Westslope Cutthroat Trout Population Monitoring in the Upper Oldman River Watershed, 2018–2022

Alberta Conservation Association

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EXECUTIVE SUMMARY

Westslope cutthroat trout (*Oncorhynchus clarki lewisi*) (WSCT) populations have declined to approximately 5% of their historical distribution in Alberta and the species is listed as *Threatened* under the *Species at Risk Act*. In 2018, the *Livingstone-Porcupine Hills Land Footprint Management Plan* was introduced by the Government of Alberta to manage the long-term cumulative impacts of human footprint on public lands in the Eastern Slopes. The resulting Livingstone Public Land Use Zone encompasses the largest remaining WSCT core area in Alberta. Current land-use restrictions and habitat recovery activities in these critical habitats should benefit native trout fish populations and aid in species recovery. To support recovery actions within the public land use zone, we initiated a multi-year study (2018–2022) to monitor WSCT populations in four high priority critical habitat areas in the upper Oldman River WSCT core area: Livingstone River, upper Oldman River, Dutch Creek, and Hidden Creek. We established 39 electrofishing index sites across these sub-watersheds and surveyed each site with backpack and tote barge electrofishing equipment for five consecutive years.

In each study year, we captured three fish species in all sub-watersheds: westslope cutthroat trout, bull trout (*Salvelinus confluentus*), and mountain whitefish (*Prosopium williamsoni*). Westslope cutthroat trout was the most abundant species, composing the majority of the catch and captured at all sites at least once during the study. Total relative abundance of WSCT (≥ 70 mm fork length) (fish/300m) was highest in the Livingstone River and upper Oldman River watersheds and lowest in the watersheds of Dutch Creek and Hidden Creek. Abundance of adult WSCT (≥ 153 mm fork length) was highest in the Livingstone River and upper Oldman River watersheds, primarily in higher order, mainstem streams. Abundance of juvenile WSCT (≥ 70–<153 mm fork length) was highest in lower order, tributary streams in all watersheds except Hidden Creek, where we captured a higher proportion of adults. Westslope cutthroat trout were generally bigger in larger, higher order mainstem streams and smaller in low order tributary streams in all watersheds. Mean WSCT size was smallest in all watersheds in 2021 and 2022 as we captured a higher proportion of juvenile fish than in previous years.

Results from our sampling series have captured current native trout population data in four of six priority watersheds in the upper Oldman River WSCT core area. This time series dataset can be used to determine the sustainability of each WSCT population, aid in species recovery, and be used as a baseline to monitor long-term changes in WSCT abundance and distribution in response to the new land-use restrictions and proposed habitat restoration activities in the upper Oldman River WSCT core area.

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1.0   INTRODUCTION

Westslope cutthroat trout (WSCT) (*Oncorhynchus clarkii lewisi*) populations have declined to approximately 5% of their historical distribution in Alberta (Fisheries and Oceans Canada 2019) and are listed as *Threatened* under the federal *Species at Risk Act* (Government of Canada 2023a). Two main threats identified in the WSCT recovery plan were degradation of habitat and population fragmentation (Fisheries and Oceans Canada 2019) because of cumulative impacts associated with industrial, commercial, agricultural, and recreational activities occurring in core areas. The Upper Oldman (UOM) River watershed is one of the largest remaining WSCT core areas in Alberta (Fisheries and Oceans Canada 2019). In 2018, the Government of Alberta (GOA) established the *Livingstone-Porcupine Hills Land Footprint Management Plan* to guide the long-term management of cumulative effects of human footprint on public lands in the Eastern Slopes (Alberta Environment and Parks 2018). This plan led to the creation of the Livingstone-Porcupine Hills Public Land Use Zone (PLUZ), which encompasses the UOM River WSCT core area. The plan is designed to reduce cumulative impacts on the landscape by changing land-use patterns and allowing existing land-use footprints to recover (Alberta Environment and Parks 2018). It also incorporates WSCT recovery goals by reducing recreational land-use impacts in areas identified as critical WSCT habitat (Alberta Environment and Parks 2018).

Populations of WSCT in six priority sub-watersheds of the UOM River WSCT core area are expected to benefit from these land-use restrictions. Long-term monitoring and ongoing evaluation are essential for tracking the effectiveness of mitigation/recovery efforts and trends in WSCT populations and habitat conditions (Fisheries and Oceans Canada 2019). Alberta's Fish Sustainability Index (FSI) is a standardized assessment tool that provides a landscape-level overview of fish sustainability within the province and enables broad-scale evaluation of management actions and land-use planning (MacPherson et al. 2014). The FSI tool enables the assessment of changes to the sustainability of each WSCT population in response to reduced cumulative impacts and recovery of existing land-use footprints in the PLUZ.

Alberta Conservation Association (ACA) completed a five-year study to monitor WSCT distribution, abundance, and population structure in four Hydrologic Unit Code (HUC) 10 priority watersheds in the UOM River WSCT core area. This study generated data between 2018 and 2022 on natural variation in WSCT populations within GOA priority areas, which inform fisheries managers regarding population responses to changes in recreation management in the Livingstone-Porcupine Hills (Alberta Environment and Parks 2017). Data collected in this study will aid WSCT recovery and feed into Alberta's FSI ranking as a baseline for future monitoring efforts.

2.0   STUDY AREA

We conducted our study in the UOM River WSCT core area located along the eastern slopes of southwestern Alberta, approximately 130 km southwest of Calgary, Alberta (Figure 1). The study area is within the Livingstone-Porcupine PLUZ, which includes the Bob Creek Wildland, Don Getty Wildlands, Livingstone Natural Area, and Beehive Natural Area.

Land-use activities in the area include forestry, cattle grazing, off-highway vehicle use, wilderness camping, equestrian riding, hiking, hunting, and angling (Alberta Environment and Parks 2018). Numerous metallurgical coal leases slated for mountain top removal projects are encompassed in the study area. In 2018–2019, mining exploration surveys were initiated for a short duration before coal mining in these areas was indefinitely deferred in 2021.

The UOM watershed encompasses the largest remaining WSCT core habitat area in Alberta and includes six HUC 10 watersheds listed as critical habitat (Fisheries and Oceans Canada 2019). Our study focuses on four of the six high priority watersheds: Livingstone River, UOM River, Dutch Creek, and Hidden Creek. Several fish species occur in the study area: WSCT, rainbow trout (*Oncorhynchus mykiss*), westslope cutthroat x rainbow trout hybrid, bull trout (*Salvelinus confluentus*), and mountain whitefish (*Prosopium williamsoni*).
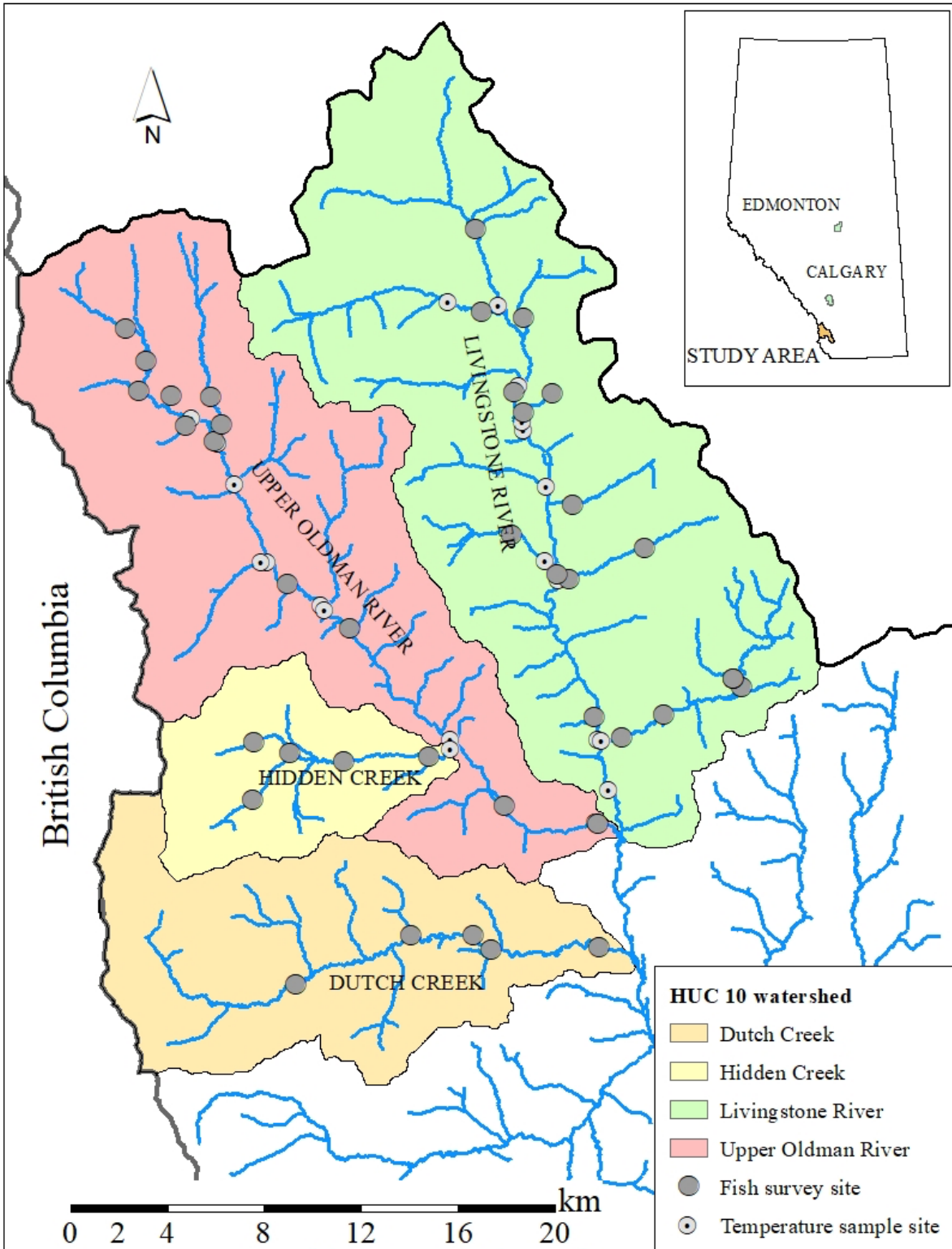
Figure 1. Electrofishing and temperature survey sites in the upper Oldman River westslope cutthroat trout core area, 2018–2022. Inset map shows the study area within the province of Alberta.

