# Idaho Tributary Monitoring

## 2023 Annual Project Update

Idaho Tributary Habitat Acquisition and Fishery Enhancement Program,
Appendix A

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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 2023, Berry Creek, Char Creek, Jeru Creek, Mosquito Creek, Spring Creek, and exploratory sites on Lightning Creek were surveyed to evaluate salmonid abundance and distribution. This is the third time these streams were sampled since the five-year rotational protocol began in 2009. A total of 27 shocking sections were sampled using backpack electrofishing from June 28 to August 29, 2023. Westslope Cutthroat Trout *Oncorhynchus lewisi* was the most abundant species overall with densities ranging from 0.9 to 22.8 fish per 100 $m^2$, similar to those observed in 2013 and 2018. Overall densities were comparable to those observed for all species in all streams in 2013 and 2018 except for Brook Trout in Spring Creek. In 2015 and 2017 mitigation removals were conducted throughout Spring Creek to reduce densities of Brook Trout due to concerns of infectious pancreatic necrosis virus. Densities were greatly reduced in 2018 and remained relatively low in 2023.

# 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 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 were conducted using backpack electrofishing in 27 LPO and CFR tributaries on a five-year rotation (Bouwens and Jakubowski 2017). 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 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 Berry Creek, Char Creek, Jeru Creek, Mosquito Creek, Spring Creek, and exploratory surveys were conducted on Lightning Creek in 2023 (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 (Bouwens and Jakubowski 2017). 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 located upstream of the uppermost site. Abundance estimates were generated only for fish $\geq$75 mm in total length as smaller fish did not consistently recruit to electrofishing gear (Bouwens and Jakubowski 2017). 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 at 20-meter intervals. Sample sites were closed using block nets at the downstream end of each survey site to prevent escapement during downstream electrofishing passes.

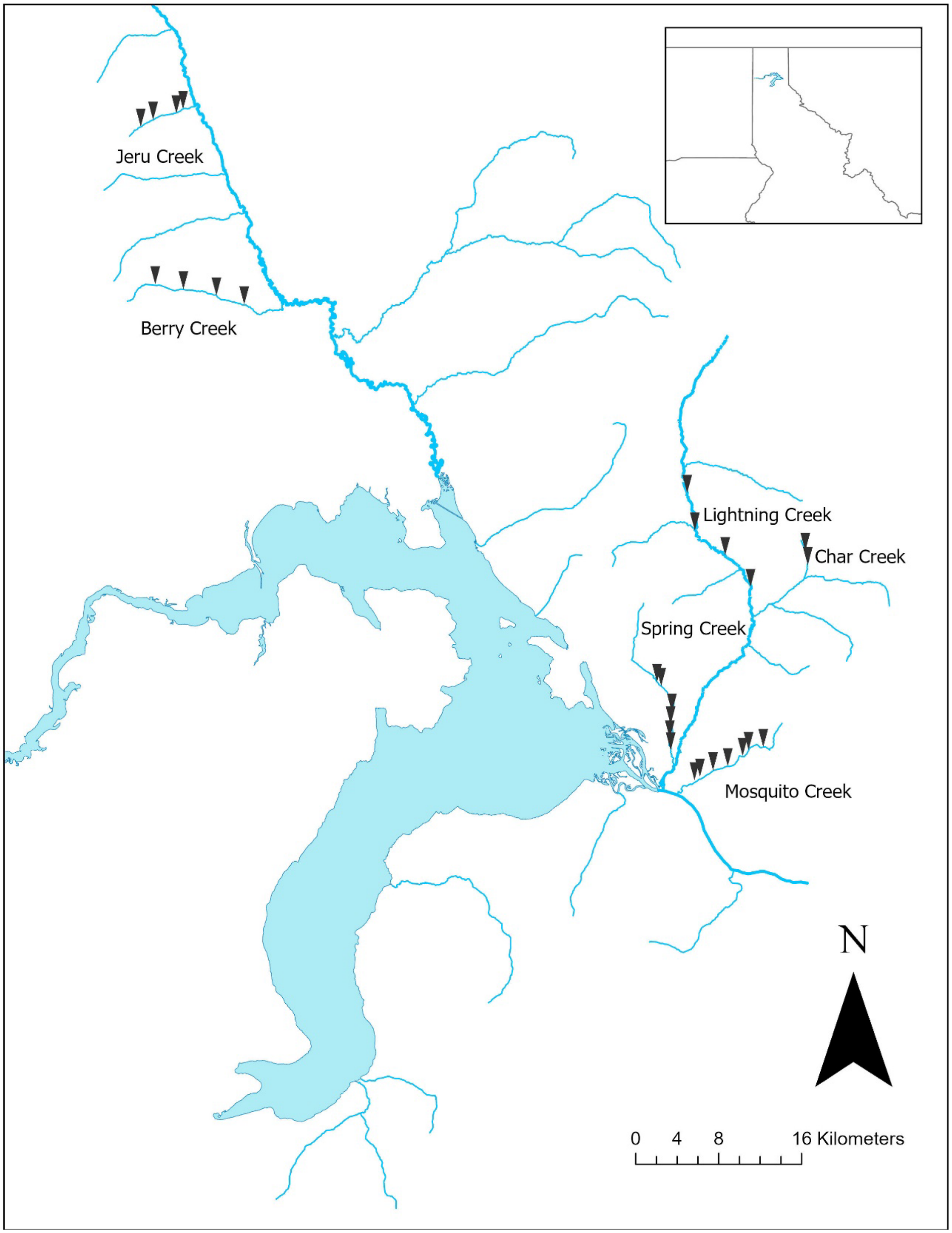


Figure 1. Monitoring sections denoted by the black arrows on Berry, Char, Jeru, Mosquito, Spring, and Lightning creeks in 2023.

