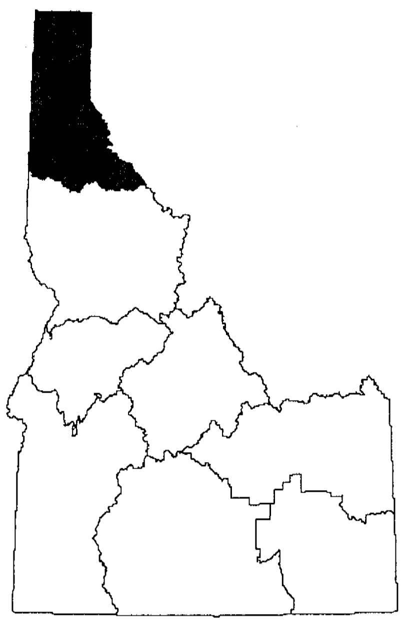
FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME

FISHERY MANAGEMENT ANNUAL REPORT

Virgil Moore, Director



PANHANDLE REGION

2010

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2010 Panhandle Region Annual Fishery Management Report

Lakes and Reservoir Investigations

COEUR D'ALENE LAKE FISHERY INVESTIGATION

ABSTRACT

During July 2010 we surveyed the kokanee population in Coeur d'Alene Lake using both trawling and hydroacoustic methodologies. By trawling, we found that age-3 kokanee densities increased 50% from the previous year to 52 fish/ha. Hydroacoustic surveys indicated a 56% increase to 96 age-3 kokanee/ha. We attribute this increase in kokanee to the lack of Chinook salmon *O. tshawytscha* stocking during 2007 and 2008, and to a good year for kokanee production calculated at 34.5 kg/ha/yr. A total of 134 Chinook salmon redds were counted in the Coeur d'Alene River and St. Joe River drainage. We did not attempt to destroy any Chinook redds because of the upturn in the kokanee population. In addition to the naturally spawning Chinook salmon, 20,421 age-0 hatchery Chinook salmon were stocked in Lake Coeur d'Alene. Stocking took place in June and September to test the timing of stocking.

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INTRODUCTION

Kokanee *Oncorhynchus nerka* are one of the most important sport fish species in the Panhandle Region. Populations have been established in all the larger lakes in the Region and several of the smaller lakes are stocked annually. Kokanee first established in Lake Pend Oreille in the 1930's by emigrating down the Clark Fork River from Flathead Lake, Montana. Kokanee were stocked into Flathead Lake in 1916 and were originally from wild stocks from Lake Whatcom, Washington. Once kokanee were established in Lake Pend Oreille, Idaho Department of Fish and Game (IDFG) transplanted them to Coeur d'Alene, Spirit, and Priest Lakes in the 1930's and 1940's. Self-sustaining populations were soon established and kokanee fisheries typically provided 50% to 90% of the angling effort in the large northern Idaho lakes. The Lake Whatcom stock of kokanee are described as "late spawners" typically using shoreline gravel rather than tributary streams and spawning from November through early January.

The kokanee 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 to reduce kokanee numbers 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 *Stizostedion vitreum*, 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 were below the desired range of 30 to 50 fish/ha since 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 of data 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. In 2009, we documented a very pronounced increase in the kokanee population. We attributed this increase to an increase in the productivity of the lake and the lack of stocking Chinook salmon in 2007 and 2008. This report covers IDFG's efforts to monitor kokanee and Chinook salmon in 2010, and manage both populations to improve the sport fishery in Coeur d'Alene Lake.

OBJECTIVES

IDFG's objectives for the management of Coeur d'Alene Lake are to manage "for a kokanee yield fishery and limited Chinook salmon trophy fishery" (IDFG 2008). Chinook salmon management direction is for greater catches of 1.5-9 kg fish rather than fewer but larger fish (11+ kg) (IDFG 2008).

To accomplish these objectives, we worked on several tasks. We monitored the kokanee population by both trawling and hydroacoustics to determine if kokanee were near the densities needed for a good yield fishery. We counted Chinook salmon redds in tributaries to the lake as an index of salmon abundance. We also continued our test to determine the best time to stock hatchery Chinook salmon by tagging and releasing hatchery produced fish during September and June. Our hope was to find a way to improve the initial survival of stocked Chinook salmon. Lastly, we graphed the relationship between the number of Chinook salmon stocked and the resulting number of kokanee adults to attempt to develop a method for better balancing our stocking program with the kokanee population.

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 lewisi*, and mountain whitefish *Prosopium williamsoni*. Introduced fish species include kokanee, Chinook salmon, rainbow trout, brook trout *Salvelinus fontinalis*, largemouth bass *Micropterus salmoides*, smallmouth bass *Micropterus dolomieu*, pumpkinseed *Lepomis gibbosus*, bluegill *Lepomis macrochirus,* green sunfish *Lepomis cyanellus*, yellow perch *Perca flavescens*, black crappie *Pomoxis nigromaculatus*, brown bullhead *Ameiurus nebulosus*, black bullhead *A. melas*, channel catfish *Ictalurus punctatus*, and northern pike *Esox lucius*.

METHODS

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 1.79 m/s by an 8.8 m boat. Twenty-one transects were trawled on Coeur d'Alene Lake during the dark phase of the moon on August 10 and 11, 2010. Trawl transects were in the same locations as previous years with one exception. One transect at the northern end of the lake was repositioned so that it did not cross another transect (Figure 1). 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. Whole scales were placed between glass slides with a drop of water and examined with a microfiche reader to determine ages.

Because trawling was conducted in July and because Coeur d'Alene Lake kokanee may grow substantially between August and late November when they spawn, experimental gill nets were used to capture adults during spawning. Kokanee were netted on December 7, 2010. The gill net was set near Higgins Point for about 10 min. 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 following length to fecundity regression (Rieman 1992):

$$Y = 3.98x - 544$$

Where: X =mean length of female kokanee spawners (mm)
Y =mean number of eggs per female

We used the trawl estimates to calculate the mean annual mortality rate of kokanee in Coeur d'Alene Lake. A catch curve was built using trawl abundance estimates of each cohort of kokanee as it grew from age-0 to age-3. FAST software was used to calculate the average mortality rate for the specific cohort. We also plotted similar data for the kokanee in Lake Pend Oreille for comparison. Data for Lake Pend Oreille used the mean annual mortality from age-0 to age-4 since these kokanee live a year longer.

Kokanee Estimates by Hydroacoustics

We conducted a lake-wide, mobile, hydroacoustic survey on Coeur d'Alene Lake to monitor the kokanee population. This was the third such survey ever done on this lake. The survey was conducted on the nights of August 17 and 18, 2010. 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 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 lake was divided into four sections for this survey. Wolf Lodge Bay was separated into its own section, like last year, since past surveys showed it contained unusually high densities of kokanee fry. 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. Also, this pattern follows the general rule of using a triangular design (zigzags) when the transect length is less than twice the transect spacing (Simmonds and MacLennan 2005). The starting point of the first transect in each section was chosen randomly. Boat speed was approximately 2.4 m/s (boat speed did not affect our calculations of fish density).

We determined kokanee abundance using echo integration techniques. SonarData's Echoview software, version 4.9, 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.

Two methods were used to split the hydroacoustic density estimate into population estimates of each age class of kokanee. In the northern sections of the lake (sections 1A and 1B), fry were split from older age classes of kokanee based on *in-situ* target strengths. A clear break in the target strength – frequency distribution was seen at -47 dB [approximately 80 mm total length (Love 1971)] and therefore fry were defined as targets between -60 dB and -47 dB. Kokanee of age classes 1 to 3 were defined as those targets between -46.9 and -33.0 dB. The arithmetic average density of these targets in each section were split into ages 1 to 3 based on the proportions of these age classes in trawl catch for that section.

In the middle and southern sections of the lake, the arithmetic mean density estimate of all kokanee by hydroacoustics (-60 dB to -33 dB) was split into the density of each age class based on its proportion in the trawl catch for that section. Kokanee fry in these sections of the lake comprised only 5%, or less, of the trawl catch. Using -47 dB as maximum target strength for fry would have overestimated fry abundance. We therefore felt that using the percentage of each age class in the trawl catch times the hydroacoustic density estimate for all fish was the more appropriate technique.

To determine a total population estimate for kokanee, the density estimates of each age class of kokanee in each section, was multiplied by area of each section and summed for the entire lake.

The results of the hydroacoustic surveys in 2009 and 2010 were used to calculate a production estimate of the kokanee population by two different methods. The methods included the Summation Method and the Instantaneous Growth Rate Method as described in Hayes et al. (2007). The calculation interval for both methods was between the hydroacoustic sampling in July 2009 and the sampling in August 2010.

Chinook Salmon Stocking Tests

During 2009 and 2010 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. Eggs were hatched and reared to size at the Nampa Fish Hatchery before being transported to Coeur d'Alene Lake. About 10,000 fingerling Chinook salmon were tagged with a coded wire tag and stocked in each of the two months during the two years (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 is therefore to compare the survival rate of smaller fish in June to that of larger fish in September.

Chinook Salmon to Kokanee Correlations

We attempted to define a relationship between the number of salmon stocked and its effect on the adult population of kokanee to help guide management of the lake. Several correlations were plotted to compare the number of Chinook stocked against the resulting abundance of age-3 kokanee. We concentrated on only the recent data, since 1997, to allow for potential changes to the system such as low kokanee abundance in the post-flood years, and a potential increase in wild Chinook salmon. Data plots and correlation coefficients and were made using Window's Office PowerPoint 2007.

Chinook Salmon Redd Counts

Each year since 1990, we monitored the spawning of wild Chinook salmon in tributaries to Coeur d'Alene Lake. Because of restrictions on flying following a recent helicopter accident, no Department personnel participated in the survey in 2010. Instead, we hired a pilot and co-pilot to fly a helicopter (Hughes H500 C) and count salmon redds in the Coeur d'Alene River, North Fork Coeur d'Alene River, South Fork Coeur d'Alene River, Little North Fork Coeur d'Alene River and St. Joe River on September 27, 2010. We estimated the natural smolt production from these redds by assuming an estimate of 4,000 eggs per redd, and a mean egg-to-smolt survival of 10%. None of the redds were destroyed in 2010 as had been done in some previous years.

RESULTS

Kokanee Estimates by Trawling

Based on trawling, we estimated Coeur d'Alene Lake contained 660,400 (± 56%), 2,164,100 (± 45%), 1,613,300 (± 38%), and 506,200 (± 35%) kokanee of ages 0, 1, 2, and 3, respectively (Table 2). Density of age-3 kokanee was calculated at 52 fish/ha. Standing stock was estimated at 20.11 kg/ha with a total population biomass of 194 metric tonnes (t); (Table 3). Survival rates from 2009 to 2010 were 290%, 102%, and 24% for age 0 to 1, 1 to 2 and 2 to 3, respectively, based on our trawl calculations.

Kokanee fry collected in the trawl were in the 30 to 70 mm total length groups with a modal length of 40 mm (Figure 2). Age-1 kokanee ranged from 90 to 150 mm with a modal length of 130 mm. Age-2 fish ranged from 160 to 210 mm with a modal length of 190 mm. Size of the age-3 kokanee in the trawl catch ranged from 200 mm to 240 mm (Figure 2). Mean weights were 0.6, 19, 65, and 95 g for kokanee age classes 0 to 3, respectively. Mean weight of age-1 kokanee at the southern end of the lake was 36% larger than those at the northern end of the lake (20.16 g versus 14.85 g).

We collected 71 mature kokanee near Higgins Point in Wolf Lodge Bay in a 10 minute gill net set on December 7, 2010. Mean length of female kokanee was 253 mm (TL), (n=13). Males averaged 272 mm (n=58). Total length of both sexes was smaller than the previous five years, but remained larger than the sizes seen between 1976 and 1996 (Figure 3). Mean fecundity was estimated at 463 eggs per female based on their size (Rieman 1992). Most kokanee matured at age-3. Assuming a 50:50 male to female ratio, the lake contained 253,100 mature females during 2010 at a fecundity of 463 eggs/female. Potential egg deposition was estimated at 117.1 million eggs. Survival of the 25 million kokanee eggs laid in 2009 to the 660,000 fry in 2010 was calculated at 2.6% (Table 4).

Mean annual mortality rate for the cohort of kokanee that reached age-3 in 2010 was estimated at 47% (Figures 4 and 5). This was a sharp improvement from the 87% mean annual mortality of the cohort that matured in 2008, and was the lowest annual mortality rate since 1996. A plot of mean mortality rates from kokanee in Lake Pend Oreille showed a similar pattern. Both systems showed a pronounced increase in mortality in the mid-1990's that remained high through 2008.

Kokanee Estimates by Hydroacoustics

Hydroacoustic estimates for Coeur d'Alene Lake were calculated for 2010. We found the lake contained 4,025,000 kokanee fry (417/ha), 3,089,000 age-1 kokanee (320/ha), 3,042,000 age-2 kokanee (315/ha), and 923,000 age-3 kokanee (96/ha). Total abundance was 11,079,000 kokanee (1,148/ha) (Table 5).

The highest densities of kokanee fry were found at the northern end of the lake particularly in Wolf Lodge Bay (Table 5). Most of the kokanee spawning is believed to occur along road fills in this bay, and it appeared that most of the fry remained in the northern sections of the lake throughout the summer. Only low densities of fry were found in the middle and southern sections.

The highest abundance estimates for age-1 to age-3 kokanee were found in the middle section of the lake. We estimated this section contained 2.3 million age-1 kokanee, 2.4 million age-2 kokanee and over 700,000 age-3 kokanee.

Target strengths of kokanee at the northern end of Coeur d'Alene Lake formed a bimodal distribution (Figure 6). The lower decibel mode corresponded to fry, with the higher decibel mode corresponding to kokanee of ages 1 to 3. As expected, fry could be enumerated separately in the northern section of the lake, but the older age classes needed to be partitioned based on their percentage in the trawl catch.

We calculated survival rates of kokanee based on the changes between last year's and this year's hydroacoustic survey results. From age-0 to age-1, age-1 to age-2, and age-2 to age-3, we calculated survival at 86%, 123%, and 25%, respectively (Table 6).

We estimated kokanee production by two different methods in 2010. By the "Summation Method", we calculated that Coeur d'Alene Lake grew 333 t of kokanee (35 kg/ha/yr) (Table 7). By the "Instantaneous Growth Rate" method we estimated production at 399 t (41 kg/ha/yr) (Table 7). Difference between the two estimates was 17%. The total weight of all kokanee that died in 2010 was 218 t (23 kg/ha/yr). By subtracting the mortality from the production estimated by the Summation Method, we calculated the kokanee population should have had a net increase of 115 t (333 t – 218 t). Biomass estimates indicated the population increased a total of 117 t; from 229 t in 2009 to 346 t in 2010.

Chinook Salmon Stocking Tests

No results are yet available for the Chinook salmon stocking test. Anglers have reported catching a few adipose clipped Chinook of age-0 or age-1, but these small fish were released. Approximately 25 "Angler Diaries" were given to members of the Lake Coeur d'Alene Anglers

Association to keep track of fin clipped and non-fin clipped salmon that they catch. Efforts to monitor the fishery and recover tags should be continued for the next several years.

Chinook Salmon to Kokanee Correlations

Two regressions between Chinook salmon and adult kokanee were found to have good correlations. Our best correlation was between the number of age-3 kokanee and the number of Chinook salmon stocked 2 and 3 years previous (r^2= 0.75, based on a linear relationship) (Figure 7).

A good correlation was also found between the number of age-3 kokanee and the number of Chinook salmon stocked 2 years previous plus half the number of salmon stocked 3 years previous (r^2= 0.70) (Figure 8). This regression takes into account that the Chinook salmon stocked three years previous were still present in the lake, but reduced by mortality.

A weaker correlation was found when we regressed age-3 kokanee abundance against our combined estimate of hatchery and wild Chinook salmon (r^2= 0.26). This regression included an estimate of wild Chinook salmon which makes up a considerable portion of all the salmon in the lake.

Chinook Salmon Redd Counts and Stocking

We counted 112 Chinook salmon redds in the Coeur d'Alene River drainage and 22 in the St. Joe River during 2010 (Table 8). The highest number of redds were found in the reach between the Cataldo Mission and the confluence with the South Fork of the Coeur d'Alene River.

In previous years we limited wild Chinook salmon spawning to no more than 100 redds in the Coeur d'Alene Lake drainage. This year we did not attempt to destroy any of the 134 redds. We estimated roughly 53,600 smolts would be produced naturally from the 134 redds.

DISCUSSION

Kokanee Population Estimates

Most age classes of kokanee in Coeur d'Alene Lake greatly increased in abundance over the last two years. For example, estimates of age-3 kokanee increased from 28,000 in 2008, to 337,000 in 2009, to 506,000 in 2010 based on trawling (Table 2). Similar increases were noted in the hydroacoustic estimates of kokanee as adult abundance increased from 39,000 in 2008, to 592,000 in 2009, to 923,000 in 2010 (Table 6). This pronounced increase is particularly remarkable considering the low parental stock from which it originated. The estimated 506,000 adults this year came from 34,000 adults in 2006 for an increase of 1,388% within one generation. Recoveries such as this illustrate the strong resiliency of a kokanee population within good habitat.

We attribute this pronounced increase in the population mostly to two factors. First, the lack of Chinook salmon stocking in 2007 and 2008 should have reduced predation. This fits the correlation between the numbers of Chinook salmon stocked and the resulting abundance of adult kokanee seen in Figures 7 and 8. It is interesting to note that survival rates in the younger age classes of kokanee appeared very high, but survival from age 2 to 3 remained low (Table 6). This is somewhat contrary to the thinking that a lack of Chinook salmon stocking in 2007 and 2008 should now be reducing the predation on older kokanee stocks. Monitoring survival rates in future years will help our understanding of the role of stocking and predation.

Second, 2010 appeared to be an excellent year for kokanee growth. Our calculations of production indicated the lake grew about 35 kg/ha of new kokanee flesh between sampling dates (Table 7). This was a 58% increase over last year's estimate of 22 kg/ha. Such boosts in annual production could allow kokanee to get ahead of predation and increase in biomass. To date, we do not have a good understanding of what constitutes a good growing year for kokanee. One possibility was that 2010 was a more normal water year, which was proceeded by two winters of high snowpack. The high water years could add nutrients to the lake, which could then take an additional year, or a year of clearer water, to be fully utilized.

By trawling, kokanee fry abundance appeared to drop for the second straight year and reached a new record low of 68 fry/ha (Table 2). The hydroacoustic survey indicated that kokanee fry were low, but not critically low with an estimated density of 417 fry/ha. This was slightly higher than the 370 fry/ha measured by acoustics in 2009, but well below the 1,086 fry/ha estimated in 2008. We believe the trawl tends to underestimate fry abundance as their numbers decline. The echograms show the highest densities of fry were at the shallower end of Wolf Lodge Bay and near the shorelines on some transects. Trawling tends to miss these areas since hauls are conducted only towards the center of the bays. We conclude that 2010 was a low year for fry production but not as critically low as the trawling would indicate. We therefore recommend close monitoring of this cohort but do not recommend drastic reductions in Chinook salmon stocking.

Chinook Salmon to Kokanee Correlations

A reasonably good trend was found in correlations of adult kokanee abundance and Chinook salmon stocking (Figure 7 and 8). Adult kokanee were inversely proportional to the number of Chinook salmon stocked 2 and 3 years earlier, and also to the number of Chinook salmon stocked 2 years earlier and one half the number stocked 3 years earlier. This latter correlation was meant to take into account that mortality would be a factor on the older group of Chinook salmon.

The two and three year lag time is an important point. A year class of kokanee appeared to be affected by both the year class of Chinook salmon that were the same age, and also the year class of Chinook salmon that were a year younger. Therefore the low year class of kokanee fry in 2010 would be influenced by the Chinook salmon stocking in 2010 and 2011. This gives managers one additional year to decide on an appropriate Chinook salmon stocking level after fry abundance has been estimated.

During 2009 and 2010, we tested a fall stocking of Chinook salmon that were released in Wolf Lodge Bay. Results of this stocking will not be available for a year or two as these fish enter the fishery. If fall stocking proves successful, we could then monitor the kokanee population in July, and decide on the appropriate number of Chinook salmon to stock in September. This would help to balance Chinook salmon and kokanee even in the first year that a weak or strong year class of kokanee was detected.

A reasonable objective for this lake would be to have 30-50 adult kokanee/ha present in the July trawl sampling (Rieman and Maiolie 1995). This translates to an adult year class of 290,000 to 480,000 kokanee. Both of these two correlations indicate that Chinook salmon stocking would need to be held fairly low in 2011 to reach the desired kokanee density. These correlations were developed with kokanee starting from a very low level. We would suspect that higher amounts of Chinook salmon could be stocked on a recovered population of kokanee. We therefore recommend a moderate stocking of 20,000 Chinook salmon in 2011. Keeping the stocking level constant for a few years will also help us to see the amount of annual variation in the kokanee population.

Before 1996, there was almost no discernable trend between stocking Chinook salmon and adult kokanee abundance. We found good numbers of adult kokanee even in some years of high Chinook salmon stocking. After 1996, it appeared the system changed. The changes could include several factors. Wild Chinook salmon that naturally spawn in the drainage could be more numerous than in the earlier years. Evidence for this includes the finding that wild Chinook salmon supported most of the harvest of 2,500 fish in 2009. Secondly, post 1996 kokanee were starting from a lower number of eggs. This may have allowed the Chinook salmon to have a more pronounced influence on adult kokanee numbers. If this was the case, returning to more abundant year classes of kokanee may allow for more Chinook salmon stocking than indicated by the correlations in Figures 7 and 8.

A plot of the estimated total number of Chinook salmon (both wild and hatchery fish) was only weakly correlated to kokanee abundance (Figure 9). We suspect this was due to our rather rough estimates of the number of wild smolts entering the lake. To date, no direct abundance estimate for any age class of Chinook salmon has been made. One concern is that wild salmon could exponentially increase causing declines in the kokanee population. Chinook salmon in Lake Superior have been successfully at naturally spawning to the extent that most of the salmon are wild (Peck et al. 1999). They recognized that an abundance of naturalized Chinook salmon would reduce the need for stocking, but would also decrease their ability to manage salmon populations and their effect on the fish community. Similar findings were made for Lake Huron where 80% of the Chinook salmon is now believed to be of natural origin (Johnson et al. 2010). We therefore recommend continued close monitoring of the number of salmon redds and the abundance of kokanee as indicators of the abundance of wild salmon.

Kokanee Mortality

One finding noted during this study was a synchrony of the mortality rates of the Coeur d'Alene and Lake Pend Oreille kokanee populations (Figure 4). Coeur d'Alene Lake and Lake Pend Oreille are in two separate drainages. Both lakes have different predator species. Both lakes also have very different conditions of kokanee spawning habitat. One lake has opossum shrimp *Mysis diluviana* and one lake does not. Yet both populations have had a similar pattern of kokanee mortality since the mid-1990's. We recommend continuing to compare these two lakes in the future to note factors which could affect both systems such as weather, runoff, management changes, or other over-reaching effects. Another suggestion would be to recalculate the mortality rates in each system excluding the number of fry from the catch curve.

Kokanee fry are not completely recruited to the trawl gear and would therefore reduce the estimate of mortality.

MANAGEMENT RECOMMENDATIONS

1. Publicize the kokanee fishery in Coeur d'Alene Lake to see if fishing pressure can be increased on these stronger year classes of kokanee.

2. Sample the harvest of Chinook salmon in 2011 to look for adipose clipped fish and evaluate the two stocking strategies.

3. Stock a limited number (about 20,000) of Chinook salmon in Wolf Lodge Bay. If possible, salmon should be marked with adipose fin clips, be tagged with coded wire tags, and released during June and September to continue the test of stocking methods.

4. Continued close monitoring of kokanee and Chinook salmon redds to note any indication the naturalized population of salmon is increasing.

Table 1. List of tagged Chinook salmon stocked in Coeur d'Alene Lake during 2009 and 2010. These fish are part of 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

Table 2. Estimated abundance of kokanee made by midwater trawl in Coeur d'Alene Lake, Idaho, from 1979-2010. To follow a particular year class of kokanee, read right one column and up one row.

Sampling	Age Class				Total	Age
Year	Age-0	Age-1	Age-2	Age 3/4		3/ha
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
Mean 1979 -2006	3,856,285	1,552,078	1,516,930	762,574	7,568,930	79

Table 3. Kokanee population estimates and standing crop (kg/ha) in each section of Coeur d'Alene Lake based on trawl sampling on August 10 and 11, 2010.

Section	Age-0	Age-1	Age-2	Age-3	Standing Stock (kg/ha)
1	482,700	196,100	222,500	56,700	11
2	161,300	1,251,400	1,296,200	400,100	25
3	16,400	716,600	94,600	49,400	15
Whole lake total	660,400	2,164,100	1,613,300	506,200	20
90% confidence limits as a percent	56%	45%	38%	35%	

Table 4. Estimates of female kokanee spawning escapement, potential egg deposition, fall abundance of kokanee fry, and their subsequent survival rates in Coeur d'Alene Lake, Idaho, 1979-2009. All data were based on trawl sampling.

Year	Estimated female escapement	Estimated potential number of eggs ($x10^6$)	Fry estimate the following year ($x10^6$)	Percent egg to fry survival
2010	253,100	117		
2009	48,540	25	0.66	2.6
2008	13,852	10	0.75	7.8
2007	17,100	13	3.04	23.4
2006	16,900	12	3.60	28.9
2005	-[a]	-[a]	7.34	-[a]
2004	101,000	76	-[a]	-[a]
2003	91,000	62	7.38	12.0
2002	35,000	25	3.30	13.2
2001	12,650	10	3.50	34.0
2000	37,700	32	7.10	22.2
1999	28,000	19	4.18	22.6
1998	39,000	26	4.09	15.7
1997	90,900	54	3.60	6.67
1996	707,000	358	3.00	0.84
1995	1,425,000	446	4.02	0.90
1994	250,000	64	2.00	0.31
1993	240,000	92	5.95	6.46
1992	488,438	198	5.57	2.81
1991	631,500	167	3.03	1.81
1990	657,777	204	4.86	1.96
1989	516,845	155	3.00	1.94
1988	362,000	119	3.04	2.55
1987	377,746	126	3.42	2.71
1986	368,633	103	6.89	6.68
1985	530,631	167	2.17	1.29
1984	316,829	106	4.13	3.90
1983	441,376	99	0.70	0.71
1982	358,200	120	1.51	1.25
1981	550,000	184	4.54	2.46
1980	501,492	168	2.43	1.45
1979	256,716	86	1.86	2.20

[a] No estimate could be made due to missing trawl data in 2005.

Table 5. Kokanee population estimates in each section of Coeur d'Alene Lake based on hydroacoustic sampling on August 17, 2010.

Section	Age-0	Age-1	Age-2	Age-3
1A	1,434,820	94,971	54,017	10,835
1B	2,284,586	326,656	547,562	149,093
2	297,790	2,310,331	2,393,003	738,631
3	8,166	356,798	47,071	24,614
Whole lake total	4,025,362	3,088,755	3,041,653	923,173

Table 6. Kokanee population estimates for Coeur d'Alene Lake made by hydroacoustics during 2009 and 2010. Survival rate was calculated between years.

Year	Age-0	Age-1	Age-2	Age-3
2010	4,025,400	3,088,800	3,041,700	923,200
Survival rate	86%	123%	25%	
2009	3,573,700	2,466,900	3,738,100	591,800

Table 7 . Estimates of kokanee production in Coeur d'Alene Lake by the Summation Method and the Instantaneous Growth Rate Method (Hayes et al. 2007).

Kokanee year class	Weight (g)	Weight gain (g)	Instantaneous growth rate	Population Estimate	Mean Population Estimate	Biomass (t)	Mean Biomass (t)	Production[1] (t)	Production[2] (t)
New Fry – 2010	0.15			13,417,873		2.01			
		0.45	1.3863		8,721,618		2.21	3.9	3.06
Age-0 2010	0.60			4,025,362		2.4			
Age-0 2009	0.42			3,573,687		1.50			
		18.34	3.7992		3,331,221		29.70	61.1	112.83
Age-1 2010	18.76			3,088,755		57.9			
Age-1 2009	13.45			2,466,863		33.18			
		51.46	1.5740		2,754,258		115.29	141.7	181.47
Age-2 2010	64.91			3,041,653		197.4			
Age-2 2009	41.20			3,738,147		154.01			
		54.16	0.8392		2,330,660		121.01	126.2	101.55
Age-3 2010	95.36			923,173		88.0			
Total								333	399

[1] Production calculated by the Summation Method (multiplying mean population estimate by weight gain.

[2] Production calculated by the Instantaneous Growth Rate Method (multiplying instantaneous growth rate by mean biomass).

Table 8. Chinook salmon redd counts in the Coeur d'Alene (Cd'A) River drainage, St. Joe River and Wolf Lodge Creek, Idaho, 1990-2008.

	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

Table 9. Number of Chinook salmon stocked and estimated number of naturally produced Chinook salmon entering Coeur d'Alene Lake, Idaho, 1982-2007. 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

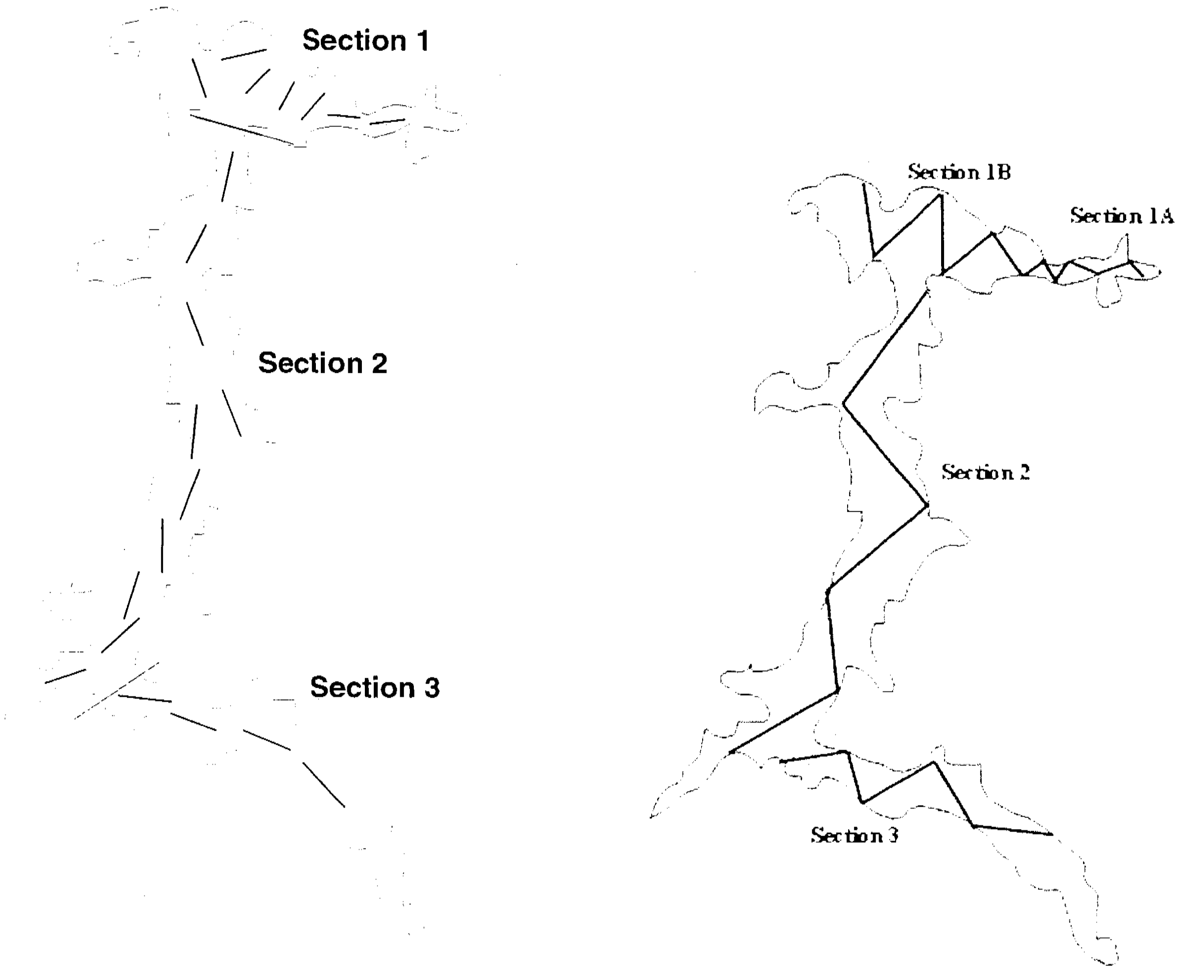

Figure 1. Location of 21 midwater trawling transects (top left), and 21 hydroacoustic transects (top right), in three sections of Coeur d'Alene Lake, Idaho, used to estimate kokanee population abundance in 2009.

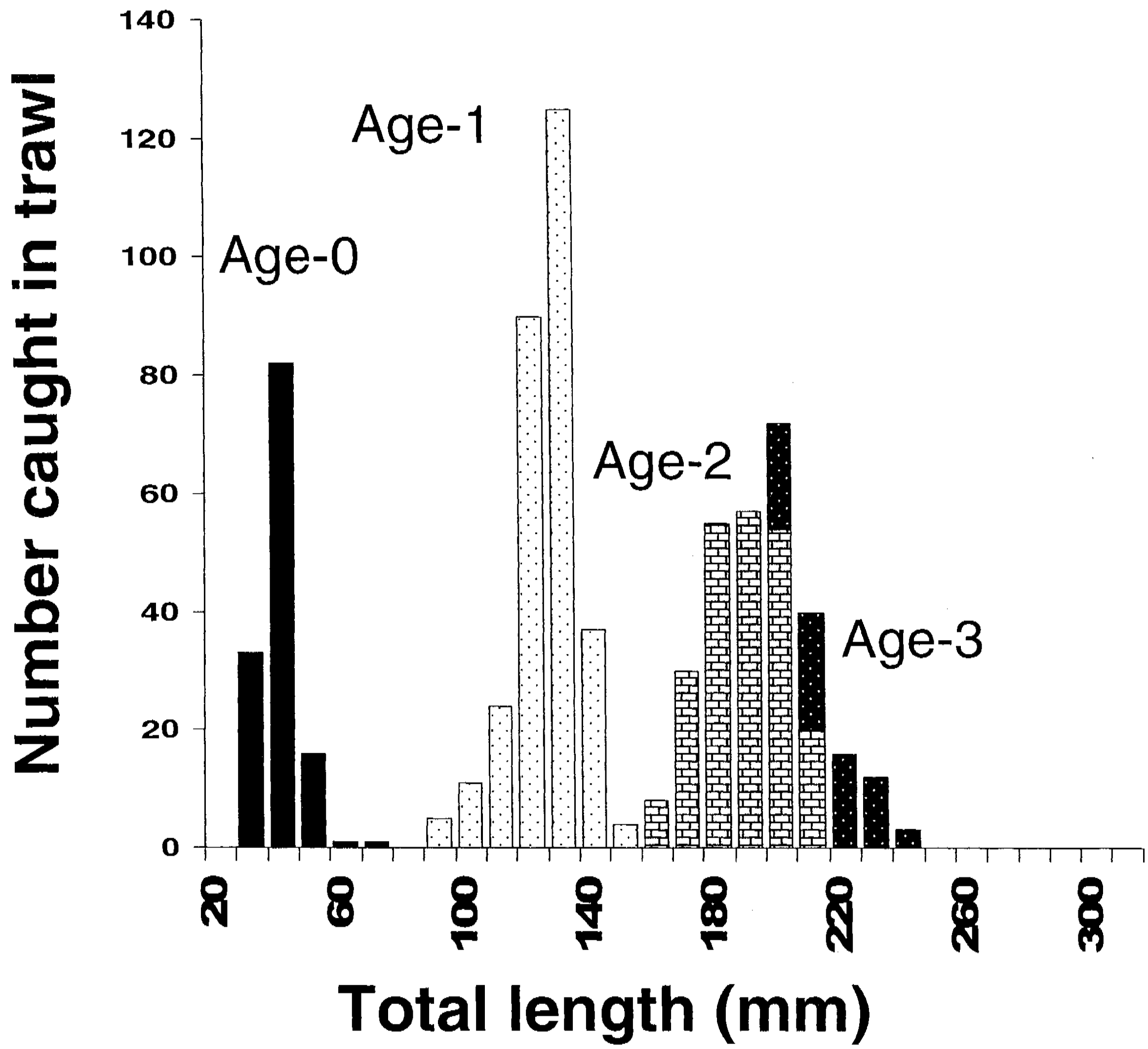

Figure 2. Length-frequency distribution of kokanee sampled in Coeur d'Alene Lake while trawling during 2010.

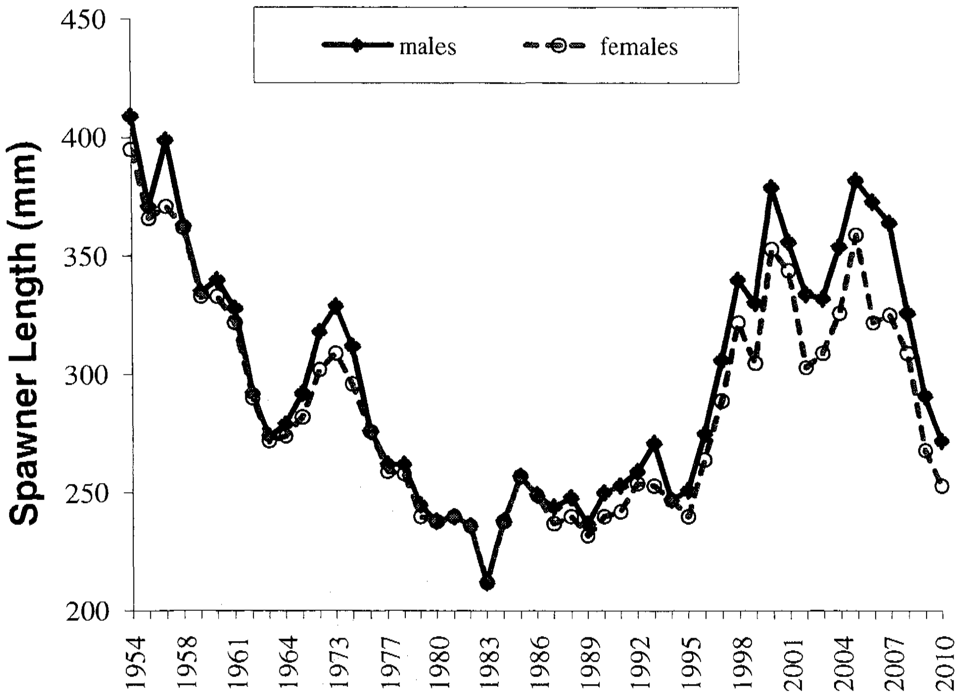

Figure 3. Mean total length of mature male and female kokanee in Coeur d'Alene Lake, Idaho, from 1954 to 2010. Years where mean lengths were identical between sexes were a result of averaging male and female lengths together.

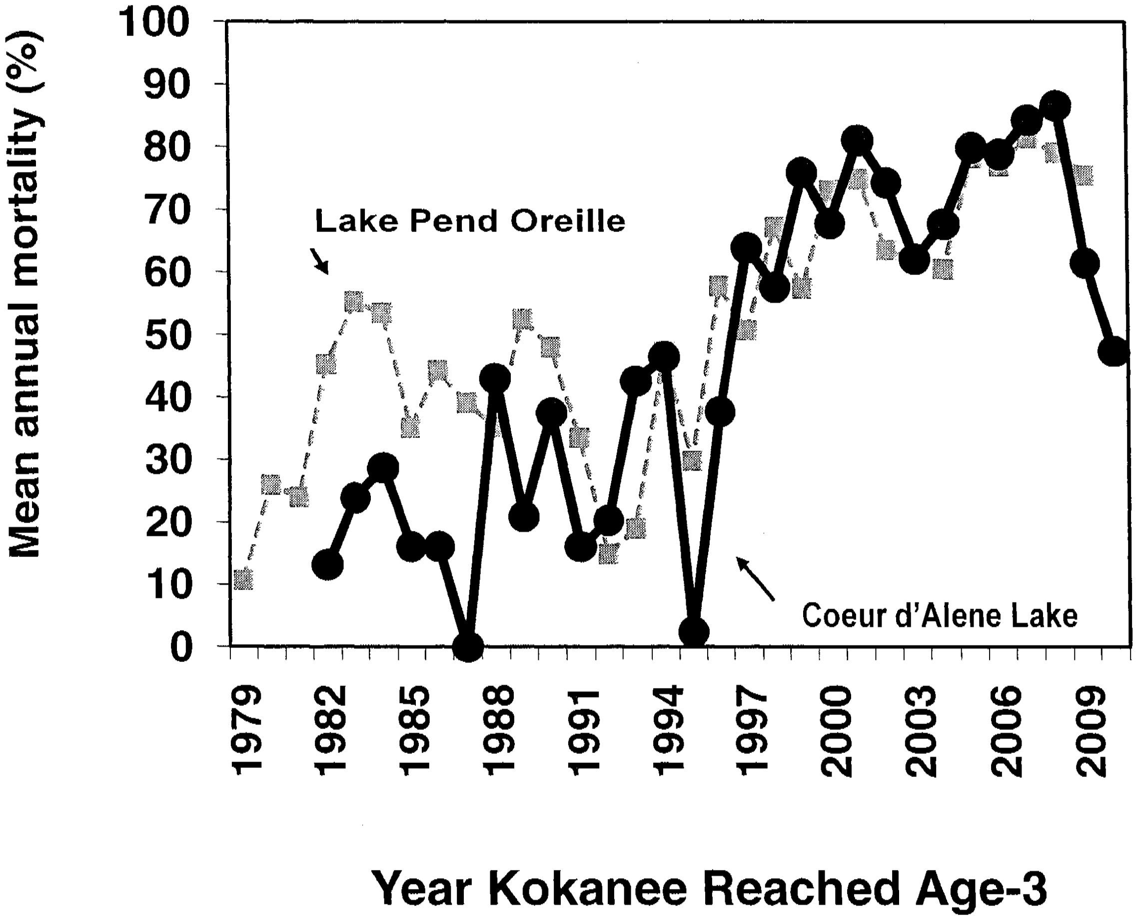

Figure 4. Mean annual mortality of a cohort of kokanee from age-0 to age-3 in Coeur d'Alene Lake (black line) and from age-0 to age-4 in Lake Pend Oreille (grey line).

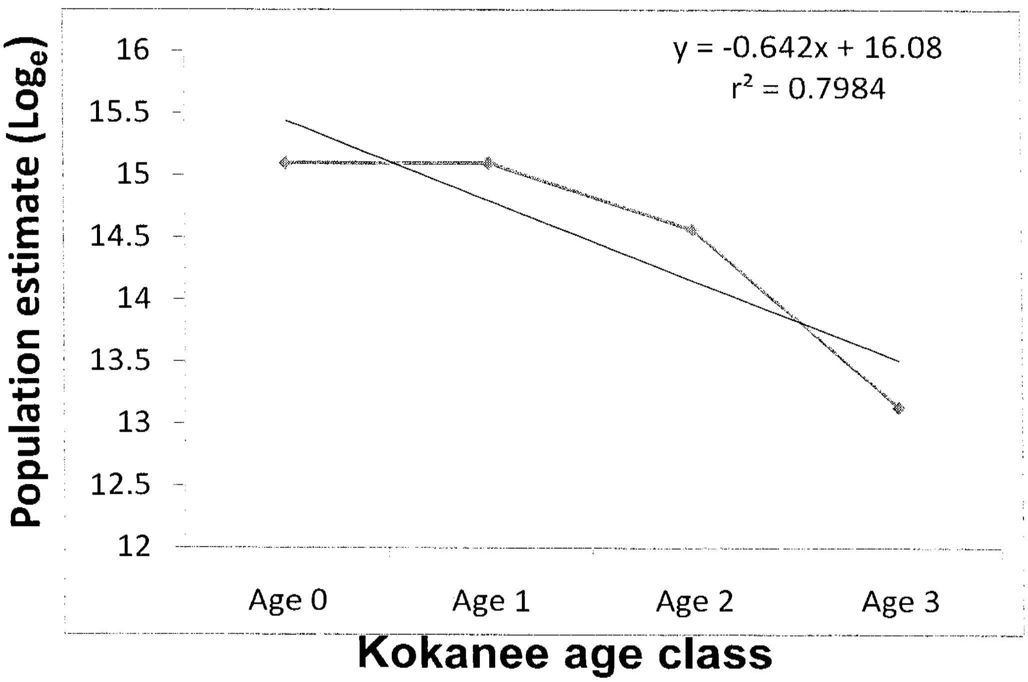

Figure 5. Catch curve for the adult year class of kokanee in Coeur d'Alene Lake during 2010. Annual mortality was estimated at 0.474 and added to the data in Figure 4.

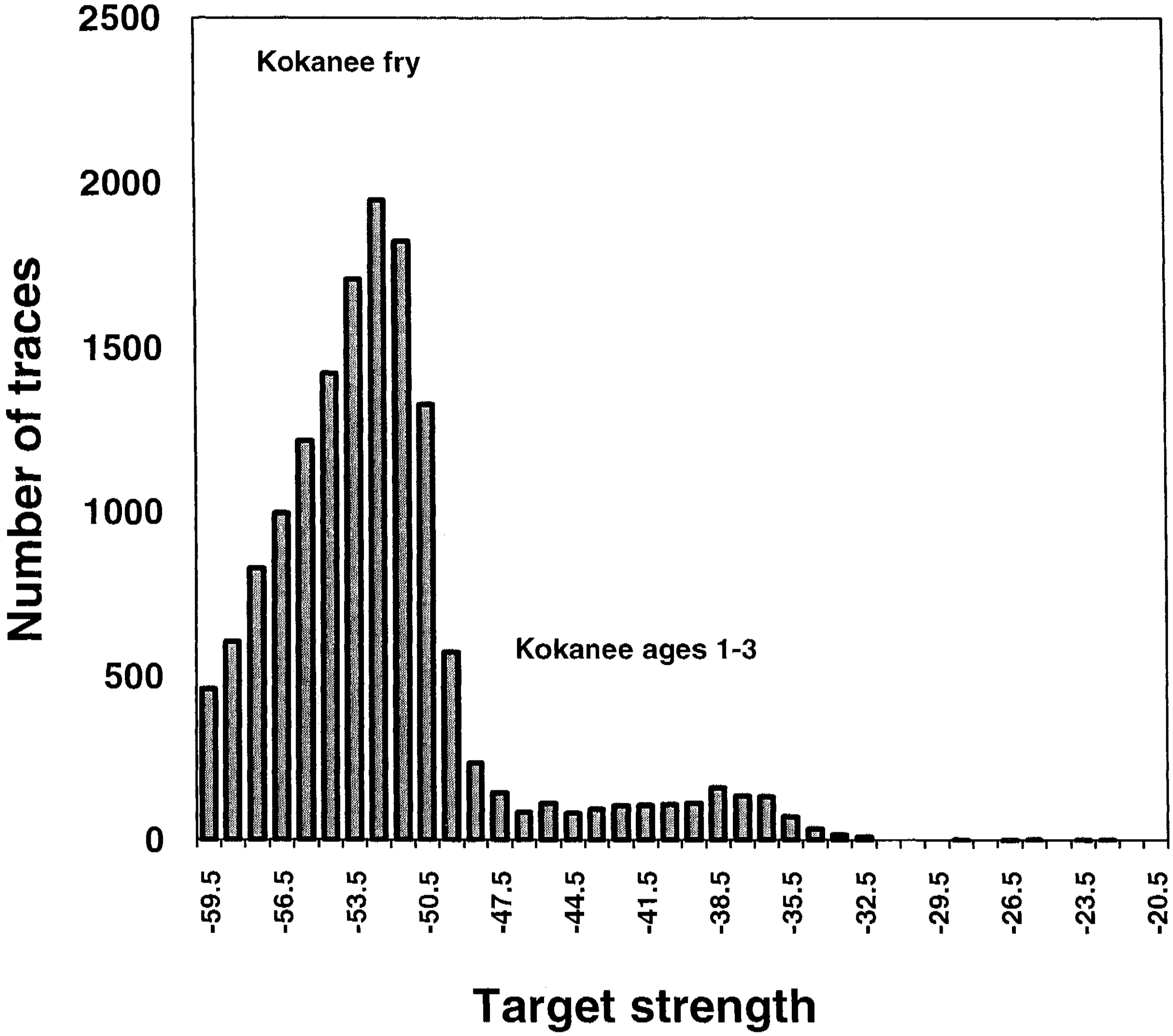

Figure 6. Target strength-frequency distribution of fish within the kokanee layer in Section 1A while conducting hydroacoustic surveys on Coeur d'Alene Lake during 2010. A trace was a single returned echo from a single fish. Fry were defined as targets between -60 dB and -47 dB, and older age classes of kokanee as targets between -47 dB and -33 dB. This section had the highest density of fry in Coeur d'Alene Lake.

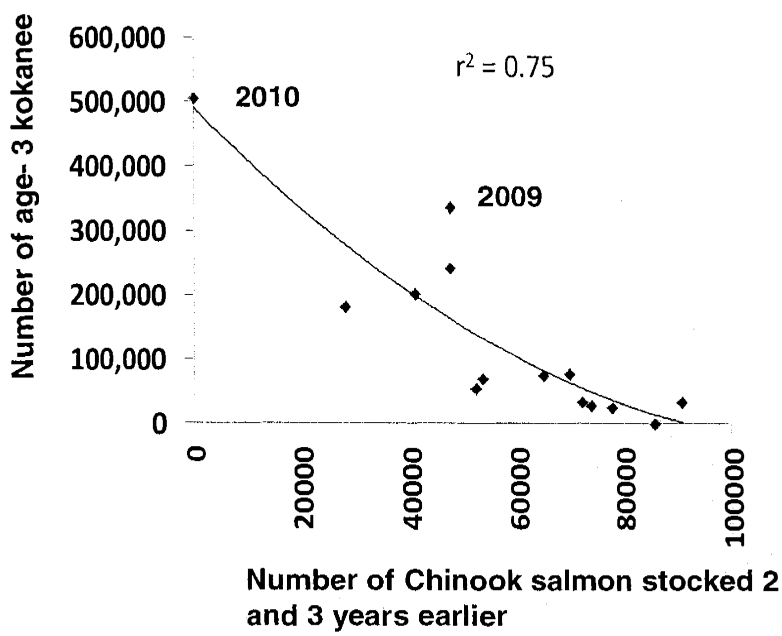

Figure 7. Relationship between the numbers of Chinook salmon stocked 2 and 3 years previous in Coeur d'Alene Lake, Idaho, and the number of age-3 kokanee. Correlation coefficient was based on a linear relationship.

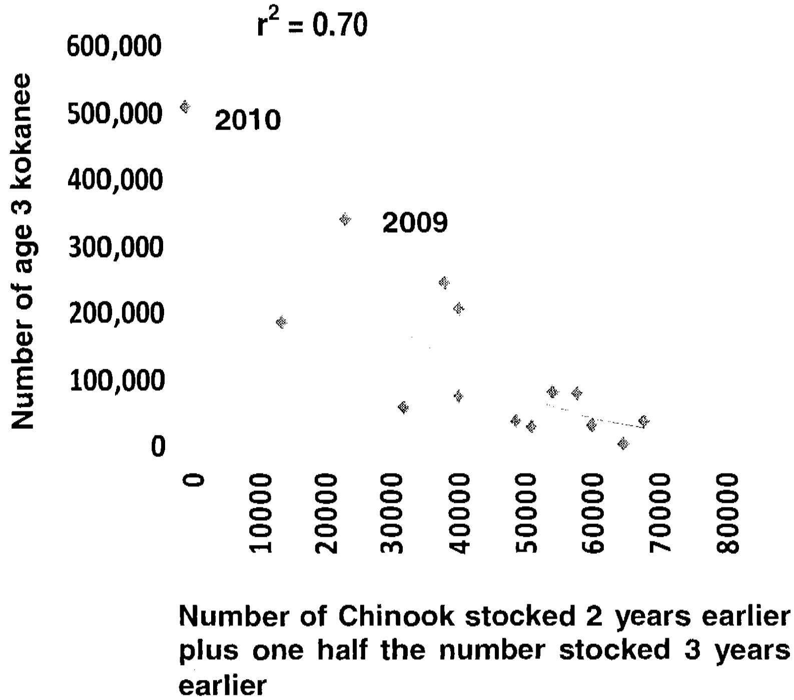

Figure 8. The relationship between the number of Chinook salmon stocked 2 years previous plus one half the number stocked 3 years previous and the number of age-3 kokanee in Coeur d'Alene Lake as estimated by trawling. Taking one half the number stocked 3 years previous was done to account for mortality on the older cohort.

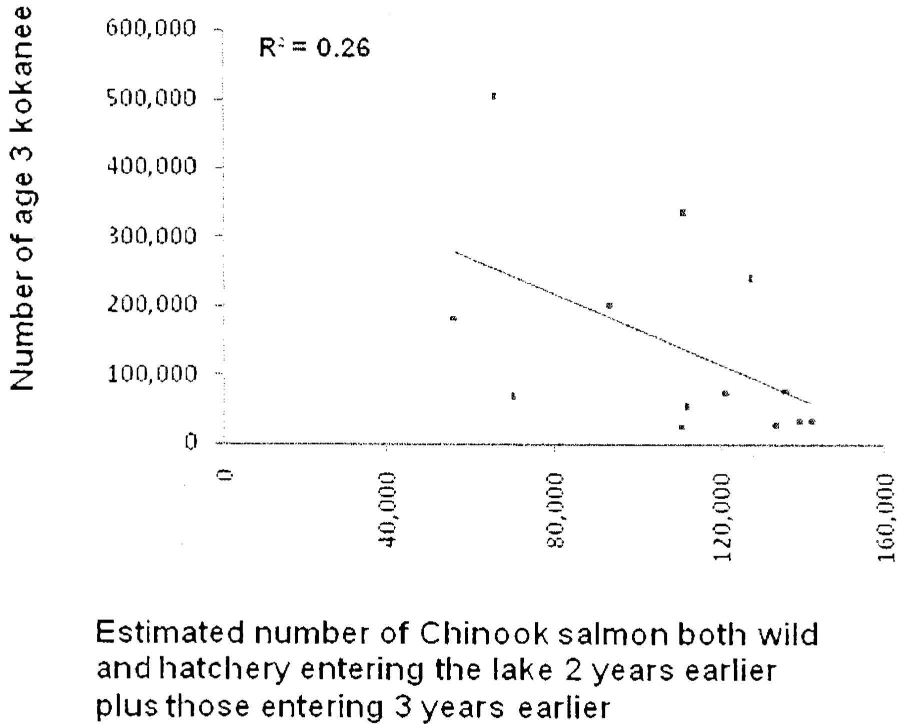

Figure 9. Relationship between the number of Chinook salmon smolts entering Coeur d'Alene Lake 2 and 3 years previous (of both wild and hatchery origin) and the number of age-3 kokanee in the lake estimated by trawling. Data are for the years 1997 to 2010.

Lakes and Reservoir Investigations

HAYDEN LAKE FISHERY INVESTIGATION

ABSTRACT

We conducted a creel survey on Hayden Lake from February 1, 2010 to January 31, 2011. A total of 1,217 anglers were surveyed during 1,170 separate interviews. Total estimated effort on the lake was 74,000 hours. This effort was spread out between several species with the majority of anglers targeting smallmouth bass, northern pike, and largemouth bass. Anglers caught an estimated 60,805 fish during the year. Estimated catch was comprised of 33,946 smallmouth bass, 12,326 largemouth bass, 7,202 black crappie, 5,052 yellow perch, 2,094 northern pike, 147 trout, and 38 bullheads. In 2010, harvest rates for trout are 98% lower than what were seen in 1968. Likewise, in 2010, we saw a 64% reduction since 1982 in anglers specifically targeting trout. With backpack electrofishing gear, we collected seven samples from spawning rainbow and westslope cutthroat trout in Hayden Creek in late-April, 2010. Of these, two were genotyped to be rainbow trout, two to be westslope cutthroat trout, and three were genotyped to be rainbow/ westslope cutthroat trout F1 hybrids. Of the trout samples collected from anglers in the creel survey, 55% were either hybrids or > F1 hybrids. The other five were genotyped as rainbow trout. Mean total length was greatest in those genotyped as hybrids. Of the three creeks walked to count redds, Hayden Creek had the most with 39 redds, followed by Yellowbanks Creek (8), and then Mokins Creek (3). Density of Mysis shrimp ranged from 758/ m^2 to 1,099/ m^2 with an average of 975/ m^2. Mysis densities have remained high in comparison with other water bodies. Hayden Lake was the third lowest in Zooplankton Quality Index (ZQI) of 14 lakes investigated.

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INTRODUCTION

IDFG conducted an economic survey in 2003 to assess angler spending associated with fishing trips throughout Idaho. In that survey, Hayden Lake was the second most economically important lake in Kootenai County and the fourth most economically important in the Panhandle Region. According to the survey, anglers spent over $1.5 million on over 23,000 fishing trips to Hayden Lake in 2003 alone. Hayden Lake provides excellent fishing for multiple fish species and is popular for anglers across the Panhandle as well as non-residents. Historically, Hayden Lake was a popular fishery for native cutthroat trout from the early 1900s to 1950s. Unfortunately, over that time period, this fishery declined until catch rates were less than 1 fish/hr in the creel (Mauser 1978). Slow growth rates, poor survival, low stocking densities, and a long history of overharvest were thought to be responsible for this decline by the early 1970s (Mauser 1978).

In response to the declining trout population, IDFG undertook multiple efforts to increase trout survival and growth. In the early 1970s, freshwater shrimp were introduced to the lake to provide an alternative food source and increase trout growth rates. IDFG increased stocking rates of rainbow and cutthroat trout in Hayden Lake from 4 fish/acre to 100 fish/acre by the 1980s. In addition to this, in the 1990s IDFG stocked various strains of rainbow trout to determine which had better growth and survival. Despite these efforts, trout catch rates continued to decline.

In 1983 smallmouth bass were introduced into Hayden Lake to provide increased fishing opportunities in response to the declining trout populations. Although this fishery was successful in creating a popular littoral fishery, it also increased predation on fingerling trout. This, in combination with northern pike being illegally introduced to the lake in the early 1990s, is thought to be the top contributing factor to natural mortality of trout in the lake. Had predation not increased during this time period, the previously mentioned efforts to increase trout survival may have been more successful.

Westslope cutthroat and rainbow trout are now naturally produced from tributaries to Hayden Lake such as Hayden, Mokens, and Yellowbanks creeks. Historically, a picket-weir fish trap was operated on Hayden Creek in the early 1940s to count spawners (>1,500) and harvest eggs from mature adult fish that had been previously planted upstream (Mauser 1978). Stocking of fingerling rainbow and westslope cutthroat trout continued into the 1990s at the north end of the lake either at the public boat launch or in Hayden Creek in an effort to boost trout production and improve the fishery. Despite stocking, catch rates continued to decline, presumably due to increasing predation in the shallow habitats of the north end. In an effort to reduce predation mortality on stocked fingerling trout, the stocking location was moved to the south end of Hayden Lake at what is now Hayden Marina. As with other efforts, however, this change in stocking location did not appear to increase trout densities.

Creel surveys have been conducted on Hayden Lake in 1979 and 1982 (Goodnight and Mauser 1980; Ellis 1983). The last creel survey done in 1994-1995 (Davis et al. 2000) showed that fishing effort increased over 100% from 1982 to 1995. Likewise, the total number of fish caught in the creel also increased significantly; however, the majority of fish caught were now smallmouth bass and northern pike.

OBJECTIVES

1. Assess fishing effort, catch, and harvest on the Hayden Lake fisheries through a year-long creel survey.

2. Enumerate redds in Hayden, Mokins, and Yellowbanks creeks and evaluate genetic composition of trout caught in the fishery and those sampled in the tributaries.

3. Estimate density of mysis shrimp and zooplankton in the lake.

4. Compare historical trout management strategies and make recommendations on how to increase catch rates.

STUDY AREA

Hayden Lake is located approximately five kilometers north of Coeur d Alene Lake in the Idaho Panhandle. The lake is approximately 1,500 hectares and has a maximum depth at approximately 65m (Figure 10). Hayden creek, the largest tributary to Hayden Lake, flows south and west for approximately 11.5km from its headwaters at 1,525m, to its mouth at the northern tip of the lake at an elevation of approximately 685m. Other smaller tributary streams include Mokins, Yellowbanks, Jim, Windy, Colburn, Harrison creeks, along with several small unnamed tributaries.

METHODS

Creel Survey

We conducted a year-long creel survey on Hayden Lake between February 1, 2010 and January 31, 2011. Randomly selected creel counts from a boat were performed on 2 weekdays and 2 weekend days for each work period (two week interval). Count times (2 per count day) were also randomly selected and split by a.m. and p.m. depending on day length. The survey was conducted during daylight hours and was stratified by shift (a.m. vs. p.m.). Shift length was defined in the a.m. as being the time from sunrise until noon, and times in the p.m. were defined as the time from noon until sunset. Sunset and sunrise were defined by the official 2010 NOAA calendar. To obtain specific creel information, we conducted interviews of anglers during each survey work period. Interviews were always done in conjunction with counts and we set a minimum number of completed trip interviews at 20%. Interviews were conducted on the lake by boat and at the Honeysuckle and Sportsman's Park boat ramps.

Calculations of fishing pressure, harvest, and catch rates were made using Creel Application Software (CAS) version 2.1 from South Dakota State University. Due to an inability for the CAS program to calculate catch rate by species for those targeting those particular species, we calculated catch rates by hand in Microsoft Excel.

Tributary Surveys and Genetics

In 2010, the fishing season for Panhandle tributaries was extended; in order to understand if trout production is still occurring in Hayden tributaries and requiring protection, we walked the three main tributaries (Hayden, Mokins, and Yellowbanks creek) to count adults and redds and collect genetics from adult fish remaining in the stream. We conducted adult and redd count surveys on Hayden, Mokins, and Yellowbanks creeks the week of April 20, 2010. Backpack electrofishing gear was used to obtain samples from adult fish that were observed. Tissue samples obtained from adult fish in Hayden Creek were preserved in 50% denatured ethanol until laboratory analysis was performed. In addition to samples obtained from the tributaries, samples were also taken from trout that were seen in the creel throughout the year. With respect to genetic analysis, the 18 samples from Hayden Creek and Hayden Lake were screened with seven co-dominant diagnostic nuclear DNA (nDNA) markers (OM55, Occ34, Occ35, Occ36, Occ37, Occ38 and Occ42). These nDNA markers are co-dominant Simple Sequence Repeat (SSR) markers which are diagnostic based on size differences in the Polymerase Chain Reaction (PCR) products between rainbow trout and cutthroat trout (Ostberg and Rodriquez 2002). All seven loci are multiplexed in a single PCR amplification and run on the 3100 fragment analyzer.

Mysis Shrimp and Zooplankton Abundance

To evaluate pelagic food density of the lake, we conducted zooplankton and mysis shrimp surveys. We sampled Mysis shrimp July 15, 2010 to estimate density throughout the lake. All sampling occurred at night during the dark phase of the moon. Three sites were sampled from the northern, middle, and southern end of the lake (9 total samples). We used a 1 m hoop net with 1,000 µm mesh for the net and collection bucket. Collected Mysis shrimp were preserved in 50% denatured ethanol until laboratory analysis was performed. During laboratory analysis, all age classes of Mysis shrimp were enumerated to determine total density within the water column. Zooplankton was sampled mid-July in three separate locations throughout the lake. For a full detail of methodology and analysis see the ZQI chapter of this report.

RESULTS

Creel Survey

We surveyed a total of 1,217 anglers during 1,170 separate interviews from February 1, 2010 to January 31, 2011 (Table 10). Most of the interviews occurred in the 6/21/2010 interval (Table 11). Anglers from 16 different states were interviewed, with the majority (88%) being Idaho residents (Table 12). A total of 293 parties of anglers were interviewed after their fishing day was completed on Hayden Lake, representing approximately 25% of the total interviews. Total estimated effort over a 12 month period was approximately 74,000 hours (Table 12). Effort was spread out between several species with the majority of anglers targeting smallmouth bass, northern pike, and largemouth bass respectively (Table 13). Anglers caught an estimated 60,805 fish during the year, with an estimated 33,946 smallmouth bass, 12,326 largemouth bass, 7,202 black crappie, 5,052 yellow perch, 2,094 northern pike, 147 trout, and 38 bullheads (Table 13). Catch and harvest rates were highest for those targeting yellow perch, followed by smallmouth bass and black crappie. The species with the highest percent of harvest: catch ratio was trout at 63%, followed by black crappie at 32%, and northern pike at 23% of the landed fish being harvested. Aside from bullheads, the species with the lowest percent harvest was largemouth and smallmouth bass (Table 13). Proportion of anglers fishing for trout was lower in 2010 than 1982 (Table 14). Past creels show a reduction in harvest rate for trout since 1968 (Table 15).

Tributary Surveys and Genetics

We collected seven tissue samples from spawning rainbow and westslope cutthroat trout in Hayden Creek in late-April, 2010. Of these, two were genotyped to be rainbow, two to be westslope cutthroat, and three were genotyped to be rainbow/ westslope cutthroat F1 hybrids (Table 17). Of the trout samples collected from anglers in the creel survey, 55% were either hybrids or > F1 hybrids. The other five were genotyped as rainbow trout. Mean total length was greatest in those genotyped as hybrids (751 mm; Table 18)

Of the three creeks walked to count redds, Hayden Creek had the most with 39 redds, followed by Yellowbanks Creek (8), and then Mokins Creek (3; Table 19). The majority of the redds in Hayden Creek were >1 m in diameter, while none of the redds in Yellowbanks and Mokins creeks exceeded 0.5 m. Only the first four rkm of each stream were walked to count redds.

