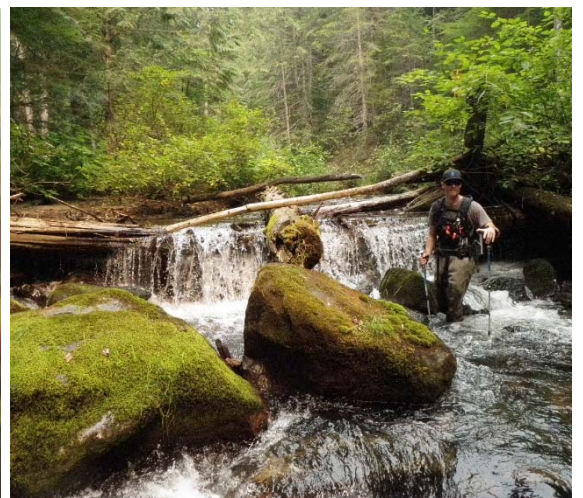


Bonanza Creek Kokanee Spawning - 2015



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This program was made possible with funding provided by Columbia Basin Trust



Bonanza Creek Kokanee Spawning - 2015

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31 December 2015

Project Number: VE52552.2015.001



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Jeremy Baxter, Mountain Water Research

EXECUTIVE SUMMARY

Kokanee (*Oncorhynchus nerka*), a freshwater resident salmonid, migrate from Slocan Lake into Bonanza Creek to spawn in the fall. The last comprehensive assessment of Kokanee escapement to Bonanza Creek was conducted in 1999 at which time approximately 30,000 spawners were enumerated throughout the lowest 8.6 km of the creek. In 2013, only 1,720 Kokanee were enumerated by a one-time count in Bonanza Creek and a log jam concentrated spawners to the lowermost 3 km. As a result of this observation, a study was proposed to evaluate Kokanee spawning abundance and investigate potential Kokanee migration barriers in Bonanza Creek in fall 2015. A key element of this study was to educate local residents and stewardship group volunteers on techniques used to complete Kokanee spawning surveys.

In total, approximately 27,000 spawning Kokanee were enumerated in the index survey area between Slocan Lake and the Bonanza Road Bridge in 2015. Four log jams were identified as partial migration barriers, however, a small proportion of Kokanee were observed spawning upstream of these log jams. Additional years of Kokanee spawning surveys in Bonanza Creek are recommended to determine if the partial migration barriers observed in 2015 become full barriers under other water level conditions during the spawning period.

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1 INTRODUCTION

Kokanee (*Oncorhynchus nerka*), a freshwater resident salmonid, migrate into spawning habitats during the late summer and fall. Bonanza Creek, a tributary that drains into the north end of Slocan Lake, may provide spawning habitat for a substantial proportion of the Kokanee that reside in Slocan Lake. However, there has been limited monitoring of Slocan Lake Kokanee spawning tributaries.

Kokanee spawn during the late summer and fall, typically when water temperature drops below 12°C (McPhail 2007). Kokanee die after spawning and fertilized eggs are left to incubate in the gravels from 1.5 to 3 months, depending on water temperature, at which time Kokanee fry emerge and migrate to the lake. Kokanee will typically spend 3 or 4 years in the lake before returning to spawn in their natal streams or nearshore areas (McPhail 2007).

Bonanza Creek has sporadically been stocked with both Gerrard Rainbow Trout (*Oncorhynchus mykiss*) and Kokanee including the outplanting of 796,960 eyed Kokanee eggs one kilometer upstream from the Bonanza Creek mouth in 1986 (Chirico 1993; Kokanee Forest Consulting Ltd. 1997). A comprehensive assessment of Kokanee spawning and spawning habitat availability in Bonanza Creek was completed in fall 1999. The spawning population was estimated at approximately 30,000 and Kokanee were distributed throughout the lower 8.6 km of Bonanza Creek (Gebhart 2000). A log jam at 8.6 km did not appear to limit the movement of spawners, however, upstream spawning habitat was limited by a high gradient section and upstream beaver dams (Figure 1.1-1; Gebhart 2000). Hydroacoustic surveys of Slocan Lake conducted in 1999 and 2001 confirmed spawning estimates (Gebhart 2000) and estimated the total Slocan Lake Kokanee spawning population to be between 50,000 and 100,000 (Sebastian et al. 2002). These estimates indicated that between 30-60% of Slocan Lake Kokanee spawned in Bonanza Creek in 1999.

