Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams

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Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams
Project # 199700400
2001 Annual Report

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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 Planning Council (NPPC). The NPPC 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 NPPC 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 and the Columbia Basin Blocked Area Management Plan (1998). 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 seven streams and four lakes on the Spokane Indian Reservation were completed by 2000. Assessments of the Little Spokane River and its tributaries, tributaries to the Pend Oreille River, small lakes in southern Pend Oreille County, and water bodies within and near the Spokane Indian Reservation were conducted in 2001. 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.

Redband rainbow trout (*Onchorynchus mykiss*) are also likely to be petitioned for ESA listing in the near future. 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.

The Upper Columbia Blocked Area Management Plan (1998) states the overarching vision of the Blocked Area fish managers is to achieve a healthy Columbia River ecosystem that supports viable and genetically diverse fish species that in turn provide direct benefits to society, including harvest. The Blocked Area fish managers have further defined two alternative visions for the currently Blocked Area:

(1) Development of a stable Upper Columbia River producing sustainable resident fish populations and harvest, equal to the level of historical (pre-dam) conditions, and/or

(2) Re-introduction of anadromous salmon and steelhead runs above Chief Joseph and Grand Coulee dams in areas where they historically occurred and to restore anadromous and resident fish abundance and harvest to historical levels.

The 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. The JSAP project is successful when managers use synthesized information to successfully implement management recommendations and ultimately achieve stated goals and objectives in the Upper Columbia Blocked Area Management Plan and Subbasin Plans. 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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Introduction

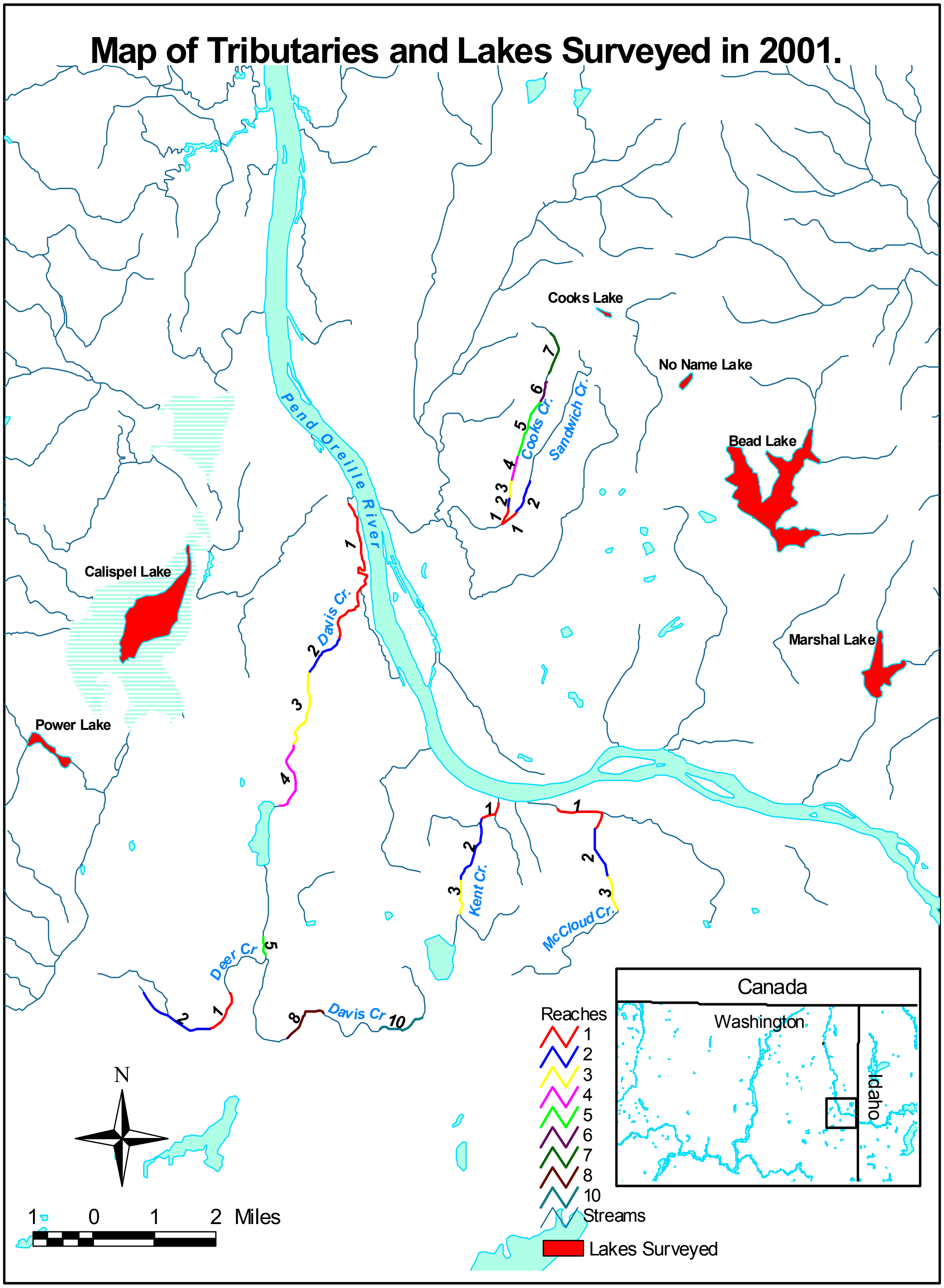
During field season 2001, the Kalispel Natural Resource Department (KNRD) conducted fish and habitat inventories of seven tributaries to the Pend Oreille River. KNRD, in cooperation with Eastern Washington University Department of Biology, conducted zoological investigations of five lakes in southern 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 southern Pend Oreille County, WA.

Fish and habitat evaluations of Davis Creek and Deer Creek were completed as substitution for fisheries investigations of Power Lake and Calispell Lake. Water levels and lake access were not adequate for gill net use or launching an electrofishing boat. The following report summarizes the results of data collection activities in the seven tributaries and five lakes (Figure 1), 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

Seven tributaries to the Pend Oreille River were surveyed in southern Pend Oreille County, WA (see USGS Topographic maps 1:24,000 scale). Cook's Creek and Sandwich Creek are small tributaries in the Skookum Creek watershed east of the Pend Oreille River (confluence in Township 32 North, Range 44 East, Section 11). Cooks and Sandwich creeks have a drainage basin area of 1104 hectares (ha). Marshall Creek was surveyed from LeClerc Creek Road to Duncan Springs in Township 32 North, Range 45 East, Section 34. Marshall Creek is ephemeral above Duncan Springs. Kent and McCloud Creeks, west of the Pend Oreille River, were surveyed from their respective culverts on Highway 20 southeast of the community Dalkena (T32N, R44E, Sections 35 and 36 respectively), and have drainage basin areas of 1347 ha. And 1635 ha. Respectively. Davis Creek flows into the Pend Oreille River from the west approximately 1.5 km south of Usk, WA. The Davis Creek survey began upstream at the Davis Road boat launch (T32N, R44E, Section 16). Deer Creek, a tributary to Davis Creek originates in T31N, R44E, Section 8. Davis Creek and Deer Creek have a combined drainage basin area of 5743 ha.

Figure 1. Map of Tributaries and Lakes Surveyed in 2001.



The majority of the land base in southern Pend Oreille County is in private ownership. Over 83% of stream reaches surveyed in 2001 were on private land. Impacts from residential development, roads and associated culverts, logging, grazing, and channel alteration were commonly observed in the watersheds. Land access was denied in parts of Davis Creek (reaches 6 and 7; 1.5 km), Deer Creek (lower 1.2 km), and McCloud Creek (upper 1.2 km). Wherever possible reach overview surveys were completed to qualitatively characterize these inaccessible reaches.

Of the five lakes surveyed in 2001, all but Power Lake and Calispell Lake were located east of the Pend Oreille River. Calispell Lake is located in T32N, R43E. Cooks and Mystic Lakes are both small sub-alpine lakes located in T33N, R44E. Bead and Marshall lakes, both larger sub-alpine lakes, are located in T32&33N, R45E, and T32N, R45E respectively. Lake surface areas were calculated and appear in Appendix 1.

Methods

The JSAP stream habitat survey methodology (modified from KNRD stream survey methodology, 1997) contained four facets: transect surveys, reach overviews, interreach comparisons and fish surveys. Habitat surveys were broken into two components: transect surveys and reach overview surveys. Transect surveys were the division of the stream into 90-meter (m) segments. Primary pools, spawning habitat and acting woody debris counts were collected for the entire length of each 90-m segment. The remainder of the habitat quality parameters (Table 1) such as habitat type, substrate, habitat function, bank stability, and embeddedness were collected at the end of each 90-m segment (the actual transect site). This method allowed for a number value to be assigned to each habitat quality parameter. Reaches were defined by stretches of stream with common gradient, substrate and vegetation. Breaks between two homogeneous areas defined a new reach. Reach overview surveys were the visual observation and description of variables occurring within each reach (Table 2). Each reach was permanently marked and flagged using aluminum tags and flagging as a reference point for long-term monitoring.

Following the compilation of transect data, an interreach comparison was conducted using the mean values for each reach. Threshold values were established for embeddedness, bank stability, pool-riffle ratio, spawning gravel, and primary pools (Table 3). All threshold values were obtained from Hunter (1991) and/or MacDonald et al. (1991). The mean data for each reach was analyzed by using these threshold criteria. Each habitat value that did not fall within the threshold was counted as habitat that is unsatisfactory for quality or quantity. Information from interreach comparisons and electrofishing were used to draw conclusions on the effects of degraded habitat quality and non-native salmonids on native salmonid species.

Table 1. Transect variables and method of collection.

Variable	Method of collection
Habitat Type	Visually determine habitat types (i.e., pool, riffle, glide, pocketwater, run, alcove).
Dominant Substrate Size	Visually determine largest percentage of substrate for that habitat type (i.e., silt, sand, gravel, cobble, boulder, bedrock).
Habitat Function	Visually determine habitat functions (i.e., winter, summer, spawning or unusable).
Spawning Gravel Amount and Quality	Measure potential square meters of spawning gravels within each transect and quality (i.e. gravel size, location and current velocity Kalispel internal doc.1-95) Good = All criteria met. Fair = 2 criteria met. Poor = 1 criteria met.
Stream Depths	Measure depth at 1/4, 1/2, 3/4 across channel to the nearest cm.
Habitat Widths	Measure each specific habitat type in a transect to the nearest 0.1m.
Primary Pools	Count of number of pools with length or width greater than the avg. width of stream channel within each transect. Measure length.
Cobble Embeddedness	Visual estimate of the percentage fine or coarse sediment surrounding substrate / Actual measurement was recorded with an embed meter approximately every 20 transects. Regression of the estimated numbers with the actual measurements calculated a correction factor for all estimated values.
Bank Stability	Visual estimate of the length in meters of unstable bank per transect for possible sediment sources.

Table 1. *continued*

Variable	Method of collection
Stream Channel Gradient	Using a clinometer measure percent slope.
Acting Woody Debris	Number of woody debris with a diameter >10cm and a length >1m in the stream.
Residual Pool Depth	The average pool depth by averaging the deepest portion of the primary pool and the primary pool tailout. Measure to the nearest cm.

Table 2. Reach variables and method of collection.

Variables	Method of Collection
Air and Water Temperature	Thermometer reading in Celsius.
Channel Type	A general classification of channel type based on channel morphology (see Rosgen 1994).
Average Embeddedness	Estimate of the average embeddedness for the entire reach. Actual measurement is recorded with an embed meter approximately every 20 transects, Regression of the estimated numbers with the actual measurements calculated a correction factor for all estimated values.
Dominant Habitat Type	Dominant habitat type for the reach (i.e., pool, riffle, glide, pocketwater, run, alcove).
Disturbance	Estimation of the effects of land use practices (i.e. logging, roads, cattle, mining).
Aquatic Vegetation	Estimation of the occurrence of aquatic vegetation for the reach (i.e., abundant, fairly common, scarce, none).
Shading	Visual estimation of the amount of stream shaded by canopy along the stream reach
Habitat Quality	Estimation of the habitat quality for the entire reach (i.e., good, fair, poor).
Other	Any notable attribute not required for recording that can be recorded for reference to impact, or in interest to habitat quality.

Table 3. Interreach comparison threshold values (after Hunter 1991; MacDonald 1991).

Limiting Factors	Threshold Value
Embeddedness	Any value ≤30% or ≥ 70%
Bank Stability	Any value ≤ 75%
Pool - Riffle Ratio	Any value ≤ .5:1 or ≥ 1.5:1
Spawning Gravel	Three lowest cumulative values
Primary Pools	Any value <10.5/km

Fish population data were collected using multiple pass depletion sampling techniques (Murphy and Willis 1996, Heimbuch et al. 1997). Daytime sampling was conducted during the period from 19 September 2001 through 5 November 2001. Lengths of electrofishing stations equaled 10% of each stream reach up to 100 m and selected so that the area sampled was representative of the reach. Block nets were set at the upstream and downstream boundaries to prevent immigration and emigration during the sampling period. Upon capture fish were transferred to 5-gallon holding containers of stream water until processing. Fish were anesthetized with Tricaine-S brand tricaine methanesulfonate (MS-222) (Western Chemical Inc., Ferndale, WA) prior to identification, weighing, and measuring. Once fish were processed they were held in 20-gallon containers until fully recovered and returned to the stream.

Life history and population data were addressed by species presence, relative abundance, size (age class), and density (fish per 100 m^2). Population estimates were obtained using 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. The standard size/age classes for salmonid species (Table 4) were determined according to Espinosa (1988).

Fish densities were calculated by dividing the population estimate by the total sample area (station length x mean width). This density was multiplied by 100 to yield number of fish per $100m^2$. For some species within stream reaches, Microfish 2.2 population estimations 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.

Table 4. Fish species size/age class distributions (Espinosa 1988).

Species	Age	Length
Cutthroat Trout Rainbow Trout	0+	< 65 mm FL
	1+	65-110 mm FL
	2+	111-150 mm FL
	3+	151-200 mm FL
	4+	201-305 mm FL
	BIG	> 305 mm FL
Bull Trout Brook Trout Brown Trout	0+	< 65 mm FL
	1+	65-115 mm FL
	2+	116-165 mm FL
	3+	166-210 mm FL
	4+	211-305 mm FL
	BIG	>305 mm FL
Mountain Whitefish	N/A	< 100 mm
	N/A	100 - 305 mm
	N/A	> 305 mm
Sculpin	Total Number	Record Species If Possible
Sucker	Total Number	Record Species If Possible

Results and Discussion

Habitat assessments and fish surveys were conducted on seven tributaries to the Pend Oreille River in 2001. In total 30.8 km (19.2 miles) of streams were surveyed for habitat quality and quantity. Impacts from current and historic land use practices including logging, road building, residential development, agriculture production, and grazing were evident, as 83% of stream reaches surveyed were in private ownership.

High substrate embeddedness, lack of high quality spawning gravel, and instream habitat diversity were the most common limiting factors identified in surveys. Average embeddedness ranged from 46.7% to 98.5% (X=77.6, sd=16.7). Lack of adequate spawning gravel quantity occurred in nearly all reaches surveyed. Gravels of a suitable size for spawning salmonids were often covered at least partially with silt, sediment, or sand. Deforestation of the riparian zone, road building, and channel alteration for agriculture production and livestock grazing has negative impacts on native salmonids (Roni and Quinn 2001, Grizzel and Wolff 1998, Murphy et al. 1981, Platts et al. 1989). Although stream degredation is detrimental to native salmonids, it generally favors introduced salmonid species that are generally more tolerant of lower quality habitat conditions (Andersen and Maroney 2001).

Twenty-two reaches totaling 1940 m were electrofished between 18 September and 5 November 2001. Thirteen species representing six families totaling 2065 fish were recorded (Table 5). Salmonid species accounted for 68.1% of the total capture (N=1406). Of the five salmonid species encountered, eastern brook trout (*Salvelinus fontinalis*) was the most commonly taken species overall (N=1171). Brook trout captures accounted for 83.3% of the salmonid and 56.7% of the total catch. Westslope cutthroat trout accounted for 11.6% of the salmonid capture (N=163). The remaining species accounted for 5.1% of the salmonid capture and include brown trout (*Salmo trutta*) (4.6%, N=65), mountain whitefish (*Prosopium williamsoni*) (0.3%, N=4), and rainbow trout (0.2%, N=3).

Eight species representing five families of non-salmonids accounted for 31.9% of the total catch (N=659). Brown bullhead (*Ictalurus* nebulosus, Ictaluridae) was the most abundant non-salmonid species comprising 41.0% (N=270) of the non-salmonid capture (13.1% of the total capture). Three cyprinids, northern pikeminnow (*Ptychocheilus oregonensis*) (N=116), redside shiner (*Richardsonicus balteatus*)(N=10), and tench (*Tinca tinca*) (N=28) accounted for

17.6%, 1.5%, and 4.2% of the non-salmonid capture respectively. Sculpin species (Cottidae) and largescale sucker (*Catastomus macrochirus*, Catosomidae) accounted for 11.4% (N=75) and 2.4% (N=16) of the non-salmonid catch respectively. Two centrarchids, largemouth bass (*Micropterus salmoides*) (N=32) and pumpkinseed (*Lepomis gibbosus*) (N=112) accounted for 4.9% and 17.0%.

Population and density estimates, calculated for each species by stream reach, appear in Table 6. Brook trout were present in all streams and 14 of 22 reaches. Densities ranged from 7.3 to 220.8 fish/100 m^2, with a mean density of 75.5 fish/100 m^2.

Table 5. Species composition and relative abundance of all fish sampled in 2001.

Common Name	Scientific Name	Spp. Code	Number	% respective capture	% of total capture
Salmonids					
Brook trout	*Salvelinus fontinalis*	BKT	1171	83.3%	56.7%
Brown trout	*Salmo trutta*	BRT	65	4.6%	3.1%
Rainbow trout	*Oncorhynchus mykiss*	RBT	3	0.2%	0.1%
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*	CTT	163	11.6%	7.9%
Mountain whitefish	*Prosopium williamsoni*	MWF	4	0.3%	0.2%
Subtotal Salmonids:			1406	100.0%	68.1%
Non-Salmonids					
Northern pikeminnow	*Ptychocheilus oregonensis*	NPM	116	23.7%	5.6%
Redside shiner	*Richardsonius balteatus*	RSS	10	2.0%	0.5%
Tench	*Tinca tinca*	TNCH	28	5.7%	1.4%
Largescale sucker	*Catostomus macrochirus*	LSS	16	3.3%	0.8%
Brown bullhead	*Ictalurus nebulosus*	BBH	270	55.2%	13.1%
Largemouth bass	*Micropterus salmoides*	LMB	32	6.5%	1.5%
Pumpkinseed	*Lepomis gibbosus*	PUSE	112	22.9%	5.4%
Sculpin spp.	*Cottus* spp.	SCUL	75	15.3%	3.6%
Subtotal Non-Salmonids:			489	100.0%	31.9%
Total Captured:			2065		

Table 6. Total capture, with population and density estimates, of fish sampled in 2001 by reach.

Stream Reach	-Spp.	Pass			Tot. Capt.	Density #/100 m^2	Pop Est.	X^2	Std. Err.	95% Conf. Interval		Cap. Prob.	Std. Err.	95% Conf. Interval	
		1	2	3											
COK-04	BKT	8	2		10	15.2	10	0.29	0.7	10.0	11.7	0.83	0.15	0.49	1.18
COK-05	BKT	6	2		8	7.3	8	0.44	0.9	8.0	10.0	0.80	0.19	0.34	1.26
COK-06	BKT	16	15	7	38	72.2	52	1.18	13.2	38.0	78.5	0.35	0.14	0.08	0.62
COK-07	BKT	39	22		61	175.0	84	0.07	18.4	61.0	120.5	0.47	0.14	0.19	0.76
DAV-01	BBH	4	3		7	2.3	8	0.69	3.1	7.0	15.4	0.58	0.36	-0.26	1.42
DAV-01	BRT	7	8		15	4.3									
DAV-01	LMB	16	4		20	5.7	20	0.58	1.1	20.0	22.2	0.83	0.11	0.61	1.06
DAV-01	LSS	3	1		4	1.1	4	0.22	0.6	4.0	5.9	0.80	0.27	-0.07	1.67
DAV-01	MWF	4	0		4	1.1									
DAV-01	NPM	56	30		86	33.1	116	0.05	19.8	86.0	155.2	0.49	0.12	0.26	0.72
DAV-01	PUSE	1	1		2	0.6									
DAV-01	RSS	1	0		1	0.3									
DAV-01	TNCH	11	3		14	4.0	14	0.50	1.0	14.0	16.1	0.82	0.13	0.53	1.11
DAV-02	BBH	1	0		1	0.3									
DAV-02	BRT	19	4		23	5.9	23	0.44	1.0	23.0	25.0	0.85	0.09	0.66	1.05
DAV-02	LSS	8	2		10	2.6	10	0.29	0.7	10.0	11.7	0.83	0.15	0.49	1.18
DAV-02	NPM	11	4		15	3.9	15	1.00	1.3	15.0	17.7	0.79	0.15	0.48	1.10
DAV-02	RSS	6	3		9	2.3	9	1.14	1.3	9.0	12.0	0.75	0.22	0.25	1.25
DAV-02	TNCH	1	0		1	0.3									
DAV-03	BRT	14	11	2	27	7.8	29	2.83	2.7	27.0	34.6	0.56	0.12	0.31	0.81
DAV-03	LSS	0	1	1	2	0.3									
DAV-04	BBH	168	94		262	64.7	375	0.02	43.9	288.5	461.5	0.45	0.07	0.31	0.59
DAV-04	LMB	6	6		12	2.1									
DAV-04	PUSE	73	36		109	24.1	140	0.04	17.8	109.0	175.2	0.53	0.10	0.33	0.72
DAV-04	TNCH	11	2		13	2.2	13	0.18	0.6	13.0	14.4	0.87	0.12	0.61	1.12
DAV-05	BKT	80	46	18	144	41.5	162	1.03	8.6	145.0	179.0	0.51	0.06	0.40	0.63
DAV-05	RBT	1	2	0	3	0.8									
DAV-05	SCUL	22	20	14	56	14.4									
DAV-08	BKT	98	52	17	167	121.3	182	1.68	7.0	168.3	195.7	0.56	0.05	0.46	0.66
KEN-01	BKT	132	30		162	220.8	170	0.02	4.6	162.0	179.1	0.78	0.05	0.69	0.87
KEN-01	CTT	10	2		12	15.6	12	0.21	0.7	12.0	13.5	0.86	0.13	0.58	1.14
KEN-02	BKT	74	33		107	81.3	130	0.06	13.2	107.0	156.2	0.58	0.09	0.40	0.75
KEN-02	CTT	84	20		104	68.1	109	0.07	3.8	104.0	116.5	0.78	0.06	0.66	0.89
KEN-03	BKT	10	2		12	8.6	12	0.21	0.7	12.0	13.5	0.86	0.13	0.58	1.14
KEN-03	CTT	38	9		47	35.0	49	0.06	2.4	47.0	53.9	0.78	0.08	0.62	0.95
KEN-03	PUSE	1	0		1	0.7									
MCC-02	BKT	171	46		217	165.7	232	0.05	7.0	218.3	245.7	0.74	0.04	0.66	0.83
SAN-01	BKT	33	8		41	93.3	42	0.31	1.9	41.0	45.9	0.80	0.08	0.64	0.97
SAN-02	BKT	10	6		16	28.6	20	0.26	6.5	16.0	33.6	0.53	0.25	0.00	1.06
DER-01	BKT	144	27		171	103.5	176	0.07	3.4	171.0	182.8	0.82	0.04	0.75	0.90
DER-01	SCUL	12	7		19	11.2	24	0.22	7.3	19.0	39.1	0.53	0.23	0.04	1.01
DER-02	BKT	23	11		34	9.1	41	0.12	7.4	34.0	56.0	0.58	0.16	0.25	0.90

(Refer to Table for species codes. Pop. Est. is the estimated population from Microfish 2.2. X^2 critical values found in Zar 1999, α =. 05. 95% confidence intervals correspond to population estimates and capture probability.)

Cook's Creek

Seven reaches totaling 5.2 Kilometers (km) were surveyed in Cook's Creek. The survey started at the confluence of Cook's Creek and Sandwich Creek at elevation 628 m, and ended at the headwater springs (elevation 853 m). Current and historic timber harvest, residential development, and livestock grazing were commonly observed in the watershed. Several logging roads and driveways cross the creek. Channel characteristics and habitat attributes of Cook's Creek appear in Table 7. Limiting factor attributes appears in Table 8.

Average stream width was 1.1 m and depth was 9.6 cm with small gravel the dominant substrate in 46.2% of transects. The dominant habitat type was riffle. Upper or lower threshold limits were exceeded for substrate embeddedness, spawning gravel, primary pools, and pool to riffle ratio. Sediment levels and substrate embeddedness were relatively high in all reaches of Cook's Creek (X=80.3%), and sand and silt were recorded as the dominant substrate in 40.8% of transects. Spawning gravel was recorded in three reaches totaling 21.5 m^2, although all gravel was classified as low quality. Primary pool density for Cook's Creek was 12.2/km with only the upper three reaches having pool densities above the threshold limit of 10.5/km.

Six electrofishing stations totaling 420 m were sampled in Cook's Creek. Brook trout were the only fish species encountered during electrofishing sessions or habitat assessments. Fish were observed in the first transect of reach 1, but lack of distinct channel and low flow prevented electrofishing in the reach. No fish were captured in reaches two or three. Densities ranged from 7.3 to 175.0 fish per 100 m^2 (Figure 2) in reaches 4-7. The highest densities occurred above and below a beaver pond in reaches 6 and 7. The largest individual was 179 mm total length (TL) and the mean size was 71.0 mm ± 28.5 mm TL (N=116). Age/size 0+ and 1+ fish accounted for 81% of the catch (Figure 3).

Table 7. Channel characteristics and habitat attributes of Cook's Creek by reach.

Reach/ Length (m)		**Average Width (m)**	**Average Depth (cm)**	**Channel Type**	**Average Gradient (%)**	**Dominant Substrate**	**Residual Pool D. (cm)**	**Percent Pool**	**Percent Riffle**	**Percent Run**	**Acting LWD (#/100m)**
1	630	1.6	15.8	A6	7.8	Silt	17.8	0	26.1	73.9	6
2	540	0.8	3.8	A4/Aa+4	11.3	Small Gravel	16.7	0	100	0	12.6
3	270	0.6	10.8	G4	0.8	Silt	10	0	55.6	44.4	0
4	540	1.1	10.7	B6	1.7	Silt	15	11.8	16.2	55.9	13.3
5	1260	1.1	9.4	B4	1.3	Small Gravel	20.5	6.9	61	32.1	17.9
6	720	1.2	10.0	B4	1.6	Small Gravel	22.1	0	63.4	36.6	15.1
7	540	0.8	6.2	Aa+3	18.2	Cobble	15.8	0	100	0	15.7
Total 5200		**1.1**	**9.6**		**5.6**	**Small Gravel**	**18.8**	**3.5**	**54.9**	**39.6**	**13.3**

Table 8. Limiting factor attributes of Cook's Creek by reach.

Reach	**Substrate Emded. (%)**	**Bank Stability (%)**	**Spawning Gravel (m^2)**	**Primary Pools/km**	**Pool : Riffle Ratio**
	Threshold values				
	Any value ≤30% or ≥ 70%	Any value≤ 75%	Three lowest cumulative values	Any value <10.5/km	Any value < .5:1 or > 1.5:1
1	67.9	99.9	10	6.3	0:1
2	74.2	100	0.5	5.6	0:1
3	86.7	100	0	3.7	0:1
4	95.8	100	0	9.3	1:1
5	92.1	99.7	11	18.3	.1:1
6	87.1	99.6	0	12.5	0:1
7	46.7	98.8	0	18.5	0:1
Total	**80.3**	**99.7**	**21.5**	**12.2**	**0:1**

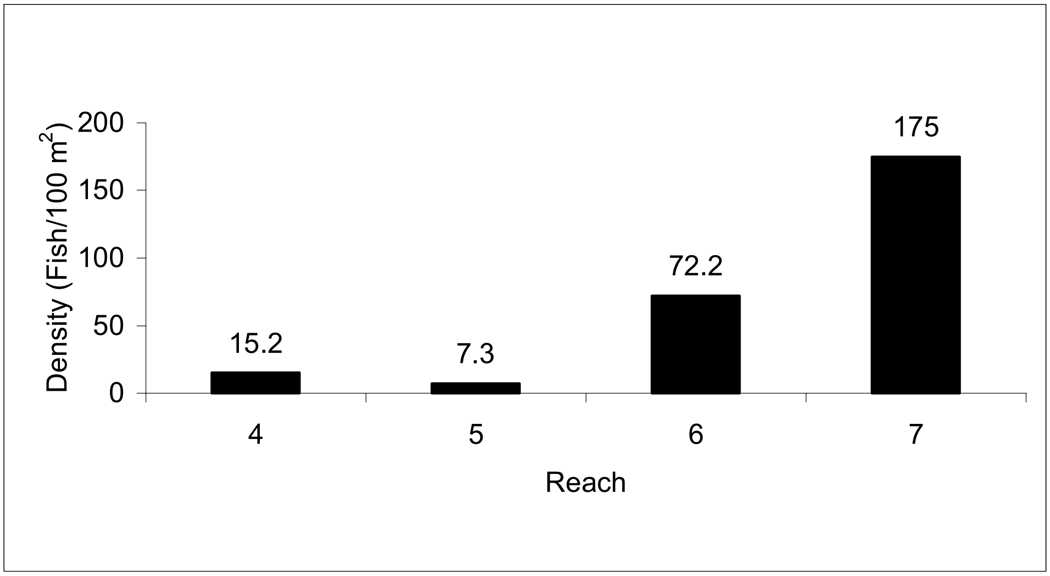


Figure 2. Estimated densities of brook trout sampled in Cook's Creek by reach.

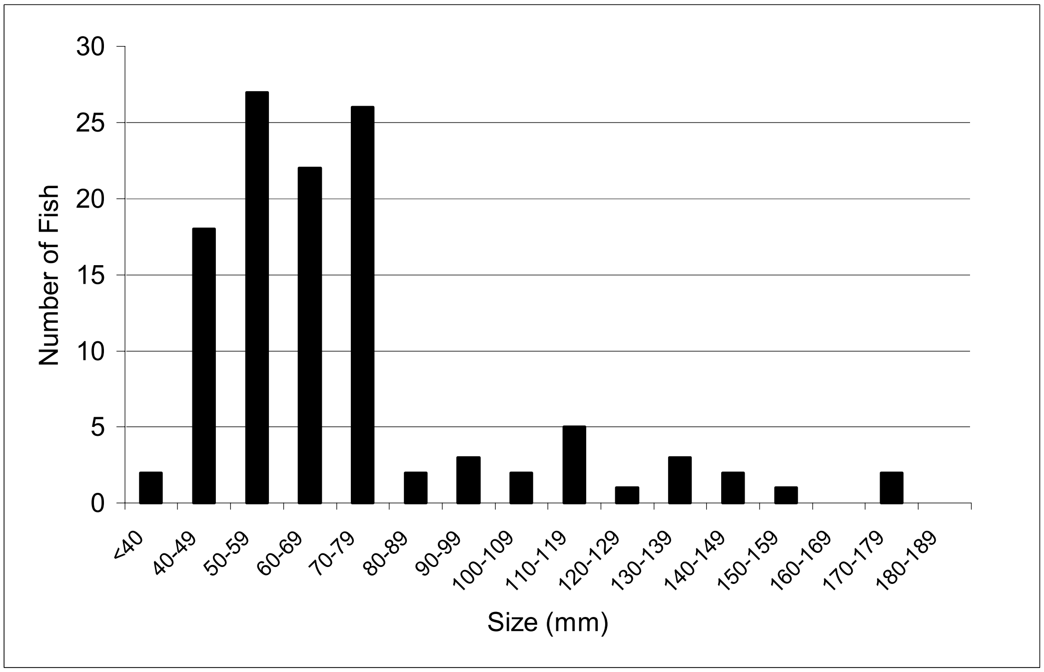


Figure 3. Length frequency distribution of brook trout sampled in Cook's Creek.

Reach 1

The Cook's Creek survey started at the confluence of Cook's and Sandwich Creeks at an elevation of 628 m. Reach 1 Measured 630 m. and was classified as an A6 type Channel (See Table). A small spring flows into the creek about 300 m. from the confluence, which has been dammed and once provided drinking water for an abandoned cabin. Several springs and seeps flow into the lower portion of this reach. The channel is intermittent, braided, and boggy with skunk-cabbage (*Symplocarpus foetidus*) and alder (*Alnus incana*) being the primary riparian plant species. Silt was the dominant substrate, but small gravel was present in 40.9% of transects with average embeddedness of 43.8%. Ten square meters of spawning gravel were present above the bog. Primary pool density (6.3/km) and pool:riffle ratio (0:1) were below threshold limits in reach 1. Fish were observed in the first transect, but the reach was not electrofished due to intermittent flow and lack of a distinct channel.

Reach 2

Reach 2 started at an abandoned driveway culvert and ended at a meadow edge 540 m. upstream. The reach started in a dense hawthorne (*Cretageous douglasii*) thicket, and continued upstream through cedar (*Thuja plicata*) forest. The top of the reach was littered with trash including beds, bottles, and an old car. Reach 2 was classified as an A4 channel with small gravel as the dominant substrate (57.0%). Although acting LWD was more plentiful in the reach, fewer primary pools were recorded. Average pool length was 0.9 m and average maximum depth was 23.3 cm. No fish were observed or captured in reach 2. It appears that high embeddedness (X=74.2%) and lack of pool habitat (5.6 pools/km) may be limiting factors for this reach.

Reach 3

Reach 3 was classified as a G4 type channel that was 270 m in length and flowed through a small meadow. The north and south forest edges marked the beginning and ending of the reach. The incised channel averaged 0.6 m in width with steep undercut banks. Forty meters of braided channel with lateral bank instability was also observed. Small gravel was relatively common (44% of transects), although embeddedness levels exceeded the threshold for spawning gravel (X=80%). No fish were observed or captured in the electrofishing station in reach 3.

Possible limiting factors for this reach include high embeddedness, lack of primary pools (3.7/km), low pool to riffle ratio (0:1), lack of LWD (0/100m), and very little riparian cover.

Reach 4

Reach 4 was 540 m in length and classified as a B6 type channel. The reach was located in mixed conifer forest ending at a gradient change 20 m north of Barry Road. Sand and silt were the dominant substrates with small gravel present in 16.2% of transects. Average embeddedness exceeded threshold limits for all substrates (95.8%). More acting LWD was present in Reach 4 than previous reaches (13.3/100m) creating primary pool habitat (9.3/km). One 60-meter electrofishing station was sampled in 2001. Brook trout was the only species captured with a density estimated at 15.2 fish per 100 m^2 (N=10).

Reach 5

Reach 5 was a B4 type channel and was 1260 m in length. A culvert under forest road #039 marks the top of the reach. The area has been heavily logged resulting in high sedimentation and substrate embeddedness. Medium and small gravel were the dominant substrates in 61% of transects, although most was highly embedded (mean embeddedness 92.7%). Spawning gravel totaling 11 m^2 was recorded, but all was of poor quality. Reach 5 had more LWD (17.9/100m) and primary pools (18.3/km) than reach 4, but lower fish density. One 100-m electrofishing station was sampled in 2001. Brook trout was the only species captured and density was estimated at 7.3 fish per 100 m^2 (N=8).

Windthrown trees within the riparian buffer zone were increasing sediment delivery in one section. Several up-rooted trees within the channel that fell away from the stream had root boles exposed to erosion. Grizzel and Wolff (1998) reported that 85% of sediment delivered to stream channels in roadless forest buffers in northwest Washington was the result of windthrow events within 3 meters of the channel. Dense alder dominated deciduous vegetation was growing in these forest openings along the stream. Riparian zones dominated by alder and associated plant communities generally do not supply sufficient LWD, limiting channel diversity and sediment storage capacity (Bilby and Ward 1991). Although logging activities generally increase LWD density in the short term, adequate forest buffers are important for long-term

LWD recruitment. Forest practice applications and watersheds subject to timber harvest should be monitored to ensure proper stream type identification and the riparian protections each afford.

Reach 6

Reach 6 was 720 m in length and classified as a B4 Channel. The top of the reach terminated at a large beaver pond. The pond measured 150 m long by 40 m at its widest point. The dam measured 2.5m tall by 15m wide. Riffle was the dominant habitat type in 63.4% of transects. Like other reaches in the Cook's creek watershed, substrate embeddedness exceeded threshold values in reach 6 (87.1%). Small gravel was present in 76.3% of transects although high embeddedness (82%) rendered it useless as salmonid spawning habitat. Brook trout was the only species captured in 60-meters of electrofishing effort. Estimated density in reach 6 was high at 72.2 fish per 100 m^2 (N=38).

Reach 7

Reach 7 started in dense alder and aspen (*Populus tremuloides*) at the northern edge of the beaver pond and terminated at the headwaters in a clear-cut meadow. The reach was 540 m in length and classified as an Aa+ 3 channel. Average gradient in reach 7 was 18.2% with step pool morphology. Cobble was the dominant substrate with average embeddedness of 26.7%. Overall substrate embeddedness was the lowest of any reach in Cook's creek averaging 46.7%. Riffles were recorded in 100% of transects, and primary pool density was the highest of any reach (18.5 pools/km). One series of cascades near the headwaters had a gradient greater than 60% that created a permanent passage barrier. Sixty meters were electrofished below the barrier. A high density of brook trout (175.0 fish/100 m^2, N=61) was estimated, the beaver pond downstream is likely functioning as a reservoir for rearing and overwintering.

Sandwich Creek

Two reaches totaling 1530 meters were surveyed in Sandwich Creek. The survey started at the confluence of Cook's and Sandwich Creeks at an elevation of 628 m and terminated 90 meters above an unmarked logging road in dense alder and vine maple (*Acer circinatum*). The slough downstream of the confluence of Sandwich and Cook's Creeks to Skookum Creek was not surveyed. This reach measures 2200 meters, characterized by low valley wetland conditions with wide (>20 m), slow, slack water channel and associated mud and organic debris substrate and wetland plant community.

Intermittant stream flow and areas of high sedimentation and embeddedness appear to be limiting factors above the slough in Sandwich Creek. See Tables 9 and 10 for channel characteristics, habitat attributes, and limiting factor attributes. Average stream width and depth were 0.8 m and 4.1 cm respectively. Small gravel was the dominant substrate and riffle was the dominant habitat type. Low pool-riffle ratios were recorded, but primary pool densities (16.3 pools/km) were above the lower threshold limit. Two logging roads and culverts were recorded. One culvert was perched >0.5 m above a plunge pool creating a possible outfall barrier. Adaquate fall spawning gravel was recorded in both reaches (34 m^2 total) and abundant spring spawning gravel was observed in reach 2.

Table 9. Channel characteristics and habitat attributes of Sandwich Creek by reach.

Reach/ length (m)		**Average Width (m)**	**Average Depth (cm)**	**Channel Type**	**Average Gradient (%)**	**Dominant Substrate**	**Residual Pool D. (cm)**	**Percent Pool**	**Percent Riffle**	**Percent Run**	**Acting LWD (#/100m)**
1	540	0.9	7	B4	2.1	Small Gravel	18	0	55.8	44.2	4.6
2	990	0.7	2.6	A4	9.7	Small Gravel	19.4	15.6	74	10.4	15.1
Total 1530		**0.8**	**4.1**		**7.0**	**Small Gravel**	**18.9**	**9.3**	**66.7**	**24.0**	**11.4**

Table 10. Limiting factor attributes of Sandwich Creek by reach.

Reach	**Substrate Emded. (%)**	**Bank Stability (%)**	**Spawning Gravel (m^2)**	**Primary Pools/km**	**Pool : Riffle Ratio**
	Threshold values				
	Any value ≤30% or ≥ 70%	Any value≤ 75%	Three lowest cumulative values	Any value <10.5/km	Any value < .5:1 or > 1.5:1
1	50.8	100	17.5	16.7	0:1
2	71.4	100	16.5	16.2	.1:1
Total	**64.1**	**100**	**34**	**16.3**	**0:1**

Two electrofishing stations totaling 150 m were sampled in Sandwich Creek. Brook trout were the only fish species encountered during electrofishing sessions or habitat assessments. Densities ranged from 93.3 fish/100 m^2 in reach 1 to 28.6 fish/100 m^2 in reach 2. The largest individual was 142 mm TL, with a mean size of 80.6 mm ± 19.3 mm TL (N=57) (Figure 4). Age/size class 1+ accounted for 82.5% of captures.

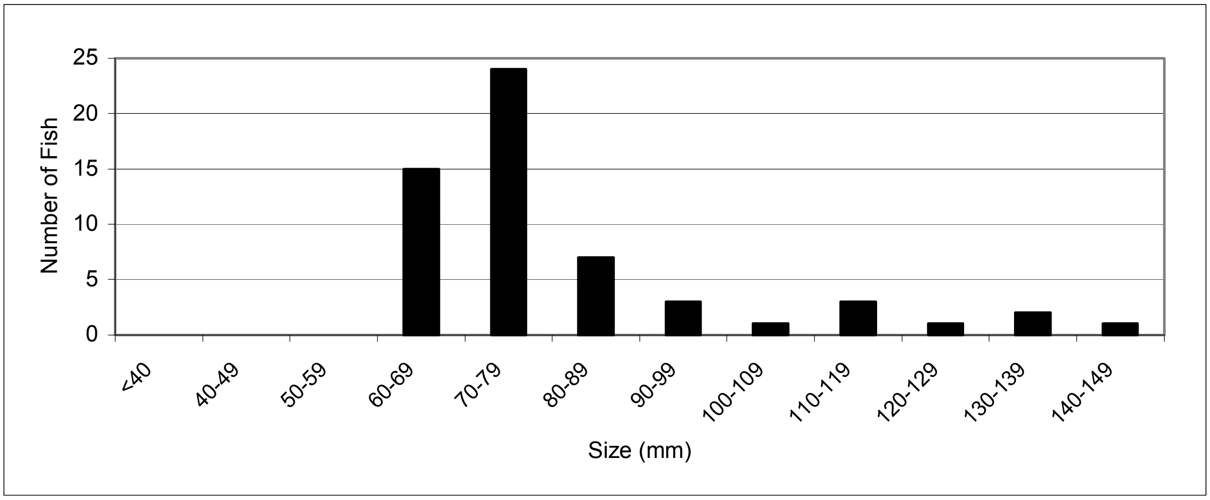


Figure 4. Length frequency distribution of brook trout sampled in Sandwich Creek.

Reach 1

Reach one of the Sandwich Creek survey started at the confluence of Cook's and Sandwich Creeks at an elevation of 628 m. The reach was 540 m in length and classified as a B4 type channel. Gravel and small gravel were the dominant substrates, recorded in 55.8% of transects. Mean embeddedness of gravels was 10.0% and 42.5% respectively. Acting large woody debris density (4.6/100 m) and pool to riffle ratio were low, but primary pool density remained fairly high at 16.7 pools/km with an average length of 1.83 m, maximum depth of 23.4 cm, and residual pool depth of 18.0 cm. All other limiting factor attributes were within threshold limits. Spawning gravel was moderately abundant (17.5 m^2) and rated as fair quality. One culvert perched >0.5 m above a plunge pool was observed on an unmarked, private logging road. Road culverts can be barriers to migration usually because of outfall barriers, excessive water velocity in the culvert, insufficient water in the culvert, lack of resting pools below culverts, or a combination of these conditions (Yee and Roelofs 1980). Although heights of outfall drops that constitute passage barriers have been debated, resident adult trout can generally negotiate a vertical jump of 1 foot (0.3 meters) (Yee and Roelofs 1980).

Brook trout was the only fish species captured in 50 meters of electrofishing. Fish density in reach 1 was much higher than reach 2 at 93.3 fish per 100 m^2 (N=41). This is probably a function of greater water flow and stream width and depth in reach 1 than reach 2.

Reach 2

Reach 2 was an A4 type channel and was 990 m in length. The reach started at a gradient change above a logging road and terminated in a dense alder and vine maple thicket. Channel width and depth (0.7 m and 2.6 cm respectively) were less in the reach and water flows became intermittent 180 m below the terminus. Primary pools were abundant (16.2 per km) and relatively deep (mean depth 22.2 cm, length 1.82 m, residual pool depth 19.4 cm), although many were isolated from the main channel where flow was intermittent. Gravel and small gravel were the dominant substrates, recorded in 76.6% of transects and 16.5 m^2 of fair quality spawning gravel was recorded. Abundant spring spawning gravel was also observed within the bank-full width but outside the wetted width at the time of the survey. Overall, embeddedness was higher in reach 2 (71.4%). Low flow appeared to be limiting in reach 2. Brook trout density was estimated at 28.6 fish per 100 m^2 after electrofishing efforts resulted in 16 captures in 100 linear meters.

Marshall Creek

After reconnaissance of the Marshall Creek watershed on September 10th 2001, it was decided that habitat assessment and fish sampling was impossible. Discussions with local landowners revealed that the original stream channel from Marshall Lake has been diverted for agriculture production. The original channel is ephemeral (dependant on lake level) and dry from Duncan Springs to the lake at the time of the survey. Duncan Springs is located 15 m above Le Clerc Road. Water from the spring is piped downstream to Le Clerc Road for drinking water collection. The channel is covered with plastic, boards, and pipes for this purpose. Water from the spring is piped from the Le Clerc Road culvert into the first of two trout rearing ponds

(Stahl's Trout Farm). Both ponds have permanent fish passage barriers. Marshall Creek above its inflow into Marshall Lake is scheduled for surveying in 2002.

Kent Creek

Three reaches totaling 3.47 km were surveyed in Kent Creek. The survey started at the culvert under SR 20 just west of Deeter Road (elevation 622 m), and ended upstream at a confluence with a small unnamed tributary (elevation 768 m). Water flow in Kent Creek above this spring fed tributary was intermittent with few small isolated pools. In total three culverts and four bridges were observed crossing the stream, most of which were private driveways from Deeter Road. One culvert in reach 1 was identified as a possible passage barrier, with an outfall drop of 0.5 m and low water flow inside the pipe.

Logging and road building activities were the major impacts observed in all reaches. Overall, embeddedness was moderately high at 70.7% although only one reach surpassed the threshold limit. Horse grazing and watering was impacting the stream in the first 2 transects of reach 1, causing unstable banks and increased fine sediment deposition. Channel characteristics and habitat attributes appear in Table 11. Upper or lower threshold limits were exceeded for substrate embeddedness in reach 1 and pool to riffle ratio in all three reaches (Table 12).

Table 11. Channel characteristics and habitat attributes of Kent Creek by reach.

Reach/ Length (m)		**Average Width (m)**	**Average Depth (cm)**	**Channel Type**	**Average Gradient (%)**	**Dominant Substrate**	**Residual Pool D. (cm)**	**Percent Pool**	**Percent Riffle**	**Percent Run**	**Acting LWD (#/100m)**
1	727	1.1	8	C4	0.9	Small Gravel	33.1	14.4	30	55.6	8.2
2	1827	1.6	9.1	B3	2.7	Cobble	29.7	21.8	54.9	23.3	10.2
3	918	1.4	6.1	A3	5.6	Cobble	28	0	89.1	6	12.7
Total 3470		**1.5**	**8.0**		**3.3**	**Cobble**	**30.3**	**14.5**	**62.3**	**23.2**	**10.6**

Table 12. Limiting factor attributes of Kent Creek by reach.

Reach	**Substrate Emded. (%)**	**Bank Stability (%)**	**Spawning Gravel (m^2)**	**Primary Pools/km**	**Pool : Riffle Ratio**
	Threshold values				
	Any value ≤ 30% or ≥ 70%	Any value≤ 75%	Three lowest cumulative values	Any value <10.5/km	Any value < .5:1 or > 1.5:1
1	85.6	93.7	16	41.7	.1:1
2	67	99.7	29	21.2	.3:1
3	65	99.3	0	29.1	0:1
Total	**70.7**	**98.4**	**45**	**27.4**	**.1:1**

Three electrofishing stations totaling 270 meters were sampled in Kent Creek. Brook trout and cutthroat trout were encountered in all three stations. Fish density varied greatly between reaches. Brook trout density varied from 8.6 to 220.8 fish per 100 m^2, and cutthroat trout varied from 15.6 to 68.1 fish per 100 m^2 (Figure 5). The largest individual brook trout was 195 mm TL and the mean size was 78.0 mm ± 30.4 mm TL (N=281). The largest cutthroat was 154 mm TL and the mean size was 72.7 mm ± 29.1 mm TL (N=161) (Figure 6). Relative densities of brook and cutthroat trout were negatively correlated (r = -1). Reach 1 was dominated by brook trout, comprising 93.1% of the total capture. Reach 2 had nearly equal relative densities (brook trout = 50.7%, cutthroat trout = 49.3%). Reach 3 was dominated by cutthroat trout comprising 79.5% of the capture. Fish in the age/size classes 0+ and 1+ accounted for 84.1% of the total capture of both species. Although brook and westslope cutthroat trout were the only species documented, many of the cutthroat displayed phenotypic resemblances to rainbow trout, suggesting possible hybridization.

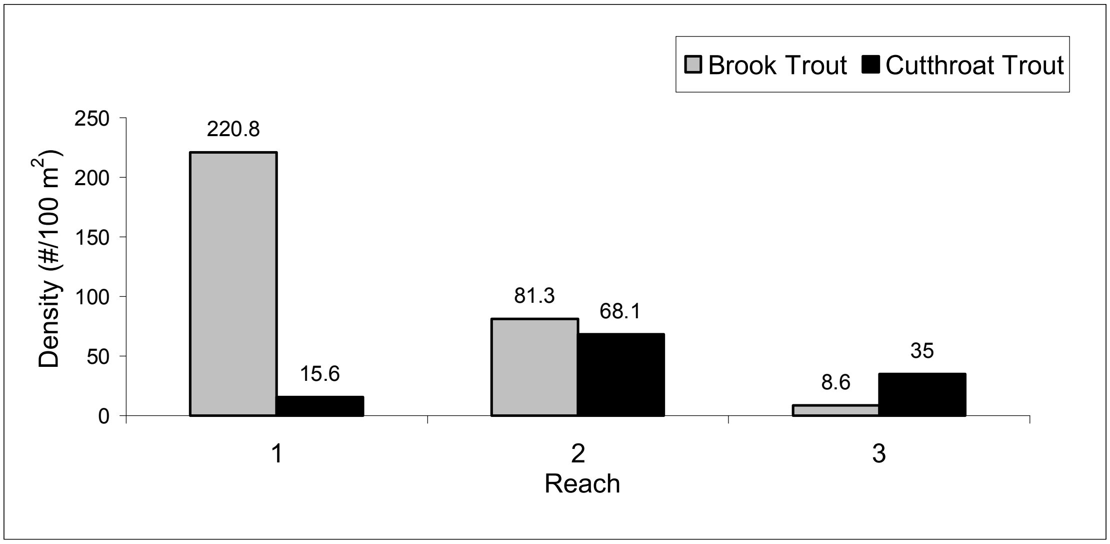


Figure 5. Estimated densities of brook and westslope cutthroat trout sampled in Kent Creek by reach.

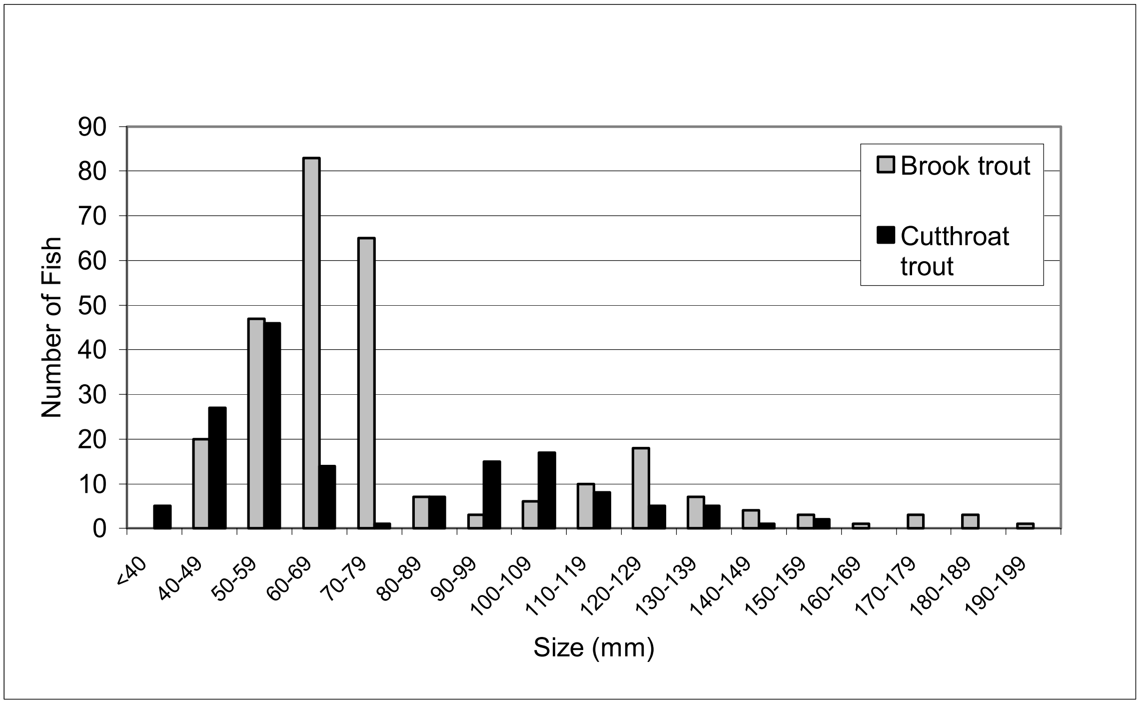


Figure 6. Length frequency distributions of brook and westslope cutthroat trout sampled in Kent Creek.

Reach 1

Reach 1 of the Kent Creek survey started at the SR 20 culvert north of Deeter Road (elevation 622 m). The reach measured 727 meters with a C4 type channel ending at a culvert under Deeter Road. The culvert was perched with an outfall drop of 0.7 m to the plunge pool identified as a possible migration barrier. Horse grazing and watering were impacting the stream in the first two transects. Bank instability, bank failure, trampling, and exposed clay beds were observed along the stream in this section. Overall embeddedness was above the threshold limit and the highest of the three reaches surveyed (X=85.6%). Sand and silt were recorded in 34.4% of transects but the dominant substrate was small gravel (43.3%). Spawning gravel totaling 16 m^2 was recorded. Only five square meters of the spawning gravel was classified as good or fair.

Although large woody debris density was the lowest of the three reaches at 8.2 pieces per 100 meters, primary pool density was highest (41.7 pools/km). Large pools formed by meanders were present in this low gradient reach (mean gradient = 0.9%). The mean pool length was 3.84 m with an average maximum depth of 42.6 cm. One electrofishing station (70 meters) was sampled, resulting in 174 total captures. Salmonid density was high (236.4 fish per 100 m^2) a result of abundant pool habitat, deep undercut banks for cover, and overall habitat diversity. Brook trout density was estimated at 220.8 fish per 100 m^2 (N=162) Moderate numbers of cutthroat trout were also captured (15.6 fish per 100 m^2, N=12).

Reach 2

Reach 2 had a B4 type channel with an average gradient of 2.7% and was 1827 meters in length. No passage barriers or culverts were observed but two bridges were present in the reach. Slightly more LWD was present in reach 2 (10.2 pieces/100 m). Impacts from logging, road building, and residential development were evident. Several homes were located along the stream in the lower portion of the reach. Overall habitat diversity was good with pool, riffle, and run habitats well represented (21.8%, 54.9%, and 23.3% respectively). Mean substrate embeddedness was within the threshold limit (67.0%) with cobble and gravels dominant in 33.7% and 32.2% of transects respectively. Twenty-nine square meters of spawning gravel were recorded, although all was of poor quality due to high embeddedness. Like reach 1, relatively large pools (average length of 3.33 m, average max. depth 36.2 cm) with undercut banks and riparian cover were plentiful (21.2 pools/km).

One electrofishing station totaling 100 meters was sampled in 2001, resulting in 211 total captures. Brook trout density was estimated at 81.3 fish per 100 m^2 (N=162) and cutthroat trout density was 68.1 fish per 100 m^2 (N=104). It appears that habitat degradation and non-native brook trout are having less an impact in the upper reaches of Kent Creek.

Reach 3

Reach 3 measured 918 meters beginning at a private bridge and extending upstream to the confluence with an unnamed, spring-fed tributary. This was the terminus of the Kent Creek survey. The main channel was dewatered above the tributary and no habitat measurements were taken. Few isolated pools existed but no fish were observed. A water control structure on the north end of Mountain Meadows Lake that controls flow of a second tributary to Kent Creek was closed at the time of the survey. According to local landowners water only passes in early spring.

The reach was classified as an A3 channel with an average gradient of 5.6 % and mean width of 1.4 m and depth of 6.1 cm. One culvert and 2 bridges associated with logging roads and private drives were observed in reach 3. Cobble was the dominant substrate in 46.6% of transects with an average embeddedness of 46.8%. Although overall embeddedness was within threshold limits (mean 65%) and small gravel was the dominant substrate in 26.2% of transects, average embeddedness of gravels (85.0%) was above the upper threshold limit for spawning gravel. Primary pools of high quality (29.1 pools per km) were recorded and appear to provide adequate cover and refuge for salmonids.

The reach three electrofishing station measured 100 m and resulted in the capture of 60 fish. Cutthroat trout were the dominant species accounting for 79.5% of the capture (N=47) and an estimated density of 35 fish/100 m^2. Brook trout density was estimated at 8.6 fish/100 m^2 (N=12). Two non-salmonids were encountered in reach 3. One yellow perch was observed outside the electrofishing sample area, and one pumpkinseed was captured in the station. The pumpkinseed measured 88 mm and weighed 13 g. These two fish are thought to have washed downstream through the Mountain Meadows Lake water control structure during spring high flow.

Excessive sedimentation of spawning size gravel and low water flow appeared to be limiting in reach 3. Sediment has adverse impacts on salmonid reproduction and rearing, invertebrate production, species diversity, bedload transport, water quality, and stream depth

(MacDonald *et al*. 1991, Beschta and Platts 1986, Hynes 1970). Substrate embeddedness greater than 20 percent decreases salmonid alevin emergence from interstitial spaces by 30 to 40 percent (Hynes 1970). Platts (1974) reported that cutthroat trout were common only in undisturbed reaches of streams in the Salmon River drainage of Idaho.

Genetically pure westslope cutthroat trout are estimated to exist in only 2-4% of their historic stream distribution (McIntyre and Reiman 1995). Habitat loss and degradation, competition with non-native species, hybridization with rainbow trout and other cutthroat sub-species, and overfishing have contributed to the decline. This supports the argument that protection of high quality habitat is essential for the continued existence of westslope cutthroat populations (Liknes and Graham 1988).

Genetically distinct native populations of westslope cutthroat trout have been documented in tributaries to the Pend Oreille River that have shown little interbreeding or introgression with hatchery stocks (Shaklee and Young 2000). Shaklee and Young (2000) suggest that management and conservation of westslope cutthroat trout should be focused at this fine (individual tributaries) geographic scale. Microsatallite DNA characterization of the Kent Creek stock is recommended to determine genetic purity, possible hatchery origin, and potential hybridization with rainbow trout in Kent Creek. If the Kent Creek stock is determined pure, managers should explore possibilities for habitat enhancement and non-native species removal (brook trout). Mountain Meadow Lake should also be investigated due to its seasonal connectivity to the creek.

McCloud Creek

Three reaches totaling 4.1 km were surveyed in McCloud Creek (Figure). The survey started at the culvert under SR 20 at elevation 628 m and ended upstream (elevation 744 m) east of McCloud Creek Road 675 m before the intersection with a private drive. Access was denied to the upper 1.2 km of reach 3 by landowners. Agriculture, logging, and roads were the major impacts in the watershed. The mean of each channel characteristic, habitat attribute, and limiting factor attribute was calculated for each reach and the entire stream and appear in Tables 13 and 14.

The average width and depths were 1.4 m and 17.1 cm, and the mean gradient was 2.7%. Upper or lower threshold limits were exceeded for substrate embeddedness, spawning gravel, and primary pool abundance. Sediment levels and substrate embeddedness were relatively high in all reaches of McCloud Creek (X=79.0%), and only reach 2 had embeddedness levels within the threshold limits (X=60.9%). Overall, cobble was the dominant substrate (34.6% of transects).

Table 13. Channel characteristics and habitat attributes of McCloud Creek by reach.

Reach/ Length (m)		**Average Width (m)**	**Average Depth (cm)**	**Channel Type**	**Average Gradient (%)**	**Dominant Substrate**	**Residual Pool D. (cm)**	**Percent Pool**	**Percent Riffle**	**Percent Run**	**Acting LWD (#/100m)**
1	1710	1.3	28.1	E6	0.5	Silt	45	32.4	16.6	51	0.8
2	1365	1.4	9.9	B3	3.1	Cobble	22.8	41.7	58.3	0	7.1
3	935	1.4	8.4	A3	5.5	Cobble	19.4	17.5	66.2	7.8	12
Total 4100		**1.4**	**17.1**		**2.7**	**Cobble**	**22.8**	**32.3**	**43.0**	**22.6**	**5.6**

Table 14. Limiting factor attributes of McCloud Creek by reach.

Reach	**Substrate Emded. (%)**	**Bank Stability (%)**	**Spawning Gravel (m^2)**	**Primary Pools/km**	**Pool : Riffle Ratio**
	Threshold values				
	Any value ≤ 30% or ≥ 70%	Any value≤ 75%	Three lowest cumulative values	Any value <10.5/km	Any value < .5:1 or > 1.5:1
1	95.3	100	10	4.1	2:1
2	60.9	99.4	25	35.6	.6:1
3	77.7	99.5	0.5	43.4	.4:1
Total	**79.0**	**99.7**	**35.5**	**23.0**	**.7:1**

Electrofishing stations in reach 1 and 2 each measured 100 m. Reach 3 was not sampled due to access being denied by landowner. No fish were encountered in the reach 1 electrofishing station, although brook trout were observed in the upper 200 m during the habitat survey. Brook trout was the only species captured in the reach 2 sampling station. Population density was estimated at 165.7 fish/100 m^2 (N=217). The mean size was 88.2 mm ± 32.6 mm TL and ranged from 44 mm TL to 203 mm TL (Figure 7). Age/size classes 0+ and 1+ accounted for 76.5% of total captures. Age/size class distribution was 0+ = 35.2%, 1+ = 41.3%, 2+ = 22.5%, and 3+ = 1.0%.

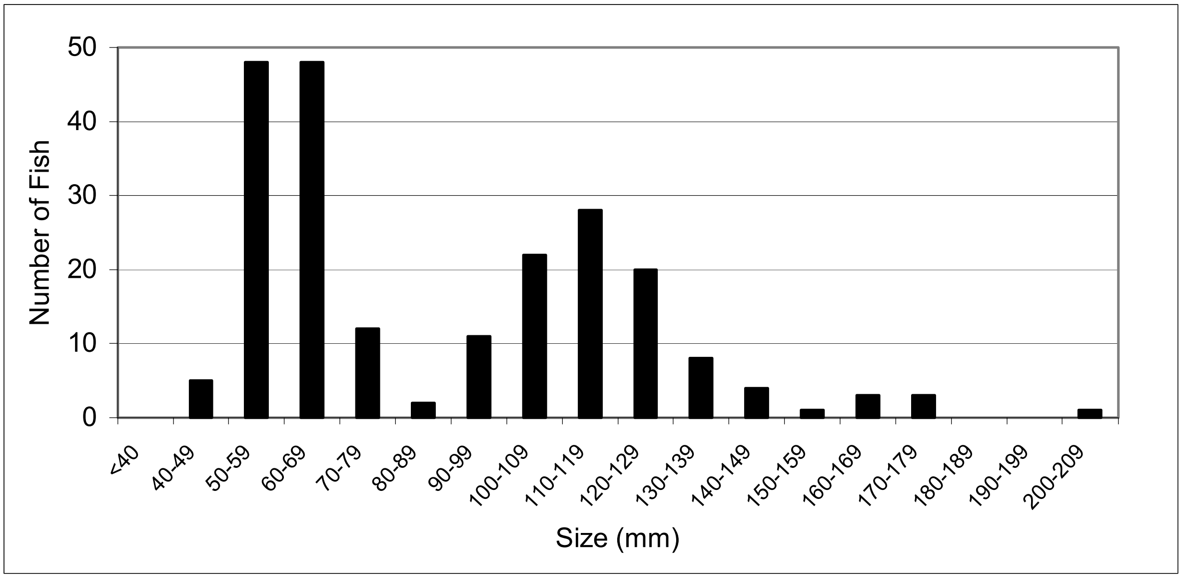


Figure 7. Length frequency distribution of brook trout sampled in McCloud Creek.

Reach 1

Reach 1 of the McCloud Creek survey started at the culvert where the creek flows under SR 20 west of McCloud Creek Road. Downstream of reach 1, McCloud Creek becomes a shallow, wide slough before emptying into the Pend Oreille River. The reach was classified as an E6 type channel that extended upstream 1710 meters to the railroad trestle that intersects McCloud Creek Road. The channel has been entrenched and straightened for roughly 1100 meters through a reed canary-grass (*Phalaris arundinacea*) field used for straw production. A large steel dam (2 m high) spanned the narrow northern portion of the meadow. The gates were open on the dam at the time of the survey.

The channel had an average width of 1.3 m and depth of 28.1 cm, with sand and silt dominant in 77.7% of transects. Average embeddedness was 95.3%. Two culverts were observed, neither of which appeared to inhibit fish passage due to low gradient (0.5%) in the reach. LWD and primary pools were lacking (4.1/km and 0.8 pools/100 m) and run habitat was recorded in 51.0% of transects.

An alder thicket in the upper 200 m provided higher quality fish habitat upstream of the incised channel. The alders provided the majority of riparian cover in the reach. Spawning sized gravel (10 m^2; fair quality), riffle habitat, and pools were present in this section. Brook trout were observed here during habitat surveys but no fish were observed or captured during electrofishing downstream of this section.

Reach 2

Reach 2 measured 1365 m and was classified as a B3 channel. The railroad trestle on the downstream edge and the intersection of McCloud Creek Road and Marne Lane marked the reach boundaries. The dominant habitat type was riffle (58.3%) with average width and depth of 1.4 m and 9.9 cm and gradient of 3.1%. The dominant substrate was cobble and average embeddedness was 60.9%. Pool habitat was recorded in 41.7% of transects and primary pools were estimated at 35.6 pools/km. Average pool length and maximum depth were 2.58 m and 30.3 cm respectively. Acting LWD density was low at 7.1 pieces/100 m, largely due to alder being the primary riparian species, which generally does not reach size requirements to be classified as LWD. Spawning gravel was highest in reach two at 25 m^2, although all was of poor quality due to high level of embeddedness. Three culverts were observed in reach two. Brook trout was the only species observed or captured (N=217). Brook trout TL ranged from 44 mm to 203 mm and averaged 88.2 ± 32.6 mm TL. Density was estimated at 165.7 fish/100 m^2.

Reach 3

Reach 3 began at the intersection of Marne Lane and McCloud Creek Road and extended upstream 935 meters. The upper 1.2 km of stream to the headwaters was not surveyed due access being denied by landowner. Gradient was greater in reach 3 at 5.5%, resulting in a channel classification of A3. Average width (1.4 m), depth (8.4 cm), and dominant substrate (cobble) were all similar to reach 2. Overall substrate embeddedness was higher at 77.7%, and spawning sized gravels averaged 72.5% embedded. High embeddedness of gravels resulted in only 0.5 m^2 being classified as suitable for spawning. LWD density was higher (12.0 pieces /100 m); as a result primary pools were abundant (43.4 pools/km). Deep undercut banks and large boulders were observed in the reach. Localized erosion sources were observed along McCloud Creek Road and game watering areas where stream banks have been trampled. Fish sampling did not occur in reach 3 due to denied access and safety concerns, although brook trout were observed during habitat surveys. Fish larger than 200 mm were observed in one large dugout plunge pool downstream of a driveway culvert.

Davis Creek

Ten reaches totaling 13.6 km were assessed in Davis Creek. The survey started 3.5 km upstream of the mouth of Davis Creek. The backwater slough from the mouth to this point was not surveyed due to high water depth, width, lack of channel, and unstable substrate (silt and organic debris). Reaches 1-4 were located between the confluence with the Pend Oreille River and the outlet of Davis Lake. Water flow, habitat characteristics, and fish species composition in the first four reaches varied greatly from conditions upstream of Davis Lake and are treated somewhat separately here.

Reaches 5-10 were located from the inlet to Davis Lake to the headwater pond (beaver) 10.1 km upstream, just north of Deer Valley Road and west of Deeter Road (Township 31N, Range 44E, Section 15). Significant portions of the upper watershed were not surveyed due to land access denial, wetland and slough conditions, and heavy beaver activity. Wherever possible reach overview surveys were conducted to qualitatively assess inaccessible stream segments. These include reaches 6, 7, and 9 in entirety and portions of reaches 5 and 8.

Impacts from current and historic land use practices were evident in nearly all reaches of Davis Creek. Effects of road construction, logging, grazing, channel alteration, agriculture, and residential development were evident in the watershed. The mean of each channel characteristic, habitat attribute, and limiting factor attribute were calculated for each reach and appear in Tables 15 and 16. Sediment levels and substrate embeddedness were high in nearly all reaches (X=66.9% below Davis Lake, 91.2% above). Reaches 2 and 3 were the only reaches with embeddedness levels within the threshold limits (X=61.9% and X=46.7% respectively). The first 3 reaches contained the only spawning gravel recorded in the stream, with localized large gravel deposits totaling 336.5 m^2. Acting LWD density was low in nearly all reaches, ranging from 1.1 to 13.9 pieces/100 m (X=5.4/100m). Primary pools ranged from 7.8 to 19.8 per km with mean number below Davis Lake (15.6/km) slightly higher than above (12.7/km). Several series of beaver dams in low gradient (< 0.5%) stream segments created series of pools and runs of substantial width and depth. Reach 2 had a series of dammed pools with sustained depths greater than 110 cm for over 130 meters.

