















in exactly the same locations, mean stream wetted widths measured were approximately the same as those measured in 2016 (Bouwens and Jakubowski 2017).

TABLE 1. Locations of tributary monitoring sites sampled in 2021. Coordinates are the downstream extent of sampling sites.

Stream	Section	Date	Latitude	Longitude	Reach Length (m)	Mean Wetted Width (m)
Morris	1	7/8/21	48.21913	-116.10786	100	5.15
	2	7/7/21	48.21383	-116.09908	100	5.45
Trestle	2	7/13/21	48.28909	-116.33229	100	8.01
	4	7/12/21	48.29724	-116.30798	100	7.15
	6	7/12/21	48.30209	-116.28387	100	8.08
	8	7/14/21	48.30823	-116.26079	100	4.97
	10	7/14/21	48.32040	-116.24296	100	3.90
Caribou	12	7/15/21	48.33490	-116.23025	100	2.43
	1	7/19/21	48.47126	-116.56372	100	4.80
	3	7/21/21	48.46936	-116.58545	100	5.50
	5	7/27/21	48.46403	-116.61151	100	5.15
	7	7/27/21	48.45788	-116.63580	100	3.23
Hellroaring	9	7/28/21	48.44832	-116.65673	100	2.30
	1	8/3/21	48.49416	-116.58337	100	4.70
	3	8/5/21	48.49359	-116.60547	100	3.73
	5	8/4/21	48.49242	-116.63212	100	4.02
McCormick	7	8/9/21	48.49476	-116.65932	100	1.88
	1	8/12/21	48.57666	-116.62140	100	3.62
	3	8/16/21	48.57359	-116.65494	100	1.60
	5	8/10/21	48.56252	-116.67830	100	1.43

The multiple-pass data from the five streams were added to a regression model to estimate fish abundance from a single-pass based on the first pass collections of a multiple-pass depletion estimate (Figure 2). Modeling suggests that the first pass collections described approximately 97% of the variation in estimated abundance from multiple-pass samples ( $n = 195$ ,  $P < 0.01$ ). This technique continues to be a valuable tool to reduce sampling effort in each reach, thus allowing sampling to occur at more locations per field season. In addition, utilizing single-pass sampling methods reduces the exposure of fish to the side effects of electrofishing and reduces handling stress.



