Idaho Tributary Monitoring

2022 Annual Project Update

Idaho Tributary Habitat Acquisition and Fishery Enhancement Program, Appendix A

Prepared by:

Andrew L. Ransom
Fishery Biologist
Avista

Prepared for:

Avista
Noxon, MT

and

Idaho Department of Fish and Game
Boise, ID

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ABSTRACT

In cooperation with Avista and Idaho Fish and Game, stream fish monitoring surveys are conducted on 27 Lake Pend Oreille tributaries on a five-year rotational basis. In 2022, East Fork Lightning Creek, North Fork Gold Creek, Porcupine Creek, Rattle Creek, Savage Creek, and Wellington Creek were surveyed to evaluate salmonid abundance and distribution. This is the third time these streams were sampled since the protocol began in 2009. Shocking sections were sampled using backpack electrofishing from July 12 to August 15, 2022. A total of 19 sections were sampled. Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* was the most abundant species overall with densities ranging from 1.8 to 10.2 fish per 100m^2; however, this was decline from the last sample in 2017 in many areas. Total fish biomass increased most dramatically in Rattle Creek, largely driven by a 2.7 fish per 100m^2 increase in Bull Trout *Salvelinus confluentus* and a 2.8 fish per 100m^2 increase in Westslope Cutthroat Trout. Rainbow Trout *O. mykiss* exhibited population stability across the drainages, showing an increase in densities in a subset of creeks and a decline in others.

INTRODUCTION

The Idaho Tributary Habitat Acquisition and Fishery Enhancement Program, funded by Avista through the Clark Fork Settlement Agreement (CFSA), supports ongoing research and monitoring fish surveys in Idaho tributaries to the Clark Fork River (CFR) and Lake Pend Oreille (LPO). The purpose of these annual surveys is to collect standardized trend monitoring data that can be used to (1) evaluate the ongoing efforts in aquatic habitat protection and enhancement of LPO and CFR tributaries; (2) address the impacts and mitigation efforts related to load-following and dissolved gas supersaturation produced by the Clark Fork hydroelectric project; and (3) inform decisions regarding future mitigation efforts. Research and monitoring surveys have largely focused on identifying changes in fish abundance, species composition, and distribution. These surveys are conducted using backpack electrofishing in 27 LPO and CFR tributaries on a five-year rotation. Acquiring this information enables broad-scale evaluation of the effectiveness management actions have on juveniles of migratory and stream dwelling salmonids. These actions include aquatic habitat protection and restoration in tributaries, Lake Trout *Salvelinus namaycush* and Walleye *Sander vitreus* suppression, and kokanee *Oncorhynchus nerka* enhancement in LPO. In addition, the data collected from these monitoring surveys are used to evaluate the location, purpose, and need for future habitat enhancement projects. All of these management actions are supported through the CFSA. In addition to this work, we will continue to look for opportunities to make new observations by surveying tributaries not previously sampled, and to perform other monitoring or sampling as necessary and as time allows.

METHODS

Tributary monitoring surveys were conducted on North Fork Gold Creek, East Fork Lightning Creek, Porcupine Creek, Rattle Creek, Savage Creek, and Wellington Creek in 2022 (Figure 1). Stream survey sections were established on systematic 1-kilometer intervals progressing upstream from the mouth of each stream. Typically, a 100 m section was sampled for each kilometer of stream, except on longer streams where sections were sampled every-other kilometer. Although not always possible, every attempt was made to sample the same stream sections during each year of sampling. The farthest upstream survey site was determined based on whether water was present or fish were suspected to be absent further upstream as a result of fish not being sampled in the adjacent downstream section. In a few instances, the uppermost site was established where past sampling results suggested further surveys would provide low expected variation among additional sample sites. Abundance estimates only included fish $\geq$ 75 mm in total length. Target species include all salmonids. Sample sites were typically 100 m in length, and the mean wetted width of each site was calculated based upon six cross sectional measurements within the sampled section at 0, 20, 40, 60, 80, and 100 meters. Sample sites were closed using block nets at the downstream end of each survey site to prevent escapement during downstream electrofishing passes.

