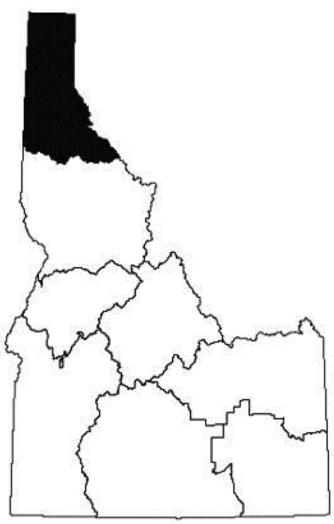
FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME

FISHERY MANAGEMENT ANNUAL REPORT

Virgil K. Moore, Director



PANHANDLE REGION

2013

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CHAPTER 1: COEUR D'ALENE LAKE FISHERY INVESTIGATIONS

ABSTRACT

Coeur d'Alene Lake provides one of Idaho's most popular Kokanee *Oncorhynchus nerka* fisheries and one of its best fisheries for resident Chinook Salmon *O. tshawytscha.* Maintaining these fisheries requires keeping Kokanee (prey) and Chinook Salmon (predator) populations in balance. During 2013, Kokanee abundance remained within the desirable range with 39 age 3 and 4 Kokanee/ha based on trawling and 65 age 3 and 4 Kokanee by hydroacoustics. Indications were that predation on Kokanee was beginning to increase as adult Kokanee densities were starting to decline and adult sizes were starting to increase. During 2013, we stocked 20,000 fingerling Chinook Salmon into Coeur d'Alene Lake for the fifth straight year. This moderate level of stocking has allowed Kokanee numbers to increase during the past several years. Unfortunately, none of the hatchery fish were recorded out of 64 Chinook Salmon weighed in during the Big One Derby indicating a lack of recruitment into older age classes. Numbers of Chinook Salmon redds increased from a total of 94 last year to 129 redds in 2013.

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INTRODUCTION

The Kokanee *Oncorhynchus nerka* fishery in Coeur d'Alene Lake peaked in 1979 with 578,000 fish harvested and remained at 120,000 to 239,000 Kokanee harvested during the 1980's (Rieman and LaBolle 1980; Fredericks et al. 1997). Fall Chinook Salmon *O. tshawytscha* were introduced into Coeur d'Alene Lake in 1982 as a biological tool to reduce Kokanee abundance and increase their size at harvest. Fall Chinook Salmon were chosen as the preferred predator for a variety of reasons: their relatively short and semelparous life cycle compared to other species (Lake Trout *Salvelinus namaycush*, Kamloops Rainbow Trout *O. mykiss*, Walleye *Sander vitreus*, Brown Trout *Salmo trutta*); ability to manage the predators numbers; and the benefit provided by a Chinook Salmon fishery. Chinook Salmon have established a naturally reproducing population by spawning in the Coeur d'Alene and St. Joe river systems. Both naturally produced and hatchery stocked Chinook Salmon are used to achieve the desired density of these predators.

Adult Kokanee densities dropped below the desired range of 30 to 50 fish/ha during the high run-off year of 1996. Based on trawling, age 3 Kokanee densities were below 10 fish/ha in 8 of the 11 years between 1997 and 2008, and were at 3 fish/ha in 2006, 2007 and 2008. Our concern was that Chinook Salmon predation was impacting, rather than benefiting, the Kokanee fishery. Efforts to improve the predator-prey balance included not stocking Chinook Salmon in 2007 and 2008, attempting to limit wild Chinook Salmon spawning to 100 redds, reducing the Kokanee limit to 6 fish, and closing the Kokanee fishery during some fall seasons to limit the harvest of spawning fish. In 2009, 2010 and 2011, we documented a very pronounced increase in the Kokanee population as adult abundance increased to 35, 52, and 80 adults/ha, respectively. During 2012 we noted indications of a decline in Kokanee abundance as adult sizes began to increase and hydroacoustic estimates of ages 1 to 4 Kokanee declined. This report documents our efforts to balance Kokanee and Chinook Salmon populations during 2013, and to manage both populations to improve the sport fisheries in Coeur d'Alene Lake.

OBJECTIVES

IDFG management objectives for Coeur d'Alene Lake include managing the kokanee population at a level that provides a yield fishery of a size agreeable to anglers and provides forage for Chinook Salmon (IDFG 2013).

STUDY AREA

Coeur d'Alene Lake is located in northern Idaho near the town of Coeur d'Alene. It is a natural lake of 12,742 ha with 9,648 ha of pelagic habitat used by kokanee. The native sportfish within the lake are Bull Trout *Salvelinus confluentus*, Westslope Cutthroat Trout *O. clarkii*, and Mountain Whitefish *Prosopium williamsoni*. Introduced fish species include Kokanee, Chinook Salmon, Largemouth Bass *Micropterus salmoides*, Smallmouth Bass *M. dolomieu*, Pumpkinseed *Lepomis gibbosus*, Bluegill *L. macrochirus,* Green Sunfish *L. cyanellus*, Yellow Perch *Perca flavescens*, Black Crappie *Pomoxis nigromaculatus*, Brown Bullhead *Ameiurus nebulosus*, Black Bullhead *A. melas*, and Northern Pike *Esox lucius*.

METHODS

Kokanee Estimates by Hydroacoustics

We conducted a lake-wide, mobile, hydroacoustic survey on Coeur d'Alene Lake to monitor the Kokanee population. The survey was conducted on the nights of August 12 and 13, 2013. We used a Simrad EK60 split-beam, scientific echosounder with a 120 kHz transducer to estimate kokanee abundance. Ping rate was set at 0.3 s/ping. A pole-mounted transducer was located 0.52 m below the surface, off the port side of the boat, and pointed downward. The echosounder was calibrated in the spring of 2013 using a 23 mm copper calibration sphere to set the gain and to adjust for signal attenuation to the sides of the acoustic axis. We used Simrad's ER60 software to determine, and input, the calibration settings. Calibration was re-checked prior to the survey and the gain adjusted to bring the calibrations sphere to its nominal value.

The lake was divided into three sections for this survey (Figure 1). We followed a uniformly spaced, zigzag pattern of 21 transects traveling from shoreline to shoreline (Figure 1). The zigzag pattern was used to maximize the number of transects that could be completed in one night. This pattern followed the general rule of using a triangular design (zigzags) when the transect length was less than twice the transect spacing (Simmonds and MacLennan 2005). The starting point of the first transect in each section was originally chosen randomly, but the same transects have been followed each year. Boat speed was approximately 1.4 m/s at the northern end of the lake and 2.3 m/s in the remainder of the lake (boat speed did not affect our calculations of fish density).

We determined Kokanee abundance using echo integration techniques. SonarData's Echoview software, version 5.4, was used to view and analyze the collected data. A box was drawn around the Kokanee layer on each of the echograms and integrated to obtain the nautical area scattering coefficient (NASC) and analyzed to obtain the mean target strength of all returned echoes. This integration accounted for fish that were too close together to detect as a single target (MacLennan and Simmonds 1992). Densities were then calculated by the equation:

$$\text{Density (fish/ha)} = (\text{NASC} / 4\pi 10^{TS/10})\ 0.00292$$

where:

NASC is the total backscattering in m^2/nautical mile^2, and
TS is the mean target strength in dB for the area sampled.

We calculated a density estimate of fry directly from the echograms. First a total Kokanee density for all fish was calculated by echo integration. Then a virtual echogram was built of the corrected target strengths. The percentage of fish between -60 dB and -50 dB on the echogram was then multiplied by the total Kokanee density.

Ninety percent confidence intervals were calculated for the estimates of fry and older age classes of Kokanee. Since we had small sample sizes from a contagious distribution, density estimates were transformed (logx+1), and an error bound calculated by the method for stratified systematic sampling. Error bounds were antilogged and placed around the arithmetic means (Elliott 1983).

We estimated the abundance of Kokanee between the ages of 1 and 4 based on their percentage in the trawl catch for that section. Kokanee between the ages of 1 and 4 were defined as any fish in the kokanee layer with a target strength between -47 and -33 dB.

Kokanee Estimates by Trawling

We used a midwater trawl, as described by Bowler et al. (1979), and Rieman (1992), and modified to a fixed-frame trawl in 2003 (Maiolie et al. 2004), to estimate the Kokanee population in Coeur d'Alene Lake. The net was 2.2 m wide by 3.01 m tall by 10.5 m long and was towed through the water at a speed of 1.55 m/s by an 8.8 m boat. Twenty transects were trawled on Coeur d'Alene Lake during the dark phase of the moon on August 1 and 2, 2013. Trawl transects were in the same locations as in previous years (Figure 1), however three transects at the southern end of the lake were omitted since most Kokanee were within 3 m of the lake's bottom. Data were analyzed as a stratified systematic sampling design. Densities of Kokanee within each lake section were averaged to determine an arithmetic mean and multiplied by the area of that section to determine the section's abundance. Ninety percent confidence limits were placed around the estimates based on techniques for stratified systematic sampling. Kokanee total lengths were measured within a 10 mm size group, weighed, and scales were collected from representative length groups for age analysis. Scales were pressed between plastic laminated slides and examined with a microfiche reader to determine ages.

Kokanee Lengths and Adult Ages

We measured adult Kokanee each year in the spawning season to see if their length met the objectives for the lake. During 2013, a single gillnet was set for 10 min near the Higgins Point boat ramp on December 3. The monofilament gillnet was 46 m long with 50 mm bar mesh. Potential egg deposition (PED) was estimated as the number of female Kokanee spawners (half the mature population based on midwater trawling) multiplied by the average number of eggs produced per female. The average number of eggs produced per female Kokanee was calculated using the length to fecundity regression established by Rieman (1992).

A sample of adult Kokanee was aged by examination of their otoliths. Otoliths were extracted from the Kokanee and immediately placed in a drop of water on a microscope slide. Bright light was focused below the whole otolith to show growth rings.

Chinook Salmon Stocking Tests

Between 2009 and 2013 we stocked Chinook Salmon during June and September as a test to determine the best stocking strategy. Eggs from Tule Fall Chinook salmon were obtained from the Big Creek Hatchery located 16 miles east of Astoria, Oregon. Between 2009 and 2012 eggs were hatched at Cabinet Gorge Fish Hatchery and reared to size at the Nampa Fish Hatchery before being transported to Coeur d'Alene Lake. During 2013, salmon smolts were reared at the Mackay Hatchery and the June spawning group was returned to the Nampa Hatchery prior to stocking in the lake. All of the salmon fingerlings were given an adipose fin clip and had a coded wire tag inserted into their snout. About 10,000 fingerling Chinook Salmon were stocked in each of the two months (Table 1). All of the Chinook Salmon were released at the Mineral Ridge boat ramp in Wolf Lodge Bay at the northeastern side of the lake. Size at release varied with the date of release, i.e. larger fingerlings were stocked in September than in June. The test was therefore to compare the survival rate of smaller Chinook Salmon stocked in June to that of larger fish stocked in September.

Chinook Salmon Redd Counts

Each year since 1990, we monitored the spawning of wild Chinook Salmon in tributaries to Coeur d'Alene Lake. Early surveys were done from a helicopter. Beginning in 2012 and continuing in 2013, we floated the main spawning sections of the Coeur d'Alene and St. Joe rivers using canoes. Two canoes, with one or two paddlers in each, surveyed each section with one boat floating down each side of the river. The lower section of the Coeur d'Alene River was first floated on September 18, 2013, and the lower section of the St. Joe River was floated on September 20, 2013. All redds encountered in these initial surveys were marked by placing a handful of white quartz gravel in the redd and marking its location with GPS. This was done to see if the earliest redds would be difficult to find in the later surveys.

Four sections of the two rivers were surveyed in early October, 2013. We surveyed the redds on the North Fork Coeur d'Alene River between the Little North Fork Coeur d'Alene River and the South Fork Coeur d'Alene River on October 1. On October 2 and 4, we counted redds in the St. Joe River from Calder to St. Joe City. On October 3, we surveyed the Coeur d'Alene River from Enaville to Cataldo. And lastly, the lower South Fork Coeur d'Alene River was surveyed on October 7.

We estimated the natural smolt production from the redd counts by assuming an estimate of 4,000 eggs per redd and a mean egg-to-smolt survival of 10%. No redds were destroyed in 2013 as had been done in some previous years when redd abundance exceeded our management objective of 100 redds.

Aging Adult Chinook Salmon

Sixteen carcasses of Chinook Salmon were recovered from the Coeur d'Alene River and sagittal otoliths were removed from fish, cleaned, and placed in coin envelopes. Otoliths were aged using similar methods as described by Heidinger and Clodfelter (1987). Prior to aging, otoliths were sectioned into halves by hand and sanded with 1200 grit wetted sandpaper to polish the reading surface. The reading surface was then burned golden brown using a candle and placed posterior side down in putty. Glycerin was used to immerse otoliths and annuli were observed under a dissecting microscope.

RESULTS

Kokanee Estimates

Based on trawling, we estimated approximately 373,000 adult Kokanee, for a density of 39 fish/ha. Age-1 and age-2 Kokanee populations were estimated at 3.7 and 1.3 million, respectively (Table 2). The hydroacoustic-based estimate of the total Kokanee population was 19.9 million, with a mean density of 2,066 fish/ha (Table 3). Based on the hydroacoustic analysis of small targets, we estimated 11.7 million of these fish were Kokanee fry (1,214 fry/ha). Our estimate of Kokanee between the ages of 1 and 4 was 8.2 million (Table 4).

The highest densities of Kokanee fry were found at the northern end of the lake in Wolf Lodge and Cougar bays (Table 3). Most of the Kokanee spawning was believed to occur along road fills at the northern end of the lake, and it appeared that most of the fry remained in this section during mid-summer. Lower densities of fry were found in the middle and southern sections. Density of Kokanee between the ages of 1 and 3 was also highest in the northern and middle sections of the lake (Table 3).

Target strengths of Kokanee at the northern end of Coeur d'Alene Lake formed a bimodal distribution (Figure 2). We split fry from older age classes of Kokanee at a target strength of -50 dB based on this distribution. We used this decibel level to separate Kokanee fry from older age classes in each section of the lake.

Kokanee Lengths and Adult Ages

Modal length of Kokanee in the trawl was 110 mm, 160 mm, and 200 mm for age-1, age-2, and age-3 fish, respectively (Figure 3). Spawning Kokanee ranged from 220 to 360 mm, with a modal size of 270 mm (Figure 4). Mean size of male Kokanee during the spawning season was 272 mm (n=200), and female Kokanee averaged 259 mm (n=18; Figure 5). Male Kokanee ranged from 255 mm to 346 mm and female Kokanee ranged from 256 mm to 288 mm. Mean lengths were slightly less than last year (Figure 5).

Chinook Salmon Redd Counts

The number of Chinook Salmon redds counted in the Coeur d'Alene and St. Joe Rivers increased in 2013. We found 129 redds, up from 94 redds the previous year (Table 5). The most heavily used section for spawning was in the Coeur d'Alene River between the South Fork Coeur d'Alene River and Cataldo (Table 5). The trend in wild Chinook Salmon spawning since the flood year of 1996 appeared to be increasing in a linear fashion, but was widely variable (Figure 6).

We did not attempt to destroy any of the Chinook Salmon redds, and therefore estimated roughly 51,600 smolts would be produced naturally along with the 20,100 that were stocked (Table 6).

Chinook Aging

We found Chinook Salmon ranged from three to five years of age based on examination of 16 otoliths. Salmon ranged in length from 559 mm to 830 mm. (Figure 7). The majority of Chinook Salmon appeared to be five years old.

Chinook Salmon Stocking Tests

No Chinook Salmon with coded wire tags (CWT) were turned in by anglers during 2013. Also, during the "Big One Chinook Derby" and the "Members-Only Derby," none of the weigh masters reported seeing any Chinook Salmon with adipose fin clips even though they were personally contacted by IDFG and instructed to watch for them.

DISCUSSION

Kokanee abundance in Coeur d'Alene Lake continues to be at an optimal density to provide for a productive fishery and an abundant forage base for Chinook Salmon. Abundance of age-1 and age-2 Kokanee indicate the adult population will continue to be at an optimal level for the coming years, barring any unexpected impact to the population.

Based on evaluation of Chinook Salmon harvest, the fishery continues to be comprised almost entirely of naturally produced fish. 2013 marks the fourth year of a dual comparison of spring and fall released fish, with each group being marked by CWT. To date, neither group has performed well; suggesting release timing is not the factor limiting survival of hatchery juveniles. The shift in rearing facilities in 2013 to Mackay Hatchery, which uses colder water, may improve the stocking program. If continued evaluation does not demonstrate an improved contribution of hatchery raised fish, termination of the Chinook Salmon augmentation program should be considered.

While the number of Chinook Salmon redds in the Coeur d'Alene River has increased in the past decade, the redd counts since the late 1980's do not suggest the population is likely to grow exponentially and collapse the kokanee population. Possibly, environmental factors that have historically impacted the Kokanee population have simultaneously impacted the Chinook Salmon population, preventing excessive imbalance and a Kokanee population collapse. Though attempting to control Chinook Salmon spawner escapement or spawning success does not appear to be necessary at this time, it should be closely monitored in the coming years to ensure the population does not become overabundant.

MANAGEMENT RECOMMENDATIONS

1. Sample the harvest of Chinook Salmon in 2014 to look for adipose clipped fish and evaluate the two stocking strategies.

2. Consider other strains of salmon and other locations of stocking to see if hatchery-produced fish will recruit to the fishery.

3. Closely monitor the Kokanee population by trawling and hydroacoustics and adjust Chinook Salmon stocking to maintain balance. Key indicators that should be examined include: the mortality rate of a cohort of Kokanee, mean adult Kokanee size, density of Kokanee adults, and the number of Chinook Salmon redds.

Table 1. List of tagged Chinook Salmon stocked in Coeur d'Alene Lake between 2009 and 2013 as a test to determine the best month and size for stocking.

Date stocked	Number of Chinook Salmon stocked	Tag code	Fin clip	Mean length at stocking (total length in mm)	Mean weight (g)
6/3/09	10,570	10-63-70,10-74-04	Adipose	135	28
6/3/09	127	none	Adipose	--	--
9/9/09	10,936	10-92-71	Adipose	180	65
9/9/09	617	none	Adipose	--	--
6/21/10	10,300	10-90-70, 10-91-71	Adipose	150	40
9/15/10	10,121	10-34-80,10-8- 72	Adipose	194	87
6/27/11	10,000	10-48-73 and 10-34-27	Adipose	178	28
10/4/11	10,132	10-01-53	Adipose	171	57
6/25/12	10,148	10/96/77 and 10/97/77	Adipose	150	35
9/19 /12	10,220	10-1-53	Adipose	205	88
6/24/13	10,202	10-67-71	Adipose	147	32
10/1/13	9,898	10-01-47	Adipose	173	49

Table 2. Estimated abundance of Kokanee made by midwater trawl in Coeur d'Alene Lake, Idaho, from 1979-2013. To follow a particular year class of Kokanee, read right one column and up one row.

Sampling Year	Age Class				Total	Age 3 and 4 /ha
	Age-0	Age-1	Age-2	Age 3/4		
2013	1,349,000	3,663,000	1,319,000	373,000	6,704,000	39
2012	-	-	-	-	-	-
2011	3,049,000	1,186,000	1,503,000	767,000	6,505,000	80
2010	660,400	2,164,100	1,613,300	506,200	4,943,900	52
2009	731,600	1,611,800	2,087,400	333,600	4,764,400	35
2008	3,035,000	3,610,000	1,755,000	28,000	8,428,000	3
2007	3,603,000	2,367,000	136,000	34,000	6,140,000	3
2006	7,343,000	1,532,000	91,000	33,900	8,999,000	3
2005	-	-	-	-	-	-
2004	7,379,000	1,064,000	141,500	202,400	8,787,000	21
2003	3,300,000	971,000	501,400	182,300	4,955,000	19
2002	3,507,000	934,000	695,200	70,800	5,207,000	7
2001	7,098,700	929,900	193,100	25,300	8,247,000	3
2000	4,184,800	783,700	168,700	75,300	5,212,600	8
1999	4,091,500	973,700	269,800	55,100	5,390,100	6
1998	3,625,000	355,000	87,000	78,000	4,145,000	8
1997	3,001,100	342,500	97,000	242,300	3,682,000	25
1996	4,019,600	30,300	342,400	1,414,100	5,806,400	146
1995	2,000,000	620,000	2,900,000	2,850,000	8,370,000	295
1994	5,950,000	5,400,000	4,900,000	500,000	12,600,000	51
1993	5,570,000	5,230,000	1,420,000	480,000	12,700,000	50
1992	3,020,000	810,000	510,000	980,000	5,320,000	102
1991	4,860,000	540,000	1,820,000	1,280,000	8,500,000	133
1990	3,000,000	590,000	2,480,000	1,320,000	7,390,000	137
1989	3,040,000	750,000	3,950,000	940,000	8,680,000	98
1988	3,420,000	3,060,000	2,810,000	610,000	10,900,000	63
1987	6,880,000	2,380,000	2,920,000	890,000	13,070,000	93
1986	2,170,000	2,590,000	1,830,000	720,000	7,310,000	75
1985	4,130,000	860,000	1,860,000	2,530,000	9,370,000	263
1984	700,000	1,170,000	1,890,000	800,000	4,560,000	83
1983	1,510,000	1,910,000	2,250,000	810,000	6,480,000	84
1982	4,530,000	2,360,000	1,380,000	930,000	9,200,000	97
1981	2,430,000	1,750,000	1,710,000	1,060,000	6,940,000	110
1980	1,860,000	1,680,000	1,950,000	1,060,000	6,500,000	110
1979	1,500,000	2,290,000	1,790,000	450,000	6,040,000	46

Table 3. Kokanee population estimates in each section of Coeur d'Alene Lake based on hydroacoustic sampling during 2013.

Section	Age-0	Age-1	Age-2	Age-3	Age-4	Total
1a Wolf Lodge Bay	2,199,600	614,600	0	20,600	11,500	2,846,300
1b Northern	4,908,700	1,397,400	0	61,400	53,700	6,421,200
2 Middle	4,601,600	2,885,100	1,458,700	337,800	84,800	9,368,000
3 Southern	0	881,200	386,500	30,900	0	1,298,600
Total	11,709,900	5,778,300	1,845,200	450,700	150,000	19,934,100
Density (fish/ha)	1,214	599	191	47	16	2,066

Table 4. Estimated abundance of Kokanee made by hydroacoustic surveys with age classes split by trawl percentages for Coeur d'Alene Lake, Idaho, from 2008-2013. To follow a particular year class of Kokanee, read right one column and up one row.

Sampling year	Age class						Total	Age 3 and 4/ha
	Age-0	Age-1	Age-2	Age-3	Age-4	Age 1 through 4		
2013	11,709,900	5,778,300	1,845,200	450,700	150,000	8,224,200	19,934,100	62
2012[a]	12,772,000	-	-	-	-	6,547,000	19,319,000	-
2011	10,847,000	2,610,000	2,868,000	1,596,000	0	7,074,000	17,921,000	165
2010	4,025,000	3,089,000	3,042,000	923,000	0	7,054,000	11,079,000	96
2009	3,574,000	2,467,000	3,738,000	592,000	0	6,797,000	10,371,000	61
2008	10,479,000	3,572,000	1,650,000	39,200	0	5,261,200	15,740,000	4

[a] No trawling was conducted in 2012 to partition Kokanee year classes.

Table 5. Chinook Salmon redd counts in the Coeur d'Alene (Cd'A) River drainage, St. Joe River, and Wolf Lodge Creek, Idaho, 1990-20013.

	Coeur d'Alene River								St. Joe River					Wolf Lodge Creek	
Date	Catalaldo Mission to S.F. Cd'A River	South Fork Cd'A to L.N.F. Cd'A River	L.N.F. Cd'A to Steamboat Creek	Steamboat Creek to Steel Bridge	Steel Bridge to Beaver Creek	South Fork Cd'A River	Little North Fork Cd'A River	Coeur d'Alene River Subtotal	St. Joe City to Calder	Calder to Huckleberry Campground	Huckleberry Campground to Marble Creek	Marble Creek to Avery	St. Joe River Subtotal	Wolf Lodge Creek	Total
1990	41	10	-	-	-	-	-	51	4	3	3	0	10	--	66
1991	11	0	2	-	-	-	-	13	0	1	0	0	1	-	14
1992	29	5	3	1	-	-	-	21	18	1	2	0	21	-	63
1993	80	11	6	0	-	-	-	97	20	4	0	0	24	-	121
1994	82	14	1	0	0	13	0	110	6	0	1	1	8	-	118
1995	45	14	1	2	0	-	2	64	1	0	0	0	1	-	65
1996	54	13	13	0	0	4	0	84	59	5	7	0	71	-	155
1997	18	5	6	3	1	0	0	33	20	2	2	0	24	-	57
1998	11	3	1	0	0	0	0	15	3	1	0	2	6	4	25
1999	7	5	0	0	0	0	0	12	0	0	0	0	0	5	17
2000	16	20	3	0	0	5	1	45	5	0	0	0	5	3	53
2001	18	13	2	1	0	4	0	38	21	15	-	-	36	4	78
2002	14	10	6	0	0	3	0	33	14	4	0	0	18	0	51
2003	27	17	2	0	0	5	0	51	15	9	3	0	27	0	78
2004	24	36	4	2	0	4	1	71	15	3	0	0	18	1	90
2005	30	7	3	0	0	8	1	49	7	3	0	0	10	1	60
2006	30	80	14	7	0	10	0	141	15	1	0	0	16	-	157
2007	63	20	4	1	0	13	0	101	23	4	0	0	26	-	127
2008	79	6	1	2	0	4	0	92	13	3	1	0	17	-	109
2009	70	23	1	0	0	13	0	107	9	1	0	0	10	-	117
2010	71	16	7	9	0	8	0	112	20	0	2	0	22	-	134
2011	79[a]	12[a]	5	0	0	17	2	115	-	-	-	-	-	-	134[b]
2012[a]	65	7	-	-	-	13	-	85	9	-	-	-	9	-	94
2013[a]	108	2	-	-	-	14	-	124	4	-	-	-	4	1	129

[a] Redds counted by ground survey.
[b] Total based on a proportion of the previous 5 years.

Table 6. Number of Chinook Salmon stocked and estimated number of naturally produced Chinook Salmon entering Coeur d'Alene Lake, Idaho, 1982-2012. The number of Chinook Salmon redds is the number left undisturbed the previous fall.