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3.0   MATERIALS AND METHODS

3.1   Site selection

We selected fish survey sites in each watershed using the Generalized Random Tessellation Stratification (GRTS) algorithm (Stevens and Olsen 2004, Olsen et.al. 2012) available in the spsurvey library using the R software package (R Core Team 2019, Dumelle et al. 2023). Using ArcGIS 10.8.1© we created a pool of possible survey locations by placing a series of evenly spaced points along order three or higher streams (Strahler 1957); all fishless streams, upstream of permanent fish barriers were eliminated from the site selection process. Survey locations were stratified into two groups: backpack electrofishing streams (order 3, 4, and 5, and <10 m wetted width), and tote barge electrofishing streams (order 5 and 6, and >10 m wetted width). Our point spacing was based on minimum sample distance criteria listed in *Standards for Sampling Small Streams in Alberta* (GOA 2013) and varied by stratum; point spacing for backpack electrofishing streams was 300 m, and 500 m for tote barge electrofishing streams (GOA 2013). We allocated survey sites in each watershed with an unequal probability based on the variance from previous WSCT catch-per-unit-effort (CPUE) data measured in each stratum; strata with high variance were assigned more sample sites than strata with low variance. A total of 39 spatially balanced survey sites were randomly selected in the UOM River WSCT core area: 17 in Livingstone River watershed, 12 in Upper Oldman River watershed, and five in both Hidden Creek and Dutch Creek watersheds (Figure 1 and Appendix 1). Most of our sites were backpack electrofishing sites (n = 30), as tote barge electrofishing sites were limited to the lower reaches of the Livingstone River (n= 4) and the UOM River (n = 5).

3.2   Data collection

Electrofishing surveys followed provincial guidelines that specify site lengths for small wadeable streams be 300 m and 500 m for large wadeable streams (GOA 2013). To maintain the temporal and spatial balance in the sample design, our fish surveys were completed in order from the site list generated by the GRTS algorithm. In 2020, COVID-19 restrictions delayed fish surveys to late August, which limited our sampling window to completing only half of our sites (n = 20), and in this instance, we conducted fish surveys in each watershed in GRTS site list order.

Our backpack electrofishing surveys were conducted in crews of two, with one person operating the Smith-Root © LR 20 backpack electrofisher and the second person capturing fish with a dip net. Backpack sites were sampled in an upstream direction, sampling all fish habitat types with equal effort. We surveyed sites in 50-m transects and collected fish and habitat measurements at each transect section. Our backpack surveys were conducted between July and August, following spring freshet when flow conditions were suitable for wading.

Our tote barge electrofishing surveys were conducted in a crew of four, with one person operating the tote barge efisher (Smith-Root © GPP), a second person sampling with a telescopic anode, and two other people catching fish with dip nets. Tote barge efishing surveys were conducted in a downstream direction sampling all fish habitat types with equal effort. We surveyed tote barge sites in 100-m transects and collected fish and fish habitat measurements at each transect section. Our tote barge surveys were conducted in the first half of August to optimize fish catches and ensure safe wading conditions.

Immobilized fish were removed from the stream and revived in a live well before being measured and released back into the stream in an area where they would not be recaptured. We collected biological data from each fish, including species, fork length (FL, mm), total length (mm), and weight (g); fish injuries and deformities were also recorded. We collected tissue samples (upper caudal fin clip) from the first 30 black-spotted trout per survey site for genetic analysis. Tissue samples were immersed in 95% denatured ethyl alcohol solution and stored in a 1.5 mL microcentrifuge cryo-tubes. We collected instream fish habitat information for each site at every transect segment, including wetted and rooted widths (m), stream habitat type composition (run, riffle, pool %), maximum depth (m), water temperature (°C), stream (flow) stage, and specific conductivity (µs/cm).

We collected annual stream temperature data at 19 locations in most of our sample streams in the study area (Figure 1) to determine correlations between fish catch and stream temperature data. We monitored annual summer stream temperatures between May 15 and August 31 using HOBO pendant MX © water temperature loggers. Each year, we installed data loggers in early spring before freshet and removed them in September before ice formation. Each data logger was affixed to an anchor (i.e., tree, boulder, stream substrate) at a suitable instream location where they would be least affected by fluctuating flow levels and solar influence.

3.3   Data analysis

Using R software package (R Core Team 2019), we calculated annual mean (± 95% Confidence Intervals [CI]) WSCT relative abundance (catch-per-unit-effort [CPUE], fish/300 m) for each watershed by bootstrapping fish catch totals for all sites 10,000 times with replacement. In 2020, relative abundance estimates were calculated using fish catch totals from the sites we subsampled. Mean relative abundance estimates were calculated for each stratum and WSCT FSI maturity category: total WSCT ($\geq$70 mm FL), juvenile WSCT ($\geq$70–<153 mm FL), and adult WSCT ($\geq$153 mm FL). Mean relative abundance (± 95% CI) estimates were also calculated for each stratum and bull trout (BLTR) FSI maturity category: total BLTR ($\geq$70 mm FL), sub-adult BLTR ($\geq$70–<150 mm FL), and adult BLTR ($\geq$150 mm FL).

We calculated WSCT hooking damage (%) by site in all study years. Hooking damage calculations were completed for adult WSCT (≥153 mm FL) in mainstem streams, because hooking-related injuries were most commonly observed in this group. Fish and fish habitat data were entered in the provincial Fish and Wildlife Management Information System database (Microsoft Excel©) and submitted to the GOA.

4.0   RESULTS

4.1   Fish catch

We captured three fish species (WSCT, BLTR, and mountain whitefish [MNWH]) in all watersheds in all sampling years (Table 1 and Appendices 2–6). Total catches (≥70 mm FL) of all species ranged from 1,020–2,750 between 2018 and 2022; total catch in 2020 (n = 677) was considerably less than in other study years as we only sampled half of our sites (n = 20). Westslope cutthroat was the most abundant species, composing most of the catch and captured at all sites at least once during the study. Westslope cutthroat trout was the only species caught in the UOM River watershed, upstream of the UOM River falls.

Bull trout were widely distributed throughout the UOM watershed but were considerably less abundant than WSCT, except in the Hidden Creek watershed where we captured a higher number of BLTR (Appendices 2–8). Overall, BLTR catches were highest in colder, groundwater-fed streams such as Hidden Creek, Mean Creek, and the upper reach of the Livingstone River.

Abundance and distribution of MNWH was low compared to those of WSCT and BLTR (Appendices 2–6). Mountain whitefish were absent in streams in the upper reaches of all watersheds and were commonly captured in the lower reaches of the Livingstone and UOM rivers and infrequently captured in the lower reaches of Dutch Creek and Hidden Creek. Mountain whitefish catch during the study was composed mostly of juvenile-sized fish and a few adults. Mountain whitefish catches in the lower reaches of the Livingstone and UOM rivers were notably higher in 2022 than previous years. Overall, fish catches for all species varied from year to year in each watershed, which was likely a result of the seasonal variability in stream flows and water temperatures (Appendices 9 and 10).

Hooking-related injuries on fish were commonly observed in Livingstone River, UOM River, Dutch Creek, and Hidden Creek. The most common hooking-related injury included damage to the mouth (maxillary and premaxillary), jaw, and gill cover, with some fish sustaining multiple injuries. Every year we observed hooking-related injuries on all species captured; however, the most severe and highest proportion of injuries were observed on adult WSCT (≥153 mm FL)

(Appendix 11). Hooking-related injuries on adult WSCT varied between years and were highest in the Livingstone and UOM rivers, and considerably lower in Dutch Creek and Hidden Creek.

Table 1. Total fish caught using electrofishing in the upper Oldman River westslope cutthroat trout core area, 2018–2022.

Year	Species[1]	Livingstone River		Upper Oldman River		Dutch Creek	Hidden Creek	Total
		Backpack sites	Tote barge sites	Backpack sites	Tote barge sites	Backpack sites	Backpack sites	
2018	WSCT	553	90	354	119	36	38	1,190
	BLTR	55	37	0	49	19	43	203
	MNWH	0	12	0	36	1	0	49
2019	WSCT	275	85	219	164	33	32	808
	BLTR	18	25	0	79	15	43	180
	MNWH	0	2	0	29	1	0	32
2020[2]	WSCT	133	51	242	81	30	5	542
	BLTR	17	3	0	72	7	19	118
	MNWH	0	7	0	8	0	2	17
2021	WSCT	787	98	256	1,170	76	16	2,403
	BLTR	29	46	0	142	25	59	301
	MNWH	0	26	0	19	0	1	46
2022	WSCT	558	87	164	568	61	23	1,461
	BLTR	24	26	0	137	21	69	277
	MNWH	0	27	0	95	3	0	125

Header note: Number of fish captured ($\geq$70 mm FL)

[1] WSCT = westslope cutthroat trout, BLTR = bull trout, MNWH = mountain whitefish
[2] COVID-19 subsample year (n = 20 sites)

4.2 Relative abundance and distribution of westslope cutthroat trout

Relative abundance of WSCT (≥70 mm FL) varied from year to year in each watershed and by electrofishing capture technique (Tables 2 and 3). Overall, mean relative abundance of total WSCT for both electrofishing methodologies was highest in the UOM River and Livingstone River watersheds and lowest in the watersheds of Hidden Creek and Dutch Creek. Juvenile WSCT (≥70–<153 mm FL) abundance was higher in backpack electrofishing streams than tote barge electrofishing streams, except in 2022, when we captured the highest number of juvenile fish of the study in the UOM River using tote barge equipment (Appendix 6). Conversely, adult WSCT (≥153 mm FL) abundance was lowest in backpack electrofishing streams and highest in tote barge electrofishing streams, and highest overall in the UOM River mainstem (Tables 2 and 3).

