MONTANA FISH, WILDLIFE & PARKS

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Project Title: Montana Statewide Fisheries Management

Job Title: (3110 LAKE KOOCANUSA AND KOOTENAI RIVER BASIN BULL TROUT MONITORING REPORT)

Abstract:

Montana Fish Wildlife and Parks collects population and habitat information for bull trout streams in the Kootenai River drainage. Surveys include juvenile abundance estimates, streambed core sampling, substrate scoring, redd counts, and gillnetting.

Juvenile bull trout abundance estimates are conducted within reference reaches of index streams. Most tributaries below Libby Dam have shown at least some decreases from peak values of juvenile bull trout abundance with significant declining trends apparent in West Fork Quartz, Pipe, O'Brien, and Keeler Creeks. Grave Creek, upstream of Libby Dam, appears to have stable juvenile bull trout abundance through time. Substrate scores are also presented for the juvenile bull trout abundance monitoring reaches.

Bull trout redds are counted annually in nine spawning tributaries in the Kootenai River drainage. While redd counts in all streams have declined from peak values, spawning tributaries upstream of Libby Dam have not displayed a significant declining trend over the past 10 years. Collectively, bull trout spawning tributaries between Libby Dam and Kootenai Falls have exhibited a significant declining trend in redd numbers over the past 10 years. Below Kootenai falls, no significant trend is apparent, except in the disjunct Keeler Creek population where redd counts have been significantly declining over the last 10 years. Core sampling data are also presented for spawning streams.

The bull trout population in Lake Koocanusa has been monitored using spring sinking gillnets since 1975. Since an experimental fishery for bull trout was initiated in 2004, no apparent trend exists for bull trout catch per net in Lake Koocanusa and mean values appear higher than those from the earliest sampling records.

LAKE KOOCANUSA AND KOOTENAI RIVER BASIN BULL TROUT MONITORING REPORT

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EXECUTIVE SUMMARY

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INTRODUCTION

Montana Fish, Wildlife & Parks (MWFP) listed bull trout *Salvelinus confluentus* as a species of special concern in 1994, and in 1998 the United States Fish and Wildlife Service (USFWS) listed bull trout as threatened under the Endangered Species Act. Bull trout in the Kootenai River drainage represent geographically distinct and important populations within their range.

The bull trout population upstream of Libby Dam in Lake Koocanusa is quite complex in that most adults rear and mature in the Montana portion of the reservoir while much of the spawning and juvenile rearing occurs in the BC portion of the drainage. Environmental and anthropogenic factors impacting bull trout in such a large system are also complex and poorly understood. Since the creation of Lake Koocanusa, the bull trout population in this portion of the Kootenai River drainage has become resilient. Likely existing at adult densities much higher than the free-flowing river, the population increased following ESA listing and elimination of targeted angling. In 2004, the USFWS authorized limited sport fishing for bull trout at Lake Koocanusa as requested by Montana Fish, Wildlife & Parks after the fishery was deemed to have reached recovery goals. Threats to bull trout upstream of Libby Dam include illegal fish introductions, illegal harvest, and water quality and quantity impairment from rural development, mining, water diversions, drought, and historic forestry practices. Critical spawning streams include the Grave Creek drainage in the U.S. and the Wigwam and other upper Kootenay River tributaries in B.C. Nodal habitats are provided in Lake Koocanusa, the Tobacco River, and the Kootenay River in Canada.

Bull trout in the middle Kootenai are generally restricted to 29 miles of river from Libby Dam downstream to Kootenai Falls. Because of this geographic restriction, bull trout are threatened by the low number of spawning streams (Fisher River, Libby Creek, Pipe Creek, and Quartz Creek drainages) available. Risks from nonnative fish species, illegal harvest, historic forestry practices and rural development are further exacerbated by Libby Dam. Dam operations have been considered a high risk for Kootenai drainage bull trout (Montana Bull Trout Scientific Group 1996a) as unnatural flow fluctuations, reduced nutrient inputs from Koocanusa acting as a sink, and gas supersaturation from spilling water could all negatively impact bull trout persistence. While a dense population of adult bull trout typically occurs seasonally below Libby Dam, the origins and fates of these individuals are not well understood. From genetic analyses, entrainment and subsequent survival of bull trout through Libby Dam is apparent (DeHaan et al. 2008; DeHaan and Adams 2011), but the contributions of these fish to the middle Kootenai population is unknown.

Bull trout are found below Kootenai Falls in O'Brien Creek, Callahan Creek, and in Bull Lake. The latter is a disjunct population that migrates downstream out of Bull Lake through Lake Creek, then upstream in Keeler Creek. Most bull trout found below Kootenai Falls inhabit the lower Kootenai River and Kootenay Lake during most of the year.

It is the intention of MFWP to manage bull trout populations as sport fisheries, which requires relevant population information to be compiled. MFWP monitors indexes of Kootenai drainage bull trout populations, life histories, and habitats to assess status and trends. Juvenile bull trout abundance estimates, substrate assessment, and redd counts are conducted in spawning and rearing streams. The subadult and adult bull trout population in Lake Koocanusa is further assessed through annual spring gillnet surveys and angler catch card returns. This report will help provide MFWP and other relevant stakeholders with the best available information regarding bull trout populations in the Kootenai River drainage. Specific survey method development and background information for this report can be found in Deleray et al. (1999) and Hensler and Benson (2018). Analyses and figures were generated using Microsoft Excel at a significance level of 0.05 unless otherwise noted.

DESCRIPTION OF STUDY AREA

Kootenai River Drainage

The Kootenai River basin is an international watershed that encompasses parts of British Columbia (B.C.), Montana, and Idaho (Figure 1). The headwaters of the Kootenai River originate in Kootenay National Park, B.C. The river flows south within the Rocky Mountain Trench to the reservoir created by Libby Dam, which is located near Libby, Montana. From the reservoir, the river turns west, passes through a gap between the Purcell and Cabinet Mountains, enters Idaho, and then loops north where it flows into Kootenay Lake, B.C. The waters leave the lake's West Arm and flows south to join the Columbia River at Castlegar, B.C. In terms of runoff volume, the Kootenai is the second largest Columbia River tributary. In terms of watershed area (36,000 km^2 or 8.96 million acres), it ranks third (Knudson 1994).

Nearly two-thirds of the 485-mile-long channel, and almost three-fourths of the Kootenai watershed is located within the province of British Columbia. Roughly twenty-one percent of the watershed lies within Montana (Figure 1), and six percent is in Idaho (Knudson 1994). The Continental Divide forms much of the eastern boundary, the Selkirk Mountains the western boundary, and the Cabinet Range the southern. The Purcell Mountains fill the center of the river’s J-shaped course to Kootenay Lake. Throughout, the basin is mountainous and heavily forested.

Libby Reservoir (Lake Koocanusa) and its tributaries receive runoff from 47 percent of the Kootenai River drainage basin. The reservoir has an annual average inflow of 10,615 cubic feet per second (cfs). Three Canadian rivers, the Kootenay, Elk, and Bull, supply 87 percent of the inflow (Chisholm et al. 1989). The Tobacco River and numerous small tributaries flow into the reservoir south of the International Border.

Major tributaries to the Kootenai River below Libby Dam include the Fisher River (838 sq. mi.; 485 average cfs), Yaak River (766 sq. mi. and 888 average cfs) and Moyie River (755 sq. mi.; 698 average cfs). Kootenai River tributaries are characteristically high-gradient mountain streams with bed material consisting of various mixtures of sand, gravel, rubble, boulders, and drifting clay and silt, predominantly of glacial/lacustrine origin. Fine materials, due to their instability during periods of high stream discharge, are continually eroded and re-deposited as gravel bars, forming braided channels with alternating riffles and pools.

Streamflow in unregulated tributaries generally peaks in May and June after the onset of snow melt, then declines to low flows from November through March. Flows also peak with rain-on-snow events. Kootenai Falls, a 20-foot-high waterfall and natural fish-migration barrier, is located eleven miles downstream of Libby, Montana.

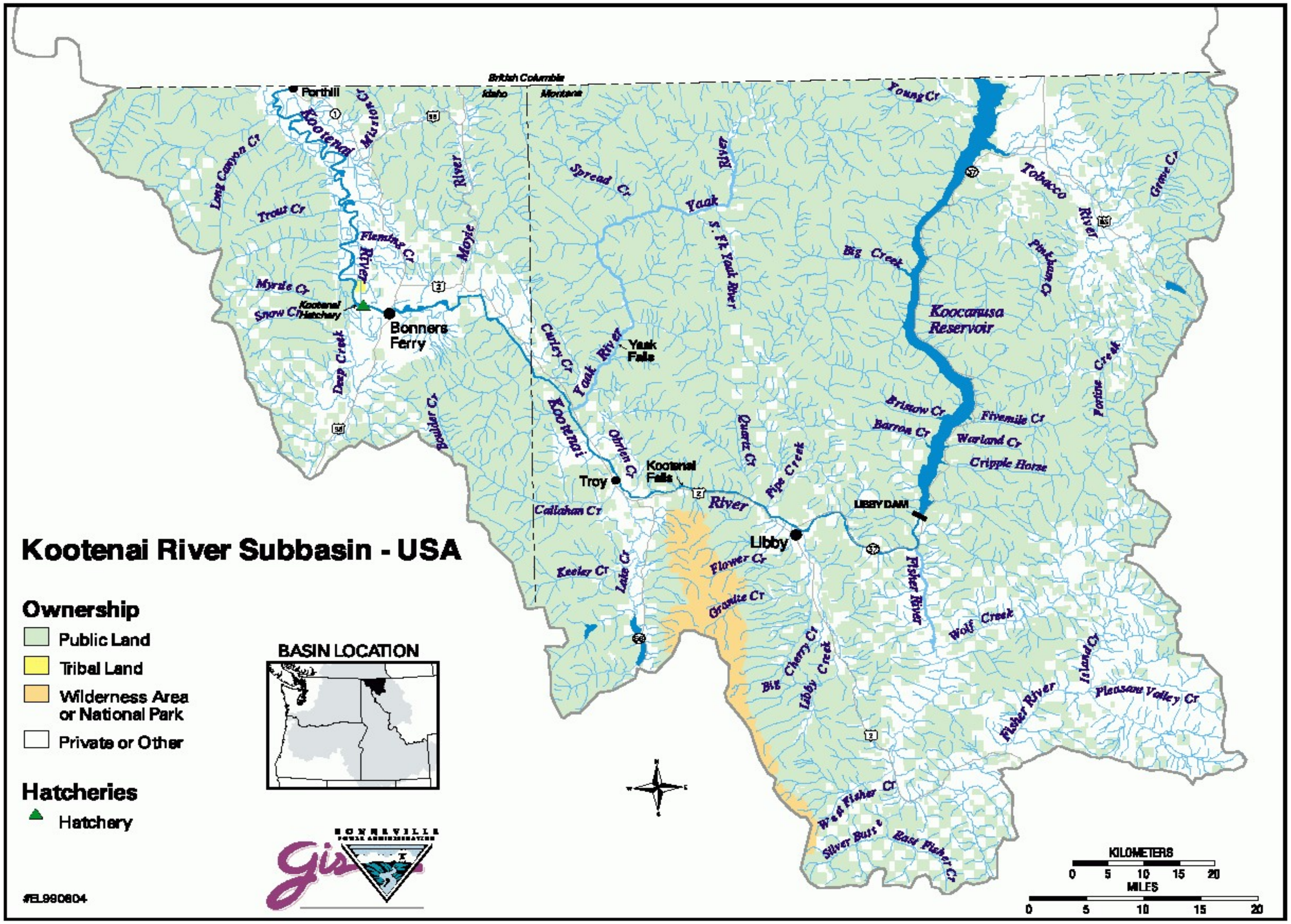

Figure 1. Kootenai River Basin (Montana, Idaho and British Columbia, Canada).

Libby Dam and Lake Koocanusa

Lake Koocanusa was created under an International Columbia River Treaty in 1964 between the United States and Canada for cooperative water development of the Columbia River Basin (Columbia River Treaty 1964). Lake Koocanusa inundated 109 stream miles of the mainstem Kootenai River in the United States and Canada, and 40 miles of tributary streams in the U.S. that provided habitat for spawning, juvenile rearing, and migratory passage for salmonids.

Libby Dam is a 113-m (370-ft) high concrete gravity structure with three types of outlets: sluiceways (3), operational penstock intakes (5 operational, 8 possible), and a gated spillway. The dam crest is 931 m long (3,055 ft), and the widths at the crest and base are 16 m (54 ft) and 94 m (310 ft), respectively. A selective withdrawal system was installed at Libby Dam to allow for temperature-controlled release of water from the reservoir.

Completion of Libby Dam in 1972 created the 109-mile Lake Koocanusa. Specific morphometric data for Lake Koocanusa are presented in Table 1. Filling Lake Koocanusa inundated and eliminated 109 miles of the mainstem Kootenai River and 40 miles of critical, low-gradient tributary habitat. This conversion of a large segment of the Kootenai River from a lotic to lentic environment changed the aquatic community (Paragamian 1994). Replacement of the inundated habitat and the community of life it supported are not possible. However, mitigation efforts are underway to protect, reopen, or reconstruct the remaining tributary habitat to offset the loss. Fortunately, in the highlands of the Kootenai Basin, tributary habitat quality is high. The headwaters are relatively undeveloped and retain a high percentage of their original wild attributes and native species complexes. Protection of these remaining pristine areas and reconnection of fragmented habitats are high priorities for bull trout and other native species.

Table 1. Morphometric data presented for Lake Koocanusa.

Surface elevation	
maximum pool	749.5 m (2,459 ft)
minimum operational pool	697.1 m (2,287 ft)
minimum pool (dead storage)	671.2 m (2,222 ft)
Area	
maximum pool	188 sq. km (46,500 acres)
minimum operational pool	58.6 sq. km (14,487 acres)
Volume	
maximum pool	7.24 km^3 (5,869,400 acre-ft)
minimum operational pool	1.10 km^3 (890,000 acre-ft)
Maximum length	145 km (90 mi)
Maximum depth	107 m (350 ft)
Mean depth	38 m (126 ft)
Shoreline length	360 km (224 mi)
Shoreline development	7.4 km (4.6 mi)
Drainage area	23,271 sq. km (8,985 sq. mi)

Fish Species

Twenty species of fish are present or have been found in Koocanusa Reservoir and/or the Kootenai River drainage (Table 2). The reservoir currently supports an important fishery for kokanee *Oncorhynchus nerka* and rainbow trout *Oncorhynchus mykiss* (Gerrard strain), and a bull trout fishery that was re-opened in 2004 (Hensler and Benson, 2007) which is currently one bull trout per year harvest. The annual fishing pressure has ranged from 30,000 to over 100,000 angler days. The Kootenai River below Libby Dam is a trophy rainbow trout fishery, and the state record fish was harvested there in 1997 (over 33 pounds). Bull trout *Salvelinus confluentus* are captured incidentally in the tailrace by anglers targeting the trophy rainbow trout.

Table 2. Current relative abundance (A=abundant, C=common, R=rare, N = Not Found) and abundance trend from1975 to 2018 (I=increasing, S = stable, D = decreasing, U = unknown) of fish species present in Lake Koocanusa and the Kootenai River drainage.

Common Name	**Scientific Name**	**Relative Abundance/Trend Reservoir**		**Relative Abundance drainage**	**Trend (Y/N)**	**Native**
<u>Game fish species</u>						
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*	R	D	C	S	Y
Rainbow trout	*Oncorhynchus mykiss*	R	D	C	S	Y
Bull trout	*Salvelinus confluentus*	C	S	C	I	Y
Brook trout	*Salvelinus fontinalis*	R	U	A	S	N
Lake trout	*Salvelinus namaycush*	N	U	R	U	N
Brown trout	*Salmon trutta*	N	U	R	I	N
Kokanee salmon	*Oncorhynchus nerka*	A	U	R	U	N
Mountain whitefish	*Prosopium williamsoni*	R	D	A	S	Y
Burbot	*Lota lota*	R	D	R	D	Y
Largemouth bass	*Micropterus salmoides*	R	U	R	U	N
Smallmouth bass	*Micropterus dolomieu*	N	U	C	I	N
White sturgeon	*Acipenser transmontanus*	R	D[a]	R	D	Y[b]
Northern pike	*Esox lucius*	R	U	R	U	N
Black Crappie	*Pomoxis Nigromaculatus*	N	U	R	I	N
Yellow perch	*Perca flavescens*	C	I	R	U	N
Northern Pike	*Esox Lucius*	R	U	C	I	N
<u>Non-game fish species</u>						
Pumpkinseed	*Lepomis gibbosus*	R	U	R	U	N
Redside shiner	*Richardsonius balteatus*	R	D	C	U	Y
Peamouth chub	*Mylocheilus caurinus*	A	I	C	U	Y
Northern pikeminnow	*Ptychocheilus oregonensis*	A	S	C	U	Y
Largescale sucker	*Catostomus macrocheilus*	A	S	C	U	Y
Longnose sucker	*Catostomus catostomus*	C	D	R	U	Y

[a] Five white sturgeon were relocated from below Libby Dam to the reservoir. At least one of these fish moved upriver out of the reservoir while two have been accounted for from angler reports; one verified mortality.

[b] Several anecdotal reports exist of white sturgeon above Kootenai Falls although surveys to date have failed to validate any reports.

JUVENILE BULL TROUT ABUNDANCE ESTIMATES

Estimation of fish population abundance is necessary for understanding basic changes in numbers, species composition, recruitment, year class strength and trends. MFWP conducts annual juvenile bull trout population estimates in nine Kootenai drainage spawning and rearing streams: Grave Creek, West Fork Quartz Creek, Pipe Creek, West Fisher Creek, Bear Creek, O'Brien Creek, Keeler Creek, Callahan Creek, and Libby Creek upstream of Libby Falls.

Methods

Juvenile bull trout population estimates are conducted on index reaches of each stream with mobile electrofishing gear using DC current and employing multiple pass depletion techniques similar to Shepard et al. (1984). A block net is placed at the lower end of each section. Electrofishing commences at the upper end of the reach and moves toward the lower end. After two removal passes are completed, we estimate the probability of capture (P) using the following formula.

$$P = (C1 - C2) / C1$$

Where: C1 = number of fish (~age 1* or older) captured during the first pass and

C2 = number of fish (~age 1* or older) captured during the second pass.

**Length at age one is based on 20+ years of length frequency data for each stream.*

Based on fish captured during the first two passes, if $P < 0.6$, an additional pass is conducted. Population estimates and associated 95% confidence intervals are computed using *Fisheries Analysis +*, a proprietary software package developed by MFWP.

Sampling locations are consistent between years and were selected based on accessibility and proximity to historic and current redd locations. Section lengths vary between streams and years due to considerable shifting of streambeds during some years and presence of suitable riffle breaks for section demarcation.

Results

Grave Creek

The Grave Creek juvenile bull trout abundance monitoring section is located just upstream of the Clarence Creek confluence and has varied from 163m to 220m in length. This is the only juvenile bull trout abundance monitoring section in the U.S. for the Lake Koocanusa population. It is a relatively stable section but has been periodically affected by high flows and beaver activity. Juvenile bull trout abundance estimates in Grave Creek have ranged from 5.8 fish / 100 m^2 in 2012 to 19.9 fish / 100 m^2 in 2023 (Table 3), and there is no significant trend for all years sampled (Figure 2). The 2023 juvenile bull trout density estimate may be misleadingly high due to either extremely low flows as mean stream widths were by far the lowest on record, or due to stream width measurement error.

Table 3. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older juvenile bull trout calculated from electrofishing in the reference section of Grave Creek, 1997 - 2023.