	Hatchery Produced				Naturally Produced		
Year	Number	Stock	Rearing Hatchery	Fin Clip	Previous year redd counts	Estimated Smolts	Total
1982	34,400	Bonneville	Hagerman	--	--	--	34,400
1983	60,100	Bonneville	Mackay	--	--	--	60,100
1984	10,500	L. Michigan	Mackay	--	--	--	10,500
1985	18,300	L. Michigan	Mackay	Left Ventral	--	--	18,300
1986	30,000	L. Michigan	Mackay	Right Ventral	--	--	30,000
1987	59,400	L. Michigan	Mackay	Adipose	--	--	59,400
1988	44,600	Coeur d'Alene	Mackay	Left Ventral	--	--	44,600
1989	35,400	Coeur d'Alene	Mackay	Right Ventral	--	--	35,400
1990	36,400	Coeur d'Alene	Mackay	Adipose	52	20,800	57,200
1991	42,600	Coeur d'Alene	Mackay	Left Ventral	70	28,000	70,600
1992	10,000	Coeur d'Alene	Mackay	Right Ventral	14	5,600	15,600
1993	0	--	--	--	63	25,200	25,200
1994	17,300	Coeur d'Alene	Nampa	Adipose	100	40,000	57,300
1995	30,200	Coeur d'Alene	Nampa	Left Ventral	100	40,000	70,200
1996	39,700	Coeur d'Alene	Nampa	Right Ventral	65	26,000	65,700
1997	12,600	Coeur d'Alene	Nampa	Adipose	84	33,600	46,200
1998	52,300	Priest Rapids	Cabinet G.	Left Ventral	57	22,800	75,100
1999	25,500	Big Springs	Cabinet G.	Right Ventral	25	10,000	35,500
2000	28,000	Big Springs	Nampa	Adipose	17	6,800	34,800
2001	0	--	--	--	53	21,200	21,200
2002	41,000	Big Springs	Nampa	Left Ventral	78	31,200	72,200
2003	44,800	Big Springs	Nampa	Right Ventral	51	20,400	65,200
2004	46,000	Big Springs	Nampa	Adipose	78	31,000	77,000
2005	26,300	L. Sacajawea	Nampa	Left Ventral	90	36,000	62,300
2006	47,600	L. Sacajawea	Nampa	Right Ventral	59	23,600	71,200
2007	0				100	40,000	40,000
2008	0				65	26,000	26,000
2009	21,500	Big Creek	Nampa	Adipose + coded wire tag	100	40,000	61,500
2010	20,421	Big Creek	Nampa	Adipose + coded wire tag	100	40,000	60,421
2011	20,132	Big Creek	Nampa	Adipose + coded wire tag	134	53,600	73,700
2012	20,368	Big Creek	Nampa	Adipose + coded wire tag	134	53,600	74,000
2013	20,100	Big Creek	Mackay/ Nampa	Adipose + coded wire tag	94	37,600	58,000

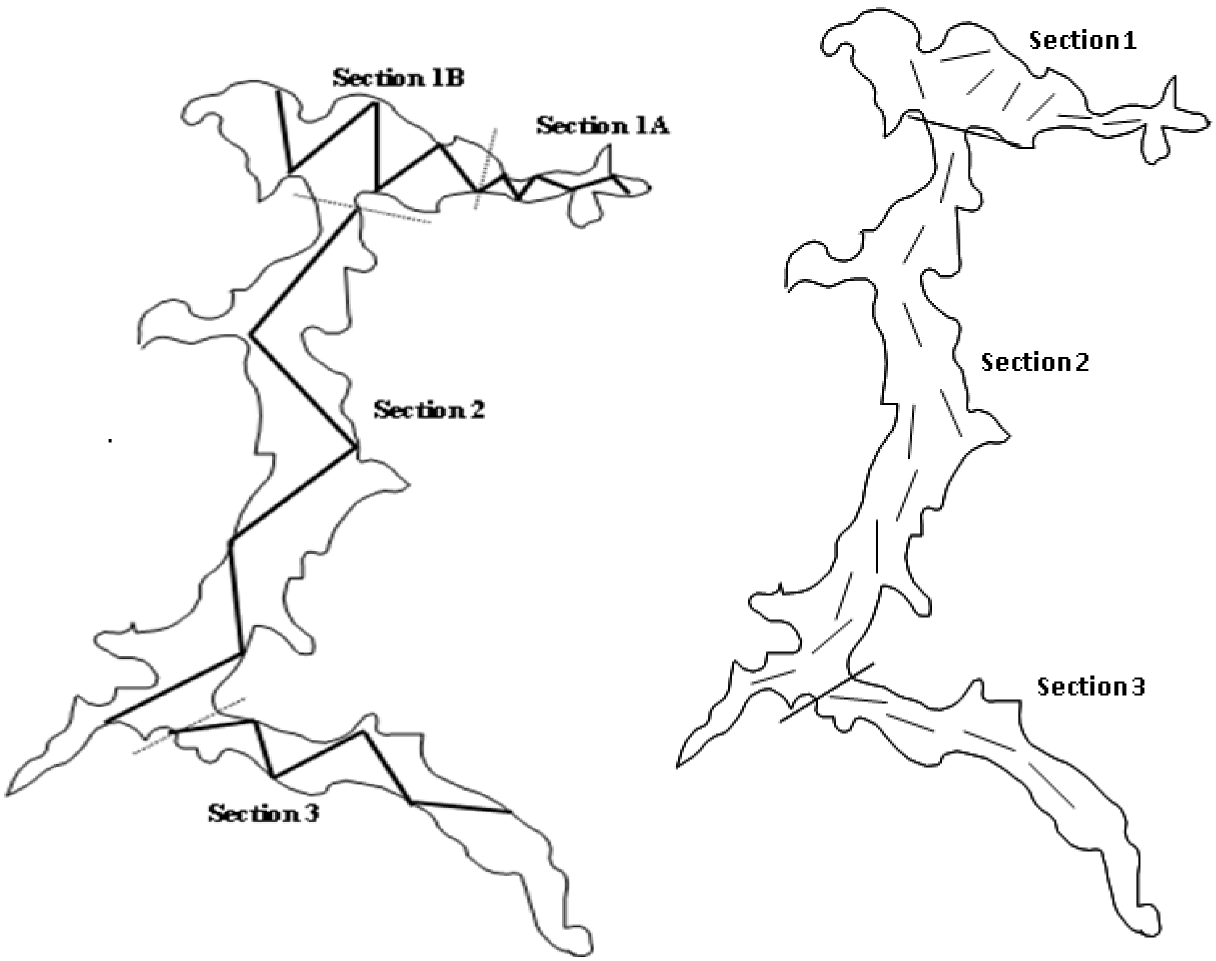

Figure 1. Location of hydroacoustic transects (left) and trawling locations (right) in Coeur d'Alene Lake, Idaho, used to estimate Kokanee population abundance in 2013.

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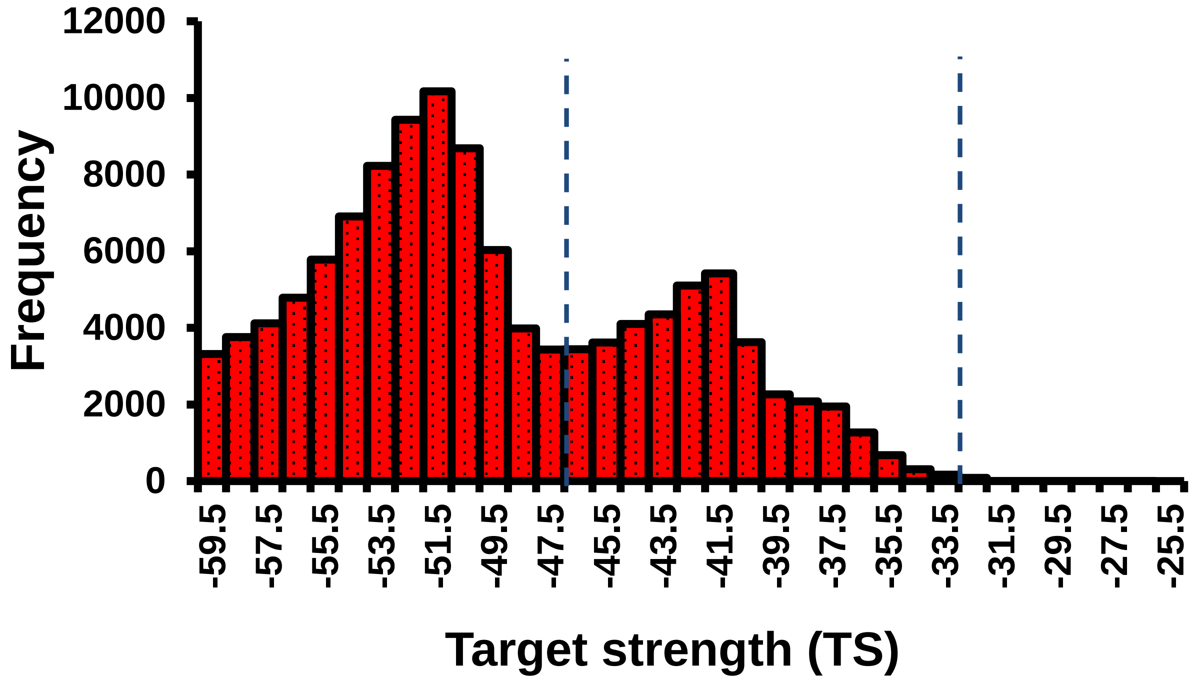

Figure 2. Target strength-frequency distribution of fish within the Kokanee layer in Coeur d'Alene Lake during 2013. Plots are of each single returned echo from a single fish. Fry were defined as targets between -60 dB and -47 dB, and older age classes of Kokanee as targets between -47 dB and -33 dB.

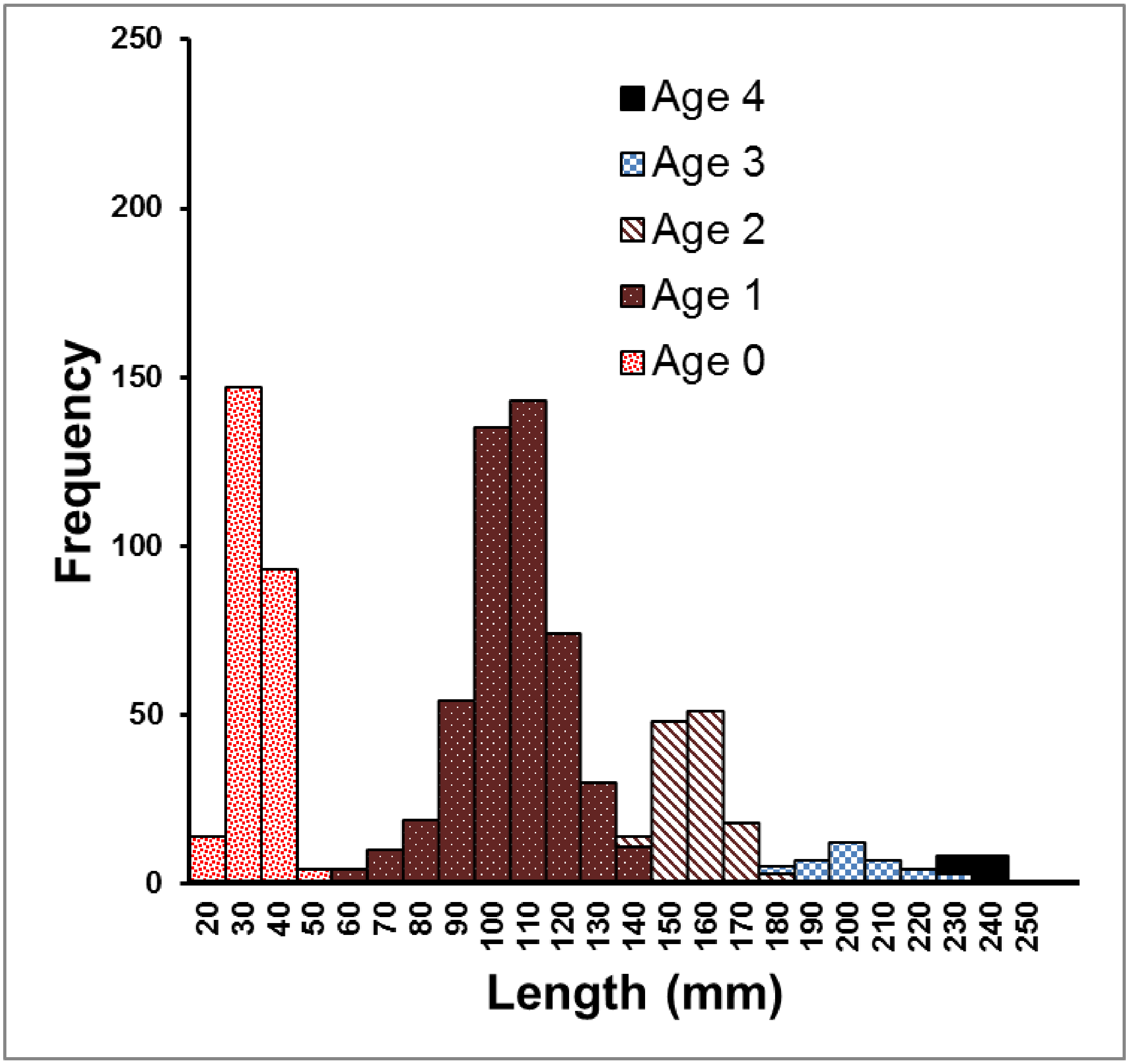

Figure 3. Length-frequency distribution of Kokanee caught by mid-water trawling in Coeur d'Alene Lake during 2013.

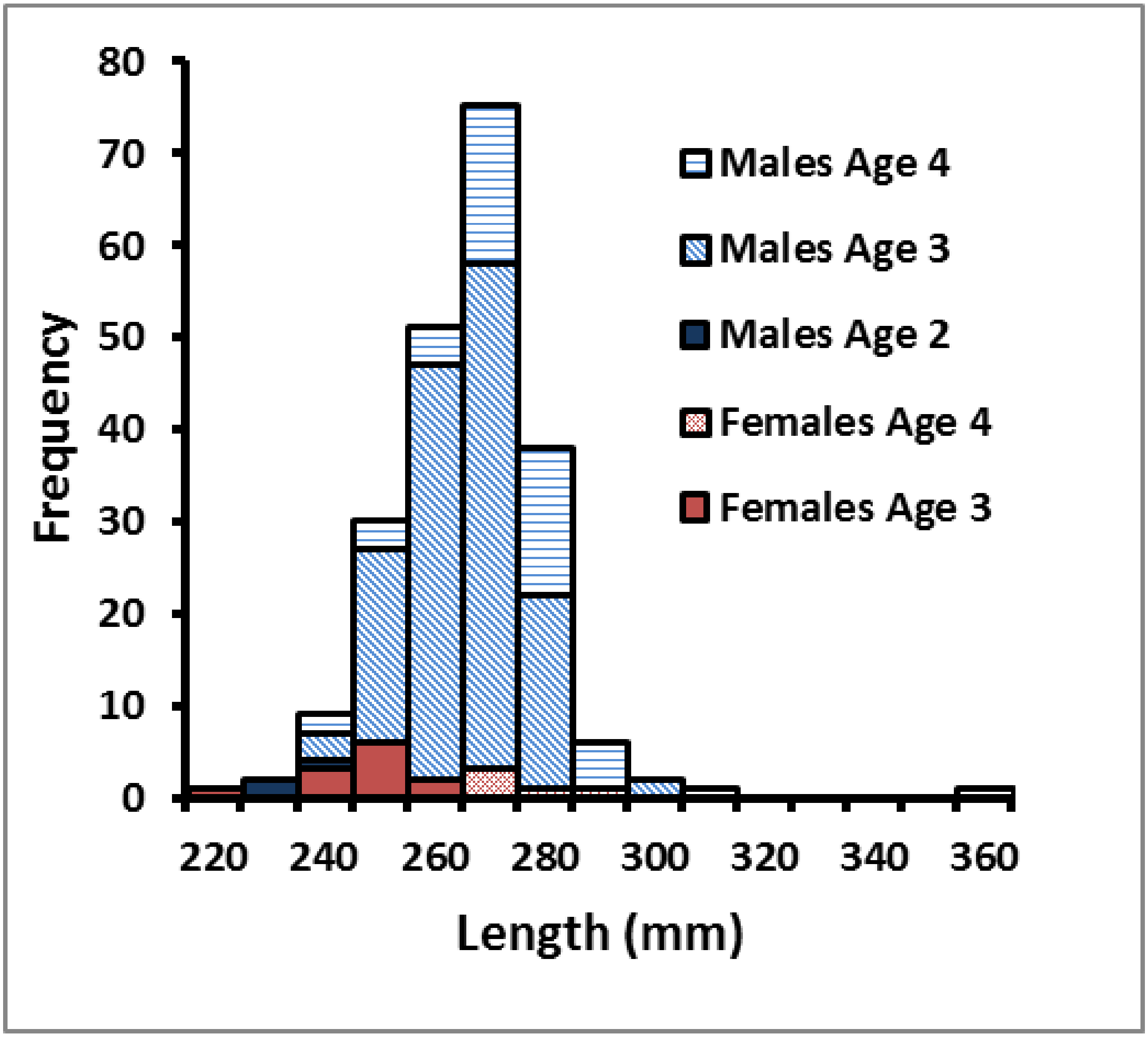

Figure 4. Length-frequency distribution of Kokanee gillnetted on December 3, 2013 in Coeur d’Alene Lake.

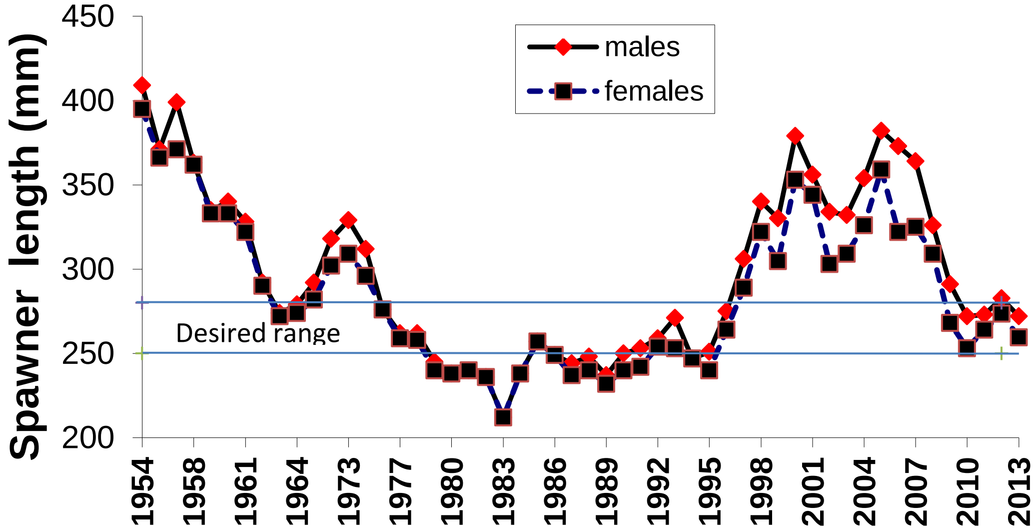

Figure 5. Mean total length of mature male and female Kokanee in Coeur d'Alene Lake, Idaho, from 1954 to 2013. Years where mean lengths were identical between sexes were a result of averaging male and female lengths together. Horizontal lines depict a desired range between 250 mm and 280 mm.

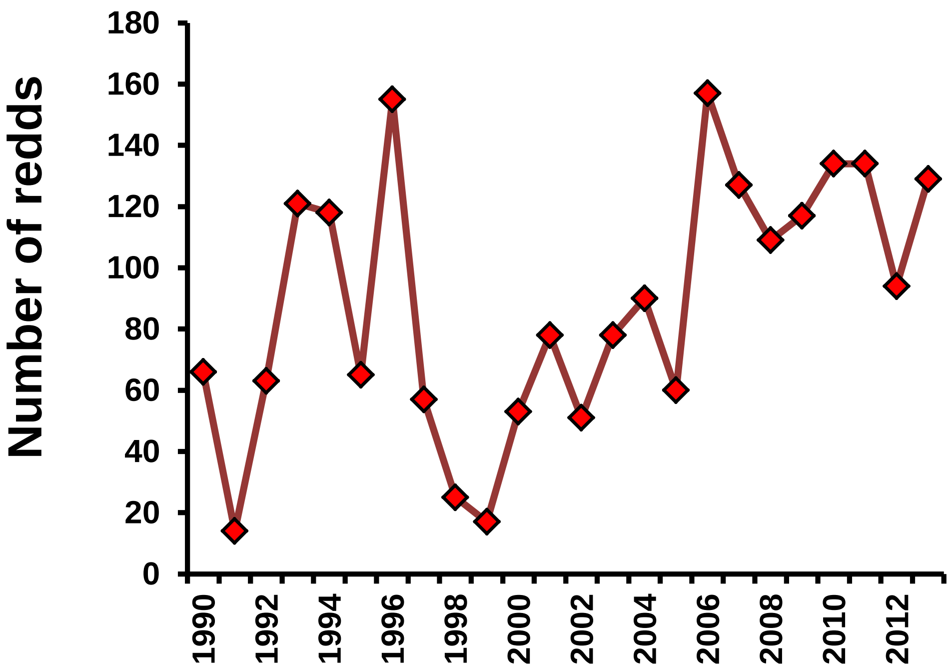

Figure 6. Numbers of Chinook Salmon redds counted in tributaries to Coeur d'Alene Lake, Idaho, between 1990 and 2013.

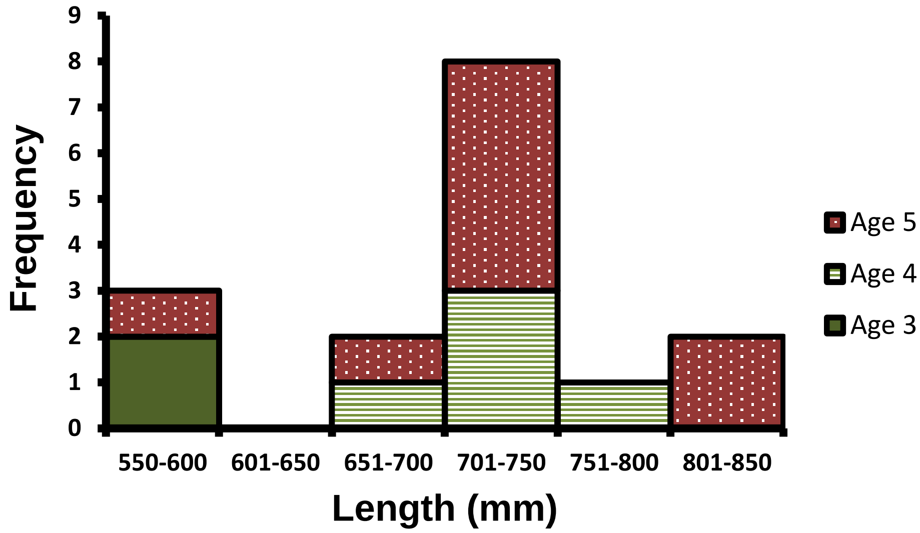

Figure 7. Length frequency distribution of post-spawn Chinook Salmon collected from the Coeur d'Alene River, Idaho during 2013.

CHAPTER 2 - PRIEST LAKE KOKANEE ASSESSMENT

ABSTRACT

We examined Kokanee populations in Priest Lake to gain a better understanding of population trajectory and the likelihood of maintaining a consistent Kokanee fishery. Kokanee densities, based on hydroacoustic surveys, remained almost identical to the previous year's survey with an estimated 30 Kokanee fry/ha and 14 age 1-4 kokanee/ha. These estimates were considered to be very low Kokanee densities that were not indicative of an increasing population. Conversely, visual counts of Kokanee spawning on the shoreline increased to 31,745 fish, which was about an order of magnitude higher than most counts between 2001 and 2010 and suggests a growing population. Kokanee spawners were found to mature at 3 and 4 years of age.

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INTRODUCTION

During 2013, we investigated Priest Lake to help evaluate alternatives for future fishery management. As stated in the current fishery management plan, a decision is needed on whether to manage the lake primarily for Kokanee *Oncorhynchus nerka,* Westslope Cutthroat Trout *O. clarkii lewisi,* and Bull Trout *Salvelinus confluentus* or to continue management primarily for Lake Trout *S. namaycush* (IDFG 2013). Beginning in 2013, IDFG began a graduate research project with the University of Idaho to develop a better understanding of Lake Trout population dynamics. The increasing Kokanee population in recent years and the resultant interest in a Kokanee fishery have prompted a more concerted effort to assess the population beyond the spawner counts which have been conducted since 2001.

STUDY AREA

Priest Lake is located in Idaho's panhandle about 28 km south of the Canadian border. Surface area of the lake is 9,446 ha with 8,190 ha of open water habitat greater than 12 m deep.

The main fishery in the lake for the last 3 decades has been for Lake Trout. The lake also has a fishery for Kokanee that reopened in 2011 and was gaining interest among anglers. A smaller catch-and-release fishery for Westslope Cutthroat Trout also exists. Historically the fishery was primarily for Cutthroat Trout and Bull Trout. A survey in 2003 estimated that anglers spent $3.6 million while making 20,000 fishing trips to the lake (Grunder et al. 2008). A more recent survey in 2011 estimated anglers spent $5.9 million and the number of trips stayed the same at 20,000 trips (IDFG, unpublished data).

METHODS

We conducted a lake-wide, mobile, hydroacoustic survey on Priest Lake to monitor the Kokanee population. Methods were very similar to the approach used the previous year and followed the same transects. The survey was conducted on the night of August 15, 2013. We used a Simrad EK60 split-beam, scientific echosounder with a 120 kHz transducer to estimate Kokanee abundance. Ping rate was set at 0.25 to 0.30 s/ping. A pole-mounted transducer was located 0.52 m below the surface, off the port side of the boat, and pointed downward. The echosounder was calibrated prior to the survey using a 23 mm copper calibration sphere to set the gain and to adjust for signal attenuation to the sides of the acoustic axis. We used Simrad's ER60 software to determine, and input, the calibration settings. The echosounder was also re-checked with the calibration sphere before the start of the survey and the gain increased by 0.1 to match the nominal value of the sphere.

We followed a uniformly spaced, zigzag pattern of 15 transects stretching from shoreline to shoreline (Figure 1). The zigzag pattern was used to maximize the number of transects that could be completed in one night. The pattern followed the general rule of using a triangular design (zigzags) when the transect length was less than twice the transect spacing (Simmonds and MacLennan 2005). The starting point of the first transect at the northern end of the lake was originally chosen at random. Boat speed was approximately 2.4 m/s, which was just above idling speed (990 revolutions/min) for the boat.

We determined Kokanee abundance using echo integration techniques. SonarData's Echoview software, version 5.4, was used to view and analyze the collected data. A box was drawn around the Kokanee layer on each of the echograms and integrated to obtain the nautical area scattering coefficient (NASC) and analyzed to obtain the mean target strength of all returned echoes. This integration accounted for fish that were too close together to detect as a single target (MacLennan and Simmonds 1992). Densities were then calculated by the equation:

$$\text{Density (fish/ha)} = (\text{NASC} / 4\pi 10^{TS/10})\ 0.00292$$

where:

NASC is the total backscattering in m^2/nautical mile^2, and
TS is the mean target strength in dB for the area sampled.

All fish in the pelagic layer between 10 m and 30 m were considered to be Kokanee based on past trawling work. We calculated a density estimate of fry directly from the echograms. First a total Kokanee density for all fish was calculated by echo integration. Then a virtual echogram was built of the corrected target strengths. We then multiplied the total Kokanee density estimate on each transect by the percentage of small targets between -60 dB and -45 dB that were thought to be fry. Large targets were not excluded from the analysis since Kokanee in Priest Lake were known to exceed 440 mm in our collection of spawning Kokanee during 2012.

Ninety percent confidence intervals were calculated for the estimates of fry and older age classes of Kokanee. The entire lake was considered to be one section, without stratification by area. Since we had small sample sizes from a clumped (contagious) distribution, density estimates were transformed ($\log_{10}$ x+1), and an error bound calculated using a Student's T distribution. Error bounds were antilogged and placed around the arithmetic means (Elliott 1983). Arithmetic means were used since it was thought to be an unbiased estimate of the true population mean and would be consistent with methodology used on Spirit and Coeur d'Alene lakes.

We used the estimate that Priest Lake contained 8,190 ha of pelagic habitat usable by kokanee (Maiolie et al. 2013). This area was 62% larger than the estimate of pelagic habitat used in previous studies dating back to the late 1970s. Investigators who wish to compare Kokanee abundance estimates in this report to previous data should correct for this change in lake area.

We also sampled Kokanee in Priest Lake by mid-water trawling. Trawling was conducted on the nights of August 3rd and 4th, 2013, which was the dark phase of the moon. Sixteen trawls were conducted in the open water areas of the lake. We used a midwater trawl, as described by Bowler et al. (1979), and Rieman (1992), and modified to a fixed-frame trawl in 2003, to estimate the Kokanee population in Coeur d'Alene Lake. The net was 2.2 m wide by 3.01 m tall by 10.5 m long and was towed through the water at a speed of 1.55 m/s by an 8.8 m boat. Densities of Kokanee were averaged to determine an arithmetic mean and multiplied by the area of the lake to determine Kokanee abundance. Ninety percent confidence limits were placed around the estimates based on a Student's t distribution. Kokanee total lengths were measured within a 10 mm size group, weighed, and scales were collected from representative length groups for age analysis. Scales were pressed in a plastic laminated and examined on a microfiche reader to determine ages. We attempted to use estimates of individual age groups based on their percentage in the trawl catch to partition hydroacoustic data; however, only 6

Kokanee were collected by trawling precluding our ability to accurately estimate age-class abundance.

Spawning Kokanee in Priest Lake were netted to obtain size, sex, and age class information. A gillnet was set for 15 min near the Priest Lake State Park boat ramp at Indian Creek on November 6, 2013. The monofilament gillnet was 46 m long with panels of different mesh sizes. We aged the Kokanee by examining their freshly removed, whole otoliths under a light microscope and counting annuli. Sexes were determined by examining the fish's external characteristics.

RESULTS

Based on hydroacoustics, we estimated Priest Lake contained 30 Kokanee fry/ha (-34% to +51%, 90% confidence limits) and 14 Kokanee age-1 to age-4 fish/ha (-29% to +40%, 90% confidence limits) (Table 1). These values were expanded using a lake area of 8,190 ha of pelagic habitat. This yielded a population estimate of Kokanee of 247,800 fry and 111,200 Kokanee ages 1 to 4.

Target strengths of Kokanee during the hydroacoustic survey showed the typical bimodal distribution of a Kokanee population. Target strengths, however, were larger than typical for most northern Idaho Kokanee populations, which was expected given the large size of the fish caught by fishermen and seen on the previous year's spawning survey. Based on the bimodal distribution, we split Kokanee fry from older age classes at -44.0 dB.

The hydroacoustic survey on Priest Lake showed two distinct layers of fish. A pelagic layer, thought to be Kokanee, existed between 10 and 30 m. A second benthic layer of fish was found at depths around 50 m. This benthic layer was not found in Coeur d'Alene Lake, and was likely a mixture of Lake Trout and Pygmy Whitefish (Maiolie and Fredericks, 2013).

