

PROJECT REPORT: Salish Sucker Conservation in the Little Campbell River Watershed 2018-2021

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1.0 Introduction

Salish Sucker (*Catostomus sp. cf. catostomus*), thought to be extirpated from the Little Campbell River (LCR), was found to have a remnant population, discovered and confirmed in 2012 (Yip et al. 2012) by A Rocha Canada and Pearson Ecological. Since 2012, A Rocha has been conducting annual surveys to assess abundance and distribution within suitable habitat across the watershed. Salish Sucker are listed as Threatened in Canada under the Species at Risk Act due to population decline, limited suitable habitat and ongoing threats of habitat degradation and predation from aquatic invasive species (Fisheries and Oceans Canada 2020).

Over the past three years, A Rocha has been working to improve understanding of population dynamics and habitat conditions in the Little Campbell River watershed and to improve habitat conditions through restoration and protection. The main threats facing Salish Suckers in the LCR watershed are: hypoxia, habitat degradation/fragmentation, seasonal low flows and knowledge gaps related to population abundance and distribution. This report outlines the monitoring results to quantify the impact of these threats and provides recommendations on how to best address these threats into the future. Specifically, this includes:

- annual population estimates using mark-recapture protocols,
- continuous water quality monitoring using Hydrolab Sondes to quantify extent of the threat of hypoxia, and
- flow monitoring at hydrometric stations in partnership with BC Ministry of FLRORD and dry reach measurement to quantify extent of the threat of low flows.

Habitat improvement projects were also completed to restore over 1500m² of important riparian habitat for Salish Suckers and a Watershed Report Card was completed to share the condition of the watershed with decision makers and neighbours and raise awareness of the importance of improving conditions for species at risk. These components of the project will be reported separately.

2.0 Methods

2.1 Salish Sucker Mark/Recapture

Mark/Recapture surveys were conducted to obtain an estimate of Salish sucker abundance in two reaches of the LCR: (1) Campbell Heights Industrial Park Surrey BC and (2) Red Willow

Ranch Langley BC (Figure 1). The Red Willow Ranch reach was selected because it is a known spawning location for the Salish Sucker and has been monitored since 2017. The Campbell Heights Industrial Park reach was selected because juvenile Salish Suckers were observed there by a consultant in Jan 2019, so we wanted to confirm this location as a spawning site. Mark/recapture methods followed the guidelines outlined by Pearson (2015) for capture, safe handling and tagging best practices. Surveys were conducted over two weeks in April 2020 (Table 1). Traps were set for three nights at each reach for both weeks. One week of no trapping occurred in between week 1 and week 2 trapping sessions.

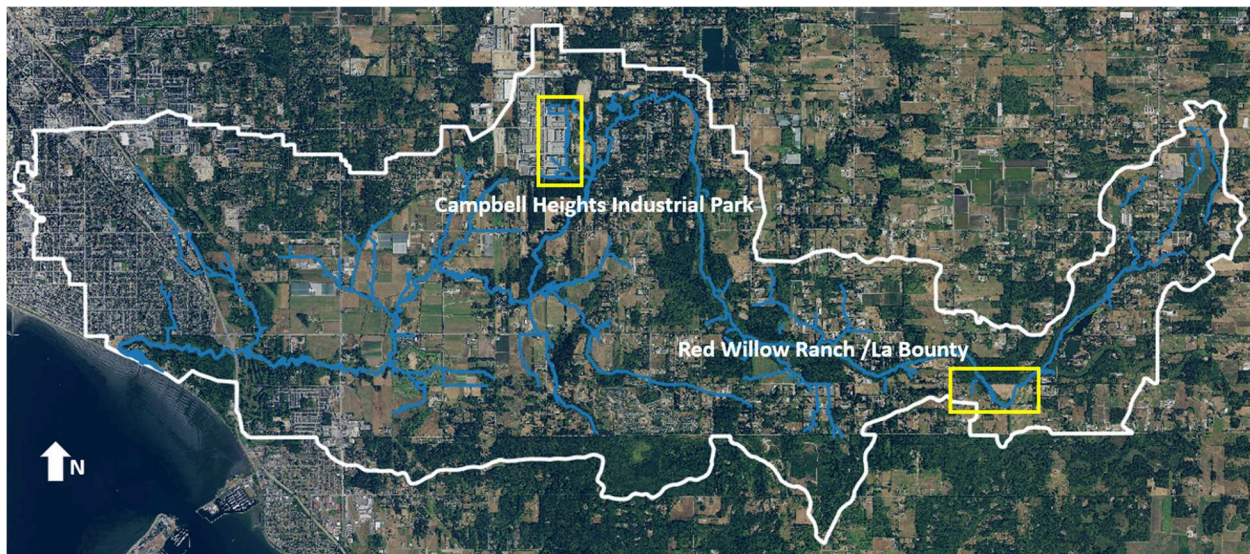


Figure 1 Little Campbell River watershed map depicting the two Salish sucker monitoring sites for April 2020 monitoring, Campbell Heights Industrial Park and Red Willow Ranch.

Table 1 Timing of Salish sucker Mark/Recapture surveys in the Little Campbell River Watershed in April 2020.

Reach	Week 1	Week 2
Campbell Heights	2020-04-05 to 2020-04-08	2020-04-19 to 2020-04-22
Red Willow Ranch	2020-04-08 to 2020-04-11	2020-04-22 to 2020-04-25

2.1.1 Equipment

Large Feddes traps were used for trapping fish and were baited with cat food. Coloured fluorescent elastomer solution was used with a syringe to mark individual fish. Equipment used to manage traps and collected fish consisted of buckets, measuring board, UV light, kayak, paddles, life jacket and a thermos with ice to keep the elastomer solution cool. An iPad was used to manage collected data in the field using the FileMaker app. A Garmin GPSMAP 62

handheld navigator was used to collect location data. Water quality data were obtained using YSI ProODO handheld Optical Dissolved Oxygen Meter (DO percent and DO mg/L) and an Oakton Instruments Waterproof Multiparameter PCSTestr 35 (temperature, pH, and specific conductivity).

2.1.2 Mark/Recapture Protocol

Feddes traps were placed approximately 50 m apart or in good habitat. On day two traps were moved to more successful areas to ensure maximum number of Salish Suckers being trapped. Traps were placed in deep sections of the reach. Ideally traps were placed in depths greater than 70 cm in depth as per (Pearson 2015). Traps were placed parallel with the flow of water in the river. Traps were baited with cat food, were set over night and were picked up in the morning.

At each trap water quality parameters were collected including dissolved oxygen, pH, specific conductivity, and temperature. The content of each trap was collected in a bucket filled with stream water. Non target species were identified, counted, and returned to the river. Any caught salmonids were also measured to fork length before being returned to the river. Salish Suckers were retained and placed into water, a solution of clove oil and ethanol (1:9 concentration) was added to the water as an anesthetic to relax the fish so they were more easily handled. Once anesthetized the fork length and sex of each individual was recorded. Existing VIE (Table 2) tags from previous surveys were noted as well. Individuals were then given a new VIE tag with yellow elastomer and unique position so as to tell apart when and where the individual was captured. The fish were then placed in a bucket with fresh stream water to recover before being released back into the stream.

