



Fish and Habitat Assessment of Stetattle Creek

Natural Resource Technical Report NPS/NOCA/NRTR—2014/924



ON THE COVER

Bull trout spawning in Stetattle Creek, October 2013.
Photograph by: North Cascades National Park

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Natural Resource Technical Report NPS/NOCA/NRTR—2014/924

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December 2014

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Anthony, H., and A. Rawhouser. 2014. Fish and habitat assessment of Stetattle Creek. Natural Resource Technical Report NPS/NOCA/NRTR—2014/924. National Park Service, Fort Collins, Colorado.

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Abstract

To restore lost power generation capacity at the Diablo Powerhouse, Seattle City Light has proposed excavating up to 19,500 cubic yards of material from the alluvial fan of Stetattle Creek. Stetattle Creek is the only tributary to Gorge Reservoir in which bull trout spawning has been documented and is the primary spawning stream for native rainbow trout. Disturbance or habitat alteration of this stream or its alluvial fan could negatively impact the rainbow trout population in addition to the federally threatened bull trout. To better understand the extent and nature of the potential impacts related to the Diablo Powerhouse Tailrace Project, National Park Service staff conducted a series of surveys in 2013 to assess fish use, spawning habitat, substrate structure, and the benthic macroinvertebrate communities in the lower 0.5 miles of Stetattle Creek and its alluvial fan. Snorkel surveys indicated that rainbow trout and native char were actively using the entire survey area including the area proposed to be excavated as part of the Tailrace Project. Observations of rainbow trout indicated that this population initiated spawning in early June and continued spawning through the end of July. The infrequent nature of native char observations made it difficult to determine the duration of the spawning season; however, it appears that adult fish were entering Stetattle Creek towards the end of September and continued spawning through the end of November. Data from benthic macroinvertebrate samples indicate that the alluvial fan is likely providing a good source of prey items for the Gorge Lake fish population.

Raw data from underwater fish counts and redd surveys are available in Excel spreadsheet format from the North Cascades National Park Aquatic Ecologist and at the NPS Data Store (<https://irma.nps.gov/App/Portal/Home>).

Acknowledgments

The authors thank Seattle City Light for providing the funding to conduct this assessment and Dr. Ed Connor of Seattle City Light for facilitating its implementation.

Introduction

Background

Stetattle Creek is a third-order tributary (Strahler 1952) that enters Gorge Lake near the town of Diablo, Washington. Together, Stetattle Creek and Gorge Lake support native wild populations of rainbow trout (*Oncorhynchus mykiss*, RBT), Dolly Varden (*Salvelinus malma*, DV), bull trout (*Salvelinus confluentus*, BT) and non-native Eastern brook trout (*Salvelinus fontinalis*, EBT). To restore the power generation capacity at the Diablo Powerhouse, Seattle City Light (SCL) has proposed excavating up to 19,500 cubic yards of material from the alluvial fan of Stetattle Creek (<https://pepc.nps.gov/projectHome.cfm?projectId=45325>). The removal of cobble and gravel substrates in this area may potentially cause head-cutting in Stetattle Creek that could disrupt spawning and rearing habitat upstream of the dredging; eliminate spawning and rearing habitat in Stetattle Creek's alluvial fan; and directly impact fish through noise and sediment pollution. These potential impacts are of particular concern because Stetattle Creek is the only tributary in the Gorge Lake watershed where spawning occurs, and fish access to Stetattle Creek is constrained to the lowest 1.3 miles of the creek by an impassable waterfall (Tappel 1989, SCL 2012).

To better understand the extent and nature of the potential impacts related to the Diablo Powerhouse Tailrace Project (hereinafter "the Tailrace Project") National Park Service Staff conducted a series of surveys in 2013 to assess fish use, spawning habitat, substrate structure, and the benthic macroinvertebrate communities in the lower 0.5 miles of Stetattle Creek and its alluvial fan.

Objectives

The objectives of the Stetattle Creek and alluvial fan surveys were to determine:

- The timing and amount of RBT and BT spawning in the lower reach of Stetattle Creek that could potentially be impacted by head-cutting;
- The amount of potential spawning habitat that is available in the lower reach of Stetattle Creek that could potentially be impacted by head-cutting;
- The species and size class of fish using the mouth of Stetattle Creek and Gorge Lake in the vicinity of the proposed dredging;
- The ecological condition of Stetattle Creek upstream of the proposed dredging as indicated by the benthic invertebrate community;
- The abundance and ecological condition of the benthic invertebrate community of Gorge Lake in the vicinity of the proposed dredging.

Methods

Habitat Assessment

Stream and Alluvial Fan Habitat

A modified United States Forest Service Level 2 aquatic habitat survey (USFS 2007) was conducted on lower Stetattle Creek during seasonal low flow conditions to document existing habitat conditions. The survey started at the tail crest of the pool located beneath the Stetattle Creek Bridge and continued upstream to the head of the pool above the 2003 landslide (approximately RM 0.5). Additionally the habitats associated with Stetattle Creek's alluvial fan were surveyed to describe existing habitat conditions, locations and dimensions (Figures 1 and 2). Channel attributes surveyed included unit type (pool, riffle, run, side channel); wetted length; wetted and bankfull widths; the maximum and average depth of riffles; the maximum and tail crest depth of pools; the dominant and subdominant substrates for each unit; the amount of large woody debris within the bankfull channel; the length of unstable banks; and the condition of riparian vegetation.

Spawning Habitat

Spawning habitat and general substrate composition were assessed by counting and measuring patches of gravel that were considered suitable for spawning. In order to be considered as suitable spawning habitat gravel patches had to be $\geq 0.25 \text{ m}^2$ in area, consist of particles that had an intermediate axis between 8 and 130 mm, be located within the bankfull channel, and be located in areas of moving water (Baxter and McPhail 1996, Schuett-Hames 1996). Field crews measured the position of each patch of spawning habitat in relation to its distance from the Stetattle Creek Bridge and the edge of the right bank and measured its length, width, the water depth above it, and the size of five randomly selected substrate particles.

In addition to the spawning habitat survey a Wolman Pebble Count (Wolman 1954) was conducted in the lowest 200 m of Stetattle Creek to establish a baseline condition of the stream substrate. The pebble count was conducted within the bankfull channel starting at the Stetattle Creek Bridge and consisted of 500 particles that were randomly collected along 11 transects.

Fish and Redd Surveys

Underwater fish counts (snorkel surveys) and redd surveys were conducted throughout the lowest 0.5 miles of Stetattle Creek and in the habitats associated with the alluvial fan at the mouth of Stetattle Creek (Figures 1 and 3). The surveys were completed in the spring between May 21st and July 22nd during the period of RBT staging and spawning and between August 27th and November 12th during the period of BT staging and spawning. The surveys were conducted by a team of two people working upstream with one person conducting the underwater fish count and one recording data. Water clarity, flow and water temperature were measured at the beginning of each survey. Field staff identified and tallied fish as RBT, EBT or native char (NC) and placed each fish into 50-mm size classes. Native char consisted of a composite of DV and BT which were indistinguishable in the field. Redds were identified, counted and flagged as the team worked upstream, and only new redds were counted during subsequent surveys. If a fish was present on a redd, it was ascribed to that species and redds with no fish present at the time of survey were recorded as "unknown" in origin.

Two additional surveys were conducted on June 26th and July 17th, 2013 to assess efficacy of the snorkel surveys and fish use in the shallow side-channel habitat associated with site S1 (Figure 3). This site was selected due to its low velocity which facilitated observing and capturing fish as well as placement of a block net to prevent fish from escaping the survey area. These surveys were conducted using a Smith-Root backpack-mounted electro-fishing unit. During these surveys, a block-net was stretched across the bottom of the habitat unit to prevent fish from escaping and three electro-fishing passes were made through the site. Fish were collected, revived in a bucket of cold water and released after they were identified and counted as previously described.

Benthic Macroinvertebrates

Benthic invertebrates (BMI) provide the primary autochthonous food resources for fish in the Gorge system and also serve as indicators of the ecological condition. Field crews collected three benthic invertebrate kick-net samples from the lower 300 meters of Stetattle Creek and three samples from the alluvial fan. Each sample consisted of a composite of four, two-square-foot kick samples collected from riffle habitats that were less than 45 cm deep. The individual kick samples locations in Stetattle Creek were randomly selected to characterize the lower reach of the stream, and the individual kick samples locations from the alluvial fan consisted of judgment samples that were selected to characterize the different types of habitat that were present. Within the alluvial fan, two samples were collected from Riffle #2, and one sample was collected from Riffle #1 (Figure 2). All samples were sent to Aquatic Biology Associates, Inc. in Corvallis, OR for identification and enumeration following guidelines outlined by the Northwest Bioassessment Work Group. Following identification and enumeration, summary statistics were generated for a series of bioassessment metrics that have been used to assess the ecological condition of streams in the North Cascades and Skagit River watershed (Unpublished Report, Reed Glesne, Aquatic Ecologist, North Cascades National Park) along with additional metrics that augmented an understanding of the project area. Results from this assessment will be used to provide an assessment of baseline conditions in Stetattle Creek should head-cutting occur and provide information about the abundance of food resources for fish.