Table 15. Channel characteristics and habitat attributes of Davis Creek by reach.

Reach/ Length (m)		**Average Width (m)**	**Average Depth (cm)**	**Channel Type**	**Average Gradient (%)**	**Dominant Substrate**	**Residual Pool D. (cm)**	**Percent Pool**	**Percent Riffle**	**Percent Run**	**Acting LWD (#/100m)**
1	1620	3.5	34.7	C4	0.5	Small Gravel	60.1	25	24.4	45.7	1.1
2	1250	3.9	30	C4	1	Small Gravel	58.8	40.5	36.3	23.1	6.4
3	2100	3.7	24.4	F6	1.2	Silt	44.6	27.9	49.5	22.6	8.3
4	2009	5.8	67.7	F6	0.5	Silt	128	39	0	61	1.3
1-4 6980		**4.0**	**34.8**		**0.8**	**Small Gravel**	**58.0**	**33.3**	**29.6**	**35.8**	**4.7**
5	2423	3.9	52.3	F6	1.1	Silt	76.3	35.9	38.5	25.6	2.4
6	1685	Not Surveyed									
7	1111	Not Surveyed									
8	1404	1.5	14.8	F5	1.3	Sand	29.7	0	100	0	13.9
9	1230	Not Surveyed									
10	1346	1.2	11.1	B5	2	Sand	22.1	14.2	79.2	6.7	4.6
5-10 6620		**1.8**	**19.7**		**1.5**	**Sand**	**33.9**	**17.5**	**70.8**	**11.7**	**8.0**

Table 16. Limiting factor attributes of Davis Creek by reach.

Reach	**Substrate Emded. (%)**	**Bank Stability (%)**	**Spawning Gravel (m^2)**	**Primary Pools/km**	**Pool : Riffle Ratio**
	Threshold values				
	Any value ≤ 30% or ≥ 70%	Any value≤ 75%	Three lowest cumulative values	Any value <10.5/km	Any value < .5:1 or > 1.5:1
1	81.1	98.4	207	19.1	.4:1
2	61.9	98.6	121.5	13.9	.6:1
3	46.7	97.8	8	19.8	.5:1
4	100	97.2	0	5.6	0:1
1-4	**66.9**	**98.1**	**336.5**	**15.6**	**.6:1**
5	71	100	0	8.9	.5:1
6	Not Surveyed				
7	Not Surveyed				
8	93.6	100	0	19.4	0:1
9	Not Surveyed				
10	98.5	99.5	0	7.8	.1:1
5-10	**91.2**	**99.8**	**0**	**12.7**	**0:1**

Seven electrofishing stations (100 m each) were sampled in 2001, resulting in the capture of 1007 fish representing 12 species (Table 17). The four electrofishing stations downstream of Davis Lake produced 64.3% (N=637; 9 species) of the total catch. Above Davis Lake three reaches were surveyed resulting in 370 captures from 3 species. Brook trout, sculpin spp., and rainbow trout were the only species encountered above the lake, conversely these species were absent from surveys below the lake.

Table 17. Total catch and relative abundance of fish sampled in Davis Creek by reach.

Reach	BBH	BRT	LMB	LSS	MWF	NPM	PUSE	RSS	TNCH	BKT	RBT	SCUL	Total
1	7	15	20	4	4	86	2	1	14				153
2	1	23		10		15		9	1				59
3		27		2									29
4	262		12				109		13				396
5										144	3	56	203
8										167			167
Total	270	65	32	16	4	101	111	10	28	311	3	56	**1007**
%	26.8%	6.5%	3.2%	1.6%	0.4%	10.0%	11.0%	1.0%	2.8%	30.9%	0.3%	5.6%	100.0%

Overall, brook trout was the most abundant species captured comprising 30.9% of the total catch and 84.1% of the catch above Davis Lake. The largest individual measured 345 mm and weighed over 300 g. The mean TL was 100.6 mm ± 51.2 mm. Age/size classes 0+ and 1+ accounted for 70.6% of the brook trout take. Sculpin spp. and rainbow trout accounted for 15.9% (N=56) and 0.8% (N=3) of the catch above Davis Lake respectively. Mean TL of sculpin was 58.9 mm ± 13.7 mm and the largest individual measured 84 mm. Mean TL of rainbow trout was 140.3 mm ± 11.1 mm and the largest individual measured 152 mm.

Brown bullhead was the most abundant species encountered below Davis Lake (N=270) accounting for 26.8% of the total capture and 42.4% of the take below the lake. Relative abundance of the remaining species (% capture below Davis Lake) follow in declining order: pumpkinseed (17.4%, N=111), northern pikeminnow (15.9%, N=101), brown trout (10.2%, N=65), largemouth bass (5.0%, N=32), tench (4.4%, N=28), largescale sucker (2.5%, N=16), redside shiner (1.6%, N=10), and mountain whitefish (0.6%, N=4).

The largest individual brown bullhead measured 210 mm TL and the mean TL was 92.7 mm ± 25.7 mm. Mean TL of largemouth bass was 109.8 mm ± 32.7 mm and the largest individual measured 147 mm TL. The largest individual largescale sucker measured 153 mm TL and the mean TL was 85.0 mm ± 31.0 mm. The largest individual northern pikeminnow measured 247 mm TL and the mean TL was 98.3 mm ± 50.4 mm. Mean TL of mountain whitefish was 64.0 mm ± 4.8 mm and the largest individual measured 164 mm TL. The largest individual pumpkinseed measured 112 mm TL and the mean TL was 65.4 mm ± 12.4 mm. The largest individual redside shiner measured 100 mm TL and the mean TL was 84.9 mm ± 21.0 mm. Mean TL of tench was 140.8 mm ± 62.4 mm and the largest individual measured 296 mm TL. Length frequency distributions were calculated for brown trout and brook trout and appear in Figure 8. Estimated fish densities for species captured in reaches 1-4 appear in Figure 9.

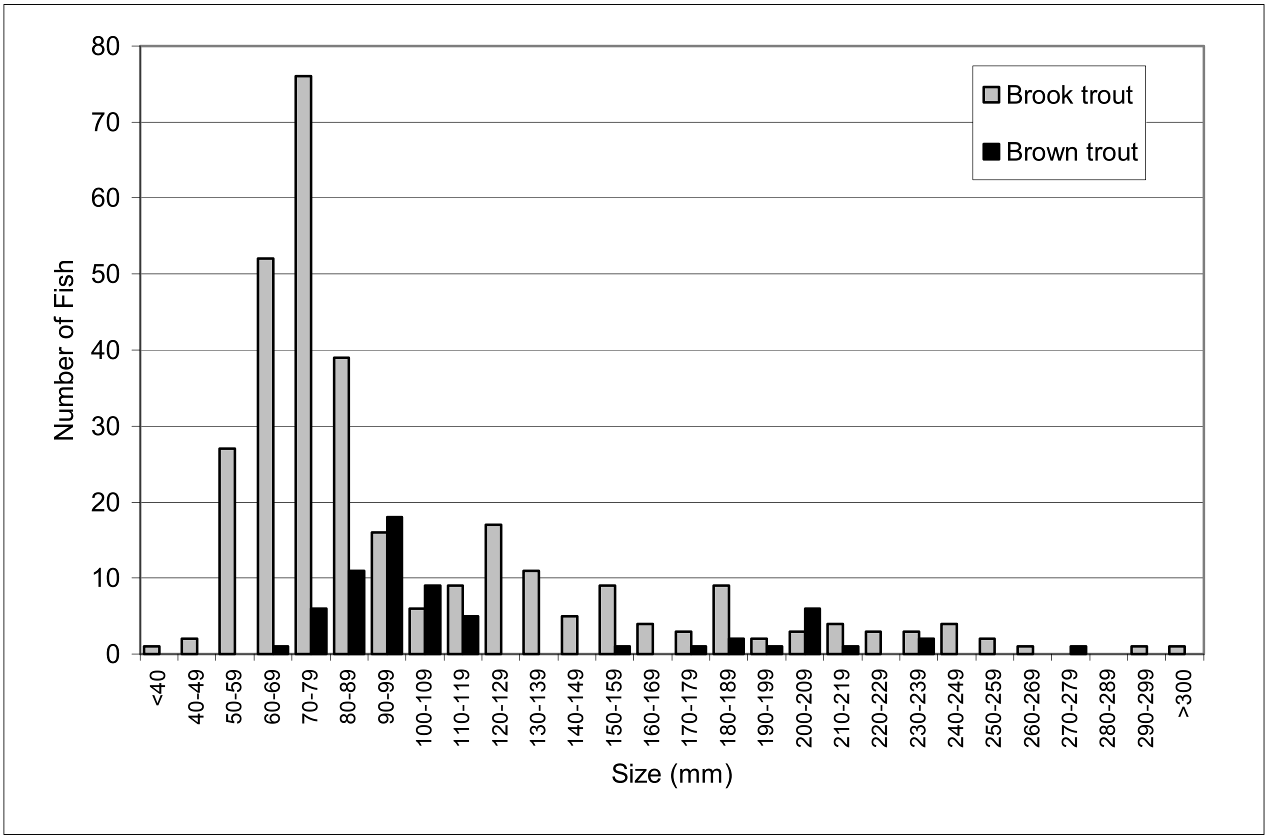


Figure 8. Length frequency distribution of brook and brown trout sampled in Davis Creek.

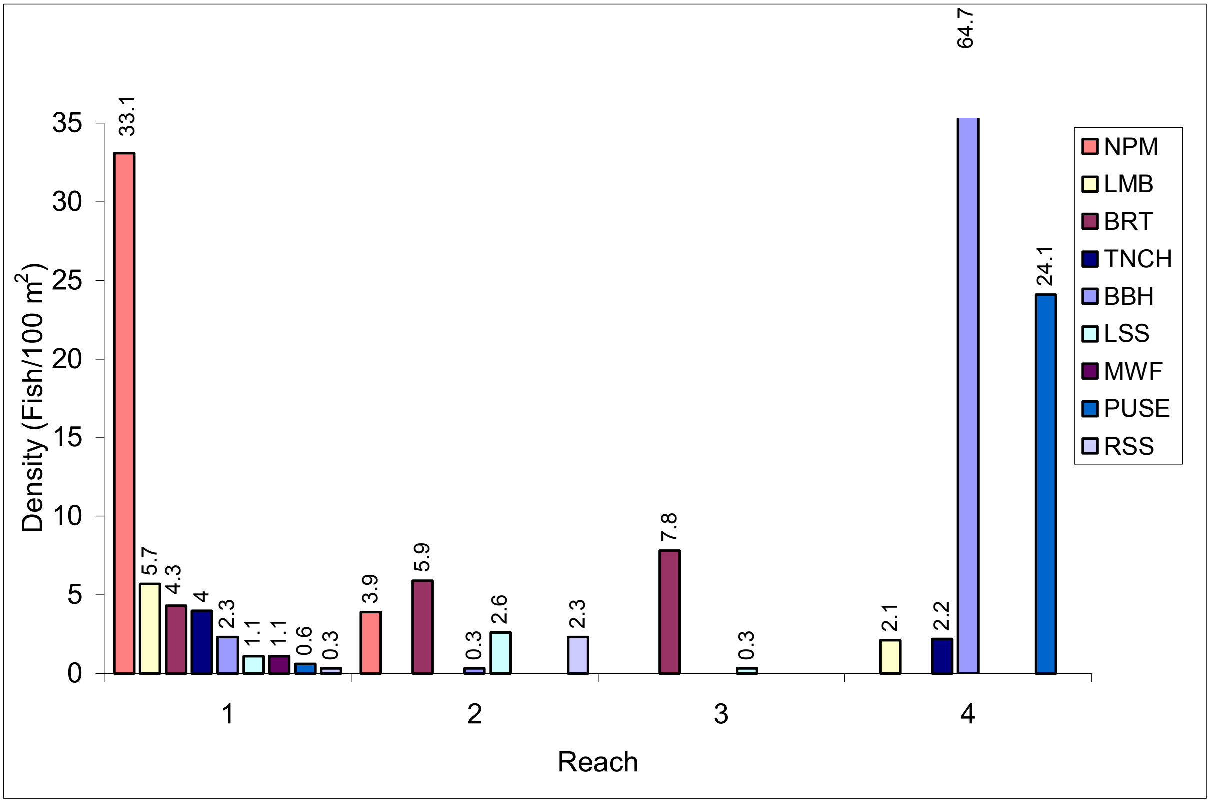


Figure 9. Estimated densities of fish captured in reaches 1 – 4 of Davis Creek (NPM; Northern pikeminnow, LMB; largemouth bass, BRT; brown trout, TNCH; tench, BBH; brown bullhead, LSS; largescale sucker, MWF; mountain whitefish, PUSE; pumpkinseed, RSS; redside shiner).

Reach 1

The Davis Creek habitat survey started 3.5 km upstream of the confluence with the Pend Oreille River. The backwater slough from the mouth to the Davis Road boat launch was not surveyed. Reach 1 was classified as a C4 type channel and measured 1620 meters. The road culvert under Garden Lane marked the upper boundary. The channel was deep (mean depth 34.7 cm), wide (3.5 m mean wetted width), and sinuous with low gradient (0.5%). Small gravel was the dominant substrate recorded in 74.2% of transects with an average embeddedness of 78.1%; above the threshold limit. Several gravel deposits suitable for salmonid spawning were recorded, however, totaling 207.0 m^2.

Large woody debris density was the lowest of any reach at 1.1 pieces/km. LWD recruitment is low as the stream meanders through grass meadows with little deciduous or coniferous cover. Many large pools created by meanders in the stream had deep undercut banks providing the only cover to speak of. Primary pool density was 19.1 pools/km with average length, and average maximum depths of 10.5 m, and 85.3 cm respectively. High substrate embeddedness, lack of riparian cover, and low LWD abundance appear to be limiting factors in reach 1.

One 100-meter electrofishing station was sampled resulting in the capture of 153 individuals from nine species. Northern pikeminnow was the most abundant species comprising 56.2% of the capture (N=86), with density estimated at 33.1fish/100 m^2. The eight other species captured were (in descending order of relative abundance): largemouth bass (N=20, 13.1%, 5.7/100m^2), brown trout (N=15, 9.8%, 4.3/100m^2), tench (N=14, 9.2%, 4.0/100m^2), brown bullhead (N=7, 4.6%, 2.3/100m^2), largescale sucker and mountain whitefish (both N=4, 2.6%, 1.1/100m^2), pumpkinseed (N=2, 1.3%, 0.6/100m^2), and redside shiner (N=1, 0.7%, 0.3/100m^2).

Reach 2

Reach 2 began at the culvert under Garden Lane and extended 1250 m upstream to a privately owned wood bridge over the creek. The stream had a C4 type channel that flowed through a small valley with meadows interspersed with alder thickets. The mean width was 3.9 m and the depth was 30.0 cm. Pools and riffles were the dominant habitat types recorded in 40.5% and 36.3% of transects respectively. Large primary pools created by beaver dams and meanders were fairly abundant (13.9 pools/km). The average maximum depth was 78.8 cm and average length was 13.26 m. LWD density was low (6.4 pieces/100 m), a result of coniferous riparian canopy (recruitment) absent in the reach. Small gravel, with average embeddedness of 51.1%, was the dominant substrate recorded in 44.8% of transects. Spawning gravel totaled 121.5 m^2, all of which was classified as poor quality due to level of embeddedness.

Six species and 59 individuals were captured in the reach 2 electrofishing station (100 m). Brown trout was the most abundant species accounting for 39.0% of the capture (N=23). Brown trout density was estimated at 5.9 fish per 100 m^2. Northern pikeminnow (N=15) accounted for 25.4% of the capture and had an estimated density of 3.9 fish/100 m^2. Largescale sucker and redside shiner accounted for 16.9% (N=10) and 15.3% (N=9) of the take respectively with densities of 2.6 and 2.3 fish/100 m^2. Brown bullhead and tench were each represented by one individual.

Reach 3

Reach 3 began at the wood bridge over the stream and extended 2100 m upstream to the West Calispel Road culvert. Overall, reach 3 was classified as an F6 type channel with silt the dominant substrate in 42.6% of transects. The first 900 m of the reach flowed through coniferous forest dominated by cedar, with higher gradient (2-4%), and fast flowing water over exposed bedrock and cobble (B1 channel type). Cobble was the dominant substrate in 21.4% of transects with average embeddedness of 13.8%. Eight square meters of spawning gravel was observed in the lower portion of the reach.

Cattle and beaver activity heavily impacted the upper 1200 m of the reach. Silt substrate was recorded in all transects of this relatively flat section (gradient 0.5%). Cattle watering and grazing has resulted in trampled stream banks and heavy sediment deposition in places. Large beaver ponds and wetland conditions prevented surveying in the upper 470 m of the reach. Twenty-nine fish representing two species were captured in our 100-meter electrofishing station. Brown trout (N=27) density was estimated at 7.8 fish/100m^2. Seventy-six percent of brown trout captured were in the age/size class 1+. Largescale sucker (N=2) density was estimated at 0.5 fish/100m^2.

Reach 4

Reach 4 began at the culvert under West Calispel Road and extended 2009 m to the outlet of Davis Lake. Cattle grazing, roads, and agricultural practices are heavily impacting the stream in reach 4. Only the first 720 m were surveyed due to channel straightening along highway 211. In this entrenched section the stream averages 3.0-4.0 m wide and 1-1.5 m deep with silt substrate. Beaver activity in the first 720 m created deep pools and wetland conditions. Pool and run habitats were recorded in 100% of transects surveyed. Average pool length was 57.5 m and average maximum depth was 137.5 cm. LWD density was low at 1.3 pieces/100m. Riparian vegetation was dominated by reed canary-grass, and very little deciduous or coniferous cover was observed.

Electrofishing of one 100-meter station resulted in the capture of 396 fish representing 4 species. Brown bullhead accounted for 66.2% of the take (N=262) with an estimated density of 64.7 fish/100 m^2. Pumpkinseed was the second most abundant species (N=109, 27.5% of take) with a density of 24.1 fish/100 m^2. Tench (N=13) and largemouth bass (N=12) accounted for 3.3% and 3.0% of the capture respectively.

Reach 5

Reach 5 measured 2423 m from Davis Lake upstream to the set of double power lines that head north south along Hwy 211. The upper portion from the highway 211 culvert to the power lines was surveyed (471 m). Approximately 100 m upstream of the power lines is the confluence of Deer and Davis Creeks, but private landowner denied access to the stream. Downstream of Hwy 211 the stream becomes a wetland before flowing into Davis Lake. Average depth in reach 5 was 52.3 cm and width was 3.9 m, and silt was the dominant substrate (61.5% of transects). Alder was the primary riparian species contributing little to LWD density (2.4 pieces/100m). Beaver dams were observed in the upper ½ of the reach providing pool habitat averaging 14.0 m long with average max depth of 101.3.

Brook trout, sculpin spp, and rainbow trout were captured in one 100-m electrofishing station. Brook trout accounted for 70.9% of the capture (N=144) at an estimated density of 41.5 fish/100 m^2. Sculpin (N=56, 27.6%) density was estimate at 14.4 fish/100 m^2. Three rainbow trout accounted for 1.5% of the capture and had a density of 0.8 fish/100 m^2.

Reaches 6,7

Land access was denied to reaches six and seven. The reaches flow through Deer Valley in clear-cut forest, grazed pastures, and alder thickets. The channel is much smaller above the confluence with Deer Creek and reach 7 is entrenched through the grazed meadow south of Deer Valley Road. Channel alteration, sedimentation, and lack of LWD are likely limiting factors in reaches 6 and 7.

Reach 8

Reach 8 measured 1404 m and was classified as an F5 channel. The reach began at the double power lines north of Deer Valley Road and terminated at the beaver ponds on Duck Lane at William's Wildlife Area. Average width was 1.5 m, depth was 14.8 cm, and gradient averaged 1.3%. The creek flowed through mixed conifer forest and alder thickets. Riffle was recorded as the dominant habitat type in all transects. Sand and silt were the dominant substrates in 95.2% of transects. Average embeddedness was 94.6%. LWD density was the highest of any reach in Davis Creek (13.9 pieces/100 m) and primary pools were abundant (19.4 pools/km). A natural barrier approximately 700 m upstream from the lower reach boundary was recorded. The 15 m high series of steep falls and cascades flowed over bedrock and large boulders with gradient over 35%. Directly upstream of the falls was a series of remnant and active beaver dams creating wetland conditions. Electrofishing of the lower portion of the reach occurred on October 2nd 2001. Brook trout was the only species captured in the 100-meter sample station. Density was estimated at 121.3 fish/100 m^2 (N=167).

Reach 9

No habitat parameters were measured in reach 9. The reach began at the beaver ponds in Williams Wildlife Area. Wetland conditions existed with surface water from springs flowing into the basin in the lower 330 m. Above the wetland the channel was dewatered for 500 m. Access was denied to the upper portion of the reach through Sherman's Meadow. Water was visible in dugout cattle watering holes and a ditch through the meadow.

Reach 10

Reach 10 began at the Sherman Meadow fence line and extended 1346 m upstream to the headwater beaver pond north of Deer Valley Road and west of Deeter Road. The reach was classified as a B5 type channel with average width of 1.2 m and depth of 11.1 cm. Sand was the dominant substrate (86.7%) with highly embedded (X=92.5%) small gravel present in 13.3% of transects. LWD and primary pool densities were low (4.6 pieces/100m and 7.8 pools/km). Three migration barriers were recorded in the reach. The first two barriers occur where the creek flows over bedrock and boulder falls and chutes with sustained gradient >34% for 90 meters. A culvert on a private logging road creates an outfall and velocity barrier with no plunge pool below it. Brook trout were observed below the barriers during the habitat survey but electrofishing above the barrier resulted in no captures.

Deer Creek

Two reaches totaling 3060 m were surveyed in Deer Creek. The survey began 1690 m upstream from the confluence of Deer and Davis Creeks at elevation 2270 ft. Access was denied to the first 1690 m by the landowner. The survey terminated near the headwater springs in pastures south of Rocky Gorge Road. Small gravel was the dominant substrate (35.5% of transects). Average width and depths were 2.3 m and 22.0 cm respectively, and mean gradient was 1.1%. Logging, grazing, and heavy beaver activity were the dominant habitat disturbances observed in the watershed. Beavers have created permanent and seasonal wetland conditions in most of the upper watershed. Only 360 m of the stream are free flowing above of the Rocky Gorge Road culvert. Channel characteristics, habitat attributes, and limiting factor attributes of Deer Creek appear in tables 18 and 19.

Table 18. channel characteristics and habitat attributes of Deer Creek by reach.

Reach/ Length (m)		**Average Width (m)**	**Average Depth (cm)**	**Channel Type**	**Average Gradient (%)**	**Dominant Substrate**	**Residual Pool D. (cm)**	**Percent Pool**	**Percent Riffle**	**Percent Run**	**Acting LWD (#/100m)**
1	1440	1.7	17.8	F4	1	Small Gravel	42.5	0	41.9	58.1	6.2
2	1620	4.5	39	B3	1.6	Cobble	25.8	44.4	45.6	0	11.9
Total 3060		**2.3**	**22.0**		**1.1**	**Small Gravel**	**38.1**	**17.4**	**43.4**	**35.3**	**7.3**

Table 19. Limiting factor attributes of Deer Creek by reach.

Reach	**Substrate Emded. (%)**	**Bank Stability (%)**	**Spawning Gravel (m^2)**	**Primary Pools/km**	**Pool : Riffle Ratio**
	Threshold values				
	Any value ≤30% or ≥ 70%	Any value≤ 75%	Three lowest cumulative values	Any value <10.5/km	Any value < .5:1 or > 1.5:1
1	93.8	97.5	0	9.7	0:1
2	60	100	0	13.9	.3:1
Total	**83.8**	**98.0**	**0**	**10.6**	**.1:1**

Two electrofishing stations, 100-meters each, resulted in the capture of 224 fish. Brook trout was the dominant species comprising 91.5% (N=205) of the capture. The largest individual measured 219 mm TL and the mean TL was 98.6 mm ± 43.5 mm. Age/size classes 0+ and 1+ accounted for 63.4% of the total captures. Sculpin sp. (N=19) accounted for 8.5% of the take with mean TL 79.9 mm ± 9.5 mm. The largest individual sculpin measured 97 mm. Length frequency distribution of brook trout appear in Figure 10.

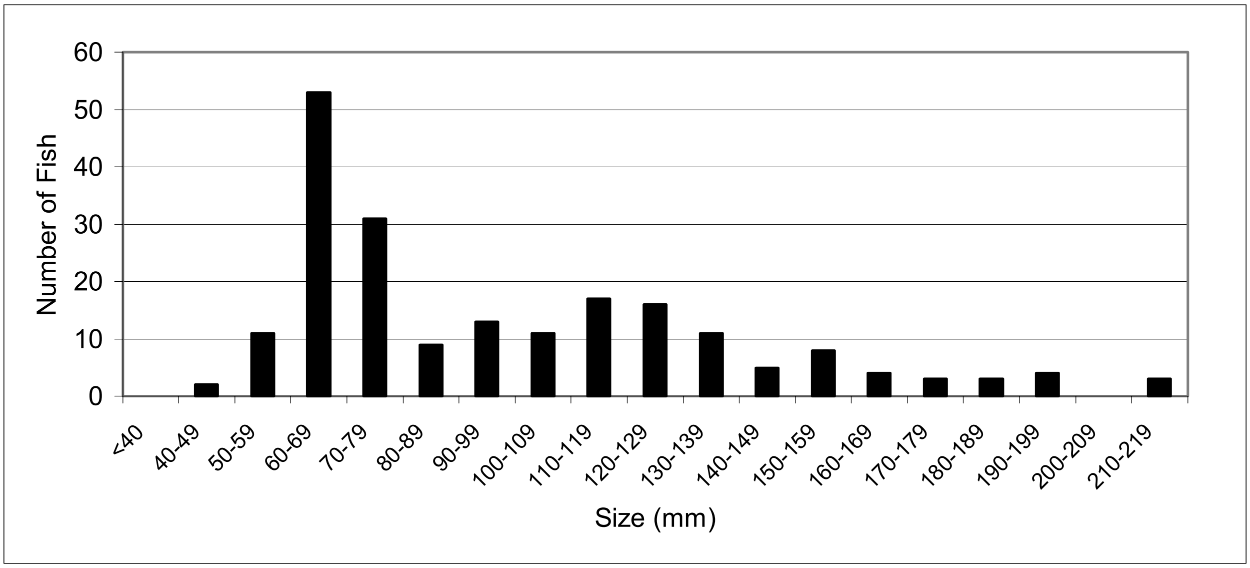


Figure 10. Length frequency distribution of brook trout sampled in Deer Creek.

Reach 1

Reach 1 began at the property boundary of Cummings Construction gravel pit and extended upstream 1440 m through alder stands that lined the stream. The stream was classified with an F4 type channel with small gravel the dominant substrate in 42.3% of transects. Large quantities of sand resulted in an average embeddedness of 87.5%, above the threshold limit for spawning. The stream averaged 1.7 m wide and 17.8 cm deep in reach 1. Primary pool density was 9.7 pools/km with average depth of 58.0 cm and length of 7.86 m. Meanders through the sand substrate created pools with deep undercut banks providing good winter habitat. LWD density was relatively low at 6.2 pieces/100 m. Grazing activities in the reach, and the downstream section not surveyed, are impacting the banks in several places.

Upstream of the Rocky Gorge Road culvert, stream morphology is dominated by beaver activity. A series of eight small beaver dams create pool habitat that extends 540 m until gradient increases from 0.5% to 3.5%. Electrofishing occurred downstream from Rocky Gorge Road. One 100-meter station yielded 190 fish. Brook trout (N=171) accounted for 90% of the capture. Density was estimated to be 103.5 fish/100 m^2. Sculpin sp. density was estimated at 11.2 fish/100 m^2 (N=19).

Reach 2

Reach 2 measured 1620 m and was classified as a B3 type channel. The reach began at the gradient change upstream of the reach 1 beaver ponds and terminated near the headwater springs. No distinct channel was present above the first 360 m, where the stream is a large semi-permanent wetland complex. Large remnant beaver dams were observed; one measured nearly 100 m wide with a hut measuring 8 m in diameter. The gradient in the first 4 transects ranged from 2.0% to 4.0% and flattened to <0.5% above.

Before reaching the wetlands the stream flows through recently (<5 years) logged forest and uprooted trees, slash, and debris are abundant in and along the stream (LWD 11.9 pieces/100 m). Cobble and small gravel were the dominant substrates in the first 360 m (30.6% and 25.0% respectively). Average embeddedness was 60.0%. Primary pool density was 13.9 pool/km with average maximum depth of 34.2 cm and length of 5.3 m. One electrofishing station measuring 100 meters resulted in 34 brook trout captures. Density was estimated at 9.1 fish/100 m^2.

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Appendix 1

Biological Investigation of Seven 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 seven lakes in the Pend Oreille River Drainage. Assessment included collection of replicate samples necessary for water quality, phytoplankton, zooplankton, and zoobenthos characterization of each water body. The seven lakes included Power Lake, Calispell Lake, Cooks Lake, Mystic Lake, No Name Lake, Bead Lake, and Marshall Lake, all of Pend Oreille Co, Washington.

Methods

Study Sites: The seven water bodies included in this study were Bead, Marshall, Mystic, No Name, Cooks, Calispell, and Power Lakes. All lie within the Pend Oreille River drainage of northeast Washington State. Location and morphometric data are provided in Table 1. Bead and Marshall Lakes are large (297 and 80 ha, respectively) and deep (55 and 30 m, respectively) oligotrophic montane lakes with limited shoreline development. Mystic, No Name and Cooks Lakes are small montane lakes (surface area < 10 ha and depth < 10 m). Power Lake is a 25 ha reservoir that can have a water depth up to 11 m. Calispell Lake is a wetland with expansive shallow (depth < 1 m) open water.

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 two meter 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). All of the above collections occurred in the water column above the deepest location in each lake. Water quality samples were collected mid August and late September of 2001 and June of 2002. 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.

Zooplankton: Zooplankton samples were collected during mid August and late September of 2001 and during June of 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 Bead lake one replicate sample was collected from within each of the three arms of the lake. In Marshall Lake, a single sample was collected from each of the two arms of the lake, as well as from within the central basin. In both lakes, each sample consisted as a single tow from a depth of ten meters to the surface. The total volume of lake water sampled in each ten meter tow was equal to 283.5 liters. In each of the four smaller lakes, three replicate samples were collected from the deep water location. Each individual sample was a single vertical tow from 1 meter above the lake bottom to the lake surface. In Calispell Lake, three replicate samples were collected, each as a single 5 meter horizontal tow with the net ring suspended below the water surface and above the lake sediment by a float. 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 Bottrell et al (1976)

Zoobenthos: Benthic invertebrate samples were collected using an Eckman dredge and substrate incubation samplers. During our mid August 2001 sampling, five replicate Hester-Dendy incubation samplers (each composed of ten 10 x 10 cm masonite plates) were placed on the bottom of each lake where water depth ranged from 2.5 - 5 meters. The Hester-Dendy samplers were retrieved the last week of September 2001. Upon retrieval, each set of plates was disassembled, and the aufwuchs on each plate scraped onto a 250 um mesh sieve. The sieve contents were dipped in 95% ethanol for 1 minute, then stored in 70% EtOH until they were sorted.

Two replicate Eckman dredge samples were collected at each of 2.5 and 5 m along three separate transects in each lake. In Bead Lake we located one transect in each arm. In Marshall Lake dredge transects were located in each arm and in the central basin. Transects were randomly located around the perimeter of each lake in Mystic, No Name, and Power Lakes. Dredge samples were not collected from Cooks Lake as the lake was dry, nor were dredge samples collected from Calispell 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).

Results and Discussion:

Water Quality: temperature, dissolved oxygen, and chlorophyll profiles for Bead and Marshall lakes are presented in Figures 1 and 2 for each of the August 2001, September 2001, and June 2002 sample dates. Both lakes show strong thermal stratification on each sample date. Dissolved oxygen profiles indicate abundant oxygen concentrations at all depths (DO concentrations in excess of 5.0 mg l^{-1}), with the general trend of increased oxygen concentrations in the hypolimnion. Chlorophyll densities on the August and September sample dates in both lakes were approximately 2 ug l-1, indicating low algal standing crop which is typical of low productivity lakes. Additionally, our June 2002 sampling suggests Bead Lake experiences a late spring algal bloom, as chlorophyll densities were approximately ten fold those observed during the previous year's late summer sampling. Nitrate and phosphate concentrations were very low in both lakes on the 15 August 2001 sample date. The only detectable nutrient among both lakes was an average of 0.25 mg l-1 of nitrate in Marshall Lake (Table 2). Secchi disk depths were

9.5 m, 11 m, and 9 m in Bead Lake on each of the sample dates, respectively. In Marshall Lake, secchi disk depths were 12 m, 13 m, and 10 m on the August, September, and June sample dates.

Figures 3 and 4 illustrate the temperature, dissolved oxygen, and chlorophyll profiles of Mystic and No Name Lakes, respectively. Most noticeably, both lakes are polymictic (do not stratify). Even in mid August, when temperate monomictic and polymictic lakes are expected to show strong thermal stratification, both lakes are isothermal through their entire depth. Chlorophyll densities were low suggesting low algal standing crop as seen in the larger Bead and Marshall Lakes. DO profiles indicate ample oxygen (> 5 mg l^{-1}) through the entire water column. Secchi disk depths in Mystic Lake were 2 m, 2.3 m, and 2 m for the August and September 2001, and June 2002 sample dates, respectively. In No Name Lake, secchi disk depths were 4.2 m, 5 m, and 5 m. As for all of the lakes mentioned above, nitrate concentrations in Mystic and No Name Lakes were below detectable limits. Phosphate concentrations in Mystic Lake averaged 0.015 mg l^{-1}, and in No Name Lake, 0.10 mg l^{-1} (Table 2).

Dissolved oxygen, temperature, and chlorophyll profiles of Power Lake are presented in Figure 5. No samples were collected from Power Lake in 2002. August of 2001, Power Lake shows evidence of measure variation with depth, but no evidence of typical stratification (i.e. epilimnion, metalimnion, hypolimnion). Rather, temperature, dissolved oxygen, and chlorophyll all decrease with increased water depth. During September, the lake was destratified and isometric for all measures but dissolved oxygen. Unlike the lakes mentioned above, Power Lake exhibits more algal standing crop, and low levels of oxygen in the deeper waters (DO levels approach 0 mg l^{-1}), suggesting it is a relatively productive water body. Secchi disk depths on 14 August and 29 September were 0.5 m and 0.85 m, respectively, further suggesting relatively high productivity. Nitrate levels were undetectable and phosphate levels averaged 0.32 mg l^{-1} (Table 2).

Cooks Lake evaporated to a mere puddle during this study. On 15 August, 2001 the maximum depth of the lake was approximately 1.5 m. Water temperature was 24 ^{o}C. Dissolved oxygen and chlorophyll concentrations in water collected from a depth of 0.75 meters were 7.1 mg l^{-1} and 6.7 ug l^{-1}, respectively. The secchi disk depth was 1.0 m. By the time the lake was sampled again on 29 September the maximum depth had decreased to just over 0.5 m. Temperatures had decreased to 18.5 ^{o}C. Dissolved oxygen and chlorophyll concentrations were 8.4 mg l^{-1} and 18.9 ug l^{-1}, respectively. Both nitrate and phosphate levels were undetectable (Table 2).

Calispell Lake was also atypical of the lakes included in this survey as it is an expansive and shallow wetland. Water depths did not exceed 30 cm, and were often just a few cm, thus hampering efforts to collect limnological data. On 15 August and on 29 September, a canoe was launched into the outlet of the wetland, and paddled approximately 200 meters into the wetland proper. Samples were collected from the surface waters. Temperature, dissolved oxygen, and chlorophyll levels were 32 ^{o}C, 7.6 mg l^{-1}, and 3.4 ug l^{-1} on the 15 of August, respectively. 29 September, temperature, dissolved oxygen, and chlorophyll levels were 14.6 ^{o}C, 8.4 mg l^{-1}, and 4.4 ug l^{-1}, respectively. Nitrate levels were undetectable and phosphate levels averaged 0.29 mg l^{-1} (Table 2).

Phytoplankton Composition and Biovolume: Table 3 includes all of the phytoplankton taxa encountered among the seven lakes surveyed and includes a diverse variety of organisms from among the freshwater divisions. Most of the richness was observed within the Chlorophyta (green algae) and the Chrysophyta (diatoms). Tables 4 through 10 list the phytoplankton taxa identified from each individual water body. Figures 6 and 7 illustrate algal biovolume, by algal division, for each individual water body.

Bead and Marshall lakes include very low biovolume (< 0.1 mm^3 l^{-1}) of small and edible algae (Figure 6 and Tables 4 and 5). Chlorophyta were the major phytoplankton constituents in both lakes and on both dates with smaller contributions from pyrrophytes, cryptophytes, and chrysophytes in Bead lake, and chrysophytes in Marshall Lake. Inedible and toxic blue-green algae were not detected in either water body on either of the 2001 sample dates.

The phytoplankton constituents of Mystic Lake are presented in Table 6. At 0.45 and 1.7 mm^3 l^{-1} for August and September, respectively, algal biovolume was more than ten fold the values in Bead and Marshall Lakes, but not indicative of high productivity. Biovolume constituents include primarily chrysophytes in August and both chrysophytes and blue-green algae in late September (Figure 7).

The phytoplankton constituents of No Name Lake are presented in Table 7. Biovolume totaled 1.4 mm^3 l^{-1} on 15 August, and 0.2 mm^3 l^{-1} on 29 September. Those taxa making sizable contributions to biovolume include Chloropytes and Chrysophytes in August and Chlorophytes and Cryptophytes at the end of September.

Phytoplankton constituents of Power Lake are included in Table 8. Biovolume values in Power lake were the highest recorded in this survey (12.5 mm^3 l^{-1} on 15 August and 16.5 mm^3 l^{-1} on 29 September) and approximately 1000 fold greater than the biovolume values observed in the largest and least productive Bead and Marshall Lakes (Figure 6). Although there exists a variety of phytoplankton taxa in this small reservoir, those species making a significant contribution to biovolume are the colonial eubacteria (blue-green algae) *Anabaena* and *Aphanizomenon*, which have the potential to form large colonies and are toxic to planktonic herbivores.

The phytoplankton constituency of Cooks and Calispell Lakes are presented in Tables 9 and 10, respectively. Both lakes contain a wide variety of phytoplankton with most of the richness among the green algae. Cooks Lake possessed the second highest biovolume of this survey with 15 August values at 2.6 mm^3 l^{-1} and a biovolume of 5.1 mm^3 l^{-1} on 29 September. During late summer, those taxa contributing to biovolume included a diverse mixture of green algae, diatoms, blue-green and cryptophytes. By late September, the biovolume was primarily a result of a huge increase in cryptophyte biovolume which was primarily composed of cells of the small and edible genus, *Cryptomonas*. Although Calispell Lake has little open water, it does contain a rich assemblage of phytoplankton. Biovolume estimates on both sample dates were approximately 1 mm^3 l^{-1}, and were composed of blue-green algae, diatoms and green algae in August, and the cryptophyte *Cryptomonas* in late September.

Zooplankton: Constituents and their densities, biomass, and average lengths are presented in figures 8 through 14. In Bead Lake, the zooplankton included *Daphnia thorata*, *Holopedium gibberum*, *Bosmina longirostris*, *Epischura nevadensis*, and *Diacyclops thomasi* (Figure 8). Individual species densities were all quite low, and the highest observed density was 3 *Daphnia thorata* liter^{-1} on 20 June, 2002. Similarly, biomass levels of any one species did not exceed 10 ug dry mass liter^{-1}. Two of the species present in Bead Lake (*D. thorata* and *Epischura*) have the potential for body lengths close to 2 mm, and with the presence of Epischura which is an invertebrate predator, there is the suggestion that predation by fishes has little impact on the plankton composition of Bead Lake, and that plankton densities are limited by low primary productivity.

Marshall Lake possess exactly the same constituents as were observed in Bead Lake (Figure 9), though here, *Daphnia thorata* and *Diacyclops* densities exceeded 5 individuals liter^{-1}, and *Daphnia* biomass exceeded 40 ug liter^{-1}, on the August and June sample dates. And similar to Bead Lake, Marshall Lake zooplankton body lengths for many species were close to 1 mm. This evidence, and the inclusion of *Epischura* in the plankton, suggest that planktivory by fishes has little impact on zooplankton composition and productivity.

Mystic Lake zooplankton data are presented in Figure 10. Constituents were similar to those in Bead and Marshall Lakes, except the large bodied *Daphnia* in Mystic Lake was *Daphnia rosea*, and the large bodied invertebrate predator *Epischura* was absent and replaced with a member of the genus *Diaptomus* which tend to be exclusively herbivores. Individual species densities were higher than in the two larger lakes, and individual densities of at least one large-bodied species approached or exceeded 20 individual liter^{-1} on each sample date, which contributed to biomass levels exceeding 100 ug liter^{-1} on each sample date (Figure 10). Average body lengths of all species but the diminutive *Bosmina* were between 0.75 and 1.0 mm. Mystic lakes appears to support higher zooplankton productivity than do Bead and Marshall Lakes. And, here again, there is little evidence fish predation has much impact on the zooplankton constituency of the water body.

No Name Lake included seven species of crustacean zooplankton which is more than any lake included in the survey (Figure 11). Although species richness was highest in this water body, densities were low (< 5 inds. liter^{-1}) for all species on all sample dates, except for *Daphnia pulex* and *Cyclops vernalis* from the 29 September samples. On this date *Daphnia pulex* densities were in excess of 20 individuals liter^{-1}, and biomass was in excess of 200 ug liter^{-1} dry mass. Average body lengths of several species exceeded 1.0 mm on each sample date (Figure 11).

Power Lake zooplankton included *Daphnia rosea*, *Bosmina longirostris*, and *Cyclops vernalis* (Figure 12). Plankton densities were higher on 15 August than on 29 September. Both *Daphnia* and *Cyclops* densities were approximately 10 individuals liter^{-1}, and *Bosmina* exceeded an astonishing 70 individual liter^{-1}. Average lengths of Daphnia and Cyclops in August, and for Daphnia in September were between 0.75 and 1.0 mm, her again suggesting vertebrate planktivory is not an important regulatory factor for the zooplankton in Power Lake.

Although Cooks Lake evaporated to a mere puddle during this study, it does have the potential to support several large bodied species of zooplankton and can have species specific biomass values that approach 200 ug dry mass liter^{-1} (Figure 13). Further several of the species present had average body length values that were approximately 1.0 mm. Thus, during periods of increased moisture availability, Cooks Lake should have the potential to support plankton composition similar to other small lakes in the region.

Calispell Lake included zooplankton constituents which were similar to the other six lakes in the survey, although (with the exception of *Bosmina*) densities, biomass and average length were all quite low relative to the other lakes (Figure 14).

Zoobenthos: Tables 11-17 report the results of the benthic organism assessments of the seven lakes surveyed. All of the lakes include a variety of insect, crustacean, and molluscan grazers and detritivores. Power Lake (Table 15) is the only water body with low benthic organism richness and with constituents which are exclusively associated with consuming decomposing organic matter.

Conclusions: Of the lakes included in this survey, only one water body appears to exhibit signs of high productivity, that being Power Lake. Algal standing crop in this lake was unusually high compared to other lakes in the Pend Oreille River drainage, and included almost exclusively inedible and toxic blue-green algae. Further the benthic organisms were almost exclusively chironomids. Both suggest an overly productive or eutrophic water body.

Calispell Lake is also an unusual water body and stands apart from the other lakes in the survey as an expansive wetland. Although many of the constituents of this lake are typical of what one would consider a lake, this wetland cannot be expected to have physical or chemical properties that are associated with lacustrine water bodies.

Further, 2001 was no doubt an unusual year for Cooks Lake. The rapid decline in the lake level, which ultimately resulted in the complete drying up of the water body, had to concentrate nutrients and organisms in the remaining waters of the basin. Thus one gets an exaggerated view of the lake's productivity. Under normal hydrologic conditions there is no reason one should suspect Cooks Lake would have phytoplankton, zooplankton or zoobenthos constituents that are different from other small water bodies in the Pend Oreille River Drainage.

Bead and Marshall lakes are clearly typical of low productivity or oligotrophic montane lakes. As both possess deep bathymetries, well defined thermal stratification, abundant oxygen, and evidence of low productivity. Mystic and No Name lakes show evidence of being only slightly more productive than the two large lakes. They would be best described as oligomesotrophic. Finally, all of the lakes, with the exception of Calispell, include zooplankton constituents and average sizes which suggest low predation pressure from vertebrate planktivores. Thus, all of these water bodies have at least some potential to support increased biomass of salmonids.

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Table 1. Lake location, surface area, depth, number of sample sites and general sample site location.

Lake	**Location (Township)**	**Surface Area (Ha)**	**Maximum Depth (m)**	**# Study Sites**	**Site Locations**
Bead	32N & 33N R 45E	297	52	3	One per arm
Marshall	32N R 45E	80	28	3	One per arm & Main basin.
Mystic	33N R 45E	6.6	7	2	SW & NE ends
No Name	32N R 45E	7.4	10	2	Central basin & west end
Cooks	33N R 45E	4.6	5	2	East & west ends
Power	32N R 43E	26	11	2	Northwest & Southeast ends
Calispell	32N R 43E	140	1	1	North end (see text for expl.)

Table 2. Nitrate and phosphate concentrations (mg l^{-1}) and pH for each of 7 Pend Oreille Co., Washington lakes, 15 August, 2001. Values represent the average of duplicate samples collected from a depth of one meter over the deepest bathymetric location in each lake.

Lake	**Phosphate**	**Nitrate**	**pH**
Bead	0.00	< 1.0	6
Marshall	0.25	< 1.0	6
Mystic	0.02	< 1.0	6
No Name	0.10	< 1.0	6
Cooks	0.00	< 1.0	6
Power	0.32	< 1.0	7
Calispell	0.29	< 1.0	6.5

Table 3. Phytoplankton identified from Seven Lakes in Pend Oreille Co., WA, 15 August and 29 September, 2001.

Division	Class	Genus and species
Chlorophyta	Chlorophyceae	*Ankistrodesmus falcatus*
		Chlamydomonas sp.
		Cosmarium sp.
		Crucigenia sp.
		Gleocystis sp.
		Pediastrum boryanum
		Quadrigula chodatii
		Scenedesmus bijuga
		Scenedesmus quadricauda
		Schroederia setigera
		Staurastrum paradoxum
		Tetraedron minimum
Chrysophyta	Bacillariophyceae	*Achnanthes* sp.
		Asterionella formosa
		Cyclotella sp.
		Fragilaria crotonensis
		Melosira herzogii
		Melosira italica
		Synedra sp.
	Chrysophyceae	*Dinobryon bavaricum*
		Dinobryon sertularia
		Mallomonas sp.
Cryptophyta	Cryptophyceae	*Cryptomonas* sp.
		Rhodomonas sp.
Eubacteria	Cyanobacteria	*Anabaena* sp.
		Aphanocapsa sp.
		Aphanizomenon flos-aquae
		Merismopedia sp.
Euglenophyta	Euglenophyceae	*Euglena* sp.
Pyrrophyta	Dinophyceae	*Ceratium hirundella*
		Glenodinium sp.

Table 4. Phytoplankton identified from Bead Lake, Pend Oreille Co., WA, 15 August and 29 September, 2001.

Division	**Class**	**Genus and species**
Chlorophyta	Chlorophyceae	*Ankistrodesmus falcatus* *Chlamydomonas* sp.
Chrysophyta	Chrysophyceae	*Dinobryon bavaricum* *Dinobryon setularia* *Mallomonas* sp.
Cryptophyta	Cryptophyceae	*Cryptomonas* sp. *Rhodomonas* sp.
Pyrrophyta	Dinophyceae	*Glenodinium* sp.

Table 5. Phytoplankton identified from Marshall Lake, Pend Oreille Co., WA, 15 August and 29 September, 2001.

Division	**Class**	**Genus and species**
Chlorophyta	Chlorophyceae	*Chlamydomonas* sp. *Pediastrum boryanum* *Scenedesmus bijuga*
Chrysophyta	Bacillariophyceae	*Achnanthes* sp. *Asterionella formosa* *Cyclotella* sp.
	Chrysophyceae	*Dinobryon sertularia* *Mallomonas* sp.
Cryptophyta	Cryptophyceae	*Cryptomonas* sp. *Rhodomonas* sp.
Pyrrophyta	Dinophyceae	*Glenodinium* sp.

Table 6. Phytoplankton identified from Mystic Lake, Pend Oreille Co., WA, 15 August and 29 September, 2001.

Division	**Class**	**Genus and species**
Chlorophyta	Chlorophyceae	*Chlamydomonas* sp. *Cosmarium* sp. *Crucigenia* *Staurastrum paradoxum*
Chrysophyta	Bacillariophyceae	*Achnanthes* sp. *Asterionella formosa* *Cyclotella* sp. *Fragilaria crotonensis* *Synedra* sp.
	Chrysophyceae	*Mallomonas* sp.
Cryptophyta	Cryptophyceae	*Cryptomonas* sp. *Rhodomonas* sp.
Eubacteria	Cyanobacteria	*Anabaena* sp. *Aphanocapsa* sp.

Table 7. Phytoplankton identified from No Name Lake, Pend Oreille Co., WA, 15 August and 29 September, 2001.

Division	**Class**	**Genus and species**
Chlorophyta	Chlorophyceae	*Chlamydomonas* sp. *Crucigenia* sp. *Gleocystis* sp. *Quadrigula chodatii* *Scenedesmus bijuga* *Staurastrum paradoxum* *Tetraedron minimum*
Chrysophyta	Bacillariophyceae	*Cyclotella* sp. *Synedra* sp.
	Chrysophyceae	*Mallomonas* sp.
Cryptophyta	Cryptophyceae	*Cryptomonas* sp. *Rhodomonas* sp.
Eubacteria	Cyanobacteria	*Aphanocapsa* sp.
Euglenophyta	Euglenophyceae	*Euglena* sp.

Table 8. Phytoplankton identified from Power Lake, Pend Oreille Co., WA, 15 August and 29 September, 2001.

Division	**Class**	**Genus and species**
Chlorophyta	Chlorophyceae	*Chlamydomonas* sp. *Cosmarium* sp. *Scenedesmus bijuga*
Chrysophyta	Bacillariophyceae	*Achnanthes* sp. *Melosira herzogii* *Melosira italica*
	Chrysophyceae	*Mallomonas* sp.
Cryptophyta	Cryptophyceae	*Cryptomonas* sp. *Rhodomonas* sp.
Eubacteria	Cyanobacteria	*Anabaena* sp. *Aphanizomenon flos-aquae*
Pyrrophyta	Dinophyceae	*Ceratium hirundella*

Table 9. Phytoplankton identified from Cooks Lake, Pend Oreille Co., WA, 15 August and 29 September, 2001.

Division	**Class**	**Genus and species**
Chlorophyta	Chlorophyceae	*Ankistrodesmus falcatus*
		Chlamydomonas sp.
		Crucigenia sp.
		Oocystis sp.
		Scenedesmus bijuga
		Schroederia setigera
		Staurastrum paradoxum
Chrysophyta	Bacillariophyceae	*Fragilaria crotonensis*
		Gyrosigma sp.
		Melosira italica
		Navicula sp.
		Synedra sp.
	Chrysophyceae	*Mallomonas* sp.
Cryptophyta	Cryptophyceae	*Cryptomonas* sp.
		Rhodomonas sp.
Eubacteria	Cyanobacteria	*Anabaena* sp.
		Gloeocapsa sp.
		Oscillatoria sp.
Pyrrophyta	Dinophyceae	*Ceratium hirundella*

Table 10. Phytoplankton identified from Calispel Lake, Pend Oreille Co., WA, 15 August and 29 September, 2001.

Division	**Class**	**Genus and species**
Chlorophyta	Chlorophyceae	*Ankistrodesmus falcatus*
		Chlamydomonas sp.
		Scenedesmus bijuga
		Scenedesmus quadricauda
		Schroederia setigera
		Staurastrum paradoxum
Chrysophyta	Bacillariophyceae	*Cyclotella* sp.
		Fragilaria crotonensis
		Melosira italica
	Chrysophyceae	*Mallomonas* sp.
Cryptophyta	Cryptophyceae	*Cryptomonas* sp.
		Rhodomonas sp.
Eubacteria	Cyanobacteria	*Anabaena* sp.
		Aphanizomenon flos-aquae
		Merismopedia sp.
Euglenophyta	Euglenophyceae	*Euglena* sp.

Table 11. Bead Lake benthic invertebrates collected 21 September 2001 (Hester Dendy plates), and 30 September 2001 (Eckman Dredge).

Hester Dendy Plates

Site	Rep	Order	Genus	Species	Number
	1	Trichoptera	Cernotina	sp.	4
		Ephemeroptera	Callibaetis	sp.	2
		Amphipoda	Hyalella	azteca	1
	2	Trichoptera	Cernotina	sp.	2
		Ephemeroptera	Callibaetis	sp.	1
		Amphipoda	Hyalella	azteca	4

Dredge Samples

Site	Rep	Order	Genus	Species	Number	Number m^{-2}
East Inlet	2.5m	Tichoptera	Cernotina	sp.	2	50
		Diptera	Chironomidae	sp.	3	75
		Amphipoda	Hyalella	azteca	6	150
East Inlet	5m	Diptera	Chironomidae	sp.	2	50
		Amphipoda	Hyalella	azteca	1	25
East Inlet	10m	Diptera	Chironomidae	sp.	7	175
East Arm	2.5m	Amphipoda	Hyalella	azteca	2	50
East Arm	5m	Nothing in this sample				
East Arm	10m	Diptera	Chironomidae	sp.	1	25

Table 12. Marshall Lake benthic invertebrates collected 21 September 2001 (Hester Dendy plates), and 30 September 2001 (Eckman Dredge).

Hester Dendy Plates

Site	Rep	Order	Genus	Species	Number
	1	Diptera	Chironomidae	sp.	2
		Ephemeroptera		sp.	1
		Amphipoda	Hyalella	azteca	42
	2	Diptera	Chironomidae	sp.	1
		Amphipoda	Hyalella	azteca	8
	2	Diptera	Chironomidae	sp.	1
		Amphipoda	Hyalella	azteca	12

Dredge Samples

Site	Rep	Order	Genus	Species	Number	Number m^{-2}
	2.5m	Amphipoda	Hyalella	azteca	6	150
		Odonata	Cordulia	sp.	2	50
		Odonata	Epitheca	sp.	1	25
		Gastropoda	Planorbidae	sp.	1	25
		Bivalvia	Sphariidae	sp.	5	125
	2.5m	Amphipoda	Hyalella	azteca	4	100
		Odonata	Cordulia	sp.	2	50
		Ephemeroptera	Callibaetis	sp.	1	25
		Gastropoda	Planorbidae	sp.	4	100
		Bivalvia	Sphariidae	sp.	2	50
	5m	Diptera	Chironomidae	sp.	17	425
		Amphipoda	Hyalella	azteca	31	775
		Ephemeroptera	Callibaetis	sp.	1	25
	5m	Diptera	Chironomidae	sp.	16	400
		Amphipoda	Hyalella	azteca	1	25
	10m	Diptera	Chironomidae	sp.	10	250
		Amphipoda	Hyalella	azteca	2	50
	10m	Diptera	Chironomidae	sp.	2	50

Table 13. Mystic Lake benthic invertebrates collected 21 September 2001 (Hester Dendy plates), and 30 September 2001 (Eckman Dredge).

No Hester Dendy Plates Retrieved

Dredge Samples

Site	Rep	Order	Genus	Species	Number	Number m^{-2}
	2.5m	Odonata	Somatochlora	sp.	1	25
	2.5m	Odonata	Somatochlora	sp.	1	25
		Odonata	Coenagrion	sp.	2	50
		Diptera	Chironomidae	sp.	1	25
	5m	Diptera	Chironomidae	sp.	3	75
	5m	Diptera	Chironomidae	sp.	4	100

Table 14. No Name Lake benthic invertebrates collected 21 September 2001 (Hester Dendy plates), and 30 September 2001 (Eckman Dredge).

Hester Dendy Plates

Site	Rep	Order	Genus	Species	Number
	1	Diptera	Chironomidae	sp.	2
		Amphipoda	Hyalella	azteca	5
		Gastropoda	Gryralulus	sp.	1
		Bivalvia	Sphaeridae	sp.	2
	2	Diptera	Chironomidae	sp.	5
		Amphipoda	Hyalella	azteca	4
		Gastropoda	Gryralulus	sp.	1
		Bivalvia	Sphaeridae	sp.	3
		Ephemeroptera	Callibaetis	sp.	2
		Ephemeroptera	Caenis	sp.	1

Dredge Samples

Site	Rep	Order	Genus	Species	Number	Number m^{-2}
	2.5m	Diptera	Chironomidae	sp.	11	275
		Amphipoda	Hyalella	azteca	3	75
	2.5m	Diptera	Chironomidae	sp.	1	25
		Bivalvia	Sphaeridae	sp.	1	25
	5m	Diptera	Chironomidae	sp.	12	300
	5m	Diptera	Chironomidae	sp.	12	300
		Diptera	Chaoborus	sp.	1	25

Table 15. Power Lake benthic invertebrates collected 21 September 2001 (Hester Dendy plates), and 30 September 2001 (Eckman Dredge).

Hester Dendy Plates

Site	Rep	Order	Genus	Species	Number
	1	Diptera	Chironomidae	sp.	36
		Amphipoda	Hyalella	azteca	3

Dredge Samples

Site	Rep	Order	Genus	Species	Number	Number m^{-2}
1	1	Diptera	Chironomidae	sp.	6	150
	2	Diptera	Chironomidae	sp.	10	250
	3	Diptera	Chironomidae	sp.	2	50
		Ologochaeta	Naididae	sp.	1	25
	4	Diptera	Chironomidae	sp.	2	50

Table 16. Cooks Lake benthic invertebrates collected 21 September 2001 (Hester Dendy plates), and 30 September 2001 (Eckman Dredge).

Hester Dendy Plates

Site	**Rep**	**Order**	**Genus**	**Species**	**Number**
	1	Diptera	Chironomidae	sp.	4
		Odonata	Aeshna	sp.	3
		Odonata	Coenagrion	sp.	8
		Gastropoda	Physella	sp.	3
		Ephemeroptera	Caenis	sp.	1
		Hirudinea		sp.	2

No dredges collected, lake was dry

Table 17. Calispel Lake benthic invertebrates collected 21 September 2001 (Hester Dendy plates), and 30 September 2001 (Eckman Dredge).

Hester Dendy Plates

Site	**Rep**	**Order**	**Genus**	**Species**	**Number**
1	1	Odonata	Epitheca	sp.	1
		Ephemeroptera	Caenis	sp.	3
		Diptera	Chironomidae	sp.	12
		Amphipoda	Hyalella	azteca	39
		Gastropoda	Physella	sp.	4
		Hirudinea		sp.	1
		Bivalvia		sp.	1
2	1	Odonata	Epitheca	sp.	3
		Ephemeroptera	Caenis	sp.	2
		Diptera	Chironomidae	sp.	29
		Diptera	Ceraptogonidae	sp.	1
		Amphipoda	Hyalella	azteca	19
		Gastropoda	Physella	sp.	4
		Hirudinea		sp.	2
		Bivalvia		sp.	1
		Annelida/Oligo		sp.	26
3	1	Amphipoda	Hyalella	azteca	2
		Hirudinea		sp.	2

Dredge Samples

Site	**Rep**	**Order**	**Genus**	**Species**	**Number**	**Number m^{-2}**
1	1	Diptera	Chironomidae	sp.	26	650
2	1	Diptera	Chironomidae	sp.	1	25
3	1	Diptera	Chironomidae	sp.	6	150
4	1	Diptera	Chironomidae	sp.	3	75

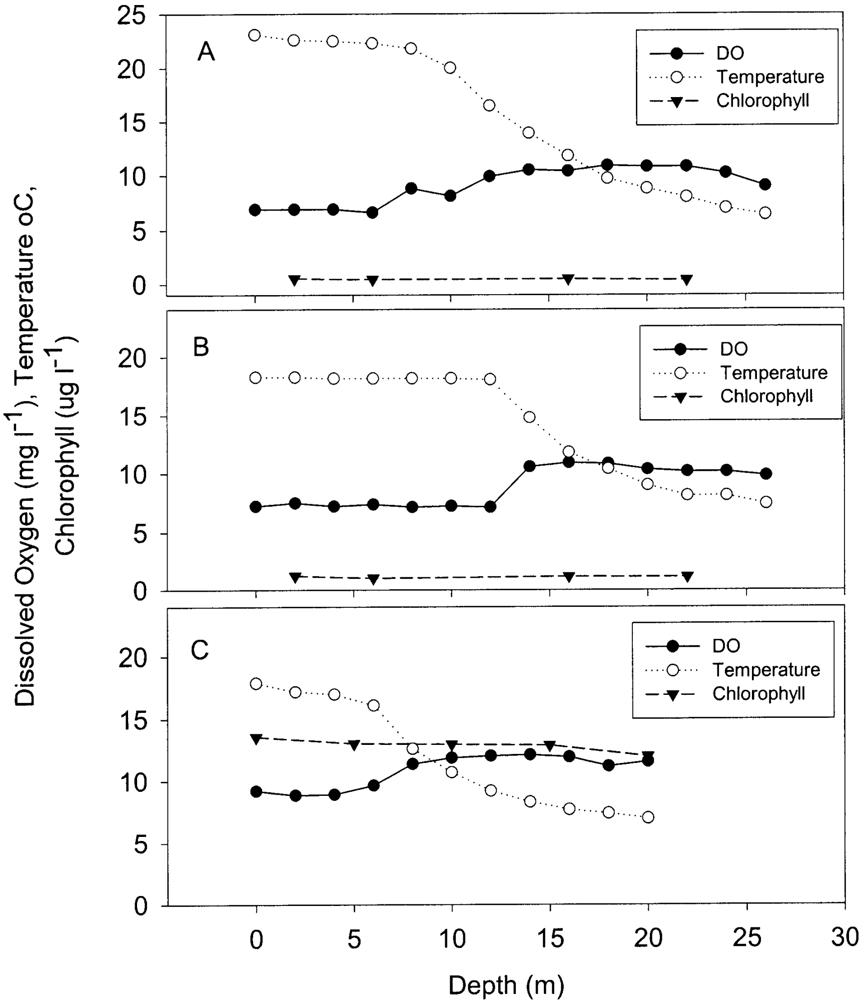

Figure 1. Temperature, dissolved oxygen, and chlorophyll profiles for Bead Lake, WA, collected 15 August (A) and 29 September (B) 2001 and 20 June (C), 2002.

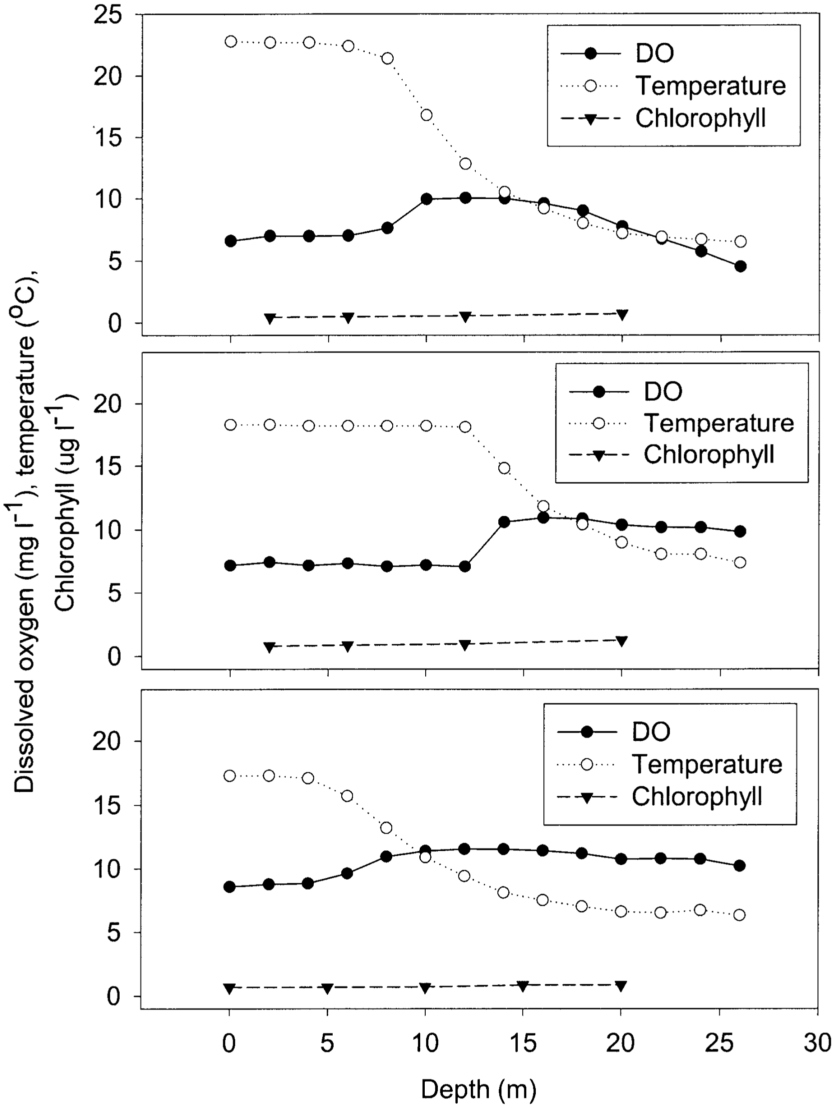

Figure 2. Dissolved oxygen, temperature, and chlorphyll profiles for Marshall Lake, 15 August (A) and 29 September (B), 2001, and 20 June (C), 2002.

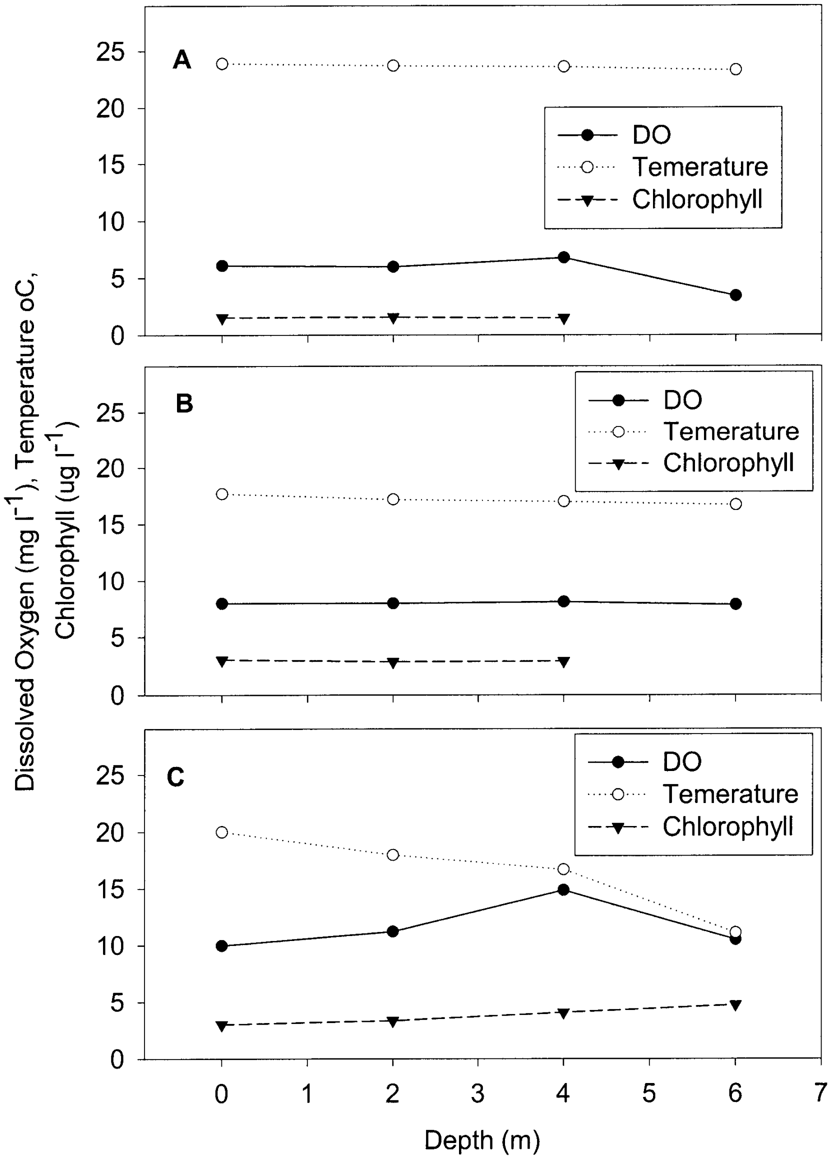

Figure 3. Temperature, dissolved oxygen, and chlorophyll profiles for Mystic Lake, WA, collected 15 August (A) and 29 September (B) 2001 and 20 June (C), 2002.

