IDAHO SALMONID RESEARCH AND MONITORING UPDATE - 2015

Idaho Tributary Habitat Acquisition and Enhancement Program, Appendix A

Idaho Tributary Salmonid Abundance Monitoring

Pend Oreille Basin Bull Trout Redd Monitoring

Dissolved Gas Supersaturation Control, Mitigation, and Monitoring Program, Appendix F5

Lake Pend Oreille Survival Study

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter 1 **Idaho Tributary Salmonid Abundance Monitoring**

ABSTRACT

Monitoring surveys are conducted on 25 Lake Pend Oreille tributaries on a five-year rotational basis. In 2015, Grouse Creek, North Fork (N.F.) Grouse Creek, South Fork (S.F.) Grouse Creek, Rapid Lightning Creek, and West Gold Creek were monitored for salmonid abundance and distribution. This is the second time these streams were sampled since the rotational program began in 2009. Overall, densities of most species in Grouse Creek were similar to those measured in 2010, with the exception of Rainbow Trout *Oncorhynchus mykiss* and Westslope Cutthroat Trout *O. clarkii lewisi*, which both decreased by more than half. In N.F. Grouse Creek, the densities of Brook Trout *Salvelinus fontinalis* and Westslope Cutthroat Trout were reduced as compared to those measured in 2010, while Rainbow Trout densities increased. Rainbow Trout were the most abundant species sampled in S. F. Grouse Creek, although Brook Trout, Bull Trout *S. confluentus*, Westslope Cutthroat Trout, and Brook Trout x Bull Trout and Westslope Cutthroat Trout x Rainbow Trout hybrids were also caught. Rainbow Trout were most abundant in the lower sections of Rapid Lightning Creek, transitioning to a mixture of Brook Trout, Westslope Cutthroat Trout, and Westslope Cutthroat Trout x Rainbow Trout hybrids in the middle sections, and Brook Trout and Westslope Cutthroat Trout in the upper sections. West Gold Creek supports one of the highest densities of Westslope Cutthroat Trout among all the LPO tributaries, and Bull Trout and Westslope Cutthroat Trout densities have increased since the stream was last monitored in 2009.

INTRODUCTION

The Idaho Tributary Habitat Acquisition and Fishery Enhancement Program, funded through the Clark Fork Settlement Agreement (CFSA), supports ongoing research and monitoring activities in Idaho tributaries to the Clark Fork River and Lake Pend Oreille (LPO). The purpose of these activities is to evaluate the ongoing efforts in aquatic habitat protection and enhancement and to address impacts and mitigation efforts related to load-following and dissolved gas supersaturation produced by the Clark Fork hydroelectric projects. Research and monitoring activities have largely focused on monitoring abundance and distribution of salmonids in Idaho tributaries to LPO through completion of electrofishing surveys and Bull Trout *Salvelinus confluentus* redd counts. Monitoring surveys are conducted on 25 LPO tributaries, generally on a five-year rotational basis. These surveys provide the ability to follow general trends in fish abundance, species composition, and distribution. This information will enable broad-scale evaluation of the effects associated with efforts in aquatic habitat protection and restoration in LPO tributaries, Lake Trout *S. namaycush* suppression in LPO, and kokanee *O. nerka* enhancement in LPO. All of these management actions are supported through the CFSA. In addition, these data are used to evaluate the location, purpose, and need for future habitat enhancement projects.

METHODS

Grouse Creek, N.F. Grouse Creek, S.F. Grouse Creek, Rapid Lightning Creek, and West Gold Creek were monitored in 2015. Stream survey reaches were established on systematic 1 km intervals progressing upstream from the mouth in each stream. Typically, a 100 m section was sampled for each kilometer of stream, except on longer streams, where an every-other kilometer section was sampled. Decisions to sample every-other section were made depending on stream access constraints, expected fish densities, water availability, and time constraints. Although not always possible, every attempt was made to sample the same stream sections during each year of sampling. The farthest upstream survey site was defined as either the section where water was no longer found or where fish were no longer captured and consequently not suspected to be present further upstream. In a few instances, the uppermost site was based on past sampling results relative to species composition and/or abundance that suggested further surveys would provide low expected variation among additional sample sites. Abundance estimates only included fish ≥75mm (total length; TL) due to sampling efficiency considerations. Sample sites were typically 100 m in length, and the average wetted width of each site was calculated based upon cross sectional measurements collected on 10-m intervals over the sampled section. Sample sites were closed using block nets at the downstream end of each survey site to prevent escapement during downstream electrofishing passes.

Fish were collected using a Smith-Root backpack electrofishing unit and pulsed DC settings, typically at 40-50 Hz, 2 ms, and 500 to 700 volts. Collected fish were held in a bucket prior to measurement, and the water was exchanged frequently to maintain an even temperature and oxygenation. Fish were identified to species, measured (TL; mm) and weighed (g). Species and hybrid crosses were identified phenotypically. Characteristics used in identifying Westslope Cutthroat Trout *O. clarkii lewisi* x Rainbow *O. mykiss* Trout hybrids included throat slashes typically of light intensity or broken in form and exhibiting heavy spotting below the lateral line and toward the anterior end of the fish. Bull Trout x Brook Trout *S. fontinalis* hybrids were identified as individuals exhibiting typical Bull Trout form, but with the presence of some vermiculation and/or irregular spotting on the dorsal fin.

Genetic tissue samples were collected from Bull Trout, and all suspected Bull Trout x Brook Trout hybrids. Subsamples of Westslope Cutthroat Trout, Rainbow Trout and Westslope Cutthroat x Rainbow Trout hybrids were sacrificed for otolith extraction and subsequent age estimation. Additionally, sex and maturity was determined for sacrificed fish by observing gonad development.

Multiple-pass removal estimates (Zippin 1958) were conducted in combination with single pass samples to estimate fish abundance, by species, in each tributary stream. For each stream, a single site was randomly selected and a multiple-pass estimate was generated for that section. For each multiple-pass estimate, sequential passes were conducted until fish captures from a single pass did not exceed 20% of the total capture by species of the first pass. Typically, two or three passes were necessary to satisfy this criterion. Abundance estimates and associated 95% confidence intervals were derived for two- and three- pass samples using calculations for removal estimates in closed populations (Hayes et al. 2007). The total catch on the first pass was reported as the population estimate when no additional individuals of a particular species were captured on subsequent passes. In cases where the lower limit of a confidence interval was less than the total number of fish captured, the total number of fish captured was reported as the lower limit.

After conducting multiple-pass sampling at a random site, the remaining sections of the stream were sampled using a single pass. This was done to increase the number of possible sample sites visited in a field season, as each single pass sample required less time to complete than a multiple-pass sample. Abundances were estimated from single pass samples by generating a multiple-pass regression model of abundance based on first pass collections (Meyer and Schill 1999). The multiple-pass regression model was generated using data collected from 25 LPO tributary streams sampled between 2009 and 2015 (including the present years' data), on all target species (Ryan and Jakubowski 2011a, 2011b, 2012, Ryan et al. 2014).

Density estimates were reported as the number per 100 m^2. Average density estimates for each stream were calculated by species for all sections sampled that contained fish and may have included data from sections where a given species was not detected.

RESULTS

Thirty-two sections were surveyed within all sampled tributaries between July 21 and September 6, 2015 (Table 1-1). Fish were detected at 31 of the 32 sites sampled.

TABLE 1-1. Locations (UTM) of survey sections sampled in tributaries to Lake Pend Oreille, Idaho during 2015 monitoring. Waypoints represent the approximate lower extent of each survey section.

Stream	Section	Date	Datum	Zone	Easting	Northing	Reach Length (m)	Avg. Width (m)
Grouse Creek	6	7/30/2015	WGS 84	11U	541380	5361707	100	7.3
	8	7/30/2015	WGS 84	11U	543001	5363201	100	10.7
	10	8/4/2015	WGS 84	11U	544178	5364399	100	7.2
	12	8/4/2015	WGS 84	11U	544891	5365726	100	11.1
	14	8/4/2015	WGS 84	11U	546270	5366443	100	5.8
	16	8/4/2015	WGS 84	11U	547677	5367114	100	8.0
	18	8/5/2015	WGS 84	11U	549514	5367565	100	5.4
	20	8/5/2015	WGS 84	11U	551608	5367106	100	6.5
	22	8/6/2015	WGS 84	11U	553152	5367144	100	6.2
	24	8/10/2015	WGS 84	11U	554143	5368410	100	7.6
	26	8/10/2015	WGS 84	11U	556191	5399810	100	5.8
	28	8/11/2015	WGS 84	11U	557455	5370163	100	4.9
	30	8/11/2015	WGS 84	11U	558964	5369441	100	2.9
N.F. Grouse Creek	1	8/12/2015	WGS 84	11U	546263	5367150	100	3.6
	3	8/18/2015	WGS 84	11U	546682	5368861	100	5.4
	5	8/18/2015	WGS 84	11U	547802	5370117	100	3.2
	7	8/13/2015	WGS 84	11U	548283	5371761	100	3.5
	9	8/13/2015	WGS 84	11U	549606	5373170	100	4.0
	11	8/17/2015	WGS 84	11U	551188	5373785	100	3.3
S. F. Grouse Creek	1	10/6/2015	WGS84	11U	554261	5366581	100	2.8
Rapid Lightning Creek	1	7/21/2015	WGS 84	11U	544461	5357345	100	10.4
	3	7/22/2015	WGS 84	11U	545738	5358397	100	9.7
	5	7/23/2015	WGS 84	11U	547452	5358851	100	8.8
	7	7/23/2015	WGS 84	11U	549289	5358777	100	8.0
	9	7/27/2015	WGS 84	11U	550710	5360224	100	5.4
	11	7/27/2015	WGS 84	11U	551788	5361164	100	6.0
	14	7/28/2015	WGS 84	11U	553609	5362070	100	3.5
	16	7/28/2015	WGS 84	11U	555737	5362487	100	4.2
	18	7/29/2015	WGS 84	11U	556930	5363677	100	4.4
W. Gold Creek	1	8/19/2015	WGS 84	11U	540549	5311150	100	3.4
	3	8/25/2015	WGS 84	11T	538938	5310178	100	2.4
	5	8/20/2015	WGS 84	11T	537501	5309189	100	2.5

Data from five stream sections (one from each monitored stream) were added to a regression model to estimate fish abundance from a single pass based on first pass collections (Figure 1-1) of a multiple-pass depletion estimate. Based on the developed linear model, the first pass collections described approximately 98% of the variation in estimated abundance from multiple-pass samples (n=137, p<0.01).