Year	N	95% CI Lower Bound	95% CI Upper Bound	p	Density (#/100m^2)
1997	158	146	171	0.72	9.7
1998	184	175	194	0.77	11.4
1999	139	114	166	0.57	8.6
2000	165	147	183	0.50	10.1
2001	165	147	183	0.67	11.6
2002	115	102	131	0.66	8.5
2003	156	147	166	0.75	15.6
2004	153	149	159	0.83	13.3
2005	157	148	167	0.76	14.9
2006	123	110	138	0.67	9.3
2007	144	136	154	0.76	12.6
2008	127	121	135	0.78	11.4
2009	127	106	151	0.59	12.1
2010	104	96	115	0.72	7.9
2011	Not Sampled				
2012	73	71	78	0.82	5.9
2013	96	91	104	0.76	10.5
2014	110	99	124	0.68	10.3
2015	140	123	158	0.65	14.4
2016	105	93	120	0.66	8.7
2017	Not Sampled				
2018	146	129	164	0.66	12.4
2019	215	197	233	0.69	18.7
2020	113	111	117	0.85	9.5
2021	93	87	102	0.74	7.6
2022	116	105	129	0.69	10.3
2023	157	146	169	0.73	19.9

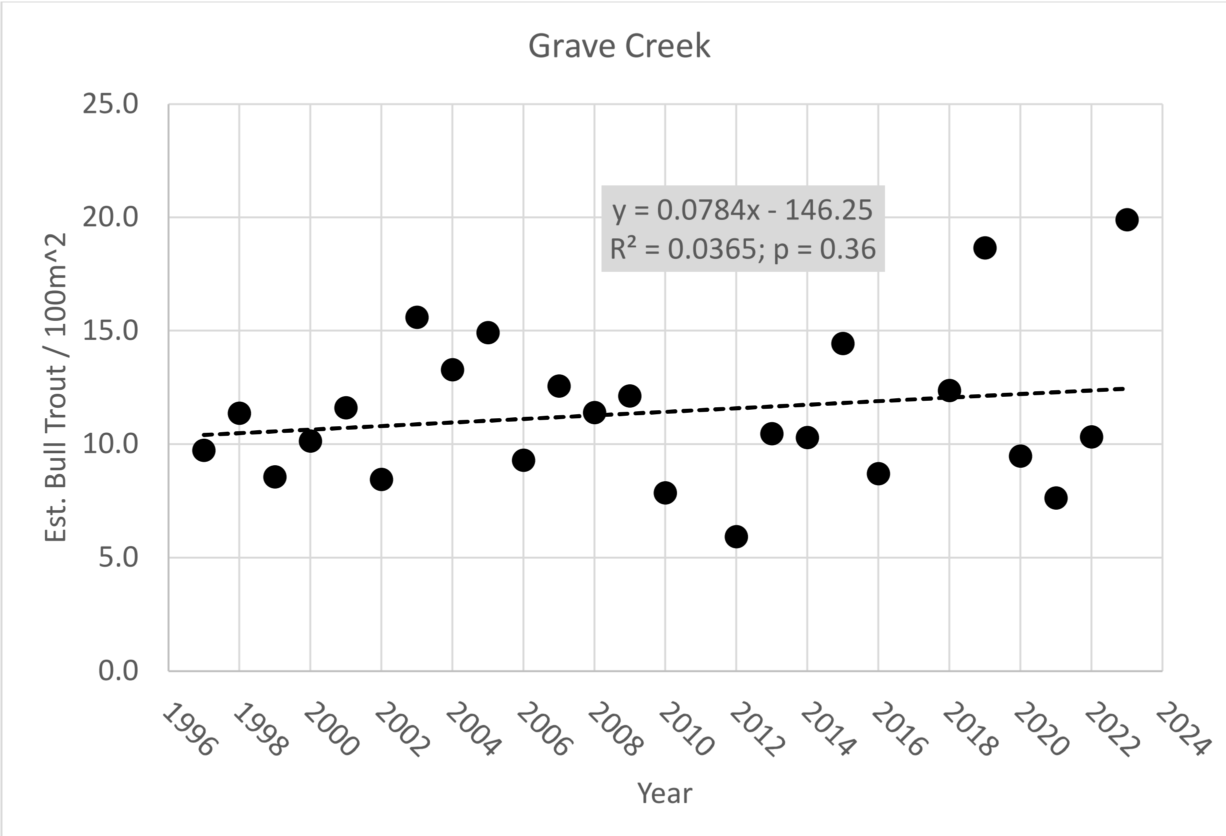

Figure 2. Estimated abundance of age 1+ juvenile bull trout in Grave Creek by sampling year.

West Fork Quartz Creek

The West Fork Quartz Creek juvenile bull trout abundance monitoring section is located at the FS 399 road bridge crossing. The section has varied in length from 165 m to 248 m. High spring flows and downfall from wind events has impacted the length of the abundance estimation section. West Fork Quartz Creek was chosen for juvenile abundance monitoring rather than the mainstem of Quartz Creek because it historically contained the most redds. Juvenile bull trout abundance estimates in West Fork Quartz Creek have ranged from 0.6 fish / 100 m^2 to 11.0 fish / 100 m^2 (Table 4). A significant declining trend (slope = -0.298, R^2 = 0.649, $P < 0.001$) is apparent for the period of record, with some of the lowest estimates in recent years (Figure 3).

Table 4. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older juvenile bull trout calculated from electrofishing in the reference section of West Fork Quartz Creek, 1997 - 2023.

Year	N	95% CI Lower Bound	95% CI Upper Bound	p	Density (#/100m^2)
1997	76	76	77	0.94	5.7
1998	84	78	93	0.72	6.8
1999	Not Sampled				
2000	75	68	86	0.69	7.9
2001	92	81	107	0.65	7.7
2002	89	85	96	0.77	11.0
2003	70	68	74	0.67	7.7
2004	74	72	79	0.82	8.1
2005	64	61	70	0.76	7.3
2006	61	57	68	0.73	6.7
2007	62	62	66	0.86	6.7
2008	98	93	106	0.76	10.2
2009	41	41	42	0.95	4.5
2010	52	51	55	0.84	5.7
2011	41	41	43	0.89	4.7
2012	16	16	17	0.89	1.7
2013	49	48	53	0.81	4.9
2014	42	36	54	0.61	4.5
2015	22	22	22	0.96	2.4
2016	23	23	25	0.85	2.5
2017	21	21	23	0.84	2.2
2018	6	6	7	0.75	0.6
2019	33	33	35	0.87	3.6
2020	32	31	36	0.80	3.6
2021	25	25	27	0.86	2.9
2022	6	6	7	0.75	0.6
2023	7	No Recaptures		1.00	0.8

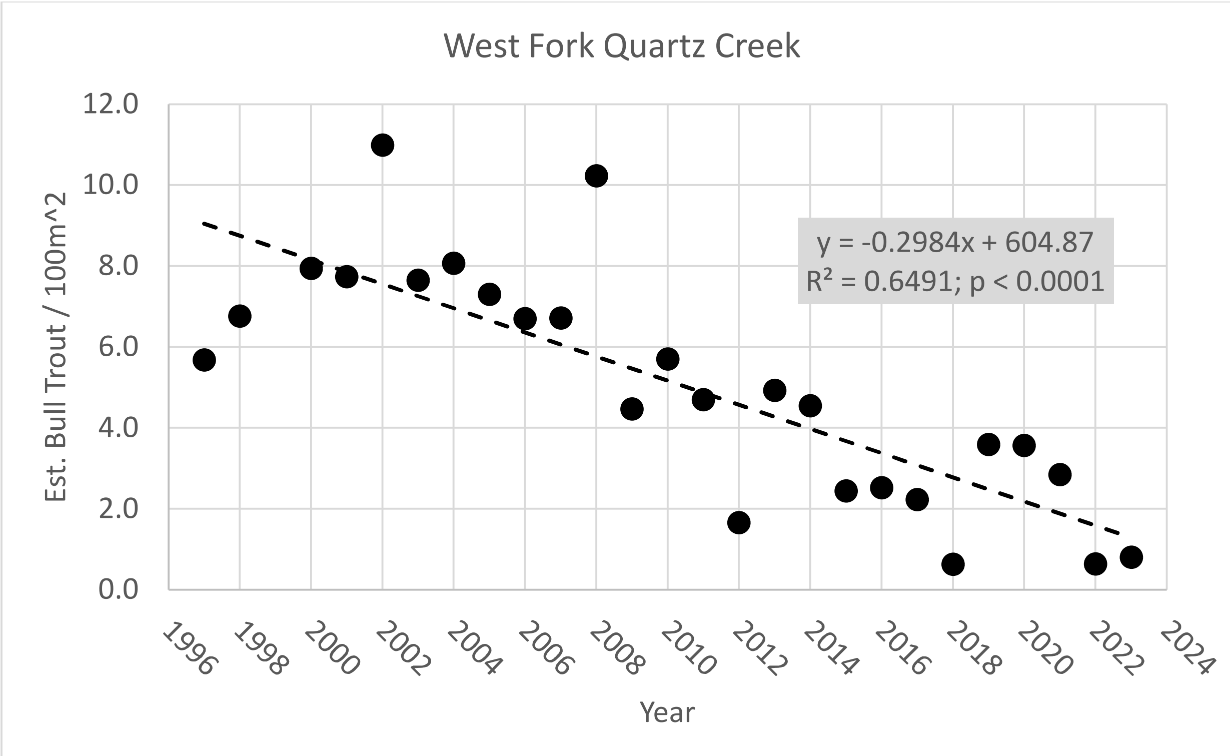

Figure 3. Estimated abundance of age 1+ juvenile bull trout in W. F. Quartz Creek by sampling year.

Pipe Creek

The Pipe Creek juvenile bull trout abundance monitoring section is located approximately 3 miles below the confluence with East Fork Pipe Creek and has varied in length from 147 m to 206 m since 1999 due to changes caused by spring flows and downfall from wind events. Historically redds have been observed both above and below the section. Juvenile bull trout abundance estimates in Pipe Creek are typically low and have ranged from 0 fish / 100 m^2 in several years to 2.1 fish / 100 m^2 in 2003 (Table 5). A significant declining trend (slope = -0.054, R^2 = 0.397, P < 0.001) occurs for the period of record with no juvenile bull trout captured during the last three years (Figure 4).

Table 5. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older juvenile bull trout calculated from electrofishing in the reference section of Pipe Creek, 1998 - 2023.

Year	N	95% CI Lower Bound	95% CI Upper Bound	p	Density (#/100m^2)
1998	14	No Recaptures		1.00	0.6
1999	21	21	23	0.68	1.5
2000	11	11	12	0.90	0.8
2001	17	15	25	0.63	1.6
2002	18	17	23	0.71	1.8
2003	23	22	27	0.76	2.1
2004	22	22	24	0.85	1.6
2005	12	No Recaptures		1.00	1.0
2006	7	7	9	0.78	0.6
2007	0	No Juveniles Caught		1.00	0.0
2008	1	No Recaptures		1.00	0.1
2009	0	No Juveniles Caught		1.00	0.0
2010	4	No Recaptures		1.00	0.3
2011	4	4	5	0.80	0.3
2012	15	14	19	0.70	1.1
2013	16	No Recaptures		1.00	1.5
2014	6	6	7	0.86	0.6
2015	6	No Recaptures		1.00	0.6
2016	2	No Recaptures		1.00	0.2
2017	0	No Juveniles Caught		1.00	0.0
2018	0	No Juveniles Caught		1.00	0.0
2019	2	No Recaptures		1.00	0.2
2020	6	No Recaptures		1.00	0.6
2021	0	No Juveniles Caught		1.00	0.0
2022	0	No Juveniles Caught		1.00	0.0
2023	0	No Juveniles Caught		1.00	0.0

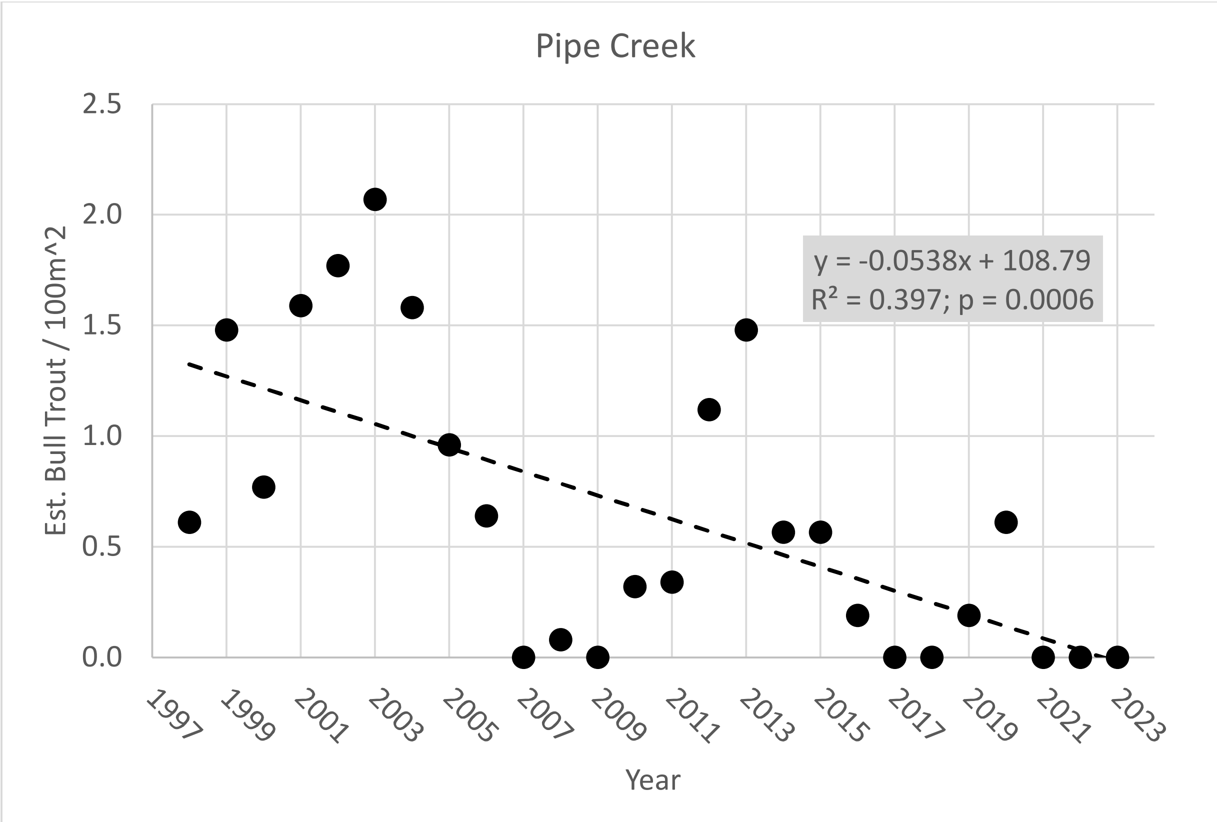

Figure 4. Estimated abundance of age 1+ juvenile bull trout in Pipe Creek by sampling year.

West Fisher Creek

The West Fisher Creek juvenile abundance monitoring section is centered on the FS 231 road bridge and was first sampled in 2002. The section has varied from 198m to 284m in length due to shifting channel conditions associated with high flow events. Estimated juvenile bull trout abundance is typically low and has varied annually between 0 fish / 100 m^2 to 2.4 fish / 100 m^2 (Table 6). In 2023, no juvenile bull trout were captured resulting in the lowest abundance estimate on record for West Fisher Creek. Overall, juvenile bull trout in West Fisher Creek have displayed a non-significant but slightly declining trend (slope = -0.032, R^2 = 0.092, P = 0.170) since monitoring began in 2002 (Figure 5).

Table 6. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older juvenile bull trout calculated from electrofishing in the reference section of West Fisher Creek, 2002 - 2023.

Year	N	95% CI Lower Bound	95% CI Upper Bound	p	Density (#/100m^2)
2002	37	35	42	0.75	2.4
2003	9	9	11	0.82	0.6
2004	5	5	6	0.83	0.3
2005	2			1.00	0.1
2006	8	8	11	0.73	0.4
2007	31	30	35	0.77	1.6
2008	3	3	4	0.75	0.1
2009	31	31	32	0.91	1.6
2010	9	9	10	0.90	0.4
2011	17	17	18	0.90	0.7
2012	54	50	62	0.71	2.3
2013	13	13	15	0.81	0.6
2014	18	18	20	0.82	0.8
2015	18	18	20	0.86	0.8
2016	21	19	28	0.66	1.0
2017	1	No Recaptures		1.00	0.1
2018	24	24	26	0.83	1.2
2019	9	9	11	0.82	0.4
2020	18	18	20	0.67	0.8
2021	1	No Recaptures		1.00	0.1
2022	5	No Recaptures		1.00	0.3
2023	0	No Juveniles Caught		1.00	0.0

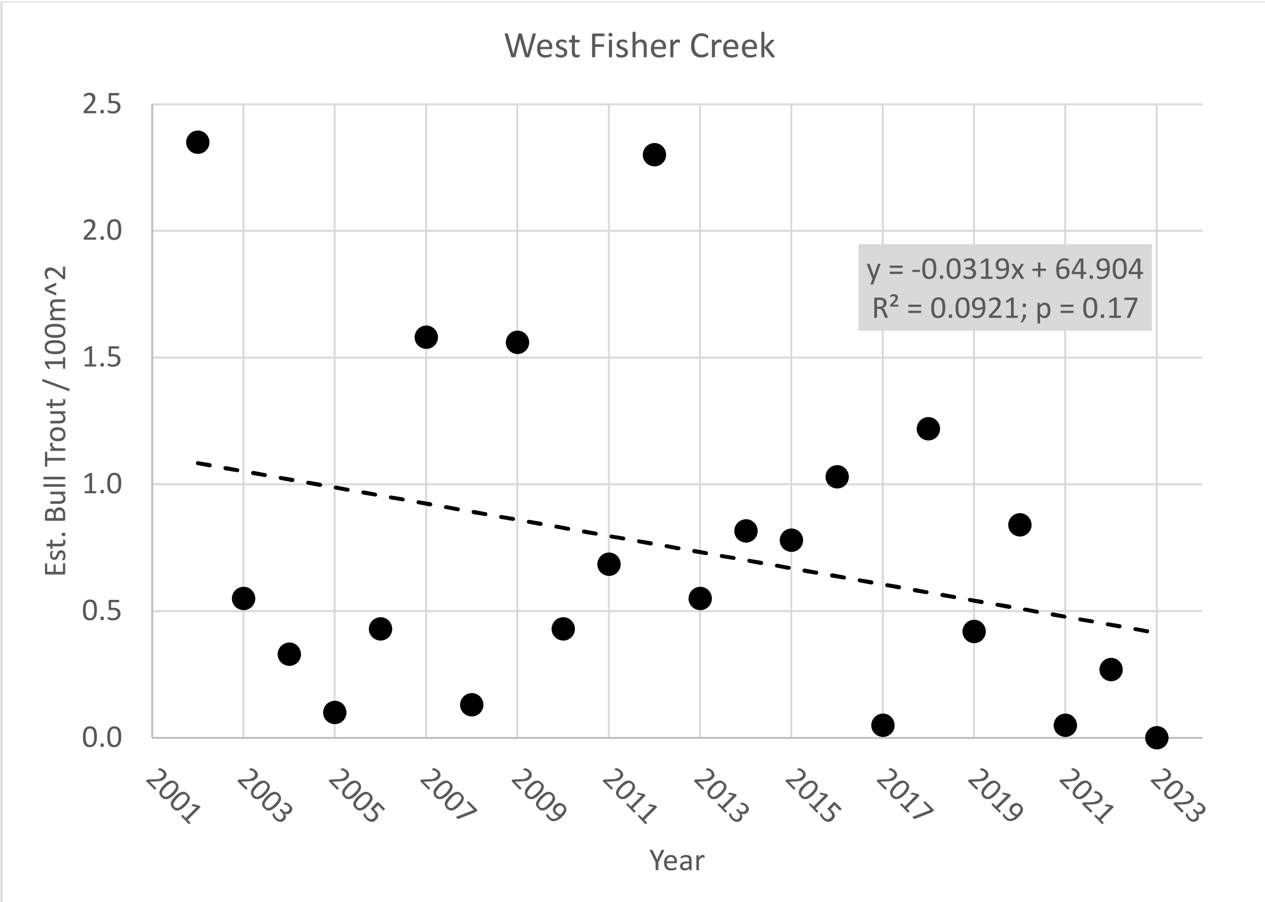

Figure 5. Estimated abundance of age 1+ juvenile bull trout in West Fisher Creek by sampling year.

Bear Creek

The Bear Creek juvenile bull trout abundance monitoring section is centered on the FS 278 road bridge and has varied in length from 131 m to 231 m due to changes caused by spring flows and downfall from wind events. This is a relatively stable stream reach with moderate estimated densities of juvenile bull trout ranging from 0.4 fish / 100 m^2 to 10.4 fish / 100 m^2 (Table 7). From 1999 to present, juvenile bull trout abundance in Bear Creek has displayed a weak but slightly declining trend (slope = -0.052, R^2 = 0.027, P = 0.431) (Figure 6).

Table 7. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older juvenile bull trout calculated from electrofishing in the reference section of Bear Creek, 1999 - 2023.

