Slocan Lake Bull Trout Redd Counts – 2016

FWCP Study No. COL-F17-F-1280

Jeremy T.A. Baxter[1] and Robyn L. Irvine[2]

Prepared for:
Crystal Klym
Fish & Wildlife Compensation Program - Columbia
601-18th Street
Castlegar, B.C.
V1N 2N1

The FWCP is a Partnership of:

January 23, 2017 – Final Report

[1]Mountain Water Research, 107 Viola Crescent, Trail BC, V1R 1A1
e-mail: jbaxter@redmtn.ca

[2] Poisson Consulting Ltd., 4216 Shasheen Road, Nelson BC, V1L 6X1
e-mail: robyn@poissonconsulting.ca

Cover Photos: 2016 Wilson Creek Bull Trout redd survey and Silverton Creek male Bull Trout protecting spawning gravels.

Suggested Citation:

J.T.A. Baxter and R.L. Irvine (2017). Slocan Lake Bull Trout Redd Monitoring 2016. *FWCP Project No. COL-F17-1280* Fish and Wildlife Compensation Program Columbia Basin, Castlegar. A Mountain Water Research and Poisson Consulting Ltd. Final Report.

EXECUTIVE SUMMARY

This report summarizes the results of the fourth year of study carrying out adfluvial Bull Trout redd counts on tributaries to Slocan Lake for the Fish and Wildlife Compensation Program (FWCP) in Fall 2016. All creeks with Bull Trout accessible habitat were surveyed in late September 2016 to count redds and spawning fish. Redd surveys were conducted in Carpenter, Dennis, Fennell, Maurier, Shannon, Sharp, Silverton, Wee Sandy, Wilson, and Wragge Creeks to estimate adult abundance and determine the relative contribution of individual streams to the Slocan Lake Bull Trout population. Spawning Bull Trout or redds were found in Carpenter, Dennis, Silverton, Wee Sandy, Wilson and Wragge Creeks. This project ties directly to the FWCP Large Lake, Stream and Species of Interest action plans, which include the goals of inventory and assessment as well as habitat protection and restoration planning for Bull Trout as a focal species of the Columbia Basin.

During the 2016 surveys of all study streams, 105 redds and 5 unspawned females were enumerated. Total redd counts and unspawned female counts were used to estimate Bull Trout spawner escapements for each stream using an expansion factor of 2.4. The escapement was estimated at 264 Bull Trout for the 2016 spawning season. The estimated abundance of spawning Bull Trout was 194 in 2013, 389 in 2014, and 314 in 2015. The average spawner escapement over all years is 290 fish.

The Slocan Lake Bull Trout population continues to be 'At Risk' as designated in the provincial species status summary report. This rating is due to: 1) the spawning escapement values estimated being consistently less than 500 fish; 2) the habitat available to the fish has either remained stable or has decreased in quality through time; 3) the overall population trend remains unknown since it needs to be assessed over 2 generations (14 years), and; 4) the severity, scope and immediacy of threats to the population have increased or remained stable. Planned logging and recreational development in the Silverton Creek watershed is of significant concern for increasing the threats rating given the highly crucial nature of this creek in providing the majority of the Bull Trout spawning habitat for the Slocan population. Development plans in the Dennis/Wilson watershed may also be of concern since Wilson Creek is also a stronghold of Bull Trout Spawning in the watershed and may be of considerable importance in low water years. More conservative management of the fishing and increased enforcement for poaching may be warranted to prevent the Slocan Lake Bull Trout from reaching critically low levels.

In 2016, Silverton Creek contained 71% of the total spawning and Wilson Creek had 19% of the escapement. Over the past four years of monitoring, Silverton Creek has consistently been the most utilized system ranging from 50% (2015)- 90% (2013). Wilson Creek has consistently been second in importance with a range from 10% (2013) – 42% (2015). The remainder of the spawning population moves between systems with accessible habitat and suitable conditions. These smaller percentage systems are important as well for providing limited redundancy should there be a significant issue in one of the main systems. This geographic pattern highlights the critical importance of maintaining the habitat and integrity of important systems such as Silverton and Wilson Creek to maintain Bull Trout recruitment in the watershed.

ACKNOWLEDGEMENTS

Several people dedicated their time and efforts to ensure the successful completion of this project. Their help is greatly appreciated.

- **Fish and Wildlife Compensation Program:** Crystal Klym;
- **Ministry of Forests, Lands and Natural Resource Operations:** Steve Arndt;
- **Tarala Tech:** Clint Tarala;
- **AMEC, Foster, Wheeler**: Crystal Lawrence;
- **Schick and Associates**: Jody Schick;
- **Pavan and Associates:** Gary Pavan.

Mountain Water Research would also like to thank the **Slocan Lake Stewardship Society** and the **Slocan River Stream Keepers** for their continued support.

This Project was funded by the Fish and Wildlife Compensation Program on behalf of its program partners BC Hydro, the Province of B.C., Fisheries and Oceans Canada, First Nations and Public Stakeholders who work together to conserve and enhance fish and wildlife impacted by the construction of BC Hydro dams.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

The Bull Trout (*Salvelinus confluentus*) population in the Slocan Lake watershed is a recreationally important population. In addition to being an important sport fish in the Slocan Lake watershed, Bull Trout are a keystone predator and important ecosystem component of the lake and its tributaries. Historically, this population was not well studied, and this has been partially addressed by the FWCP project over the past four years assessing spawning locations, escapement estimates, habitat needs and potential locations and ideas for restoration of this population. Redd counts and habitat assessments carried out during the redd surveys have provided an index of the abundance of Bull Trout spawners and potential responses of the population to enhancement projects since the pilot in 2013 (Baxter and Irvine, 2014) and the full monitoring program (2014-2016) surveying all accessible tributaries for barriers, redds and fish (Irvine and Baxter, 2016).

Slocan Lake Bull Trout were historically connected to the Kootenay and Columbia River systems and the overall Columbia basin through the Slocan River. The movement patterns and potential for interchange of gene flow for this population is now truncated by hydro-electric development on the Kootenay and Columbia Rivers. High water temperatures in the Slocan River may also potentially limit the mobility of the Slocan Lake Bull Trout in the present day. It is considered likely that significant declines in abundance and diversity occurred in the Slocan population following the loss of connectivity with adult rearing habitats in the lower Kootenay and Columbia systems following hydroelectric development in the early 1990s (Hagen and Decker, 2011; Hirst, 1991).

In an assessment of the impacts of dam construction and flow regulation on Bull Trout populations throughout the Canadian portion of the Columbia River watershed, Slocan River Bull Trout were identified as a population of high conservation concern, and it was recommended that these fish be given priority in future management (Hagen, 2008; Hagen and Decker, 2011). Hagen and Decker (2011) considered the Slocan population as a whole met major criteria with respect to known threats to population perseverance for this species in their native range, including: isolation from other populations and from productive rearing habitats, small population size, possible evidence of negative population growth, unfavourable thermal regimes in remaining habitats, and encroachment and competition by native and non-native species. Threats to this population additionally include a regularly managed angling harvest, harvest pressure through poaching, sediment loading and habitat degradation in spawning and rearing streams, increasing water temperature from climate change and linear development and population sizes of spawners that may limit genetic adaptability and variation.

