

2020 Pend Oreille Basin Bull Trout Redd Monitoring Annual Project Update

Idaho Tributary Habitat Acquisition and Enhancement Program, Appendix A

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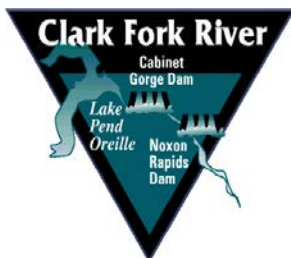
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ABSTRACT

Redd counts are used as an index of abundance to gauge the relative strength of adult Bull Trout *Salvelinus confluentus* escapement in Lake Pend Oreille basin tributaries. Counts are conducted annually during the month of October in 22 tributaries and are performed by two individuals who physically walk each stream and tally observed redds in a single pass. A total of 469 Bull Trout redds (all considered migratory) were counted among all surveyed streams in 2020. For all streams combined, counts were 29% below the previous 10-year average. Overall, mild weather in 2020 was conducive to counting redds, but a rain event may have negatively influenced visibility on the Pack River.

INTRODUCTION

Redd counts are used across the range of Bull Trout *Salvelinus confluentus* to monitor population trends. They are typically used as an index of abundance to gauge the relative strength of adult escapement (Al-Chokhachy et al. 2005). Redd counts require less effort to conduct than other traditional monitoring methods, such as trapping, yet provide information on adult Bull Trout abundance at the watershed and/or population level. However, redd counts are not without their limitations, as the technique has been shown to be prone to observer variability (Dunham et al. 2001). In addition, annual variation in flows, water clarity, spawner timing, and survey conditions (e.g., rain or lighting conditions) all can influence individual stream counts (Dunham et al. 2001). As a result, caution should be used when interpreting redd count results, particularly from one year to the next. However, redd counts are one of the most reliable techniques for monitoring long-term trends in adult Bull Trout abundance.

METHODS

With assistance from other agencies and Avista, Idaho Department of Fish and Game staff conducted annual Bull Trout redd counts on 22 tributaries to Lake Pend Oreille (LPO) and the Clark Fork River in 2020. In addition, Idaho Department of Lands and U.S. Fish and Wildlife Service employees completed surveys on the Middle Fork East River and Uleda Creek (tributaries to the lower Priest River). Redds were located visually by walking standardized sections within each tributary (Tables 1 and 2). Bull Trout redds were defined as areas of clean gravels at least 0.3 x 0.6 m in size with gravels at least 76 mm in diameter having been moved by the fish and with a mound of loose gravel downstream from a depression (Pratt 1984). In areas where one redd was superimposed over another, each distinct depression was counted as an individual redd. GPS coordinates were collected at each redd and adult Bull Trout (alive or dead) were recorded if present. Novice observers were paired with more experienced counters in lieu of a formal training session, which had the added benefit of increased safety. Counters were considered “experienced” if they had participated in LPO redd count surveys for at least one year under the direction of another experienced counter. Beginning in 2012, redd surveys were discontinued on the Clark Fork River and Twin Creek because counts at both locations were believed to be heavily influenced by Avista’s ongoing upstream Bull Trout transport program and provided little meaningful long-term index information.

In addition, the reach of Char Creek above a fish passage barrier first noted in 2008 (Jakubowski and Ryan 2009) has not been surveyed since 2009. The observed barrier is located approximately 150 m upstream from the confluence with East Fork Lightning Creek.

TABLE 1. Survey streams for annual Bull Trout redd counts in tributaries to the lower Priest River, Lake Pend Oreille, and the lower Clark Fork River, Idaho.

Stream	Section Description (approximate length in km)
Caribou Cr.	Between Caribou Creek road crossings at 1 km and 7 km (6.0 km)
Char Cr.	Mouth to barrier (0.2 km)
East Fork Lightning Cr.	Savage to Thunder Creek (5.0 km)
Granite Cr.	Mouth to Road 278 crossing (6.4 km)
Grouse Cr.	Flume Creek to 2.4 km beyond gate at end of Road 280 (6.5 km)
Hellroaring Cr.	Mouth to falls (2.4 km)
Johnson Cr.	Mouth to falls (1.5 km)
Lightning Cr.	Rattle Creek mouth to falls (3.2 km)
Middle Fork East R.	Idaho Department of Lands (IDL) Road 1012 crossing to IDL Road 10 crossing (9.2 km)
Morris Cr.	Mouth to Trail 132 crossing (2.5 km)
North Gold Cr.	Mouth to falls (1.2 km)
Pack River	Road 231 bridge near McCormick Cr. to falls located 0.4 km downstream of W. Branch (2.8 km)
Porcupine Cr.	Mouth to S. Fork (3.2 km)
Rattle Cr.	Mouth to falls by upper bridge (5.7 km)
Savage Cr.	Mouth to Trail 61 crossing (2.0 km)
South Gold Cr.	Mouth to 0.2 km upstream of W. Gold confluence (2.4 km)
Strong Cr.	Lower Reach: Mouth upstream 1 km to top of hillside slide (1.0 km) Upper Reach: Forest Service boundary upstream 1 km (1.0 km)
Sullivan Springs	Mouth upstream 0.4 km (0.4 km)
Trestle Cr.	1.6 km upstream of mouth to approximately 1.0 km upstream of road 275 switchback, at the confluence with first southeast bank un-named tributary (11.1 km)
Uleda Cr.	Mouth to IDL Road 101 crossing (2.0 km)
Wellington Cr.	Mouth to falls (0.5 km)
West Gold Cr.	Lakeview Rd. bridge to confluence with S. Gold Cr. (0.7 km)

TABLE 2. Latitude and longitude (WGS 84) of the downstream and upstream boundaries of the annual Bull Trout redd count survey reaches in tributaries to the lower Priest River, Lake Pend Oreille, and the lower Clark Fork River, Idaho.

Stream	Downstream		Upstream	
	Latitude	Longitude	Latitude	Longitude
Caribou Cr.	48.4716N	116.5648W	48.4579N	116.6408W
Char Cr.	48.2620N	116.0682W	48.2726N	116.0646W
East Fork Lightning Cr.	48.2475N	116.0980W	48.2621N	116.0395W
Granite Cr.	48.0852N	116.4249W	48.0845N	116.3550W
Grouse Cr.	48.4667N	116.2675W	48.4780N	116.2060W
Hellroaring Cr.	48.4946N	116.5689W	48.4938N	116.6003W
Johnson Cr.	48.1365N	116.2247W	48.1286N	116.2319W
Lightning Cr.	48.3266N	116.1725W	48.3525N	116.1766W
Middle Fork East R.	48.3797N	116.7923W	48.3883N	116.6822W
Morris Cr.	48.2236N	116.1174W	48.2126N	116.0896W
North Gold Cr.	47.9734N	116.4525W	47.9725N	116.4395W
Pack River	48.5768N	116.6119W	48.5991N	116.6368W
Porcupine Cr.	48.2676N	116.1237W	48.2538N	116.1570W
Rattle Cr.	48.3266N	116.1725W	48.3204N	116.1138W
Savage Cr.	48.2475N	116.0980W	48.2427N	116.0725W
South Gold Cr.	47.9709N	116.4543W	47.9536N	116.4523W
Strong Cr. (Lower Reach)	48.2408N	116.3010W	48.2449N	116.2950W
Strong Cr. (Upper Reach)	48.2519N	116.2881W	48.2554N	116.2853W
Sullivan Springs	48.0839N	116.4219W	48.0823N	116.4175W
Trestle Cr.	48.2893N	116.3312W	48.3298N	116.2340W
Uleda Cr.	48.3876N	116.7075W	48.3702N	116.7045W
Wellington Cr.	48.2908N	116.1628W	48.2935N	116.1695W
West Gold Cr.	47.9536N	116.4523W	47.9518N	116.4605W

RESULTS AND DISCUSSION

Redd counts were conducted October 12–23, 2020. Favorable weather and stream flows made for ideal surveying conditions. A total of 469 Bull Trout redds (all considered migratory) were counted among all surveyed streams in 2020 (Table 3). This was 31 less (6%) than the total counted during 2019. Most stream counts were below past averages (Tables 4–8, Figures 1–10).

Redd count data are inherently variable due to changing survey conditions, spawning timing, stream morphology, and variability among surveyors. For example, a consulting firm surveyed the Pack River in 2019 and observed a higher number of Bull Trout redds than were observed several days later as part of the standardized annual survey (Jason Scott, Geoengineers, Inc., personal communication). A rain event occurred between these two surveys and caused an increase in both discharge and gauge height that may have contributed to this variation. Attempts have been made to standardize sampling by surveying during the same time each year and providing consistent training for surveyors, but annual variability will always exist. For example, several redds were reported in McCormick Creek during the previously mentioned 2019 watershed survey, but when officially surveyed in 2020 no redds were observed. Watershed assessments have been made on several watersheds in the lower Clark Fork River-LPO area (e.g., CES 1998; Golder Associates 2003 and 2006; RDG 2009; PWA 2004). A recurring finding in these assessments was that these watersheds are inherently dynamic and are geomorphically unstable. Therefore, it is not surprising that redd counts in specific watersheds and tributaries fluctuate with the habitat conditions, both short- and long-term. It is important to remember that these data are collected to provide general long-term trends, and it is appropriate to interpret these data cautiously, particularly over short time periods. Despite the sources of variation and shortcomings, redd counts are a reliable long-term monitoring tool for Bull Trout and remain the most widely-used technique for monitoring adult population trends.

Table 3. Bull Trout redd counts by year from all tributaries to Lake Pend Oreille, the lower Clark Fork River, and the lower Priest River, Idaho 1984–2020.

Year	Total of all streams	Year	Total of all streams
1984	881	2003	836
1985	930	2004	781
1986	412	2005	940
1987	555	2006	1,256
1988	478	2007	654
1989	543	2008	584
1990	503	2009	866
1991	423	2010	654
1992	447	2011	815
1993	656	2012	652
1994	631	2013	781
1995	320	2014	717
1996	610	2015	553
1997	527	2016	359
1998	726	2017	782
1999	705	2018	702
2000	732	2019	500
2001	710	2020	469
2002	890	2000-2019 Avg	738
		2010-2019 Avg	652

Table 4. Bull Trout redd counts by year from tributaries the Lightning Creek drainage, Idaho 1984–2020. Bold text indicates the sum of counts for the drainage.

Year	Lightning Cr.	East Fork	Savage Cr.	Char Cr.	Porcupine Cr.	Wellington Cr.	Rattle Cr.	Morris Cr.	Lightning Drainage Total
1984	9	24	12	9	52	18	32	-	156
1985	46	132	29	11	32	15	21	-	286
1986	14	8	-	0	1	7	10	-	40
1987	4	59	0	2	9	2	35	-	111
1988	-	79	-	-	-	-	-	-	79
1989	-	100	-	-	-	-	-	-	100
1990	-	29	-	-	-	-	-	-	29
1991	-	-	-	-	-	-	-	-	0
1992	11	32	1	9	4	9	10	-	76
1993	2	27	6	37	6	4	8	-	90
1994	5	28	6	13	1	9	0	-	62
1995	0	3	0	2	2	1	1	-	9
1996	6	49	0	14	0	5	10	-	84
1997	0	22	0	1	0	2	2	-	27
1998	3	64	0	16	0	1	15	-	99
1999	16	44	4	17	4	22	13	1	121
2000	4	54	2	11	4	8	12	1	96
2001	7	36	4	2	0	7	67	0	123
2002	8	58	15	8	0	7	33	7	136
2003	8	38	7	7	5	8	37	1	111
2004	9	77	15	14	10	7	34	1	167
2005	22	50	7	15	14	6	34	3	151
2006	9	51	25	20	8	29	21	16	179
2007	3	34	0	1	8	9	2	0	57
2008	10	38	8	5	8	10	24	6	109
2009	11	85	5	1	15	4	62	6	189
2010	0	26	6	4	11	7	43	9	106
2011	20	64	1	9	13	6	65	0	178
2012	1	11	-	0	2	5	59	0	78
2013	1	26	5	4	4	5	8	3	56
2014	4	22	6	2	15	11	63	14	137
2015	11	17	5	0	0	8	5	0	46
2016	-	19	1	0	14	3	5	3	45
2017	3	80	19	0	10	5	20	32	169
2018	8	87	15	4	29	15	32	18	208
2019	13	35	3	2	13	7	47	0	120
2020	3	10	6	2	14	6	12	0	53
2010-2019 Avg	8	41	8	5	10	8	34	6	121
2010-2019 Avg	7	37	7	2	11	7	32	7	109

Table 5. Bull Trout redd counts by year from tributaries directly connected to the north end of Lake Pend Oreille and the lower Clark Fork River, Idaho 1984–2020. Bold text indicates the sum of counts for each drainage.

