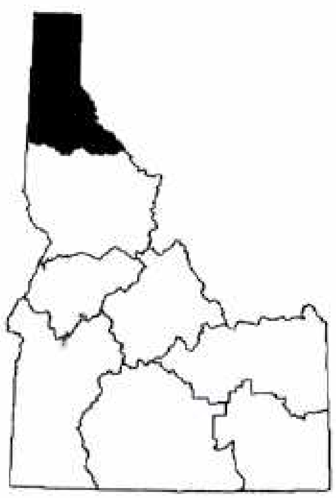
FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME

FISHERY MANAGEMENT ANNUAL REPORT

Cal Groen, Director



PANHANDLE REGION
2007

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2007 Panhandle Region Fisheries Management Report

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2007 Panhandle Region Fisheries Management Report

Lowland Lakes and Reservoir Investigation

COEUR D'ALENE LAKE FISHERY INVESTIGATION

ABSTRACT

A mid-water trawl was used to estimate the kokanee *Oncorhynchus nerka* population in Coeur d'Alene Lake in early August, 2007. Trawl results indicated a near record low number of adult kokanee, with the total population of age-3 fish estimated at 34,000 or 3 fish/ha. Standing stock was estimated at 17 kg/ha. We estimated 136,000 age-2, and 2,367,000 age-1 kokanee and 3.6 million age-0 kokanee.

We used a helicopter to conduct Chinook salmon *O. tshawytscha* redd surveys 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. We counted 101 Chinook salmon redds in the Coeur d'Alene River drainage and 26 in the St. Joe River. At total of 62 Chinook salmon Redds were excavated to reduce natural production in the Coeur d'Alene River. NO age-0 hatchery Chinook salmon were stocked in Lake Coeur d'Alene in 2007.

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INTRODUCTION

Although kokanee are not native, they are one of the most important sport fish species in the Panhandle Region. Populations have been established in most of the oligotrophic lakes in Idaho. Kokanee first entered Lake Pend Oreille via the Clark Fork River during the winter flood of 1933 from fish that emigrated 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. Kokanee spawners in northern Idaho are classified as "late spawners" typically using shoreline gravel rather than tributary streams and spawn from November through early January. Annual monitoring of kokanee populations is critical to evaluating the status of these important fisheries.

The kokanee fishery peaked in 1979 with 578,000 fish harvested but then quickly declined by the early 1980's when kokanee became too numerous and mean size decreased. Fall Chinook salmon were introduced into Coeur d'Alene Lake in 1982 as a biological tool to reduce kokanee abundance and improve the yield fishery. Fall Chinook salmon was 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, Kamloops rainbow trout, walleye, brown trout); ability to manage predator/prey numbers; and the benefit provided by a Chinook fishery. Kokanee densities of 30 - 50 age-3 kokanee/ha provide the highest catch rates for desirable size (280 mm) fish (Rieman and Maiolie 1995). Chinook management goals call for greater catches of 1.5 - 9 kg fish rather than fewer but bigger fish. A mix of hatchery and wild Chinook were used to achieve management goals.

Recently adult kokanee densities have dropped below the desired levels. Based on trawling, age-3 kokanee densities were below 10 fish/ha in seven of the last nine years, and were at 3 fish/ha in 2006 and 2007. Our concern is that Chinook predation may be exceeding what is needed to improve the kokanee fishery.

OBJECTIVES

1. Manage for a kokanee yield fishery and limited Chinook salmon trophy fishery in Coeur d'Alene Lake.

METHODS

We used a mid-water trawl, as described by Bowler et al. (1979), Rieman and Meyers (1990), and Rieman (1992), to estimate the kokanee populations in Coeur d'Alene Lake and Spirit Lake.

Twenty-two transects were trawled on Coeur d'Alene Lake during the dark phase of the moon on August 7-8. Trawl transects were selected using a stratified random sample design and were in identical locations (as near as possible) to those used in previous years (Figure 1). Kokanee were measured and weighed, and scales and otoliths were collected from representative length groups for age analysis.

Because trawling was conducted in August 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. Kokanee spawner lengths were determined by collecting a sample of fish on December 4, 2007. The gill net was set at depths of 3 - 5 m near Higgins Point for approximately one hour. Potential egg deposition (PED) was estimated as the number of female kokanee spawners (half the mature population based on mid-water 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

IDFG personnel used a helicopter to conduct Chinook redd surveys 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 October 8, 2007. We estimated the natural production using these redd counts, an estimate of 4,000 eggs per redd, and a mean egg-to-smolt survival of 10%. In an effort to reduce natural production Department personnel used a high pressure fire pump mounted in our drift boat and shovels to excavate and destroy excess redds.

RESULTS

Trawl results in Coeur d'Alene Lake indicated the third lowest number of adult kokanee in 28 years, with the total population of age-3 fish estimated at 34,000 or 3 fish/ha, far below the 28 year mean of 762,000 and the 10 year mean of 100,000 age-3 kokanee and nearly identical to 2006 (Table 1). We estimated 2,367,000 age-1 kokanee, well above the 28 year average of 1,534,000 and the highest number since 1994 (Table 1). Age-2 kokanee were estimated at 136,000 far below the 28 and 10-year means of 1.5 million and 238,000 respectively. The estimated population of age-0 kokanee was 3.6 million nearly identical to the 28-year mean of 3.7 million fish. The standing stock of kokanee in Coeur d'Alene Lake was estimated at 17.12 kg/ha, a decrease from the 2006 estimate of 25.71 kg/ha. Consistent with previous years, the highest age-0 kokanee densities were in the northern section of the lake (Table 2).

Kokanee fry collected in the trawl ranged from 36 to 65 mm TL. Age-1 kokanee ranged from 90 to 170 mm with a modal length of around 129 mm. Age-2 fish ranged from 180 to 230 mm. Size of the age-3 kokanee at the time of trawling ranged from 250 mm to 326 mm (Figure 2). Typical of kokanee in Coeur d'Alene Lake, maturity was primarily at age-3 and all of the age-3 kokanee captured were mature. Mean weights were 0.86, 16.3, 60.7, and 239.5 g for kokanee age classes 0-3, respectively.

In a 30 minute gill net set on December 4, 2007 we collected 82 kokanee spawners near Higgins Point in Wolf Lodge Bay. Males outnumbered females, with around 28% of the sample being females. Female mean length was 325 mm (TL), (N=23, SD=28.6 mm). Male mean and modal lengths were 364 and 361 mm respectively, (N=59 SD=27.1 mm). Mean length of spawners was comparable to 2006. Kokanee spawner length in Coeur d'Alene Lake during the past 10 years has been larger than they have been since the late 1950's (Figure 3). Mean fecundity was estimated at 749 eggs per female based on a mean female spawner length of325 mm, and PED was approximately 13 million eggs (Table 3). This is the third lowest PED in29 years and far below the average (119 million). The average PED for the past 10 years is 33 million eggs.

We counted 127 Chinook salmon redds in the Coeur d'Alene River drainage and 26 in the St. Joe River (Table 4). Conditions for counting were favorable (clear skies and clear water), and we were able to see most redds easily.

Management goals call for no more than 100 Chinook salmon redds in the Coeur d'Alene River drainage, therefore, 62 Chinook salmon redds were destroyed in the Coeur d'Alene River on October 24, 2007. All 62 redds were in a 1.6 km section of river just upstream of the 1-90 Kingston exit. This section of river was chosen because of the high concentration of redds and availability of boat access points.

We estimated natural production based on the remaining 65 undisturbed redds using an estimated 4,000 eggs per redd, and a mean egg-to-smolt survival of 10%. Based on these figures, we estimate smolt production for wild Chinook salmon to be 26,000 fish entering Coeur d'Alene Lake in 2008.

No age-0 hatchery Chinook salmon were stocked in 2007. The total age-0 wild Chinook salmon from 2006 entering Coeur d'Alene Lake in 2007 was estimated to be about 40,000 fish (Table 5).

DISCUSSION

The age-2 and age-3 kokanee populations in Coeur d'Alene Lake remains below the long-term average, however, age-0 and age-1 estimates are above or near the long term average. As in the previous eight years, the low densities have resulted in much larger than average kokanee. Fish from the age-3 population appear to be similar in length to recent years but the age-3 estimate is the third lowest recorded in 28 years. Despite the low abundance the late summer fishery remains very popular at the north end of the lake due to the size of mature fish. Age-0 kokanee numbers have been remarkably stable in the past 11 years. This may be the result of our underestimating the population of spawners. Rieman (1992) noted that capture efficiency decreases with increasing size. Hydroacoustic surveys confirmed the inefficiency of the trawl on large, adult kokanee, and may explain the high PED to fry survival rates observed in the past 10 years. The same comparison data indicates that the trawler is very efficient for age-0 kokanee (Fredericks et al. 2000).

The spawning escapement in 2007 was nearly the weakest since trawling began in1979, and nearly identical to 2006. PED was around 13 million eggs. Because of the size of mature kokanee at trawling (250 - 326 mm) in 2007, and the decreased capture efficiency with increasing size (Rieman 1992); we most likely underestimated the population of spawners. This suggests escapement of spawners the last few years was greater than trawl-based estimates indicate, and may partially account for the exceptionally high PED to fry survival rates since1999 (Table 3).

Reiman and Meyers (1990) suggested kokanee become vulnerable to anglers at about 180 mm and vulnerability increases with size. They further hypothesized that exploitation may increase dramatically in populations with densities of age-3 fish less than 10 to 20 per ha and could result in the collapse of the fishery. Our August trawling results indicate density of age-3 fish to be 3 kokanee/ha. Concern for a collapse resulted in IDFG reducing the kokanee bag limit in 2006 from 25 to 6 kokanee. Trawling results in August 2008 will dictate whether this regulation is sufficient or a complete closure is needed.

Over the past 26 years we have stocked an average of 30,500 age-0 hatchery Chinook salmon in Coeur d'Alene Lake (Table 3) and for only the third time no hatchery Chinook salmon were stocked in the lake.

For the third time since 1990 Chinook salmon redd counts have exceeded 100, requiring excavation of excess redds. The efficacy of this technique is questionable as Chinook salmon eggs were found buried under up to 0.5 m of gravel substrate. Superimposition of redds also made it difficult to identify the actual egg pocket. An alternative technique to reducing the number of redds or reducing the wild Chinook salmon population should be explored. Discussions relative to an alternative to culling redds have included using a weir to capture pre-spawn adults, using electrofishing jet boats to capture adults and using anglers.

Additionally we made changes relative to both Chinook salmon and kokanee bag limits in 2006.The bag limit on Chinook was raised from 2 to 6 fish and the kokanee bag limit was reduced from 25 to 6 fish. The aggregate limit for kokanee and Chinook salmon was set at 6 fish to reduce kokanee harvest and to encourage anglers to harvest more Chinook.

MANAGEMENT RECOMMENDATIONS

1) Discontinue Chinook salmon stocking until mid-water trawling results indicate an increase in kokanee numbers.

2) Continue to monitor the kokanee population with the mid-water trawl.

3) Continue to encourage catch-and-keep Chinook salmon fishing.

4) Evaluate methods to remove adult Chinook from the Coeur d'Alene River prior to actual spawning.

5) Conduct creel survey during the Chinook salmon derbies to determine the extent of hatchery Chinook contribution to creel.

Table 1. Estimated abundance of kokanee made by mid-water trawl in Coeur d'Alene Lake, Idaho, from 1979-2007 (No trawling estimate in 2005). To follow a particular year class of kokanee, read up one row and right one column.

Sampling Year	Age Class Age 0+	Age 1+	Age 2+	Age 3/4+	Total	Age 3+/ha
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
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
Previous ẍ	**3,856,285**	**1,552,078**	**1,516,930**	**762,574**	**7,568,930**	**79**

Table 2. Kokanee population estimates and standing crop (kg/ha) in each section of Coeur d'Alene Lake, Idaho, August 7-8, 2007.

Section	Age 0	Age 1	Age 2	Age 3	Kg/ha
1	2,682,294	666,436	0	0	5.30
2	920,215	1,287,903	110,602	34,249	6.50
3	0	412,917	25,502	0	5.32
Whole lake	**3,602,509**	**2,367,257**	**136,104**	**34,249**	6.02
(90% CI)	905,367	859,090	56,162	33,177	

Table 3. 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, 1979-2007.

Year	Estimated female escapement	Estimated potential number of eggs ($x10^6$)	Fry estimate the following year ($x10^6$)	Percent egg to fry survival
2007	17,100	13		
2006	16,900	12	3.60	28.9
2005	N/A	N/A	7.34	N/A
2004	101,000	76	*	*
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

* no estimate could be made due to missing trawl data in 2005.

Table 4. Chinook salmon redd counts in the Coeur d'Alene River drainage, St.Joe River, and Wolf Lodge Creek, Idaho, 1990-2007

Location	1990	91	92	93	94	95	96	97	98	99	2000	2001	2002	2003	2004	2005	2006	2007
Coeur d'Alene River																		
Cataldo Miss to S.F. Cd'A R	41	11	29	80	82	45	54	18	11	7	16	18	14	27	24	30	30	63
S.F. Cd'A to L.N.F. Cd'A R	10	0	5	11	14	14	13	5	3	5	20	13	10	17	36	7	80	20
L.N.F. Cd'A to Steambt Cr	--	2	3	6	1	1	13	6	1	0	3	2	6	2	4	3	14	4
Steamboat Cr to steel bridge	--	--	1	0	0	2	0	3	0	0	0	1	0	0	2	0	7	1
Steel bridge to Beaver Cr	--	--	--	--	0	0	0	1	0	0	0	0	0	0	0	0	0	0
S. F. Cd'A River	--	--	--	--	13	--	4	0	0	0	5	4	3	5	4	8	10	13
L.N.F. Cd'A River	--	--	--	--	0	2	0	0	0	0	1	0	0	0	1	1	0	0
Coeur d'Alene R Subtotal	51	13	38	97	110	64	84	33	15	12	45	38	33	51	71	49	141	101
St. Joe River																		
St. Joe City to Calder	4	0	18	20	6	1	59	20	3	0	5	21	14	15	15	7	15	23
Calder to Huckleberry C.G.	3	1	1	4	0	0	5	2	1	0	0	15	4	9	3	3	1	4
Huckleberry C.G. to Marble Cr	3	0	2	0	1	0	7	2	0	0	0	--	0	3	0	0	0	0
Marble Creek to Avery	0	0	0	0	1	0	0	0	2	0	0	--	0	0	0	0	0	0
St. Joe River Subtotal	10	1	21	24	8	1	71	24	6	0	5	36	18	27	18	10	16	26
Wolf Lodge Creek	--	--	--	--	--	--	--	--	4	5	3	4	0	0	1	1	--	--
TOTAL	**66**	**14**	**63**	**121**	**118**	**65**	**155**	**57**	**25**	**17**	**53**	**78**	**51**	**78**	**90**	**59**	**157**	**127**

Table 5. 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 redds is the count from the previous fall.

Year	Hatchery Produced				Naturally Produced		
	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

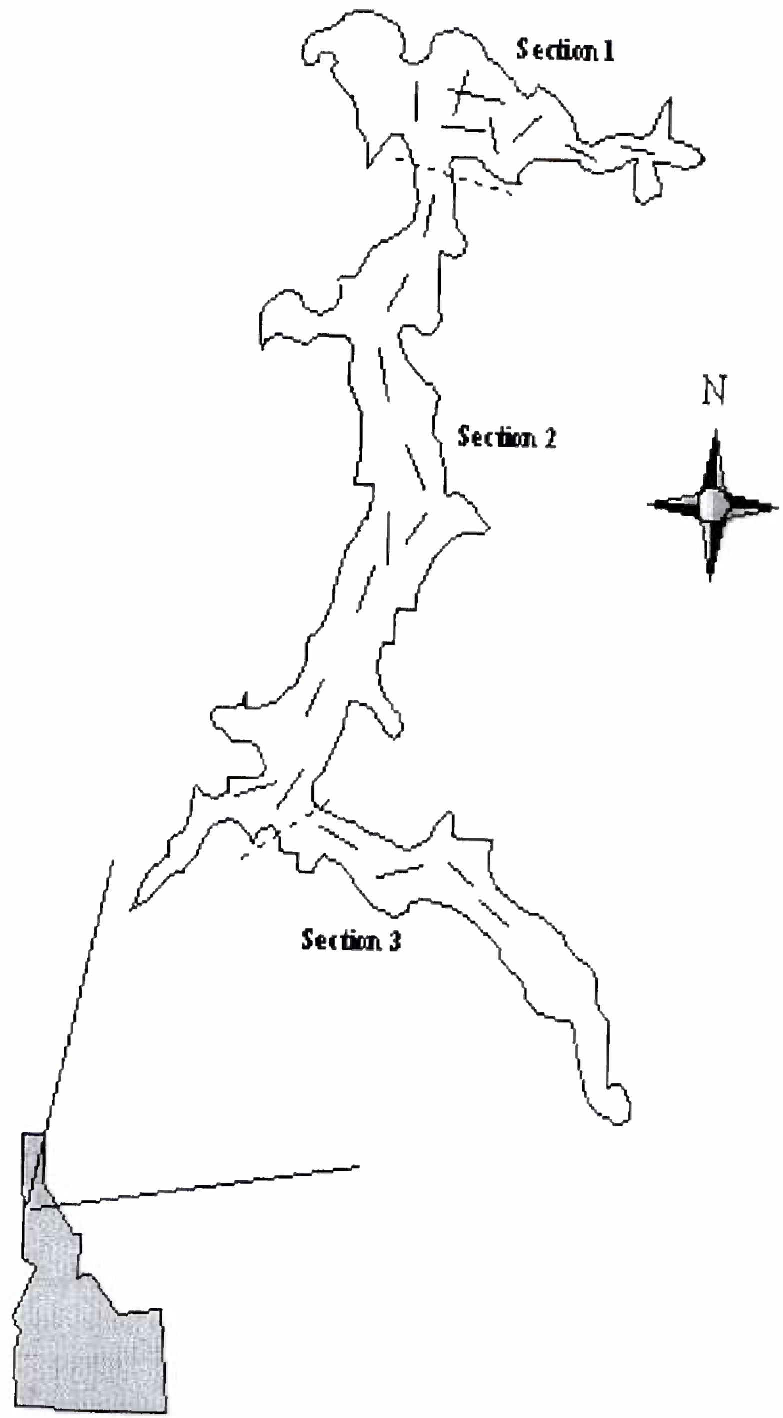

Figure 1. Location of 22 mid-water trawling transects in three sections of Coeur d'Alene Lake, Idaho, used to estimate kokanee population abundance in 2007.

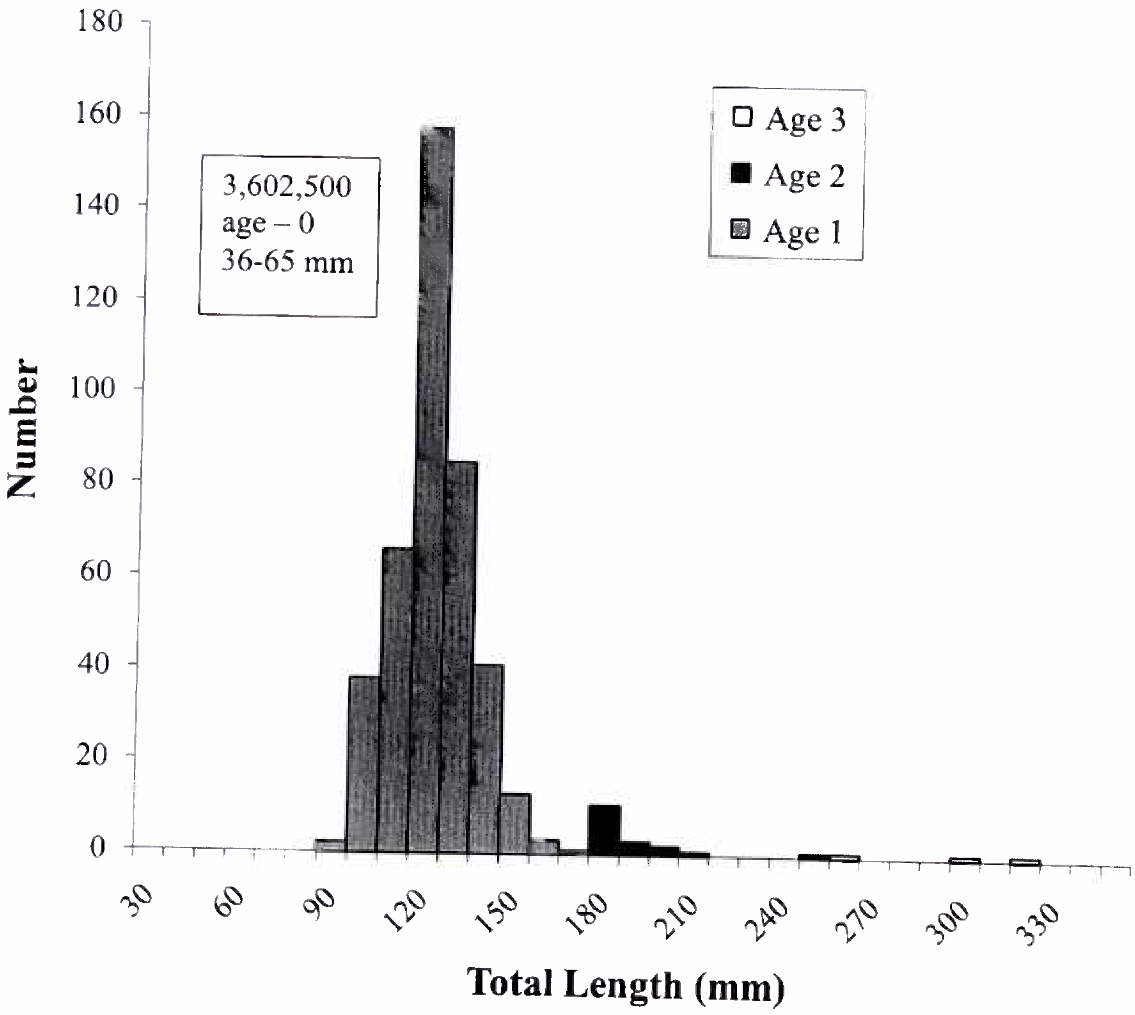

Figure 2. Length frequency and age of kokanee collected by mid-water trawling in Coeur d' Alene Lake, Idaho, in 2007.

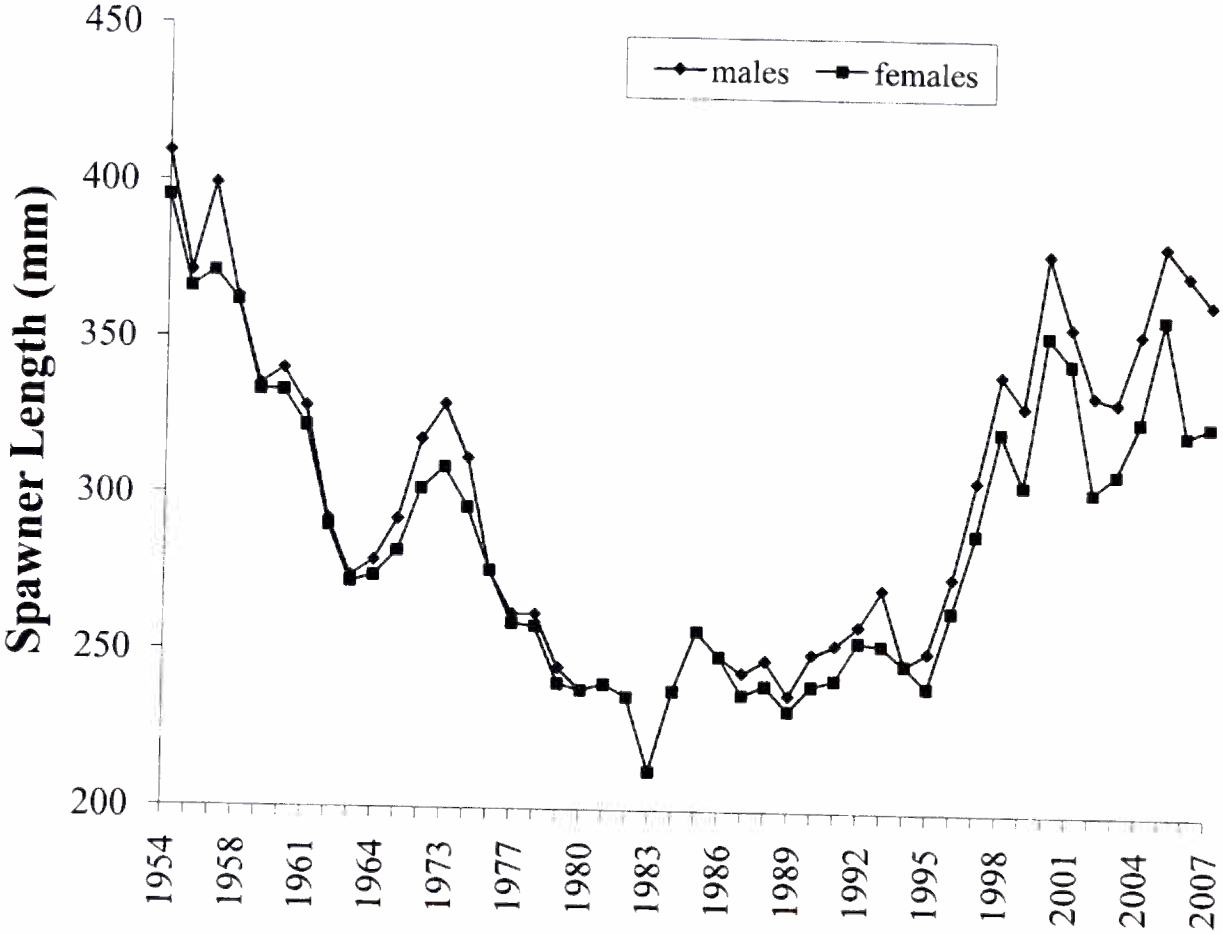

Figure 3. Mean total length of male and female kokanee spawners in Coeur d'Alene Lake, Idaho, from 1954 to 2007. Year where mean lengths were identical between sexes are a result of averaging male and female lengths.

2007 Panhandle Region Fisheries Management Report

Lowland Lakes and Reservoir Investigations

PRIEST LAKE INVESTIGATION

ABSTRACT

We counted a total of 2,145 kokanee spawners at five historic locations along the shoreline of Priest Lake in November. The numbers of kokanee spawners observed at each of the five sites on Priest Lake were as follows; Copper Bay 308, Huckleberry Bay 38, Cavanaugh Bay 463, Hunt Creek beach 1,296, and Indian Creek beach 40. The spawner count was lower than the peak count of 6,117 kokanee made in 2004.

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INTRODUCTION

Historically, Priest Lake had fisheries for cutthroat trout O. *clarkii,* bull trout *Salvelinus confluentus* and kokanee. By the 1980's the fishery was dominated by lake trout *S. namaycush* harvest. This investigation was to monitor the abundance of spawning kokanee to determine if their abundance was increasing.

STUDY AREA

Priest Lake is located in the northwestern corner of the Idaho Panhandle about 29 km south of the Canadian border. The lake has 99.8 km of shoreline, a surface area of 9,453 ha, and a maximum depth of 103 m. Priest Lake is largely surrounded by coniferous forest and is known for its low productivity and clear water.

OBJECTIVE

Provide a limited harvest of kokanee in Priest Lake.

METHODS

Lakeshore areas of Priest Lake were surveyed to determine the location of kokanee spawning and to quantify the number of spawners. Kokanee spawner counts were conducted in fives historic spawning areas on November 5, 2007. 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 4).

RESULTS

A total of 2,145 kokanee spawners were counted at five shoreline sites in Priest Lake. Number of kokanee spawners observed at each of the five sites on Priest Lake were as follows; Copper Bay 308, Huckleberry Bay 38, Cavanaugh Bay 463, Hunt Creek beach 1,296, and Indian Creek beach 40 (Table 6). No significant change in mean length has been observed in Priest Lake adult kokanee over the past five years. Mean lengths (TL) of 7 male and 3 female kokanee were 399 and 385 mm in 2007 (Figure 5).

DISCUSSION

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 *Mysis relicta* 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 recently the Priest Lake kokanee population has been considered all but extirpated. Changes in water level management may have resulted in a rebounding kokanee population as our kokanee spawner count data suggests there are more kokanee today in Priest Lake than there has been in 20 years. We have been counting kokanee spawners at five historic sites since 2001, averaging 3,257 fish per year. Priest Lake spawning kokanee numbers were down from 2006. We counted 2,145 kokanee spawners at the five sites compared to 3,145 in 2006. Prior to 2002, timing of winter draw down may have adversely affected spawning success and survival of beach spawned eggs and fry in redds. In 2001 Idaho Water Resources Board (IWRB) and IDFG proposed several amendments to the 1996 kokanee recovery plan suggesting the lake level be lowered starting October 1st in order to reach the 0.0 feet goal at the outlet gauge by November 1st. Lower lake levels ensure a higher success rate for kokanee redds because the water is at its lowest level before kokanee initiate spawning. Kokanee spawning activity in Priest Lake peaks in mid-November. Since 2002 Priest Lake has been drafted to near the 0.0 goal on October 31st.

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor kokanee spawner numbers on Priest and Upper Priest Lakes and expand surveys to include lower sections of historic spawning tributaries.

2. Consider re-instituting a limited harvest fishery for kokanee in Priest and Upper Priest lakes.

Table 6. Counts of shoreline spawning kokanee salmon in Priest Lake and Upper Priest Lake, Idaho, 2001- 2007.

Location	2001	2002	2003	2004	2005	2006	2007
Priest Lake							
Copper Bay	588	549	1237	1584	906	1288	308
Cavanaugh Bay	523	921	933	1673	916	972	463
Huckleberry Bay	200	49	38	359	120	43	38
Indian Crk Bay	222	0	0	441	58	0	40
Hunt Crk Mouth	232	306	624	2060	2961	842	1296
Upper Priest Lake							
West shoreline	10	---[1]	---[1]	---[1]	---[1]	---[1]	---[1]
Total	**1775**	**1825**	**2832**	**6117**	**4961**	**3145**	**2145**

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

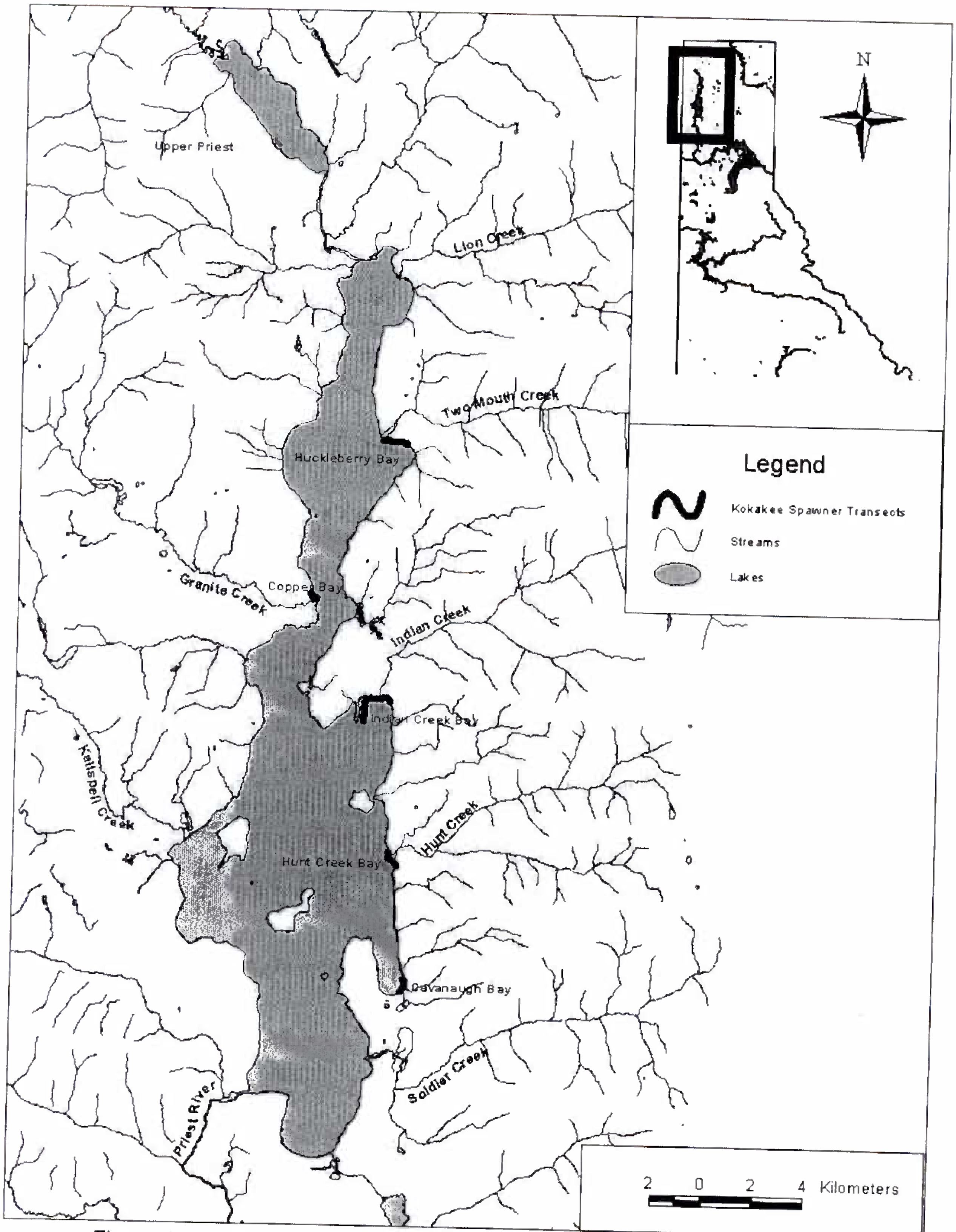

Figure 4. Location of kokanee spawner counts on Priest Lake, Idaho, 2007.

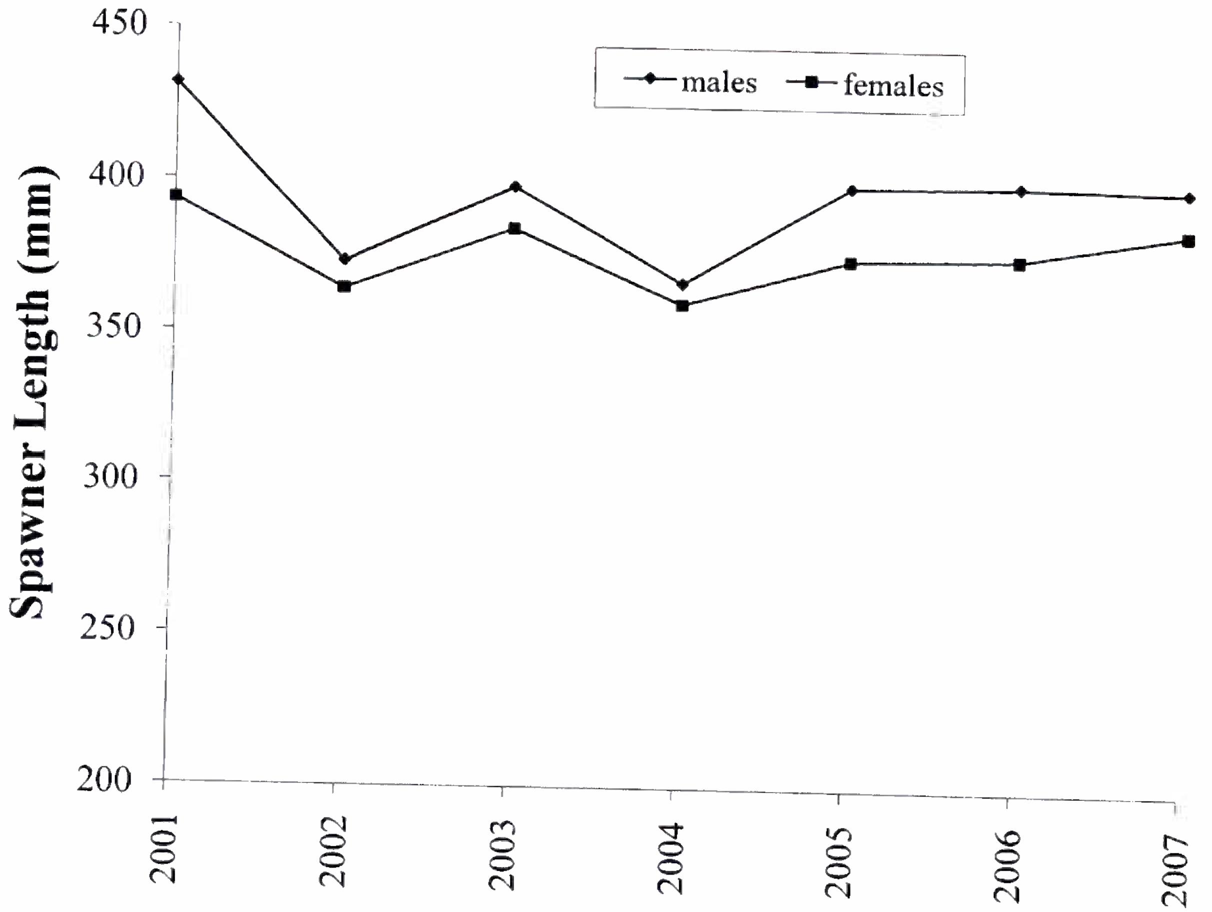

Figure 5. Mean total length of male and female kokanee spawners in Priest Lake, Idaho, from 2001 to 2007.

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UPPER PRIEST LAKE BULL TROUT ENHANCEMENT

ABSTRACT

Harbor Fisheries, Inc. of Baileys Harbor, Wisconsin was contracted to gill net and remove lake trout from Upper Priest Lake in 2007 using their 47 foot commercial gill net boat with funding from the USFWS. Gill nets were fished from June 6th through June 16th, 2007. Catch rates of lake trout varied among locations and days in Upper Priest Lake. Catch rates were generally higher along shorelines and lower in deeper mid-lake sets. Catch rates were generally higher at the start of the effort, and tapered off over the 11 day effort. We fished a total of 53.9 km of gill net (33.5 mi) averaging 4,907 m net/day. A total of 1,982 lake trout were caught and removed. Processed lake trout were filleted and given to various food banks throughout the Idaho Panhandle for distribution to the indigent.

Abundance of lake trout was estimated using a Leslie Depletion Model (Ricker 1975). We estimated lake trout population abundance at 2,307 fish. Adult lake trout abundance was also estimated at 3,702 using a Peterson mark-recapture estimate. Density of the lake trout in Upper Priest Lake (4.07 - 6.5 adults/ha) was average compared with other North American populations. Regardless of the abundance estimator, we feel we have proven that we are able to remove a significant portion of the lake trout population from Upper Priest Lake in a short amount of time.

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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. In Press). Historically, native bull trout provided a trophy fishery in Upper Priest Lake with an annual catch of 1,800 fish in the 1950s (Bjornn 1957). Bull trout harvest was eliminated in 1984, but no positive response in the fishery 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. In Press).

Native westslope cutthroat trout were also historically abundant in the Priest lakes with 30 fish limits common in the 1940s (Mauser et al. 1988). Over harvest, interspecific and intraspecific competition, and degradation of spawning habitat all led to the decline of cutthroat trout in the Priest lakes. Harvest of cutthroat was eliminated 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 the mid-1980s at which time they were through 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 Venard 1999). 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. Annual removal has ranged from 150 and 1,100 lake trout every year from Upper Priest Lake.

METHODS

Sampling Gear

Harbor Fisheries, Inc. of Baileys Harbor, Wisconsin was contracted to gill net and remove lake trout from Upper Priest Lake in 2007 using their 47 foot commercial gill net boat. Funding for this contract was provided by the U. S. Fish and Wildlife Service (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 64 mm to 89 mm randomly arranged in each net. Individual gill nets were tied together end to end to create a continues net ranging from 823 m to 16,646 m. Using a variety of mesh sizes reduces the overall effects of size selectivity and allows us to sample fish as small as 150 mm.

Gill nets were fished from June 6th through June 16, 2007. 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 set 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.

Data Collection

Two weeks prior to the June removal effort (May 23-24) IDFG used gill nets to conduct a marking run. A total of 47 lake trout were captured, marked with an adipose clip and release for a Peterson population estimate. During our recapture run lake trout were measured, examined for tags or clips and killed. Processed lake trout were filleted and given to various food banks throughout the Idaho Panhandle for distribution to the indigent.

Statistical Analysis

Lake trout abundance was estimated from data on numbers of lake trout captured, marked and recaptured. We used an Adjusted Petersen Estimate (Ricker 1975) to calculate the population size (N).

$$N = \frac{(M+1)(C+1)}{R+1}$$

with a sampling variance of:

$$V(N) = \frac{N^2(C-R)}{(C+1)(R+2)}$$

Where:

M = the number of marked fish,
C = catch or sample taken from the population, and
R = number of recaptured marks in the sample

The Peterson Estimate operates under the following assumptions:

1. Marked fish did not lose their marks.
2. Fish were not overlooked when recaptured.
3. Marked and unmarked fish were equally vulnerable during recapture runs (non-learning behavior).
4. Marked fish must redistribute in the population when released.
5. The population was closed (no movement in or out of study area)
6. No mortality occurred during the estimate.

RESULTS

During our 11 day effort to suppress lake trout abundance in Upper Priest Lake we averaged 4,904 m net/day. A total of 1,982 lake trout were caught and removed. Daily catch of lake trout ranged from 90 - 348 fish. Lake trout ranged from 169 - 912 mm with a mean of 421.4 mm TL (Figure 6).

A total of seven bull trout were capture and released alive. Bull trout ranged from 405-745 mm with a mean length of 588 mm.

Catch rates of lake trout varied among locations and days in Upper Priest Lake during June, 2007. Catch rates were generally higher along shorelines and lower in deeper mid-lake sets. Catch rates were generally higher at the start of the effort and tapered off over the 11 day effort. However, there was a precipitous decline in catch from day 1-4 then an increase on day 5 followed by a steady drop in catch for the remainder of the effort. On days 1-4 we concentrated our efforts on shoreline areas that have been traditional lake trout producers over the years. With the steady decrease in catch rates, we decided on the fifth day to take advantage of the high quality electronics on the commercial gill net boat and searched for areas offshore with concentrations of lake trout. Several mid-lake locations were identified as having good concentrations of lake trout. Therefore, for the remainder of our effort, we concentrated on these mid-lake, deep water schools (Figure 7).

Using a Leslie Depletion Model (Ricker 1975) we estimated lake trout population abundance at 2,307 fish (Figure 8). This suggested we may have removed up to 86% of the lake trout in Upper Priest Lake (Dr. Mike Hansen personnel communication).

Twenty five lake trout were recaptured during our removal effort. Our Peterson mark-recapture population estimate for Upper Priest Lake was 3,702 lake trout indicating we may have captured and removed 55 percent of the lake trout in Upper Priest Lake in our 11 day effort.

DISCUSSION

The lake trout population in Upper Priest Lake has grown rapidly in the last decade. In 1998 the lake trout population was estimated at 859 fish (Fredericks 1999). Density of lake trout (4.07 - 6.5 adults/ha) in 2007 in Upper Priest Lake was average compared with other North American populations (mean = 4.35 adults/ha, range 0.87 - 14.21; Hansen et al. 2007 In press). The range of 4.07 - 6.5 adults/ha was a function of which abundance estimator was used. The density of lake trout in Lake Pend Oreille was estimated at (0.28 adults/ha) in 2006. This seems low; however, the percent of surface area suitable for lake trout in Lake Pend Oreille is probably around 50%. Whereas in Upper Priest Lake nearly 100% of the surface area could be considered usable lake trout habitat.

Regardless of the abundance estimator, analysis suggests we are able to remove a significant portion of the lake trout population from Upper Priest Lake in a short amount of time.

We have known for years that Upper Priest Lake cannot be treated as a closed system and until lake trout immigration from Priest Lake is minimized our removal efforts are a temporary fix. IDFG is currently working with various other agencies to rebuild and modify the break-water wall at the lower end of the Thorofare. Our vision is to reconfigure the break-water wall to include a much smaller opening for boat traffic and allow the operation of strobe lights, or an electrical or mechanical weir to prevent the upstream migration of lake trout from Priest Lake to Upper Priest Lake.

Our plan for 2008 includes duplicating our 2007 effort with the same contractor, Harbor Fisheries (Bailey's Harbor, Wisconsin). Duplicating our 2007 effort and comparing results of the two studies should provide us with an estimate of how many lake trout are immigrating into Upper Priest Lake on yearly basis. During May 2008 we also plan to set parallel gill nets at the outflow of Upper Priest Lake to document the direction and timing of lake trout movement during spring.

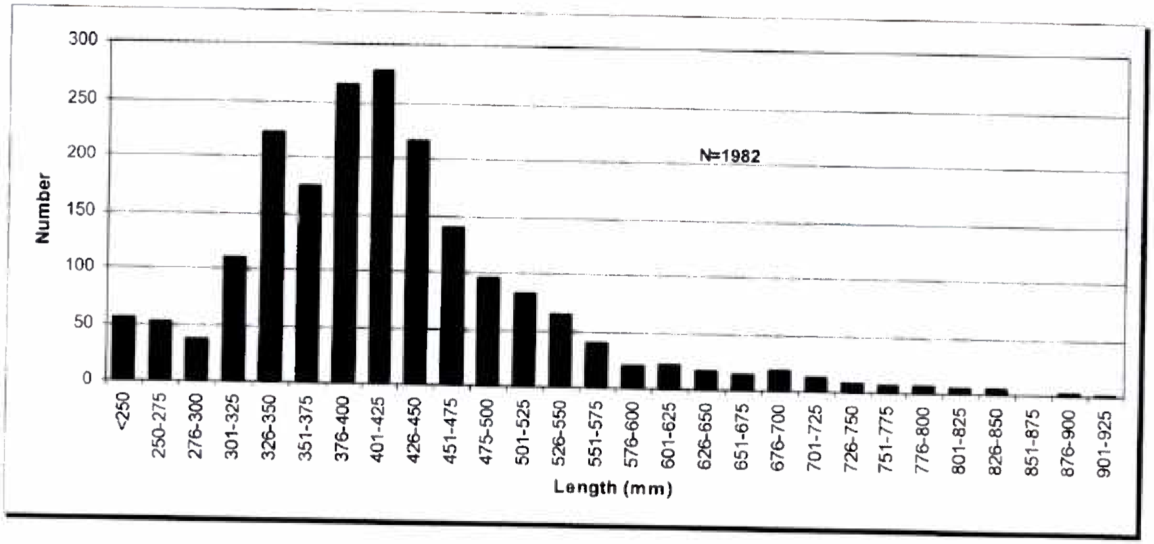

Figure 6. Length frequency of lake trout caught in gill nets in Upper Priest Lake, Idaho, from June 6 through June 16, 2007.

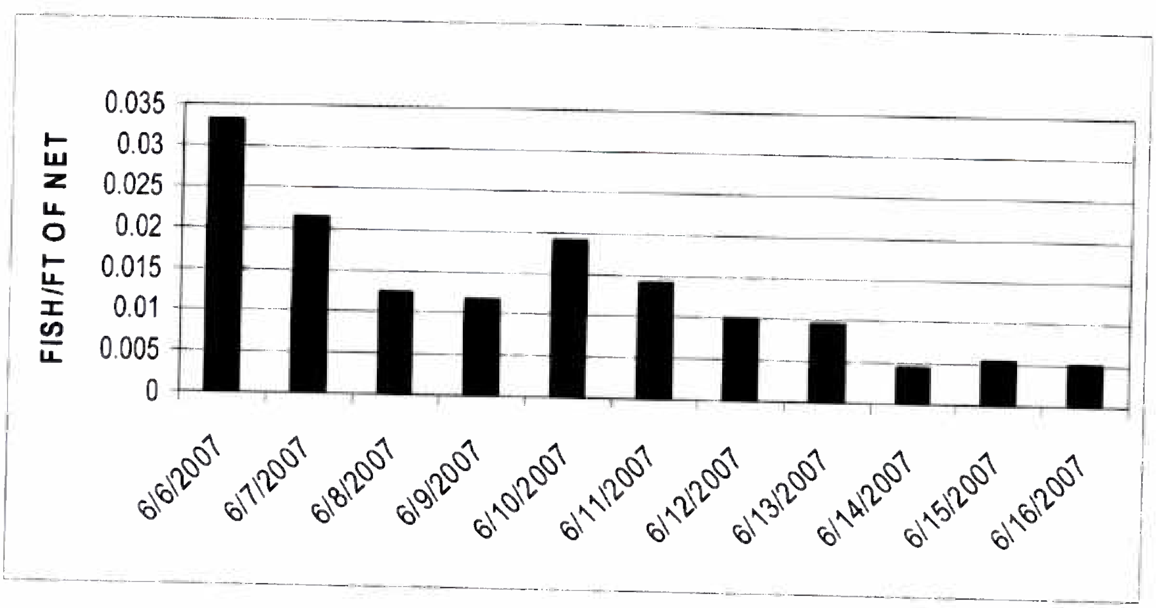

Figure 7. Catch rate of lake trout caught per day per foot of net over 11 days of sampling by gill nets in Upper Priest Lake, Idaho from June 6 through June 16, 2007.

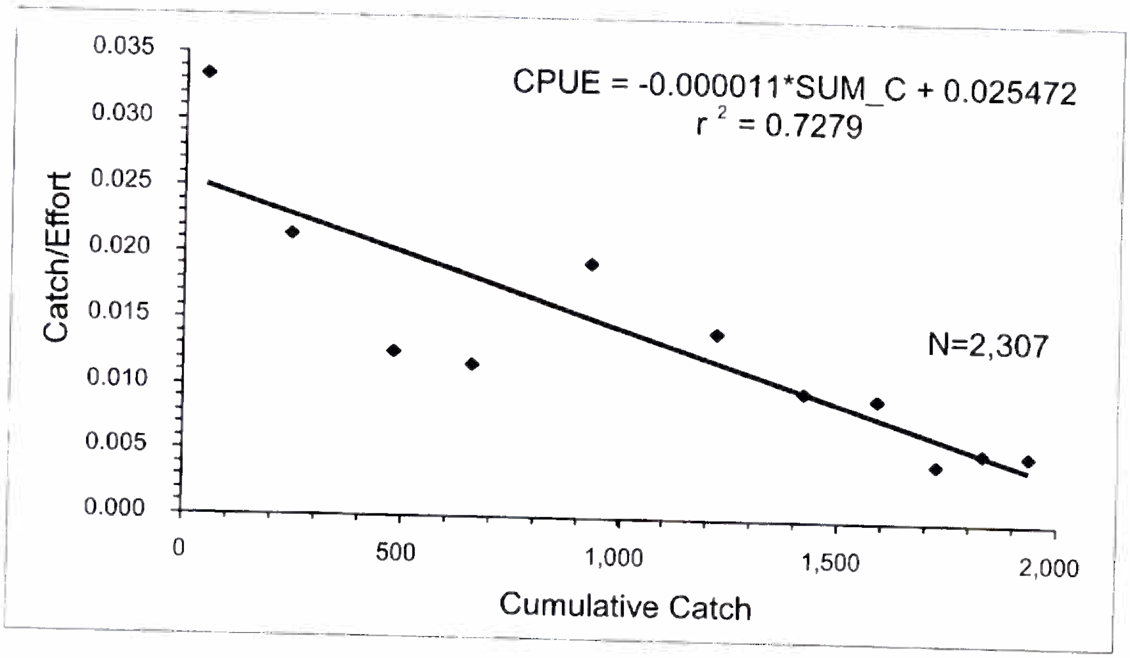

Figure 8. Leslie Depletion Model (Ricker 1975) abundance estimate for lake trout captured by gill nets in Upper Priest Lake, Idaho from June 6 through June 16, 2007.

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SPIRIT LAKE INVESTIGATION

ABSTRACT

We estimated the kokanee population in Spirit Lake during July 2007 by using mid-water trawling and hydroacoustics. Based on trawling, the adult kokanee density was 35 fish/ha with a total population of age-3 fish at 20,400. We estimated 41,460 age-2; 210,100 age-1; and 439,900 age-0 kokanee for a total population estimate of 711,900 fish. The standing stock of kokanee in Spirit Lake was estimated at 25.9 kg/ha. The kokanee population was also estimated using mobile hydroacoustics. Using this method, the lake was estimated to contain 597,000 age-0 (fry); 349,000 age-1; 69,000 age-2; and 34,000 age-3 kokanee.

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INTRODUCTION

Spirit Lake was one of the best producers of kokanee in the Pacific Northwest. In a review of 28 lakes in Idaho, Washington, Oregon, Montana, Utah, Colorado, and British Columbia, Spirit Lake produced several times more kokanee, per area, than most other lakes (12.7 kg harvested/ha, Meyer and Rieman 1990). Although smaller than some of the other kokanee lakes in the Panhandle Region, Spirit Lake contains an important kokanee fishery with a harvest of nearly 60,000 fish (Meyer and Rieman 1990). Our efforts in 2007 were to monitor the kokanee population in the lake and determine if management efforts are sustaining the population at the appropriate levels for a yield fishery.

STUDY AREA

Spirit Lake is located at the western edge of the Panhandle Region. The lake has a surface area of 598 ha, is 27 m deep, has 18 µ/l of total phosphorus, and a mean Secchi transparency of 3.9 m. Area used as kokanee habitat was measured at 585 ha.

OBJECTIVE

Maintain a yield kokanee fishery (Idaho Fish and Game 2007).

METHODS

We used a mid-water trawl, as described by Bowler et al. (1979), Rieman and Meyers (1990), and Rieman (1992), to estimate the kokanee population in Spirit Lake.

Five transects were trawled on Spirit lake on July 17, 2007. Trawl transects were selected using a stratified random sample design and were in identical locations (as near as possible) to those used in previous years (Figure 9). Kokanee were measured and weighed, and scales and otoliths were collected from representative length groups for age analysis.

A hydroacoustics survey was conducted on Spirit Lake on July 24, 2007. We surveyed seven transects in a zigzag fashion across the lake (Figure 9). We used a Simrad EK60 portable scientific echo-sounder equipped with a 120 kHz split beam transducer mounted on a vertical pole. The echo-sounder was set to ping at 0.3 s intervals.

We determined kokanee abundance using echo integration techniques (Maclennan and Simmonds 1992). Echoview software version 3.10.135.03 was used to view and analyze the data. Hydroacoustic traces (a single returned echo from a fish) were accepted if they were between -60 and -33 dB and the echo length was between 30% and 180% of the original pulse length at a point 6 dB below the peak echo value. Additionally, the correction value returned from the transducer gain model could not exceed a two-way maximum gain compensation of 6.0 dB (therefore, it included all targets within the 3 dB beam width) and the maximum standard deviation of the minor and major axis angles was less than 0.6 degrees.

Targets were considered kokanee fry if they were under -45 dB. Targets between -44.9 dB and -33 dB were considered kokanee of ages 1 to 3 (Figure 10). Abundance estimate of these targets was multiplied by the percentage of kokanee in each age class caught in the mid-water trawl to obtain age specific abundance estimates.

RESULTS

Based on trawling, we estimated Spirit Lake contained 752 fry/ha (Table 7). Kokanee in age classes 1, 2, and 3 were estimated at 359, 71, and 35 fish/ha, respectively. Based on hydroacoustics, fry densities were estimated at 1,021 fry/ha in the kokanee layer (Table 7). Fry were highest on the west side of the lake with densities reaching close to 2,000/ha, but were also high at the outflow arm at 900 fry/ha. Kokanee of ages 1 to 3 were estimated at 772 fish/ha. These kokanee were also highest on the western side of the lake and steadily dropped toward the eastern side. We estimated the lake contained 349,102 age-1 kokanee; 68,646 age-2 kokanee; and 33,872 age-3 kokanee.

DISCUSSION

Densities of kokanee in Spirit Lake appear to be sufficient to provide a good yield fishery. Rieman and Maiolie (1995) recommended 30 - 50 kokanee/ha of harvestable size fish to maximize catch rate, yield, and effort in kokanee fisheries. Spirit Lake at 35 kokanee/ha is at the lower end of this range, but should provide a good fishery. Fry densities at over 1,000 fish/ha, by hydroacoustics, should be sufficient to maintain an abundant population of adult fish.

MANAGEMENT RECOMMENDATION

Monitor kokanee on an annual basis to determine fry densities and survival rates.

Table 7. Kokanee population estimates based on mid-water trawling (and hydroacoustics in 2007) from 1981 through 2007 in Spirit Lake, Idaho.

	Age Classes					
Year	Age-0	Age-1	Age-2	Age-3	Total	Age-3+/ha
2007	439,919	210,122	41,460	20,409	711,910	35
2007*	597,285	349,102	68,646	33,872	1,048,905	58
2005	508,000	202,000	185,000	94,000	989,100	21
No trawl surveys completed from 2001 through 2004						
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	9,800	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 (1981-2005)	**199,300**	**145,500**	**106,300**	**55,500**	**507,500**	**89**

Note: No trawling took place from 2001-2004 and 2006 due to low water preventing us from launching the 33 ft. trawler.

*Hydroacoustics

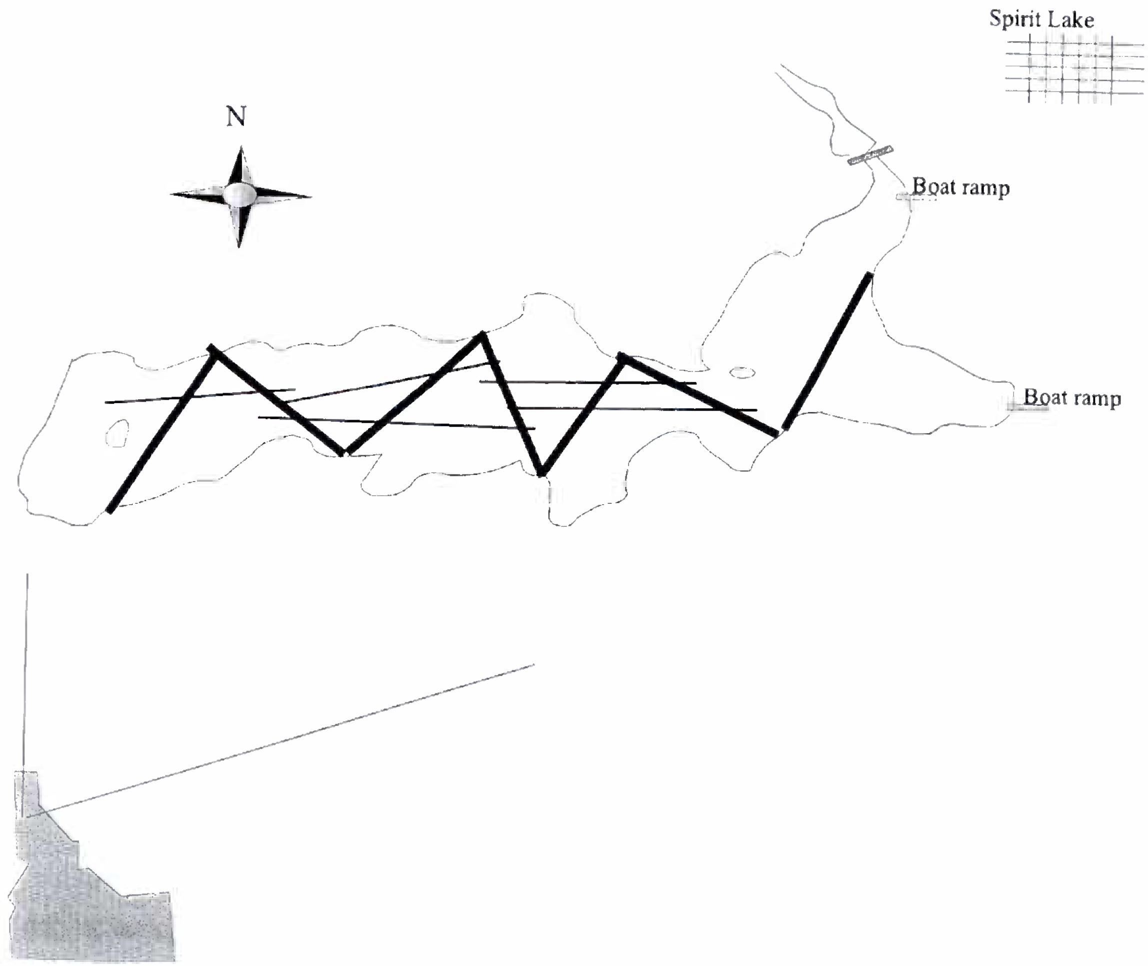

Figure 9. Location of five mid-water trawling transects (fine lines) and seven hydroacoustic transects (bold zigzag lines) in Spirit Lake, Idaho, used to estimate kokanee population abundance in 2007.

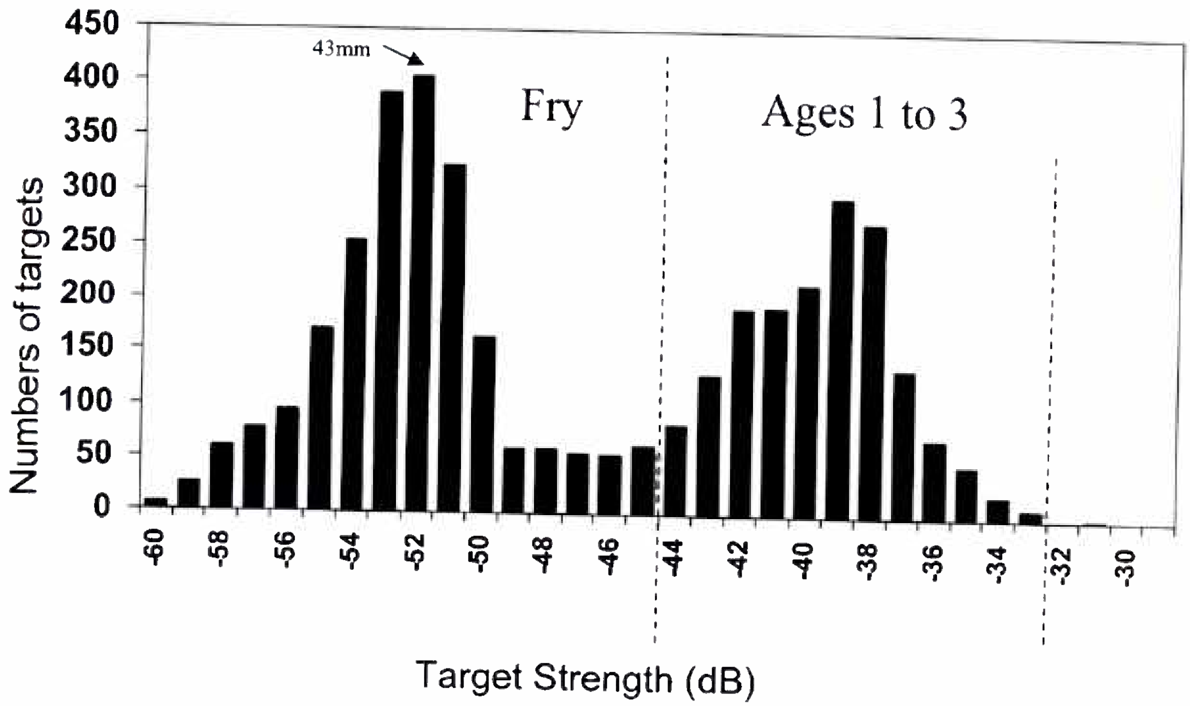

Figure 10. Target strengths of kokanee in Spirit Lake, Idaho, on July 24, 2008. Modal length of fry was estimated at 43 mm.

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Lowland Lakes and Reservoir Investigations

MISCELLANEOUS LOWLAND LAKE SURVEYS

ABSTRACT

Lowland lake surveys were conducted on Shepherd, Jewel, Hauser, and Rose Lakes in 2007. Surveys were conducted to evaluate the effectiveness of stocking efforts, particularly tiger muskellunge *Esox lucius* x *Esox masquinongy* in Shepherd and Hauser Lakes, rainbow out *Oncorhynchus. mykiss,* channel catfish *Ictalurus punctatus,* and bluegill *Lepomis macrochirus* in Jewel Lake, and channel catfish in Rose Lake.

No tiger muskellunge were captured in Shepherd Lake and only two fish were captured in Hauser Lake. Both of these fish were below the harvestable size. In Jewel Lake, the introduction of channel catfish appears to have reduced the population of yellow perch *Perea flaveseens* and numbers of bluegill have increased, though few are in the quality range. Few rainbow trout were captured in Jewel Lake and individuals largely represented one year class. In Rose Lake channel catfish have become well established with above average condition.

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INTRODUCTION

We assessed the fish populations in various lowland lakes in the Panhandle Region to determine the effects of different management actions. Our objective is to provide a diversity of angling opportunities for area fishermen.

STUDY AREAS

Shepherd Lake

Shepherd Lake, a 41 ha lake, is located in Bonner County 1.6 km southeast of Sagle, Idaho (Figure 11). Property bordering the lake is largely owned by IDFG and we maintain two campgrounds and a public boat ramp. A boat launch is located on the northeast shoreline and the lake is managed as an "Electric Motors Only" lake under IDFG fishing regulations.

Tributaries to the lake are intermittent and the outlet, Fry Creek, is a tributary to Lake Pend Oreille. The maximum depth of the lake is approximately 13 m. The shoreline of Shepherd Lake is largely covered by macrophytes, which provide extensive littoral habitat. The northern end of the lake is very shallow «1 m) and nearly covered in its entirety with lily pads.

Shepherd Lake is managed as a warmwater fishery under general season and limits. Largemouth bass *Micropterus salmoides,* black crappie *Pomoxis nigromaculatus,* yellow perch, and pumpkinseed *L. gibbosus* have been present in the lake since before the 1950s. Bluegill were stocked in Shepherd Lake in 1989 and 1990 and tiger muskellunge were stocked beginning in 1989 until present. A survey was conducted in 1992 to evaluate the effectiveness of these stocking efforts, however only one tiger muskellunge and no bluegill were captured. Other species present in the lake were likely introduced by anglers.

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 succumbing 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 (Figure 12).

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 muskellunge and channel catfish were stocked in the lake. Tiger muskellunge (150 mm fish) and channel cats (150 mm fish) were stocked most recently in 2007. The Idaho state record tiger muskellunge was captured in Hauser Lake in 2001, weighing 17.4 kg and measuring 1,230 mm.

A lowland lake survey was conducted in 1992 to evaluate the stocking success of channel catfish and tiger muskellunge. A total of 22 channel catfish were captured and showed growth rates comparable to Carlander (1969). No tiger muskellunge were captured. In 1999, a survey was initiated to evaluate the abundance and size structure of yellow perch and black crappie in comparison with the 1992 survey. The survey showed no evidence that perch and crappie were negatively impacted by tiger muskellunge and channel catfish.

Jewel Lake

Jewel Lake is located in Bonner County 5.6 kilometers southeast of Laclede, Idaho. The lake covers an area of 12 ha. Maximum depth is approximately 10 m. Most of the land around the lake is owned by a single landowner (Hulquist) who has allowed public access since 1951. Currently, the Department maintains the access site in exchange for public use. A boat ramp maintained by IDFG is located on the southwest shoreline and the lake is managed as an "Electric Motors Only" waterbody (Figure 13).

During the fall of 1989, Jewel Lake was treated with rotenone to remove a population of stunted perch and create a trout fishery. Fingerling Westslope cutthroat trout, Henrys Lake cutthroat x rainbow hybrids, and kokanee fry were stocked in the spring of 1990 (Davis 1996). The lake was sampled in November 1990 and results showed that trout species would enter the fishery (minimum harvest length 356 mm) by mid-season 1991. In a 1992 lake survey, yellow perch were again captured and constituted 31% of the total catch (Davis 1996). By 1998, yellow perch constituted 99% of the total catch (Fredericks 2002). How the population re-established itself is unknown.

Catchable triploid Kamloops rainbow trout were stocked annually beginning in 2002 and were last stocked in May of 2007. Channel catfish were stocked beginning in 2001 and 1,000 fingerlings were last stocked in 2006. In 2000, approximately 300 bluegill were transplanted from Rose Lake.

From 1990 - 2004, Jewel Lake was managed as a "quality trout" fishery: 2 fish limit with none under 14", barbless, artificial flies and lures only, and a season extending from the last Saturday in April, through November 30. In 2005 the lake was designated as a family fishing water with a year-round season, no length limit, limit of 6 bass and 6 trout, and no bag limit on other species.

Rose Lake

Rose Lake is located 1.6 km north of the town of Rose Lake, Idaho. The lake covers an estimated 12 ha and is connected to a wetland and the Coeur d'Alene River by a channel at the south end of the lake. A boat ramp managed by IDFG is located on the eastern shoreline (Figure 14).

Approximately 1,000 fall Chinook were stocked in 1998 and 14,000 bluegill were stocked in 1990. Both species were stocked one year. Channel catfish were stocked beginning in 1982 and were most recently stocked in July of 2007.

METHODS

We conducted lowland lake surveys in 2007 using procedures outlined in the Standard Lowland Lakes Survey Manual. We used two trap nets, two floating and two sinking gill nets set overnight, and one hour of electrofishing effort on each lake. Shepherd Lake was electrofished and nets set the night of June 19th. Jewel Lake was netted and electrofished on the night of June 25th. Hauser Lake was netted and electrofished on the night of June 26th and Rose Lake was netted and electrofished on the night of June 27th. Electrofishing on Rose Lake totaled only 20 minutes due to technical issues.

We used a Smith-Root SR-16 electrofishing boat to assess fish populations. Electrofishing was conducted at night concentrating our efforts along the shoreline in an attempt to collect all species. Gill nets and trap nets were set perpendicular to shore, set at dusk and retrieved the following morning. After capture, fish were identified, weighed (g) and measured to the nearest mm.

Proportional stock density (PSD; Anderson 1980) was calculated as:

$$PSD= \frac{\text{number of fish} \geq \text{minimum quality length}}{\text{number of fish} \geq \text{minimum stock length}} \quad \frac{x}{100}$$

Relative stock density (RSD) was calculated using the same formula for fish greater than or equal to the preferred length. Estimates were used to compare fish populations against stock density index ranges for balanced fish populations (Willis et al. 1993). In addition, condition of fish was indexed using relative weight (Wr), represented by the equation:

$$Wr=(W/Ws) * 100$$

Where W is the weight of an individual fish and Ws is a length-specific standard weight resultant of a weight:length regression representative of the species:

$$\log_{10}(Ws) = a' + b * \log_{10}(L)$$

Where a' is the intercept and b is the slope and L is the total length of the individual fish. Values were calculated by 10 mm length categories and missing values were estimated. Mean Wr values of 100 indicate ecological and physiological optimals (Anderson and Neumann 1996, Blackwell et al. 2000).

RESULTS

Shepherd Lake

Fish species diversity in Shepherd Lake was low. Gamefish species captured included: largemouth bass, bluegill, pumpkinseed, yellow perch, black crappie, and brown bullhead *Ameirus nebulosus* (Figures 15 and 16). No tiger muskellunge were captured during sampling efforts. No nongame species were captured.

Bluegill was the most abundant fish species, comprising 42% of the total catch, and 23% of the total biomass. Bluegill averaged 136 mm in length, ranging from a minimum of 51 mm to a maximum of 196 mm (Figure 17). Whereas a large number of bluegill were in the quality (150 mm) range with a PSD (PSD; Anderson 1980) of 51, no individuals were captured from the preferred (200 mm) category. Condition, as indexed by Wr, was good with an average of 114, and nearly all size categories scoring 100 or higher. Relative weight showed a slight decrease with increasing fish length (Figure 18).

Pumpkinseed comprised 35% of the total catch and 17% of the biomass. Individuals averaged 130 mm with a range of 90 - 192 mm.

Largemouth bass was the third most abundant species in terms of total catch (11%) and most abundant in terms of total biomass (47%). Average length was 275 mm with a range of 81 - 530 mm (Figure 19). The PSD was 30, which is below the generally accepted stock density (Gabelhouse 1984) and is lower than the PSD of 49 recorded in 1997 (Fredericks 1998). The RSD-P value was 17, which is in the acceptable range. Modde and Scalet (1985) recommended optimum PSD values in the range of 12 - 26 in Montana. Condition was fair with an average Wr=63, and all size categories scoring less than 80. Relative weight showed a slight decrease with increasing fish length (Figure 20).

Hauser Lake

Gamefish in Hauser Lake comprised 93% of fish captured and 68% of the total biomass and include black crappie, bluegill, channel catfish, kokanee, largemouth bass, pumpkinseed, rainbow trout, tiger muskellunge, cutthroat trout, brown bullhead, and yellow perch (Figures 21 and 22). The non-game species tench *Tinca tinca* (7%) was also captured and contributed 32% to the total biomass.

Bluegill was the most abundant species (47%) and contributed 8% to the total biomass. No bluegills were reported in previous sampling efforts on Hauser Lake and were likely transplanted by fishermen. Average length for bluegill was 114 mm with a minimum length of 41 mm and a maximum of 187 mm (Figure 23). Few fish in the quality (150 mm) range were captured with a PSD value of 16 and no fish in the preferred (200 mm) range were captured. Condition as indexed by relative weight was above average with Wr=146 and all size categories scoring higher than 90. Relative weight showed little difference among size categories (Figure 24).

Pumpkinseeds were second in abundance by number (16%) and contributed 2% to the total biomass. Average length was 106 mm with a range of 78 - 160 mm.

Largemouth bass constituted 11% of the total catch and 22% of the total biomass. Individuals averaged 267 mm with a range of 74 - 460 mm (Figure 25). PSD was 40 and RSD-P was 19, both at the low end of the generally accepted stock density index (Gabelhouse 1984). Relative weight was fair with Wr =71, with over one third of size categories scoring higher than 80. Relative weight showed a decrease with increasing fish length (Figure 26).

Channel catfish constituted 5% of the total catch, but constituted 23% of the total biomass. Average length was 401 mm with a range of 184 - 650 mm (Figure 27). Condition as indexed by relative weight was consistent among all lengths of fish captured with an above average Wr=119.

Salmonid catch was concentrated on the southern shoreline along a riprapped roadside. Banks in this area sloped steeply. Kokanee (N=11) were all captured in one gill net on the southern shoreline and averaged 249 mm in length with a range of 215 - 300 mm. Rainbow trout (N=10) averaged 230 mm in length with a range of 197 - 260 mm. Both kokanee and rainbow trout were of hatchery origin and represented a narrow size range.

Jewel Lake

All fish captured from Jewel Lake were gamefish species and included: bluegill, rainbow trout, channel catfish, yellow perch, black crappie, and pumpkinseed (Figures 28 and 29).

Yellow perch comprised nearly half (47%) of the total catch and 40% of the total biomass captured. Individuals were small, averaging 152 mm with a minimum of 102 mm and a maximum of 199 mm. In 1998, average length was 150 mm with a maximum of 239 mm. No fish greater than 200 mm in length were captured. Condition of fish as indexed by relative weight was fair with an average Wr=84, and decreased relative weight with increasing fish length.

Bluegill catch constituted 33% of the total catch and 12% of the total biomass. Only five fish were in the quality range, resulting in a low PSD=2. Length averaged 95 mm, with a range of 36 - 157 mm (Figure 30). Condition of bluegill was good with Wr=106 and nearly all size categories scoring over 90, with little change relative to fish length (Figure 31).

Hatchery rainbow trout numbers increased since the previous survey in 1998; however, no cutthroat trout or kokanee were captured. Rainbow trout constituted 8% of the total catch and 23% of the total biomass. Average length for rainbow trout was 242 mm with a range of 186 - 298 mm (Figure 32).

Channel catfish constituted 2% of the total catch by number and 18% by weight. Length averaged 305 mm with a range of 210 - 446 mm (Figure 33).

Rose Lake

The catch from Rose Lake included game fish species (76 % of total catch) largemouth bass, bluegill, channel catfish, black crappie, northern pike, pumpkinseed, yellow perch, and brown bullhead (Figures 34 and 35). Nongame species (33% of total catch) included tench.

Largemouth bass constituted 20% of the total catch and 13% of the total biomass. Individuals averaged 265 mm in length, with a range of 100 - 437 mm (Figure 36). Values for PSD (39) and RSD-P (14) were below the generally accepted stock density. Condition, as indexed by relative weight, was poor with an average Wr=62, and the majority of size categories scoring less than 70. Relative weight decreased with increasing fish length (Figure 37).

Channel catfish constituted 16% of the total catch and 23% of the total biomass. Fish lengths averaged 382 mm with a range from 281-590 mm (Figure 38). Condition of channel cats was high with an average Wr=127, which was consistent for all fish lengths captured.

Bluegill constituted 19% of the total catch and 3% of the total biomass. Individuals averaged 137 mm in length, with a range of 72 - 185 mm (Figure 39). PSD was in the acceptable range with PSD=30, though no individuals captured were in the preferred category. In 1995, bluegill average length (50 - 180 mm) was similar to this survey, as was PSD (29). Condition of bluegill was above average with Wr=125, and most size categories scored higher than 90. Relative weight showed an increase with larger fish sizes (Figure 40).

DISCUSSION

Shepherd Lake

No bluegill were captured in a 1992 survey but by 1998 bluegill was the most abundant species with PSD and RSD-P values of 46 and 7, respectively (Fredericks 1998). PSD values have since increased; however, no individuals were captured from the preferred range during 2007 sampling. This may be a result of fisherman applying more pressure on this species or of heavy aquatic vegetation affecting capture of these large individuals.

Less than 1/3 of the largemouth bass captured were of harvestable size (>300 mm). The quality of the fishery decreased from a PSD of 49 reported by Fredericks (1998), and relative weight was similar as compared with the 1997 survey when most values were below 90. The large bluegill population does not appear to be becoming an important food source for bass as evidenced by the lack of increase in relative weight and the lack of harvestable bass is a result of fishing pressure.

Hauser Lake

Only two tiger muskellunge were captured during sampling efforts on Hauser Lake, constituting the same percentage as in 1998 (0.3%). Both individuals were in the quality range but not of harvestable size. Channel catfish increased in total percentage of catch from 1.7% in 1992, to 2.2% in 1998, and 4% in 2007. Stocking densities of both species were reduced on the recommendation of Fredericks (2002) to 550 every three years for tiger muskellunge and 8,000 catfish on alternate years. This reduction may not have been ample to sustain fisheries for black crappie and yellow perch.

Tiger muskellunge and channel catfish populations may be negatively impacting forage species including black crappie, yellow perch, and pumpkinseed as evidenced by reduced numbers (Table 8). Fredericks (2002) found no evidence of negative effects on these forage species relative to abundances in the 1992 survey. However, in 2007 numbers of all three species declined with only three black crappie and 13 yellow perch captured. Pumpkinseed total catch was half of what it was in 1992 (32%) and 1998 (30%). Bluegill were not previously reported in samples from Hauser Lake but now constitute the single most abundant species in the lake. No green sunfish were captured during this survey. Numbers of these forage species may have been low as a result of extensive weed beds obscuring fish. The 1999 survey was conducted on June 28th, nearly the same date as the 2007 survey, so numbers should be comparable between these surveys.

Largemouth bass saw a reduction in total catch from 16% in 1998, to 11% in 2007. However, for this survey, PSD was higher than in 1998 (PSD 11, RSD-P 2) and higher than the 1992 sample (PSD=23, RSD-P= 4). In conjunction with low condition scores, this seems to indicate competition for food resources is limiting growth.

Jewel Lake

Fredericks (2002) recommended adding bluegill or largemouth bass to diversify the fishery as well as channel catfish to reduce yellow perch numbers. The addition of channel cats may have impacted yellow perch, as their percent of the catch was reduced by half from the 1998 survey when they totaled 99% of the catch. Few bluegill were in the quality designation and do not appear to be contributing a substantial fishery.

As a result of poor growth and lack of trout, the lake should continue to be managed as a put-and-take trout fishery and other warmwater fisheries should be considered. Stocking of tiger muskellunge should be resumed if a suitable; disease free hatchery population is identified.

Rose Lake

Several factors contributed to low numbers of largemouth bass and bluegill captured in Rose Lake. First, sampling was conducted in June when aquatic vegetation was prevalent and likely hampered electrofishing effort, and second electrofishing only consisted of 20 minutes.

Largemouth bass were not reaching large size (only 28% of the catch was of harvestable length) and condition was below average, likely as a result of fishing pressure.

Channel catfish have become well established and are providing a good fishery in Rose Lake.

MANAGEMENT RECOMMENDATIONS

1. Heavy vegetation in Shepherd Lake poses a problem for anglers trying to access warmwater species. This vegetation may also alter our survey results as by June the dense mats of vegetation limit our electrofishing effectiveness. Another lake survey should be conducted in April or May to provide a clearer picture of the community structure.

2. In Jewel Lake continue put-and-take stocking of rainbow trout under Family Fishing Water regulations. Consider stocking a predator species (largemouth bass and/or tiger muskellunge) if an acceptable disease free source is identified.

Table 8. Comparison of Hauser Lake, Idaho, fishery characteristics between 1992 (Davis1996), 1999 (Fredericks 2002), and 2007.

Species	Maximum size			% by number			% by weight		
	1992	1999	2007	1992	1999	2007	1992	1999	2007
Yellow perch	250	245	180	18.6	14.7	3	2.2	2.1	<1
Black crappie	90	275	205	2.3	11.1	<1	1.1	8	<1
Tiger muskie	--	1,110	523	0	0.3	<1	0	12.7	1
Channel catfish	370	660	650	1.7	2.1	5	2.2	7.9	23
Largemouth bass	450	435	460	16.3	25.8	11	11.8	22	22
Rainbow trout	350	395	260	1.6	1.6	2	2.6	2.8	1
Brown bullhead	330	325	288	10.3	6.9	7	11.7	9	9
Tench	450	465	460	15.4	7.2	7	60.7	28	33
Green sunfish	140	105	--	1.4	<1	--	<1	<1	--
Bluegill	--	--	160	--	--	47	--	--	8
Kokanee	--	--	300	--	--	2	--	--	1
Cutthroat trout	--	--	303	--	--		--	--	--
Pumpkinseed	195	200	187	32.3	30	16	7.3	7.5	2

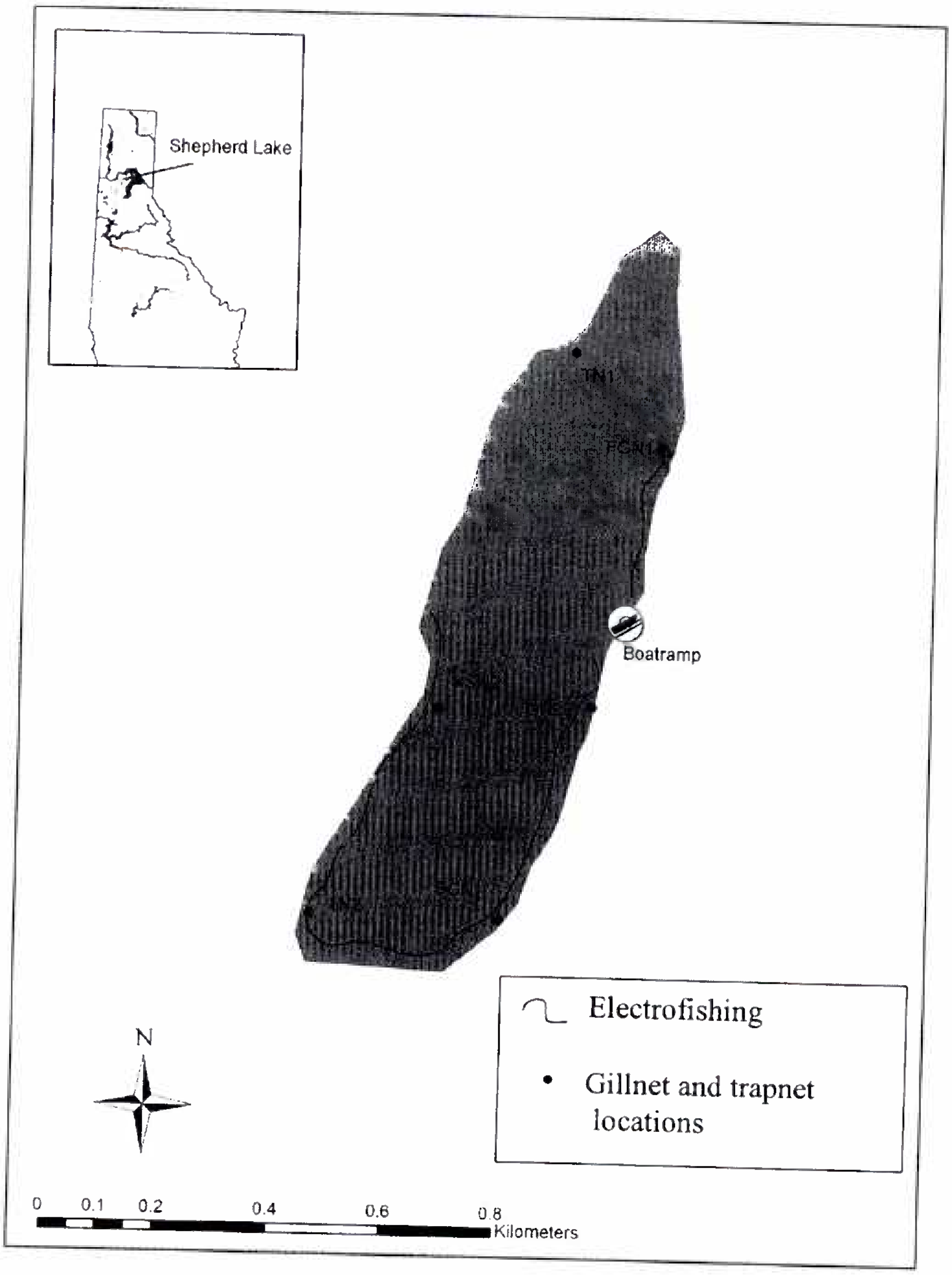

Figure 11. Locations of trap nets (TN1 and TN2), floating gill nets (FGN1 and FGN2), sinking gill nets (SGN1 and SGN2), and shoreline electrofishing during a lowland lake survey in June 2007, Shepherd Lake, Idaho.

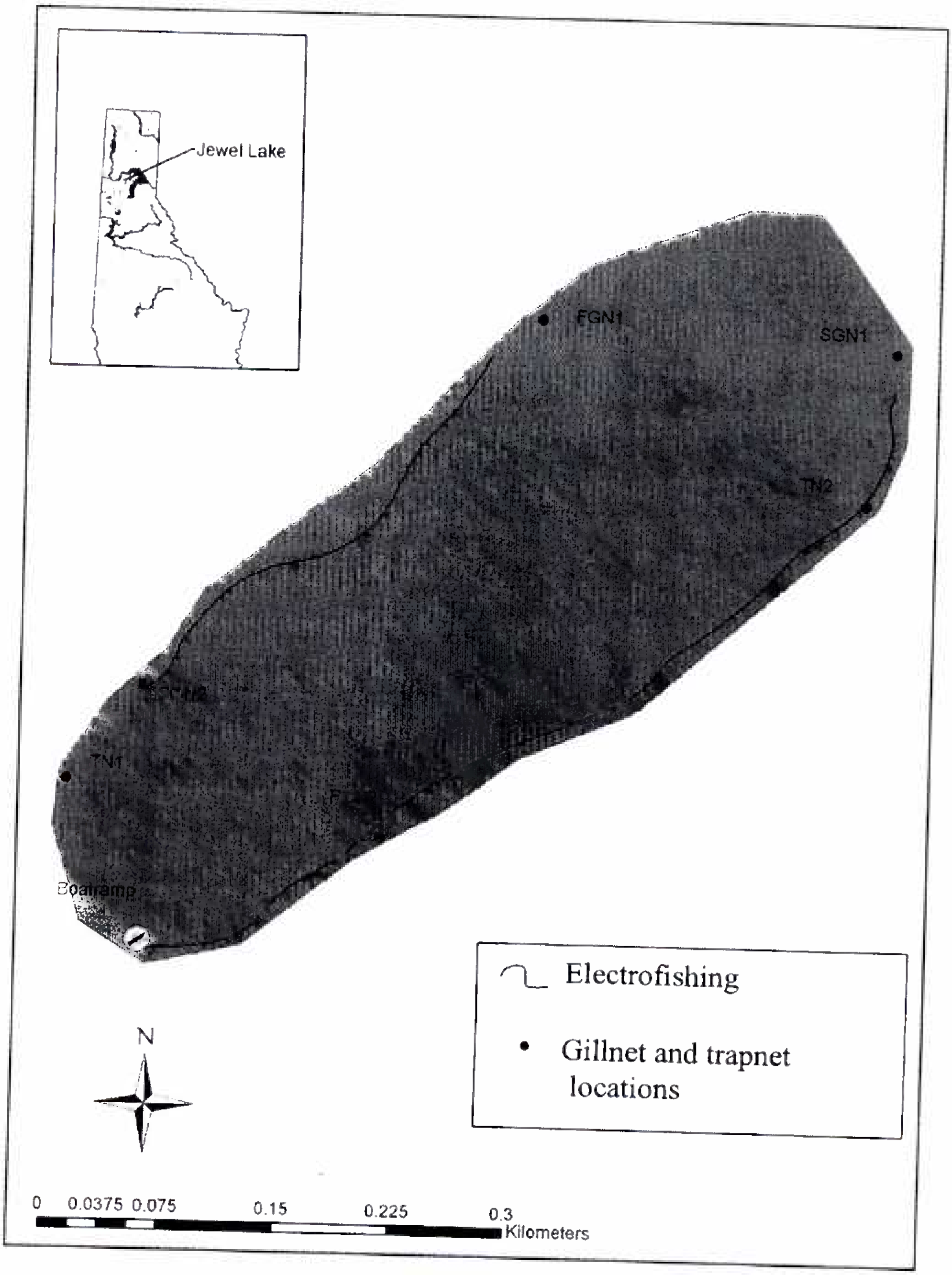

Figure 13. Locations of trapnets (TN1 and TN2), floating gillnets (FGN1 and FGN2), sinking gillnets (SGN1 and SGN2), and shoreline electrofishing during a lowland lake survey in June 2007, in Jewel Lake, Idaho.

