COAL CREEK FISHERIES MONITORING STUDY NO. VIII

AND

FOREST-WIDE FISHERIES MONITORING - 1989

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INTRODUCTION

This report contains information on the continued assessment and monitoring of fish populations and instream habitat in the upper Flathead River drainage. This study's primary purpose is to document annual trends in fish population and habitat parameters. Over time, these fishery variables may be compared with information on development in the drainage to show if and how forest management activities are affecting the fishery.

The study, funded by Flathead National Forest (FNF), was initiated by the Montana Department of Fish, Wildlife and Parks (MDFWP) in 1981 (Shepard and Graham 1982) and continued through 1982 (Shepard and Graham 1983a). These efforts contributed to an ongoing data collection program for monitoring the effects of land management activities on native fish populations and aquatic habitat (Shepard and Graham 1983b).

During 1983 and 1984, the study focused mainly on the Coal Creek drainage and was contracted to the Cooperative Fisheries Research Unit at Montana State University (MCFRU). The original monitoring program continued along with preliminary examination of the relationship between substrate composition and bull trout embryo survival to emergence (Weaver and White 1985). The 1985 study, conducted by MDFWP, involved only a portion of the original program including estimation of late summer fish abundance, evaluation of substrate composition in important spawning areas and assessment of the 1985 bull trout spawning run (Weaver and Fraley 1985). The Montana Department of Fish, Wildlife and Parks completed these activities annually from 1985 through 1988, using existing methods and sampling sites allowing comparable results (Weaver and Fraley 1986, 1988, Weaver 1989).

Under the current contract, MDFWP estimated late summer fish abundance for two sections in the Coal Creek drainage and two Swan River tributary sections. We counted bull trout spawning sites in the Coal Creek drainage and two tributaries to the Middle Fork. We identified all major stream features in the Challenge Creek drainage and evaluated substrate composition in five important bull trout spawning areas and one westslope cutthroat spawning area in upper basin tributaries (Table 1). The 1989 contract also included an evaluation of the habitat enhancement project in the South Fork of Coal Creek. Fieldwork was conducted from July 1989 through May 1990 through a cooperative effort by MDFWP and FNF personnel. As in past years, existing methodologies and sampling locations were used ensuring comparable results. Core sampling at several coring sites was delayed until March and April, 1990; however, we sampled all contract sites prior to the spring runoff period.

In addition to the activities reported, MDFWP completed electrofishing estimates in 23 tributary sections, bull trout redd counts in 12 major spawning streams, westslope cutthroat redd counts in 6 important spawning streams, and rainbow trout redd counts in 2 spawning streams. We completed substrate sampling in 21 other spawning areas during the 1989 season. Results of these additional 1989 monitoring efforts in the Flathead drainage will be presented in future reports.

Table 1. Description of study sites and activities specified under the 1988 contract.

Drainage	Creek	Sampling Area Name	Location	Activity: Fish Abundance	Bull Trout Redd Count	Substrate Monitoring	Habitat Enhancement	Feature ID
North Fork Flathead								
	North Coal	South Fork Bridge	SW 1/4 Sec 24 T34N R22W	X	-	-	-	-
		N. Coal Coring site	NW 1/4 Sec 23 T34N R22W	-	-	X	-	-
		Monitoring section	NE 1/4 Sec 30 T34N R22W downstream to NE 1/4 Sec 34 T34N R22W	-	X	-	-	-
	South Fork Coal	South Fork	NE 1/4 Sec 26 T34N R22W	X	-	X	-	-
		Lower rehab.	SW 1/4 Sec 26 T34N R22W	X	-	-	X	-
		Upper rehab	SW 1/4 Sec 26 T34N R22W	X	-	-	X	-
		Monitoring section	NW 1/4 Sec 34 T34N R22W downstream to NW 1/4 Sec 30 T34N R22W	-	X	-	-	-
	Mathias	Monitoring section	SW 1/4 Sec 5 T33N R22W downstream to NW 1/4 Sec 34 T34N R22W	-	X	-	-	-
Middle Fork Flathead								
	Granite	Coring site	SW 1/4 Sec 7 T28N R13W	-	X	X	-	-
	Challenge	Coring site	NW 1/4 Sec 32 T29N R13W	-	-	X	-	-
		Sediment contrib. zone	NE 1/4 Sec 28 T29N R13W	-	-	-	-	X
	Morrison	Monitoring Section	NW 1/4 Sec 9 T28N R13W downstream to NE 1/4 Sec 9 T27N R13W	-	X	-	-	-
South Fork Flathead								
	Hungry Horse	Lower coring site	NW 1/4 Sec 22 T30N R18W	-	-	X	-	-
Swan River								
	Goat	Coring site	SE 1/4 Sec 10 T23N R17W	X	-	X	-	-
	Jim	888 Bridge	NW 1/4 Sec 32 T22N R17W	-	-	X	-	-
	Elk	9591 Bridge	NE 1/4 Sec 16 T20N R17W	X	-	-	-	-