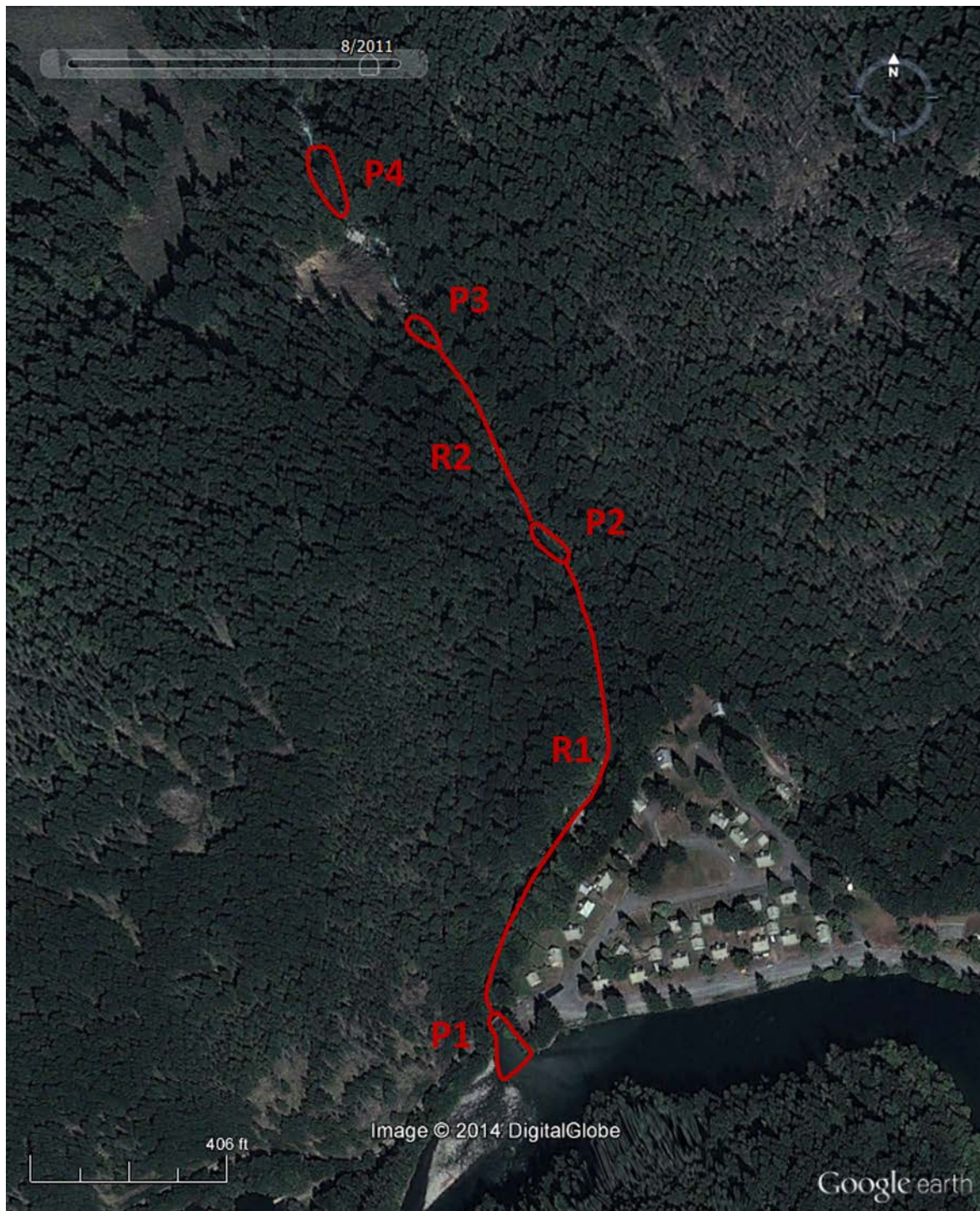


Figure 1. Aerial photograph overlaid with habitat units that were identified in Stetattle Creek (Google Earth background adapted from an August 2011 image). The habitat units are identified as follows: P1 = Pool #1, R1 = Riffle #1, P2 = Pool #2, R2 = Riffle #2, P3 = Pool #3 and P4 = Pool #4.



Figure 2. Aerial photograph overlaid with habitat units that were identified as part of Stetattle Creek's alluvial fan (Google Earth background adapted from an August, 2011 image). Dashed lines indicate approximate locations of transects used to collect benthic invertebrate samples. The habitat units are identified as follows: SC1 = Side Channel #1, SC2 = Side Channel #2, R1 = Riffle #1, and R2 = Riffle #2.



Figure 3. Aerial photograph overlaid with locations of snorkel survey sites (S1-S3) within Stetattle Creek's alluvial fan (Google Earth background adapted from an August 2011 image).

Results

Habitat Assessment

Stream and Alluvial Fan Habitat

The Stetattle Creek habitat survey was conducted during seasonal low flow conditions (Figure 4) and encompassed a total of 844 m of stream habitat. A total of seven habitat units were delineated during the survey consisting of four pools and three riffles (Table 1). Pool surface area constituted 19% of the available habitat, and riffles composed the remaining 81%. The lower reach of Stetattle Creek was found to be highly constrained by steep hill slopes and by a levee reinforced with concrete that extended along 350 meters of the east bank. Observations of streambed structure and composition indicated that head-cutting in Stetattle Creek could extend 680 m upstream from the start of Pool #1 to Pool #3 where head-cutting may be constrained by large boulders and bedrock (Figure 5).

Four habitat units were delineated in the Stetattle Creek alluvial fan habitat survey (Figure 2 and Table 2). The survey proceeded from the downstream extent of the mid-channel gravel bar located at the mouth of Stetattle Creek to the bottom of Pool #1 below the Stetattle Creek Bridge (Figure 1 and 2). Side Channel #1 consisted of a low velocity perennial backwater habitat that receives flow from Stetattle Creek during periods of spring and summer runoff (Figure 6). Side Channel #2 was dry at the time of the survey; however, flow was observed in this habitat unit during the spring spawning surveys (Figures 7 and 8). Riffle #1 and Riffle #2 were habitats primarily shaped by flows from the Skagit River as it exits the Diablo Powerhouse, and were differentiated from each other by a gradient break and the higher flow velocity present in Riffle #1.

Table 1. Wetted dimensions of the habitat units surveyed in Stetattle Creek during seasonal low flow conditions.

Habitat Unit	Maximum Depth (m)	Average Depth (m)	Tail Crest Depth (m)	Residual Depth (m)	Length (m)	Width (m)
Pool 1	2.50	N/A	0.70	1.8	55	15.6
Riffle 1	0.86	0.31	N/A	N/A	394	16.2
Pool 2	2.20	N/A	4.70	2.5	38	14.8
Riffle 2	0.92	0.26	N/A	N/A	166	18.7
Pool 3	3.00	N/A	0.46	2.54	27	11.8
Riffle 3	1.70	0.65	N/A	N/A	113	11.4
Pool 4	2.50	N/A	0.42	2.08	51	15.8

Table 2. Dimensions of habitat units associated with the alluvial fan located at the mouth of Stetattle Creek measured during seasonal low flow conditions.

Habitat Unit	Maximum Depth (m)	Average Depth (m)	Length (m)	Width (m)	Area (m ²)
Side Channel 1	1.20	0.58	74	8	592
Side Channel 2	0	0	62	5*	310*
Riffle 1	N/A	N/A	114	45	5130
Riffle 2	0.81**	0.34**	65**	33**	2145**

* Wetted width estimated based on hydrologic indicators.

