Middle Spokane River Baseline Fish Population Assessment

Final Report 2012

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Abstract

The Federal Energy Regulatory Commission (FERC) issued a new license for the Spokane River Hydroelectric Project (FERC No. 2545) on June 18, 2009. This study is intended to provide a baseline assessment of the fish population between Upper Falls Dam and Upriver Dam on the Spokane River in Washington and meet the license requirements identified in Appendix B, section 5.3 (D) 1. Three consecutive years of boat electrofishing surveys were conducted on the middle Spokane River as a baseline assessment of the fish community between Upper Falls and Upriver dams 2010-2012. The fish assemblage observed was comprised of Cyprinidae (minnows), Catostomidae (suckers), Salmonidae (trout and salmon), Cottidae (sculpin), Centrarchidae (bass and sunfish) and Percidae (perch). Redband trout (35.4%) was the most abundant species followed by largescale sucker and redside shiner collected in 2012. Redband trout have exhibited an increasing trend in abundance throughout the three years of this study while largescale sucker has decreased. Non-native sport fish collected included hatchery origin rainbow trout, brown trout, kokanee salmon, smallmouth bass and yellow perch.

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Introduction

The Spokane River originates at the outlet of Lake Coeur d'Alene in Idaho and flows through the city of Spokane, WA approximately 179 km westerly to the Columbia River in eastern Washington. Avista Corporation (Avista) owns five hydroelectric developments (HED) (Post Falls Dam, Upper Falls Dam, Monroe Street Dam, Nine Mile Dam, and Long Lake Dam) operated under a single license and comprise the Spokane River Project (FERC 2009; WDOE 2009). The Federal Energy Regulatory Commission (FERC) issued a new license (license) for the Spokane River Hydroelectric Project (FERC No. 2545) on 18 June 2009 (FERC 2009) ordering Paragraph E of the FERC license incorporated the Washington Department of Ecology's (WDOE) Certification Conditions under Section 401 of the Federal Clean Water Act (WDOE 2009). The condition that describes this study can be found in Appendix B, Section 5.3 (D) 1 of the license. The Washington Department of Fish and Wildlife (WDFW) was contracted to assist Avista in conducting a three-year baseline assessment of the fishery between Upper Falls Dam (rkm 120.5) and Upriver Dam (rkm 129.0) that would provide information pertinent to the understanding of the potential impacts of the Upper Falls aesthetic spill operational changes on resident fish between the two dams. This report presents the results of the third year (2012) effort following the approved July 2010 – January 2013 scope of work.

Few studies have been conducted on the fishery in the middle Spokane River between Upper Falls Dam and Upriver Dam, including the Upper Falls Reservoir. The first formal fish population assessment conducted in the middle Spokane River revealed a fish assemblage comprised of native Cyprinids, Salmonids, Catostomids, and Cottids (sculpin), as well as non-native Salmonids (hatchery origin rainbow trout and brown trout) and Centrarchids (bass and sunfish) (O'Connor and McLellan 2008). Recent genetic analysis in the upper (Post Falls to Upriver dams) and the lower (Monroe Street to Nine Mile dams) Spokane River indicated wild rainbow trout were the Columbia River redband subspecies *Oncorhynchus mykiss gairdneri* (hereafter referred to as redband trout) with limited hatchery introgression (Small et al. 2007). Current angling regulations in the middle Spokane River follow general statewide harvest regulations for rivers (daily limit of any 2 trout over 8 inches) and allow year-round angling, whereas regulations in the upper and lower Spokane River promote conservation of redband trout through harvest restrictions and selective gear guidelines. In accordance with Article 405 of the license, Avista annually stocks 6,000 adipose fin clipped, sterile, catchable sized rainbow trout into Upper Falls Reservoir to supplement the recreational fishery.

Study Area

The Upper Falls HED is owned and operated by Avista, whereas the City of Spokane owns and operates the Upriver Hydroelectric Project (Upriver Dam) just upstream on the Spokane River. Both facilities have very little active storage capacity and are operated as run-of-the-river, where inflow discharge equals outflow discharge. The study area, hereafter referred to as the middle Spokane River, was the stretch of the Spokane River between Upper Falls (rkm 120.5) and Upriver dams (rkm 129.0) which lies within the city limits of Spokane, Washington (Figure 1).

The study area was stratified into two distinct sections identified by different physical characteristics. The upper free-flowing section downstream of the Upriver Dam (rkm 125.0-129.0) was characterized by a single, relatively narrow channel with two shallow riffles separated by medium depth (1-2 m) runs and deep pools (>3 m). Substrates in the free-flowing section were typically large with many boulders >1 m in diameter. Sand and gravel deposits were associated the two riffles (rkm 124.4 and 127.1). The transition between the upper and lower sections occurred just downstream of Greene Street at the tail out of a riffle (rkm 125.0). The lower section (rkm 120.5-125.0) was wider (>35 m), slower, and typically shallower (≤1 m) than the free-flowing section. The lower half of the section included a few deep pools (>4 m). The forebay of Upper Falls Dam extended approximately 1 km upstream with depths 3-10 m. Substrates in the lower section were mostly large cobble with two areas of sand and gravel deposition (rkm 120.7 and 121.5). Old bridge abutments in the form of large timber boxes filled with a variety of cobbles and boulders were observed at three locations on both sides of the river extending to near the water surface.

