North Fork Snoqualmie River Trout Abundance, Length-Frequency and Stomach Contents Monitoring Report

For 2014

Black Canyon Hydroelectric Project
FERC Project No. P-14110
December 2014

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1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION and BACKGROUND

This report documents results of trout studies conducted during 2014 at sites on the North Fork Snoqualmie River ("North Fork") as part of the Federal Energy Regulatory Commission (FERC) licensing process for the Black Canyon Hydroelectric Project ("Project", FERC No. 14110). The Project has been in the licensing process by Black Canyon Hydro LLC (BCH) since 2009.

As part of the licensing process, BCH has conducted studies to determine baseline conditions of several potentially-affected resources including aquatic resources defined to include (among other water-related factors) fish and aquatic invertebrates. It is customary in the FERC licensing process to conduct baseline surveys in such a manner as to facilitate comparisons of resource factors both pre- and after-Project construction.

Baseline ("pre-Project") North Fork Fish distribution and abundance studies have been conducted by various researchers in 2012, 2013, and 2014. These studies were conducted in the North Fork stream reach potentially affected by the Project, called the "Bypassed Reach". This reach extended from the location of Project Intake at Stream Mile (SM) 5.3 to the Project tailrace exit at SM 2.6.

Aquatic resources from 2012 through 2014 have indicated that rainbow was the predominant trout species in the Bypassed Reach, although other trout species, particularly cutthroat and brook trout, have been found in other North Fork reaches. Because of the overall dominance of rainbow trout in the Bypassed Reach, all references to trout in this report are to rainbows.

1.2 STUDY OBJECTIVE

The overall objective of the trout monitoring studies to date has been to determine the distribution and relative abundance and length frequency distribution of trout in each of four North Fork study sites prior to Project construction. Study results for 2014 were part of an ongoing before- and after-construction trout monitoring series. In addition, BCH has begun monitoring trout stomach contents to better determine food habits and relationships between stream invertebrate and fish populations.

1.3 SUMMARY of FINDINGS

The data collected in the 2014 monitoring study were compared to results of Aquatic Resources Studies conducted by BCH in August 2013 and the results of a preliminary fish abundance study conducted from the confluence with the mainstem at Stream Mile (SM) 0.0 to the USGS stream gage at SM 9.2 by Thompson and Donahue in August 2012 (Thompson and Donahue 2012). These comparisons were focused on the number of resident trout observed in four intensive study

sites selected as part of the Aquatic Resources Study (BCH 2014a). Statistical analysis of the 2014 trout observations are summarized below:

1. Relative abundance estimates, defined as the number of trout observations per unit effort, were significantly different among Study Sites but were not significantly different among the three study years; and

2. Trout length frequency, an index of age, was significantly different among Study Sites for observations made in August 2014. Length frequency was not significantly different among the three years within each study site.

To assure consistency among these and future monitoring studies, specific measures are included as recommendations at the end of this report. These measures involve snorkeling technique, field communications and field note inclusions, which would enhance comparisons among fish populations, growth rates and food habits throughout both pre- and post-construction periods.

Trout Abundance, Length Frequency and Stomach Contents
Monitoring Report for 2014

Black Canyon Hydroelectric Project
FERC Project No. P-14110
November 2014

2.0 INTRODUCTION and BACKGROUND

2.1 INTRODUCTION

This report documents results of trout abundance and age-class studies conducted during 2014 at Study Sites on the North Fork Snoqualmie River ("North Fork") as part of the Federal Energy Regulatory Commission (FERC) licensing process for the Black Canyon Hydroelectric Project ("Project", FERC No. 14110). The Project would be located approximately 4-miles northeast of North Bend in King County, Washington. The Project would have a generating capacity of 25-megawatts (MW) and would be located predominantly on private lands. The run-of-river project would divert up to 900 cubic feet per second (cfs) from an approximately 2.7-mile-section of the North Fork referred to as the "Bypassed Reach" (Figure 1).

2.2 BACKGROUND

The Project has been in the licensing process by Black Canyon Hydro LLC (BCH) since 2009. During that time period, BCH and its contractors have completed aquatic resources field and analysis studies from 2012 through 2014.

Trout abundance documentation in the Project Study Area began in 2012 when BCH contracted Thompson and Donahue (2012) to assess the abundance and distribution of trout in North Fork reaches that were not studied as part of the Snoqualmie River Game Fish Enhancement Plan Research Study (Thompson, Whitney, and Lamb 2011) due to safety considerations. In 2013, BCH, in association with Fairbanks Environmental Associates, conducted further trout abundance studies as part of the overall Aquatic Resources Study. The survey area and methods in each of these studies was somewhat different and are described as:

- 2012: Two or three snorkelers and one technician began at the USGS gage 12142000 at Stream Mile (SM) 9.2 and proceeded downstream to the confluence of the North Fork with the Middle Fork Snoqualmie River at SM 0.0.

- 2013: Two snorkelers and two technicians began at SM 1.60 and proceeded upstream to SM 6.54. The two deeply-incised canyon sections of the North Fork were not surveyed due to safety considerations.

- 2014: Two snorkelers and one technician completed surveys from the downstream boundary and worked upstream in four stream segments selected for intensive studies as part of the Aquatic Resources Study (BCH 2014)

To make a direct comparison of the relative abundance of trout among the three years, only observations of trout recorded in the four study sites were used. These four study sites were selected to represent the reaches in which they were located.