Table 2. Estimated mean (± 95% CI) relative abundance (CPUE fish/300 m) of westslope cutthroat trout captured by backpack electrofishing in the upper Oldman River westslope cutthroat trout core area, 2018–2022.

Watershed	Maturity class	Relative abundance (fish/300 m)				
		2018	2019	2020[a]	2021	2022
Livingstone River	Total WSCT (≥70 mm)	42.6 (27.1–60.5)	21.2 (9.8–35.5)	18.9 (4.0–36.9)	60.9 (23.9–103.6)	42.9 (15.2–76.3)
	Juvenile WSCT (<153mm)	28.4 (16.6–41.2)	14.7 (6.1–25.8)	13.9 (2.4–27.6)	55.6 (21.6–95.8)	36.9 (12.4–66.2)
	Adult WSCT (≥153 mm)	14.1 (7.5–22.8)	6.4 (2.8–11.7)	5.1 (1.4–9.7)	5.0 (2.0–8.3)	5.9 (1.7–11.2)
Upper Oldman River	Total WSCT (≥70 mm)	50.5 (28.1–83.6)	31.2 (15.9–51.7)	60.5 (46.8–70.8)	36.7 (18.1–57.3)	23.3 (7.1–44.0)
	Juvenile WSCT (<153mm)	33.2 (12.1–65.6)	16.2 (5.9–31.0)	35.5 (27.2–43.5)	29.0 (11.3–51.4)	20.5 (4.4–41.9)
	Adult WSCT (≥153 mm)	17.6 (10.1–25.4)	15.1 (8.9–22.4)	25.1 (13.0 –37.0)	7.8 (3.6–12.6)	3.0 (1.4–4.7)
Dutch Creek	Total WSCT (≥70 mm)	7.2 (2.8–11.6)	6.6 (3.0–10.2)	10.1 (3.0–22.0)	15.2 (9.4–20.8)	12.2 (8.2–16.0)
	Juvenile WSCT (<153mm)	5.2 (1.4–9.0)	4.4 (1.8–7.0)	5.4 (2.0–12.0)	11.6 (6.8–16.4)	10.4 (5.6–14.6)
	Adult WSCT (≥153 mm)	2.0 (0.8–3.0)	2.2 (0.6–3.8)	4.7 (1.0–10.0)	3.6 (1.4–5.8)	1.8 (1.0–2.6)
Hidden Creek	Total WSCT (≥70 mm)	7.7 (1.0–14.2)	6.4 (2.0–10.8)	3.0	3.2 (0.4–7.2)	4.6 (1.8–7.4)
	Juvenile WSCT (<153mm)	2.4 (0.0–5.2)	2.6 (0.6–4.6)	1.0	1.4 (0.0–4.2)	1.8 (0.6–3.6)
	Adult WSCT (≥153 mm)	5.2 (1.0–9.4)	3.8 (1.4–6.2)	2.5	1.8 (0.4–3.2)	2.8 (0.8–5.4)

[a] COVID-19 subsample year (n = 20 sites); only one site was surveyed in the Hidden Creek watershed.

Table 3. Estimated mean (± 95% CI) relative abundance (CPUE fish/300 m) of westslope cutthroat trout captured by tote barge electrofishing in the upper Oldman River westslope cutthroat trout core area, 2018–2022.

Watershed	Maturity class	Relative abundance (fish/300 m)				
		2018	**2019**	**2020[a]**	**2021**	**2022**
Livingstone River	Total WSCT (≥70 mm)	13.5 (8.8–20.0)	12.8 (7.9–17.4)	15.3 (12.6–18)	14.7 (6.4–26.2)	15.2 (10.3–19.2)
	Juvenile WSCT (<153mm)	1.6 (0.0–3.6)	2.6 (0.6–6.0)	3.9 (0.0–7.8)	6.6 (2.0–14.0)	5.7 (3.6–7.5)
	Adult WSCT (≥153 mm)	11.8 (7.5–16.4)	10.2 (6–13.8)	11.4 (10.2–12.6)	8.1 (4.2–12.2)	9.5 (7.1–12)
Upper Oldman River	Total WSCT (≥70 mm)	14.3 (5.8–28.6)	19.7 (8.9–37.3)	16.2 (9.6–22.8)	30.6 (14.2–55.6)	68.8 (16.9–160.0)
	Juvenile WSCT (<153mm)	3.0 (0.6–7.0)	2.9 (1.0–5.8)	4.8 (3.0–8.4)	17.5 (5.2–36.8)	53.5 (6.5–135.1)
	Adult WSCT (≥153 mm)	11.2 (5.2–21.4)	16.7 (7.6–31.8)	11.4 (6.6–14.4)	12.8 (8.2–19.2)	15.8 (10.0–25.1)

[a] COVID-19 subsample year (n = 20 sites)

4.2.1. Livingstone River watershed

For backpack electrofishing streams, mean relative abundance of total WSCT was highest in 2021 at 61 fish/300 m, and lowest in 2020 at 19 fish/300 m (Table 2). Total WSCT catches decreased in Ridge Creek, the upper Livingstone River, and Deep Creek following 2018 surveys (Appendices 2–6). Mean abundance of juvenile WSCT was highest in 2021 at 56 fish/300 m and lowest in 2020 at 14 fish/300 m (Table 2). Abundance of juvenile fish was considerably higher in White Creek and Beaver Creek than at all other backpackable streams in the watershed, especially in 2021 and 2022 (Appendices 2–6). Mean abundance of adult WSCT was highest in 2018 at 14 fish/300 m and lowest in 2020 and 2021 at 5 fish/300 m (Table 2).

For tote barge electrofishing streams, mean abundance of total WSCT did not vary by much and was highest in 2020–2022 at 15 fish/300 m, and lowest in 2019 at 13 fish/300 m (Table 3). Juvenile WSCT abundance was highest in 2021 at 7 fish/300 in 2021 and lowest in 2018 at 2 fish/300 m (Table 3). Adult WSCT abundance was highest in 2018 at 12 fish/300 m and lowest in 2021 at 8 fish/300 m (Table 3).

4.2.2. Upper Oldman River watershed

For back-pack electrofishing streams, mean abundance of total WSCT in the UOM River watershed was highest in 2020 at 61 fish/300 m and lowest in 2022 at 23 fish/300 m (Table 2). Abundance of juvenile WSCT was highest in 2020 at 36 fish/300 m and lowest in 2019 at 16 fish/300 m (Table 2). In 2018 and 2022, we caught a much higher number of fish in Pasque Creek than other backpack electrofishing streams in the watershed (Appendices 2–6). Abundance of adult WSCT in backpack electrofishing stream were highest in 2020 at 25 fish/300 m and lowest in 2022 at 3 fish/300 m (Table 2). Abundance of adult WSCT decreased in 2021 and 2022 compared to fish abundance in previous years.

For tote-barge electrofishing streams, relative abundance of total WSCT was highest in 2022 at 69 fish/300 m and lowest in 2018 at 14 fish/300 m (Table 3). Abundance of juvenile WSCT increased consecutively between years from its lowest in 2018 at 3 fish/300 m, to its highest in 2022 at 54 fish/300 m (Table 3). Relative abundance of adult WSCT did not vary by much and was highest in 2019 at 17 fish/300 m and lowest in 2018 and 2020 at 11 fish/300 m (Table 3).

4.2.3. Dutch Creek watershed

Relative abundance of total WSCT in the Dutch Creek watershed varied marginally in backpack electrofishing streams, from 7 fish/300 m (2018 and 2019) to 15 fish/300 m (2021) (Table 2). Similarly, mean relative abundance of juvenile WSCT was highest in 2021 at 12 fish/300 m and lowest in 2019 at 4 fish/300 m (Table 2). Abundance of adult WSCT was highest in 2020 at 5 fish/300 m and similarly low in 2018, 2019, and 2022 at 2 fish/300 m (Table 2).

4.2.4   Hidden Creek watershed

For backpack electrofishing streams, mean abundance of total WSCT in the Hidden Creek watershed varied slightly between years and was the only watershed in the study where adult WSCT relative abundance was greater than juveniles. Overall, total WSCT catches were highest in the downstream reaches of Hidden Creek and lowest upstream in headwater reaches (Appendices 2–6).

Mean abundance of total WSCT in the Hidden Creek watershed was highest in 2018 at 8 fish/300 m and lowest at 3 fish/300 m in both 2020 and 2021; only one site (Site 23) was surveyed in 2020 (Table 2). Mean abundance of juvenile WSCT in the Hidden Creek watershed was lowest in the study ranging from 1 fish/300 m in 2020 to 3 fish/300 m in 2019 (Table 2); most juvenile fish were captured upstream of the Hidden Creek/South Hidden Creek confluence. Relative abundance of adult WSCT was highest in 2018 at 5 fish/300 m and lowest in 2021 at 2 fish/300 m (Table 2); adult WSCT were primarily captured in the lower reach of Hidden Creek (Appendices 2–6).

4.3   Westslope cutthroat trout size structure

Overall, WSCT captured in the UOM River watershed were generally bigger in larger, higher order streams (tote barge electrofishing) and smaller in, lower order streams (backpack electrofishing streams) (Table 4 and Appendices 12–15). In 2021 and 2022, the mean size of WSCT decreased in all watersheds except Hidden Creek as we caught a higher proportion of juvenile WSCT in each watershed than in previous years.

Westslope cutthroat trout size distribution in backpack electrofishing streams ranged from young-of-year to adult-sized fish (Table 4 and Appendices 12–15). With exception to the Hidden Creek watershed, the average size of WSCT backpack electrofishing streams did not exceed 200 mm (FL). The average size of WSCT captured using backpack electrofishing equipment was biggest in the Hidden Creek watershed, followed in order by the watersheds of Dutch Creek, UOM River, and Livingstone River. The biggest WSCT captured in the study was from Hidden Creek, which measured 452 mm (FL) (2020).

