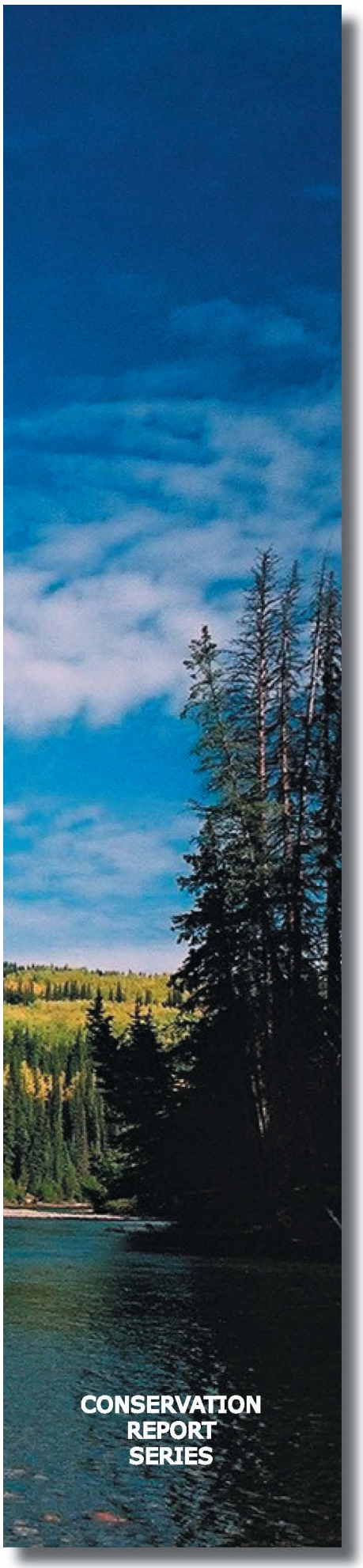

Eastern Slopes Fisheries Inventory, 2018 – 2019

Alberta Conservation Association

Eastern Slopes Fisheries Inventory, 2018 – 2019

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EXECUTIVE SUMMARY

Fishery inventories provide resource managers with information on fish species abundance, distribution, and habitat. This information is a key component of responsible land-use planning. Alberta Environment and Park's Fish Sustainability Index (FSI) is a standardized process of assessment that provides the framework within which fishery inventories must occur for greatest relevance to government managers and planners. Our objective was to describe fish distribution, abundance, and habitat in the James River watershed of Alberta, with emphasis on bull trout (*Salvelinus confluentus*) in order to address data deficiencies for this FSI priority species. Bull trout are particularly sensitive to habitat change and are listed as *Threatened* in Alberta (Saskatchewan and Nelson rivers populations).

Priority areas for fishery inventories were identified in consultation with project partners and included the James River and its tributaries. From June 19 to June 28, 2018 and July 16 to August 13, 2019 we sampled fish at 50 sites randomly distributed throughout five watersheds classed as hydrologic unit code (HUC) 10: Willson Creek, Upper James River, Middle James River, South James River, and Lower James River. Sites were sampled using backpack and tote-barge electrofishing gear. In 2018 and 2019, we measured stream temperature (hourly) in the HUC 10 watersheds (except Willson Creek).

We captured 987 fish, including 90 bull trout ranging in size from 41 mm to 504 mm fork length. Bull trout were detected at eight sites in the Willson Creek HUC 10 watershed and at two sites in the Upper James River HUC 10 watershed; bull trout were not detected at any sites in the Middle, South or Lower James river HUC 10 watersheds. Ten sites (of the 50 sites sampled) across all watersheds had zero captures of any fish species. The Willson Creek HUC 10 watershed had the highest median relative abundance of bull trout at 2.1 (CL = 0.7 – 4.7) bull trout per 100 m. Highly suitable thermal habitat for bull trout existed in the Upper James watershed, as well as Teepee Pole Creek and Upper Stoney Creek (major tributaries in the James River watershed) in the summer months of 2019. Large gravel and cobble substrate were predominantly found throughout the Willson Creek and Upper James River HUC 10 watersheds, a habitat quality preferred by bull trout.

Our study provides current information on stream habitats, and the abundance and distribution of FSI priority species within the James River and its tributaries. This information helps land managers balance the diverse values of the land base upon which they operate, and is critical for the conservation of native fish species that are particularly sensitive to habitat degradation, including bull trout.

Key words: Alberta, James River watershed, Willson Creek, FSI, bull trout, distribution, abundance.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

Fishery inventories provide resource managers with information on fish species abundance, distribution, and habitat. This information is a key component of responsible land-use planning. Alberta Environment and Park's (AEP) Fish Sustainability Index (FSI) is a standardized process of assessment that provides a landscape-level overview of the sustainability of fish populations within Alberta, and enables broad-scale evaluation of management actions and land-use planning (MacPherson et al. 2014).

The FSI evaluates fish species on four groups of metrics: population integrity, population productivity, threats, and data reliability (MacPherson et al. 2014). Fishery inventory data are particularly suited to the evaluation of population integrity (adult and immature fish density) and productive potential (geographic extent) metrics. When conducting fishery inventories in Alberta, watersheds are scaled using a hydrological unit code (HUC) appropriate for the focal fish species, with HUC 2 being the coarsest level and HUC 10 being the finest level.

Priority species identified by AEP for FSI assessment in the James River watershed include bull trout (*Salvelinus confluentus*) and mountain whitefish (*Prosopium williamsoni*) (MacPherson et al. 2014). Mountain whitefish are ranked as *Secure* in Alberta (Government of Alberta 2017), whereas bull trout are listed as *Threatened* (Saskatchewan and Nelson rivers populations) (COSEWIC 2012, Government of Canada 2019). Bull trout have specific habitat requirements (cold, clean, complex, and connected), are sensitive to habitat changes, and are thought to reflect general ecosystem health (COSEWIC 2012). This sensitivity, coupled with their relatively wide distribution, make bull trout an ideal species for monitoring sustainability in the James River watershed. Bull trout populations are being assessed at a HUC 10 scale.

We had two objectives for this study:

1. Describe bull trout distribution, abundance, and habitat in the James River watershed to address FSI data deficiencies.

2. Describe distribution and abundance of other fish species and stream habitat in priority HUC 10 watersheds identified by project partners.

2.0 STUDY AREA

The James River originates in Kiska/Willson Public Land Use Zone west of Sundre, Alberta and flows approximately 102 km eastward to its confluence with the Red Deer River. The watershed is approximately 872 km^2 and major tributaries within the watershed include Willson Creek, Bread Creek, Teepee Pole Creek, South James River, and Stony Creek (Figure 1). Land-use activities within this watershed include forestry, agriculture, oil and gas exploration, and recreation (Aquality Environmental Consulting Ltd. 2009). Historical fish stocking in the watershed has included Arctic grayling (*Thymallus arcticus*), brook trout (*Salvelinus fontinalis*), brown trout (*Salma trutta*), cutthroat trout (*Oncorhynchus clarkii*), rainbow trout (*Oncorhynchus mykiss*), walleye (*Stizostedion vitreum*), and yellow perch (*Perca flavescens*) (AEP 2020). Priority HUC 10 watersheds for sampling were identified in consultation with project partners, with highest priority given to areas in the bull trout range where current fishery inventory data are absent or dated. Our study area in the James River watershed (HUC 8) consists of the following HUC 10 watersheds: Willson Creek (W), Upper James River (UJ), Middle James River (MJ), Lower James River (LJ), and South James River (SJ) (Figure 2).

