Native Salmonid Research and Monitoring Progress Update

2009

Idaho Tributary Habitat Acquisition and Fishery Enhancement Program,
Appendix A

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Native Salmonid Research and Monitoring – 2009 Update

This is an annual update of work completed within the Native Salmonid Research and Monitoring project of the Idaho Tributary Habitat Acquisition and Fishery Enhancement Program, Appendix A of the Clark Fork Settlement Agreement. Completed project components in 2009 included tributary salmonid abundance monitoring in the Twin Creek, Johnson Creek, Granite Creek, Gold Creek, and Strong Creek drainages and bull trout redd monitoring on Lake Pend Oreille/Lower Clark Fork River tributaries. The intent of this update is to provide a summary of annual research and monitoring efforts. This update will be followed by a comprehensive report of cumulative annual efforts from a larger subset of sampled tributaries to Lake Pend Oreille and the Lower Clark Fork River in 2011.

Tributary Salmonid Abundance Monitoring

METHODS

We completed fish population surveys in Lake Pend Oreille (LPO) tributaries as part of a comprehensive effort to follow general trends in fish abundance, species composition, and distribution on a stream wide scale. In addition, this information in combination with information gathered from other tributaries within the project boundaries of the Clark Fork Settlement Agreement (CFSA) will enable broad scale evaluation of impacts associated with efforts in aquatic habitat protection and restoration accomplished through CFSA activities. We systematically established survey sites at intervals of approximately one kilometer from the mouth of each sampled stream through the upper reaches. Upper survey site boundaries were defined as the point where water was no longer found, fish were no longer sampled, or where consistent sampling results suggested further survey's were not necessary due to low expected variation among sample sites (Table 1). In some cases survey sites were separated by reaches of intermittent flow. In these scenarios lack of water did not describe the upper most survey site. We replicated selected survey sites in Granite, Gold, and Twin creeks sampled in previous years and used these sites to evaluate trends in fish abundance.

We collected fish using a Smith Root backpack electrofishing unit and pulsed DC settings at 50Hz, 2ms, and 800 to 900 volts). We identified, measured (total length; mm) and weighed (g) collected fish. A subsample of westslope cutthroat, rainbow trout and cutthroat trout x rainbow trout hybrids were sacrificed for otolith extraction and subsequent age estimation.

We used multi-pass removals (Zippin 1958) to estimate abundance of tributary fish populations in the Twin Creek, Johnson Creek, Granite Creek, Gold Creek, and Strong Creek drainages in 2009. Because of poor capture efficiency on small fish, abundance estimates only included fish $\geq$75mm (total length; TL). Sample sections were typically 100 m in length. Sections were closed using block nets at the downstream end of each survey section to prevent escapement during downstream electrofishing passes. We completed sequential passes until captures of an individual pass was no more than 20% of the total capture by species of the previous pass.

Typically, we completed two to three passes per survey site. We calculated abundance estimates and associated 95% confidence intervals for two and three pass samples using methods for removal estimates in closed populations (Hayes et. al). We reported the total catch on the first pass as the population estimate when all the individuals of a particular species were captured on the first pass. In cases where lower confidence bounds were less than the total number of fish captured, the total number of fish captured was reported as the lower bound. We reported density estimates as the number per 100 m^2. Density ranges included only those sites where a given species was sampled, while reported average densities included all sampled survey sites where fish were present. Sampled fishes were also used to describe population characteristics within sampled streams including age structure, size structure, and species composition.

We alternated multi-pass removals with single pass removal samples in each drainage. Single pass samples were implemented to increase the number of possible sample sites visited in a season as each single pass requires less time than a multi-pass sample. We estimated abundances from single pass samples from a multi-pass regression model of abundance based on first pass collections (Meyer and Schill 1999). We developed a single model that included sample data from all tributaries and all target species. Capture efficiencies were consistent among all tributaries and species providing support that model predictions were valid across these boundaries.

Table 1. Locations (UTM) of survey sections sampled during 2009 Lake Pend Oreille tributary abundance monitoring efforts. Waypoints represent the approximate lowermost point of each survey section. Sections where water was present are indicated by a yes in the water field. Section length, mean width, and square area are listed for each survey section.

STREAM	SITE	DATE	DATUM	ZONE	E	N	WATER	SECTION (m)	AVG WIDTH(M)	VOL (100 m^2)
GOLD CREEK	1*	7/30/2009	WGS84	11	541227	5312552	Yes	100	7.475	7.5
GOLD CREEK	2*	8/7/2009	WGS84	11	541400	5312225	Yes	100	6.4	6.4
GOLD CREEK	3	8/10/2009	WGS84	11	540897	5311141	No	NA	NA	0.0
GOLD CREEK	4	8/10/2009	WGS84	11	541354	5310342	No	NA	NA	0.0
GOLD CREEK	5	8/10/2009	WGS84	11	541340	5309502	No	NA	NA	0.0
GOLD CREEK	6	8/10/2009	WGS84	11	541944	5308760	No	NA	NA	0.0
GOLD CREEK	7	8/14/2009	WGS84	11	542272	5307878	Yes	100	2.825	2.8
GOLD CREEK	8	8/6/2009	WGS84	11	542409	5306806	Yes	109	2.25	2.5
GOLD CREEK	9	8/6/2009	WGS84	11	542569	5306040	Yes	103	1.6875	1.7
WEST GOLD CREEK	10	8/11/2009	WGS84	11	540549	5311150	Yes	100	3.275	3.3
WEST GOLD CREEK	11	8/13/2009	WGS84	11	539624	5310628	Yes	100	3.2125	3.2
WEST GOLD CREEK	12	8/20/2009	WGS84	11	538938	5310178	Yes	100	3.275	3.3
WEST GOLD CREEK	13	8/20/2009	WGS84	11	538069	5309591	Yes	100	3.125	3.1
WEST GOLD CREEK	14	8/25/2009	WGS84	11	537270	5308990	Yes	100	3.575	3.6
WEST GOLD CREEK	15	8/31/2009	WGS84	11	536809	5308361	Yes	100	2.45	2.5
GRANITE CREEK	1	7/22/2009	WGS84	11	543415	5326191	Yes	100	4.5625	4.6
GRANITE CREEK	2*	7/23/2009	WGS84	11	544144	5326068	Yes	100	5.05	5.1
GRANITE CREEK	3	7/23/2009	WGS84	11	545205	5326073	Yes	100	7.4625	7.5
GRANITE CREEK	4	7/27/2009	WGS84	11	546067	5326084	Yes	100	5.75	5.8
GRANITE CREEK	5	7/27/2009	WGS84	11	546921	5326562	Yes	100	6.3625	6.4
GRANITE CREEK	6	7/28/2009	WGS84	11	547609	5326374	Yes	100	5.4875	5.5
GRANITE CREEK	7	7/29/2009	WGS84	11	548457	5325585	Yes	100	4.95	5.0
GRANITE CREEK	8	8/4/2009	WGS84	11	548918	5325062	Yes	100	5.1375	5.1
GRANITE CREEK	9	8/4/2009	WGS84	11	549074	5324124	Yes	100	3.6875	3.7
GRANITE CREEK	10	8/5/2009	WGS84	11	549904	5323412	Yes	100	4.275	4.3
JOHNSON CREEK	1	7/20/2009	WGS84	11	557380	5331040	Yes	100	4.85	4.9

Table 1 Continued.