METHODS

Fish abundance Estimates

We made juvenile fish abundance estimates by electrofishing 150-m sections in selected tributaries to the North Fork of the Flathead and the Swan rivers. We used the same sections sampled during past years and equipment and procedures described by Shepard and Graham (1983b).

We calculated juvenile bull trout (Age I+) population estimates for important rearing areas in the North and South Forks of Coal Creek, Elk Creek and Goat Creek. We estimated cutthroat trout populations (Age I+) in both Coal Creek sections. We compared these estimates with records from electrofishing during previous years to assess trends in fish abundance. We applied the technique to assess population fluctuation described by Platts and Nelson (1988). These authors defined the maximum relative fluctuation (M_s) as the percentage difference between the highest and lowest value of each population statistic relative to the lowest value:

$$M_s = \frac{X_{max} - X_{min}}{X_{min}} \times 100 \; ;$$

X_{max} = largest annual value and X_{min} = smallest annual value.

This statistic related the largest observed change to the smallest observed value during the study period, and gives an indication of the magnitude of potential for change of each population statistic evaluated.

They used average relative fluctuation (A_s) to describe the magnitude of change in each population statistic with respect to the mean value of that statistic over the course of the study:

$$A_s = \frac{X_{max} - X_{min}}{X_{avg}} \times 100 \; ;$$

X_{max} and X_{min} are as above and X_{avg} = average value over the entire study period.

Total biomass (B_t), the estimated total trout weight, and areal biomass (B_a), the estimated trout weight per unit surface area, were computed as:

$$B_t = NW \text{ and } B_a = \frac{B_t}{lw} \; ;$$

N = estimated trout population size. W = mean trout weight, l = length of the stream section, and w = mean width of the study section.

In conjunction with the 1989 electrofishing efforts, we began to test juvenile bull trout populations for hybridization with eastern brook trout in Swan River tributaries. We retained 25 bull trout from our Goat Creek section for electrophoretic analysis.

Bull Trout Spawning Site Inventories

We conducted bull trout spawning site inventories in sections of Coal, Morrison, and Granite creeks recommended for annual monitoring by Shepard and Graham (1983b). We also surveyed Mathias Creek. Preliminary bull trout spawning surveys indicated final redd counts could begin during the last week of September. Final surveys were conducted by crews walking down the channel. We enumerated, classified, and located all observed redds as described by Shepard and Graham (1983b). We compared counts to past surveys of the same tributary section and by the major drainages as a whole, to evaluate trends in spawner escapement.

Spawning Area Substrate Composition

We collected substrate samples from known westslope cutthroat and bull trout spawning areas in the upper Flathead drainage to document trends and to evaluate potential fry production. Important bull trout spawning areas sampled included those in North Coal, South Fork Coal, Granite, Goat, and Jim creeks. Westslope cutthroat spawning areas sampled included Challenge Creek.

We used standard 15.24 cm hollow core sampler following procedures described by Shepard and Graham (1982). We placed samples in labeled bags and transported to the Flathead National Forest Soils Lab in Kalispell for analysis. After drying, each core sample was passed through the following sieve series:

76.1 mm	(3.00 inch)
50.8 mm	(2.00 inch)
25.4 mm	(1.00 inch)
19.0 mm	(0.75 inch)
12.7 mm	(0.50 inch)
9.52 mm	(0.38 inch)
6.35 mm	(0.25 inch)
4.76 mm	(0.19 inch)
2.00 mm	(0.08 inch)
0.85 mm	(0.03 inch)
0.42 mm	(0.016 inch)
0.063 mm	(0.002 inch)
Pan	(<0.002 inch)

