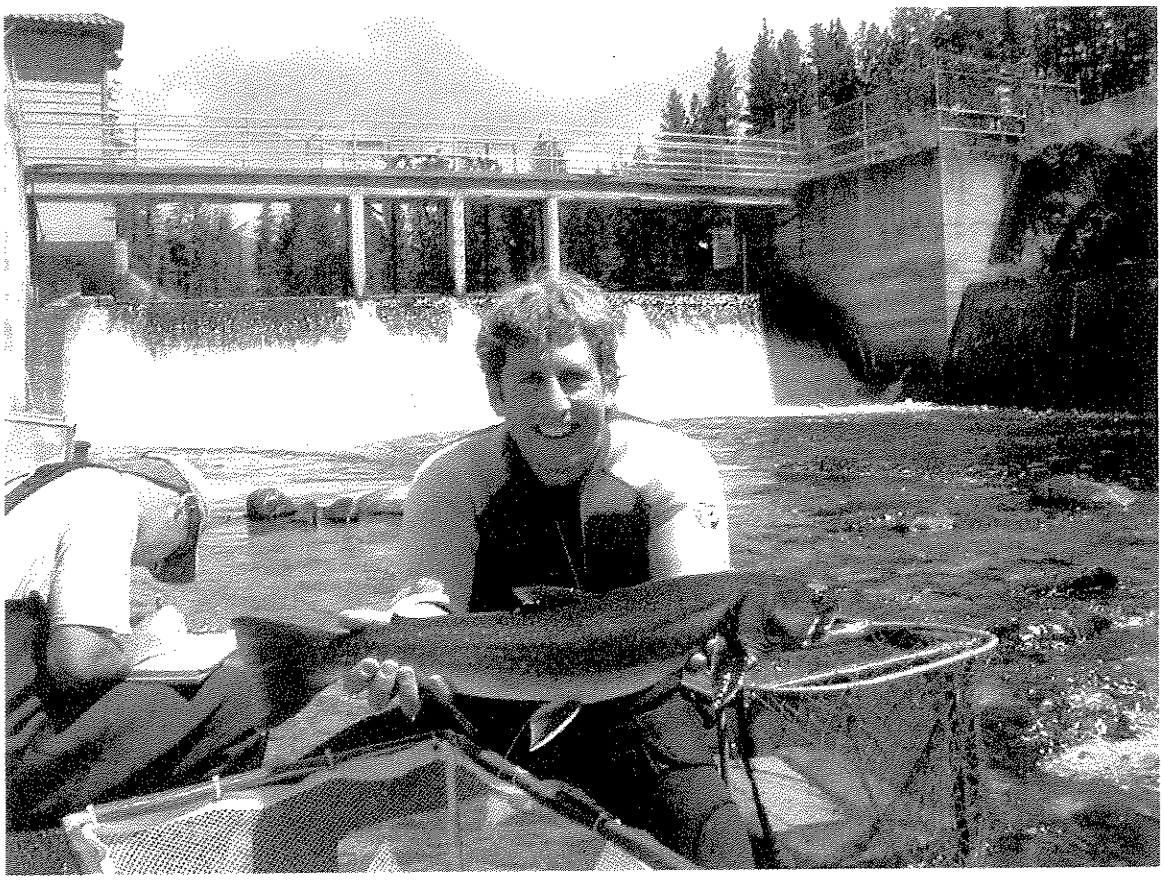
F-78-R-5&6
F-113-R-1&2
Project 3240
Region 2
Also,
F-06-17

RATTLESNAKE CREEK

FISHERIES ASSESSMENT AND ENHANCEMENT 1999-2003



Ladd Knotek, Raven Rashap and David Schmetterling
Montana Fish, Wildlife & Parks
Missoula, Montana

February 2004

ACKNOWLEDGEMENTS

Many people have contributed to this project and in the implementation of fisheries enhancement work on Rattlesnake Creek including: Ron Pierce, Pat Saffel, Katie Kneeshaw, Jeni Corbin, Bruce Farling, Casey Jensen, Grant Yelliott, Arnie Wick, Brad Liermann, Jim McFee, Craig Podner, Brian Riggers, Shane Hendrickson, Taylor Scott, Larry Evans, and Mike Bader.

Special thanks to members of the West Slope and Montana State Chapters of Trout Unlimited for support on enhancement projects and assistance with sampling. Dr. Bill Granath and his staff completed *T. tubifex* research and were instrumental in gaining approval for fish passage. Thanks to the Mountain Water Company (MWC) staff for their cooperation and helpfulness in providing fish passage at the dam. Jeff McLaughlin and his staff designed the MWC Dam fish ladder and provided oversight during construction – the project would not have been completed without their expertise. TNT Excavating did a great job of constructing the fish ladder.

Thanks to the landowners and water users that have incorporated fish screens at their diversions on Rattlesnake Creek: Desmond McDonald, Dennis Sain, Richard Alderson, and Doug Grimm. Skip Hegman designed and installed the Brencail fish screens.

Thanks to Mountain Water Company for their support and financial contributions in fish passage endeavors at the dam. Montana Power Company, Northwestern Energy, Smurfit-Stone Container Corporation/Montana CHEER, Lolo National Forest, Missoula Conservation District, the Future Fisheries Improvement Program and Montana Fish, Wildlife and Parks have provided funding and support for this project.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

INTRODUCTION AND PROJECT OBJECTIVES

Rattlesnake Creek is a large, perennial tributary to the Clark Fork River located near Missoula in western Montana. The stream has tremendous recreational and biological value, particularly with respect to the Clark Fork River fishery and native fish populations. Rattlesnake Creek is an important source of salmonid recruitment for the middle Clark Fork River and is one of four major tributaries in this area that are known to support migratory bull trout (*Salvelinus confluentus*) spawning. In addition, the proximity to an urban area and 'National Wilderness and Recreation Area' designation for most of the drainage make Rattlesnake Creek a high profile stream in western Montana. For these reasons, the drainage has become an area of focus for fishery survey and enhancement activities.

This report outlines a series of assessments and enhancement efforts designed to characterize and improve fish populations in the Rattlesnake Creek drainage. Most aspects of the project relate directly to identification of problems or limiting factors for fish populations, followed by evaluation and implementation of fish enhancement opportunities that address those problems. Specific objectives of the project were to:

1) Describe the status of the fishery including site characteristics, fishing regulations and fishing pressure;

2) Identify limiting factors for fish populations, particularly fluvial bull trout and westslope cutthroat trout (*Oncorhynchus clarki lewisi*), in Rattlesnake Creek;

3) Describe current fish species composition, distribution and relative abundance throughout the drainage;

4) Assess the status and risk of genetic introgression in native salmonids and whirling disease contamination in upper Rattlesnake Creek;

5) Implement and monitor fisheries enhancement projects including upstream fish passage at Mountain Water Company Dam and installation of fish screens to reduce entrainment losses in irrigation diversions.

BACKGROUND

Site Description

Rattlesnake Creek is a third order tributary to the Clark Fork River that originates in the Rattlesnake Wilderness and Recreation Area and flows approximately 23 miles to its mouth in the city of Missoula, Montana (Figure 1). The drainage encompasses approximately 81 square miles (21,000 ha) and is managed primarily by the United States Forest Service (Lolo National Forest). The lower five miles of the stream run primarily through private property in the outskirts of Missoula.

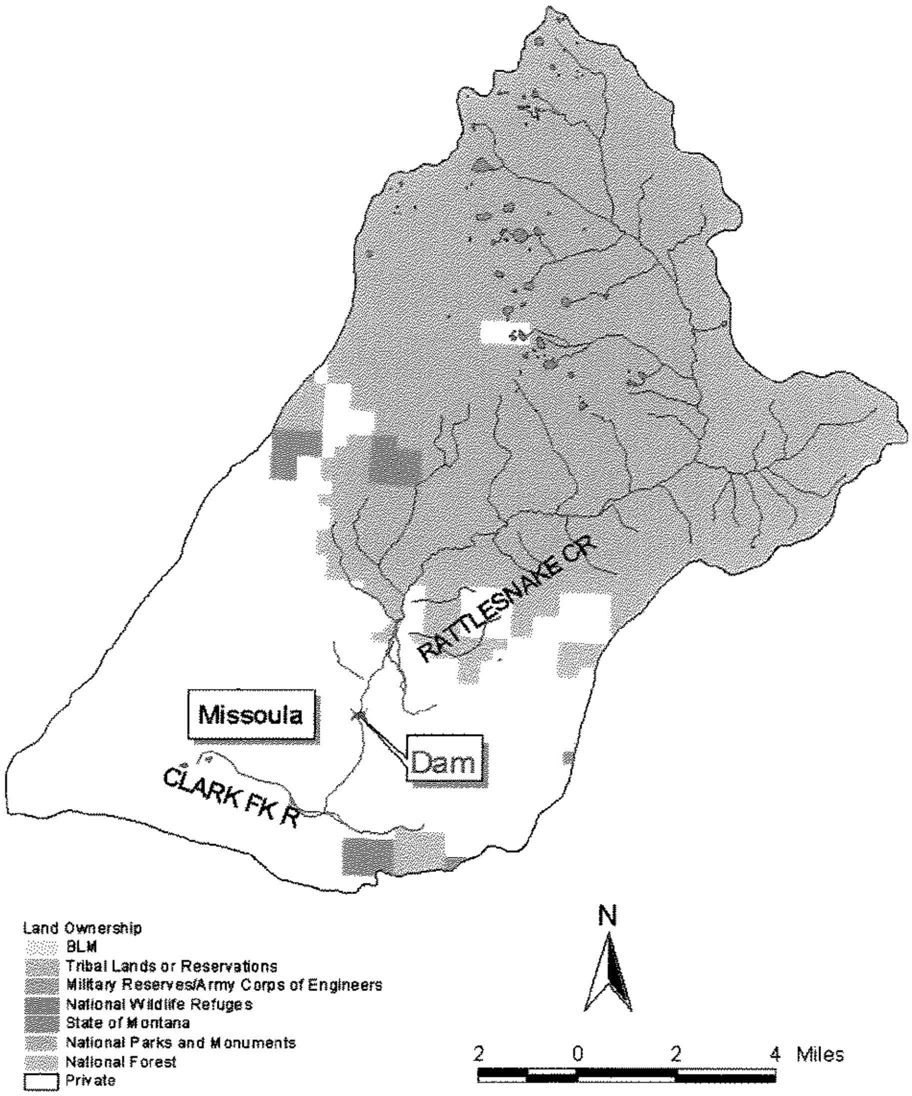


Figure 1. Map of Rattlesnake Creek drainage.

The range of flows recorded in lower Rattlesnake Creek from 1958-1967 (abandoned United States Geologic Survey gauge at mile two) ranged from 0.3 to 1830 cfs. Flood recurrence data are shown in Table 1. Flows in July-September ranged from 2.4-302 cfs. During this period, minimum flows were heavily influenced by water withdrawals by Mountain Water Company (MWC) and other water users. Mountain Water Company owns and operates a dam located at stream mile four. This facility was formerly the primary water supply source for Missoula, but the city has since developed access to an aquifer groundwater supply. Rattlesnake Creek is now the back-up water source for the city. Current water use on Rattlesnake Creek includes six small irrigation diversions originating in the lower five miles. Capacity of these diversions is approximately 25-32 cfs during operation in April – September. Typical base flows for Rattlesnake Creek are now 40-70 cfs at the mouth during the irrigation season.

Table 1. Flood recurrence data for Rattlesnake Creek from the United State Geological Survey (USGS).

Recurrence Interval (yrs)	**Discharge (cfs)**
2	1,300
5	1,720
10	1,980
25	2,290
50	2,510
100	2,720

Rattlesnake Creek water temperatures typically range from 2-18 °C (34-64 °F) near the mouth. Historical water temperature data did not include continuous measurements through summer and winter seasons. However, we monitored temperature with continuously recording thermographs from April-October in most years of this project (see Appendix A). Summer maximum daily water temperatures peaked in late July to early August at 16-18 ° C (61-64 °F) at MWC Dam at stream mile four in 2001-2003. Maximum water temperatures observed in 2002-2003 were likely inflated by low water conditions in these drought years.

Various water quality measurements were collected in 1999-2001 as part of MFWP stream monitoring and tubifex surveys (Wyatt et al. 2000). The findings of Wyatt et al. (2000) are summarized in Table 2 for five sample sites sampled upstream of the MWC Dam on 10/8/99 and 6/16/00 (see Appendix B for full report). Measurements taken at a sixth site were not included as results were distinctly different and it was not clear whether disparate values reflect the influence of the dam or characteristics of the sample site.

Table 2. Water quality measurements collected by Wyatt et al (2000) during oligochaete collections at 5 sites on Rattlesnake Creek upstream of the MWC Dam.

Measurement	Mean	Range
Temperature (C)	7.0	5.0 – 8.4
PH	7.50	6.89 – 8.90
Dissolved Oxygen (%)	83.8	63.3 – 89.4
Conductivity (uS/cm)*	19.8	18.5 – 22.2
Total Dissolved Solids*	9.8	9.2 - 11.1

* Only sampled on 6/16/00

Habitat condition in the upper ~ 20 miles of Rattlesnake Creek is excellent as this portion is encompassed by the wilderness and recreation area on the Lolo National Forest. The stream has nine perennial tributaries, many of which originate at one of the ~45 high elevation lakes in the watershed. The main stem channel flows through a relatively steep valley (mean stream gradient ~4 %) overall, but includes several sections of wider, low gradient meadows. The valley bottom is an open pine-larch forest, with dense cottonwood and shrub communities along the stream. This healthy riparian corridor, along with beaver activity and adequate large woody debris in the channel, create a diversity of aquatic habitats.

The lower five miles of Rattlesnake Creek that flows through Missoula and developed city outskirts has been altered and degraded significantly. In this reach, the channel has been straightened and confined by levees to control flooding and promote channel stability. This section was historically braided and unstable as the stream reached the lower gradient Missoula Valley. In addition, several irrigation structures including private diversions and the MWC Dam (~mile four) were constructed to provide water for agricultural lands and the city of Missoula. Instream habitat complexity is low in this reach, side channels are infrequent and much of the large woody material has been removed or mobilized.

Rattlesnake Creek Fishery

The Rattlesnake Creek drainage offers a range of fishing opportunities from wilderness lake and stream fisheries to urban angling in downtown Missoula. Voluntary catch-and-release angling is prevalent in all stream reaches. In the lower reach (within Missoula), rainbow trout (*O. mykiss*) and brown trout (*Salmo trutta*) are the predominant sport species. However, anglers focus on staging westslope cutthroat trout, mountain whitefish (*Prosopium williamsoni*) and occasionally bull trout at the stream mouth and several other locations where adult fish congregate seasonally. Upper reaches of the stream offer a popular westslope cutthroat and brook trout (*S. fontinalis*) fishery that is not accessible by motorized vehicles.

Wilson & Blount (1985) provided a good description of fish assemblage characteristics and the fishery in upper Rattlesnake Creek. In this study, modified Peterson mark and recapture techniques and creel surveys were used in determining that westslope cutthroat trout dominated relative abundance and angler catch in upper reaches (stream mile 10-14). Bull trout and brook trout were present in lower numbers. Population densities varied among survey sections and seasonally (28 - 1,335 westslope cutthroat trout per mile). Cutthroat trout catch rates were extremely high (3.6 per hr) and the investigators estimated that 86% of cutthroat trout over four inches (102 mm) were caught and released.

There are approximately 45 high elevation lakes (0.3 - 43 acres) that lie within the designated wilderness portion of the Rattlesnake watershed. Approximately half of these lakes have been stocked with various combinations of westslope cutthroat trout, rainbow trout and Yellowstone cutthroat trout. Although none have been stocked since 1988, many lakes still support self-sustaining trout populations and excellent fisheries. Fishing pressure is light on most of these waters due to limited accessibility

Fishing regulations have traditionally been liberal in lower Rattlesnake Creek (downstream of the MWC Dam) and restrictive in upper reaches. Creel restrictions focus on protection of native trout (westslope cutthroat trout and bull trout) and limited harvest of other salmonids. The reach from MWC Dam upstream to the mouth of Beescove Creek has been closed to fishing since 1940. This regulation was instituted to protect the Missoula city water supply, but now acts as a protective measure for bull trout and westslope cutthroat trout populations since the city currently uses groundwater sources. Fishing regulations on the reach of Rattlesnake Creek upstream of the Beescove Creek confluence (opened to angling since 1985) specified artificial lures and catch-and-release only restrictions to allow angler opportunity, while protecting native fishes. The standard 5 trout daily limits apply to all high elevation Rattlesnake Wilderness lakes.

In the 2002-2003 fishing regulation cycle, regulations for Rattlesnake Creek were modified to protect adult spawning salmonids and native populations. A comparison of fishing regulations before and after 2002 is found in Table 3.

Table 3. Fishing regulation changes on Rattlesnake Creek

Regulations 1985-2001	Regulations in 2002-2003
Upstream of Beescove Cr.: Open entire year, artificial lures, catch-and-release only. Bull trout fishing prohibited	Upstream of Beescove Cr.: *Brown and rainbow trout:* combined trout limit 3 daily, none > 15 inches *Brook trout*: 20 daily and possession *Cutthroat trout*: catch-and-release *Bull trout:* fishing prohibited Artificial lures only
Beescove Cr. downstream to MWC Dam: Closed to fishing entire year.	Beescove Creek to 100 yards downstream of MWC dam: Closed to fishing entire year
Downstream of MWC Dam: 5 trout daily and in possession, 1 over 14" and up to 20 brook trout (standard stream regulations). Bull trout fishing prohibited	100 yards downstream of MWC Dam to mouth: Artificial lures only *Brown and rainbow trout:* combined trout limit 3 daily, none over 15 " *Brook trout*: 20 daily and possession *Cutthroat trout*: catch-and-release *Bull trout:* fishing prohibited

Fishing pressure on Rattlesnake Creek likely varies between reaches. Anecdotal observations suggest that fishing pressure is light upstream of Beescove Creek in the Rattlesnake Recreation corridor since this reach begins six miles upstream of the trailhead in an area accessible only by non-motorized transportation. Fishing pressure estimates on Rattlesnake Creek (Table 4) reflect use of the entire drainage (MFWP Statewide Angler Surveys, 1989-2001). Overall fishing pressure on the stream has fluctuated since 1989, but has remained within the range of angler use estimated for nearby streams of similar size (e.g., Gold Creek, Ninemile Creek, Fish Creek, Lolo Creek). These comparisons are somewhat biased, however, as the six mile reach in the middle portion of Rattlesnake Creek (~ 40% of the prime fishable water) is closed to angling.

Table 4. Total fishing pressure estimates in angler-days for Rattlesnake Creek from MFWP state-wide angling pressure survey (mail survey) in 1989-2001.

Year	Rattlesnake Cr. – entire year*	Error	Rattlesnake Cr. – summer only**	Error
2001	1,280	455	1,280	455
1999	1,266	482	1,222	480
1997	938	411	853	402
1995	197	104	197	104
1993	1915	736	1775	722
1991	1231	537	693	361
1989	458	156	399	145

* Survey period runs from March – February.

** Summer survey period includes May – September.

Factors Limiting Fish Populations

Factors limiting fish abundance and production in Rattlesnake Creek include a large number of interacting variables that cumulatively affect fish populations. The most obvious problem is a complete barrier to upstream fish passage created by the MWC Dam at stream mile four. This structure likely impacts all species and life stages of fish. However, the greatest impacts are likely to native fluvial fish (e.g., bull trout and westslope cutthroat trout) that cannot access preferred spawning areas and thermal refugia. Prior to ~1985, limited upstream fish passage was accompanied by reduced instream flows downstream of the MWC Dam as water was diverted for the city of Missoula. Since that time, water diversion has been limited to the 25-32 cfs used by the six smaller canals in lower Rattlesnake Creek as this stream no longer provides city water. Although these small diversions may significantly reduce instream flow during severe drought conditions, their most significant impact is believed to be fish entrainment. High numbers of juvenile salmonids and sculpin (*Cottus* spp.) captured in canals during the irrigation season are likely lost to the Clark Fork River system.

Non-native fish introductions and species management has also limited some native fish populations. Although introduced trout provide the base of the Clark Fork River fishery, these species also present problems for recovery of native trout. Introduced rainbow, brown and brook trout likely compete with native trout when these species occur in the same water body. Rainbow trout and brook trout also hybridize readily with westslope cutthroat trout and bull trout, respectively. These compromises were not heavily considered when non-native trout introductions were encouraged or completed by fisheries management agencies in the early and mid 1900s. Today, managers are faced with the difficult task of recovering threatened native stocks despite the presence and importance of introduced trout species.

Accessibility and the proximity of Rattlesnake Creek to a major population center make the fishery very susceptible to illegal harvest. Anglers have traditionally targeted lower Rattlesnake Creek (particularly at MWC Dam tailrace and stream mouth) as migratory fish stage for spawning or congregate to take advantage of the thermal refuge from warm Clark Fork River temperatures in summer. Steps have been taken to improve enforcement of protective fishing regulations, but the impact of illegal harvest has not been quantified.