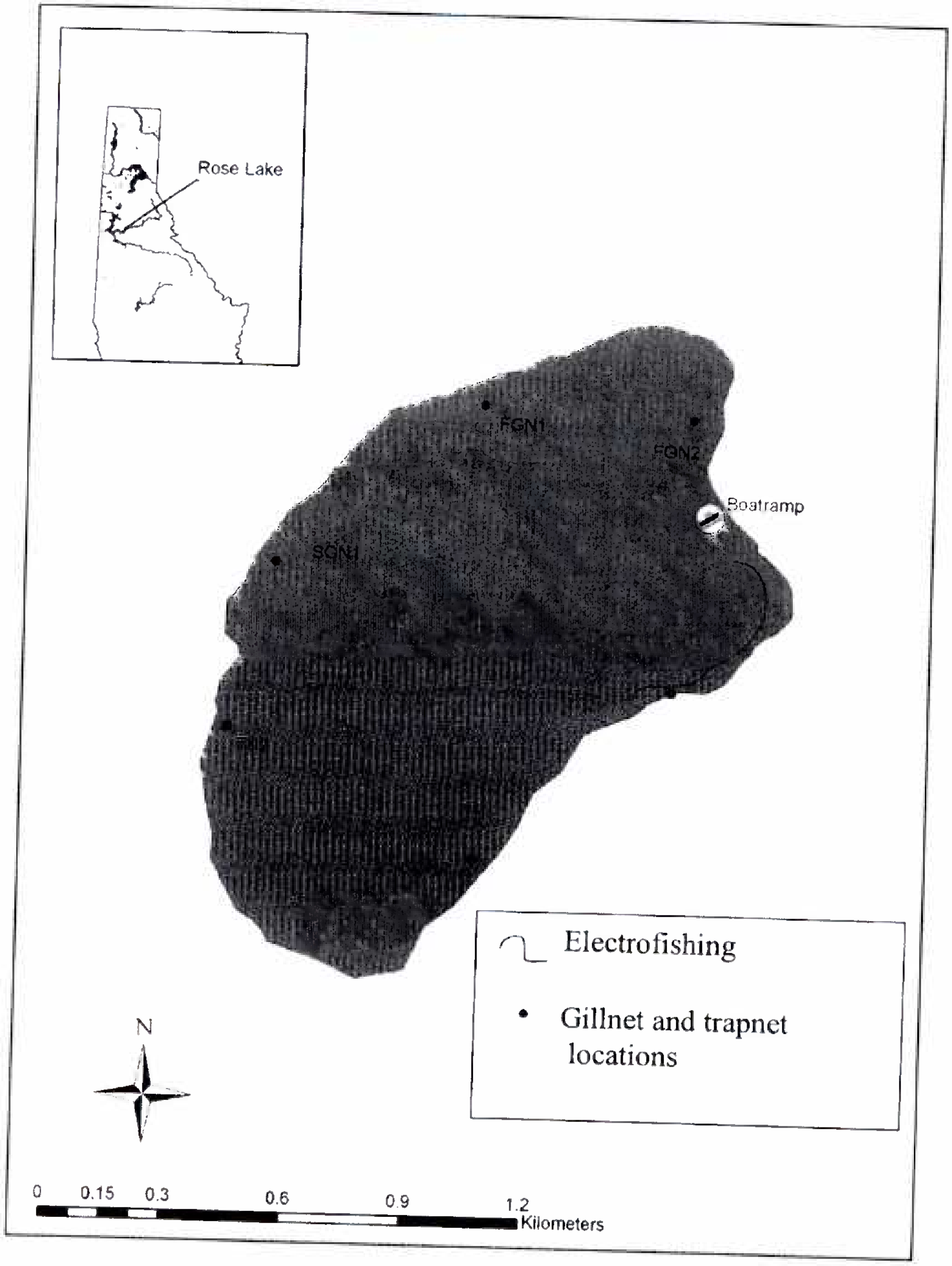

Figure 14. Locations of trapnets (TN1 and TN2), floating gillnets (FGN1 and FGN2), sinking gillnets (SGN1 and SGN2), and shoreline electrofishing during a lowland lake survey in June 2007, in Rose Lake, Idaho.

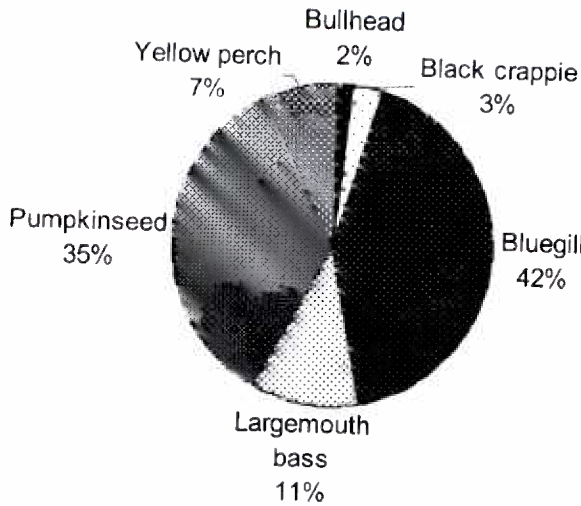

Figure 15. Relative abundance of all species by number collected during the lowland lake survey of Shepherd Lake, Idaho, 2007.

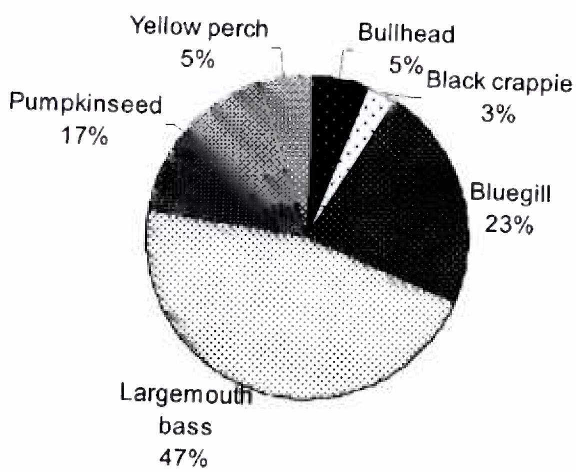

Figure 16. Relative abundance of all species by weight collected during the lowland lake survey of Shepherd Lake, Idaho, 2007.

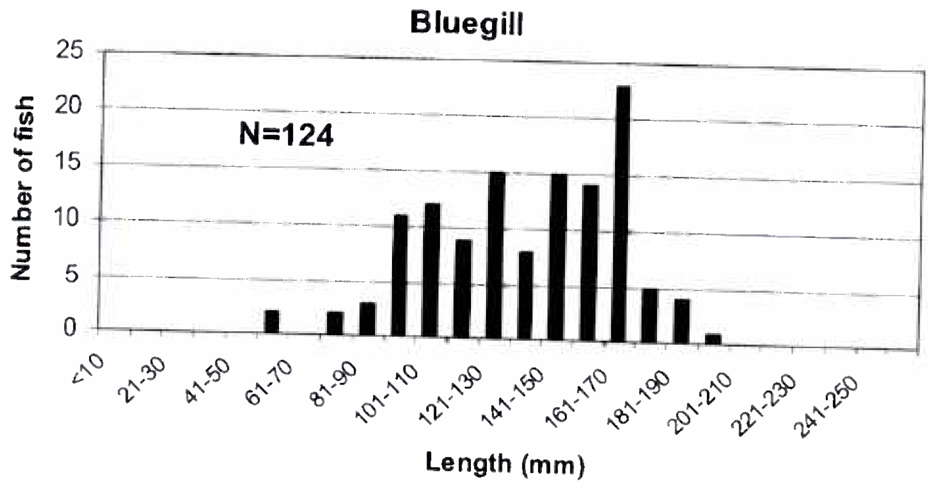

Figure 17. Length frequency of bluegill captured during the lowland lake survey on Shepherd Lake, Idaho, 2007.

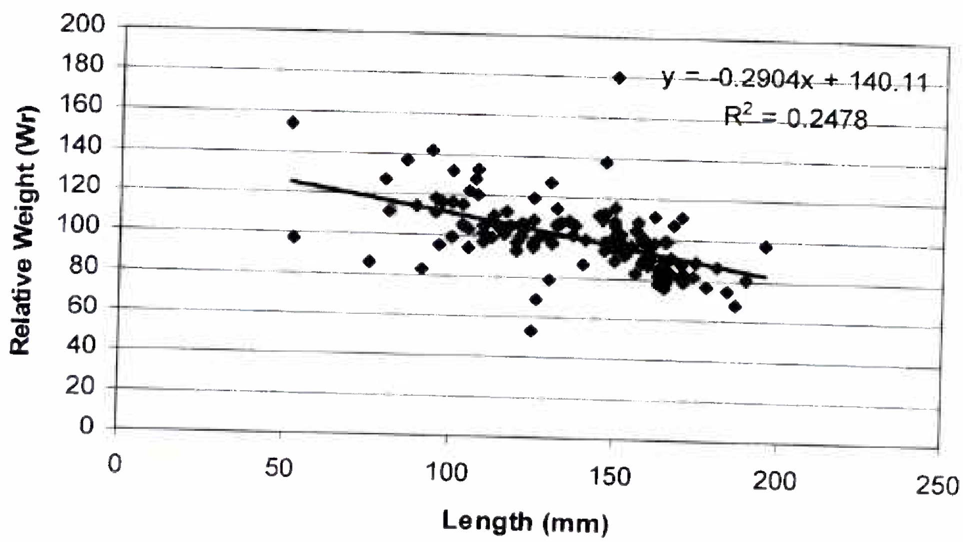

Figure 18. Regression showing the correlation between relative weight (Wr) and length of bluegill captured during the lowland lake survey on Shepherd Lake, Idaho, 2007.

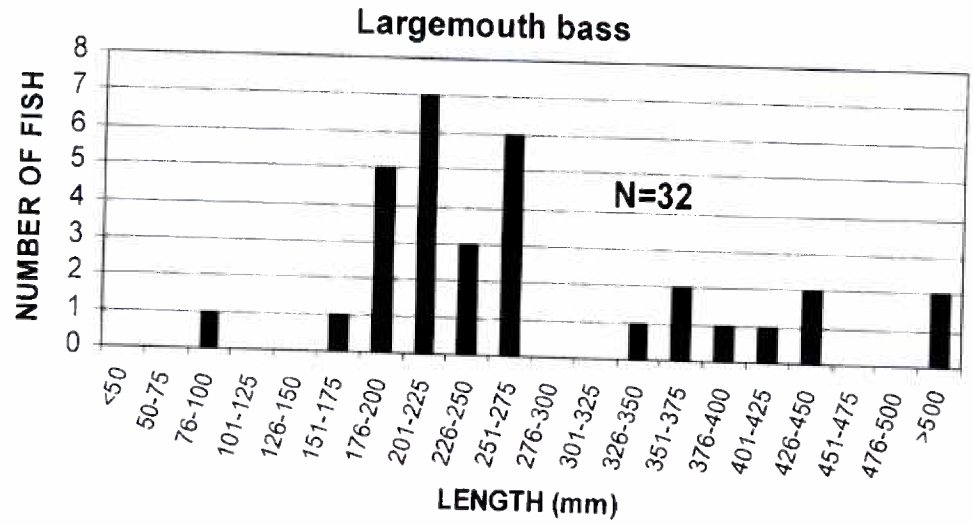

Figure 19. Length frequency of largemouth bass collected during the lowland lake survey on Shepherd Lake, Idaho, 2007.

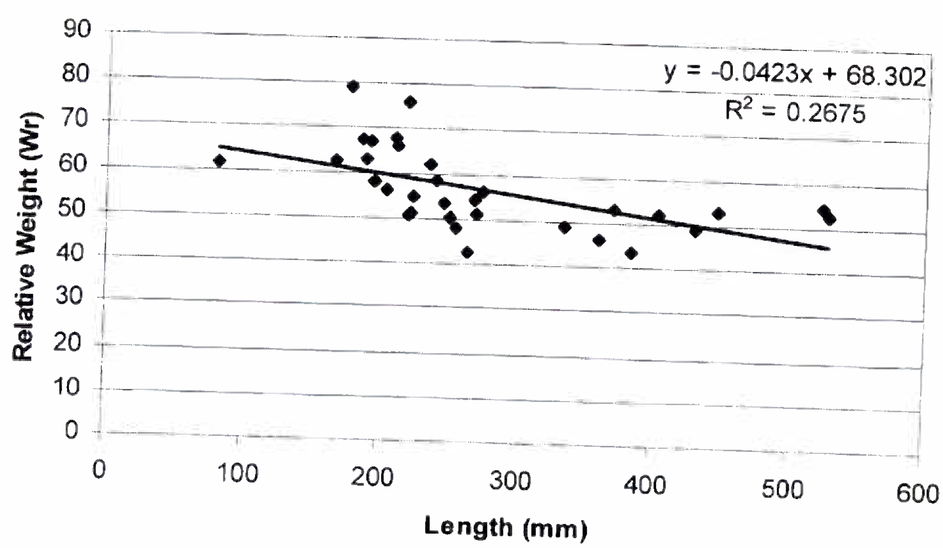

Figure 20. Regression showing the correlation between relative weight (Wr) and length (mm) of largemouth bass captured during the lowland lake survey on Shepherd Lake, Idaho, 2007.

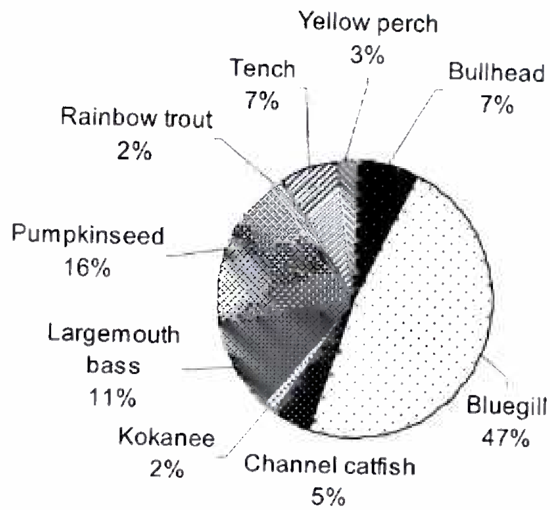

Figure 21. Relative abundance of all species by number collected during the lowland lake survey of Hauser Lake, Idaho, 2007. Black crappie, tiger muskellunge, and cutthroat trout made up less than 1% of the total catch by number.

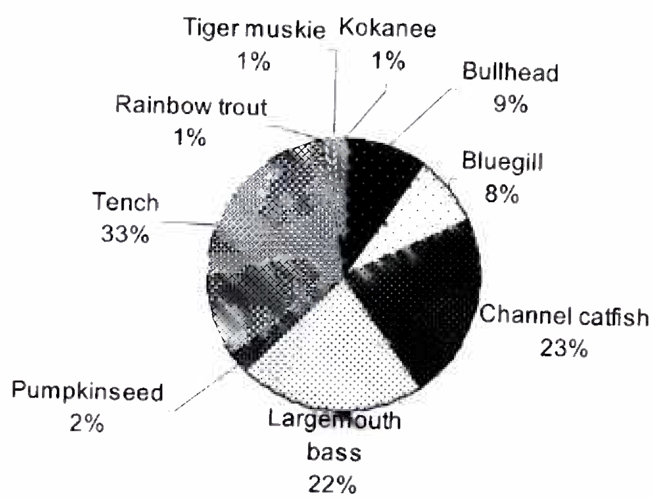

Figure 22. Relative abundance of all species by weight collected during the lowland lake survey of Hauser Lake, Idaho, 2007. Black crappie, yellow perch, and cutthroat trout made up less than 1% of the total catch by weight.

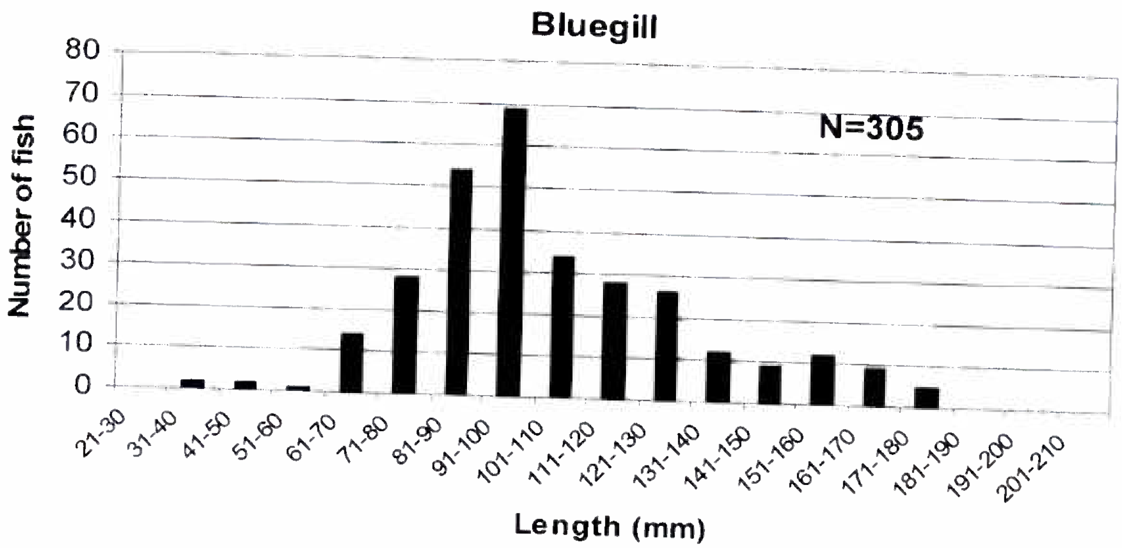

Figure 23. Length frequency of bluegill captured during a lowland lake survey of Hauser Lake, Idaho, 2007.

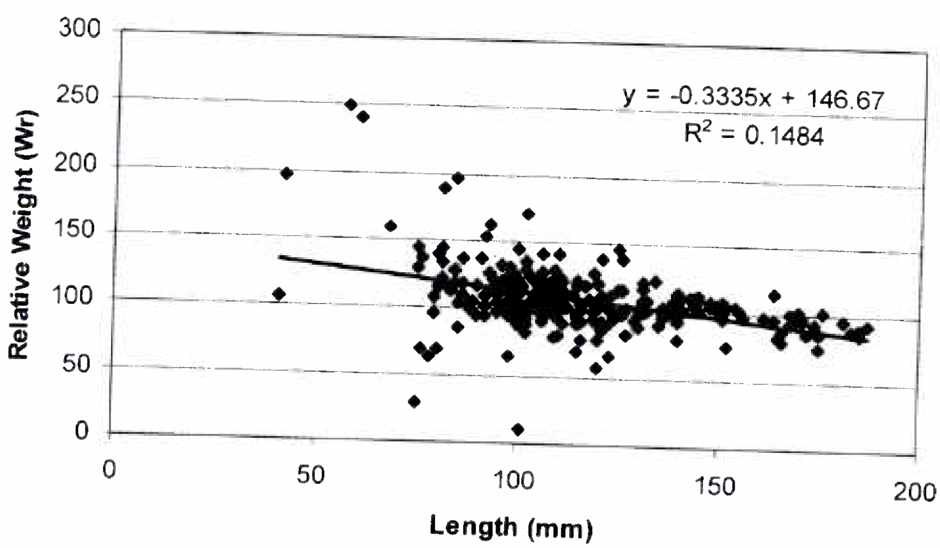

Figure 24. Regression showing the correlation between relative weight (Wr) and length of bluegill captured during a lowland lake survey of Hauser Lake, Idaho, 2007.

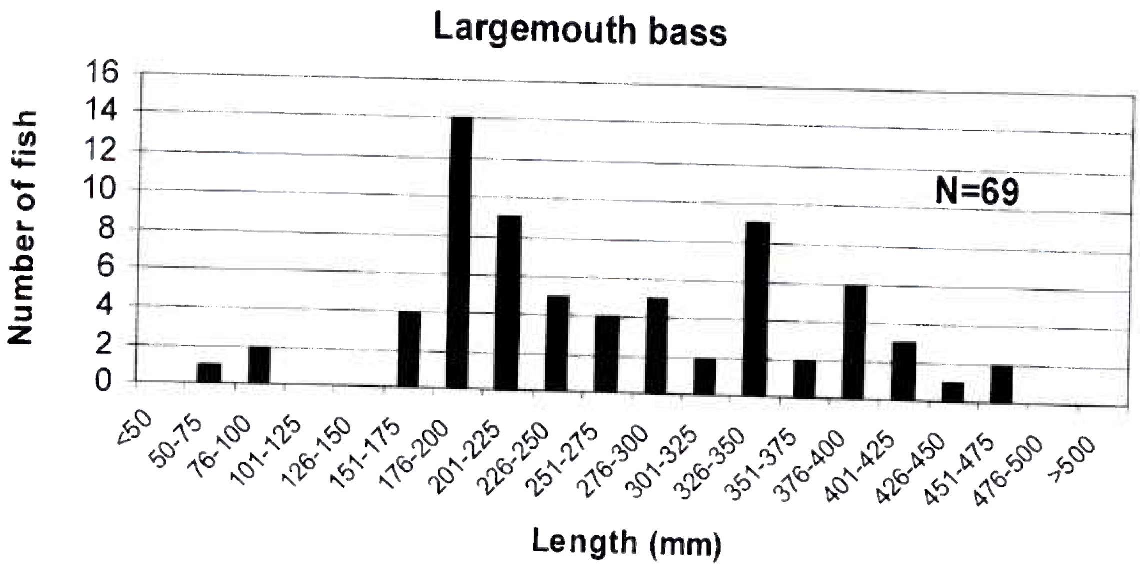

Figure 25. Length frequency of largemouth bass captured during a lowland lake survey of Hauser Lake, Idaho, 2007.

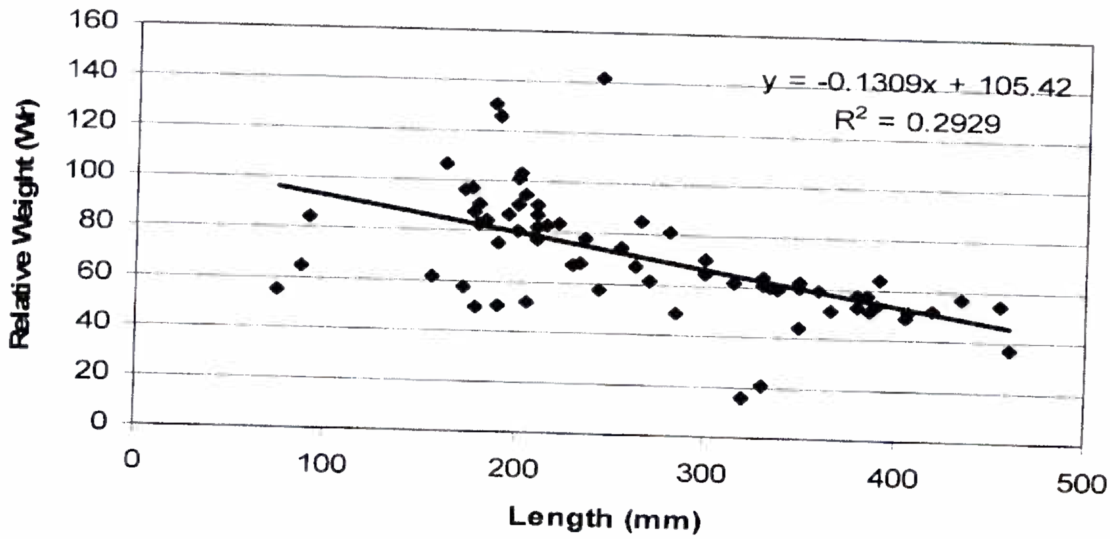

Figure 26. Regression showing the correlation between relative weight (Wr) and length of largemouth bass collected during a lowland lake survey of Hauser Lake, Idaho, 2007.

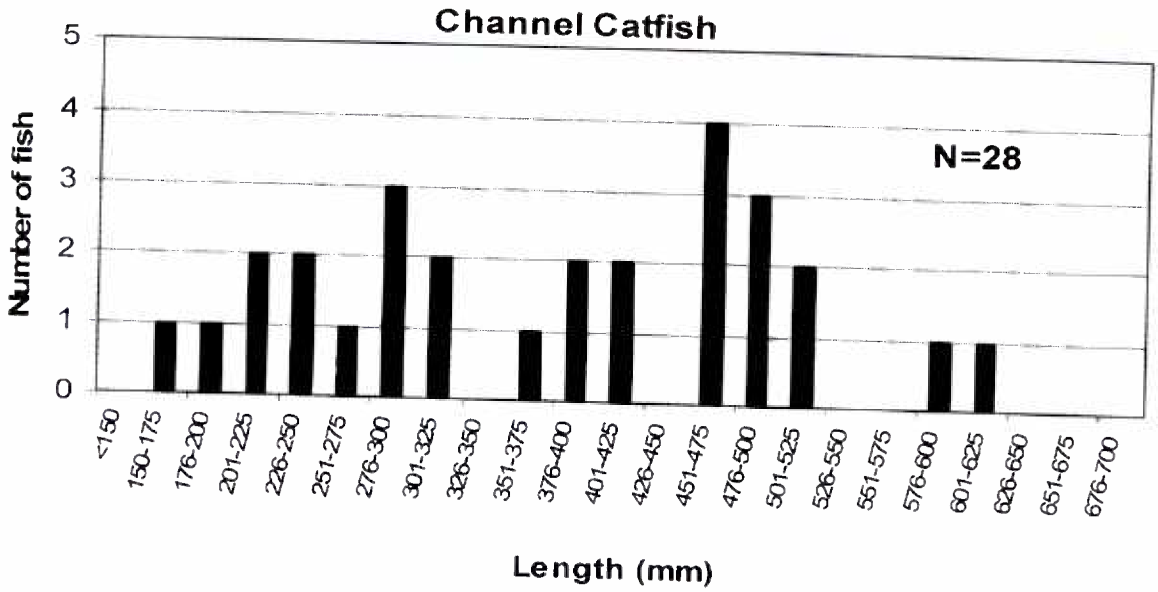

Figure 27. Length frequency of channel catfish captured during a lowland lake survey of Hauser Lake, Idaho, 2007.

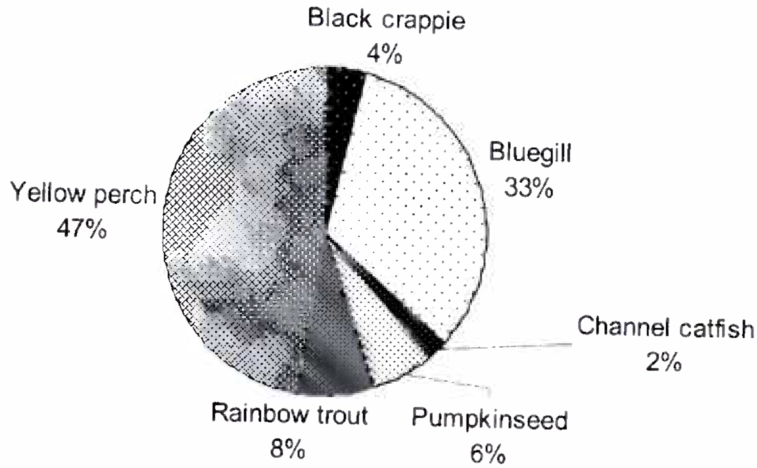

Figure 28. Relative abundance of all species by number collected during the lowland lake survey of Jewel Lake, Idaho, 2007.

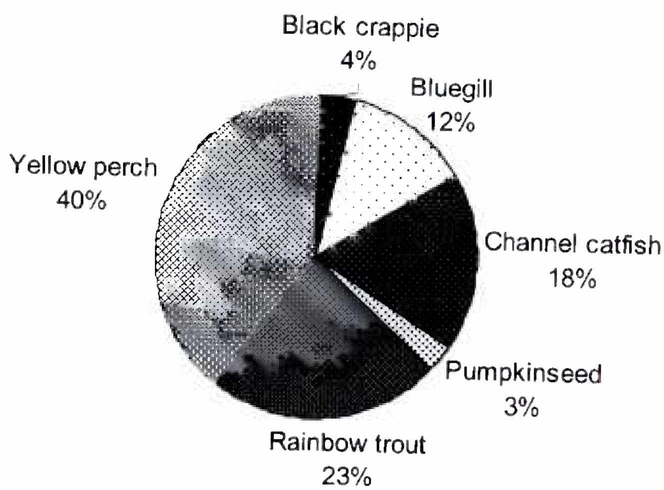

Figure 29. Relative abundance of all species by weight collected during the lowland lake survey of Jewel Lake, Idaho, 2007.

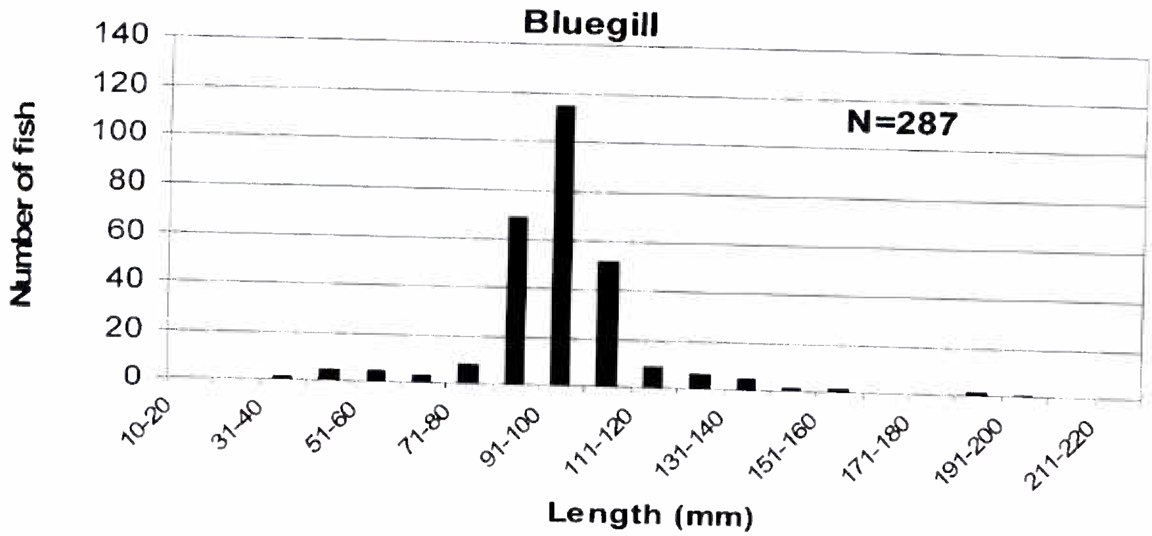

Figure 30. Length frequency of bluegill captured during a lowland lake survey of Jewel Lake, Idaho, 2007.

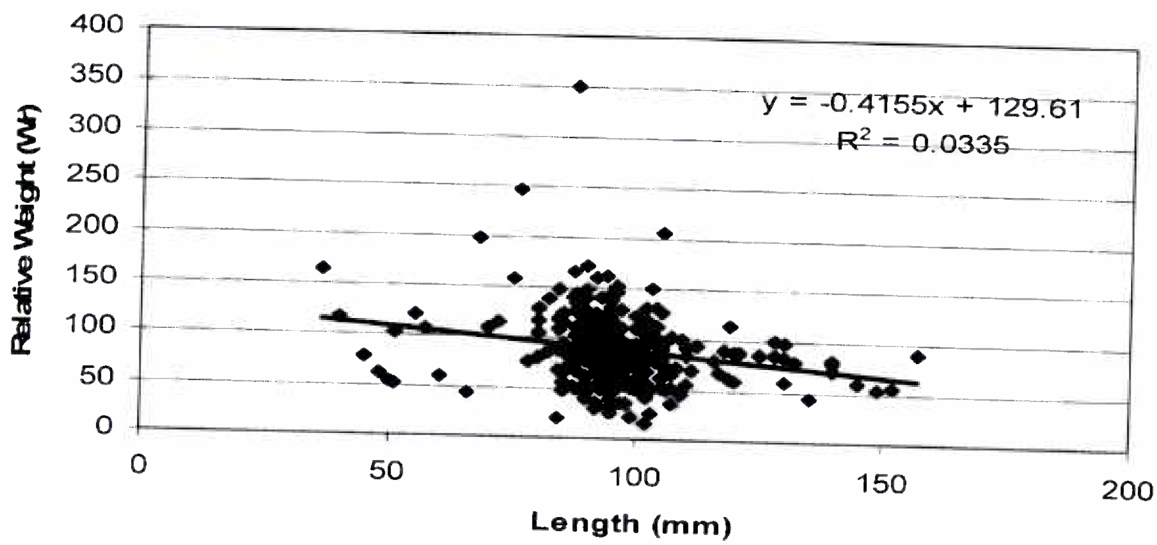

Figure 31. Regression showing the correlation between relative weight (Wr) and length of bluegill captured during a lowland lake survey of Jewel Lake, Idaho, 2007.

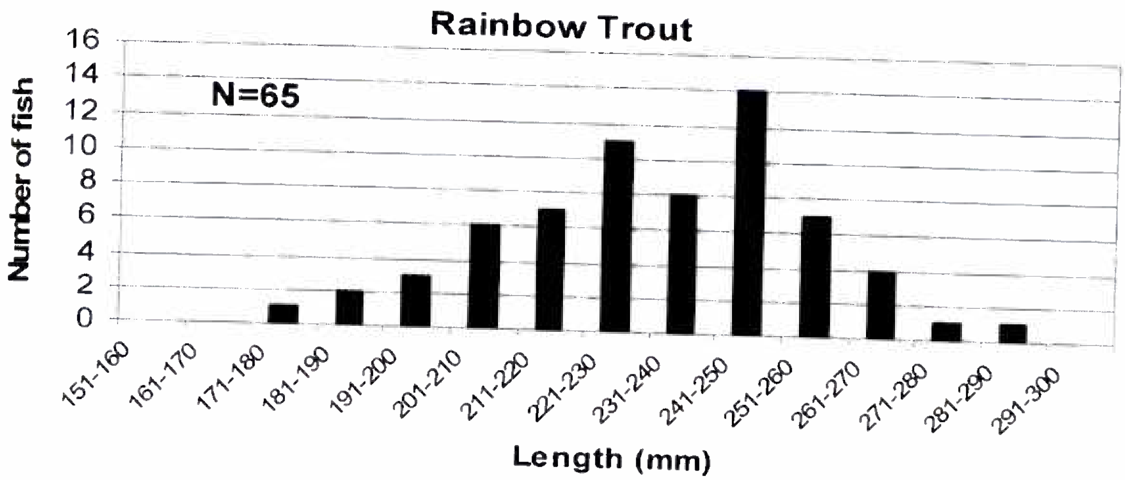

Figure 32. Length frequency of rainbow trout captured during a lowland lake survey of Jewel Lake, Idaho, 2007.

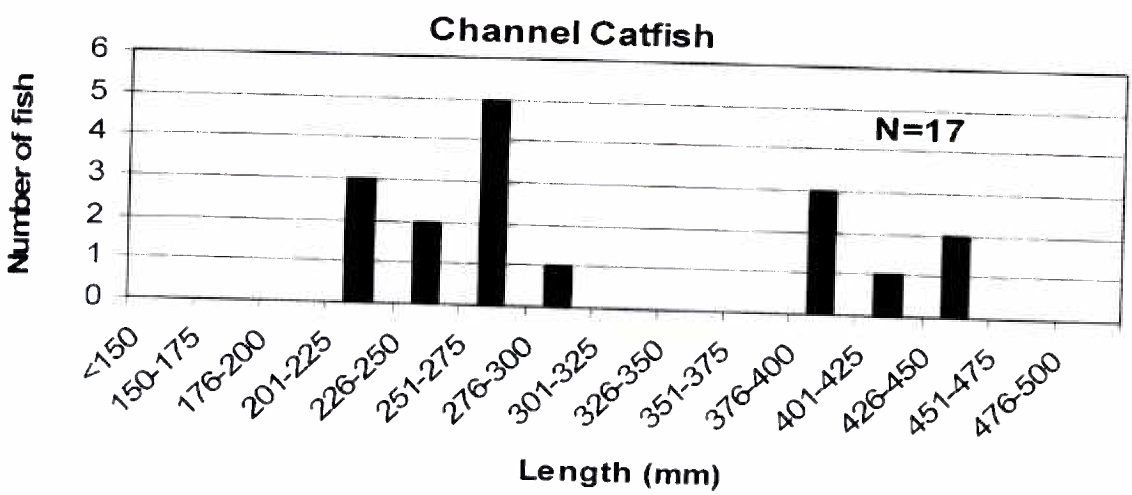

Figure 33. Length frequency of channel catfish captured during a lowland lake survey of Jewel Lake, Idaho, 2007.

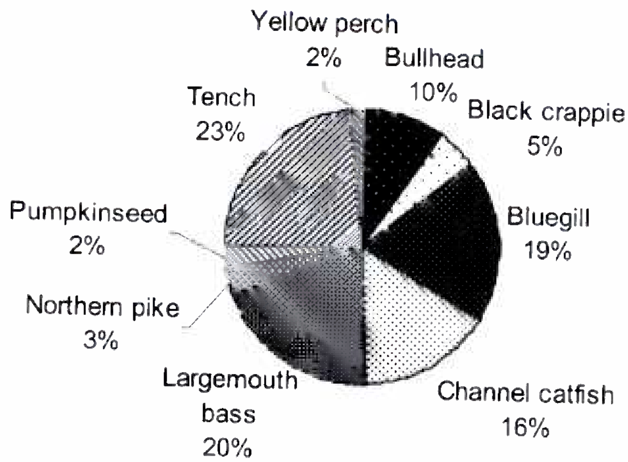

Figure 34. Relative abundance of all species by number collected during the lowland lake survey of Rose Lake, Idaho, 2007.

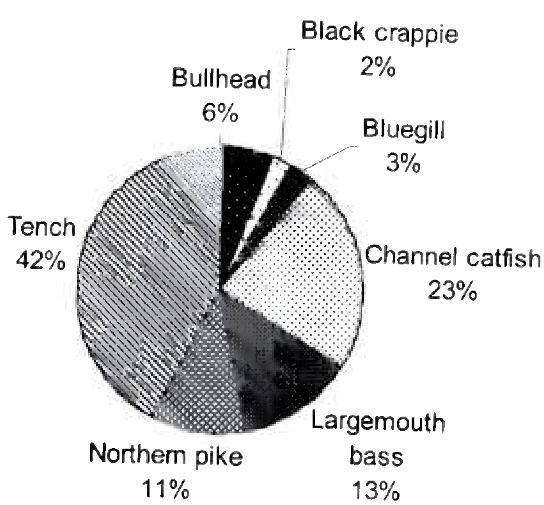

Figure 35. Relative abundance of all species by weight collected during the lowland lake survey of Rose Lake, Idaho, 2007. Yellow perch and pumpkinseed constituted less than 1% of the total weight.

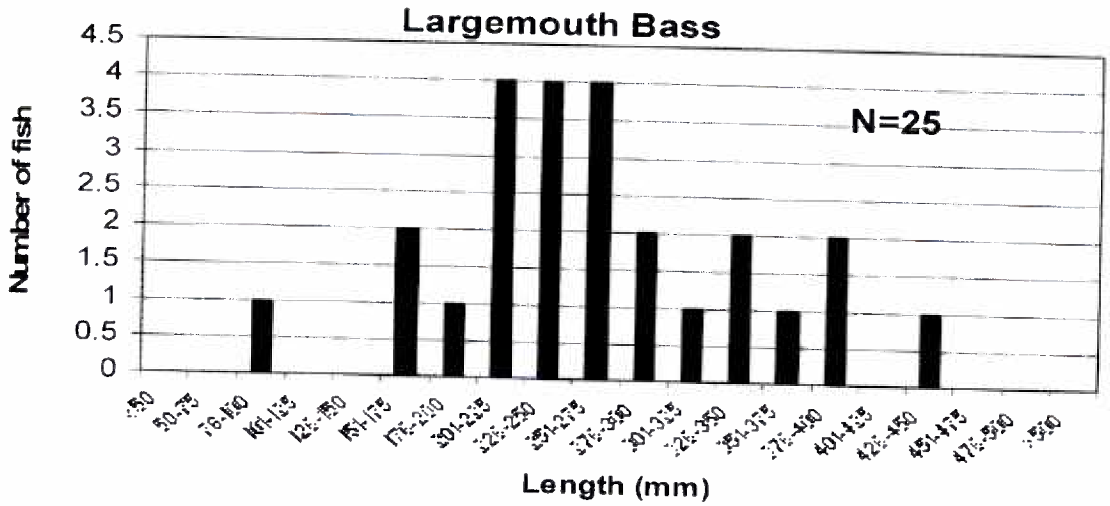

Figure 36. Length frequency for largemouth bass captured during a lowland lake survey of Rose Lake, Idaho, 2007.

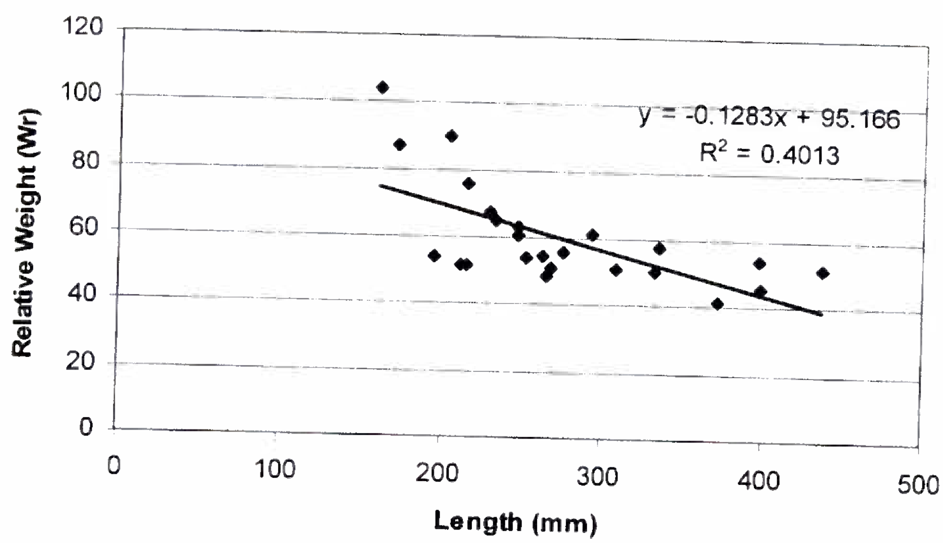

Figure 37. Regression showing the correlation between relative weight (Wr) and length of largemouth bass captured during a lowland lake survey of Rose Lake, Idaho, 2007.

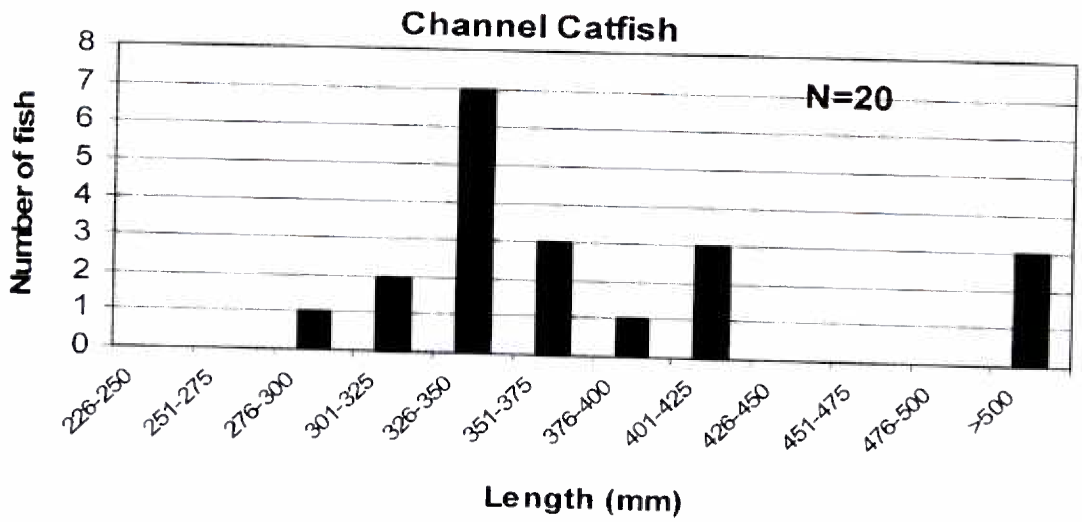

Figure 38. Length frequency for channel catfish captured during a lowland lake survey of Rose Lake, Idaho, 2007.

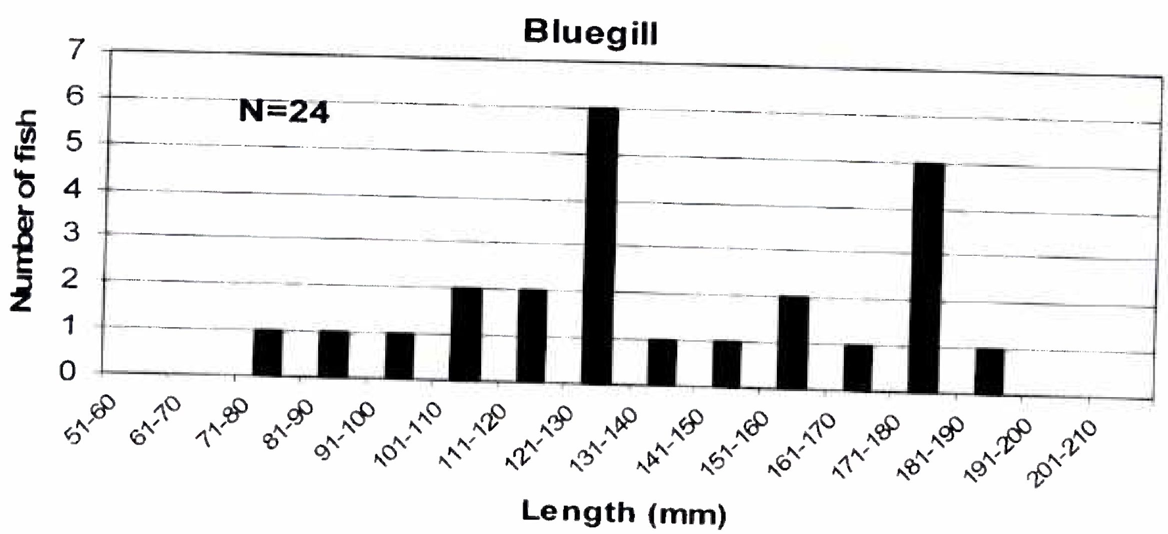

Figure 39. Length frequency for bluegill captured during a lowland lake survey of Rose Lake, Idaho, 2007.

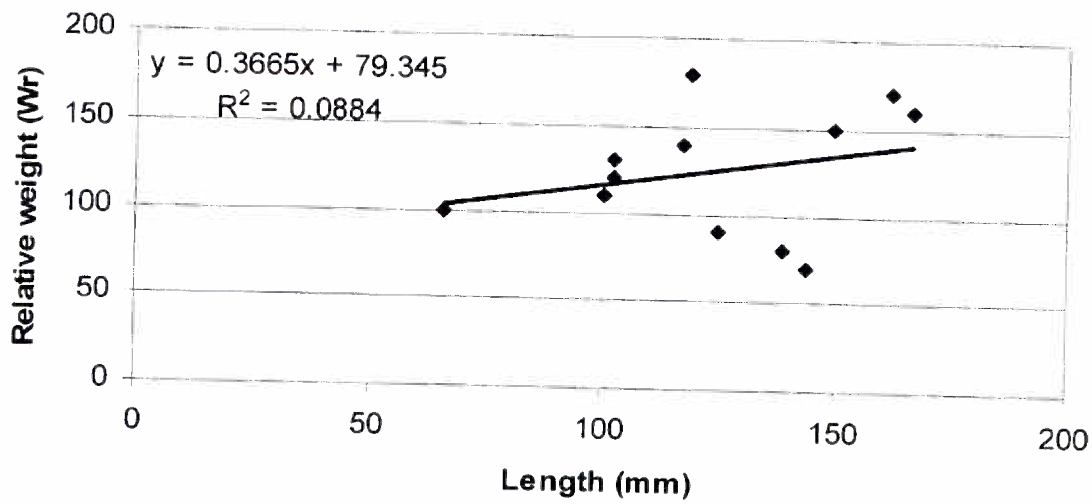

Figure 40. Regression showing the correlation between relative weight (Wr) and length of bluegill captured during a lowland lake survey of Rose Lake, Idaho, 2007.

2007 Panhandle Region Fisheries Management Report

Rivers and Streams Investigations

BULL TROUT REDD COUNTS

ABSTRACT

We conducted bull trout redd counts in tributaries of Priest River, Pend Oreille Lake, Kootenai River, St. Joe River, and Little North Fork of the Clearwater River in September and October 2007 to add to the long-term trend data set. These counts were used to estimate spawning run size, help with management strategies, assess restoration activities and evaluate whether federal recovery goals were met in each of the core areas that occur in the IDFG Panhandle Region.

We counted seven redds in the Upper Priest Lake basin, 654 bull trout redds in the Pend Oreille Lake and Priest River drainage, three redds in the Kootenai River drainage, 93 redds in the St. Joe River drainage, and 136 redds in the Little North Fork of the Clearwater River drainage. Improving trends in bull trout redd abundance were apparent for the Pend Oreille Lake, Little North Fork Clearwater River and St. Joe River basins whereas a decline in redd numbers was apparent in the Priest Lake basin and the Kootenai River basin.

Five Federal Bull Trout Recovery core areas are located at least partially in the IDFG Panhandle. These are the Priest Lake, Pend Oreille Lake, Kootenai River, Coeur d'Alene Lake and North Fork Clearwater River core areas. Four recovery goals must be met in each of the core areas before bull trout can be considered recovered. In 2007, all four of the recovery goals were not met in any of the core areas. Three of the four recovery goals were being met in the Pend Oreille Lake Core Area in 2007, although all four recovery goals were met the previous five years. Bull trout abundance has more than doubled in the last five years in the North Fork Clearwater River core area. If this trend continues, all recovery goals for this core area will be met in 10 years. The Kootenai River Core Area may reach all of its recovery goals once higher flows return to the basin, based on past redd counts. The Priest Lake and Coeur d'Alene Lake core areas are far from meeting all of their recovery goals, and considerable progress must occur before these bull trout populations can be considered as recovered.

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INTRODUCTION

Bull trout within the Klamath and Columbia River basins were listed as threatened on June 10, 1998 under the Endangered Species Act. As a result of this listing, recovery plans for bull trout in specific geographic areas (recovery units) were developed by experts in the field (USFWS 2002). Each recovery unit is separated into core areas (river or lake basins) and for each core area it describes conditions, defines recovery criteria, and identifies specific recovery actions for bull trout. The Panhandle Region of the Fish and Game encompasses part or all of the following recovery units: Clark Fork River, Kootenai River, Coeur d'Alene Lake Basin, and Clearwater River. Core areas of these recovery units that occur in the Panhandle Region are Priest Lake, Pend Oreille Lake, Kootenai River, Coeur d'Alene Lake, and the North Fork Clearwater River (USFWS 2002).

The overall goal of the Bull Trout Draft Recovery Plan is to ensure the long-term persistence of self-sustaining, complex, interacting groups of bull trout distributed throughout the species' native range so that the species can be delisted (USFWS 2002). To accomplish this goal, the following recovery criteria addressing distribution, abundance, habitat and connectivity were identified.

1. Maintain the current distribution of bull trout and restore their distribution in previously occupied areas.
2. Maintain stable or increasing trends in abundance of bull trout.
3. Restore and maintain suitable habitat conditions for all bull trout life history stages and strategies.
4. Conserve genetic diversity and provide opportunity for genetic exchange.

For core areas that occur within or overlap into the IDFG Panhandle Region, the distribution and abundance recovery criteria will be met when the total number of stable local populations and the total number of adult bull trout have reached the levels indicated in Table 9.

Trend recovery criteria will be met when the overall bull trout populations in specified core areas are accepted, under contemporary standards of the time, to be stable or increasing, based on at least 10 years of monitoring data.

Connectivity criteria will be met when migratory forms are present in all local populations and when intact migratory corridors among all local populations in the core area provide opportunity for genetic exchange and diversity.

Bull trout have been found to have a strong fidelity to their natal streams (Spruell et al. 1999), their redds are relatively easy to count (Pratt 1984), and redds are only a measure of the reproductive adults. These attributes make redd counts an appropriate technique for evaluating trends in adult bull trout population strength. In addition, redd counts are relatively quick and inexpensive to conduct when compared to other techniques such as weiring, netting, or electroshocking. For these reasons the status of bull trout populations in each of the core areas are evaluated through redd counts. Bull trout redds are counted in each of the core areas in the IDFG Panhandle Region. These counts not only allow evaluation the status of bull trout in each of the core areas as it pertains to recovery, but they also help guide future management decisions and assess the success of recovery actions.

STUDY SITES

Bull trout redds were counted in tributaries of the Priest River, Pend Oreille Lake, Kootenai River, St. Joe River, and Little North Fork Clearwater River drainages where bull trout were believed to spawn (Figures 41 - 46). 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 North Fork Clearwater River. The boundary of the Kootenai River and North Fork Clearwater River core areas span outside of the Panhandle Region. Selection of survey streams was dependent on available time and results of previous surveys. Streams where no redds were found for several consecutive years were often discontinued to allow more time to investigate new streams.

OBJECTIVES

1. Quantify bull trout redds and spawning escapement in Priest Lake, Pend Oreille Lake, Kootenai River, Coeur d'Alene Lake and North Fork Clearwater River core areas.
2. Assess whether bull trout abundance in each of the core areas meets recovery criteria outlined in the federal Bull Trout Draft Recovery Plan.
3. Survey additional streams to assess occurrence of bull trout spawning.

METHODS

Bull Trout Spawning Surveys

Bull trout redds were counted in selected tributaries of the Priest Lake, Priest River, Pend Oreille Lake, Kootenai River, St. Joe River, and Little North Fork of the Clearwater River basins where bull trout were known or believed to occur. Counts in each of these basins were summarized in the core area they occurred in. Redd counts in the Middle Fork East River, North Fork 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. In Press a). All redds were counted at similar times (September and October) as had occurred in the past (DuPont et al., In Press b). 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, attempts were made to use only those individuals who attended a bull trout redd count training exercise on September 18, 2007. 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 North Fork Clearwater core areas occurred outside the Panhandle Region. Redd count data for these areas were obtained from the personnel responsible for conducting these surveys.

To help assess potential limiting factors, all man-made fish passage barriers noticed during the redd counts were documented. We also attempted to ascertain who the responsible parties were for the documented barriers.

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. 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 the same as Fraley and Shepherd (1998) found in the Flathead Lake system. Baxter and Westover (1999) and Downs and Jakubowski (2003) found that repeat spawning is common for adfluvial bull trout where 90-100% of the surviving bull trout spawned in consecutive years. For this reason we decided to use the total spawning escapement calculated from redd counts in the Priest, Pend Oreille and Coeur d'Alene Lake core areas as an estimate for the total number of adults. We recognize this will give us a conservative estimate, as bull trout in every tributary in the Panhandle do not spawn every year (DuPont et al., In Press a; Downs and Jakubowski 2006). The one exception to this is for the Little North Fork Clearwater, where research by Schriever and Schiff (2002) found that anywhere from 50 - 75% of the adult bull trout return to spawning grounds in consecutive years. Consequently, for the Little North Fork Clearwater, we multiplied the spawning escapement by 1.33 (75% repeat spawners) to estimate how many adults occurred in the core area. The total number of adult bull trout associated with each tributary and each core area was compared to the criteria specified in the Bull Trout Draft Recovery Plan to determine the status of the different bull trout populations.

To evaluate whether the population of adult bull trout in each core area was stable or increasing, we used a linear regression with sample year as the independent variable and the number of redds as the dependent variable. Other studies have used regressions to evaluate whether bull trout populations were stable or increasing; however, each of these cases they either used non-parametric techniques (Rieman and Meyers 1997) or converted the redd counts using a $\log_e$ transformation (Maxell 1999). We did not convert the data or use non-parametric techniques because we believe it is easier for most individuals to visualize trends and understand how bull trout abundance is changing if the actual redd count data are used (no transformation or ranking of the data).

For a simple linear regression, if the slope of the regression line is greater than or equal to zero and 10 or more years of redd count data exists, then a bull trout population can be considered as stable or increasing. A significant ($P < 0.10$) slope of the regression line was preferred to assess whether a particular population is stable or increasing; however, we did not rely solely on a statistically significant relationship. As the abundance of individuals in a population reaches its carrying capacity and/or stabilizes (slope of regression line near zero), there is no significant relationship. When a statistically significant relationship ($P < 0.10$) does not occur, interpretation and professional judgment must be used to determine if the amount of variation seen around a regression line is too great for a particular population to be considered stable or increasing.

RESULTS

Priest Lake Core Area

A total of seven bull trout redds were counted in the Upper Priest River basin on October 3, 2007 (Figure 41 and Table 10). All of these redds were counted in Upper Priest River. This is the first time we have not documented a bull trout redd in any of the other spawning tributaries of Upper Priest Lake. Brook trout redds have been observed in many of the streams surveyed. For this reason, any redd smaller than 350 mm in diameter were not included in the bull trout redd counts. The number of redds counted in 2007 was the lowest recorded, and was 80 times lower than what was counted in 1985 when similar reaches were compared (Figure 47 and Table 10). By expanding the number of redds observed by 3.2 fish/redd, we calculated the spawning escapement of bull trout for the Upper Priest Lake basin to be 22 fish. The recovery goal is 1,000 adults for the Priest Lake Basin (Table 11). A significant downward trend is evident in the abundance of bull trout in the Priest Lake Core Area, especially if one evaluates redds counted during 1985 and 1986 (Figure 47 and Table 12).

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

Pend Oreille Lake Core Area

A total of 654 bull trout redds were counted in the Pend Oreille Lake Core Area during October 9-15, 2007, of which 456 (70%) were in the six index streams (Trestle, East Fork Lightning, Gold, North Gold, Johnson, and Grouse creeks) (Figure 42 and 43, and Table 13). This is about half the number of redds observed in 2006 (record high counts) and the lowest since 1997. Declines from 2006 to 2007 were observed in 19 of the 21 streams surveyed (Table 13). Gold Creek for the third time in the past four years had the highest redd count total (179). By expanding the number of redds observed by 3.2 fish/redd, we calculated the spawning escapement of bull trout for the Pend Oreille Lake Core Area to be 2,118 fish (this includes 25 fish passed upstream of Cabinet Gorge Dam) (Table 14). This is below the recovery goal of 2,500 adults for the Pend Oreille Lake Core Area for the first time in the past six years (Tables 9 and 11). Seven tributaries in the Pend Oreille Basin had an estimated spawning escapement of 100 adults, or at least 32 redds (Table 13 and 14). The recovery goal states at least six populations with over 100 adults must occur in the Pend Oreille Lake Core Area (Tables 9 and 11).

When the redd counts were evaluated from 1983 to 2007 (1986, 1988-91 and 1995 were not evaluated) the linear regression showed a positive slope of 2.8 redds/year (Figure 48 and Table 12), although this regression was not significant ($P = 0.353$). However, if we only evaluate that data from 1992 to 2007 (1995 was not evaluated), a significant ($P < 0.064$) positive trend was calculated (11.9 redds/year) despite the large decline we observed in 2007.

Besides the dams located on the Pend Oreille River (Albeni Falls Dam) and Clark Fork River (Cabinet Gorge Dam, Noxon Rapids Dam and Thompson Falls Dam), several other man-made migration barriers to bull trout were known to occur in the Pend Oreille Lake Core Area. This includes the city water diversion on Strong Creek and the hatchery and city water diversion on Spring Creek. Currently, spawning and rearing bull trout populations are not known to occur in Strong Creek or Spring Creek. A barrier (old log crossing) on Uleda Creek (tributary to the Middle Fork East River), which was a total block to upstream movement to bull trout, was blasted out in 2004 by IDL (funding was provided by the USFWS). Removal of this barrier more than tripled the amount of spawning and rearing habitat in Uleda Creek. Four bull trout redds were counted upstream of this barrier in 2004, although none have been located upstream of it since.

In addition to these man-made barriers, excessive bedload deposition has caused channel intermittency on lower Lightning Creek, Rattle Creek, Savage Creek, East Fork Lightning Creek and Granite Creek. We recognize bedload deposition is a natural process; however, we believe past timber management and poor road construction and maintenance practices have contributed to increased amounts of bedload deposition. This in turn is believed to increase the length and duration of the channel intermittency in these streams. Each of these streams support spawning and rearing bull trout populations, and in the past over 100 adults historically ascended them. Work occurred on Granite Creek in 2005 and 2006 to eliminate the intermittent stream reach.

In 2007, three of the four recovery goals were met in the Pend Oreille Lake Core Area. All four recovery goals were met the previous five years (2002 to 2006). The three recovery goals being met in 2007 were, seven local populations had over 100 adults (six are required), the overall bull trout population was increasing (the overall population must be stable or increasing) and efforts were being made to maintain the current distribution of bull trout and restore their distribution in previously occupied areas. The one recovery goal that was not met was the adult bull trout population estimate did not exceed 2,500 fish. Our adult bull trout estimate was 2,116 fish based on redd counts.

Three different groupings of streams (all streams, index streams and Lightning Creek tributaries) were evaluated separately to help determine why we were seeing improvements in the abundance of bull trout between 1992 and 2006. All three showed increasing trends in redd counts since 1992, although the slope for all three was different (Table 12). When evaluating all streams combined (22 streams) there has been on average an increase of about 28.4 redds/year (slope). This projects to an increase of 1.3 redds/stream per year. The slope for the six index streams was about 11.9 redds/year, which averaged an increase of 2.0 redds/stream each year. When evaluating only the Lightning Creek tributaries (7 streams) there has been on average an increase of about 4.6 redds/year. This averaged out to about an increase of 0.7 redds/stream every year.

Kootenai River Core Area

Three tributaries (North Callahan, South Callahan and Boulder creeks) were surveyed on October 9, 2007 for bull trout redds in the Idaho portion of the Kootenai River Core Area, and a total of three redds were counted (Figure 44 and Table 15). This was the sixth year redds were counted in all three tributaries. The three redds observed during 2007 were the lowest counted over the six year period and was about 10 times lower than we observed during 2006. Higher flows occurred when conducting redd count surveys in 2007, which made redd detection difficult. 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 10 fish.

With only six years of redd counts occurring on the three Idaho, Kootenai River tributaries, trend analysis would be unreliable. The current six year trend is negative, decreasing at a rate of 3.0 redds per year (slope); although this trend is not significant (Table 12 and Figure 49).

In the Montana portion of the Kootenai River Core Area, 139 redds were counted during 2007 (Table 15). This converts (3.2 fish/redd) to an estimated spawning escapement to 445 fish. When combined with the Idaho spawning escapement (10 fish), the total spawning escapement for the Kootenai River Core Area comes out to 455 fish. No corrections were made for fish that do not spawn every year to come up with the total number of adult fish that occur in the core area. As a result, the estimated spawning escapement of 455 for the entire Kootenai River Core Area is conservative. The recovery goal is 1,000 fish (Table 11). During 1999, an estimated 733 bull trout occurred in the Montana section of the core area. No streams were surveyed in Idaho during this year, but based on the average number of redds counted over the past five years (17 redds), the total number of adult bull trout that occurred in the entire Kootenai River Core Area likely exceeded 800 fish.

Two local populations (spawning tributaries) were believed to have over 100 adults in the Kootenai River Core Area during 2007. These tributaries include Quartz Creek (112 adults) and O'Brien Creek (246 adults). To reach the recovery goal for this core area there must be five populations of over 100 adults (Table 11). During 1999, five local populations were believed to have had at least 100 adults, assuming North Callahan Creek followed similar trends as was observed in Montana.

Trend analysis (linear regression) of bull trout redds in three Montana tributaries that have been counted consistently since 1990 indicate this population is significantly ($P = 0.064$) increasing (Table 12 and Figure 50). Redd counts from 2002 to 2007 were lower than those between 1998 and 2001, although they were higher than what were observed between 1990 and 1996 (Figure 50). Starting in 1996, bull trout redds were counted consistently in five Montana streams. Analysis of this data suggests that since 1996 the bull trout population has decreased slightly (Table 12 and Figure 50). Although the abundance of bull trout in Montana appears to be down from what was observed from 1998 to 2001, if we look at a longer time frame (1991 to 2007) the population appears to be increasing. Due to the short time frame (six years) bull trout abundance has been assessed in Idaho and the very low count that was observed in 2007 (three redds), there is uncertainty on the stability of this bull trout population.

It was believed that excessive bedload deposition has caused channel intermittency in Pipe Creek and Bear Creek in Montana which have prevented bull trout from accessing sections of these streams. Low flows in this region in the past seven years are believed to have exacerbated this problem. We recognize bedload deposition is a natural process; however, past timber management and poor road construction and maintenance practices may have contributed to increased bedload deposition, and this in turn, increased channel intermittency.

Coeur d'Alene Lake Core Area

IDFG counted 93 redds in the three index stream reaches of the St. Joe River drainage on September 25, 2007 (Table 16 and Figure 45). The U.S. Forest Service surveyed another eight streams on September 15, 2007 and counted one redd bringing the total number of redds counted in the St. Joe River to 94 (Table 16). This is the most redds ever counted (93 redds were counted in 2005). All redds were counted in four different streams (Medicine Creek, Wisdom Creek, Heller Creek and Red Ives Creek). The 32 redds counted in Wisdom Creek was a record high, and was two to three times higher than was observed in most previous years. Medicine Creek had the highest count (55 redds). The 87 redds counted in Medicine Creek and Wisdom Creek combined represented 93% of all redds counted in the entire Coeur d'Alene Lake Core Area during 2007. 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, the spawning escapement of bull trout for the Coeur d'Alene Lake Core Area was estimated to be 301 fish, which is considerably lower than the recovery goal of 1,100 adults (Tables 9 and 11). No bull trout redds were observed downstream of Red Ives Creek. The recovery goal is an annual spawning escapement of at least 300 bull trout downstream of Red Ives Creek.

An upward significant (P = 0.038) trend in the abundance of bull trout redds since 1992 was calculated (increasing by 3.6 redds/year) for the Coeur d'Alene Lake Core Area if one evaluates all the streams surveyed (Figure 51 and Table 12). Many of these streams have not been surveyed consistently and some of the stream reaches were surveyed by individuals inexperienced in counting redds. If we evaluate only those streams that have been consistently surveyed by experienced counters (the three index streams), a significant (P = .002) upward trend (increasing by 3.6 redds/year) was also evident (Figure 51 and Table 12). Based on these significant increasing trends, we concluded that the bull trout population in the Coeur d'Alene Lake Core Area is stable or increasing.

Several complete and/or partial barriers occur in streams where we believe bull trout spawning and rearing is occurring. Red Ives Creek has a diversion dam on it within 2 km of the mouth that we believe blocks upstream migration of most bull trout. We have had reports of a few spawning bull trout upstream of the dam, but believe this dam blocks upstream migration of most bull trout. Entente Creek has a culvert barrier just upstream from where bull trout redds have been reported in the past, and there appears to be suitable habitat upstream of the culvert. Other barriers may occur in streams that we believe have the potential to support spawning and rearing bull trout populations.

North Fork Clearwater River Core Area

Bull trout redd surveys were conducted on September 26, 2007 in the upper Little North Fork Clearwater River basin. During this survey, 136 redds were counted, which was an all time high since redd counts were initiated in 1994 (Figure 46 and Table 17). We did not survey Canyon Creek or Buck Creek during 2007 due to their remote location. Five redds were counted in Buck Creek in 2003. Since 2001 we have evaluated new streams to better assess where bull trout are spawning in the Little North Fork Clearwater River. We've observed bull trout spawning in many different streams, but not necessarily on a consistent basis (Table 17).

To estimate the spawning escapement of bull trout in the Little North Fork Clearwater River, we first added 10% to the total redd count (multiply by 1.11) to account for streams not surveyed in 2005 (Buck Creek represented 10% of redds in 2003). Then, by expanding this corrected number of redds (151) by 3.2 fish/redd, the spawning escapement of bull trout for the upper Little North Fork Clearwater River was estimated to be 483 fish. USFS counted 85 redds in the North Fork Clearwater River and Breakfast Creek drainages in 2007 (Table 18). Not all streams were surveyed in the North Fork Clearwater River drainage every year due to their remote locations and time constraints. Based on previous redd counts (Table 18), it is believe that during 2007 about 24% of the redds were not counted due to reduced numbers of streams surveyed. By adding 24% to this count (multiply by 1.32), the estimated number of redds was 112. By expanding this corrected number of redds (112) by 3.2 fish/redd, the spawning escapement of bull trout for the North Fork Clearwater River and Breakfast Creek drainages was estimated to be 359 fish. When combined with the upper Little North Fork Clearwater River, this gives us a total spawning escapement of 842 bull trout for the North Fork 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 1,120 adult bull trout that occurred in the North Fork Clearwater Core Area during 2007. This is considerably lower than the recovery goal of 5,000 adult bull trout (Table 11).

Evaluating the trend in redd counts in the North Fork Clearwater Core Area is difficult due to the irregularity in counting the same stream reaches throughout the years, adding new reaches, and inconsistency in counting redds that were created by resident fish. If we only look at those stream reaches that we have counted consistently in the Little North Fork Clearwater (Lund Creek, Little Lost Lake Creek, Lost Lake Creek and the Little North Fork Clearwater upstream of Lund Creek) a significant ($P < 0.001$) increasing trend (increasing by 6.6 redds/year) was evident (Figure 52 and Table 12). From 2001 to 2006, the stream reaches we surveyed for redds in the Little North Fork Clearwater River and North Fork Clearwater River was fairly consistent. When we evaluated only these data, a significant ($P = 0.018$) increasing trend (increasing by 21.1 redds/year) was observed (Figure 53 and Table 12).

No natural barriers to bull trout migration were identified in the Little North Fork Clearwater River basin. However, the Clearwater Region has identified barriers in the North Fork Clearwater River that are believed to block upstream migration to bull trout in Isabella Creek (unknown cause), Quartz Creek (land slide), and Slate Creek (culvert).

DISCUSSION

Priest Lake Core Area

Bull trout redd counts from 1985 to 2007 indicate the bull trout population in the Upper Priest Lake basin has declined significantly. The number of bull trout spawning in these tributaries in 2007 was 50 to 80 times lower than what we observed in the 1980's. For the first time, we observed no redds outside of Upper Priest River. In the 1980's, 20 to 40 redds were typically counted in Gold Creek and Hughes Fork, two or the major tributaries of Upper Priest River. Redds have not been observed in most of the smaller tributaries for the last three to six years. This information supports work conducted on Upper Priest Lake where bull trout numbers appeared to be declining significantly and only larger bull trout remain (DuPont et al., 2007). It seems evident that the expanding population of lake trout in Upper Priest Lake poses an overwhelming threat to the adfluvial bull trout population (Fredericks et al. 2002; Donald and Alger 1993). If this bull trout population declines further it will likely be extirpated. Bull trout redd counts by Mauser (1986) documented a similar collapse on tributaries of Priest Lake where the number of redds observed in tributaries declined from double digits to zero from 1983 to 1985. This decline in redds occurred several years after a crash in the bull trout population was noticed in Priest Lake.

The sudden drop in redds counted in 2007 (four times lower than counted in 2006) may not be totally related to lake trout. Rains in early October raised water levels in Upper Priest River making detection of redds more difficult. Most people conducting these redd surveys suggested that they were fairly confident with their counts and believed they saw most of the redds. Bull trout redd counts also declined substantially in the Pend Oreille Lake Core Area and the Kootenai River Core Area from 2006 to 2007 suggesting that the decline may be more weather related. We examined air temperatures and stream flows to determine if they could help explain why a drop in bull trout redds occurred between 2006 and 2007. For unusual weather patterns to have an impact on the spawning escapement in 2007, it would have had to have occurred during their spawning year (1999-2001) or when they were rearing in the streams (2000-2002). No extreme air temperatures or peak flow events occurred during this period, but the second lowest mean annual flow event between 1950 and 2007 occurred during 2001 (Figure 14). We assume that during years with extreme low flows, the carrying capacity of streams would be much lower. Bull trout abundance in streams that were near or at their carrying capacity could have been significantly reduced by the flows that occurred in 2001. It's unlikely that tributaries of Upper Priest Lake were near their carrying capacity for bull trout, due to the low number of redds we have observed over the past 15 years. Low flows could also influence survival in other ways we have not explored.

Considerable efforts have been made in Upper Priest Lake to reduce lake trout abundance. These efforts have removed over 5,000 lake trout at a rate of over 500 lake trout a year between 1997 and 2006 (DuPont et al. In Press c). During 1998, it was estimated that about 75% of the lake trout (912 in all) were removed from Upper Priest Lake, (Fredericks et al. 2002). The reason this bull trout population has persisted may be due to these efforts. Unfortunately, lake trout appear to repopulate Upper Priest Lake by migrating up from Priest Lake through the Thorofare faster than we can remove them (Fredericks et al. 2002). In 2007, lake trout removal involved a 47 foot commercial gillnet boat that set around 54 km of gillnet over an 11 day period. During these 11 days, they removed around 2,000 lake trout, which was estimated to be around 86% of the fish recruited to the gear (DuPont et al. In Prep). This information indicates that despite these removal efforts lake trout abundance more than doubled between 1998 and 2007. Continued lake trout removal coupled with blocking migration of lake trout through the Thorofare is necessary for this bull trout population to persist. Unfortunately, there may not be a technological fix to eliminate the threat from immigration.

The total bull trout spawning escapement for the Priest Lake Core Area was estimated at 22 fish in 2007. This is considerably lower than the recovery goal of 1,000 adult fish with at least five local populations having over 100 adults. Few of the tributaries of Priest Lake have been surveyed for redds since 1986 when Mauser (1986) documented the collapse of this population. Bull trout are known to still occur in some of the tributaries of Priest Lake (DuPont et al., In Press d), but probably contribute few adult fish to the entire core area. North Indian Creek, one of the few tributaries of Priest Lake where juvenile bull trout occur, was surveyed in 2004 and 2006, but no redds were located.

One man-made barrier was noted during our survey that we believe blocks upstream migration of bull trout. This barrier is a U.S. Forest Service culvert located where F.S. road 1013 crosses Gold Creek (T63N, R5W, Section 17). Currently, bull trout habitat below this culvert is not fully utilized, but spawning and rearing habitat should not be artificially limited for this depressed population.

Pend Oreille Lake Core Area

The number of bull trout redds counted in the Pend Oreille Lake Core Area in 2007 (654) was almost half of what was documented in 2006 (1,256) and was the fewest since 1997. This decline was noted in almost all of the tributaries and is of some concern. This decline could be related to the expanding lake trout population in Pend Oreille Lake. This lake trout population increased exponentially from 1999 to 2006 and it was estimated that over 35,755 fish were in the lake in 2006 (Hansen et al. In Press). The biggest threat to the entire bull trout population in the Pend Oreille Lake Core Area is believed to be from lake trout (LPOBTWAG 1999). Findings from Donald and Alger (1993) and Fredenberg (2002) suggest that over time bull trout will not persist in the presence of lake trout. Priest Lake and Flathead Lake, Montana have experience dramatic declines in bull trout numbers as lake trout numbers increased (Mauser 1986; Deleray et al. 1999). The kokanee population (major prey item for lake trout and bull trout) is a fraction of what it once was and is at risk of collapsing if changes don't occur soon. If kokanee collapse, we would likely see bull trout declines shortly after as occurred in both Priest Lake and Flathead Lake. Considerable effort has been put into controlling the lake trout population in Pend Oreille Lake through angler incentive programs, trap netting and gillnetting, and it is believed that these efforts have reversed this increasing trend (Hughes et al. In Press). Future removal efforts will target spawning lake trout which should greatly suppress their numbers.

The decline in bull trout redds in 2007 could also be a short duration event related to past weather patterns. As noted earlier, the second lowest mean annual flow event between 1950 and 2007 was observed in most rivers and streams in northern Idaho during 2001 (Figure 14). These low flows could have negatively influenced juvenile bull trout that were rearing in streams at this time. Many of the bull trout rearing in stream in 2001 would start spawning in 2007. We assume that during years with extreme low flows, the carrying capacity of streams would be much lower. Bull trout abundance in streams that were near or at their carrying capacity, which likely occurred in many Pend Oreille Lake tributaries, could have been significantly reduced by the flows that occurred in 2001. If flows in 2001 were responsible for the redd count decline in 2007, we will likely see redd counts rebound in a year or two.

Despite the decline in redd counts in 2007; trend analysis indicates the bull trout population in the Pend Oreille Lake Core area is stable or increasing. Evaluation of the spawning tributaries (22 in all) since 1983 show the trend increasing at a rate of 5.6 redds/year, although this trend was not significant ($P = 0.343$). When we evaluated only those redd counts since 1992, a significant increasing trend was evident. Although the decline in redd counts in 2007 was of concern, in 2006, record high redd counts were observed in six different tributaries (Trestle Creek, Granite Creek, Gold Creek, Wellington Creek, Morris Creek and Middle Fork East River) and in four other streams (Savage Creek, Char Creek, Sullivan Creek and Uleda Creek) the highest counts in at least the past nine years were observed. These counts indicated that this bull trout population was increasing throughout the core area, not just in a few key tributaries. This information is encouraging and suggests the bull trout population in the Pend Oreille Lake core area can remain strong even if catastrophic events were to impact several spawning tributaries. We believe that regardless of whether the decline in redds in 2007 was due to lake trout, low flows in 2001, or some other issue, efforts around the lake will insure the bull trout spawning escapement will quickly rebound. It should be noted that during November of 2006 the Pend Oreille Lake basin experienced extreme rain events. Flows on Lightning Creek exceeded a 150 year peak flow event. These flows may have significantly reduced bull trout spawning success and juvenile survival in many spawning and rearing tributaries. These impacts will likely show up in the 2011 to 2014 spawning escapement.

Redd counts in the Middle Fork East River and Uleda Creek were added to the Pend Oreille Lake Core Area in 2003 when bull trout were documented to spend their adult life in Pend Oreille Lake (DuPont et al. In Press a). Redd counts first occurred in the Middle Fork East River basin in 2001; however, only a portion of the spawn area was counted. In 2002, the redd counts covered the entire stream reach where bull trout were believed to spawn, but the counts occurred in mid October after brook trout had began spawning. This made it difficult to distinguish between brook and bull trout redds. The first year accurate redd counts were collected was 2003 when all know spawning areas were assessed and counts occurred on September 30th after the bull trout were finished spawning and before brook trout had begun. Future redd counts in the Middle Fork East River drainage will occur near the end of September, two weeks before redd counts in the rest of the Pend Oreille Lake Core Area.

The significantly increasing trend in the number of redds counted since 1992 (all streams combined) is believed to be largely a response to changes in fishing regulations in Pend Oreille Lake that occurred in 1994 (harvest changed from 2 to 1 fish) and 1996 (changed to catch-and-release). If improvements in habitat were the main reason for the increasing trends we would expect to see these increases in only a few tributaries where these habitat improvement projects occurred. Those streams having high variability in their redd counts typically have unstable and/or degraded habitat conditions (Rieman and Myers 1997) such as Rattle Creek, Grouse Creek, Johnson Creek and the Pack River. However, periodic increases in the number of redds counted in these streams indicate they have the potential to support strong, stable bull trout populations once improvements occur. Those streams where consistently low redd counts have occurred since 1986 (Lightning Creek, Savage Creek, Morris Creek and Porcupine Creek) may require considerable time and money to recover the population and/or they may have little potential to support high numbers of bull trout.

In the Lightning Creek tributaries, the number of bull trout redds has increased at a slower rate than other tributaries of Pend Oreille Lake. Habitat in the Lightning Creek tributaries is believed to be degraded and of lower quality than the other bull trout tributaries in Pend Oreille Lake (PBTTAT 1998), suggesting that the abundance of bull trout in Lightning Creek were and continue to be suppressed more by the quality of the habitat than past fishing pressure. Significant efforts to protect and restore habitat in tributaries of Lake Pend Oreille, have likely contributed to the increase in bull trout numbers we have seen since 1992 (Downs and Jakubowski 2003). These types of efforts are necessary to ensure bull trout populations will continue to increase in the Pend Oreille Lake Core Area.

Efforts are also occurring to increase the distribution and/or population strength of bull trout in the Pend Oreille Lake Core Area by addressing man-made barriers. All of the barriers believed to be suppressing bull trout abundance are being evaluated and/or efforts are being taken to correct the problem. For example, a historic stream crossing that occurred about 0.6 km upstream from the mouth of Uleda Creek, a tributary of the Middle Fork East River, was removed in 2004. Removing this barrier more than tripled the amount of available high quality spawning and rearing habitat for bull trout in this stream. Uleda Creek is an important stream reach in the Middle Fork East River basin for this bull trout population as the highest densities of juvenile bull trout and no brook trout were found there. Removal of this barrier could lead to significant increases in this bull trout population which should start being recognized after one bull trout generation (6-8 years). Efforts to evaluate entrainment and the potential for upstream fish passage over Albeni Falls Dam on the Pend Oreille River (Geist et al. 2004) and Cabinet Gorge Dam on the Clark Fork River (Lockard et al. 2003) are ongoing. Improvements in fish passage at these dams could result in significant increases in the bull trout population in the Pend Oreille Lake Core Area.

Efforts to correct an intermittent stream reach on Granite Creek occurred in 2005 and 2006 (Chris Downs, IDFG, personal communication). This intermittent stretch of stream occurred about 1 km upstream from the mouth which had blocked bull trout migration to one of the top bull trout streams in the core area. In past years, bull trout were trapped and transported by this barrier. In 2006 and 2007, surface flows occurred throughout this reach of stream allowing bull trout to migrate through naturally.

In 2007, three of the four bull trout recovery goals were being met in the Pend Oreille Lake Core Area. All four recovery goals were met the previous five years (2002 to 2006). The three recovery goals being met in 2007 were: 1) seven local populations had over 100 adults (six are required); 2) the overall bull trout population was increasing (the overall population must be stable or increasing); and 3) efforts were being made to maintain the current distribution of bull trout and restore their distribution in previously occupied areas. The one recovery goal that was not met was the adult bull trout population estimate did not exceed 2,500 fish. Our adult bull trout estimate was 2,116 fish based on redd counts. Assuming we will be able to successfully reduce lake trout numbers, we believe the bull trout spawning escapement will rebound in the next year or two and all recovery goals will be met.

If the bull trout population in the Pend Oreille Lake Core Area increases to the point that extreme weather patterns will not cause the bull trout population to drop below its recovery goals, and lake trout have been suppressed, we believe a limited harvest of bull trout on Pend Oreille Lake could be allowed without impacting the overall population. A limited harvest of bull trout may generate angler interest and concern about the species, which could translate to support for continued efforts to improve this fishery. Any harvest allowed on this fishery should not exploit weak local populations or result in not meeting any of the stated recovery goals.

Kootenai River Core Area

North and South Callahan creeks are the only two streams that appear to be important spawning habitat for bull trout in the Idaho portion of the Kootenai River Core Area. Many other Kootenai River tributary streams have been surveyed in Idaho over the years, but bull trout redds were not found except for a few in Boulder Creek (Walters, IDFG, per. communication). Only three redds were counted in Idaho in 2007 which was about 10 times lower than what was observed in 2006. We are unsure if counts were accurate or if the high flows during our surveys prevented us from making accurate counts. Redd counts in the Montana section of the Kootenai River were similar between 2006 (140 redds) and 2007 (139 redds) suggesting the high flows may have biased counts. Extreme flows during November of 2006 caused extensive bedload movement and habitat change in North and South Callahan creeks and may have deterred bull trout from entering these streams.

The majority of the bull trout population in the Kootenai River Core Area is in Montana. During 2007, 98% of the documented redds were counted in Montana. Over the five-year period prior to 2007, a minimum of 76% of the redds were found in our neighboring state. Although bull trout spawning in Idaho are included in the same core area as fish spawning in Montana, Kootenai Falls appears to separate these populations (O'Brien Creek in Montana is also downstream of the falls). In addition, bull trout upstream and downstream of the falls likely have different life cycles further isolating them. Evidence 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 Creek, Pipe Creek and West Fisher River) appear to have a fluvial lifecycle where they over-winter in the Kootenai River (Jody Walters, personal communication, IDFG). Telemetry work has shown that bull trout can navigate Kootenai Falls, but it appears bull trout that spawn below the falls mix very little with bull trout from above the falls. For this reason, we should not expect to see the same trends in bull trout abundance between these two populations. Additionally, Canada allows harvest of bull trout in Kootenay Lake whereas it is catch-and-release in Idaho and Montana; further suggesting trends may be different.

The adult bull trout population estimate for the entire Kootenai River Core Area was 454 fish during 2007. This estimate is believed to be conservative, as during 2007, low flows may have blocked or prevented bull trout from entering some of the Montana spawning streams (Mike Hensler, MFWP, personal communication). In fact, the drop in bull trout numbers observed from 2002 to 2007 in the Kootenai River watershed may be in response to drought (Mike Hensler, MFWP, personal communication).

Entrainment of bull trout from Lake Koocanusa through Libby Dam may bolster the population in the Kootenai River Core Area. Redd counts downstream of Libby Dam more than doubled after the floods of 1996 and 1997. Lake Koocanusa has a thriving bull trout population, and entrainment through Libby Dam could be high in flood years. To test whether bull trout entrained over Libby Dam contribute to the spawning escapement in Montana tributaries, Montana Fish, Wildlife, and Parks put radio transmitters in bull trout downstream of Libby Dam. During this study, none of the radio tagged bull trout made migrations into known spawning tributaries in Montana (Mike Hensler, MFWP, personal communication). Most of these fish remained near Libby Dam, although some made migrations downstream into Idaho. It's still not clear what role entrainment plays in the population status of bull trout in the Kootenai River Core Area.

It appears that none of the recovery goals were being met in the Kootenai River Core Area in 2007 (Table 11); however, we may not be far from meeting recovery goals. During 1999, we believe five bull trout populations had spawning escapements over 100 adults which meets the recovery goal. The spawning escapement for the entire core area in 1999 likely exceeded 800 fish (the goal is 1,000 adults). Based on radio telemetry studies, many bull trout below Libby Dam do not spawn every year; consequently, many more adults were in the core area than redd counts indicate. Possibly over 1,000 adult bull trout were in the core area in 1999, and if the drought cycle ends, it is very likely we will see bull trout numbers increase.

Coeur d'Alene Lake Core Area

Redd counts in the Coeur d'Alene Lake Core Area indicate three areas (Medicine Creek, Wisdom Creek, Heller Creek and the upper St. Joe River) located in the upper St. Joe River basin are responsible for producing the vast majority of the bull trout in the entire core area (93 of 94 redds were counted in these three streams during 2007). In the 1930s, bull trout were documented in most of the major tributaries in the St. Joe River and some in the St. Maries Rivers (IDFG 1933). The apparent loss of bull trout in so many tributaries underscores the need to learn more about the major sources of mortality and limiting factors. This knowledge may be necessary before proper actions can be taken to restore this bull trout population.

About 93% (87 out of 94) of the bull trout redds counted in 2007 were in Medicine Creek and Wisdom Creek, which are within 3 km of each other. This places almost the entire bull trout population in the Coeur d'Alene Lake Core Area at risk from one catastrophic event. Currently, a dense stand of lodge pole pine and large amounts of dead and dying timber characterize the area, which makes it a prime spot for an intense fire. However, the trend in abundance of redds in the three index streams (Medicine Creek, Wisdom Creek and the upper St. Joe River) is increasing. Increasing redd counts in 2007 gives us some confidence that the bull trout populations in the index streams are not in jeopardy of collapsing in the near future. The 32 redds counted in Wisdom Creek during 2007 was a record high. This is promising as it spreads the risk between Wisdom and Medicine creeks. Unfortunately, only one redd was counted outside the three index streams in 2007, indicating much work is needed to allow this bull trout population to spread out and reduce their risk of collapse from one catastrophic event. Stream habitat restoration work was conducted in Heller Creek and is in the planning stages for Sherlock Creek to reduce impacts from historic mining. Hopefully these efforts will allow bull trout to successfully re-establish in these streams. No bull trout redds have been counted in the drainage downstream of Red Ives Creek since 2002. The Bull Trout Draft Recovery Plan goal is to have a spawning escapement of 300 bull trout downstream of Red Ives Creek.

Redd surveys in Medicine Creek have consistently produced the highest counts in the Coeur d'Alene Lake Core Area, and 55 redds counted in 2007 represented about 59% of all the redds counted. It is believed that Medicine Creek is critical to the persistence of bull trout in the Coeur d'Alene Lake Core Area. Ironically, the habitat in Medicine Creek is altered. Several stream segments still remain channelized from mining activities that occurred in the early 1900's. These channelized stream reaches provide poor spawning and rearing habitat. The USFS should investigate the potential for habitat restoration in Medicine Creek.

Currently, only one of the bull trout recovery goals (population appears to be stable or increasing) is being met in the Coeur d'Alene Lake Core Area. Man-made barriers still exist that block bull trout migrations and the adult population size is estimated to be 301 fish. The current recovery plan specifies a stable or increasing population, with full access to potential spawning streams, and 1,100 adult spawners, 300 downstream of Redd Ives Creek and 300 in the Coeur d'Alene River watershed. Given current conditions, the recovery goals should be re-evaluated to determine whether or not they are even feasible.

No attempts were made to survey tributaries of the Coeur d'Alene River for bull trout redds due to a lack of documented presence. Anglers have reported catching bull trout in recent years from the Coeur d'Alene River, although biologists have verified none. Snorkel surveys are conducted on an annual basis in the Coeur d'Alene River and no bull trout have been observed since these surveys began in 1973. Two different anglers indicated they caught bull trout from the South Fork Coeur d'Alene River at the mouth of Bear Creek. Bear Creek is known to have a strong brook trout population and brook trout are often misidentified as bull trout. A snorkel survey covering 34 km of the South Fork Coeur d'Alene River occurred during 2006 and no bull trout were observed.

North Fork Clearwater River Core Area

The 221 redds counted in the North Fork Clearwater River (NFCR) and Little North Fork Clearwater River (LNFCR) in 2007 was the highest historical observation. Many streams in this core area are not counted on an annual basis due to their remoteness. As a results, the spawning escapement in this core area is higher than the redd counts indicate. The number of stream reaches surveyed has changed over the years and only since 2001 has the number of stream reaches surveyed occurred in a somewhat consistent manner. From 2001 to 2006, an increasing trend was observed in the NFCR and LNFCR basins. If we combine these data, bull trout redds have been increasing at a rate of about 21 redds/year over 28 streams. This increasing trend suggests the bull trout population in the North Fork Clearwater River Core Area is stable or increasing.

More bull trout redds (60% more) were counted in the LNFCR basin than in the NF basin in 2007. Despite this difference, it is unlikely more bull trout actually spawned in the LNF basin than in the NF basin during 2007 for four reasons: 1) the NFCR basin is over five times larger than the LNFCR basin; 2) due to the remote nature and large size of the NFCR basin many potential spawning streams are not surveyed; 3) six known spawning streams were not surveyed in the NFCR basin during 2007 (only seven streams are regularly surveyed in the LNFCR basin); 4) fishermen indicate bull trout numbers in the NFCR have increased substantially over the last 10 years.

The 136 redds observed in the LNFCR was 18% higher than observed in 2006 and 66% higher than in 2005, suggesting the LNFCR bull trout population may be growing exponentially. If so, we could continue to see large increases in redd counts over the next few years. Increasing numbers of redds in tributaries of the LNFCR do not appear to be related to improving habitat conditions, as most of these streams are fairly remote with little human disturbance. Improvements in bull trout numbers can be attributed to fishing regulations changes in 1994 from a 2 fish limit to no harvest on bull trout. Bull trout are prone to over-exploitation especially when large congregations of bull trout occur in a few pools (DuPont et al. In Press e).

Currently, two of the four recovery goals are being be met in the North Fork Clearwater River Core Area (Table 11). There are around 20 local populations in the recovery area, (the goal is 11), and we believe the population is stable or increasing. The two goals not being met are barriers still exist in the North Fork Clearwater River watershed that should be corrected and the estimated adult population size of 1,120 is well short of the goal of 5,000. Due to the remote nature of this core area many potential spawning tributaries are not surveyed; making this population estimate conservative. In addition, in several NFCR tributaries, only short stream segments are surveyed further limiting redd counts. Despite these limitations, bull trout redd counts have more than doubled in the last five years in the North Fork Clearwater River core area. If this trend continues, all recovery goals for this core area will be met in 10 years.

