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Montana Fish, Wildlife & Parks

BROADWATER POWER PROJECT

FISHERIES MITIGATION REPORT

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Broadwater Power Project
Mitigation Report

Introduction

This report is intended to assess the effectiveness of three fisheries projects that were implemented in 1991 in response to the Toston Dam retrofit. These projects included the Confederate Creek spawning enhancement project, installation of a ditch siphon at the junction of Deep Creek and the Montana Ditch to eliminate a barrier to fish passage, and four years of wild brown trout egg collection, hatchery rearing of brown trout fry, and reintroduction into the Canyon Ferry – Missouri River complex.

An evaluation plan was developed in order to establish objectives for each project and outline techniques used to monitor effectiveness of the mitigation projects (FWP 1991). The following objectives were identified for each project:

1) Confederate Creek Spawning Habitat Improvement: projected to produce 27,500 brown trout and 27,500 rainbow trout fry annually.

2) Egg collection and hatchery rearing of wild brown trout: projected to produce 100,000 juvenile brown trout per year for four years.

3) Construction of the Deep Creek siphon: projected to eliminate a seasonal fish barrier and re-establish trout spawning runs. Projected fry production was estimated at 18,348 brown trout and 15,539 rainbow trout annually.

Methods

A variety of fisheries techniques were used to monitor the effectiveness of mitigation projects. These techniques were used to monitor spawning effort, fry production, and recruitment of juvenile trout into the adult population. In addition to fisheries parameters, temperature, discharge and fish habitat were also monitored in Deep Creek and Confederate Creek to determine if any abiotic factors influenced project effectiveness. A summary of fisheries techniques used to monitor project effectiveness is provided below.

Fry Trapping

Procedure: This technique consists of the placement of one or more funnel shaped traps near the mouths of streams during juvenile migration downstream. The number of juveniles captured in traps are then used to estimate the total numbers of fry migrating from natal streams.

Benefits: Fry trapping provides information about the total numbers and timing of fry migration from natal streams.

Limitations: Fry trapping only captures migratory juveniles. Some juvenile salmonids rear for one or more years in natal streams prior to migration. In addition fry traps are prone to becoming clogged with debris during periods of high flow, which greatly reduces capture efficiency and increases fry mortality within traps. Significant brown trout fry movement may occur during high spring flows; therefore, brown trout fry production may not be accurately estimated.

Redd Counts

Procedure: Redds are spawning sites created by spawning salmonids. Redds are visible to trained observers and can be counted while simply walking slowly and carefully along the bank of a stream.

Benefits: Counting the numbers of redds observed in a given stream gives reliable information of the total spawning effort in a stream. In addition, spawning fish can often be observed, providing data regarding the numbers of spawners using a given stream.

Limitations: Water clarity, high flows and icing conditions can reduce accuracy of redd counts by reducing visibility.

Electrofishing of Juveniles

Procedure: A stream reach is sampled using electrofishing techniques. Catch per unit effort (CPUE) data acquired can be used to determine an index of relative abundance of young of the year (YOY) trout. Relative abundance data can then be used to track trends in YOY production in a stream over time.

Benefits: This technique can be used to determine if mitigation projects are increasing total numbers of trout fry in the Missouri River and its tributaries. This technique can also provide information of the numbers of fry remaining in streams after the typical migration period.

Limitations: this method provides only an index of abundance and may not be useful for quantifying actual numbers of YOY remaining in a given stream reach.

Missouri River Population Estimates

Procedure: Predetermined reaches of the Missouri River are sampled using electrofishing techniques from a jet boat.

Benefits: Effectively samples adult fish (> 10 inches) populations in large river systems. Data obtained from this technique can be used to determine population estimates or catch per unit effort data. When populations are tracked over time recruitment to the system can be estimated.

Limitations: This technique does not typically provide an estimate of trout density for fish less than 10 inches. Resident fish densities are difficult to obtain during seasonal migration.

Fish Marking and Recovery

Procedure: Hatchery reared brown trout are marked by clipping a fin prior to introduction in to the Missouri River. All fish captured by various sampling techniques used in the Canyon Ferry-Missouri River complex were examined for fin clips.

Benefits: Comparisons between marked (hatchery reared) and wild fish (unmarked) will determine the relative contribution of hatchery reared fish and wild fish in the Missouri River.

Limitations: Fins will occasionally regenerate making identification of hatchery fish difficult.

Adult Trapping

Procedure: A concrete weir traps all spawning fish ascending a spawning tributary.

Benefits: Gives very good information concerning total spawning effort by brown trout and rainbow trout.

Limitations: Evaluates only the numbers of fish ascending tributaries to spawn. Fry production must be inferred from the number of spawners.

Screw Trap

Procedure: A screw trap consists of a large rotating drum suspended between two pontoons. Drum rotation is powered by water flowing through a series of baffles in the drum. Any fish caught in the drum is deposited in a trap box at the rear of the trap.

Benefits: Gives a good estimate of fry outmigration even during periods of high flows.

Limitations: A minimum depth and flow is required to operate the trap. The trap can not be in slow moving water or water that is too shallow (about 3 feet deep).

Evaluation of Specific Mitigation Objectives

The objective of each mitigation project is best evaluated by determining the number of juvenile fish ultimately recruited to the Missouri River Drainage. The techniques listed above were used in various combinations to determine the effectiveness of each project. Results of project specific monitoring are listed below.

Confederate Creek Spawning Enhancement Project

The Confederate Creek spawning enhancement project was implemented in 1991. Channel modifications and placement of suitable spawning gravel created 1,100 square feet of new riffle habitat for rainbow trout and brown trout spawning. Assumptions and projections of the project include (Interfluve 1990):

1 redd per 20 feet
55 redds in project area without significant superimposition
2,500 eggs per redd
20% survival of fry to outmigration
27,500 rainbow trout fry produced annually
27,500 brown trout fry produced annually

Techniques used to evaluate the effectiveness of the project included redd counts, fry trapping, and electrofishing. Condition of spawning habitat and water temperature was also monitored. Water temperature was monitored from 1991-1994. Temperature monitoring was ceased after results showed that water temperatures in Confederate Creek are favorable for trout spawning, incubation and rearing (Appendix A Figures 1-3).

Habitat monitoring conducted in conjunction with Inter-Fluve Inc. before and after spring runoff events indicated channel changes and flushing of placed spawning gravel. In 1993 the channel was widened and additional larger sized gravel was placed in the project area to lower velocities at high flows and retain gravel. However, the additional gravel was also flushed from the system and it is believed that the channel will not retain smaller bed materials without major channel modifications.

Redd counts were the most useful technique for determining the extent of total spawning effort of both rainbow and brown trout in Confederate Creek. Fry trapping and electrofishing provided qualitative data only because significant fry movement occurs during high flows, which are difficult to sample with these techniques.

Rainbow trout redd surveys were conducted from March through June and brown trout surveys were conducted from October through December 1991 – 2001 (Table 1). The survey area extended from the mouth to approximately 1 mile upstream. Redds were counted in three reaches, below the project area, in the project area, and above the project area to evaluate project effectiveness. Results of redd counts from are summarized in Table 1.

Total rainbow trout redds observed in the lower 1 mile of Confederate Creek ranged from 49 to 226 between 1991 and 2001 (Table 1). This represents a high level of spawning activity in lower Confederate Creek by rainbow trout. However, areas of the survey reach were not used uniformly by rainbow trout. The majority of spawning occurred above the project area in most years and roughly equal amounts of spawning occurred below and in the project area throughout the period (Appendix A Figure 3).

Redd counts likely underestimate total spawning effort by rainbow trout for several reasons. First, spring redd counts are done during periods of high flows which impede observer visibility. Secondly, rainbow trout spawned on all available substrate in the area which, led to significant superimposition of redds. This makes it very difficult to identify individual redds in a given area. Finally the survey period did not include the entire spawning period in many cases. Therefore, it is likely that spawning occurred after many surveys were complete and total redd production was not accounted for.