Year	N	95% CI Lower Bound	95% CI Upper Bound	p	Density (#/100m^2)
1999	101	94	111	0.73	6.0
2000	74	72	79	0.81	6.2
2001	80	74	89	0.72	7.7
2002	67	66	70	0.85	6.2
2003	108	104	115	0.79	8.4
2004	46	44	51	0.77	2.6
2005	84	74	98	0.65	4.1
2006	73	69	80	0.75	3.5
2007	17	17	18	0.94	1.3
2008	8	8	9	0.89	0.4
2009	39	35	48	0.66	2.4
2010	128	117	141	0.70	7.4
2011	119	107	133	0.68	5.6
2012	108	98	121	0.69	5.4
2013	82	78	89	0.77	5.2
2014	116	101	134	0.64	6.1
2015	130	124	138	0.78	10.4
2016	46	44	51	0.77	2.7
2017	84	78	93	0.72	5.2
2018	79	72	89	0.55	4.3
2019	33	30	40	0.68	2.2
2020	50	37	74	0.36	2.7
2021	82	81	85	0.87	4.6
2022	134	126	144	0.75	6.3
2023	56	54	61	0.78	3.7

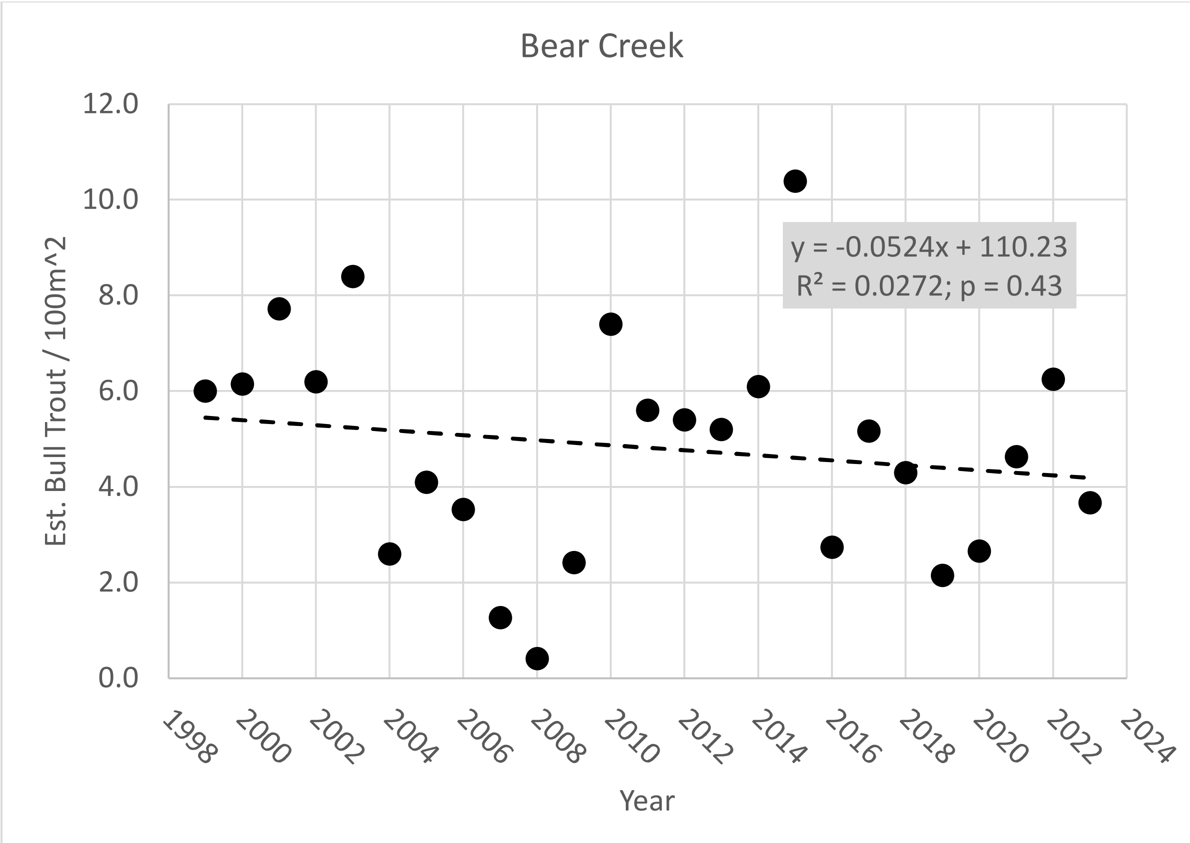

Figure 6. Estimated abundance of age 1+ juvenile bull trout in Bear Creek by sampling year.

O'Brien Creek

The O'Brien Creek juvenile bull trout abundance monitoring section has been centered on FS 4445 road bridge near Lynx Creek since 2006. Prior to that, abundance estimates were conducted in a reach centered on the FS 331 road bridge above Rabbit Creek but was moved downstream because of beaver encroachment. The current section has been consistently 155 m long since 2006. O'Brien Creek is one of two tributaries below Kootenai Falls in Montana that support bull trout spawning and rearing from the Kootenai River.

After obtaining a juvenile bull trout density estimate of 3.3 fish / 100m^2 in 2006 at the current monitoring reach, estimates fell to 1.1 fish / 100m^2 and lower for all subsequent years (Table 8). Juvenile bull trout abundance has displayed a slight but significant (slope = -0.036, R^2 = 0.35, P = 0.01) decreasing trend since 2007 (Figure 7), including two years (2017 and 2018) where no juvenile bull trout were captured.

Table 8. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older juvenile bull trout calculated from electrofishing in the reference section of O'Brien Creek, 2006 - 2023.

Year	N	95% CI Lower Bound	95% CI Upper Bound	p	Density (#/100m^2)
2006	31	31	31	0.97	3.3
2007	5	No Recaptures		1.00	0.5
2008	11	11	12	0.92	1.1
2009	5	No Recaptures		1.00	0.5
2010	8	8	10	0.80	0.7
2011	7	7	8	0.88	0.6
2012	2	No Recaptures		1.00	0.2
2013	9	9	11	0.82	0.8
2014	3	No Recaptures		1.00	0.3
2015	1	No Recaptures		1.00	0.1
2016	1	* 1 caught 2nd run		1.00	0.1
2017	0	No Juveniles Caught		1.00	0.0
2018	0	No Juveniles Caught		1.00	0.0
2019	3	* 1 caught 1st run, 2 caught 2nd run		1.00	0.3
2020	1	No Recaptures		1.00	0.1
2021	1	No Recaptures		1.00	0.1
2022	6	6	7	0.75	0.5
2023	2	No Recaptures		1.00	0.2

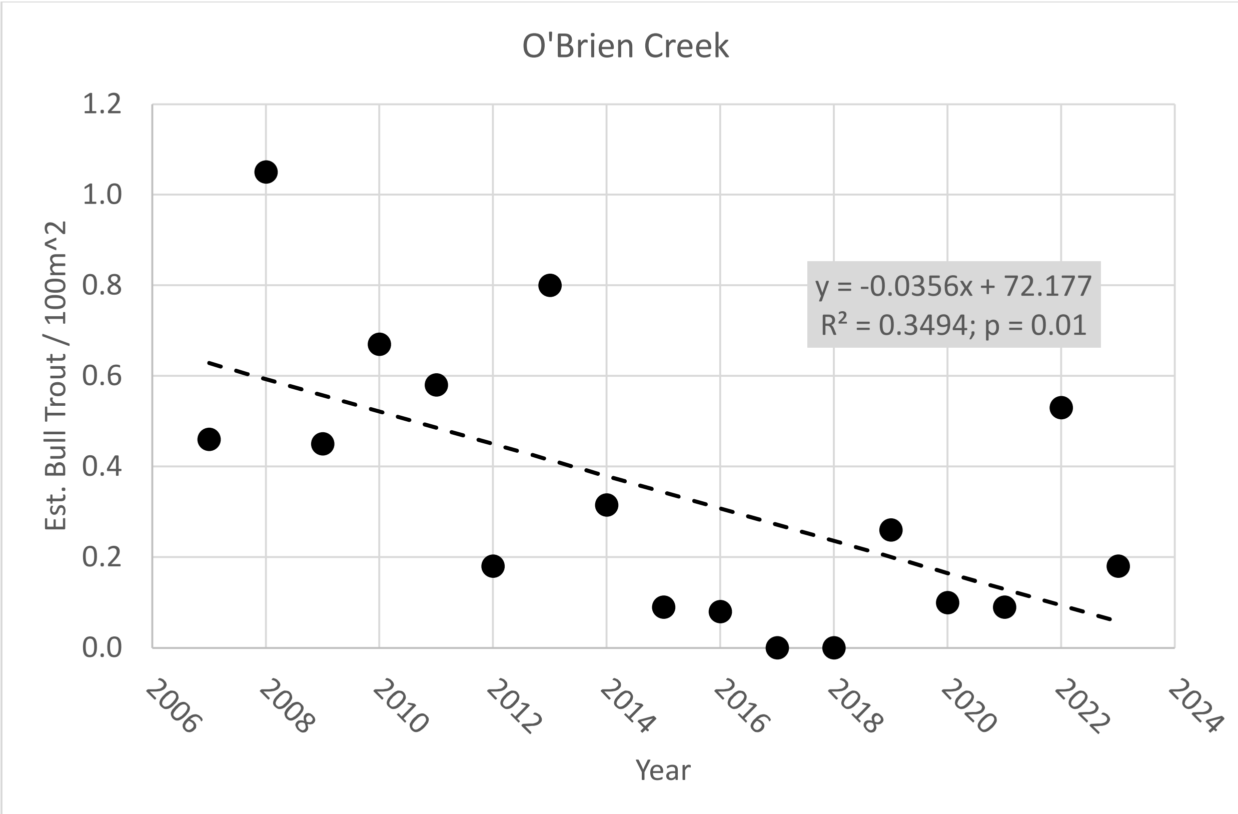

Figure 7. Estimated abundance of age 1+ juvenile bull trout in O'Brien Creek by sampling year.

Keeler Creek

Bull trout that spawn in Keeler Creek (including the North, South and West Forks) are adfluvial fish that migrate downstream out of Bull Lake into Lake Creek, then upstream into Keeler Creek. This downstream spawning migration is unique when compared to other bull trout populations (Montana Bull Trout Restoration Team 1996a). A micro-hydropower dam constructed in 1916 and a series of high gradient waterfalls on Lake Creek are barriers to all upstream fish passage. Keeler Creek likely supplies some recruitment to the Kootenai River through one-way downstream migration.

The Keeler Creek juvenile bull trout abundance monitoring section is located approximately 1 mile below the North Fork Keeler confluence. The section length was relatively constant between 180m and 230m, except in 2023 when it was shortened to 127m. Juvenile bull trout densities were relatively stable from 1998 through 2016, ranging from 1.0 fish / 100 m^2 to 5.1 fish / 100 m^2 (Table 9). Since 2016, densities have remained well below 1.0 fish / 100 m^2. Juvenile bull trout abundance in Keeler Creek has displayed a significant declining trend (slope = -0.076, R^2 = 0.271, P = 0.019) through time with consistently low abundance in recent years (Figure 8).

Table 9. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older juvenile bull trout calculated from electrofishing in the reference section of Keeler Creek, 1998 - 2023.

Year	N	95% CI Lower Bound	95% CI Upper Bound	p	Density (#/100m^2)
1998	78	49	130	0.28	3.7
1999	24	19	38	0.53	1.3
2000	26	15	69	0.34	1.5
2001	41	39	46	0.61	2.1
2002	33	32	36	0.80	1.7
2003	54	49	63	0.68	2.9
2004	27	27	29	0.84	1.4
2005	17	17	18	0.94	1.0
2006	29	29	31	0.85	1.4
2007	38	38	39	0.93	2.4
2008	25	25	27	0.86	1.3
2009	85	80	93	0.75	4.7
2010	99	96	104	0.81	5.1
2011	Not Sampled				
2012	29	28	33	0.78	1.7
2013	51	47	59	0.70	2.8
2014	28	28	30	0.85	1.6
2015	22	22	23	0.88	1.3
2016	20	20	21	0.91	1.3
2017	7	No Recaptures		1.00	0.4
2018	11	11	13	0.79	0.7
2019	8	8	10	0.80	0.5
2020	9	9	10	0.75	0.6
2021	5	No Recaptures		1.00	0.3
2022	9	9	10	0.75	0.6
2023	6	6	7	0.86	0.6

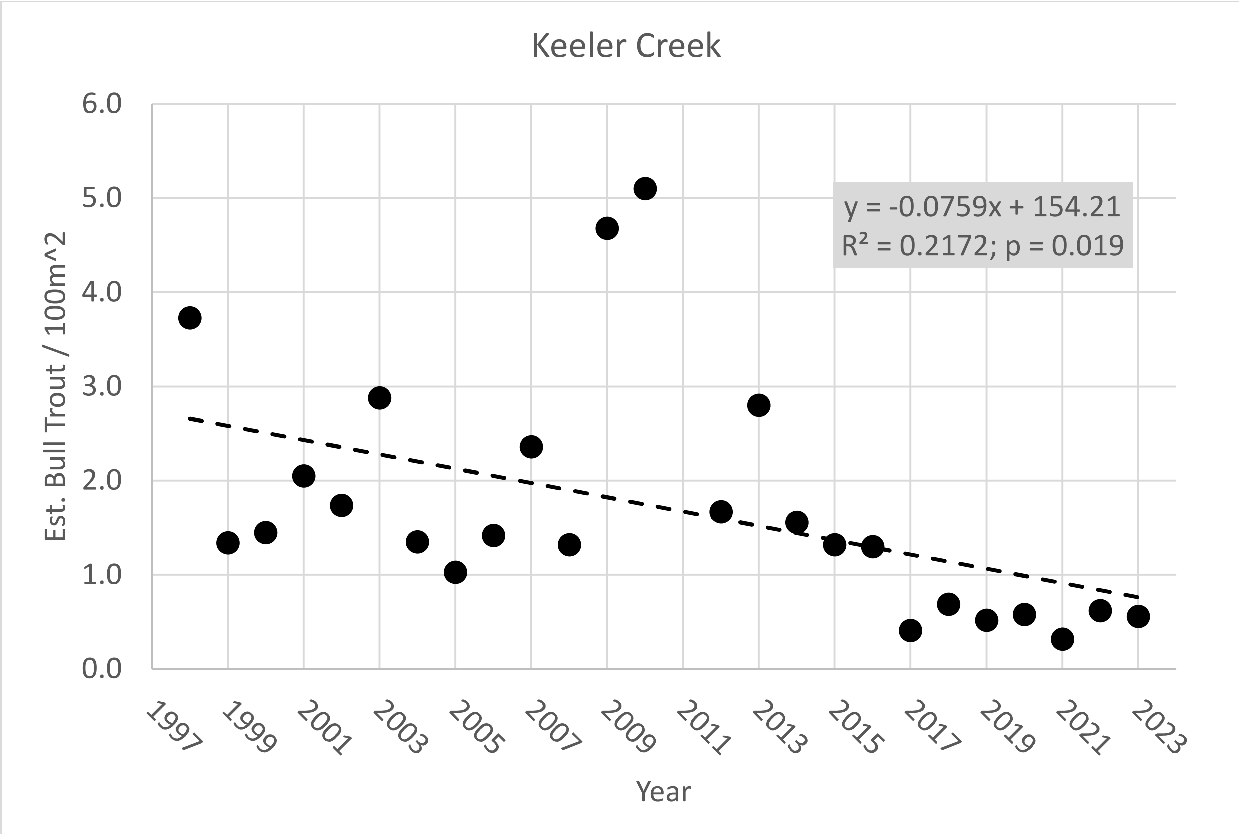

Figure 8. Estimated abundance of age 1+ juvenile bull trout in Keeler Creek by sampling year.

Callahan Creek

The Callahan Creek juvenile bull trout abundance monitoring section is located on North Callahan Creek just upstream of the confluence with South Callahan Creek at the FS 414 road bridge. The section has varied in length from 155 m to 219 m due to changes from high spring flows and downfall from wind events. North Callahan Creek was selected for abundance monitoring because the majority of redds observed from year to year are in that tributary. Densities of juvenile bull trout are variable in this section and have ranged from 0 fish / 100 m^2 to 2.4 fish / 100 m^2 (Table 10). Overall, juvenile bull trout abundance in Callahan Creek has displayed a non-significant but slightly declining trend (slope = -0.049, R^2 = 0.166, P = 0.075) since monitoring began in 2003 (Figure 9).

Table 10. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older juvenile bull trout calculated from electrofishing in the reference section of Callahan Creek, 2003 - 2023.

Year	N	95% CI Lower Bound	95% CI Upper Bound	p	Density (#/100m^2)
2003	10	10	11	0.83	0.6
2004	43	42	46	0.82	2.4
2005	35	34	39	0.79	2.2
2006	11	11	12	0.85	0.6
2007	4	4	5	0.80	0.2
2008	0	No Juveniles Caught		1.00	0.0
2009	11	11	12	0.92	0.5
2010	40	40	42	0.87	1.7
2011	Not Sampled				
2012	12	12	13	0.86	0.5
2013	25	25	27	0.08	1.0
2014	18	18	19	0.90	0.7
2015	41	40	44	0.82	2.1
2016	1	No Recaptures		1.00	0.1
2017	0	No Juveniles Caught		1.00	0.0
2018	6	6	7	0.86	0.3
2019	9	9	10	0.90	0.4
2020	20	20	21	0.87	1.1
2021	5	5	7	0.71	0.3
2022	4	4	5	0.80	0.2
2023	1	No Recaptures		1.00	0.1

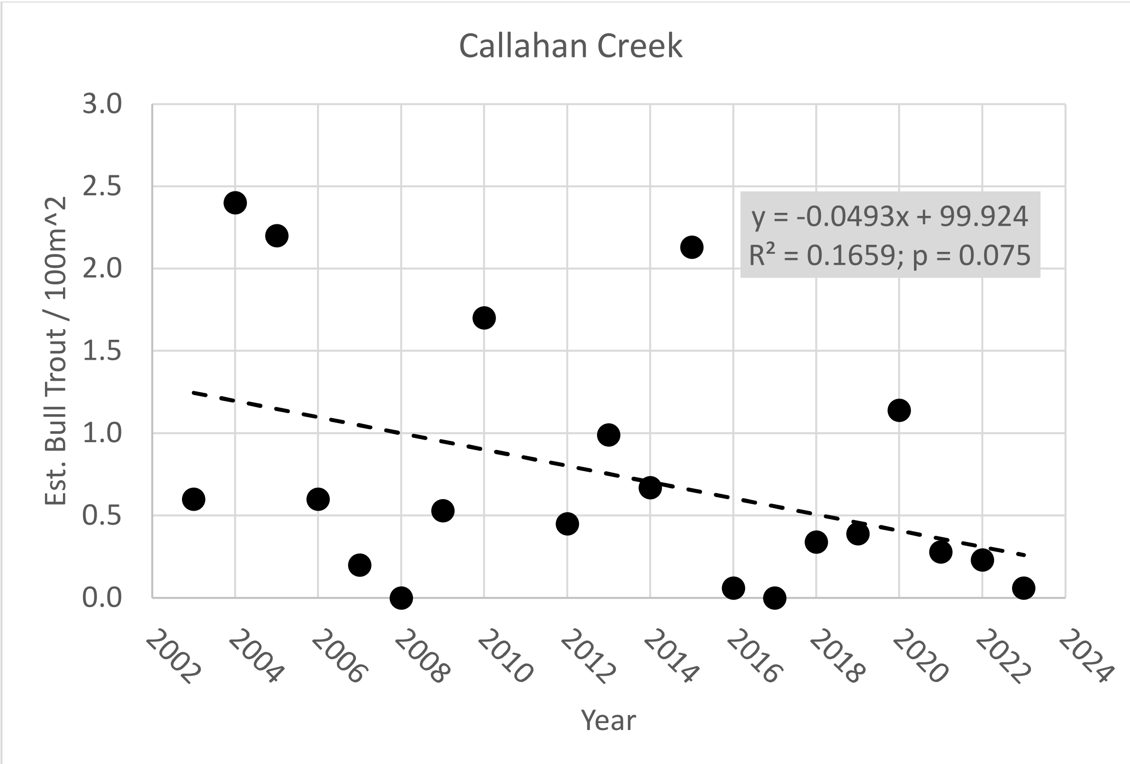

Figure 9. Estimated abundance of age 1+ juvenile bull trout in Callahan Creek by sampling year.