The recovery goal for the entire North Fork Clearwater Core Area (5,000 adults) is twice that of the Pend Oreille Lake Core Area (2,500 adults). The Pend Oreille Lake Core area is believed to support one of the strongest bull trout populations in Idaho. The sterile nature of the streams in the North Fork Clearwater Core Area is believed to limit primary production and in turn fish biomass. As a result, we should not expect to see the same densities of bull trout as the Pend Oreille Lake Core Area where many of the spawning tributaries are low elevation spring fed streams and a large stable lake provides high survival for maturing juveniles and over-wintering adults. For these reasons, we question the recovery goal of 5,000 adults in the North Fork Clearwater River Core Area. We suggest that this portion of the recovery plan be re-evaluated and a more realistic goal be developed.

MANAGEMENT RECOMMENDATIONS

1. Continue to annually monitor bull trout spawning escapement through redd counts in the Priest Lake Pend Oreille Lake, Kootenai River, St. Joe River and Little North Fork Clearwater River watersheds.

2. Using redd counts, annually evaluate the status of bull trout in each of the core areas that occur in the Idaho Panhandle Region.

3. Investigate new streams/stream reaches where bull trout spawning may be occurring.

4. Continue to provide annual training to all people who will be conducting redd counts in the Panhandle Region.

5. Discuss with USFS the feasibility of habitat restoration in Medicine Creek and/or Wisdom Creek.

6. Conduct a survival study on bull trout in the St. Joe River Basin to better evaluate population limiting factors.

7. Re-evaluate the recovery goals for the North Fork Clearwater River Core Area.

Table 9. Abundance criteria required before bull trout can be considered as recovered in the following basins of Northern Idaho (USFWS 2002).

Core Area	Recovery Criteria		
	Minimum number local of populations with more than 100 adults	Minimum number of adults in the entire core area.	Trend in abundance
Priest Lake basin	5	1,000	Stable or Increasing
Pend Oreille Lake basin	6	2,500	Stable or Increasing
Kootenai River basin[A]	5	1,000	Stable or Increasing
Coeur d'Alene Lake basin	NA	1,100[B]	Stable or Increasing
North Fork Clearwater River basin[C]	11 (> 100 adults not required)	5,000	Stable or Increasing

[A] This core area includes tributaries in Idaho and Montana.

[B] This value is the desired annual spawning escapement - not the total number of adults in the core area. At least 800 must occur in the St. Joe River watershed (300 must occur downstream of Red Ives Creek) and 300 in the Coeur d'Alene River watershed.

[C] Only the Little North Fork Clearwater River, a tributary of the North Fork Clearwater River basin, is located in the Panhandle Region.

Table 10. Description of bull trout redd count transect locations, distance surveyed and number of redds counted in the Priest Lake basin, Idaho, from 1985 to 2007.

Stream	Transect Description	Length (km)	1985	1986	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Upper Priest	Falls to Rock Cr.	12.5	--	--	--	--	--	--	15	4	15	33	7	7	17	8	5	13	21	5
	Rock Cr. to Lime Cr.	1.6	--	--	--	2	1	1	2	0	3	7	0	2	0	0	0	0	1	0
	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
	Snow Cr. to Hughes Cr.	11.0	--	--	--	0	0	--	0	3	7	4	2	8	3	13	2	10	0	1
	Hughes Cr. to Priest Lake	2.3	--	--	--	0	0	--	0	--	--	0	0	--	--	--	--	--	--	--
Rock Cr.	Mouth to F.S. trail 308	0.8	--	--	0	0	--	--	2	1	0	--	0	0	0	--	1	0	0	0
Lime Cr.	Mouth upstream 1.2 km	1.2	4[b]	1[b]	0	0	--	--	0	2	0	1	0	0	0	0	0	0	0	0
Cedar Cr.	Mouth upstream 3.4 km	3.4	--	--	--	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0
Ruby Cr.	Mouth to waterfall	3.4	--	--	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
	F.S. road 622 to Trail 311	4.0	35[c]	2[c]	2	0	7	1	2	0	0	0	0	0	0	1	2	1	1	0
	F.S. road 622 to mouth	7.1	4[d]	0[d]	--	1	--	--	2	3	1	0	2	6	1	0	1	1	1	0
Bench Cr.	Mouth upstream 1.1 km	1.1	1	2	0	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0
Jackson Cr.	Mouth to F.S. trail 311	1.8	--	--	4	0	0	0	0	0	0	--	--	--	0	0	0	0	1	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
Boulder Cr.	Mouth to waterfall	2.3	--	--	0	0	0	--	0	0	0	--	0	--	--	--	--	0	--	0
Trapper Cr.	Mouth upstream 0.8 km	5.0	--	--	--	4	4	2	5	3	8	2	0	1	0	0	0	0	--	0
Caribou Cr.	Mouth to old road crossing	2.6	--	--	--	1	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
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

[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 11. The status of bull trout populations during 2007 in each of the cores areas that occur in the Idaho Panhandle Region.

Core Area	2006 adult bull trout population estimate	Recovery goal	No. of local populations that have more than 100 adults	Recovery goal	Is this population stable or increasing?	Have 10 or more years of data been collected?	Are there streams that have known man-made barriers that block bull trout migrations?
Priest Lake	22	1000	0	5	no	yes	yes - Gold Creek
Kootenai River	454	1000	2	5	no	yes	None in Idaho
Pend Oreille Lake	2,118	2500	7	6	yes	yes	yes - Clark Fork and Pend Oreille rivers
Coeur d'Alene Lake	301	1100	2	NA	yes	yes	Yes - Red Ives, Entente, Cascade and Bluebell
N.F. Clearwater River	1,120	5000	21[a]	11[a]	yes	no	None in L.N.F. Clearwater

[a] A total of 100 adults or more are not required.

Table 12. Statistics for the linear regression of bull trout redds counted in different watershed in bull trout recovery core areas included in the Idaho Panhandle Region during 2007.

Streams/Core Area	Years evaluated	No. of observations	R value	R square	P value	Slope (Redd Coefficient)	Redd Standard Error
Upper Priest - 1985 sites	1985-2007	15	-0.820	0.672	0.000	-2.519	0.488
Upper Priest - all streams	1996-2007	12	-0.548	0.300	0.065	-2.000	0.966
Kootenai River - Idaho streams	2002-2007	6	-0.441	0.194	0.382	-3.000	3.057
Kootenai River - three MT streams	1990-2007	18	0.445	0.198	0.064	3.425	1.724
Kootenai River - all MT streams	1996-2007	12	-0.142	0.020	0.661	-1.720	3.805
Pend Oreille - index streams	1983-2007	23	0.203	0.041	0.353	2.837	2.988
Pend Oreille - index streams	1992-2007	15	0.488	0.238	0.065	11.908	5.910
Pend Oreille - all streams	1983-2007	19	0.230	0.053	0.343	5.574	5.710
Pend Oreille - all streams	1992-2007	15	0.704	0.496	0.003	28.366	7.938
Lightning Creek - all tribs	1992-2007	15	0.551	0.304	0.033	4.575	1.920
St Joe River - index streams	1992-2007	16	0.717	0.514	0.002	3.634	0.944
St Joe River - all streams	1992-2007	16	0.522	0.272	0.038	2.509	1.096
LNF Clearwater - four streams	1996-2007	13	0.841	0.707	0.000	6.633	1.286
LNF Clearwater - all streams	2001-2007	7	0.917	0.841	0.004	17.036	3.312
NF Clearwater - all streams	2001-2007	7	0.460	0.211	0.299	4.107	3.549
NF and LNF Clearwater	2001-2007	7	0.887	0.787	0.008	21.143	4.926

Table 13. Number of bull trout redds counted per stream in the Pend Oreille Lake, Idaho, Core Area, from 1983 to 2007.

Stream	1983[a]	1984	1985	1986[b]	1987[c]	1988	1989	1990	1991[d]	1992	1993	1994	1995[e]	1996	1997	1998	1999	2000[f]	2001[f,g]	2002[g]	2003[h]	2004	2005	2006[i]	2007[j]
CLARK FORK R.	--	--	--	--	--	--	--	--	--	2	8	17	18	3	7	8	5	5	6	7	8	1	--	3	2
Lightning Cr.	28	9	46	14	4	--	--	--	--	11	2	5	0	6	0	3	16	4	7	8	8	9	22	9	3
East Fork	110	24	132	8	59	79	100	29	--	32	27	28	3	49	22	64	44	54	36	58	38	77	50	51	34
Savage Cr.	36	12	29	--	0	--	--	--	--	1	6	6	0	0	0	0	4	2	4	15	7	15	7	25	0
Char Cr.	18	9	11	0	2	--	--	--	--	9	37	13	2	14	1	16	17	11	2	8	7	14	15	20	1
Porcupine Cr.	37	52	32	1	9	--	--	--	--	4	6	1	2	0	0	0	4	4	0	0	5	10	14	8	8
Wellington Cr.	21	18	15	7	2	--	--	--	--	9	4	9	1	5	2	1	22	8	7	7	8	7	6	29	9
Rattle Cr.	51	32	21	10	35	--	--	--	--	10	8	0	1	10	2	15	13	12	67	33	37	34	34	21	2
Johnson Cr.	13	33	23	36	10	4	17	33	25	16	23	3	4	5	27	17	31	4	34	31	0	32	45	28	32
Twin Cr.	7	25	5	28	0	--	--	--	--	3	4	0	5	16	6	10	19	10	1	8	3	6	7	11	0
Morris Cr.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1	0	7	1	1	3	16	0
Strong Creek	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	0	--	0	--	--	--
NORTH SHORE																									
Trestle Cr.	298	272	298	147	230	236	217	274	220	134	304	276	140	243	221	330	253	301	335	333	361	102	174	395	145
Pack River	34	37	49	25	14	--	--	--	--	65	21	22	0	6	4	17	0	8	28	22	24	31	53	44	16
Grouse Cr.	2	108	55	13	56	24	50	48	33	17	23	18	0	50	8	44	50	77	18	42	45	28	77	55	38
EAST SHORE																									
Granite Cr.	3	81	37	37	30	--	--	--	--	0	7	11	9	47	90	49	41	25	7	57	101	149	132	166	104
Sullivan Springs	9	8	14	--	6	--	--	--	--	0	24	31	9	15	42	10	22	19	8	15	12	14	15	28	17
North Gold Cr.	16	37	52	8	36	24	37	35	41	41	32	27	31	39	19	22	16	19	16	24	21	56	34	30	28
Gold Cr.	131	124	111	78	62	111	122	84	104	93	120	164	95	100	76	120	147	168	127	203	126	167	200	235	179
West Gold Cr.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	0
PRIEST RIVER																									
M.F. East River	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	8	21	20	48	71	34
Uleda Creek	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	4	3	7	4	7	2
N.F. East River	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	0	--
Total 6 index streams[k]	570	598	671	290	453	478	543	503	423	333	529	516	273	486	373	597	541	623	566	691	591	462	580	794	456
Total of all streams	814	881	930	412	555	478	543	503	423	447	656	631	320	610	527	726	705	732	710	890	836	781	940	1256	654
Lightning Cr.-Total	301	156	286	40	111	79	100	29	0	76	90	62	9	84	27	99	120	95	123	129	110	166	148	163	57

[a] Incomplete surveys occurred on Porcupine and Grouse creeks.
[b] Incomplete surveys occurred on Grouse, Rattle, and East Fork Lightning creeks.
[c] Incomplete surveys occurred on Granite Creek.
[d] Early snow fall prevented counts in many streams (East Fork of Lightning Creek was not included in index counts).
[e] Observations were impaired by high runoff in all streams except Sullivan Spings, N. Gold and S. Gold creeks, and the Clark Fork River.
[f] A headcut barrier prevented access to most spawning areas on Johnson creek in 2000, and also potentially on Granite Creek in 2001.
[g] Incomplete surveys occurred on M.F. East River.
[h] Observation were impaired by high runoff in Trestle Creek.
[i] Large early spawning kokanee made it difficult to distinguish bull trout redds from kokanee redds in Sullivan Springs.
[j] Observation impaired by high water in Uleda and Savage creeks.
[k] Index streams include Trestle, East Fork Lightning, Gold, North Gold, Johnson, and Grouse creeks.

Table 14. Estimated number of adult bull trout associated with each tributary where redds were counted in the Pend Oreille Lake Core Area from 1983 to 2007.

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
CLARK FORK R.																									
Lightening Cr	90	29	147	45	13					6	26	54	58	10	22	26	16	16	19	22	26	3		10	6
East Fork	352	77	422	26	189	253	320	93		35	6	16	0	19	0	10	51	13	22	26	26	29	70	29	10
Savage Cr.	115	38	93		0					102	86	90	10	157	70	205	141	173	115	186	122	246	160	163	109
Char Cr.	58	29	35	0	6					3	19	19	0	0	0	0	13	6	13	48	22	48	22	80	0
Porcupine Cr.	118	166	102	3	29					29	118	42	6	45	3	51	54	35	6	26	22	45	48	64	3
Wellington Cr.	67	58	48	22	6					13	19	3	6	0	0	0	13	13	0	0	16	32	45	26	26
Rattle Cr.	163	102	67	32	112					29	13	29	3	16	6	3	70	26	22	22	26	22	19	93	29
Johnsons Cr.	42	106	74	115	32	13	54	106	80	32	26	0	3	32	6	48	42	38	214	106	118	109	109	67	6
Twin Cr.	22	80	16	90	0					51	74	10	13	16	86	54	99	13	109	99	0	102	144	90	102
Morris Cr.										10	13	0	16	51	19	32	61	32	3	26	10	19	22	35	0
Strong Cr																	3	3	0	22	3	3	10	51	0
NORTH SHORE														6						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
Pack River	109	118	157	80	45					208	67	70	0	19	13	54	0	26	90	70	77	99	170	141	51
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
EAST SHORE																									
Granite Cr.	10	259	118	118	96					0	22	35	29	150	288	157	131	80	22	182	323	477	422	531	333
Sullivan Springs	26	23	41		19					0	77	99	29	48	134	32	70	61	26	48	38	45	48	90	54
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
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
West Gold Cr.																									
PRIEST RIVER																									
M.F. East River																									
Uleda Creek																			13	26	67	64	154	227	109
N.F. East River																			10	13	10	22	13	22	6
Trap and Transport																						3	0	0	
																			35	35	35	40		29	19
Total 6 index str.	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
Total all streams	2602	2817	2972	1318	1776	1530	1738	1610	1354	1430	2099	2019	1024	1951	1686	2323	2256	2342	2307	2883	2710	2539	3037	4038	2118
Lightning Cr. - Total	873	452	829	116	322	229	290	84	0	220	261	180	26	244	78	287	348	276	357	374	319	481	429	522	182

Table 15. The number of bull trout redds counted per stream in the Idaho and Montana sections of the Kootenai River Core Area from 1990 to 2007.

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

[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 16. The number of bull trout redds counted by stream in the St. Joe River basin, Idaho, from 1992 to 2007. 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
Aspen Cr.	--	--	--	--	--	--	--	--	--	--	0	--	--	--	--	--
Bacon Cr.	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bad Bear Cr.	--	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--
Bean Cr.	14	--	--	0	--	--	--	--	--	--	--	0	--	--	--	--
Beaver Cr.	2	2	0	0	0	0	1	0	--	0	0	0	0	0	0	0
Bluff Cr.- East Fork	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
California Cr.	2	4	0	2	3	0	--	--	0	0	0	0	0	0	0	0
Copper Cr.	--	--	0	--	0	--	--	--	--	--	0	0	0	--	--	0
Entente Cr.	--	--	--	--	--	--	--	0	--	--	1	0	--	--	--	--
Fly Cr.	1	--	--	0	0	0	2	0	--	--	1	0	0	0	--	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
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
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
Ruby Cr.	0	1	--	8	--	--	--	--	--	--	--	--	--	--	--	--
Sherlock Cr.	0	3	0	2	1	1	0	1	0	--	--	0	0	0	0	0
Simmons Cr. - Lower	--	0	0	0	--	--	--	--	--	0	--	--	--	--	--	--
Simmons Cr. - NF to Three Lakes	--	5	0	--	--	--	--	--	--	--	--	--	--	--	--	--
Simmons Cr. - Three Lakes to Rd 1278	--	3	5	5	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	--	--	--	--	--	--	--	--	--	--
Simmons Cr. - East Fork	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--
St. Joe River - below Tento Creek	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--
St. Joe River - Spruce Tree CG to St. J. Lodge	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--
St. Joe River - St. Joe Lodge to Broken Leg	--	--	--	4	--	--	--	--	--	--	--	--	--	--	--	--
St. Joe River - Broken Leg Cr upstream	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--
St. Joe River - Bean to Heller Cr.	0	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
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[a]	0	4	11	3	13	9	9	11	19	12	32
Yankee Bar	1	0	--	--	--	0	--	--	1	0	0	0	0	0	3	0
Total - Index Streams[c]	22	48	55	42	38	19	15	69	48	40	54	46	72	91	83	93
Total - All Streams	42	71	62	64	48	23	21	70	49	41	56	46	79	93	91	94
Number of streams counted	16	23	19	21	16	17	12	13	8	9	14	14	13	11	11	11

[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 17. Number of bull trout redds counted per stream in the Little North Fork Clearwater River basin, Idaho, from 1994 to 2007. Numbers in parentheses are redds smaller than 300 mm in diameter.

Stream	Length (km)	1994[a]	1996	1997	1998	1999	2000	2001	2001[b]	2002	2003	2004	2005	2006	2007
Buck Creek	4.8	--	--	--	--	--	--	--	--	--	5	--	--	--	--
Canyon Creek	5.5	--	--	--	--	--	--	--	--	--	0	--	--	--	--
Butte Creek	1.2	--	--	--	--	--	--	--	5	0	--	--	--	--	--
Rutledge Creek	2.9	--	--	--	--	--	--	--	--	--	1	1	6	0	--
Rocky Run Creek	4.7	--	--	--	--	--	--	--	--	5	1	3	21	13	6 (2)
Lund Creek	3.9	0	7	2	2	1	1	13	5	7	7 (1)	5	19	7	30
Little Lost Lake Creek	3.9	0	1	1	1	7	3	1	--	2 (4)	4 (3)	15 (1)	1	34 (4)	31 (5)
Lost Lake Creek	3.0	0	0	0	0	--	1	--	--	0	--	1	--	10	13
Little North Fork Clearwater River															
1268 Bridge to Lund Cr.	7.0	--	--	--	--	--	--	--	17	6	13	8	16	18	20
Lund Cr. to Lost Lake Cr.	3.8	--	--	3	1	9	8	3	12	5 (2)	7	5	8	16	21
Lost Lake Cr. to headwaters	5.4	0	2	0	0	--	5	1	--	5	5 (1)	5	11	13	8
Total for all streams	41.9	0	10	6	4	17	18	18	39	30 (6)	43 (5)	43 (1)	82	111 (4)	129 (7)

[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 18. Number of bull trout redds counted per stream in the North Fork Clearwater River and Breakfast Creek basins, Idaho, from 1994 to 2007. These streams all occur in the IDFG Clearwater Region and were counted by personnel from the Clearwater Region or U.S. Forest Service.

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

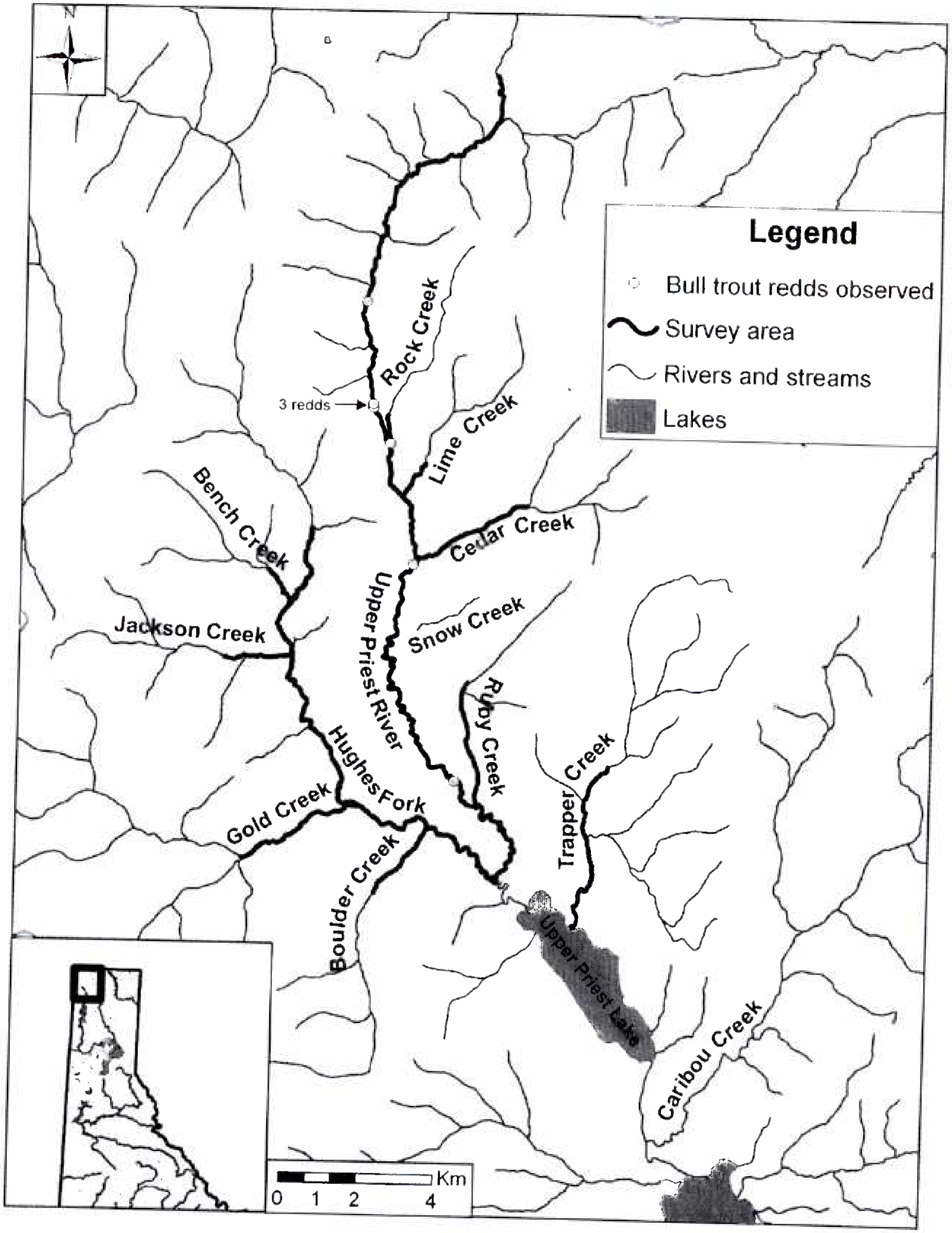


Figure 41. Stream reaches surveyed for bull trout redds in the Upper Priest Lake basin, Idaho, during October 3, 2007 and the locations of where redds were observed.

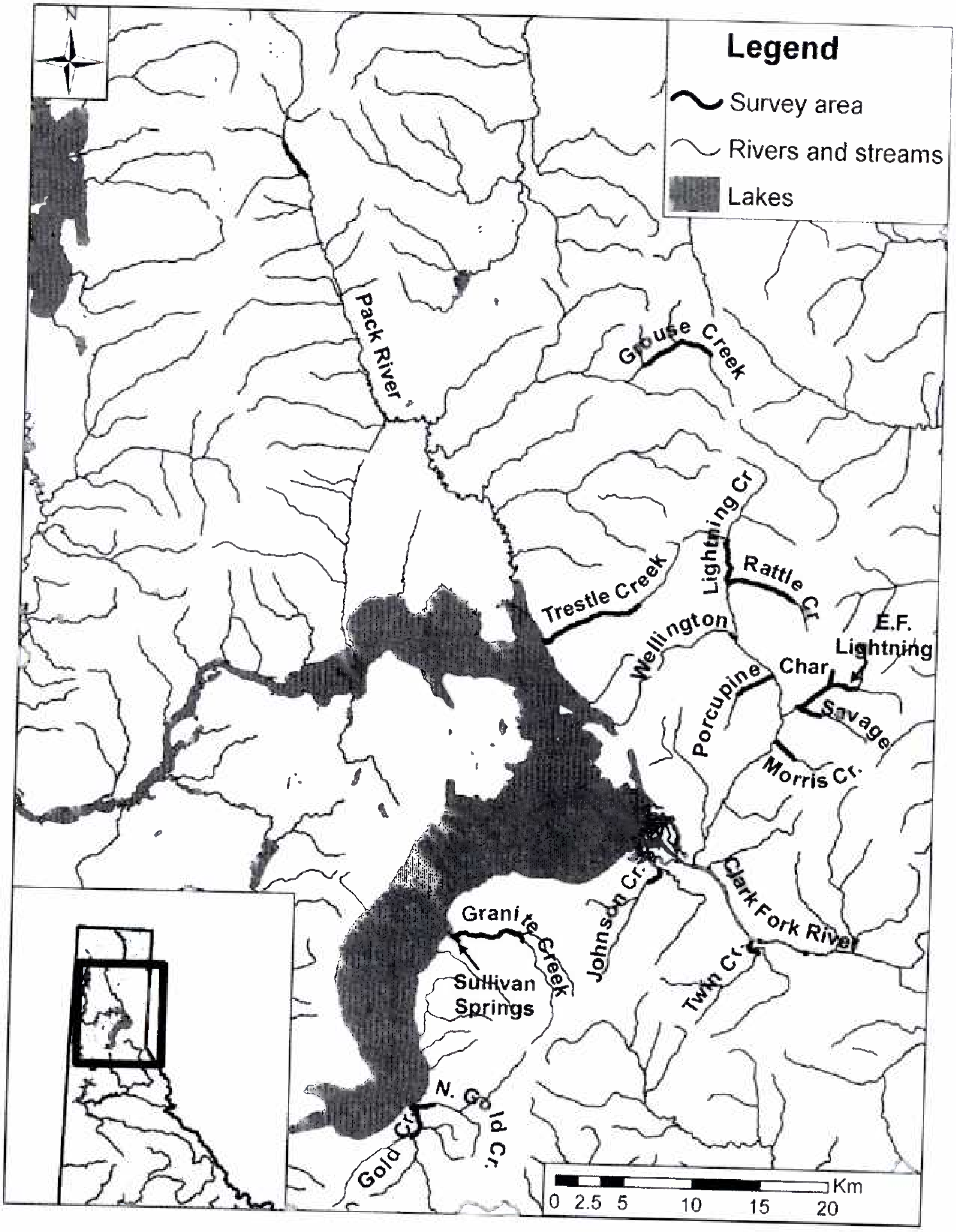


Figure 42. Stream reaches surveyed for bull trout redds in the Pend Oreille Lake basin, Idaho, on October 9-15, 2007.

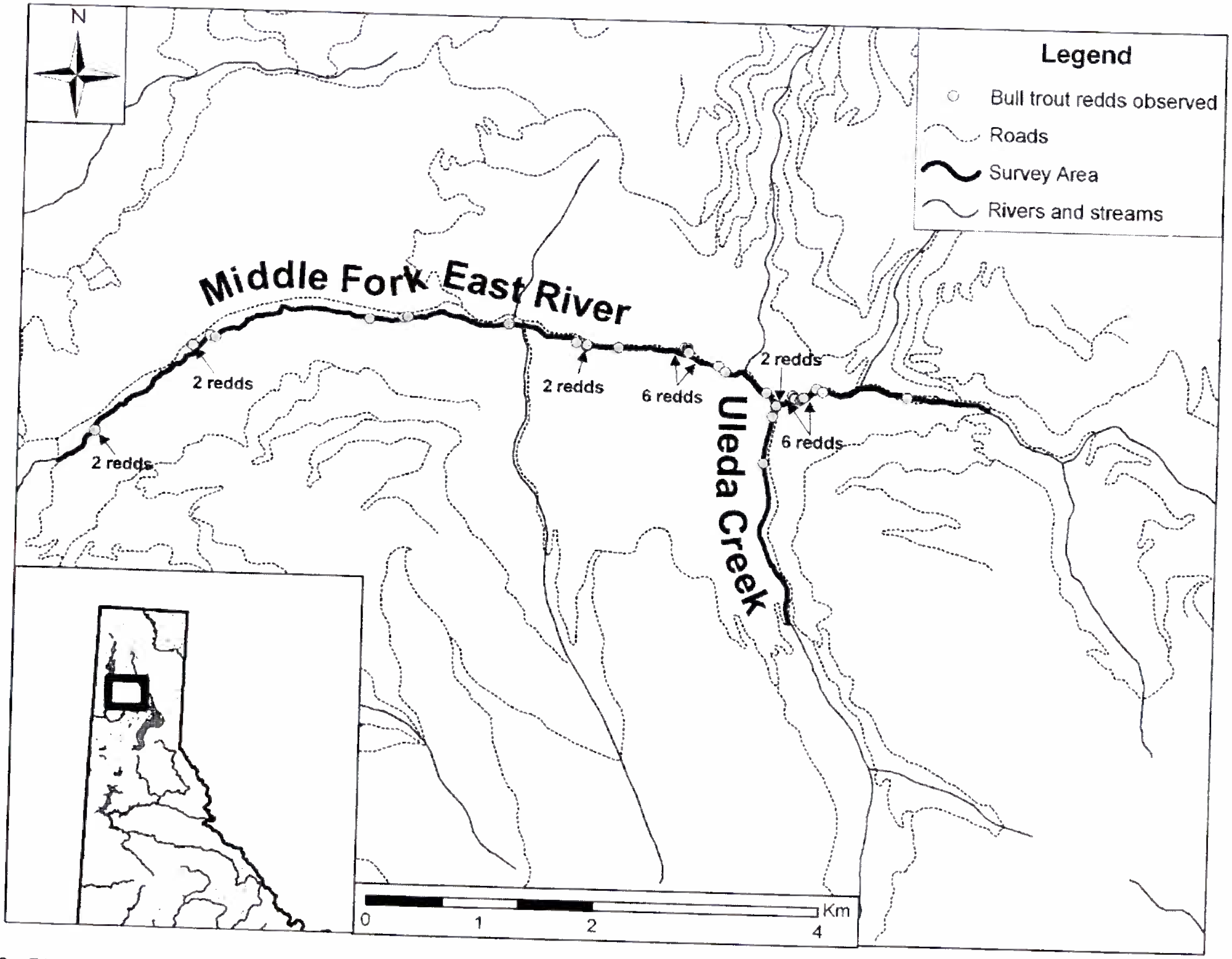


Figure 43. Stream reaches surveyed for bull trout redds in the Middle Fork East River basin, Idaho, on October 2, 2007 and the locations of where redds were observed.

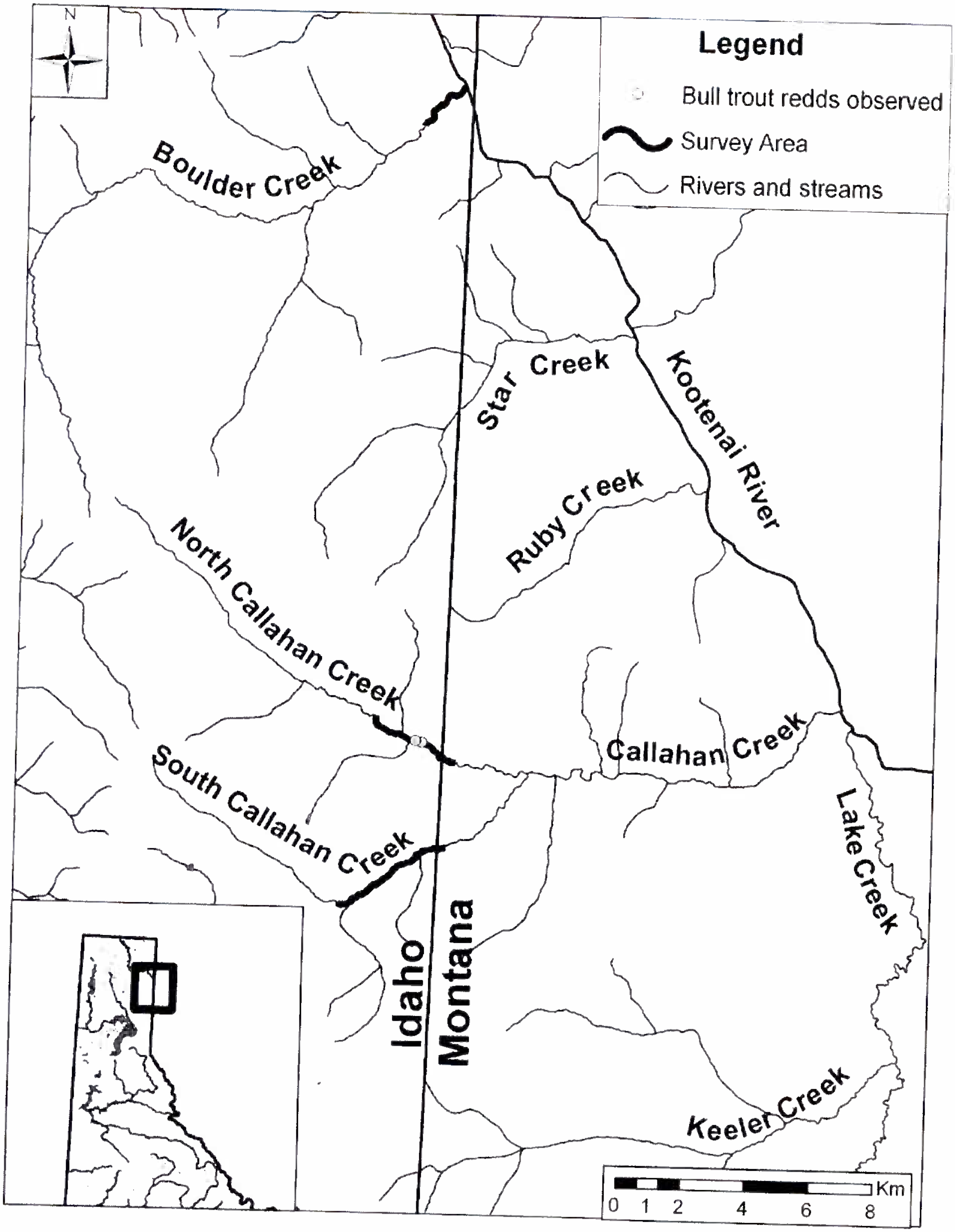


Figure 44. Stream reaches surveyed for bull trout redds in the Kootenai River watershed, Idaho, on October 9, 2007 and the locations of where redds were observed.

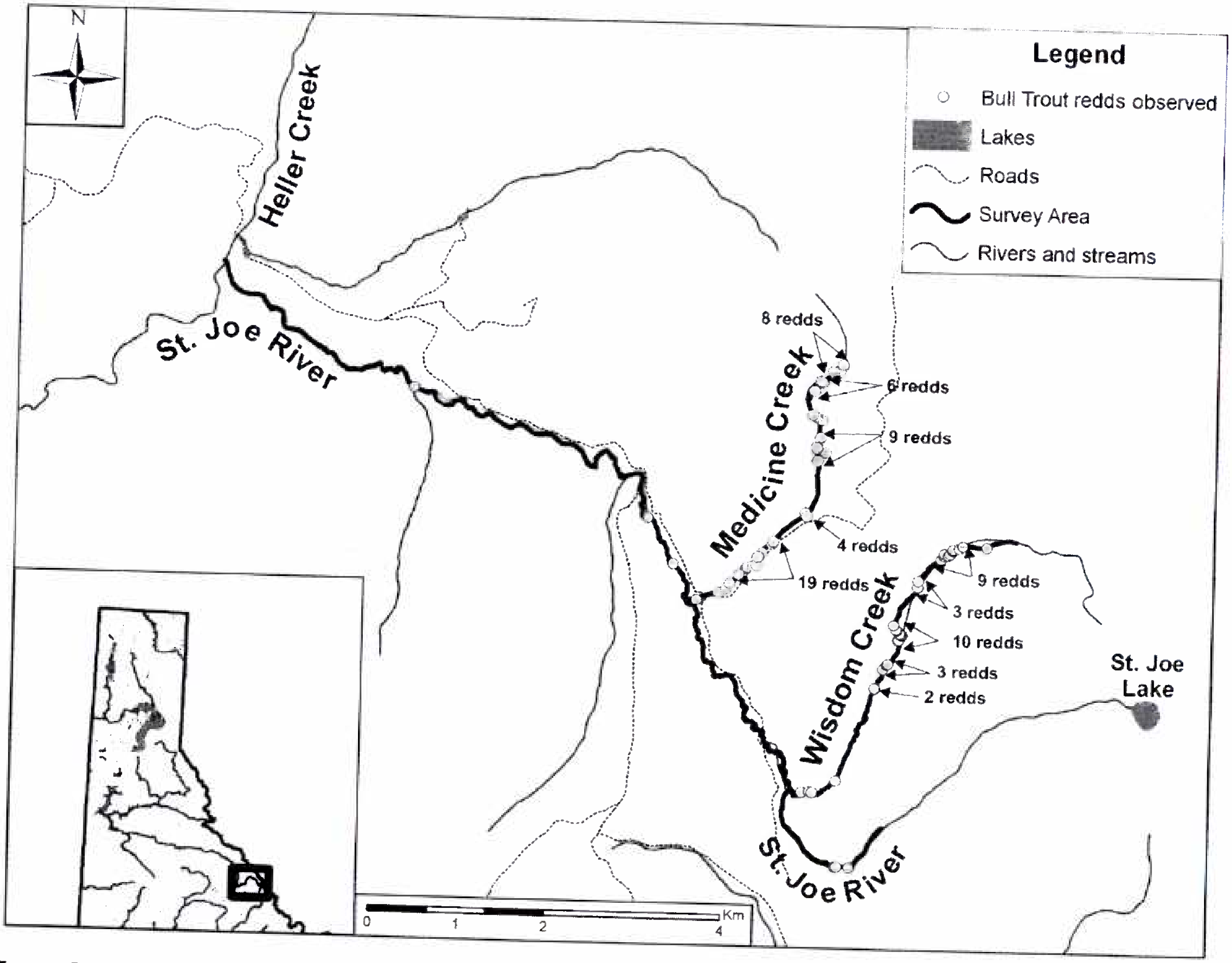


Figure 45. Stream reaches surveyed for bull trout redds in the St. Joe River basin, Idaho, on September 25, 2007 and the locations where redds were observed.

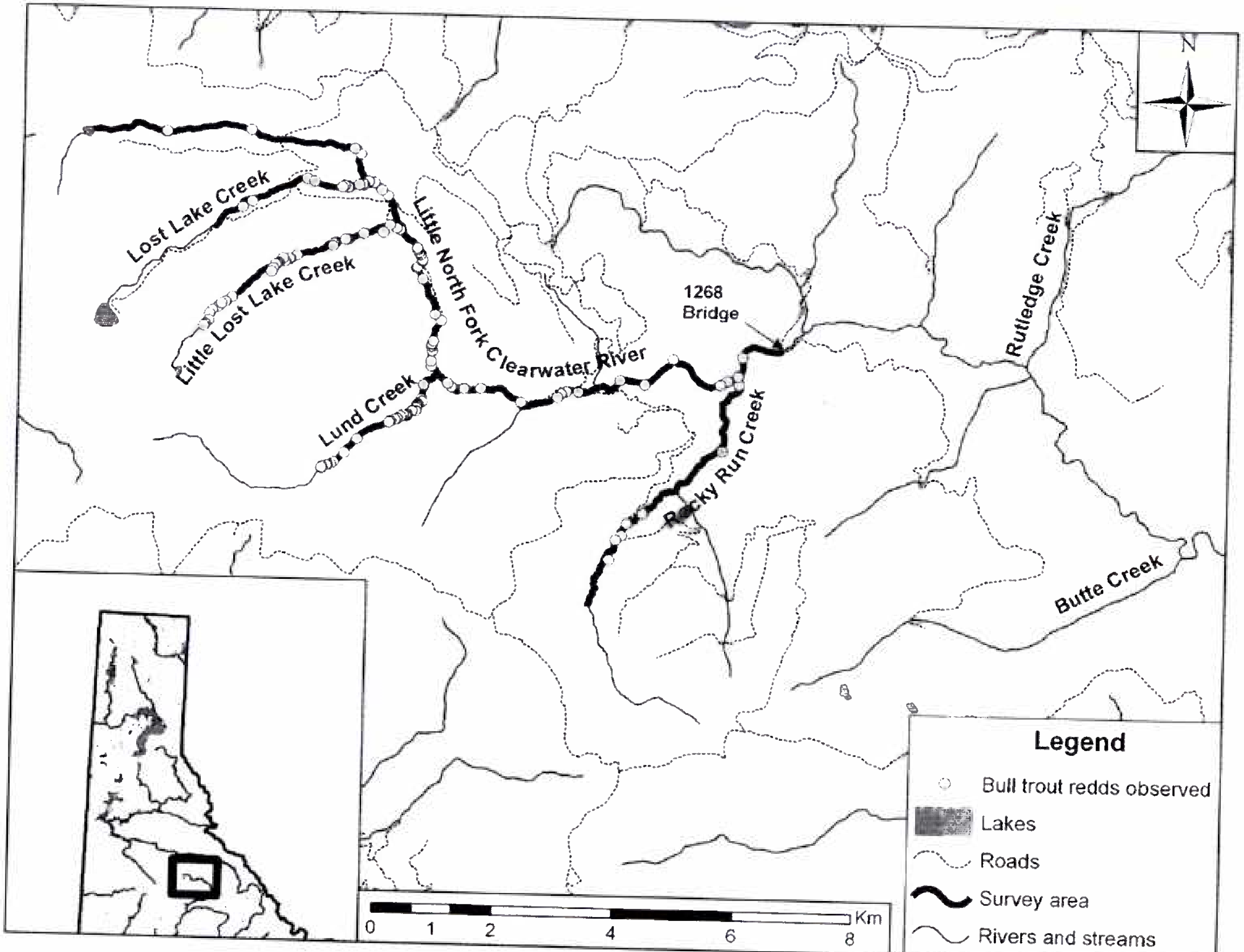


Figure 46. Stream reaches surveyed for bull trout redds in the Little North Fork Clearwater River basin, Idaho, on September 26, 2007 and the locations where redds were observed.

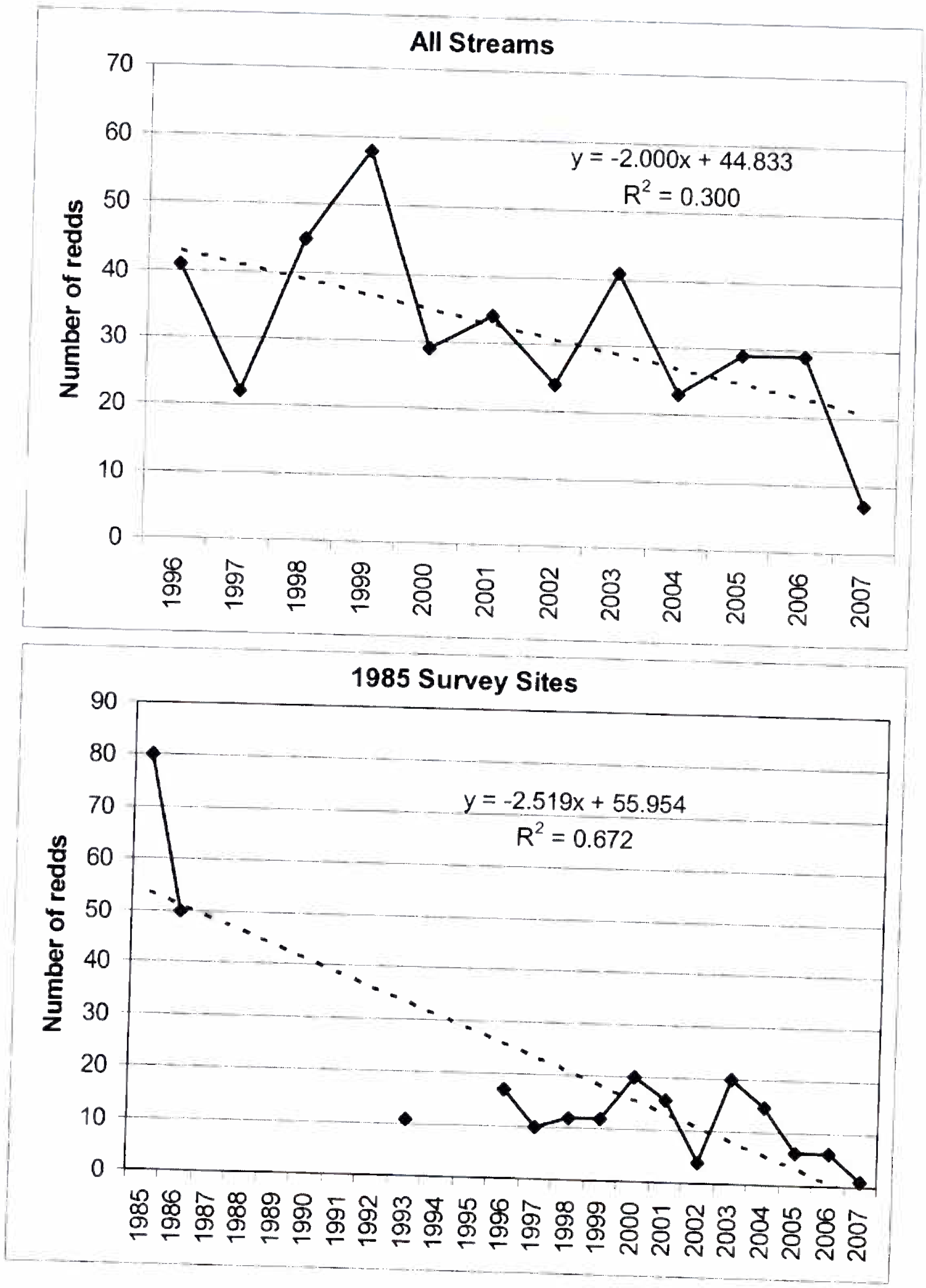


Figure 47. Linear regressions depicting trends in bull trout redd counts (all streams combined and only those sites surveyed during 1985) over time in the Priest Lake Core Area (Upper Priest Lake basin only), Idaho.

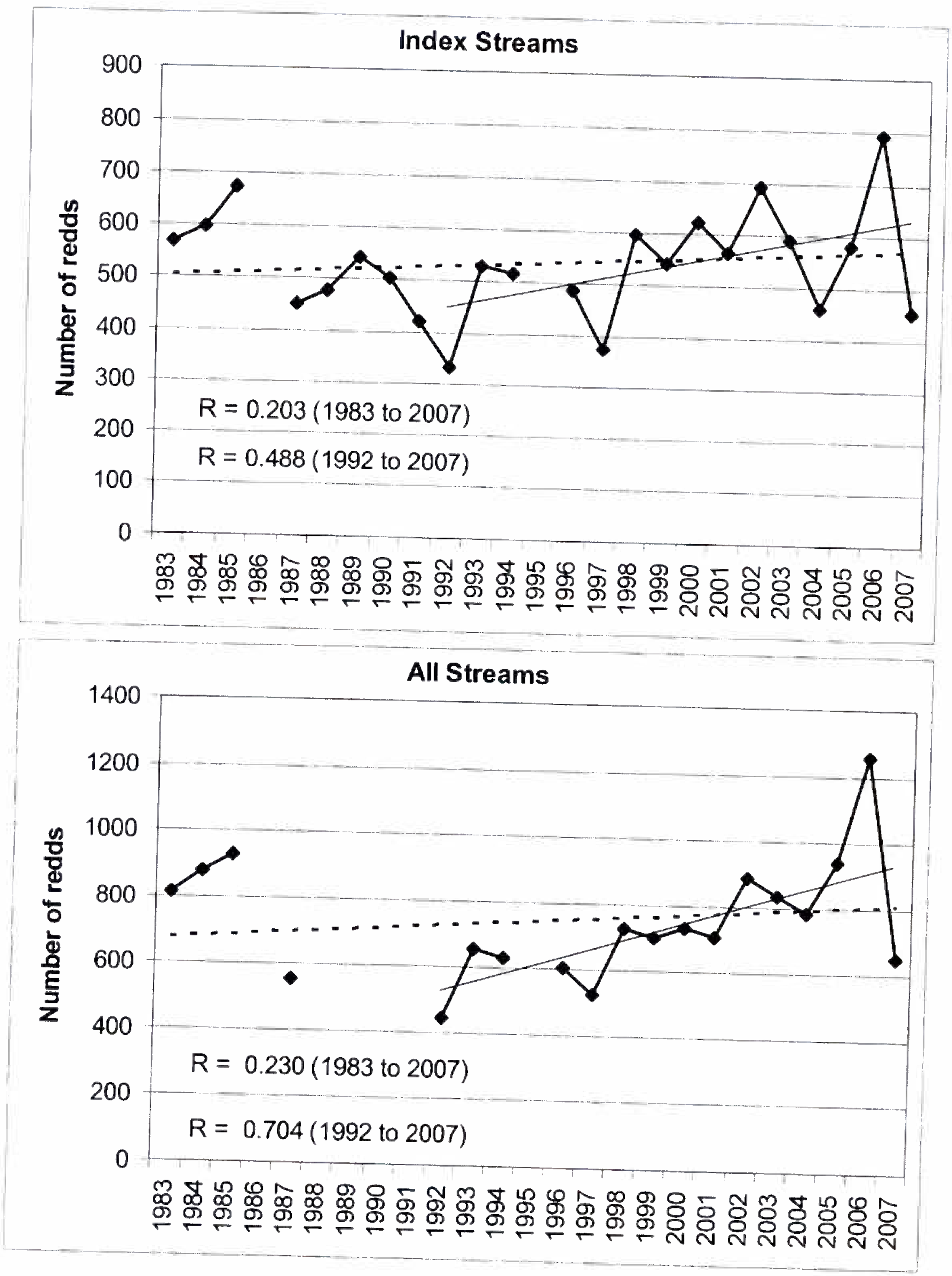


Figure 48. Linear regressions depicting trends in bull trout redd counts (six index streams and all streams combined) over time in the Pend Oreille Lake Core Area, Idaho. Dashed trend lines are for redd counts between 1983 and 2007, whereas solid trend lines are for redd counts between 1992 and 2007.

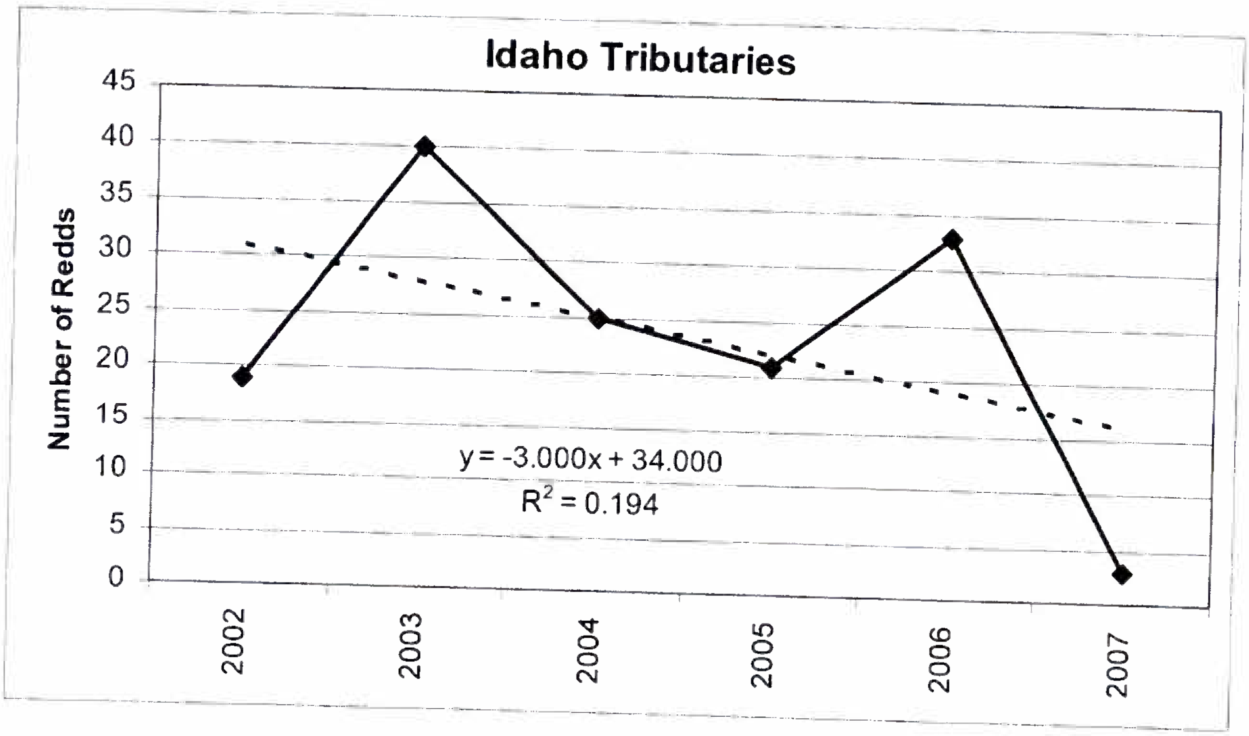


Figure 49. Linear regressions depicting trends in bull trout redd counts in tributaries in the Idaho section of the Kootenai River Core Area from 2002 to 2007.

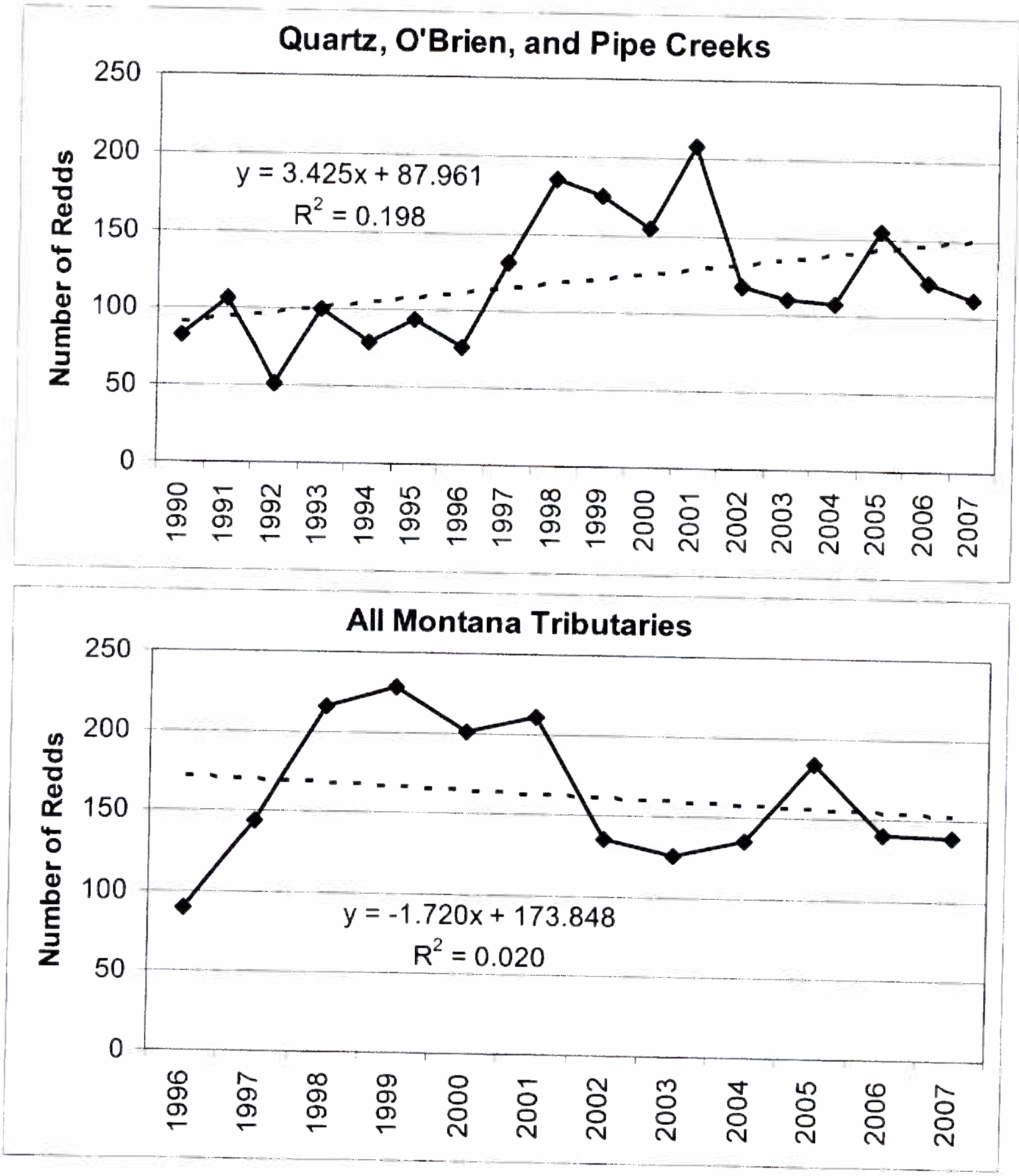
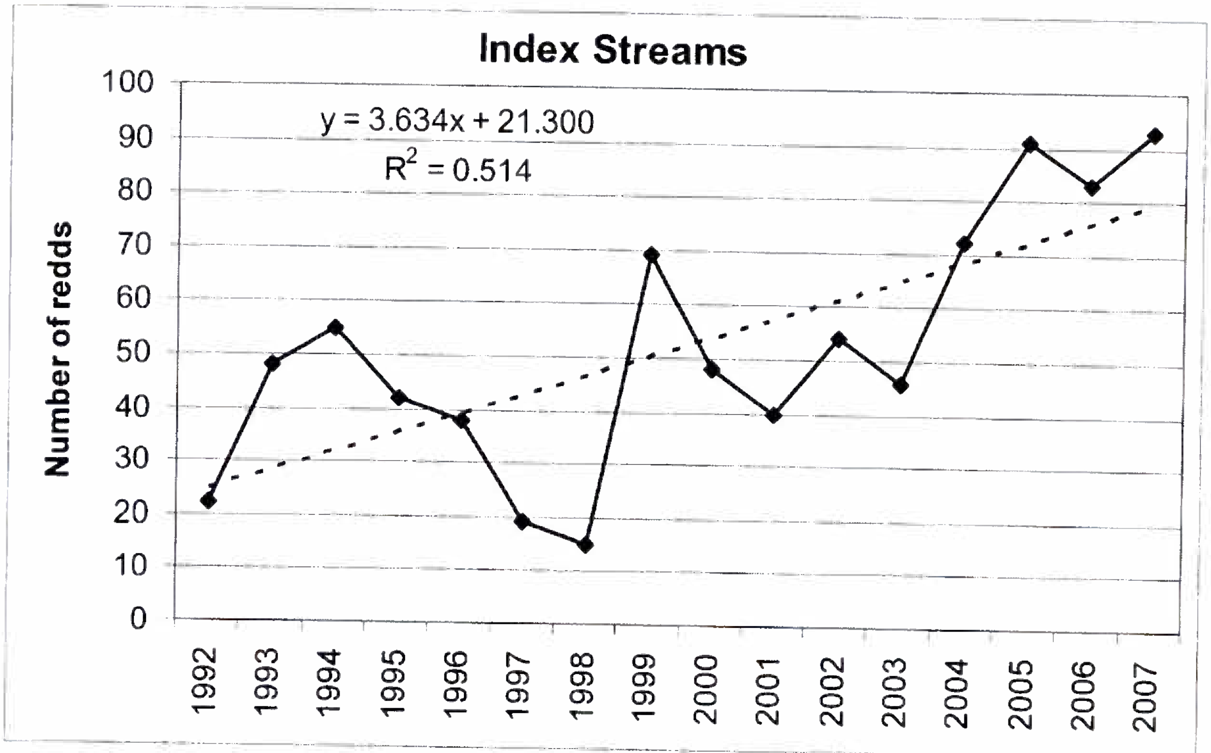


Figure 50. Linear regressions depicting trends in bull trout redd counts in select tributaries (Quartz, O'Brien, and Pipe Creeks) and all tributaries in the Montana section of the Kootenai River Core Area.



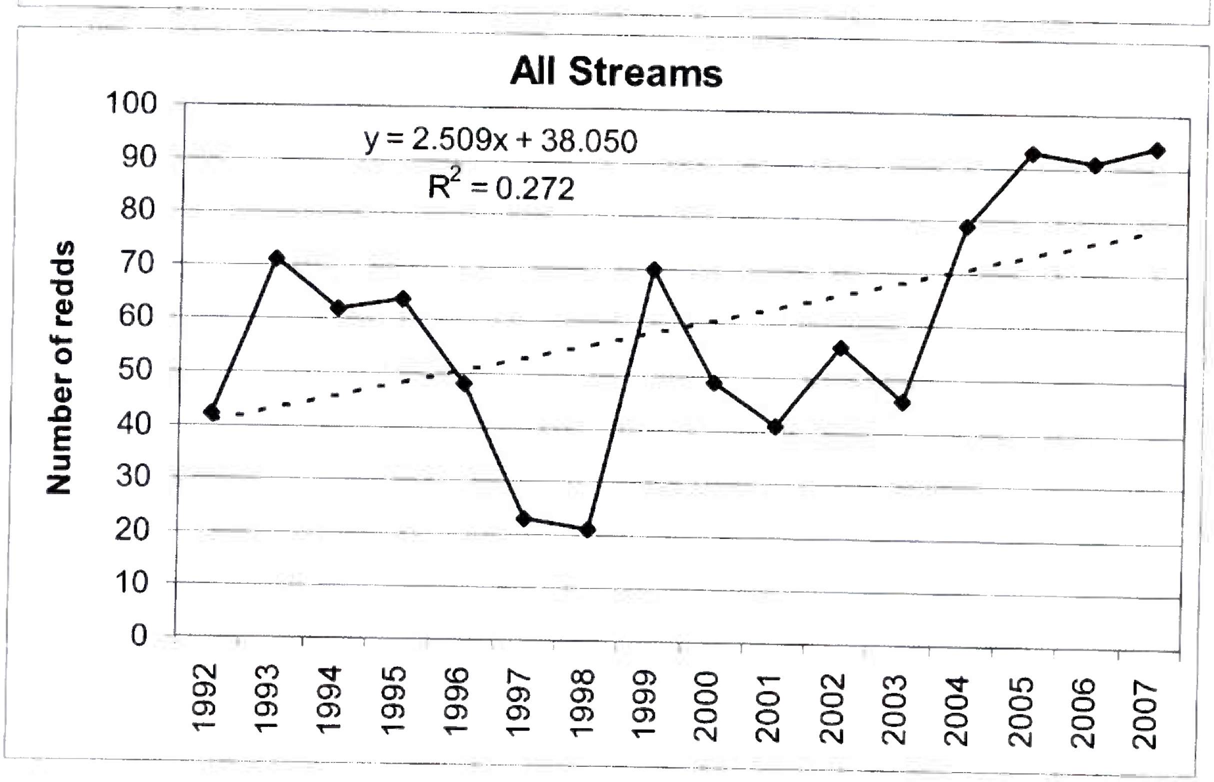


Figure 51. Linear regressions depicting trends in bull trout redd counts (three index streams and all streams combined) in the St. Joe River section of the Coeur d'Alene Lake Core Area, Idaho, from 1992 to 2007.

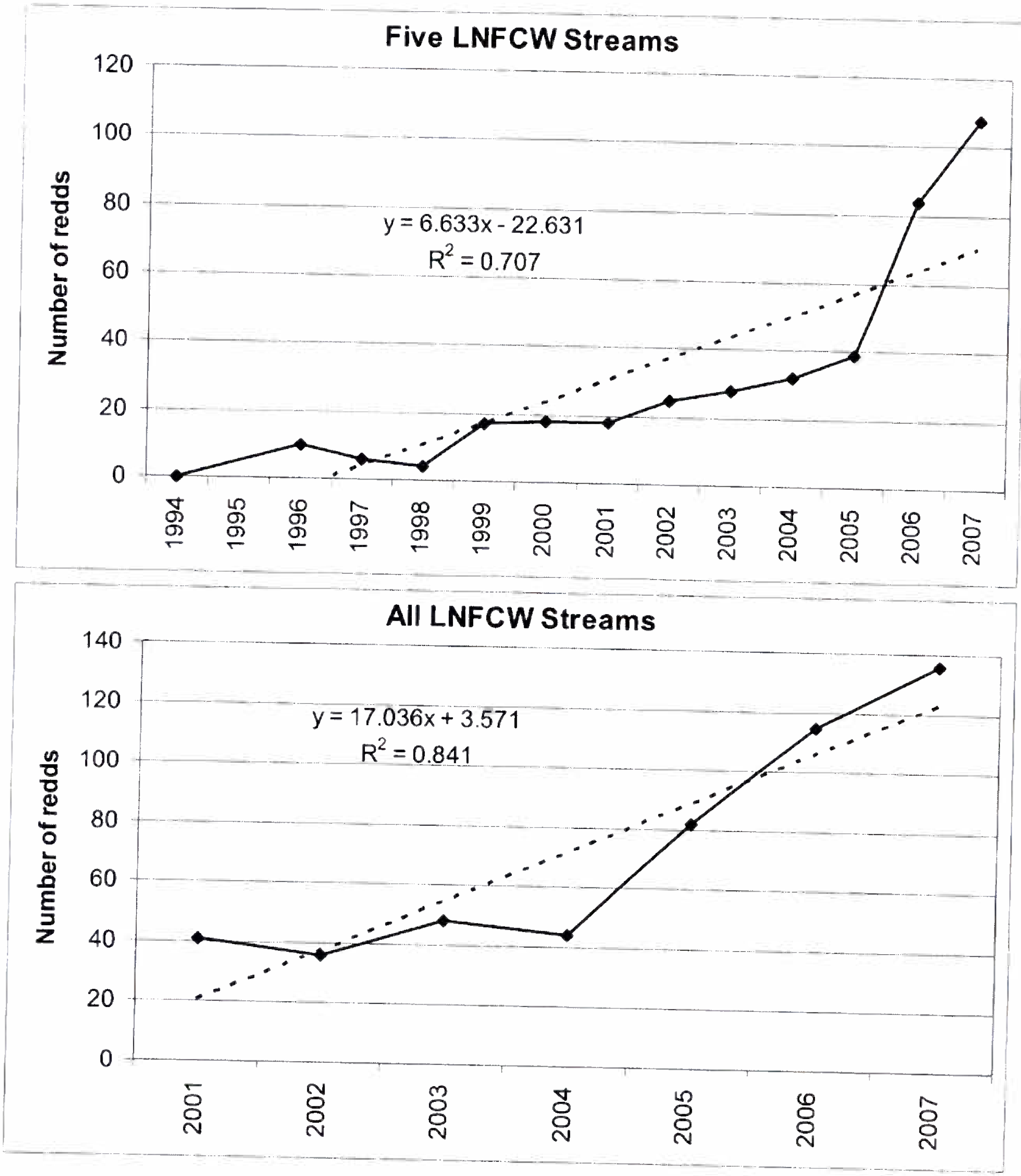
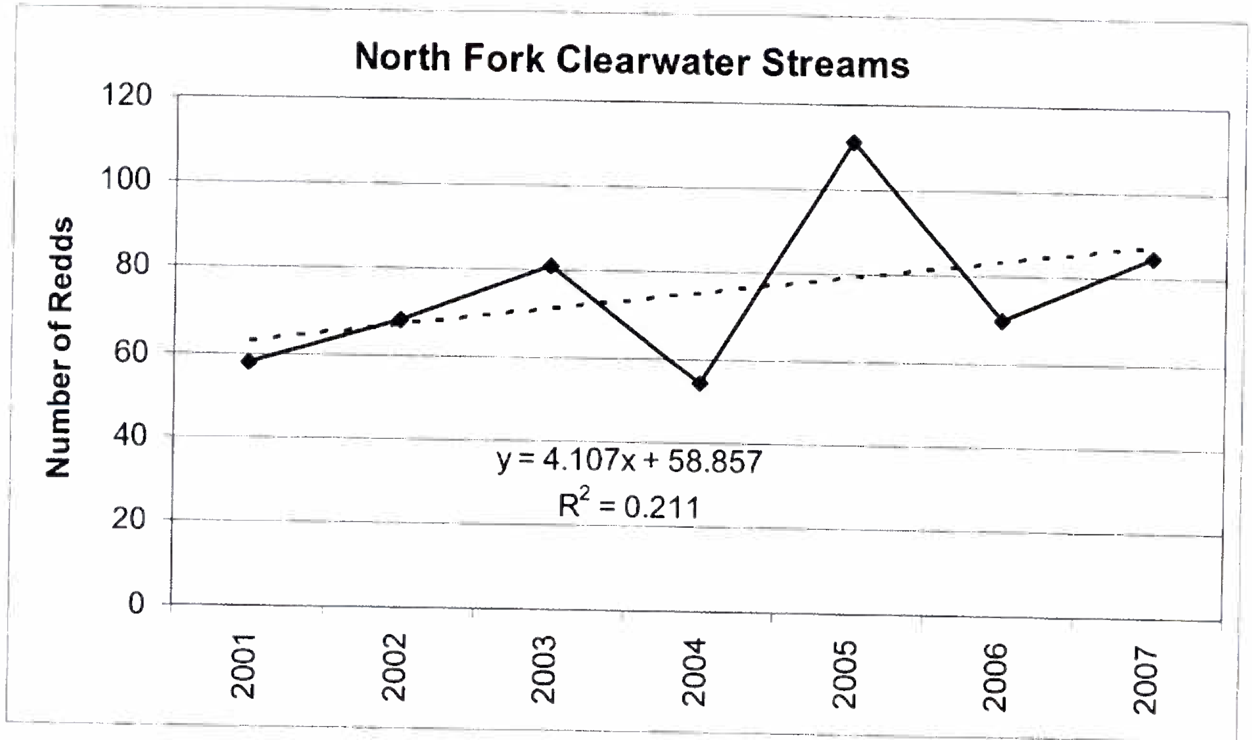


Figure 52. Linear regressions depicting trends in bull trout redd counts (five consistently counted streams and all streams combined) over time in the Little North Fork Clearwater River basin, Idaho.



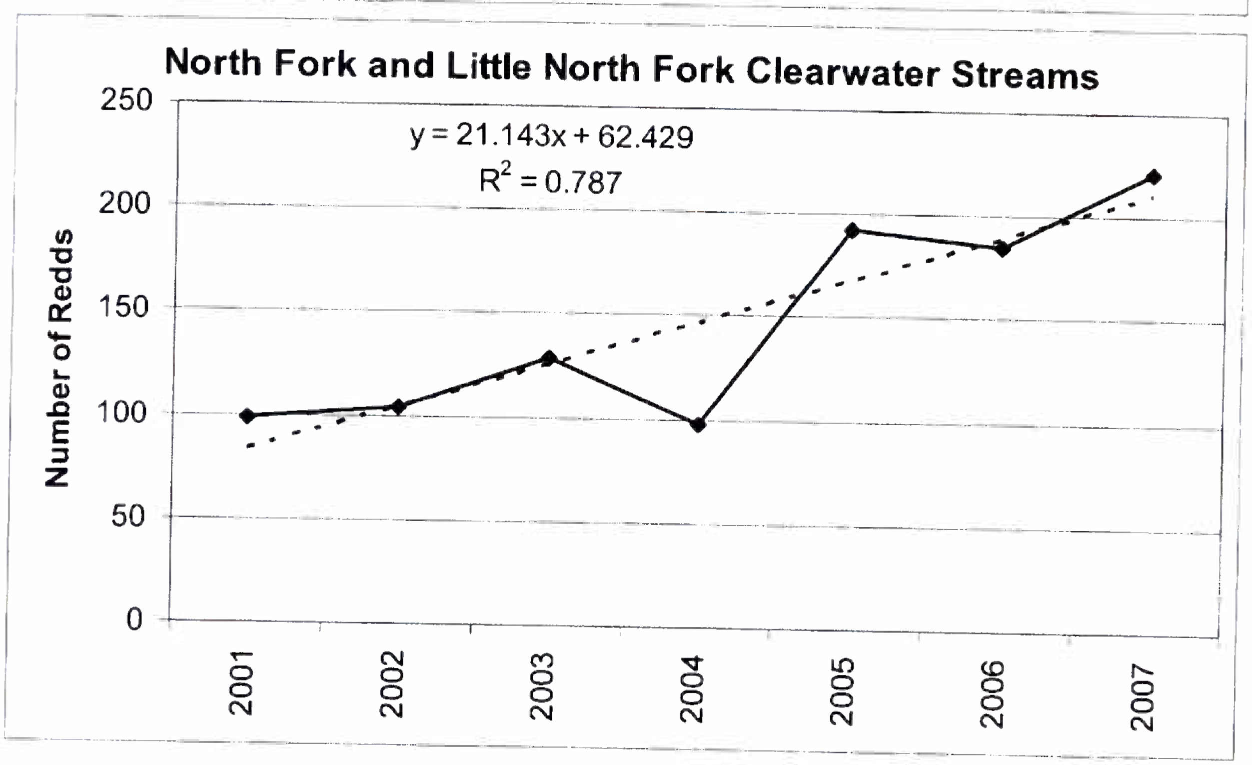


Figure 53. Linear regressions depicting trends in bull trout redd counts from 2001 to 2007 in the North Fork Clearwater River and the Little North Fork Clearwater River, Idaho, combined.

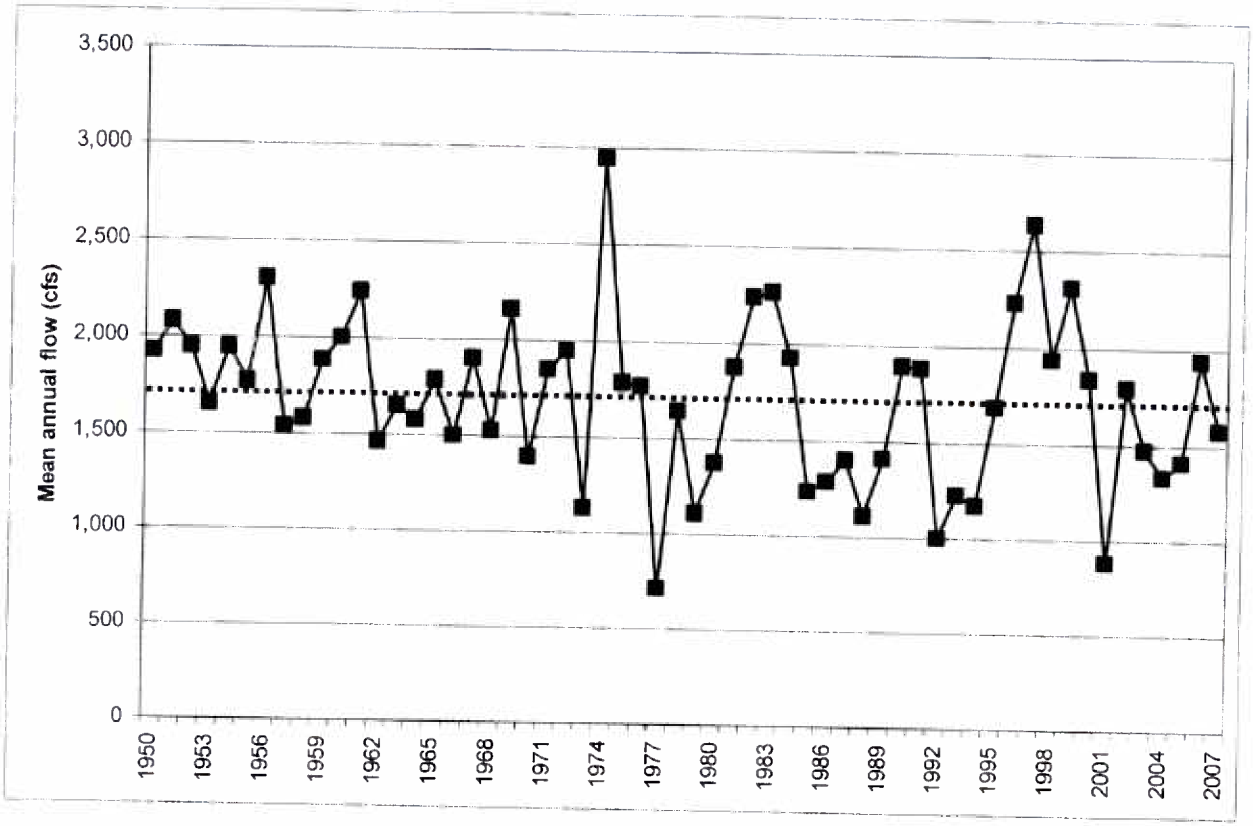


Figure 54. The mean annual flows that occurred in the Priest River, Idaho, near the town of Priest River. The dashed line indicates the average, mean annual flow from 1950 to 2007.

Rivers and Streams Investigations

ST. JOE RIVER AND NORTH FORK COEUR D'ALENE RIVER SNORKEL SURVEYS

ABSTRACT

In August 2007, a total of 35 transects in the St. Joe River and 43 transects in the North Fork Coeur d'Alene River (NFCDR) system were snorkeled to estimate trout and mountain whitefish *Prosopium williamsoni* abundance and their size distribution. Mean densities of age-1 and older cutthroat trout were 0.82 fish/100 m^2 in the St. Joe River and 1.04 fish/100 m^2 in the NFCDR system. Both rivers showed increasing trends in abundance of cutthroat trout following the declines observed after the 1996 and 1997 flood events and had reached or exceeded what was observed pre-flooding. Densities of cutthroat trout ≥ 300 mm in length were 0.32 fish/100 m^2 in the St. Joe River and 0.23 fish/100 m^2 in the NFCDR. Both rivers showed increasing trends in abundance of cutthroat trout ≥ 300 mm following the declines observed after the 1996 and 1997 flood events and were at or near record highs in 2007.

Densities of mountain whitefish were 1.59 fish/100 m^2 in the St. Joe River and 3.83 fish/100 m^2 in the NFCDR during 2007. Both rivers showed increasing trends in abundance of mountain whitefish following the declines observed after the 1996 and 1997 flood events and were at or near all-time highs.

Fourteen rainbow trout were observed in the St. Joe River whereas 304 (0.23 fish/100 m^2) were observed in the NFCDR during 2007. Rainbow trout were observed upstream of Prospector Creek in the St. Joe River for the second time since 1998 when they were stocked. In the NFCDR all the rainbow trout were observed in the downstream reaches where limited angler harvest is allowed. Rainbow trout were last stocked into rivers and streams in the Panhandle Region in 2002. All rainbow trout observed were offspring from natural reproduction.

No bull trout were observed in the St. Joe River in 2007. This does not coincide with the record high number of bull trout redds counted in the St. Joe watershed during 2007.

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INTRODUCTION

Westslope cutthroat trout are a highly sought after game fish native to northern Idaho attracting anglers from around the United States. In northern Idaho, the major cutthroat trout fisheries occur in many of the larger rivers and streams. During 1996, over 60,000 hours of fishing effort was estimated to have occurred on the St. Joe and Coeur d'Alene rivers, two of the more popular rivers for cutthroat trout fishing in the Panhandle Region (Fredericks et al. 1997). Evidence suggests fishing pressure for cutthroat trout has continued to increase in the Panhandle Region (Fredericks et al. 1997).

In the early 1900s, many considered the streams and rivers in northern Idaho to be some of the finest trout streams in America. The local newspaper of St. Maries, Idaho frequently reported catches of seven to nine-pound trout, and trips where anglers caught 50-100 cutthroat trout averaging three to five pounds in a few hours (Rankel 1971). By the 1960s, cutthroat trout abundance had declined in many rivers in the Panhandle and studies were initiated to determine why these declines had occurred and what could be done to restore the fishery (Mallet 1967; Dunn 1968; Rankel 1971; Bowler 1974; Lewynsky 1986). This research found that declines in the fishery were largely a response 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). As efforts were made to correct the decline in the fishery, it was necessary to monitor trends in fish numbers to evaluate recovery efforts. Sampling transects were set up in the St. Joe and Coeur d'Alene rivers that have been snorkeled on a regular basis (Rankel 1971; Bowler 1974). Fish counts in these trend transects were successful in documenting how changes in fishing regulations and/or habitat have influenced cutthroat trout densities.

Transects were established in the St. Joe River in 1969 and in the Coeur d'Alene River in 1973. The long term trend data sets collected from these snorkel transects are important in documenting how changes in fishing regulations, habitat and weather patterns influence trends in fish populations. To ensure this data is collected in a consistent manner and to increase the ease of locating the snorkel sites, this report details technique one should use to collect the data. The goal of this report is to evaluate the status of the fishery in the St. Joe River and NFCDR system and assess how changes in fishing regulations, habitat and weather patterns have influenced the fishery.

OBJECTIVES

1. Estimate salmonid density and trends in abundance in snorkeling transects in the St. Joe and NFCDR rivers and evaluate how changes in fishing regulations, habitat and weather patterns have influenced the fishery.

2. Describe the methods one should follow when conducting snorkel surveys at established trend sites.

3. Compile existing historic data from past snorkel surveys conducted on the St. Joe River and NFCDR system.

STUDY SITES

St. Joe River

Twenty-eight snorkel transect (SJ01-SJ28) were established in the St. Joe River during 1969 by selecting sites considered good cutthroat trout habitat (Rankel 1971). These transects spanned from Avery, Idaho upstream to Ruby Creek, a distance of about 76 river km. Due to channel shifting and changes in stream habitat, two of the original transects (SJ24 and SJ25) were moved about 50 - 100 m downstream to reaches that had similar characteristics to historical habitat conditions. Six additional transects (SJ29 - SJ35) were added between Avery and Calder, Idaho (39 km of river) during 1993 (Nelson et al. 1996). These transects were selected based on fish holding capabilities, access, and permanence for future study. All combined, a total of 35 snorkel transects occur in the St. Joe River spanning a total of 115 km of river (Figure 55). Coordinates for the location of each of these transects are displayed in Appendix A and photographs (taken in 2002 or 2003) of each of the samples locations are displayed and described in the 2003 annual report (DuPont et al., in press b). These photos not only show pictures of transects, but also depict where snorkeling should start and end and the approximate length of stream that should be snorkeled. Photos of the original transects taken in 1969 can be viewed in DuPont et al. (In Press a), and provide a good comparison over time. During 2007 we snorkeled all 35 transects.

North Fork Coeur d'Alene River

Thirty-eight snorkel transects in the NFCDR system were initially established in 1973 by selecting sites that were considered good cutthroat trout habitat (Bowler 1974). Twenty-three of these transects were in the NFCDR (85 river km), 10 were in the Little North Fork Coeur d'Alene River (LNFCDR) (36 river km) and five were 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. Modified transect boundaries were selected based on closeness and similarity to original site, access, and permanence for future study. Transects where locations have been altered from their original location in the NFCDR system include TP01, NF17, NF20 and NF23, LNF02, LNF04. During 2002, three additional transects (LNF10, LNF12 and LNF 13) were added into the LNFCDR in the catch-and-release area bringing the number of transects in this area to five. This was accomplished to better evaluate whether differences in fish densities occurred between the catch-and-release and harvest areas of the LNFCDR. Two temporary snorkel transects (TP R1 & TP R2) were established during 2002 in the upstream portion of Tepee Creek where the USFS had completed stream restoration in 2001. These sites were added to evaluate how fish densities respond to restoration, over time. This brings the total number of transects that were snorkeled in the Coeur d'Alene basin during 2007 to 43, which spans about 138 km of river (Figure 56). Thirteen sites were on the LNFCDR; seven were on Tepee Creek and 23 on the NFCDR. Coordinates for the location of each of these transects are displayed in Appendix A and photographs (taken in 2002 through 2004) of each of the samples locations are described and displayed in photos in the 2003 annual report (DuPont et al., in press b). These photos not only show transects, but also depict where snorkeling should start and end and the approximate length of stream that should be snorkeled. Photos of the original transects taken in 1973 can be viewed in DuPont et al. (In Press a), and provide a good comparison of sites over time.

The actual names of the Coeur d'Alene River transects have changed since 1973. By 2002, some river reaches had transect numbers that increased as you moved upstream whereas in other reaches the numbers increased as you moved downstream. Because of this confusion, the transect numbers were changed in 2003. Transect numbers now increase as you progress up the river system. Tributary nomenclature also increases as you move upstream from major rivers. The same numbering system is used in the St. Joe River and LNFCDR. Hopefully, this will eliminate confusion and prevent any changes in the numbering scheme in the future.

METHODS

The methods described below were used during 2007 to evaluate trends in fish abundance in the St. Joe River and NFCDR system. We suggest these techniques be followed when conducting snorkel surveys on any river or large stream in the Panhandle Region to ensure data is collected in a consistent manner. Consistency is necessary to develop trends over time and for comparison to other waterbodies with similar habitat. It is also needed to evaluate how changes in fishing regulations, habitat and weather patterns have influenced fish age structure and populations over time.

Snorkel techniques used at each transect were based on sightability and transect width. Our intent was to be certain that all fish in the transect were visible to the divers and few or no fish were overlooked. In the wider transects or in more turbid water where one diver could not easily see fish across the river, two divers were used, one on each side of the river. Divers began at the upstream end of the transect and snorkeled downstream, as the size of the river generally precluded upstream counts. When snorkeling in pairs we tried to remain parallel and the snorkeler counted only those fish that passed. This prevents double counting of fish that often spook out in front of one snorkeler and then swim past the other. In areas where pocket water was the dominant habitat or shallow turbulent water limited visibility, transects were snorkeled in an upstream direction. In addition, when the stream channel was < 10 m in width, the transect was snorkeled upstream. Often when snorkeling narrow channels, fish will attempt to escape downstream leading to low counts. Where woody debris or boulders were common, the snorkeler often has to swim around them to ensure all fish were counted. Counts were periodically duplicated using different divers to check for accuracy. If noticeable differences occurred in fish counts or estimates of fish lengths between snorkelers, discussions regarding discrepancies were made and then the transect was re-snorkeled.

When snorkeling in calm water, it is best to remain fairly motionless and near the surface. Motion can induce downstream flight, even out of the survey area. Snorkeling near the stream edge or away from where most of the fish are holding can also significantly reduce startling fish downstream. It's also important to snorkel to the very end of the transect, which typically should be the tail-out of a pool, glide or run. We have often observed large numbers of fish moving downstream in-front of snorkelers until they reach the end of the transect (tail-out). At this point, fish will often swim back upstream past the snorkelers to access deeper water. If the snorkeler did not swim to the end of the reach, these fish would remain at the end of the transect and go uncounted. For this reason, no transect should end in the middle of a pool, run or glide.

Repeated snorkel surveys at the same site has revealed that when water temperatures are ≤ 12°C cutthroat trout will often seek cover under substrate or large woody debris making them difficult to observe. For this reason, on colder days it is recommended to snorkel the larger more downstream transects earlier in the day and the more upstream smaller stream reaches later in the day when water temperatures increase.

Estimates of fish abundance were limited to age 1+ fish (>75 mm), as summer counts for young-of-the-year (YOY) fishes are typically unreliable. Most YOY cutthroat trout will be smaller than 80 mm during surveys in July and occupy the shallow stream margins where snorkeling is less effective (Thurow 1994). All observed fish were recorded for each transect by species in 75 mm length groups. Prior to snorkeling, each observer practiced estimating the lengths of plastic pipes to ensure accurate estimates of fish lengths were made. Throughout the snorkel surveys, we periodically held these practice sessions to maintain accuracy.

After completing fish counts, we measured the length and width of each transect with a rangefinder to determine the surface area (m^2) surveyed. At least four width measurements should be taken to get an average stream width of the transect surveyed. Characteristics of the transects were also recorded at each site. This type of information could help explain why changes in counts occur over time. Transect characteristics collected included: habitat type, maximum depth, amount and type of available cover, water temperature and visibility (see Appendix B for data sheets we used). Research by Thurow et al. (2006) has found that the accuracy of snorkel counts can vary from year to year based on water temperature, flow and visibility. They suggest correction factors should be developed based on these variables to make counts more comparable from year to year. To accomplish this, periodic efforts in the future should be made to calculate actual population estimates (mark/recapture efforts) for particular snorkel reaches. Over time differences between actual population estimates from snorkel counts can be modeled using temperature, flow and visibility to develop a correction factor. Visibility should be measured by having a snorkeler move away from shore to the point they are no longer visible. At this point somebody on shore should measure the distance between the snorkeler and shore using a range finder. Temperature can be calculated using a hand held thermometer and flows can be downloaded off the internet from the nearest gauging station.

In an effort to accurately locate and duplicate snorkel surveys, transect locations were recorded as waypoints using a Global Positioning System (Garmin GPS). In addition, photographs of each site were taken with permanent landmarks in the photo including starting and ending points of each transect. Prior to conducting the snorkel surveys, the most up-to-date coordinates should be downloaded into a GPS unit and used to navigate to the site. Once near the transect, the most recent photos should be used to locate the exact beginning and end points.

Periodically, channel shifting, bedload movement, and/or blow outs will alter a site so it is no longer representative of the original transect habitat (changed from a pool to a riffle). Many of the transects were originally selected because they represented good habitat for particular fish species (cutthroat trout and/or bull trout). When transect habitat drastically changes, continuing to conduct counts at this site may lead to misleading density estimates, which could lead to false assumptions about the fishery. Consequently, when a transect changes substantially so that it does not represent its original characteristics, a new transect should be selected. Old photographs and habitat descriptions should be evaluated before a decision to move the transect. New transects should be selected based on the following conditions, which are listed in their order of importance: 1) closeness to original transect; 2) similarity to original site; 3) access (avoid posted private property); and 4) permanence for future study (avoid areas where the channel appears to be shifting constantly).

The NFCDR system was snorkeled during the first week in August whereas the St. Joe River was snorkeled the second week in August. Snorkeling should annually be repeated on these dates.

DATA ANALYSIS

Fish counts for each transect were converted to density (fish/100 m^2) to standardize data and make it possible to compare counts within the watershed as well as to other watersheds. Average densities of each salmonid species (all sizes) and for cutthroat trout ≥ 300 mm were calculated for the entire St. Joe River and NFCDR system as well as for different stream reaches within each watershed (roadless vs. roaded, catch-and-release (C&R) vs. limited harvest (LH), upstream vs. downstream etc). These averages were calculated by summing the total number of fish counted in a particular reach or stream and dividing it by the total area snorkeled. It is important to note that this is not the same as calculating an average from the density recorded at each snorkel transect within a particular reach or stream. The densities of these fishes were added to the long-term data set to evaluate their trends in abundance. This was accomplished by graphing the average fish density over time. Attempts were made to assess why trends were occurring by evaluating when changes in fishing regulations, known climatic events (floods, droughts or extreme cold), habitat improvement projects and factors causing habitat degradation occurred.

From 1970 to 1990 the average stream width and length of each transect snorkeled in the St. Joe River was not recorded. During these years, attempts were made to snorkel the exact same reaches as were set up in 1969. For this reason, the same area that was snorkeled in 1969 was also used for calculating fish densities from 1970 to 1990.

To evaluate whether densities of cutthroat trout differed between the different stream reaches in the St. Joe River and NFCDR system we conducted an analysis of variance (ANOVA) on the density of fish in each of the transect sites. We used a p-value ≤ 0.10 to denote when a significant difference in density occurred between stream reaches. This value is often used to show significance when evaluating fish and wildlife populations for management purposes (Peterman 1990; Johnson 1999; Anderson et al. 2000). When an ANOVA showed that a significant difference ($p \leq 0.10$) in cutthroat trout density occurred between the stream reaches we used Fisher's Least-Significance-Difference Test to evaluate which stream reaches differed significantly. Fisher's Least-Significance-Difference Test was chosen for this analysis as this test tends to maximize the power, which increases that ability to show statistically significant differences with low sample sizes (Milliken and Johnson 1992).