Mysis Shrimp and Zooplankton Abundance

Density of mysis shrimp was relatively consistent between locations (Table 20) and ranged from 758/m^2 to 1,099/m^2 with an average of 975/m^2. Mysis densities have remained high in comparison with other water bodies (Table 21).

Of the 14 lakes sampled for zooplankton in 2010, Hayden had the fourth highest in Zooplankton Productivity Ratio (ZPR) (zooplankton in 750:500 um). However, it was the third lowest when looking at total grams/m^3 and ZQI, which takes into account total zooplankton abundance (Table 34 in the ZQI and Stocking Rates section of this report).

DISCUSSION

Hayden Lake has seen a considerable reduction in trout catch and harvest since the late 1960s. Mauser (1978) indicated that in 1968, catch rates of less than one fish/hr provided a marginal trout fishery for Hayden Lake anglers. In 2010, harvest rates for trout are 98% lower than what were seen in 1968. Likewise, in 2010, we saw a 64% reduction since 1982 in anglers specifically targeting trout.

Although smallmouth bass and unlawfully introduced northern pike have provided a substantial warmwater fishery for anglers on the lake, these species may have negatively affected trout fingerling survival. Nelson et al. (1997) suggested several possible causes of the decline included the loss of fingerlings through the outlet, predation, survival of the strain of trout stocked, water chemistry where they were raised, or a combination of these. Since this assessment in

1995, trout catch has further declined to where only 147 trout were estimated to have been caught in 2010. In relation to the factors Nelson et al. (1997) identified as responsible for the decline, the only one factor that has substantially changed since then is the increase in predatory fish species.

In addition to factors identified by Nelson et al. (1997) additional factors may be contributing to the extreme reduction in trout numbers. Stocking records indicate that we have slowly moved stocking dates to where now there is no stocking of fingerling trout in the fall and spring stocking occurs earlier in the spring (April; Table 16). Yule et al. 2000 indicated that fall stocking may benefit trout survival because predators feed less actively during fall and winter months. The additional problems with stocking too early in the spring are a lack of adequate zooplankton densities to sustain growth. Stocking fingerlings later in the spring or waiting until the fall to stock may increase their survival in Hayden Lake.

One additional factor that may be influencing predation risk is the reduction in the size of fish we stock during the spring. Mean total pounds of fish (fry and fingerling trout) stocked into Hayden Lake was approximately 3.4% of the total numbers stocked from 1969-1992, 5.5% from 1993-1999, and 1.6% from 2000-2011 (Figure 11). Similarly, this reduction in size of fish is also seen when just examining fingerlings stocked (Figure 12). The size of fingerlings stocked can directly affect their vulnerability to predation (Walters et al. 1997). Yule et al. (2000) found through their size-at-stocking evaluations of Wyoming ponds that rainbow trout >229 mm in total length were invulnerable to walleyes in the largest size-classes (483-533 mm). Similarly, Gunn et al. (1987) found that stocking larger lake trout generally provided greater returns to the creel in mid-western lakes than stocking small size classes. It stands to reason that stocking larger size trout in Hayden Lake would inevitably reduce their risk of predation and increase survival.

Survival of a particular strain of stocked rainbow trout into the lake is poorly understood. Nelson et al. (1997) showed that domestic Kamloops reared at Trout Lodge appeared to grow faster in Hayden Lake when compared to Black Canyon Kamloops and Kamloops/steelhead hybrids. Nelson et al. (1997) also indicated that these fish can grow to >500mm by age-3. Presently, it is unclear as to what strain of fish make up what is left of the Hayden Lake trout fishery. Although a relatively low sample size, genetics testing of trout collected in the 2010 creel showed that over 50% of them are hybridized, inevitably meaning they were naturally produced in Hayden Creek. In the future, testing of particular strains will be very useful in rebuilding this fishery. There are, however, obstacles such as logistics and expense of marking each strain, which will need to be addressed if this type of a study will be effective.

Considering the poor state of the current open-water fishery, it may be beneficial to stock kokanee in the interim in order to increase this type of angling effort. Survival and growth of kokanee should be very high since the density of Mysis shrimp is clearly at very high densities as well. In order to replace the quality fishery that trout provided in Hayden Lake, stocking kokanee at low densities should result in a high quality fishery while we rebuild trout populations.

MANAGEMENT RECOMMENDATIONS

1) Stock and evaluate 40,000 larger fingerling triploid rainbow trout in the fall to improve trout catch rates.

2) Stock 500 catchable size rainbow trout at Honeysuckle boat launch to evaluate if exploitation is high enough to warrant catchable stocking in the future.

3) Stock and evaluate 100,000 kokanee fingerlings into Hayden Lake to provide an interim open-water fishery for anglers.

4) Sample zooplankton more frequently in order to get a better picture of when to change stocking times.

5) Move default spring stocking date to coincide with peak of preferred zooplankton production, and evaluate success.

Table 10. Number of anglers interviewed on Hayden Lake during the 2010 creel survey.

Interval Start Date	Total Interviews for Interval
2/1/10	45
2/15/10	12
3/1/10	27
3/15/10	67
3/29/10	45
4/12/10	56
4/26/10	70
5/10/10	63
5/24/10	88
6/7/10	85
6/21/10	145
7/5/10	42
7/19/10	97
8/2/10	72
8/16/10	11
8/30/10	63
9/13/10	76
9/27/10	41
10/11/10	26
10/25/10	8
11/8/10	12
11/22/10	0
12/6/10	3
12/20/10	12
1/3/11	2
1/17/11	2
Total	1,170

Table 11. State of residency of anglers fishing Hayden Lake during the 2010 creel survey.

State of Residency	Number of Anglers	Percent of Total
Idaho	1067	87.67
California	24	1.97
Washington	84	6.90
Arizona	6	0.49
Montana	9	0.74
Oregon	7	0.58
Alaska	1	0.08
Utah	1	0.08
Georgia	2	0.16
Colorado	2	0.16
Texas	1	0.08
Canada	6	0.49
Wyoming	1	0.08
Nebraska	1	0.08
Hawaii	1	0.08
Florida	1	0.08
Non-Resident	3	0.25
Total	1,217	100

Table 12. Estimated and observed fishing effort (angler hours) on Hayden Lake during the 2010 creel survey.

Interval Start Date	Sum of Total Estimated Effort (h)	Sum of Observed Effort (h)	% of Total Estimed Effort
2/1/10	1,074	950	1.4
2/15/10	401	282	0.5
3/1/10	1,210	777	1.6
3/15/10	1,748	1,152	2.4
3/29/10	1,949	1,152	2.6
4/12/10	1,913	1,148	2.6
4/26/10	4,489	2,964	6.0
5/10/10	5,728	3,557	7.7
5/24/10	4,345	2,752	5.8
6/7/10	7,681	4,881	10.3
6/21/10	8,102	4,937	10.9
7/5/10	7,140	4,729	9.6
7/19/10	5,742	3,527	7.7
8/2/10	7,041	4,278	9.5
8/16/10	4,551	2,999	6.1
8/30/10	3,236	2,053	4.4
9/13/10	2,393	1,466	3.2
9/27/10	2,380	1,520	3.2
10/11/10	978	569	1.3
10/25/10	542	320	0.7
11/8/10	307	196	0.4
11/22/10	0	0	0.0
12/6/10	64	64	0.1
12/20/10	432	432	0.6
1/3/11	372	366	0.5
1/17/11	532	518	0.7
Total	74,350	47,587	100.0

Table 13. Estimated total fishing effort (angler hours), total catch and harvest, and catch and harvest rates for each species targeted during the 2010 creel.

Species Sought	Time Estimated Effort (h)	Percent of Total Time	Total Estimated Catch	Total Estimated Harvest	Estimated Catch Rate	Estimated Harvest Rate	% Harvested
Anything	13,440	18.08	--	--	--	--	--
Trout	11,034	14.84	147	93	0.013	0.008	63.31
Black Crappie	5,806	7.81	7,202	2,297	1.24	0.40	31.89
Largemouth bass	12,301	16.54	12,326	62	1.00	0.01	0.51
Smallmouth bass	16,437	22.11	33,946	2,610	2.07	0.16	7.69
Northern Pike	15,045	20.24	2,094	476	0.14	0.03	22.73
Yellow Perch	256	0.34	5,052	938	19.71	3.66	18.57
Bullhead	31	0.04	38	0	1.24	0.00	0.00
Total	74,350	100	60,805	6,476	--	--	--

Table 14. Proportion of observed fishing effort for targeted species on Hayden Lake in 1982 and 2010.

	1982		2010	
Species Sought	Effort (h)	Total Time	Effort (h)	Time
Trout	1,348	79	722	15
Black Crappie	193	11	380	8
Largemouth bass	146	9	804	17
Yellow Perch	29	2	17	0.3
Other Speceis*	--	--	2,940	60
Total	1,716	100	4,862	100

Table 15. Comparison of creel survey results from Hayden Lake, Idaho by survey year.

Estimate	1968	1979	1982	1994-95	2010
Residents	--	70%	83%	--	88%
Angler hours	15,690	20,788	34,421	85,595	74,350
Interviewed anglers	--	268	741	--	1,217
Total Catch	--	--	41,177	52,289	60,805
All Trout					
Catch	--	--	7,073	4,258	147
Harvest	6,546	1,431	2,396	1,941	93
Catch rate (fish/h)	--	--	0.26[a]	0.09[b]	0.013[c]
Harvest rate (fish/h)	0.42[d]	0.07[e]	0.09	0.03	0.008
Smallmouth bass					
Catch	--	--	--	16,034	33,946
Harvest	--	--	--	313	2,610
Catch rate (fish/h)	--	--	--	0.06	2.1
Harvest rate (fish/h)	--	--	--	0.00	0.16
Largemouth bass					
Catch	--	--	587	6,088	12,326
Harvest	--	--	161	180	62
Crappie					
Catch	--	--	7,504	4,971	7,202
Harvest	--	--	5,127	1,462	2,297
Northern Pike					
Catch	--	--	--	--	2,093
Harvest	--	--	--	1,919	476
Perch					
Catch	--	--	--	25,065	5,052
Harvest	--	--	--	21,063	938

a: catch and harvest rate were taken from Ellis 1983 indicating 79% of effort was targeting trout.
b: catch and harvest rate taken from Appendix F and G in Nelson et al. 1997.
c: catch and harvest rate determined by hand calculating proportion targeting trout (not determined from CAS).
d: catch and harvest rate taken from Ellis 1983. Does not reflect hours specific to targeting trout. Presume > 85% targeting trout however.
e: catch and harvest rate taken from Goodnight and Mauser 1990. Does not reflect hours specific to targeting trout as well.

Table 16. Stocking numbers and timing of fingerling (3-6”) rainbow and westslope cutthroat trout since 1983 in Hayden Lake, ID.

	January	February	March	April	May	June	July	August	September	October	November	December	Total stocked
2011				268,800									268,800
2010				269,800									269,800
2009						225,531							225,531
2008						251,141							251,141
2007						324,000							324,000
2006				272,958									272,958
2005					136,488				79,980				216,468
2004					120,844								120,844
2003									137,124				137,124
2002						297,050			173,257				470,307
2001					38,800	36,562				23,173			98,535
2000						270,000							270,000
1999										245,112			245,112
1998									296,055				296,055
1997									302,268				302,268
1996									271,626				271,626
1995						92,235			14,720	85,333			192,288
1994					135,625				56,100	79,560			271,285
1993										192,185			192,185
1992						121,632							121,632
1991						84,275	148,200			150,150			382,625
1990			3,366		208,495				210,000				421,861
1989	263,610				6,930								270,540
1988				95,700									95,700
1987				50,000	273,600				43,239				366,839
1986					158,625			24,335					182,960
1985			3,531				12,035		156,100				171,666
1984							260,400						260,400
1983						115,000		17,490		95,550			228,040

Table 17. Phenotype, genotype, and other characteristics of trout sampled in Hayden Creek and in the 2010 Hayden Lake Creel.

Date	Location	Phenotype	Genotype	Length (mm)	Weight (lbs)	GPS	Sample #	Sex
4/21/2010	Hayden Creek	RBT	RBT	762	11	012	A	F
4/21/2010	Hayden Creek	WCT	HYB	775	10	012	B	M
4/21/2010	Hayden Creek	HYB	HYB	718	10.1	013	C	M
4/21/2010	Hayden Creek	UNK	RBT				D	
4/21/2010	Hayden Creek	WCT	HYB	760	11.5	014	E	F
4/21/2010	Hayden Creek	WCT	WCT	510	3.8	015	F	F
4/21/2010	Hayden Creek	WCT	WCT	550	4.8	015	G	M
3/27/2010	Hayden Lake	RBT	RBT	559			1	
4/10/2010	Hayden Lake	UNK	RBT	724			2	F
5/8/2010	Hayden Lake	RBT	HYB	610			3	
5/8/2010	Hayden Lake	UNK	>F1 HYB	610			4	
5/8/2010	Hayden Lake	UNK	HYB	609			5	
5/8/2010	Hayden Lake	RBT	RBT	711			6	
5/8/2010	Hayden Lake	RBT	>F1 HYB	609			7	
5/8/2010	Hayden Lake	RBT	HYB	419			8	
5/8/2010	Hayden Lake	RBT	RBT	711	12.4		9	
6/10/2010	Hayden Lake	UNK	RBT	610			10	
6/11/2010	Hayden Lake	UNK	>F1 HYB	660			11	

Table 18. Mean total length by genotype of trout sampled in Hayden Creek and in the Hayden Creel in 2010.

Genotype	Mean TL (mm)
>F1 Hybrid	626
Hybrid	751
Rainbow Trout	680
Westslope Cutthroat Trout	540

Table 19. Number of redds and adult trout counted in tributaries to Hayden Lake in 2010.

Tributary	Date	Species	# adults	# juveniles	# redds
Hayden Creek	4/20/10	rbt	4	1	
	4/20/10	wct	2		
	4/20/10	bkt	1		
	4/20/10				11
	4/23/10	rbt			
	4/23/10	wct			
	4/23/10	bkt			
	4/23/10				28
Mokins Creek	4/22/10				3
Yellowbanks Creek	4/22/10				8

Table 20. Mysis shrimp density sampled in mid July on Hayden Lake.

Date	Site #	Adults	YOY	Location (UTM)	Depth (m)	#/m^2
7/15/10	1	537	326	0518821 5289548	35	1099
7/15/10	2	246	521	0519988 5289715	35	977
7/15/10	3	213	382	0521999 5289296	20	758
7/15/10	4	113	722	0522566 5291527	25	1064
Average						975

Table 21. Present and historical Mysis shrimp densities sampled in North Idaho water bodies.

Water body	Years Introduced	Year established	Year	Month	Mean #/m^2
Hayden Lake	1974	1984	2010	July	975
Hayden Lake			1987	June	1,234
Priest Lake	1965-1967	1971	1988	June	137
Pend Oreille Lake	1966-1970	1972	2010	June	468
Pend Oreille Lake			1988	June	2,148

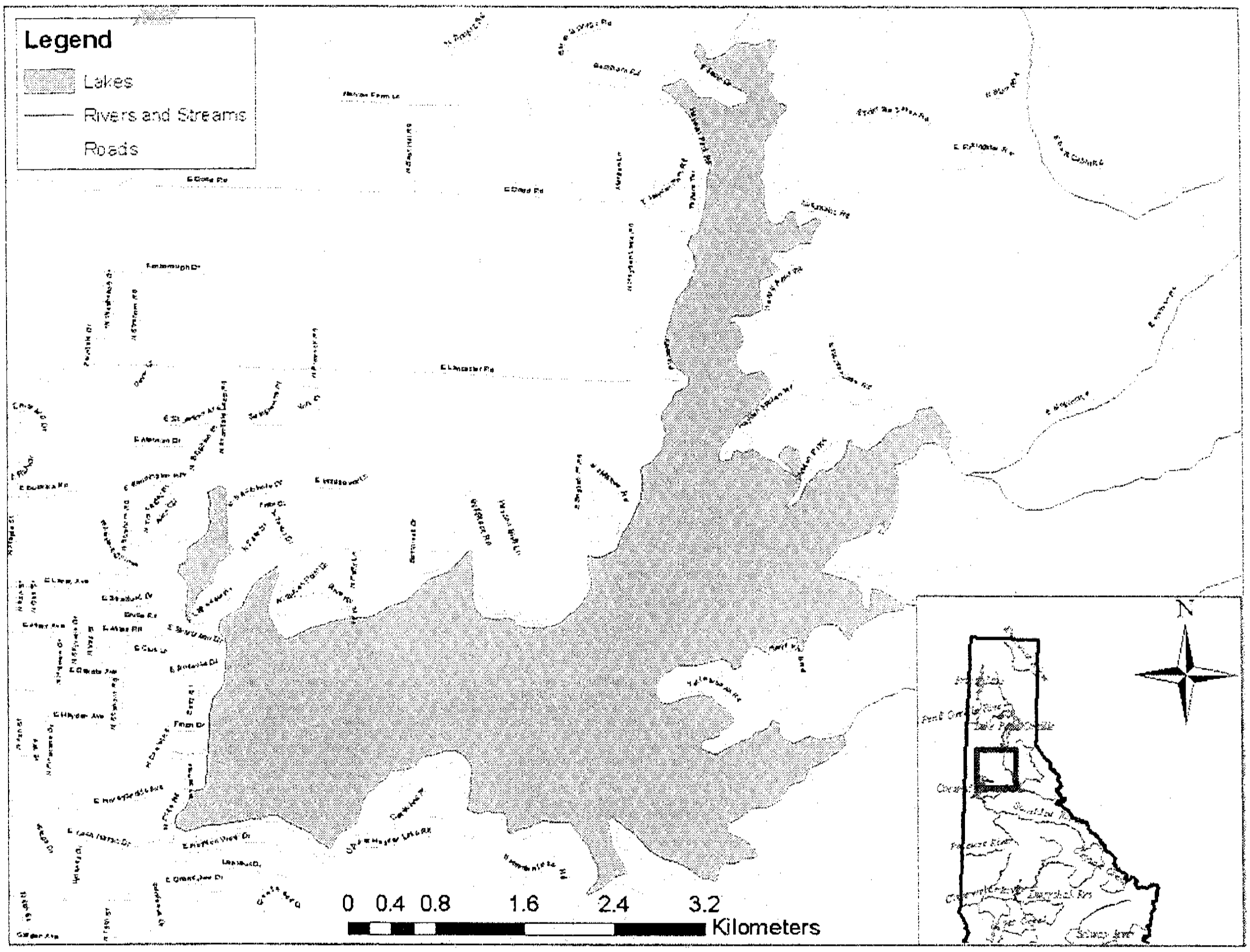

Figure 10. Hayden Lake, Idaho

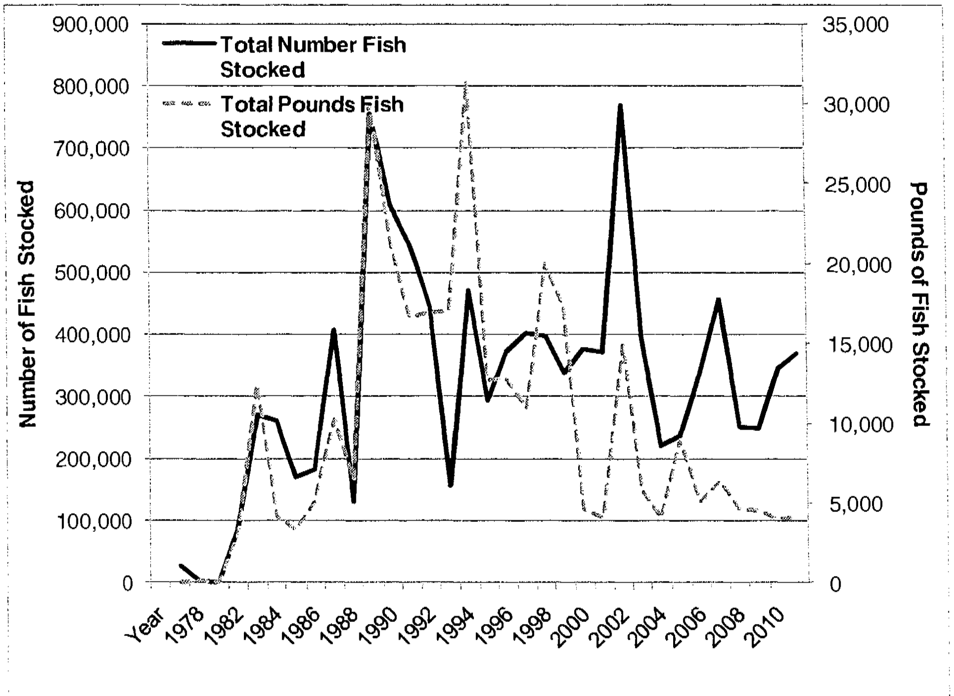

Figure 11. Stocking numbers and pounds of fry (0-76 mm) and fingerling (76-156 mm) rainbow and westslope cutthroat trout in Hayden Lake, ID.

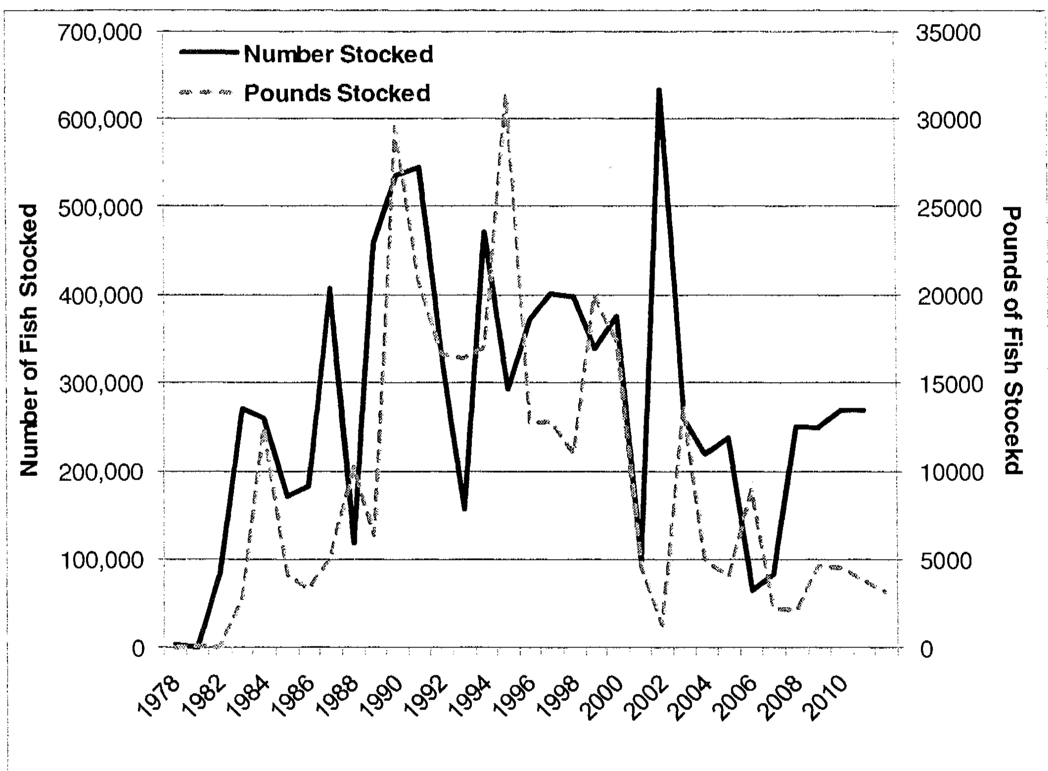

Figure 12. Stocking numbers and pounds of only fingerling (76-156 mm) rainbow and westslope cutthroat trout in Hayden Lake, ID.

2010 Panhandle Region Annual Fishery Management Report

Lakes and Reservoir Investigations

LOWLAND LAKES HATCHERY TROUT EXPLOITATION

ABSTRACT

In 2010 we evaluated the harvest rate of stocked, catchable-sized rainbow trout in Lower Twin, Hauser, Fernan lakes and Stoneridge Reservoir. Two hundred rainbow trout were tagged with Floy T-bar anchor tags and released in each lake with each lake receiving 100 fish in April and 100 in June. As of December 31, 2010, angler harvest rates for hatchery rainbow trout were estimated to range from a low of 2% in Hauser Lake to a high of 34% in Fernan Lake.

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INTRODUCTION

In Idaho, approximately 15 million trout are produced per year in 13 hatcheries by IDFG for resident trout angling. Rainbow trout and cutthroat trout *O. clarkii* are most often stocked in Idaho's lakes and reservoirs and in 2010, 16% were of catchable size (≥150 mm). Hatchery trout are used primarily in habitats not capable of supporting wild production sufficient to meet angler demand (IDFG 2007). Catchable rainbow trout raised for put-and-take use in the Panhandle Region are usually Trout Lodge or Hayspur strain raised at Mackey, Grace or Nampa Hatcheries. The fish are transported to either Sandpoint or Mullan Hatchery, and then distributed throughout the spring and summer. The Trout Lodge strain is used throughout the Panhandle Region for a variety of reasons including availability, growth, feed conversion and disease resistance. Only triploid (i.e. sterile) rainbow trout were stocked in the Panhandle Region in 2010. The cost of production and distribution averaged $1.41 per catchable trout stocked from the Mullan Hatchery and $0.83 per catchable stocked from the Sandpoint Hatchery in the Panhandle Region in 2010.

OBJECTIVE

To optimize use (harvest by anglers) of hatchery produced trout.

STUDY SITES

Lower Twin Lake

Lower Twin Lake is located in Kootenai County, Idaho, 16 km north of Coeur d'Alene, Idaho. Upper and Lower Twin lakes are connected by a shallow channel, and three public boat ramps provide access. Lower Twin Lake has a surface area of 158 ha, with a mean depth of 6.9 m and a maximum depth of 19.1 m. Fish Creek is the largest tributary in the system entering Upper Twin Lake on the western shoreline. Water leaves the system through the outlet on the southern end of the Lower Twin Lake forming Rathdrum Creek.

The Twin Lakes support two story fisheries for both warm and coldwater species. Nearly all of the species present in the two lakes are introduced warmwater species or stocked trout. Our 2002 fishery survey of Lower Twin Lake yielded catches of largemouth bass, black crappie, yellow perch, pumpkinseed, green sunfish, northern pike, brown bullhead and tench *Tinca tinca*. Green sunfish and northern pike were illegally introduced in the 1980's. Fourteen hatchery rainbow trout were captured in our 2002 survey ranging from 247-392 mm indicating some trout survived from the previous year.

Management of the fishery is under general statewide regulations and includes the stocking of both catchable and fingerling trout. Lower Twin Lake is stocked with 9,000 catchable rainbow trout, 5-8,000 fingerling cutthroat trout and 60,000 kokanee salmon fry on an annual basis. Kokanee stocking rates and frequency have varied considerably over the last ten years due to availability of kokanee fry.

Hauser Lake

Hauser Lake is located in Kootenai County 24 km northwest of Coeur d'Alene, Idaho, and covers approximately 223 ha. The western and northern shorelines are blanketed in macrophytes whereas the eastern shoreline has rock outcrops and riprap along a roadside with steep bank slopes. Inflow to the lake includes several small tributaries and ground water and outflow is minimal, eventually flowing into the Rathdrum Aquifer. Mean depth is 6.4 m with a maximum depth of 12.2 m. A public boat ramp operated by Kootenai County Parks and Waterways is located on the southwest end of the lake.

Hauser Lake has popular fisheries for warmwater and hatchery introduced species. Beginning in 1968, the lake was extensively stocked with rainbow trout. Cutthroat trout stocking began in 1978 and has continued until present time and kokanee have been stocked since the early 1990s. Beginning in 1989, both tiger muskie *E. Masquinongy* X *E. Lucius* and channel catfish were stocked in the lake. Tiger muskies (150 mm fish) were last stocked in 2007 and channel catfish (150 mm fish) were stocked most recently in 2010. The Idaho state record tiger muskie was captured in Hauser Lake in 2001, weighing 17.4 kg and measuring 123 cm. Hauser Lake is stocked with 15-17 thousand triploid Troutlodge kamloop rainbow trout, 2,500-5,500 channel catfish and 60,000 kokanee/yr. Hauser Lake is managed under general fishing regulations.

Stoneridge Reservoir

Stoneridge Reservoir is located 56 km north of Coeur d'Alene and 64 km southwest of Sandpoint, Idaho in Bonner County. The reservoir is part of Stoneridge Golf and Recreation Community, a time-share resort. The 1.6 kilometer long man-made reservoir was created in 1970 when an earth and cement dam was formed across Blanchard Creek. The land around the reservoir is private property belonging to the recreational club and public access to the reservoir has been limited and inconsistent since 2001. Stoneridge Reservoir is stocked with 3,000 triploid kamloop rainbow trout /yr.

Fernan Lake

Fernan Lake is located in Kootenai County, just east of Coeur d'Alene, Idaho. The watershed is approximately 4,872 ha with 102 ha inside the Coeur d'Alene city limits. Fernan Lake has a surface area of 121 ha, a mean depth of 3.7 m, and a maximum depth of 7.6 m. Water quality studies conducted by Idaho Department of Environmental Quality classifies Fernan Lake as meso-eutrophic (DEQ 1997).

Most of the Fernan Lake shoreline is forested while the northwest corner of the lake lies within the Fernan Lake Village corporate limits. Public access is limited to two boat ramps, one on the east and another on the west end of the lake and several newly created roadside access points.

In 1993, IDFG conducted a fishery survey and angler survey to assess the fishery. Ten species of gamefish and two species of non-game fish were found with largemouth bass being the most abundant species (Davis et al., 1993). Cutthroat trout comprised 1.6% of the fish collected in that survey. With its close proximity to Coeur d'Alene, Fernan Lake is heavily fished year-round receiving 100,000 hours of effort in 1993. Fernan Lake is managed as a Family Fishing Water. Fernan Lake is stocked annually with 3,000-5,000 channel catfish of catchable size, 19,000 triploid Kamloops rainbow trout catchables and 5,000-7,000 westslope cutthroat trout fingerlings.

METHODS

Eight hundred Trout Lodge strain rainbow trout were tagged with Floy T-bar anchor tags and released in Hauser, Fernan, Lower Twin Lakes and Stoneridge Reservoir with each waterbody receiving 100 fish in April and 100 in June. Rainbow trout reached an average weight of 2.5 fish per pound and a mean length of 250 mm at the time fish were stocked.

All fish used in this study were raised at the IDFG Nampa Hatchery, then transferred to and distributed by the Sandpoint Hatchery. On the day of stocking, trout were crowded, randomly removed from the raceway, and loaded into the fish transport truck for stocking. Rainbow trout were tagged with orange Floy T-bar anchor tags with the tag inserted just below the dorsal fin. Tags were labeled on two sides with one side stating "IDFG 1-866-258-0338" and the other side with a tag number. IDFG operates a toll free automated hotline and website through which anglers could report tags, although some tags were mailed in or dropped off at the Panhandle Regional Office. Additionally IDFG distributes posters and stickers to license vendors, regional offices and sporting goods outlets that publicize the tagging efforts and explain how to report tags and what the information is used for.

To determine angler exploitation, the number of fish harvested by anglers (determined by tags returns) was divided by the number of fish we tagged. We assumed a 53% reporting rate, which is typical of non-reward tags (Meyer et al. 2010), and adjusted the return rate accordingly to provide an exploitation estimate. Tag loss was assumed to be 8.2% while tagging mortality was assumed to be 3% based on work conducted on rainbow trout by Meyer et al. (2010).

RESULTS

Through December 31, 2010, 33 of the 200 tagged rainbow trout in Stoneridge Reservoir were returned. Through the same time period, anglers reported catching 14, and 35 of the 200 tagged rainbow trout stocked in Lower Twin and Fernan Lakes respectively. Anglers reported catching only 3 of the 200 tagged rainbow trout stocked in Hauser Lake. After correcting for the angler report rate, tag loss, and tagging mortality, angler exploitation was estimated to range from a low of 2% for hatchery rainbow trout in Hauser Lake to a high of 34% in Fernan Lake in 2010 (Table 22). Statewide, in 2009 tags were returned using the tag return 1-800 hotline (48%), website (45%), by mail (2%) returned to the Regional office in person (5%) Meyer et al. (2010).

When combining 2009 and 2010 rainbow trout catchable tag returns our results suggest a high percentage of hatchery trout in the Panhandle Region are caught by Idaho residents. Idaho residents returned 77-100% of the tagged rainbow trout in 2009 and 2010 (Table 22). The mean number of days between stocking and capture or days-at-large ranged from 8 days in Hauser Lake to 52 days in Lower Twin Lake. A total of 161 people caught and reported 194 tags in 2009 and 2010 with 21 anglers reported catching more than one tagged trout, or in other words, 13% of the anglers caught 29% of the trout reported.

DISCUSSION

Angler tag return rates for Stoneridge and Fernan lakes to date are estimated at 33% and 34% respectively with both lakes in the upper end of values reported for other Idaho lakes and reservoirs. On average, exploitation for hatchery rainbow trout across Idaho lakes and reservoirs from 2006-10 was 15.9%, and ranged from 0-79% (Meyer et al. 2010). It is important to note that harvest estimates for the four lake sampled in 2010 do not reflect season-long estimates and as more tags are reported we will refine our angler exploitation estimates. Kelso and Round lakes are included on Table 22. These lakes were evaluated in 2009 and their corrected exploitation estimates which encompass a full 365-day period are reported as such.

The difference in return rates between Hauser Lake and the other three Panhandle Region Lakes evaluated in 2010 may be explained by water-specific influences, specifically differences in productivity, thermal and oxygen refugia, and depth. Hauser Lake is relatively shallow with a mean depth of 6.4 m and a maximum depth of 12.2 m with suitable trout habitat in late August being limited to the metalimnetic zone approximately 4-7 m from surface because of high epilimnetic temperatures and low hypolimnetic oxygen levels (Fredericks et al. 2002). Another explanation could be a reduction in salmonid angling pressure perhaps due to angler attrition or because of the increase in water sport activity on the lake. Because of the proximity to Coeur d'Alene and Spokane, Washington, Hauser Lake is used extensively by water skiers, jet skiers, and pleasure boaters. Other possible explanations might be poor survival of the hatchery fish or predation. We will repeat our exploitation study on Hauser Lake in 2011 to reassess the 2010 estimate.

In 2009 we evaluated the harvest rates of stocked, catchable-sized trout in Kelso and Round lakes. Our 2010 hatchery trout evaluation revealed some "hold-overs" in these lakes. From Round Lake we received 7 catchable trout tag returns after December 31, 2009. Six of these "hold-overs" were caught by ice fishermen in January or February and one was caught in May 2010 (Table 22). Similarly, from our 2009 catchable stocking in Kelso Lake, we received six tag returns after December 31, 2009, three by ice fishermen and three caught in April-June, 2010 (Table 22).

In 2011 we will continue our systematic assessment of catchable rainbow trout return-rates in Panhandle Region lakes and adjust planting priorities based on established stocking criteria which include impacts to native fish, accessibility, return to creel rates, catch rates and the ability of a water body to provide a fishery without stocking. This may require eliminating lightly fished lakes or increase the frequency of stocking in heavily fished lakes.

MANAGEMENT RECOMMENDATIONS

1. Continue lowland lakes stocking evaluations with evaluation of Bull Moose, Brush, Smith, and Robinson and Jewel Lakes in 2011

2. Reevaluate return-to-creel in Hauser Lake.

Table 22. Estimates of angler exploitation, % resident anglers, and days-at-large for hatchery rainbow trout at various Panhandle Region lakes sampled in 2009 and 2010.

Lake	Year of Study	Number of Tags	Tags Returned as of 12/31	Tags Returned w/in 1 year	Number of different anglers	Corrected Exploitation Rate	Percent Idaho Resident	Mean Days at Large
Round	2009	200	29	*36	34	36%	91	103
Kelso	2009	200	67	*73	58	79%	86	50
Hauser	2010	200	3	N/A	3	2%	100	8.3
Fernan	2010	200	35	N/A	31	34%	100	90
L Twin	2010	200	14	N/A	13	15%	85	52.5
Stoneridge	2010	200	33	N/A	22	33%	77	49

*tag returns for full 365 day evaluation.

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Lakes and Reservoir Investigations

SPIRIT LAKE KOKANEE POPULATION STUDIES

ABSTRACT

Spirit Lake is northern Idaho's highest producer of kokanee on an area basis. It is managed for a high yield kokanee fishery and unlike our other kokanee lakes, does not contain a large population of kokanee predators. We monitored the kokanee population by midwater trawling and conducting hydroacoustic surveys. By combining both methodologies we estimated the lake contained 366,800 (627/ha), 587,000 (1,000/ha), 113,400 (194/ha), and 78,600 (134/ha) kokanee of ages 0 to 3, respectively. We also estimated the lake contained a standing stock of 67 kg/ha of kokanee with a production rate of 61 kg/ha/year. Potential egg deposition was estimated at 17.0 million eggs. Survival from last year's eggs to this year's fry was estimated at 3.0%. Based on these results Spirit Lake had more than a sufficient number of adult kokanee in the fishery, more than adequate egg deposition and continues to grow kokanee very well. No kokanee stocking appeared to be needed at this time.

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OBJECTIVE

Maintain a high yield (produce harvestable kokanee for anglers) kokanee fishery in Spirit Lake.

INTRODUCTION

IDFG transplanted kokanee from Lake Pend Oreille to Spirit Lake in the 1930's and 1940's. These fish originated from Lake Whatcom, Washington, and are "late spawners" that typically spawn during November through early January on shoreline gravel rather than in tributary streams (Winans et al 1996). In addition, early spawning strains of kokanee were stocked in 2000, 2001, 2004, 2007 and 2008 to insure adequate recruitment of kokanee fry. Spirit Lake had the highest yield of kokanee (12.7 kg/ha) of any of the 28 kokanee fisheries in northern Idaho, Washington, Oregon, Montana, Utah, Colorado, and British Columbia listed by Rieman and Meyers (1990). Concerns were raised by anglers during the winter of 2007-08 and the spring of 2008 that the kokanee fishery had declined because of their limited catch. Monitoring during July 2008 showed good numbers of kokanee with adult abundance at 35 fish/ha. Spirit Lake had a good, prolonged ice cover during the winter of 2008-09, and 2009-10. Groups of ice fishermen were having limit catches (15 fish/person/day) on most mornings. Summer anglers during 2009 and 2010 also appeared to be doing well, although no creel data was available. We conducted our annual kokanee monitoring during August 2010 to see if kokanee were being over harvested and determine the appropriateness of the 15 fish limit.

STUDY SITE

Spirit Lake is located near the town of Spirit Lake in the northern panhandle of Idaho. It has a surface area of 598 ha, with 585 ha of kokanee habitat. Maximum depth of the lake is about 27 m.

For northern Idaho, Spirit Lake is a fairly rich body of water. Chlorophyll 'a' was measured at 5.3 µg/l (Soltero and Hall 1984), total phosphorus was 18 µg/l, Secchi transparency was 3.9 m, conductance was 240 μmhos/cm^2, and the morphoedaphic index was 22.0 (Rieman and Myers 1990). Based on this concentration of total phosphorus the general level of lake productivity would be classed as meso-eutrophic (Wetzel 1975). This lake also was known to carry the highest biomass of kokanee in northern Idaho at 54.5 kg/ha (Rieman and Myers 1991).

Kokanee in Spirit Lake are mostly naturally reproducing. However, during the last decade, early spawning kokanee were stocked in 2000 (200,000 fry), 2001 (198,000 fry), 2004 (200,000 fry), 2007 (163,000 fry) and 2008 (169,000 fry). No additional kokanee were stocked in Spirit Lake in 2009 or 2010.

METHODS

Trawling

We used a midwater trawl, as described by Bowler et al. (1979), Rieman and Meyers (1990), and Rieman (1992), to estimate the kokanee populations in Spirit Lake. Five trawl hauls were made in Spirit Lake on August 12, 2010. Trawl transects were selected using a systematic sample design and were in similar locations as those used in previous years (Figure 13). Kokanee were measured and weighed, and scales were collected from representative length groups for age analysis. The average number of eggs produced per female kokanee was calculated using the regression of kokanee length to fecundity found in Rieman (1992). Ninety percent confidence intervals (CI) were placed on the arithmetic mean density estimates using a Student's t distribution.

We calculated a separate abundance estimate for early spawning kokanee based on the color of their flesh. Using flesh color to differential stocks is an unproven technique that needs to be validated; however, the lake contained some kokanee that had dark red flesh when compared to most of the kokanee from the lake. Evidence that these fish were early spawning kokanee included that they were often the largest fish within a cohort, that they matured mostly at age-2 instead of age-3, and some of these fish where getting their spawning coloration by the August 12 trawling date. Differentiating the two stocks of kokanee allowed us to evaluate the success of the fry stocking.

Hydroacoustics

A hydroacoustic survey was conducted on Spirit Lake during the night of August 16, 2010. This was the fifth time that a hydroacoustic survey was conducted on this water body. We used a Simrad EK 60 scientific echosounder with a 6.5^{o} transducer. The transducer was mounted on a pole on the port side of the boat and pointed straight down. The boat traveled at 7.4 km/h while surveying the lake. Ten evenly spaced transects were established perpendicular to the long axis of the lake, with the starting point of the first transect chosen at random (Figure 13). This survey was identical to the one used in 2009, but was a change in the survey design from the seven transects arranged in a zig-zag pattern that were used in 2004, 2007, and 2008. The design used in 2009 and 2010 was more labor intensive, but should give better statistical confidence and eliminate concerns over autocorrelation at the beginning and end of transects (Simmonds and MacLennan, 2005).

Kokanee densities were estimated by echo integration. We used EchoView software version 4.9 to calculate nautical area scattering coefficients (NASC) and mean target strengths (in situ). NASC values were calculated by drawing a box around the kokanee layer on the volume backscattering (Sv) fileset and having the software integrate backscattering in this region on echoes with a minimum uncorrected target strength (TS) threshold of -66 dB and a maximum threshold of -20 dB. Age 0 kokanee densities were calculated directly from the echograms by including all targets with corrected TS between -60.0 dB and -47.0 dB. The arithmetic mean density of fry was calculated for the 10 transects and multiplied by the area of the lake (585 ha) to obtain an abundance estimate for fry. To calculate a population estimate for kokanee between the ages of 1 and 3, we calculated an arithmetic mean density of kokanee between -46.9 dB and -

33.0 dB, split this density estimate into a population estimate of each age class by multiplying times the percentage of kokanee in each age class in the combined trawl catch. Density of each age class was then multiplied by the area of the lake to calculate abundance.

We calculated the 90% confidence interval on age-0 kokanee and for kokanee ages 1 through 3 combined. Confidence intervals were calculated on the log transformed density estimates ($\log_{10}$ X+1) since our sample size was small, n=10, and our variance was greater than the mean. We used the Student's T distribution for calculating the variance on the transformed data. Confidence intervals were placed around the arithmetic mean to give the least biased estimate of mean and confidence interval (Elliot 1983).

We calculated the biomass, production, and mortality (by weight) of the kokanee population in Spirit Lake based on the 2009 and 2010 annual hydroacoustic estimates split into age classes based on trawl catch. Biomass was the total weight of kokanee within the lake at the time of our population estimate. It was calculated by multiplying the population estimate of each kokanee year class by the mean weight of kokanee in that year class as determined in the trawl catch. The year class weights were summed to determine the lake's overall kokanee biomass and divided by the area of kokanee habitat to determine standing stock. A second method was also tried as a way to estimate biomass solely on the basis of hydroacoustic data. First all ten transects were connected in one file. Then an analysis region was drawn around the kokanee layer in all ten transects and the corrected target strength of all kokanee seen on all transects was averaged. This gave us the mean target strength of all fish in the kokanee layer without averaging the averages of the target strength on each transect.

Kokanee production was defined as the weight of flesh grown by the kokanee population regardless of whether the fish was alive or dead at the end of the year (Ricker 1975). We used the Summation Method developed by Newman and Martin (1983) and presented in Hayes et al. (2007), where :

$$\hat{P} = \overline{N} \; \Delta \; \overline{w}$$

where $\hat{P}$ = production estimate for a kokanee cohort between years one and two, $\overline{N}$ = estimated mean abundance of the cohort between years one and two, and $\Delta \overline{w}$= estimated change in mean weight of individuals of the cohort from year one to year two. Total annual production of kokanee was calculated as the sum of the production of each cohort.

We defined kokanee mortality by weight as the weight of kokanee flesh that was lost from the population due to all forms of mortality between years. We calculated mortality by weight as:

$$\hat{A}_{wt} = \overline{w} \; \Delta \; N$$

where $\hat{A}_{wt}$ = estimated annual mortality of a kokanee cohort for a year by weight, $\overline{w}$ = the mean weight of kokanee between years one and two within the cohort, and Δ N is the change in the estimated number of kokanee in a cohort between years one and two (the number lost from a cohort). Results were summed across all cohorts to estimate total weight of all kokanee that died during the year.

RESULTS

Trawling

By trawling, we estimated the lake contained 138,200 age-0 kokanee (±36%, 90% C.I.), 459,900 age-1 kokanee (± 56%), 88,800 age-2 kokanee (± 46%), and 61,600 age-3 kokanee (± 43%), with a total population of 748,500 kokanee (± 38%) (Table 23). Modal sizes of kokanee for each age class were 40 mm, 150 mm, 200 mm, and 230 mm for ages 0 to 3, respectively (Figure 2). Standing stock of the kokanee population was estimated at 52.6 kg/ha with a total biomass of 30.7 t.

We also estimated the potential number of eggs that could be laid by this kokanee population in the fall of 2010 based on the trawling data. We found that kokanee over 220 mm were mature and 50% of the kokanee between 210 mm and 220 mm had matured. This corresponded to mostly age-3 late spawning fish and age-2 early spawning fish. Assuming a 1:1 male to female ratio, we estimated the lake contained 35,900 adult female kokanee. Using a mean length of spawners of 230 mm (assumes no growth between July and November), and 371 eggs/female, we estimated kokanee in Spirit Lake had a potential egg deposition of 13.3 million eggs.

Separate population estimates were made for kokanee believed to be of the early spawning strain based on trawling. We estimated the lake contained 20,400 (± 101%, 90% C.I.) age-2 early spawning kokanee. No early spawners were seen in any other age class. The biomass of this age class was estimated at 2.0 t with a standing stock of 3.36 kg/ha. Survival estimates from stocking 168,741 fry in 2008 to age-2 kokanee in 2010 was 12%.

Hydroacoustics

Two size groups of kokanee were noted based on target strengths, which corresponded to fry and all other age classes (Figure 15). Based on this distribution, and the size break between fry and age-1 kokanee in the trawl catch, we divided fry from older age classes of kokanee at -47.0 dB. The modal length of fry was -49.5 dB or about 56 mm (Love (1971). This agreed with the modal size of fry in the trawl catch, which was 55 mm.

Using this size break at -47 dB, we estimated the lake contained 366,800 (627 fish/ha) age-0 kokanee (90% CI, -16% to +19%), and 779,000 (1,332 fish/ha) age 1 through 3 kokanee (90% CI, -29% to +40%). The proportions of kokanee in the trawl catch, exclusive of fry, were: 75.35% age-1, 14.56% age-2, and 10.09% age-3. Based on these proportions we estimated the lake contained 587,000 (1,003 fish/ha) age-1 kokanee, 113,400 (194 fish/ha) age-2 kokanee, and 78,600 (134 fish/ha) age-3 kokanee (Table 24).

We estimated the potential egg production of the kokanee population based on the hydroacoustic results. In the trawl catch, 13% of the age-2 kokanee and 98% of the age-3 kokanee were mature. Applying these percentages to the hydroacoustic population estimate, we calculated the lake contained 45,900 female kokanee, at a 50:50 male to female proportion. The lake therefore contained 17.0 million eggs assuming 371 eggs/female.

Last year, 2009, we estimated the potential egg deposition was 12.4 million. This year's fry production was 366,800, giving an egg-to-fry survival rate of 3.0%.

Kokanee production was estimated at 35.5 t (60.6 kg/ha/yr) for the lake (Table 25). The most productive age class was between fry and age-1 kokanee, which grew nearly 21 t of fish flesh this past year. Biomass of kokanee was 39.5 t, standing stock was 67 kg/ha (Table 25), and mortality by weight was 26 t (44 kg/ha/yr). Based on these data, the production to biomass ratio was 0.9:1. Mean NASC estimate for the lake was 646 m^2/nautical $mile^2$ (Figure 16).

We also calculated kokanee biomass as if no trawl data were available to split kokanee into age classes. We examined 5,338 single targets on the ten transects. Mean target strength was -40.96 dB or 157 mm. Mean density on the ten transects was 1,961 fish/ha. Kokanee 157 mm in length averaged 36.5 g in the trawl catch (kokanee length to weight data would be available from other years or lakes if no trawling were conducted). A biomass estimate of kokanee based on hydroacoustic data was therefore 41.9 t (1,961 fish/ha times 36.5 g/fish times 585 ha). This is only about 6% different from the estimated 39.5 t of biomass calculated by the combined hydroacoustic and trawling method that split the population into age groups and multiplied each age group by its mean weight.

DISCUSSION

Kokanee abundance

Kokanee fisheries seem to optimize at 30 to 50 adults/ha based on trawl catch (Rieman and Maiolie 1995). Within this range, kokanee density and size-dependant catchability tend to maximize the angling effort, catch rate, and yield. Based on trawling, we estimated Spirit Lake contained 105 age-3 kokanee/ha (± 43%). This would indicate kokanee densities were double the desired amount. A lowering of adult densities could improve the fishery, but local anglers generally accept the smaller fish (5 to 7 per pint jar) and the ice fishery appears to do well with the higher densities. We also have little control over kokanee abundance in this lake other than stocking (or not stocking) or changing harvest limits. Considering the variability in kokanee populations, the regulation changes in 2011 to a region-wide 15 kokanee limit, the often high exploitation of kokanee during winter, and the low density of kokanee in other lakes, we recommend no change in the management of this lake.

Kokanee regulations were reduced from 25 fish to 15 fish in 2000. This seemed to have the desired effect as kokanee numbers rebounded by the next population estimate in 2005 (Table 1). During the winter of 2008-09 and the summer of 2009, Spirit Lake had a very popular sport fishery. Kokanee mortality from age-2 to age-3 was 70% based on hydroacoustics. We suspect this high mortality was at least partly due to increased angler harvest. During the past year, July 2009 to August 2010, mortality from age-2 to age-3 was a more moderate 45% by hydroacoustics. These recent years show the variability in mortality and likely angler exploitation. Therefore the 15 kokanee limit may be appropriate for this lake.

Population estimates for kokanee that are made by combining hydroacoustics with trawling were likely the better estimate. This method combines the large volume of water sampled by hydroacoustics with the ability of the trawl to collect representative samples of kokanee for aging. By the combined method, total kokanee densities in Spirit Lake have been fairly stable at just over 1 million kokanee for the last 3 years (Table 24). Adult kokanee abundance has also remained fairly stable at 60,000 to 80,000 fish (Table 24). Two year classes that should be monitored are the above normal abundance of age-1 kokanee, and the lower than average number of fry.

Hydroacoustic sampling indicated a decline in the year class of age-2 kokanee for the second straight year, but it remains fairly strong at 113,400 fish. Age-2 kokanee were mostly 180 to 220 mm in total length (Figure 14), which was smaller than the 210 to 240 mm lengths measured between 1981 and 1991 (Rieman and Meyers 1990, Rieman 1992). These fish will be the bulk of the fishery in 2011. Based on size and abundance of age-2 kokanee, we would expect to have a good fishery again in 2011.

Kokanee fry abundance in Spirit Lake declined to 366,800 fish (630 fry/ha) based on hydroacoustics (Table 24). Although low, this year class should be sufficiently strong to produce a good year class of adults. Even at a conservatively high mortality rate of 60%, these fry would yield an adult population of 40 age-3 kokanee/ha, which should be sufficient for a good fishery. We also estimated 13 million eggs would be laid in 2010 to become fry in 2011. This should be sufficient for the next generation depending on over-winter survival. No supplemental stocking of kokanee therefore appeared to be needed.

The stocking of early spawning strain of kokanee fry was successful in that it added 6,800 age-2 fish to the population in 2009 and 20,400 age-2 fish in 2010. The 12% survival rate from stocking to age-2 showed a good ability of these fish to survive in the lake. We do not know, however, whether this stocking contributed to an increase in kokanee abundance or whether they replaced a similar amount of natural production.

Kokanee production for Spirit Lake was estimated at 61 kg/ha/yr between 2009 and 2010 (Table 25). For comparison, this is about 6 to 8 times the kokanee production of Lake Pend Oreille (8 to 11 kg/ha/yr between 1995 and 2007, agency files). Standing stock of kokanee was cited in Rieman and Myers (1991) at 54.5 kg/ha. In our study it was estimated at 67.5 kg/ha by hydroacoustics and 52.6 kg/ha based on trawling. It therefore appears Spirit Lake remained a very productive lake for growing kokanee.

NASC (nautical area scattering coefficients) values are a sum of the areal backscattering of fish in the analyzed kokanee layer (Simmonds and MacLennan 2005). Figure 16 compares NASC values for kokanee surveys for several lakes in Idaho. These data indicated Spirit Lake had a relatively high abundance of kokanee for waters in northern Idaho. Only Anderson Ranch Reservoir in southern Idaho had a higher NASC value during our recent surveys. NASC values are a measurement of area of the targets, and so may not directly correlate with fish biomass when comparing bodies of water. A better approach to compare waters would be to estimate kokanee biomass from NASC and the calculated mean target strength. We found this estimate agreed well with the estimate of biomass calculated based on the combined method that used weight and abundance of each year class in the trawl catch. We recommend that future authors conducting hydroacoustic surveys record both NASC and mean target strength, and estimate kokanee biomass for each survey to help provide a common denominator when comparing lakes.

In last year's report, we mentioned that establishing a naturally reproducing run of early spawning kokanee could be beneficial to the lake. A second source for recruitment could be helpful should the late spawning kokanee have poor egg survival in shoreline spawning areas. The redder flesh color is also welcomed by some anglers. Lastly, we suspect that early spawning kokanee may have a higher vulnerability to angling. An admittedly cursory look at anglers catch at times showed a higher percentage of early spawning kokanee than were seen in the trawl catch. We mentioned last year that enhancing the early spawning run up Brickle Creek would require the breaching of three small beaver dams during the September spawning run. In 2010 those beaver dams were gone. A local trapper caught the beaver and an adjacent property owner removed the dams. Early spawning kokanee therefore had free access to the stream and should have had a reasonable chance to spawn. Unfortunately, the only early spawning kokanee we collected this year were age-2 fish; likely from the stocking in 2008. This would indicate that there was little or no natural reproduction of this strain up to now. Biologists should look for these fish in future trawl samples.

MANAGEMENT RECOMMENDATIONS

1. We recommend continuing to examine the trawl catch for early spawning kokanee to see if a self-sustaining population is developing. If early spawning kokanee are reproducing, breach the beaver dams in Brickle Creek as needed.

2. We also recommend that no supplemental stocking of kokanee is needed this year.

Table 23. Kokanee population estimates based on midwater trawling from 1981 through 2009 in Spirit Lake, Idaho.

Year	Age Class				Total	Age-3+/ha
	Age-0	Age-1	Age-2	Age-3		
2010	138,200	459,900	88,800	61,600	748,500	105[a]
2009	260,700	182,600	75,900	30,000	549,200	51[a]
2008	281,600	274,400	188,800	56,400	801,200	96
2007	439,919	210,122	41,460	20,409	711,910	35
2006	--	--	--	--	--	--
2005	508,000	202,000	185,000	94,000	989,100	161
2001-04	--	--	--	--	--	--
2000	800,000	73,000	6,800	7,800	901,900	13
1999	286,900	9,700	50,400	34,800	381,800	61
1998	28,100	62,400	86,900	27,800	205,200	49
1997	187,300	132,200	65,600	6,500	391,600	11
1996	--	--	--	--	--	--
1995	39,800	129,400	30,500	81,400	281,100	142
1994	11,800	76,300	81,700	19,600	189,400	34
1993	52,400	244,100	114,400	11,500	422,400	20
1992	--	--	--	--	--	--
1991	458,400	215,600	90,000	26,000	790,000	45
1990	110,000	285,800	84,100	62,000	541,800	108
1989	111,900	116,400	196,000	86,000	510,400	150
1988	63,800	207,700	78,500	148,800	498,800	260
1987	42,800	164,800	332,800	71,700	612,100	125
1986	15,400	138,000	116,800	35,400	305,600	62
1985	149,600	184,900	101,000	66,600	502,100	116
1984	3,300	16,400	148,800	96,500	264,900	168
1983	111,200	224,000	111,200	39,200	485,700	68
1982	526,000	209,000	57,700	48,000	840,700	84
1981	281,300	73,400	82,100	92,600	529,400	162
Mean abundance from 1981-2005	199,300	145,500	106,300	55,500	507,500	89

[a] Does not include similar- sized age-2 early spawners.

Table 24. Kokanee population estimates based on hydroacoustic surveys in Spirit Lake, Idaho. NASC is the nautical area scattering coefficient and TS is the target strength.

	Age Class							
Year	Age-0	Age-1	Age-2	Age-3	Total	Mean NASC	Mean TS	Age 3/ha
2010	366,800	587,000	113,400	78,600	1,145,800	646	-41.34	134[b]
2009	567,500	345,100	142,400	60,200	1,115,200	448		103[b]
2008	553,500	292,500	198,700	60,700	1,105,400	505		103
2007	495,900	266,900	52,500	25,900	841,200	494		44
2004	279,000	-[a]	-[a]	-[a]	916,800	458		-

[a] No trawling was conducted in 2004 to delineate kokanee in age classes 1 to 3.
[b] Does not include mature age-2 kokanee that were of similar-size to age-3 late spawners.

Table 25. Calculations of kokanee production for Spirit Lake between 2009 and 2010. Production for an age class was estimated by multiplying mean abundance times the gain in weight for a cohort. Biomass was estimated by multiplying the 2010 weight times the 2010 abundance for each cohort.

Age class	2009 weight (g)	2010 fry weight (g)	2010 Weight (g)	Weight gain (g)	2009 abundance	2010 abundance	Mean abundance	Production (t)	Biomass of age class in 2010 (t)
New Fry - 0		0.15	1.2	1.05	1,222,650	366,795	794,723	0.8	0.4
0 to 1	0.65		36.29	35.64	567,453	586,981	577,217	20.6	21.3
1 to 2	34.09		75.51	41.42	345,052	113,392	229,222	9.5	8.6
2 to 3	75.31		116.61	41.3	142,402	78,628	110,515	4.6	9.2
3 to 4	108.76		108.76	0	60,247	0	30,124	0.0	0.0
Total (t)								35.5	39.5
Total (kg/ha)								60.6	67.47

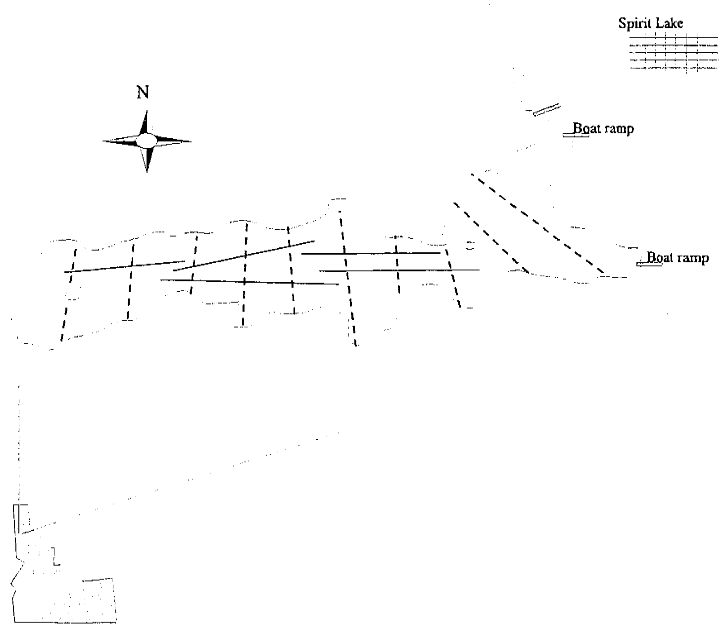

Figure 13. Location of five midwater trawling transects (solid lines) and ten hydroacoustic transects (dashed lines) used to estimate kokanee population abundance in Spirit Lake, Idaho during 2010.

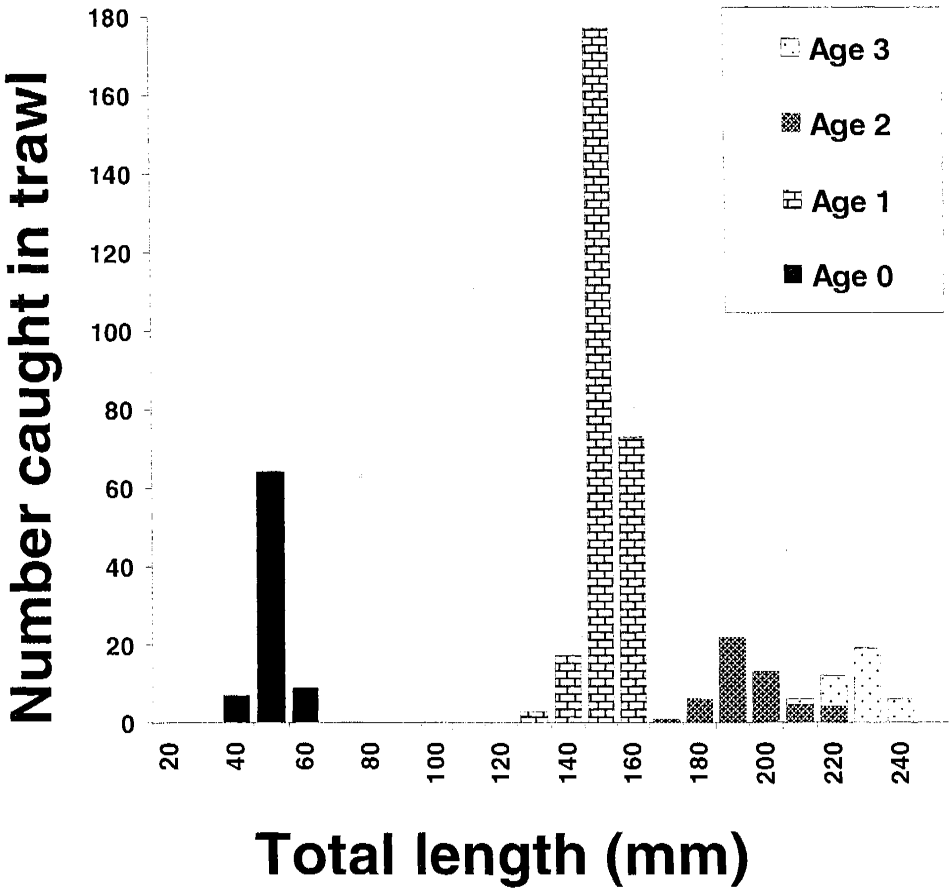

Figure 14. Length-frequency distribution of kokanee caught while trawling Spirit Lake, Idaho, August 12, 2010.

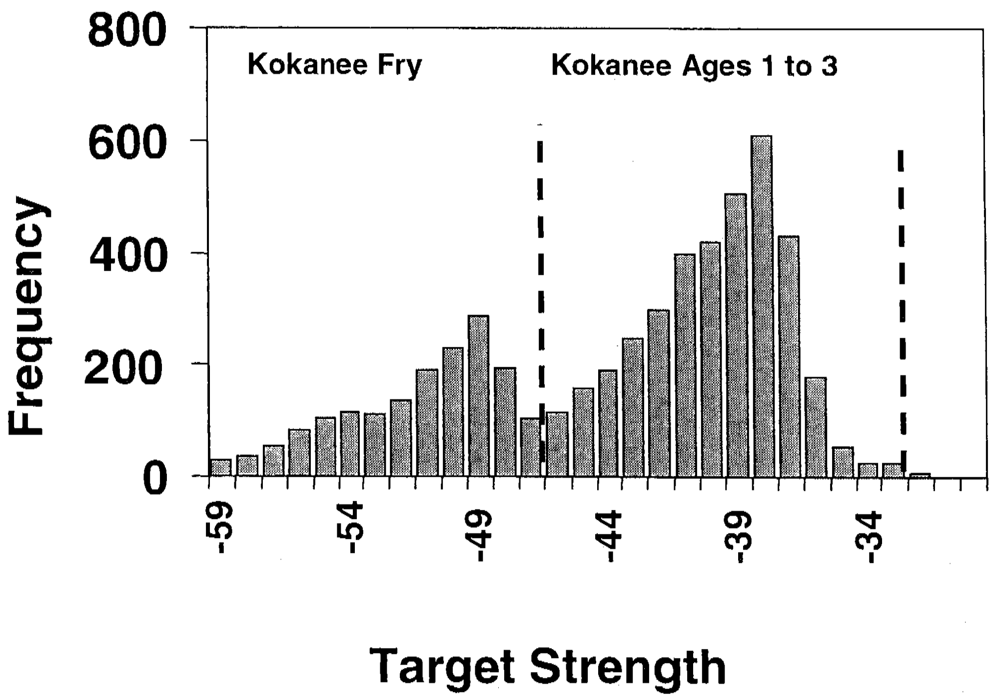

Figure 15. Target strength - frequency distribution of kokanee in Spirit Lake, Idaho, on August 16, 2010.