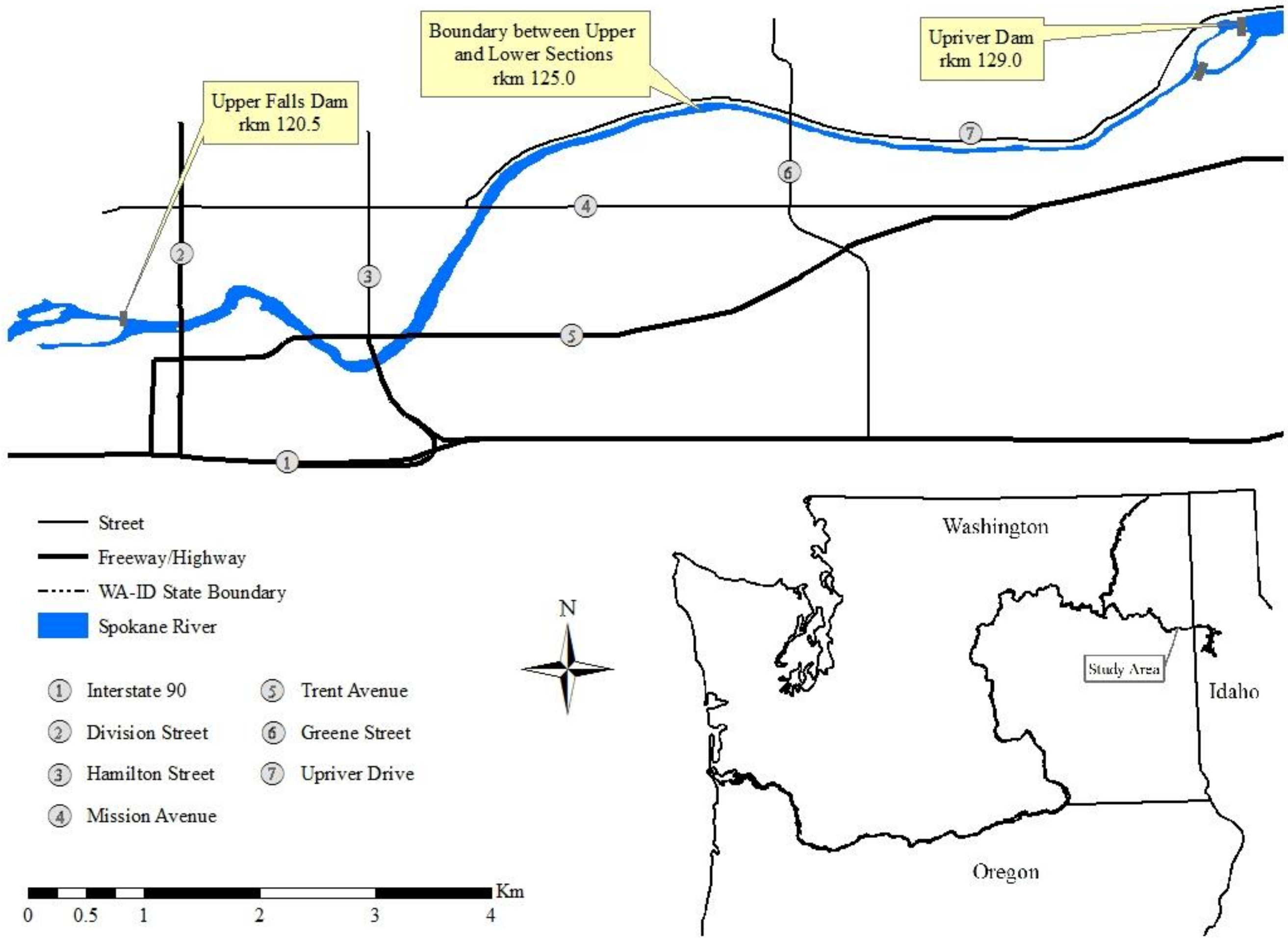

Figure 1. The middle Spokane River between Upper Falls and Upriver dams, Spokane County, Washington.

Methods

Fish were captured using boat electrofishing. A random sample strategy was employed with individual sample site locations generated using a general random tessellation stratified (GRTS) design (Stevens and Olsen 2004). The GRTS strategy supplied spatially balanced randomly chosen sample locations. Spatially balanced sampling strategies are recommended for stock assessment surveys to promote unbiased estimates of mean catch-per-unit-of-effort (*C/f*), to speed the positioning of sample gears, allow for better understanding of distribution, and to improve precision (Hilborn and Walters 1992; Bernard et al. 1993). The SPSURVEY package (version 2.1; available at: http://cran.r-project.org/web/packages/spsurvey/index.html) for the R statistical program (version 2.10.1; available at http://www.r-project.org/) and ArcGIS 10 (ESRI, Redlands, CA) were used to draw the GRTS sample locations.

A total of 12 randomly selected sites were surveyed, five in the upstream free-flowing section and seven in the lower section. Fish were captured using boat electrofishing. The electrofishing in the free-flowing section was conducted using a drift boat mounted with a Smith-Root 2.5 GPP electrofishing unit. Two Smith-Root 5.0 GPP outboard motor powered electrofishing boats were used to sample the sites in the lower section. A crew of three individuals, one rower/driver and two netters, completed the electrofishing surveys. Sites were sampled moving in a downstream direction, beginning at the randomly selected sample location, parallel to the shoreline for a total of 600 s of electrofisher "on" time. Boat speed was maintained so that each sample section was approximately 400 m in length. All electrofishing was conducted at night, beginning at dusk and continued until all sites within that section were completed. Electrofisher settings were: voltage=low (50-100), percent varied from 20-40, pulse rate was 30 and 60 pulses per second direct current (DC), and amperage 2.0-2.5.

All fish collected were identified to species, measured for fork length (FL; mm), weighed (g), and examined for tags, marks, and physical anomalies. All data were recorded in pencil on waterproof standardized data sheets. Rainbow trout captured with an intact adipose fin were considered wild redband trout. Unmarked redband trout ≥65 mm FL were injected with a full duplex (FDX) PIT tag (Destron Fearing, TX1411SST-1, 134.2 kHz) according to the methods described in CBFWA (1999). Redband trout <200 mm FL were given a left pelvic (ventral) fin clip in addition to the PIT tag. Redband trout ≥200 mm FL were affixed with an individually numbered Floy® FD-94 tag at the left base of the dorsal fin (Guy et al. 1996) in addition to the PIT tag. The Floy tags were inscribed with a contact phone number to facilitate angler tag returns. Redband trout tagged and fin clipped for this study will facilitate evaluation of population closure for the redband trout abundance estimate downstream of Monroe Street Dam as part of the Redband Trout Spawning and Emergence Study (McLellan and Lee 2011; Lee 2012; Lee *in prep*).