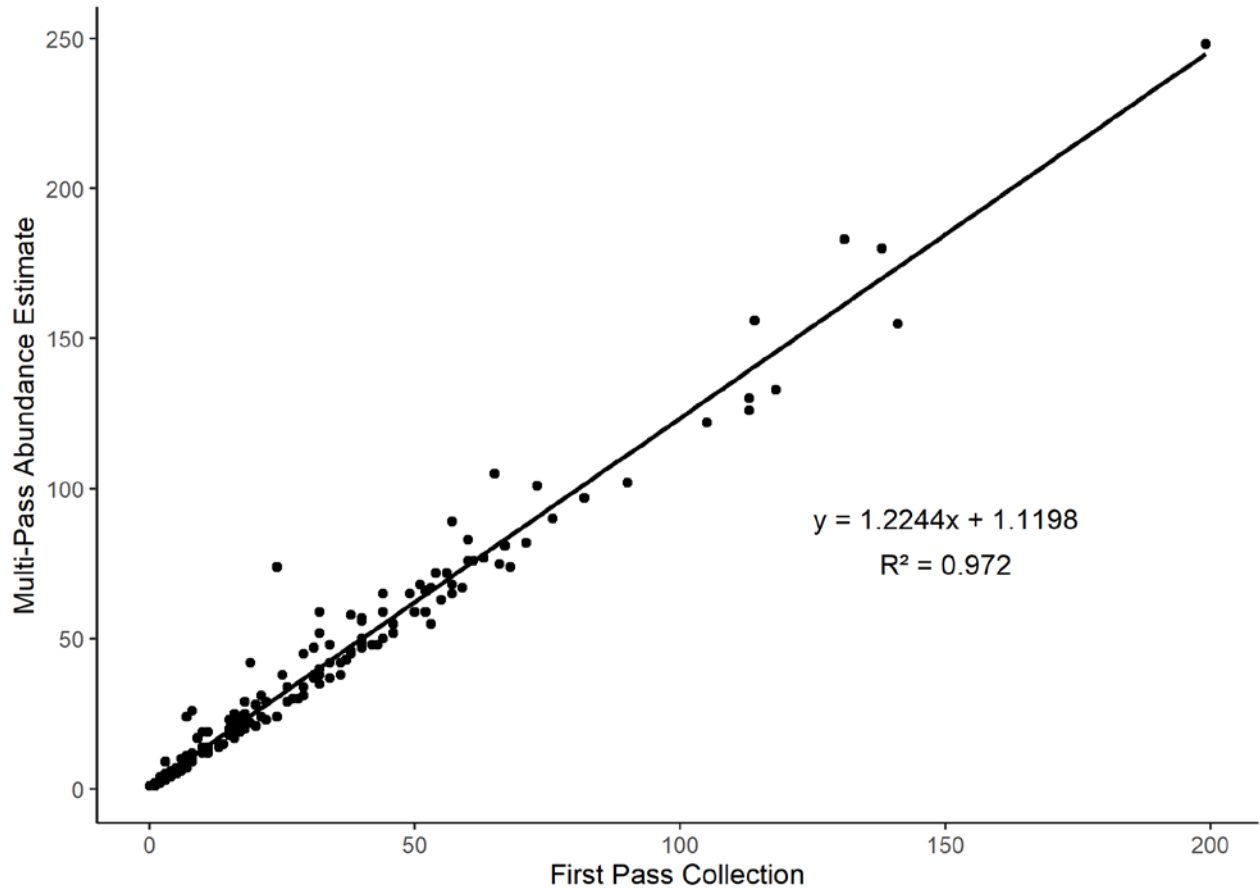


FIGURE 2. Regression model showing the relationship of estimated trout abundance (fish/100 m) between multiple-pass methods and the number of fish captured on the first pass. Data represent combined 2009–2021 multiple-pass removal efforts for salmonids  $\geq 75$  mm total length in tributaries of Lake Pend Oreille, Idaho.

### *Morris Creek*

Two sections of Morris Creek representing two kilometers of stream were sampled in 2021 (Table 1; Figure 1). Westslope Cutthroat Trout had the highest density in this stream (11.0/100 m<sup>2</sup>) followed by BLT (Table 2). Overall BLT density in 2021 was higher than measured in 2016 but less than 2011. Westslope Cutthroat Trout density declined slightly since 2016, although not to the levels measured in 2011 (Table 3).

TABLE 2. Length and density estimates by section and species for Morris Creek in 2021. Combined mean estimates include data from all sections where fish were encountered, even if that particular species was not detected.

Section (km)	Species	Total Length (mm)			Fish/100 m			Fish/100 m <sup>2</sup>			
		n	Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
1	BLT	6	130.0	124	135	8.9	6.0	19.6	1.7	1.2	3.8
	WCT	35	112.6	75	207	44.2	35.0	55.0	8.6	6.8	10.7
	WRHY	4	167.8	159	176	6.4	4.0	17.1	1.2	0.8	3.3
2	BLT	20	124.9	107	143	26.0	15.3	36.7	4.8	2.0	7.6
	WCT	53	136.9	75	249	74.0	63.2	84.8	13.6	7.6	19.6
Total	BLT	26	126.1	107	143	17.4			3.2		
	WCT	88	127.2	75	249	59.1			11.1		
	WRHY	4	167.8	159	176	3.2			0.6		

TABLE 3. Mean density estimates (fish/100 m<sup>2</sup>) for all sections combined where fish were sampled by stream, year, and species 2009–2021. Combined mean estimates include data from all sections where fish were encountered, even if that particular species was not detected.