Mid-water trawling of Priest Lake yielded the following estimates of each age class of Kokanee: 129,200 fry (16/ha), 32,400 age-1 (4/ha), 8,100 age-2 (1/ha), and 8,000 age-3 (1/ha). Ninety percent confidence intervals on the estimates were +/- 75% on age 0 Kokanee, 101% on age 1 Kokanee, 175% on age-2 Kokanee, and 175% on age-3 Kokanee. However, because of the low catch (only one age-2 and one age-3 Kokanee), the estimates and confidence limits are of limited use. Length frequency distribution of trawl caught Kokanee ranged from 30 cm to 340 cm (Figure 2).

Counts of Kokanee spawning along five shoreline sites were the highest in recent years (Table 2; Figure 3). We counted a total of 31,745 Kokanee in 2013. Estimates were 1,070 at Copper Bay, 26,770 at Hunt Creek, 2,295 at Cavanaugh Bay, 1,270 at Indian Creek, and 340 at Huckleberry Bay (Table 2). We collected 84 Kokanee in our gillnet sample of spawners near Indian Creek. Mature Kokanee ranged in size from 31 cm to 41 cm. Spawners were found to include both age 3 and age 4 Kokanee (Figure 4). Males were larger than their female counterparts in both age classes (Figure 4).

DISCUSSION

As in 2012, Kokanee densities in 2013, based on both trawling and hydroacoustic surveys, were very low in Priest Lake. The estimate of 30 fry/ha in 2013 (and 29 fry/ha in 2012) are nearly two orders of magnitude lower than other regional lakes with abundant Kokanee populations (Figure 5). The estimate of age 1-4 Kokanee was also quite low. We found 14 age 1-4 Kokanee/ha in Priest Lake (and 13/ha in 2012) compared to a mean density of 914/ha in Coeur d'Alene and 2,065 in Spirit lakes, respectively.

Based on hydroacoustic and trawl estimates of the population and age structure, the Kokanee population in Priest Lake does not appear to be rapidly increasing. Both hydroacoustic and trawl surveys indicated a very low abundance of adults, and low abundance of fry in 2012 and 2013 certainly doesn't forecast a high abundance of older age classes in the coming years.

Kokanee spawner counts, however, project a conflicting, and more optimistic picture. In 2013, the observation of over 30,000 fish exceeded the total number of adults estimated in the trawl and hydroacoustic estimates. Shoreline spawner counts are only a crude approximation of the total number of spawners for a number of reasons—counting large numbers is very difficult, many fish are too deep to count, and we only count a portion of the lakeshore. For these reasons, the single day counts we conduct annually are likely significant *underestimates* of the actual spawner abundance. The rapid increase in spawner counts would seem to reflect a population that *is* increasing, and indicate trawling and hydroacoustics are both underestimating the population.

Methods to more effectively estimate all age-classes of Kokanee, and better understand survival bottlenecks will be invaluable in evaluating management alternatives in Priest Lake.

MANAGEMENT RECOMMENDATIONS

1. Conduct a thorough creel survey to characterize the current fishery, to include catch rates, total effort, and harvest of Lake Trout and Kokanee.

2. Attempt to develop better population estimates of Kokanee in Priest Lake through hydroacoustics or modified trawl netting.

3. Estimate exploitation rates of Lake Trout and Kokanee using tagging, population estimates and creel survey data.

4. Monitor the total mortality rate of Kokanee in Priest Lake to determine the extent of predation.

5. Work with university researchers to develop better understanding of trophic structure and food web dynamics of Priest Lake.

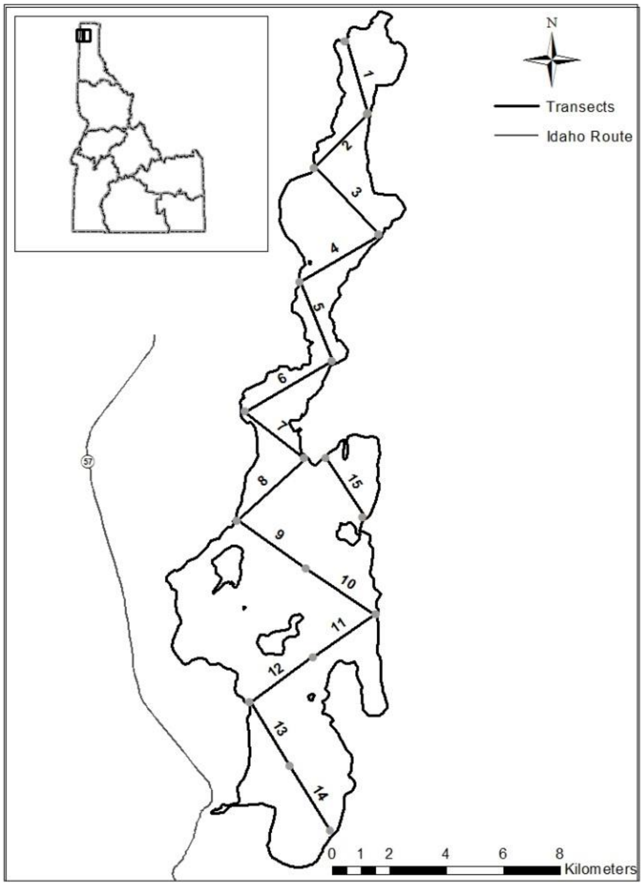
Table 1. Results of a hydroacoustic survey on Priest Lake on the nights of August 15, 2013. Transect locations are shown in Figure 1.

Transect number	Depths analyzed (m)	Number single targets	NASC (m^2/nautical mile^2)	Mean TS (dB)	Total density (fish/ha)	Percent fry	Fry density (fish/ha)	Percent age 1-4	Age 1-4 density (fish/ha)
1	10-30 m	14	0.65	-45.09	5	71%	3	29%	1
2	10-30 m	33	6.56	-45.54	55	94%	51	6%	3
3	10-30 m	31	10.40	-39.50	22	61%	13	39%	8
4	10-30 m	31	20.83	-37.61	28	58%	16	42%	12
5	10-30 m	48	39.89	-37.58	53	65%	34	35%	19
6	10-30 m	38	20.95	-38.82	37	58%	21	42%	16
7	10-30 m	34	14.60	-42.33	58	79%	46	21%	12
8	10-30 m	51	22.87	-38.75	40	35%	14	65%	26
9	10-30 m	48	9.44	-41.86	34	71%	24	29%	10
10	10-30 m	69	21.04	-43.97	122	93%	113	7%	9
11	10-30 m	91	11.14	-43.34	56	68%	38	32%	18
12	10-30 m	59	36.32	-37.87	52	36%	18	64%	33
13	10-30 m	30	22.14	-40.89	63	70%	44	30%	19
14	10-30 m	12	22.56	-36.72	25	50%	12	50%	12
15	10-30 m	10	8.56	-36.79	9	40%	4	60%	6
Mean					44		30		14

Table 2. Counts of Kokanee spawners along the shoreline of Priest Lake.

Location	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Copper Bay	588	549	1,237	1,584	906	1,288	308	223	400	37	750	7,995	1,070
Cavanaugh Bay	523	921	933	1,673	916	972	463	346	550	331	1,340	3,135	2,295
Huckleberry Bay	200	49	38	359	120	43	38	0	37	18	90	665	340
Indian Creek Bay	222	0	0	441	58	0	40	27	15	49	1,050	830	1,270
Hunt Creek Mouth	232	306	624	2,060	2,961	842	1,296	884	1,635	1,410	16,103	14,570	26,770
Total	**1,765**	**1,825**	**2,832**	**6,117**	**4,961**	**3,145**	**2,145**	**1,480**	**2,637**	**1,845**	**19,333**	**27,195**	**31,745**

Figure 1. Map of Priest Lake showing the location of transects used in a hydroacoustic survey of the lake in 2013. List adjacent to the figure gives the starting and ending point of each transect.



Transect number	Location
1	48^{o} 44.105 N x 116^{0} 51.216 W
	48^{o} 42.752 N x 116^{0} 50.490 W
2	48^{o} 42.752 N x 116^{0} 50.490 W
	48^{o} 41.685 N x 116^{0} 51.965 W
3	48^{o} 41.685 N x 116^{0} 51.965 W
	48^{o} 40.469 N x 116^{0} 50.052 W
4	48^{o} 40.469 N x 116^{0} 50.052 W
	48^{o} 39.509 N x 116^{0} 52.258 W
5	48^{o} 39.509 N x 116^{0} 52.258 W
	48^{o} 38.042 N x 116^{0} 51.267 W
6	48^{o} 38.042 N x 116^{0} 51.267 W
	48^{o} 37.034 N x 116^{0} 53.687 W
7	48^{o} 37.034 N x 116^{0} 53.687 W
	48^{o} 36.185 N x 116^{0} 51.942 W
8	48^{o} 36.185 N x 116^{0} 51.942 W
	48^{o} 34.963 N x 116^{0} 53.804 W
9	48^{o} 34.963 N x 116^{0} 53.804 W
	48^{o} 34.112 N x 116^{0} 51.784 W
10	48^{o} 34.112 N x 116^{0} 51.784 W
	48^{o} 33.288 N x 116^{0} 49.723 W
11	48^{o} 33.288 N x 116^{0} 49.723 W
	48^{o} 32.423 N x 116^{0} 51.475 W
12	48^{o} 32.423 N x 116^{0} 51.475 W
	48^{o} 31.535 N x 116^{0} 53.247 W
13	48^{o} 31.535 N x 116^{0} 53.247 W
	48^{o} 30.357 N x 116^{0} 52.023 W
14	48^{o} 30.357 N x 116^{0} 52.023 W
	48^{o} 29.169 N x 116^{0} 50.815 W
15	48^{o} 36.208 N x 116^{0} 51.323 W
	48^{o} 35.115 N x 116^{0} 50.215 W

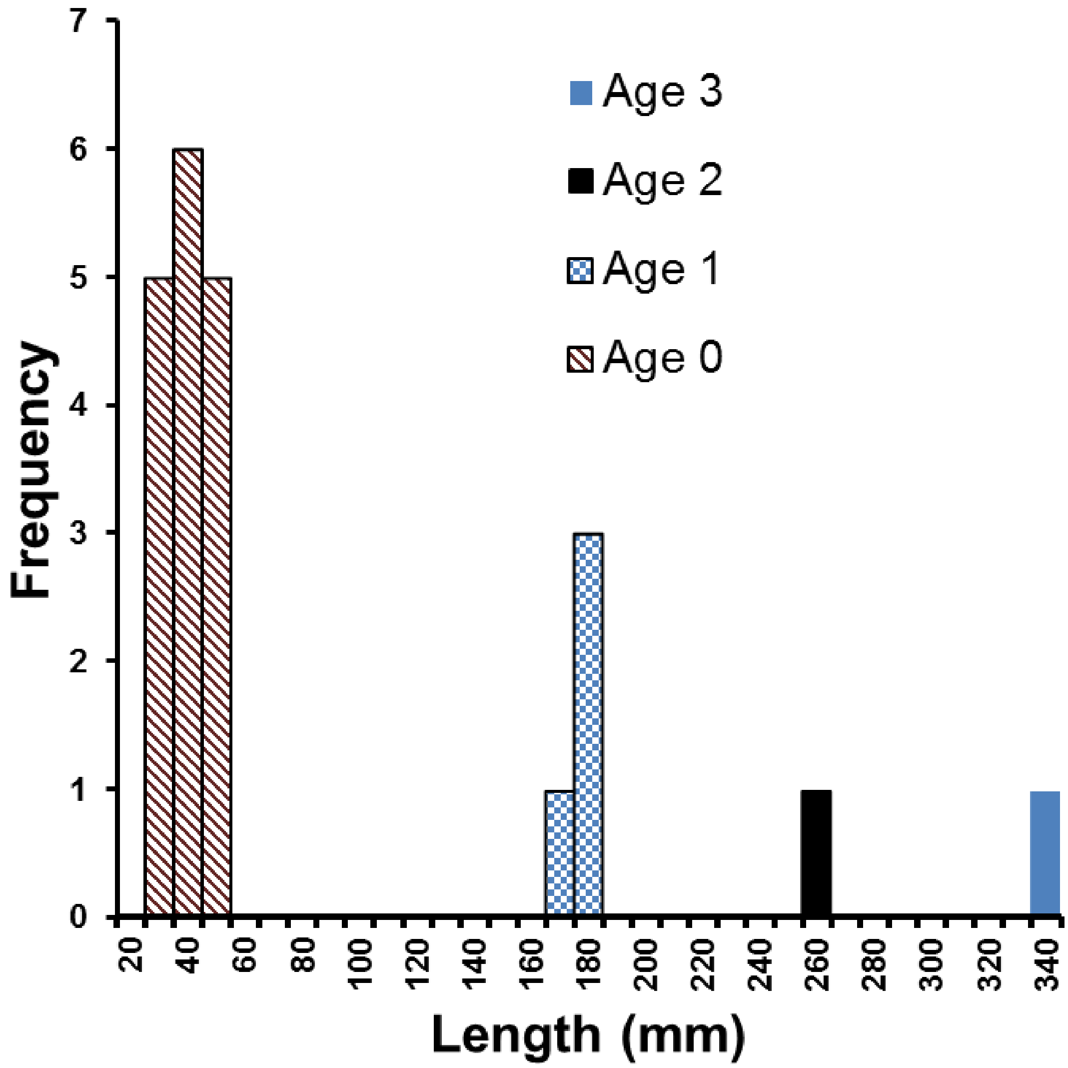


Figure 2. Length-frequency distribution of Kokanee caught while mid-water trawling in Priest Lake, Idaho, during 2013.

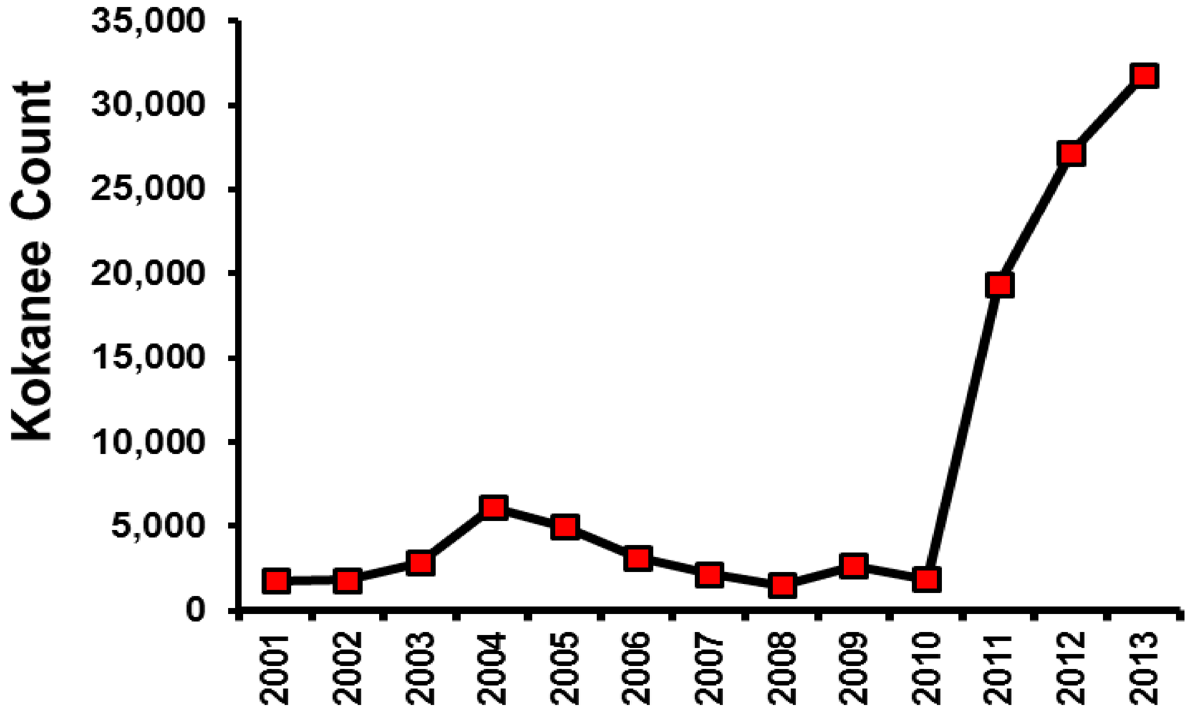


Figure 3. Counts of Kokanee spawning alone the shoreline of Priest Lake, Idaho, 2001 to 2013.

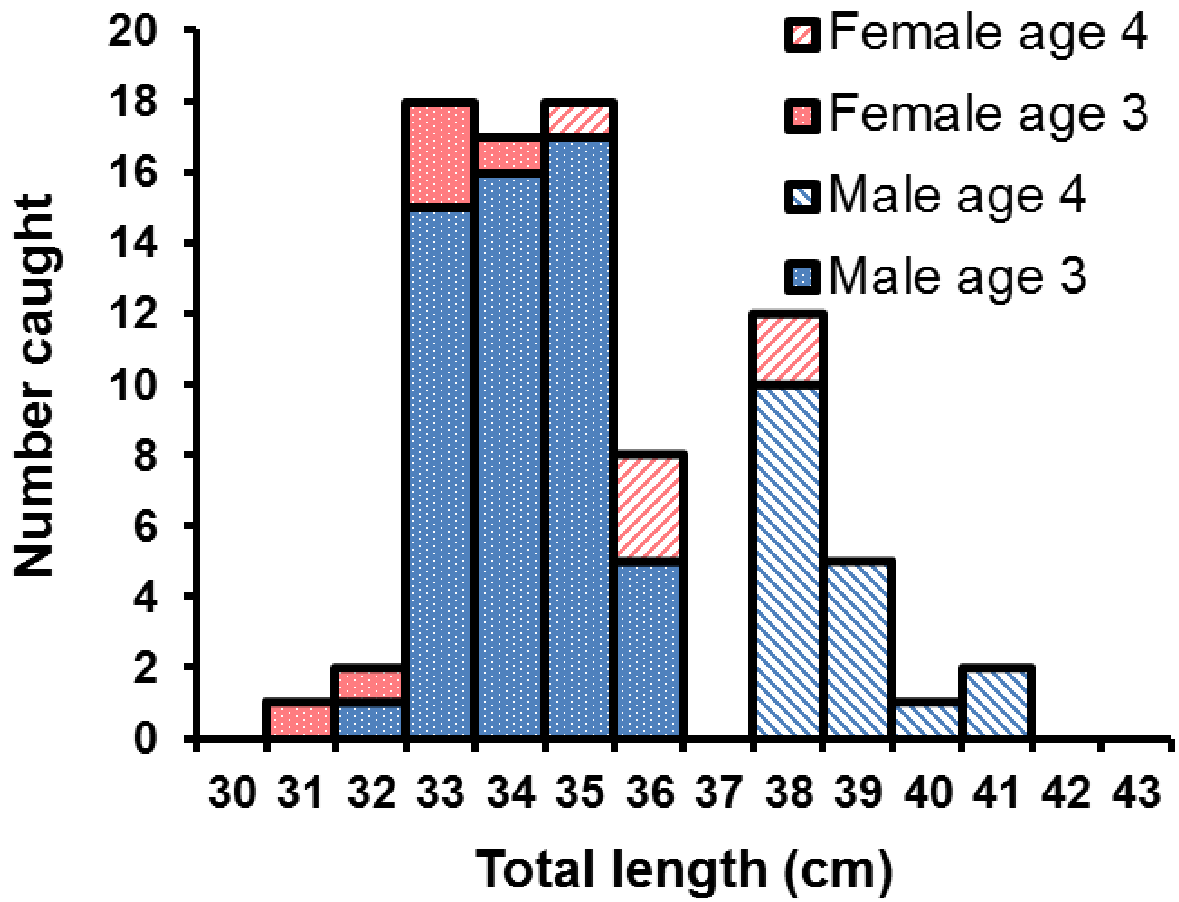


Figure 4. Length frequency distribution of Kokanee spawners collected on the shoreline of Priest Lake on November 6, 2013.

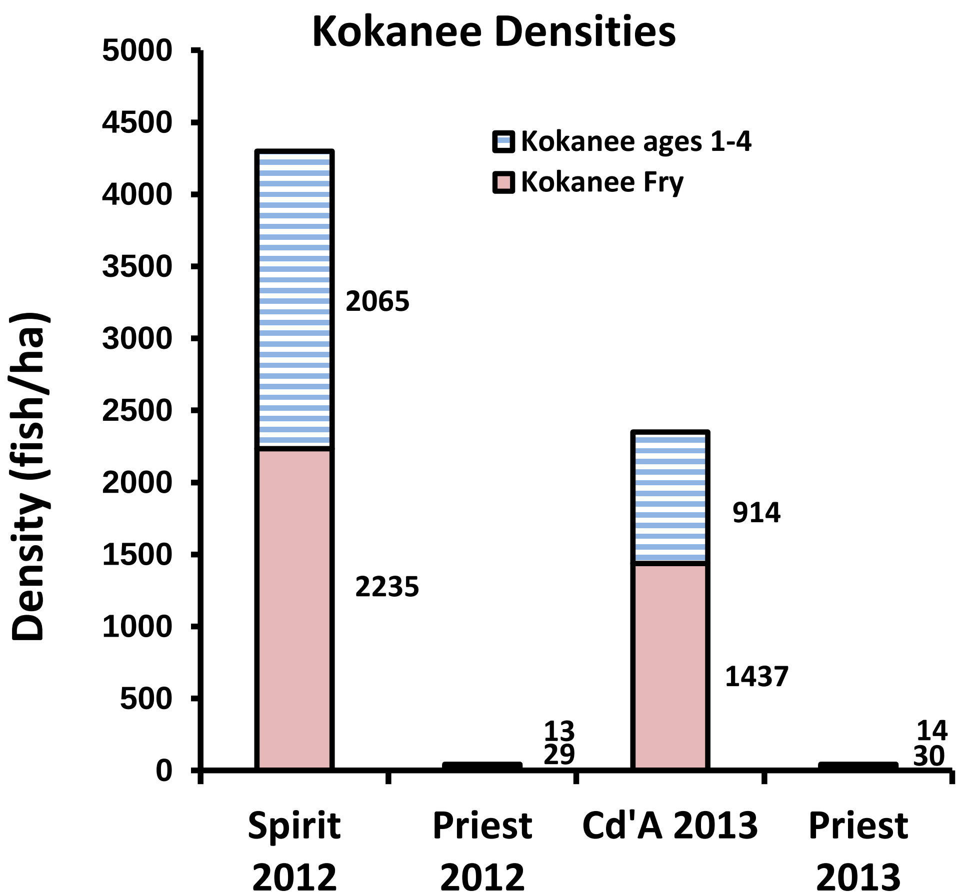


Figure 5. Density of Kokanee fry and older age classes (1-4) in Priest Lake as compared with Coeur d'Alene (Cd'A) and Spirit lakes.

CHAPTER 3: UPPER PRIEST LAKE AND THOROFARE LAKE TROUT CONTROL

ABSTRACT

Upper Priest Lake is currently being managed for the protection of native species. In support of this objective, removal of non-native Lake Trout *Salvelinus namaycush* has occurred since 1998 in an effort to avoid interspecies competition and predation. In 2013 gill nets were used to remove lake trout during a one week period from May 18th to May 24, 2013. A total of 3,844 Lake Trout were removed in this effort.

Immigration by Lake Trout into Upper Priest Lake is possible through the Thorofare connecting Upper Priest Lake to Priest Lake. In an attempt to reduce Lake Trout immigration, we placed trap nets in the Thorofare from October 23 through November 20, 2013. We caught and removed 40 Lake Trout during this effort.

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INTRODUCTION

Historically native Bull Trout *Salvelinus confluentus* provided a trophy fishery in Upper Priest Lake with an annual catch of 1,800 fish in the 1950's (Bjorn 1957). Bull Trout harvest was eliminated in 1984, but no positive response in the population resulted (Mauser et al. 1988). The Bull Trout population in Upper Priest Lake was considered severely depressed while the population in Priest Lake was considered functionally extinct (DuPont et al. 2007).

Native Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* were also historically abundant in Priest Lake and Upper Priest Lakes with 30 fish limits common in the 1940's (Mauser et al. 1988). Over harvest, interspecific competition, predation, and degradation of spawning habitat all led to the decline of Cutthroat Trout in Priest Lakes. Cutthroat Trout were closed to harvest in 1988.

In Upper Priest Lake the Lake Trout population has grown rapidly during the past 30 years. Non-native Lake Trout *often* suppress other native and non-native species through predation and/or competition (Donald and Alger 1993; Fredenberg 2002; Hansen et al. 2008.) Lake Trout were not known to be present in Upper Priest Lake until the mid-1980s at which time they were thought to have begun migrating from Priest Lake (Mauser 1986). In 1998 the Lake Trout population in Upper Priest Lake was estimated at 859 fish (Fredericks and Vernard 2001). In an effort to reduce threats to dwindling Bull Trout and Cutthroat Trout populations, the Idaho Department of Fish and Game (IDFG) has been using gill nets to reduce Lake Trout abundance in Upper Priest Lake since 1998. Removal efforts have collected between 150 and 5,000 Lake Trout annually from Upper Priest Lake (Fredericks et al. 2013). The netting efforts demonstrated that Upper Priest Lake is not a closed system. Some immigration occurs through the Thorofare from Priest Lake, a 3.2 km long river which connects the two lakes. Between natural recruitment and immigration, Upper Priest Lake appears to be recolonized by the following year. This report documents our efforts in 2013 to remove Lake Trout from Upper Priest Lake and prevent immigration from Priest Lake via the Thorofare.

OBJECTIVES

Our objective for Upper Priest Lake is to "restore native fish populations." Our intent is to maintain native populations of Bull Trout, Cutthroat Trout, and Pygmy Whitefish *Coregonus coulteri* .

STUDY SITE

Upper Priest Lake is located approximately 21 kilometers (km) south of the Idaho-British Columbia border in the northwest corner of the Idaho Panhandle. It is a glacial lake that has roughly 13 km of shoreline, a surface area of 566 hectares (ha), a maximum depth of approximately 31 meters (m), and a maximum temperature of 21 ^{o}C. The lake is bathtub shaped with steep walls and a flat bottom. Upper Priest and Priest lakes are held at 743 m elevation from the end of spring run off until mid-October via a small dam located at the outlet of Priest Lake. Upper Priest Lake is connected to Priest Lake by a channel known as the Thorofare. The Thorofare is roughly 3.2 km long, 70 m wide, and 1.5-3 m deep at summer pool elevation. At low pool, water depth in the Thorofare outlet is < 0.15 m blocking most boat traffic.

METHODS

Lake Trout Removal from Upper Priest Lake

In 2013, Lake Trout removal efforts at Upper Priest Lake were completed between May 18th and May 24th 2013. Hickey Brothers Research, Limited Liability Company (LLC) was contracted to provide equipment and labor for completion of the netting project. An 11 m commercial gill net boat was used to complete sampling efforts. Funding for the lake trout removal effort was provided by the United States Fish and Wildlife Service (USFWS).

Monofilament sinking gill nets were used to capture and remove lake trout from Upper Priest Lake. Individual gill nets were 91 m long by 2.7 m high. Nets were tied together end to end to create a single long net string. Effort units were measured as net boxes. Each box of net was equivalent to approximately 273 m or three 91 m nets. Each net set or combination of boxes contained a standardized range of mesh sizes including 45 mm, 51 mm, 57 mm, 64 mm, and 76 mm stretched mesh. Daily effort was split between morning and afternoon sets for each day. The combined effort per day was 30 boxes of gill net. A total of 180 boxes of gill net were placed over seven days. Both morning and afternoon sets were made on each day except the initial and final netting dates during which only one set was made on each date.

The combined total effort for the initial and final day of netting was 30 boxes. Typically 18 boxes of net were set in the AM and 12 boxes of net were set in the PM. The combined effort by mesh size was consistent within AM and PM sets respectively, for all sets except on the initial and final days of netting. On the initial day of netting 18 boxes of net were set in the PM. On the final day of netting 12 boxes of net were set in the AM. The time between net placement and initiating net lifting ranged between two to five hours for all sets. Gill nets were set throughout Upper Priest Lake over the course of the sampling period at depths ranging from 10 m to 31 m. Placement of nets in and around the primary inlets and outlet of Upper Priest Lake were avoided to reduce by-catch of Bull Trout and Westslope Cutthroat Trout. Catch rate was measured as catch per effort or fish per net box per day. Cumulative Lake Trout catch was tallied by date. Abundance of Lake Trout in UPL prior to netting removal was estimated using a Leslie Depletion Model (Ricker 1975).

Tagged fish were present in Upper Priest Lake during the 2013 removal effort. Lake Trout captured in gill nets from Upper Priest Lake in late April and early May 2013 were marked with T-bar style tags. Tagged fish were collected in association with an ongoing graduate research project (Mike Quist, University of Idaho, personal communication). A total of 83 tagged Lake Trout had been released prior to removal efforts. Tagged Lake Trout were captured with sinking gill nets. Gill net mesh sizes ranged from 38 mm to 127 mm. All Lake Trout captured during the 2013 removal effort were examined for tags. Recapture rates observed during removal efforts were intended to facilitate population estimation.

