Henry M. Jackson Hydroelectric Project No. 2157

Technical Memorandum:
Spada Lake Reservoir Gill Net Survey
October 2017

Prepared by:

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1.0 INTRODUCTION

As described in Public Utility District No. 1 of Snohomish County's (District's) Spada Lake Recreational Fishery Plan (SLRF Plan, District 2011), for the Jackson Hydroelectric Project (Project), beginning in 2012 and once every five years thereafter, the District agreed to conduct October fish population sampling in Spada Lake Reservoir (using gill nets) patterned after previous surveys conducted by the Washington Department of Fish and Wildlife (WDFW) and the District (Pfeifer et al. 1999, Meridian Environmental and Shuksan Fisheries Consulting 2008). The SLRF Plan further stipulates that the sampling is to focus on the existing trout populations; although, the District also collected additional data on largescale sucker and non-native brown bullhead. The SLRF Plan stipulates analyses will include species composition, species catch per unit effort, size structure, and condition factor. Finally, the SLRF Plan stipulates the District will prepare a technical memorandum upon completion of each survey that describes the results and compares them with previous survey efforts (District 2011). This report serves as the District's technical memorandum describing the results of the October 2017 Spada Lake Reservoir gill net survey.

2.0 METHODS

In 2017, the District used the same trout sampling methods that were employed during the 2007 and 2012 October surveys (Meridian Environmental and Shuksan Fisheries Consulting 2008), including the same primary field staff, gill net types, and net set locations. A combination of 4 floating and 6 sinking horizontal variable-mesh gill nets were deployed overnight on October 10 and 11, 2017. Previous sampling was conducted October 16-17 and 23-24 (2007), and October 1-3 (2012). As stipulated in the SLRF Plan (District 2011), all gill nets were 1.8 meters deep by 38.1 meters long with 5 separate 7.6 meter-wide mesh panels of 2.5-, 3.2-, 3.8-, 5.1-, and 6.4-centimeter stretch mesh monofilament.

2.1 NET SET LOCATIONS AND TIMING

Gill nets were set over-night in established index zones with demonstrated high trout catch per unit effort (CPUE), such as areas located along the shoreline and near tributary inlets including the South Fork and mainstem of the Sultan River, and Williamson Creek. At the request of WDFW, the net set duration in 2017 was somewhat less than in previous years and was limited to darkness (to the extent possible) to protect foraging loons. In 2012, nets were generally set in the afternoon and retrieved in the morning. In 2007, nets were set over-night, but time between setting and retrieving was longer than in 2012 and 2017 as nets were generally set in the morning and retrieved in the afternoon the following day. Figure 1 depicts net set locations in 2007, 2012 and 2017. Due to the low reservoir elevation encountered during the 2017 survey, nets could not be deployed in the Williamson Creek and upper Sultan River arms, as these areas were de-watered. However, nets were set in the delta areas of these two

tributaries where sufficient water was present (e.g., the gill nets used were 6 feet (1.8 m) deep so depths at least 6 feet or greater were selected).