Table 1. Summary of spring and fall redd surveys Confederate Creek 1991-2001

Year	Period of Spring Counts	# of Counts	Total Rainbow Trout Redds	Period of Fall Counts	# of Counts	Total Brown Trout Redds
1991	15 April-26 April	2	49	8 October-6 December	8	11
1992	10 March-14 May	13	87	16 October-20 November	5	18
1993	29 March-3 June	9	50	20 October-9 December	4	10
1994	21 March-26 May	6*	226	14 October-2 December	4	5
1995	24 March-17 April	3	75	20 October-4 December	5	6
1996	15 April-10 May	4	141	2 December	1*	0
1997	10 May	1	42	21 October-21 November	2	1
1998	14 April-2 June	4	198	7 October-3 December	4	9
1999	2 May-24 May	3	118	27 October-22 November	4	8
2000	20 March-1 May	3	194	Not done	Not Done	Not Done
2001	24 May	1	61	6 November-13 November	3	0

*poor visibility or icing conditions

Brown trout spawning effort in Confederate Creek was very low throughout the 1991-2001 period. Total observed brown trout redds ranged from 0-18 in the entire 1-mile reach from 1991-2001 (Table 1). Brown trout that did use Confederate Creek tended to use the project area for spawning more than other areas in the survey reach until 1994. After 1994 spawning use became greater in other areas of the stream, presumably due to the flushing of gravel from the area (Appendix A Figure 4).

Fry trapping was ineffective during periods of high flow because traps became clogged with debris very quickly. Unfortunately this represents the period of highest fry movement and no quantitative estimates of fry outmigration could be made. However some information could be obtained from this sampling. Results of fry trapping in Confederate Creek show that rainbow trout fry production is generally high (Table 2).

Rainbow trout fry migrate from late April to mid August and range in size from 25 mm in late April to 54 mm total length in mid August (Appendix A Figures 5-8). In contrast, brown trout were captured in greatest numbers in 1991 and declined steadily through 1994. No brown trout were captured from 1995-1997. A marked increase in brown trout fry was noted during 1998 but the trend was short lived, as no juvenile brown trout were noted in fry traps during 1999 or 2001 (Table 3).

Table 2. Summary of rainbow trout fry trapping Confederate Creek 1991-2001

Year	Total Trap Nights	Total estimated fry produced during trapping periods	YOY per trap night
1991	12	126	10.5
1992	15	473	31.5
1993	13	1321	101.6
1994	7	146	20.9
1995	10	1385	138.5
1996	8	1432	179.0
1997	5	1035	207
1998	5	888	177.6
1999	3	100	33.3
2000	No Trapping	No Trapping	No Trapping
2001	7	237	33.8

Table 3. Summary of brown trout fry trapping Confederate Creek 1991-2001

Year	Total Trap Nights	Total estimated fry produced during trapping periods	YOY per trap night
1991	12	1357	113
1992	15	264	17.6
1993	13	154	11.8
1994	7	4 brown trout captured entire period	0.57
1995	10	No brown trout captured	0
1996	8	No brown trout captured	0
1997	5	No brown trout captured	0
1998	5	312	62.4
1999	3	No brown trout captured	0
2000	No Trapping	No Trapping	No Trapping
2001	7	No brown trout captured	0

Electrofishing was intended to complement fry trapping data by providing information on juvenile trout that did not migrate during the fist year of life and therefore were not sampled during fry trapping. This technique provided trend data only because it is inefficient to sample juvenile trout using this technique. Therefore, quantitative data could not be obtained. Rainbow trout and brown trout YOY relative abundance data are presented in Table 4. Electrofishing did show that rainbow trout and brown trout use Confederate Creek for rearing prior to migration. Rainbow trout abundance is generally high and shows a rapid increase during 2000 and 2001. Brown trout abundance has been very low for most of the period.

Sampling in 1992, 1993 and 2000 shows a consistently higher abundance of brown trout than other sampling years (Table 4, Appendix A Figure 9). This is partially explained by the relatively high numbers of redds produced in 1991,1992 and 1999. Consequently more brown trout juveniles were captured in both fry trapping and electrofishing operations. Sampling times also differed between 1992,1993 and 2000. Electrofishing was conducted in early to mid August during these years, all other years were sampled between mid September and late October. Therefore, it is possible that some brown trout migrate to Canyon Ferry Reservoir between mid August and mid September.

Table 4. Rainbow trout and brown trout catch per unit effort summary Confederate Creek

Year	Date	Rainbow Trout/100 sec	Brown Trout/100 sec
1992	8/14	7.4	3.9
1993	8/5	4.4	3.1
1994	9/15	NT	NT
1995	10/5	6.6	0.2
1996	10/9	3.8	0.1
1997	9/17	2.6	0.1
1998	11/17	2.8	0
1999	10/27	3.0	0.9
2000	8/1	17.7	3.4
2001	10/11	11.8	0

Data collected during 10 years of monitoring the Confederate Creek spawning enhancement project show that rainbow trout have exceeded fry production objectives while brown trout have not met fry production objectives. A decline in brown trout abundance in the Missouri River-Canyon Ferry complex and flushing of spawning gravel from the project area are two factors that likely have influenced brown trout spawning failure in Confederate Creek.

Egg collection and hatchery rearing of wild brown trout

Objectives of this project were to collect 150,000 wild brown trout eggs per year for four years. Eggs were to be raised in a hatchery and returned to the Missouri River system. It was estimated that there would be approximately 30% egg and fry mortality at the hatchery and 100,000 juvenile brown trout would be returned to the wild annually. Egg collections were proposed to take place from 1991-1994; however, the 1994 egg take was postponed until 1997.

Between 1991 and 1997 a total of 557,841 eggs were collected from wild brown trout, which resulted in 331,584 brown trout fry being returned into the Missouri River system (Table 5). Hatchery reared brown trout were released in the Missouri River, Canyon Ferry and Deep Creek. All brown trout imprinted to Deep Creek received adipose clips and the majority of brown trout planted into the Missouri River and Canyon Ferry received right pelvic fin clips for future identification.

In addition to quantifying the number of brown trout introduced into the Missouri River-Canyon Ferry complex, additional monitoring was completed to determine the fate of hatchery reared brown trout and estimate the long-term contribution to the brown trout population. This was best accomplished by monitoring the abundance of brown trout in the Missouri River and Canyon Ferry Reservoir.

Table 5. Summary of egg take and fry stocking 1991-1998

Year	**# Green Eggs Collected**	**# Fry Stocked (Date)**
1991	157,500	--
1992	144,424	33,000 (June) 61,000 (Sept)
1993	125,617	22,000 (July) 41,000 (Aug)
1994	No Eggs Collected	27,000 (Sept) 60,000 (July)
1997	130,300	--
1998	No eggs collected	50,624 (May) 36,960 (June)
Totals	557,841	331,584

Brown trout abundance in the Missouri River was monitored regularly from 1979-2001. Results of this monitoring show a steady decline in brown trout abundance in the Missouri River. Population sampling in 1992 revealed that brown trout numbers were at an all time low of 55 brown trout, measuring greater than 10 inches, per mile. In addition the smaller size groups (10-17.9 inches) experienced the largest decline, which suggests that recruitment is limited (Figure 1).

Subsequent sampling in the Toston-Deepdale section in 1998, 1999, 2000 and 2001 did not capture enough brown trout to make accurate population estimates. Because of the decline in brown trout numbers, monitoring techniques were changed to catch per unit effort sampling, where the numbers of brown trout captured per minute were recorded in a subsection of the Toston-Deepdale reach. The catch per unit effort section extended from the Toston Bridge downstream to the mouth of Crow Creek, approximately 2.5 miles.

Catch per unit effort ranged from 0.09-0.63 brown trout per minute between 1997-2001 (Figure 2). Brown trout trends from 1997-2001 show a slightly decreasing trend; however, fluctuations in the trend are large and future population levels would be difficult to predict from the known information.

Figure 1. Brown Trout per mile Toston-Deepdale Section Missouri River.