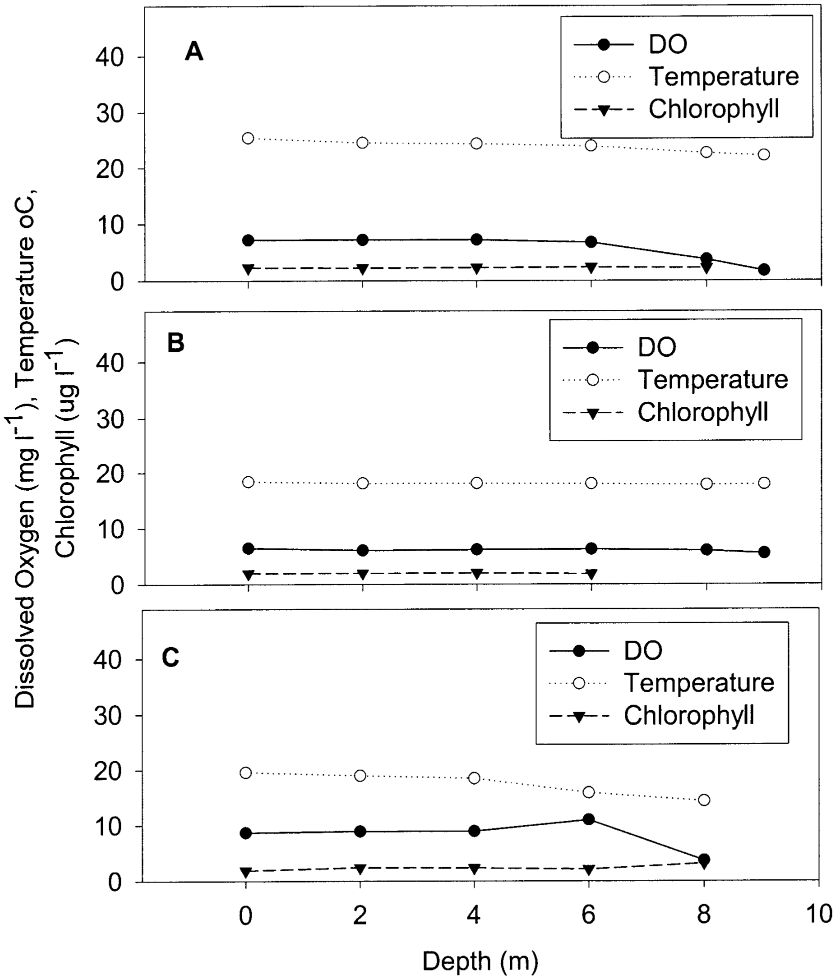

Figure 4. Temperature, dissolved oxygen, and chlorophyll profiles for No Name Lake, WA, collected 15 August (A) and 29 September (B) 2001 and 20 June (C), 2002.

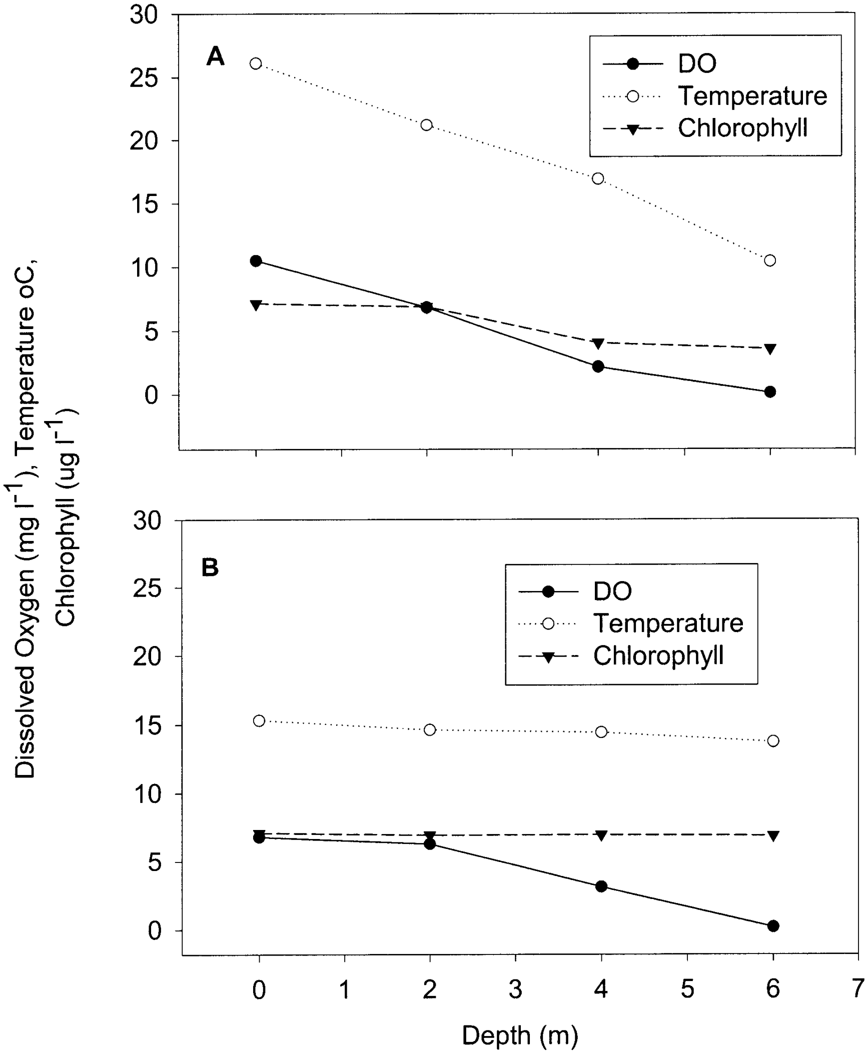

Figure 5. Temperature, dissolved oxygen, and chlorophyll profiles for Power Lake, WA, collected 15 August (A) and 29 September (B) 2001.

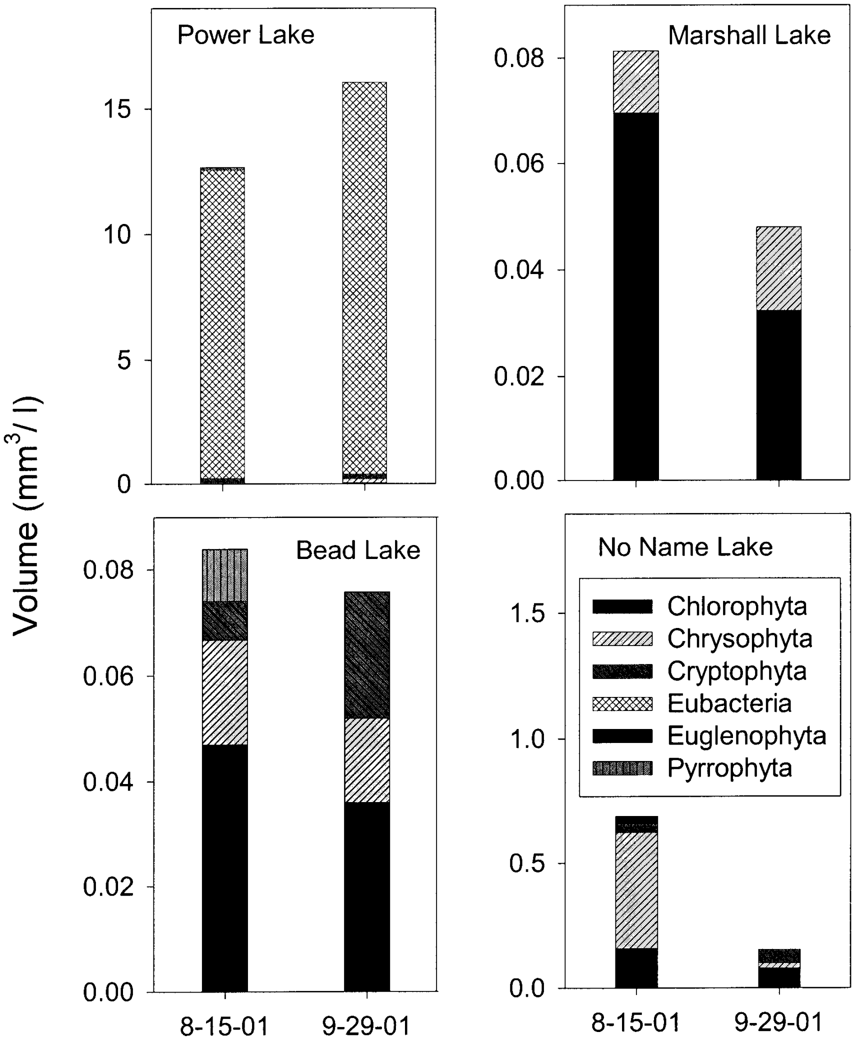

Figure 6. Phytoplankton biovolume, by algal division, for each of Power, Marshall, Bead and No Name Lakes, August and September 2001.

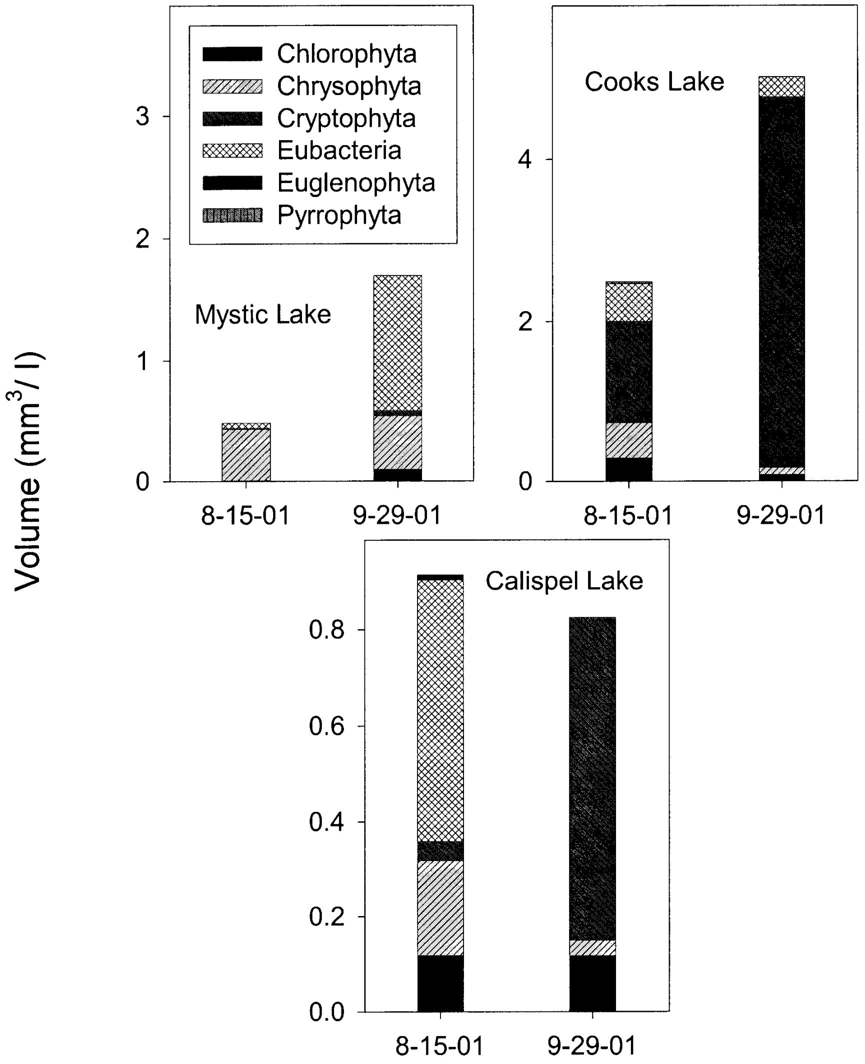

Figure 7. Phytoplankton biovolume, by algal division, for each of Mystic, Cooks, and Power Lakes August and September 2001.

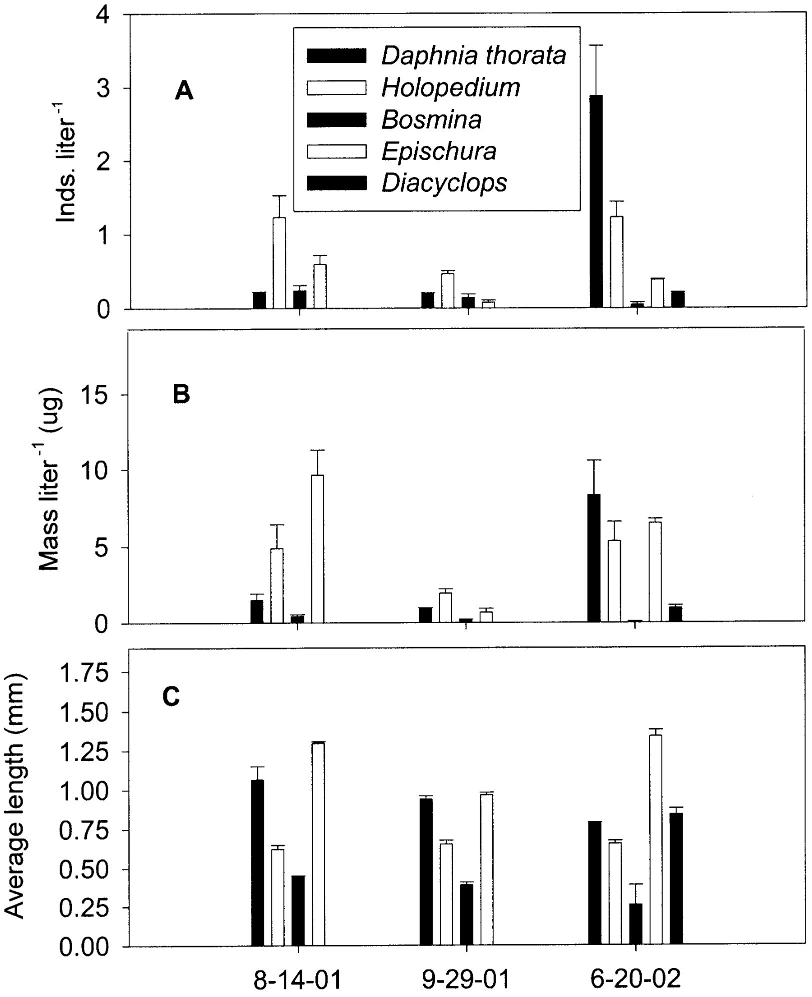

Figure 8. Mean (& SE) zooplankton density (A), biomass (B), and average length (C) of zooplankton collected from Bead Lake during 2001 and 2002.

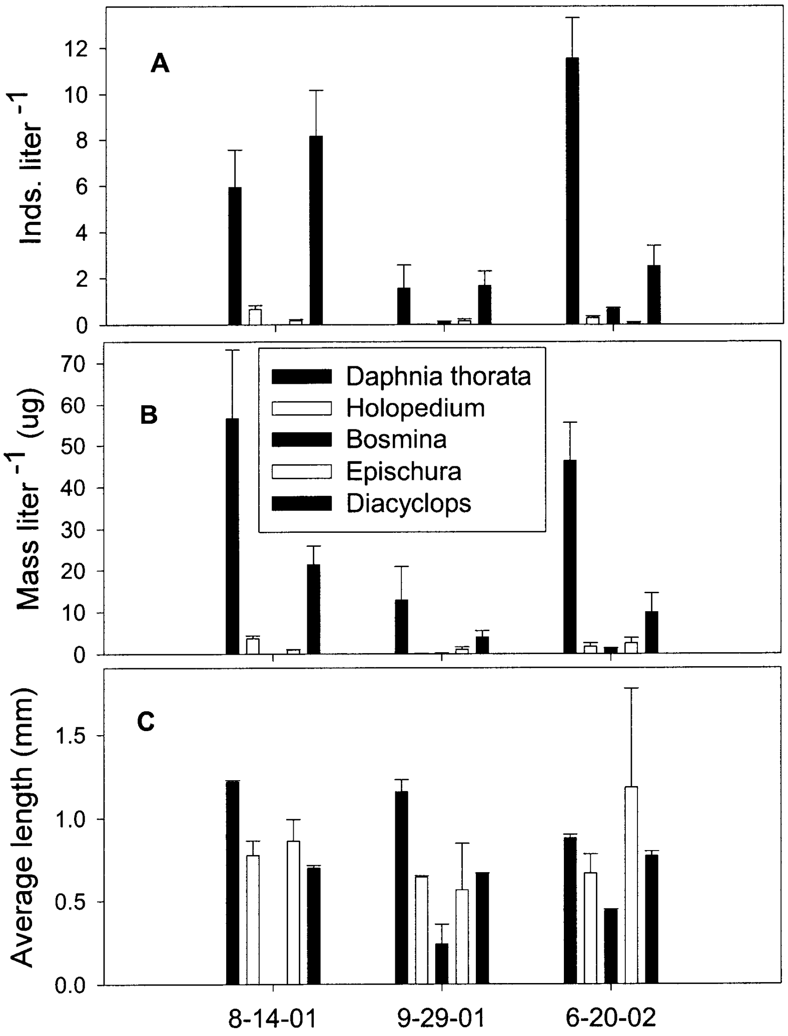

Figure 9. Mean (&SE) of zooplankton density (A), biomass (B), and average length (C) of zooplankton collected from Marshall Lake during 2001 and 2002.

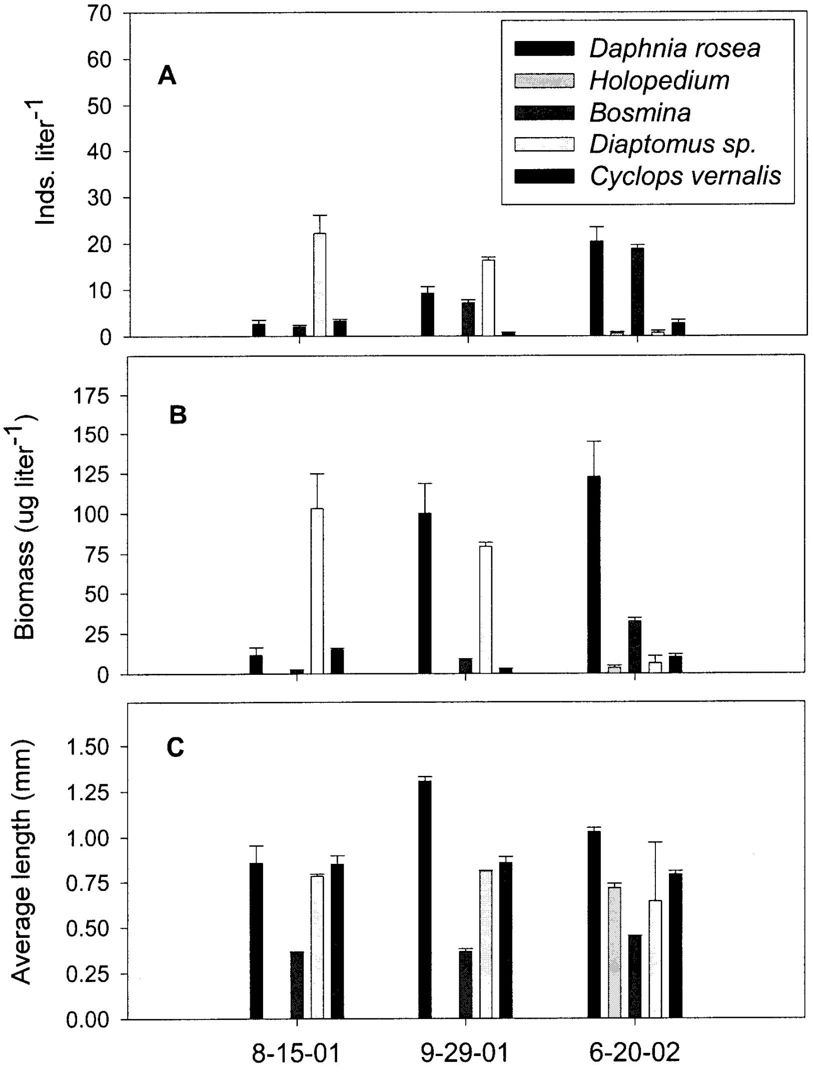

Figure 10. Mean (&SE) of zooplankton density (A), biomass (B), and average length (C) of zooplankton collected from Mystic Lake during 2001 and 2002.

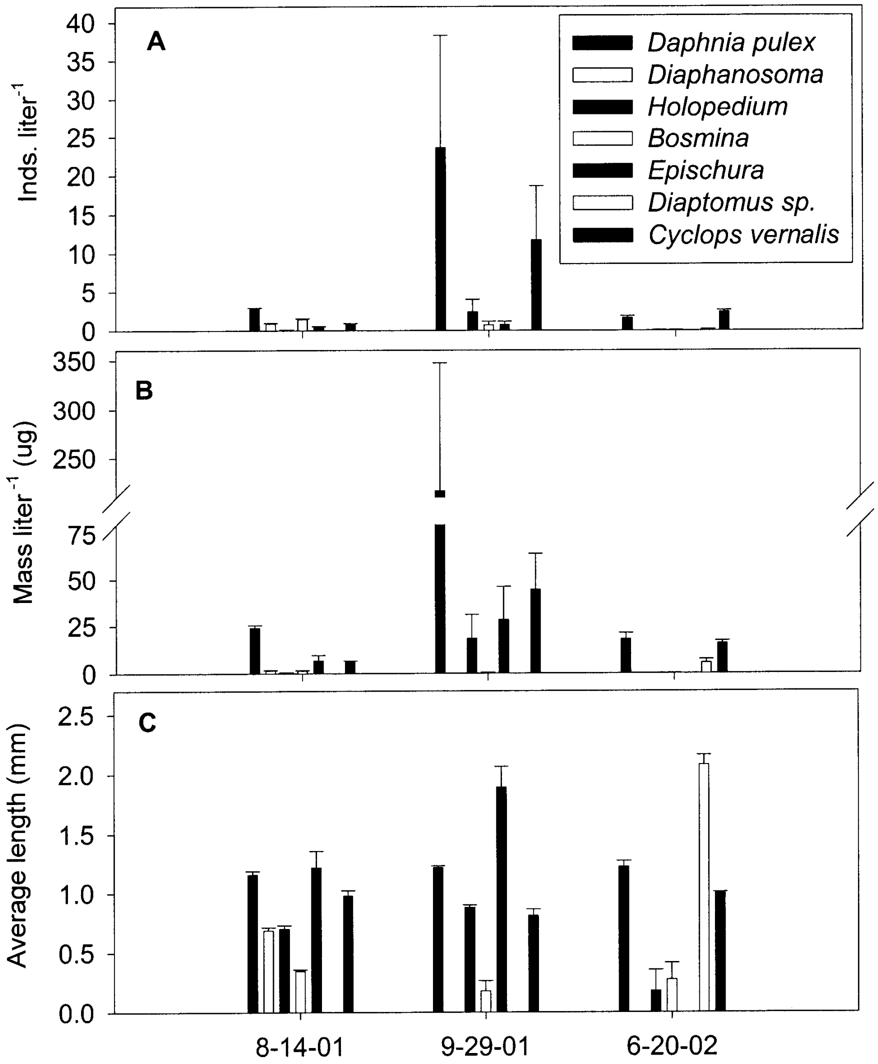

Figure 11. Mean (&SE) zooplankton density (A), biomass (B), and average length (C) of zooplankton collected from No Name Lake during 2001 and 2002.

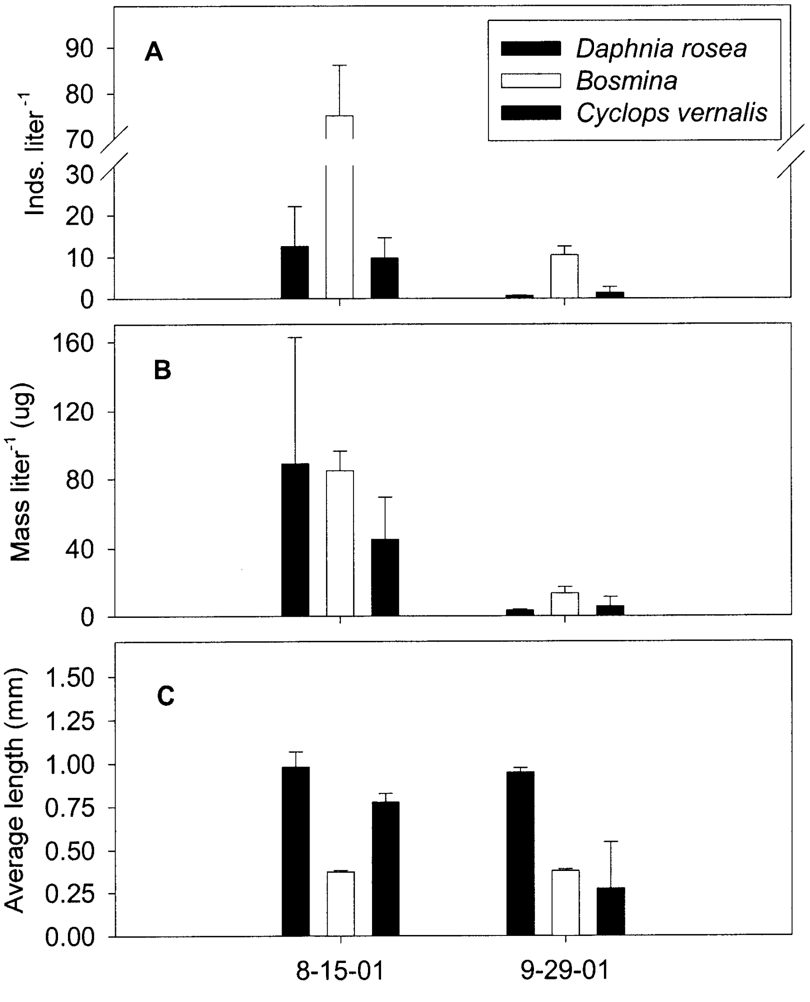

Figure 12. Mean (&SE) zooplankton density (A), biomass (B), and average length of zooplankton collected from Power Lake during 2001.

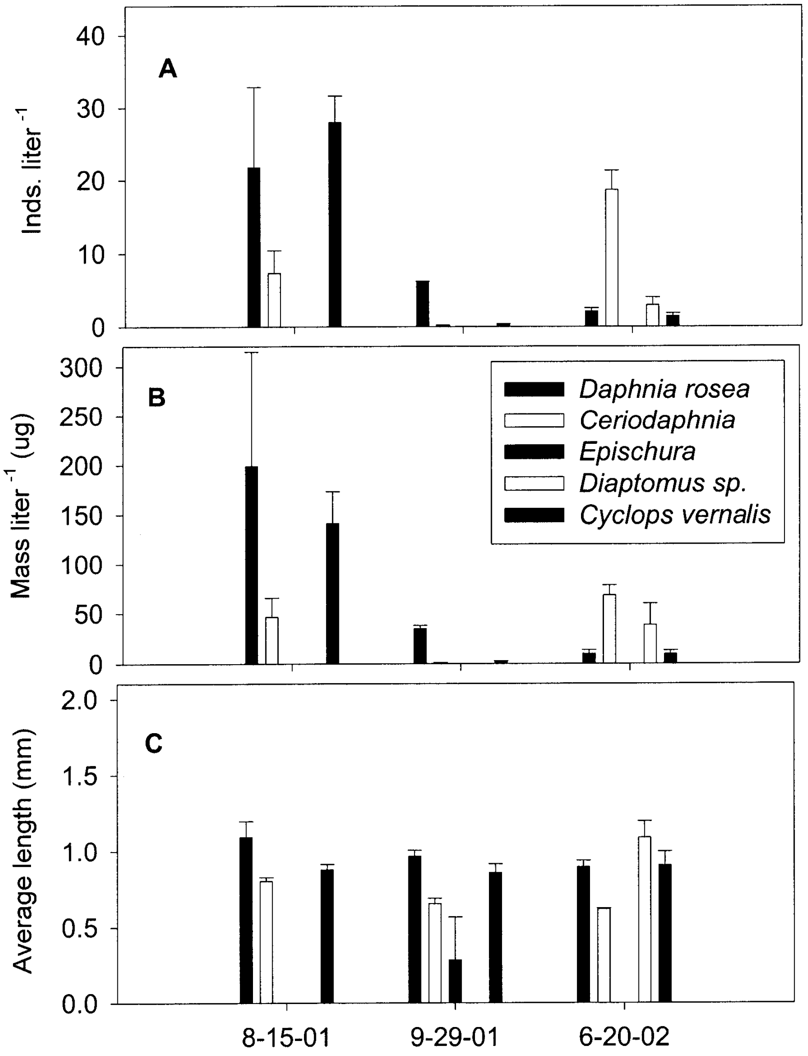

Figure 13. Mean (&SE) zooplankton density (A), biomass (B), and average length (C) of zooplankton collected during 2001 and 2002 from Cooks Lake.

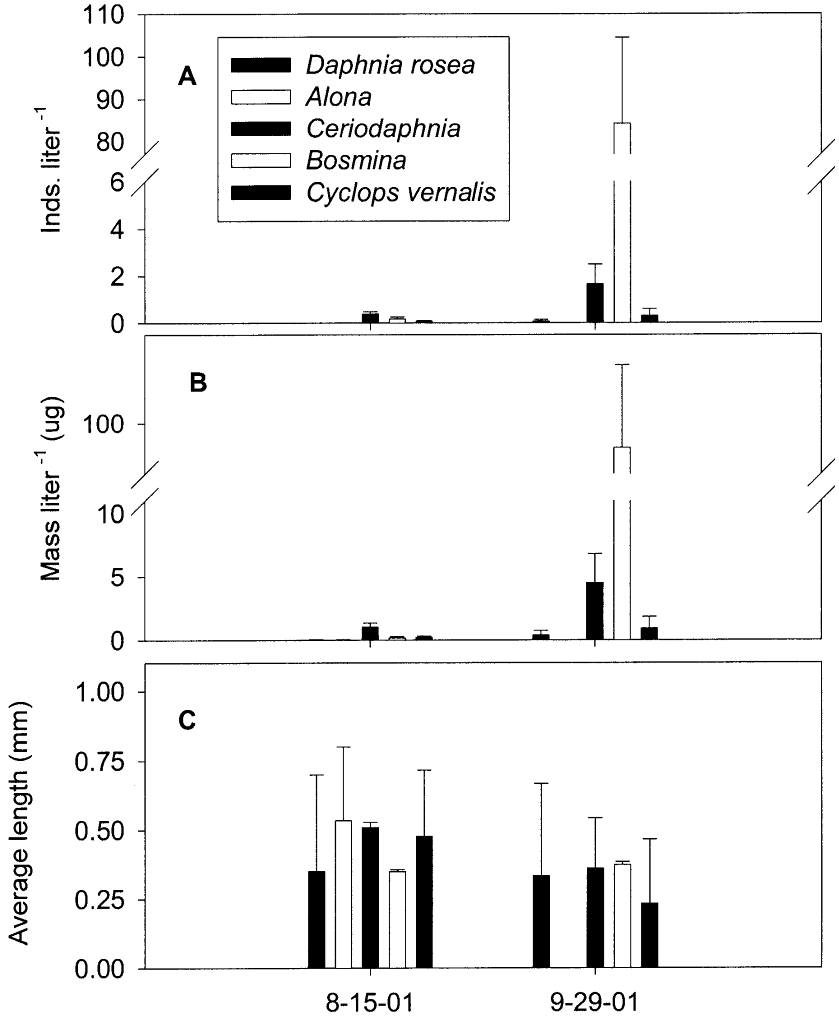

Figure 14. Mean (&SE) of zooplankton density (A), biomass (B) and average length (C) of zooplankton collected from Calispell Lake during August and September of 2001.

Appendix 2

This summary details the database integration, project coordination, data standardization, and GIS development activities during the 2001 JSAP project year.

- Several field and report maps were generated for Jason McLellan (WDFW) in support of JSAP data collection within the Little Spokane River Watershed.
- Converted fishery and habitat datasets received from WDFW on tributaries and the main stem Little Spokane River into Microsoft Access Database.
- Generated GIS point coverages for the Little Spokane Watershed on temperature monitoring stations, fish migration barriers, and stream reach breakpoints.
- Build GIS event data tables for the Little Spokane River Watershed and all KNRD surveys in the Pend Oreille River Watershed.
- Produced status maps of JSAP collected data through 2001.
- Developed a request for proposals (RFP) for database integration consultation. RFP was sent to eight database / GIS development companies, four of which responded. Proposals will be reviewed and a sub-contract awarded in 2002 for development of an integrated JSAP database.
- Held one annual meeting between all JSAP participants. Meeting topics included project progress, scope of work and budget negotiation, standardization of historical and current datasets, and integrated database consultation needs.

2001 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 1.

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

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December 2002

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Abstract

Little baseline instream habitat or fish distribution data had been collected on the free flowing portions of the Little Spokane River drainage, except for fish surveys of the lower 27.0 km of the Little Spokane River. The objectives of this study were to determine baseline habitat conditions and fish distribution and density in nine tributaries of the Little Spokane River, as part of a multi-year effort to survey the entire drainage. Habitat parameters were measured at each fish survey site. Fish were collected by backpack electrofishing. The streams surveyed were Bear, Beaver, Buck, Deer, Dry, Heel, Otter, and Spring Heel Creeks, and the West Branch Little Spokane River. The West Branch Little Spokane River was the largest stream surveyed according to mean wetted width (10.7 m) and mean depth (48 cm). Beaver Creek was the smallest stream based on wetted width (1.8 m; tied with Otter Creek) and discharge (0.01 m^3/s). Otter Creek had the highest discharge of all of the streams surveyed (0.62 m^3/s). The dominant substrate in each stream surveyed was sand, except Beaver Creek, which was dominated by gravel. The greatest diversity of fish was in the West Branch Little Spokane River (13 species) and the lowest was in Heel Creek (1 species). At least one species of trout was collected in each stream. The proportion of stock size brook trout or legal size rainbow and brown trout was ≤ 4.0% in all of the streams, except for brown trout in the West Branch Little Spokane River (9.7%). However, densities of brown trout in the West Branch Little Spokane River were low (≤ 4 fish/100 m^2). Overall, angling opportunities were limited due to few stock or legal length trout and limited access. Microsatellite DNA analysis of rainbow populations in Deer and Otter Creeks suggested that they were interior redband rainbow. Microsatellite DNA analysis of rainbow populations in Buck Creek suggested that there was substantial influence of coastal rainbow trout on this population.

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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; Kalispel Tribe Natural Resources Department), Spokane Tribe of Indians, Colville Confederated Tribes, and Coeur d'Alene Tribe of Indians. The objective of the JSAP is to assess fish stocks and generate a management plan for protection, mitigation, and enhancement of resident fish in the blocked area watersheds above Chief Joseph and Grand Coulee Dams. In order to perform joint stock assessment, the participants need to develop a central database of fisheries related data for the blocked area that would be 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 and 2002. This document describes survey results for the initial year of sampling. Our objectives were to: 1) determine baseline values of fish habitat, distribution, relative abundances, and densities in the Little Spokane River and its tributaries, and 2) characterize the genetic structure of the potentially native trout populations in the drainage.

Little Spokane River History

When the first Europeans arrived in the region, the fish community of the Little Spokane River system was comprised of chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*), resident trout (*Oncorhynchus* spp.), mountain whitefish (*Prosopium williamsoni*), pygmy whitefish (*P. coulteri*), and suckers (*Catostomus* spp.) (Scholz et al. 1985; Hallock and Mongillo 1998). There was reportedly a small run of sockeye salmon that migrated up the Little Spokane River to Chain Lake (WDFW Region 1 lake management file, 1956). The fish species composition in the system has changed since the arrival of European settlers.

Construction of Little Falls Dam on the Spokane River in 1911 prevented salmon and steelhead from returning to the system. Timber harvest, agriculture, and residential development have been extensive throughout the drainage since the late 1800's. There have also been numerous introductions of non-indigenous fish species, which further changed the species composition (WDFW, unpublished hatchery records).

To date (2001), there has been little instream habitat or fish distribution data collected on the Little Spokane River or its tributaries. The only habitat information collected on the Little Spokane River system was standardized stream assessment surveys conducted by the Washington Department of Ecology (WDOE) and temperature monitoring conducted by the Spokane County Conservation District (SCCD). The stream assessment surveys were conducted in 1994 at two sites on the Little Spokane River, river kilometer (rkm) 18.9 (Pine River Park) and rkm 37.1 (Chattaroy), and at one site on Dragoon Creek (WDOE, unpublished data). During their assessments WDOE calculated a Benthic-Index of Biotic Integrity (B-IBI) value at each site (Plotnikoff and Wiseman 2001). The Little Spokane River had B-IBI values of 33 at both sites, which indicated that the stream was in "fair condition, with slight impairment of biological conditions" (WDOE, www.ecy.wa.gov/programs/eap/fw_benth/fwb_sites.html). Dragoon Creek had a B-IBI value of 37, which suggested that the stream was in "good condition, with natural biological conditions indicated" (WDOE, www.ecy.wa.gov/programs/eap/fw_benth/fwb_sites.html).

The SCCD monitored water temperatures with thermographs at two locations in the Little Spokane River (rkm 21.1, below the mouth of Deadman Creek and rkm 75.6, Scotia Road), as well as in the West Branch Little Spokane River at rkm 5.1 (Eloika Lake Road), between May 3rd and October 1st, 1999. They monitored a third site on the Little Spokane River, at rkm 51.2 (Deer Park-Milan Road), from October 1st, 1999 to May 31st, 2001. The SCCD also monitored temperatures in Deadman, Dragoon, and Otter Creeks from August 22nd, 2000 to June 6th, 2001.

The majority of the fish data collected prior to 1980 was in the form of unpublished Washington Department of Game (hereafter referred to as WDFW) creel surveys (1938-1972) and post-rehabilitation reports (WDFW, unpublished data). The creel survey data was sporadic for most of the streams and lakes in the system and the exact locations of data collection were not provided. However, the creel surveys indicated what species (particularly game fish) were present. The post-rehabilitation reports for the lakes in the Little Spokane River also provided information about what species were present, but were of limited value since the rehabilitations changed the species composition. Species present in the Little Spokane River system, reported in WDFW creel surveys and post-rehabilitation reports between 1938 and 1978, included;

cutthroat trout (*O. clarki*), eastern brook trout (*S. fontinalis*), kokanee (*O. nerka*), rainbow trout (*O. mykiss*), mountain whitefish, tench (*Tinca tinca*), largescale suckers (*C. macrocheilus*), black crappie (*Pomoxis nigromaculatus*), green sunfish (*Lepomis cyanellus*), pumpkinseed (*L. gibbosus*), largemouth bass (*Micropterus salmoides*), yellow perch (*Perca flavescens*), black bullhead (*Ameiurus melas*), and brown bullhead (*A. nebulosus*) (WDFW, unpublished data).

The majority of the fish surveys in the Little Spokane River system were conducted on the lakes (Table 1). Eloika Lake was surveyed on two occasions to evaluate warmwater fish populations. The initial sample of Eloika Lake was conducted in 1978 by WDFW (Zook 1978). Eloika Lake was sampled a second time in 2000 by the WDFW Region 1 Warmwater Team (Divens et al. 2002b). The WDFW Region 1 Warmwater Team also conducted standardized warmwater fish surveys on Diamond (1999), Fan, and Sacheen Lakes (2000) (Phillips and Divens 2000; Divens et al. 2002a; Divens et al. 2002c). Biologists from WDFW conducted gill net surveys of Horseshoe, Trout, and Chain Lakes between 1993 and 1997 to determine the presence of pygmy whitefish (Mongillo and Hallock 1995; Hallock and Mongillo 1998). A second survey of Chain Lake was completed by WDFW in 1999, in an attempt to collect kokanee samples for genetic analysis (Polacek and Baldwin 1999). The lakes within the system that have not had any survey work conducted on them were surrounded by private property and did not allow public access.

The fish population data that was collected in 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. Hartung and Meier (1980; 1995) electrofished the Little Spokane River at 11 sites between rkm 9.1 and rkm 27.0. They were attempting to determine the effects of cyanide on fish. Cyanide was present in groundwater that entered the Little Spokane River near Wandermere (rkm 10.9) (Hartung and Meier 1980; 1995). The cyanide was leaching into the groundwater from equipment at Kaiser Aluminum Corporation (Hartung and Meier 1980; 1995). They concluded that there were no detectable effects of cyanide and they identified 21 and 12 species of fish in 1980 and 1995, respectively (Hartung and Meier 1980; 1995) (Table 1). Biologists from Washington Water Power Company, now known as Avista Utilities, electrofished various unknown sites in the lower 17.0 km of the river in 1988, during which they collected eight species of fish (Pfeiffer 1988) (Table 1). In 2001, Dr. Allan Scholz, from Eastern

Washington University (EWU), and his students electrofished at four sites in the lower 16.0 km of the Little Spokane River and identified 10 species of fish (EWU, unpublished data) (Table 1).

The only recorded fish survey on Otter Creek was conducted in 1974, in preparation for a water rights hearing. The WDFW and WDOE personnel sampled two sites on Otter Creek near Valley Road (rkm 0.6), where they collected rainbow and eastern brook trout (Table 1) (WDFW, unpublished data).

In 1983, WDOE biologists conducted a fish survey on Deadman Creek approximately 55 meters upstream of the Kaiser Aluminum Corporation outfall (rkm 3.5), to estimate fish losses due to chlorinated wastewater that was inadvertently released into the creek by Kaiser (Kittle 1983). Kittle (1983) reported collecting rainbow trout, catfish, and forage fishes (suckers, northern pikeminnows, shiners, and sculpins) (Table 1).

Two sites have been surveyed on Dartford Creek. The first survey was conducted approximately 3 km upstream from the mouth, in 1986 (WDFW, unpublished data). The second was survey was conducted near its mouth, in 1992 (WDFW, unpublished data). Rainbow trout was the only fish species reported at each site (Table 1).

A single site (location unknown) was sampled on Deer Creek in 1978, where eastern brook trout were collected (WFDW, unpublished data). In 1999, Dr. Scholz (EWU) and his students electrofished one site on Deer Creek and they collected brook trout and rainbow trout. They also electrofished one site in each of Buck, Little Deer, Little Deep, and South Fork Deadman Creeks and West Branch Little Spokane River, three sites on Deadman Creek, and two sites on the upper Little Spokane River (river km's 63.5 and 81.5) in 1999 (EWU, unpublished data). They collected 17 species of fish (Table 1). Three sites were surveyed by EWU on Dragoon Creek in 2001 and they identified six species of fish (EWU, unpublished data) (Table 1).

Table 1. Fish species reported to occur within the Little Spokane River system.

Common Name	**Species Name**	**Location**	**Source**
Salmonidae			
Brown Trout	*Salmo trutta*	Eloika Lake	Divens et al. (2002b)
		Little Spokane River	Hartung and Meier (1980); EWU, unpubl. data 2001
		Sacheen Lake	WDFW, unpubl. data 2000
		W. Branch Little Spokane River	EWU, unpubl. data 1999
Eastern Brook Trout	*Salvelinus fontinalis*	Buck Creek	EWU, unpubl. data 2000
		Deer Creek	WDFW, unpubl. data 1978; EWU, unpubl. data 1999
		Dragoon Creek	EWU, unpubl. data 2001
		Little Deer Creek	EWU, unpubl. data 1999
		Little Spokane River	EWU, unpubl. data 1999
		Otter Creek	WDFW, unpubl. data 1974
		Sacheen Lake	Divens et al. (2002c)
		S. Fork Deadman Creek	EWU, unpubl. data 1999
		Trout Lake	WDFW, unpubl. data 1993
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*	Buck Creek	EWU, unpubl. data 2000
		Chain Lake	Polacek and Baldwin (1999)
		Dartford Creek	WDFW, unpubl. data 1986, 1992
		Deadman Creek	EWU, unpubl. data 1999
		Deer Creek	EWU, unpubl. data 1999
		Diamond Lake	Phillips and Divens (2000)
		Dragoon Creek	EWU, unpubl. data 2001
		Eloika Lake	Divens et al. (2002b)
		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

Common Name	**Species Name**	**Location**	**Source**
		Trout Lake	WDFW, unpubl. data 1993
Mountain Whitefish	*Prosopium williamsoni*	Chain Lake	WDFW, unpubl. data 1993; Polacek and Baldwin (1999)
		Horseshoe Lake	WDFW, unpubl. data 1993
		Little Spokane River	Hartung and Meier (1980, 1995); Pfeiffer (1988); EWU, unpubl. data 2001
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. (2002b)
		Fan Lake	Divens et al. (2002a)
		Little Spokane River	Hartung and Meier (1980, 1995)
Cyprinidae			
Carp	*Cyprinus carpio*	Little Spokane River	Hartung and Meier (1980)
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*	Deadman Creek	EWU, unpubl. data 1999
		Little Deep Creek	EWU, unpubl. data 1999
		Little Spokane River	Hartung and Meier (1980, 1995); Peden (1987); EWU, unpubl. data 2001
Northern Pikeminnow	*Ptychocheilus oregonensis*	Chain Lake	WDFW, unpubl. data 1993; Polacek and Baldwin (1999)
		Dragoon Creek	EWU, unpubl. data 2001
		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
		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*	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
Tench	*Tinca tinca*	Chain Lake	WDFW, unpubl. data 1993; Polacek and Baldwin (1999)
		Eloika Lake	Zook (1978); Divens et al. (2002b)

Common Name	Species Name	Location	Source
		Fan Lake	Divens et al. (2002a)
		Little Spokane River	Hartung and Meier (1980)
		Sacheen Lake	Divens et al. (2002c)
		Trout Lake	WDFW, unpubl. data 1993
		W. Branch Little Spokane River	EWU, unpubl. data 1999
Catostomidae			
Bridgelip Sucker	*Catostomus columbianus*	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. (2002b)
		Fan Lake	Divens et al. (2002a)
		Little Spokane River	Hartung and Meier (1980)
		Sacheen Lake	Divens et al. (2002c)
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
Green Sunfish	*Lepomis cyanellus*	Diamond Lake	Phillips and Divens (2000)
		Eloika Lake	Zook (1978); Divens et al. (2002b)
		Fan Lake	Divens et al. (2002a)
		Horseshoe Lake	WDFW, unpubl. data 1995
		Sacheen Lake	Divens et al. (2002c)
		Trout Lake	WDFW, unpubl. data 1993
Largemouth Bass	*Micropterus salmoides*	Diamond Lake	Phillips and Divens (2000)
		Eloika Lake	Zook (1978); Divens et al. (2002b)

Common Name	**Species Name**	**Location**	**Source**
		Fan Lake	Divens et al. (2002a)
		Little Spokane River	Hartung and Meier (1980); Pfeiffer (1988)
		Sacheen Lake	Divens et al. (2002c)
		Trout Lake	WDFW, unpubl. data 1993
		W. Branch Little Spokane River	EWU, unpubl. data 1999
Pumpkinseed	*Lepomis gibbosus*	Diamond Lake	Phillips and Divens (2000)
		Eloika Lake	Zook (1978); Divens et al. (2002b)
		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. (2002c)
		W. Branch Little Spokane River	EWU, unpubl. data 1999
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. (2002b)
		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. (2002b)
		Trout Lake	WDFW, unpubl. data 1993
		W. Branch Little Spokane River	EWU, unpubl. data 1999
Ameiurus			
Black Bullhead	*Ameiurus melas*	Eloika Lake	Divens et al. (2002b)
Brown Bullhead	*Ameiurus nebulosus*	Diamond Lake	Phillips and Divens (2000)
		Eloika Lake	Divens et al. (2002b)
		Little Spokane River	Hartung and Meier (1980); EWU, unpubl. data 1999
		Sacheen Lake	Divens et al. (2002c)
		Trout Lake	WDFW, unpubl. data 1993
Yellow Bullhead	*Ameiurus natalis*	Eloika Lake	Zook (1978); Divens et al. (2002b)
		Fan Lake	Divens et al. (2002a)
		Horseshoe Lake	WDFW, unpubl. data 1995
		W. Branch Little Spokane River	EWU, unpubl. data 1999
Cottidae			
Sculpin spp.	*Cottus* spp.	Buck Creek	EWU, unpubl. data 2000

Common Name	**Species Name**	**Location**	**Source**
		Dragoon Creek	EWU, unpubl. data 2001
		Little Spokane River	EWU, unpubl. data 1999
Mottled Sculpin	*Cottus bairdi*	Little Spokane River	Hartung and Meier (1980, 1995); Peden (1987)

Stocking History

Fish have been planted in the Little Spokane River basin over the last 110 years. Several species of fish were planted, including rainbow trout, brown trout, cutthroat trout, eastern brook trout, lake trout, steelhead, kokanee, bass, crappie, yellow perch, and catfish (WDFW, unpublished hatchery records; A. Scholz, EWU, personal communication). The unpublished WDFW plant records for the Little Spokane River drainage from 1933 through 2001 are listed in Appendix A. The stocking regime for the Little Spokane River drainage in 2001 included approximately 1,500 rainbow trout in the Little Spokane River, 7,400 brown trout and 14, 000 rainbow trout in Diamond Lake, 19,000 eastern brook trout and 5,000 rainbow trout in Sacheen Lake, 7,500 rainbow trout in Horseshoe Lake, 2,000 rainbow trout in Fan Lake, and 5,000 brown trout in Eloika Lake.

Study Area

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. The Little Spokane River originates from groundwater flow approximately 3 km southeast of Newport, and it flows in a south-southwesterly direction until its confluence with the Spokane River (Long Lake) at rkm 90.6. Before it crosses into Spokane County, the Little Spokane River flows through Chain Lake. Three other lakes, Reflection, Little Trout, and Bailey, are also directly connected to the Little Spokane River. The outlet of Reflection Lake, Sheets Creek, flows in to Dry Creek just upstream of its confluence with the Little Spokane River. Bear Creek flows through Little Trout Lake, as it makes its way toward its confluence with the Little Spokane River. Bailey's Lake, located just south of Little Trout Lake, is occasionally connected with Bear Creek via a small outlet ditch (WDFW, unpublished data).

The West Branch Little Spokane River originates at Diamond Lake. The out flow of Diamond Lake, Moon Creek, flows into Sacheen Lake. The outlet of Sacheen Lake is the designated beginning of the West Branch Little Spokane River. As the West Branch Little Spokane River makes its way toward its confluence with the Little Spokane River, at rkm 52.8, it flows through Trout, Horseshoe, and Eloika Lakes. Lost and Fan Lakes are also connected directly to the West Branch Little Spokane River via tributary streams. Spring Heel Creek flows through Lost Lake and continues into the West Branch, just upstream of Horseshoe Lake. Fan Lake is connected to the West Branch via a short outlet stream located upstream of Eloika Lake.

Nine tributaries of the Little Spokane River were surveyed in 2001: Bear, Beaver, Buck, Deer, Dry, Heel, Otter, and Spring Heel Creeks, and the West Branch Little Spokane River (Table 2). Bear Creek originated from two springs located approximately 1.0 km west of Eloika Lake. Bear Creek flows in a southerly direction through Little Trout Lake and runs into the Little Spokane River at rkm 44.8.

The headwaters of Beaver, Buck, and Heel Creeks occur in the Huckleberry Mountains north of Horseshoe Lake. Beaver Creek originally flowed into Fan Lake, but was diverted directly into the West Branch Little Spokane River at rkm 17.2 in the early 1900's to increase flows for log transport (WDFW Region 1 lake management files, 1956). Buck Creek flows into the north end of Horseshoe Lake, 19.6 km from the mouth of the West Branch Little Spokane River. Heel Creek originates northeast of Horseshoe Lake and flows into Spring Heel Creek above Lost Lake. Spring Heel Creek arises from a spring approximately 2.0 km east of its confluence with Heel Creek and flows southwesterly, through Lost Lake, to its confluence with the West Branch Little Spokane River at rkm 19.3.

The headwaters of Deer and Dry Creeks occur on the western slopes of Mount Spokane. Deer Creek flows in a southwesterly direction until its confluence with the Little Spokane River at rkm 37.0. Dry Creek flows into the Little Spokane River at rkm 55.5.

Otter Creek originates from springs that are located south of Trout Lake. Otter Creek flows into the Little Spokane River at rkm 53.9.

All of the streams surveyed in 2001 were managed under the Statewide General Freshwater Regulations. The statewide regulations permitted angling from June 1st through October 31st. Harvest regulations were two trout, eight inches (208 mm) 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, but only two could be species other than eastern brook trout. The regulations for mountain whitefish and bass were no minimum size and bag limits of 15 and 5, respectively. There were no bag limits or minimum size restrictions for any other game fish species.

Table 2. Characteristics of the tributaries surveyed in 2001. Elevations are in meters above mean sea level.

Stream	Order	Length (Km)	Headwater Elevation (m)	Mouth Elevation (m)
Bear Creek	2	11.9	634	521
Beaver Creek	2	20.1	878	594
Buck Creek	3	10.3	1,244	600
Deer Creek	4	20.9	1,305	515
Dry Creek	2	12.9	963	552
Heel Creek	2	7.7	1,280	664
Otter Creek	3	15.4	817	546
Spring Heel Creek	2	4.8	692	616
W.B. Little Spokane River	4	32.3	713	546

Study Objectives

The objectives of the study, for the surveyed streams, were as follows:

- Quantify instream habitat at fish sample sites.
- Determine the fish species present.
- Estimate relative abundances, population sizes, and densities of each fish species.
- Characterize the population structure of potentially native trout in the Little Spokane River drainage, using microsatellite DNA techniques.

Methods

Habitat Surveys

Each stream was stratified into reaches using a USGS topographic map (1:24,000 scale; Figure 1; 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 meter (m) survey sections, which 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 2; 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 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 could fit 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 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 3). 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 (Orsborn and Powers 1985). 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 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).

Discharge (Q; m^3/s) was estimated at the mouth of each stream following the habitat and fish surveys, according to the method described by Platts et al. (1983). Velocity (m/s) was measured with a Global Flow Probe®.

Stream temperatures (^oC) were monitored with Tidbit® temperature loggers (Onset Corp., MA) between June 5th and October 28th, 2001. The temperature-logging interval was every 2 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, except Dragoon Creek, which had a logger placed in the upper reaches (Figure 3). Deer Creek and the West Branch Little Spokane River had additional loggers placed in upper reaches. The Little Spokane River had two additional loggers placed in lower-middle reaches and upper-middle (Figure 3).

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.

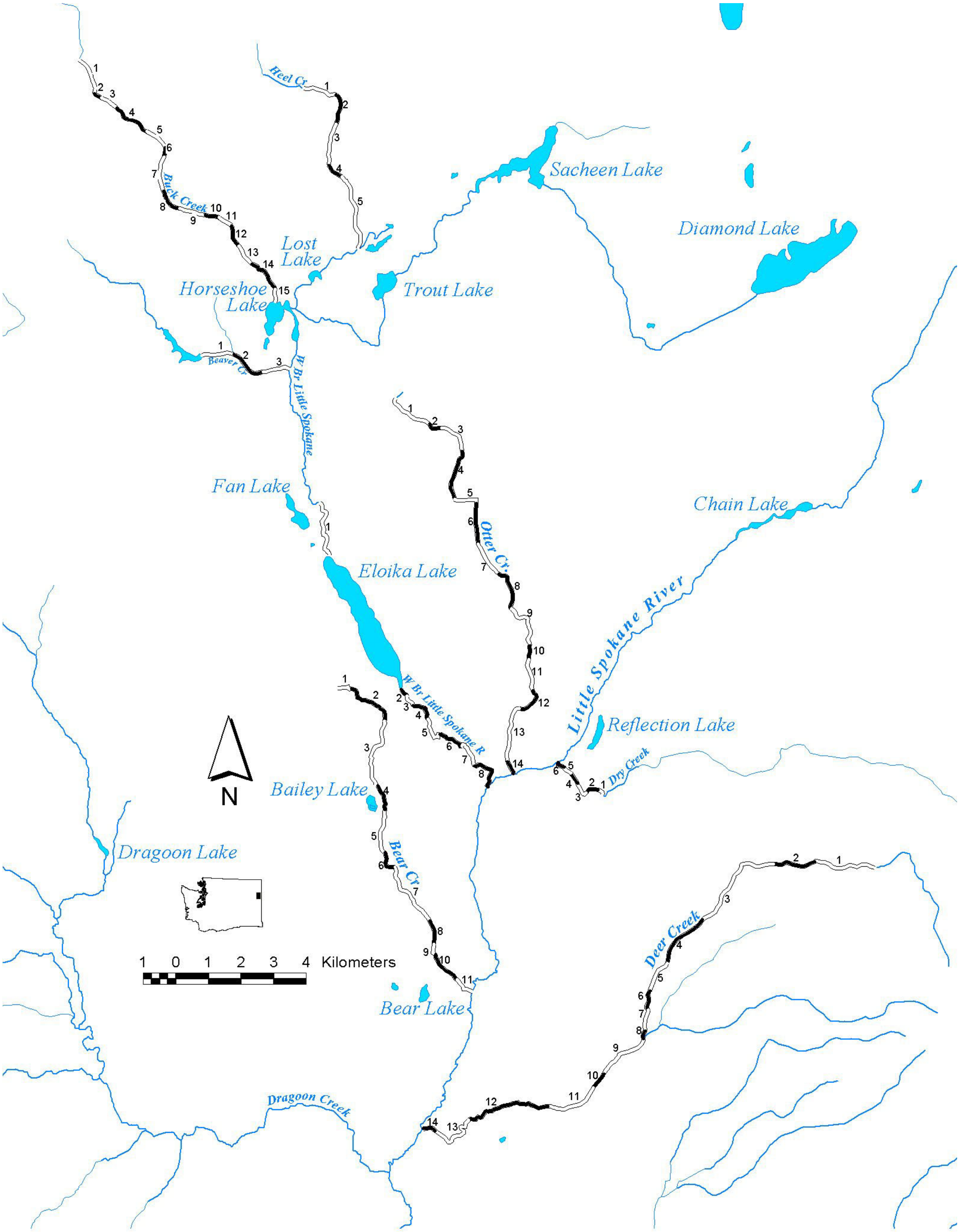

Figure 1. Habitat and fish sampling reaches.

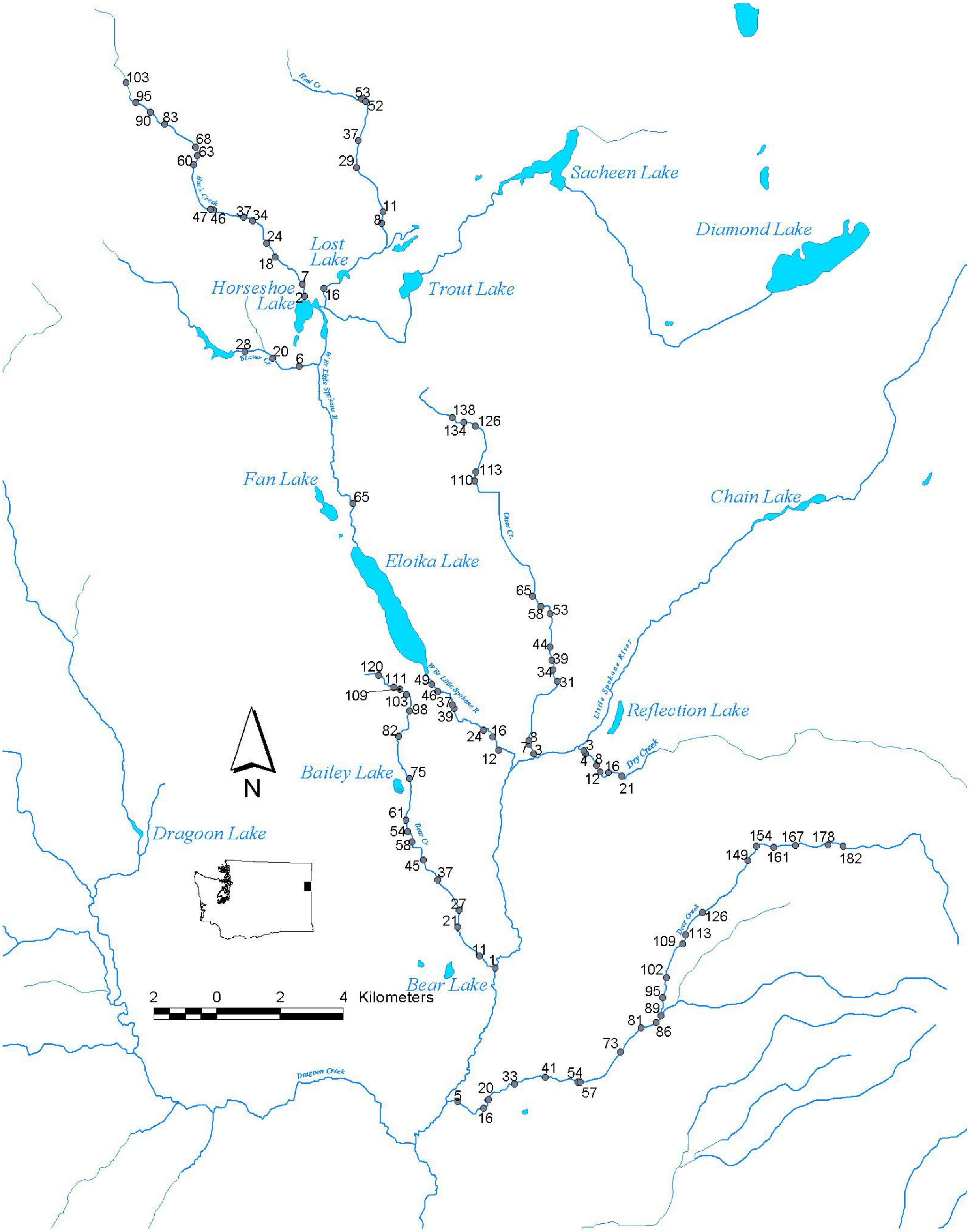

Figure 2. Habitat and fish sample sites.

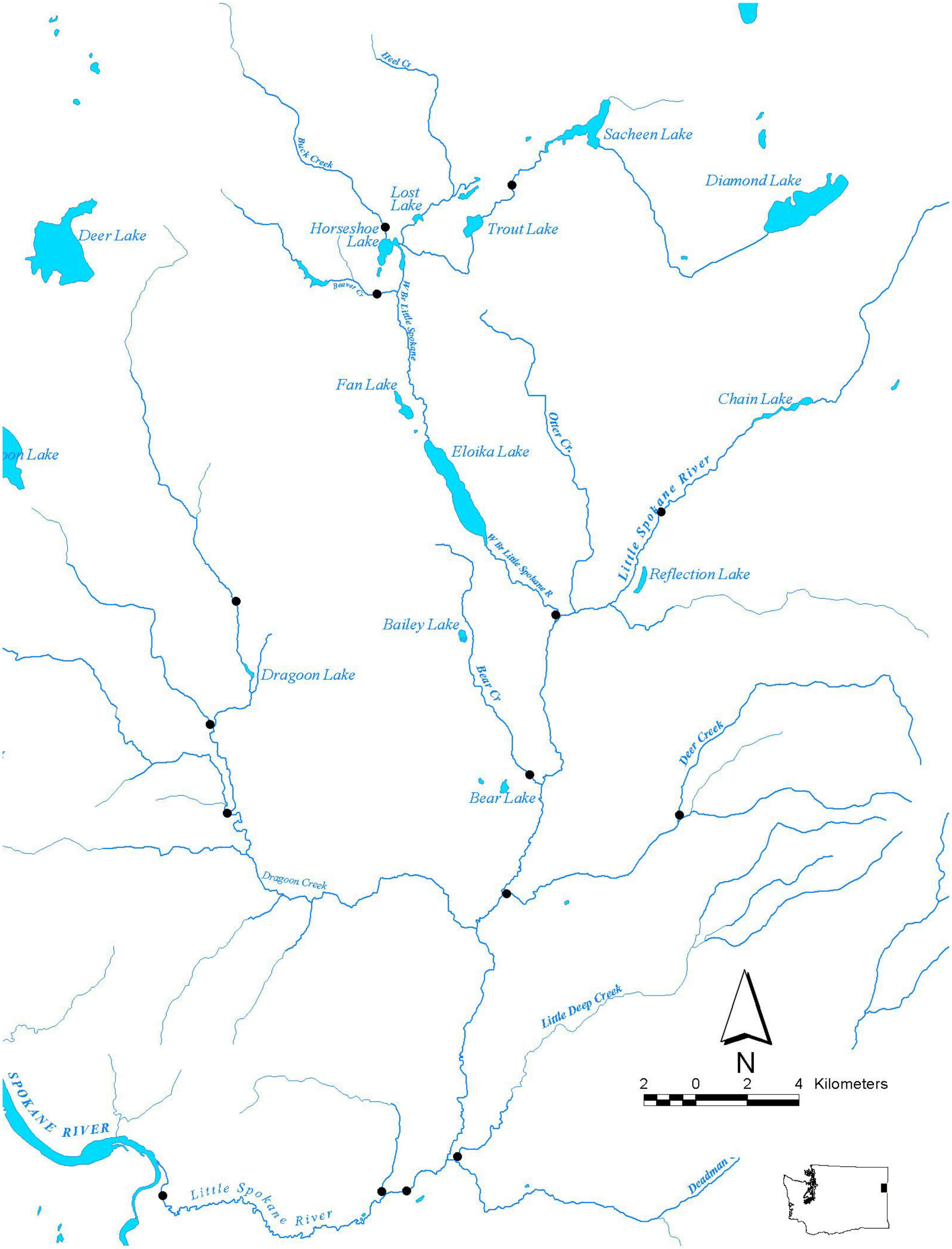

Figure 3. Locations of thermographs.

Fish Surveys

Fish presence, relative abundance, population size, and density were determined from backpack electrofishing data collected at each survey section. A three-pass removal-depletion sampling strategy was used for fish collection (White et al. 1982; Platts et al. 1983). 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 of the section, 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. Two sculpins from what appeared to be different species were collected per stream and sent to WDFW non-game fish biologist, Molly Hallock, for identification. The sculpin samples were fixed in absolute ethanol.

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 and yellow bullheads that were of stock length and the proportions of the brown and rainbow trout populations that were of legal length for harvest were calculated. Stock length was defined as the minimum length of fish with recreational value (20-26% of world record) (Gabelhouse 1984). Stock length for eastern brook trout was 200 mm TL (Anderson and Neumann 1996). The stock length for yellow bullhead was 100 mm TL (Bister et al. 2000).

Population estimates were calculated for each species of fish at each survey section using the computer program CAPTURE and model Zippin (Otis et al. 1978; White et al. 1982). Population estimates were only calculated for species when 10 or more individuals ≥ 50 mm TL of that particular species were caught. 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.

Population Characterization with DNA Analysis

Tissue samples were collected from rainbow trout populations that were identified as potentially native and reproductively isolated, for microsatellite DNA analysis. Samples were only collected from reproductively isolated populations because it was necessary that the samples represented the genetic characteristics of the entire population. If the population was open to multiple life history types or parental stocks, the fish sampled may have represented a mixture of multiple breeding populations. Reproductively isolated populations were those that occurred above barriers and were not subject to known plantings of hatchery fish within the last 10 years. Tissue samples were collected from a maximum of 10 individuals per site, at alternating sites beginning at a headwaters site where rainbow trout were collected. When insufficient sample sizes were obtained in upstream sites, more than 10 fish were sampled at the lower sites.

Samples were also collected from Spokane Hatchery stock rainbow trout (coastal strain, *O. mykiss irideus*) and Phalon Lake hatchery stock rainbow trout (redband strain, *O. mykiss gairdneri*) for tests of hatchery influences and subspecies identification. Fin tissue samples from the Spokane stock rainbow trout were archived at the WDFW Genetics Lab. On May 8, 2001, left ventral fin tissue was obtained from 100 Phalon Lake redband rainbow trout held at the WDFW Spokane Hatchery. The sample fish were taken from a pond of 30,000 fish that comprised a mixture of offspring from the spring 2000 egg take. The spring 2000 egg take was from 86 females and 95 males that were spawned at a ratio of approximately 1.1:1 (C. Vail, WDFW, personal communication).

Tissue samples from wild fish were obtained by clipping the left ventral fin of each fish. 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. 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 stock or Phalon Lake 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 stock).

Results

Bear Creek

Bear Creek was divided into 11 reaches that were sampled between August 15th and September 4thth, as well as on September 27th (Figure 1; Appendix B). A total of 16 sites were surveyed (Figure 2; Appendix C). The mean and standard deviation (SD) of each habitat parameter was calculated for the stream, as well as each reach (Table 4; Appendix D). The mean wetted width of Bear Creek was 2.9 m (SD=1.2) and the mean depth was 24 cm (SD=13) (Table 4). The dominant habitat and substrate types were run (63%) and sand (35%), respectively (Table 4). The discharge of Bear Creek on September 4th was 0.12 m^3/sec. The temperature logger placed in Bear Creek was not recovered.

Nine species of fish were collected in Bear Creek: eastern brook trout, rainbow trout, mountain whitefish, sculpins, longnose dace, speckled dace, green sunfish, bridgelip suckers, and unidentified sucker fry (n=3,473) (Table 5). Two sculpins, collected at site 120 (Reach 1), were preserved for identification. Both were identified as slimy sculpins (*Cottus cognatus*). Eastern brook trout were the most abundant species in Bear Creek, based on relative abundance (63%; n=2,240) (Table 5). The percentage of the eastern brook trout population that was of stock length was 2.0% (n=44) (Figure 4).

Eastern brook trout were collected in every reach (Table 5). Despite the lack of a passage barrier, rainbow trout, mountain whitefish, and longnose dace were only collected at the mouth of Bear Creek (Reach 11) (Table 5). Sculpins were collected in the headwaters (Reaches 1 and 2) and at the mouth (Table 5). Suckers were collected in reaches downstream of Reach 4 and green sunfish were collected in Reach 5.

Population estimates, their corresponding standard errors and 95% confidence intervals, as well as densities were calculated for eastern brook trout, rainbow trout, sculpin, longnose dace, speckled dace, and bridgelip suckers (Table 6).

Table 4. Mean values (± SD) of habitat parameters measured and counted in Bear Creek.

Sample Sizes		**Riffle Habitat**	
No. Reaches	11	No. Riffles	79
No. Sections	16	Riffle Width (m)	2.5 (± 1.1)
No. Transects	232	Riffle Occurrence (%)	34
		Pool Habitat	
Transect Measurements		No. Pools	6
Wetted Width (m)	2.9 (± 1.2)	Pool Width (m)	2.8 (± 1.2)
Bankfull Width (m)	15.2 (± 22.8)	Pool Occurrence (%)	3
Depth (cm)	24 (± 13)	**Run Habitat**	
Maximum Depth (cm)	40 (± 19)	No. Runs	149
		Run Width (m)	3.1 (± 1.2)
Survey Section Measurements		Run Occurrence (%)	63
Gradient (%)	2 (± 2)		
Water Temperature (^{o}C)	13.9 (± 2.8)	**Substrate Composition (%)**	
Air Temperature (^{o}C)	19.2 (± 6.4)	Organic	4 (± 10)
No. LWD/100 m	25 (± 18.5)	Muck	18 (± 32)
No. PP/km	0 (± 0)	Silt	15 (± 20)
		Sand	35 (± 27)
Primary Pools (PP)		Gravel	19 (± 23)
No. PP	0	Cobble	4 (± 8)
PP Width (m)	-	Rubble	2 (± 7)
PP Length (m)	-	Boulder	4 (± 11)
PP Max. Depth (cm)	-	Bedrock	0 (± 0)
PP Residual Depth (cm)	-	Embeddedness (%)	74 (± 34)

Table 5. Relative abundances (R.A.), mean total lengths (TL; ± SD), and size ranges of each species of fish collected in Bear Creek.