Year	Clark				
	Fork R.	Johnson Cr.	Twin Cr.	Strong Cr.	Trestle Cr.
1984	-	33	25	-	272
1985	-	23	5	-	298
1986	-	36	28	-	147
1987	-	10	0	-	230
1988	-	4	-	-	236
1989	-	17	-	-	217
1990	-	33	-	-	274
1991	-	25	-	-	220
1992	2	16	3	-	134
1993	8	23	4	-	304
1994	17	3	0	-	276
1995	18	4	5	-	140
1996	3	5	16	2	243
1997	7	27	6	-	221
1998	8	17	10	-	330
1999	5	31	19	-	253
2000	5	4	10	-	301
2001	6	34	1	-	335
2002	7	31	8	0	333
2003	8	0	3	-	361
2004	1	32	6	0	102
2005	0	45	7	-	174
2006	3	28	11	-	395
2007	2	32	0	-	145
2008	0	40	4	7	183
2009	1	47	0	6	279
2010	0	57	0	2	188
2011	0	54	1	11	178
2012	-	54	-	3	187
2013	-	50	-	47	133
2014	-	21	-	17	159
2015	-	5	-	0	117
2016	-	5	-	10	91
2017	-	10	-	4	75
2018	-	14	-	8	73
2019	-	5	-	0	90
2020	-	7	-	18	97
2000-2019 Avg	3	29	4	9	185
2010-2019 Avg	0	23	1	12	120

Table 6. Bull Trout redd counts by year from tributaries directly connected to the south eastern end of Lake Pend Oreille, Idaho 1984–2020. Bold text indicates the sum of counts for each drainage.

Year	North Gold Drainage Total	South Gold Cr.	West. Gold Cr.	South Gold Drainage Total	Granite Cr.	Sullivan Springs	Granite Drainage Total
1984	37	124	-	124	81	8	89
1985	52	111	-	111	37	14	51
1986	8	78	-	78	37	-	37
1987	36	62	-	62	30	6	36
1988	24	111	-	111	-	-	0
1989	37	122	-	122	-	-	0
1990	35	84	-	84	-	-	0
1991	41	104	-	104	-	-	0
1992	41	93	-	93	0	0	0
1993	32	120	-	120	7	24	31
1994	27	164	-	164	11	31	42
1995	31	95	-	95	9	9	18
1996	39	100	-	100	47	15	62
1997	19	76	-	76	90	42	132
1998	22	120	-	120	49	10	59
1999	16	147	-	147	41	22	63
2000	19	168	-	168	25	19	44
2001	16	127	-	127	7	8	15
2002	24	203	-	203	57	15	72
2003	21	126	-	126	101	12	113
2004	56	167	-	167	149	14	163
2005	34	200	-	200	132	15	147
2006	30	235	4	239	166	28	194
2007	28	179	0	179	104	17	121
2008	17	73	7	80	52	7	59
2009	28	107	5	112	106	2	108
2010	28	130	4	134	75	9	84
2011	6	56	0	56	129	11	140
2012	3	110	8	118	68	4	72
2013	28	106	29	135	217	11	228
2014	25	88	10	98	115	4	119
2015	41	69	3	72	68	0	68
2016	22	71	0	71	48	4	52
2017	54	169	3	172	96	14	110
2018	0	70	0	70	150	18	168
2019	15	96	0	96	86	11	97
2020	19	84	1	85	116	12	128
2000-2019 Avg	25	123	5	127	102	11	113

Table 7. Bull Trout redd counts by year from the Pack River drainage, Idaho 1984–2020.
 Bold text indicates the sum of counts for each drainage.

Year	Pack River	Grouse Cr.	Caribou Cr.	Hellroaring Cr.	Pack Drainage Total
1984	37	108	-	-	145
1985	49	55	-	-	104
1986	25	13	-	-	38
1987	14	56	-	-	70
1988	-	24	-	-	24
1989	-	50	-	-	50
1990	-	48	-	-	48
1991	-	33	-	-	33
1992	65	17	-	-	82
1993	21	23	-	-	44
1994	22	18	-	-	40
1995	0	0	-	-	0
1996	6	50	-	-	56
1997	4	8	-	-	12
1998	17	44	-	-	61
1999	0	50	-	-	50
2000	8	77	-	-	85
2001	28	18	-	-	46
2002	22	42	-	-	64
2003	24	45	-	-	69
2004	31	28	-	-	59
2005	53	77	-	-	130
2006	44	55	-	-	99
2007	16	38	-	-	54
2008	11	31	-	-	42
2009	4	51	-	-	55
2010	0	27	-	-	27
2011	1	116	37	-	154
2012	7	69	6	3	85
2013	6	12	47	-	65
2014	1	54	9	-	64
2015	35	48	57	2	142
2016	5	-	4	2	11
2017	57	32	51	24	164
2018	30	23	70	11	134
2019	8	25	11	23	67
2020	2	26	6	0	34
2000-2019 Avg	19	43	30	9	78
2010-2019 Avg	15	45	30	9	92

Table 8. Bull Trout redd counts by year from tributaries to the lower Priest River, Idaho 1984–2020. Bold text indicates the sum of counts for each drainage.

Year	N.F. East River	M.F. East River	Uleda Creek	MFER Total
1984	-	-	-	-
1985	-	-	-	-
1986	-	-	-	-
1987	-	-	-	-
1988	-	-	-	-
1989	-	-	-	-
1990	-	-	-	-
1991	-	-	-	-
1992	-	-	-	-
1993	-	-	-	-
1994	-	-	-	-
1995	-	-	-	-
1996	-	-	-	-
1997	-	-	-	-
1998	-	-	-	-
1999	-	-	-	-
2000	-	-	-	-
2001	-	4	3	7
2002	-	8	4	12
2003	-	21	3	24
2004	1	20	7	27
2005	0	48	4	52
2006	0	71	7	78
2007	-	34	2	36
2008	0	36	7	43
2009	-	25	16	41
2010	0	22	6	28
2011	-	28	9	37
2012	-	28	24	52
2013	-	25	14	39
2014	-	51	26	77
2015	-	51	11	62
2016	-	50	2	52
2017	-	23	1	24
2018	-	27	0	27
2019	-	9	1	10
2020	-	25	3	28
2000-2019 Avg	0	30	8	38
2010-2019 Avg	-	32	9	41

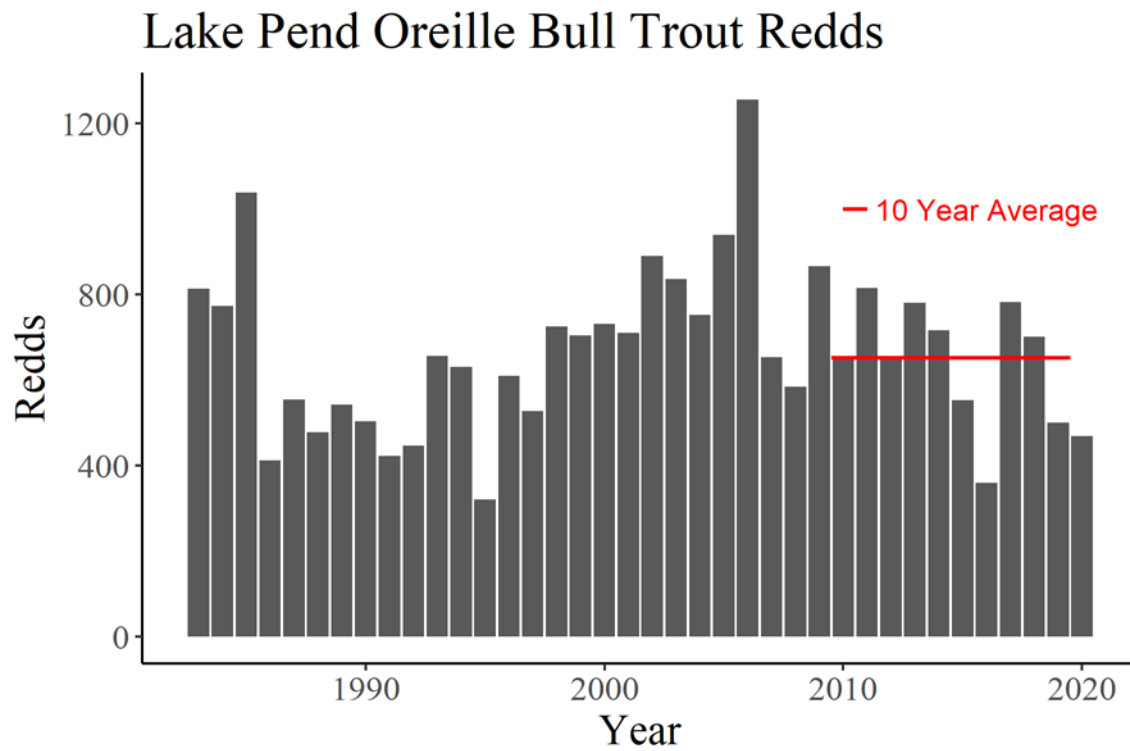


FIGURE 1. Total number of Bull Trout redds counted in all surveyed streams in the Pend Oreille drainage 1983–2020. The horizontal red line represents the 10-year average 2010–2019.

