**7/14/2002**
Lowest Temp	**7.77**	**0.33**	**0.61**
Lowest Date	**6/7/2002**	**10/26/2002**	**10/27/2002**
Logger Start Date	**6/4/2002**	**6/4/2002**	**6/4/2002**
Logger Finish Date	**6/25/2002**	**10/28/2002**	**10/30/2002**

3.3 Orazada Creek

Only one reach was surveyed on Orazada Creek (Figure 4) during 2002. At the top of reach 1 there is a culvert for the Ford Wellpinit Highway, which prohibits fish from passing. Rainbow trout (Salmo gairdneri) brook trout (Salvelinus fontinalis), and sculpin, family (Cottidae), were sampled throughout reach 1 (Table 10). A total of 24 fish were sampled in reach 1, which produced a density of 42.25 fish/100m². Out of the 24 fish sampled, 5 of them were salmonids for a density of 8.80 fish/100m². The ages of the rainbow trout consisted of: 2 that were considered 1+, and 1 that was considered 2+ in age. The ages of the brook trout consisted of, 2 that were considered to be 2+ in age (Epinosa A.1988). Although normal summer flows exclude adult fish habitat, Orazada Creek may provide important spring spawning areas for larger fish.

The habitat survey that was conducted on Orzada Creek (Table 5) started at the confluence with Spokane River (elevation 1284.3). The average gradient for reach 1 was 4.0%, which had an average depth of 42 cm and an average wetted width 0.6 m. The majority of the substrate consisted of gravel, the average embeddness was 31.6%, with the entire stream habitat type riffle-run (100%). The average bank full width and depth was 1.65m and 16.22cm respectively. Above the highway, flow is subsurface for some distance before regaining flow in the upper reaches. Based on the lack of flow and current vegetation, it would be difficult to restore connectivity.

Figure 4 Reach 1 Orazada Creek

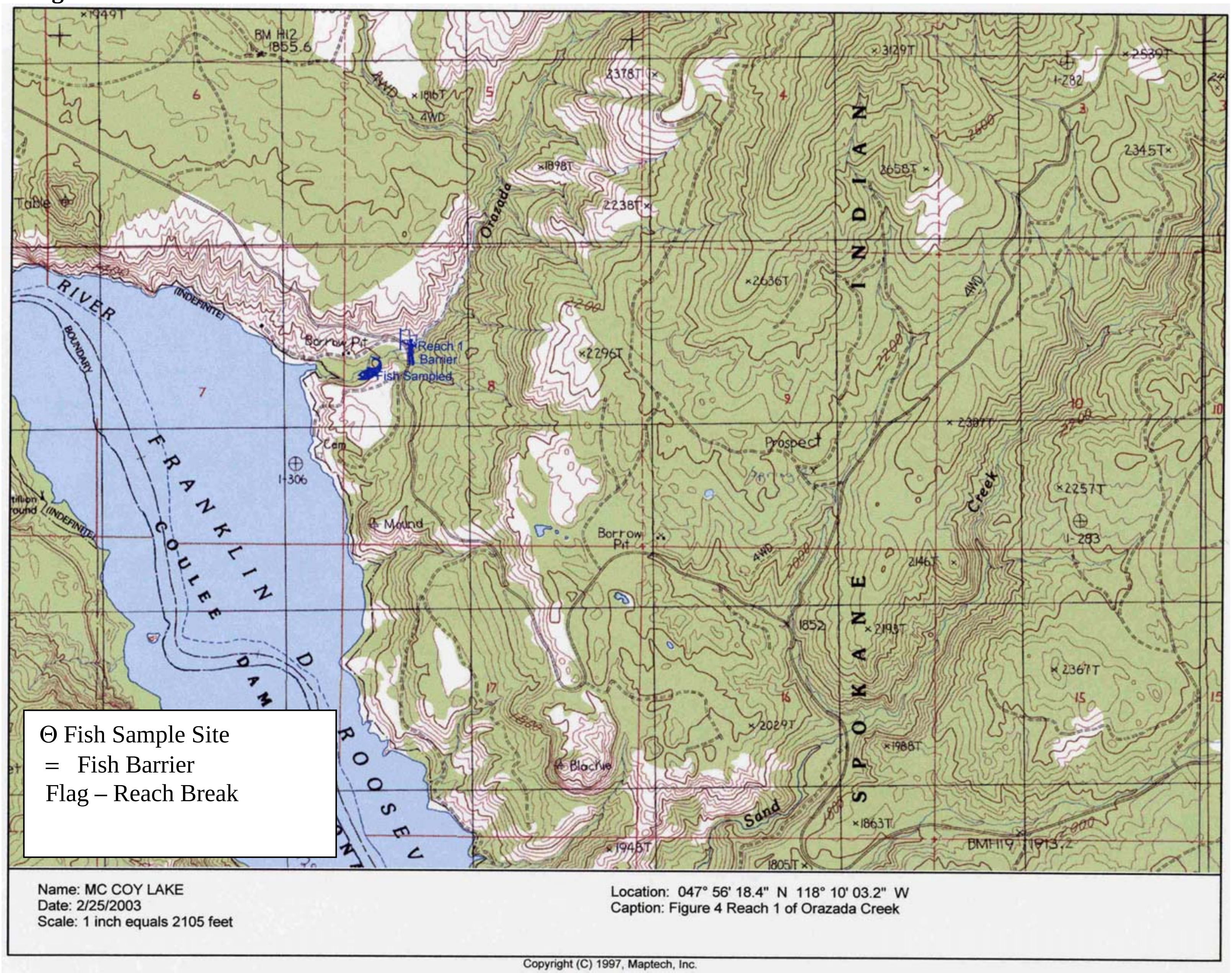


Table 5   Habitat Data for Orazada Creek, Summer 2002

Reach	1
Length (m)	780
Mean Emeddedness	31.6
Min	10
Max	100
Pool-Riffle Ratio	0:1
LWD (#/100m)	12.1
Primary Pools (#/Km)	2.6
Mean Stream Width (m)	0.6
Mean Stream Depth (cm)	4.2
Mean Gradient (%)	4
Min	3
Max	5
Substrate (% Occurrence)	
Bedrock	0
Boulders	0
Rubble	0
Cobble	0
Gravel	43.8
Small Gravel	38.8
Sand	0
Silt	17.5
Muck	0
Habitat Types	
Pool (% Occurrence)	0
Mean Width (m)	0
Min Width (m)	0
Max Width (m)	0
Riffle (% Occurrence)	70
Mean Width (m)	1.1
Min Width (m)	0.7
Max Width (m)	1.4
Run (% Occurrence)	30
Mean Width (m)	1.2
Min Width (m)	1.2
Max Width (m)	1.2

3.4 Sheep Creek

Four habitat reaches were designated on Sheep Creek (Figure 5) in 2002. Rainbow trout (Salmo gairdneri), speckled dace (Rhinichthys osculus), and redside shiner (Richardsonius balteatus) were sampled (Table 10). Rainbow trout (Salmo gairdneri) were the only fish sampled in reach 1, which had a density of 42.45 fish/100m². The ages of the rainbow trout consisted of: 3 that were considered 1+, 17 were considered 2+, and 16 that were considered 3+ in age (Epinosa A. 1988). Rainbow trout, speckled dace, and redside shiners were sampled in reach 2. A total of 97 fish were sampled in reach 2, which had a density of 112.53 fish/100m². Out of the 97 fish sampled, only 4 of them were salmonids, which calculated a density of 4.64 fish/100m². All 4 of the rainbow trout sampled were considered 1+ in age (Epinosa A. 1988). Rainbow trout, speckled dace, and redside shiners were all sampled in reach 3. A total of 109 fish were sampled in reach 3, which had a density of 145.72 fish/100m². Out of the 109 fish sampled, 2 of them were rainbow trout, which had a density of 2.67 fish/100m². The ages of the rainbow trout consisted of: 2 that were considered 1+, and 1 that was considered 2+ (Epinosa A. 1988). The only fish sampled in reach 4 were speckled dace. A total of 35 fish were sampled in reach 4 which had a density of 19.94 fish/100m2. Reaches 1-3 provided better salmonid habitat due to the larger substrate size, low embeddedness, and higher gradient.