Westslope cutthroat trout size distribution in tote barge electrofishing streams ranged from yearling-sized to adult-sized fish (Table 4 and Appendices 12–15). The mean size of WSCT captured by tote barge electrofishing varied from year to year in both the Livingstone and UOM rivers. Both rivers exhibited a bimodal size structure as we caught a higher number of small-bodied fish smaller than 200 mm (FL) and large-bodied fish larger than 300 mm (FL), and only a few fish in between (200–300 mm FL). The mean size of WSCT in the UOM River was notably smaller in 2022, as we captured considerably more juvenile fish with tote barge electrofishing equipment than in previous years, specifically at Site 21 (Appendix 6). The mean size of WSCT

was smallest in the Livingstone River in 2021 as we captured a higher proportion of juvenile fish with tote barge electrofishing equipment than adult fish. The biggest WSCT captured using tote barge electrofishing equipment in the UOM River was 450 mm (FL) (2021) and 440 mm (FL) (2022) in the Livingstone River.

Table 4. Westslope cutthroat trout mean fork length summary of all fish captured in the upper Oldman River westslope cutthroat trout core area, 2018–2022.

| Watershed | Year | Backpack efishing sites | | | Tote barge efishing sites | | |
| | | Fork length (mm) | | | Fork length (mm) | | |
		Mean ± SE	Range	n	Mean ± SE	Range	n
Livingstone River	2018	122.8 ± 2.2	28–313	687	294.2 ± 9.8	82–421	89
	2019	117.6 ± 3.3	40–381	339	275.8 ± 13.0	60–428	90
	2020[1]	116.7 ± 4.2	31–366	145	271.4 ± 37.2	84–427	54
	2021	90.1 ± 1.2	28–416	1,112	182.6 ± 10.7	65–416	99
	2022	104.5 ± 1.6	32–253	636	204.9 ± 16.5	56–440	89
Upper Oldman River	2018	126.1 ± 2.8	33–288	401	216.4 ± 7.8	58–425	120
	2019	184.2 ± 4.1	47–420	337	291.7 ± 13.8	54–442	56
	2020[1]	144.1 ± 2.6	60–300	248	270.3 ± 12.9	60–300	81
	2021	103.1 ± 2.0	45–300	585	199.0 ± 10.0	61–450	124
	2022	93.8 ± 2.8	44–239	218	136.9 ± 2.7	55–445	576
Dutch Creek[2]	2018	135.3 ± 10.7	55–313	41			
	2019	151.4 ± 14.7	55–365	41			
	2020[1]	159.6 ± 17.3	61–392	33	_		
	2021	110.2 ± 6.1	48–402	100			
	2022	112.6 ± 6.2	55–374	70			
Hidden Creek[2]	2018	201.2 ± 12.4	78–394	38			
	2019	190.7 ± 16.7	66–397	33			
	2020[1]	308.0 ± 61.3	80–452	5	_		
	2021	166.7 ± 20.2	62–362	17			
	2022	187.3 ± 14.8	90–335	23			

[1] COVID-19 subsample year (n = 20 sites)
[2] Dutch and Hidden creeks were surveyed with backpack electrofishing only

5.0 SUMMARY

Our WSCT monitoring study provides current native trout population information in four of six priority watersheds the UOM River WSCT core area. We collected five years of data (2018–2022) on WSCT abundance, distribution, and size, and results from our sample series will inform species recovery, feed into the FSI ranking, and can be used as a baseline for future monitoring efforts. These data are key to determine population responses to PLUZ land-use restrictions and habitat restoration activities in the UOM River WSCT core area.

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7.0   APPENDICES

Appendix 1.   Westslope cutthroat trout electrofishing index site location information in the upper Oldman River westslope cutthroat trout core area, 2018–2022.

Watershed (HUC10)	Waterbody	Site ID	Easting[1]	Northing	Stream order	Site length (m)
Livingstone River	Livingstone River	1	686126	5540708	6	500
	Mean Creek	4	683208	5557177	4	300
	White Creek	5	688986	5540789	5	300
	White Creek	6	692240	5541966	5	300
	Livingstone River	7	681222	5560857	5	300
	Spears Creek	8	682729	5548236	4	300
	Livingstone River	12	682822	5554130	6	500
	Deep Creek	13	685115	5546406	3	300
	Deep Creek	16	688221	5547713	3	300
	White Creek	17	687272	5539881	5	300
	Savanna Creek	19	681476	5557432	4	300
	Ridge Creek	20	685265	5549483	4	300
	Unnamed to White Creek	22	691862	5542280	3	300
	Livingstone River	25	691862	5542280	6	500
	Beaver Creek	28	683201	5553299	3	300
	Livingstone River	29	684613	5546587	6	500
	Beaver Creek	44	684379	5554073	2	300
Upper Oldman River	Oldman River	2	686278	5536314	6	500
	Oldman River	6	676058	5544350	6	500
	Oldman River	10	673478	5546217	6	500
	Oldman River	11	682412	5537046	6	500
	Unnamed to Oyster	12	666757	5556764	4	300
	Oyster Creek	16	667626	5555402	5	300
	Oldman River	21	670463	5552099	5	500
	Oldman River	29	667311	5554168	3	300
	Pasque Creek	33	670276	5553950	4	300
	Pasque Creek	37	670735	5552797	4	300
	Lyall Creek	49	669243	5552743	3	300
	Straight Creek	76	668652	5553960	2	300
Dutch Creek	Dutch Creek	1	681887	5531082	5	300
	Dutch Creek	2	678578	5531687	5	300
	Dutch Creek	3	673798	5529674	4	300
	Dutch Creek	4	686354	5531228	5	300
	Dutch Creek	5	681137	5531683	5	300
Hidden Creek	Hidden Creek	4	673563	5539209	3	300
	Hidden Creek	15	675810	5538883	5	300
	Hidden Creek	20	672034	5537284	4	300
	Hidden Creek	23	679288	5539056	5	300
	Hidden Creek	47	672081	5539653	3	300

[1] NAD 83 datum, 11U meridian

Appendix 2. Electrofishing fish catch summary (≥70 mm FL) by species in the upper Oldman River westslope cutthroat trout core area, 2018.

Watershed (HUC 10)	Waterbody	Site ID	Capture method	Site distance (m)	Sample effort (sec)	WSCT[1]	BLTR	MNWH
Livingstone River	Mean Creek	4	Backpack efishing	300	1537	0	44	0
	White Creek	5		300	1828	49	0	0
	White creek	6		300	2033	88	0	0
	Livingstone River	7		300	1413	36	3	0
	Speers Creek	8		300	1160	27	0	0
	Deep Creek	13		300	990	22	0	0
	Deep Creek	16		300	1136	32	0	0
	White Creek	17		300	1661	114	0	0
	Savanna Creek	19		300	994	4	3	0
	Ridge Creek	20		300	1107	47	0	0
	Unnamed to White Creek	22		300	1178	51	0	0
	Beaver Creek	28		300	1302	57	5	0
	Beaver Creek	44		300	1260	26	0	0
	Livingstone River	1	Tote barge efishing	500	1987	38	2	5
	Livingstone River	12		500	2020	20	22	0
	Livingstone River	25		500	1439	19	1	4
	Livingstone River	29		500	1722	13	12	3
Upper Oldman River	Unnamed to Oyster Creek	12	Backpack efishing	300	1028	21	0	0
	Oyster creek	16		300	1058	38	0	0
	Oldman river	29		300	3158	57	0	0
	Pasque Creek	33		300	1130	46	0	0
	Pasque Creek	37		300	1260	142	0	0
	Lyall Creek	49		300	1261	32	0	0
	Straight Creek	76		300	1284	18	0	0
	Oldman River	2	Tote barge efishing	500	2598	14	11	20
	Oldman River	6		500	2198	16	13	8
	Oldman River	10		500	2472	13	22	4
	Oldman River	11		500	1395	6	3	4
	Oldman River	21		500	2246	70	0	0
Dutch Creek	Dutch Creek	1	Backpack efishing	300	1300	3	1	1
	Dutch Creek	2		300	1417	2	2	0
	Dutch Creek	3		300	1451	4	7	0
	Dutch Creek	4		300	1864	14	5	0
	Dutch Creek	5		300	1562	13	4	0
Hidden Creek	Hidden Creek	4	Backpack efishing	300	1039	3	6	0
	Hidden Creek	15		300	1931	16	26	0
	South Hidden Creek	20		300	1138	1	2	0
	Hidden Creek	23		300	1621	18	9	0
	North Hidden Creek	47		300	983	0	0	0

[1] WSCT = westslope cutthroat trout; BLTR = bull trout; MNWH = mountain whitefish

Appendix 3. Electrofishing fish catch summary (≥70 mm FL) by species in the upper Oldman River westslope cutthroat trout core area, 2019.

Watershed (HUC 10)	Waterbody	Site ID	Capture method	Site distance (m)	Sample effort (sec)	WSCT[1]	BLTR	MNWH
Livingstone River	Mean Creek	4	Backpack efishing	300	1243	2	17	0
	White Creek	5		300	1575	21	0	0
	White Creek	6		300	1752	78	0	0
	Livingstone River	7		300	1008	5	0	0
	Speers Creek	8		300	1166	7	0	0
	Deep Creek	13		300	931	11	0	0
	Deep Creek	16		300	1356	12	0	0
	White Creek	17		300	1384	29	0	0
	Savanna Creek	19		300	1279	1	1	0
	Ridge Creek	20		300	974	2	0	0
	Unnamed to White Creek	22		300	1179	24	0	0
	Beaver Creek	28		300	1173	16	0	0
	Beaver Creek	44		300	920	67	0	0
	Livingstone River	1	Tote barge efishing	500	2321	32	5	0
	Livingstone River	12		500	1598	18	11	0
	Livingstone River	25		500	1308	26	3	1
	Livingstone River	29		500	1568	9	6	1
Upper Oldman River	Unnamed to Oyster Creek	12	Backpack efishing	300	1230	88	0	0
	Oyster Creek	16		300	960	30	0	0
	Oldman River	29		300	751	37	0	0
	Pasque Creek	33		300	1080	15	0	0
	Pasque Creek	37		300	1198	31	0	0
	Lyall Creek	49		300	1061	10	0	0
	Straight Creek	76		300	1072	8	0	0
	Oldman River	2	Tote barge efishing	500	2334	20	7	6
	Oldman River	6		500	1962	10	14	7
	Oldman River	10		500	2509	25	41	10
	Oldman River	11		500	2073	18	17	6
	Oldman River	21		500	1841	91	0	0
Dutch Creek	Dutch Creek	1	Backpack efishing	300	1289	10	0	0
	Dutch Creek	2		300	1235	6	6	0
	Dutch Creek	3		300	1076	2	5	0
	Dutch Creek	4		300	1271	3	2	1
	Dutch Creek	5		300	1286	12	2	0
Hidden Creek	Hidden Creek	4	Backpack efishing	300	1022	8	6	0
	Hidden Creek	15		300	1435	12	7	0
	South Hidden Creek	20		300	1260	1	2	0
	Hidden Creek	23		300	1955	11	22	0
	North Hidden Creek	47		300	899	0	1	0

[1] WSCT = westslope cutthroat trout; BLTR = bull trout; MNWH = mountain whitefish

Appendix 4. Electrofishing fish catch summary (≥70 mm FL) by species in the upper Oldman River westslope cutthroat trout core area, 2020.

