# COAL CREEK FISHERIES MONITORING STUDY NO. VI

# AND

# FOREST-WIDE FISHERIES MONITORING - 1987

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## ABSTRACT

Fish populations and aquatic habitat were inventoried continuing the assessment of the effects of forest practices on the fishery in the Flathead drainage. No distinct trend in estimated fish abundance has been observed and fluctuations of over 100 percent have occurred between electrofishing estimates. Survival rates of juvenile bull trout in Coal Creek from 1982 through 1987 averaged 45 percent from Age I to II and 41 percent from Age II to III. No adjustment for emigration of juvenile bull trout was included in these survival rates. Bull trout redd counts in 1987 were 28 percent and 6 percent greater than the 1979-1986 average in the North and Middle Fork drainages respectively. Only a weak relationship existed between bull trout spawner escapement and juvenile populations in subsequent years, suggesting populations may be controlled by other factors. Fine sediment levels (<6.35 mm) increased from 27 percent to 34 percent in lower Hungry Horse Creek and from 35 percent to 41 percent in Coal Creek at Dead Horse Bridge between 1986 and 1987. Embryo survival to emergence predictions for these spawning areas were less than 20 percent. Embryo survival predictions for spawning areas in Challenge and Granite creeks remained below 15 percent although fine materials decreased from 40 percent to 34 percent in Challenge Creek and from 52 percent to 44 percent in Granite Creek. A slight increasing trend in the smaller substrate size classes and imbeddedness resulted in lower 1987 substrate scores in Coal Creek. These lower substrate scores could indicate a reduction in substrate related rearing habitat available to fish. Increases in channel debris resulting from timber harvest, wind thrown trees and beaver activity resulted in a slight increase in instream cover. Recommendations from the study include: 1) continue monitoring fish populations, spawning area substrate quality, bull trout spawning sites and survival by age class; 2) identify sediment sources in Coal and Granite creeks, develop field equations for predicting cutthroat survival to emergence and develop correction coefficients for emigration by juvenile bull trout; and 3) investigate effects of cover on trout rearing capacities.

ACKNOWLEDGMENTS

This ongoing study has been a truly cooperative effort since its inception. Information collected this year and presented in this report resulted from efforts of many individuals including Montana Department of Fish, Wildlife and Parks personnel from both the regional and special projects offices as well as those from Flathead National Forest. Hank Dawson, Mike Enk, Steve Glutting, Rick Malta, Gary Michael, Beth Morgan-Giddings, John Wachsmuth, Chuck Weichler and Steve Zorbe assisted in field data collection. Sonny Danielson provided use of the Flathead National Forest Soils Lab for substrate sample analysis. Frances Roe typed the manuscript and critical review was provided by Hank Dawson, Bob Domrose and Mike Enk.

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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. 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 resulted in the development of a 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 was continued along with development 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 bull trout spawning areas, and assessment of the 1985 bull trout spawning run (Weaver and Fraley 1985). These activities were completed by MDFWP again in 1986, using existing methodologies and sampling sites to ensure comparable results (Weaver and Fraley 1986).

Under the current contract, late summer fish abundance was estimated in sections of two North Fork tributaries, two Swan River tributaries and one South Fork tributary. Bull trout spawning sites were enumerated in two North Fork tributaries and one tributary in both the Middle Fork and South Fork drainages. Fish habitat was reassessed in seven reaches in the Coal Creek drainage and substrate composition was evaluated in three important bull trout spawning areas and two major westslope cutthroat spawning areas in upper basin tributaries (Table 1). Fieldwork was conducted during summer and fall, 1987, through a cooperative effort by existing MDFWP and FNF personnel. As in past years, existing methodologies and sampling locations were used insuring comparable results.

In addition to the activities reported, electrofishing estimates in 13 tributary sections, bull trout redd counts in 11 major spawning streams, westslope cutthroat redd counts in four important spawning streams and substrate sampling in six other spawning areas were completed during the 1987 field season. Results of additional 1987 monitoring efforts in the Flathead drainage will be presented in future reports (MDFWP in prep., May et al. in prep.).

Table 1. Description of study sites and activities specified under the 1987 contract.

| Drainage | Creek | Sampling Area Name | Location | Activity: Fish Abundance | Activity: Bull Trout Redd Counts | Activity: Substrate Monitoring | Activity: Habitat Assessment |
|---|---|---|---|---|---|---|---|
| North Fork Flathead | | | | | | | |
| | Main Coal | South Fork Bridge | SW 1/4 Sec 24 T34N R22W | x | - | - | - |
| | | HS1 | SW 1/4 Sec 28 T34N R21W | - | - | - | x |
| | | HS2 | SW 1/4 Sec 24 T34N R22W | - | - | - | x |
| | | HS3 | SW 1/4 Sec 15 T34N R22W | - | - | - | x |
| | | North Fork Coal | SE 1/4 Sec 23 T34N R22W | - | - | x | - |
| | | Dead Horse Bridge | SW 1/4 Sec 28 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 | - |
| | | Reach I | SW 1/4 Sec 26 T34N R22W | - | - | - | x |
| | | Reach II | NE 1/4 Sec 31 T34N R22W | - | - | - | x |
| | | South Fork | NW 1/4 Sec 34 T34N R22W downstream to NW 1/4 Sec 30 T34N R22W | - | x | - | - |
| | Mathias | Reach I | NW 1/4 Sec 34 T34N R22W | - | - | - | x |
| | | Reach II | NE 1/4 Sec 5 T33N R22W | - | - | - | x |
| Middle Fork Flathead | | | | | | | |
| | Granite | Coring site | SW 1/4 Sec 7 T28N R13W | - | - | x | - |
| | Challenge | Coring site | NW 1/4 Sec 32 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 | | | | | | | |
| | Quintonkin | Old trap site | NE 1/4 Sec 16 T26N R17W | x | - | - | x |
| | Hungry Horse | Lower coring site | NW 1/4 Sec 22 T30N R18W | - | - | x | - |
| | Spotted Bear | ↓ Dean Falls | NE 1/4 Sec 36 T25N R15W | - | x | - | - |
| Swan River | | | | | | | |
| | Goat | Cutting Unit | SE 1/4 Sec 10 T23N R17W | x | - | - | - |
| | Squeezer | Old crossing | SE 1/4 Sec 21 T23N R17W | x | - | - | - |

## METHODS

### Fish Abundance Estimates

Juvenile fish abundance estimates were made by electrofishing 150-m sections in selected tributaries to the North, Middle and South forks of the Flathead River and the Swan River. All sections were previously established by MDFWP and have been sampled during past years using equipment and procedures described by Shepard and Graham (1983b).

Juvenile bull trout (Age I+) population estimates were calculated for important rearing areas in Coal, South Fork Coal, Quintonkin, Goat and Squeezer creeks. Cutthroat trout populations (Age I+) were estimated in Coal, South Fork Coal, and Quintonkin creeks. These estimates were compared by section with population estimates calculated from electrofishing during previous years to assess trends in fish abundance.

Annual survival of juvenile bull trout was estimated outside the contract in the Dead Horse Bridge electrofishing section in Coal Creek. This was the only high density bull trout rearing section which has been electrofished annually for a period of time long enough to begin to assess survival by age class. Survival estimates from Age I to II and Age II to III were calculated from data collected during annual late summer electrofishing between 1982 and 1987. These population estimates were calculated using the mark-recapture methodology (Vincent 1971).

Age classes were assigned from length frequencies observed during annual electrofishings. This breakdown varied little between years and has been confirmed by scale reading (Fraley et al. 1981). Percent survival was calculated directly from the estimated number ($\hat{N}$) of fish in each age class present during annual electrofishings. No adjustment was made for emigration so these estimates should not be viewed as actual year to year survival.

### Bull Trout Spawning Site Inventories

Bull trout spawning site inventories were conducted on the areas in Coal and Morrison creeks recommended for annual monitoring by Shepard and Graham (1983b). Reach 1 of the South Fork of Coal Creek and the Spotted Bear River were also surveyed under the current contract.

Preliminary bull trout spawning surveys conducted in conjunction with other field activities indicated final redd counts could begin during the week of September 27. Final surveys were conducted by crews of two walking down the channel. Redds were enumerated, classified and located as described by Shepard and Graham (1983b). Counts were compared 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**

Substrate samples were collected from known westslope cutthroat and bull trout spawning areas in the upper Flathead drainage to document trends in sediment deposition and to evaluate fry production. Important bull trout spawning areas sampled included those in Coal, South Fork Coal, and Granite creeks. An attempt to locate a bull trout spawning area in Quintonkin Creek and collect substrate core samples failed when no spawning was observed below the barrier falls. Core samples were to be collected from the bull trout spawning area in Quintonkin Creek because high juvenile densities suggested the stream may have contained important spawning habitat. Apparently, Quintonkin Creek was more important as a juvenile rearing area seeded by spawning which occurred elsewhere. Since substrate scoring is a better index of rearing habitat than core sampling, MDFWP recommended amending the contract to substitute substrate scoring in place of core sampling in Quintonkin Creek. FNF agreed and this change was made. Westslope cutthroat spawning areas sampled include Hungry Horse Creek along with Challenge Creek.

A standard hollow core sampler (McNeil and Ahnell 1964) was used following procedures described by Shepard and Graham (1982). Samples were placed 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) |
| 18.8 mm | (0.74 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) |

A 1.70-mm sieve was included while analyzing core samples from westslope cutthroat spawning areas. All material retained on each sieve was weighed and the percent dry weight in each size class was calculated. The mean percentage smaller than 6.35 and 1.70 mm in each cutthroat spawning area and smaller than 6.35 mm in each bull trout spawning area was compared with information collected during past years. Average survival to emergence in each of the spawning areas sampled was calculated using predictive equations developed for cutthroat trout by Irving and Bjornn (1984) and for bull trout by Weaver and White (1985). The equation used for cutthroat trout was:

$$\% \text{ survival} = 106.10029 - 0.4460803\ (S_{6.35}) - 7.7660173\ (S_{1.70}) + 0.1694598\ (S_{1.70})^2$$

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

$(S_{1.70})$ = % smaller than 1.70 mm; and

$(S_{1.70})^2$ = % smaller than 1.70 mm squared.