All Lake Trout caught during netting efforts were measured to total length (mm). Lake Trout greater than 400 mm were primarily cleaned, packed on ice, and distributed to local food banks. Remaining Lake Trout were dispatched and returned to the lake. By-catch associated with the removal effort were recorded, a portion of the by-catch was measured to total length (mm), and released.

Thorofare Netting Evaluation

With funding from USFWS, IDFG contracted with Hickey Brothers Research, LLC, in 2013 to continue evaluation of commercial trap nets to minimize Lake Trout movement into Upper Priest Lake from Priest Lake. A trap net was operated in the Thorofare between October 23 and November 20, 2013. The timing of trap net placement was chosen to correspond to peak Lake Trout migratory periods observed in previous years.

A single trap net was placed in the Thorofare approximately 400 m upstream of Priest Lake. This site was selected due to its narrow width, relatively flat streambeds and lack of debris. Leads constructed of thick 200 mm mesh extended from the trap net to the shoreline on each side, and extended from the bottom to the surface. The heart has wings or net sections that form a V-shape and are supported by floats and anchors. Trap net leads were designed to span the entire width of the Thorofare, posing navigation obstacles to boaters. As such, an eight to ten meter wide section of float line was cut out and submerged to create a passage-way near the thalweg allowing boat traffic to pass the net. A net curtain was extended horizontally from the submerged float line in the boat passage section of the net to discourage fish movement up and through the boat passage. Large signs alerted boaters well in advance that research nets were ahead. Multiple orange floats spaced six meters apart were attached to the top of the leads to help boaters recognize and avoid the trap nets. Additionally, signs with arrows and the words “boat passage” guided boaters through the passage way.

The trap net was checked three days a week. Captured Lake Trout were enumerated, measured for total length, and examined for stage of sexual maturity. Captured non-target species were measured and transported away from the net site before release.

RESULTS

Lake Trout Removal from Upper Priest Lake

We collected 3,844 Lake Trout during the seven day effort. Catch per unit effort ranged from 5 to 46 Lake Trout per box. Catch rate generally declined as cumulative effort increased (Figure 1). Estimated abundance of Lake Trout vulnerable to the gear prior to initiating removal netting in 2013 was 6,505 fish. Based on estimated abundance, removal efforts caught approximately 59% of the vulnerable Lake Trout in Upper Priest Lake (Table 1). Average size of Lake Trout collected was 309 mm and ranged from 195 mm to 880 mm.

Species caught incidental to Lake Trout in Upper Priest Lake gillnetting efforts included Bull Trout (13), Kokanee *Oncorhynchus nerka* (3), Longnose Sucker *Catostomus catostomus* (116), Largescale Sucker *C. macrocheilus* (2), Mountain Whitefish *Prosopium williamsoni* (2), Northern Pikeminnow *Ptychocheilus oregonensis* (215), Peamouth *Mylocheilus caurinus*(15), Westslope Cutthroat Trout (2), and Yellow Perch *Perca flavescens* (2). Cumulative by-catch made up only 9% of the total number of fish caught.

Lake Trout catch rates were relatively consistent between most gill net mesh sizes fished during the Upper Priest Lake Lake Trout removal effort (Table 2). Catch rate ranged from 0.10 to 0.07 Lake Trout per meter of net fished for mesh sizes between 45 mm and 64 mm. Only the 76 mm gill net mesh demonstrated a considerably different catch rate at 0.02 Lake Trout per meter net.

During UPL removal efforts, seven Lake Trout tagged in Upper Priest Lake prior to the removal effort were recaptured. In addition, one Lake Trout previously tagged in Priest Lake in 2013 was recaptured during removal efforts. No estimate of abundance was completed due to inconsistencies in capture gear between marking and recapture efforts.

Thorofare Netting Evaluation

We caught 40 Lake Trout during the 2013 trap netting effort. Lake Trout ranged from 362-654 mm (Table 3); 88% were sexually mature, of those 58% were females (Table 4). A total of eight other fish species were captured including Bull Trout, Kokanee, Largescale Sucker, Mountain Whitefish, Northern Pikeminnow, Tench *Tinca tinca,* Westslope Cutthroat Trout, and Yellow Perch (Table 3).

Lake Trout movement through the Thorofare was variable over the four week calendar period (Table 4). Water temperatures during the sampled period varied little, ranging from 4° to 8° C (Table 4). Peak movements were observed at temperatures between 5° and 6° C.

DISCUSSION

Lake Trout Removal from Upper Priest Lake

Lake Trout removal efforts in Upper Priest Lake continued to remove a large portion of Lake Trout estimated to be present prior to gill netting efforts in 2013. Removal efforts in previous years were estimated to have taken between 73% and 100% of the Lake Trout present in UPL prior to initiating removal effort (Table 1). Although the percentage of fish removed in 2013 represented only an estimated 59%, the total number of fish (3,844) removed represented the third highest total catch since 1998 (Maiolie et al. 2013).

Gill net mesh sizes and quantities fished during Upper Priest Lake removal efforts have varied considerably between years, making inferences regarding annual change in catch and abundance difficult. Previous efforts have focused on maximizing catch through manipulation of net sizes. In contrast, 2013 gill net mesh sizes selected represented the range of mesh sizes fished in previous years. In addition, the quantity of each net mesh fished in 2013 was largely consistent between days. However, the range of net mesh sizes fished in 2013 was not believed to be representative of gear to which the entire range of Lake Trout sizes present in Upper Priest Lake was vulnerable. As evidence to this, lake trout collected and tagged prior to the removal effort were largely caught in gill net mesh larger than 76 mm, the largest mesh size fished during removal effort. This discrepancy in gear between marking and recapture efforts also inhibited our use of recapture data to estimate population abundance. Although maximizing the number of Lake Trout removed should continue to be a priority, maintaining a representative range of gill net mesh sizes between 38 mm and 127 mm is recommended for future efforts to maximize the portion of the population represented by the catch. We also recommend gear be standardized within units or time frames (i.e. gill nets size and quantity fish during one day) to maximize the ability to track relative changes in abundance from year to year represented by the catch.

Thorofare Netting Evaluation

Lake Trout catch in 2013 Thorofare netting efforts represented a lower total catch than previously achieved. The cause of this reduction in catch was unclear. Thorofare netting efforts removed 355 and 305 Lake Trout in 2011 and 2012, respectively (Fredericks et al. 2013; Maiolie et al. 2013). Results could be interpreted as fewer Lake Trout migrated through the Thorofare during 2013 efforts, a reduction in effort resulted in fewer fish caught, or gear efficiency was somehow compromised. Whereas two trap nets were deployed in past years, only one was used in 2013. Nevertheless, the vast majority of fish have been caught in the lower trap net in past years, so the single net does not explain the low catch.

The most plausible explanation was few Lake Trout migrated through the Thorofare during our effort and review of the other possible interpretations likely supports this explanation. Although fewer Lake Trout were caught during the four week period in 2013, that time period represented the peak capture period for Lake Trout catches in previous years (Fredericks et al. 2013; Maiolie et al. 2013). The timing of lake trout migratory movements through the Thorofare are likely keyed in part by water temperature (Fredericks and Venard 2001). Water temperatures were measured below 15°C during the 2013 trapping period and as such were within the range of temperatures at which Lake Trout would have been expected to migrate (Fredericks and Venard 2001). Based on these observations, sample timing and temperature were calibrated to previous known high catch periods. However, gear efficiency was not quantifiable. A concerted effort was made to ensure the trap net was anchored to the bottom of the Thorofare to reduce fish movement through the trap. Unfortunately, maintenance of boat passage through the trap may have effectively reduced trap efficiency. Although a net curtain was extended from the top of the boat passage cutout to discourage fish movement up and over the passage opening, this opening could have allowed fish passage. Despite the inability to quantify the number of fish that may have passed the trap, this boat passage set up had been used in previous years suggesting trap efficiency would not likely have impacted catch significantly.

Thorofare trap net capture of Lake Trout and a variety of other fish species found in Priest and Upper Priest lakes continue to provide evidence movement between the two lakes is common. These results are consistent with other studies suggesting extensive fish movement between the lakes, especially in the fall (Fredericks and Vernard 2001). A total blocking of fish movement between the lakes could be detrimental to native fish, and any migration barrier would have to be evaluated relative to negative impacts to several species.

Implementation of seasonal passive fish barriers (i.e. large trap nets) continued to demonstrate temporarily minimizing Lake Trout immigration to Upper Priest Lake through the Thorofare is inefficient and costly. Thorofare trap netting catches have remained low over five years of fall trapping. Upper Priest Lake gill net catches during this same time period have been relatively high, removing more than tenfold the number of Lake Trout from the system. The continuation of significant Lake Trout catches during Upper Priest Lake removal netting efforts suggested movement of Lake Trout around Thorofare trap netting periods is common and or Lake Trout originating from Upper Priest Lake are a significant portion of the catch. Regardless, Lake Trout removed within the Thorofare would have contributed only a small portion of the total Lake Trout removed from Upper Priest Lake during gill netting operations had Thorofare trap netting not occurred. Thorofare trap netting, because of the specialized equipment, has required a contractor be hired to assist in setting and operating the trap. The cost of operations passed on by the contractor has ranged from $25K to over $50K. Although project partners continue to provide financial assistance to complete these efforts, long term funding has not been secured. In comparison, the cost of Upper Priest Lake gill netting operations, also assisted by contractor, has been approximately $20K to $30K.

MANAGEMENT RECOMMENDATIONS

1. As short term mitigation, continue annual gillnetting on Upper Priest Lake to maintain reduced Lake Trout abundance in support of native fish.

2. Apply consistent gear types and effort quantities during Upper Priest Lake netting to allow for inference relative to changes in the Lake Trout population and impacts of removal efforts.

3. Evaluate costs and benefits of annual Thorofare trap netting efforts and consider discontinuing fall trap netting.

4. Develop a feasible long term management strategy combining Upper and Lower Priest lakes that limits the need for segregated management.

Table 1. Lake Trout removed from Upper Priest Lake by year and associated Lake Trout population estimates prior to removal efforts.

Year	Lake Trout Removed	Estimated Population
2007	1,982	2,307
2008	2,207	2,278
2009	1,353	1,348
2010	2,551	3,346
2011	4,996	5,967
2012	5,355	7,354
2013	3,844	6,505

Table 2. Lake Trout catch from Upper Priest Lake 2013 removal efforts by gill net mesh size and relative effort by gill net mesh size. Mean total length and length ranges of Lake Trout caught were reported by associated gill net mesh sizes.

Mesh Size (in.)	Net Effort (m)	LKT Caught	LKT/m net	Mean TL (mm)	Range (mm)
45mm (1.75")	8230	784	0.10	282	197-880
51mm (2")	18105	1685	0.09	294	195-627
57mm (2.25")	6584	585	0.09	318	239-809
64mm (2.5")	9876	662	0.07	347	242-770
76mm (3")	6584	128	0.02	430	252-865

Table 3. Total number of fish caught, length ranges, and mean total lengths in trap nets set in the Priest Lake Thorofare in 2013.

Species	n	Min TL (mm)	Max TL (mm)	Mean TL (mm)
Bull Trout	2	545	553	549
Kokanee	15	285	410	356
Lake Trout	40	362	654	550
Largescale Sucker	3	450	450	450
Mountain Whitefish	11	302	352	325
Northern Pikeminnow	1	--	--	--
Tench	2	--	--	--
Westslope Cutthroat Trout	1	482	482	482
Yellow Perch	1	--	--	--

Table 4. Total number of Lake Trout captured by date, water temperature (°C), and sex during Priest Lake Thorofare trap netting in 2013.

Date	Water Temp	n	F	M
10/25/13	8	2	1	1
10/28/13	6	5	3	2
10/31/13	6	9	5	4
11/4/13	6	5	4	1
11/7/13	5	3	2	1
11/11/13	5	8	4	4
11/14/13	5	4	3	1
11/18/13	4	2	1	1
11/20/13	4	2	2	0

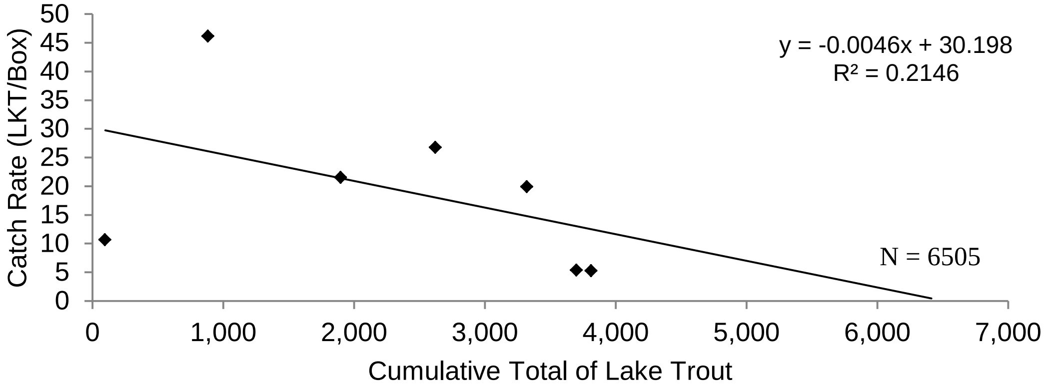

Figure 1. Cumulative Lake Trout catch plotted against catch rate (Lake Trout per box of net fish, CPUE) from Upper Priest Lake Lake Trout removal efforts in 2013. Lake Trout abundance in Upper Priest Lake was estimated by predicting the cumulative catch equal to a catch rate of zero.

CHAPTER 4: HAYDEN LAKE RAINBOW TROUT STOCKING EVALUATIONS

ABSTRACT

Hayden Lake is located north of Hayden, Idaho in the Panhandle Region and provides excellent fishing for multiple fish species. It is popular for anglers across the Panhandle as well as non-residents. Rainbow Trout *Oncorhynchus mykiss* have been stocked in Hayden Lake since the late 1960's and have historically provided a quality fishery, but represent only a small portion of the effort and catch in recent years. Identification of the cause and remedy for declining quality trout fishing opportunities in Hayden Lake has been an ongoing focus of fisheries managers, but with little improvement resulting in the fishery. In 2013, we attempted to evaluate survival of recent Rainbow Trout stocking events in Hayden Lake using standardized floating experimental gill nets to describe relative abundance of these fish in the lake post out plant. We failed to detect Rainbow Trout in our sample suggesting abundance was limited. By-catch in our sampling effort provided confidence in our sampling technique. Manipulations of the timing and size of Rainbow Trout will continue. We recommend evaluation of these stocking events in an effort to maximize return to the fishery.

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INTRODUCTION

Hayden Lake, located north of Hayden, Idaho in the Panhandle Region, provides excellent fishing for multiple fish species and is popular for anglers across the Panhandle as well as non-residents. A mix of warm water species such as Largemouth Bass *Micropterus salmoides*, Black Crappie *Pomoxis nigromaculatus*, and Yellow Perch *Perca flavescens* introduced in the late early 1900's are the primary angler focus (Maiolie et al 2011). More recent sportfish introductions into Hayden Lake also provide popular fishing opportunities. Smallmouth bass *Micropterus dolomieu*, legally introduced, and northern pike *Esox lucius*, illegally introduced, added to popular littoral fisheries (Maiolie et al. 2011). Historically, Hayden Lake provided a popular fishery for native Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi*, but Cutthroat Trout abundance has declined and now are rare in the catch (Mauser 1978; Maiolie et al. 2011). Rainbow Trout have been stocked in Hayden Lake since the late 1960's and have historically provided a quality fishery, but represent only a small portion of the effort and catch in recent years.

Identification of the cause and remedy for declining quality trout fishing opportunities in Hayden Lake has been an ongoing focus of fisheries managers. Multiple management actions have been attempted to increase trout survival and abundance and improve the recreational fishery. Management actions have included introduction of freshwater shrimp *Mysis diluviana* an alternative food source, stocking rate manipulations, and experimentation with stocking a variety of rainbow trout strains. Multiple trout stocking locations around the lake have also been used as a means to improve survival. Despite these efforts, angler catch rates on trout continue to be low (Maiolie et al. 2011).

Rainbow Trout stocking manipulations continue in an effort to maximize return to the Hayden Lake fishery. Most recently, the timing of stocking events and the size of stocked Rainbow Trout fingerlings has been the focus of efforts to improve the Hayden Lake trout fishery. Rainbow Trout fry, fingerlings, and catchables have been stocked during both spring and fall periods. In 2013, we evaluated relative return from spring and fall fingerling stocking strategies by describing relative abundance of Rainbow Trout in Hayden Lake.

OBJECTIVE

1. Evaluate current Rainbow Trout fingerling stocking strategies.

METHODS

We sampled fish from Hayden Lake using standardized floating experimental gill nets. Six nets were fished overnight between May 6 and May 7, 2013. Net set locations were randomly selected throughout the lake (Table 1).

Captured fish were recorded by net location. All fish were identified, measured to total length (mm), and checked for marks. We reported mean catch per unit effort (CPUE) as a measure of relative abundance in the lake. We intended to use proportional differences in relative abundance to explore the success of different stocking groups. We anticipated encountering two stocking groups including large Rainbow Trout fingerlings stocked in September 2011 (≥ 152 mm, adipose clipped) and fingerlings stocked in June 2012 (76 mm to 152 mm, no mark).

RESULTS

Gill net samples failed to detect any Rainbow Trout at any net location (Table 2). Gill nets did capture Brown Bullhead *Ictalurus nebulosus*, Black Crappie, Bluegill *Lepomis macrochirus*, Kokanee *Oncorhynchus nerka*, Northern Pike, Pumpkinseed *Lepomis gibbosus*, Smallmouth Bass, and Westslope Cutthroat Trout. CPUE was highest for Brown Bullhead and Kokanee, averaging 2.5 fish/net. Kokanee (186 mm to 417 mm TL) and Northern Pike were both captured at three of the six net locations. No other species was captured at more than one location. A single Westslope Cutthroat Trout was captured (180 mm TL). No fish were captured at net location four.

DISCUSSION

The absence of Rainbow Trout in our sample effort suggested stocked Rainbow Trout from fingerling stocking events in 2011 and 2012 were not abundant in Hayden Lake. We were unable to determine the relative contribution of either stocking event and conclude that neither likely exhibited good survival.

Although we did not collect any Rainbow Trout, capture of by-catch species did suggest our selected gear type was suitable for capturing Rainbow Trout. Kokanee, a pelagic oriented fish, were one of the most abundant fish in the catch and were similar in size to that expected of Rainbow Trout from the targeted stocking events. Based on the catch of Kokanee, we conclude net mesh sizes were likely suitable to capture Rainbow Trout. We assumed Rainbow Trout to be surface oriented in pelagic waters due to cool water temperature during our sample period and therefore vulnerable to floating gill nets. The presence of Kokanee in our catch also lends some credibility to this assumption, as both fish prefer water temperature of a similar range.

Our results provide some evidence that survival of stocked fingerling Rainbow Trout in Hayden Lake is low, but due to the absence of catch does not address methods to improve survival. Maiolie et al. 2011 postulated on factors related to timing of stocking events, quantity of stocked fish, and strain which led to the evaluation completed in this report. In their work, they also discussed the role fish size at stocking may play in influencing survival. Angler reports following 2011 fall stocking of large (≥ 152 mm) fingerlings and contrary to our results, suggested an increase in available Rainbow Trout in Hayden Lake during 2012. These reports may also suggest larger fall fingerlings may survive at higher rates than smaller fingerlings. Large fall fingerlings were again stocked in 2013 (IDFG, unpublished data). We recommend annual evaluation of this stocking group and future stocking efforts using methods described in this report.

MANAGEMENT RECOMMENDATION

1) Evaluate survival of large (≥ 152 mm) fall fingerling stocking efforts by describing relative abundance in Hayden Lake during the spring.

Table 1. Date, time, and location of gill net sets on Hayden Lake, Idaho completed to evaluate Rainbow Trout stocking.

Set Date	Set Time	Pull Date	Pull Time	Location	Datum	Zone	N	E
5/6/2013	6:30	5/7/2014	5:30	1	WGS84	10	518588	5289955
5/6/2013	6:50	5/7/2014	5:45	2	WGS84	10	520664	5289580
5/6/2013	7:05	5/7/2014	6:00	3	WGS84	10	521453	5290609
5/6/2013	7:20	5/7/2014	6:20	4	WGS84	10	523325	5291841
5/6/2013	7:30	5/7/2014	6:30	5	WGS84	10	522619	5292987
5/6/2013	7:40	5/7/2014	7:00	6	WGS84	10	523083	5295132

Table 2. Catch by net and species from 2013 Hayden Lake gill netting completed to evaluate Rainbow Trout stocking.

Species	1	2	3	4	5	6	Total Catch	CPUE
Brown Bullhead	--	--	--	--	--	15	15	2.5
Black Crappie	--	--	--	--	--	6	6	1.0
Bluegill	--	--	--	--	--	1	1	0.2
Kokanee	2	9	4	--	--	--	15	2.5
Northern Pike	2	--	--	--	1	4	7	1.2
Pumpkinseed	--	--	--	--	--	1	1	0.2
Smallmouth Bass	--	--	--	--	--	1	1	0.2
Westslope Cutthroat Trout	--	1	--	--	--	--	1	0.2

CHAPTER 5: MYSIS SHRIMP SURVEYS IN PRIEST AND HAYDEN LAKES

ABSTRACT

Mysis Shrimp were introduced into Priest Lake from 1965 to 1968 and Hayden Lake in 1974 with the objective of benefiting the Kokanee population. We sampled Hayden Lake on June 6 and Priest Lake on June 7, 2013 to estimate lake wide Mysis Shrimp density. In Priest Lake, we found that the Mysis Shrimp population appeared stable at a mean total density of 128 shrimp/m^2 with 28 immature and adult shrimp/m^2. This density was similar to previous estimates but was considerably lower than typical on other large lakes. In Hayden Lake, density of Mysis Shrimp ranged from 12 to 36 shrimp/m^2, with an average of 25 shrimp/m^2. Mysis Shrimp densities in Hayden Lake have decreased substantially from 2010 when average density was documented at 975 shrimp/m^2.

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INTRODUCTION

Mysis Shrimp *Mysis diluviana*, also commonly known as Opossum Shrimp, have been stocked around the globe in attempts to increase the forage base for sportfish. Mysis Shrimp were introduced into Priest Lake from 1965 to 1968 and Hayden Lake in 1974 with the objective of benefiting the Kokanee population.

In Priest Lake, shrimp were credited with helping Kokanee grow to 3 kg in 1974 and 1975. Shoals in Priest Lake in the 10 to 30 m depth range were thought to have allowed Kokanee to feed on shrimp displaced from deeper regions and temporarily trapped where fish could feed on them (Bowles et al. 1991). The Kokanee fishery, however, collapsed in 1976 possibly due to shrimp enhancing the diet of smaller Lake Trout (Bowles et al. 1991). Since the mid 1970's the fishery in Priest Lake has primarily been for Lake Trout which replaced Kokanee as the primary fishery.

In Hayden Lake, no adverse effects from shrimp have been observed. Black Crappie, Westslope Cutthroat Trout, and Rainbow Trout are all known to consume Mysis Shrimp at some level. Though the impacts on growth have not been definitively assessed, they are generally thought to be positive and Mysis Shrimp have generally been considered a benefit to the fishery.

Shrimp are not routinely sampled in northern Idaho lakes. The exception to this was Lake Pend Oreille where annual sampling showed that a sharp decline in shrimp began in 2010 and continued through 2013. By 2012, shrimp densities had declined by 98%. After the collapse of shrimp in Lake Pend Oreille, we felt it was worth investigating the densities of shrimp in other northern Idaho lakes. Such declines in shrimp abundance could have major effects on the food web and the resulting sport fisheries. This chapter includes our data on Mysis Shrimp densities for Hayden Lake and Priest lakes in 2013.

METHODS

We sampled Hayden Lake and Priest Lake on June 6 and 7, respectively to estimate Mysis Shrimp density throughout the lakes. All sampling occurred at night during the dark phase of the moon and a total of twelve sites were sampled. Vertical net tows were made from the bottom, or a depth of 46 m, to the surface with a 1 m hoop net. Area of the net mouth was 0.8 m^2. A flowmeter was placed in the net mouth at 1/3 the radius from the outside edge. The flowmeter reading was multiplied by the net area to obtain the amount of water filtered in cubic meters, then multiplied by the vertical distance towed to obtain shrimp per square meter. The net mesh was 1,000 micron with a bucket of 500 micron.

Each shrimp collected was counted, measured, and sexed. Young-of-the-year (YOY) shrimp were individuals under 10 mm. An arithmetic mean density was calculated by averaging all of the samples. We placed 90% confidence limits around the arithmetic mean.

RESULTS

We estimated average Mysis Shrimp densities in Priest Lake at 128 shrimp/m^2 with a 90% confidence interval from -36% to +55% (Table 1). YOY shrimp averaged 100/m^2 with a confidence interval from – 40% to +66%. Immature and adult shrimp averaged 28/m^2 with a confidence interval from -35% to +53% (Figure 1).

Density of Mysis Shrimp in Hayden Lake was relatively consistent between locations sampled and ranged from 12 to 36 shrimp/m^2 with an average of 25 shrimp/m^2 (Table 2). YOY shrimp represented approximately 80% of the total sample and arithmetic mean density of YOY was 20 shrimp/m^2 (Figure 2).

DISCUSSION

Mysis Shrimp appear to be at “normal” densities in Priest Lake when sampled in 2013. Cursory monitoring of the population in the early 1970’s indicated the density was about 100 mysids/m^2 (R.A. Irizarry, Idaho Department of Fish and Game, unpublished data). Sampling in June 1988 was used to estimate a density of 137 shrimp/m^2. Our samples in this study indicated densities averaged 128 shrimp/m^2. All of these samples were considered to be similar considering confidence intervals were likely rather wide. Their densities are low, but this appeared to be typical for this oligotrophic water body.

Densities of Mysis Shrimp in Hayden Lake have decreased substantially from the 2010 and previous surveys of the lake. During the 2010 survey, average density was documented at 975 shrimp/m^2 and had previously remained high in comparison with other water bodies. Similarly, after Mysis Shrimp introduction, Lake Pend Oreille and other western lakes experienced an expansion of shrimp followed by a decline (Richards et al. 1991; Beattie and Clancey 1991; Wahl et al. 2008). However, reasons for declines or factors limiting the shrimp population within Hayden Lake are uncertain and continued monitoring of Mysis shrimp within Hayden Lake is recommended.

Table 1. Densities of Mysis shrimp collected at each of 12 sites in Priest Lake during 2013.

Site	Latitude	Longitude	Water	Number	Number	Total	Density	Density	Density
60	48 41.092	116 52.332	52	19	3	22	23	4	27
62	48 41.093	116 50.893	50	13	23	36	16	28	44
53	48 39.749	116 51.578	58	19	15	34	23	18	42
49	48 37.911	116 51.601	41	136	35	171	166	43	209
45	48 36.418	116 53.067	52	74	18	92	91	22	113
39	48 35.562	116 51.705	90	99	17	116	121	21	142
40	48 35.580	116 50.861	61	104	28	132	127	34	162
31	48 34.620	116 52.196	94	38	11	49	47	13	60
29	48 34.177	116 50.915	107	114	52	166	140	64	203
24	48 33.723	116 50.924	109	245	57	302	300	70	370
10	48 32.824	116 54.411	41	67	13	80	82	16	98
15	48 33.220	116 54.423	43	49	6	55	60	7	67
Mean							100	28	128

Table 2. Density and total number of adults and YOY Mysis shrimp sampled in Hayden Lake in early June 2013.