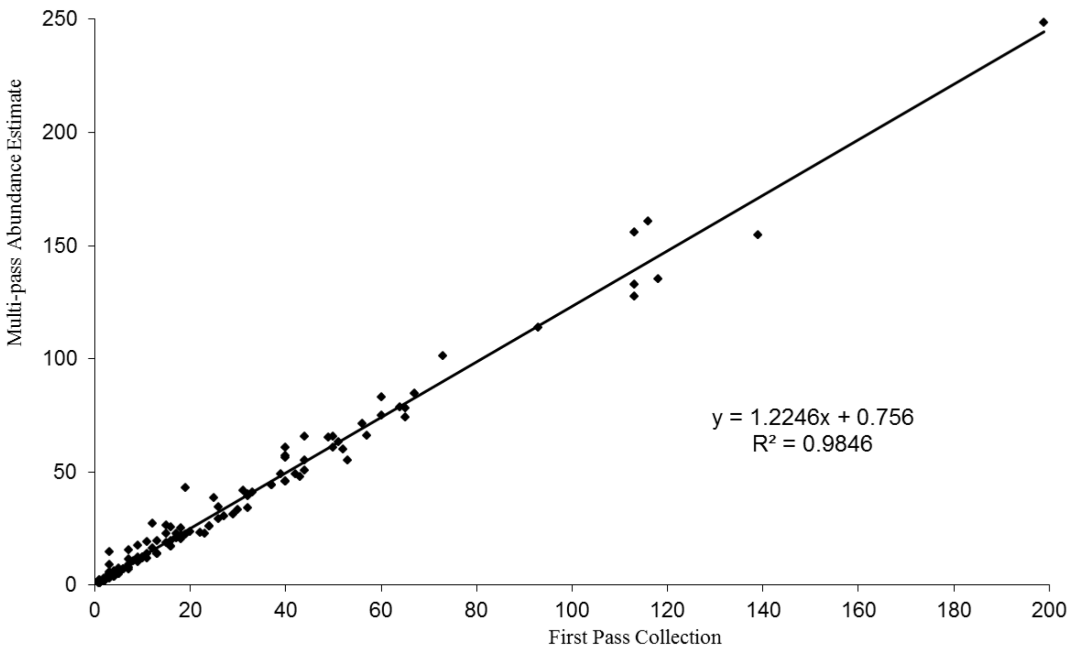

FIGURE 1-1. Regression model of the estimated trout abundance using multiple-pass methods by the number captured on the first pass. Data represent combined 2009 - 2015 multiple-pass removal efforts for salmonids ≥ 75 mm total length in Lake Pend Oreille, Idaho tributaries.

<u>Grouse Creek</u>

Thirteen sections of Grouse Creek representing 30 km of stream were sampled in 2015 (Table 1-1; Figure 1-2). Rainbow Trout were most abundant in the lower and middle reaches (downstream of Section 26), while Bull Trout were most abundant in the upper reaches (Table 1-2). The average density of Bull Trout in Grouse Creek was the highest measured among the streams surveyed in 2015 (Table 1-3). Densities for most species in Grouse Creek were similar to those measured in 2010, with the exception of Rainbow Trout and Westslope Cutthroat Trout, which decreased by more than half for each species (Table 1-4).

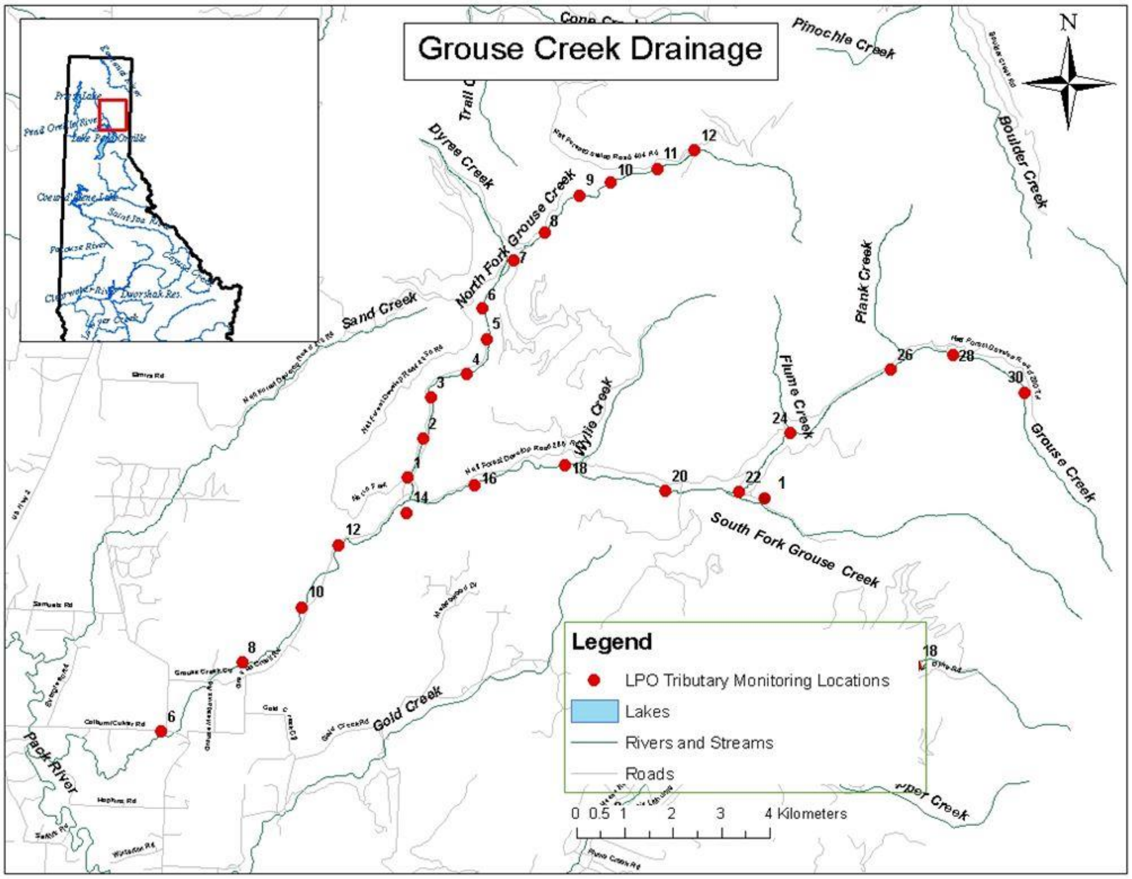

FIGURE 1-2. Map of Grouse, North Fork Grouse, and South Fork Grouse creeks, Idaho, depicting sampling locations (km).

TABLE 1-2. Length and abundance data by section and species for Grouse Creek, Idaho, 2015.

		Total Length			Fish/100 m			Fish/100 m^2		
Section (km)	Species	Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
6	RBT	107	86	153	19.1	15.0	27.3	2.6	2.1	3.7
8	RBT	96	69	126	19.1	15.0	27.3	1.8	1.4	2.6
8	WCT	96	83	105	4.4	3.0	12.6	0.4	0.3	1.2
8	MWF	82	81	83	3.2	2.0	11.4	0.3	0.2	1.1
10	RBT	121	85	191	8.1	6.0	16.3	1.1	0.8	2.3
12	RBT	133	107	172	10.6	8.0	18.7	1.0	0.7	1.7
14	BRK	232	232	232	2.0	1.0	10.2	0.3	0.2	1.8
14	RBT	91	65	120	9.3	7.0	17.5	1.6	1.2	3.0
14	BBHY	450	450	450	2.0	1.0	10.2	0.3	0.2	1.8
16	RBT	100	77	166	43.6	35.4	51.8	5.5	4.4	6.5
16	WRHY	103	103	103	2.0	1.0	10.2	0.2	0.1	1.3
18	BRK	188	161	215	3.2	2.0	11.4	0.6	0.4	2.1
18	RBT	130	71	114	26.5	21.0	34.7	4.9	3.9	6.4
18	WCT	112	90	187	6.9	5.0	15.1	1.3	0.9	2.8
18	BBHY	257	257	257	2.0	1.0	10.2	0.4	0.2	1.9
20	BLT	106	88	135	7.0	7.0	7.0	1.1	1.1	1.1
20	BRK	140	117	165	6.1	6.0	15.9	0.9	0.9	2.5
20	RBT	116	78	229	83.0	81.0	90.7	12.8	12.5	14.0
20	WCT	95	81	108	2.0	2.0	2.0	0.3	0.3	0.3
20	BBHY	226	226	226	1.0	1.0	1.0	0.2	0.2	0.2
20	WRHY	104	104	104	1.0	1.0	1.0	0.2	0.2	0.2
22	BLT	114	95	152	4.4	3.0	12.6	0.7	0.5	2.0
22	BRK	138	100	170	8.1	6.0	16.3	1.3	1.0	2.6
22	RBT	141	101	238	24.0	19.0	32.2	3.9	3.1	5.2
22	BBHY	174	174	174	2.0	1.0	10.2	0.3	0.2	1.6
24	BLT	100	91	140	13.0	10.0	21.2	1.7	1.3	2.8
24	BRK	155	139	169	5.7	4.0	13.9	0.7	0.5	1.8
24	RBT	122	74	230	58.3	50.1	66.5	7.7	6.6	8.8
24	WCT	170	133	210	5.7	4.0	13.9	0.7	0.5	1.8
24	BBHY	134	99	181	4.4	3.0	12.6	0.6	0.4	1.7
24	WRHY	127	127	127	2.0	1.0	10.2	0.3	0.1	1.3

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TABLE 1-2. Continued.