Table 2 Summary of unique elastomer tag codes from 2018 through 2020 used in the Little Campbell River by A Rocha Canada Conservation Science team.

Year	Location	Tag Code
2020	Campbell Heights	Week 1: Y1 and Week 2: Y4
2020	Red Willow Ranch	Week 1: Y2 and Week 2: Y3
2019	Campbell Heights	O1
2019	Red Willow Ranch	Week 1: O2 and Week 2: O3
2018	Red Willow Ranch	Week 1: B1 and Week 2: B2
2018	Campbell Valley Regional Park	B3 and B4

Special attention was given to females as it was spawning season. Some females were gravid and holding eggs. If a gravid female was caught she would be lightly handled and processed quickly. If there was risk of spilling eggs the female would not receive an elastomer tag but would be noted in the data files and released.

2.1.3 Data Analysis

The Lincoln-Peterson equation was used to estimate the size of each Salish sucker population in both the Red Willow Ranch and Campbell Heights. This equation assumes that the population in the study area is a closed system. It is assumed no individuals will die, be born, immigrate or emigrate between another site (Krebs, 1989).

$$N = (M(C+1)) / (R+1)$$

$$SD = \sqrt{(((M+1)(C+1)(M-R)(C-R))/((R+1)^2(R+2)))}$$

N = estimate of population size at the time of marking.

M = Marked individuals released (first sample)

C = Total number of captured individuals (second sample)

R = Number of individuals recaptured (in the second sample that are marked)

SD = standard deviation

2.2 Hydrolab monitoring

Two HYDROLAB DS5X water quality monitoring sondes (OTT HydroMet, Loveland, CO) were installed at separate locations within the Little Campbell River watershed (Figure 2): (1) downstream of 16th Avenue in Campbell Valley Regional Park and (2) downstream of 176th street at Selections Nursery. The sondes continuously collect data on temperature, dissolved oxygen, conductivity, pH, and water depth. The sondes were programmed to collect data at 15 minute intervals 24 hours a day 7 days a week. Sondes were serviced every two months. In August 2020, the Hydrolab Sondes were connected to solar-powered automated stations using FTS data logger technology to transmit the water quality data wirelessly in real-time. This allows us to track the data in real-time and enables us to respond quickly if the data isn't collecting properly or if a sensor has fouled or if the battery is running low. Kerr Wood Leidal staff assisted with the set up.

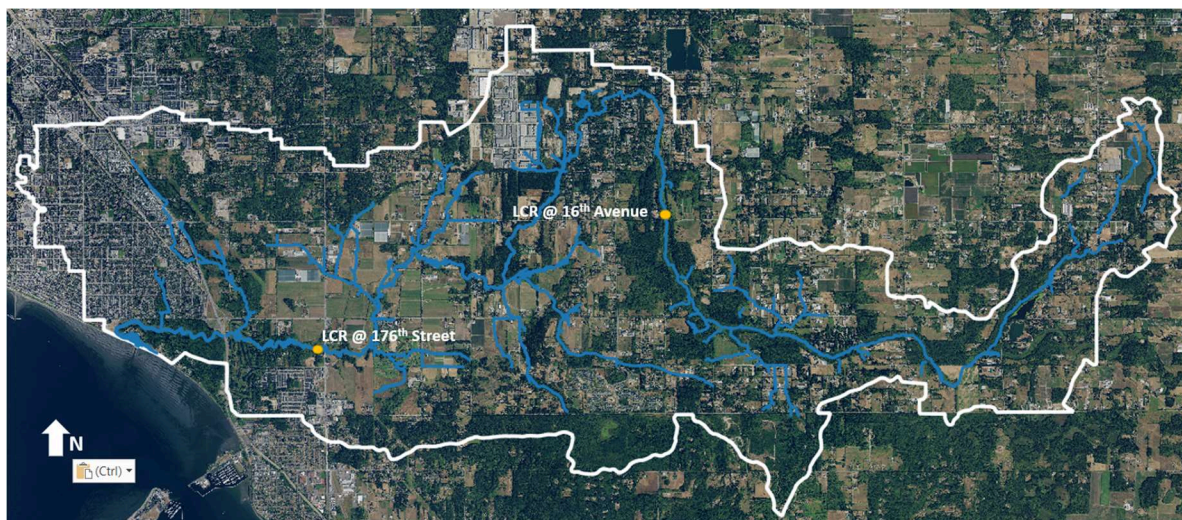


Figure 2 Little Campbell River watershed map depicting locations of the two continuous water quality monitoring stations located at 176th street and 16th Avenue.

Water quality data were graphed to visualize seasonal trends and changes. Data were also compared to the Federal Recovery Objectives for the Salish sucker (Fisheries and Oceans Canada 2021) and Provincial Water Quality guidelines for salmonids (BC Ministry of Environment 2019) (Table 3).

Table 3 Summary of water quality standards for the Salish sucker and Cutthroat trout (Fisheries and Oceans Canada 2021 and BC Ministry of Environment 2019)

Temperature	Optimal range for Cutthroat incubation (Apr 1 - Jun 1)	Optimal range for Cutthroat rearing (year-round)	Optimal range for Cutthroat spawning (Feb 15 - Mar 31)
	4.0-13.0	7.0-16.0	9.0-12.0
	Optimal range for Salish Sucker		
	6-23.0		
Dissolved Oxygen	Instantaneous minimum for all aquatic life	Long-term average for all life stages other than buried embryo/alevin	Long-term average for buried embryo/alevin
	5.0 mg/L	8.0 mg/L	11 mg/L
	Optimal range for Salish Sucker		
	> 4 mg/L		

2.2.1 Other water data from around the watershed

Water quality data were also collected at five other locations throughout the LCR watershed in sites designated as critical habitat for the Salish sucker in 2020/2021. These sites were ARC Brooksdale (March 6th, 13th, 27th and April 10 2020), Campbell Heights Industrial park (April 6th - 8th and April 20th - 22nd 2020), Red Willow Ranch (April 8th - 10th and April 22- 24th 2020), Michael and Maria's (December 18, 2020) and Wagner Hills Women's Campus (March 25th, 2020 and March 30th 2021) (Figure 3).