The Provincial Conservation Status of Bull Trout in the Slocan Valley was classified as C2 or “At Risk” in 2011. This was based on an estimate of between 200 and 500 spawning adults and on estimated habitat, exploitation and competition in the system (Hagen and Decker 2011). The past three years of redd surveys and the gathering of additional information on distribution and available habitat and habitat degradation have demonstrated that this population remains within the ‘At Risk’ category with escapement estimates from 2013, 2014 and 2015 at 194, 398 and 314 fish respectively. The risk level designation is not just based on abundance, but also on several

factors including trends in population size, available habitat for distribution as well as the threats affecting the population. The next and highest level of risk is 'High Risk' which is defined as 'extremely limited and/or rapidly declining numbers, range, and/or habitat, making the bull trout in this core area highly vulnerable to extirpation' (Hagen and Decker 2011). As part of the 2015 study, the risk rating for this population of Bull Trout was re-evaluated including knowledge on distribution and abundance and threats obtained from 2013-2015. With only the Slocan Lake tributaries included in the calculation, the population has entered the High Risk category and with all tributaries to Slocan Lake and the Slocan River included, the population of Bull Trout remains in the At Risk category (Irvine and Baxter, 2016).

Bull Trout are provincially blue-listed and their conservation is a priority to the province of British Columbia and to the Fish and Wildlife Compensation Program (FWCP). The FWCP Large Lake, Stream and Species of Interest action plans include the goals of inventory and assessment for Bull Trout as a focal species of the Columbia Basin. This project not only addresses these goals but in addition, the redd count and habitat survey data provided by this work provides information for long term management of this key species and data to inform habitat protection and restoration planning for rearing and spawning habitat, which are key targets of the Large Lake, Stream and Species of Interest FWCP action plans. The Bull Trout in the Slocan system have a typical adfluvial life history characterized by spawning and rearing in major tributaries to Slocan Lake for the first 1-4 years of life, and adult rearing in the lake. Multiple and varied options for compensation efforts and management to maintain and increase this population exist. Currently the BC Fishing Regulations allow a harvest of one Bull Trout a day per person over 30 cm in Slocan Lake and poaching within the population's spatial extent is suspected to be moderate to high based on limited resources for Conservation Officers to patrol and commonly observed poaching incidents in areas with aggregations of pre-spawning Bull Trout (P. Corbett, Pers. Comm.).

The objective of this study is to complete three years of redd count surveys of all potential Bull Trout spawning tributaries draining into Slocan Lake from 2014-2016 following on the pilot study in 2013. The project goal is the estimation of spawner distribution and abundance in the Slocan Lake population of Bull Trout and identification of restoration opportunities in the watershed.

The primary benefits of this project are to improve the understanding of the population size and trends in Slocan Lake Bull Trout, to identify opportunities for restoration and enhancement and to provide the best available scientific information for establishing management tactics to meet conservation goals. In this report, we describe the 2016 results of Slocan Lake Bull Trout redd and spawner counts for all available Bull Trout spawning habitat.

2.0 STUDY AREA

Slocan Lake is situated between the Valhalla and the Selkirk Mountain Ranges in the West Kootenay Region of British Columbia, and is approximately 39 km long and has an area of 69 km² (Figure 1). The lake is drained by the Slocan River, which flows in a southerly direction for approximately 58 km from the lake to the confluence with the Kootenay River. Elevation in the basin ranges from 480 meters at the Slocan River mouth to 2,800 meters at the height of land in the Selkirk Mountains. Within this elevation range, the system is comprised of two bio-geoclimatic zones. At lower elevations, the valley lies within the Interior Cedar-Hemlock zone, while areas in the higher elevations are found within the Engelmann Spruce-Subalpine Fir zone. Historically, the river was connected to the lower Columbia and Kootenay rivers, but hydroelectric developments in the 1940s fragmented the system from these major rivers. The Slocan used to contain now extirpated populations of Chinook Salmon (*Oncorhynchus tshawytscha*) and Steelhead Trout (*Oncorhynchus mykiss)* (Arndt, 1999; Zimmer et. al. 1998).

Redd surveys were conducted in Carpenter, Dennis, Fennell, Maurier, Shannon, Sharp, Silverton, Wee Sandy, Wilson and Wragge Creeks (Table 1). Surveys were not conducted in Evans, Hoben or Nemo creeks in 2016 since the 2014 surveys demonstrated extremely limited spawning habitat in each of these systems. Each of the streams was checked in 2016 in order to confirm the barrier was still very low down and very limited habitat remained for Bull Trout spawning. In each stream, the redd survey was initiated at the upstream migration barrier (Figure 1) and extended to the stream mouth or the lake confluence or until the end of Bull Trout spawning habitat was reached.

Table 1. Geographic information on the surveyed tributaries in the study area.

Gazetted Name	Watershed Code	Total Stream Length (km)	Order	Area (km²)	Region
Carpenter Creek	340-047200-86300	25.80	5th	221	4
Dennis Creek	340-047200-91700-04100	11.35	4th	20.36	4
Fennell Creek	340-047200-82200-33700	9.61	3	24.53	4
Maurier Creek	340-047200-82200-51800	10.96	3	23.32	4
Shannon Creek	340-047200-97700	13.76	4th	41.14	4
Sharp Creek	340-047200-86100	8.68	3rd	12.93	4
Silverton Creek	340-047200-82200	21.73	5th	120	4
Wee Sandy Creek	340-047200-89600	14.05	4th	55.39	4
Wilson Creek	340-047200-91700	40.40	6th	579	4
Wragge Creek	340-047200-96100	11.37	4th	27.6	4