Libby Creek Upstream of Libby Falls

The Libby Creek juvenile bull trout abundance monitoring section is located above Libby Falls below the Montenore mine site. The section length has ranged from 131 m to 183 m and has been monitored since 2003. This population is an isolated resident population separated from upstream movement by Libby Falls which is approximately 20m high. Estimates in this section have included resident adult bull trout up to about 350 mm total length. Estimated bull trout abundance in upper Libby Creek has ranged from 1.2 fish / 100 m^2 to 7.4 fish / 100 m^2 (Table 11) and appears to be stable across all years sampled with some annual variability but no clear trend (Figure 10).

Table 11. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older juvenile bull trout calculated from electrofishing in the reference section of Libby Creek, 2003 - 2023.

Year	N	95% CI Lower Bound	95% CI Upper Bound	p	Density (#/100m^2)
2003	26	26	27	0.90	2.9
2004	Not Sampled				
2005	55	51	63	0.72	5.2
2006	24	23	28	0.77	2.3
2007	25	22	34	0.63	2.0
2008	33	33	35	0.89	2.4
2009	82	79	109	0.62	6.1
2010	77	75	82	0.82	5.8
2011	41	39	46	0.75	2.8
2012	50	48	55	0.77	3.3
2013	63	58	72	0.71	4.5
2014	36	36	38	0.86	2.3
2015	67	64	73	0.77	4.3
2016	33	31	39	0.72	2.6
2017	23	23	24	0.89	2.0
2018	13	13	14	0.87	1.2
2019	25	22	33	0.49	2.3
2020	64	58	74	0.68	5.4
2021	93	84	105	0.68	7.4
2022	50	50	52	0.88	4.1
2023	32	32	33	0.91	3.9

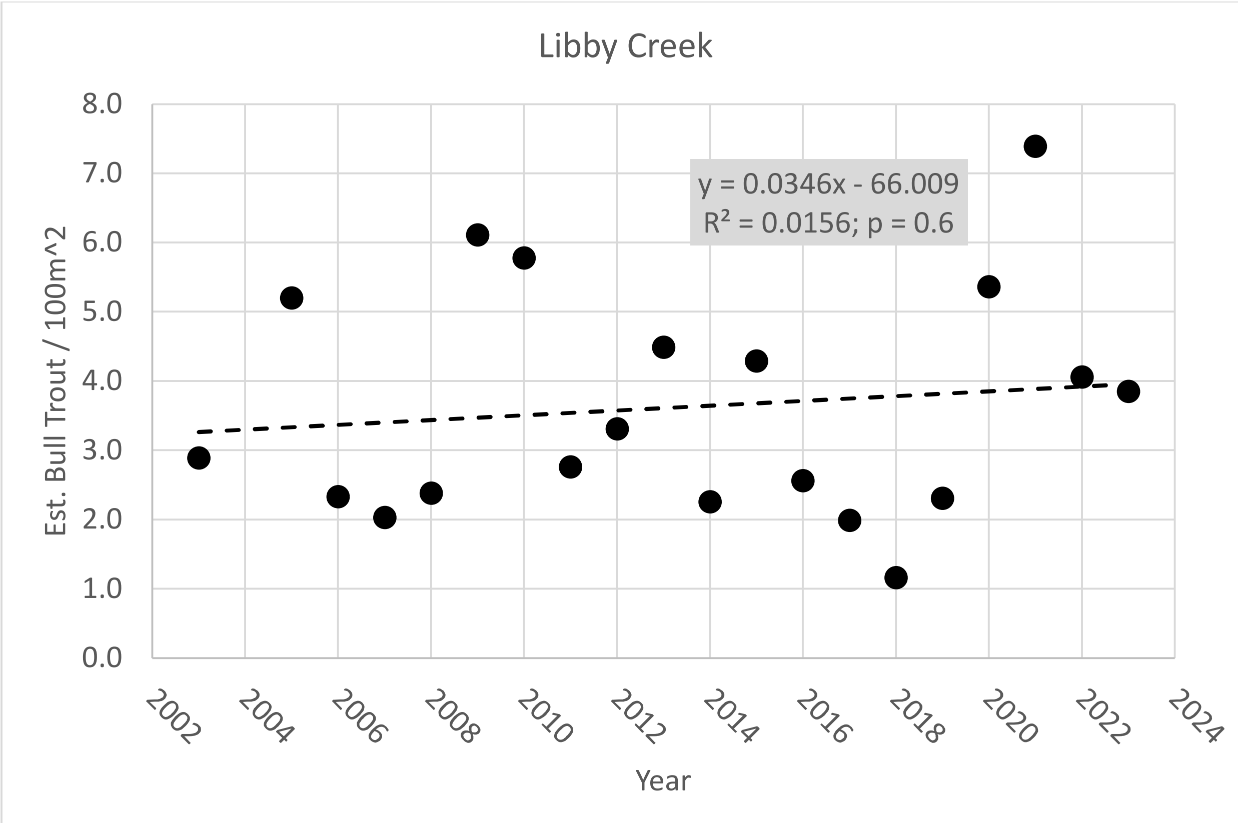

Figure 10. Estimated abundance of age 1+ bull trout in Libby Creek by sampling year.

STREAMBED CORING

High levels of fine sediment in redds have been shown to negatively impact salmonid egg to fry survival. Fine particles within the interstitial spaces impede movement of water through the gravel, reducing delivery of dissolved oxygen to and flushing of metabolic waste away from incubating embryos (Wickett 1958; McNeil and Ahnell 1964; Reiser and Wesche 1979). Weaver and Fraley (1991; 1993) found a significant inverse relationship between the percent of fine sediment and survival to emergence of westslope cutthroat trout and bull trout during incubation tests. Mean adjusted emergence success ranged from about 80 percent when no fine material was present, to less than 5 percent when half of the incubation gravel was smaller than 6.35 mm; about 30 percent survival occurs at 35 percent fines. Entombment was the major mortality factor. Bull trout spawning and incubation habitat quality in the Kootenai drainage is monitored by determining the percent fines in each spawning area through hollow core sampling across years.

Methods

Field crews use a standard 15.2 cm hollow core sampler (McNeil and Ahnell 1964) to collect four samples at each of three transects during February – March from Grave, Bear, West Fork Quartz, Pipe, West Fisher, Keeler, and O’Brien Creeks. The U.S. portion of the upper Wigwam River has not been sampled since 2016. The McNeil core sampler is inserted into the streambed to an approximate depth of 15 cm, and all substrate material inside the sampler is removed and placed into a labeled heavy-duty plastic bag. Material suspended in the water is estimated using an Imhoff settling cone (Shepard and Graham 1982) where water in the cone is allowed to settle for 20 minutes, and the sediment volume is recorded.

The bagged samples are oven dried at the Kootenai National Forest Soils Laboratory in Libby, MT and sieved through a series of mesh sizes ranging from 76.1 mm down to < 6.35 mm (Table 12). The material retained on each sieve is weighed and the percent dry weight in each size class Is calculated. The estimated dry weight of the suspended fine material from the Imhoff cones are added to the weight observed in the pan to determine percentage of fine material in each sample. Up to 12 substrate samples from each stream within a given year are pooled to determine the median percentage of streambed material smaller than 6.35 mm. Analyses of annual *mean* fine sediment in Kootenai River drainage bull trout spawning streams can be found in Dunnigan et al. 2023.

Table 12. Mesh size of sieves used to gravimetrically analyze hollow core streambed substrate samples collected from Kootenai River basin tributaries.

Mesh Size (mm)	Mesh Size (inches)
76.1 mm	3.00 inch
50.8 mm	2.00 inch
25.4 mm	1.00 inch
18.8 mm	0.74 inch
12.7 mm	0.50 inch
9.52 mm	0.38 inch
6.35 mm (Pan)	0.25 inch

Results

Core sampling since 2002 indicates variable but relatively stable fine sediment levels in most bull trout streams in the Kootenai River drainage. Median percentage of streambed material smaller than 6.35 mm is typically less than 35 percent in most years (Table 13). O'Brien Creek and Pipe Creek typically have the highest median percentage of streambed material smaller than 6.35 mm (annual means 31.1 and 30.7 respectively), suggesting egg to fry survival could be a limiting factor for bull trout in these streams. However, the trend in fine sediment through time appears stable or slightly decreasing (Figure 11).

Bear Creek, West Fork Quartz Creek, and West Fisher Creek typically have moderate fine sediment indices with the median percentage of streambed material smaller than 6.35 mm averaging around 26 for all years. Bear Creek and West Fisher Creek are quite variable annually due to mobile streambed substrate shifting between years, but no significant trend is apparent through time (Figure 12). Median percentage of fine sediment in West Fork Quartz Creek is somewhat less variable with no distinct trend through time.

North Fork Keeler Creek provides spawning and rearing habitat for the geographically isolated Bull Lake bull trout population. Median percentage of streambed material smaller than 6.35 mm is the lowest of the Kootenai drainage streams monitored, averaging 21.3 percent across of years. Furthermore, a significant ($p < 0.01$) decreasing trend in median percentage of fine sediment is apparent through time (Figure 13), suggesting egg to fry survival is not likely to limit bull trout persistence in North Fork Keeler Creek.

Grave Creek is the primary bull trout spawning tributary for the Lake Koocanusa population in Montana upstream of Libby dam. Grave Creek has relatively low fine sediment levels averaging 26.8 percent for all years. There is no apparent trend in fine sediment level through time (Figure 14), and egg to fry survival is not expected to be a limiting factor for bull trout in this stream.

Table 13. Median percentage of streambed material smaller than 6.35 mm in McNeil core samples collected from bull trout spawning areas in tributaries to the Kootenai River basin, 2002 – 2022.

Year	Grave Creek	West Fork Quartz Creek	Pipe Creek	Bear Creek	O'Brien Creek	North Fork Keeler Creek	Wigwam River U.S.	West Fisher Creek
2002	27.4	25.2	32.1	27.5	30.6	27		
2003	28.2	26.4	35.3	22	35.3	33.1		
2004	27.4	30.6	29.7	34.3	34.8	29.8	29.6	
2005	23.5	24.3	34.6	34.7	39.8	27.3	24.8	
2006	23.6	26.3	28.8	31.3	32.5	19.9	26.8	27.4
2007					29	23.9	25.9	
2008	33.2	29.6	25.1	17.4	23.1	17.4	20.3	8.9
2009	28.3	19.4	28.3	25.1	29.4	19.7	27	32.6
2010	26.5	26	36.2	25.8	30.1	14.6	24.1	27.2
2011	22.9	28.2	30.4	25	33.7	21.6		31.5
2012	28.7	23.6	28.4	33.1	29.4	23.8	25.6	30.7
2013	26.3	25.4	32.4	29	30.1	22.9		30.8
2014	28.9		32.1	24.8	28.7	22.4	25.7	31.3
2015	22.2	24.3	27.1	27.7		17.9		14.4
2016	25.5	23.6	31.4	14.4	29.9	11	29.8	
2017								
2018	26.7	30.7	31.3	19.8	25.1	13.7		25
2019	25.8	27.3	30.2	27.6	32.8	19.4		30.2
2020	28.2	25.9	29.9	23.7	32.5	17.4		27.3
2021	29.8	28.1	27.3	27.4	32.1	20.3		26.3
2022	25.3	28.2	33.3		32.5	23.4		
Average	26.8	26.3	30.7	26.1	31.1	21.3	26.0	26.4

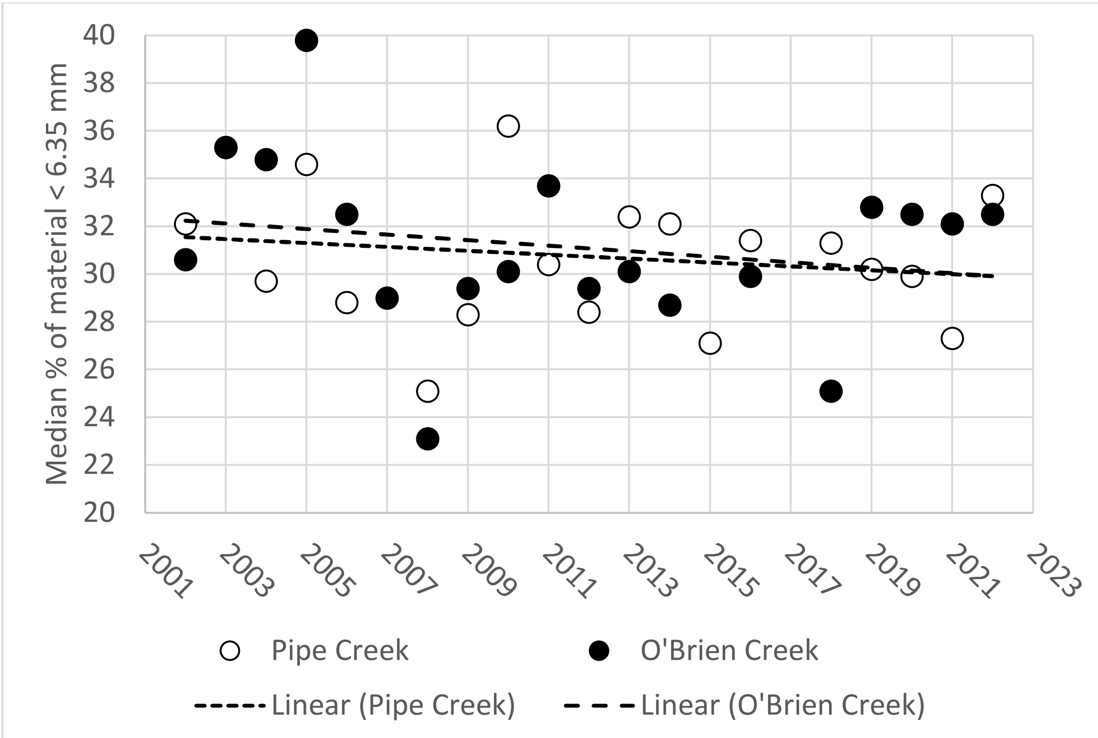

Figure 11. Median percentage of streambed material smaller than 6.35 mm in McNeil core samples from Pipe and O'Brien Creeks by sampling year.

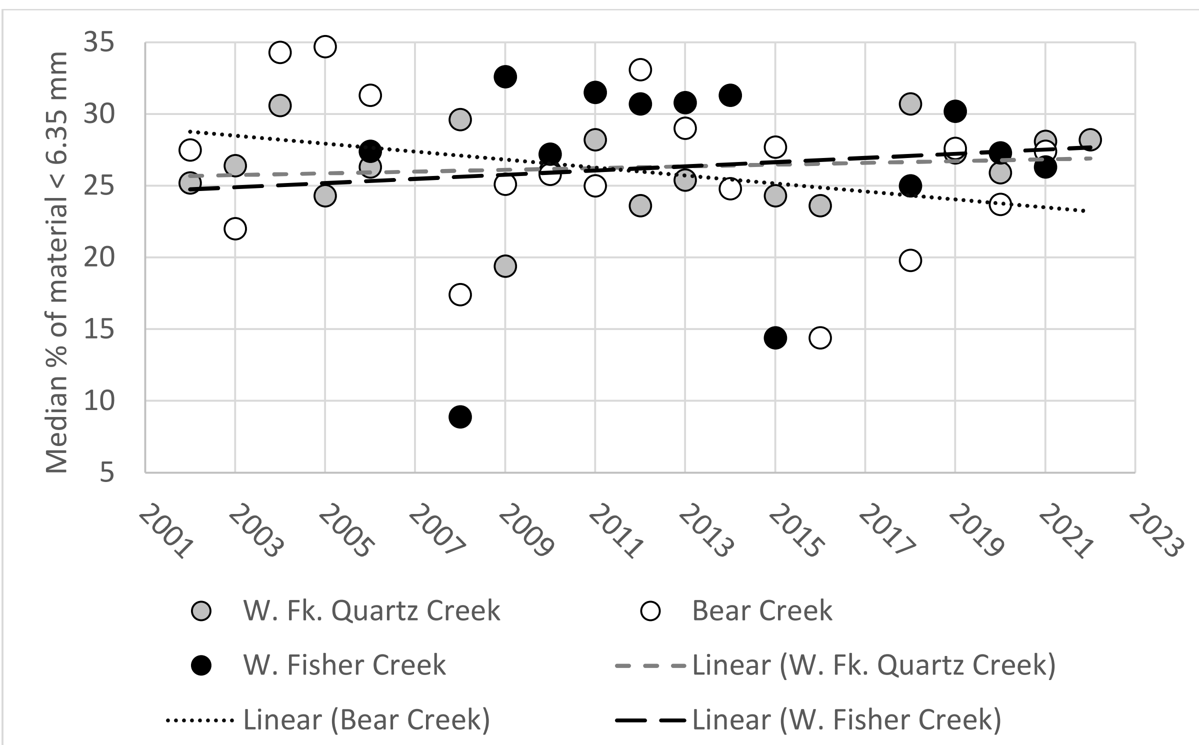

Figure 12. Median percentage of streambed material smaller than 6.35 mm in McNeil core samples from West Fork Quartz, Bear, and West Fisher Creeks by sampling year.

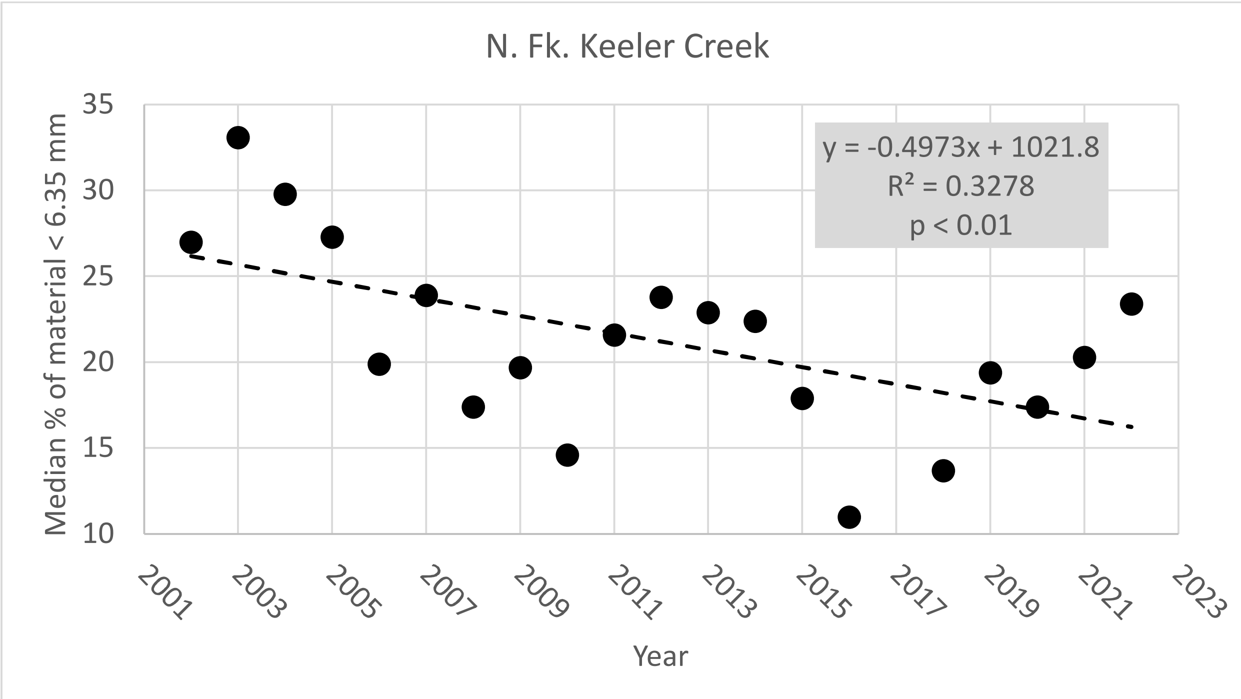

Figure 13. Median percentage of streambed material smaller than 6.35 mm in McNeil core samples from North Fork Keeler Creek by sampling year.