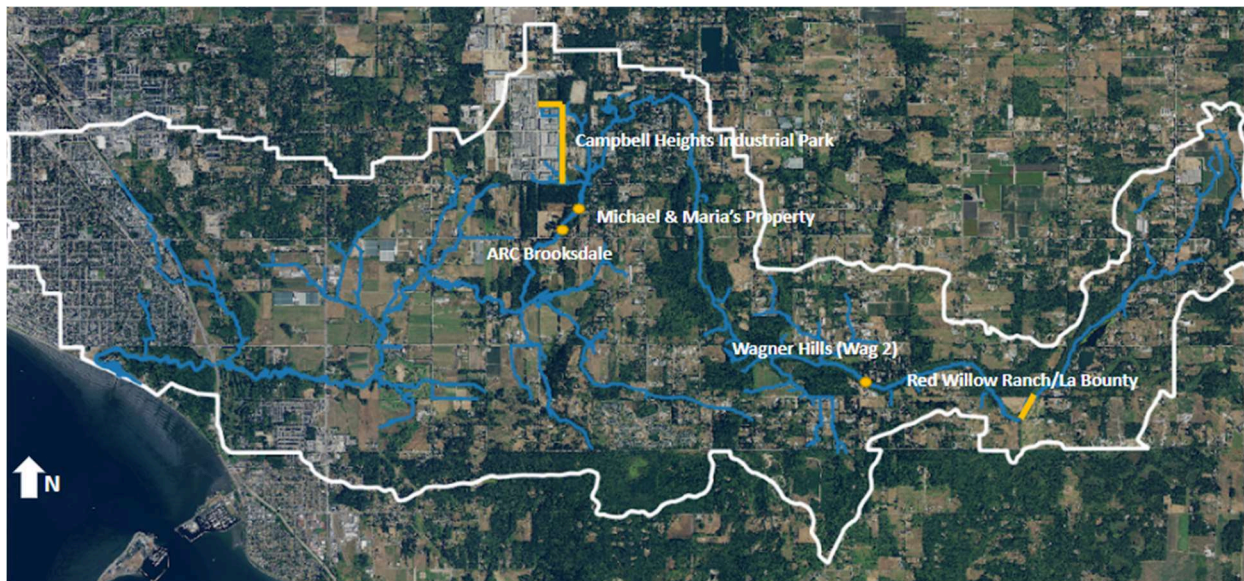


Figure 3 Little Campbell River watershed map depicting five locations where water quality was measured in Salish sucker critical habitat in 2020.

2.3 Hydrometric Monitoring

Hydrometric surveys were conducted on the Little Campbell River 2-3 times each month. During each survey information was collected on the water quality at the time of survey (pH, DO mg/L, DO%, specific conductivity and temperature). The stage depth would be recorded and measurements were taken along a cross section of the river on the A Rocha Brooksdale property. These measurements included depth, collected by using a wading rod and velocity calculated by using a current meter and current counter. The methods for this survey were based off of the Manual of B.C. Hydrometric Standards (RISC 2018) and were also informed by personal communication with Tyler Anderson (Surface Water Protection Technician, Ministry of Forests, Lands, Natural Resource Operations and Rural Development) and Cameron Stooshnoff (Surface Water Protection Officer, Ministry of Forests, Lands, Natural Resource Operations and Rural Development).

2.4 Summer Low Flow Dry Reach Monitoring

The LCR main stem goes underground east of 200th street crossing in Langley each summer in recent years, although historically (1970s) it flowed year-round. To document the extent of the dry reach, this location was regularly monitored from the start of the summer to observe when the river started to disconnect and go underground. Starting from when the disconnection was first observed and continuing every two weeks, a team of two or three would walk the length of the dry reach and would record the UTM coordinates. The 200th street crossing was then monitored weekly to determine the specific date when reconnection of the two isolated sections of the river occurred.

3.0 Results

3.1 Salish Sucker Mark/Recapture

At Campbell Heights Industrial Park survey site, a total of 39 Salish suckers were trapped and tagged (Table 4; Figure 4). In the week 2 sample, four of the captured fish were recaptured fish from week 1. Using the Lincoln-Peterson equation, the population estimate was calculated to be 70 +/- 21. The size of the trapped Salish suckers ranged from 104 mm to 195 mm. There was a mix of sex, 46% of the trapped Salish suckers were female and 54% male.

Table 4 Summary results for the 2020 Salish sucker Mark/Recapture Lincoln-Peterson population estimate in the Little Campbell River.

Campbell Heights			Red Willow Ranch	
Total Week 1	27		Total Week 1	32
Total Week 2	12		Total Week 2	11
Total Recaptured	4		Total Recaptured	2
M - Marked (week 1)	27		M - Marked (week 1)	32
C - Total Captured (week 2)	12		C - Total Captured (week 2)	11
R - Number recaptures (week 2)	4		R - Number recaptures (week 2)	2
N - Population Estimate	70		N - Population Estimate	128
Standard Deviation	21		Standard Deviation	54



Figure 5 Location of set traps for the Salish sucker and locations of observed Salish sucker in the Red Willow Ranch site, Langley BC in 2020.

3.2 Hydrolab monitoring

Data collection by the two Hydrolab sondes were to occur at 15-minute intervals 24 hours a day, 7 days a week between November 2018 and March 2021. Gaps in the data collection occurred due to equipment malfunction and repair requirements. Data collection was incomplete during the following periods:

- North of 16th Avenue within Campbell Valley Regional Park (LCR at 16th Avenue) – May-July 2020, and
- 176th Street at Selections Nursery (LCR at 176th Street) – Apr1, 2020 to December 4 2020.

Averages, maximums and minimums over the study period were calculated for temperature (°C), dissolved oxygen (mg/L), specific conductivity (µS/cm), pH and turbidity (NTUs).

3.2.1 Dissolved oxygen

Over the study period in 2020 and 2021, dissolved oxygen values at the LCR @ 16th Avenue station ranged from a minimum of 0.29 mg/L to a maximum of 11.72 mg/L (See Appendix 1 Dissolved Oxygen Figures.

Though dissolved oxygen data was not collected through the entirety of the dry season in 2020, when comparing to 2019 data at the same station, we can see that dissolved oxygen had already reached a low of 2.32 mg/L in March 2019 and an average of 1.74 mg/L by May 2019. We can assume then that in 2020 measurements were likely constantly below >4mg/L from May through October.

For the LCR at 176th Street station, dissolved oxygen values ranged from a minimum of 4.63 mg/L to a maximum of 14.89 mg/L in 2020 (Table 6). The average dissolved oxygen for the sampling period was 8.72 mg/L.

No exceedances occurred at the LCR @ 176th Street station for SSU during the ten-month survey period. However, measurements did drop below 5<mg/L which is the habitable threshold for aquatic life. This occurred in August (3.67% of measurements) and September (5.83% of measurements) 2020. Monthly averages also dropped below 8 mg/L which is the long-term chronic threshold for aquatic life and occurred in May-November (41.43% of measurements).

Table 5). The average dissolved oxygen over the time period was 5.20 mg/L. See Appendix 1 Dissolved Oxygen Figures.

Though dissolved oxygen data was not collected through the entirety of the dry season in 2020, when comparing to 2019 data at the same station, we can see that dissolved oxygen had already reached a low of 2.32 mg/L in March 2019 and an average of 1.74 mg/L by May 2019. We can assume then that in 2020 measurements were likely constantly below >4mg/L from May through October.

For the LCR at 176th Street station, dissolved oxygen values ranged from a minimum of 4.63 mg/L to a maximum of 14.89 mg/L in 2020 (Table 6). The average dissolved oxygen for the sampling period was 8.72 mg/L.

No exceedances occurred at the LCR @ 176th Street station for SSU during the ten-month survey period. However, measurements did drop below 5<mg/L which is the habitable threshold for aquatic life. This occurred in August (3.67% of measurements) and September (5.83% of measurements) 2020. Monthly averages also dropped below 8 mg/L which is the long-term chronic threshold for aquatic life and occurred in May-November (41.43% of measurements).