RESULTS

St. Joe River

Thirty-five transects were snorkeled in the St. Joe River from August 7-9, 2007 (Tables 19 and 20). A total of 848 cutthroat trout, 14 rainbow trout, and 1,639 mountain whitefish were counted (Table 19). No bull trout were observed in any transects. Cutthroat trout were observed in all of the 35 transects and were the most abundant species observed. Densities of cutthroat trout (all size classes) ranged from 0.01 to 9.42 fish/100 m^2 with an overall average of 0.82 fish/100 m^2 (Tables 19 and 21). About 39% of the cutthroat trout observed were estimated to be ≥ 300 mm in length and their overall density was calculated to be 0.32 fish/100 m^2 (Table 19 and Table 21).

Analysis of variance (ANOVA) testing indicated that significant differences (p value = 0.036) in density of cutthroat trout occurred between stream reaches in the St. Joe River (Figure 57). Fisher's LSD test (Table 22) showed that there were significantly higher densities of cutthroat trout upstream of Prospector Creek than downstream (Table 22). When we evaluated only cutthroat trout ≥ 300 mm, ANOVA testing indicated significant differences (p value = 0.084) in densities also occurred between stream reaches (Figure 57). Again, Fisher's LSD test (Table 22) showed that significantly higher densities of cutthroat trout tended to occur upstream of Prospector Creek than downstream.

Since 1969, transects in the St. Joe River have been snorkeled from the North Fork St. Joe River to Ruby Creek. Plotting the average density of cutthroat trout in this reach of river shows cutthroat trout abundance has changed over the years in response to changes in fishing regulations, extreme climatic events, and fish stocking. The lowest density of cutthroat trout (all sizes) was observed (0.27 fish/100 m^2) the first year these transects were snorkeled in 1969. In 1971, the observed density of cutthroat trout (all sizes) increased to 0.52 fish/100 m^2 (Figure 59). This increase coincides with a change in fishing regulations from a 15 fish limit for the entire river to where only 3 fish ≥ 13 inches (330 mm) could be kept each day upstream of Prospector Creek (Table 23). From 1971 to 1977 the density of cutthroat trout (all sizes) continued to increase to the point where densities in 1977 (1.60 fish/100 m^2) were about six times higher than what was observed in 1969 (Table 21 and Figure 58). From 1977 to 1980, cutthroat trout densities dropped to 0.88 fish/100 m^2, a 45% decline (Figure 58). The coldest winter recorded in St. Maries since 1950 was in the winter of 1978-1979 (Figure 59) which coincides with this decline. Fishing regulations became more restrictive during this time (Table 23) and extreme flow events were not observed (Figure 60). Following 1980, cutthroat trout densities increased to historic highs (~ 1.7 fish/100 m^2) and remained there until 1990 (Figure 58 and Table 21). From 1990 to 1994, cutthroat trout densities dropped to 1.18 fish/100 m^2, a 45% decline (Figure 58 and Table 21). The third coldest winter recorded in St. Maries since 1950 occurred in the winter of 1992 - 1993 (Figure 59) which coincides with this decline. No changes in fishing regulations or extreme flow events occurred during this period (Table 22 and Figure 60). Following 1993, cutthroat trout densities increased to an all time high in 1995 (1.99 fish/100 m^2) and remained near there until 1997.

When we evaluated trends for cutthroat trout ≥ 300 mm in length during this same time period (1969-1997), the trend was different than what was observed for other species of fish. From 1969 to 1977 the density of cutthroat trout ≥ 300 mm declined to the point where none were counted between 1974 and 1977 (Table 21 and Figure 58). Increases in the densities of cutthroat trout ≥ 300 mm in length were first observed in 1979. This increase in density occurred two years after a significant change in fishing regulations in 1977 (changed from 10 fish to 6 fish harvest with no more than 2 over 16 inches downstream of Prospector Creek; Table 23). By 1982, the density of cutthroat trout ≥ 300 mm had increased to 0.15 fish/100 m^2 and they represented about 9% of all cutthroat trout (Table 21 and Figure 58). A noticeable increase in densities of cutthroat trout ≥ 300 mm were observed again after 1988 when fishing regulations changed so that upstream of Prospector Creek all cutthroat trout had to be released and downstream of Prospector Creek only one fish over 14 inches could be harvested each day (Table 23 and Figure 58). By 1990, about 31% of the cutthroat trout were ≥ 300 mm. Densities of cutthroat trout ≥ 300 mm remained near this level until 1997.

A sharp decline in cutthroat trout densities (all sizes – 2.2 times lower; ≥ 300 mm – 5.6 times lower) was observed in 1997 and in 1998 (Table 21 and Figure 58). No changes in fishing regulations occurred around this time, but two significant flood events occurred. During February 1996, the second highest peak flow event since 1950 occurred and was followed in 1997 by the third highest mean annual flow year since 1950 (Figure 60). Following this decline, cutthroat trout densities increased steadily. By 2003, cutthroat trout densities (all sizes) reached levels similar to pre-flooding. From 2003 to 2007, cutthroat trout densities have remained relatively constant. Following the flood of 1996 and 1997, it took seven years (2004) before densities of cutthroat trout ≥ 300 mm reached pre-flood levels. From 2004 to 2007 densities have remained near record highs (Table 21 and Figure 58).

Mountain whitefish were counted in 29 of the 35 transects snorkeled during 2007 and were the most numerous fish observed (Table 19). The highest density of mountain whitefish (2.66 fish/100 m^2) was observed in the reach between the Red Ives Creek and Ruby Creek (Table 24). The overall mean density of mountain whitefish observed during 2007 (2.01 fish/100 m^2) was the second highest recorded (Table 24 and Figure 61). Mountain whitefish population declines were similar to cutthroat trout following the floods of 1996 and 1997. It took six years (2003) before mountain whitefish densities reached and exceeded what they were prior to the floods (Table 24 and Figure 61). Since 2003 densities have remained high.

Fourteen rainbow trout were counted during 2007. Four of the rainbow trout were observed upstream of Prospector Creek which is the most we have observed upstream of this point since 1998 when they were stocked (Table 25). Rainbow trout densities have steadily declined since 1969 (Table 25 and Figure 61) and correlate closely to the number of hatchery rainbow trout stocked in this reach (Figure 62).

No bull trout were counted in snorkel transects in 2007. This is only the second time since 1989 that bull trout have not been observed while sampling the St. Joe River (Figure 63).

North Fork Coeur d'Alene River

Forty-three transects were snorkeled in the NFCDR system from July 30 to August 1, 2005 (Tables 26 and 27). A total of 1,335 cutthroat trout, 304 rainbow trout, 6 brook trout and 4,873 mountain whitefish were counted (Table 26). Cutthroat trout were observed in 42 of the 43 transects snorkeled. Densities of cutthroat trout (all size classes) in these transects ranged from 0.00 to 11.05 fish/100 m^2 with an overall average of 1.04 fish/100 m^2 (Table 26). About 22% of the cutthroat trout observed were estimated to be ≥ 300 mm in length and their overall density was calculated to be 0.23 fish/100 m^2.

Analysis of variance (ANOVA) testing indicated that significant differences (p value = 0.049) in density of cutthroat trout occurred between stream reaches in the NFCDR system (Figure 28). Average cutthroat trout densities (all sizes) were higher in stream reaches within the C&R area than the LH areas, although Fisher's LSD test showed cutthroat trout densities were only significantly higher in the stream reach between Tepee Creek and Jordan Creek (Table 28 and Figure 64). When we evaluated only cutthroat trout ≥ 300 mm, ANOVA testing showed that there were significant differences (p value < 0.066) in densities between stream reaches (Figure 64). The average density of cutthroat trout ≥ 300 mm were also higher in stream reaches within the C&R area than the limited harvest areas, although Fisher's LSD test showed that cutthroat trout densities were only significantly higher in the stream reach between Tepee Creek and Jordan Creek (Table 28 and Figure 64).

Transects in the NFCDR system have been snorkeled since 1973. Plotting the average density of cutthroat trout in various reaches of this river over time shows cutthroat trout abundance has changed in response to changes in fishing regulations, extreme climatic events, and fish stocking. The lowest average densities of cutthroat trout (all sizes) observed in transects located on the main NFCDR occurred between 1973 and 1981 (Figure 65 and Table 29). During this period, significant changes in fishing regulations occurred (1975 – 1977) in which the entire Coeur d'Alene River basin changed from essentially a 15 fish limit for cutthroat trout to a 6 fish limit in the lower half of the basin and a 3 fish limit (none < 13 inches) upstream of the Yellow Dog Creek in the NFCDR and upstream of Laverne Creek in the LNFCDR (Table 23). Starting in 1988, cutthroat trout densities (all sizes) in the NFCDR steadily increased until 1997 to the point where densities were double what was observed between 1972 and 1981 (Figure 65 and Table 29). This initial increase in cutthroat trout density coincided with significant changes in the fishing regulation in 1986 and 1988 where upstream of Yellow Dog Creek and Laverne Creek it was C&R for cutthroat trout and downstream of these streams 1 fish > 14 (330 mm) in could be harvested (Table 23). This same trend was not observed when we evaluated only those cutthroat trout ≥ 300 mm in length (Figure 65 and Table 29). From 1973 to 1981, the observed density of cutthroat trout ≥ 300 mm in length increased from 0.01 fish/100m^2 to 0.05 fish/100m^2. However, from 1981 to 1996 the observed density of cutthroat trout ≥ 300 mm fluctuated but never increase above 0.08 fish/100 m^2 despite significant changes in fishing regulations. In 1996, about 11% of the cutthroat trout observed were ≥ 300 mm in length.

A noticeable decline in cutthroat trout densities (all sizes and ≥ 300 mm) were observed in the main NFCDR during 1997 and in 1998 (Figure 65 and Table 29). No changes in fishing regulations occurred around this time. However, during February 1996, the second highest flood event since 1950 occurred and was followed in 1997 by the fifth highest mean annual flow year since 1950 (Figure 66). Following this decline, densities of cutthroat trout (all sizes) increased steadily. It took five years (2005) before cutthroat trout densities (all sizes) surpassed what was observed before the floods, and in 2007 we observed the highest density recorded. From 1998 to 2002 densities of cutthroat trout ≥ 300 mm increased slowly but remained low (< 0.06 fish/100 m^2 and represented about 16% of the cutthroat trout observed (Figure 65 and Table 29). From 2002 to 2005 densities of cutthroat trout ≥ 300 mm increased to the point where record high counts were observed in each succeeding year. The density of cutthroat trout ≥ 300 mm documented in 2007 matched the record high observed in 2005. About 23% of the cutthroat trout observed in 2007 were ≥ 300 mm in length (Figure 65 and Tables 29).

From 1973 to 2007, there have been three different winters (78 - 79, 84 - 85 and 92 - 93) where the average air temperature in Kellogg, Idaho was < -3.5°C (Figure 60). Following these winters, declines in densities of cutthroat trout were not observed throughout the NFCDR watershed. However, when we examine cutthroat trout densities in the upstream C&R areas, the two lowest densities recorded (1980 and 1993) occurred following unusually cold winters. These same declines in cutthroat trout abundance were not observed in both years in the LH areas. Following the winter of 1992-93, declines in density of cutthroat trout ≥ 300 mm also occurred, although not as pronounced as it was for fish < 300 mm.

Trends in cutthroat trout densities have been quite different for the LNFCDR. For the most part, densities of cutthroat trout (all sizes and ≥ 300 mm) declined from 1973 to 1995 (Figure 65 and Table 29). From 1996 to 2005 densities (all sizes) increased steadily to the point where record high densities were observed in 2005 (0.56 fish/100 m^2) and again in 2007 (1.06 fish/100 m^2). Cutthroat trout densities (all sizes) in 2007 were higher in the LNFCDR than the

The lower reaches of the St. Joe River and NFCDR systems (LH areas) have been snorkeled less consistently than the C&R areas. However, comparison of this data suggests that since 1993 cutthroat trout densities (all size classes) in the St. Joe River (LH areas) have remained steady (Figure 70). On the other hand, cutthroat trout densities (all size classes) in the NFCDR system (limited harvest areas) have increased steadily since 1993 and in 2007 were almost six times higher than what was observed in the limited harvest areas of the St. Joe River (Figure 70). Densities of cutthroat trout ≥ 300 mm remained low between 1993 and 2002 in the LH areas of the St. Joe River and NFCDR systems (Figure 70). Starting in 2003 cutthroat trout densities (≥ 300 mm) increased in both systems although they appeared to increase at a higher rate in the NFCDR (Figure 70). In 2007, densities of cutthroat trout ≥ 300 mm were about twice as high in the LH areas of the NFCDR as the St. Joe River.

The average density of cutthroat trout (all size classes) in the NFCDR (1.06 fish/100 m^2) for the first time was higher than observed in the St. Joe River (0.82 fish/100 m^2) during 2007. Cutthroat trout densities (all sizes) between the rivers were not significantly different based on a T-test evaluation (p value < 0.404). Analysis of variance (ANOVA) testing indicated that the average density of cutthroat trout (all sizes) were significantly different (p value = 0.013) between four stream reaches in the St. Joe River and seven stream reaches in the NFCDR system. The highest average densities of cutthroat trout (all size classes) tended to be observed in the C&R areas with the highest densities occurring upstream of Prospector Creek in the St. Joe River and upstream of Tepee Creek in the NFCDR (Figure 71). Fisher's LSD testing showed that there were significantly higher densities of cutthroat trout (all size classes) in the Tepee to Jordan reach in the NFCDR than any other stream reaches in the St. Joe River or NFCDR system (Table 32).

The density of cutthroat trout ≥ 300 mm observed in the St. Joe River (0.32 fish/100 m^2) transects was higher that what was observed in the NFCDR system (0.23 fish/ 100 m^2) during 2007. The average density of cutthroat trout ≥ 300 mm was significantly higher in the St. Joe River than the NFCDR system based on a T-test evaluation (p value < 0.018). Analysis of variance (ANOVA) testing also indicated that the average densities of cutthroat trout ≥ 300 mm were significantly different (p value < 0.022) between four stream reaches in the St. Joe River and seven stream reaches in the NFCDR system. The highest average densities of cutthroat trout ≥ 300 mm were observed in the C&R areas with the highest densities occurring upstream of Red Ives Creek in the St. Joe River and upstream of Tepee Creek in the NFCDR (Figure 71). Fisher's LSD testing showed that there were significantly higher densities of cutthroat trout ≥ 300 mm upstream of Prospector Creek in the St. Joe River and upstream of Tepee Creek in the NFCDR than about any of the other stream reaches in the St. Joe River or NFCDR (Table 32).

DISCUSSION

Cutthroat Trout

St. Joe River

Cutthroat trout densities have increased in the St. Joe River 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). As a result, fishing regulations were changed in 1971 from a 15 fish limit (no size restriction) for the entire river to where only 3 fish ≥ 330 mm (13 in) could be kept each day upstream of Prospector Creek. From 1971 to 1977 the density of cutthroat trout (all size classes) counted at the snorkel transects more than tripled and was attributed to changes in the fishing regulations (Johnson and Bjornn 1975). Claims were made that more restrictive regulations had improved the fishing (Johnson and Bjornn 1978). However, when we evaluated this snorkel data, we also looked at how the density of cutthroat trout ≥ 300 mm changed. What we found is that the density of cutthroat trout ≥ 300 mm declined after the regulations were changed. In fact, between 1974 and 1977 not one cutthroat trout ≥ 300 mm was observed during snorkel surveys. It appears that survival of cutthroat trout ≥ 330 mm decreased, during this time period, because harvest was focused on a limited number of large fish. Prior to the 330 mm (13 in) minimum size limit, anglers may have kept smaller fish to eat. Apparently, fishing pressure was high enough that once cutthroat trout reached the legal size (330 mm) they were cropped off. Talking to fisherman who fished during this period, it was uncommon to catch a legal sized fish (≥ 330 mm), although smaller fish were abundant. Reduced numbers of cutthroat trout ≥ 330 mm, resulted in anglers often harvesting fish close to the minimum length (Joe DuPont, IDFG, personal communication). Although the overall catch rate for cutthroat trout increased, it appears the catch rate for fish ≥ 330 mm probably decreased up until 1977.

This analysis shows the importance of being thorough when evaluating trend data. Originally, we deduced that the changes in fishing regulations in 1971 improved the cutthroat trout fishery in the St. Joe River. Changes in the fishing regulations were effective in rebuilding and maintaining a wild cutthroat trout population, but it didn't appear to result in an increase in the abundance of legal sized fish (≥ 330 mm) for the first six years.

It wasn't until after 1977, when we actually started seeing an increase in the density of legal sized fish (≥ 330 mm) in the St. Joe River. After 1977, it appeared that densities of smaller (< 300 mm) cutthroat trout had increased (~ 6 fold increase from 1969 to 1977) to the point that fishermen were not able to crop off all the fish recruiting to a legal size (≥ 330 mm). From 1977 to 1982 densities of cutthroat trout ≥ 300 mm increased steadily from 0.0 to 0.15 fish/100 m^2 and represented 9% of all the cutthroat trout observed during snorkel surveys. Changes in fishing regulations also occurred during 1977, reducing the number of fish you could harvest downstream of Prospector Creek from essentially 10 fish to 6 fish, only 2 fish > 406 mm (16 in).

In 1988, changes occurred to the fishing regulations for the St. Joe River. Upstream of Prospector Creek all cutthroat trout had to be released and downstream of Prospector Creek only one fish over 14 inches (356 mm) could be harvested each day. These changes in the fishing regulations didn't lead to increases in the overall density of cutthroat trout in the St. Joe River; however, it did appear to result in significant increases in the density of cutthroat trout ≥ 300 mm. In 1990 the density of cutthroat trout ≥ 300 mm peaked at 0.57 fish/100 m^2; over a five-fold increase from what was observed ten years earlier in1980. In 1990, 31% of all the fish observed were ≥ 300 mm in length. Densities of cutthroat trout remained near this level until 1997. It appeared that the cutthroat trout population had already reached its carrying capacity and the regulation changes resulted in a more desirable fishery for larger fish, but not increased numbers of fish. This data demonstrates how restrictive fishing regulations must be structured to protect larger cutthroat trout in heavily fished systems. Appreciable numbers of cutthroat trout ≥ 300 mm were not observed in the St. Joe River until regulations were changed to catch-and-release in the upstream reaches and a one fish > 356 mm (14 in) daily harvest in the downstream reaches. It's also important to realize that most cutthroat trout in the St. Joe River migrate upstream into the catch-and-release areas in the summer to avoid high water temperatures (Hunt and Bjornn 1992; Fredericks et al. 2002a). In doing so, most fish are protected by C&R regulations throughout the summer. Cutthroat trout are considered an easy fish to catch (Trotter 1987) which may be a result of evolving in unproductive waters where aggressive feeding must occur to obtain adequate food supplies (Rieman and Apperson 1989). In addition, Dwyer (1990) found that Westslope cutthroat trout were the easiest to catch of three different subspecies of cutthroat trout. Lewynsky (1986) found that cutthroat trout are significantly more vulnerable to angling than rainbow trout. When exposed to similar fishing regulations, higher catch rates of cutthroat trout could lead to a dominance of rainbow trout where they occupy the same waters (Lewynsky 1986). The aggressive feeding habits that cutthroat trout display may indicate why such restrictive fishing regulations must occur to sustain desirable numbers of larger cutthroat trout in heavily fished waters.

Between 1977 and 1997, two noticeable declines (40 - 50% decrease) in the density in cutthroat trout were observed (1979 and 1993). Both of these declines occurred the year after unusually cold winters (winters of 1978 - 1979 and 1992 - 1993). Others have also found winter to be a major period of fish mortality based largely on the severity of the winter and subsequent losses of stored energy (Reimers 1963; Hunt 1969; Whitworth and Strange 1983). High fish mortality during periods of extreme cold have been attributed to frazil ice (Tack 1938), loss or destruction of habitat through anchor ice formation and hanging ice dams (Maciolek and Needham 1952; Brown 1999; Brown et al. 2000) and depletion of energy reserves (Cunjak and Power 1987; Shuter and Post 1990). Long extended cold periods appear to have the most impact on smaller fish (Shuter and Post 1990; Meyer and Griffith 1997). Shutter and Post (1990) state "that smaller fish tend to be less tolerant of starvation conditions because they exhaust their energy stores sooner." However, following the winter of 1992 - 93 declines in density of cutthroat trout ≥ 300 mm in the St. Joe River were similar to what was observed for fish < 300 mm. Often during intense cold periods, ice dams form, backing up water for miles. When these ice dams break they can scour the river bottom and damage riparian vegetation (Beltaos, 1995). Presumably these types of events would have impacts on all sizes of fish. We're not aware if this type of event happened during the winter of 1992 - 93.

A dramatic decline (55% decline) in cutthroat trout density was also observed in 1997 and 1998 in the St. Joe River. In all likelihood, the decrease in cutthroat trout density in 1998 was a delayed response to the large flood events that occurred during the winter of 1996 and spring of 1997 and not a factor of changes in fishing pressure, fishing regulations (no changes occurred during this time) or unusually cold winter temperatures (winter temperatures were not extreme). Floods have been found to impact fish populations through increases in bedload movement, changes in channel morphology, silting of spawning gravel and scouring or filling of pools and riffles (Swanston 1991; Pearson et al. 1992; Abbott 2000; DeVries 2000). Large swings 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 issues (Dan Schill, IDFG, personal communication). The decline in cutthroat trout abundance following the flood was more pronounced for cutthroat trout ≥ 300 mm as densities were 5.6 times higher prior to the flood as they were following the flood in 1998. It took five years for cutthroat trout (all sizes) to recover from the declines following the floods. It took seven years (1997 - 2004) for densities of cutthroat trout ≥ 300 mm to recover from the floods. We attribute the steady increase in cutthroat trout density following 1998 to a series of mild winters, an absence of extreme flow events and adherence by the public to the fishing regulations.

Once cutthroat trout recovered from the floods, their densities have remained relatively steady. Overall cutthroat trout densities from 2003 to 2007 on average were below (0.4 fish/100 m^2) densities observed before the floods, whereas densities of cutthroat trout ≥ 300 mm have remained at near record highs. This data suggests the size structure of the cutthroat trout population shifted towards fewer but larger fish. Cutthroat trout ≥ 300 mm represented 33 - 40% of all fish observed in the St. Joe River between 2004 and 2007, which is the highest recorded.

Changes in the fishing regulations for the St. Joe River in 2000 increased the C&R zone by about 20 km so that it extended from the confluence of the North Fork St. Joe River to the headwaters. The remainder of the river was managed with a slot limit where all cutthroat trout between 203 and 406 mm (8 and 16 in) had to be released. Previously, fish over 356 mm (14 in) could be harvested. We believe these more restrictive regulations on cutthroat trout also contributed to rapid improvement in fish densities since the floods.

The highest density of cutthroat trout (all size classes and fish ≥ 300 mm) in 2007 was observed upstream of Prospector Creek. This section of river has been C&R since 1988, whereas the section of river between the North Fork St. Joe River and Prospector Creek has been C&R for cutthroat trout since 2000. Differences in fishing regulations may explain some of the reason why differences in densities occurred between these sections of river. However, more than likely, the reason for higher densities of cutthroat trout upstream of Prospector Creek is the upper reaches of the St. Joe River maintain water temperatures throughout the summer that are more suitable to cutthroat trout than occurs downstream of Prospector Creek. Cutthroat trout in the St. Joe River have been documented to move from downstream of the North Fork St. Joe River to upstream of Prospector Creek during the summer primarily in response to temperature increases (Hunt and Bjornn 1992; Fredericks et al. 2002a). This information is substantiated by our snorkel data, as during the warmest years the highest densities of cutthroat trout were observed furthest upstream. For example in 2004 (very warm summer), the highest densities of cutthroat trout were observed upstream of Red Ives Creek (most upstream reach) whereas in 2005 (a cooler summer than 2004) the highest densities were observed lower downstream, between Prospector Creek and Red Ives Creek.

In 2000, the fishing regulations extended the C&R area downstream to the North Fork St. Joe River. Prior to this (1988-1999) one could harvest one cutthroat trout > 14 inches (330 mm) a day between the North Fork St. Joe River and Prospector Creek. This change in fishing regulation appears to be making a difference in the fishery. Between 2003 and 2007, densities of cutthroat trout ≥ 300 mm more than doubled historic counts between the North Fork St. Joe River and Prospector Creek prior to the regulation change.

During snorkel surveys, more large cutthroat trout (> 380 mm) were seen where access to the river was difficult. The habitat did not appear to differ greatly in stream reaches that had easy access versus difficult access. Probably the greatest difference between reaches is that sites with easy road access received more fishing pressure. Findings suggest that hooking mortality, illegal harvest or a combination of the two are having an impact on the number of larger fish in the St. Joe River in areas with easy road access. Research on the Coeur d'Alene River suggests that areas with easy road access suffer higher levels of illegal harvest (DuPont et al. In Press c.). Many pools snorkeled near the road appear to be fished almost daily. Schill et al (1986) found in the Yellowstone River (C&R regulations) that cutthroat trout were captured on average about 10 times a year resulting in an annual fishing mortality of about 3%.

Global warming may be having negative impacts on salmonid populations (Battin 2007; Biro et al. 2007). It's speculated that global warming can cause warmer or more extreme variations in water temperatures and flows (Whited et al. 2007). Extreme summer water temperature in the Spokane River, Idaho were believed to have increased mortality and been a significant factor in the decline of redband trout in the 1990's (Ned Horner, IDFG, personal communication). Analysis of air temperatures from St. Maries, Idaho shows there has been no relationship (R^2 = 0.004) between changes in cutthroat trout densities and summer air temperature. However, when we compared winter air temperatures to changes in cutthroat trout densities (the decline after the flood was excluded), there was a significant (p = 0.006) positive relationship (R^2 = 0.31) (Figure 72). This data suggests that increasing winter temperatures are benefiting cutthroat trout populations more than negative impacts from hot summer temperatures. Obviously, there will be a "tipping" point if summer water temperatures continue to increase where the benefits of warmer winters will be offset by the negative impacts of extreme summer temperatures. The ability of cutthroat trout to migrate upstream in the St. Joe River to more suitable water temperatures should continue to offset negative impacts of hot summer temperatures unless very large changes occur. Low densities of cutthroat trout do occur year round in the St. Joe River downstream of the North Fork St. Joe River. If summer water temperatures begin to warm, these fish will be more susceptible to negative impacts and will depend more upon cold water refugia for survival. Work by DuPont et al. (In Pess c) found that cutthroat trout in the lower NFCDR will seek out areas (side channels) where ground water upwelling occurs as thermal refugia during warm summer months. Protecting these types of habitats will become important for the persistence of this non-migratory cutthroat trout population if water temperatures continue to climb.

North Fork Coeur d'Alene River System

Snorkel surveys in the NFCDR basin first occurred in 1973 when extremely low densities of cutthroat trout were observed (0.20 fish/100 m2). These observations led researches to believe that one of the major factors leading to this suppressed fishery was overharvest (Bowler 1974) similar to what had happened in the St. Joe River (Mallet 1967; Dunn 1968; Rankel 1971). A series of changes in the fishing regulations occurred from 1975 to 1977 where the entire river was essentially changed from a 15 fish daily limit to where you could only keep three fish > 330 mm (13 in) upstream of Yellow Dog and Laverne Creek and six fish downstream of these reaches. Despite these changes in fishing regulations, from 1973 to 1981 the densities of cutthroat trout declined even further. In 1986, the first catch-and-release regulations for cutthroat trout were implemented in the NFCDR basin and by 1988 it was catch-and-release upstream of Yellow Dog and Laverne Creek and one cutthroat trout > 356 mm (14 in) could be kept downstream of these reaches. The snorkel sites were next surveyed in 1988 and the density of cutthroat trout (all size classes) in transects on the main North Fork had increased three fold from when it was last snorkeled in 1981. This information once again shows just how restrictive regulation must become before improvements in a cutthroat trout fishery can occur. The aggressive feeding habits that cutthroat trout display may indicate why such restrictive fishing regulations must occur to sustain desirable numbers of larger cutthroat trout in heavily fished waters.

From 1988 to 1997 the average cutthroat trout density (all sizes combined) increased steadily in transects on the main NFCDR to the point it was over five time higher than when it was first snorkeled in 1973. Increases in cutthroat trout densities were believed to occur from a combination of more restrictive fishing regulations, improvements in tributary habitat and reductions in heavy metal mining wastes (DuPont et al. In Press b). In 1998, a decline in cutthroat trout densities was observed, and by 2000 the density dropped to 33% lower than was observed in 1997. In all likelihood, the decrease in cutthroat trout density in 1998 was a delayed response to the large flood events that occurred during the winter of 1996 and spring of 1997 and not a factor of changes in fishing pressure, fishing regulations or unusually cold winters. As mentioned before, floods have been found to impact fish populations through increases in bedload movement, changes in channel morphology, silting of spawning gravel and scouring or filling of pools and riffles (Swanston 1991; Pearson et al. 1992; Abbott 2000; DeVries 2000). Large swings 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 issues (Dan Schill, IDFG, personal communication). Following the floods (post 1998), densities of cutthroat trout increased steadily to the point where successive all time highs were observed between 2005 and 2007. The average densities were over 8.2 times higher in 2007 than what was observed in 1973 in snorkel sites on the main NFCDR.

A spike in cutthroat trout density was recorded in 2001. Analysis of data revealed inexperienced snorkelers collected the information and skipped several sites on the NFCDR. It was also discovered that some transects were not snorkeled in their entirety.

Snorkel surveys in transects on the main NFCDR showed a different pattern when we evaluated only cutthroat trout ≥ 300 mm in length. Densities increased from 1973 to 1980, but from 1980 to 2002 no significant increase or decrease in density was observed despite significant changes in the fishing regulations. Two consecutive years of decline occurred in 1997 and 1998. This decline was not large (drop of 0.05 fish/100 m^2), although the average density in 1998 was the lowest recorded since 1973. We believe the decline was related to the floods of 1996 and 1997 as was also observed with the smaller fish. Based on telemetry work on cutthroat trout ≥ 300 mm, a combination of factors appeared to be playing a role in their suppression including, non-compliance with fishing regulations, degraded or loss of cold water refugia, degraded or loss of over-winter habitat, and degraded summer rearing habitat (DuPont et al. In Press b). However, from 2002 to 2005, the density of cutthroat trout ≥ 300 mm increased more than five-fold in the North Fork Coeur d'Alene to the point that they were the highest ever recorded. This increase in density was observed in both limited harvest and catch-and-release areas. Densities of cutthroat trout ≥ 300 mm in 2007 equaled the all time high and were about 20 times higher than was observed in 1973. Favorable weather patterns and restrictive fishing regulations may help explain why this increase occurred. A series of mild winters (1998-2005) and a lack of flood events may have increased survival of larger adult fish. In fact, the warmest winters on record in Kellogg have occurred over the last eight years (1998-2006). Future surveys will indicate whether this increase in the number of large cutthroat trout is a temporary or long-term trend and how average or below average winter temperatures will effect cutthroat trout densities.

Declines in densities of cutthroat trout were not observed throughout the North Fork Coeur d'Alene River watershed following unusually cold winters as has been observed in the St. Joe River (DuPont et al. In Press a). However, when we examine cutthroat trout densities in the upstream catch-and-release areas, the two lowest densities recorded (1980 and 1993) occurred following unusually cold winters. These same drops in cutthroat trout abundance were not observed in both years in the limited harvest areas. This may suggest a couple things. First, better overwinter habitat may have occurred in the downstream reaches. Work by DuPont et al. (In Press b) has found there are a higher frequency of deep, slow pools accompanied by wide floodplains in the downstream transects than the upstream transects. Habitat conditions are also characterized by many as good overwinter habitat (Thurow 1976; Lewynsky 1986; Bjornn and Reiser 1991; Hunt and Bjornn 1992; Schmetterling 2001). The other factor that may help explain this difference is water temperatures in the higher elevation transects get colder during winter, and consequently, cutthroat trout using these areas may experience higher mortality following unusually cold winters. Others have reported winter to be a major period of fish mortality based largely on the severity of the winter and subsequent losses of stored energy (Reimers 1963; Hunt 1969; Whitworth and Strange 1983). Long extended cold periods appear to have the most impact on smaller fish (Shuter and Post 1990; Meyer and Griffith 1997). Shutter and Post (1990) noted that smaller fish tend to be less tolerant of starvation conditions because they exhaust their energy stores sooner. However, following the winter of 1992-93 declines in density of cutthroat trout ≥ 300 mm occurred, although not as pronounced as it was for fish < 300 mm. Often during intense cold periods, ice dams form potentially backing up water for miles. When these ice dams break they can scour the river bottom and damage riparian vegetation (Beltaos, 1995). Presumably these types of events would have impacts on all sizes of fish. We're not aware if this type of event happened during the winter of 1992-93.

Restrictive fishing regulations may also have played a role in the increase in cutthroat trout ≥ 300 mm, following 2002. The first C&R regulations for cutthroat trout in the NFCDR were initiated in 1986. In the St. Joe River where habitat conditions have not appeared to suppress cutthroat trout numbers, appreciable numbers of cutthroat trout ≥ 300 mm were observed shortly after much of the population was protected by C&R regulations (DuPont et al. In Press a). Lewynsky (1986) believed one of the possible reasons the abundance of cutthroat trout did not increase from 1973 to 1981 in the NFCDR was because of non compliance with fishing regulations. In the NFCDR, it may have taken a while before the public accepted the changes in fishing regulations. Work by Schill and Kline (1995) found that in the C&R area of the North Fork, compliance with the fishing regulations was high (97% compliance) as early as 1993. However, research conducted in 2003 (> 65% annual mortality; DuPont et al. In Press b) and 2006 (73% of cutthroat trout kept were too small; DuPont et al. In Press e) showed illegal harvest of cutthroat trout ≥ 300 mm was high in many of the LH areas, especially downstream of Prichard Creek. Gigliotti and Taylor (1990) found that in waters with low densities of fish and high fishing effort, even a small amount of noncompliance with regulations (<15%) would suppress the fish population. We believe the restrictive regulation implemented in 1988 (C&R upstream of Yellow Dog and Laverne creeks and one fish > 14 inch daily limit downstream), were adequate to improve the abundance of cutthroat trout ≥ 300 mm in the NFCDR. However, a combination of illegal harvest and unfavorable weather patterns (floods) likely prevented any benefits from being expressed until 2002.

Improvements in habitat has also been associated with increases in fish densities (Fausch et al. 1988; Hicks et al. 1991) Following 2002, the density of cutthroat trout ≥ 300 mm in the NFCDR improved throughout the basin. If habitat improvements were responsible for the increase in fish density it would also be expected to have occurred basin wide. Although the flood events of 1996 and 1997 caused cutthroat trout abundance to decline, floods can also have favorable impacts on fish including increased large woody debris delivery to streams, and increases in pool depth (Swanston 1991). In Jordan Creek, a tributary to the upper NFCDR, following the floods of 1996 and 1997 it was found that pool depth actually increased (Ed Lider, personal communication). It is believed the increased flows actually scoured out pools and transported excess sediment downstream. In the past (1960-1980's), it was believed that unstable stream banks coupled with an abundance of roads located in riparian zones actually caused more sediment to be delivered to streams in the North Fork basin during floods which caused pools to be filled with sediment. However, over the years the USFS has put a considerable amount of effort into removing roads from riparian areas and stabilizing stream banks. If sediment delivery was less than sediment export during the floods of 1996 - 1997, than it is possible pool depth increased throughout the basin following these events. Most research has shown that pools tend to become shallower over time in managed watersheds, such as the NFCDR (Overton et al. 1993; Overton et al. 1995; Wood-Smith and Buffington 1996; Lee et al 1997; Kershner et al. 2004). This does not mean improvements in habitat cannot occur in a managed watershed. It just means it is unlikely we will reach conditions found in unmanaged systems.

The highest densities of cutthroat trout in the NFCDR have consistently been observed in the C&R areas upstream of Yellow Dog Creek, especially since 2002. Similar percentages of pool and run habitat occurred in the C&R areas as the LH areas, although the depths of pools and runs tended to be deeper than in the limited harvest areas (DuPont et al. In Press b). Studies in the St. Joe River (Hunt and Bjornn 1992; Fredericks et al. 2002a) found that cutthroat trout tend to move upstream during summer, likely in search of cooler water temperatures. However, DuPont et al. (In Press b) found in the Coeur d'Alene River basin that many cutthroat migrated downstream of C&R areas after spawning and did not migrate upstream during warm summer months. In addition, relatively high densities of cutthroat trout (444 - 521 fish/km) were found to occur in the free flowing reach of the Coeur d'Alene River with about half of these fish being > 250 mm (Fredericks et al. 2002 b, 2003). This suggests habitat or upstream migrations towards cooler temperatures cannot explain for the higher densities of fish in the catch-and-release areas.

It is believed that angling pressure has increased on the Coeur d'Alene River, and it is likely that fishing mortality on cutthroat trout is having an impact on areas where limited harvest is allowed (downstream of Yellow Dog Creek and Laverne Creek). New fishing regulations implemented in 2000 (release all cutthroat trout between 203 and 406 mm inches where previously fish over 356 mm could be harvested) should limit impacts from angling on this fishery. Work conducted by DuPont et al. (In Press b) suggests that high fishing pressure coupled with illegal harvest is suppressing the cutthroat trout fishery in many of the limited harvest areas. On the NFCDR downstream of Prichard Creek, annual exploitation was estimated at 69% for cutthroat trout ≥ 300 mm during 2003 with 75% of these fish being illegally kept (too small to keep) (DuPont et al. In Press b). Stocking of rainbow trout historically provided a harvest fishery in this reach of river. Creel surveys in 2006 indicate illegal harvest is still a problem in the LH area of the NFCDR as 73% of the cutthroat trout caught were between 8 (203 mm) and 16 inches (406 mm) in length (DuPont et al. In Press e).

Exploitation may not be the only reason cutthroat trout densities were lower in the LH area versus the C&R area. Rainbow trout could play a role as the LH area had the lowest cutthroat trout densities (lower NFCDR and lower LNFCDR) and the highest densities of rainbow trout during 2007. Rainbow trout represent about 31% of the trout in the LH area and were not observed in the C&R area. Rainbow trout have been found to displace cutthroat trout in many areas through competition and hybridization (Behnke 1992). Cutthroat trout are known to hybridize with rainbow trout in the NFCDR watershed. It appears that despite a long history of rainbow trout stocking, there are likely some reproductive isolating mechanisms helping to limit hybridization and introgression between these two species (either pre- or post- isolating mechanisms) in the Coeur d' Alene River basin (DuPont et al. In Press d). Starting in 2003, no rainbow trout were stocked in any free flowing waters in the Panhandle Region of Idaho. This cessation of stocking corresponded with a decline in the densities of rainbow trout observed during 2003 sampling. Cutthroat trout densities on the other hand increased in the LH area from 2003 to 2007 and have outnumbered rainbow trout (Figure 73). This increase in cutthroat trout density is likely due to not stocking rainbow trout. Harvest may also give an advantage to rainbow trout in the limited harvest areas. Cutthroat trout are considered an easy fish to catch (Trotter 1987) and Lewynsky (1986) found that cutthroat trout are significantly more vulnerable to angling than rainbow trout. When exposed to similar fishing regulations, higher catch rates of cutthroat trout could lead to a dominance of rainbow trout where they occupy the same waters (Lewynsky 1986). Fishing regulations since 2000 allowed a daily harvest of six rainbow trout of any size whereas only two cutthroat trout (none between 203 and 406 mm) could be harvested. If anglers comply with fishing the regulations, exploitation should not be a factor that leads to dominance of rainbow trout over cutthroat trout.

Telemetry worked conducted by DuPont et al. (In Press b) in the Coeur d'Alene River watershed found larger cutthroat trout are grouping in areas where colder water occurred during warm summer months. Work during 2007 (DuPont et al. In Prep) found densities of cutthroat trout ≥ 300 mm were 2 to 20 times higher in these cold water sanctuaries than in the main river. The abundance of this type of habitat has declined over the years due to road building, constricting and general development in the floodplain. If this habitat type is important in improving survival of larger cutthroat trout, its decline in abundance may also help explain why fewer cutthroat trout occur in the LH area than the C&R area.

Two temporary snorkel transects (R1 & R2) were established during 2002 in the upstream portion of Tepee Creek where the USFS had completed extensive stream restoration in 2001. These sites were added to evaluate how fish densities respond to habitat restoration over time. Cutthroat trout densities have fluctuated greatly in these sites since they were first snorkeling; which may indicate that unstable habitat conditions occur in this reach. Since completion of the work, some stream channel shifting has occurred. We expect this to continue until willows and other shrubs establish and begin to stabilize the banks. Average densities of cutthroat trout in the rehabilitation area were lower than any stream reach we surveyed suggesting habitat improvement is needed before it will support high densities of cutthroat trout.

The cutthroat trout fishery in the LNFCDR has not followed the same pattern as the NFCDR. Cutthroat trout densities in the LNFCDR declined steadily from 1988 to 1995 while they were increasing in the NFCDR during this same period. Densities of cutthroat trout ≥ 300 mm in the LNFCDR were almost nonexistent during this same period. Starting in 1996, cutthroat trout densities slowly climbed until 2007 when densities jumped considerably and for the first time exceeded what was observed in the NFCDR. It's important to realize that does not mean the densities of cutthroat trout are higher in the LNFCDR than the NFCDR. Snorkel sites have been selected based upon the potential to support cutthroat trout, and they do not represent the overall characteristics of the river. In actuality, the LNFCDR has habitat that is considered relatively poor (DuPont et al. In Press c). Splash damming was used to transport wood from the LNFCDR basin prior to 1930 (Strong and Webb 1970). These practices seriously degraded habitat in this watershed including straightening and widening the river channel, removal of large woody debris, loss of pool habitat, and destruction of riparian vegetation. Effects from these practices are still obvious today, especially in the upstream reaches. This area is dominated by riffle habitat. Pools tend to be shallow in nature and have an absence of large woody debris (DuPont et al. In Press c). Despite the degraded nature of the LNFCDR, snorkel data indicates the cutthroat trout population is increasing. The density of cutthroat trout ≥ 300 mm also appears to be improving, but at a slower rate than the smaller fish. Hopefully the large increase in smaller cutthroat trout observed in 2007 will translate into more fish over 300 mm in the future. Evidence suggests that illegal harvest is very high in the LH reach of the Little North Fork and may be playing a large role in suppressing the abundance of larger fish (DuPont et al. In Press c). Many of the larger cutthroat trout move downstream into the LH reach after spawning which puts them more at risk to both legal and illegal harvest (DuPont et al. In Press c).

St. Joe River versus the North Fork Coeur d'Alene River System

From 1993 to 1997 cutthroat trout densities were usually two to three times higher in the C&R area of the St. Joe River than what was observed in the C&R area of the North Fork Coeur d'Alene River. However, after the flood and higher water events in 1996 and 1997, declines in cutthroat trout densities were observed. Declines in density were much greater in the St. Joe River than in the NFCDR system. We believe the reason the decline was greater in the St. Joe River has to do with the difference in geomorphology. The St. Joe River has a steeper gradient, and the river is more confined between the sidewalls with little or no floodplain. During flood events on the St. Joe River, there are few areas for the river to spread out and dissipate energy. If a flood event occurs during the winter when cutthroat trout are struggling to conserve their energy and there are few areas to escape high flows, mortality could be significant. The 1996 flood occurred during the winter due to a rain on snow event. The North Fork Coeur d'Alene River system has many areas with wide floodplains where flood water can spread out, reducing its energy. Cutthroat trout in the NFCDR system have been found to move to areas with wider floodplains during winter (DuPont et al. In Press c). These floodplains can provide refugia where fish can avoid fast, turbulent water that will quickly consume winter energy reserves (Brown et al. 2001; DuPont et al. In Press c).

In 1998, the densities of cutthroat trout observed were actually higher in the C&R area of the NFCDR system than the C&R area of the St. Joe River (0.89 fish/100 m^2 vs. 0.79 fish/100 m^2 respectively). After 1998, the densities of cutthroat trout increased at a faster rate in the St. Joe River than in the NFCDR system. The faster recovery of cutthroat trout in the St. Joe River may suggest that factors such as lower habitat quality are suppressing the cutthroat trout numbers in the NFCDR system. Findings by DuPont et al. (In Press c) indicate that many of the pools and runs in the C&R area of the NFCDR system are shallower than cutthroat trout prefer. Locals claim that pools have become shallower or have filled in with sediment in the C&R areas of the NFCDR system when logging and road building increased (1960-1980). Fishing mortality could also be a factor, although it would have to be illegal harvest as these comparisons are between the C&R areas. Schill and Kline (1995) reported that illegal harvest of cutthroat trout in 1993 was low (<3% of anglers) in the C&R areas of both the St. Joe and NFCDR rivers, although slightly higher in the NFCDR. DuPont et al. (In Press c) also reported that illegal harvest in C&R areas of the NFCDR system was low. Following 2005, cutthroat trout densities have continued to climb in the C&R areas of the NFCDR reaching all time highs, whereas in the St. Joe River the growth in numbers appears to have stopped. This has allow the densities of cutthroat trout in the in the NFCDR to surpass what was observed in the St. Joe River for the first time. Densities of cutthroat trout ≥ 300 mm in length in 2007 were still about 35% higher in the St. Joe River than in the NFCDR, although the densities in both rivers had reached or were near all time highs.

When we compared the densities of cutthroat trout between the LH areas of the St. Joe River and NFCDR we saw a different pattern than occurred in the C&R areas. Cutthroat trout densities have consistently been higher in the NFCDR. Overall cutthroat trout densities in the LH area of the NFCDR have been climbing steadily since 2001, whereas they have remained flat in the St. Joe River. In 2007, cutthroat trout densities were almost six times higher in the LH areas of the NFCDR than the St. Joe River. In the St. Joe River, research indicates most cutthroat trout migrate upstream during the summer to reach areas with cooler water temperatures (Hunt and Bjornn 1992; Fredericks et al. 2002a). In the NFCDR, cutthroat trout don't make these types of migrations and instead appear to seek out areas with cold water refugia during warm summer months (DuPont et al. In Press c; DuPont et al. In Prep). The wide floodplain and its associated hyperhic flow that occur in the NFCDR are instrumental in providing this type of habitat (DuPont et al. In Press c). The floodplain in the LH areas of the St. Joe River is narrower and as a result likely provides less opportunity for areas with cold water refugia to form. Despite these differences, we did document a large increase (3.7 times higher) in the density of cutthroat trout ≥ 300 mm in the LH area of the St. Joe River in 2007. It is unknown whether this is an anomaly as this section of river was not snorkeled the previous three years. Continued evaluations will indicate whether this is a trend. Despite this increase, the density of cutthroat trout ≥ 300 mm in the LH area of the St. Joe River were still about half of what we documented in the LH area of the NFCDR.

Mountain Whitefish

Snorkel surveys showed that mountain whitefish densities remained steady in the St. Joe River from 1969 until 1997, then a fairly significant decline was documented. In all likelihood, the decrease in mountain whitefish densities in 1997 was a response to large flood events that occurred during 1996 and 1997. Since these flood events, mountain whitefish densities have rebounded. The series of mild winters from 1998 to 2003 likely played a large role in this rapid recovery. In addition, bag limits for mountain whitefish were reduced from 50 fish to 25 fish in 2000, which may also have helped speed up the recovery of this fishery.

Based on snorkel surveys, the density of mountain whitefish in the NFCDR system had gone through a series of ups and downs since 1973. Many of the down years occur immediately after unusually cold winters (1979-1980; 1992-1993) or flood events (1996). Despite drops in density by 75% to 85%, the whitefish population rebounded in about three years. Since 2000, the average whitefish density has remained steady in the North Fork Coeur d'Alene River and reached all time highs in 2005, 2006 and 2007. Since 1997 no unusual flood events or temperature variations have occurred within the basin.

Snorkel observations indicate mountain whitefish densities in the NFCDR system were about 2.3 times higher than observed in the St. Joe River during 2007. Most mountain whitefish in the NFCDR system were observed in the large, deep pools and runs in the more downstream transects. We observed the lowest mountain whitefish densities in the lower St. Joe River (downstream of the North Fork St. Joe River) where the most large, deep pools and runs occur. It is possible that in the St. Joe River, mountain whitefish like cutthroat trout, also migrate upstream during the summer to reach areas where water temperatures are more suitable. In the LH area of the NFCDR, many mountain whitefish will move into cold water refugia during the warm summer months (DuPont et al. In Prep).

Rainbow Trout

Rainbow trout were mostly observed in the LH areas of both the NFCDR and St. Joe River systems during 2007, although the densities were about 17 times higher in the NFCDR. Rainbow trout were not stocked into any rivers or streams in the Panhandle Region after 2002. Consequently, these fish were offspring from natural reproduction.

In the LH area of the NFCDR, about 31% of the trout were rainbow trout in 2007. Based on snorkel surveys and other work conducted in the NFCDR system, it appears that a natural reproducing rainbow trout population exists in the NFCDR downstream of Shoshone Creek and downstream of Laverne Creek in the LNFCDR. No rainbow trout were observed in the C&R

areas during 2007. Others have also found introduced rainbow trout to be more abundant in the lower reaches of streams where cutthroat trout occur (Paul and Post 2001; Sloat et al. 2005). Some have suggested that the ability of rainbow trout to survive prolonged exposure to temperatures > 20°C and to grow over a wider range of temperatures helps explain why rainbow trout are often located in the lower reaches of streams and cutthroat trout in the upper reaches (Bear et al. 2005). The warmest water temperatures occur in the NFCDR system (between transects 8-13) however, it is not where the highest densities of rainbow trout occurred. Water temperature certainly influences the distribution of rainbow trout; but other factors obviously play a role. Differences in geomorphology within the North Fork Coeur d'Alene River system may also be influencing the distribution of rainbow trout. The further upstream you go in NFCDR system, the mre stream gradient increases and less area is available for floodplain. Cutthroat trout that spend the summer in the upstream reaches of the NFCDR migrate to areas (often > 15 km downstream) where the river is slower, deeper and has a wider floodplain to overwinter (DuPont et al. In Press b). Cutthroat trout evolved over thousands of year to develop these migrations to maximize their survival. Introduced rainbow trout don't have this adaptation and may explain why they don't exist in the upstream reaches. Moller and VanKirk (2003) found that rainbow trout in the South Fork Snake River appear to have a competitive advantage over Yellowstone cutthroat trout *O. clarkii bouvieri* where flows were less flashy (lower peak flows and higher low flows). They speculate these types of flows provide better rearing conditions for age-1 rainbow trout that occur in the main river. Wider, well vegetated floodplains occur in the lower reaches of the NFCDR system. They moderate flows by dispersing floodwaters across the floodplain during high flow periods and releasing groundwater during low flow periods. The area with the widest and most intact floodplain occurs downstream of the South Fork Coeur d'Alene River in the Coeur d'Alene River. Rainbow trout represent about 10% of the trout species in this reach (DuPont et al. In Press e), whereas they represent over 30% of the trout species in the lower NFCDR. Water temperatures and fishing mortality are lower downstream of the South Fork Coeur d'Alene River than upstream (DuPont et al. In Press c). A combination of water temperature, geomorphology and fishing pressure all play a role in the distribution and abundance of rainbow trout in the NFCDR.

A decline in the density of rainbow trout was observed in 2003. However, since 2003, the abundance of rainbow trout has remained relatively steady. The current fishing regulations allow six rainbow trout of any size to be harvested from the Coeur d'Alene River system. These regulations do not appear to be causing the rainbow trout population to be declining in abundance, although they may be keeping the rainbow trout population from increasing. What does appear to be happening is the regulations are causing the size of the rainbow trout to decline. Fishermen regularly comment on how the size of the rainbow trout they catch has become much smaller.

In the St. Joe River, rainbow trout were observed in only two transects in the C& R area and indicates very little natural reproduction and overwinter survival is occurring upstream of the North Fork St. Joe River. Rainbow trout were observed in four of the seven transects in the LH areas, although their average density (0.02 fish/100 m^2) was 17 times lower that what occurred in the LH area of the NFCDR. The apparent difference in survival of rainbow trout in the St. Joe River versus the NFCDR is probably due to their differences in geomorphology. As mentioned earlier, the NFCDR system has a wider valley bottom, a flatter grade and more floodplain areas than occur in the St. Joe River. These attributes would moderate flows and reduce the need for non-native rainbow trout to migrate to find suitable overwintering and rearing habitat.

Rainbow trout were observed upstream of Prospector Creek in the St. Joe River for the second time since hatchery rainbow trout stocking, ceased. The observance of rainbow trout upstream of Prospector Creek could be a result of the mild winters that have occurred over the past ten years. If current weather patterns continue, warmer water temperatures could allow rainbow trout populations to spread upstream (Fausch et al. 2006; McMahon et al. 2006, Weigel et al. 2003)

Bull trout

Few bull trout have been observed while snorkeling transects in the St. Joe River. No more than four bull trout have been observed while conducting snorkel surveys since 1977. In 2007, we did not observe any bull trout while conducting our snorkel surveys. Given the limited number of observations, it's best not to use these counts to speculate on trends in their abundance. For example, a record high number of bull trout redds were counted in the St. Joe watershed during 2007 (redd counts were initiated in 1992).

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor cutthroat trout abundance in the St. Joe River and NFCDR through snorkel surveys on an annual basis.
2. Reduce illegal harvest of cutthroat trout from the NFCDR system by increasing angler awareness of the fishing regulations, increasing enforcement in problem areas, and presenting information to the public.
3. Propose a range of fishing regulation options that show how restrictive fishing regulations must be to improve the density and size structure of cutthroat trout.
4. Make public aware of the impacts changes in climate and weather patterns can have on the cutthroat trout fishery.

Table 19. Number and density of fishes observed while snorkeling transects in the St. Joe River, Idaho, during August 7-9, 2007.

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	3,368	11	14	0.42	0	35	1.04	0	0	0.01
	SJ02	2,730	12	24	0.88	0	80	2.93	55	60	0.04
	SJ03	972	6	12	1.23	1	30	3.09	0	7	0.04
	SJ04	1,095	6	15	1.37	0	30	2.74	2	15	0.04
	SJ05	3,490	5	20	0.57	0	30	0.86	5	40	0.01
	SJ06	6,397	3	24	0.38	0	45	0.70	10	40	0.01
	SJ07	4,429	18	45	1.02	0	50	1.13	0	33	0.02
Prospector Creek to Red Ives Creek	SJ08	3,480	10	35	1.01	0	60	1.72	0	50	0.03
	SJ09	2,055	2	15	0.73	0	8	0.39	0	0	0.01
	SJ10	6,158	16	50	0.81	0	180	2.92	0	80	0.04
	SJ11	2,725	11	38	1.39	0	80	2.94	0	0	0.04
	SJ12	1,379	13	45	3.26	4	95	6.89	0	0	0.10
	SJ13	3,387	13	48	1.42	0	75	2.21	0	17	0.04
	SJ14	2,731	12	24	0.88	0	40	1.46	0	15	0.02
	SJ15	2,115	3	20	0.95	0	15	0.71	0	0	0.02
	SJ16	2,208	7	22	1.00	0	7	0.32	0	3	0.01
	SJ17	2,463	22	38	1.54	0	20	0.81	0	7	0.02
	SJ18	573	20	54	9.42	0	115	20.07	0	0	0.29
	SJ19	741	3	9	1.21	0	0	0.00	0	0	0.01
	SJ20	1,335	7	20	1.50	0	4	0.30	0	0	0.02
	SJ21	719	12	18	2.50	0	15	2.09	0	15	0.05
	SJ22	1,698	14	64	3.77	0	75	4.42	0	0	0.08
Red Ives to Ruby Creek	SJ23	702	3	7	1.00	0	0	0.00	0	0	0.01
	SJ24	888	5	20	2.25	0	0	0.00	0	0	0.02
	SJ25	1,098	13	41	3.73	0	0	0.00	0	0	0.04
	SJ26	1,544	4	7	0.45	0	0	0.00	0	0	0.00
	SJ27	1,266	38	50	3.95	0	150	11.85	0	0	0.16
	SJ28	511	6	15	2.93	0	10	1.96	0	0	0.05
Calder to N.F. St. Joe	SJ29	1,393	4	4	0.29	0	37	2.66	69	12	0.03
	SJ30	11,917	4	5	0.04	0	40	0.34	131	45	0.00
	SJ31	6,683	1	3	0.04	0	43	0.64	43	30	0.01
	SJ32	7,176	11	14	0.20	1	55	0.77	29	7	0.01
	SJ33	6,740	1	1	0.01	1	0	0.00	0	0	0.00
	SJ34	2,432	4	7	0.29	3	105	4.32	35	2	0.05
	SJ35	4,674	13	20	0.43	4	110	2.35	90	25	0.03
Total	35	103,271	333	848	0.82	14	1,639	1.59	469	503	0.02

Table 20. Characteristics of transects snorkeled in the St. Joe River, Idaho, during August 7-9, 2007.

Reach	Transect	Date snorkeled	Time snorkeled	Temp (°C)	Visibility (m)	Habitat type	Max depth (m)	Dominant cover	Percent cover	Length (m)	Average width (m)	Area (m^2)
N.F. St Joe River to Prospector Creek	SJ01	8/9/2007	13:07	17.0	7.3	Riffle	0.5	LS	5	84	40.10	3,368
	SJ02	8/9/2007	12:40	15.5	7.3	Pool	5.5	LS	30	130	21.00	2,730
	SJ03	8/9/2007	11:41	15.5	7.5	Run	2.0	LS	60	80	12.15	972
	SJ04	8/9/2007	11:28	15.0	7.3	Pool	2.5	LS	45	75	14.60	1,095
	SJ05	8/9/2007	10:52	15.0	7.3	Riffle/Run	1.5	LS	15	150	23.27	3,490
	SJ06	8/9/2007	10:06	14.0	7.3	Pool	6.0	LS	5	200	31.98	6,397
	SJ07	8/9/2007	9:38	14.0	6.4	Run	1.8	LS	5	140	31.63	4,429
Prospector Creek to Red Ives Creek	SJ08	8/9/2007	9:16	14.0	7.3	Pool	7.0	LS	20	145	24.00	3,480
	SJ09	8/8/2007	16:42	17.0	6.4	Run	1.5	LS	10	80	25.68	2,055
	SJ10	8/8/2007	16:25	17.0	6.4	Pool/Glide	2.0	LS	10	250	24.63	6,158
	SJ11	8/8/2007	15:58	16.5	5.4	Run	1.2	LS	5	100	27.25	2,725
	SJ12	8/8/2007	15:32	16.5	8.2	Pool	2.6	LS	5	60.9	22.65	1,379
	SJ13	8/8/2007	13:54	15.0		Run	0.6	LS	15	115.2	29.40	3,387
	SJ14	8/8/2007	13:04	14.0	7.0	Run	1.5	LS	10	118	23.14	2,731
	SJ15	8/8/2007	12:42	14.0	6.4	Run	2.5	LS	20	135	15.67	2,115
	SJ16	8/8/2007	12:02	14.0	7.3	Pool/Riffle	2.0	LS	15	150	14.72	2,208
	SJ17	8/8/2007	11:23	14.0	5.4	Pool	9.0	LS	15	150	16.42	2,463
	SJ18	8/8/2007	10:49	12.0	7.3	Run	2.0	LS	60	48.4	11.84	573
	SJ19	8/8/2007	10:28	13.0	7.3	Run	0.7	LS	25	41.1	18.04	741
	SJ20	8/8/2007	9:52	12.5	7.3	Run	0.5	LS	40	70.4	18.96	1,335
	SJ21	8/8/2007	8:48	11.0	6.4	Pool	2.5	LS	15	40.2	17.88	719
	SJ22	8/7/2007	17:18	17.0	8.2	Pool	2.5	LS	25	70.4	24.12	1,698
Red Ives to Ruby Creek	SJ23	8/7/2007	16:30	18.0	10.0	Run	0.5	LS	40	55.7	12.60	702
	SJ24	8/7/2007	16:15	18.0	10.0	Run	0.5	LS	30	67.7	13.12	888
	SJ25	8/7/2007	15:50	18.0	10.0	Run	0.9	LS	20	62.1	17.68	1,098
	SJ26	8/7/2007	14:00	17.0	10.9	Run	0.9	LS	40	74.9	20.62	1,544
	SJ27	8/7/2007	13:40	16.0	10.9	Pool	1.9	LS	50	60.3	21.00	1,266
	SJ28	8/7/2007	13:10	16.0	10.9	Run	1.2	LS	60	40.2	12.72	511
Calder to N.F. St. Joe River	SJ29	8/9/2007	16:44	20.0	7.3	Pool	4.0	LS	5	41	33.98	1,393
	SJ30	8/9/2007	16:12	20.0	9.1	Pool	9.0	LS	20	250	47.67	11,917
	SJ31	8/9/2007	15:36	18.5	9.1	Run	2.0	LS	5	200	33.42	6,683
	SJ32	8/9/2007	15:05	20.0	6.4	Run	2.5	LS	10	218	32.92	7,176
	SJ33	8/9/2007	14:34	18.0	6.4	Run	0.7	LS	15	150	44.93	6,740
	SJ34	8/9/2007	14:02	18.0	6.4	Run	0.6	LS	10	100	24.32	2,432
	SJ35	8/9/2007	13:34	17.0	9.1	Run/Glide	0.6	LS	5	130	35.95	4,674

Table 21. 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 2007 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
Calder to North Fork St. Joe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	0.23	0.16	0.14	0.15	0.09	--	[redacted]	0.11	0.11	--	--	0.13
N.F. St. Joe to Prospector Cr.	0.01	0.00	0.07	0.04	0.01	0.11	0.08	--	[redacted]	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
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
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
All transects - entire river	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.79	0.76	1.19	1.06	1.09	0.50	--	[redacted]	0.64	0.90	--	--	0.82
N.F. St. Joe to Ruby Creek	0.27	0.29	0.52	0.58	0.63	1.23	1.40	3.10	[redacted]	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

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
Calder to North Fork St. Joe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.05	0.02	0.03	0.00	0.01	--	[redacted]	0.00	0.02	--	--	0.09
N.F. St. Joe to Prospector Cr.	0.01	0.00	0.00	0.00	0.00	0.00	0.00	--	[redacted]	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
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
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
All transects - entire river	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.26	0.20	0.19	0.25	0.06	0.05	--	[redacted]	0.12	0.13	--	--	0.32
N.F. St. Joe to Ruby Creek	0.03	0.02	0.01	0.00	0.06	0.00	0.00	0.00	[redacted]	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

1976 - transects 1-12 were not counted.
[redacted] - transects 1-4 were not counted.
[redacted] - transects 29-35 were in different locations than other years.

Table 22. Fishers Least-Significance-Difference Test matrices showing pairwise comparison probabilities of cutthroat trout densities (all sizes and ≥ 300 mm) between four stream reaches in the St. Joe River, Idaho, during 2007. Shaded cells indicate which stream reaches had significantly different ($p \leq 0.10$) cutthroat trout densities.

All sizes

	Calder.	N.F. St. Joe	Prospector	Red Ives
Calder	1.000			
N.F. St. Joe	0.454	1.000		
Prospector	0.015	0.099	1.000	
Red Ives	0.020	0.094	0.710	1.000

Cutthroat trout ≥ 300 mm

	Calder.	N.F. St. Joe	Prospector	Red Ives
Calder	1.000			
N.F. St. Joe	0.558	1.000		
Prospector	0.074	0.257	1.000	
Red Ives	0.021	0.072	0.301	1.000

Table 23. History of fishing regulations for cutthroat trout in the St. Joe River and Coeur d'Alene River, Idaho, from 1941 to 2007.

St. Joe River			
Year	CdA Lake to N.F. St Joe	N.F. St. Joe to Prospector Cr.	Prospector Cr. to headwaters
1941-1945	15 lbs plus 1 fish - not to exceed 25 fish		
1946-1950	10 lbs plus 1 fish - not to exceed 20 fish		
1951-1954	7 lbs plus 1 fish - not to exceed 20 fish		
1955-1970	7 lbs plus 1 fish - not to exceed 15 fish		
1971	7 lbs plus 1 fish - not to exceed 15 fish		3 fish, none < 13 inches
1972-1975	7 lbs plus 1 fish - not to exceed 10 fish		3 fish, none < 13 inches
1976	10 fish, only 5 > 12 inches and 2 > 18 inches		3 fish, none < 13 inches
1977-1987	6 fish, only 2 > 16 inches		3 fish, none < 13 inches
1988-1999	1 fish, none < 14 inches		3 fish, none < 13 inches
2000-2007	2 fish, none between 8"-16"	Catch-and-release	Catch-and-release

Coeur d'Alene River			
Year	CdA Lake to Yellow Dog Creek	Yellow Dog Creek to headwaters (NF CdA)	Laverne Creek to headwaters (LNF CdA)
1941-1945	15 lbs plus 1 fish - not to exceed 25 fish		
1946-1950	10 lbs plus 1 fish - not to exceed 20 fish		
1951-1954	7 lbs plus 1 fish - not to exceed 20 fish		
1955-1971	7 lbs plus 1 fish - not to exceed 15 fish		
1972-1974	7 lbs plus 1 fish - not to exceed 10 fish		
1975	7 lbs plus 1 fish - not to exceed 10 fish	3 fish, none < 13 inches	
1976	10 fish, only 5 > 12 inches & 2 > 18 inches	3 fish, none < 13 inches	
1977-1985	6 fish, only 2 > 16 inches	3 fish, none < 13 inches	
1986-1987	6 fish, only 2 > 16 inches	Catch-and-release	3 fish, none < 13 inches
1988-1999	1 fish, none < 14 inches	Catch-and-release	
2000-2007	2 fish, none between 8"-16"	Catch-and-release	

Table 24. Average density (fish/100 m^2) of mountain whitefish counted by reach during snorkel surveys from 1969 to 2007 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
Calder to N.F. St. Joe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.60	0.18	0.34	0.88	0.44	0.10	--	[illegible]	0.33	0.80	--	--	0.95
N.F. St. Joe to Prospector Cr.	0.86	0.90	0.98	0.24	1.09	0.95	1.08	--	[illegible]	1.09	0.77		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
Prospector Cr. to Red Ives Cr.	1.24	1.16	1.12	0.82	3.72	1.33	0.97	0.71	[illegible]	1.69	1.20		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
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		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
Average for all sites	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.95	0.75	1.03	1.01	0.41	0.60	--	[illegible]	0.68	1.47	--	--	1.59
NF St Joe to Ruby Creek	1.14	1.06	1.14	0.73	2.29	1.27	1.19	0.84	[illegible]	1.54	1.01		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

1976 -transects SJ01-SJ12 were not snorkeled.
1977 - transects SJ01-SJ04 were not snorkeled.
[illegible] - transects SJ05-SJ16 were only evaluated for presence/absence.
[illegible] - transects SJ01-SJ25 were only evaluated for presence/absence.
[illegible] - transect locations differed this year from other years.

Table 25. Average density (fish/100 m^2) of rainbow trout counted by reach during snorkel evaluations from 1969 to 2007 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
Calder to N.F. St. Joe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.14	0.10	0.21	0.20	0.03	0.15	--		0.04	0.03	--	--	0.02
N.F. St. Joe to Prospector Cr.	0.07	0.13	0.25	0.25	0.16	0.44	0.86	--	[illegible]	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
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
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
Average for all sites	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.10	0.08	0.11	0.17	0.02	0.16	0.00		0.02	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	[illegible]	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

1976 - transects SJ01-SJ12 were not snorkeled.
1977 - transects SJ01-SJ04 were not snorkeled.
2001 - transect locations differed this year from other years.

Table 26. Number and density (fish/100 m2) of fishes observed while snorkeling transects in the North Fork Coeur d'Alene River drainage, Idaho, during July 30 to August 1, 2007.

Reach	Transect name	Area (m^2) snorkeled	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)	Mountain whitefish: Number counted	Mountain whitefish: Density (No./100 m^2)	Brook trout counted	Largescale sucker counted	Northern pikeminnow counted	Salmonid density (No./100 m^2)
Lower North Fork (Limited Harvest Allowed)	NF1	3,955	8	29	0.73	22	0.56	550	13.91	0	80	1250	0.15
	NF1(slough)	1,498	16	21	1.40	15	1.00	305	20.36	1		10	0.23
	NF2	6,777	7	16	0.24	11	0.16	220	3.25	0	10	20	0.04
	NF3	6,631	3	31	0.47	22	0.33	560	8.45	0	40	610	0.09
	NF4	8,693	6	42	0.48	27	0.31	600	6.90	0	300	1200	0.08
	NF5	4,169	6	72	1.73	49	1.18	275	6.60	0	160	1200	0.09
	NF6	6,498	7	43	0.66	36	0.55	200	3.08	0	0	55	0.04
	NF7	5,471	21	141	2.58	39	0.71	350	6.40	0	50	0	0.10
	NF8	6,209	26	64	1.03	12	0.19	180	2.90	0	0	0	0.04
	NF9	9,990	10	39	0.39	7	0.07	10	0.10	0	0	0	0.01
	NF10	6,089	38	125	2.05	55	0.90	320	5.26	0	0	0	0.08
	NF11	5,688	4	6	0.11	1	0.02	0	0.00	0	0	0	0.00
	NF12	4,773	3	3	0.06	0	0.00	0	0.00	0	0	0	0.00
	NF13	3,090	0	0	0.00	0	0.00	0	0.00	0	0	0	0.00
North Fork (Catch-and-Release)	NF14	3,369	28	86	2.55	0	0.00	390	11.58	0	0	0	0.14
	NF15	1,895	10	92	4.86	0	0.00	650	34.31	0	0	0	0.39
	NF16	3,894	6	14	0.36	0	0.00	0	0.00	0	0	0	0.00
	NF17	10,811	16	100	0.93	0	0.00	18	0.17	0	0	0	0.01
	NF18	1,317	9	23	1.75	0	0.00	125	9.49	0	0	0	0.11
	NF19	489	7	54	11.05	0	0.00	0	0.00	0	0	0	0.11
	NF20	913	0	3	0.33	0	0.00	0	0.00	0	0	0	0.00
	NF21	726	16	64	8.82	0	0.00	0	0.00	0	0	0	0.09
	NF22	1,026	6	25	2.44	0	0.00	0	0.00	0	0	0	0.02
	NF23	418	0	1	0.24	0	0.00	0	0.00	0	0	0	0.00
Teepee Creek (Catch-and-Release)	TP01	1,412	17	57	4.04	0	0.00	0	0.00	0	0	0	0.04
	TP02	3,657	1	4	0.11	0	0.00	0	0.00	0	0	0	0.00
	TP03	925	4	5	0.54	0	0.00	0	0.00	0	0	0	0.01
	TP04	1,299	3	7	0.54	0	0.00	0	0.00	0	0	0	0.01
	TP05	1,141	0	23	2.02	0	0.00	120	10.52	0	0	0	0.13
	TPR1	1,112	3	8	0.72	0	0.00	0	0.00	0	0	0	0.01
	TPR2	1,675	1	2	0.12	0	0.00	0	0.00	0	0	0	0.00

Table 26. Continued.

Reach	Transect name	Area (m^2) snorkeled	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)	Mountain whitefish Number counted	Mountain whitefish Density (No./100 m^2)	Brook trout counted	Largescale sucker counted	Northern pikeminnow counted	Salmonid density (No./100 m^2)
Little North Fork (Limited Harvest Allowed)	LNF1	676	0	1	0.15	0	0.00	0	0.00	0	0	0	0.00
	LNF2	3,077	0	5	0.16	3	0.10	0	0.00	0	0	2	0.00
	LNF3	1,775	0	5	0.28	2	0.11	0	0.00	0	0	0	0.00
	LNF4	671	2	16	2.38	2	0.30	0	0.00	5	0	0	0.03
	LNF5	885	2	7	0.79	0	0.00	0	0.00	0	0	0	0.01
	LNF6	924	0	7	0.76	1	0.11	0	0.00	0	0	0	0.01
	LNF7	966	1	3	0.31	0	0.00	0	0.00	0	0	0	0.00
	LNF8	1,079	1	9	0.83	0	0.00	0	0.00	0	0	0	0.01
Little North Fork (Catch-and-Release)	LNF9	464	0	1	0.22	0	0.00	0	0.00	0	0	0	0.00
	LNF10	1,474	7	43	2.92	0	0.00	0	0.00	0	0	0	0.03
	LNF11	960	1	22	2.29	0	0.00	0	0.00	0	0	0	0.02
	LNF12	777	1	4	0.51	0	0.00	0	0.00	0	0	0	0.01
	LNF13	847	1	32	3.78	0	0.00	0	0.00	0	0	0	0.04
Total	43 sites	130,183	298	1,355	1.04	304	0.23	4,873	3.74	6	640	4,347	5.02

Table 27. Characteristics of transects snorkeled in the North Fork Coeur d'Alene River drainage, Idaho, during July 30 to August 1, 2007.

Reach	Transect	Date snorkeled	Time snorkeled	Temp (°C)	Visibility (m)	Habitat type	Max depth (m)	Dominant cover	Percent cover	Length (m)	Average width (m)	Area (m^2)
Lower North Fork (Limited Harvest Allowed)	NF1	8/1/2007	11:40	18.0	10.0	Pool	5	LS	20	128	30.90	3,955
	NF1(slough)	8/1/2007	12:00	16.0	10.0	Pool	2.5	LS	30	87.7	17.08	1,498
	NF2	8/1/2007	12:30	18.0	10.0	Pool	4.5	LS	15	187	36.24	6,777
	NF3	8/1/2007	13:08	18.5	10.9	Pool	3	LS	25	169.5	39.12	6,631
	NF4	8/1/2007	10:50	18.0	10.9	Pool	7	LS	10	198.4	43.82	8,693
	NF5	8/1/2007	10:15	16.5	10.9	Pool	4	LS	20	183	22.78	4,169
	NF6	8/1/2007	9:45	16.0	13.7	Pool	4	LS	10	171.9	37.80	6,498
	NF7	8/1/2007	9:30	16.0	10.0	Pool	5.5	LS	10	170	32.18	5,471
	NF8	7/31/2007	16:30	21.5	10.0	Pool	3.3	LS	10	165.2	37.58	6,209
	NF9	7/31/2007	16:05	23.0	10.0	Pool	2	LS	5	270	37.00	9,990
	NF10	7/31/2007	15:33	23.2	10.0	Run	3	LS		258	23.60	6,089
	NF11	7/31/2007	15:15	22.5	10.0	Pool	1.5	LS		175	32.50	5,688
	NF12	7/31/2007	14:53	23.0	11.0	Run/Glide	0.9	LS	35	170	28.08	4,773
	NF13	7/31/2007	14:31	22.5	11.8	Pool	1.5	LS	15	95	32.53	3,090
North Fork (Catch-and-Release)	NF14	7/31/2007	14:15	22.5	10.9	Pool	4	LS	10	143	23.56	3,369
	NF15	7/31/2007	13:38	21.0	10.8	Pool	4.5	LS	30	73.1	25.92	1,895
	NF16	7/31/2007	13:22	20.0	11.8	Run	1.3	LS	25	172	22.64	3,894
	NF17	7/31/2007	12:45	20.0	10.9	Pool	3	LS	15	375.8	28.77	10,811
	NF18	7/30/2007	10:30	17.5	9.0	Pool	2	LS	10	89	14.80	1,317
	NF19	7/30/2007	14:45	21.0	9.0	Pool/Run	1.1	LWD	30	47	10.40	489
	NF20	7/30/2007	14:15	20.5	9.0	Run	1.8	LS		55	16.60	913
	NF21	7/30/2007	13:30	19.5	9.0	Pool	2.7	LS	25	44	16.50	726
	NF22	7/30/2007	12:40	19.5	9.0	Pool	3.5	LS	15	54	19.00	1,026
	NF23	7/30/2007	12:15	18.0	9.0	Run	0.8	LS	20	33	12.67	418
Teepee Creek (Catch-and-Release)	TP01	7/30/2007	16:00	22.0	8.5	Pool	1.8	UB	15	107	13.20	1,412
	TP02	7/30/2007	16:30	23.0	8.0	Riffle/Run	0.7	LS	15	200	18.29	3,657
	TP03	7/30/2007	17:00	23.0	8.0	Pool	1.8	LS	5	68	13.60	925
	TP04	7/31/2007	11:40	16.0	9.0	Run	1	LS	20	112	11.60	1,299
	TP05	7/31/2007	11:05	16.0	9.0	Pool	2.5	LS	5	46	24.80	1,141
	TPR1	7/31/2007	10:25	15.0	10.0	Pool/Riffle	1.5	LWD	20	139	8.00	1,112
	TPR2	7/31/2007	9:50	14.0	10.0	Pool/Riffle	1.2	LWD	20	203	8.25	1,675

Table 27. Continued.

Reach	Transect	Date snorkeled	Time snorkeled	Temp (°C)	Visibility (m)	Habitat type	Max depth (m)	Dominant cover	Percent cover	Length (m)	Average width (m)	Area (m^2)
Little North Fork (Limited Harvest Allowed)	LNF1	8/1/2007	13:45	19.0	10.0	Pool/Run	1.5	SWD	5	53	12.75	676
	LNF2	8/1/2007	14:00	18.0	10.0	Pool/Run	2.2	LS	15	181	17.00	3,077
	LNF3	8/1/2007	14:20	18.0	11.0	Pool	5	LS	5	71	25.00	1,775
	LNF4	8/1/2007	14:40	19.0	10.0	Pool/Run	1.5	LWD	25	61	11.00	671
	LNF5	8/1/2007	15:05		10.0	Pool/Run	3.5	LS	15	60	14.75	885
	LNF6	8/1/2007	15:30	20.0	10.0	Pool/Run	1.2	LS	5	66	14.00	924
	LNF7	8/1/2007	15:50	20.5	12.0	Pool	1.7	LS	25	84	11.50	966
	LNF8	8/1/2007	16:15	21.0	12.0	Pool/Run	4	LS	5	65	16.60	1,079
Little North Fork (Catch-and-Release)	LNF9	8/1/2007	16:25	20.5	12	Run	0.6	LS	20	43	10.80	464
	LNF10	8/1/2007	16:35	20.0	12.0	Pool/Run	1.7	LWD	20	110	13.40	1,474
	LNF11	8/1/2007	16:50	20.5	12.0	Pool/Run	1.2	LS	15	75	12.80	960
	LNF12	8/1/2007	17:00	20.0	12.0	Pool/Riffle	2	LS	20	67	11.60	777
	LNF13	8/1/2007	17:15	20.0	12.0	Pocket water	1.2	LS	50	58	14.60	847

Table 28. Fishers Least-Significance-Difference Test matrices showing pairwise comparison probabilities of cutthroat trout densities (all sizes and ≥ 300 mm) between seven stream reaches in the North Fork Coeur d'Alene River watershed, Idaho, during 2007. Shaded cells indicate which stream reaches had significantly different ($p \leq 0.10$) cutthroat trout densities. Stream reaches labeled by bold text occurred in limited harvest areas.

All sizes

	SF - Prich	**Prich-YD**	YD-Tepee	Tepee-JC	**LNF lower**	LNF upper	Tepee
SF CdA– Prichard Cr	1.000						
Prich-Yellow Dog Cr	0.679	1.000					
YD Cr-Tepee Cr	0.367	0.238	1.000				
Tepee Cr-Jordan Cr	0.005	0.004	0.065	1.000			
LNF lower	0.770	0.875	0.249	0.002	1.000		
LNF upper	0.434	0.283	0.912	0.052	0.301	1.000	
Tepee Creek	0.713	0.483	0.627	0.022	0.534	0.706	1.000

≥ 300 mm

	SF – Prich	**Prich-YD**	YD-Tepee	Tepee-JC	**LNF lower**	LNF upper	Tepee
SF CdA– Prichard Cr	1.000						
Prich-Yellow Dog Cr	0.857	1.000					
YD Cr-Tepee Cr	0.284	0.260	1.000				
Tepee Cr-Jordan Cr	0.011	0.014	0.157	1.000			
LNF lower	0.550	0.731	0.115	0.003	1.000		
LNF upper	0.836	0.981	0.250	0.013	0.750	1.000	
Tepee Creek	0.486	0.429	0.732	0.082	0.226	0.416	1.000

Table 29. Average 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 2007.

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
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
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
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
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
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
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
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
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
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
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
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
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
Tepee Creek Rehab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.87	0.00	1.09	0.48	0.55	0.36

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
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
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
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
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
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
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
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
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
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
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
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
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
Tepee Creek Rehab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.00	0.04	0.04	0.19	0.14

Table 30. Average 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 2007.

River section	1973	1980	1981	1987	1988	1991	1993[5]	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007
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
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
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
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
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	0.014	0.19	0.01	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
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
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
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
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
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
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
Tepee Creek Rehab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.00	0.00	0.00	0.00

Table 31. Average 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 2007.

River section	1973	1980	1981	1987	1988	1991	1993[5]	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007
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
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
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
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
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	0.094	0.17	0.12	0.08
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
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
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
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
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
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
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
Tepee Creek Rehab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.00	0.00	0.00	0.00

Table 32. Fishers Least-Significance-Difference Test matrix of pairwise comparison probabilities of cutthroat trout densities (all size classes and ≥ 300 mm) between seven stream reaches in the North Fork Coeur d'Alene River basin and four from the St. Joe River basin, Idaho, during 2005. Shaded cells indicate which stream reaches had significantly different ($p \leq 0.10$) cutthroat trout densities.

All size classes

	North Fork Coeur d'Alene River Reaches							St. Joe River Reaches			
	SF-Prich	Prich-YD	YD-Tepee	Tepee-JC	LNF lower	LNF upper	Tepee	Calder	NF St. Joe	Prospector	Red Ives
SF-Prich	1.000										
Prichard-YD	0.645	1.000									
YD-Tepee	0.314	0.188	1.000								
Tepee-JC	0.001	0.001	0.039	1.000							
LNF lower	0.745	0.861	0.198	0.001	1.000						
LNF upper	0.383	0.231	0.903	0.029	0.249	1.000					
Tepee	0.683	0.434	0.588	0.010	0.488	0.675	1.000				
Calder	0.394	0.758	0.085	0.000	0.589	0.111	0.251	1.000			
NF St. Joe	0.857	0.772	0.256	0.001	0.893	0.314	0.578	0.514	1.000		
Prospector	0.189	0.107	0.996	0.012	0.094	0.877	0.505	0.029	0.146	1.000	
Red Ives	0.177	0.103	0.793	0.056	0.100	0.696	0.409	0.037	0.140	0.746	1.000

≥ 300 mm

	North Fork Coeur d'Alene River Reaches							St. Joe River Reaches			
	SF-Prich	Prich-YD	YD-Tepee	Tepee-JC	LNF lower	LNF upper	Tepee	Calder	NF St. Joe	Prospector	Red Ives
SF-Prich	1.000										
Prichard-YD	0.897	1.000									
YD-Tepee	0.440	0.417	1.000								
Tepee-JC	0.059	0.069	0.306	1.000							
LNF lower	0.668	0.805	0.253	0.025	1.000						
LNF upper	0.882	0.986	0.407	0.067	0.820	1.000					
Tepee	0.617	0.570	0.806	0.206	0.382	0.559	1.000				
Calder	0.792	0.915	0.326	0.039	0.880	0.929	0.472	1.000			
NF St. Joe	0.623	0.575	0.750	0.156	0.366	0.563	0.958	0.465	1.000		
Prospector	0.041	0.061	0.367	0.723	0.012	0.058	0.231	0.025	0.157	1.000	
Red Ives	0.006	0.010	0.074	0.463	0.002	0.009	0.042	0.004	0.024	0.197	1.000

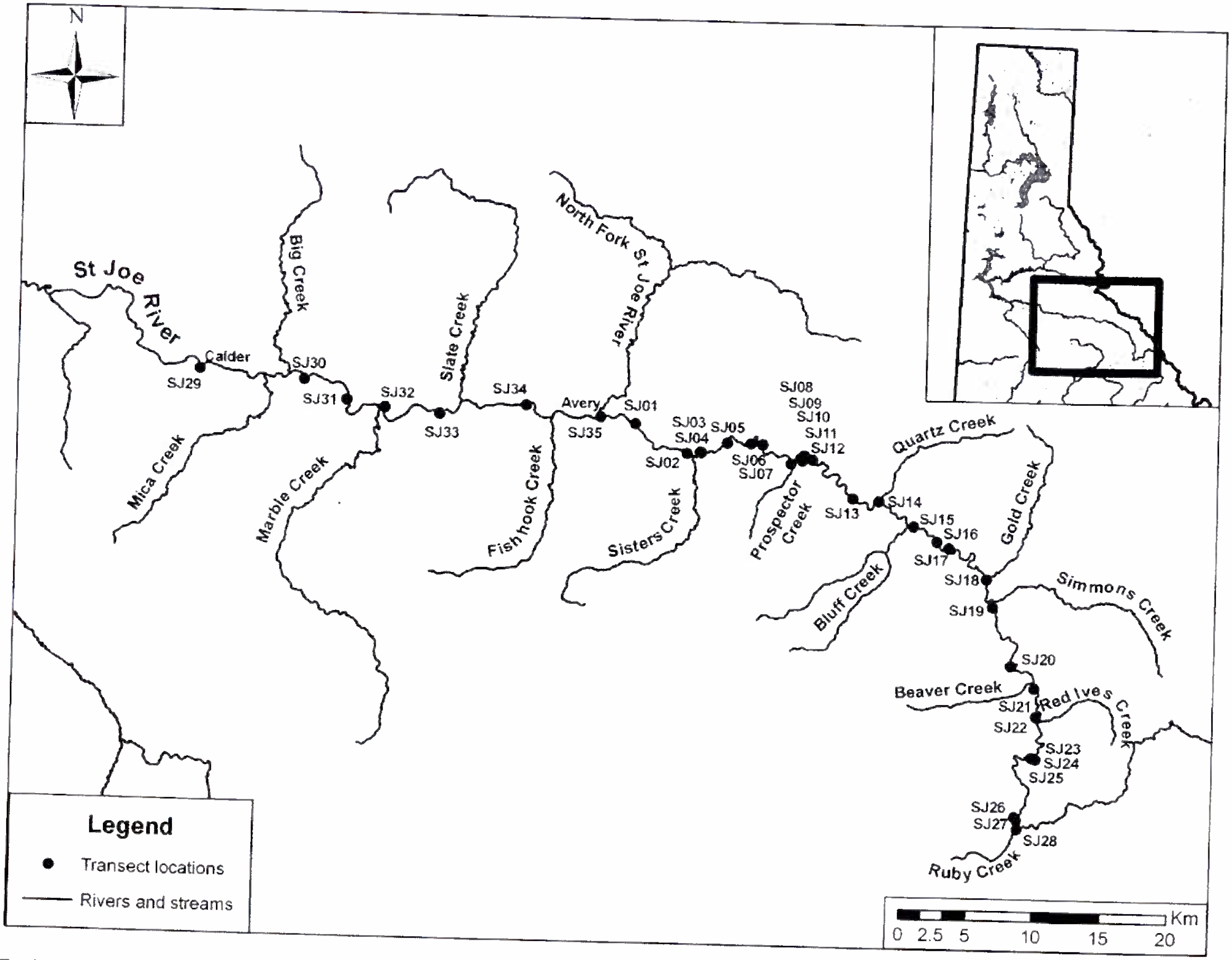


Figure 55. Location of 35 transects that were snorkeled on the St. Joe River, Idaho, during August 7-9, 2007.

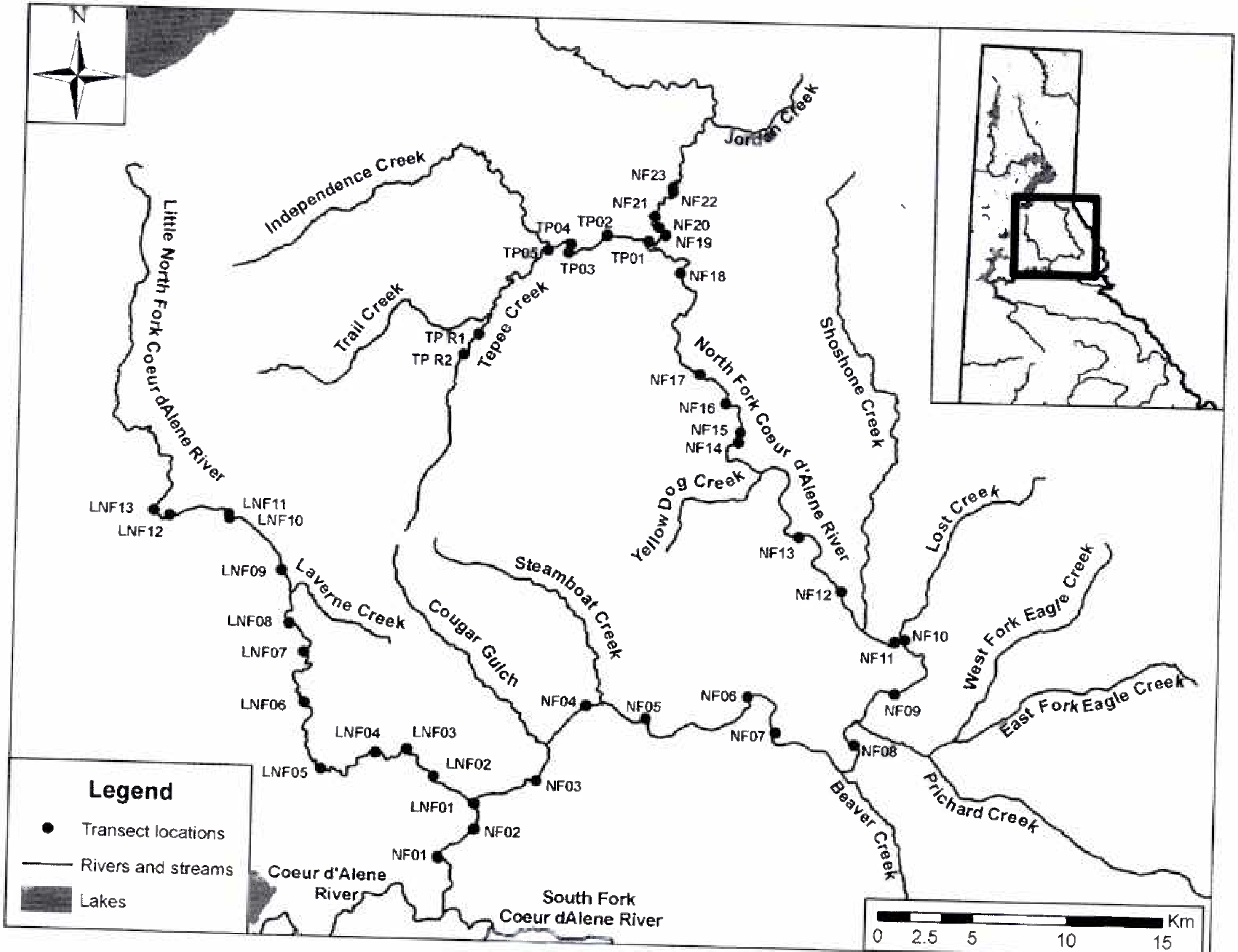
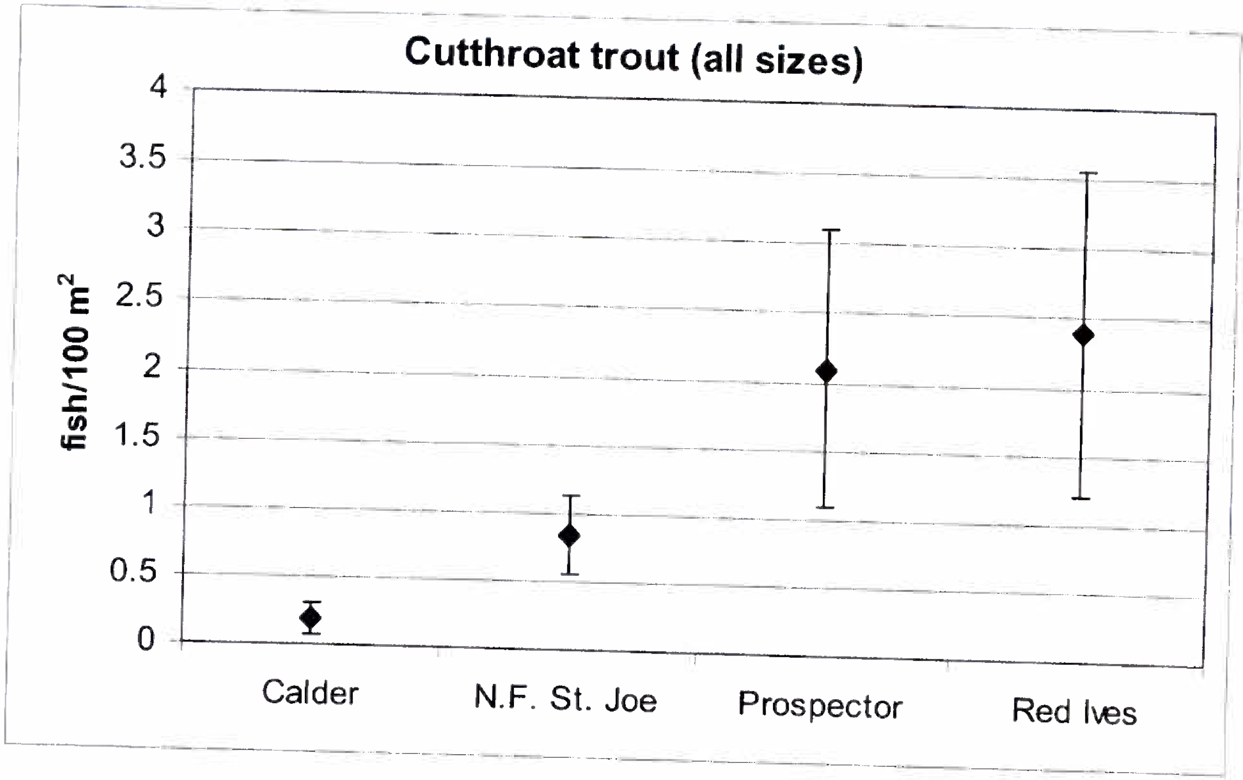


Figure 56. Location of 43 transects snorkeled on the Coeur d'Alene River, Idaho, during July 30 to August 1, 2007.