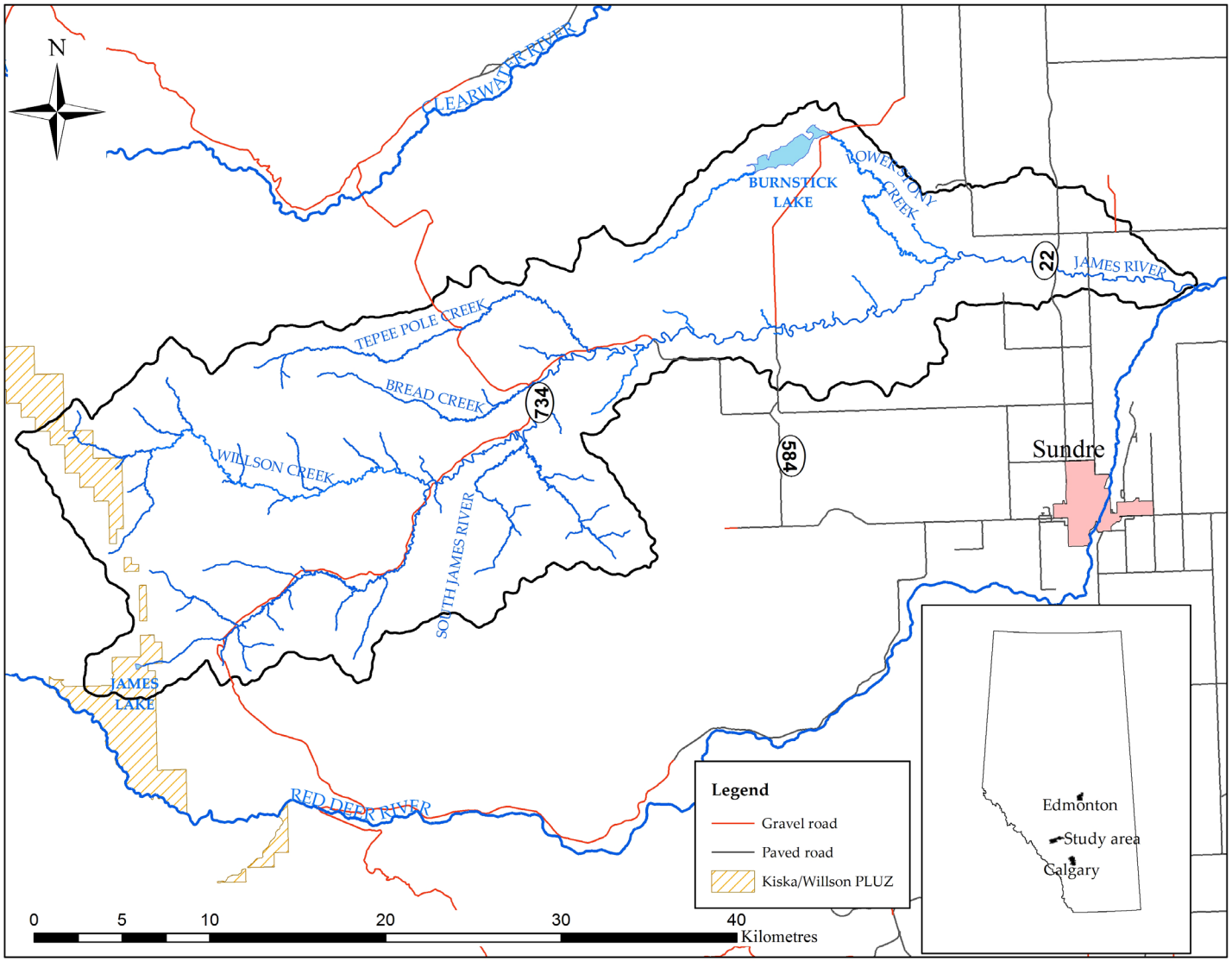


Figure 1. Map of the James River HUC 8 watershed. Inset map shows the location of the study area within the province of Alberta.

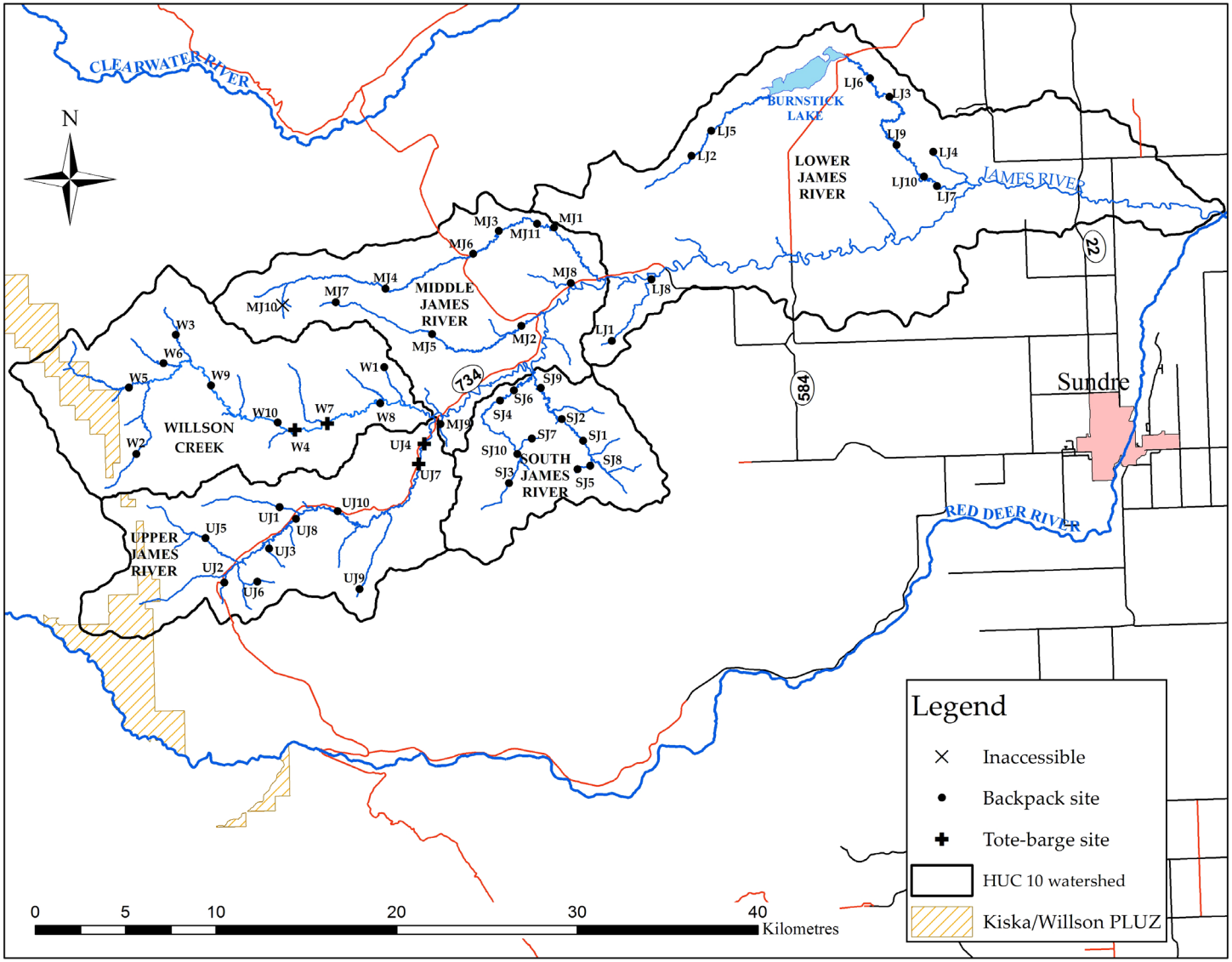


Figure 2. Map of the HUC 10 watersheds showing the location of electrofishing sites, 2018 and 2019.

3.0 MATERIALS AND METHODS

3.1 Fish distribution and abundance

From June 19 to 28, 2018 and July 16 to August 12, 2019, we sampled 50 randomly distributed sites to describe bull trout and other fish species distribution and relative abundance in the James River HUC 10 watersheds (Figure 2). The Willson Creek HUC 10 watershed was sampled in 2018 and the other four watersheds were sampled in 2019. We distributed prospective sample sites at 800-m intervals in an upstream progression along the length of third- to fifth-order streams (> 400 m; 1:20,000 scale) (Strahler 1952) within each HUC 10 watershed using a geographical information system (GIS) (ArcGIS version 10.6) and the Government of Alberta Resource Management Information Branch hydro line data layer. Sample sites were randomly selected without replacement using a Generalized Random Tessellation Stratified (GRTS) design (Stevens and Olsen 2004). We used a conservative target of ten sample sites per HUC 10 watershed based on past evaluations of our power to detect immature bull trout (Rodtka and Judd 2015, Rodtka et al. 2015). Sites were assessed in the order in which they were drawn. To accommodate non-response (inaccessible) sites, we drew a total of 13 sites per sample frame. Only one site was considered non-response and an alternate was chosen (Figure 2). The GRTS sampling design allowed us to adjust our sample size to accommodate non-response sites while maintaining a spatially balanced sample (Stevens and Olsen 2004).

A handheld Global Positioning System (GPS) was used to locate sample sites. All sampling commenced at the head of riffle habitat. Our sample protocol for backpack electrofishing required sample sites to be 300 m long (measured with a hip chain). One site (LJ8) was only 150 m long because of insufficient flow. Sites were sampled using a Smith-Root LR-20B backpack electrofisher with pulsed DC (voltage 300 V – 400 V, frequency 30 Hz – 50 Hz, and duration 6 ms – 10 ms). Two sites in the Upper James River HUC 10 watershed and two sites in the Willson Creek HUC 10 watershed were sampled using a Smith-Root SR-6 tote-barge electrofisher with a 2.5 Generator Powered Pulsator (GPP) (typical settings were 60 Hz at 40% – 50% of high range). We sampled these sites moving downstream from the start of the site with a three- or four-person crew consisting of one tote-barge operator, one anode pole operator, and one or two netters. The tote-barge sites were 500 m long (measured with a range finder), except for site W4, which was only 200 m because of equipment failure.

Electrofishing effort (seconds) was recorded at 50-m and 100-m intervals for backpack and tote-barge sites, respectively. Fish were identified to species, enumerated, and measured (fork length [FL] in mm). Bull trout were visually inspected upon capture for morphological features of hybridization with brook trout, based on criteria in Popowich et al. (2011). Immature bull trout

were defined as less than or equal to150 mm FL (ASRD and ACA 2009) when reporting abundance.

3.2 Stream habitat measurement

At all sample sites, we measured stream temperature (1°C) and ambient stream conductivity (1 µS/cm) prior to electrofishing. Ambient stream conductivity has been demonstrated to significantly affect detection of immature bull trout using electrofishing gear (Rodtka et al. 2015). We measured stream depth (0.01 m), wetted width (0.1 m), and rooted width (0.1 m) at transects spaced at 50-m and 100-m intervals for backpack and tote-barge sites, respectively. Habitat type and dominant substrate type were assessed between transects. We visually estimated the percentage (nearest 5%) of pool habitat (reduced current velocity, little surface turbulence, water deeper than surrounding areas), riffle habitat (swift flow of water over bed materials producing surface turbulence), and run habitat (uniform but swift flow of water without surface waves). Dominant substrate type was scored based on a modified Wentworth (1922) scale: fines (< 2 mm; score 0), small gravel (2 mm – 16 mm; score 1), large gravel (17 mm – 64 mm; score 2), cobble (65 mm – 256 mm; score 3), boulder (>256 mm; score 4), and bedrock (score 5).