Table 5 Summary statistics for Dissolved oxygen at LCR@16th Avenue station from 2018-2020. Exceedance values for Salish Sucker and aquatic life

Month, Year	No. of data points	Min	Max	Mean	Standard Deviation	No. of points below SSU Threshold (<4mg/L)	SSU % Exceedance	No. of points below aquatic life minimum (<5mg/L)	% Exceedance of instantaneous minimum	No. of points below long-term chronic (<8mg/L)	% Exceedance of long-term chronic guideline	No. of points below buried embryo minimum (<11mg/L)	Buried embryo % Exceedance
November, 2018	550	2.07	6.45	4.40	1.06	168.00	30.55	384.00	69.82	550.00	100.00	550.00	100.00
December, 2018	742	3.96	9.12	6.48	0.95	3.00	0.40	49.00	6.60	675.00	90.97	742.00	100.00
January, 2019	642	5.16	9.77	7.33	1.05	0.00	0.00	0.00	0.00	466.00	72.59	642.00	100.00
February, 2019	648	5.26	11.03	8.20	1.54	0.00	0.00	0.00	0.00	277.00	42.75	641.00	98.92
March, 2019	740	2.32	11.51	7.33	2.39	104.00	0.14	159.00	21.49	360.00	48.65	723.00	97.70
April, 2019	720	2.02	11.67	5.56	2.21	204.00	0.28	313.00	43.47	603.00	83.75	715.00	99.31
May, 2019	352	0.32	6.31	1.74	1.53	313.00	0.89	342.00	97.16	352.00	100.00	352.00	n/a
June, 2019	720	0.31	0.36	0.33	0.01	720.00	1.00	720.00	100.00	720.00	100.00	720.00	n/a
July, 2019	695	0.29	0.35	0.32	0.02	695.00	1.00	695.00	100.00	695.00	100.00	695.00	n/a
October, 2019	633	0.42	4.24	1.30	1.08	627.00	0.99	633.00	100.00	633.00	100.00	633.00	100.00
November, 2019	720	0.82	6.56	3.61	1.76	399.00	0.55	499.00	69.31	720.00	100.00	720.00	100.00
December, 2019	742	4.77	8.76	6.60	0.98	0.00	0.00	14.00	1.89	668.00	90.03	742.00	100.00
January, 2020	744	6.64	11.22	8.63	1.06	0.00	0.00	0.00	0.00	220.00	29.57	737.00	99.06
February, 2020	696	6.17	10.80	8.50	1.09	0.00	0.00	0.00	0.00	234.00	33.62	696.00	100.00
March, 2020	590	4.78	11.72	8.11	1.34	0.00	0.00	5.00	0.85	284.00	48.14	578.00	97.97
April, 2020	743	4.78	11.72	7.96	1.38	0.00	0.00	5.00	0.67	384.00	51.68	731.00	98.38
August, 2020	1192	0.29	1.30	0.43	0.18	1192.00	100.00	1192.00	100.00	1192.00	100.00	1192.00	n/a
September, 2020	1593	0.31	1.33	0.38	0.12	1593.00	100.00	1593.00	100.00	1593.00	100.00	1593.00	n/a
October, 2020	2951	0.30	3.20	1.11	0.75	2951.00	100.00	2951.00	100.00	2951.00	100.00	2951.00	100.00
November, 2020	2871	1.30	7.80	5.16	1.70	606.00	21.11	1014.00	35.32	2871.00	100.00	2871.00	100.00
December, 2020	2973	5.20	10.43	7.76	1.26	0.00	0.00	0.00	0.00	1852.00	62.29	2973.00	100.00
January, 2021	2971	6.22	9.40	7.86	0.73	0.00	0.00	0.00	0.00	1595.00	53.69	2971.00	100.00
February, 2021	2687	7.18	11.12	8.86	0.85	0.00	0.00	0.00	0.00	538.00	20.02	2676.00	99.59
March, 2021	2972	4.47	11.43	7.30	1.42	0.00	0.00	79.00	2.66	2052.00	69.04	2939.00	98.89
Totals	20953	0.29	11.72	5.20	0.55	6342.00	30.27	6834.00	32.62	15028.00	71.72	20897.00	99.73

Table 6 Summary statistics for Dissolved oxygen at LCR@176th Street station from 2018 and 2020. Exceedance values for Salish Sucker and aquatic life

Month + Year	# of data points	min	max	mean	SD	No. of points below SSU Threshold (<4mg/L)	SSU % Exceedance	No. of points below aquatic life minimum (<5mg/L)	% Exceedance of instantaneous minimum	No. of points below long-term chronic (<8mg/L)	% Exceedance of long-term chronic guideline	No. of points below buried embryo minimum (<11mg/L)	Buried embryo % Exceedance
December, 2018	76	9.83	11.43	10.98	0.37	0	0.00	0	0.00	0	0.00	27	35.53
March, 2020	680	9.61	13.92	11.47	0.90	0	0.00	0	0.00	0	0.00	221	32.50
April, 2020	720	8.18	11.20	9.82	0.81	0	0.00	0	0.00	0	0.00	698	96.94
May, 2020	261	6.08	11.06	9.01	1.20	0	0.00	0	0.00	53	20.31	259	99.23
June, 2020	825	6.17	10.16	7.96	1.08	0	0.00	0	0.00	460	55.76	825	100.00
July, 2020	1117	6.01	14.89	7.96	1.09	0	0.00	0	0.00	599	53.63	1114	99.73
August, 2020	1497	4.67	9.25	6.39	0.93	0	0.00	55	3.67	1400	93.52	1497	100.00
September, 2020	686	4.63	9.65	6.18	0.95	0	0.00	40	5.83	661	96.36	686	100.00
October, 2020	2445	5.92	10.44	7.92	0.94	0	0.00	0	0.00	1516	62.00	2445	100.00
November, 2020	2879	7.67	10.65	9.65	0.65	0	0.00	0	0.00	88	3.06	2879	100.00
December, 2020	345	10.15	11.17	10.81	0.21	0	0.00	0	0.00	0	0.00	294	85.22
total	11455	4.63	14.89	8.72	0.28	0	0.00	95	0.83	4777	41.70	10918	95.31

3.2.2 Water Temperature

Over the study period water temperature values at LCR @16th Avenue station ranged from a minimum of 0.16°C to a maximum of 19.21°C (Table 7). The average temperature over the entire study period was 8.38°C.

At the LCR @ 16th Avenue station temperature did not exceed the threshold of 23°C for SSU in 2020. However, measurements did exceed the CCT threshold of 16°C during August (88.34% of measurements) and September (51.29% of measurements) in 2020.

For the LCR @ 176th Street station, water temperature values ranged from a minimum of 4°C to a maximum of 19.62°C (Table 8). The average water temperature over the entire study period was 12.37°C.

Water temperate @ 176th Street station did not exceed the threshold of 23°C for SSU in 2020. However, measurements did exceed the CCT threshold of 16°C in May-September (23.11% of measurements).

Table 7 Summary statistics for water temperature at LCR@16th Avenue in 2018-2020. Exceedance values for Salish sucker and Cutthroat trout.