**Extent of habitat unit determined by changes in flow and depth characteristics.

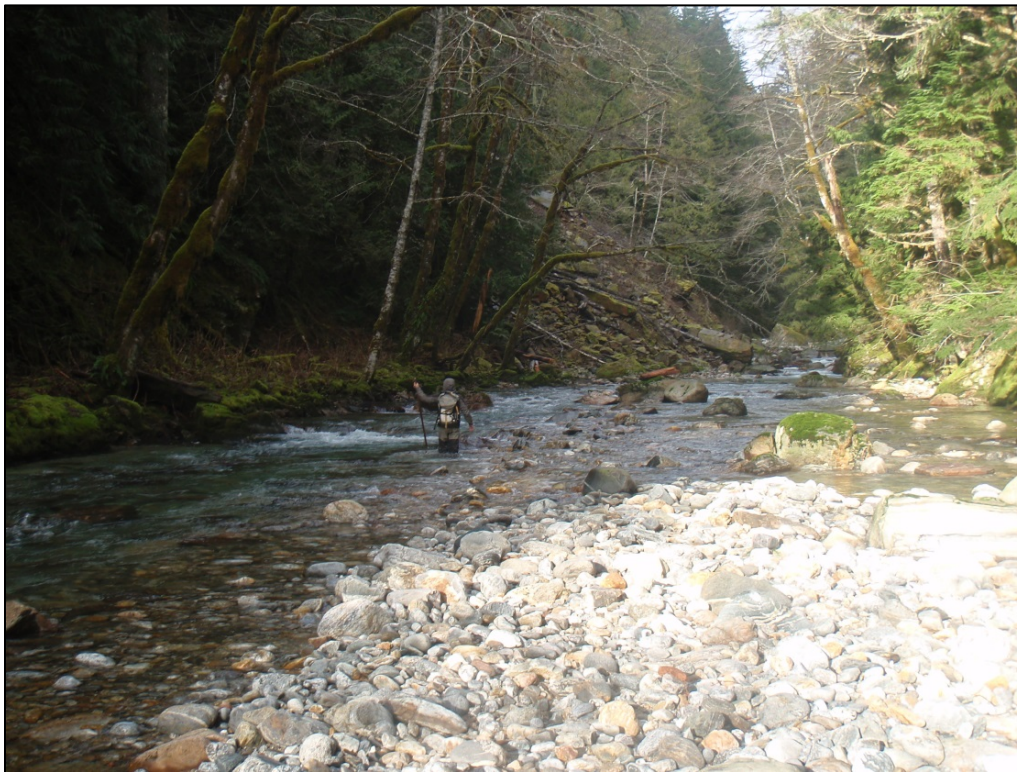


Figure 4. Photograph taken at approximate midpoint of Riffle #2 illustrating low-flow conditions during stream habitat survey.



Figure 5. Photograph of the hydrologic control located at the upstream end of Pool #3 in Stetattle Creek.



Figure 6. Photograph depicting the habitat associated with Side Channel #1 of the Stetattle Creek alluvial fan.



Figure 7. Photograph of Side Channel #2 taken during seasonal low flow conditions. Note debris that accumulates during periods of seasonal high flow.



Figure 8. Photograph of Side Channel #2 taken during spring high flow conditions showing extent of wetted channel.

Spawning Habitat

Patches of gravel substrate suitable for trout and char spawning were identified at 11 locations in the lower 793 m of Stetattle Creek (Table 3, Figure 9 and Cover Photo). Individual patches varied from 0.4 m² to 153.9 m² in size, and total suitable spawning habitat was determined to be 202.3 m². Water depths at the patches ranged from 0.00 (dry) to 0.35 m. The majority of suitable spawning habitat was observed in the first riffle (R1, Figure 1) above the Stetattle Creek Bridge. The median particle size measured from the lowest 200 m of Riffle #1 in Stetattle Creek was 102 mm (Appendix A).

Table 3. Spawning habitat surveyed in Stetattle Creek, October 2013.

Patch #	Distance from (m)		Patch Size (m)		Mean Particle Size (mm)	Water Depth (m)
	Bridge	Right Bank	Length	Width		
1	19	8.1	19.00	8.10	113.2	0.35
2	83	8.6	2.50	0.90	32.8	0.33
3	120.8	16.1	1.20	0.70	11.4	0.10
4	122.5	16	1.80	0.95	42.0	0.10
5	129.8	11.9	1.45	0.95	32.0	0.19
6	210	11	0.80	0.53	19.6	0.15
7	267	13.8	7.60	3.30	41.6	0
8	287.3	14	10.00	1.30	33.6	0
9	314.8	17.6	1.30	0.60	38.0	0.19
10	380.4	17.2	2.10	0.85	28.4	0.17
11	518.4	10.6	1.50	0.80	62.6	0.10



Figure 9. Photograph of bull trout spawning in Stetattle Creek during a fall spawning survey. This photograph depicts typical spawning habitat for bull trout in Stetattle Creek. The fish in this photograph were estimated to be 450 mm in length. Note small patch size of suitable gravel surrounded by larger substrate.

Fish and Redd Surveys

Eight surveys were conducted during the period of rainbow trout staging and spawning, and nine surveys were conducted during the period of native char staging and spawning (Table 4). High flows prohibited snorkel surveys in riffle habitats for five of the survey events and for one survey event in pool and alluvial habitats (Table 4, Appendix B). However, even when the flows were too high to safely conduct snorkel surveys, the field crew did conduct redd surveys from the stream bank and while wading in shallow water.

A total of 570 individual fish observations were made during the snorkel surveys. Rainbow trout were the most frequently encountered species constituting 86% of the fish observations that were made. Native char were much less common than RBT and accounted for 5% of the fish observations, and only a single EBT was observed during the entire survey. A surprisingly large number (8%) of fish observed could not be identified, most likely due to their small size (Tables 5 and 6), and were excluded from further analysis.

Table 4. Summary of survey effort for snorkel and redd surveys in Stetattle Creek and associated alluvial fan habitats.

Survey Emphasis	Date	Snorkel Survey Completed in all Riffle Habitats	Snorkel Survey Completed in all Pool Habitats	Snorkel Survey Completed in all Alluvial Fan Habitats	Redd Survey Completed
Rainbow Trout Staging and Spawning	5/21/2013	X	X	X	X
	6/6/2013	X	X	X	X
	6/12/2013	X	X	X	X
	6/20/2013	X	X	X	X
	6/26/2013	X	X	X	X
	7/3/2013	X	X	X	X
	7/17/2013		X	X	X
	7/22/2013		X	X	X
Native Char Staging and Spawning	8/27/2013		X	X	X
	9/16/2013	X	X	X	X
	9/23/2013			X	X
	9/24/2013	X	X	X	X
	10/17/2013	X	X	X	X
	10/22/2013	X	X	X	X
	10/28/2013		X	X	X
	11/5/2013	X	X	X	X
	11/12/2013	X	X	X	X

Table 5. Total fish observations made during the snorkel surveys of the Stetattle Creek alluvial fan.

Taxa	Size Class		
	<150 mm	150 – 299 mm	300 – 499 mm
RBT	25	60	18
NC	1	0	0
EBT	1	0	0
Unknown	13	1	0

Table 6. Total fish observations made during snorkel surveys in Stetattle Creek including the first pool (P1) located under the Stetattle Creek Bridge.

Taxa	Size Class			
	<150 mm	150 – 299 mm	300 – 499 mm	>450 mm
RBT	206	129	54	0
NC	17	2	0	3
Unknown	32	1	0	0

Snorkel surveys within Stetattle Creek were scheduled to capture the peak of spring spawning for RBT and fall spawning for NC. While many reproductive size (>150 mm in total length) RBT were observed during 2013, very few reproductive size NC or redds were observed (Table 7, Figures 14 and 17). Snorkel survey observations indicated that RBT of all size classes are likely to be found throughout the project area with peak use occurring in June and July and again in late September to early October (Figures 10, 12 and 13). Observations indicated that RBT >150 mm preferred the deeper fast-water habitat associated with site S2 and the pool habitats in Stetattle Creek (Figures 10 and 11). Fish behavior and the timing of the observations indicated that the RBT were most likely using site S2 to forage for benthic invertebrates and drifting prey items (Appendix B). Native char were observed in habitat units S1 and S3 of the alluvial fan and throughout Stetattle Creek (Figures 14, 15 and 16). However, due to the low number of observations peak spawning activity for native char could not be determined (Figure 17).

Table 7. Results of lower Stetattle Creek redd surveys, 2013.