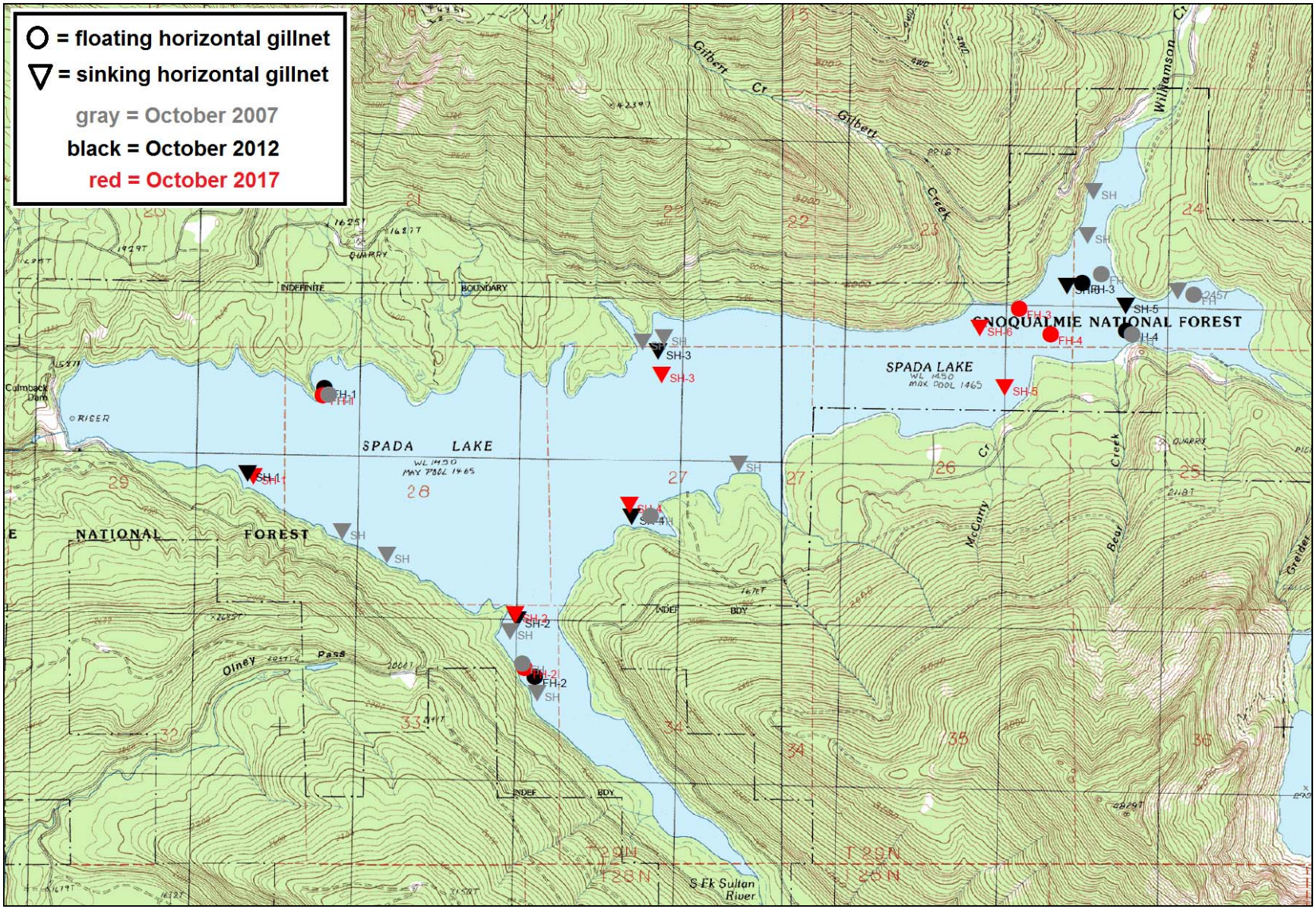

Figure 1. Net set locations in Spada Lake Reservoir in October 2007, 2012, and 2017.

2.2 DATA COLLECTION

Data collected during the 2017 survey included net set location, set duration (start and stop times), sampling depth, the number of each fish species captured, fish fork length and weight, water clarity, water temperature, and general weather conditions. Fork length was measured on a standard measuring board (in millimeters) and weight was measured using a digital scale (to the nearest gram). Biologists did not weigh trout that were still alive following their capture to avoid the use of anesthetic. Biologists also weighed a random subsample of largescale sucker and bullhead, with the goal of measuring at least 100 individuals of each species (when catch rates allowed).

During the 2017 survey, biologists classified all captured trout as either cutthroat trout (*Oncorhynchus clarkii*), rainbow trout (*O. mykiss*) or a potential hybrid of these two species. Per the methods employed in 1997 (Pfeifer et al. 1999), trout which exhibited characteristics of both species (most commonly basibranchial teeth in association with a "short" maxillary and/or lateral rainbow hues) were classified as hybrids. During the 2007 and 2012 surveys, cutthroat, rainbow and potential hybrids were not differentiated and categorized as “trout”.

In 2007 and 2012, the Spada Lake Reservoir water temperature profile was measured from the surface to a depth of 50 feet using an AquaCal® ClineFinder®. In 2017, biologists deployed a string of Onset Tidbit® thermistors set at 1, 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50-foot depth increments. The thermistors recorded water temperature at each depth once per hour during the study period (October 10 to 12, 2017). Water clarity was measured using a Secchi disk (the same disk used in 2007 and 2012).

2.3 DATA ANALYSIS

As stipulated in the SLRF Plan (District 2011), data analyses included species composition, species catch per unit effort (CPUE), size structure, and condition factor. However, only species composition metrics are reported for brook trout due to their low abundance. Metrics are defined and were assessed as follows:

Species Composition is defined as the percent total number of fish captured by species as well as the percent total weight by species. All fish were measured to length; however, not all were weighed. For fish not weighed, a weight was estimated using the length to weight relationship that was calculated from fish that were both measured and weighed.

Catch Per Unit Effort (CPUE) is defined as the total number of fish captured divided by the total number of net hours.

Biomass Per Unit Effort (BPUE) is defined as the total weight (g) of fish captured divided by the total number of net hours.

Size Structure was assessed by preparing length frequency histograms.

Condition Factor was assessed by comparing the length to weight relationship.

As reported in 2007 and 2012, "trout" is defined as the total of all rainbow, cutthroat, and potential hybrids of these two species. To facilitate comparison of 2017 data to prior years, this convention was maintained. In 2007 and 2012, all metrics were reported as the total of all floating and sinking horizontal nets combined. As the number of floating and sinking nets (and the proportion of hours fished) essentially remained the same through the three October sampling periods (Table 1), floating and sinking nets were combined for the 2017 analysis to remain consistent with prior years.

Table 1. Proportion of gill net hours by net set type 2007-2017.

Sample Date	% Horizontal Floating Gill Net Hours	% Horizontal Sinking Gill Net Hours
2017	40%	60%
2012	41%	59%
2007	39%	61%

3.0 RESULTS

The results of the 2017 survey are presented below following the analysis categories stipulated in the SLRF Plan (District 2011) including relative species composition, species CPUE, size structure, and condition factor.