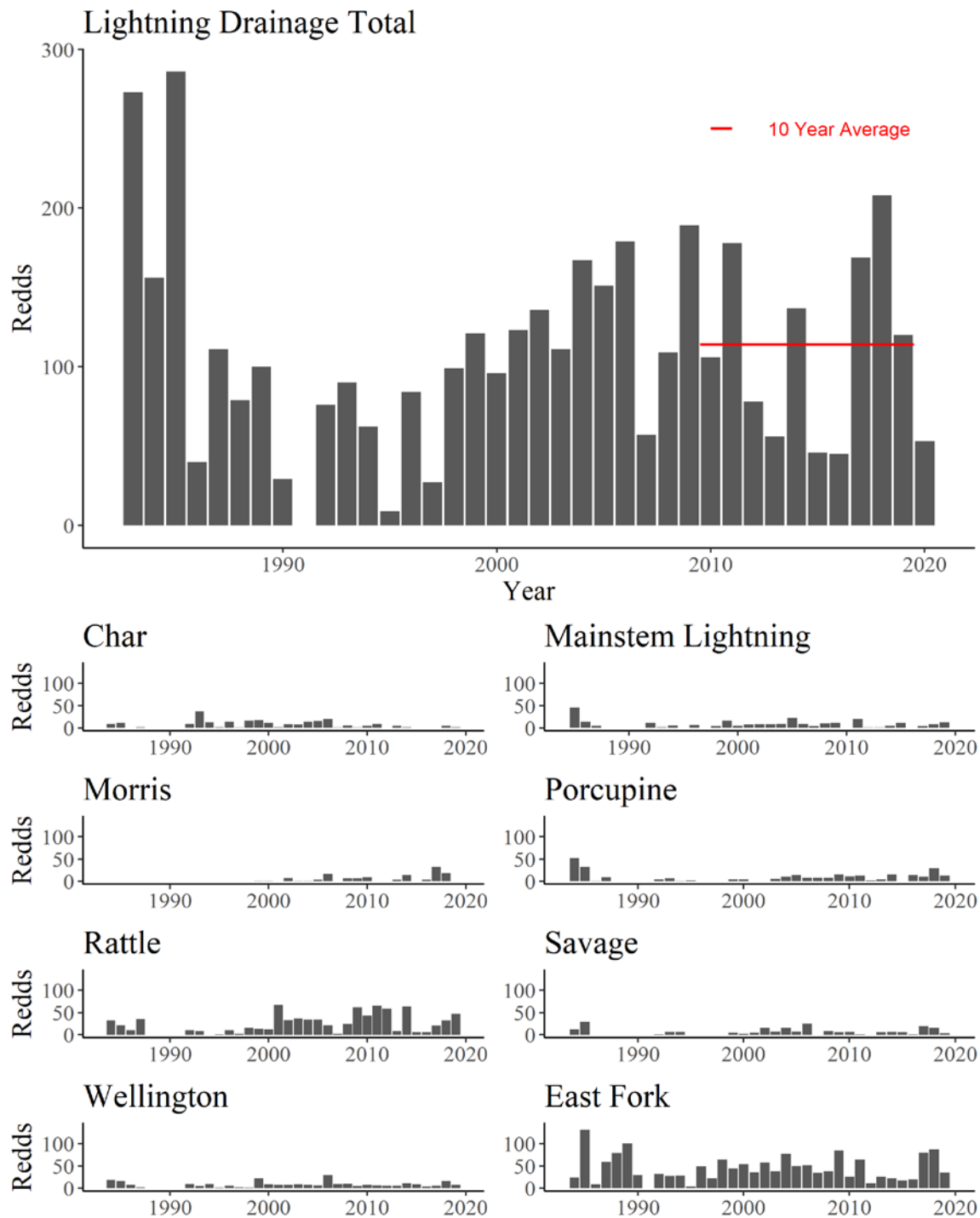


FIGURE 2. Number of Bull Trout redds counted in the Lightning Creek drainage 1983–2020. The horizontal red line represents the 10-year average 2010–2019.

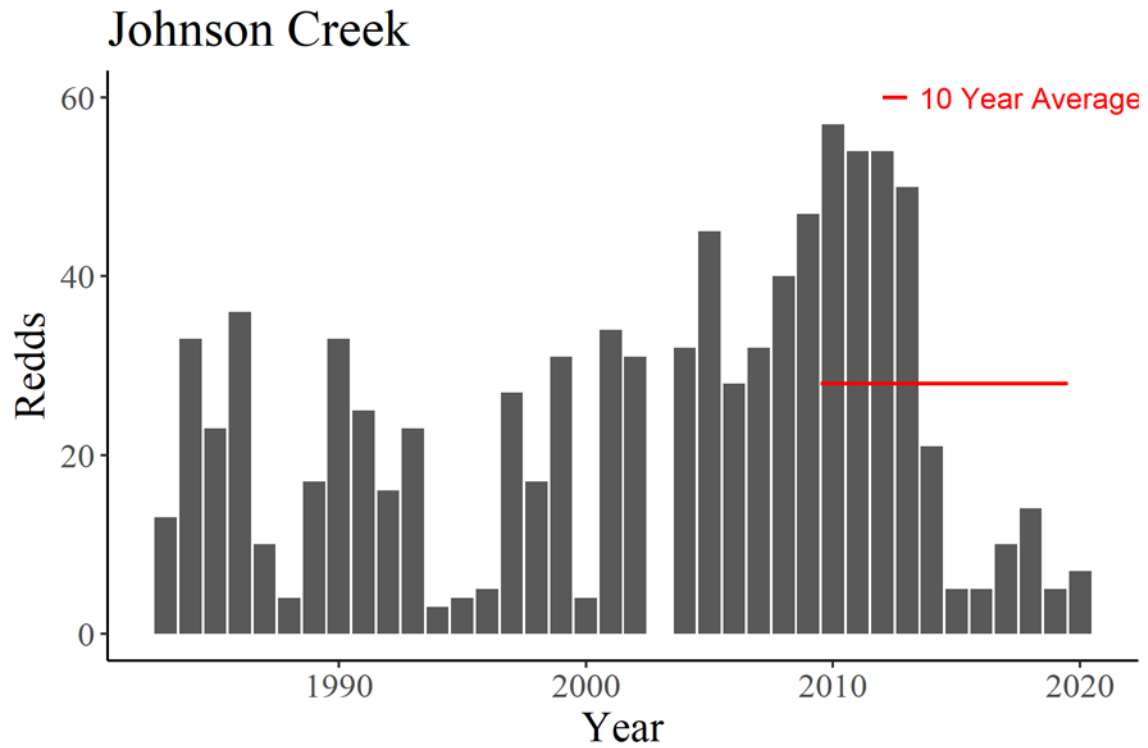


FIGURE 3. Number of Bull Trout redds counted in Johnson Creek 1983–2020. The horizontal red line represents the 10-year average 2010–2019.

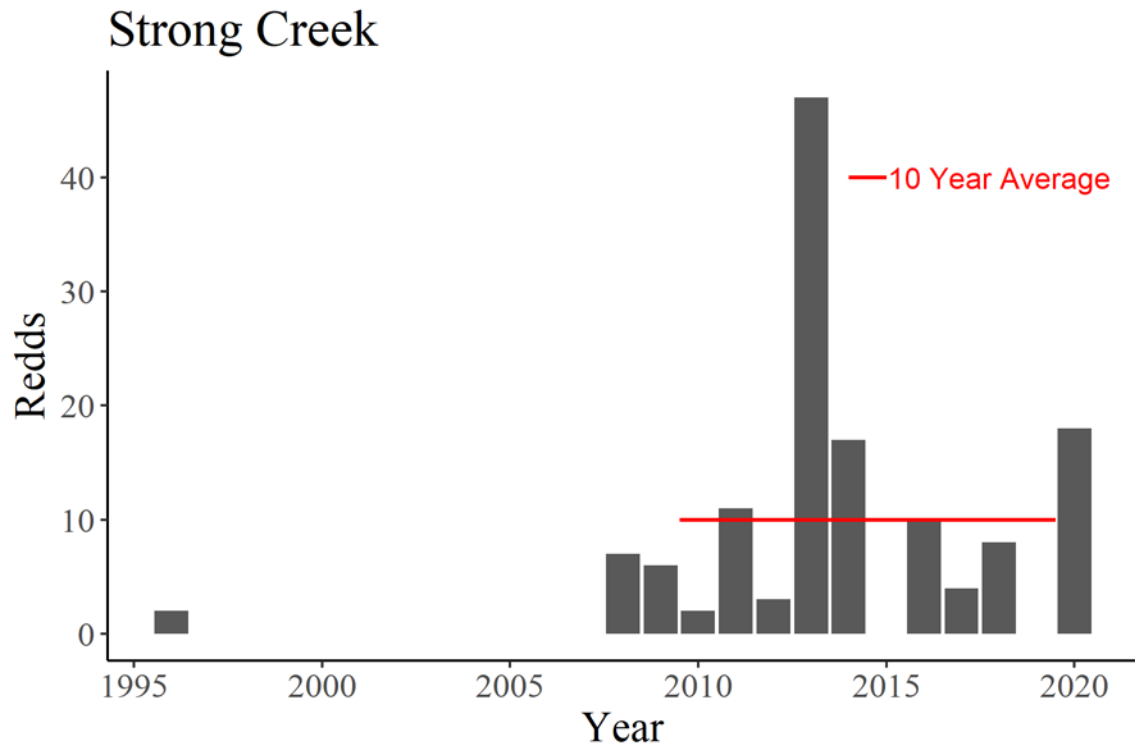


FIGURE 4. Number of Bull Trout redds counted in Strong Creek 1996–2020. The horizontal red line represents the 10-year average 2010–2019.

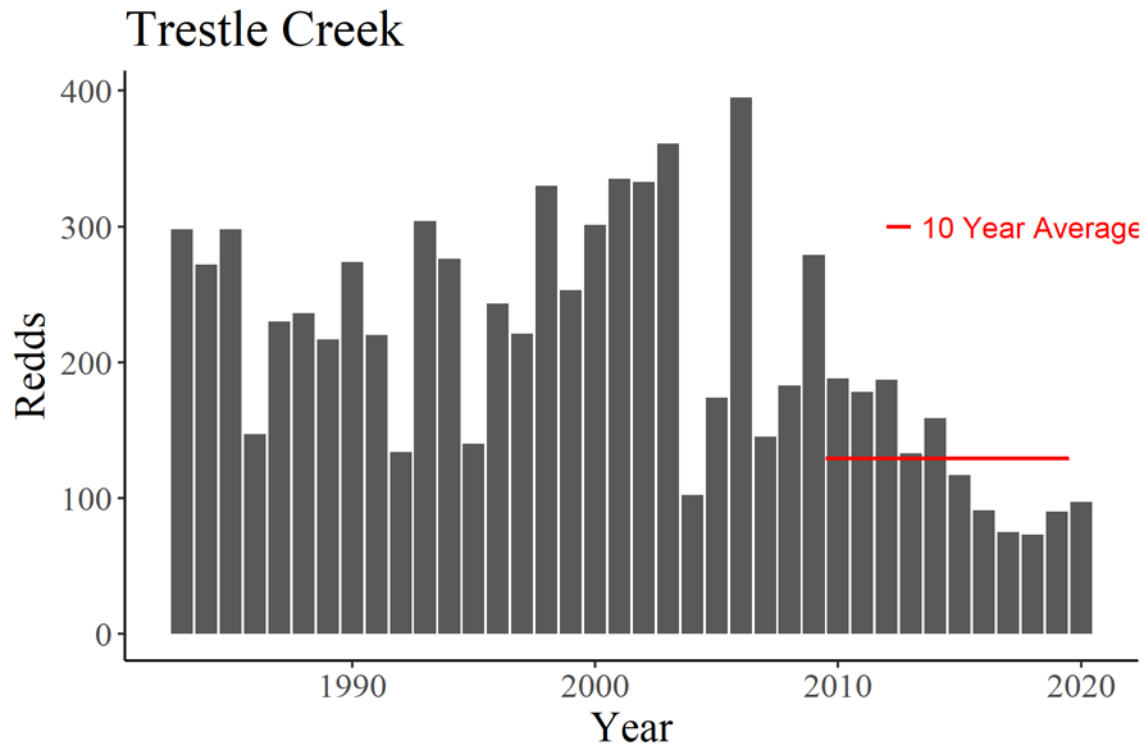


FIGURE 5. Number of Bull Trout redds counted in Trestle Creek from 1983–2020. The horizontal red line represents the 10-year average 2010–2019.