Material retained on each sieve was weighed and the percent dry weight in each size class calculated and summed cumulatively. The median percentage smaller than 6.35 mm in each spawning area was compared with information collected during the previous year using Mann-Whitney tests. We estimated average survival to emergence in each of the spawning areas sampled using field developed predictive equations for westslope cutthroat and bull trout (MDFWP unpublished data). The equation used for cutthroat trout was:

$$\% \text{ survival} = 0.655 (S_{6.35}) + 35.675$$

$(S_{6.35})$ = % smaller than 6.35 mm;

The equation used for bull trout was:

$$\% \text{ survival} = -5.13 (S_{6.35}) + 225.2$$

Habitat Enhancement

An evaluation of the 1988 habitat enhancement efforts in the South Fork of Coal Creek was included as part of the 1989 work. We electrofished both sections as previously reported and compared these estimates with pretreatment estimates.

We selected these sections for several reasons: (1) both fish species were present throughout this area and a 150 m section has been electrofished annually since 1985, providing a period of record for assessing natural population fluctuations; (2) streamside timber in this area has been harvested, limiting potential for natural recruitment of large woody debris; (3) the proximity of an undeveloped timber stand north of road 1686 provided quick access to raw materials; and (4) topography of the area allowed selection, transport and placement of raw materials with minimal impact to the timber stand, riparian zone, and stream channel itself.

We used a replicated treatment-control study design and assumed natural population fluctuations will be similar in both treatment and control sites. Treatment involved placement of whole trees with root wads attached at five locations in each section. Trees were secured in position as recommended by Seehorn (1985).

Stream Feature Identification

All major stream features (MDFWP 1983) in the Challenge Creek drainage were located and classified during surveys of the total channel area in each of the major forks. Side drainages were included in an effort to examine all areas in the sediment contributing zone. We pace located major features during field surveys and later marked these on a map. We prepared a narrative listing of major stream features beginning in the headwaters on the Continental Divide and proceeding downstream to the mouth. We included a list of major problem areas where there is some potential for corrective or stabilizing activities in the management recommendations section.

RESULTS AND DISCUSSION

Fish Abundance Estimates

The 1989 juvenile bull trout population estimates appeared within the range observed during past years (Table 2). The probability of first pass capture ($\hat{p}$) during this year's electrofishing in the North Coal section was slightly lower than the recommended level of 0.60 (Shepard and Graham 1983b). Generally, when we handle a substantial number of fish during an effort, we will make a third electrofishing run if this level of $\hat{p}$ is not obtained. Since we had an adequate $\hat{p}$ for cutthroat trout and a considerable period of record exists for comparison, the information to be gained by a third pass did not seem to justify increasing the level of the 1989 effort.

This is the first year we electrofished this particular section of Elk Creek, so no directly comparable data are available. Based on an October, 1982, Mark-Recapture estimate, Leathe et al. (1985) reported high Age I+ bull trout densities for this reach of Elk Creek (255/300 m). The 1982 section was located approximately 1.5 km downstream from the current site.

Westslope cutthroat trout population estimates for the Coal Creek drainage in 1989 appeared quite similar to past years (Table 3). Both sections contain substantial populations. We observed several young-of-the-year westslope cutthroat trout in the North Coal section. Spawning and incubation probably takes place in the general vicinity of the 317 Bridge, although high spring flows prevented us from detecting where.

We observed cutthroat trout in both Goat and Elk creeks, but could not calculate population estimates based on the low number of fish captured in these sections. We handled 6 cutthroat trout in Goat and 12 in the Elk Creek sections. We captured young-of-the-year cutthroat trout during the Elk Creek electrofishing. Leathe et al. (1985) reported rainbow trout populations in these streams.

Both Elk and Goat Creek contained eastern brook trout. We captured three young-of-the-year and a single one-year-old brook trout in the Elk Creek section. Goat Creek supports a substantial brook trout population. We calculated an estimate of 25±1 Age I and older brook trout for this section ($\hat{p}$ = .96); at least four age classes (Age 0 - Age III) were present.