Catch-per-unit-of-effort (*C*/*f*) index was calculated for all species as an index of population abundance. The *C/f* index was represented by the equation,

$$C/f = qN$$

where *C* was the number of fish captured, *f* was the unit of effort expended (previously defined as electrofisher "on" time), *q* was the catchability coefficient, and *N* was the total abundance of the target population (Hubert and Fabrizio 2007). Descriptive statistics of *C/f* mean and standard error (SE) were calculated using the local neighborhood methods of Stevens and Olsen (2004) and the SPSURVEY package in R.

Proportional size distribution (PSD) (Guy et al. 2007) was calculated for all sport species (trout and bass) captured. The PSD values were calculated by dividing the number of fish within a specific length category by the number of fish ≥ the minimum stock length, and multiplying by 100 (Anderson and Neumann 1996). For example, the $PSD_{S\text{-}Q}$ was calculated by dividing the number of fish ≥ the minimum stock length and < minimum quality length by the number of fish ≥ the minimum stock length, and multiplying by 100. Stock length was defined as the minimum length of fish with recreational value (20-26% of world record; rainbow trout=250 mm, smallmouth bass=180, brown trout=150) and quality length was defined as the minimum size of fish that anglers would like to catch (36-41% of world record; rainbow trout=400mm, smallmouth bass=280, brown trout=230) (Gabelhouse 1984). Preferred length was the minimum length of fish anglers would prefer to catch (45-55% of world record; rainbow trout=500 mm, smallmouth bass=350, brown trout=300). Memorable length was the minimum length of fish anglers would remember catching (59-64% of world record; rainbow trout=650 mm, smallmouth bass=430, brown trout=380). Trophy length was the minimum length of fish worthy of acknowledgement (74-80% of world record; rainbow trout=800 mm, smallmouth bass=510, brown trout=460). Total lengths (TL) of redband trout, hatchery rainbow trout, mountain whitefish, smallmouth bass, and brown trout were converted from fork length (FL) using the conversion factors (TL=1.071*FL, TL=1.071*FL, TL=1.1*FL, TL=1.04*FL, and TL=1.025*FL, respectively) from Carlander (1969). Stock structure indices have a binomial distribution (Gustafson 1988); thus, 80% confidence intervals (CI) were calculated for the PSD values as an indication of precision, using the method for proportions (Zar 1999).

The relative weight (W_r) index was used to evaluate the condition of sport fish collected during the study. The index was calculated as,

$$W_r = \frac{W}{W_s} \times 100$$

where W was the weight (g) of an individual fish and W_s was the standard weight of a fish of the same length calculated with the standard weight (W_s) equation (Kolander et al. 1993; Milewski and Brown 1994; Simpkins and Hubert 1997). The W_s equations were obtained from Anderson and Neumann (1996). A W_r value of 100 generally indicates that a fish is in good condition (Anderson and Gutreuter 1983; Anderson and Neumann 1996).

Scale samples (up to 5 per 10 mm length class) were collected from all sport fish and sent to the WDFW Aging Lab for analysis. Fish scales were mounted on cards, pressed in acetate, and magnified to identify annuli. Ages were determined by counting annuli. Annual growth was back calculated using the direct proportional method (LeCren 1947; DeVries and Frie 1996). Annual growth was determined by the equation,

$$L_i = \frac{S_i}{S_c} L_c$$

where L_i was the back-calculated length of the fish when the *i*th increment was formed, L_c was the length of the fish at capture, S_c was the radius of the hard part at capture, and S_i was the radius of the hard part at the *i*th increment (DeVries and Frie 1996).

Results

The middle Spokane River between Upriver and Upper Falls dams was sampled on 12 and 13 September 2012. The upper free-flowing section was sampled on 12 September 2012 and the lower section was sampled on 13 September 2012. A total of twelve fish species were collected via boat electrofishing in 2012 (Table 1). Native species (n=7) comprised 88.9% of the relative abundance. Redband trout was the most abundant species by number, whereas largescale sucker *Catostomus macrocheilus* was the most abundant by weight across all gear types and middle Spokane River sections. Redband trout was the most abundant sport fish in the middle Spokane River. Other native sport fish collected included westslope cutthroat trout *Onchorynchus clarki lewisi* and mountain whitefish *Prosopium williamsoni*. Additionally, increased numbers of hatchery origin rainbow trout have been stocked into the middle Spokane River since 2010 and comprised 5.1% of the relative abundance in 2012.

Species richness was greater in the lower section, where ten species were represented. Nine species were captured in the upper free flowing section (Table 2). Redband trout was the most abundant species in drift boat electrofishing surveys conducted in the upper section, followed by largescale sucker and mountain whitefish. Whereas, largescale sucker was the most abundant in power boat electrofishing surveys in the lower section followed by redband trout and redside shiner *Richardsonius balteatus*. One westslope cutthroat trout and one kokanee salmon *Oncorhynchus nerka* were collected during drift boat surveys in the upper section, but were not observed in the lower section. Alternatively, sculpin spp., redside shiner, and yellow perch *Perca flavescens* were collected in the lower reach but were absent from collections in the upper section.

Total catch-per-unit-effort (*C/f*) was higher in power boat electrofishing surveys (173.1 fish/h) than in drift boat surveys (136.8 fish/h; Table 2). Redband trout *C/f* (73.2 fish/h) was highest in drift boat electrofishing surveys in the upper free-flowing section. In power boat electrofishing, largescale sucker *C/f* was highest (55.7 fish/h), followed by redband trout (41.1 fish/h). Redband trout *C/f* (54.5 fish/h) was highest across both gear types followed by largescale sucker (47 fish/h).