Indirect fisheries impacts associated with physical habitat degradation are also difficult to measure. However, losses in habitat complexity, spawning and rearing habitat and floodplain associated with channelizing and straightening lower reaches of Rattlesnake Creek are an obvious limitation. Like many stream systems in western Montana, the condition of lower Rattlesnake Creek reflects more than a century of poorly regulated development and misguided engineering practices.

FISH SPECIES DISTRIBUTION AND GENETIC COMPOSITION

Introduction and Methods

In this section, we describe fish species and genetic (*Oncorhynchus*) composition in Rattlesnake Creek. This information was important for assessing current biological conditions and had significant implications for upstream fish passage projects. The Mountain Water Company (MWC) Dam on Rattlesnake Creek has been a complete barrier to upstream movement of fish and other aquatic organisms since ~1905. Because restoring upstream passage at the dam was a major objective of fisheries enhancement work on Rattlesnake Creek (see section 4 of this report), we reviewed existing fisheries information and investigated the risk of disease and genetic contamination of upstream populations. Obtaining and evaluating this information was a prerequisite to upstream fish transfers and fish passage enhancements.

Oncorhynchus Genetic Composition

In 1984 and 1985, random *Oncorhynchus* spp. samples (n=30) were collected from two reaches of Rattlesnake Creek located upstream of the MWC Dam (Don Peters, MFWP, personal communication). Trout captured by angling and backpack electrofishing were anesthetized and frozen whole. Samples were submitted to the University of Montana's Wild Trout and Salmon Genetics Laboratory (WTSGL) for genetic analysis. Protein electrophoresis was used to determine the proportion of diagnostic alleles that represented westslope cutthroat trout, rainbow trout and Yellowstone cutthroat trout (*O. clarki bouvieri*) markers.

In 2002, we collected an additional sample from a 200 m (660 ft) reach just upstream of the MWC Dam to verify high hybridization rates detected in 1985 and 1986. Fin clips were removed from a random sample (n=24) of *Oncorhynchus* spp. captured by backpack electrofishing and stored in individual vials with 95% ethanol. Samples were analyzed at the WTSGL using PINE (Paired Interspersed Nuclear Elements) analyses to determine the proportion of genetic markers characteristic of the three trout species.

Species Composition and Distribution

Historical fish sampling data collected between 1960 and 1991 at sites throughout Rattlesnake Creek indicate that species composition is variable among reaches (MFWP, unpublished data). During this period, upper reaches (upstream of the East Fork) were still inhabited predominantly by native trout and sculpin (although westslope cutthroat trout were hybridized with rainbow trout). In reaches downstream of the East Fork and upstream of the MWC Dam, native trout and sculpin were abundant, although brook trout and rainbow trout comprised a larger proportion of the community. Wilson and Blount (1985) provide the most comprehensive historical assessment of fish species composition and distribution for these reaches. Fish species composition downstream of the MWC Dam was dominated by introduced trout, particularly rainbow trout and brown trout, although most native species were still present. Non-salmonid native fish species include sculpin (*Cottus* spp.), longnose sucker (*Catostomus catostomus*), largescale sucker (C. *macrocheilus*), northern pikeminnow (*Ptychocheilus oregonensis*). Redside shiner (*Richardsonius balteatus*) and longnose dace (*Rhinichthys cataractae*) may also be present, but have not been reported.

In 1999 and 2001, we conducted surveys to update species composition and distribution information in Rattlesnake Creek. The primary goals of these surveys were to compare species composition upstream and downstream of the MWC Dam and to compare current species composition with historical data over a series of sites from stream mile one to mile twelve. Population estimates could not be obtained due to poor electrofishing efficiency and other logistic constraints.

Sampling sites (125-150 m) at least two miles apart were selected at five accessible locations on Rattlesnake Creek to determine species composition and distribution. Sites were sampled using single pass electrofishing with a Coffelt backpack mounted electrofishing unit. All fish captured were anesthetized, identified to species, measured and returned to the stream. At site four, fin clips were taken from all *Oncorhynchus* spp. for genetic analysis.

Results and Discussion

Oncorhynchus Genetic Composition

Genetic analyses confirmed that native westslope cutthroat trout in Rattlesnake Creek have hybridized with rainbow trout and Yellowstone cutthroat trout (Table 5, Figure 2). These results were expected since *Oncorhynchus* in this stream possess morphological characteristics of all three species (e.g., spotting and coloration patterns). Several of the high elevation lakes in the Rattlesnake Wilderness Area are probable sources of hybridization since they support self-sustaining populations of rainbow trout and Yellowstone cutthroat trout that were stocked in the early and mid-1900s. The outlets of these lakes are tributaries to upper Rattlesnake Creek. Genetic samples were not collected in lower Rattlesnake Creek downstream of MWC Dam because rainbow trout are the predominant *Oncorhynchus* species in this reach based on morphological characteristics. Tributaries of upper Rattlesnake Creek (e.g., East Fork) were also untested, but may contain genetically pure populations of westslope cutthroat trout.

Table 5. Results of *Oncorhynchus* genetic testing in Rattlesnake Creek upstream of Mountain Water Company Dam.

Location / Stream Mile	Legal Description	Date	n	% WCT	% YCT	% RBT
Upper Drainage ~ stream mile 13	T14N, 18W, SEC11	10/4/85	32	93.8	0.1	6.2
Middle Drainage ~ stream mile 9	T14N, 18W, SEC 20	10/3/86	30	72.8	0	22.2
Just Above Dam ~ stream mile 4	T13N, 19W, SEC 2	7/31/02	23	60.8	0	39.2

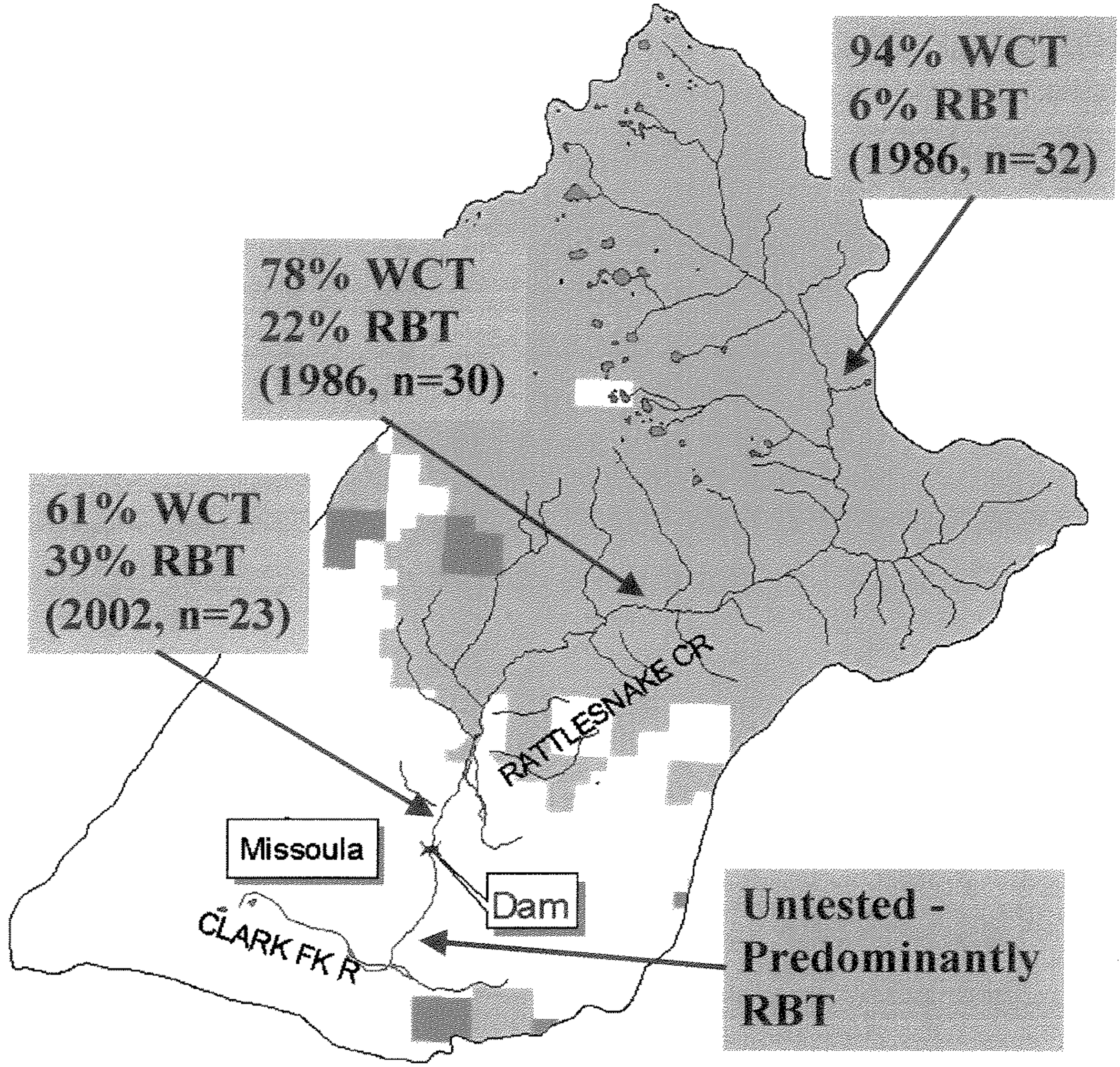


Figure 2. *Oncorhynchus* genetic testing locations and results on Rattlesnake Creek.

Species Composition and Distribution

We detected the following species while electrofishing at site 5 downstream of MWC Dam: rainbow trout, brown trout, westslope cutthroat trout, rainbow x westslope cutthroat trout hybrids, bull trout, brook trout, mountain whitefish and sculpin spp. (Table 6). Longnose sucker, largescale sucker and northern pikeminnow were not detected in electrofishing, but have been observed in snorkel surveys below MWC Dam. In electrofishing sections 1-4 upstream of the dam, we observed the same fish species except mountain whitefish were absent. We did not attempt to identify sculpin to species at any of the sample locations. In addition to fish species, tailed frogs (*Ascaphus truei*) were found at most sites on Rattlesnake Creek (Table 6).

Table 6. Results of fish species composition surveys in Rattlesnake Creek in 1999-2000.

Section	Location	Date	Species	No.	Length: Mean (Range)
	UPSTREAM OF DAM				
1 ~125 m	T14N, R18W, Sec 11 Upstream of Franklin Bridge	9/23/99	CUTT	12	195 mm (107-255 mm)
			BULL	1	201 mm
			BROOK	9	146 mm (110-220 mm)
			SCULPIN	-	Abundant
			TAILFROG	-	Abundant
2 ~125 m	T14N, R18W, Sec 15 Just Upstream of Beescove Cr. Mouth	9/23/99	CUTT	15	141 mm (90-256 mm)
			BULL	18	129 mm (65-285 mm)
			BROOK	34	130 mm (57-230 mm)
			BULL x BROOK	2	216 mm (192-240 mm)
			SCULPIN		Abundant
			TAILFROG	-	Abundant
3 ~150 m	T14N, R18W, Sec 21 ~ 1 mile upstream of Pilcher Cr. Mouth	9/23/99	CUTT	18	121 mm (96-178mm)
			BULL	7	153 mm (78-320 mm)
			BROOK	36	119 mm (62-222 mm)
			BROWN	1	142 mm
			SCULPIN		Abundant
			TAILFROG	-	Abundant
4 ~ 150m	T13N, R19W, Sec 2 Immediately upstream of Mtn Water Co. Dam	7/15/01	BROOK		*Oncorhynchus* genetics sample only
			BULL		
			CUTT		
			RAINBOW		
			RAINBOW x CUTT		
			SCULPIN		
			TAILFROG		
	DOWNSTREAM OF DAM				
5 ~250 m	T13N, R19W Sec 14 Side channel at Greenough Park	7/25/00	BROWN	22	90 mm (74-115 mm)
			RAINBOW	26	86 mm (51-102 mm)
			BROOK	5	105 mm (94-119 mm)
			BULL	2	112 mm (82-141 mm)
			CUTT	5	136 mm (95-185 mm)
			MTNWHIT	-	Common
			SCULPIN	-	Common

Species relative abundance was different at locations upstream (sections 1-4) and downstream (section 5) of the MWC Dam and varied among sections 1-4. The gradient in species distribution and relative abundance was similar to trends seen in other large Clark Fork River tributaries (Knotek et al. 2003) and in a previous study on Rattlesnake Creek (Wilson and Blount 1985). Introduced trout and mountain whitefish tend to dominate fish assemblages near stream mouths as these lower gradient, warmer reaches are the primary spawning areas for brown trout, rainbow trout and mountain whitefish. Assemblages typically transition into native trout communities (some with introduced brook trout) in upper reaches of tributaries. Bull trout and westslope cutthroat trout select high quality habitat in upper portions of tributary drainages for spawning and rearing. In addition, westslope cutthroat trout have adapted well to a resident life history in the harsh environment of higher elevation first and second order tributaries. Environmental variables such as water temperature, stream gradient, physical habitat complexity and primary productivity are believed to play an important role in these fish species interactions (Shepard et al. 1998). In Rattlesnake Creek, these general trends are compromised somewhat by the effect of rainbow trout emigration from self -sustaining high-elevation lake populations at the head of several tributaries. Differences observed among sites segregated by the dam were also influenced by the inability of adult fluvial trout to access and spawn in upstream areas.

Fish species composition (presence/absence) upstream and downstream of MWC Dam varied by only one species based on electrofishing (Table 7). The absence of mountain whitefish upstream of the dam likely reflects its preferred fluvial life history. Mountain whitefish normally occupy the lower reaches of larger tributaries or river main stems. Rattlesnake Creek has a large run of fluvial mountain whitefish that spawns in the four mile reach downstream of the dam. With installation of fish passage improvements at the dam, this population may extend its habitat use upstream. Low densities of largescale sucker, longnose sucker and northern pikeminnow have also been observed (snorkeling) downstream of MWC Dam, but were not detected in electrofishing surveys. These predominantly fluvial species are also likely absent upstream of MWC Dam for the same reasons as mountain whitefish.

Table 7. Comparison of fish species composition upstream and downstream of Mountain Water Company Dam in Rattlesnake Creek based on electrofishing surveys.

Species	**Native/ Introduced**	**Found Upstream of MWC Dam?**	**Found Downstream of MWC Dam?**
Brook trout	Introduced	Yes	Yes
Brown trout	Introduced	Yes[1]	Yes
Bull trout	Native	Yes	Yes
Mountain whitefish	Native	**No**	Yes
Rainbow trout	Introduced	Yes	Yes
Sculpin spp.	Native	Yes	Yes
Westslope cutthroat trout	Native	Yes	Yes
Yellowstone cutthroat trout	Introduced	Yes[2]	Yes (assumed)

[1] No brown trout were detected or reported upstream of MWC Dam prior to 1999

[2] Yellowstone cutthroat trout genes (0.1%) were detected in 1986, but not in 2001

Summary

Like most large Clark Fork River tributaries, Rattlesnake creeks supports a mixed (native and non-native) fish assemblage that varies in species composition and relative abundance along the length of the stream. The MWC Dam has isolated upstream fish populations and apparently eliminated obligate fluvial species from upper reaches over the past 100 years. Historical data, current sampling and high levels of *Oncorhynchus* hybridization indicate that the risk of further genetic contamination or introduction of new species into upper reaches of Rattlesnake Creek associated with providing upstream fish passage at MWC Dam is minimal. However, selective passage of fluvial trout at the dam favoring westslope cutthroat trout and bull trout may promote an assemblage with a larger native salmonid component in upper reaches.

WHIRLING DISEASE ASSESSMENT

Introduction and Methods

Whirling disease has spread rapidly across Montana's rivers and streams since its discovery in the Madison River in 1994 (Vincent 1996; Baldwin et al. 1998). Because impacts have been severe for some wild salmonid populations in Montana (Vincent 1996), Colorado (Nehring and Walker 1996) and other states, assays to detect the causative agent *Myxobolus cerebralis* and its obligatory oligochaete host *Tubifex tubifex* have become important components of many restoration and enhancement programs – particularly when fish and other aquatic organisms are being afforded new access to upstream stream reaches and isolated fish populations. The life cycle of *M. cerebralis* is shown in Figure 3.

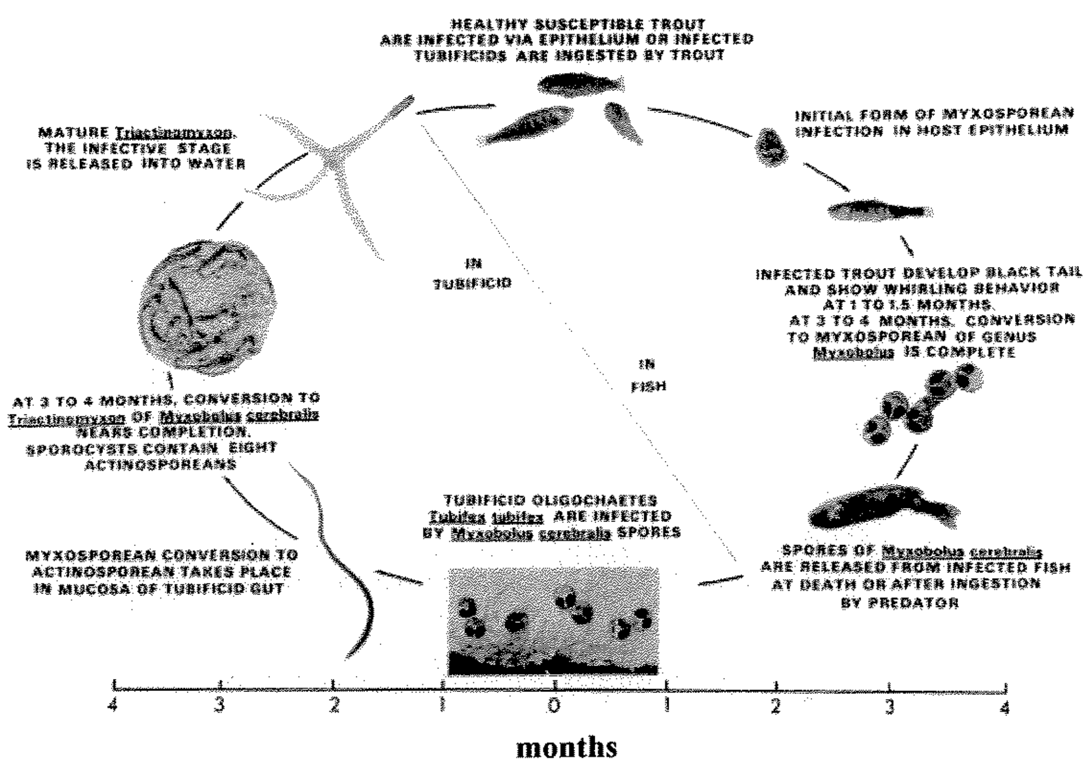


Figure 3. Life cycle for *Myxobolus cerebralis*, the causative agent of whirling disease (Diagram by Maria E. Markiw).

Since upstream passage at the MWC Dam was a major objective of fisheries enhancement efforts in Rattlesnake Creek, we conducted surveys to investigate the risk of disease transmission and genetic contamination of upstream fish populations. Prior to implementation of fish passage measures, the Montana Fish Health Committee reviewed existing data and recommended a more thorough assessment of the risk of whirling disease contamination in the upper drainage. Because of fish disease transmission concerns in Montana, committee approval is required before any new fish transfers may occur in the state. The assessment on Rattlesnake Creek had three components:

1) Histological examination of wild fish to determine whirling disease infection rates
2) Sentinel cage studies to test for the presence and severity of *M. cerebralis* infection
3) Invertebrate surveys to determine the abundance and distribution of *T. tubifex*

Whirling Disease Testing in Wild Fish

We used established protocols for assessing whirling disease infection rates in wild trout from Rattlesnake Creek (Baldwin et al. 1998). Two samples of 60 juvenile trout (comprised of rainbow, brook and brown trout) representing multiple age classes were collected using a backpack electrofishing unit from sites downstream and upstream of MWC Dam in 1999. Fish in each sample were anesthetized and sacrificed. Heads were packaged, frozen and mailed to the Washington State University Animal Disease Diagnostic Laboratory (WADDL) at Pullman, Washington for histological examination.

Sentinel Cage Investigations

Whirling disease surveys using sentinel fish exposures were undertaken in Rattlesnake Creek in 2000. These assays were performed to confirm the absence of whirling disease in Rattlesnake Creek at sites upstream and downstream of the MWC Dam as determined through previous histological examination of wild fish.