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 with one person operating the backpack electrofishing unit and two dedicated netters. 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 anesthetized using AQUI-S®20E, 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. lewisi* x Rainbow Trout *O. mykiss* 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* x Brook Trout *S. fontinalis* hybrids (BBHY) were identified as individuals exhibiting typical Bull Trout (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 BBHY. 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 2009–2023 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 27 stream sections were surveyed from June 28 to August 29, 2023 (Table 1; Figure 1). A total of seven species were sampled from these sections: BBHY, BLT, Brook Trout (BRK), Brown Trout *Salmo trutta* (BRN), Rainbow Trout (RBT), Westslope Cutthroat Trout (WCT), Mountain Whitefish *Prosopium williamsoni* (MWF), and WRHY. Non-target species, typically sculpin *Cottus sp.*, were not netted during these sampling efforts. Salmonids were detected at 21 of the 27 sites sampled. The sections of the streams monitored in 2023 all exhibited perennial flow except for Spring Creek Section 3 which was dry and Jeru Creek Section 4 which was functionally dewatered, and water temperatures ranged from 6.0 to 19.0°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, average stream widths measured were approximately within the range of those observed in 2018 and 2013 (Table 1; Ryan et al. 2014; Frawley et al. 2019). Thus, density estimates were likely not altered due to low water and stream conditions allowed for valid inter-year comparisons.

Table 1. Locations of tributary monitoring sites sampled in 2023. Coordinates are the downstream extent of sampling sites.

| Stream | Section | Date | Latitude | Longitude | Reach Length (m) | Mean Wetted Width (m) |
|---|---|---|---|---|---|---|
| Mosquito | 1 | 6/28/2023 | 48.14582 | -116.163490 | 100 | 2.6 |
| | 2 | 6/28/2023 | 48.147899 | -116.158745 | 100 | 4.1 |
| | 3 | 6/28/2023 | 48.151531 | -116.147432 | 100 | 3.4 |
| | 4 | 6/28/2023 | 48.153937 | -116.134672 | 75 | 4.1 |
| | 5 | 7/10/2023 | 48.159858 | -116.121811 | 100 | 2.3 |
| | 6 | 6/29/2023 | 48.163283 | -116.116709 | 100 | 2.0 |
| | 7 | 6/29/2023 | 48.165011 | -116.103957 | 100 | 1.9 |
| Spring | 1 | 7/10/2023 | 48.163061 | -116.184089 | 100 | 6.2 |
| | 2 | 7/10/2023 | 48.169958 | -116.184800 | 100 | 6.2 |
| | 3 | 7/10/2023 | 48.178078 | -116.184133 | 100 | 0.0 |
| | 4 | 7/12/2023 | 48.185259 | -116.183037 | 44 | 2.8 |
| | 6 | 7/11/2023 | 48.20025 | -116.192273 | 100 | 3.3 |
| | 7 | 7/12/2023 | 48.202534 | -116.195911 | 100 | 3.5 |
| Jeru | 1 | 7/18/2023 | 48.531842 | -116.606071 | 100 | 4.1 |
| | 2 | 7/17/2023 | 48.529379 | -116.611860 | 80 | 3.5 |
| | 3 | 7/17/2023 | 48.525685 | -116.632001 | 100 | 3.5 |
| | 4 | 7/17/2023 | 48.521724 | -116.642687 | 20 | 0.3 |
| Char | 1 | 7/6/2023 | 48.269933 | -116.065455 | 100 | 5.1 |
| | 2 | 7/6/2023 | 48.278119 | -116.067597 | 63 | 3.0 |
| Berry | 3 | 7/18/2023 | 48.419796 | -116.553158 | 100 | 5.7 |
| | 5 | 7/19/2023 | 48.424898 | -116.577201 | 100 | 4.3 |
| | 7 | 7/20/2023 | 48.428463 | -116.605789 | 100 | 3.1 |
| | 9 | 7/20/2023 | 48.43136 | -116.630141 | 100 | 2.8 |
| Lightning | 3 | 8/23/2023 | 48.25725 | -116.11500 | 100 | 18.5 |
| | 6 | 8/24/2023 | 48.27562 | -116.13690 | 100 | 7.7 |
| | 9 | 8/28/2023 | 48.28976 | -116.16317 | 100 | 8.4 |
| | 12 | 8/29/2023 | 48.31145 | -116.16977 | 100 | 7.7 |

The multiple-pass data from 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). This modeling illustrated that the first pass collections described approximately 97% of the variation in estimated abundance from multiple-pass samples (n = 221, $P < 0.01$). 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.