Time-trend information collected during our eight-year study period shows considerable fluctuations in fish population statistics (Table 4). Platts and Nelson (1988) reported a similar pattern and magnitude of maximum and mean annual variation in populations of cutthroat and bull trout in their Idaho study streams. Of particular interest is the magnitude of fluctuation in estimated juvenile bull trout numbers in the two sections of Coal Creek (Table 4).

Our electrofishing section in the South Fork is located near the downstream end of an area where past land management activities resulted in major channel changes. A length of channel in this area was artificially straightened and deepened in the early 70's to eliminate braiding and low summer flows. The channel area around the North Coal electrofishing section appears much more stable. Although roads are located on both sides of the stream above this site, the riparian area remains intact.

Table 2. Summary of annual population estimates for Age I and older bull trout calculated from electrofishing in the sections specified for monitoring during 1989.

Drainage	Creek	Section	Date	$\hat{N}$	95% CI	$\hat{p}$
<u>North Fork Flathead</u>						
	North Coal	317 Bridge	8/04/82	17	±9	.60
			8/25/83	18	±3	.78
			8/29/84	48	±12	.63
			8/27/85	41	±5	.77
			9/03/86	29	±12	.59
			8/05/87	47	±17	.56
			8/16/88	39	±5	.69
			9/08/89	44	±18	.54
	South Coal	Section 26	8/28/85	62	±8	.74
			8/06/87	12	±2	.48
			8/08/88	24	±2	.85
			9/29/89	14	±2	.83
<u>Swan River</u>						
	Elk	9591 Bridge	9/21/89	44	±7	.71
	Goat	Section 10	8/11/87	66	±6	.79
			8/22/88	32	±4	.80
			8/30/89	34	±2	.86

Table 3. Summary of annual population estimates for Age I and older cutthroat trout calculated from electrofishing in the sections specified for monitoring during 1989.

Drainage	Creek	Section	Date	$\hat{N}$	95% CI	$\hat{p}$
North Fork Flathead						
	North Coal	317 Bridge	8/04/82	40	±7	.72
			8/25/83	27	±4	.82
			8/29/84	48	±12	.50
			8/27/85	51	±36	.45
			9/03/86	40	±11	.64
			8/05/87	63	±2	.91
			8/16/88	51	±9	.69
			9/08/89	51	±9	.69
	South Coal	Section 26	8/28/85	63	±35	.33
			8/06/87	43	±4	.47
			8/08/88	43	±3	.83
			9/29/89	59	±10	.67

Table 4. Observed maximum and mean annual fluctuations in estimated juvenile bull and westslope cutthroat trout population sizes, total and area biomass and mean weights and lengths for electrofishing sections in the Coal Creek drainage during the period 1982 through 1988. Fluctuations are expressed as percentages of the minimum or average yearly values (maximum and mean fluctuations, respectfully).

Creek - Section	Years of data	% Fluctuation									
				Biomass							
		Number		Total (g/section)		Aereal (g/m²)		Mean Weight (g)		Mean Length (mm)	
		Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean
Bull Trout											
Coal - South Fork bridge (north Coal)	8	182	88	129	79	200	99	102	70	36	30
South Fork Coal (section 26)	4	417	178	118	81	117	80	137	84	33	29
Cutthroat Trout											
Coal - South Fork bridge (north Coal)	8	133	78	112	82	154	99	99	69	42	33
South Fork Coal	4	46	38	36	31	24	21	32	30	22	20

These observations suggest channel instability may result in larger fluctuations in juvenile bull trout numbers. The long-term effects of an increase in the magnitude of population fluctuations within any given stream segment can not be adequately assessed with existing data. However, this information tends to support the selection of bull trout as an indicator species in monitoring for potential land management effects. Continuing examination of population fluctuations may yield some index value for assessing effects of land management.

The fact that westslope cutthroat trout populations in the same sections do not respond similarly is probably due to differences in habitat preferences between the two species. Juvenile bull trout are extremely substrate oriented; westslope cutthroat trout typically occupy positions higher up in the water column.

Activity assessment and risk analysis information is being collected as part of the current Flathead Basin Commission's cooperative forest practice study. As this information becomes available, fluctuations in the various fish population statistics may become more meaningful in determining how various land management activities or specific forest practices may or may not relate to the fishery. The importance of a continuous period of record can not be over-emphasized.