STREAM	SITE	DATE	DATUM	ZONE	E	N	WATER	SECTION (m)	AVG WIDTH(M)	VOL (100 m^2)
JOHNSON CREEK	2	7/20/2009	WGS84	11	556632	5330289	Yes	100	4.625	4.6
JOHNSON CREEK	3	7/21/2009	WGS84	11	556416	5329743	Yes	100	4.4875	4.5
JOHNSON CREEK	4	7/21/2009	WGS84	11	555852	5328651	No	NA	NA	0.0
JOHNSON CREEK	5	7/21/2009	WGS84	11	555368	5327315	No	NA	NA	0.0
STRONG CREEK	1	7/14/2009	WGS84	11	552179	5343608	Yes	100	4.1375	4.1
STRONG CREEK	2	7/14/2009	WGS84	11	552968	5344710	Yes	100	3.975	4.0
STRONG CREEK	3	7/15/2009	WGS84	11	553437	5345715	Yes	100	3.625	3.6
STRONG CREEK	4	7/15/2009	WGS84	11	553947	5346600	Yes	100	--	--
STRONG CREEK	5	7/17/2009	WGS84	11	554254	5347223	Yes	100	1.675	1.7
STRONG CREEK	6	8/19/2009	WGS84	11	554433	5345975	Yes	100	1.6	1.6
TWIN CREEK	1*	7/7/2009	WGS84	11	565187	5326248	Yes	100	3.85	3.9
TWIN CREEK	2	7/8/2009	WGS84	11	564998	5325394	Yes	100	3.5875	3.6
TWIN CREEK	3	7/8/2009	WGS84	11	564262	5324682	Yes	100	3.85	3.9
TWIN CREEK	4	7/9/2009	WGS84	11	563889	5324308	Yes	100	3.7375	3.7
TWIN CREEK	5	7/9/2009	WGS84	11	562965	5323531	Yes	100	3.7625	3.8
TWIN CREEK	6	7/9/2009	WGS84	11	562612	5322833	Yes	100	3.55	3.6
TWIN CREEK	7	8/24/2009	WGS84	11	562167	5322087	Yes	100	2.3875	2.4
TWIN CREEK	8	8/24/2009	WGS84	11	561599	5321368	Yes	100	1.3625	1.4

* Indicates survey sites duplicated for abundance trends

RESULTS

We visited forty four survey sections among all sample tributaries between July 7 and August 31, 2009. Of those sites water was present at 38, and an electrofishing survey was completed (Table 1). We surveyed nine sections in Gold Creek over approximately nine kilometers of the main stem (Figure A-1). Six additional sections over approximately six kilometers were also surveyed in West Gold Creek (Figure A-1). Section 15 on West Gold Creek, the uppermost section in that stream, did not represent the upper end of potential wetted habitat. However, downstream samples suggested little variation was present among sites. We surveyed a total of ten sections in Granite Creek over approximately ten kilometers (Figure A-2). We also sampled three sections over approximately five kilometers in Johnson Creek (Figure A-3). Subsurface flows were found at survey sections four and five. We sampled a total of six and eight sections in Strong and Twin Creeks, respectively (Figures A-4, A-5). Surface flows were present at all sections. Although we found surface flows at all sections no fish were detected at Strong Creek sections four through six. These sections are likely impacted by intermittent flows in some years.

We developed a single regression model to estimate abundance based on first pass collections (Figure 1). Capture efficiencies were consistent (0.83 ± 0.05, 95% confidence intervals) among all tributaries and species providing support model predictions were valid across these boundaries. Based on the developed linear model, collections in the first pass described approximately 98% of the variation in estimated abundance from multi-pass samples.

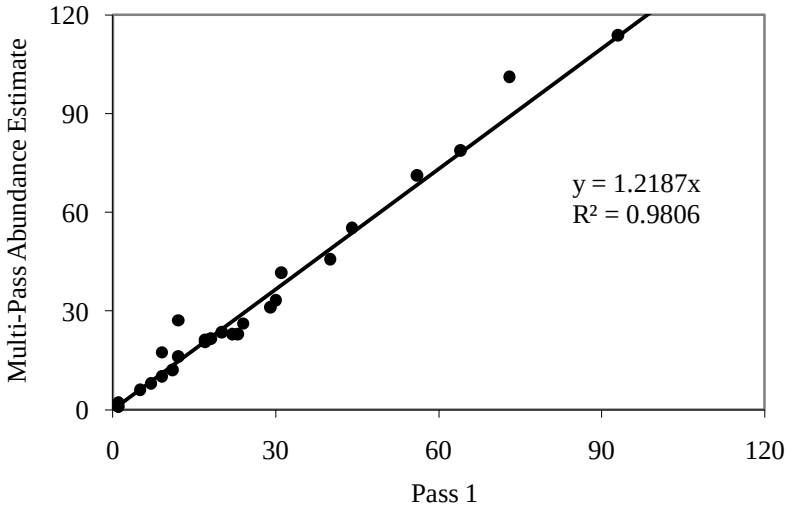

Figure 1. Regression model of estimated multi-pass abundance by first pass collections. Data represented 2009 multi-pass removal efforts in Lake Pend Oreille, Idaho tributaries including Granite, Gold, West Gold, Johnson, Strong, and Twin creeks.

Gold Creek

We collected three fish species among all survey sites on Gold Creek (Table 2). In the lower drainage including sections one and two, both westslope cutthroat trout *Oncorhynchus clarkii lewisi and* bull trout *Salvelinus confluentus* were collected. We also sampled a single westslope cutthroat x rainbow trout *Oncorhynchus mykiss* hybrid within section two. Only westslope cutthroat trout were sampled in the upper drainage including sections seven through nine. Westslope cutthroat trout densities ranged from one to 43 fish/100 m^2, with the highest densities occurring within the upper drainage. Bull trout densities ranged from eight to 14 fish/100 m^2. Westslope cutthroat trout and bull trout densities averaged among all sites were 24 and four fish/100 m^2, respectively (Table 3). Sections three through six were dry at the time of this survey. We believed intermittent flows in this section act as a barrier to migratory fishes during much of the year. Immediately downstream of section eight, a man made log crib structure was also identified as a probable migration barrier (Figure A-1).

West Gold Creek

We collected two fish species among all survey sites on West Gold Creek (Table 2). In the lower drainage including only section ten, both westslope cutthroat trout and bull trout were collected. We only sampled westslope cutthroat trout in the remainder of the drainage including sections 11 through 15. Estimated westslope cutthroat trout densities ranged from 36 to 49 fish/100 m^2 and represented the highest densities sampled in 2009. Estimated bull trout density in section 10 was 0.1 fish/100 m^2. Westslope cutthroat trout and bull trout densities averaged among all sites were 44 and 0.1 fish/100 m^2, respectively (Table 3). A high gradient section between sections 10 and 11 may potentially function as a barrier to migratory fishes in this stream explaining the absence of bull trout in the upper drainage (Figure A-1).

Granite Creek

We collected four fish species among all survey sites on Granite Creek (Table 2). Both westslope cutthroat trout and bull trout were collected at all 10 survey sites. We also sampled a single westslope cutthroat x rainbow trout hybrid and a single mountain whitefish *Prosopium williamsoni* within section two. Westslope cutthroat trout densities ranged from two to 14 fish/100 m^2, with the highest densities occurring within the upper drainage in sections seven and eight. Bull trout densities ranged from two to six fish/100 m^2. Westslope cutthroat trout and bull trout densities averaged among all sites were seven and five fish/100 m^2, respectively (Table 3).

Johnson Creek

Westslope cutthroat trout were the dominant species sampled in Johnson Creek (Table 2). We collected both westslope cutthroat trout and bull trout in only section one. We sampled only westslope cutthroat trout in all other sections. Westslope cutthroat trout densities ranged from two to 11 fish/100 m^2, with the highest densities occurring within section two. Bull trout density

in section one was 4 fish/100 m^2. Westslope cutthroat trout and bull trout densities averaged among all sites were five and one fish/100 m^2, respectively (Table 3). A water fall above section one (Johnson Creek falls) was a known barrier to migratory fish and defined the separation between presence and absence of bull trout (Figure A-3). Intermittent flows above section three prohibited fish presence at observed survey sites.

Strong Creek

We collected four fish species among all survey sites on Strong Creek (Table 2). All four species including westslope cutthroat trout, bull trout, rainbow trout, and cutthroat x rainbow trout hybrids were sampled in section one. We sampled only westslope cutthroat trout in the remaining survey sections. Westslope cutthroat trout densities ranged from seven to 17 fish/100 m^2, with the highest densities occurring in survey section two. Bull trout density in survey section one was less than one fish/100 m^2. However, all but one bull trout collected in this stream were less than 75 mm and were therefore excluded from abundance estimates. Westslope cutthroat trout and bull trout densities averaged among all sites were seven and 0.05 fish/100 m^2, respectively (Table 3). Since the early to mid 1900's fish passage has been blocked above survey section one by a water diversion structure. This structure failed in 2008 and was replaced in 2009 with a structure designed to be passable. Although water was present at survey sites five and six no fish were present. We observed intermittent flows between survey sections three and four suggesting intermittency may impact fish presence in the upper drainage.