Watershed (HUC 10)	Waterbody	Site ID	Capture method	Site distance (m)	Sample effort (sec)	WSCT[1]	BLTR	MNWH
Livingstone River	Mean Creek	4	Backpack efishing	300	1084	0	11	0
	Livingstone River	7		300	1234	1	3	0
	Spears Creek	8		300	785	23	0	0
	White Creek	17		300	1558	55	1	0
	Savanna Creek	19		300	981	1	1	0
	Ridge Creek	20		300	1015	4	0	0
	Beaver Creek	28		300	992	49	1	0
	Livingstone River	1	Tote barge efishing	500	2170	30	2	5
	Livingstone River	25		500	1467	21	1	2
Upper Oldman River	Unnamed to Oyster Creek	12	Backpack efishing	300	1120	73	0	0
	Oyster Creek	16		300	1361	64	0	0
	Oldman River	29		300	1160	64	0	0
	Oldman River	33		300	962	41	0	0
	Oldman River	6	Tote barge efishing	500	2589	38	23	6
	Pasque Creek	10		500	3216	27	41	2
	Oldman River	11		500	2003	16	8	0
Dutch Creek	Dutch Creek	1	Backpack efishing	300	1198	5	1	0
	Dutch Creek	4		300	1430	22	5	0
	Dutch Creek	5		300	1201	3	1	0
Hidden Creek	Hidden Creek	23	Backpack	300	2174	5	19	2

[1] WSCT = westslope cutthroat trout; BLTR = bull trout; MNWH = mountain whitefish

Appendix 5. Electrofishing fish catch summary (≥70 mm FL) by species in the upper Oldman River westslope cutthroat trout core area, 2021.

Watershed (HUC 10)	Waterbody	Site ID	Capture method	Site distance (m)	Sample effort (sec)	WSCT	BLTR	MNWH
Livingstone River	Mean Creek	4	Backpack efishing	300	1860	0	25	0
	White Creek	5		300	2184	168	0	0
	White Creek	6		300	1873	239	0	0
	Livingstone River	7		300	1235	2	1	0
	Spears Creek	8		300	928	14	1	0
	Deep Creek	13		300	1091	9	0	0
	Deep Creek	16		300	1020	11	0	0
	White Creek	17		300	1639	101	0	0
	Savanna Creek	19		300	1020	2	2	0
	Ridge Creek	20		300	1025	3	0	0
	Unnamed to White Creek	22		300	1563	63	0	0
	Beaver Creek	28		300	1465	55	0	0
	Beaver Creek	44		300	1399	120	0	0
	Livingstone River	1	Tote barge efishing	500	1832	53	5	4
	Livingstone River	12		500	2230	7	14	0
	Livingstone River	25		500	2236	22	11	3
	Livingstone River	29		500	2019	16	16	19
Upper Oldman River	Oldman River	6	Backpack efishing	300	1045	49	0	0
	Oldman River	10		300	1330	41	0	0
	Oldman River	11		300	914	23	0	0
	Unnamed to Oyster Creek	12		300	1113	45	0	0
	Oyster Creek	16		300	1126	87	0	0
	Oldman River	21		300	787	5	0	0
	Oldman River	29		300	1191	6	0	0
	Oldman River	2	Tote barge efishing	500	3223	30	13	4
	Pasque Creek	33		500	2162	20	27	4
	Pasque Creek	37		500	2713	24	76	7
	Lyall Creek	49		500	2532	47	26	4
	Straight Creek	76		500	2611	132	0	0
Dutch Creek	Dutch Creek	1	Backpack efishing	300	1718	11	3	0
	Dutch Creek	2		300	1602	16	9	0
	Dutch Creek	3		300	1520	5	7	0
	Dutch Creek	4		300	1840	20	4	0
	Dutch Creek	5		300	1931	24	2	0
Hidden Creek	Hidden Creek	4	Backpack efishing	300	984	2	7	0
	Hidden Creek	15		300	1494	3	23	0
	Hidden Creek	20		300	1258	0	2	0
	Hidden Creek	23		300	1526	11	22	1
	Hidden Creek	47		300	876	0	5	0

[1] WSCT = westslope cutthroat trout; BLTR = bull trout; MNWH = mountain whitefish

Appendix 6. Electrofishing fish catch summary (≥70 mm FL) by species in the upper Oldman River Westslope cutthroat trout core area, 2022.

Watershed (HUC 10)	Waterbody	Site ID	Capture method	Site distance (m)	Sample effort (sec)	WSCT[1]	BLTR	MNWH
Livingstone River	Mean Creek	4	Backpack efishing	300	1769	0	21	0
	White Creek	5		300	1297	164	0	0
	White Creek	6		300	1284	153	0	0
	Livingstone River	7		300	1594	0	3	0
	Spears Creek	8		300	1311	41	0	0
	Deep Creek	13		300	1601	7	0	0
	Deep Creek	16		300	883	11	0	0
	White Creek	17		300	2170	106	0	0
	Savanna Creek	19		300	1117	1	0	0
	Ridge Creek	20		300	976	1	0	0
	Unnamed to White Creek	22		300	773	29	0	0
	Beaver Creek	28		300	1211	18	0	0
	Beaver Creek	44		300	1109	27	0	0
	Livingstone River	1	Tote barge efishing	500	2176	34	5	21
	Livingstone River	12		500	2169	13	14	0
	Livingstone River	25		500	2172	26	3	3
	Livingstone River	29		500	2103	14	4	3
Upper Oldman River	Unnamed to Oyster Creek	12	Backpack efishing	300	1100	17	0	0
	Oyster Creek	16		300	1382	21	0	0
	Oldman River	29		300	946	4	0	0
	Pasque Creek	33		300	1280	80	0	0
	Pasque Creek	37		300	1407	38	0	0
	Lyall Creek	49		300	955	0	0	0
	Straight Creek	76		300	1216	4	0	0
	Oldman River	2	Tote barge efishing	500	2632	25	12	9
	Oldman River	6		500	3291	60	41	32
	Oldman River	10		500	3227	43	65	42
	Oldman River	11		500	2224	24	19	12
	Oldman River	21		500	1280	416	0	0
Dutch Creek	Dutch Creek	1	Backpack efishing	300	1548	12	4	0
	Dutch Creek	2		300	1554	15	9	0
	Dutch Creek	3		300	815	5	1	0
	Dutch Creek	4		300	1512	11	3	3
	Dutch Creek	5		300	1435	18	4	0
Hidden Creek	Hidden Creek	4	Backpack efishing	300	922	5	8	0
	Hidden Creek	15		300	1302	9	17	0
	Hidden Creek	20		300	812	1	1	0
	Hidden Creek	23		300	2653	7	41	0
	Hidden Creek	47		300	843	1	2	0

[1] WSCT = westslope cutthroat trout; BLTR = bull trout; MNWH = mountain whitefish

Appendix 7. Estimated mean (± 95% CI) relative abundance (fish/300 m) of bull trout captured by backpack electrofishing in the upper Oldman River westslope cutthroat trout core area, 2018–2022.

| Watershed	Maturity class	Relative abundance (fish/300 m)				
		2018	**2019**	**2020[a]**	**2021**	**2022**
Livingstone River	Total BLTR (≥70 mm)	4.2 (0.2–11.2)	1.4 (0–4.1)	2.4 (0.4–5.4)	2.2 (0.1–6.2)	1.6 (0–4.7)
	Sub-adult BLTR (<150 mm)	0.2 (0–0.5)	0.2 (0–0.5)	1.4 (0–4.0)	1 (0–3.0)	0.2 (0–0.6)
	Adult BLTR (≥150 mm)	4.1 (0.2–10.7)	1.2 (0–3.5)	1 (0.4–1.6)	1.2 (0.1–3.2)	1.6 (0–4.7)
Upper Oldman River	Total BLTR (≥70 mm)					
	Sub-adult BLTR (<150 mm)	0	0	0	0	0
	Adult BLTR (≥150 mm)					
Dutch Creek	Total BLTR (≥70 mm)	3.8 (2.0–5.6)	3 (0.4–5.6)	2.3 (1.0–5.0)	5.0 (2.8–7.4)	4.2 (2.2–6.8)
	Sub-adult BLTR (<150 mm)	2.6 (1.2–4.4)	1.4 (0–3.0)	1.0 (0–3.0)	3.8 (2.2–5.6)	3.4 (1.6–6.2)
	Adult BLTR (≥150 mm)	1.2 (0.6–1.8)	1.6 (0.4–2.8)	1.3 (1.0–2.0)	1.2 (0.6–1.8)	0.8 (0.2–1.4)
Hidden Creek	Total BLTR (≥70 mm)	8.6 (2.0–17.8)	7.6 (2.4–14.8)	10.1 (1.0– 19.0)	11.8 (4.2–19.4)	13.9 (2.8–28.4)
	Sub-adult BLTR (<150 mm)	6.8 (1.2–14.2)	4.8 (1.0–11.0)	5.5 (1.0–10.0)	7.8 (3.4–13.2)	8 (0.4–21.6)
	Adult BLTR (≥150 mm)	1.8 (0.6–3.4)	2.8 (1.4–4.2)	5.0 (1.0–9.0)	4.0 (0.6–7.8)	5.8 (2.2–10.4)

[a] COVID-19 subsample year (n = 20 sites) - only one site was surveyed in the Hidden Creek watershed.