Thompson and Donahue (2012) and BCH (BCH 2014a, the report for 2013 surveys) concluded that rainbow and cutthroat trout were the predominant trout species at the four North Fork Study Sites. On review of the 2013 trout studies, BCH and consulting resource agencies agreed to conduct studies in 2014 to further monitor fish abundance and to document the trout spawning period. The Spawning Period report (BCH 2014b) is available at the Project website (www.blackcanyonhydro.com/resources/documents).

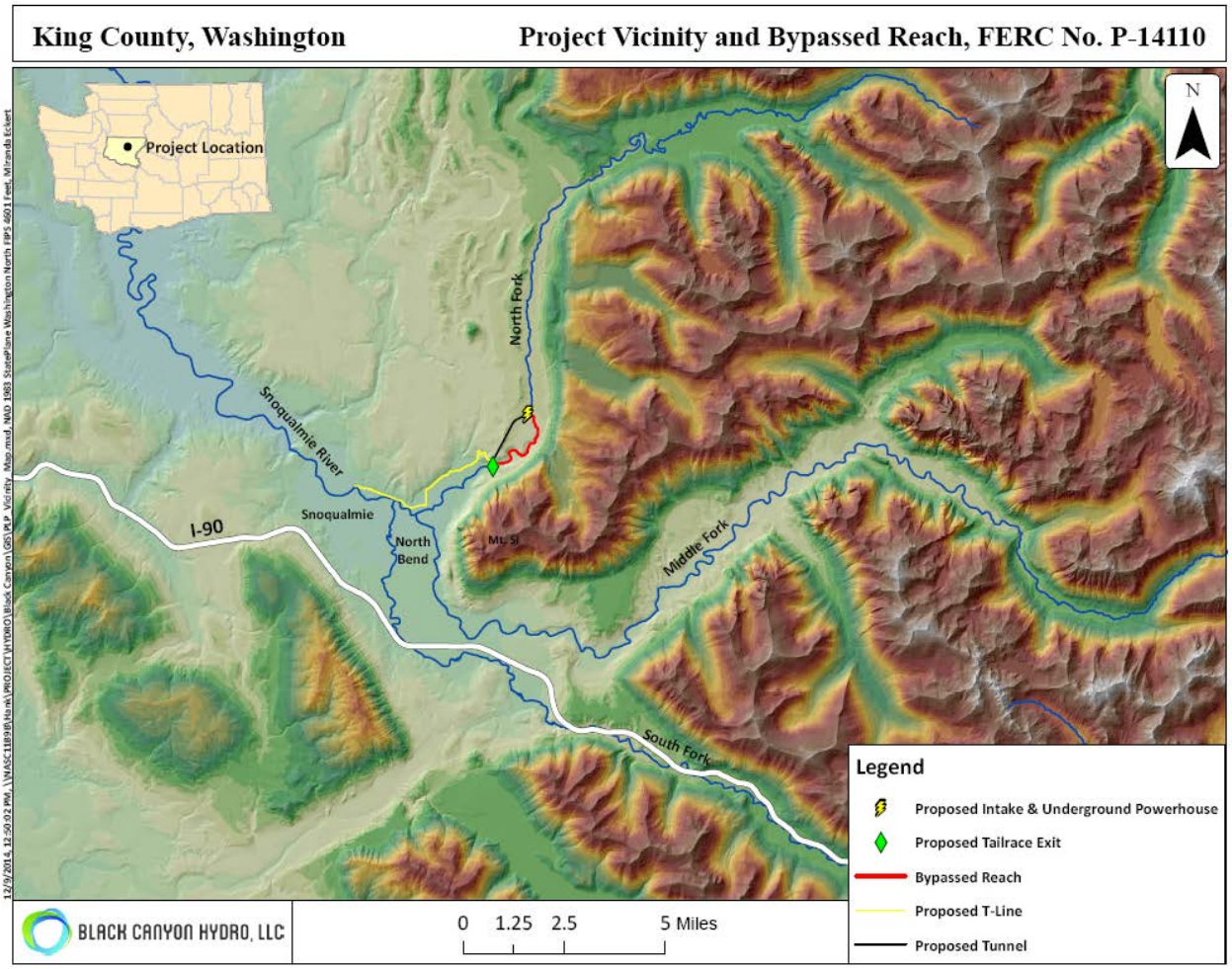

Figure 1. Black Canyon Hydroelectric Project Vicinity Map.

3.0 DESCRIPTION OF STUDY

3.1 STUDY DESCRIPTION and OBJECTIVES

Long-term Project-related trout monitoring studies were outlined in the 2013 Aquatic Resources Study Report (BCH 2014a). The objectives of the 2014 monitoring studies were to:

1. Document relative abundance of trout in four selected Study Sites;
2. Conduct length-frequency analysis of trout within each of the four Study Sites; and
3. Compare 2014 results with those from earlier North Fork trout studies

3.2 OVERALL STUDY APPROACH

The primary focus of this fish monitoring study was on rainbow and cutthroat trout. Largescale sucker and mountain whitefish were also present downstream of Fantastic Falls. However, three of the Project Study Sites are located upstream of this documented fish passage barrier where largescale sucker and mountain white fish have not been observed. Native sculpin were also present above Fantastic Falls.