Twin Creek

We collected five fish species among all survey sites on Twin Creek (Table 2) including brook trout *Salvelinus fontinalis*, brown trout *Salmo trutta*, rainbow trout, westslope cutthroat trout, and sculpin *cottus spp*. We did not target sculpin in this survey and total lengths were primarily less than 75 mm, therefore we did not estimate abundance. No westslope cutthroat trout were collected in sections one or two. We collected only rainbow trout in survey section two, only brook trout and westslope cutthroat trout in survey sections three through six, and only westslope cutthroat trout in survey section seven. Westslope cutthroat trout densities ranged from one to 15 fish/100 m^2, with the highest densities occurring within the upper drainage. No bull trout were sampled in Twin Creek. Westslope cutthroat trout density averaged 4 fish/100 m^2 (Table 3). We confirmed a water fall between survey sections two and three as a barrier to migratory fish and noted this feature defined the separation between presence and absence of westslope cutthroat trout (Section A-5).

Table 2. Results of 2009 tributary monitoring by stream, sample site, and species. Total captured includes all lengths, while only fish ≥ 75 mm were included in abundance estimates (EST N). In cases of non-declining catch, abundance estimates were minimum estimates defined as the total catch, and no confidence intervals were calculated. Abundance of non-target species including unidentified *Oncorhynchus* (ONC) and *Cottus* (SCL) species was not estimated.

STREAM	SECTION	SPECIES	CAUGHT	MIN TL	MAX TL	Est. N	95% CI		DENSITY/100m^2
GOLD CREEK	1	BLT	101	91	202	101	99	105	14
GOLD CREEK	1	WCT	6	82	95	6	6	6	1
GOLD CREEK	2	BLT	45	100	189	54	44	65	8
GOLD CREEK	2	WCT	6	145	238	7	6	18	1
GOLD CREEK	2	WRHY	1	105	105	1	1	12	0
GOLD CREEK	7	WCT	122	65	230	114	110	120	40
GOLD CREEK	8	WCT	97	42	205	79	76	84	32
GOLD CREEK	9	WCT	64	56	180	76	65	87	43
WEST GOLD CREEK	10	BLT	2	111	122	2	2	4	1
WEST GOLD CREEK	10	WCT	177	62	251	161	156	167	49
WEST GOLD CREEK	11	WCT	138	66	217	152	141	164	47
WEST GOLD CREEK	12	WCT	155	70	216	155	153	158	47
WEST GOLD CREEK	13	WCT	97	75	234	118	107	129	38
WEST GOLD CREEK	14	WCT	126	75	179	128	126	131	36
WEST GOLD CREEK	15	WCT	99	63	209	110	98	121	45
GRANITE CREEK	1	BLT	20	57	299	16	16	17	4
GRANITE CREEK	1	WCT	16	76	201	17	16	22	4
GRANITE CREEK	2	BLT	39	55	340	26	17	32	5
GRANITE CREEK	2	MWF	1	165	165	1	25	41	0
GRANITE CREEK	2	WCT	31	75	195	38	21	37	7
GRANITE CREEK	2	WRHY	1	101	101	1	1	12	0
GRANITE CREEK	3	BLT	50	45	200	27	23	37	4
GRANITE CREEK	3	WCT	22	67	210	21	21	23	3
GRANITE CREEK	4	BLT	12	51	173	12	31	49	2
GRANITE CREEK	4	WCT	12	70	182	13	1	12	2

Table 2 Continued.

STREAM	SECTION	SPECIES	CAUGHT	MIN TL	MAX TL	Est. N	95% CI	DENSITY/100m^2	STREAM
GRANITE CREEK	5	BLT	35	61	168	33	33	35	5
GRANITE CREEK	5	WCT	24	70	226	24	23	26	4
GRANITE CREEK	6	BLT	21	51	148	24	10	23	4
GRANITE CREEK	6	WCT	21	81	226	26	11	24	5
GRANITE CREEK	7	BLT	24	49	152	23	23	23	5
GRANITE CREEK	7	WCT	77	56	221	71	68	77	14
GRANITE CREEK	8	BLT	27	116	199	33	20	35	6
GRANITE CREEK	8	WCT	52	72	233	62	21	37	12
GRANITE CREEK	9	BLT	23	108	199	23	23	24	6
GRANITE CREEK	9	WCT	31	96	234	31	31	32	8
GRANITE CREEK	10	BLT	17	122	185	21	27	44	5
GRANITE CREEK	10	WCT	25	103	196	30	51	73	7
JOHNSON CREEK	1	BLT	20	82	169	21	20	23	4
JOHNSON CREEK	1	WCT	12	75	190	12	12	13	2
JOHNSON CREEK	2	WCT	40	75	195	49	40	60	11
JOHNSON CREEK	3	WCT	10	145	185	10	10	11	2
STRONG CREEK	1	BLT	12	42	115	1	1	1	0
STRONG CREEK	1	ONC	1	58	58	1	NA	NA	NA
STRONG CREEK	1	RBT	1	177	177	1	1	1	0
STRONG CREEK	1	WCT	52	60	255	46	45	48	11
STRONG CREEK	1	WRHY	1	99	99	1	1	1	0
STRONG CREEK	2	WCT	87	53	220	69	58	80	17
STRONG CREEK	3	WCT	55	52	215	26	26	27	7
TWIN CREEK	1	BRK	8	55	176	5	4	16	1
TWIN CREEK	1	BRN	3	38	467	1	1	12	0
TWIN CREEK	1	RBT	3	72	100	2	2	13	1
TWIN CREEK	1	SCL	2	54	76	NA	NA	NA	NA
TWIN CREEK	2	RBT	76	54	171	55	53	60	15

Table 2 Continued.

STREAM	SECTION	SPECIES	CAUGHT	MIN TL	MAX TL	Est. N	95% CI		DENSITY/100m^2
TWIN CREEK	3	BRK	13	106	235	16	13	27	4
TWIN CREEK	3	WCT	2	149	171	2	2	13	1
TWIN CREEK	4	BRK	47	39	213	42	41	44	11
TWIN CREEK	4	WCT	8	116	175	8	8	8	2
TWIN CREEK	5	BRK	18	45	209	19	16	31	5
TWIN CREEK	5	WCT	18	96	187	22	18	33	6
TWIN CREEK	6	BRK	1	133	133	NA	NA	NA	NA
TWIN CREEK	6	WCT	38	57	183	22	21	24	6
TWIN CREEK	7	WCT	32	73	170	37	30	48	15

BLT = bull trout
BRK = brook trout
BRN = brown trout
BBHY = brook trout x bull trout hybrid
MWF = mountain whitefish
ONC = unidentified Oncorhynchus spp.
RBT = rainbow trout
SCL = unidentified sculpin spp.
WCT = westslope cutthroat trout
WRHY = westslope cutthroat x rainbow trout hybrid

Table 3. Mean estimated density of sampled salmonids among all sample locations from 2009 Lake Pend Oreille tributary monitoring. Density estimates represent only fish ≥ 75 mm.