The sentinel cage study was a controlled experiment used to detect the *M. cerebralis parasite* and assign levels of whirling disease infection. Detection of whirling disease relied on histological examination of hatchery rainbow trout placed in sentinel cages. Cages were placed at two locations: one just upstream of the MWC Dam and one approximately one mile downstream. The sentinel cages consisted of an 18"x 24" cylindrical screened container placed into a site that allowed stream water to flow through the cage. Each cage contained 50 uninfected rainbow trout (35-60 mm) supplied by a state fish hatchery. Timing of field exposure was based on anticipated mean daily temperatures in the 50's °F (10-15 °C), which correlates with peak triactinomyxon (TAM) production, and corresponds to peak infection rates in fish (Vincent 2000). The exposure period for each live cage was standardized at 10 days. At the end of the 10-day exposure period, trout were removed and taken to Pony, Montana, where they were held for an additional 80 days at a constant 50 °F (10 °C) temperature to insure the whirling disease infection would reach its maximum intensity (Vincent 2000). At the end of the 90-day period, all the surviving fish were sacrificed and sent to WADDL for histological examination based on the MacConnel-Baldwin histological grading scale (Baldwin et al. 2000). The results of this histological rating are presented as mean grade infection. Mean grade infections above 2.7 are likely to result in population level declines (Vincent 2002). Each sentinel cage site also had an accompanying thermograph to establish mean daily water temperatures during the exposure period.

Tubifex tubifex Surveys

In 1999 and 2000, researchers from the University of Montana conducted a survey in the Rattlesnake Creek drainage for the oligochaete worm known as *Tubifex tubifex* (Wyatt et al. 2000, full report in Appendix B). This worm is an obligatory host for the parasite (*Myxobolus cerebralis*) that causes whirling disease in salmonids. The parasite cannot complete its life cycle and be transmitted to trout in the absence of *T. tubifex*. The survey was undertaken to evaluate the potential for significant whirling disease infection should the stream be exposed to the parasite. Although *T. tubifex* abundance is not a definitive determinant of M. cerebralis density and disease potential, it can provide an indication of whirling disease risk for salmonids.

Study sites were intentionally chosen in areas containing oligochaete habitat to more efficiently survey the drainage for *T. tubifex*. Five sites were selected upstream of the MWC Dam and one was located downstream of the dam (see map in Appendix B). All sites were sampled in October 1999 and again in June 2000 using a modified kick-net method (Gilbert and Granath, 2001). Samples were then processed in the laboratory using methods described in Wyatt et al. (2000) where investigators attempted to identify each Oligochaete to species.

Results and Discussion

Whirling Disease Testing in Wild Fish and Sentinel Cages

Laboratory results from wild fish and captive (sentinel caged) fish from Rattlesnake Creek indicated that whirling disease was not present in the drainage. The mean grade infection for all samples was 0, indicating that *M. cerebralis* spores were not detected in histological examination of trout heads.

Tubifex tubifex Surveys

Low overall densities of oligochaetes were found at all sample sites on both sampling dates. Most of the samples consisted of immature individuals. Although oligochaetes cannot be identified to the species level with sexually immature individuals, it was evident that *T. tubifex* was not abundant in Rattlesnake Creek. Probable specimens with diagnostic characteristics (hair and pectinate chaetae) were only found at a few sites and at low abundances. Further, none of the worms collected from Rattlesnake Creek released *M. cerebralis* TAMs (the life stage of the parasite that infects salmonids) when isolated in the laboratory.

Summary

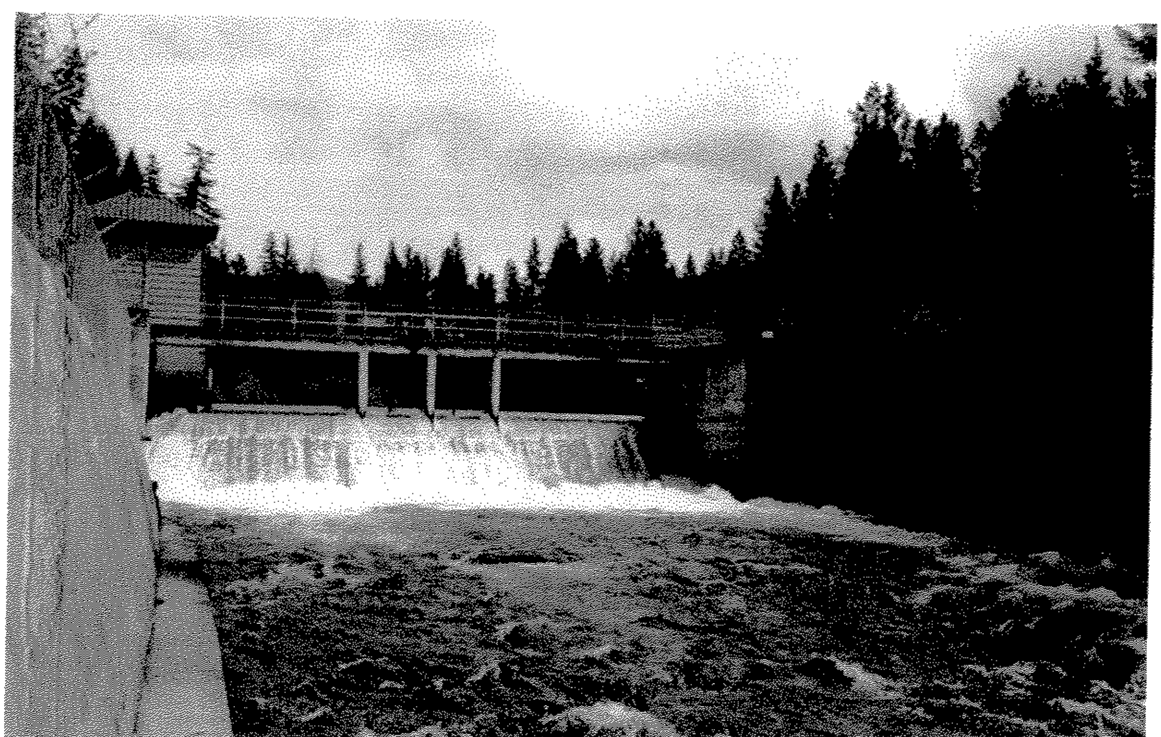
Assessments in 1999-2000 indicated no signs of whirling disease or the *M. cerebralis* parasite in wild or captive fish. The combination of these data with other attributes of the drainage (e.g., low water temperatures and low *T. tubifex* abundance) led investigators and the Montana Fish Health Committee to conclude that Rattlesnake Creek, in its present condition, would not likely be threatened by whirling disease if *M. cerebralis* were introduced. The likelihood of recent or future exposure of Rattlesnake Creek to *M. cerebralis* is high given that the parasite was detected in 1999 in the Clark Fork River within five miles of Rattlesnake Creek.

IMPLEMENTATION AND ASSESSSMENT OF UPSTREAM FISH PASSAGE AT MOUNTAIN WATER COMPANY DAM

Introduction

The MWC Dam was constructed in 1905 approximately four miles upstream of the mouth of Rattlesnake Creek. It currently serves as a reserve (back-up) water supply facility for the city of Missoula, Montana. The dam crest is approximately 10 ft high (without flashboards installed) and likely has completely impeded upstream fish passage past this point since construction.

All fish species in Rattlesnake Creek are likely affected by the dam. Many fluvial species are unable to reach natal spawning areas and stream-resident fish are unable to complete seasonal upstream movements within the drainage. Impeded upstream passage of migratory salmonids is the most visible impact and has been reported at the dam repeatedly in the past century (MFWP, unpublished data). Adult fluvial bull trout have been documented at the base of the dam during the spawning migration period each year since 1996 and fluvial westslope cutthroat trout are present in large numbers each spring during their spawning period (MFWP, unpublished data). Adult fluvial rainbow trout congregate in March - May, but this species spawns primarily in lower reaches of Rattlesnake Creek (downstream of the dam). Although brown trout, brook trout and mountain whitefish are abundant in the lower four miles of Rattlesnake Creek, we have not observed congregations of these species (adults) in the dam tailrace area during their fall migration and spawning periods.



Mountain Water Company Dam on Rattlesnake Creek

Data collected in 1999-2000 on Rattlesnake Creek (previous two report sections) provide a current baseline for identifying factors limiting fish population and for addressing biological concerns associated with enhancement activities. Upstream fish passage at MWC Dam was recognized as the most important fisheries enhancement objective. Consequently, we focused on information related to potential disease, genetic and species contamination resulting from passing fish and other organisms upstream of a long term barrier. In fall 2000, the Montana Fish Health Committee reviewed our evaluation of these risks and recommended implementation of fish passage improvements at the dam.

In 2001-2003, MFWP and several project partners iteratively developed upstream fish passage upgrades at MWC Dam. The overall goal of the project was to enhance fluvial westslope cutthroat trout and bull trout populations by affording migrating adults access to upstream spawning areas in Rattlesnake Creek. In conjunction with facility improvements, we incorporated radio telemetry, fish tagging and various other sampling efforts to improve and evaluate the project.

Methods

In 2001 and 2002, we collected preliminary data related to permanent fish passage designs and began manually moving migratory bull trout and westslope cutthroat trout past the dam (interim fish passage). Since fish moving upstream congregate in the dam afterbay or tailrace, a series of snorkel surveys and fish capture attempts were conducted throughout the westslope cutthroat trout and bull trout migration periods (April-September). Objectives of these sampling activities were to:

(1) Assess abundance of fluvial adult trout by species that are impeded by the dam;
(2) Document the timing of fluvial trout spawning migrations in Rattlesnake Creek as indicated by congregations of each species at the dam;
(3) Evaluate behavior of adult trout in the tailrace (selection of ladder location);
(4) Monitor behavior and movement of bull trout captured and moved over the dam;
(5) Determine distribution and movement of cutthroat trout and rainbow trout captured at the dam;
(6) Provide interim upstream fish passage for fluvial bull trout and westslope cutthroat trout.

In 2001, snorkel surveys were completed by one or two MFWP personnel weekly from April-August to visually estimate fish abundance by species. This period encompasses the expected times of migration for spawning rainbow trout, westslope cutthroat trout and bull trout. Trout were captured by angling and by floating an experimental gill net through the tailrace. These procedures were effective during all periods except high flow conditions where water velocities and high turbidity precluded sampling (2-3 weeks in late May – early June). Captured fish were anesthetized, measured and sorted by species. All bull trout were implanted with passive integrated transponder (PIT) tags (injected under the pelvic girdle) and cutthroat trout were marked with numbered plastic Floy tags anchored near the dorsal fin. We also surgically implanted radio transmitters in several bull trout each year (see telemetry section below). Adult bull trout and westslope cutthroat trout were moved manually upstream of the dam. Stream temperature and stage (gauge height) were measured at the dam throughout the project.

In 2002, we repeated sampling similar to 2001 and evaluated conceptual designs for permanent fish passage. The preferred design included a ladder entrance located approximately 100 ft downstream of the dam spillway and at least 80 ft downstream of where fish normally congregate. Therefore, a 'test ladder' was constructed to evaluate several aspects of the design and overall project (see photo below). The test ladder consisted of a 16 ft section of Denil fish ladder (2'x 2') which carried 2-3 cfs of water siphoned from the sedimentation reservoir upstream of the dam. Fish ascending the ladder were collected in a large (~ 5 ft diameter x 4 ft deep) holding tank controlled with a one-way entrance gate. Attraction flow (2-3 cfs) was provided with an additional, adjacent siphon pipe. The test ladder was used to directly evaluate the efficacy of the proposed ladder site over a range of river flow conditions. The apparatus also provided a more efficient method of capturing fish congregated at the dam, monitoring timing of migration, etc.

Test ladder installed at Mountain Water Company Dam on Rattlesnake Creek in 2002.

Bull Trout Radio Telemetry

We used radio telemetry as a tool in evaluating upstream fish passage options at MWC Dam. Six adult bull trout captured in the tailrace were implanted with individually coded radio-transmitters in 2001 and 2002 (three each year). We also installed a data logging station at the test ladder in July 2002 to determine if telemetered fish in the tailrace approached or entered the structure without entering the fish trap. Specific methods and results are described in the *Bull Trout Radio Telemetry* section of this report.

Permanent Fish Ladder Installation and Monitoring

In April 2003, permanent facilities were installed to provide upstream fish passage for adult salmonids (see photo below). A schematic of the fish ladder is attached in Appendix C. We monitored fish movement up the ladder with a weir trap installed at the upstream end of the sedimentation reservoir (where trout exit the fish ladder and return to the stream). The trap was operated continuously from Apr 19 – Aug 15, except during two periods (Apr 28 - May 5 and May 28 – June 3) when extreme high water or scheduling problems occurred. When in operation, the trap was checked daily and any fish captured were anesthetized, measured and sorted. All westslope cutthroat trout and bull trout were examined for previous marks before being released upstream of the trap. We clipped adipose fins and inserted PIT tags in any un-marked bull trout. Rainbow trout, brown trout and brook trout were not placed in the stream upstream of the dam.

Permanent fish ladder installed at Mountain Water Company Dam in 2003.

In order to estimate passage efficiency, we snorkeled the MWC Dam tailrace at least once per week. We monitored the total number of adults of each species congregated at the dam and were able to identify individual bull trout in some cases. These repeated surveys were useful in estimating the efficiency of fish passage facilities. In order to encourage bull trout to use the fish ladder, we also installed a weir fence across the channel just upstream of the ladder entrance (shown in photo above) on July 10. The weir was in place until ladder operation was terminated.

Floy Tag Returns

All westslope cutthroat trout transported over the dam in 2001 and 2002 were tagged with yellow plastic Floy tags to evaluate the movement and range of migrations through voluntary information provided by anglers. Capture location and tag numbers were reported by anglers on the Clark Fork River during the summers of 2001and 2002. We also collected timing and growth information from tagged trout re-captured at MWC Dam in subsequent years.

Trout Growth and Hook Scar Rates

Each trout captured at the MWC Dam in 2002 and 2003 was measured and examined. Because cutthroat trout and bull trout were marked with Floy tags and PIT tags, respectively, we were able to directly measure growth rates for re-captured individuals. In addition, we examined the mouth, jaw, and face of westslope cutthroat trout and rainbow trout to identify hook scars. Scars from angling are visible as holes, bruises or ripped tissue on the head and can serve as an index of catch-and-release fishing pressure and catch rates. We did not attempt to identify hook scars on fish with obvious head injuries from attempting to ascend the dam.

Results and Discussion

Trout Spawning Migrations and Upstream Passage in 2001and 2002

Through snorkel surveys, netting and operation of the test ladder, we documented the abundance and timing of trout spawning migrations in the MWC Dam tailrace during spring and summer 2001 and 2002. Fall spawning species including mountain whitefish, brook trout and brown trout were present during the survey period, but were not abundant. Periodic surveys at the dam in fall 2001 and 2002 indicate that these species do not congregate at the dam in large numbers during spawning periods. Table 8 summarizes findings at the dam during 2001 and 2002.

There was considerable overlap in trout spawning migration timing and peaks were closely tied to stream temperature (Figure 4) and discharge cues. Consistent with previous reports, rainbow trout migrations peaked in April-early May (Schmetterling and McEvoy 1999, Berg 1990), westslope cutthroat trout peaked in late May - early June (Schmetterling 2001) and bull trout abundance was highest in July (Schmetterling 2003; Schmetterling and McEvoy 1999). Observed delays and overlap in migration timing between westslope cutthroat trout and rainbow trout (measured through snorkel surveys and capture at the test ladder) was likely exaggerated by the high abundance of hybrid rainbow x cutthroat individuals and limited fish passage efficiency at the dam. Trout accumulated and often remained at the dam for weeks as they attempted to ascend it.

Table 8. Summary of fish observed and transported over Mountain Water Company Dam on Rattlesnake Creek during spring and summer 2001-2002.

SPECIES (ADULTS)	TIMING[a]	ESTIMATED # AT DAM[b]	# MOVED OVER DAM	SIZE RANGE[c]
2001				
Rainbow Trout	~3/15 – 5/22	130-150	14	330-474 mm
W. Cutthroat Trout	~5/1 – 6/23	90-120	60	256-489 mm
Bull Trout	~ 6/23 – 8/4	30-40	26[d]	358-818 mm
Brown Trout	-	10-20	0	-
Brook Trout	-	<10	0	-
Mtn Whitefish	-	30-60	0	-
2002				
Rainbow Trout	~4/1 - 5/31	130-150	0	340-504 mm
W. Cutthroat Trout	~ 5/5 – 6/20	90-120	58	285-460 mm
Bull Trout	~ 6/19-8/20	30-40	28*	350-810 mm
Brown Trout	-	10-20	0	-
Brook Trout	-	<10	0	-
Mtn Whitefish	-	30-60	0	-

[a] Timing = the period when adult fluvial trout species congregated at the dam

[b] Estimated # at Dam = total estimated number of adults and sub-adults observed (while snorkeling) in tailrace

[c] Size range includes only those fish captured and measured

[d] Radio transmitters were implanted in 6 adult bull trout at the dam in 2001 & 2002

The bull trout migration period was somewhat earlier than anticipated. This may have been partially due to the high water temperatures and low water levels associated with drought conditions in 2001 and 2002, but bull trout have adopted an early spawning migration strategy in many Clark Fork Basin tributaries where low water and high summer water temperatures are common (Swanberg 1997; Schmetterling 2003). Bull trout congregating at the dam likely did not experience significant delays since we moved adults past the dam on a consistent basis.

We manually transported 118 adult westslope cutthroat trout and 54 adult bull trout past the dam in 2001 and 2002. In 2001, most cutthroat trout were angled and bull trout were captured by angling or netting. In 2002, all cutthroat trout were captured in the test ladder and bull trout were primarily captured with nets. Based on tagging, snorkel surveys and catch rates in the test ladder trap, we estimated that 50-70% of the westslope cutthroat trout that congregated at the dam were captured in the test ladder (Table 8). The efficiency for bull trout was only 4-8%. However, use of the test ladder may have been underestimated due to trap loss; fish that entered the trap at the top of the test ladder could exit and swim back down the ladder. When ~10 trout were intentionally left in the trap to evaluate trap loss on three different occasions, all exited the trap within 24 hr. Bull trout showed little attraction to the test ladder, likely due to the limited flow volume and the small, un-natural character of the structure.

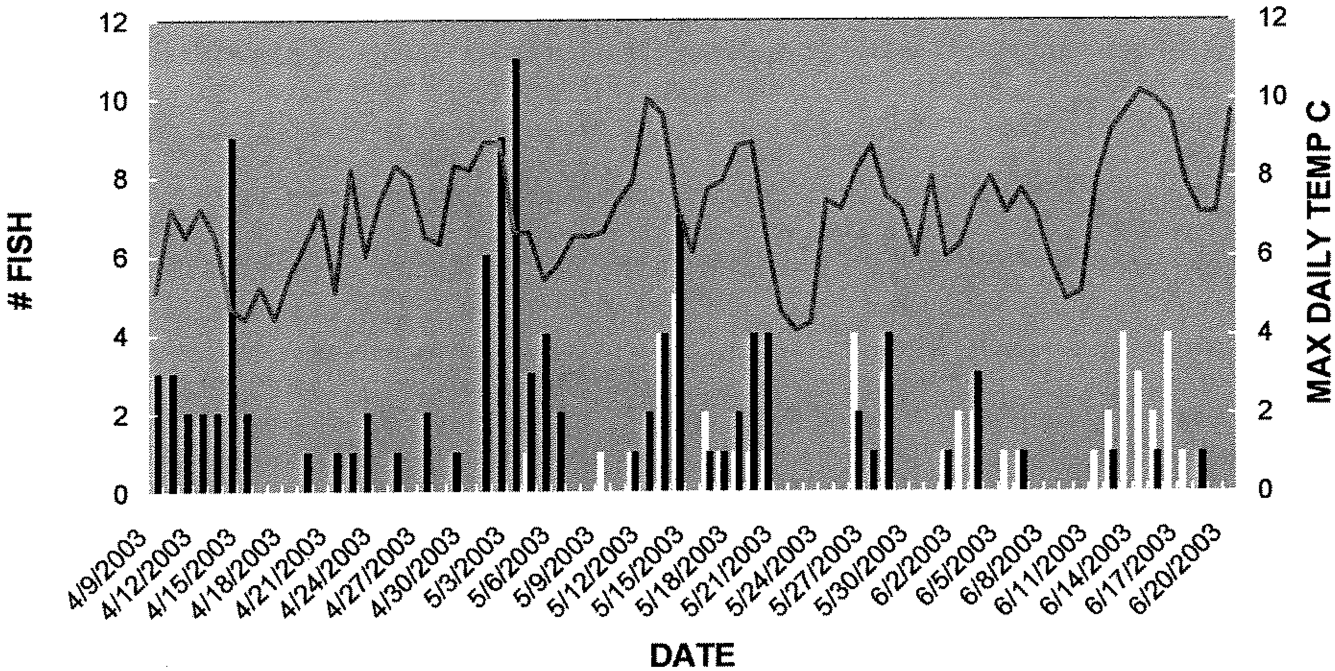


Figure 4. Maximum daily stream temperature (gray line) versus the timing of westslope cutthroat trout (white bars) and rainbow trout (black bars) capture in the test ladder at MWC Dam in 2002.