In 2018, we measured summer (July 1 – August 31) stream temperature (1°C) every hour at six stations located throughout the James River HUC 8 watershed to describe the thermal habitats available (Figure 3). In 2019, we replicated the stream temperature monitoring and added six more stations throughout the James River HUC 8 watershed. The Willson Creek HUC 10 watershed was excluded from our monitoring because another organization was already monitoring stream temperatures in the watershed. All fish and habitat information acquired in the field was submitted for inclusion into the AEP Fisheries and Wildlife Management Information System (FWMIS) database.

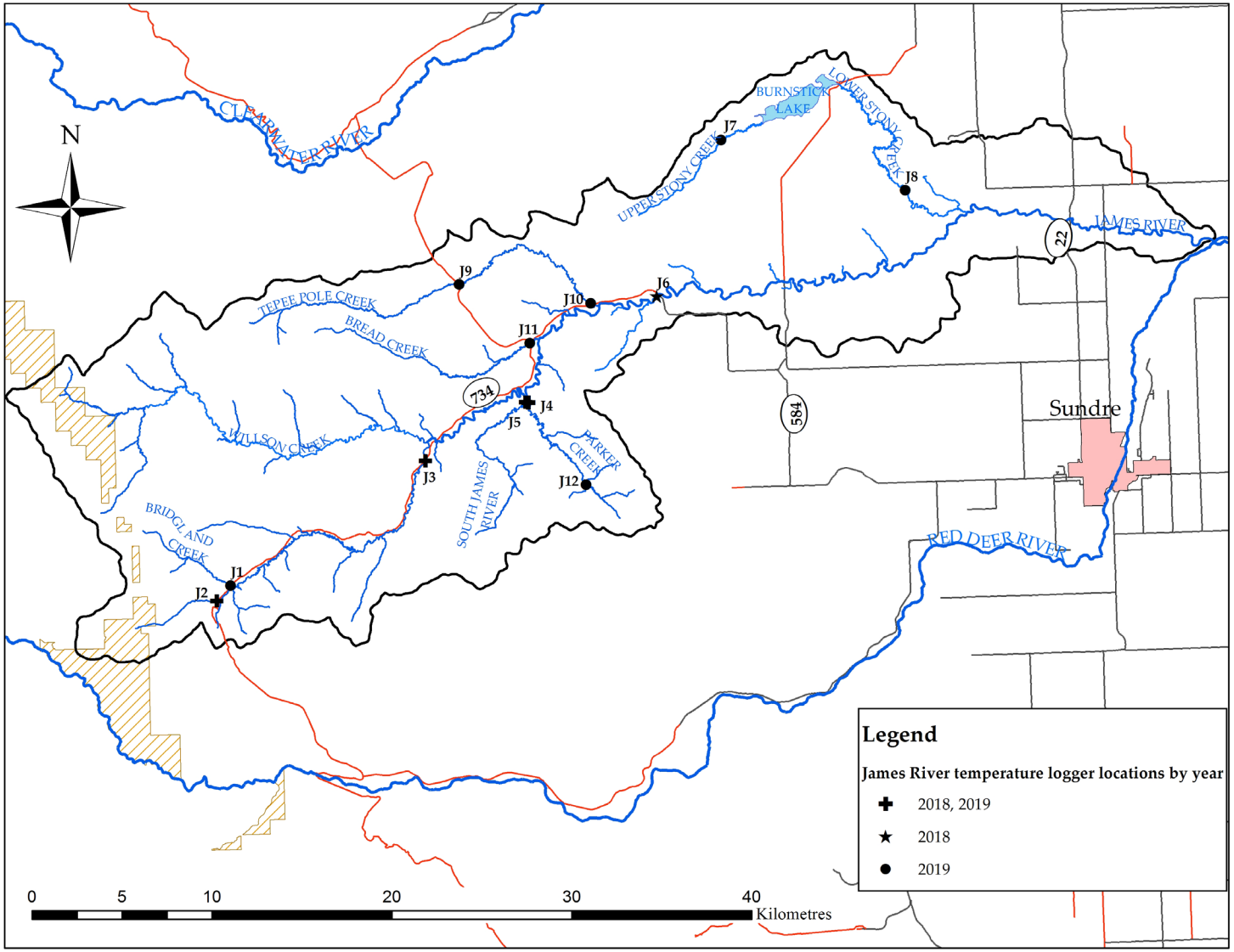


Figure 3. Map of the James River HUC 8 watershed showing the location of stream temperature stations, 2018 and 2019.

4.0 RESULTS

4.1 Fish distribution and abundance

We sampled 46 sites with backpack electrofishing gear and four sites with tote-barge electrofishing gear, resulting in a total sampling effort of more than 60,000 seconds over 15.4 km of stream. Site-specific location information is provided in Appendix 1. In total, we captured 987 fish (Table 1). In addition to bull trout, our catch included: brook trout, brown trout, brook stickleback (*Culaea inconstans*), fathead minnow (*Pimephales promelas*), lake chub (*Couesius plumbeus*), longnose dace (*Rhinichthys cataractae*), longnose sucker (*Catostomus catostomus*), mountain sucker (*Catostomus platyrhynchus*), mountain whitefish, pearl dace (*Margariscus margarita*), spoonhead sculpin (*Cottus ricei*), walleye, and white sucker (*Catostomus commersonii*).

Bull trout and mountain whitefish were only captured in the Willson Creek and the Upper James River HUC 10 watersheds (Figure 4), with total catches of 90 and 14, respectively (Table 1). None of the bull trout captured showed evidence of hybridization with brook trout. Brook trout were the most abundant and widespread sampled fish and were detected in every HUC 10 watershed and at 35 of the 50 sites sampled (Table 1). Ten sites spread across all watersheds had zero fish captures (of any species) (Figure 4). Site-specific catch data are provided in Appendix 2.

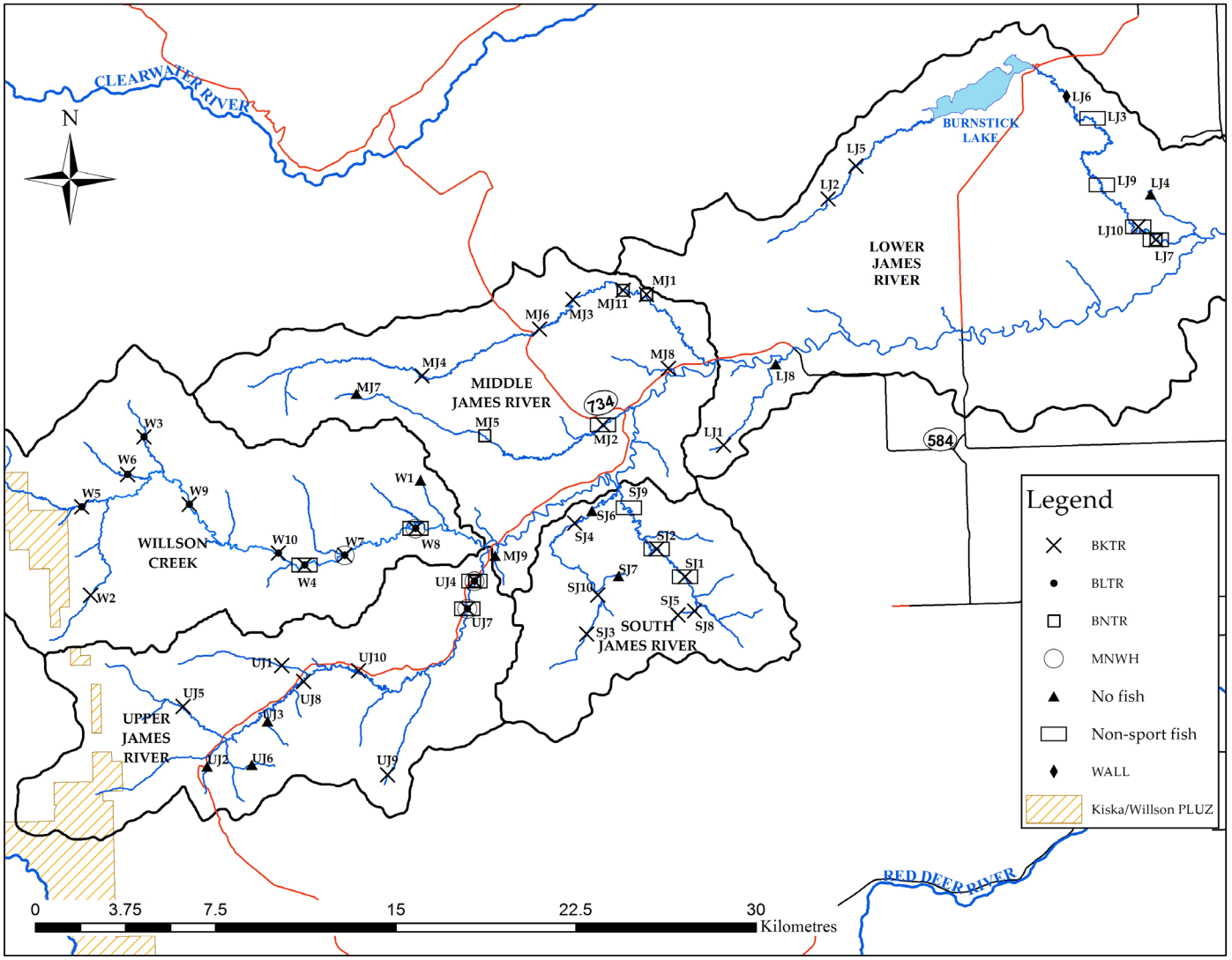


Figure 4. Map of the HUC 10 watersheds showing the distribution of sport fish species captured using backpack and tote-barge electrofishing gear, June 19 to June 28, 2018 and July 16 to August 13, 2019. Species codes: BKTR = brook trout, BLTR = bull trout, BNTR = brown trout, MNWH = mountain whitefish, WALL = walleye.