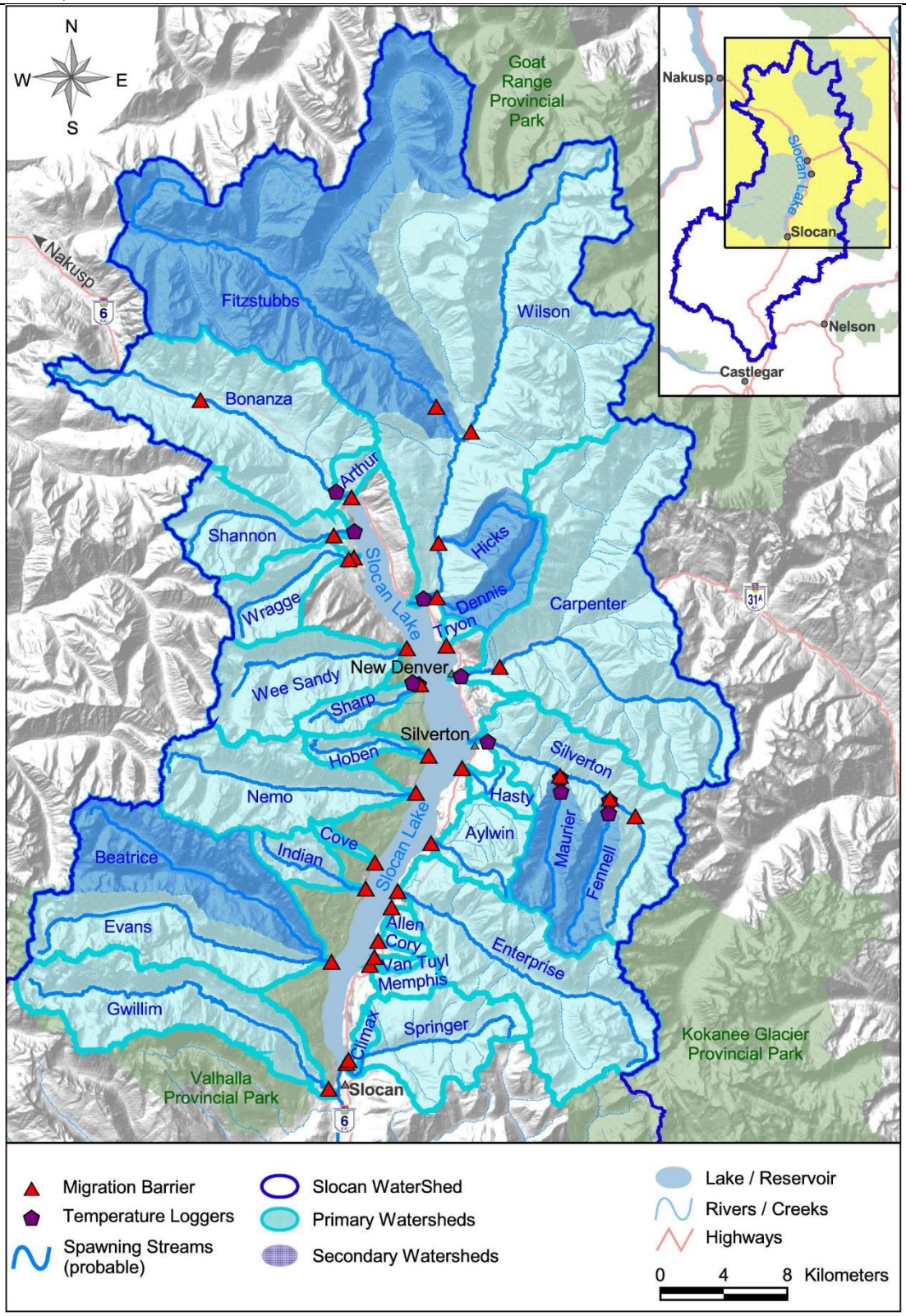

Figure 1. **The Slocan Lake study area showing migration barriers to spawning Bull Trout in all tributaries and locations of 2016 temperature loggers.**

3.0 METHODS

3.1 Redd Surveys

As an index of adult Bull Trout escapement the method of visual counts of redds in the substrate that indicate spawning activity and egg deposition was used (Dunham et al., 2001; Rieman and Myers, 1997). Redd counts are one of the least expensive and least invasive adult population assessment methods and under appropriate conditions, can be precise indicators of abundance (Johnston et al., 2007).

Redd surveys began in late September based on timing determined in 2013. Redd surveys were conducted by a crew of two people, each equipped with waders and polarized glasses, who walked downstream from the barriers parallel to one another on either side of the stream. All observed redds and spawners were enumerated, recorded and marked with a handheld GPS device for each survey area. Where possible, the sex and approximate fork length (visual estimate) of individual fish was also recorded. We assumed that females not associated with redds were unspawned females and would construct redds after the survey was completed. We counted each unspawned female as one redd when estimating the number of redds for each stream. If an index area could not be completed in one day (typically, five kilometers can be surveyed in a day) the survey was resumed the following day.

There are three potential classifications for an excavation found by a survey crew: 1) natural stream scour 2) viable redd, 3) test dig. There are several characteristics that may be present to allow redds to be differentiated from natural scour:

- Circular, dish-shaped excavations in the creek bed material, accompanied by a gravel deposit beginning in the excavated pit and spilling out of it in a downstream direction
- The overall pit is broader than the area where gravel is deposited over the eggs
- A steep pit wall, with perched substrate that can be easily dislodged into the pit
- Bright and clean substrate, and sand deposited in the area of quiet water created by the upstream edge of the pit
- Tail stroke marks or excavation marks around the redd or alongside the front portion of the gravel deposit

Test digs are very similar to redds but are usually smaller in size, with a shorter and narrower mound of gravels around the downstream edge, and have no gravel deposit swept into the pit, which would indicate at least one egg deposition event.

Redd survey dates ranged from September 26th to 30th (Table 2). Complete surveys from the migration barriers to the mouth were conducted in all creeks listed in Table 2.

Table 2. Redd survey dates for each stream in the study area 2016.

Stream	Date Surveyed	Barrier UTM	Distance (km) (Barrier to Mouth)
Carpenter Creek	27 Sept	11 U 475707 5537963	3.34
Dennis Creek	30 Sept	11 U 471944 5542447	0.32
Fennell Creek	26 Sept	11U 482842 5529788	0.05
Maurier Creek	26 Sept	11U 479701 5531232	0.04
Shannon Creek	28 Sept	11 U 465467 5546352	1.58
Sharp Creek	28 Sept	11 U 470896 5536987	0.04
Silverton Creek	26-27 Sept	11 U 483409 5529352	13.19
Wee Sandy Creek	28 Sept	11 U 470059 5539265	0.10
Wilson Creek	29 Sept	11 U 474092 5552886	14.85
Wragge Creek	28 Sept	11 U 466733 5544963	0.75

3.2 Escapement Estimate

We searched the literature for studies where redds were counted throughout the entire spawning area within a system, and these counts compared to complete counts of kelts at downstream weirs or resistivity counters (i.e., approximate total escapement). The number of adults (kelts) per redd derived from these studies ranged from 1.0 to 4.3 and are summarized in previous reports on this project (e.g., (Irvine and Baxter, 2016)). The expansion factor used herein was averaged from those studies and was 2.4 adults per redd. The average value is approximate since some studies reported only the range in values.

For the escapement estimate we assumed that all unspawned females not associated with a redd were going to construct one. The escapement estimate equation uses total number of redds and unspawned females multiplied by the expansion factor (2.4) (Baxter and Decker 2010, Decker and Hagen 2007) to calculate the total Bull Trout escapement (N) for an individual stream. The escapement estimate equation is:

$$N = (redds + unspawned\ females) * 2.4$$

3.3 Temperature Measurements

Eight Onset TidbiT v2 temperature loggers were deployed in the study area and one temperature logger was deployed outside of the study area in Glade Creek (
Table 3). Selkirk College students sampled Bull Trout in 2013 in Glade Creek (R. Vandenbos, Pers. Comm.). To provide an indication of Bull Trout range, Glade Creek was monitored in-kind during 2016 as the furthest possible downstream Bull Trout spawning tributary in the Slocan Valley watershed (Slocan River included). The loggers recorded the water temperature every 15 minutes and were downloaded in September 2016. Temperature data were imported into R (Version 3.3.2), inspected for any errors or outliers and plotted for all 2015 data by creek (R Core Team, 2016). The logger in Silverton Creek was plotted from its initial deployment in July 2013 until the most recent download. Two additional temperature loggers were also deployed in Fennel and Maurier Creeks (Silverton Creek tributaries) as outlined in the below table and reports of Bull Trout in Glade Creek led to instrumentation of that creek as well.

Table 3. Temperature logger location, deployment and retrieval dates.

Stream	Temperature Logger UTM	Deployment Date	Retrieval Date
Bonanza Creek	11 U 465628 5549120	October 15, 2015	September 30, 2016
Carpenter Creek	11 U 473473 5537503	September 28, 2015	September 30, 2016
Fennel Creek	11U 482825 5529712	August 26, 2015	September 30, 2016
Glade Creek	11U 460370 5469967	February 6, 2016	September 25, 2016
Maurier Creek	11U 479721 5531148	August 26, 2015	September 30, 2016
Shannon Creek	11 U 466757 5546625	September 29, 2015	September 28, 2016
Sharp Creek	11U 470856 5536977	September 29, 2015	September 28, 2016
Silverton Creek	11U 475163 5533384	September 29, 2015	September 30, 2016
Wilson Creek	11 U 471109 5542398	September 29, 2015	September 29, 2016

3.4 Data Preparation and Plotting

The Bull Trout fish and redd count data for the Slocan Lake tributaries were collected by Mountain Water Research and databased in a customized relational Access database by G. Pavan. Poisson Consulting Ltd. carried out plotting and data QA/QC before interpretation of trends. Pavan and Associates created the maps from the spatial data collected in the field by the Mountain Water Research team. The data were plotted and prepared from the database using R version 3.3.2 (R Core Team, 2016).