Section (km)	Species	Total Length Mean	Min.	Max.	Fish/100 m Est.	95% CI -	95% CI +	Fish/100 m^2 Est.	95% CI -	95% CI +
26	BLT	110	86	223	43.6	35.4	51.8	7.5	6.1	8.9
26	RBT	119	102	172	15.5	12.0	23.6	2.7	2.1	4.1
26	WCT	131	93	170	8.1	6.0	16.3	1.4	1.0	2.8
26	BBHY	182	126	262	4.4	3.0	12.6	0.8	0.5	2.2
26	WRHY	121	87	206	8.1	6.0	16.3	1.4	1.0	2.8
28	BLT	105	78	146	73.0	64.8	81.2	14.9	13.2	16.6
28	RBT	1130	130	130	2.0	1.0	10.2	0.4	0.2	2.1
28	WCT	131	79	217	21.6	17.0	29.8	4.4	3.5	6.1
28	WRHY	193	193	193	2.0	1.0	10.2	0.4	0.2	2.1
30	BLT	87	76	97	62.0	53.8	70.2	21.4	18.5	24.2
30	WCT	114	78	172	37.5	30.0	45.7	12.9	10.3	15.8

TABLE 1-3. Mean estimated density (fish/100m^2) of salmonids in Lake Pend Oreille, Idaho tributaries from 2011-2015. Average density values were calculated by species for all surveyed sections where fish were caught.

Stream	Year last surveyed	BLT	BRK	BRN	RBT	WCT	MWF	BBHY	WRHY
Grouse Creek	2015	3.6	0.3	0.0	3.5	1.7	<0.01	0.2	0.2
N.F. Grouse Creek	2015	0.2	2.2	0.0	6.4	4.1	0.0	0.0	0.1
S.F. Grouse Creek	2015	0.7	2.5	0.0	15.1	0.7	0.0	2.5	2.9
Rapid Lighting Creek	2015	0.0	3.3	0.0	1.1	6.4	0.3	0.0	0.2
West Gold Creek	2015	2.2	0.0	0.0	0.0	50.8	0.0	0.0	0.0
Granite Creek	2014	6.3	0.0	0.0	0.0	6.4	0.0	0.0	<0.1
Gold Creek	2014	2.5	0.0	0.0	0.0	32.0	0.0	0.0	0.2
Strong Creek	2014	3.2	0.0	0.0	<0.1	19.0	0.0	0.0	<0.1
Johnson Creek	2014	1.0	0.0	0.0	0.0	7.0	0.0	0.0	0.0
Twin Creek	2014	0.1	7.6	0.5	1.3	3.3	0.0	0.0	1.4
Berry Creek	2013	0.0	0.2	0.0	0.5	11.0	0.0	0.0	0.8
Char Creek	2013	0.0	0.0	0.0	0.0	75.0	0.0	0.0	0.0
Jeru Creek	2013	0.2	0.0	0.0	0.7	5.6	0.0	0.0	3.1
Mosquito Creek	2013	0.0	4.9	0.2	0.0	3.4	0.0	0.0	0.2
Spring Creek	2013	0.0	16.5	0.1	0.2	0.9	0.1	0.0	0.3
E.F. Lightning Creek	2012	3.1	0.1	0.0	2.8	4.5	0.0	0.5	0.4
Hellroaring Creek	2012	0.2	<0.1	0.0	4.0	0.0	0.0	0.0	0.2
McCormick Creek	2012	0.0	0.0	0.0	0.5	1.7	0.0	0.0	0.3
Porcupine Creek	2012	1.0	5.4	0.0	0.0	10.5	0.0	0.0	0.9
Rattle Creek	2012	4.6	0.0	0.0	0.6	5.8	0.0	0.0	0.1
Savage Creek	2012	5.1	0.0	0.0	<0.1	3.9	0.0	0.0	0.7
Wellington Creek	2012	1.3	0.1	0.0	0.5	10.4	0.0	0.0	0.4
Caribou Creek	2011	3.1	0.3	0.0	1.2	6.1	0.0	0.0	0.7
Morris Creek	2011	5.8	0.0	0.0	0.0	7.0	0.0	0.0	1.8
Trestle Creek	2011	1.8	0.0	0.0	<0.1	4.5	0.1	0.0	1.0

TABLE 1-4. Current year and historic salmonid density (fish/100m^2) estimates by tributary stream, 2009-2015.

Stream	Year	BLT	BRK	RBT	WCT	MWF	BBHY	WRHY
Grouse Creek	2010	3.5	0.4	8.2	3.6	0.6	0.2	0.3
	2015	3.6	0.3	3.5	1.7	<0.01	0.2	0.2
N.F. Grouse Creek	2010	0.0	4.1	5.0	5.9	0.0	0.0	0.3
	2015	0.2	2.2	6.4	4.1	0.0	0.0	0.1
S.F. Grouse Creek	2013	1.3	3.0	7.6	1.3	0.0	0.0	3.3
	2015	0.7	2.5	15.1	0.7	0.0	2.5	2.9
Rapid Lighting Creek	2010	<0.1	3.2	1.0	5.2	1.2	0.0	0.3
	2015	0.0	3.3	1.1	6.4	0.3	0.0	0.2
West Gold Creek	2009	0.1	0.0	0.0	43.7	0.0	0.0	0.0
	2015	2.2	0.0	0.0	50.8	0.0	0.0	0.0

N.F. Grouse Creek

Six sections were identified for sampling in N.F. Grouse Creek; however, no fish were caught in the uppermost Section (Table 1-1; Figure 1-2). Rainbow Trout were the most abundant species in the lower creek (Sections 1 through 7), while Westslope Cutthroat Trout were abundant and the only species caught in Section 9 (Table 1-5). Overall Rainbow and Westslope Cutthroat trout densities were moderate as compared to other streams sampled in 2015 (Table 1-3). The densities of Brook and Westslope Cutthroat Trout were reduced as compared to those measured in 2010, while Rainbow Trout densities increased by approximately 28% (Table 1-4).

TABLE 1-5. Length and abundance data by section and species for North Fork Grouse Creek, Idaho, 2015.

		Total Length			Fish/100 m			Fish/100 m^2		
Section (km)	Species	Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
1	BLT	114	114	114	1.0	1.0	1.0	0.3	0.3	0.3
1	BRK	75	75	75	1.0	1.0	1.0	0.3	0.3	0.3
1	RBT	104	82	152	49.0	48.0	51.7	13.6	13.3	14.4
3	BLT	127	115	138	3.2	2.0	11.4	0.6	0.4	2.1
3	RBT	103	83	142	46.1	37.9	54.3	8.5	7.0	10.0
5	BLT	164	164	164	2.0	1.0	10.2	0.6	0.3	3.2
5	BRK	104	77	147	11.8	9.0	20.0	3.7	2.8	6.2
5	RBT	119	90	197	30.1	24.0	38.3	9.4	7.5	12.0
7	BRK	128	89	235	31.4	25.0	39.6	9.0	7.1	11.3
7	RBT	110	95	137	24.0	19.0	32.2	6.9	5.4	9.2
7	WCT	120	76	214	15.5	12.0	23.6	4.4	3.4	6.8
7	WRHY	109	109	109	2.0	1.0	10.2	0.6	0.3	2.9
9	WCT	112	75	186	81.6	73.4	89.8	20.4	18.3	22.4
11	No Fish									

S.F. Grouse Creek

One section was sampled in S.F. Grouse Creek (Table 1-1; Figure 1-2). Rainbow Trout were the most abundant species sampled, although Brook Trout, Bull Trout, Westslope Cutthroat Trout, and Brook Trout x Bull Trout and Westslope Cutthroat Trout x Rainbow Trout hybrids were also caught (Table 1-6). The average density of over 15 Rainbow Trout/100 m^2 was the highest recorded in any of the monitored streams (Table 1-3) and almost twice the average density measured in 2013 (Table 1-4).

TABLE 1-6. Length and abundance data by section and species for South Fork Grouse Creek, Idaho, 2015.

		Total Length			Fish/100 m			Fish/100 m^2		
Section (km)	Species	Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
1	BRK	111	75	147	6.9	5.0	15.1	2.5	1.8	5.4
1	RBT	93	75	118	42.4	34.2	50.6	15.1	12.2	18.1
1	WCT	85	85	85	2.0	1.0	10.2	0.7	0.4	3.6
1	BBHY	93	87	98	6.9	5.0	15.1	2.5	1.8	5.4
1	WRHY	78	75	85	8.1	6.0	16.3	2.9	2.1	5.8

Rapid Lightning Creek

Nine sections were sampled in Rapid Lightning Creek representing 18 river km (Table 1-1; Figure 1-3). Rainbow Trout were most abundant in the lower sections, transitioning to a mixture of Brook Trout, Westslope Cutthroat Trout, and Westslope Cutthroat Trout x Rainbow Trout hybrids in the middle sections, and Brook Trout and Westslope Cutthroat Trout in the upper sections (Table 1-7). Westslope Cutthroat and Brook Trout densities were moderate as compared to other streams sampled in 2015 (Table 1-3) and densities of all species captured were similar to those documented in 2009 (Table 1-4).