Appendix 8. Estimated mean (± 95% CI) relative abundance (fish/300 m) of bull trout captured by tote barge electrofishing in the upper Oldman River westslope cutthroat trout core area, 2018–2022.

Watershed	Maturity class	Relative abundance (fish/300 m)				
		2018	**2019**	**2020[a]**	**2021**	**2022**
Livingstone River	Total BLTR (≥70 mm)	5.5 (0.9–10.2)	3.7 (2.2–5.7)	0.9 (0.6–1.2)	6.9 (4.3–9.0)	1.8 (0.6–2.7)
	Sub-adult (<150 mm)	2.2 (0.3–5.1)	1.6 (0.9–2.5)	0.3 (0–0.6)	2.4 (1.5–3.3)	0.4 (0–0.9)
	Adult (≥150 mm)	3.3 (0.6–8.7)	2.1 (1.0–3.1)	0.6 (0.6–0.6)	4.5 (2.7–5.7)	1.3 (0.3–2.5)
Upper Oldman River	Total BLTR (≥70 mm)	5.9 (1.9–9.8)	9.5 (3.4–17.6)	14.3 (4.8–24.6)	16.9 (6.2–32.2)	16.4 (5.2–29.8)
	Sub-adult BLTR (<150 mm)	2.2 (0.8–3.4)	4.2 (1.0–7.8)	7.2 (2.4–11.4)	10.2 (2.6–20)	9.9 (2.2–18.6)
	Adult BLTR (≥150 mm)	3.7 (1.1–6.5)	5.3 (1.8–9.6)	7.3 (2.4–13.2)	7.0 (2.3–11.9)	6.5 (2.8–10.1)

[a] COVID-19 subsample year (n = 20 sites).

Appendix 9. Hydrometric data measured in the Oldman River at Range Road 13A (Station 05AA035), 2018–2022 (Government of Canada 2023b).
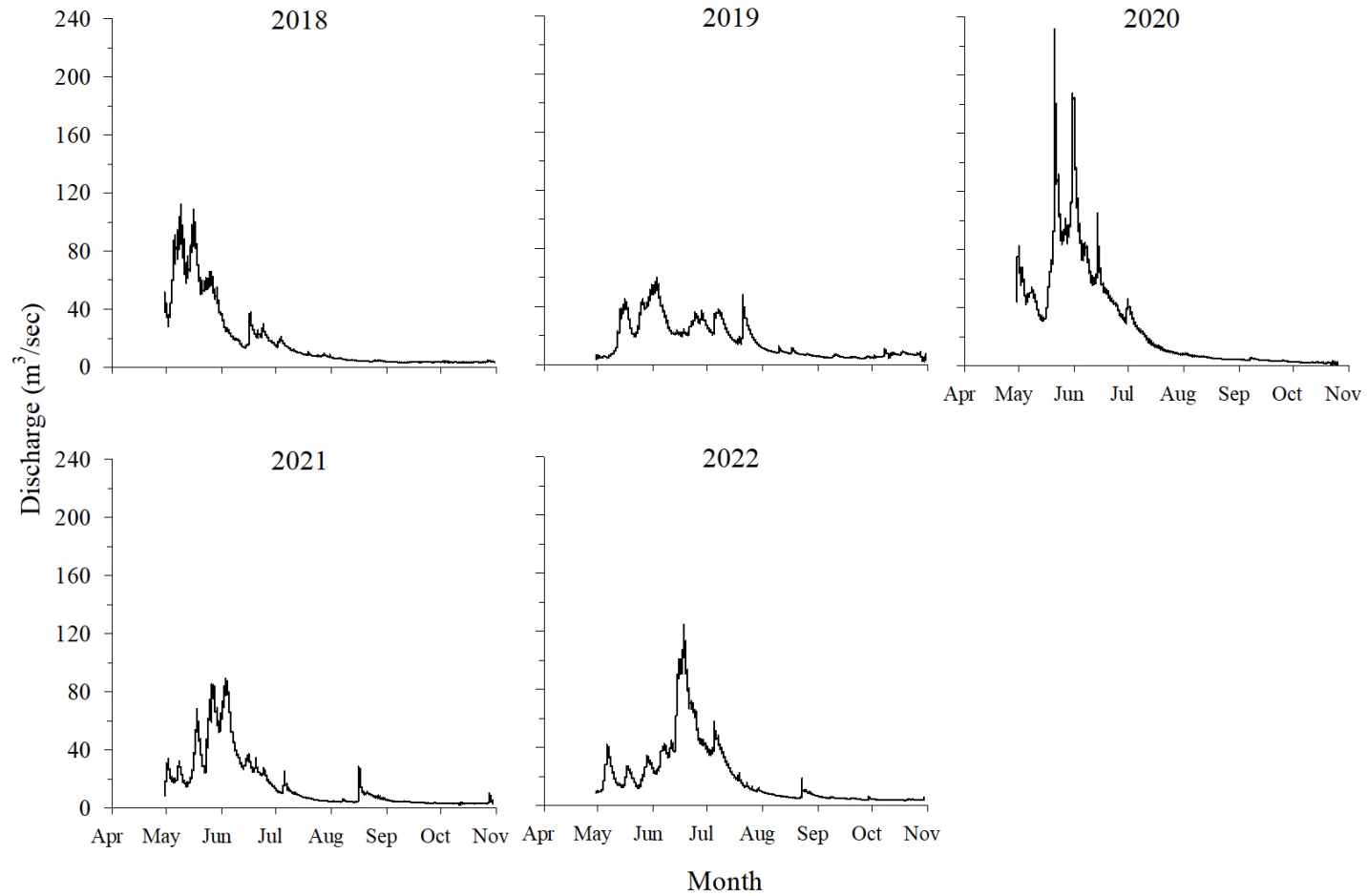
Appendix 10. Stream temperature data summary collected in the upper Oldman River westslope cutthroat trout core area, 2018–2022.

| Watershed	Waterbody	Site ID	2018		2019		2020		2021		2022	
			Mean temp (°C) (±SD)	Temp range (°C)	Mean temp (°C) (±SD)	Temp range (°C)	Mean temp (°C) (±SD)	Temp range (°C)	Mean temp (°C) (±SD)	Temp range (°C)	Mean temp (°C) (±SD)	Temp range (°C)
Livingstone River	Livingstone River	LVG1	7.0 ± 1.15	3.3–12.5	6.5 ± 1.01	1.9–11.8	6.5 ± 1.3	3.3–12.7	7.6 ± 1.46	2.8–13.1	6.4 ± 1.62	1.5–12.0
		LVG2	8.0 ± 1.50	2.8–15.4	5.0 ± 1.31	1.2–8.9	7.3 ± 1.88	2.1–14.7	9.6 ± 2.43	2.2–16.9	7.2 ± 2.33	0.5–14.7
		LVG3	10.3 ± 1.96	3.8–17.8	9.2 ± 1.83	2.6–16.9	9.6 ± 2.62	2.7–18.2	11.3 ± 2.65	2.7–19.4	9.5 ± 2.95	0.4–17.1
		LVG4	10.6 ± 1.98	4.0–17.8	9.7 ± 1.83	3.0–17.1	ND	ND	11.8 ± 2.69	3.0–19.6	9.9 ± 2.95	1.1–16.6
	White Creek	WHT1	11.4 ± 1.78	5.2–18.5	10.3 ± 1.69	3.8–17.2	10.6 ± 2.18	3.4–17.9	12.5 ± 2.53	4.2–21.2	ND	ND
	Deep Creek	DEP1	ND	ND	7.8 ± 1.16	2.2–14.4	7.5 ± 1.16	3.0–14.3	8.6 ± 1.40	3.3–17.2	7.6 ± 1.58	0.8–14.20
	Speers Creek	SPR1	ND	ND	5.6 ± 1.84	1.2–11.3	7.4 ± 2.45	1.8–14 .7	8.6 ± 1.40	3.3–17.2	ND	ND
	Savanna Creek	SVN1	5.6 ± 1.30	2.0–10.1	5.1 ± 1.21	1.2–9.4	5.5 ± 1.16	1.5–11.2	6.6 ± 1.40	1.4–11.7	5.4 ± 1.82	0.4–10.5
	Beaver Creek	BVR	8.6 ± 1.68	3.6–13.2	ND	ND	8.2 ± 1.76	3.3–12.7	9.8 ± 2.29	2.9–14.2	7.9 ± 2.65	0.1–12.4
Upper Oldman River	Upper Oldman River	OLD1	7.8 ± 1.84	2.3–15.7	7.2 ± 1.71	1.4–14.4	4.9 ± 0.8	2.2–7.0	7.9 ± 1.99	2.1–14.1	7.5 ± 2.88	0.9–15.7
		OLD2	8.3. ± 1.96	2.5–15.6	7.2 ± 1.68	1.8–13.8	7.6 ± 2.30	2.0–14.2	ND	ND	7.3 ± 2.69	1.0–14.8
		OLD3	9.6 ± 2.20	3.0 –17.3	8.3 ± 1.90	2.5–14.8	ND	ND	10.1 ± 2.68	2.5–17.2	8.6 ± 3.14	1.3–16.3
		OLD4	10.1 ± 2.28	3.3–17.7	8.8 ± 1.98	2.8–16.2	9.2 ± 2.84	2.5–17.0	10.4 ± 2.71	2.7–17.8	8.9 ± 3.08	1.7–16.5
	Pasque Creek	PSQ1	ND	ND	7.7 ± 2.08	0.8–16.0	8.7 ± 2.84	1.8–17.3	10.4 ± 3.01	1.9–19.3	8.5 ± 3.54	0.5–18.9
	Lyall Creek	LYL1	ND	ND	4.0 ± 0.87	0.1 –7.7	4.2 ± 1.21	1.3–6.7	5.0 ± 1.34	1.4– 8.8	ND	ND
Hidden Creek	Hidden Creek	HDN1	7.7 ± 1.42	3.2–13.2	6.3 ± 1.47	1.9–11.4	ND	ND	7.2 ± 1.82	2.3–11.8	6.4 ± 1.90	1.3–11.8

Appendix 11. Adult westslope cutthroat (≥153 mm FL) hooking damage summary observed in mainstem streams in the upper Oldman River westslope cutthroat trout core area, 2018–2022.