Stream	Year	BLT	BRK	BRN	RBT	WCT	MWF	BBHY	WRHY	Total
Caribou Creek	2021	7.5	0.8	0.0	13.6	19.4	0.0	0.0	2.0	43.7
	2016	1.8	0.1	0.0	0.8	9.0	0.0	0.0	0.2	11.9
	2011	3.1	0.3	0.0	1.2	6.1	0.0	0.0	0.7	11.4
Morris Creek	2021	3.2	0.0	0.0	0.0	11.1	0.0	0.0	1.2	15.6
	2016	0.7	0.0	0.0	0.0	11.5	0.0	0.0	0.4	12.6
	2011	5.8	0.0	0.0	0.0	7.0	0.0	0.0	1.8	14.6
Trestle Creek	2021	1.4	0.0	0.0	0.5	8.5	0.0	0.0	0.5	11.0
	2016	1.5	0.0	0.0	0.0	12.5	0.0	0.0	0.0	14.0
	2011	1.8	0.0	0.0	<0.1	4.5	0.1	0.0	1.0	7.4
Hellroaring Creek	2021	0.6	1.4	0.0	19.3	0.8	0.0	0.0	0.0	22.1
	2016	0.2	0.0	0.0	7.1	0.1	0.0	0.0	0.0	7.4
	2012	0.2	<0.1	0.0	4.0	0.0	0.0	0.0	0.2	4.4
McCormick Creek	2021	3.8	0.0	0.0	0.0	13.2	0.0	0.0	0.0	17.0
	2016	0.0	0.0	0.0	0.0	11.3	0.0	0.0	0.0	11.3
	2012	0.0	0.0	0.0	0.5	1.7	0.0	0.0	0.3	2.5
Grouse Creek	2020	1.4	0.1	0.0	4.5	3.2	0.3	<0.1	0.3	9.8
	2015	3.6	0.3	0.0	3.5	1.7	<0.1	0.2	0.2	9.5
	2010	3.5	0.4	0.0	8.2	3.6	0.6	0.2	0.3	16.8
N. Grouse Creek	2020	0.0	1.2	0.0	3.3	3.4	0.0	0.0	0.1	8.0
	2015	0.2	2.2	0.0	6.4	4.1	0.0	0.0	0.1	13.0
S. Grouse Creek	2010	0.0	4.1	0.0	5.0	5.9	0.0	0.0	0.3	15.3
	2020	1.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	3.9
	2015	0.7	2.5	0.0	15.1	0.7	0.0	2.5	2.9	24.4
Rapid Lighting Creek	2013	1.3	3.0	0.0	7.6	1.3	0.0	0.0	3.3	16.5
	2020	0.0	1.7	0.0	0.4	2.6	<0.1	0.0	<0.1	4.7
	2015	0.0	3.3	0.0	1.1	6.4	0.3	0.0	0.2	11.3
West Gold Creek	2010	<0.1	3.2	0.0	1.0	5.2	1.2	0.0	0.3	10.9
	2020	0.0	0.0	0.0	0.0	47.6	0.0	0.0	0.0	47.6
	2015	2.2	0.0	0.0	0.0	50.8	0.0	0.0	0.0	53.0
Gold Creek	2009	0.1	0.0	0.0	0.0	43.7	0.0	0.0	0.0	43.8
	2019	2.2	0.0	0.0	0.0	19.5	0.0	0.0	1.3	23.0
	2014	2.5	0.0	0.0	0.0	32.0	0.0	0.0	0.2	34.8
Granite Creek	2009	4.4	0.0	0.0	0.0	23.6	0.0	0.0	<.01	28.0
	2019	4.5	0.0	0.0	0.1	12.1	0.0	0.0	0.4	17.1
	2014	6.3	0.0	0.0	0.0	6.4	0.0	0.0	<0.1	12.7
Strong Creek	2009	4.6	0.0	0.0	0.0	6.7	0.2	0.0	0.0	11.5
	2019	2.2	0.0	0.0	0.5	19.3	0.0	1.7	0.1	23.8
	2014	3.2	0.0	0.0	<0.1	19.0	0.0	0.0	<0.1	22.3
Johnson Creek	2009	0.1	0.0	0.0	0.1	7.2	0.0	0.0	0.1	7.5
	2019	0.8	0.0	0.0	0.0	9.1	0.0	0.0	0.4	10.3
	2014	1.0	0.0	0.0	0.0	7.0	0.0	0.0	0.0	8.0
Twin Creek	2009	1.4	0.0	0.0	0.0	5.1	0.0	0.0	0.0	6.5
	2019	0.0	4.2	0.3	3.9	3.2	0.0	0.0	0.2	11.8
	2014	0.1	7.6	0.5	1.3	3.3	0.0	0.0	1.4	14.2
	2009	0.0	2.7	0.3	2.0	3.8	0.0	0.0	0.0	8.8