Reach	n	R. A. (%)	Mean TL (mm)	Min TL (mm)	Max. TL (mm)
1					
Eastern brook trout	129	96	109 (± 3)	49	238
Sculpin spp.	5	4	69 (± 21)	36	86
2					
Eastern brook trout	440	85	111 (± 45)	45	247
Sculpin spp.	75	15	68 (± 16)	29	88
3					
Eastern brook trout	471	75	114 (± 41)	50	245
Speckled dace	153	25	62 (± 7)	40	88
4					
Eastern brook trout	3	5	209 (± 5)	203	213
Speckled dace	62	95	50 (± 9)	32	71
5					
Eastern brook trout	63	13	146 (± 35)	75	247
Speckled dace	414	84	62 (± 11)	32	97
Green sunfish	11	2	51 (± 17)	41	101
Bridgelip sucker	3	1	131(± 15)	114	140
Sucker fry (unident.)	2	<1	53 (± 6)	48	57

Reach	n	R. A. (%)	Mean TL (mm)	Min TL (mm)	Max. TL (mm)
6					
Eastern brook trout	111	48	103 (± 41)	60	260
Speckled dace	120	52	63 (± 12)	34	97
Bridgelip sucker	1	<1	200	200	200
Sucker fry (unident.)	1	<1	56	56	56
7					
Eastern brook trout	358	81	94 (± 25)	54	202
Speckled dace	80	18	62 (± 14)	21	100
Bridgelip sucker	4	1	149 (± 69)	70	208
Sucker fry (unident.)	2	<1	60 (± 4)	57	62
8					
Eastern brook trout	221	99	84 (± 28)	54	183
Bridgelip sucker	2	1	149 (± 26)	130	167
9					
Eastern brook trout	340	100	85 (± 30)	49	244
10					
Eastern brook trout	80	92	99 (± 35)	56	187
Sucker fry (unident.)	7	8	60 (± 4)	52	64
11					
Eastern brook trout	24	8	120 (± 40)	78	192
Rainbow trout	17	5	141 (± 27)	82	185
Mountain whitefish	6	2	109 (± 5)	103	116
Sculpin spp.	227	72	52 (± 20)	23	106
Longnose dace	28	9	57 (± 11)	48	109
Bridgelip sucker	12	4	91 (± 28)	61	133
Sucker fry (unident.)	1	<1	56	56	56
Total					
Eastern brook trout	2,240	63	102 (± 39)	45	260
Rainbow trout	17	<1	141 (± 27)	82	185
Mountain whitefish	6	<1	109 (± 5)	103	116
Sculpin spp.	307	9	56 (± 20)	23	106
Longnose dace	28	1	57 (± 11)	48	109
Speckled dace	829	23	61 (± 11)	21	100
Green sunfish	11	<1	51 (± 17)	41	101
Bridgelip sucker	22	1	117 (± 47)	61	208
Sucker fry (unident.)	13	<1	58 (± 5)	48	64

Table 6. 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 Bear Creek. Population and density estimates were only calculated for fish species with 10 or more individuals collected.

Reach	**Site**	**N**	**SE**	**Lower 95% CI**	**Upper 95% CI**	Density (#/100 m^2)
Eastern brook trout						
1	120	129	1.4123	129	135	47
2	111	133	3.9806	130	146	56
2	109	164	5.7923	158	182	65
2	103	165	4.1008	161	178	60
3	98	521	40.4874	462	625	177
3	82	116	15.1916	99	165	41
5	61	33	0.7717	33	33	8
5	58	30	1.2034	30	38	7
6	54	120	5.2244	114	136	45
7	45	142	5.0954	137	158	32
7	37	229	2.7473	227	238	52
8	27	243	8.5824	232	266	137
9	21	356	6.4156	348	374	138
10	11	88	5.1709	83	105	27
11	1	26	2.8107	25	39	20
Rainbow trout						
11	1	17	0.8519	17	17	13
Sculpin spp.						
2	111	36	15.7273	26	108	15
2	109	27	3.5737	25	43	11
2	103	16	3.4893	15	34	6
11	1	108	0.3888	93	157	83
Longnose dace						
11	1	28	2.3417	27	39	21
Speckled dace						
3	98	13	1.1196	13	19	4
3	82	161	10.7692	148	192	57
5	61	360	18.8096	333	409	89
5	58	83	9.8045	73	116	18
6	54	121	6.2065	114	140	45
7	45	48	4.1616	45	65	11
7	37	28	4.0500	26	46	6
Bridgelip sucker						
11	1	12	0.9415	12	12	9

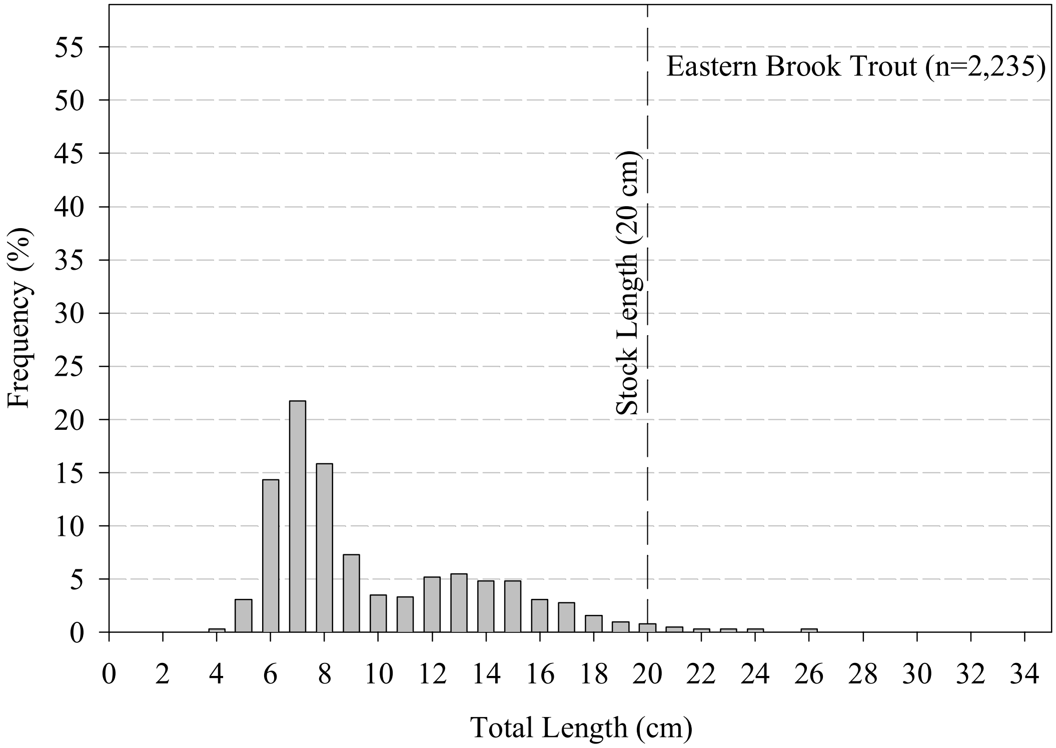

Figure 4. Length-frequency distributions of eastern brook trout collected in Bear Creek.

Beaver Creek

Beaver Creek was divided into three reaches that were sampled on August 13th, 14th, and 20th (Figure 1; Appendix B). Three sites were surveyed on Beaver Creek (Figure 2; Appendix C). The mean of each habitat parameter was calculated for the stream, as well as each reach (Table 7; Appendix E). The mean wetted width was 1.8 m (SD=0.8) and the mean depth was 6 cm (SD=3) (Table 7). The dominant habitat and substrate types were run (63%) and gravel (35%), respectively (Table 7). The discharge of Beaver Creek on August 14th was 0.01 m^3/sec.

Three definite natural and one definite human-made fish passage barriers were identified on Beaver Creek (Figure 5; Appendix L). Moving in an upstream direction the first of the three natural barriers was a landslide that buried 16.2 m of the stream. The landslide was a natural occurrence in a steep section of the stream, approximately 800 m upstream of Horseshoe Lake Road. The second barrier was a waterfall (5.0 m vertical height) located 10 m upstream from the top of the landslide. The crest of the falls was 0.3 m wide and there was no landing pool at the top, just a steep cascade. The plunge pool was small, 1.7 m long, and had a maximum depth of

24 cm. The third barrier was also a waterfall (5.1 m vertical height), located 20 m upstream of the previous waterfall. The human-made barrier was a dam, located at the upper end of our survey reaches. The earthen dam was approximately 50 m wide and 30 m high. Beaver Creek also went dry between the mouth and 200 m below Horseshoe Lake Road.

The temperature of Beaver Creek was measured 1,753 times with a thermograph between June 5th and October 28th. Daily average, maximum, and minimum temperatures were determined (Figure 6). Mean temperature was 11.09 (SD=3.36) °C, with a maximum of 18.42 °C on July 10th and a minimum of 2.61 °C on October 28th.

Eastern brook trout and rainbow trout were the only species of fish collected (n=764) (Table 8). Eastern brook trout were the most abundant species collected, based on relative abundance (96%; n=743)(Table 8). There were no brook trout of stock length collected (Figure 7).

Population estimates, their corresponding standard errors and 95% confidence intervals, and densities were calculated for eastern brook trout and rainbow trout (Table 9).

Table 7. Mean values (± SD) of habitat parameters measured and counted in Beaver Creek.

Sample Sizes		**Riffle Habitat**	
No. Reaches	3	No. Riffles	14
No. Sections	3	Riffle Width (m)	1.3 (± 0.6)
No. Transects	50	Riffle Occurrence (%)	27
		Pool Habitat	
Transect Measurements		No. Pools	5
Wetted Width (m)	1.8 (± 0.8)	Pool Width (m)	2.1 (± 0.7)
Bankfull Width (m)	3.3 (± 1.0)	Pool Occurrence (%)	10
Depth (cm)	6 (± 3)	**Run Habitat**	
Maximum Depth (cm)	12 (± 6)	No. Runs	32
		Run Width (m)	1.8 (± 0.7)
Survey Section Measurements		Run Occurrence (%)	63
Gradient (%)	1 (± 1)		
Water Temperature (^{o}C)	13.0 (± 4.9)	**Substrate Composition (%)**	
Air Temperature (^{o}C)	22.0 (± 10.3)	Organic	0 (± 0)
No. LWD/100 m	17 (± 7)	Muck	0 (± 0)
No. PP/km	0 (± 0)	Silt	12 (±16)
		Sand	25 (± 18)
Primary Pools (PP)		Gravel	35 (± 21)
No. PP	0	Cobble	22 (± 17)
PP Width (m)	-	Rubble	6 (± 11)
PP Length (m)	-	Boulder	0 (± 3)
PP Max. Depth (cm)	-	Bedrock	0 (± 0)
PP Residual Depth (cm)	-	Embeddedness (%)	36 (± 25)

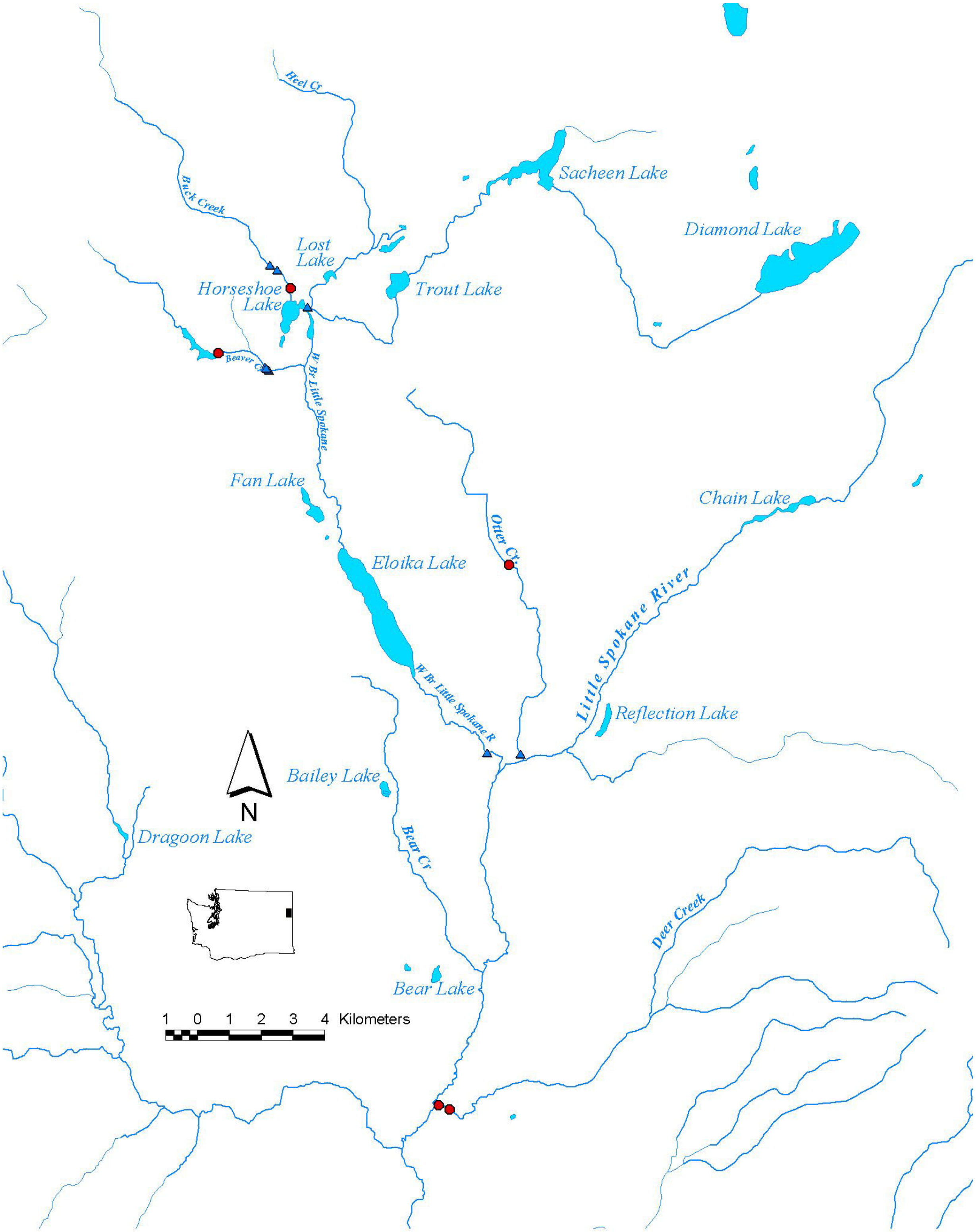

Figure 5. Locations of natural and human-made fish passage barriers. Circles represent human-made barriers and triangles represent natural barriers.

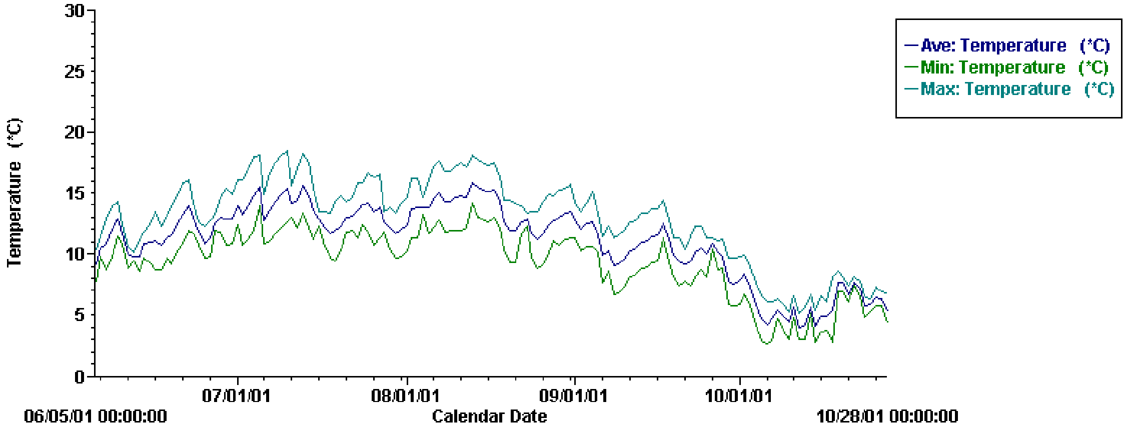

Figure 6. Mean, minimum, and maximum daily temperatures recorded on Beaver Creek.

Table 8. Relative abundances (R.A.), mean total length (TL; ± SD), and size range of each species of fish collected in Beaver Creek.

Reach	n	R.A. (%)	Mean TL (mm)	Min TL (mm)	Max. TL (mm)
1					
Eastern brook trout	83	100	84 (± 7)	67	98
2					
Eastern brook trout	403	100	64 (± 21)	38	178
3					
Eastern brook trout	257	92	76 (± 36)	37	194
Rainbow trout	21	8	93 (± 10)	77	114
Total					
Eastern brook trout	743	96	70 (± 27)	37	194
Rainbow trout	21	4	93 (± 10)	77	114

Table 9. 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 Beaver Creek. Population and density estimates were only calculated for fish species with 10 or more individuals collected.

Reach	Site	N	SE	Lower 95% CI	Upper 95% CI	Density (#/100 m^2)
Eastern brook trout						
1	28	84	1.5971	84	91	54
2	20	358	5.7048	351	373	175
3	6	225	6.9707	217	245	128
Rainbow trout						
3	6	21	0.5669	21	21	12

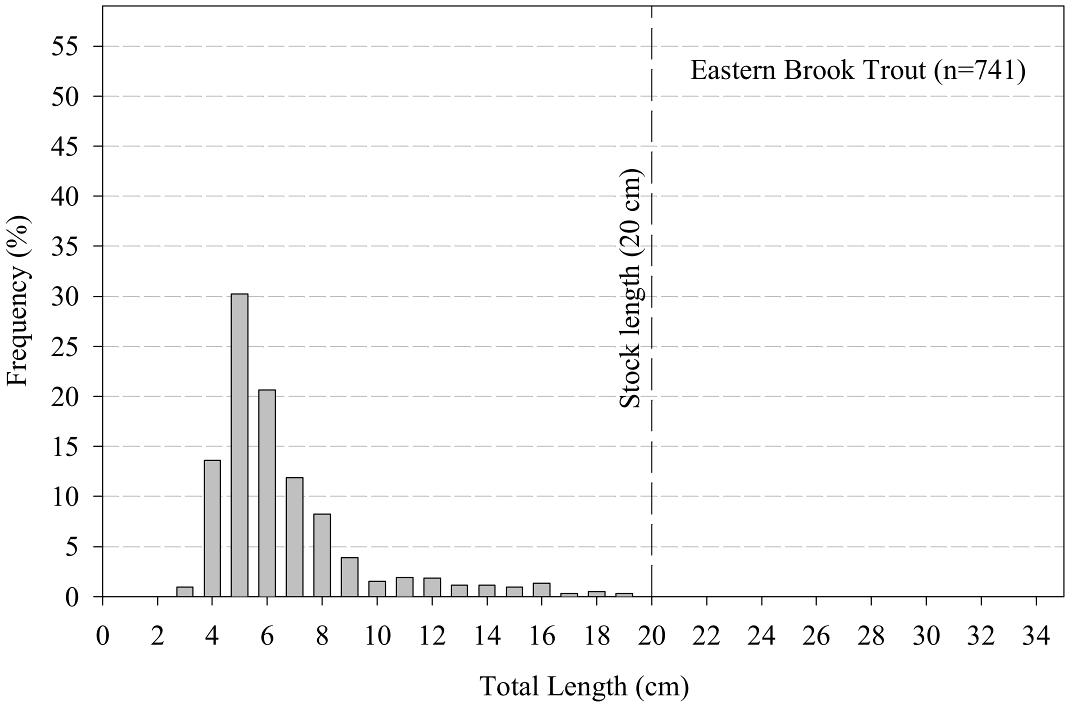

Figure 7. Length-frequency distribution of eastern brook trout collected in Beaver Creek.

Buck Creek

Buck Creek was divided into 15 reaches that were sampled between June 13th and July 10th (Figure 1; Appendix B). A total of 16 sites were surveyed (Figure 2; Appendix C). The mean of each habitat parameter was calculated for the stream, as well as each reach (Table 10; Appendix F). The mean wetted width of Buck Creek was 3.5 m (SD=1.3) and the mean depth was 13 cm (SD=6) (Table 10). The dominant habitat and substrate types were riffle (75%) and sand (45%), respectively. The discharge of Buck Creek on July 10th was 0.04 m^3/sec.

Two definite natural and one potential human-made fish passage barriers were identified on Buck Creek (Figure 5; Appendix L). Moving in an upstream direction, the first natural barrier was located approximately 1 km upstream from the Horseshoe Lake Road crossing. The barrier was described as a chute. The chute was 8.0 m long, with a gradient of 36%. The width at the crest was 1.0 m. There was no landing pool at the crest and the stream had a 35^o bend just after the crest, prior to a resting pool. The second natural barrier was also a chute, located approximately 400 m upstream of the first chute. The chute was 4.4 m long, with a gradient of

35%. The width at the base of the chute was 0.5 m and the width at the crest was 0.6 m. The human-made barrier was a culvert at the Horseshoe Lake Road crossing, approximately 200 m above the stream mouth. The mouth of the culvert (2.3 m diameter) was 0.8 m high, but boulders at its base required fish to leap 1.25 m horizontally as well. The plunge pool was deep (66 cm), but short (2.0 m) adding difficulty to the jump.

The temperature of Buck Creek was measured 1,753 times with a thermograph between June 5th and October 28th. Daily average, maximum, and minimum temperatures were determined (Figure 8). Mean temperature was 11.72 (SD=3.43) °C with a maximum of 18.69 °C on July 10th and a minimum of 3.99 °C on October 28th.

Three species of fish were collected in Buck Creek: eastern brook trout, rainbow trout, and sculpin (n=887) (Table 11). Four sculpins were collected from site 7 (Reach 14) and preserved for identification. All four were identified as slimy sculpins. Rainbow trout were the most abundant fish species, based on relative abundance (84%; n=743) (Table 11). The percentage of the rainbow trout population that was of legal length for harvest was 0.1% (n=6) (Figure 9).

Rainbow trout were collected in every reach (Table 11). Sculpins were collected in Reaches 14 and 15, and a single eastern brook trout was collected in Reach 15 (Table 11). Reaches 14 and 15 were below the most downstream waterfall and Reach 15 was below the culvert at Horseshoe Lake Road. Population estimates, their corresponding standard errors and 95% confidence intervals, and densities were calculated for rainbow trout and sculpins (Table 12).

The rainbow trout population above the upper most natural barrier was sampled for microsatellite DNA analysis. Fin tissue samples were collected from a total of 50 individuals, 10 per site, from sites 24, 37, 47, 83, and 95. The mean total length of the fish sampled for tissue was 137 mm (SD=32).

Table 10. Mean values (± SD) of habitat parameters measured and counted in Buck Creek.

Sample Sizes		**Riffle Habitat**	
No. Reaches	15	No. Riffles	202
No. Sections	15	Riffle Width (m)	3.2 (± 1.2)
No. Transects	250	Riffle Occurrence (%)	75
		Pool Habitat	
Transect Measurements		No. Pools	58
Wetted Width (m)	3.5 (± 1.3)	Pool Width (m)	3.1 (± 1.4)
Bankfull Width (m)	5.1 (± 2.0)	Pool Occurrence (%)	21
Depth (cm)	13 (± 6)	**Run Habitat**	
Maximum Depth (cm)	26 (± 12)	No. Runs	11
		Run Width (m)	4.2 (± 1.7)
Survey Section Measurements		Run Occurrence (%)	4
Gradient (%)	3 (± 2)		
Water Temperature (°C)	10.5 (± 4.0)	**Substrate Composition (%)**	
Air Temperature (°C)	17.5 (± 7.5)	Organic	0 (± 1)
No. LWD/100 m	44 (± 18)	Muck	0
No. PP/km	1.3 (± 1.2)	Silt	5 (± 15)
		Sand	45 (± 27)
Primary Pools (PP)		Gravel	21 (± 16)
No. PP	19	Cobble	23 (± 22)
PP Width (m)	4.4 (± 1.2)	Rubble	3 (± 6)
PP Length (m)	6.5 (±1.6)	Boulder	1 (± 3)
PP Max. Depth (cm)	56 (± 16)	Bedrock	1 (± 9)
PP Residual Depth (cm)	38 (± 8)	Embeddedness (%)	38 (± 25)

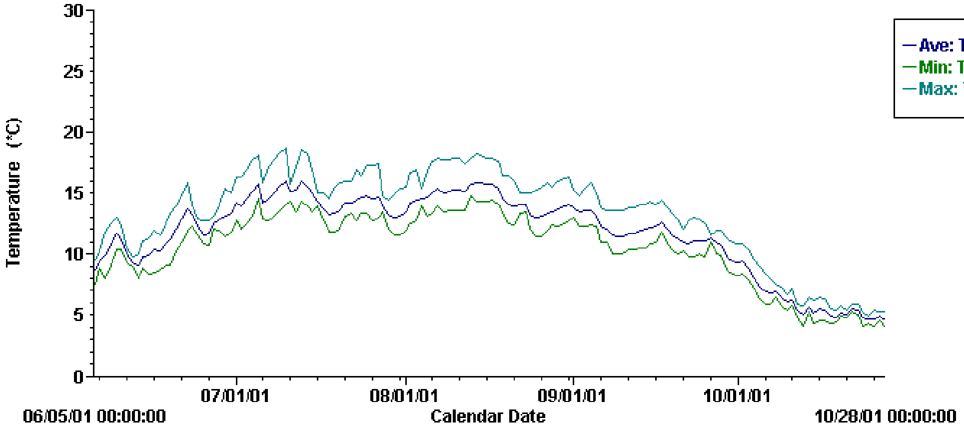

Figure 8. Mean, minimum, and maximum daily temperatures recorded on Buck Creek.

Table 11. Relative abundances (R.A.), mean total lengths (TL; ± SD), and size ranges of each species of fish collected in Buck Creek.

Reach	n	R. A. (%)	Mean TL (mm)	Min TL (mm)	Max. TL (mm)
1					
Rainbow trout	17	100	73 (±16)	45	92
2					
Rainbow trout	12	100	107 (±35)	43	166
3					
Rainbow trout	15	100	105 (±28)	74	169
4					
Rainbow trout	25	100	92 (±33)	48	161
5					
Rainbow trout	25	100	112 (±32)	48	183
6					
Rainbow trout	32	100	106 (±32)	49	162
7					
Rainbow trout	36	100	105 (±29)	65	166
8					
Rainbow trout	26	100	104 (±39)	48	175
9					
Rainbow trout	75	100	118 (±33)	64	218
10					
Rainbow trout	116	100	118 (±34)	68	215
11					
Rainbow trout	120	100	108 (±29)	61	178
12					
Rainbow trout	20	100	118 (±33)	67	169
13					
Rainbow trout	65	100	109 (±29)	65	198
14					
Rainbow trout	71	60	98 (±35)	30	202
Sculpin spp.	48	40	67 (±13)	45	93
15					
Eastern brook trout	1	1	135	135	135
Rainbow trout	88	48	97 (±32)	43	206
Sculpin spp.	95	51	66 (±11)	37	90
Total					
Eastern brook trout	1	<1	135	135	135
Rainbow trout	743	84	107 (±33)	30	218
Sculpin spp.	143	16	66 (±12)	37	93

Table 12. 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 Buck Creek. Population and density estimates were only calculated for fish species with 10 or more individuals collected.

Reach	**Site**	**N**	**SE**	**Lower 95% CI**	**Upper 95% CI**	**Density (#/100 m^2)**
Rainbow trout						
1	103	14	0.1753	14	14	9
2	95	11	1.0198	11	11	4
3	90	15	0.7682	15	15	5
4	83	23	1.1627	23	31	8
5	68	24	1.3894	24	33	7
6	65	33	2.8629	32	46	12
7	60	37	2.1055	37	47	9
8	47	29	5.1806	26	52	6
9	46	84	6.0899	78	104	19
10	37	119	2.4286	117	128	23
11	34	131	6.1235	125	150	33
12	24	21	1.4786	21	29	5
13	18	70	3.8483	67	84	19
14	7	83	9.8045	73	116	26
15	2	98	7.6905	90	122	33
Sculpin spp.						
14	7	49	4.7390	46	67	16
15	2	109	11.2377	97	145	36

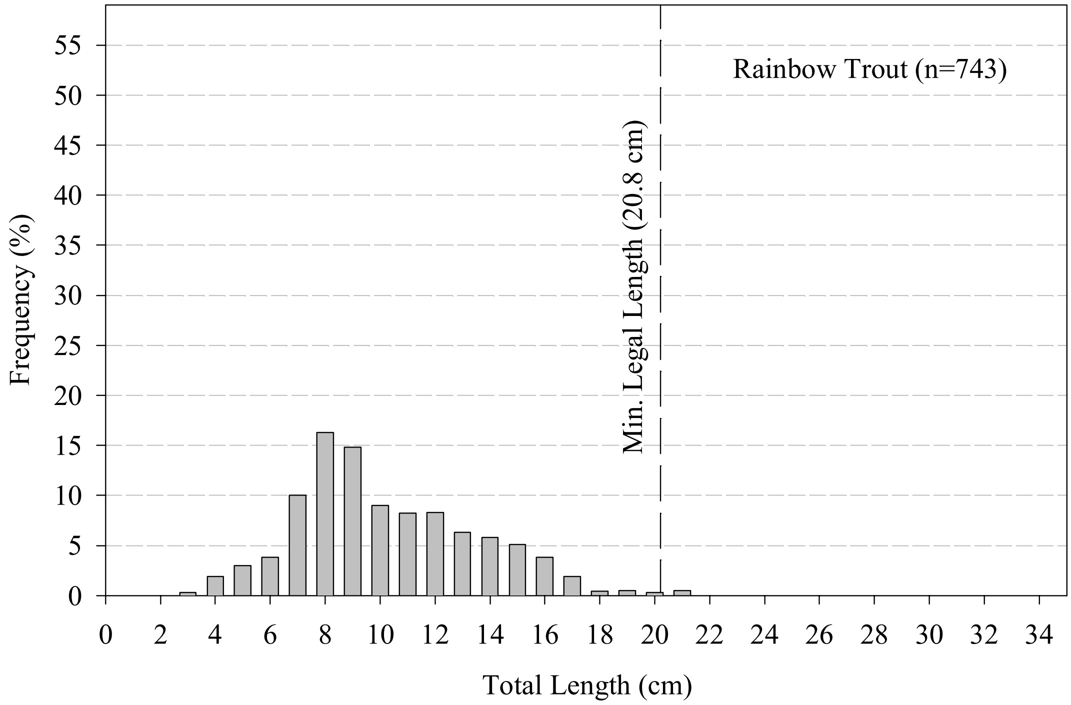

Figure 9. Length-frequency distribution of rainbow trout collected in Buck Creek.

Deer Creek

Deer Creek was divided into 14 reaches that were sampled between September 11th and October 10th (Figure 1; Appendix B). A total of 22 sites were surveyed (Figure 2; Appendix C). The mean of each habitat parameter was calculated for the stream, as well as each reach (Table 13; Appendix G). The mean wetted width of Deer Creek was 2.3 m (SD=1.0) and the mean depth was 10 cm (SD=8) (Table 13). The dominant habitat and substrate types were riffle (52%) and sand (54%), respectively (Table 13). The discharge of Deer Creek was not measured due to equipment failure.

Two potential human-made fish passage barriers were identified on Deer Creek (Figure 5; Appendix L). The first was the crossing at Highway 2. The crossing was a concrete culvert (approx. 20 m long) with flat walls (approx. 3.0 m tall) and a flat bottom (2.3 m wide). The vertical height to the mouth was 0.7 m, with a horizontal distance to the landing pool of 0.6 m. The plunge pool was 4.0 m long and 69 cm deep. The landing pool was 4 cm deep. The second was concrete culvert under the railroad track, located approximately 200 m upstream from the

Highway 2 crossing. The culvert had flat, smooth walls and bottom, and was 7.9 m wide, and approximately 50.0 m long. The leaping height to the mouth was 0.5 m from a large plunge pool (6.9 m long; 53 cm deep). There was no landing pool and the landing surface was shallow water (5 cm) flowing across the flat concrete over a 1.5 m wide section. The stream also went dry between the Elk-Chattaroy Road and the railroad crossing.

The thermograph placed near the mouth of Deer Creek was not recovered. A citizen removed the thermograph placed in upper Deer Creek on July 25th. They mistakenly thought it was a radio transmitter a poacher had hidden in the stream. However, the temperature of upper Deer Creek was measured 600 times with the thermograph, between June 5th and July 25th. Daily average, maximum, and minimum temperatures were determined (Figure 10). Mean temperature was 13.41 (SD=2.66) °C with a maximum of 20.17 °C on July 10th and a minimum of 6.94 °C on June 5th.

Eastern brook trout, rainbow trout, sculpins, and a single longnose dace were collected in Deer Creek (n=4,310) (Table 14). Four sculpins were collected from site 109 (Reach 5) and preserved for identification. All four were identified as mottled sculpin (*Cottus bairdi*). Rainbow trout were the most abundant fish species, based on relative abundance (54%; n=2,311) (Table 14). The percentage of the eastern brook trout population that was of stock length was 1.1% (n=17) (Figure 11). The percentage of the rainbow trout population that was of legal length for harvest was 0.5% (n=12) (Figure 11).

Brook and rainbow trout were collected in all sampling reaches, except Reach 13 where no fish were collected (Table 14). Sculpins were collected in Reaches 3 through 9 and 14. The longnose dace was collected in Reach 14.

Population estimates, their corresponding standard errors and 95% confidence intervals, and densities were calculated for eastern brook trout, rainbow trout, and sculpin at each site where 10 or more individuals were collected (Table 15).

The rainbow trout population above the highway barrier was sampled for microsatellite DNA analysis. Fin tissue samples were collected from a total of 100 individuals, 10 per site, from sites 5, 33, 57, 81, 89, 102, 113, 149, 161, and 182. The mean total length of the fish sampled for fin tissue was 148 mm (SD=30).

Table 13. Mean values (± SD) of habitat parameters measured and counted in Deer Creek.

Sample Sizes		**Riffle Habitat**	
No. Reaches	14	No. Riffles	200
No. Sections	22	Riffle Width (m)	2.1 (± 0.9)
No. Transects	366	Riffle Occurrence (%)	52
		Pool Habitat	
Transect Measurements		No. Pools	69
Wetted Width (m)	2.3 (± 1.0)	Pool Width (m)	2.4 (± 0.9)
Bankfull Width (m)	4.3 (± 1.4)	Pool Occurrence (%)	18
Depth (cm)	10 (± 8)	**Run Habitat**	
Maximum Depth (cm)	21 (± 14)	No. Runs	114
		Run Width (m)	2.3 (± 1.1)
Survey Section Measurements		Run Occurrence (%)	30
Gradient (%)	2 (± 1)		
Water Temperature (^{o}C)	8 (± 3)	**Substrate Composition (%)**	
Air Temperature (^{o}C)	12 (± 5)	Organic	1 (± 4)
No. LWD/100 m	29 (± 14)	Muck	0 (± 2)
No. PP/km	10 (± 13)	Silt	11 (± 18)
		Sand	54 (± 26)
Primary Pools (PP)		Gravel	20 (± 22)
No. PP	23	Cobble	7 (± 14)
PP Width (m)	3.4 (± 1.3)	Rubble	3 (± 8)
PP Length (m)	6.4 (± 2.5)	Boulder	2 (± 9)
PP Max. Depth (cm)	56 (± 24)	Bedrock	2 (± 11)
PP Residual Depth (cm)	35 (± 14)	Embeddedness (%)	63 (± 34)

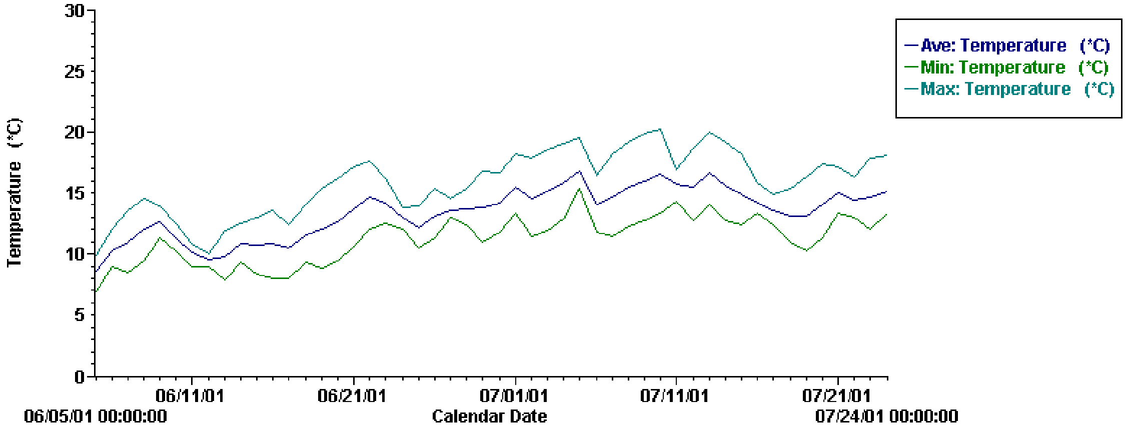

Figure 10. Mean, minimum, and maximum daily temperatures recorded on upper Deer Creek.

Table 14. Relative abundances (R.A.), mean total lengths (TL; ± SD), and size ranges of each species of fish collected in Deer Creek.

Reach	n	R. A. (%)	Mean TL (mm)	Min TL (mm)	Max. TL (mm)
1					
Eastern brook trout	155	57	70 (± 33)	39	201
Rainbow trout	115	43	94 (± 41)	27	198
2					
Eastern brook trout	126	37	72 (± 19)	32	164
Rainbow trout	211	63	77 (± 33)	33	218
3					
Eastern brook trout	112	22	84 (± 28)	36	221
Rainbow trout	367	71	70 (± 31)	34	198
Sculpin spp.	37	7	41 (± 21)	26	94
4					
Eastern brook trout	209	63	76 (± 24)	50	201
Rainbow trout	110	33	82 (± 34)	40	198
Sculpin spp.	15	4	49 (± 15)	31	83
5					
Eastern brook trout	173	65	82 (± 25)	52	174
Rainbow trout	60	23	104 (± 35)	42	194
Sculpin spp.	33	12	61 (± 20)	28	112
6					
Eastern brook trout	163	57	84 (± 31)	51	252
Rainbow trout	86	30	106 (± 31)	49	198
Sculpin spp.	38	13	63 (± 19)	28	90
7					
Eastern brook trout	129	55	83 (± 28)	54	284
Rainbow trout	84	36	93 (± 30)	52	188
Sculpin spp.	20	9	72 (± 11)	38	90
8					
Eastern brook trout	66	28	115 (± 40)	66	227
Rainbow trout	139	59	99 (± 32)	38	184
Sculpin spp.	31	13	67 (± 17)	29	92

Reach	n	R. A. (%)	Mean TL (mm)	Min TL (mm)	Max. TL (mm)
9					
Eastern brook trout	259	28	86 (± 24)	33	218
Rainbow trout	462	50	95 (± 28)	45	191
Sculpin spp.	195	22	60 (± 16)	28	95
10					
Eastern brook trout	142	38	99 (± 38)	60	240
Rainbow trout	230	62	107 (±3 2)	48	202
11					
Eastern brook trout	30	18	136 (± 37)	75	204
Rainbow trout	139	82	121 (± 38)	60	232
12					
Eastern brook trout	29	18	118 (± 41)	68	234
Rainbow trout	135	82	104 (± 41)	41	227
13					
No Fish	-	-	-	-	-
14					
Eastern brook trout	11	5	75 (± 8)	65	89
Rainbow trout	173	82	83 (± 37)	37	211
Sculpin spp.	25	12	62 (± 12)	24	87
Longnose dace	1	1	72	72	72
Total					
Eastern brook trout	1,604	37	85 (± 32)	32	284
Rainbow trout	2,311	54	92 (± 36)	27	232
Sculpin spp.	394	9	59 (± 18)	24	112
Longnose dace	1	<1	72	72	72

Table 15. 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 Deer Creek. Population and density estimates were only calculated for fish species with 10 or more individuals collected.

Reach	Site	N	SE	Lower 95% CI	Upper 95% CI	Density (#/100 m^2)
Eastern brook trout						
1	182	60	3.2277	58	73	51
1	178	77	2.9725	75	88	53
2	167	124	2.0451	123	132	86
3	161	49	1.1293	49	56	35
3	154	23	5.7356	20	50	12
3	149	43	0.2298	43	43	22
4	126	106	1.0162	106	112	73
4	113	106	2.7816	104	116	49
5	109	178	3.1861	175	188	79
6	102	168	3.1594	165	178	69
7	95	134	3.2587	131	145	57
8	89	78	8.1935	70	106	35
9	86	94	6.4551	88	115	34
9	81	177	2.2489	175	185	79
10	73	146	2.9084	144	156	41
11	57	7	0.3273	7	7	2

Reach	Site	N	SE	Lower 95% CI	Upper 95% CI	Density (#/100 m^2)
11	54	23	1.1622	23	31	7
12	41	16	0.0000			5
12	33	13	1.1197	13	19	4
14	5	11	1.0198	11	11	4
<u>Rainbow trout</u>						
1	182	46	0.8263	46	46	39
1	178	43	0.5248	43	43	30
2	167	178	1.7798	177	185	123
3	161	84	0.5331	84	84	59
3	154	83	2.0567	82	91	43
3	149	84	1.4817	84	91	42
4	126	69	0.9223	69	75	47
4	113	30	0.7254	30	30	14
5	109	60	1.5413	60	67	27
6	102	85	0.5810	85	85	35
7	95	85	1.6898	85	93	36
8	89	149	8.8167	139	175	66
9	86	297	4.2355	292	309	108
9	81	172	1.5769	172	179	77
10	73	242	6.1183	235	259	68
11	57	77	1.6735	77	85	25
11	54	65	2.4389	64	75	19
12	41	77	1.6737	77	85	23
12	33	55	2.2422	54	64	16
14	5	167	7.0456	158	187	67
<u>Sculpin spp.</u>						
5	109	35	9.9535	28	78	16
6	102	41	13.3888	32	98	17
8	89	44	26.7209	28	171	20
9	86	84	26.4741	61	185	31
9	81	185	76.5450	115	471	82
14	5	31	9.7741	25	75	12

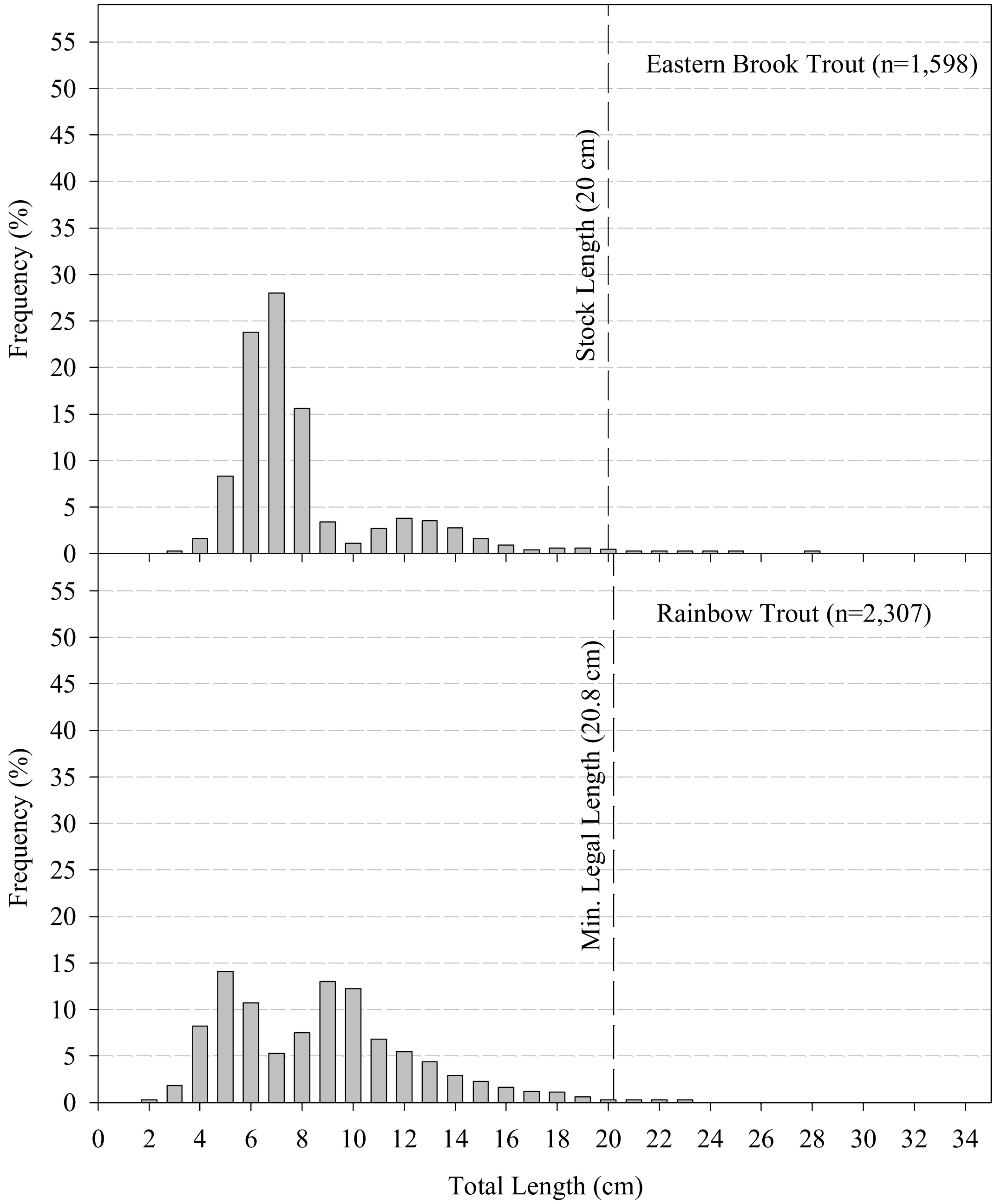

Figure 11. Length-frequency distribution of eastern brook and rainbow trout collected in Deer Creek.

Dry Creek

Dry Creek was divided into six reaches that were sampled between September 5th and September 26th (Figure 1; Appendix B). A total of six sites were surveyed (Figure 2; Appendix C). The mean of each habitat parameter was calculated for the stream, as well as each reach (Table 16; Appendix H). The mean wetted width of Dry Creek was 2.7 m (SD=0.8) and the mean depth was 18 cm (SD=8) (Table 16). The dominant habitat and substrate types were riffle (52%) and sand (44%), respectively (Table 16). The discharge of Dry Creek on September 25th was 0.12 m^3/sec.

Eight species of fish were collected in Dry Creek: brown trout, eastern brook trout, rainbow trout, mountain whitefish, sculpins, longnose dace, northern pikeminnow, and largemouth bass (n=1,424) (Table 17). Four sculpins were collected from site 3 (Reach 6) and preserved for identification. Two were identified as torrent sculpins (*Cottus rotheus*) and two were identified as mottled sculpins. Rainbow trout were the most abundant fish species, based on relative abundance (36%; n=507), although eastern brook trout (33%; n=474) and sculpin (30%; n=423) abundances were relatively similar (Table 17). The percentage of the eastern brook trout population that was of stock length was 1.5% (n=7) (Figure 11). The percentage of the rainbow trout population that was of legal length for harvest was 0.4% (n=2) (Figure 12).

Eastern brook trout, rainbow trout, and sculpins were collected in all sampling reaches (Table 17). A single brown trout was collected in Reach 4 (Table 17). Northern pikeminnow were collected in Reaches 5 and 6 (Table 17). The mountain whitefish, longnose dace, and largemouth bass were collected in Reach 6, near the mouth and below the confluence with Sheets Creek (Table 17).

Population estimates, their corresponding standard errors and 95% confidence intervals, and densities were calculated for eastern brook trout, rainbow trout, and sculpin (Table 18).

Table 16. Mean values (± SD) of habitat parameters measured and counted in Dry Creek.

Sample Sizes		**Riffle Habitat**	
No. Reaches	6	No. Riffles	54
No. Sections	6	Riffle Width (m)	2.6 (± 0.7)
No. Transects	98	Riffle Occurrence (%)	54
		Pool Habitat	
Transect Measurements		No. Pools	6
Wetted Width (m)	2.7 (± 0.8)	Pool Width (m)	2.5 (± 0.9)
Bankfull Width (m)	3.7 (± 0.9)	Pool Occurrence (%)	6
Depth (cm)	18 (± 8)	**Run Habitat**	
Maximum Depth (cm)	33 (± 13)	No. Runs	40
		Run Width (m)	2.8 (± 0.8)
Survey Section Measurements		Run Occurrence (%)	40
Gradient (%)	3 (± 1)		
Water Temperature (^{o}C)	9 (± 1)	**Substrate Composition (%)**	
Air Temperature (^{o}C)	15 (± 5)	Organic	4 (± 8)
No. LWD/100 m	48 (± 29)	Muck	1 (± 3)
No. PP/km	3 (± 5)	Silt	16 (± 22)
		Sand	44 (± 23)
Primary Pools (PP)		Gravel	22 (± 18)
No. PP	2	Cobble	5 (± 9)
PP Width (m)	2.7 (± 0.3)	Rubble	3 (± 8)
PP Length (m)	5.3 (± 0.3)	Boulder	3 (± 9)
PP Max. Depth (cm)	71 (± 8)	Bedrock	1 (± 6)
PP Residual Depth (cm)	48 (± 1)	Embeddedness (%)	58 (± 32)

Table 17. Relative abundances (R.A.), mean total lengths (TL; ± SD), and size ranges of each species of fish collected in Dry Creek.

Reach	n	R. A. (%)	Mean TL (mm)	Min TL (mm)	Max. TL (mm)
1					
Eastern brook trout	140	55	102 (± 41)	41	291
Rainbow trout	29	12	101 (± 52)	41	198
Sculpin spp.	83	33	71 (± 18)	25	121
2					
Eastern brook trout	195	60	93 (± 29)	61	224
Rainbow trout	91	28	67 (± 29)	37	179
Sculpin spp.	38	12	61 (± 22)	29	103
3					
Eastern brook trout	86	39	87 (± 24)	59	204
Rainbow trout	102	46	69 (± 25)	33	168
Sculpin spp.	35	15	53 (± 19)	29	90
4					
Brown trout	1	<1	111	111	111
Eastern brook trout	26	13	99 (± 26)	71	174
Rainbow trout	119	57	72 (± 25)	37	198
Sculpin spp.	62	30	61 (± 22)	31	98
5					
Eastern brook trout	17	9	119 (± 28)	92	167
Rainbow trout	109	55	77 (± 24)	43	215
Sculpin spp.	64	32	67 (± 29)	30	135
Northern pikeminnow	7	4	53 (± 8)	35	59
6					
Eastern brook trout	10	5	162 (± 41)	108	224
Rainbow trout	57	26	91 (± 43)	46	323
Mountain whitefish	2	1	127 (± 12)	118	135
Sculpin spp.	141	64	58 (± 26)	27	129
Longnose dace	1	<1	52	52	52
Northern pikeminnow	4	2	55 (± 6)	51	64
Largemouth bass	5	2	82 (± 2)	78	84
Total					
Brown trout	1	<1	111	111	111
Eastern brook trout	474	33	97 (± 34)	41	291
Rainbow trout	507	36	76 (± 32)	33	323
Mountain whitefish	2	<1	127 (± 12)	118	135
Sculpin spp.	423	30	62 (± 24)	25	135
Longnose dace	1	<1	52	52	52
Northern pikeminnow	11	1	54 (± 7)	35	64
Largemouth bass	5	<1	82 (± 2)	78	84

Table 18. 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 Dry Creek. Population and density estimates were only calculated for fish species with 10 or more individuals collected.

Reach	**Site**	**N**	**SE**	**Lower 95% CI**	**Upper 95% CI**	**Density (#/100 m^2)**
Eastern brook trout						
1	21	158	8.8763	147	184	67
2	16	205	4.9171	200	219	67
3	12	90	3.3962	88	102	29
4	8	28	2.3417	27	39	11
5	4	17	0.5312	17	17	7
6	3	10	0.8594	10	10	3
Rainbow trout						
1	21	26	1.6296	26	35	11
2	16	76	2.1990	75	85	25
3	12	91	2.5281	89	100	29
4	8	109	2.8000	107	119	43
5	4	112	3.8304	108	124	49
6	3	56	1.8996	56	65	18
Sculpin spp.						
2	16	28	4.0516	26	46	9
3	12	25	6.6388	21	56	8
4	8	43	4.3148	40	61	17
6	3	123	73.8214	68	441	39

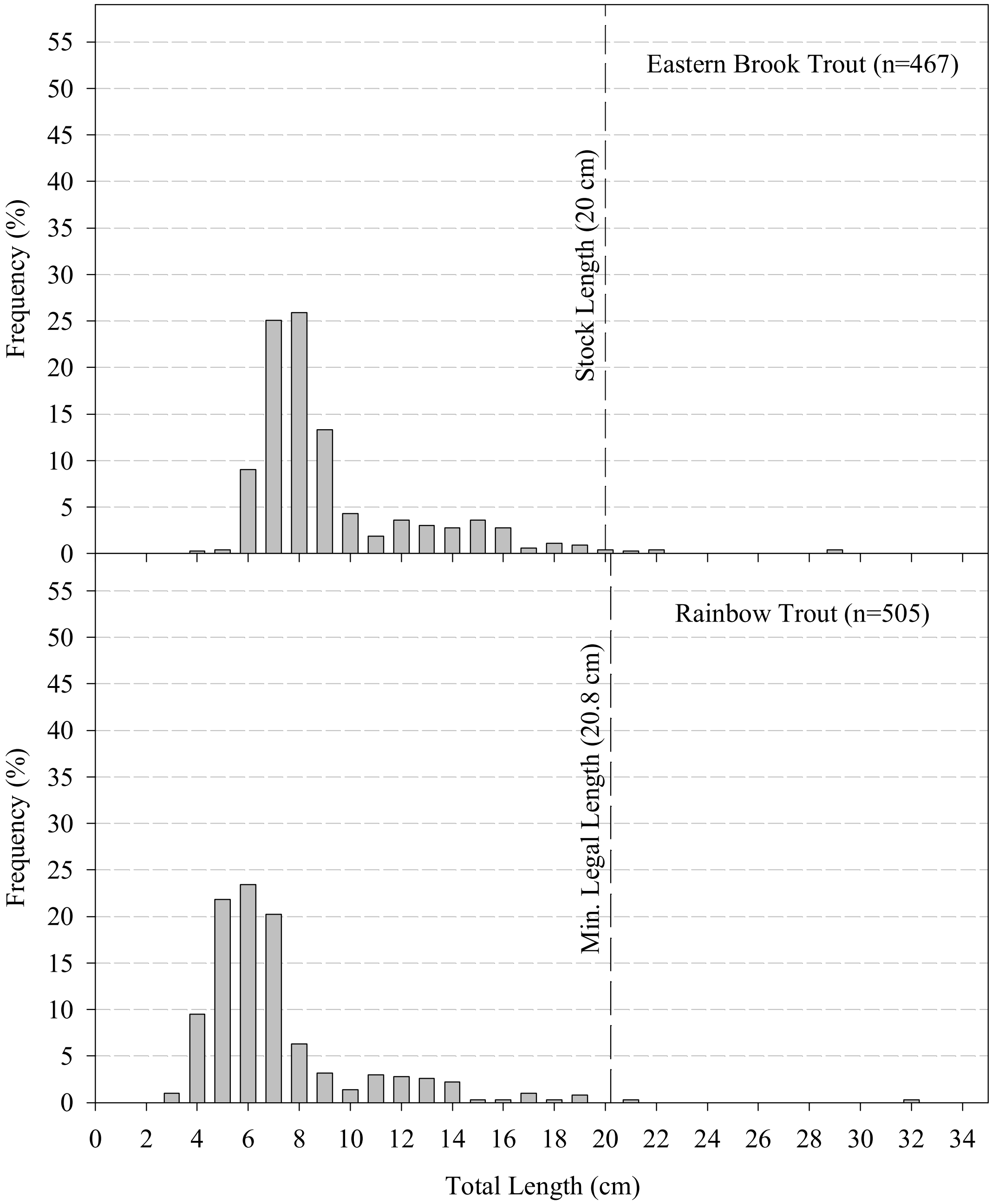

Figure 12. Length-frequency distributions of eastern brook and rainbow trout collected in Dry Creek.

Heel Creek

Heel Creek was divided into five reaches that were sampled between July 2nd and July 5th (Figure 1; Appendix B). A total of six sites were surveyed (Figure 2; Appendix C). The mean of each habitat parameter was calculated for the stream and each reach (Table 19; Appendix I). The mean wetted width of Heel Creek was 2.0 m (SD=0.6) and the mean depth was 10 cm (SD=5) (Table 19). The dominant habitat and substrate types were riffles (52%) and sand (39%), respectively (Table 19). The discharge of Heel Creek on August 13th was 0.04 m^3/sec.

Eastern brook trout were the only species of fish collected (n=349) (Table 20). The percentage of the eastern brook trout population that was of stock length was 0.3% (n=1) (Figure 13). Brook trout were collected in all sampling reaches. The population estimates ranged from 21 to 96, with densities ranging from 9 to 48 fish/100 m^2 (Table 21).

Table 19. Mean values (± SD) of habitat parameters measured and counted in Heel Creek.

Sample Sizes		**Riffle Habitat**	
No. Reaches	5	No. Riffles	82
No. Sections	6	Riffle Width (m)	1.9 (± 0.7)
No. Transects	102	Riffle Occurrence (%)	73
		Pool Habitat	
Transect Measurements		No. Pools	28
Wetted Width (m)	2.0 (± 0.6)	Pool Width (m)	1.7 (± 0.8)
Bankfull Width (m)	3.2 (± 0.9)	Pool Occurrence (%)	25
Depth (cm)	10 (± 5)	**Run Habitat**	
Maximum Depth (cm)	19 (± 8)	No. Runs	2
		Run Width (m)	1.7 (± 0.3)
Survey Section Measurements		Run Occurrence (%)	2
Gradient (%)	5 (± 3)		
Water Temperature (^{o}C)	12 (± 3)	**Substrate Composition (%)**	
Air Temperature (^{o}C)	19 (± 4)	Organic	0 (± 0)
No. LWD/100 m	54 (± 17)	Muck	0 (± 0)
No. PP/km	5 (± 5)	Silt	2 (± 6)
		Sand	39 (± 23)
Primary Pools (PP)		Gravel	30 (± 21)
No. PP	3	Cobble	14 (± 15)
PP Width (m)	3.2 (± 1.9)	Rubble	4 (±7)
PP Length (m)	4.2 (± 1.9)	Boulder	10 (± 19)
PP Max. Depth (cm)	46 (± 8)	Bedrock	0 (± 4)
PP Residual Depth (cm)	27 (± 3)	Embeddedness (%)	40 (± 24)

Table 20. Relative abundances (R.A.), mean total lengths (TL; ± SD), and size ranges of each species of fish collected in Heel Creek.

Reach	n	R. A. (%)	Mean TL (mm)	Min TL (mm)	Max. TL (mm)
1					
Eastern brook trout	35	100	101 (± 34)	63	172
2					
Eastern brook trout	22	100	101(± 27)	32	146
3					
Eastern brook trout	74	100	84 (± 31)	32	170
4					
Eastern brook trout	66	100	105 (± 32)	35	178
5					
Eastern brook trout	152	100	108 (± 36)	35	209
Total					
Eastern brook trout	349	100	101 (± 34)	32	209

Table 21. 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 Heel Creek. Population and density estimates were only calculated for fish species with more 10 or more individuals collected.

Reach	Site	N	SE	Lower 95% CI	Upper 95% CI	Density (#/100 m^2)
1	53	37	2.2214	36	47	19
2	52	21	1.0210	21	26	9
3	37	64	2.8255	62	75	41
4	29	67	2.3123	66	77	30
5	11	96	11.0600	84	132	48
5	8	64	3.1983	61	76	32

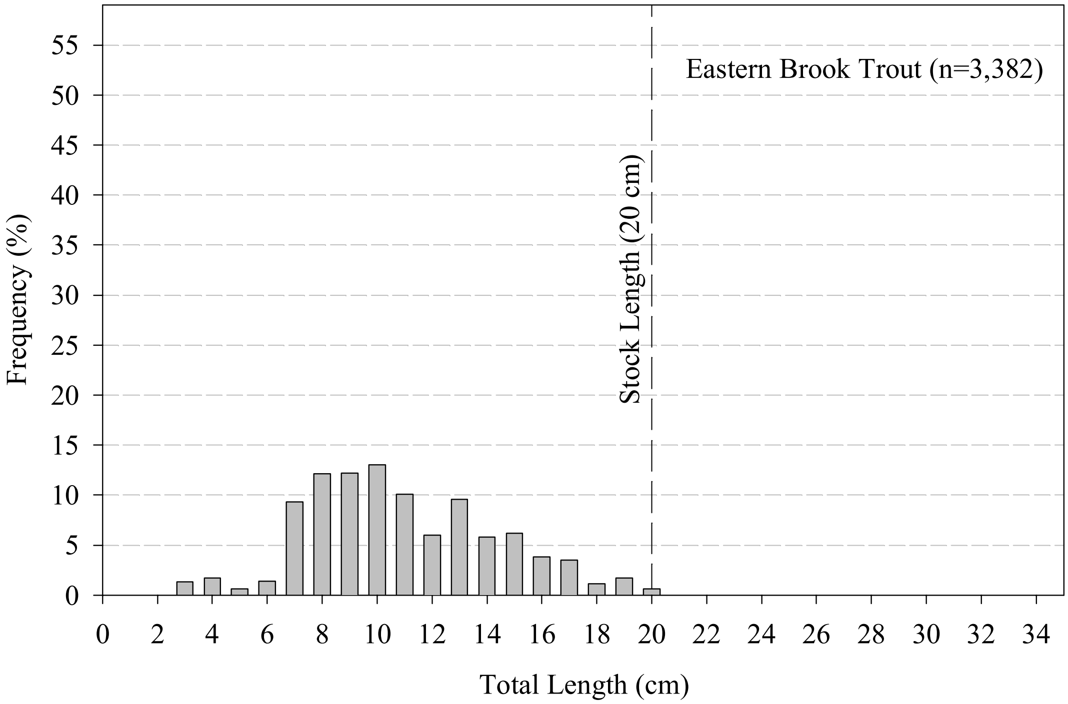

Figure 13. Length-frequency distribution of eastern brook trout collected in Heel Creek.

Otter Creek

Otter Creek was divided into 14 reaches that were sampled between July 24th and August 8th (Figure 1; Appendix B). A total of 15 sites were surveyed (Figure 2; Appendix C). The mean of each habitat parameter was calculated for the stream and each reach (Table 22; Appendix J). The mean wetted width of Otter Creek was 1.8 m (SD=1.1) and the mean depth was 15 cm (SD=9) (Table 22). The dominant habitat and substrate types were run (57%) and sand (51%), respectively (Table 22). The discharge of Otter Creek on August 28th was 0.62 m^3/sec.

One definite natural and one definite human-made fish passage barriers were identified on Otter Creek (Figure 5; Appendix L). The natural barrier was a waterfall and chute located 400 m upstream of the mouth and 100 meters downstream of Valley Road. The waterfall and chute were connected, with the chute occurring immediately below the falls. The waterfall was 1.3 m tall and required a horizontal jump distance of 2.1 m. There was no landing pool above the falls and a large log was lying over the stream at the crest of the falls. The chute was 4.2 m long and had a gradient of 23%. The plunge pool (2.5 m long; 47 cm deep) was located below the chute. The human-made fish barrier was an earthen dam (3.5 m vertical) that created an irrigation pond, located 800 m downstream from the Allen Road crossing. The pond was filled by a spring and had a culvert stand pipe for an outlet. Otter Creek was dry between Highway 2 and the irrigation pond.

Six species of fish were collected in Otter Creek: brown trout, brook trout, rainbow trout, mountain whitefish, sculpins, and speckled dace (n=2,604) (Table 23). Four sculpins were collected from site 7 (Reach 13) and preserved for identification. All four were identified as mottled sculpins. Eastern brook trout were the most abundant fish species, based on relative abundance (63%; n=1,642) (Table 23). The percentage of the eastern brook trout population that was of stock length was 1.5% (n=24) (Figure 14). The percentage of the rainbow trout population that was of legal length for harvest was 3.1% (n=14) (Figure 14).

No fish were collected in Reach 4 and no sites were sampled in Reaches 5, 6, and 7 because they were dry. Eastern brook trout were collected in all sampling reaches where there were fish present (Table 47). Rainbow trout were collected in Reaches 9 through 14 (Table 23). Speckled dace were collected in Reaches 1, 3, and 8 through 11 (Table 23). Sculpin were collected in Reaches 13 and 14 (Table 23). The brown trout and mountain whitefish were collected in Reach 14 (Table 23).

Population estimates, their corresponding standard errors and 95% confidence intervals, and densities were calculated for eastern brook trout, rainbow trout, mountain whitefish, sculpin, and speckled dace (Table 24).

The rainbow trout population above the waterfall was sampled for microsatellite DNA analysis. Fin tissue samples were collected from 50 individuals. Tissue samples were collected from 19 fish at site 7, 12 fish at site 8, eight fish at site 34, two fish at site 39, five fish at site 44, and two fish at both sites 53 and 58. The mean total length of the fish sampled for tissue was 166 mm (SD=38).

Table 22. Mean values (± SD) of habitat parameters measured and counted in Otter Creek.

Sample Sizes		**Riffle Habitat**	
No. Reaches	14	No. Riffles	77
No. Sections	15	Riffle Width (m)	2.4 (± 1.2)
No. Transects	241	Riffle Occurrence (%)	31
		Pool Habitat	
Transect Measurements		No. Pools	29
Wetted Width (m)	1.8 (± 1.1)	Pool Width (m)	2.2 (± 1.0)
Bankfull Width (m)	2.8 (± 1.4)	Pool Occurrence (%)	12
Depth (cm)	15 (± 9)	**Run Habitat**	
Maximum Depth (cm)	27 (± 15)	No. Runs	139
		Run Width (m)	1.3 (± 0.6)
Survey Section Measurements		Run Occurrence (%)	57
Gradient (%)	2 (± 2)		
Water Temperature (^{o}C)	12 (± 2)	**Substrate Composition (%)**	
Air Temperature (^{o}C)	22 (± 4)	Organic	2 (± 5)
No. LWD/100 m	20 (± 13)	Muck	15 (± 31)
No. PP/km	6 (± 8)	Silt	13 (± 16)
		Sand	51 (± 31)
Primary Pools (PP)		Gravel	9 (± 17)
No. PP	9	Cobble	4 (± 9)
PP Width (m)	2.5 (± 1.1)	Rubble	2 (± 5)
PP Length (m)	5.5 (± 2.2)	Boulder	5 (± 14)
PP Max. Depth (cm)	54 (± 11)	Bedrock	1 (± 4)
PP Residual Depth (cm)	34 (± 6)	Embeddedness (%)	84 (± 27)

Table 23. Relative abundances (R.A.), mean total lengths (TL; ± SD), and size ranges of each species of fish collected in Otter Creek.

Reach	n	R. A. (%)	Mean TL (mm)	Min TL (mm)	Max. TL (mm)
1					
Eastern brook trout	69	99	102 (± 37)	57	196
Speckled dace	1	1	54	54	54
2					
Eastern brook trout	98	100	103 (± 41)	50	203
3					
Eastern brook trout	212	100	77 (± 35)	39	213
Speckled dace	1	<1	71	71	71
4, 5, 6, 7					
No Fish	-	-	-	-	-
8					
Eastern brook trout	150	75	87 (± 34)	43	196
Speckled dace	51	25	69 (± 11)	39	89
9					
Eastern brook trout	479	98	79 (± 30)	34	215
Rainbow trout	4	1	116 (± 24)	100	152
Speckled dace	4	1	73 (± 14)	53	85
10					
Eastern brook trout	233	74	123 (± 44)	56	283
Rainbow trout	5	1	181 (± 9)	169	191
Speckled dace	78	25	69 (± 10)	48	99
11					
Eastern brook trout	155	84	118 (± 42)	52	243
Rainbow trout	14	8	119 (± 47)	49	178
Speckled dace	15	8	73 (± 14)	56	96
12					
Eastern brook trout	188	61	86 (± 37)	32	208
Rainbow trout	118	39	73 (± 36)	34	170
13					
Eastern brook trout	28	7	150 (± 35)	91	286
Rainbow trout	180	43	95 (± 55)	40	259
Sculpin spp.	214	50	72 (± 26)	21	114
14					
Brown trout	1	<1	95	95	95
Eastern brook trout	30	10	109 (± 36)	51	168
Rainbow trout	131	43	87 (± 48)	40	222
Mountain whitefish	21	7	112 (± 5)	98	119
Sculpin spp.	124	40	66 (± 28)	24	112
Total					
Brown trout	1	<1	95	95	95
Eastern brook trout	1,642	63	94 (± 41)	32	286
Rainbow trout	452	17	89 (± 50)	34	259
Mountain whitefish	21	1	112 (± 5)	98	119
Sculpin spp.	338	13	70 (± 27)	21	114
Speckled dace	150	6	70 (± 11)	39	99

Table 24. 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 Otter Creek. Population and density estimates were only calculated for fish species with more 10 or more individuals collected.