Construction of a test ladder to evaluate certain aspects of the proposed fish passage design proved to be a useful step in the overall project. Based on information collected for rainbow trout, cutthroat trout and bull trout over a range of flow conditions in 2002, we concluded that the proposed fish passage concept could be successful with some modification. The biggest concern was detection and use of a ladder entrance located ~80 ft downstream of the tailrace pool where trout congregate. Fluvial rainbow trout and westslope cutthroat trout were able to detect and enter the test ladder at all flow conditions, but fish passage efficiency was much lower during base stream flow conditions. During high flow conditions, the confined tailrace area is extremely turbulent and fish naturally congregate in the protected eddy at the ladder entrance. Onset of discharge peaks were also typically associated with increased stream temperature, which appeared to encourage active upstream migration. During low flow periods, the large pool immediately below the spillway provides cover, low velocities and direct inflow of water cascading over the spillway. The attractiveness of the test ladder was also limited by low flow volume (~4 cfs from ladder and attraction pipe) and a small, un-natural setting. Based on these perceived limitations, we modified the final fish passage design to include greater flow volume for attraction and a more natural, rock step-pool fish ladder entrance. We also created a more attractive staging area (deep pool with cover) near the entrance using rock weirs (grade controls) that spanned the channel and incorporated large trees.

Evaluating Fish Passage Alternatives with Bull Trout Radio Telemetry

We used radio telemetry in evaluating certain aspects of the preferred fish passage design in 2001 and 2002. The *Bull Trout Radio Telemetry* section of this report describes these and other results in detail.

In summary, we found that all telemetered bull trout placed in the sedimentation reservoir upstream of MWC Dam successfully returned to Rattlesnake Creek via the reservoir head gate within three days. This determination was important in evaluating our preferred fish passage design because fish would pass from the proposed fish ladder into the sedimentation reservoir. Evidence of fish quickly exiting the reservoir through the head gate alleviated concerns related to fish not locating an exit or passing downstream through the historic reservoir outlet.

We detected no attempts by telemetered bull trout in the MWC dam tailrace to approach or enter the Denil test ladder in 2001. We speculate that bull trout could detect the ladder and outflow (based on response by adult rainbow trout and westslope cutthroat trout), but avoided entry due to inadequate ladder flows (1.5-2 cfs), the un-natural character of the ladder structure and the location of the ladder entrance. Bull trout primarily occupied the large pool below the spillway that was approximately 80 ft upstream of the ladder entrance.

Installation and Monitoring of Permanent Fish Ladder in 2003

Installation of permanent fish passage facilities was completed in early April 2003 and operation began on April 18. The total abundance of westslope cutthroat trout and rainbow trout congregated at the dam was similar to 2001 and 2002. We estimated that the fish ladder successfully passed 80-90% of these fish based on weekly snorkel surveys (Table 9). Unlike 2001 and 2002, delays appeared minimal when the ladder was in operation based on snorkel surveys and ripeness of fish captured in the upstream trap. Although upstream fish passage was not provided for early April and two later periods, the timing of cutthroat trout and rainbow trout spawning migrations (Figure 5) was similar to 2002 (Figure 4).

Table 9. Summary of adult salmonids captured in upstream trap after ascending permanent fish ladder at the MWC Dam in 2003.

Species	Adults Captured	Period of Capture	Size Range
Rainbow Trout	84	Apr 19 – Jun 19	279-508 mm
W. Cutthroat Trout	63	Apr 19 – Jun 18	296-462 mm
Cutthroat X Rainbow	56	Apr 22 – Jun 21	260-490 mm
Bull Trout	13	Jun 30 - Aug 4	377-653 mm
Brown Trout	1	May 15	380 mm
Mountain Whitefish	0	-	-
Brook Trout	0	-	-

Only fish that appeared to be genetically pure westslope cutthroat trout or those with obvious westslope cutthroat trout characteristics (cutthroat x rainbow hybrids) were released in Rattlesnake Creek upstream of the trap. All rainbow trout were released downstream of the dam. Re-capture of these fish (marked with a fin punch) upstream of the ladder was minimal.

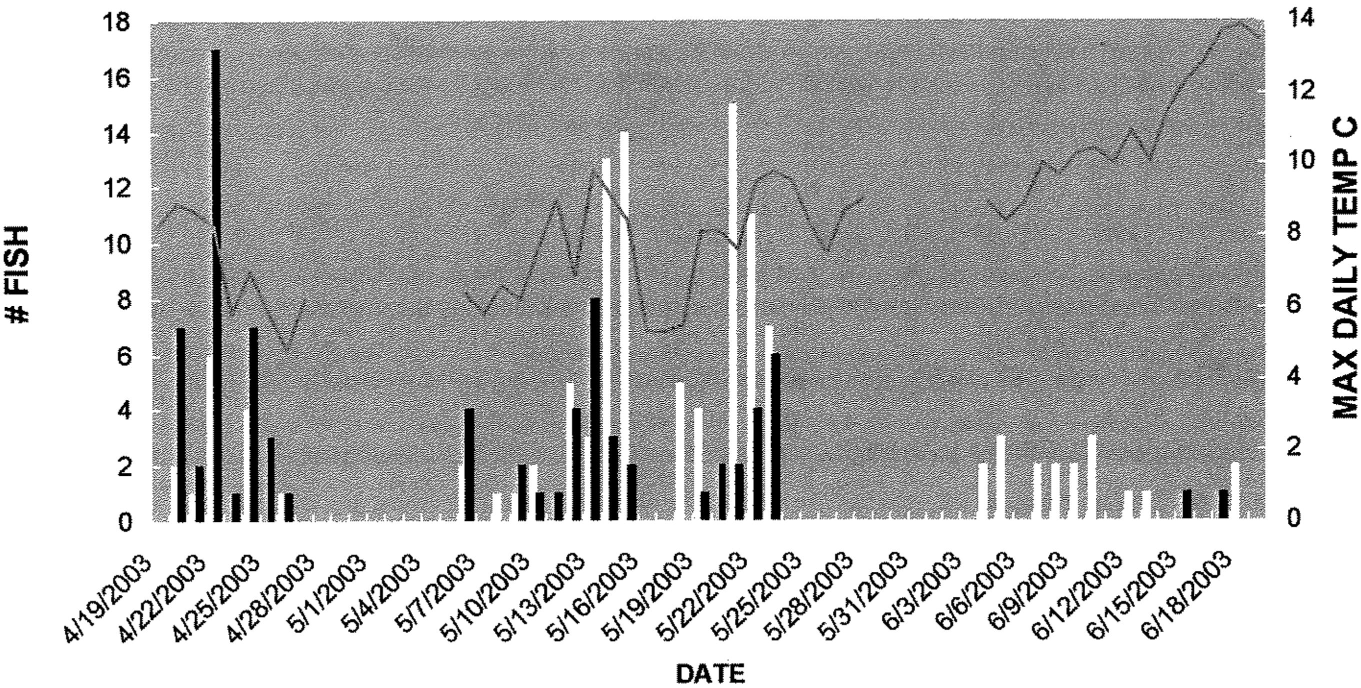


Figure 5. Maximum daily stream temperature (gray line) versus the timing of westslope cutthroat trout (white bars) and rainbow trout (black bars) capture in trap at MWC dam in 2003.

The number of bull trout captured in our trap (13) in 2003 was low relative to the number observed and captured below the dam in 2001 and 2002. However, we suspect that our trap catch was not representative of the total number of fluvial bull trout that approached the dam and utilized the fish ladder. The efficiency in passing fluvial bull trout past the dam in 2003 was believed to be >50%. Congregations (>5) of adult bull were never observed in the MWC dam tailrace in 2003 as in previous years. This may simply indicate low abundance, but subsequent bull trout redd counts were the highest observed in the five years of record (see *Bull Trout Redd Count* section). In addition, several individual bull trout with recognizable marks were observed downstream of the dam for a short period, but were never captured in the trap. Radio telemetry and previous snorkel surveys indicated that migrating adults remained in the tailrace for extended periods if they were unable to move past the dam. We suspect that some individuals that ascended the fish ladder would not enter the trap and returned to Rattlesnake Creek via another route (jumped the 1-2 ft retaining wall or exited through the alternative reservoir outlet). These data suggest that we may have also underestimated ladder effectiveness for westslope cutthroat trout.

The weir fence installed just upstream of the fish ladder entrance had no noticeable affect on capture rate of bull trout in the trap or the number of bull trout that snorkelers observed below the dam. The fence was installed for approximately the final 70% of the bull trout migration period (July 10-Aug 15), with 62% (8 of 13) of the total bull trout catch occurring during this period. We observed only one bull trout that was able to move past the fence to the spillway.

Operational Schedule and Species Selective Passage at Fish Passage Facilities

The primary goal of fish passage upgrades at MWC Dam was enhancement of fluvial westslope cutthroat trout and bull trout populations. While there are no recognized detrimental aspects of passing of fluvial bull trout, there are significant considerations for westslope cutthroat trout. Currently, the *Oncorhynchus* assemblage upstream of MWC Dam consists of a mixture of pure westslope cutthroat trout, rainbow trout and hybrids of the two species (see *Genetic Composition* section). In implementing the upstream fish passage upgrades, we hoped to benefit cutthroat trout populations by augmenting recruitment and increasing the cutthroat trout genetic component. Since fluvial rainbow trout and westslope cutthroat trout readily hybridize when sympatric (Behnke 1992), increasing cutthroat trout genetic composition would entail excluding or limiting rainbow trout spawning as cutthroat trout are enhanced. By excluding rainbow trout (and hybrids), trout recruitment potential for Rattlesnake Creek and the Clark Fork River would be limited.

There are two plausible methods for species-selective fish passage at MWC Dam. The first is capturing and sorting fish similar to 2003. Limited resources preclude this alternative in the long term. Because trout migration timing varies among species and is tied to environmental cues (i.e., stream temperature), selective operation of the fish ladder is the second alternative. However, as displayed in Figures 4 and 5, there is substantial temporal overlap between spawning migrations of rainbow trout, westslope cutthroat trout and hybrids. For instance, if upstream fish passage was provided when major cutthroat trout migrations began (maximum daily water temperatures reach 10 °C, ~ May 10 in 2002 and 2003), we estimate that > 35% of adult trout passed would be rainbow trout. In addition, self-sustaining rainbow trout populations in high elevation lakes likely continue to contribute emigrants to downstream populations.

Delayed spawning by rainbow trout is another complicating factor. If early rainbow trout migrants are delayed at the dam until upstream fish passage is provided, this may encourage hybridization if these fish remain in the tailrace and move upstream with westslope cutthroat trout. There are also questions related to the spatial distribution of westslope cutthroat trout and rainbow trout spawning. Schmetterling (2001), Pierce et al. (2004) have observed that cutthroat trout spawn in middle and upper reaches of tributaries in the upper Clark Fork River basin, while rainbow trout typically spawn in lower reaches. There is clearly overlap in these spatial trends, particularly when hybrids are considered. However, if there is significant spatial segregation in spawning location among species in Rattlesnake Creek, time-selective operation of the fish ladder may be irrelevant.

Examination of these issues will continue as we collect additional data and evaluate the impacts of upstream fish passage at the dam. Radio telemetry may be a useful for investigating spawning locations of rainbow trout and cutthroat trout. In the interim, we will continue with a conservative approach of operating the fish ladder only during westslope cutthroat trout and bull trout migration periods.

Angler Tag Returns

Six of 110 westslope cutthroat trout tagged with Floy tags at MWC Dam were recaptured in the Clark Fork River and reported by anglers in 2001and 2002 (Table 10). Re-capture locations spanned from five miles upstream to approximately 25 miles downstream of the mouth of Rattlesnake Creek. This was similar to the range determined for telemetered bull trout and westslope cutthroat trout in other Clark Fork River basin investigations (Schmetterling 2001). Although angler reporting rate was poor, these limited data indicate that Rattlesnake Creek serves as a source of recruitment for a large portion of the Clark Fork River near Missoula.

Table 10. Recapture information provided by anglers on the Clark Fork River for westslope cutthroat trout tagged at Mountain Water Company Dam in 2001-2002.

Date Taged	Length	Recapture Date	Location	Miles from Rattlesnake Cr.
5/8/01	359 mm	6/23/01	Natural Pier near Alberton	25
5/22/01	360 mm	9/19/01	Kelly Island west of Missoula	5
5/22/01	390 mm	9/27/01	Kelly Island west of Missoula	5
5/29/02	420 mm	11/8/02	Harper's Bridge west of Missoula	7
6/3/02	365 mm	5/30/03	Kelly Island west of Missoula	5
6/5/02	385 mm	6/27/02	~ 2 miles below Milltown	3 upstream

Fluvial Bull Trout and Westslope Cutthroat Trout Growth Rates

We re-captured 10 westslope cutthroat trout and 9 bull trout that had been measured and marked the previous year(s) at MWC Dam (Table 11). Annual growth rates were calculated from repeated measurements.

Table 11 . Annual growth rates for fluvial westslope cutthroat trout and bull trout captured at MWC Dam on Rattlesnake Creek.

Species	Sample Size	Mean Annual Growth	SD	Range
W. Cutthroat Trout	10	6 mm	5.0 mm	0 - 12 mm
Bull Trout	9	42 mm	21.2 mm	13 – 63 mm

Length differences over consecutive years for most westslope cutthroat trout were within the range of expected measurement error for observers (< 6 mm). Once mature, growth is extremely slow in this species as energy stores are diverted to gonadal development (Shepard et al. 1984). The slow growth in adults and short life expectancy explains the limited size distribution observed for all adult fluvial cutthroat trout captured at the dam (Figure 6). Bull trout exhibited higher growth rates and a much broader length distribution. Bull trout are a longer-lived species that continue to grow after maturity (Shepard et al. 1984). Growth rates observed for both species should be used cautiously because of small sample size and possible effects of tagging in reducing growth. However, the growth rates we observed for mature westslope cutthroat trout and bull trout explain the differences in cumulative size distribution for these species.

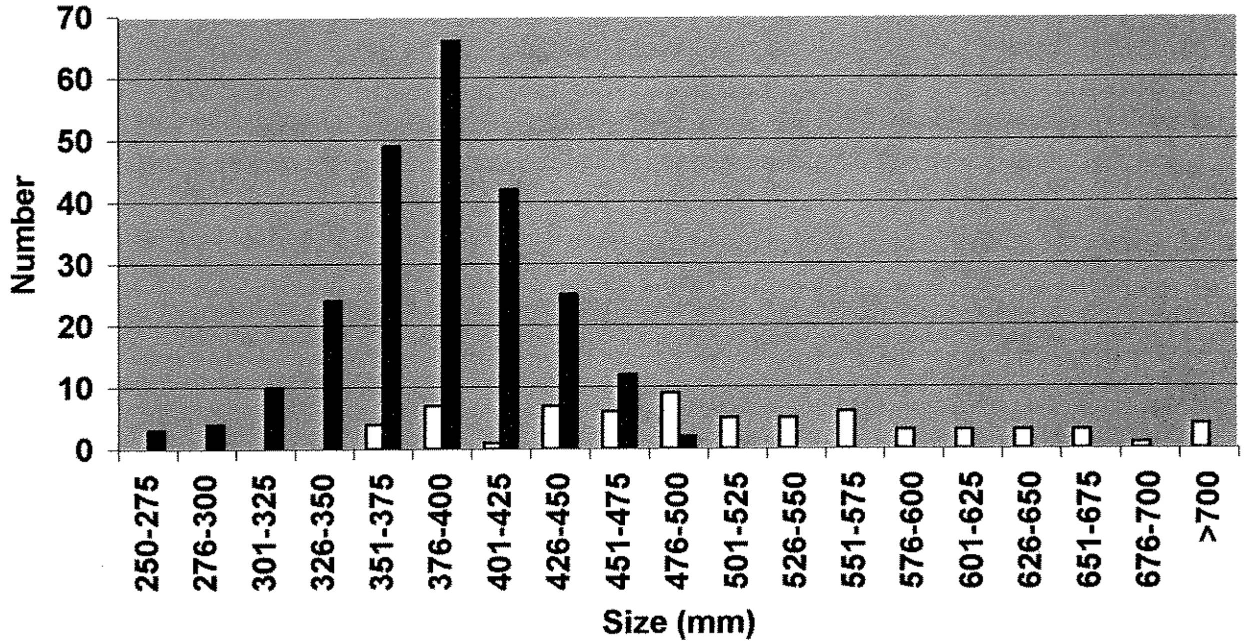


Figure 6. Size distribution of migratory bull trout (white bars, n=67) and westslope cutthroat trout (black bars, n=237) captured at MWC Dam on Rattlesnake Creek in 2001-2003.

Hook Scar Rates

We found high incidence of hook scars and differences between adult rainbow trout and westslope cutthroat trout captured at the MWC Dam in 2002 and 2003 (Table 12). Hook scar rates were significantly higher for these fluvial trout in Rattlesnake Creek relative to two nearby Clark Fork River sections sampled in 1999-2002 (Knotek et al. 2003). These data are likely explained by high fishing pressure at the mouth of Rattlesnake Creek in April-June when cutthroat trout and rainbow trout are staging. The only Clark Fork River estimate (Superior-Fall) with relatively high hook scar rates for cutthroat trout

(46%) was conducted after the most intense period of angling pressure for this reach (summer). High hook scar rates are an indication of high catch rates, as well as successful catch-and-release angling. In Rattlesnake Creek, high hook scar rates are alarming because of additional stress and delayed mortality (Taylor and White 1992) that could be occurring in staging and migrating adults preparing to spawn. However, we have not (anecdotally) observed unusually high mortality rates in these spawning populations.

Table 12. Comparison of hook scar rates for fluvial rainbow trout and cutthroat trout captured on Rattlesnake Creek and the Clark Fork River in 1999-2003.

Location	**Rainbow trout % with hook scars (n)**	**W. cutthroat trout % with hook scars (n)**
Rattesnake Creek – MWC Dam Spring 2002-2003	*23 % (64)*	*59 % (100)*
Clark Fork River – Milltown Spring 1999-2002	8-10 % (>600)	18-28 % (>150)
Clark Fork River – Superior Fall 1999	9 % (733)	46 % (86)

Significant differences in hook scar rates between rainbow trout and westslope cutthroat trout are consistent with findings at other locations (Knotek et al. 2003; MFWP, unpublished data). Westslope cutthroat trout are extremely susceptible to angling and consistently support higher angler catch rates than co-existing fluvial rainbow trout and brown trout at similar densities (MFWP, unpublished data). Hook scar rates for bull trout are more similar to cutthroat trout than introduced trout species (MFWP unpublished data). However, at the MWC dam, we could not confidently identify hook scars on bull trout due to facial injuries and deformities caused by repeated attempts to ascend the concrete spillway.

On Rattlesnake Creek and the Clark Fork River, fishing regulations could have biased hook scar rates for different species and sizes of trout. Regulations for cutthroat trout include catch-and-release only for all sizes throughout the year. Regulations for rainbow trout in all areas investigated are three rainbow or brown trout per day < 15 in (end of May - November) and catch-and-release only in winter and early spring (Dec - end of May). Since most fluvial rainbow trout are > 15 in, we did not consider this a significant concern in comparisons on Rattlesnake Creek. Differences in hook scar rates among size classes of rainbow trout in the Clark Fork River sections will be addressed in future investigations.

BULL TROUT REDD COUNTS

Introduction and Methods

Redd counts are a common tool for monitoring escapement of adult fluvial bull trout (Dunham et al. 2001; Spalding 1997). Redds, or nests, are excavated by spawning females and can be counted by trained personnel in consistent stream sections to serve as an index of spawning adult abundance, level of spawning activity and as an indication of anticipated recruitment in the succeeding generation (Deleray et al. 1999). In western Montana, bull trout generally spawn during the first three weeks of September and have high fidelity to natal tributaries (Fraley and Shepard 1989). Redds of fluvial bull trout (migratory fish that rear in tributary streams, reach maturity in larger rivers and return to natal tributaries to spawn) are easy to identify as adults (>16 in) and redds are generally large (>3 ft long; Kondolf and Wolman 1993; Fraley and Shepard 1989). Typical redds constructed by resident adults (those that spend their entire life in a tributary stream) can be more difficult to identify due to smaller average adult body size, redd size and stream substrates utilized.

Investigations in the Swan River drainage in northwest Montana (Baxter 1997) indicated that bull trout selected spawning sites that were within or immediately downstream of reaches that gained subsurface water (upwelling areas). Bull trout spawning typically occurs in areas influenced by groundwater (Allan 1980; Fraley and Shepard 1989). These areas tend to remain open during harsh winter conditions when adjacent stream reaches ice over or accumulate anchor ice (Deleray et al. 1999). High groundwater exchange keeps eggs from freezing and helps prevent suffocation.

Bull trout spawn in reaches with gradients of less than two percent (Fraley and Shepard 1989). Water depths at the upstream edge of adfluvial bull trout redds ranged from 4-24 inches (mean 12 inches) and water velocities ranged from 0.3 – 2.0 ft/sec (mean 1.0 ft/sec) in the Flathead Drainage (Fraley et al. 1981; Kitano et al. 1994).