Table 3. Continued.

Stream	Year	BLT	BRK	BRN	RBT	WCT	MWF	BBHY	WRHY	Total
E.F. Lightning Creek	2017	0.3	0.1	0.0	10.5	2.7	0.0	0.0	1.7	15.3
Berry Creek	2018	0.0	0.2	0.0	1.0	11.7	0.0	0.0	0.2	13.1
	2013	0.0	0.2	0.0	0.5	11.0	0.0	0.0	0.8	12.5
Jeru Creek	2018	0.0	0.0	0.0	1.4	9.5	0.0	0.0	1.1	12.0
	2013	0.2	0.0	0.0	0.7	5.6	0.0	0.0	3.1	9.6
Mosquito Creek	2018	0.0	3.6	0.1	0.3	7.4	0.0	0.0	0.5	11.9
	2013	0.0	4.9	0.2	0.0	3.4	0.0	0.0	0.2	8.7
Spring Creek	2018	0.0	3.7	0.1	1.3	0.9	0.0	0.0	0.2	6.2
	2013	0.0	16.5	0.1	0.2	0.9	0.1	0.0	0.3	18.1
Char Creek	2018	0.0	0.0	0.0	0.0	25.3	0.0	0.0	0.0	25.3
	2013	0.0	0.0	0.0	0.0	75.0	0.0	0.0	0.0	75.0
	2012	3.1	0.1	0.0	2.8	4.5	0.0	0.5	0.4	11.4
Porcupine Creek	2017	0.3	3.4	0.0	0.3	12.1	0.0	0.0	0.3	16.4
	2012	1.0	5.4	0.0	0.0	10.5	0.0	0.0	0.9	17.8
Rattle Creek	2017	0.8	0.0	0.0	0.3	5.1	0.0	0.0	0.1	6.3
	2012	4.6	0.0	0.0	0.6	5.8	0.0	0.0	0.1	11.1
Savage Creek	2017	1.6	0.0	0.0	0.2	9.3	0.0	0.0	1.7	12.8
	2012	5.1	0.0	0.0	<0.1	3.9	0.0	0.0	0.7	9.7
Wellington Creek	2017	0.3	0.0	0.0	2.3	12.1	0.0	0.0	1.0	15.7
	2012	1.3	0.1	0.0	0.5	10.4	0.0	0.0	0.4	12.7
N. Gold Creek	2017	0.0	0.0	0.0	0.0	10.6	0.0	0.0	0.0	10.6
Branch N. Gold Creek	2017	0.0	0.0	0.0	0.0	23.0	0.0	0.0	0.0	23.0

***Trestle Creek***

Six sections covering 12 kilometers were sampled in Trestle Creek in 2021 (Table 1; Figure 1). Bull Trout and WCT were the most abundant species sampled followed by WRHY and RBT (Table 4). Densities of BLT and WCT were similar to levels measured in 2010 and 2015, however RBT and WRHY increased (Table 3).

TABLE 4. Length and density estimates by species for Trestle Creek in 2021. Combined mean estimates include data from all sections where fish were encountered, even if that particular species was not detected.