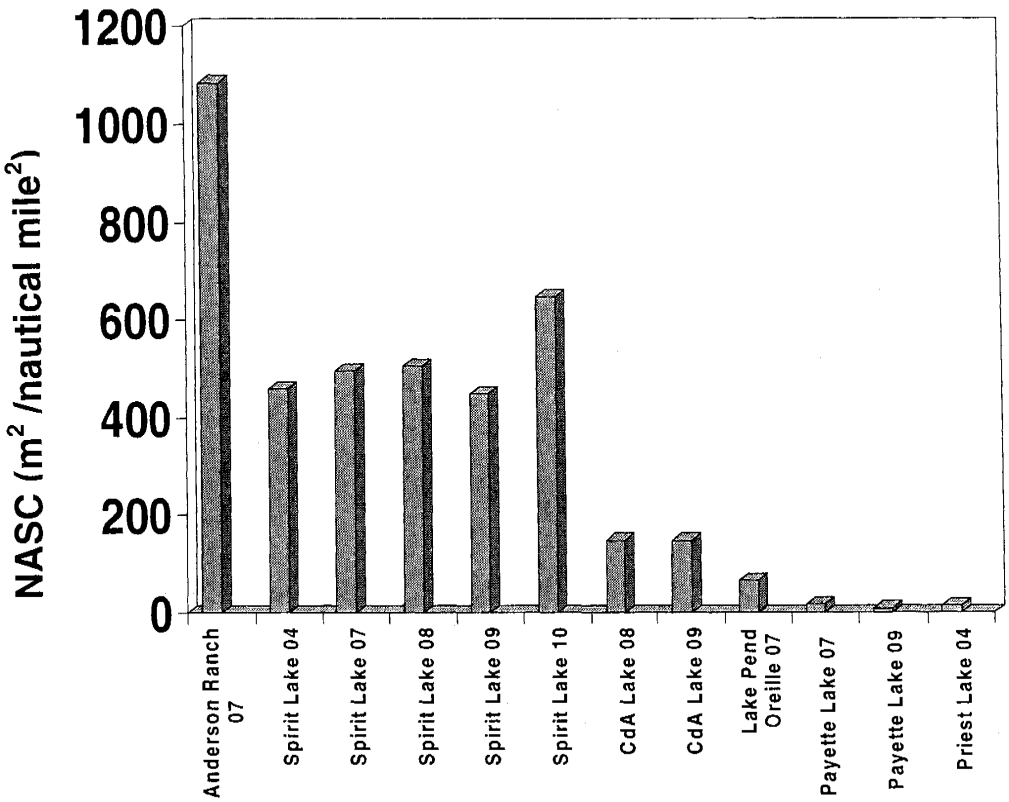

Figure 16. Nautical area scattering coefficients (NASC) for several lakes and reservoirs in Idaho.

2010 Panhandle Region Annual Fishery Management Report

Lakes and Reservoir Investigations

UPPER PRIEST LAKE AND THOROFARE LAKE TROUT CONTROL

ABSTRACT

Hickey Bros. Fisheries, Inc. of Baileys Harbor, Wisconsin was contracted to use gill nets to remove lake trout from Upper Priest Lake in 2010 using their 36 foot (11 m) commercial gill net boat with funding from the U. S. Fish and Wildlife Service (USFWS). Gill nets were fished from May 23-29, 2010. We fished a total of 43 km of gill net (26.6 mi) averaging 6,109 m net/day. A total of 2,551 lake trout were caught and removed. Based on a Leslie Depletion Model (Ricker 1975) we estimated lake trout population abundance at the beginning of the effort to be 3,346 fish which suggests we removed approximately 76% of the population. With funding from USFWS, Kalispell Tribe, and U. S. Forest Service (USFS), IDFG contracted with Hickey Bros. Fisheries, Inc. in 2010 to continue evaluation of trap nets to minimize lake trout movement into Upper Priest Lake from Priest Lake. From September 24 through October 26, 2010, we used trap nets and gill nets to capture fish in the Thorofare. Trap nets were placed approximately 200 m upstream of Priest Lake and approximately 100 m downstream of Upper Priest Lake. We caught 241 lake trout and three bull trout during this effort. Lake trout ranged from 460 mm to 900 mm (TL). Lake trout movement through the Thorofare increased as surface water temperatures neared 10.5°C. Peak movement was observed on October 18 when 34 lake trout were captured.

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INTRODUCTION

It has been well documented that introduced lake trout have the tendency to suppress other native and non-native species through predation and/or competition (Donald and Alger 1993, Fredenberg 2002, Hansen et al. 2008.) Historically, native bull trout 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 ensued (Mauser et al. 1988). The bull trout population in Priest Lake is considered functionally extinct while the population in Upper Priest Lake is severely depressed (DuPont et al. 2007).

Native westslope cutthroat trout 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 the Priest Lakes. Cutthroat trout were closed to harvest in 1988

In Upper Priest Lake the lake trout population appears to have grown rapidly in the past 25 years. Lake trout were not known to be present in Upper Priest Lake until mid-1980s at which time they were thought to have begun migrating from Priest Lake (Mauser 1986). In 1998 the Upper Priest Lake lake trout population was estimated at 859 fish (Fredericks and Vernard 2001). In an effort to reduce threats to dwindling bull trout and cutthroat populations, IDFG has been using gill nets to reduce lake trout abundance in Upper Priest Lake since 1998. Between 150 and 2,500 lake trout have been removed nearly every year from Upper Priest Lake (Liter et al. 2010 in press). The netting efforts demonstrated that Upper Priest Lake is not a closed system. It has become increasingly evident that without a migration barrier in the Thorofare to limit immigration from Priest Lake, Upper Priest Lake will likely be dominated by lake trout (Fredericks and Vernard 2001).

METHODS

Lake Trout Removal

Hickey Bros. Fisheries, Inc. of Baileys Harbor, Wisconsin was contracted to use gill nets to remove lake trout from Upper Priest Lake in 2010 using their 36 foot (11 m) commercial gill net boat. Funding for this contract was provided by the USFWS. Gill nets used in Upper Priest Lake were 91 m long by 2.7 m high designed with multiple panels of graded mesh sizes ranging from 50 mm to 89 mm randomly arranged in each net. Individual gill nets were tied together end to end to create a continuous net ranging from 1,645 m to 6,644 m.

Gill nets were fished from May 23-29, 2010. Nets were set throughout the lake and were moved based on catch rates at a particular site and the discretion of the netting crew. Gill nets were set perpendicular to shore when fishing shoreline areas and at various angles when fishing deeper offshore areas. Nets were fished from around 0500 hrs to 1900 hrs. and averaged 11.1 hrs of soak time daily. Nets were set on the bottom at depths ranging from 10-31 m. A concerted effort was made to avoid incidental bull trout captures by avoiding areas known to hold concentrations of bull trout.

Fish were measured (TL) and all fish greater than 300 mm in length were cleaned, packed on ice and sent to local food banks for distribution. Fish less than 300 mm were returned as biomass to the lake bottom.

Thorofare Netting Evaluation

With funding from USFWS, Kalispell Tribe, and USFS, IDFG contracted with Hickey Bros. Fisheries, Inc. in 2010 to continue evaluation of commercial trap nets to minimize lake trout movement into Upper Priest Lake from Priest Lake. From September 24 through October 26, 2010, we used trap nets and gill nets to capture fish in the Thorofare. Monofilament, sinking gill nets were set perpendicular to the flow behind (upstream) of the lower trap net to monitor effectiveness.

Because the trap net leads were designed to span the entire width of the Thorofare, posing navigation obstacles to boaters, an 8-10 m wide section of float line was submerged to create a passage-way near the thalweg to allow boat traffic movement. Large signs alerted boaters well in advance that research nets were ahead. Multiple orange floats spaced 6 m apart were attached to the top of the leads to help boaters recognize and avoid the trap nets. Additionally, signs with arrows and "boat passage" guided boaters through the passage way.

Trap nets were placed approximately 200 m upstream of Priest Lake and approximately 100 m downstream of Upper Priest Lake. These sites were selected due to their 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, extending from the bottom to the surface. These visible leads divert fish into an enclosure called the heart. The heart has wings or net sections that form a V-shape and are supported by floats and anchors. Once inside the heart, fish swim through a tunnel and become trapped in a boxlike receptacle called a pot (Figure 17). Fish trapped in the pot remain alive, until it is raised up to the boat where lake trout are dipped out with a long handled net and removed. Captured lake trout were enumerated; measured (mm total length) and stage of sexual maturity and ripeness were recorded. Captured bull trout and cutthroat trout were measured and transported away from the net site before release.

RESULTS

Lake Trout Removal

During our seven-day effort we averaged 6,109 m net/day. A total of 2,551 lake trout were caught and removed. Daily catch of lake trout ranged from 183-592 fish. Lake trout ranged from 106-885 mm with a mean of 310 mm total length (Figure 18).

Catch rates of lake trout varied among locations and days in Upper Priest Lake during May, 2010. Catch rates were generally higher along shorelines and lower in deeper mid-lake sets. Daily catch was generally higher at the start of the effort and tapered off over the seven-day effort (Figure 20).

Using a Leslie Depletion Model (Ricker 1975) we estimated the lake trout population to be 3,346 fish at the beginning of the effort (Figure 21). Assuming equal catchability of all lake trout, our removal efficiency would be approximately 76%.

A total of 22 bull trout were captured and 20 were released alive (Figure 19). Bull trout ranged from 230-590 mm with a mean length of 358 mm. Other species caught include one pygmy whitefish *Prosopium coulteri,* 20 longnose sucker *Catostomus catostomus*, 52 largescale sucker *C. macrocheilus*, 35 northern pikeminnow *Ptychocheilus oregonensis*, 13 peamouth chub *Mylocheilus caurinus*, one yellow perch *Perca flavescens* and three kokanee salmon.

Thorofare Netting Evaluation

We caught 241 lake trout and three bull trout during this effort. Lake trout ranged from 460 mm to 900 mm (TL) (Figure 22); all were sexually mature and half (120) were females. Three bull trout were captured and released and ranged from 380 mm to 495 mm. We also captured 50 cutthroat trout ranging from 290 to 480 mm (Table 27). Other species caught include smallmouth bass, rainbow trout, kokanee salmon, brook trout, largescale and longnose suckers *Catostomus spp*, mountain whitefish, northern pikeminnow, brown bullhead, and tench. A total of 879 fish were captured (Table 27).

Lake trout movement through the Thorofare increased as surface water temperatures neared 11.2°C. This observation is consistent with other studies that suggest lake trout begin to arrive at spawning sites when surface water temperatures near 12°C (Dux 2005; Gunn 1995). Peak movement was observed on October 18 when 34 lake trout were captured. Lake trout catch was at its highest from October 12 through 26. Trap nets were removed on October 22, however, gill nets were set the night of October 25-26, the conclusion of our netting effort, 21 lake trout were captured indicating lake trout were still moving through the Thorofare.

The percentage of post spawn females reached 69% on the last day of the study (Table 28). From this we can conclude that lake trout spawning was initiated in late-October when water temperatures declined to 11.2-10°C and likely ended early to mid-November based on an average spawning duration for lake trout of 2-3 weeks (MacLean et al. 1981).

Trap nets were removed on October 22 when water levels reached low-pool, eliminating access for our 28.5' (8.7 m) boat. Large boat traffic through the Thorofare is eliminated as water depth is reduced to 100-200 mm in the first 100 m above Priest Lake at the completion of draw-down.

DISCUSSION

Lake Trout Removal

In 2010 we captured and removed 2,551 lake trout from Upper Priest Lake and using a Leslie Depletion Model estimated the lake trout population abundance to be 3,346 fish at the start of our removal effort. The past four years of lake trout removal has demonstrated that we are effective at removing a significant portion of the lake trout population in a very short amount of time, but that Upper Priest Lake is being re-populated annually by mature fish from Priest Lake, as well as juvenile fish recruiting to the population from within Upper Priest Lake.

In 2010 we captured and removed more lake trout than any other year, however, we believe this is a function of gill net mesh size. Mean length of lake trout removed from Upper

Priest Lake in 2007 was 421 mm TL (Figure 23) and has decrease each year. Mean length of lake trout removed in 2010 was 310 mm TL. In 2010 we included 50 mm (2 inch) mesh whereas in previous years our smallest mesh size was 64 mm. Of the 2,551 lake trout captured in 2010, 45% (1,145) were captured in 50 mm mesh (Table 29). The length frequency histogram in Figure 23 illustrates the increased catch of juvenile lake trout in 2010 compared to 2007. It should also be noted that this small mesh accounted for only 17% of our netting effort. When all fish captured in 50 mm mesh are excluded, the length frequency histogram in Figure 24 illustrates a notable shift in lake trout size structure and mean length since 2007. This is indicative of a population being heavily exploited.

A total of 22 bull trout were captured in 2010 compared to 22 in 2009, 13 in 2008 and 7 in 2007. Bull trout ranged from 230-590 mm. The 230 mm bull trout is among the smallest collected in recent years. Seven of the bull trout collected (32%) in 2010 were ≤ 305 mm. The fact that we continue to see a reduction in adult lake trout numbers and increases in juvenile bull trout numbers suggests that we are improving bull trout recruitment in Upper Priest Lake. Additionally, bull trout redd counts in the Upper Priest Lake drainage were up in 2010 for the third year in a row and the highest recorded since 1999 (Table 30).

Thorofare Netting Evaluation

Results of this study indicate the Thorofare is a passage corridor for lake trout as well as westslope cutthroat, bull trout, mountain whitefish, and other species. These results are consistent with other studies suggesting extensive fish movement between the lakes, especially in the fall (Fredericks 1999; Fredericks and Vernard 2001). A total blocking of fish movement between the lakes could be detrimental to native fish, and any migration barrier will have to be evaluated relative to negative impacts to species other than lake trout.

Over the past few years IDFG has researched the use of strobe lights and an electric weir as a means of minimizing immigration by lake trout to Upper Priest Lake. Effectiveness, financial constraints, and social implications make either of these options unrealistic. In addition to initial costs, as well as maintenance and operating costs, variable flows, floating debris, and limited access for maintenance are factors needing consideration when discussing potential fish barriers. Additionally, any structure inhibiting boat passage would conflict with the popular use of the Thorofare by boaters.

The use of commercial fishermen with decades of experience netting lake trout, operating and constructing specialized boats, and building custom nets was vital to the success of the project. Though initial net configurations during the 2009 experimentation were to some extent ineffective, the commercial fishermen contracted for the project were able to adjust the trap nets and placement to where they were virtually impassable by lake trout. Key adjustments in 2010 included using scuba divers to insure the net had no gaps between the substrate and the lead line, using larger throats on the trap net, and construction of a boat passage slot that used a "bib" to discourage lake trout from passing through.

A seasonal, passive fish barrier, such as large trap nets, may prove to be an effective means of minimizing lake trout immigration through the Thorofare. Fredericks and Vernard (2001) reported lake trout movement through the Thorofare is greatest during October and November, coinciding with the timing of spawning. Trap nets set at either end of the Thorofare from September through mid- November could significantly reduce movement of lake trout while not barring native fish migrations. It's our observation that boat traffic is greatly reduced during the fall months, and this project demonstrated that trap nets could be effectively used to block fall migrations of lake trout through a low gradient river channel, while with proper signage, still provide passage for watercraft.

IDFG is currently working with the Idaho Water Resource Board to modify the Outlet Structure Operation guidelines specified in the Priest River Basin Plan Amendment to delay the drawdown of Priest Lake to late-November, 2011. Delaying the drawdown will allow us access to the Thorofare and the ability to continue netting until mid November or through the lake trout spawning season should we secure funding to further evaluate potential netting methods to minimize lake trout movement into Upper Priest Lake from Priest Lake.

MANAGEMENT RECOMMENDATIONS

1. Continue annual netting to reduce lake trout abundance through current State Fish Management Plan period.
2. Continue to investigate methods to minimize lake trout immigration from Priest Lake to increase effectiveness of annual suppression efforts.

Table 27. Total number of fishes captured in gill nets and trap nets, total length ranges and mean lengths during Priest Lake Thorofare netting evaluation, September and October, 2010.

	Total Captured	Gillnets	Trapnets	Range TL (mm)	Mean TL (mm)
Lake trout	241	59	182	460-900	592
Bull trout	3	2	1	380-495	420
Westslope cutthroat	50	21	29	290-480	411
WSCXRBT	10	3	7	420-675	454
Rainbow trout	3	0	3	355-470	418
Brook trout	1	1	0		300
Kokanee	136	6	130	240-500	307
Mountain whitefish	23	0	23	290-310	302
Smallmouth bass	10	6	4	250-430	375
Tench	70	25	45		
Largescale sucker	242	94	148		
Longnose sucker	16	0	16		
Northern pikeminnow	73	10	63		
Brown bullhead	1	0	1		

Table 28. Total number of lake trout captured by date, water temp C° and percent of females spawned out at lower and upper sites during Priest Lake Thorofare netting evaluation 2010.

Date	Lower site	Upper site	Total captured	Water temperature (°C)	Percent females post spawn
24-Sep	13	1	14		
27-Sep	7	0	7		
28-Sep	4	0	4		
29-Sep	4	0	4		
30-Sep	3	0	3		
1-Oct	1	0	1	14.8	
4-Oct	1	0	1	14.1	
5-Oct	2	0	2	14.3	
6-Oct	6	0	6	13.7	
7-Oct	2	0	2	12.8	
8-Oct	4	0	4	12.5	
11-Oct	7	1	8	11.8	
12-Oct	20	2	22	11.3	
13-Oct	20	1	21	10.7	
14-Oct	18	2	20	10.7	
15-Oct	12	0	12	11.1	
18-Oct	33	1	34	10.1	
19-Oct	14	0	14	9.9	17
20-Oct	21	0	21	9.4	16
22-Oct	13	7	20	10.3	29
26-Oct	13	8	21		69

Table 29. Number of lake trout caught in each gill net mesh size in Upper Priest Lake, Idaho from May 23 through May 29, 2010.

Mesh size	Number caught	Mean length (mm)	Range (mm)	Percent of catch	Percent of effort
50mm (2")	1141	271	205-670	0.45	0.17
63 mm (2.5")	979	336	153-855	0.38	0.42
75 mm (3")	357	350	266-825	0.14	0.25
89 mm (3.5")	74	436	169-885	0.03	0.17

Table 30. Results from commercial lake trout removal and Upper Priest River and tributaries bull trout redds count 2007-2010.

	Lake trout			Bull trout		
	Lake trout removed	Estimated population	Mean total length (mm)	Bull trout captured	Mean total length (mm)	Upper Priest River redd counts
2007	1,982	2,307	421	7	588	7
2008	2,207	2,278	390	13	511	22
2009	1,353	1,348	388	22	408	34
2010	2,551	3,346	310	22	358	42

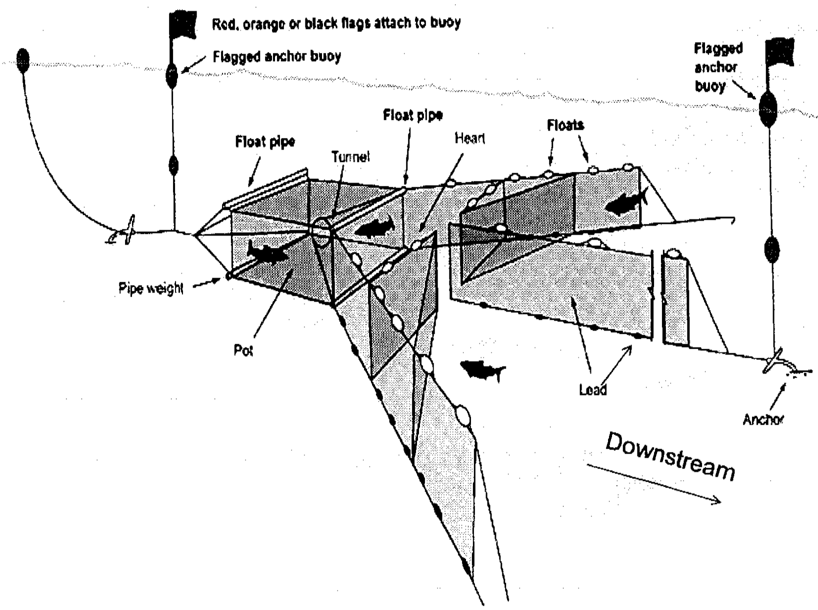

Figure 17. Illustration of a trap net used in Priest Lake Thorofare. Image redrawn from one provided by the University of Wisconsin Sea Grant Advisory Services.

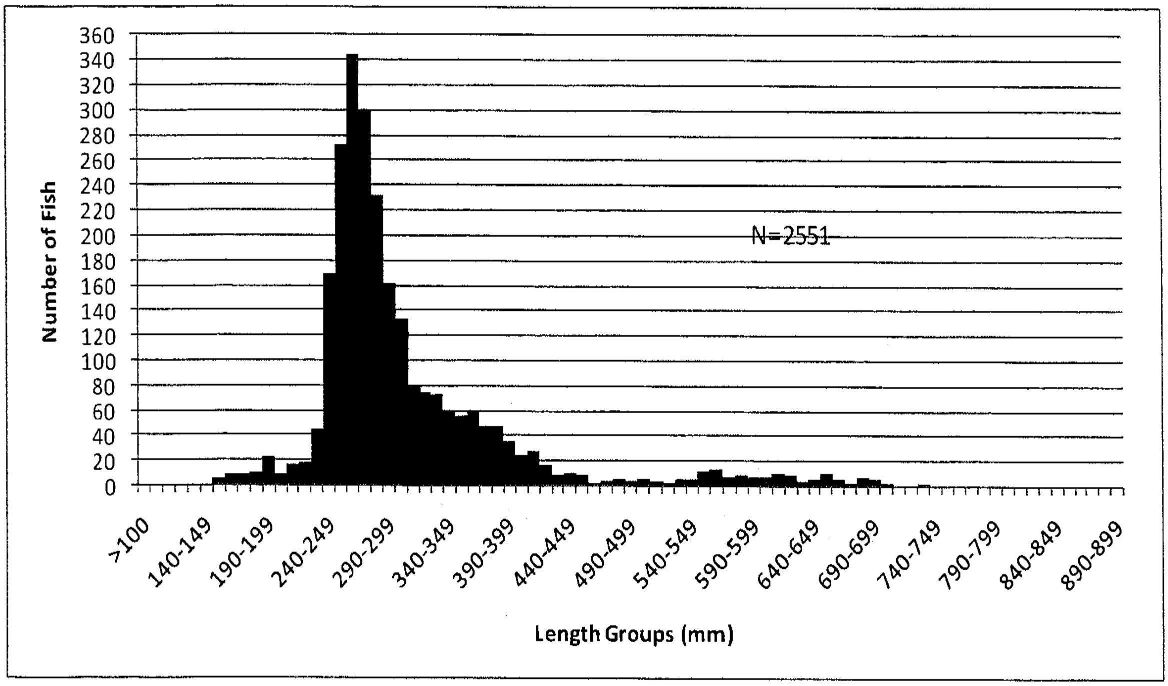

Figure 18. Length frequency of lake trout caught in gill nets in Upper Priest Lake, Idaho, from May 23 through May 29, 2010.

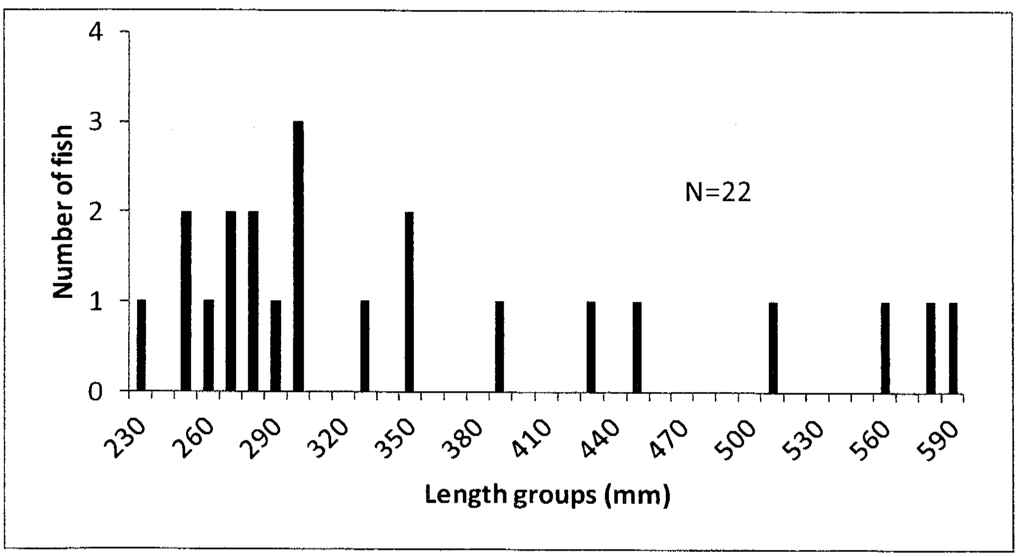

Figure 19. Length frequency of bull trout caught in gill nets in Upper Priest Lake, Idaho, from May 23 through May 29, 2010.

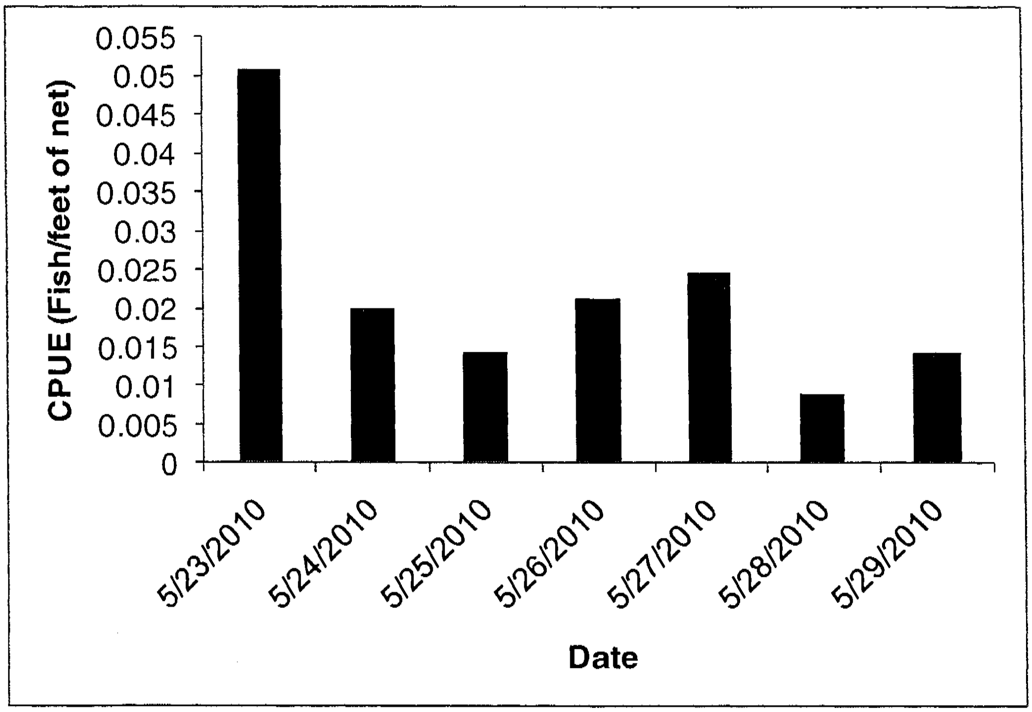

Figure 20. CPUE of lake trout caught per day over 7 days of sampling by gill nets in Upper Priest Lake, Idaho from May 23 through May 29, 2010.

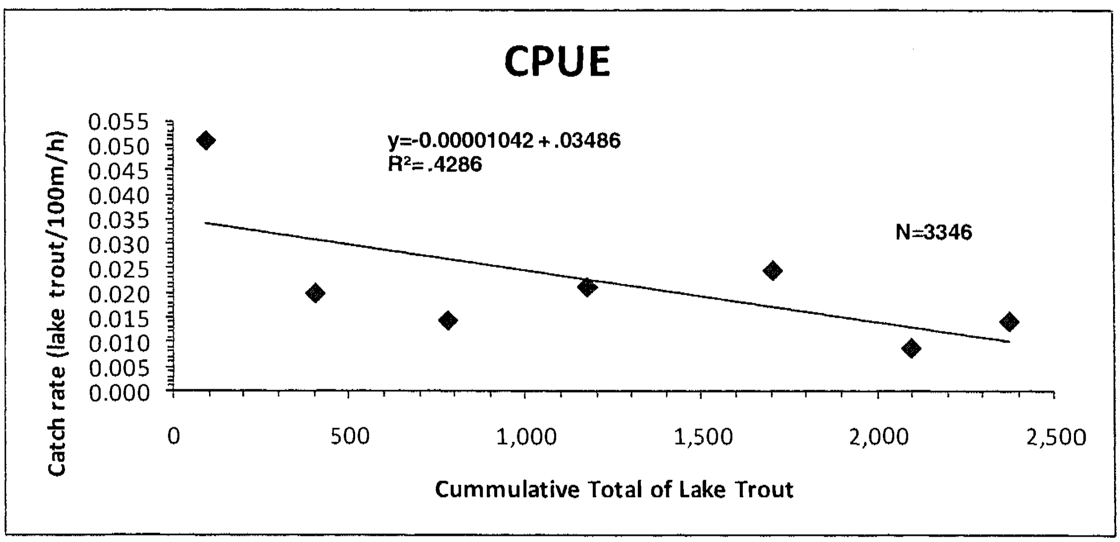

Figure 21. Leslie Depletion Model (Ricker 1975) abundance estimate for lake trout captured by gill nets in Upper Priest Lake, Idaho from May 23 through May 29, 2010.

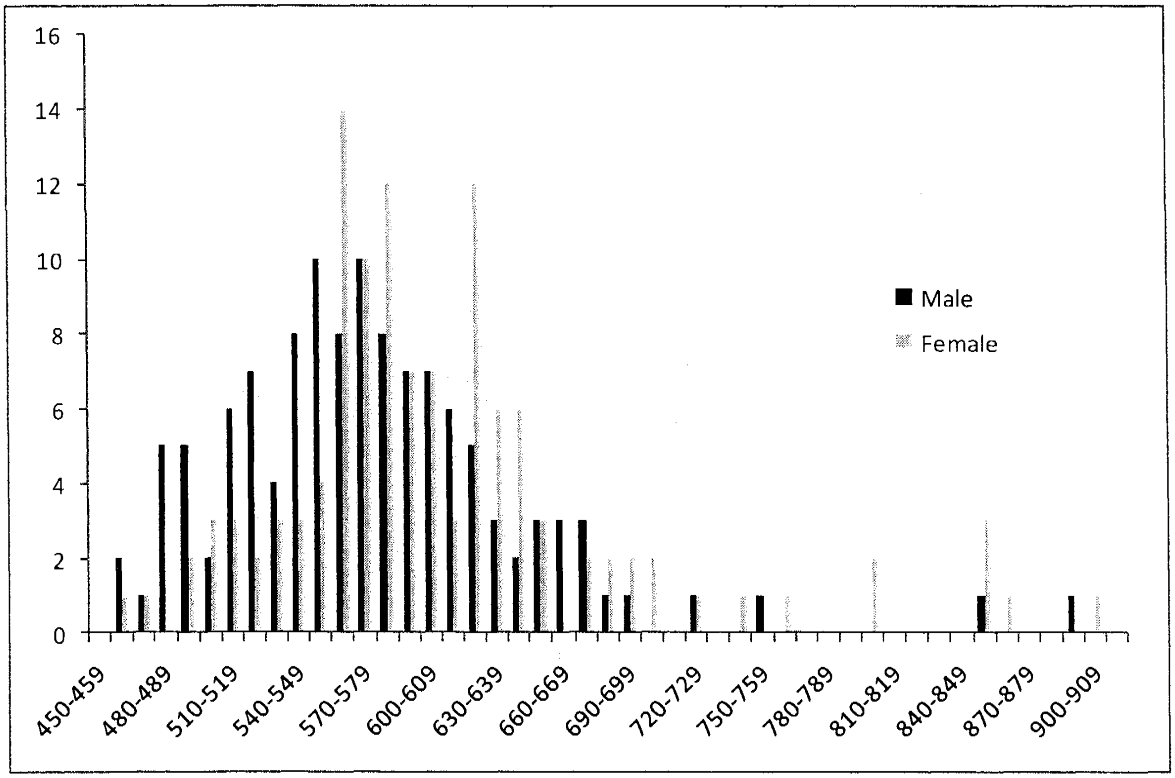

Figure 22. Length frequency of lake trout caught in trap nets and gill nets in Priest Lake Thorofare netting evaluation during September and October 2010.

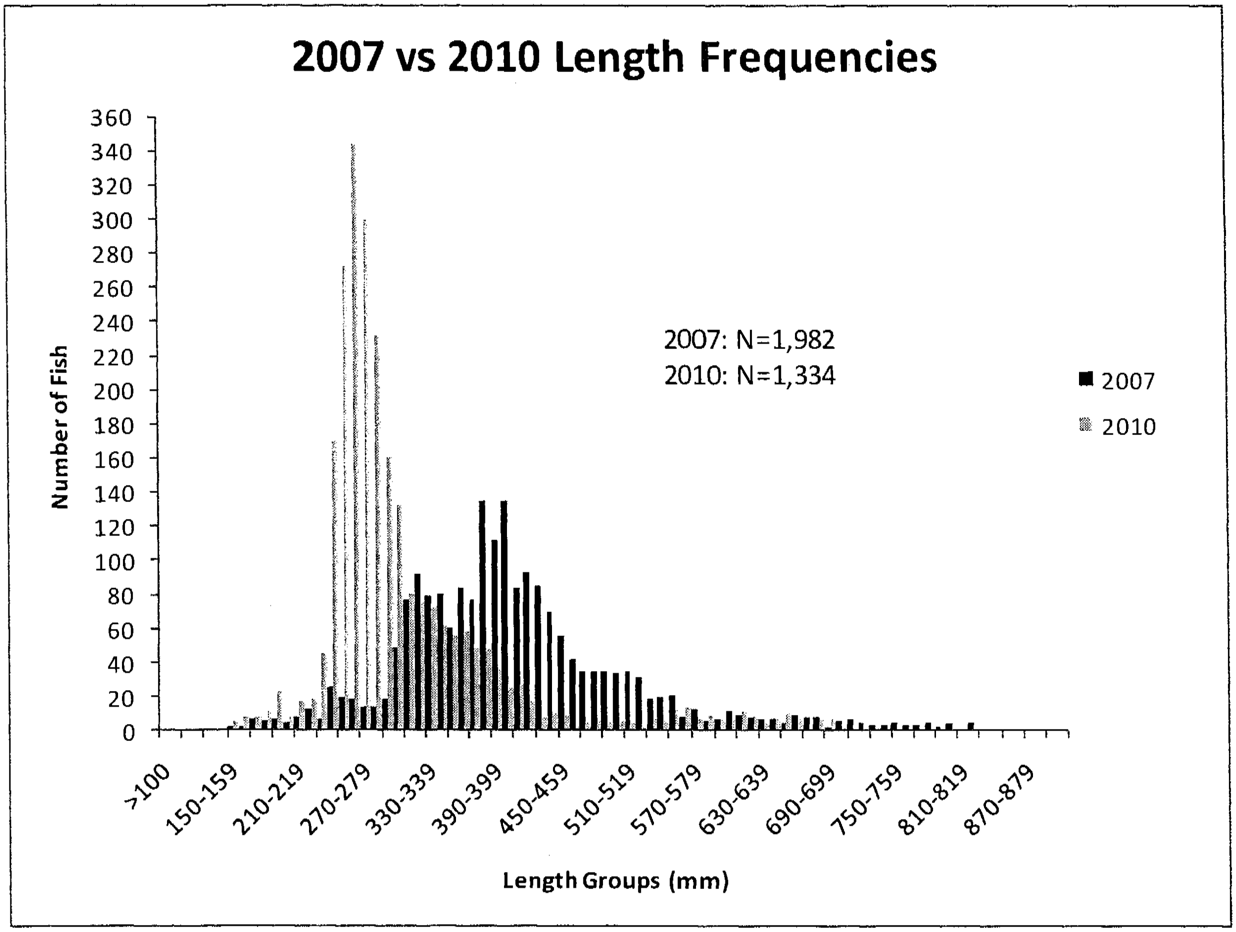

Figure 23. Length frequency of lake trout caught in gill nets in Upper Priest Lake, Idaho, May, 2010 and 2007.

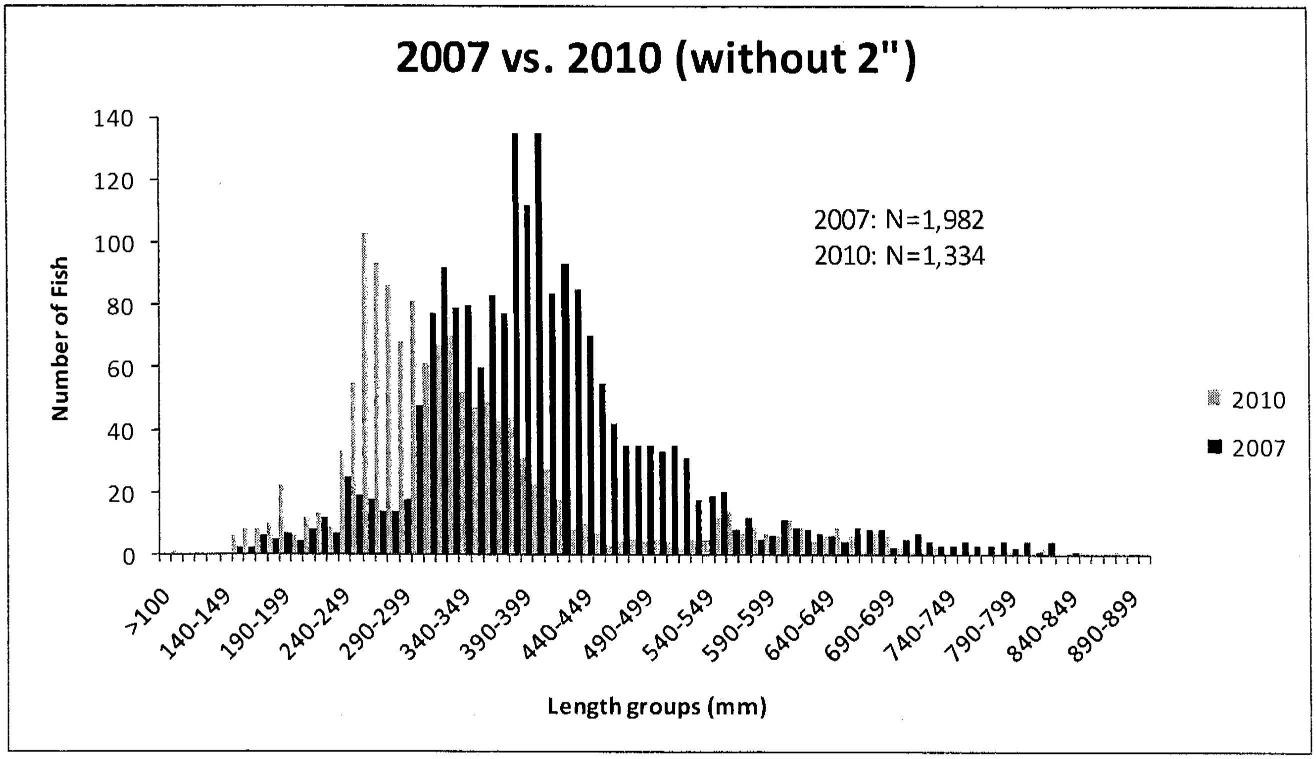

Figure 24. Length frequency of lake trout caught in gill nets in Upper Priest Lake, Idaho, in 2007, and 2010 excluding fish caught in 50 mm mesh gill net in 2010.

2010 Panhandle Region Annual Fishery Management Report

Lakes and Reservoir Investigations

PRIEST LAKE KOKANEE SPAWNER SURVEY

ABSTRACT

We counted kokanee spawners at five historic shoreline sites in Priest Lake. We counted a total of 1,835 kokanee spawners on November 3, 2010. This is down from the mean count since 2001 of 2,875 spawners.

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INTRODUCTION

A self-sustaining population of kokanee was established in Priest Lake in the early 1940's, and they soon became the most abundant game fish. Harvest of kokanee in 1956 was estimated at 100,000 fish (Bjornn 1957). Kokanee in Priest Lake are classified as "late spawners" typically using shoreline gravel rather than tributary streams and spawn from November through early January.

From the early 1950's to the early 1970's kokanee provided most of the fishing in Priest Lake with an annual harvest of 30,000-100,000 fish. The introduction of opossum shrimp in the early 1960's lead to dramatic increases in lake trout numbers and elimination of the popular kokanee fishery in the late 1970's. In 1978, only 4,500 kokanee were harvested in Priest Lake. Based on trawling estimates the population of age-3 kokanee in Priest Lake in 1987 was only 2,776 fish (Mauser and Ellis1985).

Until around 2000 the Priest Lake kokanee population had been considered all but extirpated. Around that time we began receiving reports of aggregations of spawning kokanee at several locations around the lake, indicating a depressed, but persistent population. We have been counting kokanee spawners at five historic sites since 2001, averaging 2,875 fish per year.

STUDY AREA

Priest Lake is a glacial lake located in the northwest corner of the Idaho Panhandle about 30 km south of the Canadian border (Figure 25). The lake is in the Selkirk Mountain range amid a coniferous forest watershed of 1600 km^2. Priest Lake has about 100 km of shoreline, a surface area of 9,454 ha, a mean depth of 38 m, and a maximum depth of 112 m. The lake is known for its low productivity and clear water.

OBJECTIVE

Provide a limited consumptive (some angler harvest opportunity) harvest of kokanee in Priest Lake.

METHODS

Kokanee spawner counts were conducted in fives historic spawning areas on Priest Lake on November 3, 2010. Surveys were conducted using a boat with two observers standing on the bow while a third person drove the boat contouring the shoreline at a depth of about 3 m. Each observer counted spawners and an average of the two counts was used as the estimate for each of the five sites. Our efforts were concentrated on the area between the Granite Creek delta and Copper Bay, Indian Creek campground and marina, Cavanaugh Bay Marina, Hunt Creek delta and Huckleberry Bay (Figure 25).

RESULTS

A total of 1,835 kokanee spawners were counted at five shoreline sites in Priest Lake (Table 31). Number of kokanee spawners observed at each of the five sites on Priest Lake were as follows; Copper Bay 37, Huckleberry Bay 18, Cavanaugh Bay 331, Hunt Creek beach 1,410, and Indian Creek beach 49 (Table 31). Few dead kokanee were observed and were too deep to retrieve, therefore, no mean length of spawners was obtained. Mean lengths of spawners appeared to be similar to past years.

In 2009 and 2010 the majority of Priest Lake kokanee spawned near the mouth of Hunt Creek in water as deep as six m. This is in contrast to 2001-03 when the majority of kokanee were spawning in Cavanaugh Bay and Copper Bay in water 15 cm to 0.5 m deep.

DISCUSSION

Priest Lake spawning kokanee numbers were down from 2009 when 2,637 spawners were counted and down from the 10-year average of 2,875 spawners.

In 2003, IDFG proposed an amendment to the Idaho Water Resources Board (IWRB) Priest River Basin Plan suggesting the lake level be lowered starting October 1 in order to reach the 0.0 feet (0.0 m) goal at the outlet gauge by November 1. Kokanee spawning activity in Priest Lake peaks in mid-November and lower lake levels before kokanee initiate spawning should have ensured a higher success rate for kokanee redds because the water is at its lowest level. Prior to 2002, we speculated that timing of winter draw down adversely affected spawning success and survival of beach spawned eggs and fry in redds. Since 2002 Priest Lake has been drafted to near the 0.0 goal on October 31, however, we have not seen a positive response on the kokanee population. Spawning kokanee numbers peaked in 2004 at 6,117 fish and has declined nearly every year to 1,835 in 2010 (Table 31).

IDFG is currently working with IWRB to at least temporarily suspend the 2003 amendment to the Outlet Structure Operation plan and return to a delayed drawdown in 2011. A delayed drawdown will allow us to expand our Thorofare lake trout movement study into mid-November. The current draw-down dates preclude access to the Thorofare and the ability to continue netting until mid-November or through the entire lake trout spawning season.

Despite water level manipulation and protective regulations we have not seen a positive response in kokanee numbers in Priest Lake. In 2010, we removed the "no harvest" regulation on Priest Lake kokanee and are offering anglers the opportunity to harvest kokanee after 8 years of closure. We will continue monitor kokanee spawner numbers in Priest Lake in the future.

MANAGEMENT RECOMMENDATION

1. Continue to monitor kokanee spawner numbers on Priest and Upper Priest Lakes.

Table 31. Counts of shoreline spawning kokanee salmon in Priest Lake and Upper Priest Lake, Idaho, 2001-2010.

Location	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Priest Lake										
Copper Bay	588	549	1237	1584	906	1288	308	223	400	37
Cavanaugh Bay	523	921	933	1673	916	972	463	346	550	331
Huckleberry Bay	200	49	38	359	120	43	38	0	37	18
Indian Crk Bay	222	0	0	441	58	0	40	27	15	49
Hunt Crk Mouth	232	306	624	2060	2961	842	1296	884	1635	1410
Upper Priest Lake										
West shoreline	10	---[1]	---[1]	---[1]	---[1]	---[1]	---[1]	---[1]	---[1]	
Total	**1775**	**1825**	**2832**	**6117**	**4961**	**3145**	**2145**	**1480**	**2637**	**1835**

[1] Upper Priest Lake was not included in the spawner counts due to low water in the Thorofare and no access to the lake.

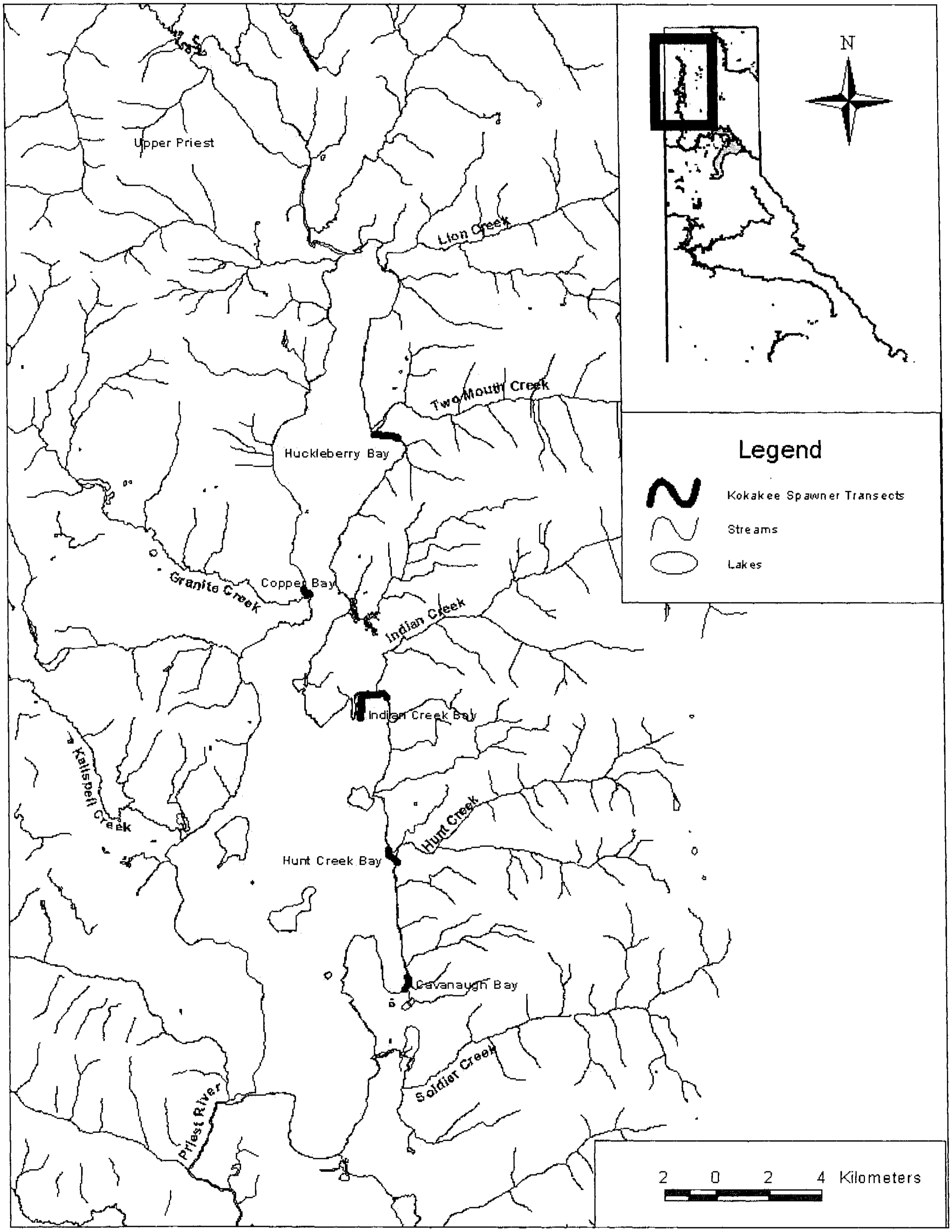

Figure 25. Location of kokanee spawner counts on Priest Lake, Idaho, 2009.

Lakes and Reservoir Investigations

PYGMY WHITEFISH INVESTIGATIONS IN UPPER PRIEST LAKE

ABSTRACT

We conducted hydroacoustic surveys and bottom trawling on Upper Priest Lake during 2009 and 2010 to investigate the size and species composition of the fish population. The two hydroacoustic surveys yielded similar mean density estimates of 376 fish/ha and 354 fish/ha in the deeper waters of the lake. Based on target strengths, the bulk of the fish were small; between 25 mm and 140 mm. Bottom trawling near the center of the lake collected 187 fish of which 91.4% were pygmy whitefish *Coregonus Coulteri*, 4.8% were lake trout, and 3.8% were slimy sculpins *Cottus cognatus*. Netted pygmy whitefish ranged from 60 mm to 140 mm in total length. Based on percent composition and the density from the hydroacoustics, we estimated the lake contained approximately 150,000 pygmy whitefish.

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INTRODUCTION

Upper Priest Lake is being managed for the conservation of native species. For the past 14 years, a vigorous netting program has been conducted to remove lake trout in an effort to recover bull trout and cutthroat trout. We conducted hydroacoustic surveys of the lake, before and after the netting in 2009 in an attempt to document the removal of lake trout. Numerous small fish were recorded during these surveys. We therefore used a bottom trawl during 2010 to determine the species of these fish. This report documents our efforts to estimate lake trout abundance with hydroacoustics and quantify the benthic fish population in waters over 10 m deep in Upper Priest Lake.

OBJECTIVES

The objective for Upper Priest Lake is to "restore native fish population" (IDFG 2007).

STUDY AREA

Upper Priest Lake is a 570 ha lake in northern Idaho, 22 km south of the Canadian boarder. The lake has no road access, but is easily reachable by boat by traveling through the Thorofare from Priest Lake. Upper Priest Lake is "bath tub" shaped in profile with a maximum depth of 31.7 m (depth measured on our surveys with a temperature-corrected depth sounder). Lake is oligotrophic with very clear water that originates in the granitic watershed of the Selkirk mountain range.

Fish species within the lake include cutthroat trout, bull trout, lake trout, pygmy whitefish *Coregonus Coulteri* (Figure 26), mountain whitefish, slimy sculpins *Cottus cognatus*, largescale suckers, and longnose suckers.

METHODS

Two hydroacoustic surveys were conducted on Upper Priest Lake, one on May 28, 2009 and one on July 1, 2009. Both surveys used the same ten transects that formed a zig-zag pattern down the length of the lake (Figure 27). Location of the transects were defined by waypoints established along the shoreline and navigated to by radar and chartplotter (Table 32). In between the two survey dates, extensive gill netting was conducted that removed 1,353 lake trout. Therefore the second survey was analyzed to note if the decline in lake trout could be quantified.

Hydroacoustic surveys used the same format as the one on Spirit Lake in 2009 (Fredericks et al. in press). A Simrad split beam echosounder with a 6.5° cone was used in a downscanning orientation at a ping rate of 0.3 to 0.4 s/ping. Surveys were conducted only at night. Boat speed while sampling was 5 km/h. Since our initial interest was to attempt to estimate lake trout abundance, we analyzed the depths of the lake below 10 m on transects 1, 2, 3, 10 and 11, and below 20 m on all other transects. We measured a contour map of the lake with a compensating polar planimeter to calculate that Upper Priest Lake contained about 433 ha of habitat over 10 m deep.

Statistics used on this lake were similar to those used on our kokanee populations. Mean densities were based on the arithmetic mean. Confidence intervals were calculated based on a log (x+1) transformation and placed around the arithmetic mean (Elliott 1983).

We conducted bottom trawling on Upper Priest Lake to determine fish species composition. Trawling was conducted at night on June 23, 2010. Mouth of the trawl was 2.5 m wide by 56 cm high with the net being 6.5 m long. The net had a bar mesh of 2.5 cm in the front section with a 2 mm woven stretched mesh in the cod end. Three trawls were made parallel to the long axis of the lake and parallel to each other. Trawls started at a water depth of 30 m and the net was towed using 152 m of cable at 4.5 km/h for 15 to 25 min. Netted fish were placed on ice until the next morning and measured to length. Later, otoliths from a sample of fish were removed, embedded in epoxy, sectioned, polished, and later aged.

RESULTS

Both hydroacoustic surveys showed rather high densities of small fish in the deeper waters of Upper Priest Lake (Figure 28). Fish densities ranged from 28 to 1,216 fish/ha on the various transects (Table 33). On both surveys the highest densities were found on transects 2 and 3 at the northern end of the lake. Mean density was 376 fish/ha (90% CI, -46% to +83%) on May 28, 2009 survey, and 354 fish/ha (90% CI, -24% to +30%) on the July 1, 2009 survey. Densities of fish over -36 dB, or 285 mm (Love 1971), were 0.72 fish/ha on the May survey and 0.76 fish/ha on the July survey (Table 33).

Fish in both hydroacoustic surveys were predominantly small. Average total length was 69 mm on the May survey and 70 mm (Love 1971) on the July survey. Target strength-frequency distribution on both surveys showed multiple peaks indicating several different year classes may be present (Figure 29).

One hundred eighty-seven fish were collected in the three bottom trawls; 91% pygmy whitefish, 5% lake trout, and 4% slimy sculpin. Since slimy sculpin would likely lie directly on the lake bottom, they would not be seen in our hydroacoustic surveys. We therefore calculated that deep targets were likely 95% pygmy whitefish and 5% lake trout by excluding the sculpin. Total length of the pygmy whitefish ranged from 60 mm to 140 mm. Lake trout ranged from 90 mm to 210 mm and slimy sculpin ranged from 70 to 80 mm (3 were released alive without measurement) (Figure 30).

We calculated a population estimate of pygmy whitefish by expanding the density estimates. First we calculated Upper Priest Lake contained about 433 ha of habitat over 10 m deep by measuring a contour map of the lake with a compensating polar planimeter. We then calculated the lake contained 155,000 pygmy whitefish by multiplying the May density of 376 fish/ha, times 433 ha of area, times the 95% species composition of pygmy whitefish. A similar estimate of 146,000 pygmy whitefish was calculated using the July density estimate.

Ages of the pygmy whitefish ranged from 2 to 6 years old (Figure 31).

DISCUSSION

This study showed that Upper Priest Lake held a strong population of about 150,000 pygmy whitefish. It was interesting that their population appeared to be doing well even though lake trout colonized the lake in the 1980's. Despite their small size, pygmy whitefish seemed to have some method of avoiding lake trout predation, although the mechanism is unclear. In Flathead Lake, Montana, pygmy whitefish were the third most preyed upon species by lake trout after lake whitefish and yellow perch (Beauchamp et al. 2006).

The two hydroacoustic surveys failed to show the decline in fish abundance that occurred with the gill netting and removal of 1,353 lake trout. In fact the two surveys were surprising similar, both for all fish, and for only fish over 285 mm (Table 33). We suspect that lake trout were so close to the bottom of the lake that they were missed in the survey. Although these methods failed to quantify lake trout abundance, they did provide some new information on the abundance of pygmy whitefish.

Growth rate of pygmy whitefish was slow, relative to other sportfish, with fish taking 6 years to reach 140 mm (Figure 31). However, in Lake Superior two pygmy whitefish of 8 years of age were 140 mm long (Eschmeyer and Bailey 1955), so growth rate maybe typical for pygmy whitefish.

A limitation of this study was that we assumed lake trout and pygmy whitefish were equally vulnerable to the bottom trawl when we calculated species composition. A second limitation was that this population estimate of pygmy whitefish only includes fish far enough off of the bottom to be detected by the echosounder. This estimate therefore may be considered a minimum estimate.

MANAGEMENT RECOMMENDATIONS

1. Repeat this survey at 5 year intervals to monitor the health of the pygmy whitefish population in Upper Priest Lake.
2. A similar approach is recommended for assessing the pygmy whitefish populations in Spirit Lake, Priest Lake and the bays and outflow arm of Lake Pend Oreille.

Table 32. Waypoints on Upper Priest Lake used during the 2009 hydroacoustic surveys.

Transect number	Starting location	Ending location
1	48° 48.032' N	48° 47.690 N
	116° 54.224 W	116° 54.542 W
2	48° 47.690 N	48° 47.808 N
	116° 54.542 W	116° 593.915 W
3	48° 47.808 N	48° 47.288 N
	116° 593.915 W	116° 54.244 W
4	48° 47.288 N	48° 47.537 N
	116° 54.244 W	116° 53.294 W
5	48° 47.537 N	48° 46.922 N
	116° 53.294 W	116° 53.778 W
6	48° 46.922 N	48° 47.192 N
	116° 53.778 W	116° 52.738 W
7	48° 47.192 N	48° 46.535 N
	116° 52.738 W	116° 53.359 W
8	48° 46.535 N	48° 46.726 N
	116° 53.359 W	116° 52.531 W
9	48° 46.726 N	48° 46.217 N
	116° 52.531 W	116° 52.917 W
10	48° 46.217 N	48° 46.442 N
	116° 52.917 W	116° 52.025 W
11	48° 46.442 N	48° 45.991 N
	116° 52.025 W	116° 52.283 W

Table 33. Densities and sizes of fish seen below 20 m during two hydroacoustic surveys on Upper Priest Lake during 2009. A total of 1,353 lake trout were removed between the two survey dates.

	May 28, 2009			July 1, 2009		
Transect number	Total Density (fish/ha)	Mean Size (mm)	Density Fish >285 mm (fish/ha)	Total Density (fish/ha)	Mean Size (mm)	Density Fish >285 mm (fish/ha)
1	90	55	0.00	458	53	0.00
2	1216	59	3.30	527	60	0.00
3	950	61	0.00	626	64	1.16
4	442	81	0.00	436	73	0.00
5	366	88	0.99	281	74	0.54
6	176	97	2.07	247	83	0.00
7	146	85	0.90	243	92	2.04
8	261	78	0.60	309	77	0.00
9	179	66	0.00	206	90	3.86
10	286	45	0.00	440	57	0.00
11	28	47	0.00	118	42	0.00
Mean	376	69	0.72	354	70	0.76

Figure 26. Photograph of a pygmy whitefish collected from Upper Priest Lake in 2010.

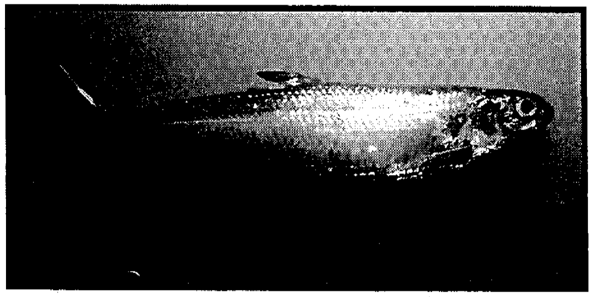


Figure 27. Map of Upper Priest Lake showing location of hydroacoustic transects (dotted lines) and trawl locations (solid lines).

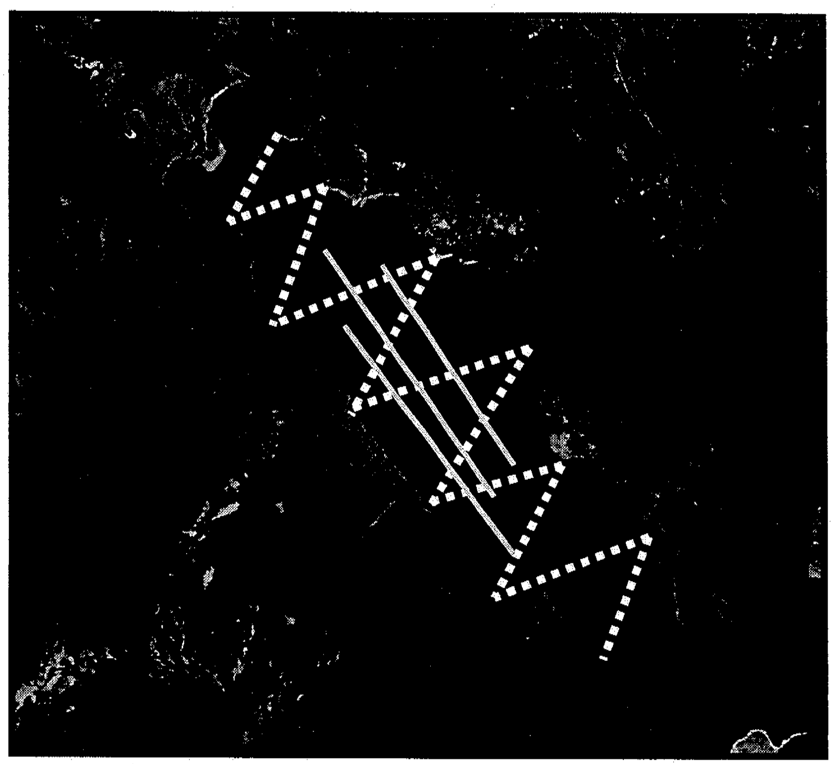
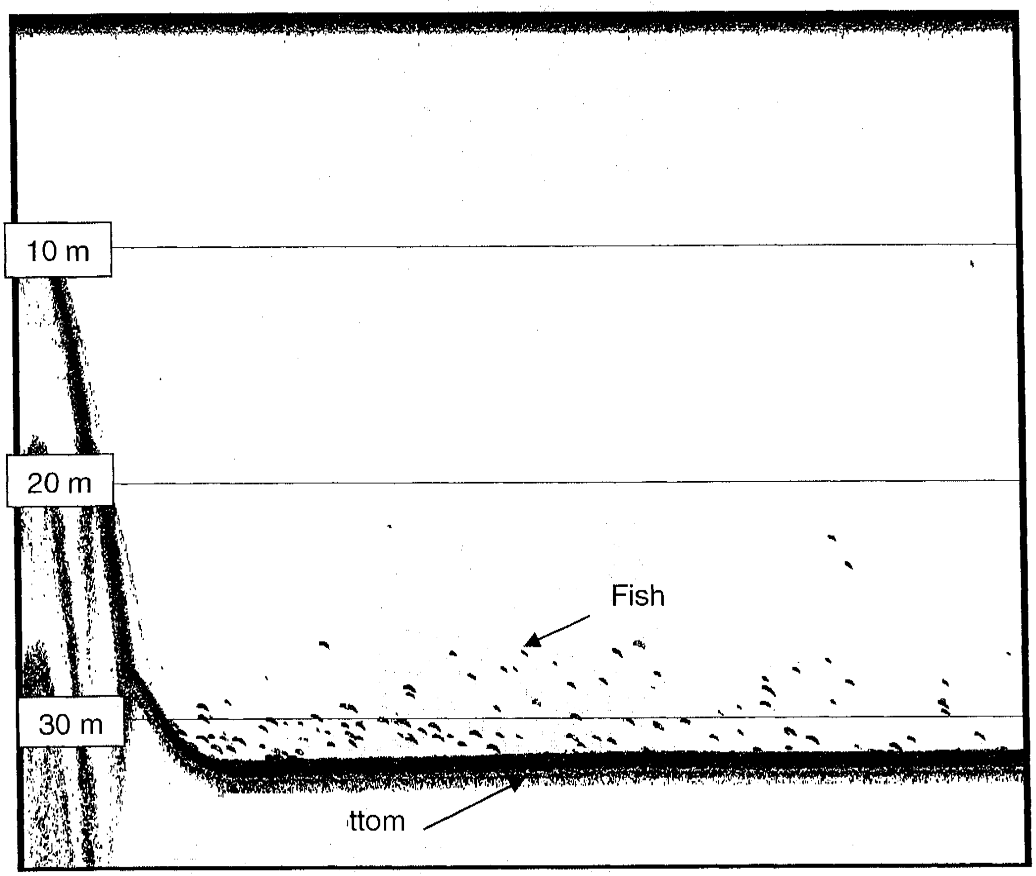


Figure 28. Section of an echogram of Upper Priest Lake during the July 1, 2009 survey. Note the presence of numerous small fish near the lake's bottom at depths below 20 m.



