



**Ecofish Research Ltd.**  
202 – 250 Dogwood Street  
Campbell River, B.C. V9W 2X9  
**Phone:** 778-346-3933  
info@ecofishresearch.com  
www.ecofishresearch.com

## MEMORANDUM

**TO:** Debbi Stanyer, Brookfield Renewable Energy Group  
**FROM:** Harlan Wright, Dip. Tech., and Adam Lewis, M.Sc., R.P.Bio., Ecofish Research Ltd.  
**DATE:** November 28, 2017  
**FILE:** 1085-25

**RE: Summary of fisheries monitoring completed on the Kokish River in 2017 for the Kokish River Hydroelectric Project**

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This memorandum summarizes the ongoing fisheries work carried out in 2017 for the Kokish River Hydroelectric Project (the Project). Work was conducted by Ecofish Research Ltd. (Ecofish) and MJ Lough Environmental Consultants Ltd. (MJL) for Kwagis Power Limited Partnership (Kwagis) to meet the requirements for Year 4 of the Project's Operational Environmental Monitoring Plan (OEMP) (Lewis *et al.* 2014<sup>1</sup>). In this year, monitoring effort continued as in previous years for flow compliance, water temperature, water quality, and invertebrate drift, but was reduced for fish community (Table 1). Although fish community monitoring is not prescribed for Year 4 in the OEMP, reduced monitoring, which consisted of monitoring adult migration and abundance only at powerhouse and intake locations, was conducted in Year 4 to ensure fish passage conditions were maintained. Stream channel morphology was assessed in 2017 because a 1 in 10-year flood event occurred in this year.

The main objective of this memo to provide a summary of the 2017 fish community monitoring results (Section 1); however we have additionally provided a summary of accomplishments for other monitoring parameters addressed in Year 4 (Sections 2 through 5), details of which will be presented in the annual OEMP report.

### 1. ADULT FISH MIGRATION AND ABUNDANCE

A total of eight snorkel surveys were completed in 2017: five during the winter steelhead migration and spawning period (between February 28 and April 26, 2017), to assess winter steelhead abundance and migration, and three during the summer steelhead and fall salmon migration period, between September 8 and November 16, 2017 (Table 2). The objective of surveys in Year 4 was to ensure that fish passage conditions were maintained at the intake and powerhouse. Fall surveys on October 30 and November 16 were purposefully conducted when flows were moderately high, and the plant was operating, to assess potential Project effects on fish migration. Winter steelhead

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<sup>1</sup> Lewis, F.J.A., T. Hatfield, H. Wright, M. Lough, S. Hay, and Xuezhong Yu. 2014. Kokish River Hydroelectric Project: Operational Environmental Monitoring Plan. Consultant's report prepared for Kwagis Power Limited Partnership by Ecofish Research Ltd., February, 2014.



surveys were conducted in sections 1, and the summer/fall surveys were conducted in sections 1 and 3. (Map 1, Table 3). Full river surveys in sections 1, 2, and 3 will resume in Year 5.

The number of adult fish counted during snorkel surveys in 2017 is shown in Table 2 and a scatterplot of steelhead counts within each survey section is provided in Figure 1. During the winter steelhead migration period, a maximum of 12 steelhead were observed, on March 6, 2017. All were observed in the lower diversion reach, upstream of the powerhouse. Fewer fish were observed during the remaining spring surveys. Redds were also observed during spring surveys: a total of 7 and 6 redds were recorded on April 12 and 26, respectively. The distribution of redds was evenly split between sections upstream and downstream of the powerhouse.

During summer and fall surveys, the maximum number of steelhead recorded was 24, which were observed on September 8, 2017, in section 3, between the outlet of Ida Lake to km 10.5 (approximately 1 km below the intake). Twenty-three of these were observed upstream of the intake, and one was observed below the falls, downstream of the intake. On October 30, 2017, a total of 16 steelhead were observed in section 1: 10 upstream and 6 downstream of the powerhouse. A total of two steelhead were recorded under higher flow conditions on November 16, both of which were observed below the powerhouse.