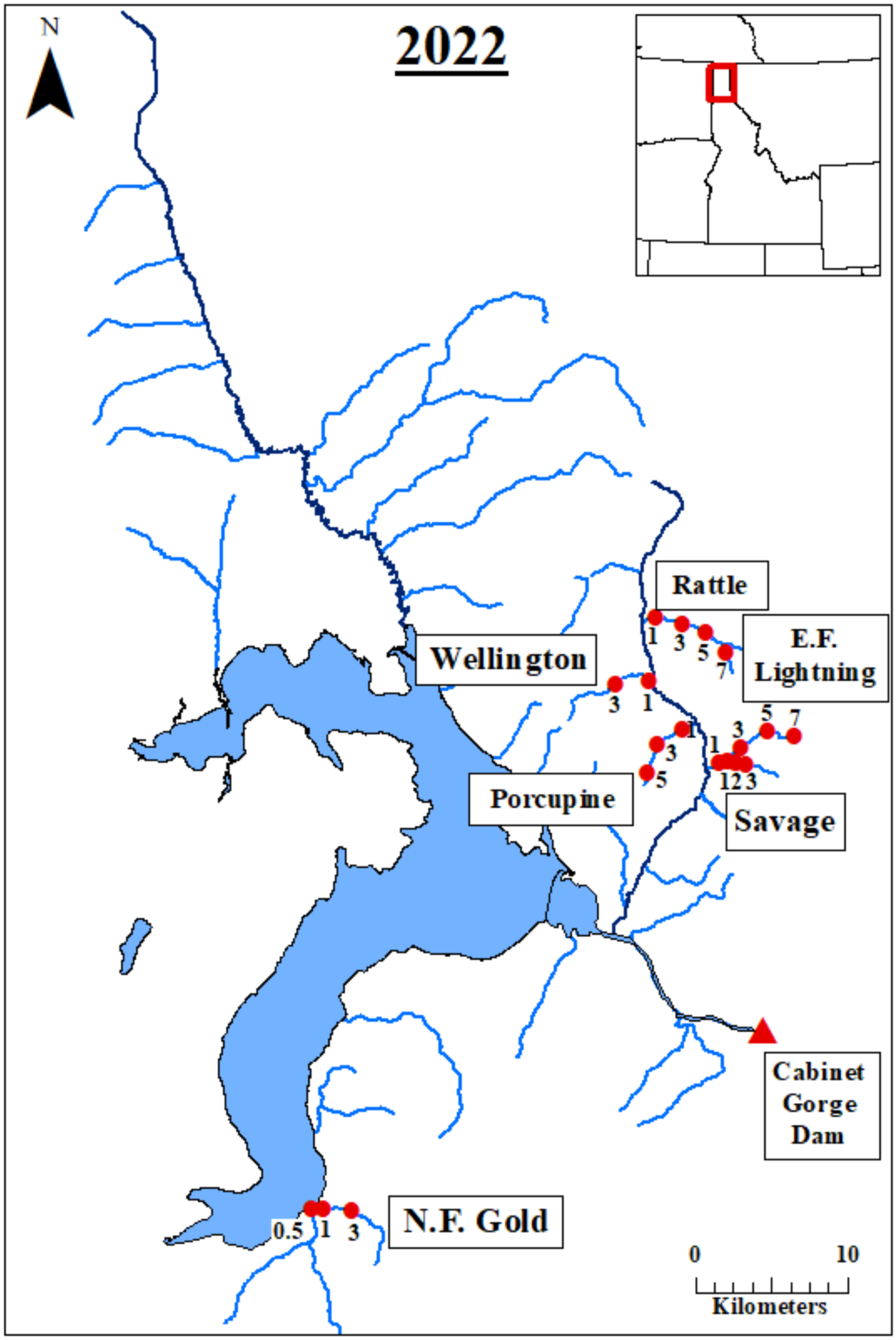

Figure 1. Monitoring sections in North Fork Gold, East Fork Lightning, Savage, Rattle, Porcupine, and Wellington creeks in 2022.