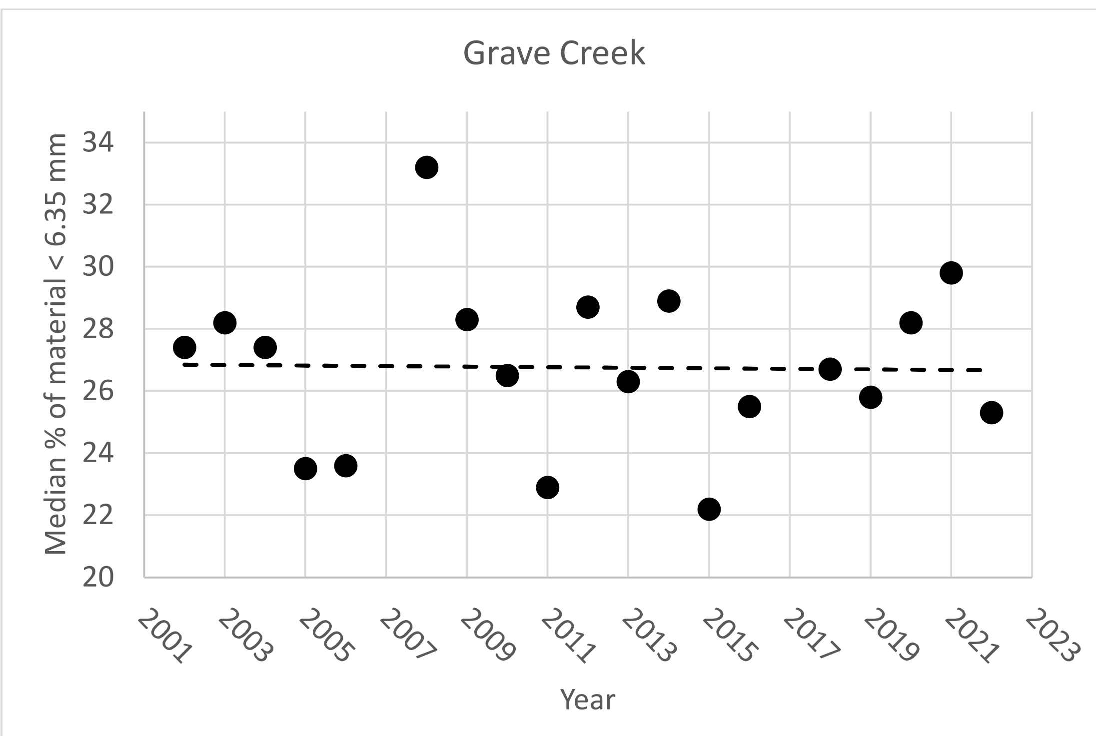

Figure 14. Median percentage of streambed material smaller than 6.35 mm in McNeil core samples from Grave Creek by sampling year.

SUBSTRATE SCORING

Juvenile bull trout rear for up to four years in Kootenai Basin tributaries. Snorkel and electrofishing observations during past studies indicate juvenile bull trout are extremely substrate-oriented and can be territorial (Fraley and Shepard 1989). This combination of traits results in partitioning of suitable rearing habitat and a carrying capacity for each stream. Substrate-related habitat potential is monitored by calculating substrate scores (Leathe and Enk 1985).

Substrate composition influences distribution of juvenile bull trout and rearing capacities of nursery streams. Sediment accumulations reduce pool depth, cause channel braiding or dewatering, and reduce interstitial spaces among larger streambed particles (Megahan et al. 1980, Shepard et al. 1984, Everest et al. 1987). Juvenile bull trout are almost always found in close association with the substrate (McPhail and Murray 1979, Shepard et al. 1984, Weaver and Fraley 1991). A significant positive relationship existed between substrate score and juvenile bull trout densities in Swan River tributaries (Leathe and Enk 1985) and Flathead River tributaries (Weaver and Fraley 1991), where a high substrate score was indicative of large particle sizes and low score of embeddedness (Crouse et al. 1981). This relationship is thought to reflect substrate types favoring over winter survival (Pratt 1984, Weaver and Fraley 1991).

A substrate score is an overall assessment of streambed particle size and embeddedness. Large particles that are not embedded in finer materials provide more interstitial space that juvenile bull trout favor. This situation generates a higher substrate score. Low substrate scores occur when smaller streambed particles and greater embeddedness limit the interstices within the streambed.

Methods

MFWP assesses substrate related habitat quality during juvenile bull trout abundance estimates in Kootenai drainage tributaries. Substrate scoring involves visually assessing the dominant and subdominant streambed substrate particles, along with embeddedness across 10 equally spaced transects. Surveyors assign a rank to both the dominant and subdominant particle size classes in each cell (Table 14). They also rank the degree to which the dominant particle size is embedded (Table 14). The three ranks are summed, obtaining a single variable for each cell. A mean of all transects in a section results in the substrate score.

Table 14. Characteristics and ranks for computing substrate scores (modified by Leathe and Enk 1985 from Crouse et al. 1981).

Rank	Characteristic
	Particle Size Class (dominant and subdominant)
1	Silt and/or detritus
2	Sand (< 2.0mm)
3	Small gravel (2.0 - 6.4 mm)
4	Large gravel (6.5 - 64.0 mm)
5	Cobble (64.1 - 256.0 mm)
6	Boulder and/or bedrock (> 256.0 mm)
	Embeddedness
1	Completely embedded or nearly so (75% - 100%)
2	50% - 75% embedded
3	25% - 50% embedded
4	5% - 25% embedded
5	Unembedded

Results

Substrate scores for the juvenile bull trout abundance monitoring section of each stream are found in Table 15. In general, embedded substrate is not an overriding factor in Kootenai drainage index streams. The scores from most of the streams continue to compare favorably with Flathead River basin streams where Flathead Basin Cooperative Forest Practice Study determined that scores of 10.0 or less threatened juvenile bull trout rearing capacity and scores 9.0 or less impaired rearing capacities (Deleray et al. 1999).

Table 15. Summary of Kootenai Drainage substrate scores the stream sections monitored at juvenile population estimate sites in Kootenai River basin stream, 1998 - 2023.

Year	Grave Creek	West Fork Quartz Creek	Pipe Creek	Bear Creek	West Fisher Creek	O'Brien Creek	Keeler Creek	Callahan Creek	Libby Creek above falls
1998	13.4	13.2	13			11.5	12.8		
1999			14	13		12.2	14.4		
2002	13.2	13.2	13.7	13.6	13.1	10.6	12.4		
2003	14.3	13.3	12.3	14.6	13.8	11.9	13.2	14.5	14.3
2004	13.8	14.5	12.1	13.8	12.9	10.9	15.5	15.5	
2005	12.8	14.1	12.9	13.7	14.1	11.8	13.4	13.9	13.6
2006	13.9	14.1	12.8	13.5	13.3	12.3	14.1	14.1	13.4
2007	13.2	13.4	14.1	15.5	15.1	12.8	15.5	14	15.2
2008	13.1	13.9	12.4	13.9	13.3	12.7	15	14.8	12.8
2009	13.8	14.5	12.7	13.9	13.8	13.1	15.2	14.9	13.7
2010	12.7	15.5	12.8	13	14	12.4	14.3	15.1	13.1
2011		14.4	12.4	12.4	12	13.3			13.1
2012	12.4	14.6	14.1	12.6	14.6	12.8	13.4	14.9	12.9
2013	13.2	12.6	12.4	12.2	13.7	13.3	13.5	14.2	14.8
2014	14.9	14.7	13.2	14.4	14.7	13.8	15.6	14.9	14
2015	15.8	14.6		15.1	14.6	13.8	15.2	15.6	11.3
2016	14.8	15.8	14.1	13.4	12	10.5	13.8	13.7	15.4
2017		13.5	14.6	14.6	14.5	9.5	12.3	12.6	14.4
2018	15.3	15.9	14.1	12.4	13.2	12.7	15.3	14.3	11.9
2019	15.5	15.9	15.2	14.7	14.4	14.3	15	16	15.4
2020	12.8	14.3	14.1	10.9	13.1	13.5	14.2	15.7	15.1
2021	15.2	16.1	14.5	14.5	14.8	12.5	15.7	15.9	12.9
2022	14.9	12.6	13.8	13.8	14	14.2	12.7	14.6	15.6
2023	12.1	11.4	11	11.6	14.7	12.5	14.6	15.9	14.2
Mean	**13.9**	**14.2**	**13.3**	**13.5**	**13.8**	**12.5**	**14.2**	**14.8**	**13.9**

BULL TROUT REDD COUNTS

A reliable survey of annual spawner escapement is a valuable element of any fisheries monitoring program. These data are frequently used as measures of anticipated production in succeeding generations. They also provide an index of success in regulating the fishery. Observations during past studies indicate that migratory fish populations in the Kootenai System consistently use the same stream sections for spawning. Similar findings resulted from spawning site surveys in the Flathead and Clark Fork River drainages (Montana Fish, Wildlife & Parks, Kalispell, unpublished file data; MBTSG 1996a, 1996b). As a result of specific spawning habitat requirements, the majority of bull trout spawning is clustered in a small portion of the available habitat, making these areas critical to bull trout production.

Methods

MFWP conducts annual bull redd counts to monitor escapement in eight critical spawning tributaries in the Kootenai River drainage. Basin-wide surveys were conducted in the 1990s to determine the proper timing and geographical extent of bull trout spawning. These basin-wide surveys led to the identification of index stream reaches, which consistently contain most the spawning sites within each tributary and are counted annually (Hoffman et al. 2002). Redd surveys are conducted in October and November after bull trout have spawned in the West Fisher, Grave, Quartz, Bear (a tributary to Libby Creek), Keeler, Pipe, and O'Brien Creeks and the Wigwam River. Personnel from the British Columbia Ministry of Environment conduct redd counts on the Wigwam River and Upper Kootenay River tributaries in Canada. Idaho Fish and Game personnel complete redd counts on North Callahan Creek in Idaho.

Observers visually identify and enumerate redds by the presence of a pit or depression and associated tail area of disturbed gravel. In addition to counting, size and location of redds and presence of adult bull trout are also noted. Surveyors also record potential barriers to spawning bull trout as encountered.

Results

Lake Koocanusa Population

Grave Creek and the upper Wigwam River are the only streams in Montana where bull trout redds are monitored for the Lake Koocanusa population. In British Columbia, Canada redds are monitored in the Wigwam River, which includes the tributary streams Bighorn, Desolation and Lodgepole Creeks. Bull trout redds are also counted in White River, and in Skookumchuck, Blackfoot and Wild Horse Creeks which are tributaries of the upper Kootenay River in British Columbia. Redd counts for the Lake Koocanusa bull trout population are listed in Appendix 1.

Grave Creek

MFWP counted redds in Grave Creek (including Blue Sky and Clarence creeks) for the first time in 1983, as well as in 1984, 1985, and annually since 1993. Grave Creek is surveyed from the confluence of Cat Creek upstream to near the mouth of Lewis Creek (approximately 4.9 miles), where it becomes intermittent. Most redds in Grave Creek have been located between the confluence of Clarence and Lewis creeks.

Bull trout redd counts in the Grave Creek drainage peaked in 2003 at 245 redds but have since declined to less than 100 redds since 2019 (Figure 15). Over the past ten years redd counts in Grave Creek appear to be declining by an average of about 4 redds per year, but this trend is not statistically significant (r^2 = 0.26; p = 0.16).

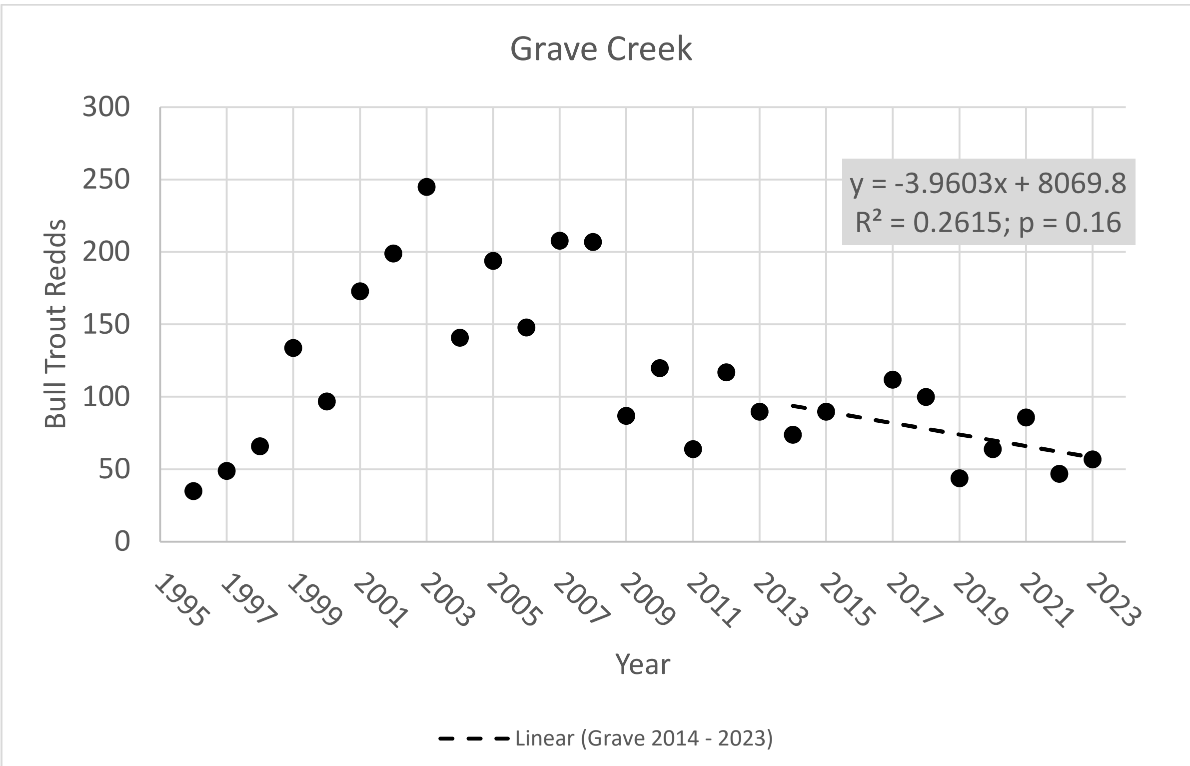

Figure 15. Bull trout redd counts from 1996 through 2023 for Grave Creek and trend analysis for the last ten years (2014 – 2023).

Wigwam Drainage and Upper Kootenay River Tributaries in British Columbia

Wigwam River drainage bull trout redd counts began in 1995 and increased annually until the peak in 2006, except for 2005 when a landslide partially blocked access to traditional upstream redd locations (Figure 16). Beginning in 2004, anglers have been able to legally target bull trout in the Montana portion of Lake Koocanusa via a catch card system, and in some years limited harvest was permitted as the fishery is adaptively managed based on redd indices (Stephens and Benson 2021, 2023). Over the last ten years, redd counts in the Wigwam drainage have displayed a declining trend (r^2 = 0.55; p = 0.014), but currently remain above 1,000 and appear to be increasing during the most recent five years. Total redds counted in all monitored Lake Koocanusa bull trout spawning habitat in British Columbia indicates no significant trend since 2017 ($r^2 = 0.01$; $p = 0.52$) which is when the full suite of four Upper Kootenay River tributaries was first counted annually (Figure 16).

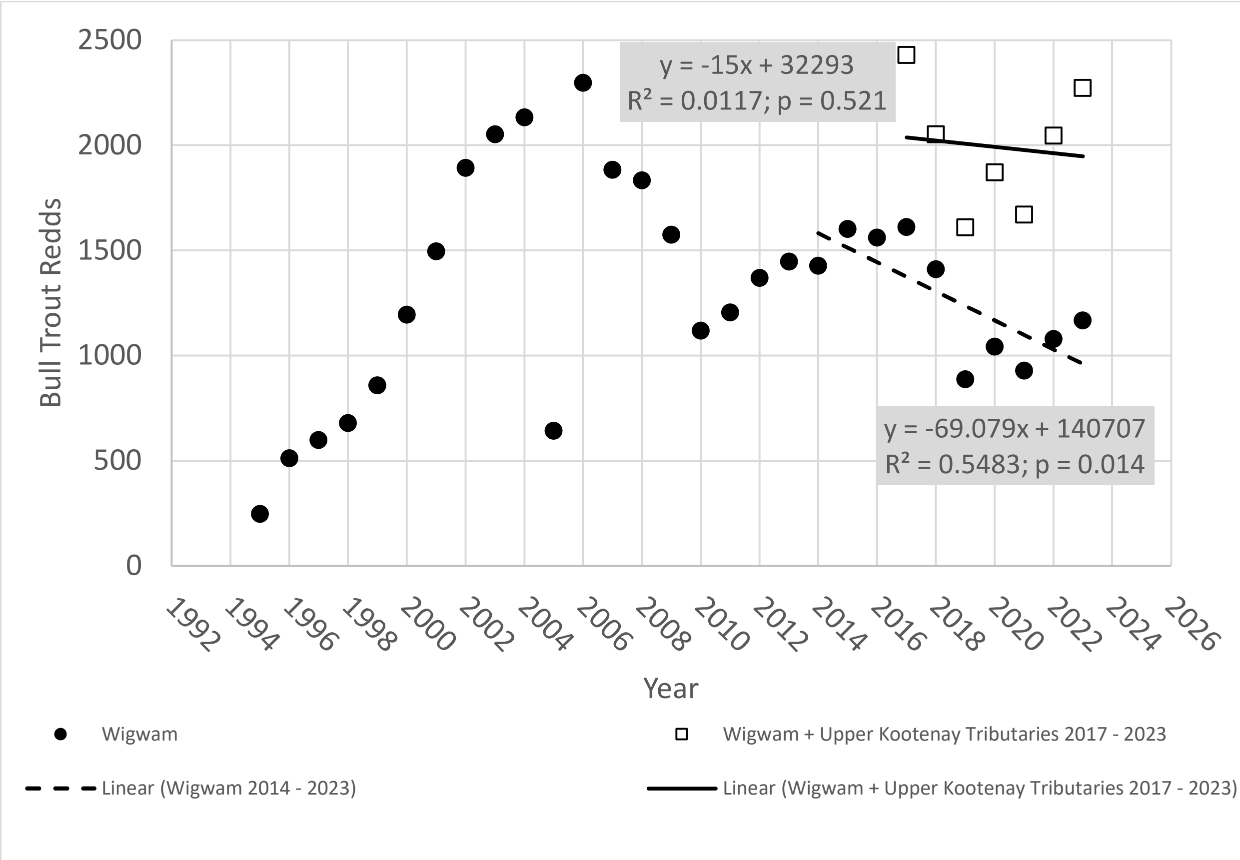

Figure 16. Bull trout redd counts from 1995 through 2023 for the Wigwam River drainage and from 2017 through 2023 for upper Kootenay River tributaries. Trend analyses are for the last ten years (2014 – 2023) in the Wigwam River drainage and the last seven years (2017 – 2023) in the upper Kootenay River tributaries.

Middle Kootenai Population: Libby Dam to Kootenai Falls

Four bull trout spawning tributaries to the Kootenai River exist from Libby Dam downstream to Kootenai Falls: West Fisher, Bear (Libby Creek tributary), Pipe, and Quartz Creeks (Appendix 2). Since peaking at 192 redds around 2000, total redd counts for this section of the Kootenai River have continued to decline (Figure 17.) Over the last ten years, redd counts for the middle Kootenai River tributaries have declined on average by 2.5 redds per year ($r^2 = 0.01$; $p = 0.52$) averaging 30 redds per year.

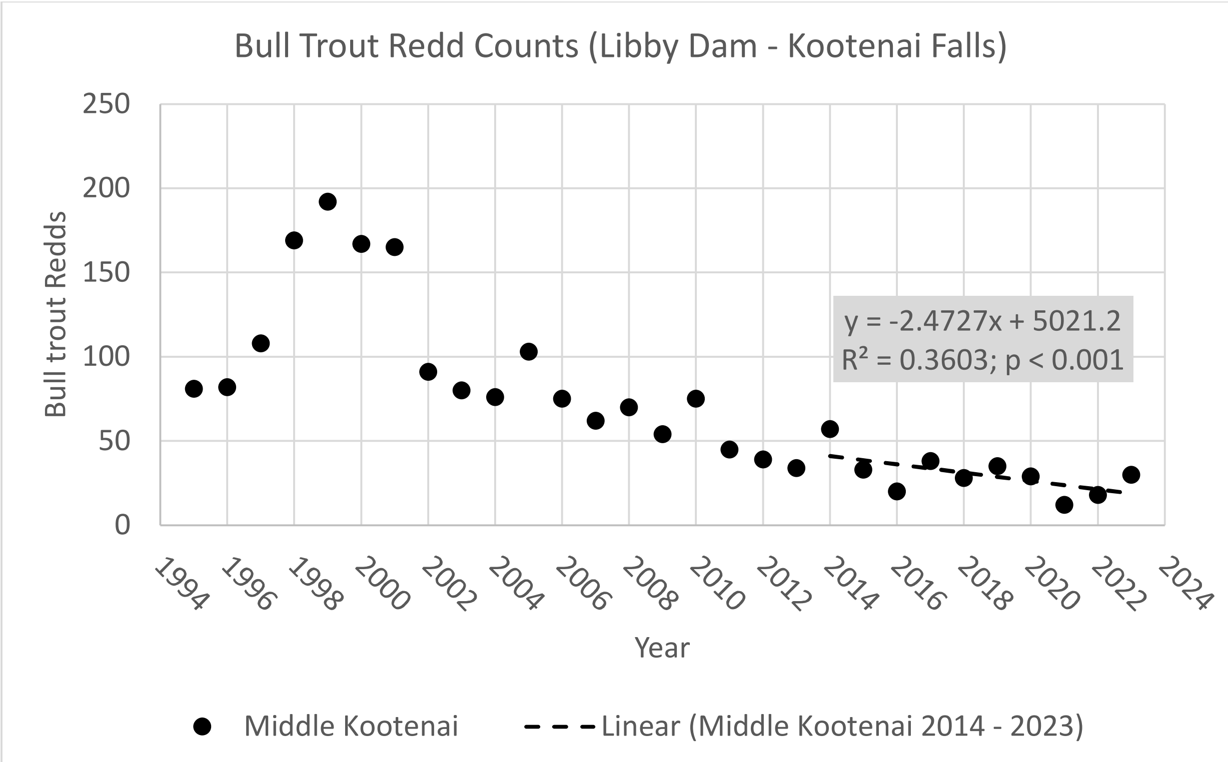

Figure 17. Bull trout redd counts from 1995 through 2023 for four bull trout spawning tributaries between Libby Dam and Kootenai Falls. Trend analysis for the last ten years (2014 – 2023).