The habitat surveys that were conducted on Sheep Creek (Table 6) started at the confluence with Little Tshimikain Creek, up to reach 4 of Sheep Creek next to Drum Rd. The gradients between reaches 1-3 were similar, with an average gradient of 4.1%. The average depth for reach 1 was 10.9 cm and the average wetted width was 1.7m while the average bank full width and depth was 4.1m and 39.17cm respectively. The majority of the substrate consisted of cobble, and the average embeddness was 19.8%. The majority of the habitat type was riffle-run (92.3%) with a small percentage being pool (7.7%) habitat. The average depth for reach 2 was 10.2 cm, and the average wetted width was 1.8m. The average bank full width and depth was 4.6m and 15.17cm respectively. The majority of the substrate consisted of cobble, and the average embeddness was 21.8%. The majority of the habitat type was riffle-run (83.4%), with pool habitat types increasing to (16.6%). The average depth for reach 3 was 9.5 cm and the average wetted width was 1.3m while the average bank full width and depth was 3.4m and 22.83cm respectively.

The majority of the substrate consisted of cobble and the average embeddness was 19.5%. The majority of the habitat type was riffle-run (76.4%), with pool habitat types increasing to (23.6%). The average depth for reach 4 was 23.8 cm, and the average wetted width was 2.7m while the gradient decreased to 1.2%. The majority of the substrate was muck and the average embeddness was 96.8%. The majority of the habitat type was pools (69.1%) while riffle-runs decreased to (30.9%).

No temperature loggers were placed in Sheep Creek. The nearest water quality and flow station is Lt-4 (Figure 6). Similar to many of the streams of Little Tshimikain Creek basin, the upper "Cottonwood Flats" is characterized by low gradient reaches leading towards higher gradients and larger substrate producing better salmonid habitat (Crossley 2001).

Figure 5 **Reaches 1-4 of Sheep Creek**

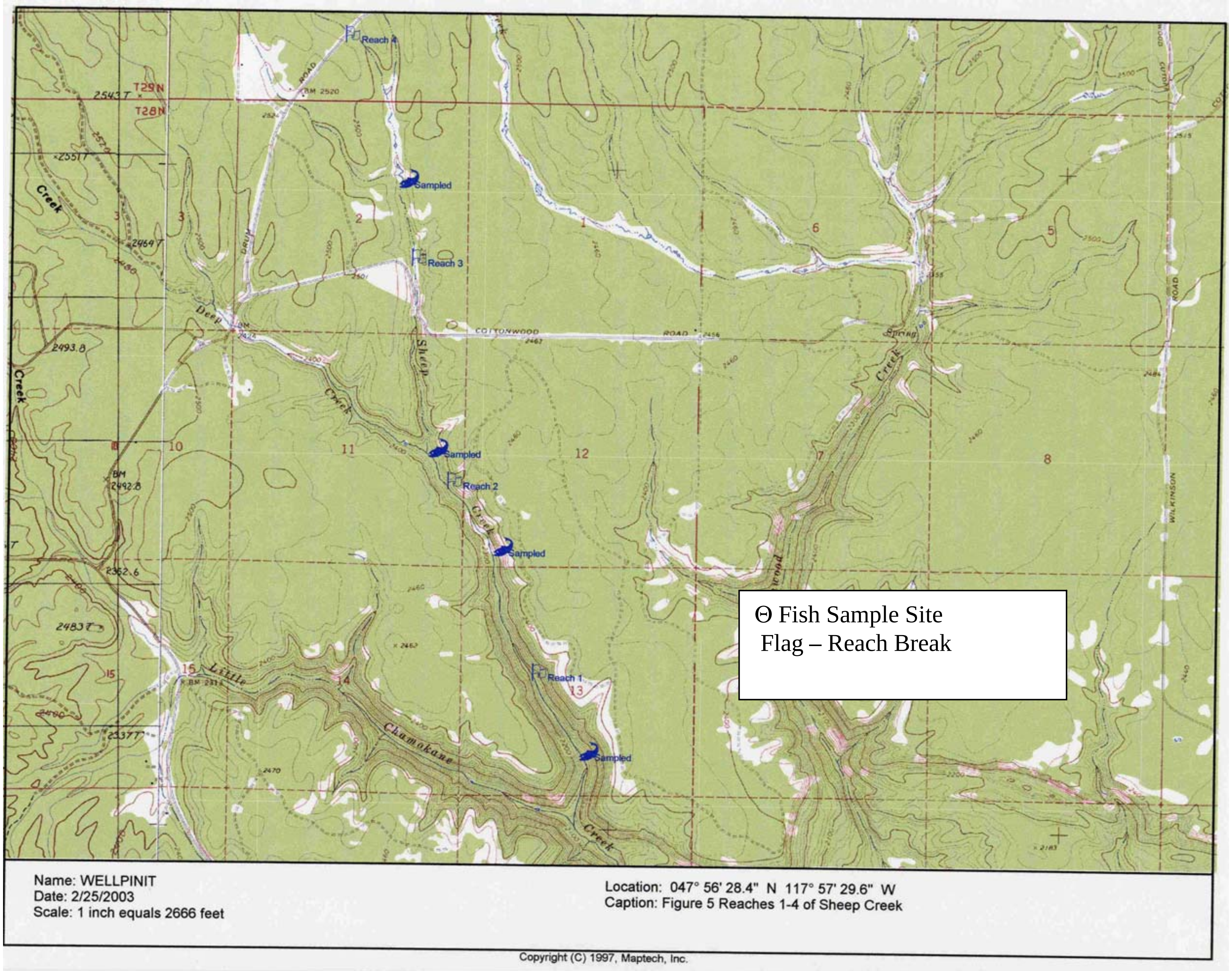


Table 6 Habitat Data for Sheep Creek, Summer 2002

Reach	1	2	3	4	Combined
Length (m)	1500	1500	1500	2040	6540
Mean Emeddedness	19.8	21.8	19.5	96.8	41.1
Min	10	10	10	10	10
Max	68	100	100	100	100
Pool-Riffle Ratio	0:1	3:1	1:1	7:1	8:1
LWD (#/100m)	10.9	11.9	12.7	0	8.1
Primary Pools (#/Km)	14	14	14.7	13.7	14.1
Mean Stream Width (m)	1.7	1.8	1.3	2.7	1.9
Mean Stream Depth (cm)	10.9	10.2	9.5	23.8	14.4
Mean Gradient (%)	4.4	4	3.8	1.2	3.5
Min	3	3	2.5	1.1	1.1
Max	6	5	6	1.3	6
Substrate (% Occurrence)					
Bedrock	0	0	0	0	0
Boulders	0	0	0	0	0
Rubble	17.6	9.1	21.1	0	8.7
Cobble	59.6	60.3	45.9	0	31.7
Gravel	18.1	28.3	20.4	0	12.7
Small Gravel	4.6	2.3	0	0	1.4
Sand	0	0	2.5	19.7	8.9
Silt	0	0	0	3.3	1.4
Muck	0	0	10.1	77	35
Habitat Types					
Pool (% Occurrence)	7.7	16.6	23.6	69.1	38.7
Mean Width (m)	3.3	2.4	1.9	4.5	3.7
Min Width (m)	3.3	2	1.2	1.5	1.2
Max Width (m)	3.3	3	3.2	12	12
Riffle (% Occurrence)	43.4	30.6	11.6	1.4	17.6
Mean Width (m)	1.7	1.5	0.9	0.7	1.4
Min Width (m)	0.9	0.6	0.4	0.5	0.5
Max Width (m)	3.2	2	1.5	0.8	3.2
Run (% Occurrence)	49	52.8	64.8	29.5	43.7
Mean Width (m)	1.6	1.8	1.2	2.3	1.7
Min Width (m)	1.2	1	0.4	0.5	0.4
Max Width (m)	2	3.2	2.3	6.2	6.2