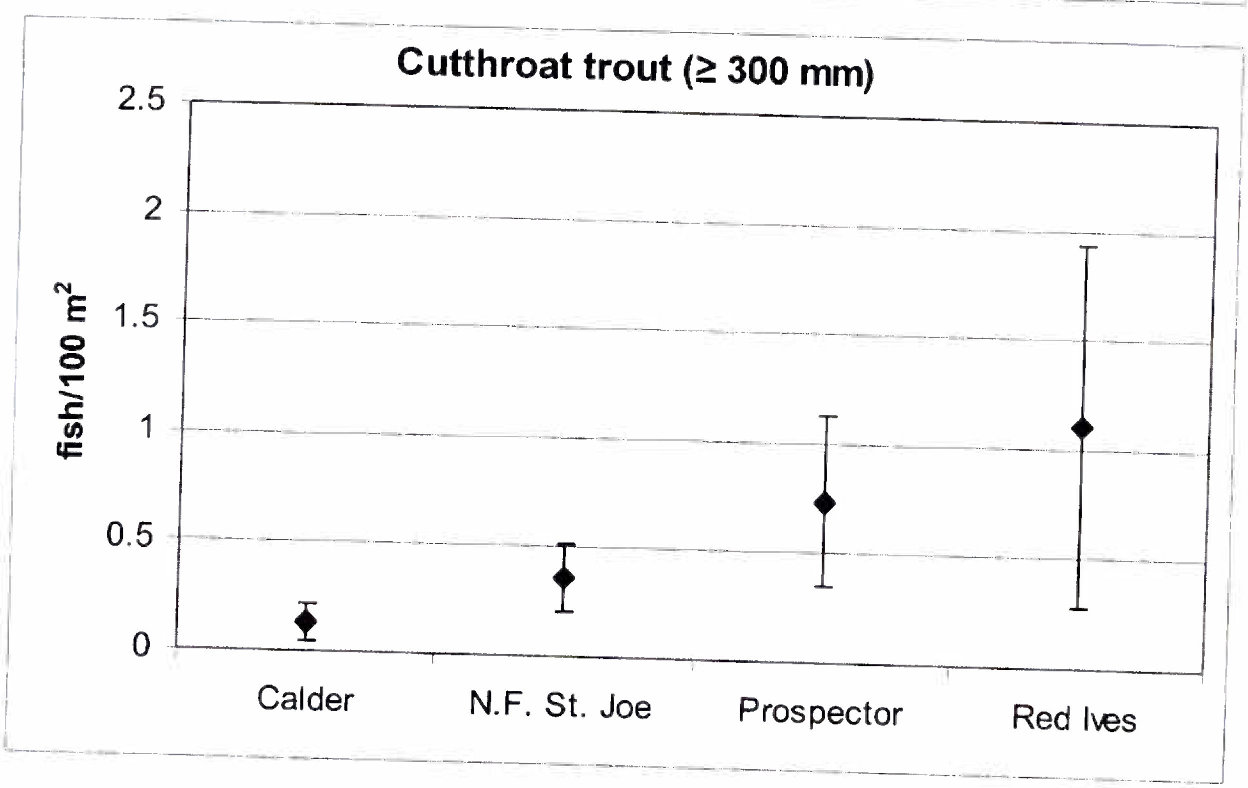


Figure 57. Average cutthroat trout density and 90% confidence intervals (all sizes and only those ≥ 300 mm) determined from snorkeling four different reaches in the St. Joe River, Idaho, during 2007.

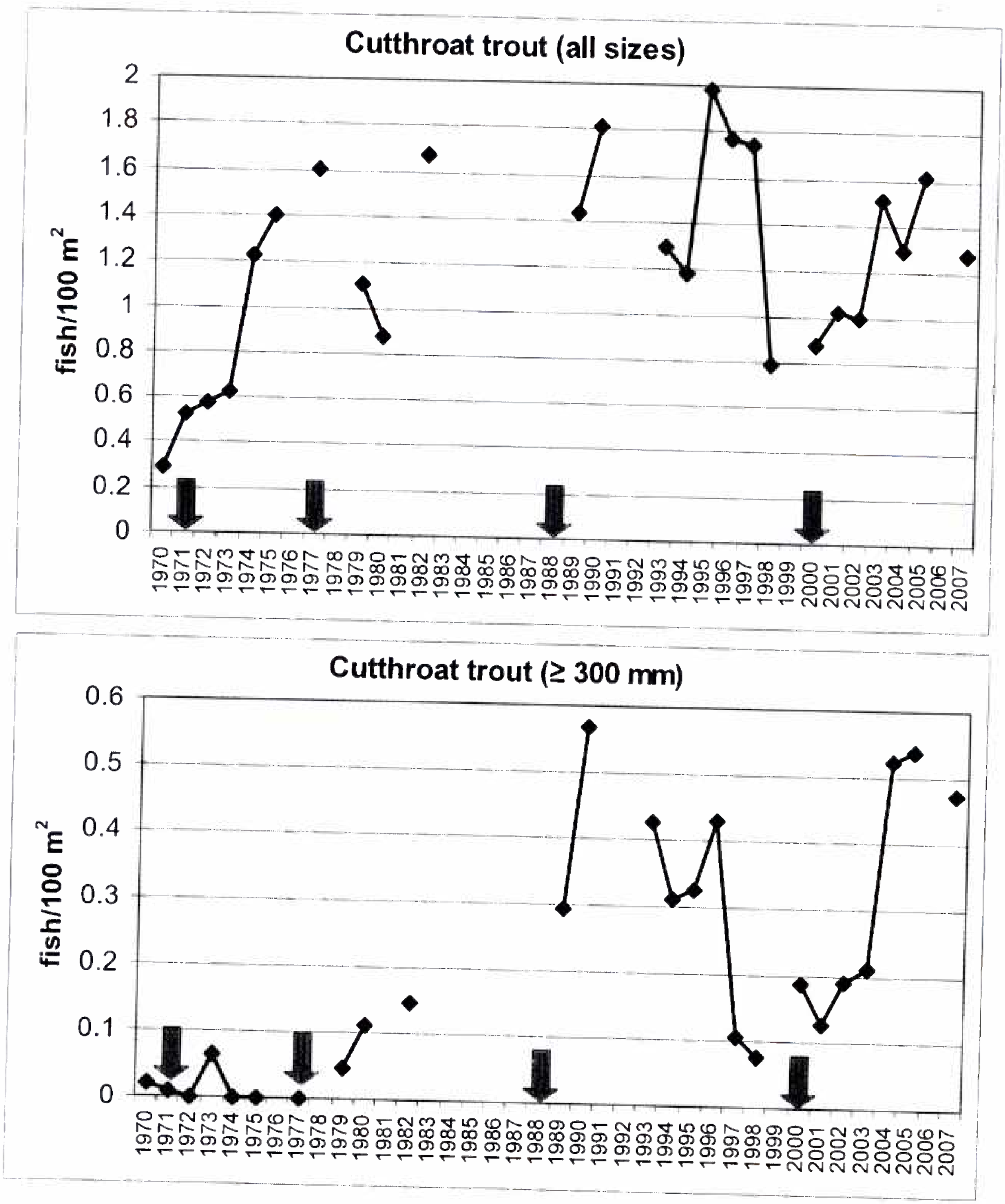


Figure 58. Average density (fish/100 m2) of all size classes of cutthroat trout and cutthroat trout ≥ 300 mm observed while snorkeling the St. Joe River, Idaho, between the North Fork St. Joe River and Ruby Creek from 1969 to 2007. Arrows signify when significant changes occurred in cutthroat trout fishing regulations. Refer to Table 5 to see how regulations changed in these years.

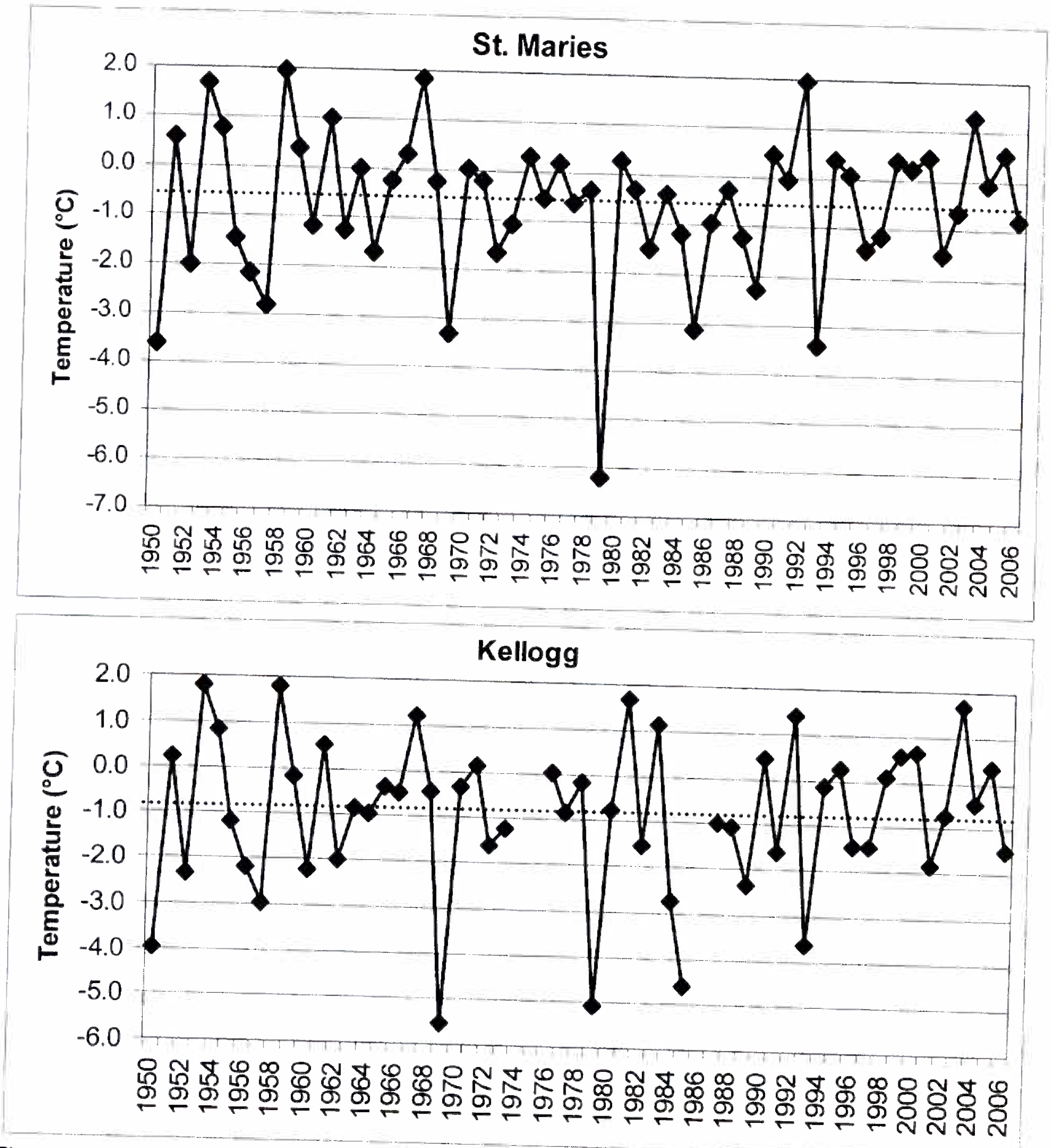


Figure 59. Average air temperature (°C) during winter (Dec-Feb) from 1950 to 2006 in St. Maries and Kellogg, Idaho. The dotted line represents the average winter temperature since 1950.

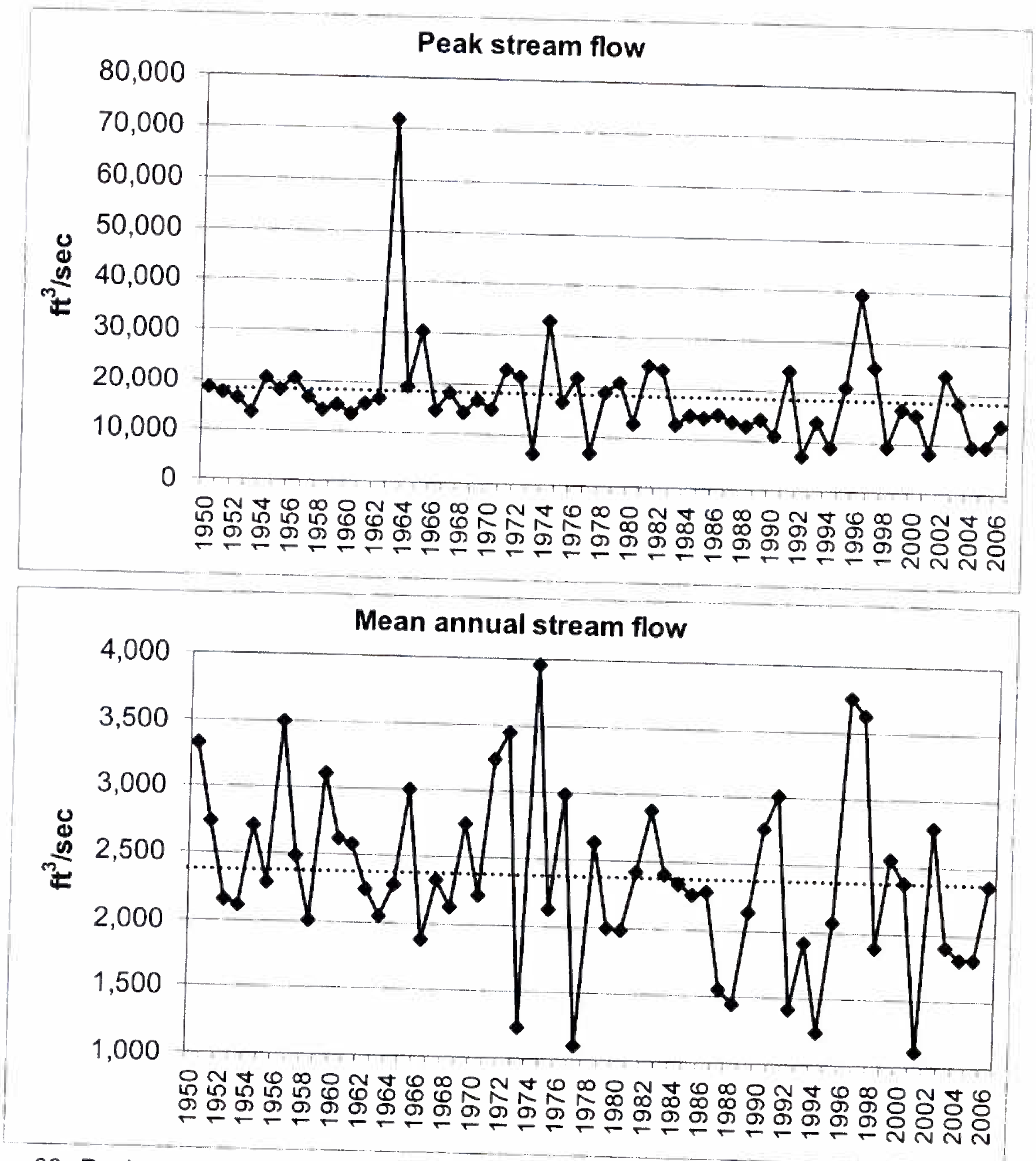


Figure 60. Peak stream flow and mean annual stream flow documented by USGS for the St. Joe River, Idaho, at Calder from 1950 to 2006. The dotted lines indicate the average flow since 1950.

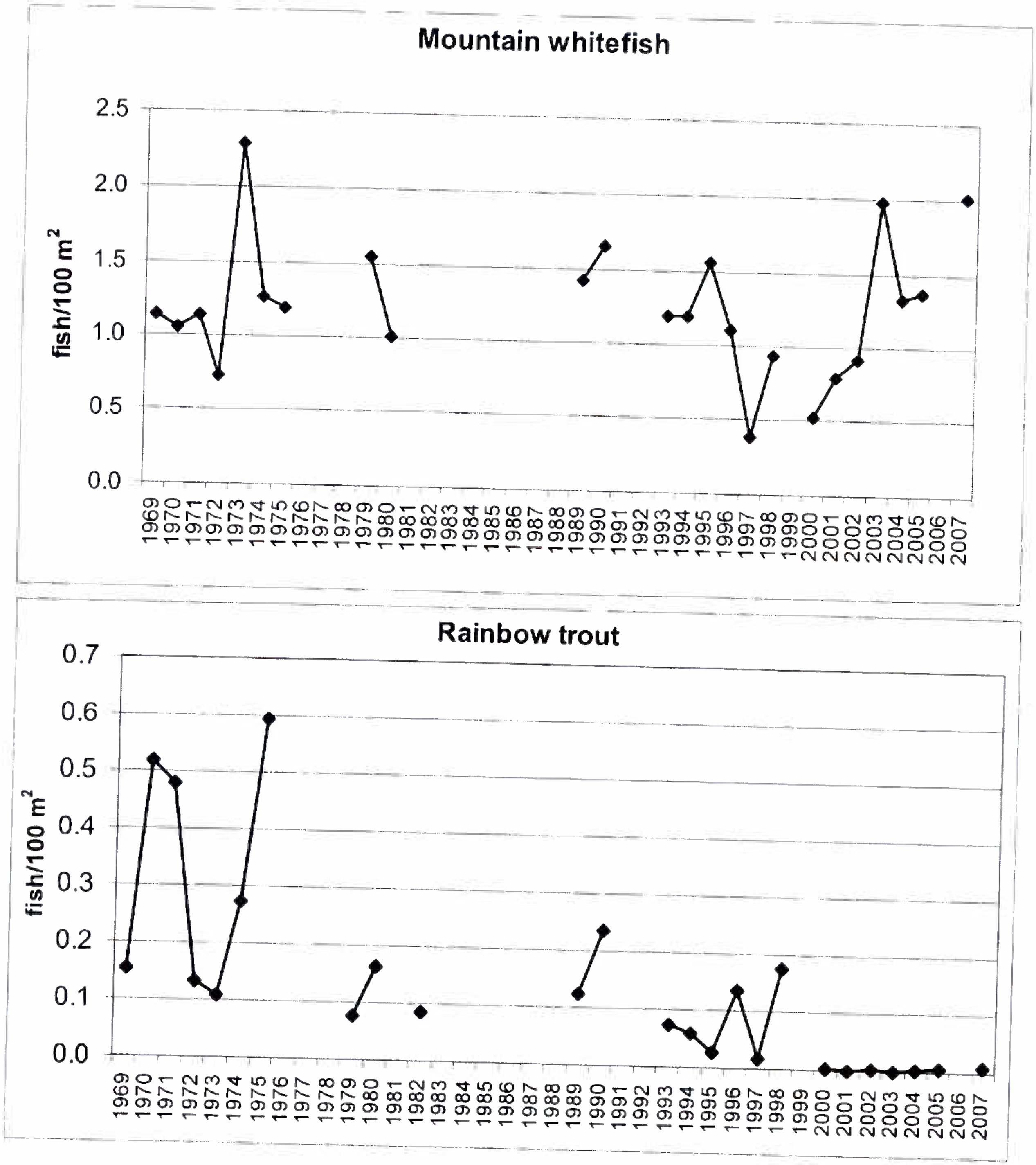


Figure 61. Average density (fish/100 m^2) of mountain whitefish and rainbow trout observed while snorkeling the St. Joe River, Idaho, between the North Fork St. Joe River and Ruby Creek from 1969 to 2007.

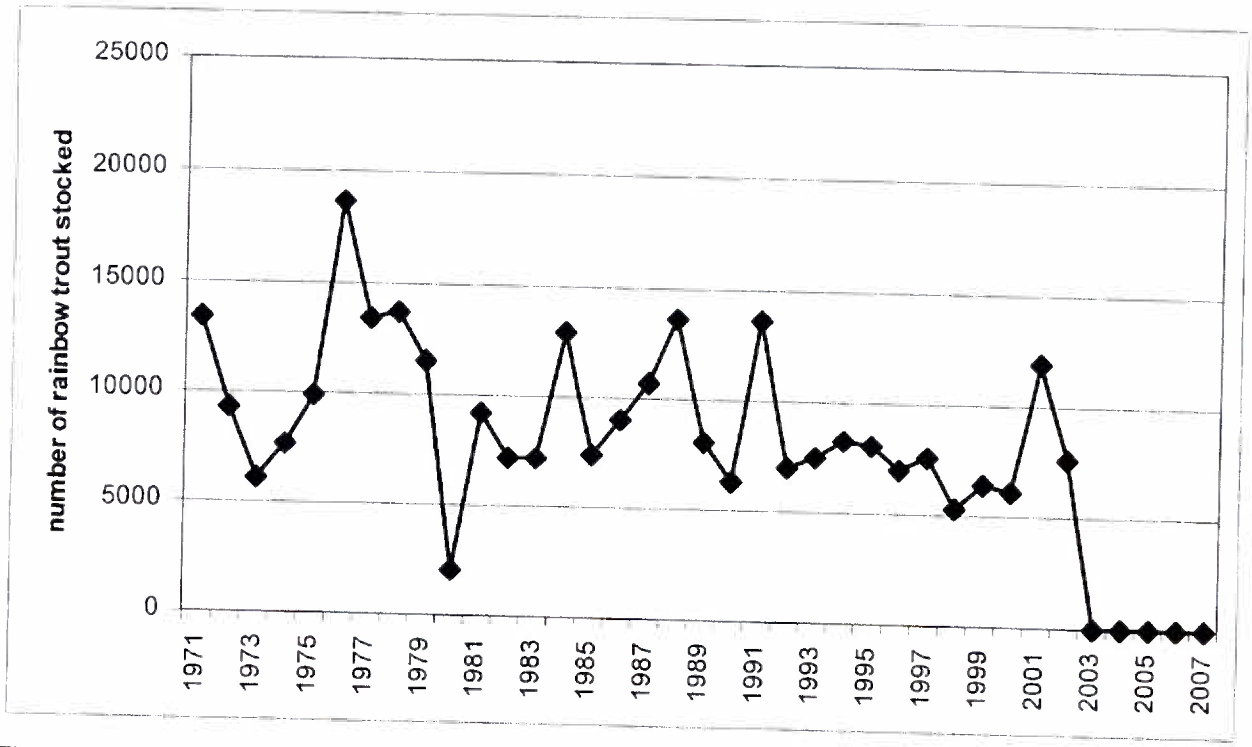


Figure 62. Number of rainbow trout > 150 mm in length stocked in the St. Joe River, Idaho, between 1971 and 2007. Prior to 1971, over 170,000 rainbow trout were stocked annually in the St. Joe River.

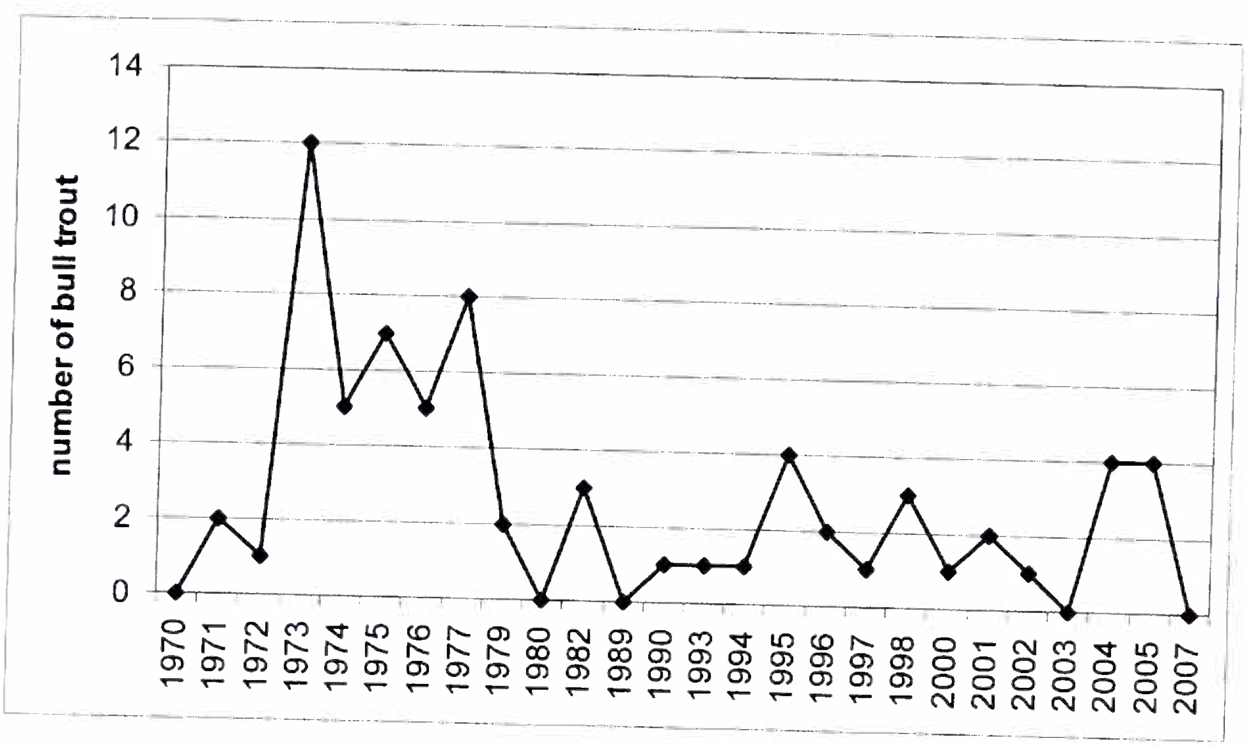
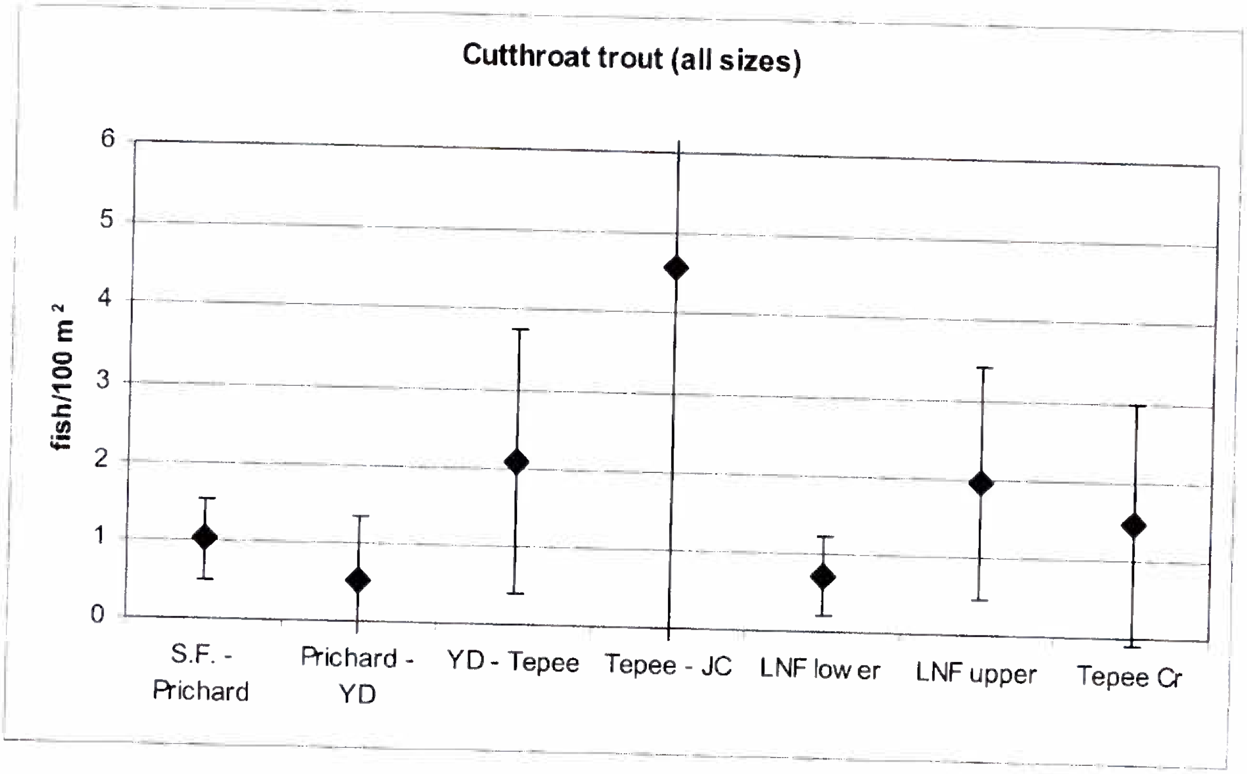


Figure 63. Number of bull trout counted while snorkeling transects in the St. Joe River, Idaho, from 1969 to 2007.



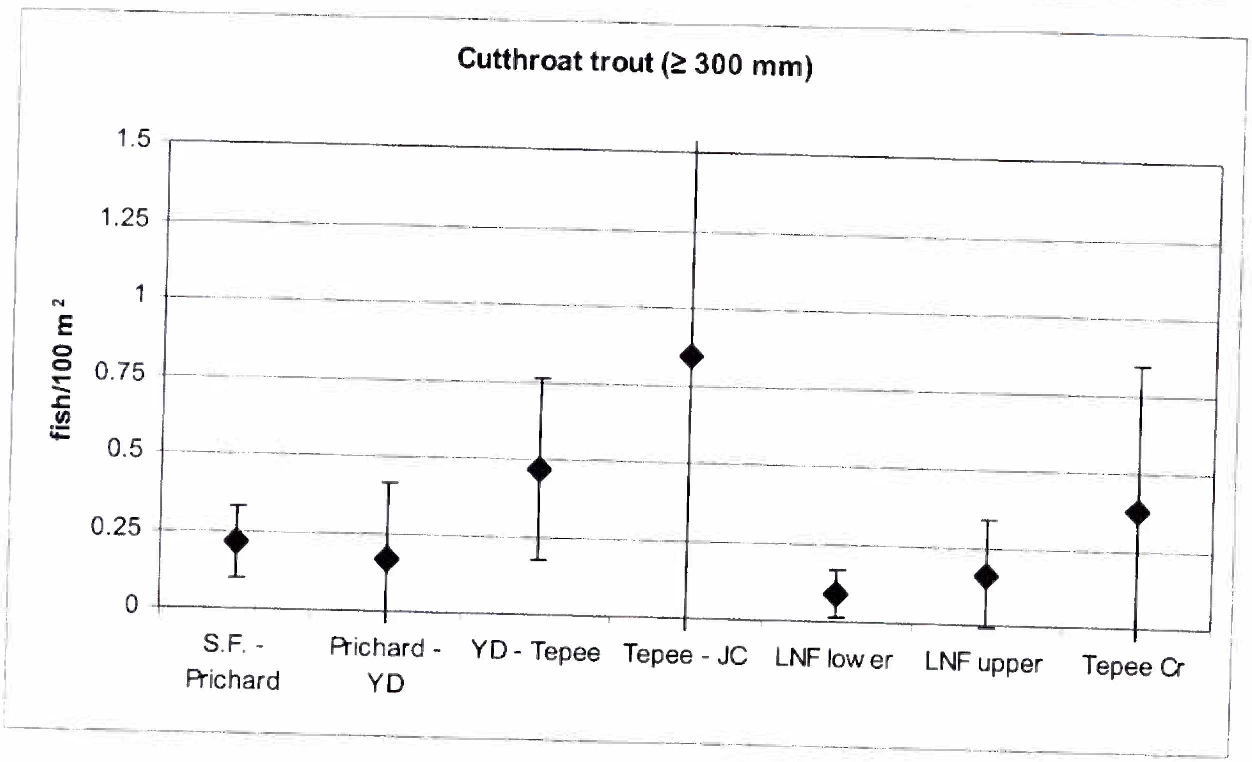


Figure 64. Average density (fish/100 m^2) of cutthroat trout and 90% confidence intervals (all sizes and only fish ≥ 300 mm) observed while snorkeling transects in seven different reaches in the North Fork Coeur d'Alene River watershed, Idaho, during 2007.

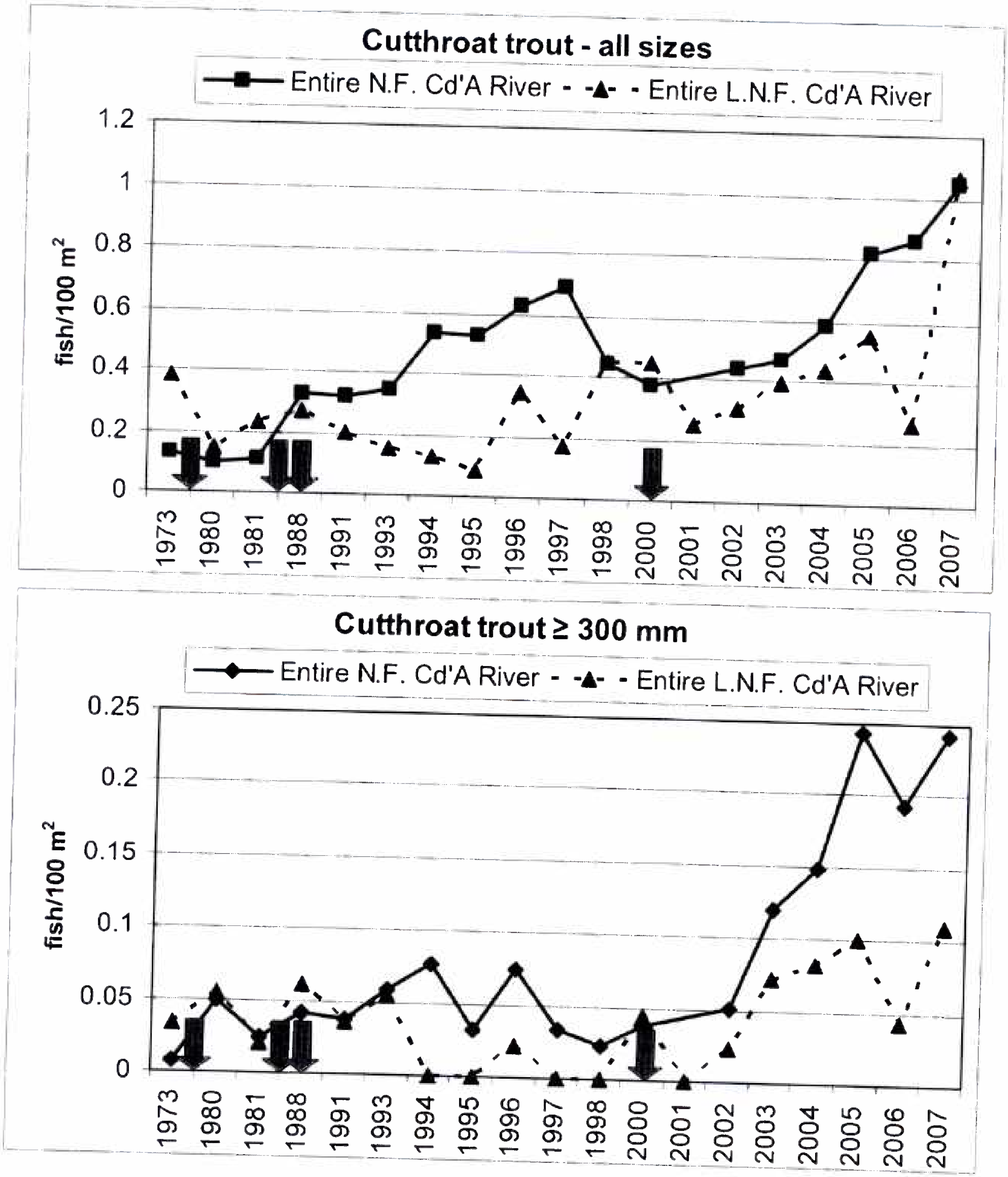
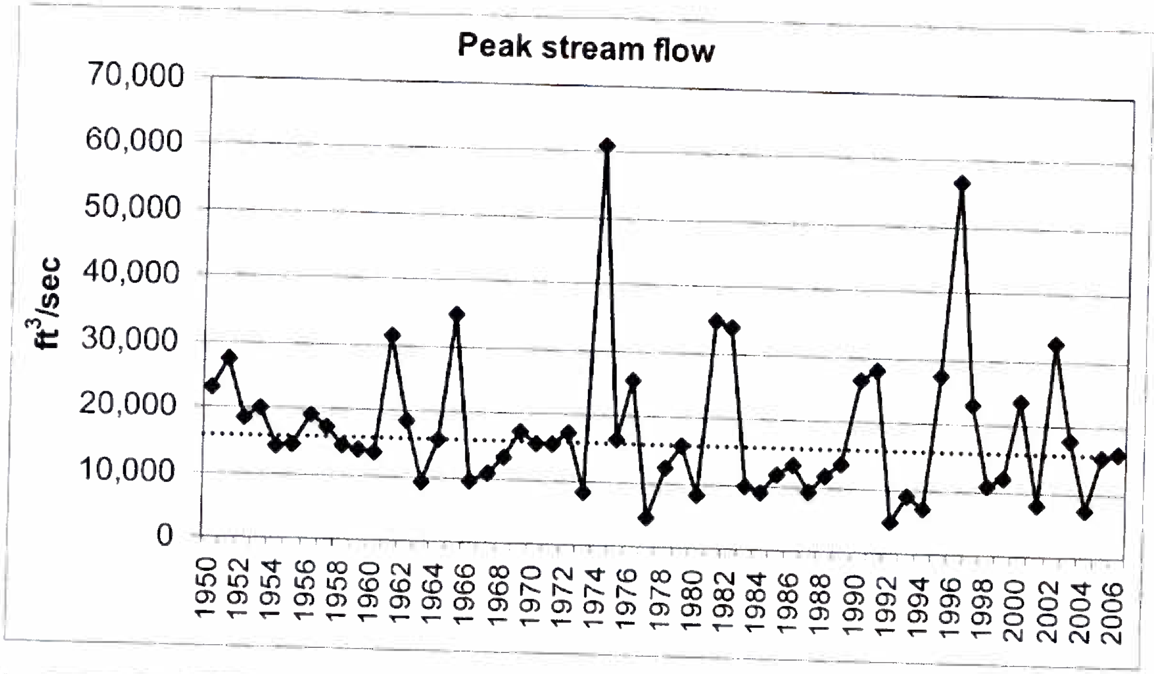


Figure 65. Average density (fish/100 m^2) of all size classes of cutthroat trout and cutthroat trout ≥ 300 mm observed while snorkeling transects in the North Fork Coeur d'Alene River (N.F. Cd'A) and Little North Fork Coeur d'Alene River (L.N.F. Cd'A), Idaho, from 1973 to 2007. Arrows signify when significant changes occurred in the cutthroat trout fishing regulations. Refer to Table 5 to see how regulations changed in these years.



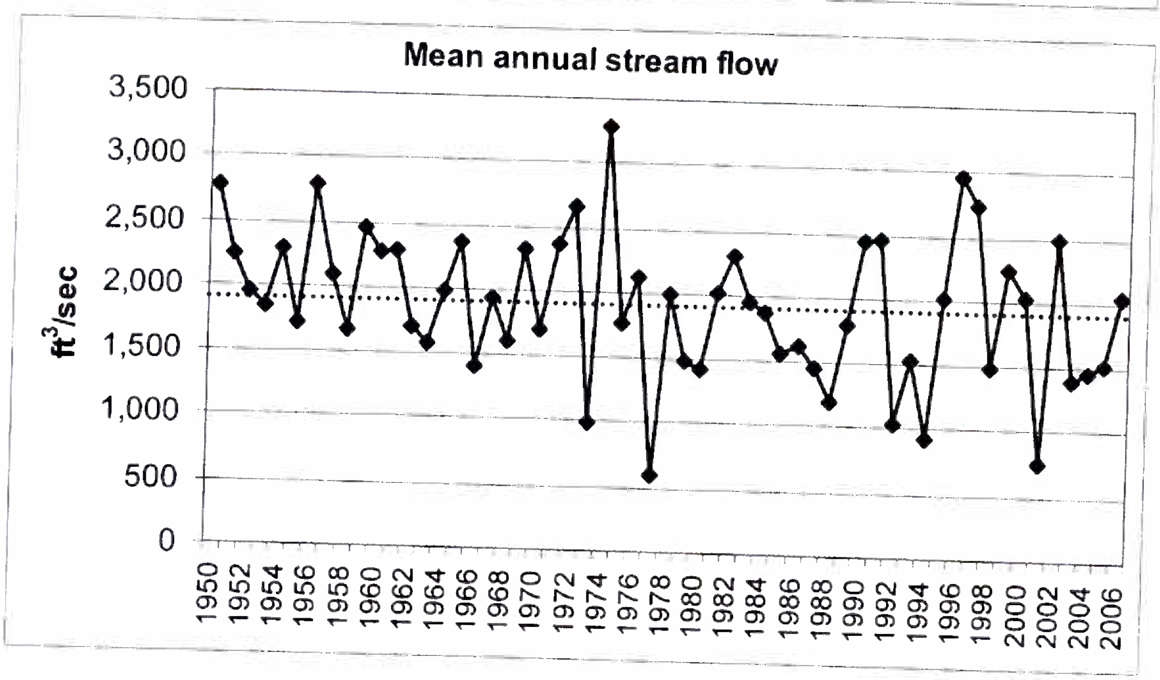


Figure 66. Peak stream flow and mean annual stream flow documented by USGS for the North Fork Coeur d'Alene River, Idaho, at Enaville from 1950 to 2006. The dotted line indicates the average flow since 1950.

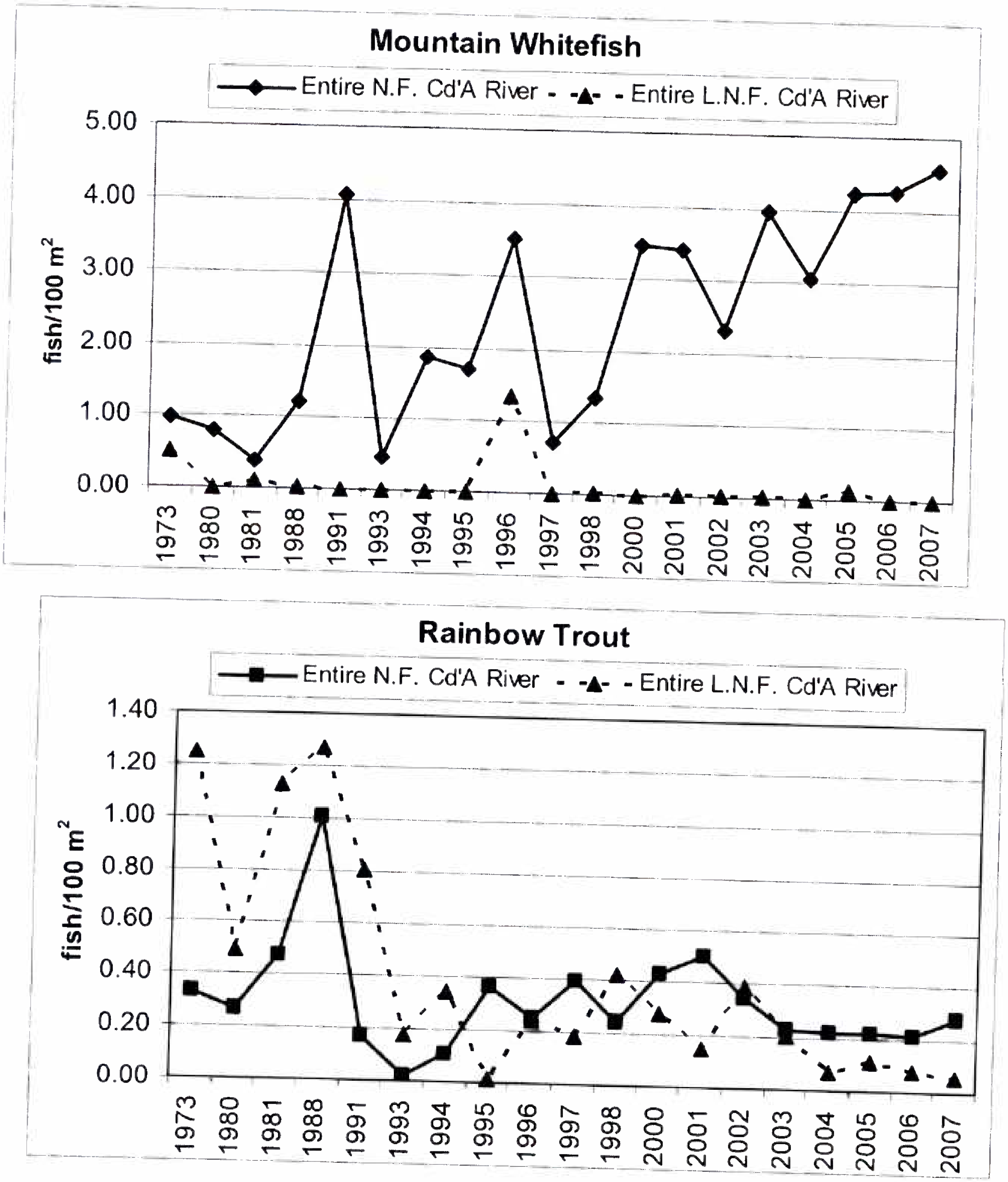


Figure 67. Average density (fish/100 m^2) of mountain whitefish and rainbow trout observed while snorkeling transects in the North Fork Coeur d'Alene River (N.F. Cd'A) and Little North Fork Coeur d'Alene River (L.N.F. Cd'A), Idaho, from 1973 to 2007.

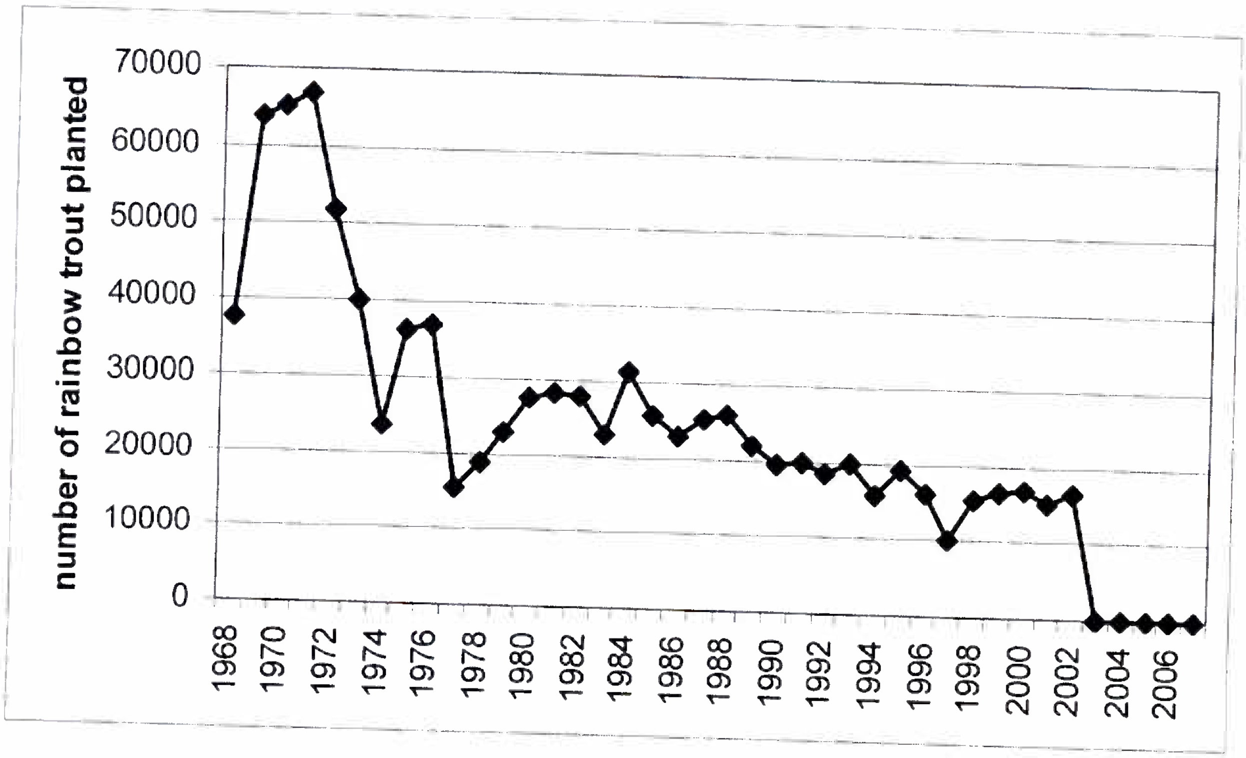


Figure 68. Number of rainbow trout > 150 mm in length stocked in the North Fork Coeur d'Alene River system, Idaho, between 1968 and 2007.

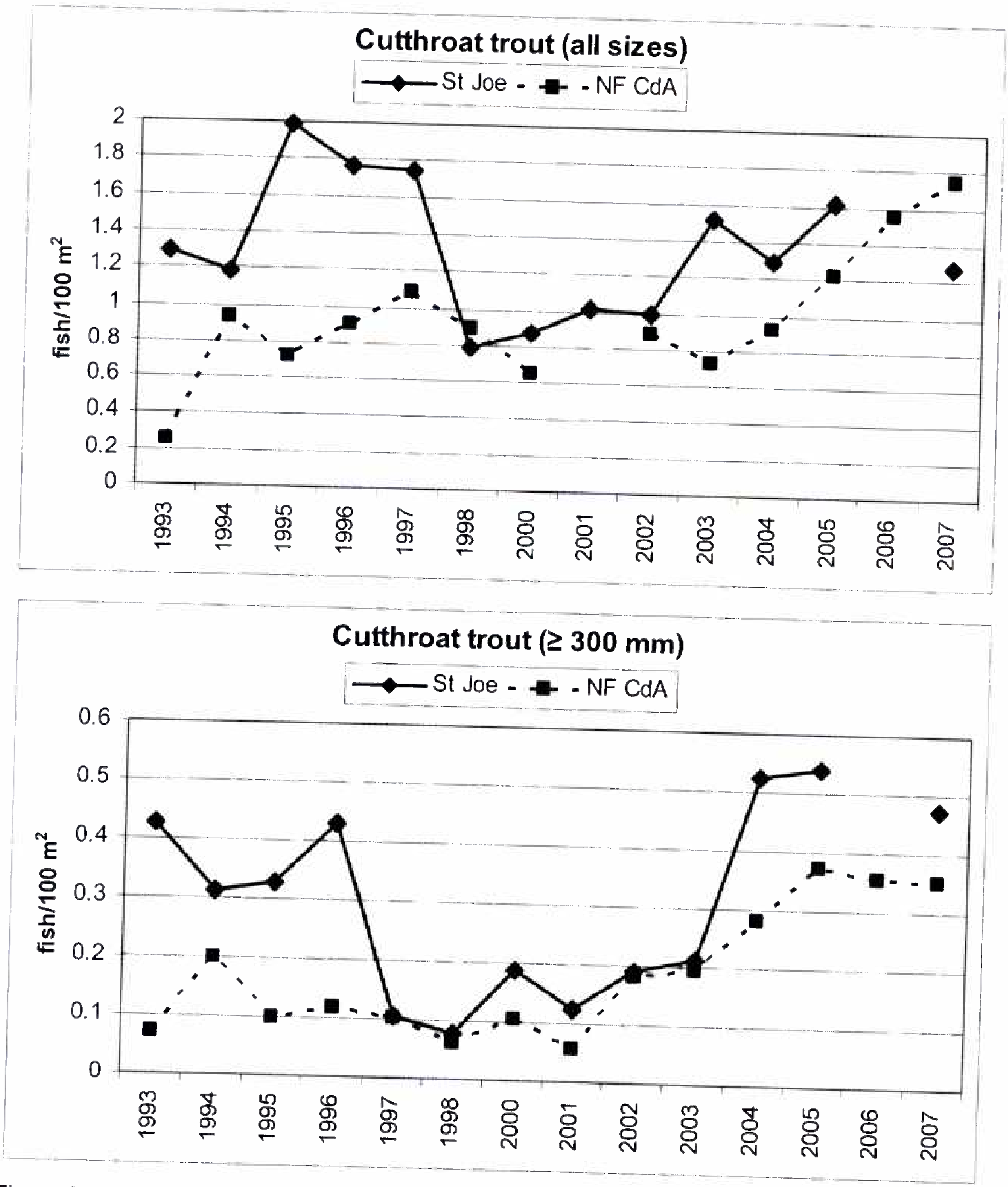


Figure 69. Average density (fish/100 m^2) of cutthroat trout (all sizes and only fish ≥ 300 mm) observed while snorkeling transects in the catch-and-release areas of the St. Joe River (North Fork St. Joe River to Ruby Creek, 28 transects) and North Fork Coeur d'Alene River system (upstream of Yellow Dog Creek in the North Fork and upstream of Laverne Creek in the Little North Fork, 20 transects), Idaho, from 1993 to 2007.

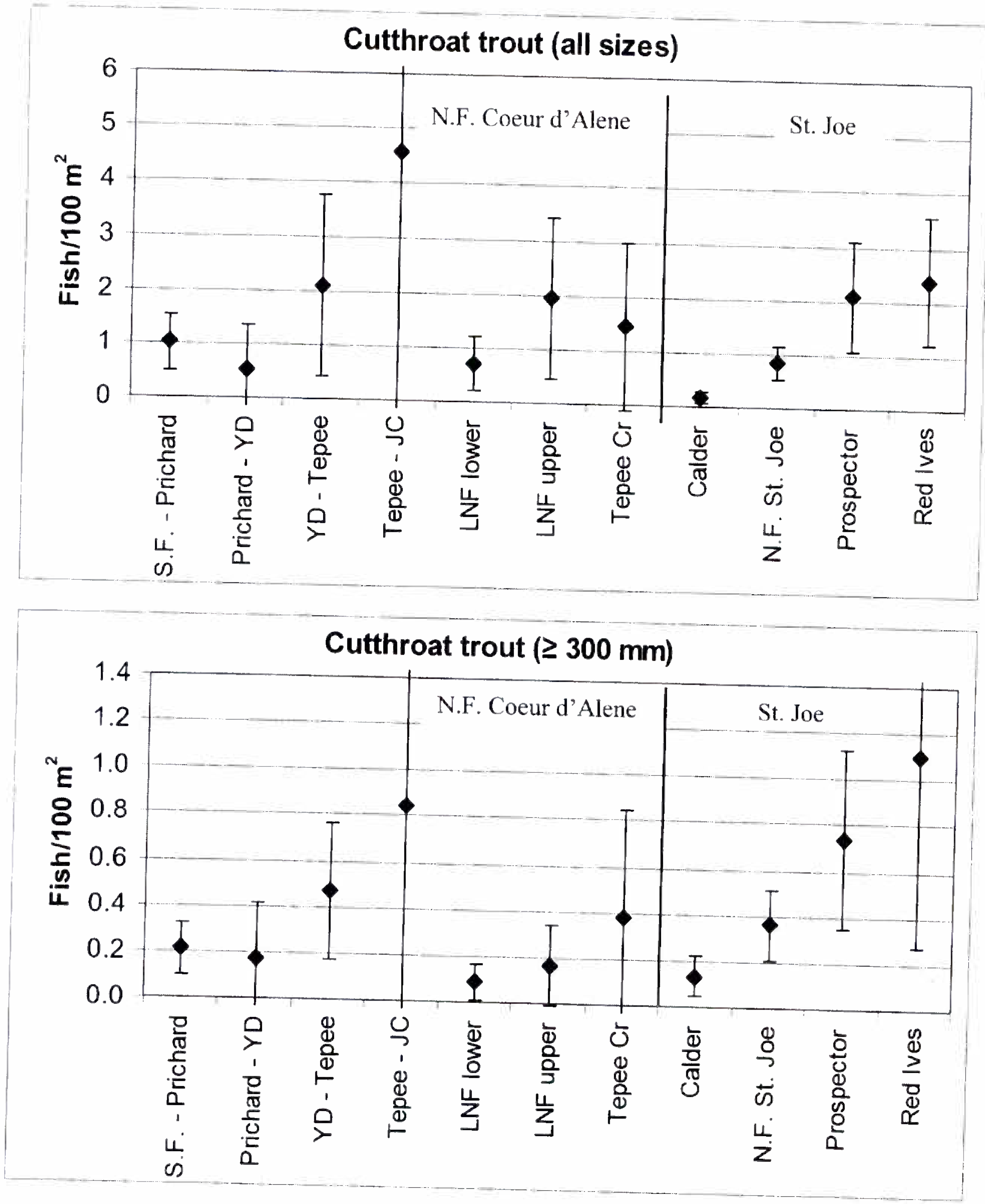


Figure 71. Average density (fish/100 m2) of cutthroat trout and 90% confidence intervals (all sizes and only fish ≥ 300 mm) observed while snorkeling seven different reaches in the North Fork Coeur d'Alene River and four different stream reaches in the St. Joe River, Idaho, during 2007.

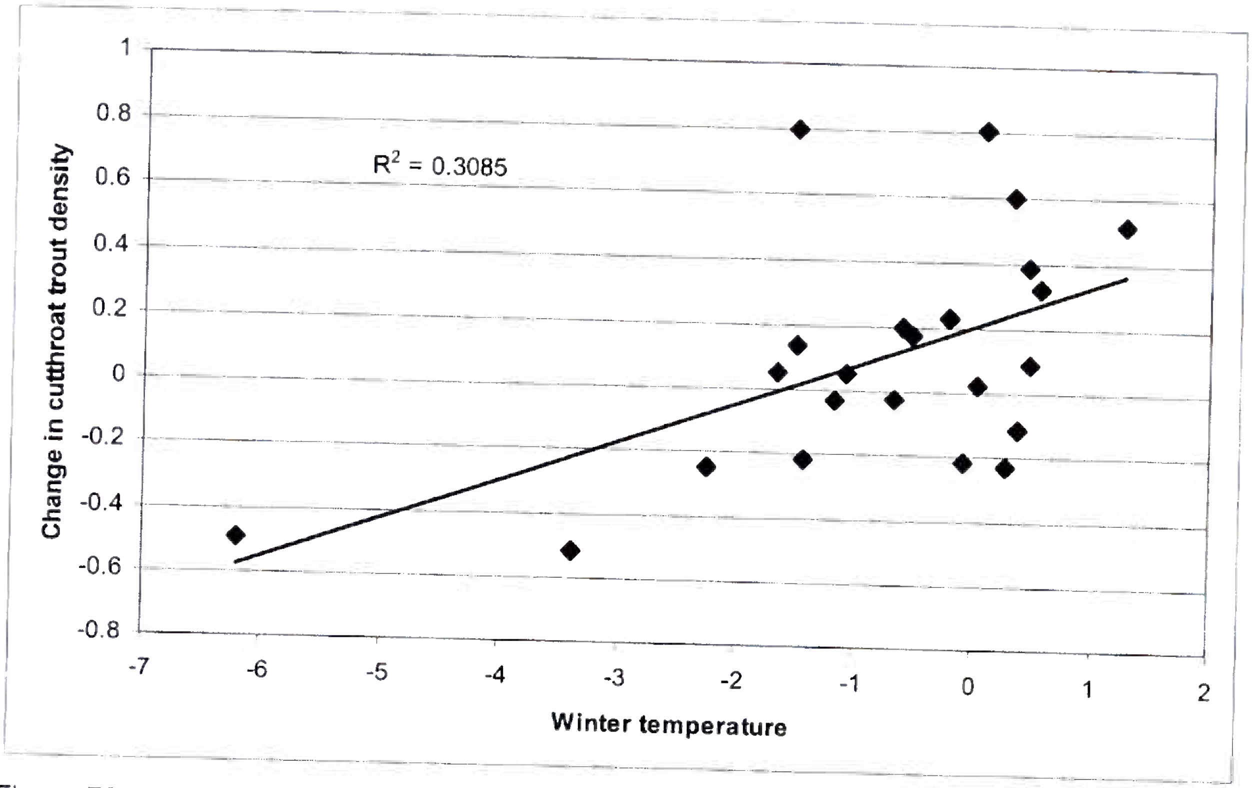


Figure 72. Linear regression showing the relationship between the change in cutthroat trout density and the average winter (December through February) air temperature (St. Maries, Idaho) that proceeded it.

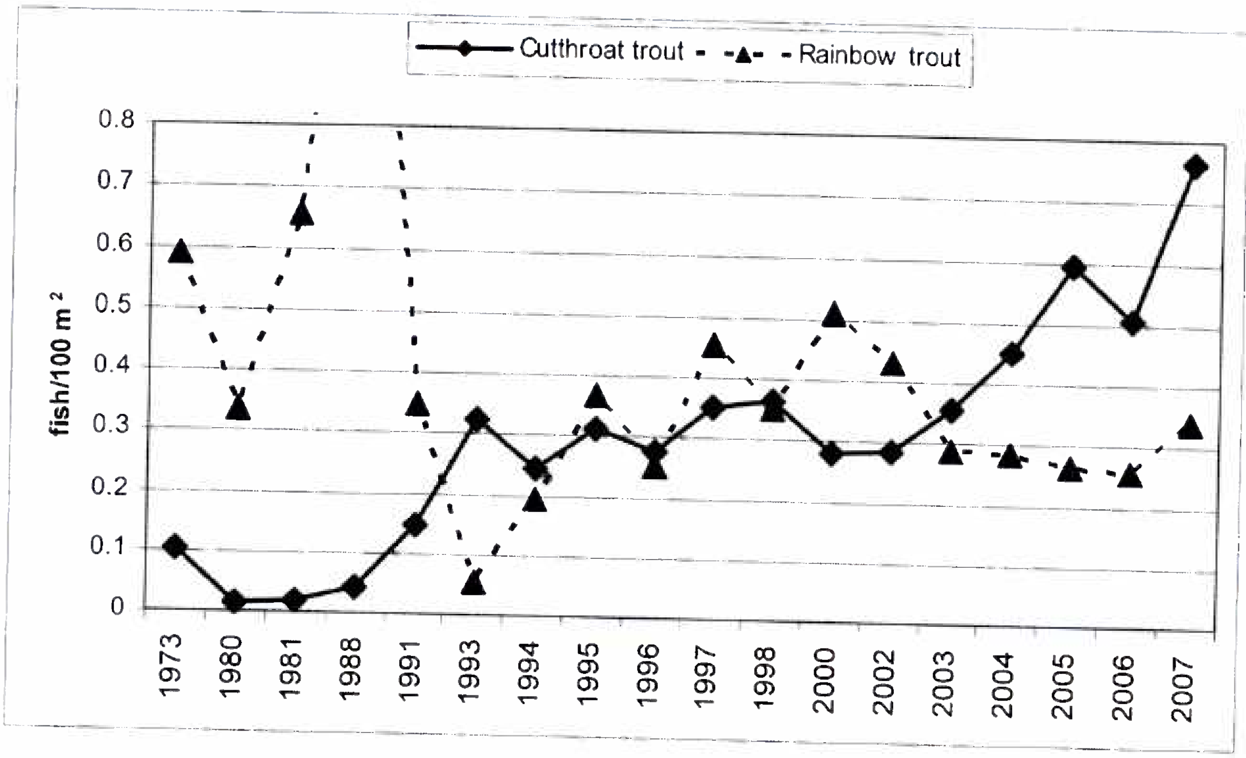


Figure 73. Average densities (fish/100 m2) of all sizes of cutthroat trout and rainbow trout observed when snorkeling transects in the limited harvest areas of the North Fork Coeur d'Alene River system (downstream of Yellow Dog Creek in the North Fork and downstream of Laverne Creek in the Little North Fork), Idaho, from 1973 to 2007.

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MARBLE CREEK BULL TROUT PASSAGE ASSESSMENT

ABSTRACT

Upstream fish passage past four splash dams on Marble Creek, a tributary of St. Joe River, Idaho was assessed on July 23, 2007. Fish passage past these dams is critical to the re-colonization of bull trout in the upper reaches and tributaries of Marble Creek. Our assessment concluded that two of the four splash dams were likely fish passage barriers while the other two splash dams were not. Our evaluation did identify two natural drops or falls that could be barriers to migrating fish when stream flows were low. Based on this assessment we believe bull trout can access Homestead Creek.

Access to Delaney Creek, Freezeout Creek and upper Marble Creek was still blocked by splash dams in 2007. Habitat observed in these tributaries is suitable for spawning and juvenile rearing of bull trout and are critical to the success of the re-colonization of bull trout in the Marble Creek watershed.

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INTRODUCTION

According to the Federal Draft Bull Trout Recovery Plan, before bull trout recovery can be considered in the Coeur d'Alene Lake basin, the number and distribution of spawning bull trout populations must expand (USFWS 2002). The Draft Bull Trout Recovery Plan lists streams where it is believed that bull trout can re-colonize once current threats are removed. Marble Creek is one of the streams believed to have a high potential for bull trout recovery, but splash dams prevent bull trout from re-colonizing much of Marble Creek. The splash dams were constructed in 1915 and remained in operation until 1931 (USFS 2003). These dams were used to back up water so they would float a raft of logs. Water behind a dam would be released all at once so that the ensuing flush of water would transport the logs down to the next splash dam downstream. This procession would continue downstream until the logs would reach the St. Joe River. In 2003, it was concluded that fish passage above a splash dam 18 km upstream from the mouth of Marble Creek was possible due to its degradation from a flood in 1996 (DuPont et al. In Press). With the destruction of this dam, bull trout potentially had access to over 160 km of stream, some of which appeared to be high quality spawning and rearing habitat at elevations over 1,219 m (DuPont et at. In Press). Upstream from this dam there were still a series of splash dams that could potentially block access of bull trout to these quality spawning and rearing streams. The purpose of this survey was to evaluate these splash dams and determine if upstream fish passage was possible for adult bull trout which would allow them to reach high quality spawning and rearing habitat.

STUDY SITE

Marble Creek flows into the St Joe River about 94 km upstream from its mouth. Marble Creek is about 41 km in length and throughout its watershed there were potentially 10 splash dams that could prevent bull trout from reaching spawning and rearing habitat (Figure 74). Four of these splash dams in particular had the ability to block bull trout from accessing an abundance of high quality spawning and rearing habitat. These four splash dams were located on the main stem of Marble Creek 25.6, 29.5, 30.3 and 40.8 km upstream from the mouth (Figure 74). Over 100 km of 2nd order or larger streams exist above these splash dams. These tributaries are over 1,219 m in elevation and believed to have the most potential to support rearing bull trout (Figure 74).

OBJECTIVES

1. Evaluate whether four splash dams on the main stem of Marble Creek were barriers to upstream fish passage of adult bull trout.
2. Discuss alternatives to providing fish passage past any of the splash dams that were considered barriers.

FINDINGS

We surveyed 10.9 km of Marble Creek on July 23, 2007 from the most upstream crossing of USFS Road 321 to where Trail 261 crossed Marble Creek (Figure 74). Four splash dams and two natural falls were documented in this reach of stream and assessed for fish passage (Table 33).

The first splash dam (Splash Dam 1) did not block fish passage. Over time, Marble Creek had totally eroded around the west side of the structure. The new channel did not flow through any part of the splash dam and no sudden drops in elevation occurred.

The second dam (Splash Dam 2) was over 3 m high. Most of the flow cascaded over this dam along its east side (Appendix C). A lack of pool habitat coupled with high gradient would not allow a bull trout to navigate its way over this drop. Significant flows also occurred through the log structures on the east side of the dam. Although we were doubtful that adult bull trout could navigate through the logs or ascend the cascading falls, it was impossible to determine this with certainty. This splash dam was constructed by logs ranging from 0.2-1.0 m in diameter which were anchored to each other with spikes and a criss-crossing log pattern. Rocks were placed inside the log structure to help hold it in place. It appeared the reason most of the flow occurred along the east side of the dam was due to natural degradation from past floods and weathering. Those logs that remained in place were relatively large (> 0.7 m in diameter) and appeared to be largely intact.

The third splash dam (Splash Dam 3) was a total block to upstream fish passage (Appendix D). The majority of flow was directed over a 3 m vertical drop or passed through narrow slots in the logs. The vertical fall is more than bull trout can jump and we did not observe any possible route through the dam. The dam structure was 3 m high and spanned the wetted width of Marble Creek. Logs used to construct the splash dam ranged from 0.2-1.0 m in diameter. This dam was constructed similar to Splash Dam 2, but it appeared to be very stable and entirely intact. After nearly 100 years of use, sediment had filled the channel to the top of the dam. This would allow large debris or substrate to pass over the dam during higher flows without causing much damage to the structure.

The 4th splash dam (Splash Dam 4) was nearly non-existent. The dam had nearly eroded away and provides no potential block to upstream fish passage

Two natural falls in Marble Creek were observed between splash dams 3 and 4. Flows were concentrated into a narrow (1.5 m) channel causing extreme velocities. Large boulders occurred in the plunge pools, limiting the depth and pool area upstream migrating fish would need to jump the barrier. The first falls (Falls 1) was cascading, with a total drop of about 3 m. The second falls (Fall 2) was near vertical with an elevation drop of 2.5 m. Based on these characteristics we felt the drop and water velocities were too high and the jumping pool inadequate for bull trout to negotiate these falls during periods of low flows. However, based on the moss line in this canyon (see Appendix E), during higher flows the drops over these falls would be significantly diminished, the jumping pool would become deeper and multiple routes would be possible for fish to attempt passage.

DISCUSSION

Based on our survey, we believe two splash dams in Marble Creek are still fish passage barriers and prevent bull trout from reaching streams that provide quality spawning and rearing habitat. These barriers will restrict movement of bull trout into several streams over 1,219 m in elevation, most notably are Delaney Creek, Freezeout Creek, Duplex Creek and upper Marble Creek. Many streams above 1,219 m in elevation in the upper St. Joe River and Little North Fork Clearwater River have been found to have thriving bull trout populations (DuPont et al. In Press).

Bull trout access to over 160 km of Marble Creek and its tributaries has been blocked by splash dams since their introduction in 1915 (USFS 2003). Bull trout were documented in Boulder Creek, Deveggio Creek, and Eagle Creek in the Marble Creek watersheds in the early 1930s (IDFG 1933). All of these streams entered Marble Creek below a splash dam 18 km upstream from the mouth that we believe was a fish passage barrier until 1996. To the best of our knowledge, bull trout were not documented upstream of this splash dam prior to 1996. We do not have records of species present in the Marble Creek drainage prior to 1933, although we believe that bull trout occurred throughout the higher elevations in the Marble Creek watershed prior to the construction of the splash dams. In the flood of 1996, the splash dam 18 km upstream from the mouth of Marble Creek was destroyed and no longer a barrier to adult bull trout migration (DuPont et al. In Press). This passage provided the potential for bull trout to migrate upstream and enter potential spawning and rearing streams. Upstream from this splash dam there were no potential barriers for at least 8 km - the location of Splash Dam 1. Several streams enter Marble Creek in this reach, including Bussel, Cranberry and Hobo creeks. All of these streams have reaches that extend above 1,219 m in elevation; however, they all have splash dams below the 1,219 m elevation mark. Fish passage at those sites is unknown.

Homestead Creek flows into the east side of Marble Creek upstream of Splash Dam 1. Since Splash Dam 1 does not inhibit bull trout movement, nearly all of Homestead Creek, much of which occurs all above 1,219 m, is accessible. Near the headwaters of Homestead Creek another splash dam exists, although it is not known if this dam blocks upstream passage. Cornwall Creek also occurs just upstream of Splash Dam 1. Cornwall Creek flows into the western side of Marble Creek, and based on its elevation, is another stream that could potentially provide spawning and rearing habitat for bull trout. Cornwall Creek also has a splash dam on its main reach near the 1,219 m elevation. Fish passage beyond this point is unknown.

The second dam (Splash Dam 2) probably blocks upstream fish passage. Considerable flow occurs around and through the east side of the splash dam, but the 3 m drop is probably more that bull trout can handle. With fish passage above this second splash dam improbable, it blocks off 25 km of potential bull trout spawning and rearing habitat. Upstream from this site, all tributaries and the remaining reaches of Marble Creek are above 1,219 m in elevation. The largest tributary between Splash Dams 2 and 3 is Duplex Creek, which potentially provides bull trout spawning and rearing habitat. The stream gradient in Duplex Creek would limit bull trout use to the lower half, assuming no natural barriers occur. No known man made barriers occur in Duplex Creek drainage that would restrict bull trout movement. The logs that support Splash Dam 2 appeared stable.

Splash Dam 3 occurs about 2.3 km upstream of Duplex Creek. This splash dam completely blocks all upstream fish passage. We crawled around the splash dam evaluating its structure and it appeared in very good shape and entirely intact. Floods will likely have minimal impacts because sediment build up on the upstream side of the dam allows substrate and other debris to flow over the splash dam with minimal contact. Based on its stability and resistance to flood impacts, Splash Dam 3 could potentially pose as a fish barrier for the foreseeable future. If fish passage is desired above this splash dam, alternative passage routes would have to be developed. Upstream of Splash Dam 3 is Freezeout Creek, Delaney Creek and the upper reaches of Marble Creek. These streams are above 1,219 m in elevation and contain what we believe to be the best bull trout spawning and rearing habitat in the Marble Creek watershed.

Splash Dam 4 poses no threat to fish passage. Degraded over time, the splash dam is none existent and provides no obstacle for migrating fish.

Because two of the splash dams we evaluated are believe to be fish barriers and could potentially block passage for the foreseeable future, efforts should begin to find a solution to allow fish access around these structures. It should be noted that preserving the historical significance of the splash dams is a concern as numerous people visit these sites. Any work done on or around these splash dams would require approval by the USFS which would entail NEPA analysis and approval from the State Historic Preservation Office. One possible solution would be to blast away the failing east side of Splash Dam 2, and to create a channel around the west side of Splash Dam 3. This type of action would remove the fish passage problem, but would still preserve the majority of these splash dams and their historical significance.

We encountered two natural falls between Splash Dams 3 and 4 that could potentially pose a passage barrier to adult bull trout. The first fall was cascading with a total elevation drop of approximately 3 m (Appendix E). The second fall had a 2.5 m vertical drop. Both of these falls occurred in a narrow (1.5 m) bed rock canyon. During higher flows we believe the drops to these falls would be significantly reduced and several possible routes would be available. During these conditions, we believe adult bull trout (> 500 mm) would be able to pass these falls.

MANAGEMENT RECOMMENDATIONS

1. Discuss with the USFS techniques that could be used to provide fish passage around splash dams 2 and 3 while maintaining their historical significance.

2. Assess whether the splash dams in Homestead Creek and Hobo Creek prevent bull trout from reaching quality spawning and rearing habitat.

3. Periodically assess the condition of the splash dams to determine if fish passage has changed.

4. Periodically assess the fishery in those tributaries of Marble Creek where we believe bull trout can successfully re-colonize. If these streams are not re-colonized by bull trout in 10 years, it may be wise to discuss the possibility of re-introducing bull trout into areas where we believe high quality habitat exists.

Table 33. The location of splash dams and falls in Marble Creek, Idaho, that were evaluated for fish passage on July 23, 2007.

Structure assessed	Coordinate (Datum: WGS 84)		Km upstream from mouth	Provide passage?
	Latitude	Longitude		
Splash Dam 1	47.10822	-116.06245	25.6	Yes
Splash Dam 2	47.09914	-116.02272	29.5	Probably not
Splash Dam 3	47.09404	-116.01625	30.3	No
Falls 1	47.09163	-116.01317	30.7	Possibly
Falls 2	47.08984	-116.01228	30.9	Possibly
Splash dam 4	47.07668	-116.00719	40.8	Yes

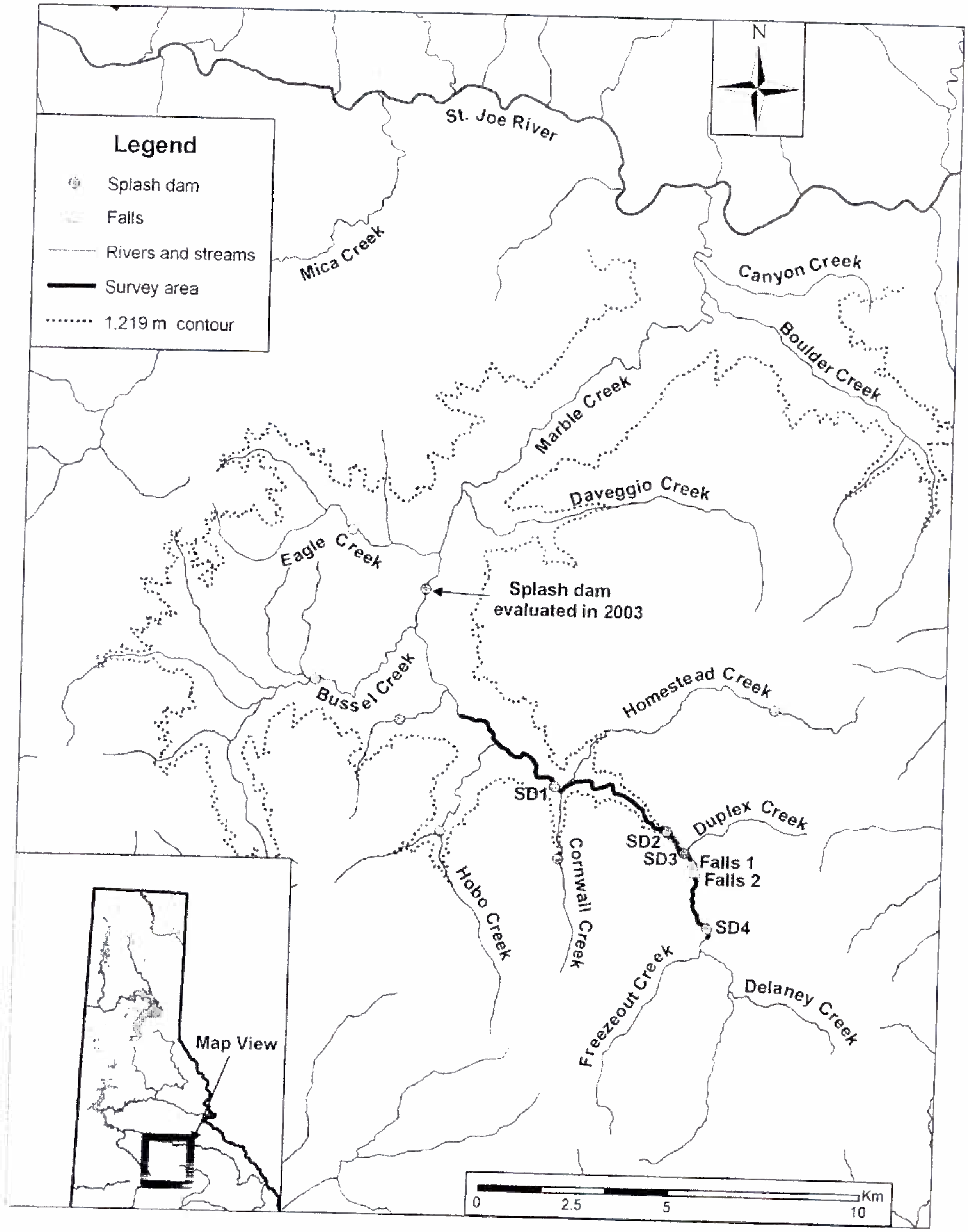

Figure 74. The location of the splash dams in the Marble Creek watershed, Idaho, that have the potential to block bull trout from accessing spawning and rearing habitat, including those splash dams (SD) and falls that were surveyed on July 23, 2007 to assess whether they were fish barriers.

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SUMMER USE OF SIDE CHANNEL HABITAT BY FISHES IN THE NORTH FORK COEUR D'ALENE RIVER, IDAHO

ABSTRACT

Large aggregations of westslope cutthroat trout, mountain whitefish, and to a lesser extent rainbow trout were observed moving into cold water side channels during the summer months of July and August in the NFCDR. Use of side channels varied throughout the day and the season, as well as by size-classes of salmonids. The use of side channel thermal refugia was much greater for salmonids ≥ 300 mm and movement of salmonids into side channel habitats appeared to be triggered by rising main river water temperatures and temperature divergences between the main river and the side channels. Larger salmonids were not evenly distributed in the side channels, and channel physical features varied widely. Salmonids ≥ 300 mm used side channels that were both deep (≥ 2 m) and cold (≤ 20° C). In addition to suitable temperatures and depths, the presence of adequate flows in the side channels also appeared important for use by larger salmonids. Temperature modeling showed water temperatures in the side channels were influenced primarily by a channel's location in the floodplain, riparian vegetation cover, and substrate composition in both the riverside, and opposite side banks. Thermal imaging flights were used to identify cold water springs and areas important for thermal refugia. Springs and upwelling hyporheic flows were more common in undeveloped areas in the floodplain. The areas with large amounts of hyporheic upwelling were also associated with declining longitudinal main river water temperatures and increased presence of thermal refugia. Protection of remaining hyporheic flowpaths and thermal refugia is important for the conservation of summer habitat for westslope cutthroat trout in the NFCDR. Enhancement efforts should focus on increasing depths (≥ 2 m) adjacent to the main river in side channels identified to provide thermally suitable habitat. Side channel construction should be focused in areas identified to have high concentrations of floodplain springs to ensure interception of existing hyporheic flow paths.

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In addition to providing overwintering habitat, off channel habitat also provides refugia for salmonids during high flow events (Swales and Levings 1984, Yrjana et al. 2002). Backwater floodplain habitats have also been shown to provide rearing habitat for juvenile coho salmon (Henning et al. 2006) and cutthroat trout (Moore and Gregory 1988). Finally, Morley et al. (2005) found large numbers of juvenile salmonids using both natural and constructed side channels as both summer and winter habitat.

The seasonal importance of side channels has been well documented for juvenile fish; however, the role of side channels in the seasonal ecology of adult salmonids remains relatively unstudied in the Panhandle Region. In the NFCDR in northern Idaho, large numbers of adult westslope cutthroat trout have been observed using side channels as thermal refugia during the warm summer months (DuPont et al. In Press). These findings raised concerns as floodplain development in the NFCDR has reduced the river's ability to shift course and form new side channel habitat. These concerns prompted a study to determine how important side channels were to cutthroat trout as summer cold water refugia and investigate ways to improve and protect side channel habitat important to cutthroat trout.

OBJECTIVES

1. Evaluate the relative importance of side channel habitat for cutthroat trout and other salmonids during peak water temperatures.
2. Identify factors that influence cutthroat densities in side channels during summer.
3. Identify factors that influence water temperatures in side channels.
4. Identify important floodplain areas for protection, candidate areas for development, and future side channel construction.

STUDY AREA

The NFCDR is located in northern Idaho and extends 123 km from its confluence with Coeur d'Alene River to its headwaters (Figure 74). This river and its tributaries drain belt series geology in a dendritic pattern with non-glaciated alluvial valleys. The watershed encompasses over 232,000 ha and has a 50 year mean annual flow of approximately 54 m^3/sec, and a 50 year mean peak flow of approximately 512 m^3/sec (USGS site 12413000; Enaville). Elevations in the NFCDR watershed range from 640 m at its confluence with the South Fork Coeur d'Alene River to 2,077 m at its highest peak. About 70% of the watershed occurs between 914 and 1,372 m in elevation, which is considered to be sensitive to winter rain-on-snow events. The highest peak flows that have occurred in the NFCDR drainage have been a result of winter rain-on-snow events. Peak flows over 850 m^3/sec occur at a rate of once every 8 years, with the highest ever recorded peak flow (1,727 m^3/sec) occurring during the winter of 1974. Peak spring flows during 2007 were 575 m^3/sec, and the mean annual flow was 52 m^3/sec.

The NFCDR watershed is predominately (93%) managed by the USFS who have intensively managed these watersheds for timber harvest over the last 100 years (Strong and Webb 1970). Prior to 1930, splash dams and log drives were common in the main NFCDR

METHODS

Thermographs (HOBO and TidbiT data loggers by Onset) were used to collect water temperatures in 27 side channel transect locations and six main river locations on an hourly basis. The thermographs were calibrated in an ice bath to test for accuracy. Only those thermographs that were accurate to within 0.2°C were used for this study. All Hobo data loggers were placed in water tight plastic canisters. These canisters were then bolted into 75 mm diameter sections (125 mm long) of steel pipe to keep them submerged on the bottom. The Tidbit data loggers were wired directly inside a 50 mm diameter copper pipe. All thermographs were then placed in the deepest water at each transect and remained in place for at least the duration of the study (June to September of 2007).

To inventory the habitat at each of the side channels selected for our study, we started at the mouth of each side channel and then proceeded upstream systematically at 50 m intervals until we reached the end of the side channel. If the side channel was less than 200 m in length we collected data every 25 m. At each cross sectional transect, we collected data to characterize the canopy cover, type of riparian vegetation, habitat type, substrate in the channel bottom and both banks, maximum depth, water temperature, and wetted width (Appendix F). Canopy cover was determined using a densiometer (Platts et al. 1987), maximum depth was measured with a measuring rod, temperature was measured with a hand held thermometer, stream width was measured with a laser range finder, and all other variables were estimated visually. Through use of ArcGIS and satellite imagery we also determined whether tributaries entered each side channel, the location of the side channel within the floodplain, the maximum distance between the side channel and the main river, and the relative density of vegetation between the side channel and the main river.

We used snorkeling surveys to assess the fishery in each of the 26 side channel transects and 9 main river transects. Our intent when snorkeling was to be reasonably certain that all of the fish in transects were visible to the divers, and few or no fish were overlooked. Two divers were used in transects located in wider reaches or in more turbid water where one diver could not easily see fish across the transect. Divers began at the downstream end of each side channel transect and snorkeled upstream, however, depths and current required the river snorkel transects to be snorkeled downstream. When snorkeling in pairs, we tried to remain even with each other and the snorkeler counted only those fish that passed. This prevented double counting of fish that often spook out in front of one snorkeler and then swim past the other. Where woody debris or boulders were common, the snorkeler would often have to swim around them to ensure all fish were counted. We periodically duplicated counts using different divers to check for accuracy. If there were noticeable differences in fish counts or estimates of fish length between snorkelers, discussions as to why this occurred were made and then the transect was re-snorkeled.

Estimates of fish abundance were limited to age-1 and older fish (>75 mm), as summer counts for young of the year (YOY) fishes are typically unreliable. Most YOY cutthroat trout will be smaller than 80 mm during surveys in July and August, and occupy the shallow stream margins where snorkeling is less effective (Thurow 1994). All observed fish were recorded by species in 75 mm length groups. Prior to snorkeling, each observer practiced estimating the lengths of plastic pipes to ensure accurate estimates of fish lengths were made. Throughout the snorkel surveys we periodically held these practice sessions to maintain our accuracy and precision.

After completing fish counts, we measured the length and width of each transect with a laser rangefinder to determine the surface area (m^2) surveyed. At least four width measurements were taken to get an average width of the transect. Transect characteristics collected included: habitat type (percent pool, riffle, run, or glide), maximum depth, amount and watershed (Strong and Webb 1970). These activities resulted in a straightened and less complex river channel as log jams, woody debris, large boulders, and sharp channel bends were removed. After 1931, road systems were developed to export logs. Many of these roads were constructed along streams, and the riparian areas are now considered the most altered portion of the entire watershed (IDEQ 2001). The road density in the watershed averages 5 km/km^2, and the NFCDR watershed is considered the most densely roaded forest watershed in the entire Columbia River Basin (Quigley et al. 1996). Much of the floodplain in the lower 40 km of the NFCDR is privately owned, and has been developed for housing or agriculture. Placer and hard rock mining occurred in the NFCDR, mainly in the Prichard Creek and Beaver Creek watersheds. This hard rock mining resulted in elevated levels of heavy metals in the substrates of both of these drainages. Extensive restoration has taken place since the 1980's with over 1,600 km of roads removed in the watershed and 48 km of streams treated.

The NFCDR supports native stocks of westslope cutthroat trout, mountain whitefish, largescale sucker *Catostomus catostomus*, northern pikeminnow *Ptychocheilus oregonensis,* redside shiner *Richardsonius balteatus*, longnose dace *Rhininchthys cataractae*, speckled dace *R. osculus,* torrent sculpin *Cottus rhotheus* , shorthead sculpin *C. confusus* and mottled sculpin *C. bairdi.* Native bull trout, which were once common in some tributaries, have virtually disappeared from this drainage. Introduced rainbow trout, brook trout and Chinook salmon also occur in the watershed. Cutthroat trout are the most abundant trout in the Coeur d'Alene River, and attract hundreds of fisherman each year. Interstate 90 provides easy access to the North Fork Coeur d'Alene River and the river annually receives over 33,000 hours of fishing pressure a year (Fredericks et al. 1997). In 2007, the fishing regulations allowed 2 cutthroat trout (none between 8 and 16 inches) to be harvested daily. Six rainbow trout, 25 mountain whitefish, and 25 brook trout could also be harvested daily. Catch-and-release areas occurred farther upstream and out of our study area.

Our study area extended about 50 km upstream from the mouth of the South Fork Coeur d'Alene River to Shoshone Creek (Figure 74). Within the study area, the NFCDR can be described as a B3 stream type. This stream type is characterized by having a gradient ranging from 2-4%, with predominately cobble substrate and moderately steep valleys, and gentle side slopes (Rosgen 1996). The floodplain in this section of river typically exceeded 200 m in width. Side channels occur throughout the study area where the main river has shifted paths over time.