Salmon species observed during surveys in 2017 included Coho, Pink, and Chum; no Sockeye or Chinook were observed (Table 1). Three early run Coho were observed in section 3 on September 8: one was upstream of the intake and 2 were below the falls downstream of the intake. A total of 5 and 3 Coho were observed in section 1 during surveys October 30 and November 16, respectively, all of which were observed upstream of the powerhouse. A total of 14 Chum and 4 Pink salmon were observed downstream of the powerhouse on October 30. No Pink or Chum salmon were observed during the November snorkel survey. Low numbers of salmon were observed during fall surveys in section 1 relative to observations in previous years, and this may have been partially attributed to elevated flows and reduced survey coverage which may have decreased detectability.

Cutthroat Trout, Rainbow Trout, and Dolly Varden Char were also observed during snorkel surveys in 2017 (Table 1). One adult Cutthroat Trout was observed on 4 occasions in Section 1. Eight Rainbow Trout were observed in Section 3 on September 8, and one and two individuals were observed during April surveys in Section 1. Counts of 4 and 3 Dolly Varden Char were observed in Section 1 during the October 30 and November 16 snorkel surveys.

## **2. FLOW COMPLIANCE**

Stage and flow data are collected to measure Project compliance with the terms and conditions of the water licence and to provide measures of environmental conditions that assist in the interpretation of changes in biological components of the monitoring program. Instream Flow Releases were set through the terms of the Environmental Assessment Process, after baseline



environmental assessments. Ramping rates, measured as stage change, were established based on DFO criteria to reduce potential fish stranding for fry at sensitive sites within the diversion and downstream reaches.

Hydrometric stations have been established at three locations on the Kokish River to provide real-time, instantaneous stage and flow data for the life of the project: downstream of the intake, upstream of the powerhouse, and downstream of the powerhouse. The uppermost site, located downstream of the intake, is the compliance point for monitoring Instream Flow Releases and diversion ramping rates. The station upstream of the powerhouse provides information on flow attenuation and travel time through the diversion reach, and the downstream station is the compliance point for monitoring ramping downstream of the powerhouse.

Station servicing and discharge measurements were collected at different flows during Year 4, as they have been in all monitoring years. Stage-discharge rating curve updates were conducted for the compliance gauge below the intake, following flood flows in November 2017, which are used to monitoring instream flow as well as ramping rate compliance. An annual hydrology report will be produced to detail the status and present stage and discharge data for each hydrometric station.

### **3. WATER QUALITY**

Water sampling was conducted during the winter, spring, summer and fall seasons in 2017 to assess whether changes in water quality as a result of project operations are adversely affecting productive capacity for fish. Four monitoring sites were established in upstream, diversion, and downstream locations. Water quality parameters assessed included dissolved oxygen, total gas pressure, turbidity, total suspended solids, total dissolved solids, specific conductivity, total alkalinity, pH, total phosphorus, ortho-phosphorus, ammonia, nitrite, and nitrate. A tailrace monitoring site was also established specifically for total gas pressure monitoring.

Water temperature is monitored through continuous temperature recorders that were installed in the East Fork Kokish River and Bonanza River, upper and lower diversion reach, Tributary 27, the downstream reach below the powerhouse, and in the headpond. In the headpond, nine temperature loggers were installed that were evenly spaced across the full width of the channel. Air temperature loggers were also installed in the vicinity of the intake and powerhouse to facilitate modelling and analysis of the effects of change in water flow on water temperature. Water temperature monitoring will determine project effects on stream temperature and assess whether these effects will affect growth, survival, or reproductive success of Kokish River fish populations.

### **4. INVERTEBRATE DRIFT**

Monitoring of invertebrate drift is required for the Project due to the high fisheries values within the diversion reach, and the reliance of fish on invertebrates for food. Invertebrate drift sampling was conducted mid-August and late September 2017 at the same four sites sampled during baseline



surveys: two upstream control sites located in the East Fork Kokish River and in the Bonanza River below Ida Lake, one site in the lower diversion reach upstream of the Powerhouse, and one site downstream of the Powerhouse. At each site, five drift nets were deployed in unison across the channel to sample the aquatic and terrestrial invertebrate drift for a minimum of four hours. Invertebrate samples were preserved and submitted for laboratory analysis to determine taxonomic identification, density, and biomass. The results from the 2014, 2015, 2016 and 2017 operational sampling will be compared with baseline data to determine if project operations have caused a change in the invertebrate drift abundance, biomass, and/or species composition.