Date	Site #	Location (Lat; Lon)	Depth (m)	Adults	YOY	Mean #/m^2
6/6/13	1	47 46.248; 116 41.393	51	8	12	25
6/6/13	2	47 46.113; 116 41.935	55	6	10	20
6/6/13	3	47 46.259; 116 42.403	53	11	12	28
6/6/13	4	47 45.938; 116 42.422	56	3	22	31
6/6/13	5	47 45.282; 116 41.670	52	1	10	14
6/6/13	6	47 45.131; 116 41.885	52	0	22	27
6/6/13	7	47 45.482; 116 42.380	55	4	24	34
6/6/13	8	47 45.601; 116 42.608	56	7	22	36
6/6/13	9	47 45.952; 116 43.835	54	8	17	31
6/6/13	10	47 45.947; 116 44.075	52	2	12	17
6/6/13	11	47 45.765; 116 44.324	53	2	23	31
6/6/13	12	47 45.521; 116 44.328	49	0	10	12
Average						**25**

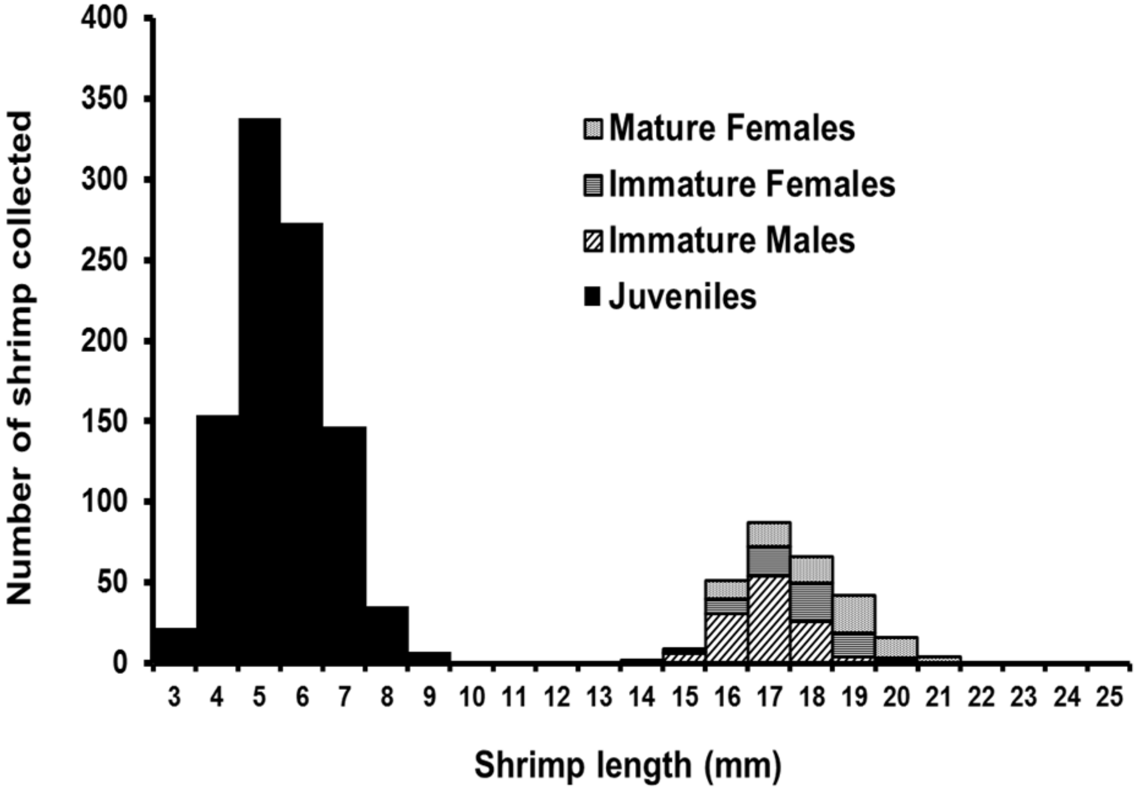

Figure 1. Size distribution of Mysis shrimp collected at random locations in Priest Lake, Idaho, on June 6, 2013.

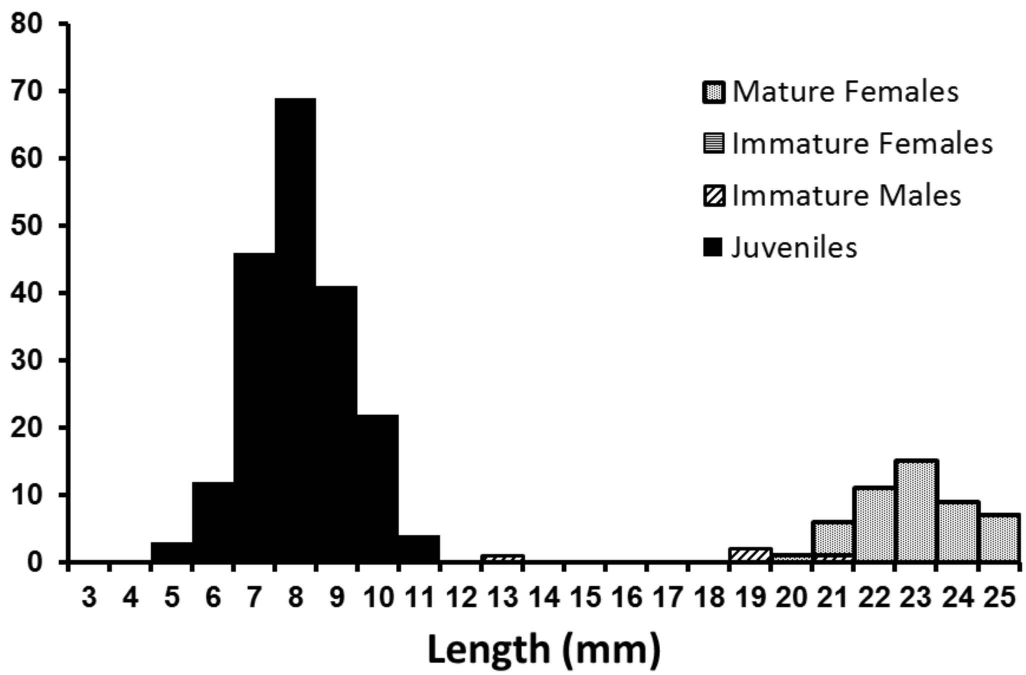

Figure 2. Size distribution of Mysis shrimp collected at standardized locations from Hayden Lake, Idaho, on June 6, 2013.

CHAPTER 6: EXPLOITATION OF WALLEYE IN THE PEND OREILLE RIVER

ABSTRACT

Beginning in the spring of 2012 we conducted an evaluation of Walleye *Sander vitreus* harvest rates in Pend Oreille Lake and the Pend Oreille River. From April through August 2012, a total of 257 Walleye were tagged by angling and electrofishing, primarily in the northern portion of the lake and the transitional area between Pend Oreille Lake and the Pend Oreille River. Ten of the Walleye were incidentally captured and tagged by Avista crews while electrofishing in the Clark Fork River. An additional two Walleye were tagged in the Clark Fork River in 2013. As of October 16, 2013, a total of 17 Walleye had been caught by anglers. Of those, 14 were harvested. Annual exploitation, adjusted for reporting rate and tag loss was estimated at 4.5% and total use (accounting for caught and released fish) was estimated at 6%. Exploitation and total use through October, 2013 (generally 15-18 months) were not much higher at 5.6% and 8.6%, respectively. The evaluation indicates angler harvest is well below a level that would affect the growth or size structure of the population.

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INTRODUCTION

Walleye *Sander vitreus* were illegally established in the upstream waters of the lower Clark Fork River within the Noxon Reservoir reach in the early 1990's (Huston 1994). They were first documented in the Idaho portion of the drainage during a fishery survey of the Pend Oreille River in 2005 (Schoby et al. 2007). In 2011, the Idaho Department of Fish and Game (IDFG) completed a survey of walleye abundance and distribution in Lake Pend Oreille and the Pend Oreille River following standardized Fall Walleye Index Netting protocols (FWIN; Ryan and Fredericks 2013). At that time Walleye were present in low abundance, but widely distributed and demonstrated characteristics such as fast growth, good condition, and early maturity consistent with a potentially expanding population.

Angler interest in Walleye has increased along with the population. While some anglers have advocated a management strategy that would encourage the growth of the population, others are concerned about potential adverse impacts to the existing sport fishery and native fish populations. IDFG policy states that where Walleye have been illegally introduced, they will not be managed with size or bag limits. The liberal limits have been a point of contention with some anglers who believe the population is currently being overharvested. A description of exploitation (annual harvest) rates and total use (percentage of the population that is harvested *or* caught and released) is essential to understanding the impact angling is having on Walleye abundance and size structure.

OBJECTIVE

IDFG's stated objective in managing illegally introduced Walleyes is to reduce their impact to native fish populations and existing sport fisheries (IDFG 2013). The IDFG will monitor these populations and if possible, eliminate them or control their expansion. In support of this objective, the IDFG's policy is to not restrict harvest where unauthorized introductions have occurred. This project was undertaken to assess the impacts the current level of angling has on the abundance and size structure of the Walleye population.

METHODS

From April through August 2012, a total of 257 Walleye were tagged by angling and electrofishing, primarily in the northern portion of the lake and the transitional area between Pend Oreille Lake and the Pend Oreille River (Table 1). The majority of tagged Walleye were captured by a volunteer angler (Chad Landrum). Ten of the Walleye were incidentally captured and tagged by Avista crews while electrofishing in the Clark Fork River. An additional two Walleye were tagged in the Clark Fork River in 2013. Tagged Walleye ranged from 254 to 673 mm with a mean size of 436 mm (Figure 1).

Fish were tagged using Floy T-bar anchor tags inserted just below the dorsal fin. To facilitate and standardize tag reporting procedures, we utilized IDFG's "Tag-You're-It" program. Each tag was individually numbered and labeled with a toll free automated hotline through which anglers can easily report tags. Additionally IDFG distributes posters and stickers to license vendors, regional offices, and sporting goods outlets that explain the tagging effort, how to report tags, and how the information is used.

To determine angler exploitation, the number of fish harvested by anglers (determined by tag returns) was divided by the number of fish we tagged. We adjusted the return rate to account for angler reporting and tag loss. We assumed a 68% reporting rate for non-reward tags and a 10% tag loss rate, which are walleye-specific estimates of return rates and tag loss rates developed by Meyer et al. (2010).

Because the majority (89%) of fish was tagged the first three weeks of July, 2012, we summarized the number of tags reported at the end of June, 2013 and considered this an estimate of annual exploitation and total use. Though some of the tags would have been at large slightly over 365 d, and others were out slightly less, the effect on the exploitation estimate was negligible.

RESULTS

After one year at large, nine Walleye were reported as harvested and an additional three were caught and released. Correcting for tag loss and reporting rate, annual exploitation was estimated at 4.5% (± 4.4% at 90% C.I.) and total use (accounting for caught and released fish) was estimated at 6% (± 5.1% at 90% C.I.). Through October, 2013, (generally 15-18 months at large) a total of 17 Walleye have been reported by anglers. Of these, 14 were harvested and three were released. Exploitation and total use through the additional months were not much higher at 7% (± 5% at 90% C.I.) and 8.6% (± 6% at 90% C.I.) respectively.

DISCUSSION

Angler exploitation rates observed during the period of study were well below a level needed to affect either size structure or abundance. Walleye exploitation rates of 20-30% are common across North America (Serns and Kempinger 1981; Baccant and Colby 1996). In a synopsis of Walleye population characteristics from North American lakes, Baccant and Colby (1996) found that Walleye populations did not collapse when exploited at rates below 20%, and some withstood exploitation rates exceeding 30%.

Our evaluation suggests that fishing regulations have little bearing on the Walleye population. At current rates of exploitation, angling will not be an effective tool to suppress or control the expansion of the Walleye population.

MANAGEMENT RECOMMENDATIONS

1. Retain current regulations for Walleye and periodically evaluate angler exploitation through the “Tag-You’re-It” system.

2. Continue to monitor walleye populations through the Fall Walleye Index Netting program (FWIN) and assess changes in size structure and recruitment.

Table 1. Summary of date, capture method and number of Walleye tagged in the Clark Fork River, Pend Oreille Lake, and the Pend Oreille River from April 23, 2012 through June 17, 2013.

Date	Collection Method	General Location	Number Tagged	Number Reported
Apr 23, 2012	Electrofishing	North shore	3	0
May 8, 2012	Electrofishing	North shore	1	0
May 10, 2012	Electrofishing	Clark Fork R.	1	0
May 13, 2012	Electrofishing	Clark Fork R.	1	0
May 17, 2012	Electrofishing	Clark Fork R.	4	2
May 22, 2012	Electrofishing	Clark Fork R.	2	0
Jun 20, 2012	Angling	North shore	1	0
Jun 25, 2012	Angling	North shore	1	0
Jul 1, 2012	Angling	North shore	27	0
Jul 3, 2012	Electrofishing	Clark Fork R.	1	0
Jul 5, 2012	Angling	North shore	28	3
Jul 7, 2012	Angling	North shore	10	3
Jul 8, 2012	Angling	North shore	10	2
Jul 9, 2012	Angling	North shore	77	3
Jul 10, 2012	Angling	North shore	21	1
Jul 16, 2012	Angling	North shore	20	0
Jul 17, 2012	Angling	North shore	27	2
Jul 18, 2012	Angling	North shore	4	0
Jul 19, 2012	Electrofishing	Clark Fork R.	1	0
Jul 20, 2012	Angling	North shore	6	0
Jul 27, 2012	Angling	Pend Oreille R.	9	0
Aug 16, 2012	Electrofishing	Clark Fork R.	1	0
Aug 26, 2012	Electrofishing	Clark Fork R.	1	0
Apr 28, 2013	Electrofishing	Clark Fork R.	1	1
Jun 17, 2013	Angling	Clark Fork R.	1	0
Total			**259**	**17**

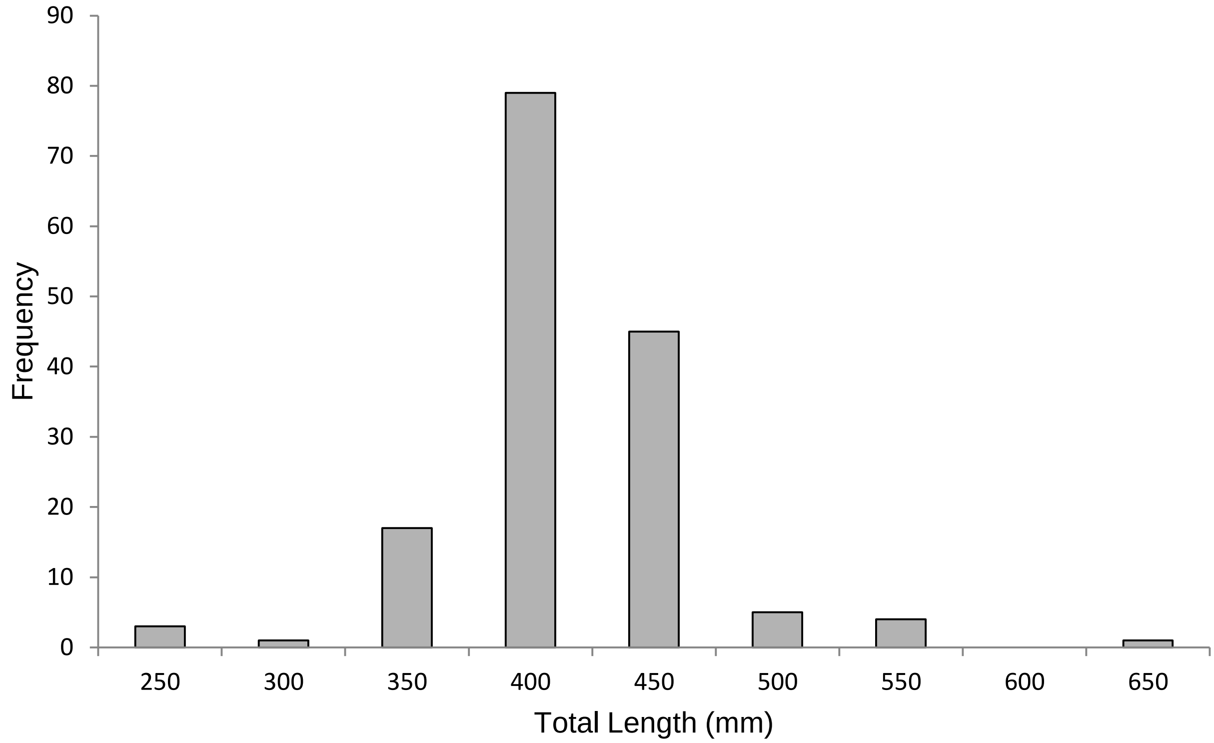

Figure 1. Length frequency of Walleye tagged and released in the Clark Fork River, Pend Oreille Lake, and Pend Oreille River.

CHAPTER 7: PANHANDLE REGION MOUNTAIN LAKE INVESTIGATIONS

ABSTRACT

We sampled two lakes from August 28-29, 2013 to evaluate stocking programs for Arctic Grayling *Thymallus arcticus* and Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* and to evaluate overwinter survival of fish in Noseeum Lake. Noseeum and Steamboat lakes are stocked on odd numbered years. Survival of stocked fish at Noseeum Lake was previously observed to be low and believed to be impacted by overwinter conditions. Stocking rate for Arctic Grayling in Steamboat Lake was reduced in 2000 following observations of slow growth rates. We conducted standard mountain lake surveys on both lakes in August of 2013 to evaluate to what extent previously observed conditions continued. We collected a total of 13 Westslope Cutthroat Trout comprised of a single year class from Noseeum Lake and 43 Arctic Grayling comprised of two year classes from Steamboat Lake. No evidence of winter kill was found in either lake contrary to previous surveys completed at Noseeum Lake. The number and average total length of Grayling collected from Steamboat Lake was considerably larger than the number collected and the average total length of Grayling during the 2009 survey, suggesting reduced stocking rates have provided the desired response in the fishery.

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INTRODUCTION

There are around 140 mountain lakes in northern Idaho of which Idaho Department of Fish and Game (IDFG) currently stocks 51 of them to provide fishing opportunities for the public. Species stocked include Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi*, Rainbow Trout *O. mykiss*, Golden Trout *O. aquabonita* and Arctic Grayling *Thymallus arcticus*. Of the remaining 87 un-stocked lakes, approximately 15-20 have known Brook Trout populations. The majority of stocked lakes contain Rainbow and/or Westslope Cutthroat trout and are stocked with fry on a two year cycle. Stocking rates vary depending on lake elevation. In addition, there are seven lakes in the Panhandle Region managed for Arctic Grayling and/or Golden Trout.

An evaluation of mountain lake stocking rates was completed in 2009 and focused on modifications in stocking rates made in 2000 which addressed variation in growth relative to lake elevation (Fredericks et al. 2009). In that evaluation, low overwinter survival of Westslope Cutthroat Trout was observed in Noseeum Lake. In addition, slow growth rates in Arctic Grayling in Steamboat Lake were observed. Based on recommendations from this survey, Noseeum Lake was restocked with Westslope Cutthroat Trout and stocking rates for Arctic Grayling in Steamboat Lake were reduced.

In 2013, we conducted two mountain lake surveys to evaluate overwinter survival of stocked fish in Noseeum Lake since 2009 and improvements in growth of Arctic Grayling following reductions in stocking rates.

OBJECTIVES

1. Evaluate overwinter survival of Westslope Cutthroat Trout in Noseeum Lake.

2. Evaluate changes in Arctic Grayling stocking rates in Steamboat Lake

METHODS

Fish Sampling

We determined the presence of fish using gill nets and visual observations. Gill nets were set over-night for approximately 12 hours. Gill nets were 46 m in length made up of six, 7.5 m panels. Stretched mesh sizes of the various panels ranged from 25 to 100 mm. We recorded species, length, and weight of all fish netted, and collected otoliths for age analysis. We examined the stomach contents of a random subsample of fish by visual examination in the field. We categorically assessed the quality and quantity of spawning habitat in the inlets and outlets of lakes, and we recorded any observed spawning activity.

We used otolith analysis to estimate fish length-at-age, and then converted the relationship to estimate the age at which fish in the lake could be expected to achieve a length of 250 mm.

Amphibian Sampling

We conducted amphibian surveys using a modified version of the visual encounter survey (VES) technique (Crump and Scott 1994; Schriever and Rhodes 2002). Two observers conducted a search of the entire perimeter of each sampled lake by walking and wading along the lake shoreline typically between 1000 and 1600 hours. Amphibians were identified to species and classified within the following life stage classes: adult, sub-adult, larvae, and egg mass.

RESULTS

Fish Sampling

A total of 13 Westslope Cutthroat Trout were sampled from Noseeum Lake. Only one year class from the 2009 stocking event was sampled. The largest fish sampled was 305 mm and mean length at age 4 of Westslope Cutthroat Trout was 252 mm. Dragonfly larvae was also the most observed forage species for Cutthroat Trout in Noseeum Lake. No adequate spawning habitat or spawning activity was observed.

We collected a total of 43 Arctic Grayling from Steamboat Lake. Two year classes of Arctic Grayling were present within our sample, indicating survival from the 2009 and 2007 stocking events. The largest Arctic Grayling captured was 392 mm and average total length of Arctic Grayling was 205 mm. Mean length at age for age four (n=41) and age six fish (n=2) was 197 mm and 366 mm respectively. Mean age at 250 mm was 5.1 years old for Grayling. Fish diet analysis documented dragonfly larvae as the most observed forage species. No adequate spawning habitat or spawning activity was observed.

Amphibian Sampling

VES surveys documented: Adult Columbia Spotted Frogs (*Rana luteiventris)* and other unidentifiable larvae in Steamboat Lake. Adult and sub adult Columbia Spotted Frogs and one rocky mountain tailed frog (*Ascaphus montanus)* were documented at Noseeum Lake.

DISCUSSION

Fish Sampling

Our survey results suggested overwinter survival of Westslope Cutthroat Trout in Noseeum Lake improved since 2009. Hardy et al. 2010 found no fish in Noseeum Lake in 2009 despite regular stocking events preceding their survey. Westslope Cutthroat Trout were detected in our survey and estimated fish ages suggested sampled fish were stocked in 2009 (post survey). Barton and Taylor (1996) documented that increased winter mortality has occurred during periods of low oxygen and when snow cover has persisted for long periods. Hardy et al. (2010) stated that the Panhandle Region experienced excessive snowfall over the previous two winters prior to their survey. However, since then annual snowfall has been substantially less, possibly contributing to the improved survival of Westslope Cutthroat Trout within Noseeum Lake.

Although we documented that fish stocked in Noseeum Lake in 2009 survived, we did not detect other age classes. IDFG stocking records indicated Noseeum Lake was also stocked with Westslope Cutthroat Trout in 2011. No small fish were observed while completing our survey and none were sampled. Although average size of two year old fish would likely have been small, our sampling gear should have been adequate to detect this age class. Gill nets used in our 2013 surveys caught Arctic Grayling in Steamboat Lake in sizes below 180 mm.

Average size and maximum length of Arctic Grayling was considerably larger in 2013 than 2009 survey results. Hardy et al. (2010) suggesting growth rates increased following reductions in stocking rates. Maximum length of Arctic Grayling sampled increased over 140 mm while representing the same maximum age. Hardy et al. (2010) suggested Arctic Grayling in Steamboat Lake would likely not reach 250 mm at stocking rates evaluated in 2009. In contrast, we estimated Arctic Grayling would reach 250 mm in 5.1 years, below the maximum observed age present in the lake in 2013.

Amphibian Sampling

Surveys showed amphibians were present in lakes that are regularly stocked with fish. A rocky mountain tailed frog was observed in Noseeum Lake which to our knowledge has not been previously documented in this area. Amphibian surveys indicated the mountain lake stocking program in the Panhandle Region is consistent with IDFG objectives for preserving healthy native fauna.

MANAGEMENT RECOMMENDATIONS

1. Maintain reduced Arctic Grayling stocking rates in Steamboat Lake.

2. Maintain Westslope Cutthroat Trout stocking in Noseeum Lake and repeat surveys periodically to determine if out plant survival is sporadic.

CHAPTER 8: AN EVALUATION OF HARVEST RESTRICTIONS FOR MANAGEMENT OF BLACK CRAPPIE IN NORTHERN IDAHO LAKES

ABSTRACT

Where abundant, Black Crappie *Pomoxis nigromaculatus* offer popular fisheries in northern Idaho lakes. Although typically managed for high yield with no harvest restrictions in Idaho, Black Crappie harvest restrictions have been applied on Hayden Lake due to concerns of overexploitation on large crappie. Although harvest restrictions may be used to enhance Black Crappie fisheries, it is unclear whether population dynamics of Black Crappie in northern Idaho lakes are suitable for application of harvest restrictions such as minimum length limits and bag limits. The objective of this investigation was to describe the dynamics of Black Crappie populations in several northern Idaho lakes for use in evaluating the suitability of harvest restrictions in these waters. We sampled Black Crappie using trap nets and electrofishing gear in Hayden and Twin lakes. We were unsuccessful at collecting sufficient numbers of Black Crappie to adequately describe populations in the sampled lakes. We recommended altering the timing of sampling efforts in 2014 to enhance collections and address our evaluation objectives.

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INTRODUCTION

Black Crappie *Pomoxis nigromaculatus* were introduced to many of Idaho's northern lakes during the early 1900's (IDFG, unpublished data). Where abundant, Black Crappie provide popular sport fisheries. Targeted angler effort and associated catch of Black Crappie is significant in some of the regions lakes (Maiolie et al. 2011; Fredericks et al. 2013).

Although typically managed for high yield with no harvest restrictions in Idaho, Black Crappie harvest was restricted in Hayden Lake beginning in 1990 due to concerns of overexploitation on large crappie (Maiolie et al. 1991). Current rules include a minimum length limit of 254 mm and a harvest limit of six fish daily. Although atypical of crappie management in Idaho, average angler catch for Black Crappie at Hayden Lake appears larger than observed in other regional waters, providing a quality fishing experience. Other regional waters, such as Twin Lakes and Fernan Lake, provide popular Black Crappie fisheries with no harvest restrictions. Anecdotal information from anglers suggests average Black Crappie size in the catch at these waters is smaller than that observed in Hayden Lake. Angler exploitation of Black Crappie in Hayden Lake has been estimated near 30% with harvest restrictions in place. Angler exploitation of Black Crappie in other waters of the region has not been estimated in recent years.

Growth rates of Black Crappie in northern Idaho lakes are not clearly understood. Where investigated, information on Black Crappie growth rates are conflicting and suggest crappie growth may vary within waters and between waters in the Panhandle Region (Davis and Horner 1995; Nelson et al. 1996). However, sample sizes used in these evaluations have been limited and as such may have prohibited accurate portrayal of Black Crappie growth in regional lakes. Statewide evaluations of Black Crappie growth suggested Hayden lake fish grow at rates comparable or higher than other selected waters around the state (Lamansky 2011).

Understanding the influence of Black Crappie harvest restrictions on fishery quality is important not only for ensuring harvest restrictions are effective where currently applied on Hayden Lake, but also in evaluation of their application on other northern Idaho waters. Restrictions such as minimum length limits are likely only effective when crappie populations experience rapid growth and low natural mortality (Allen and Miranda 1995). Available knowledge does not provide adequate information for judging whether northern Idaho Black Crappie population dynamics exhibit conditions suitable for effective use of such harvest restrictions.

The objective of this investigation was to describe the dynamics of Black Crappie populations in several northern Idaho lakes. Information gathered would be used to evaluate the suitability of harvest restrictions, including minimum length limits and bag limits, for increasing the availability of large crappie and the effectiveness of minimizing the risk of over exploitation.

METHODS

We selected three target lakes known to support popular crappie fisheries to investigate population dynamics of Black Crappie in northern Idaho waters. Hayden, Twin, and Fernan lakes are located in the Panhandle region of Idaho near Coeur d'Alene. Harvest restrictions for Black Crappie existed only on Hayden Lake.

We attempted to collect adequate samples of Black Crappie from Hayden and Twin lakes during late June and early October of 2013. We used trap nets and nighttime boat electrofishing to complete sampling efforts and to determine if gear effectiveness differed substantially. Both standard trap and fyke style nets were used in sampling. We selected random sites and or random starting points on each lake prior to sampling. Trap nets were placed at each random sample location regardless of bathymetry. In some locations we attempted to shorten trap net leads to minimize depth over traps and trap leads with the intent of maximizing trap effectiveness. Predetermined random starting points were used as sample locations for electrofishing efforts. We completed 600 seconds of effort beginning at each random start location.

We sampled ten randomly selected sites for four days (two days for each site) in spring and fall within Hayden Lake using trap nets. We sampled six randomly selected sites for one day in the spring and ten random sites for two days in the fall within Twin Lakes. Nets were allowed to soak overnight for approximately 24 hours. Both lakes were also sampled in the spring via boat electrofishing. We sampled five randomly selected electrofishing sites on Hayden Lake and eight sites on Twin Lakes. We intended to sample Fernan Lake, but did not in 2013 due to our experiences with limited catch at Hayden and Twin lakes.

Total length (mm), weight (g), and sex were recorded and sagittal otoliths were removed from each crappie captured. To determine age of each Black Crappie, whole otoliths were submersed in water in a black-bottomed dish and viewed with a dissecting microscope using reflected light to determine annuli.

We intended to compare population metrics between waters to explore the suitability of harvest restrictions at providing quality Black Crappie fisheries. Length at age was estimated as a surrogate of growth. We intended to estimate mortality rates through application of catch curves to catch at age data. Comparisons of relative abundance would be made using mean catch per unit effort (CPUE). We did not complete data analysis as intended due to limited catch in all waters sampled.

RESULTS

Hayden Lake

We collected a total of 31 Black Crappie from Hayden Lake in spring sampling efforts. No crappie were collected during fall sampling. A total of nine Black Crappie were collected from trap nets and 22 were collected via electrofishing. A total of three year-classes were present within our sample which consisted of ages three to five (Figure 1). Average total length at age of crappie at time of capture was 182 mm at age three, 214 mm at age four and 229 mm at age five and total lengths ranged from 149-242 mm, respectively.