4.0 RESULTS

4.1 Redd Count Surveys

In 2016, redd surveys were conducted from September 26 until September 30 (Table 2). Water clarity conditions were excellent, and there was no evidence of redd scour prior to the surveys. In total, 34.24 km of stream were surveyed, and 105 redds and 5 unspawned females were observed for all streams combined (
Table 4).

Table 4. Total number of Bull Trout redds and unspawned females in surveyed Slocan Lake tributaries 2016

Tributary	Accessible Length (km)	Unspawned Females	Redd Count
Carpenter Creek	3.34	0	2
Dennis Creek	0.55	1	5
Fennel Creek	0.05	0	0
Maurier Creek	0.04	0	0
Shannon Creek	1.58	0	0
Sharp Creek	0.04	0	0
Silverton Creek	13.2	3	75
Wee Sandy Creek	0.10	0	1
Wilson Creek	14.9	1	20
Wragge Creek	0.44	0	2
Totals	34.24	5	105

Redd counts varied from 1 redd in Wee Sandy Creek to 75 redds in Silverton Creek. The total surveyed redds and maps showing the spatial distribution are presented in approximate order of most abundant to least abundant.

4.1.1 Silverton Creek and Tributaries

In 2016, 75 redds and 3 unspawned females were observed in Silverton Creek. The redds found in Silverton Creek account for 71% of the total escapement in 2016. The habitat with the highest redd densities, is consistently located in the reaches immediately above and below Maurier Creek (Figure 2). Both Fennell and Maurier creeks have gradient barriers within the first 100 m from their creek mouths and neither had any unspawned females or redds in 2016. According to the Fisheries Information Summary System (FISS) populations of resident Bull Trout are known to occur upstream of the adfluvial barriers in both Fennel and Maurier creeks.

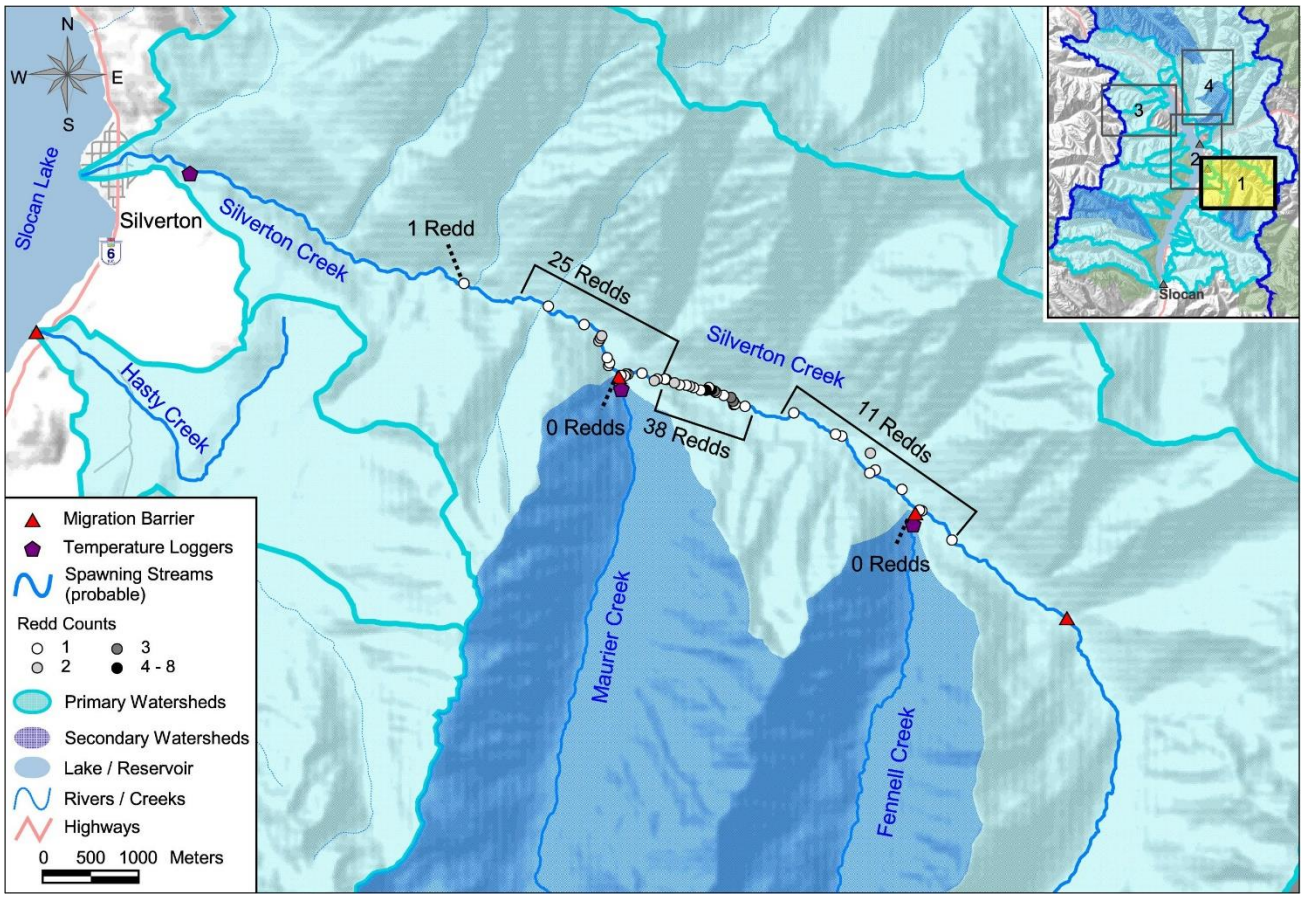

Figure 2. Bull Trout barriers and redd assessment results for Silverton Creek and tributaries, 2016.

4.1.2 Wilson Creek and Tributaries

In 2016, 20 redds and 1 unspawned female were observed in Wilson Creek and 5 redds and 1 unspawned female in Dennis Creek which together account for 24.6% of the total escapement (

Figure 3).