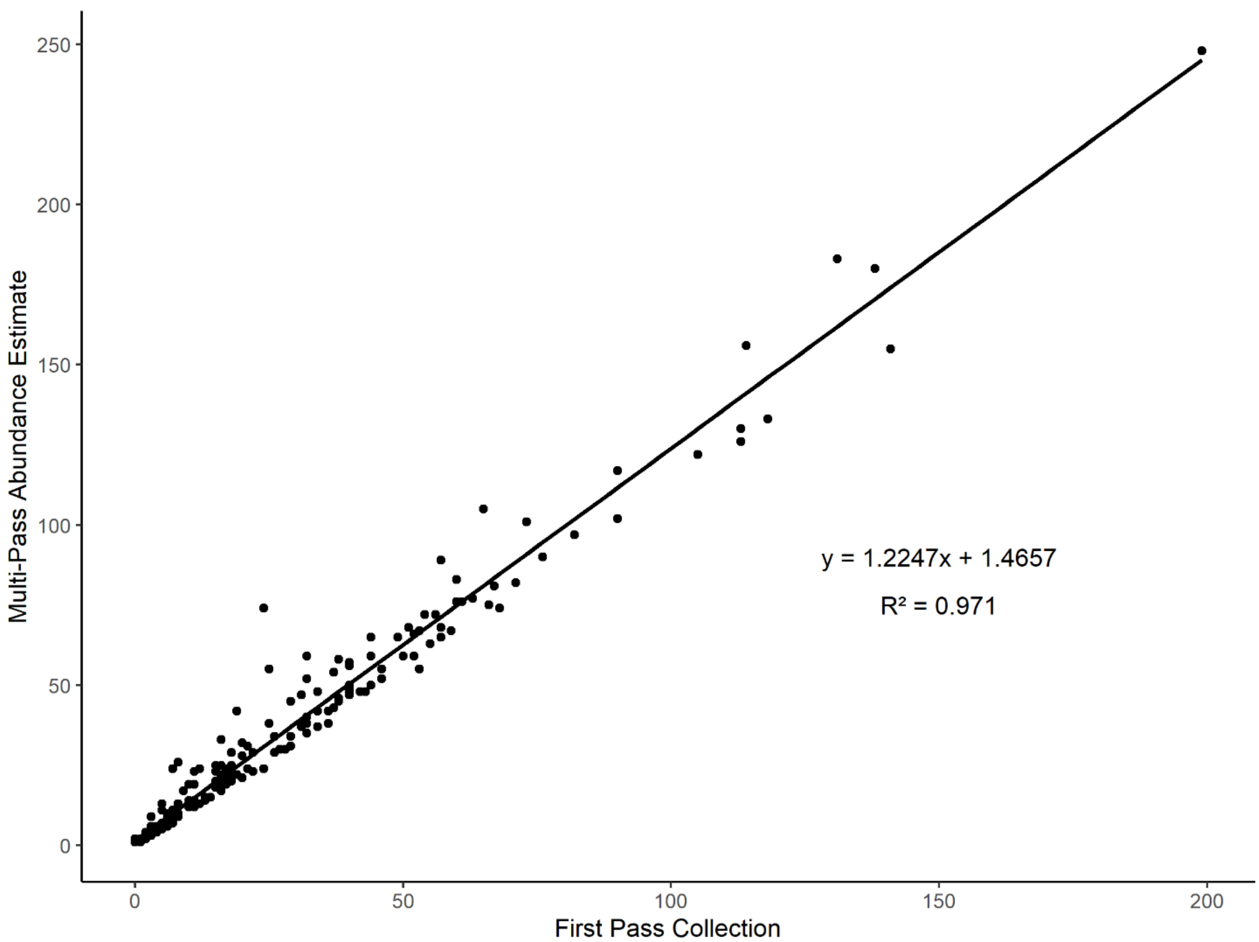


Figure 2. Regression model showing the relationship of estimated trout abundance (fish/100 m) between multiple-pass methods and the number of fish captured on the first pass. Data represent combined 2009–2023 multiple-pass removal efforts for salmonids ≥ 75 mm total length in tributaries of Lake Pend Oreille, Idaho (N = 221).

***Berry Creek***

Four sections of Berry Creek representing eight stream-kilometers were sampled in 2023 (Table 1). Five sections were identified on Berry Creek for sampling, however, as in 2013 and 2018, Section 1 was dry so it was not sampled (Frawley et al. 2019). Westslope Cutthroat Trout were the most abundant salmonid in this stream followed by RBT (Tables 2 and 3). Brook Trout and WRHY were sampled at low densities. Additionally, a single BLT was sampled in 2023 which was the first detection of BLT in Berry Creek.

Table 2. Fish length and density estimates by section and species for Berry Creek in 2023. Combined mean estimates include data from all sections where fish were encountered, even if that species was not detected.

| Section (km) | | Total Length (mm) | | | | Fish/100 m | | | Fish/100 m$^2$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Species | n | Mean | Min. | Max. | Est. | 95% CI - | 95% CI + | Est. | 95% CI - | 95% CI + |
| 3 | BLT | 1 | 138 | 138 | 138 | 2.7 | 1 | 13.3 | 0.5 | 0.2 | 2.3 |
| | BRK | 3 | 164 | 145 | 182 | 5.1 | 3 | 15.7 | 0.9 | 0.5 | 2.7 |
| | RBT | 11 | 125 | 93 | 265 | 14.9 | 11 | 25.5 | 2.6 | 1.9 | 4.5 |
| | WCT | 29 | 114 | 76 | 217 | 37 | 29 | 47.6 | 6.5 | 5.1 | 8.3 |
| | WRHY | 4 | 90 | 79 | 116 | 6.4 | 4 | 17 | 1.1 | 0.7 | 3.0 |
| 5 | WCT | 52 | 128 | 75 | 213 | 54 | 52 | 64.6 | 12.6 | 12.1 | 15.0 |
| | WRHY | 2 | 164 | 152 | 177 | 2 | 2 | 12.6 | 0.5 | 0.5 | 2.9 |
| 7 | WCT | 64 | 125 | 79 | 198 | 79.8 | 69.2 | 90.5 | 25.5 | 22.1 | 28.9 |
| 9 | No fish | - | - | - | - | - | - | - | 0 | 0 | 0 |
| Total | BLT | 1 | 138 | 138 | 138 | 0.9 | | | 0.2 | | |
| | BRK | 3 | 164 | 145 | 182 | 1.7 | | | 0.3 | | |
| | RBT | 11 | 125 | 93 | 265 | 5 | | | 4.4 | | |
| | WCT | 145 | 114 | 75 | 217 | 57 | | | 13.6 | | |
| | WRHY | 6 | 90 | 79 | 177 | 2.8 | | | 0.5 | | |

Table 3. Mean density estimates (fish/100 m$^2$) for all sections combined where fish were sampled by stream, year, and species 2009–2023. Combined mean estimates include data from all sections where fish were detected, even if that species was not detected. Streams presented separately by five-year rotational sampling schedule that included three sampling events.