Fish were collected using a Smith-Root backpack electrofishing unit with pulsed DC settings, typically at 40–50 Hz, 2 ms, and 500–800 V. All salmonid species were collected and held in a bucket prior to measurement. Bucket water was exchanged frequently to maintain suitable temperature and oxygenation. Individuals were identified to species, enumerated, and measured for total length. Species and hybrid crosses were identified phenotypically. Characteristics used to identify suspected Westslope Cutthroat Trout *O. clarkii lewisi* (WCT) x Rainbow Trout *O. mykiss* (RBT) hybrids (WRHY) included throat slashes of light intensity or broken in form and exhibiting heavy spotting below the lateral line and toward the anterior end of the fish. Bull Trout *Salvelinus confluentus* (BLT) x Brook Trout *S. fontinalis* (BRK*)* hybrids (BBHY) were identified as individuals exhibiting typical BLT form, but with the presence of some vermiculation or irregular spotting on the dorsal fin. Genetic tissue samples were collected, processed, and archived from a subset of BLT and all suspected BBHYs. Additionally, all BLT > 100 mm were implanted with a 12 mm full duplex passive integrated transponder (PIT) tag in the dorsal sinus.

Multiple-pass removal estimates (Zippin 1958) were conducted in combination with single-pass samples to estimate fish abundance in each tributary. For each stream, a single site was randomly selected to be a three-pass depletion sample to allow for the estimation of fish abundance. Resulting abundance estimates and associated 95% confidence intervals were derived using calculations for removal estimates in closed populations (Hayes et al. 2007). In cases where the lower limit of a confidence interval was less than the total number of fish captured, the total number of fish captured was reported as the lower limit.

The remaining sections of the stream were sampled using a single pass. This was done to increase the number of possible sample sites visited in a field season, as each single-pass sample required less time to complete than a multiple-pass sample. Abundance was estimated from single-pass samples by generating a multiple-pass regression model of abundance based on first pass collections (Meyer and Schill 1999). A single multiple-pass regression model was built using data collected from LPO tributary streams sampled 2009–2022 from all target species combined, including the present years' data (Figure 2). Fish density for each section (fish/m^2) was calculated by dividing the linear abundance by the mean wetted width of the reach. Mean density (fish/m^2) estimates for each stream were calculated by species for all sections sampled that contained fish of any target species and may have included data from sections where a given species was not detected (i.e., all sampled reaches were combined).

RESULTS AND DISCUSSION

A total of 19 stream sections were sampled from July 12 to August 15, 2022 (Table 1; Figure 1). Six species were sampled from these sections; BBHY, BLT, BRK, WCT, RBT, and WRHY. Fish were detected at all the sites sampled. The sections of the streams monitored in 2022 all exhibited perennial flow, and water temperatures ranged 6.5–13.0°C during the days sampled. These temperatures were below the lethal limits for most salmonid species (Behnke 1992) so we did not expect to have reduced fish abundance or atypical fish distribution directly resulting from low water and high temperatures. Although likely not measured in exactly the same locations, mean stream wetted widths measured were wider or approximately the same as those measured in 2017 (Table 1; Bouwens et al. 2019).

Table 1. Locations of tributary monitoring sites sampled in 2022. Coordinates are the downstream extent of sampling sites.