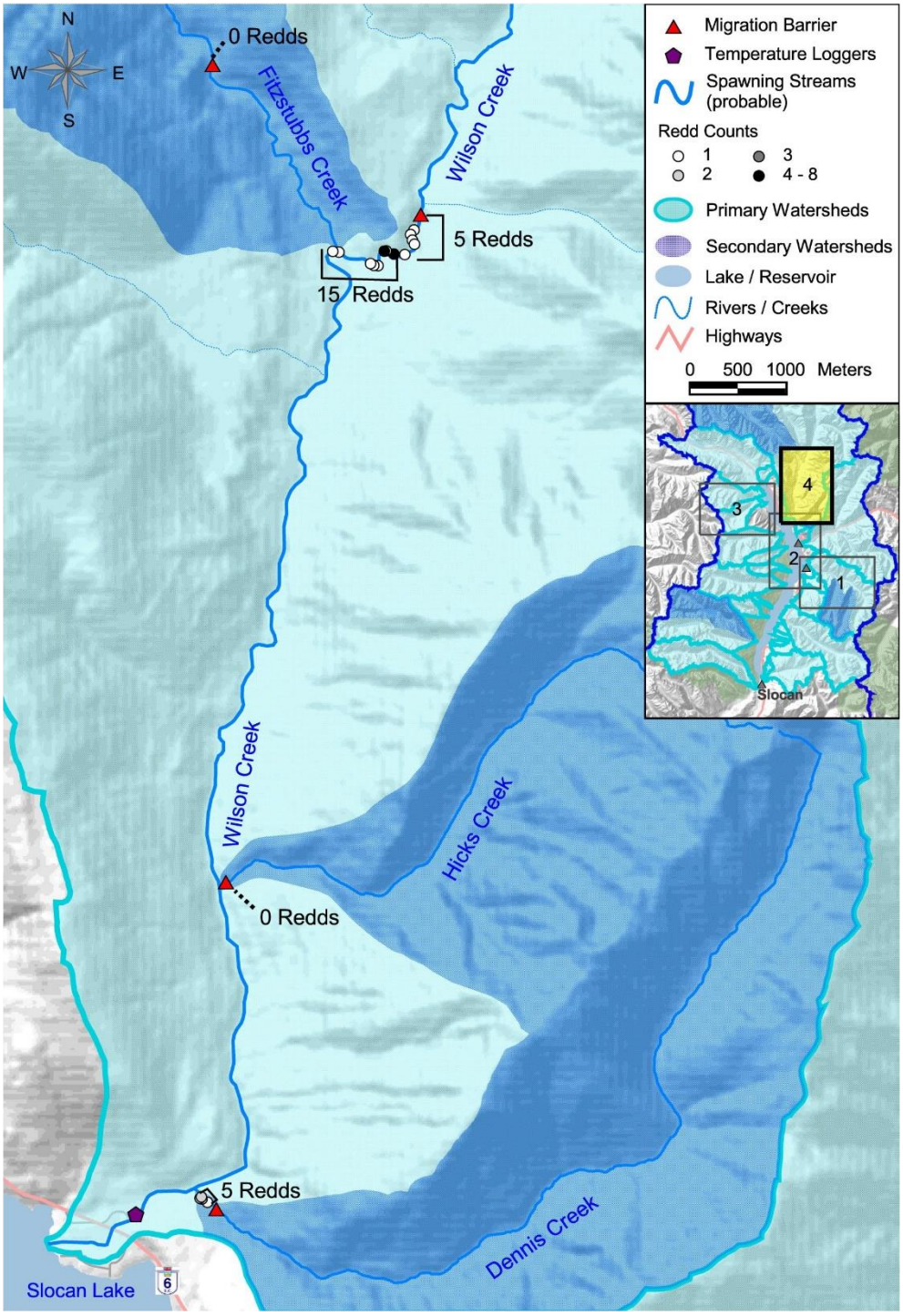

Figure 3. Bull Trout barriers and redd assessment results for Wilson Creek and tributaries, 2016.

4.1.3 Carpenter, Wee Sandy, and Sharp Creeks

In 2016, 2 redds and 0 unspawned females were observed in Carpenter Creek which is 1.8% of the total escapement (Figure 4). One redd was observed in Wee Sandy Creek for 0.9% of the escapement and no redds nor females were observed in Sharp Creek.

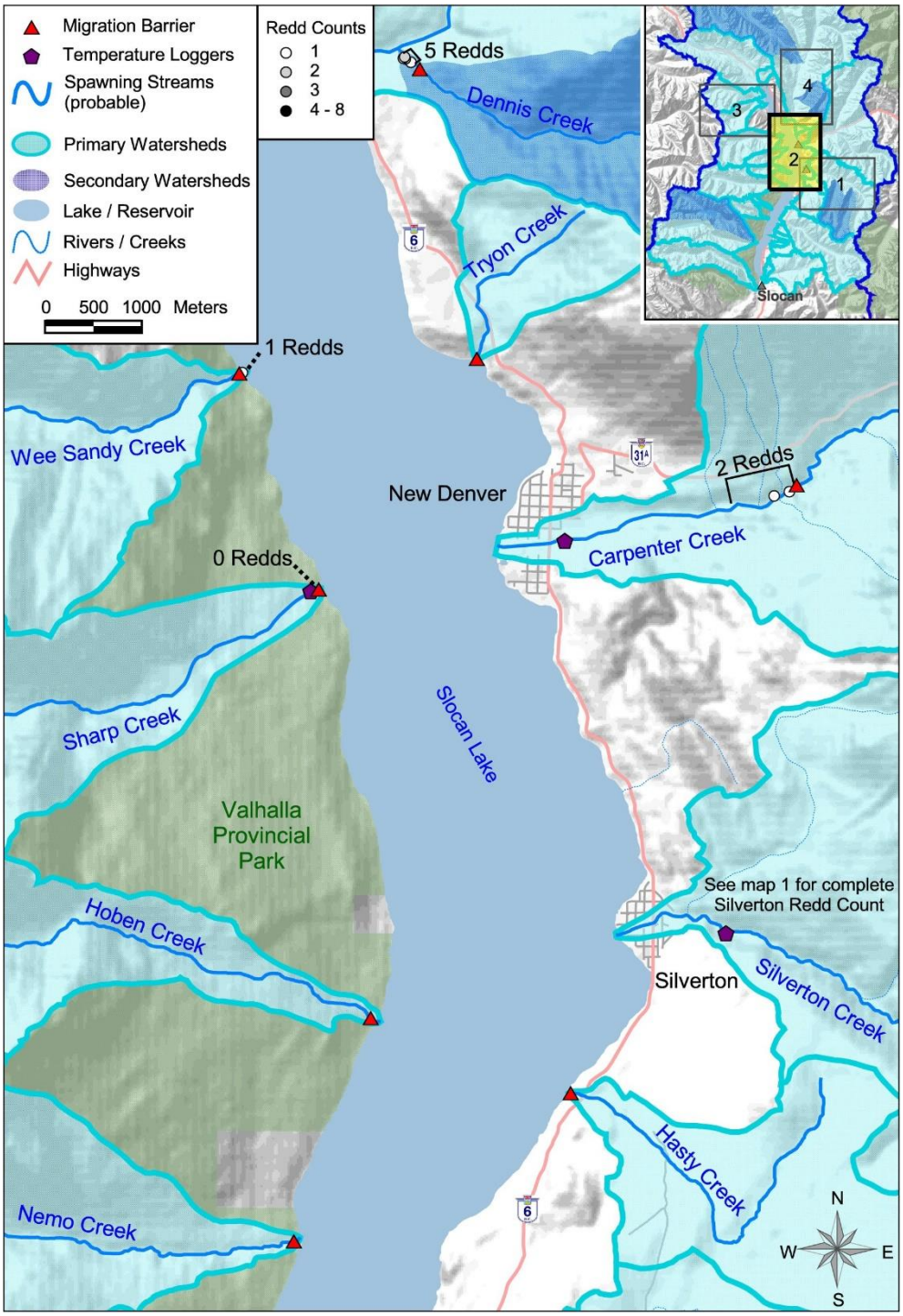

Figure 4. **Bull Trout barriers and redd assessment results for Carpenter, Sharp, and Wee Sandy Creeks, 2016.**

4.1.4 Wragge and Shannon Creeks

In 2016, 2 redds and 0 unspawned females were observed in Wragge Creek which is 1.8% of the total escapement. Shannon Creek did not have any redds nor unspawned females in this spawn year (Figure 5).