| Stream | Year | BLT | BRK | BRN | RBT | WCT | MWF | BBHY | WRHY | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Berry Creek | 2023 | 0.2 | 0.3 | 0 | 4.4 | 13.6 | 0 | 0 | 0.5 | 19 |
| | 2018 | 0 | 0.2 | 0 | 1 | 11.7 | 0 | 0 | 0.2 | 13.1 |
| | 2013 | 0 | 0.2 | 0 | 0.5 | 11 | 0 | 0 | 0.8 | 12.5 |
| Jeru Creek | 2023 | 0 | 0.3 | 0 | 3.5 | 3.4 | 0 | 0.2 | 0.6 | 8.1 |
| | 2018 | 0 | 0 | 0 | 1.4 | 9.5 | 0 | 0 | 1.1 | 12 |
| | 2013 | 0.2 | 0 | 0 | 0.7 | 5.6 | 0 | 0 | 3.1 | 9.6 |
| Mosquito Creek | 2023 | 0.2 | 1.8 | 0.3 | 0.2 | 3.5 | 0 | 0 | 0.3 | 6.3 |
| | 2018 | 0 | 3.6 | 0.1 | 0.3 | 7.4 | 0 | 0 | 0.5 | 11.9 |
| | 2013 | 0 | 4.9 | 0.2 | 0 | 3.4 | 0 | 0 | 0.2 | 8.7 |
| Spring Creek | 2023 | 0.1 | 4.8 | 0.4 | 0.5 | 1.3 | 0.4 | 0 | 0 | 7.1 |
| | 2018 | 0 | 3.7 | 0.1 | 1.3 | 0.9 | 0 | 0 | 0.2 | 6.2 |
| | 2013 | 0 | 16.5 | 0.1 | 0.2 | 0.9 | 0.1 | 0 | 0.3 | 18.1 |
| Char Creek | 2023 | 0 | 0 | 0 | 0 | 22.8 | 0 | 0 | 0 | 22.8 |
| | 2018 | 0 | 0 | 0 | 0 | 25.3 | 0 | 0 | 0 | 25.3 |
| | 2013 | 0 | 0 | 0 | 0 | 75 | 0 | 0 | 0 | 75 |
| Lightning Creek | 2023 | 0.2 | 0.2 | 0.13 | 3.05 | 0.18 | 0 | 0.1 | 0.13 | 3.99 |
| E.F. Lightning Creek | 2022 | 1 | 0.1 | 0 | 3.4 | 2 | 0 | 0.1 | 0.8 | 7.4 |
| | 2017 | 0.3 | 0.1 | 0 | 10.5 | 2.7 | 0 | 0 | 1.7 | 15.3 |
| | 2012 | 3.1 | 0.1 | 0 | 2.8 | 4.5 | 0 | 0.5 | 0.4 | 11.4 |
| Porcupine Creek | 2022 | 0.1 | 6.4 | 0 | 1.1 | 8.5 | 0 | 0.1 | 0.7 | 16.9 |
| | 2017 | 0.3 | 3.4 | 0 | 0.3 | 12.1 | 0 | 0 | 0.3 | 16.4 |
| | 2012 | 1 | 5.4 | 0 | 0 | 10.5 | 0 | 0 | 0.9 | 17.8 |
| Rattle Creek | 2022 | 3.5 | 0 | 0 | 0.1 | 7.9 | 0 | 0 | 0.2 | 11.7 |
| | 2017 | 0.8 | 0 | 0 | 0.3 | 5.1 | 0 | 0 | 0.1 | 6.3 |
| | 2012 | 4.6 | 0 | 0 | 0.6 | 5.8 | 0 | 0 | 0.1 | 11.1 |
| Savage Creek | 2022 | 1.9 | 0 | 0 | 0.4 | 1.8 | 0 | 0 | 1.2 | 5.3 |
| | 2017 | 1.6 | 0 | 0 | 0.2 | 9.3 | 0 | 0 | 1.7 | 12.8 |
| | 2012 | 5.1 | 0 | 0 | <0.1 | 3.9 | 0 | 0 | 0.7 | 9.7 |
| Wellington Creek | 2022 | 0.9 | 0.2 | 0 | 0.7 | 10.2 | 0 | 0.2 | 1.6 | 13.8 |
| | 2017 | 0.3 | 0 | 0 | 2.3 | 12.1 | 0 | 0 | 1 | 15.7 |
| | 2012 | 1.3 | 0.1 | 0 | 0.5 | 10.4 | 0 | 0 | 0.4 | 12.7 |
| N. Gold Creek | 2022 | 0.5 | 0 | 0 | 0.4 | 4.4 | 0 | 0 | 0.2 | 5.5 |
| | 2017 | 0 | 0 | 0 | 0 | 10.6 | 0 | 0 | 0 | 10.6 |
| Caribou Creek | 2021 | 7.5 | 0.8 | 0 | 13.6 | 19.4 | 0 | 0 | 2 | 43.7 |
| | 2016 | 1.8 | 0.1 | 0 | 0.8 | 9 | 0 | 0 | 0.2 | 11.9 |
| | 2011 | 3.1 | 0.3 | 0 | 1.2 | 6.1 | 0 | 0 | 0.7 | 11.4 |

Table 3 Continued.

