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TRENDS IN FISH POPULATIONS AT THE LEVE CREEK MINE

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ABSTRACT

The Line Creek Mine has been operating in the Line Creek valley in southeastern B.C. since 1982. Line Creek is a tributary of the Fording and Elk rivers in the Kootenay/Columbia basin and supports indigenous populations of bull trout, westslope cutthroat trout and mountain whitefish and rarely, introduced brook trout and rainbow trout. A section of the upper main stem of Line Creek was covered by a rock drain and portions of the main stem of South Line Creek and Line Creek have been relocated to accommodate mining operations.

The fish populations in Line Creek have been the subject of irregular studies since 1975. The only major changes in fish populations have been an increase in the number of adult bull trout spawning in Line Creek and a reduction in fish densities in 1995. A 78% increase in spawning activity, as indicated by average number of redds, was detected between the period from 1983 and 1989 compared to the period from 1991 to 1994 and was attributed to a change in angling regulations implemented on the Elk River system in 1985. A subsequent 77% increase in the spawning activity which occurred during the period from 1995 to 1996 could not be attributed to a specific cause, although angling regulations may again have been the principal factor. Densities of juvenile bull trout, cutthroat trout and all trout decreased significantly in upper Line Creek and upper South Line Creek in 1995 due to a flood which occurred in June of 1995.

Despite some losses of rearing habitat for juvenile bull trout, the adult bull trout spawning in Line Creek have not been measurably affected by the Line Creek Mine, but have been positively affected by changes to angling regulations.

INTRODUCTION

The Line Creek Mine is located in the valley of Line Creek in southeastern British Columbia and has operated since 1982. Pits are located on Line Ridge on the north side of the valley. The mine is currently expanding to Horseshoe Ridge on the south side of the valley. A haul road and conveyor are used to transport coal down Line Creek canyon to the plant located in the Elk River valley.

Some minor channel changes during the construction phase of mine development were necessary to construct seven bridges and a haul road through Line Creek Canyon. In 1985, 1989/90 and 1992 portions

of the main stem of Line Creek were relocated to accommodate treatment facilities and haul road changes. In 1989/90 a section of lower South Line Creek was relocated. In 1991, 1.2 km of the main stem of Line Creek was covered by a rock drain.

Investigations of the fish populations in Line Creek were conducted in 1975 (B.C. Research 1977); 1981 (Caravetta 1981), 1983, 1986 and 1987 (Allan 1987); 1990 (Allan 1990), 1991 (Pisces 1991), and each year from 1993 to 1996 (Allan 1993, 1994, 1995, Carson 1997). Line Creek supports populations of indigenous bull trout *(Salvelinus confluentus),* westslope cutthroat trout *(Oncorhynchus clarki)* and mountain whitefish *(Prosopium williamsoni)* and rarely, introduced brook trout *(S. fontinalis)* and rainbow trout *(O. mykiss).* The bull trout population consists of an adult cohort which winters in the Elk and Fording rivers and migrates into Line Creek to spawn in the fall, and a juvenile cohort that rears in Line Creek. The cutthroat population is largely resident in Line Creek, however the mountain whitefish population is migratory, entering Line Creek in the spring on a feeding migration from the Elk and Fording rivers and leaving in the fall.

This paper uses the results of the fisheries investigations previously cited and records of mine operations provided by Line Creek Resources Limited to assess changes, and the probable cause of changes, in the fish populations in the Line Creek system.

METHODS

Fish were captured using a variety of techniques during the fisheries studies previously cited and are described in detail in those documents. Elœtrofishing and fish trapping were the most frequently used fish capture methods. Commencing in 1987, population estimates were obtained during the majority of the studies, using either the mark/recapture method (1987) or the maximum likelihood removal method (1993 to 1996 inclusive). In 1981 fish were trapped using a temporary trap. A permanent fish trap was constructed near stream km 1.8 in 1983 and was operated in 1983, 1987, 1993. 1994 and 1995. The bull trout, cutthroat trout and mountain whitefish passing upstream or downstream through the trap were enumerated and the fish measured to fork length (mm) and weighed (g). Bull trout and larger specimens of cutthroat trout and mountain whitefish were tagged with numbered tags inserted near the dorsal fin. In 1983, radio transmitters were inserted into the gut of eight bull trout and their movements subsequently tracked.