The equation used for bull trout was:

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

**Instream Habitat Assessment**

Aquatic habitat in main Coal Creek was evaluated using a line transect methodology similar to that described by Herrington and Dunham (1967) and used in previous surveys of Coal Creek (Shepard and Graham 1983a, Weaver and White 1985). Transects were located at 25 randomly selected sites per kilometer in three established sections, located:

1. approximately 0.5 km below Dead Horse Bridge (HS1);

2. approximately 0.3 km above South Fork Bridge (HS2); and

3. above the Coal Ridge Lookout trailhead (HS3).

Point estimates of the following parameters were made at 1.0-m intervals across each transect:

1. instream cover;

2. overhead cover; and

3. two predominant substrate size classes (Table 2).

In addition to the transect data, visual estimates of compaction, imbeddedness and D-90 were made. Depth was recorded at each point and the maximum depth on the transect was noted. Wetted width and channel width were also measured across each transect. Terminology used in the habitat assessment process was defined by MDFWP (1983). These data were summarized and compared to results of the previous surveys. Substrate scores (Leathe and Enk 1985) were also calculated from the transect data and compared to information collected during past studies at these three areas in main Coal Creek.

Table 2. Substrate size class, imbeddedness, instream cover and bank cover criteria and codes.

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Substrate size class codes

1. Particulate organic matter, silt or detritus
2. Less than 2.0 mm in diameter - sand
3. 2.0 to 6.4 mm in diameter - small gravel
4. 6.4 to 64.0 mm in diameter - large gravel
5. 64.0 to 254.0 mm in diameter - cobble
6. Larger than 254.0 mm in diameter - boulder, bedrock

Imbeddedness codes

1. Completely imbedded or nearly so
2. 3/4 imbedded
3. 1/2 imbedded
4. 1/4 imbedded
5. Unimbedded

Instream cover codes

0. None
1. Aquatic vegetation
2. Logs ⎤
3. Debris ⎬------------Below water surface
4. Boulders ⎦
5. Logs ⎤
6. Debris ⎬------------Above water surface
7. Boulders ⎦
8. Man-made structure

Bank cover codes

0. None
1. Undercut bank, log or root mass
2. Overhang <2 m above water surface
3. Overhang from 2 m up to canopy overstory
4. Overstory canopy

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The original stream habitat methodology used by MDFWP during the 1979 baseline assessment (MDFWP 1983) was used to complete surveys on reaches 1 and 2 of both the South Fork of Coal Creek and Mathias Creek. Results of these surveys were compared to the original baseline information collected from these reaches during late summer, 1979.

MDFWP mapped the presence and location of woody debris in two sections of Coal Creek during summer, 1982 (Shepard and Graham 1983a). One section was located within the riparian cut area, approximately 2.0 km above the South Fork Road Bridge. The other section was located downstream, 0.5 km above Dead Horse Road Bridge.

During late July 1983, semipermanent photopoints were established and the channel area in each section was photodocumented (Weaver and White 1985). Landmarks (i.e., mature trees, boulders) identifying transects were marked with red paint. A tape was stretched from these numbered landmarks at approximately a $90^{o}$ angle to the channel. The photographer's location on this transect was selected for maximum effectiveness and the distance from the landmark and compass heading of the lense were recorded. An Olympus OM-1 with a Zuiko 50 mm lense and Kodak 100 ASA color print film were used. This procedure was repeated during November 1987. The 1987 photographs were compared to the 1985 series to document debris recruitment and movement. Changes observed between the initial photography in 1983 and the 1985 series were discussed by Weaver and White (1985).

## RESULTS AND DISCUSSION

### Fish Abundance Estimates

Estimated juvenile bull trout populations showed annual fluctuations in most sections censused during this monitoring program (Table 3). Low probability of capture during the first pass of a two-pass estimate (p) indicates the estimate may be questionable. Shepard and Graham (1983b) recommended a p of 0.6 or greater for reliable two-pass estimates. Considering this, the 1987 juvenile bull trout estimate for the South Fork of Coal Creek (12 ±2) must be viewed cautiously, especially with only a single year of data prior to this year. All other juvenile bull trout estimates during 1987 approached or exceed acceptable levels of p (Table 3). No p values were reported with estimates for Quintonkin Creek in 1983 and Squeezer Creek in 1984 because a mark-recapture methodology was used.

The Dead Horse Bridge section of main Coal Creek has been electrofished annually since 1982 using the mark-recapture technique of population estimation. This continuous record allowed estimation of survival of juvenile bull trout from Age I to Age II and from Age II to Age III in this section (Table 4). Poor efficiency of block nets and electrofishing gear in containing and capturing small fish prevented estimation of the number of young-of-the-year bull trout, so survival from Age 0 to Age I could not be calculated.

Estimated survival from Age I to Age II averaged 45 percent ranging from 32 to 60 percent during the five years from which data were available (Table 4). Age II to Age III survival estimates were similar, averaging 41 percent during four years and ranging from 17 to 63 percent. These survival estimates must be considered minimum values because we were unable to satisfactorily factor in emigration of Age I and older fish from the stream section. Juvenile emigration of Age I and older fish has been documented by downstream trapping making survival estimates difficult. Eighteen percent of the bull trout smolts trapped during past studies were Age I, 49 percent were Age II and 32 percent were Age III (Fraley and Shepard (in prep)).

Weaver and Fraley (1986) reported the possibility of a relationship between spawner escapement and juvenile bull trout populations in subsequent years. Comparison of bull trout redd numbers observed annually between 1980 and 1985 in the Dead Horse Bridge spawning area with the estimated number of Age I fish between 1982 and 1987 in the associated electrofishing section showed this relationship was not as strong as originally thought (Figure 1). The period of record is just beginning to reach the length necessary to assess juvenile survival by age class and spawner-juvenile relationships in Coal Creek.

Table 3. Summary of electrofishing population estimates for Age I and older bull trout in areas specified for monitoring during 1987.

| Drainage | Creek | Section | Date | $\hat{N}$ | 95% C.I. | $\hat{p}$ |
|---|---|---|---|---|---|---|
| North Fork Flathead | | | | | | |
| | Coal | South Fork Br. | 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 |
| | South Fork Coal | Section 26 | 8/28/85 | 62 | ± 8 | .74 |
| | | | 8/06/87 | 12 | ± 2 | .48 |
| South Fork Flathead | | | | | | |
| | Quintonkin | Trap site | 9/19/83 | 241[a] | ±82 | -- |
| | | | 9/17/87 | 77 | ± 6 | .78 |
| Swan River | | | | | | |
| | Goat | Cutting unit Sec 10 | 9/30/82 | 48[b] | ± 9 | .65 |
| | | | 8/11/87 | 66 | ± 6 | .79 |
| | Squeezer | Road crossing Sec 21 | 9/27/84 | 142[a] | ±86 | -- |
| | | | 8/12/87 | 61 | ±10 | .69 |

a/ Population estimates for 300 m sections.
b/ Population estimate for a 122 m section.

Table 4. Juvenile bull trout population estimates ($\hat{N}$) by age class and percent survival of Age I to Age II and from Age II to Age III in the Dead Horse Bridge electrofishing section.

| Spawning Year | Age 0[a] | $\hat{N}$ Age I | Survival (Percent) | $\hat{N}$ Age II | Survival (Percent) | $\hat{N}$ Age III |
|---|---|---|---|---|---|---|
| | 1981 | 1982 | | 1983 | | 1984 |
| 1980 | -- | 84 | (42) | 35 | (17) | 6 |
| | 1982 | 1983 | | 1984 | | 1985 |
| 1981 | -- | 59 | (32) | 19 | (63) | 12 |
| | 1983 | 1984 | | 1985 | | 1986 |
| 1982 | -- | 62 | (53) | 33 | (54) | 18 |
| | 1984 | 1985 | | 1986 | | 1987 |
| 1983 | -- | 108 | (60) | 65 | (29) | 19 |
| | 1985 | 1986 | | 1987 | | 1988 |
| 1984 | -- | 86 | (40) | 34 | (--) | ?? |
| | 1986 | 1987 | | 1988 | | 1989 |
| 1985 | -- | 126 | (--) | ?? | (--) | ?? |
| | | | $\bar{x}$ = 45 (n=5) | | $\bar{x}$ = 41 (n=4) | |

[a] Poor efficiency of electrofishing gear and block nets in capturing small fish prevented population estimation of young-of-the-year (Age 0) bull trout so Age 0 to Age I survival rate could not be calculated.