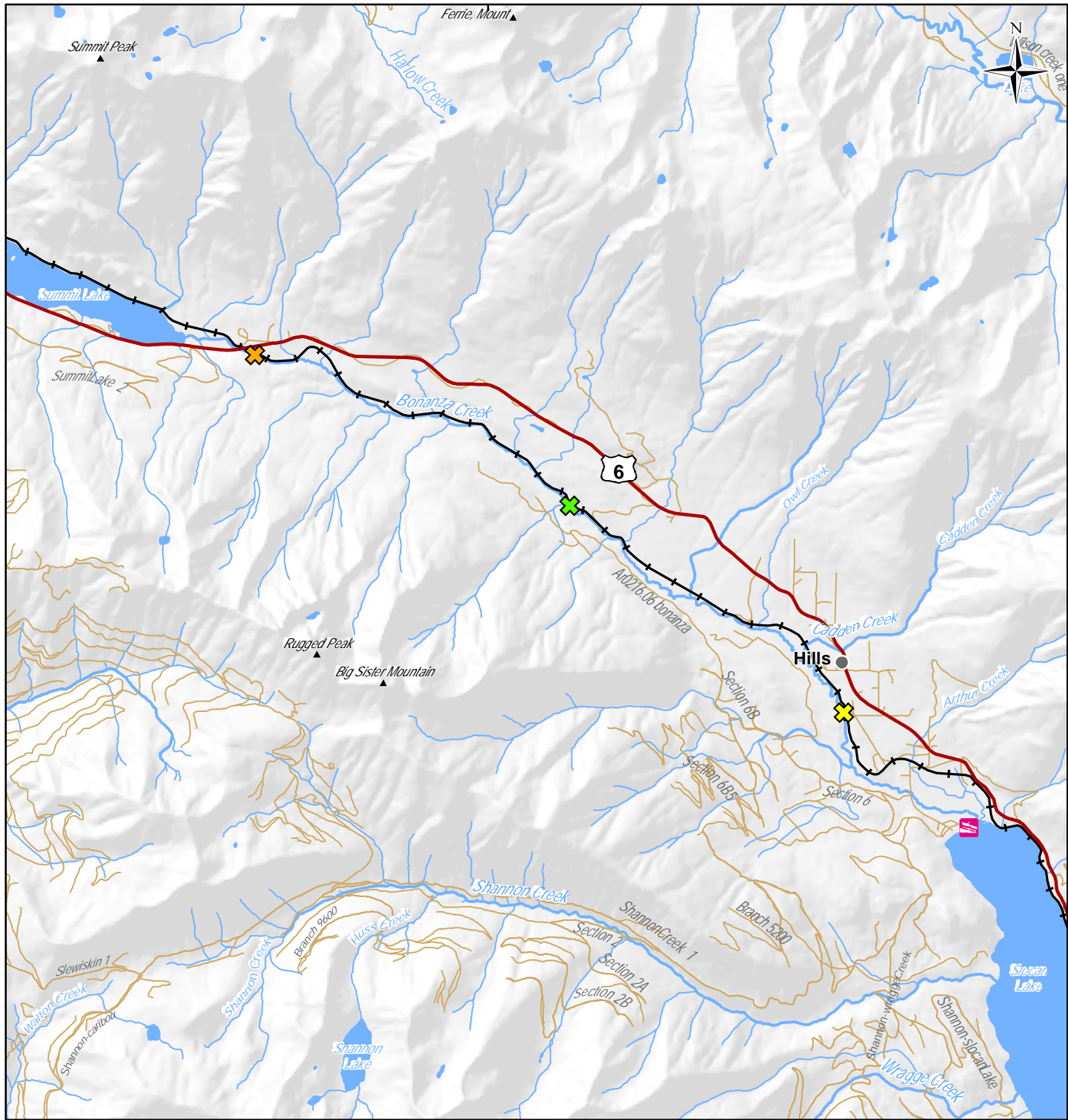
Gebhart (2000) observed a peak spawning count of 19,800 Kokanee on September 26-27, 1999. Recently, Baxter and Irvine (2014) enumerated 1,720 Kokanee spawning in Bonanza Creek on September 26, 2013. Though this one-time count may not have been conducted during peak spawning for that year, the number of fish observed was lower than during any of the enumeration surveys completed in 1999 with the exception of the final survey at the end of October. During the one enumeration survey conducted in 2013, a log jam was noted approximately 3 km upstream from Slocan Lake (Figure 1.1-1). Kokanee were observed from the lake to below the log jam but were not observed upstream. As a result of these observations, a study was proposed to evaluate Kokanee spawning abundance and investigate potential Kokanee migration barriers in Bonanza Creek in fall 2015. A key element of this study was to educate local residents and stewardship group volunteers on techniques used to complete Kokanee spawning surveys. This project was made possible with funding from Columbia Basin Trust.