Table 1. Number of sites (of a possible ten per watershed) where fish were detected in each HUC 10 watershed and total catch (#) of fish species using backpack and tote-barge electrofishing gear, June 19 to June 28, 2018 and July 16 to August 13, 2019. Species codes: BKTR = brook trout, BLTR = bull trout, BNTR = brown trout, BRST = brook stickleback, FTMN = fathead minnow, LKCH = lake chub, LNDC = longnose dace, LNSC = longnose sucker, MNSC = mountain sucker, MNWH = mountain whitefish, PRDC = pearl dace, SPSC = spoonhead sculpin, WALL = walleye, WHSC = white sucker.

	Site detections (n) per HUC 10 watershed					
Species	Lower James River	Middle James River	South James River	Upper James River	Willson Creek	Total catch (%)
BKTR	5	7	7	7	9	643 (65)
BLTR	0	0	0	2	8	90 (9)
BNTR	1	3	0	1	0	5 (1)
BRST	1	0	0	0	0	1 (0)
FTMN	1	0	0	0	0	1 (0)
LKCB	1	1	0	0	0	8 (1)
LNDC	5	1	3	2	1	193 (20)
LNSC	0	1	1	0	0	2 (0)
MNSC	2	0	0	0	0	7 (1)
MNWH	0	0	0	2	2	14 (1)
PRDC	2	0	0	0	0	2 (0)
SPSC	0	0	0	1	0	6 (1)
WALL	1	0	0	0	0	1 (0)
WHSC	3	0	0	0	0	14 (1)
						987

Our bull trout catch ranged in size from 41 mm to 504 mm FL, and mainly consisted of immature fish (n = 76) (Table 2). Length frequency histograms of our bull trout, brook trout, brown trout, and mountain whitefish catch are in Appendix 3.

Table 2. Size distribution of brook trout, bull trout, brown trout, and mountain whitefish captured in each HUC 10 watershed using backpack and tote-barge electrofishing gear, June 19 to June 28, 2019 and July 16 to August 13, 2019. Species codes: BKTR = brook trout, BLTR = bull trout, BNTR = brown trout, MNWH = mountain whitefish. SD = standard deviation.

HUC 10 Watershed	Fork length (mm)	Fish Species			
		BKTR	BLTR	BNTR	MNWH
Lower James River	n	186	0	1	0
	Mean ± SD	98 ± 51	—	226 ± 0	—
	Range	35 – 286	—	—	—
Middle James River	n	166	0	3	0
	Mean ± SD	111 ± 48	—	113 ± 11	—
	Range	33 – 212	—	101 – 122	—
South James River	n	17	0	0	0
	Mean ± SD	147 ± 39	—	—	—
	Range	42 – 206	—	—	—
Upper James River	n	155	7	1	9
	Mean ± SD	125 ± 49	131 ± 25	98 ± 0	164 ± 104
	Range	26 – 270	111 – 168	—	45 – 387
Willson Creek	n	119	83	—	5
	Mean ± SD	135 ± 41	119 ± 64	—	318 ± 117
	Range	32 – 260	41 – 504	—	115 – 395

The median relative abundance (catch per 100 m) of bull trout was highest in the Willson Creek HUC 10 watershed. Bootstrapped median relative abundances (10,000 replicates) of brook trout, brown trout, bull trout, and mountain whitefish for each HUC 10 watershed are provided in Table 3.

Table 3. Bootstrapped median relative abundance (10,000 replicates) of brook trout, bull trout, brown trout, and mountain whitefish in each HUC 10 watershed, based on data from backpack and tote-barge electrofishing, June 19 to June 28, 2018 and July 16 to August 13, 2019. Species codes: BKTR = brook trout, BLTR = bull trout, BNTR = brown trout, MNWH = mountain whitefish. CL = confidence limits.

HUC 10 watershed	Median catch/100m (95% CL)			
	BKTR	BLTR	BNTR	MNWH
Lower James River	1.2 (0.0 – 7.7)	0	0.0 (0.0 – 0.0)	0
Middle James River	6.5 (0.0 – 9.3)	0	0.0 (0.0 – 0.3)	0
South James River	0.7 (0.0 – 0.8)	0	0	0
Upper James River	4.7 (0.0 – 8.0)	0.0 (0.0 – 0.1)	0.0 (0.0 – 0.0)	0.0 (0.0 – 0.2)
Willson Creek	4.4 (1.0 – 6.3)	2.1 (0.7 – 4.7)	0	0.0 (0.0 – 0.2)

4.2 Stream habitat measurement

Stream substrate composition was similar in the Upper James River and Willson Creek HUC 10 watersheds, with cobble and large gravel substrates being dominant throughout (Table 4). Large gravel and cobble substrate are habitat qualities preferred by bull trout (ASRD and ACA 2009). The Willson Creek HUC 10 watershed had a wide flood plain and occasional braided sections of stream and, consequently, the wetted and rooted widths in this HUC 10 watershed were largest (Table 4). See Appendix 4 for site-specific habitat measurements.

Table 4. Summary of stream habitat measurements in each HUC 10 watershed collected while backpack and tote-barge electrofish sampling, June 19 to June 28, 2018 and July 16 to August 13, 2019. Substrate codes: B = boulder, C = cobble, F = fines, LG = large gravel, SG = small gravel. SD = standard deviation.

Measurement	HUC 10 watershed				
	Lower James River	Middle James River	South James River	Upper James River	Willson Creek
Stream temperature (˚C)					
Mean ± SD	14 ± 5	13 ± 3	10 ± 1	9 ± 2	10 ± 2
Range	6 – 22	7 – 17	9 – 13	6 – 12	7 – 15
Ambient conductivity (µS/cm)					
Mean ± SD	230 ± 44	141 ± 49	147 ± 46	257 ± 52	151 ± 61
Range	129 – 261	61 – 220	82 – 210	159 – 302	52 – 211
Mean wetted width (m)					
Mean ± SD	3.7 ± 2.2	3.7 ± 2.4	3.7 ± 2.5	4.1 ± 3.4	5.1 ± 3.6
Range	0.3 – 10.0	0.4 – 9.9	0.3 – 11.8	0.4 – 13.2	0.2 – 14.7
Mean rooted width (m)					
Mean ± SD	5.6 ± 3.5	6.3 ± 3.6	5.4 ± 3.6	6.6 ± 5.9	10.1 ± 8.4
Range	0.3 – 15.4	0.4 – 13.1	0.3 – 13.0	0.3 – 29.1	0.4 – 49.0
Mean maximum depth (m)					
Mean ± SD	0.43 ± 0.20	0.30 ± 0.18	0.49 ± 0.25	0.32 ± 0.24	0.36 ± 0.18
Range	0.11 – 0.84	0.08 – 1.08	0.06 – 1.29	0.05 – 1.29	0.15 – 0.84
Modal stream stage	Moderate	Moderate	High	Moderate	Moderate
Modal substrate					
Primary	F	LG	LG	LG	C
Secondary	SG	SG	SG	C	LG

Stream temperature plays an important role in aquatic community processes and has been correlated to fish species distribution and abundance (Rieman et al. 2007, Isaak et al. 2012). Summer stream temperatures generally were lower in 2019 than in 2018. In 2019, highly suitable thermal habitat for bull trout (i.e., mean summer stream temperature ≤ 10°C; Isaak et al. 2009) was present in the James River HUC 8 watershed above the mouth of Willson Creek and the

headwaters of Teepee Pole Creek and Upper Stony Creek (Table 5). Temperature data from logger J1 in 2018 (logger dry) and J6 in 2019 (logger vandalized) are not included in Table 5. The temperature logger at station J8 was installed downstream of Burnstick lake, which may have influenced the stream temperatures during the summer months. A two-day moving average of stream temperatures recorded at each station is presented in Appendix 5.

Table 5. Summary of stream temperature measurements in the James River watershed from five stations, July 1 to August 31, 2018 and 11 stations, July 1 to August 31, 2019.

Station	UTM Location NAD 83 Zone 11		2018		2019	
	Easting	Northing	Mean ± SD temperature (°C)	Temperature range (°C)	Mean ± SD temperature (°C)	Temperature range (°C)
J1	613767	5734779	—	—	9 ± 2	4 – 14
J2	613040	5733941	11 ± 2	6 – 17	10 ± 2	6 – 15
J3	624586	5741766	13 ± 2	7 – 20	10 ± 2	5 – 17
J4	630234	5745031	13 ± 3	6 – 22	11 ± 2	7 – 18
J5	630270	5745005	14 ± 4	6 – 25	11 ± 3	4 – 19
J6	637531	5750915	15 ± 3	9 – 22	—	—
J7	641284	5759678	—	—	10 ± 2	6 – 16
J8	651359	5756766	—	—	17 ± 2	10 – 23
J9	626580	5751493	—	—	9 ± 3	2 – 16
J10	633788	5750398	—	—	11 ± 3	6 – 18
J11	630410	5748285	—	—	12 ± 3	6 – 21
J12	633618	5740299	—	—	11 ± 3	6 – 19

5.0 SUMMARY

Alberta Conservation Association sampled 50 sites located throughout five HUC 10 watersheds within the James River HUC 8 watershed using backpack and tote-barge electrofishing. We detected bull trout in the Willson Creek and Upper James River HUC 10 watersheds, with the Willson Creek watershed having the highest relative abundance of bull trout. We detected brook trout in each HUC 10 watershed and it was the most abundant species captured. Stream temperature measurements during the two years of the study indicate that 2019 summer temperatures were highly suitable for bull trout in the James River HUC 8 watershed above the mouth of Willson Creek. Cobble and large gravel substrate were dominant throughout the Willson Creek and Upper James River HUC 10 watersheds, a habitat quality preferred by bull trout.