3.2.1 Relative Abundance

Precisely estimating trout abundance in the North Fork Bypassed Reach would be very difficult due to the complexity of habitat types, channel morphology, and difficulty of sampling. An alternate approach is to monitor the change in relative abundance of fish over time within representative reaches (Hayes, et. al. 2007). The observed number of trout in the selected study sites would provide an index of relative abundance of trout over a period of years. Relative abundance is estimated as catch per unit effort (CPUE) or, when snorkeling is used, observations per unit effort (OPUE). The primary assumption to this method is that, fish are equally "catchable" (in this case "observable") during each survey effort (Hubert and Fabrizio 2007). ‘Observability’ would be affected by a number of variables such as water clarity, water temperature, flow, velocity, depth and life stage (Dolloff, Hankin and Reeves 1993). To assure comparability among snorkel surveys, they were conducted during the late summer low flow period when water clarity, water temperature, velocity, flow, depth, and life stage conditions were similar from year to year and therefore observablility among survey years would be similar.

3.2.2 Length Frequency

In this study, we used the length of observed trout as an index of age based on scale and otolith analysis completed by Thompson Whitney and Lamb (2011). The comparison of number of trout observed in each length class in each study site and from year to year, then, would provide a tool for determining if Project operations were effecting the size structure of the trout population (Neumann and Allen 2007). Similar to relative abundance analysis, observations of fish length can be affected by sampling methods, time of year, and flow conditions. Conducting snorkeling surveys during the late summer low flow conditions would ensure that observations were made when flow conditions were similar.

3.2.3 Stomach Contents

Some trout were captured at the various study sites and their stomach contents removed and preserved. These were compared to similar samples taken in 2013 to note consistency of fish food habits across study years.

4.0 METHODS

4.1 STUDY SITES

Four Study Sites were established as part of the Aquatic Resources Study that was completed in August 2013 (BCH 2014). Two of the Study Sites were located within the proposed Bypassed Reach. Two study sites were selected as reference study sites that would not be affected by the project; one Study Site was approximately 0.65 miles downstream of the proposed tailrace and one site was approximately 0.32 miles upstream of the proposed intake site. These four study sites were selected to be representative of the river segment in which they were located. The frequency of habitat types in each Study Site was similar to the frequency of habitat type in its respective river segment. The location of each study site is illustrated on Figure 2. Descriptions and photographs of each Study Site are included as Figures 3-6.

4.2 STUDY DATES and TIMES

Snorkeling surveys were conducted during the late summer low flow period in each of the surveys conducted in 2012, 2013, and 2014. This period was chosen primarily for safety consideration when water velocity and turbulence was at a minimum. This period was also selected to minimize variables that would alter the probability of observation of fish between years. All surveys were conducted during daylight hours.

All snorkeling surveys in 2014 were conducted on August 19. Snorkeling sessions at each Site were approximately 45 minutes in duration.