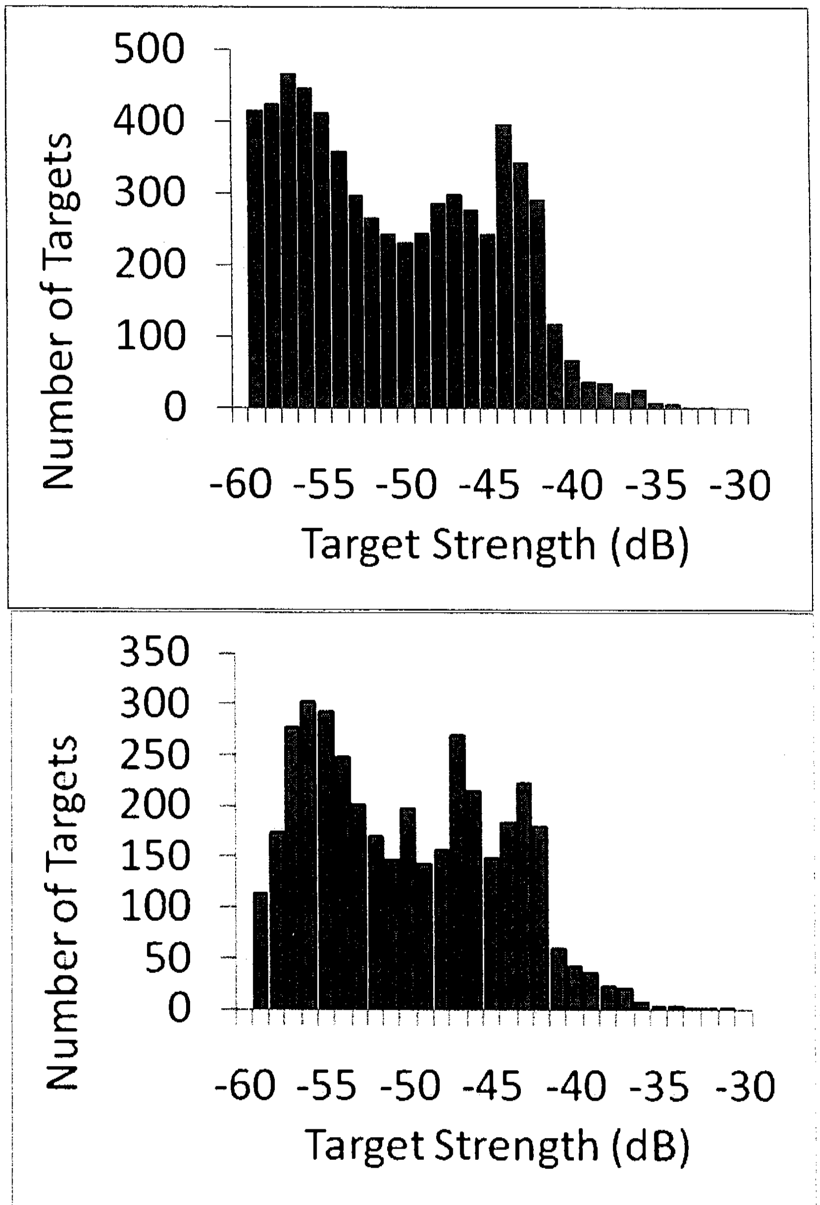
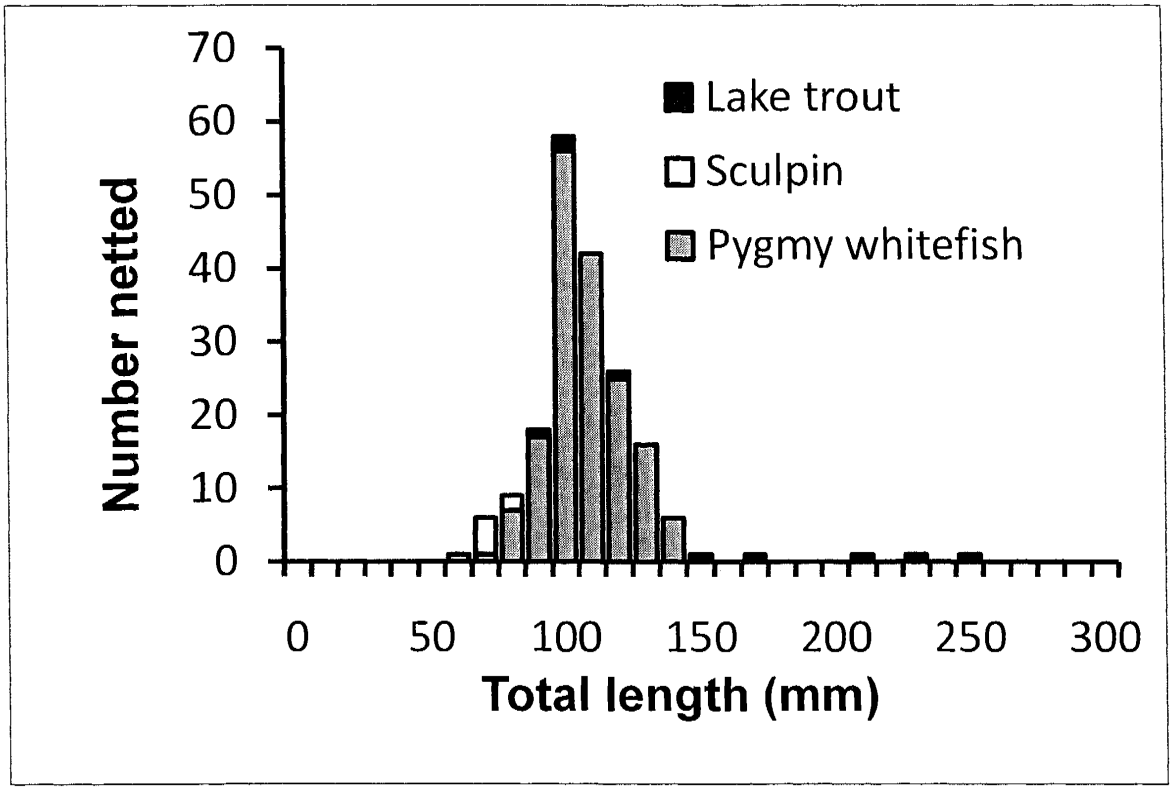


Figure 29. Target strengths of fish seen below 10 m in Upper Priest Lake on two surveys conducted in 2009. Top figure is the May 28, 2009 survey. Lower figure is the July 1, 2009 survey.

Figure 30. Length frequency distribution of fish collected in bottom trawls in Upper Priest Lake in 2010.



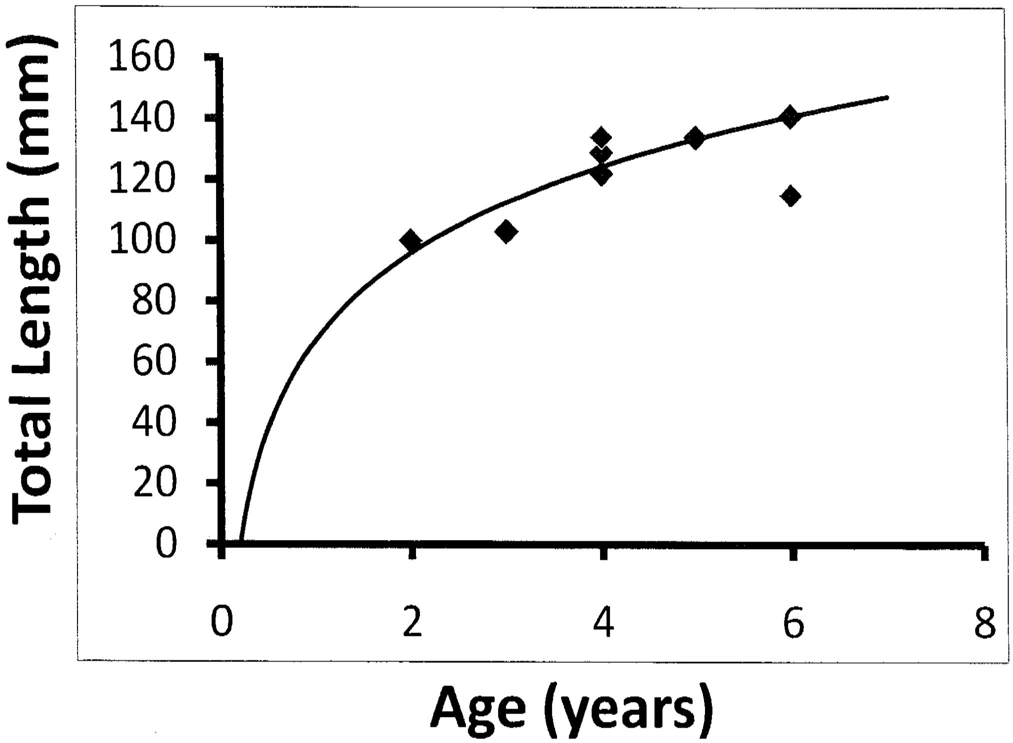


Figure 31. Ages and lengths of pygmy whitefish in Upper Priest Lake, Idaho. Fish were collected by bottom trawling on June 23, 2010.

Lakes and Reservoir Investigations

ZOOPLANKTON RATIO AND STOCKING RATE ANALYSIS IN LOWLAND LAKES

ABSTRACT

Zooplankton density in the 14 lakes sampled ranged from 0.60 g/m in Jewel Lake to 4.33 g/m in Cocollala Lake. Zooplankton Productivity Ratio (ZPR) ranged from 0.24 in Cocollala Lake to 1.37 in Upper Twin Lake. Zooplankton Quality Index (ZQI) ranged from 0.21 in Jewel Lake to 1.37 in Kelso Lake. Current fish stocking densities for 11 out of the 14 lakes sampled were within or approximately 25% +/- of literary suggested stocking range. Two lakes Smith and Fernan lakes were between 65 and 75% under the stocking range, while Upper Twin Lake was approximately 75% above the suggested stocking range.

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INTRODUCTION

The survival of trout fingerling stocked at different times of the year is significantly related to the presence of larger zooplankton present in the water column (Dillon 1996). Due in part to the expense of zooplankton sampling and identification, basic fisheries monitoring have often failed to include these data as part of their stocking program. In an effort to incorporate a broad survey of zooplankton densities and compare our stocking rates with criteria developed by Teuscher (1999) we sampled 14 lakes which are routinely stocked with catchable and/or fingerling trout.

OBJECTIVES

1. Evaluate zooplankton densities as it relates to current fish stocking densities in routinely stocked waters of North Idaho.

METHODS

Zooplankton was collected using three mesh size nets: 153, 500, and 750um. A single sample with each size net was taken from a maximum of 10 m depth at each waterbody. The samples were then preserved in denatured ethyl alcohol at a concentration of 1:1 (sample volume:alcohol). After approximately ten days in alcohol, phytoplankton was removed from the samples and each sample was blotted dry and weighed to the nearest g (wet weight). Samples were taken in July from 14 lakes in the Panhandle Region.

We analyzed the data using the zooplankton productivity ratio method (ZPR) as defined as the ratio of preferred to usable zooplankton (zooplankton sampled by the 750:500um). In addition, to account for the overall abundance of zooplankton in the sample we utilized the zooplankton quality index (ZQI) calculation developed by Teuscher (1999), where ZQI = ((500 +750um)ZPR)/ depth of tow.

Teuscher (1999) identified general stocking criteria in association with ZQI. These stocking criteria are as follows: Stock less than 75 fingerlings/0.4 ha or catchables in waters with ZQI of ≤ 0.1, stock 75-100 fingerlings/0.4 ha in waters with ZQI of 0.1 – 1.0, and stock 150-300/ fingerlings/0.4 ha with ZQI ≥ 1.0.

RESULTS

Zooplankton density in the 14 lakes sampled ranged from 0.60 g/m in Jewel Lake to 4.33 g/m in Cocollala Lake (Table 34). ZPR ranged from 0.24 in Cocollala Lake to 1.37 in Upper Twin Lake. ZQI ranged from 0.21 in Jewel Lake to 1.37 in Kelso Lake.

In relation to ZQI, all of the lakes stocked with either fingerling trout or kokanee fell within a suggested stocking density of 75-100 fish/0.4 ha (Teuscher 1999). Current stocking densities for 11 out of the 14 lakes sampled were within or approximately 25% +/- this suggested stocking range. Two lakes Smith and Fernan lakes were between 65 and 75% under the stocking range, while Upper Twin Lake was approximately 75% above the suggested stocking range. Bonner Lake (not currently stocked) ranked third highest in ZQI (0.85) of the lakes investigated.

DISCUSSION

Our cursory overview of zooplankton densities using the ZQI method developed by Teuscher (1999) shows that most of our lakes are well within the bounds of having adequate zooplankton densities. According to this measure, lakes such as Fernan and Smith lakes may be able to support increases in fingerling densities in the future.

Several lakes that were sampled are currently being stocked with catchables rather than fingerlings. Although zooplankton levels are good, certain limnological characteristics such as depth and area lend them to be managed as such. With respect to ZQI, this lake seems to have the densities of quality size zooplankton to support fingerling stocking between 75-100 fish/ha.

ZQI allows us a very general look at the relative density of quality zooplankton in our lakes with respect to current stocking densities. Caution should be taken, however, in making large-scale management decisions based on these data since they do not take into account natural production of fish already present the particular waterbody. Although variable based on year-class abundance, cropping from fish naturally produced would inevitably affect the density of quality zooplankton available for stocked trout and kokanee fingerlings.

MANAGEMENT RECOMMENDATION

1. Maintain current stocking rates of trout in North Idaho lakes investigated.

Table 34. Zooplankton density, ZQI, ZPR, and stocking density by species for 14 lakes sampled in the Idaho Panhandle in July, 2011.

						Fingerling Species Stocked				Catchables Stocked	Current Fingerling	ZQI Suggested Fingerling
Waterbody	Density g/m	ZQI	ZPR	Calc Acres	Hectares	WCT	ES Kokanee	Kamloops	Total	Kamloops	Stocking Density	Stocking Density
Jewel Lake	0.60	0.21	0.91	32	13				–	6,000	0	75-100
Mirror Lake	0.62	0.26	1.00	91	36		5,000		5,000	6,000	55	75-100
Hayden Lake	0.66	0.28	0.93	3,858	1,543	100,000		270,000	370,000	-	96	75-100
Spirit Lake	0.88	0.30	0.83	1,549	620	25,000	200,000 *		225,000	-	145	75-100
Smith Lake	1.49	0.39	0.59	27	11	750			750	6,000	28	75-100
Lower Twin Lake	1.98	0.43	0.44	390	156	8,500	60,000		68,500	9,000	176	75-100
Fernan Lake	1.35	0.48	0.68	365	146	7,500			7,500	20,000	21	75-100
Cocollala Lake	4.33	0.48	0.24	815	326	20,000		25,000	45,000	-	55	75-100
Hauser Lake	3.04	0.56	0.34	601	240	15,000	60,000		75,000	19,000	125	75-100
Robinson Lake	2.37	0.59	0.48	55	22				–	8,000	0	75-100
Upper Twin Lake	1.23	0.75	1.37	526	210				–	2,000	0	75-100
Round Lake	2.64	1.26	0.85	43	17				–	8,000	0	150-300
Kelso Lake	2.88	1.35	0.72	55	22				–	10,000	0	150-300
Bonner	1.41	0.85	0.98	241	96				–	-	0	75-100

2010 Panhandle Region Annual Fishery Management Report

Lakes and Reservoir Investigations

LATERAL LAKES BASS INVESTIGATIONS

ABSTRACT

We surveyed largemouth and smallmouth bass populations in Blue, Black, and Swan lakes to estimate fish density and angler exploitation. We collected 664 largemouth bass and 150 smallmouth bass in Blue, Black, and Swan lakes in May, 2010. We marked all bass and conducted a mark-recapture study ten days later to determine population size. We Floy tagged 324 bass to determine angler exploitation. The population of largemouth bass (all size classes) was 655 in Black Lake, 1,017 in Blue Lake and 1,306 in Swan Lake. Population estimates for largemouth bass ≥ 305mm were 481 in Swan Lake, 497 in Black Lake and 859 in Blue Lake. We estimated the population of smallmouth bass (all size classes) in Black Lake to be approximately 720. PSD for largemouth bass were high at 71 in Swan Lake, 79 in Black Lake and 85 in Blue Lake. Calculated RSD-16 was 19 in Blue Lake, 23 in Black Lake and 25 in Swan Lake. Density of largemouth bass was 1.6 fish/ha in Swan Lake, 3.3 fish/ha in Black Lake and 6.1 fish/ha in Blue Lake. Mean Wr were 95 in Blue Lake, 99 in Swan Lake and 100 in Black Lake. A combined length frequency of the three lakes showed sizes ranged from 66 mm to 560 mm, PSD was 80, and RSD-16 was 22. Exploitation was low and ranged from no harvest in Blue and Swan lakes to 8.2 % in Black Lake. Total annual mortality was 26 in Swan Lake, 33 in Black Lake and 37 in Blue Lake. Total annual mortality was similar to what was reported for Cave (31), Medicine (25), and Killarney (14) lakes in 1998, and lower than what was reported in 1981 and 1982 for Thompson (56), Medicine (71), Blue (44) and Swan (49) Lakes. This is evidence that our relatively liberal bag limits on largemouth bass currently have minimal impact on lateral lakes' largemouth bass populations.

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INTRODUCTION

The eight lateral lakes or "chain lakes" are adjacent to and connected to Coeur d'Alene Lake via the Coeur d'Alene River. They are well known for their largemouth bass fisheries, which take advantage of the warm and relatively shallow waters. Two lakes (Blue and Anderson lakes) had quality bass regulations implemented in the mid-1980s to provide higher quality fisheries. The lateral lakes and their largemouth bass populations have been the focus of several studies (Bowles 1985; Rieman 1987; Fredericks et al. 2002; Hardy et al. 2010), which have evaluated exploitation, annual mortality, and size structure. To assess impacts of increased tournament fishing, changing demographics of bass fisherman, and the elimination of the minimum size restriction on largemouth bass in 2008, we evaluated the largemouth bass fishery in Blue, Black, and Swan lakes in 2010.

OBJECTIVES

1. Evaluate size structure, density, survival, and total population size of largemouth bass populations in Blue, Black, and Swan lakes and compare with past studies.

2. Estimate exploitation of largemouth bass in these lakes and compare with past studies.

STUDY SITES

The lateral lakes are a series of eight low-lying, shallow lakes approximately 24 km southeast of Coeur d'Alene, Idaho (Figure 32). The lakes are connected to the Coeur d'Alene River and, like Coeur d'Alene Lake itself, are maintained at a greater depth through the summer by Post Falls Dam. Access to the lakes varies. Most have improved boat ramps, cement outhouses and camping areas, while a few are accessible only by boat. In this study, three lakes were sampled: Blue, Black and Swan lakes. Surface area of the lakes sampled ranged from 141 ha (Blue Lake) to 302 ha (Swan Lake).

METHODS

To evaluate the largemouth bass populations in the lateral lakes and compare fish density and angler exploitation with surveys from past decades, we collected largemouth and smallmouth bass in three of the eight lakes in 2010. Bass were initially collected and marked using boat electrofishing on Blue, Black, and Swan lakes from May 11th to 13th. To estimate the populations, a second "recapture" effort was conducted approximately 10 days later (May 18th - 20th). This allowed the fish to redistribute evenly throughout the lakes. All bass ≥305 mm were marked with colored Floy tags inserted below the dorsal fin. In order to get a population estimate on bass under this size class, all bass less than 305 mm received a round punch mark in the dorsal fin. Floy tags were labeled with a specific ID number and telephone reporting number for anglers to call and report information about the fish captured. IDFG operates this toll free automated hotline and website through which anglers can report tags. Additionally IDFG distributes posters and stickers to license vendors, regional offices and sporting goods outlets that publicize the tagging efforts and explain how to report tags and what the information is used for.

To estimate population size, we utilized Chapman's modification of the Petersen Method (Ricker 1975; Krebs 1999):

$$N = ([M+1]*[C+1] / [R+1]) - 1$$

Where: N = population estimate
M = number of marked fish
C = number of fish captured during the recapture sample
R = number of recapture marks in the recapture sample

Confidence intervals (95%) were calculated based on the Poisson distribution was obtained following Ricker (1975) and Seber (1982).

Due in part to procedural error, not all smallmouth bass in Black Lake received marks. Population characteristics for smallmouth bass were only estimated on Black Lake since too few were captured during sampling of Blue and Swan lakes.

Additionally, we calculated bass relative weights (Wr), which compares weights of largemouth bass found in the lateral lakes to that of a standard developed from multiple populations. Relative weight was calculated using the formula:

$$Wr = (W/Ws) \times 100,$$

where W is the actual fish weight, and Ws is a standard weight for fish of the same length. Minimum total lengths to calculate Ws were 150 mm for largemouth bass as specified by (Wege and Anderson 1978).

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 assumed a 43% reporting rate, which is typical of largemouth bass non- reward tags (Meyer et al. 2009), and adjusted the return rate accordingly to provide an exploitation estimate. Tag loss was assumed to be 13.1% based on work conducted on largemouth bass by Meyer et al (2009). The unadjusted exploitation rate was calculated according to Ricker (1975) as the number of fish with tags caught by anglers that were harvested, divided by the total number of fish tagged and released into the system.

PSD and RSD, which are numerical descriptors of length-frequency data (Anderson 1976), were calculated for bass sampled. PSD is calculated as number of fish ≥ minimum quality length/ number of fish ≥ minimum stock length. In our case, quality length (% related to world record size; Anderson 1980) was set at 305 mm and stock length (approx. size recruited to the sampling gear; Gabelhouse 1984) was set at 200 mm. RSD is calculated similarly only substituting quality length in the aforementioned equation for a specified length to be examined. In our case, we defined this length as 406 mm, since it matches up with the quality regulation on Anderson and Blue lakes. This is denoted as RSD-16. PSD for smallmouth bass was determined using 180mm for stock length and 280mm for quality length as defined by Gabelhouse (1984). RSD for smallmouth bass was determined using ≥ 305 mm as preferred length anglers would like to catch.

Aging was accomplished by scale analysis. At least ten fish from each 10 mm size group were collected for aging. Scales were impressed onto cellulose acetate slides and viewed on a microfiche reader at 42X magnification. Age composition of each population was estimated by development of age keys (Devries and Frie 1996) to proportion ages within each 50 mm length category. Total annual mortality was estimated by generating catch curves from the age frequency data and using the FAST software for each specific parameter. Growth information was determined by using the Von Bertalanffy equation through the FAST software as well.

RESULTS

We collected 664 largemouth bass and 150 smallmouth bass in Blue, Black, and Swan lakes in May, 2010. All bass were marked to determine population size and we Floy tagged 324 to determine angler exploitation. The population of largemouth bass (all size classes) was 655 in Black Lake, 1,017 in Blue Lake and 1,306 in Swan Lake (Table 35). Population estimates for largemouth bass ≥ 305 mm were 481 in Swan Lake, 497 in Black Lake and 859 in Blue Lake. We estimated the population of smallmouth bass (all size classes) in Black Lake to be approximately 720 (Table 35). Calculated PSDs for largemouth bass were high at 71 in Swan Lake, 79 in Black Lake and 85 in Blue Lake. (Table 36). Calculated RSD-16 were 19 in Blue Lake, 23 in Black Lake and 25 in Swan Lake. Density of largemouth bass was 1.6 fish/ha in Swan Lake, 3.3 fish/ha in Black Lake to 6.1 fish/ha in Blue Lake. Mean Wr of bass collected were 95 in Blue Lake, 99 in Swan Lake and 100 in Black Lake. Reflected somewhat in the PSD and RSDs, variation of length frequencies between lakes sampled is shown in Figures 33 - 35. Examining all of these lakes as one population, total lengths of all the bass sampled ranged from 66 mm to 560 mm, PSD was 80, and RSD-16 was 22 (Figure 36). Mean total length of largemouth bass in Swan Lake (306 mm) was significantly smaller than what was sampled in Blue and Black (362 and 351 respectively; $p < 0.00$).

As of December 31, 2010, 17 tags were reported by anglers, of which, 82% were released. The majority (70%) of the tags reported were captured between May and June. Exploitation for these lakes was low and ranged from no harvest in Blue and Swan lakes to 8.2 % in Black Lake (Table 2). Only 6% (n=1) of the tags returned were from non-resident anglers. Unlike 2009 lateral lake data, according to tag returns in 2010, no movements (natural or human influenced) occurred between lakes.

Comparisons of 2010 population size and PSD in Blue Lake with those made in 2009 show similar size and density estimates (Table 35). A significant increase in PSD in Blue Lake occurred since 2009 sampling (Table 36). Length frequencies of largemouth bass in 2010 were higher in proportion of fish >305 mm than was represented in the 2009 sample of Blue Lake (Figure 34).

Mortality estimates were similar in each of these lakes (Table 36). Total annual mortality was highest for largemouth bass in Blue Lake at 37% and lowest in Swan Lake at 25% (Table 36; Figure 37). The total annual mortality estimate for smallmouth bass in Black Lake was 47 and the instantaneous mortality was 0.63 (Figure 38).

Mean length-at-age for Blue, Black, and Swan lakes was comparable to region wide means reported by Dillon (1991; Table 37). We converted length-at-age information into age-at-length (Table 36) for comparison to statewide means of largemouth bass growth reported by Dillon (1991). Mean age at 300 mm for Black, Blue, and Swan lakes were 4.3, 4.5, and 4.7 years, respectively, which is comparable to the 1989-90 statewide average of 4.4 years. Mean age at 300 mm for smallmouth bass in Black Lake was 5.2 years. Age at 400 mm was 6.9, 6.9, and 7.3 respectively, slightly lower than the statewide average of 6.2 years.

Smallmouth bass mean length-at-age for Black Lake was comparable to that found in Coeur d'Alene Lake in 1997, (Fredericks et al. 2000) and the Pend Oreille River in 2010 (in this report; Table 38). Catch curve information was not reported due to a violation of the assumption of constant recruitment to the population.

DISCUSSION

The size structure of largemouth bass in the lateral lakes sampled in 2010 was well above the accepted stock density index ranges (Gabelhouse 1984) that indicate balanced populations. The density and size structure of largemouth bass in the lateral lakes have remained relatively unchanged over the past 11 years. Fredericks et al. (2002) reported similar densities in several of the lateral lakes in 1998, and showed that exploitation was also generally low at 7.5%. Similarly, based on our tagging assessment, anglers did not overharvest largemouth bass in the lateral lake system in 2010. This overall reduction in exploitation from the early 1980s is not unexpected given the increase in catch-and-release oriented anglers.

The significant increase in PSD of Blue Lake from 2009 and 2010 was primarily due to the increased catch of largemouth bass between 340 – 390 mm in length. Sampling in Blue Lake can be difficult because the relatively steep shoreline which caused the majority of bass to be too deep to uniformly sample. The appearance of this size class in the 2010 sample is evidence that these fish were probably present in 2009 but not sampled.

Total annual mortality was similar to what was reported by Fredericks in 1998 for Cave, Medicine, and Killarney lakes, and lower than what was sampled by Rieman in 1981 and 1982. Also similar to Fredericks et al. (2002) findings, total annual mortality for largemouth bass in Black, Blue, and Swan Lakes was the primary a function of natural mortality rather than fishing mortality. This is evidence that our relatively liberal bag limits on largemouth bass, currently have minimal impact on lateral lakes' largemouth bass populations.

Growth of smallmouth bass in Black Lake is comparable to what was seen in the Pend Oreille River in 2010 and consistent with a population that is not forage limited (Dillon 1992). Smallmouth bass were first seen in Coeur d'Alene Lake in 1990 (Fredericks et al. 2002). It is unclear as to the exact time when smallmouth bass became established in Black Lake, but it was presumably in the last 7-10 years since none were sampled in the chain lakes in 1998. A relatively young population could skew catch curve results in that a greater proportion of younger fish would be represented. Therefore, catch curve and other population characteristics were not generated since recruitment was not constant across all age classes sampled.

MANAGEMENT RECOMMENDATIONS

1. Maintain current bass regulations on lateral lakes.
2. Continue to monitor exploitation rates periodically in the future to determine if further protection is needed.
3. Sample smallmouth bass populations in Black Lake in the future following full recruitment to each age class.

Table 35. Population estimates for largemouth and smallmouth bass in different size groups for Blue, Black, and Swan lakes sampled in May, 2010.

Size Class	Lake	Species	M	R	C	Population estimate	Lower 95% Con. Limit	Upper 95% Con. Limit
All lengths	Blue	LMB	128	17	141	1,017	650	1,681
	Black	LMB	98	15	105	655	407	1,116
	Swan	LMB	138	9	93	1,306	722	2,613
≥ 305	Blue	LMB	115	16	125	859	541	1,433
	Black	LMB	71	11	82	497	289	934
	Swan	LMB	74	6	44	481	239	1,055
≤ 305	Blue	LMB	13	1	16	118	36	216
	Black	LMB	27	4	23	133	60	336
	Swan	LMB	64	3	49	812	332	2,031
All lengths	Black	SMB	79	2	26	719	263	1,800

Table 36. Proportional Stock Density (PSD), Relative Stock Density at 16 inches (RSD-16), Population estimates (fish ≥ 305mm), and additional population characteristics of largemouth bass in the three lakes sampled in May, 2010. Comparisons with lakes sampled in 1981, 1982, 1998, and 2009 are also given.

Sample Year	Lake	PSD	RSD-16	Population Estimate	Lower 95% Confidnece Limit	Upper 95% Confidnece Limit	Density fish/ha	Annual Exploitation	LMB Regulation	Total Annual Mortality (A)	Instantanious Mortality (Z)	Age @ 300mm	Age @ 400mm
2010	Black	79	23	497	289	934	3.3	8.2	6 fish; any size	33	0.41	4.3	6.9
	Blue	85	19	859	541	1,433	6.1	0	2 fish; none under 16"	37	0.47	4.5	6.9
	Swan	71	25	481	239	1,055	1.6	0	6 fish; any size	26	0.25	4.7	7.3
2009	Anderson	82	51	543	341	1,104	2.5	0.0	2 fish; none under 16"				
	Blue	57	22	1185	484	2,966	8.4	4.0	2 fish; none under 16"				
	Cave	79	23	898[a]	558	1,531	2.0[a]	11.7	6 fish; any size				
	Medicine	91	35					17.3	6 fish; any size				
	Killarney	76	33	424	211	930	2.1	2.6	6 fish; any size				
	Thompson	71	27	440	227	773	1.9	21.0	6 fish; any size				
1998[b]	Cave	45	4	736	224	1,248	2.6	13%	6 fish; none under 12"	31	0.37	4.3	6.7
	Medicine	56	9	490	34	946	5.3	7%	6 fish; none under 12"	25	0.29	4.5	6.9
	Killarney	89	67	538	118	958	2.6	0	6 fish; none under 12"	14	0.15	4.0	6.3
1981-82[c]	Thompson			4200[d]			21[d]	61%	10 fish; any size; only 3 > 17"	56	0.82		
	Medicine			2200[d]			23[d]	66%	10 fish; any size; only 3 > 17"	71	1.23		
	Blue								10 fish; any size; only 3 > 17"	44	0.58		
	Swan								10 fish; any size; only 3 > 17"	49	0.66		

a: Estimates were combined due to low number of recaps in Medicine.
b: Data from Fredericks et al. (2002).
c: Data from Reiman (1987).
d: Population estimates and densities were determined for fish 150mm and greater.

Table 37. Mean length-at-capture (annulus formation) of largemouth bass collected in Black, Blue, and Swan lakes, Idaho, in May 2010, as compared to regional mean (Dillon 1991).

	Length at capture (annulus formation)														
Waterbody	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
Black Lake	83	-	227	283	337	374	400	420	470	471	505	509	520	532	556
Blue Lake	-	138	206	294	327	366	402	424	453	479	503	510	526	-	-
Swan Lake	-	145	196	270	316	363	386	425	448	470	487	510	528	533	-
Region 1 mean	72	145	206	260	303	325	380	414	432	-	-	-	-	-	-

Table 38. Mean length-at-capture (annulus formation) of smallmouth bass collected in Black Lake, Idaho, in 2010, as compared to statewide mean and other regional waters.

	Length at capture (annulus formation)								
Waterbody	I	II	III	IV	V	VI	VII	VIII	IX
Black Lake (2010)	-	131	155	235	287	371	417	431	480
Pend Oreille River (2010)[a]	60	157	231	265	304	372	396	439	452
Hayden Lake (1991)[b]	77	127	181	244	291	323	339	398	421
Coeur d' Alene Lake (1997)[c]	75	131	197	238	315	350	-	-	-
Idaho mean[d]	79	147	206	257	300	333	384	-	-

a: Data from this report
b: Data from Dillon (1992).
c: Data from Fredericks et al. (2000)
d: Data from Dillon (1992)

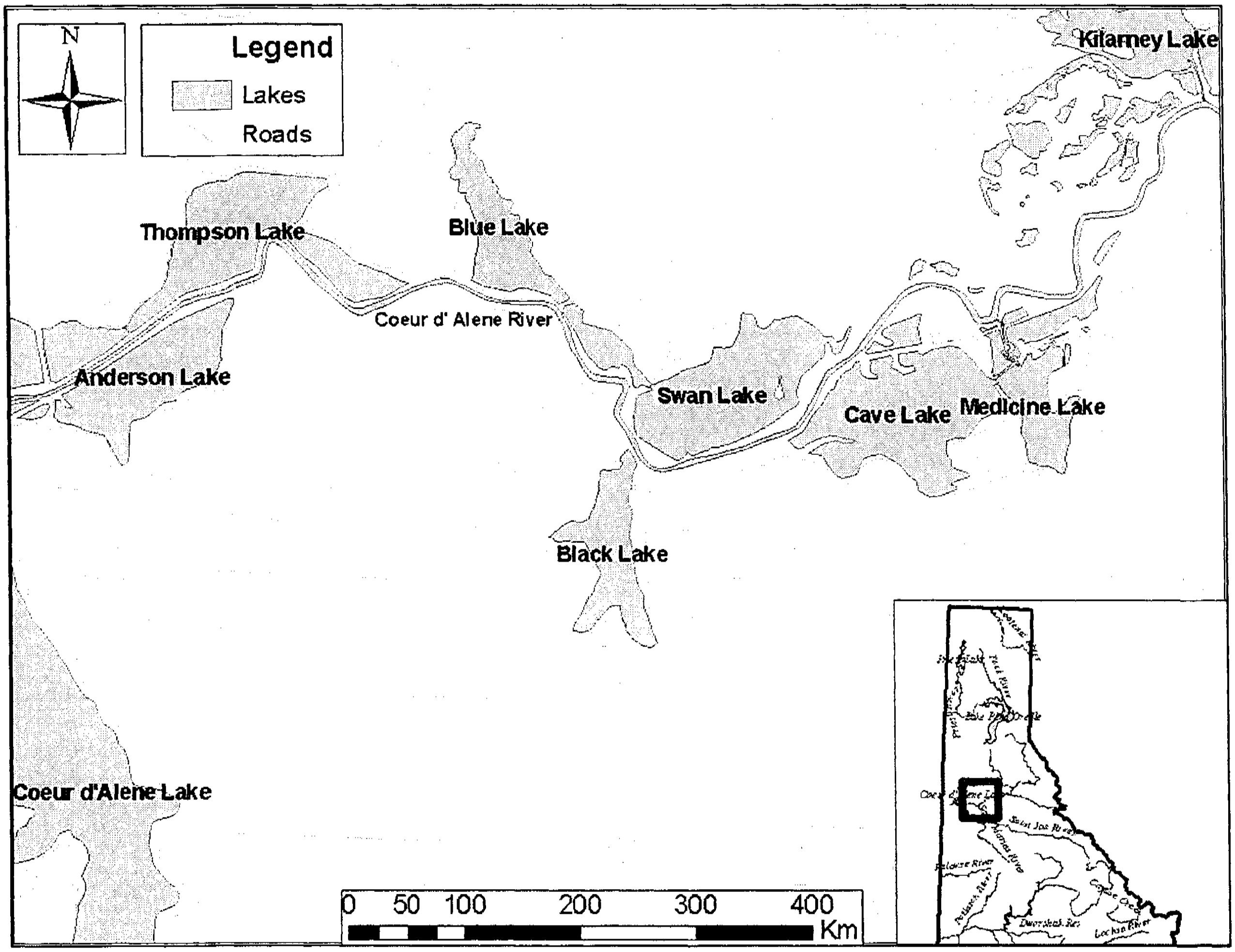

Figure 32. Locations of the lateral lakes in the Idaho Panhandle.

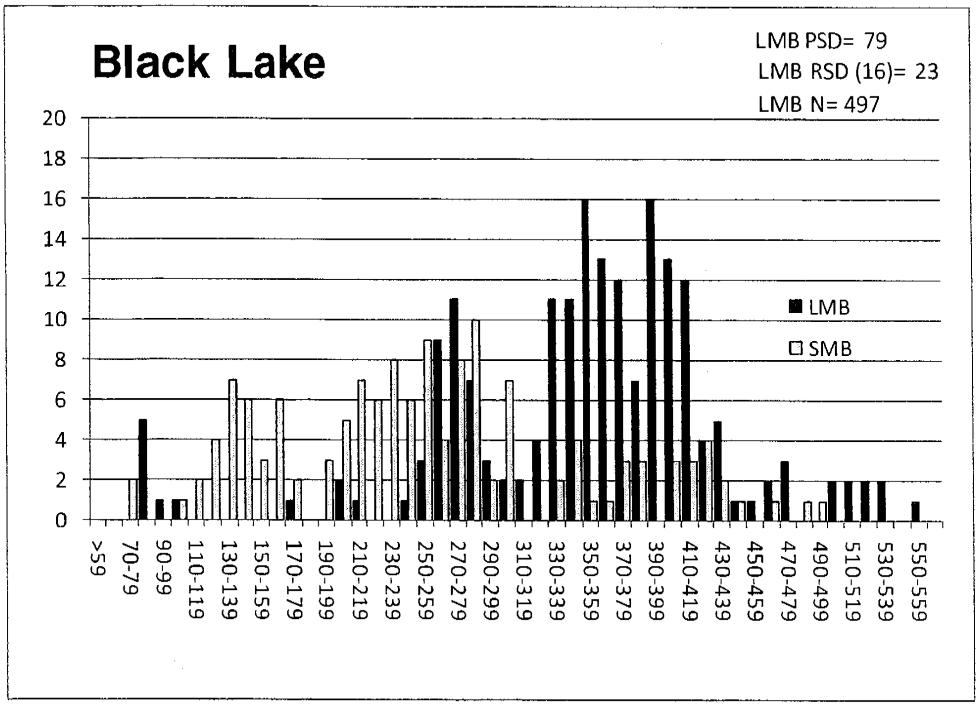

Figure 33. Length frequency distribution of largemouth and smallmouth bass collected in Black Lake, Idaho in May, 2010.

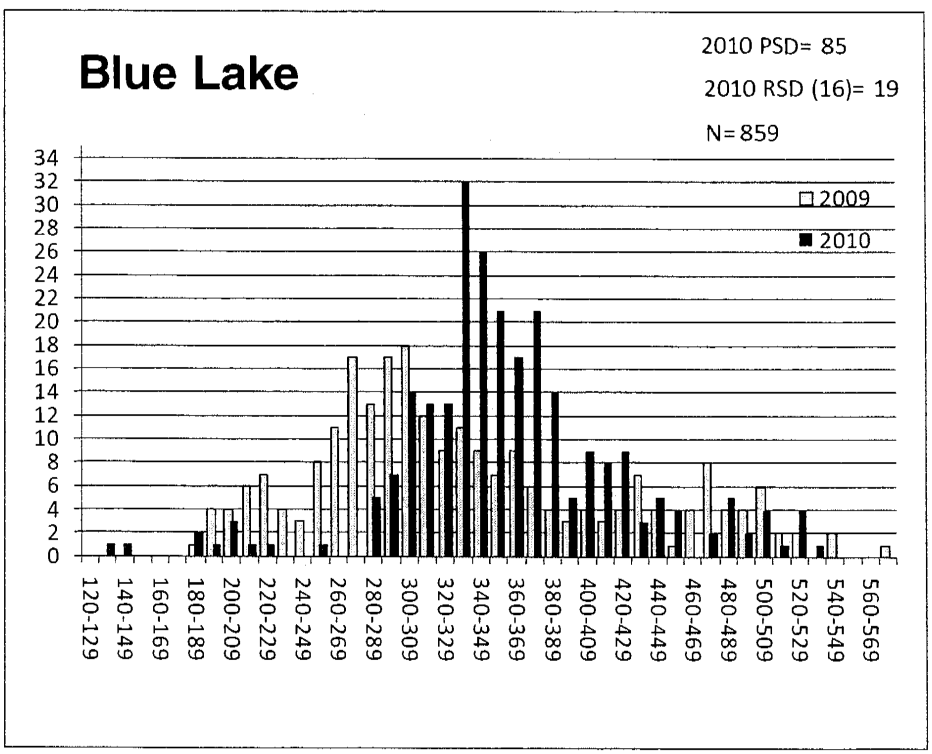

Figure 34. Length frequency distribution of largemouth bass collected in Blue Lake, Idaho in May, 2009 and 2010.

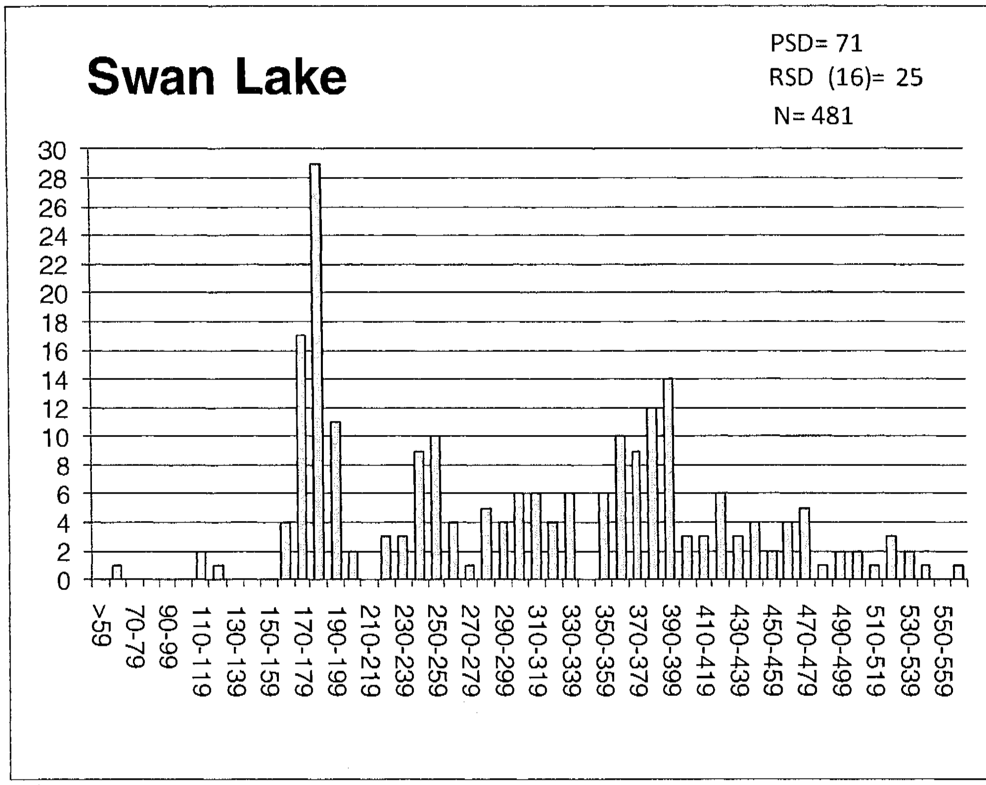

Figure 35. Length frequency distribution of largemouth bass collected in Swan Lake, Idaho in May, 2010.

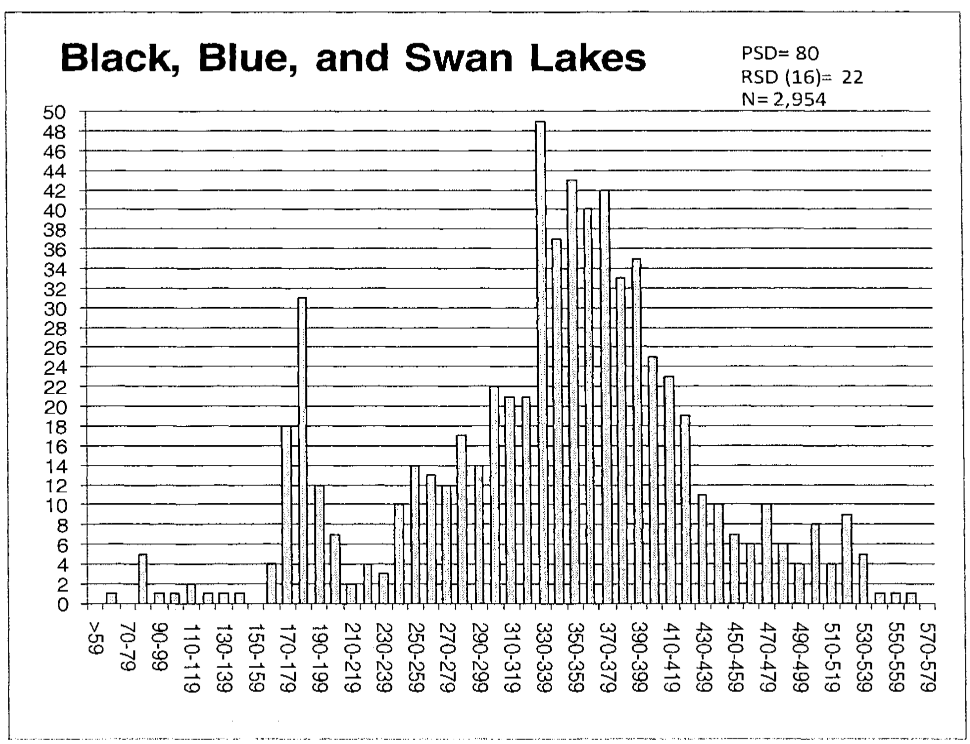

Figure 36. Length frequency distribution of largemouth bass collected in three lateral lakes (Blue, Black, and Swan lakes, Idaho in May, 2010.

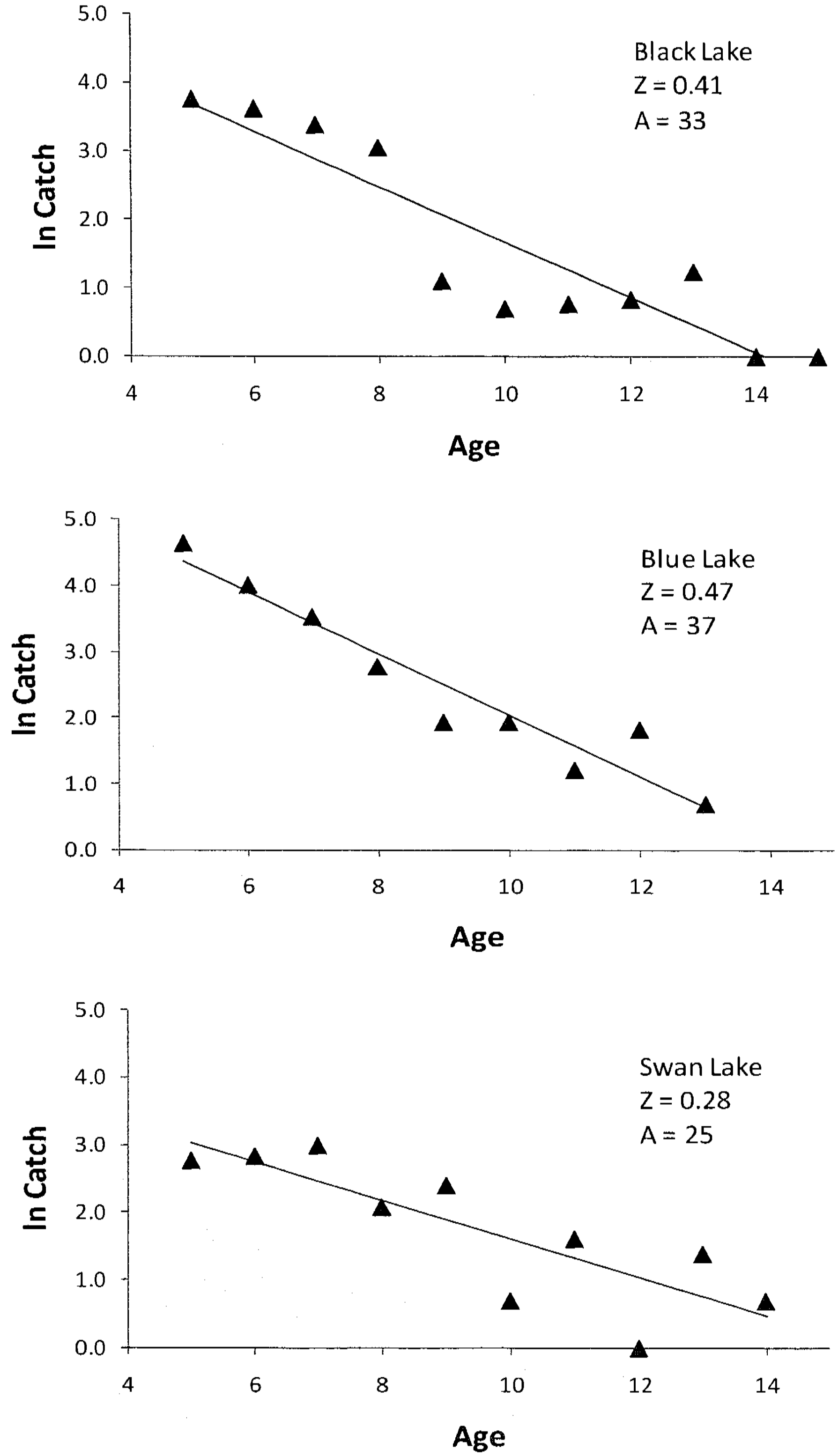

Figure 37. Catch curves used to estimate total instantaneous mortality (Z) and total annual mortality (A) of largemouth bass collected in three lateral lakes (Blue, Black, and Swan lakes), Idaho in May, 2010.

2010 Panhandle Region Annual Fishery Management Report

River and Stream Investigations

BULL TROUT REDD COUNTS

ABSTRACT

In September and October, 2010, with the help of multiple agency personnel, we conducted bull trout counts in the Priest, Kootenai, Pend Oreille, and Little North Fork of the Clearwater basins. We counted 42 redds in tributaries to Upper Priest Lake, 3 in Lower Priest Lake basin, 654 bull trout redds in the Lake Pend Oreille (LPO) basin, 10 redds in tributaries to the Kootenai River, 69 redds in the St. Joe River drainage, and 64 redds in tributaries to the Little North Fork of the Clearwater River. Many LPO tributaries demonstrated reductions from 2009 totals, despite an overall improving trend in bull trout redds. Reductions were most dramatically noted in tributaries to the north shore of LPO and the lower Clark Fork River including the Pack River, Grouse Creek, and Lightning Creek. Upper Priest Lake tributaries showed an improvement from 2009 counts. Although the overall trend shows a decline, redd counts have been increasing significantly since 2007. In a similar way, redd counts in the Kootenai Core Area also indicate an apparent overall declining trend in bull trout numbers.

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INTRODUCTION

Bull trout redd counts are conducted in each of the core recovery areas to monitor long term trends in these populations. Redd counts not only allow us to evaluate the status of the populations in these areas as they pertain to each of the recovery criteria, but they also help in directing future management and recovery activities.

STUDY SITES

Bull trout redds were counted in streams within the Priest River, Pend Oreille Lake, Kootenai River, St. Joe River, and Little North Fork (LNF) Clearwater River drainages where bull trout are known to spawn (Figures 39-44). These watersheds make up all or part of five different core areas that occur in the IDFG Panhandle Region (USFWS 2002). These core areas are Priest Lake, Pend Oreille Lake, Kootenai River, Coeur d'Alene Lake and NF Clearwater River. The boundary of the Kootenai River and NF Clearwater River core areas span outside of the Panhandle Region.

OBJECTIVE

1. Quantify bull trout redds and spawning escapement in Priest Lake, Pend Oreille Lake, Kootenai River, Coeur d'Alene Lake and NF Clearwater River core areas.

METHODS

Bull Trout Spawning Surveys

We counted bull trout redds in selected tributaries of the Priest Lake, Priest River, Pend Oreille Lake, Kootenai River, St. Joe River, and LNF Clearwater basins where bull trout were known or believed to occur. We summarized counts in each of these basins in the core area they occurred in. Redd counts in the Middle Fork (MF) East River, NF East River and Uleda Creek (tributaries of Priest River) were added to the Pend Oreille Lake Core Area in 2003 when these bull trout were documented to spend their adult life in Pend Oreille Lake (DuPont et al. 2009). We counted all redds at similar times (late September and October) as had occurred in the past. Survey techniques and identification of bull trout redds followed the methodology described by Pratt (1984). Research has demonstrated the level of observer training and experience may influence the accuracy of redd counts (Bonneau and LaBar 1997; Dunham et al. 2001). To reduce observer variability in bull trout redd counts, we held a bull trout redd count training exercise on September 21, 2010. To add to our knowledge on preferred bull trout spawning areas and to help evaluate recovery efforts, the location of redds was recorded on maps and/or GPS units during redd counts. Sections of the Kootenai River and NF Clearwater core areas occurred outside the Panhandle Region. We obtained redd count data for these areas from the personnel from partner agencies responsible for conducting these surveys.

Data Analysis

To estimate the spawning escapement or population abundance (depending on recovery area) of bull trout in streams, we used Downs and Jakubowski (2006) findings where on average, 3.2 adult bull trout entered tributaries of Lake Pend Oreille for every redd that was counted during annual redd count surveys. We decided to use this adult to redd ratio because this estimation came from one of the core areas in the Panhandle Region, and because it is consistent with that found in the Flathead Lake system (Fraley and Shepherd; 1998). See Dupont et al. (2009) for further justification.

RESULTS

Priest Lake Core Area

We counted a total of 42 bull trout redds in the Upper Priest River basin on September 28, 2010 (Figure 39 and Table 39). The majority of these redds were counted in Upper Priest River (25 out of 34). We also surveyed in the lower Priest Lake basin, including the NF Indian Creek and NF Granite Creek, tributaries of Priest Lake. A total of three bull trout redds were observed in NF Indian Creek. By expanding the number of redds observed by 3.2 fish/redd, we estimated the spawning escapement of bull trout at 134 fish for the Upper Priest Lake basin and 10 for the lower lake (144 total). Since 1985, a significant ($P = < 0.001$) downward trend across consistently surveyed sites is evident in the abundance of spawning bull trout in the Priest Lake Core Area (Figure 40; Table 39). The long term trend in bull trout redds counts in the Upper Priest Basin appears to be in decline over the past 10 years; however, in the short term redd numbers have been improving over the past couple of years.

One man-made barrier was noted during our survey that we believe blocks upstream migration of bull trout. This barrier is a USFS culvert located where F.S. road 1013 crosses Gold Creek (T63N, R5W, Section 17).

Pend Oreille Lake Core Area

We completed bull trout redd counts on 22 tributary streams and the Clark Fork River between October 8 and 19, 2010. A total of 654 bull trout redds were observed across all sample locations (Table 40; Figure 41). Index streams surveyed since 1983, accounted for 456 of the total observed redds in 2010. Redd counts ranged from a low of zero redds in the Twin Creek to a high of 188 redds in Trestle Creek. Based on 2010 redd counts the expanded (3.2 fish per redd) adult bull trout spawning population consisted of at least an estimated 2,093 individuals (Table 41). We estimated five local populations to have more than 100 adult spawning fish.

Redd counts in the Middle Fork East River were down from previous years, with only 28 redds counted in the mainstem Middle Fork East River and Uleda Creek (Figure 41). We located a single bull trout redd above the old barrier on Uleda Creek. This barrier was removed via blasting in 2004. This is only the second time redds were documented above this previous barrier.

Regression analysis of bull trout redd counts from the LPO core area across years continued to demonstrate an increasing trend in relative abundance bull trout. Evaluation of both index streams and all streams surveyed demonstrated positive trends in bull trout redds counted. However, only counts for all streams between 1992 and 2010 were significant ($\alpha \leq 0.1$, $P = 0.05$). A separate analysis of all streams surveyed was included for survey years from 1992 to 2008 because a data gap in the time series existed where only index streams were surveyed during the period from 1988 to 1991 (Table 40, Figure 43). Redd count values from 1986 and 1995 were also excluded from analyses because counts in these years were largely compromised by either water conditions or incomplete counts.

Kootenai River Core Area

We surveyed three tributaries (North Callahan, South Callahan, and Boulder creeks) on October 17th and 20th 2010 for bull trout redds in the Idaho portion of the Kootenai River Core Area, and a total of 10 redds were counted (Figure 44; Table 42). This was the ninth year surveys were conducted in all three of these tributaries. Redd counts were similar to 2009, and below average when compared to the past 9 years of sampling. By expanding the number of redds observed by 3.2 fish/redd, we calculated the spawning escapement of bull trout for the Idaho portion of the Kootenai River Core Area to be 32 fish. The long term trend in bull trout redds counts in the Kootenai River basin appears to be in decline over the past 9 years (Figure 45; Table 42).

In the Montana portion of the Kootenai River Core Area, 102 redds were counted during 2010 (Table 42). Redd counts in this section of the Kootenai currently exhibit a declining trend (Figure 46). The total redd count of this section converts to an estimated spawning escapement to 326 fish. When combined with the Idaho spawning escapement (32 fish), the total spawning escapement for the Kootenai River Core Area is 358 fish.

Coeur d'Alene Lake Core Area

The IDFG, USFS, and Coeur d'Alene Tribe counted 54 redds in the three index stream reaches of the St. Joe River drainage on September 22, 2010 (Figure 47; Table 43). The USFS along with the Coeur d'Alene Tribe surveyed another five streams and counted 15 additional redds bringing the total number of redds counted in the St. Joe River to 69 (Table 43). The majority (78%) of all the redds were counted in the three index streams (Medicine Creek, Wisdom Creek, St. Joe River from Heller Creek to upstream barrier). As in previous years, no attempts were made to search for bull trout redds in the Coeur d'Alene River basin. Expanding the number of redds observed by 3.2 fish/redd, we estimated the spawning escapement of bull trout for the Coeur d'Alene Lake Core Area to be 221 fish. We observed three bull trout redds downstream of Red Ives Creek in Beaver Creek. Redd counts in Wisdom Creek have decreased from 32 in 2007 to only one redd surveyed in 2010.

Including all streams surveyed, there is an increasing trend in the abundance of bull trout redds since 1992 for the Coeur d'Alene Lake Core Area (Figure 48; Table 43). Redd numbers in the streams that have been consistently surveyed by experienced counters (the three index streams), also exhibits an increasing trend since 1992 (Figure 48; Table 43). Although we saw a decline in redd counts from last year's counts, we still concluded that based on the trends the bull trout population in the Coeur d'Alene Lake Core Area is stable or increasing.

As far as migration barriers go, we believe that the diversion dam within 2 km of the mouth of Red Ives Creek may block upstream migration of most bull trout. Entente Creek has a culvert barrier just upstream from where bull trout redds had been reported and there appears to be suitable habitat upstream of the culvert. In addition to this, beaver dams on the mainstem of the St. Joe River between Medicine and Wisdom Creek could be potential barriers. Other barriers may occur in streams that have the potential to support spawning and rearing bull trout populations.

North Fork Clearwater River Core Area

Along with the USFS, we counted 64 redds in the upper LNF Clearwater River basin on September 23, 2010 (Figure 49 and Table 44). Counts were 48% lower this year than in 2006 and 2007 and similar to what was counted in 2009.

Adding the 10% to account for streams not surveyed in 2010 and expanding this by the number of fish per redd, we estimated the spawning escapement of bull trout for the upper LNF Clearwater River to be 227 fish.

The USFS and IDFG counted 81 redds in the NF Clearwater River and Breakfast Creek drainages in 2010 (Figure 49; Table 45). As with the LNF Clearwater River, not all streams were surveyed in the NF drainage due to their remoteness. Based on previous redd counts, it is believed that during 2010 about 24% of redds were not counted due to unsurveyed streams. By expanding this corrected number of redds by 3.2 fish/redd, we estimated the spawning escapement of bull trout for the NF Clearwater River and Breakfast Creek drainages to be 342 fish. When combined with the upper LNF Clearwater River, this gives us a total spawning escapement of 569 bull trout for the NF Clearwater River Core Area. We multiplied the spawning escapement by 1.33 (at least 25% are not repeat spawners), which gives us a total of 757 adult bull trout that occurred in the NF Clearwater Core Area during 2010.

Evaluating only those stream reaches that we have counted consistently in the LNF Clearwater (Lund Creek, Little Lost Lake Creek, Lost Lake Creek and the LNF upstream of Lund Creek), an increasing trend is evident (Figure 50; Table 44). Evaluating the total LNF and NF Clearwater redd counts from 2001 to 2010, redds count trends also appear to be increasing over about 28 streams (Figure 51).

DISCUSSION

Priest Lake Core Area

It is well documented that the bull trout population in the Priest Lake Core Area are in decline and at risk of collapse (Mauser 1986; Fredericks et al. 2002; Dupont et al. 2009). This year's redd counts in the Priest Lake basin were the highest they have been since counts in 2003 and above the average counts since we began recording surveys in 1983.

The primary cause for the decline in the bull trout population in the basin is likely the expanding population of lake trout which continually poses an overwhelming threat to the adfluvial bull trout population (Fredericks et al. 2002; Donald and Alger 1993). An on-going effort to remove lake trout from the upper lake has been underway for several years, with the intention of reducing bull trout predation. Although the effectiveness of this removal is uncertain at this time, the hope is that this will translate to increasing number of spawning adult bull trout. In addition to predation by lake trout of sub-adults entering the lake, juvenile bull trout also face predation and competition by non-native brook trout in all the rearing tributaries to both the upper and lower Priest Lake.

Few of the tributaries of Priest Lake have been surveyed for redds since 1986 when Mauser (1986) documented the collapse of this population. Relatively few bull trout spawn in tributaries of Priest Lake and probably contribute only a few adult fish to the entire core area.

Pend Oreille Lake Core Area

Despite an overall improving trend in bull trout redds, many LPO tributaries demonstrated reductions from 2009 totals. Reductions were most dramatically noted in tributaries to the north shore of LPO and the lower Clark Fork River including the Pack River, Grouse Creek, and Lightning Creek. No explanatory relationship has been defined for the causal mechanism of these variations in counts. However, these drainages all historically have experienced high channel instability. Reduced counts may correspond to high flows that occurred in the fall of 2006 that resulted in major channel alterations and potential impacts to the fish community.

LPO bull trout redd surveys in 2010 were likely impacted by in-stream conditions at several locations, possibly resulting in minimum counts in these locations. Disturbed substrates resulting from abundant early spawning kokanee in eastside LPO tributaries including North Gold, Gold, and Granite creeks as well as Sullivan Springs limited identification of bull trout redds where kokanee and bull trout spawning overlapped. Redd counts in impacted areas likely represented minimum estimates.

Migratory barriers in typical spawning locations were not document in most surveyed tributaries. Adequate flows in most tributaries provided migratory corridors even in streams typically exhibiting intermittency issues. A passage barrier has been present in Char Creek since 2008 and remained in 2010 resulting in access to only approximately 200 m of that stream. In the Middle Fork East River, a partial "log jam" barrier exists during low water above the confluence of Keokee Creek (Figure 42). This barrier can and should be modified on the south side in order to allow enough flow at low water to pass adult fish.

Kootenai River Core Area

In the Idaho portion of the Kootenai River Core Area, North and South Callahan Creeks and to a lesser extent Boulder creek are the only streams identified as important bull trout spawning tributaries in the Idaho portion of the Kootenai River Core Area. Counts in the Kootenai River Core Area were again very low compared to when these surveys began in 2002.

In terms of the entire Kootenai River Core Area, the majority of the bull trout population is located in Montana tributaries. Similar to 2009, during 2010, 90% of the total redds were counted in Montana. Previous radio tracking data indicates that fish spawning downstream of the falls in North and South Callahan Creeks and O'Brien Creek are mostly adfluvial coming from Kootenay Lake, B.C. Canada (Jody Walters, personal communication, IDFG). Bull trout spawning upstream of the falls in Montana (Quartz Creek, Bear Cree, Pipe Creek and West Fisher River) appear to have a fluvial life cycle where they overwinter in Kootenai River (Jody Walters, IDFG, personal communication, IDFG). This suggests we may not see the same trends in bull trout abundance between these two populations. In addition, Canada allows harvest of bull trout in Kootenay Lake, which may also influence trends in the lower Kootenai River tributaries.

Coeur d'Alene Lake Core Area

As is typical of the St. Joe River redd counts, although multiple streams were sampled in the St. Joe in 2010, only a few streams (Medicine Creek, Heller Creek and the upper St. Joe River) were responsible for producing the majority of bull trout in the entire core area (78% of redds were counted in these streams during 2010). Most years, a significant number of redds are counted in Wisdom Creek, however, only a single redd was counted here in 2010. The reduction in numbers is has us looking at potential migration barriers such as beaver dams in the mainstem of the St. Joe. The current population size of 221 fish in the core area is considerably lower than the recovery population size of 1,100. We are not aware of any spawning and rearing of bull trout currently occurring in the Coeur d'Alene River drainage.

North Fork Clearwater River Core Area

We estimated there were 757 adult bull trout that occurred in the NF Clearwater River Core Area. The 145 redds counted this year was slightly lower than the 151 counted in 2008 and noticeably lower than the 221 redds counted in 2007. This reduction in redds counted was primarily in the LNF Clearwater River. Even with this in mind, the redd counts in the LNF Clearwater River are on an overall increasing trend in their index streams.

A number of streams in this core area are not counted on an annual basis due to their remoteness, and as a results, the spawning escapement in this core area is likely higher than the redd counts indicate. In addition, in several tributaries of the NF only short stream segments are surveyed which possibly further limits the final counts. Despite these limitations, bull trout redd counts have remained steady for the past five years in the NF Clearwater River core area.

MANAGEMENT RECOMMENDATION

1. Continue to monitor bull trout spawning escapement through redd counts in the Priest Lake Pend Oreille Lake, Kootenai River, St. Joe River and LNF Clearwater River watersheds. This includes counting the remote sections of the LNF every 3 - 5 years.

Table 39. Description of bull trout redd count transect locations, distance surveyed and number of redds counted in the Priest Lake basin, Idaho, from 1985 to 2010.