Our study provides current information on stream habitats, and the abundance and distribution of bull trout, a FSI priority species, as well as other fish species within the James River HUC 8 watershed. This information helps land managers balance the diverse values of the landbase upon which they operate, and is critical for the conservation of bull trout and other native fish species that are particularly sensitive to habitat degradation.

6.0 LITERATURE CITED

Alberta Environment and Parks (AEP). 2020. Fish and Wildlife Internet Mapping Tool – Public Version. 2020. Available online at https://maps.alberta.ca/FWIMT_Pub/Viewer/?Viewer=FWIMT_Pub [Accessed 20 February 2020].

Alberta Sustainable Resource Development (ASRD) and Alberta Conservation Association (ACA). 2009. Status of the bull trout (*Salvelinus confluentus*) in Alberta: Update 2009. Wildlife Status Report No. 39 produced by Alberta Sustainable Resource Development, Edmonton, Alberta, Canada. 48 pp.

Aquality Environmental Consulting Ltd. 2009. Red Deer River state of the watershed report. Report prepared for the Red Deer River Watershed Alliance, Red Deer, Alberta, Canada. 834 pp.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2012. COSEWIC assessment and status report on the bull trout *Salvelinus confluentus* in Canada. Report produced by Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario, Canada. 103 pp.

Government of Alberta. 2017. Alberta wild species general status listing – 2015. Report produced by the Government of Alberta, Edmonton, Alberta, Canada. 24 pp.

Government of Canada. 2019. COSEWIC List of wildlife species assessed (including October 2019). URL: https://species-registry.canada.ca/index-en.html#/documents/1151. [Accessed 25 March 2020].

Isaak, D., B.E. Rieman, and D. Horan. 2009. A watershed-scale monitoring protocol for bull trout. Gen. Tech. Rep. RMRS-GTR-224 produced by the U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado, United States. 25 pp.

Isaak, D., S. Wollrab, D. Horan, and G. Chandler. 2012. Climate change effects on stream and river temperatures across the northwest U.S. from 1980 – 2009 and implications for salmonid fishes. Climatic Change 113: 499–524.

MacPherson, L., M. Coombs, J. Reilly, M.G. Sullivan, and D.J. Park. 2014. A generic rule set for applying the Alberta fish sustainability index, second edition. Report produced by Alberta Environment and Sustainable Resource Development, Edmonton, Alberta, Canada. 51 pp.

Popowich, R.C., P.A. Venturelli, J.D. Stelfox, and E.B. Taylor. 2011. Validation of morphological characteristics used for field identification of bull trout × brook trout hybrids. North American Journal of Fisheries Management 31: 548–553.

Rieman, B.E., D.J. Isaak, S. Adams, D. Horan, D. Nagel, C. Luce, and D. Myers. 2007. Anticipated climate warming effects on bull trout habitats and populations across the Interior Columbia River Basin. Transactions of the American Fisheries Society 136: 1552–1565.

Rodtka, M., and C. Judd. 2015. Abundance and distribution of bull trout in the Muskeg River watershed, 2014. Data Report, D-2015-002, produced by Alberta Conservation Association, Sherwood Park, Alberta, Canada. 18 pp + App.

Rodtka, M.C., C.S. Judd, P.K.M. Aku, and K.M. Fitzsimmons. 2015. Estimating occupancy and detection probability of juvenile bull trout using backpack electrofishing gear in a west-central Alberta watershed. Canadian Journal of Fisheries and Aquatic Sciences 72: 742–750.

Stevens Jr, D.L., and A.R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association 99 (465): 262–278.

Strahler, A.N. 1952. Hypsometric (area-altitude) analysis of erosional topography. Geological Society of America Bulletin 63: 1117–1142.

Wentworth, C.K. 1922. A scale of grade and class terms for clastic sediments. The Journal of Geology 30: 377–392.

7.0 APPENDICES

Appendix 1. Summary of backpack and tote-barge electrofishing site locations (NAD 83, Zone 11) in the Lower James River (LJ), Middle James River (MJ), South James River (SJ), Upper James River (UJ), and Willson Creek (W) HUC 10 watersheds, 2018 and 2019.

Site ID	Date (dd/mm/yyyy)	UTM		Distance (m)	Effort (s)
		Easting	Northing		
LJ1	18/07/2019	634624	5746928	300	1,268
LJ2	18/07/2019	638978	5757186	300	1,465
LJ3	22/07/2019	649980	5760544	300	934
LJ4	23/07/2019	652399	5757395	300	766
LJ5	22/07/2019	640130	5758555	300	1,821
LJ6	22/07/2019	648888	5761462	300	959
LJ7	07/08/2019	652616	5755494	300	1,396
LJ8	18/07/2019	636789	5750316	150	399
LJ9	23/07/2019	650371	5757781	300	1,580
LJ10	07/08/2019	651883	5756036	300	1,580
MJ1	07/08/2019	631419	5753209	300	1,849
MJ2	06/08/2019	629597	5747779	300	1,200
MJ3	09/08/2019	628340	5753006	300	1,180
MJ4	08/08/2019	622070	5749820	300	1,593
MJ5	09/08/2019	624669	5747323	300	962
MJ6	08/08/2019	626959	5751767	300	1,393
MJ7	08/08/2019	619330	5749082	300	709
MJ8	23/07/2019	632330	5750123	300	1,318
MJ9	09/08/2019	625107	5742336	300	590
MJ11	09/08/2019	630437	5753381	300	1,262
SJ1	16/07/2019	633020	5741450	300	1,806
SJ2	16/07/2019	631836	5742610	300	1,499
SJ3	17/07/2019	628921	5739067	300	967
SJ4	17/07/2019	628426	5743686	300	1,037
SJ5	16/07/2019	632720	5739854	300	912
SJ6	17/07/2019	629139	5744206	300	1,055
SJ7	17/07/2019	630240	5741487	300	523
SJ8	16/07/2019	633415	5740024	300	957
SJ9	16/07/2019	630684	5744329	300	1,235
SJ10	17/07/2019	629383	5740692	300	1,433

Appendix 1. cont.

Site ID	Date (dd/mm/yyyy)	UTM		Distance (m)	Effort (s)
		Easting	Northing		
UJ1	11/08/2019	616226	5737752	300	1,259
UJ2	10/08/2019	613124	5733563	300	534
UJ3	09/08/2019	615641	5735449	300	1,163
UJ4	13/08/2019	624251	5741277	500	1,856
UJ5	10/08/2019	612117	5736047	300	1,132
UJ6	10/08/2019	614990	5733628	300	1,253
UJ7	13/08/2019	623950	5740119	500	1,610
UJ8	11/08/2019	617137	5737093	300	1,698
UJ9	10/08/2019	620629	5733196	300	850
UJ10	11/08/2019	619420	5737535	300	1,261
W1	28/06/2018	622001	5745485	300	595
W2	21/06/2018	608273	5740682	300	949
W3	20/06/2018	610489	5747279	300	1,395
W4	19/06/2018	617184	5741940	200	801
W5	21/06/2018	607898	5744369	300	1,258
W6	27/06/2018	609807	5745715	300	1,339
W7	27/06/2018	618854	5742350	300	1,659
W8	28/06/2018	621795	5743460	300	1,091
W9	27/06/2018	612382	5744464	300	1,410
W10	19/06/2018	616090	5742437	500	2,053

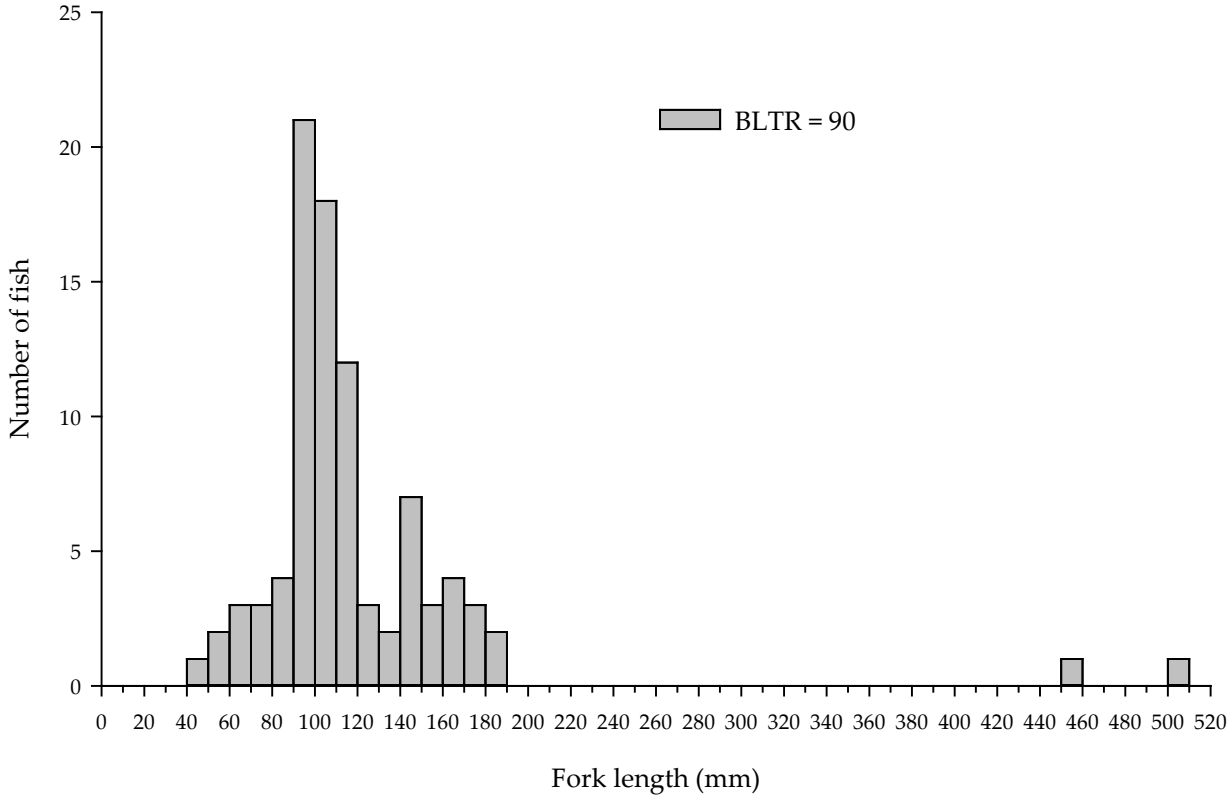
Appendix 2. Summary of backpack and tote-barge electrofishing fish catch in the Lower James River (LJ), Middle James River (MJ), South James River (SJ), Upper James River (UJ), and Willson Creek (W) HUC 10 watersheds, 2018 and 2019. Species codes: BKTR = brook trout, BLTR = bull trout, BNTR = brown trout, BRST = brook stickleback, FTMN = fathead minnow, LKCH = lake chub, LNDC = longnose dace, LNSC = longnose sucker, MNSC, mountain sucker, MNWH = mountain whitefish, PRDC = pearl dace, SPSC, spoonhead sculpin, WALL = walleye, WHSC = white sucker