Date of Survey	Location	Species	Number of New Redds
6/6/2013	P2	RBT	2
6/26/2013	R1	RBT	1
10/22/2013	P4	NC	2
11/5/2013	P3	NC	1
11/19/2013	P2	NC	1
11/19/2013	P4	NC	1

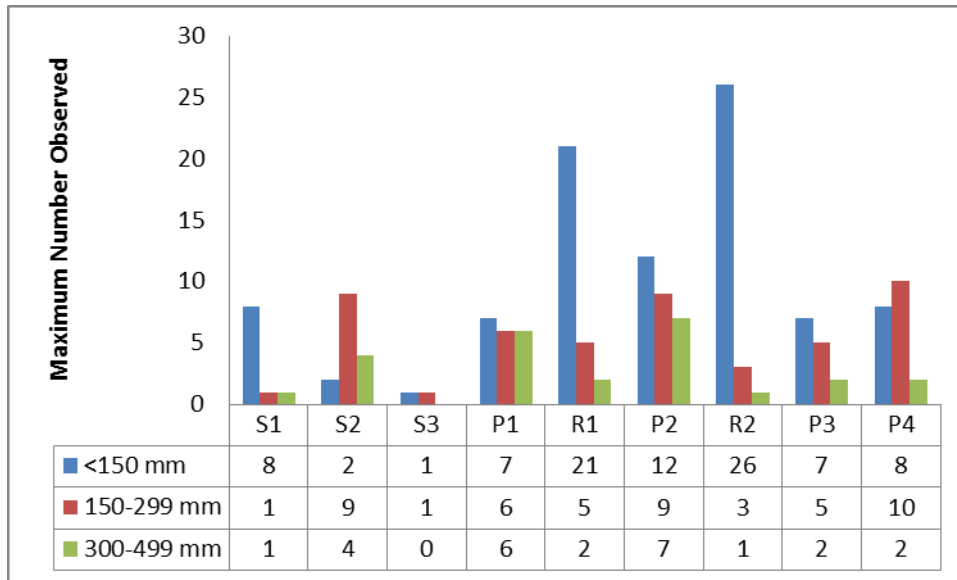


Figure 10. The maximum number of rainbow trout observed during a single snorkel survey in the habitats associated with Stetattle Creek. Sites S1-S3 were located within the Stetattle Creek alluvial fan, while pool sites P1-P4 and riffle sites R1 and R2 were located within Stetattle Creek.

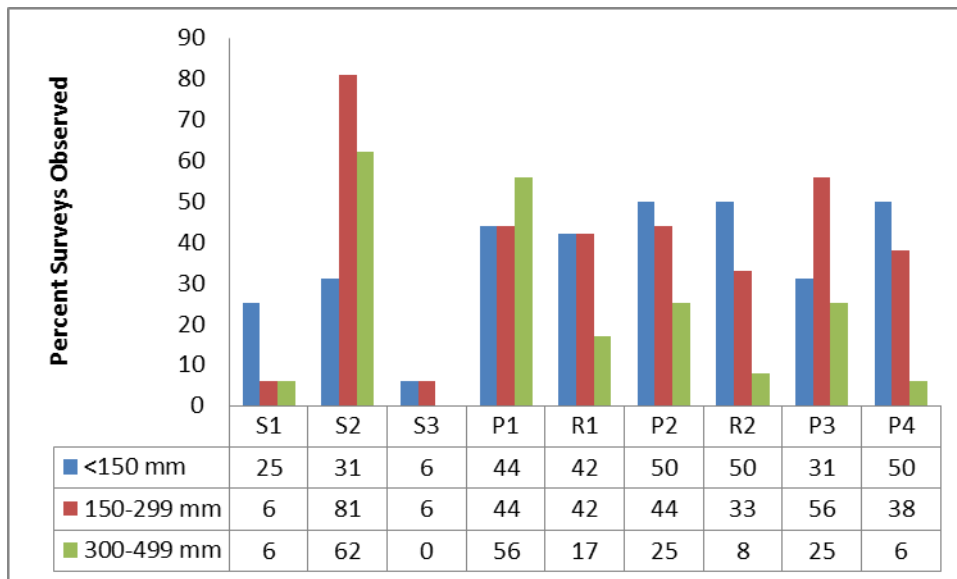


Figure 11. The percentage of snorkel surveys that rainbow trout were observed in the habitats associated with Stetattle Creek. Sites S1-S3 were located within the Stetattle Creek alluvial fan, while pool sites P1-P4 and riffle sites R1 and R2 were located within Stetattle Creek.

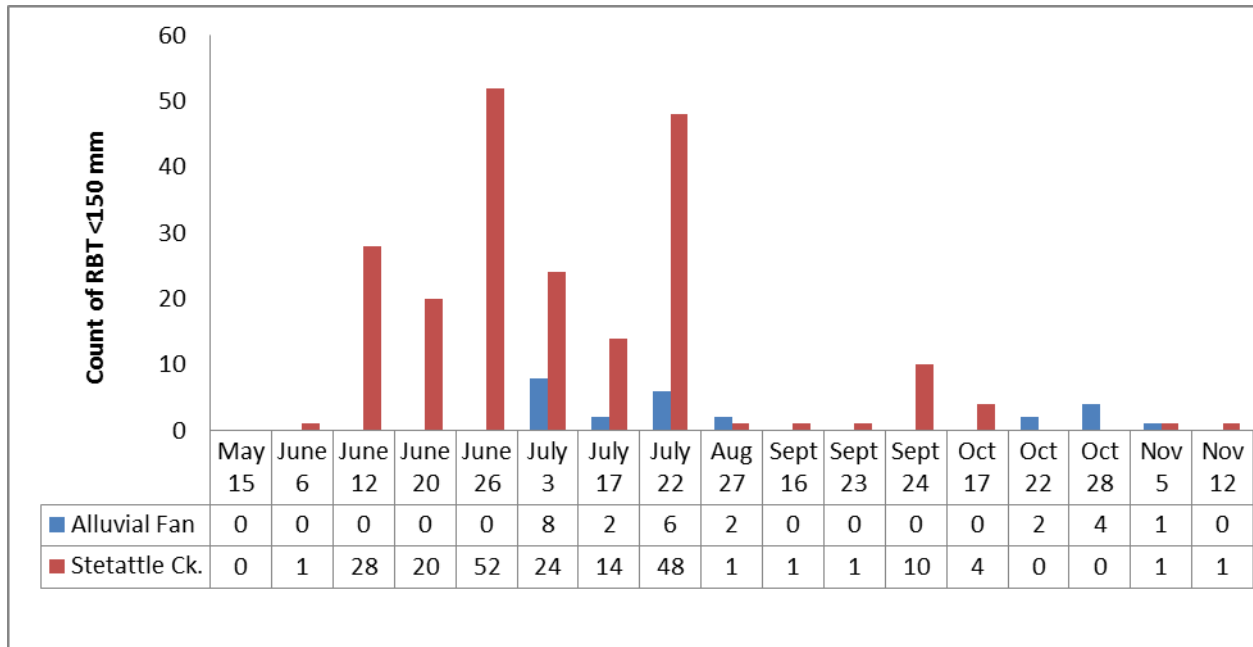


Figure 12. Seasonal observations of rainbow trout less than 150 mm counted during the snorkel surveys in habitats associated with Stetattle Creek.

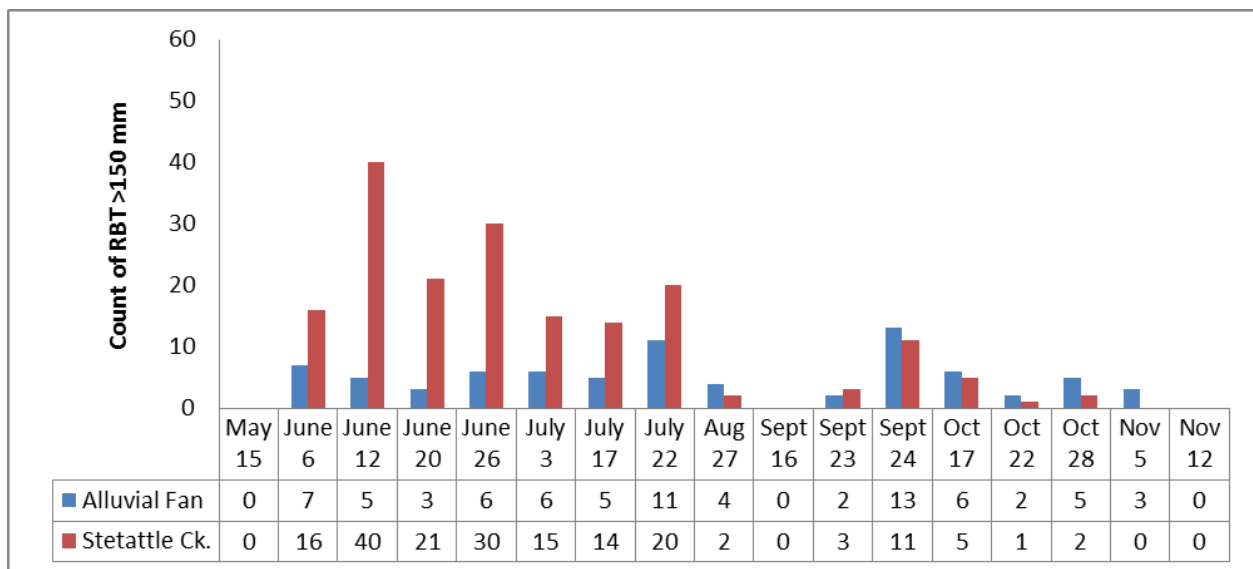


Figure 13. Seasonal observations of rainbow trout greater than 150 mm counted during the snorkel surveys in the habitats associated with Stetattle Creek.