Reach	**Site**	**N**	**SE**	**Lower 95% CI**	**Upper 95% CI**	**Density (#/100 m^2)**
Eastern brook trout						
1	138	70	1.3628	70	77	57
2	134	103	3.7872	100	116	138
3	126	183	4.1785	178	195	148
8	65	105	2.4483	148	159	98
9	58	253	5.8460	246	269	163
9	53	226	4.4036	221	239	138
10	44	243	4.6288	237	256	118
11	39	51	0.9384	51	57	27
11	34	105	1.5470	105	112	60
12	31	190	3.3931	186	200	75
13	8	16				5
13	7	12	0.3555	12	12	3
14	3	31	1.4622	31	39	9
Rainbow trout						
11	34	11	0.0820	11	11	6
12	31	90	3.1856	87	101	36
13	8	101	6.3589	95	122	30
13	7	79	2.0660	78	87	19
14	3	126	4.5867	121	140	35
Mountain whitefish						
14	3	21	0.8486	21	21	6
Sculpin spp.						
13	8	130	23.9725	104	209	38
13	7	109	22.1831	86	185	27
14	3	177	84.0507	105	505	49
Speckled dace						
8	65	57	6.5530	51	81	53
10	44	79	2.3947	78	89	38
11	39	11	0.3844	11	11	6

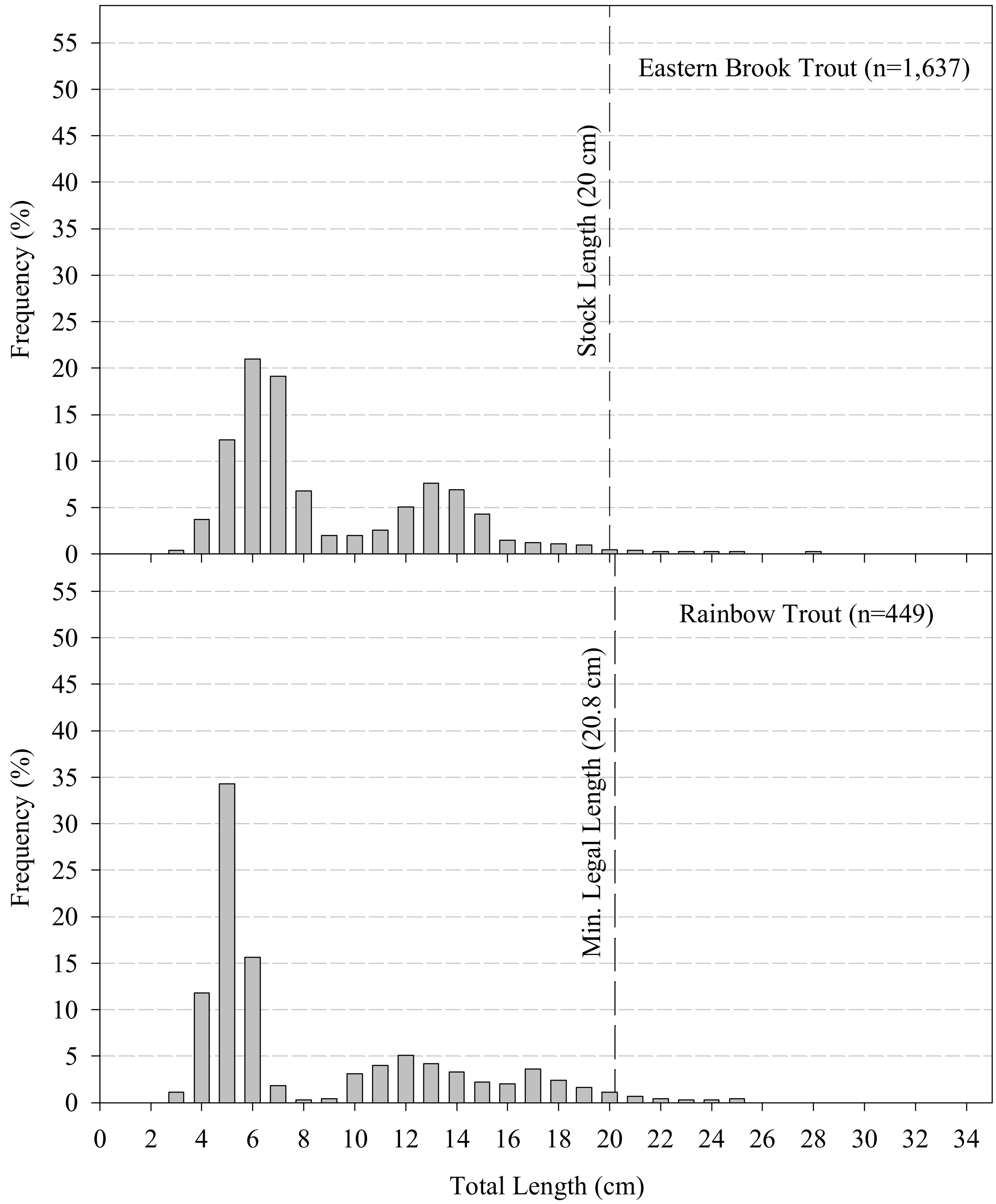

Figure 14. Length-frequency distributions of eastern brook trout and rainbow trout collected in Otter Creek.

Spring Heel Creek

A single section was surveyed on Spring Heel Creek on July 9th (Figure 2; Appendix C). The mean wetted width of the survey section was 2.9 m (SD=1.3) and the mean depth was 29 cm (SD=18) (Table 25). Each habitat type was represented equally (33%) and the dominant substrate was sand (72%) (Table 25).

Three species of fish were collected in Spring Heel Creek: eastern brook trout, largemouth bass, and yellow bullhead (n=25) (Table 26). Eastern brook trout were the most abundant fish species, based on relative abundance (80%; n=20) (Table 26). The population estimate of eastern brook trout was 20, with a density of 7 fish/100 m^2 (Table 27).

Table 25. Mean values (± SD) of habitat parameters measured and counted in Spring Heel Creek.

Sample Sizes		**Riffle Habitat**	
No. Reaches	1	No. Riffles	6
No. Sections	1	Riffle Width (m)	2.3 (± 0.6)
No. Transects	18	Riffle Occurrence (%)	33
		Pool Habitat	
Transect Measurements		No. Pools	6
Wetted Width (m)	2.9 (± 1.3)	Pool Width (m)	3.7 (± 1.7)
Bankfull Width (m)	3.8 (± 1.6)	Pool Occurrence (%)	33
Depth (cm)	29 (± 18)	**Run Habitat**	
Maximum Depth (cm)	47 (± 26)	No. Runs	6
		Run Width (m)	2.2 (± 0.5)
Survey Section Measurements		Run Occurrence (%)	33
Gradient (%)	1		
Water Temperature (^{o}C)	20	**Substrate Composition (%)**	
Air Temperature (^{o}C)	25	Organic	1 (± 2)
No. LWD/100 m	27	Muck	6 (± 22)
No. PP/km	10	Silt	2 (± 4)
		Sand	72 (± 31)
Primary Pools (PP)		Gravel	6 (± 15)
No. PP	1	Cobble	3 (± 7)
PP Width (m)	6.3	Rubble	2 (± 4)
PP Length (m)	9.2	Boulder	1 (± 3)
PP Max. Depth (cm)	115	Bedrock	6 (± 15)
PP Residual Depth (cm)	64	Embeddedness (%)	41 (± 17)

Table 26. Relative abundances (R.A.), mean total lengths (TL; ± SD), and size ranges of each species of fish collected in Spring Heel Creek.

Reach	n	R. A. (%)	Mean TL (mm)	Min TL (mm)	Max. TL (mm)
Eastern brook trout	20	80	161 (± 73)	53	253
Largemouth bass	1	4	195	195	195
Yellow bullhead	4	16	90 (± 40)	54	125

Table 27. 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 Spring Heel Creek. Population and density estimates were only calculated for fish species with 10 or more individuals collected.

Reach	Site	N	SE	Lower 95% CI	Upper 95% CI	Density (#/100 m^2)
-	6	20	0.4589	20	20	7

West Branch Little Spokane River

The West Branch Little Spokane River was divided into eight reaches, below Fan Lake Road, that were sampled between July 11th and July 23rd (Figure 1; Appendix B). A total of eight sites were surveyed (Figure 2; Appendix C). The mean of each habitat parameter was calculated for the stream and each reach (Table 28; Appendix K). The mean wetted width of the West Branch Little Spokane River was 10.7 m (SD=3.3) and the mean depth was 35 cm (SD=20) (Table 28). The dominant habitat and substrate types were run (57%) and sand (28%), respectively (Table 28). The discharge of the West Branch Little Spokane River on September 20th was 0.35 m^3/sec.

Two definite natural fish passage barriers were identified on the West Branch Little Spokane River (Figure 5; Appendix L). The first barrier was a complex of waterfalls and chutes, located 1200 m upstream from the mouth. Beginning at the top of the barrier, there was a waterfall (8.7 m vertical, 7.4 m horizontal), with large plunge (7.3 m long; 200 cm deep) and landing (5.4 m long; 58 cm deep) pools. Immediately below the plunge pool for the first waterfall was a landing pool (2.2 m long; 46 cm deep) for the second waterfall (2.8 m vertical, 4.5 m horizontal). The second waterfall fell directly onto a chute that was 12.5 m long. The stream was 1.1 m wide at the top of the chute and it spread to 3.5 m by the end. The maximum water depth on the chute was 5 cm mid way up it. The stream flowed over a 0.5 m high waterfall at the end of the chute. At the base of the waterfall there was a second chute (5.0 m long; 0.8 m wide) that the stream flowed down, and then it flowed over a final waterfall (0.5 m vertical). Below the final waterfall, there was a large plunge pool (13.0 m long; 230 cm deep). The second fish passage barrier was a waterfall (44.1 m vertical) where the West Branch Little Spokane River flowed in to Horseshoe Lake.

The temperature of the lower West Branch Little Spokane River was measured 1,753 times with a thermograph, between June 5th and October 28th. Daily average, maximum, and minimum temperatures were determined (Figure 15). Mean temperature was 17.00 (SD=5.36) °C with a maximum of 28.65 °C on July 4th and 10th and a minimum of 5.78 °C on October 24th.

The temperature of the upper West Branch Little Spokane River was measured 1,753 times with a thermograph, between June 5th and October 28th. Daily average, maximum, and minimum temperatures were determined (Figure 16). Mean temperature was 15.68 (SD=5.27) °C with a maximum of 27.01 °C on August 14th and a minimum of 4.69 °C on October 26th.

Thirteen species of fish were collected in the West Branch Little Spokane River (n=970) (Table 29). Four sculpins were collected at site 12 (Reach 8) and preserved for identification. All four were identified as mottled sculpin. Sculpin were the most abundant fish species, based on relative abundance (21%; n=208); followed by yellow bullhead (19%; n=180) and longnose dace (18%; n=171). The percentages of the brown and rainbow trout populations that were of legal length for harvest were 9.7% (n=6) and 4.0% (n=1), respectively (Figure 17). Length-frequency distributions were also developed for largemouth bass and yellow bullhead (Figure 18).

Yellow bullheads were collected in all sampling reaches (Table 29). Rainbow trout, mountain whitefish, sculpin, and longnose dace were only collected in Reach 8, which was below the most downstream waterfall (Table 29). Brown trout, sucker fry, pumpkinseed, yellow perch, and yellow bullhead were collected above and below the waterfall. Tench, bluegill, largemouth bass, and grass pickerel were only collected above the waterfall.

Population estimates, their corresponding standard errors and 95% confidence intervals, and densities were calculated for eastern brook trout, rainbow trout, mountain whitefish, sculpin, and speckled dace (Table 30).

Table 28. Mean values (± SD) of habitat parameters measured and counted in Spring Heel Creek.

Sample Sizes		**Riffle Habitat**	
No. Reaches	8	No. Riffles	35
No. Sections	8	Riffle Width (m)	7.6 (± 3.5)
No. Transects	86	Riffle Occurrence (%)	34
		Pool Habitat	
Transect Measurements		No. Pools	18
Wetted Width (m)	10.7 (± 3.3)	Pool Width (m)	5.9 (± 4.1)
Bankfull Width (m)	12.6 (± 3.4)	Pool Occurrence (%)	18
Depth (cm)	35 (± 20)	**Run Habitat**	
Maximum Depth (cm)	63 (± 33)	No. Runs	49
		Run Width (m)	11.1 (± 2.8)
Survey Section Measurements		Run Occurrence (%)	48
Gradient (%)	2 (± 1)		
Water Temperature (^{o}C)	20 (± 3)	**Substrate Composition (%)**	
Air Temperature (^{o}C)	20 (± 6)	Organic	1 (± 7)
No. LWD/100 m	20 (± 20)	Muck	5 (± 14)
No. PP/km	3 (± 5)	Silt	8 (± 11)
		Sand	28 (± 23)
Primary Pools (PP)		Gravel	11 (± 12)
No. PP	2	Cobble	12 (± 12)
PP Width (m)	15 (± 1)	Rubble	8 (± 11)
PP Length (m)	23 (± 9)	Boulder	10 (± 13)
PP Max. Depth (cm)	141 (± 28)	Bedrock	15 (± 28)
PP Residual Depth (cm)	79 (± 10)	Embeddedness (%)	32 (± 25)

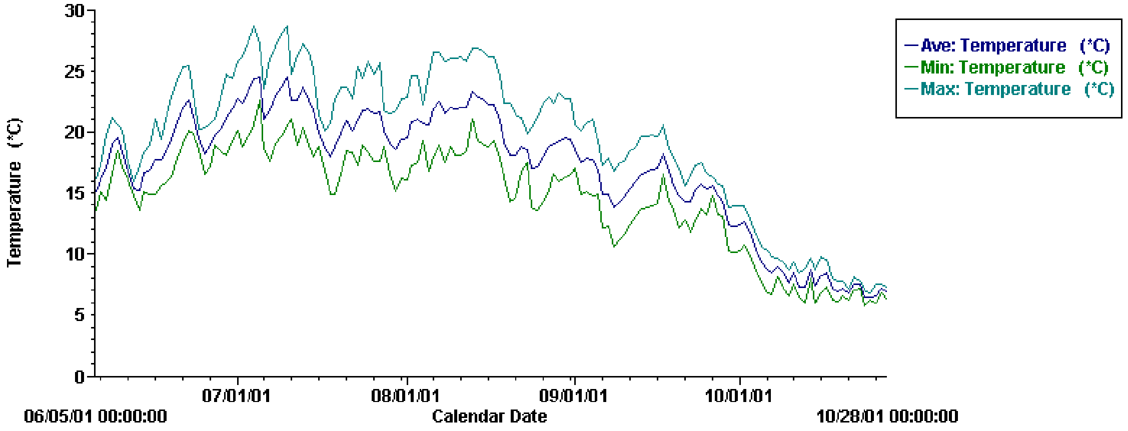

Figure 15. Mean, minimum, and maximum daily temperatures recorded near the mouth of the West Branch Little Spokane River.

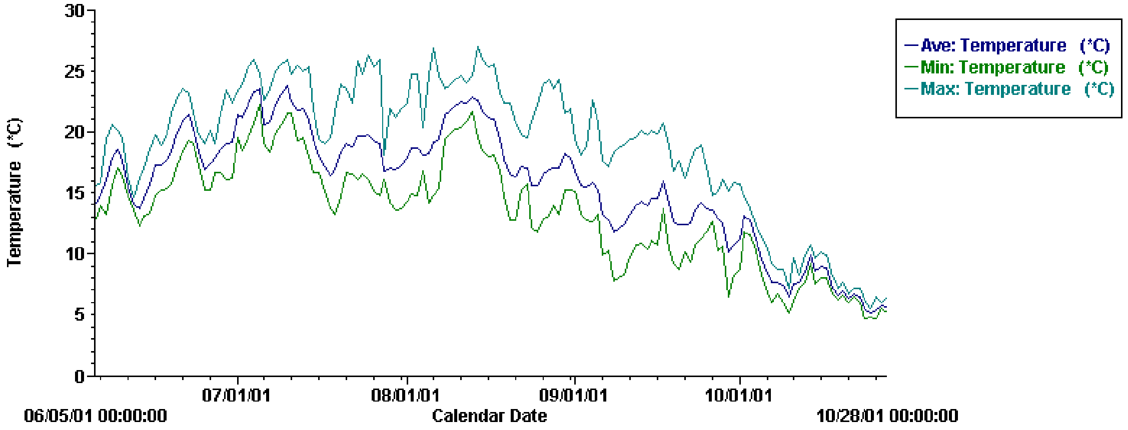

Figure 16. Mean, minimum, and maximum daily temperatures recorded on the upper West Branch Little Spokane River.

Table 29. Relative abundances (R.A.), mean total lengths (TL; ± SD), and size ranges of each species of fish collected in the West Branch Little Spokane River.

Reach	n	R. A. (%)	Mean TL (mm)	Min TL (mm)	Max. TL (mm)
1					
Brown trout	37	85	80 (± 7)	61	94
Tench	1	3	51	51	51
Sucker spp. (unident.)	1	3	36	36	36
Yellow bullhead	4	9	123 (± 10)	111	135
2					
Brown trout	1	4	191	191	191
Largemouth bass	7	28	39 (± 6)	33	48
Yellow perch	5	20	48 (± 2)	45	51
Yellow bullhead	12	48	126 (± 54)	57	234
3					
Brown trout	2	1	245 (± 23)	228	261
Tench	9	5	159 (± 155)	23	423
Sucker fry (unident.)	6	3	49 (± 2)	47	52
Bluegill	1	1	54	54	54
Pumpkinseed	4	2	65 (± 7)	58	74
Largemouth bass	123	67	41 (± 9)	34	125
Grass pickerel	6	3	117 (± 21)	80	135
Yellow perch	14	8	45 (± 4)	40	54
Yellow bullhead	18	10	146 (± 39)	65	215
4					
Tench	4	20	60 (± 41)	19	96
Sucker fry (unident.)	1	5	42	42	42
Pumpkinseed	1	5	75	75	75
Largemouth bass	1	5	61	61	61
Yellow perch	3	15	47 (± 1)	46	48
Yellow bullhead	10	50	139 (± 28)	89	167
5					
Brown trout	12	10	91 (± 5)	83	100
Tench	1	<1	97	97	97

Reach	n	R. A. (%)	Mean TL (mm)	Min TL (mm)	Max. TL (mm)
Sucker fry (unident.)	64	53	50 (± 7)	24	84
Largemouth bass	1	<1	54	54	54
Yellow bullhead	43	36	119 (± 44)	16	184
6					
Brown trout	5	13	177 (± 73)	97	236
Sucker fry (unident.)	6	15	48 (± 4)	44	55
Yellow bullhead	29	72	133 (± 27)	85	170
Sucker fry (unident.)	17	34	52 (± 6)	38	65
Grass pickerel	1	2	114	114	114
7					
Brown trout	2	4	165 (± 104)	91	238
Yellow bullhead	30	60	111 (± 28)	82	164
8					
Brown trout	3	1	95 (± 3)	93	98
Rainbow trout	25	5	119 (± 47)	42	231
Mountain whitefish	15	3	90 (± 7)	82	105
Sculpin spp.	208	43	68 (± 16)	24	92
Longnose dace	171	35	61 (± 23)	42	129
Sucker fry (unident.)	29	6	52 (± 6)	40	64
Pumpkinseed	1	<1	112	112	112
Yellow perch	2	<1	43 (± 3)	41	45
Yellow bullhead	34	7	120 (± 27)	62	160
Total					
Brown trout	62	6	100 (± 48)	61	261
Rainbow trout	25	3	119 (± 47)	42	231
Mountain whitefish	15	1	90 (± 7)	82	105
Sculpin spp.	208	21	68 (± 16)	24	92
Longnose dace	171	18	61 (± 23)	42	129
Tench	15	1	121 (± 128)	19	423
Sucker fry (unident.)	124	13	50 (± 7)	24	84
Bluegill	1	<1	54	54	54
Pumpkinseed	6	1	75 (± 19)	58	112
Largemouth bass	132	14	41 (± 9)	33	125
Grass pickerel	7	1	116 (± 19)	80	135
Yellow perch	24	2	45 (± 4)	40	54
Yellow bullhead	180	19	125 (± 36)	16	234

Table 30. 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 West Branch Little Spokane River. Population and density estimates were only calculated for fish species with 10 or more individuals collected.

Reach	**Site**	**N**	**SE**	**Lower 95% CI**	**Upper 95% CI**	**Density (#/100 m^2)**
Brown trout						
1	65	42	4.9993	39	62	4
5	37	16	6.4216	13	49	1
Rainbow trout						
8	12	27	3.5755	25	43	3
Mountain whitefish						
8	12	22	11.8453	16	82	3
Sculpin spp.						
8	12	379	118.1970	248	764	46
Longnose dace						
8	12	186	43.4051	139	328	22
Yellow bullhead						
2	49	12	1.0221	12	12	1
3	46	27	12.3039	20	86	3
4	39	10	0.4188	10	10	1
5	37	45	4.6652	41	63	4
6	24	33	4.1018	30	50	4
7	16	38	8.6977	32	74	3
8	12	65	38.9977	39	243	8

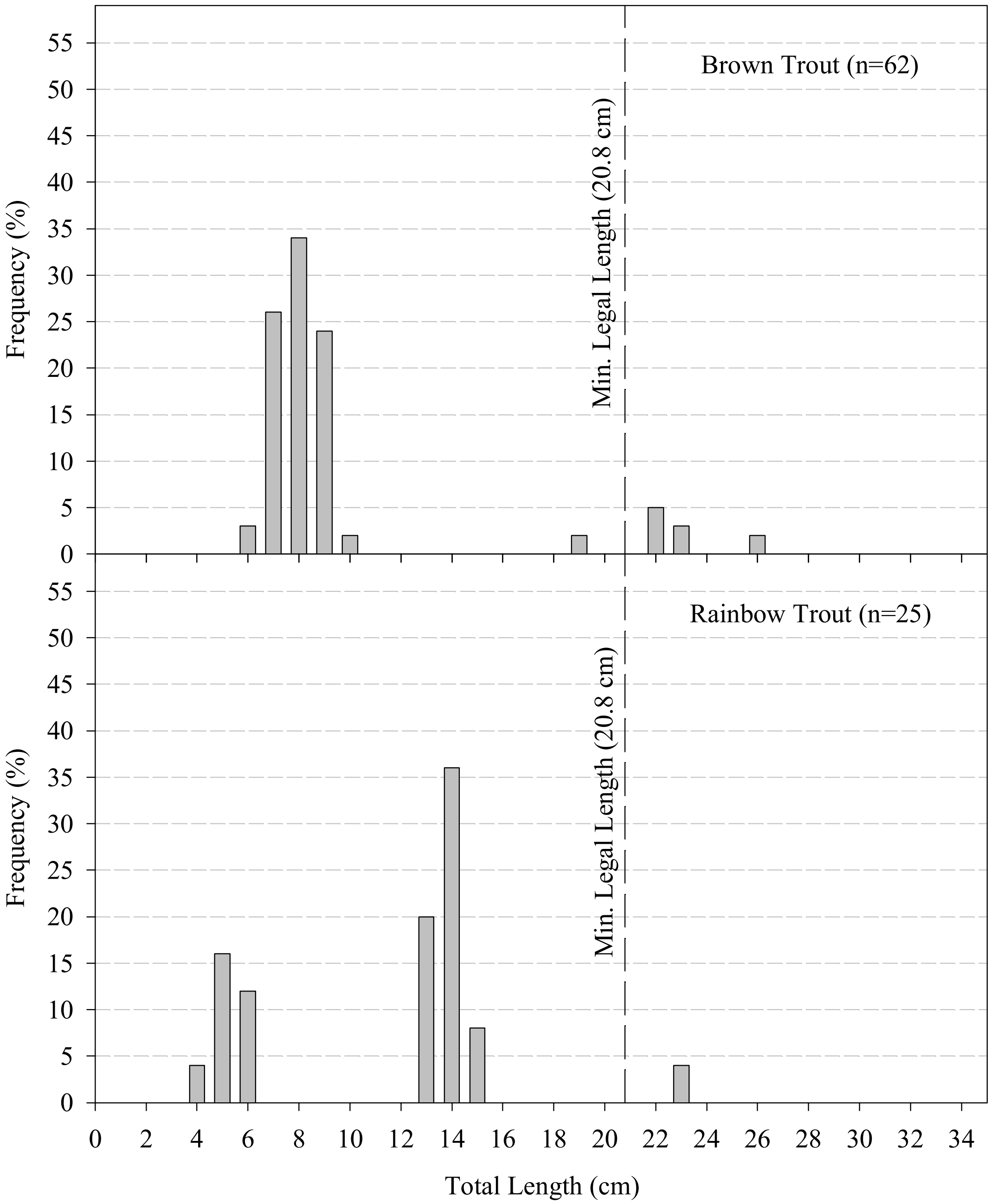

Figure 17. Length-frequency distributions of brown trout and rainbow trout collected in the West Branch Little Spokane River.

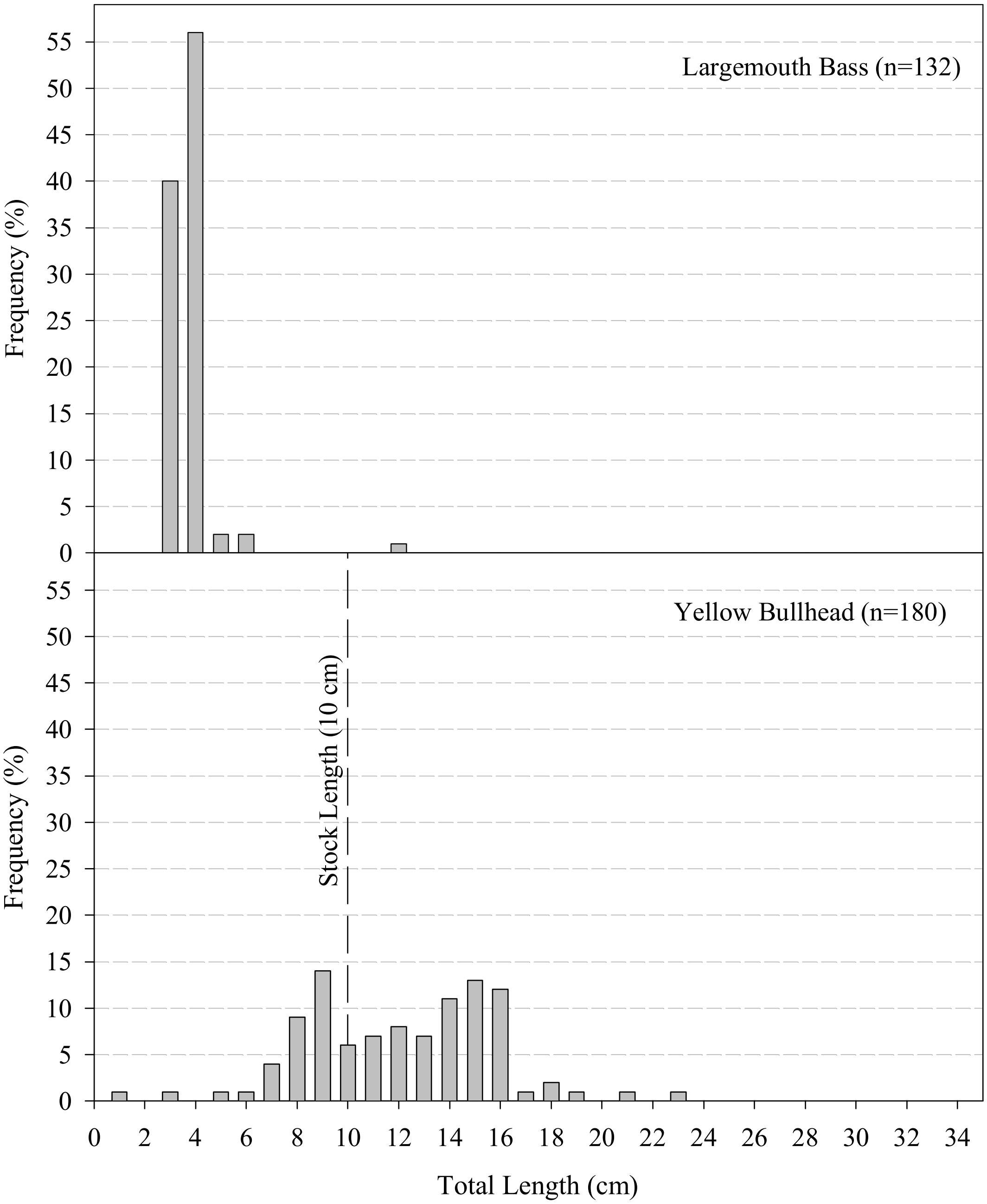

Figure 18. Length-frequency distributions of largemouth bass and yellow bullhead collected in the West Branch Little Spokane River.

Population Characterization with DNA Analysis

The WDFW Genetics Laboratory conducted the microsatellite DNA analysis and statistical tests on five rainbow trout populations: three from tributaries of the Little Spokane River and two hatchery stocks (Appendix N). Hypothesis one, that the rainbow trout in sampled streams comprise one single, interbreeding population, was rejected. Each population was genetically distinct. The second hypothesis, that the rainbow trout in the sampled streams are genetically indistinguishable from one or more hatchery strain (Spokane stock or Phalon Lake stock) was rejected. The third hypothesis, that the rainbow trout in the sampled streams were interior redband strain not coastal strain was accepted for Otter and Deer Creeks and rejected for Buck Creek. In cluster analysis, Buck Creek was closely related to the Spokane Hatchery strain, suggesting substantial influence of coastal rainbow trout (Appendix N).

Other Streams

The temperatures of Beaver Creek (tributary to Dragoon Creek), the West Branch Dragoon Creek, upper Dragoon Creek, Little Deep Creek, Dartford Creek, and the Little Spokane River at Elk (upper-middle), Wandermere (lower-middle), and the mouth (lower) were measured 1,753 times with a thermograph, between June 5th and October 28th (Figures 19 through 26). Mean temperature of Beaver Creek was 12.03 (SD=3.39) °C, with a maximum of 18.51 °C on July 10th and a minimum of 3.98 °C on October 13th. Mean temperature of the West Branch Dragoon Creek was 12.82 (SD=3.87) °C, with a maximum of 20.96 °C on July 10th and a minimum of 4.45 °C on October 6th. Mean temperature of upper Dragoon Creek was 12.11 (SD=4.61) °C, with a maximum of 24.86 °C on August 13th and a minimum of 2.96 °C on October 6th. Mean temperature of Little Deer Creek was 11.74 (SD=2.79) °C, with a maximum of 18.01 °C on July 4th and 10th and a minimum of 4.94 °C on October 5th and 6th. Mean temperature of Dartford Creek was 11.60 (SD=2.22) °C, with a maximum of 16.26 °C on July 10th and a minimum of 5.83 °C on October 6th. Mean temperature of the Little Spokane River at Elk (upper-middle) was 15.80 (SD=4.26) °C, with a maximum of 25.48 °C on July 10th and a minimum of 5.98 °C on October 24th. Mean temperature of the Little Spokane River at Wandermere (lower-middle) was 14.63 (SD=3.35) °C, with a maximum of 21.34 °C on July 10th and a minimum of 7.64 °C on October 13th and 26th. Mean temperature of the Little Spokane River near its mouth was 13.19 (SD=2.34) °C, with a maximum of 18.43 °C on July 4th and 10th and a minimum of 8.28 °C on October 24th.

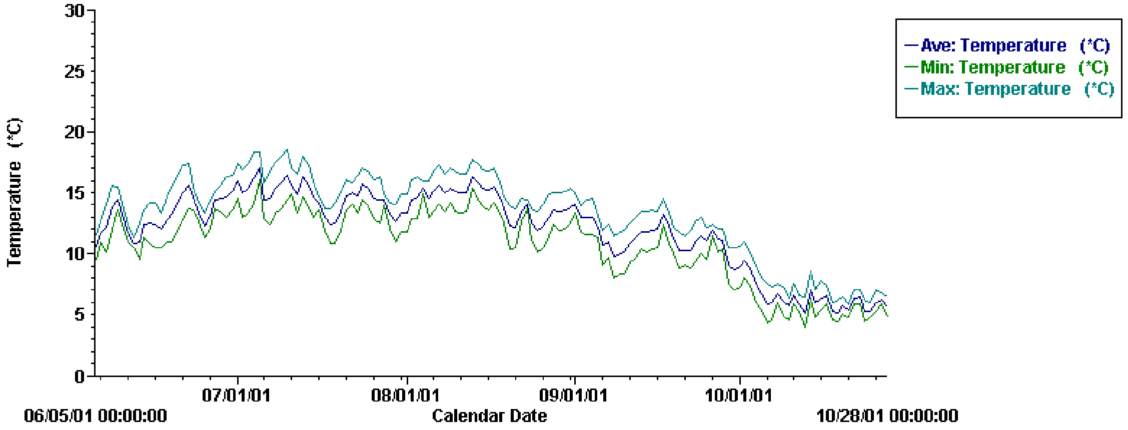

Figure 19. Mean, minimum, and maximum daily temperatures recorded on Beaver Creek, tributary to Dragoon Creek.

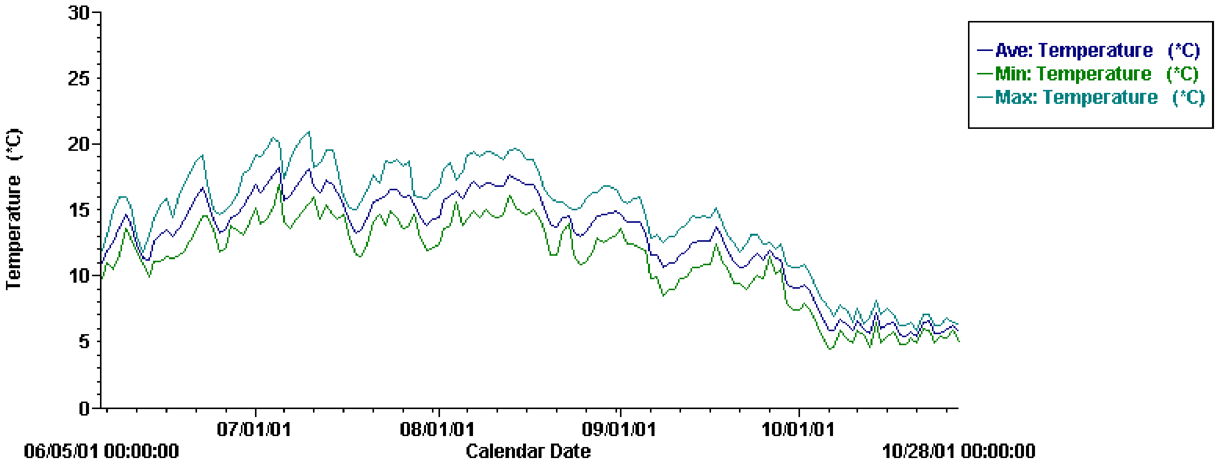

Figure 20. Mean, minimum, and maximum daily temperatures recorded on the West Branch Dragoon Creek.

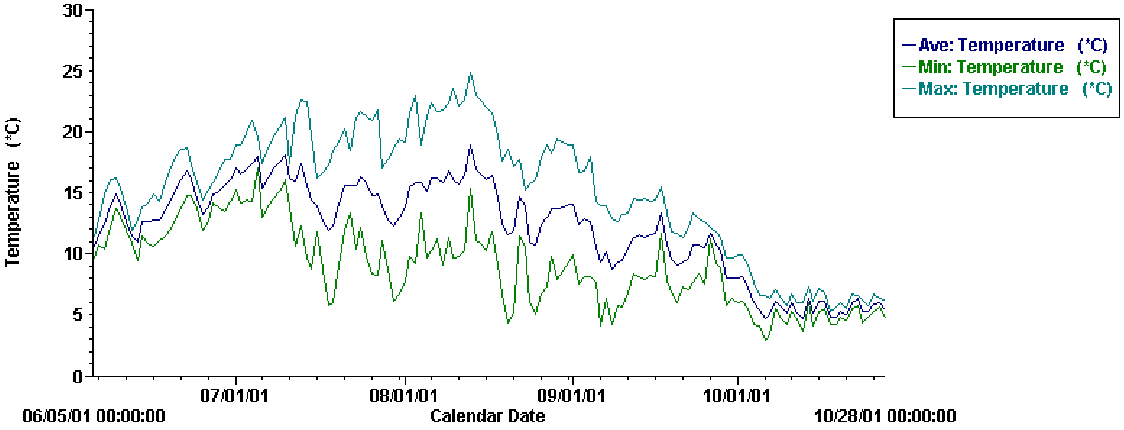

Figure 21. Mean, minimum, and maximum daily temperatures recorded on upper Dragoon Creek.

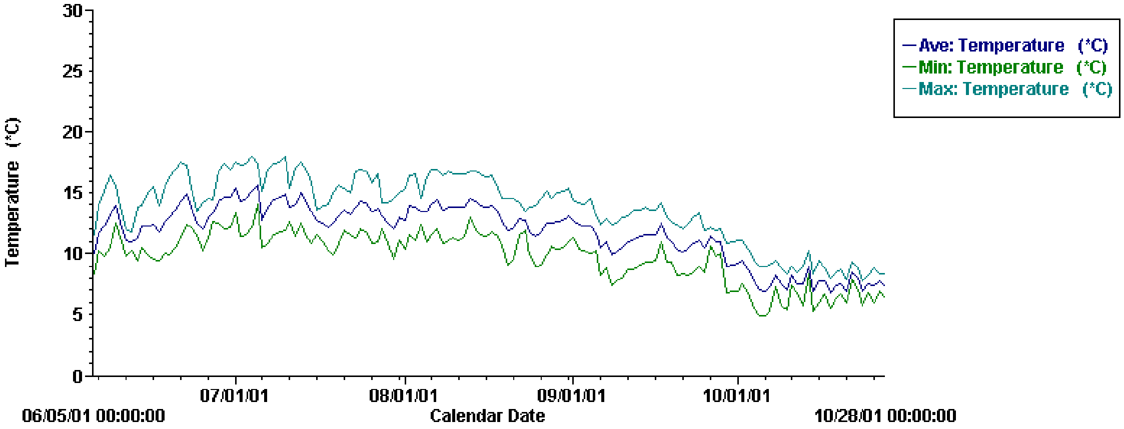

Figure 22. Mean, minimum, and maximum daily temperatures recorded on Little Deep Creek.

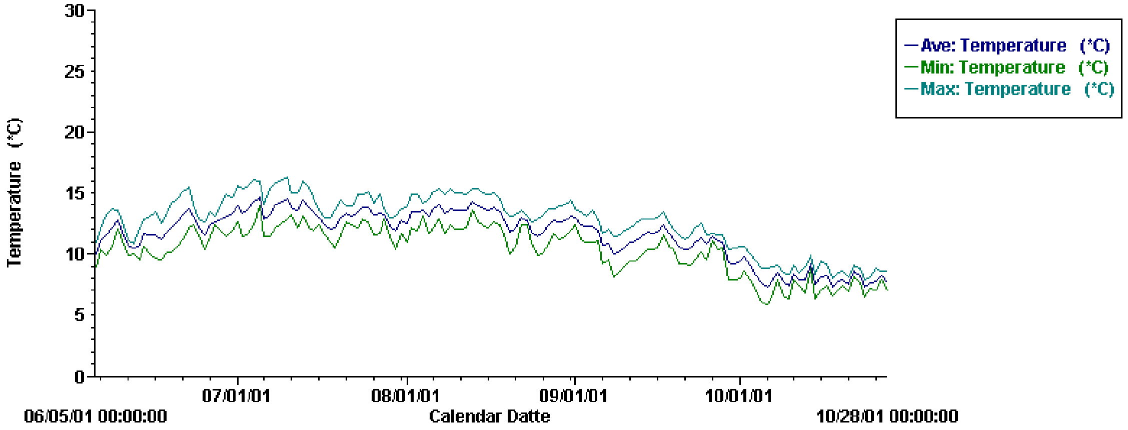

Figure 23. Mean, minimum, and maximum daily temperatures recorded on Dartford Creek.

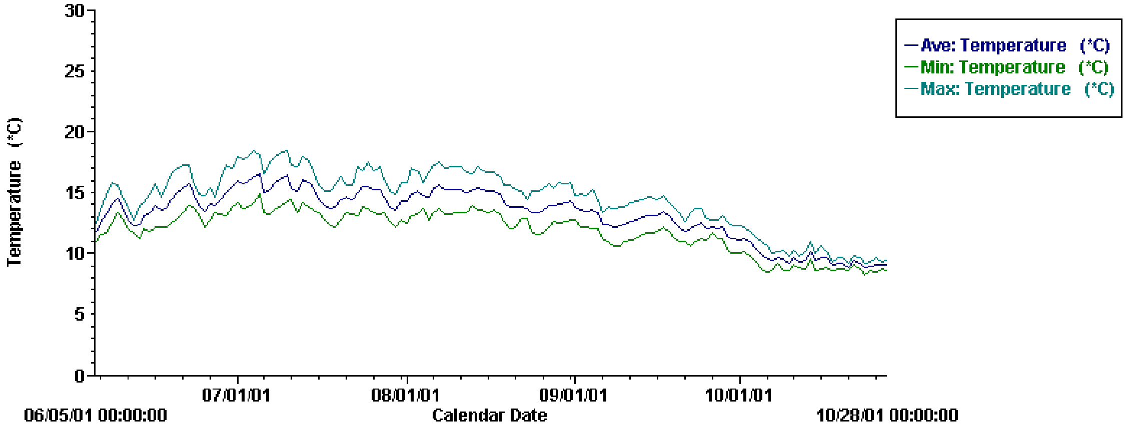

Figure 24. Mean, minimum, and maximum daily temperatures recorded near the mouth of the Little Spokane River.

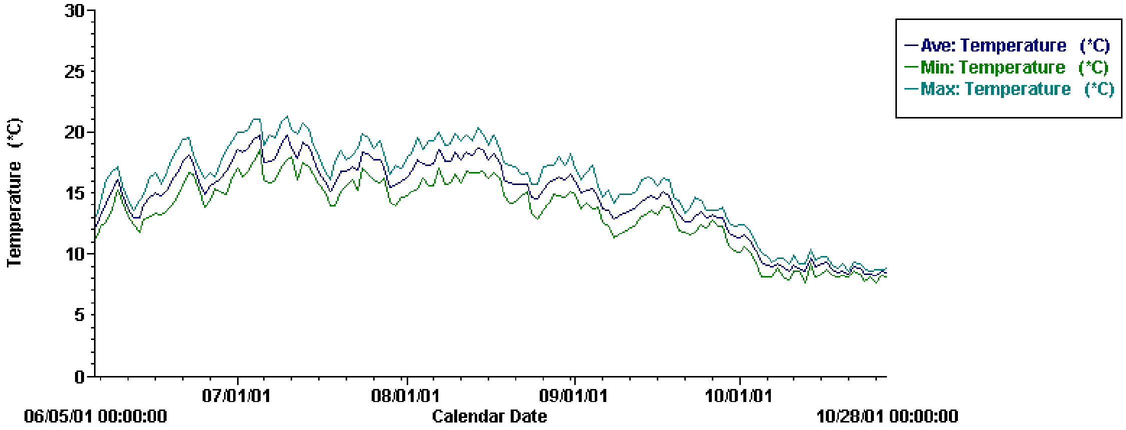

Figure 25. Mean, minimum, and maximum daily temperatures recorded on the Little Spokane River at Wandermere.

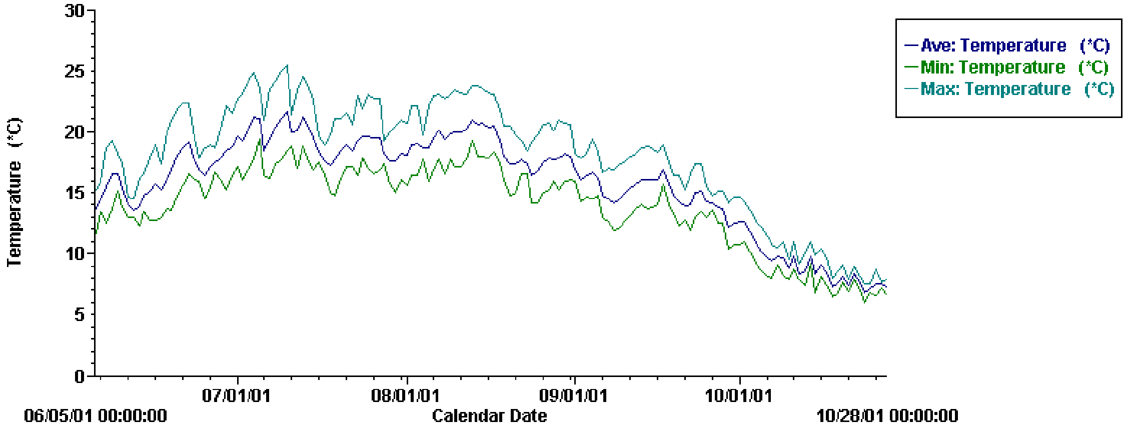

Figure 26. Mean, minimum, and maximum daily temperatures recorded on the Little Spokane River at Elk.

Discussion

Bear Creek

Bear Creek had the greatest bankfull width (15.2 m) of the streams surveyed in 2001, which was due to large bankfull widths in Reaches 2 and 3 (19.7 m and 64.7 m, respectively). Mean bankfull widths in Bear Creek did not exceed 6.5 m in any reaches except 2 and 3, which were wide wetlands (up to 75 m) with the stream flowing through them. Presumably during high water periods, the water level of the entire wetland increases allowing fish to access the entire wetland.

The dominant substrate in Bear Creek was sand. The relatively high proportion of sand substrate was likely the result of increased sedimentation and erosion due to human-related impacts, such as timber harvest, road building, and agriculture (Marcus et al. 1990, and references within).

Large amounts of fine substrates (sand and smaller) may limit trout growth, over-winter survival, and reproduction. Sand fills the interstitial spaces between larger substrate particles, decreasing macroinvertebrate production and prey availability. When sand bed load was experimentally increased in a midwestern stream, benthic macroinvertebrate densities declined by 50% (Alexander and Hansen 1986). The Little Spokane River and its tributaries have numbers of taxa and densities of benthic macroinvertebrates that would be considered low to low-normal when compared to other streams in the area (Dr. B. Lang, EWU, personal communication).

The availability of cobble-boulder substrate for concealment cover has been demonstrated to be important over-winter habitat for juvenile trout (Griffith and Smith 1993; Meyer and Griffith 1997). The high concentration of sand substrate and high embeddedness (74%) indicated interstitial concealment spaces and over-winter habitat were limited.

Steelhead and chinook salmon embryo survival was inversely related to the concentration of spawning substrate material less than 25.4 mm in diameter (Tappel and Bjornn 1983). An inverse relationship was also found between the emergent survival of steelhead and coho salmon (*O. kisutch*) and the concentration of 1-3 mm sand particles in spawning gravel (Phillips et al. 1975). Despite having high concentrations of sand substrates, several streams, including Bear Creek, in the Little Spokane system have groundwater inflow that may be adequate for successful spawning. Rainbow trout embryo survival was not significantly related to substrate size in groundwater-fed streams with sufficient inter-gravel dissolved oxygen levels and flow rates (Sowden and Power 1985).

Eastern brook trout were planted in Bear Creek in 1941 by WDFW (WDFW, unpublished hatchery records). Rainbow trout were stocked by WDFW in 1936 and 1939 (WDFW, unpublished hatchery records). Brook trout were present throughout Bear Creek, but rainbow trout were only collected near the mouth. Rainbow trout likely failed to establish a population due to habitat conditions, either directly from habitat preference or indirectly through interspecific competition. The habitat in Bear Creek was dominated by low velocity habitats (63% runs) and small substrates (68% sand, silt, and muck). Brook trout dominated rainbow trout in slow flow habitats (Cunjak and Green 1984), and were more aggressive, captured more prey, and grew better than rainbow trout regardless of temperature or macrohabitat (Magoulick and Wilzbach 1998). Brook trout occupied stream reaches with larger substrates than those occupied by rainbow trout in southern Ontario streams (Stoneman and Jones 2000).

Age 0 brook trout were most abundant according to the length-frequency distribution of the population. The increase in the frequency of fish that were between 12 and 15 cm TL may have constituted a second age class. However, it was likely a compilation of fish from multiple age classes based on the broad distribution of lengths at the peak and the life span of brook trout, which has been reported to reach up to 8 years in slow growing populations. Brook trout growth appeared to be slow, indicated by the lack of size classes. The steep decline in frequency of fish after the first size class suggested that survival of age 0 brook trout was low. The gradual decline in frequencies of fish per size class after the first year indicated that survival was higher for ages 1 and older. Survival may have been lower than indicated by the length-frequency distribution, because the proportions of fish of each age were likely not 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.

Habitat appeared to influence the distributions of speckled dace and slimy sculpins in Bear Creek. Speckled dace were collected in reaches characterized as having high compositions of fine substrates (sand, silt, muck; ≥ 74%) and low compositions of riffle habitat (≤ 4%). Slimy sculpins occupied reaches with gravel and larger substrates present and high composition of riffle habitat (60-83%). Slimy sculpins were generally found in riffles among the rocks of clear streams (Wydoski and Whitney 1979).

Bear Creek was the only stream surveyed where green sunfish were collected, however they have been collected in Diamond, Sacheen, Trout, Horseshoe, Fan, and Eloika Lakes (Phillips and Divens 2000; Divens et al. 2002a; Divens et al. 2002b; Divens et al. 2002c; WDFW, unpublished data). The lakes were not connected to the Bear Creek drainage, but Eloika Lake was 1.0 km from the upper reaches of Bear Creek and 3.0 km from Little Trout Lake. The close proximity of the two systems would have allowed for easy transport of green sunfish from one to the other by anglers. The stocking of green sunfish in the West Branch Little Spokane River system was undocumented, so it was possible that they were also planted in the Bear Creek system at the same time.

Bear Creek appeared to offer limited angler opportunities due to few stock or legal length trout and limited access. The brook trout population was the only game fish population large enough to provide angling opportunities. However, only 2.0% of the population was of stock length, or the length that would provide recreational value. Access to Bear Creek was generally restricted due to private land ownership adjacent to the stream. All of the landowners we had contact with during this study expressed that they did not and would not allow access to anglers.

Beaver Creek

Beaver Creek was the smallest stream based on wetted width (1.8 m; tied with Otter Creek) and discharge (0.01 m^3/s). The dominant substrate in Beaver Creek was gravel (35%), unlike the rest of the streams, which were dominated by sand. The maximum summer temperature of Beaver Creek (18.42 ^{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 temperatures recorded were within the preferred ranges of brown, eastern brook, and rainbow trout (15 to 21 ^{o}C) (Coutant 1977).

There was one relatively obvious size/age class (age 0) of brook trout from the length-frequency distribution. The more gradual decline on the right side of the distribution suggests some length overlaps between age 0 and older fish. The steep decline in frequencies between 7 cm and 10 cm suggested that survival of age 0 (and possibly age 1) brook trout was low. Survival after fish reached 10 cm TL appeared to be high. The growth rates of brook trout, based on the length-frequency distribution, appeared to be slow with high overlap in lengths between cohorts. Otolith analysis is needed to determine the age structure, as well as growth and survival rates.

Despite having never been stocked, according to WDFW stocking records, rainbow trout were present in Beaver Creek. The rainbow trout in Beaver Creek may have been seeking thermal refuge or occupying rearing habitat. The West Branch Little Spokane River had maximum summer temperatures (27.01 ^{o}C below Sacheen Lake; 28.65 ^{o}C at the mouth) that exceeded the upper avoidance temperatures reported for rainbow trout (20 ^{o}C) (Coutant 1977). For further discussion of the temperature regime see the West Branch Little Spokane River section below.

A fluvial or adfluvial rainbow trout population may have used the lower reaches of Beaver Creek as rearing habitat, based on the small sizes of fish collected (≤ 115 mm TL). It was unknown if a fluvial population occupied stretches of the West Branch that were not surveyed or if there are adfluvial populations in Eloika, Fan, or Horseshoe Lakes. Warm water temperatures in the West Branch likely prevented its use by rainbow trout in the summer, above the lower waterfall, suggesting an adfluvial population. Only one site was sampled below the waterfalls on Beaver Creek, so it was possible that adult rainbow trout were present and our effort was not adequate to detect them. Additional sampling should be conducted in the lower reaches of Beaver Creek, during the summer, to determine the presence of adult rainbow trout. If no adult rainbow trout are detected, the life history of the rainbow trout that occupy Beaver Creek should be examined.

Angling opportunities in Beaver Creek were, for all practical purposes, nonexistent due to the lack of stock and legal size trout (0.0%) and stream access. Access was restricted due to private land ownership adjacent to the stream and all of the landowners we had contact with expressed that they did not and would not allow access to anglers.

Buck Creek

Buck Creek was the second largest stream surveyed based on wetted width (3.5 m). Buck Creek had the highest percent composition of riffle habitat (75%) and the second highest of pool habitat (21%). Buck Creek was the second steepest stream surveyed, based on gradient (3%), along with Dry Creek. Similar to Bear Creek, high concentrations of sand may limit trout production in Buck Creek, although mean embeddedness was relatively low (38%). The high concentrations of sand in Buck Creek were likely related to timber harvest.

Buck Creek had a culvert at Horseshoe Lake Road that was identified as a fish barrier during this study. The culvert appeared to be a contentious issue with local landowners, some of whom expressed concern that the culvert blocked access to spawning habitat for kokanee that migrate up the stream from Horseshoe Lake and altered spawning habitat below the culvert. Prior to the culvert, which was placed circa 1990, there was a bridge that allowed fish passage (J. McNeill, landowner, personal communication). The amount of salmonid spawning gravel above the culvert should be quantified and options to restore fish passage should be explored.

There were no records of brook trout plants in Buck Creek; however, a single brook trout was collected near the mouth, which likely immigrated from an adjacent population.

Rainbow trout were native to the Little Spokane River system and were also stocked extensively in the drainage. The rainbow trout population in Buck Creek may have been established from one or more of the hatchery plantings (Appendix A) (WDFW, unpublished hatchery records). Microsatellite DNA analysis indicated that the rainbow trout population in Buck Creek was distinct from the Spokane Hatchery stock of rainbow trout (coastal origin), but the two populations were closely related in cluster analysis (Appendix N). The relatively close relationship between the Buck Creek and the Spokane Hatchery strain rainbow trout indicated that the Buck Creek rainbow population's ancestry may have included a substantial component of coastal rainbow hatchery genes (Appendix N).

The length-frequency distribution of rainbow trout in Buck Creek 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.

Buck Creek was sampled by EWU below the culvert at Horseshoe Lake Road on two days in the fall of 2000 to collect spawning kokanee for DNA analysis (EWU, unpublished data). Similar to the 2001 survey, eastern brook trout, rainbow trout, and sculpins were collected (EWU, unpublished data). They also captured spawning kokanee and a single grass pickerel (EWU, unpublished data). The absence of kokanee in the 2001 sample was expected, since sampling was conducted in July. The occurrence of the grass pickerel was surprising because the habitat (riffle-pool sequences) in Buck Creek was not typical grass pickerel habitat (Wydoski and Whitney 1979).

Angling opportunities for trout in Buck Creek were limited due to the low numbers of legal size rainbow trout and limited access. The proportion of legal size rainbow trout in Buck Creek was 0.1%. Timber companies, who granted access to the public, owned all but the lower 1.5 km of the land adjacent to Buck Creek. The timber company land was part of a cooperative road closure management area, designed to protect wildlife, so it was not accessible to motor vehicles. Anglers would have to travel a minimum of 6.0 km by foot from the nearest access point to reach the creek making access fairly difficult. The lower 1.5 km was posted no trespassing.

The greatest recreational value from Buck Creek may come indirectly from its use by Horseshoe Lake kokanee as a spawning stream. Between 1948 and 1972, kokanee comprised 95.1% of the angler harvest on Horseshoe Lake (n=4,334 observed on 57 creel days) (WDFW, unpublished data). Kokanee harvest has not been evaluated since 1972, but local landowners claimed that the kokanee fishing has declined in recent years. The decline may have been related to predation by lake trout that were planted in the early 1980's and/or decreased reproduction as a result of lost spawning habitat in Buck Creek. The decline in kokanee numbers should have resulted in a relatively large mean size, because kokanee growth is density dependent. However, the mean total length of kokanee was short, when compared to other local low-density kokanee populations, suggesting that kokanee densities were adequate based on the current carrying capacity of the lake (Table 31). Increases in recruitment of kokanee, as the result of access to additional spawning habitat, may not improve the quality of the kokanee fishery. Increased densities would likely result in smaller sizes and yield (pounds of fish harvested) may not change or could decrease. The Horseshoe Lake kokanee population should be monitored to determine trends in abundance. Tracking population trends would be most easily accomplished by monitoring the spawning run in Buck Creek, either with an adfluvial trap and/or redd counts. Trapping is recommended because it would allow for collecting data to evaluate age and growth information. If the Horseshoe Lake kokanee population is a regional priority, additional research should be conducted to determine the factors limiting the population and ways to improve them.

Table 31. Comparison of mean total lengths of kokanee from local lakes with populations generally considered to have low densities.

Lake	n	Mean TL (SD)	Source
Horseshoe Lake[a]	3	245 (23)	WDFW, unpublished data 1993
Horseshoe Lake[b]	7	291 (16)	WDFW, unpublished data 1995
Horseshoe Lake[b]	62	248 (18)	EWU, unpublished data 2000
Chain Lake[a]	8	337 (18)	WDFW, unpublished data 1993
Chain Lake[a]	25	347 (44)	Polacek and Baldwin (1999)
Chain Lake[b]	75	393 (25)	EWU, unpublished data 2000
Deer Lake[a]	10	464 (82)	WDFW, unpublished data 2000
Lake Roosevelt, age 2[b]	2,420	299 (25)	McLellan et al. (2001)
Lake Roosevelt, age 3[b]	206	428 (33)	McLellan et al. (2001)

[a] Spring sample.
[b] Fall sample (spawners).

Deer Creek

Based on the majority of the size related habitat features (e.g. wetted width, depth, etc.), Deer Creek was an intermediate size stream when compared to the others sampled in 2001. Similar to Bear Creek, high concentrations of sand may limit trout production in Deer Creek. The high concentration of sand was likely the result of timber harvest and agriculture.

The temperatures in upper Deer Creek were only measured until July 25th, because a citizen removed the thermograph. The maximum temperature recorded in upper Deer Creek exceeded the WAC maximum for Class A coldwater streams (18 ^{o}C). However, the maximum temperature was within the preferred range of eastern brook and rainbow trout (15 to 21 ^{o}C) (Coutant 1977). It was possible that summer temperatures exceeded the maximum reported, however, the majority (10 of 12) of the maximum temperatures recorded on the other streams occurred in early July.

There were no WDFW stocking records for brook trout in Deer Creek. The brook trout were likely established prior to 1933, with fish from U.S. Fish Commission or county sponsored stocking programs (A. Scholz, EWU, personal communication).

Two distinct size/age classes were visible on the length-frequency distribution of eastern brook trout in Deer Creek. The large number of fish in the first size class and small numbers following suggested that first year survival was low and subsequent annual survival was high.

The large proportion of fish in the first size class may have also been the result of a strong year 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 brook trout population.

The origin of the rainbow trout population in Deer Creek was unknown. Prior to the construction of Little Falls Dam on the Spokane River, steelhead migrated up Deer Creek to spawn. The rainbow trout population in Deer Creek has been hypothesized to be descendants of residualized steelhead or a native population of resident redband trout. Rainbow trout from Deer Creek were observed with morphological characteristics thought to be consistent with redband rainbow trout (A. Scholz, EWU, personal communication). However, the rainbow trout population in Deer Creek may have been established from the hatchery planting in 1936 (Appendix A) (WDFW, unpublished hatchery records). Microsatellite DNA analysis indicated that the rainbow trout population in Deer Creek was comprised of interior redband rainbows and there was little indication of coastal rainbow trout influence on the population (Appendix N).

There were two distinct size/age classes of rainbow trout in Deer Creek that were roughly equal in proportion, which indicated that first year survival was high. Survival rates decreased for subsequent size/age classes. Growth appeared to be relatively slow, as indicated by the small size of age 2 fish (9-10 cm TL) and the lack of distinct size classes after age 2. Otoliths need to be analyzed to determine age, growth, and survival characteristics.

Mottled sculpins were present in reaches where the compositions of substrate that was gravel size and larger exceeded 10%, with the exception of Reaches 1 and 2. Reaches 1 and 2 may not have been accessible to sculpins due to a small chute located at the upstream end of Reach 3, that was not considered a total fish migration barrier because it could be ascended by adult trout. The chute was 1.8 m long and 0.3-0.4 m wide with small plunge and landing pools.
One longnose dace was collected in deer Creek, between the Highway 2 barrier and the railroad barrier. We sampled 50% of stream that was between the barriers, using block nets and three consecutive passes, so it was unlikely that a viable population went undetected. The most likely explanation for its occurrence was that it moved down from above the railroad barrier. No fish were collected at the site sampled 600 m above the railroad culvert and residents said it had been dry for most of the summer. However, residents also indicated that there was a spring “just upstream” of the railroad culvert that provided flow to the lower stream throughout the summer.

We did not sample between the spring and railroad culvert, so it was possible that a small population of longnose dace was isolated to a short stretch of stream above the railroad culvert.

Two previous single site fish surveys were conducted on Deer Creek. The initial electrofishing sample on Deer Creek, in 1978, only yielded brook trout (WDFW, unpublished data). The 1999 survey, conducted by EWU, resulted in collections of brook and rainbow trout (EWU, unpublished data). Similar to the two previous sampling occasions, eastern brook and rainbow trout were collected in 2001. Unlike the previous collections, sculpins and longnose dace were also collected in 2001. The differences between the previous samples and those in 2001 were likely due to sample size. There were 22 sites sampled in 2001 versus one in both 1978 and 1999. The previous surveys did not sample enough of the stream to detect the other species.

Deer Creek offered limited angler opportunities due to a lack of stock and legal length trout and access. The proportion of the brook trout population that was of stock length and the rainbow trout population that was of legal length were 1.1% and 0.5%, respectively. Access to Deer Creek was generally restricted due to private land ownership adjacent to the streams. The landowners we had contact with expressed that they did not and would not allow access to anglers.

Dry Creek

Eastern brook trout were planted in Dry Creek in 1954 and Reflection Lake in 1997, and rainbow trout were planted in 1936 (WDFW, unpublished hatchery records). The length-frequencies of the brook and rainbow trout populations in Dry Creek were similar and interpreted in the same way. Only one distinct size/age class of brook and rainbow trout was collected in Dry Creek. The steep decline in numbers of fish after age 0 indicated that first year survival was low. The lack of obvious size/age classes after age 0, suggested survival rates were high and growth was slow. The lack of size classes indicated either: 1) slow growth, because there appeared to be substantial overlap in the lengths of fish of various ages, or 2) only one age class was present. In the latter case, trout may utilize Dry Creek for only a portion of their life cycle. However, it was unknown if fluvial populations of brook and/or rainbow trout from the Little Spokane River use Dry Creek as a spawning tributary. The steep declines in fish after age 0 may have also been the result of juvenile out migration. The occurrence of apparently adult fish (>

150 mm) suggests that resident populations of both species occur in Dry Creek. Otolith analysis should be conducted to determine the age structure, survival rates, and growth rates of the brook and rainbow populations in Dry Creek. Studies should be conducted to determine the various life history strategies that depend on Dry Creek.

Densities of brook and rainbow trout in Dry Creek appeared to be related to habitat. Brook trout had higher densities than rainbow trout in the most upstream (highest elevation) reaches, with substrate dominated by sand and silt (≥ 64%) and low percent occurrence of riffle habitats (< 30%). Brook trout were reported to occupy significantly higher elevations and gradients, and narrower habitats than rainbow trout in Wyoming streams (Bozek and Hubert 1992). Elevation, considered an indicator of climate (temperature) (Bozek and Hubert 1992), probably had no impact on differences in densities in Dry Creek. The difference in elevations between the lowest elevation high-density brook and highest elevation high-density rainbow trout reaches were no greater than 15 m. While not measured, the climatic differences between the reaches with high densities of brook and rainbow trout were likely negligible. The effect of gradient was not apparent in Dry Creek. The densities of brook trout in were higher than those of rainbow trout in reaches with gradients of 2% and 3%, and rainbow densities were greater in reaches with gradients of 2, 3, and 5%. Wetted width did not appear to influence densities of brook and rainbow trout in Dry Creek. The wetted widths of reaches dominated by brook trout (2.3-3.1 m) were the same as those dominated by rainbow trout (2.3-3.1 m).

Water velocity, indicated by habitat type, may have influenced the densities of sympatric brook and rainbow trout. Riffle habitats, by definition, had higher velocities than pools or runs. Our data indicated that brook trout had a competitive advantage in lower velocity habitats (pool and runs). Cunjak and Green (1984) found that brook trout dominate rainbow trout in slow flow habitats. However, Cunjak and Green (1984) also reported that neither species had a competitive advantage in fast flow habitats. Magoulick and Wilzbach (1998) reported that eastern brook trout were more aggressive, captured more prey, and grew better than rainbow trout regardless of temperature or macrohabitat. Based on these studies, we should have observed equal or higher densities of brook trout in all reaches. The apparent dominance of rainbow trout in certain reaches suggests that there were additional factors influencing densities.

Substrate size was another habitat factor that may have influenced domination by one species or the other in sympatric brook and rainbow trout populations. Similar to our observations, brook trout have been reported to occupy stream reaches with smaller substrates than those occupied by rainbow trout in southern Ontario streams (Stoneman and Jones 2000).

A single brown trout was collected in Dry Creek. According to WDFW records, brown trout were never stocked in Dry Creek, but they were planted in the Little Spokane River in 10 years between 1980 and 1993 (WDFW, unpublished hatchery records). Brown trout have been collected in the Little Spokane River (Hartung and Meier 1980; EWU, unpublished data). The brown trout in Dry Creek likely moved in from the Little Spokane River to avoid warm water temperatures or were rearing. The low densities of brown trout suggest that the stream was not an important rearing stream for brown trout.

The six juvenile largemouth bass collected in Dry Creek were assumed to have entrained out of Reflection Lake. The origin of the bass in Reflection Lake was unknown.

Dry Creek offered limited angler opportunity due to the lack of stock and legal length trout, as well as limited access. The proportion of the population of brook trout that were of stock length and of rainbow trout that were of legal length was 1.5% and 0.4%, respectively. Access to Dry Creek was restricted due to private land ownership adjacent to the streams. The landowners we had contact with expressed that they did not and would not allow access to anglers.

Heel Creek

Heel Creek was the steepest (mean gradient = 5%) stream surveyed. Heel Creek had the second highest percent composition of riffle habitat (73%) and highest of pool habitat (25%). Similar to Bear Creek, high concentrations of sand may limit trout production in Heel Creek. There was timber harvest occurring in the Heel Creek drainage that may have been responsible for the high concentrations of sand substrate.

There were no WDFW records of fish being stocked in Heel Creek, but brook trout were collected there. The brook trout in Heel Creek may have been stocked prior to 1933, with fish from U.S. Fish Commission or county sponsored stocking programs (A. Scholz, EWU, personal communication). Brook trout may have immigrated from populations in connected streams, such as Spring Heel Creek or the West Branch Little Spokane River, or been transplanted by anglers.

Heel Creek offered little in recreational value to anglers due to the lack of stock length brook trout, despite having adequate public access. The proportion of the brook trout population in Heel Creek that was of stock length or longer was 0.3%. Heel Creek was the most accessible stream surveyed in 2001. A timber company owned the majority of the property adjacent to the stream and they granted access to the public for a small fee. A logging road ran parallel to the stream for most of its fish bearing length.

Otter Creek

Otter Creek was the smallest stream surveyed, based on wetted width (1.8 m tied with Beaver Creek) and bankfull width (2.8 m). However, Otter Creek had the highest discharge of all of the streams surveyed (0.62 m^3/s). The discharge in Otter Creek was 1.8 times greater than that of the West Branch Little Spokane River and 5.2 times greater than that of the next largest streams, Bear and Dry Creeks (0.12 m^3/s). The large difference in discharge between Otter Creek and the West Branch may have been the result of timing. Discharge was measured on Otter Creek on August 28th and on the West Branch on September 20th. Similar to Bear Creek, high concentrations of sand may limit trout production in Otter Creek. The high concentration of sand was likely the result of past timber harvest and agricultural activities.

There were two distinct size/age classes of eastern brook trout in Otter Creek. Compared to the other brook trout streams surveyed, decline between the first and second size/age classes was moderately steep. Based on the moderate decline, first year survival of brook trout appeared relatively high. The relatively large gap between the peak lengths in the two size classes indicated that first year growth was good. Survival after age 1 was low. Otolith analysis is needed to determine the age structure, survival rates and growth rates of the population.

The origin of rainbow trout in Otter Creek was unknown. Steelhead and rainbow trout were native to the Little Spokane River system (Scholz et al. 1985), but Otter Creek had a potential barrier near its mouth. The rainbow trout population in Otter Creek may have been established from the hatchery planting in 1936 (Appendix A) (WDFW, unpublished hatchery records). Microsatellite DNA analysis indicated that the rainbow trout population in Otter Creek was comprised of interior redband rainbows and there was little indication of coastal rainbow trout influence on the population (Appendix N).

The distribution of rainbow trout in Otter creek extended upstream as far as the irrigation pond dam near Allen Road. The dam prevented the movement of rainbow trout into the headwaters. The location of the only documented stocking of rainbow trout in Otter Creek was not recorded, but it appeared to have had little impact on what we believe was resident a population comprised of interior redband rainbow trout (Appendix N). The eastern brook trout planting may have occurred above the dam, based on their presence above it, but there may have been other undocumented stocking events prior to the dams construction or upstream of it.

Three size/age classes were apparent in the length-frequency distribution of Otter Creek rainbow trout. The steep decline in frequency between the first and second size/age groups indicated that first year survival was low. The gradual decline in subsequent size/age classes was characteristic of high survival rates. The occurrence of three distinct size classes suggest that growth rates were good, in comparison to the other rainbow trout streams surveyed. Otolith analysis is needed to determine the age structure, survival rates and growth rates of the population.

Similar to Dry Creek, the densities of brook and rainbow trout in Otter Creek appeared to be related to habitat conditions. Rainbow trout densities, in Otter Creek, were greater than those of brook trout in downstream reaches (lower elevations), with higher gradients (≥ 7%), greater wetted widths (≥ 3.6 m), substrates dominated by gravel, rubble, and boulder (≥ 61%), and high percent occurrence of riffle habitats (≥ 73%). Bozek and Hubert (1992) reported that rainbow trout in Wyoming streams occupied significantly lower elevations, lower gradients, and wider stream reaches than brook trout. Similar to Bozek and Hubert (1992), rainbow trout occurred in higher densities in lower elevation reaches of Otter Creek. Elevation, considered an indicator of climate (temperature) (Bozek and Hubert 1992), probably had little impact on differences in densities of brook and rainbow trout. The difference in elevations (climate/temperature) between the lowest high-density brook and highest high-density rainbow trout reaches were no greater than 15 m, so the climatic differences were likely negligible.