3.1 SPECIES COMPOSITION

Over the past 10 years, the relative abundance of fish species in Spada Lake Reservoir (as determined during the October surveys) has shifted from a mixed trout and brown bullhead assemblage to dominance by trout and largescale sucker. Suckers were first documented upstream of Culmback Dam during the District's 2007 surveys. Brown bullhead relative abundance and biomass declined since the October 2007 survey (Table 2). Brook trout have remained at low relative abundance and biomass since the 2007 October survey (Table 2).

Table 2. Relative species composition.

Species Year	Total Weight		Total Number		Size Range (mm FL)	
	Grams	%	Number	%	Minimum	Maximum
Trout						
2017	17,320	54%	157	37%	121	400
2012	16,037	32%	247	31%	100	349
2007	22,984	77%	275	50%	60	325
Bullhead						
2017	1,003	3%	27	6%	100	210
2012	4,428	9%	277	35%	83	177
2007	5,186	17%	260	48%	83	210
Sucker						
2017	13,435	42%	240	56%	90	345
2012	29,504	59%	277	35%	95	346
2007	1,689	6%	11	2%	176	300
Brook Trout						
2017	179	0.6%	2	0.5%	215	225
2012	0	0.0%	0	0.0%	NA	NA
2007	102	0.3%	1	0.2%	225	225

Trout species composition was dominated by coastal cutthroat trout during the 2017 survey (Table 3, photos 1 and 2) with maxillaries extended well beyond the eye, orange slashes under the lower jaw, profuse body and caudal fin spotting, and basibranchial teeth.

Table 3. Proportion of cutthroat, rainbow, and hybrids of these two species caught in Spada Lake Reservoir – 2017.

Sampling Date	% Cutthroat Trout	% Potential Hybrid	% Rainbow Trout
2017	76%	18%	6%

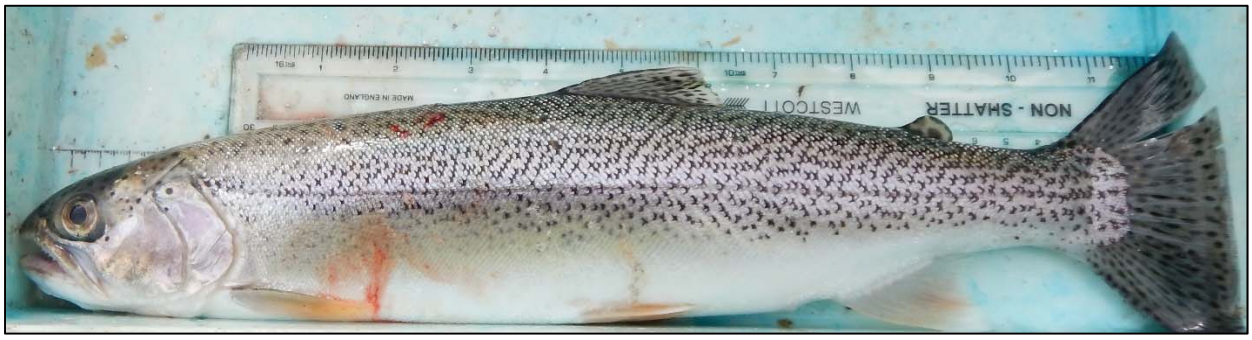

Photo 1. Mature female cutthroat trout (October 2017).

Photo 2. Cutthroat trout (October 2017).

3.2 CATCH PER UNIT EFFORT

Trout average and total CPUE was variable from 2007 to 2017 October surveys (Table 4). Bullhead CPUE was lower during the 2017 survey compared to prior years. Sucker CPUE was greater during the 2012 survey and continued to remain high in the 2017 survey (compared to 2007). These trends are consistent in both total CPUE (Table 4) and average CPUE (Table 4). BPUE has increased over time for trout since 2007 (Table 4). However, bullhead and sucker BPUE was lower during the 2017 survey compared to the 2012 survey (Table 4).

Table 4. Species CPUE and BPUE.

Species Year	Average CPUE (fish/hr) ± 80% C.I.	Total CPUE (fish/hr)	Total BPUE (grams/hr)	Total Effort (gill net hrs)
Trout				
2017	0.88 ± 1.26	0.85	96.4	179.7
2012	1.19 ± 0.81	1.25	81.0	198.0
2007	0.70 ± 0.07	0.70	58.5	392.9
Bullhead				
2017	0.15 ± 0.29	0.15	5.6	179.7
2012	1.37 ± 1.74	1.40	22.4	198.0
2007	0.66 ± 0.14	0.66	13.2	392.9
Sucker				
2017	1.26 ± 2.18	1.34	74.8	179.7
2012	1.39 ± 1.19	1.40	149.0	198.0
2007	0.03 ± 0.01	0.03	4.3	392.9

3.3 SIZE STRUCTURE AND CONDITION FACTOR

The proportion of trout 304 mm (12 inches) in length or longer was greater during the 2017 survey (Table 5) and several relatively large and robust adult trout were captured (photos 3 and 4). Trout length frequency shifted to somewhat longer fish overall compared to prior surveys (Figure 2). Bullhead length frequency shifted to longer fish (Figure 3), and sucker length frequency shifted to shorter fish (Figure 4) compared to prior surveys.