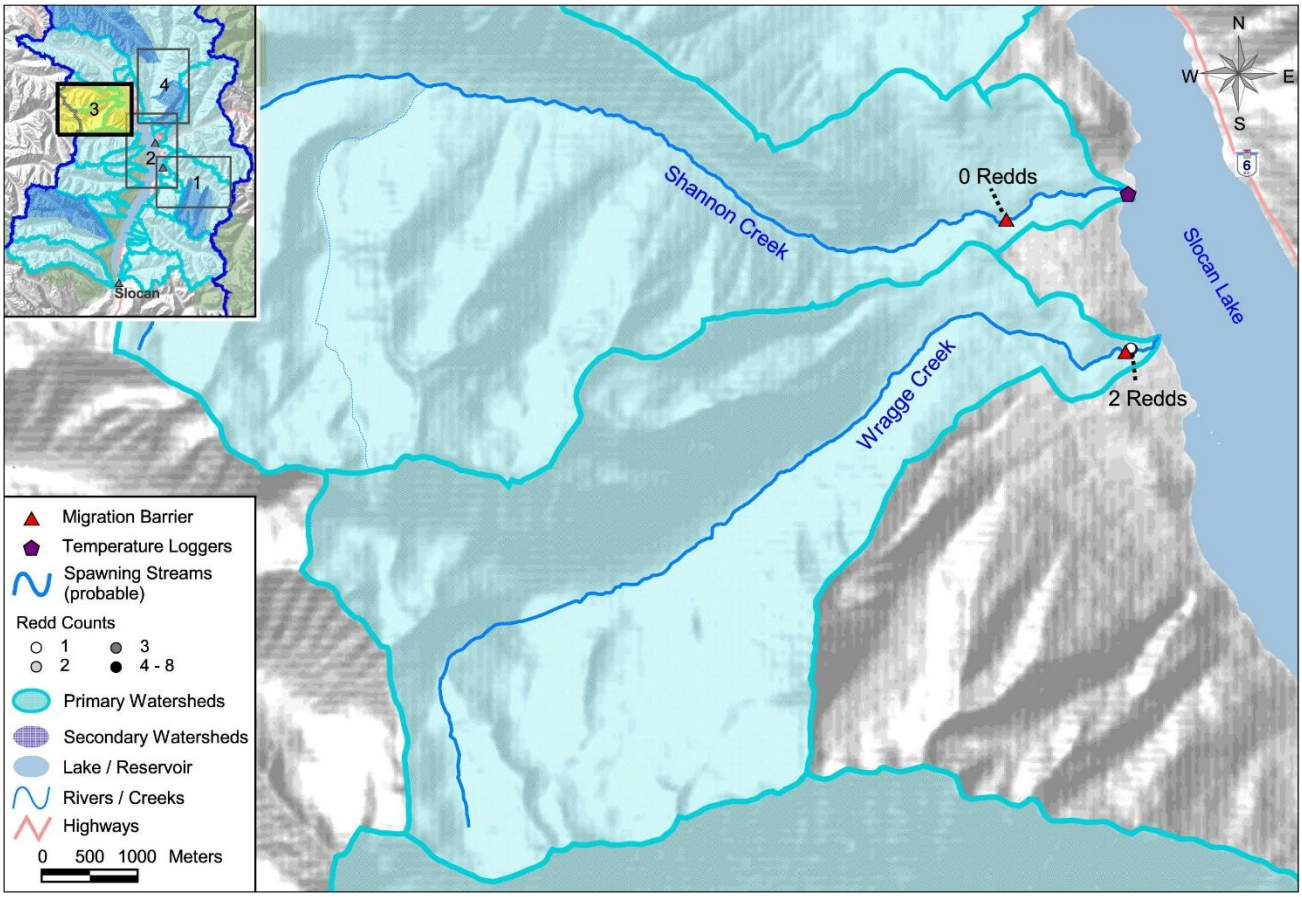

Figure 5. **Bull Trout barriers and redd assessment results for Wragge and Shannon Creeks, 2016.**

4.2 Escapement Estimate

Bull Trout escapement (assuming 2.4 adults per redd) of all accessible Slocan Lake tributaries in 2016 was 264 adults with Silverton Creek making up the largest proportion of the total spawning fish with 71% of the redds (Table 5). The escapement estimate was mainly based on redd numbers with only 5 unspawned females observed during the surveys indicating accurate timing for the surveys in 2016. The escapement numbers through the four years of the study have ranged from just under 200 fish to almost 400 fish (Table 6) with no years greater than 500 fish. The average total escapement across the four years is 290.3 fish.

Table 5. Slocan Lake tributary redd count and unspawned females with percent totals for the 2016 surveyed streams where Bull Trout spawning was observed.

Tributary	Redd Count Plus Unspawned Females	Percentage of Redds (%)
Silverton Creek	78	70.9
Wilson Creek	21	19.1
Dennis Creek	6	5.5
Carpenter Creek	2	1.8
Wragge Creek	2	1.8
Wee Sandy Creek	1	0.9
Totals	110	~100%

Table 6. Slocan Lake tributary escapement estimates through time assuming 2.4 adults per redd. The 2013 data were derived from a partial survey of available spawning creeks.

Spawn Year	Escapement
2013	194
2014	389
2015	314
2016	264
Average	290.3

4.3 Water Temperature

Data loggers were downloaded in Fall 2016 and several loggers are now deployed year-round to allow winter temperatures and ATUs to be calculated annually. Most of the creeks in which temperature was monitored stayed below 15°C with the warmest creeks being Glade, Bonanza and Carpenter (Figure 6). Sharp Creek was the coolest creek overall while Carpenter and Fennell Creeks showed the widest diel variation in water temperature throughout the spring and early summer period. Silverton creek shows a relatively similar temperature curve by year for the 3

years of record, with the low water year of 2015 showing higher peak temperatures on average and wider diel variation in the summer months (Figure 7).

The water temperature in Silverton Creek has been measured since Fall 2013 so the incubation and emergence timing in the main spawning creek has been calculated for the three spawn years (Table 7). It was assumed that the start of incubation was October 1 given the approximate mean timing of spawning completion in each year. For incubation to 50% hatch, 340 ATUs is cited as typical if the creek temperatures range from 1.2-5.4°C and 635 ATUs for full fry emergence (Fraley and Shepard, 1989). The optimal temperature for egg survival is between 2-4°C and the temperature dropped below 4°C in Silverton on October 10, 2013, on November 9, 2014 and on November 3, 2015. In the 2013-14 incubation season the water temperature stayed between 0-4°C until April 17, 2014 and in the 2014-15 incubation season, the water went above 4°C on March 21, 2015. In the 2015-16 spawn year, the temperature dropped slightly below zero in late December, 2015 and went above 4°C on March 31, 2016.

Table 7. Accumulated Thermal Units for 50% hatch (340 ATUs) and full emergence (635 ATUs) by spawn year for Bull Trout redds in Silverton Creek.

Spawn Year	340 ATU Date (50% hatch estimate)	635 ATU Date (emergence estimate)
2013-14	March 26	June 2
2014-15	January 12	April 25
2015-16	January 28	April 27

Since the program start in 2013, redds have only been observed in Wilson Creek directly upstream of Fitzstubbs Creek and in Dennis Creek. Spot water temperature measurements taken each year during the surveys have recorded that Fitzstubbs Creek is on average 2 degrees Celsius warmer than Wilson Creek and Dennis Creek. The warm lake-headed water from Fitzstubbs Creek seems to play a significant role as to where Bull Trout spawn in the Wilson Creek drainage.