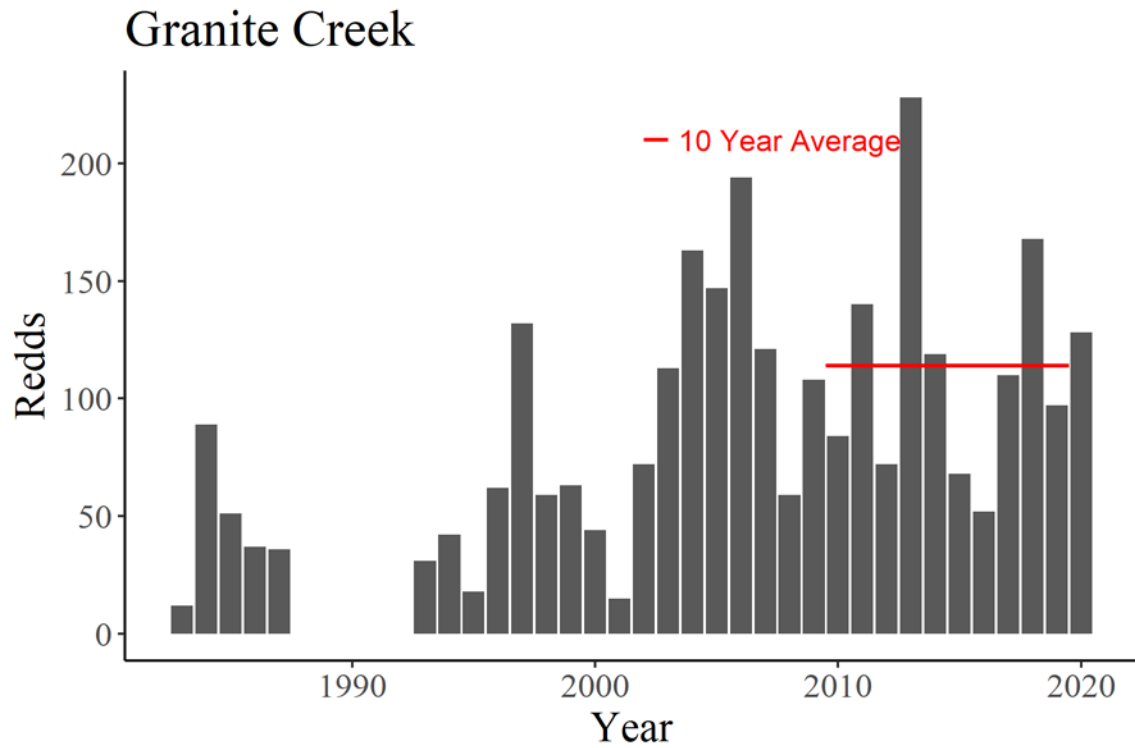


FIGURE 6. Number of Bull Trout redds counted in the Granite Creek drainage 1983–2020. The horizontal red line represents the 10-year average 2010–2019.

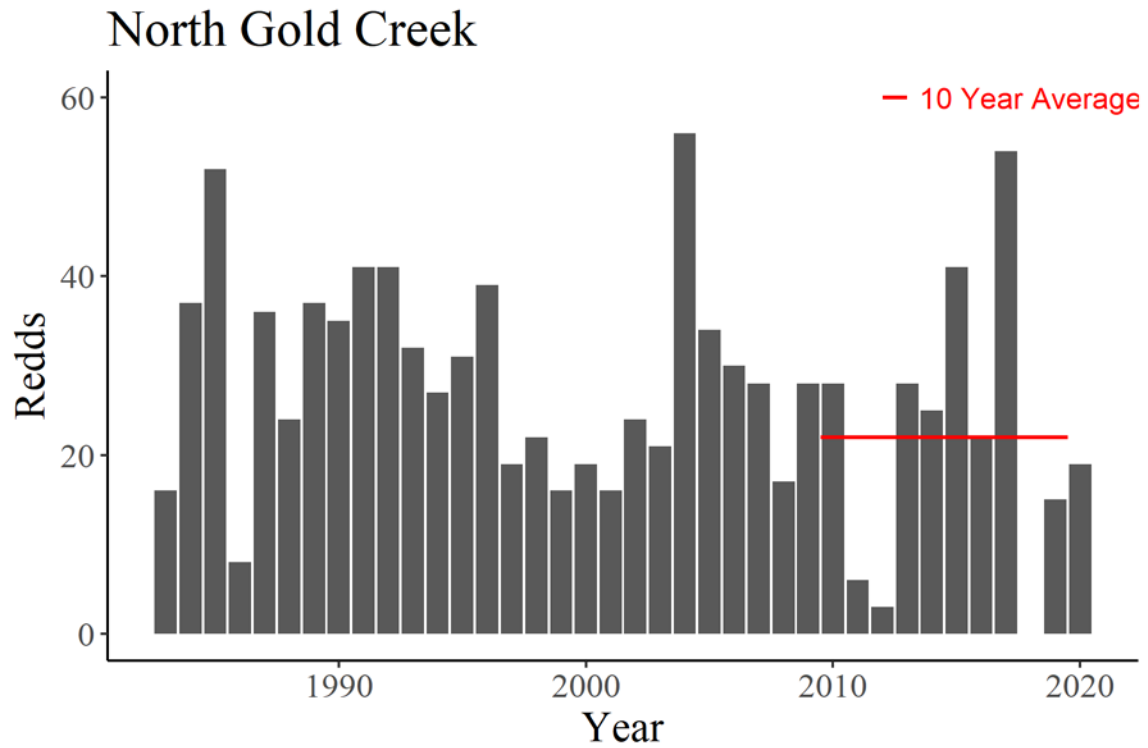


FIGURE 7. Number of Bull Trout redds counted in the North Gold Creek 1983–2020. The horizontal red line represents the 10-year average 2010–2019.

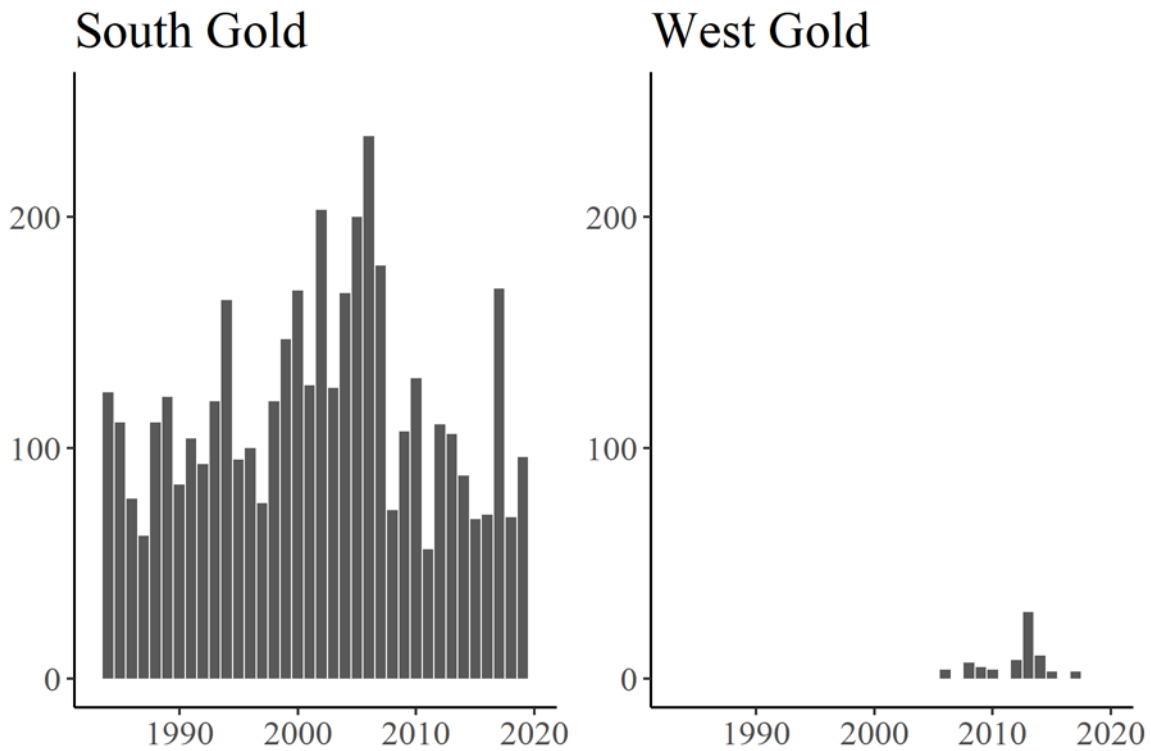
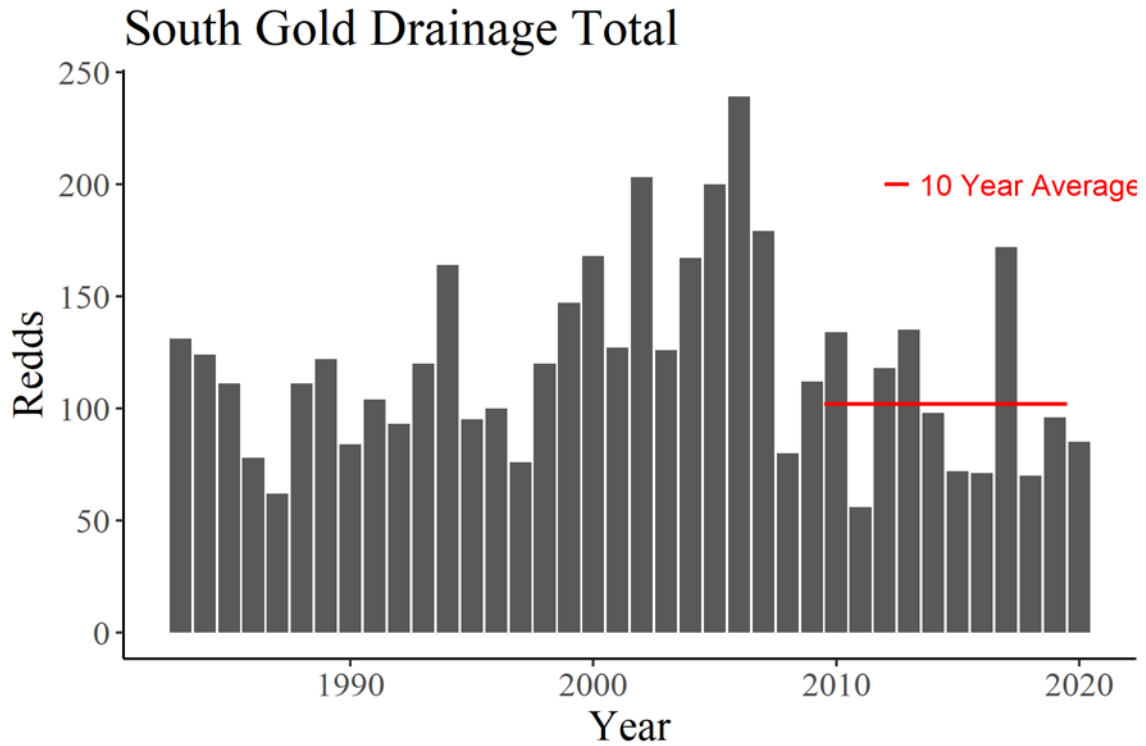


FIGURE 8. Number of Bull Trout redds counted in the South Gold Creek drainage 1983–2020. The horizontal red line represents the 10-year average from 2010–2019.