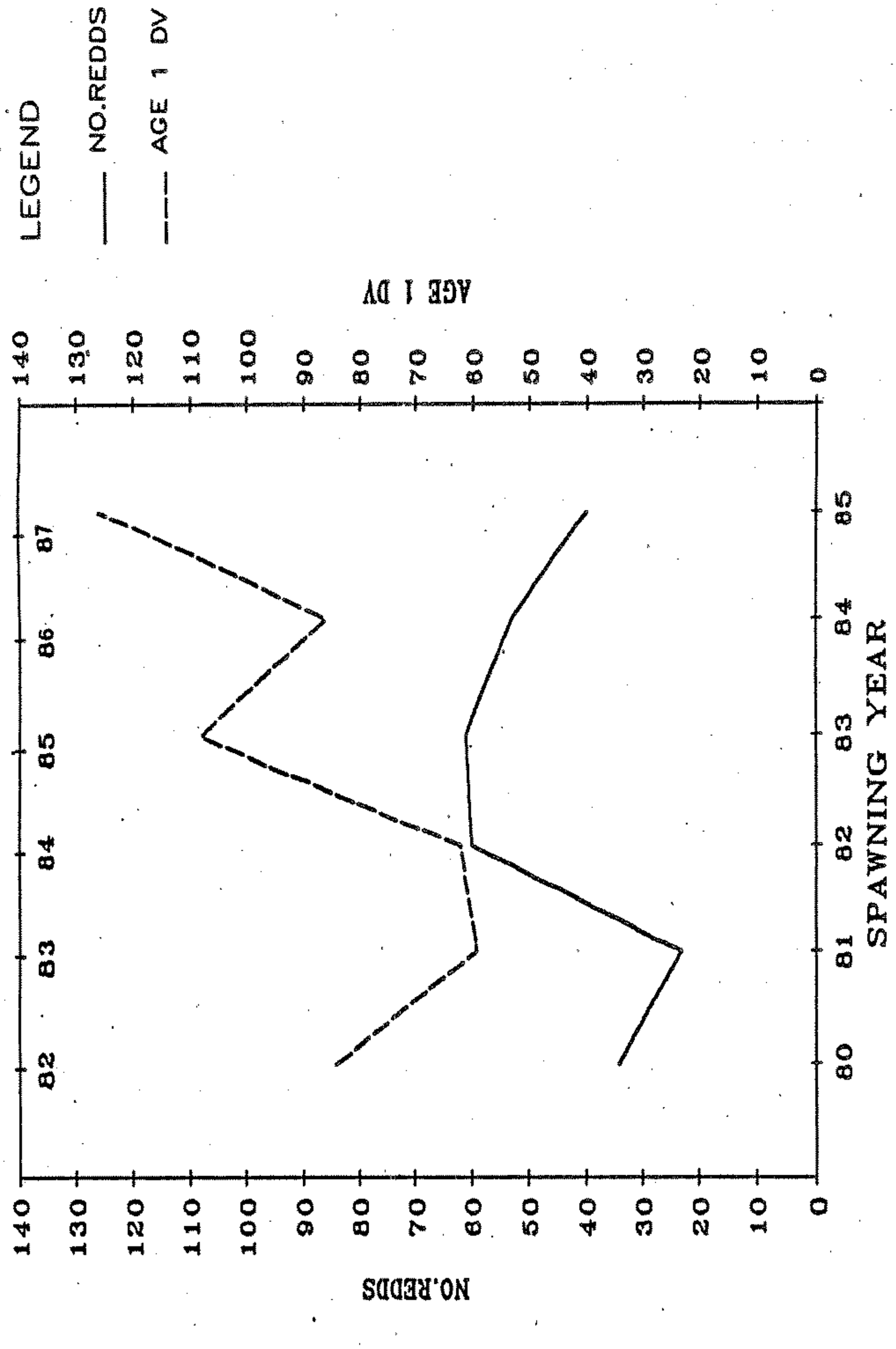



Figure 1. Comparison of the number of bull trout redds and resulting year class strength in the Dead Horse Bridge section of Coal Creek.

This weak relationship between spawner escapement and resulting year class strength suggests juvenile bull trout population levels may be controlled by other factors. The 1987 population estimate of 179 Age I+ bull trout/150 m in the Dead Horse Bridge section was the highest on record to date and indicates an estimated increase of approximately 20 fish over previous high estimates in 1984 and 1985. A spring storm accompanied by high winds resulted in a number of streamside trees falling into the channel area near Dead Horse Bridge. The increase in channel cover was documented by the 1987 instream debris photography (Appendix A, plates A8 - A10) and by the habitat survey on HS1. One large spruce tree fell and a portion of it remained lodged in the Dead Horse Bridge electrofishing section resulting in an increase in instream cover. Although the increase was not quantified, it is possible that it may have been responsible for this year's higher juvenile bull trout population estimate. If so, this suggests that rearing habitat may control population levels and raises the possibility that rearing capacity may be increased by more instream cover. Fraley and Graham (1982) reported trout cover was one of the variables which best described fish densities in Flathead tributaries. Pratt 1984 reported that juvenile bull trout distributed themselves along the stream bottom in areas of low water velocity and were highly associated with submerged cover.

This type of instream cover becomes more important as levels of fine sediments increase filling interstitial spaces in streambed substrate. These interstitial spaces in unimbedded cobble-rubble substrate were the cover type most utilized by smaller bull trout (Pratt 1984). Substrate scores reflect this filling and are presented in the Habitat Assessment sections of this report.

Population estimates for westslope cutthroat trout showed similar annual fluctuations (Table 5). In general, stream sections selected for monitoring westslope cutthroat trout abundance were smaller than those utilized for juvenile bull trout population estimation. The recent large fluctuations in estimated cutthroat numbers may in part be due to extremely low summer flows in these smaller streams.

Low $\hat{p}$ values associated with the cutthroat trout estimates for the South Fork of Coal Creek during both annual samplings make these estimates highly questionable (Table 5). A mark-recapture estimate was completed on Quintonkin Creek in 1983, so no p value was reported with this estimate. Discussion of fluctuations in cutthroat populations and changes in habitat will be presented by May et al. (1988).

**Spawning Site Inventories**

We identified 48 and 49 redds, respectively, in the specified reaches of Coal Creek and Morrison Creek. The count for Coal

Table 5. Summary of electrofishing population estimates for age I and older westslope cutthroat trout in areas specified for monitoring in 1987.

| Drainage | Creek | Section | Date | $\hat{N}$ | 95% C.I. | $\hat{p}$ |
|---|---|---|---|---|---|---|
| North Fork Flathead | | | | | | |
| | Coal | South Fork Br. | 8/04/82 | 32 | ± 6 | .74 |
| | | | 8/25/83 | 27 | ± 4 | .82 |
| | | | 8/29/84 | 31 | ± 9 | .65 |
| | | | 8/27/85 | 36 | ±12 | .33 |
| | | | 9/03/86 | 40 | ±11 | .64 |
| | | | 8/05/87 | 63 | ± 2 | .91 |
| | South Fork Coal | Section 26 | 8/28/85 | 63 | ±35 | .33 |
| | | | 8/06/87 | 43 | ± 4 | .47 |
| South Fork Flathead | | | | | | |
| | Quintonkin | Trap site | 9/19/83 | 92[a/] | ±47 | -- |
| | | | 9/17/87 | 27 | ± 5 | .75 |

a/ Population estimate for a 300-m section.

Creek was higher than the 1979-1986 average of 40 redds; the count for Morrison Creek was lower than the 1979-1986 average of 59 redds (Table 6). Bull trout spawning in Morrison Creek may have been limited in 1987 by low flows and the presence of a channel debris barrier located 5.5 km above the Middle Fork Flathead River.

No redds were located in the South Fork of Coal Creek in 1987. USFS personnel located two redds in an aerial survey of the Spotted Bear River in the South Fork Flathead drainage.

Overall, redd counts for index streams in the Flathead Basin were higher than average in 1987 (Table 6). The 1987 count of 277 redds in the North Fork drainage is about 30 percent higher than the 1979-1986 average of 216. The count for the Middle Fork drainage was 149 redds, slightly higher than the 1979-1986 average of 140. We identified 290 redds in index tributaries of the Swan drainage, 39 percent more than the 1982-1986 average of 209 (Table 6).

Annual fluctuations of the number of redds in Coal Creek roughly approximate trends in total numbers of redds in all monitoring areas of tributaries in the North Fork drainage from 1979-1987 (Figure 2). Trends of redd abundance in Morrison Creek are very similar to trends in total numbers of redds in all monitoring areas of tributaries in the Middle Fork drainage.

## Spawning Area Substrate Composition

Relatively high percentages of material smaller than 6.35 mm in diameter resulted in low predicted embryo survival to emergence for both species at all contract sites, except for the South Fork of Coal Creek (Table 7). Results from the site above the South Fork Bridge in main Coal Creek (North Fork) are not currently available and will be presented as an addendum to this report.

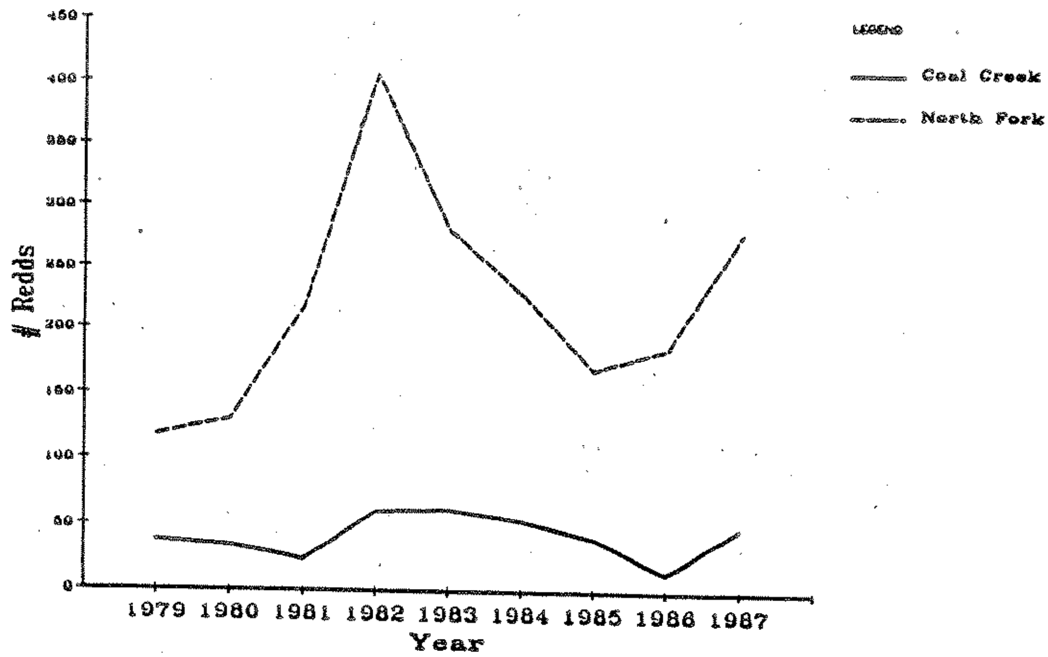
This year's information from westslope cutthroat trout spawning areas represents the second year of data for assessing trends in sediment deposition and prediction of embryo survival to emergence (Table 7). Several fluvial westslope cutthroat redds were core sampled in Challenge Creek during 1981 (Shepard et al. 1982). Sieve analysis of these samples showed 29 and 12 percent of the material collected was smaller than 6.35 and 1.70 mm respectively. This resulted in a predicted cutthroat embryo survival to emergence of 24 percent. Although comparison of samples taken in natural redds with those collected from undisturbed substrate in the spawning area may not be entirely valid (Chapman and McLeod 1987), the 1981 data provides a reference point five years prior to the onset of current data collection. The 1986 core sampling in Challenge Creek showed a major increase in fine sediment from an unidentified source had occurred since 1982, resulting in an average predicted survival of only 5 percent for this important westslope cutthroat spawning