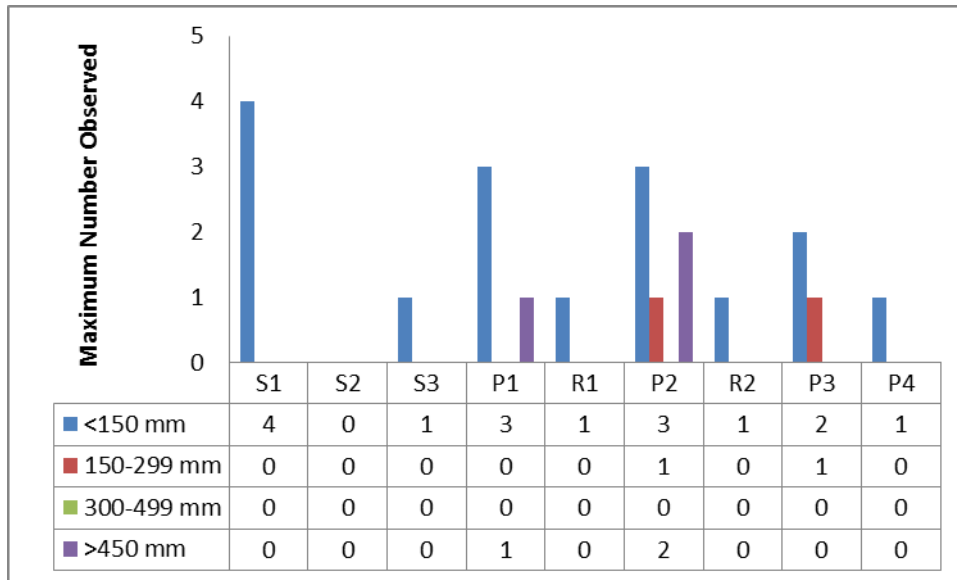


Figure 14. The maximum number of native char observed during a single snorkel survey in the habitats associated with Stetattle Creek. Sites S1-S3 were located within the Stetattle Creek alluvial fan, while pool sites P1-P4 and riffle sites R1 and R2 were located within Stetattle Creek.

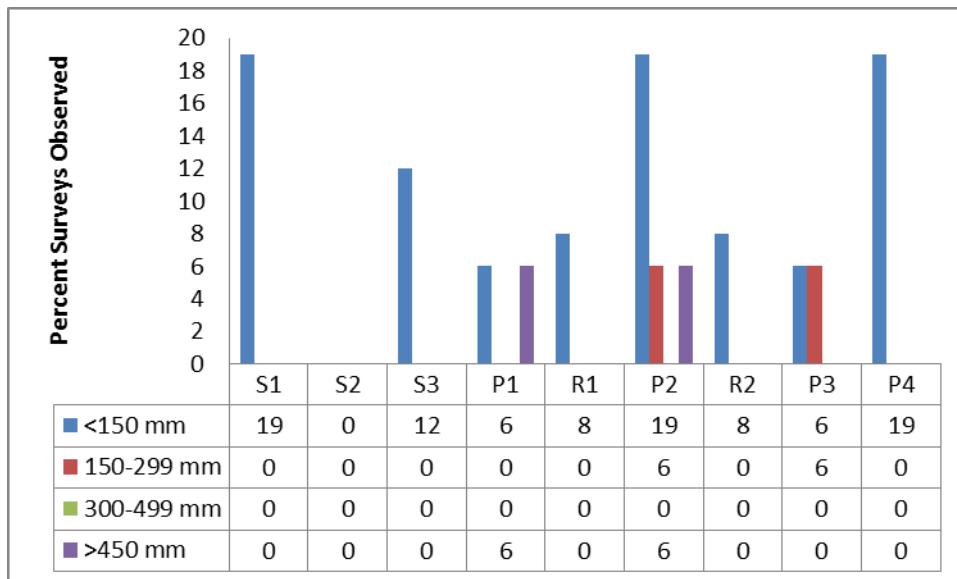


Figure 15. The percentage of snorkel surveys that native char were observed in the habitats associated with Stetattle Creek. Sites S1-S3 were located within the Stetattle Creek alluvial fan, while pool sites P1-P4 and riffle sites R1 and R2 were located within Stetattle Creek.

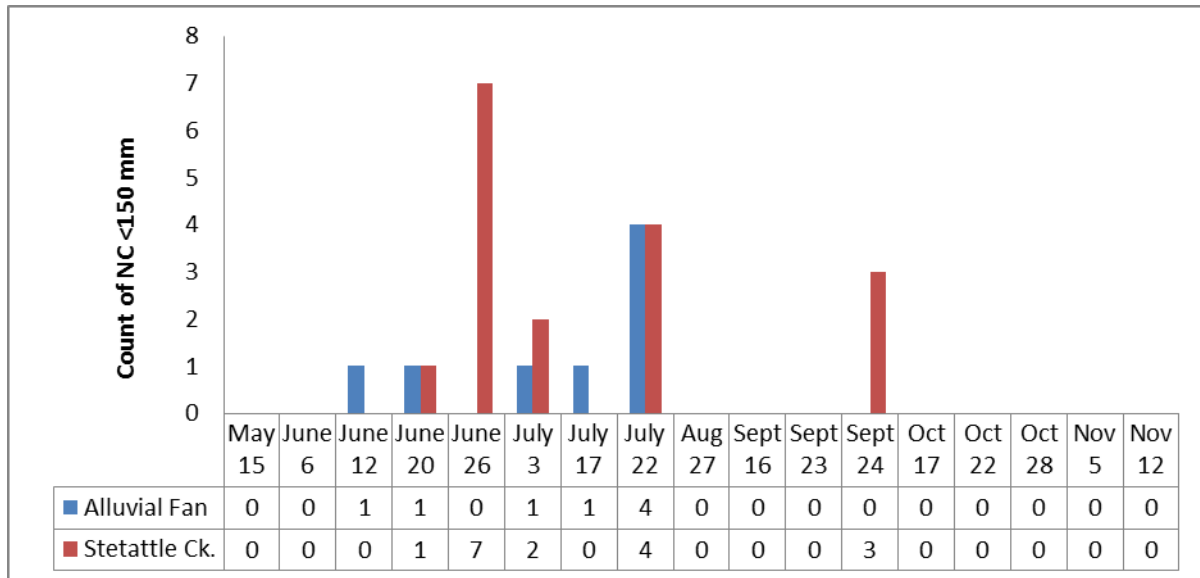


Figure 16. Seasonal observations of native char less than 150 mm counted during the snorkel surveys in habitats associated with Stetattle Creek.

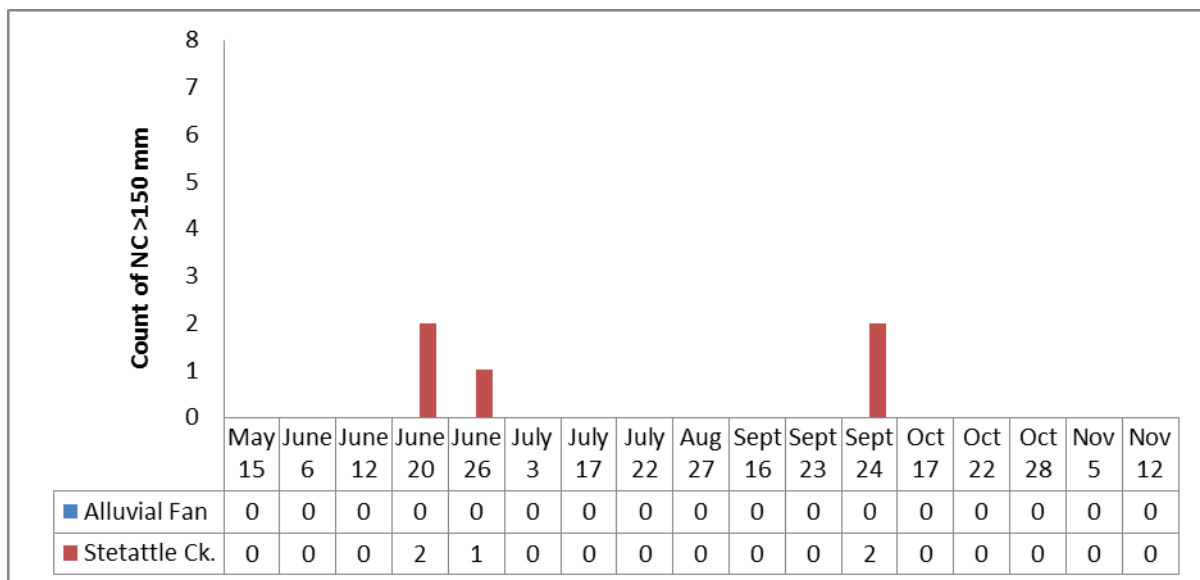


Figure 17. Seasonal observations of native char greater than 150 mm counted during the snorkel surveys in habitats associated with Stetattle Creek.