The majority of redband trout (86%) were in the $PSD_{S\text{-}Q}$ category, while the remaining fish were in the $PSD_{Q\text{-}P}$ category (Table 3). Half of the brown trout collected were in the $PSD_{Q\text{-}P}$ while other half were in the $PSD_{P\text{-}M}$, although the sample size was minimal (n=4). All hatchery origin rainbow trout and smallmouth bass *Micropterus dolomieu* collected were in the $PSD_{S\text{-}Q}$ category.

Redband trout mean FL was 258 mm (SD=91) and ranged from 74 to 432 mm (Table 4). Mean weight was 269 g (SD=213) and ranged from 4 to 932 g. Mean W_r of redband trout was 88 (SD=7) (Figure 2). Hatchery origin rainbow trout mean FL was 259 mm (SD=43) and ranged from 209 to 359 mm. Mean weight of hatchery rainbow trout was 215 g (SD=110) and ranged from 113 to 501 g. Mean Wr of hatchery rainbow trout was 87 (SD=6) (Figure 3). Smallmouth bass mean FL was 159 mm (SD=46) and ranged from 82 to 232 mm. Mean weight was 75 g (SD=58) and ranged from 10-197 g. Mean W_r for smallmouth bass was 100 (SD=7) (Figure 4). Additionally, mean FL for mountain whitefish was 250 mm (SD=115) and ranged from 132 to 389 mm while mean weight was 325 g (SD=317) and ranged from 28 to 751 g. Mean W_r of mountain whitefish was 91 (SD=11) (Figure 5). Brown trout mean FL was 295 mm (SD=133) and ranged from 129 to 449 mm. Mean weight was 476 g (SD=511) and ranged from 24 to 1,177 g. Mean W_r of brown trout was 98 (SD=10). Relative weight of brown trout was not graphed due to small sample size (n=4).

Redband trout (n=107) were aged from 0 to 6 years (Table 5). Redband age 0 to 3 years (2010-2012 cohorts) made up 97 percent of the redband captured. Smallmouth bass (n=11) ranged in age from 1 to 3 years (Table 6). Mountain whitefish (n=20) were aged from 0 to 6 years; however, mountain whitefish >350 mm may be older than the scale age as annuli stack up on the scale edge making them difficult to age accurately (Lucinda Morrow, WDFW Ageing Lab, personal communication). The 2010 and 2011 cohorts of mountain whitefish (age 1 and age 2) were absent from the catch (Table 7), while more than half (n = 12) of the mountain whitefish collected were age 0. The only yellow perch collected was age 2.

Discussion

This study identified a fishery comprised predominantly of native salmonids, catostomids and cyprinids. Cottids, non-native salmonids, centrarchids, and percids were also collected in low abundances. The fish assemblage observed in 2012 was similar to that reported in previous years by Lee and McLellan (2011) and King and Lee (2012) with a few notable differences. Redband trout was the most abundant species collected in the current survey (2012) comprising 34.54% of the total catch (Table 8). Largescale sucker, which had been the most abundant species in total electrofishing in all previous surveys since 2007, was the second most abundant species accounting for 29.7% of the relative abundance. Westslope cutthroat trout and kokanee salmon were observed for the first time during our surveys; however, only one individual of each species was collected sot it is unlikely that these species represent a viable resident population. These two fish were likely entrained from Lake Coeur d'Alene where known self sustaining populations exist. Kokanee salmon were historically stocked into the lake and many of the tributaries (Idaho Department of Fish and Game 2012, available at: http://fishandgame.idaho.gov/public/fish/stocking/). Westslope cutthroat trout are indigenous to the Lake Coeur d'Alene drainage (Behnke 2002). Yellow perch has been present in all three years of the present study; however, collections have amounted to a single specimen each year.

Redband trout *C/f* increased substantially throughout the three years of this study (Table 8). The increases were observed in both the upper and lower sections. Redband trout drift boat electrofishing *C/f* increased from 59.9 in 2010 to 64.4 in 2011 and 73.2 fish/h in 2012. Redband trout power boat electrofishing *C/f* in the lower section increased from 29.2 in 2010 to 36.7 in 2011 and 41.1 in 2012. It is not known if the increase in abundance is primarily due to natural reproduction within the middle Spokane River, entrainment from the upper Spokane River above Upriver Dam or a combination natural reproduction and entrainment. Northern pikeminnow and largescale sucker exhibited declines in total electrofishing *C/f* since 2010. The change for both species was most notable in the lower section where northern pikeminnow *C/f* declined from 76.4 fish/h in 2010 to 13.7 fish/h in 2012 and largescale sucker decreased from 136.2 fish/h in 2010 to 55.7 fish/h in 2012 (Lee and McLellan 2011). Length frequency distribution of largescale sucker shows an ageing population with little recruitment in recent years (Figure 6). Since 2010, only 7 of 441 largescale suckers collected were less than 350 mm FL, suggesting the majority of the fish are at least age 4 or greater (Wydoski and Whitney 2003). Although abundance of northern pikeminnow has decreased, the length frequency has remained more evenly distributed across size classes throughout the three years of this study.

Redband trout proportional size distribution has changed throughout this study with an increasing proportion of fish in the $PSD_{S\text{-}Q}$ category and decreasing proportion of $PSD_{Q\text{-}P}$ category fish (Table 9). A higher proportion of $PSD_{S\text{-}Q}$ category fish is the result of the strong 2010 cohort and many of the 2011 cohort recruiting to stock size. The actual number of $PSD_{Q\text{-}P}$ category fish has remained fairly consistent throughout the three years of this study.