3.5 Tshimikain Creek

Fish sampling on Tshimikain Creek (Figure 6) will be done in the 2003 fiscal year. Water quality and flow data were collected in reach 1 from January 2002, to August 2002 of Tshimikain Creek (Table 9).

Two habitat reaches (1-2) were surveyed on Tshimikain Creek (Table 7.2) in 2002. Habitat surveys that were conducted on Tshimikain Creek started at the confluence of the Spokane River and reach 1 ends at the Martha Boardman Rd. bridge, while reach2 ends at Tshimikain Falls. Reach 1-2 had a gradient of 1.3%. Reach 1 had an average actual depth of 41.1cm and an average wetted width of 7.3m while the bank full width was 10.2m and 39.33cm respectively. The majority of the substrate was gravel 51.1%, and an average embeddness of 27.8%. The majority of the habitat types were riffle (44.5%), run (34.2%), and pools (21.3%). Reach 2 had an average water depth of 41.7cm and a wetted width of 6.1m with an average bank full width of 10.55m and depth 62.83cm. The majority of the substrate was cobble 54.8%, and an average embeddness of 27.7%. The majority of the habitat types were riffle (51.2%), run (27.2%), and pools (21.6%). Mean spring flows have been recorded as high as 626 cfs (USGS, 1997), which aids in the part of fine sediments transport and reduced embeddedness.

The temperature logger placed in Tshimikain Creek (Table 7.3) is recognized as Lower Tshimikain and was placed directly downstream of the lower bridge. Lower Tshimikain daily maximum average for the month of June was 18.02ºC, July 19.97ºC, August 18.46ºC, September 14.55ºC, and October 9.69ºC. The highest seven day maximum average from June to October was 21.60ºC in the month of July. Water quality standards were exceeded periodically from June 10th to September 1st.Water quality standards were exceeded from September 2nd to September 25th with a highest seven day average of 16.14ºC. Water quality standards were exceeded from October 2nd to October 12th with a highest seven day average of 12.44ºC.

Figure 6 Reaches 1-2 of Tshimikain Creek

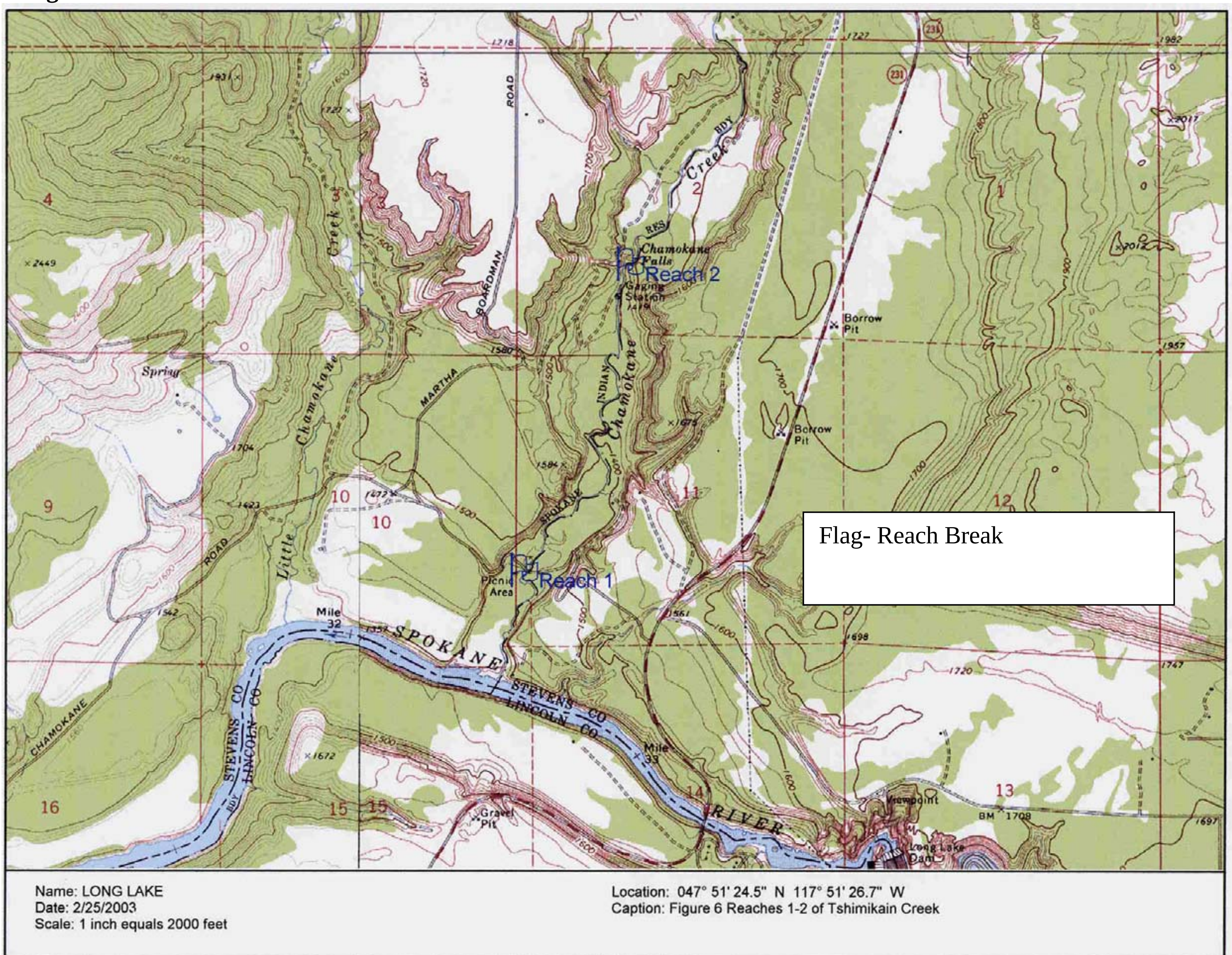


Table 7.1 Habitat Data for Tshimikain Creek, Summer 2002

Reach	1	2	Combined
Length (m)	720	2100	2820
Mean Emeddedness	27.8	27.7	27.7
Min	10	10	10
Max	100	100	100
Pool-Riffle Ratio	3:1	5:1	4:1
LWD (#/100m)	10.3	5.1	6.5
Primary Pools (#/Km)	13.9	15.7	15.2
Mean Stream Width (m)	7.3	6.1	6.4
Mean Stream Depth (cm)	41.1	41.7	41.5
Mean Gradient (%)	1.3	1.3	1.3
Min	1	1	1
Max	2	2	2
Substrate (% Occurrence)			
Bedrock	0	0	0
Boulders	9.2	0	2.7
Rubble	0	5	3.5
Cobble	3.6	54.8	39.9
Gravel	51.1	33.8	38.8
Small Gravel	14.8	0	4.3
Sand	21.3	6.4	10.7
Silt	0	0	0
Muck	0	0	0
Habitat Types			
Pool (% Occurrence)	21.3	21.6	21.5
Mean Width (m)	9.4	5.2	5.9
Min Width (m)	8.7	4.2	4.2
Max Width (m)	10	6.8	10
Riffle (% Occurrence)	44.5	51.2	49.2
Mean Width (m)	6.5	6.5	6.5
Min Width (m)	3.2	3.2	3.2
Max Width (m)	9.6	10.7	10.7
Run (% Occurrence)	34.2	27.2	29.3
Mean Width (m)	7.5	6.5	6.8
Min Width (m)	5	1.5	1.5
Max Width (m)	10.1	8.4	10.1