West Fisher Creek

Redd counts in West Fisher Creek have been variable for the period of record with a peak of 27 in 2005 (Figure 18). Only a single redd was counted each year from 2020 through 2022, and no redds were observed in 2023. Over the last ten years, bull trout redd counts in West Fisher Creek have displayed a significant declining trend averaging -1.2 redds per year ($r^2 = 0.69$; $p = 0.005$).

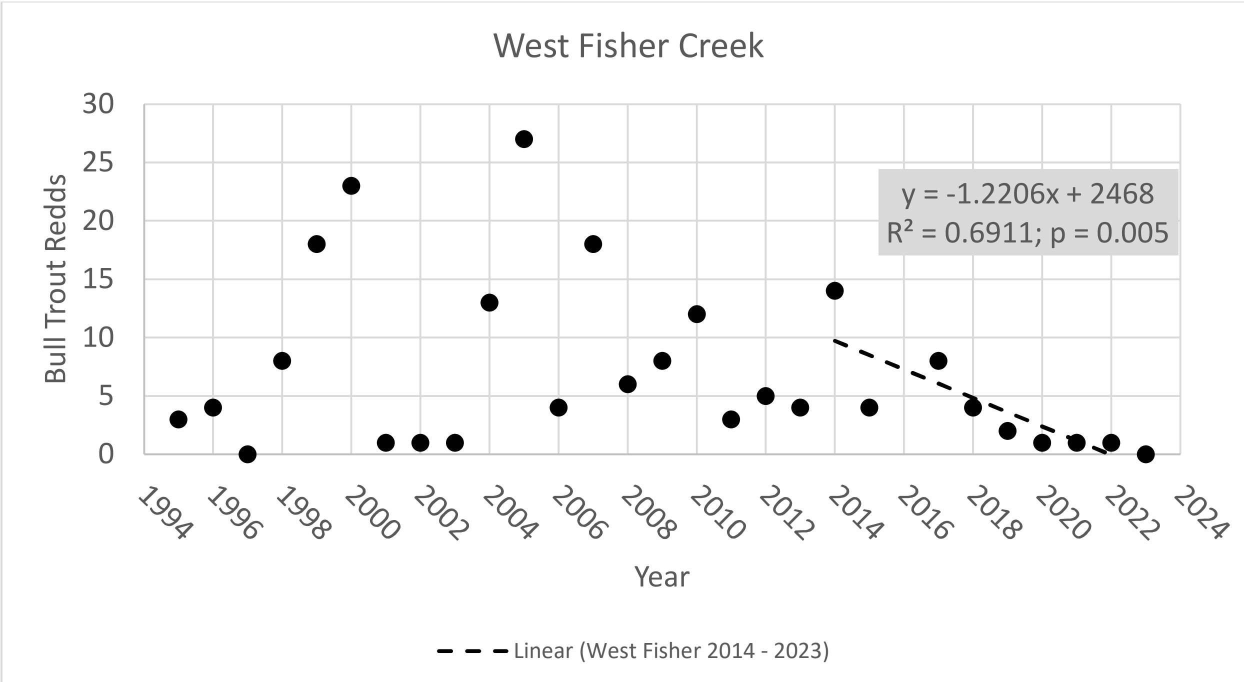

Figure 18. Bull trout redd counts from 1995 through 2023 for West Fisher Creek and trend analysis for the last ten years (2014 – 2023).

Bear Creek

Redd counts in Bear Creek, a tributary of Libby Creek, peaked around 1999 at 36 redds and have since generally declined (Figure 19). Over the last ten years, redd counts in Bear Creek have declined on average at a rate of 0.3 redds per year, but this trend is not significant ($r^2 = 0.05$; $p = 0.55$).

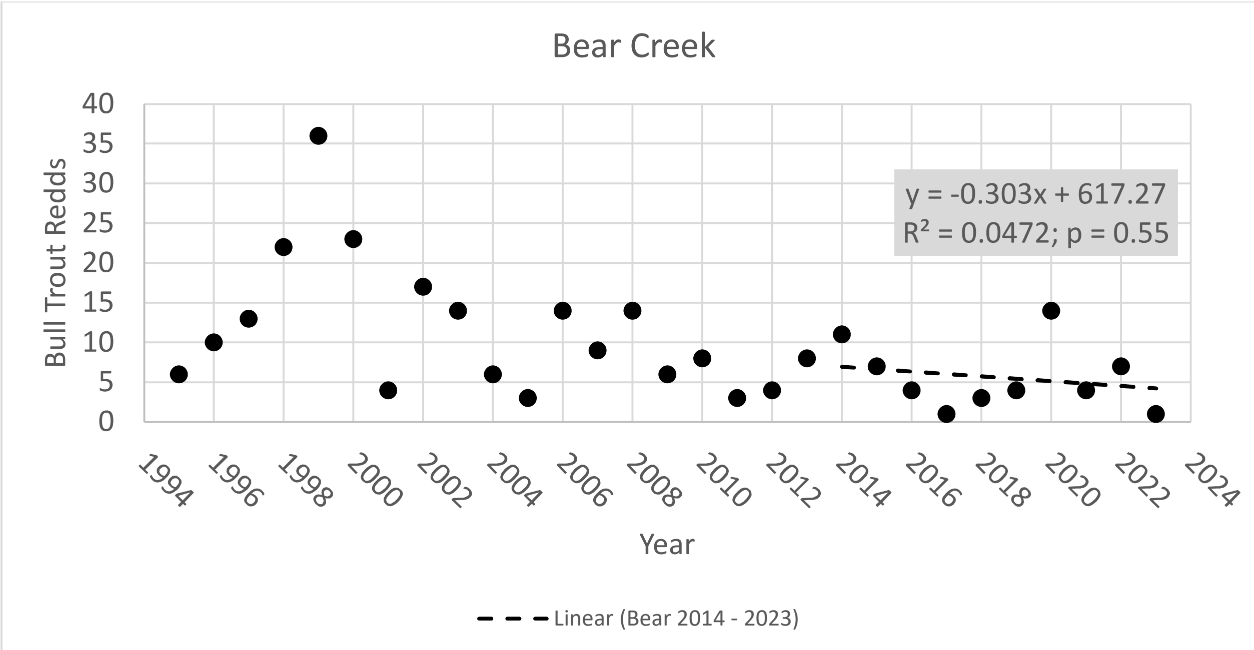

Figure 19. Bull trout redd counts from 1995 through 2023 for Bear Creek and trend analysis for the last ten years (2014 – 2023).

Pipe Creek

Bull trout redd counts in Pipe Creek peaked in 1999 at 36 redds, and have since generally decreased over the next several years (Figure 20). In five of the last 10 years, no redds were observed. During this time period, redd counts decreased on average by 0.25 redds per year but this trend is not significant (r^2 = 0.05; p = 0.53).

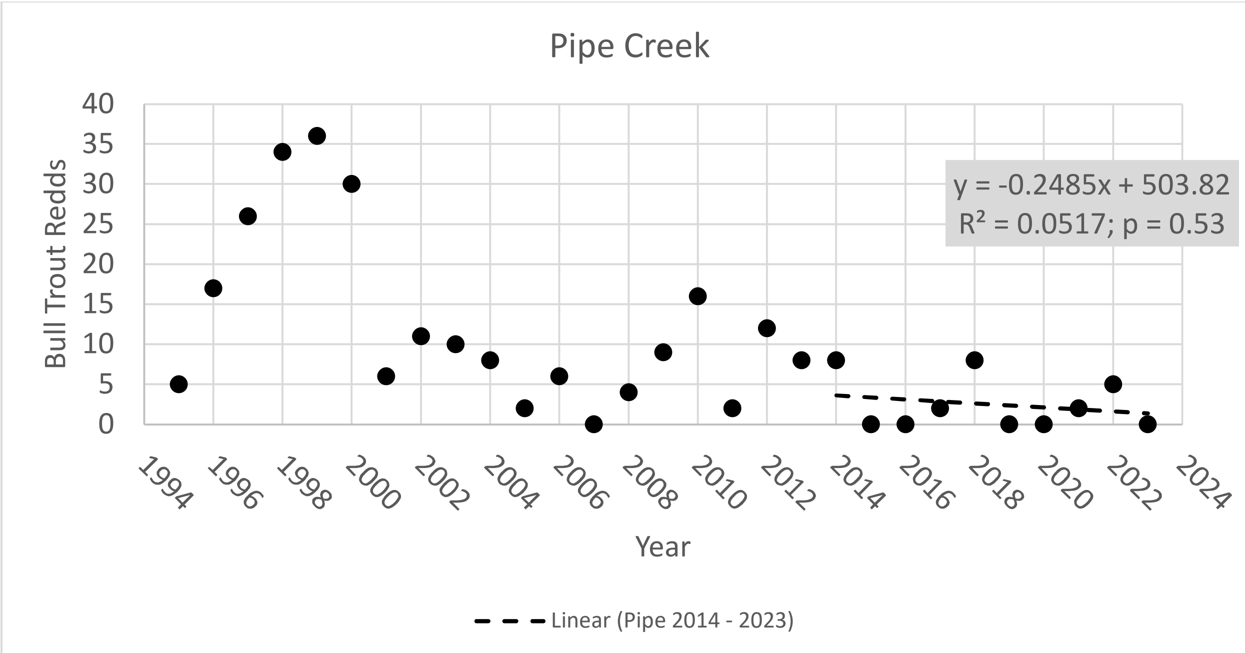

Figure 20. Bull trout redd counts from 1995 through 2023 for Pipe Creek and trend analysis for the last ten years (2014 – 2023).

Quartz Creek

Bull trout redds are counted in mainstem Quartz Creek and West Fork Quartz Creek. Redds in the Quartz Creek drainage peaked in 2001 at 154 but have since declined to less than 50 annually since 2007 (Figure 21). Over the past ten years redd counts have been somewhat variable and have not exhibited a significant trend ($r^2 = 0.09$; $p = 0.39$), averaging 18 redds annually for this time period.

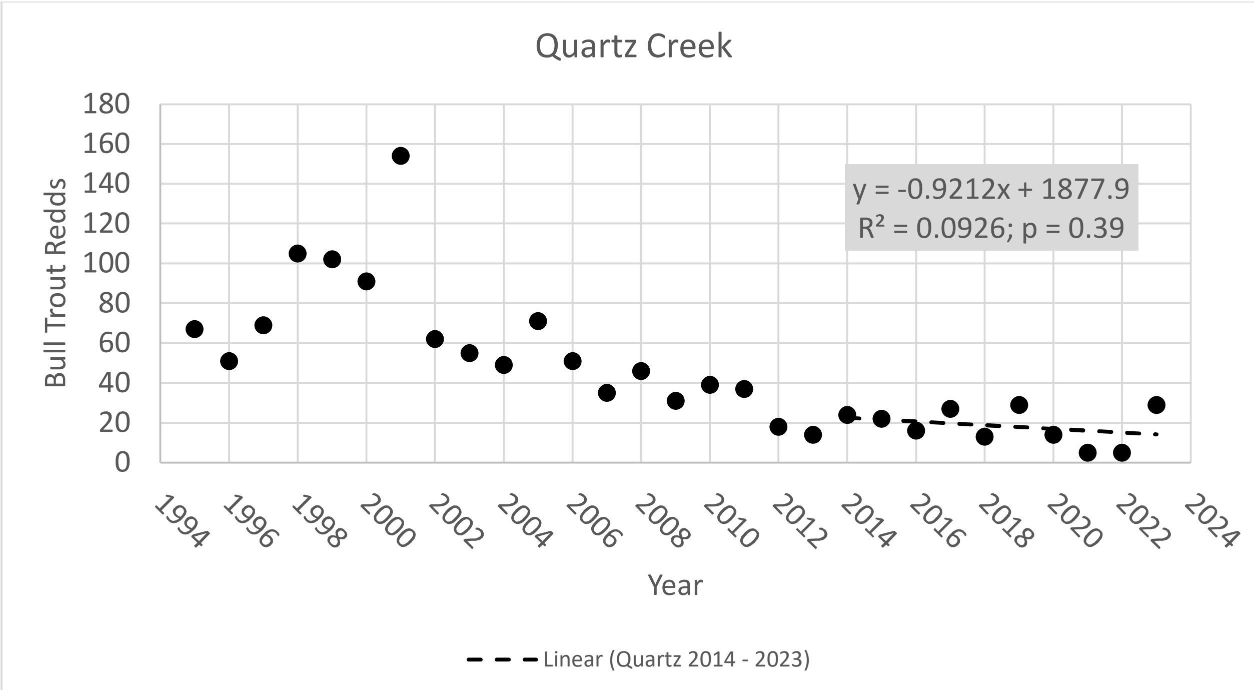

Figure 21. Bull trout redd counts from 1995 through 2023 for Quartz Creek and trend analysis for the last ten years (2014 – 2023).

Lower Kootenai Population: Downstream of Kootenai Falls

O'Brien and Callahan Creeks are the two bull trout spawning tributaries to the Kootenai River from Kootenai Falls downstream to the Montana - Idaho border (Appendix 3). The Keeler Creek drainage supports bull trout spawning for a population isolated from the rest of the Kootenai River drainage by a dam constructed near a natural waterfall barrier. These bull trout migrate downstream out of Bull Lake into Lake Creek, then up Keeler Creek to spawn.

O'Brien Creek

Bull trout redd counts in O'Brien Creek generally increased until 2008 with a peak count of 86 in 2005 (Figure 22). In 2021, only five redds were observed which represents the lowest count for the period of record. Over the past ten years, redd counts in O'Brien Creek have been declining at an average rate of -1.7 redds per year, but this trend is not significant (r^2 = 0.32; p = 0.09).

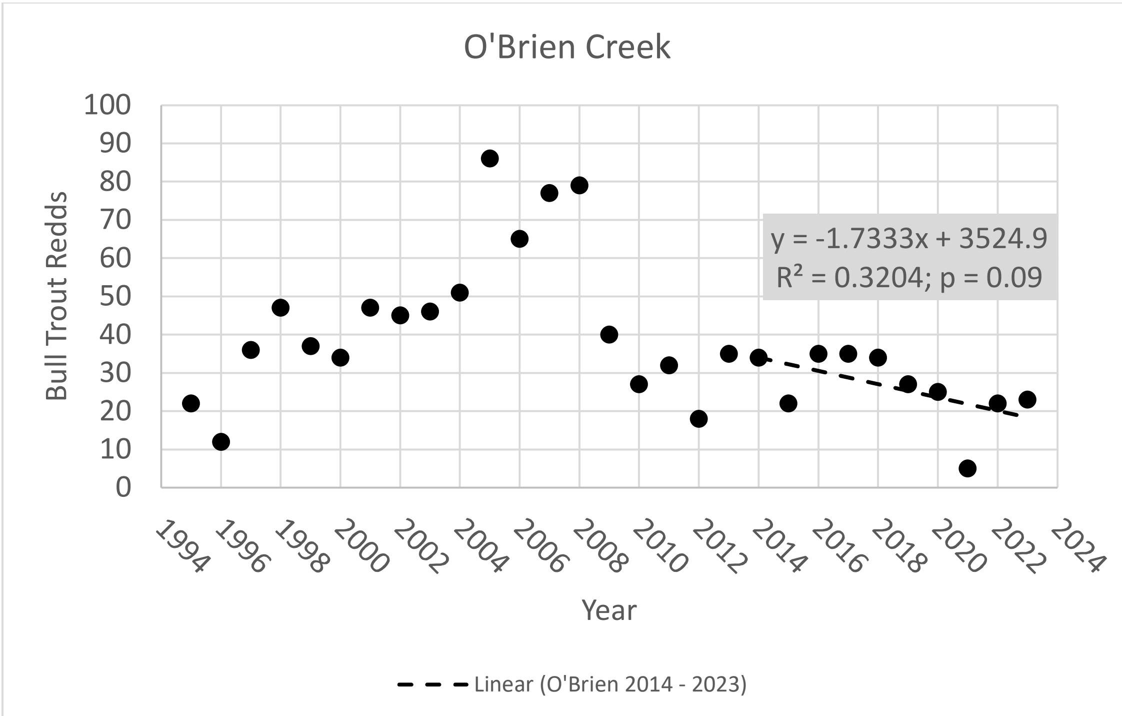

Figure 22. Bull trout redd counts from 1995 through 2023 for O'Brien Creek and trend analysis for the last ten years (2014 – 2023).

Callahan Creek

Bull trout redd counts in the Callahan Creek drainage include both North and South Callahan Creeks. Early redd counts were variable with a peak of 42 in 2003, then declined to less than 15 beginning in 2009 (Figure 23). Over the last ten years, redd counts in the Callahan Creek drainage appear to be modestly increasing at an average rate of 0.56 redds per year, but this trend is not significant ($r^2 = 0.17$; $p = 0.31$)

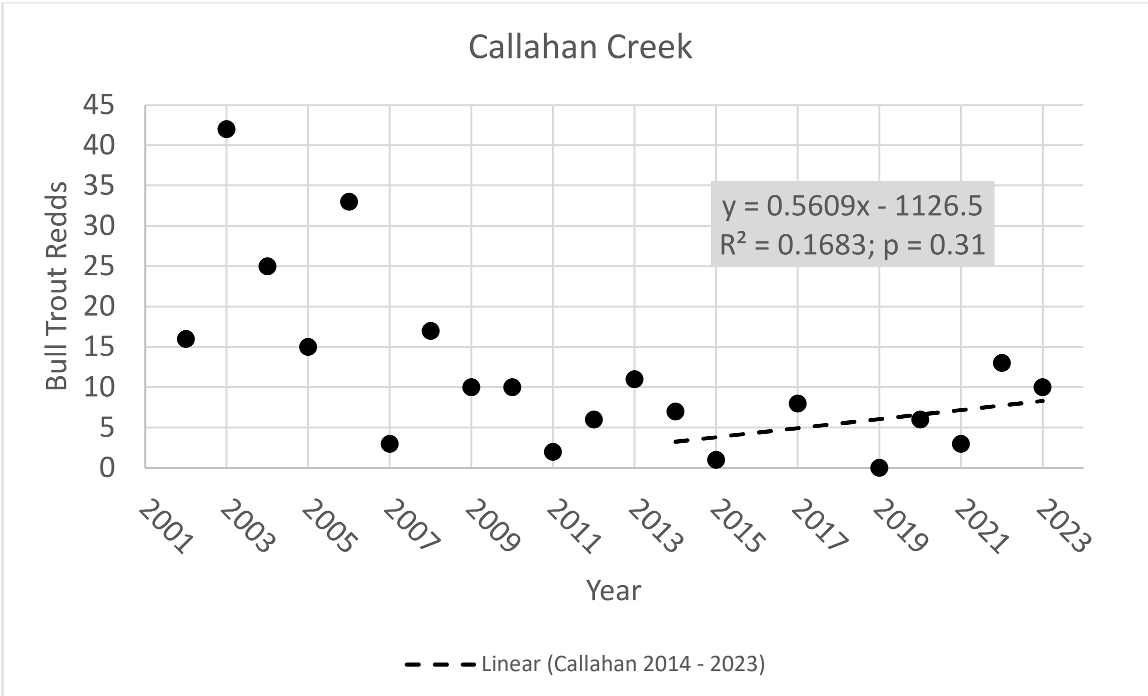

Figure 23. Bull trout redd counts from 2002 through 2023 for Callahan Creek and trend analysis for the last ten years (2014 – 2023).