	SPECIES (Mean fish/100 m^2)						
STREAM	BRK	BLT	BRN	MWF	RBT	WCT	WRHY
GOLD CREEK	0.00	4.38	0.00	0.00	0.00	23.56	0.04
GRANITE CREEK	0.00	4.62	0.00	0.24	0.00	6.69	0.02
JOHNSON CREEK	0.00	1.42	0.00	0.00	0.00	5.10	0.00
STRONG CREEK	0.00	0.05	0.00	0.00	0.05	7.15	0.05
TWIN CREEK	2.72	0.00	0.32	0.00	2.01	3.75	0.00
WEST GOLD CREEK	0.00	0.11	0.00	0.00	0.00	43.67	0.00

LT = bull trout
BRK = brook trout
BRN = brown trout
MWF = mountain whitefish
RBT = rainbow trout
WCT = westslope cutthroat trout
WRHY = westslope cutthroat x rainbow trout hybrid

Abundance Trends

We found the species composition described by 2009 abundance surveys at selected sites was generally consistent with prior electrofishing surveys (Table 4, Downs and Jakubowski 2003, 2005a,2005b, 2006, 2007, Ryan et al. 2009, Jakubowski and Ryan 2009). Rainbow trout and westslope cutthroat x rainbow trout hybrids have been present in Granite Creek samples in low abundance at site two (previously labeled as the lower most Granite Creek site) in three of five survey years including 2009. In 2009, westslope cutthroat x rainbow trout hybrids were present in Gold Creek at survey site two in low abundance. Although inconsistent with previous electrofishing surveys of fish abundance conducted at this site since 2002, westslope cutthroat x rainbow trout hybrids have been described genetically in Gold Creek in previous years (Ardren et al. 2008). Bull trout and westslope cutthroat were the most abundant species present in all streams except Twin Creek. Non-native fishes including brook trout, brown trout, and rainbow trout have consistently been present and typically more abundant in Twin Creek. Inconsistent with previous surveys, we found no bull trout present in 2009 Twin Creek samples. Bull trout abundance in Twin Creek in previous sample years has been highly variable suggesting absence may reflect typical annual variations. In addition, absence may also reflect poor adult spawning escapement in recent years likely following multiple years of transporting Montana origin adult bull trout that may have previously strayed to Twin Creek to spawn. Also inconsistent with previous surveys, we detected mountain whitefish in low abundance in Granite Creek.

Bull trout and westslope cutthroat densities at survey sites evaluated for abundance trends remained relatively stable among survey years (Figure 2, Downs and Jakubowski 2003, 2005a,2005b, 2006, 2007, Ryan et al. 2009, Jakubowski and Ryan 2009) although we considered maximum replications of four to five years to not be adequate to describe significant trends. Some independence occurred among confidence bounds on estimated bull trout and westslope cutthroat densities at sites on Gold Creek suggesting differences in abundance may

have existed between some years. However, estimated densities varied no more than three fish per 100 square meters. Estimated bull trout densities in Granite Creek demonstrated greater variation among years, but appeared relatively consistent since 2005. Estimated westslope cutthroat trout densities in Granite Creek also demonstrated greater variation than Gold Creek and appear to reflect a more apparent increasing trend. Twin Creek was inconsistent with the general trends described in other tributaries as no bull trout were detected. Estimated bull trout densities in Twin Creek from 2002 and 2003 demonstrated considerable variation ranging from less than one to greater than four fish per 100 square meters suggesting 2009 results may reflect typical annual variations at this site as previously described.

Table 4. Estimated densities of sampled species from selected Lake Pend Oreille/Lower Clark Fork River, Idaho tributaries at repeated survey sites sampled in multiple years using electrofishing gear.

STREAM	Site	YEAR	BLT	BRK	BRN	RBT	MWF	WHRY	WCT
Granite Creek	2	2004	3	--	--	> 1	--	--	3
Granite Creek	2	2005	6	--	--		--	--	4
Granite Creek	2	2006	3	--	--	> 1	--	> 1	5
Granite Creek	2	2007	2	--	--	--	--		12
Granite Creek	2	2009	5	--	--	--	> 1	> 1	8
Gold Creek	1	2004	14	--	--	--	--	--	1
Gold Creek	1	2005	16	--	--	--	--	--	0
Gold Creek	1	2006	15	--	--	--	--	--	2
Gold Creek	1	2009	14	--	--	--	--	--	1
Gold Creek	2	2004	11	--	--	--	--	--	1
Gold Creek	2	2005	8	--	--	--	--	--	1
Gold Creek	2	2006	9	--	--	--	--	--	1
Gold Creek	2	2009	8	--	--	--	--	> 1	1
Twin Creek	1	2002	1	> 1	> 1	2	--	--	--
Twin Creek	1	2003	4	3	4	> 1	--	--	--
Twin Creek	1	2009	0	1	> 1	1	--	--	--

BLT = bull trout
BRK = brook trout
BRN = brown trout
MWF = mountain whitefish
RBT = rainbow trout
WCT = westslope cutthroat trout
WRHY = westslope cutthroat x rainbow trout hybrid

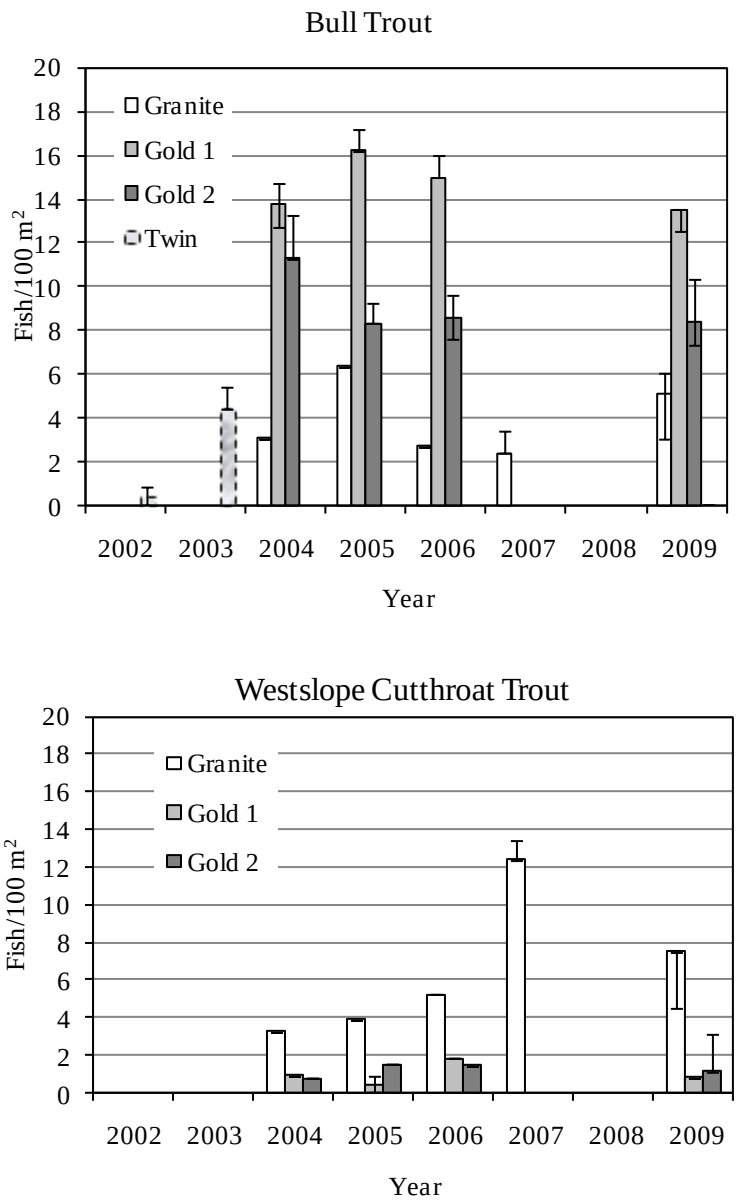

Figure 2. Estimated density and associated 95% confidence bounds of bull trout and westslope cutthroat from selected Lake Pend Oreille/Lower Clark Fork River, Idaho tributaries at repeated survey sites sampled in multiple years using electrofishing gear.

Bull Trout Redd Monitoring

METHODS

Idaho Department of Fish and Game, with assistance from Avista fishery staff, conducted redd counts on 19 tributaries to Lake Pend Oreille (LPO), as well as the Clark Fork River. In addition, surveys were completed on the Middle Fork East River and Uleda Creek (tributaries to the lower Priest River). Redds were located visually by walking along annually monitored sections within each tributary (Table 1). Redds were defined as areas of clean gravels at least 0.3 x 0.6 m in size with gravels of at least 76.2 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 redd, each distinct depression was counted as one redd.