Table 7.2 Temperature Data for Tshimikain Creek, Summer 2002

Data Logger	**Lower (T-1)**
June High	21.53
June Low	9.59
June avg.	**15.56**
June Daily Max avg.	**18.02**
July High	22.03
July Low	11.31
July avg.	**16.67**
July Daily Max avg.	**19.97**
August High	20.21
August Low	10.38
August avg.	**15.3**
August Daily Max avg.	**18.46**
September High	17.92
September Low	7.27
September avg.	**12.6**
September Daily Max avg.	**14.55**
October High	13.02
October Low	1.48
October avg.	**7.25**
October Daily Max avg.	**9.69**
Total avg. Temp	**13.47**
Highest Temp	**22.03**
Highest Date	**7/14/2002**
Lowest Temp	**1.48**
Lowest Date	**10/30/2002**
Logger Start Date	**6/4/2002**
Logger Finish Date	**10/30/2002**

3.6 Little Tshimikain Creek

Habitat reaches 8 through 11 on Little Tshimikain Creek (Figure 8) were surveyed in 2001. In 2002, habitat surveys were completed on reaches 12 and 13 completing all mainstem habitat surveys on Little Tshimikain Creek.

Water Quality and flow data were collected in reach 8 from January 2002, to August 2002 in Little Tshimikain Creek (Table 9).

Relative fisheries abundance surveys were completed on reaches 8 through 13 in 2002 (Table 10). Speckled dace (Rhinichthys osculus), redside shiner (Richardsonius balteatus), bridgelip sucker (Catostomus columbianus), and rainbow trout (Salmo gairdneri), were all sampled in Little Tshimikain Creek. A total of 14 dace, suckers, and shiners were sampled in reach 8, which had a density of 15.93 fish/100m². A total of 23 fish (rainbow, dace, and shiners) were sampled in reach 9, which had a density of 18.03 fish/100m². Ten of the twenty-three fish were rainbow trout which had a density of 18.15 fish/100m². The ages of the rainbow trout consisted of: 1 was considered 0+, 4 were considered 1+, 3 were considered 2+, and 2 were considered 3+ (Epinosa A. 1988). In reaches 10 through 13 140, 80, 58, and 45 speckled dace and redside shiners were sampled producing densities of 180.88, 365,80, 105.26, and 81.6 fish/100m² respectively.

The habitat surveying for reach 12 (Table 8.2) had a gradient of 1.3%, with an average water depth of 32cm and an average wetted width of 2.2m. The bank full width and depth was 1.7m and 26.67cm respectively. The majority of the substrate was silt 65.8%, with an embeddness of 96.3%. The majority of the habitat types were pools (79.5%), with a small percentage being riffle-run (20.5%) habitat. Reach 13 had a gradient of 1.6% and an average depth of 12.3cm, with an average wetted width of 1.6m. The majority of the substrate was muck (68.1%), with an average embeddness of 86.5%. The majority of the habitat type was riffle-run (75.8%), with a small percentage of pool habitat (24.2%).

The two temperature loggers placed in Little Tshimikain Creek (Table 8.3) are recognized as Lower Little Tshimikain and Upper Little Tshimikain. Lower Little Tshimikain daily maximum average for June was 20.89ºC, July 23.18ºC, August

20.75ºC, September 14.97ºC, and October 8.98ºC. The highest seven day maximum average from June to October was 25.41ºC in the month of July. Water quality standards were exceeded periodically from June 8th to September 1st. Water quality standards were exceeded from September 2nd to September 24th with a highest seven day average of 16.95ºC. Water quality standards were exceeded from October 2nd to October 12th with a highest seven day average of 12.24ºC. Upper Little Tshimikain daily maximum average for June was 20.06ºC, July 22.7ºC, August 18.7ºC, September 15.1ºC, and October 8.68ºC. The highest seven day average from June to October was 25.57ºC in the month of July. The water quality standards were exceeded periodically from June 9th to August 25th. The water quality standards had been exceeded from September 2nd to September 25th with a highest seven day average of 16.57ºC. Water quality standards had been exceeded from October 2nd to October 12th with a highest seven day average of 12.46ºC.