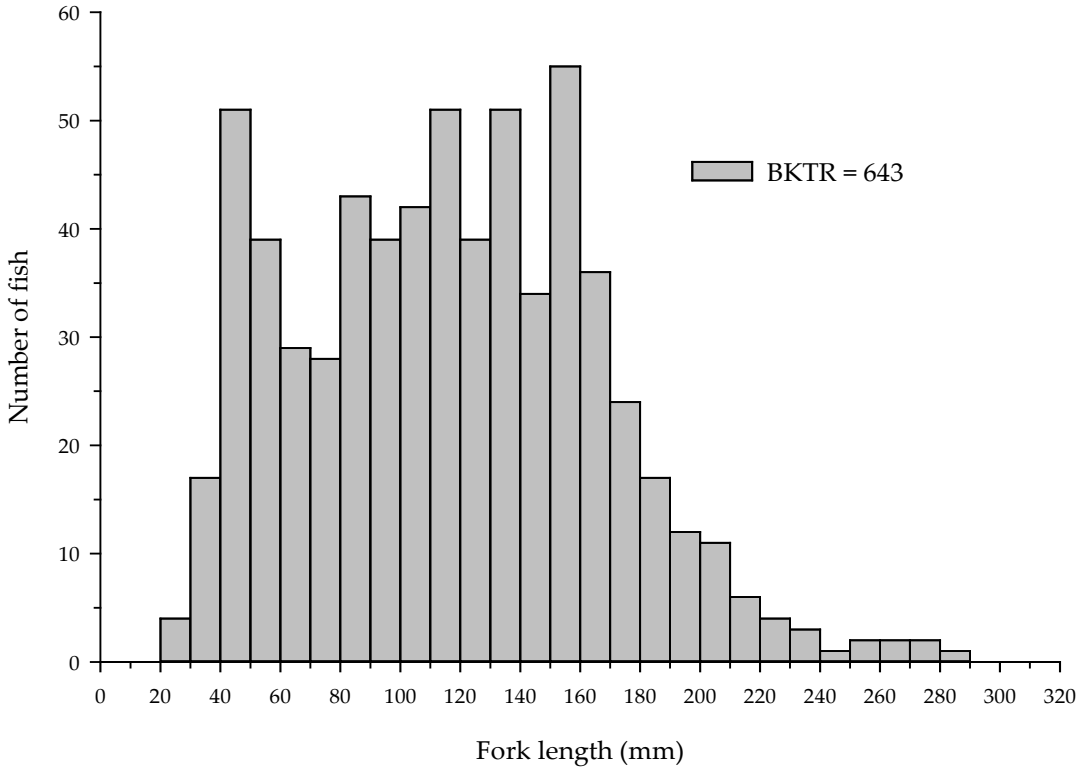
Site ID	Species													
	BKTR	BLTR	BNTR	BRST	FTMN	LKCB	LNDC	LNSC	MNSC	MNWH	PRDC	SPSC	WALL	WHSC
LJ1	7	0	0	0	0	0	0	0	0	0	0	0	0	0
LJ2	21	0	0	0	0	0	0	0	0	0	0	0	0	0
LJ3	0	0	0	0	0	0	1	0	0	0	1	0	0	0
LJ4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LJ5	112	0	0	0	0	0	0	0	0	0	0	0	0	0
LJ6	0	0	0	0	0	0	1	0	0	0	0	0	1	0
LJ7	13	0	1	0	0	0	26	0	1	0	1	0	0	1
LJ8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LJ9	0	0	0	1	1	3	79	0	0	0	0	0	0	9
LJ10	33	0	0	0	0	0	21	0	6	0	0	0	0	4
MJ1	37	0	1	0	0	0	0	0	0	0	0	0	0	0
MJ2	9	0	0	0	0	5	18	1	0	0	0	0	0	0
MJ3	18	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ4	25	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ5	0	0	1	0	0	0	0	0	0	0	0	0	0	0
MJ6	21	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ8	35	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ11	21	0	1	0	0	0	0	0	0	0	0	0	0	0

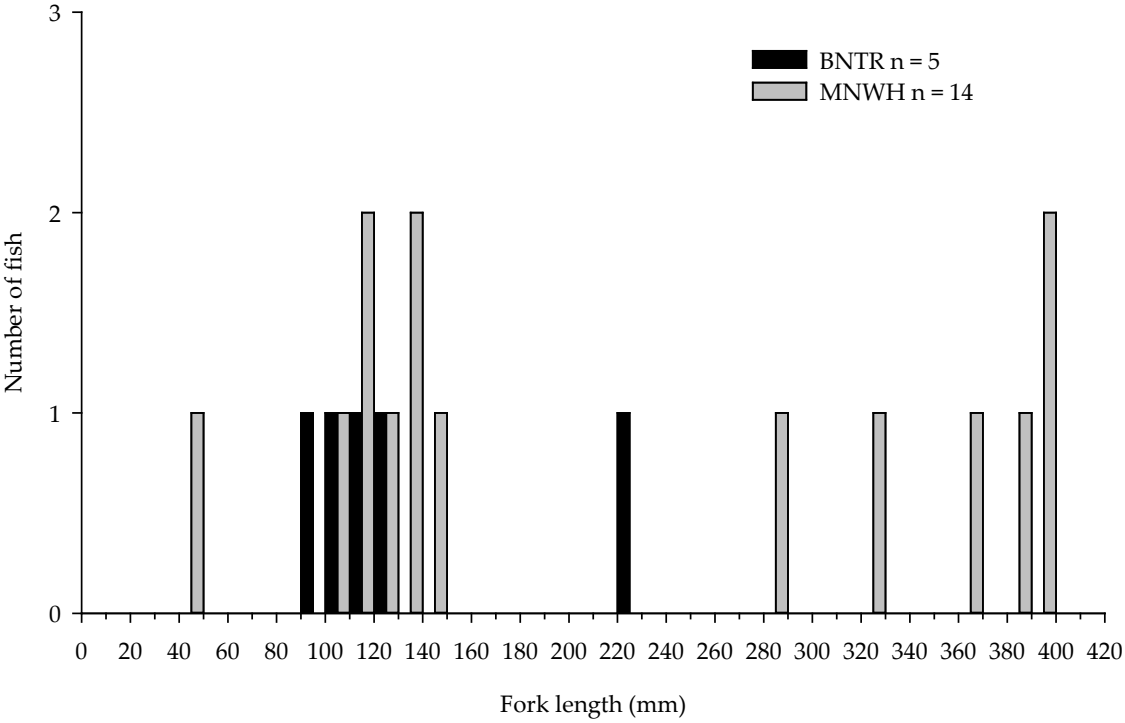
Appendix 2. cont.

Site ID	Species													
	BKTR	BLTR	BNTR	BRST	FTMN	LKCB	LNDC	LNSC	MNSC	MNWH	PRDC	SPSC	WALL	WHSC
SJ1	5	0	0	0	0	0	4	0	0	0	0	0	0	0
SJ2	1	0	0	0	0	0	4	1	0	0	0	0	0	0
SJ3	2	0	0	0	0	0	0	0	0	0	0	0	0	0
SJ4	2	0	0	0	0	0	0	0	0	0	0	0	0	0
SJ5	2	0	0	0	0	0	0	0	0	0	0	0	0	0
SJ6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SJ7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SJ8	2	0	0	0	0	0	0	0	0	0	0	0	0	0
SJ9	0	0	0	0	0	0	2	0	0	0	0	0	0	0
SJ10	3	0	0	0	0	0	0	0	0	0	0	0	0	0
UJ1	24	0	0	0	0	0	0	0	0	0	0	0	0	0
UJ2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UJ3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UJ4	14	6	1	0	0	0	29	0	0	7	0	3	0	0
UJ5	27	0	0	0	0	0	0	0	0	0	0	0	0	0
UJ6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UJ7	35	1	0	0	0	0	7	0	0	2	0	0	0	0
UJ8	33	0	0	0	0	0	0	0	0	0	0	0	0	0
UJ9	2	0	0	0	0	0	0	0	0	0	0	0	0	0
UJ10	20	0	0	0	0	0	0	0	0	0	0	0	0	0
W1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W2	20	0	0	0	0	0	0	0	0	0	0	0	0	0
W3	16	4	0	0	0	0	0	0	0	0	0	0	0	0
W4	14	5	0	0	0	0	0	0	0	0	0	3	0	0
W5	19	17	0	0	0	0	0	0	0	0	0	0	0	0
W6	13	5	0	0	0	0	0	0	0	0	0	0	0	0
W7	4	14	0	0	0	0	0	0	0	4	0	0	0	0
W8	3	4	0	0	0	0	1	0	0	1	0	0	0	0
W9	8	14	0	0	0	0	0	0	0	0	0	0	0	0
W10	22	20	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 3. Length frequency histograms of bull trout, brook trout, brown trout, and mountain whitefish, captured using backpack and tote-barge electrofishing gear in the James River HUC 10 watersheds, 2018 and 2019. Species codes: BKTR = brook trout, BLTR = bull trout, BNTR = brown trout, MNWH = mountain whitefish.