Within the study area, we identified 63 different side channels through use of satellite imagery and on the ground surveys. We selected 21 of these side channels for this study (Figure 75). These side channels were selected based on connectivity with the main river (none were selected that were not connected during mid-June), length (none under 100 m in length were selected), and depth (none with maximum depths < 1 m were selected). Within each of these side channels, we selected one to three transects to conduct fish and habitat surveys and temperature assessments. These transects were selected based on areas we thought cutthroat trout could occupy and we could effectively snorkel. In total, we selected 27 different transects to conduct our analysis (Figure 75). Transects ranged from 45 m to 300 m in length, and all ended at shallow (< 0.2 m) constrictions. We believed this would prevent most fish from leaving the transect during our surveys. Upon surveying transect 14-1, it became evident that the abundance of wood that occurred in the channel made snorkel surveys ineffective and unreliable. For this reason we dropped transect 14-1 from our study, which brought the total number of side channels we surveyed to 20 and the total number of transects to 26. For comparative purposes, we also snorkeled nine different transects in the main river (Figure 76). These nine transects were annual trend sites that have been snorkeled since 1973, and they were selected based on what was believed to be good cutthroat trout habitat (Bowler 1974). Thermographs were also placed in the main river at six locations that were spaced out at about 8 km intervals (Figure 3).

type of available cover (estimated % of surface area), substrate composition, aquatic vegetation (estimated % of surface area), water temperature, flow, and visibility (Appendix G). We visually estimated habitat composition, aquatic vegetation, cover, and substrate composition. Maximum depth was calculated with a calibrated meter, water temperature with a handheld thermometer, and flow using a Marsh-McBirney flow meter. Because the flow meter proved ineffective at lower water velocities, we summarized the flow data into five categories of relative flow. Visibility was measured by having a snorkeler move away from shore to the point they could not be observed. At this point, the distance between the snorkeler and shore was measured using a laser range finder.

We conducted snorkel surveys and habitat assessments for each of the side channel transects four times throughout the summer starting on June 25, 2007. These surveys were repeated about every two weeks and ended on August 9, 2007 (Table 34). The main river was snorkeled once on July 31 and August 1, 2007.

We assessed fish use in the shallow reaches of the 20 side channels through electrofishing. We selected transects to electrofish using a stratified random sample by ranking all the side channels from coldest to warmest and then dividing them evenly into three even groups (cold, moderate or warm). These side channels were then divided into 100 m transects of which we randomly chose five from each group for electrofishing. If we chose a transect that we believed had maximum depths > 1 m, another transect was randomly selected. While electrofishing, we attempted to net all fishes observed, and all fish captured were identified to species and measured for total length. The length, average width (at least four width measurements), and bottom temperature of the area sampled were also measured for each transect. Because temperatures in each side channel were not uniform throughout, the actual temperature of the transect we sampled often did not reflect the temperature grouping it was originally assigned. For this reason, when we summarized the electrofishing data it was grouped together to reflect the relative abundance of fishes that occurred in shallow sections of all side channels.

DATA ANALYSIS

We used the snorkel data to evaluate whether densities of salmonids (cutthroat trout, rainbow trout, and mountain whitefish) differed between the side channels and the main river. Because the main river was snorkeled on July 31 and August 1, we used only the snorkel data from the side channels collected during the fourth (last) round of sampling (August 1 to 9) for this comparison. Data from 5 of the 26 side channel transects were not used because they lost connectivity to the main river before temperatures warmed in the main channel. Cutthroat trout density data from 21 side channel transects and nine main river transects were averaged and tested for differences using a nonparametric Wilcoxon Rank Sum Test (Higgins 2004), with an alpha level of 0.10 to denote significance. The alpha level of 0.10 is often used to determine significance when evaluating fish and wildlife populations for management purposes (Peterman 1990, Johnson 1999, Anderson et al. 2000).

Temperature data from 23 side channel locations and 6 main river locations were summarized using the maximum weekly maximum temperature (MWMT) and maximum average weekly temperature (MAWT) metrics (Dunham et al. 2005). We tested for differences in the mean MWMT between the side channels and main river using a Wilcoxon Rank Sum Test (Higgins 2004), with an alpha level of 0.10 used to denote significance. Thermographs from four of the side channel sites were lost during the study and consequently, were not included in our analysis.

To assess the movement of salmonids ≥ 300 mm into the side channels, we calculated mean densities during each of the four time periods. Density data was used only from transects containing target salmonids. For cutthroat trout and rainbow trout we evaluated data from eight transects and for mountain whitefish six transects. Differences in fish densities between the time intervals were tested using a Kruskal-Wallis Test (Higgins 2004), with an alpha level of 0.10 used to denote significance. When the Kruskal-Wallis Test showed that a significant difference ($p \leq 0.10$) in density occurred between the time intervals, we used Tukey's Rank-Based HSD Tests (Higgins 2004) to identify pair-wise differences in fish densities between the time intervals. Density differences between time intervals were used to asses when adult salmonids began moving into side channel habitat.

The side channels selected for the study varied considerably in length, from 108 m up to 925 m. Since side channel lengths varied, we selected more than one snorkel transect in five side channels at locations we thought could potentially support larger cutthroat trout. A total of six additional transects were also selected. To determine if salmonids ≥ 300 mm moved up the side channels into these six transects as the main river temperatures warmed, we calculated mean densities during each of the four time periods. Differences in fish densities between time intervals were tested using a Kruskal-Wallis Test with an alpha level of 0.10 used to denote significance. When the Kruskal-Wallis Test showed that a significant difference ($p \leq 0.10$) in density occurred between the time intervals, we used Tukey's Rank-Based HSD Tests to identify pair-wise differences in fish densities. Density differences between time intervals were used to assess whether salmonids ≥ 300 mm moved up the longer side channels during the summer.

We assessed whether salmonids ≥ 300 mm moved into or out of side channels throughout the day in relation to water temperatures. To accomplish this, we snorkeled four different side channel transects (2-1, 2-2, 4-1, and 8-1) that were known to support salmonids ≥ 300 mm during four time periods on August 1, 2007. These time periods were spaced throughout the day so that the first one occurred in the morning (coolest water temperatures) and the last one occurred in the afternoon (warmest water temperatures). To evaluate whether the abundance of salmonids ≥ 300 mm differed between the four time periods, we compared the numbers of each salmonid that was observed in each transect to the maximum number of each salmonid that was observed in that transect during the day. This would essentially tell us what percentage of the maximum of each salmonid species used the transect during each time period. These percentages were then averaged for all four transects, by time period (mean use). To evaluate whether salmonid use differed between the four time periods, we conducted an analysis of variance (ANOVA) on the mean use value for each salmonid during each time period. We used a p-value ≤ 0.10 to denote when a significant difference in use occurred between time periods. When an ANOVA showed that a significant difference ($p \leq 0.10$) in use occurred between time periods, we used Fisher's Least-Significance-Difference Test to evaluate which time periods differed significantly. Fisher's Least-Significance-Difference Test was chosen for this analysis as this test tends to maximize the power, which increases the ability to show statistically significant differences with low sample sizes (Milliken and Johnson 1992).

We used thermograph data and data collected from habitat inventories of each side channel to evaluate habitat characteristics that could explain the densities of salmonids ≥ 300 mm that were observed in the side channels. Because each of the snorkel events over the four sample periods were not independent, we calculated average salmonid densities for each transect for snorkel periods 2-4. We did not include data from the first snorkel period as salmonids had not moved into the side channels at this date. We also averaged the habitat characteristics collected at each transect for snorkel periods 2-4. To evaluate the influence of habitat attributes on densities of salmonids ≥ 300 mm in the side channels we used Yohai's MM-Estimation Robust Regression Analysis (Yohai 1987). Nonparametric modeling methods were necessary because of extreme non-normality and skewness in the fish density distributions. Additionally, outliers in the fish density data made the Yohai's MM-Estimation Robust Regression Analysis more appropriate than standard least squares multiple regression, as MM-Estimation protects from overly influential points in both the x and y space (Yohai 1987). The outlying points were not thrown out prior to analysis because these represented side channels with adult salmonid densities that were considerably higher than those observed at other side channels. Thus, we felt it was important to include these points in our analysis because they represented what appeared to be the best side channel habitat in the study area. Finally, variables were added to the model using stepwise regression methods (Ott and Longnecker 2001). Variables were first added in a forward step-wise direction, then checked by starting over and going in the backward step-wise direction. Both directions of adding variables to the stepwise regression model yielded identical results, and thus were used as the final models. Only variables that showed a significant relationship ($p \geq 0.10$) for the specified salmonids species were included in the model.

After developing linear models for predicting densities of cutthroat trout ≥ 300 mm based on habitat attributes, we looked at each attribute in more detail to see how they influenced fish distribution. For example, if maximum depths showed a significant relationship with cutthroat trout density, what depths did cutthroat trout prefer? This type of information would be useful when determining how to construct a side channel that cutthroat could use as cold water refugia. To accomplish this we created frequency histograms that showed how the significant habitat variables were distributed in the 26 side channel transects surveyed. We then overlaid this histogram with another that showed how cutthroat trout were distributed in these side channels in relation to each habitat variable. Emphasis was placed on transects with higher densities of cutthroat trout ≥ 300 mm than occurred in the main river. Because cutthroat trout are the species that will drive any future side channel construction, we also examined how significant habitat variables for cutthroat trout related to rainbow trout and mountain whitefish densities.

An information-theoretic modeling approach (Burnham and Anderson 2002) was used to evaluate the influence of side channel morphology and riparian habitat features on water temperatures in the side channels. Prior to modeling we reduced the number of independent variables (collected during the side channel habitat inventory) used with best subset regression analysis (Ott and Longnecker 2001) and limited the number of independent variables to five to avoid over-fitting the model. In the best subset regression analysis, the R^2 value was used as criterion for "best", and the subset of variables with the highest R^2 value represented the best set of a given number of variables. Once a subset of five variables was identified for inclusion in the modeling, Akaike's Information Criterion (AIC) (Akaike 1973) was used to select the best model using those five independent variables. After AIC model selection, least squares multiple regression was used to estimate the regression coefficients in the linear model.

We modeled the effects of side channel features on temperatures within the side channel using both the maximum average weekly temperature and maximum weekly temperature metrics. Both metrics were used in modeling because different temperature metrics can be influenced by different features, and both average and maximum temperatures are biologically relevant (Johnson 2004). Since the side channel temperatures were regulated by upwelling groundwater, this modeling essentially evaluated the side channel features influencing hyporheic flow into the side channels, which is a crucial factor for stream temperature buffering (Poole and Berman 2001).

Airborne Thermal Sensing Survey

To help evaluate how water temperatures were influenced by landscape scale characteristics, the USFS (funded through EPA) contracted Watershed Science Inc. to conduct an airborne thermal sensing survey. This survey gave us a snapshot in time of the water temperatures in the main river, adjoining tributaries, springs, and side channels that occurred within the floodplain of the study area. The airborne thermal sensing survey occurred on August 9, 2007, 13:48 to 14:51 pst. When compared to thermograph data collected in the main river, the thermal sensing data was within 0.5°C in all cases. As part of their contract, Watershed Sciences, Inc. submitted a report of their airborne thermal sensing study (Watershed Sciences Inc. 2007). The methods used to conduct this survey and display the data are presented in their report.

One of the products the airborne thermal sensing study produced was a longitudinal temperature profile within the floodplain of the NFCDR, Idaho, from the South Fork Coeur d'Alene River to Shoshone Creek. This profile showed the median water temperatures in the main channel, contributing streams, and surrounding springs. We overlaid the river km locations from this profile and the locations of the springs onto a floodplain map we developed for the study area. This floodplain map was created using ArcGIS, 1:24,000 U.S. Geological Survey topographic map, and satellite imagery. This floodplain map was produced to show where the historic floodplain was located and areas where development (roads, homes, farming, trailer parks, dikes) has restricted the river's ability to migrate. Through use of this map in conjunction with the airborne thermal sensing data, we were able to assess spring locations and where the river cooled or warmed in relation to development. This data allowed us to identify important floodplain areas that contributed to cooling of the main river, or because they were areas where future side channel construction would likely be successful in creating cold water refugia.

RESULTS

Side Channel Species Use and Comparison to Main River

We snorkeled 26 different transects in 20 side channels to help evaluate importance to salmonids between June 25 and August 9, 2007. Through these surveys, we observed 9,918 fishes representing 10 different species. Northern pikeminnow (41%) and mountain whitefish (34%) were the most abundant species observed (Table 35). Cutthroat trout were the fourth most abundant species (6% of total) and the most abundant trout species (Table 35). Rainbow trout and brook trout were also observed, but each represented less than 3% of the species recorded. For comparative purposes, we snorkeled nine transects in the main NFCDR on July 31 and August 1, 2007. We observed 8,624 fishes representing seven different species. Northern pikeminnow (50%) and mountain whitefish (34%) were the most abundant species (Table 36). Cutthroat trout were the fourth most abundant (6% of total) observed, and the most abundant trout species (Table 36). Three percent of the fish were rainbow trout, and no brook trout were observed in the main river.

The sizes of cutthroat trout, rainbow trout, and mountain whitefish observed while snorkeling side channels ranged from about 75 mm to 550 mm in length (Figures 78 - 79).

About 64% of the cutthroat trout, 43% of the rainbow trout, and 74% of the mountain whitefish were ≥ 300 mm in length (Figures 78 - 79, Table 37). In the main river 20% of the cutthroat trout, 17% of the rainbow trout and 26% of the mountain whitefish were ≥ 300 mm in length (Figures 78 - 79, Table 37). About 12% of the brook trout observed were ≥ 300 mm in length in the side channels, whereas none were observed in the river (Figure 79, Table 37).

We also backpack electrofished 16 different 100 m transects in the side channels from July 25 to August 13, 2007 to evaluate species use in habitat less than 1 m deep. We sampled 1,284 fishes representing 15 different species (Table 38). Northern pikeminnow (17%), speckled dace (15%), and brook trout (15%) were the most abundant species (Table 38). Cutthroat trout, rainbow trout and mountain whitefish all represented less than 1% of the species sampled. The largest cutthroat trout, rainbow trout, and mountain whitefish sampled were 138 mm, 189 mm, and 76 mm respectively.

To assess whether the densities of salmonids differed between side channels and main NFCDR, we compared the mean density between the last snorkeling event (August 1 to August 9) in the side channels with the mean density in the main river (July 31 to August 1). The mean density of cutthroat trout, rainbow trout, and mountain whitefish (all < 300 mm) were significantly higher (Wilcoxon Rank Sum; P = 0.003, 0.004, 0.001) in the main river than in the side channels (Figures 80 - 81). However, the mean densities of cutthroat trout and mountain whitefish ≥ 300 mm were significantly higher (Wilcoxon Rank Sum, P = 0.0152, P = .0004) in the side channels than in the main river (Figures 80 - 81). The mean density of rainbow trout ≥ 300 mm was significantly lower (Wilcoxon Rank Sum; P = 0.08) in the side channels than the main river (Figure 80).

<u>Timing of Side Channel Use by Salmonids</u>

The daily maximum water temperature in the main river (averaged across six sites) increased about 12°C from when we first started snorkel surveys (June 25, 2007) to when the highest average maximum temperature of 23°C was recorded on July 23, 2007 (Figure 82). The daily maximum temperatures in the side channels (averaged across 26 sites) were approximately 3 - 7°C cooler than those observed in the main river during the four periods when we conducted our snorkel surveys (Table 34, Figure 82). A Wilcoxon Rank Sum Test showed that the mean maximum weekly maximum temperature for the side channels was significantly cooler (P = 0.0004) than what was observed in the main river.

Because larger salmonids (≥ 300 mm) displayed the greatest use of side channel habitat, all analysis in this section focused on larger fish. Cutthroat trout were consistently observed in eight different side channels transects (not including upstream transects). Based on density estimates in these eight side channels transects, cutthroat trout ≥ 300 mm moved into side channels around the second week of July (July 9 to 17) when daily maximum water temperatures began exceeding approximately 21°C (Figures 82 - 83) in the main river. Mean cutthroat trout densities increased over eight-fold between the first (June 25 to July 3) and second (July 9 to 17) sample periods. Cutthroat trout densities remained fairly steady from the second to fourth (last) sample periods. From the second to fourth sample period (July 9 to August 9), mean cutthroat trout densities were on average 3.6 times higher in the eight side channel transects than observed in the main river. Significant differences (Kruskal-Wallis, P = 0.017) in densities of cutthroat trout occurred between the four sample periods, with pair-wise comparisons (Tukey's Rank Based HSD Procedure) showing that cutthroat trout densities were significantly lower during the first sample period (June 25 to July 3) than the last three.

Rainbow trout were consistently observed in eight different side channel transects (not including upstream transects). The mean densities of rainbow trout ≥ 300 mm in the eight side channel transects were similar to what was observed in the main river through the first two sample periods (June 25 to July 17) (Figure 83). During the third sample (July 23 to 31), when water temperatures reached their peak (23°C), rainbow trout densities increased over three fold in the eight side channel transects (Figures 82 - 83). When compared to the main river, mean rainbow trout density in the eight side channel transects were over four times higher during the third sampling period. Rainbow trout densities declined by about half from the third to fourth sample period (Figure 83). The maximum daily water temperature in the main river declined from 22.4 °C to 20.6 °C during this same period (Table 34, Figure 82). Kruskal-Wallis Tests (P = 0.131) failed to show a significant difference in rainbow trout densities between the four sample periods despite over a fourfold difference between the second and third sample periods. The relatively small sample sizes (8 transects/group) combined with high variability likely reduced our statistical power to detect differences that may have existed between the time intervals.

Mountain whitefish were consistently observed in six different side channel transects. The mean density of mountain whitefish ≥ 300 mm in these transects increased about 16 fold from the first to the third sampled periods (Figure 84). During this same period the mean maximum daily water temperature in the main river increased from 17.9°C to 22.4°C (Table 34, Figure 82). The mean mountain whitefish density during the third sample period was over 6 times higher than was observed in the main river (Figure 84). The mean mountain whitefish density declined from the third to the fourth sample period, but was still over four times higher than what was observed in the main river. Kruskal-Wallis testing (P = 0.195) failed to show a significant difference in mountain whitefish densities between the four sample periods despite approximately a 16 fold difference between the first and third sample periods. Once again this was likely due to small sample sizes and high variability leading to low statistical power.

Movement of cutthroat trout, rainbow trout, and mountain whitefish into or out of side channels throughout daylight hours was evaluated on August 1, 2007. To estimate this movement snorkeling occurred over four time periods, in four different side channel transects known to be used by salmonids (Table 39 Figure 85). The average water temperature in the main river on this day was near its lowest (<17°C) when we started snorkeling and rose steadily to near its maximum (> 21°C) when we conducted our last snorkel round (Figure 85). Approximately 70% of the maximum number of cutthroat trout (≥ 300 mm) that were observed in the four side channel transects were observed during the first time period (Figure 86). This essentially means that 70% of the cutthroat trout that used these side channels on August 1, 2007 were found in the channels during the first snorkel period (Figure 86). Cutthroat trout use did not change appreciably until the third time period when about 96% of the fish were observed in the side channels (Figure 86). Water temperatures in the main river increased on average from 18.8°C to 20.1°C during this time period (Table 39, Figure 85). Cutthroat trout use dropped to 84% of the total during the last time period when water temperatures in the main river reached their maximum. Analysis of Variance (ANOVA) testing (P = 0.455) failed to show that cutthroat trout use changed throughout the day in these side channels.

Rainbow trout and mountain whitefish (≥ 300 mm) showed similar patterns of use throughout the day in the four side channel transects. Fewer than 40% of the fish were observed during the first time period, around 45% of the fish were observed during the second time period, and over 90% were observed during third period (Figure 86). Rainbow trout use dropped to around 80% of the total during the last time period. ANOVA testing found that use of rainbow trout and mountain whitefish in side channels differed significantly (rainbow trout, P =

0.029; mountain whitefish, P = 0.003) over the four time periods. Pair-wise comparisons using Fisher's Least-Significance-Difference Tests showed that densities of rainbow trout and mountain whitefish tended to be significantly lower during the first two time periods than the second two (Table 40). The water temperature in the main river increased on average from 18.8°C to 20.1°C during the period when rainbow trout and mountain whitefish showed large movements into the side channels.

Side Channel Movement

We evaluated whether salmonids moved into side channels by examining fish densities over four sampling periods (Table 34, Figure 82) in the transects that were upstream of the main river. There were six different side channels transects that met this description (Table 35). Densities of cutthroat trout, rainbow trout, and mountain whitefish (≥ 300 mm) in these upstream side channel transects were considerably lower than what was observed in the main river regardless of which sample period we evaluated (Figures 87 - 88). Densities of all fish tend to increase after the first sample period, but none of these changes were significant (cutthroat trout, P = 0.889; rainbow trout, P = 0.663; mountain whitefish, P = 0.865) based on Kruskal-Wallis testing.

Fish densities in one of the six transects (2-2) we evaluated showed that salmonids ≥ 300 mm will move short distances up side channels past constrictions with suitable depth. Side channel transect 2-2 was 46 m from the river and to reach it the fish had to move past a constriction that was about 1 m deep. Over time this constriction became progressively shallower. By August 1, the water depth at this constriction had decreased to about 0.5 m, and few salmonids (over 12 fold decline) moved past it even though cool water temperatures (< 14°C) and ample depth (max depth of 3 m) occurred up-channel. Transect 15-1 was 143 m long and fish were commonly observed at its upstream boundary. However, transect 15-2, which was 170 m upstream had depths > 2 m, and cold water temperatures (< 10°C), did not have an increase in salmonids density (≥ 300 mm) over time. The riffle between these two transects had flow velocity that were considered high, and water depths were typically around 0.2 m.

Salmonid Density Monitoring

To evaluate the influence of various habitat attributes on densities of salmonids ≥ 300 mm in the side channels, we used Yohai's MM-Estimation Robust Regression Analysis (Yohai 1987). We used data characterizing 27 different habitat variables in this analysis (Table 48). Out of these 27 variables, two showed a significant relationship in explaining the density of cutthroat trout ≥ 300 mm in the side channels assessed (Table 41). These two variables were the maximum depth to temperature ratio and visibility. Combined, these two variables explain approximately 48% of the variation in cutthroat trout density observed in the side channels. For rainbow trout and mountain whitefish, maximum depth was the most significant variable influencing density and temperature did not show a significant relationship (Table 41). Additionally, rainbow trout densities were significantly related to percent bedrock substrates and overhead canopy cover, while mountain whitefish densities were related to visibility, the amount of small woody debris in-channel, and the transect's distance to the main river (Table 41).

In an effort to assess which variables were most important (maximum depths, water temperatures, and flows) to cutthroat trout ≥ 300 mm, we looked at how these attributes occurred in the side channels and how cutthroat trout were distributed. We elected to look at flows versus visibility, which had a significant relationship with cutthroat trout density, for three reasons: 1) flows were moderately correlated to visibility ($\rho = 0.43$); 2) relative flow velocity was moderately correlated with densities of cutthroat trout ≥ 300 mm ($\rho = 0.40$); and 3) it was easier to understand how to create a side channel with flow versus one that has higher visibility water conditions. The maximum depth in side channel transects ranged from 0.8 m to 6.0 m (Table 42). Cutthroat trout (≥ 300 mm) were observed at least once in side channels with maximum depths throughout this range (Figure 89). Seven of the side channel transects had cutthroat trout densities greater than what was observed in the main river (0.17 fish/100 m^2). Six of these transects (86%) had maximum depths > 2 m (Figure 89). The maximum weighted mean temperature (MWMT) in side channel transects ranged from 10.5 to 25.0 °C (Table 42). Cutthroat trout (≥ 300 mm) were located at least once in side channels throughout this temperature range (Figure 90). All side channel transects that had cutthroat trout densities greater than what was observed in the main river had a MWMT < 20°C (Figure 90). When we evaluated how flow influenced cutthroat trout use, we found that no cutthroat trout (≥ 300 mm) were observed in side channel transects with zero flow. Side channel transects with cutthroat trout densities greater than what was observed in the main river all had relative flows greater than 1 unit (Figure 91).

When we evaluated how maximum depth, temperature, and flows influenced rainbow trout and mountain whitefish (≥300 mm) distribution in side channels we found similar patterns as observed with cutthroat trout. The only differences were that rainbow trout were found in water that was shallow and warmer than water used by cutthroat trout (Figures 92 - 94). Additionally, mountain whitefish appeared to prefer maximum depths > 2.5 m (Figures 95 - 97).

Temperature Modeling

We modeled the relationship between side channel morphology, riparian habitat features, and water temperatures in side channels using an information-theoretic approach (Burnham and Anderson 2002). We used data characterizing 27 different habitat variables in this analysis. Best subset regression analysis reduced the number of variables used in modeling to five for each temperature metric. The variables used in modeling mean average weighted temperature (MAWT) were valley location, percent fines in the bottom substrate, percent gravels in the bottom substrate, percent boulder in the river-side bank, and light riparian vegetation levels (Table 43). Using these five variables, we used AIC model selection methods to identify the most economical model. The best model included all five variables and explained approximately 81% of the variation in MAWT observed in the 20 side channels we assessed. The variables used in modeling MWMT were percent fines in the riverside bank, percent boulder, bedrock, and cobble in the opposite side bank, and average distance between the river and the side channel (Table 43). Using AIC model selection methods the best model contained all five variables, and explained approximately 75% of the variation in MWMT observed in the side channels.

Airborne Thermal Sensing

The results presented in the following paragraph are from the final contract report from Watershed Sciences Inc. (2007).

The airborne thermal sensing flight took place on August 9, 2007, from 13:48 to 14:51. When compared to thermograph data collected in the main river, the thermal sensing data was within 0.5°C in all cases. The median channel temperatures for the North Fork Coeur d'Alene River were plotted from the confluence of the South Fork Coeur d'Alene River upstream about 50 river km to Shoshone Creek (Figure 98). Water temperatures ranged between 16.2-21.1 °C and generally decreased in a downstream direction (Figure 98). There were 26 surface inflows documented (streams, side channels and sloughs) into the North Fork Coeur d'Alene River with 14 contributing water that was cooler than the main river (Figure 98, Table 45). In addition, 35 spring inputs were documented during the analysis (Figure 98, Table 46). A spring was classified as any distinct discharge that was not associated with a tributary or other obvious surface inflow. All 35 springs had cooler water temperatures than the main river.

Through ArcGIS, we developed a map of the floodplain for the 50 km reach of our study area (Figure 99). The total historic floodplain area in this reach was calculated to be 1,428 ha. The floodplain ranged from about 50 m to 1,200 m in width. The narrowest floodplain widths tended to occur in the upper 11 km of our study area. As of 2007, development reduced the area where the river could shift course by 36%, and the widest floodplain width to about 700 m (Figure 99). Road development has resulted in the largest decline in floodplain area, followed by temporary structures such as trailer parks and private recreation areas (Table 47). Flooding can still occur throughout many of the areas considered to be lost floodplain; however, under their current management the river will not be allowed to shift course in developed areas.

Through use of this floodplain map and the airborne thermal sensing data, we found that springs were most prevalent in floodplain areas where the river could shift course (Figure 99). Declining main river temperatures were prevalent in areas associated with an abundance of springs, whereas river temperatures tended to increase in areas where springs were not detected (Figures 98 - 99). River cooling also occurred where sudden floodplain constrictions (3 fold decrease in width within 100 m length of river) were located (river km 20 and 31). There were several areas (river km 6.5, 23, and 38) where the floodplain widths decreased by about 50% in a 100 m reach, but they were not associated with a noticeable decline in river temperature (Figures 98 - 99).

DISCUSSION

Patterns of Side Channel Use

Side channels were found to provide important cold water refugia to cutthroat trout in the lower NFCDR. However, this was only true for larger fish, especially those over 300 mm in length. Movement of Westslope cutthroat trout ≥ 300 mm into side channel habitats in mid July coincided with both increases in main river water temperatures, and the temperature divergence between the main river and the side channels. While average daily maximum temperatures in the main river exceeded 22° C, average maximum side channel temperatures stayed consistently around 15° C. During the mid-summer period of elevated river temperatures, cutthroat trout densities in the side channels used as thermal refugia increased eight fold. The pattern of fish movement into the side channels while the temperatures diverged between the main river and the channels suggests these areas were being used as thermal refugia by cutthroat trout. Similarly, Baird and Krueger (2003) observed large aggregations of brook and rainbow trout move into cold water refugia formed by upwelling groundwater and tributary confluences during the summer when main river water temperatures exceeded 20° C. Breau et al. (2007) observed large aggregations of juvenile Atlantic salmon in New Brunswick congregating in cold water refugia in response to elevated summer river temperatures exceeding 24°C. Furthermore, use of cold water tributaries as thermal refugia by migrating adult summer steelhead (High et al. 2006) and Chinook salmon (Goniea et al. 2006) has been linked with increases in main stem Columbia River water temperatures. Gowan and Fausch (2007) suggested that trout will use movement to monitor habitats as they change temporally and adjust their locations according to changing conditions. Bear et al. (2007) found that both Westslope cutthroat trout and rainbow trout growth declines significantly at temperatures above 20° C, with optimal growth temperatures around 13° C for both species. Reduced growth at elevated temperatures should provide strong incentive for cutthroat trout to seek thermal refugia. This further supports our conclusion that fish movement into the side channels during this study was primarily driven by rising main river temperatures, coupled with more stable and colder side channel temperatures. In contrast, Schrank et al. (2003) found no evidence that Bonneville cutthroat trout moved into cold water refugia during summer despite river temperatures reaching 27° C. However, this observation was based only on a sample of six fish, and they did not quantify availability of cold water refugia in their study area.

Movement of mountain whitefish and rainbow trout ≥ 300 mm into side channels used as thermal refugia occurred in late July and coincided with the peak in main river water temperatures. Rainbow trout abundance tripled in the side channels during the third sampling period, when the average daily maximum water temperature in the main river was 22.4° C. Similarly, during the third sampling period mountain whitefish densities in side channel thermal refugia were 16 times higher than during the first sampling period. The observed peak of rainbow trout use of thermal refugia during periods of maximum river temperatures has been observed by multiple studies (Kaya et al. 1977, Mathews and Berg 1994, Ebersole et al. 2001, Sutton et al. 2007). Furthermore, studies in Adirondack streams found rainbow trout used available thermal refugia less than native brook trout during periods of elevated summer stream temperatures (Baird and Krueger 2003). This pattern of movement where rainbow trout and mountain whitefish densities peaked later in the summer and during higher main river temperatures suggests these species may be less dependent on cold water refugia in this river system. While the significance of reduced dependence of rainbow trout on thermal refugia in the NFCDR was not fully assessed, it may have strong implications as other studies have found rainbow trout can displace cutthroat trout in low elevation reaches (Griffith 1988), and temperatures can influence the success of salmonid invasions (Fausch 2007). Thus existing thermal refugia in the lower reaches of the NFCDR may be preventing displacement of cutthroat trout by rainbow trout in these areas.

Differences in the patterns and magnitude of side channel use may have been due to differences in temperature preferences, preferred habitat features, or competitive interactions between the three species. Cutthroat trout used side channels in large numbers throughout the summer. In contrast, mountain whitefish and rainbow trout use of side channel thermal refugia occurred over a shorter period, with smaller aggregations of rainbow trout observed. Bear et al. (2007) found survival of juvenile Westslope cutthroat trout decreased at temperatures above 20° C, while survival of juvenile rainbow trout did not decrease until temperatures exceeded 24° C. Additionally, Westslope cutthroat trout survival was significantly lower than rainbow trout survival at temperatures above 20° C, and rainbow trout exhibited significantly higher resistance to acute temperature exposure over 20° C (Bear et al. 2007). Literature on temperature preference for mountain whitefish is limited, however, Ihnat and Bulkley (1984) reported acute temperature preference varies seasonally, and the maximum temperature preference of 17.7° C occurred during the pre-spawning period. These studies suggest that the differences in the use of side channels as thermal refugia by salmonids in our study may have been related to differences in temperature preference between the three species. If rainbow trout prefer slightly higher temperatures than other salmonids, we would expect to find rainbow trout less dependent on thermal refugia than the other species. In contrast, other studies indicate that the side channel use by rainbow trout may not be related to temperature preferences. For example, numerous studies have found rainbow trout use of thermal refugia to be highly variable, even during periods of extreme river temperatures (Mathews et al. 1994, Baigun et al. 2000, Ebersole et al. 2001); indicating factors other than temperature may have strong influences on thermal refugia use. Although many potential thermal refugia may be available, there suitability for use by large numbers of fish may be highly variable due to physical and chemical characteristics (Ebersole et al. 2003a). Finally, Magnuson et al. (1979) suggested that competition and availability of other resources can influence the use of thermal resources by fishes. Although we did not attempt to quantify competitive interactions in this study, the large aggregations observed would suggest competition for space, food, or other resources may have occurred.

Strong size structured differences in side channel habitat use by Westslope cutthroat trout were also observed in this study. Almost 64% of cutthroat trout observed in the side channels were ≥ 300 mm. In contrast, 20% of cutthroat trout in the main river were ≥ 300 mm. Similarly, Breau et al. (2007) observed the oldest age classes of juvenile salmon occupied the coldest regions of thermal refugia used during periods of elevated stream temperature. Ebersole et al. (2001) documented that the largest rainbow trout occupied the coldest portions of thermal refugia used in northeast Oregon streams. The differences in side channel habitat use by different size classes of salmonids may be due to differences in thermal tolerances. Bear et al. (2007) found smaller Westslope cutthroat trout and rainbow trout had significantly higher survival at temperatures above 20° C than larger fish. Furthermore, Meeuwig et al. (2004) found the effects of different thermal regimes on Lahontan cutthroat trout varied with the initial mass of the fish, with the effects of altered thermal regimes being more pronounced in larger fish. The dominance of Westslope cutthroat trout ≥ 300 mm in side channel habitat use may also be the result of intra-specific competition. Magnuson et al. (1979) suggested that intra-specific competition for thermal resources is similar to competition for food, and often results in the dominant individuals competitively excluding other individuals from the preferred temperature range. Size related differences in habitat use are common in other salmonids (Mäki-Petäys et al. 2004, Al-Chokhachy and Budy 2007) and are often most pronounced in the summer (Baltz et al. 1991). In reality, temperature tolerance and intra-specific competition may not be completely independent events when associated with size structured habitat shifts, as increased tolerance to temperature extremes may be an evolutionary adaptation to being competitively excluded from optimal temperature ranges. Regardless of the mechanism causing the size structured use of thermal refugia, the presence of larger fish in these habitats indicates their importance to cutthroat trout on the study area.

Size related differences in side channel habitat use in the NFCDR were also observed for mountain whitefish and rainbow trout. Almost 74% of mountain whitefish observed in the side channels were ≥ 300 mm, whereas only 26% of mountain whitefish in the main river were ≥ 300 mm. There was also a larger percentage of rainbow trout ≥ 300 mm in the side channels than the main river, although the difference was less distinct. Although the use of side channel thermal refugia by larger mountain whitefish suggests side channels may be preferred during periods of extreme river temperatures, the overall timing of side channel thermal refugia use by mountain whitefish and rainbow trout suggests these areas are not as important for these species as they are for cutthroat trout

In addition to varying by fish size throughout the summer, use of side channel habitats as thermal refugia also appeared to vary throughout the day. Although some degree of diel changes in density were recorded for all species, diel fluctuations in densities were most pronounced for rainbow trout and mountain whitefish. As temperatures increased in the main river throughout the day, so did the densities of mountain whitefish and rainbow trout in the side channels. Densities of cutthroat trout in the side channels increased slightly throughout the day, although, these increases were not significant. Similar to our observations, other studies have documented peak use of thermal refugia by rainbow trout during the peak in daily temperatures (Ebersole et al. 2001, Sutton et al. 2007). Since trout can use movement to monitor changing habitat conditions over time (Gowan and Fausch 2002), the diel movements we observed may have been due to increasing river temperatures. However, movement of fish can also be used to maximize foraging opportunities (Gowan and Fausch 2002), and the movement out of side channels we observed may have been to maximize foraging opportunities in the main river. The high densities of fish observed in side channel thermal refugia during this study would indicate that food availability was likely limited, thus movement may have been foraging related. If food availability in the side channels were limited due to the high densities of fish observed, this would infer a competitive advantage to fish able to move out of the channels and into the main river to feed. Although our data are limited to only one day, they suggest that cutthroat trout make less movement into and out of the side channels than rainbow trout. Once again this suggests that cutthroat trout are more dependent on existing side channel thermal refugia than rainbow trout in this river system.

Differences in the densities of fish ≥ 300 mm between the side channels and the main river indicate the relative importance of side channel habitat for salmonids in our study. Densities of Westslope cutthroat trout and mountain whitefish in the observed side channels were significantly larger than the densities observed in the main stem Coeur d'Alene River. Although the average densities of rainbow trout observed in the side channels were significantly lower than the main river, aggregations of fish were still observed in some channels. The observed side channels in this study varied considerably in their physical features, and thus were not all used equally. Aggregations of salmonids in thermal refugia larger than those found elsewhere in the same river have been reported in numerous other studies (Kaya et al. 1977, Brown and Mackay 1995, Baird and Krueger 2003, Ebersole et al. 2001, Sutton et al. 2007, Breau et al 2007). The larger aggregations of cutthroat trout in available cold water refugia suggests that these habitats are limited spatially (Brown and MacKay 1995, Power et al. 1999), and may be critically important for this species due to the potential for cumulative sub-lethal effects of high temperatures (Meeuwig et al. 2004). Furthermore, density may not always reflect habitat quality; however, we did observe the dominant larger fish in these areas, suggesting a density reflected quality in our observations (Van Horne1983).

Electrofishing shallow reaches (≤ 1 m) of the side channel habitats showed that these areas are not used extensively by cutthroat trout, rainbow trout, or mountain whitefish of any size in the lower reaches of the NFCDR. In contrast, other studies have found side channels provided important habitat for juvenile salmonids (Swales and Levings 1984, Giannico and Hinch 2003, Morley et al. 2005). In the NFCDR, juvenile salmonids often use tributary streams as rearing habitat (DuPont et al. *in press*); thus, side channels are not likely as important for juvenile rearing habitat. However, multiple size classes of non-native brook trout were found to use cold side channels. Interestingly, brook trout are not observed in the main stem NFCDR

(DuPont, unpublished data), suggesting the existence of brook trout in this system is closely linked to side channel habitats. Brook trout are fall spawners, and the occurrence and prevalence of winter floods can limit their invasion into cutthroat trout habitat (Dunham et al. 2002). In the NFCDR winter rain-on-snow floods and high bedload movements are common. Furthermore, the use of off-channel habitat such as side channels as refugia from high flow events by salmonids is well documented (Swales and Levings 1984, Yrjana et al. 2002). Thus, it is likely that side channel areas provide protection from high flow events for developing brook trout eggs, allowing their persistence in these off-channel areas. In addition to providing habitat for non-native brook trout, the shallow backwater areas of cold side channels also provide habitat for multiple species of native and non-native fish not normally observed in the main river.

The ontogenic differences in habitat use, diel and seasonal movement patterns, and the significantly larger densities of cutthroat trout ≥ 300 mm in the side channels than the main river suggests the importance of these seasonal habitats for this species in the NFCDR. The reduced use of thermal refugia by rainbow trout in the lower reaches of the study area suggests these habitats are not as critical for this species. This finding has strong implications for conservation of Westslope cutthroat trout in the lower reaches of the NFCDR, as other studies have documented rainbow trout displacing cutthroat trout in low elevation reaches in the western United States (Griffith 1988, Paul and Post 2001). Our findings indicate that displacement of cutthroat trout by rainbow trout in lower elevation reaches may be facilitated by a reduced dependence on colder water in these areas. Furthermore, low elevation reaches commonly have human disturbances that destroy and limit availability off channel habitats that may serve as thermal refugia for native species. This was the case on our study area, where 36% of the floodplain has been lost to human development. Further losses in the floodplain could feasibly facilitate displacement of cutthroat trout by rainbow trout in the lower reaches of the NFCDR.

This study is unique in documenting the importance of side channel habitat as thermal refugia during the summer by larger salmonids. Other studies have documented the use of side channels as rearing habitat for juvenile salmonids (Swales and Levings 1984, Giannico and Hinch 2003). Other studies have also documented the use of thermal refugia by adult fish (Nielsen et al. 1994, Baigun et al. 2000, Goniea et al. 2006, High et al. 2006), and indicated the potential of side channels to function as thermal refugia (Ebersole et al. 2003a), however no previous studies that we are aware of have documented the use of side channels as thermal refugia by large numbers of adult salmonids. These findings demonstrate the potential for side channels to provide important seasonal habitats for adult trout, and have implications for conservation of active floodplains, hyporheic flow paths, off-channel habitats, and thermal refugia that may be beneficial in similar river systems.

Factors Influencing Densities of Salmonids ≥ 300 mm in the Side Channels

Densities of adult Westslope cutthroat trout in side channel habitats were influenced by the ratio of maximum depth to bottom temperature and water visibility within the side channels. The interaction between depth and temperature had the strongest influence on cutthroat trout densities in the side channels, with channels that were both deeper and colder containing the highest densities of fish. Specifically, adult cutthroat trout used side channels that were ≥ 2 m deep, with temperatures that stayed ≤ 20° C. Similarly, Baird and Krueger (2003) found use of tributary confluences as thermal refugia by brook and rainbow trout was influenced by depth; with fish selecting deeper areas. Breau et al. (2007) also found use of cold water refugia by juvenile Atlantic salmon was influenced by water temperature and depth. In this study, salmon thermal refugia did not appear to move up the longer side channels, but stayed in the cold deep reaches close to the mouth. It is also important to note that a large amount of variability remained unexplained in this model (r^2 = 0.375), indicating the presence of other factors influencing side channel use by mountain whitefish.

Surprisingly, temperature alone was not significant in any of the adult salmonid density models. This is likely related to the fact that nearly all of the side channels were colder than the main river, and thus had potential to function as thermal refugia. That temperature influenced side channel use is apparent in the fact that no side channels with maximum temperatures ≥ 20° C contained large aggregations of salmonids ≥ 300 mm in this study. Despite most of the channels being colder than the main river, they varied widely in their physical characteristics, and subsequently their suitability for use by fish was highly variable. The absence of temperature as a significant factor in the density modeling thus likely reflects the fact that nearly all of the channels were suitable thermally, but use of the available thermally suitable habitat was dictated by physical habitat characteristics. This is similar to other studies that concluded temperature was the driving force behind thermal refugia occupancy, but specific use of thermal refugia was dictated by other habitat features (Baigun et al. 2000, Sutton et al. 2007). Additionally, Picard et al. (2003) found models predicting presence or absence of brook trout based solely on temperature indices were much more effective at predicting absence than presence. This was because thermally unsuitable habitat will not likely be used; however, presence in thermally suitable habitat is often influenced by other factors (Picard et al. 2003). Furthermore, the use of thermal refugia can depend on the ambient river temperatures at the reach level (Ebersole et al. 2001). While we monitored river temperatures over a broad spatial scale, we did not monitor river temperatures at a spatial resolution fine enough to detect differences in side channel densities based on main river temperatures adjacent to each specific side channel reach. Additionally, all of the density models left a considerable amount of variation unexplained (Table 41), which is likely at least partially due to the relatively small sample sizes for modeling (n = 21), combined with the high natural variability in the use of these habitats. Lastly, we did not monitor dissolved oxygen levels in the side channels, and this factor can significantly influence the suitability of thermal refugia for use by fish (Ebersole et al. 2003a). In summary, large aggregations of Westslope cutthroat trout were limited to side channels > 2 m deep, with temperatures < 20° C, and some degree of flow present.

Temperature Modeling

Our results suggest the factors showing a significant relationship with MAWT in the side channels were a channel's location in the floodplain and the levels of riparian vegetation surrounding side channels. Specifically, a side channel being located against the floodplain valley wall led to significantly colder MAWT. Similarly, Ebersole et al. (2003a) found groundwater upwelling frequently occurred where steam channels came into contact with valley walls. Additionally, light riparian vegetation levels showed a positive significant relationship with MAWT in the side channels. Both Ebersole et al. (2003a) and Johnson (2004) found experimental shading can lower stream temperatures; however, Ebersole et al. (2003a) found no correlation between canopy coverage and longitudinal temperature in cold water patches. Our results also showed no relationship between canopy coverage and water temperature (P = 0.9255), which was likely due to the large amounts of groundwater regulating in-channel temperatures. Lastly, lower MAWT was associated with increases in bolder substrate in the riverside bank, as well as fine and gravel substrate in channel. Coarse substrates often have increased hydraulic conductivity (Kasahara and Hill 2006), which can lead to increased hyporheic exchange (Morrice et al. 1997). Therefore boulder substrates in the riverside bank likely facilitated subsurface flow from the main river and into the side channels. Fine substrates in channel can reduce hyporheic exchange (Kasahara and Hill 2008), therefore fine substrates in colder channels likely just facilitated retention of groundwater coming in through the bank substrates (i.e. prevented groundwater from leaving out the bottom of the channel) and probably did not increase rates of hyporheic exchange in channel. Additionally, the deposition of fines and gravels in the side channel habitats is likely facilitated with high flow events in this river system. Therefore, the smaller substrates in cold channels may have been a function of decreased flow velocities during high flow events, allowing these substrates to settle.

Weekly maximum temperatures in the side channels were most strongly influenced by substrate composition in the side channel bank opposite the river. Specifically, increased bedrock substrate in the opposite bank led to decreased MWMT. Increased cobble and boulder substrates in the opposite bank, and fines in the riverside bank, led to increased MWMT. The porosity of these substrates likely influenced the rate and retention of hyporheic exchange in the side channels (Kasahara and Hill 2006). Finally, increases in the average distance between the main river and the side channels led to significantly decreased temperatures. Larger distances indicate water flowing subsurface from the main river, which would likely decrease the temperature of the water.

Combined with modeling results, the effects of physical features on the different temperature metrics within the side channels can be used to hypothesize a model of groundwater flow into the side channels. While the models for each temperature metric were slightly different, they both included parameters indicating that a channels location in the floodplain, as well as in-channel substrates may influence water temperatures. Additionally, the MAWT model (r^2 = .8111) explained more variation than the MWMT model (r^2 = .7551). The most significant variable influencing temperatures in the side channels was the side channel's location in the floodplain. Similar to Ebersole et al. (2003a), we found groundwater upwelling was common in channels against floodplain valley walls. It is likely that water flowing subsurface may be forced to the surface when it comes into contact with the impermeable bedrock walls. We commonly observed subsurface flow entering the side channels laterally from the riverside banks. This suggests that much of the subsurface water entering the side channels was flowing from the main river and through the bar separating the river from the side channels before entering the channel. Increasing the distance between the river and the side channel led to decreased water temperatures in the side channels. Increasing the distance the subsurface water flows from the river to the side channel would mean increasing the amount of time the water spends subsurface, which may decrease the water temperatures. Additionally, the riverside bank being composed of boulder substrates led to decreased temperatures, while the bank being composed of fine substrates led to increased temperatures. This indicates that as the water flows subsurface from the river and into the side channel, the porous bolder substrates in the bank may allow more subsurface flow to enter the channel, while less permeable fine substrates reduce the flow (Kasahara and Hill 2006). Furthermore, the substrate composition in the bank opposite of the riverside was also significantly related to water temperatures in the side channels. Increasing amounts of porous cobble and bolder in the opposite bank led to increased water temperatures, while increasing bedrock composition in the opposite bank led to decreasing water temperatures. This indicates that the impermeable bedrock in the opposite bank may prevent groundwater from going subsurface out the opposite side of the channel, while porous substrate in the opposite side bank may facilitate more subsurface movement (Kasahara and Hill 2006). Thus, we hypothesize that the channel's location in the floodplain is the dominant factor shaping the amount of upwelling groundwater, and the role of substrate in shaping side channel water temperatures lies in regulating the inflow and retention of groundwater within the channels.

Airborne Thermal Sensing

The airborne thermal sensing report provided by Watershed Sciences Inc. for the NFCDR shows an observed downstream cooling trend in the river. This is opposite of the downstream warming trends that typically occur, and suggests the presence of strong temperature buffers in this system (Poole and Berman 2001). The temperature buffers in this system exist in the form of springs formed by hyporheic flow entering the river from subsurface (Watershed Sciences Inc. 2007). In addition to a general downstream cooling trend, a cooling effect was also observed near several constrictions of bounded alluvial valley segments. This result is similar to results found in other studies documenting hyporheic upwelling commonly occurring at the downstream end of bounded alluvial valley segments (Baxter and Hauer 2000, Pepin and Hauer 2002).

Springs formed by upwelling hyporheic flow in the NFCDR system most commonly occur in areas with an intact floodplain (Figure 99). Much of the floodplain in the lower reaches of this system is privately owned, and development has caused significant loss of intact floodplain in these areas. The most common cause of floodplain loss is road construction, which permanently limits natural movement of the river. Limiting the natural floodplain dynamics leads to destruction of existing off-channel habitats, and may prevent new side channel formation. Additionally, the largest cooling trends in the main river were associated with areas of intact floodplain. In contrast, warming main river trends were associated with developed areas, which have implications for floodplain conservation. As previously mentioned we believe the available thermal refugia in the lower reaches of the river are critical for cutthroat. This fact, coupled with the current state of habitat loss in the lower reaches, suggests the critical importance of protecting these areas from further development and habitat loss. Examples of such areas can be found (but are not limited to) near river kilometers 4, 10, 11, 27, 28, 31, 32 (Figure 99).

We suspect the downstream cooling effect observed in this system may differ from those in other northern Idaho river systems. In other rivers such as the St. Joe, North Fork Clearwater, and Lochsa resident fish have been found to move long distances upstream to reach cooler waters during summer. These rivers are more canyon-like and lack the floodplain and alluvial valley habitat that are necessary to form hyporheic flow. In the NFCDR trout migrate long distances to upstream spawning grounds; however, summer movements occur over short distances and are more localized (DuPont et al. *in press*).

Implications for Side Channel Conservation and Enhancement

This study has documented the importance of side channel habitats as cold water refugia for larger salmonids in the NFCDR during periods of elevated temperatures. Similar studies have documented the importance of other types of thermal refugia for salmonids of various life history stages during periods of thermal stress both in the summer (Mathews and Berg 1997, Baird and Krueger 2003, Breau et al. 2007, Sutton et al. 2007) and winter (Brown and Mackay 1995). The large aggregations of fish observed using thermal refugia in both this and other studies (Brown and Mackay 1995, Baird and Krueger 2003, Breau et al. 2007, Sutton et al. 2007) suggests that these habitats are spatially limited (Brown and Mackay 1995, Power et al. 1999). Cumulative small scale losses of such thermal refugia can turn good trout habitat into poor habitat (Power et al. 1999, Poole and Berman 2001), thus conservation of these habitats is of critical importance. Conservation of thermally stable off channel habitats for use as thermal refugia by Westslope cutthroat trout during the summer may also provide benefits during other seasons (Brown and Mackay 1995). Furthermore, the importance of thermal refugia to cutthroat trout will likely increase over time, as global climate change poses a serious threat to trout habitat in the western United States (Keleher and Rahel 1996, Rahel et al. 1996, Jager et al. 1999).

The first logical step in conservation or enhancement of side channel thermal refugia is protecting the important habitats already identified. Our study indicates that conserving existing cold side channels in the lower reaches of the NFCDR system is important due to the large degree of habitat loss that has already occurred. This would include side channels 2, 3, 4, 6, 7, 10, and 15 but not be limited to these areas as additional springs have been identified (Figure 99). Cutthroat trout populations are healthy in these lower reaches (DuPont, unpublished data); however, changes in thermal regimes can facilitate spread of invasive salmonids (Fausch 2007). Therefore, protecting existing side channel thermal refugia should aid in maintaining local cutthroat trout populations. Much of the floodplain in these areas is privately owned, therefore, conserving suitable habitats will require strong cooperation with private landowners. The upper reaches of the study area are mostly under the jurisdiction of the USFS, and therefore may be easier to conserve. Nonetheless, coordinated efforts should be made to conserve the cold side channels already identified on federal lands, as well as the cold springs identified through thermal imaging. Additional efforts should be made to protect floodplain connectivity at the downstream end of bounded alluvial valley segments (river km 20 and 31), as this and other studies have indicated these areas commonly have large amounts of upwelling hyporheic groundwater (Baxter and Hauer 2000, Pepin and Hauer 2002). Proactive conservation of cold off-channel habitats will also be more cost effective in the long term, as methods to protect existing habitats are often less expensive, more effective, and easier to implement than restoration efforts (Kauffman et al. 1997). Finally, these hyporheic flow paths are not static systems, and large variations in these processes have been reported by other authors (Ebersole et al. 2003b, Wright et al. 2005). Therefore, protection of intact floodplain will facilitate natural hydrologic processes and allow the river channel to shift and form new off-channel habitat.

Enhancement of existing side channel habitats may provide an effective way to increase the suitability of unused thermal refugia to adult salmonids. Restoration efforts that focus on ecological processes will likely be more effective than a single species or group of species approach (Kaufmann et al. 1997). However, this is not always possible, and in these situations, stream enhancement for a specific group of species can still be a viable option (Kaufmann et al. 1997). Ebersole et al. (2003a) suggested that not all cold water patches are suitable thermal refugia for fish due to varying levels of dissolved oxygen concentrations. We did not measure dissolved oxygen levels in our study; however, the larger aggregations of fish suggested that dissolved oxygen levels were adequate in side channels that were used as thermal refugia. Low dissolved oxygen could, however, have attributed to the lack of use of some of the channels by salmonids in our study. Additionally, Ebersole et al. (2001) found that many cold water patches were too small or shallow to be used by large numbers of fish. Our results agree with these studies, as adequate depth had a strong influence on side channel use by adult salmonids. Based on the results of our study perhaps the single most effective enhancement approach available is reconnecting existing cold water side channels that loose connection with the main river during low flows, and ensuring adequate depths are maintained by physically manipulating the mouths of these channels. There were many observed side channels in our study that remained colder than the main river and provided adequate flows but were not used by large numbers of fish because they lacked suitable depth. Examples of side channels that would be good candidates for enhancement include numbers 3, 7, 10, 17, 18, 19, and 20 (Figure 76, Table 42). Efforts to maintain depth of 2.0 m or more in these or other cold areas will likely provide the largest benefit to adult cutthroat in our study area. Adequate depths need to be maintained directly up channel from the main river, as fish did not appear to move up-channel past depths < 1.0 m, even when suitable habitat was available upstream. Lastly, efforts to maintain or restore adequate levels of riparian vegetation will benefit side channel habitats and diel temperature fluctuations.

In areas where suitable side channel habitat has been lost due to floodplain development or river constriction, constructing new side channels to be used as thermal refugia may prove effective. If side channel construction is a desired option, we recommend locating channels in areas identified to have significant groundwater upwelling, as this has proved effective in other studies (Morley et al. 2005). This would provide a cold water source and reduce the likelihood of producing a channel that will not be cold enough to be used as thermal refugia. Similarly, Morley et al. (2005) reported artificial side channels constructed over known groundwater upwelling sites maintained groundwater flow and had cooler summer temperatures and warmer winter temperatures than natural side channels. Concentrated springs identified through thermal imaging may provide adequate amounts of groundwater upwelling for side channel construction include the areas near river kilometers 4, 10, 25, 27, 31, 32, 33, 36, 38, 40, 46, 47, and 50 (Figure 99). Since our study found side channel temperatures were influenced mainly by location, riparian vegetation canopy cover, and substrate composition in the riverside bank, these factors should also be considered. Ideally a constructed side channel would be located in an area with significant groundwater upwelling alongside the valley wall. To provide the most benefit to salmonids in the NFCDR system, channels should be constructed so that adequate depths (≥ 2.0 m) are maintained immediately up-stream of the river in the side channel, and river depths adjacent to the mouth of the side channel remain ≥ 1 m. If financially feasible, side channels should be of adequate length and constructed so that they contain pool-riffle sequences within the channel. This would promote subsurface flow, as hyporheic flow within channel commonly down wells at the head of riffles and up wells at the tail of riffles (Pool and Berman 2001, Kasahara and Hill 2006), and longer side channels may increase the likelihood of intercepting hyporheic flow. Using coarser substrates in-channel creates higher hydraulic conductivity, which can increase hyporheic flow (Kasahara and Hill 2006, Kasahara and Hill 2008). Furthermore, increasing the in channel hydraulic gradient can increase hyporheic exchange in constructed riffles (Kasahara and Hill 2006) and may have a stronger influence on hyporheic exchange than the size of the substrate used in the channel (Kasahara and Hill 2008). In addition to promoting channel complexity through construction of pool-riffle sequences, placing large wood in the channel may be beneficial, as large wood in-channel can help maintain pool depth (Johnson et al. 2005), and channel spanning log structures are often associated with in channel hyporheic flow (Baxter and Hauer 2000).

If side channel habitat is constructed or enhanced, periodic maintenance will likely be required to ensure these dynamic channels maintain desired characteristics. Since depth is important for the use of side channel habitats as thermal refugia by adult salmonids, efforts need to ensure adequate depths are maintained over time. Studies have shown that both full and partial spanning in-stream structures used in restoration can maintain depth over time in small streams (Crispin et al. 1993, Schmetterling and Pierce 1999), and may be effective in maintaining depth within side channels. In contrast, Morley et al. (2005) used no in-channel structures in their constructed side channels, and found no noticeable change in depths over a ten year period. In addition to maintaining depth, maintenance of hyporheic flow over time is necessary. Hyporheic flows may be reduced over time (Kasahara and Hill 2006), which can be facilitated by fine sediments settling over porous substrates (Kasahara and Hill 2008). In this study, however, we commonly observed considerable groundwater upwelling in side channels that had small layers of fine sediment overlaying more porous substrates, suggesting fine substrates were not significantly reducing rates of hyporheic exchange in the observed side channels. One final maintenance concern involves the ability of flooding to cause significant changes in channel morphology, as well as both surface and subsurface flow paths (Wondzell and Swanson 1999). Although flooding helps create side channels, it also has the potential to destroy or alter the physical and subsurface flow characteristics desired in side channels over time (Wondzell and Swanson 1999). Previous side channel construction projects have dealt with this reality by constructing large dikes between the river and the side channel to prevent future flooding from altering the suitability of constructed side channels for target fish species (Sheng et al. 1990). Thus, any future side channel construction efforts in the NFCDR floodplain should consider the possible influences of high flow events on constructed channels.

Table 34. The average daily maximum temperature (DMT - C°) during four sampling periods in the side channels and in the main North Fork Coeur d'Alene River, Idaho.

		Average DMT	
Sample period	Dates	River	Side channel
1	June 25 to July 3, 2007	17.9	12.5
2	July 9 to July 17, 2007	22.0	14.5
3	July 23 to July 31, 2007	22.4	15.4
4	August 1 to August 9, 2007	20.6	15.1

Table 35. The number of fish observed while snorkeling side channel transects on the North Fork Coeur d'Alene River, Idaho, during four sampling periods from June 25 to August 9, 2007. Transects numbers that end in a "1" started at the mouth of the side channel whereas those that ended in a "2" or "3" occurred upstream from the mouth.

Transect	WCT	RBT	BRK	MWF	TRS	LSS	NPM	RSS	LND	PMK	Total
1-1							1,082	701		2	1,785
2-1	15	4		871		44	1,115	200			2,249
2-2	14	9		100			190				313
3-1	2		17	2			10			40	71
3-2			5	8							13
4-1	32	48		769			111				960
5-1		1		1					5		7
6-1	61	68		109		1	1				240
7-1				63							63
7-2	12	27	31	117							187
7-3	2	5	5								12
8-1	19	27	1	37		40	160	300			584
9-1				7			304				311
10-1							75				75
10-2		1	9	21							31
11-1	6	2			1						9
12-1				4		40	950				994
13-1	19	19	4	9							51
15-1	399	24	14	1,240							1,677
15-2	28	4	72								104
16-1	6	7	1			2	30				46
17-1			5			1					6
18-1			26								26
19-1		2	13			59	20				94
20-1	1		2			1					4
21-1	3	1		2							6
Total	619	249	205	3,360	1	188	4,048	1,201	5	42	9,918
Percent	6.2	2.5	2.1	33.9	0.0	1.9	40.8	12.1	0.1	0.4	100.0

WCT = Westslope cutthroat trout, RBT = rainbow trout, BRK = brook trout, MWF = mountain whitefish, TRS = Torrent sculpin, LSS = largescale sucker, NPM = Northern pikeminnow, RSS = redside shiner, LND = longnose dace, PMK = pumpkinseed.

Table 36. The number of fish observed while snorkeling transects in the main North Fork Coeur d'Alene River, Idaho, on July 31 and August 1, 2007.

Transect	WCT	RBT	MWF	CHS	LSS	NPM	LND	**Total**
NF1	29	22	550		80	1250		1,931
NF2	16	11	220		10	20		277
NF3	31	22	560		40	610		1,263
NF4	42	27	600		300	1200		2,169
NF5	72	49	275		160	1200		1,756
NF6	43	36	200			55		334
NF7	141	39	350	1	50		1	582
NF8	64	12	180					256
NF9	39	7	10					56
Total	477	225	2,945	1	640	4,335	1	8,624
Percent	5.5	2.6	34.1	0.0	7.4	50.3	0.0	100.0

WCT = Westslope cutthroat trout, RBT = rainbow trout, MWF = mountain whitefish, CHS = Chinook salmon; LSS = largescale sucker, NPM = Northern pikeminnow, LND = longnose dace.

Table 37. The percent of salmonids ≥ 300 mm in length observed while snorkeling side channels and the main North Fork Coeur d'Alene River, Idaho, during the summer of 2007.

	Percent ≥ 300 mm	
Species	Side channel	Main river
Cutthroat trout	62.4	19.7
Rainbow trout	43.1	17.3
Mountain whitefish	74.4	25.9
Brook trout	11.6	NA

Table 38. The number of fish sampled through electrofishing transects approximately 100 m in length in side channels located along the North Fork Coeur d'Alene River, Idaho, from July 25 to August 13, 2007. The transect number has been recorded as two numbers spaced by a ".". The first number indicates what side channel the sampling occurred in and the second number indicates how many meters (times 100) upstream from the mouth the sampling occurred.

Transect	Temp	Time	WCT	RBT	BRK	MWF	TRS	SHS	LSS	LNS	NPM	RSS	LND	SPD	TEN	PMK	BBH	Total
3.2	12.5	9:55			3		2	1	17		42	30	1	29		25		150
3.4	10.0	11:00			52			1								22		75
5.3	18.0	12:00							5		87	33		11	1	15	3	155
6.2	10.0	13:46	1		4		2		4	6	76	1			1	1		96
7.6	18.5	14:50	2	1	8		11	3					13	4				42
7.9	20.0	15:41		1	16		5	11			2		16	1				52
11.1	17.5	10:05	1	3			56	27					5					92
11.2	17.0	9:58			4		13	7	4				3					31
13.2	14.0	10:48			1	3			8		7			10				29
15.1	12.0	13:16			22		7		1	2			3	9				44
15.5	12.0	16:00	1	2	39		6	2			3							53
17.3	15.5	14:00							6	56				62	6			130
17.4	14.0	15:00							5	49				72				126
18.3	10.0	11:50	2		24		1	2										29
18.4	9.0	12:03	1		21		23	20		1	1							67
19.0	22.0	10:10							24	17			72					113
Total	NA	NA	8	7	194	3	126	74	74	131	218	64	113	198	8	63	3	1,284
Percent	NA	NA	0.6	0.5	15.1	0.2	9.8	5.8	5.8	10.2	17.0	5.0	8.8	15.4	0.6	4.9	0.2	100.0

WCT = Westslope cutthroat trout, RBT = rainbow trout, BRK = brook trout, MWF = mountain whitefish, TRS = torrent sculpin, SHS = shorthead sculpin, LSS = largescale sucker, LNS = longnose sucker, NPM = Northern pikeminnow, RSS = redside shiner, LND = longnose dace, SPD = speckled dace, TEN = tench, PMK = pumpkinseed, BBH = brown bullhead.

Table 39. Average temperatures observed in the four snorkeled side channels and the main North Fork Coeur d'Alene River, Idaho, during four time periods on August 1, 2007.

Time period	Time	Average temperature (°C)	
		River	Side channels
1	8:30 to 9:50	17.0	15.0
2	10:50 to 12:30	18.8	15.8
3	13:25 to 14:50	20.1	16.5
4	15:30 to 16:45	21.1	17.0

Table 40. Pair-wise comparisons (Letter group) of the average percent of maximum cutthroat trout, rainbow trout, and mountain whitefish observed in four side channels across four time periods using Fishers Least-Significance-Difference tests with a p-value of 0.10 denoting significant differences.

Time Period	Time	Average Percent of Maximum			Pairwise Comparison		
		Cutthroat	Rainbow	Whitefish	Cutthroat	Rainbow	Whitefish
1	8:30 to 9:50	69	25	39	A	A	A
2	10:50 to 12:30	66	47	44	A	AB	A
3	13:25 to 14:50	96	90	98	A	C	B
4	15:30 to 16:45	84	79	98	A	BC	B

Table 41. Results of Yohai's MM-Estimation Robust Regression Analysis that shows the linear model of attributes that significantly (< 0.10) influenced densities of cutthroat trout, rainbow trout, and mountain whitefish ≥ 300 mm in length in side channels along the North Fork Coeur d'Alene River, Idaho, during the summer of 2007.

Species	**Linear Model**	R^2
Cutthroat Trout	Y = -0.1172 + 1.4617(md/bt) + 0.0088(v)	0.476
Rainbow Trout	Y = -0.0036 + 0.0215(md) + 0.0165(bed) - 0.0011(cc)	0.334
Mountain Whitefish	Y = -1.0748 + 0.4501(md) + 0.0472(v) + 0.0133(sw) - 0.0008(d)	0.375

md = maximum depth, bt = instantaneous bottom temperature, v = visibility, bed = percent bedrock substrate, cc = canopy cover, sw = quantity of small woody debris, d = distance from the main river.

Table 42. Habitat attributes of side channel transects along the North Fork Coeur d'Alene River, Idaho, that were found to have a significant relationship with cutthroat trout, rainbow trout or mountain whitefish (≥ 300 mm) densities during the summer of 2007.

Side channel	Density (fish ≥ 300 mm/100 m^2)			Maximum depth (m)	MWMT	Relative flow	Visibility (m)	% small wood	% bedrock	Canopy cover	Distance from river
	Cutthroat	Rainbow	Whitefish								
1-1	0.00	0.00	0.00	1.7	20.1	0	5.1	6.0	0.7	23.4	0
2-1	0.23	0.05	12.76	4.0	17.3	2	11.6	1.7	0.0	12.0	0
2-2	0.19	0.13	0.74	2.9	14.0	2	10.4	0.7	3.3	4.4	39
3-1	0.04	0.00	0.07	1.4	15.4	1	10.1	3.3	0.0	34.9	0
3-2	0.00	0.00	0.00	6.0	10.5	1	6.0	5.0	6.7	13.8	270
4-1	0.60	0.50	13.35	2.9	18.5	3	12.8	7.3	0.0	19.5	0
5-1	0.00	0.00	0.00	0.8	21.1	0	13.4	0.7	0.0	9.8	0
6-1	0.21	0.23	0.71	2.1	19.7	5	12.1	5.3	0.0	14.3	0
7-1	0.00	0.00	0.00	0.9	19.5	5	10.6	0.3	0.0	12.8	0
7-2	0.02	0.02	0.00	1.5	17.7	4	11.5	1.3	0.0	5.7	433
7-3	0.00	0.00	0.00	1.6	17.5	3	14.6	6.7	0.0	8.0	710
8-1	0.12	0.17	0.52	2.1	20.0	2	12.1	2.7	0.0	1.7	0
9-1	0.00	0.00	0.00	1.4	19.1	0	6.4	6.7	0.0	17.0	55
10-1	0.00	0.00	0.00	1.3	19.5	1	10.6	11.7	0.0	6.8	0
10-2	0.00	0.00	0.07	1.9	15.6	1	6.4	6.7	0.0	21.8	27
11-1	0.07	0.00	0.00	0.8	19.3	3	16.4	0.7	0.0	21.4	0
12-1	0.00	0.00	0.00	1.7	18.2	0	2.5	8.7	0.0	36.2	0
13-1	0.98	0.35	0.07	1.3	12.6	4	7.9	13.3	0.0	1.5	0
15-1	2.71	0.21	8.58	2.8	12.9	5	7.6	0.7	11.7	29.3	0
15-2	0.30	0.04	0.00	2.3	10.1	4	7.3	1.0	0.0	12.3	310
16-1	0.02	0.00	0.00	1.5	22.0	4	8.8	0.3	0.0	7.9	0
17-1	0.00	0.00	0.00	1.0	14.9	2	6.3	16.7	0.0	15.4	0
18-1	0.00	0.00	0.00	1.9	15.8	3	7.3	3.3	0.0	22.2	100
19-1	0.00	0.00	0.00	1.0	18.8	1	13.4	2.7	0.0	13.3	100
20-1	0.00	0.00	0.00	1.0	14.5	2	10.9	15.0	0.0	14.4	0
21-1	0.00	0.00	0.00	1.3	25.0	5	10.3	3.7	0.0	14.9	0

Table 43. Information-theoretic (AIC) modeling of factors influencing maximum average weekly temperature (MAWT) and maximum weekly maximum temperature (MWMT) in side channels along the North Fork Coeur d'Alene River, Idaho, during the summer of 2007.

MAWT

Variables in Model	AIC	Δ AIC	R^2
lrv fine grav boldbr vw	21.6013	-	0.8111
lrv grav boldbr vw	27.1044	5.5031	0.7134
lrv fine boldbr vw	30.7874	9.1861	0.6484
lrv boldbr vw	31.1824	9.5811	0.5983
fine grav boldbr vw	31.8467	10.2454	0.6271

MWMT

Variables in Model	AIC	Δ AIC	R^2
dist finebr boldbo bedbo cobbo	40.7598	-	0.7551
dist finebr boldbo cobbo	44.2710	3.5112	0.6972
dist boldbo cobbo bedbo	47.5913	6.8315	0.656
dist cobbo bedbo	48.6296	7.8698	0.6133
dist finebr cobbo bedbo	49.5213	8.7615	0.6295

lrv = light riparian vegetation, fine = in-channel fine substrate, grav = in-channel gravel substrate, boldbr = boulder substrate in the riverside bank, vw = channel location against valley wall, dist = distance between side channel and main river, finebr = fine substrate in the riverside bank, boldbo = boulder substrate in the opposite side bank, bedbo = bedrock substrate in the opposite side bank, cobbo = cobble substrate in the opposite side bank.

Table 44. Multiple regression models of factors influencing maximum average weekly temperature (MAWT) and maximum weekly maximum temperature (MWMT) in side channels along the North Fork Coeur d'Alene River, Idaho, during the summer of 2007.

Metric	Linear Model	R^2
MAWT	Y = 30.5245 - 4.4474(vw) - 0.5269(boldbr) - 0.4130(grav) - 0.1171(fine) + 3.4443(lrv)	0.8111
MWMT	Y = 9.3107 - 0.3141(bedbo) - 0.0264(dist) + 0.3271(cobbo) + 0.0875(boldbo) +0.0774(finebr)	0.7551

lrv = light riparian vegetation, fine = in-channel fine substrate, grav = in-channel gravel substrate, boldbr = boulder substrate in the riverside bank, vw = channel location against valley wall, dist = distance between side channel and main river, finebr = fine substrate in the riverside bank, boldbo = boulder substrate in the opposite side bank, bedbo = bedrock substrate in the opposite side bank, cobbo = cobble substrate in the opposite side bank.

Table 45. Water temperatures of tributaries and other surface inflows as determined through airborne thermal sensing on August 9, 2007 in comparison to the main North Fork Coeur d'Alene River, Idaho, with left (L) or right (R) bank designation when looking downstream (as reported in Watershed Sciences Inc. 2007).

Tributaries	River Kilometer	Tributary Temp (°C)	Main Stem Temp (°C)	Difference
SF Coeur d'Alene (L)	0.07	17.4	16.5	0.9
Prado Creek (R)	3.71	19.6	18.1	1.5
side slough (R)	4.57	21.1	18.1	3.0
old channel/slough (R)	5.75	22.1	17.8	4.3
NF Coeur d'Alene (R)	7.42	18.6	18.2	0.4
Lightner Draw (R)	7.69	17.4	18.5	-1.1
Studer Creek (R)	8.22	18.4	18.1	0.3
unnamed-cold (R)	10.66	14.6	17.5	-2.9
Cougar Gulch (R)	13.30	14.3	18.4	-4.1
Steamboat Creek (R)	17.22	17.6	17.9	-0.3
Coal Creek-very small (L)	20.85	11.0	17.7	-6.7
Graham Creek (L)	23.66	13.8	17.4	-3.6
Cinnabar Creek (L)	26.11	10.9	17.1	-6.2
cold side channel (L)	26.36	16.3	17.4	-1.1
side channel (R)	26.58	20.8	17.4	3.4
Brown Creek (R)	28.61	16.9	18.6	-1.7
side channel/shadow (L)	31.75	11.9	19.1	-7.2
Hopkins Creek (R)	32.06	16.0	18.9	-2.9
Hopkins Creek/spring (R)	32.29	10.6	18.7	-8.1
Cedar Creek (L)	33.30	11.6	19.3	-7.7
Beaver Creek (L)	35.89	15.3	19.6	-4.3
Prichard Creek (L)	39.95	15.7	20.4	-4.7
Clee Creek (L)	46.30	18.4	18.5	-0.1
Lost Creek (L)	47.71	14.8	20.3	-5.5
Shoshone Creek (L)	50.20	19.4	20.4	-1.0

Table 46. Water temperatures of springs as determined through airborn thermal sensing on August 9, 2007 in comparison to the main North Fork Coeur d'Alene River, Idaho, with left (L) or right (R) bank designation when looking downstream. (as reported in Watershed Sciences Inc. 2007).

Springs	River Kilometer	Spring Temp (°C)	Main Stem Temp (°C)	Difference
spring (R)	3.58	11.8	18.1	-6.3
spring (L)	6.72	11.4	17.9	-6.5
spring (L)	23.35	9.2	17.4	-8.2
spring (L)	25.23	6.9	17.2	-10.3
spring (L)	25.27	9.4	17.4	-8.0
spring (R)	25.34	10.0	17.1	-7.1
spring (L)	30.82	15.1	18.8	-3.7
spring (R)	30.89	11.5	18.5	-7.0
spring/shadow (L)	31.59	15.1	19.4	-4.3
small spring (L)	32.15	15.8	18.9	-3.1
spring (L)	32.37	15.5	18.8	-3.3
Spring on Hopkins (R)	32.52	10.0	19.1	-9.1
spring/very small (L)	32.71	16.1	19.5	-3.4
spring/shadow (L)	34.01	16.1	19.6	-3.5
spring/shadow (R)	35.04	12.4	19.2	-6.8
spring (R)	37.61	16.3	19.4	-3.1
spring (L)	38.16	10.0	19.4	-9.4
spring (L)	38.24	10.4	19.2	-8.8
spring (L)	38.35	12.1	19.4	-7.3
spring (L)	39.62	16.5	19.6	-3.1
spring (R)	39.80	16.1	20.0	-3.9
spring - side channel (R)	42.58	14.6	19.4	-4.8
spring (R)	46.48	14.0	18.7	-4.7
spring (R)	46.63	15.2	18.6	-3.4
spring (R)	46.93	15.8	18.9	-3.1
spring (R)	48.48	10.3	20.3	-10.0
spring (R)	48.79	17.3	20.1	-2.8
spring (R)	49.37	12.3	20.4	-8.1
spring (R)	49.59	14.7	20.6	-5.9
spring (L)	50.08	15.8	20.8	-5.0

Table 47. The amount and causes of floodplain loss in comparison to the historic floodplain area (1,428 hectares) along the lower 50 km of the North Fork Coeur d'Alene River, Idaho.

Reasons for flooplain loss	Hectares lost	Percent lost
Roads	225	16%
Temporary structures	138	10%
Permanent structures	111	8%
Dikes	38	3%
Total	513	36%

Table 48. Variables used in step-wise robust regression to evaluate the factors influencing densities of cutthroat trout, rainbow trout, and mountain whitefish ≥ 300 mm in length in side channels along the North Fork Coeur d'Alene River, Idaho, during the summer of 2007.

Transect	Time	BT	Vis	%Pool	%Run	%Glide	%Riffle	MD	%Aq Veg	%TC	%LW	%SW	%LS	%UC	%OH	% OC	%FS	%GS	%CS	%BLD	%BED	GWF	CC	DFM	SMD	RD	RF
1-1	1107	17.25	5.7	100	0	0	0	1.705	58.75	42.75	2.75	4.75	0	1.5	15	16.25	79.25	5.5	14.5	0.25	0.5	-0.09	23.4	0	1.7	0.202	0
2-1	1138.75	15.75	11.9	100	0	0	0	4.115	31.25	21.5	0.5	1.75	17	0	0	3	30	25	27.5	16.25	1.25	-0.13	12.0	0	4	0.202	2
2-2	1177.25	13.625	10.1	100	0	0	0	2.895	1.75	28	0	0.5	16.25	0	0	11.25	2.5	32.5	46.25	15	3.75	-0.10	4.4	41	2	0.202	2
3-1	1049.75	15.25	10.8	95	5	0	0	1.3575	77.5	49	1	3	0	2.5	12.5	30	30	37.5	32.5	0	0	0.01	34.9	0	1.2	0.202	1
4-1	1208	16.5	13.2	96.25	0	0	3.75	2.925	1.75	35.25	1.75	5.5	23.75	1.25	3	0	38.75	13.75	22.5	25	0	0.01	19.5	0	2.9	0.202	3
5-1	1223	16	13.9	10	0	90	0	0.85	2	7.25	0	0.5	0	0	0.5	6.25	12.5	40	45	2.5	0	0.00	9.8	0	0.72	0.202	0
6-1	1119.25	16	13.0	52.5	43.75	0	3.75	2.3	0.75	35.25	0.75	4	25	1.25	4.25	0	10	26.25	38.75	25	0	-0.02	14.3	0	2.5	0.103	5
7-1	1343.75	16	12.2	10	3.75	86.25	0	0.915	47.5	27.5	0	0.25	0.5	2.25	3.25	21.25	17.25	30	52.5	0.25	0	0.44	12.8	0	0.35	0.045	5
7-2	1478	16.25	13.4	58.25	6.25	33.75	1.75	1.505	23.75	27.5	0	1	18.75	0	1.5	6.25	10	26.25	37.5	26.25	0	0.23	5.7	433	0.3	0.045	4
8-1	1403.5	17.5	12.8	82.5	0	17.5	0	2.075	2	42.5	13.75	2.5	20	0	0	6.25	36.25	13.75	25	25	0	-0.01	1.7	0	1.8	0.045	2
9-1	1208	15.5	7.0	75	0	25	0	1.46	2.25	22.5	7.5	5.5	0	3.75	5.75	0	80.75	7.75	11.25	0.25	0	0.02	17.0	55	0.2	0.045	0
10-1	1206.75	15.75	10.9	98.75	1.25	0	0	1.385	6.25	29	0	9	16.25	0	0	3.75	13.75	40	28.75	17.5	0	0.00	6.8	0	1.4	0.045	1
11-1	1459.25	17	16.2	13.75	26.25	58.75	1.25	0.8	5.5	15	0	0.75	9.25	0.25	1.75	3	0.75	22	54.75	22.5	0	0.04	21.4	0	0.8	0.069	3
12-1	1405.25	16.75	5.3	100	0	0	0	1.67	5.5	43.25	0	7.75	13.25	1.75	20	0.5	71	4	7.5	17.5	0	0.01	36.2	0	1.3	0.069	0
13-1	1337.25	16	8.7	55	30	0	15	1.27	25	44.25	12.5	12.5	14.25	0	0	5	37.5	26.25	20	16.25	0	-0.25	1.5	0	0.7	0.108	4
15-1	1315.5	13.125	8.2	96.25	0	3.75	0	2.925	45	45.75	7.5	0.75	22.5	0	0	15	36.25	11.25	12.5	28.75	11.25	0.34	29.3	0	1.7	0.108	5
15-2	1162	8.75	9.2	96.25	2.5	0	1.25	2.245	15	27.75	0.5	1	23.75	0	0	2.5	37.5	12.5	25	23.75	1.25	0.31	12.3	310	0.08	0.108	4
16-1	1205.25	19.125	9.3	62.5	33.75	2.5	1.25	1.435	0.25	28.25	1	0.25	26.25	0	0.75	0	8.75	20	47.5	23.75	0	0.04	7.9	0	1.2	0.108	4
17-1	1439.25	15	6.8	100	0	0	0	0.97	81.25	53	20	12.5	20	0	0	0.5	75	0.75	3	21.25	0	0.01	15.4	0	0.8	0.384	2
20-1	1072	13.5	10.5	98.75	0	0	1.25	0.965	91.25	66.75	0	12.5	9.25	0	0	45	88.75	0	0	11.25	0	-0.02	14.4	0	0.8	0.419	2
21-1	1103.5	18.125	11.0	43.75	32.5	0	23.75	1.3875	1.5	27.25	0.25	3.25	13.75	7.5	2.5	0	16.25	23.75	42.5	17.5	0	0.04	14.9	0	1.8	0.100	5

Bt = bottom temperature, vis = visibility, %pool = percent pool habitat, %run = percent run habitat, %glide = percent glide habitat, %riffle = percent riffle habitat, md = max depth, %aq veg = percent aquatic vegetation, %tc = percent total cover, %lw = percent large woody cover, %sw = percent small woody cover, %ls = percent large substrate cover, %uc = percent undercut bank cover, %oh = percent overhead cover, %fs = percent fine substrate, % gs = percent gravel substrate, % cs = percent cobble substrate, %bld = percent boulder substrate, %bed = percent bedrock substrate, gwf = estimated groundwater flow, cc = canopy coverage, dfm = distance from mouth, smd = smallest max depth, rd = density of fish in closest main river transect, rf = relative flow.

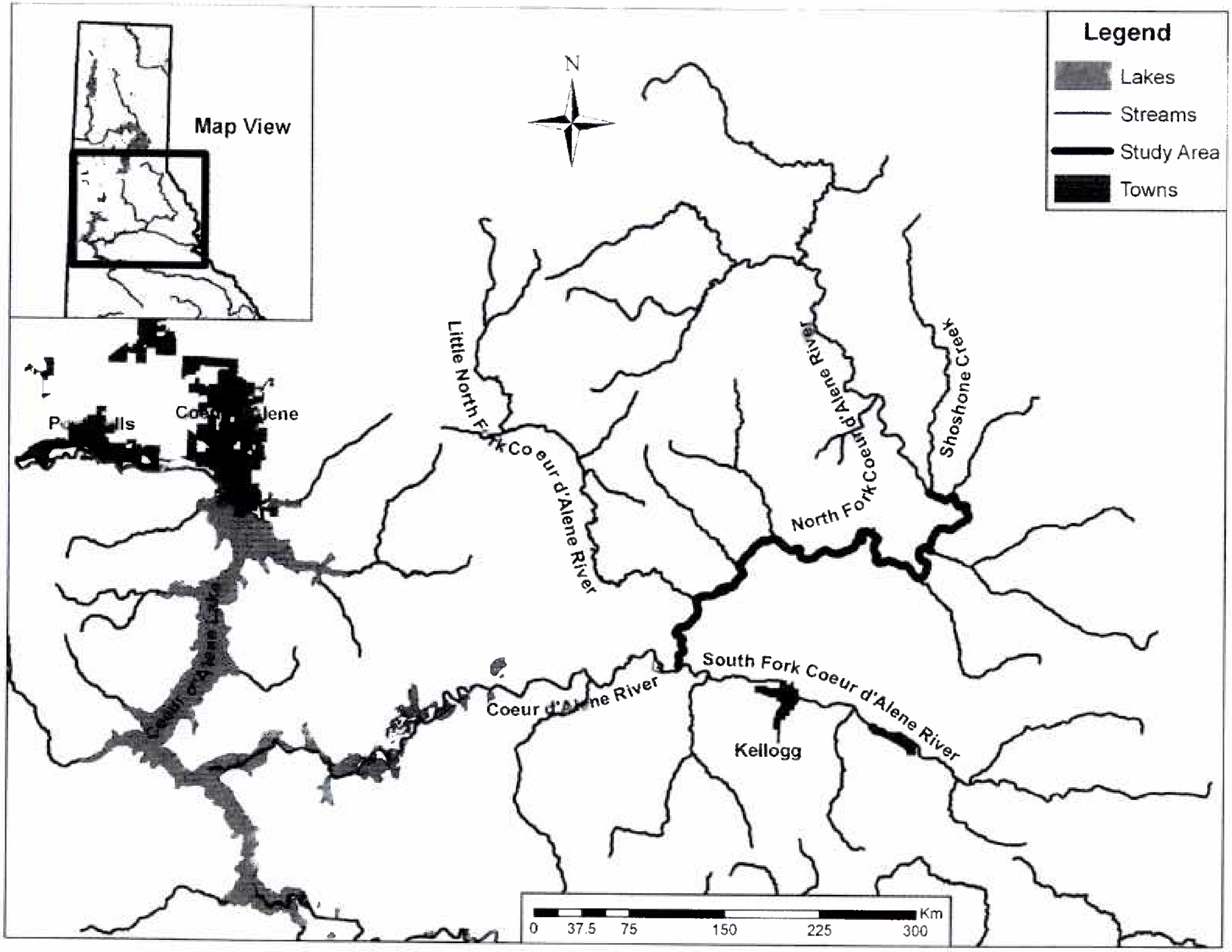

Figure 75. The location of the 50 km study reach on the North Fork Coeur d'Alene River, Idaho.

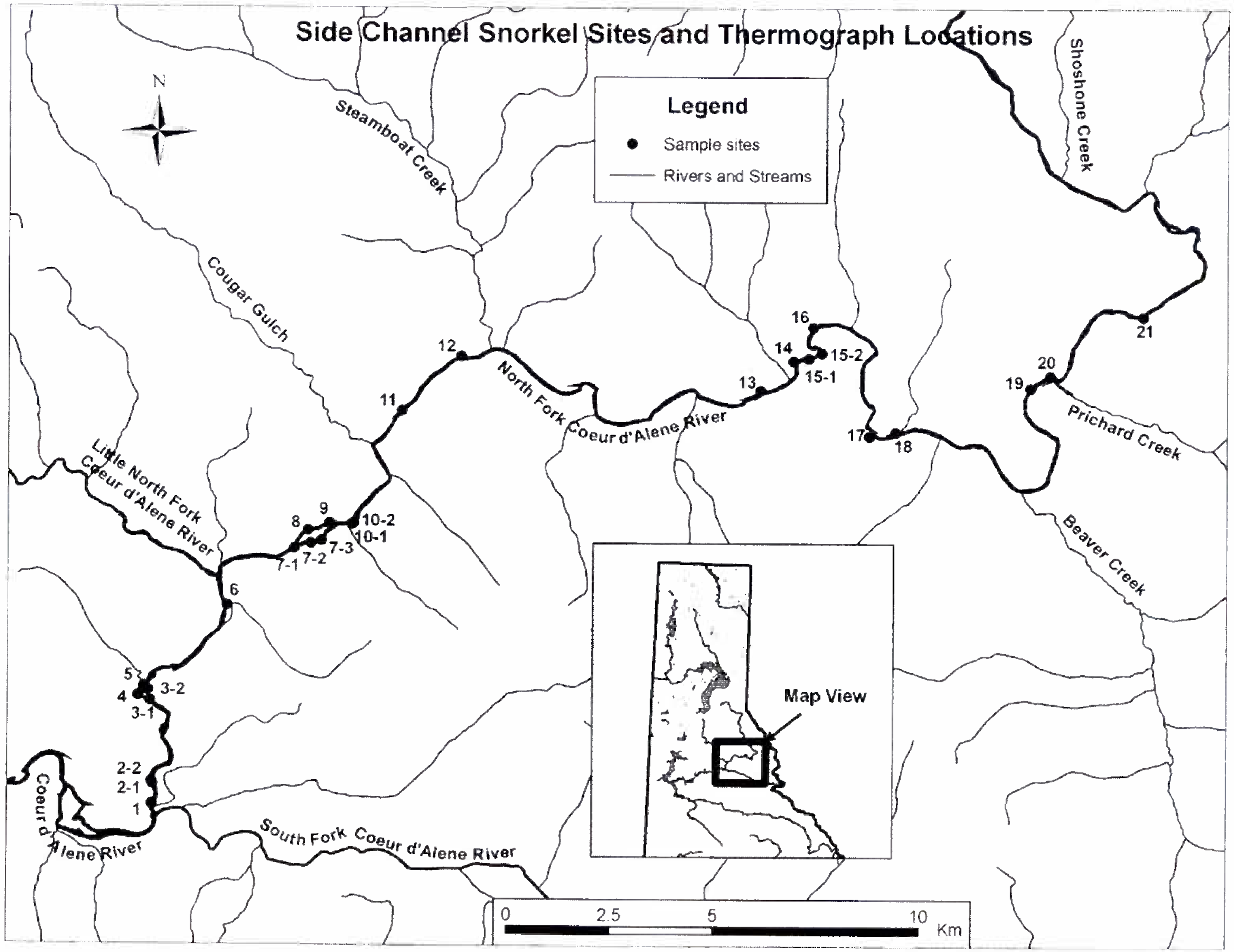

Figure 76. Locations of side channel transects along the North Fork Coeur d'Alene River, Idaho, that were selected for fisheries and habitat assessments during the summer of 2007.