| Stream | Year | BLT | BRK | BRN | RBT | WCT | MWF | BBHY | WRHY | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Morris Creek | 2021 | 3.2 | 0 | 0 | 0 | 11.1 | 0 | 0 | 1.2 | 15.6 |
| | 2016 | 0.7 | 0 | 0 | 0 | 11.5 | 0 | 0 | 0.4 | 12.6 |
| | 2011 | 5.8 | 0 | 0 | 0 | 7 | 0 | 0 | 1.8 | 14.6 |
| Trestle Creek | 2021 | 1.4 | 0 | 0 | 0.5 | 8.5 | 0 | 0 | 0.5 | 11 |
| | 2016 | 1.5 | 0 | 0 | 0 | 12.5 | 0 | 0 | 0 | 14 |
| | 2011 | 1.8 | 0 | 0 | <0.1 | 4.5 | 0.1 | 0 | 1 | 7.4 |
| Hellroaring Creek | 2021 | 0.6 | 1.4 | 0 | 19.3 | 0.8 | 0 | 0 | 0 | 22.1 |
| | 2016 | 0.2 | 0 | 0 | 7.1 | 0.1 | 0 | 0 | 0 | 7.4 |
| | 2012 | 0.2 | <0.1 | 0 | 4 | 0 | 0 | 0 | 0.2 | 4.4 |
| McCormick Creek | 2021 | 3.8 | 0 | 0 | 0 | 13.2 | 0 | 0 | 0 | 17 |
| | 2016 | 0 | 0 | 0 | 0 | 11.3 | 0 | 0 | 0 | 11.3 |
| | 2012 | 0 | 0 | 0 | 0.5 | 1.7 | 0 | 0 | 0.3 | 2.5 |
| | | | | | | | | | | |
| Grouse Creek | 2020 | 1.4 | 0.1 | 0 | 4.5 | 3.2 | 0.3 | <0.1 | 0.3 | 9.8 |
| | 2015 | 3.6 | 0.3 | 0 | 3.5 | 1.7 | <0.1 | 0.2 | 0.2 | 9.5 |
| | 2010 | 3.5 | 0.4 | 0 | 8.2 | 3.6 | 0.6 | 0.2 | 0.3 | 16.8 |
| N. Grouse Creek | 2020 | 0 | 1.2 | 0 | 3.3 | 3.4 | 0 | 0 | 0.1 | 8 |
| | 2015 | 0.2 | 2.2 | 0 | 6.4 | 4.1 | 0 | 0 | 0.1 | 13 |
| | 2010 | 0 | 4.1 | 0 | 5 | 5.9 | 0 | 0 | 0.3 | 15.3 |
| S. Grouse Creek | 2020 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9 | 3.9 |
| | 2015 | 0.7 | 2.5 | 0 | 15.1 | 0.7 | 0 | 2.5 | 2.9 | 24.4 |
| | 2013 | 1.3 | 3 | 0 | 7.6 | 1.3 | 0 | 0 | 3.3 | 16.5 |
| Rapid Lighting Creek | 2020 | 0 | 1.7 | 0 | 0.4 | 2.6 | <0.1 | 0 | <0.1 | 4.7 |
| | 2015 | 0 | 3.3 | 0 | 1.1 | 6.4 | 0.3 | 0 | 0.2 | 11.3 |
| | 2010 | <0.1 | 3.2 | 0 | 1 | 5.2 | 1.2 | 0 | 0.3 | 10.9 |
| West Gold Creek | 2020 | 0 | 0 | 0 | 0 | 47.6 | 0 | 0 | 0 | 47.6 |
| | 2015 | 2.2 | 0 | 0 | 0 | 50.8 | 0 | 0 | 0 | 53 |
| | 2009 | 0.1 | 0 | 0 | 0 | 43.7 | 0 | 0 | 0 | 43.8 |
| | | | | | | | | | | |
| Gold Creek | 2019 | 2.2 | 0 | 0 | 0 | 19.5 | 0 | 0 | 1.3 | 23 |
| | 2014 | 2.5 | 0 | 0 | 0 | 32 | 0 | 0 | 0.2 | 34.8 |
| | 2009 | 4.4 | 0 | 0 | 0 | 23.6 | 0 | 0 | <.01 | 28 |
| Granite Creek | 2019 | 4.5 | 0 | 0 | 0.1 | 12.1 | 0 | 0 | 0.4 | 17.1 |
| | 2014 | 6.3 | 0 | 0 | 0 | 6.4 | 0 | 0 | <0.1 | 12.7 |
| | 2009 | 4.6 | 0 | 0 | 0 | 6.7 | 0.2 | 0 | 0 | 11.5 |
| Strong Creek | 2019 | 2.2 | 0 | 0 | 0.5 | 19.3 | 0 | 1.7 | 0.1 | 23.8 |
| | 2014 | 3.2 | 0 | 0 | <0.1 | 19 | 0 | 0 | <0.1 | 22.3 |
| | 2009 | 0.1 | 0 | 0 | 0.1 | 7.2 | 0 | 0 | 0.1 | 7.5 |
| Johnson Creek | 2019 | 0.8 | 0 | 0 | 0 | 9.1 | 0 | 0 | 0.4 | 10.3 |
| | 2014 | 1 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 8 |

Table 3 Continued.

| Stream | Year | BLT | BRK | BRN | RBT | WCT | MWF | BBHY | WRHY | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Johnson Creek | 2009 | 1.4 | 0 | 0 | 0 | 5.1 | 0 | 0 | 0 | 6.5 |
| Twin Creek | 2019 | 0 | 4.2 | 0.3 | 3.9 | 3.2 | 0 | 0 | 0.2 | 11.8 |
| | 2014 | 0.1 | 7.6 | 0.5 | 1.3 | 3.3 | 0 | 0 | 1.4 | 14.2 |
| | 2009 | 0 | 2.7 | 0.3 | 2 | 3.8 | 0 | 0 | 0 | 8.8 |

***Char Creek***

Two sections covering two kilometers were sampled in Char Creek in 2023, with WCT being the only fish species sampled (Table 1). There are two barriers to fish passage in this creek - one downstream of Section 1 and the second between sections 1 and 2. The barrier downstream of Section 1 is a log jam while the next barrier is a series of bedrock waterfalls. Similar to 2013 and 2018, no fish were collected in Section 2 (Table 4). Given the barrier to fish passage and the lack of fish present in all three years of sampling, Section 2 should be removed from the sampling protocol.