In order to maintain consistency over the three study years, all surveys were conducted September 12-15 of each year when water temperatures were 12-15 °C. Despite efforts to conduct consistent fisheries surveys, variable hydrologic characteristics occur annually in the middle Spokane River. Mean discharge measured at Post Falls (USGS gage no. 12419000) during the current survey was 23.1-23.5 m^3/s, whereas discharge during the 2010 (35.1-35.7 m^3/s) and 2011 (32.3 m^3/s) surveys were substantially greater (Available at: http://waterdata.usgs.gov/, accessed 12/13/2012). Additionally, during the 212 day period that encompassed the spring freshet (January-July), there were 101 days that mean discharge exceeded 250 m^3/s in 2012 (mean daily discharge = 329.8 m^3/s), compared to 34 days in 2010 (mean daily discharge = 166 m^3/s) and, 136 days in 2011(mean daily discharge = 421 m^3/s). The variable hydrologic conditions experienced in the Spokane River determine when Avista implements the aesthetic spill procedures at the Upper Falls Dam annually. Avista's Upper Falls aesthetic spill Standard Operating Procedure (SOP) is to release approximately 9.06 m^3/s during the day and then approximately 2.83 m^3/s at night (T. Vore, Avista, personal communication). Since flows in the Spokane River exceed the aesthetic flow requirement during the majority of any year, the aesthetic spill SOP is typically implemented during July, August and September, the low flow period.

Many physical, chemical and biological factors may affect the abundance and distribution of fish species in reservoirs although none were directly investigated in this study (Swales 2009, Michaletz et al. 2012). The variable hydrologic conditions throughout the three years of this study including flow and temperature at the time of the surveys and duration and magnitude of the spring freshet may affect the abundance and distribution of fish species in the middle Spokane River. An evaluation of entrainment conducted on the Spokane River Hydroelectric Project suggested that high spring flows were likely responsible for the majority of the downstream movement of fish from the upper Spokane River, although entrainment at Upriver Dam was not evaluated (Parametrix 2004). Biological factors, such as food availability, predation, and interspecific and intraspecific competition could also contribute to distribution and composition of the fish community observed in this study. Other factors that may play a role in shaping the fish community include natural mortality, fishing mortality and recreational harvest.

Management objectives of the Washington Department of Fish and Wildlife for the middle Spokane River focus on conservation of native species while providing an urban recreational fishery. The increasing trend of redband trout abundance suggests that the population is not being exploited by angler harvest under the current regulations. In accordance with the license, the number of hatchery origin rainbow trout stocked into the middle Spokane River was increased to 6,000 catchable triploid rainbow trout annually beginning in 2010, which has led to increased angling opportunities.

The purpose of this three year assessment was to provide information pertinent to the potential effect of the aesthetic spill operation at Upper Falls Dam on resident fish. This study described the species composition, abundance, and condition of the fish community and identified general trends, such as an increase in redband trout and mountain whitefish abundance and a general decrease in largescale sucker and northern pikeminnow abundance. Due to the timing and magnitude of the Upper Falls aesthetic spill operation, the potential to negatively impact the reservoir fish community to any measurable degree is minimal. Information gained from this study about the current composition of the fishery in the middle Spokane River can be used to develop management strategies that support conservation efforts for resident native fish and improve management of the urban recreational fishery.

Table 1. Species composition (%) by number (n) and weight (kg) of fish collected with all gear types in the middle Spokane River, Spokane County, WA (September 2012).

Species	Common Name	By Number		By Weight (kg)	
		n	%	n	%
Ptychocheilus oregonensis	Northern pikeminnow	17	5.4	17	3.9
Richardsonius balteatus	Redside shiner	24	7.6	24	0.2
Catostomus macrocheilus	Largescale sucker	94	29.7	94	70.1
Onchorhynchus clarki lewisi	Westslope cutthroat trout	1	0.3	1	0.1
Onchorhynchus mykiss gairdneri	Redband trout	109	34.5	109	17.6
O. mykiss	Rainbow trout (hatchery)	16	5.1	16	2.1
Onchorhynchus nerka	Kokanee salmon	1	0.3	1	<0.1
Prosopium williamsoni	Mountain whitefish	21	6.6	21	4.1
Salmo trutta	Brown trout	5	1.6	5	1.4
Cottus spp.	Sculpin spp.	15	4.7	14	0.1
Micropterus dolomieu	Smallmouth bass	12	3.8	12	0.5
Perca flavescens	Yellow perch	1	0.3	1	<0.1

Table 2. Number (n), relative abundance (%), and catch-per-unit-effort (*C/f*) by gear type, of fish collected in the middle Spokane River, Spokane County, WA (September 2012).

Electrofishing Gear	Drift boat			Power boat			Total Electrofishing		
Effort (h)	0.833			1.167			2.000		
Species	n	%	*C/f* (80% CI)	n	%	*C/f* (80% CI)	n	%	*C/f* (80% CI)
Northern pikeminnow	1	0.9	1.2 (1.3)	16	7.9	13.7 (4.2)	17	5.4	8.5 (2.4)
Redside shiner	0	0.0	0.0	24	11.9	20.6 (11.3)	24	7.6	12.0 (6.6)
Largescale sucker	29	25.4	34.8 (9.2)	65	32.2	55.7 (10.5)	94	29.7	47.0 (7.6)
Westslope cutthroat trout	1	0.9	1.2 (1.3)	0	0.0	0.0	1	0.3	0.5 (0.5)
Redband trout	61	53.5	73.2 (21.4)	48	23.8	41.1 (11.5)	109	34.5	54.5 (11.1)
Rainbow trout (hatchery)	2	1.8	2.4 (2.5)	14	6.9	12.0 (7.3)	16	5.1	8.0 (4.3)
Kokanee salmon	1	0.9	1.2 (1.3)	0	0.0	0.0	1	0.3	0.5 (0.5)
Mountain whitefish	14	12.3	16.8 (6.6)	7	3.5	6.0 (5.3)	21	6.6	10.5 (4.0)
Brown trout	2	1.8	2.4 (1.6)	3	1.5	2.6 (2.8)	5	1.6	2.5 (1.8)
Sculpin spp.	0	0.0	0.0	15	7.4	12.9 (6.2)	15	4.7	7.5 (4.0)
Smallmouth bass	3	2.6	3.6 (1.7)	9	4.5	7.7 (2.7)	12	3.8	6.0 (1.8)
Yellow perch	0	0.0	0.0	1	0.5	0.9 (0.9)	1	0.3	0.5 (0.5)

Table 3. Proportional size distribution (80% CI) of trout and bass species captured in the middle Spokane River, Spokane County, WA (September 2012). The PSD length classes were stock (S), quality (Q), preferred (P), memorable (M), and trophy (T). For example, the values under S-Q indicate the proportion of stock length fish of each species that were between the stock length and the quality length. The values for the length categories of each species are provided in the methods.