Twin Lakes

We collected a total of 28 Black Crappie from Twin Lakes in spring sampling efforts and a single Black Crappie during fall trap net sampling. In the spring, all crappie excluding one were collected via electrofishing. A total of four year-classes were sampled with ages ranging from age one to age five with an absent age two year-class (Figure 2). Average total length at age of crappie at the time of capture was 83 mm at age one, 171 mm at age three, 198 mm at age four and 201 mm at age five. Total lengths ranged from 62 to 201 mm.

DISCUSSION

Due to a small sample size, a full comparison and evaluation of population metrics within these two lakes was limited until a larger sample can be obtained. Reasons for low catch rates in both Hayden and Twin Lakes were not specifically known, but were likely attributable to the timing of sampling (McInerny and Cross 2006). A study of Black Crappie movement documented greatest daily movement in April and declining amounts of movement in the following months before summer within South Dakota (Guy et al. 1992). Our spring sampling may have occurred too late in the year to effectively sample crappie in these waters. Other factors such as lake morphometry, water chemistry, and aquatic macrophyte coverage can have substantial effects on catchability of Black Crappie (McInerny and Cross 2006). Notably, both sample waters exhibit a substantial amount of shoreline habitat with steep gradients that may have limited the effectiveness of sampling gear, primarily trap nets.

Fall sampling efforts may have been impacted more directly by water temperatures. Black Crappie tend to seek the warmest water temperatures within lakes and prefer temperatures between 20˚C and 30˚C (Neill and Magnuson 1974). Thus, catchability of Black Crappie in the fall is reduced when compared to spring sampling because of fall turnover and warmer water temperatures being located in deeper offshore habitats where trap nets are less effective (McInerny and Cross 2006). In general, surface water temperatures during our sampling period were consistent with some recommended sampling conditions for fall trap netting (McInerny and Cross 2006), but still resulted in limited catch.

We recommend additional efforts be completed to provide a more robust sample. The timing of sampling efforts should be adjusted to maximize catch. We recommend sampling be conducted primarily in late April and early May to better associate with near shore spawning concentrations. We expect catch rates will be higher during this period. Sampling during this period will likely result in length and age biases in the catch associated with mature larger Black Crappie and will require recognition of this limitation (Miranda and Boxrucker 2009). We also recommend continued evaluation of both trap nets and electrofishing to determine the utility of each gear in the selected waters during periods with higher capture probability. Our catch appeared to be limited most using electrofishing gear. However, electrofishing gear has been recommended for collection of Black Crappie in Idaho (Lamansky 2011). Others have recommended trap nets for standardized sampling of crappie in lentic waters (Miranda and Boxrucker 2009).

MANAGEMENT RECOMMENDATIONS

1. Complete additional sampling in 2014 focusing efforts during late April and early May.

2. Continue to use trap nets and electrofishing gear to determine the utility of each gear in sampling Black Crappie in northern Idaho lakes.

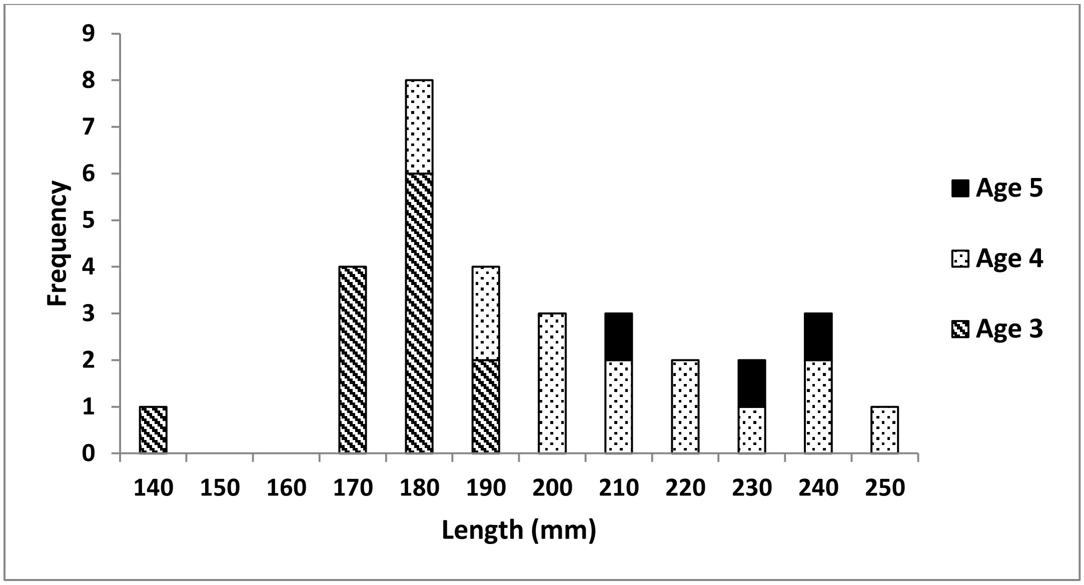

Figure 1. Length frequency distribution of Black Crappie collected via trap nets and boat electrofishing in Hayden Lake in the spring of 2013.

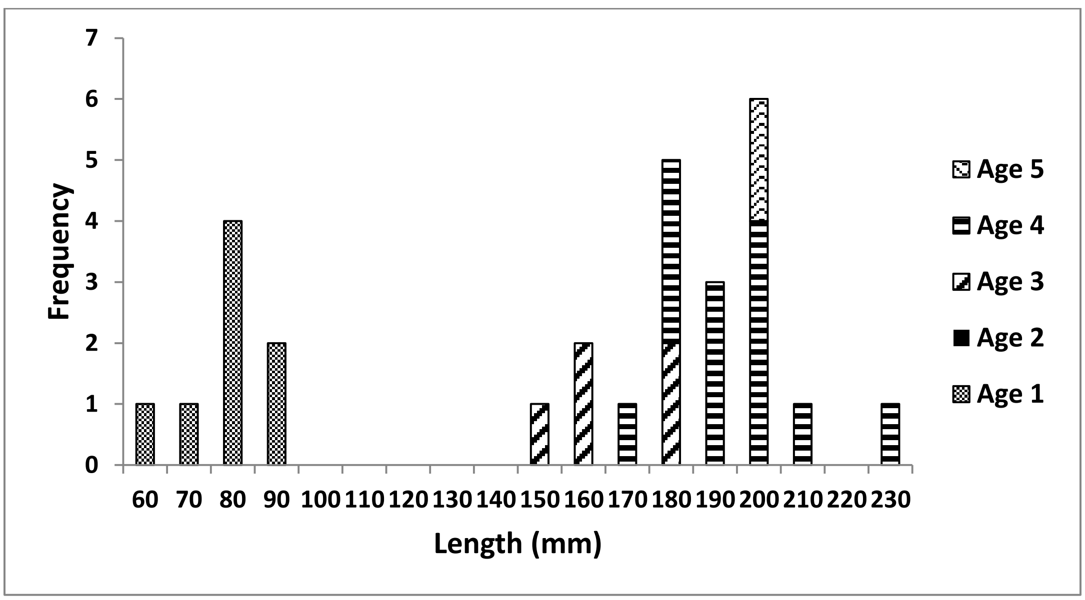

Figure 2. Length frequency distribution of Black Crappie collected via trap nets and boat electrofishing in Twin Lakes in the spring of 2013.

CHAPTER 9: TROUT SURVEYS IN THE COEUR D'ALENE AND ST. JOE RIVERS

ABSTRACT

We monitored fish densities at established transects in the Coeur d'Alene and St. Joe river drainages as part of a long term data set to evaluate a variety of fishery management and habitat improvement efforts. We snorkeled 44 transects in the Coeur d'Alene River and 35 in the St. Joe River. Densities of Cutthroat Trout *Oncorhynchus clarkii lewisi* greater than 300 mm total length were 0.24 fish/100 m^2 in the Coeur d'Alene River drainage and 0.68 fish/100 m^2 in the St. Joe River drainage. This was consistent with a trend of improving densities of Cutthroat Trout over 300 mm during the last 15 years.

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INTRODUCTION

During 2013 we monitored fish densities in the Coeur d'Alene and St. Joe river drainages. Monitoring was part of a long-term data series to examine the overall effects of changing fishing rules, habitat improvements, weather, and other conditions that might affect fish populations. We snorkeled at established sites in each river and counted the fish as was done in previous years. Data collected in 2013 were compared to previous counts to determine trends in the fish populations.

STUDY SITES

The North Fork (NF) Coeur d'Alene River has its headwaters in the Coeur d'Alene and Bitterroot mountains and flows into Coeur d'Alene Lake. Our 44 sampling sites surveyed in 2013 were spread throughout the NF Coeur d'Alene River and Little North Fork (LNF) Coeur d'Alene River (Figure 1). Snorkel transects for monitoring fish abundance were established in the North Fork Coeur d'Alene River in 1973 (Bowler 1974).

The St. Joe River lies to the south of the Coeur d'Alene River drainage. Its headwaters lie in the Bitterroot Mountains and it also flows into Coeur d'Alene Lake. We surveyed 35 sites in the mainstem of the St. Joe River from Ruby Creek to Calder (Figure 2). Twenty eight of the snorkel sites were established in 1969 between Avery and Ruby Creek (Rankel 1971). Seven additional transects were added in 1993 between Avery and the town of Calder (Davis et al. 1996).

METHODS

Snorkeling sites were located by Global Positioning System (GPS) coordinates and photographs in all three drainages. Sites were the same as those used in 2012, but some had changed since the earliest surveys. For example in cases where a pool had filled in, a nearby pool was selected and a new GPS coordinate was recorded. This practice has been done over the years of this trend survey as the river has shifted positions (DuPont et al. 2009).

Snorkeling was used at each site to estimate fish abundance following standardized methods described by DuPont et al. (2009). We snorkeled 44 transects on the NF Coeur d'Alene River from July 30 to August 9, 2013, and 35 transects on the St. Joe River from August 13 through 15, 2013. In the upper most headwaters only one snorkeler was used, however we used two snorkelers, one on each side of the river, at most sites.

RESULTS

North Fork Coeur d'Alene River

We counted a total of 1,217 Cutthroat Trout *Oncorhynchus clarkii lewisi*, 134 Rainbow Trout *O. mykiss*, 1 Brook Trout *Salvelinus fontinalis*, 3,851 Mountain Whitefish *Prosopium williamsoni*, 289 Northern Pikeminnow *Ptychocheilus oregonensis*, and 14 Largescale Suckers *Catostomus macrocheilus* in the Coeur d'Alene River transects (Appendix A). Densities of Cutthroat Trout in all size classes on all transects averaged 0.75 fish/100 m^2. Densities of all sizes of Cutthroat Trout were very similar to 2012 (Figure 3). Density of cutthroat over 300 mm averaged 0.24 fish/100 m^2, which is also nearly identical to that observed in 2012 (Figure 4). We estimated Mountain Whitefish densities at 2.37 fish/100 m^2 for the entire survey in the Coeur d'Alene drainage during 2013 (Appendix A), continuing an increasing trend in the NF Coeur d'Alene River over the last 20 years (Figure 5). We estimated the density of Rainbow Trout at 0.01 fish/100 m^2 in both the LNF Coeur d'Alene River and the lower reach of the NF Coeur d'Alene River. In the upper reaches of the NF Coeur d'Alene River (upstream of Yellow Dog Creek) Rainbow Trout density was much lower at 0.04 fish/100 m^2 (Appendix A). Their densities dropped in the early 1990's with the reduction of stocking, but they have remained in the system at lower densities since this time (Figure 6). The locations of Rainbow Trout were localized in both rivers with more Rainbow Trout found in the lower reaches (Appendix A).

St. Joe River

We counted a total of 1,465 Cutthroat Trout, 20 Rainbow Trout, 1,998 Mountain Whitefish, 1,104 Largescale Sucker, 1,909 Northern Pikeminnow, and 3 Bull Trout *S. confluentus* during the survey in the St. Joe River (Appendix B). Density of Cutthroat Trout over 300 mm averaged 0.68 fish/100 m^2. In the reach from the NF St. Joe to Ruby Creek, the density of Cutthroat Trout over 300 mm was 1.1 fish/100 m^2 (Figure 7). This is the highest density of larger fish estimated since the surveys began in 1969. Total density of Cutthroat Trout of all sizes averaged 1.42 fish/100m^2. In the reach from the NF St. Joe to Ruby Creek, the density of all Cutthroat Trout was 2.3 fish/100 m^2, which is continuing an upward trend since 1998 (Figure 8). Only 20 Rainbow Trout were seen during the 2013 survey. Rainbow Trout density dropped in 2000 and has remained low since this time (Figure 9). The observation of three Bull Trout is within the typical range from recent years (Figure 10). Mountain Whitefish were at the highest density in the St. Joe River since counts began with 1.94 fish/100m^2 (Figure 11, Appendix B). They were seen in nearly every section of the river that we surveyed.

DISCUSSION

North Fork Coeur d'Alene River

Past researchers found declines in the Coeur d'Alene River fishery were directly related to over harvest, habitat degradation, and toxic mine wastes (Rankel 1971; Bowler 1974; Lewynsky 1986; Rabe and Sappington 1970; Mink et al. 1971). Efforts such as habitat improvements and fishing rule changes have been on-going to try to mitigate these impacts. It appears as though these efforts are having the desired effect. Cutthroat Trout densities in the NF Coeur d'Alene River have greatly increased since we began our surveys in the early 1970's. Despite annual variability, we've continued to see an upward trend, particularly in the past two decades. Though changes in fishing rules and angler behavior are undoubtedly a key factor, improvements in physical habitat and water quality along with favorable weather conditions have also contributed to the positive trend in trout densities.

St. Joe River

The St. Joe River has shown a pronounced increase in the abundance of Cutthroat Trout over 300 mm, particularly since 1997 (Figure 7). The trend continued in 2013, with a nearly 40% increase in larger fish in that portion of the river upstream of the NF St. Joe River. Density of all sizes of Cutthroat Trout also increased and were the highest ever recorded, with the exception of the anomalously high estimate in 1976 (Figure 8). Densities of Rainbow Trout in the St. Joe River remain low. The low abundance and decrease in distribution and population in the past 30 years suggests Rainbow Trout are not a significant threat to the Cutthroat Trout population in the St. Joe River.

MANAGEMENT RECOMMENDATIONS

1. Continue to periodically evaluate densities of Cutthroat Trout through snorkel surveys in the Coeur d'Alene and St. Joe rivers.

2. Maintain catch and release rules on Cutthroat Trout in the Coeur d'Alene and St. Joe rivers.

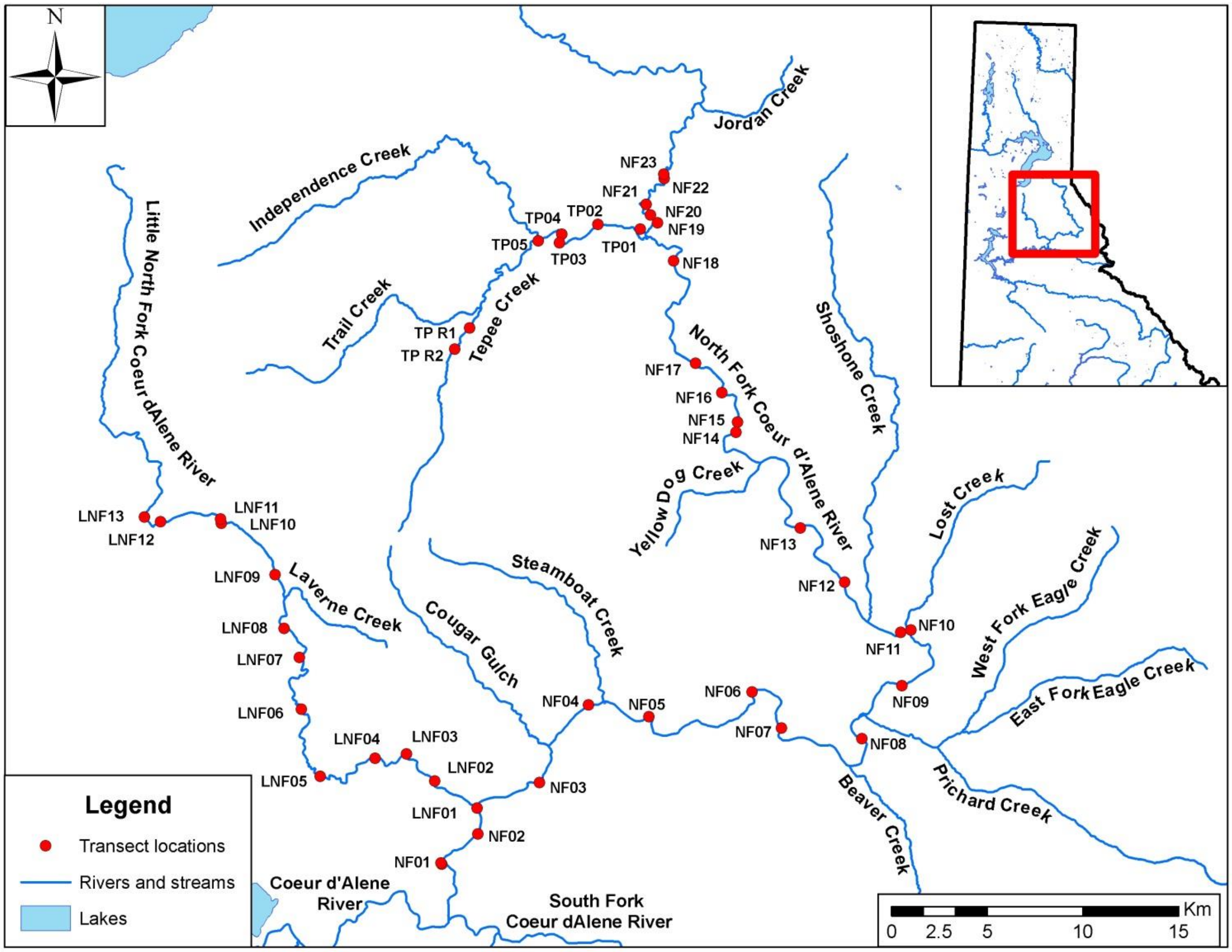

Figure 1. Location of 42 transects snorkeled on the Coeur d'Alene River, Idaho during July 24-27, 2012.

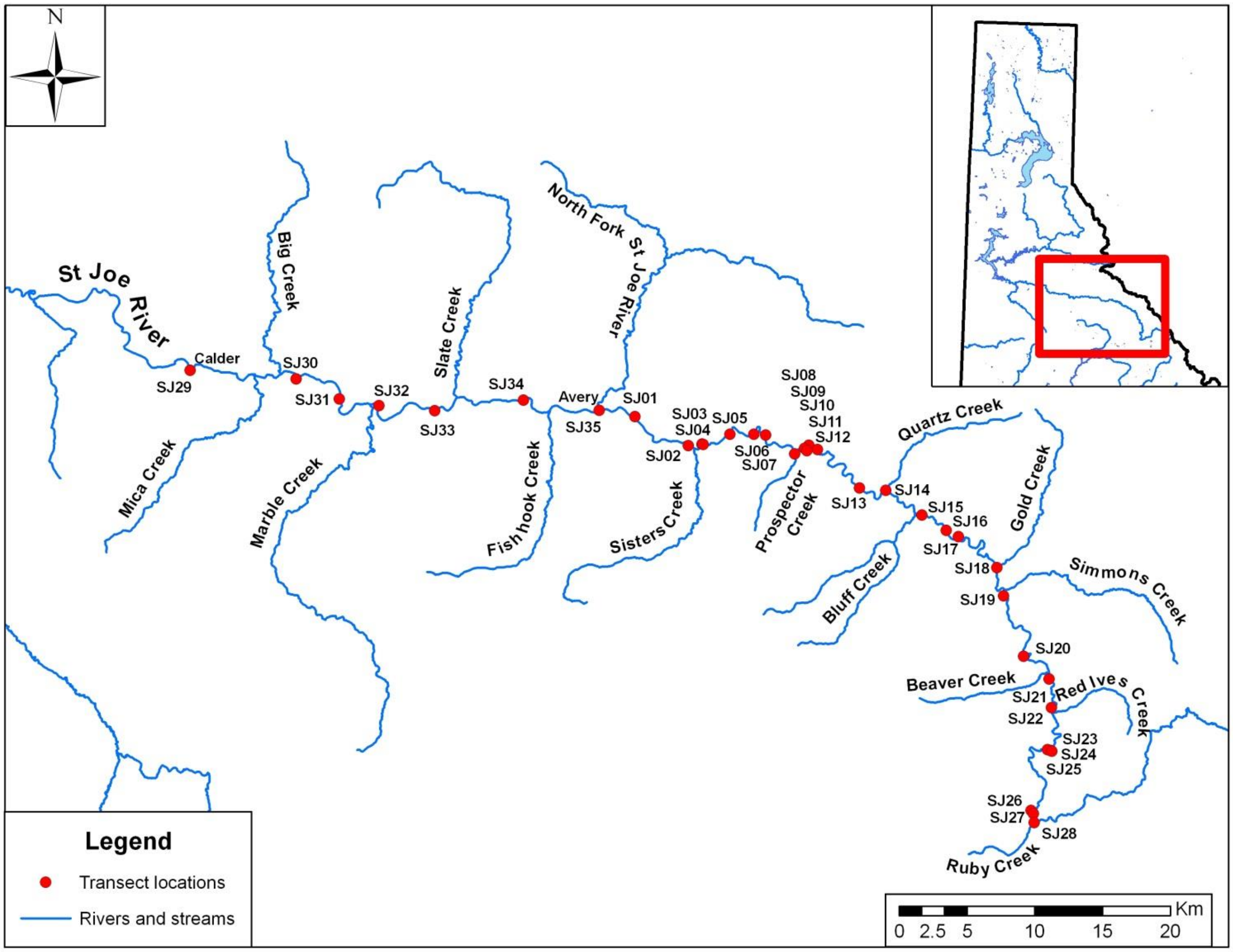

Figure 2. Location of 35 transects that were snorkeled on the St. Joe River, Idaho, during July 31- August 2, 2012.

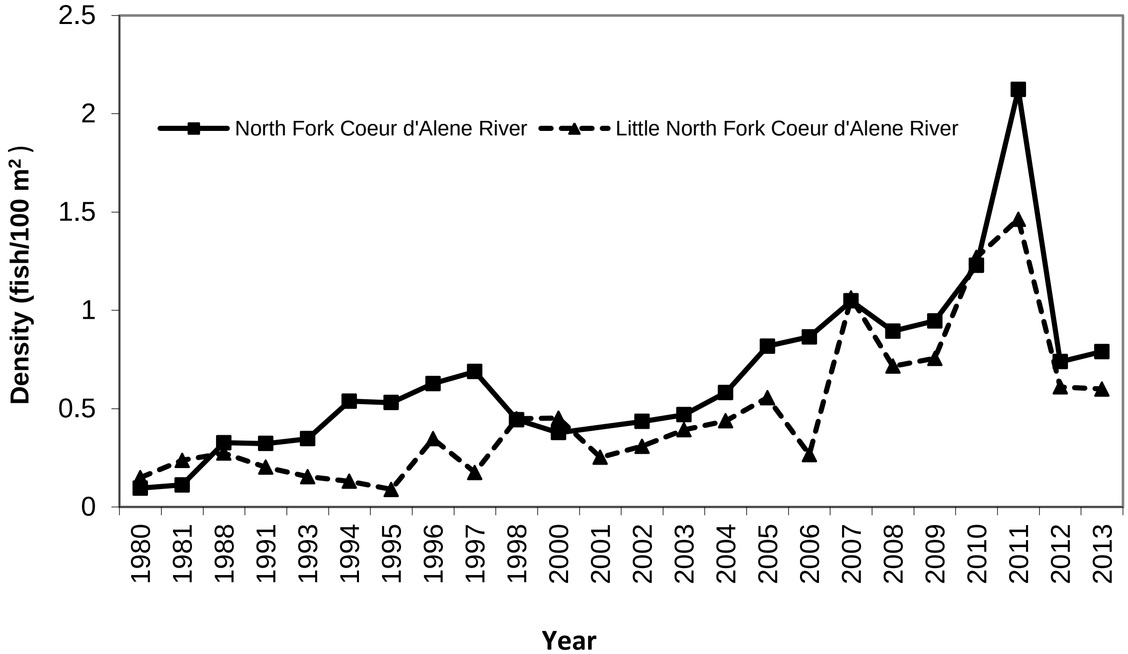

Figure 3. Densities of Cutthroat Trout of all sizes in the North Fork and Little North Fork of the Coeur d’Alene River, Idaho.

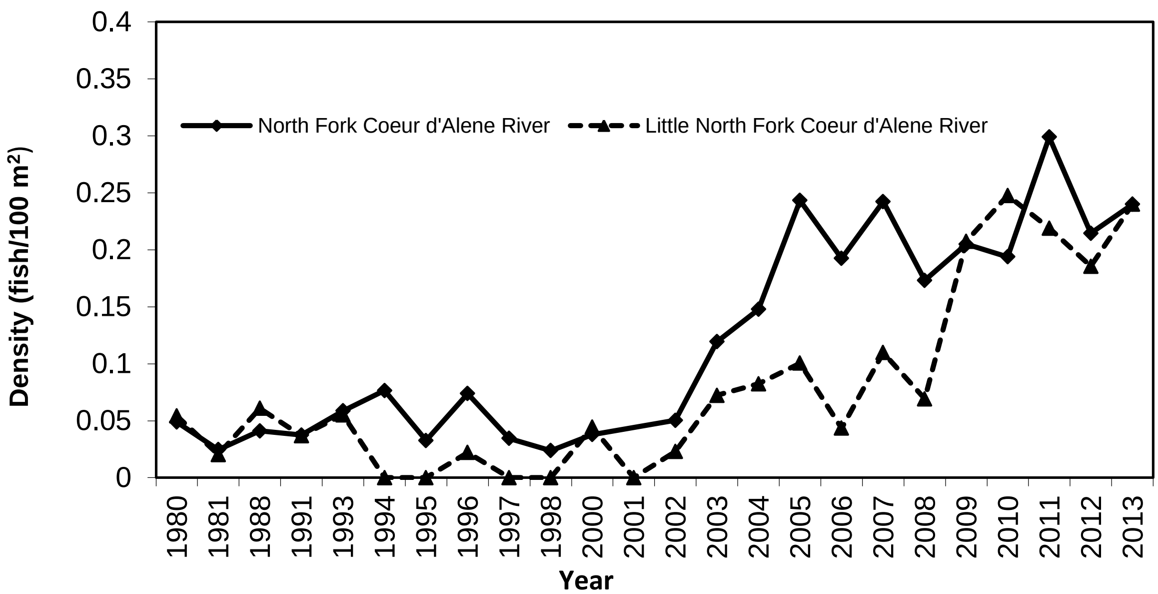

Figure 4. Densities of Cutthroat Trout >300 mm in the North Fork and Little North Fork of the Coeur d’Alene River, Idaho.

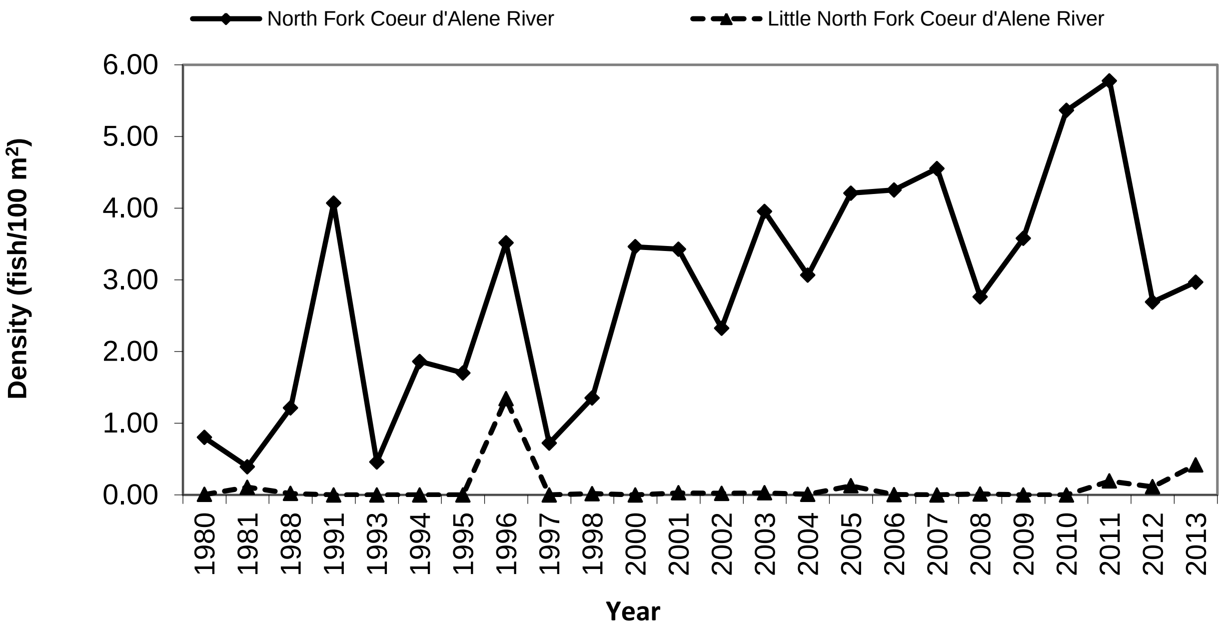

Figure 5. Densities of Mountain Whitefish in the North Fork and Little North Fork of the Coeur d'Alene River, Idaho.