In Rattlesnake Creek, we established redd count sections to monitor the abundance of fluvial and large resident adult bull trout. Rattlesnake Creek is unique among Clark Fork Basin streams in that it has retained fluvial and resident bull trout population components (MFWP, unpublished data). The primary purpose of these redd counts was to track fluvial bull trout population response after fish passage upgrades and other fishery enhancements were completed. However, since redds constructed by fluvial fish cannot be distinguished from those of large resident fish, the total count represents both components. Basin-wide redd surveys were completed upstream of MWC Dam in 1999 and 2000 to identify bull trout spawning locations in Rattlesnake Creek. Experienced field crews completed surveys by walking the channel and visually searching for redds. Redds were identified by the presence of a pit or depression and associated tail area of clean (bright) gravel (Deleray et al. 1999; Spalding 1997).

Based on these surveys, two reaches of 1.0 and 2.25 miles were selected in 2000 as redd monitoring sections because they contained all of the redds located in the drainage (Figure 7). The total number of definitive redds in a particular reach was totaled to determine a 'count' for monitoring purposes. Counts were completed between

September 26 and September 29 annually by consistent personnel. All redds that we included in counts were > 3 ft in length from head of pit to tail (visual estimate) and likely represented spawning resident and fluvial adults greater than 16 inches (Kondolf and Wolman 1993; Fraley and Shepard 1989). Smaller redds (if observed) constructed by resident bull trout were not included.

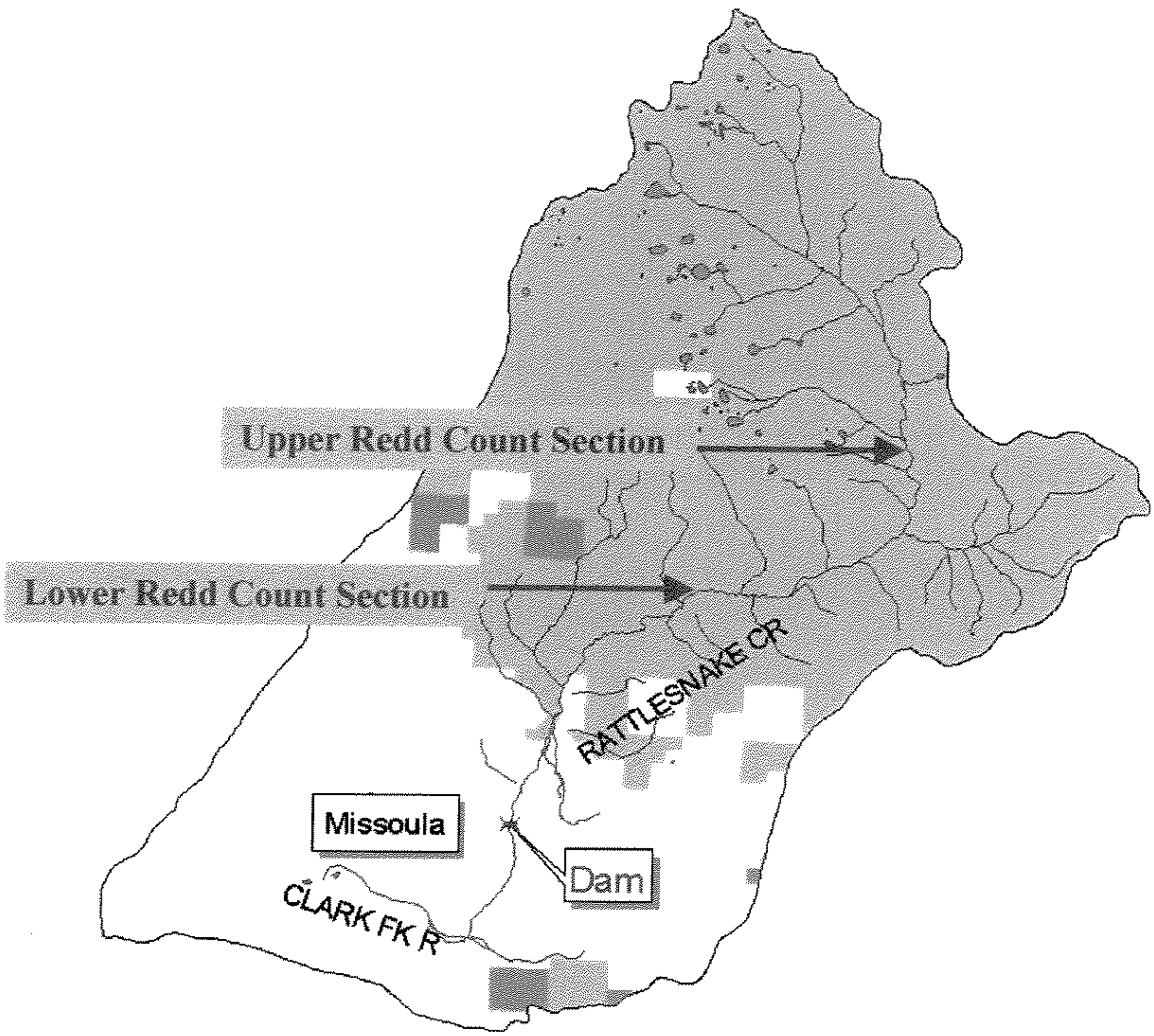


Figure 7. Location of bull trout redd count sections in Rattlesnake Creek

Results and Discussion

Bull trout redd counts from 1999-2003 suggest a significant positive response to upstream fish passage at MWC Dam (Table 13). Counts completed in 1999 and 2000 are considered a baseline for pre-project spawning activity by large resident bull trout since spawning areas were not accessible to fluvial adults during this period. The abundance of redds was enhanced in 2001 and 2002 by manually transporting 26 and 28 adults (respectively) over MWC Dam. In 2003, upstream fish passage at the dam was provided by a fish ladder constructed around the east portion of the spillway (see prior section of this report). Fluvial bull trout population size and redd abundance in Rattlesnake Creek is expected to increase further with continued access to spawning areas and affiliated enhancement activities that reduce anthropogenic mortality (e.g., screening irrigation diversions and protective fishing regulations). Riemen and Meyers (1997) recommend 10 years of monitoring in index reaches to identify trends in population abundance.

Table 13. Bull trout redd counts in Rattlesnake Creek monitoring sections.

	SECTION I	SECTION II	TOTAL
1999 (9/28/99)	12	No Count	12[a]
2000 (9/29/00)	8	4	12
2001 (9/27/01)	24	6	30 [b]
2002 (9/27/02)	19	10	29[b]
2003 (9/26/03)	29	4	33[c]

a The upper monitoring section was not established until 2000.
b In 2001-2002, adult bull trout were transported over Mountain Water Company Dam, which contributed to increased redd numbers.
c In 2003, upstream fish passage was provided by the permanent fish ladder.

The validity of redd count index sections as indices of total redd abundance was evaluated using basin-wide surveys and radio telemetry. Redd surveys completed throughout the upper Rattlesnake Creek Drainage in 1999 and 2000 indicated that redds were concentrated in our selected index reaches. In fact, no redds were located outside these reaches. In the future we will periodically repeat basin-wide surveys to ensure that index sections are representative of redd abundance throughout the drainage. Radio telemetry also confirmed the validity of selected redd count locations (see *Bull Trout Radio Telemetry* section of this report). All five telemetered bull trout captured and transported over MWC Dam in 2001 and 2002 spawned within the lower redd count section.

The timing of resident and fluvial bull trout spawning in Rattlesnake Creek (Sept 1- Sept 25) was consistent with observations in other Montana streams (MFWP, unpublished data; Deleray et al. 1999). In addition to redds included in our surveys, small (< 14 in) resident adult bull trout were occasionally observed spawning in index reaches. As expected, these redds were difficult to identify after adults left and are not reflected in redd counts. Redd counts serve as an *index* of spawning activity and adult abundance in Rattlesnake Creek, but do not represent total expected offspring abundance as stock-recruitment curves have not been developed for this species in Montana.

BULL TROUT RADIO TELEMETRY

Introduction and Methods

Radio telemetry has become a common tool for assessing fish behavior, movement and habitat use. Although sample size is often small, information gained from individuals over long periods of time can provide insights that are unattainable using traditional fisheries methods. We used radio telemetry to examine or corroborate several facets of our projects on Rattlesnake Creek. Specifically, bull trout captured at MWC Dam were implanted with transmitters to: 1) confirm the validity of redd count monitoring sections, 2) document seasonal movements and migration timing, and 3) evaluate the efficacy of upstream fish passage proposals at the dam.

Six adult bull trout captured below the dam (3 each year) were implanted with individually coded radio-transmitters (7.7-11.0 g) in 2001 and 2002 (Table 14). Surgeries were completed in 1.5-2.5 minutes using standard techniques (Schmetterling 2001) in July when water temperatures were < 12 °C (54°F). In 2001, all three telemetered fish were moved over the dam and placed in the sedimentation basin after surgery. In 2002, two fish were moved over the dam and one was returned to the dam tailrace. Telemetered fish were generally tracked weekly with Lotek SRX 400 receivers, but were tracked more frequently during upstream migration to the dam and spawning, and less frequently during late fall and winter. Tracking continued throughout the life of each transmitter or until fish mortality.

Table 14. Data summary for bull trout implanted with radio-transmitters at Mountain Water Company Dam in 2001 and 2002.

FISH #	DATE	LENGTH	TRANSMITTER WT (LIFE)	RELEASE LOCATION
22-40	7/6/01	610 mm	8.9 g (598 d half duty)	Sedimentation Basin
22-41	7/6/01	630 mm	10.0 g (560 d)	Sedimentation Basin
22-42	7/10/01	680 mm	10.0 g (560 d)	Sedimentation Basin
22-34	7/11/02	465 mm	7.7 g (418 d)	Dam Tailrace
22-32	7/26/02	521 mm	7.7 g (418 d)	Sedimentation Basin
22-46	7/26/02	810 mm	10.0 g (839 d half duty)	Sedimentation Basin

In 2002, we attempted to use telemetered bull trout in evaluating the efficacy of upstream fish passage alternatives at MWC Dam. We tracked telemetered fish (n=3) daily at the dam during the bull trout migration period to assess their response to the test ladder described in previous sections of this report. Since bull trout are primarily nocturnal, we also deployed a remote receiver station with recorder at the Denil fish ladder to determine if bull trout were approaching or entering the ladder at night. The receiver and data recorder were programmed to operate continuously at one minute intervals.

Telemetered bull trout at MWC Dam on Rattlesnake Creek in 2001

Results and Discussion

Spawning Location and Timing

Fluvial bull trout congregated at the MWC dam between June 25 and August 10 in 2001 and 2002. As described in Table 15, five of the six bull trout implanted with transmitters were transported upstream of MWC Dam between July 6 and August 1. All of these fish exited the sedimentation basin within three days after transport. Bull trout then moved progressively upstream for 1.5-4 weeks until they reached identified spawning areas (lower redd count section) located 4-7 miles upstream of the dam. All telemetered fish (one spawned in both years) spawned in the lower redd count monitoring section during the anticipated spawning period (9/1-9/25), suggesting that this is a valid reach for assessing adult escapement and spawning activity. Telemetry also confirmed that redd counts are being conducted at the appropriate time (9/25-9/28 annually); within 2 weeks after the conclusion of spawning. Redd count data are presented in the *Bull Trout Redd Counts* section of this report.

Table 15. Spawning and migration data for telemetered bull trout in Rattlesnake Creek

Fish #	Date Moved Over Dam	Approximate Spawning Date / Location	Overwinter Location
22-40	7/6/01	9/5/01-9/10/01 Lower Redd Count Section	T13N R20W Sect 21 Clark Fork near Kelly Island
22-40	8/1/02	9/4/02-9/17/02 Lower Redd Count Section	T14N R18W Sect 20 Rattlesnake Cr.– Frazier Cr. mouth
22-41	7/6/01	9/1/01-9/15/01 Lower Redd Count Section	T14N R21W Sect 14 Clark Fork near Rock/Albert Cr
22-42	7/10/01	9/5/01-9/22/01 Lower Redd Count Section	Mountain Water Co Dam forebay - Assumed deceased
22-32	7/26/02	9/10/02-9/20/02 Lower Redd Count Section	T14N R18W Sect 20 Rattlesnake Cr.– Frazier Cr. mouth
22-46	7/26/02	9/10/02-9/20/02 Lower Redd Count Section	N/A- Deceased 1 month after spawning

Home Range, Habitat Use and Migration Timing

Surprisingly, bull trout did not promptly exit Rattlesnake Creek once spawning was completed. Telemetered fish remained in the 4-5 mile reach immediately upstream of the dam for at least two months after termination of spawning and two fish apparently over-wintered just downstream of the lower spawning reach in 2002. This behavior is generally inconsistent with other bull trout telemetry studies in the upper Clark Fork River basin. Pierce et al. (2004), Schmetterling (2002) and Swanberg (1997) found that most fluvial bull trout left Blackfoot River tributaries shortly after spawning if stream discharge was adequate. In some instances, low stream discharge and the dam spillway (obstacle to downstream migration) may have delayed bull trout migrating out of Rattlesnake creek. However, telemetered adults remained more than a mile upstream of the dam during post-spawn periods in 2001 and 2002.

Two of the six telemetered bull trout in Rattlesnake Creek migrated downstream past the MWC Dam to the Clark Fork River between November and March after spawning in 2001. One of these fish repeated this post-spawn movement in 2002. These individuals remained at approximately the same locations in the Clark Fork River (see Table 15) for 5-7 months before returning to Rattlesnake Creek. This main stem river behavior and consecutive years spawning is not unusual for fluvial bull trout in western Montana (Swanberg 1997).

Evaluation of Fish Passage

Three telemetered bull trout were among adults congregated in the MWC Dam tailrace in 2001. All three fish remained below the dam spillway throughout most of the migration period (July). Two of the fish made movements of up to 1000 ft downstream of the dam during this period, but then returned to the tailrace.

Although movements within the tailrace area were common and infrequent forays downstream occurred, no attempts to approach or enter the Denil fish ladder were detected for any of the bull trout. The entrance to the ladder was located ~ 80 ft downstream of the tailrace pool where the fish congregated. We speculate that bull trout could detect the ladder and outflow (based on the response of adult *Oncorhynchus* spp.), but avoided entry due to inadequate flows (1.5-2 cfs) or the unnatural character of the Denil structure.

As mentioned above, all telemetered bull trout placed in the sedimentation reservoir upstream of MWC Dam successfully returned to Rattlesnake Creek via the reservoir head gate within three days. This determination was important in evaluating our preferred fish passage design because fish would pass from the proposed fish ladder into the sedimentation reservoir. Evidence of fish quickly exiting the reservoir through the head gate alleviated concerns related to fish locating an exit or passing downstream out the reservoir outflow spillway.

ASSESSMENT AND REDUCTION OF FISH LOSSES IN IRRIGATION DIVERSIONS

Introduction and Methods

Diversion of river or stream water for irrigation and other agricultural purposes is a common practice throughout the western United States. In Montana, most major diversions and the water rights that legitimize them date back more than 100 years. Facilities and practices used in diverting water are often traditional methods that only consider water capture and transfer efficiency. Unfortunately, there are significant biological and hydrologic impacts associated with traditional diversion methods. One of the most common impacts is fish entrainment. Fish entrained with water in irrigation canals are often killed or lost to the stream system from which they originated (Swanberg 1997).

Entrainment in irrigation diversions is a typical source of juvenile and adult salmonid losses in western Montana streams (Pierce et al. 1997). In Rattlesnake Creek and other tributaries of the Clark Fork River, irrigation diversions typically entrain age-0 and juvenile salmonids as they move downstream out of spawning and rearing areas. Although fish species composition in diversion ditches is usually similar to that of the source stream, the magnitude of fish losses varies considerably with the size, location and orientation of the canal entrance.

Six small (2-7 cfs) irrigation diversions are currently operated on the lower 5 miles of Rattlesnake Creek (Figure 8, Table 16). These diversions were originally constructed to irrigate agricultural lands and provide stock water, but are now used primarily for watering residential lawns. In this report section, we describe recent sampling to assess fish entrainment losses in these diversions, fish screening efforts to reduce entrainment where necessary, and post-project monitoring to evaluate the success of fish screen projects.

Table 16. Active irrigation ditches on lower Rattlesnake Creek in 2003.

Diversion Name	~ cfs	Screened? (yr)	Screen Type
Cobban	4-6	Yes (2002)	Brencail
Hamilton-Day	2-4	Yes (2002)	Brencail
Hughes-Fredline	2-4	No	-
Hallenbeck	5-7	No	-
Quast	5-7	Yes (1998)	Brencail
Williams	3-5	Yes (1999)	McKay Self-Cleaning

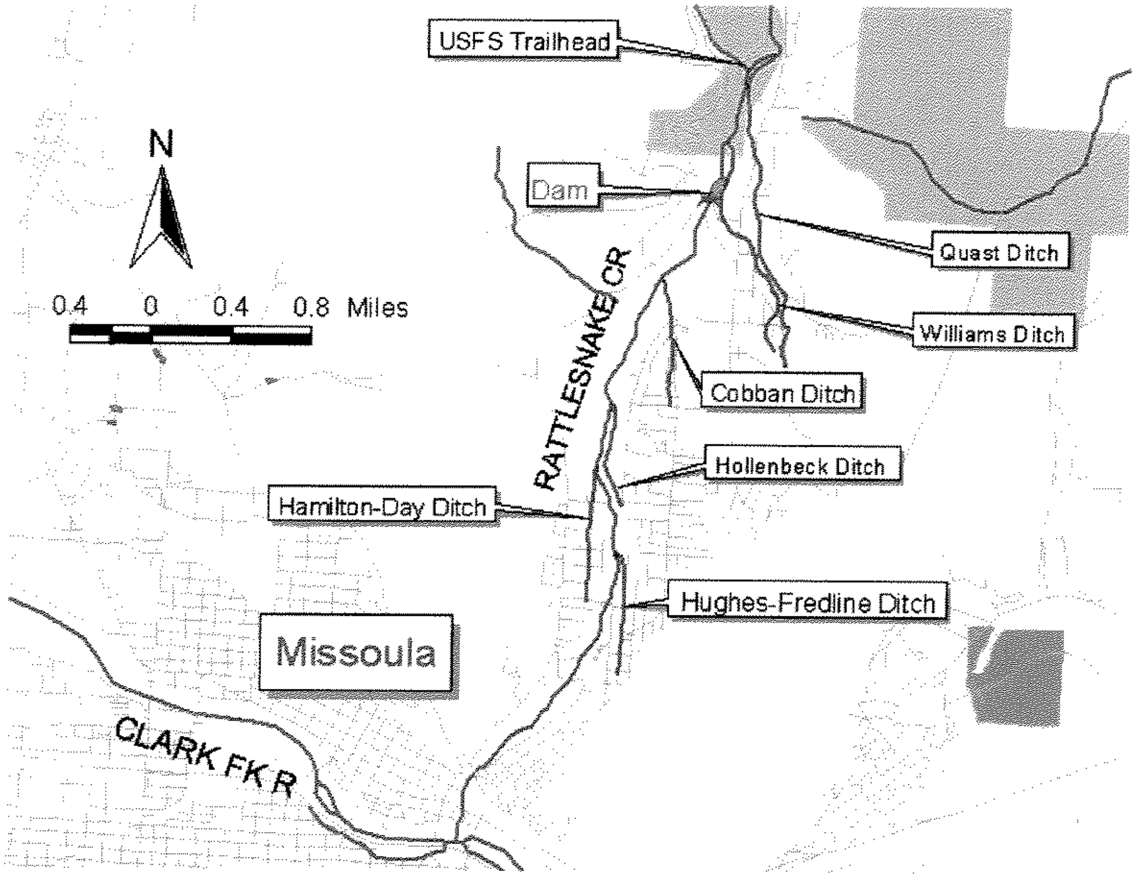


Figure 8. Irrigation diversions in lower Rattlesnake Creek.

Electrofishing in Irrigation Canals

In 2001-2003, we used a Coffelt backpack–mounted electrofishing unit to measure fish entrainment in diversions from Rattlesnake Creek. Diversion canals were sampled for a minimum of 250 ft in an upstream direction to the diversion point on Rattlesnake Creek or 'head gate'. Although diversions were typically operated from April-October, sampling was concentrated in August-September each year when fish densities were high in canals. Captured fish were identified to species, measured and released in Rattlesnake Creek.

We sampled both screened and unscreened diversion canals to estimate trout losses and evaluate the effectiveness of screens already installed. Since fish screens were installed on the Coban and Hamilton-Day canals during the study period (2002), pre- and post-project data were collected for these diversions. The Williams and Quast diversions were screened by Lolo National Forest personnel in 1997-1999.

Results and Discussion

Fish Entrained in Unscreened Diversions

Although there was some variation in species composition and fish density, trout were abundant in all unscreened diversion canals (Table 17). Overall fish species composition was similar to lower Rattlesnake Creek, but the relative abundance of bull trout was much higher in the Coban and Hamilton-Day diversions relative to the stream. Similarly, disproportionately high concentrations and subsequent losses of bull trout have also been found in diversions from the North Fork of the Blackfoot River (Pierce et al. 1997). Juvenile salmonids, especially bull trout, normally use side channels and stream margins as rearing habitat. Small irrigation ditches with abundant vegetation and cover likely mimic these habitats and attract juvenile fish. We suspect that entrainment in small diversions is particularly prevalent in lower Rattlesnake Creek as this reach (through Missoula) has been channelized and confined where it was historically braided, with abundant side channels and rearing habitat.