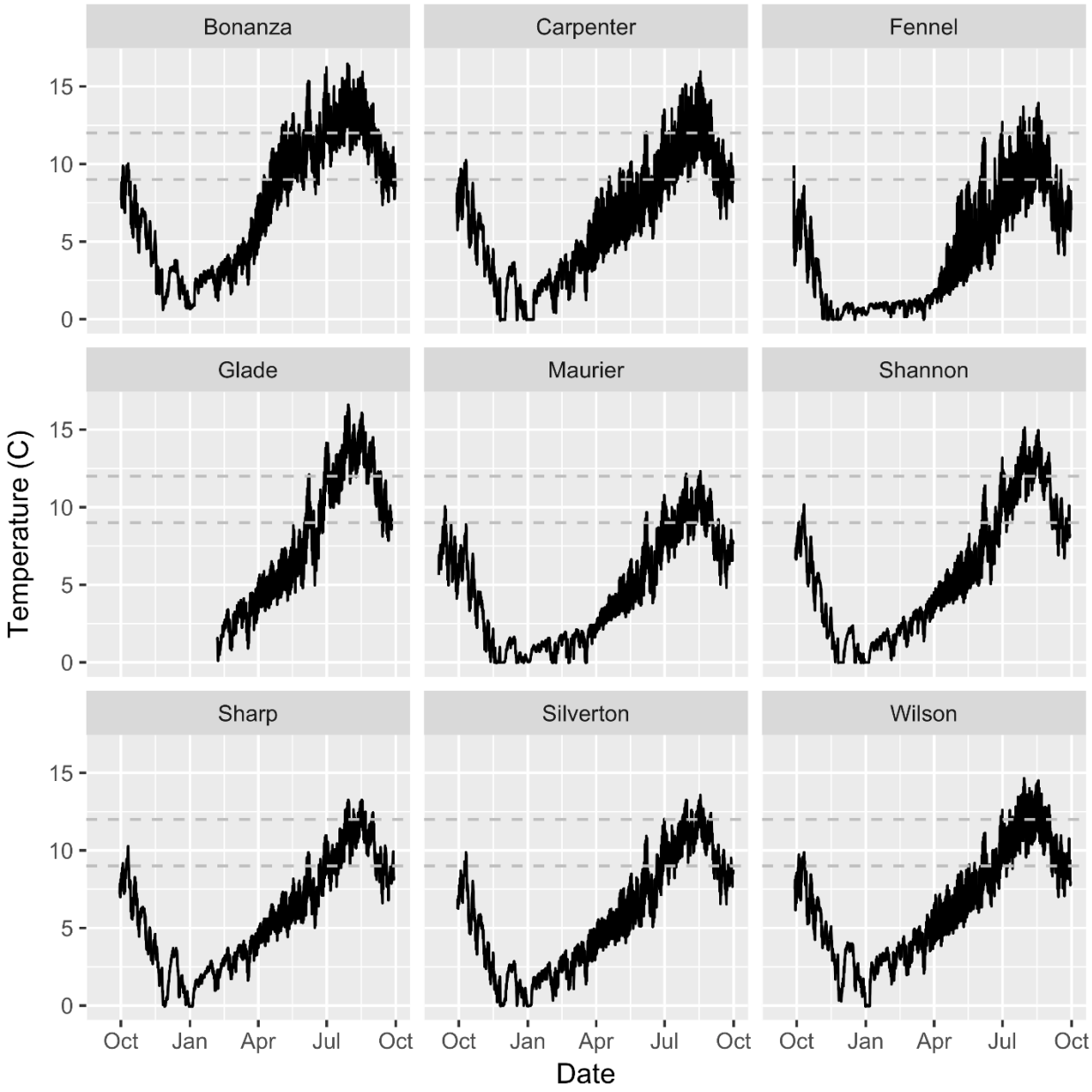

Figure 6. **Water temperature (°C) by date for a subset of the surveyed creeks in the Slocan Lake watershed surveyed for Bull Trout spawning, 2015-2016. Temperature thresholds for migration (12°C) and spawning (9°C) are marked with horizontal dashed lines.**

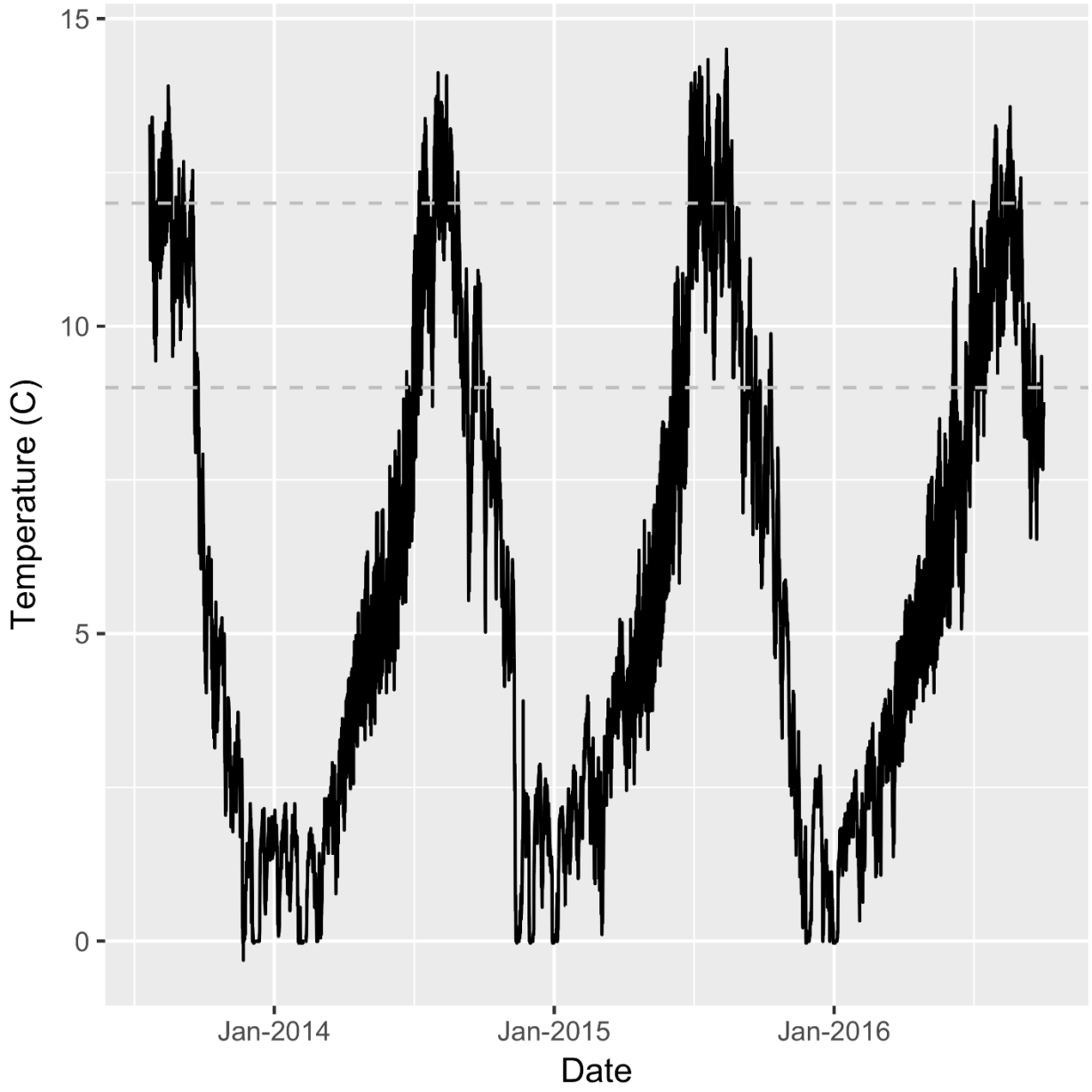

Figure 7. **Water temperature (°C) for Silverton Creek 2013-2016. Temperature thresholds for migration (12°C) and spawning (9°C) are marked with horizontal dashed lines.**

5.0 DISCUSSION

The escapement estimates over the four years of this study have ranged from 194 to 389 Bull Trout in the tributaries to Slocan Lake. Although redd surveys can be biased due to missing redds or false positive identifications of redds that are not present, the usage by this project of experienced observers and most of the same observers from year to year minimizes these sources of observer bias (Dunham et al., 2001). These estimates are considered to be a good index of abundance through time.