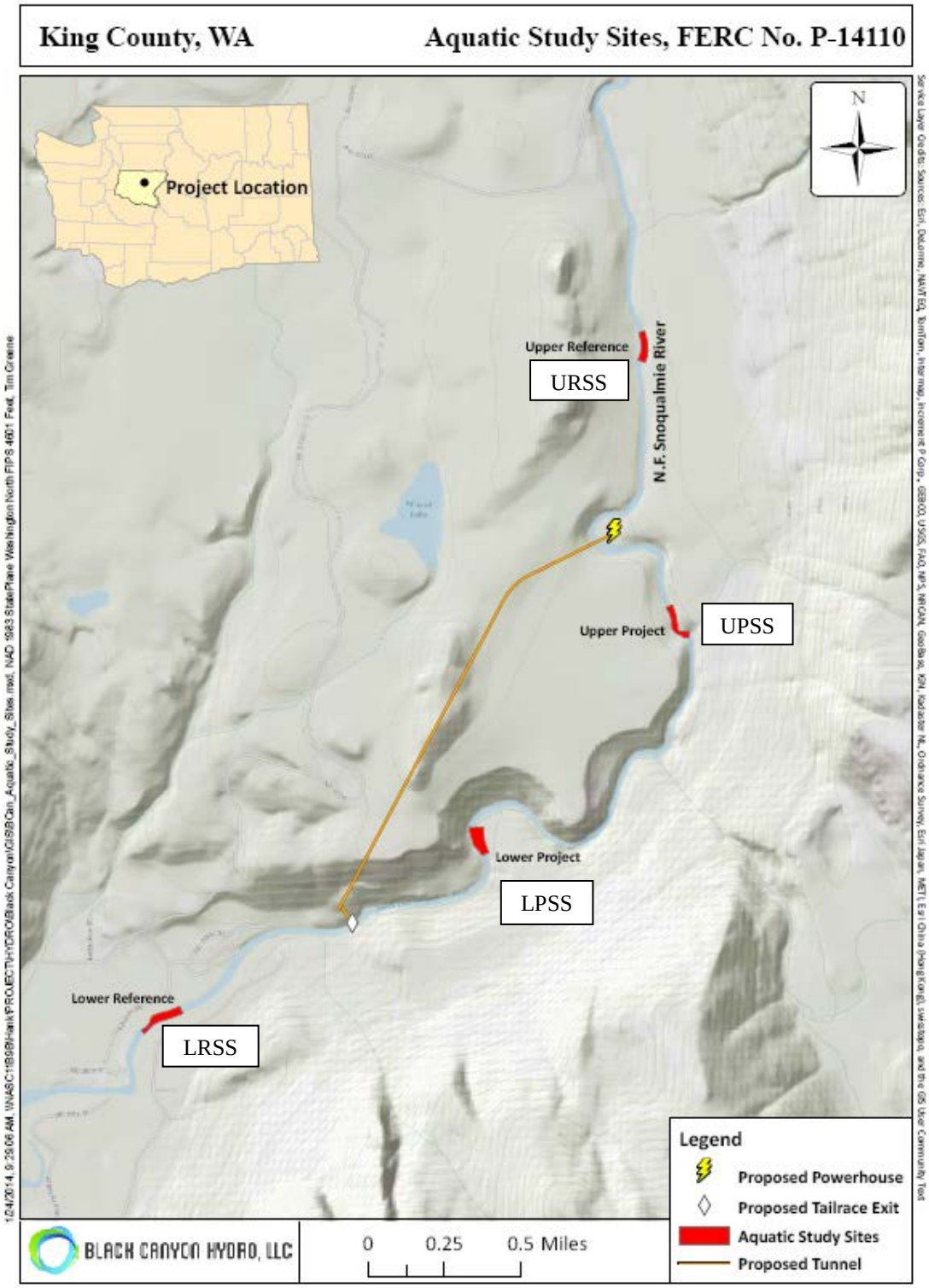

Figure 2. Location of the four study sites selected for resident fish monitoring.

1. Lower Reference Study Site (LRSS) 707 feet long: Accessed from Ernie's Grove and located downstream of the Bypassed Reach and adjacent to the Project lower gage site. This Study Site includes one long glide, one long riffle, a short cascade and one deep pool (Figure 3).

Figure 3. Lower Reference Study Site; August 5, 2013, Flow=99 cfs at BCH lower gage.

2. Lower Project Study Site (LPSS) 505 feet long: Accessed from the Canyon Springs trail and downstream from the springs. This site had a moderate gradient with several pools, riffles, and cascades similar to the lower section of the Bypassed Reach (Figure 4).

Figure 4. Lower Project Study Site, August 6, 2013. Flow=94 cfs at BCH lower gage.

3. Upper Project Study Site (UPSS) 673 feet long. Accessed from an existing logging road and short trail, this Study Site was at the boundary between the upper segment of Black Canyon and a moderate gradient reach downstream of the proposed intake. This Study Site included a complex of pools, riffles, and cascades similar to the upper section of the Bypassed Reach (Figure 5).

Figure 5. Upper Project Study Site, August 7, 2013. Flow=71 cfs at BCH upper gage.

4. Upper Reference Study Site (URSS) 529 feet long. Accessed from an existing logging road and short trail, this Study Site was approximately 0.32 miles upstream of the proposed intake . This Site had a low to moderate gradient with pools, riffles and glides (Figure 6).

Figure 6. Upper Reference Study Site August 8, 2013. Flow=68 cfs at BCH upper gage.

4.3 SNORKELING PROCESS

Observations of trout were made by visual observations of two biologists snorkeling in an upstream direction from the downstream boundary of the Study Site. Trout were identified to species when possible and to genus when species specific traits were not observed.

Each snorkeler made observations from one bank to the center of the stream working in a zig-zag pattern. An additional field-team member walked along the river bank along with the snorkelers and recorded observations of fish from the snorkelers and the habitat type in which the fish were observed. Scaled illustrations of rainbow and cutthroat trout were used in the field to estimate fish length and identify trout species and life stages.

4.4 ABUNDANCE ESTIMATES

Relative abundance was estimated with observations per unit effort (OPUE). To standardize the effort at each study site, the time spent in the water was divided by 60 minutes and the Study Site length was divided by a standard length of 500 feet. An "Effort Factor" (EF) was the product of these ratios:

Effort Factor = Snorkel time/60 minutes X Study site length/500 feet

Snorkel time, length of Study Site and effort factor for each Study Site is listed below in Table 1.

Table 1. Length, Snorkel time and Effort for each Study Site surveyed in August 2014

Study Site	Length (feet)	Length/500ft	Snorkel time (minutes)	Snorkel Time/60min	Effort Factor
LRSS	707	1.41	35	0.58	0.82
LPSS	505	1.01	45	0.75	0.76
UPSS	673	1.35	52	0.87	1.17
URSS	529	1.06	45	0.75	0.79

Snorkeling surveys were conducted at these Study Sites in 2012 and in 2013 however, the objective of these previous two surveys was somewhat different and snorkeling was continuous through the Study Sites. We have been able to isolate the data of observations of trout in the Study Sites for both the 2013 and 2012 surveys and we have been able to determine the time spent in each Study Site in the 2013 survey however, we can only estimate the time spent in each Study Site in the 2012 survey. The raw GPS data from the 2012 survey was time-stamped at the time it was downloaded from the receiver unit. We estimated that Thompson and Donahue spent approximately 45 minutes in each study site in 2012 based on their field experience and need to survey a longer stream length. The snorkel time and effort for the 2013 and 2012 surveys are listed in Tables 2 and 3, respectively.

Table 2 Length, Snorkel time and Effort for each Study Site surveyed in August 2013

Study Site	Length (feet)	Length/500ft	Snorkel time (minutes)	Snorkel Time/60min	Effort Factor
LRSS	707	1.41	103	1.72	2.43
LPSS	505	1.01	60	1.00	1.01
UPSS	673	1.35	56	0.93	1.26
URSS	529	1.06	60	1.00	1.06

Table 3. Length, Estimated Snorkel time and Effort for each Study Site surveyed in August 2012

Study Site	Length (feet)	Length/500ft	Estimated Snorkel time (minutes)	Snorkel Time/60min	Effort Factor
LRSS	707	1.41	45	0.75	1.06
LPSS	505	1.01	45	0.75	0.76
UPSS	673	1.35	45	0.75	1.01
URSS	529	1.06	45	0.75	0.79

4.4.1 Statistical Analysis

A two-way analysis of variance (ANOVA) was used to compare the relative abundance of trout between Study Sites and between years. ANOVA is an appropriate method for analysis of data that is measured repeatedly over time when physical habitat variables are fixed and the data set is balanced, that is the number of observations are equal from year to year at each study site. (Hubert and Fabrizio 2007). Where a significant difference of variance was found, a paired t-test was used to rank the data sets.