Species	No. Stock Length	S-Q	Q-P	P-M	M-T
Redband trout	72	86 (58-91)	14 (10-24)	0	0
Rainbow trout (hatchery)	11	100	0	0	0
Brown trout	4	0	50 (17-86)	50 (17-86)	0
Smallmouth bass	4	100	0	0	0

Table 4. Species, number measured and weighed (n), mean fork length (mm; ±standard deviation), range of fork length, mean weight (g), and range of weight of fish collected by electrofishing in the middle Spokane River, Spokane County, WA (September 2012).

Species	n	Mean FL (SD)	Range of FL	n	Mean Wt. (SD)	Range of Wt.
Northern pikeminnow	17	301 (72)	159 - 496	17	380 (368)	44 - 1,538
Redside shiner	24	90 (30)	27 - 142	24	12 (9)	1 - 42
Largescale sucker	94	457 (89)	37 - 564	94	1,247 (360)	1 - 1,882
Westslope cutthroat trout	1	231	231	1	149	149
Redband trout	109	258 (91)	74 - 432	109	269 (213)	4 - 932
Rainbow trout (hatchery)	16	259 (43)	209 - 359	16	215 (110)	113 - 501
Kokanee salmon	1	138	138	1	30	31
Mountain whitefish	21	250 (115)	132 - 389	21	325 (317)	28 - 751
Brown trout	5	295 (133)	129 - 449	5	476 (511)	24 - 1,177
Sculpin spp.	15	89 (14)	52 - 113	14	9 (4)	1 - 17
Smallmouth bass	12	159 (46)	82 - 232	12	75 (58)	10 - 197
Yellow perch	1	142	142	1	33	33

Table 5. Mean fork length (mm ±standard error; SE) at age of redband trout collected in the middle Spokane River, Spokane County, WA (September 2012).

Cohort	Age	n	Fork Length (SE)
2012	0	19	102 (5)
2011	1	39	233 (3)
2010	2	35	317 (5)
2009	3	11	371 (7)
2008	4	1	392
2007	5	1	432
2006	6	1	432

Table 6. Mean back-calculated fork length at annulus formation and mean annual growth (±SE) by cohort of smallmouth bass collected in the middle Spokane River, Spokane County, WA (September 2012).

Cohort	n	Mean Fork Length at Annulus Formation		
		1	2	3
2011	2	37 (3)		
2010	2	40 (0)	79 (0)	
2009	7	47 (3)	96 (5)	143 (11)
Grand means	11	44 (2)	97 (4)	143 (9)
Annual Growth		44 (2)	47 (5)	47 (5)

Table 7. Mean back-calculated fork length at annulus formation and mean annual growth (±SE) by cohort of mountain whitefish collected in the middle Spokane River, Spokane County, WA (September 2012).

Cohort	n	Mean Fork Length at Annulus Formation					
		1	2	3	4	5	6
2011	0						
2010	0						
2009	1	164	291	325			
2008	3	168 (4)	303 (26)	335 (16)	354 (14)		
2007	4	189 (4)	281 (2)	316 (3)	341 (6)	355 (6)	
2006	1	164	268	301	324	340	359
Grand means	9	177(5)	288 (9)	322 (6)	344 (6)	352 (4)	359
Annual Growth		177 (5)	112 (10)	34 (3)	22 (3)	14 (1)	18

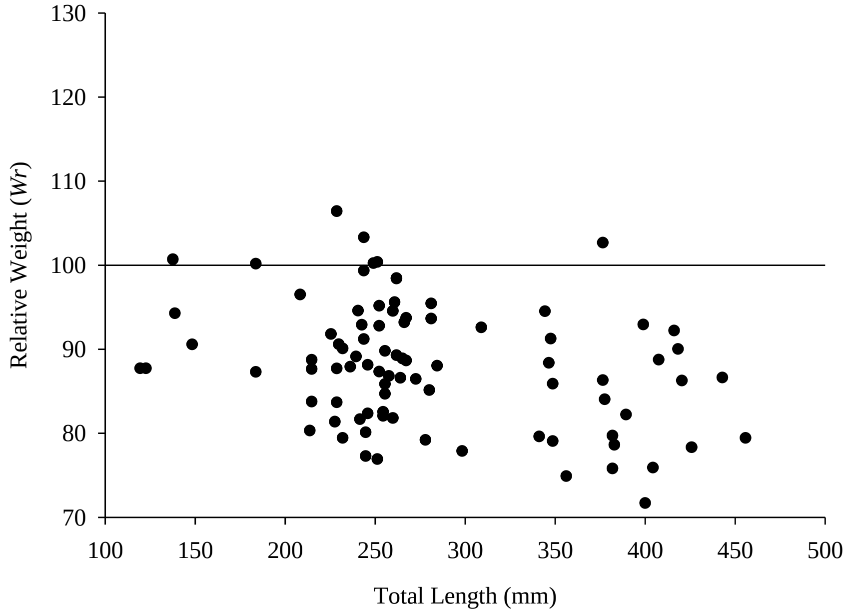

Figure 2. Relative weight (*Wr*) of redband trout (≥120 mm TL; n=95) captured in the middle Spokane River, Spokane County, WA (September 2012).