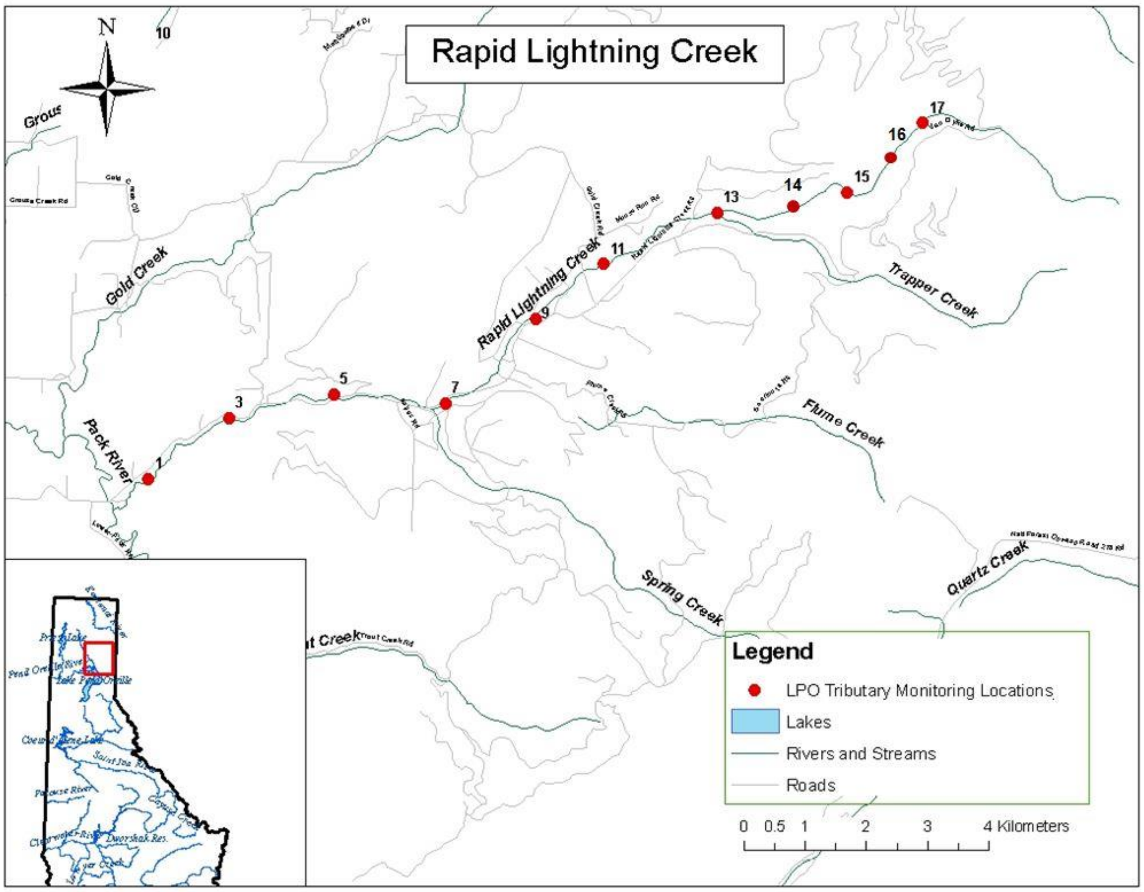

FIGURE 1-3. Map of Rapid Lightning Creek, Idaho, depicting sampling locations (km).

TABLE 1-7. Length and abundance data by section and species for Rapid Lightning Creek, Idaho, 2015.

		Total Length			Fish/100 m			Fish/100 m^2		
Section (km)	Species	Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
1	BRK	287	255	318	3.2	2.0	11.4	0.3	0.2	1.1
1	RBT	143	94	323	28.9	23.0	37.1	2.8	2.2	3.6
1	MWF	77	71	81	4.4	3.0	12.6	0.4	0.3	1.2
3	BRK	190	130	255	8.1	6.0	16.3	0.8	0.6	1.7
3	RBT	118	91	238	59.5	51.3	67.7	6.1	5.3	7.0
3	WCT	101	87	117	9.3	7.0	17.5	1.0	0.7	1.8
3	WRHY	113	100	126	6.9	5.0	15.1	0.7	0.5	1.6
3	MWF	99	82	161	20.3	16.0	28.5	2.1	1.6	2.9
5	BRK	136	74	184	8.1	6.0	16.3	0.9	0.7	1.9
5	RBT	194	128	239	6.9	5.0	15.1	0.8	0.6	1.7
5	WCT	141	99	287	11.8	9.0	20.0	1.3	1.0	2.3
5	WRHY	154	107	205	8.1	6.0	16.3	0.9	0.7	1.9
7	BRK	134	107	166	4.4	3.0	12.6	0.6	0.4	1.6
7	WCT	163	93	314	14.2	11.0	22.4	1.8	1.4	2.8
7	WRHY	104	104	104	2.0	1.0	10.2	0.2	0.1	1.3
9	BRK	131	75	190	27.7	22.0	35.9	5.1	4.1	6.6
9	WCT	123	94	214	19.1	15.0	27.3	3.5	2.8	5.1
11	BRK	134	75	210	57.4	55.0	61.7	9.6	9.2	10.3
11	WCT	128	83	212	43.1	37.0	165.4	7.2	6.2	27.6
14	BRK	127	93	186	35.0	28.0	43.2	10.0	8.0	12.4
14	WCT	111	77	192	27.7	22.0	35.9	7.9	6.3	10.3
16	BRK	142	97	165	8.1	6.0	16.3	1.9	1.4	3.9
16	WCT	124	72	178	64.4	56.2	72.6	15.3	13.4	17.3
18	WCT	117	75	215	84.0	75.8	92.2	19.1	17.2	21.0

West Gold Creek

Three sections were sampled in West Gold Creek in 2015 (Table 1-1; Figure 1-3). The only species caught were Bull Trout and Westslope Cutthroat Trout. The abundance of Bull Trout was highest in the lower reaches of the watershed, while the abundance of Westslope Cutthroat Trout increased in higher reaches (Table 1-8). West Gold Creek supports one of the highest densities of Westslope Cutthroat Trout among all the LPO tributaries (Table 1-3), and Bull Trout and Westslope Cutthroat Trout densities have increased since the stream was last monitored in 2009 (Table 1-4).

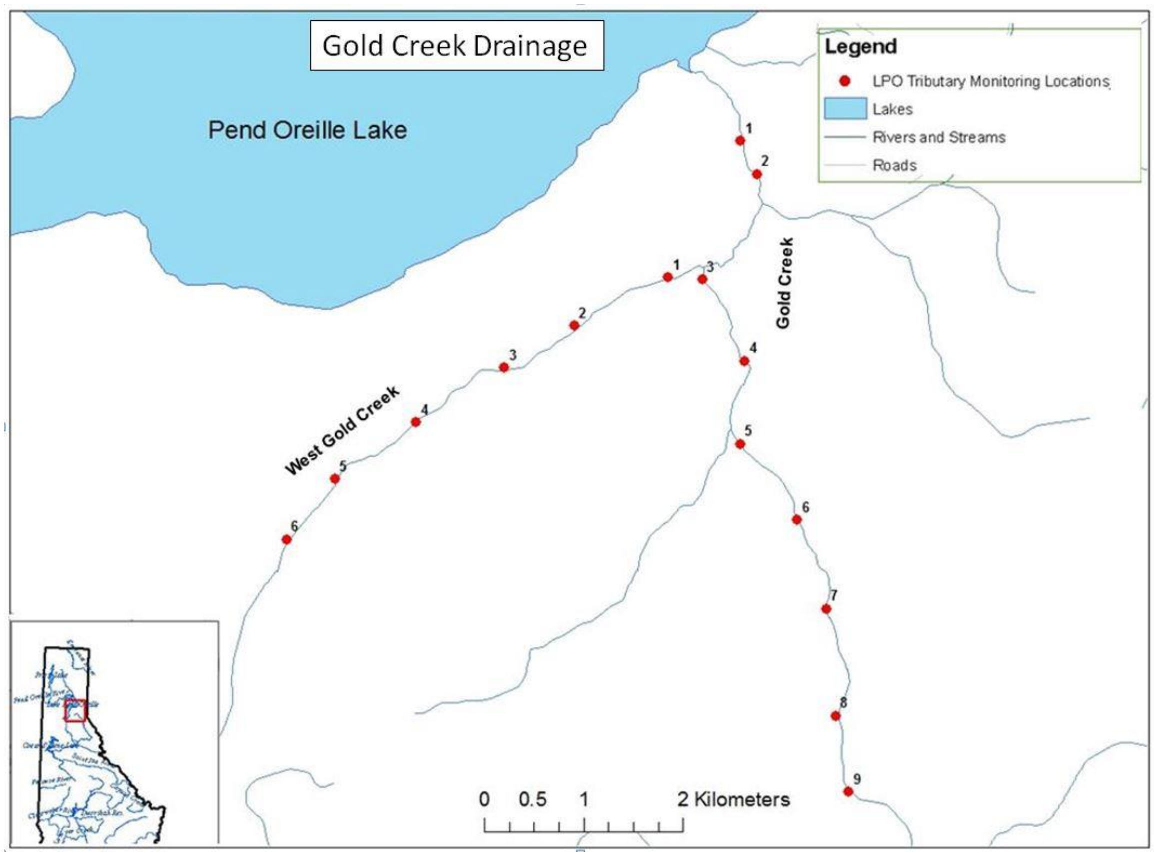

FIGURE 1-4. Map of the Gold Creek, Idaho drainage, depicting sampling locations (km).

TABLE 1-8. Length and abundance data by section and species for West Gold Creek, Idaho, 2015.

		Total Length			Fish/100 m			Fish/100 m^2		
Section (km)	Species	Mean	Min.	Max.	Est.	95% CI -	95% CI +	Est.	95% CI -	95% CI +
1	BLT	109	91	123	19.1	15.0	27.3	5.6	4.4	8.0
1	WCT	118	75	221	85.3	77.0	93.5	25.1	22.7	27.5
3	BLT	106	65	146	2.0	2.0	2.0	0.8	0.8	0.8
3	WCT	110	75	203	133.0	133.0	139.0	55.4	55.4	57.9
5	WCT	110	74	197	179.5	171.1	188.0	71.8	68.4	75.2

DISCUSSION

The summer of 2015 was the warmest, driest summer in the Northwest since records began in 1910 (http://www.ncdc.noaa.gov/extremes/cei/regional-overview). Despite the extreme air temperatures and lack of precipitation, the sections of the streams monitored in 2015 all exhibited perennial flow, and on the days sampled measured water temperatures averaged 14° C and never exceeded 23° C. These temperatures were below the upper limits generally accepted to be harmful to most trout species (Benhke 1992), so we did not expect to have reduced fish abundance directly resulting from low water and high temperatures. Although likely not measured in exactly the same locations, average stream widths measured in 2015 were very similar to those measured in 2010 (Ryan and Jakubowski 2011b). Thus, density estimates were likely not inflated due to low water and allowed for valid between-year comparisons.

Overall, the general trend of higher Rainbow and Brook trout abundance lower in the watershed and transitioning to Bull Trout and Westslope Cutthroat Trout higher in the drainages was apparent in the streams surveyed in 2015. In some situations (N.F. Grouse Creek, Rapid Lightning Creek, West Gold Creek) barriers were present (Hoelscher and Bjorn 1989), but in others (e.g., Grouse Creek) the transition to native species was not related to access from downstream.

In N.F. Grouse Creek, a barrier is located in Section 7. It is a 2 m high bedrock fall, with a 1 m fall located immediately upstream. A large overhanging rock, which the lower fall drops onto, prevents fish from being able to effectively use the plunge pool to leap. Brook Trout and Rainbow Trout were most prevalent below the barrier, while Westslope Cutthroat Trout were most abundant above the barrier.