Figure 7 Reaches 8-13 of Little Tshimikain Creek

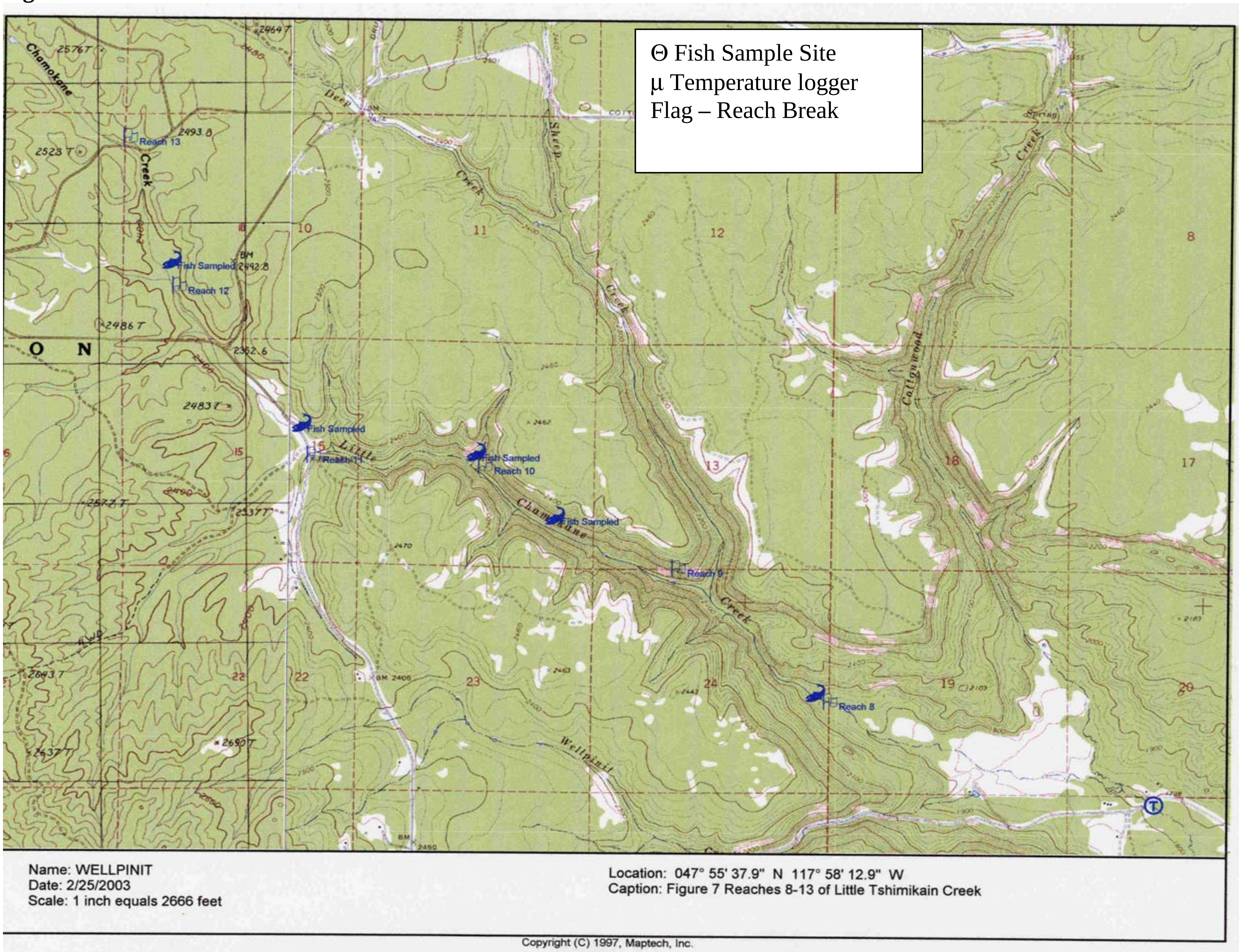


Table 8.1 Habitat Data for Little Tshimikain Creek, Summer 2002

Reach	12	13	Combined
Length (m)	1500	1380	2880
Mean Emeddedness	96.3	86.5	91.6
Min	60	20	20
Max	100	100	100
Pool-Riffle Ratio	N/A	N/A	N/A
LWD (#/100m)	6.3	17.4	11.6
Primary Pools (#/Km)	14.7	12.3	13.5
Mean Stream Width (m)	2.2	1.6	1.9
Mean Stream Depth (cm)	32	12.3	22.6
Mean Gradient (%)	1.3	1.6	1.4
Min	1	1	1
Max	2	2	2
Substrate (% Occurrence)			
Bedrock	0	0	0
Boulders	0	0	0
Rubble	0	2.8	1.1
Cobble	0	3.6	1.4
Gravel	0.9	1.7	1.2
Small Gravel		4.4	1.7
Sand	2.1	13.3	6.5
Silt	65.8	6.1	42.5
Muck	31.2	68.1	45.6
Habitat Types			
Pool (% Occurrence)	79.5	24.2	57.9
Mean Width (m)	3.7	4.4	3.8
Min Width (m)	1	0.8	0.8
Max Width (m)	15	7.9	15
Riffle (% Occurrence)	0	0	0
Mean Width (m)	0	0	0
Min Width (m)	0	0	0
Max Width (m)	0	0	0
Run (% Occurrence)	20.5	75.8	42.1
Mean Width (m)	1	1.4	1.3
Min Width (m)	0.5	0.5	0.5
Max Width (m)	1.7	4	4

Table 8.2 Temperature Data for Little Tshimikain Creek, Summer 2002

Data Logger	Lower Little (LT-1)	Upper Little (LT-2)
June High	25.93	24.6
June Low	10.56	10.93
June avg.	**18.25**	**17.77**
June Daily Max avg.	**20.89**	**20.06**
July High	26.81	26.69
July Low	12.88	12.79
July avg.	**19.85**	**19.74**
July Daily Max avg.	**23.18**	**22.7**
August High	22.83	20.41
August Low	11.64	11.24
August avg.	**17.23**	**15.83**
August Daily Max avg.	**20.75**	**18.7**
September High	19.71	19.92
September Low	9.32	6.44
September avg.	**14.52**	**13.18**
September Daily Max avg.	**14.97**	**15.1**
October High	13.04	13.25
October Low	2.31	0.62
October avg.	**7.68**	**6.94**
October Daily Max avg.	**8.98**	**8.68**
Total avg. Temp	**15.5**	**14.69**
Highest Temp	**26.81**	**26.69**
Highest Date	**7/12/2002**	**7/12/2002**
Lowest Temp	**2.31**	**0.62**
Lowest Date	**10/27/2002**	**10/29/2002**
Logger Start Date	**6/4/2002**	**6/4/2002**
Logger Finish Date	**10/29/2002**	**10/29/2002**

Table 9 Water Quality and Flow Averages from January to August 2002

Streams	Temp	D.O.	Cond.	pH	Flow
Mc-1	5.97	11.59	345.62	8.25	0.67
Mc-3	6.89	11.02	281.58	8.47	0.71
Mc-4	9.07	10.4	277.09	7.43	1.28
T-1	8.76	11.49	308.24	8.03	43.33
Lt-4	6.68	10.98	107.9	7.5	8.59

Table 10 Shocking Data for Fish Sampling, Summer 2002

Steam	Reach	Method	Area(m2)	Total Fish Sampled	Density (#/100m2)	Total Salmonid	Salmonid Density (#/100m2)	Depletion Calculation: Pop. Est. #/100m2	Lower/Upper Pop. Conf. Inter.
Ente'	1	shock	64.35	11	17.34	6	9.46		
Orazada	1	shock	56.8	24	42.25	5	8.8	8.80	6.21/11.71
Sheep	1	shock	84.8	36	42.45	36	42.45	47.17	36.50/57.84
Sheep	2	shock	86.2	97	112.53	4	4.64	4.64	2.38/6.90
Sheep	3	shock	74.8	109	145.72	2	2.67		
Sheep	4	shock	175.5	35	19.94	0	0	0	0
L-Tshimikain	8	shock	87.9	14	15.93	0	0	0	0
L-Tshimikain	9	shock	127.6	23	18.03	10	7.83	7.34	5.71/9.96
L-Tshimikain	10	shock	77.4	140	180.88	0	0	0	0
L-Tshimikain	11	shock	21.87	80	365.8	0	0	0	0
L-Tshimikain	12	shock	55.1	58	105.26	0	0	0	0
L-Tshimikain	13	shock	55.1	45	81.6	0	0	0	0

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Resident Fish Stock Status Above Chief Joseph And Grand Coulee Dams

Colville Confederated Tribes 2002 Annual Report

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Abstract: This report is for the time period of March 1**,** 2002 Through February 28, 2003

The Colville Tribes primary objective is to cooperatively work with the Kalispel Tribe on the Joint Stock Assessment Project (JSAP) to find, compile and transform as much existing historical Colville Tribes data into an acceptable electronic form. These data are then incorporated into the centralized JSAP database at the Kalispel office. Historical data has been gathered for over 30 years by the Colville Confederated Tribes, Fish and Wildlife Department. Data from before1990 is mostly in hardcopy form. After 1990, these data are a mixture of hardcopy forms and different electronic formats. All that meets the requirements outlined by the Kalispel Tribe needs to be verified, entered, and formatted before it is copied and distributed to participants in an acceptable electronic format. The Colville Tribes collected, entered, verified, transformed, and delivered 488,899 kilobytes of data to the Kalispel Tribe for inclusion into the JSAP database in 2002. Although we had hoped to produce more data considerable knowledge has been acquired that should increase data production next year.