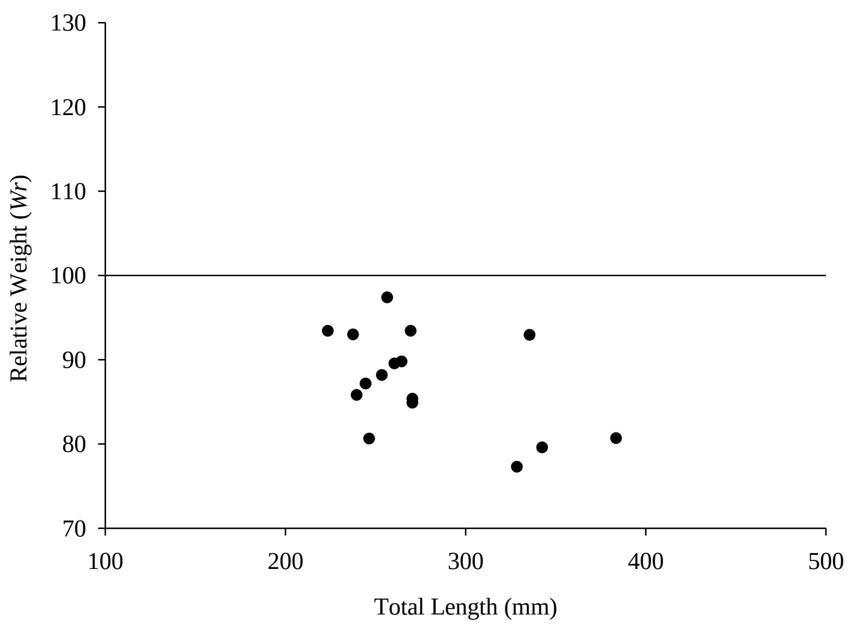

Figure 3. Relative weight (*Wr*) of hatchery origin rainbow trout (≥ 120 mm TL; n=16) captured in the middle Spokane River, Spokane County, WA (September 2012).

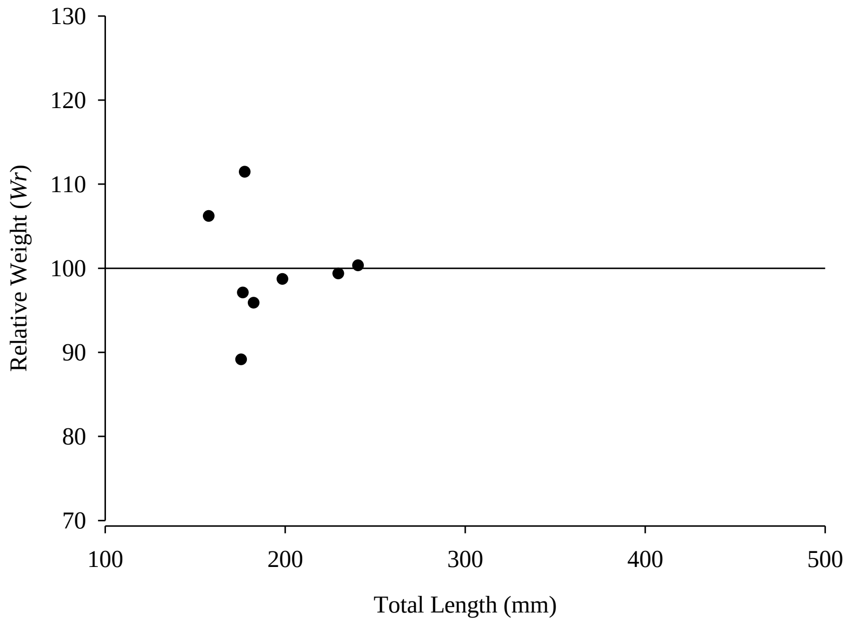

Figure 4. Relative weight (*Wr*) of smallmouth bass (≥150 mm TL; n=8) captured in the middle Spokane River, Spokane County, WA (September 2012).

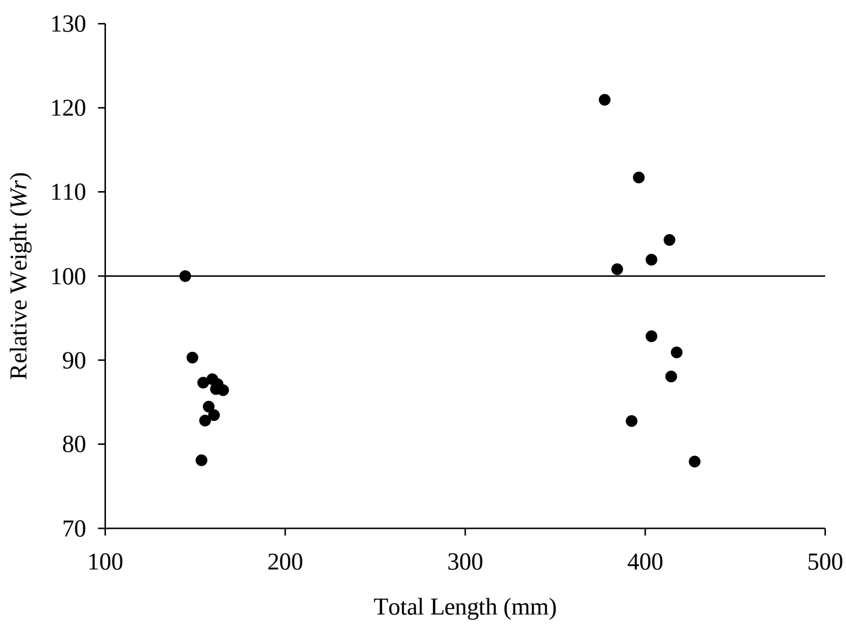

Figure 5. Relative weight (*Wr*) of mountain whitefish (≥140 mm TL; n=21) captured in the middle Spokane River, Spokane County, WA (September 2012).