Unlike the Wyoming study, rainbow trout had higher densities than brook trout in high gradient reaches in Otter Creek. The observed difference may have been due to differences in longitudinal characteristics of the streams in the two studies. Upstream reaches in Wyoming tended to have higher gradients, larger substrate sizes, and narrower widths (Bozek and Hubert 1992). Because Otter Creek was a spring creek, upstream reaches had lower gradients, smaller substrate sizes, and narrower widths. Gradient did not influence densities in Dry Creek, but gradients were lower than those in Otter Creek where rainbow trout had higher densities than brook trout. Gradient was not independent of velocity, steeper slopes have greater velocities, so velocity may have had more of an influence on brook and rainbow trout densities in sympatric populations. Wetted widths were greater in reaches with higher densities of rainbow trout than brook trout, similar to Wyoming streams (Bozek and Hubert 1992). The wetted widths of reaches dominated by rainbow trout (3.6-3.7 m) were greater than those dominated by brook trout (1.1-2.5 m). Wetted widths did not influence densities in Dry Creek. Differences in densities in Otter Creek were likely related to other habitat features, such as velocity or substrate.

Velocity, indicated by the occurrence of riffle habitat, likely influenced the densities of sympatric brook and rainbow trout. Riffle habitats, by definition, had higher velocities than pools or runs. Rainbow trout, in Otter Creek, had higher densities than brook trout in reaches higher velocities (≥ 73% riffle habitat). Cunjak and Green (1984), found that brook trout dominate rainbow trout in slow flow habitats, neither species had a competitive advantage in fast flow habitats. Magoulick and Wilzbach (1998) reported that eastern brook trout were more aggressive, captured more prey, and grew better than rainbow trout regardless of temperature or macrohabitat. Based on these studies, we should have observed equal or higher densities of brook trout in all reaches observed. The apparent dominance of rainbow trout in certain reaches suggests that there were multiple factors influencing the densities.

Substrate composition may have influenced the densities of sympatric brook or rainbow trout populations. In Otter Creek, rainbow trout had higher densities than brook trout in reaches with large substrate (gravel or larger). Rainbow trout have been demonstrated to occupy stream reaches with larger substrates than those occupied by brook trout in southern Ontario streams (Stoneman and Jones 2000). The densities of brook and rainbow trout in Otter Creek were likely related to habitat features, particularly velocity and substrate particle size.

A single brown trout was collected near the mouth of Otter Creek. According to WDFW records, brown trout have never been stocked in Otter Creek. However, brown trout were planted in the Little Spokane River in 10 years between 1980 and 1993 (WDFW, unpublished hatchery records). The brown trout in Otter Creek likely moved in from the Little Spokane River to avoid warm water temperatures or was rearing. The low densities of brown trout suggest that Otter Creek was not an important rearing stream.

Mottled sculpins were only collected in Reaches 13 and 14 of Otter Creek, which had high gradient (7-8%), high percent composition of cobble and larger substrates (> 48%), and a high percent composition of riffle habitat (≥ 73%) or low percent composition of run habitat

(0%). Mottled sculpins were typically found in streams with moderate to rapid current and rubble, gravel, or rock bottoms (Wydoski and Whitney 1979).

Fish distribution data on Otter Creek, prior to 2001, was collected on a single occasion in 1974 (WDFW, unpublished data). Two sites, approximately 0.5 km upstream from the mouth, were electrofished: one below a culvert and one above. They captured eastern brook trout and rainbow trout (WDFW, unpublished data 1974). Similar to the previous survey, eastern brook and rainbow trout were collected in approximately the same area in 2001 (sites 7 and 8, Reach 13). Unlike the previous collections, sculpins were also collected in the area in 2001. Sculpins were likely present in 1974, but they were probably not reported due to their lack of value as a game fish.

Otter Creek offered limited angler opportunities due to a lack of stock and legal length trout and access. The proportion of the brook trout population that was of stock length and the rainbow trout population that was of legal length were 1.5% and 3.2%, respectively. Access to Otter Creek was generally restricted due to private land ownership adjacent to the streams. The landowners we had contact with expressed that they did not and would not allow access to anglers.

Spring Heel Creek

Eastern brook trout and rainbow trout were planted in Spring Heel Creek (WDFW, unpublished hatchery records). During our survey, no rainbow trout were collected in Spring Heel Creek. They were likely present, but were not detected because of the limited number of sample sites (n=1).

The largemouth bass in the Spring Heel Creek probably came from Lost Lake, which was upstream of the sample site. A large school of largemouth bass fry was observed in Lost Lake. The origin of the bass in Lost Lake was unknown.

West Branch Little Spokane River

The West Branch Little Spokane River was the largest stream surveyed according to mean wetted width (10.7 m) and mean depth (48 cm), and the second largest according to mean bankfull width (12.6 m) and discharge (0.35 m^3/s). The West Branch Little Spokane River was almost three times as wide (wetted width) as the next widest stream, Buck Creek (3.5 m), and twice as deep (mean depth) as the next deepest stream, Bear Creek (24 cm). Similar to Bear Creek, high concentrations of sand may limit trout production in the West Branch Little Spokane River. The high concentration of sand was likely the result of past timber harvest and agriculture.

The West Branch Little Spokane River was the warmest stream monitored in 2001, with a mean temperature of 17.00 ^{o}C and maximum of 28.65 ^{o}C at the mouth. The summer maximum temperature recorded on the West Branch Little Spokane River, at its mouth and below Sacheen Lake, exceeded the WAC maximum for Class A coldwater streams (18 ^{o}C). The warm water temperatures in the West Branch Little Spokane River were likely the result of surface inflow from the lakes in the system.

Maximum temperatures in the West Branch Little Spokane River, at both sites, exceeded the upper avoidance levels reported for adult brown, eastern brook, and rainbow trout (19, 20, and 20 ^{o}C, respectively) (Coutant 1977; Garrett and Bennett 1995). Maximum temperatures in the West Branch Little Spokane River, at its mouth and below Sacheen Lake, exceeded 20.0 ^{o}C on 83 and 72 days, respectively. Summer temperatures limit salmonid production in the West Branch Little Spokane River.

The mean temperature recorded in the West Branch Little Spokane River by SCCD from May through September (18.80 ^{o}C) was higher than that recorded near the mouth in 2001 (17.00 ^{o}C) (SCCD, unpublished data). However, the maximum temperatures were similar in the two studies (1999 max. = 28.54 ^{o}C; 2001 max. = 28.65 ^{o}C) (SCCD, unpublished data). The difference in means was likely the result of normal year to year variation.

Despite being planted in the West Branch Little Spokane River on six occasions between 1938 and 1945 and extensively in the drainage between 1933 and 2001 (163 occasions; Appendix A) (WDFW, unpublished hatchery records), no brook trout were collected in the West Branch Little Spokane River. The lack of brook trout was likely the result of warm summer water temperatures. We only sampled the lower third of the West Branch Little Spokane River, so brook trout may have occupied stretches of the river that were not sampled. However, use of the river by brook trout was likely minimal due to unsuitable maximum summer temperatures.

Despite being planted in the West Branch Little Spokane River and the majority of the upstream lakes and streams between 1933 and 2001 (WDFW, unpublished hatchery records), rainbow trout were only collected below the barrier falls near the mouth. Rainbow trout probably were not present above the falls because of water temperatures that exceeded their upper avoidance levels. However, only the lower third of the river was sampled, so it was possible that rainbow trout occupied reaches upstream. Due to the appearance of three size/age classes present in the West Branch Little Spokane River below the barrier falls, it was likely that wild reproduction occurred in the river. We did not know whether the reproduction occurred upstream of the falls and the fish emigrated/entrained or if the reproduction occurred below the falls. The larger rainbow trout (> 200 mm TL) may have been hatchery fish that had migrated from lakes in the West Branch Little Spokane River or from the Little Spokane River.

As previously discussed, the occurrence of juvenile rainbow trout in Beaver Creek suggested the existence of an fluvial or adfluvial rainbow trout population in the West Branch system above the lower waterfall near the mouth and below the waterfall above Horseshoe Lake. Due to the high water temperatures in the river, it was more reasonable to assume that there was an adfluvial population in one of the lakes. The life history strategies of rainbow trout in the West Branch should be investigated.

Brown trout were collected in the West Branch Little Spokane River, despite having never been planted in the river. However, they had been stocked in the Eloika and Sacheen Lakes (WDFW, unpublished hatchery records). Catchable size brown trout (approx. mean size = 200 mm TL) were stocked in Eloika Lake by WDFW in 2000 and 2001, but there was evidence that brown trout were naturally reproducing in the system. Of the 62 brown trout collected in the West Branch Little Spokane River, 55 were < 110 mm TL and considered juveniles occurring as a result of natural reproduction.

The data suggests that the majority of the brown trout spawning and rearing occurs upstream of Eloika Lake. All of the brown trout collected upstream of Eloika Lake were juveniles and comprised 67% (n=37) of the total juvenile catch in the West Branch Little Spokane River. The data for the river upstream of Eloika Lake was limited by sample size (n=1), however the density of brown trout was four times greater at this site (4 fish/100m^2) than any of the others sampled (≤ 1 fish/100m^2).

Most of the warmwater fish collected during surveys of the West Branch Little Spokane River were introduced in to Eloika and Fan Lakes by WDFW in 1934 and 1936. The stocking records indicated that bass, crappie, catfish (bullheads), and yellow perch were planted (WDFW, unpublished data). Sunfish species (pumpkinseeds, green sunfish, and bluegill), tench, and grass pickerel stocking events were not recorded, but likely occurred prior to 1933 as part of the U.S. Fish Commission stocking program. A single juvenile bluegill (54 mm TL) was collected in Reach 3, approximately 500 m downstream of Eloika Lake, but no bluegill were collected in WDFW Warmwater surveys of Diamond, Sacheen, Fan, and Eloika Lakes (Phillips and Divens 2000; Divens et al. 2002a; Divens et al. 2002b; Divens et al. 2002c). However, a bluegill was captured in Horseshoe Lake in 1995 and a bluegill was captured in the West Branch Little Spokane River upstream of Eloika Lake in 1999 (WDFW, unpublished data; EWU, unpublished data).

Mountain whitefish were only collected below the lower barrier falls in 2001, but were collected in Horseshoe Lake in 1993 (WDFW, unpublished data). No mountain whitefish were captured in surveys of Eloika, Fan, Trout, Sacheen, and Diamond Lakes (Zook 1978; Phillips and Divens 2000; Divens et al. 2002a; Divens et al. 2002b; Divens et al. 2002c; WDFW, unpublished data). Warm water temperatures likely limit mountain whitefish use of the West Branch Little Spokane River during the summer. Mountain whitefish generally occupy streams with mean temperatures ranging from 9 to 11 ^{o}C (Wydoski and Whitney 1979).

The fish species composition in the West Branch Little Spokane River was similar to the species compositions in the upstream lakes. Eleven of the 13 species collected in the West Branch Little Spokane River were collected in at least one of the upstream lakes during previous surveys (Zook 1978; Phillips and Divens 2000; Divens et al. 2002a; Divens et al. 2002b; Divens et al. 2002c; WDFW, unpublished data). The two species that were not collected in upstream lakes were mottled sculpins and longnose dace. No adult suckers were collected in this survey and no suckers were collected in surveys of Diamond, Sacheen, Fan, and Eloika Lakes (Zook 1978; Phillips and Divens 2000; Divens et al. 2002a; Divens et al. 2002b; Divens et al. 2002c). However, adult longnose suckers were collected in Trout and Horseshoe Lakes in 1993 (WDFW, unpublished data).

Similar to all of the other streams surveyed, the West Branch Little Spokane River appeared to offer limited angler opportunities. The West Branch had higher proportions of legal sized trout (brown trout; 9.7%) compared to the other streams surveyed (≤ 4.0%), but the relatively low densities (≤ 4 fish/100 m^2) indicate poor angling potential. The West Branch had a yellow bullhead population that could be recreationally valuable, due to the high proportion of stock length fish (69%).

Access to the West Branch Little Spokane River was restricted due to private land ownership adjacent to the river. All of the landowners we had contact with expressed that they did not and will not allow access to anglers. There was a small, unimproved area near Eloika Lake Road where people were accessing the river. No anglers were observed, but it appeared that they could access the river at that site. Land ownership at the site was unknown.

Other Streams

The summer maximum temperatures of Beaver (Dragoon Creek tributary), upper Dragoon Creek, the West Branch Dragoon Creek, and the Little Spokane River exceeded the WAC maximum for Class A coldwater streams (18 ^{o}C). Dartford Creek was the only stream monitored that did not exceed 17^{o}C (mean = 11.60 ^{o}C and max. = 16.26 ^{o}C).

The maximum temperatures of Beaver Creek (Dragoon Creek tributary) and the Little Spokane River, at its mouth, 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 upper Dragoon Creek, the West Branch Dragoon Creek, and 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 59 days. Summer temperatures may limit salmonid production in the upper Little Spokane River.

Mean and maximum water temperatures declined at successive downstream monitoring sites in the Little Spokane River. Mean water temperatures at Elk, Wandermere, and the mouth were 15.08, 14.63, and 13.19 ^{o}C, respectively. The declining temperatures were likely the result of cold groundwater inflow that reportedly occurs near Wandermere (Hartung and Meier 1980; 1995).

Temperature data recorded by SCCD on the Little Spokane River was not comparable to data collected during this project, because it was collected at different sites and in different years. However, they were reported to show annual variations in temperature in Little Spokane River between Elk and Wandermere. Temperatures were measured by SCCD at two sites located between the Elk and Wandermere sites that were monitored in 2001. They monitored one site (rkm 21.1) from May through September 1999 and one (rkm 51.2) from October 1999 through May 2001 (mean for site at rkm 51.2 calculated for June-October 2000) (SCCD, unpublished data). The mean summer temperatures recorded by SCCD at both sites (1999 mean = 15.37 ^{o}C; 2000 mean = 14.96 ^{o}C) were similar to those recorded at Elk (15.80 ^{o}C) and Wandermere (14.63 ^{o}C).

Recommendations

- Identify habitat restoration opportunities, particularly related to decreasing sediment loading, with statistically defensible evaluation plans.
- Identify the human-made fish migration barriers that should be removed or improved to restore fish passage.
- Establish methods to educate and encourage landowners to limit agricultural impacts on riparian habitat.
- Collect otoliths from each trout population to determine age structures, growth rates, and survival rates.
- Microsatellite DNA characterization of the rainbow trout populations that have not been evaluated to determine purity and distinction from other stocks. Collections should be made from each breeding population in each stream.
- Identify the life history strategies of fish populations in the Little Spokane system.
- Quantify the potential salmonid spawning habitat above the Buck Creek culvert at Horseshoe Lake Road.
- Attempt to secure funding to replace the culvert on Buck Creek at Horseshoe Lake Road with an appropriately engineered structure that would restore fish passage.
- Monitor the kokanee spawning run in Buck Creek.
- Determine limiting factors for the Horseshoe Lake kokanee population, particularly related to lower Buck Creek.

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Appendices

Appendix A.

Table A1. Fish plants in the Little Spokane River drainage by WDFW. Data from unpublished hatchery records. EB = eastern brook trout, CT = cutthroat trout, RB = rainbow trout, WE = walleye, K = kokanee, BT = brown trout, SH = steelhead, B = bass (general), C = crappie (general), CF = catfish (general), and YP = yellow perch.

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Baileys Lake	1947	RB	10,270	3.5	Inches	
Baileys Lake	1947	RB	3,956	4	Inches	
Baileys Lake	1948	RB	10,500	4	Inches	
Baileys Lake	1949	RB	10,000	4	Inches	
Baileys Lake	1949	RB	4,664	5	Inches	
Baileys Lake	1949	RB	3,374	4.5	Inches	
Baileys Lake	1951	RB	10,000	1250	No./Lb.	
Baileys Lake	1951	RB	7,500	8	No./Lb.	
Baileys Lake	1952	RB	15,000	600	No./Lb.	
Baileys Lake	1953	RB	8,100	15	No./Lb.	
Baileys Lake	1954	RB	11,550	154	No./Lb.	
Baileys Lake	1955	RB	14,850	110	No./Lb.	
Baileys Lake	1956	RB	10,050	150	No./Lb.	
Baileys Lake	1957	RB	10,500	175	No./Lb.	
Baileys Lake	1958	RB	10,065	165	No./Lb.	
Baileys Lake	1959	RB	10,000	125	No./Lb.	
Baileys Lake	1960	RB	7,520	160	No./Lb.	
Baileys Lake	1961	RB	5,000	40	No./Lb.	
Baileys Lake	1962	RB	7,800	120	No./Lb.	
Baileys Lake	1963	RB	5,032	210	No./Lb.	
Bear Creek	1936	RB	10,000	3	Inches	
Bear Creek	1939	RB	1,500	4	Inches	
Bear Creek	1941	EB	12,495	1	Inches	
Beaver Creek	1946	EB	11,365	1.5	Inches	
Beaver Creek (Dragoon Trib.)	1941	EB	24,985	1	Inches	
Beaver Creek (Dragoon Trib.)	1944	EB	8,500	1	Inches	
Beaver Creek (Dragoon Trib.)	1944	EB	5,100	1	Inches	
Beaver Creek (Dragoon Trib.)	1944	RB	9,300	3	Inches	
Beaver Creek (Dragoon Trib.)	1945	EB	21,550	1.5	Inches	
Beaver Creek (Dragoon Trib.)	1946	RB	6,466	4	Inches	
Beaver Creek (Dragoon Trib.)	1946	RB	16,808	1.5	Inches	
Buck Creek	1941	RB	27,090	1.25	Inches	
Buck Creek	1943	RB	24,466	1	Inches	
Buck Creek	1944	RB	42,040	1	Inches	
Buck Creek	1947	RB	36,000	1	Inches	
Chain Lakes	1937	K	55,000	1	Inches	
Chain Lakes	1938	K	50,000	0.75	Inches	
Chain Lakes	1939	K	114,700	1	Inches	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Chain Lakes	1940	K	149,900	0.75	Inches	
Chain Lakes	1940	RB	4,893	4	Inches	
Chain Lakes	1941	K	105,000	0.88	Inches	
Chain Lakes	1941	RB	5,997	5	Inches	
Chain Lakes	1942	K	153,200	1	Inches	
Chain Lakes	1942	RB	9,995	3	Inches	
Chain Lakes	1943	K	200,000	1	Inches	
Chain Lakes	1943	RB	12,975	3	Inches	
Chain Lakes	1944	K	144,400	1	Inches	
Chain Lakes	1944	RB	15,300	4	Inches	
Deadman Creek	1934	EB	22,540	5	Inches	
Deadman Creek	1934	RB	17,500	1.25	Inches	
Deadman Creek	1935	EB	75,000	2.5	Inches	
Deadman Creek	1936	RB	8,000	3	Inches	
Deadman Creek	1936	RB	8,000	3	Inches	
Deadman Creek	1938	RB	1,500	4	Inches	
Deadman Creek	1939	RB	8,040	1.88	Inches	
Deadman Creek	1939	RB	3,000	4	Inches	
Deadman Creek	1941	EB	24,998	1	Inches	
Deadman Creek	1941	RB	5,605	5	Inches	
Deadman Creek	1943	RB	10,255	3	Inches	
Deadman Creek	1949	RB	3,000	7.5	Inches	
Deadman Creek	1950	RB	2,002	7	Inches	
Deadman Creek	1951	RB	3,000	7	No./Lb.	
Deadman Creek	1952	RB	2,500	5	No./Lb.	
Deadman Creek	1953	RB	617	2.5	Lb.s	
Deadman Creek	1954	RB	3,800	5	No./Lb.	
Deadman Creek	1955	RB	1,600	4	No./Lb.	
Deer Creek	1936	RB	10,000	3	Inches	
Diamond Lake	1933	EB	40,000	0	N/A	
Diamond Lake	1933	EB	40,000	0	N/A	
Diamond Lake	1933	EB	40,000	0	N/A	
Diamond Lake	1933	EB	47,576	0	N/A	
Diamond Lake	1933	EB	100,000	0	N/A	
Diamond Lake	1933	K	119,800	0	N/A	
Diamond Lake	1933	K	110,000	0	N/A	
Diamond Lake	1933	RB	24,000	0	N/A	
Diamond Lake	1934	EB	50,000	1.75	Inches	
Diamond Lake	1934	EB	39,310	2	Inches	
Diamond Lake	1934	EB	43,200	2	Inches	
Diamond Lake	1934	EB	32,400	2.5	Inches	
Diamond Lake	1934	EB	60,600	5	Inches	
Diamond Lake	1934	K	85,000	1	Inches	
Diamond Lake	1934	K	90,000	1	Inches	
Diamond Lake	1935	EB	15,000	3	Inches	
Diamond Lake	1935	EB	1,625	3	Inches	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Diamond Lake	1935	EB	1,500	3	Inches	
Diamond Lake	1935	K	60,000	1.25	Inches	
Diamond Lake	1935	K	140,000	1.25	Inches	
Diamond Lake	1935	RB	8,500	4	Inches	
Diamond Lake	1935	RB	2,500	4	Inches	
Diamond Lake	1936	EB	11,500	5	Inches	
Diamond Lake	1936	EB	7,500	6	Inches	
Diamond Lake	1936	K	150,000	1	Inches	
Diamond Lake	1936	RB	1,000	5	Inches	
Diamond Lake	1937	EB	3,500	8	Inches	
Diamond Lake	1937	EB	2,500	8	Inches	
Diamond Lake	1937	K	128,000	1	Inches	
Diamond Lake	1937	RB	2,000	7	Inches	
Diamond Lake	1937	RB	4,000	5	Inches	
Diamond Lake	1937	RB	2,000	3	Inches	
Diamond Lake	1937	SH	7,600	6	Inches	
Diamond Lake	1937	SH	10,000	4	Inches	
Diamond Lake	1938	K	71,924	1	Inches	
Diamond Lake	1938	K	59,824	1	Inches	
Diamond Lake	1938	RB	1,200	6	Inches	
Diamond Lake	1938	RB	2,000	5	Inches	
Diamond Lake	1938	RB	3,000	5	Inches	
Diamond Lake	1938	SH	11,514	5	Inches	
Diamond Lake	1939	K	281,000	1	Inches	
Diamond Lake	1939	K	249,925	1	Inches	
Diamond Lake	1939	RB	600	6	Inches	
Diamond Lake	1939	RB	600	6	Inches	
Diamond Lake	1939	RB	600	6	Inches	
Diamond Lake	1939	RB	600	6	Inches	
Diamond Lake	1939	RB	4,994	5	Inches	
Diamond Lake	1939	RB	9,986	4	Inches	
Diamond Lake	1939	RB	5,000	3	Inches	
Diamond Lake	1940	K	249,800	0.75	Inches	
Diamond Lake	1940	RB	6,998	4	Inches	
Diamond Lake	1940	RB	5,889	4	Inches	
Diamond Lake	1940	RB	9,192	4	Inches	
Diamond Lake	1940	RB	14,550	4	Inches	
Diamond Lake	1940	RB	4,223	4	Inches	
Diamond Lake	1941	RB	9,254	5	Inches	
Diamond Lake	1941	RB	5,999	5	Inches	
Diamond Lake	1942	CT	164	0	N/A	
Diamond Lake	1942	EB	51	0	N/A	
Diamond Lake	1942	RB	66	0	N/A	
Diamond Lake	1942	RB	47,665	4	Inches	
Diamond Lake	1943	RB	12,000	4	Inches	
Diamond Lake	1943	RB	12,000	4	Inches	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Diamond Lake	1943	RB	12,000	4	Inches	
Diamond Lake	1943	RB	15,600	4	Inches	
Diamond Lake	1943	RB	15,600	4	Inches	
Diamond Lake	1943	RB	15,600	3	Inches	
Diamond Lake	1943	RB	10,000	4	Inches	
Diamond Lake	1943	RB	10,000	4	Inches	
Diamond Lake	1944	RB	14,465	5	Inches	
Diamond Lake	1944	RB	9,999	4	Inches	
Diamond Lake	1944	RB	6,400	6	Inches	
Diamond Lake	1944	RB	7,296	6	Inches	
Diamond Lake	1944	RB	11,994	6	Inches	
Diamond Lake	1944	RB	10,765	6	Inches	
Diamond Lake	1944	RB	8,213	7	Inches	
Diamond Lake	1944	RB	5,760	7	Inches	
Diamond Lake	1944	RB	4,800	7	Inches	
Diamond Lake	1944	RB	4,060	8	Inches	
Diamond Lake	1944	RB	3,500	8	Inches	
Diamond Lake	1944	RB	2,576	8	Inches	
Diamond Lake	1944	RB	14,000	5	Inches	
Diamond Lake	1945	RB	7,773	5	Inches	
Diamond Lake	1945	RB	7,150	5	Inches	
Diamond Lake	1945	RB	5,950	6	Inches	
Diamond Lake	1945	RB	9,930	4	Inches	
Diamond Lake	1945	RB	12,000	4	Inches	
Diamond Lake	1945	RB	11,040	4	Inches	
Diamond Lake	1945	RB	13,250	3	Inches	
Diamond Lake	1945	RB	14,380	3	Inches	
Diamond Lake	1945	RB	14,380	3	Inches	
Diamond Lake	1945	RB	5,587	6	Inches	
Diamond Lake	1945	RB	12,390	4	Inches	
Diamond Lake	1945	RB	9,325	4	Inches	
Diamond Lake	1945	RB	20,300	4	Inches	
Diamond Lake	1945	RB	20,300	4	Inches	
Diamond Lake	1945	RB	7,192	4	Inches	
Diamond Lake	1946	RB	10,815	4	Inches	
Diamond Lake	1946	RB	6,710	6.5	Inches	
Diamond Lake	1946	RB	7,338	6.5	Inches	
Diamond Lake	1946	RB	7,000	6.5	Inches	
Diamond Lake	1946	RB	6,730	6.5	Inches	
Diamond Lake	1946	RB	230	6.5	Inches	
Diamond Lake	1946	RB	7,650	5.75	Inches	
Diamond Lake	1947	RB	9,450	5.5	Inches	
Diamond Lake	1947	RB	9,135	5.5	Inches	
Diamond Lake	1947	RB	9,275	5.5	Inches	
Diamond Lake	1947	RB	9,275	5.5	Inches	
Diamond Lake	1947	RB	9,591	5	Inches	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Diamond Lake	1947	RB	9,900	5	Inches	
Diamond Lake	1947	RB	9,544	5.5	Inches	
Diamond Lake	1947	RB	7,139	5.5	Inches	
Diamond Lake	1947	RB	8,250	5.5	Inches	
Diamond Lake	1947	RB	8,250	5.5	Inches	
Diamond Lake	1948	RB	8,683	5	Inches	
Diamond Lake	1948	RB	9,648	5	Inches	
Diamond Lake	1948	RB	10,130	5	Inches	
Diamond Lake	1948	RB	10,128	5	Inches	
Diamond Lake	1948	RB	10,128	5	Inches	
Diamond Lake	1948	RB	10,130	5	Inches	
Diamond Lake	1948	RB	10,130	5	Inches	
Diamond Lake	1948	RB	10,130	5	No./Lb.	
Diamond Lake	1948	RB	10,130	5	Inches	
Diamond Lake	1948	RB	10,130	5	Inches	
Diamond Lake	1948	RB	6,825	6	Inches	
Diamond Lake	1948	RB	4,634	6	Inches	
Diamond Lake	1948	RB	5,250	6.5	Inches	
Diamond Lake	1948	RB	5,250	6.5	Inches	
Diamond Lake	1948	RB	5,250	6.5	Inches	
Diamond Lake	1948	RB	1,500	6.5	Inches	
Diamond Lake	1948	RB	9,351	5	Inches	
Diamond Lake	1948	RB	14,738	5	Inches	
Diamond Lake	1949	RB	15,811	6	Inches	
Diamond Lake	1949	RB	14,504	6	Inches	
Diamond Lake	1949	RB	8,999	6.5	Inches	
Diamond Lake	1949	RB	8,999	5	Inches	
Diamond Lake	1949	RB	17,420	5	Inches	
Diamond Lake	1949	RB	7,872	5	Inches	
Diamond Lake	1949	RB	5,040	5.5	Inches	
Diamond Lake	1949	RB	1,348	5.5	Inches	
Diamond Lake	1949	RB	6,000	5.5	Inches	
Diamond Lake	1949	RB	6,748	5.5	Inches	
Diamond Lake	1949	RB	2,503	5.5	Inches	
Diamond Lake	1949	RB	5,519	5	Inches	
Diamond Lake	1949	RB	8,800	5	Inches	
Diamond Lake	1950	RB	4,800	6	Inches	
Diamond Lake	1950	RB	15,075	6.5	Inches	
Diamond Lake	1950	RB	6,800	6.5	Inches	
Diamond Lake	1950	RB	21,050	5.5	Inches	
Diamond Lake	1950	RB	13,200	6.5	Inches	
Diamond Lake	1950	RB	19,825	6	Inches	
Diamond Lake	1950	RB	8,100	6.5	Inches	
Diamond Lake	1950	RB	8,923	5.5	Inches	
Diamond Lake	1950	RB	6,750	7	Inches	
Diamond Lake	1951	RB	18,000	9	No./Lb.	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Diamond Lake	1951	RB	8,000	8	No./Lb.	
Diamond Lake	1951	RB	10,995	11	No./Lb.	
Diamond Lake	1951	RB	22,000	11	No./Lb.	
Diamond Lake	1951	RB	20,000	10	No./Lb.	
Diamond Lake	1951	RB	12,750	10	No./Lb.	
Diamond Lake	1951	RB	9,150	15	No./Lb.	
Diamond Lake	1951	RB	11,000	11	No./Lb.	
Diamond Lake	1951	RB	5,280	11	No./Lb.	
Diamond Lake	1951	RB	20,800	16	No./Lb.	
Diamond Lake	1951	RB	12,200	10	No./Lb.	
Diamond Lake	1952	RB	15,800	10	No./Lb.	
Diamond Lake	1952	RB	39,780	9	No./Lb.	
Diamond Lake	1952	RB	41,140	17	No./Lb.	
Diamond Lake	1952	RB	8,700	15	No./Lb.	
Diamond Lake	1952	RB	3,600	4.5	No./Lb.	
Diamond Lake	1952	RB	5,957	7	No./Lb.	
Diamond Lake	1952	RB	1,725	5	No./Lb.	
Diamond Lake	1953	RB	21,840	12	No./Lb.	
Diamond Lake	1953	RB	12,980	11	No./Lb.	
Diamond Lake	1953	RB	20,000	10	No./Lb.	
Diamond Lake	1953	RB	26,225	11	No./Lb.	
Diamond Lake	1953	RB	8,200	8	No./Lb.	
Diamond Lake	1953	RB	18,240	12	No./Lb.	
Diamond Lake	1953	RB	16,150	9.5	No./Lb.	
Diamond Lake	1953	RB	2,100	7	No./Lb.	
Diamond Lake	1953	RB	3,150	13	No./Lb.	
Diamond Lake	1953	RB	25,760	14	No./Lb.	
Diamond Lake	1954	RB	12,000	12	No./Lb.	
Diamond Lake	1954	RB	16,740	9	No./Lb.	
Diamond Lake	1954	RB	31,400	10	No./Lb.	
Diamond Lake	1954	RB	22,000	11	No./Lb.	
Diamond Lake	1954	RB	2,310	11	No./Lb.	
Diamond Lake	1954	RB	8,100	9	No./Lb.	
Diamond Lake	1954	RB	21,050	10.5	No./Lb.	
Diamond Lake	1954	RB	10,640	7	No./Lb.	
Diamond Lake	1954	RB	25,160	8.5	No./Lb.	
Diamond Lake	1955	RB	16,260	6	No./Lb.	
Diamond Lake	1955	RB	3,000	5	No./Lb.	
Diamond Lake	1955	RB	19,760	9.5	No./Lb.	
Diamond Lake	1955	RB	19,550	8.5	No./Lb.	
Diamond Lake	1955	RB	11,900	7	No./Lb.	
Diamond Lake	1955	RB	38,720	8	No./Lb.	
Diamond Lake	1955	RB	3,400	10	No./Lb.	
Diamond Lake	1955	RB	1,210	5	No./Lb.	
Diamond Lake	1956	RB	57,360	9	No./Lb.	
Diamond Lake	1956	RB	60,000	10	No./Lb.	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Diamond Lake	1956	RB	29,640	13	No./Lb.	
Diamond Lake	1956	RB	18,980	13	No./Lb.	
Diamond Lake	1956	RB	18,822	13.5	No./Lb.	
Diamond Lake	1957	RB	30,000	10	No./Lb.	
Diamond Lake	1957	RB	6,300	9	No./Lb.	
Diamond Lake	1957	RB	27,060	11	No./Lb.	
Diamond Lake	1957	RB	15,300	9	No./Lb.	
Diamond Lake	1958	RB	52,740	9	No./Lb.	
Diamond Lake	1958	RB	94,880	10	No./Lb.	
Diamond Lake	1959	RB	31,200	5	No./Lb.	
Diamond Lake	1959	RB	18,180	6	No./Lb.	
Diamond Lake	1959	RB	25,620	7	No./Lb.	
Diamond Lake	1960	EB	3,250	325	No./Lb.	
Diamond Lake	1960	RB	8,249	250	No./Lb.	
Diamond Lake	1960	RB	48,950	70	No./Lb.	
Diamond Lake	1960	RB	48,950	70	No./Lb.	
Diamond Lake	1960	RB	39,900	70	No./Lb.	
Diamond Lake	1960	RB	48,990	70	No./Lb.	
Diamond Lake	1960	RB	148,800	93	No./Lb.	
Diamond Lake	1961	CT	39,600	600	No./Lb.	
Diamond Lake	1961	CT	49,450	250	No./Lb.	
Diamond Lake	1961	RB	4,860	1.25	Lb.s	
Diamond Lake	1961	RB	202,220	50	No./Lb.	
Diamond Lake	1962	CT	100,000	310	No./Lb.	
Diamond Lake	1962	CT	44,390	300	No./Lb.	
Diamond Lake	1962	RB	163,375	120	No./Lb.	
Diamond Lake	1963	RB	300,300	130	No./Lb.	
Diamond Lake	1964	RB	100,320	132	No./Lb.	
Diamond Lake	1964	RB	5,415	2	Lb.s	
Diamond Lake	1964	RB	143,800	105	No./Lb.	
Diamond Lake	1964	RB	69,550	150	No./Lb.	
Diamond Lake	1965	RB	270,000	125	No./Lb.	
Diamond Lake	1965	RB	90,000	150	No./Lb.	
Diamond Lake	1965	RB	90,700	125	No./Lb.	
Diamond Lake	1966	RB	299,950	100	No./Lb.	
Diamond Lake	1968	CT	100,000	200	No./Lb.	
Diamond Lake	1969	CT	101,567	236	No./Lb.	
Diamond Lake	1969	CT	151,300	85	No./Lb.	
Diamond Lake	1970	CT	125,993	80	No./Lb.	
Diamond Lake	1970	CT	15,900	60	No./Lb.	
Diamond Lake	1971	CT	195,996	28	No./Lb.	
Diamond Lake	1971	CT	76,470	50	No./Lb.	
Diamond Lake	1972	CT	117,900	35	No./Lb.	
Diamond Lake	1973	RB	20,025	4	No./Lb.	
Diamond Lake	1973	RB	101,400	30	No./Lb.	
Diamond Lake	1974	CT	60,185	43	No./Lb.	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Diamond Lake	1974	RB	1,200	1.5	Lb.s	
Diamond Lake	1974	RB	30,000	5.5	No./Lb.	
Diamond Lake	1974	RB	1,437	2.2	No./Lb.	
Diamond Lake	1975	CT	10,005	23	No./Lb.	
Diamond Lake	1975	CT	65,300	25	No./Lb.	
Diamond Lake	1975	RB	20,650	7	No./Lb.	
Diamond Lake	1975	RB	676	4	No./Lb.	
Diamond Lake	1976	CT	34,400	43	No./Lb.	
Diamond Lake	1976	CT	51,570	54	No./Lb.	
Diamond Lake	1976	CT	15,600	20	No./Lb.	
Diamond Lake	1976	RB	10,064	7.4	No./Lb.	
Diamond Lake	1977	RB	10,080	6	No./Lb.	
Diamond Lake	1977	RB	10,017	4.2	No./Lb.	
Diamond Lake	1978	CT	52,365	6.5	No./Lb.	
Diamond Lake	1978	CT	70,560	72	No./Lb.	
Diamond Lake	1978	CT	70,470	81	No./Lb.	
Diamond Lake	1978	CT	23,485	11	No./Lb.	
Diamond Lake	1978	CT	47,075	35	No./Lb.	
Diamond Lake	1978	CT	40,365	69	No./Lb.	
Diamond Lake	1979	CT	100,000	46	No./Lb.	
Diamond Lake	1980	CT	43,550	65	No./Lb.	
Diamond Lake	1980	CT	122,075	65	No./Lb.	
Diamond Lake	1980	CT	84,350	70	No./Lb.	
Diamond Lake	1981	CT	21,400	107	No./Lb.	
Diamond Lake	1981	CT	34,500	92	No./Lb.	
Diamond Lake	1981	CT	154,750	43	No./Lb.	
Diamond Lake	1981	CT	32,200	20	No./Lb.	
Diamond Lake	1981	RB	9,000	10	No./Lb.	
Diamond Lake	1981	RB	63,212	18	No./Lb.	
Diamond Lake	1981	RB	9,000	10	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1981	RB	27,532	26	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1981	RB	23,980	21.8	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1981	RB	11,700	18	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1983	CT	69,875	65	No./Lb.	Westslope-Twin Lakes
Diamond Lake	1983	CT	35,280	42	No./Lb.	Westslope-Kings Lake
Diamond Lake	1983	CT	37,840	44	No./Lb.	Westslope-Kings Lake
Diamond Lake	1983	CT	13,880	8	No./Lb.	Westslope-Ford
Diamond Lake	1983	CT	27,360	14.4	No./Lb.	Westslope-Ford
Diamond Lake	1984	CT	23,400	52	No./Lb.	Westslope-Kings Lake
Diamond Lake	1984	CT	27,900	39	No./Lb.	Westslope-Ford
Diamond Lake	1988	CT	5,376	2.8	No./Lb.	Westslope-Ford
Diamond Lake	1988	CT	5,488	2.8	No./Lb.	Westslope-Ford
Diamond Lake	1988	CT	5,580	3	No./Lb.	Westslope-Ford
Diamond Lake	1988	CT	5,085	3	No./Lb.	Westslope-Ford
Diamond Lake	1988	CT	4,914	2.7	No./Lb.	Westslope-Ford
Diamond Lake	1988	CT	4,887	2.7	No./Lb.	Westslope-Ford

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Diamond Lake	1988	CT	4,060	2.8	No./Lb.	Westslope-Ford
Diamond Lake	1988	CT	4,928	2.8	No./Lb.	Westslope-Ford
Diamond Lake	1988	CT	37,620	57	No./Lb.	Westslope-Kings Lake
Diamond Lake	1988	CT	49,300	58	No./Lb.	Westslope-Kings Lake
Diamond Lake	1988	CT	42,300	47	No./Lb.	Westslope-Kings Lake
Diamond Lake	1988	CT	46,060	47	No./Lb.	Westslope-Kings Lake
Diamond Lake	1988	CT	24,750	45	No./Lb.	Westslope-Kings Lake
Diamond Lake	1988	RB	246	0.4	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1988	RB	1,440	2	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1988	RB	8,400	5.6	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1988	RB	8,305	5.5	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1988	RB	8,700	5.8	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1988	RB	8,700	5.8	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1988	RB	3,944	5.8	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1989	CT	30,288	48	No./Lb.	Westslope-Kings Lake
Diamond Lake	1989	CT	56,870	47	No./Lb.	Westslope-Kings Lake
Diamond Lake	1989	CT	53,579	65.5	No./Lb.	Westslope-Kings Lake
Diamond Lake	1989	RB	4	0.3	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1989	RB	16	0.6	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1990	CT	38,400	48	No./Lb.	Westslope-Kings Lake
Diamond Lake	1990	CT	36,480	48	No./Lb.	Westslope-Kings Lake
Diamond Lake	1990	CT	37,278	32.7	No./Lb.	Westslope-Kings Lake
Diamond Lake	1991	CT	29,797	43.5	No./Lb.	Westslope-Kings Lake
Diamond Lake	1991	CT	9,408	73.5	No./Lb.	Westslope-Twin Lakes
Diamond Lake	1991	CT	57,825	45	No./Lb.	Westslope-Twin Lakes
Diamond Lake	1991	CT	17,760	37	No./Lb.	Westslope-Kings Lake
Diamond Lake	1991	RB	18	0.5	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1992	CT	17,387	53.5	No./Lb.	Westslope-Kings Lake
Diamond Lake	1992	CT	21,300	30	No./Lb.	Westslope-Kings Lake
Diamond Lake	1992	CT	3,375	22.5	No./Lb.	Westslope-Kings Lake
Diamond Lake	1992	RB	20	0.3	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1992	RB	10,080	63	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1992	RB	30,000	50	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1993	RB	16	0.3	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1993	RB	50,400	70	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1993	RB	50,049	83	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1993	RB	49,780	76	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1994	RB	50,368	64	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1994	RB	48,360	60	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1994	RB	52,160	64	No./Lb.	Spokane-McCloud R. CA
Diamond Lake	1995	RB	35,283	57	No./Lb.	
Diamond Lake	1995	RB	35,340	57	No./Lb.	
Diamond Lake	1995	RB	14,690	56.5	No./Lb.	
Diamond Lake	1995	RB	30,318	62	No./Lb.	
Diamond Lake	1995	RB	36,512	56	No./Lb.	
Diamond Lake	1995	RB	26,695	38.3	No./Lb.	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Diamond Lake	1996	RB	45,144	114	No./Lb.	
Diamond Lake	1997	RB	182	0.2	No./Lb.	
Diamond Lake	1997	RB	2,000	2.5	No./Lb.	Lyons Ferry surplus
Diamond Lake	1997	RB	69,768	17	No./Lb.	
Diamond Lake	1997	RB	2,800	2.5	No./Lb.	
Diamond Lake	1997	RB	250	0.28	No./Lb.	
Diamond Lake	1998	RB/SH	1,000	1.5	Lb.s	Rufus Woods Net Pen - triploids
Diamond Lake	1999	RB	80	0.4	No./Lb.	Spokane
Diamond Lake	1999	RB	120	0.25	No./Lb.	Spokane
Diamond Lake	1999	RB	18,180	5.6	No./Lb.	Spokane
Diamond Lake	1999	RB	6,878	4	No./Lb.	Spokane
Diamond Lake	2000	BT	4,031	5.8	No./Lb.	Ford
Diamond Lake	2000	RB	150	0.25	No./Lb.	Spokane
Diamond Lake	2000	RB	639	0.5	No./Lb.	Spokane
Diamond Lake	2001	BT	7,369	5.1	No./Lb.	Ford
Diamond Lake	2001	RB	1,770	4.85	No./Lb.	Spokane
Diamond Lake	2001	RB	11,990	5.1	No./Lb.	Diamond Lake net pen - Spokane
Diamond Lake	2001	RB	63	0.423	No./Lb.	Spokane
Diamond Lake	2001	RB	137	0.16	No./Lb.	Spokane
Dragoon Creek	1934	EB	30,000	4	Inches	
Dragoon Creek	1934	EB	45,080	5	Inches	
Dragoon Creek	1934	RB	8,250	4	Inches	
Dragoon Creek	1936	CT	10,750	4.5	Inches	
Dragoon Creek	1936	RB	28,000	3	Inches	
Dragoon Creek	1936	RB	30,000	3	Inches	
Dragoon Creek	1936	RB	10,000	3	Inches	
Dragoon Creek	1937	CT	8,000	3.5	Inches	
Dragoon Creek	1937	RB	5,000	5	Inches	
Dragoon Creek	1937	RB	9,665	1.5	Inches	
Dragoon Creek	1938	RB	900	4	Inches	
Dragoon Creek	1938	RB	100	10	Inches	
Dragoon Creek	1938	RB	3,000	4	Inches	
Dragoon Creek	1938	RB	1,200	6	Inches	
Dragoon Creek	1939	RB	6,989	4	Inches	
Dragoon Creek	1939	RB	3,412	3	Inches	
Dragoon Creek	1940	EB	45,000	1	Inches	
Dragoon Creek	1941	EB	24,985	1	Inches	
Dragoon Creek	1941	RB	10,180	5	Inches	
Dragoon Creek	1942	RB	20,000	1.5	Inches	
Dragoon Creek	1943	RB	14,985	3	Inches	
Dragoon Creek	1943	RB	11,394	3	Inches	
Dragoon Creek	1944	RB	15,000	4	Inches	
Dragoon Creek	1944	RB	15,000	4	Inches	
Dragoon Creek	1945	RB	19,490	0	N/A	
Dragoon Creek	1946	RB	16,994	5	Inches	
Dragoon Creek	1947	RB	14,348	4	Inches	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Dragoon Creek	1948	EB	3,592	2	Inches	
Dragoon Creek	1948	RB	3,374	7	Inches	
Dragoon Creek	1949	RB	2,520	7.5	Inches	
Dragoon Creek	1949	RB	2,483	7.5	Inches	
Dragoon Creek	1950	RB	14,500	4.5	Inches	
Dragoon Creek	1951	RB	5,000	7	No./Lb.	
Dragoon Creek	1952	RB	5,000	5	No./Lb.	
Dragoon Creek	1953	RB	7,780	6	No./Lb.	
Dragoon Creek	1953	RB	2,550	7.5	No./Lb.	
Dragoon Creek	1954	RB	3,300	11	No./Lb.	
Dragoon Creek	1959	BT	35,390	295	No./Lb.	
Dragoon Creek	1964	BT	2,697	87	No./Lb.	
Dragoon Creek	1977	BT	1,008	21	No./Lb.	
Dragoon Creek	1979	BT	1,000	25	No./Lb.	
Dragoon Creek	1980	BT	1,050	35	No./Lb.	
Dragoon Creek	1983	BT	300	12	No./Lb.	Mt. Shasta California
Dragoon Creek	1985	RB	350	5	No./Lb.	Spokane-McCloud R. CA
Dragoon Creek	1986	EB	450	3.6	No./Lb.	E. Brook-Ford (Owhi Lake)
Dragoon Creek	1988	EB	120	4	No./Lb.	E. Brook-Ford (Owhi Lake)
Dragoon Creek	1989	EB	400	4	No./Lb.	E. Brook-Ford (Owhi Lake)
Dry Creek	1936	RB	10,000	3	Inches	
Dry Creek	1954	EB	2,550	850	No./Lb.	
E.B. Little Spokane River	1938	EB	8,000	3	Inches	
E.B. Little Spokane River	1938	RB	3,000	5	Inches	
E.B. Little Spokane River	1939	EB	4,992	3	Inches	
E.B. Little Spokane River	1939	RB	4,998	4	Inches	
E.B. Little Spokane River	1940	EB	4,992	3	Inches	
E.B. Little Spokane River	1941	EB	49,950	1	Inches	
Eloika Lake	1934	B	1,000	0	N/A	
Eloika Lake	1934	B	2,000	0	N/A	
Eloika Lake	1934	B	3,000	0	N/A	
Eloika Lake	1934	C	500	0	N/A	
Eloika Lake	1934	C	1,000	0	N/A	
Eloika Lake	1934	C	1,000	0	N/A	
Eloika Lake	1934	CF	1,000	0	N/A	
Eloika Lake	1934	CF	1,000	0	N/A	
Eloika Lake	1934	CF	1,000	0	N/A	
Eloika Lake	1934	YP	1,000	0	N/A	
Eloika Lake	1934	YP	1,000	0	N/A	
Eloika Lake	1936	YP	1,200	3	Inches	
Eloika Lake	1986	BT	5,016	11.4	No./Lb.	Ford (Mt. Shasta, CA)
Eloika Lake	1987	BT	5,014	4.6	No./Lb.	Ford (Mt. Shasta, CA)
Eloika Lake	1987	BT	10,038	21	No./Lb.	Ford (Mt. Shasta, CA)
Eloika Lake	1988	BT	200	0.5	No./Lb.	Ford (Mt. Shasta, CA)
Eloika Lake	1988	BT	5,040	4.5	No./Lb.	Ford (Mt. Shasta, CA)
Eloika Lake	1988	BT	10,011	14.1	No./Lb.	Ford (Mt. Shasta, CA)

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Eloika Lake	1989	BT	475	0.5	No./Lb.	Ford (Mt. Shasta, CA)
Eloika Lake	1989	BT	5,040	4.2	No./Lb.	Ford (Mt. Shasta, CA)
Eloika Lake	1989	BT	10,050	15	No./Lb.	Ford (Mt. Shasta, CA)
Eloika Lake	1990	BT	5,005	5.5	No./Lb.	Ford (Mt. Shasta, CA)
Eloika Lake	1990	BT	4,930	17	No./Lb.	Ford (Mt. Shasta, CA)
Eloika Lake	1991	BT	2,515	4.3	No./Lb.	Ford (Mt. Shasta, CA)
Eloika Lake	1992	BT	3,015	4.5	No./Lb.	Ford (Mt. Shasta, CA)
Eloika Lake	1993	BT	3,000	5	No./Lb.	Ford (Mt. Shasta, CA)
Eloika Lake	1994	BT	3,003	4.2	No./Lb.	Ford (Mt. Shasta, CA)
Eloika Lake	1995	BT	3,000	4	No./Lb.	Ford
Eloika Lake	1997	BT	3,000	4	No./Lb.	Ford
Eloika Lake	1998	BT	3,015	4.5	No./Lb.	Ford
Eloika Lake	1999	BT	3,000	5	No./Lb.	Ford
Eloika Lake	2000	BT	4,015	5.5	No./Lb.	Ford
Eloika Lake	2001	BT	5,070	5.2	No./Lb.	Ford
Fan Lake	1934	B	4,000	0	N/A	
Fan Lake	1934	C	1,000	0	N/A	
Fan Lake	1934	CF	4,000	0	N/A	
Fan Lake	1934	YP	1,000	0	N/A	
Fan Lake	1936	B	200	2.5	Inches	
Fan Lake	1941	RB	5,000	4.5	Inches	
Fan Lake	1942	RB	3,250	7	Inches	
Fan Lake	1942	RB	5,000	1	Inches	
Fan Lake	1943	RB	4,400	6	Inches	
Fan Lake	1943	RB	6,710	6	Inches	
Fan Lake	1944	RB	35,000	1	Inches	
Fan Lake	1944	RB	2,250	9	Inches	
Fan Lake	1944	RB	2,500	9	Inches	
Fan Lake	1945	RB	2,700	8	Inches	
Fan Lake	1945	RB	3,298	8	Inches	
Fan Lake	1945	RB	5,400	5.5	Inches	
Fan Lake	1945	RB	4,770	5.5	Inches	
Fan Lake	1946	EB	2,180	1.5	Inches	
Fan Lake	1947	RB	4,900	9	Inches	
Fan Lake	1947	RB	4,900	9	Inches	
Fan Lake	1947	RB	8,975	4.5	Inches	
Fan Lake	1947	RB	6,330	4.5	Inches	
Fan Lake	1949	RB	10,010	5.5	Inches	
Fan Lake	1950	RB	13,975	6.5	Inches	
Fan Lake	1951	RB	7,200	9	No./Lb.	
Fan Lake	1951	RB	6,717	8	No./Lb.	
Fan Lake	1951	RB	6,080	10	No./Lb.	
Fan Lake	1952	RB	18,020	8.5	No./Lb.	
Fan Lake	1953	RB	5,000	10	No./Lb.	
Fan Lake	1953	RB	10,020	8	No./Lb.	
Fan Lake	1954	RB	6,300	9	No./Lb.	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Fan Lake	1954	RB	13,680	12	No./Lb.	
Fan Lake	1956	CT	7,254	558	No./Lb.	
Fan Lake	1956	CT	48,238	542	No./Lb.	
Fan Lake	1957	CT	52,240	950	No./Lb.	
Fan Lake	1957	CT	3,000	1200	No./Lb.	
Fan Lake	1958	CT	60,075	325	No./Lb.	
Fan Lake	1962	CT	40,240	440	No./Lb.	
Fan Lake	1962	RB	46,200	60	No./Lb.	
Fan Lake	1963	CT	30,240	280	No./Lb.	
Fan Lake	1964	CT	30,250	275	No./Lb.	
Fan Lake	1965	CT	50,000	300	No./Lb.	
Fan Lake	1966	CT	20,000	50	No./Lb.	
Fan Lake	1967	CT	30,000	50	No./Lb.	
Fan Lake	1968	CT	35,000	100	No./Lb.	
Fan Lake	1969	CT	35,900	80	No./Lb.	
Fan Lake	1970	CT	35,200	80	No./Lb.	
Fan Lake	1971	CT	25,000	50	No./Lb.	
Fan Lake	1976	CT	30,000	20	No./Lb.	
Fan Lake	1977	CT	35,460	43	No./Lb.	
Fan Lake	1978	CT	14,450	17	No./Lb.	
Fan Lake	1978	CT	20,580	49	No./Lb.	
Fan Lake	1979	CT	30,003	32	No./Lb.	
Fan Lake	1980	CT	30,020	38	No./Lb.	
Fan Lake	1980	CT	1,872	1.3	No./Lb.	
Fan Lake	1981	CT	30,010	28.5	No./Lb.	
Fan Lake	1981	CT	959	1.4	No./Lb.	
Fan Lake	1984	CT	10,100	4	No./Lb.	Westslope-Ford
Fan Lake	1984	CT	25,000	25	No./Lb.	Westslope-Ford
Fan Lake	1985	CT	25,330	17	No./Lb.	Westslope-Ford
Fan Lake	1986	CT	3,045	2.9	No./Lb.	Westslope-Ford
Fan Lake	1986	CT	22,005	27	No./Lb.	Westslope-Ford
Fan Lake	1987	CT	25,305	21	No./Lb.	Westslope-Ford
Fan Lake	1988	CT	25,200	28	No./Lb.	Westslope-Kings Lake
Fan Lake	1990	CT	7,119	6.3	No./Lb.	Westslope-Kings Lake
Fan Lake	1990	CT	7,030	32.7	No./Lb.	Westslope-Kings Lake
Fan Lake	1990	RB	7,025	5	No./Lb.	Spokane-McCloud R. CA
Fan Lake	1990	RB	7,020	6.5	No./Lb.	Spokane-McCloud R. CA
Fan Lake	1991	CT	8,100	20	No./Lb.	Westslope-Kings Lake
Fan Lake	1992	CT	6,000	30	No./Lb.	Westslope-Kings Lake
Fan Lake	1993	CT	8,019	37.3	No./Lb.	Westslope-Kings Lake
Fan Lake	1994	RB	8,040	67	No./Lb.	Spokane-McCloud R. CA
Fan Lake	1995	RB	1,015	5.8	No./Lb.	Spokane
Fan Lake	1995	RB	25,636	58	No./Lb.	Spokane
Fan Lake	1995	RB	25,200	60	No./Lb.	Spokane
Fan Lake	1996	RB	1,000	5	No./Lb.	Spokane
Fan Lake	1997	RB	1,275	5.1	No./Lb.	Spokane

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Fan Lake	1998	RB	1,000	5.5	No./Lb.	Spokane
Fan Lake	1999	RB	1,000	5.7	No./Lb.	Spokane
Fan Lake	2000	RB	2,007	4.9	No./Lb.	Spokane
Fan Lake	2001	RB	2,009	4.8	No./Lb.	Spokane
Horseshoe Lake	1982	LT	4,123	21.7	No./Lb.	Mackinaw-Tunison NY
Horseshoe Lake	1983	LT	10,080	140	No./Lb.	Mackinaw-Jenny L. WY
Horseshoe Lake	1985	LT	4,200	35	No./Lb.	Mackinaw-Jenny L. WY
Horseshoe Lake	1986	LT	2,184	39	No./Lb.	Mackinaw-Jenny L. WY
Horseshoe Lake	1989	RB	5,127	3.5	No./Lb.	Spokane-McCloud R. CA
Horseshoe Lake	1989	RB	6,320	3.2	No./Lb.	Spokane-McCloud R. CA
Horseshoe Lake	1990	RB	6,412	4.5	No./Lb.	Spokane-McCloud R. CA
Horseshoe Lake	1990	RB	6,666	6.6	No./Lb.	Spokane-McCloud R. CA
Horseshoe Lake	1991	RB	9,600	6.4	No./Lb.	Spokane-McCloud R. CA
Horseshoe Lake	1992	RB	5,423	4.5	No./Lb.	Spokane-McCloud R. CA
Horseshoe Lake	1992	RB	4,613	4.5	No./Lb.	Spokane-McCloud R. CA
Horseshoe Lake	1993	RB	4,103	4.6	No./Lb.	Spokane-McCloud R. CA
Horseshoe Lake	1994	RB	4,056	4.8	No./Lb.	Spokane-McCloud R. CA
Horseshoe Lake	1995	RB	7,566	5.2	No./Lb.	Spokane
Horseshoe Lake	1996	RB	7,497	4.9	No./Lb.	Spokane
Horseshoe Lake	1997	RB	6,375	5.1	No./Lb.	Spokane
Horseshoe Lake	1998	RB	7,500	5.5	No./Lb.	Spokane
Horseshoe Lake	1999	RB	7,664	5.7	No./Lb.	Spokane
Horseshoe Lake	2000	RB	7,475	4.5	No./Lb.	Spokane
Horseshoe Lake	2001	RB	7,499	4.7	No./Lb.	Spokane
Little Spokane River	1933	CT	143,730	0	N/A	
Little Spokane River	1933	CT	96,000	0	N/A	
Little Spokane River	1933	EB	60,000	0	N/A	
Little Spokane River	1933	EB	50,000	0	N/A	
Little Spokane River	1933	RB	10,000	0	N/A	
Little Spokane River	1933	RB	131,655	0	N/A	
Little Spokane River	1934	CT	308,150	3.5	Inches	
Little Spokane River	1934	EB	30,000	2.5	Inches	
Little Spokane River	1934	RB	9,250	1.25	Inches	
Little Spokane River	1935	EB	40,000	1.25	Inches	
Little Spokane River	1935	EB	40,000	1.25	Inches	
Little Spokane River	1935	EB	50,000	2.5	Inches	
Little Spokane River	1936	EB	25,000	1.75	Inches	
Little Spokane River	1936	RB	58,000	3	Inches	
Little Spokane River	1936	RB	10,650	3	Inches	
Little Spokane River	1936	RB	22,000	5	Inches	
Little Spokane River	1936	RB	6,000	5	Inches	
Little Spokane River	1937	CT	8,000	3.5	Inches	
Little Spokane River	1937	EB	750	4	Inches	
Little Spokane River	1937	RB	750	4	Inches	
Little Spokane River	1937	RB	2,325	6	Inches	
Little Spokane River	1937	RB	6,090	7	Inches	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Little Spokane River	1937	RB	10,560	5	Inches	
Little Spokane River	1938	RB	1,200	4	Inches	
Little Spokane River	1938	RB	2,000	5	Inches	
Little Spokane River	1938	RB	1,400	4	Inches	
Little Spokane River	1938	RB	100	10	Inches	
Little Spokane River	1938	RB	3,000	4	Inches	
Little Spokane River	1939	RB	9,988	4	Inches	
Little Spokane River	1940	CT	5,756	4	Inches	
Little Spokane River	1940	RB	6,990	4	Inches	
Little Spokane River	1941	RB	17,990	4	Inches	
Little Spokane River	1941	RB	16,391	4	Inches	
Little Spokane River	1942	RB	18,800	3	Inches	
Little Spokane River	1943	RB	13,990	4	Inches	
Little Spokane River	1943	RB	20,790	3	Inches	
Little Spokane River	1944	RB	17,100	3	Inches	
Little Spokane River	1944	RB	22,480	3	Inches	
Little Spokane River	1945	RB	26,265	0	N/A	
Little Spokane River	1948	RB	6,125	7	Inches	
Little Spokane River	1948	RB	3,507	7	Inches	
Little Spokane River	1948	RB	792	8	Inches	
Little Spokane River	1949	RB	2,000	6.5	Inches	
Little Spokane River	1949	RB	3,708	7.5	Inches	
Little Spokane River	1949	RB	3,199	6.5	Inches	
Little Spokane River	1949	RB	3,152	6.5	Inches	
Little Spokane River	1951	RB	15,080	7	No./Lb.	
Little Spokane River	1952	RB	5,000	5	No./Lb.	
Little Spokane River	1953	RB	10,080	6	No./Lb.	
Little Spokane River	1980	BT	3,400	34	No./Lb.	
Little Spokane River	1981	RB	4,800	40	No./Lb.	
Little Spokane River	1981	RB	4,800	40	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1983	BT	10,000	16	No./Lb.	Mt. Shasta California
Little Spokane River	1983	RB	22,410	249	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1984	BT	120	2.5	No./Lb.	Mt. Shasta California
Little Spokane River	1984	BT	9,900	110	No./Lb.	Ford (Mt. Shasta, CA)
Little Spokane River	1984	BT	10,160	12.7	No./Lb.	Ford (Mt. Shasta, CA)
Little Spokane River	1984	BT	1,096	13.7	No./Lb.	Ford (Mt. Shasta, CA)
Little Spokane River	1984	EB	11,700	45	No./Lb.	E. Brook-Ford (Owhi Lake)
Little Spokane River	1984	RB	936	1.8	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1984	RB	46,065	111	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1984	RB	2,937	11	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1984	RB	2,000	400	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1984	RB	600	60	No./Lb.	Ross Lake
Little Spokane River	1984	RB	1,514	14.7	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1986	BT	1,026	11.4	No./Lb.	Ford (Mt. Shasta, CA)
Little Spokane River	1986	RB	18,000	450	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1986	RB	3,480	40	No./Lb.	Spokane-McCloud R. CA

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Little Spokane River	1987	BT	5,000	4	No./Lb.	Ford (Mt. Shasta, CA)
Little Spokane River	1987	EB	6,624	72	No./Lb.	E. Brook-Ford (Owhi Lake)
Little Spokane River	1987	RB	11,760	70	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1987	RB	875	35	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1988	BT	4,025	3.5	No./Lb.	Ford (Mt. Shasta, CA)
Little Spokane River	1988	EB	36,386	113	No./Lb.	E. Brook-Ford (Owhi Lake)
Little Spokane River	1988	RB	1,000	5	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1988	RB	1,046	1.7	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1988	RB	25,070	218	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1988	RB	6,243	38.3	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1989	BT	4,952	3.5	No./Lb.	Ford (Mt. Shasta, CA)
Little Spokane River	1989	RB	1,000	2	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1989	RB	15,048	228	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1990	BT	2,000	100	No./Lb.	Ford (Mt. Shasta, CA)
Little Spokane River	1990	EB	17,712	1968	No./Lb.	E. Brook-Ford (Owhi Lake)
Little Spokane River	1990	RB	22	0.1	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1990	RB	363	2.2	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1990	RB	1,116	31	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1991	BT	5,418	86	No./Lb.	Ford (Mt. Shasta, CA)
Little Spokane River	1991	RB	1,000	2.9	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1991	RB	506	2.2	No./Lb.	E. Brook-Ford (Owhi Lake)
Little Spokane River	1992	RB	1,000	2.5	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1993	BT	651	2.1	No./Lb.	Ford (Mt. Shasta, CA)
Little Spokane River	1993	BT	50	2.1	No./Lb.	Ford (Mt. Shasta, CA)
Little Spokane River	1993	RB	1,040	3.2	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1993	RB	50	3.2	No./Lb.	Spokane-McCloud R. CA
Little Spokane River	1999	RB	2,000	4	No./Lb.	Spokane
Little Spokane River	2000	RB	2,001	4.35	No./Lb.	Spokane
Little Spokane River	2001	RB	1,470	3	No./Lb.	Spokane
Little Spokane River	1995	RB	1,907	4.1	No./Lb.	Spokane
Little Spokane River	1996	RB	1,820	4	No./Lb.	Spokane
Little Spokane River	1996	RB	2,000	2.5	No./Lb.	Spokane
Little Spokane River	1996	RB	2,415	2.5	No./Lb.	Spokane
Little Spokane River	1996	RB	50,725	16.4	No./Lb.	Spokane
Little Spokane River	1996	RB	14,285	12.4	No./Lb.	Spokane
Little Spokane River	1997	RB	4,033	3.7	No./Lb.	Spokane
Little Spokane River	1998	RB	1,617	3.3	No./Lb.	Spokane
Lost Lake	1940	K	50,700	0	N/A	
Lost Lake	1953	EB	10,283	1582	No./Lb.	
Lost Lake	1957	EB	5,012	716	No./Lb.	
Moon Creek	1934	EB	10,000	1.25	Inches	
Moon Creek	1935	EB	20,000	1.25	Inches	
Moon Creek	1935	EB	20,000	1.25	Inches	
Moon Creek	1936	EB	15,000	1.75	Inches	
Moon Creek	1937	EB	25,000	1.25	Inches	
Moon Creek	1940	EB	10,363	0.75	Inches	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Moon Creek	1941	EB	35,200	1	Inches	
Moon Creek	1954	EB	3,400	850	No./Lb.	
Moon Creek	1978	EB	200	2	No./Lb.	
Mud Creek	1948	EB	1,500	2	Inches	
Mud Creek	1950	EB	10,300	1	Inches	
Mud Creek	1974	RB	180	3	No./Lb.	
Mud Creek	1976	EB	263	3.5	No./Lb.	
Mud Creek	1977	RB	516	4.3	No./Lb.	
Mud Creek	1978	RB	215	3.3	No./Lb.	
Otter Creek	1936	RB	10,000	3	Inches	
Otter Creek	1941	EB	12,495	1	Inches	
Otter Creek	1944	EB	10,200	1	Inches	
Otter Creek	1949	EB	9,200	1	Inches	
Reflection Lake	1997	EB	1,025	41	No./Lb.	Ford
Sacheen Lake	1933	EB	50,000	0	N/A	
Sacheen Lake	1933	EB	50,000	0	N/A	
Sacheen Lake	1934	EB	60,000	1.25	Inches	
Sacheen Lake	1935	EB	40,000	1.25	Inches	
Sacheen Lake	1936	EB	8,000	5	Inches	
Sacheen Lake	1939	CT	160	4	Inches	
Sacheen Lake	1939	CT	51	6	Inches	
Sacheen Lake	1939	EB	51	6	Inches	
Sacheen Lake	1939	EB	21	4	Inches	
Sacheen Lake	1939	EB	10,000	3	Inches	
Sacheen Lake	1939	RB	21	4	Inches	
Sacheen Lake	1939	RB	51	6	Inches	
Sacheen Lake	1949	RB	15,431	5	Inches	
Sacheen Lake	1949	RB	15,007	5	Inches	
Sacheen Lake	1949	RB	7,627	5	Inches	
Sacheen Lake	1949	RB	11,835	5	Inches	
Sacheen Lake	1950	RB	19,513	6	Inches	
Sacheen Lake	1950	RB	10,400	6.5	Inches	
Sacheen Lake	1950	RB	10,800	6.5	Inches	
Sacheen Lake	1950	RB	4,988	6.5	Inches	
Sacheen Lake	1950	RB	9,976	6.5	Inches	
Sacheen Lake	1951	RB	10,000	10	No./Lb.	
Sacheen Lake	1951	RB	17,800	10	No./Lb.	
Sacheen Lake	1951	RB	12,535	11	No./Lb.	
Sacheen Lake	1951	RB	10,600	10	No./Lb.	
Sacheen Lake	1952	RB	19,800	6	No./Lb.	
Sacheen Lake	1952	RB	15,900	5	No./Lb.	
Sacheen Lake	1952	RB	14,560	8	No./Lb.	
Sacheen Lake	1952	RB	7,860	6	No./Lb.	
Sacheen Lake	1952	RB	1,890	4.5	Inches	
Sacheen Lake	1953	RB	8,000	8	No./Lb.	
Sacheen Lake	1953	RB	56,000	7	No./Lb.	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Sacheen Lake	1953	RB	14,140	7	No./Lb.	
Sacheen Lake	1954	RB	52,500	7.5	No./Lb.	
Sacheen Lake	1954	RB	8,000	8	No./Lb.	
Sacheen Lake	1954	RB	4,050	13.5	No./Lb.	
Sacheen Lake	1955	RB	2,114	2	Lb.s	
Sacheen Lake	1955	RB	13,500	5	No./Lb.	
Sacheen Lake	1955	RB	3,000	6	No./Lb.	
Sacheen Lake	1955	RB	18,000	47	No./Lb.	
Sacheen Lake	1955	RB	4,265	4	No./Lb.	
Sacheen Lake	1955	RB	11,262	6	No./Lb.	
Sacheen Lake	1956	RB	1,300	2.5	Lb.s	
Sacheen Lake	1956	RB	4,690	7	No./Lb.	
Sacheen Lake	1956	RB	6,640	8	No./Lb.	
Sacheen Lake	1956	RB	3,680	5.5	No./Lb.	
Sacheen Lake	1956	RB	10,600	6.5	Inches	
Sacheen Lake	1956	RB	18,400	8	No./Lb.	
Sacheen Lake	1956	RB	7,500	5	No./Lb.	
Sacheen Lake	1956	RB	4,400	5	No./Lb.	
Sacheen Lake	1956	RB	3,200	8	No./Lb.	
Sacheen Lake	1956	RB	10,500	7	No./Lb.	
Sacheen Lake	1957	RB	1,000	1.5	Inches	
Sacheen Lake	1957	RB	750	1.5	Inches	
Sacheen Lake	1957	RB	15,660	9	Inches	
Sacheen Lake	1957	RB	9,000	9	No./Lb.	
Sacheen Lake	1957	RB	6,000	8	No./Lb.	
Sacheen Lake	1957	RB	14,080	8	No./Lb.	
Sacheen Lake	1957	RB	7,200	8	No./Lb.	
Sacheen Lake	1957	RB	7,650	9	No./Lb.	
Sacheen Lake	1957	RB	4,565	5.5	No./Lb.	
Sacheen Lake	1958	RB	1,317	2	Lb.s	
Sacheen Lake	1958	RB	9,940	2.6	No./Lb.	
Sacheen Lake	1958	RB	18,000	6	No./Lb.	
Sacheen Lake	1958	RB	33,750	7.5	No./Lb.	
Sacheen Lake	1958	RB	256,000	10	No./Lb.	
Sacheen Lake	1959	RB	1,670	2.5	Inches	
Sacheen Lake	1959	RB	9,000	6	No./Lb.	
Sacheen Lake	1959	RB	27,000	6	No./Lb.	
Sacheen Lake	1959	RB	9,600	6	No./Lb.	
Sacheen Lake	1959	RB	8,030	5.5	Inches	
Sacheen Lake	1960	RB	3,600	3	No./Lb.	
Sacheen Lake	1960	RB	3,600	3	No./Lb.	
Sacheen Lake	1960	RB	690	3	No./Lb.	
Sacheen Lake	1960	RB	2,400	4	No./Lb.	
Sacheen Lake	1960	RB	2,690	4.5	No./Lb.	
Sacheen Lake	1960	RB	5,980	4	No./Lb.	
Sacheen Lake	1960	RB	5,580	3.2	No./Lb.	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Sacheen Lake	1960	RB	5,110	3.2	No./Lb.	
Sacheen Lake	1960	RB	6,390	4	No./Lb.	
Sacheen Lake	1960	RB	6,170	4	Inches	
Sacheen Lake	1960	RB	4,890	3.5	Inches	
Sacheen Lake	1960	RB	3,500	3.5	Inches	
Sacheen Lake	1961	EB	10,190	425	No./Lb.	
Sacheen Lake	1961	RB	71,960	185	No./Lb.	
Sacheen Lake	1961	RB	68,900	260	No./Lb.	
Sacheen Lake	1962	EB	109,000	82	No./Lb.	
Sacheen Lake	1963	EB	76,300	115	No./Lb.	
Sacheen Lake	1964	EB	36,472	6.5	No./Lb.	
Sacheen Lake	1965	EB	52,620	4.5	No./Lb.	
Sacheen Lake	1965	EB	32,400	60	No./Lb.	
Sacheen Lake	1965	EB	38,100	100	No./Lb.	
Sacheen Lake	1966	EB	51,400	130	No./Lb.	
Sacheen Lake	1967	EB	50,000	100	No./Lb.	
Sacheen Lake	1969	EB	5,221	2.3	No./Lb.	
Sacheen Lake	1969	EB	30,000	6	No./Lb.	
Sacheen Lake	1969	EB	28,600	11	No./Lb.	
Sacheen Lake	1970	EB	230	2.5	Lb.s	
Sacheen Lake	1970	EB	624	1.3	No./Lb.	
Sacheen Lake	1970	EB	51,483	4	Inches	
Sacheen Lake	1970	EB	125,550	135	No./Lb.	
Sacheen Lake	1971	EB	150,000	120	No./Lb.	
Sacheen Lake	1972	EB	51,250	85	No./Lb.	
Sacheen Lake	1973	EB	1,000	1	Lb.s	
Sacheen Lake	1973	EB	36,000	4.5	No./Lb.	
Sacheen Lake	1973	EB	173,115	90	No./Lb.	
Sacheen Lake	1973	EB	17,390	4	No./Lb.	
Sacheen Lake	1973	RB	700	5	Lb.s	
Sacheen Lake	1974	EB	10,125	5.4	No./Lb.	
Sacheen Lake	1974	EB	60,008	37	No./Lb.	
Sacheen Lake	1975	EB	505	2	Lb.s	
Sacheen Lake	1975	EB	16,300	3.5	No./Lb.	
Sacheen Lake	1975	EB	70,358	31.6	No./Lb.	
Sacheen Lake	1976	EB	10,003	3.5	No./Lb.	
Sacheen Lake	1977	EB	327	2.25	Lb.s	
Sacheen Lake	1977	EB	60,032	104	No./Lb.	
Sacheen Lake	1977	RB	2,101	1.7	No./Lb.	
Sacheen Lake	1977	RB	8,150	3	No./Lb.	
Sacheen Lake	1978	EB	12,220	4.7	No./Lb.	
Sacheen Lake	1978	EB	3,784	4.3	No./Lb.	
Sacheen Lake	1978	EB	45,898	106	No./Lb.	
Sacheen Lake	1978	RB	450	4	Lb.s	
Sacheen Lake	1978	RB	530	2	Lb.s	
Sacheen Lake	1979	EB	15,027	4.3	No./Lb.	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Sacheen Lake	1980	EB	2,229	1.2	No./Lb.	
Sacheen Lake	1980	EB	35,016	4.6	No./Lb.	
Sacheen Lake	1980	EB	101,480	150	No./Lb.	
Sacheen Lake	1980	RB	30,000	120	No./Lb.	
Sacheen Lake	1981	EB	500	1.03	No./Lb.	
Sacheen Lake	1981	EB	1,000	1	No./Lb.	
Sacheen Lake	1981	EB	20,117	4.4	No./Lb.	
Sacheen Lake	1981	EB	51,500	103	No./Lb.	
Sacheen Lake	1981	RB	10,080	6	No./Lb.	
Sacheen Lake	1981	RB	51,500	103	No./Lb.	
Sacheen Lake	1982	EB	35,616	168	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1982	EB	44,950	145	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1982	RB	50,400	112	No./Lb.	
Sacheen Lake	1982	RB	50,400	112	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1983	EB	41,480	122	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1983	EB	38,700	129	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1983	RB	51,590	77	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1984	EB	80,300	146	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1984	RB	50,000	80	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1985	EB	36,450	90	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1985	EB	44,220	134	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1985	EB	10,508	14.2	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1985	RB	50,400	84	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1986	EB	40,320	112	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1986	EB	39,884	118	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1986	RB	50,400	90	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1987	EB	4,060	2.8	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1987	EB	41,943	123	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1987	EB	40,500	135	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1987	RB	50,250	75	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1988	EB	50,809	149	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1988	RB	25,025	65	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1988	RB	30,914	58	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1989	EB	4,560	3.8	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1989	EB	5,850	3.9	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1989	EB	2,620	4	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1989	EB	51,084	132	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1989	RB	4,012	5.9	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1989	RB	50,400	63	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1990	EB	2,854	1.1	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1990	EB	5,600	3.5	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1990	EB	6,697	3.7	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1990	EB	13,072	17.2	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1990	RB	9,504	6.6	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1990	RB	10,494	6.6	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1991	BT	300	0.3	No./Lb.	Ford (Mt. Shasta, CA)