## **5. STREAM CHANNEL MORPHOLOGY**

Following baseline data collection, ongoing assessments of stream channel morphology are required to ensure that any changes to sensitive habitats are identified. A full stream geomorphology assessment is required following the first large flood event that occurs after Project commissioning (i.e., the first 1 in 10-year event or greater, as determined by hydrology records at the intake), or at five years after construction, whichever comes first.

In late 2016, an event greater than a 1 in 10-year event did occur, triggering a full stream geomorphology assessment in summer 2017 (Year 4). This assessment was completed in late August and involved collecting the same data that had been collected during baseline surveys in the fall of 2013. Data collection included topographic monitoring, sediment sampling, photographic monitoring, and spawning gravel surveys within each of the stream sections. The results of the Year 4 field study will be analysed against baseline data using a before and after comparison to assess potential Project effects on the stream's channel morphology.



## 6. SUMMARY

This memorandum summarizes the ongoing fisheries work carried out by Ecofish in 2017 in accordance with requirements for Year 4 of the Kokish River Hydroelectric Project OEMP. The study components include assessments of adult fish migration and abundance, flow compliance, water quality and temperature, invertebrate drift, and stream channel morphology. Field work scheduled to occur during the winter of 2017/18 includes winter water quality sampling, flow compliance monitoring, and maintenance of the hydrometric stations.

Yours truly,

**Ecofish Research Ltd.**

Prepared by:

*Signed*

Harlan Wright, Dip. Tech.

Environmental Technician/Task Manager

Reviewed by:

*Signed*

Adam Lewis, M.Sc., R.P.Bio.

Fisheries Biologist/Principal

## **Disclaimer:**

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**Table 1. Operational monitoring parameters for the Kokish River Hydroelectric Project and their baseline and monitoring requirements, in terms of frequency, duration, and reporting.**

Monitoring Parameter	Component	Monitoring Type	Baseline Requirements		Monitoring Requirements		
			Frequency	Duration	Frequency	Duration <sup>1</sup>	Reporting <sup>2</sup>
Flow Compliance	Instream Flow	Compliance/Effectiveness	Continuous	Three Years	Continuous	Life of Project	Annually
	Ramping Rates	Compliance	n/a	n/a	Once <sup>3</sup>	Project Commissioning	Once <sup>3</sup>
		Compliance	n/a	n/a	Continuous	Life of Project	Annually
Water Temperature	Overall Project	Response	Continuous	Two Years	Continuous	Years 1, 2, 3, 4, and 5	Annually
Stream Channel Morphology	Overall Project	Response	Once	One Assessment	Once	After 1 in 10 year flow or Year 5	Once
Fish Community	Juvenile Abundance	Response	Annually	Two Years	Annually	Years 1, 2, 3, 5, and 10	Annually
	Adult Migration and Abundance	Response	Annually	Two Years	Annually	Years 1, 2, 3, 5, and 10	Annually
	Headpond Assessment	Response	Annually	Once	Annually	Years 1, 2, 3, 5, and 10	Annually
Water Quality	Overall Project	Response	Quarterly	Two Years	Quarterly	Years 1, 2, 3, 4, and 5	Annually
Invertebrate Drift	Overall Project	Response	Bi-annually	Two Years	Bi-annually	Years 1, 2, 3, 4, and 5	Annually

<sup>1</sup> Monitoring may be extended beyond the duration listed here based on recommendations in the monitoring reports and based on feedback from regulatory agencies

<sup>2</sup> Non-compliance must be reported within 24 hrs and measures taken to ameliorate risk

<sup>3</sup> Ramping rate tests may need to be conducted more than once to capture different species and life stages