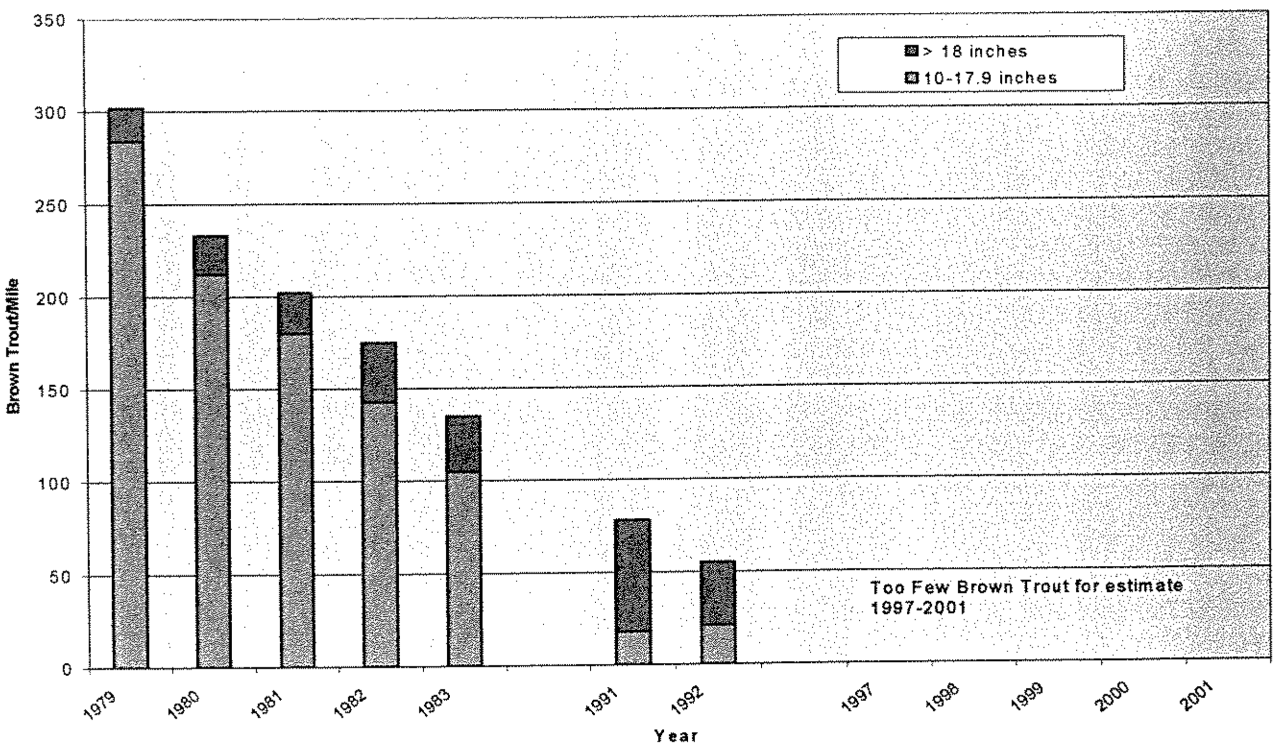
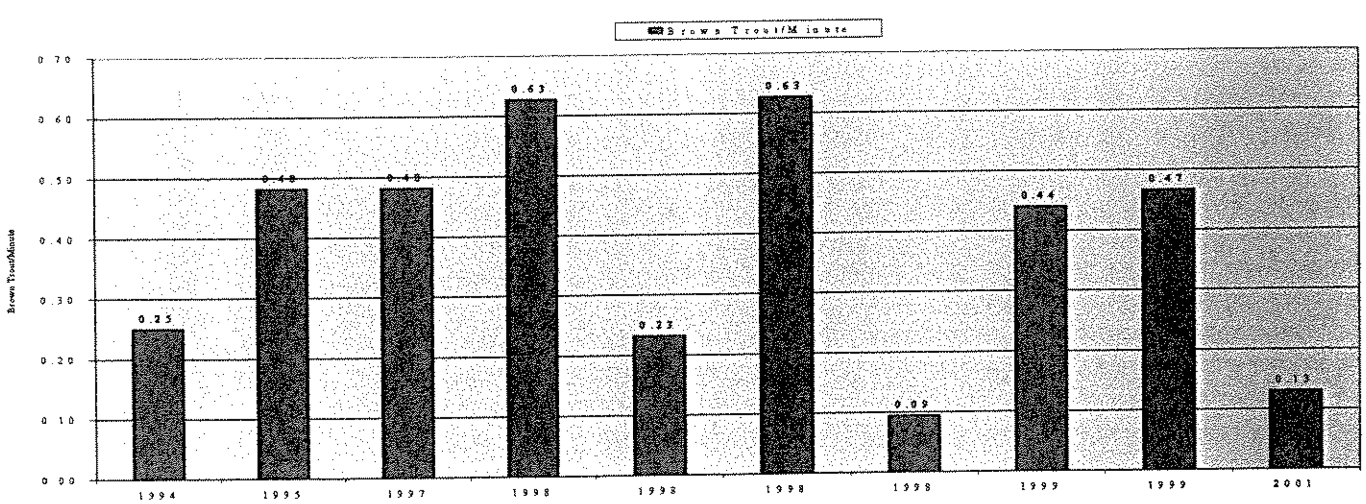


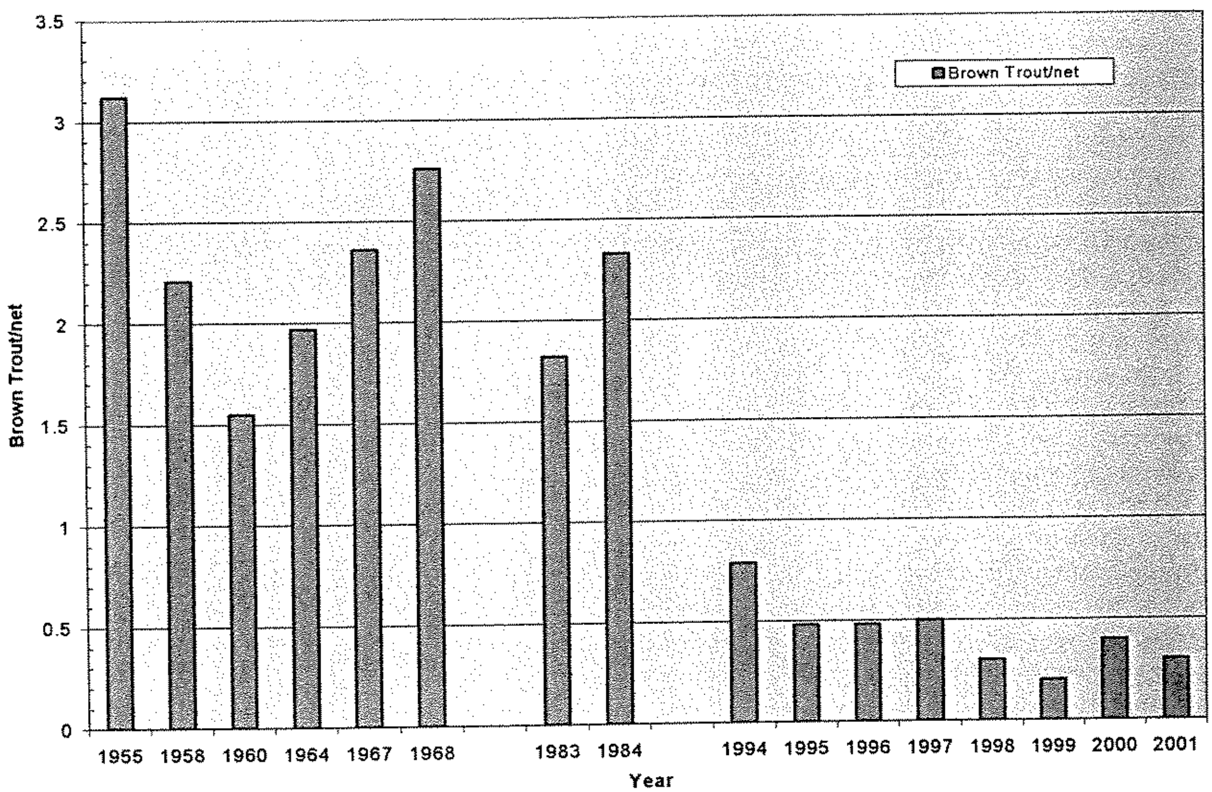
Figure 2. Catch per unit effort Toston-Crow Creek Section Missouri River.



*Sampling in 1994, 1995 and 1997 was done in conjunction with other sampling procedures and shock times for these runs were not recorded. Shock times for this run was determined by substituting the average of all other shocking times recorded during CPUE sampling.

In addition to sampling the Missouri River, FWP regularly samples Canyon Ferry Reservoir to evaluate population trends in several fish species including brown trout. From 1955 to 1984 brown trout occurrences in sinking gill nets ranged from 1.55 to 3.12 brown trout per net. Brown trout numbers have declined since 1984, ranging from 0.2-0.5 brown trout per net from 1994-2001(Figure 3). Although brown trout numbers are low in Canyon Ferry reservoir the population trend appears stable since 1994.