Trout condition factor in 2017 was similar to 2012, which was somewhat higher than condition observed during the 2007 survey (Figure 5). Of note is that several nearly mature cutthroat females (Photo 3) and males were observed. The stomach content of one large cutthroat (>350 mm in length) was coarsely examined in the field and what appeared to be a relatively large juvenile sucker (approximately 80 mm in length) was observed (Photo 4).

Table 5. Number and proportion of trout greater than 304 mm in length (12 inches) captured in Spada Lake Reservoir.

Sampling Year	Total Number	% of Total
2017	19	12%
2012	2	0.8%
2007	2	0.7%

Photo 3. Cutthroat trout female with near fully mature eggs captured during Spada Lake Reservoir sampling in October 2017.

Photo 4. Cutthroat trout with sucker in stomach captured during Spada Lake Reservoir sampling in October 2017 (noted after coarse dissection in the field).

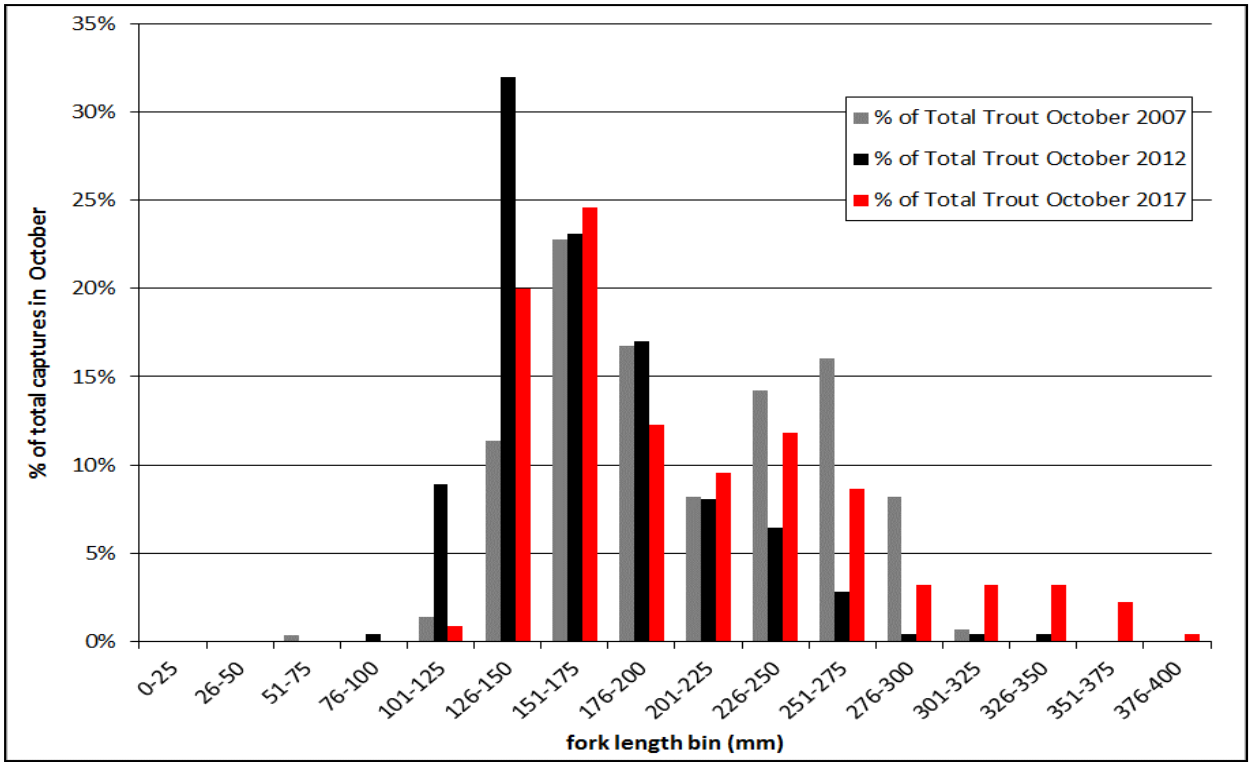

Figure 2. Length frequency distribution of trout.