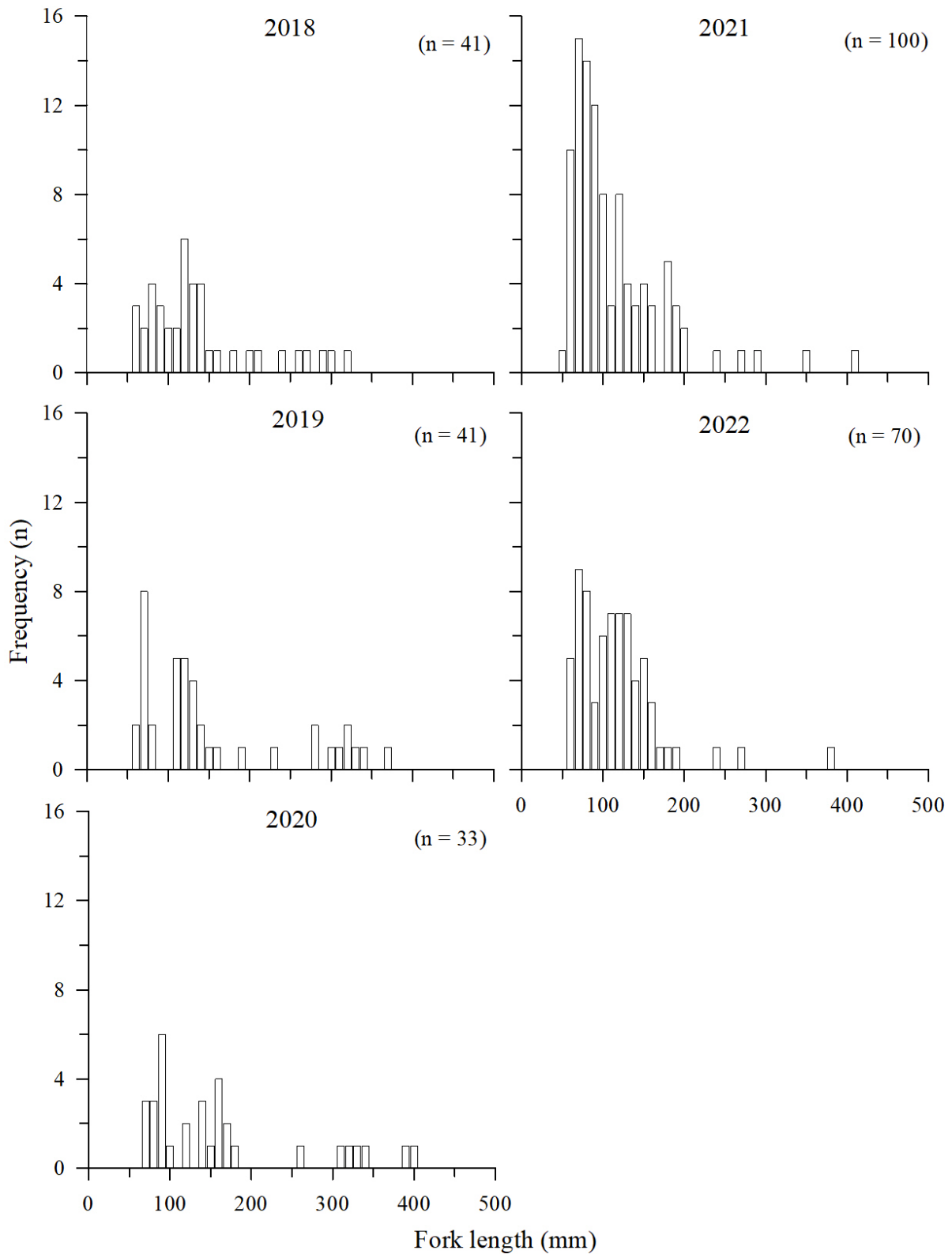| Waterbody	Site #	2018			2019			2020			2021			2022			Average ± SD WSCT hook damage (%)
		Total WSCT (n)	WSCT hook damage (n)	WSCT hook damage (%)	Total WSCT (n)	WSCT hook damage (n)	WSCT hook damage (%)	Total WSCT (n)	WSCT hook damage (n)	WSCT hook damage (%)	Total WSCT (n)	WSCT hook damage (n)	WSCT hook damage (%)	Total WSCT (n)	WSCT hook damage (n)	WSCT hook damage (%)	
Livingstone River	1	29	10	34%	34	1	3%	17	4	24%	24	6	25%	22	3	14%	(19.9% ± 12.0)
	25	19	7	37%	26	16	62%	21	10	48%	16	4	25%	17	4	24%	(38.9% ± 16.0)
	29	10	4	40%	13	3	23%	NA	NA	NA	9	5	56%	10	5	50%	(42.2% ± 14.3)
	12	20	1	5%	20	1	5%	NA	NA	NA	5	3	60%	9	2	22%	(23.1% ± 26.0)
	7	30	0	0%	5	1	20%	NA	NA	NA	0	0	0%	0	0	0%	(5% ± 10.0)
	Total	**108**	**22**	**20%**	**98**	**22**	**22%**	**38**	**14**	**37%**	**54**	**18**	**33%**	**58**	**14**	**24%**	**(27.4% ± 7.2)**
Upper Oldman River	2	11	4	36%	20	10	50%	NA	NA	NA	18	5	28%	21	2	10%	(30.9% ± 17.0)
	11	6	0	0%	18	6	33%	11	0	0%	19	5	26%	14	1	7%	(13.4% ± 15.5)
	6	14	6	43%	10	5	50%	24	10	42%	10	4	40%	24	5	21%	(39.1% ± 10.9)
	10	11	2	18%	26	6	23%	22	6	27%	18	4	22%	17	10	59%	(29.9% ± 16.5)
	21	52	0	0%	92	1	1%	NA	NA	NA	41	1	2%	56	0	0%	(0.9% ± 1.2)
	29	32	0	0%	37	0	0%	41	0	0%	17	0	0%	3	0	0%	0
	Total	**126**	**12**	**10%**	**203**	**28**	**14%**	**98**	**16**	**16%**	**123**	**19**	**15%**	**135**	**18**	**13%**	**(13.7% ± 2.6)**
Dutch Creek	4	3	0	0%	3	0	0%	10	0	0%	3	0	0%	1	0	0%	0
	1	3	0	0%	11	0	0%	3	0	0%	6	0	0%	1	0	0%	0
	5	3	0	0%	14	1	7%	1	0	0%	7	0	0%	1	0	0%	(1.4% ± 3.2)
	2	0	0	0%	11	2	18%	NA	NA	NA	2	1	50%	3	0	0%	(17.1% ± 23.6)
	3	1	0	0%	2	0	0%	NA	NA	NA	0	0	0%	3	0	0%	0
	Total	**10**	**0**	**0%**	**41**	**3**	**7%**	**14**	**0**	**0%**	**11**	**1**	**9%**	**1**	**0**	**0%**	**(3.3% ± 4.5)**
Hidden Creek	23	11	1	9%	12	2	17%	4	0	0%	4	0	0%	2	0	0%	(5.2% ± 7.6)
	15	11	0	0%	12	0	0%	NA	NA	NA	3	0	0%	8	0	0%	0
	4	3	0	0%	8	0	0%	NA	NA	NA	2	0	0%	3	0	0%	0
	Total	**25**	**1**	**4%**	**32**	**2**	**6%**	**4**	**0**	**0%**	**9**	**0**	**0%**	**14**	**0**	**0%**	**(2.1% ± 2.9)**