Figure 3. Brown Trout per Sinking Net Canyon Ferry Reservoir



Survival of stocked brown trout and their overall contribution to the population over time was evaluated by examining the numbers of marked fish that were captured during Missouri River, Deep Creek and Canyon Ferry sampling. The Missouri River-Canyon Ferry complex brown trout population is currently very low. Therefore, one would expect a relatively large proportion of marked fish in a given sample if stocked fish had a good survival rate.

Extensive Missouri River sampling conducted from 1997-2001 recovered a total of 5 brown trout with right pelvic clips (Missouri River and Canyon Ferry introductions) and a total of 8 brown trout with adipose clips (Deep Creek imprints). No marked brown trout have been recovered from Canyon Ferry.

The movements of 27,000 juvenile brown trout stocked into Deep Creek in 1994 were also monitored at the weir. Monitoring results showed that approximately 5% of the stocked fish migrated to the Missouri River in 1995. Migrating brown trout juveniles tended to move during periods of higher flow and during the new moon. The bulk of migrating brown trout were 80-100 mm total length (Rehwinkle 1995).

Movements of adult and juvenile brown trout were monitored with a concrete weir during the late summer and fall from 1992-1996. The total numbers of adult brown trout ascending Deep Creek was very low throughout the period; a total of 45 adult brown trout were caught between 1992-1994. Adult brown trout captured at the weir totaled 78 in 1995 but only 5 were captured in 1996. Trapping was discontinued in 1996 because it was evident that very few brown trout ascended the stream to spawn. However, the trap was operated from 10/20-11/7 in 1999 to supplement earlier information on adult brown trout use in Deep Creek. No brown trout were captured during this effort. Very few of the imprinted brown trout were captured at the weir during the entire period.

Although in excess of 100,000 eggs were collected annually from the Missouri River, hatchery survival was generally lower than anticipated. Numbers of brown trout fry returned to the Missouri River ranged from 63,000-94,000 annually, which was lower than expected (Table 5). Drought conditions accompanied by high water temperatures and low stream flow resulted in delayed stocking dates to improve fry survival in the wild. Unfortunately, fry mortality in the hatchery was higher than expected. This was primarily due to cannibalism in the raceways. As a result, the number of fry available for stocking was reduced accordingly. In addition it was noted that brown trout did not grow as well as hoped in the hatchery environment and stocked fish were in poor condition.

Extensive monitoring efforts in the Missouri River-Canyon Ferry Complex have shown that brown trout abundance is very low but population trends appear stable in recent years. In addition very few marked fish were captured despite significant monitoring efforts in the Missouri River, Canyon Ferry Reservoir and Deep Creek. This suggests that planted brown trout had very poor survival, left the system, or were not detected in sampling efforts.

Upstream migration is blocked by the Toston Dam and downstream movements are unlikely because of the Canyon Ferry Dam; therefore, it is not likely that planted brown trout left the system. It is also unlikely that large numbers of marked fish escaped sampling efforts because sampling techniques are highly efficient at capturing adult fish and a significant sampling effort was made in years following the stocking. Therefore, it is highly probable that stocked fish had low survival rates, did not reproduce and contributed very little to the brown trout population in the Missouri River-Canyon Ferry complex.

Construction of the Deep Creek Siphon to Re-establish Fish Migration Patterns and Spawning Runs

Prior to 1991 the Montana Ditch created a seasonal barrier to fish migration near the mouth of Deep Creek. In response to this problem a siphon was constructed to transport water from the Montana Ditch under the channel of Deep Creek. This removed a seasonal barrier and provided spawning access to 2.2 miles of stream including about 5,000 square feet of spawning gravel. The intent of this mitigation project was to re-establish fish migration patterns and provide additional area for brown trout and rainbow trout spawning.

Assumptions (Inter-Fluve and FWP survey)
Redd size: Brown Trout 18.7 ft^2; Rainbow Trout 14.5 ft^2
Eggs per redd: Brown Trout 2747; Rainbow Trout 1804
10% survival to outmigration
50% of available spawning habitat actually available

Projected number of redds and fry produced:
Brown Trout- 134 redds, 18,348 fry
Rainbow Trout-172 redds, 15,539 fry

A combination of redd counts, fry trapping, electrofishing and operation of an adult trap were used to evaluate success of re-establishing fish migration and spawning runs in Deep Creek. Prior to project implementation, a concern was raised about water quality due to irrigation withdrawals, excessive sedimentation, elevated water temperatures and localized loss of riparian vegetation. A plan was developed to address these concerns and restore water quality in Deep Creek (Final Monitoring Plan Deep Creek Watershed and Spawning Enhancement Project 1999). The plan identified a number of water quality problems, identified baseline conditions and set goals for restoring water quality. Restoration activities were begun in 1996 and completed in 1999. The plan called for monitoring a number of habitat and water quality parameters including: total suspended solids, amount of eroding banks, numbers of rainbow trout ascending Deep Creek, macro-invertebrates, maximum water temperature, and minimum flows. In general watershed restoration activities have had mixed success. The amount of eroding banks has been reduced although temperature and minimum flows remain problematic due to continuing drought and warm temperatures. In addition, large wildfires in the summer of 2000 and extensive beaver activity have confounded total suspended solids and channel monitoring results. Results of this monitoring effort are presented in Appendix B.

Both spring and fall redd counts were conducted to monitor rainbow and brown trout spawning in Deep Creek. Spring redd counts were conducted in April and May and fall redd counts were conducted in November.

Spring redd counts were conducted in the lower 2 miles of Deep Creek between 1991 and 1993 (Figure 4). Results show a high degree of spawning activity by rainbow trout below the Broadwater-Missouri Ditch Siphon (Table 6). In addition spawning rainbow trout from the Missouri River have been seen over 20 miles upstream from the mouth of Deep Creek spawning in small tributaries where spawning habitat is excellent.

Table 6. Summary of spring (rainbow trout) redd surveys Deep Creek 1991-1993

Year	Location of count	Period of counts	Number of Counts	# Redds observed
1991	Mouth-Broadwater Missouri siphon	23 April-7 May	1	118
1992	Mouth-Lightning Barn Lane	27 March-13 May	1	190
1993	Mouth-Carson Lane	2 April	1	23

Fall redd counts show a high level of spawning activity by brown trout in Deep Creek. However, redd count distribution is divided into two reaches, one immediately below the Montana Ditch siphon, and another upstream of the Clopton Lane bridge. No groundwater influence is evident for several miles above the trap site making this area less attractive for brown trout spawning. Therefore, most brown trout spawning takes place between Clopton Lane and the Highway 12 bridge where groundwater influences occur. A minor amount of brown trout spawning also occurs between the mouth of Deep Creek up to the Montana Ditch Crossing. Brown trout spawning below the trap site are primarily migratory fish from the Missouri River or Canyon Ferry and generally produce less than 5 redds per year. Deep Creek receives groundwater inflows from the Montana Ditch below the trap, which makes the area attractive to brown trout spawners.

Brown trout redd surveys were conducted in November (Table 7). Most spawing activity was observed in the upper reaches of the survey area and above impassable beaver dams. In addition all spawners observed ranged in length from 11-14 inches. It is very likely that the majority of all spawners observed were resident fish and not adfluvial brown trout from the Missouri River.

Table 7. Summary of fall (brown trout) redd surveys Deep Creek 1991-2001

Year	Location of count	Period of counts	Number of Counts	# Redds observed
1991	Clopton Lane Highway 12	18 Nov.-12 Dec.	1	75
1999	Clopton Lane-Highway 12	Nov. 30	1	206
2001	Clopton Lane-Highway 12	Nov 15-16	1	151

Fry trapping in Deep Creek was conducted from 1991-1993 and again in 2001. Fry trapping was ineffective in obtaining a quantitative estimate of numbers of fry migrating from Deep Creek because the majority of fry are thought to move during periods of highest flow. Fry trapping is ineffective during high flows because traps clog frequently. A screw trap was deployed in Deep Creek just below the trap site during spring of 2001,however, insufficient flows and stream depths prevented the trap from operating properly. Funnel traps set during 2001 also failed to capture any brown or rainbow trout outmigrants (Table 8). Fry trapping did show that rainbow and brown trout migrate from early April through late July.