Keeler Creek

Bull trout redd counts in the Keeler Creek drainage include the mainstem as well as the North and South Forks. Redd counts peaked in 2005 at 170 but have since declined to less than 20 annually in recent years (Figure 24). Over the last ten years, Keeler Creek redd counts have continued to significantly decline at an average rate of 2.6 redds per year ($r^2 = 0.67$; $p = 0.007$).

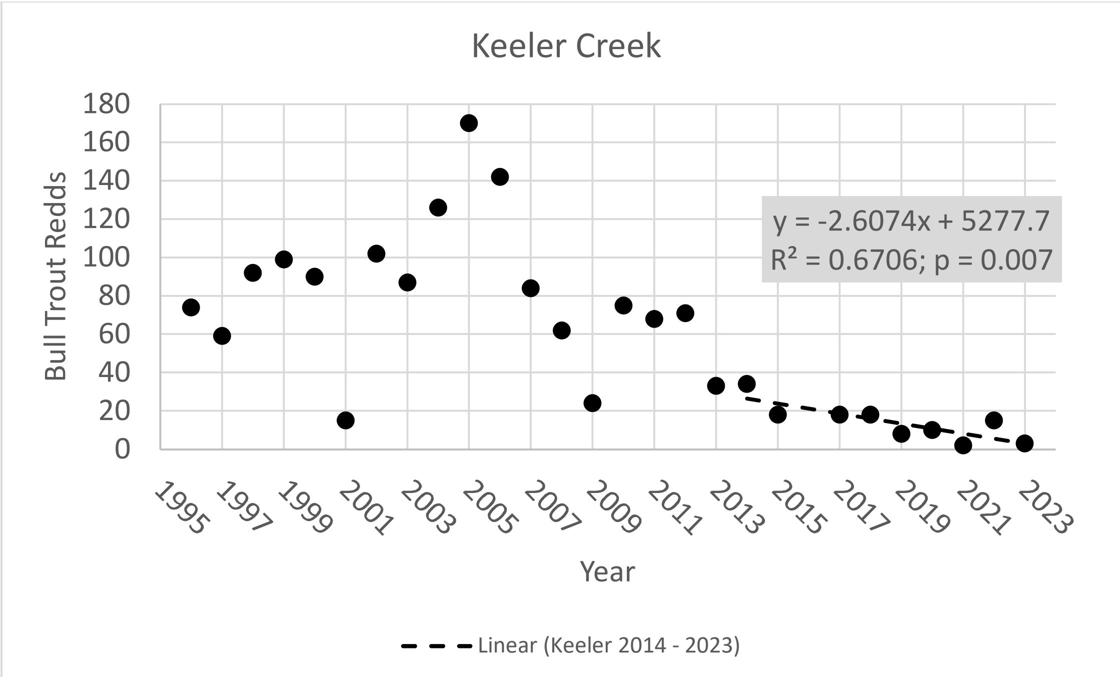

Figure 24. Bull trout redd counts from 1996 through 2023 for Keeler Creek and trend analysis for the last ten years (2014 – 2023).

LAKE KOOCANUSA GILLNET MONITORING

Methods

MFWP has used experimental gillnets to monitor fish population trends in Lake Koocanusa since 1975. Two sections, Rexford and Canada, are currently sampled in the spring with 14 sinking gillnets in each section although historical effort and sections included additional sites (Dunnigan et al 2019). Fish species abundance is expressed as fish/net and used to assess changes through time.

Results

Prior to ESA listing and protection in Montana, gillnet catch of bull trout was stable at relatively low levels. Once fishing for bull trout was eliminated beginning in 1994, bull trout catch per gillnet in Lake Koocanusa displayed a significant increasing trend ($R^2 = 0.535$). Following the reestablishment of a limited fishery that has been adaptively managed, mean bull trout catch in spring gillnets has varied annually displaying no trend, indicating the contemporary stability of the population (Stephens and Benson 2021, 2023) (Figure 25).

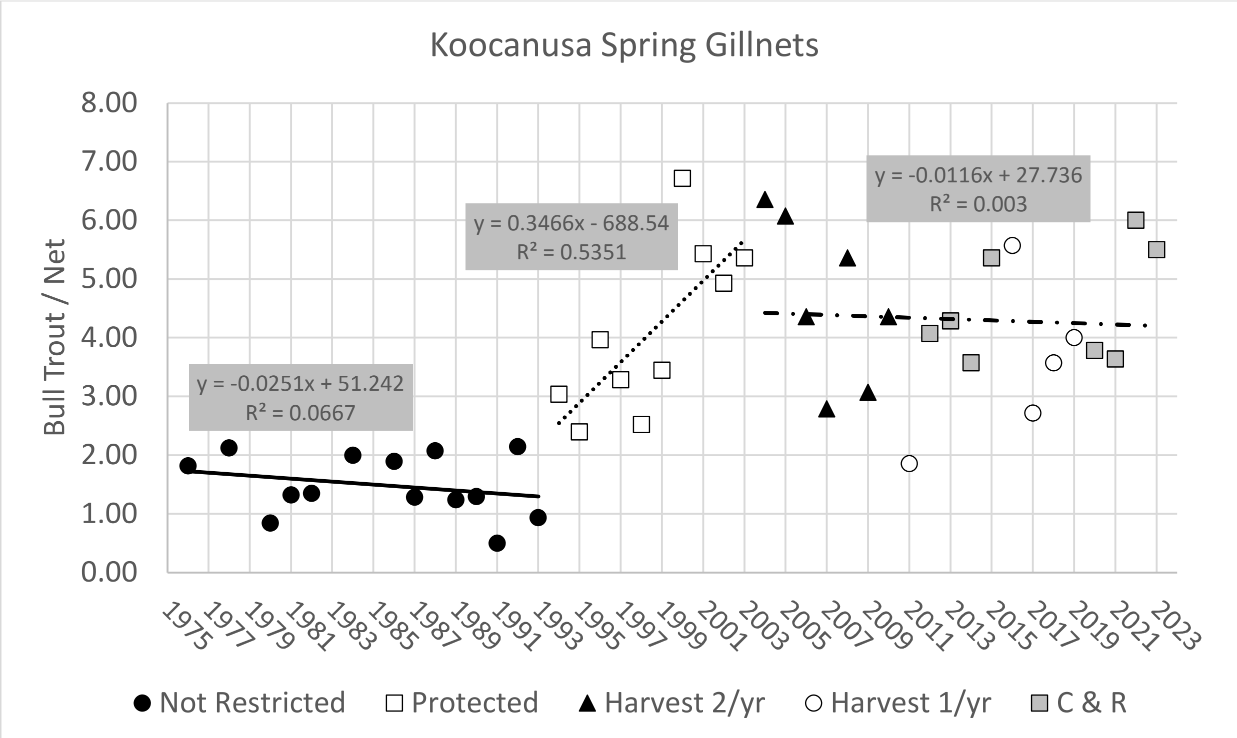

Figure 25. Mean bull trout catch per spring gillnet in Lake Koocanusa by year and harvest management regulation.

DISCUSSION

Tributary Habitat Suitability

Substrate core sampling indicates relatively stable fine sediment composition through time in Kootenai River drainage bull trout tributaries. O'Brien and Pipe Creeks typically have the highest median percentage of streambed material smaller than 6.35 mm, suggesting these streams could be most vulnerable to low egg to fry survival. The other Kootenai River mainstem tributaries and Grave Creek, the primary spawning stream in the U.S. for the Lake Koocanusa bull trout population, have moderate levels of fine sediment that is not believed to significantly impact egg to fry survival. North Fork Keeler Creek, spawning tributary for the Bull Lake population, has the lowest median percentage of fine sediment and has been trending toward further reduced levels of fines through time.

Substrate scores for the Kootenai drainage bull trout streams suggest juvenile habitat is likely not limiting in the tributaries. While whole stream habitat quality was not assessed, habitat indices in the juvenile bull trout monitoring sections compare favorably with Flathead River basin streams and represent conditions well above those considered to threaten or impair juvenile bull trout rearing capacities.

Lake Koocanusa Bull Trout Population

Gillnetting in Lake Koocanusa represents the longest temporal trend monitoring data set for this bull trout population. Catch per net increased following ESA listing and remains higher than pre-ESA listing values despite the establishment of a limited recreation fishery for bull trout, indicating no significant population trend since 2004 (Stephens and Benson 2021, 2023).

Redd count indices for the Lake Koocanusa bull trout population indicate declines from peak values but relative stability in recent years. The exception is the Wigwam River drainage which has continued a declining redd count trend over the past ten years, but with evidence of a recent increasing trend since 2019 . However, total redds counted in the upper Kootenay River drainage, which includes the Wigwam River drainage, has remained stable between 1,500 and 2,500 redds annually since all spawning locations were collectively surveyed beginning in 2017 with no apparent trend.

Grave Creek juvenile bull trout abundance estimates have not displayed a significant trend for all years sampled, with the two highest abundance estimates occurring recently in 2019 and 2023. While not statistically significant, recent redd counts over the last 10 years in Grave Creek appear to be declining. When evaluating the relationship between redd counts and juvenile abundance using a three-year offset, i.e. 2005 fall redd counts could explain 2008 summer juvenile abundance (two year old juveniles), no correlation was detected ($r^2 = 0.03$; $p = 0.48$) (Figure 26).

Several factors likely influence the current status and historic trends observed for the Lake Koocanusa bull trout population. Most notably, construction of Libby Dam created a large reservoir environment that is undoubtedly capable of supporting more bull trout than could the free-flowing Kootenai River pre-impoundment. Furthermore, the unintentional introduction and establishment of kokanee salmon in the reservoir provided abundant, high-quality forage for bull trout to survive, grow, and enhance individual fitness. Restrictive regulations and ESA listing benefited bull trout through protective mechanisms. Through a combination of improved foraging and overwintering habitat, abundant forage, and adaptive fishery management, the bull trout in Lake Koocanusa have become a robust, relatively stable population that represents one of the species' strongholds throughout its range.

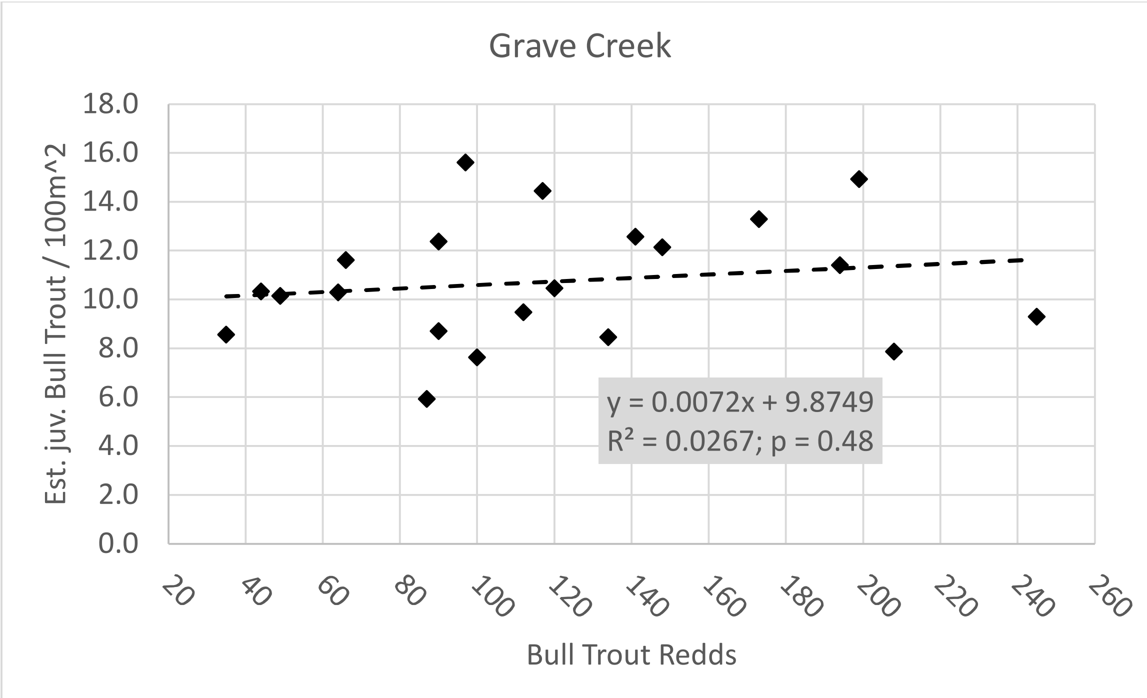

Figure 26. Relationship between bull trout redd counts and juvenile abundance using a three-year offset, i.e. 2005 fall redd counts could explain 2008 summer juvenile abundance (primarily two year old juveniles) in Grave Creek.

Kootenai River Bull Trout Population – Downstream of Libby Dam

Total bull trout redds counted in Kootenai tributaries below Libby Dam have declined from peak counts in 1999. A significant declining trend in total redd counts for this population is apparent even over the past ten years. While O'Brien and West Fisher Creeks are the only spawning tributaries with recent significant declining trends, non-significant declines in Quartz, Pipe and Bear have cumulatively resulted in significant reductions in bull trout redd counts below Libby Dam over the past ten years.

Juvenile bull trout abundance estimates for this population have similarly declined through time. West Fork Quartz, Pipe, and O'Brien Creeks have displayed significantly declining juvenile bull trout abundance for the period of record while West Fisher, Bear and Callahan Creeks have exhibited nonsignificant declining trends. For the streams with significant declining juvenile bull trout abundance, a significant positive relationship is apparent between juvenile abundance and redd counts three years prior (Figures 27 – 29). This suggests adult bull trout escapement positively influences juvenile tributary abundance. Juvenile to adult survival between life stages involving outmigration to the mainstem Kootenai River and returning to tributaries as adult spawners may be limiting the bull trout populations in the Kootenai River below Libby Dam (Prebyl et al. 2021).

Just as Libby Dam drastically altered the ecological landscape for bull trout upstream in Lake Koocanusa, bull trout in the Kootenai River below Libby Dam are invariably impacted by the presence and operation of the dam. A relatively dense population of adult bull trout typically exists in the Kootenai River tailrace from Libby Dam downstream roughly 3.5 miles to the Fisher River confluence. Sylvester and Stephens

(2011) reported population estimates from 2004 to 2010 in this reach and determined between approximately 175 and 1,100 bull trout were present depending on the year. A nearly significant positive relationship ($r^2 = 0.64$; $p = 0.056$) exists between these abundance estimates and bull trout redd counts between Libby Dam and Kootenai Falls (MFWP, data on file) (Figure 30).

Furthermore, genetic analyses in the Libby Dam tailrace indicate a substantial proportion of adult bull trout in this reach were likely spawned in tributaries upstream of Libby Dam and viably entrained through Libby Dam. From 2004 through 2009, over 500 bull trout genetics samples were collected from below Libby Dam and analyzed for natal stream assignment. Results of these analyses indicated that 61 percent of all bull trout sampled below the dam were assigned to natal tributaries upstream, ranging from 50 to 65 percent depending on collection year (DeHaan et al. 2008; DeHaan and Adams 2011).

It is therefore apparent that the bull trout population in the Kootenai River below Libby Dam is inevitably influenced by dam operations and environmental conditions upstream in Lake Koocanusa. Entrainment of bull trout occurs at unknown levels and likely varies annually depending on water management strategies at Libby Dam, which often is a result of water availability. The fate and reproductive contributions of entrained bull trout in the Kootenai River is currently poorly understood. Furthermore, variable levels of kokanee entrainment (forage availability) through Libby Dam may influence bull trout growth and survival which can impact overall population fitness.

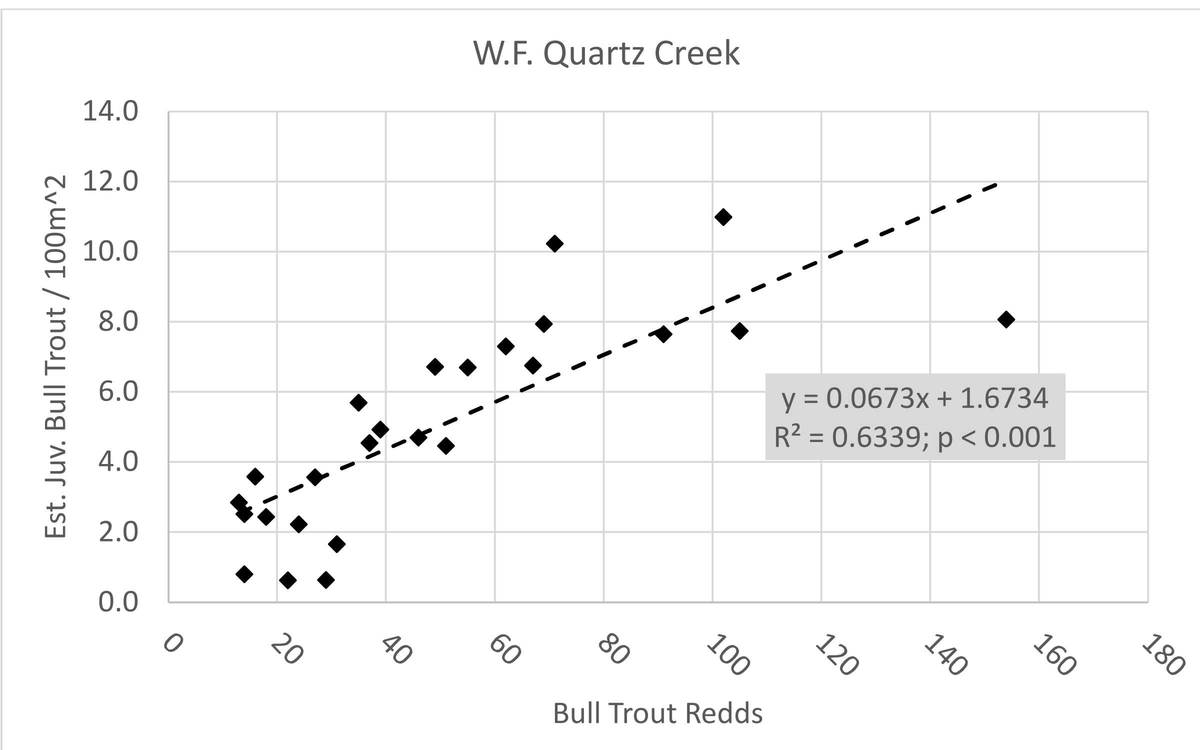

Figure 27. Relationship between bull trout redd counts and juvenile abundance using a three-year offset, i.e. 2005 fall redd counts could explain 2008 summer juvenile abundance (primarily two year old juveniles) in the Quartz Creek drainage.

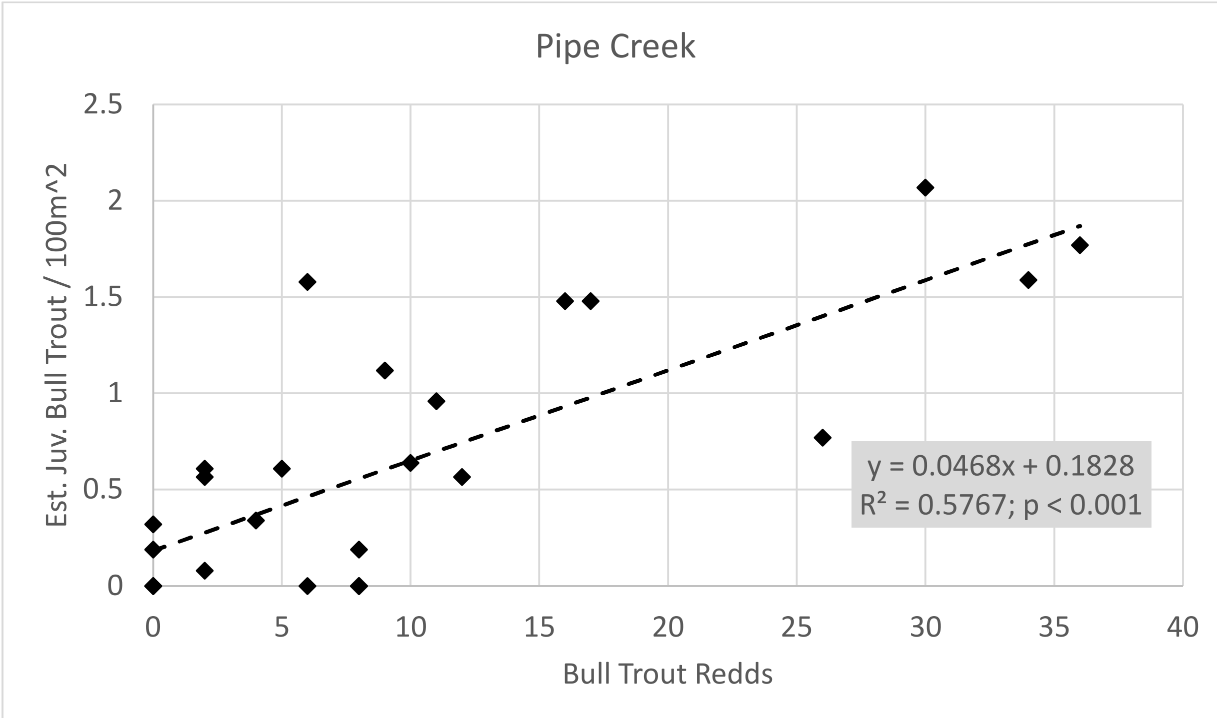

Figure 28. Relationship between bull trout redd counts and juvenile abundance using a three-year offset, i.e. 2005 fall redd counts could explain 2008 summer juvenile abundance (primarily two year old juveniles) in Pipe Creek.