**Table 2. Summary of adult fish observed during 2017 snorkel surveys in the Kokish River.**

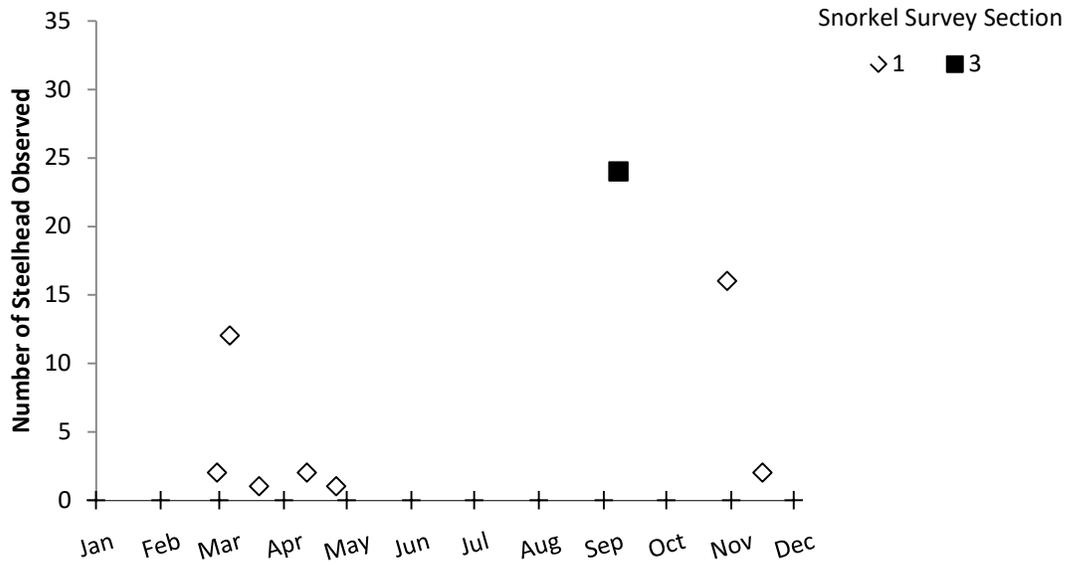
Survey Date	River Section	Fish Observed <sup>1</sup>							
		ST	CO	CM	PK	CT	RB	DV	UNK
28-Feb	1	2	0	0	0	1	0	0	0
06-Mar	1	12	0	0	0	1	0	0	0
20-Mar	1	1	0	0	0	0	0	0	0
12-Apr	1	2	0	0	0	0	2	0	0
26-Apr	1	1	0	0	0	0	1	0	0
08-Sep	3	24	3	0	0	0	8	0	2
30-Oct	1	16	5	14	4	1	0	4	0
16-Nov	1	2	2	0	0	1	0	3	0