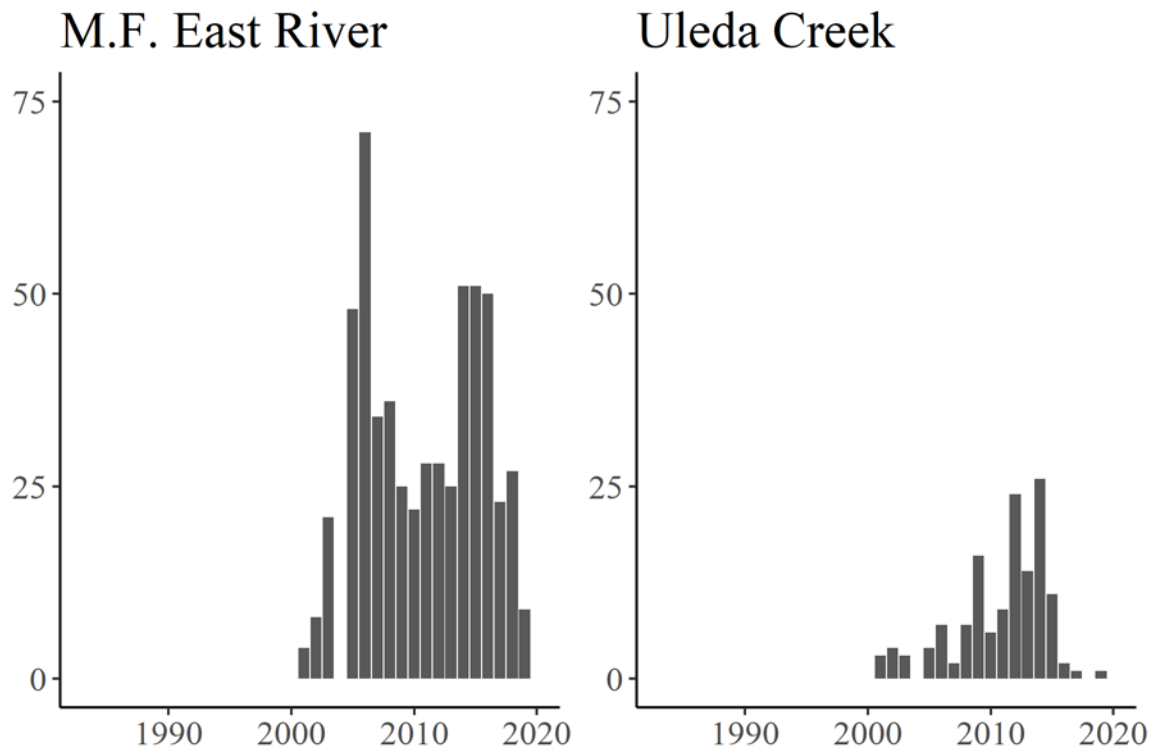
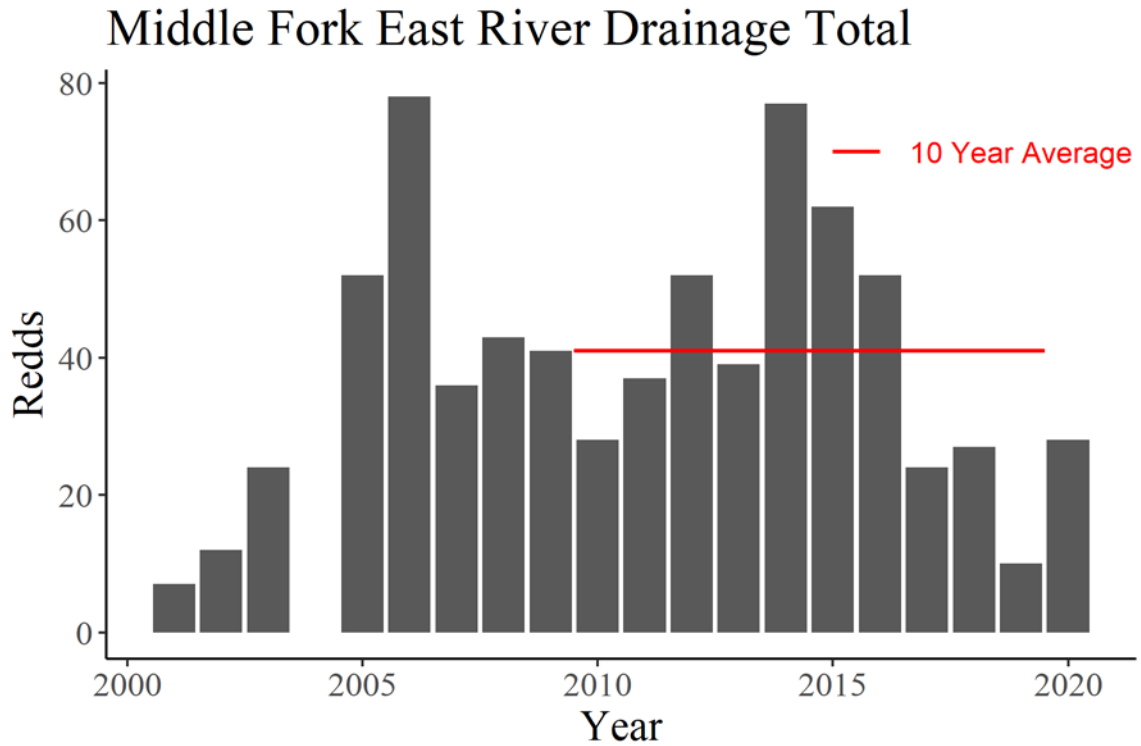


FIGURE 9. Number of Bull Trout redds counted in the Middle Fork East River drainage 2000–2020. The horizontal red line represents the 10-year average 2010–2019.

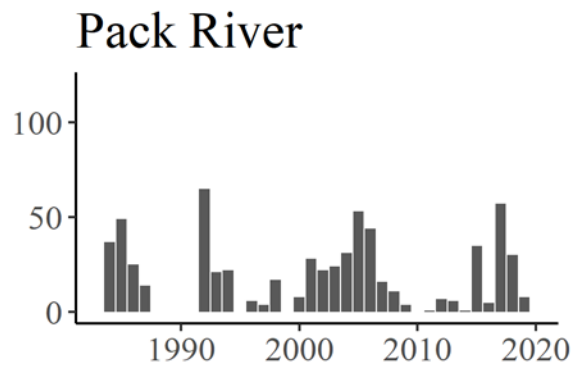
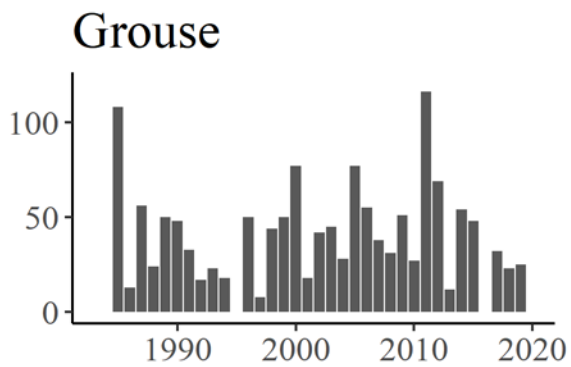
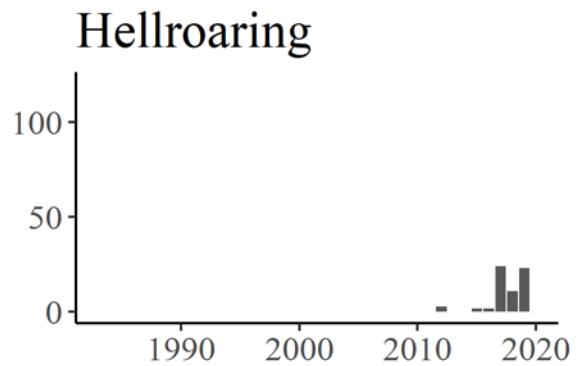
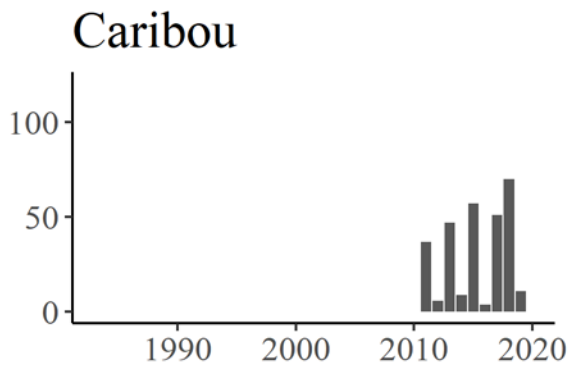
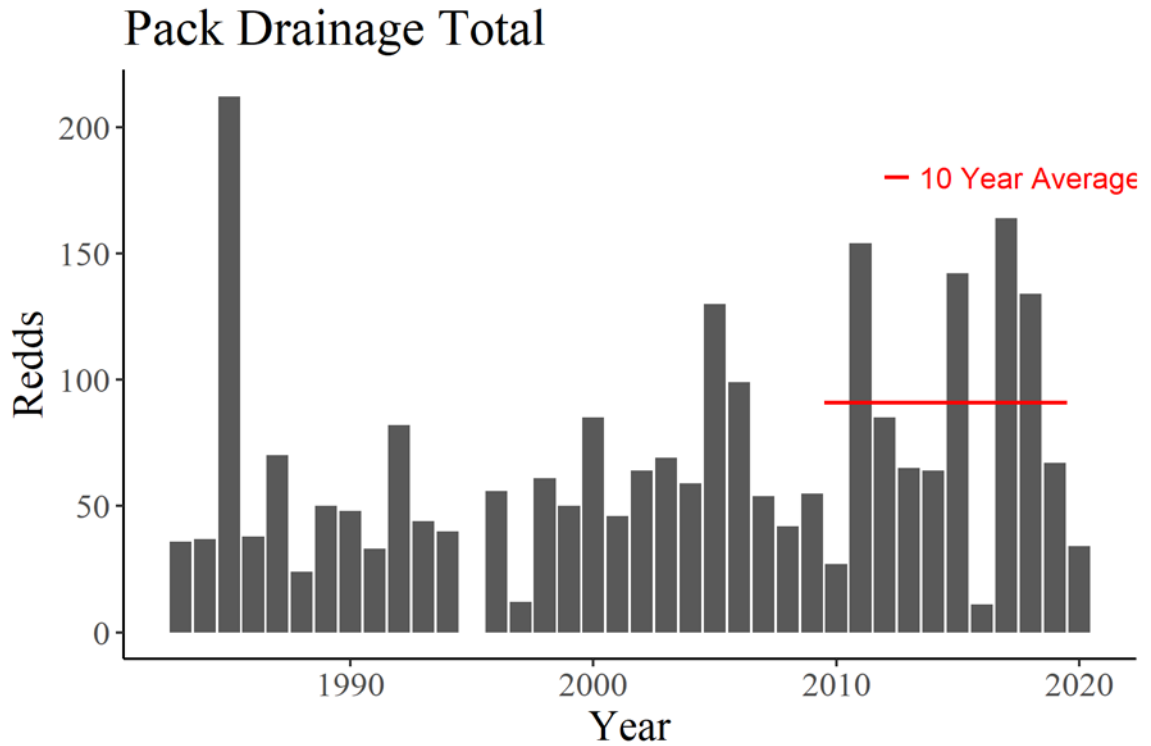


FIGURE 10. Number of Bull Trout redds counted in the Pack River drainage 1983–2020. The horizontal red line represents the 10-year average 2010–2019.

Tributaries within the LPO basin often experience large rainfall events during the winter when snowpack has already been established (rain-on-snow events). This can result in catastrophic flooding and widespread bedload movement throughout the watershed, and likely causes negative effects on incubating Bull Trout eggs (Rieman and McIntyre 1996). A historic rain-on-snow event in December of 2015 completely restructured the Pack and Lightning drainages to the extent where much of each creek was unrecognizable. A majority of the in-stream large woody debris was removed, and new channels were formed. This may have resulted in severely reduced Bull Trout recruitment in the Pack and Lightning drainages. This year (2020) is five years after the event, which is about when a majority of that year class would have matured and returned to spawn. As a result, the 2015 rain-on-snow event may explain the notably low counts for 2020.

The act of physically walking each of these streams provides a rudimentary annual evaluation of current fish habitat conditions. For example, in recent years it was noticed that in South Gold Creek a dry reach low in the watershed presents a barrier to Bull Trout migration in late summer (Jakubowski and Bouwens 2018). A decline in redd counts was observed for 2018 and 2019, yet counts increased in 2020 and suggest this barrier may not be as detrimental as previously thought. A fish passage barrier may also be developing in Wellington Creek. In 2018, we noticed that a large amount of bedload had accumulated behind a large fallen tree near its confluence with Lightning Creek. This forced a substantial portion of stream flow to filter sub-surface through the bedload, while the remainder carved out small channels through the riparian zone around the blockage. During the time of the survey in 2019, fish passage was completely blocked and would have required Bull Trout to ascend the stream during higher spring flows to access spawning reaches. The same conditions continued in 2020, and it appears this situation may continue to worsen. Similar to Char Creek, migration may be completely blocked in the near future. However, habitat restoration may benefit spawning Bull Trout in tributaries where barriers to migration exist. For example, a longstanding barrier located immediately upstream of the mouth of Johnson Creek was removed in the fall of 2019 and summer of 2020. During fall redd surveys, all redds that were observed were located above the previous barrier, suggesting the project was a success.