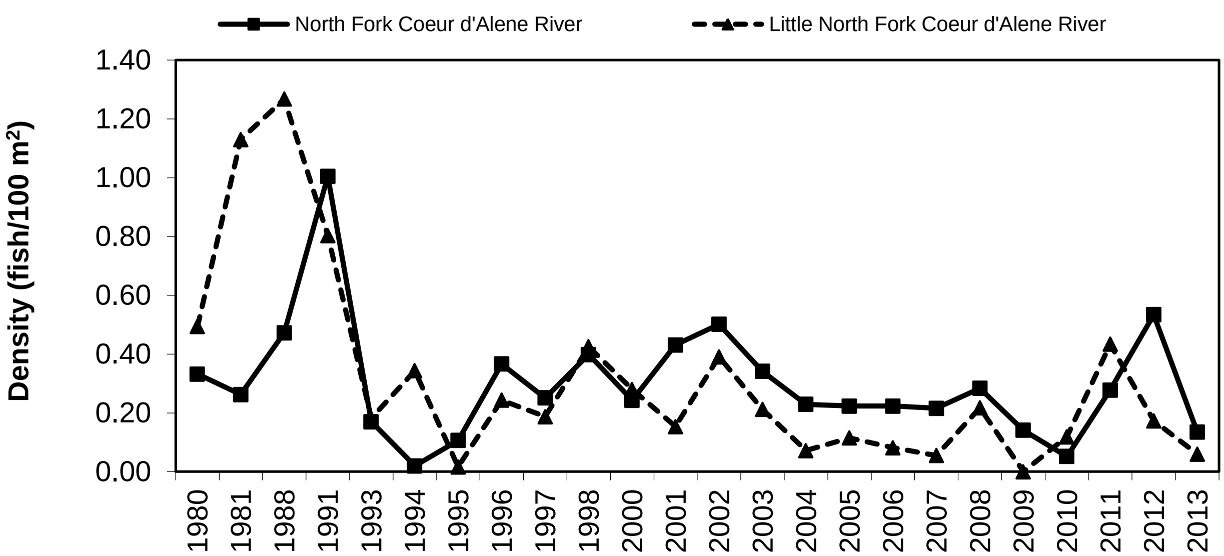

Figure 6. Densities of Rainbow Trout in the North Fork and Little North Fork of the Coeur d'Alene River, Idaho.

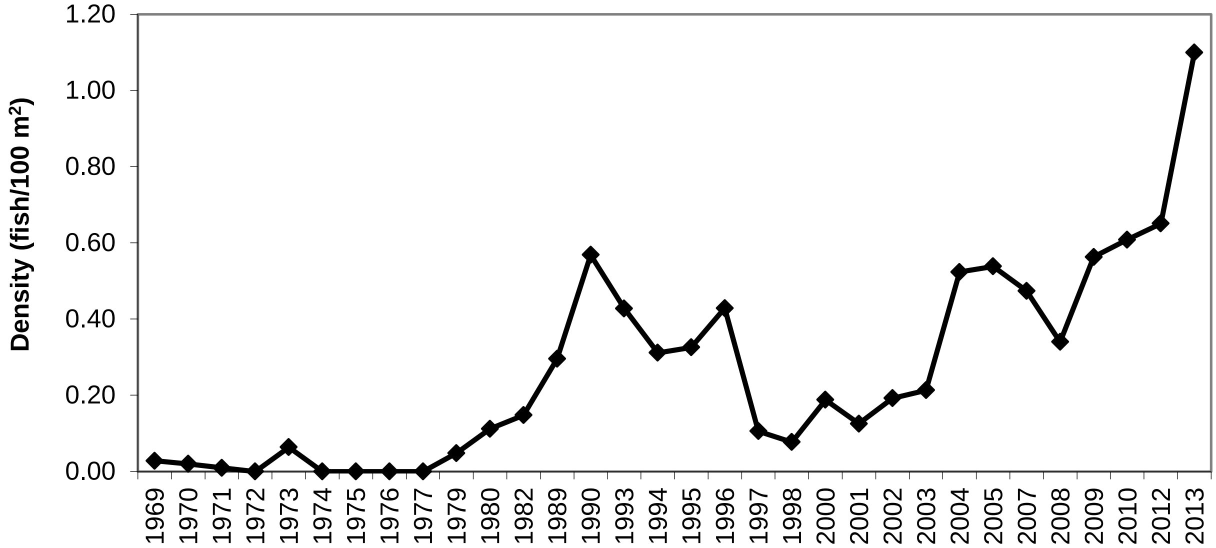

Figure 7. Densities of Cutthroat Trout >300 mm in the St. Joe River from the North Fork to Ruby Creek, Idaho.

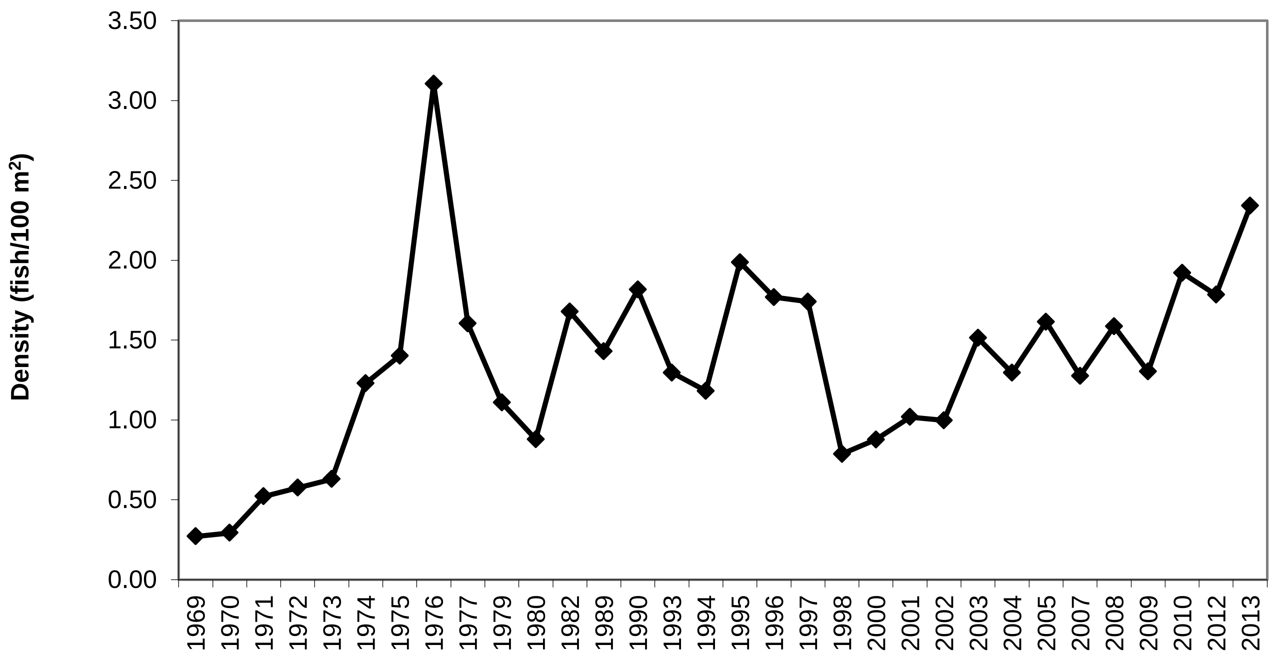

Figure 8. Densities of Cutthroat Trout of all sizes in the St. Joe River from the North Fork to Ruby Creek, Idaho.

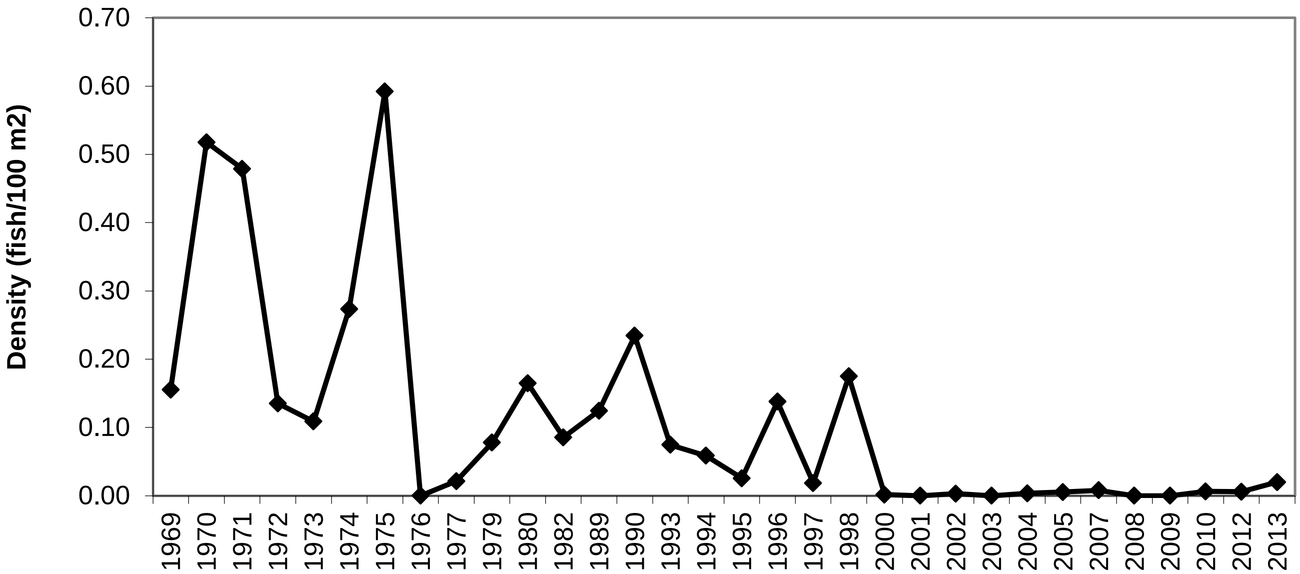

Figure 9. Densities of Rainbow Trout in the St. Joe River, Idaho.

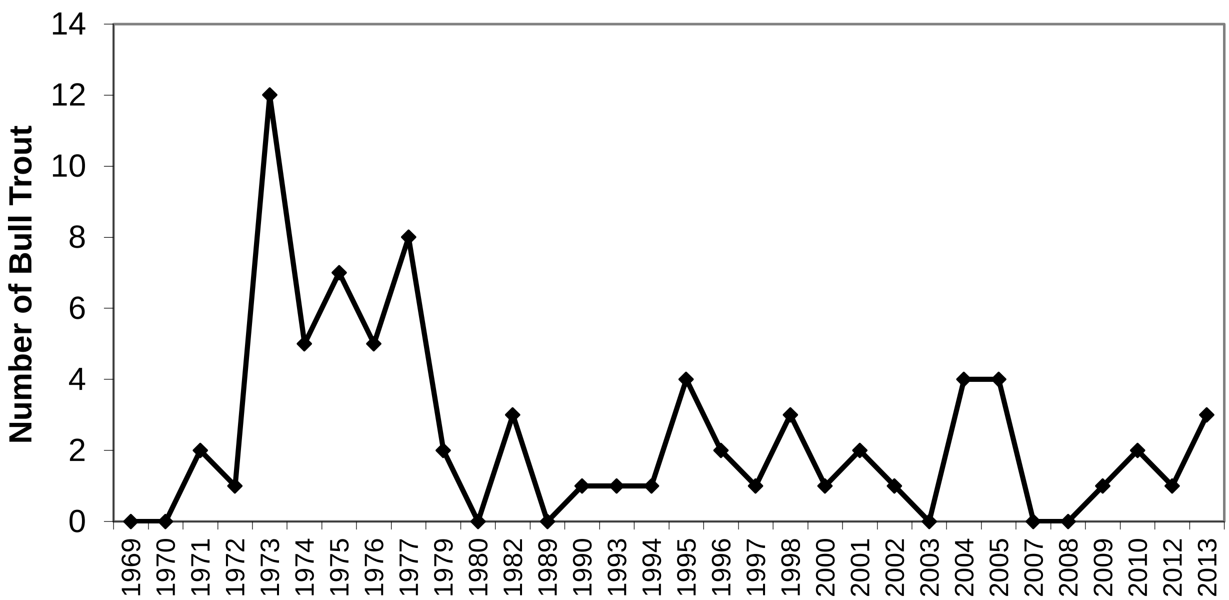

Figure 10. Number of Bull Trout observed in snorkel transects in the St. Joe River, Idaho.

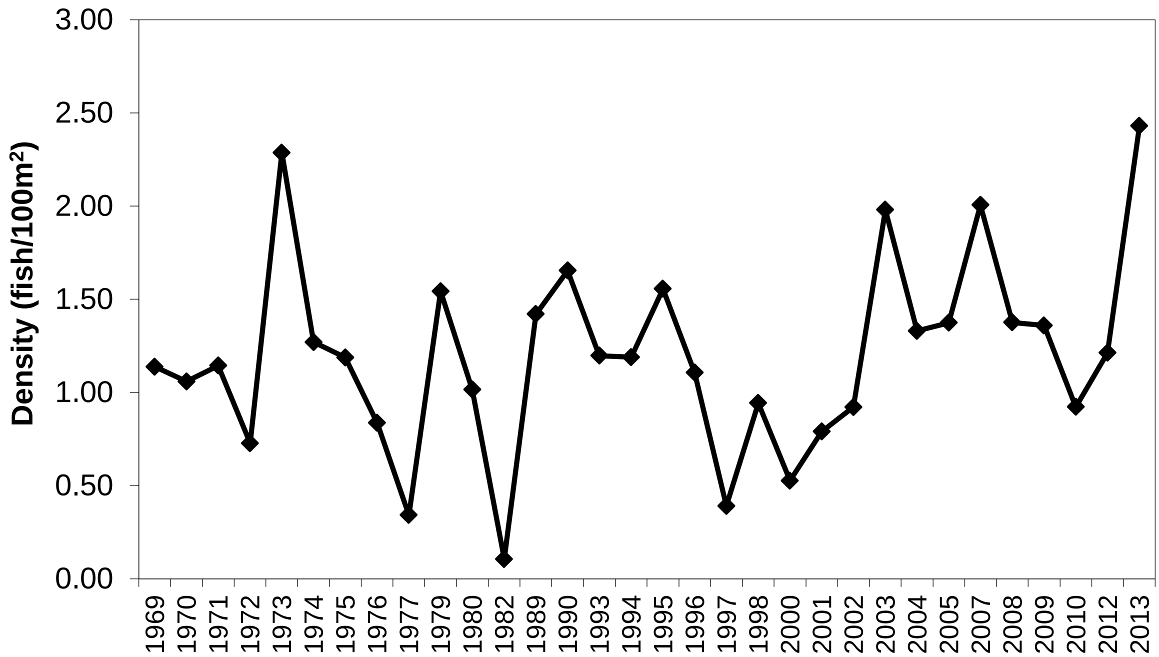

Figure 11. Densities of Mountain Whitefish in the St. Joe River, Idaho.

CHAPTER 10: BULL TROUT REDD COUNTS

ABSTRACT

In 2013, we counted bull trout redds as an index of adult abundance in each of the major drainages in northern Idaho's Panhandle Region. Bull trout redd surveys detected a total of 889 redds, including; 781 in the Pend Oreille drainage, 53 redds in the Upper Priest Lake drainage, 44 in the St. Joe drainage, and 11 in the Kootenai River drainage. Redd count totals from 2013 represented both increases and declines relative to averages of count totals from the previous ten year period, but did not reflect dramatic shifts in count abundance in any core area.

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INTRODUCTION

Bull trout *Salvelinus confluentus* were listed by the U.S. Fish and Wildlife Service (USFWS) as a threatened species under the Endangered Species Act in 1999. Idaho Department Fish and Game (IDFG) personnel, along with employees of other agencies, annually count bull trout redds in some of the core recovery areas to monitor long term trends of these populations. Redd counts allow for evaluation of the status of the populations in these areas and to help in directing future management and recovery activities.

STUDY SITES

Bull trout redds were counted in headwater streams within the Priest River, Lake Pend Oreille, Kootenai River, and St. Joe River drainages where bull trout were known to spawn. These watersheds make up all or part of four different core areas that occur in the IDFG Panhandle Region. The boundaries of the Kootenai River core area extends outside of the Panhandle Region so our counts represent only a fraction of the population in these core areas.

METHODS

We counted bull trout redds in selected tributaries of the Priest Lake, Priest River, Lake Pend Oreille, Kootenai River, and St. Joe River where bull trout were known or believed to occur. We summarized counts by basins or core area. Redd counts in the Middle Fork (MF) East River and Uleda Creek (tributaries of Priest River) were added to the Lake Pend Oreille Core Area in 2003 when these bull trout were documented to spend their adult life in Lake Pend Oreille (Dupont et al. 2009). We located redds visually by walking along annually monitored sections within each tributary. Bull trout 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. Redd surveys were conducted during the standardized time periods (late September/ early October). Redd locations were recorded on maps and/or recorded by global positioning system (GPS).

To reduce observer variability in counting bull trout redds, we held a redd survey training event. The training was held on Trestle Creek, a Lake Pend Oreille tributary. Training focused on identifying standard characteristics of bull trout redds.

We compared bull trout redd count totals by core area to prior count years to assess dramatic shifts in redd abundance. Total redd counts were compared to averages of counts from the previous ten years of sampling. Comparisons were generally qualitative references to increases or declines relative to previous count averages.

In 2013, we did not complete redd surveys on the Clark Fork River or Twin Creek, areas historically counted within the Lake Pend Oreille drainage. Survey counts at both of these locations were believed to be influenced heavily by ongoing upstream bull trout transport programs associated with Cabinet Gorge Dam and provided little meaningful information. In addition, no survey was completed on Char Creek above a fish passage barrier noted first in 2008. The observed barrier was located approximately 150 m upstream from the confluence with East Fork Lightning Creek.

RESULTS AND DISCUSSION

Lake Pend Oreille Core Area

We completed Lake Pend Oreille core area redd counts between October 15 and 24, 2013. A total of 781 bull trout redds were counted among all surveyed streams (Table 1). Six index streams counted consistently since 1983 accounted for 355 of the total redds. Overall counts were below the previous ten year averages for total and index counts of 804 and 523, respectively.

Stream conditions on Lake Pend Oreille core area tributaries may have impacted survey results. Surveyors noted on several streams that a high water event pre-redd survey may have impacted detection of existing redds. In these locations gravels appeared to be recently mobilized and may have disrupted visible redds.

Priest Lake Core Area

We completed Priest River core area redd counts on September 27, 2013. We counted 53 bull trout redds between seven surveyed streams in the core area (Table 2). Overall counts increased from the previous year and were above the previous ten year average for combined counts of 28 redds.

Establishment of a core index set of survey reaches for the Priest River core area was recommended by Maiolie et al 2013. Tributaries surveyed in 2013 represented a core group of streams in which bull trout redd surveys have been conducted frequently since 1993 and in which bull trout redds have been commonly observed. These streams are recommended as index reaches for future surveys.

St Joe. River Core Area

St Joe River core area redd counts were completed between September 17 and 25, 2013. We counted 44 bull trout redds between eight surveyed streams in the core area (Table 3). Consistently counted index streams accounted for 22 of the total number of redds counted. Index and total counts represented a decline from previous years and from the previous ten year average for index streams of 67 redds.

The number of streams surveyed per year in the St. Joe River core area has varied considerably over time. Interpretation of total count values should be done cautiously. We recommend focusing future efforts primarily on index streams and recommend considering a semi-annual count schedule.

Kootenai River Core Area

Kootenai River core area redd counts were completed on tributary streams on October 17, 2013. A total of 11 bull trout redds were observed between three surveyed streams in Idaho. (Table 4). An additional 69 bull trout redds were observed in Montana tributaries to the Kootenai River. Total count of bull trout redds among these streams (80) increased from the previous two years, but was less than the previous ten year average of 137 redds.

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor bull trout spawning escapement through completion of redd surveys.

2. Continue to balance the frequency and location of surveys with the availability of time and intended use of collected data.

Table 1. Bull Trout redd counts by year from tributaries of Lake Pend Oreille, Clark Fork River, and Pend Oreille River, Idaho.

Stream (*Index)	Avg 1983-2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Clark Fork R.	8	1	0	3	2	0	1	0	0	--	--
Lightning Cr.	10	9	22	9	3	10	11[b]	0	20	1	1
East Fork Cr. *	50	77	50	51	34	38	85	26	64	11[b]	26
Savage Cr.	8	15	7	25	0[b]	8	5	6	1	--[b]	5
Char Cr.	10	14	15	20	1	5[e]	1[e]	4[e]	9[e]	0[b,e]	4[e]
Porcupine Cr.	9	10	14	8	8	8	15	11	13	2[b]	4
Wellington Cr.	9	7	6	29	9	10	4[b]	7	6	5	5
Rattle Cr.	21	34	34	21	2	24	62[b]	43	65	59	8
Johnson Cr. *	19	32	45	28	32	40	47	57	54	54	50
Twin Cr.	9	6	7	11	0	4	0	0	1	--	--
Morris Cr.	2	1	3	16	0	6	6	9	0	0[b]	3
Strong Cr.	1	0	--	--	--	7	6	2	11	3	47
Trestle Cr. [a] *	258	102[b]	174	395	145	183	279	188	178	187	133
Pack R.	22	31	53	44	16	11	4	0	1	7	6
Grouse Cr. *	37	28	77	55	38	31	51	27	116	69	12
Granite Cr.	37	149	132	166	104	52	106[c]	75[c]	129[c]	68	217
Sullivan Springs Cr.	15	14	15	28	17	7[c]	2[c]	9[c]	11[c]	4	11
North Gold Cr. *	28	56	34	30	28	17	28[c]	28[c]	6[c]	3[b]	28
Gold Cr. *	117	167	200	235	179	73	107[c]	130[c]	56[c]	110[c]	106[c]
W. Gold Cr.	NA	--	--	4	0	7	5	4	0	8	29
M.F. East R.	11	20	48	71	34	36	25	22	28	28	25
Uleda Cr.	3	7	4	7	2	7[b]	16	6	9	24	14
N.F. East R.	NA	1	0	0	--	0	--	0	--	--	--
Caribou Creek	NA	--	--	--	--	--	--	--	37	6	47
Hellroaring	NA	--	--	--	--	--	--	--	--	3	--
Total 6 index streams	507	462	580	794	456	382	597	456	474	434	355
Total of all streams	635	781	940	1256	654	584	866	654	815	652	781

[a] Additional approx. 0.5 km reach immediately upstream of index reach on Trestle Creek added in 2001
[b] Impaired observation conditions (ice, high water, etc)
[c] Abundant early spawning Kokanee made identification of bull trout redds in lower reaches difficult
[d] Partial Count
[e] Barrier excluded Bull Trout from accessing typical spawning habitat

Table 2. Bull Trout redd counts by year from the Upper Priest River, Idaho and selected tributaries. Redd surveys were not completed on all stream reaches in all years between 1993 and 2003. As such, averaged redd counts for surveys completed between these years may include fewer completed counts.

Stream	Transect Description	Length (km)	Avg. 1993 -2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Upper Priest River	Falls to Rock Cr.	12.5	13	5	13	21	5	14	5	17	10	36	34
	Rock Cr. to Lime Cr.	1.6	2	0	0	1	0	0	2	4	1	0	7
	Lime Cr. to Snow Cr.	4.2	6	12	3	4	1	5	10	3	1	3	6
	Snow Cr. to Hughes Cr.	11.0	4	2	10	0	1	2	4	0	7	2	2
	Hughes Cr. to Priest Lk	2.3	0	--	--	--	--	--	--	0	0	0	--
Rock Cr.	Mouth to F.S. trail 308	0.8	< 1	1	0	0	0	0	0	1	0	0	--
Lime Cr.	Mouth upstream 1.2 km	1.2	< 1	0	0	0	0	0	0	0	0	0	--
Cedar Cr.	Mouth upstream 3.4 km	3.4	< 1	0	0	0	0	0	0	0	0	0	--
Ruby Cr.	Mouth to waterfall	3.4	0	--	0	--	0	0	0	0	--	--	--
Hughes Cr.	Trail 311 to trail 312	2.5	1	0	0	0	0	0	0	0	0	0	--
	F.S. road 622 to Trail 311	4.0	1	2	1	1	0	0	5	0	7	5	0
	F.S. road 622 to mouth	7.1	2	1	1	1	0	0	3	11	3	2	1
Bench Cr.	Mouth upstream 1.1 km	1.1	< 1	0	0	0	0	0	0	0	0	0	--
Jackson Cr.	Mouth to F.S. trail 311	1.8	0	0	0	1	0	0	0	0	0	0	--
Gold Cr.	Mouth to Culvert	3.7	3	0	1	0	0	1	5	6	2	4	3
Boulder Cr.	Mouth to waterfall	2.3	0	--	0	--	0	0	0	0	--	0	--
Trapper Cr.	Mouth upstream 5.0 km upstream from East Fork	5.0	3	0	0	--	0	0	0	0	--	0	--
Caribou Cr.	Mouth to old road crossing	2.6	< 1	--	--	--	--	--	--	0	--	--	--
All stream reaches combined		70.5	32	23	29	29	7	22	34	42	31	52	53

Table 3. Bull Trout redd counts by year from the St Joe River, Idaho and selected tributaries. Redd surveys were not completed on all stream reaches in all years between 1992 and 2003. As such, averaged redd counts for surveys completed between these years may include fewer completed counts.

Stream Name	Avg 1992 - 2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Aspen Cr.	0	--	--	--	--	--	--	--	--	--	--
Bacon Cr.	0	--	--	--	--	--	0	--	--	0	--
Bad Bear Cr.	0	--	--	--	--	--	--	--	--	--	--
Bean Cr.	7	--	--	--	--	--	1	--	--	1	0
North Fork Bean Creek	--	--	--	--	--	--	--	--	--	19	8
Unnamed tributary to N.Fk. Bean	--	--	--	--	--	--	--	--	--		3
Beaver Cr.	<1	0	0	0	0	0	0	3	--	0	--
Bluff Cr.- East Fork	0	--	--	--	--	--	--	--	--	--	--
California Cr.	1	0	0	0	0	0	2	--	--	0	--
Cascade Creek	--	--	--	--	--	--	--	--	--	2	--
Copper Cr.	0	0	--	--	0	0	--	--	--	--	--
Entente Cr.	<1	--	--	--	--	--	--	--	--	--	--
Fly Cr.	1	0	0	--	0	2	1	0	--	0	--
Gold Cr. Lower mile	0	--	--	--	--	--	--	--	--	--	--
Gold Cr. Midde	0	--	--	--	--	--	--	--	--	--	--
Gold Cr. Upper	1	--	--	--	--	--	--	--	--	--	--
Gold Cr. All	1	0	--	--	--	--	--	--	--	--	--
Heller Cr.	<1	7	1	5	0	0	3	9	5	5	--
Indian Cr.	0	--	--	--	--	--	--	--	--	--	--
Medicine Cr.*	28	52	62	71	55	71	41	48	35	20	20
Mill Cr.	--	--	--	--	--	--	--	--	--	9	6
Mosquito Cr.	1	0	0	--	--	--	--	--	--	--	--
My Cr.	--	--	--	--	--	--	--	--	--	0	--
Pole	--	--	--	--	--	--	--	--	--	0	--
Quartz Cr.	0	--	--	--	--	--	--	--	--	--	--
Red Ives Cr.	<1	0	1	0	1	1	--	2	4	0	--
Ruby Cr.	3	--	--	--	--	--	--	--	--	0	--
Sherlock Cr.	1	0	0	0	0	3	--	1	--	2	--
Simmons Cr. - Lower	0	--	--	--	--	1	0	--	--	--	--
Simmons Cr. - NF to Three Lakes	3	--	--	0	--	--	0	--	--	--	--
Simmons Cr. - Three Lakes to Rd 1278	2	--	--	0	--	--	0	--	--	--	--
Simmons Cr. - Rd 1278 to Washout	<1	--	--	--	--	--	0	--	--	--	--
Simmons Cr. - Upstream of Washout	0	--	--	--	--	--	0	--	--	--	--

Table 3. Continued.