Stream	Section	Date	Latitude	Longitude	Reach Length (m)	Mean Wetted Width (m)
N.F. Gold	0.5	7/12	47.972870	-116.45093	100	4.7
	1	7/13	47.972925	-116.44019	100	5.5
	3	7/12	47.972323	-116.41484	100	4.8
E. F. Lightning	1	7/21	48.24406	-116.10238	100	10.3
	3	7/26	48.25380	-116.08357	100	7.1
	5	7/26	48.26358	-116.05984	100	5.4
	7	7/25	48.26095	-116.03556	100	4.5
Savage	1	7/18	48.24549	-116.09388	100	6.8
	2	7/20	48.24471	-116.08744	100	7.4
	3	7/18	48.24327	-116.07825	100	6.5
Rattle	1	7/28	48.32890	-116.16149	100	6.1
	3	7/27	48.32599	-116.13735	100	6.1
	5	8/3	48.32075	-116.11676	100	5.1
	7	8/15	48.30935	-116.09783	100	2.3
Porcupine	1	8/2	48.26315	-116.13511	100	5.8
	3	8/9	48.25373	-116.15661	100	4.8
	5	8/10	48.25205	-116.17416	100	2.8
Wellington	1	8/1	48.29171	-116.16532	100	7.7
	3	8/2	48.28932	-116.19622	100	5.7

The multiple-pass data from the six 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 ($n = 215$, $P < 0.01$). 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.