In Rapid Lightning Creek, a falls is located at approximately river km 2.7. However, the distribution of Rainbow Trout upstream of the falls suggest that it is not a complete barrier, at least during some flows. Another potential barrier was identified upstream of survey Section 5 in Ryan and Jakubowski (2011b) based on the lack of Rainbow Trout higher in the watershed. The exact location of this barrier has not been verified. In 2015, Brook Trout and Westslope Cutthroat Trout were abundant above this section as expected, but one Rainbow Trout x Westslope Cutthroat hybrid was identified above this barrier, suggesting passage is possible at least during some conditions for Rainbow Trout. Brook Trout have not been captured upstream of Section 16, but no barrier has been identified in this reach and the reason for this shift is unknown.

A barrier upstream of Section 1 on West Gold Creek has been considered a complete blockage to Bull Trout passage. It consists of two approximately 1.5 m high falls over large boulders. However, in 2015 two juvenile Bull Trout, most likely from different age classes based upon their lengths, were captured above this barrier. This is believed to be the first time juvenile Bull Trout have been documented upstream of this location which suggests passage of these falls of adult BLT was possible during some conditions.

The Grouse Creek drainage (including N.F. and S.F. Grouse creeks) exhibited the highest Rainbow Trout densities among the surveyed streams. The Rainbow Trout caught in the Grouse Creek drainage were likely all juvenile fish, as they averaged approximately 110 mm in length and none exceeded 238 mm. Large-bodied migratory Rainbow Trout are known to migrate from LPO to spawn in this drainage, which suggests that the majority of Rainbow Trout found in this drainage will likely exhibit a migratory life history. This is consistent with results from Campbell et al. (2013), which suggest fish from Grouse Creek genetically resemble adfluvial Gerrard strain Rainbow Trout from the Kootenay

Hatchery and/or Kootenay Lake. The fish assemblage shifts to native salmonids (Bull Trout and Westslope Cutthroat Trout) upstream of approximately river km 28.

Rainbow Trout and Westslope Cutthroat Trout x Rainbow Trout hybrid densities were especially high in S.F. Grouse Creek. Only one section has been sampled in this stream, once in 2013 and once in 2015. The longitudinal distribution of Rainbow and Westslope Cutthroat trout in this stream is unknown and further work is warranted to better understand the Cutthroat Trout population and the relatively high hybridization rates encountered in this system. We recommend sampling more sections in S.F. Grouse Creek the next time it is surveyed.

Though Brook Trout x Bull Trout hybrids have been found in low numbers in several streams during previous sampling efforts (Downs and Jakubowski 2006; Ryan and Jakubowski, 2012 and 2013), the greatest numbers of Brook Trout x Bull Trout hybrids have been captured in the Grouse Creek drainage. In 2015, a total of 11 out of 41 genetic samples collected for species identification were found to be from Brook Trout x Bull Trout hybrids during laboratory testing. All 11 samples were correctly identified in the field as being from hybrids.

In S.F. Grouse Creek, only one section (located in the lower end of the drainage) has been sampled. This section contains low densities of Bull Trout and high densities of both Brook Trout and Brook Trout x Bull Trout hybrids. A likely reason for the high density of hybrids is the large number of Brook Trout present in this reach. The few adult Bull Trout returning to this reach to spawn are likely to encounter numerous Brook Trout, and with few other Bull Trout present, the odds favor them pairing with non-native Brook Trout. To further exacerbate the problem, one study using samples collected from five western Montana streams found that about one-quarter of the Brook Trout x Bull Trout hybrids tested were actually backcrosses to their parental species (Kanda et al. 2002). In contrast, hybrids have not been found in N.F. Grouse Creek, despite low Bull Trout densities and high Brook Trout densities. This is likely due to less overlap in their spatial distribution. The upper sections of N.F. Grouse Creek contain the highest densities of Brook Trout, while few or no Bull Trout are found in the upper reaches. In mainstem Grouse Creek, high densities of Bull Trout, but low densities of Brook Trout produced few hybrids. Brook Trout were fairly widely dispersed, being found in six of the thirteen sections sampled. In this case, the chance of interaction between the species is relatively low due to low Brook Trout densities.

Recommendations:

1) Continue standardized 5-year rotational tributary sampling.
2) Increase sampling effort on S.F. Grouse Creek to better understand the fish assemblage in this stream.
3) Collect habitat and water temperature data as part of standardized monitoring protocol to link with fish assemblage data. These data will help direct future habitat enhancement projects and other management activities.

Chapter 2 **Pend Oreille Basin Redd Count Monitoring**

ABSTRACT

Redd counts are typically used as an index of abundance to gauge the relative strength of adult Bull Trout escapement from year to year. The number of Bull Trout redds have been counted in 22 LPO tributaries since 1983. In 2015, 553 redds were counted in 20 streams, 297 of which were counted in six index streams. Collectively, counts in index streams were below the past 10- and 20-year averages. Historically low streamflow in 2015 likely precluded some fish from ascending spawning tributaries. Conditions in 2015 serve as a reminder that redd count data are inherently variable due to changing survey conditions, spawning timing, surveyor ability and experience, and stream morphology. Therefore, it is important to remember that these data are collected to provide general long-term trend data and should be interpreted cautiously, particularly over short time periods.

INTRODUCTION

Redd counts are used across the range of Bull Trout *Salvelinus confluentus* to monitor population trends. They are typically used as an index of abundance to gauge the relative strength of adult escapement from year to year. Redd counts require less effort to conduct than other traditional monitoring methods such as trapping, yet provide information on adult Bull Trout abundance at the watershed and/or population level. However, redd counts are not without their limitations, as the technique has been shown to be prone to observer variability (Dunham et al. 2001). In addition, annual variation in flows, water clarity, spawner timing, survey conditions (e.g. rain or lightning conditions) all can influence individual streams' counts. Nevertheless, they remain an important monitoring tool for Bull Trout populations and do provide a rough-scale index of abundance.

METHODS

Idaho Department of Fish and Game, Avista, US Fish and Wildlife Service, Idaho Department of Lands, and US Forest Service staff conducted Bull Trout redd counts on 20 tributaries to Lake Pend Oreille (LPO) or the Clark Fork River in 2015. In addition, Kalispel Tribe and US Fish and Wildlife Service employees completed surveys on the Middle and North Fork East rivers and Uleda Creek (tributaries to the lower Priest River). Redds were located visually by walking standardized sections within each tributary (Table 2-1). Bull Trout redds were defined as areas of clean gravels at least 0.3 x 0.6 m in size with gravels at least 76 mm in diameter having been moved by the fish, and with a mound of loose gravel downstream from a depression (Pratt 1984). In areas where one redd was superimposed over another, each distinct depression was counted as an individual redd. A training session was conducted pre-season by experienced personnel to familiarize surveyors with these techniques. Redd surveys were conducted during the standardized time periods of the second and third weeks of October. Beginning in 2012, redd surveys were discontinued on the Clark Fork River and Twin Creek because counts at both of these locations were believed to be influenced heavily by Avista's ongoing upstream Bull Trout transport programs and provided little meaningful long-term index information. In addition, no survey was completed on Char Creek above a fish passage barrier first noted in 2008 (Jakubowski and Ryan 2009). The observed barrier was located approximately 150 m upstream from the confluence with East Fork Lightning Creek.

TABLE 2-1. Survey streams for annual Bull Trout redd counts in tributaries to Lake Pend Oreille and lower Clark Fork River, Idaho.

Stream	Section Description (approximate length; km)
Caribou Cr.	Between Caribou Creek road crossings at 1 km and 7 km (6.0)
Char Cr.	Mouth to falls (1.2)
East Fork 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 2.4 km beyond gate at end of road 280 (6.5)
Hellroaring Cr.	Mouth to falls (2.4)
Johnson Cr.[a]	Mouth to falls (1.5)
Lightning Cr.	Rattle to Quartz (3.2)
Morris Cr.	Mouth to trail 132 crossing (2.5)
N Gold Cr.[a]	Mouth to falls (1.2)
Pack River	Road 231 bridge near McCormick Cr. to Falls located 0.4 km downstream of W. Branch (2.8)
Porcupine Cr.	Mouth to S. Fork (3.2)
Rattle Cr.	Mouth to falls by upper bridge (5.7)
Savage Cr.	Mouth to trail 61 crossing (2.0)
Strong Cr.	Mouth upstream 3 km (3.0)
Sullivan Springs	Mouth upstream 0.4 km (0.4)
Trestle Cr.[a]	1.6 km upstream of mouth to approximately 1.0 km upstream of road 275 switchback, at the confluence with first southeast bank un-named tributary (11.1 km)
Wellington Cr.	Mouth to falls (0.5)
West Gold Cr.	Lakeview Rd. bridge to confluence with Gold Cr. (0.7)

[a] Index stream.

RESULTS

Lake Pend Oreille redd counts were completed between October 7 and 22, 2015. Streamflow conditions were considered favorable for accurate counts; however, extreme drought and low water conditions were evident. In addition, sunny conditions in September and October promoted high algal growth, which may have obscured some redds in more open areas.

A total of 553 Bull Trout redds (all considered migratory) were counted among all surveyed streams (Table 2-2). The six index streams counted consistently since 1983 accounted for 297 (54%) of the total redds (Table 2-2). Counts were roughly 25 to 30 percent below the previous ten 10-year averages for both total and index counts, but within the range of variability documented over the last 33 years (Figures 2-1 and 2-2).

TABLE 2-2. Bull Trout redd counts by year from tributaries of Lake Pend Oreille, Clark Fork River, and Pend Oreille River, Idaho, 1995-2015.