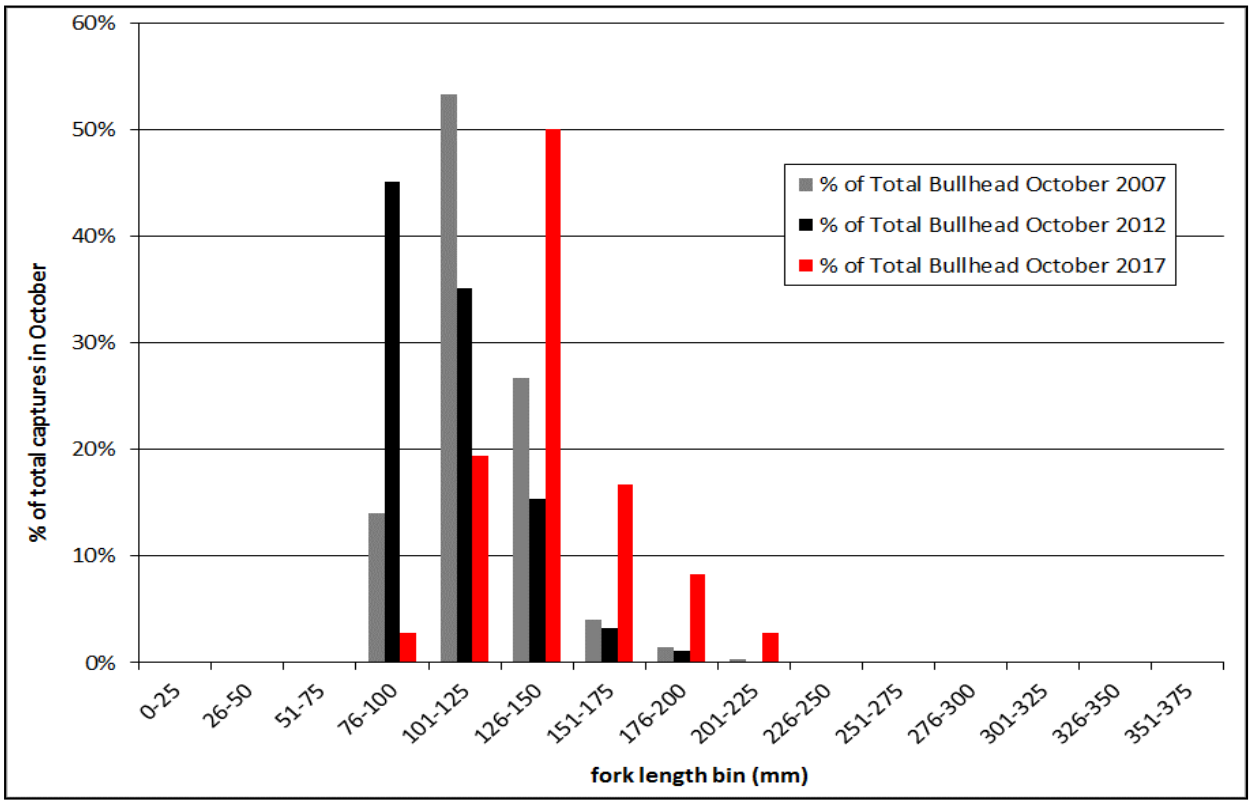

Figure 3. Length frequency distribution of bullhead.

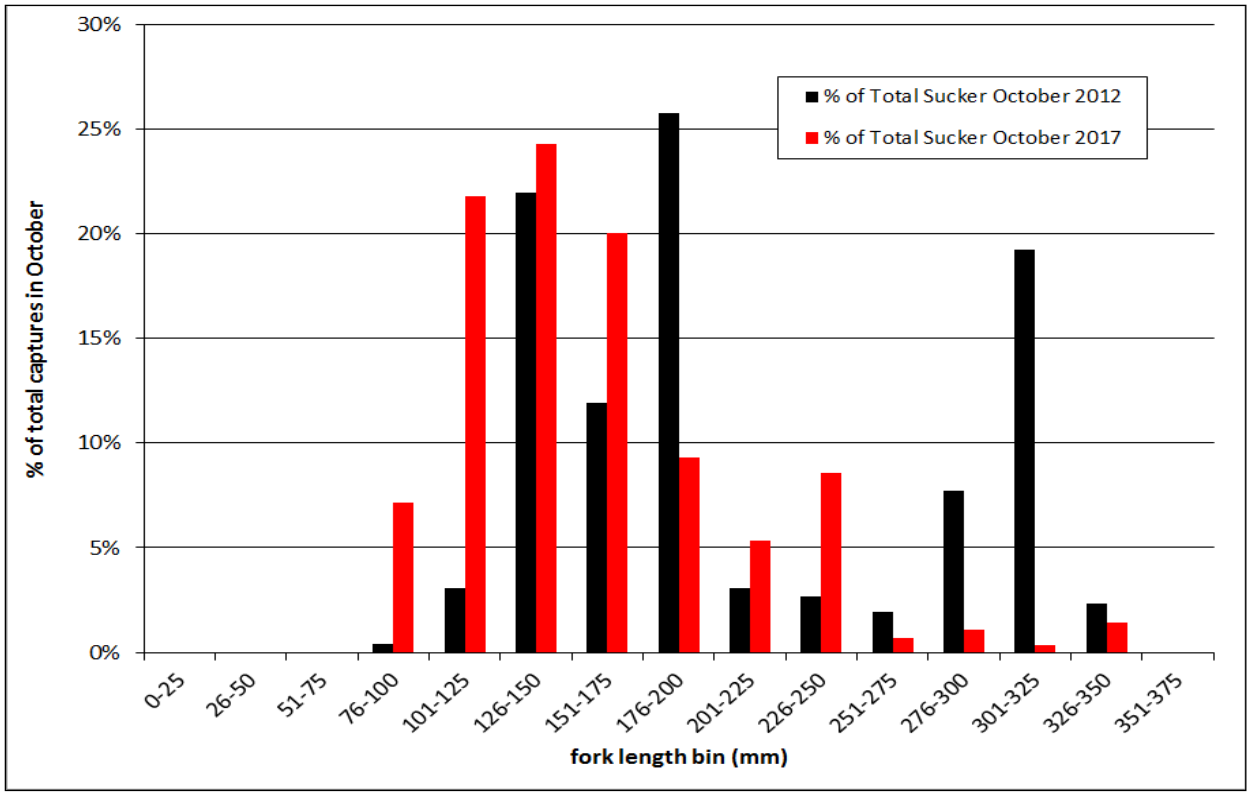

Figure 4. Length frequency distribution of largescale sucker.