1.1 Objectives

The objectives of the project were as follows:

1. Evaluate Kokanee spawning abundance in Bonanza Creek in 2015;
2. Evaluate options for enhancement and/or restoration of Kokanee spawning habitat; and,
3. Teach local volunteers how to conduct Kokanee spawning surveys.

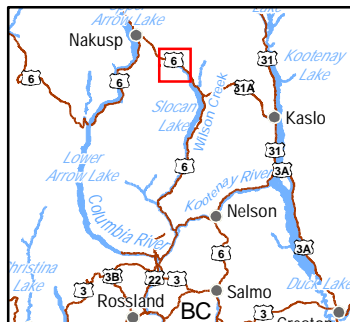
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Legend

- Populated Place
- ✕ Kokanee Migration Barrier - 1999
- ✕ Kokanee Migration Barrier - 2013
- ✕ Coarse Fish Barrier
- 🚤 Boat Launch
- Road
- +— Railway - Abandoned
- Stream
- Waterbody



CLIENT:



PROJECT:

Kokanee Spawning in Bonanza Creek

TITLE:

Bonanza Creek Overview

DATE:

December, 2015

Figure 1.1-1

GIS FILE:

02-01-001_study_area_overview

COORDINATE SYSTEM:

NAD 1983 UTM Zone 11N

JOB No:

VE52552

ANALYST:

MY

QA/QC:

CL

Reference:

DataBC Data Distribution Service
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<http://www.data.gov.bc.ca/>

Geogratis/Geobase
 Open Government License - Canada
<http://data.gc.ca/eng/about-datagcca>



2 STUDY AREA

Slocan Lake is situated between the Valhalla and Selkirk mountain ranges, is approximately 39 km long and has an area of 69 km². The lake is fed by numerous tributaries, including Bonanza Creek at the north end of the lake, and is drained by Slocan River at the south end. Bonanza Creek is the outflow tributary of Summit Lake and flows 14 km to drain into the north end of Slocan Lake (Figure 1.1-1). A coarse fish barrier is located approximately 1.2 km downstream of Summit Lake and historically this was the only barrier in the creek preventing upstream migration (Figure 1.1-1; Chirico 1993). The creek is a 3rd order stream and located in the Interior Cedar Hemlock biogeoclimatic zone (Kokanee Forests Consulting Ltd. 1997). The creek is accessible for most of its length via an abandoned rail grade and by roads or private property in the most downstream reach.

3 METHODS

The following methods were used to facilitate volunteer education and monitor the spawning population of Kokanee in Bonanza.

3.1 Water Temperature Monitoring

An Onset Tidbit v2 temperature logger ($\pm 0.2^{\circ}\text{C}$ accuracy) measured water temperature every 15 minutes near the Bonanza Road Bridge. The logger has been logging at this location since November 2014 and continues to log at this time. Data was downloaded using the HOBOWare Pro for Windows software and exported to Excel. Data was inspected in the field for erroneous readings when Tidbits were being redeployed.

3.2 Site Reconnaissance and Habitat Summary

A reconnaissance survey was completed on August 25, 2015. A two person crew accessed the creek via a trail at the end of Baldwin Road in Hills, BC and surveyed the creek for potential Kokanee spawning areas, migration barriers and access points over the approximately 4 km to Slocan Lake (Figure 1.1-1). An index survey area was established that had good access and could be completed during each survey by staff and volunteers.

Details of potential migration barriers were recorded during the reconnaissance survey. Information collected included the location, debris type, height, coverage area, photos and potential options for removal. Description of the habitat type and substrate above and below potential migration barriers was also recorded.