Table 4. Fish lengths and density estimates by species for Char Creek in 2023. Combined mean estimates include data from all sections where fish were encountered, even if that species was not detected.

| Section (km) | Species | Total Length (mm) | | | | Fish/100 m | | | Fish/100 $m^2$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | n | Mean | Min. | Max. | Est. | 95% CI - | 95% CI + | Est. | 95% CI - | 95% CI + |
| 1 | WCT | 116 | 129 | 75 | 211 | 117 | 117 | 127.72 | 22.8 | 22.8 | 24.9 |
| 2 | No fish | - | - | - | - | - | - | - | 0 | 0 | 0 |
| Total | WCT | 116 | 129 | 75 | 211 | 117 | | | 22.8 | | |

***Jeru Creek***

Four sections were sampled in Jeru Creek representing four kilometers of stream (Table 1). Riparian vegetation along Section 4 was severely overgrown and prevented field staff from effectively sampling this functionally dewatered section. Rainbow Trout were the most abundant species in this stream with WCT having similar densities (Tables 5). Two Brook BBHY were sampled in Jeru Creek in 2023 which is the first time these hybrids have been observed in this stream (Table 5).

Table 5. Length and density estimates by species for Jeru Creek in 2023. Combined mean estimates include data from all sections where fish were encountered, even if that species was not detected.

| Section (km) | Species | Total Length (mm) | | | | Fish/100 m | | | Fish/100 m$^2$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | n | Mean | Min. | Max. | Est. | 95% CI - | 95% CI + | Est. | 95% CI - | 95% CI + |
| 1 | BBHY | 2 | 140 | 138 | 141 | 2 | 2 | 12.6 | 0.5 | 0.5 | 3.1 |
| | BRK | 4 | 183 | 141 | 222 | 4 | 4 | 14.6 | 1.0 | 1.0 | 3.6 |
| | WCT | 24 | 107 | 76 | 156 | 25 | 24 | 35.6 | 6.2 | 5.9 | 8.8 |
| | WRHY | 3 | 127 | 81 | 187 | 3 | 3 | 13.6 | 0.7 | 0.7 | 3.3 |
| 2 | RBT | 4 | 113 | 107 | 123 | 6.4 | 4 | 17 | 1.8 | 1.1 | 4.9 |
| | WCT | 10 | 146 | 76 | 193 | 13.7 | 10 | 24.3 | 3.9 | 2.9 | 6.9 |
| | WRHY | 2 | 118 | 106 | 131 | 3.9 | 2 | 14.5 | 1.1 | 0.6 | 4.1 |
| 3 | RBT | 25 | 121 | 86 | 180 | 32.1 | 25 | 42.7 | 9.2 | 7.1 | 12.2 |
| 4 | No Fish | - | - | - | - | - | - | - | 0 | 0 | 0 |
| Total | BBHY | 2 | 140 | 138 | 141 | 0.7 | | | 0.2 | | |
| | BRK | 4 | 183 | 141 | 222 | 1.3 | | | 0.3 | | |
| | RBT | 29 | 120 | 86 | 180 | 12.8 | | | 3.6 | | |
| | WCT | 34 | 118 | 76 | 193 | 12.9 | | | 3.4 | | |
| | WRHY | 5 | 124 | 81 | 187 | 2.3 | | | 0.6 | | |

***Mosquito Creek***

Seven sections were sampled in Mosquito Creek representing seven kilometers of stream (Table 1). No fish were detected in Section 7. Westslope Cutthroat Trout were the most abundant salmonid in this stream, followed by BRK (Tables 3 and 6). Westslope Cutthroat Trout hybrids and BRN occurred at low densities in 2023 (Tables 6). Rainbow Trout were not detected in 2013 despite the presence of WRHY hybrids; however, they were detected at low densities in 2018 and 2023 (Table 6). Additionally, a single BLT was sampled in 2023 which is the first observation of BLT in Mosquito Creek.

Table 6. Length and abundance data by section and species for Mosquito Creek in 2023. 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$^2$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | n | Mean | Min. | Max. | Est. | 95% CI - | 95% CI + | Est. | 95% CI - | 95% CI + |
| 1 | BLT | 1 | 139 | 139 | 139 | 2.7 | 1 | 13.3 | 1.0 | 0.4 | 5.1 |
| | BRK | 17 | 144 | 80 | 218 | 22.3 | 17 | 32.9 | 8.6 | 6.5 | 12.7 |
| | BRN | 2 | 111 | 104 | 118 | 3.9 | 2 | 14.5 | 1.5 | 0.8 | 5.6 |
| | RBT | 1 | 86 | 86 | 86 | 2.7 | 1 | 13.3 | 1.0 | 0.4 | 5.1 |
| | WCT | 1 | 133 | 133 | 133 | 2.7 | 1 | 13.3 | 1.0 | 0.4 | 5.1 |
| | WRHY | 1 | 200 | 200 | 200 | 2.7 | 1 | 13.3 | 1.0 | 0.4 | 5.1 |
| 2 | WCT | 2 | 138 | 133 | 144 | 3.9 | 2 | 14.5 | 1.0 | 0.5 | 3.6 |
| | WRHY | 2 | 130 | 121 | 140 | 3.9 | 2 | 14.5 | 1.0 | 0.5 | 3.6 |
| 3 | BRK | 5 | 160 | 101 | 203 | 7.5 | 5 | 18.2 | 2.2 | 1.5 | 5.3 |
| | WCT | 9 | 136 | 102 | 192 | 12.5 | 9 | 23.08 | 3.6 | 2.6 | 6.7 |
| | WRHY | 1 | 116 | 116 | 116 | 2.7 | 1 | 13.3 | 0.8 | 0.3 | 3.9 |
| 4 | WCT | 17 | 123 | 77 | 245 | 22.3 | 17 | 32.9 | 5.4 | 4.1 | 7.9 |
| 5 | WCT | 5 | 119 | 88 | 183 | 7.6 | 5 | 18.2 | 3.3 | 2.2 | 8.0 |
| 6 | WCT | 13 | 140 | 102 | 195 | 13 | 12 | 23.6 | 6.6 | 6.1 | 11.9 |
| 7 | No fish | - | - | - | - | - | - | - | - | - | - |
| Total | B LT | 1 | 139 | 139 | 139 | 0.5 | | | 0.2 | | |
| | BRK | 22 | 148 | 80 | 28 | 5 | | | 1.8 | | |
| | BRN | 2 | 111 | 104 | 118 | 0.7 | | | 0.3 | | |
| | RBT | 1 | 86 | 86 | 86 | 0.5 | | | 0.2 | | |
| | WCT | 47 | 131 | 77 | 245 | 10.3 | | | 3.5 | | |
| | WRHY | 4 | 144 | 116 | 200 | 1.6 | | | 0.3 | | |