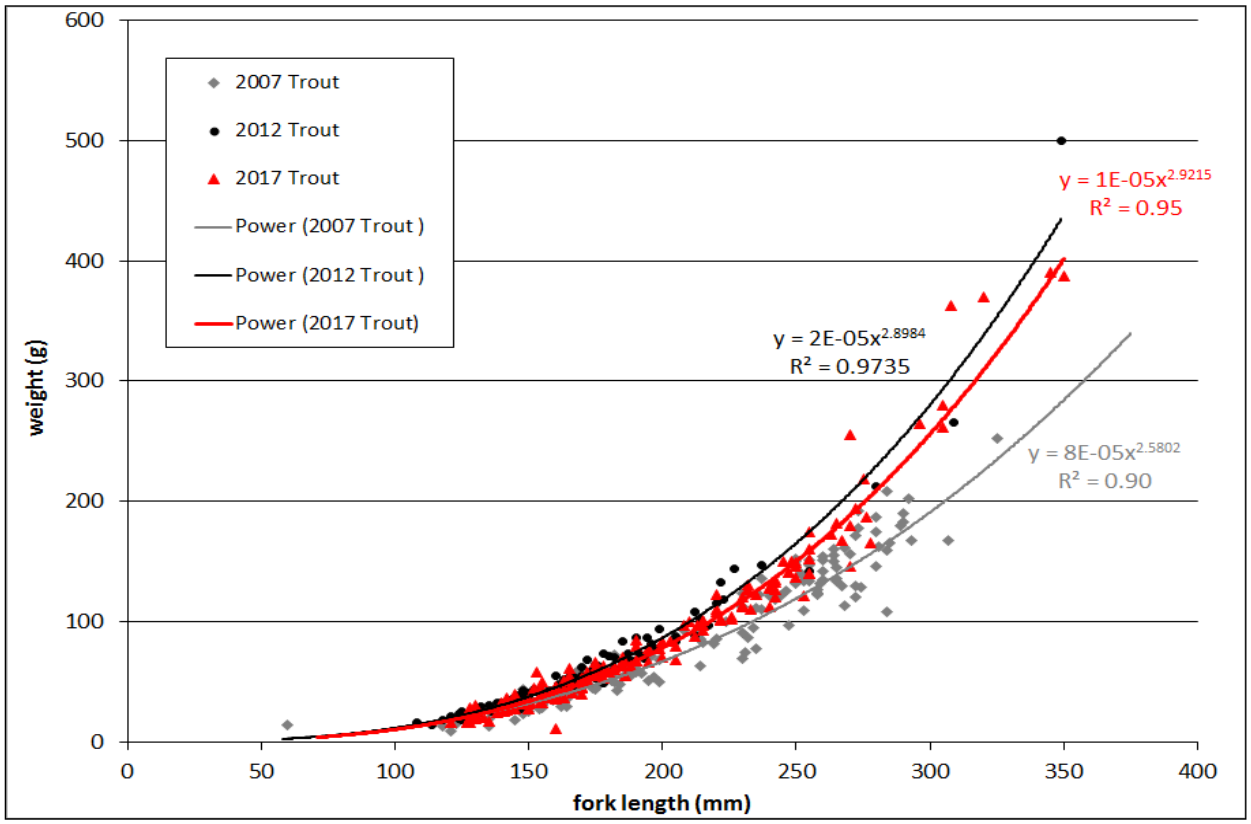

Figure 5. Length to weight relationship of trout.

3.4 ENVIRONMENTAL CONDITIONS

The water temperature profile during the 2017 survey was intermediate compared to the profiles measured during 2007 and 2012 (Figure 6). However, the continuous temperature measurement during the 2017 exhibited variability in temperature at depth during the survey period (Figure 7).