Stream	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	95-14 average	05-14 average
Clark Fork R.	**18**	**3**	**7**	**8**	**5**	**5**	**6**	**7**	**8**	**1**	**0**	**3**	**2**	**0**	**1**	**0**	**0**					**4**	**1**
Lightning Cr.	0	6	0	3	16	4	7	8	8	9	22	9	3	10	11	0	20	1	1	4	11	7	8
E. F. Lightning Cr.*	3	49	22	64	44	54	36	58	38	77	50	51	34	38	85	26	64	11	26	22	17	43	41
Savage Cr.	0	0	0	0	4	2	4	15	7	15	7	25	0	8	5	6	1		5	6	5	6	7
Char Cr.	2	14	1	16	17	11	2	8	7	14	15	20	1	5	1	4	9	0	4	2	0	8	6
Porcupine Cr.	2	0	0	0	4	4	0	0	5	10	14	8	8	8	15	11	13	2	4	15	0	6	10
Wellington Cr.	1	5	2	1	22	8	7	7	8	7	6	29	9	10	4	7	6	5	5	11	8	8	9
Rattle Cr.	1	10	2	15	13	12	67	33	37	34	34	21	2	24	62	43	65	59	8	63	5	30	38
Morris Cr.					1	1	0	7	1	1	3	16	0	6	6	9	0	0	3	14	0	4	6
Lightning Drain. Total	**9**	**84**	**27**	**99**	**121**	**96**	**123**	**136**	**111**	**167**	**151**	**179**	**57**	**109**	**189**	**106**	**178**	**78**	**56**	**137**	**46**	**111**	**124**
Johnson Cr.*	**4**	**5**	**27**	**17**	**31**	**4**	**34**	**31**	**0**	**32**	**45**	**28**	**32**	**40**	**47**	**57**	**54**	**54**	**50**	**21**	**5**	**31**	**43**
Twin Cr.	**5**	**16**	**6**	**10**	**19**	**10**	**1**	**8**	**3**	**6**	**7**	**11**	**0**	**4**	**0**	**0**	**1**					**6**	**3**
Strong Creek		**2**						**0**		**0**				**7**	**6**	**2**	**11**	**3**	**47**	**17**	**0**	**10**	**13**
Trestle Cr.*	**140**	**243**	**221**	**330**	**253**	**301**	**335**	**333**	**361**	**102**	**174**	**395**	**145**	**183**	**279**	**188**	**178**	**187**	**133**	**159**	**117**	**232**	**202**
Granite Cr.	9	47	90	49	41	25	7	57	101	149	132	166	104	52	106	75	129	68	217	115	68	87	116
Sullivan Springs	9	15	42	10	22	19	8	15	12	14	15	28	17	7	2	9	11	4	11	4	0	14	11
Granite Drain. Total	**18**	**62**	**132**	**59**	**63**	**44**	**15**	**72**	**113**	**163**	**147**	**194**	**121**	**59**	**108**	**84**	**140**	**72**	**228**	**119**	**68**	**101**	**127**

-continued-

Table 2-2. Continued.

Stream	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	95-14 average	05-14 average
North Gold Cr.*	**31**	**39**	**19**	**22**	**16**	**19**	**16**	**24**	**21**	**56**	**34**	**30**	**28**	**17**	**28**	**28**	**6**	**3**	**28**	**25**	**41**	**25**	**23**
S. Gold Cr.*	95	100	76	120	147	168	127	203	126	167	200	235	179	73	107	130	56	110	106	88	69	131	128
W. Gold												4	0	7	5	4	0	8	29	10	3	7	7
S. Gold Drain.Total	**95**	**100**	**76**	**120**	**147**	**168**	**127**	**203**	**126**	**167**	**200**	**239**	**179**	**80**	**112**	**134**	**56**	**118**	**135**	**98**	**72**	**134**	**135**
M.F. East River							4	8	21	20	48	71	34	36	25	22	28	28	25	51	51	30	37
Uleda Creek							3	4	3	7	4	7	2	7	16	6	9	24	14	26	11	9	12
MFER Total	**0**	**0**	**0**	**0**	**0**	**0**	**7**	**12**	**24**	**27**	**52**	**78**	**36**	**43**	**41**	**28**	**37**	**52**	**39**	**77**	**62**	**28**	**48**
N.F. East River										**1**	**0**	**0**		**0**		**0**						**0**	**0**
Pack River	0	6	4	17	0	8	28	22	24	31	53	44	16	11	4	0	1	7	6	1	35	14	14
Grouse Cr.*	0	50	8	44	50	77	18	42	45	28	77	55	38	31	51	27	116	69	12	54	48	45	53
Caribou																	37	6	47	9	57	25	25
Hellroaring																		3			2	3	3
Pack Drain. Total	**0**	**56**	**12**	**61**	**50**	**85**	**46**	**64**	**69**	**59**	**130**	**99**	**54**	**42**	**55**	**27**	**154**	**85**	**65**	**64**	**142**	**64**	**78**
Total 6 index streams *	273	486	373	597	541	623	566	691	591	462	580	794	456	382	597	456	474	434	355	369	297	505	490
Total of all streams	320	610	527	726	705	732	710	890	836	781	940	1256	654	584	866	654	815	652	781	717	553	738	792

* Index stream.

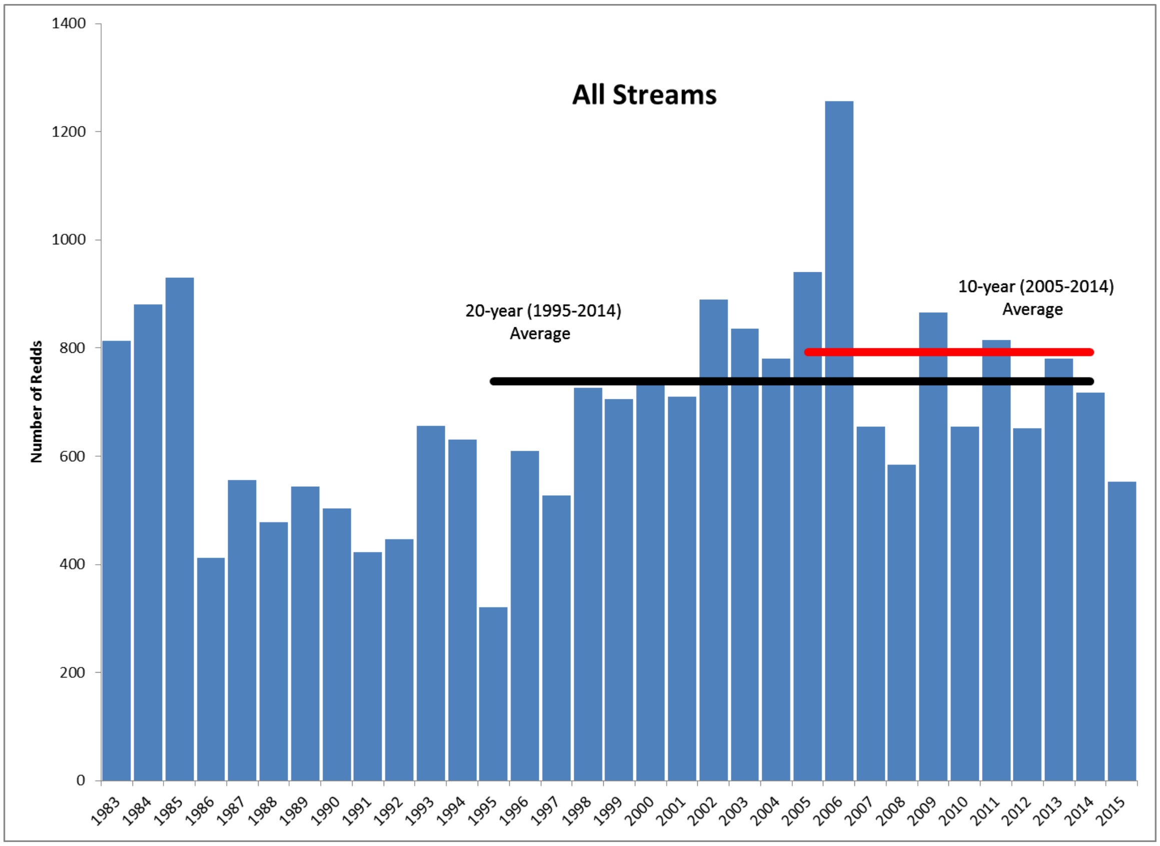

FIGURE 2-1. Number of Bull Trout redds counted in all surveyed streams in the Lake Pend Oreille drainage, 1983 to 2015.

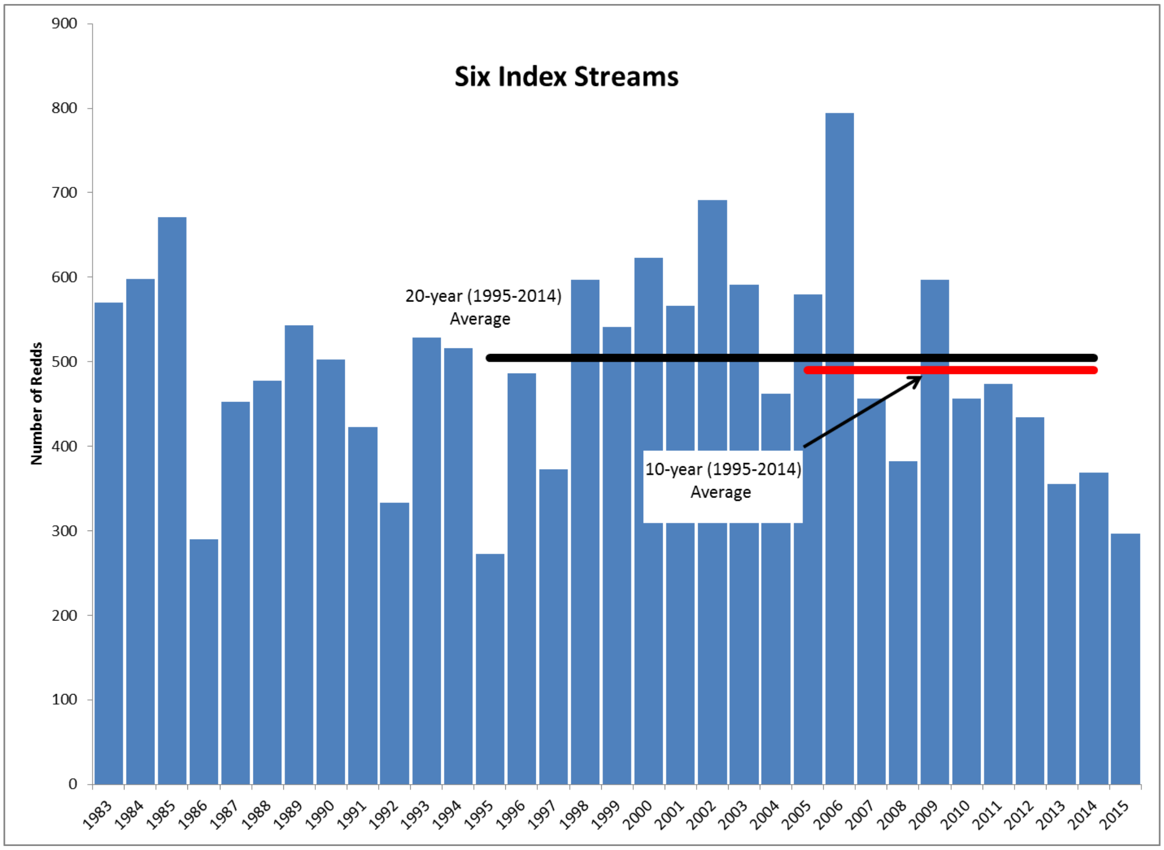

FIGURE 2-2. Number of Bull Trout redds counted in six index streams in the Lake Pend Oreille drainage, 1983 to 2015.