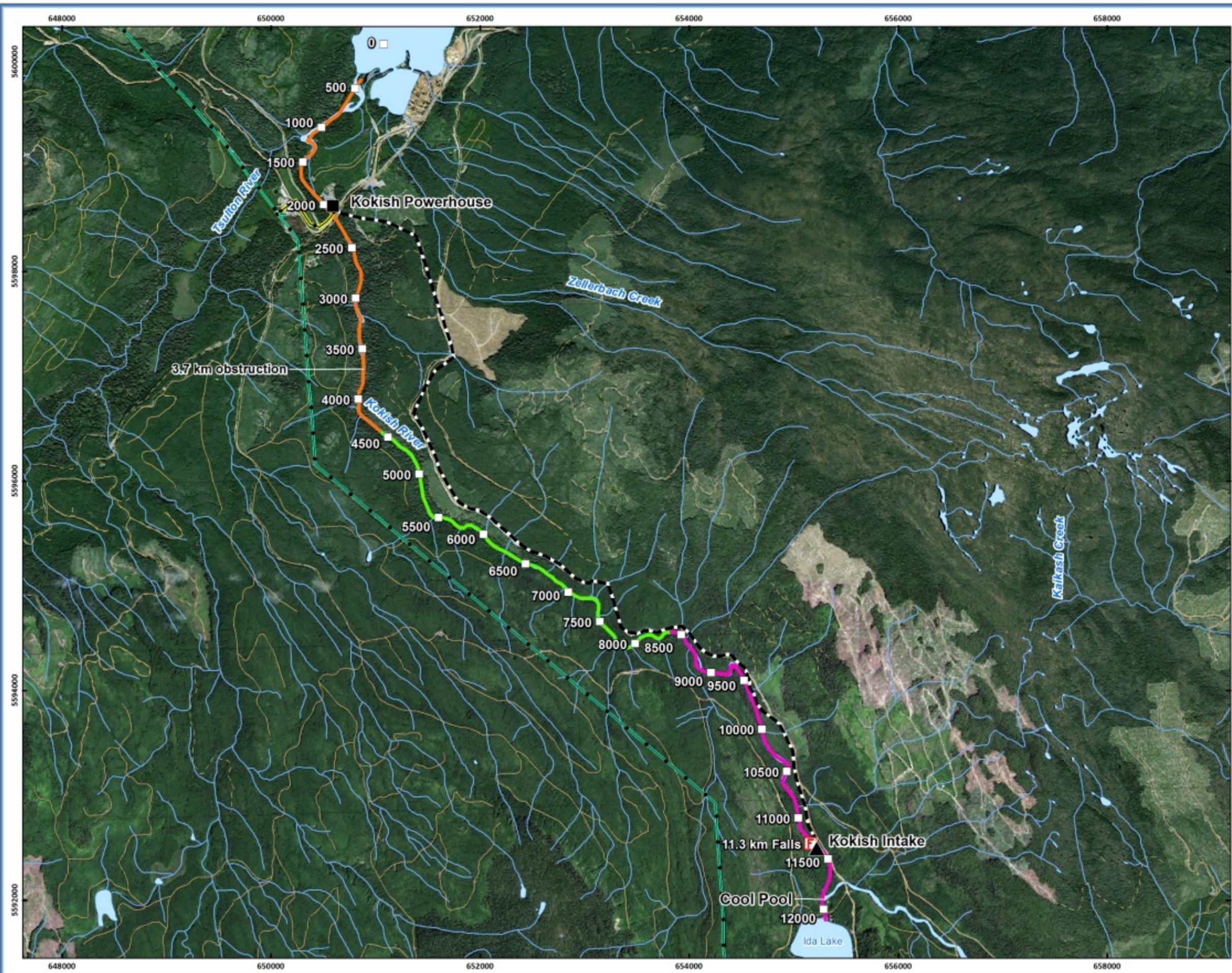
<sup>1</sup>ST = Steelhead; CO = Coho Salmon; CM = Chum Salmon; PK = Pink Salmon; CT = Cutthroat Trout; RB = Rainbow Trout; DV = Dolly Varden Char; UNK = Unidentified Adult Salmon or Steelhead

**Table 3. Snorkel survey locations for adult fish migration and abundance monitoring in Kokish River. Surveys were only conducted in Sections 1 and 3 in Year 4 (2017).**

Section	Start Point (km)	Finish Point (km)	Description
Section 1	4.4	0.0	Bottom of lower canyon to estuary
Section 2	8.4	4.4	Lower canyon
Section 3	12.0	8.4	Outlet of Ida Lake to top of lower canyon

Figure 1. Number of adult steelhead observed during snorkel surveys in the Kokish River in 2017.





KOKISH RIVER HYDROELECTRIC PROJECT  
**Kokish River  
 Fish Migration  
 Snorkel Survey Sections**

- Legend**
- Chainage (500m)
  - Ⓡ Falls
  - Snorkel Survey Sections**
  - Section 1
  - Section 2
  - Section 3
  - Infrastructure**
  - ▲ Intake
  - Powerhouse
  - Penstock
  - Transmission Line
  - Existing Transmission Line
  - Existing Road
  - Forest Tenure Road



**MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES**

0 0.25 0.5 1 1.5 Km  
 Scale: 1:35,000

NO.	DATE	REVISION	BY
1	15/03/2016	KOK_SnorkelSurveys_2016Mar15	
2			
3			
4			
5			

Date Saved: 15/03/2016  
 Coordinate System: NAD 1983 UTM Zone 9N

Map 1