Table 8. Fry trapping Deep Creek 1991 - 2001

Year	Trapping Period	Number Trap Nights	# Rainbow Trout Captured	# Brown Trout Captured
1991	May 20-July 18	8	3	2
1992	April 19-July 31	28	163	12
1993	March 31-July 26	45	90	90*
2001**	July 10-July 20	4	0	0

*Does not include brown trout fingerlings planted in Deep Creek in 1993.

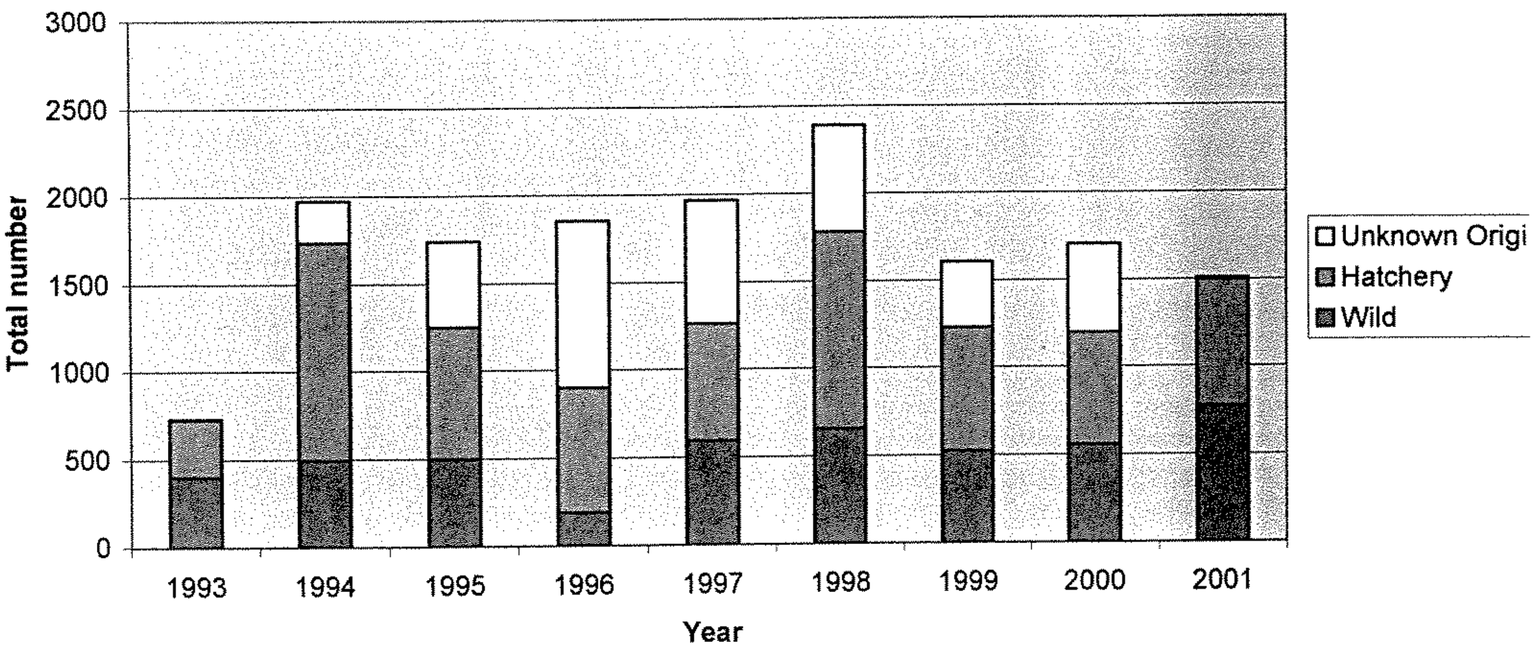
** Screw trap data not included. Trap never functioned properly due to low flows.

Electrofishing was intended to estimate the numbers of juveniles that did not migrate during the first year of life. Electrofishing in Deep Creek was conducted in late summer and fall at various locations in Deep Creek. This monitoring was able to show an index of abundance, not actual numbers of rearing fry. Results of electrofishing monitoring show the presence of rearing rainbow trout and brown trout in Deep Creek at moderate to low abundance. Not surprisingly, abundance of brown trout fry was greatest in the areas of highest redd production, below the Montana Ditch and above Clopton Lane. Rainbow trout fry were found in highest densities in the same areas as brown trout (Appendix B Table 2).

Although trapping of adult rainbow and brown trout was not called for in the preliminary evaluation plan, this technique was used to determine the size of spawning runs entering Deep Creek. This information can then be used to infer fry production. A permanent concrete weir has been used to trap brown and rainbow trout spawners since 1993. Data collected at this trap provides is very useful for evaluating benefits of the siphon installation to brown and rainbow trout.

Numbers of rainbow trout captured at the weir ranged from 730-2,386 per year during the 1993-2001 period (Figure 4). Traps were pulled in early May during 1993, 1996 and 1997 due to high flows (Appendix B Figures 1-5). Data indicate that rainbow trout generally move upstream to spawn during periods of rising flows; therefore total numbers of rainbow trout using Deep Creek are likely much higher than reported for these years. Conversely, 1998-2001 represent years of lower flows and the trap was operated the entire spawning season. It is likely that in excess of 90% of all rainbow trout ascending Deep Creek were captured during these years.

Figure 4. Total Numbers of Rainbow Trout Captured at the Deep Creek Weir 1993-2001



To effectively evaluate spawning success it is useful to examine numbers of rainbow trout of wild origin returning to spawn in Deep Creek. This gives an index of previous spawning success in the stream. Trapping data shows that the majority of wild fish begin spawning runs early in the season and it is likely that most wild rainbow spawners were captured even in years when the trap had to pulled early due to high flows.

Total numbers of rainbow trout ascending Deep Creek to spawn clearly exceed the projected spawning use (172 redds). Numbers of wild fish have remained relatively stable since 1993 and make up approximately 50% of the rainbow trout captured at the weir.

Adult brown trout were monitored with the weir during the late summer and fall from 1992-1996. The total numbers of adult brown trout ascending Deep Creek was very low throughout the period; a total of 45 adult brown trout were caught between 1992-1994. Adult brown trout captured at the weir totaled 78 in 1995 but only 5 were captured in 1996. Trapping was discontinued in 1996 because it was evident that very few brown trout ascended the stream to spawn. Clearly brown trout objectives of the siphon project have not been met.

Conclusions

Monitoring of fishery trends in Confederate Creek, Deep Creek, Missouri River and Canyon Ferry Reservoir has been conducted since project implementation began in 1991. The following is a summary of basic conclusions of fishery monitoring of the three primary projects intended to mitigate potential fishery impacts due to the Broadwater Power Project.

Confederate Spawning Enhancement

- Rainbow spawning exceeded objectives
- Brown trout spawning did not meet objectives
- Enhancement of spawning habitat was short lived due to scouring of spawning gravel during spring run-off
- Temperature regime was favorable for rainbow and brown trout spawning and rearing

Brown Trout Egg Collection and Stocking of Juvenile Fish

- Exceeded objective of collecting 100,000 green eggs per year for 4 years.
- Hatchery mortality was higher than expected
- Number of fry stocked were lower than expected due to higher than expected hatchery mortality
- Stocked brown trout apparently had very low survival based on the low number of marked fish observed in the Missouri River and Canyon Ferry
- Stocked brown trout had no positive effect on Missouri River-Canyon Ferry population.
- Fish imprinted at Deep Creek did not establish a significant spawning run
- Monitoring indicated a steady decline of brown trout numbers in Missouri-CFR complex from 1970 through about 1994. Brown trout numbers currently are very low but appear stable from 1995 through 2001.