4.5 Length Frequency

Total length of the fish was used as an index of the age-class. Trout were grouped by sizes of 0-2 inches, 2-4 inches, 4-6 inches, 6-9 inches, 9-12 inches, 12-15 inches, and >15 inches total length. We classified the observed trout into these seven size classes to correspond with ages listed in Table 4. These length classes were described in the Final Aquatic Resources Study Plan (BCH 2013) and the corresponding ages were determined with scale and otolith samples collected and reported by Thompson, Whitney and Lamb (2011). Scaled illustrations of rainbow and cutthroat trout which were used in the field to calibrate the snorkeler's observations for length observed underwater.

Table 4. Size classes of observed fish with estimated age of the fish in years.

Size	YOY*	2" - 4"	4" - 6"	6" - 9"	9" - 11"	12"	≥ 15"
Age (years)	< 1	1 – 2	2 - 3	3 - 4	5 – 6	>6	

*YOY: young-of-the-year were hatched in June and July

4.5.1 Analysis of Length Class

A relative-frequency histogram was prepared of length class data from each Study Site for each year. First, the corresponding effort factor was applied to calculate the OPUE in each length class and then, the relative frequency was calculated as a percentage of the total number of trout OPUE in each Study Site and each year. Relative frequency was analyzed with a two-way ANOVA blocked by the Study Site and year.

4.6 STOMACH CONTENTS

A number of adult trout were captured by hook-and-line fishing with barbless hooks. These fish were anesthetized, measured for length and weight, and stomach contents were sampled with handheld stomach pumps. These fish were then allowed to regain equilibrium and released into the stream. Stomach contents were preserved in 90 percent ethanol solution and transferred to Aquatic Biology Associates, Inc. for identification and analysis.

5.0 RESULTS

5.1 TROUT RELATIVE ABUNDANCE

A total of 291 trout were observed in the four study sites with nearly one half of the total number observed in the LPSS. The fewest fish were observed at the URSS. Table 5 below lists the number of trout observed at each Study Site with effort factor and OPUE. One four-inch and one six-inch mountain whitefish were observed in the LRSS. No largescale sucker were observed. The river discharge measured at the USGS gage 12142000 ranged from 95 cfs to 100 cfs on August 19, 2014, the date of this survey.

Table 5. Number of trout observed , effort factor and observations per unit effort at each Study Site in 2014

Study Site	Trout Observed	Effort Factor	Observations per Unit Effort
LRSS	69	0.82	84
LPSS	144	0.76	190
UPSS	63	1.17	54
URSS	15	0.79	19

The number of trout, effort factor and OPUE calculated for each Study Site for 2013 and 2012 are listed below in Tables 6 and 7, respectively. A comparison of the OPUE for each Study Site and each year is shown in Figure 7.

Table 6. Number of trout observed , effort factor and observations per unit effort at each Study Site in 2013

Study Site	Trout Observed	Effort Factor	Observations per Unit Effort
LRSS	71	2.43	29
LPSS	84	1.01	83
UPSS	100	1.26	80
URSS	48	1.06	45

Table 7. Number of trout observed , effort factor and observations per unit effort at each Study Site in 2012

Study Site	Trout Observed	Effort Factor	Observations per Unit Effort
LRSS	68	1.06	64
LPSS	162	0.76	214
UPSS	49	1.01	49
URSS	6	0.79	8