3.3 Volunteer Training

One objective of this project was to train local volunteers how to enumerate spawning Kokanee. A volunteer training session was organized for September 4, 2015. The training session was advertised via email to local residents and stewardship groups including the Slocan Lake Stewardship Society (SLSS) and Hills Recreation Society, posters in New Denver and Silverton as well as on social media. Thirteen volunteers participated in the training that included a discussion of Kokanee life history, spawning survey techniques, survey equipment, safety considerations and data management. A small section of Bonanza Creek was surveyed with the group and a contact list was made for volunteers interested in participating in future surveys.

3.4 Kokanee Spawning Surveys

Six Kokanee spawning surveys occurred from late August to late October to assess spawning abundance (Table 3.4-1).

An index area was established between the Bonanza Road Bridge and Slocan Lake and Kokanee in this section were enumerated during all surveys (Figure 1.1-1). Kokanee spawning surveys were conducted by a minimum two-person crew; additional crew members and volunteers assisted with various surveys. Surveys were conducted by walking upstream along the water's edge and enumerating the number of Kokanee observed. Kokanee behaviours were evaluated individually with the number of migrating/holding and spawning fish enumerated separately. The number of carcasses observed were also enumerated.

Table 3.4-1: Summary of dates, crew members and sections of Bonanza Creek surveyed to enumerate spawning Kokanee in 2015.

Date	Crew*	Volunteers*	Comments
20-Aug-15	CL, JB	-	Lowest 200 m surveyed
25-Aug-15	CL, JB	-	Reconnaissance survey of lowest ~ 4 km
4-Sep-15	CL, JB	13 participants	Volunteer training; index area survey
16-Sep-15	CL, JB	JF, BR	Index area survey
1-Oct-15	CL, JB, CT	JF, BR, DC	Survey of lowest ~ 5 km including index area
16-Oct-15	CL, JB	-	Index area survey

Notes: CL = Crystal Lawrence, JB = Jeremy Baxter, CT = Clint Tarala, JF = John Fyke, BR = Brad Raymond and DC = Dale Caton

3.5 Data Analysis

Kokanee escapement was estimated using peak counts, which is the highest count value observed in a spawning season, and applying an expansion factor of 1.5. This is a standard expansion factor used in southern B.C. rivers for estimating Kokanee escapement and is consistent with studies used in the west Kootenay Region (e.g., AMEC 2013). While Area-Under-the-Curve (AUC) estimates absolute escapement, this method requires inclusion of residency time and observer efficiency and the study of these parameters were outside the scope of this program. In addition, more simplistic methods, such as mean counts (average over all surveys), have been shown to outperform more complex and data intensive estimation methods such as AUC (Holt and Cox 2008).

This estimate of total number of spawners in the index survey area was also expanded to provide an estimate of the total number of Kokanee spawning in all accessible areas of Bonanza Creek. This was completed by comparing the proportion of spawners that were observed in the index section to that observed when the entire creek was surveyed on October 1, 2015 and increasing the number observed in the index survey area during the peak count by this proportion.

Water temperature data was compiled to evaluate hourly and daily average water temperatures during the Kokanee spawning period. Water temperature was evaluated in relation to biological requirements of spawning Kokanee.

4 RESULTS

The results of water temperature monitoring and spawning enumeration surveys are provided below.

4.1 Water Temperature

Daily average water temperature dropped below 12°C, the temperature at which Kokanee begin to migrate into spawning tributaries, on August 22, 2015 (Figure 4.1-1). Hourly water temperature varied from a low of 6.5°C and maximum of 12.5°C between August 22 and October 1, 2015.