Electrophoretic analysis confirmed that bull trout and eastern brook trout hybrids were present in two Swan River tributaries. We sent 25 juvenile bull trout from the Goat Creek electrofishing section and a single fish which appeared to have intermediate characteristics from Lion Creek to the Genetics Lab at the University of Montana. Testing showed one fish from the Goat Creek sample and the fish from Lion Creek were brook trout-bull trout hybrids. No other Swan River tributary bull trout populations have been genetically tested to date.

Leary et al. (1983) found only male hybrids from Montana streams suggesting sterility in the offspring of bull and brook trout crosses. The best characteristics for hybrid identification are vertebral and pyloric caeca counts. Hybrids have high counts for both of these features. The bull trout has low numbers for pyloric caeca and the brook trout has low vertebral counts (Leary et al. 1983). Hybrids that Cavender (1978) observed had darker pigmentation on all of their body parts, mottling on their dorsal fin and ventral fins that were tri-colored. Hybrids also had consistently smaller, light spots on their flanks than bull trout. These characteristics were present on the fish from Lion Creek. We recommend further genetic sampling in regularly monitored Swan River tributaries to document this phenomenon.

Bull Trout Spawning Site Inventories

We identified 121 bull trout redds in the Coal Creek drainage during 1989. Fifty of these were located in the annual monitoring section while field crews observed 29, 33, and 9 redds in North Coal, South Fork Coal, and Mathias creeks, respectively (Table 5). In the Middle Fork drainage, Morrison and Granite creeks contained 63 and 31 bull trout redds, respectively (Table 5).

We completed the 1989 bull trout redd counts between September 27 and October 30. Based on the number of redds observed in areas selected for annual monitoring (Shepard and Graham 1983b), the 1989 spawning run appeared slightly

Table 5. Summary of annual bull trout redd counts by section for the streams specified for inventory during 1989.

Creek	Section	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Coal												
	Above the South Fork	--	4	7	25	13	3	--	22	--	10	29
	Below the South Fork (Monitoring area)	38	34	23	60	61	53	40	13	48	52	50
S. Fork Coal		--	19	24	9	3	5	--	4	--	24	33
Mathias		--	10	10	17	12	8	--	10	--	19	9
Granite		14	34	14	34	31	47	24	37	34	32	31
Morrison		25	75	32	86	67	38	99	52	49	50	63

above average in the North and Middle Forks and considerably stronger than average in the Swan River drainage. The 1989 count of 244 redds in North Fork tributary monitoring areas exceeded the ten-year average figure of 228 by 7 percent. The 1989 Middle Fork monitoring count of 158 redds is 10 percent grater than the 10-year average of 143. Swan River tributary monitoring areas averaged 236 redds during the past seven years. The 1989 total of 371 was 57 percent greater than this average figure. The Swan River bull trout spawning run has shown an increasing trend since 1986, when four major spawning streams were closed to fishing year round.

During the past two years, low flows and an actively migrating channel have combined to form a migration barrier preventing adult bull trout from using the portion of Morrison Creek above km 5.5 (Weaver 1989). This year, we captured a pair of adult bull trout in our electrofishing section at km 18.5 and field crews observed 28 redds above km 5.5 during 1989 redd counts. Higher flows probably allowed better fish passage this year; however, the problem may occur again in future low flow years.

Spawning Area Substrate Composition

We have sampled streambed substrate composition at two sites in the upper Coal Creek drainage annually since 1985 (Table 6). We observed significant decreases ($p < 0.10$) in the median percentage of material smaller than 6.35 mm in both forks of Coal Creek between 1985 and 1986. No significant change has occurred since this time in the South Fork. We observed a significant increase ($p < 0.05$) between 1987 and 1988 in the North Coal sampling area. The 1989 sampling showed no significant change has occurred since this increase.

We identified active sediment sources in both of these areas during stream feature identification surveys (Weaver 1989). Major management-related sediment contributing areas in the upper South Fork Drainage are above a series of relatively stable beaver dams. A large amount of deposited material is currently stored behind these dams. No major land disturbing activities have taken place in the drainage above this sampling site since our period of record began in 1985.