The re-calculation in 2016 of the risk category showed that with conservative assumptions, this population of Bull Trout is considered 'High Risk' if only the Slocan Lake tributaries are used in the calculation and is 'At Risk' if the tributaries for the Slocan River are also included and the assumption is made that they contain suitable habitat and water temperatures (Irvine and Baxter, 2016). In order to determine the risk of this population more definitively, a proposal has been submitted to assess the spawning in the tributaries to the Slocan River as well for the 2017 field year. What is known now about this population is that the habitat used by adult Bull Trout for spawning is mainly in two Slocan River tributaries (Lemon Creek and Little Slocan River), which makes them more vulnerable to any negative changes in their utilized habitats. Bull Trout have also been documented in Glade Creek (the furthest downstream tributary to possibly have Bull Trout spawning habitat in the Slocan Valley watershed) and a complete redd count survey from the barrier to the mouth was conducted in-kind by Mountain Water Research on September 25th and again on October 9th. No redds or spawners were observed in Glade Creek in 2016.

The spawning habitat for these ecologically and recreationally important fish species is mainly provided by Silverton Creek and Wilson Creek with a small amount of spawning observed each year in several small tributaries around the lake. Silverton Creek is the most important creek by a large margin in most years, though one hypothesis is that Wilson may have greater spawning importance in years of low flow based on the percentage usage in 2015, but this only has one year of data to support the idea at this point. Wilson Creek tends to be warmer than Silverton and temperature thresholds are related to land use practices as well as climate change (Parkinson et al., 2016) and may limit the utility of Wilson in the future without remediation of open sections of the river from road clearing and forestry. With a slight shift in temperature, creeks can move from a Bull Trout dominated system to a Rainbow Trout dominated system and there is a current push towards protecting and identifying temperature sensitive streams across BC in order to ensure that cold water species such as Bull Trout still have sufficient habitat in perpetuity (Parkinson et al., 2016).

The life history demonstrated by this portion of the Slocan Lake watershed population of Bull Trout is assumed to be short distance migrations from Slocan lake into adjacent tributaries. This life history pattern has the advantage of managing the habitat fragmentation that negatively affects this species over its range, but has the disadvantage of vulnerability to disturbances that have the potential to influence a significant proportion of the spawning and rearing habitat with spatially restricted habitat use (Tennant et al., 2016). This is of concern to this population because if anything happened to negatively impact Silverton Creek, there would be very limited recruitment from other creeks unless major compensatory behaviours occurred. There are ongoing requests for development in the area including a water withdrawal increase from Dennis Creek for microhydro, road developments for forestry in the Silverton watershead, glading and changes in road use from cat skiing operations in Silverton and there may be others unknown to the authors. It is crucial that the key habitats and the cold waters of the critical habitat of this species be maintained through careful management of development and conservation in the area and through thoughtful restoration projects.

In 2015 the Bull Trout enhancement, restoration and compensation opportunities in the Slocan Lake watershed were assessed as part of the Slocan Lake Bull Trout redd count study conducted for FWCP (Irvine and Baxter 2016). In addition to the enhancement evaluation for FWCP, representatives from the Slocan Lake Stewardship Society, the Valhalla Wilderness Society, the Village of Silverton and Interfor also requested the Bull Trout enhancement options for Silverton Creek as Interfor has a harvest plan to log in the Silverton Creek drainage in 2016 and 2017. Interfor initiated two of the enhancement options in 2016. The old cribbing along the Silverton Creek Forest Service Road was removed and the stream bank was protected (Figure 8), and the old rotten bridge, which was collapsing in the stream was removed. The projects were part of Interfor's road upgrades to allow logging truck transport and instream work occurred within the Bull Trout window identified by the Province of BC. Instream boulder placement to increase fish habitat was not completed as part of these works.

Figure 8. **Unstable cribbing removal from Silverton Creek completed by Interfor (Top-Before-2015 and Bottom-After-2016).**

6.0 REFERENCES

Arndt, S. 1999. Slocan River Summer Temperatures in 1997 and 1998: Implications for Rainbow Trout Distribution and Production. Prepared for: Columbia Basin Fish and Wildlife Compensation Program. 40 pp.

Baxter, J.T.A., and Irvine, R.L. 2014. Adfluvial Bull Trout Spawner Abundance in Selected Tributaries of Slocan Lake - 2013. A Mountain Water Research and Poisson Consulting Ltd. Report, Fish and Wildlife Compensation Program - Columbia, Castlegar, B.C.

Dunham, J., Rieman, B., and Davis, K. (2001). Sources and Magnitude of Sampling Error in Redd Counts for Bull Trout. North American Journal of Fisheries Management *21*, 343–352.

Fraley, J.J., and Shepard, B.B. (1989). Life History, Ecology and Population Status of Migratory Bull Trout (Salvelinus confluentus) in the Flathead Lake and River System, Montana. Northwest Science *63*, 133–143.

Hagen, J. (2008). Impacts of dam construction in the upper Columbia Basin, British Columbia, on bull trout (Salvelinus confluentus) production, fisheries, and conservation status (Nelson, BC: Fish and Wildlife Compensation Program).

Hagen, J., and Decker, S. (2011). The status of Bull Trout in British Columbia: A synthesis of Available Distribution, Abundance, Trend and Threat Information (Victoria, B.C.: Ecosystems Branch, Ministry of Environment).

Hirst, S.M. (1991). Impacts of the Operation of Existing Hydroelectric Developments on Fishery Resources in British Columbia. (Vancouver, B.C.: Department of Fisheries and Oceans).

Irvine, R.L., and Baxter, J.T.A. (2016). Slocan Lake Bull Trout Redd Counts - 2015 (Castlegar, B.C.: Fish and Wildlife Compensation Program - Columbia).

Johnston, F.D., Post, J.R., Mushens, C.J., Stelfox, J.D., Paul, A.J., and Lajeunesse, B. (2007). The demography of recovery of an overexploited bull trout, *Salvelinus confluentus*, population. Canadian Journal of Fisheries and Aquatic Sciences *64*, 113–126.

Parkinson, E.A., Lea, E.V., Nelitz, M.A., Knudson, J.M., and Moore, R.D. (2016). Identifying Temperature Thresholds Associated with Fish Community Changes in British Columbia, Canada, to Support Identification of Temperature Sensitive Streams: STREAM TEMPERATURE AND FISH COMMUNITIES. River Research and Applications *32*, 330–347.

R Core Team (2016). R: A Language and Environment for Statistical Computing (Vienna, Austria: R Foundation for Statistical Computing).

Rieman, B.E., and Myers, D.L. (1997). Use of Redd Counts to Detect Trends in Bull Trout (Salvelinus confluentus) Populations. Conservation Biology *11*, 1015–1018.

Tennant, L.B., Gresswell, R.E., Guy, C.S., and Meeuwig, M.H. (2016). Spawning and rearing behavior of bull trout in a headwater lake ecosystem. Environmental Biology of Fishes *99*, 117–131.

Zimmer, M., Petrovcie, S., and Kage, K. 1988. Slocan River Overview Fish Habitat Assessment and Restoration Process. Report prepared for Slocan Forest Products Ltd. by Timberland Consultants Ltd., Nelson, B.C., March 1988.