In 1986, 1987, 1989, 1990, 1991 and from 1993 to 1996 inclusive, bull trout spawning surveys were conducted on Line Creek. The surveys were conducted from the stream banks several times each fall. The number and location of redd sites and the number of fish on each redd site was recorded.

RESULTS

The covering of 1.2 km of the main stem of Line Creek with a rock drain and dump has resulted in the loss of approximately 1.2 km of stream constituting 7200 square metres of habitat. The majority of this habitat was rearing habitat used by juvenile bull trout although some cutthroat use was also documented A gain of 5092 m^2 of habitat for cutthroat trout and juvenile bull trout was realized by removing debris barriers on South Line Creek, allowing fish to occupy a section of stream previously barren of fish.

The various diversions of the main stem of Line Creek yielded a minor gain of total stream channel length, from 840 m of original channel to 945 m of relocated channel. Although habitat quality in the relocated channel was marginally less than in the original, natural channel, despite some habitat enhancement, the additional channel length compensated for the difference in quality such that no loss of useable habitat resulted. The relocation of lower South Line Creek resulted in a net loss of channel length, from 320 m to 240 m. The relocated channel also offered somewhat lower quality habitat, despite habitat enhancement, than the original, natural channel, so that a net loss of stream habitat resulted. No other changes in habitat that might effect fish populations, such as stream flow regimes or water quality, have been observed or measured.

Fish Populations

There have been few changes in fish species composition or distribution in the Line Creek system. The Line Creek rock drain precluded use of a 1.2 km section of channel, near the upper limit of fish distribution, which had previously been occupied by bull trout and cutthroat trout. Consequently, the upstream limit of fish distribution has been moved downstream. The removal of debris that barred upstream fish passage in South Line Creek has moved the fish distribution limit upstream approximately 760 metres. The capture of one specimen of rainbow trout and two specimens of brook trout in 1987 are new records for both species in Line Creek. None have been captured since. A water fall near km 3.7 on

Line Creek constitutes the upstream distribution limit for mountain whitefish, brook trout and rainbow trout.

The densities of cutthroat trout and juvenile bull trout have varied to some degree since densities were first determined in 1987 (Table 1). The trend until 1995 had been towards increasing densities. Between 1994 and 1995, there were statistically significant ($p = 0.05$) reductions in the densities of juvenile bull trout, cutthroat trout and all trout in upper Line Creek and upper South Line Creek, but not in the Line Creek Canyon index section. Some recovery was evident in 1996, particularly for the cutthroat trout population.

Table 1. Densities (n/100m^2) of cutthroat trout (CTTR), juvenile bull trout (BLTR) and all trout in index sections in Line Creek and South Line Creek. Numbers with the same superscript are significantly different (p=0.05). Data from Allan 1987, 1993, 1994, 1995 and Carson 1997.

		1987	1993	1994	1995	1996
Upper Line Creek	CTTR		1.2	1.3[a]	0.8[a]	2.5
	Juvenile BLTR		3.5	5.0[b]	1.7[b]	1.0
	All trout	2.9	4.9	6.3[c]	2.3[c]	3.3
Line Creek Canyon	CTTR			0.4	0.2[d]	1.4[d]
	Juvenile BLTR			0.8	1.1	1.1
	All trout			1.1	1.3	2.6
Upper South Line Creek	CTTR		1.7	1.1[e]	2.1[e]	
	Juvenile BLTR		1.9[h]	5.2[f,h]	0.2[f]	
	All trout	4.7	4.1	6.6[g]	2.3[g]	
Lower South Line Creek	CTTR					
	Juvenile BLTR			3.8		
	All trout			4.5		