Month, Year	# of data points	min	max	mean	SD	No. of points above SSU Threshold (>23°C)	SSU % Exceedance	No. of points above CCT threshold (>16°C)	CCT % exceedance
November, 2018	558	2.69	9.18	6.10	1.70	0.00	0.00	0.00	0.00
December, 2018	742	0.23	7.59	4.27	2.01	0.00	0.00	0.00	0.00
January, 2019	642	1.54	6.52	4.31	1.28	0.00	0.00	0.00	0.00
February, 2019	657	0.02	5.27	0.69	1.22	0.00	0.00	0.00	0.00
March, 2019	740	0.18	10.45	4.86	3.35	0.00	0.00	0.00	0.00
April, 2019	710	7.87	12.51	10.09	0.98	0.00	0.00	0.00	0.00
May, 2019	352	9.34	16.89	13.20	1.77	0.00	0.00	7.00	1.99
June, 2019	720	13.67	16.95	15.32	0.70	0.00	0.00	89.00	12.36
July, 2019	695	15.54	17.97	16.61	0.62	0.00	0.00	539.00	77.55
September, 2019	132	14.74	16.80	15.80	0.63	0.00	0.00	51.00	38.64
October, 2019	633	3.45	11.20	8.08	1.81	0.00	0.00	0.00	0.00
November, 2019	720	0.36	9.26	4.88	2.00	0.00	0.00	0.00	0.00
December, 2019	742	0.29	6.67	4.44	1.47	0.00	0.00	0.00	0.00
January, 2020	744	0.09	7.29	4.00	2.49	0.00	0.00	0.00	0.00
February, 2020	696	1.75	7.85	4.40	1.29	0.00	0.00	0.00	0.00
March, 2020	590	1.74	6.89	4.60	1.14	0.00	0.00	0.00	0.00
April, 2020	10	6.66	7.34	6.96	0.24	0.00	0.00	0.00	0.00
August, 2020	1192	15.48	19.21	17.36	1.09	0.00	0.00	1053.00	88.34
September, 2020	1593	13.45	17.01	15.82	0.85	0.00	0.00	817.00	51.29
October, 2020	2951	4.52	14.34	10.50	3.09	0.00	0.00	0.00	0.00
November, 2020	2871	3.40	10.18	6.16	1.47	0.00	0.00	0.00	0.00
December, 2020	2973	1.60	7.86	4.52	1.68	0.00	0.00	0.00	0.00
January, 2020	2971	1.54	7.72	4.66	1.53	0.00	0.00	0.00	0.00
February, 2020	1163	0.16	6.33	3.60	2.07	0.00	0.00	0.00	0.00
March 2021, 2020	2972	3.65	8.25	5.84	1.05	0.00	0.00	0.00	0.00
Total	18696	0.16	19.21	8.38	0.81	0.00	0.00	1870.00	10.00

Table 8 Summary statistics for water temperature at LCR@176th Street stations in 2018-2020. Exceedances values for Salish sucker and Cutthroat trout.

Month, Year	# of data points	min	max	mean	SD	No. of points above SSU Threshold (>23°C)	SSU % Exceedance	No. of points above CCT threshold (>16°C)	CCT % exceedance
December, 2018	274.00	3.76	8.04	5.57	0.78	0.00	0.00	274.00	100.00
January, 2019	739.00	3.20	7.21	5.18	1.01	0.00	0.00	0.00	0.00
February, 2019	14.00	5.58	5.78	5.68	0.05	0.00	0.00	0.00	0.00
March, 2020	680.00	2.45	10.35	6.44	1.48	0.00	0.00	0.00	0.00
April, 2020	720.00	6.62	13.66	10.55	1.81	0.00	0.00	0.00	0.00
May, 2020	319.00	10.16	17.48	13.73	1.71	0.00	0.00	34.00	10.66
June, 2020	966.00	14.85	18.24	16.30	0.69	0.00	0.00	670.00	69.36
July, 2020	1723.00	13.78	19.62	16.53	1.32	0.00	0.00	989.00	57.40
August, 2020	1633.00	14.26	19.01	16.44	0.94	0.00	0.00	1082.00	66.26
September, 2020	787.00	13.80	16.40	15.20	0.60	0.00	0.00	74.00	9.40
October, 2020	2445.00	5.60	14.70	10.57	2.34	0.00	0.00	0.00	0.00
November, 2020	2875.00	4.50	11.10	7.07	1.30	0.00	0.00	0.00	0.00
December, 2020	341.00	4.00	6.50	4.98	0.58	0.00	0.00	0.00	0.00
total	11809.00	4.00	19.62	12.37	0.61299297	0.00	0.00	2849.00	24.13

3.2.3 Other water data from around the Watershed

Water quality data were also collected at ARC Brooksdale, Campbell Heights Industrial park, Red Willow Ranch, Wagner Hills Women's Campus and Michael and Maria's private property in 2020/2021. All five sites are considered critical habitat for the Salish sucker. These five sites all remained within the parameters outlined in (Table 3) for all variables including Specific conductivity, dissolved oxygen, pH and temperature for both measurements collected in the outlined survey periods (Table 9).

Table 9 Summary Statistics for water quality from surveys throughout the Little Campbell river in 2020

Site	Year	Month	Avg. Specific conductivity	Avg. DO mg/L	Avg. DO %	Avg. pH	Avg. Temperature
ARC Brooksdale	2020	March	183.43	12.03	98.00	7.48	7.57
ARC Brooksdale	2020	April	205.00	12.10	102.00	7.99	8.90
Campbell Heights	2020	April	315.87	8.85	81.39	7.39	11.19
Red Willow Ranch	2020	April	152.69	7.69	68.38	7.18	10.12
Wagner Hills Women's Campus	2021	March	151.10	15.00	126.00	7.70	9.40
Wagner Hills Women's Campus	2020	March	152.00	10.29	85.40	7.00	7.30
Michael & Maria	2020	December	123.80	10.60	84.00	7.11	6.40

3.3 Hydrometrics

Hydrometric surveys were conducted from March 3rd, 2020 to April 10th, 2021. The lowest discharge measured for this time period was 0.0881 m³/s on October 7th 2020. The highest discharge value was recorded on March 3, 2020 with a measurement of 2.49 m³/s.

In 2020, discharge dropped below 10% Mean Annual Discharge (0.272 m³/s) as defined by Rood and Hamilton (1994) from June-October (Figure 6). A discharge of 10% of MAD is considered the minimum for short-term survival of fish and other aquatic organisms. At less than 10% MAD, the stream is considered severely degraded (Newcombe and Ptolemy 1985).