DISCUSSION

Historically low water levels likely impacted the abundance of redds in 2015. The summer of 2015 was the warmest, driest summer in the Northwest since records began in 1910 (http://www.ncdc.noaa.gov/extremes/cei/regional-overview). Many streams had dry sections and were potentially impassable to fish for the majority of the summer and fall. The low number of redds in 2015 does not necessarily imply that fewer Bull Trout were present in the LPO watershed. Barriers to fish passage due to low water were noted in upper Grouse Creek, E.F. Lighting Creek, West Gold Creek, Char Creek and possibly Morris Creek in 2015. The mouth of Lightning Creek was dry from early-July through early-November. In a more "normal" year, Lightning Creek is dry from roughly late-August to late-September or early-October. It is likely that some fish were unable to ascend the watershed and did not spawn or spawned in alternative locations. For example, the number of adult Bull Trout captured in the Clark Fork River downstream of Cabinet Gorge Dam that genetically assigned to Lightning Creek tributaries was higher than average (22%) (Bernall and Duffy 2016). We suspect these were fish that could not ascend Lightning Creek because of the absence of flow. In addition, at least three redds (two with associated adult Bull Trout) were noted in the Clark Fork River downstream of the outlet of Lightning Creek in November, presumably from fish that were not able to ascend the watershed to their natal stream. Further, several unspawned mature female Bull Trout were caught incidentally in the Lake Trout netting program on October 13 and

14 that we suspect would have already spawned in the absence of drought conditions. These fish were genetically tested and all assigned to the Lightning Creek drainage.

Above average redd counts occurred in some of the watersheds that had more flow, further supporting the influence of flow conditions on survey results. For example, the Upper Pack River had the highest count since 2006, and the count in Caribou Creek was an all-time high. The count in North Gold Creek was the highest since 2004, and the Middle Fork East River count was above the 10- and 20- year averages. To the best of our knowledge, these streams had continuous flow throughout the year. Thus, some fish may have strayed from streams that were inaccessible (e.g., Lightning Creek drainage) to those with available water and contributed to the higher counts we observed in those streams.

The number of redds counted in Trestle Creek may not represent all the spawning activity in both 2014 and 2015. A storm event in the summer of 2014 blew down a large number of trees in Trestle Creek, covering approximately 500 m of the stream so thickly that is was impossible to access the stream to count redds in this reach. Bull trout redds were counted upstream of this blow-down in both years indicating that fish were still able to navigate the obstacle, but it is unknown how many redds were hidden in this new habitat.

Redd count data are inherently variable due to changing survey conditions, variable spawning timing, variability among surveyors, and variable stream morphology. Attempts have been made to standardize sampling by surveying during the same time each year and providing consistent training for surveyors, but annual variability will always exist based upon run timing, weather, and specific personnel. Watershed assessments have been made on several watersheds in the Lower Clark Fork-LPO areas (e.g. CES 1998; Golder Associates 2003 and 2006; RDG 2009; PWA 2004). A recurring finding in these assessments was that these watersheds are inherently dynamic and are geomorphically unstable. Therefore, it is not surprising that redd counts in specific watersheds and tributaries fluctuate with the habitat, both short- and long-term. Over the years, attempts have been made to document why specific redd counts might deviate from what might be expected in a more “normal” year. It is important to remember that these data are collected to provide general long-term trend data and it is appropriate to interpret these data cautiously, particularly over short time periods. For example, some streams (e.g., Granite Creek) have become much more important as Bull Trout spawning streams since redd data have been collected, while others, like Trestle Creek, don’t seem to support as many redds as they did in the past. However, Trestle Creek is an index stream, while Granite Creek is not. Due to this documented change in Bull Trout spawning use, it may be more appropriate to consider data for all monitored streams instead of just the index streams to assess the overall trends in the LPO system.

Recommendations:

1) Continue performing all existing redd count surveys annually.
2) Collect gonad maturity data on Bull Trout mortalities caught incidentally in the Lake Trout suppression project in late fall and combine with genetic ID to assess

the relative frequency of Bull Trout, by natal stream, that appeared to have not spawned during the prior months.

Chapter 3 **Lake Pend Oreille Survival Study**

ABSTRACT

A study was initiated in 2011 to estimate Bull Trout *Salvelinus confluentus* survival from juvenile outmigration to adult return using half-duplex (HDX) Passive Integrated Transponder (PIT) tag technology in Trestle and Granite creeks, both tributaries of Lake Pend Oreille (LPO). A total of 1,039 Bull Trout and 1,035 Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* have been PIT-tagged in these two streams since 2011. Through 2015, 169 of these Bull Trout and 138 of these Westslope Cutthroat Trout have been detected emigrating to LPO. Eighteen Bull Trout and nine Westslope Cutthroat Trout have been detected returning as adults. In addition, over 4,500 Bull Trout have been tagged in LPO as part of the LPO Lake Trout suppression program, 400 of which have been subsequently detected in Trestle and Granite Creeks. It is important to note that these data are preliminary and should not be interpreted as survival estimates. Detection data have not been adjusted for antenna efficiency, and especially for more recently tagged fish, not enough time has passed to allow for each tagging year's cohort to mature.

INTRODUCTION

A study was initiated in 2011 to estimate Bull Trout *Salvelinus confluentus* survival from juvenile outmigration to adult return using half-duplex (HDX) Passive Integrated Transponder (PIT) tag technology. Bull Trout in-lake survival will be estimated by monitoring juvenile Bull Trout emigration to Lake Pend Oreille (LPO) from selected tributaries and quantifying subsequent returns of adult Bull Trout to these tributaries. This project was proposed as a follow-up to previous estimation of in-lake survival using similar techniques, which was completed in 2008 (Ryan et al. 2009). It is anticipated that ongoing predator suppression activities in LPO will increase in-lake Bull Trout survival by reducing direct mortality and competition, while increasing available food resources (e.g., kokanee *Oncorhynchus nerka*) for Bull Trout. This project will allow for quantification of in-lake survival rates in the coming years.

Two tributaries were selected for this study: Granite Creek, a tributary on the eastern shoreline of LPO, and Trestle Creek, a tributary entering LPO on the northern shoreline. Both tributaries support Bull Trout and Westslope Cutthroat Trout O. *clarkii lewisi* and variable spawning by both early- and late-run kokanee. Both tributaries have been influenced by habitat restoration and conservation efforts through Clark Fork Settlement Agreement (CFSA) programs (Avista 1999). These tributaries have accessible locations and land ownership that allow for installation of PIT tag antenna arrays.

Bull Trout redd counts in Granite Creek have varied considerably since standard redd surveys began in 1983, with annual totals ranging from 0 to 217 (see Table 2-2, Chapter 2, above). Substantial in-stream habitat restoration was completed on Granite Creek during the mid-2000's to improve fish passage conditions. In addition, acquisition of important properties within the riparian corridor has supported ongoing conservation efforts in this drainage by reducing potential impacts from residential development. Improved adult escapement in recent years has been largely credited to these efforts. The average number of redds in Granite Creek over the last 10 years was 120, ranging from 52 in 2008 to 217 in 2013.

Trestle Creek has consistently supported one of the largest populations of spawning Bull Trout in the LPO system. The average number of redds counted in Trestle Creek over the last 10 years was 202, ranging from 117 in 2015 to 395 in 2006. Physical habitat conditions in this stream are generally considered to be good, and Trestle Creek is considered a priority tributary stream in the LPO watershed (PBTAT 1998). Legacy effects from past logging and road construction, as well as potential impacts from future timber harvest and road construction (through changes in forest management priorities) have largely been addressed in the watershed.

METHODS

Remote HDX PIT tag antenna arrays have been operating nearly continuously in Granite and Trestle creeks since 2011 to detect emigrating Bull Trout juveniles and immigrating adult Bull Trout. Antenna arrays consist of two independent, swim-through loop antennas that provide tag detection and allow for determination of travel direction. Antenna loops were constructed of 10 gauge multi-stranded copper wire. Each antenna loop was constructed to span the bankfull channel width. Wire loops were encased in standard garden hose and/or PVC-lined air hose for protection. Wire loops were suspended from a rope spanning the creek channel and anchored to the channel bottom using rebar stakes with affixed hooks. Antennas were operated by multiple-antenna HDX readers (Oregon RFID). A single multiple-antenna HDX reader was installed at each tributary location to operate two antennas positioned in an array approximately 10 m apart. Readers were powered by 120 volt AC power and converted to 12 volt DC power either through an AC/DC power converter or through the use of a DC battery charging system.

The PIT tag antenna arrays were operated continuously after installation. Antenna performance was monitored and stored data were downloaded at least monthly during operation. When antenna performance was found to be limited or failures were found, the antenna were re-tuned or repaired as soon as possible. A waterproof marker tag (Oregon RFID) mounted within the field of one antenna loop per array was used to monitor antenna operation between data downloads. The marker tag was programmed to produce detections at approximately 15 minute intervals. Marker tag detection was used as an indication of proper antenna operation.

Juvenile Bull Trout and all Westslope Cutthroat Trout were tagged with 12 mm HDX PIT tags to monitor emigration and subsequent immigration in LPO tributaries. Juvenile fish were collected for tagging opportunistically throughout the occupied reaches of each stream using standard electrofishing techniques (See Chapter 1), usually during August and September. Collected fish were anesthetized, measured to the nearest mm, PIT tagged, and released. Only fish 100 mm or greater were tagged. Each PIT tag was injected in the anterior dorsal sinus using 1.4 mm syringes. Upon recovery from anesthesia, tagged fish were released within the same general area in which they were collected.