Electrofishing surveys indicated that snorkel surveys were underestimating the number of fish <150 mm that occurred in the survey area and that EBT are more prevalent than snorkel surveys indicated (Table 8).

Table 8. Results comparing fish captured during electrofishing in habitat unit S1 of Stetattle Creek with number of fish observed during snorkel surveys (in parenthesis) conducted on the same date.

Survey Date	Size Class	Rainbow Trout	Native Char	Brook Trout
6/26/2013	<50 mm	2	0	1
	50 - 99 mm	7	1	1
	100 - 150 mm	0	0	0
Total		9 (0)	1 (0)	2 (0)
7/17/2013	<50 mm	2	0	0
	50 - 99 mm	22	15	4
	100 - 150 mm	0	3	1
Total		24 (0)	18 (0)	5 (0)

Benthic Macroinvertebrates

Results from the BMI metrics indicate that the lower reach of Stetattle Creek was not functioning at its full ecological potential when compared to reference condition streams - streams that are considered to be functioning at their full ecological potential (Stetattle Creek Samples 1-3, Table 9). Since the alluvial fan samples were collected from habitat types where reference conditions have not been established, it was not possible to determine their ecological status (Unpublished Report, Reed Glesne, Aquatic Ecologist, North Cascades National Park). Overall, the abundance of benthic invertebrates was higher in Stetattle Creek than for most of the alluvial fan except for Riffle #2 (Appendix C). Metrics for cold stenothermal and cool eurythermal invertebrates indicated that water temperature in the habitats associated with the alluvial fan were colder than in Stetattle Creek.

Table 9. Benthic invertebrate metric values for the samples collected in Stetattle Creek and the reference condition threshold for each metric established for streams in the North Cascades.

Metric	Reference Threshold	Stetattle Ck. 1	Stetattle Ck. 2	Stetattle Ck. 3	Alluvial Fan 1	Alluvial Fan 2	Alluvial Fan 3
Abundance	N/A	608	837	678	344	280	611
Richness							
Total Richness	43	39	51	39	22	25	45
EPT Richness	33	26	33	26	12	20	27
Community Composition							
% Ephemeroptera	87	51	60	71	38	33	55
% Plecoptera	28	11	11	6	5	35	13
% Trichoptera	26	3	4	3	12	12	5
EPT/Chironomidae (log10)	2.4	0.6	0.8	0.8	0.7	1.4	0.7
Feeding Guild							
% Scraper	60	21	26	25	8	26	32
% Shredder	16	5	2	1	16	42	14
Collector Richness*	5	9	16	13	11	6	14
Life History							
% Univoltine*	46	54	53	42	84	88	63
Tolerance							
Hilsenhoff Biotic Index*	0.9	3.3	3.1	3.5	2.8	2.6	3.8
% Tolerant Taxa*	0	0	0.3	0.4	0.4	0	1.3
% Highly Intolerant Taxa	78	12	14	22	0.4	2	2
Intolerant Taxa Richness	13	13	15	13	5	11	14
% Cold & Cool Water Adapted	N/A	16	14	13	50	68	46

* Metric response increases with increasing stress. All other metrics decrease in value with increasing levels of stress.

Discussion

Snorkel surveys indicated that RBT and NC were actively using the entire survey area including the habitats associated with the alluvial fan that are proposed to be excavated as part of the Tailrace Project. Spawning activity appeared to be limited to the tail crests of the pools starting approximately 400 m above the proposed excavation activity. However, it is uncertain if the low number of redds documented for both RBT and NC was due to depauperate populations of fish in the Gorge watershed or the abnormal hydrologic regime created by the drawdown of Gorge Lake during the spawning seasons for both RBT and NC (Figure 18). If the lake levels did limit spawning activity in Stetattle Creek, it is possible that the lower 400 m of the stream could support more spawning activity than was documented as part of these surveys.

If it is the case that the low numbers of NC spawning adults counted during these surveys are the result of low population numbers, then our findings indicate that this local population may contain far fewer than the 200 adult spawners needed for a viable population (USFWS 2004).

The timing of staging and spawning behaviors for RBT and NC were similar to those observed in Ross Lake. Observations of RBT indicated that this population initiated spawning in early June (Table 7) and continued spawning through the end of July (Figure 13). The infrequent nature of NC observations made it difficult to determine the duration of the spawning season; however, it appears that adult fish were entering Stetattle Creek towards the end of September (Figure 17) and continued spawning through the end of November (Table 7). Given the uncertainty associated with the timing of adult BT migration into Stetattle Creek for spawning, we believe that under “normal” conditions, when Gorge Lake is at full pool, it is possible that BT could begin spawning migration by September 1st. Considering this information, any construction activity within or adjacent to Stetattle Creek should be limited to the month of August, or any time from December 1st through May 31st.

Snorkel and electrofishing surveys revealed that native fish are actively using the alluvial fan of Stetattle Creek. Native char juveniles, as well as RBT juveniles and adults, appear to be utilizing this habitat for foraging and rearing (Figures 10 and 14, Table 8, Appendix B). Data from benthic invertebrate samples also indicate that Riffle #1 of the alluvial fan is likely providing a good source of prey items for the Gorge Lake fish population (Table 9).

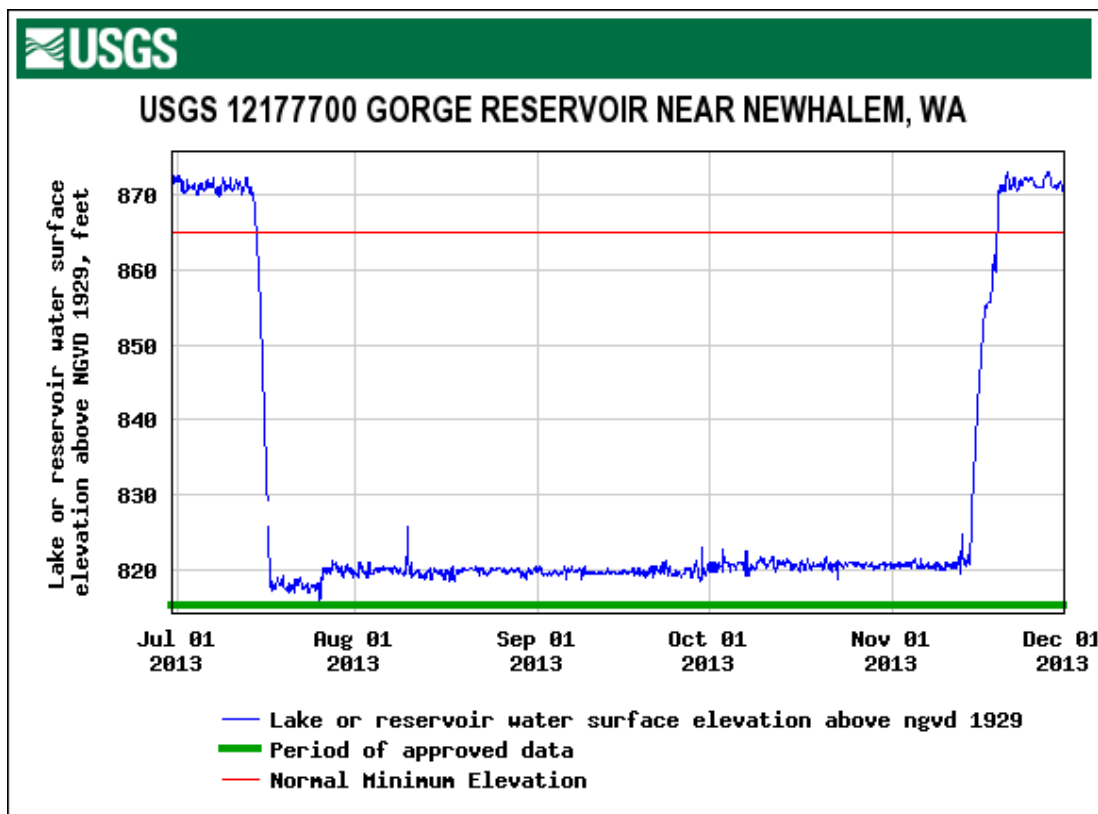


Figure 18. Water levels in Gorge Lake from July 1st to November 30th, 2013. The drawdown of Gorge Lake began on July 14th and continued until November 20th.