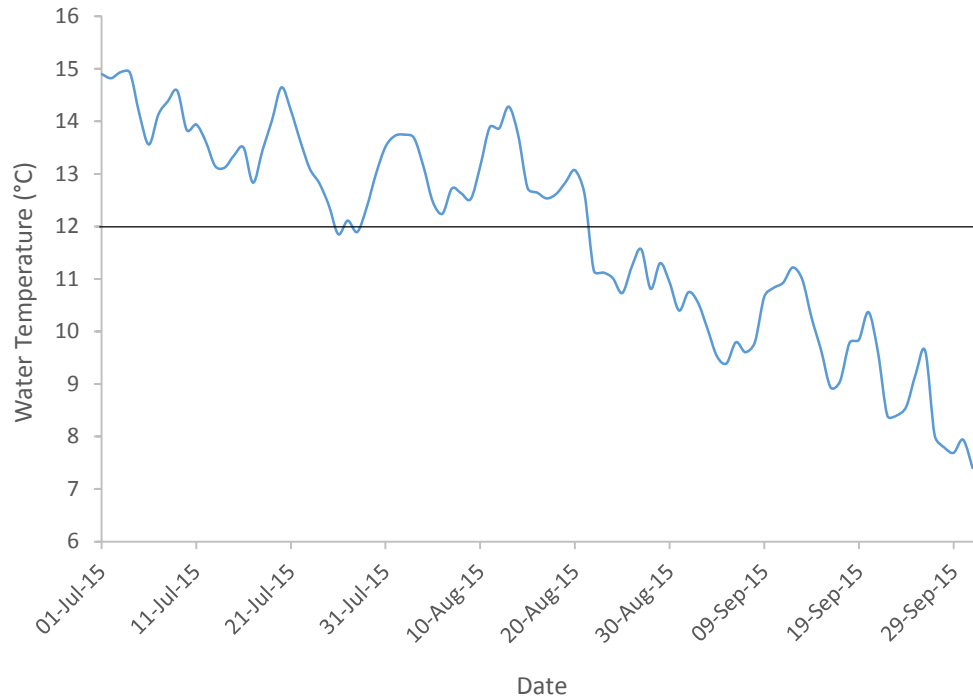


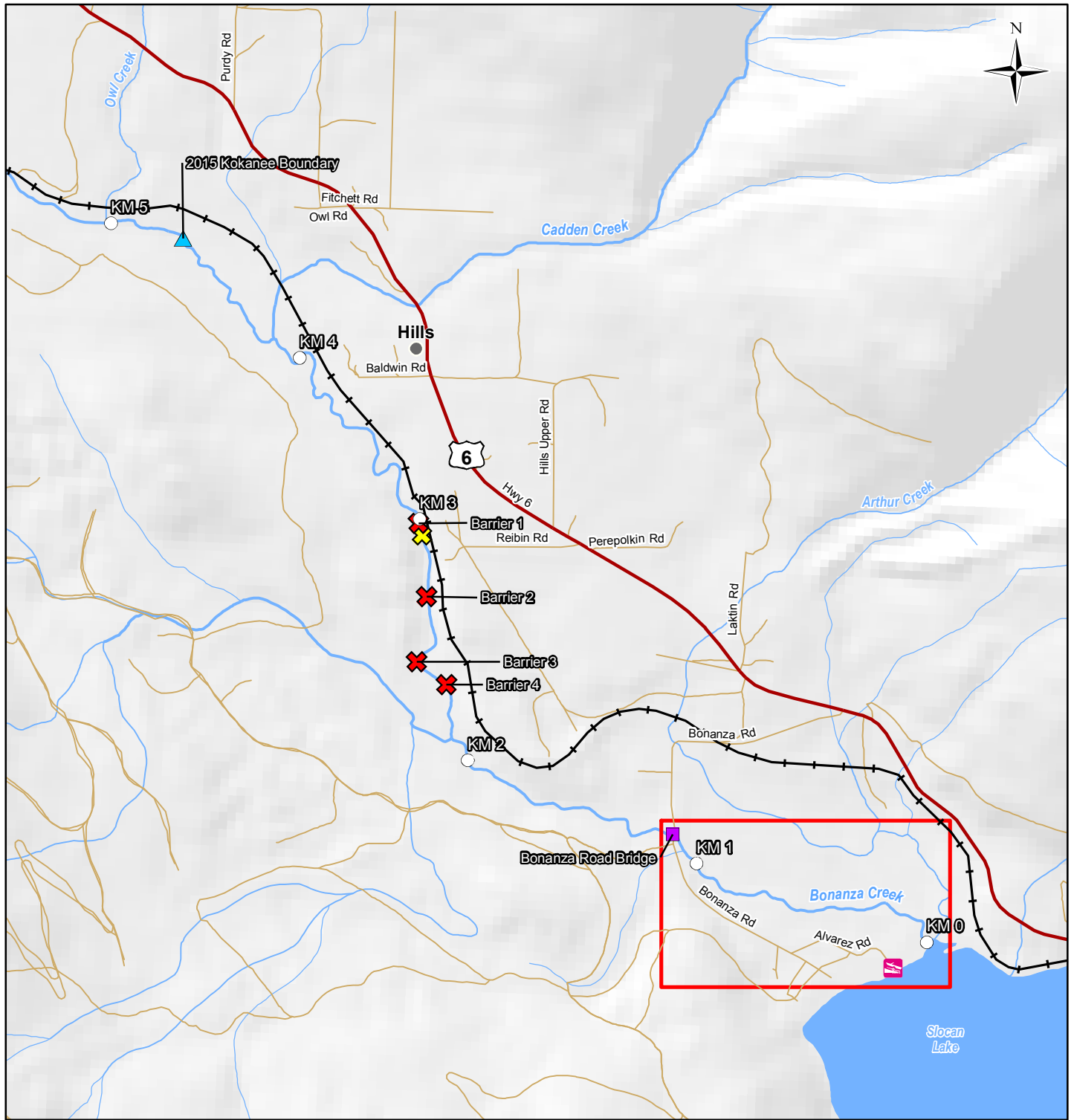
Figure 4.1-1 Daily water temperature (°C) in Bonanza Creek between July and October, 2015.