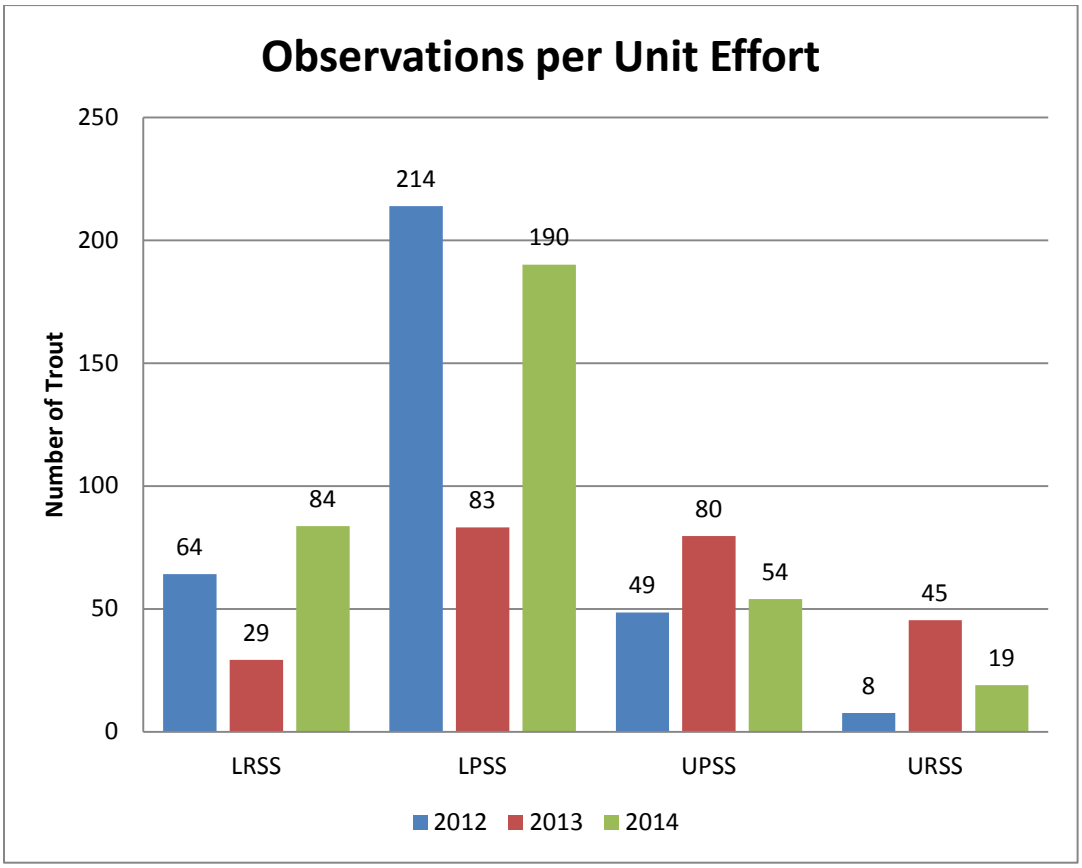

Figure 7. Observations per unit effort for each Study Site and each year.

5.1.1 Statistical Analysis

A two-way ANOVA of the OPUE blocked by Study Site and by year found that there was a significant difference between Study Sites (p=0.031) but there was no significant difference between years (p=0.630). A series of t-tests of means rank the OPUE at each Study Site in order from highest relative abundance of trout to lowest as:

LPSS > LRSS = UPSS > URSS

5.2 Length and Age Frequency

Observations of trout recorded in each length class at each Study Site are listed below in Table 8. The relative frequency of length illustrated in Figure 8 is a histogram of the proportion of OPUE in each length class to the total number of trout OPUE in the respective Study Site.

Table 8. The number of trout observed in each length class at each Study Site in 2014.

Study Site	Length	Total	YOY	2" - 4"	4" - 6"	6" - 9"	9" - 12"	≥ 12"	≥ 15"
LRSS	770	69	11	12	22	21	3	0	0
LPSS	505	144	5	9	19	73	33	4	1
UPSS	673	63		4	5	33	19	2	0
URSS	529	15	0	4	6	1	4	0	0

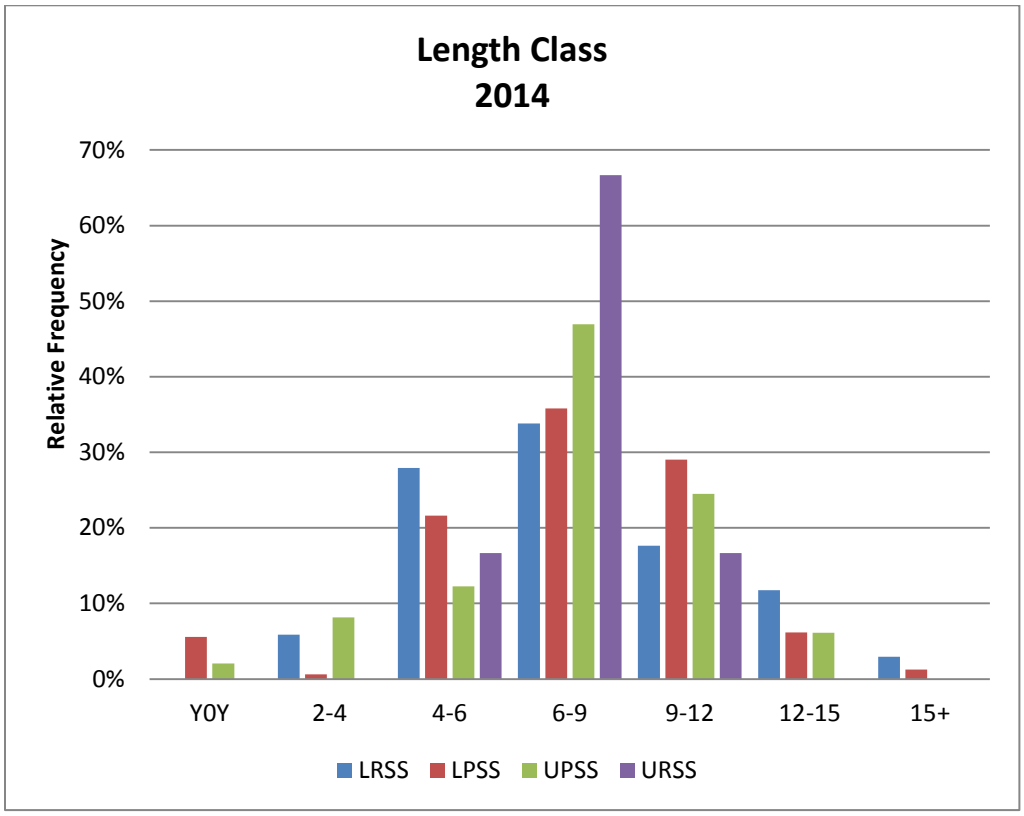

Figure 8. Histogram of the relative frequency of length class in each Study Site for 2014.