We used a nonparametric rank-correlation procedure, Kendall's tau b ($\alpha = 0.05$) (Daniel 1990), to test for trends in the long-term LPO redd count data set (Rieman and Myers 1997), as recommended in the Lake Pend Oreille Bull Trout Conservation Plan. Data for the year 1995 were not used for any streams except the mainstem Clark Fork River, Sullivan Springs, North Gold and Gold creeks in this analysis because poor water visibility due to high water conditions likely affected the accuracy of the counts in that year. In addition, we did not use the 1983 data point for Grouse Creek or the 1986 data points for Rattle and East Fork Lightning creeks because some segments of these streams that may have contained relatively substantial numbers of redds were not counted. Long-term trends were evaluated using the full data set (1983-present). Short-term trends were evaluated using data collected since 2000.

RESULTS

Survey crews completed bull trout redd counts between 9 and 17 October, 2009. Redd counts ranged from a low of zero redds in Twin Creek to a high of 279 redds in Trestle Creek (Table 2). A total of 866 bull trout redds were observed across all sample locations. Index streams surveyed since 1983, accounted for 597 of the total observed redds in 2009. Based on 2009 LPO drainage redd counts, the expanded (3.2 fish per redd) adult bull trout spawning population consisted of at least an estimated 2,771 individuals. Seven local populations were estimated to have more than 100 adult spawning fish.

We detected significant positive trends in bull trout redd counts in both Lightning Creek and Porcupine Creek over the ten year period from 2000 to 2009 (Table 3). Long-term significant trends were also detected on the Clark Fork River (negative), Granite and Gold creeks, and collectively among all streams (all positive). Our results are largely consistent with the 2008 survey year although significant trends in Lightning and Porcupine creeks were new findings in 2009. In addition, no significant trend was detected in relation to the Middle Fork East River as was observed in 2008 (Jakubowski and Ryan 2009).

Table 1. Survey streams for annual bull trout redd counts in tributaries to Lake Pend Oreille, Idaho.

STREAM	SECTION DESCRIPTION (APPX. LENGTH (km))
Char Cr	Mouth to falls (1.2)
Clark Fork River	Spawning channel (N/A)
E. Fk. Lightning Cr[a]	Savage to Thunder Creek (5.0)
Gold Cr[a]	Mouth to 0.2 km upstream of W. Gold confluence (2.4)
Granite Cr	Mouth to road 278 crossing (6.4)
Grouse Cr[a]	Flume Creek to end of road 280 (2.4 km beyond gate) (6.5)
Johnson Cr[a]	Mouth to falls (1.5)
Lightning Cr	Rattle to Quartz (3.2)
Morris Cr	Mouth to trail 132 crossing (N/A)
N. Gold Cr[a]	Mouth to falls (1.2)
Pack R	Road 231 bridge near McCormick Cr to Falls located 0.4 km downstream of W. Branch (2.8)
Porcupine Cr	Mouth to S.Fk. (3.2)
Rattle Cr	Mouth to falls by upper bridge (5.7)
Savage Cr	Mouth to trail 61 crossing (2.0)
Strong Cr	Mouth to diversion barrier (N/A)
Sullivan Springs	Mouth upstream 0.4 km (0.4)
Trestle Cr[a]	1.6 km upstream of mouth to 0.5 km upstream of the road 275 switchback (10.4 km); 0.5 km upstream of road 275 switchback upstream to confluence with first southeast bank un-named tributary (0.5 km)
Twin Cr	Mouth to River Road (1.5)
Wellington Cr	Mouth to falls (0.5)

[a] Denotes "index" stream

Table 2. 2009 Bull trout redd counts from tributaries of Lake Pend Oreille, Clark Fork River, and Pend Oreille River, Idaho.

STREAM	Avg 1983-1999	2000 [e]	2001[d,e]	2002[d]	2003[d]	2004[d,k]	2005[d]	2006[d,l]	2007[d,m,n]	2008[d,l]	2009[d,l]
Clark Fork R.	9	5	6	7	8	1	0	3	2	0	1
Lightning Cr.	11	4	7	8	8	9	22	9	3	10	11
East Fork Cr.	51	54	36	58	38	77	50	51	34	38	85
Savage Cr.	8	2	4	15	7	15	7	25	0	8	5
Char Cr.	11	11	2	8	7	14	15	20	1	5	1
Porcupine Cr.	11	4	0	0	5	10	14	8	8	8	15
Wellington Cr.	9	8	7	7	8	7	6	29	9	10	4
Rattle Cr.	16	12	67	33	37	34	34	21	2	24	62
Johnson Cr.	19	4	34	31	0	32	45	28	32	40	47
Twin Cr.	10	10	1	8	3	6	7	11	0	4	0
Morris Cr.	1	1	0	7	1	1	3	16	0	6	6
Strong Cr.	2	--	--	0	--	0	--	--	--	7	6
Trestle Cr.	241	301	335	333	361	102	174	395	145	183	279
Pack R.	23	8	28	22	24	31	53	44	16	11	4
Grouse Cr.	35	77	18	42	45	28	77	55	38	31	51
Granite Cr.	34	25	7	57	101	149	132	166	104	52	106
Sullivan Springs Cr.	16	19	8	15	12	14	15	28	17	7	2
North Gold Cr.	30	19	16	24	21	56	34	30	28	17	28
Gold Cr.	108	168	127	203	126	167	200	235	179	73	107
W. Gold Cr.	NA	--	--	--	--	--	--	4	0	7	5
M.F. East R.	NA	--	4	8	21	20	48	71	34	36	25
Uleda Cr.	NA	--	3	4	3	7	4	7	2	7	16
N.F. East R.	NA	--	--	--	--	1	0	0	--	0	--
Total 6 index streams [c]	481	623	566	691	591	462	580	794	456	382	597
Total of all streams	598	732	710	890	836	781	940	1256	654	584	866

[a] Represents partial counts due to early snow fall (E. Fk. Lightning not included in index count)
[b] Observation conditions impaired by high water
[c] Index streams include Trestle, East Fork Lightning, Gold, North Gold, Johnson, and Grouse Creeks.
[d] Includes an additional apprx. 0.5 km reach immediately upstream of index reach on Trestle Creek
[e] A headcut barrier prevented access to most of spawning area on Johnson creek in 2000, and also potentially on Granite Creek in 2001.
[f] Additional redds observed in Dry Gulch (Granite Creek tributary)
[j] Incomplete surveys on Porcupine and Grouse creeks in 1983, and on Grouse, Rattle, and E.Fk. Lightning creeks in 1986, and on Granite in 1987 of varying amounts. See Pratt (1984) and Hoelscher and Bjornn (1989)
[k] Observation conditions impaired by high water in Trestle Creek
[l] Large early spawning kokanee made it difficult to distinguish bull trout redds from kokanee redds in Sullivan Springs, Granite Cr, N. Gold Cr, and Gold Cr
[m] Flows were up and counting conditions were difficult in Savage and Uleda creeks
[n] Severe flooding in the Lightning Creek drainage in Nov. 2006 had significant adverse impacts on some stream channels

Table 3. Correlations between year and redd count (trends) for bull trout populations monitored from 1983 to 2009 in tributaries to Lake Pend Oreille, Idaho. The total number of years actually included for each evaluation is described by valid years. Tau b represents the direction and magnitude of observed trend.