4.2 Identification of Migration Barriers

The site reconnaissance survey was conducted on August 25, 2015. Four bed-loaded log jams were identified as potential migration barriers close to the location that was identified in 2013 (Figure 4.2-1). Log jams were located approximately 2.3 to 3 km upstream of Slocan Lake (Figure 4.2-1). Details and photos of each potential barrier are provided in Appendix A. Kokanee had not migrated as far upstream as the potential barrier during the reconnaissance survey.

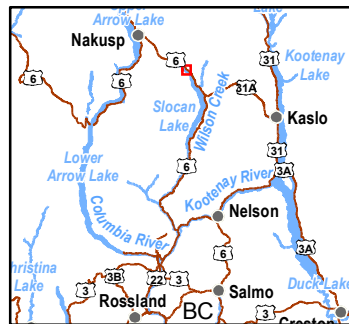
On October 1, 2015, the Kokanee enumeration survey was extended upstream of the index survey area to re-evaluate the potential migration barriers after Kokanee had dispersed throughout the stream. At this time, it was determined the log jams did not completely block migration as Kokanee were observed upstream of all potential barriers that had been identified. Therefore, migration throughout the Bonanza Creek system may have been limited by a series of bed-loaded log jams in 2015, but none of them were complete barriers to upstream migration.

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Legend

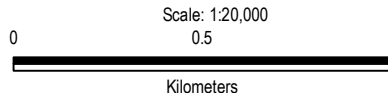
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- Potential Kokanee Migration Barriers – 2015
- Bonanza Road Bridge
- 2015 Kokanee Boundary
- River Kilometers
- Kokanee Migration Barrier - 2013
- Boat Launch
- Road
- Railway - Abandoned
- Stream
- Index Survey Area
- Waterbody



<p>CLIENT: Columbia Basin Trust</p>	
<p>PROJECT: Kokanee Spawning in Bonanza Creek</p>	
<p>TITLE: Kokanee Spawning and Potential Migration Barriers in Bonanza Creek – 2015</p>	
<p>DATE: December, 2015</p>	<p>Figure 4.2-1</p>
<p>GIS FILE: 02-01-002_study_area_zoom</p>	
<p>COORDINATE SYSTEM: NAD 1983 UTM Zone 11N</p>	<p>JOB No: VE52552</p>
<p>ANALYST: MY</p>	<p>QA/QC: CL</p>

Reference:

- DataBC Data Distribution Service
- Open Government License (<http://www.data.gov.bc.ca/>)
- Geogratis/Geobase
- Open Government License - Canada (<http://data.gc.ca/eng/about-datagca>)



4.3 Summary of Habitat Types in Kokanee Spawning Area

Habitat between river Km 4.8 and 3.0, the area upstream of the potential migration barriers to approximately 200 m downstream of Owl Creek, is primarily run with sections of spawning gravels and deeper holding areas dispersed throughout. Beaver dams were observed in this section but none were blocking upstream migration at this time. The section of creek where the bed-loaded log jams were observed (river Km 2.3 to 3.0) was higher gradient riffle with primarily boulder/cobble substrate and small pockets of spawning gravels. Habitat downstream of the barriers to the mouth at Slocan Lake (river Km 0 to 2.3) becomes lower gradient with spawning gravels and wood/deep pools for holding throughout with short (~100 m) higher gradient sections of riffle with larger substrate. A detailed habitat summary of the Kokanee spawning area in Bonanza Creek was completed by Gebhart (2000).