Trends in tributary-specific contribution to the Bull Trout metapopulation in LPO appear to be developing. A major driver to this observed decline likely stems from the reduction in counts in Trestle Creek, which does not support as many redds as it did historically. However, contemporary counts may be stabilizing at this reduced number, and the stream still accounts for a relatively high number of redds per year. Granite and South Gold creeks have become much more important as Bull Trout spawning streams since the redd data collection began, and now account for similar redd numbers to Trestle Creek. The Pack and Lightning drainages remain inconsistent, and further research may be beneficial to determine specific drivers of these differences. Annual redd count surveys now incorporate all streams where Bull Trout are known to spawn within the Idaho portion of the LPO basin and can be considered a comprehensive index of the spawning population.

RECOMMENDATIONS

- 1) Continue to perform standardized redd count surveys in LPO tributaries on an annual basis.
- 2) Document the prevalence of stream intermittency to investigate the likelihood of fish being precluded from entering natal tributaries.
- 3) Investigate the potential for variability in redd counts depending on environmental conditions.
- 4) Conduct a formal evaluation of the potential removal of the Char Creek passage barrier.
- 5) Further investigate the potential migration barrier in lower South Gold Creek.
- 6) Further investigate the developing blockage near the mouth of Wellington Creek.
- 7) Continue to investigate reports of Bull Trout redds in McCormick Creek.

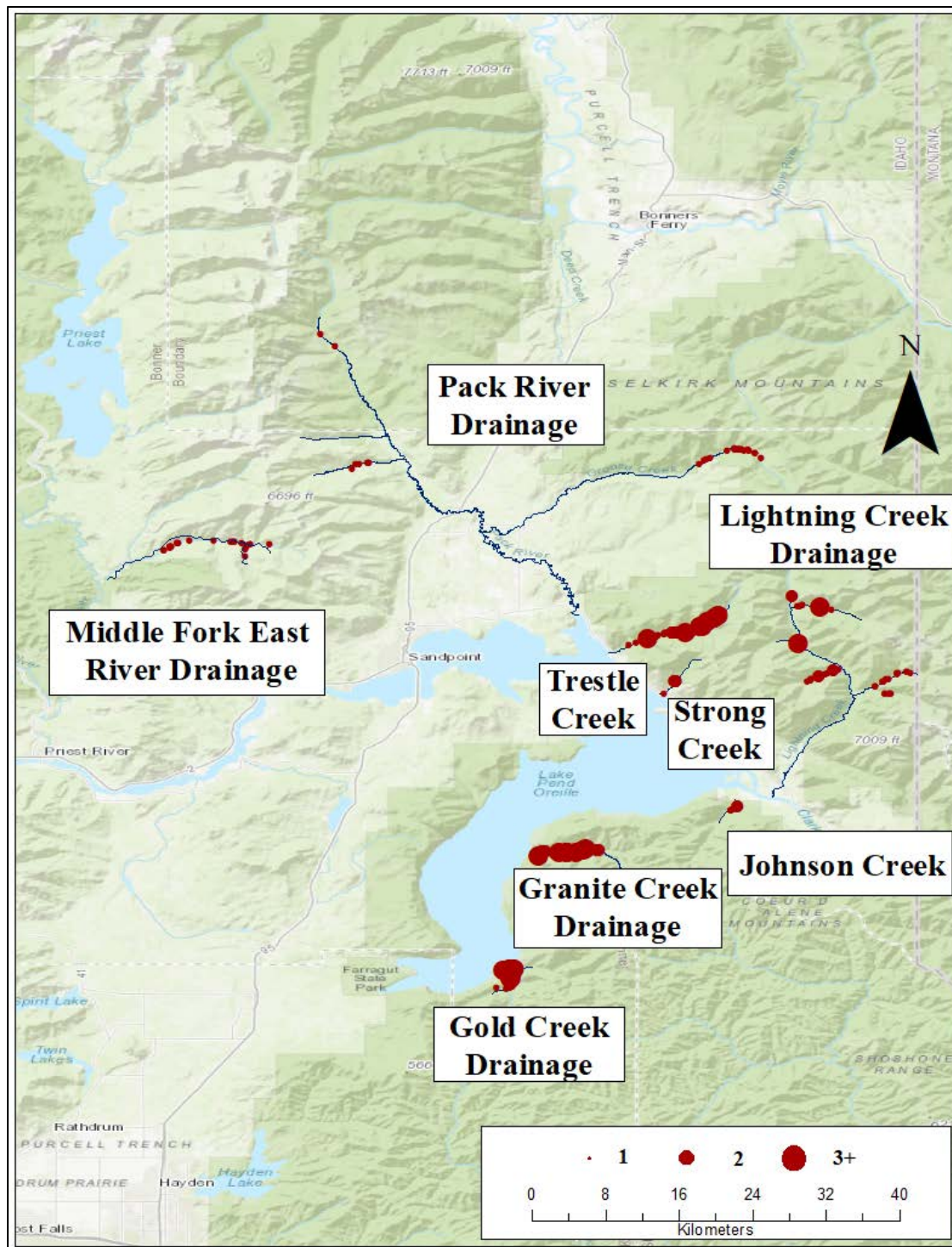
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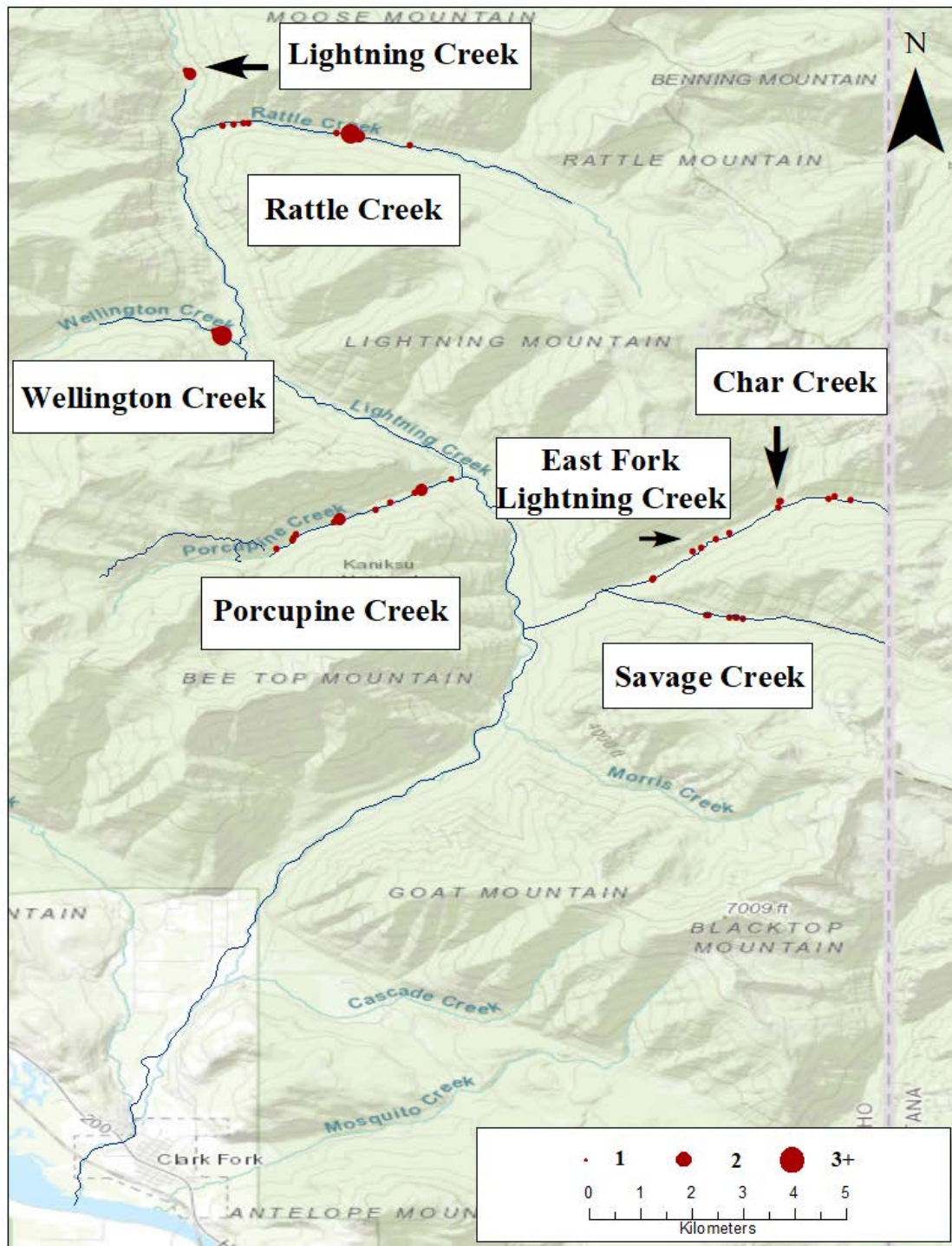
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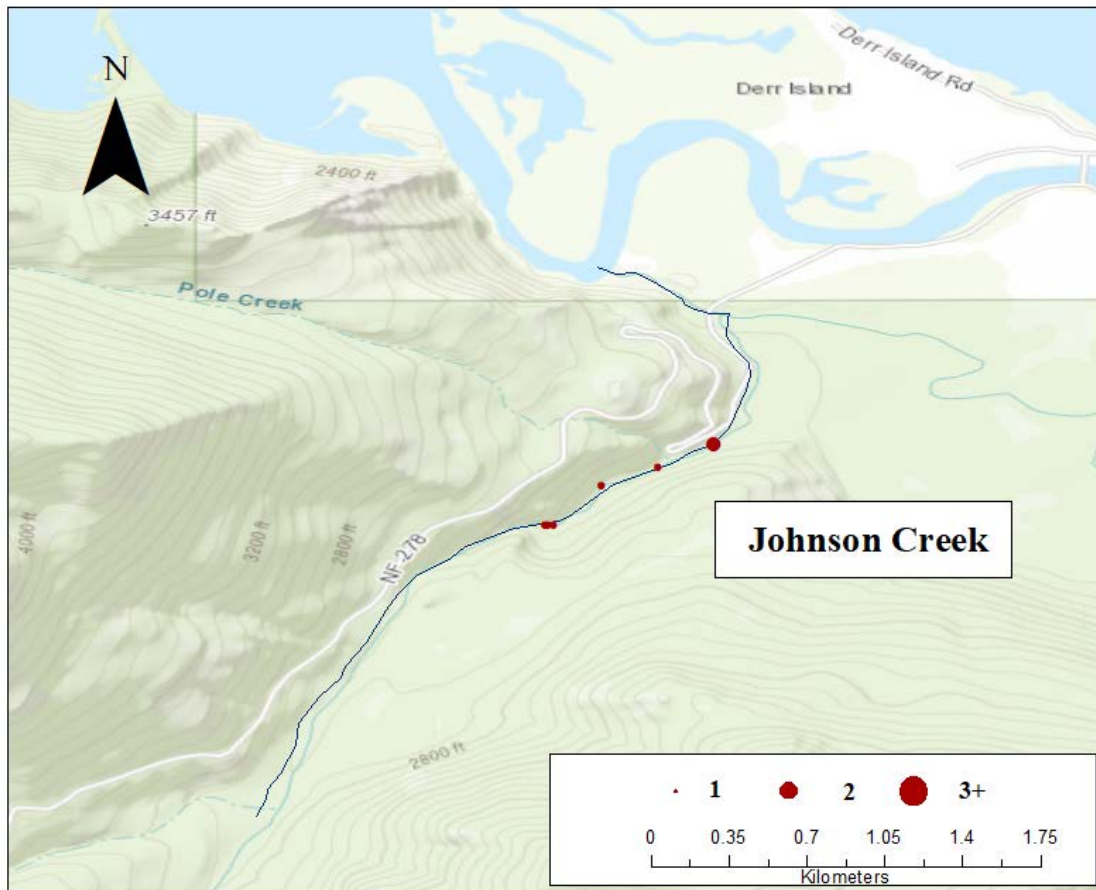
SUPPLEMENTARY MATERIAL