Stream	Transect Description	Length (km)	1985	1986	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Upper Priest River	Falls to Rock Cr.	12.5	--	--	--	--	--	--	15	4	15	33	7	7	17	8	5	13	21	5	14	5	17
	Rock Cr. to Lime Cr.	1.6	--	--	--	2	1	1	2	0	3	7	0	2	0	0	0	0	1	0	0	2	4
	Lime Cr. to Snow Cr.	4.2	12[a]	5[a]	--	3	4	2	8	1	10	9	9	5	1	16	12	3	4	1	5	10	3
	Snow Cr. to Hughes	11.0	--	--	--	0	0	--	0	3	7	4	2	8	3	13	2	10	0	1	2	4	0
	Hughes Cr. to Priest	2.3	--	--	--	0	0	--	0	--	--	0	0	--	--	--	--	--	--	--	--	--	0
Rock Cr.	Mouth to F.S. trail	0.8	--	--	0	0	--	--	2	1	0	--	0	0	0	--	1	0	0	0	0	0	1
Lime Cr.	Mouth upstream 1.2	1.2	4[b]	1[b]	0	0	--	--	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0
Cedar Cr.	Mouth upstream 3.4	3.4	--	1	--	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Ruby Cr.	Mouth to waterfall	3.4	--	--	0	0	--	--	--	0	0	--	--	--	0	--	--	0	--	0	0	0	0
Hughes Cr.	Trail 311 to trail 312	2.5	1	17	7	3	2	0	1	4	0	1	0	0	0	1	0	0	0	0	0	0	0
	F.S. road 622 to Trail	4.0	35[c]	2[c]	2	0	7	1	2	0	0	0	0	0	0	1	2	1	1	0	0	5	0
	F.S. road 622 to	7.1	4[d]	0[d]	--	1	--	--	2	3	1	0	2	6	1	0	1	1	1	0	0	3	11
Bench Cr.	Mouth upstream 1.1	1.1	1	2	0	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jackson Cr.	Mouth to F.S. trail	1.8	--	--	4	0	0	0	0	0	0	--	--	--	0	0	0	0	1	0	0	0	0
Gold Cr.	Mouth to Culvert	3.7	24	23	5	2	6	5	3	0	1	1	9	5	2	2	0	1	0	0	1	5	6
Boulder Cr.	Mouth to waterfall	2.3	--	--	0	0	0	--	0	0	0	--	0	--	--	--	--	0	--	0	0	0	0
Trapper Cr.	Mouth upstream 5.0	5.0	--	--	--	4	4	2	5	3	8	2	0	1	0	0	0	0	--	0	0	0	0
Caribou Cr.	Mouth to old road	2.6	--	--	--	1	0	0	0	0	0	--	--	--	--	--	--	--	--	--	--	--	0
All stream reaches combined		70.5	80[e]	50[e]	18	18	28	12[f]	41	22	45	58	29	34	24	41	23	29	29	7	22	34	42
Only those stream reaches counted during 1985-6		23.8[g]	80	50	14[h]	11	21[h]	8[f]	17	10	12	12	20	16	4	20	15	6	6	1	6	23	20

[a] Redds were counted from Lime Creek to Cedar Creek, which is about 1/2 the distance that is currently counted.
[b] Redds were counted from the mouth to FS road 1013, which is about 1/4 of the distance that is currently counted.
[c] About 2/3 of the distance was counted in 1985 and 1986 that is currently counted.
[d] Redds were counted from FS road 622 to the FS Road 1013, which is about 1/3 of the distance that is currently counted.
[e] Redds were counted in about 1/5 of the stream reaches where they are currently counted.
[f] During 1985 and 1986 about 15 km of stream was counted.
[g] Two of the stream reaches were not counted.
[h] Observation conditions were impaired by high runoff.

Table 40. Number of bull trout redds counted per stream in the Pend Oreille Lake, Idaho, Core Area, from 1983 to 2010.

STREAM	Avg 1983-2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Clark Fork R.	8	6	7	8	1	0	3	2	0	1	0
Lightning Cr.	11	7	8	8	9	22	9	3	10	11[b]	0
East Fork Cr.	51	36	58	38	77	50	51	34	38	85	26
Savage Cr.	7	4	15	7	15	7	25	0[b]	8	5	6
Char Cr.	11	2	8	7	14	15	20	1	5[e]	1[e]	4[e]
Porcupine Cr.	11	0	0	5	10	14	8	8	8	15	11
Wellington Cr.	9	7	7	8	7	6	29	9	10	4[b]	7
Rattle Cr.	16	67	33	37	34	34	21	2	24	62[b]	43
Johnson Cr.	18	34	31	0	32	45	28	32	40	47	57
Twin Cr.	10	1	8	3	6	7	11	0	4	0	0
Morris Cr.	1	0	7	1	1	3	16	0	6	6	9
Strong Cr.	2	--	0	--	0	--	--	--	7	6	2
Trestle Cr. [a]	244	335	333	361	102[b]	174	395	145	183	279	188
Pack R.	22	28	22	24	31	53	44	16	11	4	0
Grouse Cr.	38	18	42	45	28	77	55	38	31	51	27
Granite Cr.	33	7	57	101	149	132	166	104	52	106[c]	75[c]
Sullivan Springs Cr.	16	8	15	12	14	15	28	17	7[c]	2[c]	9[c]
North Gold Cr.	30	16	24	21	56	34	30	28	17	28[c]	28[c]
Gold Cr.	112	127	203	126	167	200	235	179	73	107[c]	130[c]
W. Gold Cr.	NA	--	--	--	--	--	4	0	7	5	4
M.F. East R.	NA	4[d]	8[d]	21	20	48	71	34	36	25	22
Uleda Cr.	NA	3[d]	4[d]	3	7	4	7	2	7[b]	16	6
N.F. East R.	NA	--	--	--	1	0	0	--	0	--	0
Total 6 index streams	489	566	691	591	462	580	794	456	382	597	456
Total of all streams	605	710	890	836	781	940	1256	654	584	866	654

[a] additional apprx. 0.5 km reach immediately upstream of index reach on Trestle Creek added in 2001
[b] Impaired observation conditions (ice, high water, ect)
[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 41. The estimated number of adult bull trout associated with each tributary where redds were counted in the Pend Oreille Lake, Idaho, Core Area from 1983 to 2010. Stream counts shaded indicate when over 100 adults were associated with it. Total counts shaded in gray indicate when the entire population exceeded 2,500 fish.

Stream	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CLARK FORK R.	--	--	--	--	--	--	--	--	--	6	26	54	58	10	22	26	16	16	19	22	26	3	--	10	6	0	3	0
Lightning Cr.	90	29	147	45	13	--	--	--	--	35	6	16	0	19	0	10	51	13	22	26	26	29	70	29	10	32	35	0
East Fork	352	77	422	26	189	253	320	93	--	102	86	90	10	157	70	205	141	173	115	186	122	246	160	163	109	122	272	83
Savage Cr.	115	38	93	--	0	--	--	--	--	3	19	19	0	0	0	0	13	6	13	48	22	48	22	80	0	26	16	19
Char Cr.	58	29	35	0	6	--	--	--	--	29	118	42	6	45	3	51	54	35	6	26	22	45	48	64	3	16	3	13
Porcupine Cr.	118	166	102	3	29	--	--	--	--	13	19	3	6	0	0	0	13	13	0	0	16	32	45	26	26	26	48	35
Wellington Cr.	67	58	48	22	6	--	--	--	--	29	13	29	3	16	6	3	70	26	22	22	26	22	19	93	29	32	13	22
Rattle Cr.	163	102	67	32	112	--	--	--	--	32	26	0	3	32	6	48	42	38	214	106	118	109	109	67	6	77	198	138
Johnson Cr.	42	106	74	115	32	13	54	106	80	51	74	10	13	16	86	54	99	13	109	99	0	102	144	90	102	128	150	182
Twin Cr.	22	80	16	90	0	--	--	--	--	10	13	0	16	51	19	32	61	32	3	26	10	19	22	35	0	13	0	0
Morris Cr.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	3	0	22	3	3	10	51	0	19	19	29
Strong Creek	--	--	--	--	--	--	--	--	--	--	--	--	--	6	--	--	--	--	--	0	--	0	--	--	--	22	19	6
NORTH SHORE																										0	0	0
Trestle Cr.	954	870	954	470	736	755	694	877	704	429	973	883	448	778	707	1056	810	963	1072	1066	1155	326	557	1264	464	586	893	602
Pack River	109	118	157	80	45	--	--	--	--	208	67	70	0	19	13	54	0	26	90	70	77	99	170	141	51	35	13	0
Grouse Cr.	6	346	176	42	179	77	160	154	106	54	74	58	0	160	26	141	160	246	58	134	144	90	246	176	122	99	163	86
EAST SHORE																										0	0	0
Granite Cr.	10	259	118	118	96	--	--	--	--	0	22	35	29	150	288	157	131	80	22	182	323	477	422	531	333	166	339	240
Sullivan Springs	26	23	41	--	19	--	--	--	--	0	77	99	29	48	134	32	70	61	26	48	38	45	48	90	54	22	6	29
North Gold Cr.	51	118	166	26	115	77	118	112	131	131	102	86	99	125	61	70	51	61	51	77	67	179	109	96	90	54	90	90
Gold Cr.	419	397	355	250	198	355	390	269	333	298	384	525	304	320	243	384	470	538	406	650	403	534	640	752	573	234	342	416
West Gold Cr.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13	0	22	16	13
PRIEST RIVER																										0	0	0
M.F. East River	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13	26	67	64	154	227	109	115	80	70
Uleda Creek	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10	13	10	22	13	22	6	22	51	19
N.F. East River	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	0	0	--	0	--	0
Total 6 index streams	1824	1914	2147	928	1450	1530	1738	1610	1354	1066	1693	1651	874	1555	1194	1910	1731	1994	1811	2211	1891	1478	1856	2541	1459	1222	1910	1459
Total of all streams	2602	2817	2972	1318	1776	1530	1738	1610	1354	1430	2099	2019	1024	1951	1686	2323	2256	2342	2272	2848	2675	2499	3008	4019	2093	1869	2771	2093

Table 42. The number of bull trout redds counted per stream in the Idaho and Montana sections of the Kootenai River Core Area from 1990 to 2010.

Stream	Length (km)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
IDAHO																						
North Callahan Creek	3.3	--	--	--	--	--	--	--	--	--	--	--	--	13	30	17	12	29	3	17	10	9
South Callahan Creek	4.3	--	--	--	--	--	--	--	--	--	--	--	--	4	10	8	8	4	0	0	0	1
Boulder Creek	1.8	--	--	--	--	--	--	--	--	--	--	--	2	2	0	0	1	0	0	0	0	0
MONTANA																						
Quartz Creek	16.1	76	77	17	89	64	67	47	69	105	102	91	154	62[d]	55	49	71	51	35	46	31	39
O'Brien Creek	6.9	--	25	24	6	7	22	12	36	47	37	34	47	45	46	51	81	65	77	79	40	27
Pipe Creek	12.9	6	5	11	6	7	5	17	26	34	36	30	6[a]	11	10	8	2	6	0	4	9	16
Bear Creek	6.9	--	--	--	--	--	6	10	13	22	36[b]	23	4[c]	17	14	6	3	14	9	14	6	8
West Fisher Creek	16.1	--	--	--	2	0	3	4	0	8	18	23	1	1	1	21	27	4	18	6	8	12
Idaho Total	9.4	0	0	0	0	0	0	0	0	0	0	0	2	19	40	25	21	33	3	17	10	10
Montana Total	58.9	82	107	52	103	78	103	90	144	216	229	201	212	136	126	135	184	140	139	149	94	102
Quartz/O'Brien/Pipe	35.9	82	107	52	101	78	94	76	131	186	175	155	207	118	111	108	154	122	112	129	80	82
Total all streams	68.3	82	107	52	103	78	103	90	144	216	229	201	214	155	166	160	205	173	142	166	104	112

[a] A human built dam (stacked up cobble) was constructed downstream of the traditional spawning area.
[b] This count includes redds constructed by resident and migratory fish.
[c] Libby Creek was dewatered at the Highway 2 bridge, downstream of Bear Creek spawning sites, during the bull trout spawning run.
[d] A log jam may have been a partial barrier.

Table 43. The number of bull trout redds counted by stream in the St. Joe River basin, Idaho, from 1992 to 2010. The Idaho Department of Fish and Game has counted the index streams since 1995. All other stream reaches were counted by the U.S. Forest Service and/or volunteers.

Stream Name	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Aspen Cr.	--	--	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--
Bacon Cr.	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--
Bad Bear Cr.	--	0	0	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--
Bean Cr.	14	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--
Beaver Cr.	2	2	0	0	0	0	1	0	--	0	0	0	0	0	0	0	0	0	3
Bluff Cr.- East Fork	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
California Cr.	2	4	0	2	3	0	--	--	0	0	0	0	0	0	0	0	0	2	--
Copper Cr.	--	--	0	--	0	--	--	--	--	--	0	0	0	--	--	0	0	--	--
Entente Cr.	--	--	--	--	--	--	--	0	--	--	1	0	--	--	--	--	--	--	--
Fly Cr.	1	--	--	0	0	0	2	0	--	--	1	0	0	0	--	0	2	1	0
Gold Cr. Lower mile	--	0	--	--	--	0	--	0	--	--	--	0	--	--	--	--	--	--	--
Gold Cr. Midde	--	--	--	0	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--
Gold Cr. Upper	--	2	--	--	1	1	0	--	--	--	--	--	--	--	--	--	--	--	--
Gold Cr. All	--	--	--	--	--	--	--	--	--	1	0	--	0	--	--	--	--	--	--
Heller Cr.	0	0	0	0	--	1	0	0	0	--	0	0	7	1	5	0	0	3	9
Indian Cr.	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Medicine Cr.	11	33	48	17[a]	23[a]	13[a]	11[a]	48[a]	43	16	42	28	52	62	71	55	71	41	48
Mosquito Cr.	0	--	0	0	4	0	2	--	--	--	--	--	0	0	--	--	--	--	--
Quartz Cr.	--	--	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--
Red Ives Cr.	--	0	1	1	0	1	0	0	0	0	0	0	0	1	0	1	1	--	2
Ruby Cr.	0	1	--	8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sherlock Cr.	0	3	0	2	1	1	0	1	0	--	--	0	0	0	0	0	3	--	1
Simmons Cr. - Lower	--	0	0	0	--	--	--	--	--	0	--	--	--	--	--	--	1	0	--
Simmons Cr. - NF to Three Lakes	--	5	0	--	--	--	--	--	--	--	--	--	--	--	0	--	--	0	--
Simmons Cr. - Three Lakes to Rd 1278	--	3	5	5	0	0	0	0	--	--	--	--	--	--	0	--	--	0	--
Simmons Cr. - Rd 1278 to Washout	--	0	0	0	1	0	1	0	--	--	--	--	--	--	--	--	--	0	--
Simmons Cr. - Upstream of Washout	--	0	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	0	--
Simmons Cr. - East Fork	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--
St. Joe River - below Tento Creek	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
St. Joe River - Spruce Tree CG to St. J. Lodg	--	--	--	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	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
St. Joe River - Heller to St. Joe Lake	10[b]	14[b]	3[b]	20	14	6	0	10	2	11	3	9	9	10	0	6	8	1	5
Three Lakes Creek	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Timber Cr.	--	0	1	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Wampus cr	--	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Washout cr.	--	3	0	0	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--
Wisdom Cr	1	1	4	5	1	0	4	11	3	13	9	9	11	19	12	32	27	8	1
Yankee Bar	1	0	--	--	--	0	--	--	1	0	0	0	0	0	3	0	0	--	--
Total - Index Streams [c]	12	34	52	25	15	6	4	21	48	40	54	46	72	91	83	93	106	50	54
Total - All Streams	32	57	59	47	25	10	10	22	49	41	56	46	79	93	91	94	113	57	69
Number of streams counted	15	22	18	20	15	16	11	12	8	9	14	14	13	11	11	11	12	15	8

[a] These counts differed from what the U.S. Forest Service counted.

[b] These counts did not include from California Creek to Medicine Creek, a reach where bull trout spawning typically occurs.

[c] Index streams include Medicine Creek, St. Joe River from Heller Creek to St. Joe Lake, and Wisdom Creek.

Table 44. Number of bull trout redds counted per stream in the Little North Fork Clearwater River basin, Idaho, from 1994 to 2010. Numbers in parentheses are redds smaller than 300 mm in diameter.

Stream	Length (km)	1994	1996	1997	1998	1999	2000	2001	2001[a]	2002	2003	2004	2005	2006	2007	2008	2009	2010
Buck Creek	4.8	--	--	--	--	--	--	--	--	--	5	--	--	--	--	--	--	--
Canyon Creek	5.5	--	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--
Butte Creek	1.2	--	--	--	--	--	--	--	5	0	--	--	--	--	--	--	--	--
Rutledge Creek		--	--	--	--	--	--	--	--	--	1	1	6	0	--	--	--	--
Rocky Run Creek	1.5	--	--	--	--	--	--	--	--	5	1	3	21	13	6 (2)	--	8	10
Lund Creek	3.9	0	7	2	2	1	1	13	5	7	7 (1)	5	19	7	30	22	11	6
Little Lost Lake Creek	3.9	0	1	1	1	7	3	1	--	2 (4)	4 (3)	15 (1)	1	34 (4)	31 (5)	14	5	19
Lost Lake Creek	3.0	0	0	0	0	--	1	--	--	0	--	1	--	10	13	8	9	7
Little North Fork Clearwater River																		
1268 Bridge to Lund Cr.	7.0	--	--	--	--	--	--	--	--	17	6	13	8	16	18	20	13	3	6
Lund Cr. to Lost Lake Cr.	3.8	--	--	3	1	9	8	3	12	5 (2)	7	5	8	16	21	9	11	9
Lost Lake Cr. to headwaters	5.4	0	2	0	0	--	5	1	--	5	5 (1)	5	11	13	8	20	14	7
All stream reaches surveyed	40.0	0	10	6	4	17	18	18	39	30 (6)	43 (5)	43 (1)	82	111 (4)	129 (7)	86	61	64
Trend sites (five streams)	20	0	10	6	4	17	18	18	17	25	28	32	39	84	108	73	50	48

[a] Streams were surveyed between 9/16/1994 and 9/19/1994 - one week earlier than surveys in following years.

[b] These redds were counted by personnel from the Clearwater Region.

Table 45. Number of bull trout redds counted per stream in the North Fork Clearwater River and Breakfast Creek basins, Idaho, from 1994 to 2010. These streams all occur in the IDFG Clearwater Region and were counted by IDFG personnel from the Clearwater Region or the U.S. Forest Service.

Stream Surveyed	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
North Fork Clearwater River	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--
Black Canyon	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--
Bostonia Creek	0	0	0	0	0	4	1	1	1	18	12	15	14	26	13	15	15
Boundary Creek	--	--	--	--	--	--	--	--	--	2	3	10	--	--	--	0	--
Collins Creek	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--	--
Goose Creek	--	--	--	--	--	--		1	0	2	1	12	8	1	0	2	0
Hidden Creek	--	--	--	--	--	--	--	--	1	0	--	--	--	--	--	--	--
Isabella Creek	--	--	--	--	--	--	--	--	1	1	0	0	--	1	1		--
Kelley Creek - North Fork	--	--	--	--	--	--	--	14	--	--	--	--	--	--	--	6	--
Lake Creek	--	--	--	--	--	--	19	7	20	14	5	2	5	3	0	2	0
Little Moose Creek	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--	--
Long Creek	--	--	--	--	--	--			5	0	8	10	1	6	10	11	--
Moose Creek	--	--	--	--	--	--	0	0	0	0		0	0	0	0	0	0
Niagra Gulch	--	--	--	--	--	--	2	5	6	10	3	4	2	2	2	4	6
Orogrande Creek	--	--	--	--	--	--	--	--	--	--	--	0	--	--	--	--	--
Osier Creek	--	--	--	--	--	--	3	0	2	0	--	--	--	--	--	--	--
Placer Creek	3	1	2	2	2	7	4	2	4	6	2	3	5	2	3	1	3
Pollock Creek	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--
Quartz Creek	--	--	--	--	--	--	--	4	0	0	0	0	--	--	8	--	--
Ruby Creek	--	--	--	--	--	0	0	--	--	--	--	--	--	--	--	--	--
Skull Creek	--	--	--	--	--	--	--	--	0	6	5	3	--	4	9	--	--
Slate Creek	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	0	--
Swamp Creek	--	--	--	--	--	--	2	0	1	0	0	2	--	1	--	--	--
Upper NF	--	--	--	--	--	--	--	--	--	7	3	6	--	--	--	0	--
Vanderbilt Gulch	--	--	--	--	--	--		24	18	13	12	41	35	39	43	49	57
Weitas Creek	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--
Windy Creek	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--
Breakfast Creek	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Floodwood Creek	--	--	--	--	--	--	--	--	4	0	0	--	--	--	--	--	--
Gover Creek	--	--	--	--	--	--	--	--	--	1	0	--	--	--	--	--	--
Stony Creek	--	--	--	--	--	--	--	--	4	0	0	--	--	--	--	--	--
Total for all streams	3	1	2	2	2	13	32	58	68	81	54	111	70	85	89	90	81

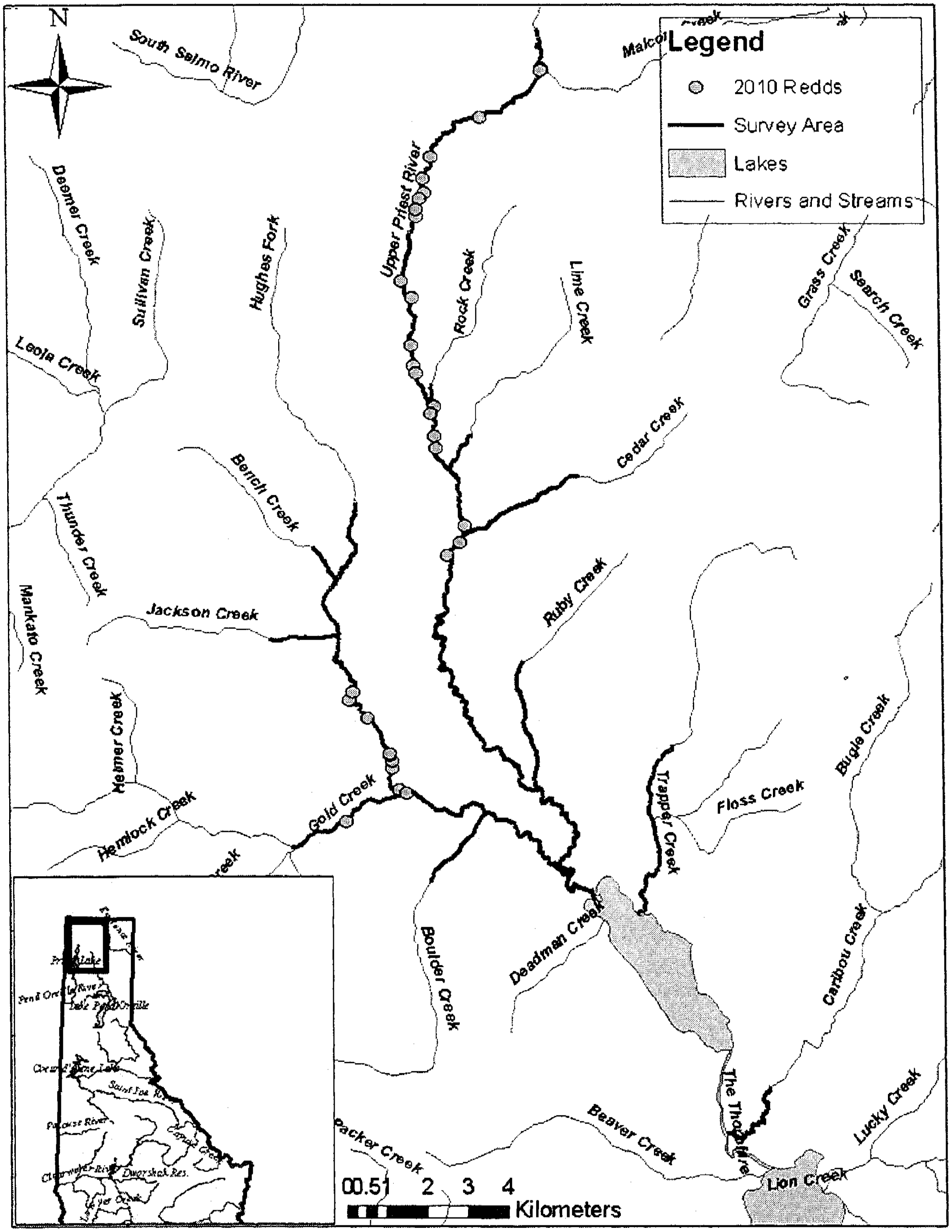
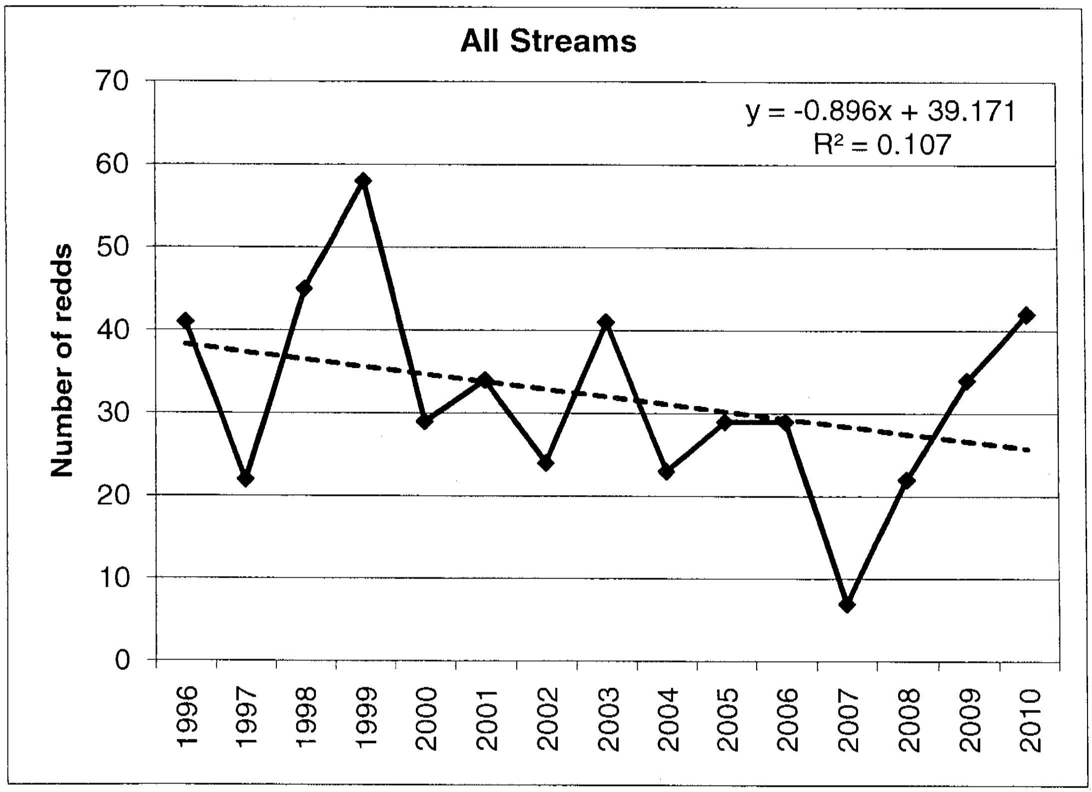


Figure 39. Stream reaches surveyed for bull trout redds in the Upper Priest Lake basin, Idaho, during September 28, 2010 and the locations of where redds were observed.



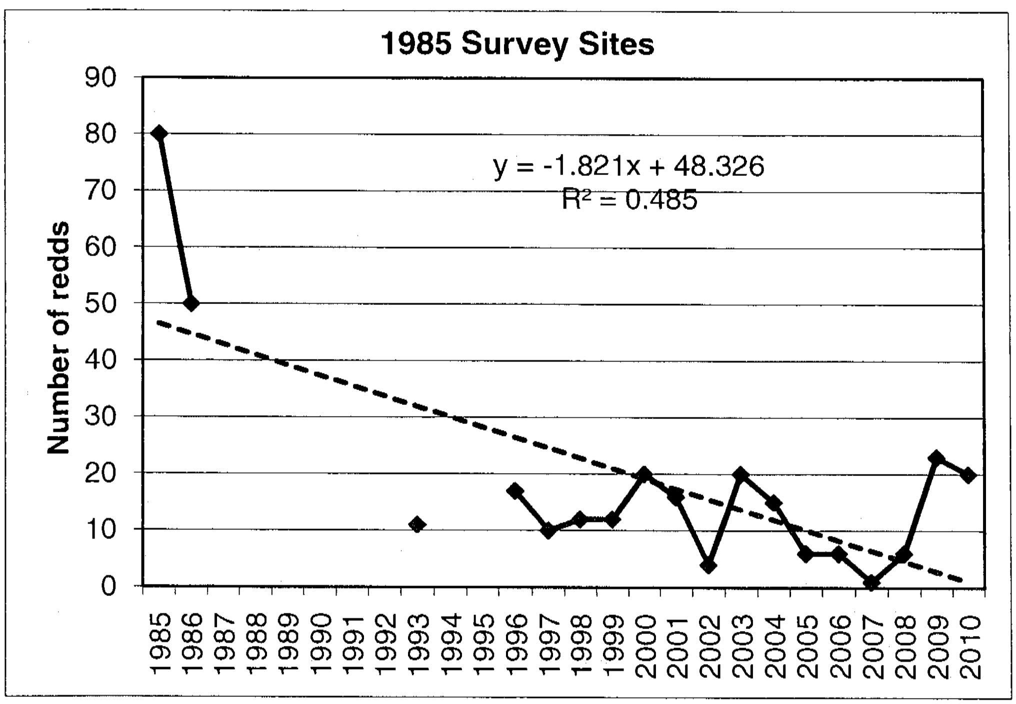


Figure 40. Linear regressions depicting trends in bull trout redd counts (all streams combined and only those sites surveyed during 1985) over time in the Priest Lake Core Area (Upper Priest Lake basin only), Idaho.

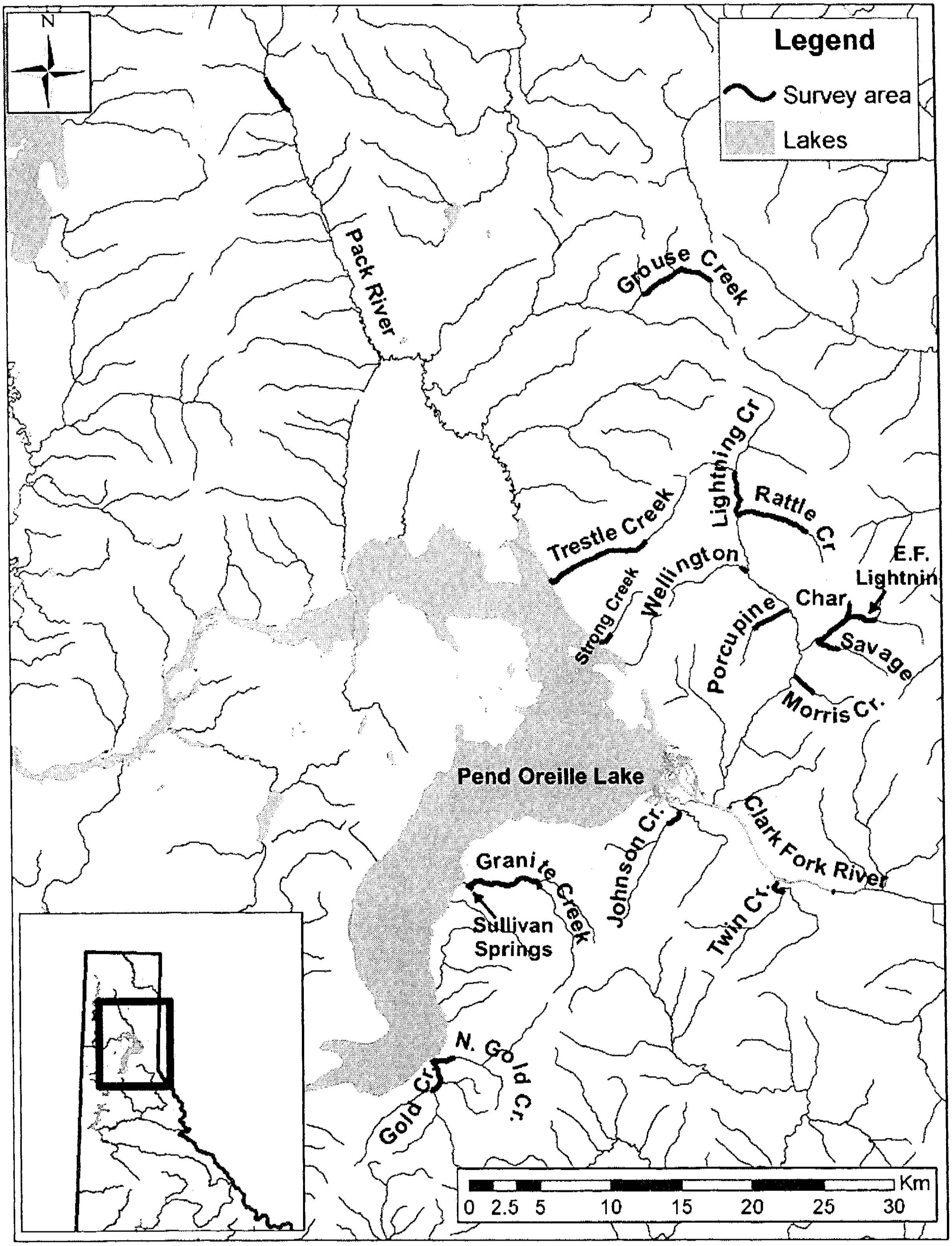
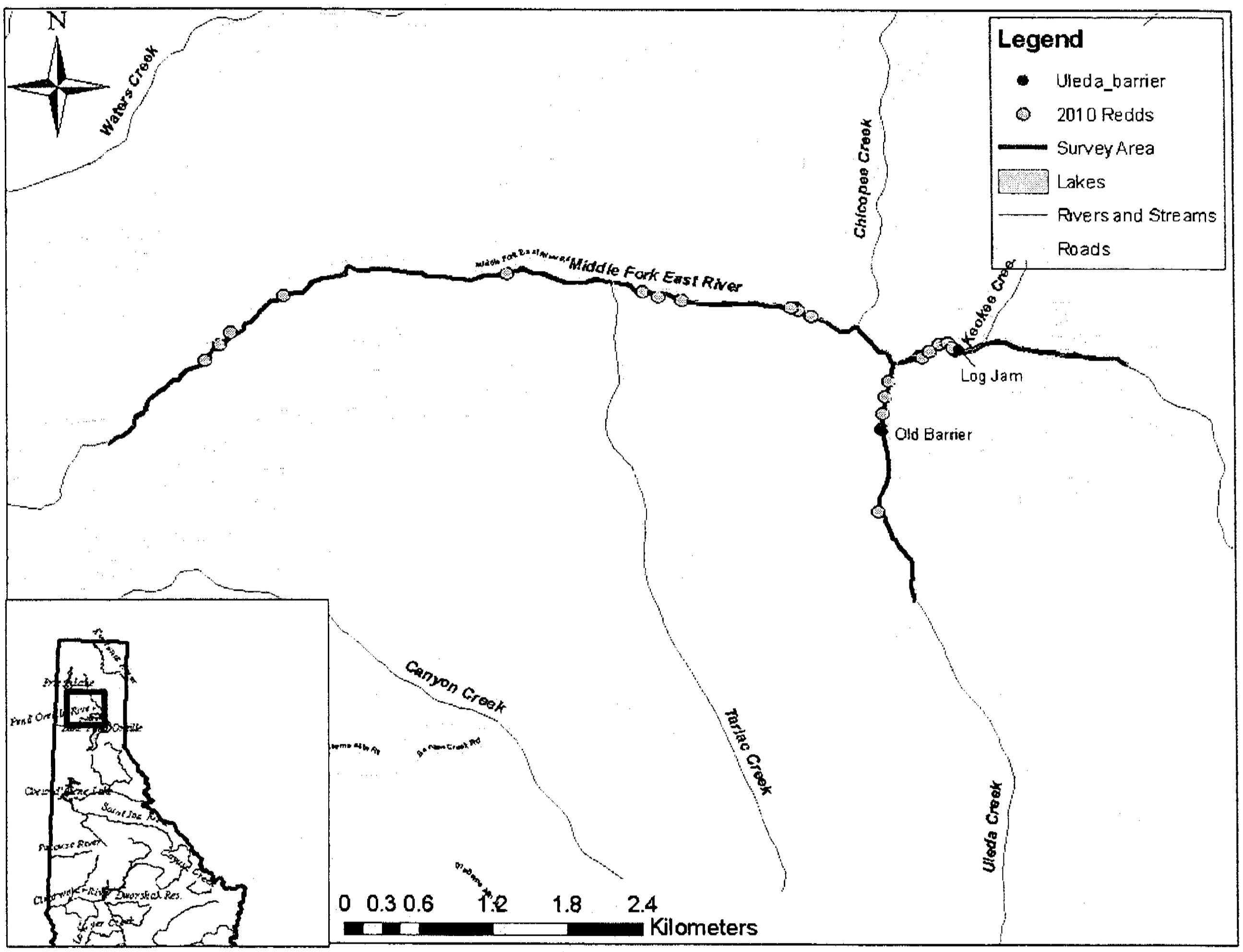
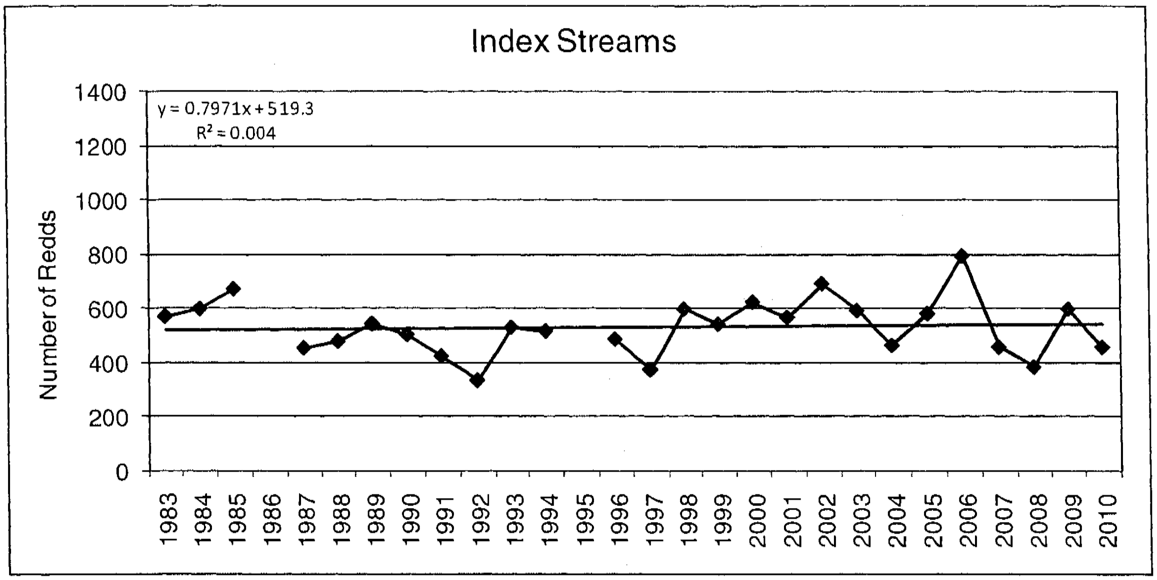


Figure 41. Stream reaches surveyed for bull trout redds in the Pend Oreille Lake basin, Idaho, on October 9 - 17, 2010.

Figure 42. Stream reaches surveyed for bull trout redds in the Middle Fork East River basin, Idaho on October 7, 2010 and the locations of where redds were observed.





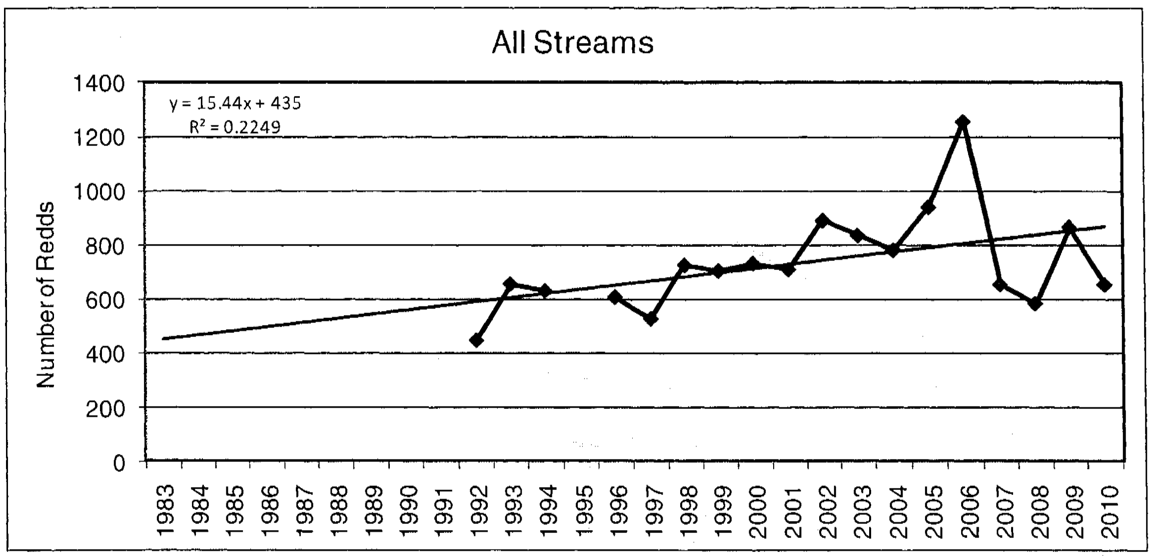


Figure 43. Linear regressions depicting trends in bull trout redd counts (six index streams and all streams combined) over time in the Pend Oreille Lake Core Area, Idaho.

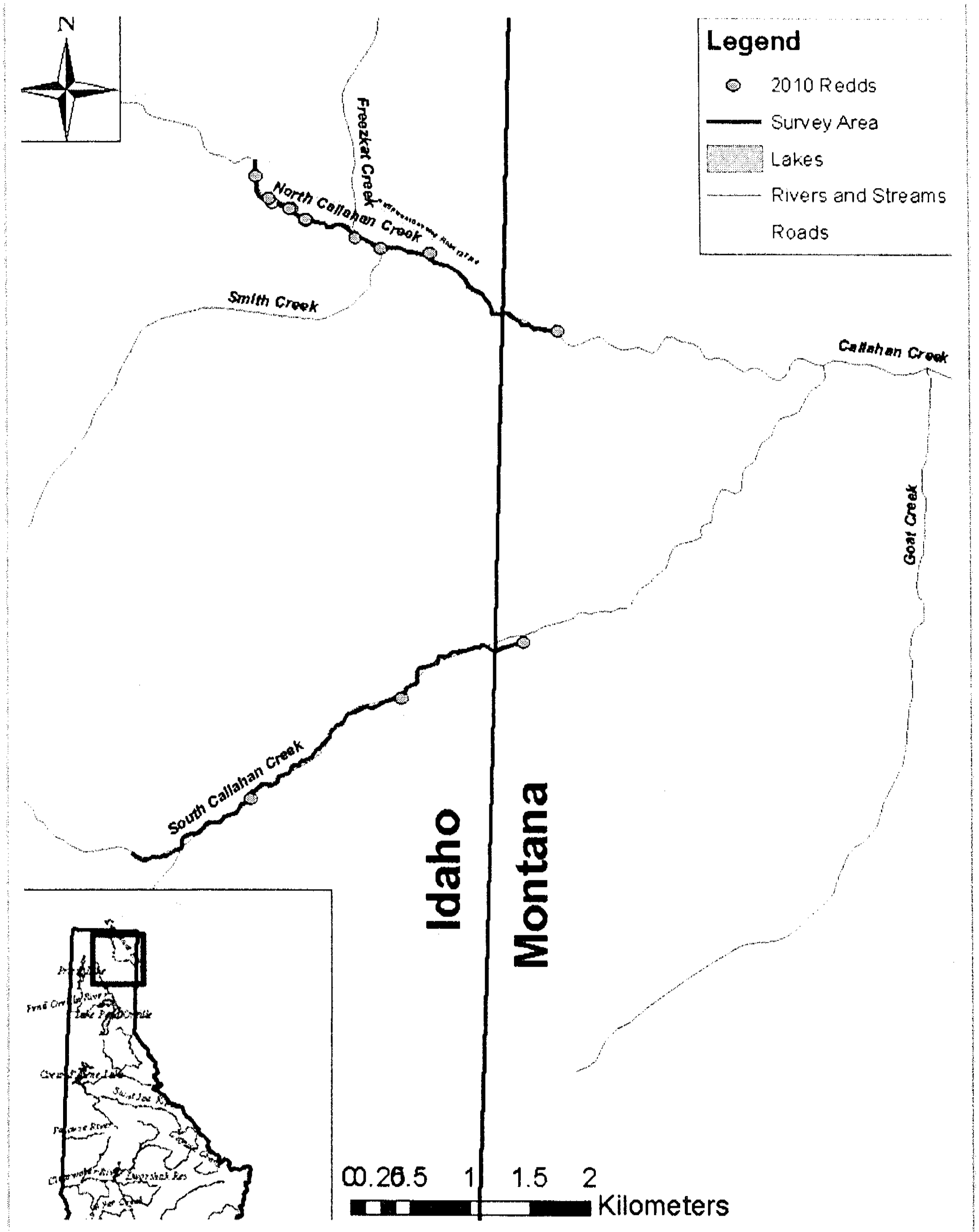


Figure 44. Stream reaches surveyed for bull trout redds in the Kootenai River watershed, Idaho, on October 17th and 20th, 2010 and the locations of where redds were observed.

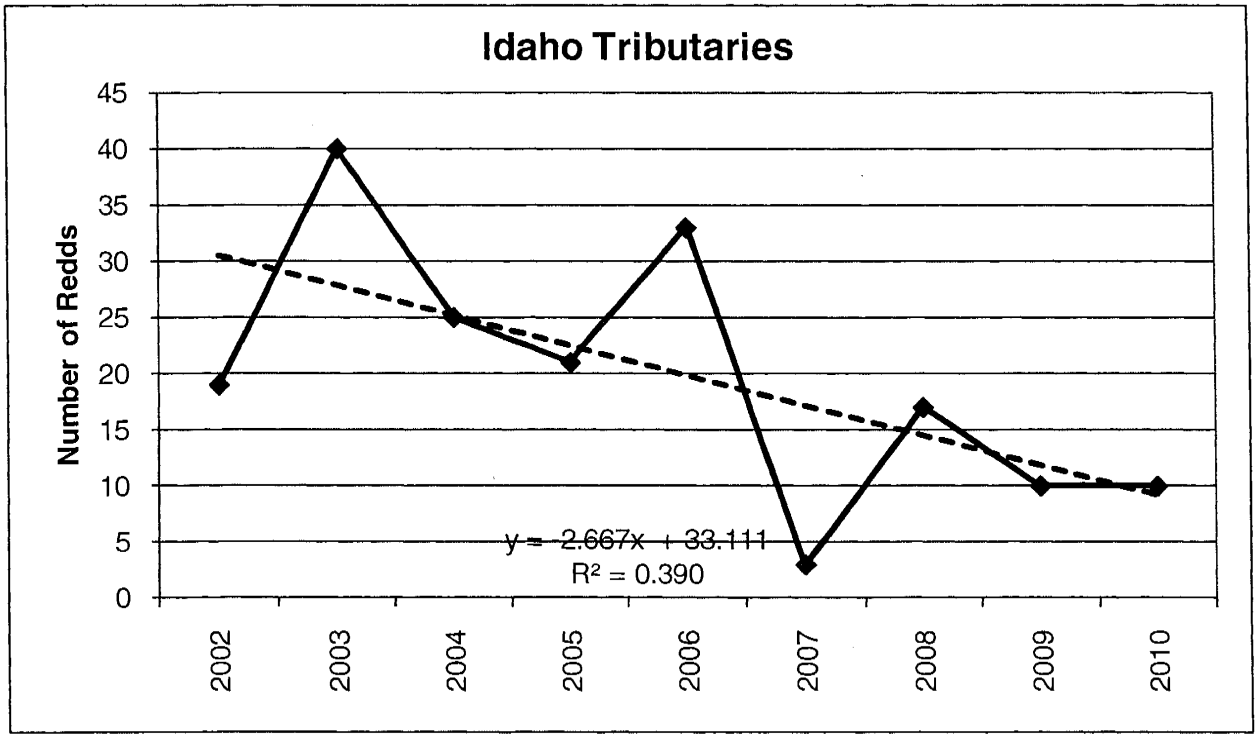
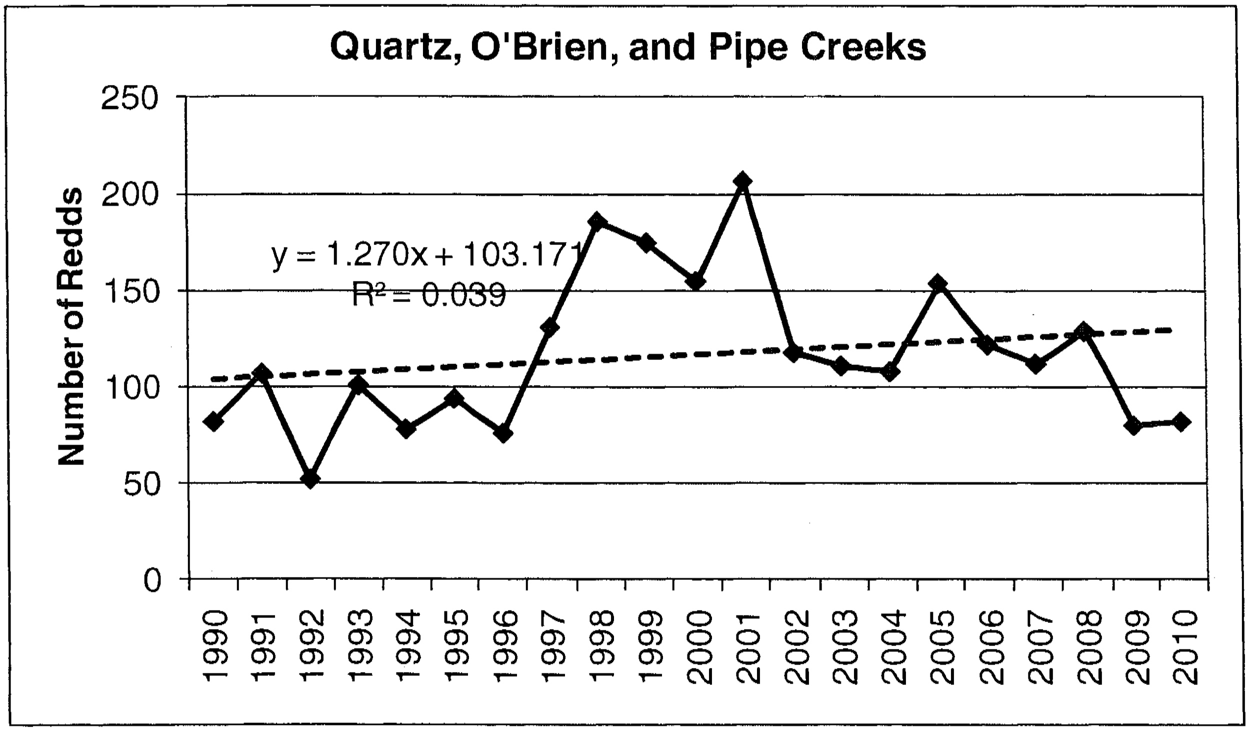


Figure 45. Linear regressions depicting trends in bull trout redd counts in tributaries in the Idaho section of the Kootenai River Core Area from 2002 to 2010.



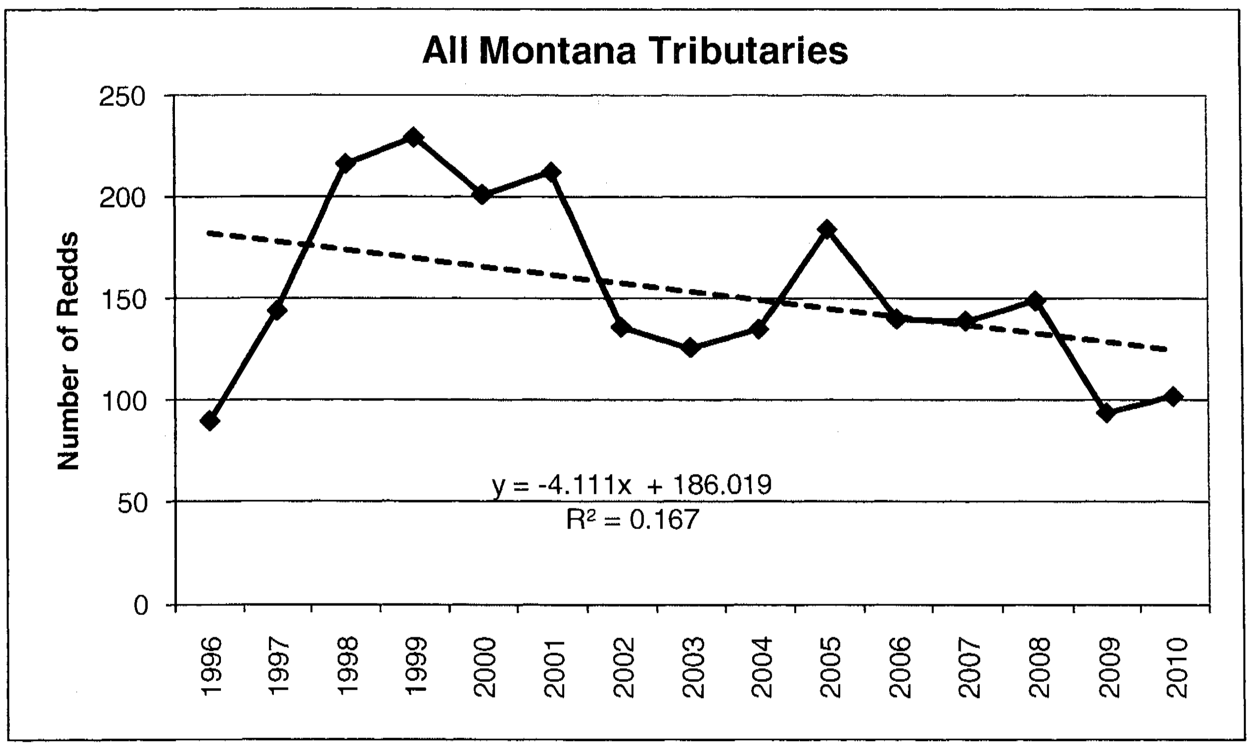


Figure 46. Linear regressions depicting trends in bull trout redd counts in select tributaries (Quartz, O'Brien, and Pipe Creeks) and all tributaries in the Montana section of the Kootenai River Core Area.

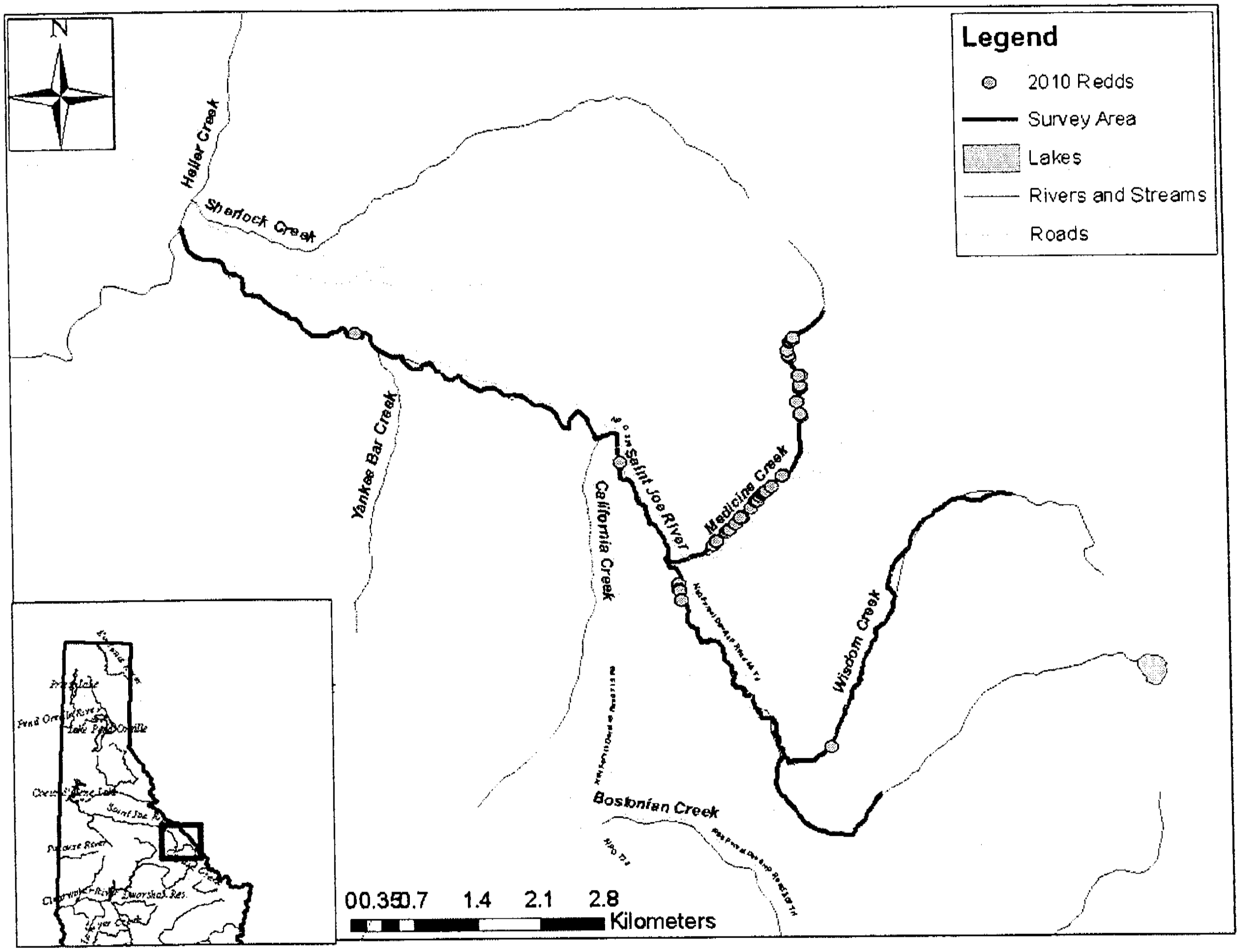
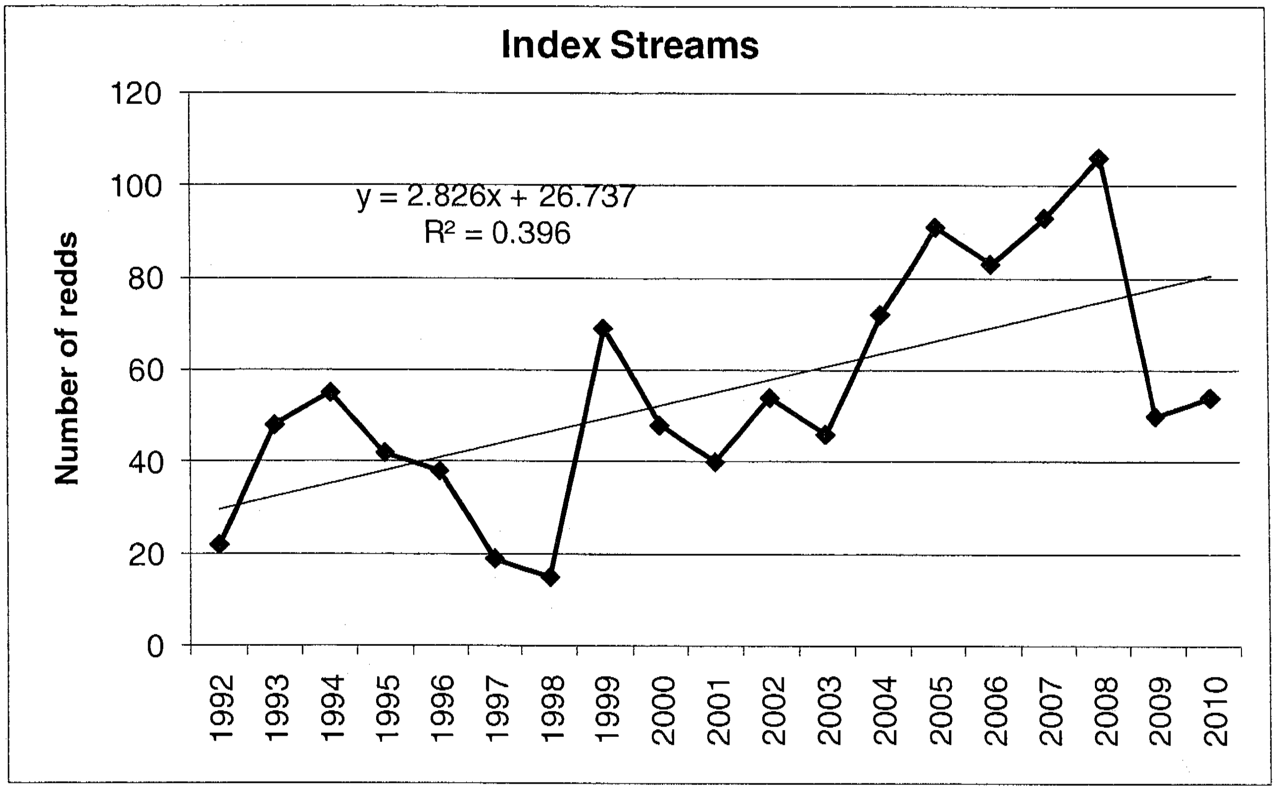


Figure 47. Stream reaches surveyed for bull trout redds in the St. Joe River basin, Idaho, on September 22, 2010 and the locations where redds were observed.



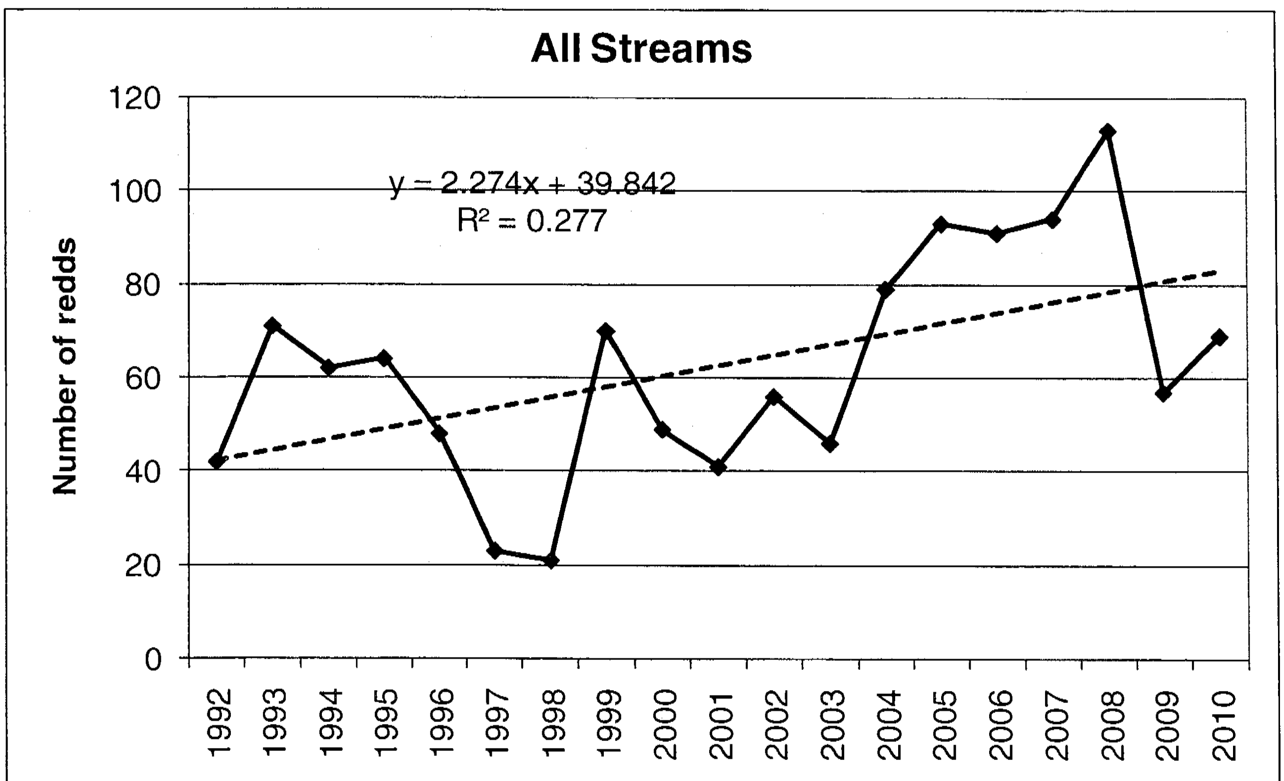


Figure 48. Linear regressions depicting trends in bull trout redd counts (three index streams and all streams combined) in the St. Joe River section of the Coeur d'Alene Lake Core Area, Idaho, from 1992 to 2010.