BKTR = 643
Number of fish
Fork length (mm)
0
10
20
30
40
50
60
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320


BNTR n = 5
MNWH n = 14
Number of fish
Fork length (mm)
0
1
2
3
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420

Appendix 4. Summary of habitat measurements at electrofishing sites in Lower James River (LJ), Middle James River (MJ), South James River (SJ), Upper James River (UJ), and Willson Creek (W) HUC 10 watersheds, 2018 and 2019. Substrate codes: B = boulder, C = cobble, F = fines, LG = large gravel, SG = small gravel.

Site ID	Temp (°C)	Ambient cond. (µS/cm)	Mean wetted width ± SD (m)	Mean rooted width ± SD (m)	Mean depth ± SD (m)	Dominant/ secondary substrate	Mean % pool (min - max)	Mean % riffle (min - max)	Mean % run (min - max)
LJ1	6	173	1.4 ± 0.5	2.2 ± 0.9	0.21 ± 0.08	LG/C	0(0 - 0)	100(100-100)	0(0-0)
LJ2	10	218	2.7 ± 0.6	4.0 ± 2.1	0.42 ± 0.16	F, LG/C, F, LG	1(0-5)	13(0-30)	87(70-100)
LJ3	21	257	7.2 ± 1.6	11.0 ± 3.2	0.71 ± 0.08	F/SG	0(0-0)	0(0-0)	100(100-100)
LJ4	13	129	0.5 ± 0.2	0.7 ± 0.5	0.3 ± 0.11	F/SG	0(0-0)	2(0-5)	98(95-100)
LJ5	10	254	3.1 ± 0.6	4.3 ± 1.0	0.34 ± 0.07	LG/SG	0(0-0)	82(75-90)	18(10-25)
LJ6	22	261	4.6 ± 1.5	7.3 ± 2.1	0.7 ± 0.07	F/SG	0(0-0)	0(0-0)	100(100-100)
LJ7	15	260	5.2 ± 1.5	8.5 ± 0.8	0.31 ± 0.09	C/LG	2(0-5)	66(40-100)	33(0-60)
LJ8	12	244	2.0 ± 1.2	2.5 ± 1.1	0.27 ± 0.09	F/SG	0(0-0)	2(0-5)	98(95-100)
LJ9	18	249	4.3 ± 1.0	6.9 ± 1.5	0.62 ± 0.12	SG/F	0(0-0)	2(0-10)	98(90-100)
LJ10	15	250	5.6 ± 1.3	7.2 ± 2.0	0.33 ± 0.15	LG/C	3(0-5)	57(40-70)	41(30-55)
MJ1	17	181	7.1 ± 2.1	10.2 ± 1.8	0.32 ± 0.08	C/LG	2(0-5)	85(80-100)	13(0-20)
MJ2	16	166	3.9 ± 1.1	7.6 ± 1.7	0.28 ± 0.11	LG/C, LG	7(0-20)	39(10-60)	54(40-70)
MJ3	12	138	5.1 ± 1.2	9.7 ± 0.8	0.37 ± 0.22	C, LG/LG	3(0-10)	44(20-60)	53(40-70)
MJ4	14	99	3.2 ± 0.8	4.9 ± 1.1	0.47 ± 0.15	SG/F	2(0-5)	41(10-65)	58(35-90)
MJ5	12	79	2.6 ± 0.6	3.8 ± 0.6	0.24 ± 0.1	SG/C, LG	4(0-10)	21(15-30)	75(65-80)
MJ6	15	163	6.0 ± 1.5	8.2 ± 1.7	0.39 ± 0.31	SG/LG	0(0-0)	31(0-50)	69(50-100)
MJ7	11	61	1.2 ± 0.5	2.1 ± 0.8	0.10 ± 0.02	C, LG/LG	1(0-5)	84(65-95)	15(5-30)
MJ8	13	149	2.0 ± 0.5	4.7 ± 1.8	0.32 ± 0.16	SG/F, LG, SG	6(0-15)	38(20-60)	56(40-80)
MJ9	7	220	0.5 ± 0.2	0.9 ± 0.4	0.19 ± 0.08	LG/F, LG	1(0-5)	53(30-75)	46(20-70)
MJ11	12	155	5.5 ± 1.9	10.8 ± 1.6	0.30 ± 0.17	LG/C	3(0-10)	23(10-40)	73(60-90)

Appendix 4. cont.

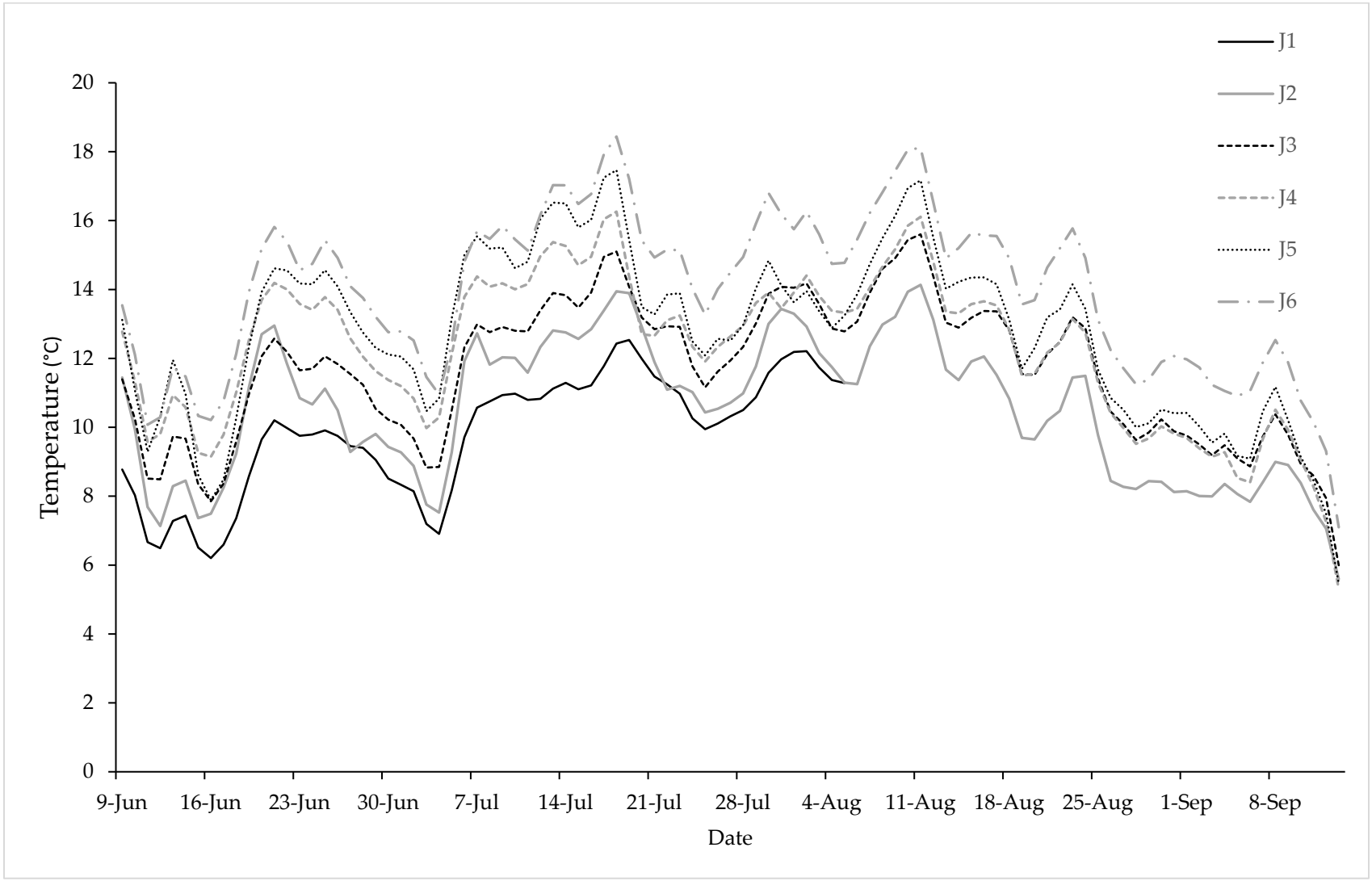
Site ID	Temp (°C)	Ambient cond. (µS/cm)	Mean wetted width ± SD (m)	Mean rooted width ± SD (m)	Mean depth ± SD (m)	Dominant/ secondary substrate	Mean % pool (min-max)	Mean % riffle (min-max)	Mean % run (min-max)
SJ1	11	107	3.5 ± 1.0	4.4 ± 0.8	0.53 ± 0.26	LG/C	0(0-0)	40(10-60)	60(40-90)
SJ2	9	102	3.9 ± 0.7	6.0 ± 1.2	0.43 ± 0.12	SG/LG	7(0-25)	33(0-60)	61(30-95)
SJ3	9	210	3.2 ± 0.7	4.0 ± 1.4	0.53 ± 0.21	SG/LG	0(0-0)	87(60-100)	13(0-40)
SJ4	10	192	6.7 ± 2.3	10.6 ± 1.5	0.58 ± 0.28	LG/C	12(0-25)	52(40-60)	37(25-60)
SJ5	13	129	1.4 ± 0.5	2.3 ± 0.9	0.50 ± 0.27	LG/SG	0(0-0)	40(30-60)	60(40-70)
SJ6	9	191	7.5 ± 1.3	9.9 ± 1.1	0.32 ± 0.04	LG/SG	3(0-10)	81(70-100)	17(0-30)
SJ7	9	82	0.8 ± 0.4	2.1 ± 1.2	0.20 ± 0.09	F/SG	0(0-0)	7(0-20)	93(80-100)
SJ8	12	123	0.9 ± 0.3	0.9 ± 0.3	0.75 ± 0.32	F/SG	0(0-0)	12(0-60)	88(40-100)
SJ9	12	133	5.6 ± 0.8	10.0 ± 1.6	0.39 ± 0.11	LG/SG	2(0-5)	28(20-50)	71(50-80)
SJ10	10	196	3.1 ± 1.5	3.4 ± 1.6	0.67 ± 0.13	LG/C	10(0-15)	14(0-20)	76(65-100)
UJ1	6	227	2.2 ± 0.7	3.5 ± 1.4	0.27 ± 0.14	LG/C, SG	0(0-0)	70(50-85)	30(15-50)
UJ2	8	299	1.3 ± 0.6	2.1 ± 0.4	0.20 ± 0.08	C/LG	4(0-10)	85(70-100)	11(0-20)
UJ3	8	249	1.5 ± 0.3	2.7 ± 0.6	0.14 ± 0.04	C/LG	1(0-5)	88(75-100)	12(0-25)
UJ4	12	302	10 ± 1.8	16.1 ± 1.9	0.77 ± 0.32	B/C	3(0-10)	73(30-90)	24(10-70)
UJ5	9	289	4.4 ± 1.2	6.2 ± 1.5	0.17 ± 0.03	LG/C	0(0-0)	100(100-100)	0(0-0)
UJ6	7	178	1.1 ± 0.4	1.5 ± 0.7	0.21 ± 0.07	C/F	3(0-5)	24(20-30)	73(65-80)
UJ7	10	285	9.4 ± 2.1	18.2 ± 5.8	0.60 ± 0.17	C/C, LG	1(0-5)	85(70-100)	14(0-30)
UJ8	9	286	5.1 ± 1.2	6.8 ± 1.2	0.47 ± 0.15	LG/SG	3(0-10)	33(10-45)	65(50-80)
UJ9	9	159	1.0 ± 0.3	2.3 ± 1.1	0.13 ± 0.09	C, LG/LG	2(0-5)	53(40-75)	45(25-60)
UJ10	9	295	6.4 ± 2.3	9.7 ± 2.0	0.32 ± 0.07	LG/C, LG	3(0-10)	51(25-90)	47(10-75)