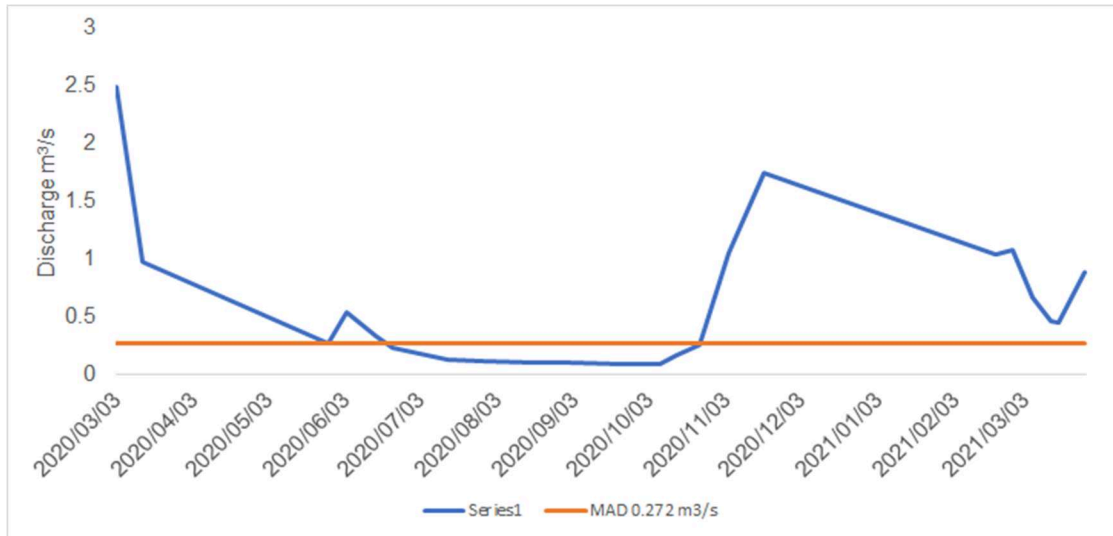


Figure 6 Measured discharge values for the Little Campbell River at the A Rocha Canada Brooksdale site just North of 16th Avenue Surrey B.C. Measurements recorded from March 2020 to April 2021.

Hydrometric data was first collected as part of this project in June 2019. A similar trend was observed, that the discharge fell below 10% of MAD from June through November (Figure 7).

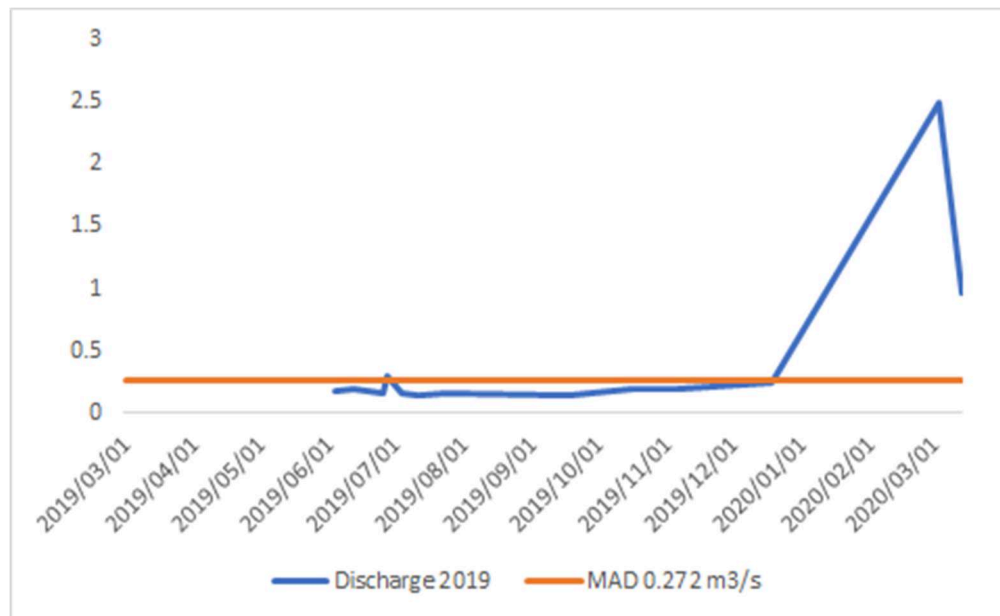


Figure 7 Measured discharge values for the Little Campbell River at the A Rocha Canada Brooksdale site just North of 16th Avenue Surrey B.C. Measurements recorded from June 2019 to March 2020.

The depth at the stage ranged from a maximum of 0.571 m on March 3rd, 2020 and a minimum depth of 0.19 m on October 7th, 2020 (Figure 8).

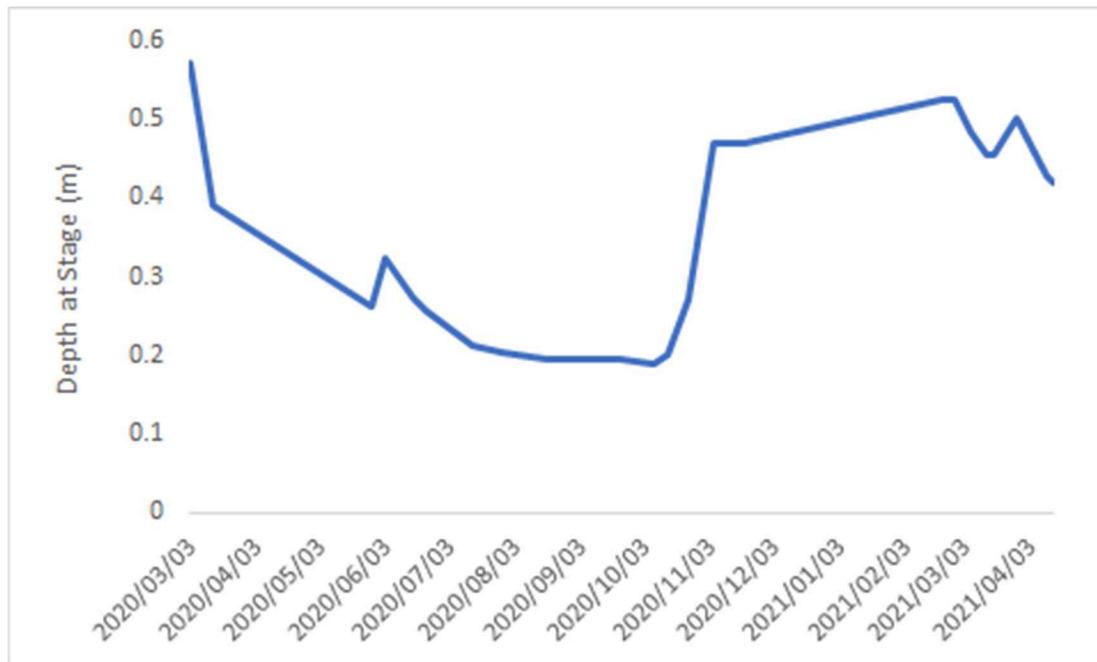


Figure 8 Measured stage depth values for the Little Campbell River at the A Rocha Canada Brooksdale site just North of 16th Avenue Surrey B.C. Measurements recorded from March 2020 to April 2021.

3.4 Dry reach monitoring

In 2020 the dry reach of the river was first observed to disconnect on July 16th (Table 10). Due to the Covid 19 pandemic and staffing constraints, monitoring surveys were conducted starting in June. There was a period of time in the month of April where there was very little rain and above average temperatures. During this time, it is possible that the river started to disconnect and reconnect when the rains returned. Therefore, our observation on July 16th could have been the second time the river disconnected in 2020.

Table 10 Summary of disconnect and reconnection dates for the Little Campbell river dry reach 2018-2020.