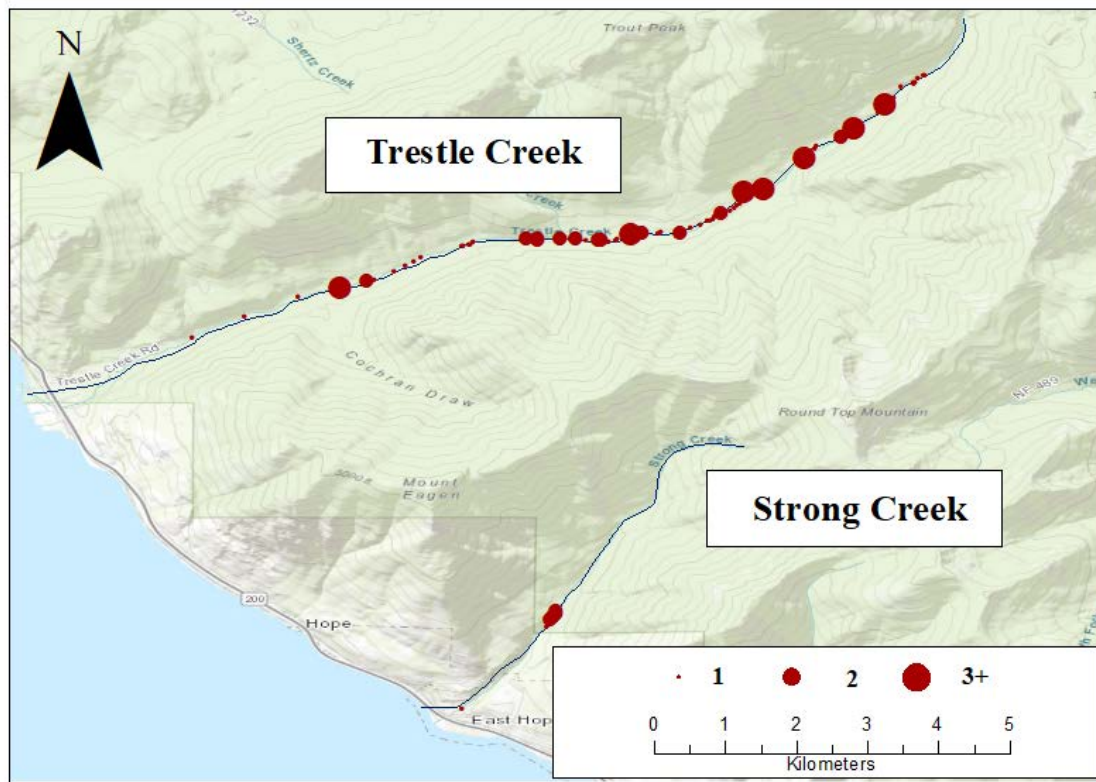
Supplemental Figure 1. Map of the Lake Pend Oreille basin outlining all drainages and sub-drainages surveyed for Bull Trout redds. Number of redds at each location is described by incrementally larger circle shapes (legend).



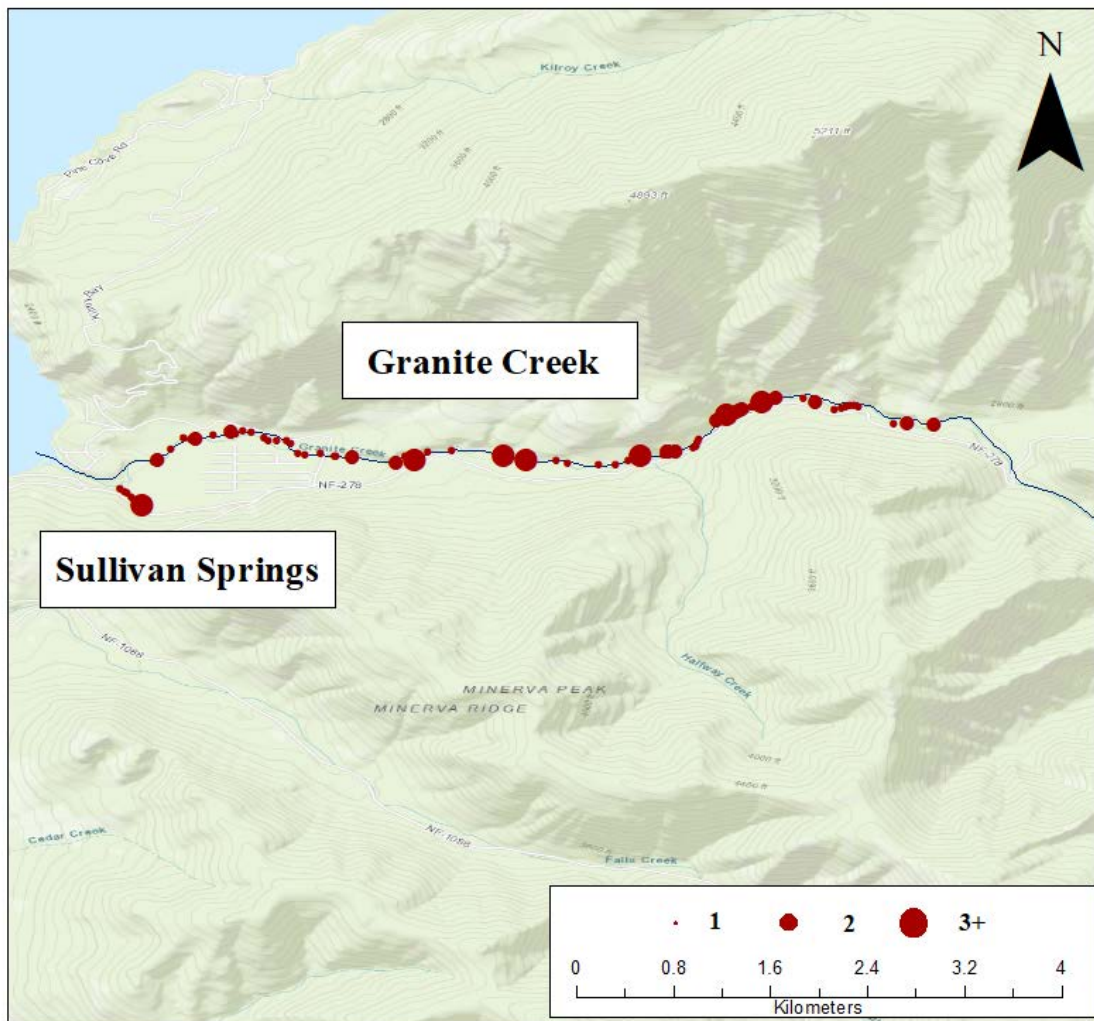
Supplemental Figure 2. Distribution map of Bull Trout redds observed in the Lightning Creek drainage in 2020. Number of redds at each location is described by incrementally larger circle shapes (legend).



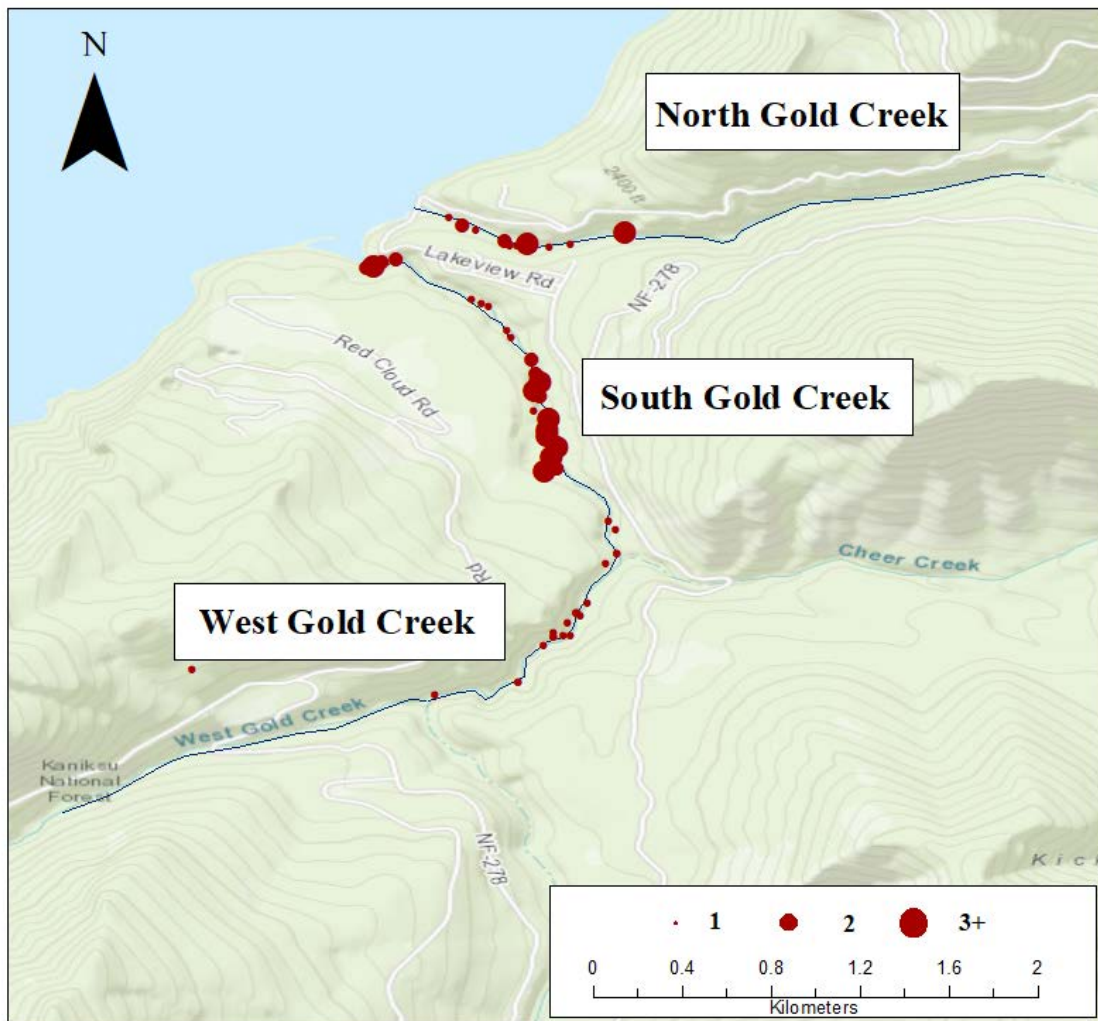
Supplemental Figure 3. Distribution map of Bull Trout redds observed in Johnson Creek in 2020. Number of redds at each location is described by incrementally larger circle shapes (legend).