Introduction

The Resident Fish Stock Status Project, also referred to as the Joint Stock Assessment Project (JSAP), was started in 1998 at the request of tribal and state fish management agencies in the blocked area (that part of the Columbia Basin above Chief Joseph and Grand Coulee Dams**).** The primary objective is to jointly perform stock assessment and generate a management plan for protection, mitigation, and enhancement of blocked area resident fish. To perform joint stock assessment, participants need a common database, and early reviews of available data identified both useful collections and major gaps in the biological data record for resident fish.

The Colville Confederated Tribes is one of four organizations that are currently working under the Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams project. The Colville Confederated Tribes (CCT), under this project, will compile, analyze and transform historical fish and fish habitat data on all water bodies within and near the Colville Indian Reservation (CIR).

Information gathered by other CCT projects will be provided to the JSAP for inclusion. Information considered important for inclusion includes habitat information, fish distribution information, stocking histories, and results of enhancement projects, and monitoring and evaluation data. The JSAP database is an important planning and critical management tool for activities such as implementing management recommendations and measuring progress toward achieving stated goals and objectives in the Upper Columbia Blocked Area Management Plan and Subbasin Plans. The CCT will assist with this effort by gathering needed historical baseline data.

Goal: To gather, verify, enter, and deliver all existing fish and fish habitat data collected by the Colville Tribes Fish and Wildlife and Environmental Trust Departments for inclusion into the JSAP database.

Objective 1. Utilize existing data and ongoing research in order to compile a complete inventory of the baseline conditions of resident fish stocks and habitat in the Blocked Area.

Task 1:Compile and consolidate relevant fish and habitat data on the Colville Reservation and adjacent water bodies.

1.1: Purge and consolidate the Tribal Fish and Wildlife Division, Tribal Environmental Trust and Tribal Water Quality Division databases (both electronic and hardcopy) into acceptable database formats for inclusion into the centralized database maintained by the Joint Stock Assessment Project.

Objective 2. Use the centrally stored and managed data collection to cooperatively manage the Blocked Area.

Task 1: Provide technical and public representation and satisfy project administrative requirements.

1.1 Attend project coordination and development meetings

1.2 Provide quarterly and annual reports

Methods

Hardcopy and electronic data was collected from CCT Fish and Wildlife, and Environmental Trust departments. Electronic data were verified for accuracy and the departments were contacted when information was needed to clarify information or if data appeared inaccurate to determine the potential cause and correct error whenever possible. Data was filtered to reduce redundancies and insure precision before electronic copies were formatted into Microsoft Excel or Access formats and transmitted or delivered to the Kalispel Tribe for inclusion into the JSAP database. Hardcopy data was collected, organized, and categorized to determine its usefulness for inclusion into the JSAP database. Before data was entered any data of questionable accuracy or quality was either considered important or disregarded based in interviews with other multiple CCT departmental fish biologists. Hardcopy data that was determined to be meet the criteria set-up by the Kalispel Tribe for inclusion was entered into Microsoft Excel or Access formats using electronic scanning when possible and entered by hand and reviewed for accuracy when this was not possible. Once a month, accumulated data was sent to the Kalispel Tribes for inclusion into the main database unless the quantity of data required this to be sooner or no data needed to be sent. Regular meetings and phone conversations with the Kalispel Tribe were used to insure data meet the establish standards for inclusion into the JSAP database and to exchange programmatic information. The CCT staff was involved in all JSAP meetings to provide input to the database development and data collection.

Results

Through the performance period of this contract, the CCT provided 488,899 kilobyte of data for inclusion into the JSAP database (Table 1). Early in the performance period, little data was processed because CCT staff did not have a clear understanding of the duties and procedures. These problems were rectified and the CCT staff now has a clear understanding of the duties and considerable improvements were made in data processing later in the year. Technological problems were encountered with attempting to enter data into Win-fin. This software was used in an attempt to produce synergies with data entry by providing a standard platform that would be functional for both JSAP and the Colville Tribes Fish and Wildlife Department purposes. At present these issues have been worked out and data entry is proceeding and if additional problems arise in the future it is possible to us another platform (i.e. direct entry into Excel). Technological problems were also encountered with electronic scanning equipment and software. Documents had large numbers of errors and fixing these errors often took more time then entering the document by hand. New Omnipage9 software is being used in an attempt to fix these problems and work is ongoing. If this new software does not improve data-entry efficiencies of hardcopy documents, then keyboard data entry will be used and scanning procedures will no longer be considered an option.

Table 1. All documents delivered by the Colville Tribes during 2002 to the Kalispel Tribe for inclusion into the JSAP database with reference numbers, titles, and file sizes.

2002 JSAP documents and file sizes			
Document Name		**kb**	**MB**
Environmental Trust Data			
1	RBThabpassimprv2001SOW	42	
2	BPA Bonn Env Foundation Proposal 2nd	178	
3	Rainbow Trout Project Notes	19	
4	HGMP Attachment 1	26	
5	198503800	387	
6	198503800n	2385	
7	198503800nfinal	2414	
8	198503800part1	360	
9	1998AOP2	47	
10	2001RevisedAOP	358	
11	2001SOWccthat	284	
12	8503800-2000	211	
13	8503800-2001	333	
14	8503800	7	
15	85038002000	423	
16	CCT Hatchery ID	19	
17	CCTHAT~3	4	
18	CCTHGMPRBT1	375	
19	Fish Hatchery	1744	
20	FY-2001IntSOWAOP	82	
21	FY-2001full.SOWAOPletter	81	
22	HGMP	140	
23	HGMP1	150	
24	HGMPEBT	791	
25	HGMPTABLE1	172	
26	Int.AOP2001	135	
27	LEGALR~1	20	
28	PRODUC-97	387	
29	PRODUC-98	508	
30	Prodrept95	116	
31	Rainbow Trout	31	
32	Rational	21	
33	Production report 1996	200	

Table 1. Continued

Document Name		kb	MB
34	Stocking list	19	
35	TABLE 24 96 Hatchery and Netpen Release Data	75	
36	Winthrop 1980 marking and planting info	307	
37	HGMPEBT	811	
38	Figure2HGMP	70	
39	Figure1RBTHGMP	70	
40	Est. Tribal Harvest CJD/10 yr avg.	552	
41	Est. Tribal Harvest CJD/1980	1526	
42	Est. Tribal Harvest CJD/1981	1486	
43	Est. Tribal Harvest CJD/1982	1344	
44	Est. Tribal Harvest CJD/1983	1858	
45	Est. Tribal Harvest CJD/1984	1428	
46	Est. Tribal Harvest CJD/1985	956	
47	Est. Tribal Harvest CJD/1986	1213	
48	Est. Tribal Harvest CJD/1987	1233	
49	Est. Tribal Harvest CJD/1988	900	
50	Est. Tribal Harvest CJD/1989	1831	
51	Est. Tribal Harvest CJD/1990	578	
52	Est. Tribal Harvest CJD/1991	951	
53	Est. Tribal Harvest CJD/1992	625	
54	Est. Tribal Harvest CJD/1993	1704	
55	L.G Temp D.O. July 79	9126	
56	Little Goose EBTStocking History pg.1	6625	
57	Little Goose RBTStocking History pg.2	7467	
58	Omak Lake Creel data dec98-nov99	3501	
59	Omak Lake Creel data dec99-nov00	5551	
60	Omak Lake creel census 7/80 2/8	4382	
61	Owhi Lake Creel Winter98	72	
62	Survey Form 1-30-98 (scan)	3955	
Total Environmental Trust Data			**72.7**
Tribal Reservation Lake Studies			
63	Misc. Word Documents	48400	
64	FairBanks' Redband Report2002	47	
65	Creel Info Twin Lakes80(scan)	12992	