Fish trapping operations on Line Creek have not been overly successful in determining the total number of adult bull trout using Line Creek for spawning. The adults usually begin to arrive prior to commencement offish trapping operations, so that the early part of the run has often been missed. Volume of flow has also affected the efficiency of the traps and fish have been reluctant to enter the traps in some years. Data gathered from fish trapping has revealed that the average size of the adult bull trout has decreased since 1981, the first year of trapping, and that very large individuals have become scarcer. Tag returns from anglers and others and the radio telemetry program conducted in 1983 have revealed that the majority of the adult bull trout that use Line Creek for spawning spend the late fall, winter and spring in the main stem of the Elk River, largely between Hosmer and Elko Dam. Recaptures of mountain whitefish

tagged at the Line Creek fish trap have been reported in winter and spring, mostly from the main stem of the Elk River in the vicinity of Sparwood. 'Only one tagged cutthroat trout has been recaptured outside of the Line Creek system.

Spawning surveys have revealed that the number of adult bull trout spawning in Line Creek has increased since 1986 (Table 2).

Table 2. Number of bull trout spawning sites in Line Creek. Data from Allan 1987, 1990, 1993, 1994, 1995, Carson 1997 and Pisces 1991.

1986	1987	1989	1990	1991	1993	1994	1995	1996
35	28	28	56	56	48	56	114	77

The increase in the average number of number of spawning sites between the period from 1986 to 1989 and the period from 1990 and 1994 is significantly different ($p = 0.05$, unequal variance).

DISCUSSION AND CONCLUSION

Platts and Nelson (1988) have noted that "fish populations are dynamic and may fluctuate considerably, even over relatively short periods of time, regardless of human influence". The response of trout populations to natural events, particularly variation in stream flow, may render conclusions about the influence of land use activities spurious (Platts and Nelson 1988). Allan (1994) suggested that some of the changes in juvenile bull trout density in Line Creek and South Line Creek might be attributed to fluctuations in year class strength, which was positively related to volume of stream discharge at spawning time. The only significant change in the density juvenile bull trout or cutthroat trout in Line or South Line creeks occurred in 1995. A major flood occurred in the Line Creek basin in early June of 1995. Floods have a major influence on the survival offish in streams (Hynes 1972, Seegrist and Gard 1972, Hanson and Waters 1974, Erman et al. 1988), particularly young trout. The reduction in densities which occurred in 1995 has been attributed to the flood rather than to volume of discharge at spawning time, or to any other factors.

The only other significant change in fish populations in the Line Creek system has been the increase in the level of spawning activity by migrant adult bull trout. Some loss of juvenile bull trout rearing habitat has occurred, which would be expected to reduce recruitment to the adult cohort and subsequently reduce the level of spawning activity. Since commencement of mining, the number of adult bull trout spawning

in Line Creek has increased. The cause of the increase first detected in 1990 has been attributed to changes in angling regulations implemented in the Elk River system in 1985 which resulted in increased survival of the adult bull trout cohort (Allan 1993). A second increase in spawning activity detected in 1995, the year of the major flood on Line Creek, may also have been due to an angling regulation change implemented on the Elk River system in 1995. Similar responses of adult bull trout populations to regulation changes have been reported elsewhere (Ratliff 1992, Stelfox and Egan 1995). The increase in bull trout spawning activity in Line Creek should increase recruitment to the juvenile cohort. The loss of rearing habitat in the Line Creek system, although relatively minor at this time, may become significant if juvenile use of rearing habitat increases in the future.

Despite some loss of rearing habitat due to mining operations, the juvenile bull trout population in Line Creek and South Line Creek appears to be largely controlled by stochastic events, particularly stream flow regimes. If the loss of juvenile rearing habitat was significant, a reduction in recruitment to the adult population would likely be evident. Instead, the number of adult spawners using Line Creek has increased, apparently due to changes in angling regulations in the Elk River system which has increased survival of the adult cohort. To date, the Line Creek Mine has had little, if any, measurable, direct effect on fish populations in the Line Creek system.

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