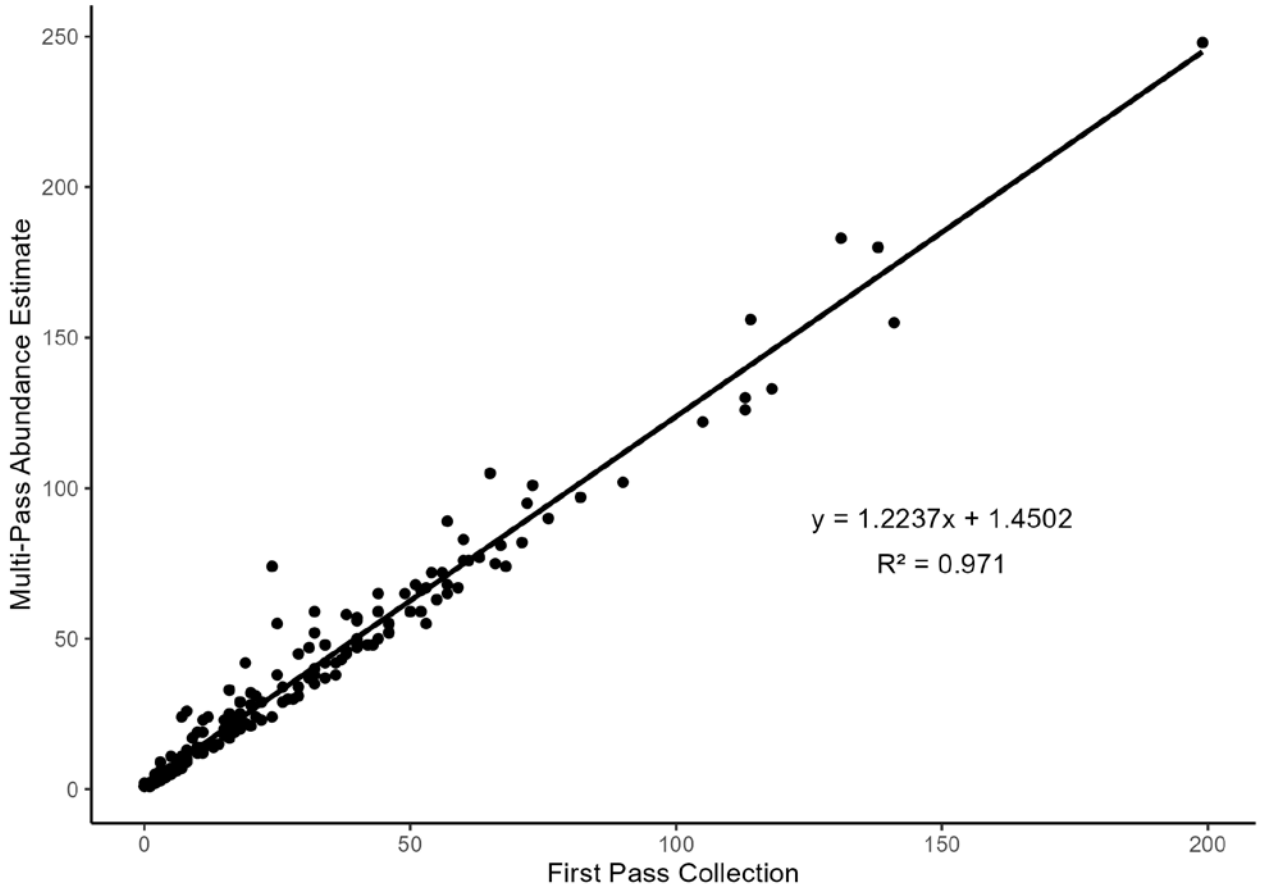

Figure 2. Regression model showing the relationship of estimated trout abundance (fish/100 m) between multiple-pass methods and the number of fish captured on the first pass. Data represent combined 2009–2022 multiple-pass removal efforts for salmonids ≥ 75 mm total length in tributaries of Lake Pend Oreille, Idaho (N = 216).

North Fork Gold Creek

Three sections of N.F. Gold Creek representing three kilometers of stream were sampled in 2022 (Table 1; Figure 1). Westslope Cutthroat Trout had the highest density in this stream (4.4/100 m^2) followed by BLT (Table 2). Bull Trout, RBT, and WRHY were all documented in the creek for the first time in 2022 (Table 2 and 3). Section 0.5 was included in this year's sampling in order to provide a more detailed assessment of fish populations downstream of a waterfall barrier above section one.

Table 2. Fish length and density estimates by section and species for North Fork Gold Creek in 2022. Combined mean estimates include data from all sections where fish were encountered, even if that particular species was not detected.

Section		Total Length (mm)				Fish/100 m			Fish/100 m^2		
(km)	Species	n	Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
0.5	BLT	3	121.0	99	143	5.1	3.0	15.8	1.1	0.6	3.4
	RBT	3	105.0	77	149	5.1	3.0	15.8	1.1	0.6	3.4
	WCT	1	141.0	141	141	2.7	1.0	13.4	0.6	0.2	2.9
	WRHY	1	84.0	84	84	2.7	1.0	13.4	0.6	0.2	2.9
1	BLT	3	103.0	95	113	3.0	3.0	13.7	0.5	0.5	0.5
	WCT	14	140.9	92	198	14.0	10.0	24.7	2.5	2.2	2.8
3	WCT	38	120.63	60	214	48.0	38.0	58.7	10.0	7.9	12.2
Total	BLT	6	112.0	95	143	2.7			0.5		
	RBT	3	105.0	77	149	1.7			0.4		
	WCT	53	126.4	60	214	21.6			4.4		
	WRHY	1	84.0	84	84	0.9			0.2		

Table 3. Mean density estimates (fish/100 m^2) 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
E.F. Lightning Creek	2022	1.0	0.1	0.0	3.4	2.0	0.0	0.1	0.8	7.4
	2017	0.3	0.1	0.0	10.5	2.7	0.0	0.0	1.7	15.3
	2012	3.1	0.1	0.0	2.8	4.5	0.0	0.5	0.4	11.4
Porcupine Creek	2022	0.1	6.4	0.0	1.1	8.5	0.0	0.1	0.7	16.9
	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	2022	3.5	0.0	0.0	0.1	7.9	0.0	0.0	0.2	11.7
	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	2022	1.9	0.0	0.0	0.4	1.8	0.0	0.0	1.2	5.3
	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	2022	0.9	0.2	0.0	0.7	10.2	0.0	0.2	1.6	13.8
	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	2022	0.5	0.0	0.0	0.4	4.4	0.0	0.0	0.2	5.5
	2017	0.0	0.0	0.0	0.0	10.6	0.0	0.0	0.0	10.6
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
	2010	0.0	4.1	0.0	5.0	5.9	0.0	0.0	0.3	15.3
S. Grouse Creek	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
	2013	1.3	3.0	0.0	7.6	1.3	0.0	0.0	3.3	16.5
Rapid Lighting Creek	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

	2010	<0.1	3.2	0.0	1.0	5.2	1.2	0.0	0.3	10.9

Table 3. Continued.