Table 6. Bull trout redd counts for selected areas of tributaries chosen for monitoring in the Flathead drainage (from Montana Department of Fish, Wildlife and Parks 1988).

| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|
| North Fork: | | | | | | | | | |
| Big | 10 | 20 | 18 | 41 | 22 | 9 | 9 | 12 | 22 |
| Coal | 38 | 34 | 23 | 60 | 61 | 53 | 40 | 13 | 48 |
| Whale | 35 | 45 | 98 | 211 | 141 | 133 | 94 | 90 | 143 |
| Trail | 34 a/ | 31 a/ | 78 | 94 | 56 | 32 | 25 | 69 | 64 |
| Total | 117 | 130 | 217 | 406 | 280 | 227 | 168 b/ | 184 | 277 |
| Middle Fork: | | | | | | | | | |
| Morrison | 25 a/ | 75 | 32 a/ | 86 | 67 | 38 | 99 | 52 | 49 |
| Granite | 14 | 34 | 14 a/ | 34 | 31 | 47 | 24 | 37 | 34 |
| Lodgepole | 32 | 14 | 18 | 23 | 23 | 23 | 20 | 42 | 21 |
| Ole | | 19 | 19 | 51 | 35 | 26 | 30 | 36 | 45 |
| Total | 71 | 142 | 83 | 194 | 156 | 134 | 173 b/ | 167 | 149 |
| Total, North and Middle Fork | 188 | 272 | 300 | 600 | 436 | 361 | 341 | 351 | 426 |

| | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|
| Swan drainage: | | | | | | |
| Elk | 56 | 91 | 93 | 19 | 53 | 162 |
| Goat | 33 | 39 | 31 | 40 | 56 | 31 |
| Squeezer | 41 | 57 | 83 | 24 | 55 | 64 |
| Lion | 63 | 49 | 88 | 26 | 46 | 33 |
| Total | 193 | 236 | 295 | 109 | 210 | 290 |

a/ Counts may be underestimated due to incomplete survey.
b/ High flows may have obliterated some of the redds.



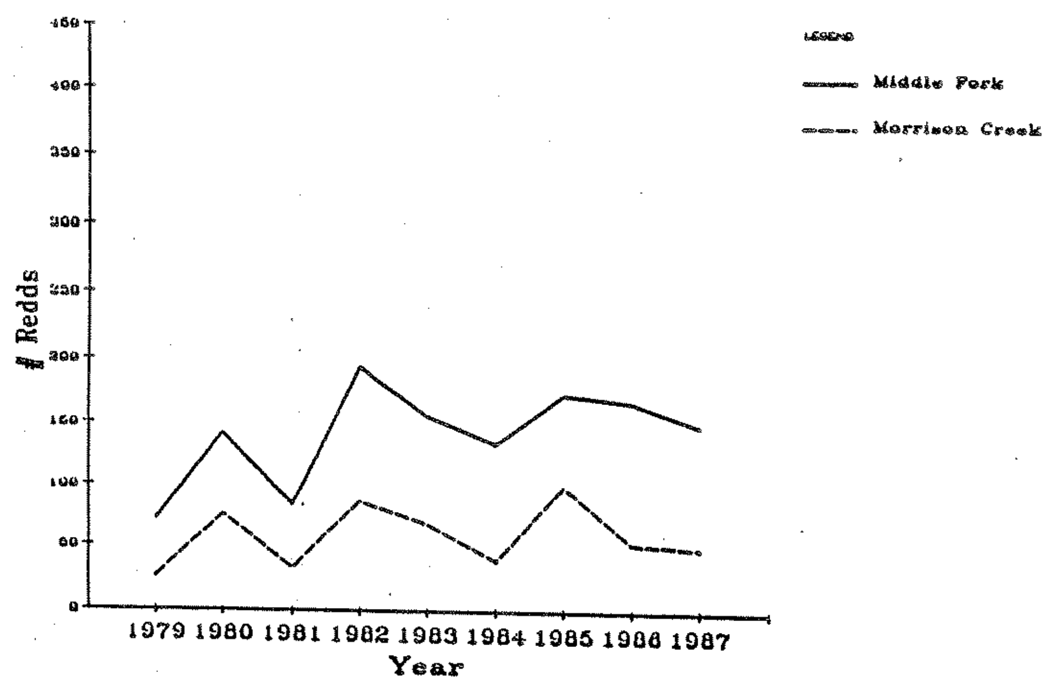




Figure 2. Number of bull trout redds counted in monitoring areas of Coal and Morrison creeks and number of bull trout redds counted in all monitoring areas in the North and Middle Fork drainage, 1979-1987.

Table 7. Summary of annual mean cumulative percentages of substrate material smaller than 1.70 and 6.35 mm in diameter and mean predicted survival to emergence from core samplings of undisturbed sites in known westslope cutthroat and bull trout spawning areas.

| Spawning area | Year | n | $\bar{x}$ % < 6.35 mm | $\bar{x}$ % < 1.70 mm | $\bar{x}$ Predicted survival (%) |
|---|---|---|---|---|---|
| Westslope cutthroat | | | | | |
| Challenge Creek | | | | | |
| | 1986 | 12 | 40 | 17 | 5 |
| | 1987 | 12 | 34 | 16 | 12 |
| Hungry Horse Creek | | | | | |
| Lower site | 1986 | 8 | 27 | 10 | 35 |
| | 1987 | 11 | 34 | 13 | 19 |
| Bull trout | | | | | |
| Coal Creek | | | | | |
| | 1981 | 10 | 33 | -- | 56 |
| | 1982 | 19 | 38 | -- | 30 |
| | 1983 | 20 | 37 | -- | 35 |
| | 1984 | 18 | 33 | -- | 56 |
| | 1985 | 20 | 36 | -- | 31 |
| | 1986 | 16 | 35 | -- | 46 |
| | 1987 | 18 | 41 | -- | 19 |
| South Fork Coal Creek | | | | | |
| | 1985 | 12 | 37 | -- | 24 |
| | 1986 | 12 | 32 | -- | 59 |
| | 1987 | 12 | 33 | -- | 57 |
| Granite Creek | | | | | |
| | 1982 | 10 | 42 | -- | 8 |
| | 1986 | 8 | 52 | -- | 0 |
| | 1987 | 12 | 44 | -- | 14 |

area (Table 7). Results of current core sampling suggested a slight recovery.

Electrofishing estimates completed in this section of Challenge Creek showed densities of westslope cutthroat trout declined from 126/100 $m^2$ during 1981 to 77 and 66/100 $m^2$ in 1982 and 1983, respectively. No estimates were made during 1984 or 1985. Estimated density during 1986 was 112/100 $m^2$ and a further increase was observed in 1987. Although population estimates and results of core sampling both suggested a decline in rearing habitat quality between 1981 and 1986, the relationship remains clouded due to other factors. The electrofishing section in Challenge Creek was a typical small cutthroat stream where lower than average late summer flows may have resulted in large fluctuations in cutthroat densities. Stream trapping in Challenge Creek showed the westslope cutthroat population consisted of both resident and fluvial fish, again raising the problem of quantifying emigration from a particular stream section. Another complicating factor was that survival to emergence predictions reported for cutthroat trout were calculated based on a laboratory developed relationship between levels of fine sediment and cutthroat embryo survival. Areas of upwelling groundwater in natural stream channels are often selected as spawning sites and may partially mitigate high levels of fine sediment. Groundwater influence has not been adequately simulated in laboratory studies, consequently, predictive equations developed in laboratory environments probably underestimate embryo survival. Future work should include efforts to quantify effects of emigration and development of field equations for survival to emergence prediction for cutthroat trout.

The cutthroat trout spawning area core sampled in Hungry Horse Creek showed an increase in fine sediment between 1986 and 1987 (Table 7). Substrate sampling in the Hungry Horse drainage should continue to determine if this increasing trend continues. Predicted survival to emergence has dropped to less than 20 percent in the Hungry Horse Creek spawning area (Table 7).

The bull trout spawning area in Coal Creek has been core sampled annually since 1981 (Table 7). The South Fork of Coal Creek has been sampled annually since 1985 and the bull trout spawning area in Granite Creek was sampled in 1982 and during the past two years (Table 7).

The South Fork of Coal Creek contained levels of fine material similar to 1986 with survival predictions currently at 57 percent. The lowest predicted survival in this spawning area (24 percent) occurred during the initial year of core sampling, when the percentage of material smaller than 6.35 mm averaged 37 percent (Table 7).

A major increase in fine material from unidentified sources occurred in Coal Creek's Dead Horse Bridge spawning area between

1986 and 1987. The percentage of material smaller than 6.35 mm averaged 41 percent in 18 core samples collected from undisturbed gravel. Average predicted survival was only 19 percent (Table 7). Extensive road development and logging took place in the drainage during the Coal Ridge timber sale. Currently, the Department of State Lands is developing a portion of Coal Creek State Forest just upstream from Dead Horse Bridge. As previously stated, no source of sediment recruitment has been identified but extreme care must be exercised to avoid further increases in sediment levels in this important spawning area.