Year	Observed Disconnected	Observed Reconnected
2018	June 19	November 16
2019	June 5	October 22
2020	July 16	October 16

At its largest extent, the dry reach measured 1.6 km in length. In previous years the dry reach was longer, in 2018 it measured 1.7 km in length and in 2019 it was 1.8 km (Figure 9). This is

likely due to more frequent rain events through the summer of 2020 compared to 2018 and 2019.



Figure 9 Little Campbell River dry reach located in Langley B.C. North of 24th and extending both East and West off of 200th Street.

On October 16, 2020 after a large rain event the river was observed to reconnect just east of the 200th street stream crossing. The dry section of the river is now considered a barrier to fish passage as salmon were observed moving up river and reached the Semiahmoo hatchery fish fence on September 24, 2020. The spawning salmon are assumed to have been held in pools downstream of the dry reach until rains returned on October 16, reconnecting the river.

4.0 Discussion/Recommendations

4.1 Salish Sucker Abundance

Since 2017, annual Salish Sucker abundance estimates have appeared relatively stable at the Red Willow Ranch reach; however, there was a decrease in abundance observed in 2020 (Figure 10). This is thought to be due to the timing of the survey. The first week of surveys we were likely capturing the end of the spawning season. During the second week we observed less SSU likely because they had already started to disperse away from the spawning grounds. Mark recapture surveys should be continued to assess SSU population on a watershed scale.

This can be done by adding more survey sites in known spawning locations throughout the watershed and conducting the surveys simultaneously.

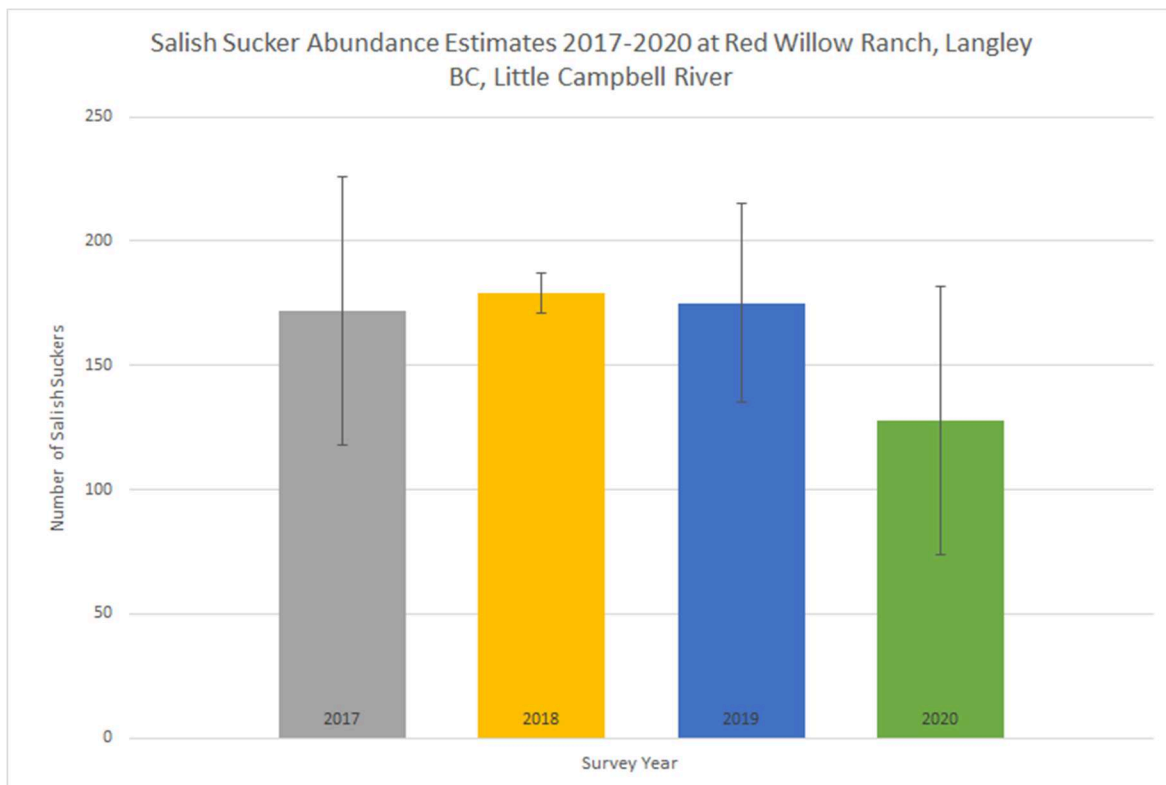


Figure 10 Summary of Salish sucker population estimates between 2017 and 2020 at Red Willow Ranch in Langley, BC Canada.

4.2 Water Quality

The water data collected from 2018 through 2020 shows that there are serious concerns for both water quality and water quantity in the Little Campbell River. Aquatic life is likely undergoing stress as locations within the watershed drop below optimal threshold for both temperature and dissolved oxygen. The Salish Sucker is known for being able to tolerate lower levels of dissolved oxygen compared to other aquatic species. However, even their populations are at risk as areas in the main stem, such as the LCR@16th Avenue site where dissolved oxygen levels dip as low as 0.29 mg/L and remain under 4mg/L for approximately six months of the year. These hypoxic conditions need to be continually monitored and actions need to be taken to address the problem. All aquatic species are at risk due to changing conditions and increasing rates of habitat loss.

Water temperatures exceeded optimal thresholds for Cutthroat trout and other aquatic species. If trends continue, we will likely also see water temperatures continue to increase over time.

More restoration work is needed along the Little Campbell River to create larger forested riparian buffers that will provide shade to aid in keeping water temperatures low throughout the warmer months. Maintenance is required on these projects to ensure that native vegetation can outcompete invasive vegetation and become mature full canopies.