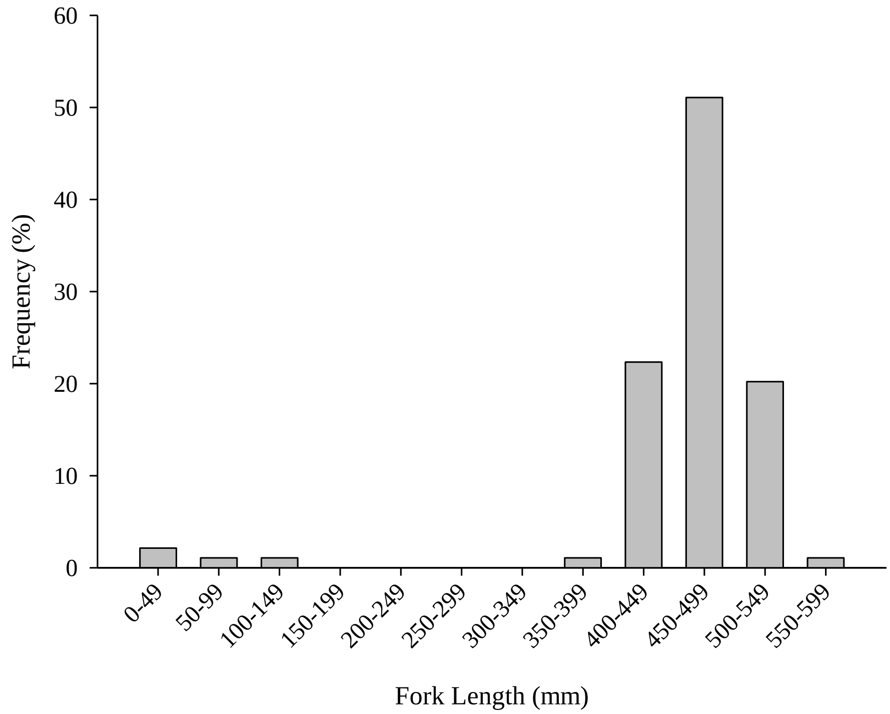

Figure 6. Length frequency distribution of largescale sucker (n=94) collected in the middle Spokane River, Spokane County, WA (September 2012).

Table 8. Comparison of the total number of fish collected by power boat and drift boat electrofishing (n), relative abundance (%), total electrofishing effort, and *C/f* (fish/h)for fish species collected in the middle Spokane River by O'Connor and McLellan (2008), Lee and McLellan (2011), King and Lee (2012) and the current survey (September 2012).

	2007[a] 11 Sites (1.83h)			2010[b] 12 Sites (1.97 h)			2011[c] 12 Sites (2.02 h)			2012 12 Sites (2.00 h)		
Species	n	%	*C/f* (80% CI)	n	%	*C/f* (80% CI)	n	%	*C/f* (80% CI)	n	%	*C/f* (80% CI)
Northern pikeminnow	128	30.8	33.3 (16.1)	105	20.7	52.4 (6.1)	46	12.3	23.0 (5.1)	17	5.4	8.5 (2.4)
Redside shiner	12	2.9	5.5 (5.2)	35	6.9	17.5 (13)	28	7.5	14.0 (6.2)	24	7.6	12.0 (6.6)
Largescale sucker	194	46.8	69.8 (15.9)	221	43.6	111.8 (14.4)	114	30.6	56.4 (12.2)	94	29.7	47.0 (7.6)
Bridgelip sucker	0	0	0.0 (0.0)	0	0	0.0 (0.0)	1	0.3	0.5 (0.5)	0	0.0	0.0 (0.0)
Westslope cutthroat trout	0	0	0.0 (0.0)	0	0	0.0 (0.0)	0	0	0.0 (0.0)	1	0.3	0.5 (0.5)
Redband trout	29	7	15.8 (8.5)	77	15.2	39.5 (7.8)	94	25.2	46.3 (10.7)	109	34.5	54.5 (11.1)
Rainbow trout (hatchery)	7	1.7	3.3 (2.5)	8	1.6	4.0 (1.7)	11	2.9	5.5 (3.2)	16	5.1	8.0 (4.3)
Kokanee salmon	0	0	0.0 (0.0)	0	0	0.0 (0.0)	0	0	0.0 (0.0)	1	0.3	0.5 (0.5)
Mountain whitefish	18	4.3	9.8 (6.4)	8	1.6	4.2 (2.3)	18	4.8	8.9 (7.8)	21	6.6	10.5 (4.0)
Brown trout	2	0.5	1.1 (1.0)	1	0.2	0.5 (0.5)	4	1.1	1.9 (1.1)	5	1.6	2.5 (1.8)
Sculpin	15	3.6	8.2 (3.7)	26	5.1	13.1 (3.9)	38	10.2	18.9 (4.3)	15	4.7	7.5 (4.0)
Smallmouth bass	10	2.4	5.5 (2.8)	24	4.7	12 (3.9)	18	4.8	9.0 (3.3)	12	3.8	6.0 (1.8)
Largemouth bass	0	0	0.0 (0.0)	1	0.2	0.5 (0.5)	0	0	0.0 (0.0)	0	0.0	0.0 (0.0)
Yellow perch	0	0	0.0 (0.0)	1	0.2	0.5 (0.6)	1	0.3	0.5 (0.6)	1	0.3	0.5 (0.5)

[a]O'Connor and McLellan (2008)
[b]Lee and McLellan (2011)
[c]King and Lee (2012)

Table 9. Number of stock length redband trout and PSD values for fish collected during annual electrofishing surveys in the middle Spokane River (2010-2013).

Year	No. Stock Length	S-Q	Q-P	P-M	M-T
[a]2010	41	71 (60-80)	29 (18-40)	0	0
[b]2011	55	82 (73-88)	18 (12-27)	0	0
2012	72	86 (58-91)	14 (10-24)	0	0

[a] Lee and McLellan (2011)
[b]King and Lee (2012)

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