Appendix 12. Length-frequency distribution of westslope cutthroat trout captured by backpack and tote barge electrofishing in the Livingstone River HUC10 watershed, 2018–2022.
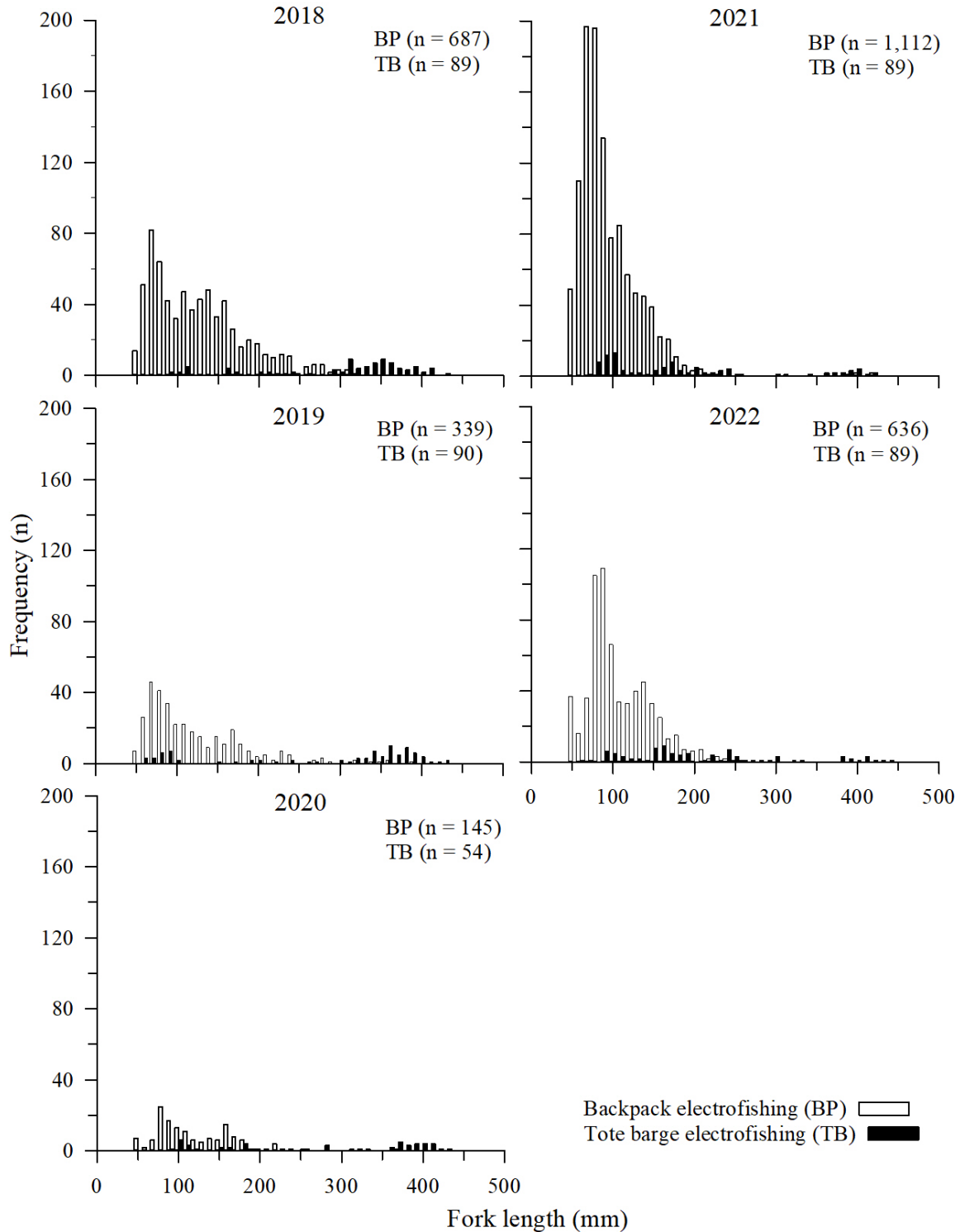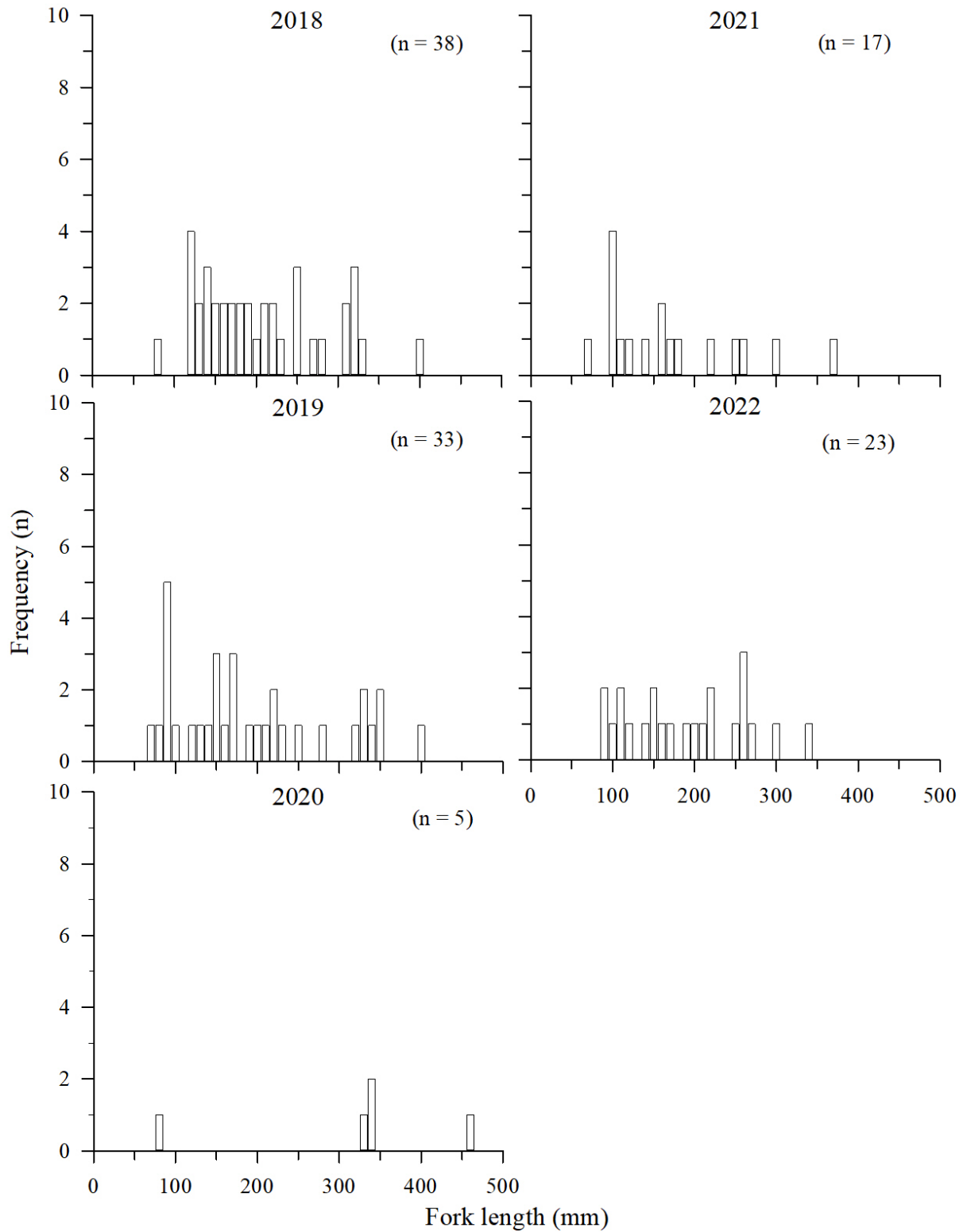
Appendix 13. Length-frequency distribution of westslope cutthroat trout captured by backpack and tote barge electrofishing in the upper Oldman River HUC10 watershed, 2018–2022.
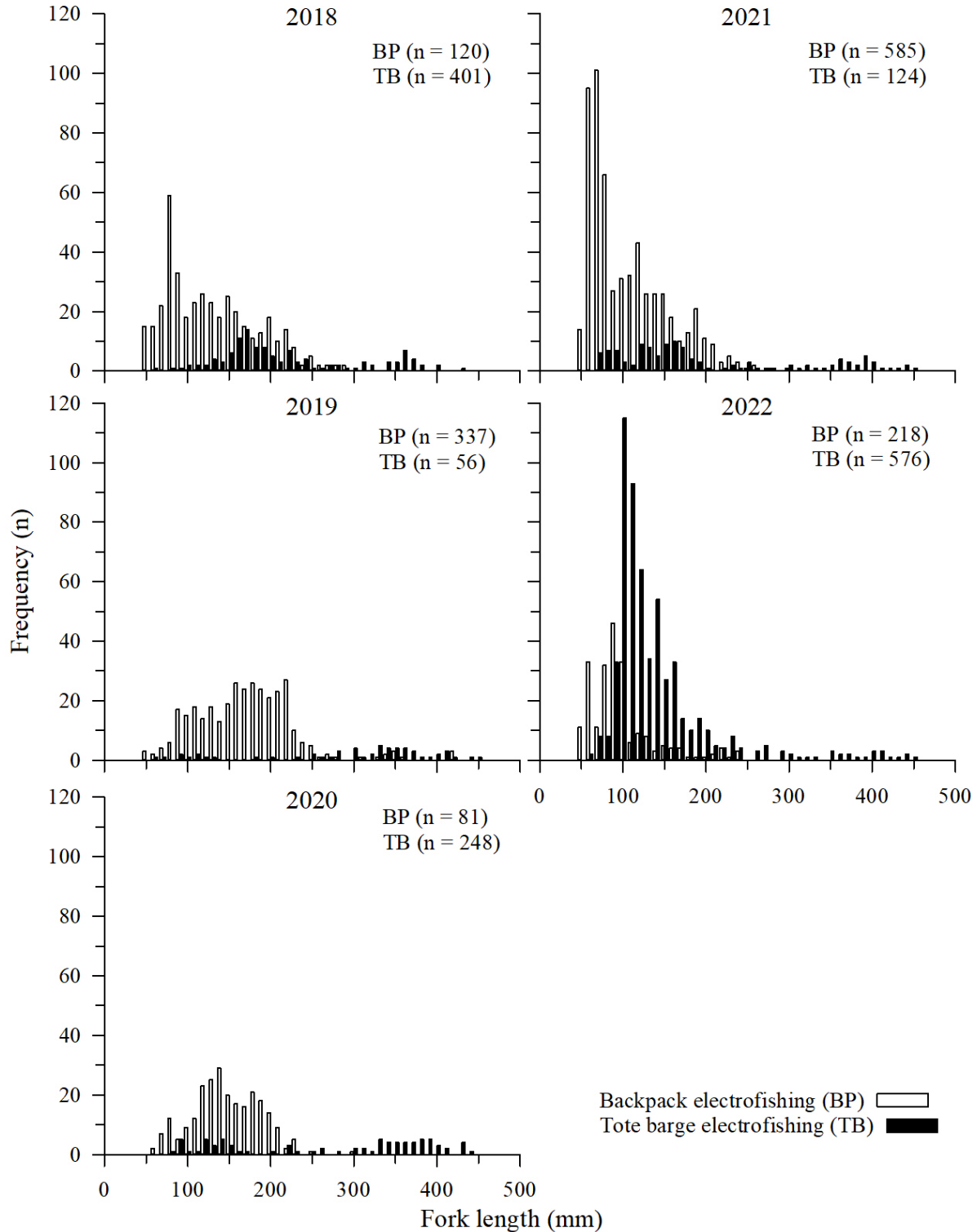
Appendix 14. Length-frequency distribution of westslope cutthroat trout captured by backpack electrofishing in the Dutch Creek HUC10 watershed, 2018–2022.

Appendix 15. Length-frequency distribution of westslope cutthroat trout captured by backpack electrofishing in the Hidden Creek HUC10 watershed, 2018–2022.