***Spring Creek***

Six sections were sampled in Spring Creek representing six kilometers of stream (Table 1). A total of seven sections are identified as monitoring sites on Spring Creek; however, we did not have landowner permission to access Section 5. Brook Trout were the most abundant salmonid in this stream, followed by RBT and WCT (Table 7). Brown Trout and WRHY were the least abundant of the species sampled (Table 7). In 2015 and 2017, a total of 862 BKT were removed from Spring Creek throughout the stream as part of an effort to determine the distribution and frequency of infectious pancreatic necrosis virus in the lower Clark Fork River and its tributaries (Bouwens et al. 2019). The removal of BKT appears to have reduced densities as they have remained at similar levels to 2018 (3.5 fish/100 $m^2$) and much lower than 2013 (16.5 fish/100 $m^2$; Table 1). Interestingly, no other species has seen a similar increase in densities which may indicate that habitat in Spring Creek is suitable for high BKT densities but no other salmonid species. Additionally, a single BLT was sampled in 2023 which is the first observation of BLT in Spring Creek.

Table 7. Length and abundance data by section and species for Spring Creek in 2023. 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$^2$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | n | Mean | Min. | Max. | Est. | 95% CI - | 95% CI + | Est. | 95% CI - | 95% CI + |
| 1 | BRN | 5 | 84 | 76 | 93 | 7.6 | 5 | 18.2 | 1.2 | 0.8 | 2.9 |
| | RBT | 8 | 101 | 81 | 135 | 11.3 | 8 | 21.9 | 1.8 | 1.3 | 3.5 |
| 2 | BLT | 1 | 172 | 172 | 172 | 2.7 | 1 | 13.3 | 0.4 | 0.2 | 2.2 |
| | BRK | 21 | 137 | 75 | 186 | 27.2 | 21 | 37.8 | 4.4 | 3.4 | 6.1 |
| | BRN | 4 | 183 | 92 | 269 | 6.4 | 4 | 17 | 1.0 | 0.7 | 2.8 |
| | RBT | 3 | 109 | 90 | 124 | 5.2 | 3 | 15.7 | 0.8 | 0.5 | 2.6 |
| | MWF | 1 | 81 | 81 | 81 | 2.7 | 1 | 13.29 | 0.4 | 0.2 | 2.2 |
| 3 | No fish | - | - | - | - | - | - | - | - | - | - |
| 4 | BRK | 18 | 132 | 95 | 212 | 23.5 | 18 | 34.1 | 8.4 | 6.4 | 12.2 |
| | WCT | 4 | 142 | 124 | 183 | 6.4 | 4 | 17 | 2.3 | 1.4 | 6.1 |
| 5 | No fish | - | - | - | - | - | - | - | - | - | - |
| 6 | BRK | 11 | 117 | 76 | 137 | 28.4 | 22 | 39 | 8.7 | 6.7 | 12.0 |
| | WCT | 9 | 134 | 95 | 197 | 13 | 5 | 23.6 | 4.0 | 1.5 | 7.2 |
| 7 | BRK | 22 | 103 | 76 | 184 | 9 | 6 | 19.6 | 2.6 | 1.7 | 5.7 |
| Total | B LT | 1 | 172 | 172 | 172 | 0.5 | | | 0.1 | | |
| | BRK | 72 | 123 | 75 | 212 | 17.62 | | | 4.8 | | |
| | BRN | 9 | 128 | 76 | 269 | 1.52 | | | 0.4 | | |
| | MWF | 1 | 81 | 81 | 81 | 0.5 | | | 0.1 | | |
| | RBT | 11 | 103 | 81 | 135 | 3.3 | | | 0.5 | | |
| | WCT | 13 | 136 | 95 | 197 | 1.28 | | | 1.3 | | |

***Lightning Creek***

An exploratory survey was conducted on the mainstem Lightning Creek for the first time to determine fish distributions and densities previously unknown in this stream. Four sections were sampled in Lightning Creek representing four kilometers of stream (Table 1). Rainbow

Trout exhibited the highest densities, with low densities of all other salmonids (Table 8). This is the first survey conducted on mainstem Lightning Creek, thus a time series comparison of densities cannot be conducted.