Sediment levels in samples from the spawning area in Granite Creek increased from 42 percent smaller than 6.35 mm in 1982 to 52 percent in 1986, resulting in a survival prediction of zero (Table 7). The annual averages reported have included sites located in a trail crossing where bull trout redds have been observed during redd counts. This year, the six cores taken from the crossing averaged 47 percent smaller than 6.35 mm while the six taken in the spawning area approximately 300 m upstream averaged 41 percent. Survival predictions averaged 5 and 22 percent, respectively. Sediment levels in the Granite Creek spawning area may have been increased by the Skyland Road slump and current developments in the area have the potential to further degrade important spawning gravel quality.

Core samples taken in nine natural bull trout redds during 1987 were compared to those taken from undisturbed substrate in bull trout spawning areas (n=65). The six samples from the Granite Creek Trail crossing were not included. Natural redds contained an average of 35 percent material smaller than 6.35 mm and mean predicted survival was 45 percent. Substrate composition in undisturbed sites averaged 34 percent smaller than 6.35 mm resulting in a mean predicted survival to emergence of 54 percent basin wide. Current levels of fine sediment warrant concern for bull trout embryo survival to emergence and juvenile rearing habitat in Coal Creek's Dead Horse Bridge area and in Granite Creek. Ongoing development in both drainages creates the potential for further degradation of both spawning and rearing habitat in these important bull trout streams.

### Instream Habitat Assessment

Averages of physical habitat measurements in the three sections of main Coal Creek differed little between 1983 and 1987 (Tables 8, 9 and 10). Observed differences in channel width were most likely due to random site selection. Lower flows during the 1987 surveys accounted for the increased number of pool and riffle habitat units and fewer runs and multiple channel habitat units. Pools were more easily identified during lower flows. Substrate composition and imbeddedness also remained similar, although a slight increasing trend in the smaller substrate size classes and imbeddedness was observed, resulting in lower substrate scores in 1987 (Table 11).

Table 8. Comparison of mean physical habitat measurements in the Dead Horse Bridge section (HS1) of Coal Creek collected during the summers of 1983 and 1987.

| Habitat Unit | n | Date | Flow (cfs) | Channel Width (m) | Wetted Width (m) | Average Depth (cm) | Maximum Depth (cm) | D-90 (cm) |
|---|---|---|---|---|---|---|---|---|
| Pool | 2 | 7/25/83 | 115 | 22.1 | 22.1 | 80.0 | 160 | 20.0 |
| Riffle | 4 | | | 28.3 | 20.6 | 35.2 | 150 | 18.8 |
| Run | 14 | | | 22.9 | 16.8 | 42.4 | 100 | 20.1 |
| Pocket water | 0 | | | -- | -- | -- | -- | -- |
| Multiple channels | 5 | | | 25.8 | 15.3 | 39.8 | 130 | 18.2 |
| AVERAGE | | | | 24.3 | 19.5 | 49.4 | 135 | 19.3 |
| Pool | 4 | 7/24/87 | 62 | 21.8 | 21.5 | 78 | 152 | 22.0 |
| Riffle | 10 | | | 27.9 | 24.1 | 34.8 | 149 | 19.1 |
| Run | 8 | | | 23.1 | 17.0 | 41.1 | 97 | 21.0 |
| Pocket water | 0 | | | -- | -- | -- | -- | -- |
| Multiple channels | 3 | | | 26.0 | 15.1 | 38.9 | 124 | 18.5 |
| AVERAGE | | | | 24.7 | 19.4 | 48.2 | 130.5 | 20.2 |

Table 9. Comparison of mean physical habitat measurements in the South Fork Bridge section (HS2) of main Coal Creek collected during the summers of 1983 and 1987.

| Habitat Unit | n | Date | Flow (cfs) | Channel Width (m) | Wetted Width (m) | Average Depth (cm) | Maximum Depth (cm) | D-90 (cm) |
|---|---|---|---|---|---|---|---|---|
| Pool | 1 | 7/27/83 | 63 | 12.9 | 12.9 | 58.0 | 90 | 48.0 |
| Riffle | 3 | | | 16.3 | 12.8 | 30.7 | 65 | 42.3 |
| Run | 11 | | | 14.5 | 9.8 | 35.5 | 100 | 41.4 |
| Pocket water | 7 | | | 11.4 | 9.5 | 31.8 | 65 | 43.0 |
| Multiple channels | 3 | | | 25.7 | 15.8 | 29.6 | 80 | 37.0 |
| AVERAGE | | | | 16.2 | 12.2 | 37.1 | 80 | 42.3 |
| Pool | 2 | 7/16/87 | 31 | 18.0 | 14.9 | 42.5 | 62 | 46.5 |
| Riffle | 6 | | | 14.1 | 11.0 | 16.6 | 34 | 44.3 |
| Run | 8 | | | 14.7 | 10.7 | 22.7 | 41 | 44.1 |
| Pocket water | 9 | | | 12.2 | 9.9 | 23.4 | 40 | 42.9 |
| Multiple channels | 0 | | | -- | -- | -- | -- | -- |
| AVERAGE | | | | 14.8 | 11.6 | 26.3 | 44.2 | 44.4 |

Table 10. Comparison of mean physical habitat measurements in the Riparian Cut section (HS3) of main Coal Creek collected during the summers of 1983 and 1987.

| Habitat Unit | n | Date | Flow (cfs) | Channel Width (m) | Wetted Width (m) | Average Depth (cm) | Maximum Depth (cm) | D-90 (cm) |
|---|---|---|---|---|---|---|---|---|
| Pool | 0 | 7/28/83 | 43 | -- | -- | -- | -- | -- |
| Riffle | 11 | | | 12.9 | 10.9 | 18.3 | 51 | 31.9 |
| Run | 6 | | | 12.4 | 7.9 | 27.7 | 50 | 27.7 |
| Pocket water | 4 | | | 16.3 | 11.3 | 23.8 | 46 | 24.5 |
| Multiple channels | 4 | | | 15.0 | 11.2 | 26.5 | 70 | 23.0 |
| AVERAGE | | | | 13.7 | 10.8 | 22.7 | 54.2 | 29.3 |
| Pool | 0 | 7/28/87 | 26 | -- | -- | -- | -- | -- |
| Riffle | 13 | | | 16.0 | 9.9 | 18.6 | 36 | 32.9 |
| Run | 5 | | | 15.5 | 8.7 | 25.1 | 41 | 29.5 |
| Pocket water | 3 | | | 12.1 | 9.5 | 22.9 | 40 | 26.5 |
| Multiple channels | 4 | | | 14.9 | 10.8 | 22.5 | 42 | 27.9 |
| AVERAGE | | | | 14.6 | 9.7 | 22.3 | 39.8 | 29.2 |

Table 11. Comparison of mean substrate composition imbeddedness and cover in the three habitat survey sections in main Coal Creek during late July, 1983 and 1987.

| Survey Section | HS1 | | HS2 | | HS3 | |
|---|---|---|---|---|---|---|
| Year | 1983 | 1987 | 1983 | 1987 | 1983 | 1987 |
| <u>Substrate Class</u> ($\bar{x}$%) | | | | | | |
| Organic, Silt, Sand | 22 | 24 | 9 | 10 | 10 | 11 |
| Small Gravel | 23 | 27 | 9 | 10 | 15 | 16 |
| Large Gravel | 36 | 34 | 27 | 25 | 37 | 36 |
| Cobble | 17 | 14 | 34 | 32 | 31 | 29 |
| Boulder | 2 | 1 | 21 | 23 | 6 | 8 |
| Imbeddedness ($\bar{x}$%) | 32 | 35 | 19 | 24 | 26 | 30 |
| Substrate score | 10.3 | 10.0 | 14.0 | 13.7 | 11.2 | 10.6 |
| Bank cover ($\bar{x}$%) | 15 | 11 | 46 | 35 | 30 | 24 |
| Instream cover ($\bar{x}$%) | 27 | 31 | 56 | 58 | 45 | 48 |

Overhanging bank cover less than 2.0 m was lower in all three sections during 1987 (Table 11) due to lower flows and narrower wetted widths. Most instream cover was provided by submerged logs and debris which have increased by 5 and 8 percent respectively since the 1983 surveys. Fraley and Graham (1982) identified cover as the variable most related to high trout densities in tributaries to the North and Middle forks of the Flathead River. Extreme caution should be exercised in removing any organic material from stream channels due to its importance as fish cover.

Channel characteristics in reaches I and II of the South Fork of Coal Creek and reaches I and II in Mathias Creek also remained quite similar. Most differences observed were due to lower flows during 1987 surveys and random site selection. An increase in channel debris was noted in reach I of Mathias Creek. This appeared to have resulted from a combination of timber harvest and wind-thrown trees along with an increased amount of beaver activity. A series of beaver dams and debris jams in this reach have caused channel braiding at several locations since the original survey in 1979.

The locations of instream debris accumulations in the two sections of main Coal Creek have remained relatively stable although photographs show some debris recruitment and movement has occurred since 1985 (Appendix A). In the Dead Horse Bridge section (Plates A1 - A10), comparison of photographs from site one in 1985 and 1987 shows the recent increase in medium-size logs and debris accumulated on the rootball on the left side of the channel. The medium logs spanning the channel at this site in 1985 were no longer present in 1987. The 1987 photograph of site two shows a newly recruited medium-sized tree on the gravel bar on the right while medium logs partially spanning the channel in 1985 were gone in 1987. Little change occurred at sites three through seven between 1985 and 1987. In 1985, site eight was a relatively open channel but the 1987 photograph shows newly recruited, wind-thrown trees practically covering the entire channel. Tops of several of these trees were visible on the gravel bar at site nine during 1987 and the debris accumulation along the far bank has increased since 1985. The debris pictured in the 1985 photograph of site ten was totally obscured by the newly fallen trees in 1987.