Table 1. Continued

	Document Name	kb	MB
66	1996 Hatchery and Netpen Release Data	75	
67	LRHI Accomplishments 1996	22	
68	LRHI Accomplishments By Year	19	
69	LRHI structure and Plant assessment October	24	
70	Edmund Broch, Associate Professor, WSU	13200	
	Total Reservation Lake Studies		**74.8**
	Misc. Lake Documents		
71	Misc. Word Documents	48200	
72	199001800_part1	322	
73	199001800_part2	178	
74	CBFWA Amendment LegEdits	2804	
75	SanPoil Sub C&D	29	
76	SanPoilSummary	7151	
77	CCT IRMP FEIS 9-2-2000	7353	
78	FEIS Abstract FEIS Summary	24	
79	FEIS Summary	1505	
80	IRMP Appendix	1290	
	Total Misc. Lake Documents		**69**
	FOLDERS On Local Drive		
81	Forms & form Making Info	76000	76
82	Common Names & ID Pictures, Word Documents 10	5120	5.21
83	042500E 150+ Documents	64000	64
84	042500D 238 Documents & Pictures	88200	88.2
	Excel Documents Processed		
85	Colville Table 1	16	
86	Data Entry (Winfin)	893	
87	LLID’s	35	
88	LRHIplants	23	
89	MultiYear Comparisons	79	
90	North Twin Area Codes	14	
91	South Twin Area Codes	14	
92	Bull Trout Streams	19	

Table 1. Continued

	Document Name	kb	MB
93	Bull Trout Streams other	30	
94	SCREWTRAP_SD(creel data)	69	
95	409 excel Documents, Creel Data	7362	
96	GCD BOR data 1940 to 1950	1464	
97	GCD BOR data 1950 to 59	2820	
98	GCD BOR data 1960 to 79	2321	
99	GCD BOR data 1980 to 99	3451	
100	All CJs streams data summary	168	
101	Stream Survey Data 1999	1181	
102	Stream Survey Data 2000	885	
103	Stream data summary by Year 90-99	553	
104	Flows 1999	354	
105	Monthly Stream Flows	29	
106	NN reach 2 data 1991	25	
107	Raw fish Populations Data all years	2524	
108	Raw stream survey data 1997	270	
109	Screwtrap_SD	70	
110	SNanamkin 1990	134	
111	StreamComp1990	35	
112	Stream Habitat data 1990 from NWIFC	866	
113	BuffDaph042801	14	
114	BuffDaphbiom042801	15	
115	BuffDaphlw042801	26	
116	colvbio042801	31	
117	colvlw042801	45	
118	colvzp042801	26	
119	sp01-ot	136	
120	Bomass-‘00&’01	14	
121	BeaufortScale	18	
122	BuffDaph072701	15	
123	BuffDaphbiom072701	14	
124	BuffDaphlw072701	26	
125	colvbiom072701	30	
126	colvlw072701	42	
127	colvzp072701	25	
128	BuffDaph062901	15	

Table 1. Continued

	Document Name	kb	MB
129	BuffDaphbiom062901	15	
130	BuffDaphlw062901	27	
131	colvbiom062901	31	
132	colvlw062901	41	
133	colvzp062901	26	
134	ow-ot-template	89	
135	sp00-OT	89	
136	lks-ot-6july'00	57	
137	lks-ot-7aug'00	58	
138	lks-ot-7june'00	58	
139	lks-ot-7sept'00	56	
140	lks-ot-april'00	89	
141	lks-ot-bf-6-7	86	
142	bf-levels-sp-aut	19	
143	bf-levels-spr	16	
144	bf-levels88-00	27	
145	bf-levels98-00	30	
146	lks-ot-00	62	
147	lks-secchi-00	31	
148	ZPBROCHBIOM-5-UPDATA7	159	
149	bf-secchi –graph	20	
150	lks-secchi & levels-00	31	
151	LAKESSWMP-5-7	21	
152	BF96SOT	7	
153	LG96SOT	5	
154	NT96SOT	5	
155	NUT96S-5	20	
156	OW96SOT	6	
157	RD96SOT	5	
158	ST96SOT	5	
159	Eshock Form	17	
160	Habitat Form	16	
161	Pebble Count form	16	
162	Refer Pt form	17	
163	SPR Creel Form	17	
164	Scale form	17	

Table 1. Continued

	Document Name	kb	MB
165	Voluntary creel 75-01	93	
166	Water Quality code	19	
167	01HatcheryFRNG2	708	
168	Brook Spawn (all yrs)(1)	59	
169	Brook Spawn (all yrs)	59	
170	Water TemperatureLog	64	
171	Distribution(allyears)2000	174	
172	FY-2000Sub-Yearlingstockingschedule	16	
173	FY-2000stockingschedule(fall)	15	
174	2001stockingschedule	23	
175	FY-2001 Hatchery Draft Budget	61	
176	Sep-01	16	
177	Hatcherysuppl2001	16	
178	01HatcheryFRNG2	708	
179	2002stockingschedule	31	
180	2002stockingscheduleperacre	35	
181	02Stocking streams	17	
182	94EBTSUB~4	19	
183	94FINGER~5	17	
184	94FINGER~6	17	
185	Fingerlingebtdist94	14	
186	Fingerlingrbtdist94	17	
187	LAHNTD~3	17	
188	LEGLRB~5	19	
189	Lahntdist94	17	
190	Leglrbtdist94	19	
191	RBTSUB~4	16	
192	STOCKSum94	20	
193	Stocks~3	19	
194	ebtsubdist94	15	
195	rbtsubdist94	19	
196	stocksumtable94	22	
197	EBTSUB~3 95	18	
198	FINGER~3 95	19	
199	FINGER~4 95	17	
200	Fingerlingebtdist95	17	

Table 1. Continued

	Document Name	**kb**	**MB**
201	Fingerlingrbtdist95	17	
202	LAHNTD~2	17	
203	LEGLRB~4	19	
204	Lahntdist95	17	
205	Leglrbtdist95	19	
206	RBTSUB~3	15	
207	Stocksum952	18	
208	Stocksum95	18	
209	Stocks~5	18	
210	ebtsubdist95	18	
211	rbtsubdist95	19	
212	EBTSUB~1 96	15	
213	FY-96	24	
214	FY-962	25	
215	FY-96A~1	24	
216	LAHNTD~1 96	18	
217	LEGLRB96	19	
218	LEGLRB~2	19	
219	RBTSUB~1	16	
220	StockSum96	18	
221	STOCKS~1	17	
222	STOCKS~4	17	
223	ebtsubdist96	18	
224	stocksumtable96	20	
225	EBTSUB~2 97	21	
226	FINGER~1	17	
227	FINGER~2	18	
228	FINGER~7	17	
229	FY-97C~1	31	
230	FY-97E~1	30	
231	Fingerlingebtdist97	17	
232	Fingerlingrel97	17	
233	LEGLRB97	22	
234	LEGRB~3	22	
235	Leglrbtdist97	20	
236	OMAKLakeSpawn97-98	19	