Deep Creek Siphon Project

- Rainbow trout exceeded spawning objectives, fry production objectives, however, are not conclusive
- Rainbow trout use much more than the lower 2.2 miles of stream as anticipatated. During normal/high water years rainbow spawners migrate 15 to 20 miles into high quality spawning habitat
- Brown trout failed to meet both spawning use and fry production objectives
- Habitat quality in upper Deep Creek has improved since 1996 due to implementation of a $300,000 clean water act grant

RECOMMENDATIONS FOR FUTURE ACTION

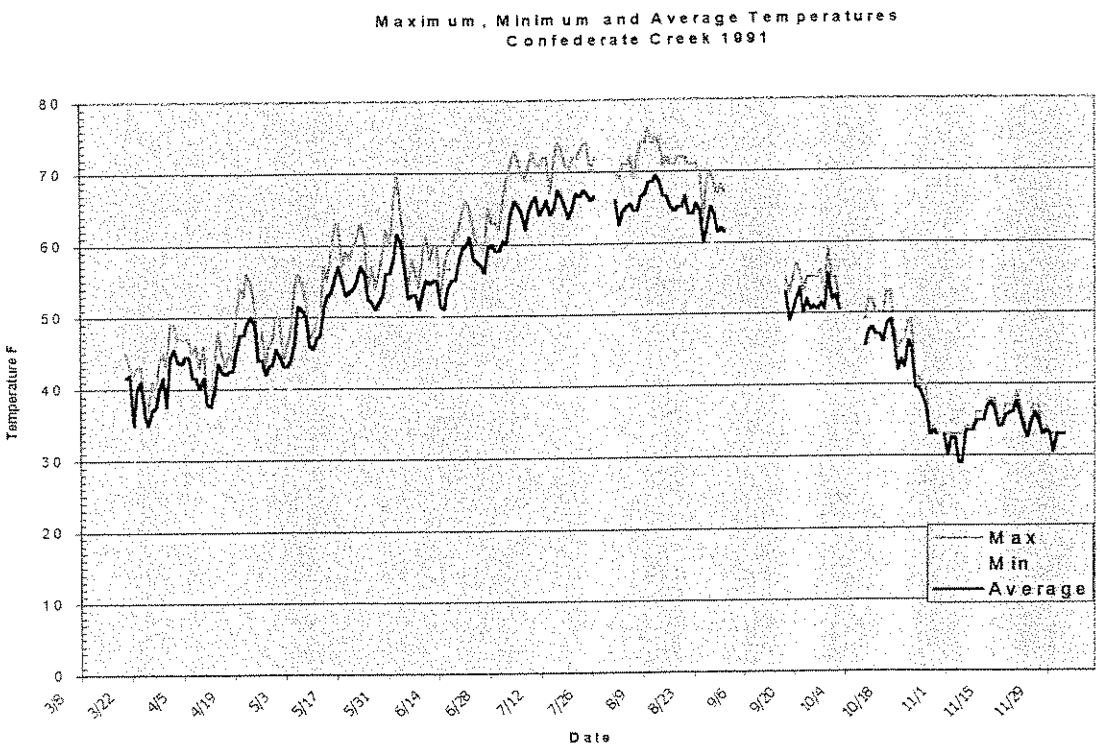
Fishery dynamics have changed significantly since 1990 when the original direction for mitigation was written. Among the many changes in the system the affect the fishery are: 1) The discovery of whirling disease, which can significantly reduce trout recruitment; 2) The development of an illegally introduced walleye population that can have a significant impact on trout survival in the system; and 3) Several years of severe drought and associated low stream flow in Deep Creek, Confederate Creek and the Missouri River. The inability to meet several of the fishery objectives in the Broadwater Power Project Mitigation package has been influenced by the above factors. In fact, the above changes in the aquatic environment may be significant enough to warrant a change in direction for future efforts to mitigate potential impacts due the Broadwater Power Project.

The mitigation strategy established in the early 1990's was directed toward producing juvenile trout that anglers could access in the receiving waters of the Missouri River and Canyon Ferry Reservoir. Considering that DNRC still has an obligation to meet mitigation objectives, it may be more feasible to attempt future projects that are limited to providing anglers trout fisheries in tributaries where factors such as whirling disease or walleye predation are not problems. Changes in the direction of mitigation, of course, will require the consent of a variety of agencies and angler groups that participated in the initial agreement.

DFWP recommends that DNRC, FERC, USFWS, and Trout Unlimited be given an opportunity to review this report prior to making a decision on how to spend existing mitigation funds and prior to determining the need for changing the overall mitigation strategy.