Current timber harvest activities are occurring in the northern fork of Coal Creek above our sampling site. We noted considerable natural erosion and slumping in the headwaters area of North Coal compared to the upper South Fork. However, we also observed several management-related sediment sources (Weaver 1989). Glacier View District personnel have completed efforts to help stabilize several of the identified problem areas.

The 1989 sampling in Granite Creek showed no significant change from last year at either sampling site (Table 6). This spawning area continues to contain high levels of fine material although some flushing of streambed gavels appears to have occurred at the old trail crossing. Predicted survival to emergence increased substantially from 1988.

In an effort to monitor streambed conditions without actually removing large amount of streambed material, we recently began planting Whitlock-Vibert boxes

Table 6. Summary of annual median percentages of substrate material smaller than 6.35 mm in diameter, Mann-Whitney test results and mean predicted embryo survival to emergence from core sampling in known spawning areas.

Spawning areas	Year	n	Median % < 6.35 mm	Test[a] results	Mean predicted survival (%)
North Coal Creek	1985	12	34.8		39
				* ↓	
	1986	12	29.3		71
				NS	
	1987	12	30.2		65
				**↑	
	1988	12	39.4		30
				NS	
	1989	12	37.8		34
South Coal Creek	1985	12	35.8		24
				* ↓	
	1986	12	31.4		29
				NS	
	1987	12	31.4		57
				NS	
	1988	12	31.4		56
				NS	
	1989	12	36.1		40
Granite Creek (trail crossing)	1982	12	44.6		13
				NS	
	1986	6	50.6		4
				NS	
	1987	6	47.6		5
				NS	
	1988	6	44.6		6
				NS	
	1989	6	39.0		32
Granite Creek (other sites)	1982	--	--	--	--
	1986	8	32.6		49
				* ↑	
	1987	6	39.8		22
				NS	
	1988	6	44.0		27
				NS	
	1989	6	44.4		17
Jim Creek (888 Bridge)	1988	12	41.1		20
				**↑	
	1990	12	50.3		1

(Table 6. continued)

Spawning areas	Year	n	Median % < 6.35 mm	Test[a/] results	Mean predicted survival (%)
Goat Creek	1984	12	15.0		75+
				NS	
	1986	12	19.4		75+
				**↑	
	1987	12	25.7		75+
				NS	
	1988	12	22.8		75+
				**↑	
	1989	11	31.9		59

[a/] NS = not significant ($p>0.10$)
* = significant at the 10 percent level
** = significant at the 5 percent level
↑ = increase
↓ = decrease

filled with marbles (Wesche et al. 1989). We lost all 12 W-V boxes planted flush in the streambed at this site in Granite Creek during a November, 1989 precipitation event. These boxes weigh approximately 1.0 kg each. Loss of the boxes suggest a considerable amount of gravel movement took place.

We sampled Jim Creek at the crossing of Forest Road #888 in December, 1988 and again during January 1990 (Table 6). The median percentage smaller than 6.35 mm in samples collected during winter, 1988 was 41.5 percent. Samples taken early in 1990 showed a median value of 50.2 percent smaller than 6.35 mm. A two tailed Mann-Whitney test indicated this increase was significant at the nominal five percent level. We observed natural bull trout spawning at this exact location during redd counts conducted in October, 1989.

A portion of the upper Jim Creek drainage has recently been developed. Extensive timber harvest and associated road construction took place on private timberlands along West Jim Creek during winter, 1988. MDFWP collected additional core samples here as part of a cooperative monitoring effort. Results suggest the development in West Jim Creek significantly changed the streambed composition in West Jim Creek below the sale area. It is not possible to determine whether the change observed in Jim Creek resulted from this activity, but the timing and magnitude of change appeared quite similar. We recommend continued sampling in these areas. A stream feature identification survey of main Jim Creek may determine whether other sediment sources recently contributed to observed increases in fine materials.

Forest Service personnel completed sampling in the Goat Creek spawning area from 1984 through 1988; this is the first year we actually collected the samples. The significant increase we reported for Goat Creek may be due to the different location of the 1989 sampling sites. Bull trout spawning did occur in the vicinity of this year's sampling site and we recommend future core sampling be completed in this area. Additional samples collected at the old sampling site could incidate whether the reported increase is real or a result of the new location.

Habitat Enhancement

All ten trees remained as placed through the 1989 runoff period. We checked the area during May and early June. At the observed flows, it appeared that we could have placed several of the trees further out in the channel and still kept them in place.