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Sacheen Lake	1991	EB	405	1.5	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1991	EB	11,700	4.5	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1991	EB	50,800	127	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1991	RB	19,200	6.4	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1991	RB	35,960	62	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1991	RB	14,280	68	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1992	BT	300	0.4	No./Lb.	Ford (Mt. Shasta, CA)
Sacheen Lake	1992	EB	1,001	1.3	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1992	EB	7,599	5.1	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1992	EB	7,420	5.3	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1992	EB	124,552	234	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1992	EB	19,352	23.6	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1992	RB	6,739	4.6	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1992	RB	5,635	4.6	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1992	RB	7,634	4.4	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1992	RB	510	3.4	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1992	RB	5,022	93	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1992	RB	50,160	66	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1993	BT	300	0.3	No./Lb.	Ford (Mt. Shasta, CA)
Sacheen Lake	1993	EB	600	1.5	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1993	EB	6,750	4.5	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1993	EB	7,360	4.6	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1993	EB	50,165	127	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1993	EB	14,283	14.5	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1993	RB	5,000	5	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1993	RB	3,225	5	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1993	RB	25,080	76	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1993	RB	25,205	71	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1993	RB	1,245	15	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1994	EB	5,100	4	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1994	EB	6,175	3.8	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1994	EB	1,170	3.6	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1994	EB	64,000	160	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1994	EB	21,016	71	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1994	EB	9,702	13.2	No./Lb.	E. Brook-Ford (Owhi Lake)
Sacheen Lake	1994	RB	7,425	4.5	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1994	RB	50,034	62	No./Lb.	Spokane-McCloud R. CA
Sacheen Lake	1995	EB	6,400	4.3	No./Lb.	Ford
Sacheen Lake	1995	EB	5,040	4.2	No./Lb.	Ford
Sacheen Lake	1995	EB	50,249	109	No./Lb.	Ford
Sacheen Lake	1995	EB	49,654	122	No./Lb.	Ford
Sacheen Lake	1995	EB	14,091	12.2	No./Lb.	Ford
Sacheen Lake	1995	RB	5,400	7.2	No./Lb.	Spokane
Sacheen Lake	1995	RB	4,602	5.2	No./Lb.	Spokane
Sacheen Lake	1995	RB	30,000	60	No./Lb.	Spokane
Sacheen Lake	1995	RB	20,150	62	No./Lb.	Spokane

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Sacheen Lake	1996	EB	5,162	4.2	No./Lb.	Ford
Sacheen Lake	1996	EB	5,065	4.2	No./Lb.	Ford
Sacheen Lake	1996	EB	5,216	3.6	No./Lb.	Ford
Sacheen Lake	1996	EB	55,440	110	No./Lb.	Ford
Sacheen Lake	1996	EB	55,000	110	No./Lb.	Ford
Sacheen Lake	1996	EB	8,735	11.3	No./Lb.	Ford
Sacheen Lake	1996	EB	2,000	11.3	No./Lb.	Ford
Sacheen Lake	1996	RB	5,540	5.4	No./Lb.	Spokane
Sacheen Lake	1996	RB	3,078	5.4	No./Lb.	Spokane
Sacheen Lake	1997	EB	9,828	4.2	No./Lb.	Ford
Sacheen Lake	1997	EB	5,085	4.5	No./Lb.	Ford
Sacheen Lake	1997	EB	49,000	140	No./Lb.	Ford
Sacheen Lake	1997	EB	51,040	110	No./Lb.	Ford
Sacheen Lake	1997	RB	9,657	5.3	No./Lb.	Spokane
Sacheen Lake	1997	RB	10,248	11.2	No./Lb.	Spokane
Sacheen Lake	1997	RB	4,000	3.2	No./Lb.	Spokane
Sacheen Lake	1998	EB	6,003	5.1	No./Lb.	Ford
Sacheen Lake	1998	EB	6,248	5.1	No./Lb.	Ford
Sacheen Lake	1998	EB	101,607	108	No./Lb.	Ford
Sacheen Lake	1998	RB	5,017	5.8	No./Lb.	Spokane
Sacheen Lake	1998	RB	5,150	5	No./Lb.	Spokane
Sacheen Lake	1999	EB	16,431	5.8	No./Lb.	Ford
Sacheen Lake	1999	EB	38	0.5	No./Lb.	Ford
Sacheen Lake	1999	EB	880	1	No./Lb.	Ford
Sacheen Lake	1999	RB	10,009	5.6	No./Lb.	Spokane
Sacheen Lake	2000	EB	2,349	5.4	No./Lb.	Ford
Sacheen Lake	2000	EB	2,782	5.3	No./Lb.	Ford
Sacheen Lake	2000	EB	318	5.3	No./Lb.	Ford
Sacheen Lake	2000	EB	15,022	5.8	No./Lb.	Ford
Sacheen Lake	2000	EB	3,549	22.9	No./Lb.	Ford
Sacheen Lake	2000	EB	13,804	23.2	No./Lb.	Ford
Sacheen Lake	2000	EB	7,665	21	No./Lb.	Ford
Sacheen Lake	2000	EB	4,263	21	No./Lb.	Ford
Sacheen Lake	2000	RB	5,000	4.9	No./Lb.	Spokane
Sacheen Lake	2001	EB	19,161	4.7	No./Lb.	Ford
Sacheen Lake	2001	RB	5,029	4.7	No./Lb.	Spokane
Spring Creek	1941	EB	24,985	1	Inches	
Spring Creek	1944	EB	8,400	1	Inches	
Spring Creek	1951	RB	2,504	8	No./Lb.	
Spring Creek	1952	RB	1,000	5	No./Lb.	
Spring Creek	1953	RB	507	1.5	Lb.s	
Spring Creek	1956	RB	125	2	Lb.s	
Spring Heel Creek	1937	EB	25,000	1.25	Inches	
Spring Heel Creek	1940	RB	18,895	1.5	Inches	
Spring Heel Creek	1941	EB	14,800	5.5	Inches	
Spring Heel Creek	1947	RB	44,900	1	Inches	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
Spring Heel Creek	1948	RB	16,590	1.5	Inches	
Trout Lake	1933	EB	50,000	0	N/A	
Trout Lake	1933	EB	48,800	0	N/A	
Trout Lake	1934	EB	25,000	1.75	Inches	
Trout Lake	1934	EB	50,000	1.75	Inches	
Trout Lake	1934	EB	21,460	5	Inches	
Trout Lake	1936	EB	8,000	5	Inches	
Trout Lake	1940	EB	20,600	0	N/A	
Trout Lake	1940	EB	4,994	5	Inches	
Trout Lake	1941	RB	5,000	4.5	Inches	
Trout Lake	1943	RB	17,980	3	Inches	
Trout Lake	1943	RB	17,990	3	Inches	
Trout Lake	1944	RB	15,725	3	Inches	
Trout Lake	1948	RB	4,397	6	Inches	
Trout Lake	1948	RB	5,314	6	Inches	
Trout Lake	1951	RB	20,000	10	No./Lb.	
Trout Lake	1953	RB	15,000	10	No./Lb.	
Trout Lake	1954	RB	16,800	7	No./Lb.	
Trout Lake	1955	RB	7,200	6	No./Lb.	
Trout Lake	1955	RB	8,000	5	No./Lb.	
Trout Lake	1956	RB	18,000	8	No./Lb.	
Trout Lake	1957	RB	15,300	9	No./Lb.	
Trout Lake	1958	RB	12,850	12	No./Lb.	
Trout Lake	1958	RB	12,540	11	No./Lb.	
Trout Lake	1959	RB	6,440	8	No./Lb.	
Trout Lake	1960	RB	8,340	7.5	No./Lb.	
Trout Lake	1960	RB	16,680	7.5	No./Lb.	
Trout Lake	1961	RB	20,770	5	No./Lb.	
Trout Lake	1962	RB	12,010	962	No./Lb.	
Trout Lake	1962	RB	19,794	6.5	No./Lb.	
Trout Lake	1963	RB	30,425	6	No./Lb.	
Trout Lake	1964	RB	29,290	5	No./Lb.	
Trout Lake	1965	RB	25,200	7	No./Lb.	
Trout Lake	1965	RB	6,000	4	No./Lb.	
Trout Lake	1966	RB	22,075	7.5	No./Lb.	
Trout Lake	1967	RB	22,380	5	No./Lb.	
Trout Lake	1968	RB	346	1	No./Lb.	
Trout Lake	1968	RB	20,925	4	No./Lb.	
Trout Lake	1969	RB	25,017	6.3	No./Lb.	
Trout Lake	1970	RB	25,165	4.6	No./Lb.	
Trout Lake	1971	RB	28,654	2	No./Lb.	
Trout Lake	1972	RB	18,000	4	No./Lb.	
W.B. Little Spokane River	1938	EB	41,400	1	Inches	
W.B. Little Spokane River	1938	EB	8,000	3	Inches	
W.B. Little Spokane River	1938	RB	2,000	5	Inches	
W.B. Little Spokane River	1939	EB	4,985	3	Inches	

Location	Year	Spp.	# Planted	Size/Count	Unit	Stock
W.B. Little Spokane River	1939	RB	1,999	4	Inches	
W.B. Little Spokane River	1940	CT	1,597	3	Inches	
W.B. Little Spokane River	1940	EB	19,950	0	N/A	
W.B. Little Spokane River	1940	EB	19,950	0	N/A	
W.B. Little Spokane River	1940	EB	19,950	1	Inches	
W.B. Little Spokane River	1940	EB	9,990	3	Inches	
W.B. Little Spokane River	1941	EB	50,830	1	Inches	
W.B. Little Spokane River	1941	EB	35,250	1	Inches	
W.B. Little Spokane River	1941	EB	70,450	1	Inches	
W.B. Little Spokane River	1943	EB	20,970	1.25	Inches	
W.B. Little Spokane River	1943	EB	20,970	1.25	Inches	
W.B. Little Spokane River	1943	EB	20,960	1.25	Inches	
W.B. Little Spokane River	1945	EB	11,040	1.25	Inches	
W.B. Little Spokane River	1945	EB	22,000	1.25	Inches	
Wethey Creek	1939	RB	19,208	2.5	Inches	
Wethey Creek	1939	RB	19,108	2.5	Inches	
Wethey Creek	1941	RB	21,991	1	Inches	
Wethey Creek	1944	EB	1,700	1	Inches	
Wethey Creek	1944	RB	4,000	3	Inches	

Appendix B.

Table B1. Starting and ending latitude and longitude (decimal degrees, DD) and lengths of the reaches surveyed in 2001.

Stream	Reach	S_Lat. (DD)	S_Long. (DD)	E_Lat. (DD)	E_Long. (DD)	Length (m)
Bear Creek	1	48.00979	117.39184	48.00941	117.38545	480
Bear Creek	2	48.00941	117.38545	48.00045	117.37201	1,624
Bear Creek	3	48.00045	117.37201	47.98307	117.37605	2,228
Bear Creek	4	47.98269	117.37472	47.97605	117.37145	819
Bear Creek	5	47.97605	117.37145	47.96424	117.37155	1,403
Bear Creek	6	47.96424	117.37155	47.96042	117.36751	693
Bear Creek	7	47.96042	117.36751	47.94569	117.35326	2,119
Bear Creek	8	47.94569	117.35326	47.93956	117.35112	757
Bear Creek	9	47.93956	117.35112	47.93649	117.35117	351
Bear Creek	10	47.93649	117.35117	47.92974	117.34168	1,065
Bear Creek	11	47.92974	117.34168	47.92636	117.33560	632
Beaver Creek	1	48.10097	117.44816	48.10132	117.43454	1,003
Beaver Creek	2	48.10132	117.43454	48.09666	117.42292	1,156
Beaver Creek	3	48.09666	117.42292	48.09735	117.41223	834
Buck Creek	1	48.18206	117.49963	48.17265	117.49290	1,185
Buck Creek	2	48.17265	117.49290	48.17154	117.49002	246
Buck Creek	3	48.17154	117.49002	48.16896	117.48381	579
Buck Creek	4	48.16896	117.48381	48.16241	117.47148	1,229
Buck Creek	5	48.16241	117.47148	48.15789	117.46383	769
Buck Creek	6	48.15789	117.46383	48.15586	117.46399	302
Buck Creek	7	48.15586	117.46399	48.14614	117.46430	1,098
Buck Creek	8	48.14614	117.46430	48.14141	117.45773	786
Buck Creek	9	48.14141	117.45773	48.13973	117.44730	829
Buck Creek	10	48.13973	117.44730	48.13890	117.44098	427
Buck Creek	11	48.13890	117.44098	48.13683	117.43600	462
Buck Creek	12	48.13683	117.43600	48.13131	117.43293	694
Buck Creek	13	48.13131	117.43293	48.12625	117.42713	697
Buck Creek	14	48.12625	117.42713	48.11907	117.41802	1,124
Buck Creek	15	48.11907	117.41802	48.11573	117.41797	393
Deer Creek	1	47.96075	117.17038	47.96247	117.19541	1,975
Deer Creek	2	47.96247	117.19541	47.96168	117.21212	1,310
Deer Creek	3	47.96168	117.21212	47.94608	117.24136	3,195
Deer Creek	4	47.94608	117.24136	47.93418	117.25553	1,803
Deer Creek	5	47.93418	117.25553	47.92637	117.26300	1,033
Deer Creek	6	47.92637	117.26300	47.92141	117.26332	641
Deer Creek	7	47.92141	117.26332	47.91566	117.26425	644
Deer Creek	8	47.91566	117.26425	47.91318	117.26508	258
Deer Creek	9	47.91318	117.26508	47.90344	117.28149	1,728
Deer Creek	10	47.90344	117.28149	47.89976	117.28553	527
Deer Creek	11	47.89976	117.28553	47.89467	117.30443	1,689
Deer Creek	12	47.89467	117.30443	47.89087	117.33651	2,711
Deer Creek	13	47.89087	117.33651	47.88802	117.35054	1,732
Deer Creek	14	47.88802	117.35054	47.88830	117.35555	389
Dry Creek	1	47.98034	117.28252	47.98199	117.28456	233
Dry Creek	2	47.98199	117.28456	47.98113	117.28922	421
Dry Creek	3	47.98113	117.28922	47.98375	117.29264	477

Stream	Reach	S_Lat. (DD)	S_Long. (DD)	E_Lat. (DD)	E_Long. (DD)	Length (m)
Dry Creek	4	47.98375	117.29264	47.98623	117.29524	379
Dry Creek	5	47.98623	117.29524	47.98812	117.29825	286
Dry Creek	6	47.98812	117.29825	47.98940	117.30096	262
Heel Creek	1	48.17466	117.40702	48.17300	117.39340	1,063
Heel Creek	2	48.17300	117.39340	48.16476	117.39347	998
Heel Creek	3	48.16476	117.39347	48.15394	117.39642	1,290
Heel Creek	4	48.15394	117.39642	48.15049	117.39083	548
Heel Creek	5	48.15049	117.39083	48.13063	117.38415	2,402
Otter Creek	1	48.08950	117.36838	48.08244	117.35375	1,446
Otter Creek	2	48.08244	117.35375	48.08151	117.34934	454
Otter Creek	3	48.08151	117.34934	48.07507	117.34087	1,067
Otter Creek	4	48.07507	117.34087	48.06194	117.34404	1,566
Otter Creek	5	48.06194	117.34404	48.06067	117.33507	773
Otter Creek	6	48.06067	117.33507	48.04992	117.33373	1,247
Otter Creek	7	48.04992	117.33373	48.04138	117.32547	1,129
Otter Creek	8	48.04138	117.32547	48.03194	117.32013	1,303
Otter Creek	9	48.03194	117.32013	48.02161	117.31213	1,556
Otter Creek	10	48.02161	117.31213	48.01778	117.31279	439
Otter Creek	11	48.01778	117.31279	48.00914	117.31120	988
Otter Creek	12	48.00914	117.31120	48.00427	117.31704	935
Otter Creek	13	48.00427	117.31704	47.98992	117.32177	1,784
Otter Creek	14	47.98992	117.32177	47.98640	117.31902	428
W.B. Little Spokane River	1	48.06060	117.39926	48.04630	117.39464	1,867
W.B. Little Spokane River	2	48.00932	117.36558	48.00719	117.36266	285
W.B. Little Spokane River	3	48.00719	117.36266	48.00495	117.36040	368
W.B. Little Spokane River	4	48.00495	117.36040	48.00113	117.35420	761
W.B. Little Spokane River	5	48.00113	117.35420	47.99704	117.34960	842
W.B. Little Spokane River	6	47.99704	117.34960	47.99381	117.34059	824
W.B. Little Spokane River	7	47.99381	117.34059	47.98854	117.33502	860
W.B. Little Spokane River	8	47.98854	117.33502	47.98245	117.32940	1,152

Appendix **C.**

Table C1. Locations of the starting point of habitat and fish survey sections. Lat.=latitude, Long.=longitude, and DD=decimal degrees.

Stream	**Reach**	**Section**	**Lat (DD)**	**Long (DD)**	**Transect Interval (m)**
Bear Cr.	11	1	47.92643	117.33601	2
Bear Cr.	10	11	47.93002	117.34260	6
Bear Cr.	9	21	47.93866	117.35143	6
Bear Cr.	8	27	47.94367	117.35138	4
Bear Cr.	7	37	47.95168	117.36071	7
Bear Cr.	7	45	47.95722	117.36669	8
Bear Cr.	6	54	47.96271	117.37095	4
Bear Cr.	5	58	47.96559	117.37319	8
Bear Cr.	5	61	47.96837	117.37375	7
Bear Cr.	3	82	47.99202	117.37668	8
Bear Cr.	3	98	47.99924	117.37232	3
Bear Cr.	2	103	48.00404	117.37356	2
Bear Cr.	2	109	48.00565	117.37723	4
Bear Cr.	2	111	48.00593	117.37942	4
Bear Cr.	1	120	48.00948	117.38581	4
Beaver Cr.	3	6	48.09715	117.42042	3
Beaver Cr.	2	20	48.09987	117.43168	4
Beaver Cr.	1	28	48.10104	117.44316	2
Buck Cr.	15	2	48.1171784	117.4178143	6
Buck Cr.	14	7	48.1208329	117.4195567	6
Buck Cr.	13	18	48.1281074	117.4304685	8
Buck Cr.	12	24	48.1322102	117.4341091	6
Buck Cr.	11	34	48.1387952	117.4406759	8
Buck Cr.	10	37	48.13945	117.4439118	8
Buck Cr.	9	46	48.1413796	117.4572667	6
Buck Cr.	8	47	48.141414	117.4580885	6
Buck Cr.	7	60	48.1543767	117.4651174	6
Buck Cr.	6	65	48.1575487	117.4637791	5
Buck Cr.	5	68	48.1593759	117.4649593	4
Buck Cr.	4	83	48.1657873	117.4778504	5
Buck Cr.	3	90	48.1691999	117.4842188	5
Buck Cr.	2	95	48.1716816	117.4905881	4
Buck Cr.	1	103	48.1778179	117.4942334	3
Deer Cr.	14	5	47.8886399	117.35184	4
Deer Cr.	13	16	47.8867408	117.3395212	3
Deer Cr.	13	20	47.8892525	117.3378352	5
Deer Cr.	12	33	47.8935966	117.3263804	6
Deer Cr.	12	41	47.8953991	117.3146967	6
Deer Cr.	11	54	47.8942235	117.3008072	6
Deer Cr.	11	57	47.8939473	117.2996332	6
Deer Cr.	10	73	47.9023085	117.2823064	6
Deer Cr.	9	81	47.9093597	117.2731513	5
Deer Cr.	9	86	47.9108862	117.2672109	4
Deer Cr.	8	89	47.9132464	117.2652287	5
Deer Cr.	7	95	47.9185465	117.2644107	4

Stream	Reach	Section	Lat (DD)	Long (DD)	Transect Interval (m)
Deer Cr.	6	102	47.9246445	117.2628538	4
Deer Cr.	5	109	47.9337675	117.2557837	4
Deer Cr.	4	113	47.9362125	117.2549604	3
Deer Cr.	4	126	47.942842	117.2464989	2
Deer Cr.	3	149	47.9577511	117.2284577	4
Deer Cr.	3	154	47.9610225	117.2253981	3
Deer Cr.	3	161	47.960786	117.2174988	2
Deer Cr.	2	167	47.9616067	117.208095	3
Deer Cr.	1	178	47.9626416	117.1949023	2
Deer Cr.	1	182	47.9617808	117.189078	2
Dry Cr.	6	3	47.98829	117.29861	7
Dry Cr.	5	4	47.98778	117.29810	5
Dry Cr.	4	8	47.98481	117.29407	4
Dry Cr.	3	12	47.98243	117.29137	5
Dry Cr.	2	16	47.98213	117.28789	6
Dry Cr.	1	21	47.98140	117.28215	5
Heel Cr.	5	8	48.13814	117.38532	4
Heel Cr.	5	11	48.14169	117.38474	4
Heel Cr.	4	29	48.15363	117.39627	4
Heel Cr.	3	37	48.16156	117.39563	3
Heel Cr.	2	52	48.17283	117.39299	4
Heel Cr.	1	53	48.17314	117.39387	4
Otter Cr.	14	3	47.98775	117.32024	7
Otter Cr.	13	7	47.99012	117.32177	7
Otter Cr.	13	8	47.99071	117.32157	7
Otter Cr.	12	31	48.00838	117.31033	4
Otter Cr.	11	34	48.01107	117.31146	4
Otter Cr.	11	39	48.01417	117.31208	3
Otter Cr.	10	44	48.01809	117.31274	4
Otter Cr.	9	53	48.02760	117.31326	3
Otter Cr.	9	58	48.02912	117.31685	3
Otter Cr.	8	65	48.03256	117.32034	2
Otter Cr.	4	110	48.06504	117.34497	1
Otter Cr.	4	113	48.06749	117.34415	2
Otter Cr.	3	126	48.08058	117.34554	3
Otter Cr.	2	134	48.08148	117.34980	2
Otter Cr.	1	138	48.08296	117.35560	3
Spring Heel Cr.	5	6	48.11976	117.40890	4
W. Branch Little Spokane River	8	12	47.98840	117.33492	10
W. Branch Little Spokane River	7	16	47.99202	117.33727	10
W. Branch Little Spokane River	6	24	47.99450	117.34156	10
W. Branch Little Spokane River	5	37	48.00065	117.35354	10
W. Branch Little Spokane River	4	39	48.00168	117.35472	10
W. Branch Little Spokane River	3	46	48.00502	117.36040	10
W. Branch Little Spokane River	2	49	48.00760	117.36276	10
W. Branch Little Spokane River	1	65	48.05826	117.39736	10

Appendix D.

Table D1. Mean values (± standard deviation) of habitat parameters measured along transects on Bear Creek.

Reach	No. Sections	No. Transects	Wet Width (m)	Bankfull Width (m)	Mean Depth (cm)	Max. Depth (cm)
1	1	17	2.8 (± 0.6)	6.3 (± 3.3)	15 (± 5)	28 (± 10)
2	3	51	2.5 (± 1.0)	19.7 (± 21.7)	13 (± 5)	25 (± 9)
3	2	29	2.9 (± 0.6)	64.7 (± 12.5)	49 (± 6)	75 (± 5)
4	1	0	-	-	-	-
5	2	25	4.3 (± 0.7)	5.8 (± 1.0)	30 (± 7)	49 (± 10)
6	1	17	2.7 (± 0.9)	2.9 (± 1.3)	22 (± 6)	36 (± 7)
7	2	26	4.4 (± 1.1)	6.5 (± 1.7)	26 (± 10)	42 (± 17)
8	1	17	1.8 (± 0.3)	1.8 (± 0.3)	28 (± 4)	43 (± 6)
9	1	16	2.6 (± 0.4)	2.6 (± 0.4)	29 (± 6)	49 (± 8)
10	1	15	3.3 (± 0.8)	4.1 (± 0.7)	15 (± 8)	27 (± 13)
11	1	17	3.1 (± 0.3)	1.4 (± 0.4)	19 (± 7)	32 (± 8)
Total	**16**	**232**	**2.9 (± 1.2)**	**15.2 (± 22.8)**	**24 (± 13)**	**40 (± 19)**

Table D2. Mean values (± standard deviation) of habitat parameters measured and counted at each survey section on Bear Creek.

Reach	No. Sections	Gradient (%)	Water Temp. (°C)	Air Temp. (°C)	No. LWD/100 m	No. PP/km
1	1	3	11.0	26.0	33	0
2	3	2 (± 1)	9.5 (± 0.9)	15.0 (± 4.1)	35 (± 19)	0 (± 0)
3	2	1 (± 0)	14.0 (± 2.1)	31.8 (± 1.8)	9 (± 8)	0 (± 0)
4	1	1	16.0	16.0	-	-
5	2	1 (± 0)	15.8 (± 1.1)	22.3 (± 3.2)	30 (± 41)	0 (± 0)
6	1	2	16.0	17.0	46	0
7	2	2 (± 0)	14.3 (± 1.8)	13.8 (± 2.5)	25 (± 13)	0 (± 0)
8	1	1	17.5	21.5	14	0
9	1	2	14.0	16.5	14	0
10	1	7	17.0	15.5	33	0
11	1	1	14.5	13.5	4	0
Total	**16**	**2 (± 2)**	**13.9 (± 2.8)**	**19.2 (± 6.4)**	**25 (± 19)**	**0 (± 0)**

Table D3. Mean width (± standard deviation) and percent occurrence of each habitat type observed on Bear Creek.

Reach	**Riffle**			Run			**Pool**		
	n	**Width (m)**	**Occurrence (%)**	**n**	**Width (m)**	**Occurrence (%)**	**n**	**Width (m)**	**Occurrence (%)**
1	15	2.6 (± 0.7)	83	0	-	0	3	2.8 (± 0.3)	17
2	32	2.4 (± 0.9)	60	18	2.5 (± 1.1)	34	3	2.8 (± 1.8)	6
3	0	-	0	29	2.9 (± 0.6)	100	0	-	0
4	-	-	-	-	-	-	-	-	-
5	0	-	0	25	4.3 (± 0.7)	100	0	-	0
6	0	-	0	17	2.7 (± 0.9)	100	0	-	0
7	5	4.2 (± 0.3)	19	21	4.5 (± 1.3)	81	0	-	0
8	0	-	0	17	1.8 (± 0.3)	100	0	-	0
9	0	-	0	16	2.6 (± 0.4)	100	0	-	0
10	13	3.4 (± 0.8)	87	2	2.7 (± 0.6)	13	0	-	0
11	11	1.2 (± 0.3)	78	4	1.3 (± 0.4)	22	0	-	0
Total	**79**	**2.5 (± 1.1)**	**34**	**149**	**3.1 (± 1.2)**	**63**	**6**	**2.8 (± 1.2)**	**3**

Table D4. Mean substrate embeddedness and percent composition of each substrate type (± standard deviation) observed on Bear Creek.

			Mean Composition (%) of Each Substrate Type								
Reach	**n**	**Embeddedness (%)**	**Organic**	**Muck**	**Silt**	**Sand**	**Gravel**	**Cobble**	**Rubble**	**Boulder**	**Bedrock**
1	17	74 (± 37)	0 (± 0)	0 (± 0)	18 (± 18)	59 (± 24)	15 (± 18)	2 (± 4)	2 (± 8)	4 (± 15)	0 (± 0)
2	51	73 (± 26)	0 (± 0)	3 (± 9)	9 (± 10)	48 (± 22)	36 (± 28)	5 (± 6)	1 (± 3)	0 (± 0)	0 (± 0)
3	29	100 (± 0)	22 (± 15)	65 (± 30)	12 (± 15)	0 (±2)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
4	-	-	-	-	-	-	-	-	-	-	-
5	25	97 (± 11)	2 (± 10)	68 (± 37)	24 (± 32)	2 (±8)	0 (± 2)	0 (± 2)	1 (± 3)	3 (± 11)	0 (± 0)
6	17	87 (± 12)	5 (± 9)	2 (± 5)	24 (± 18)	48 (±17)	15 (± 14)	1 (± 2)	1 (± 2)	5 (± 11)	0 (± 0)
7	24	41 (± 38)	1 (± 4)	10 (± 15)	23 (± 26)	33 (±25)	12 (± 17)	10 (± 12)	7 (± 12)	4 (± 8)	0 (± 0)
8	17	33 (± 33)	1 (± 5)	0 (± 0)	11 (± 17)	50 (±14)	35 (± 10)	0 (± 0)	0 (± 0)	2 (± 4)	0 (± 0)
9	16	100 (± 0)	1 (± 3)	1 (± 3)	33 (± 13)	66 (±14)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
10	15	34 (± 24)	1 (± 3)	0 (± 0)	3 (± 10)	20 (±15)	15 (± 8)	21 (± 15)	12 (± 8)	28 (± 18)	0 (± 0)
11	17	37 (± 15)	0 (± 0)	0 (± 0)	3 (± 4)	37 (±12)	48 (± 13)	1 (± 2)	5 (± 10)	6 (± 12)	0 (± 0)
Total	**228**	**74 (± 34)**	**4 (± 10)**	**18 (± 32)**	**15 (± 20)**	**35 (± 27)**	**19 (± 23)**	**4 (± 8)**	**2 (± 7)**	**4 (± 11)**	**0 (± 0)**

Appendix E.

Table E1. Mean values (± standard deviation) of habitat parameters measured along transects on Beaver Creek.

Reach	**No. Sections**	**No. Transects**	**Wet Width (m)**	**Bankfull Width (m)**	**Mean Depth (cm)**	**Max. Depth (cm)**
1	1	17	1.6 (± 0.5)	3.0 (± 0.5)	7 (± 3)	13 (± 6)
2	1	17	2.0 (± 0.6)	3.4 (± 0.4)	5 (± 2)	11 (± 5)
3	1	16	1.8 (± 1.1)	3.5 (± 1.6)	6 (± 3)	13 (± 7)
Total	**3**	**50**	**1.8 (± 0.8)**	**3.3 (± 1.0)**	**6 (± 3)**	**12 (± 6)**

Table E2. Mean values (± standard deviation) 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	9.0	13.5	23	0 (± 0)
2	1	2	11.5	19.0	19	0 (± 0)
3	1	1	18.5	33.5	10	0 (± 0)
Total	**3**	**1 (±1)**	**13.0 (± 4.9)**	**22.0 (± 10.3)**	**17 (± 7)**	**0 (± 0)**

Table E3. Mean width (± standard deviation) 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	4	1.1 (± 0.3)	24	11	1.7 (± 0.5)	65	2	1.8 (± 0.3)	11
2	8	1.7 (± 0.6)	47	8	2.3 (± 0.4)	47	1	3.0	6
3	2	0.7 (± 0.2)	12	13	1.7 (± 0.8)	76	2	2.0 (± 1.0)	12
Total	**14**	**1.3 (± 0.6)**	**27**	**32**	**1.8 (± 0.7)**	**63**	**5**	**2.1 (± 0.7)**	**10**

Table E4. Mean substrate embeddedness and percent composition of each substrate type (± standard deviation) observed on Beaver Creek.

			Mean Composition (%) of Each Substrate Type								
Reach	**n**	**Embeddedness (%)**	**Organic**	**Muck**	**Silt**	**Sand**	**Gravel**	**Cobble**	**Rubble**	**Boulder**	**Bedrock**
1	17	31 (± 19)	0 (± 0)	0 (± 0)	10 (±5)	26 (± 19)	32 (± 19)	28 (± 18)	4 (± 5)	0 (± 0)	0 (± 0)
2	17	53 (± 23)	0 (± 0)	0 (± 0)	6 (±9)	23 (± 17)	35 (± 27)	21 (± 16)	14 (± 15)	1 (± 5)	0 (± 0)
3	16	19 (± 21)	0 (± 0)	0 (± 0)	22 (±24)	26 (± 18)	37 (± 17)	16 (± 16)	0 (± 0)	0 (± 0)	0 (± 0)
Total	**50**	**36 (± 25)**	**0 (± 0)**	**0 (± 0)**	**12 (±16)**	**25 (± 18)**	**35 (± 21)**	**22 (± 17)**	**6 (± 11)**	**0 (± 3)**	**0 (± 0)**

Appendix F.

Table F1. Mean values (± standard deviation) of habitat parameters measured along transects on Buck Creek.

Reach	No. Sections	No. Transects	Wet Width (m)	Bankfull Width (m)	Mean Depth (cm)	Max. Depth (cm)
1	1	16	1.6 (± 0.3)	2.4 (± 0.6)	8 (± 3)	16 (± 6)
2	1	17	2.9 (± 0.7)	3.8 (± 0.7)	11 (± 3)	22 (± 6)
3	1	17	2.9 (± 1.0)	4.2 (± 2.2)	10 (± 4)	20 (± 6)
4	1	17	3.0 (± 0.7)	3.8 (± 1.0)	10 (± 4)	20 (± 7)
5	1	17	3.5 (± 1.0)	4.4 (± 1.1)	13 (± 5)	25 (± 9)
6	1	17	2.8 (± 0.7)	3.9 (± 0.9)	13 (± 4)	27 (± 8)
7	1	17	4.0 (± 1.0)	5.1 (± 1.2)	12 (± 5)	26 (± 10)
8	1	17	4.5 (± 1.2)	5.7 (± 1.3)	14 (± 5)	30 (± 8)
9	1	17	4.3 (± 1.1)	5.3 (± 1.4)	15 (± 7)	31 (± 11)
10	1	15	5.1 (± 1.8)	6.4 (± 1.9)	19 (± 12)	38 (± 24)
11	1	17	3.9 (± 0.7)	5.2 (± 1.2)	16 (± 7)	32 (± 10)
12	1	17	4.4 (± 0.9)	5.2 (± 1.1)	19 (± 9)	38 (± 15)
13	1	16	3.7 (± 1.2)	5.6 (± 0.9)	10 (± 4)	23 (± 8)
14	1	17	3.1 (± 0.9)	6.3 (± 1.3)	10 (± 5)	21 (± 9)
15	1	16	3.0 (± 0.8)	9.5 (± 2.3)	9 (± 3)	18 (± 5)
Total	**15**	**250**	**3.5 (± 1.3)**	**5.1 (± 2.0)**	**13 (± 6)**	**26 (± 12)**

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

Reach	**No. Sections**	**Gradient (%)**	**Water Temp. (°C)**	**Air Temp. (°C)**	**No. LWD/100 m**	**No. PP/km**
1	1	8	6.0	8.5	43	0
2	1	4	7.0	9.0	42	0
3	1	3	6.0	9.0	43	0
4	1	3	7.0	13.0	47	0
5	1	3	7.0	11.0	45	10
6	1	2	8.0	14.0	42	20
7	1	2	9.0	22.0	95	20
8	1	1	11.5	16.0	62	0
9	1	1	11.0	18.5	37	30
10	1	2	12.5	19.0	35	30
11	1	1	13.5	22.0	37	20
12	1	1	9.5	18.0	35	30
13	1	4	13.5	18.5	31	20
14	1	1	18.0	31.0	50	10
15	1	1	18.0	33.5	9	0
Total	**15**	**3 (± 2)**	**10.5 (± 4.0)**	**17.5 (± 7.5)**	**44 (± 18)**	**13 (± 12)**

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

Reach	**n**	**Wetted Width (m)**	**Length (m)**	**Max. Depth (cm)**	**Residual Depth (cm)**
1	0	-	-	-	-
2	0	-	-	-	-
3	0	-	-	-	-
4	0	-	-	-	-
5	1	2.6	5.6	42	31
6	2	3.6 (± 0.7)	5.1 (± 1.6)	42 (± 4)	28 (± 0)
7	2	3.3 (± 0.1)	7.0 (± 2.8)	47 (± 7)	34 (± 0)
8	0	-	-	-	-
9	3	4.2 (± 0.8)	6.2 (± 1.3)	52 (± 14)	37 (± 8)
10	3	5.7 (± 0.9)	7.4 (± 1.1)	75 (± 22)	49 (± 7)
11	2	4.2 (± 1.1)	9.0 (± 1.4)	55 (± 10)	39 (± 9)
12	3	5.4 (± 1.6)	5.4 (± 0.8)	63 (± 14)	39 (± 6)
13	2	4.5 (± 0.1)	6.8 (± 0.1)	67 (± 1)	41 (± 1)
14	1	3.4	5.3	39	26
15	0	-	-	-	-
Total	**19**	**4.4 (± 1.2)**	**6.5 (±1.6)**	**56 (± 16)**	**38 (± 8)**

Table F4. Mean width (± standard deviation) and percent occurrence of each habitat type observed on Buck Creek.

Reach	**Riffle**			**Run**			**Pool**		
	n	**Width (m)**	**Occurrence (%)**	**n**	**Width (m)**	**Occurrence (%)**	**n**	**Width (m)**	**Occurrence (%)**
1	13	1.5 (± 0.4)	76	0	-	0	4	1.4 (± 0.3)	24
2	16	2.9 (± 0.7)	94	0	-	0	1	3.2	6
3	16	2.9 (± 1.0)	94	0	-	0	1	2.0	6
4	17	2.8 (± 0.8)	89	0	-	0	2	1.7 (± 1.2)	11
5	15	3.5 (± 0.7)	79	0	-	0	4	1.8 (± 0.8)	21
6	14	2.6 (± 0.5)	74	0	-	0	5	2.3 (± 0.8)	26
7	14	4.2 (± 1.0)	82	0	-	0	3	3.2 (± 0.2)	18
8	16	3.7 (± 1.4)	73	0	-	0	6	2.9 (± 0.5)	27
9	11	4.7 (± 1.2)	65	1	2.6	6	5	3.9 (± 0.3)	29
10	7	4.4 (± 2.0)	47	3	6.5 (± 1.2)	20	5	5.4 (± 1.3)	33
11	13	3.2 (± 1.2)	62	3	3.6 (± 0.8)	14	5	2.9 (± 1.6)	24
12	12	3.8 (± 1.2)	60	1	4.7	5	7	3.7 (± 1.3)	35
13	11	3.3 (± 1.3)	65	0	-	0	6	3.9 (± 1.7)	29
14	13	3.3 (± 0.9)	76	1	2.9	6	3	2.6 (± 0.7)	18
15	14	2.8 (± 0.8)	82	2	3.2 (± 0.5)	12	1	2.7	6
Total	**202**	**3.2 (± 1.2)**	**75**	**11**	**4.2 (± 1.7)**	**4**	**58**	**3.1 (± 1.4)**	**21**

Table F5. Mean substrate embeddedness and percent composition of each substrate type (± standard deviation) observed on Buck Creek.

			Mean Composition (%) of Each Substrate Type								
Reach	**n**	**Embeddedness (%)**	**Organic**	**Muck**	**Silt**	**Sand**	**Gravel**	**Cobble**	**Rubble**	**Boulder**	**Bedrock**
1	16	45 (± 35)	0 (± 0)	0 (± 0)	3 (± 13)	65 (± 28)	21 (± 18)	9 (± 14)	1 (± 3)	1 (± 3)	0 (± 0)
2	17	36 (± 24)	0 (± 0)	0 (± 0)	1 (± 2)	62 (± 21)	22 (± 17)	12 (± 10)	2 (± 5)	1 (± 3)	0 (± 0)
3	17	48 (± 30)	0 (± 0)	0 (± 0)	2 (± 7)	62 (± 25)	12 (± 9)	21 (± 20)	3 (± 8)	1 (± 2)	0 (± 0)
4	17	38 (± 28)	0 (± 0)	0 (± 0)	0(± 0)	55 (± 30)	20 (± 14)	24 (± 19)	1 (± 2)	0 (± 0)	0 (± 0)
5	17	36 (± 22)	0 (± 0)	0 (± 0)	1 (± 2)	37 (± 25)	11 (± 9)	42 (± 25)	7 (± 9)	2 (± 4)	0 (± 0)
6	17	32 (± 21)	0 (± 0)	0 (± 0)	0 (± 0)	30 (± 18)	14 (± 15)	50 (± 21)	5 (± 6)	1 (± 3)	0 (± 0)
7	17	25 (± 28)	0 (± 0)	0 (± 0)	5 (± 12)	41 (± 29)	21 (± 15)	31 (± 30)	1 (± 3)	0 (± 0)	0 (± 0)
8	17	33 (± 24)	0 (± 0)	0 (± 0)	3 (± 5)	68 (± 18)	25 (± 15)	4 (± 8)	0 (± 0)	0 (± 0)	0 (± 0)
9	17	36 (± 27)	0 (± 0)	0 (± 0)	5 (± 11)	61 (± 20)	24 (± 17)	10 (± 13)	0 (± 0)	0 (± 0)	0 (± 0)
10	17	66 (± 33)	0 (± 0)	0 (± 0)	41 (± 39)	31 (± 22)	25 (± 21)	3 (± 5)	0 (± 0)	0 (± 0)	0 (± 0)
11	15	46 (± 22)	0 (± 0)	0 (± 0)	7 (± 13)	58 (± 18)	21 (± 13)	13 (± 14)	0 (± 0)	1 (± 2)	0 (± 0)
12	17	33 (± 21)	1 (± 2)	0 (± 0)	2 (± 5)	46 (± 23)	33 (± 19)	20 (± 9)	0 (± 0)	0 (± 0)	0 (± 0)
13	16	47 (± 17)	0 (± 0)	0 (± 0)	2 (± 4)	23 (± 16)	10 (± 6)	32 (± 20)	9 (± 3)	3 (± 5)	21 (± 28)
14	17	36 (± 23)	0 (± 0)	0 (± 0)	2 (± 4)	22 (± 11)	26 (± 12)	41 (± 14)	8 (± 7)	0 (± 0)	0 (± 0)
15	17	31 (± 14)	0 (± 0)	0 (± 0)	6 (± 5)	11 (± 3)	31 (± 12)	35 (± 10)	13 (± 4)	4 (± 5)	0 (± 0)
Total	**250**	**38 (± 25)**	**0 (± 1)**	**0 (± 0)**	**5 (± 15)**	**45 (± 27)**	**21 (± 16)**	**23 (± 22)**	**3 (± 6)**	**1 (± 3)**	**1 (± 9)**

Appendix G.

Table G1. Mean values (± standard deviation) of habitat parameters measured along transects on Deer Creek.

Reach	No. Sections	No. Transects	Wet Width (m)	Bankfull Width (m)	Mean Depth (cm)	Max. Depth (cm)
1	2	34	1.3 (± 0.5)	3.3 (± 1.2)	7 (± 4)	12 (± 8)
2	1	17	1.4 (± 0.5)	4.3 (± 1.5)	6 (± 3)	12 (± 5)
3	3	51	1.8 (± 0.8)	4.0 (± 1.5)	6 (± 3)	13 (± 5)
4	2	34	1.8 (± 0.7)	3.8 (± 1.1)	7 (± 3)	14 (± 5)
5	1	17	2.2 (± 0.7)	3.8 (± 0.9)	9 (± 4)	17 (± 7)
6	1	17	2.4 (± 0.5)	4.5 (± 0.9)	10 (± 5)	19 (± 8)
7	1	17	2.4 (± 0.8)	4.3 (± 1.0)	10 (± 6)	20 (± 12)
8	1	17	2.2 (± 0.6)	3.8 (± 0.8)	18 (± 13)	33 (± 19)
9	2	34	2.5 (± 0.6)	5.0 (± 2.0)	13 (± 9)	27 (± 17)
10	1	17	3.6 (± 1.0)	4.7 (± 1.6)	25 (± 12)	48 (± 24)
11	2	28	3.2 (± 0.7)	4.7 (± 0.7)	14 (± 7)	28 (± 13)
12	2	32	3.4 (± 0.8)	5.2 (± 1.4)	12 (± 5)	25 (± 10)
13	2	34	2.3 (± 0.7)	4.1 (± 0.7)	8 (± 3)	15 (± 6)
14	1	17	2.5 (± 0.9)	4.5 (± 1.0)	11 (± 7)	23 (± 14)
Total	**22**	**366**	**2.3 (± 1.0)**	**4.3 (± 1.4)**	**10 (± 8)**	**21 (± 14)**

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

Reach	No. Sections	Gradient (%)	Water Temp. (°C)	Air Temp. (°C)	No. LWD/100 m	No. PP/km
1	2	4 (± 1)	9 (± 1)	14 (± 3)	29 (± 2)	10 (± 14)
2	1	1	12	26	39	0
3	3	3 (± 0)	10 (± 2)	13 (± 0)	39 (± 7)	3 (± 6)
4	2	2 (± 1)	9 (± 2)	13 (± 2)	33 (± 1)	0 (± 0)
5	1	2	9	15	38	10
6	1	2	12	15	47	20
7	1	2	6	15	37	10
8	1	2	7	9	15	50
9	2	2 (± 1)	10 (± 1)	18 (± 2)	19 (± 13)	15 (± 7)
10	1	2	6	7	12	30
11	2	1 (± 0)	7 (± 0)	10 (± 1)	42 (± 11)	0 (± 0)
12	3	1 (± 0)	5 (± 1)	7 (± 5)	36 (± 3)	15 (± 7)
13	2	3 (± 1)	4 (± 1)	5 (± 4)	0	0 (± 0)
14	1	3	5	9	13	20
Total	**23**	**2 (± 1)**	**8 (± 3)**	**12 (± 5)**	**29 (± 14)**	**10 (± 13)**

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

Reach	**n**	**Wetted Width (m)**	**Length (m)**	**Max. Depth (cm)**	**Residual Depth (cm)**
1	2	2.1 (± 0.7)	4.8 (± 0.7)	31 (± 13)	19 (± 7)
2	0	-	-	-	-
3	1	2.2	3.8	34	19
4	0	-	-	-	-
5	1	4.0	3.4	31	19
6	2	3.4 (± 0.0)	4.9 (± 0.8)	31 (± 5)	22 (± 3)
7	1	2.3	3.0	12	12
8	5	2.7 (± 0.4)	6.2 (± 1.0)	65 (± 15)	40 (± 9)
9	3	3.4 (± 0.6)	6.4 (± 1.4)	76 (± 21)	45 (± 10)
10	3	4.5 (± 0.5)	9.9 (± 3.9)	84 (± 23)	52 (± 11)
11	0	-	-	-	-
12	3	3.4 (± 1.0)	6.6 (± 1.6)	61 (± 1)	38 (± 4)
13	0	-	-	-	-
14	2	5.6 (± 3.3)	8.9 (± 2.8)	54 (± 1)	33 (± 1)
Total	**23**	**3.4 (± 1.3)**	**6.4 (± 2.5)**	**56 (± 24)**	**35 (± 14)**

Table G4. Mean width (± standard deviation) and percent occurrence of each habitat type observed on Deer Creek.

Reach	**Riffle**			**Run**			**Pool**		
	n	**Width (m)**	**Occurrence (%)**	**n**	**Width (m)**	**Occurrence (%)**	**n**	**Width (m)**	**Occurrence (%)**
1	18	1.3 (± 0.5)	52	8	1.2 (± 0.3)	24	8	1.6 (± 0.5)	24
2	7	1.2 (± 0.3)	41	8	1.5 (± 0.4)	47	2	2.1 (± 0.8)	12
3	35	1.6 (± 0.7)	65	11	2.0 (± 1.1)	20	8	1.7 (± 0.5)	15
4	9	1.3 (± 0.6)	24	27	1.7 (± 0.7)	71	2	1.6 (± 0.6)	5
5	14	1.9 (± 0.5)	74	1	1.5	5	4	2.4 (± 1.1)	21
6	15	2.2 (± 0.7)	79	0	-	0	4	2.1 (± 0.7)	21
7	15	2.0 (± 0.7)	79	0	-	0	4	2.4 (± 0.2)	21
8	8	2.3 (± 0.9)	47	2	1.8 (± 0.1)	12	7	2.3 (± 0.4)	41
9	20	2.5 (± 0.6)	57	9	2.1 (± 0.3)	26	6	2.6 (± 0.9)	17
10	3	3.4 (± 1.6)	18	6	3.7 (± 1.0)	35	8	3.5 (± 0.9)	47
11	10	3.0 (± 0.6)	36	16	3.3 (± 0.8)	57	2	3.4 (± 0.5)	7
12	15	3.3 (± 0.8)	44	9	3.4 (± 0.7)	26	10	3.0 (± 0.4)	30
13	21	2.4 (± 0.7)	60	13	2.1 (± 0.6)	37	1	2.0	3
14	10	2.2 (± 0.8)	59	4	3.5 (± 0.6)	23	3	2.1 (± 0.7)	18
Total	**200**	**2.1 (± 0.9)**	**52**	**114**	**2.3 (± 1.1)**	**30**	**69**	**2.4 (± 0.9)**	**18**

Table G5. Mean substrate embeddedness and percent composition of each substrate type (± standard deviation) observed on Deer Creek.

			Mean Composition (%) of Each Substrate Type								
Reach	**n**	**Embeddedness (%)**	**Organic**	**Muck**	**Silt**	**Sand**	**Gravel**	**Cobble**	**Rubble**	**Boulder**	**Bedrock**
1	34	31 (± 24)	1 (± 3)	0 (± 0)	13 (± 20)	31 (± 21)	34 (± 19)	19 (± 14)	1 (± 2)	0 (± 0)	1 (± 9)
2	17	19 (± 7)	2 (± 5)	0 (± 0)	8 (± 10)	32 (± 23)	52 (± 26)	5 (± 6)	1 (± 2)	6 (± 13)	0 (± 0)
3	51	53 (± 20)	1 (± 2)	0 (± 0)	5 (± 8)	52 (± 20)	25 (± 15)	6 (± 8)	5 (± 10)	0 (± 0)	15 (± 24)
4	34	38 (± 43)	1 (± 5)	0 (± 0)	9 (± 11)	58 (± 15)	32 (± 18)	1 (± 2)	0 (± 0)	0 (± 0)	0 (± 0)
5	17	44 (± 34)	4 (± 9)	0 (± 0)	8 (± 8)	57 (± 17)	26 (± 11)	5 (± 9)	1 (± 5)	2 (± 7)	0 (± 0)
6	17	69 (± 39)	0 (± 0)	0 (± 0)	13 (± 13)	68 (± 16)	10 (± 13)	5 (± 12)	2 (± 5)	0 (± 0)	0 (± 0)
7	17	100 (± 0)	0 (± 0)	0 (± 0)	9 (± 7)	66 (± 11)	25 (± 15)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
8	17	100 (± 0)	0 (± 0)	1 (± 2)	27 (± 29)	52 (± 21)	20 (± 24)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
9	34	100 (± 0)	2 (± 5)	1 (± 2)	17 (± 25)	56 (± 27)	24 (± 28)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
10	17	81 (± 32)	3 (± 6)	2 (± 5)	41 (± 32)	42 (± 29)	1 (± 3)	3 (± 7)	9 (± 19)	0 (± 0)	0 (± 0)
11	28	98 (± 11)	0 (± 0)	1 (± 5)	11 (± 15)	86 (± 16)	0 (± 0)	0 (± 2)	0 (± 2)	0 (± 0)	0 (± 0)
12	32	77 (± 31)	1 (± 2)	1 (± 2)	12 (± 16)	70 (± 24)	4 (± 8)	8 (± 16)	3 (± 7)	0 (± 2)	0 (± 0)
13	34	48 (± 21)	0 (± 0)	0 (± 0)	0 (± 2)	42 (± 24)	16 (± 22)	23 (± 21)	10 (± 11)	9 (± 14)	0 (± 0)
14	17	58 (± 26)	0 (± 0)	0 (± 0)	1 (± 2)	50 (± 31)	2 (± 4)	22 (± 21)	12 (± 16)	14 (± 18)	0 (± 0)
Total	**366**	**63 (± 34)**	**1 (± 4)**	**0 (± 2)**	**11 (± 18)**	**54 (± 26)**	**20 (± 22)**	**7 (± 14)**	**3 (± 8)**	**2 (± 9)**	**2 (± 11)**

Appendix H.

Table H1. Mean values (± standard deviation) of habitat parameters measured along transects on Dry Creek.

Reach	No. Sections	No. Transects	Wetted Width (m)	Bankfull Width (m)	Depth (cm)	Max. Depth (cm)
1	1	17	2.3 (± 0.6)	3.3 (± 0.7)	25 (± 10)	42 (± 15)
2	1	16	3.1 (± 0.6)	3.7 (± 0.7)	19 (± 7)	35 (± 11)
3	1	17	3.1 (± 1.1)	4.5 (± 1.3)	11 (± 4)	25 (± 8)
4	1	17	2.5 (± 0.5)	3.7 (± 0.6)	13 (± 4)	26 (± 5)
5	1	17	2.3 (± 0.5)	3.0 (± 0.5)	18 (± 6)	31 (± 11)
6	1	14	3.1 (± 0.5)	4.2 (± 0.5)	24 (± 8)	43 (± 13)
Total	**6**	**98**	**2.7 (± 0.8)**	**3.7 (± 0.9)**	**18 (± 8)**	**33 (± 13)**

Table H2. Mean values (± standard deviation) of habitat parameters measured and counted at each survey section on Dry Creek.

Reach	No. Sections	Gradient (%)	Water Temp. (°C)	Air Temp. (°C)	No. LWD/100 m	No. PP/km
1	1	2	10	15	9	0
2	1	3	9	14	53	10
3	1	3	8	8	66	0
4	1	5	10	19	18	0
5	1	2	10	12	58	0
6	1	2	9	21	83	10
Total	**6**	**3 (± 1)**	**9 (± 1)**	**15 (± 5)**	**48 (± 29)**	**3 (± 5)**

Table H3. Mean wetted widths, lengths, maximum depths, and residual depths (± standard deviation) of primary pools on Dry Creek.

Reach	n	Wetted Width (m)	Length (m)	Max. Depth (cm)	Residual Depth (cm)
1	0	-	-	-	-
2	1	2.5	5.1	65	48
3	0	-	-	-	-
4	0	-	-	-	-
5	0	-	-	-	-
6	1	2.9	5.5	77	49
Total	**2**	**2.7 (± 0.3)**	**5.3 (± 0.3)**	**71 (± 8)**	**48 (± 1)**

Table H4. Mean width (± standard deviation) and percent occurrence of each habitat type observed on Dry Creek.

Reach	**Riffle**			**Run**			**Pool**		
	n	**Width (m)**	**Occurrence (%)**	**n**	**Width (m)**	**Occurrence (%)**	**n**	**Width (m)**	**Occurrence (%)**
1	5	1.8 (± 0.7)	29	12	2.6 (± 0.5)	71	0	-	0
2	0	-	0	15	3.0 (± 0.7)	88	2	2.0 (± 0.8)	12
3	14	3.0 (± 0.9)	82	3	3.8 (± 2.1)	18	0	-	0
4	15	2.5 (± 0.5)	88	2	2.8 (± 0.7)	12	0	-	0
5	11	2.3 (± 0.5)	65	5	2.2 (± 0.2)	29	1	2.8	6
6	9	3.0 (± 0.6)	60	3	2.8 (± 0.7)	20	3	2.8 (± 1.1)	20
Total	**54**	**2.6 (± 0.7)**	**54**	**40**	**2.8 (± 0.8)**	**40**	**6**	**2.5 (± 0.9)**	**6**

Table H5. Mean substrate embeddedness and percent composition of each substrate type (± standard deviation) observed on Dry Creek.

			Mean Composition (%) of Each Substrate Type								
Reach	**n**	**Embeddedness (%)**	**Organic**	**Muck**	**Silt**	**Sand**	**Gravel**	**Cobble**	**Rubble**	**Boulder**	**Bedrock**
1	17	57 (± 37)	6 (± 11)	0 (± 0)	46 (± 26)	18 (± 16)	15 (± 18)	6(± 7)	2 (± 6)	4 (± 12)	2 (± 7)
2	16	100 (± 0)	10 (± 8)	0 (± 0)	33 (± 17)	40 (± 15)	18 (± 17)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
3	17	10 (± 0)	2 (± 6)	0 (± 0)	0 (± 0)	58 (± 17)	38 (± 18)	1 (± 2)	0 (± 0)	0 (± 0)	1 (± 3)
4	17	39 (± 20)	0 (± 0)	0 (± 0)	1 (± 2)	31 (± 19)	21 (± 11)	15 (± 9)	14 (± 12)	15 (± 12)	4 (± 11)
5	17	76 (± 22)	1 (± 2)	0 (± 0)	8 (± 7)	62 (± 21)	22 (± 22)	6 (± 11)	1 (± 2)	0 (± 0)	0 (± 0)
6	14	77 (± 25)	6 (± 8)	4 (± 9)	10 (± 0)	56 (± 12)	19 (± 12)	4 (± 6)	1 (± 3)	1 (± 3)	0 (± 0)
Total	**98**	**58 (± 32)**	**4 (± 8)**	**1 (± 3)**	**16 (± 22)**	**44 (± 23)**	**22 (± 18)**	**5 (± 9)**	**3 (± 8)**	**3 (± 9)**	**1 (± 6)**

Appendix I.

Table I1. Mean values (± standard deviation) of habitat parameters measured along transects on Heel Creek.

Reach	No. Sections	No. Transects	Wet Width (m)	Bankfull Width (m)	Mean Depth (cm)	Max. Depth (cm)
1	1	17	2.0 (± 0.4)	3.0 (± 0.9)	8 (± 3)	17 (± 6)
2	1	17	2.4 (± 0.7)	3.6 (± 1.0)	8 (± 3)	19 (± 6)
3	1	17	1.6 (± 0.6)	2.7 (± 1.1)	10 (± 5)	20 (± 10)
4	1	17	2.3 (± 0.6)	3.6 (± 0.8)	9 (± 3)	21 (± 7)
5	2	34	2.0 (± 0.5)	3.0 (± 0.8)	10 (± 6)	20 (± 10)
Total	**6**	**102**	**2.0 (± 0.6)**	**3.2 (± 0.9)**	**10 (± 5)**	**19 (± 8)**

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

Reach	No. Sections	Gradient (%)	Water Temp. (°C)	Air Temp. (°C)	No. LWD/100 m	No. PP/km
1	1	9	9	16	68	0
2	1	2	10	19	57	0
3	1	3	10	14	33	10
4	1	6	14	22	76	0
5	2	5 (± 4)	14 (± 1)	21 (± 3)	44 (± 8)	10 (± 0)
Total	**6**	**5 (± 3)**	**12 (± 3)**	**19 (± 4)**	**54 (± 17)**	**5 (± 5)**

Table I3. Mean wetted widths, lengths, maximum depths, and residual depths (± standard deviation) of primary pools on Heel Creek.

Reach	n	Wetted Width (m)	Length (m)	Max. Depth (cm)	Residual Depth (cm)
1	0	-	-	-	-
2	0	-	-	-	-
3	1	4.9	2.0	52	29
4	0	-	-	-	-
5	2	2.4 (± 1.8)	5.3 (± 0.1)	43 (± 8)	27 (± 4)
Total	**3**	**3.2 (± 1.9)**	**4.2 (± 1.9)**	**46 (± 8)**	**27 (± 3)**

Table I4. Mean width (± standard deviation) and percent occurrence of each habitat type observed on Heel Creek.

Reach	Riffle			Run			Pool		
	n	Width (m)	Occurrence (%)	n	Width (m)	Occurrence (%)	n	Width (m)	Occurrence (%)
1	16	1.8 (± 0.5)	80	0	-	0	4	1.2 (± 0.6)	20
2	15	2.2 (± 0.7)	79	0	-	0	4	2.0 (± 0.9)	21
3	12	1.4 (± 0.4)	67	0	-	0	6	1.7 (± 1.0)	33
4	15	2.2 (± 0.8)	79	0	-	0	4	1.6 (± 0.5)	21
5	24	1.9 (± 0.6)	67	2	1.7 (± 0.3)	5	10	1.9 (± 0.7)	28
Total	**82**	**1.9 (± 0.7)**	**73**	**2**	**1.7 (± 0.3)**	**2**	**28**	**1.7 (± 0.8)**	**25**

Table I5. Mean substrate embeddedness and percent composition of each substrate type (± standard deviation) observed on Heel Creek.

			Mean Composition (%) of Each Substrate Type								
Reach	n	Embeddedness (%)	Organic	Muck	Silt	Sand	Gravel	Cobble	Rubble	Boulder	Bedrock
1	17	38 (± 23)	0 (± 0)	0 (± 0)	6 (± 17)	40 (± 24)	22 (± 16)	14 (± 14)	5 (± 6)	11 (± 14)	3 (± 8)
2	17	41 (± 28)	0 (± 0)	0 (± 0)	4 (± 8)	45 (± 24)	25 (± 21)	17 (± 18)	5 (± 7)	4 (± 8)	0 (± 0)
3	17	41 (± 27)	0 (± 0)	0 (± 0)	2 (± 6)	40 (± 21)	40 (± 26)	8 (± 10)	3 (± 5)	7 (± 15)	0 (± 0)
4	17	50 (± 22)	0 (± 0)	0 (± 0)	0 (± 0)	41 (± 25)	25 (± 19)	7 (± 5)	4 (± 5)	24 (± 24)	0 (± 0)
5	34	36 (± 21)	0 (± 0)	0 (± 0)	1 (± 3)	34 (± 22)	36 (± 18)	19 (± 16)	3 (± 8)	8 (± 21)	0 (± 0)
Total	**102**	**40 (± 24)**	**0 (± 0)**	**0 (± 0)**	**2 (± 6)**	**39 (± 23)**	**30 (± 21)**	**14 (± 15)**	**4 (± 7)**	**10 (± 19)**	**0 (± 4)**

Appendix J.

Table J1. Mean values (± standard deviation) of habitat parameters measured along transects on Otter Creek.

Reach	No. Sections	No. Transects	Wet Width (m)	Bankfull Width (m)	Mean Depth (cm)	Max. Depth (cm)
1	1	17	1.2 (± 0.2)	1.9 (± 0.3)	10 (± 3)	17 (± 4)
2	1	17	0.7 (± 0.2)	1.1 (± 0.3)	12 (± 5)	19 (± 7)
3	1	17	1.2 (± 0.2)	2.1 (± 0.5)	11 (± 10)	19 (± 15)
4	2	32	0.8 (± 0.2)	1.6 (± 0.3)	6 (± 2)	13 (± 5)
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	1	17	1.1 (± 0.5)	1.4 (± 0.6)	15 (± 5)	25 (± 7)
9	2	34	1.6 (± 0.4)	3.1 (± 0.7)	9 (± 4)	17 (± 7)
10	1	17	2.1 (± 0.4)	2.5 (± 0.6)	33 (± 11)	55 (± 18)
11	2	34	1.8 (± 0.5)	3.2 (± 1.4)	23 (± 6)	39 (± 8)
12	1	17	2.5 (± 0.7)	3.6 (± 0.7)	17 (± 8)	31 (± 14)
13	2	26	3.7 (± 1.1)	4.5 (± 1.1)	17 (± 6)	34 (± 10)
14	1	13	3.6 (± 0.9)	5.0 (± 0.8)	17 (± 6)	34 (± 9)
Total	**15**	**241**	**1.8 (± 1.1)**	**2.8 (± 1.4)**	**15 (± 9)**	**27 (± 15)**

Table J2. Mean values (± standard deviation) of habitat parameters measured and counted at each survey section on Otter Creek.

Reach	**No. Sections**	**Gradient (%)**	**Water Temp. (°C)**	**Air Temp. (°C)**	**No. LWD/100 m**	**No. PP/km**
1	1	1	12	19	37	0
2	1	2	14	25	3	10
3	1	1	11	25	33	20
4	2	1 (± 0)	14 (± 0)	21 (± 3)	5 (± 1)	0 (± 0)
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	1	1	10	25	10	10
9	2	1 (± 0)	11 (± 2)	23 (± 6)	31 (± 10)	0 (± 0)
10	1	1	9	19	15	0
11	2	1 (± 0)	13 (± 0)	26 (± 6)	21 (± 3)	0 (± 0)
12	1	3	11	19	46	20
13	2	7 (± 1)	12 (± 2)	20 (±6)	14 (± 3)	5 (± 7)
14	1	8	10	16	19	20
Total	**15**	**2 (± 2)**	**12 (± 2)**	**22 (± 4)**	**20 (± 13)**	**6 (± 8)**

Table J3. Mean wetted widths, lengths, maximum depths, and residual depths (± standard deviation) of primary pools on Otter Creek.