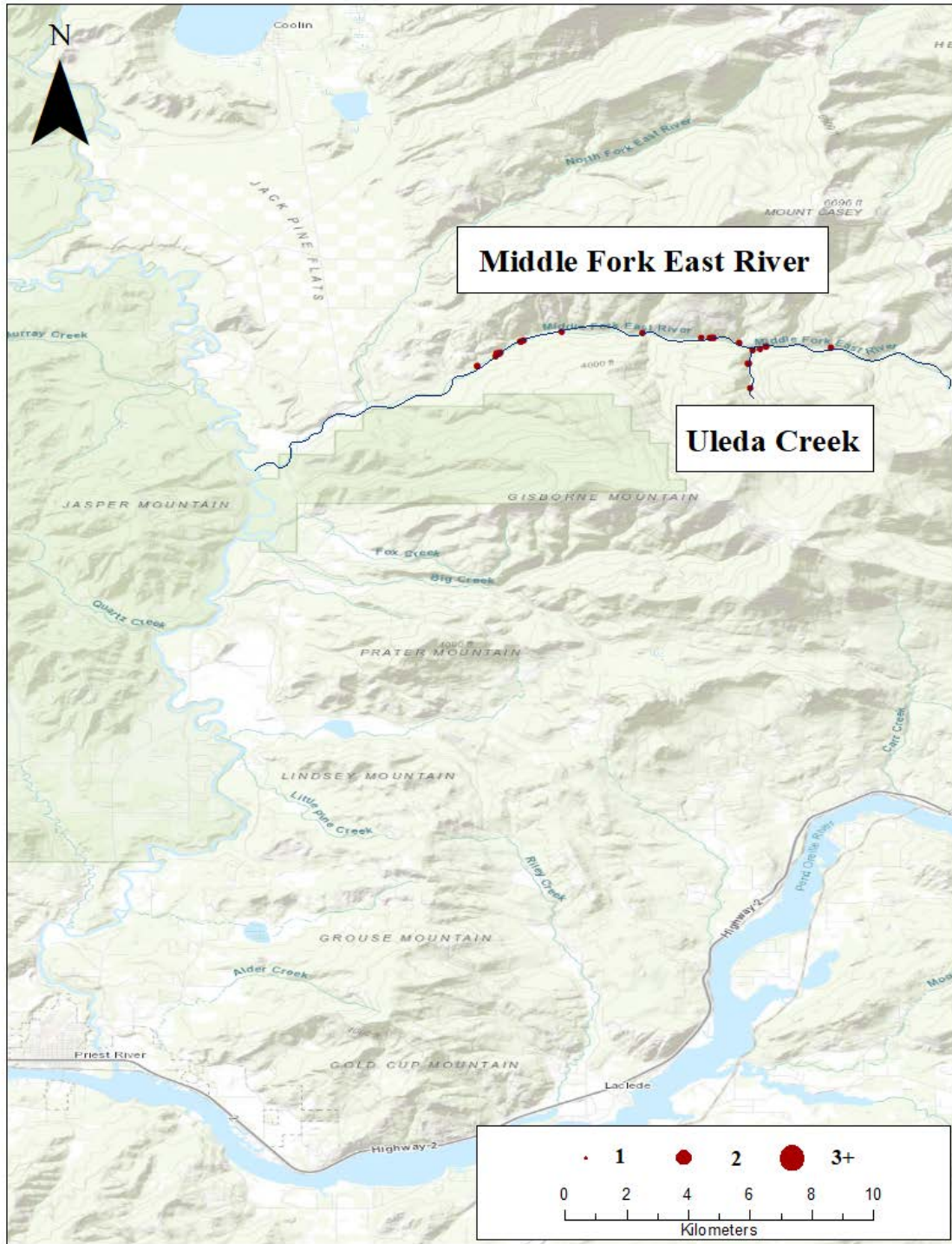
Supplemental Figure 4. Distribution map of Bull Trout redds observed in Trestle and Strong creeks in 2020. Number of redds at each location is described by incrementally larger circle shapes (legend).



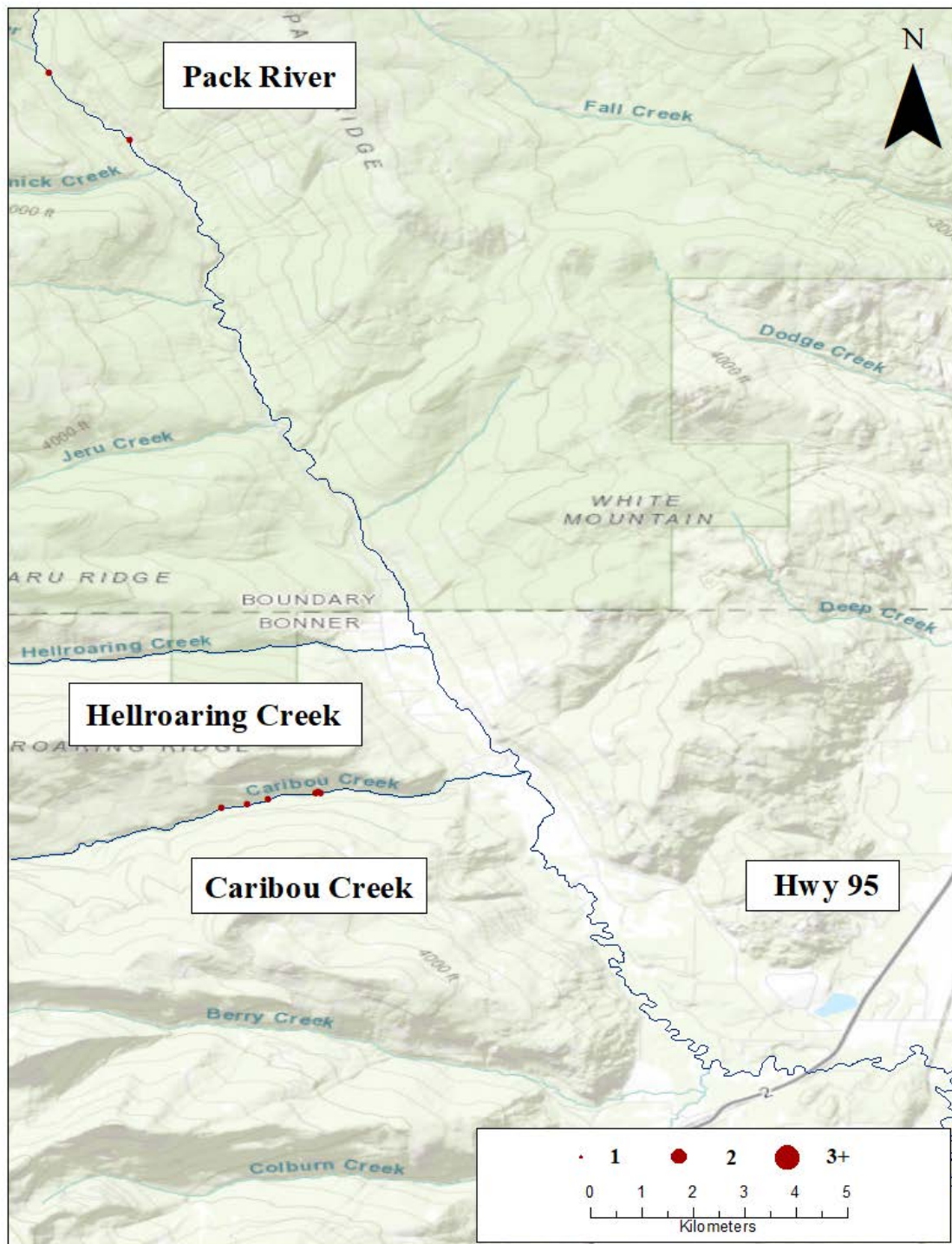
Supplemental Figure 5. Distribution map of Bull Trout redds observed in the Granite Creek drainage in 2020. Number of redds at each location is described by incrementally larger circle shapes (legend).



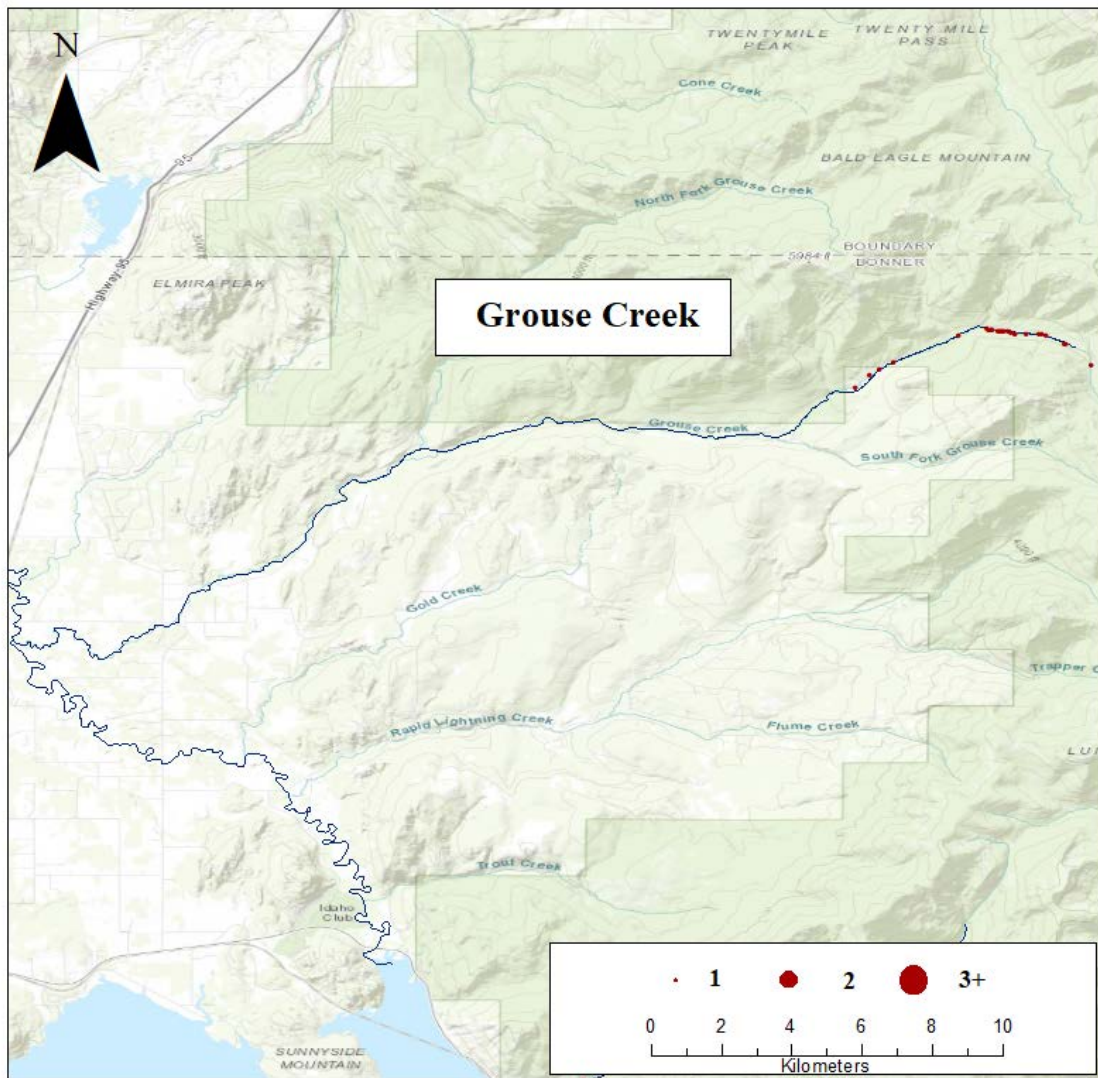
Supplemental Figure 6. Distribution map of Bull Trout redds observed in the Gold Creek drainage in 2020. Number of redds at each location is described by incrementally larger circle shapes (legend).



Supplemental Figure 7. Distribution map of Bull Trout redds observed in the Middle Fork East River drainage in 2020. Number of redds at each location is described by incrementally larger circle shapes (legend).



Supplemental Figure 8. Distribution map of Bull Trout redds observed in the Pack River drainage in 2020. Number of redds at each location is described by incrementally larger circle shapes (legend).



Supplemental Figure 9. Distribution map of Bull Trout redds observed in Grouse Creek, a tributary in the Pack River drainage in 2020. Number of redds at each location is described by incrementally larger circle shapes (legend).