We observed some redistribution of streambed material resulting from our activities. The upper treatment section contained noticeably more gravel this year than prior to the testing. Substrate score for this section declined from 13.2 to 12.8. During the 1989 bull trout redd counts, we observed a spawning site associated with one of our trees. Streambed material here was too large for spawning prior to placement of the tree.

In 1989, juvenile bull trout population estimates were 36 and 37 percent lower than the pretreatment estimates for the upper and lower treatment sections, respectively (Table 7). The estimated number of juvenile bull trout in the

Table 7. Pre- and first year post-treatment population estimates ($\hat{N}$) and percent change for Age I+ westslope cutthroat and bull trout in sections of the South Fork of Coal Creek selected for habitat enhancement testing.

Section	Pre-treatment ($\hat{N}$)	Post-treatment ($\hat{N}$)	Percent change[a]
	Westslope Cutthroat		
Upper	26±5	13± 3	↓ 50%
Lower	34±1	41±29	↑ 21%
Control	43±3	59±10	↑ 37%
	Bull Trout		
Upper	160±6	102±16	↓ 36%
Lower	65±4	41± 4	↓ 37%
Control	24±2	14± 2	↓ 42%

[a] ↑ = population increase

↓ = population decrease

control section declined by 42 percent. Because of the similar decreasing trend in estimated numbers at both treatments and the control site, treatment induced effects are not suggested. We previously discussed the large magnitude of fluctuation in bull trout population estimates for the South Fork of Coal Creek. Perhaps we should set up a similar test in a section where juvenile bull trout population appear more stable.

The 1989 westslope cutthroat trout population estimate for our control section increased by 37 percent over the 1988 estimate. We observed a 21 percent increase in estimated westslope cutthroat trout numbers in the lower treatment section, while the estimate for the upper treatment section decreased by 50 percent. This divergence in the pattern of fluctuation generally indicates treatment induced effects (Platts and Nelson 1988). However, after only a single season of treatment, any interpretations are speculative.

Stream Feature Identification

These surveys showed highly unstable channel areas existed in the Challenge Creek Drainage (Appendix A). The vast majority of the problems observed were natural and resulted from the 1964 flood event. Sediment resulting from this event is still present in large amounts resulting in channel migration, deposition, and high embeddedness levels. Westslope cutthroat trout spawning area gravel composition in Challenge Creek appears to be seriously degraded. Challenge Creek appears to contribute significantly to the high levels of fine material present in the bull trout spawning area in Granite Creek as well.

We also identified several management-related problems. Most were associated with older activities. However, we also noted several minor BMP departures associated with recent timber management activities (Appendix A).

RECOMMENDATIONS

Continuation of this monitoring program will allow a greater understanding of factors which limit fish populations in the upper Flathead Basin and how land management decisions may influence them. Based on findings in this and previous studies, we recommend the following work to be cooperatively completed by MDFWP and FNF:

1. Monitoring

   a. Continue monitoring fish populations in selected stream sections. Bull trout rearing streams with established electrofishing sections include Big, Coal, South Fork Coal, North Coal, Red Meadow, Whale, Trail Swift Ole, Morrison, Quintonkin, Elk, Goat, Lion, Squeezer, Piper, and Jim creeks. Established sections for monitoring westslope cutthroat populations include North Coal, South Fork Coal, Cyclone, Langford, Red Meadow, Swift, Akokala, Challenge, Hungry Horse, Margaret, Tiger, Lost Mare, Emery, McInernie, Felix, Harris, Logan, and Quintonkin creeks. Rainbow trout population-monitoring sections are located in Fish and Freeland creeks.

b. Maintain annual measurement of substrate quality in both westslope cutthroat and bull trout spawning areas by core sampling and complete testing of the Whitlock-Vibert box method. Monitoring sites in bull trout spawning areas include Big, Coal, North Coal, South Fork Coal, Whale, Trail, Swift, Granite, Goat, Squeezer, and Lion creeks. Coring sites in westslope cutthroat spawning areas are both upper and lower Hungry Horse, Margaret, Tiger, Emery, Challenge, Cyclone, and Swift creeks. Coring sites in rainbow trout spawning areas include Fish and Freeland creeks.

c. Continue bull trout spawning site surveys in areas recommended for annual monitoring in Flathead River and Swan River tributaries.