Table 1. Continued

	Document Name	kb	MB
237	OmakLakeSpawn97-98	18	
238	RBTSUB~2	17	
239	REARIN~1	23	
240	REARIN~2	23	
241	STOCKR~1	19	
242	STOCKS97	19	
243	STOCKS~2	19	
244	ebtsubdist97	20	
245	rbtsubdist97	20	
246	stockrate97	25	
247	stocksum97	19	
248	stocksumtable97	28	
249	FingEBTdst98	20	
250	FinglRBdst98	20	
251	LAHNTDist98	19	
252	LAHNTDist_98	18	
253	LAHNT~4	18	
254	LEGLRBdst98	23	
255	Stocksummary1998	23	
256	SubEBTdst98	18	
257	SubRBTdst98	18	
258	FinglRBdst99	20	
259	LAHNTDist99	19	
260	Stocksummary1999	23	
261	SubEBTdst99	18	
262	SubRBTdst99	18	
263	legaldist99	20	
264	CutthroatSpawn(allyears)	37	
265	CutthroatSpawn(allyears)2	39	
266	Distribution(allyears)	175	
267	HGMP STOCKDATES	14	
268	HGMPreleasedatesmode	14	
269	Owhi Brook Trout Eyed-egg to outplant survival 89	15	
270	Owhi Brook Trout Spawnincubation 89-99	15	
271	hatcheggrecptum	15	
272	lrhatchery releases96-99	21	

Table 1. Continued

	Document Name	kb	MB
273	broodyear95OwhiLk.ebtsubyearling	16	
274	broodyear95OwhiLk.SubYearlingchart	19	
275	broodyear96OwhiLk.ebtsubyearling	16	
276	broodyear96OwhiLk.SubYearlingchart	19	
277	broodyear96OwhiLk.EBTfing	16	
278	broodyear96OwhiLk.fingchart	18	
279	broodyear97OwhiLk.ebtsubyearling	16	
280	broodyear97OwhiLk.SubYearlingchart	18	
281	broodyear97OwhiLk.EBTfing	15	
282	broodyear97OwhiLk.fingchart	18	
283	broodyear98OwhiLk.ebtsubyearling	16	
284	broodyear98OwhiLk.SubYearlingchart	18	
285	broodyear98OwhiLk.EBTfing	16	
286	broodyear98OwhiLk.fingchart	18	
287	RBT 99	14	
288	Broodyear95GoldndlRBTSub	18	
289	Broodyear95GoldndlRBTSubchart	21	
290	Broodyear95GoldndlRBTfing	18	
291	Broodyear95GoldndlRBTfingchart	18	
292	Broodyear96GoldndlRBTSub	19	
293	Broodyear96GoldndlRBTSubchart	22	
294	Broodyear96GoldndlRBTfing	18	
295	Broodyear97GoldndlRBTfingchart	21	
296	Broodyear97GoldndlRBTSub	18	
297	Broodyear97GoldndlRBTSubchart	18	
298	Broodyear97GoldndlRBTfing	15	
299	Broodyear97MtWhtnyYearlingRbt	16	
300	Broodyear97MtWhtnyYearlingRbtchrt	19	
301	Broodyear98GoldndlRBTSub	18	
302	Broodyear98GoldndlRBTSubchrt	22	
303	Broodyear98Mt.WhtnyYearlingRBT	15	
304	Broodyear98Mt.WhtnyYearlingRBTchrt	18	
305	broodyear99SpoknRBTLEGL	14	
306	LEGALR~1	16	
307	LEGLRB~1	17	
308	LEGLRB~2	18	

Table 1. Continued

	Document Name	kb	MB
309	broodyear97GoldndlRBTSubgrowthrate	19	
310	broodyear97GoldndlRBTSubgrowthrate.chart	19	
311	Buffalo Lake Raw Gill Netting Data.xls_1999	19	
312	Buffalo Lake Raw Gill Netting Data_1999	18	
313	BuffLKlenth,wt,condF.XLS_1998	19	
314	BuffLKlenth,wt,condF_1998	19	
315	Buffalo Lake Raw Gill Netting Data.xls_1998	19	
316	Buffrelativeabund.XLS_1994-99	20	
317	Buffrelativeabund_1994-98	20	
318	Buffrelativeabund_1994-99	20	
319	bufgil94-97	19	
320	bufgil94-98	19	
321	IRONCR~1	17	
322	IRONCR~2	17	
323	IRONCR~3	14	
324	Iron creek fish rearing densities, segment1	16	
325	LOUICR~1	17	
326	LOUIEC~1	14	
327	Louie Cr. water temp.chart	15	
328	N.Nanamkin water temp chart	15	
329	NORTHN~1	21	
330	NORTHN~2	20	
331	Omak Lake Voluntary creel 75-01	83	
332	Voluntary creel 99-01-a	19	
333	Voluntary creel 99-01	46	
334	OWHILAcreel84-01	25	
335	S. Nanampkin Cr. Watertemp.chart	15	
336	SOUTHN~1	17	
337	SOUTHN~2	14	
338	1998legalcontribution	16	
339	Historic Twin Lake Creel Data	128	
340	Jerry Bull Trout Stream	17	
341	LLID Lake Locations	22	
342	LLID NT Lake Locations	22	
343	LLID ST Lake Locations	21	
344	Relati~1	17	

Table 1. Continued

	Document Name	kb	MB
345	Twin Lakes 78-00	38	
346	TwinLk,lengthWtCondFRelAbund 1994-2000	34	
347	salmonidRelAbund 1994-1999	18	
348	twingil98	22	
349	North Twin Lakes Raw Gill Netting Data.xls_1999	26	
350	North Twin Lakes Raw Gill Netting Data_1999	14	
351	ADULTT~1	16	
352	RNDLKF~1	18	
353	ROUNDL~1	18	
354	ROUNDL~2	18	
355	South Twin Lakes Raw Gill Netting Data.xls-1999	26	
356	South Twin Lakes Raw Gill Netting Data_1999	21	
357	South Twin Lakes Raw Gill Nett Data	22	
358	South Twin Lakes Raw Gill Nett Data.xls_1998	26	
359	South Twin Lakes Raw Gill Nett Data_1998	22	
Total Excel Documents			**33.4**
Excell Data on Local Drive			
360	Species Designation	15	
361	Streams of the Colville Reservation	28	
362	tblInherantWatershedSensitivity	48	
363	Emergency stockings	15	
364	ABC Lab Lake Chemistry80 Folder 23 xls shts.	736	
365	TL Food Habits 9 .xls .doc	134	
Access Tables Made and Sent, and On Local Hard Drive			
366	Big Goose Lake	198	
367	Buffalo Lake	168	
368	Fisheries Two		
369	Friedlander Lake	244	
370	Gold Lake	188	
371	Little Goose Lake	178	
372	North Twin Lake	604	
373	Omak Lake	970	
374	temp.12-15-98xlt1		
375	Bridge Crk LRH	136	

Table 1. Continued

	Document Name	kb	MB
376	McGinnis Lake	122	
377	Round Lake	248	
378	Simpson Lake	264	
379	Sugar Lake	96	
380	Summit Lake	122	
381	LAKESWMP		
382	Lakefdr	206	
383	Codes	556	
384	CODES1	648	
	Total Access Tables Made and Sent, and On Local Hard Drive		**4.9**
	Total Data Delivered to Kalispel Tribe During 2002 Performance Period	**488899**	**488.9**

Conclusions

The entry of historic data from Colville Tribes records is proceeding and although production has been less than expected recent improvements and a better understanding of the responsibilities of personnel involved should improve production of data in the coming year. All projects have a learning curve and some are steeper than others, but this project should be in a position to improve the kilobytes of data produced by 2 to 3 times in the next year. These improvements will greatly enhance the data contained within the JSAP database and thus assist many managers, stakeholders, and planning efforts.