Section (km)	Species	Total Length (mm)				Fish/100 m			Fish/100 m <sup>2</sup>		
		N	Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
2	WCT	74	101.3	75	232	74.0	68.0	84.8	9.2	9.2	9.3
	WRHY	1	77.0	77	77	1.0	1.0	11.7	0.1	0.1	0.1
4	BLT	2	97.0	92	102	4.0	2.0	14.7	0.6	0.3	2.1
	RBT	2	109.5	76	143	4.0	2.0	14.7	0.6	0.3	2.1
	WCT	46	104.5	75	175	57.7	46.9	68.4	8.1	6.6	9.6
	WRHY	5	90.2	80	104	7.6	5.0	18.4	1.1	0.7	2.6
6	BLT	2	134.5	95	174	4.0	2.0	14.7	0.5	0.2	1.8
	WCT	34	118.2	76	196	43.0	34.0	53.7	5.3	4.2	6.6
	WRHY	1	204.0	204	204	2.8	1.0	13.5	0.3	0.1	1.7
8	BLT	1	84.0	84	84	2.8	1.0	13.5	0.6	0.2	2.7
	WCT	30	97.9	76	177	38.1	30.0	48.9	7.7	6.0	9.8
10	BLT	11	113.5	97	130	15.0	11.0	25.7	3.8	2.8	6.6
	WCT	22	125.2	76	165	28.4	22.0	39.1	7.3	5.6	10.0
12	WCT	21	106.1	81	139	27.2	21.0	37.9	11.2	8.6	15.6
Total	BLT	16	112.2	84	174	4.3			0.9		
	RBT	2	109.5	76	143	0.7			0.1		
	WCT	227	106.8	75	232	44.7			8.1		
	WRHY	7	104.6	77	204	1.9			0.3		

***Caribou Creek***

Five sections were sampled in Caribou Creek, with WCT being abundant throughout the longitudinal gradient of the stream (Table 5). Overall biomass has greatly increased since sampling began, with abundances of BLT, RBT, and WCT all being the highest observed (Table 3).

TABLE 5. Length and density estimates by species for Caribou Creek in 2021. Combined mean estimates include data from all sections where fish were encountered, even if that particular species was not detected.

Section (km)	Species	Total Length (mm)				Fish/100 m			Fish/100 m <sup>2</sup>		
		N	Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
1	BLT	6	102.0	85	142	8.9	6.0	19.6	1.8	1.3	4.1
	BRK	2	102.0	75	129	4.0	2.0	14.7	0.8	0.4	3.1
	RBT	92	99.1	75	203	113.8	102.9	124.6	23.7	21.4	26.0
	WCT	3	149.3	95	213	5.2	3.0	15.9	1.1	0.6	3.3
	WRHY	8	108.1	87	155	11.3	8.0	22.0	2.4	1.7	4.6
3	BLT	67	107.6	79	155	68.0	57.3	78.7	12.4	11.9	12.8
	RBT	19	123.0	83	167	19.0	16.0	29.7	3.5	3.4	3.5
	WCT	43	113.5	79	203	45.0	34.3	55.7	8.2	7.4	8.9
	WRHY	10	109.5	86	156	10.0	6.0	20.7	1.8	1.5	2.1
5	BLT	48	102.3	85	145	60.1	49.4	70.8	11.7	9.6	13.8
	WCT	41	140.9	83	260	51.6	41.0	62.3	10.0	8.0	12.1
7	BLT	10	146.9	129	166	13.7	10.0	24.5	4.2	3.1	7.6
	WCT	89	129.0	96	224	110.1	99.3	120.9	34.1	30.7	37.4
9	WCT	81	123.0	76	187	100.4	89.5	111.2	43.6	38.9	48.3
Total	BLT	131	108.4	79	166	30.1			6.0		
	BRK	2	102.0	75	129	0.8			0.2		
	RBT	111	103.2	75	203	26.6			5.4		
	WCT	257	126.4	76	260	62.4			19.4		
	WRHY	18	108.9	86	156	4.3			0.8		

### *Hellroaring Creek*

Four sections were sampled in Hellroaring Creek representing seven kilometers of stream (Table 1; Figure 1). RBT represented 97% of all fish captured in the creek, with other species being captured only in the lowest reach (Table 6). A barrier to upstream fish migration exists between sections one and three (rkm 2.4), and fish captured above this are all considered to be residents. Overall fish densities throughout the creek were increased from previous years (Table 3).