If the Tailrace Project proceeds, we recommend that a series of fish, biological, and habitat surveys be conducted to determine if the effects to native wild fish and the habitat needed to support these populations are beneficial, negative or undetectable. These surveys should include:

- 1) Annual spawning and underwater fish surveys conducted from June 1st to July 30th for RBT and from September 1st to November 30th for NC. The surveys conducted to date for the Tailrace Project found that most of the redds and adult spawning fish were located in pool and tail-crest habitat. To save time and gain a better understanding of the total amount of natural reproduction occurring in the basin, as well as the number of reproductive adults, these surveys could be limited to the pool and tail-crest habitats from the mouth of Stetattle Creek to the base of the first fish passage barrier. Information gathered from these surveys could also be used to determine if recovery goals are being met for BT in the Gorge Lake watershed (USFWS 2004).
- 2) Frequent assessment of head-cutting in Stetattle Creek following periods of high discharge. High flow events will increase the likelihood of head cutting in Stetattle Creek and identifying this process early will be a critical component of implementing mitigation and restoration measures. In most cases these surveys could be conducted in conjunction with spawning surveys. If head cutting is observed surveys of longitudinal and cross sections profiles can be conducted to determine the extent and magnitude of the erosion.

- 3) A series of annual spawning surveys conducted between June 1 and July 31 and September 1 and November 30 in Pyramid Creek. These surveys are needed to determine if RBT and/or NC are currently using this stream for reproduction. Information gathered from these surveys could also be used to determine if recovery goals are being met for BT in the Gorge Lake watershed (USFWS 2004) and may ameliorate some of the concerns related to Stetattle Creek being the sole source of natural reproduction in the watershed.
- 4) Annual water quality and biological assessment (benthic invertebrate sampling) in the first riffle of Stetattle Creek to determine if the ecological functions are improving, static or declining immediately upstream of the proposed excavation. The proposed removal of riffle habitat from Stetattle Creek's alluvial fan will diminish food resources and foraging habitat, placing increased importance on maintaining or improving the ecological function of the first riffle in Stetattle Creek.
- 5) Annual substrate assessment (Wolman 1954) in the first riffle of Stetattle Creek to determine if substrate is coarsening as a result of proposed excavation activities and if the amount of spawning habitat is decreasing.
- 6) Annual electrofishing surveys conducted in the margins of the first riffle of Stetattle Creek. The removal of gravel and cobble from the mouth of Stetattle Creek will diminish the amount of juvenile rearing habitat for wild RBT and NC and these surveys will help to determine if rearing habitat is a limiting factor for these species. This is of particular concern given the large amounts of hydromodifications (350 m diking) that isolate Stetattle Creek from its historic alluvial floodplain.

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Appendix A. Wolman pebble count.

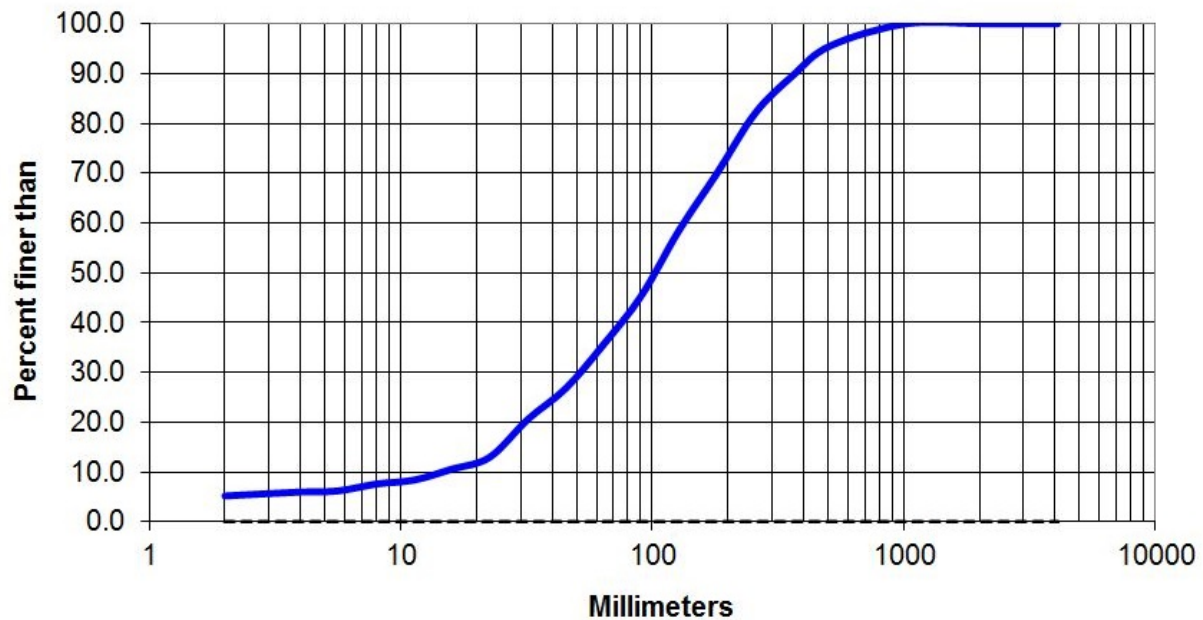


Figure A-1. Cumulative particle size distribution in the lowest 200 m of Stetattle Creek 2013.

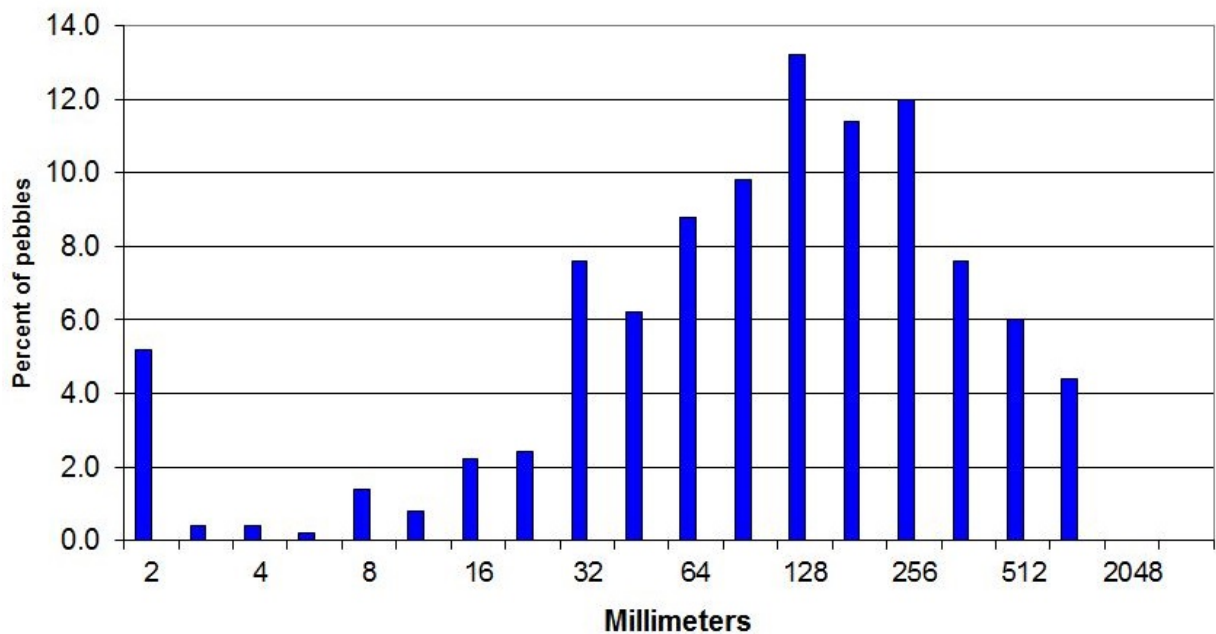


Figure A-2. Particle size histogram from the sample collected in the lowest 200 m of Stetattle Creek 2013.

Appendix B. Underwater fish counts and redd survey data.

Table B-1. Summary of snorkel survey observations made of rainbow trout less than 150 mm in total length in Stetattle Creek.

Date	S1	S2	S3	P1	R1	P2	R2	P3	P4	Total
5/21/2013	0	0	0	0	0	0	0	0	0	0
6/6/2013	0	0	0	1	0	0	0	0	0	1
6/12/2013	0	0	0	4	7	6	3	0	8	28
6/20/2013	0	0	0	3	4	1	5	3	4	20
6/26/2013	0	0	0	3	21	12	5	7	4	52
7/3/2013	8	0	0	7	0	10	0	0	7	32
7/17/2013	0	1	1	0	NA	7	NA	4	3	16
7/22/2013	6	0	0	0	NA	9	26	5	8	54
8/27/2013	1	1	0	0	NA	1	NA	0	0	3
9/16/2013	0	0	0	1	0	0	0	0	0	1
9/23/2013	0	0	0	1	NA	NA	NA	NA	NA	1
9/24/2013	0	0	0	1	2	1	1	1	4	10
10/17/2013	0	0	0	0	2	0	0	0	2	4
10/22/2013	0	2	0	0	0	0	0	0	0	2
10/28/2013	2	2	0	0	NA	0	NA	0	0	4
11/5/2013	0	1	0	0	0	0	1	0	0	2
11/12/2013	0	0	0	0	0	0	1	0	0	1

Table B-2. Summary of snorkel survey observations made of rainbow trout greater than 150 mm in total length in Stetattle Creek.