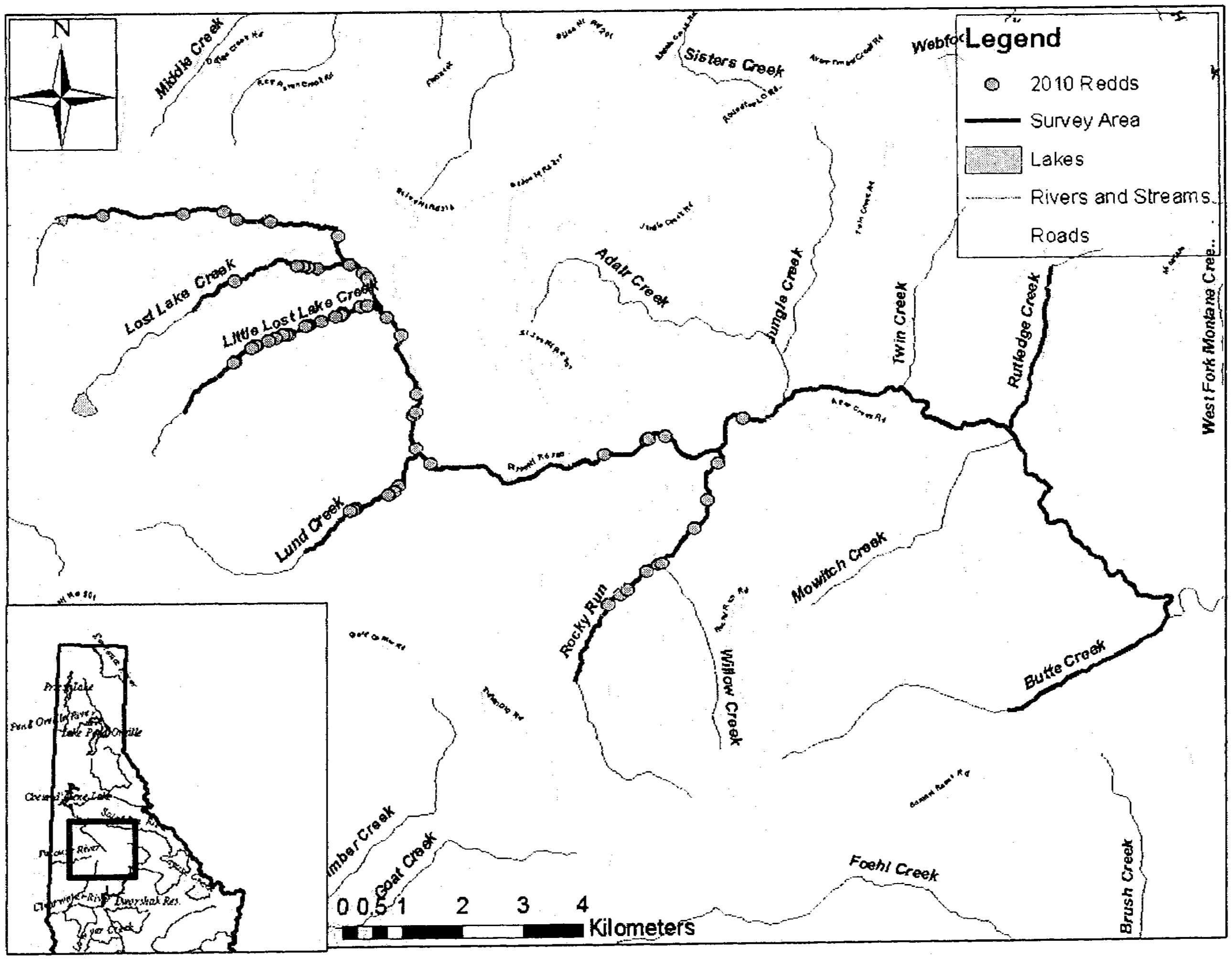


Figure 49. Stream reaches surveyed for bull trout redds in the Little North Fork Clearwater River basin, Idaho, on September 23, 2010 and the locations where redds were observed.

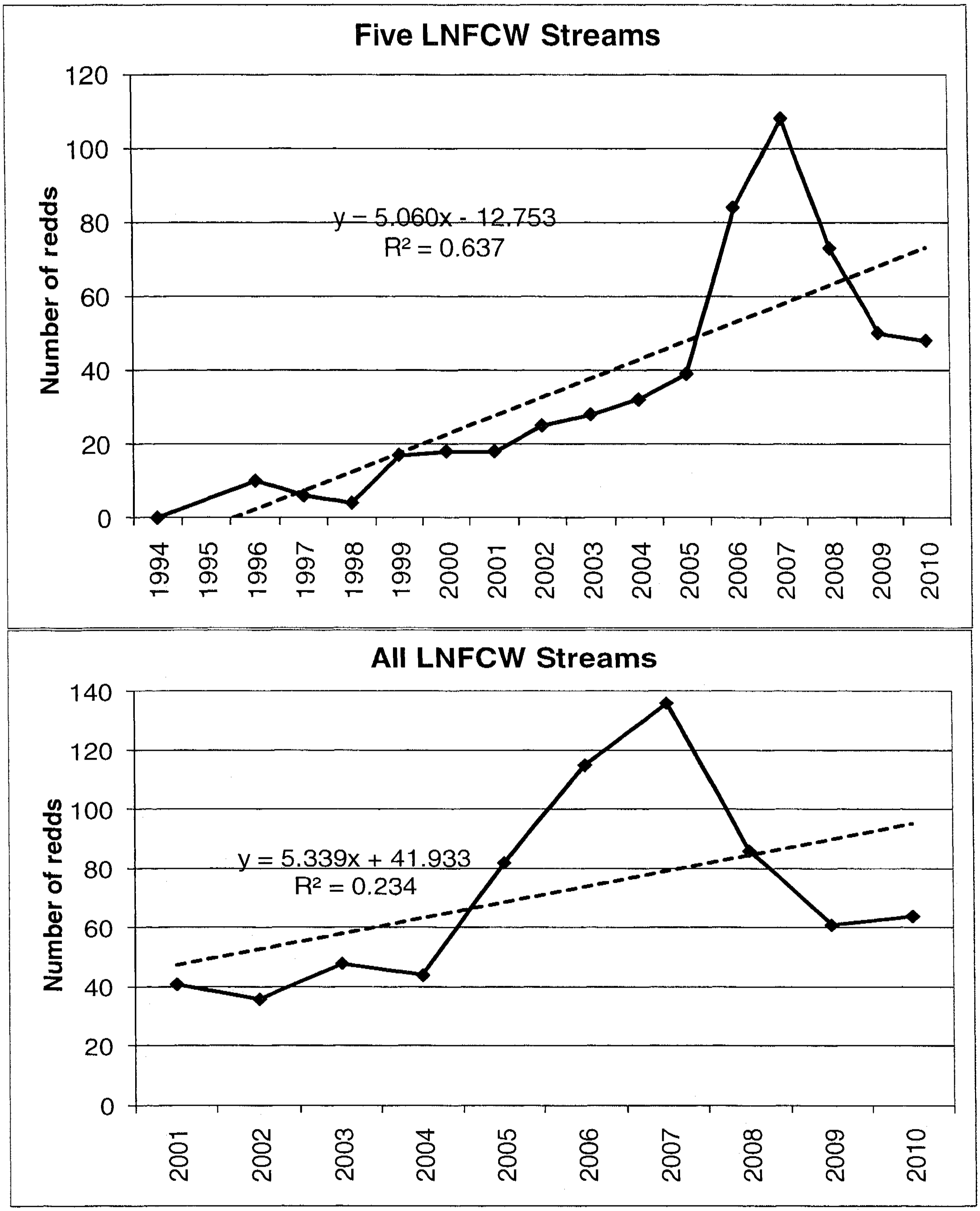
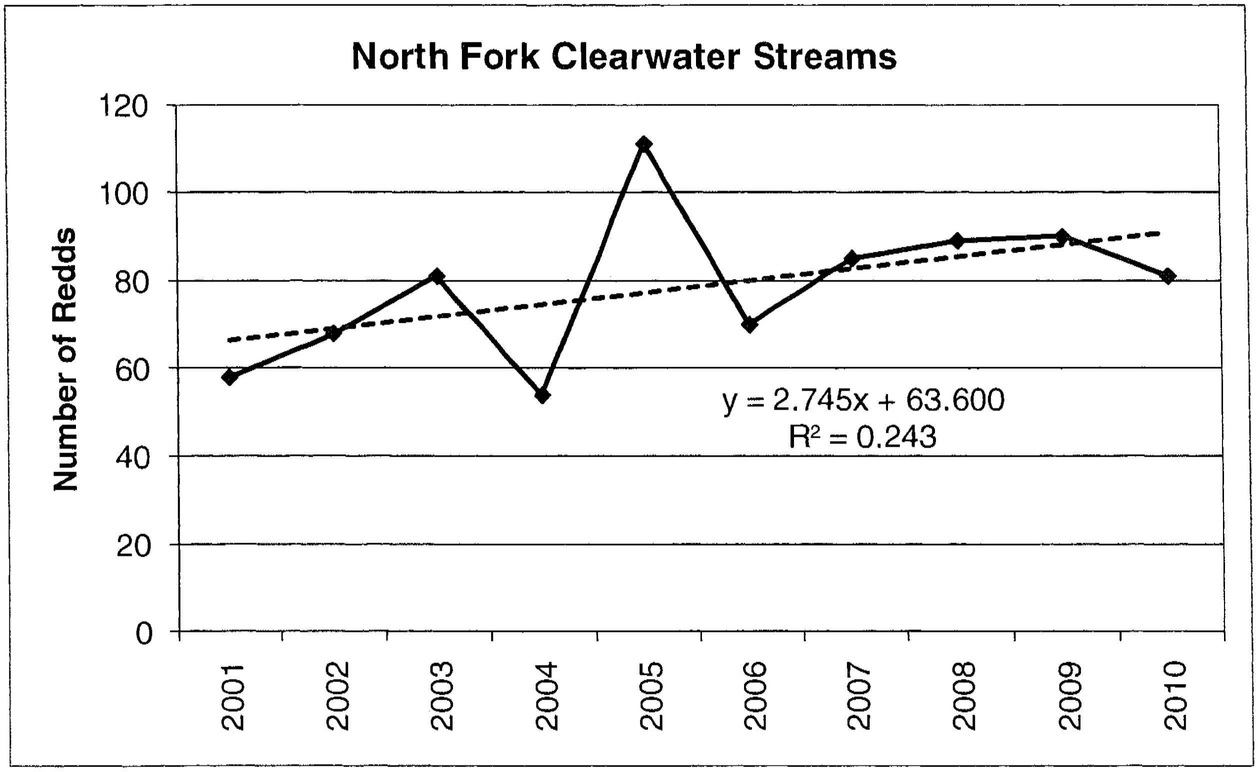


Figure 50. Linear regressions depicting trends in bull trout redd counts (five consistently counted streams and all streams combined) over time in the Little North Fork Clearwater River basin, Idaho.



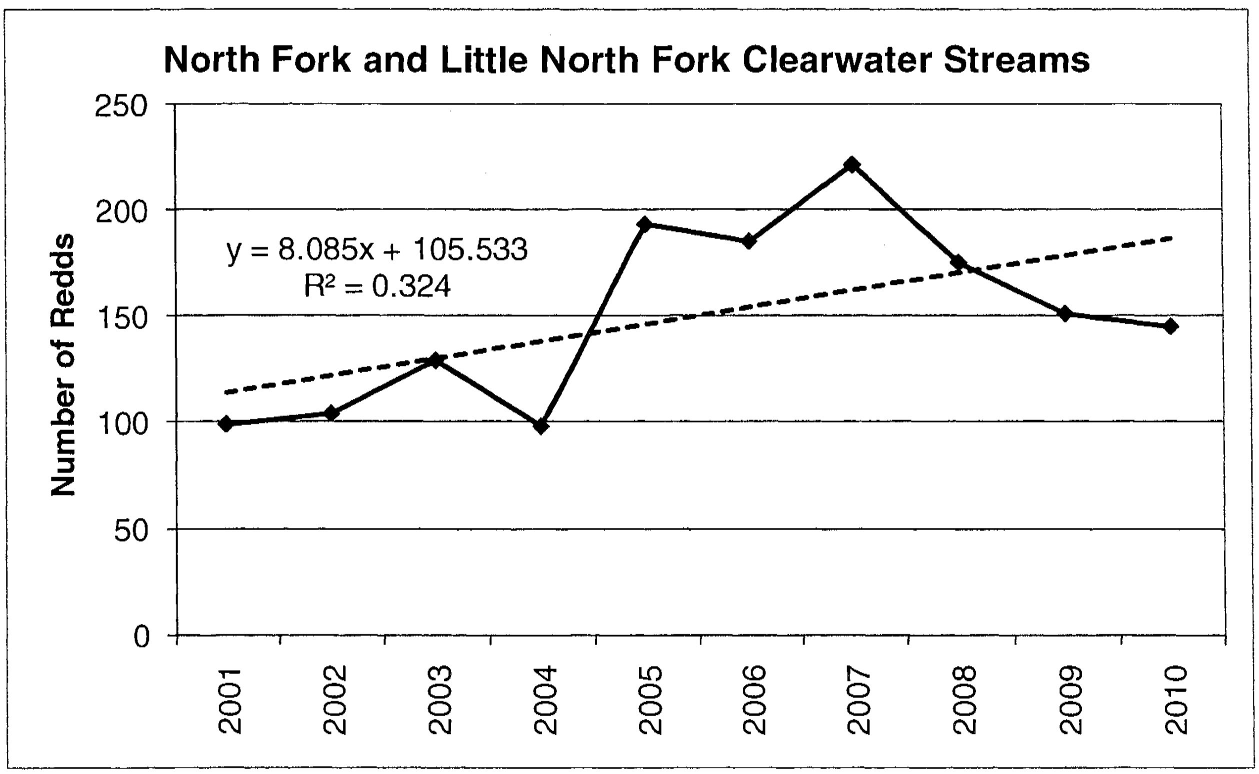


Figure 51. Linear regressions depicting trends in bull trout redd counts from 2001 to 2010 in the North Fork Clearwater River and the Little North Fork Clearwater River, Idaho, combined.

2010 Panhandle Region Annual Fishery Management Report

River and Stream Investigations

SPOKANE RIVER DRAINAGE CUTTHROAT TROUT SURVEYS

ABSTRACT

To estimate fish density and size distribution, we snorkeled a total of 35 transects in the St. Joe River, 43 in the North Fork Coeur d'Alene River, 28 in the South Fork Coeur d'Alene River from July 26th to August 11th, 2010. In addition, 36 sites in the Pine Creek drainage (a tributary to the South Fork Coeur d'Alene River) were sampled with backpack electrofishing equipment from July 26th to August 11th, 2010. Total densities of age-1 and older westslope cutthroat trout were 1.24 fish/100 m^2 in the St. Joe River, 1.20 fish/100 m^2 in the North Fork Coeur d'Alene River, and 0.01 fish/100 m^2 in the South Fork Coeur d'Alene River system. The North Fork Coeur d'Alene and St. Joe rivers exhibit increasing trends in abundance of cutthroat trout following the declines observed after the 1996 and 1997 flood events. Densities of cutthroat trout ≥ 300 mm in length were 0.40 fish/100 m^2 in the St. Joe River and 0.19 fish/100 m^2 in the North Fork Coeur d'Alene River. Densities of cutthroat trout ≥ 300 mm in the St. Joe River were up 14% from 2009 counts. Densities of cutthroat trout in the South Fork Coeur d'Alene River remain low, where only 33 cutthroat trout were observed in over 2,200 m of stream snorkeled. This is lower than the 129 cutthroat trout observed in the same transects in 2006. Taking into account apparent differences in sampling methodology, the overall density of cutthroat and brook trout in the Pine Creek drainage appears to have increased since the last surveys performed by the BLM in 2002 and 2003. The increase in brook trout was primarily seen in the EF Pine Creek and Highland Creek, while increase in cutthroat was primarily recorded in Highland Creek. We found the greatest increase in cutthroat trout density in Highland Creek in site HC 3.5 above a previous migration barrier that was removed by the BLM in 2002. A total of seven rainbow trout was observed in the St. Joe River and 378 (0.24 fish/100 m^2) were observed in the North Fork Coeur d'Alene River during 2010. In the North Fork Coeur d'Alene River, all the rainbow trout were observed in the lowest reaches of the river below Yellow Dog Creek. One bull trout was observed in the St. Joe River in 2010.

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Jim Fredericks
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INTRODUCTION

Past researchers found declines in the fishery were directly related to over harvest in the St. Joe River and a combination of over harvest, habitat degradation, and toxic mine wastes in the Coeur d'Alene River (Rankel 1971; Bowler 1974; Lewynsky 1986; Rabe and Sappington 1970; Mink et al. 1971). Efforts such as habitat improvements and fishing regulation changes were initiated early on to try and mitigate the causes for these declines in the fishery. As a result, westslope cutthroat trout populations have increased significantly and now support very popular fisheries in Idaho.

Snorkel transects for monitoring fish abundance were established in the St. Joe River in 1969, the North Fork (NF) Coeur d'Alene River in 1973 (Rankel 1971; Bowler 1974), and the South Fork (SF) Coeur d'Alene River in 2006 (DuPont et al. 2009). The long term trend data sets collected from these snorkel transects are very important in documenting how changes in fishing regulations, habitat, and weather patterns influence trends in fish populations.

The history in the SF Coeur d'Alene River and its tributaries is quite different than the NF Coeur d'Alene River. Prior to 1968, mining activity delivered such high concentrations of heavy metals to the SF Coeur d'Alene River that it prevented any life from existing in much of the river (Mink et al. 1971). In the early 1970's, as heavy metal concentrations declined, insects began appearing throughout the SF Coeur d'Alene River (Rabe and Flaherty 1974). However, it wasn't until the early 1990's that fish were reported to be surviving in the lower portions of the river. Transects were set up for the first time in 2006 in the SF Coeur d'Alene River to help monitor the recovery of this fishery and to evaluate the success of restoration activities.

Identification of limiting factors, distribution, and trend data on cutthroat trout throughout the SF Coeur d'Alene River and tributaries such as Pine Creek are important to partnering agencies (i.e., BLM) to prevent impacts to fisheries as a result of land management actions. In 2010, we received a challenge cost-share grant from BLM to add to cutthroat trend density estimates in the SF Coeur d'Alene River and to evaluate the cutthroat trout densities in Pine Creek which will serve as a tool for evaluating past and future habitat mitigation programs on BLM land in the drainage.

OBJECTIVE

1. Estimate salmonid density and trends in abundance in transects of the St. Joe River, NF and SF Coeur d'Alene rivers, and Pine Creek.

STUDY SITES

St. Joe River

We snorkeled a total of 35 transects in the St. Joe River basin during 2010, which spans a total of 115 km of river (Figure 52). Coordinates, photographs, and a history of transect location changes for each of these transects are described in DuPont et al. (2009).

North Fork Coeur d'Alene River

In the NF Coeur d'Alene River, 24 snorkel transects are located in the main river system (85 river km), 13 are in the Little North Fork (LNF) Coeur d'Alene River (45 river km) and seven are in Tepee Creek (8 river km). Some of the transect locations have been changed over the years as the river has shifted positions and pools have filled in with sediment (see DuPont et al. 2009). We snorkeled 44 transects in the Coeur d'Alene basin during 2010, which spans about 138 km of river (Figure 53).

South Fork Coeur d'Alene River

In the SF Coeur d'Alene River, 23 snorkel transects are located in the main river system (35 river km; Figure 54). Sites are spread throughout the length of the river to help determine if habitat, heavy metals, or other factors may be influencing fish densities. Sites downstream of Jackass Creek (SF1-11) were accessed by one man pontoon boats, whereas sites SF12-27 were accessed on foot. A few transect locations in 2010 had to be reestablished since the last surveys were performed in 2006. In 2010, a few transects in the SF Coeur d'Alene had to be moved as a result of shifting habitat during flood events. Photographs and a detailed description of new site locations are recorded in agency files.

Pine Creek Drainage

We set up a total of 18 electrofishing transects in the Pine Creek drainage in 2010 (Figure 55). These sites included 10 transects setup and sampled by the BLM in 2002 – 2003 prior to habitat restoration. Our sample sites were located in EF, Middle Fork (MF), and West Fork (WF) Pine, Hunter, Trapper, Langlois, Calusa, Douglas, and Highland creeks. We sampled sites in Highland Creek to evaluate the removal of a velocity barrier (culvert) and placement of a brook trout passage barrier by the BLM. Photographs of sample locations were recorded in agency files. Multiple habitat improvements in the Pine Creek drainage have been completed by BLM since the 2002 sample Appendix A.

METHODS

Field Work

Snorkeling was used to evaluate trends in fish abundance in the St. Joe, NF, and SF Coeur d'Alene rivers following standardized methods described by DuPont et al. (2009). We snorkeled transects on the SF Coeur d'Alene River from July 26th - 28th, the NF Coeur d'Alene River from August 2nd - 5th, and the St. Joe River from August 9th - 11th, 2010. All of these sample dates are consistent with previous year's sampling events.

We sampled fish populations in the Pine Creek from drainage July 12th - 23rd, 2010 with a Smith-Root SR 15 backpack electroshocker. In order to keep consistent with BLM sampling in

2002 and 2003, we performed a single-pass at their previously sampled transects. In order to estimate capture efficiency and produce a density estimate of brook trout and westslope cutthroat trout, we performed a three-pass depletion in at least one transect of each tributary sampled. We placed block nets at each end of the section during the depletion exercise. At each site, we netted, counted, and measured all fish for total length (mm). In addition, we counted amphibians that were incidental in the sample.

Data Analysis

We converted fish counts to density (fish/100 m^2) for each transect to standardize the data and allow comparison within the watershed as well as between similar watersheds. Average densities of each salmonid species (all sizes) and for cutthroat trout ≥ 300 mm were also calculated for each stream sampled. The density estimates were added to the long term data set to evaluate their trends in abundance.

For the Pine Creek drainage fish density estimates, we used the USFS MicroFish software to estimate abundance, 95% confidence limits, and capture probabilities (CP). We used regression analysis to correlate the number of fish captured during the first pass of the three-pass sampling events to the population estimates following completion of the multi-pass depletion method. We then applied this relationship to single-pass sites to estimate trout abundance. A full description can be found in Kruse et al. (1998).

Unfortunately, statistical testing to evaluate whether densities of cutthroat trout have improved following BLM habitat enhancement in the Pine Creek drainage could not be performed due to unknown sampling efficiency of pre-treatment data collected.

RESULTS

St. Joe River

We counted a total of 1,298 cutthroat trout, seven rainbow trout, and 1,111 mountain whitefish in St. Joe River transects (Table 44). One bull trout was also observed near the confluence of Gold Creek. Cutthroat trout were observed in 33 of the 35 transects we snorkeled. Densities of cutthroat trout (all size classes) at these transects ranged from 0.00 to 15.76 fish/100 m^2 with an overall average of 1.24 fish/100 m^2 (Tables 44 and 45; Figure 56). About 33% of the cutthroat trout observed were estimated to be ≥ 300mm in length and their overall density was calculated to be 0.40 fish/100 m^2.

We counted mountain whitefish in 31 of the 35 transect. Mountain whitefish were the second most numerous fish observed (Table 44). We observed the highest density of mountain whitefish (7.19 fish/100 m^2) in the reach between the Red Ives Creek and Ruby Creek (Table 46). The overall mean density of mountain whitefish estimated in 2010 was 1.06 fish/100 m^2.

As in 2009, we counted few rainbow trout (seven) during 2010. We only observed one rainbow trout upstream of the N.F. St. Joe (Table 47).

North Fork Coeur d'Alene River

We counted a total of 1,910 cutthroat trout, 378 rainbow trout, seven brook trout, and 6,881 mountain whitefish in the Coeur d'Alene River transects (Table 48). We observed cutthroat trout in 43 of the 44 transects snorkeled. Densities of cutthroat trout (all size classes) in these transects ranged from 0.00 to 5.92 fish/100 m^2 with an overall average of 1.19 fish/100 m^2 (Tables 48 and 49; Figure 57). About 18% of the cutthroat trout were estimated to be over 300 mm in length and their overall density were calculated at 0.19 fish/100 m^2 (Table 49).

Mountain whitefish were observed in 18 snorkel transects in the NF Coeur d'Alene River system in 2010 and densities ranged from 0.00 to 27.3 fish/100 m^2 with a mean density of 4.28 fish/100 m^2 (Table 50). We observed the highest densities of mountain whitefish in the lower NF Coeur d'Alene River, no whitefish in the LNF Coeur d'Alene River, and few (20) upstream of Tepee Creek (Table 50).

We observed rainbow trout in 15 snorkel transects during 2010, and densities ranged from 0.00 to 1.28 fish/100 m^2 with a mean density of 0.24 fish/100 m^2 (Table 51). All of the rainbow trout we observed in the most downstream reaches of the NF and LNF Coeur d'Alene rivers (Table 51). Of the 378 rainbow trout we observed, we estimated 44 (13%) to be over 300 mm in length. Cutthroat trout densities in the NF Coeur d'Alene River are becoming similar to what we observe in the St. Joe River (Figure 58).

South Fork Coeur d'Alene River

We counted a total of 33 cutthroat trout, seven rainbow trout, 31 brook trout, 69 mountain whitefish, and 10 Chinook salmon in the SF Coeur d'Alene River transects (Table 52). We observed cutthroat trout in nine of the 28 transects snorkeled. Densities of cutthroat trout (all size classes) in these transects ranged from 0.00 to 1.40 fish/100 m^2 with an overall average of 0.09 fish/100 m^2. We estimated about 6% of the cutthroat to be over 300 mm in length and estimated their overall density to be 0.01 fish/100 m^2. The last survey, completed in 2006, showed higher densities of cutthroat trout (Table 53). The greatest reduction in density since the 2006 survey was recorded in those transects above Canyon Creek. Flows in the SF Coeur d'Alene were similar to what was recorded in 2006 and the 10-year average (Figure 59). Heavy metal concentrations from the SF Coeur d'Alene during this time showed relatively high zinc, lead, and cadmium concentrations (Table 54).

We observed mountain whitefish in 4 snorkel transects in the SF Coeur d'Alene River system in 2010 and densities ranged from 0.00 to 4.85 fish/100 m^2 with a mean density of 0.19 fish/100 m^2. We observed the highest densities of mountain whitefish in the SF Coeur d'Alene River below Pine Creek and saw none upstream of the Pine Creek confluence (Table 52).

We counted brook trout in 10 snorkel transects during 2010. Densities ranged from 0.00 to 1.25 fish/100 m^2 with a mean density of 0.08 fish/100 m^2 (Table 52). All of the brook trout we observed were below the Twomile Creek confluence.

Pine Creek Drainage

We counted a total of 204 cutthroat trout, 178 brook trout, and 1,830 sculpin in the nine tributaries sampled in the Pine Creek drainage (Table 55). We sampled cutthroat trout in 14 of the 18 transects electrofished. Mean densities of cutthroat trout (all size classes) in these transects ranged from 0.00 to 54.6 fish/100 m^2 with an overall average of 11.1 fish/100 m^2 (Tables 52 and 53). Of the tributaries we sampled, Highland Creek had the highest density of cutthroat trout. We sampled brook trout in 11 of the 18 transects electrofished. We did not sample brook trout in Hunter, Trapper, and MF Pine creeks. Of the tributaries we sampled, EF Pine Creek had the highest density size of brook trout.

Overall, the density of cutthroat and brook trout in the Pine Creek drainage appears to have increased since the last surveys performed by the BLM in 2002 and 2003. The majority of the increase of brook trout was seen in the EF Pine Creek and Highland Creek, while the majority of cutthroat was only recorded in Highland Creek (Table 59). We found the most significant increase in cutthroat trout density in Highland Creek in site HC 3.5. No brook trout were sampled above the fish passage barrier placed by the BLM in 2002 between HC 2.9 and 3.5.

We sampled a total of 35 Idaho giant salamanders *Dicamptodon aterrimus* in 10 of the 36 sample locations in the Pine Creek drainage. We found the majority of Idaho giant salamanders located in headwater streams such as Trapper, MF Pine, and Langlois creeks (Table 59). We also sampled a total of 223 tailed frogs *Ascaphus truei*. All sample locations in the Pine Creek drainage had tailed frogs present. The majority of tailed frogs were located in MF Pine, Highland, and Douglas creeks (Table 59).

DISCUSSION

St. Joe River

Cutthroat trout densities in the St. Joe River have increased steadily since snorkel counts were first initiated in 1969. Early research indicated the depressed cutthroat trout fishery was a result of over-fishing (Mallet 1967; Dunn 1968; Rankel 1971). Changes in fishing regulations over the past three decades, in combination with improving habitat throughout the basin, have provided what is now one of Idaho's premier trout fisheries (DuPont et al. 2009).

Total densities of cutthroat trout across all size classes in the St. Joe River were 47% higher this year compared to 2009. At the same time, densities of fish >300 mm were 14% higher than 2009. The majority of the increase in larger fish occurred above the NF St. Joe River, with the highest increase in density (77%) occurring from NF St. Joe River to Prospector Creek. This is the highest cutthroat density that we have recorded in this section since surveys began in 1969.

Following the recovery of cutthroat trout from the floods of 1996 in the St. Joe River, their densities have remained relatively stable. Cutthroat trout densities in the river reach from NF. St. Joe River to Ruby Creek are the same as estimated in 1995 prior to flooding and densities of cutthroat trout ≥300 mm are currently the highest on record. Cutthroat trout ≥300 mm represented 21 - 43% of fish observed in the St. Joe River (above the North Fork) between 2004 and 2010, which is also the highest we have recorded. The combination of mild winters and expansion of catch-and-release waters to its current basin-wide designation are thought to be primarily responsible for such increases (DuPont et al. 2009).

Wide fluctuations in density over the past three decades are difficult to interpret due to the environmental and human variables involved. Implementation of catch-and-release rules for cutthroat in the drainage in 2008 all but eliminates harvest mortality, which makes it easier in the future to relate environmental factors such as flood events to changes in fish density.

North Fork Coeur d'Alene River

As with the St. Joe River, cutthroat trout densities have increased since we have begun our surveys in the early 1970's. The last four survey years have been the highest densities of cutthroat recorded. Much of this increase can likely be attributed to regulation changes and improved timber management policies throughout the basin. For a detailed breakdown of basin wide changes and how they may correlate to changes in fish densities see DuPont et al. (2009).

Westslope cutthroat trout density in the NF Coeur d'Alene River increased by 33% from 2009 estimates. We also observed a 43% increase in cutthroat density in the sections of the NF Coeur d'Alene River where we allowed harvest prior to 2008. This suggests our basin-wide catch-and-release regulation is having a positive effect. Alternatively, large fluctuations in cutthroat trout densities are not uncommon in Idaho rivers and have even been documented in wilderness rivers (Selway and Middle Fork Salmon rivers) where fishing pressure and habitat degradation are usually not significant issues (DuPont et al. 2009). Densities of cutthroat in the NF Coeur d'Alene River are approaching those in the upper St. Joe River. With continued habitat improvement and protection of cold water side channels, this trend will likely continue.

South Fork Coeur d'Alene River

In 2010 we snorkeled the SF Coeur d'Alene River for the second time since transects were established in 2006. Although cutthroat trout were located throughout the river, densities were extremely low, even upstream of Canyon Creek where densities were considerably higher in 2006. Essentially, cutthroat trout densities declined from the upstream to downstream sites. As in 2006, the relative absence of larger cutthroat trout in 2010 was also very apparent in the SF Coeur d'Alene River. In the 28 transects we snorkeled, we saw only two cutthroat trout >300 mm in length.

The low densities of trout in all sections of the river are likely a function of physical habitat and/or poor water quality. DuPont et al. (2009) proposed that the main reason for low densities of cutthroat in the SF Coeur d'Alene River was elevated heavy metals. Prior to 1971, heavy metal concentrations (cadmium and zinc) were so high that no life existed in the SF Coeur d'Alene River downstream of Canyon Creek (Ellis 1940; Mink et al. 1971). As heavy metal concentrations were reduced through intense habitat mitigation (Mink et al. 1971), fish began to re-appear and survive in the river by the 1990s. Woodward et al. (1997) found that cutthroat trout will avoid waters with zinc concentrations >28 μg/L. In 2010, zinc concentrations during our snorkel survey (near transect 12) exceeded 530 μg/L, more than 19 times the level that cutthroat trout have been found to avoid (Woodward et al. 1997). Heavy metals have not been surveyed upstream of Twomile

Creek since 1998 so any correlation with fish densities is purely speculative. Zinc concentrations upstream of Canyon Creek in 1998 were at 3 to 7 times lower than what was measured downstream.

Pine Creek and Tributaries

When we compare 2010 data with only those densities collected on the 1st pass from five tributaries sampled in 2003, we found a threefold increase in brook trout and a fivefold increase in cutthroat trout. The data collected in 2010 suggests that there were significant increases in cutthroat and brook trout densities since 2003. We, however, caution against drawing any solid conclusions for the simple reason that sampling efficiency was unknown for the pre-treatment data collected in 2003. Multiple pass data collected in 2010 allowed us to build a predictive model to estimate total density at each transect. Without the same methods performed during pre-treatment collections, even single pass comparisons are questionable.

Taking the assumption of similar capture efficiencies into consideration, the greatest increase in cutthroat trout occurred in Highland Creek where the BLM has made improvements for fish passage. In the fall of 2002, the BLM replaced a culvert that was a complete fish barrier between sites HC2.9 and HC3.5 (Appendix B). Prior to removal of the barrier, very few cutthroat trout were sampled above the barrier. Since the replacing of this culvert, along with a culvert that was a partial barrier at the mouth of Highland creek in 2004, cutthroat trout density has increased over 100 times. Similar to this, brook trout numbers have increased 18-fold in the two lower sections of Highland Creek. It is also important to note, however, that in these sections where cutthroat were sampled in 2003, none were sampled in 2010. This may suggest that some displacement through competition has occurred as a result of the increase in brook trout. During the replacement of the upper-most culvert, an additional in-stream barrier (concrete low-head structure; 3.5 m x 60 cm; Appendix B) was installed approximately 100 m downstream of HC3.5 to stop brook trout from migrating above the replaced culvert. Although no brook trout were sampled above this structure, it is not conclusive if the barrier is excluding them or if the habitat is simply not conducive to brook trout. Of the 57 fish sampled at HC2.9, which is below the intentional in-stream barrier, only one brook trout was sampled, showing that even with unimpeded movements, brook trout have not spread to the upper sections. Kondratieff and Myrick (2006) reported that brook trout have the ability to jump up to 74 cm high barriers, which were 3-5 times their body length (given a plunge pool of 40 cm). A similar study by Adams et al. (2000) found that brook trout similar in size were able to ascend barrier heights of 0.5–1.2 m. Since the Highland Creek barrier height varies from 55-65 cm in height during April, prior to runoff, we feel that the structure should only be considered a partial barrier even at the lowest of water conditions in the fall.

Although there are few pre-treatment data for most of the tributaries we sampled in 2010, we believe that the BLM habitat improvements (Appendix A) that have been completed in the drainage are likely improving densities of cutthroat trout in the upper tributaries of Pine Creek. The fisheries data we collected in 2010 should serve as an adequate pre-treatment baseline for future habitat improvement evaluations.

Aside from the Pine Creek drainage, the Idaho giant salamander is located in few other tributaries in the Spokane River drainage. Their presence may be indicative of specific favorable aquatic or riparian conditions lacking in adjacent drainages.

MANAGEMENT RECOMMENDATIONS

1. Continue monitoring trends of cutthroat trout abundance in the St. Joe River and NF Coeur d'Alene River through annual snorkel surveys.

2. Continue monitoring trends of cutthroat trout abundance in the SF Coeur d'Alene River through snorkel surveys every three years.

3. Pursue BLM challenge cost share funds to monitor cutthroat trout densities in Pine Creek every 3 - 5 years.

Table 44. Number and density of fishes observed while snorkeling transects in the St. Joe River, Idaho, during August 9th-11th, 2010.

Reach	Transect	Area (m^2) snorkeled	Cutthroat trout Number counted ≥300mm	Cutthroat trout Number counted all sizes	Cutthroat trout Density (No./100 m^2)	Rainbow trout counted	Mountain whitefish Number counted	Mountain whitefish Density (No./100 m^2)	Largescale sucker counted	Northern pikeminnow counted	Salmonid density (No./100 m^2)
N.F. St Joe River to Prospector Cr.	SJ01	3,796	5	7	0.18	0	6	0.16	2	0	0.00
	SJ02	3,452	9	34	0.98	1	70	2.03	40	25	0.03
	SJ03	1,440	14	29	2.01	0	36	2.50	1	0	0.05
	SJ04	1,725	0	26	1.51	0	24	1.39	0	1	0.03
	SJ05	3,912	33	100	2.56	0	39	1.00	0	14	0.04
	SJ06	7,080	6	32	0.45	0	10	0.14	0	3	0.01
	SJ07	2,336	19	56	2.40	0	48	2.05	0	1	0.04
Prospector Creek to Red Ives Creek	SJ08	2,479	0	8	0.32	0	5	0.20	0	7	0.01
	SJ09	2,444	9	28	1.15	0	14	0.57	0	2	0.02
	SJ10	5,796	72	191	3.30	0	32	0.55	0	7	0.04
	SJ11	2,968	16	59	1.99	1	4	0.13	0	0	0.02
	SJ12	2,229	9	35	1.57	0	16	0.72	0	4	0.02
	SJ13	2,836	21	51	1.80	0	30	1.06	0	12	0.03
	SJ14	2,373	11	50	2.11	0	29	1.22	0	1	0.03
	SJ15	1,518	7	34	2.24	1	3	0.20	0	0	0.03
	SJ16	1,791	10	49	2.74	0	3	0.17	0	0	0.03
	SJ17	2,681	3	13	0.48	0	1	0.04	0	0	0.01
	SJ18	626	21	87	13.89	1	35	5.59	0	0	0.20
	SJ19	1,134	15	21	1.85	0	0	0.00	0	0	0.02
	SJ20	1,488	18	28	1.88	0	2	0.13	0	0	0.02
	SJ21	673	33	106	15.76	0	45	6.69	0	4	0.22
	SJ22	1,793	10	25	1.39	0	23	1.28	0	1	0.03
Red Ives to Ruby Creek	SJ23	693	0	8	1.15	0	0	0.00	0	0	0.01
	SJ24	896	14	56	6.25	0	3	0.33	0	0	0.07
	SJ25	1,380	12	61	4.42	0	10	0.72	0	0	0.05
	SJ26	1,849	0	0	0.00	0	0	0.00	0	0	0.00
	SJ27	1,391	13	18	1.29	0	100	7.19	0	0	0.08
	SJ28	1,009	8	13	1.29	0	0	0.00	0	0	0.01
Calder to N.F. St. Joe	SJ29	6,464	1	2	0.03	2	32	0.50	76	0	0.01
	SJ30	8,400	3	3	0.04	1	58	0.69	83	0	0.01
	SJ31	6,560	3	11	0.17	0	128	1.95	162	40	0.02
	SJ32	5,988	8	10	0.17	0	105	1.75	52	15	0.02
	SJ33	6,546	0	0	0.00	0	73	1.12	0	0	0.01
	SJ34	2,394	0	5	0.21	0	50	2.09	55	0	0.02
	SJ35	4,867	21	42	0.86	0	77	1.58	55	10	0.02
Total	35	105,007	424	1,298	1.24	7	1,111	1.06	526	147	2.30

Table 45. Average densities (fish/100 m^2) of cutthroat trout (all sizes and only those ≥ 300 mm) counted by reach during snorkel evaluations from 1969 to 2010 in the St. Joe River, Idaho.

All sizes of cutthroat trout

Reach	1969	1970	1971	1972	1973	1974	1975	1976	1977	1979	1980	1982	1989	1990	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2007	2008	2009	2010
Calder to North Fork St. Joe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	0.23	0.16	0.14	0.15	0.09	--	0.22	0.11	0.11	--	--	0.13	0.21	0.17	0.18
N.F. St. Joe to Prospector Cr.	0.01	0.00	0.07	0.04	0.01	0.11	0.08	--	0.04	0.08	0.12	0.03	0.18	0.22	0.47	0.33	0.79	0.33	0.18	0.12	0.46	0.52	0.52	0.80	0.50	0.95	0.69	0.94	0.67	1.20
Prospector Cr. to Red Ives Cr.	0.25	0.31	0.58	0.59	0.76	1.40	1.53	3.59	1.72	1.63	1.50	2.93	2.44	2.79	2.13	1.66	2.56	2.42	2.79	1.05	1.11	1.38	1.46	2.01	1.76	2.15	1.48	2.04	1.64	2.39
Red Ives Cr. to Ruby Cr.	1.38	1.39	2.07	2.63	2.55	5.01	6.12	1.89	4.62	3.14	1.46	3.31	2.41	4.05	1.17	1.39	2.58	2.57	1.13	1.44	1.06	1.19	0.93	1.76	2.03	1.22	2.33	1.80	1.99	2.16
All transects - entire river	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.79	0.76	1.19	1.06	1.09	0.50	--	0.80	0.64	0.90	--	--	0.82	1.02	0.84	1.24
N.F. St. Joe to Ruby Creek	0.27	0.29	0.52	0.58	0.63	1.23	1.40	3.10	1.60	1.11	0.88	1.68	1.43	1.82	1.30	1.18	1.99	1.77	1.74	0.79	0.88	1.02	1.00	1.51	1.29	1.61	1.28	1.59	1.30	1.92

Cutthroat trout ≥ 300 mm

Reach	1969	1970	1971	1972	1973	1974	1975	1976	1977	1979	1980	1982	1989	1990	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2007	2008	2009	2010
Calder to North Fork St. Joe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.05	0.02	0.03	0.00	0.01	--	0.02	0.00	0.02	--	--	0.09	0.11	0.05	0.09
N.F. St. Joe to Prospector Cr.	0.01	0.00	0.00	0.00	0.00	0.00	0.00	--	0.00	0.00	0.01	0.00	0.02	0.09	0.08	0.02	0.05	0.07	0.01	0.01	0.12	0.04	0.07	0.17	0.20	0.29	0.27	0.24	0.37	0.36
Prospector Cr. to Red Ives Cr.	0.02	0.02	0.02	0.00	0.10	0.00	0.00	0.00	0.00	0.07	0.12	0.23	0.44	0.95	0.69	0.46	0.40	0.56	0.16	0.08	0.24	0.20	0.30	0.20	0.68	0.77	0.49	0.39	0.65	0.78
Red Ives Cr. to Ruby Cr.	0.12	0.11	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.17	0.47	0.40	0.81	0.88	0.72	0.47	0.70	0.76	0.13	0.26	0.18	0.11	0.24	0.41	0.95	0.27	1.15	0.48	0.84	0.65
All transects - entire river	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.26	0.20	0.19	0.25	0.06	0.05	--	0.10	0.12	0.13	--	--	0.32	0.25	0.35	0.40
N.F. St. Joe to Ruby Creek	0.03	0.02	0.01	0.00	0.06	0.00	0.00	0.00	0.00	0.05	0.11	0.15	0.30	0.57	0.43	0.31	0.33	0.43	0.11	0.08	0.19	0.13	0.19	0.21	0.52	0.54	0.47	0.34	0.56	0.61

1976 - transects 1-12 were not counted.

1977 - transects 1-4 were not counted.

2001 - transects 29-35 were in different locations than other years.

Table 46. Average density (fish/100 m^2) of mountain whitefish counted by reach during snorkel surveys from 1969 to 2010 in the St. Joe River, Idaho.

Reach	1969	1970	1971	1972	1973	1974	1975	1976	1977	1979	1980	1982	1989	1990	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2007	2008	2009	2010
Calder to N.F. St. Joe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.60	0.18	0.34	0.88	0.44	0.10	--	1.25	0.33	0.80	--	--	0.95	0.96	1.23	1.27
N.F. St. Joe to Prospector Cr.	0.86	0.90	0.98	0.24	1.09	0.95	1.08	--	--	1.09	0.77	[illegible]	0.70	1.13	0.40	2.12	1.29	1.03	0.27	1.39	0.51	0.33	0.75	2.38	1.11	1.83	1.33	1.30	1.53	0.98
Prospector Cr. to Red Ives Cr.	1.24	1.16	1.12	0.82	3.72	1.33	0.97	0.71	0.23	1.69	1.20	[illegible]	2.17	2.01	2.11	0.65	1.67	1.02	0.47	0.80	0.55	1.22	1.22	1.87	1.59	1.15	2.34	1.35	0.79	0.74
Red Ives Cr. to Ruby Cr.	1.83	1.32	1.89	2.26	1.39	2.28	2.45	1.14	1.56	2.79	1.27	[illegible]	1.32	2.22	0.66	1.03	1.73	1.60	0.35	0.38	0.47	0.56	0.37	1.12	0.99	0.93	2.66	1.83	3.60	1.57
Average for all sites	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.95	0.75	1.03	1.01	0.41	0.60	--	0.92	0.68	1.47	--	--	1.59	1.20	1.31	1.06
NF St Joe to Ruby Creek	1.14	1.06	1.14	0.73	2.29	1.27	1.19	0.84	0.34	1.54	1.01	[illegible]	1.42	1.65	1.20	1.19	1.56	1.11	0.39	0.94	0.53	0.79	0.92	1.98	1.33	1.37	2.01	1.38	1.36	0.92

1976 -transects SJ01-SJ12 were not snorkeled.

1977 - transects SJ01-SJ04 were not snorkeled.

1977 - transects SJ05-SJ16 were only evaluated for presence/absence.

1982 - transects SJ01-SJ25 were only evaluated for presence/absence.

2001 - transect locations differed this year from other years.

Table 47. Average density (fish/100 m^2) of rainbow trout counted by reach during snorkel evaluations from 1969 to 2010 in the St. Joe River, Idaho.

Reach	1969	1970	1971	1972	1973	1974	1975	1976	1977	1979	1980	1982	1989	1990	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2007	2008	2009	2010
Calder to N.F. St. Joe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.14	0.10	0.21	0.20	0.03	0.15	--	0.23	0.04	0.03	--	--	0.02	0.02	0.02	0.01
N.F. St. Joe to Prospector Cr.	0.07	0.13	0.25	0.25	0.16	0.44	0.86	--	0.01	0.14	0.10	0.18	0.28	0.43	0.15	0.10	0.07	0.37	0.06	0.46	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Prospector Cr. to Red Ives Cr.	0.25	0.94	0.82	0.05	0.09	0.18	0.47	0.00	0.04	0.04	0.27	0.01	0.00	0.10	0.01	0.05	0.01	0.03	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01
Red Ives Cr. to Ruby Cr.	0.11	0.41	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average for all sites	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.10	0.08	0.11	0.17	0.02	0.16	0.00	0.06	0.02	0.01	--	--	0.01	0.01	0.01	0.01
NF St Joe to Ruby Creek	0.16	0.52	0.48	0.14	0.11	0.27	0.59	0.00	0.02	0.08	0.16	0.09	0.12	0.23	0.07	0.06	0.03	0.14	0.02	0.17	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01

1976 - transects SJ01-SJ12 were not snorkeled.

1977 - transects SJ01-SJ04 were not snorkeled.

2001 - transect locations differed this year from other years.

Table 48. Number and density (fish/100 m^2) of fishes observed while snorkeling transects in the North Fork Coeur d'Alene River drainage, Idaho, during August 2nd – 5th, 2010.

			Cutthroat Trout				Rainbow Trout		Mountain Whitefish		Largescale Sucker	Northern Pikeminnow	Brook Trout	Salmonid Density
			Number counted <300mm	Number counted >300mm		Density (No./100 m2)		Density (No./100 m2)		Density (No./100 m2)				(No./100 m2)
Reach	Transect	Area (m2)			Total		Total		Total		Total	Total	Total	
Lower North Fork	NF1	6,364	17	1	18	0.28	29	0.46	400	6.29	200	1900	0	0.07
	NF1slough	1,278	6	3	9	0.70	7	0.55	350	27.38	0	150	3	0.29
	NF2	7,998	4	0	4	0.05	3	0.04	700	8.75	300	2500	3	0.09
	NF3	6,513	32	7	39	0.60	28	0.43	550	8.44	100	2000	0	0.09
	NF4	9,274	29	6	35	0.38	56	0.60	650	7.01	700	820	0	0.08
	NF5	7,190	46	13	59	0.82	39	0.54	450	6.26	350	800	0	0.08
	NF6	9,086	67	10	77	0.85	74	0.81	1020	11.23	0	0	0	0.13
	NF7	7,499	178	17	195	2.60	40	0.53	500	6.67	100	40	0	0.10
	NF8	6,232	367	2	369	5.92	45	0.72	470	7.54	0	0	0	0.14
	NF9	10,410	30	8	38	0.37	5	0.05	43	0.41	0	0	0	0.01
	NF10	9,444	110	45	155	1.64	28	0.30	651	6.89	0	0	0	0.09
	NF11	7,475	32	13	45	0.60	1	0.01	0	0.00	0	0	0	0.01
	NF12	6,034	14	2	16	0.27	0	0.00	0	0.00	0	0	0	0.00
	NF13	2,904	21	4	25	0.86	0	0.00	0	0.00	0	0	0	0.01
Upper North Fork	NF14	4,855	163	14	177	3.65	0	0.00	480	9.89	15	0	0	0.14
	NF15	3,097	66	30	96	3.10	0	0.00	350	11.30	0	0	0	0.14
	NF16	3,980	5	1	6	0.15	0	0.00	0	0.00	0	0	0	0.00
	NF17	10,350	73	25	98	0.95	0	0.00	150	1.45	0	0	0	0.02
	NF18	1,410	10	16	26	1.84	0	0.00	75	5.32	0	0	0	0.07
	NF19	378	13	3	16	4.23	0	0.00	0	0.00	0	0	0	0.04
	NF20	2,629	1	6	7	0.27	0	0.00	0	0.00	0	0	0	0.00
	NF21	1,268	19	8	27	2.13	0	0.00	5	0.39	0	0	0	0.03
	NF22	1,565	18	13	31	1.98	0	0.00	17	1.09	0	0	0	0.03
	NF23	668	3	1	4	0.60	0	0.00	0	0.00	0	0	0	0.01
Teepee Creek	TP01	1,743	9	11	20	1.15	0	0.00	0	0.00	0	0	0	0.01
	TP02	5,205	0	7	7	0.13	0	0.00	0	0.00	0	0	0	0.00
	TP03	1,411	14	8	22	1.56	0	0.00	14	0.99	0	0	0	0.03
	TP04	1,551	10	8	18	1.16	0	0.00	0	0.00	0	0	0	0.01
	TP05	1,103	6	2	8	0.73	0	0.00	6	0.54	0	0	0	0.01
	TPR1	1,523	2	8	10	0.66	0	0.00	0	0.00	0	0	0	0.01
	TPR2	816	2	5	7	0.86	0	0.00	0	0.00	0	0	0	0.01

Table 48. Continued

Reach	Transect	Area (m2)	Cutthroat Trout Number counted <300mm	Cutthroat Trout Number counted >300mm	Cutthroat Trout Total	Cutthroat Trout Density (No./100 m2)	Rainbow Trout Total	Rainbow Trout Density (No./100 m2)	Mountain Whitefish Total	Mountain Whitefish Density (No./100 m2)	Largescale Sucker Total	Northern Pikeminnow Total	Brook Trout Total	Salmonid Density (No./100 m2)
Upper Little North Fork	LNF1	610	1	0	1	0.16	0	0.00	0	0.00	0	0	0	0.00
	LNF2	2,855	15	5	20	0.70	12	0.42	0	0.00	0	0	0	0.01
	LNF3	2,527	3	2	5	0.20	0	0.00	0	0.00	0	0	0	0.00
	LNF4	784	15	5	20	2.55	10	1.28	0	0.00	0	0	0	0.04
	LNF5	2,252	12	6	18	0.80	0	0.00	0	0.00	0	0	0	0.01
	LNF6	1,746	18	1	19	1.09	0	0.00	0	0.00	0	0	0	0.01
	LNF7	992	15	2	17	1.71	0	0.00	0	0.00	0	0	0	0.02
	LNF8	1,858	25	15	40	2.15	1	0.05	0	0.00	0	0	0	0.02
Lower Little North Fork	LNF9	1,138	0	0	0	0.00	0	0.00	0	0.00	0	0	0	0.00
	LNF10	1,314	40	8	48	3.65	0	0.00	0	0.00	0	0	0	0.04
	LNF11	1,390	20	3	23	1.65	0	0.00	0	0.00	0	0	0	0.02
	LNF12	1,137	10	1	11	0.97	0	0.00	0	0.00	0	0	1	0.01
	LNF13	775	24	0	24	3.10	0	0.00	0	0.00	0	0	0	0.03
TOTALS	**44**	**160,625**	**1,565**	**345**	**1,910**	**1.19**	**378**	**0.24**	**6881**	**4.28**	**15**	**8210**	**7**	**5.71**

Table 49. Mean density (fish/100 m^2) of cutthroat trout (all sizes and only those ≥ 300 mm) counted in reaches of the North Fork Coeur d'Alene River (N.F. Cd'A), Little North Fork Coeur d'Alene River (L.N.F. Cd'A), and Tepee Creek, Idaho, during snorkel evaluations from 1973 to 2010.

All sizes of cutthroat trout

River section	1973	1980	1981	1987	1988	1991	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
N.F. Cd'A - S. F. Cd'A to Prichard Cr.	0.06	0.02	0.02	--	0.05	0.18	0.56	0.31	0.47	0.51	0.35	0.32	0.41	0.53	0.28	0.41	0.60	0.65	0.49	0.92	1.01	0.92	1.31
N.F. Cd'A - Prichard Cr to Yellowdog Cr.	0.05	0.00	0.02	--	0.02	0.14	0.08	0.28	0.19	0.06	0.44	0.41	0.13	0.51	0.49	0.30	0.33	0.66	0.67	0.58	0.46	0.50	0.77
N.F. Cd'A - Yellowdog Cr to Tepee Cr.	0.24	0.31	0.28	1.05	1.10	1.18	0.35	1.70	1.57	1.71	1.70	0.63	0.63	1.74	0.54	0.78	0.88	1.38	1.71	1.48	1.23	1.50	1.70
N.F. Cd'A - Tepee Cr. to Jordan Cr.	1.48	0.68	0.74	2.34	0.46	0.11	0.27	1.31	0.46	1.17	1.87	1.18	1.49	1.02	2.40	1.22	1.27	1.78	2.92	4.12	1.56	1.67	1.31
L.N.F. Cda - Mouth to Laverne Cr.	0.33	0.04	0.02	--	0.10	0.09	0.18	0.03	0.04	0.12	0.22	0.39	0.36	0.28	0.13	0.30	0.22	0.21	0.14	0.53	0.59	0.79	1.03
L.N.F. Cda - Laverne Cr. to Deception Cr.	0.79	1.03	1.95	--	0.90	0.66	0.03	0.47	0.22	0.90	0.00	0.65	0.79	0.12	0.98	0.69	0.97	1.35	0.56	2.26	1.07	0.64	1.84
Tepee Creek	0.00	0.14	0.43	0.24	0.12	0.24	0.19	0.12	0.13	0.02	0.45	1.24	0.25	0.24	0.84	0.44	0.85	0.54	1.00	1.14	0.53	0.69	0.68
Entire N.F. Cd'A River	0.13	0.10	0.11	--	0.33	0.32	0.35	0.54	0.53	0.63	0.69	0.44	0.38	0.76	0.43	0.47	0.58	0.82	0.86	1.05	0.89	0.95	1.23
Entire L.N.F. Cd'A River	0.38	0.15	0.24	--	0.27	0.20	0.15	0.13	0.09	0.35	0.17	0.45	0.45	0.25	0.31	0.39	0.44	0.56	0.27	1.06	0.72	0.76	1.27
All Transects	0.20	0.11	0.14	--	0.31	0.30	0.31	0.43	0.42	0.50	0.57	0.49	0.38	0.61	0.44	0.46	0.58	0.76	0.800	1.06	0.84	0.90	1.20
Limited harvest areas *	0.10	0.02	0.02	####	0.04	0.15	0.32	0.25	0.31	0.28	0.35	0.36	0.28	0.46	0.29	0.36	0.45	0.59	0.51	0.76	0.78	0.77	1.10
Catch and release areas	0.51	0.41	0.53	1.09	0.81	0.76	0.25	0.94	0.72	0.90	1.08	0.89	0.65	1.05	0.89	0.73	0.92	1.23	1.56	1.75	1.03	1.22	1.42
Tepee Creek Rehab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.87	0.00	1.09	0.48	0.55	0.36	0.29	0.62	0.73
N.F. Cd'A - upstream of Jordan Cr.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.51								

* Limited harvest areas for WCT changed to full catch and release in 2008.

Cutthroat trout ≥ 300 mm

River section	1973	1980	1981	1987	1988	1991	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
N.F. Cd'A - S. F. Cd'A to Prichard Cr.	0.00	0.02	0.01	--	0.01	0.01	0.08	0.01	0.01	0.04	0.00	0.00	0.01	0.03	0.01	0.10	0.13	0.13	0.07	0.20	0.13	0.17	0.10
N.F. Cd'A - Prichard Cr to Yellowdog Cr.	0.00	0.00	0.00	--	0.01	0.03	0.02	0.04	0.01	0.01	0.01	0.03	0.01	0.06	0.04	0.09	0.09	0.24	0.21	0.19	0.18	0.17	0.20
N.F. Cd'A - Yellowdog Cr to Tepee Cr.	0.02	0.12	0.04	0.12	0.08	0.13	0.04	0.31	0.07	0.14	0.11	0.02	0.07	0.07	0.12	0.21	0.25	0.52	0.36	0.32	0.22	0.25	0.36
N.F. Cd'A - Tepee Cr. to Jordan Cr.	0.07	0.35	0.20	1.25	0.23	0.06	0.23	0.37	0.29	0.30	0.21	0.18	0.38	0.09	0.44	0.24	0.43	0.69	0.74	0.81	0.54	0.60	0.48
L.N.F. Cda - Mouth to Laverne Cr.	0.02	0.02	0.00	--	0.05	0.05	0.06	0.00	0.00	0.01	0.00	0.00	0.04	0.00	0.00	0.05	0.04	0.08	0.03	0.06	0.08	0.24	0.26
L.N.F. Cda - Laverne Cr. to Deception Cr.	0.18	0.37	0.18	--	0.09	0.00	0.03	0.00	0.00	0.05	0.00	0.00	0.06	0.00	0.11	0.15	0.18	0.16	0.07	0.22	0.04	0.11	0.21
Tepee Creek	0.00	0.03	0.43	0.20	0.06	0.18	0.08	0.09	0.09	0.00	0.08	0.08	0.05	0.04	0.22	0.16	0.34	0.05	0.29	0.30	0.32	0.22	0.33
Entire N.F. Cd'A River	0.01	0.05	0.02	--	0.04	0.04	0.06	0.08	0.03	0.07	0.03	0.02	0.04	0.05	0.05	0.12	0.15	0.24	0.19	0.24	0.17	0.20	0.19
Entire L.N.F. Cd'A River	0.03	0.05	0.02	--	0.06	0.04	0.06	0.00	0.00	0.02	0.00	0.00	0.04	0.00	0.02	0.07	0.08	0.10	0.04	0.11	0.07	0.21	0.25
All Transects	0.01	0.05	0.04	--	0.05	0.04	0.06	0.06	0.03	0.06	0.03	0.02	0.04	0.03	0.06	0.12	0.15	0.21	0.18	0.23	0.17	0.21	0.21
Limited harvest areas *	0.00	0.01	0.01	--	0.01	0.02	0.06	0.02	0.01	0.02	0.00	0.01	0.02	0.03	0.01	0.09	0.10	0.15	0.11	0.18	0.14	0.18	0.15
Catch and release areas	0.04	0.17	0.15	0.33	0.10	0.11	0.07	0.20	0.10	0.12	0.10	0.06	0.11	0.06	0.18	0.19	0.28	0.37	0.36	0.35	0.27	0.26	0.35
Tepee Creek Rehab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.00	0.04	0.04	0.19	0.14	0.10	0.31	0.56

* Limited harvest areas for WCT changed to full catch and release in 2008.

Table 50. Mean density (fish/100 m^2) of all size classes of mountain whitefish counted in reaches of the North Fork Coeur d'Alene River (N.F. Cd'A), Little North Fork Coeur d'Alene River (L.N.F. Cd'A), and Tepee Creek, Idaho, during snorkel evaluations from 1973 to 2010.

River section	1973	1980	1981	1987	1988	1991	1993[5]	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
N.F. Cd'A - S. F. Cd'A to Prichard Cr.	0.75	1.47	0.18	--	3.09	6.59	0.45	2.42	2.53	5.54	0.69	1.05	7.38	4.36	2.91	6.46	4.90	5.49	6.05	6.49	3.67	5.57	8.29
N.F. Cd'A - Prichard Cr to Yellowdog Cr.	0.46	0.02	0.12	--	0.03	1.25	0.29	0.65	0.11	1.13	0.56	0.58	0.23	0.20	0.32	0.83	0.73	2.04	1.48	1.11	1.13	1.02	1.91
N.F. Cd'A - Yellowdog Cr to Tepee Cr.	3.19	1.18	1.71	1.34	1.09	5.52	1.07	2.60	1.65	5.05	1.45	3.57	2.90	4.00	2.13	2.98	3.16	4.43	4.98	5.56	3.70	3.22	4.45
N.F. Cd'A - Tepee Cr. to Jordan Cr.	0.00	0.00	0.00	0.00	0.11	0.00	0.00	1.33	2.41	1.12	0.00	2.80	0.13	0.97	0.65	0.14	0.60	0.00	0.09	0.00	0.00	0.00	0.34
L.N.F. Cda - Mouth to Laverne Cr.	0.59	0.01	0.12	--	0.03	0	0	0	0	1.88	0	0.02	0	0.04	0.03	0.04	0.01	0.19	0.01	0	0.02	0	0
L.N.F. Cda - Laverne Cr. to Deception Cr.	0.00	0.00	0.00	--	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tepee Creek	0.00	0.35	0.00	0.00	0.00	0.00	0.06	0.00	0.00	2.68	0.00	0.20	0.36	1.09	0.91	0.63	1.04	0.43	1.41	1.42	0.00	0.01	0.18
Entire N.F. Cd'A River	1.00	0.80	0.39	--	1.21	4.07	0.46	1.86	1.70	3.52	0.72	1.35	3.46	3.43	2.33	3.95	3.06	4.21	4.26	4.55	2.76	3.58	5.36
Entire L.N.F. Cd'A River	0.52	0.01	0.11	--	0.02	0.00	0.00	0.00	0.00	1.34	0.00	0.02	0.00	0.03	0.02	0.03	0.01	0.13	0.01	0.00	0.01	0.00	0.00
All Transects	0.87	0.65	0.33	--	0.96	3.18	0.37	1.35	1.26	3.03	0.52	1.00	2.78	2.49	1.85	3.18	2.52	3.40	3.56	3.83	2.21	2.80	4.35
Limited harvest areas *	0.60	0.63	0.15	--	1.12	3.29	0.32	1.42	1.37	3.28	0.51	0.70	3.21	2.59	2.02	3.70	2.74	3.75	3.81	3.99	2.41	3.25	5.20
Catch and release areas	1.77	0.71	0.95	0.80	0.64	2.86	0.52	1.14	0.97	2.61	0.53	1.93	1.53	2.20	1.35	1.73	1.93	2.43	2.91	3.45	1.62	1.73	2.34
Tepee Creek Rehab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 51. Mean density (fish/100 m^2) of all size classes of rainbow trout counted in reaches of the North Fork Coeur d'Alene River (N.F. Cd'A), Little North Fork Coeur d'Alene River (L.N.F. Cd'A), and Tepee Creek, Idaho, during snorkel evaluations from 1973 to 2010.

River section	1973	1980	1981	1987	1988	1991	1993[5]	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
N.F. Cd'A - S. F. Cd'A to Prichard Cr.	0.35	0.45	0.59	--	3.15	0.22	0.04	0.16	0.61	0.50	0.75	0.42	1.06	0.76	0.52	0.46	0.48	0.39	0.39	0.47	0.26	0.11	0.52
N.F. Cd'A - Prichard Cr to Yellowdog Cr.	0.48	0.12	0.46	--	0.14	0.20	0.01	0.08	0.14	0.02	0.12	0.06	0.03	0.11	0.00	0.01	0.08	0.06	0.09	0.21	0.01	0.00	0.09
N.F. Cd'A - Yellowdog Cr to Tepee Cr.	0.03	0.21	0.34	0.11	0.03	0.04	0.00	0.00	0.02	0.25	0.01	0.01	0.01	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N.F. Cd'A - Tepee Cr. to Jordan Cr.	0.00	0.00	0.04	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L.N.F. Cda - Mouth to Laverne Cr.	1.39	0.55	1.25	--	1.6	0.99	0.22	0.45	0.02	0.09	0.24	0.54	0.35	0.18	0.46	0.27	0.09	0.17	0.12	0.08	0.30	0.00	0.17
L.N.F. Cda - Laverne Cr. to Burnt Cabin C	0.12	0.06	0.18	--	0.05	0.03	0.00	0.00	0.00	0.62	0.00	0.00	0.00	0.00	0.13	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Tepee Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Entire N.F. Cd'A River	0.33	0.26	0.47	--	1.00	0.17	0.02	0.11	0.37	0.25	0.40	0.24	0.43	0.50	0.34	0.23	0.25	0.22	0.22	0.28	0.14	0.05	0.28
Entire L.N.F. Cd'A River	1.25	0.49	1.13	--	1.27	0.80	0.18	0.34	0.02	0.24	0.19	0.43	0.28	0.15	0.39	0.21	0.07	0.11	0.08	0.05	0.22	0.00	0.12
All Transects	0.46	0.29	0.56	--	0.99	0.27	0.04	0.14	0.28	0.22	0.32	0.27	0.38	0.39	0.33	0.21	0.21	0.19	0.19	0.24	0.14	0.04	0.24
Limited harvest areas *	0.59	0.34	0.66	--	1.49	0.35	0.05	0.19	0.37	0.25	0.46	0.35	0.51	0.51	0.43	0.29	0.29	0.27	0.26	0.34	0.19	0.06	0.34
Catch and release areas	0.03	0.12	0.21	0.06	0.02	0.03	0.00	0.00	0.01	0.16	0.00	0.00	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tepee Creek Rehab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 52. Number and density (fish/100 m^2) of fishes observed while snorkeling transects in the South Fork Coeur d' Alene River, Idaho, during July 26th-28th, 2010.