Table 17. Fish sampling in irrigation diversion canals on Rattlesnake Creek in 2001-2003.

DIVERSION – DATE SAMPLED	SECTION LENGTH	FISH SPECIES	NUMBER	SIZE RANGE
COBAN				
Aug 22, 2001 Before Screened	~ 500 ft	Bull Trout	53	53 – 243 mm
		Oncorhynchus Spp	25	48 – 210 mm
		Brown Trout	3	183 – 212 mm
		Brook Trout	16	50 – 300 mm
Sept 27, 2002 After Screened	~ 250 ft	Oncorhynchus Spp	2	50-70 mm
		Brown Trout	2	61-80 mm
Aug 19, 2003 After Screened	~ 500 ft	Oncorhynchus Spp	27	50-112 mm
HAMILTON-DAY				
June 25, 2001 Before Screened	~ 250 ft	Bull Trout	3	107 – 218 mm
		Oncorhynchus Spp	11	40 – 121 mm
		Mountain Whitefish	2	116 – 202 mm
		Brook Trout	5	69 –145 mm
Sept 27, 2002 After Screened	~ 350 ft	Oncorhynchus Spp	22	45-92 mm
		Brown Trout	33	58-82 mm
		Brook Trout	6	45-86 mm
Aug 15, 2003 After Screened	~ 500 ft	Oncorhynchus Spp	22	49-113 mm
		Brown Trout	13	51-171 mm
		Brook Trout	2	45-138 mm

Table 17. Continued.

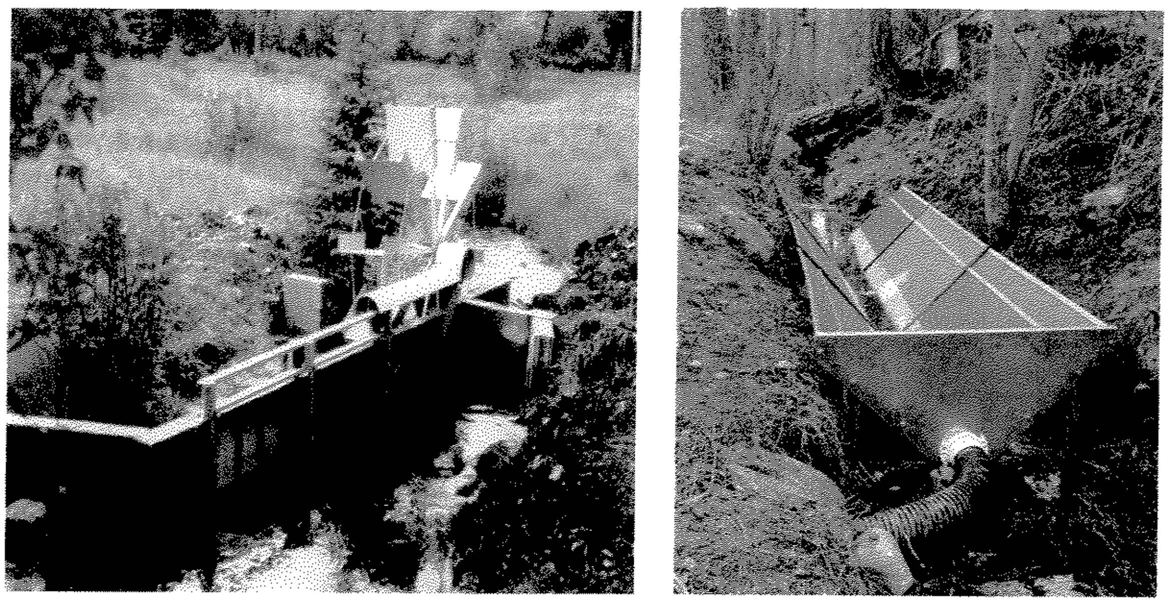
DIVERSION – DATE SAMPLED	SECTION LENGTH	FISH SPECIES	NUMBER	SIZE RANGE
QUAST				
June 23, 2001 After Screened	~ 250 ft	No Fish		
Oct 10, 2002 After Screened	~ 250 ft	Oncorhynchus spp.	1	58 mm
		Brook Trout	20	62-172 mm
Aug 19, 2003 After Screened	~ 500 ft	No Fish		
WILLIAMS				
June 23, 2001 After Screened	~ 250 ft	No Fish		
Oct 10, 2002 After Screened	~ 300 ft	No Fish		
Aug 19, 2003 After Screened	~ 500 ft	Oncorhynchus spp.	1	52 mm
		Brook Trout	2	79-84
HUGHES-FREDLINE				
Sept 27, 2002 Not Screened	~ 250 ft	Oncorhynchus spp.	12	38-122 mm
		Brown Trout	45	41-172 mm
		Brook Trout	1	58 mm
		Mtn Whitefish	5	61-85 mm
HOLLENBECK				
Aug 12, 2002 Not Screened	~ 300 ft	Oncorhynchus spp.	8	73-117 mm
		Brown Trout	15	55-242 mm
		Brook Trout	16	48-242 mm

Note: Oncorhynchus spp. refers to rainbow trout, westslope cutthroat trout & hybrids of these species

We found that relative fish abundance and species composition may change over a single irrigation season and between years. Fish appeared to accumulate in canals over the course of the summer in Rattlesnake Creek diversions and species composition changed as different species emerged from gravels or emigrated downstream. Although not shown in Table 17, the abundance of fish in unscreened diversions was much lower in June relative to September/October in 2001. Fish likely accumulate in the canals throughout the irrigation season. However, fish collected by electrofishing in canals are only a small proportion of the total number entrained and lost over an entire irrigation season. Sampling near head gates does not afford a reliable estimate of fish losses, but does provide a snapshot of fish species composition and relative abundance. We used relative fish abundance in our sampling sections as an indication of fish losses and justification for fish screens.

Installation and Effectiveness of Fish Screens

Prior to our assessments and projects, Lolo National Forest personnel installed fish screens on two diversions from Rattlesnake Creek (1997 and 1998). A self-cleaning flat plate screen was installed on the Quast canal and a manual cleaning Brencail screen was placed in the Williams canal. Sampling downstream of these fish screens in 2001-2003 indicated that they are successfully reducing fish entrainment from Rattlesnake Creek. Unfortunately, we could not measure the efficiency of these screens directly because sampling was not conducted prior to fish screen installation.



McKay self-cleaning flat plate (left) and Brencail manual cleaning (right) fish screens

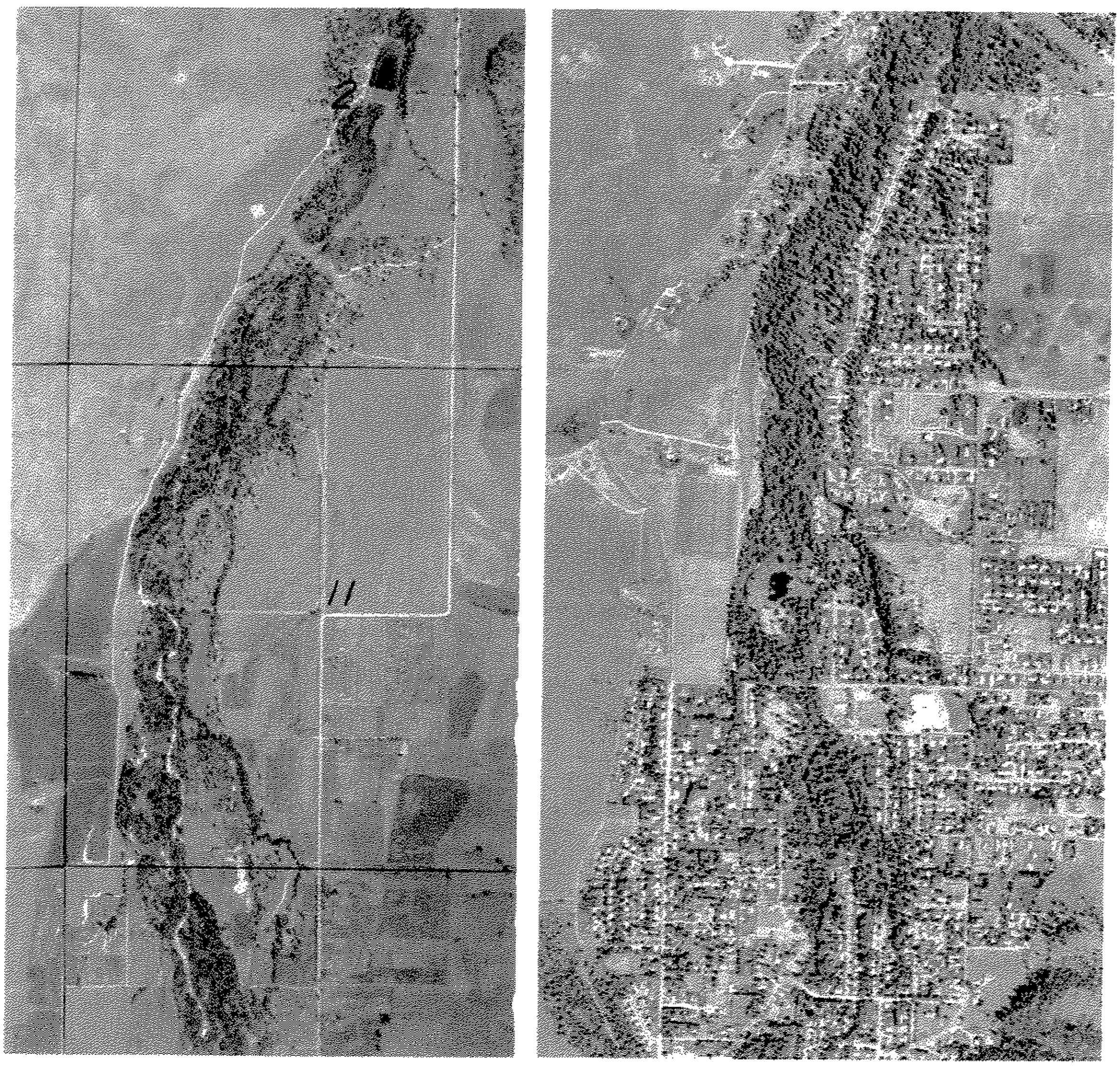
Brencail fish screens were installed on the Coban and Hamilton-Day canals after our sampling in 2001 documented high fish entrainment rates. Success in reducing entrainment was mixed for these fish screens in 2002 and 2003 (Table 17). Fish sampled downstream of the Coban fish screen in 2003 likely passed through when the bypass pipe connection was inadvertently detached. Others may have found small gaps under the screen, but overall the structure appears to be functioning properly and excluding most fish from the canal. The most noticeable improvement was the elimination of bull trout in our sampling section after screening in 2002. The effectiveness of the Hamilton-Day fish screen appears to be much lower for a number of reasons. We were not able to install a bypass flow pipe at this screen due to ditch orientation and slope constraints. In addition, fish were likely moving around and over the top of the screen as it was under-sized and poorly sealed for much of the 2002 and 2003 operation period. These deficiencies will be corrected prior to the 2004 irrigation season and we will continue to evaluate the screen's effectiveness. We intend to pursue installation of a fish screen on the Hughes-Fredline diversion which incorporates expansion of side channel spawning and rearing habitat. The Hollenbeck canal now leads to a large ornamental pond which has two outflow exits. The primary outflow returns directly back to Rattlesnake Creek. The second (continuation of irrigation water) requires limited discharge (1-2 cfs) and contained few fish when sampled in 2002. Therefore, there are no plans to screen the Hollenbeck diversion.

The Brencail fish screen design is still being tested and modified on Rattlesnake Creek diversions. This new, but relatively simple design is an inexpensive alternative for small diversions that are conducive to frequent manual cleaning and maintenance. The self-clean flat plate (McKay) fish screen is a standard, proven design that is more expensive, but requires less maintenance.

OTHER FISHERIES ENHANCEMENT OPPORTUNITIES

Increasing Habitat Complexity in Lower Reaches of Rattlesnake Creek

As previously described, the lowest 4 miles of Rattlesnake Creek has been straightened and confined to a single channel in many reaches as surrounding Missoula neighborhoods were developed in the 20th century. This section was historically braided and unstable as the stream reached the lower gradient Missoula Valley. Instream habitat complexity is now low in this reach as side channels are infrequent and much of the large woody material has been removed or mobilized. Aerial photos of this area (shown below) depict many of the changes that have occurred.



Aerial photos of lower Rattlesnake Cr. (stream mile 2-4) in 1937 (left) and 2000 (right)

An instream habitat survey conducted in 2002 substantiated these observations. With the exception of a few remaining side channels and braided sections, Rattlesnake Creek channel reaches downstream of MWC Dam were > 95% riffle and averaged less than 1 piece of large woody debris (LWD) per 100 linear ft (MFWP, unpublished data). For comparison, a reference reach within USFS ownership (Fraser Creek to Beescove Creek) contained approximately 3 pieces of LWD per 100 linear ft, with more frequent debris jams and pool habitat (> 15% of total length). We defined LWD as wood > 10 ft long and > 4 inches in diameter at one end.

Engineered channels and simplified habitat conditions limit the availability of trout spawning and rearing areas. Rainbow trout and brown trout, which dominate lower reaches, use existing side channels extensively. For instance, in 2001 we observed 47 fluvial rainbow trout redds in two side channel sections totaling < 1000 ft. Increasing the diversity of habitats in lower Rattlesnake Creek would likely increase recruitment for the Clark Fork River sport fishery and provide additional transitional habitats for migratory native fish.

In 2001-2002, a project was completed in Greenough Park (stream mile 1.5) that included reconstruction of a ~ 200 ft side channel reach and expansion of 2-3 acres of floodplain. Similar projects are possible in adjacent reaches of lower Rattlesnake Creek.

Reduction in Illegal Harvest

Key staging and spawning areas for fluvial trout continue to be popular fishing locations on Rattlesnake Creek (e.g., stream mouth). Through fishing regulation changes, angler education efforts and increased enforcement in recent years, the incidence of illegal harvest in lower Rattlesnake Creek has been reduced. In 2003, no citations for illegal harvest were issued in lower Rattlesnake Creek (including MWC Dam and the stream mouth) despite frequent patrols by game wardens (Dan Curtin, FWP Enforcement, personal communication).

Reports from the public and anecdotal observations suggest that illegal angling and harvest may still be a significant problem in reaches upstream of MWC Dam where angling is prohibited. We plan to expand enforcement efforts in these areas that are served only by non-motorized access.

Instream Flow Enhancement

The majority of valid water rights on Rattlesnake Creek are owned by Mountain Water Company as part of the Missoula municipal water supply system. Storage rights that total 2500 acre-ft on eight high elevation lakes located at the head of the drainage are a key components of this system. Since MWC is currently not using Rattlesnake Creek as a source of municipal water, the opportunity exists to use storage capacity and water rights for instream flow enhancement. Mountain Water Company has expressed interest in evaluating options for instream flow enhancement as part of their operations in the drainage. Key periods for instream flow enhancement are July-September when irrigation demands are highest and fluvial bull trout are staging and spawning in Rattlesnake Creek.

Assessment and Management of High Elevation Lakes

The Rattlesnake Creek drainage contains more than 45 lakes that range in size from 0.3 - 43 acres and 6000-7700 ft in elevation. A 1988 Rattlesnake Mountain Lakes Management Plan developed by MFWP-Region 2 summarizes the stocking history and management strategy for these waters. Of the 45 lakes identified in the plan, 15 were managed as trout fisheries with varying combinations of westslope cutthroat trout, rainbow trout and Yellowstone cutthroat trout. Six of the lakes supported self-sustaining wild populations, but most (9) were supplemented or sustained through stocking of westslope cutthroat trout prior to 1989. The remaining 30 lakes were managed as fishless waters.

Fisheries and aquatic surveys of Rattlesnake drainage lakes were completed from 1963-1982. No stocking or management activity other than occasional enforcement trips has occurred since 1988. Current fisheries surveys are needed for these waters in order to evaluate fish persistence, fish and amphibian species composition and population characteristics. This information is vital in developing an updated management plan.

We plan to initiate current lake sampling efforts in summer 2004. These assessments will include amphibian surveys, measurement of lake productivity and physical features, bathymetric mapping (fish-bearing lakes), in addition to collection of standard fisheries data. Through these surveys, we hope to further develop lake management strategies that provide quality fisheries and are compatible with sympatric and downstream aquatic communities.

LITERATURE CITED

Allan, J.H. 1980. Life history notes on the Dolly Varden char (*Salvelinus malma*) in the upper Clearwater River, Alberta. Manuscript report. Alberts Energy and Natural Resources, Fish and Wildlife Division, Red Deer, Alberta.

Baldwin, T.J., J.E. Peterson, G.C. McGree, K.D. Stagmiller, E.S. Motteram, C.C. Downs and D.R. Stanek. 1998. Distribution of *Myxobolus cerebralis* in salmonid fishes in Montana. Journal of Aquatic Animal Health 10:361-371.

Baxter, C.V. 1997. Geomorphology, land use, and groundwater-surface water interaction: a multi-scale, hierarchical analysis of the distribution and abundance of bull trout (*Salvelinus confluentus*) spawning. M.S. Thesis. University of Montana, Missoula, Montana.

Behnke, R.J. 1992. Native trout of western North America. American Fisheries Society, Monograph 6, Bethesda, Maryland.

Berg, R.K. 1999. A compilation of fishery survey information for the middle Clark Fork River drainage. Montana Fish, Wildlife and Parks, Missoula, Montana.

Deleray, M., W.L. Knotek, S. Rumsey and T.M. Weaver. 1999. Flathead Lake and River system fisheries status report. Montana Fish, Wildlife and Parks, Kalispell, Montana. 200 pp.

Dunham, J., B. Rieman and K. Davis. 2001. Sources and magnitude of sampling error in redd counts for bull trout. North American Journal of Fisheries Management 21:343-352.

Fraley, J.J., and B.B. Shepard. 1989. Life history, ecology, and population status of migratory bull trout (Salvelinus confluentus) in the Flathead Lake and River system, Montana. Northwest Science 63:133-143.

Fraley, J.J., D. Read and P.J. Graham. 1981. Flathead River fisheries study. Montana Department of Fish, Wildlife and Parks, Kalispell, Montana.

Gilbert, M.A. and W.O. Granath. 2001. Persistent infection of *Myxobolus cerebralis*, the causative agent of salmonids whirling disease, in *Tubifex tubifex*. Journal of Parasitology 87(1):101-107.

Kitano, S., K. Maekawa, S. Nakano, and K.D. Fausch. 1994. Spawning behavior of bull trout in the Flathead Drainage, Montana, with special reference to hybridization with brook trout. Transactions of the American Fisheries Society 123:988-992.

Knotek, W.L. 2003. Middle Clark Fork River drainage fisheries investigations. Federal Aid Report for F-78-R6 and F-113-R1/R2. Montana Fish, Wildlife and Parks, Missoula, Montana.

Kondolf, G. M., and M. G. Wolman. 1993. The sizes of salmonid spawning gravels. Water Resources Research 29:2275-2285.

Nehring, B. and P.G. Walker. 1996. Whirling disease in the wild: the new reality in the intermountain west. Fisheries 21 (6):28-30.

Pierce, R., R. Anderson and C. Podner. 2004. Blackfoot River restoration monitoring report for 2002-2003. Montana Fish, Wildlife and Parks, Missoula, Montana.

Pierce, R., D. Peters and T. Swanberg. 1997. Blackfoot River restoration project progress report. Montana Fish, Wildlife & Parks, Missoula, Montana. 77 pp.

Riemen, B.E. and D.L. Meyers. 1997. Use of redd counts to detect trends in bull trout (*Salvelinus confluentus*) populations. Conservation Biology 11(4):1015-1018.

Schmetterling, D.A. 2003. Reconnecting a fragmented river: movements of westslope cutthroat trout and bull trout after transport upstream of Milltown Dam, Montana. North American Journal of Fisheries Management 23:721-731.

Schmetterling, D.A. 2001. Seasonal movements of fluvial westslope cutthroat trout in the Blackfoot River drainage, Montana. North American Journal of Fisheries Management 21:507-520.

Schmetterling, DA. and D.H. McEvoy. 2000. Abundance and diversity of fishes migrating to a hydroelectric dam in Montana. North American Journal of Fisheries Management 20:711-719.

Shepard, B.B., K.L. Pratt and P.J. Graham. 1984. Life histories of westslope cutthroat trout and bull trout in the Flathead River Basin, Montana. Montana Department of Fish, Wildlife and Parks, Helena.

Shepard, B.B., M. Taper, R.G. White and S.C. Ireland. 1998. Influence of abiotic and biotic factors on abundance of stream-resident westslope cutthroat trout *Oncorhynchus clarki lewisi* in Montana streams. Final report to USDA Forest Service, Rocky Mountain Research Station, Boise, Idaho. Montana Cooperative Fishery Research Unit, Montana State Univeristy, Bozeman, Montana.

Spalding, S. 1997. Montana bull trout redd survey manual – including annotated bibliography. Montana Fish, Wildlife and Parks, Helena, Montana. 8 pp.