Appendix 4. cont.

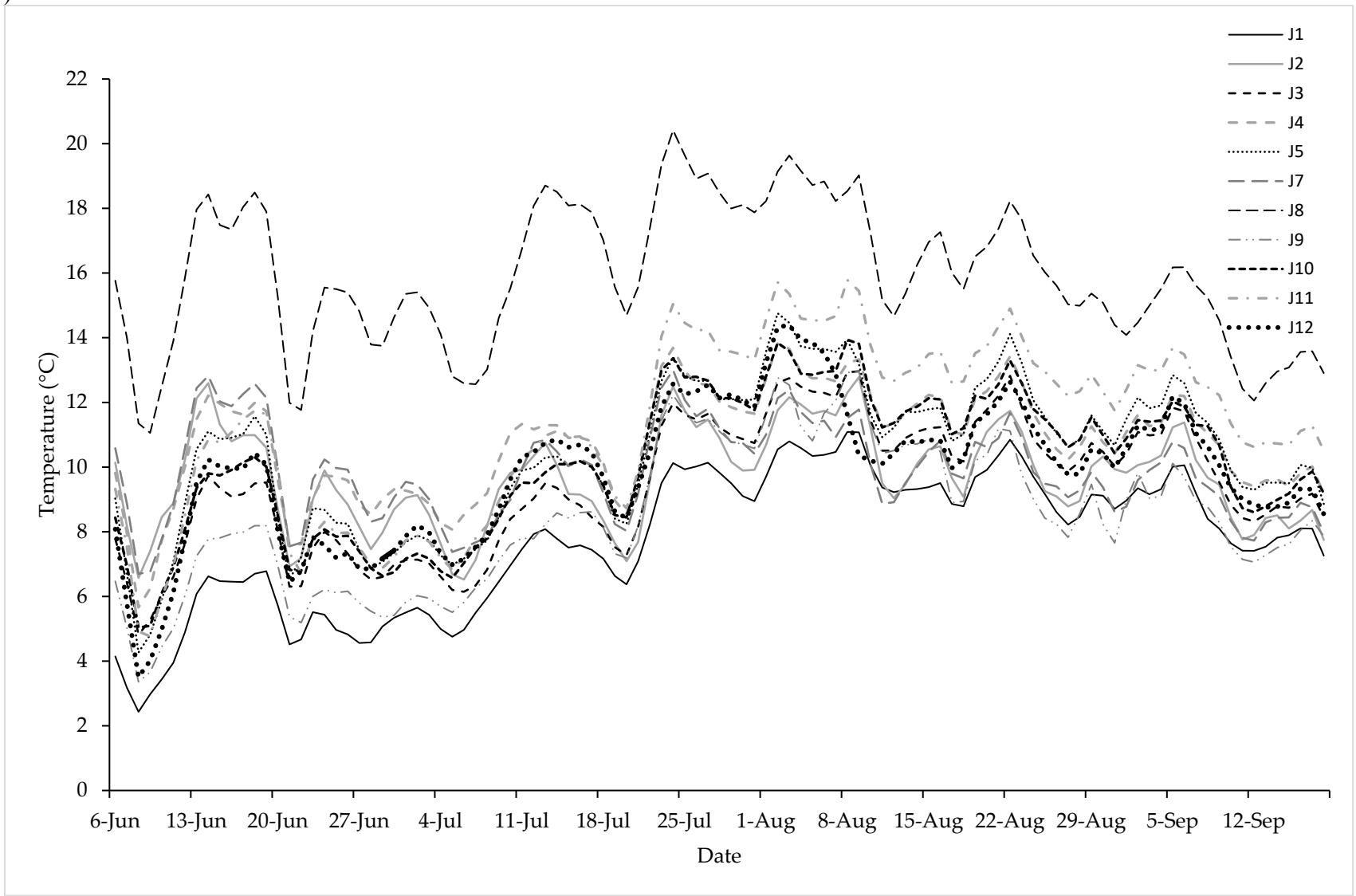
Site ID	Temp (°C)	Ambient cond. (µS/cm)	Mean wetted width ± SD (m)	Mean rooted width ± SD (m)	Mean depth ± SD (m)	Dominant/ secondary substrate	Mean % pool (min-max)	Mean % riffle (min-max)	Mean % run (min-max)
W1	9	56	0.6 ± 0.4	0.9 ± 0.4	0.36 ± 0.19	F/SG	39(0-70)	4(0-10)	57(30-95)
W2	11	191	2.4 ± 0.8	9.8 ± 5.2	0.18 ± 0.02	C/LG	0(0-0)	98(95-100)	3(0-5)
W3	9	86	2.9 ± 0.8	4.1 ± 1.2	0.28 ± 0.04	C/LG	6(0-10)	80(60-100)	14(0-35)
W4	10	175	12.1 ± 2.3	23.0 ± 8.2	0.52 ± 0.16	C/B	13(10-15)	65(60-70)	23(15-30)
W5	10	211	4.3 ± 1.1	8.0 ± 1.5	0.29 ± 0.06	C/LG	2(0-5)	69(50-90)	29(5-50)
W6	9	52	2.0 ± 1.0	2.1 ± 0.9	0.21 ± 0.03	LG/F	13(5-20)	63(30-80)	24(10-50)
W7	7	172	6.9 ± 1.6	13.6 ± 1.4	0.56 ± 0.15	C/LG	17(5-25)	74(50-95)	9(0-25)
W8	11	190	7.5 ± 2.2	17.9 ± 3.7	0.46 ± 0.16	C/LG	2(0-10)	78(40-100)	21(0-60)
W9	15	202	6.7 ± 1.8	9.6 ± 3.3	0.33 ± 0.09	LG/C	3(0-5)	55(20-95)	43(0-80)
W10	7	170	10.2 ± 3.2	21.2 ± 13.8	0.56 ± 0.19	C/B, C	2(0-5)	78(30-100)	20(0-65)

Appendix 5. Two-day moving average stream temperature at a) six stations in the James River HUC 8 watershed, 2018, and b) 11 stations in the James River HUC 8 watershed, 2019.

a)



b)


J1
J2
J3
J4
J5
J7
J8
J9
J10
J11
J12
Temperature (°C)
0
2
4
6
8
10
12
14
16
18
20
22
6-Jun
13-Jun
20-Jun
27-Jun
4-Jul
11-Jul
18-Jul
25-Jul
1-Aug
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
12-Sep
Date


Alberta Conservation
Association