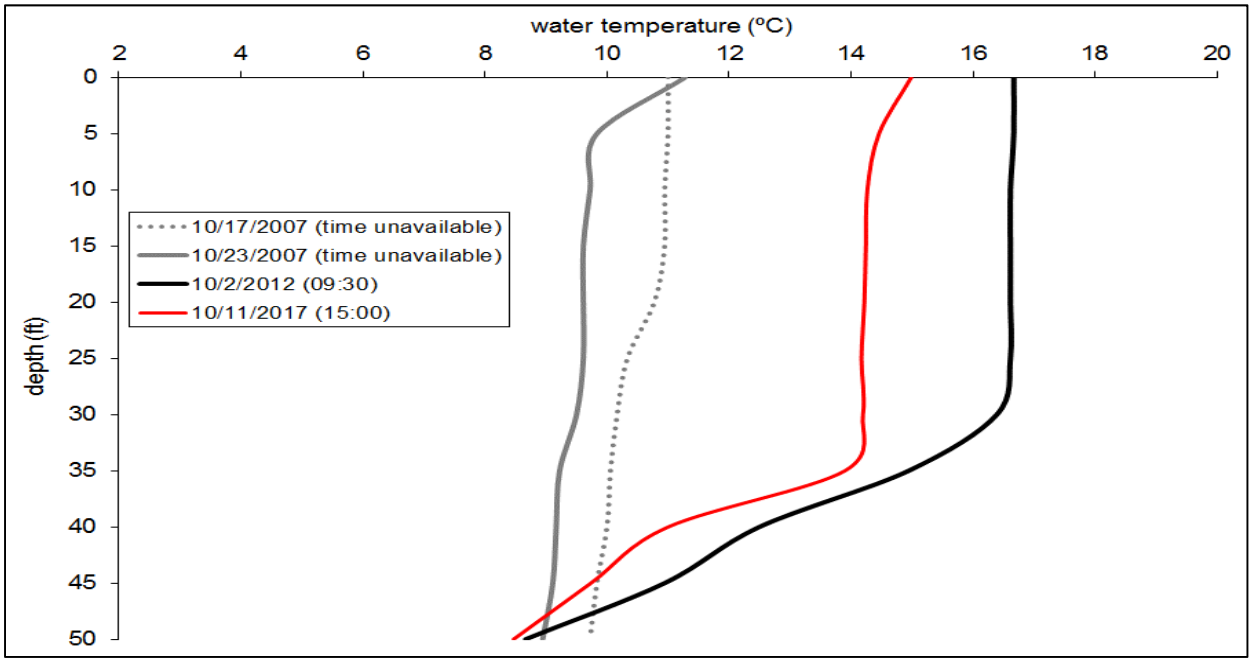

Figure 6. Water temperature profiles during Spada Lake Reservoir surveys.

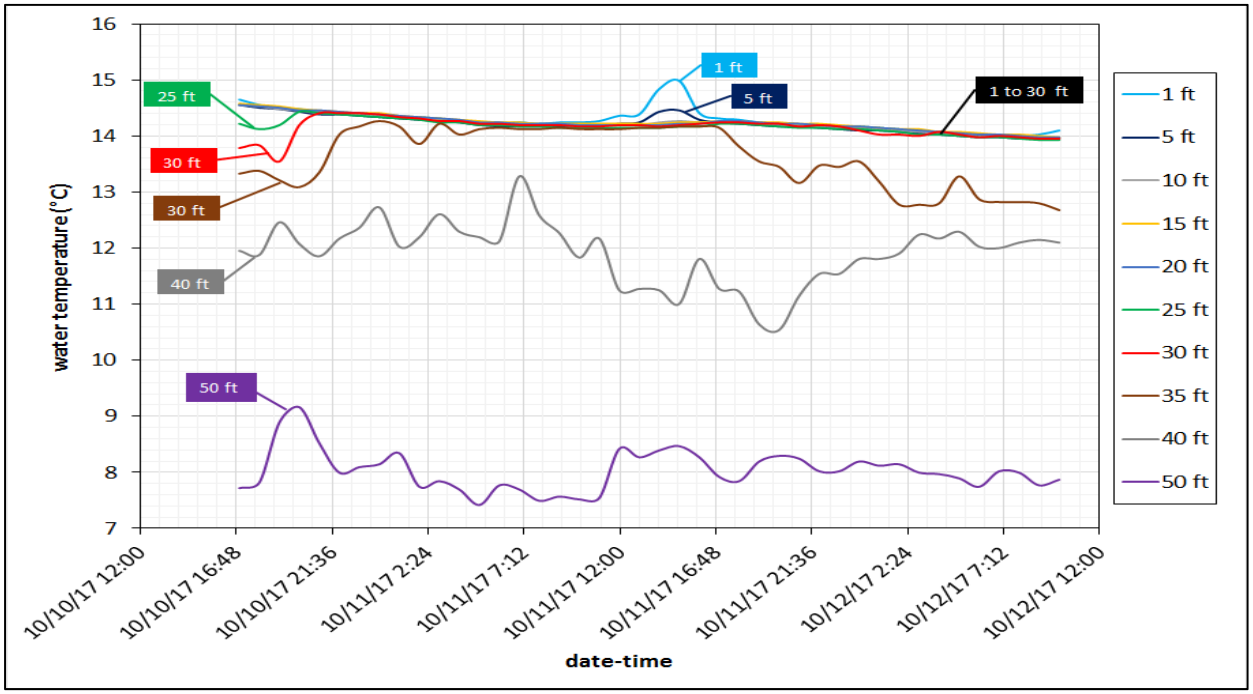

Figure 7. Thermal profile over time during 2017 Spada Lake Reservoir survey.

During the 2017 survey, Spada Lake Reservoir was about 10 feet lower than encountered in 2012, and about 30 feet lower than encountered in 2007 (Table 8). Water clarity (Secchi depth) during the 2017 survey was about the same as encountered in 2007, but less clear than encountered during the 2012 survey (Table 8). Average inflow from the South Fork Sultan River was intermediate during the 2017 survey compared to 2007 and 2012, and was colder than recorded in 2012.