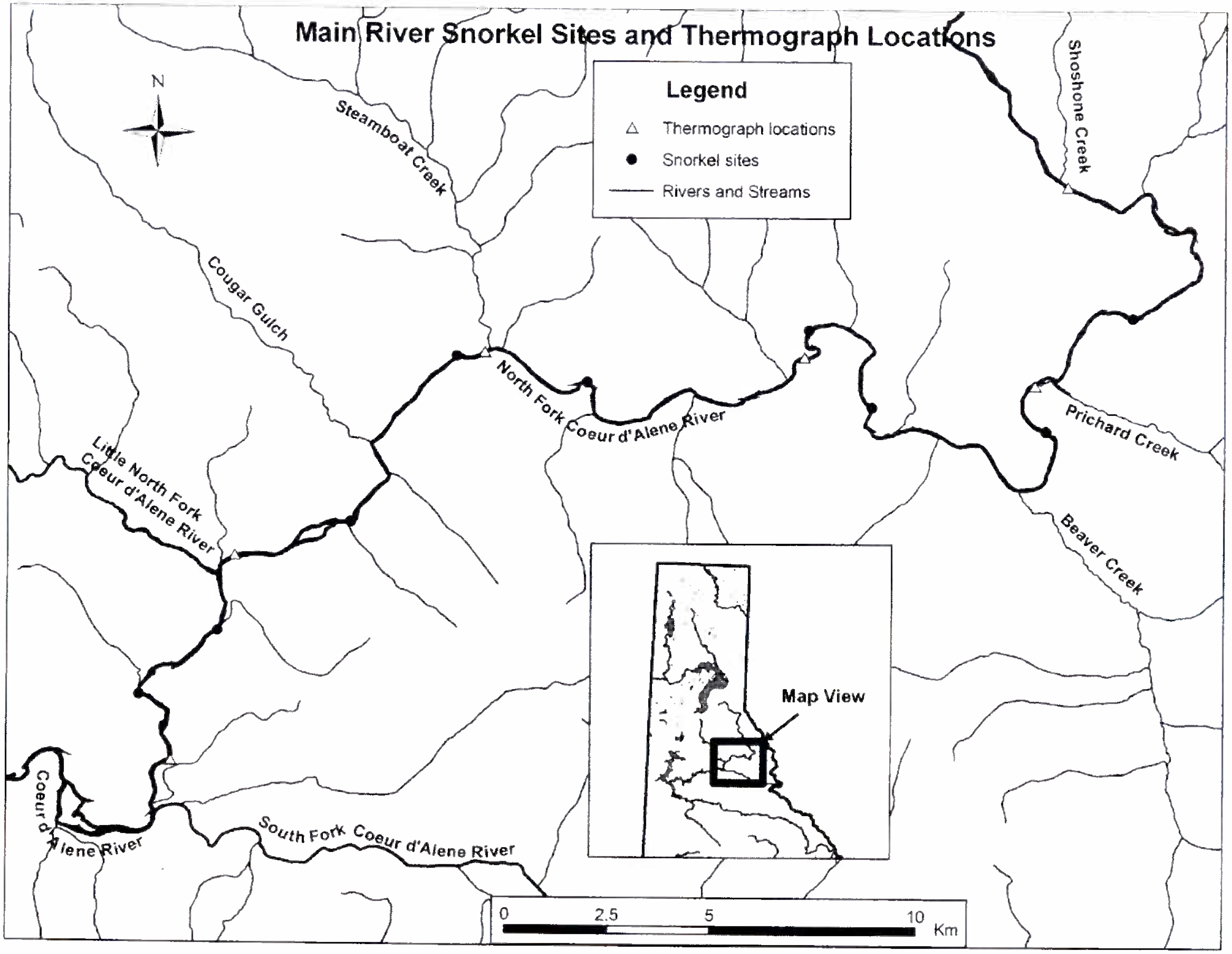

Figure 77. Locations of snorkel sites and thermographs in the North Fork Coeur d'Alene River, Idaho, during 2007.

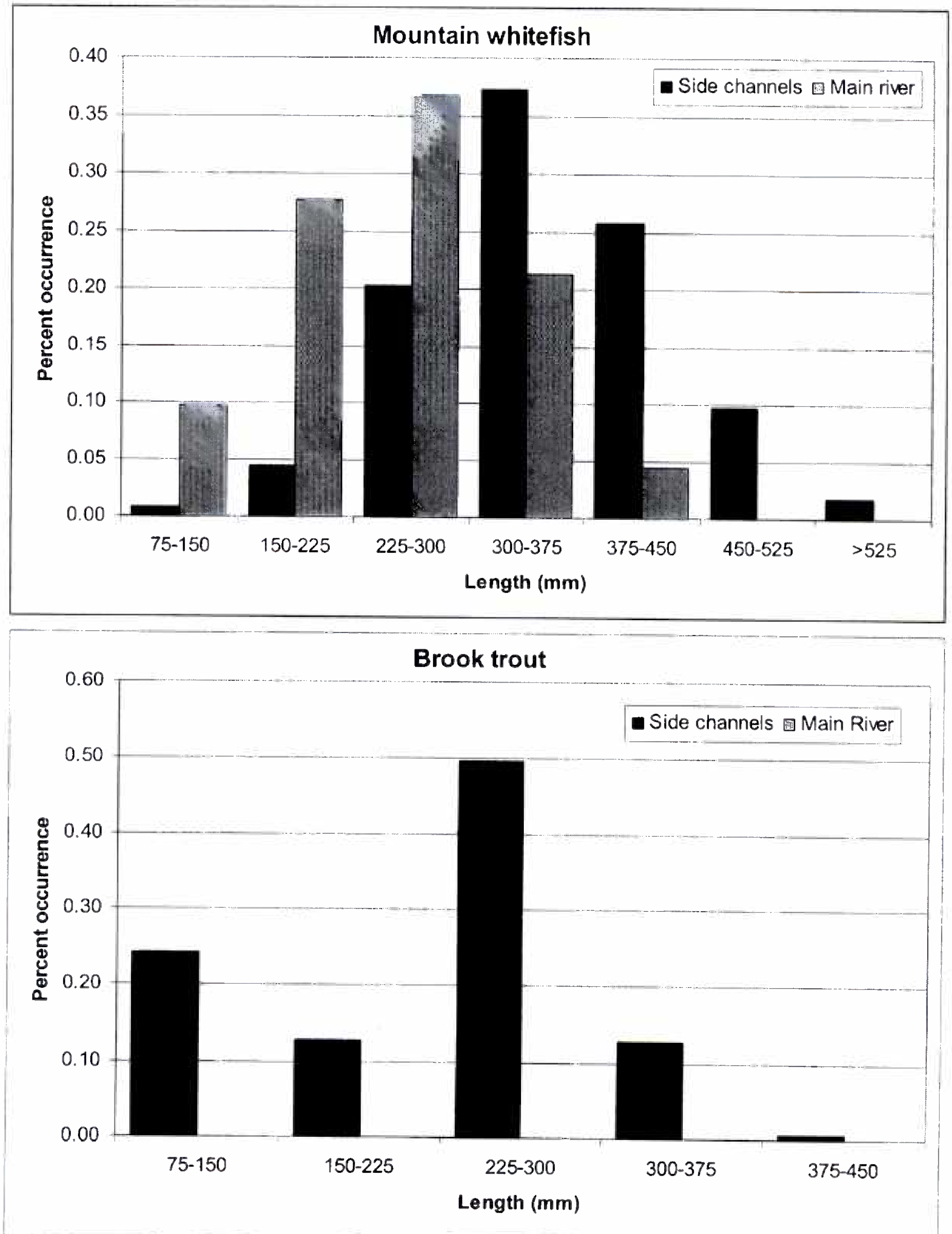

Figure 79. Length frequency histograms showing the sizes of mountain whitefish and brook trout observed while snorkeling side channels and the main North Fork Coeur d'Alene River, Idaho, during 2007.

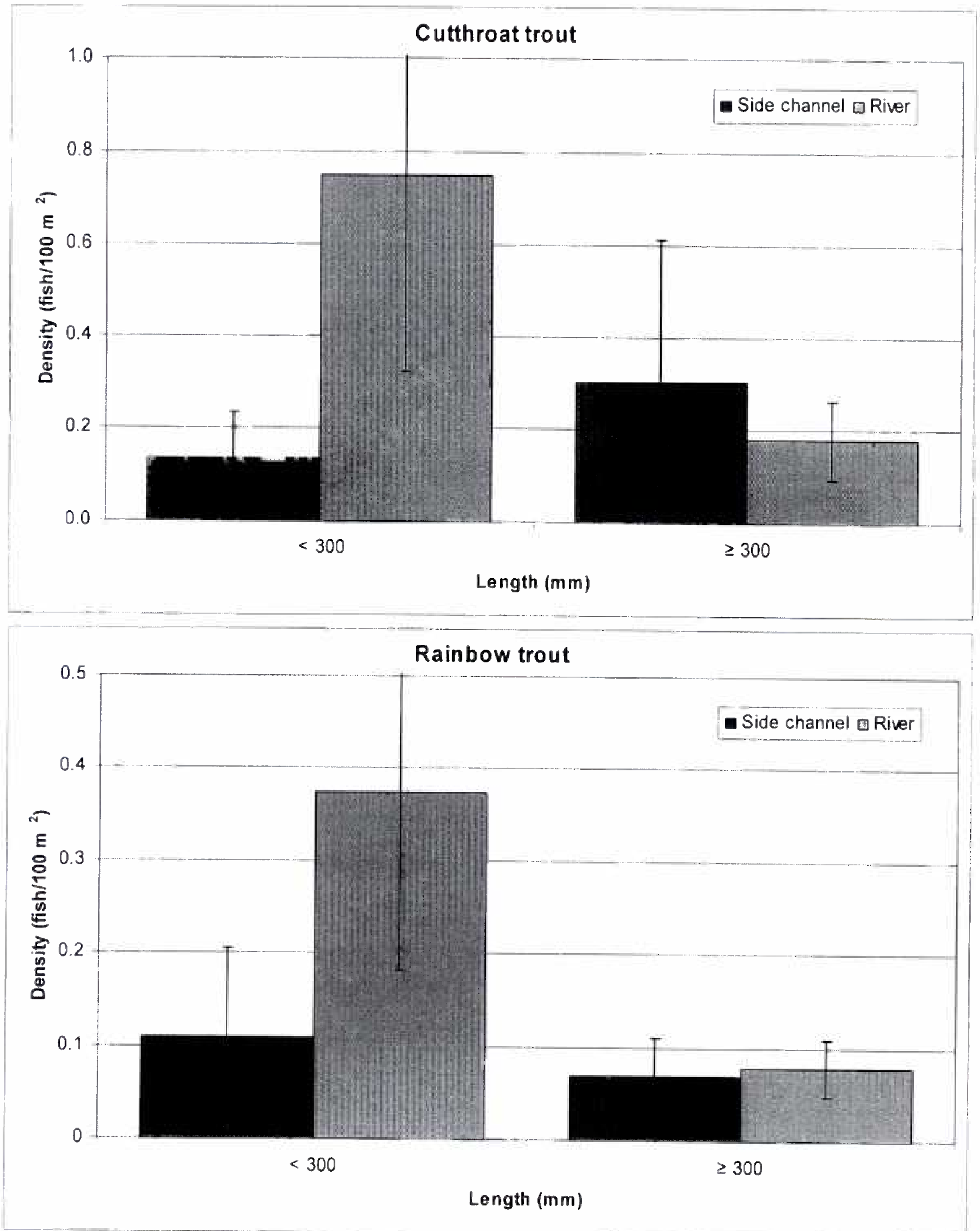

Figure 80. The average density of two size classes (< 300 mm and ≥ 300 mm) of cutthroat trout and rainbow trout observed through snorkeling 23 side channel transects and 9 transects in the main North Fork Coeur d'Alene River, Idaho, during the summer of 2007. The bars are 90% confidence intervals.

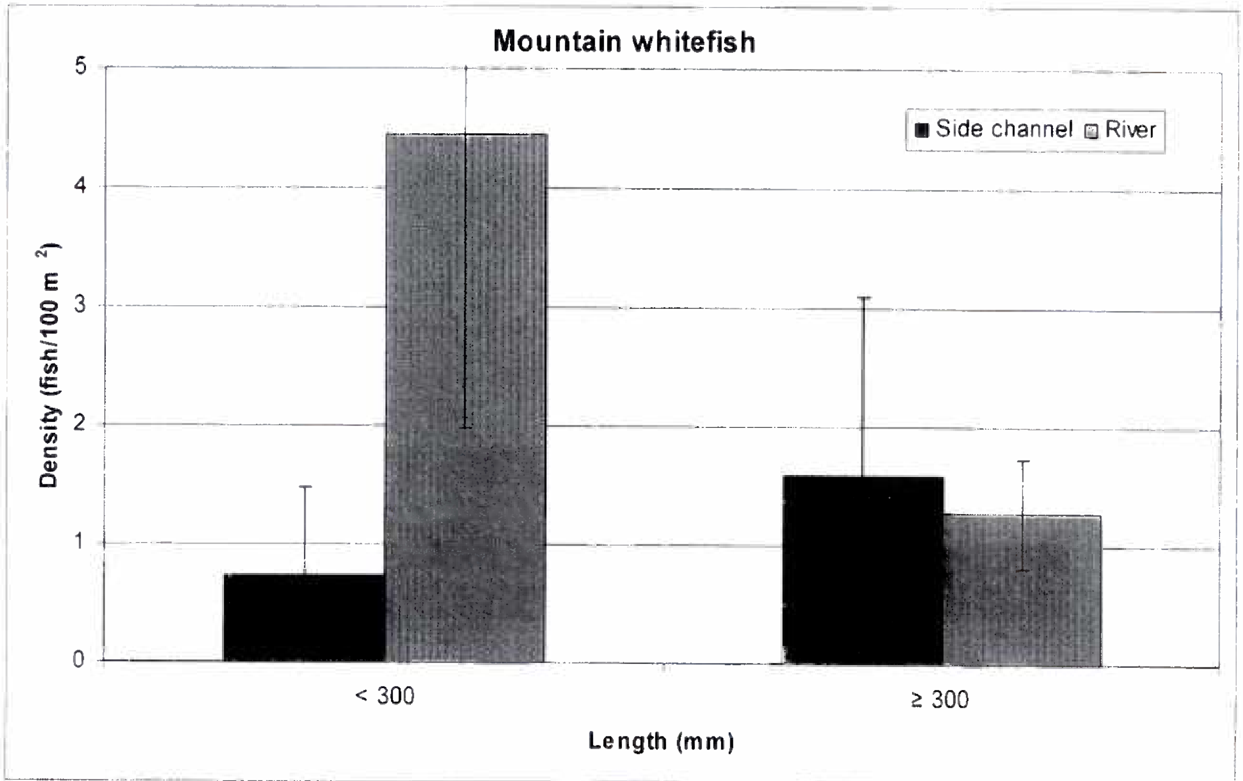

Figure 81. The average density of two size classes (< 300 mm and ≥ 300 mm) of mountain whitefish observed through snorkeling 23 side channel transects and 9 transects in the main North Fork Coeur d'Alene River, Idaho, during the summer of 2007. The bars are 90% confidence intervals.

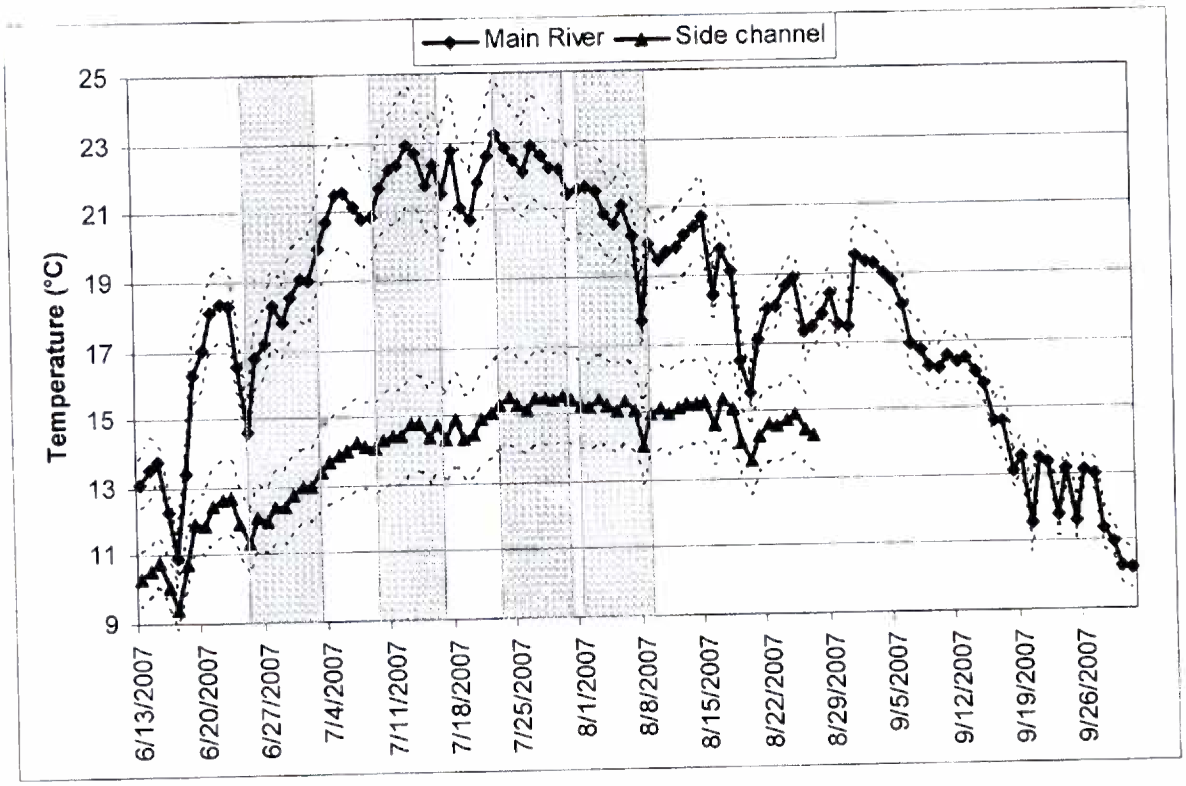

Figure 82. The average daily maximum water temperature from six main river sites and 20 different side channels on the lower North Fork Coeur d'Alene River, Idaho, during 2007. The dashed lines indicate 90% confidence intervals, and the gray bars are the time periods when the side channels were snorkeled.

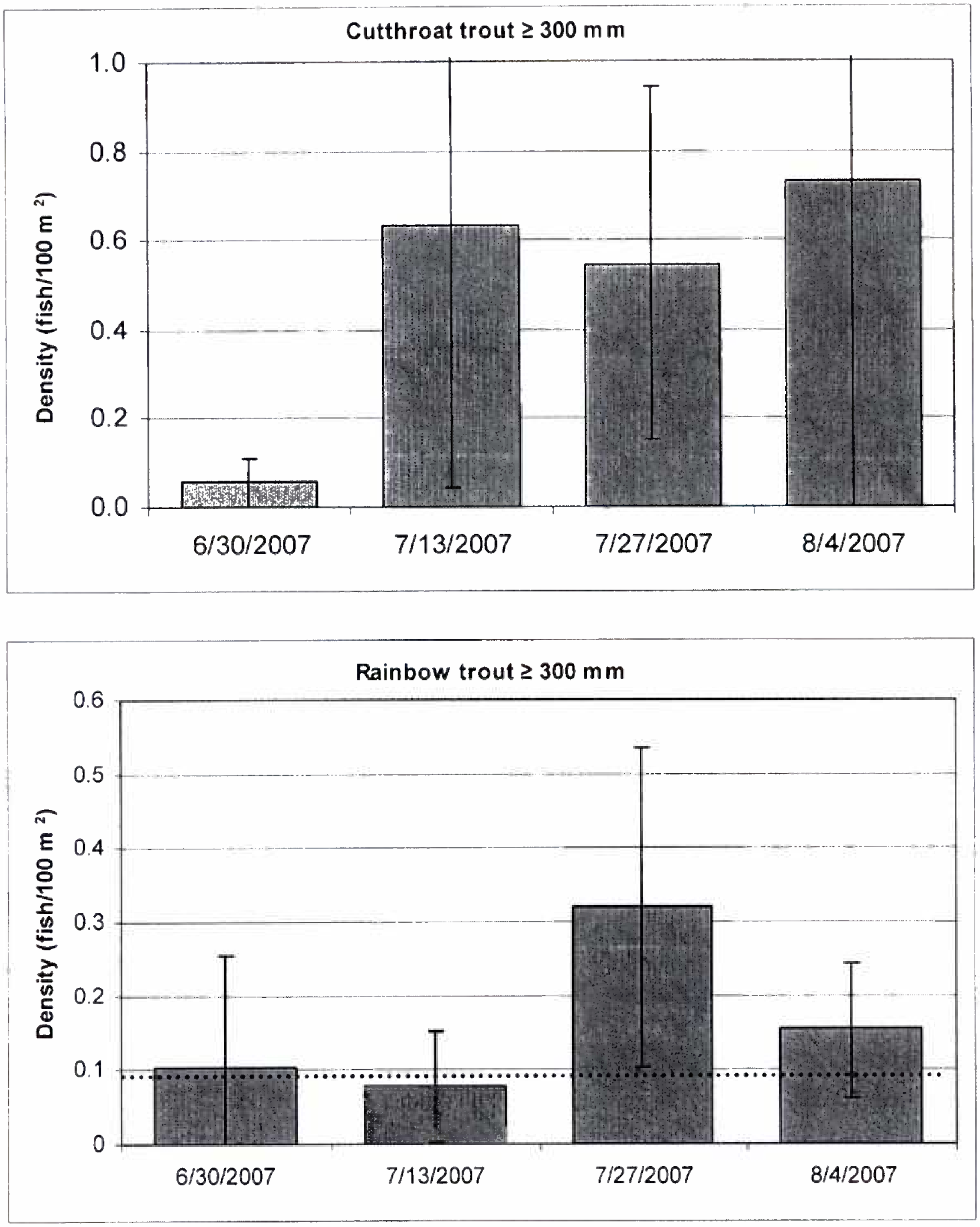

Figure 83. Densities of cutthroat trout and rainbow trout ≥ 300 mm observed during four snorkeling time periods in side channels used as thermal refugia along the North Fork Coeur d'Alene River, Idaho. The dotted lines indicate the average density of cutthroat trout or rainbow trout ≥ 300 mm that were observed in the main river during August, 2007. The bars are 90% confidence intervals.

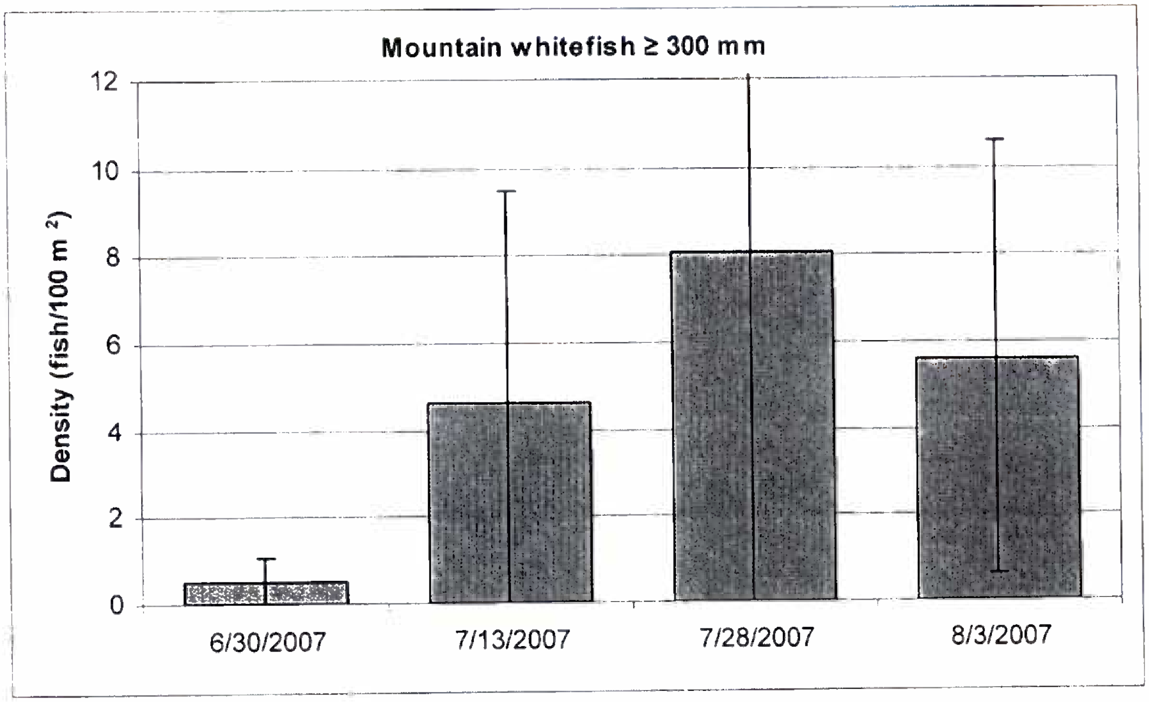

Figure 84. Densities of mountain whitefish ≥ 300 mm observed during four snorkeling time periods in side channels used as thermal refugia along the North Fork Coeur d'Alene River, Idaho. The dotted lines indicate the average density of mountain whitefish ≥ 300 mm that were observed in the main river during August, 2007. The bars are 90% confidence intervals

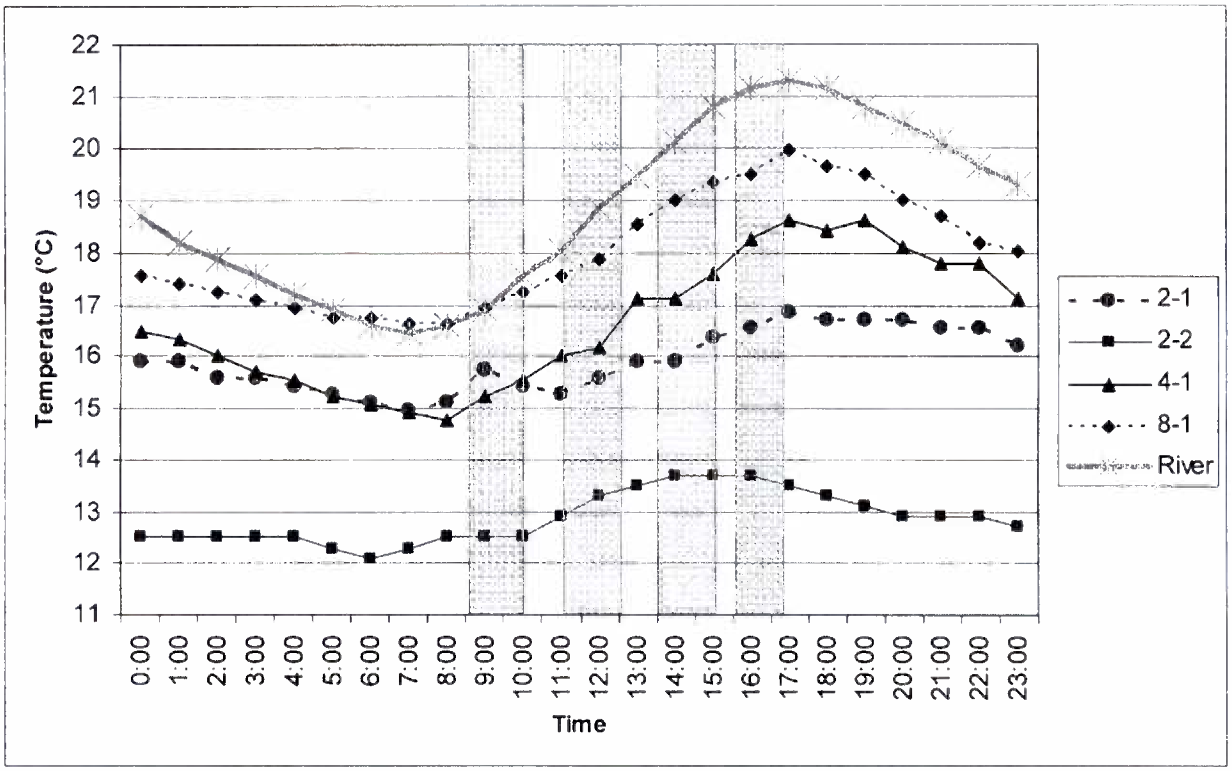

Figure 85. Hourly water temperature in four different side channels and the main North Fork Coeur d'Alene River, Idaho, on August 1, 2007. The grey bars indicate the four different time periods when the side channels were snorkeled.

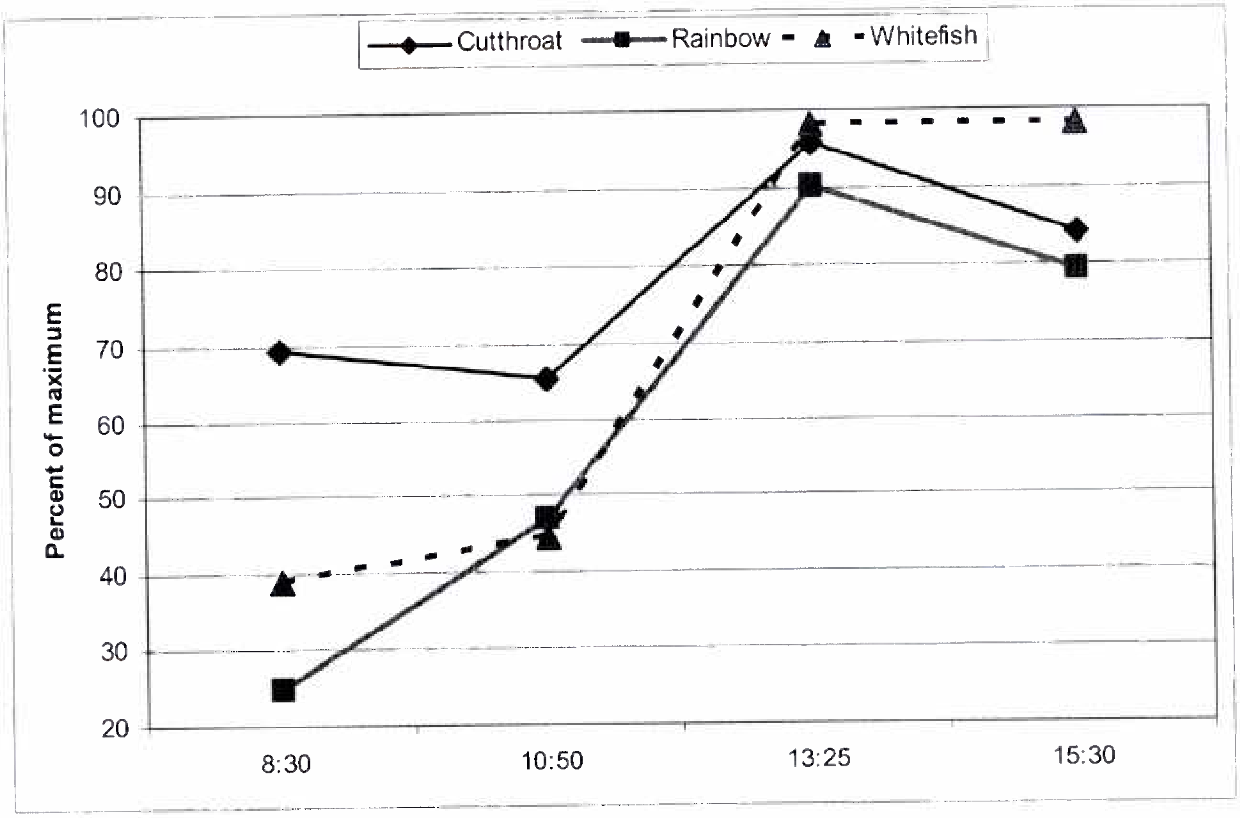

Figure 86. The average percentage of the maximum number of cutthroat trout, rainbow trout, and mountain whitefish that the were observed in four different side channels along the North Fork Coeur d'Alene River, Idaho, during four different time periods on August 1, 2007.

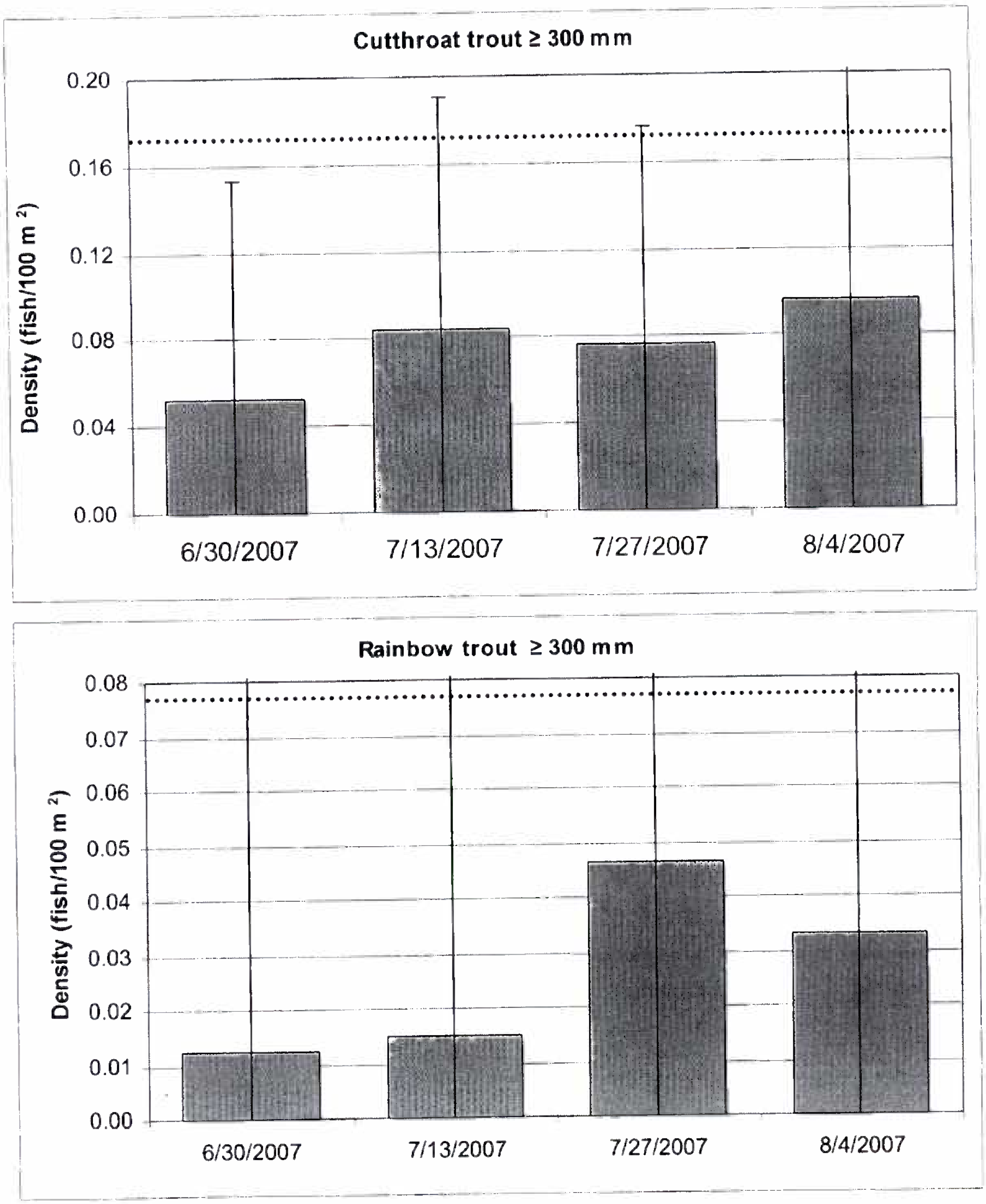

Figure 87. Densities of cutthroat trout and rainbow trout ≥ 300 mm in side channel reaches at least 60 m upstream from the main North Fork Coeur d'Alene River, Idaho during four snorkeling time periods. The dotted lines indicate the average density of cutthroat trout or rainbow trout ≥ 300 mm that were observed in the main river during August, 2007. The bars are 90% confidence intervals.

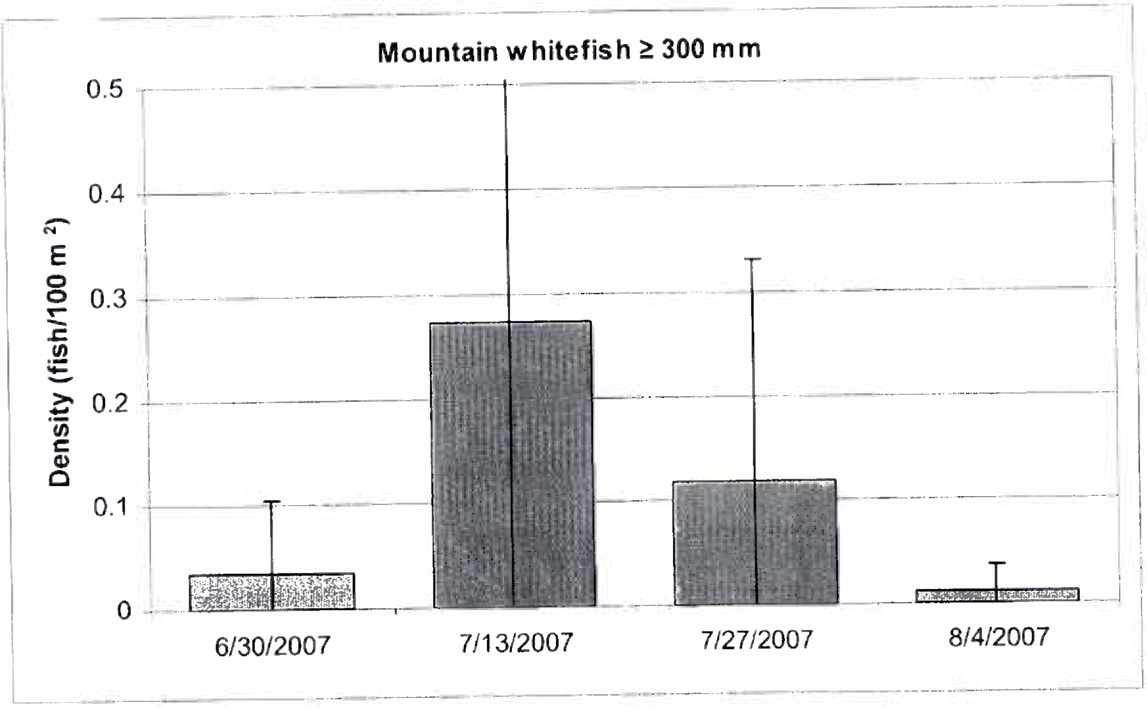

Figure 88. Densities of mountain whitefish ≥ 300 mm in side channel reaches at least 60 m upstream from the main North Fork Coeur d'Alene River, Idaho during four time periods. The average density of mountain whitefish ≥ 300 mm that was observed in the main river during August, 2007 was 1.3 fish/100 m^2. The bars are 90% confidence intervals.

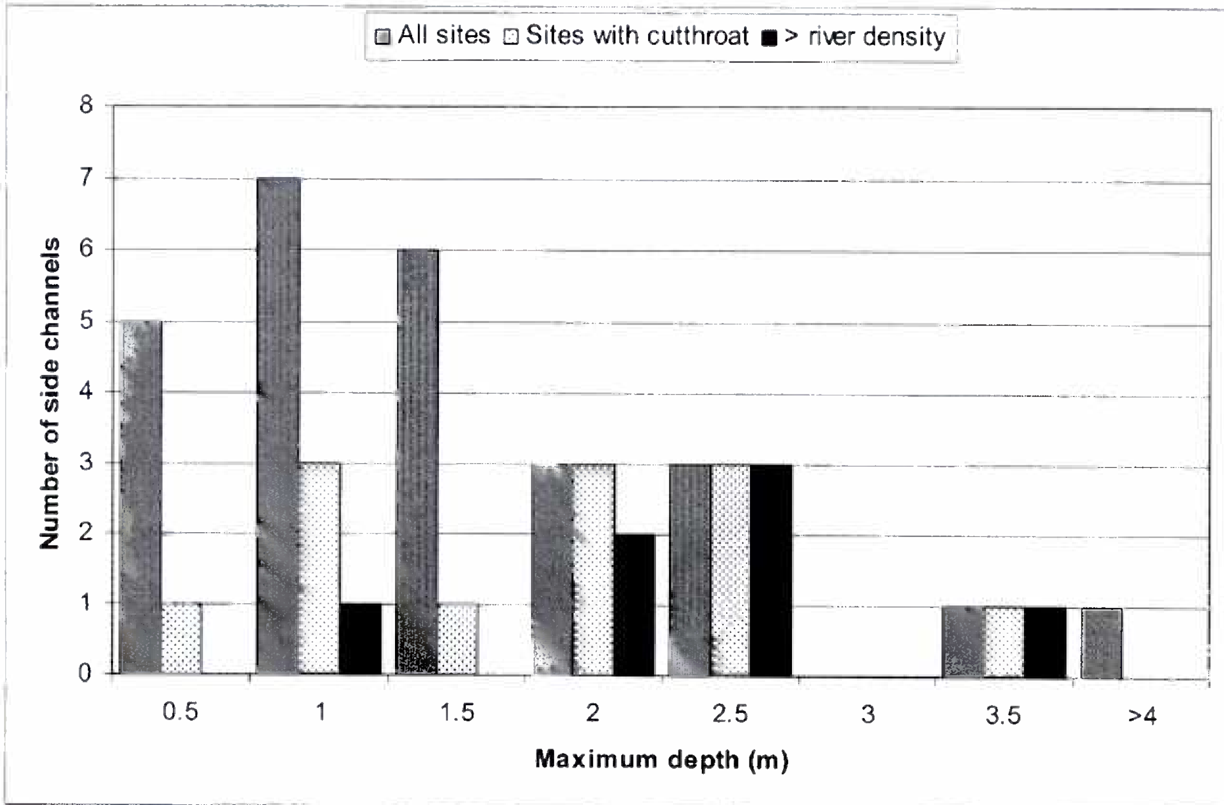

Figure 89. A frequency histogram showing the maximum depth recorded in each side channel snorkeled in comparison to the number of side channels that had at least one cutthroat trout ≥ 300 mm observed, and the number of side channels that had densities of cutthroat trout ≥ 300 mm that exceeded what was observed in the main North Fork Coeur d'Alene River, Idaho, during the summer of 2007.

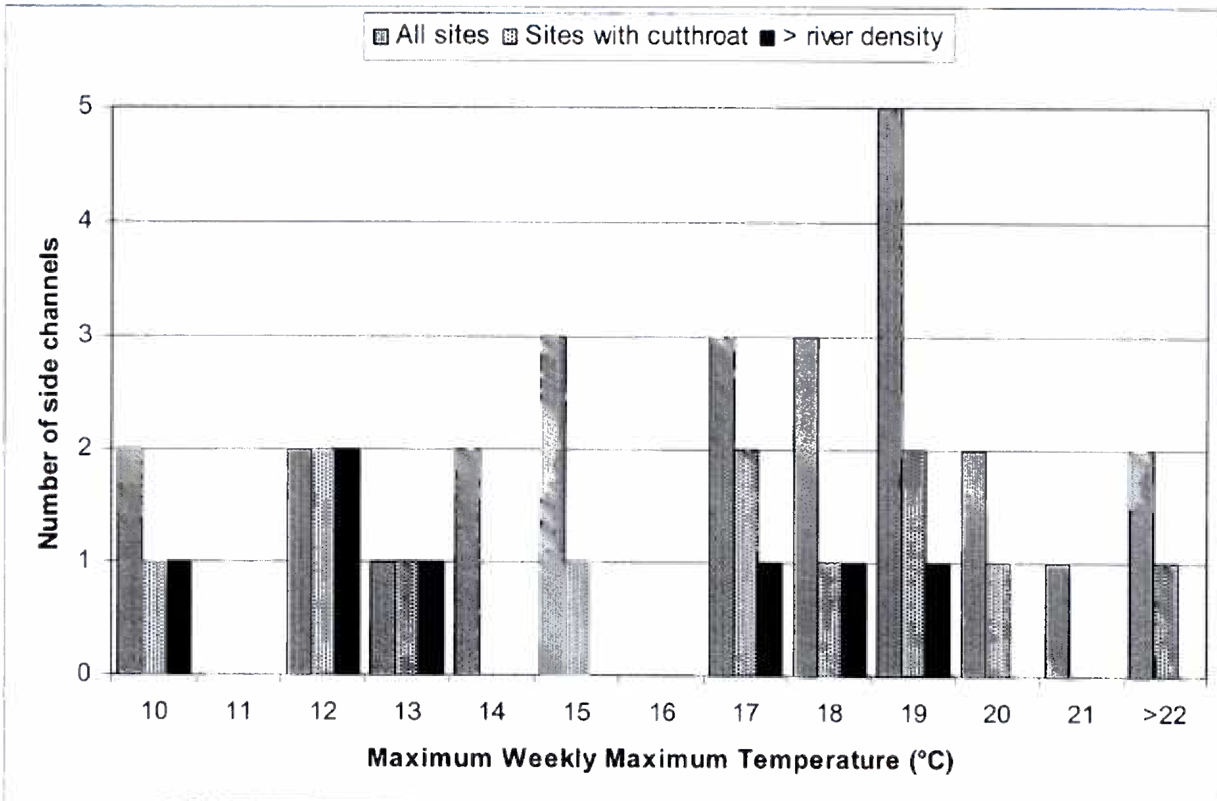

Figure 90. A frequency histogram showing the maximum weekly maximum temperature recorded in each side channel transect snorkeled in comparison to the number of transects that had at least one cutthroat trout ≥ 300 mm observed, and the number of transects that had densities of cutthroat trout ≥ 300 mm that exceeded what was observed in the main North Fork Coeur d'Alene River, Idaho, during the summer of 2007.

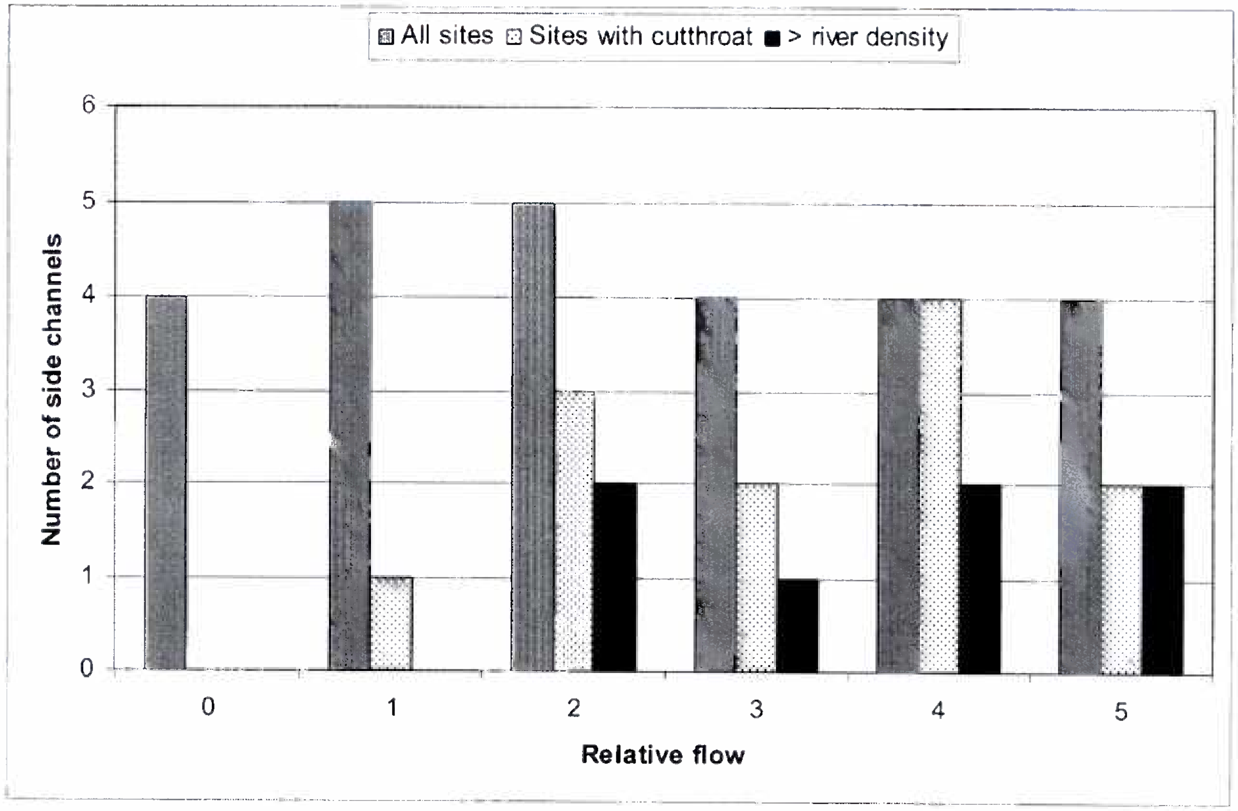

Figure 91. A frequency histogram showing the relative flow determined in each side channel snorkeled in comparison to the number of side channels that had at least one cutthroat trout ≥ 300 mm observed, and the number of side channels that had densities of cutthroat trout ≥ 300 mm that exceeded what was observed in the main North Fork Coeur d'Alene River, Idaho, during the summer of 2007.

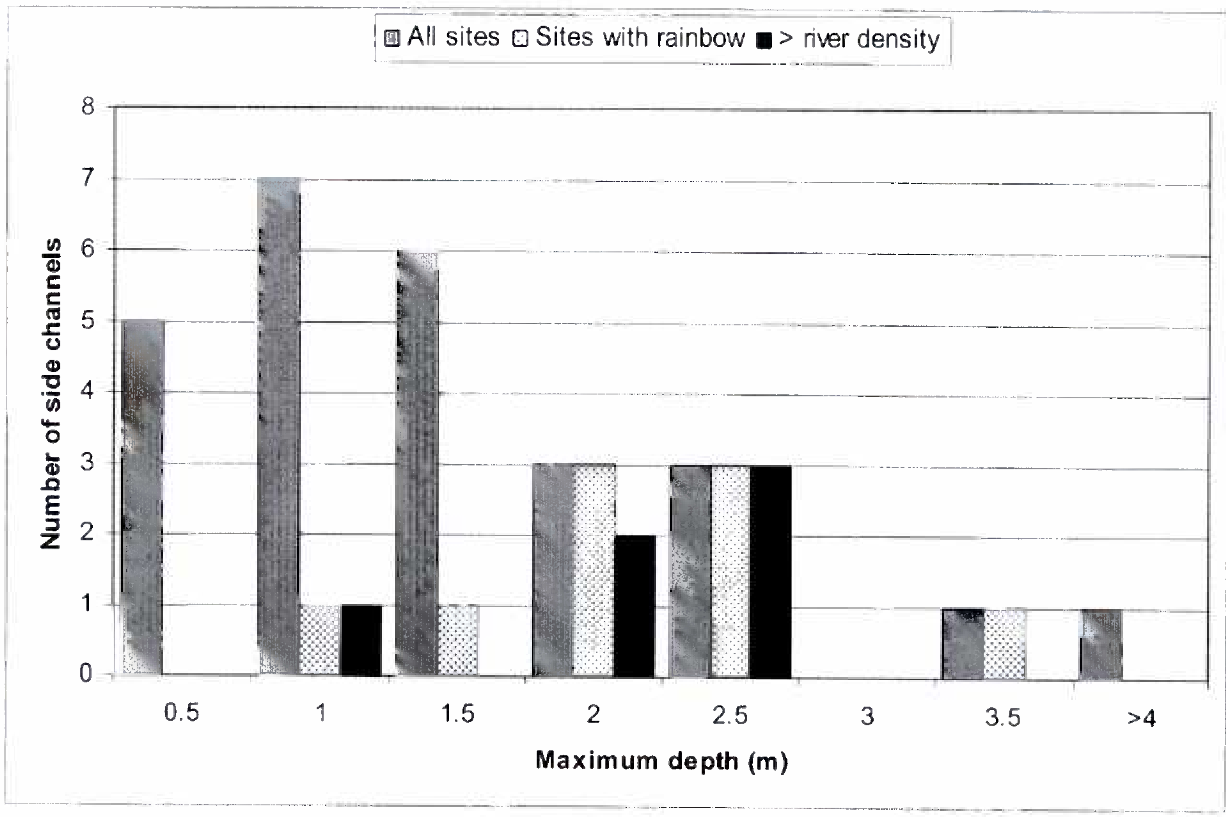

Figure 92. A frequency histogram showing the maximum depth recorded in each side channel snorkeled in comparison to the number of side channels that had at least one rainbow trout ≥ 300 mm observed, and the number of side channels that had densities of rainbow trout ≥ 300 mm that exceeded what was observed in the main North Fork Coeur d'Alene River, Idaho, during the summer of 2007.

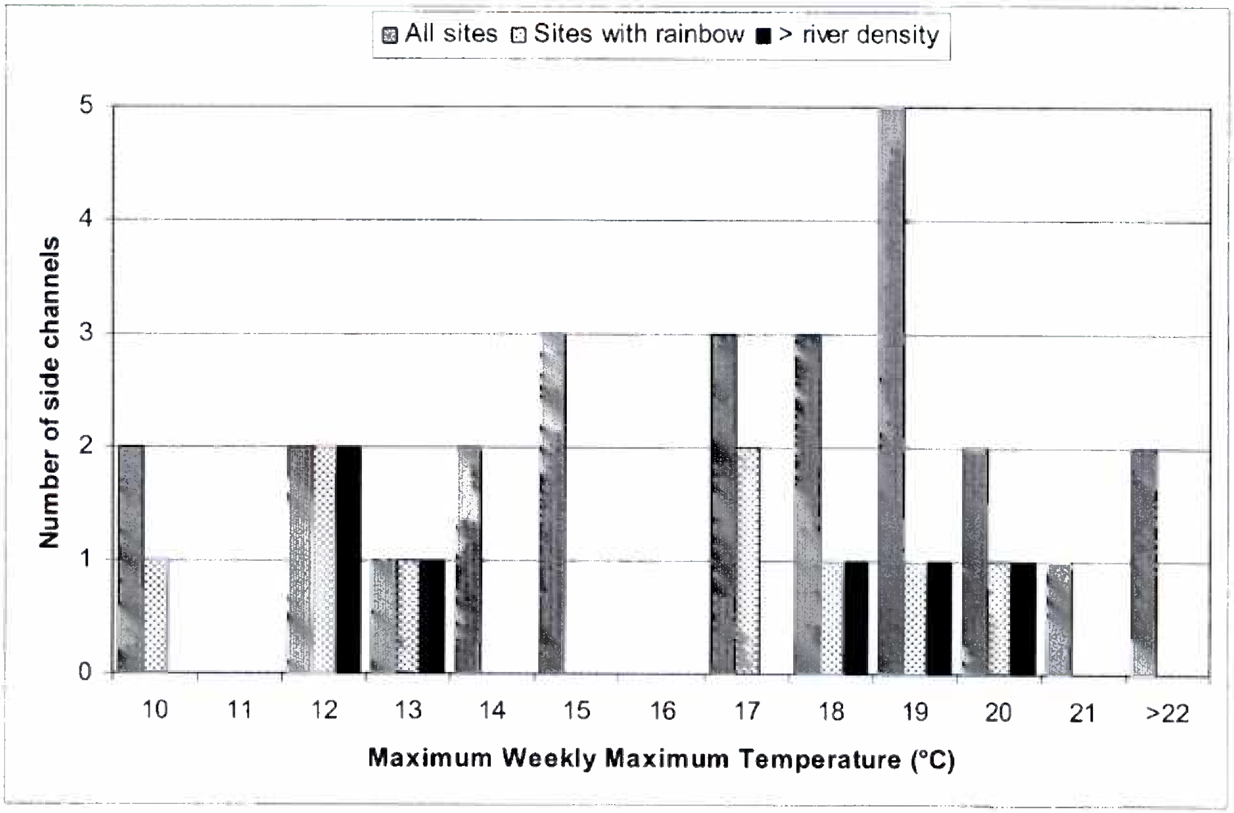

Figure 93. A frequency histogram showing the maximum weekly maximum temperature recorded in each side channel snorkeled in comparison to the number of side channels that had at least one rainbow trout ≥ 300 mm observed, and the number of side channels that had densities of rainbow trout ≥ 300 mm that exceeded what was observed in the main North Fork Coeur d'Alene River, Idaho, during the summer of 2007.

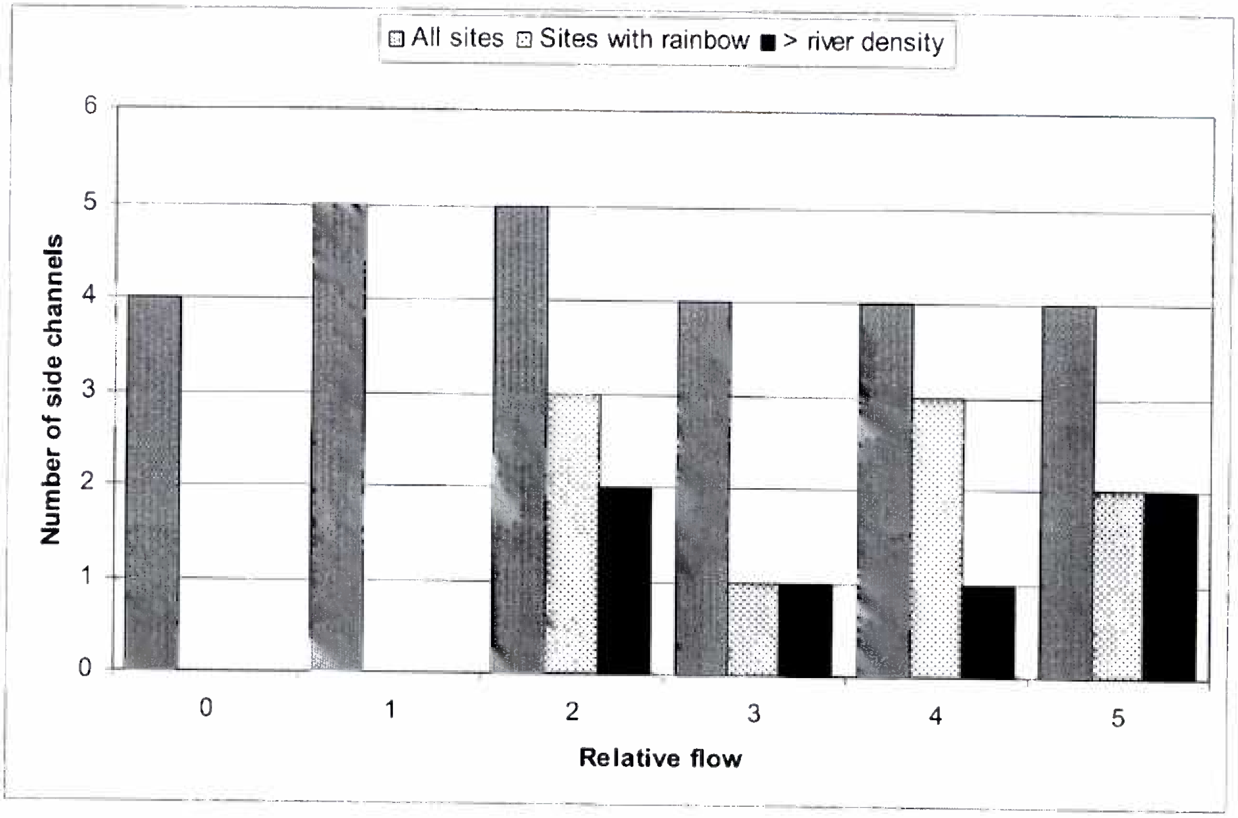

Figure 94. A frequency histogram showing the relative flow determined in each side channel snorkeled in comparison to the number of side channels that had at least one rainbow trout ≥ 300 mm observed, and the number of side channels that had densities of rainbow trout ≥ 300 mm that exceeded what was observed in the main North Fork Coeur d'Alene River, Idaho, during the summer of 2007.

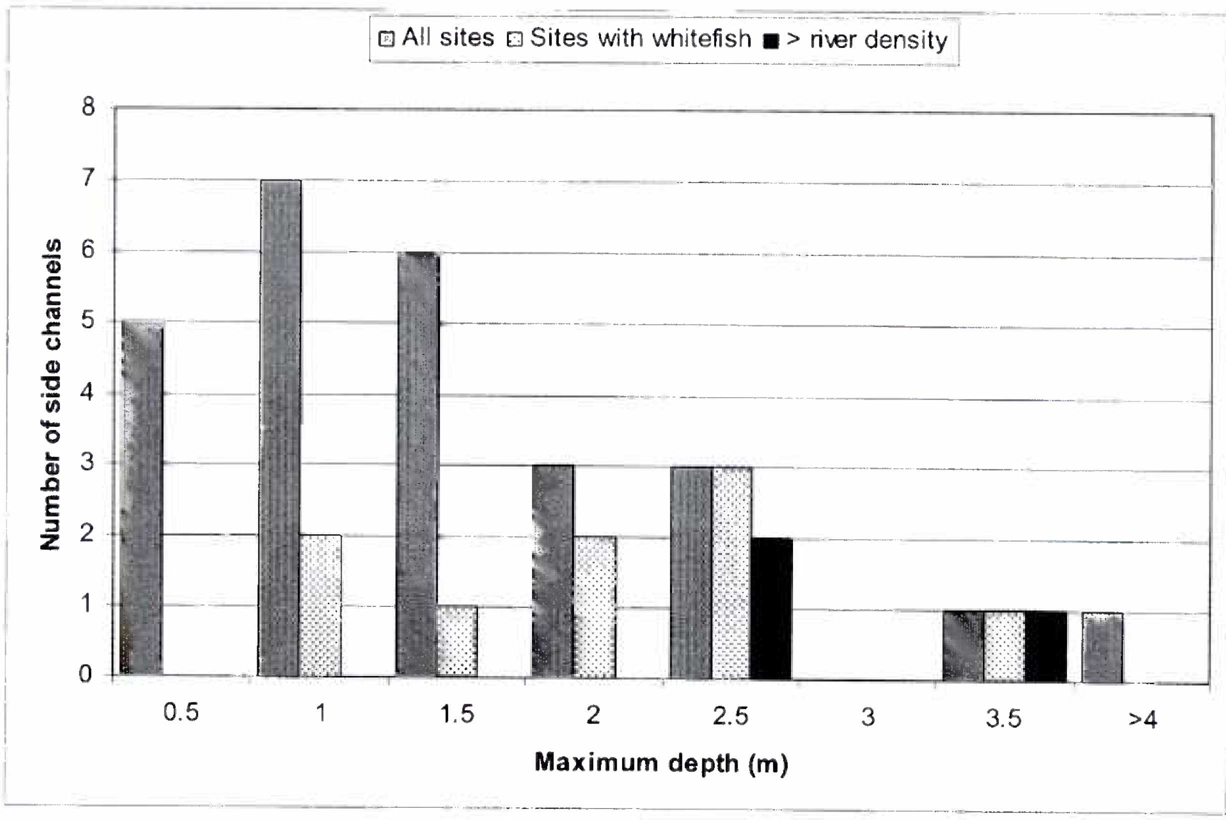

Figure 95. A frequency histogram showing the maximum depth observed in each side channel snorkeled in comparison to the number of side channels that had at least one mountain whitefish ≥ 300 mm observed, and the number of side channels that had densities of mountain whitefish ≥ 300 mm that exceeded what was observed in the main North Fork Coeur d'Alene River, Idaho, during the summer of 2007.

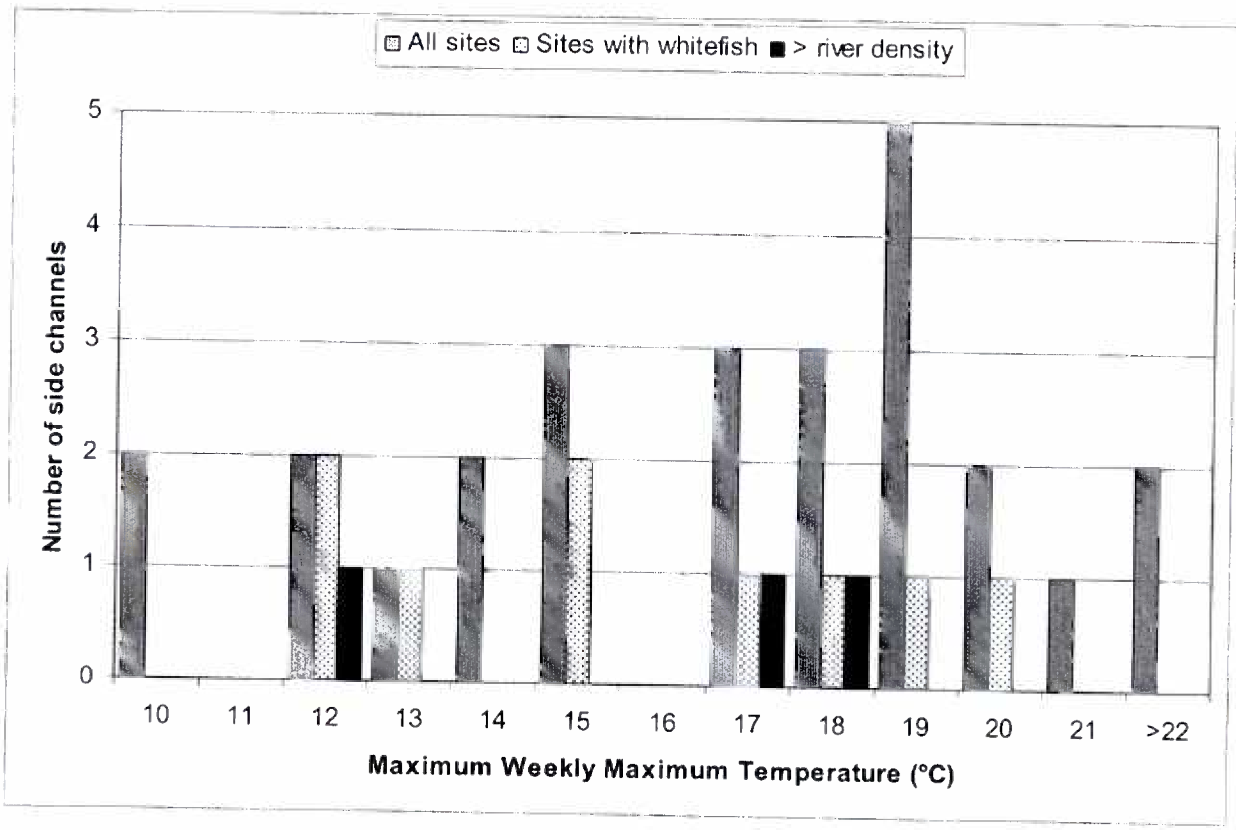

Figure 96. A frequency histogram showing the maximum weekly maximum temperature in each side channel snorkeled in comparison to the number of side channels that had at least one mountain whitefish ≥ 300 mm observed, and the number of side channels that had densities of mountain whitefish ≥ 300 mm that exceeded what was observed in the main North Fork Coeur d'Alene River, Idaho, during the summer of 2007.

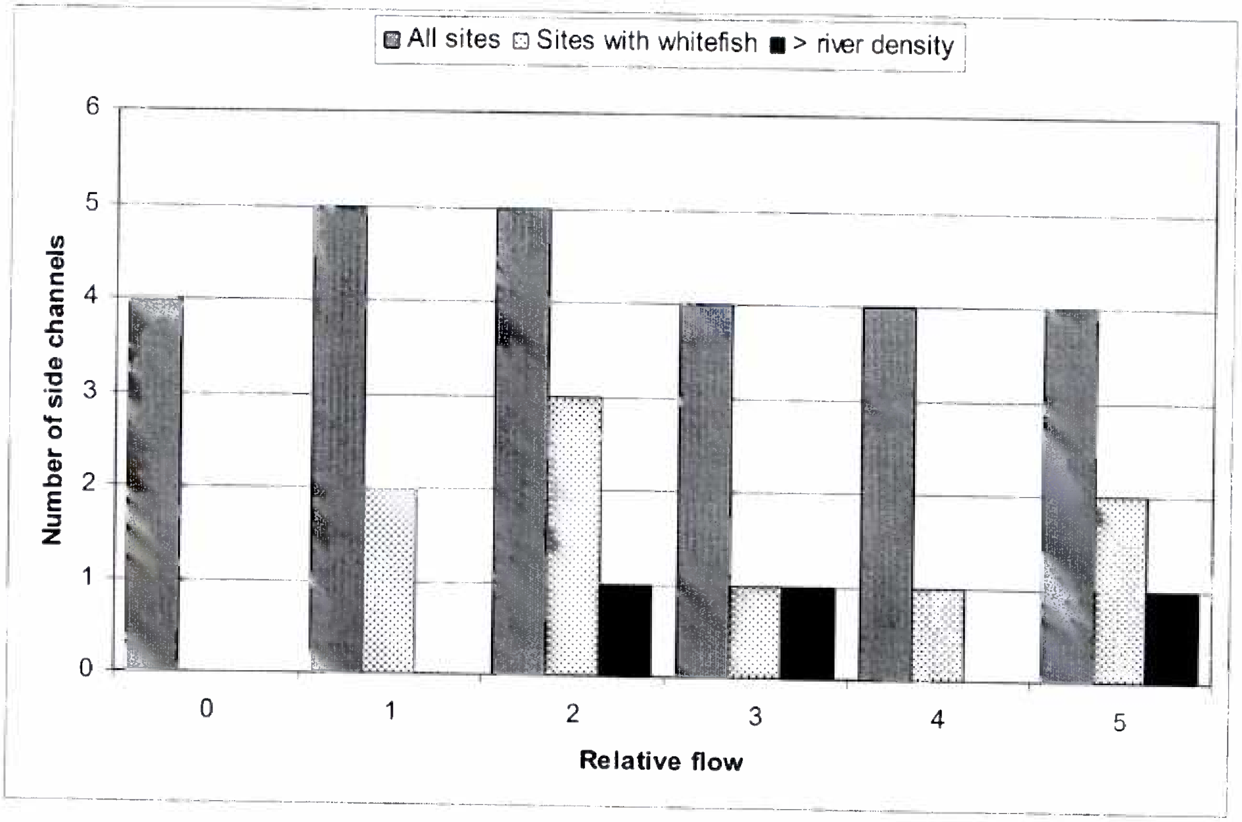

Figure 97. A frequency histogram showing the relative flow determined in each side channel snorkeled in comparison to the number of side channels that had at least one mountain whitefish ≥ 300 mm observed, and the number of side channels that had densities of mountain whitefish ≥ 300 mm that exceeded what was observed in the main North Fork Coeur d'Alene River, Idaho, during the summer of 2007.

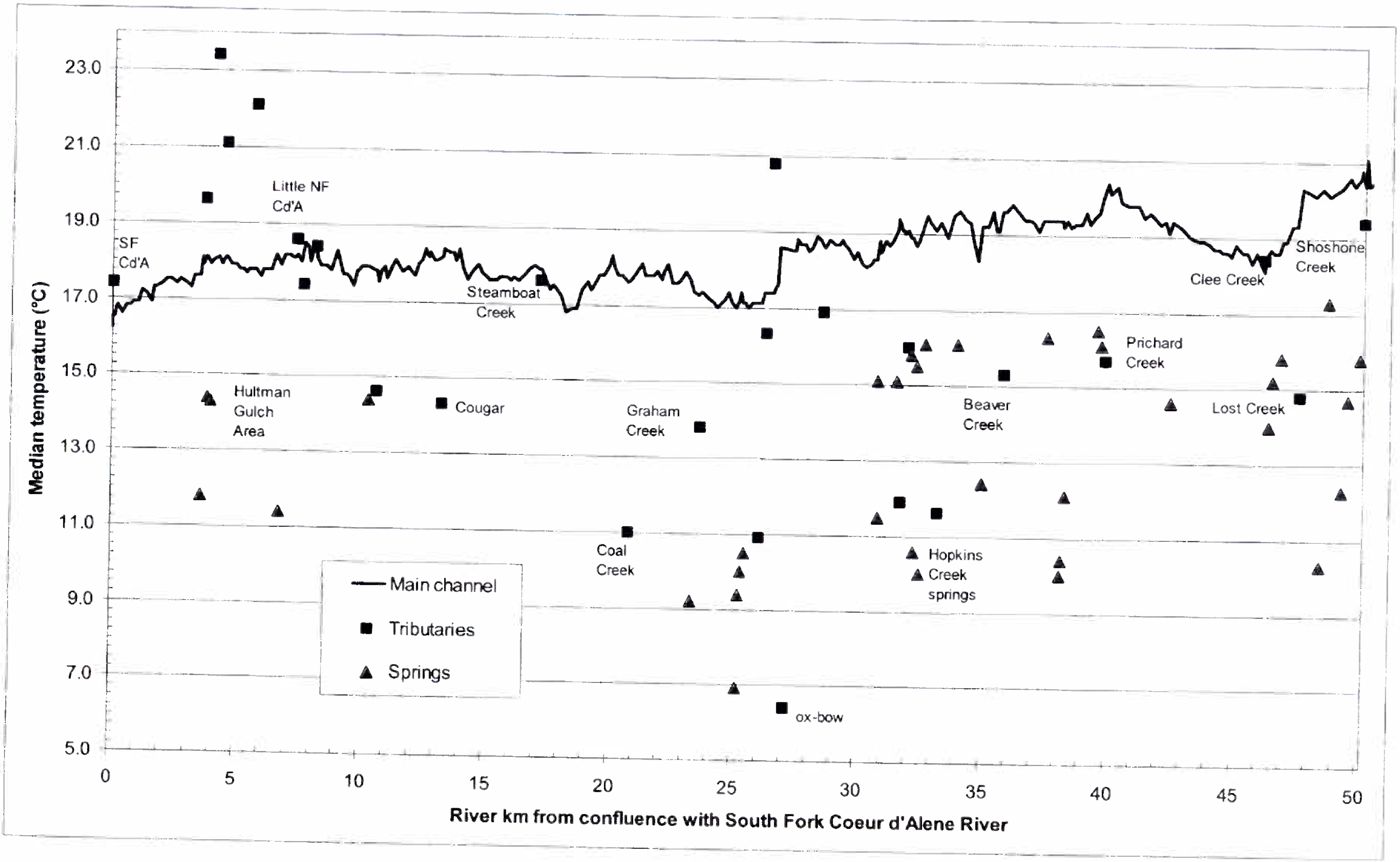

Figure 98. A longitudinal temperature profile of the North Fork Coeur d'Alene River, Idaho, from the South Fork Coeur d'Alene River to Shoshone Creek showing the median water temperatures in the main channel including temperatures of contributing streams and surrounding springs on August 9, 2007 (as reported in Watershed Sciences, Inc. 2007).

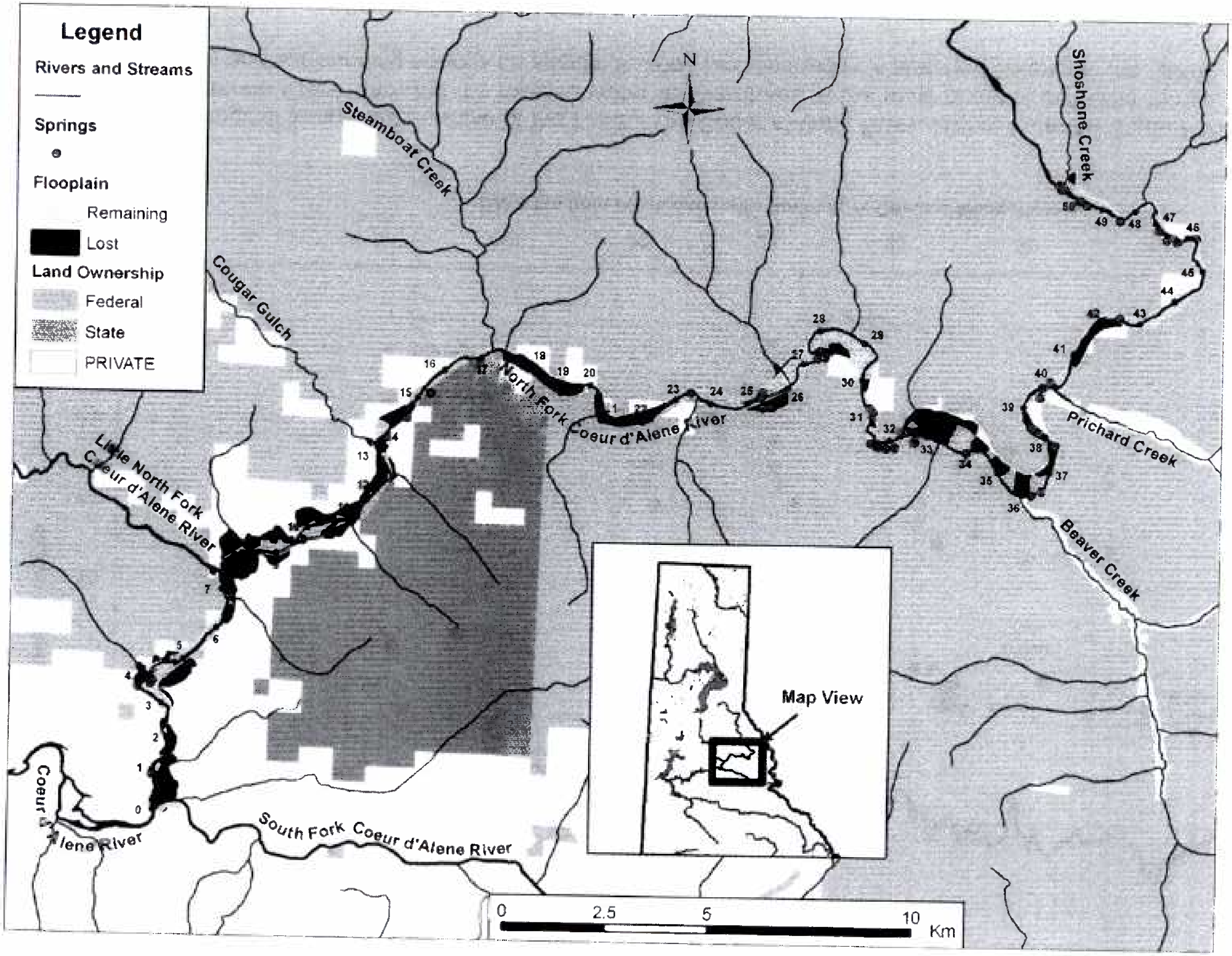

Figure 99. Coldwater springs identified in the floodplain of the lower North Fork Coeur d'Alene River, Idaho, on August 9, 2007 using airborne thermal sensing. The black dots indicate the river km starting at the South Fork Coeur d'Alene River.

Rivers and Streams Investigations

HAYDEN LAKE TRIBUTARY FISH ASSESSMENT

ABSTRACT

Major tributaries of Hayden Lake were sampled in July 2007 in order to assess distribution and abundance of trout. Sampling was conducted using electrofishing at selected sites on Hayden, East Fork Hayden, North Fork Hayden, Mokins, Nilsen, Jim, and Yellowbanks creeks. Trout species captured included Westslope cutthroat trout, rainbow trout, brook trout, hybrid cutthroat trout x rainbow trout, and small trout which were only identifiable to genus *Oncorhynchus*.

Westslope cutthroat trout were captured in all of the Hayden Lake tributaries sampled. Abundance of this cutthroat was highest in Nilsen, Mokins, and Yellowbanks creeks where few or no brook trout or rainbow trout were captured. Cutthroat trout densities were much lower in the Hayden Creek drainage where the density of brook trout has increased more than 3-fold since 1986. Cutthroat trout density showed significant negative correlations with maximum depth, stream width, and amount of woody debris. Rainbow trout density was lower than cutthroat density in all tributaries with the exception of Hayden Creek. Rainbow trout density was positively correlated with average stream width. Rainbow trout x cutthroat trout hybrids (5%) were observed but numbers of hybrids were low relative to rainbow trout (21%) and cutthroat trout (54%) numbers. Brook trout densities were high in the Hayden Creek drainage but the species was completely absent from the catch for Yellowbanks and Nilsen creeks. Densities showed a significant positive correlation with woody debris and stream temperature, and the species was most abundant in the lower reaches of Hayden Creek in areas with finer sediments.

Overall, fishes captured in the Hayden Lake tributaries were small. Only 9% of all fish captured were greater than 152 mm (6"). The majority of cutthroat trout and rainbow trout are likely adfluvial, with few resident fish. Approximately 5% of both cutthroat trout and rainbow trout represented lengths that could be considered catchable. The largest fish captured during sampling efforts was a brook trout (340 mm) and this species represented the greatest proportion of catchable fish (21%). Brook trout would provide a fishery in the Hayden Lake tributaries and a reduction in densities through harvest could increase cutthroat trout densities, particularly in the Hayden Creek drainage. Based on the findings of this study, tributaries of Hayden Lake could be opened to fishing under general trout season regulations with little risk of deleterious effects to the trout populations based on the density, life history, and length frequency of trout in these tributaries.

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INTRODUCTION

Hayden Lake, located in the Idaho Panhandle, has several popular fisheries including Westslope cutthroat trout and rainbow trout. The lake historically had a good cutthroat fishery, with fish averaging 0.7 kg and weighing as much as 2.3 kg (Ellis 1983). In 1982, a creel survey revealed that 79% of angler effort was aimed at trout species, and trout species constituted 17% of the catch and 8% of the harvest (Ellis 1983).

Trout stocking began in both Hayden Lake and Hayden Creek in the late 1960's. Hayden Creek was stocked infrequently with both cutthroat trout and rainbow trout beginning in 1967 (Appendix H). Hayden Lake has been heavily stocked with rainbow trout and cutthroat trout since 1967 (Appendix I). A management program was implemented in 1975 to restore and enhance the Westslope cutthroat trout fishery in Hayden Lake. As a result, all tributary streams were closed to fishing and a 2 fish limit with a minimum harvestable length of 356 mm was initiated. On Hayden Creek, a weir was installed in 1977 to collect spawning cutthroat and collect eggs for hatchery rearing. Fingerlings were initially released in 1977 and the project continued for several years with annual plants ranging from 12,000 to 292,000 fish (Ellis 1983). In 1980, a permanent trapping facility was constructed on Hayden Creek in order to capture trout migrating upstream for artificial spawning and to evaluate the success of the hatchery reared fry releases. More than half of the upstream spawning run during 1980 and 1981 was composed of wild cutthroat trout (Ellis 1983). The trapping facility was abandoned in 1982 because it was largely inoperable during periods of high flows when large numbers of trout were migrating upstream.

In 2007, the lake was managed as a quality trout fishery for these species with special regulations where two trout over 14 inches (355 mm) could be harvested, from the last Saturday in April thru November 30. Little sampling has been conducted in the Hayden Lake tributaries since they were closed to fishing. The USFS has conducted limited electrofishing surveys in the Hayden Creek drainage and snorkel surveys were conducted in 1985 and 1986 on the East and North Forks of Hayden Creek by IDFG in conjunction with the Bonneville Power Administration (BPA). Stocking of rainbow trout and cutthroat trout fry and fingerlings in Hayden Lake has continued and fish were most recently stocked in 2007 (Appendix H). These stocked fish provide fishing opportunities in a system otherwise limited by natural recruitment. As a result of the extensive stocking history, cutthroat populations in the system are from various stocks and no efforts have been directed at maintaining pure stocks. Recent interest in re-opening tributaries to fishing provided the impetus to evaluate the distribution and density of trout.

OBJECTIVES

1. Determine the distribution and density of fishes occurring in tributaries of Hayden Lake.
2. Assess whether adfluvial trout are the dominant life history form in tributaries of Hayden Lake.
3. Provide recommendations for managing these tributaries.

STUDY AREA

Hayden Lake, located about 9 km northeast of Coeur d'Alene, Idaho, is an oligotrophic lake covering an area of 1,538 ha with a maximum depth of 58 m. Inflow comes primarily from two tributaries, Hayden and Mokins creeks. Other smaller tributaries include Yellowbanks, Jim, Windy, Colburn, Nilsen, and Harrison creeks (Figure 100). Hayden, Mokins, Yellowbanks, Jim, and Nilsen creeks are fish bearing streams according to previous sampling. The outflow tributary is on the west side of the lake and eventually disappears into the Rathdrum Prairie aquifer.

Hayden Creek is the major tributary and drains an area of approximately 57 km^2 characterized by steep, mountainous terrain ranging from 722 m at the inlet, to 1,727 m at the head of the drainage (Mast and Clow 2000). The mean monthly discharge ranges from 0.14 m^3/s during low-flow conditions in September, to 2.25 m^3/s in April, during spring snowmelt.

The Hayden Lake tributaries we sampled included Hayden, East Fork Hayden, North Fork Hayden, Yellowbanks, Mokins, Jim, and Nilsen creeks (Figure 100). The tributaries are located entirely within the boundaries of the Coeur d'Alene National Forest and are accessible by a network of unpaved roads. Roads parallel Hayden, North Fork Hayden, and Nilsen Creeks. The North Fork of Hayden Creek is also paralleled by a USFS road, but is gated at the mouth. Most of Yellowbanks and Mokins Creeks are accessible by trail only.

METHODS

We sampled tributaries of Hayden Lake including Hayden Creek, East Fork Hayden Creek, North Fork Hayden Creek, Yellowbanks Creek, Nilsen Creek, Jim Creek, and Mokins Creek (Figure 100). Sampling was conducted using a Smith-Root SR 15 backpack electroshocker between July 9, and July 19, 2007. Transects on the North and East Forks of Hayden Creek were at locations established by the USFS. The lower-most sites on Hayden, Yellowbanks, Nilsen, Jim, and Mokins creeks were randomly selected and identified by GPS coordinates. Sites upstream of this lowermost site were selected at 1 km intervals and identified by GPS coordinates. Sampling continued upstream as time afforded or until no fish were observed. All transects were approximately 100 m in length and in each stream at least one transect was sampled using a three-pass depletion in order to estimate capture efficiency and produce a population estimate. Block nets were not used; however, all sampling started and stopped in shallow areas which would help restrict movement of fish out of the sample area. At each site, all fish were netted and counted, and trout were measured for total length (mm). In addition, amphibians and sculpin were counted at each transect.

MicroFish 3.0 (Van Deventer and Platts 1985) was utilized to calculate a population estimate at each site where multiple electrofishing passes occurred. A correction factor (capture efficiency) was developed for cutthroat trout, rainbow trout and brook trout, by averaging the sampling efficiency from the sites where depletion sampling occurred. The average capture efficiency was used to estimate the total number of each species of fish that occurred at each of the sites where one pass occurred by dividing the number of specimens captured by their associated average capture efficiency. The estimated total number of fish that occurred at each site was divided by the area of stream sampled, resulting in an estimated density (number/100 m^2) for each sample site. An average density of cutthroat trout, rainbow trout, and brook trout was calculated for each tributary surveyed by summing the population estimate from each site within a stream and dividing it by the total area electrofished.

Where cutthroat trout and rainbow trout co-existed, we were not able to identify age-0 fishes beyond genus *Oncorhynchus*. These age-0 fish were assigned as either cutthroat trout or rainbow trout in equal proportion to what we were able to identify to species. This allowed us to calculate total densities and construct length frequency graphs for both cutthroat trout and rainbow trout. These densities and length distributions could then be compared to other studies.

The USFS conducted backpack electroshofishing surveys in 2002 and 2005 on Mokins, Yellowbanks, Jim, and Nilsen creeks (USFS Unpublished data) and snorkeling surveys were conducted in 1985 and 1986 by IDFG (Gamblin 1988). These studies provided density data and length frequency information to compare to. The USFS data was limited to one transect on each tributary and sampling was conducted in October and November.

After transects were electrofished, habitat characteristics were recorded. We measured length and wetted width (at least four randomly located measurements) at each transect with a rangefinder to determine the surface area (m^2) sampled. We also recorded the percent of habitat represented by pool, riffle, run, glide, or pocket water; the maximum depth; stream gradient; number of pieces of wood; and substrate composition that occurred in the transect area (Overton et al. 1997). Stream gradient was measured with a hand-held clinometer and maximum depth was measured using a calibrated wading staff. Stream temperature was recorded with a hand-held thermometer at each site during the time of sampling. Two sizes of large woody debris (LWD) were counted (>1 m long and >10 cm in diameter and >1 m long and >30 cm in diameter). Only that portion of the wood that occurred inside the wetted width was counted and evaluated for size. The two size classifications of LWD were determined by visual estimation. These types of measurements can be used to help determine if changes in habitat may be responsible for any future changes in fish density.

Average lengths of age-1+ trout species were compared among the tributaries sampled using ANOVA to determine if differences were evident. If significant differences were detected ($P<0.10$) pairwise comparisons were made using Tukey's test. The density estimates for the cutthroat trout, rainbow trout, and brook trout calculated at each transect we surveyed were compared to their associated habitat conditions to evaluate which variables may be influencing their distribution. Comparisons between the measured habitat variables and the density of each species were evaluated using a linear regression analysis and by calculating the correlation coefficient between the variables (r). To determine if a significant relationship ($P<0.10$) occurred between the sampled species densities and individual habitat variables, an analysis of variance (ANOVA) was conducted on the regression.

RESULTS

Abundance and Distribution

A total of 2,351 trout were captured during sampling efforts on Hayden Lake tributaries. Trout species including Westslope cutthroat trout (54%), rainbow trout (21%), rainbow trout x Westslope cutthroat trout hybrid (5%), and brook trout (20%) were captured throughout the tributaries (Table 49). Due to the presence of both cutthroat trout and rainbow trout, age-0 and some age-1 fish were not identifiable beyond genus *Oncorhynchus*. These fish constituted nearly half of the total catch. In addition 2,039 sculpin were captured in the Hayden Creek drainage, including torrent sculpin *Cottus rhotheus* and shorthead sculpin *Cottus confuses*. The presence of spotted frogs *Rana luteiventris* in Mokins Creek and the East Fork Hayden Creek were noted and tailed frogs were noted in Mokins, Yellowbanks, North Fork Hayden, Hayden, and East Fork Hayden creeks (Table 49). No fish were captured in Jim Creek. At the time of sampling, this stream was intermittent and not connected to Hayden Lake.

Cutthroat trout (N=556) were captured in all tributaries sampled. Densities were highest in Nilsen, Mokins, and Yellowbanks creeks which had few or no rainbow trout or brook trout (Tables 50 and 51). Densities in Nilsen Creek and Mokins Creek were higher than what was observed in 2002 and 2005 (Table 51). Yellowbanks Creek mean density was higher in 2007 than in 2005, but was below the density estimate in 2002. In the East Fork and North Fork of Hayden Creek, mean densities of cutthroat >age-1 were three to eight times lower then what was observed in 1985 and 1986, whereas densities of rainbow trout and brook trout were higher in 2007 (Tables 52 and 53). Cutthroat trout captured in the Hayden Lake tributaries averaged 70 mm in length with a range from 23 - 248 mm (Figure 101). A majority of fish were age-0 (60%), age-1 (26%), and age-2 (12%), with few age-3+ (2%) fish. Approximately 5% of fish were large enough to consider catchable (>152 mm). The average length of cutthroat trout >age-1 was significantly different among the tributaries (ANOVA, F=7.68, P<0.001; Figure 102). Pairwise comparisons showed Hayden Creek, East Fork Hayden Creek, and Nilsen Creek, had significantly larger average lengths than both Yellowbanks Creek and Mokins Creek. North Fork Hayden Creek average length was significantly higher than Mokins Creek, but not Yellowbanks Creek.

Rainbow trout were captured in the Hayden Creek drainage and Yellowbanks Creek. The highest rainbow trout mean density was observed in Hayden Creek, exceeding the cutthroat trout density (Tables 50 and 51). However, rainbow trout densities were lower than cutthroat trout densities in other streams where they co-existed. Rainbow trout density in Yellowbanks Creek in 2007 was nearly identical to 2002 (Table 52). In the North Fork and East Fork of Hayden Creek, however, mean densities were more than 3-fold higher in 2007 than in 1985 and 1986 (Table 53). The average length of rainbow trout was similar to cutthroat trout (65 mm) with a range of 27 - 247 mm (Figure 101). The majority of fish captured were age-0 (64%) and age-1 (29%), with few fish age-2+ (7%). Approximately 5% of fish were large enough to consider catchable (>152 mm). Average length did not differ significantly among the tributaries (ANOVA, F=0.01, P=0.940; Figure 102).

Brook trout were captured in Hayden Creek drainage and Mokins Creek. The overall density of brook trout in Hayden Creek was higher nearly three times higher than cutthroat trout density (Tables 50 and 51). Brook trout density was highest in the lower reach of Hayden Creek, with fewer fish at the uppermost sites in the East Fork and North Fork (Table 50). Brook trout were also captured in Mokins Creek, though density was lower in relation to the Hayden Creek drainage. No brook trout were captured in Nilsen and Yellowbanks creeks. Sampling conducted by the USFS reported capturing two brook trout in Yellowbanks Creek in 2005 and none were captured in Mokins Creek in either 2002 or 2005 (Table 52). Density of brook trout in the East Fork and North Fork of Hayden Creek was higher in 2007 than in 1985 and 1986 (Table 53). The largest fish captured during all sampling was a brook trout (TL = 340 mm) at transect EF2 on East Fork Hayden Creek. Average length of brook trout captured was 99 mm with a range of 40 - 340 mm (Figure 101). The majority of fish captured were age-0 (60%), age-1 (22%), or age-2 (11%), with few age-3 (3%) and age-4+ (4%) fish. Brook trout had the highest proportion of the catch represented by age-3+ fish among trout species, as well as the greatest percentage (21%) of catchable size (>152 mm) fish. Among the tributaries, average length of brook trout was significantly different (ANOVA, F=7.24, P<0.001; Figure 102). Average length was significantly higher in the East Fork and North Fork of Hayden Creek than in Hayden Creek. Only two fish were captured in Mokins Creek which did not make it possible to compare to other tributaries.