Date	S1	S2	S3	P1	R1	P2	R2	P3	P4	Total
5/21/2013	0	0	0	0	0	0	0	0	0	0
6/6/2013	0	7	0	2	2	7	2	3	0	23
6/12/2013	0	4	1	10	4	16	2	5	3	45
6/20/2013	0	3	0	6	3	6	2	3	1	24
6/26/2013	1	5	0	4	5	6	1	4	10	36
7/3/2013	0	6	0	4	0	9	0	0	2	21
7/17/2013	0	5	0	2	NA	3	NA	5	4	19
7/22/2013	0	11	0	6	NA	2	NA	4	8	31
8/27/2013	0	4	0	2	NA	0	NA	0	0	6
9/16/2013	0	0	0	0	0	0	0	0	0	0
9/23/2013	1	1	0	3	NA	NA	NA	NA	NA	5
9/24/2013	0	13	0	6	4	0	0	1	0	24
10/17/2013	0	6	0	2	1	0	0	0	2	11
10/22/2013	0	2	0	0	0	0	0	1	0	3
10/28/2013	0	5	0	0	NA	0	NA	2	0	7
11/5/2013	0	3	0	0	0	0	0	0	0	3
11/11/2013	0	0	0	0	0	0	0	0	0	0

Table B-3. Summary of snorkel survey observations made of native char less than 150 mm in total length in Stetattle Creek.

Date	S1	S2	S3	P1	R1	P2	R2	P3	P4	Total
5/21/2013	0	0	0	0	0	0	0	0	0	0
6/6/2013	0	0	0	0	0	0	0	0	0	0
6/12/2013	1	0	0	0	0	0	0	0	0	1
6/20/2013	0	1	0	0	1	0	0	0	0	2
6/26/2013	0	0	0	0	0	3	1	2	1	7
7/3/2013	1	0	0	0	0	1	0	0	1	3
7/17/2013	0	1	0	0	NA	0	NA	0	0	1
7/22/2013	4	0	0	0	NA	3	0	0	1	8
8/27/2013	0	0	0	0	NA	0	NA	0	0	0
9/16/2013	0	0	0	0	0	0	0	0	0	0
9/23/2013	0	0	0	0	NA	NA	NA	NA	NA	0
9/24/2013	0	0	0	3	0	0	0	0	0	3
10/17/2013	0	0	0	0	0	0	0	0	0	0
10/22/2013	0	0	0	0	0	0	0	0	0	0
10/28/2013	0	0	0	0	NA	0	NA	0	0	0
11/5/2013	0	0	0	0	0	0	0	0	0	0
11/12/2013	0	0	0	0	0	0	0	0	0	0

Table B-4. Summary of snorkel survey observations made of native char greater than 150 mm in total length in Stetattle Creek.

Date	S1	S2	S3	P1	R1	P2	R2	P3	P4	Total
5/21/2013	0	0	0	0	0	0	0	0	0	0
6/6/2013	0	0	0	0	0	0	0	0	0	0
6/12/2013	0	0	0	0	0	0	0	0	0	0
6/20/2013	0	0	0	1	0	0	0	1	0	2
6/26/2013	0	0	0	0	0	1	0	0	0	1
7/3/2013	0	0	0	0	0	0	0	0	0	0
7/17/2013	0	0	0	0	NA	0	NA	0	0	0
7/22/2013	0	0	0	0	NA	0	0	0	0	0
8/27/2013	0	0	0	0	NA	0	NA	0	0	0
9/16/2013	0	0	0	0	0	0	0	0	0	0
9/23/2013	0	0	0	0	NA	NA	NA	NA	NA	0
9/24/2013	0	0	0	0	0	2	0	0	0	2
10/17/2013	0	0	0	0	0	0	0	0	0	0
10/22/2013	0	0	0	0	0	0	0	0	0	0
10/28/2013	0	0	0	0	NA	0	NA	0	0	0
11/5/2013	0	0	0	0	0	0	0	0	0	0
11/12/2013	0	0	0	0	0	0	0	0	0	0

Appendix C. Benthic invertebrate data.

Table C-1. Raw taxa counts for benthic invertebrates collected from Stetattle Creek.

Taxon	Stetattle Ck 1	Stetattle Ck 2	Stetattle Ck 3	Stetattle Fan 1	Stetattle Fan 2	Stetattle Fan 3
<i>Acari</i>	9	3	3			3
<i>Agraylea</i>				1		4
<i>Ameletus</i>	4		1	11	44	65
<i>Baetis bicaudatus/tricaudatus</i>	122	210	278	5	12	114
<i>Boreoheptagyia</i>			1			
<i>Brillia</i>	24	24	26	1	8	5
<i>Capniidae</i>	9	1	3	4	1	1
<i>Cardiocladius</i>		1				
<i>Ceratopogoninae</i>	1					
<i>Chaetocladius</i>						7
<i>Chironomidae</i>	12	7	3			
<i>Chloroperlidae</i>		3				
<i>Cinygmula</i>	16	12	13	16	24	101
<i>Clinocera</i>	3	9	3	1		4
<i>Clinocerinae</i> unknown larvae						1
<i>Corynoneura</i>	1	3				
<i>Crangonyx</i>				1		
<i>Dicranota</i>	11	5	7		4	1
<i>Doroneuria</i>	15	31	15			4
<i>Drunella coloradensis</i>	4	4	3			3
<i>Drunella doddsii</i>	26	31	30			8
<i>Drunella grandis/spinifera</i>	1		1			1
<i>Ecclisomyia</i>	7	4			8	
<i>Empididae</i>		1				
<i>Epeorus</i>					3	3
<i>Epeorus albertae</i> group	8	44	59			
<i>Epeorus grandis</i> group	3	1	5			
<i>Epeorus longimanus</i>	3	3				
<i>Ephemerella alleni</i>		1				
<i>Ephemerella dorothea infrequens</i>				97	7	23
<i>Ephemerella tibialis</i>	55	74	39			
<i>Eukiefferiella brehmi</i> group		1	1	1		19
<i>Eukiefferiella claripennis</i> group			3			1
<i>Eukiefferiella devonica</i> group			3			
<i>Forcipomyiinae</i>		1				
<i>Glossosoma</i>		1				
<i>Hesperoconopa</i>	3					
<i>Hexatoma</i>		1				
<i>Lepidostoma</i>	1			1	1	
<i>Lepidostoma cascadense</i>				38	23	17
<i>Lepidostoma hoodi</i> group						1
<i>Limnephilidae</i>						1
<i>Limnophyes</i>		1				
<i>Megarcys</i>						3
<i>Micropsectra</i>	5	8	4	3		19

Table C-1. Raw taxa counts for benthic invertebrates collected from Stetattle Creek (continued).

Taxon	Stetattle Ck 1	Stetattle Ck 2	Stetattle Ck 3	Stetattle Fan 1	Stetattle Fan 2	Stetattle Fan 3
<i>Nemata</i>	1				1	7
<i>Neophylax</i>		1	1			
<i>Oligochaeta</i>	65	75	36	110	40	43
<i>Oligophlebodes</i>						1
<i>Orthocladus</i> complex		7	1	4		13
<i>Ostracoda</i>				1		3
<i>Pagastia</i>				31		3
<i>Paraleptophlebia</i>	4	1	1		1	1
<i>Paraperla</i>		1				
<i>Parapsyche</i> <i>elsis</i>	1	4	1			
<i>Perlodidae</i>		1	1			3
<i>Polycentropus</i>				1		
<i>Prosimulium</i>					1	
<i>Pseudosmittia</i>						3
<i>Rhithrogena</i>	63	121	54		1	15
<i>Rhyacophila arnaudi</i>	1	1				
<i>Rhyacophila betteni</i> group	4	5	3			
<i>Rhyacophila brunnea/vemna</i> group	5	11	9			7
<i>Rhyacophila hyalinata</i> group		1	1			
<i>Rhyacophila narvae</i>					1	
<i>Rhyacophila vagrita</i>		1	2			
<i>Simulium</i>		5		3		
<i>Suwallia</i>	23	31	13		3	1
<i>Sweltsa</i>	3	7	4		1	3
<i>Taeniopterygidae</i>		9		4	67	30
<i>Thienemanniella</i>		1				
<i>Thienemannimyia</i> complex	7					5
<i>Turbellaria</i>	3	3	3			20
<i>Tvetenia bavarica</i> group	63	51	39			7
<i>Visoka cataractae</i>	1	1	1	1	1	
<i>Yoraperla</i>		1				1
<i>Zapada cinctipes</i>	15	3	4	7	16	24
<i>Zapada columbiana</i>	5	3	1		4	9
<i>Zapada frigida</i>					3	
<i>Zapada oregonensis</i> group					1	1

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 168/127396, December 2014

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