4.3 Seasonal low flows

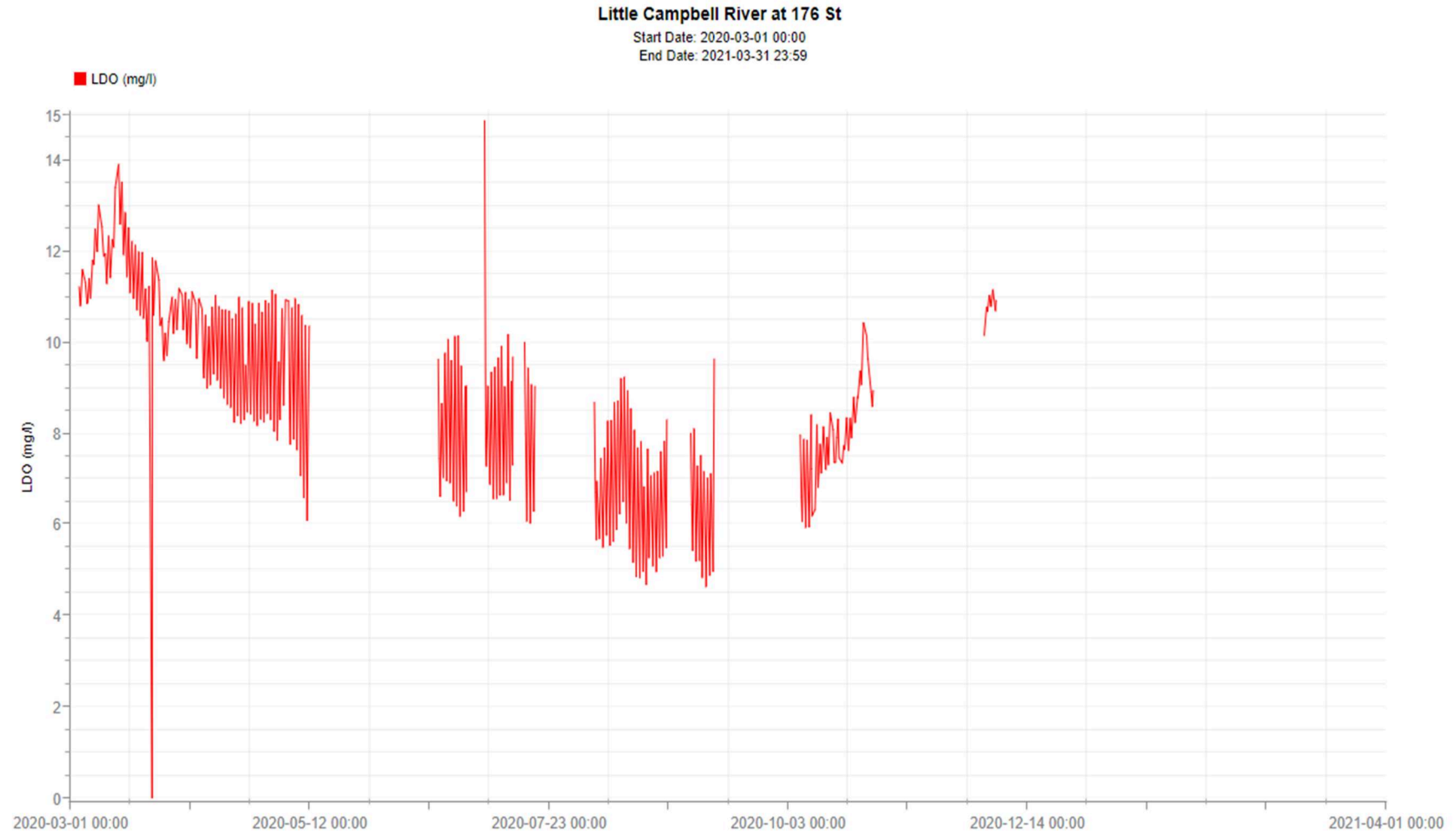
Monitoring data shows that the section of the Little Campbell River that dries out in the summer, does not reconnect until after adult summer has started to return to the river to spawn. This barrier can add stress to the adult salmon as they have to wait to gain more access to historic spawning grounds. This is a sensitive time for them as their bodies are starting to decay and puts them at higher risk of predation.

This information paired with the hydrometric data shows that ongoing surveys are required to determine change over time. Continued partnerships are also needed to ensure that water quantity concerns are being understood and that water use licenses can be managed effectively to ensure that water extraction does not have an effect on the ecology of the river.

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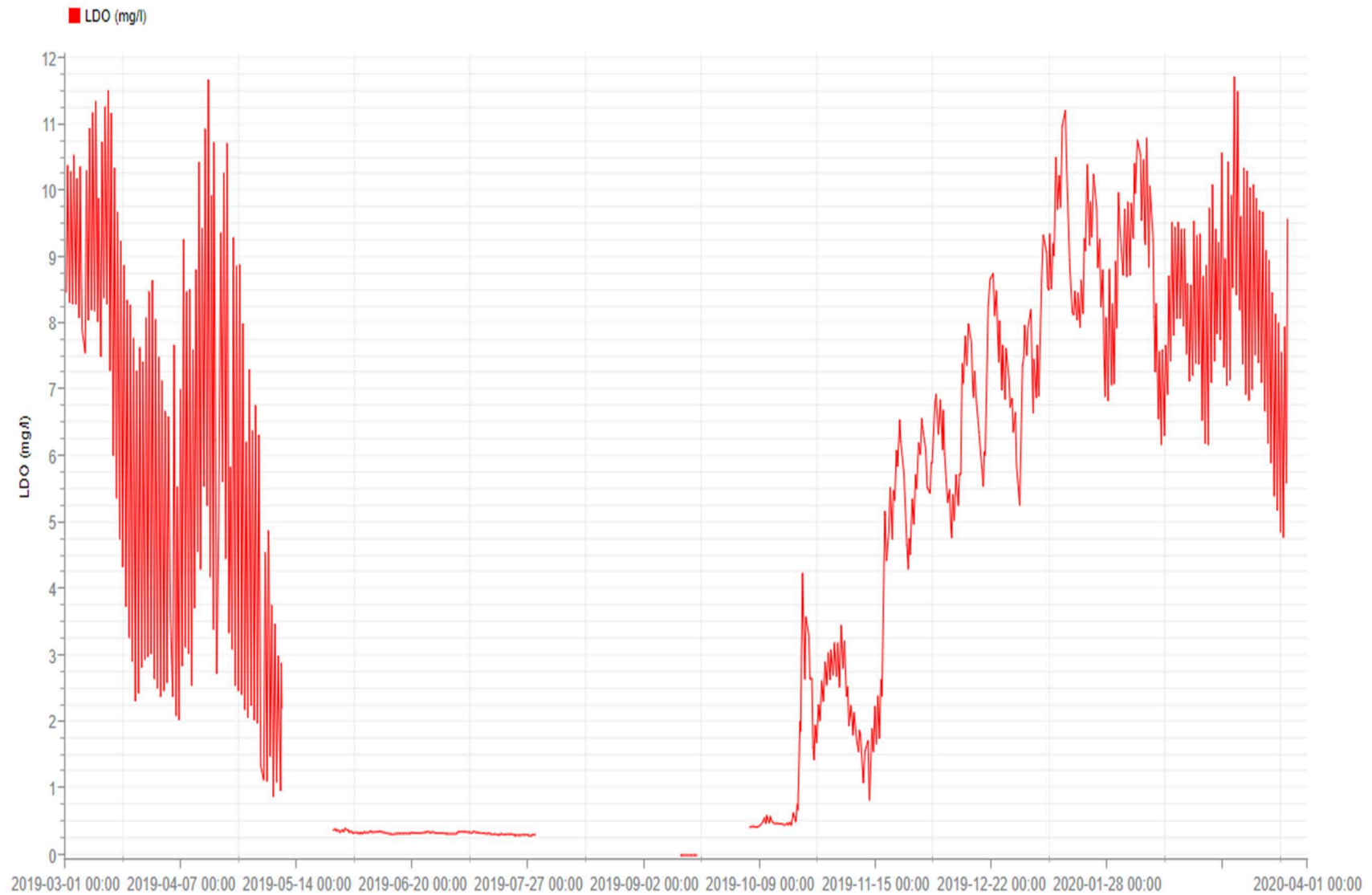
Appendix 1 Dissolved Oxygen Figures



Little Campbell River at 16 Ave (CVRP)

Start Date: 2019-03-01 00:00

End Date: 2020-03-31 23:59



Little Campbell River at 16 Ave (CVRP)

Start Date: 2020-03-01 00:00

End Date: 2021-03-31 23:59