Hybrids were present in the Hayden Creek drainage as well as in Yellowbanks Creek. Density of hybrids was lower than cutthroat trout in all of the tributaries in which both were present (Tables 50 and 51). In Yellowbanks Creek, hybrids were more abundant than rainbow trout. Average length of hybrids was similar to both cutthroat and rainbow trout at 65 mm with a range of 23 - 194 mm (Figure 101). Hybrids captured were largely age-0 (54%) and age-1 (34%) fish, with few age-2 (7%) and age-3 (6%) fish. A small proportion (6%) of the total would be considered catchable (>152 mm).

Habitat and Density Associations

We collected nine different habitat characteristics at each electrofishing transect to evaluate their relationship to trout densities (Table 54). Cutthroat trout density was significantly negative correlated with maximum depth, stream width, and large woody debris (Figure 103 and Table 55). Rainbow trout density was significantly positive correlated with stream width and percent glide habitat (Figure 103 and Table 55). Brook trout density was significantly positive correlated with temperature, woody debris, and percent pool habitat (Figure 103 and Table 55).

Correlations between trout species densities did not show any significant relationships; however, both rainbow trout and brook trout density showed a slightly negative correlation with cutthroat trout density (Table 56).

DISCUSSION

Abundance and Distribution

Cutthroat trout

Cutthroat trout were captured in every tributary and transect sampled. Overall, densities in the Hayden Lake tributaries were comparable to those found elsewhere in the Panhandle

Region (Table 57). The uncharacteristically high density in Nilsen Creek was likely a result of its very small size (less than 1.5 m). Cutthroat density in the Hayden Lake tributaries was negatively correlated with average stream width, a finding corroborated by electrofishing surveys on tributaries of the Little North Fork Clearwater River where the smallest streams had the highest densities of smaller cutthroat (Dupont et al. 2004). In this study Nilsen Creek was the smallest tributary sampled and had a cutthroat density of 143 fish/100m^2. Densities of cutthroat were also higher in tributaries where brook trout and rainbow trout were not present or where their densities were low. Cutthroat trout densities were five times lower in the East Fork and nine times lower in the North Fork of Hayden Creek in 2007 as compared with 1986, whereas brook trout density slightly increased in the East Fork and nearly doubled in the North Fork Hayden Creek. Rainbow trout density also doubled in both the East Fork and North Fork since 1986. Brook trout have displaced cutthroat populations in many Priest River tributaries, particularly where gradients are lower and sediments are finer (Dupont and Horner In Press) and similar findings have been reported by others (Shepard 2004, Dunham et al. 2002). We did not find any significant correlations between gradient and density of brook trout or cutthroat trout, however, brook trout densities in the Hayden Creek drainage were higher at the more downstream transects where lower gradient and finer sediment are predominant.

Average length of fish was small (70 mm) with the largest fish being 248 mm in length. The lack of larger fish captured in the tributaries was likely a result of life history, though this is difficult to determine. The majority of fish captured appear to exhibit an adfluvial life history based on their size distribution. A high proportion of fish (86%) were age-0 or age-1, likely rearing for one to two years in tributaries prior to migrating to Hayden Lake. Fluvial and adfluvial cutthroat trout are known to rear in smaller streams for one to four years prior to migrating to larger rivers and lakes where they spend their adult lives (Behnke 1992). A weir located in Hayden Creek in 1977 captured 251 adult cutthroat spawners during spring, with an average length around 375 mm. Six fish were aged and determined to be age-4 and age-5 individuals that had spent 1-2 years rearing in tributaries (Mauser 1978). Gamblin (1988) found populations of cutthroat trout in the East Fork and North Fork of Hayden Creek were predominantly represented by age-1 and age-2 fish. In 1985, 0% of fish in the North Fork and approximately 26% of fish in the East Fork were age-3+ fish. In 1986 age-3+ fish made up 15% and 16% of the total catch in the North Fork and East Fork, respectively. Fyke nets set at the mouth of the East and North Forks from April - June found that the average length of fish migrating downstream was 152 mm (N=2) and 133 mm (N=16), respectively (Gamblin 1988). In 2007, the proportion of the catch represented by age-3+ fish appears to have declined as compared with 1985 and 1986 age structure. This could indicate a reduction in the resident population, causing a shift in age structure or it could be a result of sampling timing. It was unclear during what time of year Gamblin conducted his surveys. If sampling occurred during spring, this likely accounts for the increased presence of larger fish in the 1985 and 1986 sample. We did capture a few fish that were likely age-3 and age-4 individuals indicating that there may be a residual life history contingent. These fish would be at the greatest risk if fishing in Hayden Lake tributaries were opened. In Yellowbanks Creek and Mokins Creek, average lengths were significantly lower than in the other tributaries, indicating that there may be more of an adfluvial component in these two tributaries.

Rainbow Trout

Rainbow trout were less abundant, overall, than cutthroat trout and distribution was less widespread. Fish were captured in Hayden, East Fork Hayden, North Fork Hayden, and Yellowbanks creeks. In Hayden Creek, density of rainbows was higher than density of cutthroat. Rainbow trout and brook trout are likely displacing cutthroat trout in this drainage. In the Hayden Creek drainage, rainbow trout were captured at all transects and densities were higher at transects with larger stream width, which is similar to the findings of other studies. Rainbow trout are typically concentrated in the lower reaches of streams whereas cutthroat trout are more typically located in the upstream reaches (Behnke 1992, Bear et al. 2007).

Rainbow trout densities in Yellowbanks were similar to previous studies but had increased in the East and North Forks of Hayden Creek. This increase is likely a result of displacement of cutthroat trout by brook trout in this drainage. A total of 23 hybrids were also captured during our sampling and constituted a small proportion (5%) of the total fish catch. Hybridization will likely continue and could cause adverse effects on the cutthroat trout population.

Similar to cutthroat trout, average length of rainbow trout was 65 mm. The majority of rainbow trout are likely exhibiting adfluvial life histories, based on size. A high proportion of fish (93%) captured were age-0 and age-1 fish, likely rearing in the tributaries and then moving to the lake after 1-2 years. Adult rainbow spawners captured at the Hayden Creek weir in 1977 averaged 415 mm in length (Mauser 1978). These larger rainbow trout adults move upstream between April and June to spawn and then move back down into the lake. The presence of a few larger age-3 and age-4 fish (7%) points to the possibility that some fish are resident.

Brook trout

Brook trout density in Hayden Creek was higher than both cutthroat and rainbow trout densities, but brook trout were absent from the catch in Yellowbanks and Nilsen Creeks which both had high densities of cutthroat. Habitat in Hayden and North Fork Hayden creeks was suitable for brook trout, particularly in terms of woody debris, low gradient, abundant pools, finer substrates, and higher temperatures. Although our temperature data was limited, brook trout density increased with higher temperature similar to the findings of other studies (McMahon et al. 2007, Benjamin et al. 2007, Paul and Post 2001). Increased densities in this drainage seem to indicate this species is moving into these habitats. The species is known to replace or displace populations of cutthroat trout (McMahon et al. 2007, Shepard 2004, Dunham et al. 2002).

The largest fish captured during our sampling efforts was a brook trout and the species constituted the greatest percentage (21%) of fish >152 mm in length (size of fish people will likely keep). This species may provide a good fishing opportunity in the Hayden tributaries.

Habitat and Density Associations

This study indicates tributaries support varying densities of trout based in part on habitat characteristics. Contrary to other research (Horan et al. 2000; Rosenfeld et al. 2000) which has shown the density of cutthroat trout tend to increase with increasing density of LWD, cutthroat trout density decreased with increased LWD. This likely occurred because areas with more LWD supported higher numbers of brook trout. Brook trout likely have displaced a portion of the cutthroat trout in Hayden Creek, North Fork Hayden Creek, and East Fork Hayden Creek, and especially in the lower gradient stream reaches with higher amounts of fine sediment. In the

Hayden Creek drainage, brook trout were more abundant at the lower sites and particularly at the lowest Hayden Creek site. These findings are consistent with what other researchers have found (McMahon et al. 2007, Shepard 2004, Dunham et al. 2002). Brook trout density was also higher in areas dominated by pool habitat, which was abundant in the lower reaches of the Hayden Creek drainage.

Rainbow trout density was correlated with average stream width; with more fish being captured at transects with greater stream width. This is similar to the findings of other research (Roper 1995, Dunnigan 1997, Muhlfeld 1999, Bear et al. 2007) which has shown that rainbow trout typically use the lower, larger sections of streams where water temperatures tend to be higher and cutthroat are restricted to cooler, upstream areas.

No significant correlations were evident between densities of trout, although cutthroat trout density showed a slightly negative correlation with brook trout density. This relationship is representative of the decreasing trend in cutthroat trout density in the Hayden Creek drainage, whereas brook trout density is increasing.

Management Implications

Based on the findings of this study, opening tributaries of Hayden Lake to fishing under the general stream seasons and regulations should not result in deleterious effects on trout populations. Under general season rules, fishing would be closed during periods when the majority of adult cutthroat trout and rainbow trout move up into the tributaries to spawn. The average length of all trout in tributaries during the sampling was small (9% of fish > 6"; 152 mm). Approximately 5% of both cutthroat trout and rainbow trout would be considered catchable fish. Length frequency data suggests that some of these fish may be residents. This segment of the population would be most at risk if tributaries are opened to fishing. Brook trout had the greatest average length and the greatest proportion of catchable size fish (21%). This non-native fish will provide a good fishing opportunity in these tributaries. Angler harvest of this species may reduce densities, particularly in the Hayden Creek drainage, which could lead to increases in density of cutthroat trout.

MANAGEMENT RECOMMENDATIONS

1. Open Hayden Lake tributaries to fishing under general trout season and rules
2. Continue to monitor abundance and distribution of trout in tributaries

Table 49. Number of trout, sculpin, and amphibians captured in tributaries of Hayden Lake, Idaho, in 2007.

	Cutthroat	Rainbow	Hybrid	Brook	Fish Total	Sculpin	Tailed frogs	Frogs
Hayden	106	389	5	269	**769**	808	3	0
E. Fork Hayden	165	30	14	67	**276**	546	546	97
N. Fork Hayden	209	95	16	117	**437**	685	70	0
Mokins	465	0	0	14	**479**	0	251	1
Nilsen	124	0	0	0	**124**	0	0	0
Yellowbanks	239	4	23	0	**266**	0	179	0
	1,308	518	58	467	**2,351**	2,039	1,049	98

Table 50. Number and density of fishes captured in tributaries of Hayden Lake, Idaho, in 2007.

Stream	Transect	Area (m^2)	Cutthroat Pop Est	Cutthroat Density (No./ 100m^2)	Rainbow Pop Est	Rainbow Density (No./ 100m^2)	Brook Pop Est	Brook Density (No./ 100m^2)	Hybrid Pop Est	Hybrid Density (No./ 100m^2)	Sculpin Total	Salmonid Density (No./100m^2)
Hayden	H1	291	20	6.9	31	10.6	200	68.8	8	2.8	56	0.3066
	H2	413	75	18.1	189	45.8	100	24.2			187	0.2132
	H3	846	17	2.0	91	10.7	48	5.7			162	0.0217
	H4	415	44	10.6	145	35.0	77	18.5			190	0.1546
	H5		47		159		23				213	
EF Hayden	EF1	168	54	32.5	3	2.0	3	2.0	12	7.2	39	0.2601
	EF2	362	66	18.3	5	1.3	10	2.8	12	3.3	111	0.0709
	EF3	265	73	27.5	10	3.9	30	11.3	2	0.8	212	0.1638
	EF4	552	44	7.9	32	5.7	48	8.8			145	0.0405
	EF5	384	52	13.6	16	4.3	20	5.2	2	0.5	135	0.0615
NF Hayden	NF1	372	83	22.3	5	1.3	10	2.7			112	0.0705
	NF2	291	79	27.0	47	16.0	38	13.2	8	2.8	239	0.2027
	NF3	465	92	19.8	32	6.9	53	11.5	6	1.3	129	0.0849
	NF4	426	76	17.8	14	3.3	73	17.2	8	1.9	115	0.0942
	NF5	312	9	2.7	101	32.3	20	6.4	10	3.2	90	0.1435
Yellow Banks	Y1	342	163	47.6	4	1.3			46	13.4		0.1821
	Y2	333	177	53.3								0.1603
	Y3	209	113	54.1								0.2584
Nilsen	N1	58	136	234.2								4.0383
	N2	97	87	89.2								0.9161
	N3		11									
Mokins	M1	198	209	105.6			2	0.8				0.5367
	M2	152	162	106.7			2	1.1				0.7086
	M3	240	170	70.7			10	4.2				0.3119
	M4	230	168	73.1			10	4.4				0.3373
	M5	145	168	115.8								0.7987

Table 51. Mean density (fish/100 m^2) of trout captured in tributaries of Hayden Lake, Idaho, in 2007.

Tributary	All Fish Density/100m^2		
	Cutthroat	Rainbow	Brook
Hayden	7.9	23.2	21.6
E. Fork Hayden	16.7	3.8	6.5
N. Fork Hayden	18.1	9.0	10.4
Yellowbanks	51.3	1.3	0.0
Nilsen	143.3	0.0	0.0
Mokins	90.9	0.0	2.8

Tributary	Age 1+ Fish Density/100m^2		
	Cutthroat	Rainbow	Brook
Hayden	1.9	7.3	7.3
E. Fork Hayden	7.0	1.3	3.2
N. Fork Hayden	6.0	2.9	4.9
Yellowbanks	15.6	0.8	0
Nilsen	46.4	0	0
Mokins	21.9	0	0.3

Table 52. Mean density (fish/100 m^2) of cutthroat trout (WCT), rainbow trout (RBT), and brook trout (BRK) captured in tributaries of Hayden Lake, Idaho, in 2007, 2005, 2002.

	2007			2005*			2002*		
Tributary	WCT	RBT	BRK	WCT	RBT	BRK	WCT	RBT	BRK
Hayden	7.9	23.2	21.6						
E. Fork Hayden	16.7	3.8	6.5						
N. Fork Hayden	18.1	9	10.4						
Yellowbanks	51.3	1.3	0	17.4	0	2.2	78.6	1.2	0
Nilsen	143.3	0	0	21.1	0	0			
Mokins	90.9	0	2.8	26.6	0	0	15.9	0	0

* Electroshocking conducted by U.S. Forest Service in October and November. Only 1 transect was sampled for each of the tributaries. (No data was available for Hayden Creek).

Table 53. Mean density (fish/100 m^2) of cutthroat trout (WCT), rainbow trout (RBT), and brook trout (BRK) captured in tributaries of Hayden Lake, Idaho, in 2007, 1986, and 1985.

	2007*			1986**			1985**		
Tributary	WCT	RBT	BRK	WCT	RBT	BRK	WCT	RBT	BRK
Hayden	1.9	7.3	7.3						
E. Fork Hayden	7	1.3	3.2	35.2	0.2	4	24.5	0	2.1
N. Fork Hayden	6	2.9	4.9	56.6	1.4	2.8	46.7	0	0
Yellowbanks	15.6	0.8	0						
Nilsen	46.4	0	0						
Mokins	21.9	0	0.3						

*Density estimates for age 1+ fish

**Snorkel surveys conducted by Idaho Fish and Game in conjunction with BPA.

Table 54. Habitat characteristics collected at electrofishing transects on tributaries of Hayden Lake, Idaho, in 2007.

Stream	Transect	Length (m)	Avg Width	Area m^2	Temp (°C)	Gradient (%)	Woody Debris >10 cm	Woody Debris >30 cm	Max Depth	Dominant Habitat	Habitat Composition Pool	Glide	Run	Riffle
Hayden	H1	78	3.7	290.6	17	1	60	26	0.8	Pool	60	15	20	5
	H2	53	7.8	413.4	16.5	0.75	12	7	0.4	Glide	0	80	15	5
	H3	123	6.9	846.2	14	2	15	4	1.0	Riffle	10	25	5	60
	H4	133	3.1	415.0	18	2.2	27	9	0.8	Run	30	0	40	30
	H5		5.9	0.0	16.5		8	9	0.7	Run	5	0	70	25
EF Hayden	EF1	61	2.8	167.8	12.5	4	5	4	0.3	Riffle	5	0	25	70
	EF2	107	3.4	361.7	16	8	6	20	0.7	Riffle	35	0	10	55
	EF3	64	4.1	265.0	14	4	19	13	0.5	Riffle	10	5	20	65
	EF4	115	4.8	552.0	14		30	19	0.7	Pool/Riffle	35	25	5	35
	EF5	104	3.7	383.8	12.5	2.25	19	4	0.6	Riffle	15	0	25	60
NF Hayden	NF1	95	3.9	372.4	12.5		4	7	0.4	Riffle	10	5	10	75
	NF2	65	4.5	290.9	15		20	7	0.8	Riffle	25	0	25	50
	NF3	125	3.7	465.0	16		11	7	0.8	Run	25	0	50	25
	NF4	146	2.9	426.3	15.5		15	8	0.5	Riffle	10	5	40	45
	NF5	93	3.4	311.6	12	2.75	39	20	0.8	Run	10	0	50	40
Yellow banks	Y1	115	3.0	342.1	15.5	1.5	15	16	0.6	Riffle	15	0	35	50
	Y2	112	3.0	332.6	15	3	24	12	0.3	Riffle	5	0	25	70
	Y3	69	3.0	209.3	13.5	2.5	5	6	0.5	Riffle	10	0	20	70
Nilsen	N1	43.5	1.3	58.0	15	0.3	15	3	0.5	Riffle	15	0	35	50
	N2	73	1.3	97.3	16	0.3	9	6	1.2	Run	15	0	65	20
	N3		<1		16					Riffle	5	0	15	80
Mokins	M1	85	2.3	198.3	16	0.5	23	13	0.5	Run	25	0	75	0
	M2	52	2.9	152.1	17	2.5			0.5	Riffle	30	0	10	60
	M3	87	2.8	240.1	16	2.5	8	3	0.3	Riffle	5	0	35	60
	M4	87	2.6	229.7	15.5	2	12	9	0.5	Riffle	20	0	20	60
	M5	50	2.9	145.0	14.5	3	3	7	0.3	Riffle	10	0	15	75

Table 55. Correlations (r) between trout densities (fish/100m2) and the habitat variable data collected from tributaries of Hayden Lake, Idaho, in 2007. Correlations shaded gray show where significant relationships occur (P<0.10).

Habitat Variable	Brook Density	Rainbow Density	Cutthroat Density
LWD	0.7063	0.1918	0.3688
Max Depth	0.2502	0.1487	0.5930
Gradient	0.3416	0.4464	0.3323
Temperature	0.4005	0.3209	0.1697
Width	0.1908	0.4597	0.5857
% Pool	[illegible]	-0.1406	-0.1233
% Glide	0.3111	0.5604	-0.2716
% Run	-0.0670	0.2231	0.2316
% Riffle	0.0094	0.0552	-0.0392

Table 56. Correlations (r) between trout densities (fish/100m2) collected from tributaries of Hayden Lake, Idaho, in 2007. No significant correlations (P<0.10) were evident.

	Brook Density	Rainbow Density	Cutthroat Density
Brook Density	-	0.2168	-0.3701
Rainbow Density	0.2168	-	-0.3742
Cutthroat Density	-0.3701	-0.3742	-

Table 57. Average density (fish/100 m2) of cutthroat trout and rainbow trout sampled from tributaries of the Little North Fork Clearwater River Butte Creek, Canyon Creek, Foehl Creek, and Sawtooth Creek in 2001 (DuPont et al. 2004), and electroshocking tributaries of Priest River including Tarlac and Tango Creeks in 2003-2004 (Dupont and Horner In press).

	Hayden Lake Tributaries						**Little North Fork Clearwater**				**Priest Basin**	
	Hayden	**E.Fork**	**N.Fork**	**Mokins**	**Nilsen**	**Yellowbanks**	**Butte**	**Canyon**	**Foehl**	**Sawtooth**	**Tarlac**	**Tango**
Cutthroat	1.9	5.8	4.8	48.9	208.2	17.5	13	0.1	0	1.4	21.3	11.6
Rainbow	5.2	1	2.7	0	0	0	0.1	1	1	0.5		

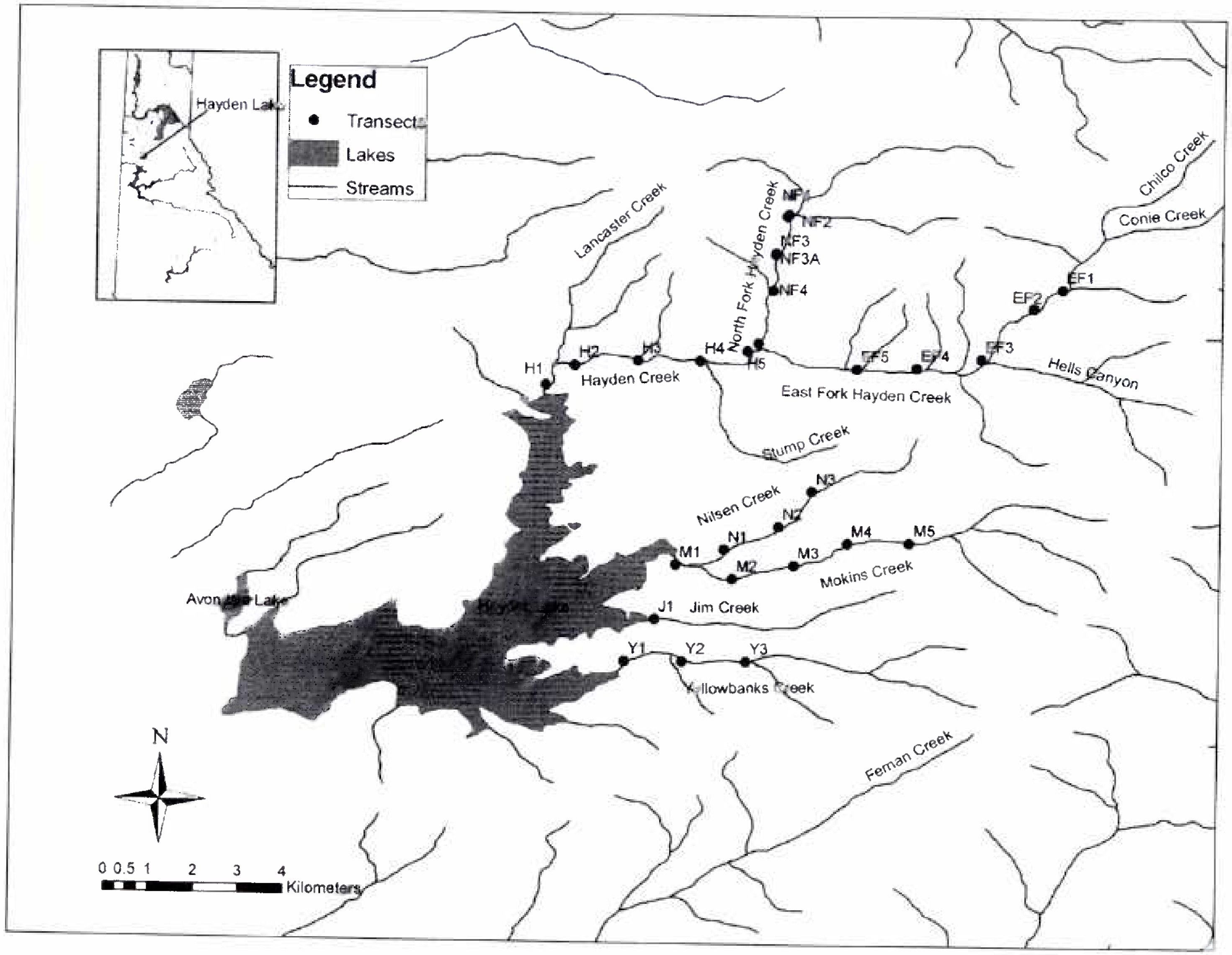

Figure 100. Transect locations on Hayden Lake, Idaho tributaries sampled by backpack electroshocking in July 2007.

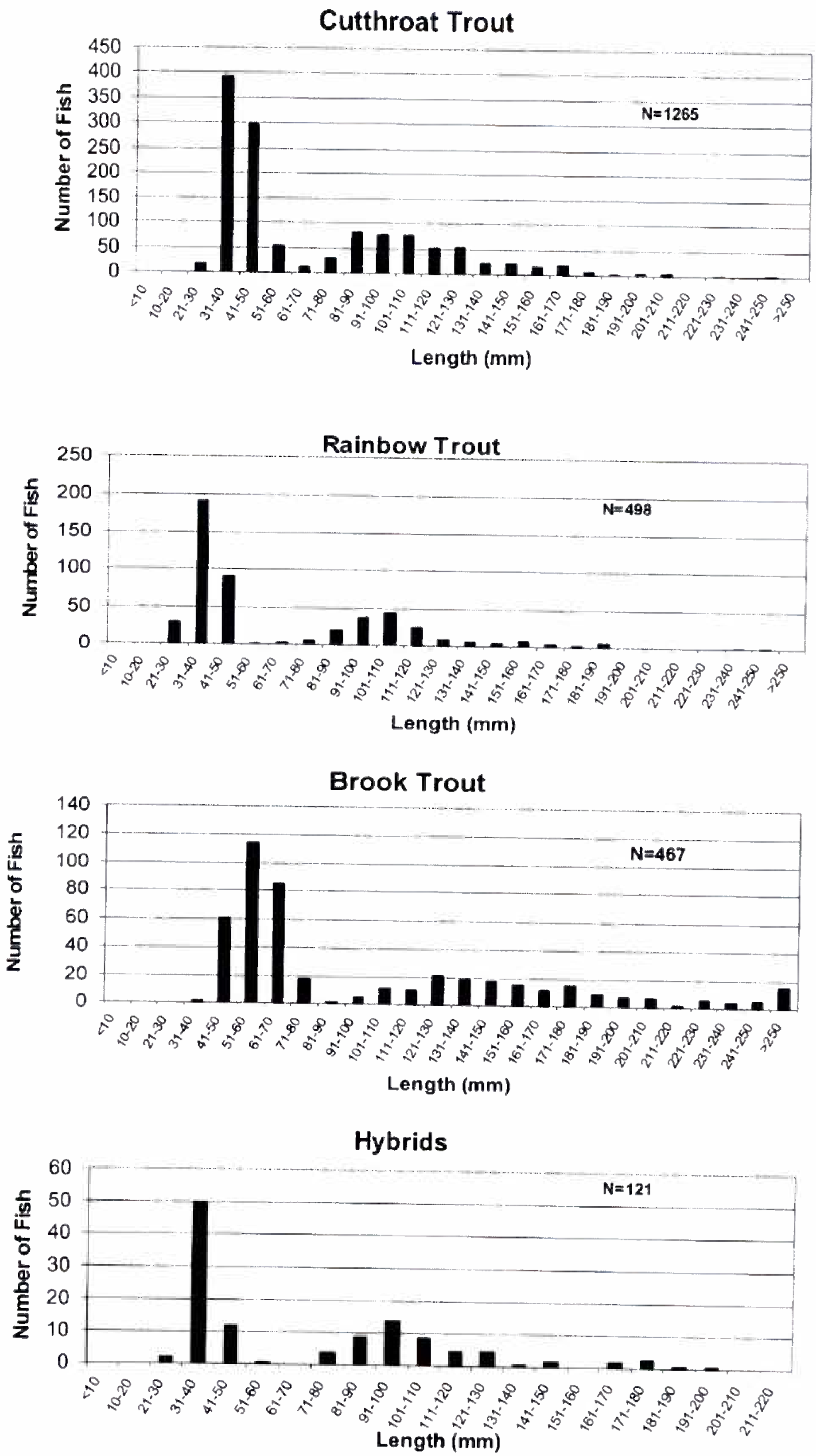

Figure 101. Length frequencies for fish captured while sampling tributaries of Hayden Lake, Idaho, in 2007.

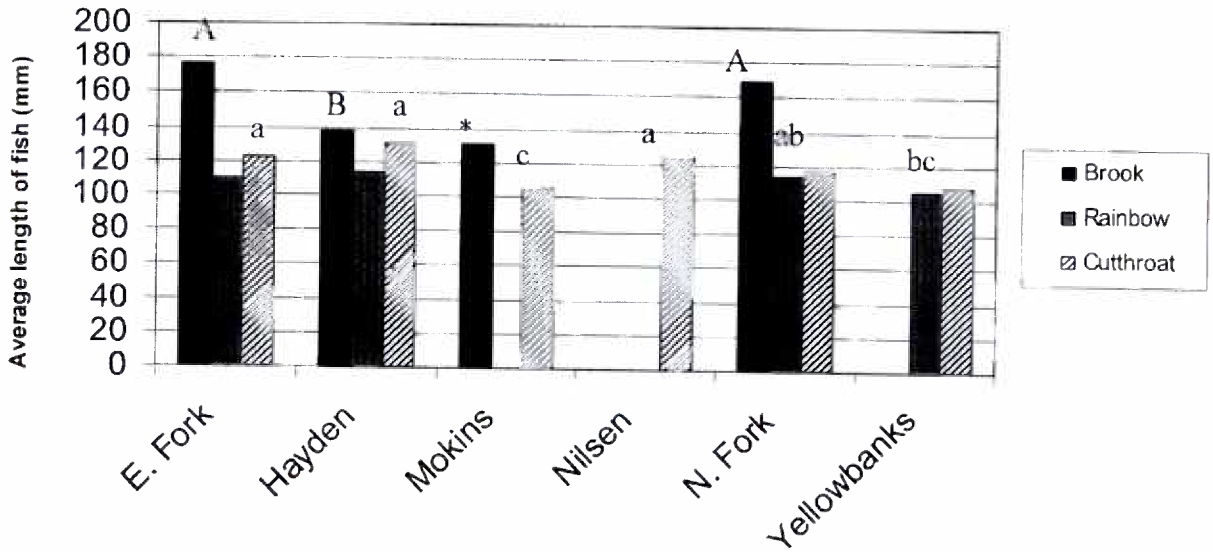

Figure 102. Average length of age-1+ fishes captured in tributaries of Hayden Lake, Idaho 2007. Columns with the same letter were not significantly different (P<0.1). *Only 2 brook trout were captured in Mokins Creek, which had high variability and was not included.

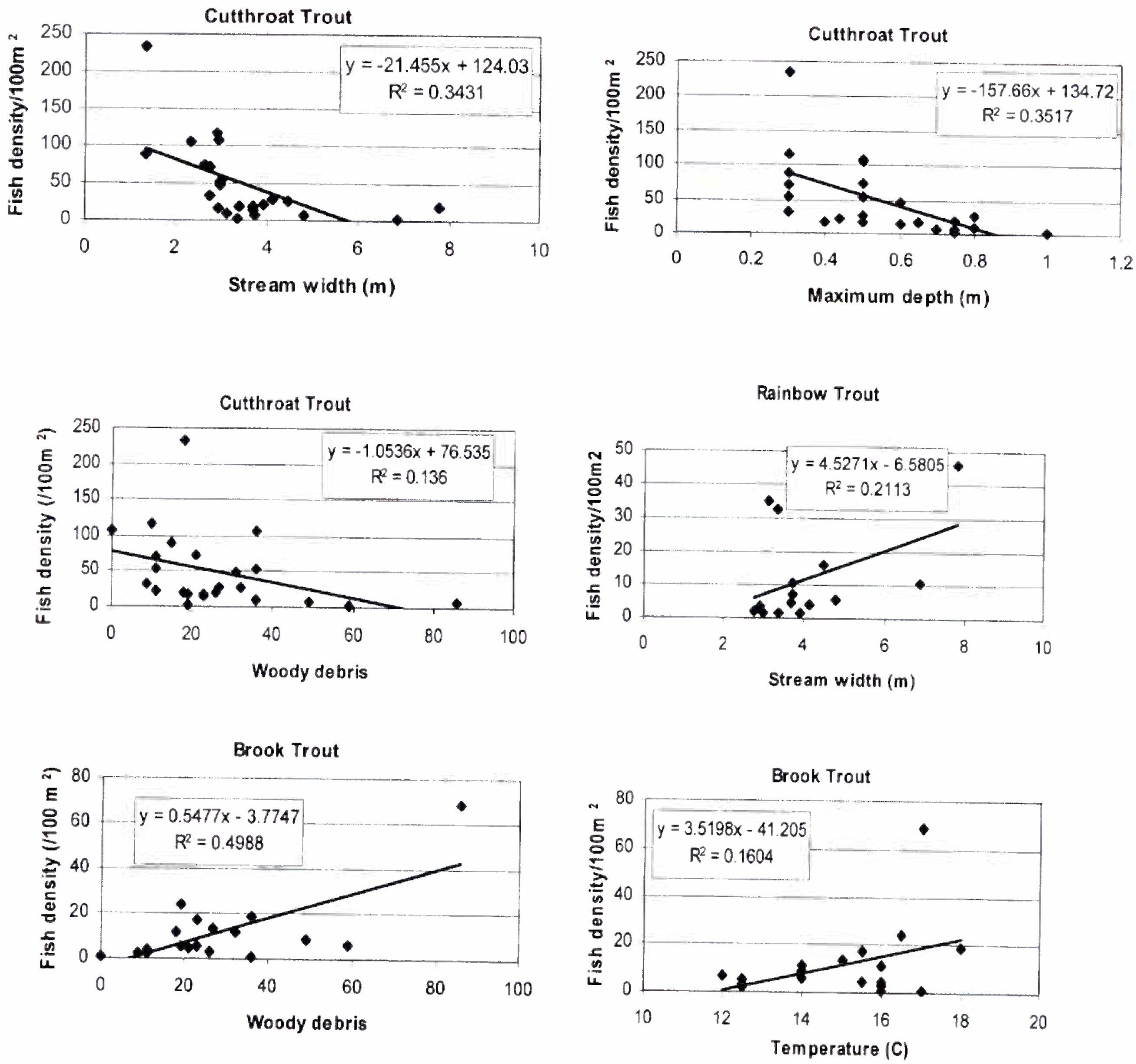

Figure 103. Linear regressions for habitat characteristics that were significantly correlated ($P<0.10$) with fish density for the three trout species captured in tributaries of Hayden Lake, Idaho, in 2007.

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Rivers and Streams Investigations

KEOKEE CREEK BROOK TROUT REMOVAL PROJECT

ABSTRACT

We conducted depletion electrofishing in Keokee Creek, a tributary of the Middle Fork East River, in 2005, 2006, and 2007, to remove an isolated brook trout population. The Middle Fork East River is the only tributary of Priest River known to support a population of bull trout. We captured brook trout, bull trout, and westslope cutthroat trout.

Abundance of brook trout was reduced over the 3 years of this study, whereas bull trout abundance increased slightly. The brook trout population estimate decreased from 346 for 2005, to 176 for 2006, and then to 39 for 2007. Brook trout depletion indicated that numbers after the first year of removal resulted in a remaining population of 75 fish; after the 2006 removal, 35 fish remained; and after 2007, 0 fish remained. Bull trout captured on the first pass increased slightly from 2006 (N=2) to 2007 (N=10) and were sampled higher in the creek in 2007 than in previous years.

Our stream temperature data suggested that throughout the summer months water temperatures in Keokee Creek remained within or below the thermal optimum (12 -16°C) for bull trout.

It is recommended that the brook trout population in Keokee Creek should be monitored again in 2009 and 2012 to evaluate the effectiveness of removal efforts. In addition, bull trout redd count surveys should be started in Keokee Creek as well as continue in the Middle Fork East River and Uleda Creek.

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INTRODUCTION

The Middle Fork East River (MFER) is the only tributary of Priest River (Figure 104) that is known to support a population of bull trout. This population was first reported in 1986 and was distributed throughout much of the MFER (Robertson and Horner 1987). Adults as large as 541 mm were sampled during this survey, indicating that at least a portion of the population had an adfluvial or fluvial life history. The MFER was electrofished in 2000 (Idaho Department of Lands 2000), 2001 (DuPont and Horner 2004, Rothrock 2003), and 2002 (DuPont and 2002) to evaluate the status of the fishery. Based on these findings, the bull trout population still exists, although its distribution appears to have diminished. Uleda Creek supported high densities of bull trout (>10 fish/100m^2), with adults as large as 700 mm in length (DuPont and Horner 2002).

MFER bull trout have a couple of attributes that make them unique as compared with other populations in the Idaho Panhandle. First, this population is relatively isolated. This population appears to use about 10 km of the MFER and its tributaries for spawning and rearing, and no other bull trout population is known to occur within 50 stream km of this population. Second, their life history includes a fluvial or adfluvial life history where the fish must swim downstream from a lake (either Lake Pend Oreille or Priest Lake) before they move upstream into the East River to spawn (Figure 104). Radio telemetry data found that fish migrated to either Lake Pend Oreille (N=4) or the Pend Oreille River (N=2) post-spawning, and overwintered in these waterbodies (DuPont et al. 2007). Three of these tagged fish returned to the East River the subsequent spring. These are traits unique to bull trout in the Pend Oreille River basin.

Bull trout redd counts have been conducted in the MFER drainage on an annual basis since 2001, although it is believed the first accurate counts occurred in 2003. Counts conducted in 2001 and 2002 overlapped with areas where brown trout *Salmo trutta* redds occurred and as a result numbers may have been skewed. Brown trout typically spawn lower in the MFER and in 2003 bull trout redd count transects were moved upstream of these areas. Redds were typically concentrated around and upstream of Uleda Creek on the MFER. In 2006, a total of 29 redds were counted above Uleda Creek, 20 of which were near and above Keokee Creek (DuPont and Horner 2002).

The MFER watershed has been managed intensively for timber for nearly a century. Road densities exceed 5 miles/mile^2; the main haul road parallels the MFER; and several historic clearcuts encompassed sections of the river as well as some of the major tributaries (Panhandle Bull Trout Technical Advisory Team 1998). Intensive timber management will continue in the watershed, although efforts are being made to close roads. The impact timber management has had on this bull trout population is unknown.

A barrier in Uleda Creek was removed in 2004 by the Idaho Department of Lands (funding provided by U.S. Fish and Wildlife Service), which increased the amount of bull trout spawning habitat in that tributary by 5 km. Four redds were counted above this barrier in 2004, and although none were counted in 2005, 2006, or 2007, this expansion in spawning habitat should result in population increases in the near future. Another partial barrier exists on the MFER above Uleda Creek; however, redds were counted above this barrier in 2006.

Robertson and Horner (1987) found that cutthroat trout was the second most abundant species in the lower Priest River drainage. Cutthroat trout densities were highest in the uppermost reach of the MFER (24.0 fish/100 m^2). Fish collected ranged from age-0 to age-3, and ranged in length from 39 - 217 mm.

The introduction and persistence of non-native brook trout in the MFER drainage may have impacted the bull trout population. The drainage supports a thriving 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 (out competed and/or hybridized with) from some of the tributaries. An isolated brook trout population was identified in Keokee Creek during a 2000 survey.

The bull trout population in the MFER has persisted despite habitat degradation and invasion by non-native species. Evaluating the distribution of fishes in Keokee Creek will aid in managing the MFER population, as well as provide some insight as to why this population has persisted and what can be done to ensure its longevity. We are optimistic that removing brook trout from Keokee Creek will reduce competition and/or hybridization among juveniles, may open additional spawning grounds to adult bull trout, and provide additional rearing areas for juvenile bull trout.

OBJECTIVES

1. Evaluate the influence of stream temperature on brook trout and bull trout distribution.
2. Remove an isolated brook trout population from Keokee Creek.

STUDY SITE

Keokee Creek is a major tributary of the MFER of Priest River, located in the Idaho Panhandle (Figure 104). The creek flows approximately 4 km from its headwaters to where it joins the MFER. The MFER 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 Avista Corporation is located at the mouth of Priest Lake and is a barrier to 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 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.

Keokee Creek ranges in elevation from 975 – 1,150 m and is characterized by relatively high gradient. Width of the creek averages 7 m with multiple, braided channels throughout the sampling reach. Keokee Creek and the uppermost reach of the MFER are entirely within land managed by the State of Idaho (Idaho Department of Lands). The riparian zone vegetation includes alder and mountain maple with mixed conifers higher upslope.

METHODS

We electrofished Keokee Creek in 2005, 2006, and 2007 from its mouth upstream until no fish were captured,. Electrofishing was conducted using a Smith-Root SR 15 backpack electrofisher and a 3 or 4-person crew. All fish were netted and counted and a representative number of fish lengths (mm) were collected during each year to develop a length frequency. 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).

In order to estimate densities, multiple days were sampled during each year with each day being considered a "pass". In 2005, we conducted six passes, in 2006 we conducted four passes, and in 2007 we conducted four passes. We used MicroFish 3.0 (Van Deventer and Platts 1985) to calculate a population estimate for each year. The population estimate for each species was divided by the area (m^2) of stream sampled, resulting in an estimated density.

To determine if water temperature was affecting the distribution of bull trout and brook trout, we used data loggers (Optic Stowaway) to record temperatures hourly at several locations. In 2005, two data loggers were located in the MFER, two in Keokee Creek, and one in Uleda Creek. Data was available from Keokee Creek from two loggers in 2006 and three in 2007. We placed temperature loggers on the shaded stream bottom where the stream would flow year round. In addition, the loggers were housed in 50 mm sections of 32 mm (1 ¼ in) copper pipe to protect them from debris and moving substrate.

Fish ages were estimated through the use of length frequency analysis by assigning ages-to-length categories.

RESULTS

We captured fish species including Westslope cutthroat trout, bull trout, brook trout, and sculpin in Keokee Creek. In addition, we captured one brook trout x bull trout hybrid in 2005. Cutthroat trout was the most abundant species during each year of sampling (Table 58). Numbers of bull trout and cutthroat trout captured on the first pass of each year increased on subsequent years, whereas numbers of brook trout decreased (Figure 105).

The brook trout population estimate in Keokee Creek decreased from 346 in 2005, to 176 in 2006, and then to 39 in 2007. The depletion indicated that numbers after the first year of removal resulted in a remaining population of 75 fish, after 2006 sampling 35 fish remained, and after 2007, 0 fish remained (Figure 106). Bull trout numbers increased slightly from 2006 to 2007 and were sampled higher in the creek in 2007 than in previous years. The number of bull trout captured on the first pass increased from 1 fish in 2005, to 2 fish in 2006, and 10 fish in 2007. Bull trout redd counts reached their highest levels since they were implemented in 2006, and were reduced by more than half in 2007 (Figure 107; Table 59). Redd counts were lower throughout the Priest River basin as well as the Lake Pend Oreille basin in 2007, compared with 2006. Similar to bull trout, the number of cutthroat trout captured also increased from 2005 to

2007. During the first pass in 2005, a total of 289 fish was captured, in 2006, a total of 386 was captured, and in 2007 a total of 597 fish was captured.

The majority of fishes captured were age-0, age-1, and age-2, with few age-3 fish. Average length of bull trout was 115 mm (N=13), with a range of 98 - 141 mm. None of the bull trout captured were older than age-2. Only four brook trout that were measured were estimated at age-3+ and few cutthroat trout were age-3+. The majority of brook trout captured were age-1 and age-2 fish with few age-0 fish.

Maximum weekly temperatures in the upper MFER and Keokee Creek in 2006 and 2007 ranged between 6°C and 14°C from June through September (Figure 6). In 2005, temperatures were taken in Keokee Creek as well as the MFER near Uleda Creek. In 2005, temperatures in Keokee Creek were similar to those in the MFER downstream of the Uleda Creek confluence. However, maximum daily temperatures in Uleda Creek and in the MFER upstream of the confluence were lower than Keokee Creek. In 2006 and 2007, the highest maximum daily temperature (14.28°C and 14.29°C) of Keokee Creek exceeded that in 2005 (12.6°C).

DISCUSSION

Efforts to reduce brook trout densities in Keokee Creek appear to have been successful after three years of removal. Densities of brook trout were reduced more than seven fold in this tributary. Brook trout removal efforts in streams have also proven effective in increasing bull trout populations where simple stream habitat occurs (Buktenica 2000). A study of three small Rocky Mountain streams showed that densities of brook trout were reduced from 11.3 to 0.6 fish/100 m^2 in Nameless Creek, from 3.4 to 0.3 fish/100 m2 in Nylander Creek, and from 2.3 to 0.2 in Irene Creek, following 3-pass depletion-removal electrofishing (Thompson and Rahel 1996). These streams had barriers in place and after 1-2 years following removal, recruitment was reported as being virtually nonexistent. An important thing to remember, however, is that complete removal of brook trout in streams is almost impossible without the use of ichthyocides, extensive long-term electrofishing removal efforts (Greswell 1991, Thompson and Rahel 1996, Buktenica 2000), and/or construction of a barrier (Thompson and Rahel 1998).

During our removal efforts, age-0 fish were not captured as effectively as age-1+ fish. After the first year of removal efforts in 2005 we saw a noticeable increase in the numbers of age-1 fish which likely indicates that we missed these individuals as age-0 fish, yet were able to capture them the following year. Thompson and Rahel (1996) similarly reported that age-0 fish were not captured as effectively as larger fish, particularly in streams with extensive overhanging cover and woody debris.

In 2007, bull trout redd counts in the MFER sharply decreased from previous years. In 2006, 20 redds were reported above Keokee Creek in the MFER in 2006 while only one redd was reported in this section in 2007. This sharp reduction in redd numbers was also seen, however, throughout the Lake Pend Oreille basin indicating that this decrease was not specific to the MFER population and that other factors such as poor counting conditions may have been responsible throughout the basin. Since no redds have been counted in Keokee Creek in the past, it is difficult to speculate if these fish are juveniles spawned in the MFER and are seeking thermal refuge at the lower end of the stream or if they were juveniles that were spawned in Keokee Creek.

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 third week of July in both 2006 and 2007. In 2002, stream reaches in the MFER with the highest densities of brook trout had the warmest water temperatures (DuPont and Horner In press a). 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). In Uleda Creek, which does not support brook trout, average daily temperature did not exceed 10°C. DuPont et al. (2002) reported that surrounding streams had daily average water temperatures only 1°C warmer than Uleda Creek, and brook trout were present. Tarlac Creek, which had temperatures about 1°C warmer than Uleda Creek, was dominated by bull trout in 1986, yet in 2002 had only brook trout. Other factors such as stream gradient, size and habitat condition may also have an influence in species distribution.

MANAGEMENT RECOMMENDATIONS

1. Conduct one pass electrofishing in 2009 on all surveyed tributaries to assess presence/absence of fish species.
2. Repeat sampling efforts again in 2012 to develop a trend set of information.
3. Annually conduct redd count surveys above Keokee Creek.

Table 58. Total number of fish captured during 3 years of sampling in Keokee Creek, Idaho.

	BRK	BLT	WCT	Total
2005	271	5	1,111	**1,387**
2006	141	5	1,365	**1,511**
2007	39	17	1,462	**1,518**
	451	**27**	**3,938**	**4,416**

Table 59 . Bull trout redd count data for the Middle Fork East River (MFER) and Uleda Creek, Idaho from 2001-2007.

	2001	2002	2003	2004	2005	2006	2007
MFER	4	8	21	20	48	71	34
Uleda	3	4	3	7	4	7	2

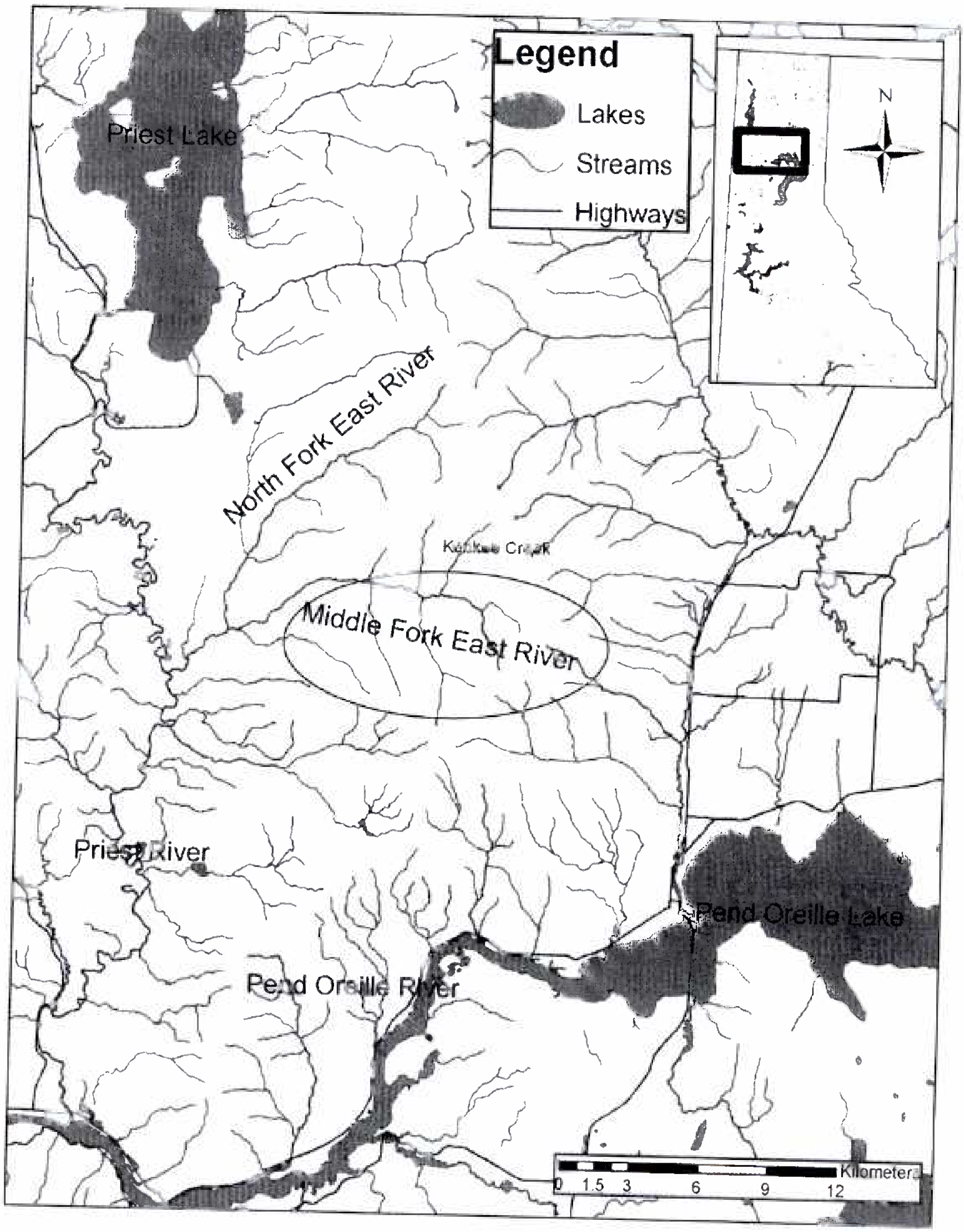


Figure 104. Map showing the Middle Fork East River and Keokee Creek, Idaho.

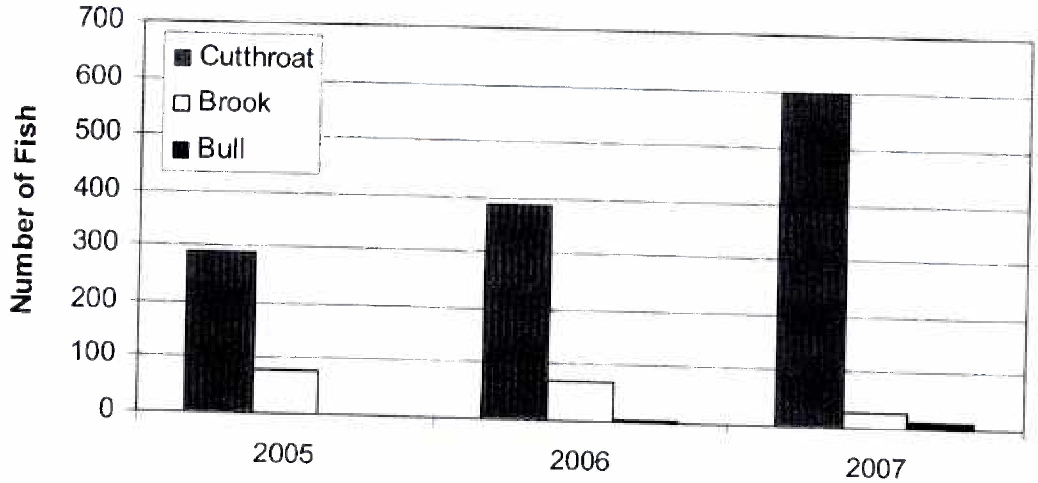


Figure 105. Number of fish captured on the first pass during 2005, 2006, and 2007, in Keokee Creek, Idaho.

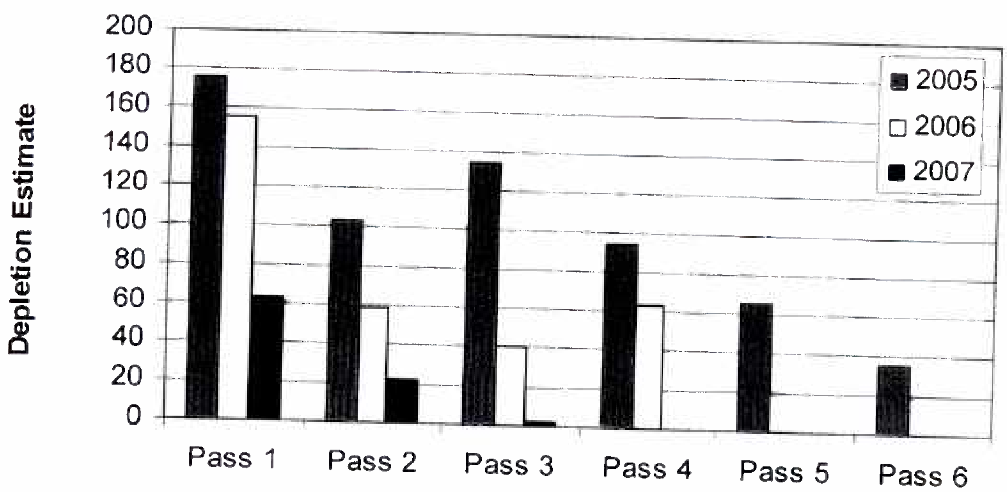


Figure 106. Brook trout depletion estimate (population estimate-number removed) by pass for 2005, 2006, and 2007 sampling in Keokee Creek, Idaho. Only 4 passes were conducted in 2006 and 3 passes were conducted in 2007.

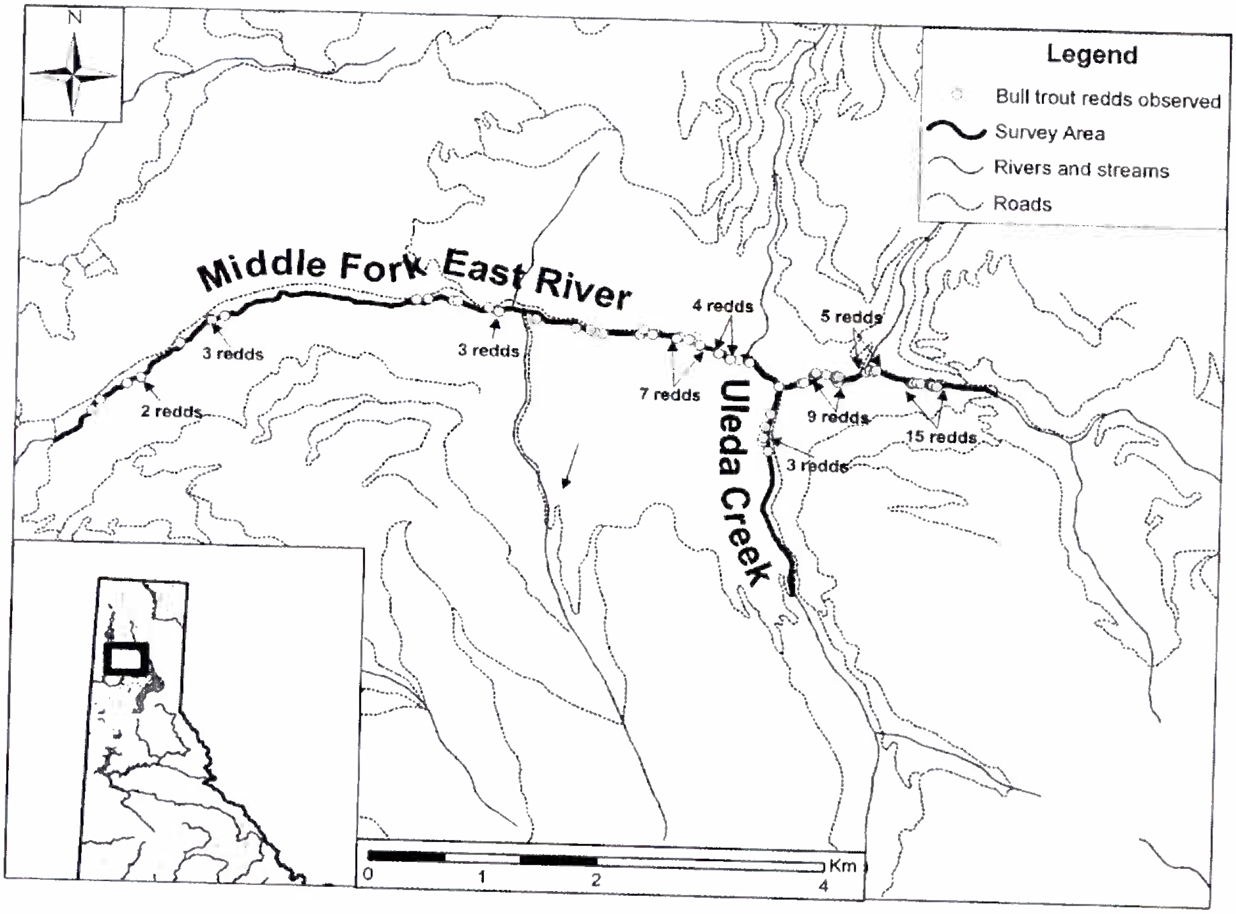


Figure 107. Stream reaches surveyed for bull trout redds in the Middle Fork East River basin, Idaho, on October 3, 2006, and the locations of where redds were observed.

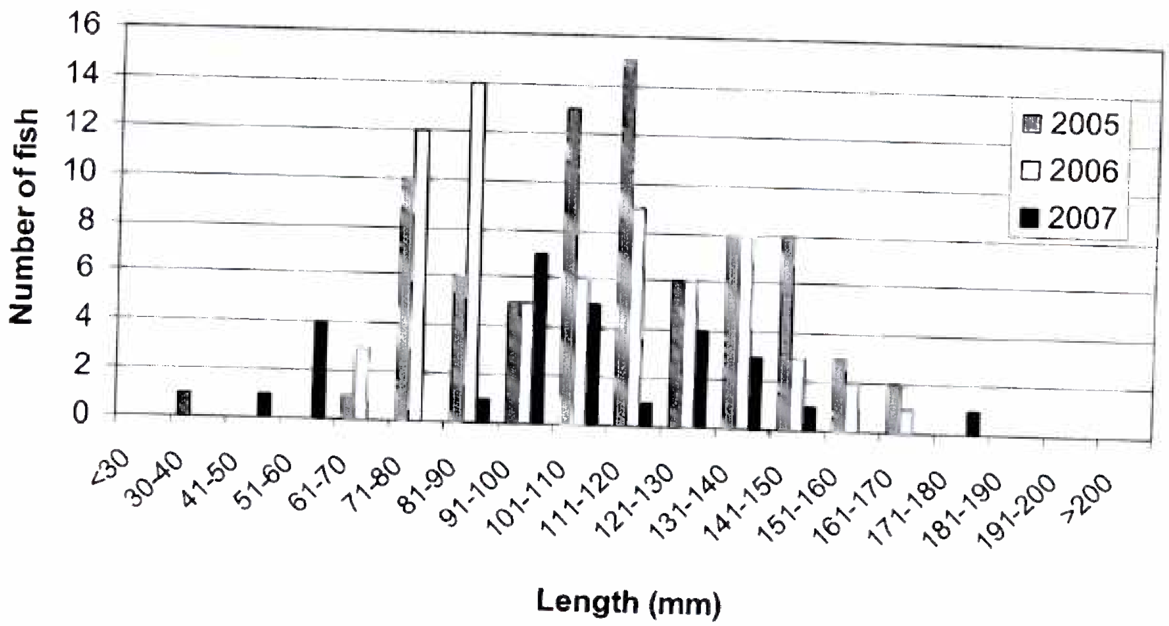


Figure 108. Brook trout length frequencies for fish captured in Keokee Creek, Idaho in 2005, 2006 and 2007.

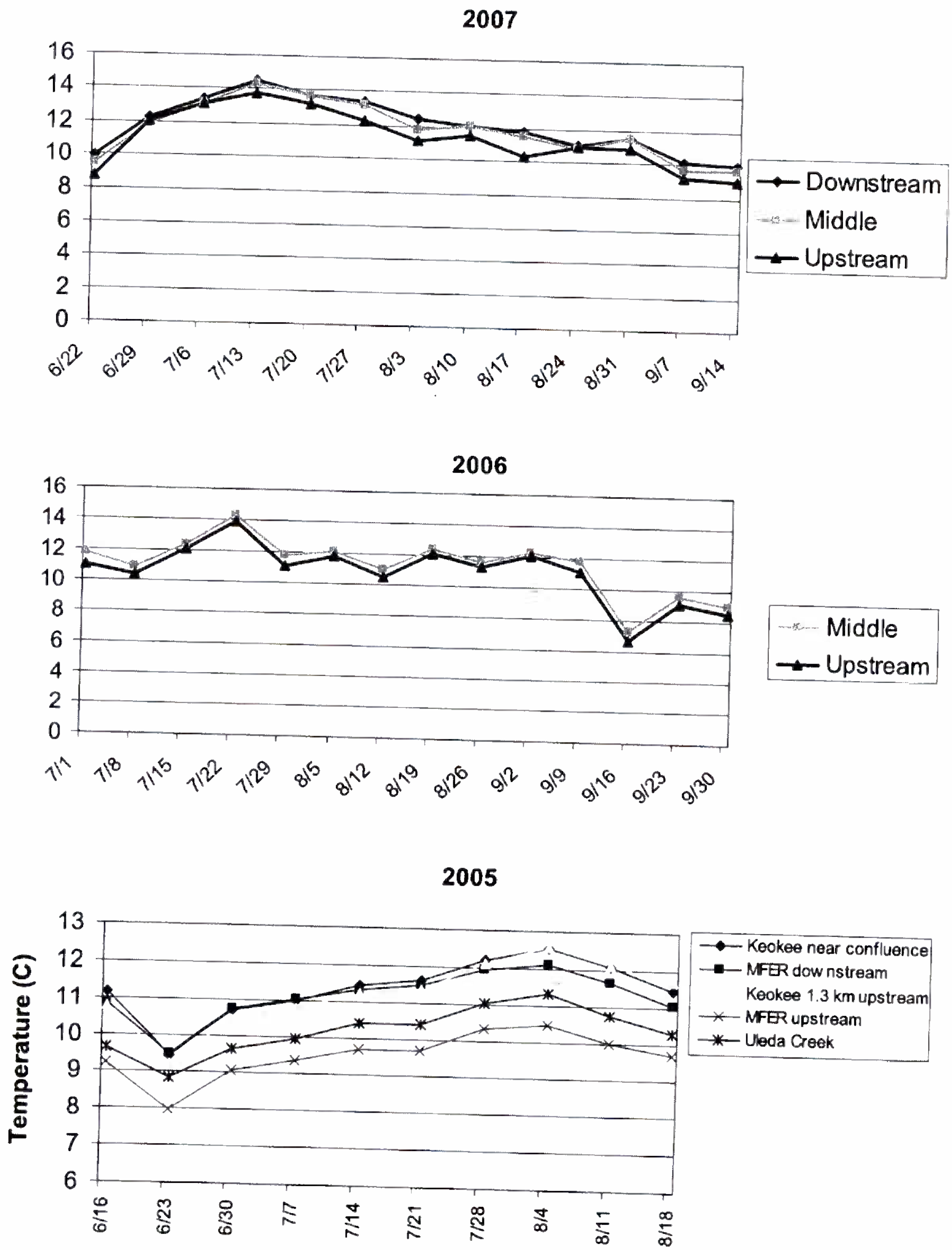


Figure 109. Maximum weekly temperatures in the Middle Fork East River, Idaho, in 2005, 2006, and 2007. In 2006 and 2007, temperature logger data were available only in Keokee Creek (info from Idaho Dept. of Lands).

APPENDICES

Appendix A. Global Position System coordinates for snorkel sites in the St. Joe River and Coeur d'Alene River, Idaho. The coordinates are projected in latitude and longitude (decimal degrees) and the map datum is WGS 84.

St Joe River

Transect	Latitude	Longitude	Elevation
SJ01	47.2472	-115.76361	2537 ft
SJ02	47.22851	-115.71101	2613 ft
SJ03	47.22973	-115.69761	2677 ft
SJ04	47.22953	-115.69646	2680 ft
SJ05	47.23679	-115.67049	2665 ft
SJ06	47.23696	-115.64747	2698 ft
SJ07	47.23684	-115.63568	2717 ft
SJ08	47.22476	-115.60712	2797 ft
SJ09	47.23052	-115.59349	2825 ft
SJ10	47.22829	-115.59755	2830 ft
SJ11	47.22700	-115.59546	2835 ft
SJ12	47.22784	-115.58518	2845 ft
SJ13	47.20284	-115.54343	2948 ft
SJ14	47.20161	-115.51797	3027 ft
SJ15	47.18574	-115.48228	3101 ft
SJ16	47.17581	-115.45828	3157 ft
SJ17	47.17174	-115.44646	3220 ft
SJ18	47.15175	-115.40846	3375 ft
SJ19	47.13305	-115.40128	3408 ft
SJ20	47.09328	-115.38104	3697 ft
SJ21	47.07837	-115.35590	3725 ft
SJ22	47.05936	-115.35289	3755 ft
SJ23	47.03062	-115.35181	3819 ft
SJ24	47.03112	-115.35331	3822 ft
SJ25	47.03141	-115.35599	3829 ft
SJ26	46.99107	-115.37104	3918 ft
SJ27	46.98897	-115.36867	3925 ft
SJ28	46.98285	-115.36786	3940 ft
SJ29	47.27022	-116.19787	2125 ft
SJ30	47.26646	-116.09424	2254 ft
SJ31	47.25411	-116.05178	2274 ft
SJ32	47.25033	-116.01289	2175 ft
SJ33	47.24777	-115.95837	2248 ft
SJ34	47.25627	-115.87234	2363 ft
SJ35	47.25058	-115.79831	2499 ft

APPENDIX B. DATA SHEET

Data sheet used when collecting information during snorkel surveys in the St. Joe River and Coeur d'Alene River, Idaho, during 2007.

IDFG Snorkel Data

Stream: ____________________ **Transect Name/Number**: ____________________

Date: ________ Time: ________ Temperature: ______ Visibility: __________ GPS Datum: __________

Observers: ____________________ No. of Snorkelers: ______ GPS Coord: (Easting) __________

(Northing) __________

Habitat Type: Pool, Riffle, Run, Glide, Pocket Water Max Depth (m): ______ Dominant Cover / % surface area: __________

Stream Length (m): __________ Stream Width (m): __________

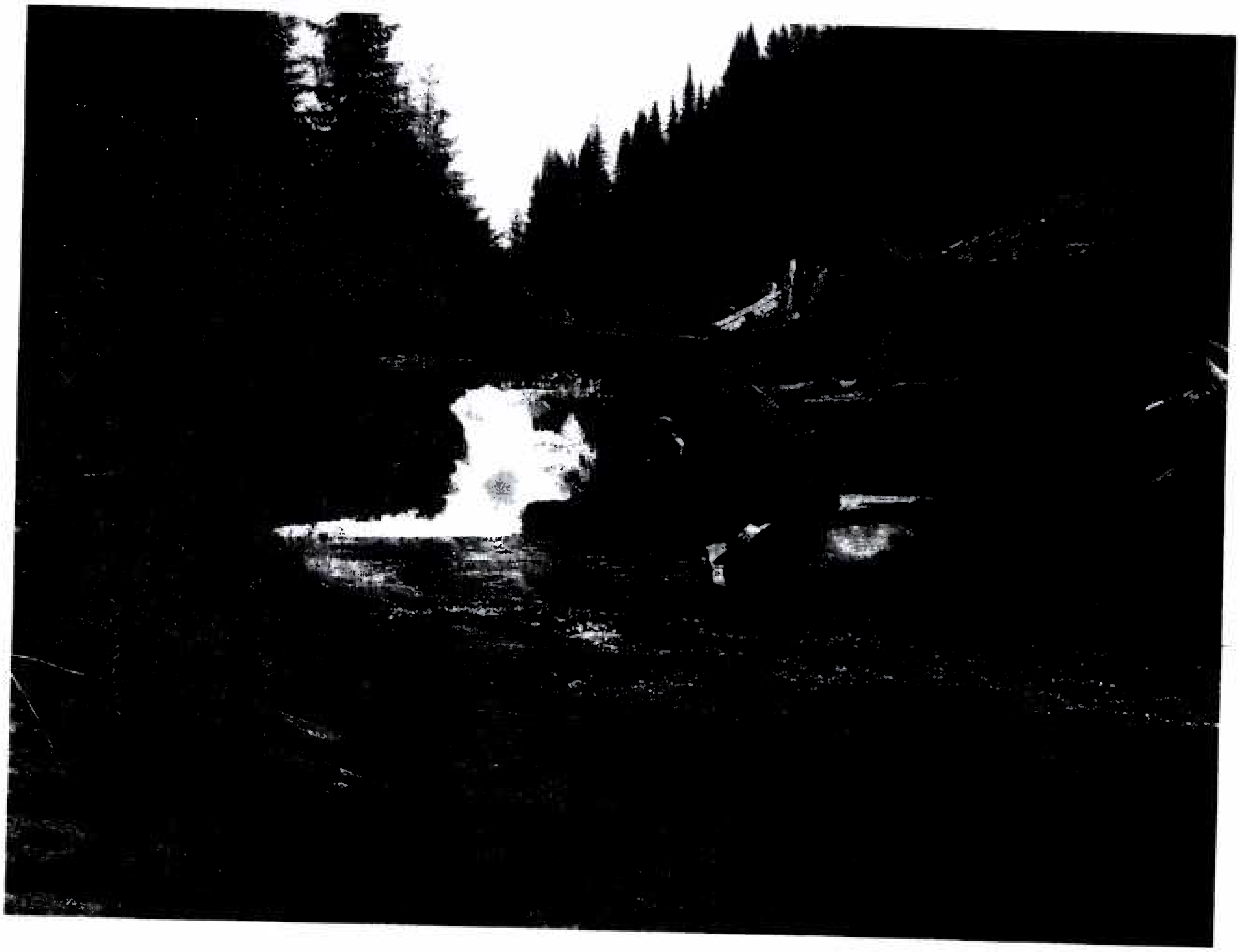
Comments: ____________________

Length	WCT 1	WCT 2	RBT 1	RBT 2	BLT 1	BLT 2	BRK 1	BRK 2	MWF 1	MWF 2	LSS 1	LSS 2	NPM 1	NPM 2	Other
<3"															
3"-6"															
6"-9"															
9"-12"															
12"-15"															
15"-18"															
18"-21"															
>21"															
Total															

Abbreviations: **WCT** = Westslope Cutthroat Trout; **RBT** = Rainbow Trout; **BLT** = Bull Trout; **BRK** = Brook Trout; **MWF** = Mountain Whitefish
MWF = Mountain Whitefish; **LSS** = Large Scale Sucker; **NPM** = Northern Pike Minnow; **RSS** = Redside Shiner; **LND** = Long Nose Dace.

Cover Types: **LWD** (large woody debris > 4"), **SWD** (small woody debris < 4")' **LS** (large substrate), **UB** (undercut banks), **OC** (ovehead cover)

APPENDIX C.

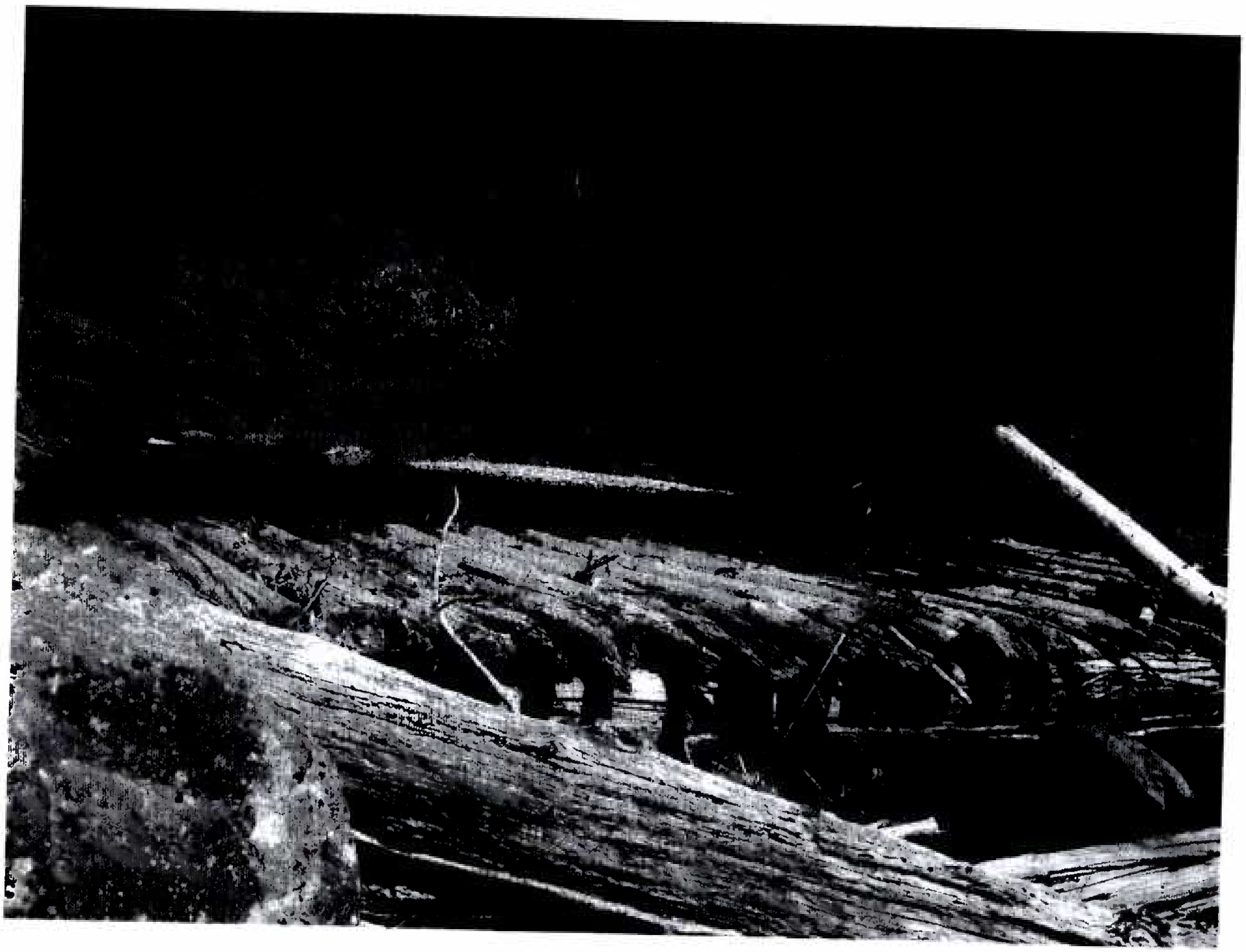


Looking upstream at Splash Dam 2 in Marble Creek, Idaho, on July 27, 2007.

APPENDIX D.

Looking upstream at Splash Dam 3 in Marble Creek, Idaho, on July 27 2007.

Appendix D (continued).



A top view of Splash Dam 3, looking upstream in Marble Creek, Idaho, on July 27 2007.

APPENDIX E.

View of Falls 1 in Marble Creek, Idaho on July 23, 2007.

Appendix F. Data sheets used to collect fish and habitat data at snorkel sites in side channels along the North Fork Coeur d'Alene River, Idaho during 2007.

N.F. Coeur d'Alene River Side Channel Study - Snorkel Data

Side channel: ____________________ **Reach Number:** ____________________

Observers: ____________________ No. of Snorkelers: ______ GPS Datum: ____________________
____________________ GPS Coord: (Easting) ____________________
(Northing) ____________________

Length	WCT		RBT		BLT		BRK		MWF		LSS		NPM		Other
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
<3"															
3"-6"															
6"-9"															
9"-12"															
12"-15"															
15"-18"															
18"-21"															
>21"															
Total															

Abbreviations: **WCT** = Westslope Cutthroat Trout; **RBT** = Rainbow Trout; **BLT** = Bull Trout; **BRK** = Brook Trout; **MWF** = Mountain Whitefish
MWF = Mountain Whitefish; **LSS** = Large Scale Sucker; **NPM** = Northern Pike Minnow; **RSS** = Redside Shiner; **LND** = Long Nose Dace.

Comments: ____________________

N.F. Coeur d'Alene River Side Channel Study - Habitat Data

Side Channel: ____________ **Reach Number:** ____________ **Photo ID:** ____________

Date:________ Time:________ Temperature: ________ (surface) ________ (bottom) Visibility:________

Habitat composition (%): ______ (Pool) ______ (Glide) ______ (Run) ______ (Riffle) Max depth (m):________ Percent aquatic veg:________

Length snorkeled (m): ________ Stream Width (m): ______ ______ ______ ______ ______ ______

Cover (%): ______ (Total coverage) ______ (Large wood) ______ (Small wood) ______ (Large substrate) ______ (Undercut bank) ______ (Overhead cover) ______ (Other)

Substrate composition (%): ______ (fines; < 2mm) ______ (gravel; 2-64 mm) ______ (cobble; 64-256 mm) ______ (boulder; > 256 mm) ______ (bedrock)

Flow into side channel

Depth										
Width										
Velocity (60%) < 0.75 m										
Velocity (20%) > 0.75 m										
Velocity (80%) > 0.75 m										
	1	2	3	4	5	6	7	8	9	10

Flow from tributary

Tributary temp:________ Side channel Temp (above):________ Side channel Temp (below):________

Depth										
Width										
Velocity (60%) < 0.75 m										
Velocity (20%) > 0.75 m										
Velocity (80%) > 0.75 m										
	1	2	3	4	5	6	7	8	9	10

Flow at snorkel site

Depth										
Width										
Velocity (60%) < 0.75 m										
Velocity (20%) > 0.75 m										
Velocity (80%) > 0.75 m										
	1	2	3	4	5	6	7	8	9	10

Appendix G. Data sheets used to characterize the habitat in side channels along the North Fork Coeur d'Alene River, Idaho, during 2007.

N.F. Coeur d'Alene Side Channel Study - Habitat Inventory

Side channel: ____________________ **Photo ID at mouth:** ____________________

Date: ____________ Observers: ______________________________

For channels < 8 m wide don't fill out 1/4 and 3/4 intervals

Transcect ___: Length from mouth: ________
GPS **E:** ____________ **N:** ____________

Left Bank	1/4 interval	Stream Center	3/4 interval	Right Bank

Dominant veg: ____________________ Avg height ______
Habitat type : ____________________

Max Depth (m): ________ Width (m): ________
Temp - bottom (°C): ________ Time: ________
Substrate

	(fine)	(sand)	(cob)	(bld)	(bed)
bottom:	____	____	____	____	____
bank-river:	____	____	____	____	____
bank-op:	____	____	____	____	____

Transect ___: Length from mouth: ________
GPS **E:** ____________ **N:** ____________

Left Bank	1/4 interval	Stream Center	3/4 interval	Right Bank

Dominant veg: ____________________ Avg height ______
Habitat type : ____________________

Max Depth (m): ________ Width (m): ________
Temp - bottom (°C): ________ Time: ________
Substrate

	(fine)	(sand)	(cob)	(bld)	(bed)
bottom:	____	____	____	____	____
bank-river:	____	____	____	____	____
bank-op:	____	____	____	____	____

Transect ___: Length from mouth: ________
GPS **E:** ____________ **N:** ____________

Left Bank	1/4 interval	Stream Center	3/4 interval	Right Bank

Dominant veg: ____________________ Avg height ______
Habitat type : ____________________

Max Depth (m): ________ Width (m): ________
Temp - bottom (°C): ________ Time: ________
Substrate

	(fine)	(sand)	(cob)	(bld)	(bed)
bottom:	____	____	____	____	____
bank-river:	____	____	____	____	____
bank-op:	____	____	____	____	____

Transect ___: Length from mouth: ________
GPS **E:** ____________ **N:** ____________

Left Bank	1/4 interval	Stream Center	3/4 interval	Right Bank

Dominant veg: ____________________ Avg height ______
Habitat type : ____________________

Max Depth (m): ________ Width (m): ________
Temp - bottom (°C): ________ Time: ________
Substrate

	(fine)	(sand)	(cob)	(bld)	(bed)
bottom:	____	____	____	____	____
bank-river:	____	____	____	____	____
bank-op:	____	____	____	____	____

Transect ___: Length from mouth: ________
GPS **E:** ____________ **N:** ____________

Left Bank	1/4 interval	Stream Center	3/4 interval	Right Bank

Dominant veg: ____________________ Avg height ______
Habitat type : ____________________

Max Depth (m): ________ Width (m): ________
Temp - bottom (°C): ________ Time: ________
Substrate

	(fine)	(sand)	(cob)	(bld)	(bed)
bottom:	____	____	____	____	____
bank-river:	____	____	____	____	____
bank-op:	____	____	____	____	____

Comments ______________________________

Appendix H. Stocking history for cutthroat trout and rainbow trout in Hayden Creek, Idaho.

Year	Species Type	Size	Number Stocked
1968	Cutthroat	Fry (0-3 Inches)	20,736
1970	Cutthroat	Fry (0-3 Inches)	36,382
1971	Cutthroat	Fry (0-3 Inches)	20,592
1972	Cutthroat	Fry (0-3 Inches)	13,900
1977	Cutthroat	Fingerling (3-6 Inches)	30,000
1978	Cutthroat	Fingerling (3-6 Inches)	48,832
1979	Cutthroat	Fingerling (3-6 Inches)	53,846
1980	Cutthroat	Fingerling (3-6 Inches)	12,432
1981	Cutthroat	Fingerling (3-6 Inches)	134,243
1986	Westslope Cutthroat	Fingerling (3-6 Inches)	49,725
1988	Westslope Cutthroat	Fingerling (3-6 Inches)	65,971
1997	Westslope Cutthroat	Fry (0-3 Inches)	100,950
1998	Westslope Cutthroat	Fry (0-3 Inches)	136,964
1999	Westslope Cutthroat	Fingerling (3-6 Inches)	11,555
2000	Westslope Cutthroat	Adults	595
			736,723

Year	Species Type	Size	Number Stocked
1968	Unspecified Rainbow	Fry (0-3 Inches)	19,800
1969	Unspecified Rainbow	Fry (0-3 Inches)	20,216
1980	Rainbow X Cutthroat	Fry (0-3 Inches)	389,490
1981	Unspecified Rainbow	Fry (0-3 Inches)	111,000
1981	Unspecified Rainbow	Fry (0-3 Inches)	63,000
1989	Domestic Kamloops	Fry (0-3 Inches)	14,847
1997	Domestic Kamloops	Fingerling (3-6 Inches)	1,336
			619,689

Appendix I. Stocking history for cutthroat trout and rainbow trout in Hayden Lake, Idaho.

Year	Species Type	Size	Number Stocked
1969	Cutthroat	Fry (0-3 Inches)	26,572
1978	Cutthroat	Catchable (6 Inches+)	742
1978	Cutthroat	Fingerling (3-6 Inches)	3,915
1979	Cutthroat	Adults	300
1981	Cutthroat	Fingerling (3-6 Inches)	529
1982	Westslope Cutthroat	Fingerling (3-6 Inches)	83,945
1983	Westslope Cutthroat	Fingerling (3-6 Inches)	42,256
1987	Westslope Cutthroat	Fingerling (3-6 Inches)	40,040
1988	Westslope Cutthroat	Fingerling (3-6 Inches)	23,490
1989	Westslope Cutthroat	Fingerling (3-6 Inches)	189,293
1990	Westslope Cutthroat	Fingerling (3-6 Inches)	116,608
1991	Westslope Cutthroat	Fingerling (3-6 Inches)	162,005
1992	Westslope Cutthroat	Fry (0-3 Inches)	107,480
1992	Westslope Cutthroat	Fingerling (3-6 Inches)	81,630
1993	Westslope Cutthroat	Fingerling (3-6 Inches)	99,998
1994	Westslope Cutthroat	Fingerling (3-6 Inches)	200,409
1995	Westslope Cutthroat	Fingerling (3-6 Inches)	100,732
1996	Westslope Cutthroat	Fingerling (3-6 Inches)	100,028
1996	Westslope Cutthroat	Catchable (6 Inches+)	5,477
1997	Westslope Cutthroat	Fingerling (3-6 Inches)	100,122
1998	Westslope Cutthroat	Fingerling (3-6 Inches)	27,313
1999	Westslope Cutthroat	Fingerling (3-6 Inches)	168,063
1999	Westslope Cutthroat	Catchable (6 Inches+)	12,600
2000	Westslope Cutthroat	Fingerling (3-6 Inches)	106,250
2002	Westslope Cutthroat	Fingerling (3-6 Inches)	163,004
2003	Westslope Cutthroat	Fingerling (3-6 Inches)	123,277
2004	Westslope Cutthroat	Fingerling (3-6 Inches)	98,872
2005	Westslope Cutthroat	Fingerling (3-6 Inches)	93,480
2006	Westslope Cutthroat	Fingerling (3-6 Inches)	64,837
2007	Westslope Cutthroat	Fingerling (3-6 Inches)	83,752
			2,427,019

Year	Species Type	Size	Number Stocked
1968	Unspecified Rainbow	Catchable (6 Inches+)	15,120
1969	Unspecified Rainbow	Catchable (6 Inches+)	16,380
1970	Unspecified Rainbow	Catchable (6 Inches+)	16,050
1971	Unspecified Rainbow	Catchable (6 Inches+)	18,840
1972	Unspecified Rainbow	Adults	2,880
1972	Unspecified Rainbow	Catchable (6 Inches+)	11,515
1973	Unspecified Rainbow	Catchable (6 Inches+)	14,750
1974	Unspecified Rainbow	Catchable (6 Inches+)	5,758
1975	Unspecified Rainbow	Catchable (6 Inches+)	4,800
1976	Unspecified Rainbow	Catchable (6 Inches+)	8,800
1983	Domestic Kamloops	Fingerling (3-6 Inches)	228,040
1984	Domestic Kamloops	Fingerling (3-6 Inches)	260,400

Appendix I (cont.)

Year	Species Type	Size	Number Stocked
1985	Domestic Kamloops	Fingerling (3-6 Inches)	168,135
1986	Domestic Kamloops	Fingerling (3-6 Inches)	158,625
1986	Wild Kamloops	Fingerling (3-6 Inches)	25,335
1987	Mt Lassen Rainbow	Fingerling (3-6 Inches)	50,000
1987	Domestic Kamloops	Fingerling (3-6 Inches)	316,839
1988	Domestic Kamloops	Fingerling (3-6 Inches)	95,700
1988	Domestic Kamloops	Fry (0-3 Inches)	12,404
1989	Domestic Kamloops	Fingerling (3-6 Inches)	32,760
1989	Wild Kamloops	Fingerling (3-6 Inches)	230,850
1989	Mt Lassen Rainbow	Fingerling (3-6 Inches)	6,930
1989	Domestic Kamloops	Fry (0-3 Inches)	42,989
1989	Eagle Lake Rainbow	Fry (0-3 Inches)	143,850
1989	Mt Shasta Rainbow	Fry (0-3 Inches)	57,858
1989	Domestic Kamloops	Fry (0-3 Inches)	51,450
1990	Rainbow X Cutthroat	Fingerling (3-6 Inches)	3,366
1990	Wild Kamloops	Fry (0-3 Inches)	72,223
1990	Domestic Kamloops	Fingerling (3-6 Inches)	199,920
1990	Pennask Rainbow	Fingerling (3-6 Inches)	8,575
1990	Domestic Kamloops	Fingerling (3-6 Inches)	6,450
1990	Splake	Fingerling (3-6 Inches)	4,709
1990	Troutlodge	Fingerling (3-6 Inches)	203,550
1991	Hayspur Rainbow	Fingerling (3-6 Inches)	84,275
1991	Domestic Kamloops	Fingerling (3-6 Inches)	148,200
1991	Troutlodge	Fingerling (3-6 Inches)	150,150
1992	Domestic Kamloops	Fingerling (3-6 Inches)	256,417
1992	Splake	Fingerling (3-6 Inches)	4,004
1993	Black Canyon Kamloops	Fry (0-3 Inches)	136,036
1993	Splake	Fingerling (3-6 Inches)	5,000
1993	Troutlodge	Fingerling (3-6 Inches)	57,400
1994	Domestic Kamloops	Fingerling (3-6 Inches)	233,660
1994	Hayspur Rainbow	Fingerling (3-6 Inches)	37,625
1995	Domestic Kamloops	Fingerling (3-6 Inches)	192,288
1996	Domestic Kamloops	Fingerling (3-6 Inches)	271,626
1997	Domestic Kamloops	Fingerling (3-6 Inches)	302,268
1998	Domestic Kamloops	Fingerling (3-6 Inches)	296,055
1999	Domestic Kamloops	Fingerling (3-6 Inches)	245,112
2000	Domestic Kamloops	Fingerling (3-6 Inches)	270,000
2001	Hayspur Kamloops Triploid	Fingerling (3-6 Inches)	36,562
2001	Hayspur Rainbow Triploid	Fingerling (3-6 Inches)	38,800
2001	Kamloops	Fingerling (3-6 Inches)	23,173
2001	Kamloops	Fry (0-3 Inches)	272,505
2001	Triploid Troutlodge Kamloop	Catchable (6 Inches+)	13,940
2002	Hayspur Kamloops Triploid	Fry (0-3 Inches)	263,409
2002	Hayspur Rainbow Triploid	Fingerling (3-6 Inches)	168,746
2002	Kamloops	Fingerling (3-6 Inches)	173,257
2003	Hayspur Kamloops Triploid	Fry (0-3 Inches)	134,999
2003	Triploid Troutlodge Kamloop	Fingerling (3-6 Inches)	137,124
2004	Hayspur Kamloops Triploid	Catchable (6 Inches+)	158,212

Appendix I (cont.)

Year	Species Type	Size	Number Stocked
2005	Hayspur Kamloops Triploid	Fingerling (3-6 Inches)	216,468
2006	Hayspur Kamloops Triploid	Fry (0-3 Inches)	272,958
2007	Hayspur Rainbow Triploid	Fry (0-3 Inches)	49,700
2007	Triploid Troutlodge Kamloop	Fry (0-3 Inches)	324,000
			7,473,351

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