5.2.1 Statistical Analysis; 2014 Length Class

An ANOVA of the data used in the histogram of relative frequency of length class (Figure 8) found a significant difference between the length class ($p<0.001$) but there was no significant difference between the Study Sites ($p=1$). A series of t-tests ranked the relative frequency of length classes as:

6-9 inch > 4-6 inch = 9-12 inch > 2-4 inch = 12-15 inch = YOY = 15+
However, 12-15 inch > 15+

5.2.2 Length Class at each Study Site between years

Histograms of the relative frequency of length class at each Study Site for each of the three years are shown in Figures 9-12.

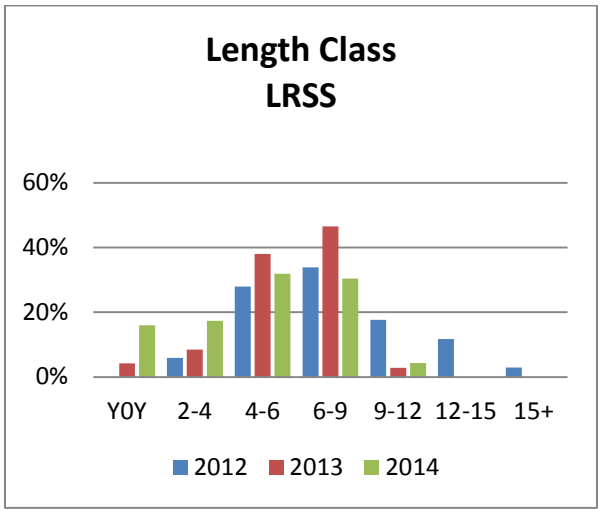

Figure 9. Relative frequency of length class in the LRSS

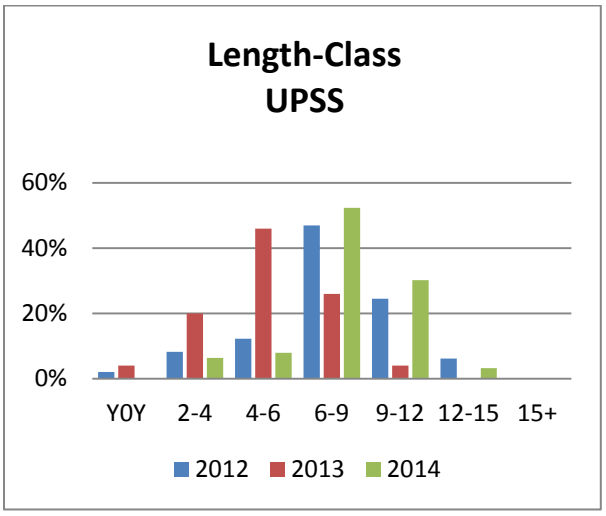

Figure 11 Relative frequency of length class in the UPSS

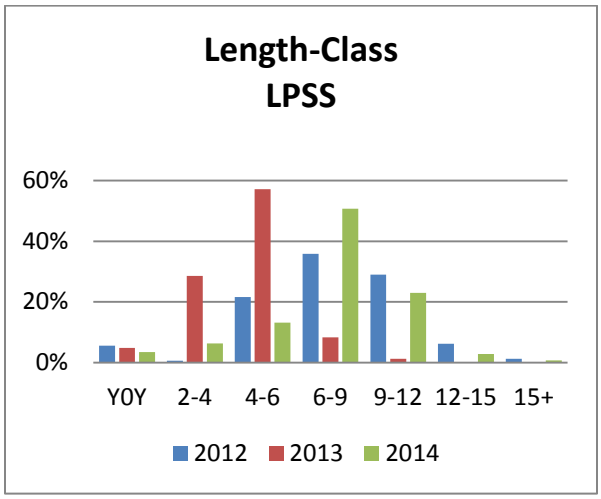

Figure 10. Relative frequency of length class in the LPSS

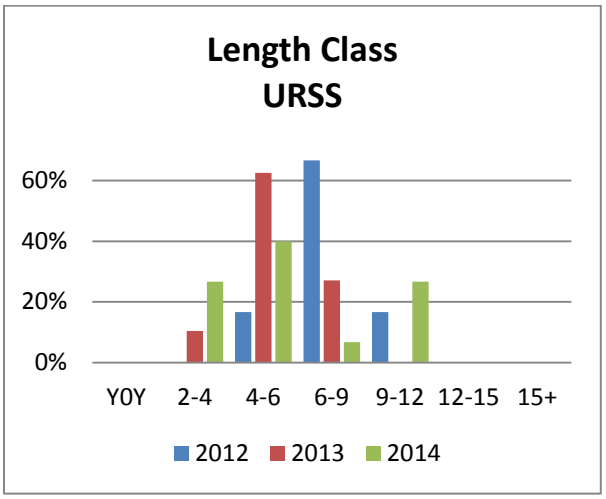

Figure 12. Relative frequency of length class in the URSS

5.2.3 Statistical Analysis of Relative Frequency

An ANOVA of the relative frequency data used in the histogram of length class observed in each separate Study Site in 2012, 2013, and 2014 found that in:

1. LRSS (Figure 9):
    a. Significant difference between the length classes ($p<0.001$)
    b. No significant difference between years ($p=1$).
2. LPSS (Figure 10):
    a. No Significant difference between the length classes ($p=0.13$)
    b. No significant difference between years ($p>1$).
3. UPSS (Figure 11):
    a. Significant difference between the length classes ($p=0.013$)
    b. No significant difference between years ($p=1$).
4. URSS (Figure 12):
    a. No Significant difference between the length classes ($p=0.13$)
    b. No significant difference between years ($p>1$).