	Period from 2000 to 2009		Period from 1983 to 2009	
Stream	Valid Years	Tau-b	Valid Years	Tau-b
Clark Fork	10	-0.43	18	-0.44[a]
Lightning Creek	10	0.52[a]	23	0.03
East Fork Lighting Creek	10	0.04	26	0.04
Savage Creek	10	0.11	22	0.05
Char Creek	10	-0.13	23	-0.07
Porcupine Creek	10	0.58[a]	23	-0.01
Wellington Creek	10	0.02	23	-0.05
Rattle Creek	10	-0.09	23	0.15
Johnson Creek	10	0.45	27	0.25
Twin Creek	10	-0.27	23	-0.14
Morris Creek	10	0.28	11	0.30
Strong Creek	4	0.55	5	0.32
Trestle Creek	10	-0.11	27	0.09
Pack River	10	-0.11	23	-0.14
Grouse Creek	10	0.00	27	0.08
Granite Creek	10	0.38	23	0.47[a]
Sullivan Springs	10	-0.18	22	0.06
North Gold Creek	10	0.18	27	-0.16
Gold Creek	10	-0.16	27	0.29[a]
West Gold Creek	4	0.33	4	0.33
Middle Fork East River	9	0.50	9	0.50
Uleda Creek	9	0.45	9	0.45
North Fork East River	4	-0.71	4	-0.71
Index Streams	10	-0.24	27	0.13
All Streams	10	0.02	27	0.30[a]

[a] Denotes significance at $\alpha \leq 0.05$

REFERENCES

Ardren, W., M. Diggs and S. Bernall. 2008. Genetic Analysis of Westslope Cutthroat Trout at CGD and Noxon Rapids Dam: Geographic Origins, Hybridization, and Management Implications. Final Report to Avista Corporation, Noxon, Montana and U.S. Fish and Wildlife Service, Creston, Montana.

Downs C., and R. Jakubowski. 2003. Lake Pend Oreille/Clark Fork River Fishery Research and Monitoring 2002 Progress Report. Project 2, 2002 bull trout redd counts; Project 3, 2002 Clark Fork River fishery assessment progress report; Project 5, 2000-2002 Trestle and Twin creeks bull trout outmigration and Lake Pend Oreille survival study; Project 6, 2002 Johnson and Granite creeks bull trout trapping; Project 7, 2002 Twin Creek restoration monitoring progress report. Report to Avista Corporation from the Idaho Department of Fish and Game, Boise.

Downs C., and R. Jakubowski. 2005a. Lake Pend Oreille/Clark Fork River Fishery Research and Monitoring 2003 Progress Report. Project 2, Lake Pend Oreille bull trout redd counts; Project 3, Clark Fork River fishery assessment; Project 5, Trestle and Twin creeks bull trout outmigration and Lake Pend Oreille survival study; Project 6, Johnson and Granite creeks bull trout trapping; Project 7, Twin Creek restoration monitoring. Report to Avista Corporation from the Idaho Department of Fish and Game, Boise.

Downs C., and R. Jakubowski. 2005b. Lake Pend Oreille/Clark Fork River Fishery Research and Monitoring 2004 Progress Report. Lake Pend Oreille bull trout redd counts; Clark Fork River fishery assessment; Trestle and Twin creeks bull trout outmigration and Lake Pend Oreille survival study; Johnson and Granite creeks bull trout trapping; Twin Creek restoration monitoring; tributary fish population monitoring. Report number IDFG 05-51 to Avista Corporation from the Idaho Department of Fish and Game, Boise.

Downs C., and R. Jakubowski. 2006. Lake Pend Oreille/Clark Fork River Fishery Research and Monitoring 2005 Progress Report. Lake Pend Oreille bull trout redd counts; Clark Fork River fishery assessment; Trestle and Twin creeks bull trout outmigration and Lake Pend Oreille survival study; Johnson and Granite creeks bull trout trapping; Twin Creek restoration monitoring; tributary fish population monitoring; lower Clark Fork River westslope cutthroat trout radio-telemetry and genetic study progress report. Report number IDFG 06-41 to Avista Corporation from the Idaho Department of Fish and Game, Boise.

Downs C., and R. Jakubowski. 2007. Lake Pend Oreille/Clark Fork River Fishery Research and Monitoring 2006 Progress Report. Lake Pend Oreille bull trout redd counts; Clark Fork River fishery assessment; Trestle and Twin creeks bull trout outmigration and Lake Pend Oreille survival study; Twin Creek restoration monitoring; tributary fish population monitoring; lower Clark Fork River westslope cutthroat trout radio-telemetry and genetic study progress report. Report number IDFG 07-45 to Avista Corporation from the Idaho Department of Fish and Game, Boise.

Ryan, R., C. Downs, and R. Jakubowski. 2009. Lake Pend Oreille/Clark Fork River Fishery Research and Monitoring 2007 Progress Report. Lake Pend Oreille bull trout redd counts; Clark Fork River fishery assessment; Trestle and Twin creeks bull trout outmigration and Lake Pend Oreille survival study; Granite Creek fish population monitoring. Report to Avista Corporation from the Idaho Department of Fish and Game, Boise.

Hayes, D. B., J. R. Bence, T. J. Kwak, and B. E. Thompson. 2007. Abundance, biomass, and production *in* Analysis and interpretation of freshwater fisheries data, C. S. Guy and M. L. Brown, editors. American Fisheries Society,Bethesda, Maryland.

Jakubowski, R. and R. Ryan. 2009. Native Salmonid Research and Monitoring Progress Update – 2008. Report to Avista Corporation, Spokane, Washington from the Idaho Department of Fish and Game, Boise.

Pratt, K. 1984. Pend Oreille trout and char life history study. Report to the Idaho Department of Fish and Game and the Lake Pend Oreille Idaho Club. Boise, Idaho.

Rieman, B.E. and D.L. Myers. 1997. Use of redd counts to detect trends in bull trout (Salvelinus confluentus) populations. Conservation Biology 11:1015-1018.

Zippin, C. 1958. The removal method of population estimation. Journal of Wildlife Management. 22(1):82-90.

Appendix A. Lake Pend Oreille Tributary Monitoring Location Maps

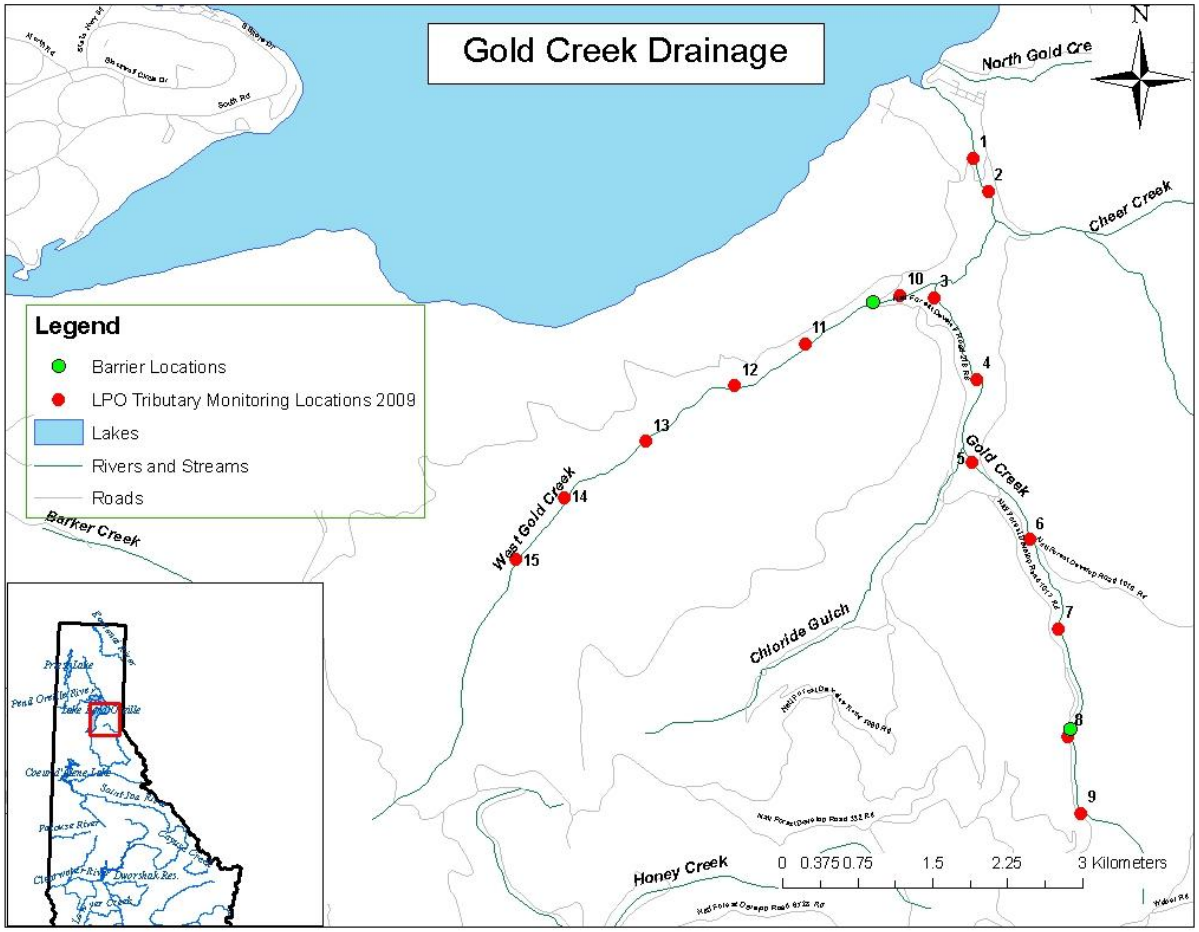

Figure A-1. 2009 tributary monitoring locations on Gold Creek and West Gold Creek, Idaho.