Individual tag detections downloaded from the PIT tag array readers included tag identification number, time and date of detection, and a record of which antenna in the array detection occurred. Tag detections at each antenna in the array allowed for determination of the direction of travel and estimation of antenna detection efficiency. Direction of travel was determined by looking at the order of detection between paired antennas in the array. For the purposes of initial reporting, in instances where fish were detected on only one of the antennas in the array, it was assumed the fish passed the other antenna and had moved past the array. Assumptions were made regarding direction of travel based upon the initial tagging date and detection history. Further analysis regarding direction of travel and detection probability will be conducted when enough time has passed for all tagged fish to have migrated to the lake, matured, and returned to spawn, which will likely be after approximately 2020.

RESULTS

Based on marker tag detection, our HDX PIT tag antenna arrays on Granite and Trestle creeks were operational for nearly 100% of the reporting period in 2015. No specific operational issues occurred during this period.

In 2015, 164 Bull Trout and 130 Westslope Cutthroat Trout were tagged in Granite Creek (Tables 3-1 and 3-2), and 192 Bull Trout and 139 Westslope Cutthroat Trout were tagged in Trestle Creek (Tables 3-3 and 3-4). From 2011 through 2015, 530 Bull Trout and 528 Westslope Cutthroat Trout were tagged in Granite Creek, and 509 Bull Trout and 507 Westslope Cutthroat Trout were tagged in Trestle Creek.

TABLE 3-1. Bull Trout tagged, detected leaving Granite Creek, and detected re-entering Granite Creek from 2011-2015.

		No. Detected Out							No. Detected Back				
Year Tagged	Number Tagged	2011	2012	2013	2014	2015	Total	%	2013	2014	2015	Total	%
2011	263	21	30	0	0	0	51	19.4	0	0	9	9	17.6
2012	20		4	9	0	0	13	65.0	0	0	0	0	0.0
2013	0												
2014	83				13	6	19	22.9		0	0	0	0.0
2015	164					40	40	24.4			0	0	0.0
Total	530	21	34	9	13	46	123	23.2	0	0	9	9	7.3

TABLE 3-2. Westslope Cutthroat Trout tagged, detected leaving Granite Creek, and detected re-entering Granite Creek from 2011-2015.

		No. Detected Out							No. Detected Back				
Year Tagged	Number Tagged	2011	2012	2013	2014	2015	Total	%	2013	2014	2015	Total	%
2011	0												
2012	199		13	8	3	0	24	12.1	3	1	2	6	25.0
2013	162			29	30	2	61	37.7	0	0	0	0	0.0
2014	37				0	2	2	5.4		0	0	0	0.0
2015	130					0	0	0.0			0	0	0.0
Total	528	0	13	37	33	4	87	16.5	3	1	2	6	6.9

TABLE 3-3. Bull Trout tagged, detected leaving Trestle Creek, and detected re-entering Trestle Creek from 2011-2015.

		No. Detected Out							No. Detected Back				
Year Tagged	Number Tagged	2011	2012	2013	2014	2015	Total	%	2013	2014	2015	Total	%
2011	197	27	7	2	0	0	36	18.3	0	1	8	9	25.0
2012	70		4	0	0	0	4	5.7	0	0	0	0	0.0
2013	0												
2014	50				2	2	4	8.0		0	0	0	0.0
2015	192					2	2	1.0			0	0	0.0
Total	509	27	11	2	2	4	46	9.0	0	1	8	9	19.6

TABLE 3-4. Westslope Cutthroat Trout tagged, detected leaving Trestle Creek, and detected re-entering Trestle Creek from 2011-2015.

		No. Detected Out							No. Detected Back				
Year Tagged	Number Tagged	2011	2012	2013	2014	2015	Total	%	2013	2014	2015	Total	%
2011	0												
2012	196		0	18	0	0	18	9.2	0	0	2	2	11.1
2013	130			3	5	2	10	7.7	0	1	0	1	10.0
2014	42				2	5	7	16.7		0	0	0	0.0
2015	139					16	16	11.5			0	0	0.0
Total	507	0	0	21	7	23	51	10.1	0	1	2	3	5.9

Through the end of 2015, approximately 23% of the PIT tagged Bull Trout (Table 3-1) and 17% of the PIT tagged Westslope Cutthroat Trout (Table 3-2) have been detected leaving Granite Creek. Nine Bull Trout have returned to Granite Creek from LPO (all tagged in 2011; Table 3-1), while six Westslope Cutthroat Trout (all tagged in 2012) have returned (Table 3-2). A smaller number of both Bull Trout and Westslope Cutthroat Trout have been detected leaving Trestle Creek (Tables 3-3 and 3-4). Nine adult Bull Trout (tagged as juveniles in 2011 and 2012) returned to Trestle Creek (Table 3-3). Three Westslope Cutthroat Trout (tagged in 2012 and 2013) returned to Trestle Creek in 2015 (Table 3-4).

Other PIT tagged fish were detected in addition to those tagged as part of this study. Since 2011, approximately 4,500 Bull Trout were incidentally-caught, PIT-tagged, and released as part of the Lake Trout suppression efforts on LPO (Wahl et al. 2015). Since 2011, 270 of these Bull Trout have been detected in Granite Creek and 130 have been detected in Trestle Creek.

Bull Trout have also been PIT-tagged as part of the Avista Appendix C Bull Trout transport program. One of these fish, captured during electrofishing efforts on September 9, 2014 in the Clark Fork River below Cabinet Gorge Dam, was determined through genetic analysis to have originated from the Lightning Creek drainage. It was then detected in Granite Creek on September 20, 2014. A similar scenario played out again in 2015, except the Bull Trout (also identified as a Lightning Creek fish) was captured on September 3 in the Cabinet Gorge Hatchery ladder trap and was detected during mid-October in Trestle Creek. A third fish was also captured in 2014 in the Clark Fork River and returned to Trestle Creek in September of 2015. This fish was genetically identified as a Trestle Creek fish.

Two-hundred and ninety Westslope Cutthroat Trout were PIT-tagged in the Clark Fork River below Cabinet Gorge Dam as part of salmonid abundance estimates in the fall of 2014 and the spring of 2015. In addition, 394 Westslope Cutthroat Trout caught below Cabinet Gorge Dam during Appendix C transport activities have also been PIT-tagged since 2014. One of these fish was detected in Granite Creek in March 2015, and three of these fish were detected in Trestle Creek in April, May, and June of 2015.

DISCUSSION

It is important to note that these data are preliminary and should not be interpreted as survival estimates. Detection data have not been adjusted for antenna efficiency, and especially for more recently tagged fish, not enough time has passed to allow for each tagging year's cohort to mature and migrate. However, upstream detection data did show that Bull Trout and Westslope Cutthroat Trout tagged as juveniles in 2011 started migrating into tributaries (presumably to spawn) beginning in 2015. As a result, subsequent years should be expected to produce information from upstream migrating adults that were tagged as juveniles.

A directed effort was made in 2015 to tag a large number of juveniles of both species. The number of juvenile fish tagged within Trestle and Granite creeks is probably sufficient to calculate survival estimates, and future project efforts will focus on monitoring these fish and analyzing data collected instead of tagging additional fish. Based upon known age at maturity data (5-6 years) we would expect the fish tagged in 2015 to fully recruit back to the spawning streams by approximately 2023. However, we plan to continue collecting data until we no longer detect presumed first-time spawners returning to the tributaries.

We noticed that some fish did not register detections on both antennas when they passed the arrays (particularly on presume downstream migrants); some only registered detections on the upstream antenna, and some only on the downstream antenna. It appears that some downstream migrants were able to pass through the antenna's field quickly without being detected. This is based on estimating their travel speed based on potential swimming speed and current velocity. The lack of detections, particularly at higher flows, is likely related to the scanning rate (approximately 6 scans/second) of each reader and the short detection distance of the antennas. Upstream-traveling fish pass through the fields more slowly, as the speed of the current subtracts from their swimming speed, so the probability of detection is higher. However, until adult fish return, it is difficult to determine what percentage of fish went undetected as downstream migrants. Fish tagged in 2011 began returning from LPO in 2014. Four out of the nine Bull Trout from Granite Creek and two out of nine Bull Trout from Trestle Creek were not detected leaving the system, but were detected when they returned. Although it is too early to calculate a correction factor for undetected tags, this will need to be done to prevent our estimated survival rates from being biased high.

The detections of fish tagged as part of other projects are valuable, and data from this study will add to a unique dataset that is only available because of the intensive management actions taking place in LPO and the lower Clark Fork River. Detections of Bull Trout tagged as part of the Lake Trout suppression program will be used as part of a larger effort to describe LPO Bull Trout population dynamics. Several of these Bull Trout have been captured multiple times during netting operations in the lake and have also been detected as part of this project in either Granite or Trestle creeks. In addition, Bull Trout are tagged as part of the CFSA Appendix C activities that involve transporting Bull Trout both above and below Cabinet Gorge Dam. These repeated capture histories lend themselves to the use of open population capture-recapture models, such as Jolly-Seber (Pollock et al. 1990) and Cormack-Jolly-Seber (Lebreton et al. 1992), to estimate apparent survival, capture probabilities, and recruitment.

Determining migration timing and survival of Westslope Cutthroat Trout has been more problematic. In general, it appears that some individual fish movements have not been associated with directed spawning migrations. In several cases, juvenile fish were detected moving out of tributaries and then re-ascending the same tributary within a short time period, probably before they have reached maturity. In addition, there is some evidence that they exhibit less stream fidelity. For example, fish originally tagged in the Clark Fork River, apparently as adults, have been detected in both Trestle and Granite creeks. Longer and more complete detection histories may be necessary to elucidate large scale migration patterns for this species.

Recommendations:

1) Continue to operate, maintain and monitor existing antenna arrays in Granite and Trestle creeks.
2) Begin combining data from multiple tagging and recapture efforts and identify appropriate analysis techniques to estimate Bull Trout population parameters.
3) Consider installing additional arrays in other major tributaries (e.g., Gold Creek, Strong Creek, North Gold Creek) to better track movement patterns and survival of Bull Trout and Westslope Cutthroat Trout.

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