In the upstream debris monitoring section (Plates A11 - A18), little change occurred at sites one through four. The debris accumulation at site five has grown between 1985 and 1987. This increase is also visible in the photograph of site six. No major changes were evident at sites seven and eight between 1985 and 1987. In general, between 1985 and 1987 most newly recruited debris occurred naturally.

The similarity of survey results while discharges were considerably lower during 1987 reflects the confined nature of the stream channels in the upper Coal Creek drainage. Shepard and

Graham (1983a) reported similar wetted widths at different discharges during surveys conducted during spring and summer of 1982. The most important outcome of the habitat reassessment was the apparent increasing trend in fine sediment levels and imbeddedness in main Coal Creek as reflected by substrate scores (Table 11). Extremely low spring flows during the last several years may have resulted in less flushing action and increased retention of fine materials. Increases in instream debris may be partially responsible for holding fish populations at current levels.

Substrate score for the Quintonkin Creek electrofishing sections was 13.0. This was the initial year of information collection concerning rearing habitat in Quintonkin Creek.

## 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, Red Meadow, Whale, Ole, Morrison, Quintonkin, Goat and Squeezer creeks. Established sections for monitoring westslope cutthroat populations include Coal, South Fork Coal, Cyclone, Langford, Red Meadow, Challenge, Hungry Horse, Margaret, Tiger, Lost Mare and Quintonkin creeks.

   b. Maintain annual measurement of substrate quality in both westslope cutthroat and bull trout spawning areas by core sampling. Monitoring sites in bull trout spawning areas include Big, Coal, South Fork Coal, Whale, Trail and Granite creeks. Coring sites in westslope cutthroat spawning areas are both upper and lower Hungry Horse, Margaret, Tiger and Challenge creeks.

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

   d. Continue to evaluate survival by age class in important bull trout rearing areas. An effort should be made to complete multi-pass population estimates for Age 0 bull trout in a portion of the Dead Horse Bridge and Morrison Creek electrofishing sections. This could be done in conjunction with annual electrofishing of each section.

2. Future Data Needs

   a. Identify sediment sources contributing to high levels of fine material existing in the Coal and Granite Creek bull trout spawning areas.

   b. Develop a predictive equation for westslope cutthroat survival to emergence under field conditions. The Hungry Horse drainage would be the best location for this work.

   c. Determine what effect juvenile bull trout emigration has on estimated survival by age class and develop correction coefficients to adjust for it.

3. Management

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

We estimate that all work recommended could be completed with approximately 300 worker days. The work on development of equations for predicting westslope cutthroat survival to emergence under actual stream conditions would be completed in cooperation with personnel working on the BPA-funded Hungry Horse Reservoir study.

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**APPENDIX A**

Photographs documenting channel areas of the two instream debris monitoring sections during early July, 1985 and early November, 1987.

Plate 1. Debris photographs showing site one in the Dead Horse Bridge section on July 4, 1985 (top) and on November 6, 1987 (bottom).

Plate 2. Debris photographs showing site two in the Dead Horse Bridge section on July 4, 1985 (top) and on November 6, 1987 (bottom).

Plate 3. Debris photographs showing site three in the Dead Horse Bridge section on July 4, 1985 (top) and on November 6, 1987 (bottom).

Plate 4. Debris photographs showing site four in the Dead Horse Bridge section on July 4, 1985 (top) and on November 6, 1987 (bottom).

Plate 5. Debris photographs showing site five in the Dead Horse Bridge section on July 4, 1985 (top) and on November 6, 1987 (bottom).

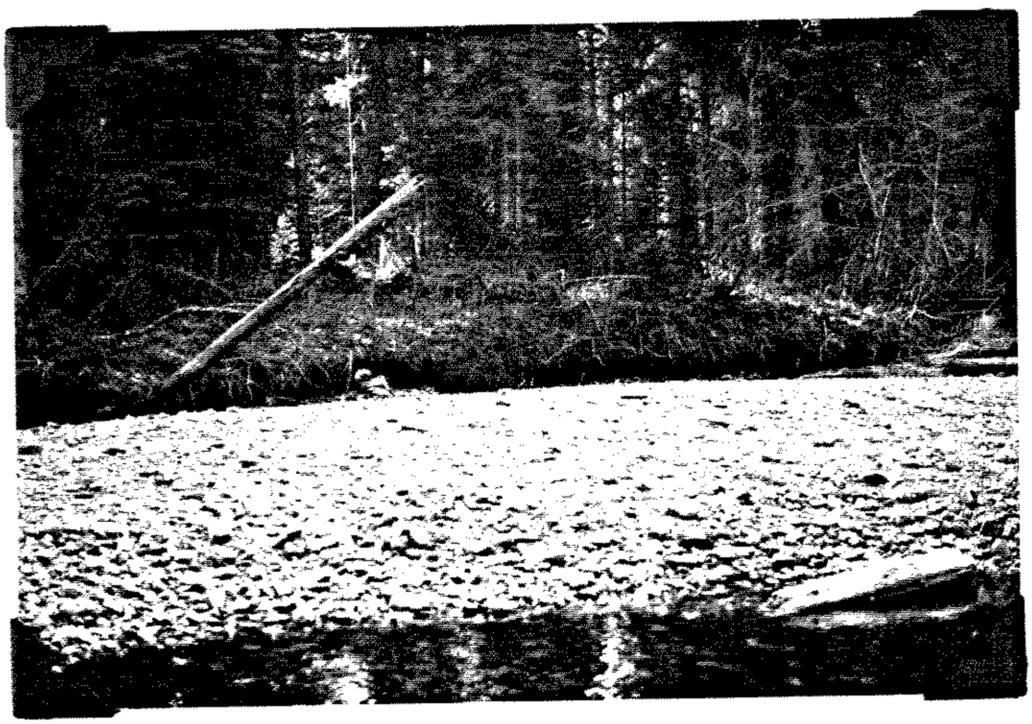


Plate 6. Debris photographs showing site six in the Dead Horse Bridge section on July 4, 1985 (top) and on November 6, 1987 (bottom).

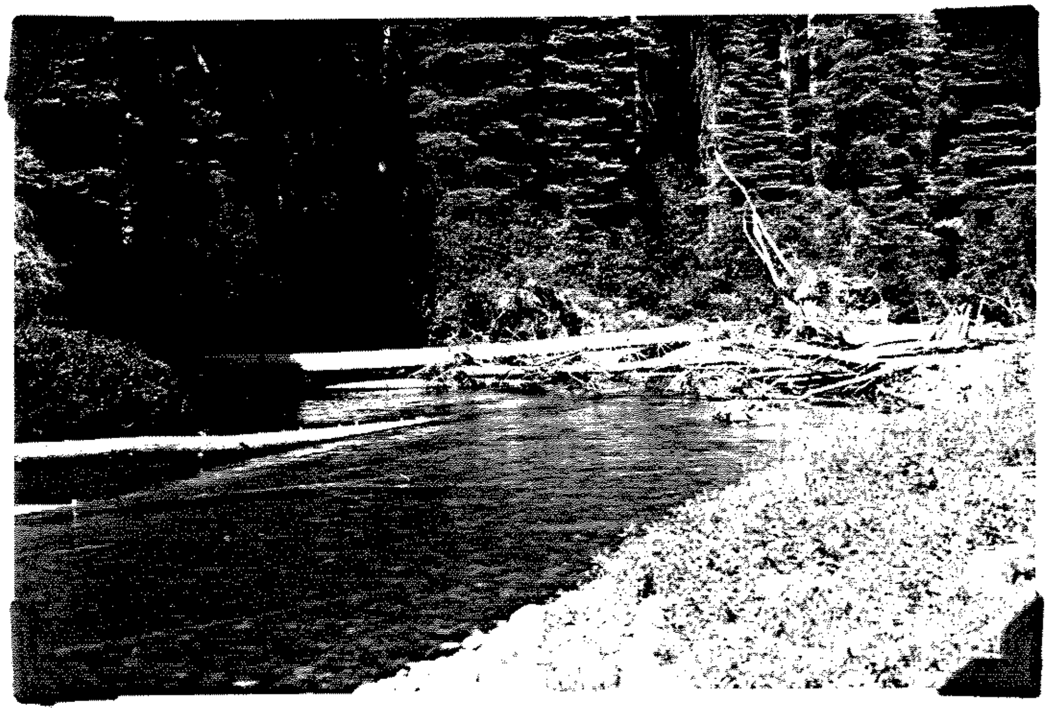
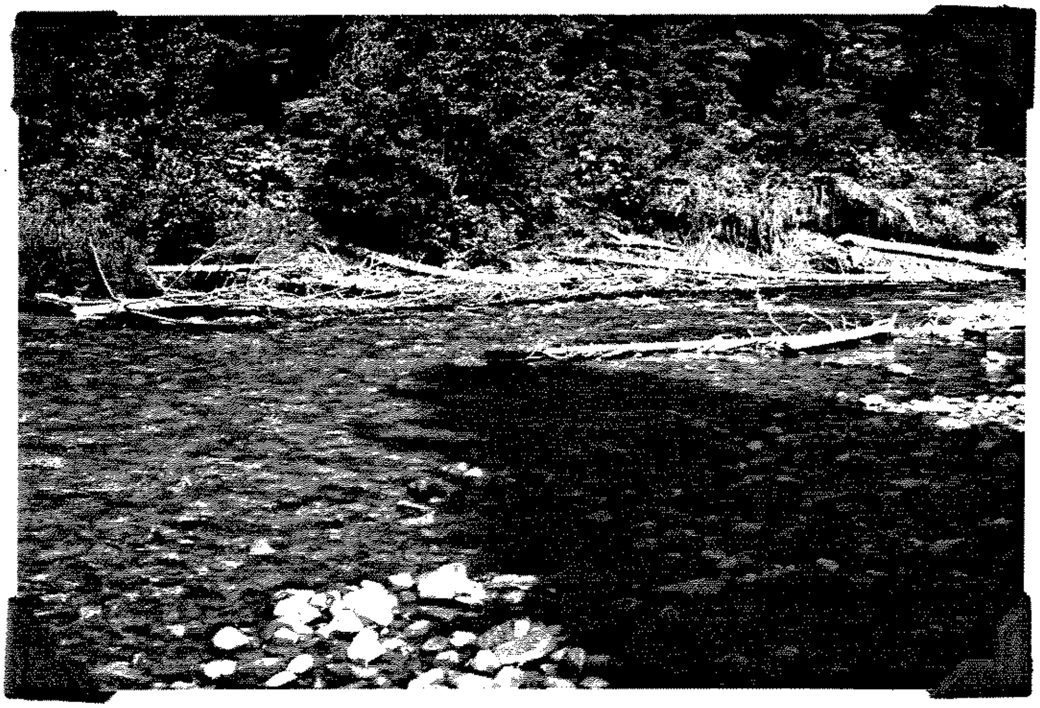


Plate 7. Debris photographs showing site seven in the Dead Horse Bridge section on July 4, 1985 (top) and on November 6, 1987 (bottom).