Appendix A
Supplemental Data Confederate Creek Spawning Enhancement Project

Figure 1. Maximum, Minimum and Average Temperatures Confederate Creek 1991-1992



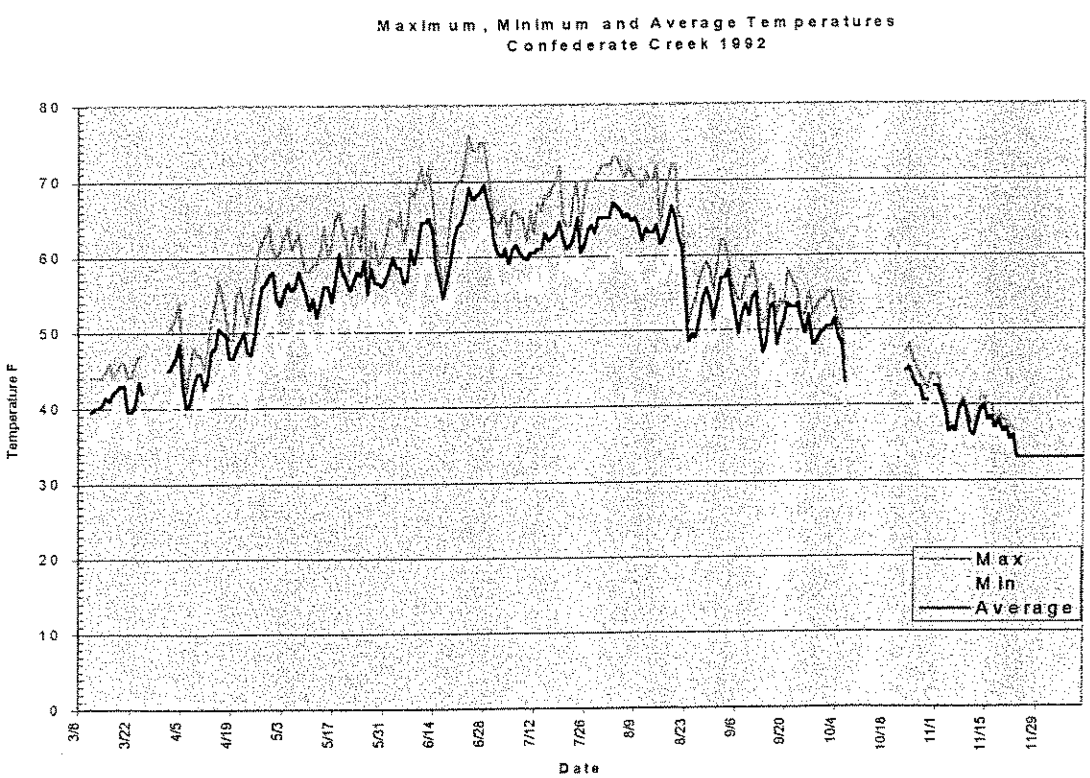


Figure 2. Maximum, Minimum and Average Temperatures Confederate Creek 1993-1994

Figure 3
Maximum, Minimum and Average Temperatures
Confederate Creek 1993

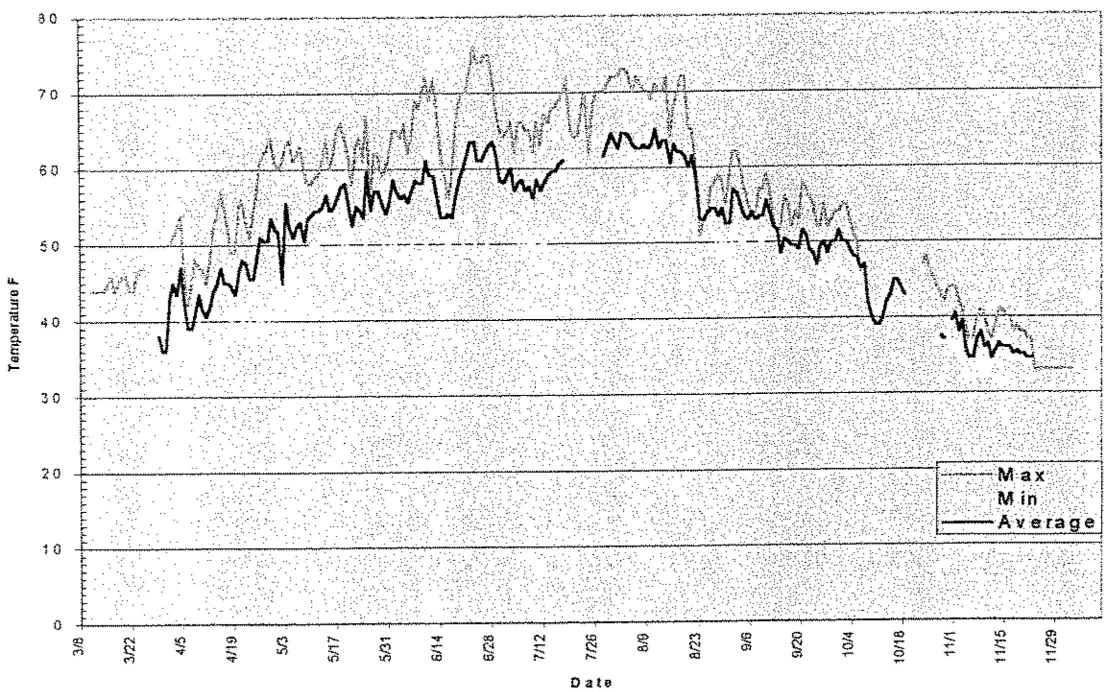


Figure 4
Maximum, Minimum and Average Temperatures
Confederate Creek 1994

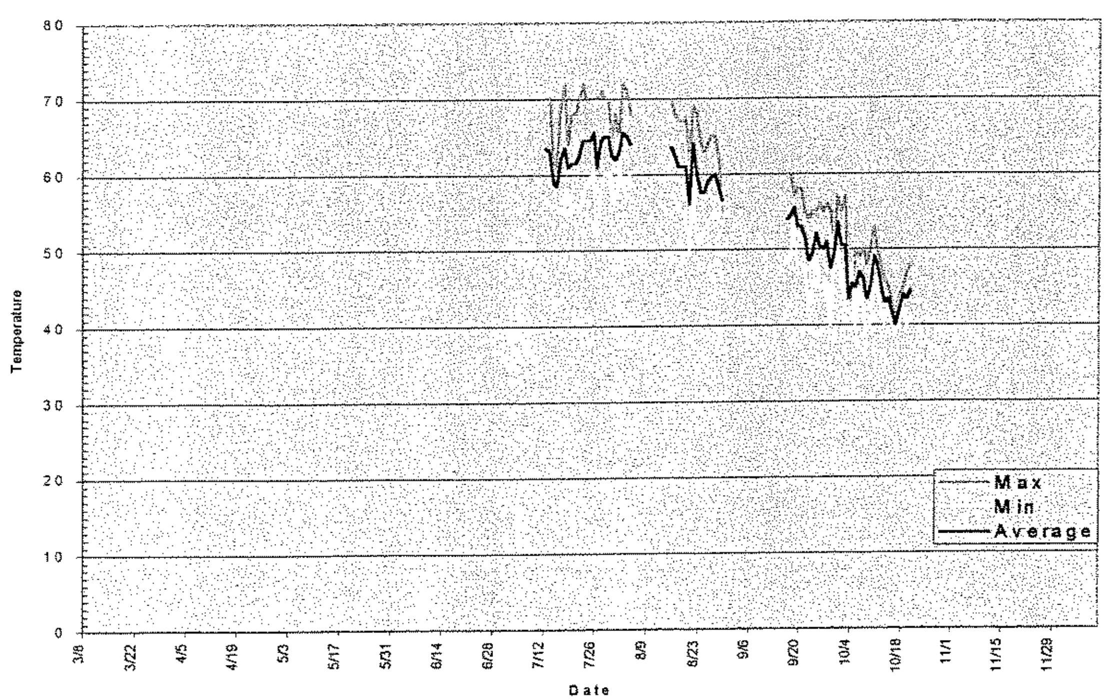


Figure 3. Spring rainbow trout redd counts, 1991 - 2001. Sites refer to location of redds in relation to habitat enhancement sites. Above site locations were not counted in 1991, 1993, and 1997. Count from 1993 is incomplete due to high water conditions.

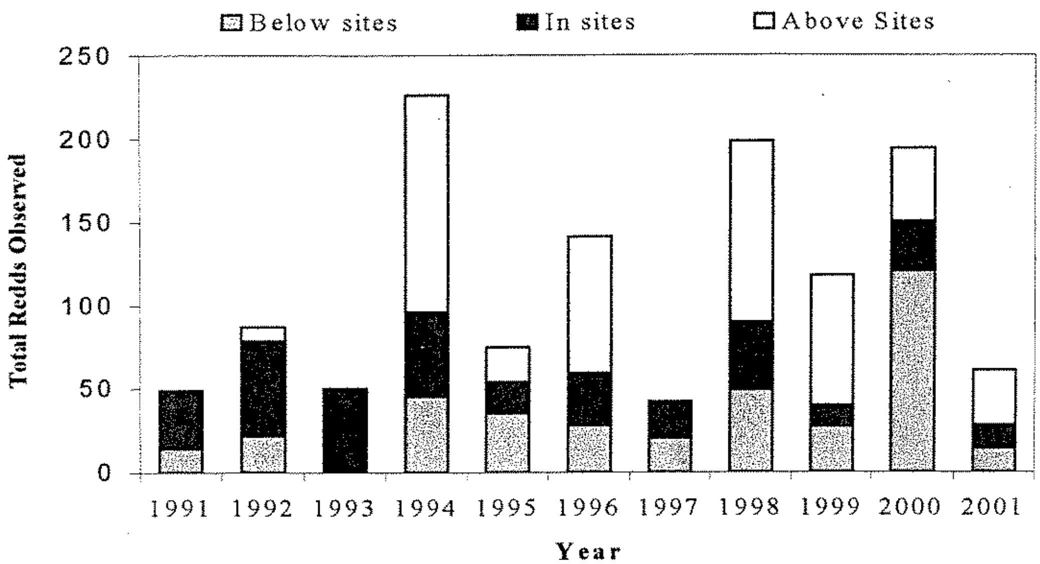


Figure 4. Fall brown trout redd counts, 1991 - 2001. Sites refer to location of redds in relation to habitat enhancement sites. Above site locations were not counted in 1991 and 1993. Below and above site locations were not counted in 1996 due to ice conditions.