Reach	**n**	**Wetted Width (m)**	**Length (m)**	**Max. Depth (cm)**	**Residual Depth (cm)**
1	0	-	-	-	-
2	1	1.3	2.9	33	24
3	2	1.4 (± 0.1)	6.2 (± 2.2)	55 (± 12)	30 (± 6)
4	0	-	-	-	-
5	-	-	-	-	-
6	-	-	-	-	-
7	-	-	-	-	-
8	1	2.5	2.0	47	33
9	0	-	-	-	-
10	0	-	-	-	-
11	0	-	-	-	-
12	2	2.7 (± 0.1)	7.6 (± 0.6)	63 (± 5)	38 (± 3)
13	1	2.7	6.0	64	44
14	2	4.1 (± 0.2)	5.6 (± 2.1)	54 (± 1)	35 (± 4)
Total	**9**	**2.5 (± 1.1)**	**5.5 (± 2.2)**	**54 (± 11)**	**34 (± 6)**

Table J4. Mean width (± standard deviation) and percent occurrence of each habitat type observed on Otter Creek.

Reach	**Riffle**			**Run**			**Pool**		
	n	**Width (m)**	**Occurrence (%)**	**n**	**Width (m)**	**Occurrence (%)**	**n**	**Width (m)**	**Occurrence (%)**
1	2	1.3 (± 0.0)	12	15	1.2 (± 0.2)	88	0	-	0
2	4	0.7 (± 0.2)	19	12	0.7 (± 0.1)	71	1	1.2	
3	7	1.3 (± 0.2)	42	5	1.1 (± 0.2)	29	5	1.2 (± 0.2)	29
4	0	-	0	32	0.8 (± 0.2)	100	0	-	0
5	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-
8	0	-	0	16	1.1 (± 0.5)	94	1	1.1	6
9	18	1.5 (± 0.3)	53	14	1.6 (± 0.4)	41	2	2.0 (± 0.1)	6
10	0	-	0	16	2.0 (± 0.4)	94	1	2.8	6
11	8	2.2 (± 0.9)	24	22	1.7 (± 0.3)	65	4	1.7 (± 0.4)	11
12	5	2.6 (± 0.7)	29	7	2.2 (± 0.4)	42	5	3.0 (± 0.7)	29
13	24	3.4 (± 1.3)	80	0	-	0	6	2.4 (± 0.9)	20
14	11	3.2 (± 0.5)	73	0	-	0	4	2.9 (± 1.4)	27
Total	**77**	**2.4 (± 1.2)**	**31**	**139**	**1.3 (± 0.6)**	**57**	**29**	**2.2 (± 1.0)**	**12**

Table J5. Mean substrate embeddedness and percent composition of each substrate type (± standard deviation) observed on Otter Creek.

			Mean Composition (%) of Each Substrate Type								
Reach	**n**	**Embeddedness (%)**	**Organic**	**Muck**	**Silt**	**Sand**	**Gravel**	**Cobble**	**Rubble**	**Boulder**	**Bedrock**
1	17	100 (± 0)	1 (± 5)	2 (± 5)	22 (± 18)	75 (± 18)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
2	17	60 (± 23)	1 (± 2)	1 (± 2)	3 (± 12)	46 (± 29)	35 (± 30)	6 (± 9)	1 (± 3)	8 (± 22)	0 (± 0)
3	17	95 (± 16)	1 (± 5)	4 (± 9)	34 (± 25)	48 (± 25)	11 (± 14)	2 (± 10)	0 (± 0)	0 (± 0)	0 (± 0)
4	32	100 (± 0)	7 (± 10)	87 (± 17)	0 (± 0)	7 (± 17)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
5	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-
8	17	100 (± 0)	0 (± 0)	15 (± 27)	21 (± 12)	65 (± 29)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
9	34	93 (± 20)	2 (± 6)	6 (± 8)	21 (± 12)	65 (± 19)	3 (± 7)	1 (± 3)	1 (± 3)	0 (± 0)	1 (± 9)
10	17	98 (± 10)	4 (± 7)	5 (± 17)	24 (± 12)	64 (± 22)	2 (± 10)	2 (± 7)	0 (± 0)	0 (± 0)	0 (± 0)
11	34	100 (± 0)	0 (± 0)	3 (± 9)	16 (± 12)	81 (± 16)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)	0 (± 0)
12	17	45 (± 35)	1 (± 2)	2 (± 4)	8 (± 10)	44 (± 20)	36 (± 23)	8 (± 10)	1 (± 3)	1 (± 2)	0 (± 0)
13	26	39 (± 18)	0 (± 0)	0 (± 0)	1 (± 4)	29 (± 17)	17 (± 12)	19 (± 16)	5 (± 6)	25 (± 25)	3 (± 7)
14	13	56 (± 23)	0 (± 0)	0 (± 0)	0 (± 0)	36 (± 27)	10 (± 12)	10 (± 7)	16 (± 12)	25 (± 20)	1 (± 5)
Total	**241**	**84 (± 27)**	**2 (± 5)**	**15 (± 31)**	**13 (± 16)**	**51 (± 31)**	**9 (± 17)**	**4 (± 9)**	**2 (± 5)**	**5 (± 14)**	**1 (± 4)**

Appendix K.

Table K1. Mean values (± standard deviation) of habitat parameters measured along transects on West Branch Little Spokane River.

Reach	No. Sections	No. Transects	Wet Width (m)	Bankfull Width (m)	Mean Depth (cm)	Max. Depth (cm)
1	1	16	11.0 (± 3.3)	12.6 (± 3.5)	34 (± 19)	65 (± 41)
2	1	10	9.6 (± 1.3)	11.1 (± 1.3)	53 (± 18)	89 (± 28)
3	1	10	10.7 (± 4.5)	12.0 (± 4.9)	40 (± 12)	74 (± 28)
4	1	10	13.7 (± 1.6)	13.9 (± 1.7)	55 (± 17)	94 (± 26)
5	1	10	12.6 (± 1.3)	13.9 (± 1.5)	25 (± 13)	48 (± 18)
6	1	10	8.2 (± 3.9)	10.5 (± 3.5)	33 (± 25)	63 (± 37)
7	1	10	11.3 (± 2.5)	15.1 (± 4.4)	20 (± 17)	39 (± 23)
8	1	10	8.3 (± 2.7)	12.0 (± 3.1)	21 (± 6)	45 (± 13)
Total	**8**	**86**	**10.7 (± 3.3)**	**12.6 (± 3.4)**	**35 (± 20)**	**63 (± 33)**

Table K2. Mean values (± standard deviation) of habitat parameters measured and counted at each survey section on West Branch Little Spokane River.

Reach	No. Sections	Gradient (%)	Water Temp. (°C)	Air Temp. (°C)	No. LWD/100 m	No. PP/km
1	1	1	21	22	60	0
2	1	1	27	22	2	0
3	1	1	20	19	13	0
4	1	1	19	19	17	0
5	1	1	17	17	2	0
6	1	3	17	17	9	10
7	1	1	21	35	38	10
8	1	5	17	16	15	0
Total	**8**	**2 (± 1)**	**20 (± 3)**	**20 (± 6)**	**20 (± 20)**	**3 (± 5)**

Table K3. Mean wetted widths, lengths, maximum depths, and residual depths (± standard deviation) of primary pools on West Branch Little Spokane River.

Reach	n	Wetted Width (m)	Length (m)	Max. Depth (cm)	Residual Depth (cm)
1	0	-	-	-	-
2	0	-	-	-	-
3	0	-	-	-	-
4	0	-	-	-	-
5	0	-	-	-	-
6	1	16	30	160	86
7	1	14	17	121	72
8	0	-	-	-	-
Total	**2**	**15 (± 1)**	**23 (± 9)**	**141 (± 28)**	**79 (± 10)**

Table K4. Mean width (± standard deviation) and percent occurrence of each habitat type observed on West Branch Little Spokane River.

Reach	Riffle			Run			Pool		
	n	Width (m)	Occurrence (%)	n	Width (m)	Occurrence (%)	n	Width (m)	Occurrence (%)
1	4	7.7 (±1.2)	22	12	10.8 (± 2.7)	67	2	7.8 (± 6.4)	11
2	0	-	0	10	9.6 (± 1.3)	100	0	-	0
3	1	5.1	12	9	10.6 (± 4.3)	76	1	5.6	12
4	0	-	0	10	13.7 (± 1.6)	100	0	-	0
5	5	7.2 (±4.7)	36	7	11.0 (± 1.6)	50	2	6.2 (± 3.7)	14
6	7	6.8 (±2.9)	64	0	-	0	4	8.7 (± 6.2)	36
7	8	10.4 (±3.3)	62	1	10.0	7	4	5.0 (± 3.9)	31
8	10	6.5 (±3.7)	67	0	-	0	5	3.6 (± 1.5)	33
Total	**35**	**7.6 (±3.5)**	**34**	**49**	**11.1 (± 2.8)**	**48**	**18**	**5.9 (± 4.1)**	**18**

Table K5. Mean substrate embeddedness and percent composition of each substrate type (± standard deviation) observed on West Branch Little Spokane River

			Mean Composition (%) of Each Substrate Type								
Reach	**n**	**Embeddedness (%)**	**Organic**	**Muck**	**Silt**	**Sand**	**Gravel**	**Cobble**	**Rubble**	**Boulder**	**Bedrock**
1	16	52 (± 22)	6 (± 16)	5 (± 13)	11 (± 7)	32 (± 24)	20 (± 13)	13 (± 14)	5 (± 5)	6 (± 9)	1 (± 3)
2	10	54 (± 12)	0 (± 0)	0 (± 0)	25 (± 19)	32 (± 16)	19 (± 16)	7 (± 5)	5 (± 5)	12 (± 14)	0 (± 0)
3	10	36 (± 18)	0 (± 0)	14 (± 19)	7 (± 9)	49 (± 13)	15 (± 13)	5 (± 7)	5 (± 5)	5 (± 7)	0 (± 0)
4	10	3 (± 7)	0 (± 0)	21 (± 24)	7 (± 8)	9 (± 12)	0 (± 0)	7 (± 5)	3 (± 7)	14 (± 23)	39 (± 26)
5	10	11 (± 7)	0 (± 0)	0 (± 0)	6 (± 6)	11 (± 7)	10 (± 7)	11 (± 8)	3 (± 4)	2 (± 5)	58 (± 27)
6	10	39 (± 23)	0 (± 0)	0 (± 0)	1 (± 3)	41 (± 20)	6 (± 5)	19 (± 15)	17 (± 13)	17 (± 6)	0 (± 0)
7	10	49 (± 12)	0 (± 0)	0 (± 0)	4 (± 5)	43 (± 25)	9 (± 8)	24 (± 17)	11 (± 7)	10 (± 7)	0 (± 0)
8	10	15 (± 23)	0 (± 0)	0 (± 0)	0 (± 0)	9 (± 12)	6 (± 5)	8 (± 7)	21 (± 18)	21 (± 12)	35 (± 37)
Total	**86**	**32 (± 25)**	**1 (± 7)**	**5 (± 14)**	**8 (± 11)**	**28 (± 23)**	**11 (± 12)**	**12 (± 12)**	**8 (± 11)**	**10 (± 13)**	**15 (± 28)**

Appendix L.

Table L1. Locations of potential fish passage barriers in the Little Spokane River drainage identified in 2001. Lat.=latitude, Long.=longitude, and DD=decimal degrees.

Stream	Type	Lat (DD)	Long (DD)	Height (m)	Length (m)	Gradient (%)
Buck Creek	Chute	48.12621	117.42703		4.4	35
Buck Creek	Chute	48.12466	117.42463		8	36
Buck Creek	Culvert	48.11901	117.41797	0.8		
Beaver Creek	Dam	48.10097	117.44811			
Beaver Creek	Waterfall	48.09770	117.42942	5.1		
Beaver Creek	Waterfall	48.09722	117.42881	5		
Beaver Creek	Landslide	48.09722	117.42881			
WB Little Spokane	Waterfall	48.11414	117.41131	44.1		
WB Little Spokane	Waterfall	47.98826	117.33471	8.7		
WB Little Spokane	Waterfall	47.98826	117.33471	2.8		
WB Little Spokane	Chute	47.98826	117.33471		12.5	15
WB Little Spokane	Waterfall	47.98826	117.33471	0.5		
WB Little Spokane	Chute	47.98826	117.33471		5	15
WB Little Spokane	Waterfall	47.98826	117.33471	0.5		
Otter Creek	Dam	48.04159	117.32624	45		
Otter Creek	Waterfall	47.98892	117.32101	1.3		
Otter Creek	Chute	47.98892	117.32101		4.2	23
Deer Creek	Culvert	47.88823	117.35437	0.73		

Appendix M.

Table M1. Locations of thermograph sites in the Little Spokane River drainage in 2001. Lat.=latitude, Long.=longitude, and DD=decimal degrees.

Stream	Location	Lat. (DD)	Long. (DD)
Bear Creek	lower	47.92984	117.34209
Beaver Creek	lower	48.09673	117.42231
Beaver Creek (Dragoon trib.)	lower	47.94662	117.50777
Buck Creek	lower	48.11983	117.41833
Dartford Creek	lower	47.78462	117.41750
Deer Creek	lower	47.88833	117.35376
Deer Creek	upper	47.91597	117.26446
Dragoon Creek	upper	47.98952	117.49452
Little Deep Creek	lower	47.79700	117.37857
Little Spokane River	Wandermere	47.78481	117.40459
Little Spokane River	mouth	47.78269	117.53002
Little Spokane River	Elk	48.02126	117.27448
WB Dragoon Creek	lower	47.91580	117.49835
WB Little Spokane River	lower	47.98534	117.32904
WB Little Spokane River	upper	48.13469	117.35259

Appendix N.

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

11 December 2002

To: Jason McLellan

From: Janet Loxterman

Subject: Little Spokane River Rainbow Trout

We examined the geographic population structure of five populations of rainbow trout (*Oncorhynchus mykiss*) from the Little Spokane River. We used genetic diversity at nine microsatellite loci (*One-102, One-114, Ots-100, Ots-103, One-108, One-101, Ots-3M, Ots-1*, and *Omy-77*) to assess population structure in the Little Spokane River using five collections - Buck Creek (01BU, n=50), Deer Creek (01BS, n=100), Otter Creek (01BQ, n=50), Phalon Lake hatchery [redband] rainbow trout (01BN, n=100), and Spokane hatchery [coastal] rainbow trout (00DF, n=100).

All nine microsatellite loci were polymorphic ranging from nine (*Ots-3M*) to 28 (*One-108*) alleles per locus. Tests for deviations from Hardy-Weinberg expectations (GENEPOP 3.3) indicated that one microsatellite locus (*One-108*) had a deficiency of heterozygous individuals in three populations (Table 1). Linkage tests revealed that three pairs of loci were in linkage disequilibrium in two populations (Table 2). These slight deviations in Hardy-Weinberg proportions and linkage equilibrium may be attributed to a variety of factors, including past bottlenecks, non-random mating, hybridization, or genetic drift.

Diversity estimates (heterozygosity and allelic richness) were similar among all populations (Table 3). Both heterozygosity and allelic richness estimates were highest in the Phalon Lake hatchery population (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 the three Little Spokane River tributary collections, 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 2 and 3). Both estimates use allele and genotype frequency data to assess differences between population pairs. These results indicate that these populations of rainbow trout represent distinct populations and are thus, not randomly interbreeding.

Further, the relationships among these distinct rainbow trout populations were examined by calculating Cavalli-Sforza and Edwards pairwise genetic distances (100 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 Deer Creek (01BS) and Otter Creek (01BQ) populations form a cluster (99% bootstrap support); the Spokane hatchery (00DF) and Buck Creek (01BU) form a group (94% bootstrap support), and the Phalon Lake hatchery population (01BN) is the most genetically divergent of the five collections (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/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.

Currently, we are screening additional microsatellite loci and adding both rainbow trout and cutthroat trout samples to our data collection. We plan to analyze data from several cutthroat trout collections, in addition to rainbow trout collections, to determine if introgression is occurring (between cutthroat trout and rainbow trout and between rainbow trout hatchery stocks and Little Spokane rainbow trout) and if it there is introgression occurring, to what extent and in what direction.

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

	Population				
Locus	Spokane Hatchery	Phalon Lake	Otter Creek	Deer Creek	Buck Creek
One-102	0.7200	0.0454	0.2517	0.0239	0.4762
One-114	0.2674	0.2566	0.4502	0.2269	0.8885
Ots-100	0.5425	0.0462	0.1852	0.0357	0.4800
Ots-103	0.1236	0.5144	0.1261	0.0520	1.0000
One-108	0.5656	**0.0000**	**0.0009**	**0.0000**	0.0027
One-101	0.3945	0.4400	0.8781	0.2106	0.2008
Ots-3M	0.5296	0.1575	0.0085	0.0543	0.4308
Ots-1	0.5605	0.4876	0.0999	0.8236	0.8698
Omy-77	0.0276	0.0430	0.3278	0.2303	0.1782

Table 2. Pairs of microsatellite loci exhibiting significant linkage disequilibrium in two populations of rainbow trout.

Population	Locus 1	Locus 2	P-value
Phalon Lake	One-102	Ots-3M	0.0000
Otter Creek	One-114	One-108	0.0000
Otter Creek	Ots-3M	Omy-77	0.0000

Table 3. Estimates of genetic diversity within five populations of rainbow trout including sample size (N), heterozygosity (He), and allelic richness (Ao).

Population	N	Avg Het	Ao
Spokane Hatchery	100	0.714	6.938
Phalon Lake	100	0.800	13.399
Otter Creek	50	0.704	8.759
Deer Creek	100	0.702	11.712
Buck Creek	50	0.760	11.533
Overall Mean		0.736	10.469

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

Population pair	Chi2	df	P-value
Phalon Lake & Spokane Hatchery	Infinity	18	Highly sign.
Otter Creek & Spokane Hatchery	Infinity	18	Highly sign.
Otter Creek & Phalon Lake	Infinity	18	Highly sign.
Deer Creek & Spokane Hatchery	Infinity	18	Highly sign.
Deer Creek & Phalon Lake	Infinity	18	Highly sign.
Deer Creek & Otter Creek	Infinity	18	Highly sign.
Buck Creek & Spokane Hatchery	Infinity	18	Highly sign.
Buck Creek & Phalon Lake	Infinity	18	Highly sign.
Buck Creek & Otter Creek	Infinity	18	Highly sign.
Buck Creek & Deer Creek	Infinity	18	Highly sign.

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

	Spokane Hatchery	Phalon Lake	Otter Creek	Deer Creek	Buck Creek
Spokane Hatchery	---				
Phalon Lake	0.1098	---			
Otter Creek	0.1238	0.0541	---		
Deer Creek	0.1598	0.0416	0.0497	---	
Buck Creek	0.0893	0.0456	0.0617	0.0785	---

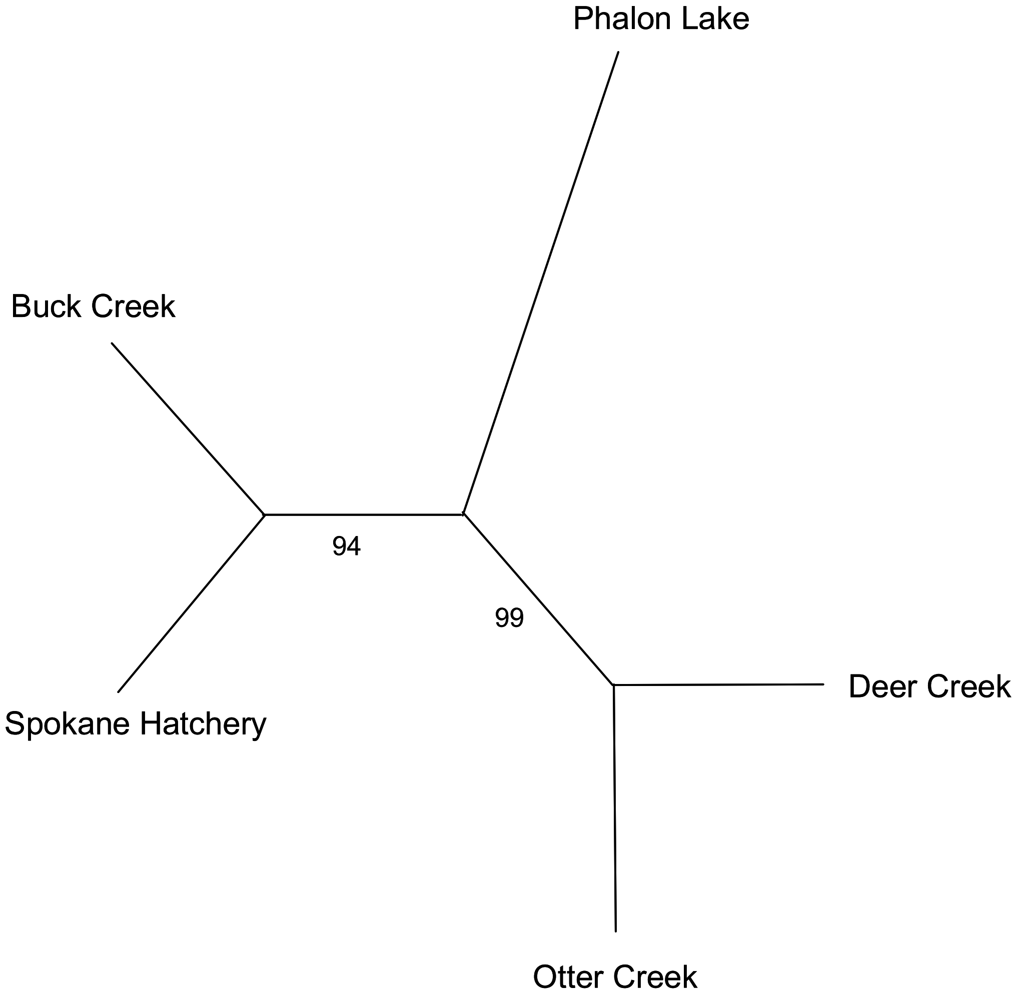

Figure 1. Consensus tree from 100 neighbor-joining trees based on Cavalli-Sforza and Edwards pairwise genetic distances for five populations of rainbow trout.

2001 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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December 2002

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 Planning Council-funded StreamNet Project.

The following summary covers activities from March 1, 2001 through February 28, 2002.

Coordination and Data Standards Development

On November 20 the JSAP Steering Committee met in Spokane. WDFW staff John Whalen, Jason McLellan, and Dick O’Connor participated.

At this meeting, WDFW staff submitted a draft scope of work and budget for FY2002. Discussions on overall Project and spending plans for 2002 took place, in the context of a funding reduction that was mandated by the Project funding source. McLellan gave an update on 2001 season sampling in the Little Spokane River system, and outlined the field locations for 2002 season sampling (continued work in the Little Spokane River and Nine Mile Reservoir). Genetic analysis of collected fish tissues, standardization of historical datasets and development of standard formats and routines to accommodate conversion to StreamNet data formats are other major objectives for FY2002. O’Connor gave a brief overview of the distinctions between generalized fish distribution/use data and fish survey (sightings) data, one of the strategic data management issues facing all Columbia Basin data collectors/managers at present.

O’Connor assisted in reviewing a Request For Proposals drafted by Jim Lemieux (JSAP Project Data Manager) to recruit a consultant to review and integrate a variety of key datasets compiled in the Blocked Area, including historical datasets from USFS and JSAP participants as well as the current Project sampling datasets. After a series of revisions, the RFP was sent out and four responses were received. O’Connor participated in a conference call with one of the responders to clarify Project directions in terms of data management, available software, and relative priority of some of the desired deliverables. We anticipate awarding the contract in May 2002, with delivery of an integrated dataset with update tools expected by December 2002.

Data Sharing Activities

WDFW headquarters staff (Dick O'Connor, Cynthia Burns) participated in a series of activities supporting compilation, standardization, and sharing of data relevant to the JSAP effort:

- O'Connor provided copies of all Paradox data tables from the WDFW Stream, Lake, and Fish Database to the JSAP Data Manager (Jim Lemieux) for potential input into the future Blocked Area integrated database.
- O'Connor worked with the JSAP Data Manager to create a map of the streams, lakes, political boundaries and other features of the Blocked Area for a report by WDFW's Dr. Jim Shaklee, a contributing geneticist for the Project.
- O'Connor worked with the JSAP Data Manager to learn and adopt his techniques in generating Arc point coverages from sampling data, in order to spatially-enable data from historical or non-JSAP collection activities.
- Burns reviewed relevant datasets provided by the Okanogan and Colville National Forests on their Web sites and created a reference notebook summarizing her findings.
- Burns researched and provided standard stream codes (LLIDs) and lake codes (WBIDs) to McLellan for all WDFW sampling sites in the Blocked Area.
- Burns provided historical hatchery stocking data for specified streams and lakes to Chris Donley (WDFW) and McLellan.
- Burns conducted an extensive review of WDFW Warmwater Team sampling data available in the Blocked Area, with a goal to identify datasets relevant to the JSAP Project and provide relevant data records to McLellan in the format he uses to manage his current sampling data. Here is a summary of the work completed:

Warmwater Data Table	JSAP equivalent	Common data elements	Action taken
Site	None	Site Descriptions	None
Survey Record	None	Codes for survey records	None
Access	None	Public recreational access points	None
Development	None	Development Impact survey	None
Vegetation	None	Vegetation surveys	None
Water Chemistry	Temperature Monitor data	Depth, temperature	Changed name to WaterChemistry2; changed design to mirror Jason's table. 206 records.
Effort	Electroshocking	Electroshocking records.	Queried to match JSAP and exported into Excel. 375 records.
Biology	Fish Data – Raw Fish	Species, length, weight, sex, Maturity.	Biology was queried to match JSAP's Mucode and the table was left intact and named Biology/JSAP, but exported into Excel. 16384 records.
Age and Growth	Fish Data -Raw Scale	Age, Species, Length of Fish, Scale length	Queried to match JSAP and exported into Excel. 1340 records.

- Burns began a review of existing and draft StreamNet data exchange formats to determine which of McLellan's JSAP sampling datasets could be converted and exchanged with StreamNet and to outline the conversion steps required. This work will be continued during the next fiscal year, with the goal of sending JSAP data to StreamNet by September 2002.

Resident Fish Stock Status Above Chief Joseph And Grand Coulee Dams

Spokane Tribe of Indians

2001 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 data on Little Tshimikain Creek, Cottonwood Creek, and Wellpinit Creek. Periphyton, phytoplankton and chlorophyll a were sampled on Benjamin, Mathews, McCoy, and Turtle Lakes. In 2001 we experienced a record drought and many portions of streams went dry. Due to the extremely dry conditions many streams were not surveyed. It may take numerous years for fish populations to reestablish throughout those areas.

Reach 7 of Little Tshimikain Creek revealed the highest density of rainbow trout in the entire stream. Cobble and gravels in reach 7, as well as cooler water influence could be the contributing factor to the higher density of salmonids. Reach 6 of Little Tshimikain was similar to reaches 4, 5, 10, and 11. These reaches are dominated by dace, suckers, and shiners confined to continuous beaver ponds where gravels and cobble are covered by silt and debris. Reaches 4 and 5 were surveyed in 2000.

Densities of speckled dace and suckers were as high as 470/100m² in Cottonwood Creek although no salmonids were sampled. Bridgelip suckers were present up through reach 5, after which dace was the only species sampled. Sculpin were found in reach 2 below emerging groundwater flows. There is heavy beaver activity from reaches 5 through 9 and suppressed shrub and overstory canopy.

Wellpinit Creek is the coldest drainage within the Little Tshimikain basin. Rainbow trout and dace were present in the lower sections although the culverts from the Ford-Wellpinit Highway may be inhibiting upstream passage. Wellpinit Creek has numerous large alder within the valley bottom and a narrow valley width with a northeasterly aspect which all assist in maintaining cooler water temperatures.

An initial survey of the four inland lakes on the reservation indicates a range of periphyton and phytoplankton productivity. Turtle Lake indicated the highest phytoplankton richness and density. The highest estimated biovolume exists in McCoy Lake followed by Turtle Lake. Although there were more species of periphyton in Turtle Lake, Mathews Lake had the highest density, biovolume and the highest chlorophyll a.

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)
- DJ Flett, Josh Flett (Technicians)
- Lake Roosevelt Fisheries Evaluation Program (Technical and Logistical)
- Spokane Tribal GIS Program (GIS & Mapping)
- Kalispel Tribe (Administration, Funding & GIS)
- Greg Abrahamson, Dominic Schmidt (NYC workers)
- Spokane Tribal Wildlife Committee (Permitting)
- Spokane Tribal Hatchery (Technical & Stocking)

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1.0 INTRODUCTION

1.1 OBJECTIVES

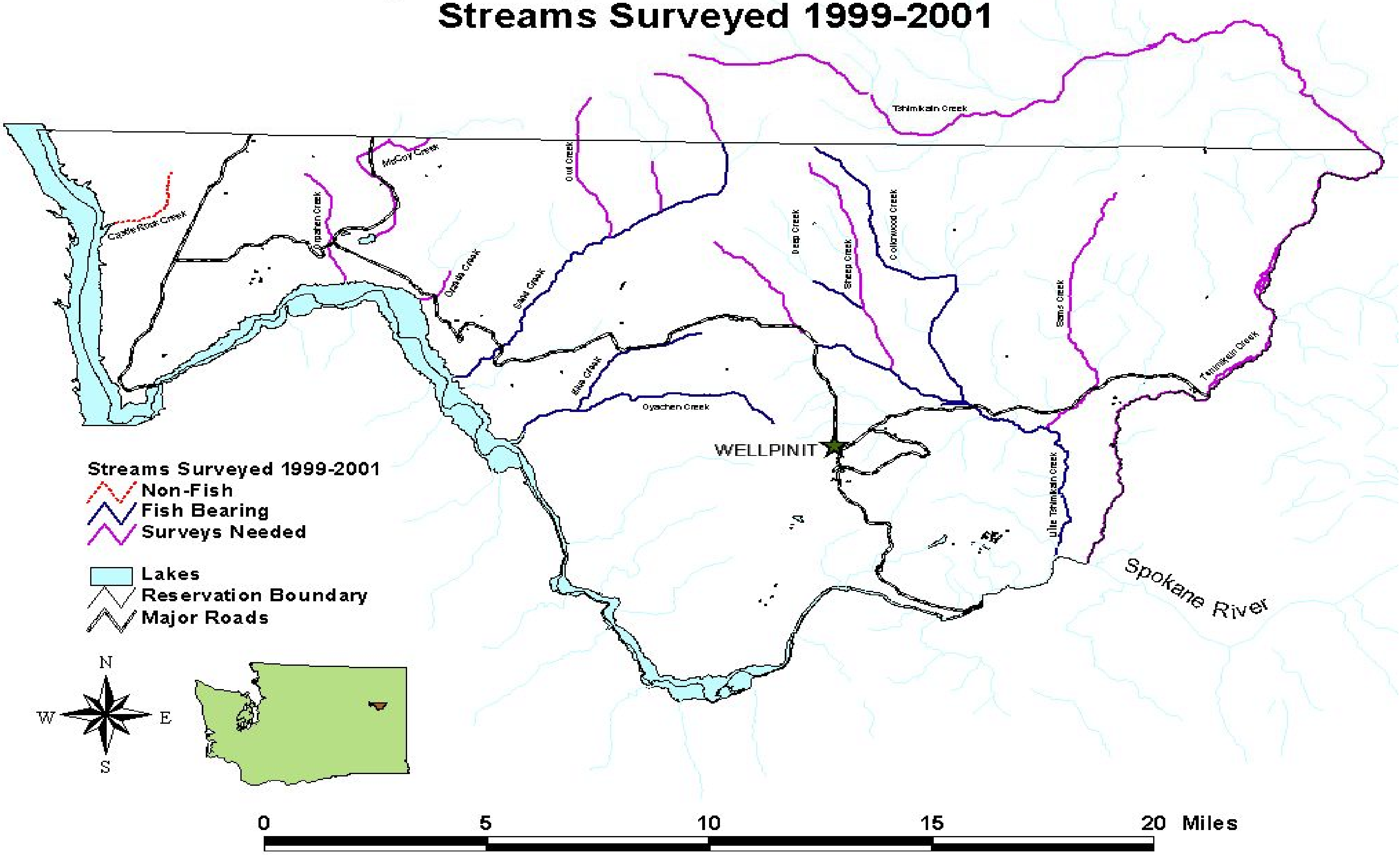
The Spokane Tribe is one of four organizations that are currently working under the "Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams" project. The Spokane Tribe, under this project, will compile and analyze historical fish and fish habitat data on all water bodies within and near 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) coverages 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 Indian Tribe for this project is reported in the 1999 Annual Report of the project, "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 3rd annual report for this project.

1.2 DESCRIPTION OF STUDY AREA

Data collection activities in 2001 were concentrated within the Spokane Indian Reservation, which is 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 Little Tshimikain Creek, Cottonwood Creek, and Wellpinit Creek. Wellpinit and Cottonwood Creeks flow into Little Tshimikain Creek. Little Tshimikain Creek flows into the pool above Little Falls Dam on the Spokane River. Periphyton, phytoplankton, and chlorophyll a data were collected on Turtle, Benjamin, McCoy, and Mathews Lake.

Figure 1: Spokane Indian Reservation Streams Surveyed 1999-2001



2.0 METHODS

2.1 STREAM HABITAT SURVEY

The stream habitat methodology in 2001 was the same as 2000 and a subset of parameters measured in 1999. In fiscal year 2000, 90-meter transects were measured, while walking directly in the channel, using a hip-chain. The information collected at each transect included: habitat identification (i.e. riffle, pool, run), 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 2.1), and an ocular estimate of substrate embeddedness. Channel gradients were obtained using a Suunto clinometer with percent scale at locations permitting visibility of flagging. 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 at least two times the tail-out depth. Large woody debris was tallied if it was at least a meter in length, and 10 cm diameter. Bankfull widths and depths were measured at representative sites within each reach.

The length of each reach averaged 20 transects (1,800 meters). Reach breaks were made at 20 transects or at significant changes in stream habitat. Data for each reach and stream was summarized. General observations were recorded in a field notebook and representative pictures were taken of each reach and special features.

2.2 RELATIVE FISH ABUNDANCE

Within each reach delineated during the habitat survey, a minimum of one site was randomly selected to collect relative fisheries abundance. Sampling procedures included either snorkeling or backpack electrofishing (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.

Table 2.1 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

Backpack electroshocking was used at all sites sampled in 2001. 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 electrofishing wand. Multiple-pass electrofishing was performed in reaches that were greater than four times the width of the wand and too shallow or turbid to snorkel effectively and all transect 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 electroshocking.

Fish per 100/m^2 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 2.2) 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 2.2 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 STREAM TEMPERATURES

Optic StowAway Temp data loggers (accuracy ±0.2 °C) were placed in all major streams on the reservation in order to obtain current temperature regimes. Temperature monitoring is a joint effort between the Water Quality Monitoring Program and this program. Temperature loggers were placed in the streams based on flow, location, and possible mine effluent effects. Temperature loggers were placed in the streams June 4, 2001 and removed by October 31, 2001 and recorded temperatures every hour.

Maximum, minimum, and average temperatures were calculated for each month. Overall maximums and minimums were calculated with their corresponding date. Relative air temperatures were collected from the forestry weather station at Wellpinit, WA. Maximum and minimum daily temperatures were used to calculate maximum and minimum monthly values as well as averages. Average monthly maximums are displayed in Table 3.4 as well as graphically (Figure 3.3).

2.4 PERIPHYTON AND PHYTOPLANKTON

Phytoplankton and periphyton were sampled on July 17, 2001 from the 4 interior reservation lakes. Phytoplankton was sampled using an integrated tube sample to a depth of 5 meters. Trainor (1978) states that the photic zone is usually the top 5 meters in fresh water. Water samples were placed in 1000 mL amber bottles and returned to the lab. In the laboratory the samples were filtered in duplicate and then delivered to Eastern Washington University (EWU) for species identification and chlorophyll a concentrations.

Periphyton samples were taken at one location on each lake using glass slides placed 1 meter below the surface for the month of September 2001. Slides were kept on ice and immediately delivered to EWU for speciation and chlorophyll a concentrations.

3.0 RESULTS AND DISCUSSION

3.1 LITTLE TSHIMIKAIN CREEK

Seven habitat reaches on Little Tshimikain Creek were surveyed in 2000. In 2001, habitat reaches were completed on reaches 8 through 11. Relative fisheries abundance surveys were completed on reaches 6 and 7. Due to the lack of water no additional fisheries surveys were completed during 2001. Speckled dace (*Rhinichthys osculus*), redside shiner (*Richardsonius balteatus*), and bridgelip sucker (*Catostomus columbianus*) were the only species sampled in reach 6. A total of 386 fish were sampled in reach 6, which had a density of 165.74 fish/100m^2. Rainbow trout (*Salmo gairdneri*), speckled dace, and redside shiners were sampled in reach 7. Reach 7 had the highest density of salmonids (Table 3.2) potentially due to the coldwater influence of Wellpinit Creek. Habitat surveys were completed up to the Wellpinit-West End Hwy (Figure 3.1). Reaches 8 and 9 had a higher gradient and lower percent embeddedness than the average reach on Little Tshimikain. The gradient decreases in reach 11 and the entire stream bottom is sand. Stream width increased from reaches 8 to 11 and water depth decreased.

Beaver ponds were the major pool-forming agent in reach 11 and much of the reach was dry due to the drought year.

Water temperatures in Little Tshimikain violate tribal water quality standards, of a 7-day average greater than 18.5ºC and no single maximum greater than 24ºC, during the months of July and August (Table 3.4). There is a slight increase in temperatures from upper Little Tshimikain to lower Little Tshimikain. Much of the summer flow is maintained by emerging subsurface flow, which keeps the temperatures similar between the upper and lower sites. Overstory canopy, which reduces instream temperature and evaporation, is limiting throughout the majority of the drainage. Although the stream is of low gradient, ponds created by beaver slow the water down and increase water temperature throughout the upper reaches (4-11) of Little Tshimikain.

Flow measurements are taken at the same locations as the temperature loggers. Low flow is approximately 3 cfs at each site during the summer months. Low flow months generally occur July through October. High flows range from 30 to 87 cfs during spring months. Higher flows are normally sustained for not more than 2 months due to the relative low elevation and aspect of the drainage. Elevations range from 1350 ft at the mouth to 4200 ft at the highest peak within the Little Tshimikain watershed.

Table 3.1 Stream habitat data from reaches 8 through 11 of Little Tshimikain, combined data from reaches 1 through 11 and reach 1 of Wellpinit Creek, 2001.

Reach	**8**	**9**	**10**	**11**	**Combined**	**1**
Length (m)	1,800	1,710	1,980	900	19,260	1710
Mean Embeddedness (%)	34.6	20	55.3	100	48.2	75
Min	10	10	10	100	0	20
Max	100	100	100	100	100	100
Pool-Riffle Ratio	2:01		4:01		2.8:1	1:01
LWD (#/100m)	1	2.5	4.3	0.7	2.6	5.4
Primary Pools (#/Km)	10	15.8	4.5	3.3	7.6	8.8
Mean Stream Width (m)	1.3	2.1	2.2	2.4	3	1.7
Mean Stream Depth (cm)	10.8	14.1	12.7	10.8	20.7	8.8
Mean Gradient (%)	1.5	1.9	1.2	1	1.2	1.3
Min	1	1	1	1	0.5	1
Max	2	3	2	1	3	2
Substrate (% Occurrence)						
Bedrock					4.6	
Boulders					1.5	
Rubble		20			6.4	
Cobble	73	64.6	39.3		33.4	4.6
Gravel	25.5	13.5	8.8		13.8	32.6
Small Gravel					3.1	
Sand	1.5	2	26.4	100	24.7	62.8
Silt					10.5	
Muck			25.5		1.9	
Habitat Types						
Pool (% Occurrence)	**45.2**	**25.7**	**50.8**	**66.3**	**62.9**	**4.3**
Mean Width (m)	3	3.4	6.1	5.3	4.5	1.4
Min Width (m)	1.6	0.8	3.5	3.9	0.8	1.4
Max Width (m)	3.8	8	12.2	6.2	18.5	1.4
Riffle (% Occurrence)	**4.2**		**0.8**		**15**	**4.6**
Mean Width (m)	0.6		0.4		3	1.5
Min Width (m)	0.4		0.4		0.4	1.5
Max Width (m)	0.7		0.4		7.1	1.5
Run (% Occurrence)	**50.6**	**74.3**	**48.3**	**33.8**	**22.1**	**91.2**
Mean Width (m)	1.9	1.9	1.7	4.1	2.4	2.9
Min Width (m)	1.2	0.6	0.8	3.2	0.6	0.7
Max Width (m)	3.3	4.5	3.2	4.9	6.8	1.8

Figure 3.1 Map of reach breaks and fish and temperature sample sites on Little Tshimikain, Wellpinit and Cottonwood Creeks in 2000-2001.

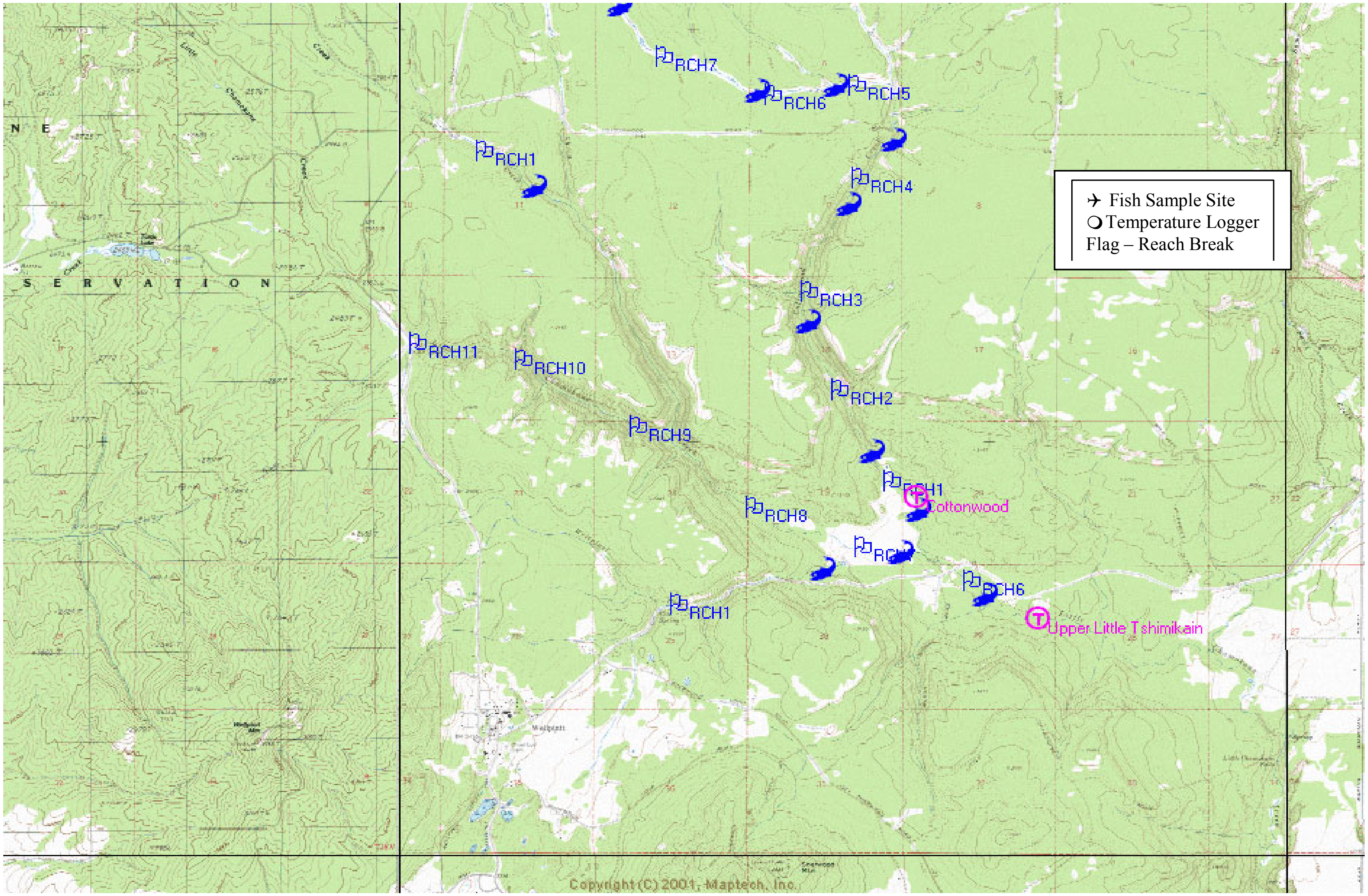


Table 3.2 2000-2001 Relative Fish Abundance in Little Tshimikain, Cottonwood and Wellpinit Creeks

											Depletion Calculation	
Date	Stream	Reach	Method	Salmonid N	Area (m^2)	Brown Trout Density	Rainbow Trout Density	Sculpin N	Other N	Salmonid Density (#/100m^2)	Pop est. #/100m^2	lower/upper pop. conf. intervals
9/7/00	L. Tshimikain	1	shock	0	174.3	0	0	88	152	0		
9/7/00	L. Tshimikain	2	shock	2	174.18	0	1.15	118	91	1.15		
9/11/00	L. Tshimikain	3	shock	8	305.7	0.33	2.29	163	308	2.62		
9/11/00	L. Tshimikain	4	shock	1	63.99	0	1.56	0	387	1.56		
9/11/00	L. Tshimikain	5	shock	0	136.89	0	0	0	504	0		
6/12/01	L. Tshimikain	6	shock	0	232.89	0	0	0	386	0		
6/11/01	L. Tshimikain	7	shock/depletion	27	154.31	0	17.5	0	261	17.5	18.15	15.49/20.80
6/11/01	Cottonwood	1	shock	0	122.78	0	0	0	578	0		
6/12/01	Cottonwood	2	shock	0	55.14	0	0	75	0	0		
6/13/01	Cottonwood	3	shock	0	50.5	0	0	0	5	0		
6/13/01	Cottonwood	4	shock	0	58.03	0	0	0	58	0		
7/11/01	Cottonwood	5	shock	0	262.5	0	0	0	117	0		
7/11/01	Cottonwood	6	shock	0	400	0	0	0	50	0		
7/12/01	Cottonwood	7	shock	0	1800	0	0	0	40	0		
7/12/01	Cottonwood	8	shock	0	140	0	0	0	65	0		
6/15/01	Cottonwood	9A	shock	0	39.79	0	0	0	94	0		
6/15/01	Cottonwood	9B	shock	0	45.72	0	0	0	118	0		
9/7/01	Wellpinit	1	shock/depletion	14	34	0	41.18	0	26	41.18	41.18	35.01/47.26

3.2 COTTONWOOD CREEK

Four habitat reaches were completed in 2000 (2000 Annual Report) on Cottonwood Creek. Five additional reaches were completed during 2001 (Figure 3.2). The headwaters of Cottonwood Creek begin north of the reservation boundary. Cottonwood is perennial from the reservation boundary for approximately 2.57 kilometers before it sub-surfaces. Flow reemerges at springs identified as the end of reach 9. Reaches 5 through 8 are similar in substrate and habitat types and are characterized by a low gradient stream with a series of pools and shallow runs caused by heavy beaver activity (Table 3.3).

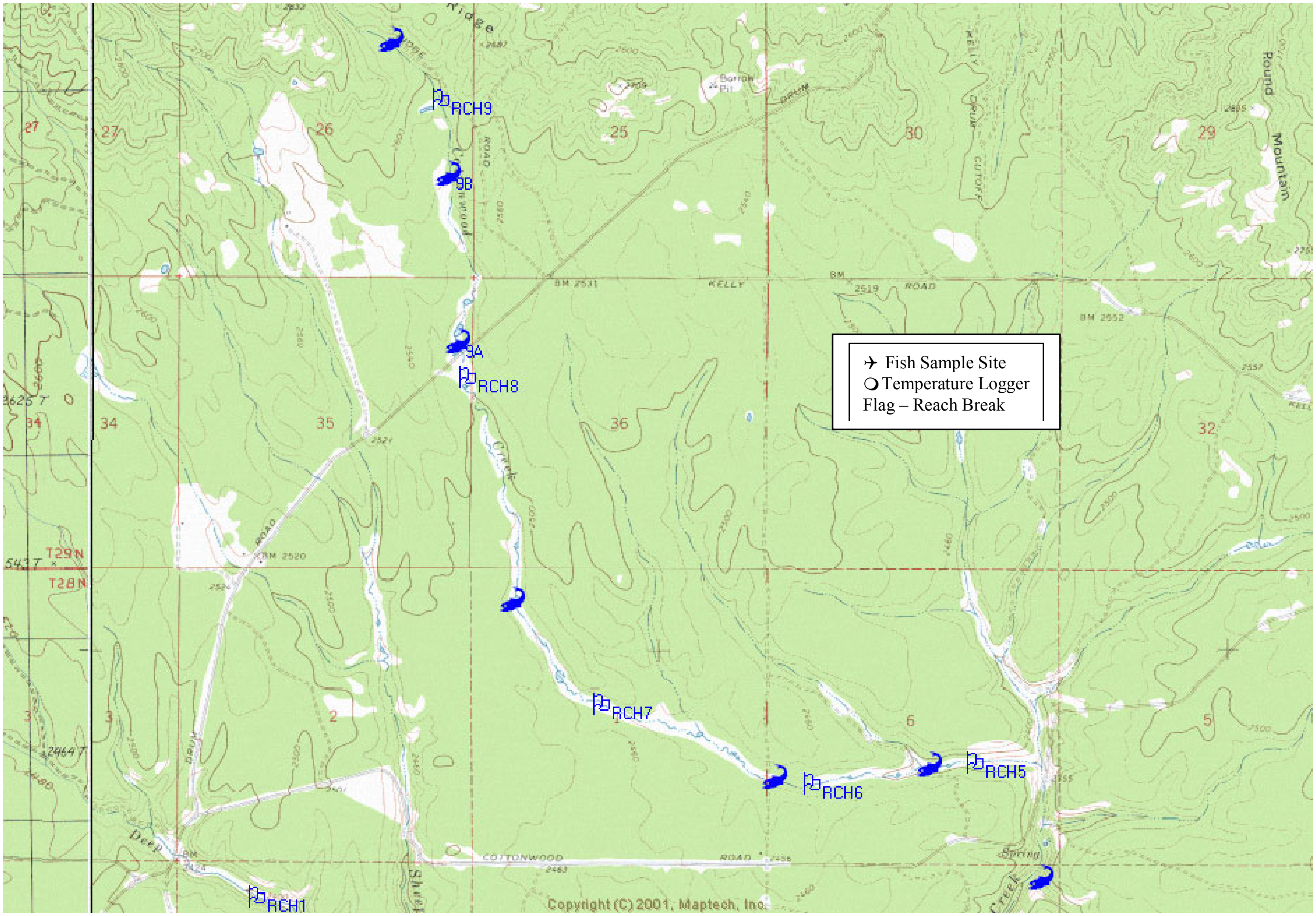
The temperature logger, which was placed in reach 1 (Figure 3.1), shows lower temperatures than exist in the upper reaches due to sub-surface flow in reaches 1 through 3. Higher temperatures in the upper reaches could be due to the numerous ponds created by beaver; the restraint on shrubs and trees to become established; and the wide valley bottom with very little overstory canopy. The low gradient reduces velocity and channelization while increasing side channels and shallow pools. There is grazing by livestock in reaches 5 through 9 and heavy winter browse by big game which may hinder overstory canopy development.

Fisheries surveys were completed in 9 reaches during 2001 (Figures 3.1 & 3.2). Speckled dace were the most predominant fish sampled followed by bridgelip suckers and sculpin. Sculpin were only found in reach 2. Numerous young dace were sampled in the upper reaches where there were exposed gravels. No salmonids were sampled in Cottonwood Creek during 2001. Salmonid absence could be attributed to the high temperatures and lack of quality habitat. Sampling produced no fish in the headwaters of Cottonwood Creek above reach 9 (Figure 3.2). Flows were measured in reach 1 (Figure 3.1) and can be as low as 0.5 cfs in the summer and as high as 30 cfs during spring run-off.

Table 3.3 2001 stream habitat data on Cottonwood Creek reaches 5 through 9 individually and reaches 1 through 9 combined.

Reach	**5**	**6**	**7**	**8**	**9**	**Combined**
Length (m)	1530	1440	1530	1800	1440	14310
Mean Embeddedness (%)	82.9	96.3	100	100	83.3	69.6
Min	10	40	100	100	10	10
Max	100	100	100	100	100	100
Pool-Riffle Ratio					3:01	10.4:1
LWD (#/100m)	3.4	4.4	7.1	5.2	4.2	3.5
Primary Pools (#/Km)	3.9	2.1	2	1.7	8.3	5.7
Mean Stream Width (m)	2.5	12.4	8.9	11.1	6.4	5.4
Mean Stream Depth (cm)	22.1	36.1	29.7	31	15.1	21.4
Mean Gradient (%)	1.4	1.4	1.1	1.2	1.5	1.5
Min	1	1	1	1	1	1
Max	2	2	1.5	1.5	2	3
Substrate (% Occurrence)						
Organic Debris						0.3
Bedrock						
Boulders						
Rubble						
Cobble	6.2	0.7				5.4
Gravel					0.5	7.5
Small Gravel					1.9	1.4
Sand	33.3				2.2	3.6
Silt		44.8	42.9	17.1	9.9	23.6
Muck	60.5	54.6	57.1	82.9	85.5	58.2
Habitat Types						
Pool (% Occurrence)	**52.4**	**91.1**	**54.2**	**68**	**84.6**	**66.7**
Mean Width (m)	2.8	16.4	13.7	16.8	28.7	11
Min Width (m)	1.3	1.3	5.3	6.8	6	1.3
Max Width (m)	4.8	50	22	40	50	50
Riffle (% Occurrence)					**0.5**	**0.7**
Mean Width (m)					0.5	1.2
Min Width (m)					0.5	0.5
Max Width (m)					0.5	1.7
Run (% Occurrence)	**47.6**	**8.9**	**45.8**	**32**	**14.9**	**32.6**
Mean Width (m)	2.3	3.5	6.3	6.4	1.9	3.3
Min Width (m)	0.4	1.9	2.8	0.8	0.5	0.4
Max Width (m)	4.9	6	8.8	14.3	7	14.3

Figure 3.2 Map of reach breaks and fish sample sites for reaches 6 through 9 on Cottonwood Creek, 2001.



3.3 WELLPINIT CREEK

Wellpinit Creek drains Wellpinit Mountain and the area near Wellpinit, WA. Wellpinit Creek flows into Little Tshimikain at Lanham's field (Figure 3.1). Major features potentially affecting this stream are the presence of Cold Springs (2.68 kilometers from the mouth), a solid waste lagoon approximately 3.5 kilometers from the mouth, and the Ford-Wellpinit Highway that runs adjacent to the stream for much of its length. Although most USGS maps show Wellpinit Creek terminating at the pond, it actually sustains perennial flow into Little Tshimikain Creek.

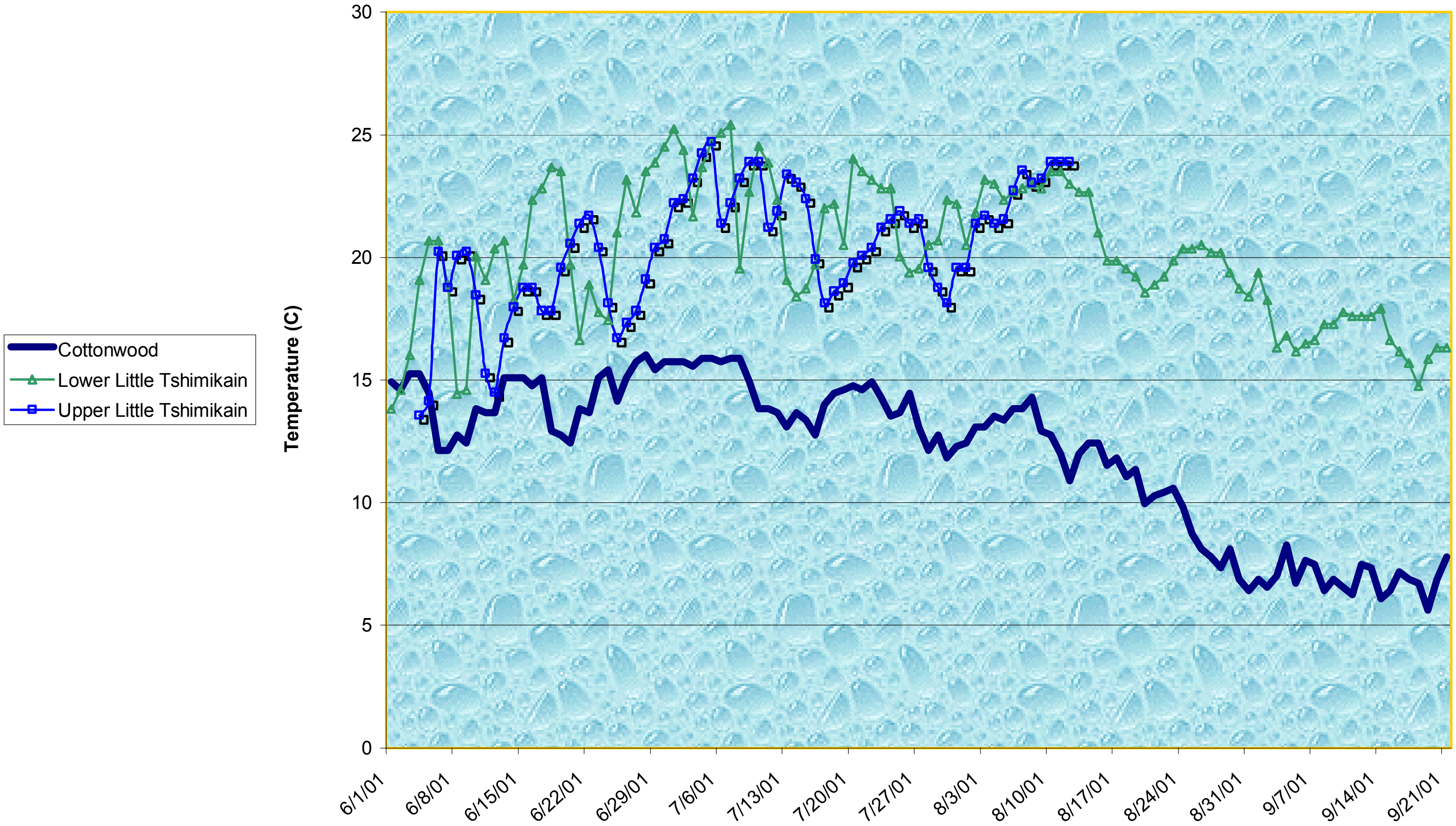
Habitat data for Wellpinit Creek are displayed in Table 3.1. Wellpinit Creek is considerably cooler, based on monthly water quality monitoring, than any other tributary to Little Tshimikain although no temperature logger was placed in the stream during 2001. Cooler waters are attributed to a productive spring, stream aspect, and dense overstory vegetation. Rainbow trout and speckled dace were the only two species found in Wellpinit Creek. Rainbow trout density was 41.18/100m^2 in the lower part of reach 1 (Table 3.2). No fish barriers were observed to the first crossing under the Ford-Wellpinit Highway although electrofishing produced no fish above that point. Wellpinit Creek may be an important area for salmonid spawning and rearing based solely on water temperature. Sand is the dominant substrate and runs are the dominant habitat type. Flows range from approximately 0.5 cfs in the summer to 8 cfs during spring run-off.

Currently there is very little disturbance from beaver, cattle, or big game in Wellpinit Creek. The presence of the highway along much of the creek may deter livestock and wildlife from the riparian area. Heavy wintertime road sanding may increase the amount of sand in the stream. Preliminary bacteria sampling shows that the solid waste lagoon has very little effect on the water quality of Wellpinit Creek.

Table 3.4 Water temperatures (ºC) in lower Little Tshimikain, upper Little Tshimikain, and Cottonwood Creeks as well as air temperature at Wellpinit from June through October, 2001.

	Little Tshimikain	**Upper Little Tshimikain**	**Cottonwood**	**Air At Wellpinit**
June max	23.68	21.72	14.93	31.11
June min	10.87	11.55	8.57	-1.11
June avg.	15.84	16.92	10.99	14.75
June max avg.	**19.24**	**18.41**	**13.04**	**24.64**
July max	25.41	24.77	15.25	35
July min	12.26	14.49	8.72	-0.56
July avg	18.09	19.62	11.9	17.11
July max avg.	**22.3**	**21.39**	**13.97**	**27.2**
Aug max	23.51	25.64	16.2	36.67
Aug min	11.8	15.43	8.87	1.67
Aug avg	17.55	19.76	12.69	19.95
Aug max avg.	**21.3**	**22.5**	**14.81**	**30.08**
Sept max	19.38	dewatered	14.46	31.67
Sept min	8.08		6.71	-2.22
Sept avg	13.7		10.75	16.01
Sept max avg.	**16.55**		**12.56**	**25.81**
Oct max	13.66	dewatered	10.58	25
Oct min	4.82		3.74	-5.56
Oct avg	8.04		6.4	6.63
Oct max avg.	**9.63**	**dewatered**	**7.39**	**14.5**
Max Temp	25.41		15.25	36.67
Max date	7/10/01		7/19/01	8/16/01
Min Temp	4.82		3.74	-5.56
Min Date	10/29/01		10/29/01	10/30/01
Logger Start	6/4/01	6/4/01	6/20/01	6/1/01
Logger End	10/31/01	10/31/01	10/31/01	10/31/01

Figure 3.3 Daily Maximum Temperatures (ºC) for Cottonwood, Lower Little Tshimikain, and Upper Little Tshimikain from June through September 2001.



3.4 INTERIOR LAKES

Tables 3.6 and 3.7 list the species of periphyton and phytoplankton found in the four interior lakes of the reservation. Density by species and total average volume by lake is listed in tables 3.6 and 3.7. In Table 3.6, a zero is represented when a specific species is present but at a density below 0.001 /cm². The average periphyton and phytoplankton chlorophyll a for each lake is listed in Table 3.5. There has been no previous periphyton or phytoplankton samples taken on the interior lakes, therefore this data serves as a baseline for comparison to future studies.

Benjamin Lake

The majority of the 7 species of phytoplankton in Benjamin Lake were composed of microplankton, blue-green algae (Eubacteria) and diatoms (Chrysophyta) at 59, 22 and 11 percent respectively (Table 3.7). The biovolume estimates indicate diatoms (Chrysophyta) composed of 55 percent of the total biovolume, microplankton composed of 30 percent of the total biovolume, and Eubacteria made up only 7 percent of the estimated biovolume.

Seven species of periphyton were identified in Benjamin Lake (Table 3.6). *Aphanocapsa* (Eubacteria) made up 85 percent of the total density although contributed to a very small portion of the biovolume. The biovolume estimates indicate Chlorophyta (80%) and Chrysophyta (20%) of the entire biovolume.

Mathews Lake

Seven species of phytoplankton were identified in Mathews Lake. Diatoms (Chrysophyta), followed by flagellates (Cryptophyta) composed 57 and 32 percent of the total density respectively. Estimated biovolume indicated a similar pattern, with diatoms composing 47 percent and flagellates composing 50 percent. Mathews Lake had the highest chlorophyll a measurements for both the phytoplankton and the periphyton.

Seven of the 9 species of periphyton were diatoms (Chrysophyta). Density estimates indicated 71 percent diatoms and 29 percent green algae (Chlorophyta), which differs from biovolume estimates indicating 87 percent green algae (*Mougeotia* sp.). Overall Mathews Lake had the highest periphyton density and biovolume of the 4 lakes, which could be partly attributed to the lack of surface agitation because of its small size and location.

McCoy Lake

Of the seven species of phytoplankton identified in McCoy Lake, none were diatoms (Chrysophyta). Flagellates (Cryptophyta) and blue-greens (Eubacteria) composed 52 and 38 percent of the total density respectively. Estimated biovolume indicated the community was composed of 86 percent blue-greens and 13 percent flagellates.

Periphyton consisted of 4 species of diatoms, which composed 56 percent of the density and 71 percent of the biovolume. *Mougeotia* sp. (green-algae) was the only other species found in McCoy Lake composed 44 percent of the density and 28 percent of the estimated periphyton biovolume. Chlorophyll a averaged from phytoplankton were 1.45 mg/M^3, the lowest of the 4 lakes. Chlorophyll a measured from periphyton was 0.20 mg/M^3, similar to Benjamin Lake (Table 3.5).

Turtle Lake

Twelve species of phytoplankton were identified in Turtle Lake, indicating the highest species richness of the interior lakes. Blue green algae (Eubacteria) and green algae (Chlorophyta) composed 48 and 46 percent of the density respectively. Specifically, *Quadrigula chodatii* (Chlorophyta) composed of 44 percent of the total density and 66 percent of the total estimated biovolume. *Aphanocapsa* sp. (Eubacteria) was the only blue green identified in Turtle Lake composed the majority of the density but only 2 percent of the biovolume.

Eleven species of periphyton were identified in Turtle Lake all included in the Chlorophyta and Chrysophyta divisions. Chlorophyta and Chrysophyta composed 80 and 20 percent of the total density respectively. *Pinnularia* sp. (Chrysophyta) composed 75 percent of the total estimated biovolume, although based on their large size, composed very little density. Chlorophyll a from periphyton were 0.07 mg/M^3 and 1.80 mg/M^3 from the integrated tube sample.

Table 3.5 Chlorophyll a sampled from the interior lakes on the Spokane Indian Reservation in 2001.

Lake	**Chlorophyll a integrated 5 m tube (average mg/M³) 7/17/01**	**Chlorophyll a periphyton (mg/M²) 10/1/01**
McCoy	1.45/1.44 avg. = 1.45	0.20
Turtle	1.45/2.15 avg. = 1.80	0.07
Benjamin	2.17/2.18 avg. = 2.18	0.25
Mathews	2.52/2.95 avg. = 2.74	3.25

Table 3.6 Periphyton species identified, density, and total average biovolume from Benjamin, Mathews, McCoy, and Turtle Lakes (October 2001).

	Density (average #/cm^2)			
	Benjamin	**Mathews**	**McCoy**	**Turtle**
Division Chlorophyta				
Class Chlorophyceae				
Cosmarium sp. Corda	0.001			
Mougeotia sp. (C.A. Agardh) Wittrock	0.001	0.044	0.007	0.002
Pediastrum boryanum (Turp.) Meneghini				0.001
Staurastrum paradoxum Meyen				0
Tetraedron minimum (A. Braun) Hansgirg				0
Sum	0.002	0.044	0.007	0.003
Percentage	7.69	28.76	43.75	20.00
Division Chrysophyta				
Class Bacillariophyceae				
Achnanthes sp. Bory	0.001	0.104	0.004	0.006
Amphipleura sp. Kutzing	0.001	0.001		0.002
Amphora sp. Ehr**.**		0.001	0.001	0.001
Cocconeis sp. Ehr.		0		
Gomphonema sp. Ehr.	0	0.001		0
Navicula sp. Bory	0	0.001	0.002	0
Pinnularia sp. Ehr.			0.002	0.001
Synedra sp. Ehr.		0.001		0.002
Sum	0.002	0.109	0.009	0.012
Percentage	7.69	71.24	56.25	80.00
Division Eubacteria				
Class Cyanobacteria				
Aphanocapsa sp. Naegeli	0.022			
Oscillatoria sp. Vaucher		0		
Sum	0.022	0	0	0
Percentage	84.62	0.00	0.00	0.00
Total Density #/ cm2 1 x 10 6th	0.026	0.153	0.016	0.015
Total Average Volume mm3/cm2	0.005	0.144	0.046	0.044

Table 3.7 Phytoplankton species, density, and total average biovolume identified from Benjamin, Mathews, McCoy, and Turtle Lakes on July 16th, 2001.

	Total organisms/liter (1×10^6)			
	Benjamin	**Mathews**	**McCoy**	**Turtle**
Division Chlorophyta				
Class Chlorophyceae				
Ankistrodesmus falcatus (Corda) Ralfs		0.034	0.017	
Chlamydomonas sp. Ehr.				0.052
Pediastrum sp. Meyen				0.021
Quadrigula chodatii (Tan.-Ful.) G.M. Smith				2.896
Scenedesmus quadricauda (Turp.) Breb.				0.034
Tetraedron minimum (A. Braun) Hansgirg	0.021			0.016
Sum	0.021	0.034	0.017	3.019
Percentage	1.46	2.78	2.06	45.79
Division Chrysophyta				
Class Bacillariophyceae				
Asterionella formosa Hass.		0.034		
Cyclotella sp. Kutzing	0.148	0.005		0.005
Navicula sp. Bory	0.017			
Class Chrysophyceae				
Dinobryon sertularia Ehr.		0.655		0.037
Mallomonas sp. Perty				0.005
Sum	0.165	0.694	0	0.047
Percentage	11.47	56.79	0.00	0.71
Division Cryptophyta				
Class Cryptophyceae				
Cryptomonas sp. Ehr.	0.011	0.106	0.011	0.011
Rhodomonas sp. Karsten	0.079	0.28	0.417	0.164
Division Pyrrophyta				
Class Dinophyceae				
Ceratium hirundella (O.F. Muell.) Dujardin		0.005		0.017
Sum	0.09	0.391	0.428	0.192
Percentage	6.25	32.00	51.88	2.91
Division Eubacteria				
Class Cyanobacteria				
Aphanizomenon flos-aquae (L.) Ralfs			0.169	
Aphanocapsa sp. Naegeli				3.163
Gloeocapsa sp. Kutzing	0.276			
Merismopedia sp. Meyen	0.042			
Oscillatoria sp. Vaucher			0.005	
Anabaena sp. Bory			0.137	
Sum	0.318	0	0.311	3.163
Percentage	22.10	0.00	37.70	47.98
Microplankton	0.845	0.103	0.069	0.172
Percentage	58.72	8.43	8.36	2.61
Total Density #/l (1 x 10 6th)	1.439	1.222	0.825	6.593
Total Average Volume mm3/l	0.334	0.392	0.547	0.405

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