Reach	Transect 2010	Habitat Type	Area (m^2)	Cutthroat trout Number counted ≥300mm	Cutthroat trout Number counted All sizes	Cutthroat trout Density (No./100 m^2)	Rainbow Trout Number Counted	Rainbow Trout Density (No./100 m^2)	Brook Trout Number Counted	Brook Trout Density (No./100 m^2)	Mountain whitefish Number Counted	Mountain whitefish Density (No./100 m^2)	Northern Pike Minnow Counted	Largescale Sucker Counted	Chinook Salmon Counted
Pine Creek to CdA River	SF1	Glide	5,078	0	0	0.00	0	0.00	1	0.02	7	0.14	0	0	0
	SF2	Pool	4,300	1	1	0.02	0	0.00	1	0.02	0	0.00	0	0	0
	SF3	Run/Glide	2,307	0	0	0.00	0	0.00	1	0.04	1	0.04	0	0	10
	SF4	Run	3,350	0	0	0.00	0	0.00	2	0.06	11	0.33	0	0	0
	SF5	Pool/Riffle	1,030	0	4	0.39	0	0.00	0	0.00	50	4.85	0	0	0
Jackass Creek to Pine Creek	SF6	Run	1,503	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
	SF7	Pool/Riffle	1,103	0	0	0.00	1	0.09	5	0.45	0	0.00	0	0	0
	SF8A	Pool/Run	884	0	0	0.00	0	0.00	1	0.11	0	0.00	0	0	0
	SF9	Run/Riffle	971	1	2	0.21	0	0.00	2	0.21	0	0.00	0	0	0
	SF10	Pool/Riffle/Run	464	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
	SF11	Pool/Run	2,026	0	3	0.15	0	0.00	0	0.00	0	0.00	0	0	0
Twomile Creek to Jackass Creek	SF12	Riffle/Run	1,710	0	7	0.41	2	0.12	8	0.47	0	0.00	0	0	0
	SF13	Pool/Riffle	642	0	9	1.40	1	0.16	8	1.25	0	0.00	0	0	0
	SF14	Pool	1,206	0	0	0.00	1	0.08	2	0.17	0	0.00	0	0	0
	SF15	Pool/Run	1,502	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
	SF16	Pool/Run	1,066	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
	SF17A	Pool/Riffle	818	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
	SF17	Pool/Run	1,283	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
	SF18	Pool/Run	934	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
	SF19A	Pool/Run	704	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
Canyon Creek to Twomile Creek	SF20	Pool/Riffle/Run	698	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
	SF21	Pool	476	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
	SF22	Riffle	842	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
	SF23	Pool/Run	434	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
	SF24	Pool/Riffle/Run	376	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0
Upstream of Canyon Creek	SF25	Pool/Riffle/Run	315	0	2	0.63	0	0.00	0	0.00	0	0.00	0	0	0
	SF26	Pool/Riffle/Run	595	0	3	0.50	1	0.17	0	0.00	0	0.00	0	0	0
	SF27	Pool/Riffle/Run	386	0	2	0.52	1	0.26	0	0.00	0	0.00	0	0	0
Total	28 sites	--	37,003	2	33	0.09	7	0.02	31	0.08	69	0.19	0	0	10

Table 53. Total density (fish/100 m^2) of cutthroat trout observed while snorkeling transects in the South Fork Coeur d'Alene River, Idaho, during 2006 and 2010.

	Snorkel Transect		Fish Density (fish/100m^2)	
Reach	2006	2010	2006	2010
Pine Creek to CdA River	SF1	SF1	0.13	0.00
	SF2	SF2	0.03	0.02
	SF3	SF3	0.15	0.00
	SF4	SF4	0.06	0.00
	SF5	SF5	0.30	0.39
Jackass Creek to Pine Creek	SF6	SF6	0.05	0.00
	SF7	SF7	0.16	0.00
	SF8	--	0.00	--
	--	SF8A	--	0.00
	SF9	SF9	0.00	0.21
	SF10	SF10	0.00	0.00
	SF11	SF11	0.00	0.15
Twomile Creek to Jackass Creek	SF12	SF12	0.79	0.41
	SF13	SF13	1.20	1.40
	SF14	SF14	0.28	0.00
	SF15	SF15	0.21	0.00
	SF16	SF16	0.10	0.00
	--	SF17A	--	0.00
	SF17	SF17	0.74	0.00
	SF18	SF18	0.25	0.00
	SF19	--	0.39	--
	--	SF19A	--	0.00
Canyon Creek to Twomile Creek	SF20	SF20	0.56	0.00
	SF21	SF21	1.80	0.00
	SF22	SF22	0.00	0.00
	SF23	SF23	0.66	0.00
	SF24	SF24	0.00	0.00
Upstream of Canyon Creek	SF25	SF25	9.44	0.63
	SF26	SF26	2.33	0.50
	SF27	SF27	2.64	0.52
		Total	0.39	0.09

Table 54. Dissolved heavy metal concentrations (ug/L) collected during 1998, 2006, and 2010 in three locations of the South Fork Coeur d'Alene River, Idaho.

	Closest Snorkel	Cadmium			Lead			Zinc		
Site	Transect	1998	2006	2010	1998	2006	2010	1998	2006	2010
Elizibeth Park	SF-12	5.7	4.1	3.5	10.0	3.4	2.8	694	573	534
Smelterville	SF-08	NA	5.8	6.4	NA	4.6	94.0	NA	846	982
Below Pine Creek	SF-03	7.6	5.3	8.4	11.0	3.5	2.8	1150	874	652

Table 55. Number of fish sampled in 14 sites and nine tributaries of Pine Creek from July 12th-23rd, 2010.

		Species		
Stream	Transect	WCT	BKT	SHS
EF Pine Creek	EFPC 3.0		19	
EF Pine Creek	EFPC 4.5	8	61	
EF Pine Creek	EFPC 2.2		11	
EF Pine Creek	EFPC 4.7	2	4	91
Highland Creek	HC 0.8		25	
Highland Creek	HC 2.0		23	
Highland Creek	HC 3.5	53		
Highland Creek	HC 2.9	56	1	
Douglas Creek	DC 0.2	1	17	290
Hunter Creek	HTR 0.11	9		213
Trapper Creek	TC 0.1	3		51
Trapper Creek	TC 2.0	4		29
WF Pine Creek	WFPC 1	5	2	141
WF Pine Creek	WFPC 2	12		94
Calusa Creek	CLSA 1	4	6	221
Langlois Creek	LNGL 1	14	9	458
Langlois Creek	LNGL 2	16		84
MF Pine Creek	MFPC	17		158
	Totals	204	178	1,830

Table 56. Number and density of brook and cutthroat trout sampled in 14 sites and nine tributaries of Pine Creek from July 12th - 23rd, 2010. Density is based on total estimated population for each transect.

Stream	Transect	SPECIES	# PASSES	PASS 1	PASS 2	PASS 3	PASS 4	TOTAL	N	Upper 95% CI	Lower 95% CI +	Fish/ 100 m^2
EF Pine Creek	EFPC 2.2	BKT	1	11				11	26	11	42	3.2
EF Pine Creek	EFPC 3.0	BKT	3	10	5	4		19	25	11	39	3.8
EF Pine Creek	EFPC 4.5	BKT	1	61				61	146	110	183	27.3
EF Pine Creek	EFPC 4.5	WCT	1	8				8	19	4	35	3.6
EF Pine Creek	EFPC 4.7	BKT	1	4				4	10	-6	25	2.5
EF Pine Creek	EFPC 4.7	WCT	1	2				2	5	-11	21	1.2
Highland Creek	HC 0.8	BKT	4	12	4	7	2	25	36	22	51	9.5
Highland Creek	HC 2.0	BKT	1	23				23	55	37	73	14.7
Highland Creek	HC 2.9	WCT	1	56				56	134	100	169	44.3
Highland Creek	HC 2.9	BKT	1	1				1	2	-14	18	0.8
Highland Creek	HC 3.5	WCT	1	53				53	127	95	160	65.0
Douglas Creek	DC 0.2	BKT	3	9	7	1		17	19	14	24	4.9
Douglas Creek	DC 0.2	WCT	3	1	0	0		1	1	--	--	0.3
Hunter Creek	HTR 0.11	WCT	3	7	2	0		9	9	8	10	2.2
Trapper Creek	TR 0.1	WCT	1	3				3	7	-8	23	2.6
Trapper Creek	TR 2.0	WCT	1	4				4	10	-6	25	6.7
MF Pine Creek	MFPC	WCT	3	10	7	0		17	18	15	20	5.0
WF Pine Creek	WFPC 1	WCT	1	5				5	12	-3	27	1.5
WF Pine Creek	WFPC 1	BKT	1	2				2	5	-11	21	0.6
WF Pine Creek	WFPC 2	WCT	1	12				12	29	13	44	4.7
Calusa Creek	CLSA 1	WCT	1	4				4	10	-6	25	1.6
Calusa Creek	CLSA 1	BKT	1	6				6	14	-1	30	2.4
Langlois Creek	LNGL 1	WCT	3	6	5	3		14	22	-6	50	5.5
Langlois Creek	LNGL 1	BKT	3	5	2	2		9	11	3	20	2.8
Langlois Creek	LNGL 2	WCT	1	16				16	38	22	55	10.8

Table 57. Mean density of brook and cutthroat trout sampled in nine tributaries of Pine Creek from July 12th - 23rd, 2010.

	Fish/100 m^2	
	BKT	WCT
Calusa Creek	2.42	1.61
Douglas Creek	4.95	0.26
EF Pine Creek	9.18	2.41
Highland Creek	8.31	54.62
Hunter Creek		2.23
Langlois Creek	2.79	8.15
MF Pine Creek		4.97
Trapper Creek		4.64
WF Pine Creek	0.58	3.06

Table 58. Mean density of brook and cutthroat trout sampled in five tributaries of Pine Creek from in 2003 and 2010. Density is based on actual numbers of fish sampled on the 1st pass and not expanded to density based on total estimated population.

Stream	Transect	Species	2003 fish/100 m^2	2010 fish/100 m^2
EF Pine Creek	EFPC 2.2	BKT	1.28	1.32
		WCT	0.64	0.00
EF Pine Creek	EFPC 3.0	BKT	0.43	1.53
		WCT	1.07	0.00
EF Pine Creek	EFPC 4.5	BKT	5.45	11.37
		WCT	1.01	1.49
EF Pine Creek	EFPC 4.7	BKT	1.39	1.03
		WCT	0.00	0.52
Highland Creek	HC 0.8	BKT	0.72	3.11
Highland Creek	HC 2.0	BKT	0.00	6.12
Highland Creek	HC 2.9	BKT	0.00	0.33
		WCT	0.00	18.44
Highland Creek	HC 3.5	WCT	0.43	27.05
Douglas Creek	DC 0.2	BKT	1.39	2.36
		WCT	3.47	0.26
Hunter Creek	HTR 0.11	WCT	3.14	1.72

Table 59. Number of amphibians sampled in 14 sites and nine tributaries of Pine Creek from July 12th - 23rd, 2010. TF = tailed frog; IGS = Idaho giant salamander.

	Number Counted	
	IGS	TF
Calusa Creek	1	4
Douglas Creek	1	31
EF Pine Creek	7	20
Highland Creek		43
Hunter Creek	6	2
Langlois Creek	5	14
MF Pine Creek	7	100
Trapper Creek	8	2
WF Pine Creek		7

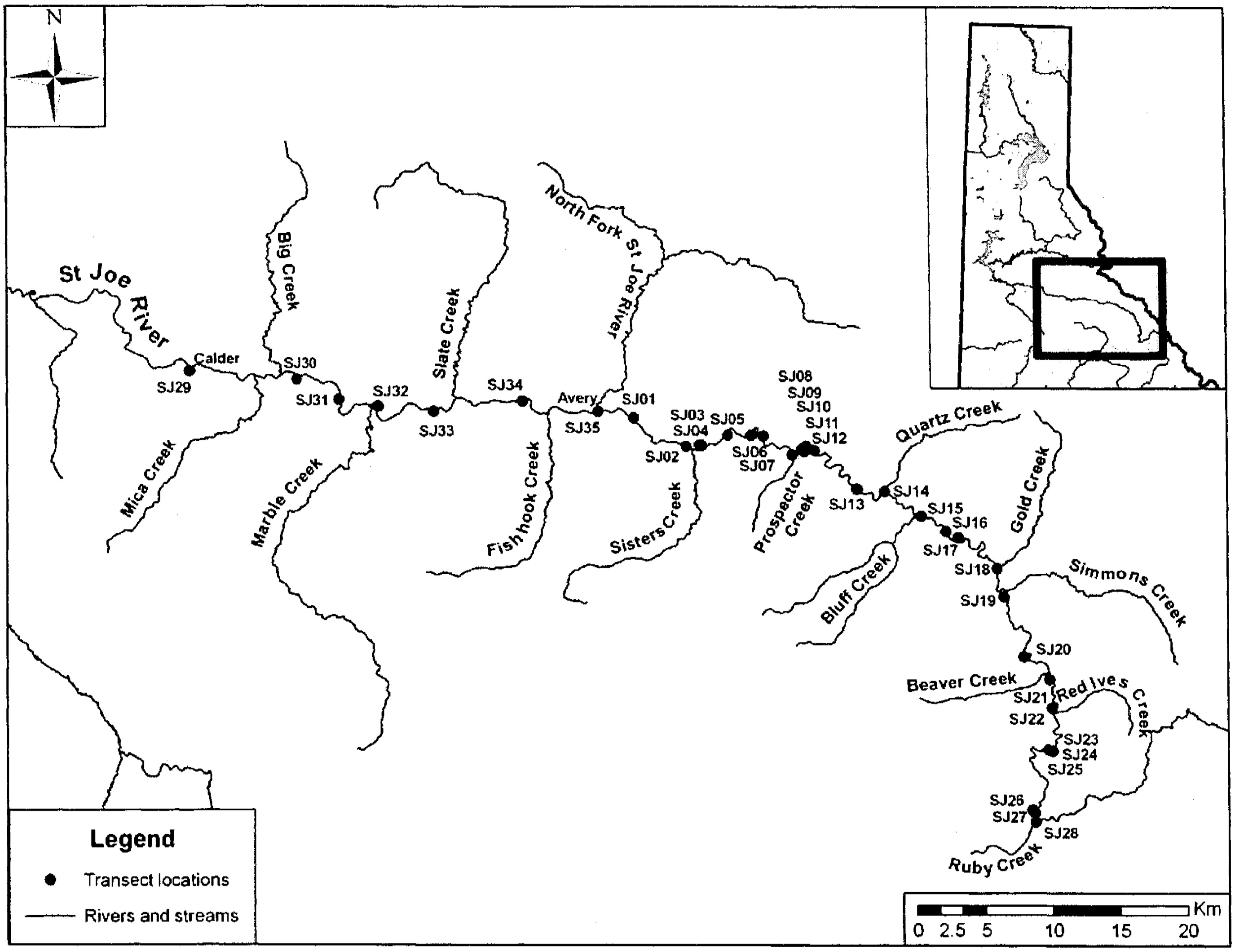

Figure 52. Location of 35 transects that were snorkeled on the St. Joe River, Idaho, during August 9th - 11th, 2010.

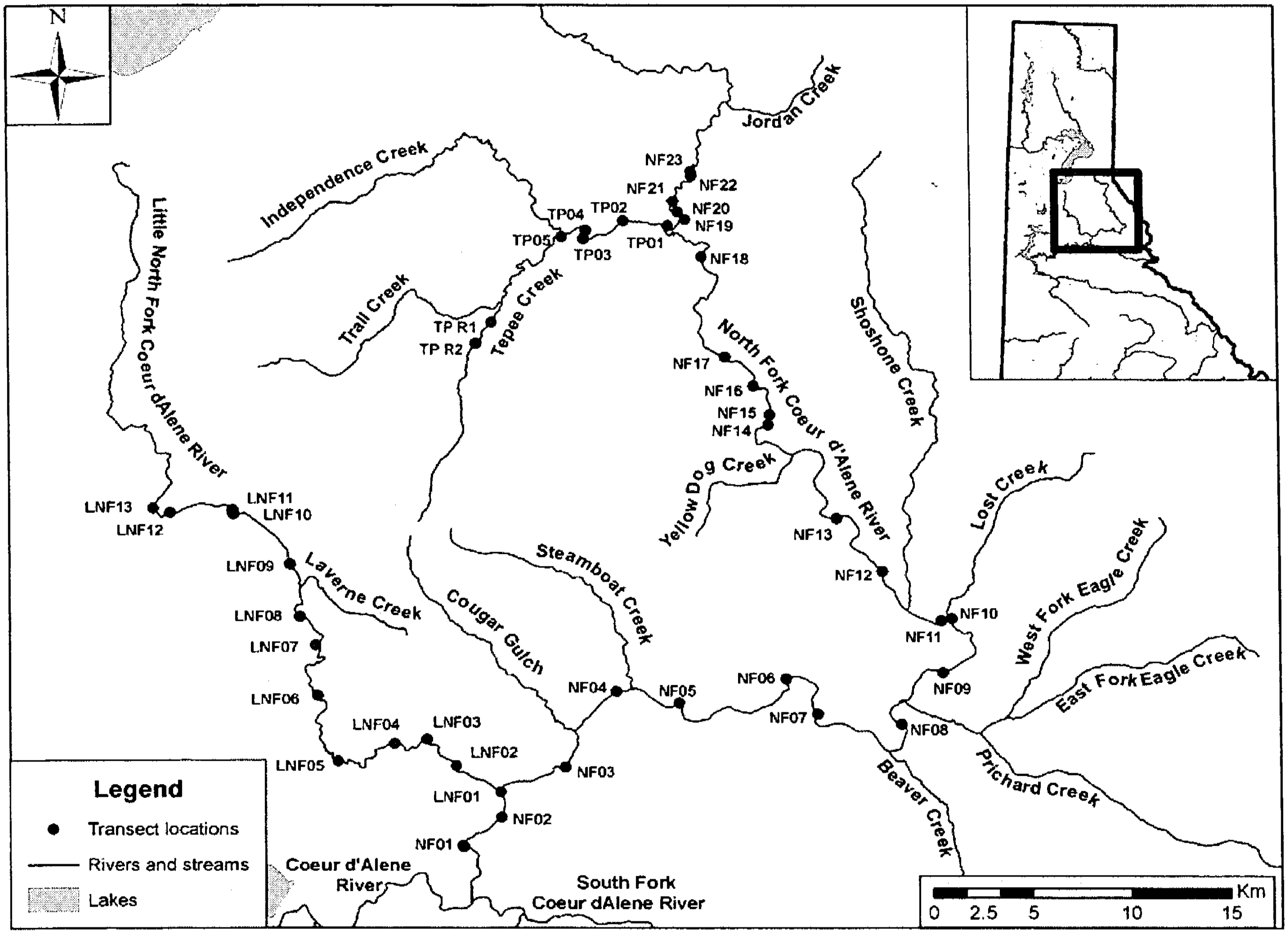

Figure 53. Location of 43 transects snorkeled on the Coeur d'Alene River, Idaho, during August 2nd - 5th, 2010.

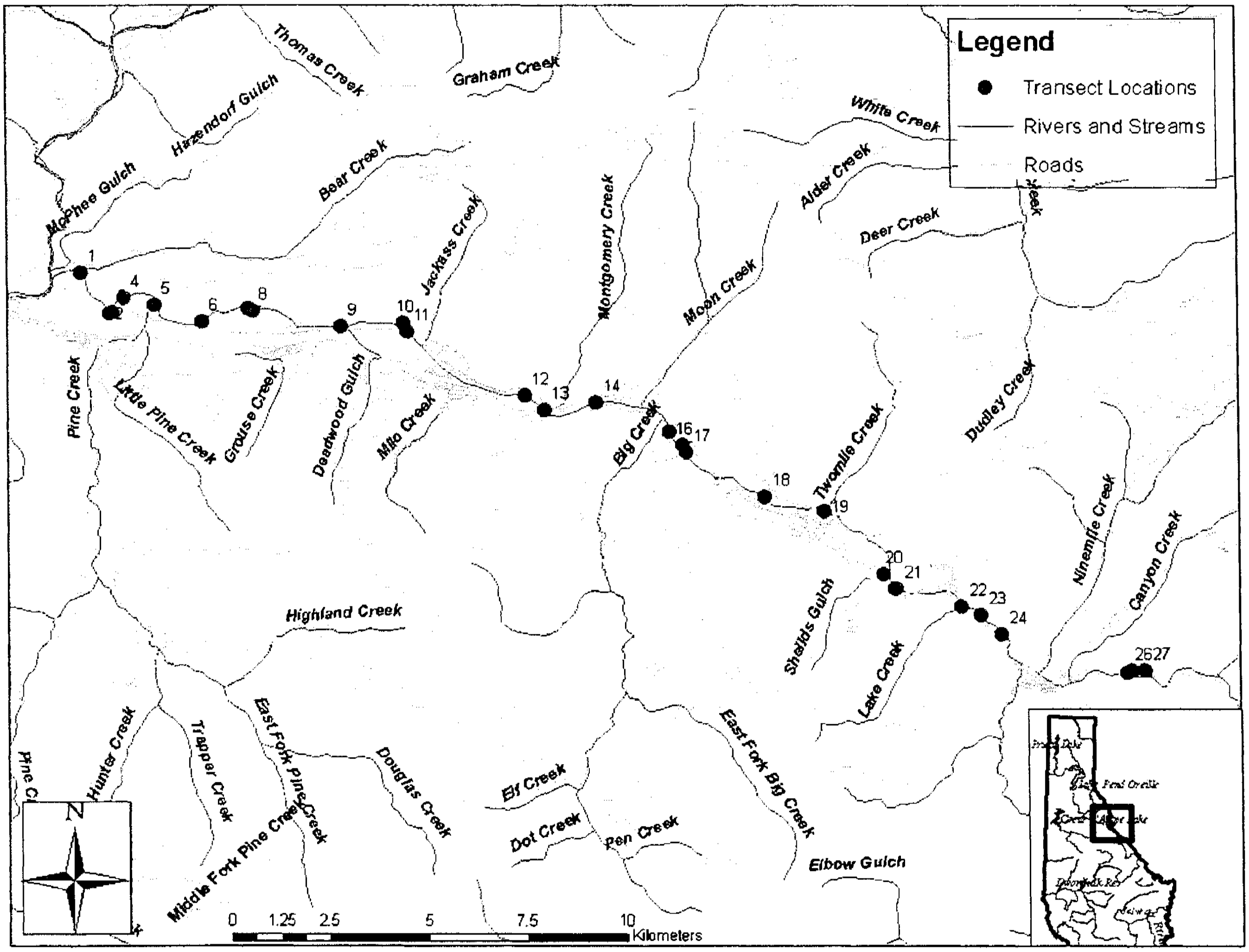

Figure 54. Location of 28 transects snorkeled on the South Fork Coeur d'Alene River, Idaho, during July 26th - 28th, 2010.

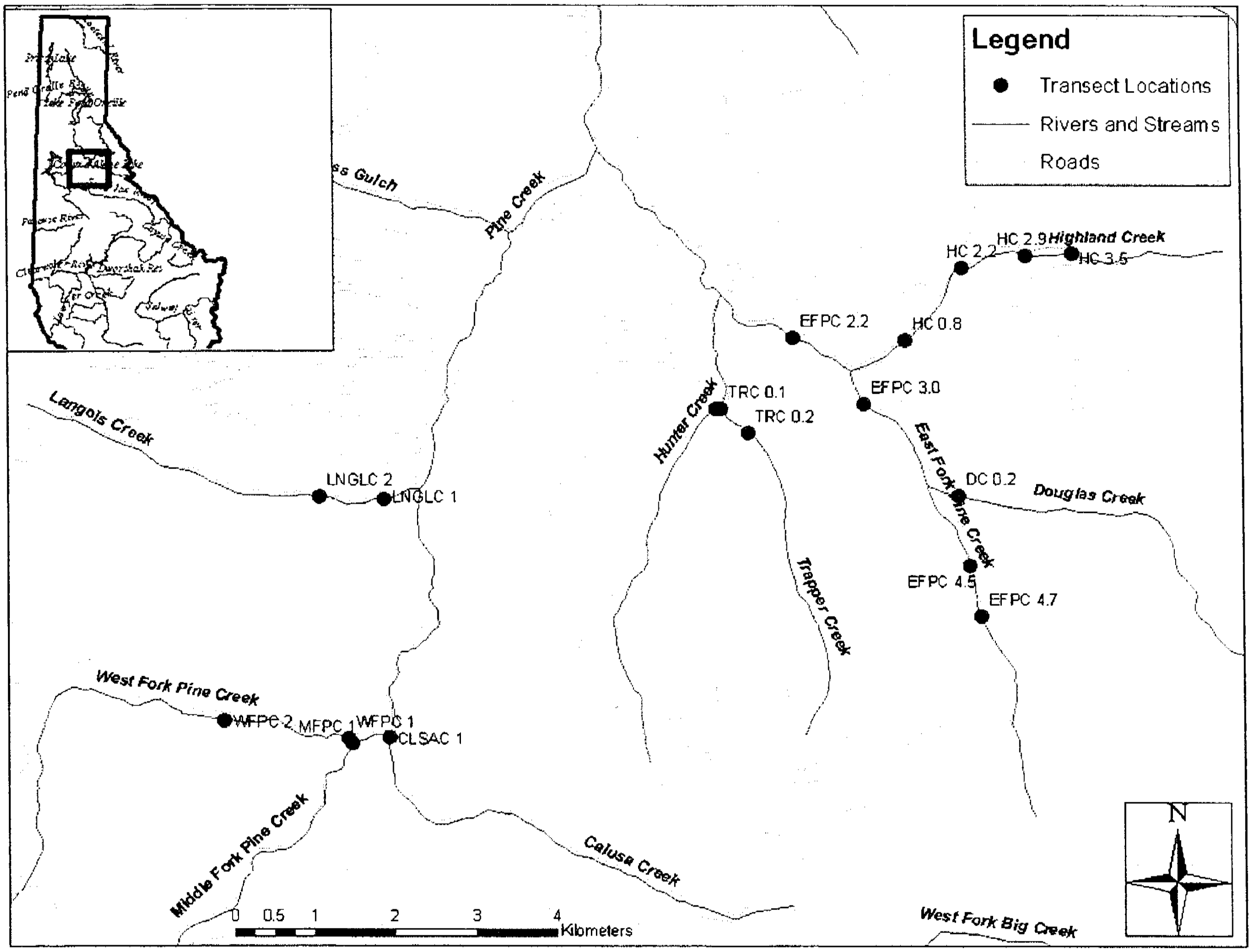

Figure 55. Location of 18 transects electrofish sampled by single and multiple pass methods during July 12th - 23rd, 2010.

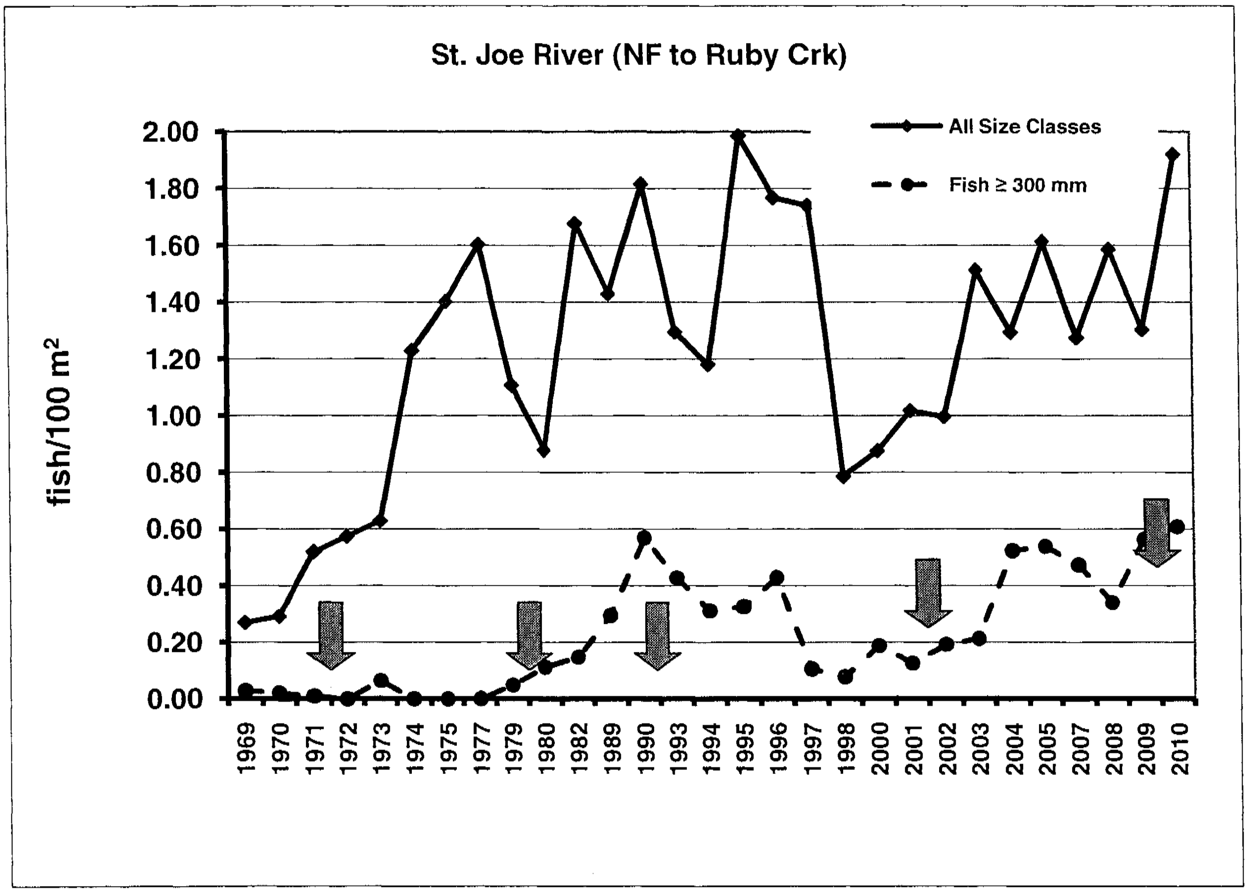

Figure 56. Average density (fish/100 m2) of all size classes of cutthroat trout and cutthroat trout ≥ 300 mm observed while snorkeling the St. Joe River, Idaho, between the NF St. Joe River and Ruby Creek from 1969 to 2010. Arrows signify when significant changes occurred in cutthroat trout fishing regulations. Refer to Dupont et al. 2009 (Table 49) for specific rule changes.

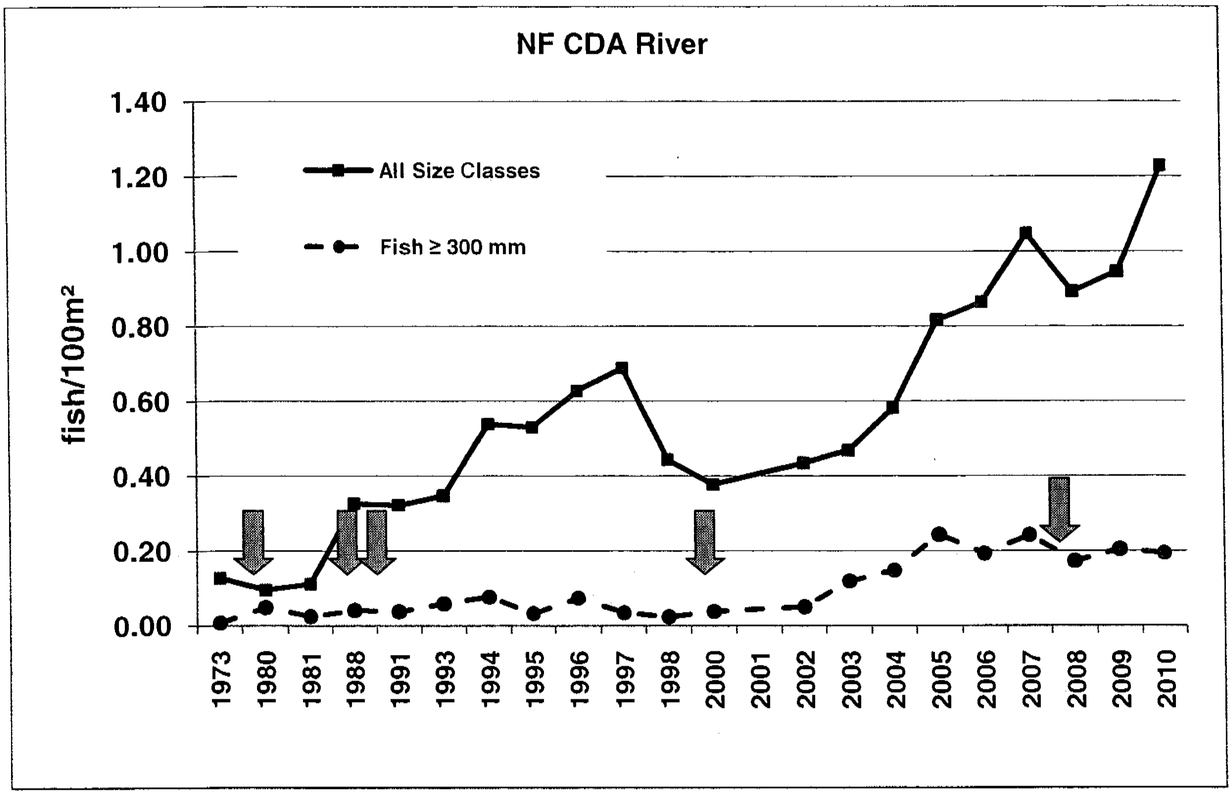

Figure 57. Average density (fish/100 m^2) of all size classes of cutthroat trout and cutthroat trout ≥ 300 mm observed while snorkeling the NF Coeur d'Alene River, Idaho from 1969 to 2010. Arrows signify when significant changes occurred in cutthroat trout fishing regulations. Refer to DuPont et al. 2009 (Table 49) for specific rule changes.

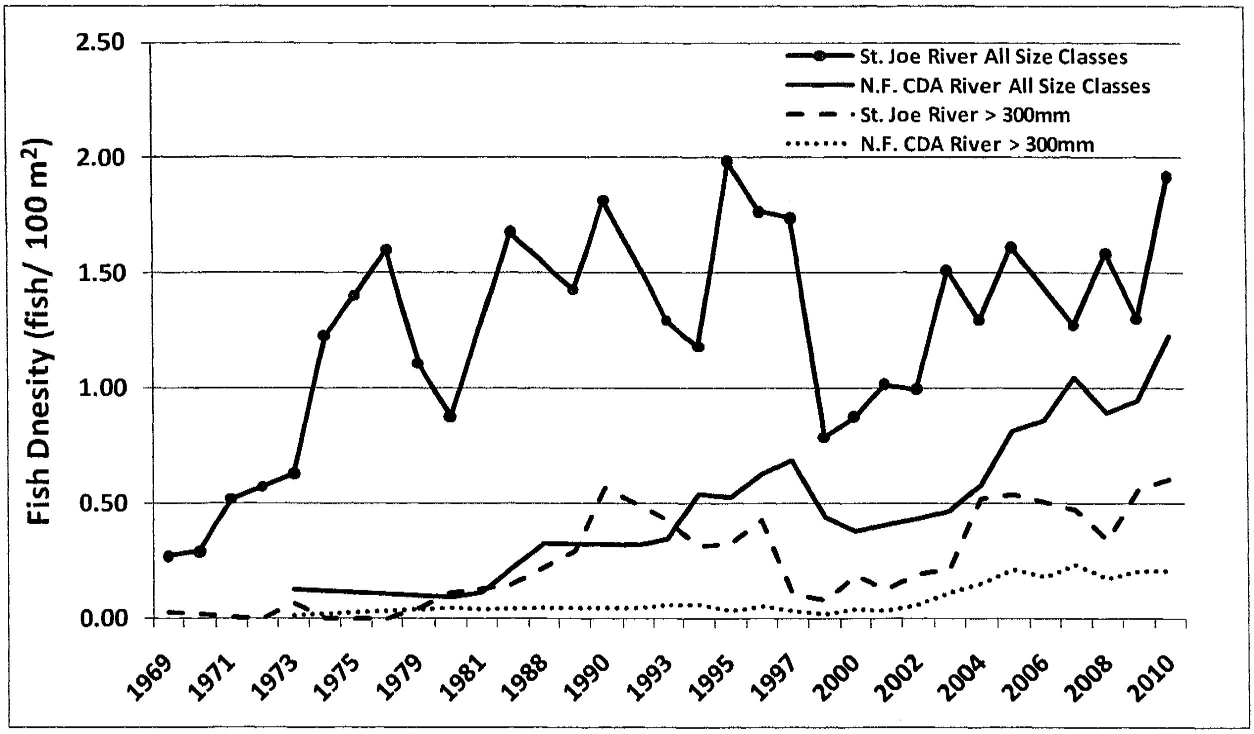

Figure 58. Average density (fish/100 m^2) of all size classes of cutthroat trout and cutthroat trout ≥ 300 mm observed while snorkeling transects in the St. Joe River and North Fork Coeur d'Alene River (N.F. Cd'A), Idaho, from 1973 to 2010.

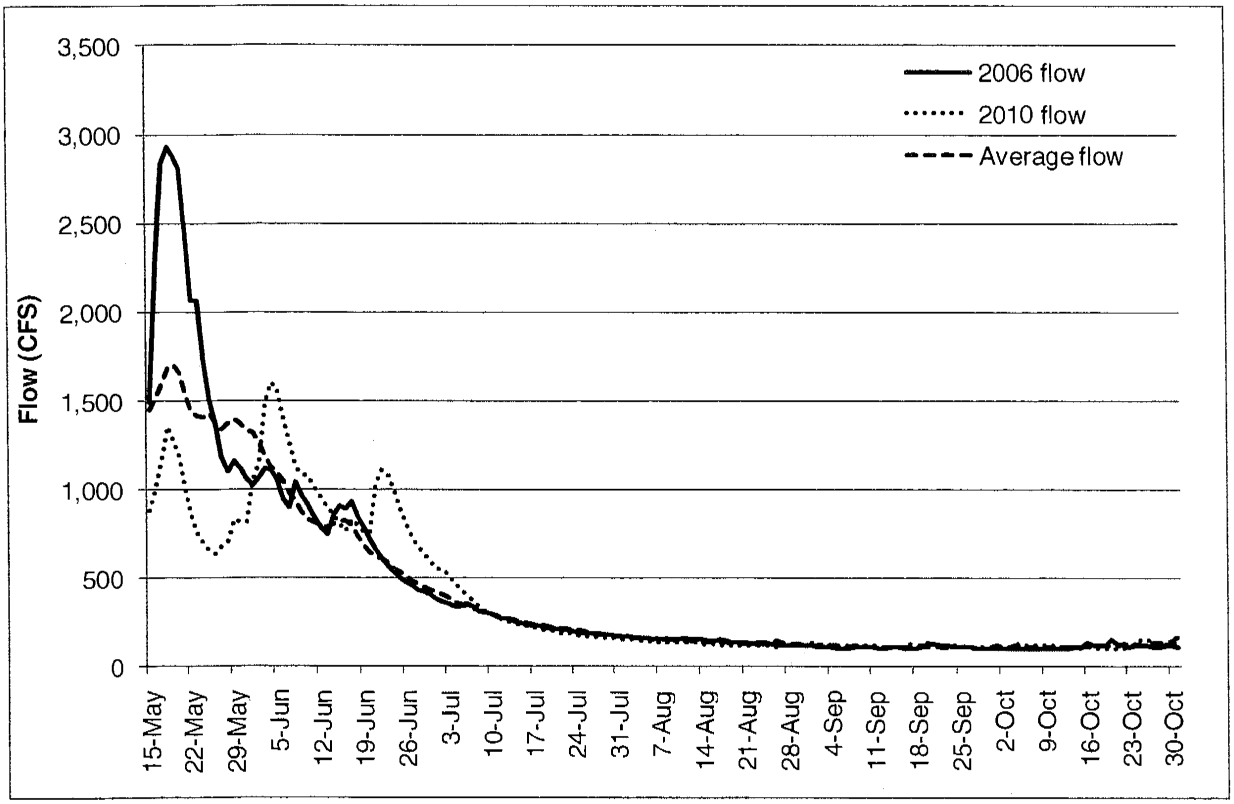

Figure 59. Average daily flow (cfs) in the South Fork Coeur d'Alene River for 2006 and 2010 compared to the approximate 20-year average.

2010 Panhandle Region Annual Fishery Management Report

River and Stream Investigations

KEOKEE AND TARLAC CREEK BROOK TROUT REMOVAL EVALUATION

ABSTRACT

In 2010 we electrofished Keokee Creek, a tributary to the Middle Fork (MF) of the East River, to evaluate westslope cutthroat trout, bull trout, and brook trout densities following past removal efforts conducted from 2005 through 2009. We also electrofished Tarlac Creek, another tributary to MF East River, to evaluate westslope cutthroat trout and brook trout densities and the feasibility of long term brook trout removal. We captured 236 westslope cutthroat trout, one bull trout, two brook trout, and one sculpin in Keokee Creek on the first pass of our sampling on August 17th, 2010. On a successive pass, we removed a total of five brook trout from the stream, which we estimated to be the entire brook trout population. We estimated our capture efficiency to be 55%. In general, mean density of westslope cutthroat trout has significantly increased in Keokee Creek since we started the brook trout removal in 2005. In Tarlac Creek, we captured 99 westslope cutthroat trout, 57 brook trout, and no bull trout on the first pass of our sampling on August 17th, 2010. We removed a total of 105 brook trout from the stream on three passes, and we estimated the brook trout population at 120 fish. We did not sample any bull trout. We calculated capture efficiency at 50%.

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INTRODUCTION

The MF East River is the only tributary of Priest River known to support a population of bull trout. The drainage also supports an abundant population of brook trout that appear to be increasing in numbers and expanding their range (Robertson and Horner 1987, DuPont and Horner 2002). Brook trout may have displaced bull trout (through competition and/or hybridization) from some of the tributaries. An isolated brook trout population was identified in Keokee Creek during a 2000 survey. Similarly, brook trout populations were sampled in Tarlac Creek, a tributary lower in the drainage, in 2002.

IDFG used multi-pass electrofishing in Keokee Creek, tributary of the MF East River, in 2005, 2006, and 2007, to remove an isolated brook trout population. The removal was viewed as a success in 2007 with zero brook trout remaining following the final removal efforts. We returned in 2009 and sampled one brook trout in using two-pass depletion. The recommendation was made to continue to evaluate population numbers of westslope cutthroat trout, bull trout, and the potential return of brook trout in Keokee.

Horner et al. (1986) reported that Tarlac Creek, a tributary to the MF East River held densities (4.4 fish/100 m^2) of juvenile bull trout and no brook trout in 1986. Several years later, DuPont and Horner (2003) reported the opposite, where his sampling efforts in 2002 showed no bull trout and high densities of brook trout. DuPont and Horner (2003) noted that Tarlac Creek is one tributary that may be possible to increase juvenile bull trout numbers through a brook trout removal efforts. In 2010, we investigated the feasibility of successfully removing brook trout Tarlac Creek.

OBJECTIVES

1. Evaluate westslope cutthroat trout, bull trout, and brook trout densities in Keokee Creek following past removal efforts conducted from 2005 - 2009.

2. Evaluate westslope cutthroat trout and brook trout densities and the feasibility of brook trout removal in Tarlac Creek.

STUDY SITES

Keokee and Tarlac creeks are major tributaries of the MF East River of Priest River, located in the Idaho Panhandle (Figure 60). The creeks flow approximately 4 km from their headwaters to where they join the MF East River. The MF East River flows about 15 km to join the North Fork East River and form the East River, which flows an additional 4 km where it enters Priest River. Priest Lake is located about 37 river km upstream from this confluence and the Pend Oreille River is located about 34 river km downstream. A dam operated by Idaho Water Resource Board is located at the mouth of Priest Lake and is a barrier to upstream fish passage a majority of the time. Albeni Falls Dam, operated by the Army Corps of Engineers, is located about 7 river km downstream of the confluence of the Pend Oreille River and Priest River and is a permanent barrier to upstream fish passage. Lake Pend Oreille is located about 37 river km upstream of the confluence of the Pend Oreille River and Priest River, and no barriers to fish migration exist between these points. The bull trout population spawning in the MF East River drainage appears to be a unique adfluvial stock which utilizes Lake Pend Oreille in their life history (DuPont et al. 2007).

These two creeks range in elevation from 850 - 1,636 m and is characterized by relatively high gradient. Width of the creeks averages about 7 m with multiple, braided channels throughout the sampling reaches. Keokee and Tarlac creeks and the uppermost reach of the MF East River are entirely within land managed by the Idaho Department of Lands (IDL). The riparian zone vegetation includes alder and mountain maple with mixed conifers higher upslope.

METHODS

We electrofished the same 500 m long reach of Keokee Creek in 2010 (Figure 61) as established by DuPont et al. (in press) in the previous studies. Electrofishing was conducted using two Smith-Root SR 15 backpack electrofishers and three-person crews. All fish were netted, counted, and measured (mm) to compare length frequencies. All fish were released (except brook trout) below the area of shocking in order not to be counted twice on the first pass. Brook trout were removed entirely during these sampling events. A rangefinder was used to measure the stream distance sampled as well as selected stream widths to estimate the area sampled (m^2). At each site, we netted, counted, and measured all fish for total length (mm). For the feasibility of brook trout removal, we sampled approximately 400 m of Tarlac Creek. The transect endpoint was identified as a significant increase in gradient and when we no longer sampled brook trout (Figure 61). In each of the streams, only westslope cutthroat trout from the first pass were used to compare population structure with previous years. To estimate abundance, 95% confidence limits, and capture probabilities (CP), we used MicroFish 3.0 (Van Deventer and Platts 1985).

RESULTS

Keokee Creek

We captured 236 westslope cutthroat trout, one bull trout, two brook trout, and one sculpin in Keokee Creek on the first pass of our sampling on August 17th, 2010 (Figure 62). These numbers are considerably lower than what was seen in previous sampling events. We removed a total of five brook trout from the stream, and we estimated the brook trout population at five fish (Table 60). We estimated our capture efficiency for a single pass at 55%. The bull trout we sampled was within the first 50 m of the transect.

Length frequency of westslope cutthroat trout captured on the first pass in 2010 (117 mm) was significantly smaller (T-test evaluation; $P < 0.001$) than what was captured in 2005 (121 mm). This difference was represented equally across all age classes (Figure 63). Mean density of westslope cutthroat trout has significantly increased in Keokee Creek since we started the brook trout removal in 2005 (Table 61).

Although no thermograph data were available for 2010 in Keokee Creek, IDL stream temperature data throughout the summer months of 2009 showed water temperatures in Keokee Creek remained within or below 14°C (Figure 64).

Tarlac Creek

We captured 99 westslope cutthroat trout, 57 brook trout, and no bull trout in Tarlac Creek on the first pass of our sampling on August 17th, 2010. We removed a total of 105 brook trout from the stream, and we estimated the brook trout population at 120 fish (Table 60). We did not sample any bull trout. We calculated single pass capture efficiency at 50%.

Length frequency of westslope cutthroat trout captured on the first pass in Tarlac Creek in 2010 (112 mm) was significantly smaller (T-test evaluation; $P < 0.001$) than what was captured in the first pass in Keokee Creek in 2005 (122 mm; Figure 63).

No thermograph data were available for Tarlac Creek either, however IDL stream temperature data throughout the summer months of 2006-2009 showed water temperatures in Tarlac Creek remained within or below 13°C (Figure 65).

DISCUSSION

Keokee Creek

Efforts to reduce brook trout densities in Keokee Creek appear to have been successful after the initial three years of removal. Densities of brook trout were reduced more than seven fold. Although we did not see a notable increase in bull trout juveniles in 2010, it is still possible densities will increase in the future. Keokee Creek seems to be unique in that habitat gradient may slow the re-colonization of brook trout. Complete eradication of brook trout in streams likely requires the use of piscicides, extensive long-term electrofishing removal efforts (Greswell 1991, Thompson and Rahel 1996, Buktenica 2000), and/or construction of a barrier (Thompson and Rahel 1998). Although the continuation of suppressing the brook trout populations in Keokee Creek has proven to be attainable, complete eradication is unlikely. With the brook trout population at very low numbers, returning periodically to Keokee Creek (once every 3 to 5 years) for physical removal should be sufficient to suppress brook trout.

The density of westslope cutthroat trout has progressively increased since 2005 in Keokee Creek; however, 2010 density estimates were lower than recorded in previous years. Since the reduction is represented across all age classes evenly, it is unknown if this is due in part to fish displacement from higher water temperatures at the time of sampling or some factor of mortality.

Stream temperature data suggested that throughout the summer months water temperatures in Keokee Creek remained within or below the bull trout's thermal optimum (12 - 16°C) as determined by McMahon et al. (1999). Temperatures peaked during the first week in August in 2009. Research and surveys suggest that where stream temperatures exceed 10-12°C brook trout have a competitive advantage over bull trout (Dambacher et al. 1992; Riehle 1993; McMahon et al. 1999).

Tarlac Creek

Tarlac Creek was dominated by bull trout in 1986, yet sampling in 2002 and 2010 showed only brook and westslope cutthroat trout. Efforts to reduce brook trout in the 500 m section of Tarlac Creek appear to have been successful in the short term. With capture efficiencies of 50%, which is as high as what we saw in the few years of removal efforts on Keokee Creek, it is likely that brook trout could be suppressed in the short term from Tarlac Creek. The bigger concerns with Tarlac Creek, as with many of our streams inundated with brook trout, are sustainability, costs, and the likelihood that bull trout will fill vacant habitat. Shepard (2010) showed that at least six and up to ten multiple-pass electrofishing removal efforts (two or more passes per effort) were necessary to eradicate brook trout from small to medium sized streams. Keokee Creek required only 4-6 removal passes in three separate years to successfully reduce brook trout. Although Tarlac Creek stream temperatures are slightly lower than Keokee Creek, much of its habitat is at lower gradient and elevation than Keokee Creek. These factors have influenced brook trout distribution (Rieman et al. 2006) and may make brook trout suppression in Tarlac Creek difficult should brook trout repopulate this stream faster than Keokee Creek.

The overall long term cost of removal coupled with the uncertainty of juvenile bull trout returning to the stream make continuing removal efforts in Tarlac Creek questionable. Single, annual removal efforts for two-to-three years have been ineffective at suppressing population and survival of brook trout in some streams (Meyer et al. 2006). Shepard (2010) indicates that in order to be effective at eradication or suppression it requires annual removal efforts for six-to-seven years or four-to-six removal efforts condensed into two-to-three years to successfully eradicate brook trout streams that have relatively high capture probabilities (> 0.8). In addition, total eradication of brook trout from streams can require between 20 - 80 days/km and cost an estimated $3,000 - $9,000/km (Shepard 2010). Taking this information into consideration, we do not recommend continuing brook trout removal in Tarlac Creek at this time, but rather recommend focusing our efforts on increasing suitable spawning habitat in the mainstem MF East River.

Redd count information has shown that the largest reduction in redd counts in the most recent years has been in the mainstem of the MF East River above the confluence of Keokee Creek. One primary factor may be a log jam barrier that is thought to be a passage barrier on low water years. Modification of this structure to allow better passage may increase the number of redds counted and in-turn may increase the number of juveniles that utilize Keokee and Uleda creeks for thermal refuge in the summer months.

MANAGEMENT RECOMMENDATIONS

1. Conduct three-pass brook trout removal electrofishing in Keokee Creek in 5 years.
2. Do not pursue brook trout suppression efforts in to Tarlac Creek at present time.
3. Continue to conduct redd count surveys above Keokee Creek.
4. Improve passage of bull trout by removing portions of log jam barrier in MF East River.
5. Conduct periodic stream surveys (every 5 to 10 years) to monitor species composition and abundance.

Table 60. Population and density estimates for Keokee Creek from 2005-2010 and Tarlac Creek in 2010.

Stream	Sample Year	Sample Area 100m^2	Species	1	2	3	4	5	6	Total	Passes	*CP*	*N*	95% CI -	95% CI +	Fish/100 m^2
Keokee Creek	2005	48.7	bkt	78	46	60	42	29	16	271	6	0.22	347	299	395	7.12
	2006			69	26	18	28			141	4	0.33	176	145	207	3.61
	2007			28	10	1	0			39	4	0.77	39	38	42	0.80
	2009			1	0					1	2	1.00	1	...	...	0.02
	2010			2	2	1				5	3	0.55	5	2	8	0.10
Tarlac Creek	2010	34.7	bkt	57	34	14				105	3	0.48	120	104	136	3.45

Table 61. Density estimates by species for Keokee Creek from 2005 - 2010 and Tarlac Creek in 2010.

		Fish/100 m^2		
Stream	Year	bkt	wct	blt
Keokee Creek	2005	7.1	5.9	0.02
	2006	3.6	7.9	0.04
	2007	0.8	12.3	0.21
	2009	0.0	10.3	0.04
	2010	0.1	4.8	0.02
Tarlac Creek	1986	2.1	0.0	4.4
	2010	3.5	2.9	0.0

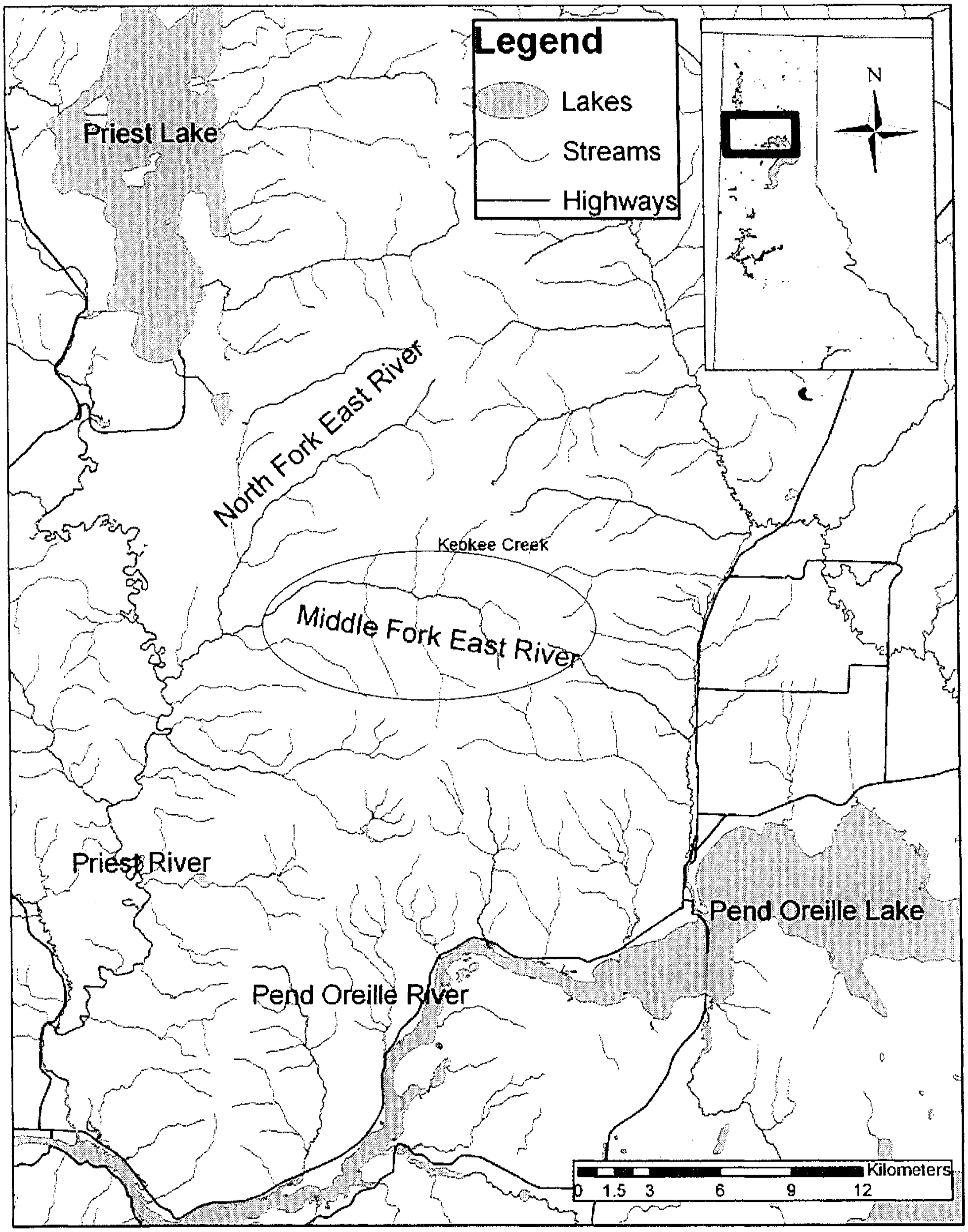

Figure 60. Map of the Middle Fork East River and Keokee Creek, Idaho.

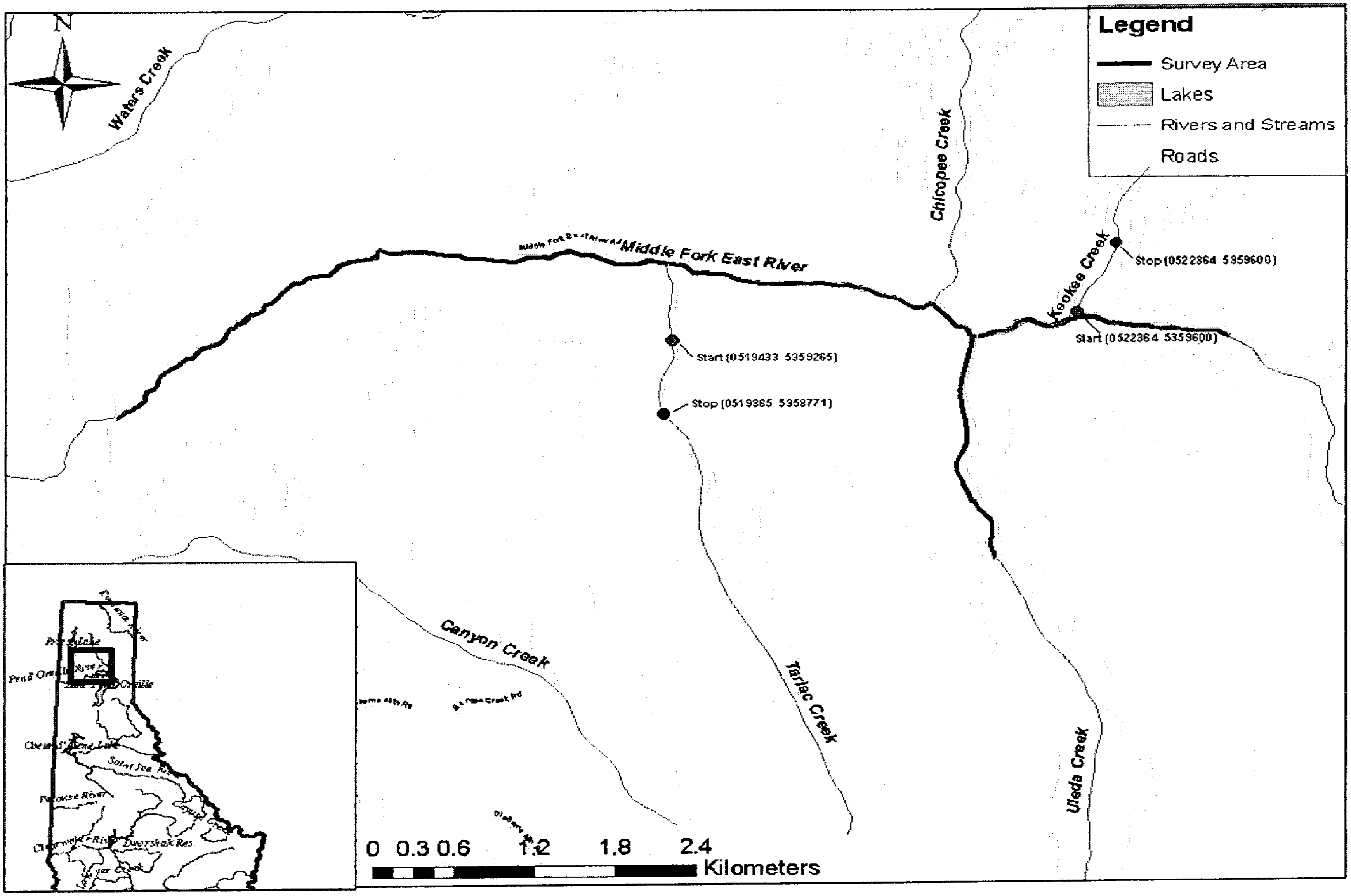

Figure 61. Locations in Keokee and Tarlac creeks used during the 2010 electrofish sampling.

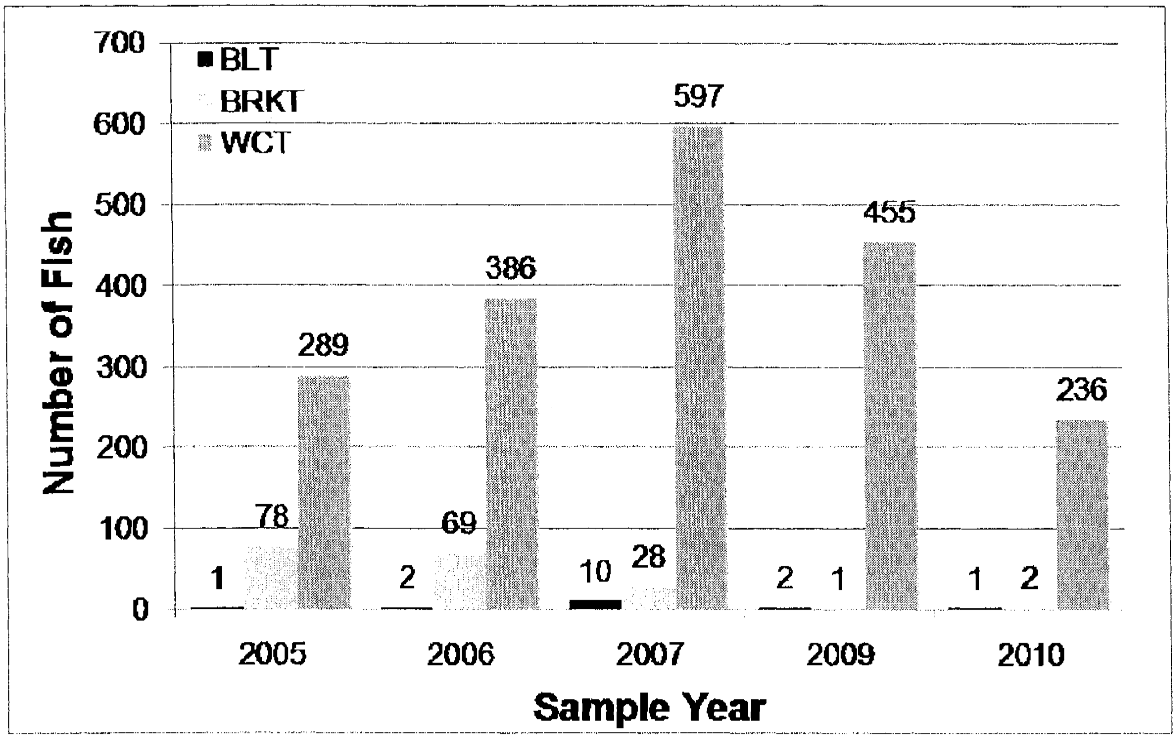

Figure 62. Number of fish captured on the first pass during 2005 – 2010 in Keokee Creek, Idaho.

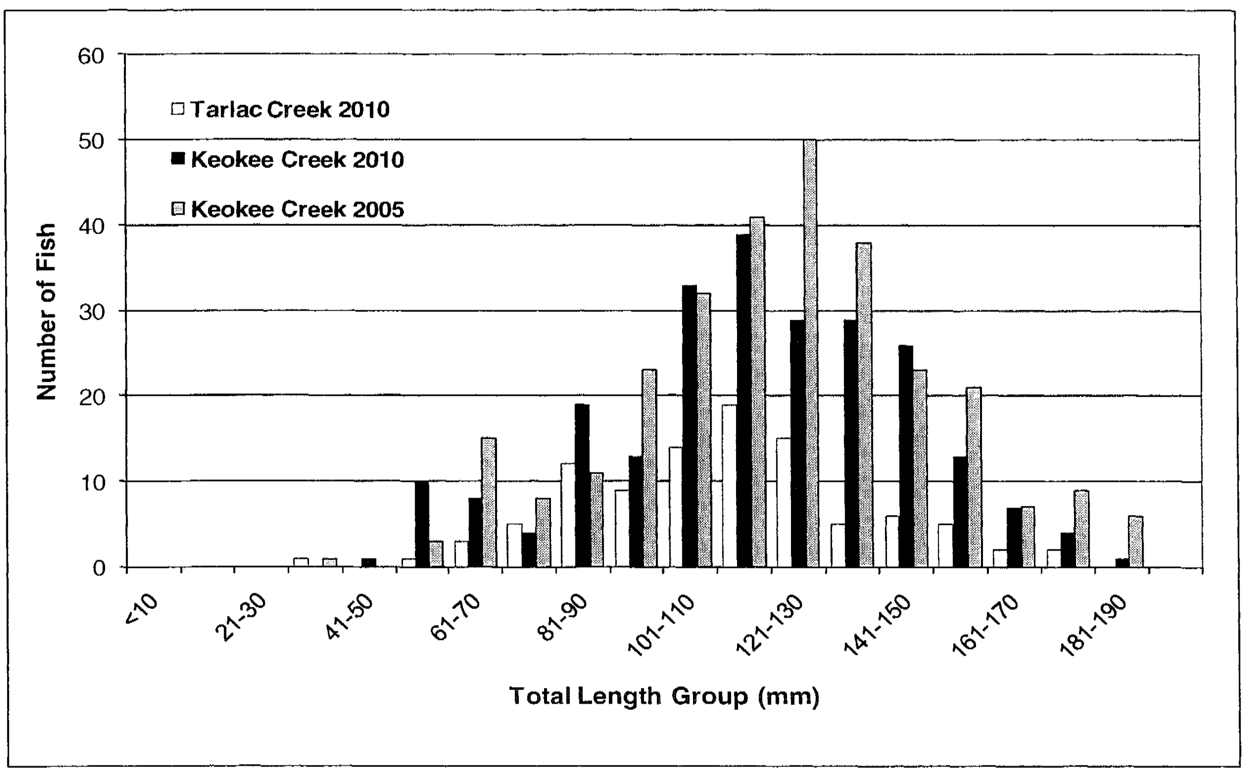

Figure 63. Westslope cutthroat trout length frequencies for fish captured on the first electrofishing pass in Keokee Creek, Idaho in 2005 and 2010.