Stream	Year	BLT	BRK	BRN	RBT	WCT	MWF	BBHY	WRHY	Total
West Gold Creek	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
	2009	0.1	0.0	0.0	0.0	43.7	0.0	0.0	0.0	43.8
Gold Creek	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
	2009	4.4	0.0	0.0	0.0	23.6	0.0	0.0	<.01	28.0
Granite Creek	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
	2009	4.6	0.0	0.0	0.0	6.7	0.2	0.0	0.0	11.5
Strong Creek	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
	2009	0.1	0.0	0.0	0.1	7.2	0.0	0.0	0.1	7.5
Johnson Creek	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
	2009	1.4	0.0	0.0	0.0	5.1	0.0	0.0	0.0	6.5
Twin Creek	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
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

East Fork Lightning Creek

Four sections covering seven kilometers were sampled in East Fork Lightning Creek in 2022 (Table 1; Figure 1). Rainbow Trout were the most abundant species sampled followed by WCT, WRHY, and BLT (Table 4). Densities of BLT and WCT increased from levels measured in 2017; however, have these species' abundance has yet not recovered to conditions observed before a major flood event in December of 2015 (Table 3).

Table 4. Length and density estimates by species for East Fork Lightning Creek in 2022. Combined mean estimates include data from all sections where fish were encountered, even if that particular species was not detected.

Section		Total Length (mm)				Fish/100 m			Fish/100 m^2		
(km)	Species	N	Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
1	BBHY	1	232	232	232	2.7	1.0	13.4	0.3	0.1	1.3
	BLT	3	158	145	165	5.1	3.0	15.8	0.5	0.3	1.5
	BRK	1	220	220	220	2.7	1.0	13.4	0.3	0.1	1.3
	RBT	57	109.5	79	163	71.2	60.4	82.0	6.9	5.9	8.0
	WCT	1	172.0	172	172	2.7	1.0	13.4	0.3	0.1	1.3
	WRHY	3	125.3	100	150	5.1	3.0	15.8	0.5	0.3	1.5
3	BLT	6	138	101	182	6.0	5.0	16.7	0.8	0.8	0.9
	BRK	1	186	186	186	1.0	0.0	11.7	0.1	0.0	0.7
	RBT	30	110.3	76	218	32.0	21.3	42.7	4.5	4.1	4.9
5	BLT	11	100.3	86	136	14.9	11.0	25.6	2.7	2.0	4.7
	RBT	8	134.3	85	167	11.2	8.0	22.0	2.1	1.5	4.0
	WCT	2	186.0	141	231	3.9	2.0	14.6	0.7	0.4	2.7
	WRHY	10	152.9	77	221	13.7	10.0	24.4	2.5	1.8	4.5
7	WCT	24	142.5	81	221	30.8	24.0	41.5	6.8	5.3	9.2
Total	BBHY	1	232	232	232	0.7			0.1		
	BLT	20	120.3	86	182	6.5			1.0		
	BRK	2	203	186	220	0.9			0.1		
	RBT	95	111.8	76	218	28.6			3.4		
	WCT	27	146.8	81	231	9.4			2.0		
	WRHY	13	146.5	77	221	4.7			0.8		

Savage Creek

Three sections were sampled in Savage Creek, with BLT and WCT being abundant throughout the longitudinal gradient of the stream (Table 5). Total fish biomass has decreased since sampling began, however this trend is largely driven by a reduction in WCT densities (Table 3). Bull Trout densities increased from 2017 but are still low compared to those observed before the 2015 flood event (Table 3).

Table 5. Length and density estimates by species for Savage Creek in 2022. Combined mean estimates include data from all sections where fish were encountered, even if that particular species was not detected.