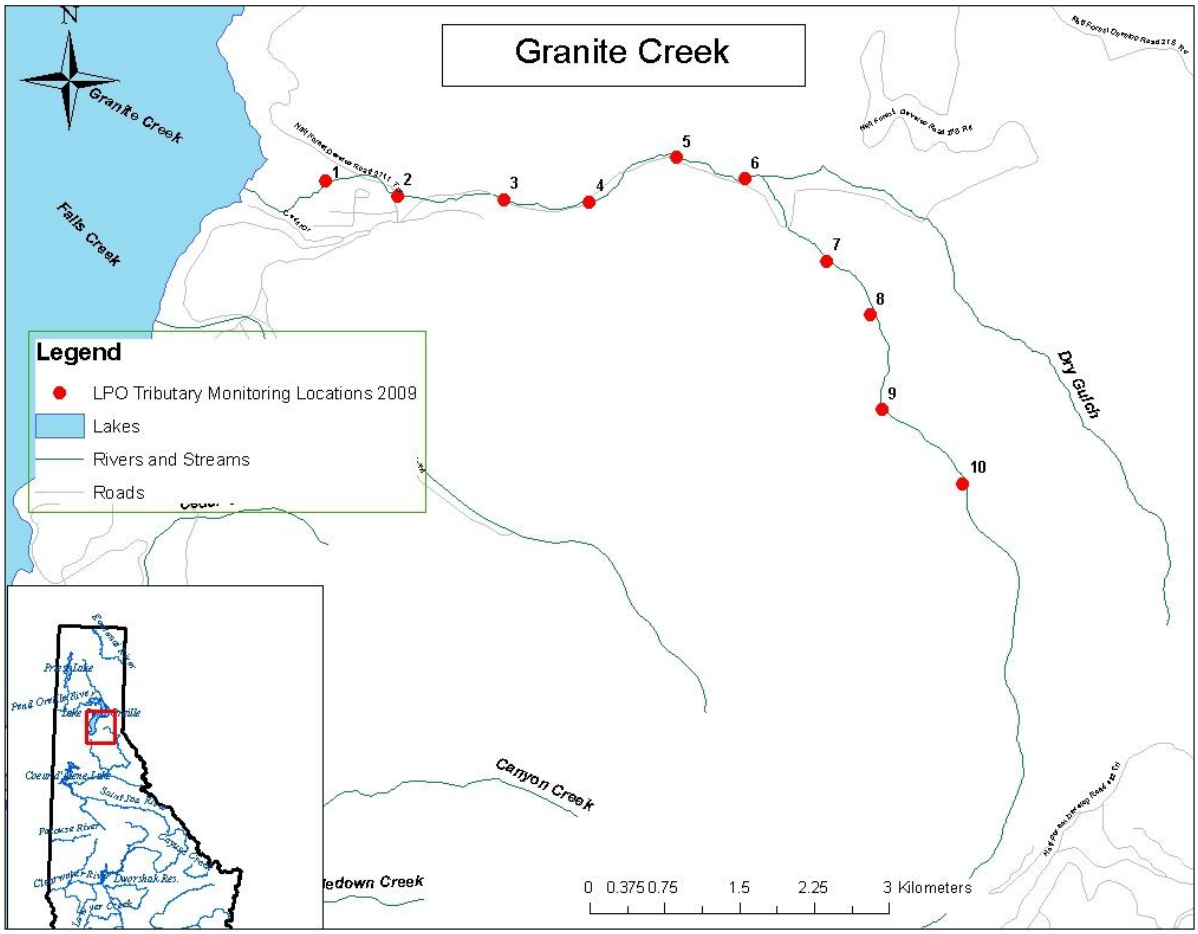

Figure A-2. 2009 tributary monitoring locations on Granite Creek, Idaho.

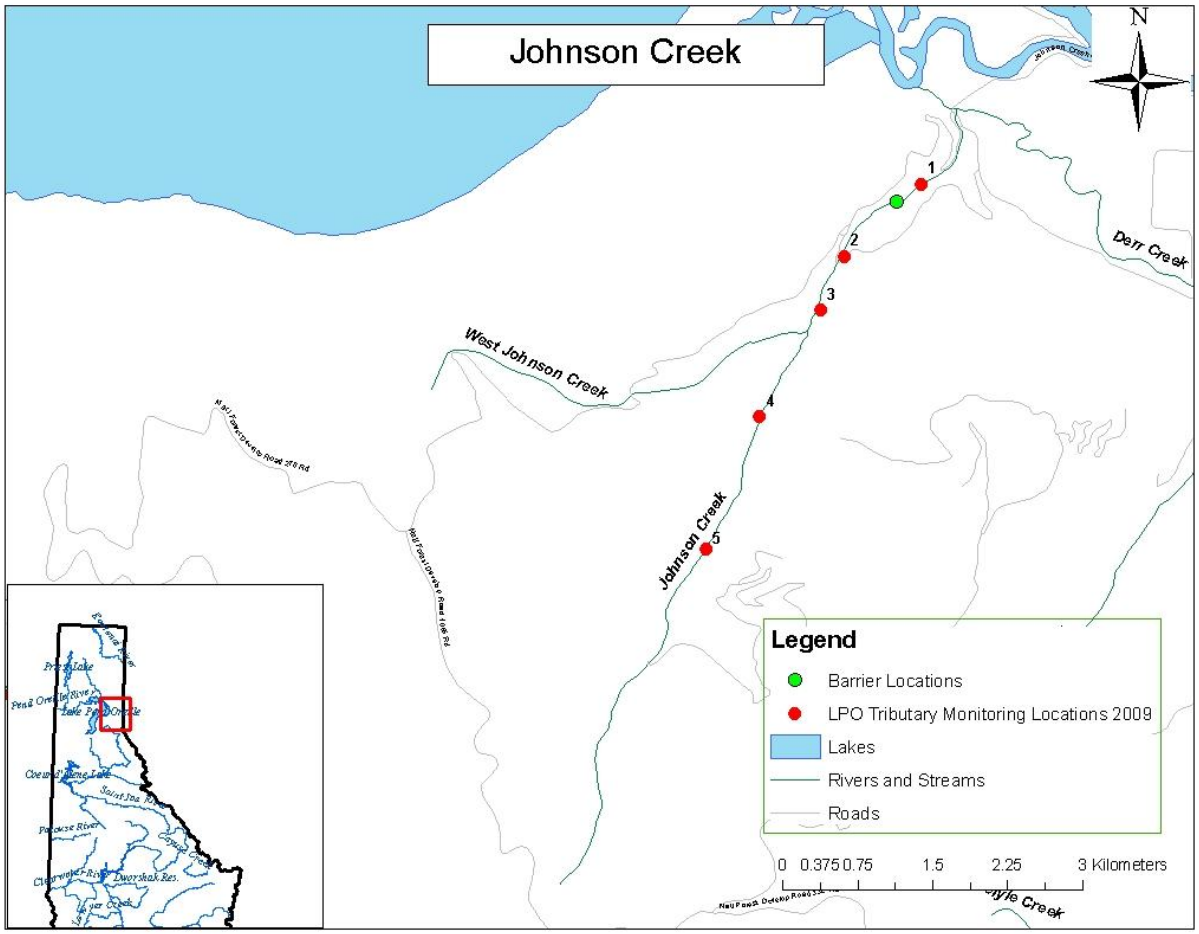

Figure A-3. 2009 tributary monitoring locations on Johnson Creek, Idaho.