TABLE 6. Length and abundance data by section and species for Hellroaring Creek in 2021. Combined mean estimates include data from all sections where fish were encountered, even if that particular species was not detected.

Section (km)	Species	Total Length (mm)				Fish/100 m			Fish/100 m <sup>2</sup>		
		N	Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
1	BLT	1	102.0	102	102	2.8	1.0	13.5	0.6	0.2	2.9
	BRK	4	111.8	102	121	6.4	4.0	17.1	1.4	0.9	3.6
	RBT	73	108.8	79	175	90.6	79.8	101.4	19.3	17.0	21.6
	WCT	2	156.5	154	159	4.0	2.0	14.7	0.8	0.4	3.1
3	RBT	56	142.8	77	201	69.9	59.1	80.6	18.7	15.8	21.6
5	RBT	97	137.9	75	270	105.0	94.2	115.8	26.1	23.8	28.5
7	RBT	19	150.4	83	195	24.7	19.0	35.4	13.1	10.1	18.8
Total	BLT	1	102.0	102	102	0.7			0.1		
	BRK	4	117.8	102	121	1.6			0.3		
	RBT	245	131.3	75	270	72.5			19.3		
	WCT	2	156.5	154	159	1.0			0.2		

### *McCormick Creek*

Three sections were sampled in McCormick Creek representing five kilometers of stream (Table 1; Figure 1). Bull Trout were documented for the first time in 2021, and Westslope Cutthroat Trout were the only other species encountered (Table 7).

TABLE 7. Length and abundance data by section and species for McCormick Creek in 2021. Combined mean estimates include data from all sections where fish were encountered, even if that particular species was not detected.

Section (km)	Species	N	Total Length (mm)			Fish/100 m			Fish/100 m <sup>2</sup>		
			Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
1	BLT	10	141.2	132	151	13.7	10.0	24.5	3.8	2.8	6.8
	WCT	29	126.4	96	192	36.9	29.0	47.6	10.2	8.0	13.2
3	WCT	21	142.1	90	190	21.0	20.0	31.7	13.1	13.1	13.2
5	No Fish										
Total	BLT	10	141.2	132	151	4.6			1.3		
	WCT	50	133.0	90	192	19.3			7.8		

An increasing trend in fish density across all species was observed in Caribou, Hellroaring, and McCormick creeks compared to the previous sampling event in 2016. These creeks are located in the upper Pack River drainage and are likely influenced by similar conditions that may be affecting fish density. Trestle and Morris creeks exhibited stable or slightly decreasing densities but are located in different areas of the LPO system and experience different environmental factors. It is currently unknown what the specific drivers to this increase are, and why they may vary from creek to creek.

In addition to these updated abundance estimates, the first documented occurrence of juvenile Bull Trout movement between tributaries to LPO was observed. A fish tagged in 2018 in an upper reach of mainstem Lightning Creek during another sample effort was recaptured in 2021 in Section Two of Morris Creek. The fish grew 30 mm in the three years it was at large and had moved approximately 15 kilometers from the initial capture location.

Data collected during our monitoring surveys provide detailed longitudinal information on distribution and abundances of salmonids in tributaries to LPO. Two full rounds of sampling have occurred thus far, and a third is scheduled for completion in 2023. We recommend continuing the current rotation and investigate long-term trends across the basin using the completed dataset.



## **RECOMMENDATIONS**

- 1) Continue standardized 5-year rotational tributary sampling.
- 2) Summarize trend data and complete a comprehensive analysis of available tributary monitoring data after the third round of sampling has been completed.

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