Section		Total Length (mm)				Fish/100 m			Fish/100 m^2		
(km)	Species	N	Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
1	BLT	5	94.8	80	133	7.6	5.0	18.3	1.1	0.7	2.7
	RBT	5	88.2	84	100	7.6	5.0	18.3	1.1	0.7	2.7
	WCT	12	120.8	76	229	16.1	12.0	26.9	2.4	1.8	3.9
	WRHY	5	91.8	78	106	7.6	5.0	18.3	1.1	0.7	2.7
2	BLT	20	124.2	86	172	23.0	12.3	33.7	3.1	2.0	4.1
	WCT	6	148.7	91	202	6.0	3.0	16.7	0.8	0.6	1.0
	WRHY	4	85.8	77	93	4.0	4.0	14.7	0.5	0.5	0.5
3	BLT	7	102.9	83	140	10.0	7.0	20.7	1.5	1.1	3.2
	WCT	10	142.8	81	234	13.7	10.0	24.4	2.1	1.5	3.8
	WRHY	10	143	77	194	13.7	10.0	24.4	2.1	1.5	3.8
Total	BLT	32	114.9	80	172	13.5			1.9		
	RBT	5	88.2	84	100	2.5			0.4		
	WCT	57	134.6	76	234	11.9			1.8		
	WRHY	19	117.5	77	194	8.4			1.2		

Rattle Creek

Four sections were sampled in Rattle Creek representing seven kilometers of stream (Table 1; Figure 1). An increase in BLT and WCT densities was observed compared to 2017 levels (Table 3) while RBT and WRHY remain low (Table 6). Total density estimates in Rattle Creek were the highest since sampling began in 2012 (Table 3).

Table 6. Length and abundance data by section and species for Rattle Creek in 2022. Combined mean estimates include data from all sections where fish were encountered, even if that particular species was not detected.

		Total Length (mm)				Fish/100 m			Fish/100 m^2		
Section (km)	Species	N	Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
1	BLT	21	96.6	76	138	27.1	21.0	37.9	4.5	3.5	6.3
	RBT	1	148	148	148	2.7	1.0	13.4	0.4	0.2	2.2
	WCT	4	125.8	84	183	6.3	4.0	17.1	1.0	0.7	2.8
	WRHY	1	186	186	186	2.7	1.0	13.4	0.4	0.2	2.2
3	BLT	48	111.2	91	161	55.0	44.3	65.7	9.0	7.2	10.9
	WCT	6	201.8	172	245	6.0	4.0	16.7	1.0	0.8	1.2
	WRHY	3	162	85	244	3.0	2.0	13.7	0.5	0.4	0.6
5	BLT	1	84	84	84	2.7	1.0	13.4	0.5	0.2	2.6
	WCT	29	137.4	75	212	36.9	29.0	47.7	7.2	5.7	9.3
7	WCT	46	125.5	85	175	57.7	47.0	68.5	22.4	18.2	26.5
Total	BLT	70	106.4	76	161	21.2			3.5		
	RBT	1	148.0	148	148	0.7			0.1		
	WCT	85	135.0	75	245	26.7			7.9		
	WRHY	4	168.0	85	244	1.4			0.2		

Wellington Creek

Two sections were sampled in Wellington Creek representing three kilometers of stream (Table 1; Figure 1). Below the migration barrier, BLT exhibited an increase in density, however both RBT and WCT declined slightly since 2017. Conversely, above the barrier, WCT increased (Table 3 and 7; Bouwens et al. 2019).

Table 7. Length and abundance data by section and species for Wellington Creek in 2022. Combined mean estimates include data from all sections where fish were encountered, even if that particular species was not detected.