Swanberg, T.R. 1997. Movements and habitat use by fluvial bull trout in the Blackfoot River, Montana. Transactions of the American Fisheries Society 126:735-746.

Taylor, M.J. and K.R. White. 1992. A meta-analysis of hooking mortality of nonanadromous trout. North American Journal of Fisheries Management 12:760-767.

Vincent, E.R. 1996. Whirling disease and wild trout: The Montana experience. Fisheries 21(6):32-33.

Vincent, E.R. 2000. Whirling disease report 1997-98. Montana Fish, Wildlife and Parks, Helena, Montana.

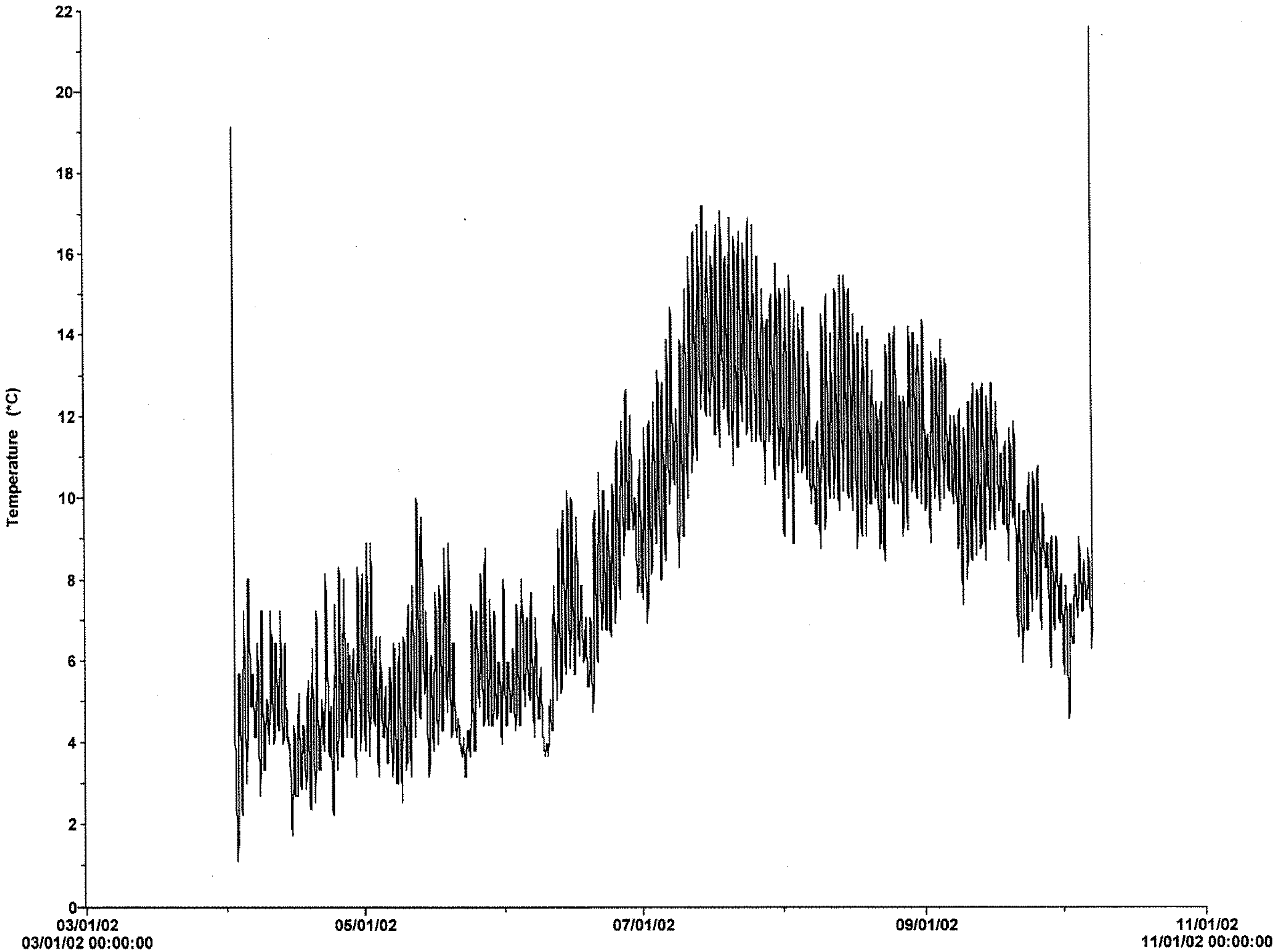
Vincent, E.R. 2002. Relative susceptibility of various salmonids to whirling disease with emphasis on rainbow and cutthroat trout. Whirling disease: reviews and current topics. American Fisheries Society Symposium 29:109-115.

Wilson, D. and G. Blount. 1985. Rattlesnake research project – 1985. Final project report submitted to numerous agencies including Montana Fish, Wildlife and Parks, Missoula, Montana. 21 pp.

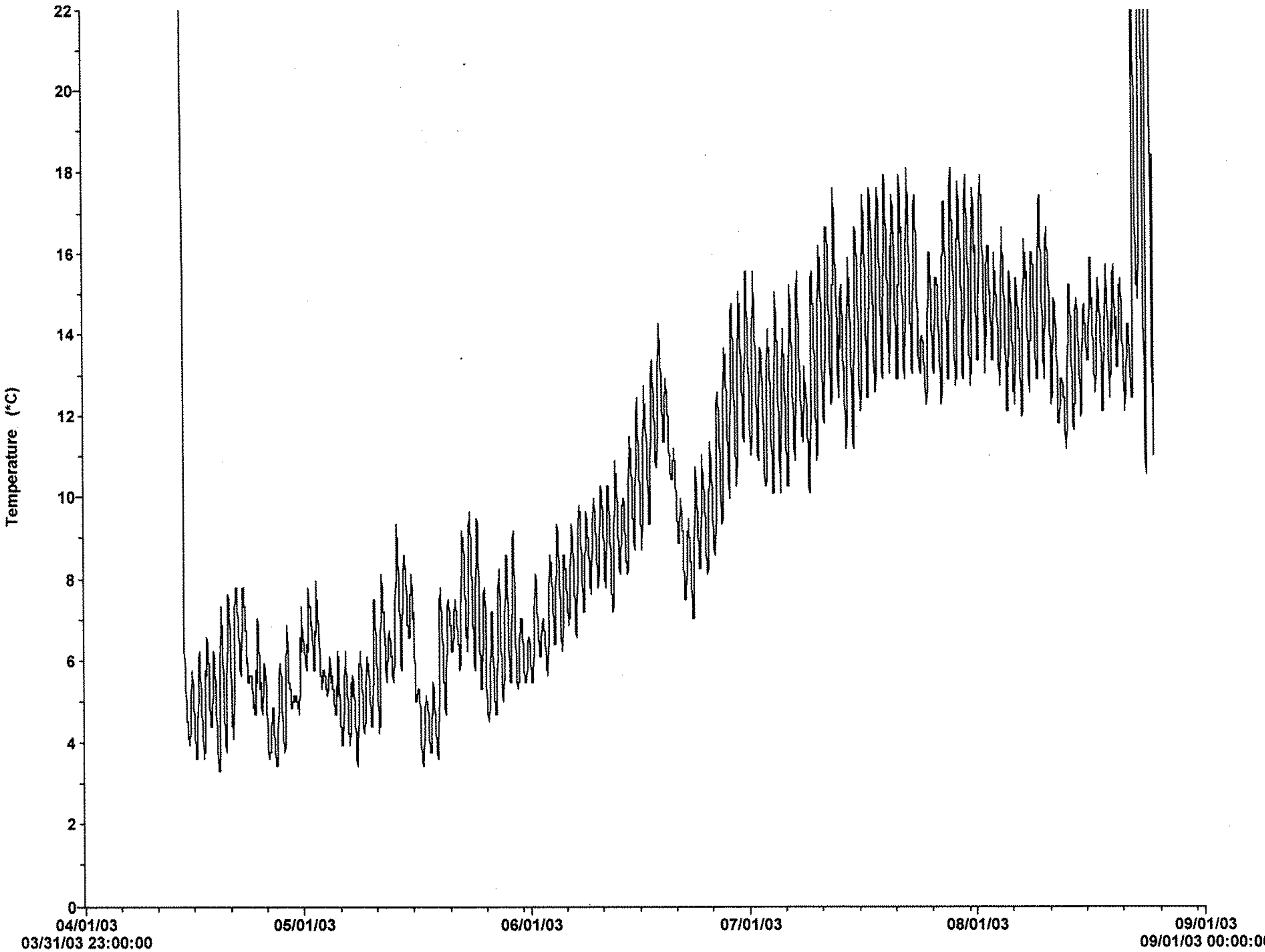
Wyatt, E.J., M.A. Gilbert and W.O. Granath, Jr. 2000. Survey of upper Rattlesnake Creek, a trout spawning tributary of the Clark Fork River (MT), for *Tubifex tubifex*. Project report submitted to Smufit-Stone Container Corporation and Montana Fish, Wildlife and Parks, Missoula, Montana. 6 pp.

APPENDIX A

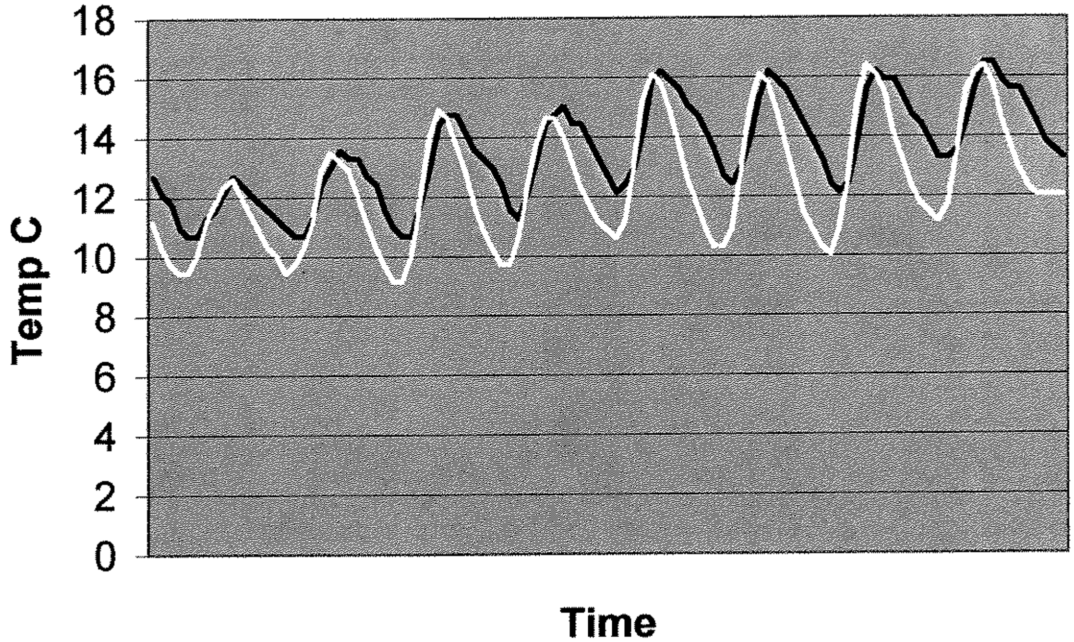
RATTLESNAKE CREEK TEMPERATURE PROFILES 2000-2003



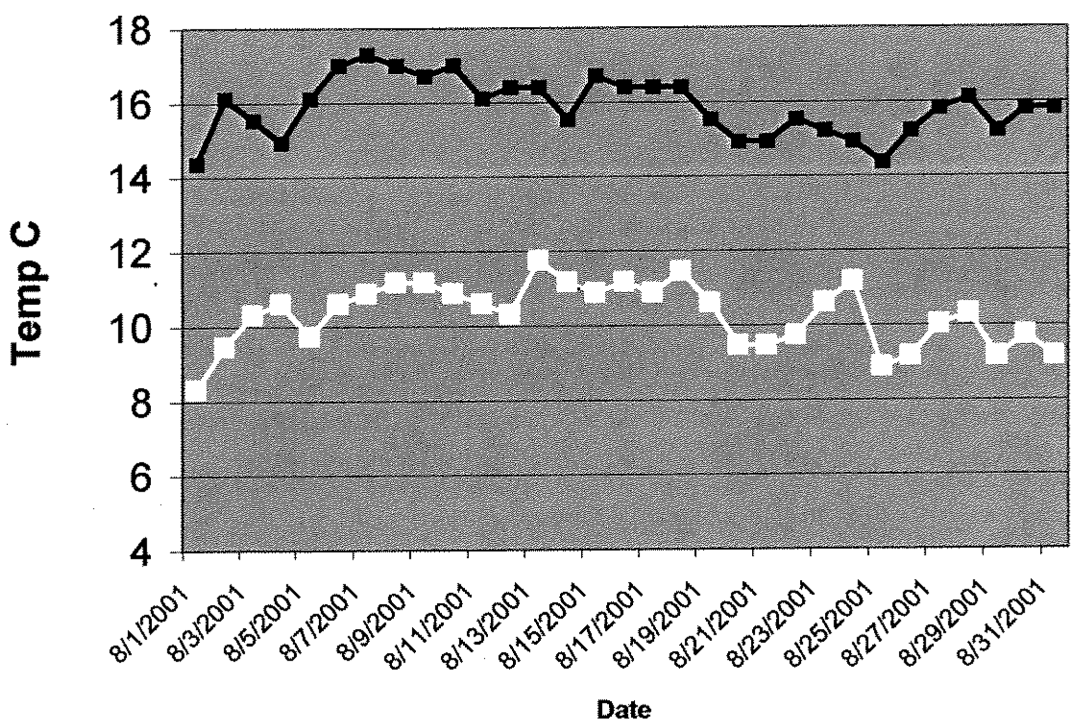
Rattlesnake Creek at MWC Dam 2002 - 1 Hr Intervals



Rattlesnake Creek at MWC Dam 2003 - 1 Hr Intervals



Comparison of temperature in MWC sedimentation basin (black line) and in Rattlesnake Creek (white line), June 27-July 5, 2001.



Minimum (white line) and maximum (black line) daily temperatures in Rattlesnake Creek at MWC Dam in August, 2001.

APPENDIX B

SURVEY OF UPPER RATTLESNAKE CREEK, A TROUT SPAWNING TRIBUTARY OF THE CLARK FORK RIVER (MT), FOR *TUBIFEX TUBIFEX*

FINAL REPORT TO SMURFIT-STONE CONTAINER CORPORATION

SURVEY OF UPPER RATTLESNAKE CREEK, A TROUT-SPAWNING TRIBUTARY OF THE CLARK FORK RIVER (MT), FOR *TUBIFEX TUBIFEX*

Elizabeth JoMay Wyatt, Michael A. Gilbert, and Willard O. Granath, Jr.*

Division of Biological Sciences
University of Montana
Missoula, MT 59812-4824

*To whom correspondence should be addressed (phone: 406-243-2975; email: snail@selway.umt.edu).

Introduction

Rattlesnake Creek is a tributary of the Clark Fork River that flows through parts of western Montana and through Missoula. Currently, an effort is underway to increase spawning habitat for bull and westslope cutthroat trout in the Clark Fork drainage. One proposal in this effort includes the modification or removal of the Mountain Water Company dam on lower Rattlesnake Creek that currently blocks fish passage. The removal or modification of this dam would open miles of prime spawning habitat. However, the Clark Fork River is known to be contaminated with *Myxobolus cerebralis*, the causative agent of salmonid whirling disease. The presence of this parasite in the Clark Fork River has lead to concerns that removal/modification of the dam would allow the parasite to spread into the upper reaches of Rattlesnake Creek, endangering the wild trout populations already established there. Therefore, the objective of this study was to survey the upper portions of Rattlesnake Creek for the presence of the aquatic oligochaete, *Tubifex tubifex*. *T. tubifex* is an obligatory host for *M. cerebralis* and the parasite cannot be transmitted to trout in its absence. An earlier, cursory study by another investigator did not detect *T. tubifex* in the Rattlesnake, so we conducted a more comprehensive survey of the creek for this oligochaete. Further, these worms were screened for the presence of *M. cerebralis* triactinomyxons (TAMs; stage of parasite that infects trout).

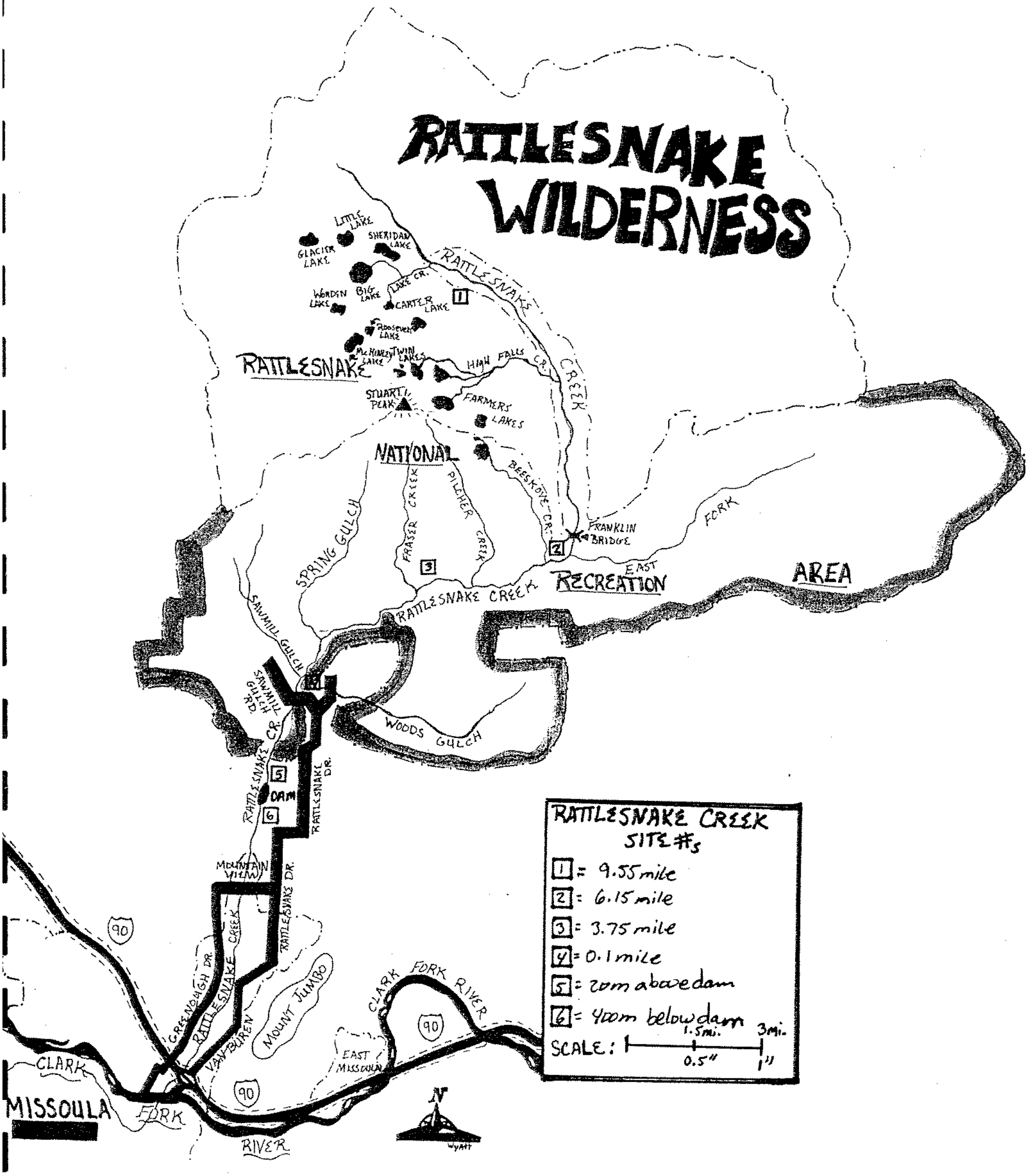
Materials and Methods

Oligochaete samples were collected from six sites on Rattlesnake Creek (Figure 1). Four of the sites were along a 9.5-mile stretch above the dam (measured from the U.S. Forest Service's gate at the north end of the parking lot of the Rattlesnake National Recreation Area), the fifth site was about 20 meters above the dam, while the sixth site was located approximately 400 meters below the dam. For all sites, areas that looked like prime *T. tubifex* habitat were intentionally selected.

Oligochaetes were collected from all sites on both October 8, 1999 and again on June 16, 2000, using a modified kick net method (Gilbert and Granath, in press). The worms were placed in 2-liter plastic containers and kept in a cooler during transport back to the laboratory. The oligochaetes were then separated, one per chamber, into 24 well tissue culture dishes, with each chamber containing 1 ml of well water and were kept in an incubator at 15°C with a photoperiod of 14 hr light: 10 hr dark. Water from each well was then periodically examined, during a three-day period, to determine if any of the worms were actively shedding TAMs. After the three-day observation period each worm was fixed in 10% neutral buffered formalin for 24 hours, followed by a secondary fixation in 70% ethanol. The worms were then mounted on microscope slides and identified based on chaetae, sexual organs (when present) and other morphological characteristics (Kathman and Brinkhurst, 1998) to the greatest resolution possible. Further, the identification of these worms was confirmed by an expert in such matters (Dr. R.D. Kathman, Aquatic Resources Center, College Grove, TN). Additionally, standard water quality parameters were measured at each site when the worms were collected (i.e. temperature, pH, dissolved oxygen, conductivity, total dissolved solids).