4.4 Kokanee Enumeration

Kokanee were observed spawning in Bonanza Creek between August 25 and October 16, 2015. The peak count was recorded on September 16, 2015 when 17,888 Kokanee were observed in the index survey area of Bonanza Creek between river Km 0 and 1.2 (Table 4.4-1). The expansion of the peak count suggests the total number of Kokanee spawning in the index survey area was 26,832 in 2015.

Table 4.4-1: Counts of spawning, holding and dead Kokanee observed in Bonanza Creek between the Bonanza Road Bridge and Slocan Lake confluence, 2015.

Date	Spawning	Holding	Dead*	Total Alive
20-Aug-15	0	0	0	0
25-Aug-15	590	2,257	0	2,847
4-Sep-15	3,028	10,945	0	13,973
16-Sep-15	10,888	7,000	98	17,888
1-Oct-15	6,485	6,800	1,000	13,285
16-Oct-15	97	0	1,200	97

Notes: Dead Kokanee were not included in the total number observed.

After completing the index area survey on October 1, 2015, the survey continued upstream to determine the extent that Kokanee had dispersed throughout Bonanza Creek (Figure 4.2-1). At that time, an additional 6,055 Kokanee (3,750 spawning and 2,305 holding) were counted between river Km 1.2 and 4.8; of these only 535 were observed upstream of Barrier 1 at river Km 3. Therefore on October 1, 2015 a total of 19,340 Kokanee were enumerated in Bonanza Creek between river Km 0 and 4.8 of which 68.7% were observed in the index survey area. If it is assumed that Kokanee utilize areas upstream of the index survey area in a similar proportion to that observed on October 1 throughout the spawning period, then approximately 39,000 Kokanee may have spawned in Bonanza Creek in 2015.

Kokanee accessed approximately 5 km of Bonanza Creek in 2015. The majority of spawning occurred in the 2.3 km downstream of log jams that were likely partial barriers to upstream migration under the water conditions in Bonanza Creek in 2015 (Figure 4.2-1).

5 DISCUSSION

The number of Kokanee spawning in Bonanza Creek in 2015 was similar to the last comprehensive assessment that was completed over 15 years ago. An estimated 27,000 to 39,000 Kokanee were observed spawning in the lower 5 km of Bonanza Creek while approximately 30,000 Kokanee were counted in the lower 8.6 km of the creek in 1999 (Gebhart 2000). The population of spawning Kokanee in 2015 was higher than anticipated based on the one count conducted in 2013 that had suggested access to historic spawning areas was possibly blocked (Baxter and Irvine 2014) and the population had decreased since 1999. It is possible that natural variability in yearly escapement occurs in Bonanza Creek and additional years of monitoring would be useful in more accurately estimating the timing of peak spawning and escapement. Accurately identifying the timing of peak spawning in the system would allow for one annual survey to be coordinated with the estimated peak that can be expanded and used as a reliable estimate of the total number of spawners.

While the log jams observed between river Km 2.3 and 3.0 may have been partial barriers in 2015, migration may be blocked if water levels are different during the spawning period. Water levels in Bonanza Creek are not monitored, however, the warm, dry conditions throughout southern British Columbia in 2015 resulted in low streamflow conditions and increased water conservation measures (MFLNRO 2015). Low streamflow may have created conditions that allowed Kokanee to migrate through the log jams that may not have been possible during a different water level year. While some Kokanee were observed spawning upstream of the log jams, the optimal spawning habitat between river Km 3.0 and 5.0 was not utilized to the extent it had been in 1999 when moderate to heavy spawning was identified in this section (Gebhart 2000).