		Total Length (mm)				Fish/100 m			Fish/100 m^2		
Section (km)	Species	N	Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
1	BBHY	2	204	187	221	2.0	1.0	12.7	0.3	0.2	0.4
	BLT	12	103	92	134	13.0	8.0	23.7	1.7	1.2	2.2
	BRK	2	133.5	107	160	2.0	0.0	12.7	0.3	0.0	0.5
	RBT	9	103.1	80	127	11.0	5.0	21.7	1.4	0.4	2.5
	WCT	29	120.6	77	186	33.0	22.3	43.7	4.3	3.2	5.4
	WRHY	22	110	76	222	24.0	13.3	34.7	3.1	2.4	3.9
3	WCT	73	129.6	76	205	90.8	80.0	101.6	16.0	14.1	17.9
Total	BBHY	2	204	187	221	1.0			0.2		
	BLT	12	103.5	92	134	6.5			0.9		
	BRK	2	133.5	107	160	1.0			0.2		
	RBT	9	103.1	80	127	5.5			0.7		
	WCT	102	127.1	76	205	61.9			10.2		
	WRHY	22	110	76	222	12.0			1.6		

Porcupine Creek

Three sections were sampled in Porcupine Creek representing five kilometers of stream (Table 1; Figure 1). Brook Trout exhibited the highest densities, primarily in upstream reaches (Table 8). Rainbow Trout and WRHY also increased slightly, while WCT and BLT declined (Table 3). A series of bedrock chutes are present in the stream between section three and five, which based on species' distribution, appears to act as a barrier to migration.

Table 7. Length and abundance data by section and species for Porcupine Creek in 2022. Combined mean estimates include data from all sections where fish were encountered, even if that particular species was not detected.

		Total Length (mm)				Fish/100 m			Fish/100 m^2		
Section (km)	Species	N	Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
1	RBT	15	116.1	90	183	19.8	15.0	30.5	3.4	2.6	5.3
	WCT	27	135.0	85	265	34.5	27.0	45.2	5.9	4.7	7.8
	WRHY	9	143.1	85	208	12.5	9.0	23.2	2.1	1.6	4.0
3	BBHY	1	213.0	213	213	1.0	0.0	11.7	0.2	0.0	0.5
	BLT	2	103.5	102	105	2.0	1.0	12.7	0.4	0.3	0.6
	BRK	5	106.6	80	153	5.0	2.0	15.7	1.0	0.6	1.5
	WCT	94	115.1	76	208	95.0	84.2	105.8	19.7	19.1	20.2
5	BRK	40	147.2	87	207	50.4	40.0	61.1	18.1	14.4	22.0
Total	BBHY	1	213.0	213	213	0.3			0.1		
	BLT	2	103.5	102	105	0.7			0.1		
	BRK	45	142.7	80	207	18.5			6.4		
	RBT	15	116.1	90	183	6.6			1.1		
	WCT	121	119.5	76	265	43.2			8.5		
	WRHY	9	143.1	85	208	4.2			0.7		

Tributaries in the Lightning Creek drainage appeared to be recovering from the catastrophic flood prior to the 2017 sample event; however, a decline in RBT and WCT may have been influenced by another flood event in spring of 2022 (USGS; https://waterdata.usgs.gov/monitoring-location/12392155/). Fall spawning BLT exhibited an increase in density compared to 2017 in most sample areas, and in some cases were higher than the original sample in 2012. Future studies should consider implementing egg survival studies during incubation to assist with population modeling (Mucciarone et al. 2022) and estimating cohort strength.

Anecdotally, a reduction in habitat complexity and in-stream woody debris was observed during sampling in streams sampled in 2022. This has resulted in severe bank incision throughout the drainage and large sediment deposits now occur at the mouth of several creeks that act as seasonal barriers at base streamflow. Observations of high macroinvertebrate densities were reported in a subset of areas in Rattle and Savage creeks, but were largely nonexistent otherwise. The change in habitats may be impacting fish recruitment and survival at multiple scales for WCT, RBT, and BLT; however, little research has been conducted to discern these effects. Future studies should seek to investigate influential factors these trends, and habitat restoration should be considered to optimize fish production.

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 investigating 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.
3) Monitor changes in stream habitat after major flood events and identify areas where strategic habitat improvements will benefit fish.

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