Stream Name	Avg 1992 - 2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Simmons Cr. - East Fork	0	--	--	--	--	--	0	--	--	--	--
St. Joe River - below Tento Creek	0	--	--	--	--	--	--	--	--	--	--
St. Joe River - Spruce Tree CG to St. J. Lodge	0	--	--	--	--	--	--	--	--	--	--
St. Joe River - St. Joe Lodge to Broken Leg	4	--	--	--	--	--	--	--	--	--	--
St. Joe River - Broken Leg Cr upstream	0	--	--	--	--	--	--	--	--	--	--
St. Joe River - Bean to Heller Cr.	0	--	--	--	--	--	--	--	--	--	--
St. Joe River - Heller to St. Joe Lake*	9	9	10	0	6	8	1	5	7	4	1
Three Lakes Creek	0	--	--	--	--	--	--	--	--	--	--
Timber Cr.	<1	--	--	--	--	--	--	--	--	--	--
Tinear Cr.	--	--	--	--	--	--	--	--	--	2	5
Wampus cr	0	--	--	--	--	--	--	--	--	--	--
Washout cr.	1	--	--	--	--	--	--	--	--	--	--
Wisdom Cr*	5	11	19	12	32	27	8	1	1	5	1
Yankee Bar	<1	0	0	3	0	0	--	--	--	--	--
Total - Index Streams*	41	72	91	83	93	106	50	54	43	29	22
Total - All Streams	49	79	93	91	94	113	57	69	52	69	44
Number of streams counted	15	13	11	11	11	12	15	8	5	18	8

* Index streams

Table 4. Bull Trout redd counts by year from the selected tributaries of the Kootenai River in Idaho and Montana below Libby Dam. Redd surveys were not completed on all stream reaches in all years between 2001 and 2003. As such, averaged redd counts for surveys completed between these years may include fewer completed counts.

Stream	Length (km)	Avg 2001-2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
IDAHO												
North Callahan Creek	3.3	23	17	10	29	3	17	10	9	2	6	9
South Callahan Creek	4.3	7	8	5	4	0	0	0	1	0	0	2
Boulder Creek	1.8	1	0	1	0	0	0	0	0	0	0	0
Idaho Total	9.4	21	25	16	33	3	17	10	10	2	6	11
MONTANA		Avg 1990-2003										
Quartz Creek	16.1	77	49	71	51	35	46	31	39	37	18	14
O'Brien Creek	6.9	30	51	81	65	77	79	40	27	32	18	35
Pipe Creek	12.9	15	8	2	6	0	4	9	16	2	12	8
Bear Creek	6.9	16	6	3	14	9	14	6	8	3	4	8
West Fisher Creek	16.1	6	21	27	4	18	6	8	12	3	5	4
Montana Total	58.9	134	135	184	140	139	149	94	102	77	57	69
Total all streams	77.7	155	160	200	173	142	166	104	112	79	63	80

CHAPTER 11: NORTHERN IDAHO SINKS DRAINAGES FISHERIES INVENTORY

ABSTRACT

We conducted fisheries surveys of three sink drainages (Lewellen, Sage, and Lost creeks) in 2013 with the objective of identifying species presence, abundance, and distribution within these isolated streams. We collected fish using backpack electrofishing equipment at sites located systematically in each drainage. We estimated abundance at each survey site using depletion sampling methods for closed populations. We detected fish at 25 of 26 sampled sites among all drainages. Only Brook Trout *Salvelinus fontinalis* were found. Estimated densities where fish were found ranged from 10.4 fish/100m^2 to 117.1 fish/100m^2. Our results suggested that although these streams were thought to once contain Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi*, they are not currently present.

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INTRODUCTION

Within the Spokane River drainage of northern Idaho are a collection of isolated sink drainages. Originating to the north and east of the Rathdrum aquifer, these streams descend from moderate elevations, dissipating once reaching the Rathdrum plain. Although isolated through geologic processes, these streams likely were historically inhabited by native Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* (IDFG 2013). However, little was understood about current fish species present in these streams and their relative distribution or abundance. What information was available suggested Brook Trout *Salvelinus fontinalis* were the dominant species (IDFG 2013).

In 2013, we conducted surveys of three sink drainages: Lewellen, Sage, and Lost creeks. The objective of survey efforts was to identify the species presence, abundance, and distribution within these isolated streams. This information will provide a general understanding of these fisheries in the Panhandle Region as well as specific information on the role these streams play in Westslope Cutthroat Trout conservation.

METHODS

Survey sites within sampled streams were established on systematic intervals from the approximate point of stream termination through the upper reaches. We approximated measured stream distances in kilometers using Garmin Base Camp mapping software (Garmin Ltd. 2009). Our upstream most survey site was chosen as the sample section where water was no longer found, fish were no longer sampled and consequently not suspected to be present further upstream, or where consistent sampling results relative to species composition and or abundance suggested further surveys would provide low expected variation among additional sample sites. Many of the sampled locations were on private lands and required landowner permission to access the stream. In some cases no landowner could be contacted or no permission was granted and therefore no survey was completed at an identified survey site location.

We collected fish using a Smith-Root backpack electrofishing unit and pulsed DC settings, typically at 600-800volts, 40-50Hz, and 2-5 M.S. Two netters captured fish. Collected fish were identified to species and measured (total length in mm).

To estimate abundance of tributary fish populations we used multiple pass removals (Zippin 1958) in combination with single pass samples. Abundance estimates only included fish $\geq$75mm (total length; TL), due to sampling efficiency considerations. Sample sections were typically 100 m in length. We closed sample sections using block nets at the downstream end of each survey section to prevent escapement during downstream electrofishing passes. On multiple pass samples we completed sequential passes until captures of an individual pass were no more than 20% of the total capture by species of the first pass. Typically, two passes were completed. We derived abundance estimates and associated 95% confidence intervals for two and three pass samples using calculations for removal estimates in closed populations (Hayes et. al 2007). 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. Average density estimates were calculated as the average by species for all sections sampled and may have included sections where a given species was not detected.

We sampled fish using multiple pass removal in combination with single pass samples in all drainages. Single pass sampling was used to increase the number of possible sample sites visited in a sample season, as each single pass required less time than a multi-pass sample. We estimated abundances 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 from data collected from 12 survey sites. A single model of abundance based on first pass collections was developed and included sample data from all tributaries. We described the consistency of capture efficiencies among all tributaries and provided support that model predictions were valid across these boundaries by calculating the coefficient of variation (CV) of sampled capture efficiencies.

RESULTS

We surveyed 26 sections among the three tributaries between July 3 and July 24, 2013. Water was present and an electrofishing survey was completed at all sections visited (Table 1). Fish were detected at 25 of 26 sites. In Lewellen Creek we visited eight sections over approximately ten kilometers of stream within the drainage (Figure 2). We sampled eight sections in Lost Creek over approximately 11 kilometers (Figure 2). No fish were collected at section 11. A total of ten sections were sampled in Sage Creek over ten kilometers (Figure 2). All sites visited contained flowing water and did so year round according to landowners. Average stream width measured at stream sites varied among streams. Average stream width in Lost Creek was 1.8 meters, 2.5 meters in Lewellen Creek, and 3.4 meters in Sage Creek (Table 1). Stream sites at lower elevations generally exhibited deeper channels, slower flows and wider stream widths. Higher elevation sites generally exhibited steep gradients and narrow stream widths. Lower elevation sites were frequently channelized and heavily influenced by anthropogenic activities. These sites generally lacked overhead cover and submerged woody debris.

We developed a single regression model to estimate abundance based on first pass collections (Figure 1). Capture efficiencies in multiple pass samples were consistent (0.79 ± 0.02, 80% CI; CV = 0.08) among tributaries, providing support that our model predictions were valid across these boundaries. Based on the developed linear model, the number of fish caught in the first pass at multi-pass sites was strongly related to the multi-pass population estimates ($P > 0.05$; R^2=0.98; n=12; SE=6.2).

We collected only Brook Trout among all sampled sites. Estimated Brook Trout densities were high throughout all three sampled streams. Average densities within each stream were 49.8 fish/100m^2 in Lost Creek, 29.2 fish/m^2 in Lewellen Creek, and 26.7 fish/100m^2 in Sage Creek. The highest density estimate was 117.1 fish/100m^2 from Lost creek section 4. However, all streams contained individual sites with density estimates of over 45 fish/100m^2. The lowest estimated density was observed in Sage Creek section 9 at 10.4 fish/100m^2. This site was also the narrowest site sampled and was relatively steep in gradient.

Length of collected Brook Trout ranged from 19 mm to 251 mm (Table 2). Average length of Brook Trout capture was similar between streams at 116 mm, 100 mm, and 120 mm in Lewellen, Lost, and Sage creeks, respectively. The largest fish was captured in a site directly downstream of a manmade pond formed by a dammed portion of Lost Creek.

DISCUSSION

Survey results suggested Westslope Cutthroat Trout were not present within the three sampled streams. The absence of Westslope Cutthroat Trout does not indicate they were never present. However, complete replacement of cutthroat trout has not been observed in other northern Idaho waters where Brook Trout were introduced, likely during the same relative time period (Ryan and Jakubowski 2012; Ryan and Jakubowski 2013). We were unable to find any reference to previous management actions in the three surveyed streams that would indicate fishery manipulations had occurred intentionally.

Average fish densities in the sampled streams were high relative to other drainages in the region. Where brook trout are common in the Lake Pend Oreille tributaries and Pine Creek a Coeur d'Alene River tributary, estimated average brook trout densities were close to half or less than observed in the sampled sinks drainages (Maiolie et al. 2011; Ryan and Jakubowski 2012). However, all three sink streams sampled exhibited productive low lying reaches with consistent water flow. Abundant and stable habitat paired with a simple fish community likely contributed to the high densities observed. Compared tributaries in the Lake Pend Oreille and Coeur d'Alene River drainages exhibited multi-species communities with a variety of water flow and habitat conditions.

Observations from field crews indicated stream access was largely difficult due to primarily private land holdings surrounding the surveyed streams. Although an evaluation of access was not an objective of this survey, these observations may be useful in thinking about recreational use and management of these waters. Landowners were generally willing to allow a survey crew to access the stream for a defined purpose, but were typically cautious in doing so. It is unlikely the angling public would be able to readily access these stream fisheries despite the availability of a high density Brook Trout population.

Table 1. Locations (UTM) of survey sections sampled during 2013 inventories of Rathdrum aquifer sinks drainages. Waypoints represent the approximate uppermost points of each survey section. Section length and average wetted width at the time of sampling are listed for each survey section.

Stream	Section	Date	Datum	Zone	N	E	Section Length (m)	Avg Width (m)
Lost Creek	1	7/22/2013	WGS84	11	503812	5292996	100	2.8
Lost Creek	4	7/3/2013	WGS84	11	503386	5295381	100	1.4
Lost Creek	5	7/8/2013	WGS84	11	503692	5296195	100	2.3
Lost Creek	6	7/8/2013	WGS84	11	503631	5297154	100	1.9
Lost Creek	8	7/3/2013	WGS84	11	503207	5296272	100	2.0
Lost Creek	9	7/22/2013	WGS84	11	502682	5297043	100	1.8
Lost Creek	10	7/9/2013	WGS84	11	502287	5297921	100	1.2
Lost Creek	11	7/9/2013	WGS84	11	502115	5298897	100	0.9
Lewellen Creek	1	7/16/2013	WGS84	11	526817	5307901	100	2.1
Lewellen Creek	4	7/10/2013	WGS84	11	529640	5307685	100	3.2
Lewellen Creek	5	7/10/2013	WGS84	11	530375	5307092	100	3.5
Lewellen Creek	6	7/11/2013	WGS84	11	531263	5306760	100	2.9
Lewellen Creek	7	7/12/2013	WGS84	11	532215	5306951	100	1.8
Lewellen Creek	8	7/24/2013	WGS84	11	533054	5306517	100	0.9
Lewellen Creek	9	7/11/2013	WGS84	11	531167	5306540	100	3.1
Lewellen Creek	10	7/12/2013	WGS84	11	531728	5305748	100	2.3
Sage Creek	1	7/15/2013	WGS84	11	524980	5304913	100	4.1
Sage Creek	2	7/15/2013	WGS84	11	526679	5305281	100	4.2
Sage Creek	3	7/15/2013	WGS84	11	526678	5305508	100	3.6
Sage Creek	4	7/16/2013	WGS84	11	527625	5305429	100	4.5
Sage Creek	5	7/24/2013	WGS84	11	528558	5305506	100	3.9
Sage Creek	6	7/17/2013	WGS84	11	529159	5304848	100	3.2
Sage Creek	7	7/17/2013	WGS84	11	529833	5304101	100	2.7
Sage Creek	8	7/17/2013	WGS84	11	530531	5303480	100	2.4
Sage Creek	9	7/19/2013	WGS84	11	530786	5302542	100	3.2
Sage Creek	10	7/19/2013	WGS84	11	531237	5303562	100	2.3

Table 2. Tributary monitoring results by stream, sampled section, and species in 2013. Catch references included all lengths (mm), while only fish ≥ 75 mm were included in abundance estimates (Est n).

Stream	Section	Min TL	Max TL	Est n	95% CI-	95% CI +	Fish/100 m^2
Lewellen Cr	1	37	221	68	63	75	32.2
Lewellen Cr	4	47	223	72	60	83	22.4
Lewellen Cr	5	42	214	170	158	182	48.6
Lewellen Cr	6	33	206	54	53	57	18.7
Lewellen Cr	7	57	194	63	60	69	35.1
Lewellen Cr	8	37	209	22	16	34	26.0
Lewellen Cr	9	48	216	82	79	88	26.5
Lewellen Cr	10	45	193	54	43	66	24.2
Lost Cr	1	32	233	149	143	157	53.2
Lost Cr	4	46	228	164	152	176	117.1
Lost Cr	5	37	201	85	75	98	36.9
Lost Cr	6	41	183	93	81	104	48.7
Lost Cr	8	37	215	105	93	116	52.4
Lost Cr	9	40	251	56	54	61	31.3
Lost Cr	10	39	190	67	55	78	55.6
Lost Cr	11	NA	NA	NA	NA	NA	NA
Sage Cr	1	19	234	161	150	173	39.4
Sage Cr	2	37	230	145	142	151	34.6
Sage Cr	3	37	220	165	156	174	45.7
Sage Cr	4	44	239	153	141	165	34.0
Sage Cr	5	40	222	60	55	68	15.3
Sage Cr	6	78	212	69	58	81	21.6
Sage Cr	7	42	221	47	45	50	17.3
Sage Cr	8	43	193	65	54	77	27.3
Sage Cr	9	37	164	33	33	35	10.4
Sage Cr	10	37	182	49	38	61	21.5

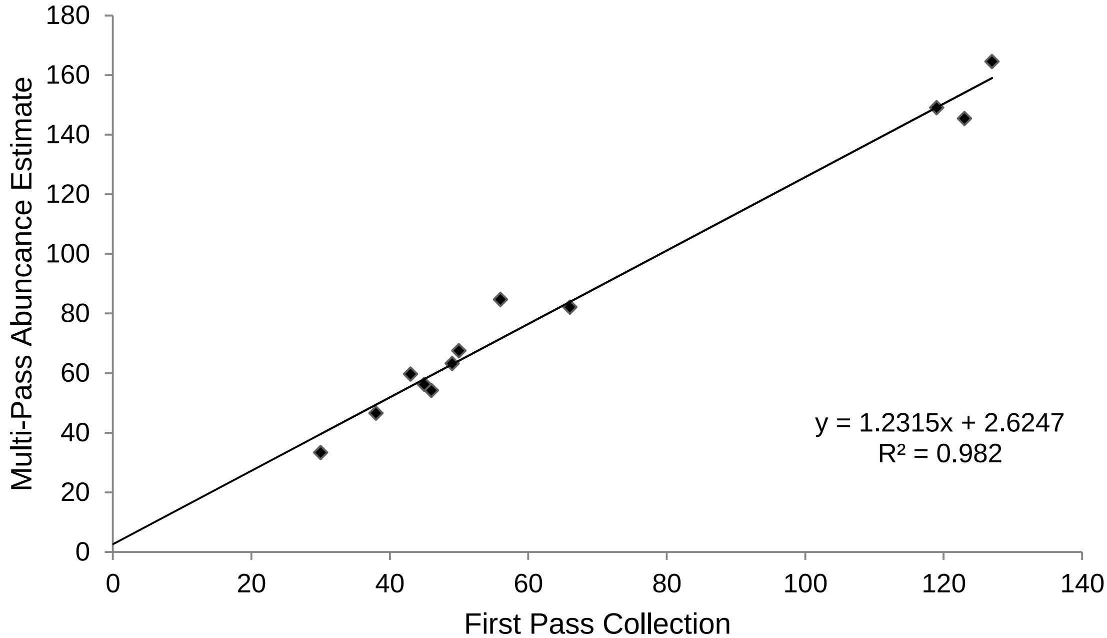

Figure 1. Regression model of estimated multi-pass abundance by first pass collections from sample sites on Lost, Lewellen, and Sage Creeks in 2013.

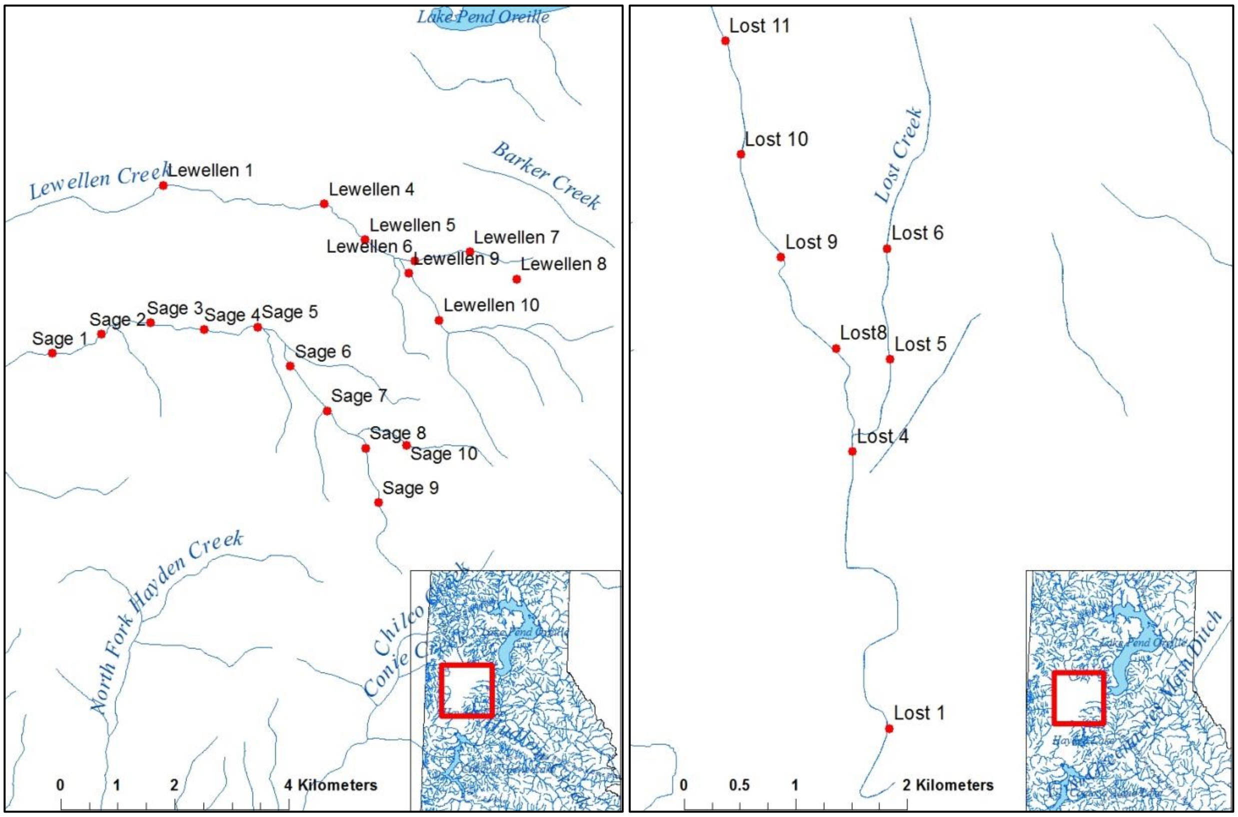

Figure 2. Sampling site locations on Lost, Lewellen, and Sage Creeks visited in 2013. Points represent the upstream end of sample reaches.

APPENDICIES

Appendix A. Number and density (fish/100 m2) of fishes observed while snorkeling transects in the Coeur d'Alene River, Idaho, during July 30 – August 9, 2013.

Transect	Area (m2)	Cutthroat Trout Number counted <300mm	Cutthroat Trout Number counted >300mm	Cutthroat Trout Total	Cutthroat Trout Density (No./100m2)	Rainbow Trout Total	Rainbow Trout Density (No./100m2)	Mountain Whitefish Total	Mountain Whitefish Density (No./100m^2)	Largescale Sucker Total	Northern Pikeminnow Total	Brook Trout Total	Salmonid Density (No./100m2)
Lower North Fork													
NF1	4,872	9	5	14	0.29	14	0.29	110	2.26	0	32	0	2.83
NF1slough	1,652	1	0	1	0.06	1	0.06	2	0.12	0	0	0	0.24
NF2	7,611	43	10	53	0.70	33	0.43	200	2.63	0	52	0	3.76
NF3	13,728	35	5	40	0.29	10	0.07	215	1.57	4	31	0	1.93
NF4	8,578	29	10	39	0.45	8	0.09	210	2.45	0	50	0	3.00
NF5	6,072	29	17	46	0.76	8	0.13	205	3.38	10	122	0	4.27
NF6	8,467	40	7	47	0.56	15	0.18	460	5.43	0	2	0	6.16
NF7	7,222	99	18	117	1.62	0	0.00	700	9.69	0	0	0	11.31
NF8	5,806	56	11	67	1.15	3	0.05	450	7.75	0	0	0	8.96
NF9	8,840	30	7	37	0.42	1	0.01	15	0.17	0	0	0	0.60
NF10	5,124	98	64	162	3.16	6	0.12	475	9.27	0	0	0	12.55
NF11	8,767	4	5	9	0.10	1	0.01	3	0.03	0	0	0	0.15
NF12	7,123	10	5	15	0.21	0	0.00	0	0.00	0	0	0	0.21
NF13	2,522	5	7	12	0.48	0	0.00	0	0.00	0	0	0	0.48
North Fork													
NF14	4,310	23	11	34	0.79	2	0.05	69	1.60	0	0	0	2.44
NF15	2,863	44	28	72	2.51	2	0.07	265	9.25	0	0	0	11.84
NF16	4,131	1	2	3	0.07	0	0.00	0	0.00	0	0	0	0.07
NF17	9,585	64	42	106	1.11	3	0.03	80	0.83	0	0	0	1.97
NF18	2,035	2	12	14	0.69	0	0.00	175	8.60	0	0	0	9.29
NF19	981	16	6	22	2.24	0	0.00	0	0.00	0	0	0	2.24
NF20	1,139	6	6	12	1.05	0	0.00	2	0.18	0	0	0	1.23
NF21	1,198	24	16	40	3.34	0	0.00	22	1.84	0	0	0	5.17
NF22	1,518	18	10	28	1.84	3	0.20	35	2.31	0	0	0	4.35
NF23	397	0	0	0	0.00	0	0.00	0	0.00	0	0	0	0.00
Little North Fork													
LNF1	1,675	4	0	4	0.24	0	0.00	0	0.00	0	0	0	0.24
LNF2	2,801	5	17	22	0.79	1	0.04	0	0.00	0	0	0	0.82
LNF3	6,104	3	3	6	0.10	2	0.03	25	0.41	0	0	0	0.54
LNF4	792	22	0	22	2.78	17	2.15	0	0.00	0	0	1	5.05
LNF5	2,026	0	14	15	0.74	3	0.15	3	0.15	0	0	0	1.04
LNF6	2,135	0	4	4	0.19	0	0.00	0	0.00	0	0	0	0.19
LNF7	1,089	2	3	5	0.46	0	0.00	0	0.00	0	0	0	0.46
LNF8	2,368	2	4	6	0.25	0	0.00	0	0.00	0	0	0	0.25

Appendix A. Continued.

Transect	Area (m2)	Cutthroat Trout Number counted <300mm	>300mm	Total	Density (No./100m2)	Rainbow Trout Total	Density (No./100m2)	Mountain Whitefish Total	Density (No./100m^2)	Largescale Sucker Total	Northern Pikeminnow Total	Brook Trout Total	Salmonid Density (No./100m2)
LNF9	868	1	0	1	0.12	0	0.00	0	0.00	0	0	0	0.12
LNF10	1,546	20	4	24	1.55	0	0.00	0	0.00	0	0	0	1.55
LNF11	1,263	0	3	3	0.24	0	0.00	0	0.00	0	0	0	0.24
LNF12	794	11	5	16	2.01	0	0.00	0	0.00	0	0	0	2.01
LNF13	758	21	3	24	3.17	0	0.00	0	0.00	0	0	0	3.17
Teepee Creek													
TP01	2,386	14	5	19	0.80	0	0.00	0	0.00	0	0	0	0.80
TP02	4,430	0	3	3	0.07	0	0.00	0	0.00	0	0	0	0.07
TP03	1,079	1	9	10	0.93	1	0.09	0	0.00	0	0	0	1.02
TP04	2,040	0	1	1	0.05	0	0.00	0	0.00	0	0	0	0.05
TP05	1,664	12	3	15	0.90	0	0.00	130	7.81	0	0	0	8.71
TPR1	1,178	16	4	20	1.70	0	0.00	0	0.00	0	0	0	1.70
TPR2	766	3	4	7	0.91	0	0.00	0	0.00	0	0	0	0.91
Totals	**162,304**	**823**	**393**	**1,217**	**0.75**	**134**	**0.08**	**3851**	**2.37**	**14**	**289**	**1**	**3.21**

Appendix B. Number and density of fishes observed in snorkeling transects in the St. Joe River, Idaho, August 13-15, 2013.

Transect	Area (m^2) snorkeled	Cutthroat Trout Number counted ≥300mm	Cutthroat Trout Number counted all sizes	Cutthroat Trout Density (No./100m^2)	Rainbow Trout Number counted	Mountain Whitefish Number counted	Mountain Whitefish Density (No./100m^2)	Largescale Sucker Number counted	Northern Pikeminnow Number counted	Salmonid Density (No./100m^2)
N.F. St. Joe River to Prospector Creek										
SJ01	3,502	3	3	0.09	0	1	0.03	0	0	0.00
SJ02	3,416	25	50	1.46	1	230	6.73	75	95	0.08
SJ03	1,184	27	51	4.31	0	45	3.80	3	0	0.08
SJ04	1,200	22	41	3.42	0	27	2.25	0	4	0.06
SJ05	3,552	26	63	1.77	0	65	1.83	4	31	0.04
SJ06	4,560	14	24	0.53	0	132	2.89	0	49	0.03
SJ07	4,732	12	43	0.91	0	26	0.55	0	28	0.01
Prospector Creek to Red Ives Creek										
SJ08	1,418	29	44	3.10	0	310	21.86	0	85	0.25
SJ09	1,931	30	52	2.69	0	25	1.29	0	1	0.04
SJ10	4,812	72	127	2.64	1	95	1.97	0	48	0.05
SJ11	2,059	35	63	3.06	0	33	1.60	0	0	0.05
SJ12	2,260	54	103	4.56	3	67	2.96	0	30	0.08
SJ13	2,291	22	41	1.79	0	50	2.18	0	21	0.04
SJ14	2,251	31	56	2.49	0	62	2.75	0	4	0.05
SJ15	1,708	14	49	2.87	0	12	0.70	0	0	0.04
SJ16	1,125	28	80	7.11	0	19	1.69	0	0	0.09
SJ17	2,523	26	69	2.74	0	8	0.32	0	0	0.03
SJ18	1,055	27	82	7.77	0	26	2.46	0	0	0.10
SJ19	874	5	27	3.09	0	4	0.46	0	0	0.04
SJ20	1,293	12	22	1.70	0	2	0.15	0	0	0.02
SJ21	624	22	56	8.98	0	34	5.45	0	4	0.14
SJ22	1,760	34	48	2.73	0	20	1.14	0	0	0.04
Red Ives to Ruby Creek										
SJ23	724	3	11	1.52	0	0	0.00	0	0	0.02
SJ24	850	12	38	4.47	0	5	0.59	0	0	0.05
SJ25	1,600	15	49	3.06	7	8	0.50	0	0	0.04
SJ26	1,448	2	2	0.14	0	0	0.00	0	0	0.00
SJ27	1,668	24	39	2.34	0	85	5.10	0	0	0.07
SJ28	869	6	7	0.81	0	0	0.00	0	0	0.01
Calder to N.F. St. Joe										
SJ29	9,535	18	22	0.23	2	50	0.52	62	52	0.01
SJ30	8,400	7	9	0.11	2	60	0.71	520	1025	0.01
SJ31	7,072	5	11	0.16	3	40	0.57	69	62	0.01

Appendix B. cont.

SJ32	6,000	14	24	0.40	0	130	2.17	170	130	0.03
SJ33	7,457	3	5	0.07	0	2	0.03	0	0	0.00
SJ34	2,257	6	15	0.66	0	125	5.54	1	75	0.06
SJ35	5,180	19	39	0.75	1	200	3.86	200	165	0.05
Total	**103,191**	**704**	**1,465**	**1.42**	**20**	**1,998**	**1.94**	**1,104**	**1,909**	**3.38**

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