Table 8. Length and abundance data by section and species for Lightning Creek in 2023. Combined mean estimates include data from all sections where fish were encountered, even if that species was not detected.

| Section (km) | Species | Total Length (mm) | | | | Fish/100 m | | | Fish/100 m$^2$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | n | Mean | Min. | Max. | Est. | 95% CI - | 95% CI + | Est. | 95% CI - | 95% CI + |
| 3 | BLT | 1 | 167 | 167 | 167 | 2.7 | 1 | 13.3 | 0.1 | 0.1 | 0.7 |
| | BRN | 1 | 138 | 138 | 138 | 2.7 | 1 | 13.3 | 0.1 | 0.1 | 0.7 |
| | RBT | 15 | 110 | 88 | 134 | 19.8 | 15 | 30.4 | 1.1 | 0.8 | 1.6 |
| 6 | BBHY | 1 | 137 | 137 | 137 | 2.7 | 1 | 13.3 | 0.4 | 0.1 | 1.7 |
| | BLT | 1 | 99 | 99 | 99 | 2.7 | 1 | 13.3 | 0.4 | 0.1 | 1.7 |
| | BRK | 2 | 133 | 130 | 136 | 3.9 | 2 | 14.5 | 0.5 | 0.3 | 1.9 |
| | BRN | 1 | 179 | 179 | 179 | 2.7 | 1 | 13.3 | 0.4 | 0.1 | 1.7 |
| | RBT | 30 | 112 | 83 | 170 | 38.2 | 30 | 48.8 | 5.0 | 3.9 | 6.3 |
| | WCT | 1 | 156 | 156 | 156 | 2.7 | 1 | 13.3 | 0.4 | 0.1 | 1.7 |
| | WRHY | 2 | 325 | 280 | 370 | 3.9 | 2 | 14.5 | 0.5 | 0.3 | 1.9 |
| 9 | BLT | 1 | 97 | 97 | 97 | 2.7 | 1 | 13.3 | 0.3 | 0.1 | 1.6 |
| | BRK | 1 | 189 | 189 | 189 | 2.7 | 1 | 13.3 | 0.3 | 0.1 | 1.6 |
| | RBT | 34 | 117 | 94 | 225 | 43.1 | 34 | 53.7 | 5.1 | 4.0 | 6.4 |
| | WCT | 1 | 157 | 157 | 157 | 2.7 | 1 | 13.3 | 0.3 | 0.1 | 1.6 |
| 12 | RBT | 5 | 167 | 104 | 262 | 7.6 | 5 | 18.2 | 1.0 | 0.6 | 2.4 |
| Total | BBHY | 1 | 137 | 137 | 137 | 0.7 | | | 0.1 | | |
| | BLT | 3 | 21 | 97 | 167 | 2.2 | | | 0.2 | | |
| | BRK | 3 | 152 | 130 | 189 | 1.7 | | | 0.2 | | |
| | BRN | 2 | 158 | 138 | 179 | 1.4 | | | 0.13 | | |
| | RBT | 84 | 117 | 83 | 262 | 27.2 | | | 3.05 | | |
| | WCT | 2 | 156 | 156 | 157 | 1.4 | | | 0.18 | | |
| | WRHY | 2 | 325 | 280 | 370 | 1.0 | | | 0.13 | | |

There are some apparent patterns among the tributaries surveyed in 2023. Westslope Cutthroat Trout were the most widely distributed and abundant salmonid species in all streams except Spring Creek and Lightning Creek (Table 3). In general, RBT was the second most abundant species, followed by BKT. Four of the streams sampled in 2023 supported BLT (i.e., Spring Creek, Mosquito Creek, Lightning Creek, and Berry Creek). These were the first observations of BLT in Spring, Mosquito, and Berry creeks (Table 3). Brown Trout had a limited distribution (only in Mosquito, Spring and Lightning creeks) and occurred at low densities when present. Additionally, WRHY densities decreased in all creeks except for Berry Creek, and BBHY were detected in Jeru Creek for the first time. Overall densities were comparable to those observed for all species in all streams in 2013 and 2018 except for BKT in Spring Creek which increased slightly following the earlier (2015 and 2017) removal of over 800 Brook Trout from this stream.

Data collected during our monitoring surveys provide detailed longitudinal information on distribution and abundances of salmonids in tributaries to LPO. Surveys conducted during 2023 concluded the third round of sampling on all tributaries. With the conclusion of three rounds of sampling on all streams a generally understanding of fish composition and longitudinal distributions throughout surveyed streams has been achieved. However, we would like to answer questions regarding production, survival, and stream habitat that are difficult to answer with the current sampling structure. We recommend transitioning to a new tributary monitoring protocol in which a subset of streams will be surveyed every year to answer these more detailed questions (Appendix A).

## RECOMMENDATIONS

1) Transition to a new tributary sampling protocol.
2) Summarize trend data and complete a comprehensive analysis of available tributary monitoring data now that 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.
4) Remove Section 2 from Char Creek.


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## APPENDIX A

***Planned Protocol***

In 2009, IDFG began implementing a rotating LPO basin-wide abundance monitoring plan. In this plan each monitored stream throughout the LPO basin would be sampled approximately once every five years. Each tributary has been sampled on the rotational schedule a total of three times allowing for a coarse-scale description of species distributions, age and size structure, and long-term abundance trends. However, following the intent of the proposed guidelines for juvenile abundance monitoring, we propose transitioning to a new schedule in which seven major streams including Rattle, Gold, Granite, Trestle, Grouse, Caribou, and East Fork Lighting creeks will be sampled on a yearly basis. The remainder of the streams would continue on a five-year rotational schedule. Transitioning to yearly sampling on a subset of streams will allow for more detailed monitoring of finer-scale changes in distribution, density, juvenile production, and responses to habitat alterations (i.e., improvement projects and natural events). Furthermore, we propose continued sampling streams on the rotational schedule that are not sampled every year to maintain a broad-scale evaluation of the lower-priority streams. To achieve this sampling, we propose reducing our sampling on each stream to two to three reaches that best represent the overall fish community of each stream as determined during our initial rotational sampling. 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.