2. Future Data Needs

a. Identify sediment sources contributing to high levels of fine material existing in other critical westslope cutthroat and bull trout spawning areas. Specifically, the Big, Jim, and Granite creek drainages should be surveyed in light of current substrate composition. A detailed sediment source analysis appears to be an excellent method to assess natural and management-related effects.

b. Determine what effect juvenile bull trout emigration has on estimates of carryover by age class.

3. Management

a. Limit the removal of any organic material from stream channels which may be used as fish cover. Continue testing to determine if juvenile bull trout and/or cutthroat trout rearing capacity could be increased by addition of instream cover.

b. Survey the following areas in the Challenge Creek drainage considering potential for corrective or stabilizing measures to reduce sediment input from identified sources:

Area	Priority
Dozer pile in new cutting unit.	1
Wash out in road in older cutting units.	2
Washed draw in older cutting units.	3
Naturally slumping area near km 20.	4
Cross drainage in newer units.	5

c. Implement measures determined feasible for stabilizing problem areas.

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APPENDIX A

Narrative description of stream features in the Challenge Creek Drainage during 1989.

This narrative description of stream features in Challenge Creek begins at the junction of Challenge and Dodge creeks, then proceeds upstream to the fork in the northeast quarter of Section 28.

Just above the mouth, I noted a major depositional area and recent beaver activity. Newly wind-thrown trees resulted in a minor sediment source at km 0.1. I observed a stable, old crossing at km 0.3 and noted old logging debris scattered throughout this area. We passed Challenge cabin and the Skyland Road culvert at km 0.6. An eroding bank (10.0 x 1.5 m) was noted at a crossing just below the cabin.

At km 1.0, Challenge Creek runs along a high, steep bank on the east. The edge of a clearcut unit was visible along the top of the slope break. The SMZ along this unit was adequate. An old cut bank (40.0 x 2.0 m) and a dry flood channel were present at km 1.2. Just above this location, I noted an old slump on the east bank. This area showed signs of recovery, but has contributed a major amount of material to the stream. Around km 1.3, the stream passes steep rock walls; first on the west side, then the east.

The second order tributary draining west from Puzzle Hills enters Challenge Creek at km 1.4. I observed two resident westslope cutthroat trout redds in the lower 100 paces of this creek. I encountered a 2.0 m waterfalls 0.1 km up along with several smaller falls in a bedrock canyon area. I saw no fish in the pools in this canyon. The SMZ along this small stream appeared adequate; some wind throw has occurred in spots.

A series of major, natural slumps were observed at km 1.5 (25.0 x 15.0 m), 2.1 (25.0 x 10.0 m), 2.2 (25.0 x 10.0 m) and 2.4 (20.0 x 15.0 m). I noted an active cut bank (25.0 x 6.0 m) at km 2.6. I found minimal SMZ width at the top of this bank. Extensive deposition and flood signs were evident throughout this area. The channel became more confined at km 3.4. Challenge Creek from this point to the upper fork in Section 28 had continuous cut banks 2.0-3.0 m high on at least one side and sometimes both. I observed numerous debris accumulations and flood sign up to 5.0 m above the water level during the survey.

The surveyor walked down road #5282 and noted any potential road or drainage problem observed. In the lower end of the unit at the road end I found a spot where the road intercepted groundwater. A cross-drain may be needed here. I also observed where oil from machinery had been drained during maintenance in this wet ditch. I saw a similar spot where groundwater was intercepted at a culvert location in the unit below the road. Soil movement through the culvert into the unit was obvious. A dozer pile in this same unit was located in a draw at the top of a steep bank overlooking Challenge Creek. Once burned, this spot may contribute sediment to Challenge Creek. Several sets of tracks converged at the pile which could funnel water through the burned area and immediately over the streambank.

I located a washed out spot in the road grade near the upstream end of the older clearcut units. Evidence of soil deposition >100 m below the road was visible. There are several draws in these older units along the south side of Challenge Creek. I found one where significant down cutting had occurred. There was no SMZ along this channel. All others appeared stable and I observed an adequate SMZ along both sides of Challenge Creek through these units.