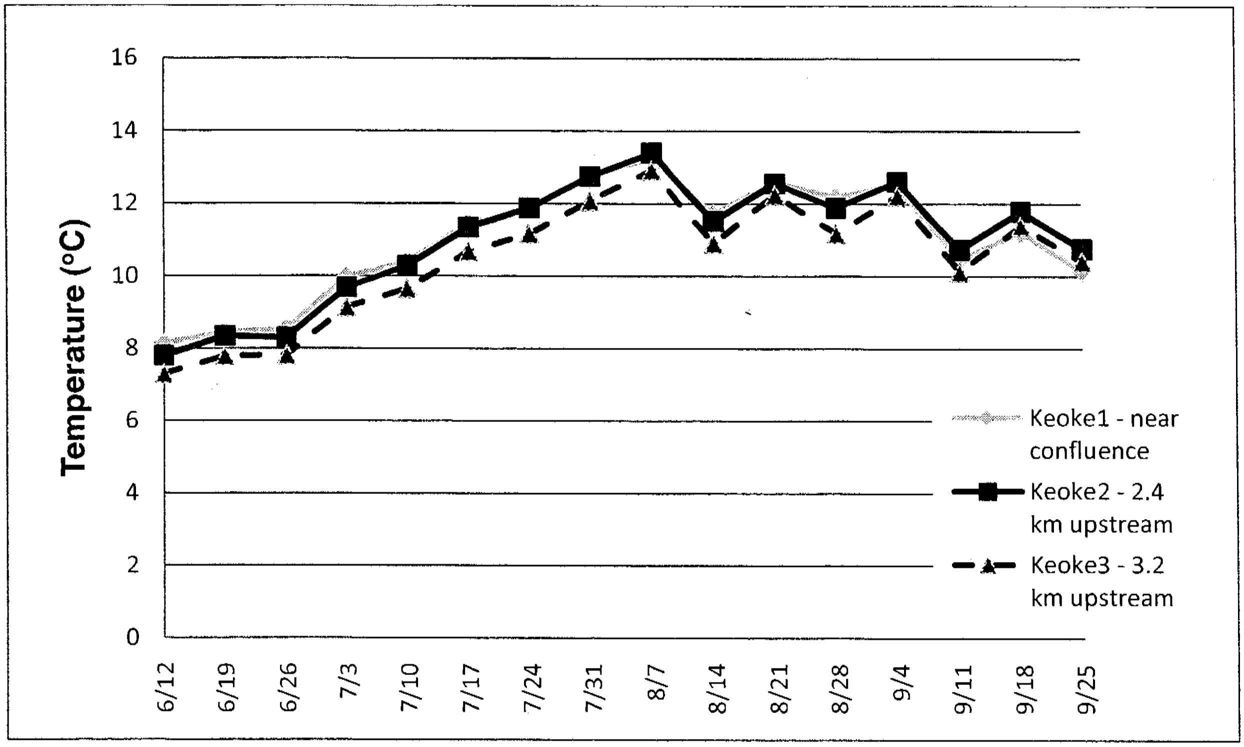

Figure 64. Maximum weekly temperatures in Keokee Creek in 2009 (data from IDL).

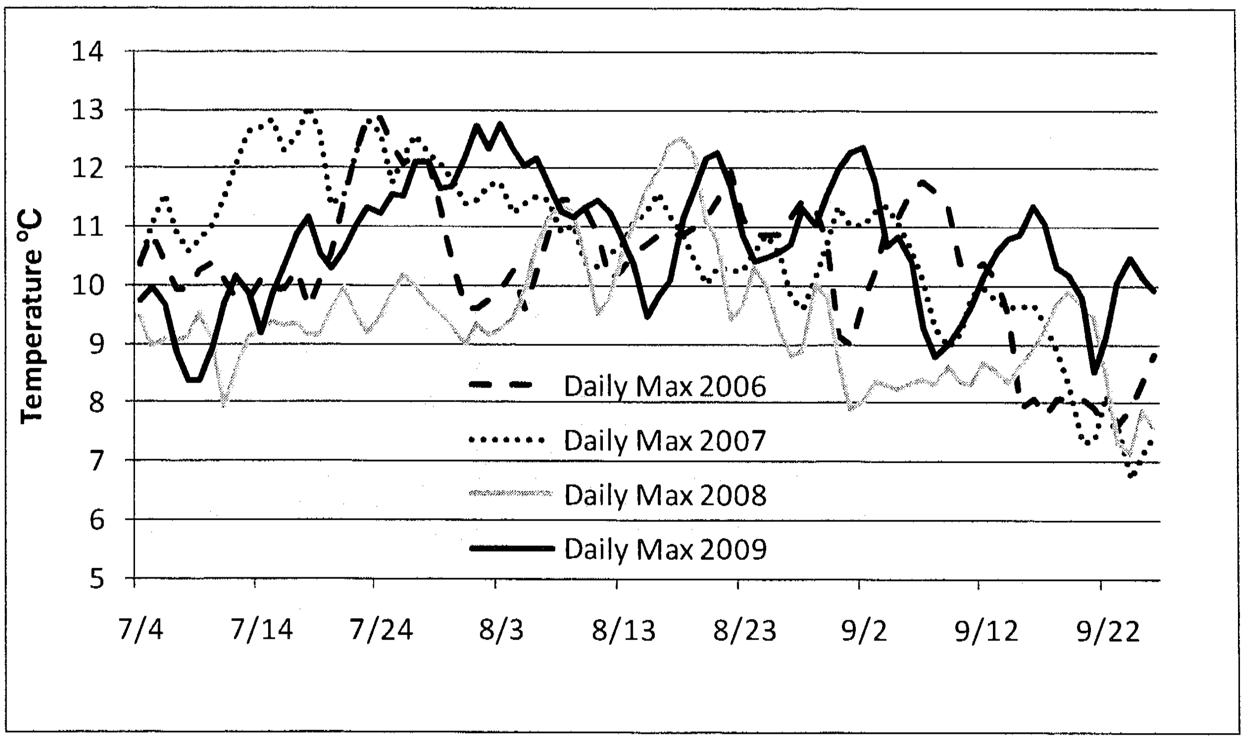

Figure 65. Maximum weekly temperatures in Tarlac Creek (near confluence) in 2006-2009 (data from IDL).

2010 Panhandle Region Annual Fishery Management Report

<u>River and Stream Investigations</u>

PEND OREILLE RIVER LITTORAL FISH COMMUNITY ASSESSMENT

ABSTRACT

From June 1st to 9th, 2010, we sampled the littoral fish community of the Pend Oreille River in Idaho. The objectives of this study were to evaluate how the fish community has changed over the past two decade, to evaluate smallmouth and largemouth bass size structure, and angler harvest rates, and to assess whether winter elevations have improved largemouth bass populations. A total of 2,176 fish representing 18 species and 6 families were captured in this survey. Changes in species composition from 1991-92 and 2005 to 2010 were notable in all habitat types especially with increases in smallmouth bass numbers and decreases in northern pikeminnow and redside shiners. Smallmouth bass went from being virtually non-existent in the 1991-92 samples to where they now represent 19% of the fish community. We captured 21 walleye ranging from 80 to 651 mm TL. Walleye were collected in all three habitat types extending the entire length of the study area with the highest catch rates in sloughs.

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INTRODUCTION

Historically, the Pend Oreille River, Idaho, provided a fishery for native salmonids including cutthroat trout, bull trout, and mountain whitefish. After construction of the Albeni Falls Dam in 1952, the free-flowing river changed to a reservoir for much of the year and the abundance of native salmonid populations declined, likely a result of fish passage barriers and changes in habitat (Dupont 1994). Fluctuating river levels have resulted in degraded habitat, particularly increased erosion, sedimentation, and water temperature (Bennett and Dupont 1993). The warmer water, created by the inundation of the river and adjoining backwaters in the spring and summer, limits use of the river by native salmonids, while favoring nonnative game fish such as largemouth bass, smallmouth bass, black crappie, pumpkinseed and yellow perch. Unfortunately, much of the low-velocity backwater habitat, important to warmwater fish, is lost in the winter with the annual drawdown. The result is a system where coldwater fish are limited by warm water in the summer, whereas warmwater fish are limited by suitable backwater habitat winter. Despite these limitations, the Pend Oreille River supports an increasingly popular fishery.

In June we conducted an extensive electrofishing survey, duplicating surveys that were completed in 2005 (Bassista et al. 2007) and in 1991-92 (Bennett and DuPont 1993). From June 1st to 9th, 2010, we sampled the littoral fish community of the Pend Oreille River in Idaho.

OBJECTIVES

The objectives of this study were to:

1. Evaluate how the fish community has changed over the past two decades.

2. To evaluate smallmouth and largemouth bass size structure, and angler harvest rates, and to assess whether winter elevations have improved largemouth bass populations.

STUDY AREA

The study area was 44.25 km of the Pend Oreille River extending from the natural outlet of Lake Pend Oreille near Sandpoint, Idaho (Long Bridge) to the Albeni Falls Dam (Figure 66). Approximately 161 km of shoreline, including sloughs and islands, have gentle to moderate steepness consisting of mostly fine sediments (<4 mm), while about 16 km of shoreline consists of riprap (DuPont 1994). The river has an average depth of 7.05 m, a maximum depth of 48.5 m, a maximum width of 3.2 km. Water levels are raised in mid-April and reach high pool (628.65 m, lake elevation) by mid-June (Bassista et al 2007).

METHODS

Littoral Fish Community Assessment

To assess the littoral fish community in the Pend Oreille River, we used night electrofishing, conducted during June 1st through 9th. Fish were sampled from three different randomly selected shoreline habitat types (sand, rock, sloughs) identified and mapped by Bennett and DuPont (1993) and Bassista et al. (2007) using a 4.8 m Smith-Root electrofishing boat. Fifty - 400 m transects were randomly selected from the 43.5 km of river between the long bridge at

Sandpoint and Albeni Falls Dam (Appendix C). Two netters collected all sizes and species of stunned fish. Captured fish were placed in a live well and then identified to species, measured for total length (TL) in millimeters (mm), weighed and released alive.

The dominant habitat type, sand, comprised 61% of the shoreline and was characterized by substrates <15 mm. The second most available habitat type, slough, comprised 28% of the shoreline and was characterized by fine sediments with high biomasses of aquatic macrophytes. The least amount of habitat type available, rock, comprised 11% of the shoreline, was characterized by substrates >15 mm, and typically contained large basalt cobble and boulders.

Shoreline electrofishing CPUE was used to index density for each species. CPUE was calculated as the number of fish caught per 10 minutes of electrofishing effort (current on time) and expressed as catch-per-time (fish/min). Species composition or relative abundance (%) of all species captured was calculated for all three habitat types and then combined for all littoral habitats. CPUE and species composition values calculated were compared to values obtained in 1991 and 1992 from Bennett and DuPont (1993) and in 2005 from Bassista et al. (2007).

Bass Size Structure and Exploitation

We calculated PSD and RSD, which are numerical descriptors of length-frequency data (Anderson 1976) for largemouth and smallmouth bass. PSD is calculated as number of fish ≥ minimum quality length/ number of fish ≥ minimum stock length. For largemouth bass, quality length (% related to world record size; Anderson 1980) was set at 300 mm and stock length (approx. size recruited to the sampling gear; Gabelhouse 1984) was set at 200 mm. RSD was calculated in the same manner only substituting quality length in the aforementioned equation for a specified length to be examined. In our case, we defined this length as 406 mm, since it matches up with the 16 inch quality regulation on the Pend Oreille River. This is denoted as RSD-16.

We calculated largemouth and smallmouth bass Wr, which compares weights of bass found in the Pend Oreille River to that of a standard developed from multiple populations. Relative weight was calculated using the formula:

$$Wr = (W/Ws) \times 100$$

where W is the actual fish weight, and Ws is a standard weight for fish of the same length. Minimum total lengths to calculate Ws were 150 mm for largemouth bass and smallmouth bass as specified by (Wege and Anderson 1978).

Largemouth and smallmouth bass aging was accomplished by scale analysis. At least ten fish from each 10 mm size group were collected for aging. Scales were impressed onto cellulose acetate slides and viewed on a microfiche reader at 42X magnification. Age composition of each population was estimated by development of age keys (Westrheim and Ricker 1978) to proportion ages within each 50 mm length category. Total annual mortality was estimated by generating catch curves from the age frequency data and using the Fisheries Analysis and Simulation Tools (FAST 2.1) model for each specific parameter (Slipke and Maceina 2002). Growth information was determined by using the Von Bertalanffy equation through the FAST software.

To determine what impact anglers were having on the bass populations in the Pend Oreille River we conducted a tagging study to evaluate angler exploitation. We tagged and released 170 largemouth and 41 smallmouth bass between June 1-9. All bass over 305 mm were marked with

Floy T-bar tags inserted below the dorsal fin. The tags were labeled with an individual number and a toll-free telephone number. IDFG operates a toll free automated hotline and website through which anglers can report tags. Anglers who caught tagged largemouth bass were encouraged by signs and posters to report the date, location, and if the fish was released or harvested. To determine angler exploitation, the number of fish harvested by anglers (determined by tag returns) was divided by the number of fish tagged. We assumed reporting rates of 43 and 52%, which is typical of largemouth bass and smallmouth bass respectively for non-reward tags (Meyer et al. 2010), and adjusted the return rate accordingly to provide an exploitation estimate. Tag loss was assumed to be 13.1 and 9.6% for largemouth bass and smallmouth bass respectively based on work conducted by Meyer et al. (2010). The unadjusted exploitation rate was calculated according to Ricker (1975) as the number of fish with tags caught by anglers that were harvested, divided by the total number of fish tagged and released into the system.

To evaluate the effects of winter water levels on largemouth bass we examined lake levels and year class strength based on catch curve analysis.

RESULTS

Littoral Fish Community Assessment

A total of 2,176 fish representing 18 species and 6 families were captured in this survey. Changes in species composition from 1991-92 and 2005 to 2010 were notable in all habitat types (Table 62). In sand habitat smallmouth bass and peamouth chub *Mylocheilus caurinus* showed considerable increases in abundance compared to previous studies. Smallmouth bass made up over 17% of the species composition in sand compared to 3.8% in 2005 and zero (0%) in the 1992-93 survey. Peamouth chub greatly increased in composition in 2010 (29%) compared to 1991-92 and 2005 when they represented 5-6% of the fish community. Alternatively, northern pikeminnow and redside shiner abundance decreased in 2010, making up only 7.2% and 0% of the species composition respectively in sand habitats (Table 62).

In rock habitats, smallmouth bass and peamouth chubs again showed considerable increases in abundance while northern pikeminnow and redside shiner abundance decreased compared to previous studies (Table 62).

The biggest change in slough habitat was the increase in peamouth chub abundance from 2 to10% in previous studies to 32% in 2010 (Table 62).

Overall, cyprinids, perchids and ictalurids accounted for a similar proportion of the catch when comparing 1991-92 (data combined) to 2010 accounting for about 50% of the catch each year (Figure 67). Salmonids decreased from 14% of the catch in 1991-92 to 6% in 2010. In contrast, centrarchids increased dramatically from 18% of the catch in 1991-92 to over 35% in 2010. The biggest change in centrarchid numbers was the increase in smallmouth bass proportion. Smallmouth bass composition increased in all habitat types and nearly tripled since 2005. Only one smallmouth bass was captured in 1991-92, increasing to 6.7% of the species composition in 2005, to comprising nearly 19% of the catch in our 2010 survey. Alternatively, northern pikeminnow and redside shiner abundance decreased in 2005 and again in 2010. Northern pikeminnow abundance decreased from over 20% in 1991-92 to 12% in 2005 to 5% in 2010, while redside shiner abundance which comprised between 8-17% of the species composition in 1991-92 declined to 1% in 2005 and were absent in our 2010 survey (Table 62).

We captured 21 walleye *Sander vitreus* ranging from 80 to 651 mm TL in our littoral fish community assessment (Figure 68). Walleye were collected in all three habitat types extending the entire length of the study area with the highest catch rates occurring in sloughs (Table 63).

Overall, the percentage of centrachids, excluding smallmouth bass (largemouth bass, black crappie, and pumpkinseeds) of the total species composition within the littoral areas of the Pend Oreille River decreased from 18.5% in 1991-92 to 16.9% in 2010 (Table 62).

As expected, largemouth bass, black crappie, pumpkinseed and yellow perch were all found in highest abundance in sloughs. Black crappie represented 3.7% of the catch in 2010 compared to 23.7% in 2005; however, black crappie density was higher than 1991-92 when Bennett and DuPont (1993) reported 1.7% each year. In the same timeframe, salmonids (westslope cutthroat, rainbow trout, brown trout, brook trout, kokanee, and mountain whitefish) decreased from 14.3% to 6%. A total of 129 salmonids were captured with brown trout being the most abundant species (56%) follow by westslope cutthroat trout (22%). Brown trout were captured in all habitat types and comprised nearly 8% of the species composition in sand habitat (Table 62). Brown trout ranged from 32 to 540 mm TL.

Largemouth bass were captured in all three habitat types and as expected were most abundant in sloughs, comprising 17.6% of the species found in these habitats (Table 62). Over all habitat types, largemouth bass relative abundance is as high or slightly higher than recorded in previous studies; however, when comparing largemouth bass CPUE, density appears to be down slightly as their CPUE (fish/min) was lower in slough habitats than either of the previous studies. In 2010, largemouth bass CPUE in sloughs was 1.02 fish/min compared to 1.19 in 2005 and 1.9 in 1991-92 (Table 63).

Smallmouth bass were captured in all habitat types and were the dominant species captured in rock habitat comprising over 52% of the species composition compared to 24% in 2005 (Table 62) . Smallmouth bass also had higher catch rates (CPUE) in all three habitat types compared to previous studies (Table 63). As expected smallmouth bass catch rates were highest in rock habitat, and they increased in density from 1.24 fish/min in 2005 to 2.15 fish/min in 2010. Overall smallmouth bass are now the second most abundant species in the Pend Oreille River comprising 18.9% of all fish captured in the three habitat types (Table 62).

CPUE for pumpkinseed, black crappie and yellow perch were lower than 2005 (Table 63). Yellow perch and pumpkinseed relative abundance were lower than previous studies while crappie numbers are lower than 2005 but comparable to 1991-92 data. In all three habitat types, peamouth chub CPUE and relative abundance increased and based on the results of our 2010 littoral fish community survey, peamouth chub are the most abundant species in the Pend Oreille River comprising 28% of the species composition (Table 62).

Bass Size Structure and Exploitation

We captured 237 largemouth bass ranging from 71 mm to 502 mm in total length (Figure 69) and 10 g to 2,240 g in weight. We captured largemouth bass from ages 1-10 with the age-5 year class being the most abundant based on electrofishing. Pend Oreille River largemouth bass exhibited growth rates comparable to other bass populations throughout Idaho (Dillon 1995), and on average reached 406 mm (Quality Length) by age-6 (Figure 70). Largemouth bass had a mean Wr of 96% (n=214) (Figure 70) and largemouth bass below 200 mm had a substantially higher Wr than fish larger than 200 mm (Figure 71). Additionally, 25% of the fish captured were considered preferred size to catch by anglers (>380 mm) as compared to 10% in 2005 and 76% were of stock length (>200 mm) as compared to 44% in 2005. Largemouth bass RSD-16 was 19 compared to

21 in 2005 (Bassista et al. 2007). PSD was 95 compared to 37 in 2005 (Bassista et al. 2007). This high PSD value is a result of few smaller largemouth bass being sampled. Of the 188 fish sampled that were larger than 180 mm (stock length) 178 were also larger than 280 mm (quality length). Based on catch curve analysis of largemouth bass age-5 to age-10, total annual mortality was 45% (Figure 72). DuPont reported total annual mortality for largemouth bass age-5 to age-15 to be around 38 to 40%. Bennett and DuPont (1993) reported Pend Oreille River largemouth bass annual mortality to be 68% in 1992.

In total, we captured 411 smallmouth bass ranging from 55 mm to 493 mm TL (Figure 73) and from 5 g to 1,680 g in weight. Smallmouth bass in the Pend Oreille River generally reach 400 mm at age-6 and growth is similar to other Idaho populations (Figure 75; Dillon 1992). We captured smallmouth bass from ages 1-9 with the age-3 year class being the most abundant based on electrofishing. Smallmouth bass had a mean Wr of 99% and Wr remained consistent across all age classes (Figure 74). Based on catch curve analysis of smallmouth bass age-3 to age-9, total annual mortality was 53% (Figure 76) compared to 69% in 2005 (Bassista et al. 2007). The percentage of stock-length smallmouth bass in the Pend Oreille River was 59% compared to 21% in 2005 and smallmouth bass PSD was 39 compared to 37 in 2005 (Bassista et al. 2007). Bassista did not sample any smallmouth bass over age-7 during the 2005 survey and as this population expands we expect to see an increasing number of older age smallmouth bass in the Pend Oreille River. Smallmouth bass PSD-16 was 3, probably due to the inefficiency of electrofishing to capture larger smallmouth bass.

Based on the number of fish reported as being harvested, angler compliance, tag loss and mortality we estimated the exploitation of largemouth bass was only around 5%. As of December 31, 2010, 15 tags were reported by anglers, of which, 80% were released. The majority, (93%) of the tagged largemouth bass reported, were captured in June and only one of the tags returned was from a non-resident angler. It should be noted that exploitation estimates for largemouth and smallmouth bass are likely low as our estimates did not include the harvest that would have occurred prior to early-June, when our survey began. Based on a large tagging study in 2006 DuPont reported annual exploitation of largemouth bass in the Pend Oreille River to be about 30%, and that 83% of the tagged largemouth bass reported as being caught in the Pend Oreille River were caught between April 30 and June 24.

Based on the number of tags reported and corrections, we estimated the exploitation of smallmouth bass was around 20% compared to 15% in 2006 (DuPont et al. 2006). As of December 31, 2010, 7 tags were reported by anglers, of which, 43% were released. The majorities (86%) of the tagged smallmouth bass reported to IDFG were captured in June and all of the tags returned were from resident anglers.

Catch curve analysis for largemouth bass age classes hatched between 2001-2006 shows relatively consistent age class strength (Figure 72). We did not see any evidence that a single high water year establishes a corresponding strong year class of largemouth bass (Figures 72 and 77).

DISCUSSION

This survey reflects some notable changes in species composition in the Pend Oreille River over the past 20 years. While every effort was made to duplicate timing, sampling locations and methodology, the described changes in some of the Pend Oreille River fish densities should be interpreted with caution. CPUE is affected by environmental variables. i.e. water temp, water clarity, and water levels. Additionally, differences in boat drivers, netters, and electrofishing output settings can all influence CPUE outcomes. However the changes we observed in species composition and relative abundance are likely reflective of the populations and significant increases in smallmouth bass numbers as well as a decrease in northern pikeminnow and redside shiner.

In a 1992-93 survey of the Pend Oreille River with over 50,000 fish collected (Bennett and DuPont 1993) no walleye were captured. Using gill net sampling in the main Pend Oreille River channel in 2005, IDFG identified the presence of walleye (n=6), however, during the 2005 littoral fish community assessment using electrofishing, no walleye were captured (Bassista et al. 2007), and by 2010 that number increased to 21. The establishment of walleye in the Pend Oreille system likely occurred from downstream emigration from Montana reservoirs. To evaluate walleye abundance, distribution, and potential impacts in the Pend Oreille River and Lake Pend Oreille, IDFG is considering implementing standardized fall gill net sampling in the Pend Oreille River in 2011.

Similarly, smallmouth bass went from being virtually non-existent in the 1991-92 samples to where they now represent 19% of the fish community, while northern pikeminnow and redside shiner abundance decreased in 2005 and again in 2010. The increase in smallmouth bass numbers may explain the reduction in northern pikeminnow numbers. Kozfkay et al. (2009) found the proportion of smallmouth bass in relation to the total catch has increased through time from 0% in 1972 and 1973 to 7% in 1995 to 11% in 2007 in the Snake River, ID while species diversity and the abundance of native fish has declined in two different reaches of the Snake River. Similarly, Vidergar documented redside shiner as the primary prey item (40 %) found in the diet of smallmouth bass in Lake Pend Oreille Lake and establishment of smallmouth bass was associated with declining redside shiner abundance in Dworshak Reservoir and Ririe Reservoir (Dillon 1992).

As largemouth bass move into the shallower, backwater areas in the spring they become especially vulnerable to harvest. In 2006, IDFG conducted an exploitation study and found largemouth bass harvest rates were between 26% and 43%, enough to limit the number of large bass in the population. DuPont reported that 81% of the tagged largemouth bass caught in 2006 were caught in one of four specific areas, Morton Slough, Cocolalla Slough, Gypsy Bay, and Chuck Slough. In 2006, the regulations allowed a harvest of six bass in the Pend Oreille River with a 12-inch minimum size (305 mm). Anglers supported a shift to quality management in 2008, which only allowed two largemouth bass with none under 16 inches (406 mm). However, the quality rule was not applied to the sloughs, allowing continued liberal harvest in the sloughs at the time when largemouth bass are most vulnerable, thus limiting the effectiveness of the quality rule. For that reason, in 2011, Quality Bass Regulations (6 fish limit, only 2 may be largemouth bass, and no largemouth bass under 16 inches) were implemented on the Pend Oreille River and adjoining sloughs. By extending the Quality Regulations to include the sloughs it was felt that the result would be reduced exploitation on larger, spawning size largemouth bass without totally eliminating angling opportunity for shoreline anglers like an area closure would.

Bennett and DuPont (1993) suggested improvements in centrarchid populations could occur in the Pend Oreille River with changes in water management. Their data suggests overwinter habitat is limiting centrarchid numbers and higher water levels during the winter may result in higher survival and increase abundance of centrarchid fishes. We hypothesized at the start of this fish survey that an increase in centrarchids species would be observed due to higher water levels in recent years. We were not able to draw any conclusions between largemouth bass year class strength, based on catch curve analysis and increased winter water levels (Figure 77) similarly, Bassista et al. (2007) failed to find a correlation between year class strength and winter lake elevations.

When compared to our 1992 survey (Bennett and DuPont 1993) it appears that centrarchids have remained relatively stable or increased slightly. Largemouth bass constituted between 1.7 and 8.4 percent of the fish community in 1991 and 1992 (Bennett and DuPont 1993). Based on our survey largemouth relative abundance in the Pend Oreille River has remained relatively consistent (Table 62).

That we did not detect a clear relationship between winter lake elevations and largemouth bass populations is not evidence that such a relationship doesn't exist. Several factors may mask or confound the relationship. Low winter water levels may affect more than just age-0 overwinter survival. Older juvenile largemouth bass may also benefit from high winter water levels and the associated increase in off-channel habitat (i.e. lower velocity water, greater depths). Higher winter water levels or a greater frequency may be necessary to achieve an increase in largemouth bass and other warmwater fish species.

Estimating year-class strength of centrarchids, other than largemouth bass is extremely difficult and was beyond the scope of this study. Age specific vulnerability of electrofishing equipment and error associated with age-estimation can affect accurate estimation of year class strength. While there may be benefits to other centrarchid species, we did not construct catch curves to evaluate the relationship between year-class strength and water levels.

Another confounding issue may be the recent invasion and removal of Eurasian watermilfoil (Myriophyllum spicatum). The Idaho Department of Agriculture and The Bonner County Eurasian Watermilfoil Taskforce have been targeting milfoil in preferred centrarchid habitat, sloughs and back water areas, in the Pend Oreille system since funding became available in 2006. The effects of Eurasian watermilfoil invasion and subsequent removal with various aquatic herbicides on sportfish production and food webs are insufficiently understood (Valley and Bremigam 2002).

Furthermore, changes in angler attitude toward bass may be a factor. Professional organizations such as B.A.S.S. and local chapters throughout north Idaho promote protection and enhancement of bass populations through catch-and-release fishing. Based on angler input, IDFG has altered fishing regulations to maintain or improve size structure by protecting large, spawning largemouth bass. Quality Bass Regulations (6-fish limit, only 2 may be largemouth bass, and no largemouth bass under 16 inches) were implemented on the Pend Oreille River and sloughs in 2011.

A more in-depth evaluation may be needed to determine if higher lake levels will benefit warmwater fish populations. Future evaluations of juvenile warmwater species, (bass, black crappie and pumpkinseed) will help better understand the effects of winter lakes levels on survival of centrarchids in the Pend Oreille River. As for largemouth bass, we recommend a follow-up exploitation study in 5-8 years to determine the impact of current regulations on larger largemouth bass in the Pend Oreille River.

MANAGEMENT RECOMMENDATIONS

1. Repeat sampling effort at least every five years to track changes in the size and composition of the fish community.

2. Conduct forage monitoring consistent with other waters in Idaho containing walleye.

Table 62. Species composition (%) of all fish captured during electrofishing surveys of the littoral area of the Pend Oreille River, Idaho. Data from 1991 and 1992 is from DuPont (1994) and data from 2005 is from Bassista et al. 2007.

	Sand				Rock				Slough				All strata combined			
	1991	1992	2005	2010	1991	1992	2005	2010	1991	1992	2005	2010	1991	1992	2005	2010
Largemouth bass	1.0	1.5	0.2	1.9	1.1	2.5	0.5	0.9	2.9	18.2	9.9	17.6	1.7	8.4	5.1	8.8
Smallmouth bass	0.0	0.0	3.8	17.2	0.0	0.0	24.5	52.3	0.0	0.0	1.0	4.9	0.0	0.0	6.7	18.9
Pumpkinseed	0.2	6.7	9.2	0.4	0.2	5.3	1.6	0.4	6.5	43.2	32.0	9.2	2.4	21.0	19.0	4.4
Yellow perch	8.3	9.0	19.2	11.2	1.1	7.7	6.3	3.1	34.6	21.1	20.8	13.7	16.0	13.5	17.4	10.7
Black crappie	1.0	0.5	28.9	2.4	0.0	1.7	19.0	1.6	3.7	2.7	22.5	5.6	1.7	1.7	23.7	3.7
Walleye	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.2	0.0	0.0	0.0	1.3	0.0	0.0	0.0	1.0
Northern pikeminnow	23.4	23.9	19.7	7.2	54.5	44.8	30.4	6.9	5.4	2.1	1.0	2.9	24.2	20.3	12.6	5.2
Tench	1.1	0.3	0.1	6.1	0.4	0.3	0.0	0.0	2.9	5.2	1.4	1.9	1.6	2.3	0.7	2.9
Peamouth	5.8	0.7	6.3	29.2	3.5	1.0	6.4	17.3	10.5	0.0	2.0	32.0	6.9	0.5	4.2	28.0
Rainbow trout	5.2	0.0	0.8	0.4	2.2	0.0	0.4	0.0	0.4	0.0	0.1	0.1	2.8	0.0	0.4	0.2
Westslope cutthroat	1.0	0.0	1.8	2.6	1.9	0.0	0.2	2.0	0.1	0.0	0.1	0.1	0.9	0.0	0.6	1.3
Brown trout	0.5	0.2	1.0	3.8	0.0	0.2	0.7	7.3	0.0	0.0	0.2	1.2	0.2	0.1	0.5	3.4
Kokanee	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2
Brook trout	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Mountain whitefish	31.5	27.8	1.1	0.3	0.7	4.5	0.0	0.9	0.5	0.5	0.0	0.1	13.4	11.2	0.3	0.3
Redside shiner	7.9	17.8	1.9	0.0	10.6	14.0	1.5	0.0	1.2	0.2	0.2	0.0	6.2	9.8	1.0	0.3
Largescale sucker	10.1	9.1	4.0	6.4	23.2	16.1	8.7	6.0	8.5	0.9	2.9	4.1	12.6	7.6	4.4	5.2
Longnose sucker	1.0	0.6	1.4	0.7	0.2	0.2	0.1	0.0	0.1	0.7	0.5	0.8	0.9	0.5	0.7	0.6
Brown bullhead	1.1	1.8	0.4	7.8	0.0	1.7	0.1	0.2	21.3	5.1	5.2	4.3	8.0	3.1	2.7	4.6

Table 63. Electrofishing catch per unit effort (CPUE) (fish/minute) of all species captured from the Pend Oreille River, Idaho. Data from 1991 and 1992 is from DuPont (1994): data from 2005 is from Bassista et al. 2007.

	Sand			Rock			Slough		
	91-92	2005	2010	91-92	2005	2010	91-92	2005	2010
Largemouth bass	0.3	0.03	0.06	0.4	0.03	0.04	1.9	1.19	1.02
Smallmouth bass	NA	0.43	0.58	NA	1.24	2.15	NA	0.13	0.28
Pumpkinseed	0.2	1.05	0.01	0.1	0.08	0.02	2.5	3.85	0.54
Yellow perch	1.1	2.19	0.38	0.2	0.32	0.13	3.8	2.51	0.79
Black crappie	0.07	3.3	0.08	0.04	0.96	0.06	0.4	2.71	0.32
Walleye	NA	0	0.03	NA	0	0.01	NA	0	0.08
Northern pikeminnow	2	2.25	0.24	3.2	1.53	0.28	1	0.13	0.17
Tench	0.05	0.02	0.2	0.03	0	0	0.32	0.17	0.11
Peamouth	0.2	0.72	0.98	0.3	0.32	0.71	0.4	0.24	1.85
Rainbow trout	0.2	0.09	0.01	0.05	0.02	0	0.02	0.01	0.01
Westslope cutthroat	0.04	0.2	0.09	0.05	0.01	0.08	0.01	0.02	0.01
Brown trout	NA	0.11	0.13	NA	0.04	0.3	NA	0.02	0.07
Kokanee	NA	NA	0.01	NA	NA	0.01	NA	NA	0.01
Brook trout	NA	NA	0.05	NA	NA	0.03	NA	NA	0
Mountain whitefish	1.9	0.13	0.02	0.2	0	0.04	0.1	0.01	0.01
Redside shiner	1	0.22	0	1	0.07	0	0.01	0.03	0
Largescale sucker	0.7	0.45	0.21	1.2	0.44	0.25	0.3	0.35	0.24
Longnose sucker	0.01	0.16	0.02	0.08	0.01	0	0.09	0.06	0.05
Brown bullhead	0.09	0.05	0.26	0.07	0.01	0.01	0.95	0.63	0.25

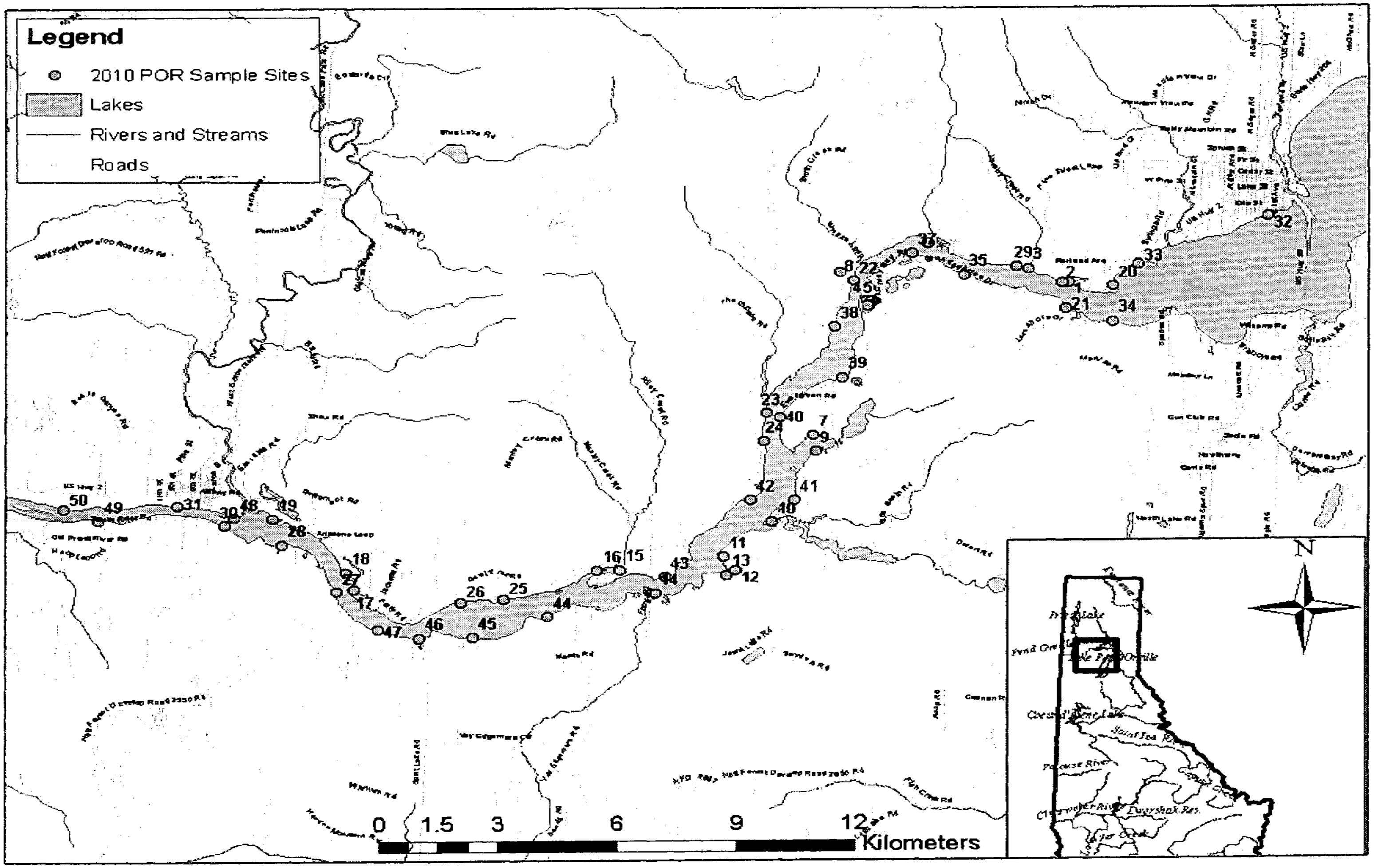

Figure 66. Pend Oreille River, Idaho study area and transect locations 2010 (GPS coordinates are in Appendix C).

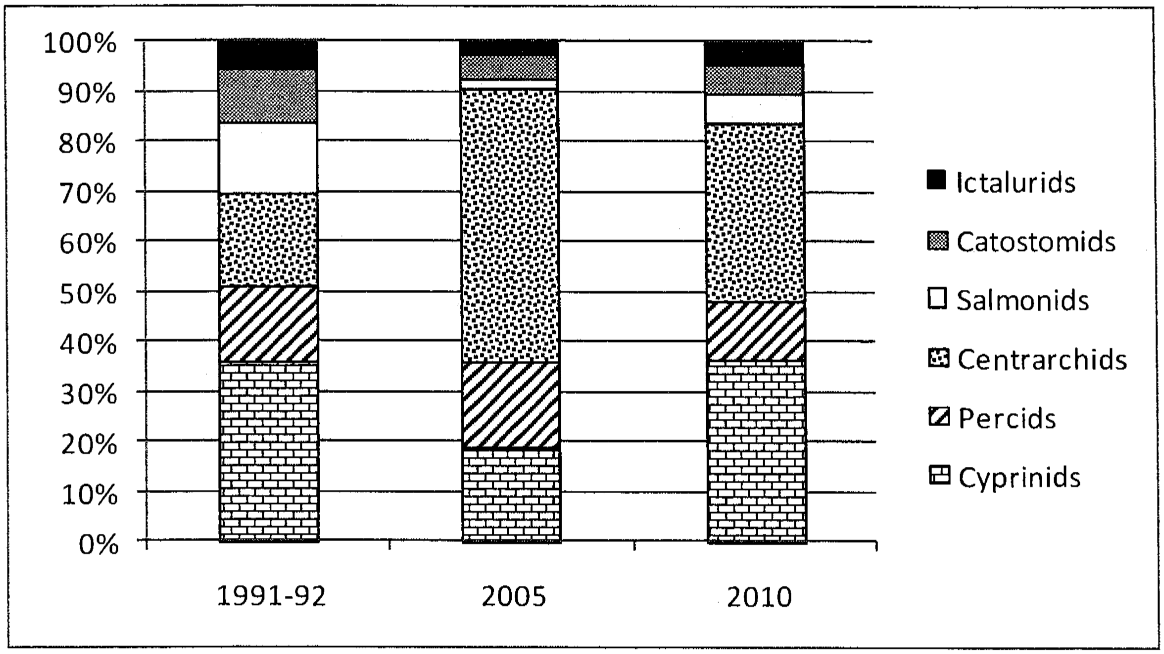

Figure 67. Percent composition of family groups collected in the Pend Oreille River, Idaho 1991-92, 2005 and 2010.

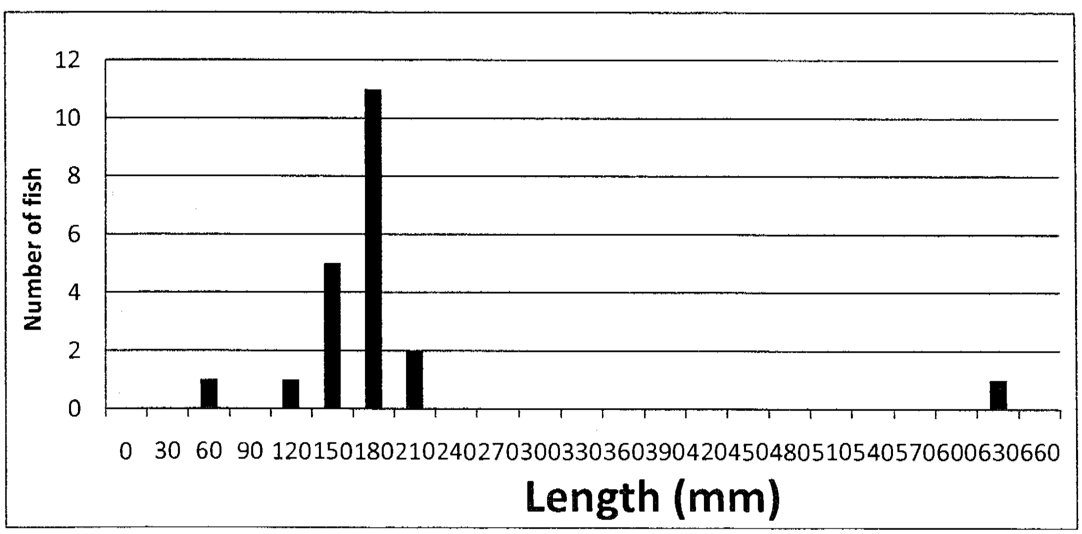

Figure 68. Length frequency of walleye captured (n = 21; mean total length = 215) during 2010 in the Pend Oreille River, Idaho.

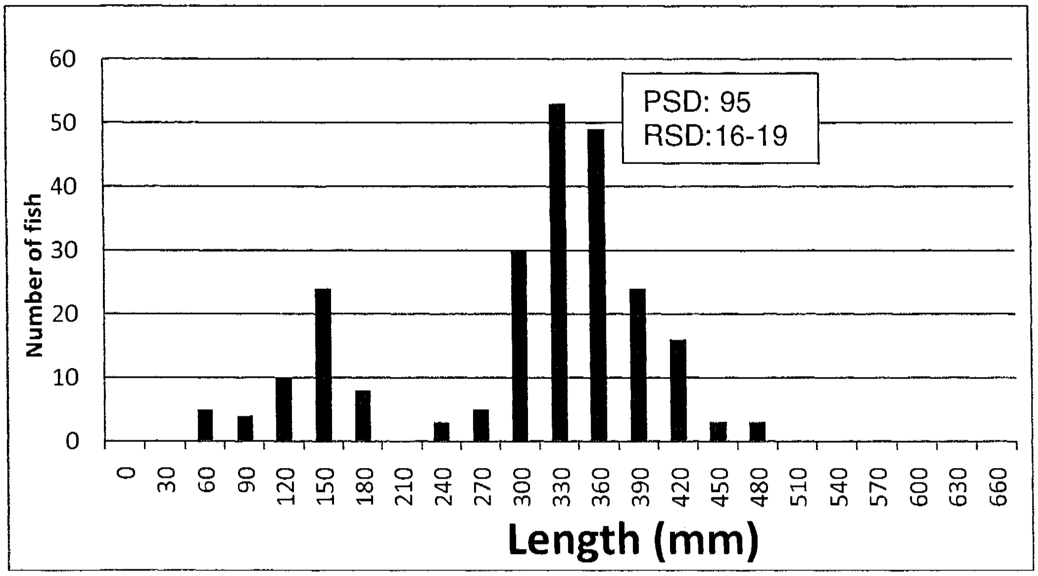

Figure 69. Length-frequency of largemouth bass captured (n = 237; mean total length = 217) during 2010 in the Pend Oreille River, Idaho

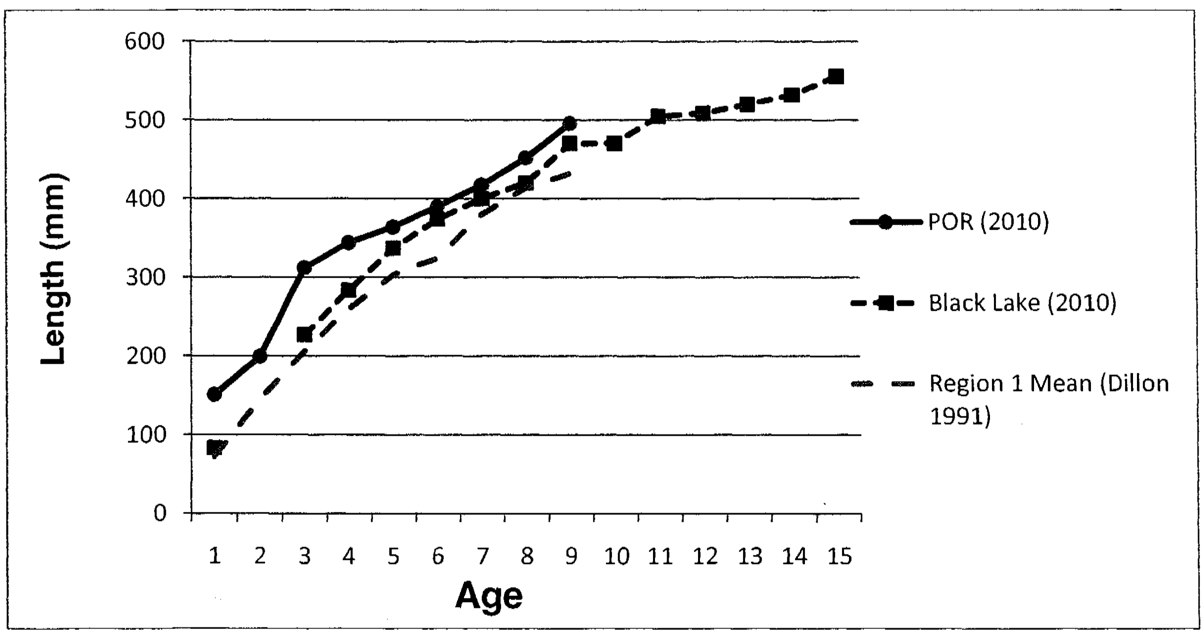

Figure 70. Length-at-age of largemouth bass collected in Pend Oreille River, Idaho, 2010.

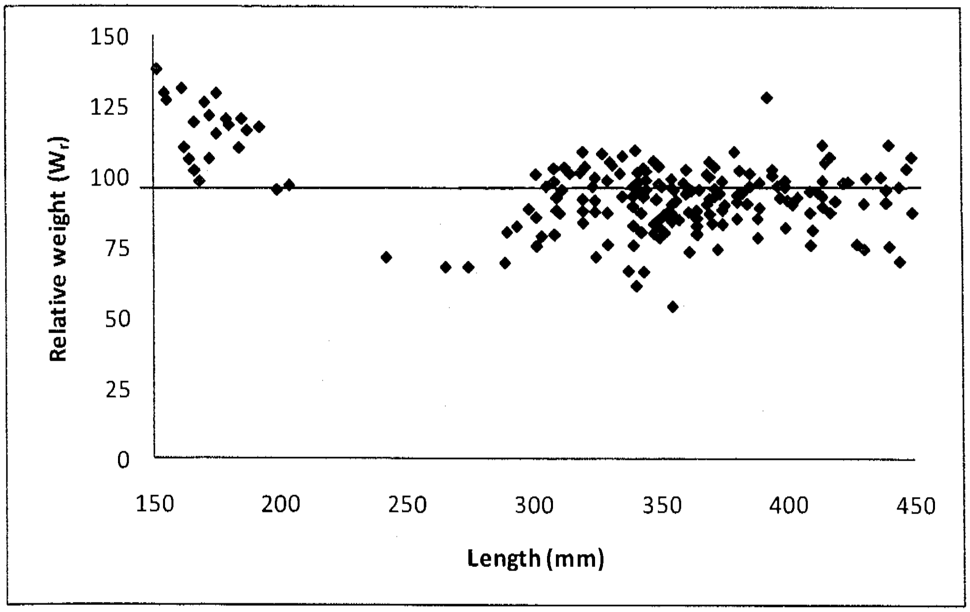

Figure 71. Relative weights (Wr) of largemouth bass (n = 214, mean = 96%) in the Pend Oreille River, Idaho, 2010.

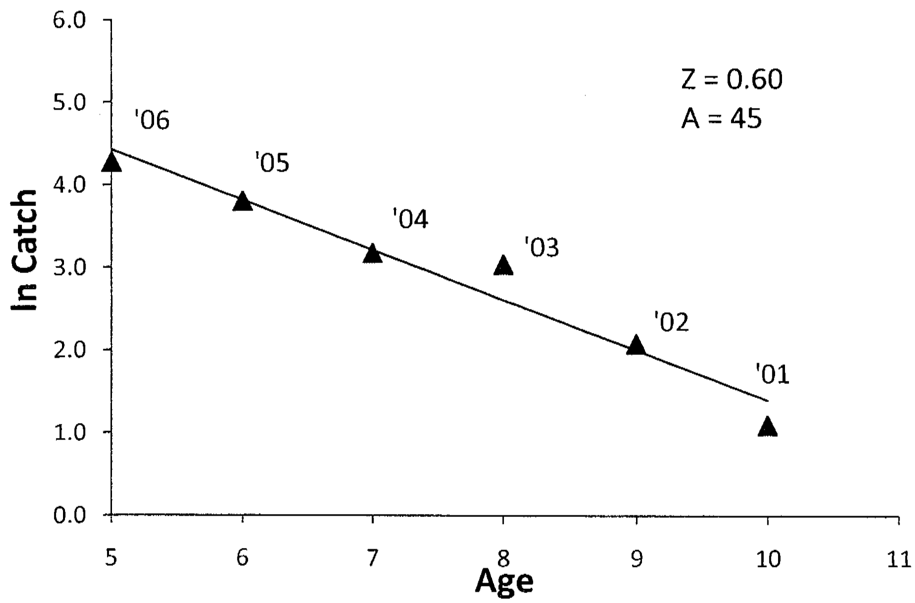

Figure 72. Catch curve used to estimate total instantaneous mortality (Z) and total annual mortality (A) of largemouth bass collected in Pend Oreille River, Idaho in June, 2010.

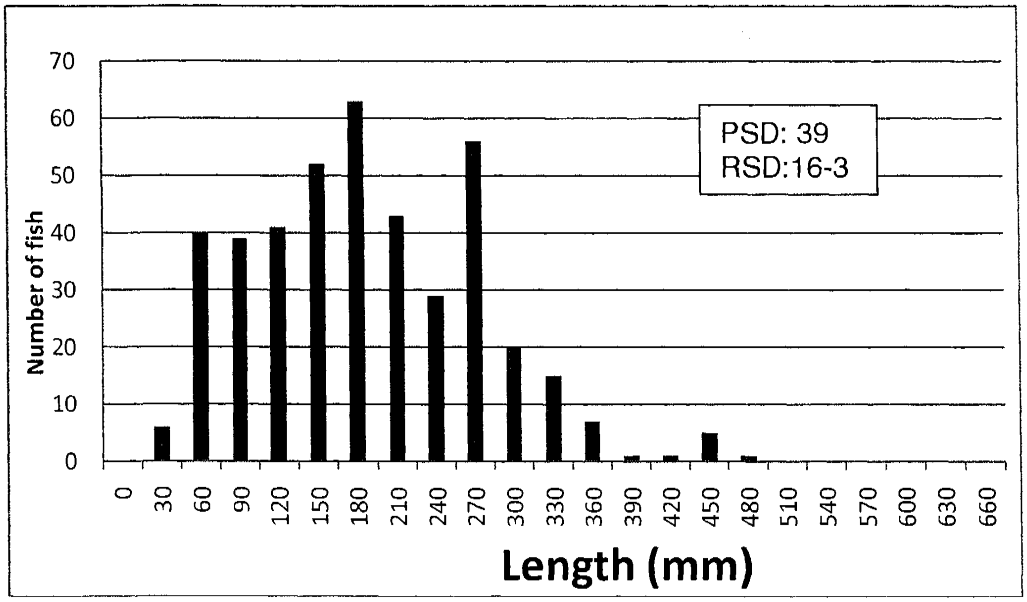

Figure 73. Length-frequency of smallmouth bass captured (n=419; mean total length = 217) during 2010 in the Pend Oreille River, Idaho.

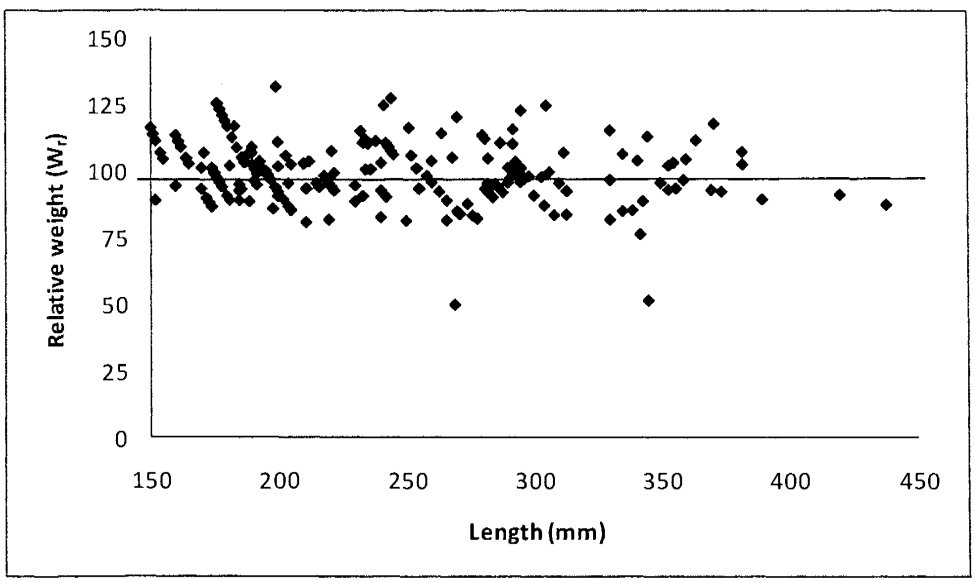

Figure 74. Relative weights (W_r) of smallmouth bass (n = 237; mean= 99%) in the Pend Oreille River, Idaho, 2010.

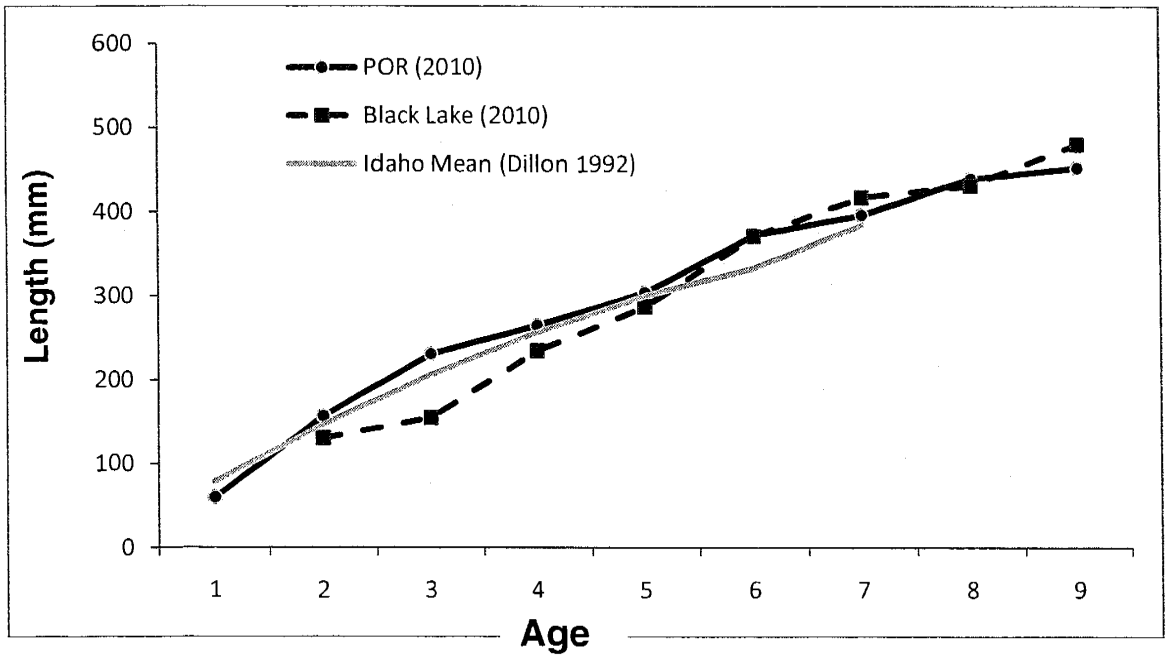

Figure 75. Age-at-length of smallmouth bass collected in Pend Oreille River, Idaho, 2010.

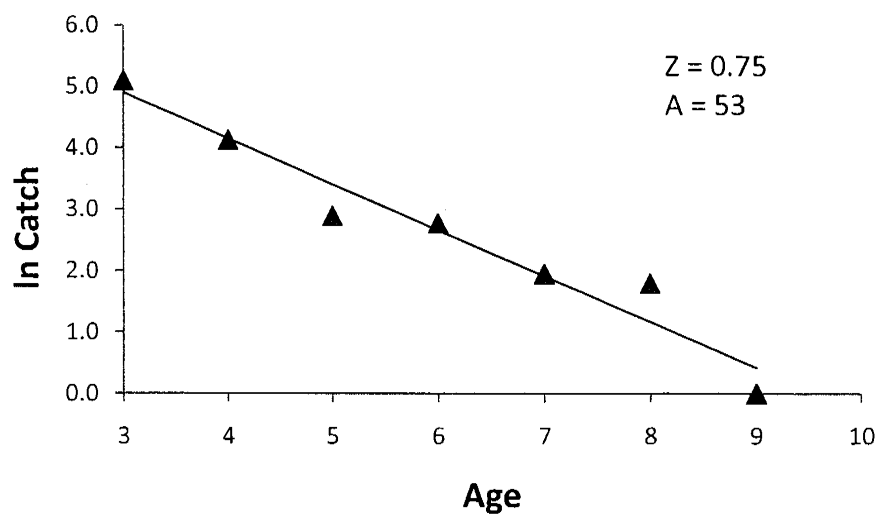

Figure 76. Catch curve used to estimate total instantaneous mortality (Z) and total annual mortality (A) of smallmouth bass collected in Pend Oreille River, Idaho in June, 2010.

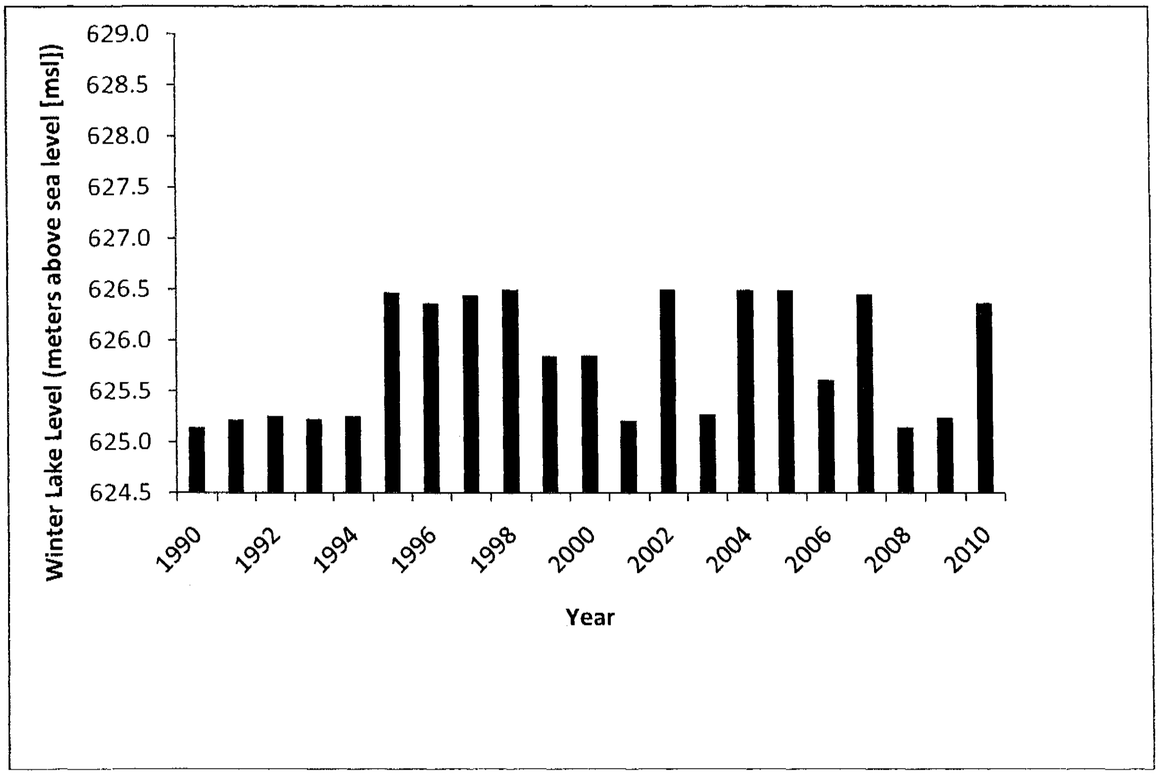

Figure 77. Winter lake levels of Lake Pend Oreille River, Idaho, between 1990 and 2010 (data from U.S. Army Corp of engineers).

APPENDICES

Appendix A. BLM habitat improvements that have occurred in the Pine Creek Drainage since 2002.

Stream	Date	Work Performed
Highland Creek	Nov-02	replacement of upper culvert (Highland Surprise) and added barrier due to apparent separation of brook trout and cutthroat trout by old culvert. Culvert was a complete barrier.
Trapper Creek	2005	culvert at mouth was replaced in 2005 (partial barrier)
Calusa Creek	2007	stabilized landslide
WF Pine Creek	2007	replaced culvert at Langlois Creek to improve fish passage
EF Pine, Highland, Trapper creeks	Annual	all have had work done including partial barrier removals (small culverts, log jams), streambank and landslide stabilization and riparian revegetation.

Removing and stabilizing mine tailings has been ongoing in the Pine Creek drainage since 1996. Work on the Constitution mine site (end of the road on East Fork Pine) was done in 2007. Another large one was the Liberal King mine, though this one was done before Kathy sampled in 2002/2003.

Appendix B. Replacement culvert immediate and installation of fish passage barrier in Highland Creek approximately 100 m below transect HC3.5. December, 2002.

Appendix C. Global Positioning System coordinates for electrofishing sites during 2010, Pend Oreille River, Idaho fisheries survey.

Pend Oreille River 2011		
Site	Latitude	Longitude
1	48.2466	-116.6188
2	48.2467	-116.6211
3	48.2505	-116.6323
4	48.2460	-116.6867
5	48.2405	-116.6848
6	48.2387	-116.6860
7	48.2026	-116.7024
8	48.1991	-116.6959
9	48.1980	-116.7016
10	48.1780	-116.7151
11	48.1680	-116.7308
12	48.1645	-116.7268
13	48.1631	-116.7298
14	48.1574	-116.7536
15	48.1637	-116.7661
16	48.1633	-116.7737
17	48.1559	-116.8553
18	48.1607	-116.8584
19	48.1749	-116.8837
20	48.2461	-116.6035
21	48.2395	-116.6191
22	48.2458	-116.6912
23	48.2084	-116.7188
24	48.2004	-116.7193
25	48.1547	-116.8047
26	48.1534	-116.8190
27	48.1551	-116.8610
28	48.1678	-116.8802
29	48.2508	-116.6366
30	48.1725	-116.9002
31	48.1777	-116.9160
32	48.2664	-116.5521
33	48.2525	-116.5953
34	48.2362	-116.6031
35	48.2480	-116.6542

Appendix C. Continued.

Site	Latitude	Longitude
36	48.2564	-116.6666
37	48.2535	-116.6717
38	48.2327	-116.6971
39	48.2188	-116.6935
40	48.2073	-116.7141
41	48.1842	-116.7081
42	48.1838	-116.7228
43	48.1622	-116.7503
44	48.1500	-116.7897
45	48.1439	-116.8146
46	48.1434	-116.8323
47	48.1452	-116.8466
48	48.1748	-116.8970
49	48.1729	-116.9426
50	48.1759	-116.9541

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