Plate 8. Debris photographs showing site eight in the Dead Horse Bridge section on July 4, 1985 (top) and on November 6, 1987 (bottom).

Plate 9. Debris photographs showing site nine in the Dead Horse Bridge section on July 4, 1985 (top) and on November 6, 1987 (bottom).



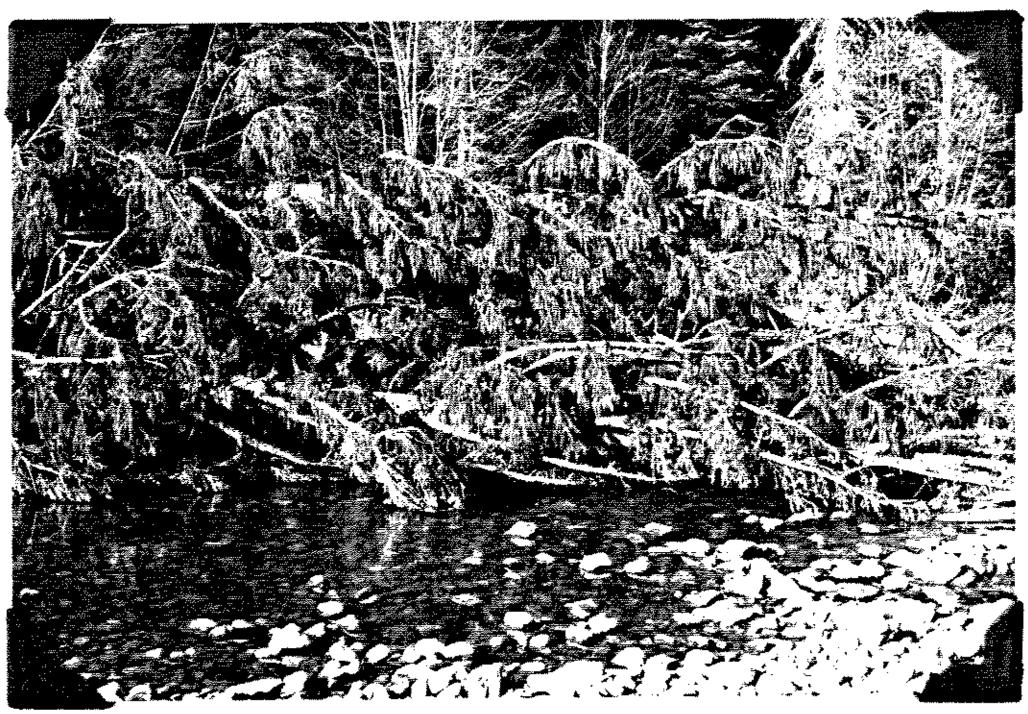
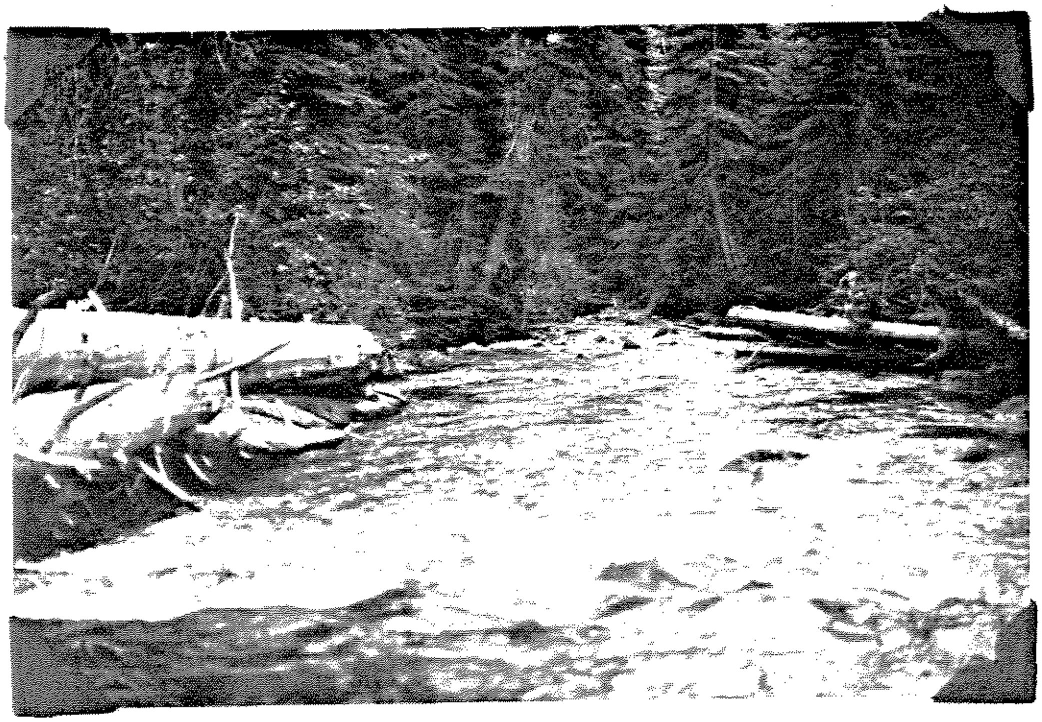


Plate 10. Debris photographs showing site ten in the Dead Horse Bridge section on July 4, 1985 (top) and on November 6, 1987 (bottom).

Plate 11. Debris photographs showing site one in the Riparian Cut section on July 4, 1985 (top) and on November 6, 1987 (bottom).



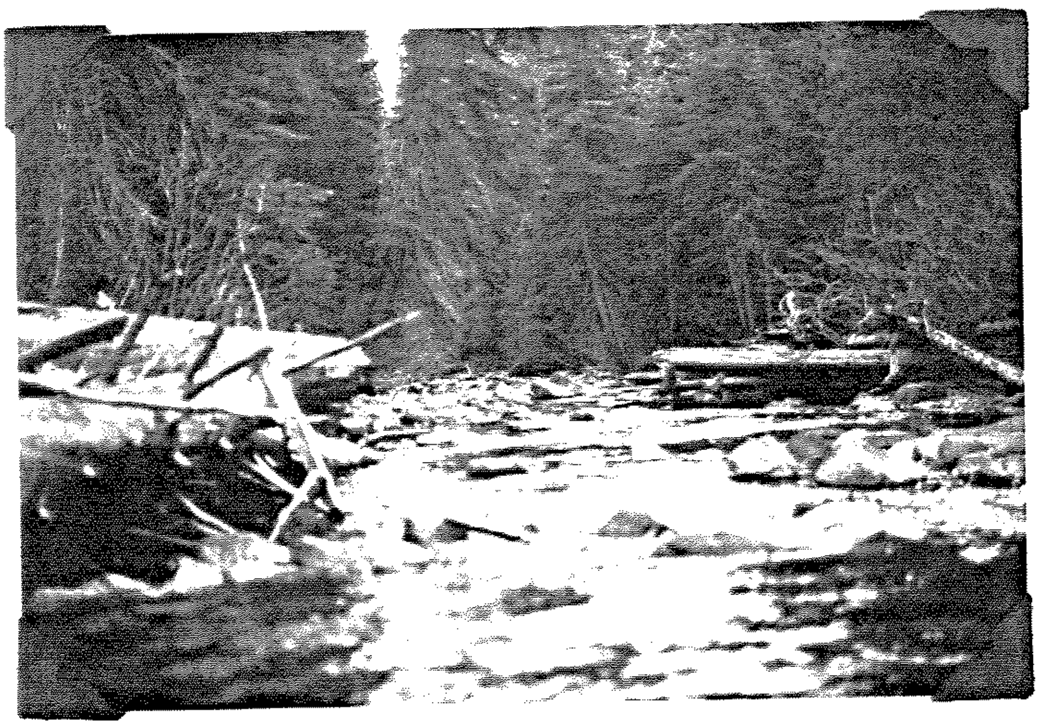


Plate 12. Debris photographs showing site two in the Riparian Cut section on July 4, 1985 (top) and on November 6, 1987 (bottom).