5.3 Stomach Contents

Of the seven stomach samples, three were empty and five had partial prey items in the samples. Table 9 below is a list of the identified prey items in order of abundance in the stomach content samples along with the percent of the biomass in the samples. Abundance of prey items was also compared to the abundance of the same Taxa identified in the 2013 macroinvertebrate sampling completed during daylight hours in the Aquatic Resources Study (BCH 2014).

Table 9. Abundance and biomass of prey items in trout stomach contents compared with the abundance of the same Taxon in the 2013 daylight macroinvertebrate samples.

Taxon	Life Stage[1]	Origin	Common name	Number Observed	Percent Abundance	Percent Biomass	Percent Abundance 2013[2]
Chironomidae	L	Aquatic	midges	10	28.57	9.43	15.77
Chironomidae	P	Aquatic	midges	6	17.14	2.12	8.50
Antocha	L	Aquatic	crane flies	4	11.43	21.29	1.26
Baetis tricaudatus	L	Aquatic	mayflies	3	8.57	13.90	7.04
Baetidae	A	Aquatic	mayflies	2	5.71	12.55	1.09
Hydroporinae	L	Aquatic	predaceous diving beetles	2	5.71	3.90	1.40
Neuroptera	L	Terrestrial	Lacewing	1	2.86	9.85	0.03
Oligochaeta	U	Aquatic	segmented worms	1	2.86	1.55	1.43
Acari	U	Aquatic	mites	1	2.86	0.55	16.28
Acentrella turbida	L	Aquatic	mayflies	1	2.86	3.12	8.05

Attenella margarita	L	Aquatic	mayflies	1	2.86	19.47	0.98
Hydropsyche	L	Aquatic	caddisflies	1	2.86	1.19	1.97
Ephydridae	L	Aquatic	shore and brine flies	1	2.86	0.75	0.00
Simulium	P	Aquatic	black flies	1	2.86	0.33	1.90

1. L = larvae; P = pupae; A = adult; U = unknown.
2. Percent abundance in 2013 macroinvertebrate drift samples (BCH 2014)

6.0 DISCUSSION

6.1 RELATIVE ABUNDANCE

The relative abundance of trout was different between the Study Sites with the highest number of trout in the LPSS and the lowest number at the URSS. Relative abundance of trout in the LRSS and the UPSS were statistically equivalent. Although there appears to be a difference of relative abundance between years at each Study Site, the ANOVA test found no significant difference. This implies that the relative of abundance of trout is equivalent from year to year within each Study Site.

6.2 LENGTH FREQUENCY

The relative frequency of length class for the 2014 observation in all four Study Sites was normally distributed, that is, the data followed a bell-shaped curve with the most trout in the 6–9 inch length class (Figure 8). There was a significant difference among the length classes however; there was no significant difference between the four Study Sites. That is, the distribution of length classes were equivalent at each Study Site and since fish length normally correlates with age (Table 4), the distribution of the age of trout was equivalent at each Study Site.

The comparison of relative frequency of length class at each Study Site for the three years found that there was no significant difference among years. This implies that the distribution of trout length classes, and therefore age, are equivalent from year to year within each Study Site.

6.3 STOMACH CONTENTS

The prey items identified in the stomach contents in this study are very similar to the prey items identified in the 2013 Aquatic Resources Study. The fish are preying on the aquatic invertebrates that are present in the stream with some selection for specific items. For example, cranefly larvae (*Antocha*) comprised 11.43 percent of the stomach content abundance making up 21.29 percent of the stomach content biomass however, the cranefly larvae was only 1.26 percent of the daylight sample abundance collected in 2013 (BCH 2014a).

7.0 RECOMMENDATIONS

Continued monitoring of the fish populations and habitat attributes in the four study sites will provide a long-term dynamics of the fish populations at each of the study sites and will be used as an index of the fish population in the BCH Bypassed Reach. The four study sites have been carefully selected to be representative of the reaches in which they are located with similar habitat types and substrate conditions. Safe access was also a consideration for selection of each of the four study sites and we recommend continued monitoring at these sites rather than continued assessment of the entire study reach especially where field technicians may be at risk.

Comparisons among the three monitoring studies compared in this report (for 2012, 2013, and 2014) were affected by differences among observation techniques used in the three studies. Although ultimate comparisons were among results of snorkeling surveys, the snorkeling techniques varied enough over the three field season to limit the quality of comparisons among years.

In future trout monitoring surveys, we suggest that the following protocols be observed:

- Snorkeling should proceed in an upstream direction within the individual study reaches;
- Length of the actual snorkeling session should be estimated or preferably, measured;
- Time of the snorkeling session should be recorded by noting onset and cessation of underwater observations. Time should only include those periods when snorkelers are actively doing underwater observations;
- Bankside observers should closely accompany snorkelers and should be able to interpret all signals sent by snorkelers regarding their observations; and
- Field conditions, particularly those which might affect underwater or bankside observations, should be recorded. These should include, but not be limited to: Atmospheric conditions (cloud cover, rain, snow, wind, air temperature etc.); Water conditions (clarity, temperature, turbulence, etc.) and any other applicable conditions as determined by the field note recorder(s).

As a final assurance of consistency, if new field crews or crew members comprise the study team from one year to the next, the departing team should endeavor to train the incoming team, preferably in the field at an actual study location.

8.0 REFERENCES

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