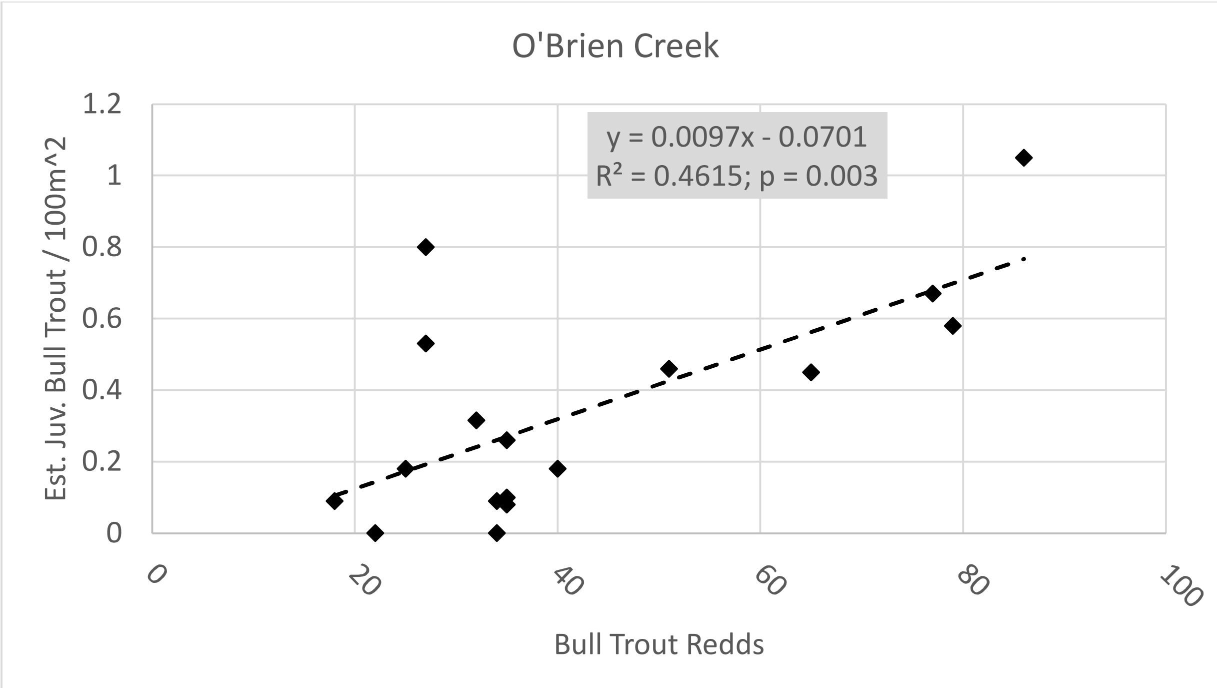

Figure 29. Relationship between bull trout redd counts and juvenile abundance using a three-year offset, i.e. 2005 fall redd counts could explain 2008 summer juvenile abundance (primarily two year old juveniles) in O'Brien Creek.

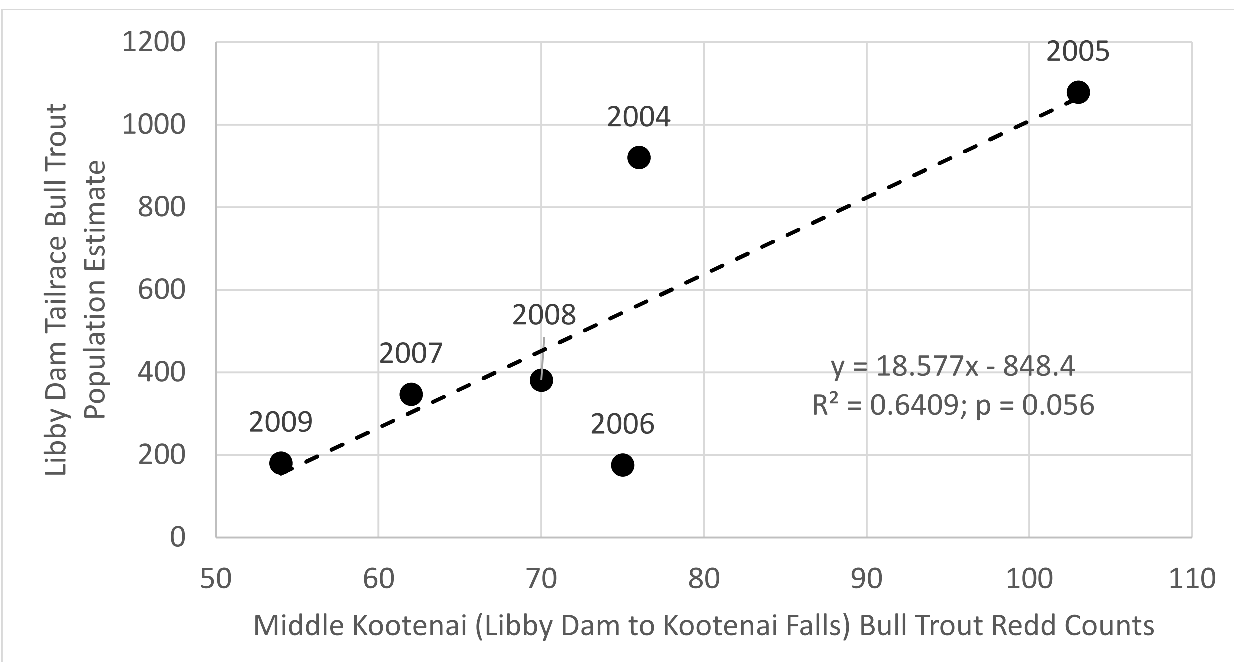

Figure 30. Relationship between bull trout abundance estimates in the Kootenai River below Libby Dam and redd counts for spawning tributaries from Libby Dam to Kootenai Falls.

Bull Lake Bull Trout Population

Both redd counts and juvenile bull trout abundance estimates in the Keeler Creek drainage have declined through time. A significant positive relationship exists between these two indices (Figure 31), suggesting adult escapement influences juvenile abundance. While the Bull Lake population was naturally vulnerable to disturbance due to its unique life history and single spawning tributary, two primary factors have driven this population toward extirpation.

Northern pike were illegally introduced into Bull Lake, likely sometime prior to 2000. By 2013, the pike population had expanded and become well established posing serious threats to bull trout through predation and competition. Furthermore in 2012 and 2013, a massive poaching event was alleged where an individual illegally harvested upwards of 70 adult bull trout from Keeler Creek and Lake Creek.

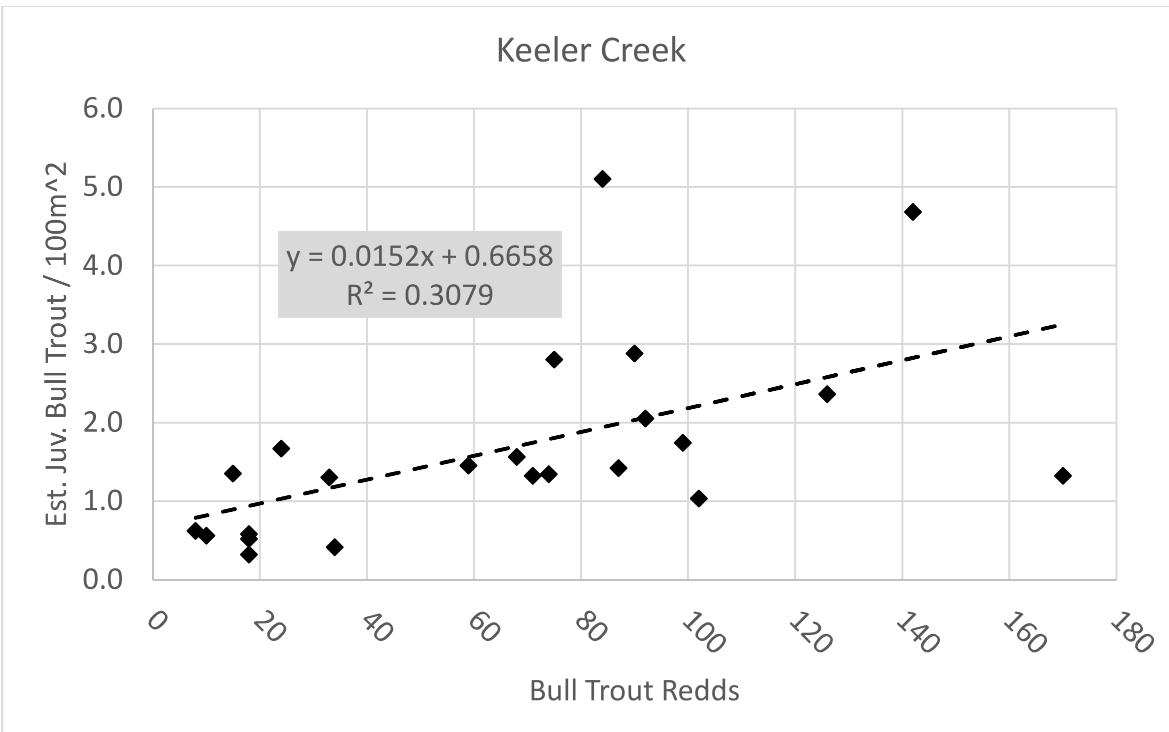

Figure 31. Relationship between bull trout redd counts and juvenile abundance using a three-year offset, i.e. 2005 fall redd counts could explain 2008 summer juvenile abundance (primarily two year old juveniles) in the Keeler Creek drainage.

CONCLUSIONS

The construction of Libby Dam forever altered the ecological landscape and population dynamics of Kootenai River drainage bull trout. Little information exists regarding bull trout populations prior to ESA listing, and even less data are available prior to the completion of Libby Dam. The Lake Koocanusa population is undoubtedly more robust than pre-dam levels as a result of vast, novel lentic habitat and abundant forage in the form of kokanee salmon. After experiencing a substantial increase in abundance following the completion of Libby Dam and ESA listing, bull trout in Lake Koocanusa continue to persist at elevated and stable levels. These adfluvial bull trout constitute one of the strongest populations within these species' range.

The bull trout population downstream of Libby Dam appears to have declined from historic peak abundances shortly after ESA listing. Dam construction and operation have certainly impacted riverine habitat conditions and bull trout life histories in this section of the Kootenai River. Entrained bull trout from Lake Koocanusa appear to substantially contribute to abundance in the mainstem river downstream of Libby Dam. However, the level to which these entrained individuals influence persistence of the downstream population across all life stages is poorly understood. As Libby Dam operations have evolved from power peaking with no ramping rate limitations to more controlled and restrictive discharge fluctuations, entrainment of all fish from Lake Koocanusa has likely been reduced through time.

The adjunct bull trout population in Bull Lake that spawns in the Keeler Creek drainage has declined substantially in recent years. Inherently at risk due to the single spawning tributary, bull trout in this system currently face many threats. An alleged poaching incident likely removed several dozen adults during migration and spawning, significantly reducing the contributions from at least two year classes. Furthermore, illegally introduced northern pike in Bull Lake have become established and abundant, resulting in persistence threats to bull trout through both competition for food resources and direct predation.

Monitoring will continue to assess the status and trend of bull trout populations in the Kootenai River drainage. It is the intention of MFWP to manage bull trout for sport fisheries and foster recovery of the species. Ongoing monitoring will continue to help compile and document relevant population information and serve to guide recovery and management actions for MFWP and other decision makers with the best and most current information available.

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APPENDICIES

Appendix 1. Summary of all bull trout redd counts for the Lake Koocanusa population.

Year	Wigwam (B.C.)	Wigwam (U.S.)	**Wigwam Total**	Skookumchuck (B.C)	White River (B.C.)	Blackfoot Creek (B.C)	Wild Horse Creek (B.C.)	**British Columbia Total Redds**	Grave Creek	Blue Sky Creek	Clarence Creek	**Grave Creek Drainage Total Redds**	**All Koocanusa Redds Counted**
1995	247		**247**					**247**					**247**
1996	500	12	**512**					**512**	24	6	5	**35**	**547**
1997	581	17	**598**	66				**664**	42	1	6	**49**	**713**
1998	673	6	**679**	105				**784**	52	1	13	**66**	**850**
1999	838	21	**859**	161				**1020**	85	10	39	**134**	**1154**
2000	1186	9	**1195**	189				**1384**	87	1	9	**97**	**1481**
2001	1477	19	**1496**	132	166			**1794**	131	13	29	**173**	**1967**
2002	1881	11	**1892**	143	153	108		**2296**	156	5	38	**199**	**2495**
2003	2043	10	**2053**	134	143	96		**2426**	173	20	52	**245**	**2671**
2004	2106	27	**2133**	140	93	91		**2457**	102	10	29	**141**	**2598**
2005	635	7	**642**	111	137	106		**996**	153	9	32	**194**	**1190**
2006	2285	13	**2298**	163	167	144		**2772**	118	8	22	**148**	**2920**
2007	1850	33	**1883**	144	193	73		**2293**	166	0	42	**208**	**2501**
2008	1827	6	**1833**	137	137	73		**2180**	170	10	27	**207**	**2387**
2009	1567	8	**1575**	64	112	0		**1751**	55	8	24	**87**	**1838**
2010	1114	4	**1118**	112	122	7		**1359**	102	9	9	**120**	**1479**
2011	1198	8	**1206**	86	206			**1498**	51	3	10	**64**	**1562**
2012	1367	3	**1370**	100	182	65		**1717**	82	12	23	**117**	**1834**
2013	1441	6	**1447**	78	124			**1649**	55	15	20	**90**	**1739**
2014	1420	7	**1427**	112	335	92		**1966**	56	5	13	**74**	**2040**
2015	1601	1	**1602**	182	340	58		**2182**	84	0	6	**90**	**2272**
2016	1561		**1561**	101	449		171	**2282**					**2282**
2017	1607	5	**1612**	200	368	116	133	**2429**	85	10	17	**112**	**2541**
2018	1408	2	**1410**	179	234	93	137	**2053**	83	3	14	**100**	**2153**
2019	888	0	**888**	166	324	143	89	**1610**	43	0	1	**44**	**1654**
2020	1042	0	**1042**	158	372	153	147	**1872**	54	0	10	**64**	**1936**
2021	922	6	**928**	114	390	105	133	**1670**	57	5	24	**86**	**1756**
2022	1070	9	**1079**	200	508	141	119	**2047**	37	0	10	**47**	**2094**
2023	1163	4	**1167**	223	609	129	145	**2273**	43	6	8	**57**	**2330**

Appendix 2. Summary of all bull trout redd counts for the middle Kootenai (Libby Dam to Kootenai Falls) population.

Year	**West Fisher Creek**	**Bear Creek**	**Pipe Creek**	Main Stem Quartz Creek	West Fork Quartz Creek	**Quartz Creek Total**	**Middle Kootenai Total Redds**
1995	**3**	**6**	**5**	41	26	**67**	**81**
1996	**4**	**10**	**17**	9	42	**51**	**82**
1997	**0**	**13**	**26**	30	39	**69**	**108**
1998	**8**	**22**	**34**	33	72	**105**	**169**
1999	**18**	**36**	**36**	14	88	**102**	**192**
2000	**23**	**23**	**30**	52	39	**91**	**167**
2001	**1**	**4**	**6**	45	109	**154**	**165**
2002	**1**	**17**	**11**	52	10	**62**	**91**
2003	**1**	**14**	**10**	29	26	**55**	**80**
2004	**13**	**6**	**8**	8	41	**49**	**76**
2005	**27**	**3**	**2**	25	46	**71**	**103**
2006	**4**	**14**	**6**	23	28	**51**	**75**
2007	**18**	**9**	**0**	20	15	**35**	**62**
2008	**6**	**14**	**4**	14	32	**46**	**70**
2009	**8**	**6**	**9**	18	13	**31**	**54**
2010	**12**	**8**	**16**	12	27	**39**	**75**
2011	**3**	**3**	**2**	7	30	**37**	**45**
2012	**5**	**4**	**12**	14	4	**18**	**39**
2013	**4**	**8**	**8**	4	10	**14**	**34**
2014	**14**	**11**	**8**	5	19	**24**	**57**
2015	**4**	**7**	**0**	17	5	**22**	**33**
2016		**4**	**0**	10	6	**16**	**20**
2017	**8**	**1**	**2**	9	18	**27**	**38**
2018	**4**	**3**	**8**	13	0	**13**	**28**
2019	**2**	**4**	**0**	22	7	**29**	**35**
2020	**1**	**14**	**0**	8	6	**14**	**29**
2021	**1**	**4**	**2**	1	4	**5**	**12**
2022	**1**	**7**	**5**	1	4	**5**	**18**
2023	**0**	**1**	**0**	29	0	**29**	**30**

Appendix 3. Summary of all bull trout redd counts for the lower Kootenai (Kootenai Falls to the Idaho border) population.

Year	**O'Brien Creek**	North Fork Callahan Creek	South Fork Callahan Creek	**Callahan Creek Drainage Total Redds**	South Fork Keeler Creek	North Fork Keeler Creek	Main Stem Keeler Creek	**Keeler Creek Drainage Total Redds**	**Lower Kootenai River Total Redds**	**O'Brien & Callahan Redds**
1995	**22**								**22**	**22**
1996	**12**						74	**74**	**86**	**12**
1997	**36**				16	18	25	**59**	**95**	**36**
1998	**47**				10	43	39	**92**	**139**	**47**
1999	**37**				5	52	42	**99**	**136**	**37**
2000	**34**				5	82	3	**90**	**124**	**34**
2001	**47**				0	4	11	**15**	**62**	**47**
2002	**45**	13	3	**16**	0	75	27	**102**	**163**	**61**
2003	**46**	32	10	**42**	0	26	61	**87**	**175**	**88**
2004	**51**	17	8	**25**	43	30	53	**126**	**202**	**76**
2005	**86**	10	5	**15**	40	45	85	**170**	**271**	**101**
2006	**65**	29	4	**33**	31	59	52	**142**	**240**	**98**
2007	**77**	0	3	**3**	4	30	50	**84**	**164**	**80**
2008	**79**	17	0	**17**	8	22	32	**62**	**158**	**96**
2009	**40**	10	0	**10**	0	0	24	**24**	**74**	**50**
2010	**27**	9	1	**10**	11	19	45	**75**	**112**	**37**
2011	**32**	2	0	**2**	10	29	29	**68**	**102**	**34**
2012	**18**	6	0	**6**	16	32	23	**71**	**95**	**24**
2013	**35**	9	2	**11**	9	21	3	**33**	**79**	**46**
2014	**34**	7	0	**7**	7	14	13	**34**	**75**	**41**
2015	**22**	1	0	**1**	0	4	14	**18**	**41**	**23**
2016	**35**								**35**	**35**
2017	**35**	6	2	**8**	0	6	12	**18**	**61**	**43**
2018	**34**				0	6	12	**18**	**52**	**34**
2019	**27**	0	0	**0**	0	0	8	**8**	**35**	**27**
2020	**25**	4	2	**6**	5	1	4	**10**	**41**	**31**
2021	**5**	1	2	**3**	0	2	0	**2**	**10**	**8**
2022	**22**	9	4	**13**	5	2	8	**15**	**50**	**35**
2023	**23**	6	4	**10**	1	0	2	**3**	**36**	**33**