Table 8. Spada Lake Reservoir water surface elevation, Secchi depth, South Fork Sultan River flow and water temperature during sampling.

Parameter	2007	2012	2017
Lake Level Elevation (ft)	1,431 ft	1,413 ft	1,402 ft
Secchi Depth (ft)	4.0 ft	16.0 ft	6.0 ft
Average Daily Flow - South Fork Sultan River[1]	132 cfs	5 cfs	42 cfs
Average Daily Water Temperature (C°) - South Fork Sultan River[1]	not recorded	9.0°C	7.1 C°

[1]USGS Gage No. 12137290 – South Fork Sultan River near Sultan, WA

4.0 DISCUSSION

Over the past 10 years, the relative abundance of fish species in Spada Lake Reservoir (as determined during the October surveys) has shifted from a mixed trout and brown bullhead assemblage to dominance by trout and largescale sucker. The 2012 and 2017 gill net survey results clearly demonstrate an increase in largescale sucker abundance and biomass compared to prior years. Historical data reviewed by Pfeifer et al. (1999) did not indicate that suckers were previously documented upstream of Culmback Dam. No largescale sucker were captured in 1997 (Pfeifer et al. 1999) and less than 30 were captured in 2007 (Meridian Environmental and Shuksan Fisheries Consulting 2008). Gill net sampling in both 1997 and 2007 was extensive, encompassing the months of April through November, with more than 2,000 gill net hours expended each year. In contrast, over 200 suckers were captured during one sample trip in October 2012. It is unknown how suckers became present in Spada Lake Reservoir post-1997, or what may have caused an apparent large increase in their relative abundance since 2007.

It is unknown what may have caused the possible shift in relative abundance and biomass between sucker and bullhead during October surveys. Data appended to Pfeifer et al. (1999) shows a relative abundance during an October 1997 survey of 94 percent trout and 6 percent bullhead (no suckers captured). Results from October surveys in 2007 and 2012 showed a much higher relative abundance of bullhead (48 percent and 35 percent, respectively). During the October 2017 survey, the relative abundance of bullhead had dropped to 6 percent, the level originally observed in 1997. Suckers are opportunistic, bottom feeders known to consume a diversity of food items. One hypothesis possible explaining the shift in species composition is that the large increase in suckers may have reduced bullhead either through direct competition

or predation on eggs; brown bullhead lay eggs in nests on the bottom in shallow water, which are habitats often used by suckers for foraging.

Trout catch rates were variable from 2007 to 2017 October surveys. However, the October 2017 results show a higher catch rate/relative abundance of trout greater than 304 mm (12 inches) in length. In addition, trout condition factor in both 2012 and 2017 was higher than in 2007. Differences in lake level, water temperature, and inflow documented between surveys may have affected fish catchability. The low lake level and low stream flow encountered during the 2017 survey appear to have concentrated pre-spawn staging cutthroat trout in the Williamson Creek and mainstem Sultan River delta areas of Spada Lake Reservoir, which may have resulted in the increased catch rate of large cutthroat trout over previous years. Potential bias in October survey catch rates due to environmental factors limits the ability to assess trends in trout metrics over time.

Pfeifer et al. (1999) does not present data on the proportion of rainbow trout, cutthroat trout, and potential hybrids of these two species for October surveys alone; therefore, comparison of October 2017 survey individual trout species relative abundance is not possible. Furthermore, future comparison of individual trout species relative abundance (i.e., rainbow to cutthroat) should be made with caution. Cutthroat trout typically spawn in winter and early spring, whereas rainbow trout typically spawn from late winter to early summer. As shown above, water temperature, reservoir level, and stream flow vary from year to year and may influence cutthroat trout migration timing upstream in October to stage for spawning. Therefore, the proportion of large cutthroat trout adults observed during October gill net surveys in relation to large rainbow trout may vary from year to year based on differences in their life history and spawn timing in relation to environmental variables.

Both Pfeifer et al. (1999) and Meridian Environmental and Shuksan Fisheries Consulting (2008) captured relatively few brook trout in Spada Lake Reservoir and the results of 2012 and 2017 surveys continue to show low relative brook trout abundance during the October surveys.

5.0 REFERENCES

Meridian Environmental, Inc. and Shuksan Fisheries Consulting, LLC. 2008. Henry M. Jackson Hydroelectric Project (FERC 2157) Relicensing, Revised Study Plan 16 Spada Lake Trout Production Draft Phase 2 Field Studies Technical Report, dated February 8, 2008. Prepared by Meridian Environmental Inc., Seattle, WA. Prepared for Public Utility District No. 1 of Snohomish County, Everett, WA

Pfeifer, B., P. Tappel, A. Vogel, M. Schuh, and W. Brunson. 1999. Spada Lake Biological Assessment and Sport Fishery Evaluation. Washington Department of Fish and Wildlife, Fish Program, Fish Management Division. December, 1999.

Public Utility District No. 1 of Snohomish County (District). 2011. Spada Lake Recreational Fishery Plan Henry M. Jackson Hydroelectric Project (FERC No. 2157), originally dated July 2010, updated September 2, 2011 per License Article 409.