At this time, removal of log jams between river Km 2.3 and 3.0 is not recommended. It has been clearly demonstrated that log jams are beneficial for the creation of spawning, rearing and overwintering habitat and unnecessary removal can result in a serious long-term decline in the complexity and diversity of aquatic ecosystems (Slaney and Zaldokas 1997). If, in the future, log jams are preventing access to spawning habitats coupled with a notable reduction in the Kokanee spawning population in Bonanza Creek, then removal may be a potential restoration recommendation. Complete or partial removal of log jams could likely be completed by skilled chainsaw operators. Machinery such as a Spider Hoe or excavator are also options. Heavy machinery could get in close proximity to the creek by way of the abandoned rail grade though access down the bank to the creek may limit the equipment capable of completing the work.

6 RECOMMENDATIONS

The following lists the recommendations to monitor and potentially enhance the population of Slocan Lake Kokanee spawning in Bonanza Creek:

1. Conduct additional years of Kokanee spawning surveys in Bonanza Creek to determine spawn timing, periodicity and peak counts.
2. Determine if the log jams observed in 2015 become full or partial barriers under other water level conditions.
3. Collect biophysical information on a subsample of spawning Kokanee from Bonanza Creek. The condition, fecundity, egg retention and egg size of spawning fish can be compared to other Kokanee stocks to provide an indication of the health of this population.

4. Engage local volunteer and stewardship groups during future surveys of Bonanza Creek. Volunteers were trained in 2015 and able to collect similar counts to experienced observers by the end of the survey period.

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Appendix A

Description and Photos of Potential Migration Barriers

Appendix A. Details of potential migration barriers observed in the lower 4 km of Bonanza Creek on August 25, 2015.

Barrier Number	UTM	Height (m)	Width (m)	Barrier Type	Description	Photo Numbers
1	11U 5550232 464733	2	14	Bedloaded Log Jam	Bedloaded log jam with silt, sand and gravel. Pool formed above. Four large boulders immediately downstream. Cascade/riffle habitat with primarily boulder/cobble substrate up and downstream.	P8250012
2	11U 5549972 464762	1.5	14	Bedloaded Log Jam	Bedloaded log jam. Two sections seperated by a vegetated island. Right downstream channel is blocked ~15 m downstream and left channel is clear below. Riffle habitat with primarily boulder/cobble substrate up and downstream. Left channel priority for removal.	P8250013 to P8250016, IMG_2994
3	11U 5549740 464727	1.5	15	Bedloaded Log Jam	Bedloaded log jam. Two sections seperated by a vegetated island with mature cedars. Likely still access under right downstream side of barrier. Riffle habitat with primarily boulder/cobble substrate up and downstream.	IMG_2995 to IMG_2998
4	11U 5549658 464832	1.5	14	Bedloaded Log Jam	Bedloaded log jam. Two sections seperated by a vegetated island. Likely still access under right downstream channel. Riffle habitat with primarily boulder/cobble substrate up and downstream.	IMG_2999 to IMG_3002



Photo 1. Barrier 1 observed facing downstream in Bonanza Creek on August 25, 2015 (JPG: P8250012).



Photo 2. Barrier 2 right downstream channel observed facing upstream in Bonanza Creek on August 25, 2015 (JPG: P8250013).



Photo 3. Barrier 2 left downstream channel observed facing upstream in Bonanza Creek on August 25, 2015 (JPG: IMG_2994).



Photo 4. Barrier 3 left downstream channel observed facing downstream in Bonanza Creek on August 25, 2015 (JPG: IMG_2996).



Photo 5. Barrier 3 right downstream channel observed facing downstream in Bonanza Creek on August 25, 2015 (JPG: IMG_2997).



Photo 6. Barrier 4 observed facing downstream in Bonanza Creek on August 25, 2015 (JPG: IMG_2999).



Photo 7. Barrier 4 observed facing upstream in Bonanza Creek on August 25, 2015 (JPG: IMG_3002).



Photo 8. Facing upstream into Bonanza Creek at the confluence with Slocan Lake, August 25, 2015.



Photo 9. High use Kokanee spawning area in Bonanza Creek at river Km 0.5 on September 16, 2015.



Photo 10. Enumerating spawning Kokanee in Bonanza Creek on September 16, 2015.



Photo 11. Participants in the Kokanee spawning survey training day in Bonanza Creek on September 4, 2015.