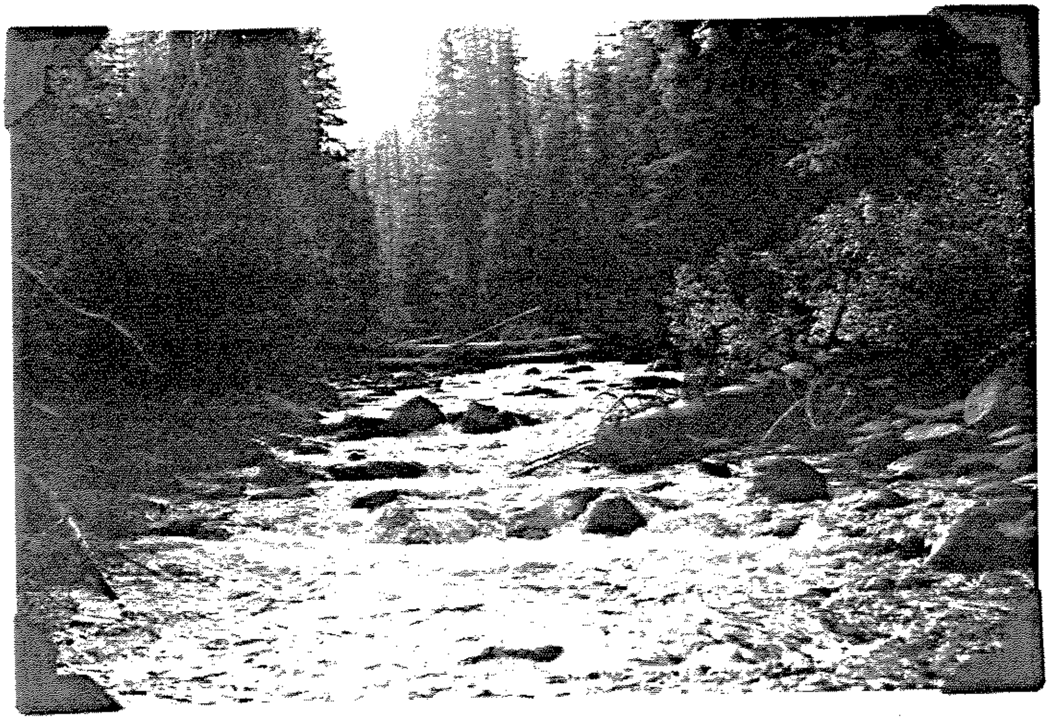


Plate 13. Debris photographs showing site three in the Riparian Cut section on July 4, 1985 (top) and on November 6, 1987 (bottom).

Plate 14. Debris photographs showing site four in the Riparian Cut section on July 4, 1985 (top) and on November 6, 1987 (bottom).

Plate 15. Debris photographs showing site five in the Riparian Cut section on July 4, 1985 (top) and on November 6, 1987 (bottom).

Plate 16. Debris photographs showing site six in the Riparian Cut section on July 4, 1985 (top) and on November 6, 1987 (bottom).

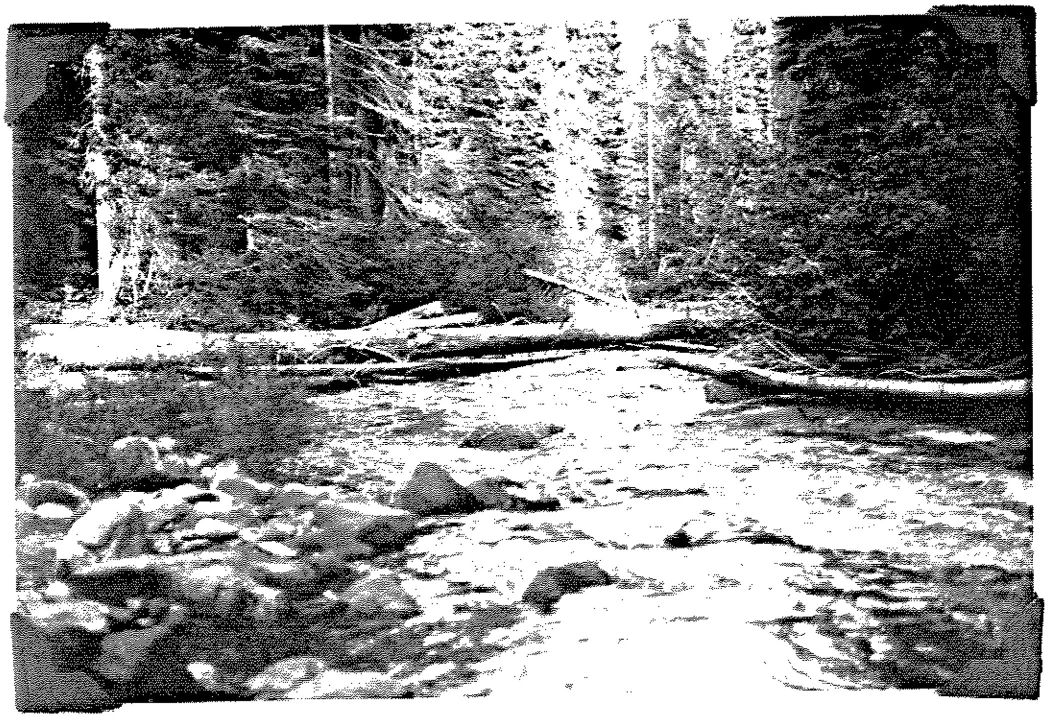
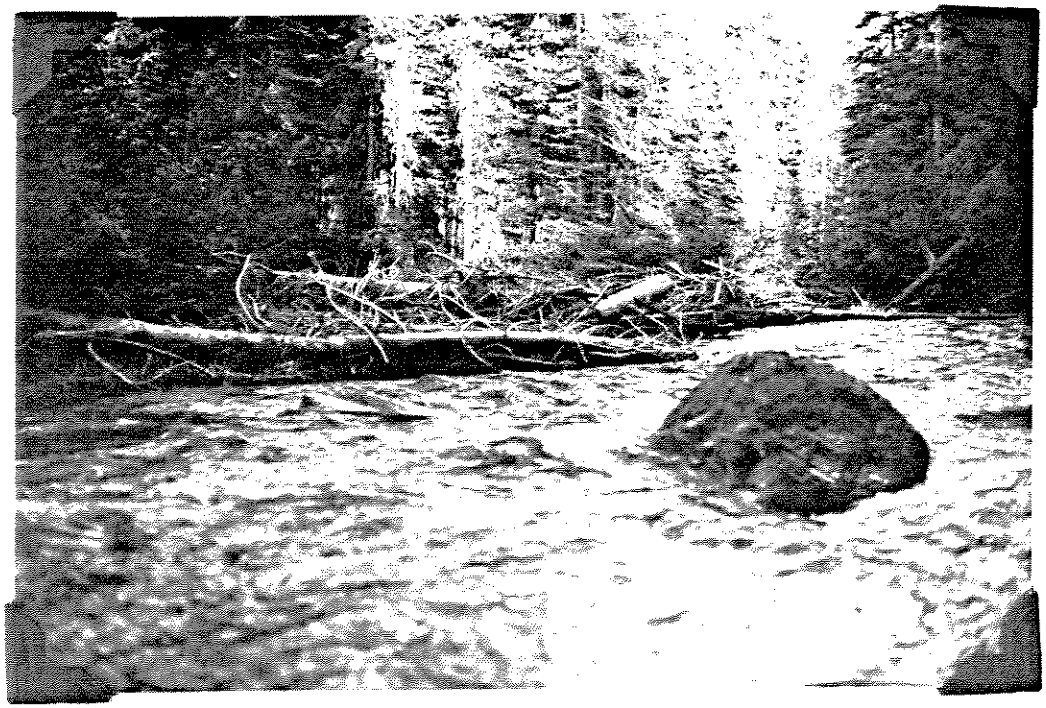


Plate 17. Debris photographs showing site seven in the Riparian Cut section on July 4, 1985 (top) and on November 6, 1987 (bottom).



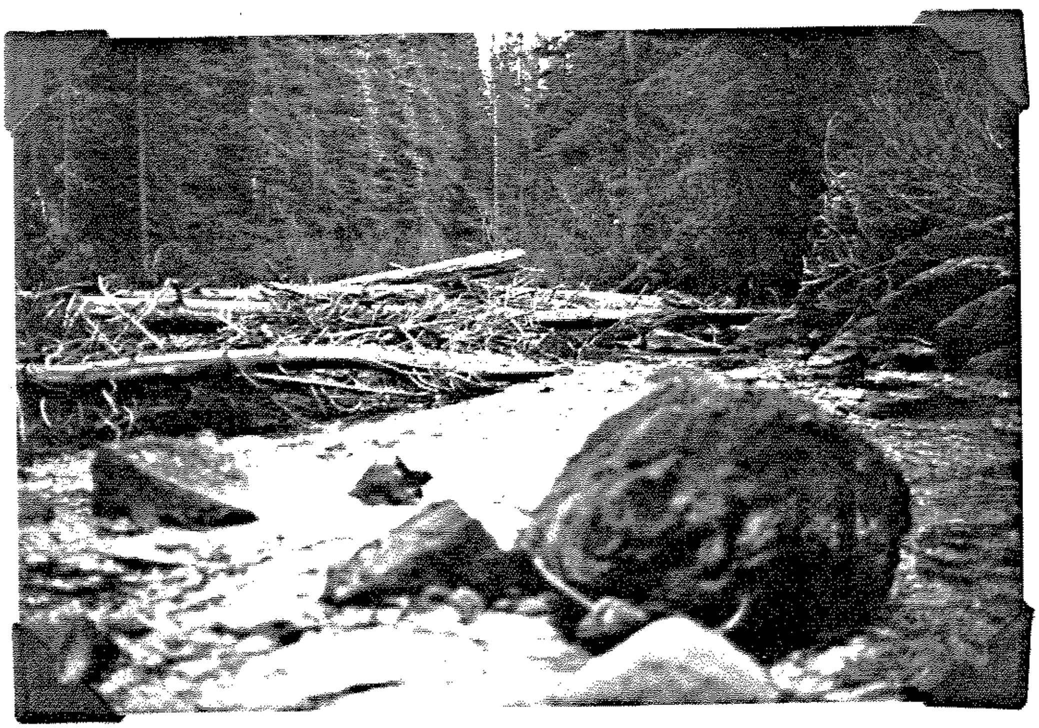


Plate 18. Debris photographs showing site eight in the Riparian Cut section on July 4, 1985 (top) and on November 6, 1987 (bottom).