Results

Although quantitative sampling procedures were not performed, the overall density of oligochaetes was low at all sites. Further, both collection dates resulted in worms that were mostly


RATTLESNAKE WILDERNESS
RATTLESNAKE
NATIONAL
RECREATION
AREA
LITTLE LAKE
SHERIDAN LAKE
GLACIER LAKE
LAKE CR.
BIG LAKE
WORDIN LAKE
CARTER LAKE
ROOSEVELT LAKE
McKINLEY LAKE
TWIN LAKES
HIGH FALLS CR.
STUART PEAK
FARMERS LAKES
RATTLESNAKE CREEK
BEESKOVE CR.
FRANKLIN BRIDGE
EAST FORK
PILCHER CREEK
FRASER CREEK
SPRING GULCH
SAWMILL GULCH
SAWMILL GULCH RD.
WOODS GULCH
RATTLESNAKE CR.
DAM
RATTLESNAKE DR.
MOUNTAIN VIEW
GREENOUGH DR.
VAN BUREN
MOUNT JUMBO
CLARK FORK RIVER
EAST MISSOULA
MISSOULA
90
N
RATTLESNAKE CREEK SITE #s
1 = 9.55 mile
2 = 6.15 mile
3 = 3.75 mile
4 = 0.1 mile
5 = 20m above dam
6 = 400m below dam
SCALE: 1.5mi. 3mi.
0.5" 1"

immature. Unfortunately, sexually mature specimens are required for the positive identification of *T. tubifex*. Despite this, it appears that *T. tubifex* is not abundant in Rattlesnake Creek. Results of the oligochaete collections are presented in Table I. Further, none of these worms released *M. cerebralis* TAMs.

Table 1. Oligochaetes present at six sample sites along Rattlesnake Creek.

Site #	Date	Oligochaete Families Present (Genera and Species, if known, are in parentheses)	Comments
1 (9.5 mile)	10/99	Tubificidae (n=16)	Tubificids were immature but had hair and pectinate chaetae, possibly *T. tubifex*.
		Tubificidae (n=1)	Immature; bifid chaetae; not likely *T. tubifex*.
		Lumbriculidae (*Rhynchelmis sp.*) (n=3)	Immature.
	6/00	Tubificidae (*Rhyacodrilus coccineus*) (n=3)	
		Lumbriculidae (*Rhynchelmis sp.*) (n=4)	Immature.
2 (6.15 mile)	10/99	No oligochaetes recovered	
	6/00	Tubificidae (*Rhyacodrilus coccineus*) (n=9)	
3 (3.75 mile)	10/99	Tubificidae (n=1)	Tubificid was immature but had hair and pectinate chaetae, possibly *T. tubifex*.
		Lumbriculidae (*Rhynchelmis sp.*, n=10; probable *Eclipidrilus sp.*, n= 4)	Lumbriculids were immature.
		Naididae (*Slavina appendiculata*) (n=2)	
	6/00	No oligochaetes recovered	
4 (0.1 mile)	10/99	Tubificidae (*Rhyacodrilus coccineus*) (n=4)	
		Lumbriculidae (*Rhynchelmis sp.*, n=6; probable *Eclipidrilus sp.* n=1)	Lumbriculids were immature.
	6/00	Lumbriculidae (*Rhynchelmis sp.*) (n=2)	Immature.
5 (20 m above dam)	10/99	Tubificidae (n=6)	Immature; bifid chaetae; not likely *T. tubifex*
		Tubificidae (*Rhyacodrilus coccineus*, n= 4; *Limnodrilus profundicola*, n=2; *Limnodrilus hoffmeisteri*, n=4, *Telmatodrilus vejdovskyi*, n=1)	Immature.
		Lumbriculidae (*Rhynchelmis sp.*) (n=8)	Immature.
	6/00	Tubificidae (*Rhyacodrilus coccineus*) (n= 4)	
6 (400 m below dam)	10/99	Tubificidae (n=3)	Immature; bifid chaetae; not likely *T. tubifex*
		Tubificidae (*Limnodrilus profundicola*, n=1; *Rhyacodrilus coccineus*, n=2)	Immature.
		Lumbriculidae (*Rhynchelmis sp.*) (n=12)	Immature
	6/00	Tubificidae (n=3)	Tubificids were immature but had hair and pectinate chaetae, possibly *T. tubifex*
		Tubificidae (*Rhyacodrilus coccineus*) (n=4)	

Results of taking standard water quality measurements at the time of oligochaete collections are presented in Table 2.

Table 2. Water quality measurements taken at each collection site along Rattlesnake Creek.

Site #	Date	Temperature (°C)	pH	Dissolved oxygen (%)	Conductivity (µS/cm)	Total dissolved solids
1 (9.55 mile)	10/99	6.8	7.60	79.2	ND*	ND*
	6/00	5.0	7.74	87.0	19.2	9.5
2 (6.15 mile)	10/99	6.9	7.31	89.5	ND*	ND*
	6/00	5.6	7.18	88.5	19.4	9.7
3 (3.75 mile)	10/99	8.4	6.89	63.3	ND*	ND*
	6/00	6.5	7.44	87.6	19.7	9.7
4 (0.1 mile)	10/99	8.3	7.20	74.2	ND*	ND*
	6/00	7.2	7.34	89.4	18.5	9.2
5 (20 m above dam)	10/99	8.1	8.90	89.9	ND*	ND*
	6/00	7.5	7.39	89.2	22.2	11.1
6 (400 m below dam)	10/99	ND**	ND**	ND**	ND*	ND*
	6/00	7.8	7.31	68.5	49.7	25.1

*ND = Not Done (equipment not available).
**Not Done because samples were taken from mud and there was not enough standing water to make accurate measurements.

Discussion and Conclusions

The major objective of this study was to survey the upper Rattlesnake Creek drainage for *T. tubifex*. Therefore, collection sites were specifically chosen in areas containing prime oligochaete habitat. Despite this, the overall abundance of oligochaetes appeared low, although quantitative sampling was not performed (i.e. random, quantitative samples would have yielded even fewer oligochaetes then we detected). Unfortunately, *T. tubifex* could not be positively identified from any of the collection sites due to the fact that probable specimens (tubificids with hair and pectinate chaetae) were sexually immature. Even so, such worms were found at few sites and in relatively low abundance (Table 1). Further, efforts to grow these worms to sexual maturity in the laboratory were not successful.

The overall water quality of Rattlesnake Creek, based on the measurements taken in this study, appears to be excellent (Table 2). Moreover, the water temperatures at the sites were quite cold. This could be important to the establishment and transmission of *M. cerebralis* since *T. tubifex* release significantly fewer TAMs below 10°C (El-Matbouli et al., 1999). Unfortunately, long-term seasonal temperature data for Rattlesnake Creek is not available.

In comparison to other studies we have conducted (e.g. Gilbert and Granath, in press) and continue to pursue, it is our opinion that upper Rattlesnake Creek, in its present condition, would not be threatened by whirling disease should fish passage around the dam occur. A combination of low water temperature, pristine habitat, and relatively low oligochaete densities would seem to make the establishment of *M. cerebralis* difficult here. Having worked extensively in other areas endemic for whirling disease, Rattlesnake Creek does not appear to meet the conditions for successful parasite transmission. However, we do realize that our non-exhaustive study had limitations. For example, *T. tubifex* may be more abundant then our results indicate, but we feel that this is a remote possibility. Also, the mere presence of possible *T. tubifex* at a few of our collection sites should not be used to infer that whirling disease will establish itself here. For example, since this simple survey was not quantitative, no data on whether there are sufficient numbers of *T. tubifex* to maintain the life cycle of *M. cerebralis* was generated. Although, given that we intentionally searched for *T. tubifex* habitat and found few oligochaetes, we feel that, if present, *T. tubifex* abundance is low. In addition, research by my laboratory and others have shown that there are genetic variants of *T. tubifex* that vary in their ability to support development and release TAMs. That is, such studies have indicated that some geographic variants of *T. tubifex* are very effective at transmitting whirling disease whereas populations of these worms in other locations are unable to transmit the parasite. Since our study did not examine the susceptibility of the presumptive *T. tubifex* that we collected, no data on their potential to transmit whirling disease was assessed. However, none of these worms were infected with *M. cerebralis*.

Literature Cited

El-Matbouli, M., T. S. McDowell, D. B. Antonio, K. B. Andree and R. P. Hedrick. 1999. Effect of water temperature on the development, release and survival of the triactinomyxon stage of *Myxobolus cerebralis* in its oligochaete host. International Journal for Parasitology. 29: 627-641.

Gilbert, M.A. and W.O. Granath, Jr. Persistent infection of *Myxobolus cerebralis*, the causative agent of salmonid whirling disease, in *Tubifex tubifex*. Journal of Parasitology, in press (scheduled for publication in volume 87, issue 1)

Kathman, R.D. and R.O. Brinkhurst. 1998. Guide to the Freshwater Oligochaetes of North America. Aquatic Resources Center, College Grove, TN. 264 p.

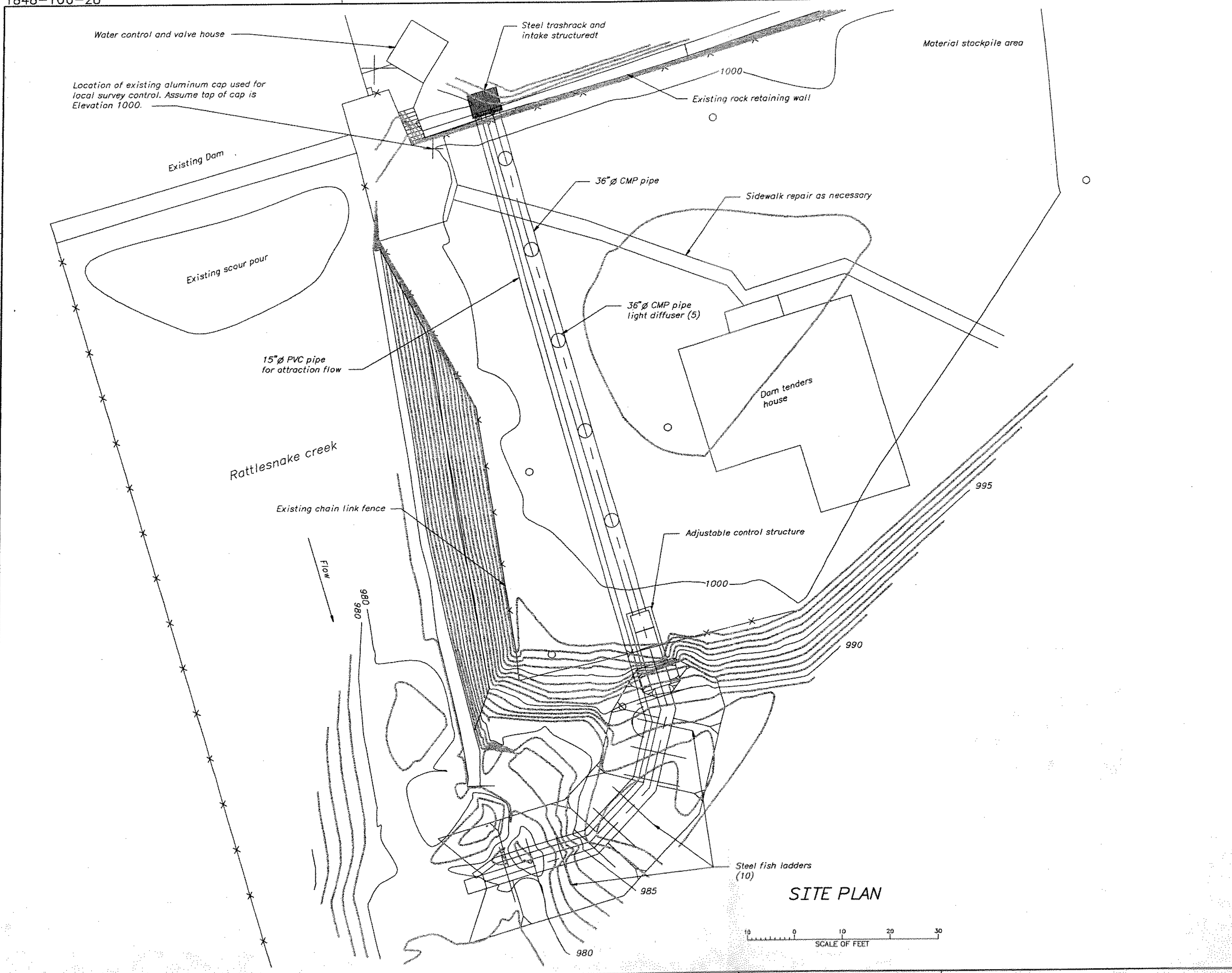
Acknowledgements

Smurfit-Stone Container Corporation, Missoula, MT, supplied financial support for this project. We also thank Ladd Knotek (Montana Fish, Wildlife and Parks) for valuable discussions concerning Rattlesnake Creek and for arranging permission to access the study sites via motorized vehicle.

APPENDIX C

PERMANENT FISH PASSAGE DESIGN AT MOUNTAIN WATER COMPANY DAM ON RATTLESNAKE CREEK

1848-100-28



ALWAYS THINK SAFETY

UNITED STATES

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

MONTANA WATER MANAGEMENT ASSISTANCE PROGRAM

RATTLESNAKE DAM FISH PASSAGE PROJECT

SITE PLAN

DESIGNED ________ CHECKED ________

DRAWN ________ TECH. APPROVAL ________

PROGRAM MANAGER

CADD SYSTEM AutoCAD Rel. 15.06

CADD FILENAME N:\CAD\MISSOULA VALLEY\RATTLESNAKE\

BOISE, IDAHO

AUGUST, 2002

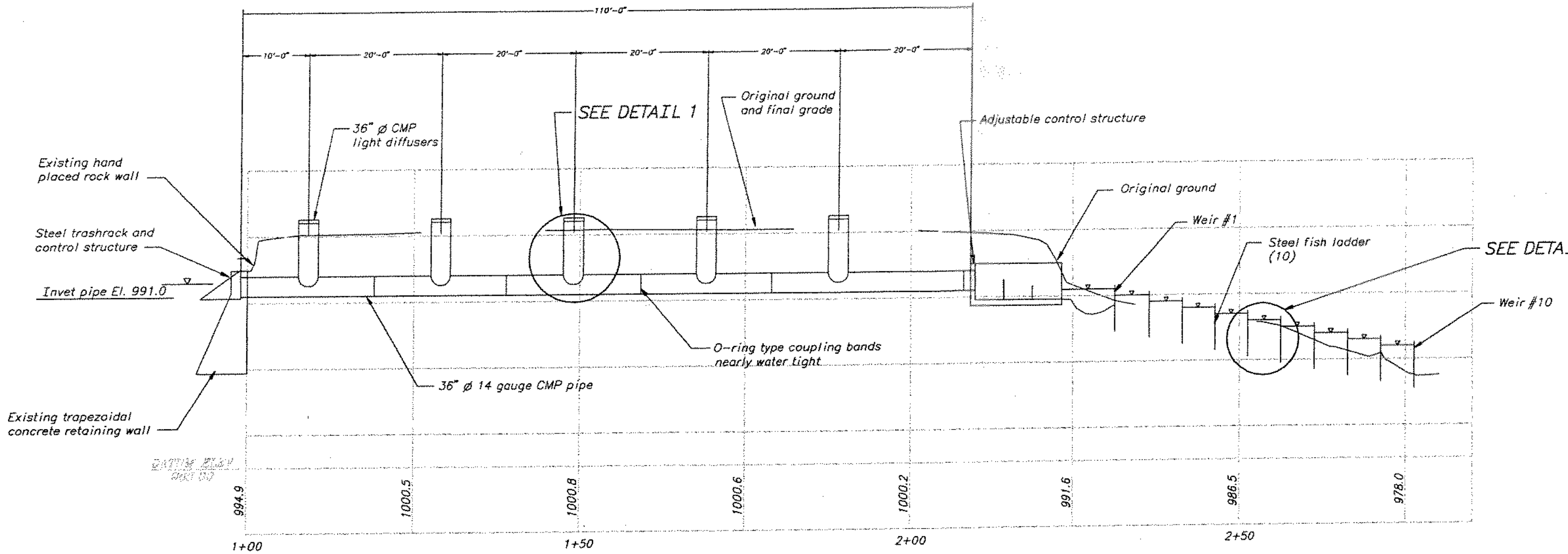
1848-100-28

Specification #

1848-100-29

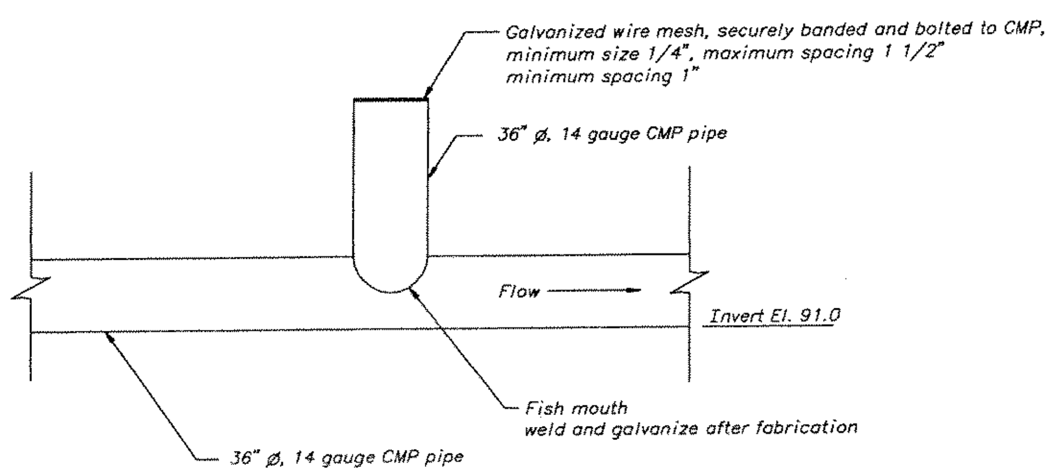
Weir	Elevation
1	991.50
2	990.50
3	989.50
4	988.50
5	987.50
6	986.50
7	985.50
8	984.50
9	983.50
10	982.50

Elevations are from top of weir.



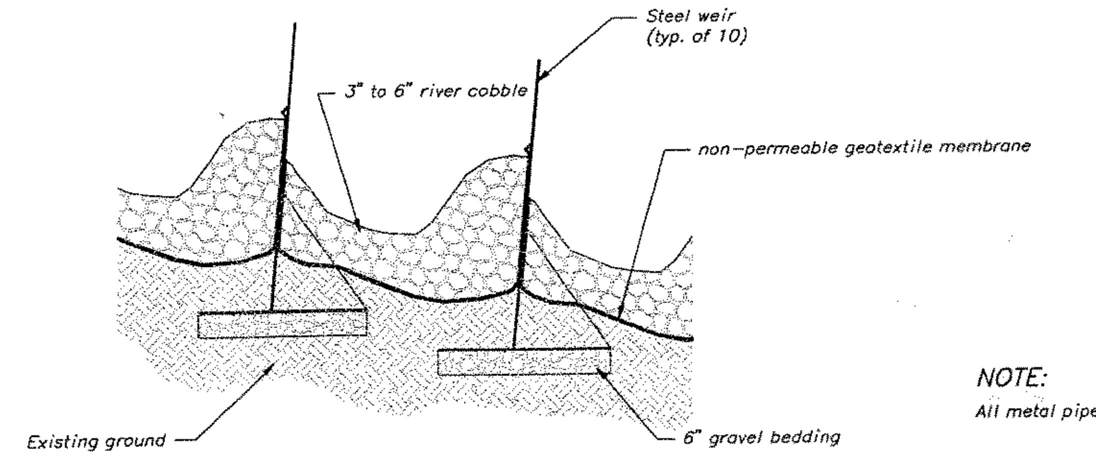
SECTION A–A

SCALE OF FEET (10, 0, 10, 20, 30)



DETAIL 1

SCALE OF FEET (1, 0, 5, 10, 15)



DETAIL 2

SCALE OF FEET (1, 0, 1, 2, 3, 4, 5)

NOTE:
All metal pipe to be galvanized.

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
MONTANA WATER MANAGEMENT ASSISTANCE PROGRAM

RATTLESNAKE DAM FISH PASSAGE PROJECT
SECTION A–A

DESIGNED ____ CHECKED ____
DRAWN ____ TECH. APPROVAL ____
PROGRAM MANAGER

CADD SYSTEM AutoCAD Rel. 15.06 | CADD FILENAME H:\CAD\MISSOULA VALLEY\RATTLESNAKE\
BOISE, IDAHO | AUGUST, 2002 | 1848-100-29

Specification #