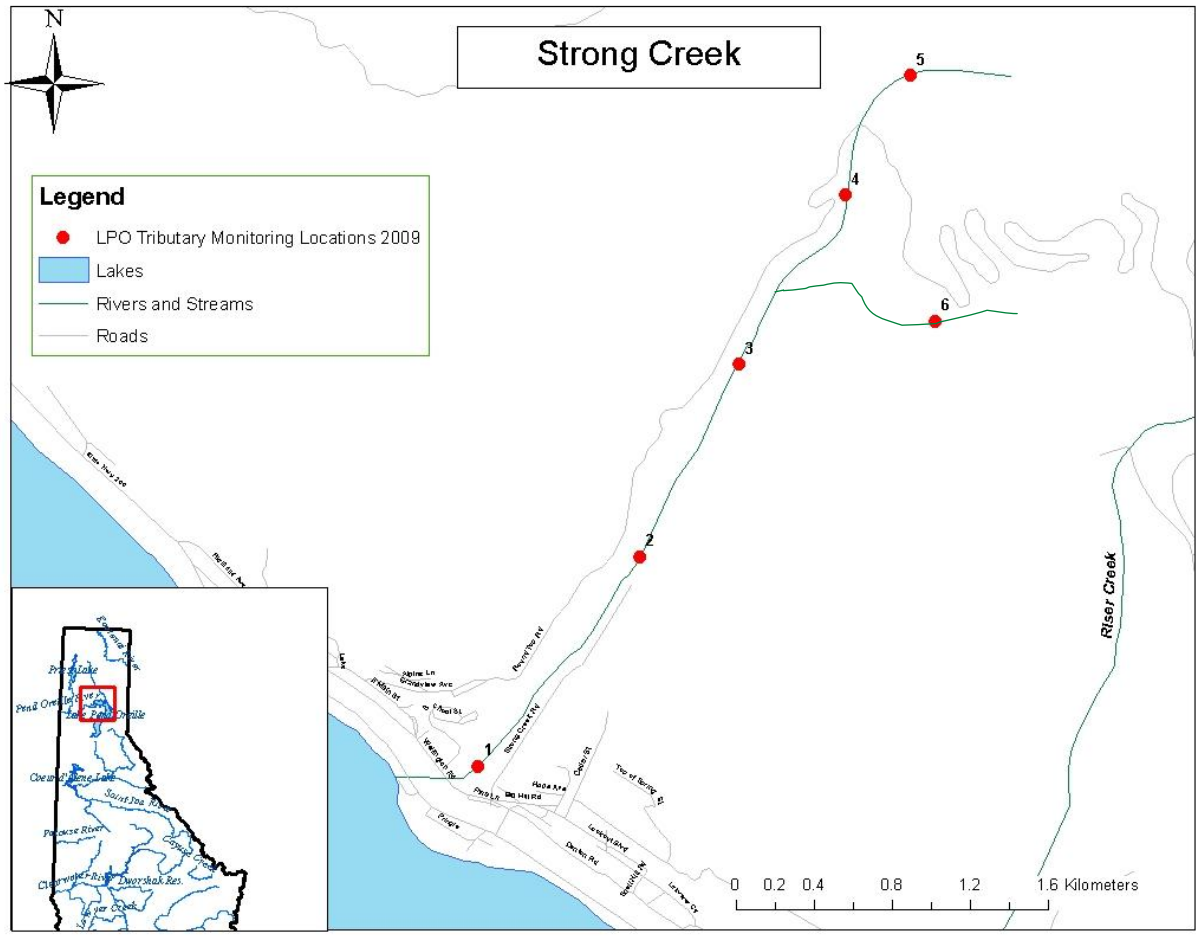

Figure A-4. 2009 tributary monitoring locations on Strong Creek, Idaho.

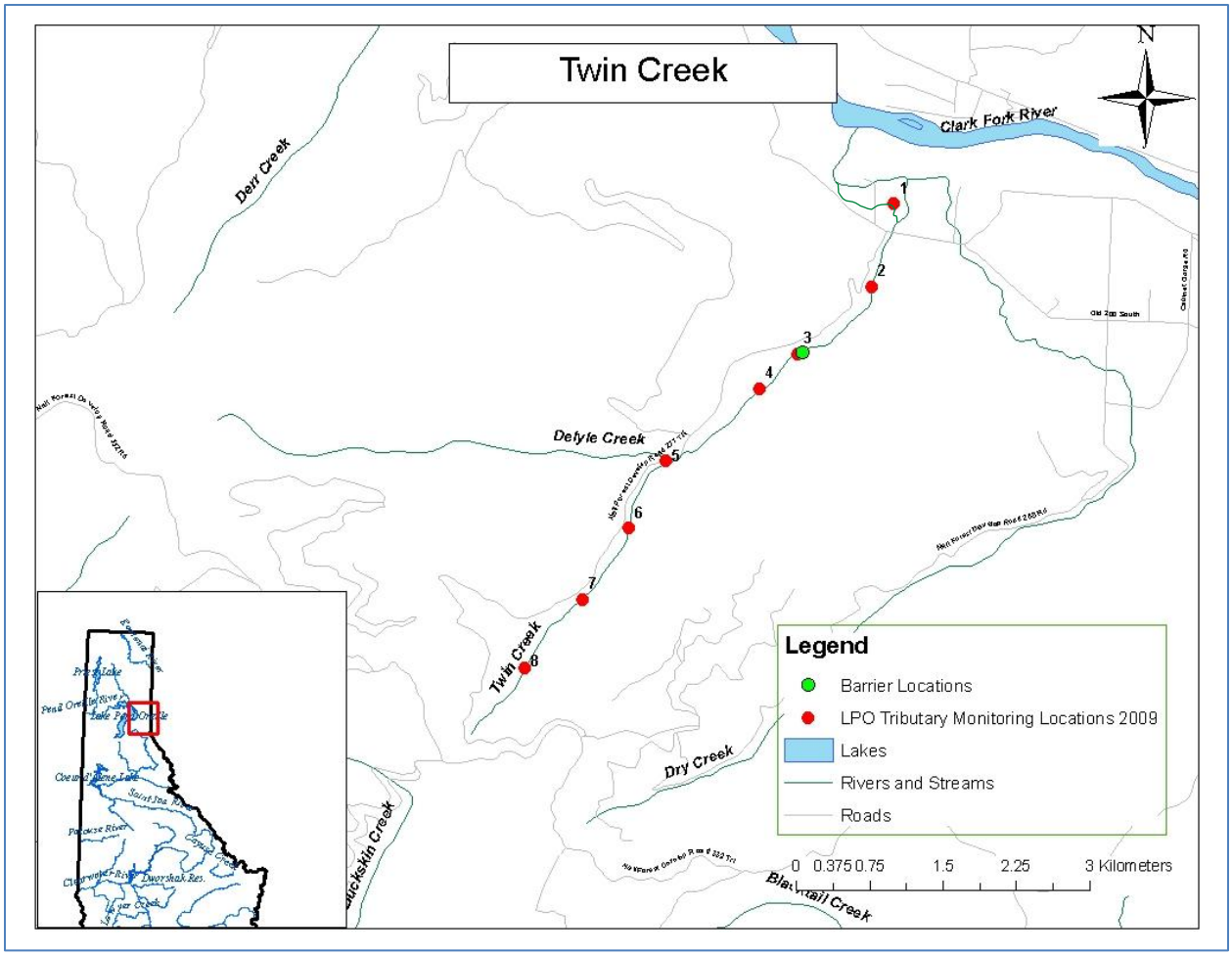

Figure A-5. 2009 tributary monitoring locations on Twin Creek, Idaho.