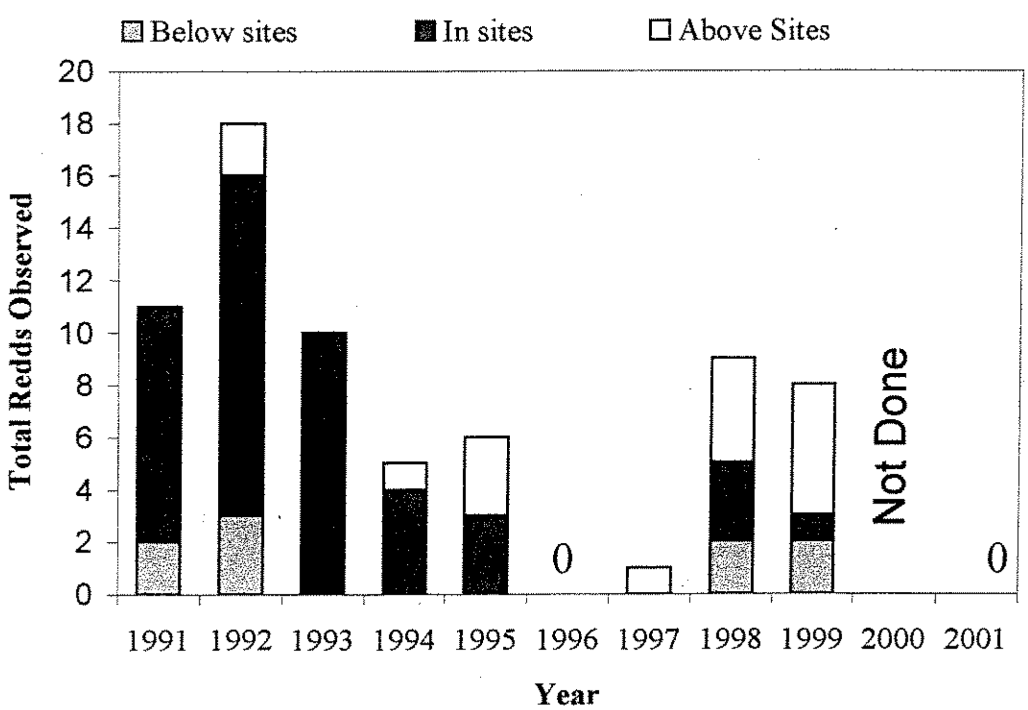
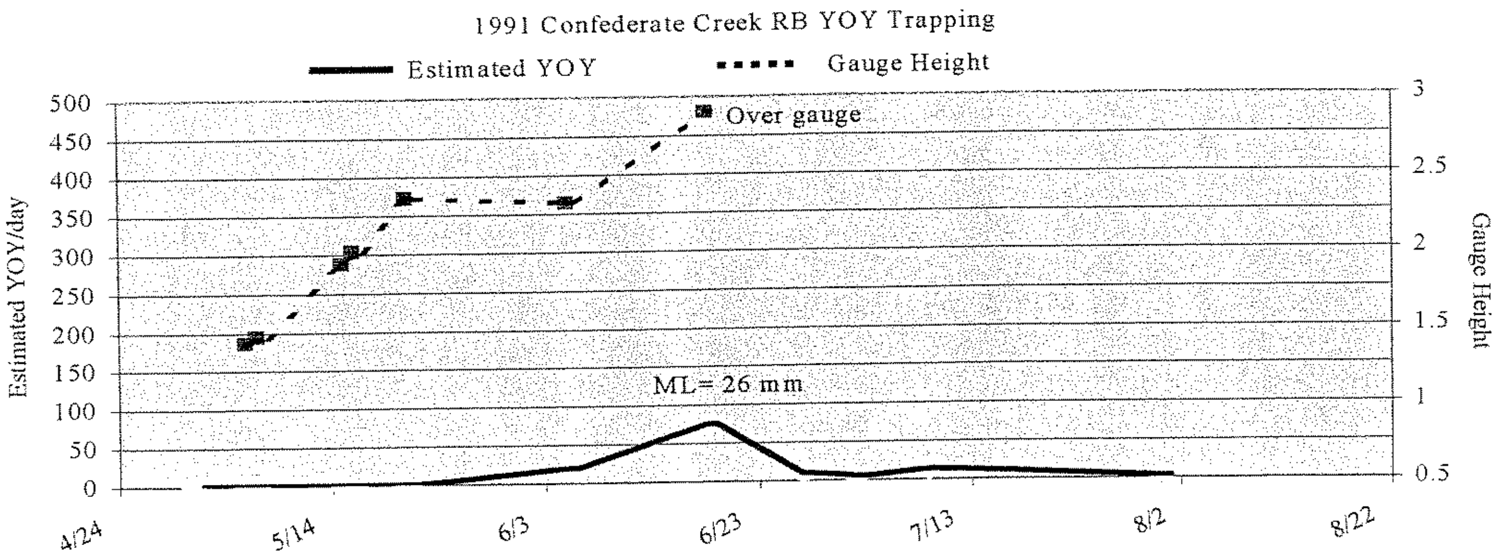
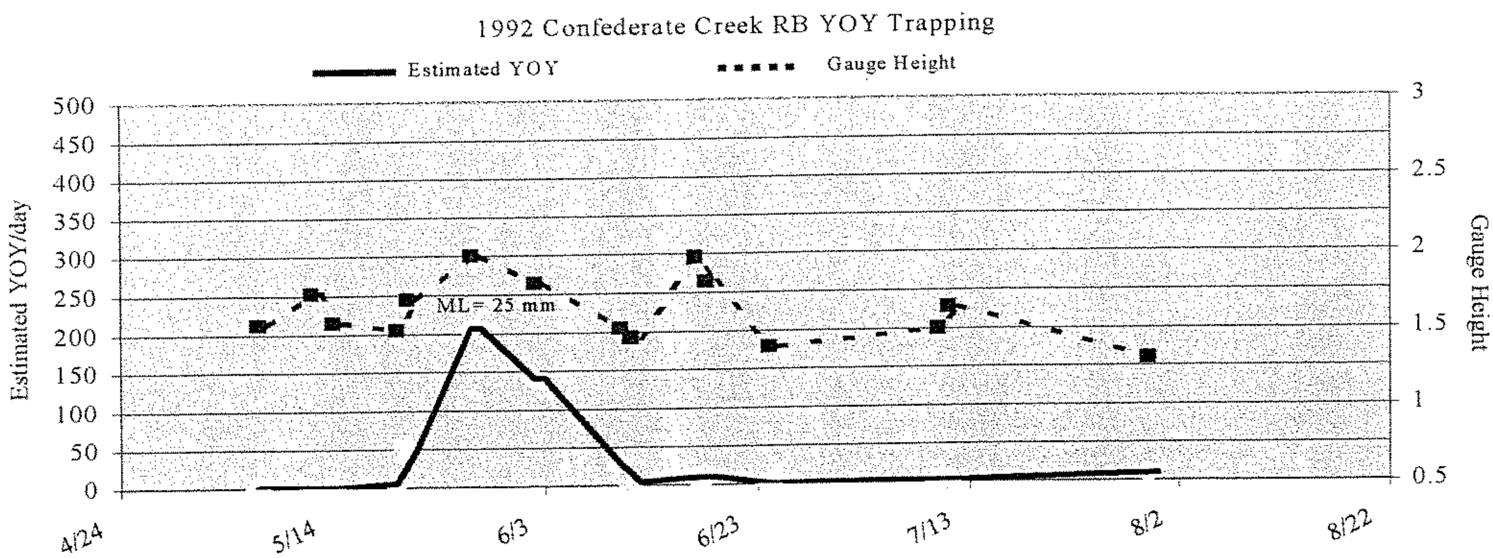


Figure 5. Number of RB YOY trapped in Confederate Creek within enhancement area, 1991 - 1993.





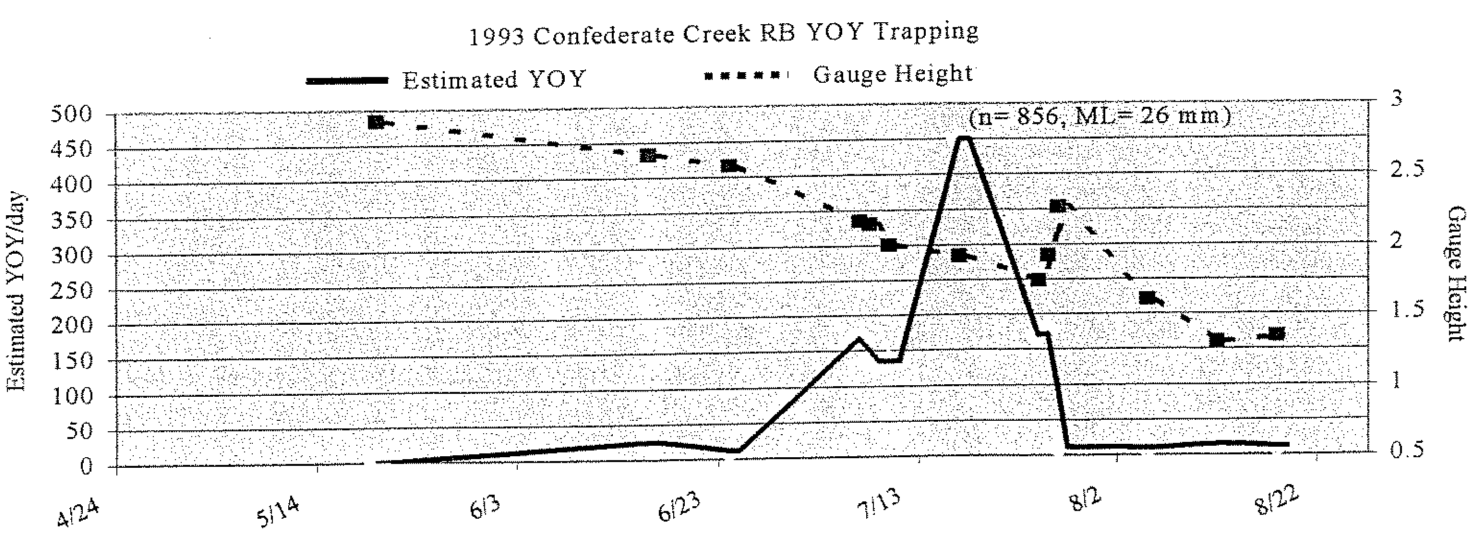


Figure 6. Number of RB YOY trapped in Confederate Creek within enhancement area, 1994 - 1996.

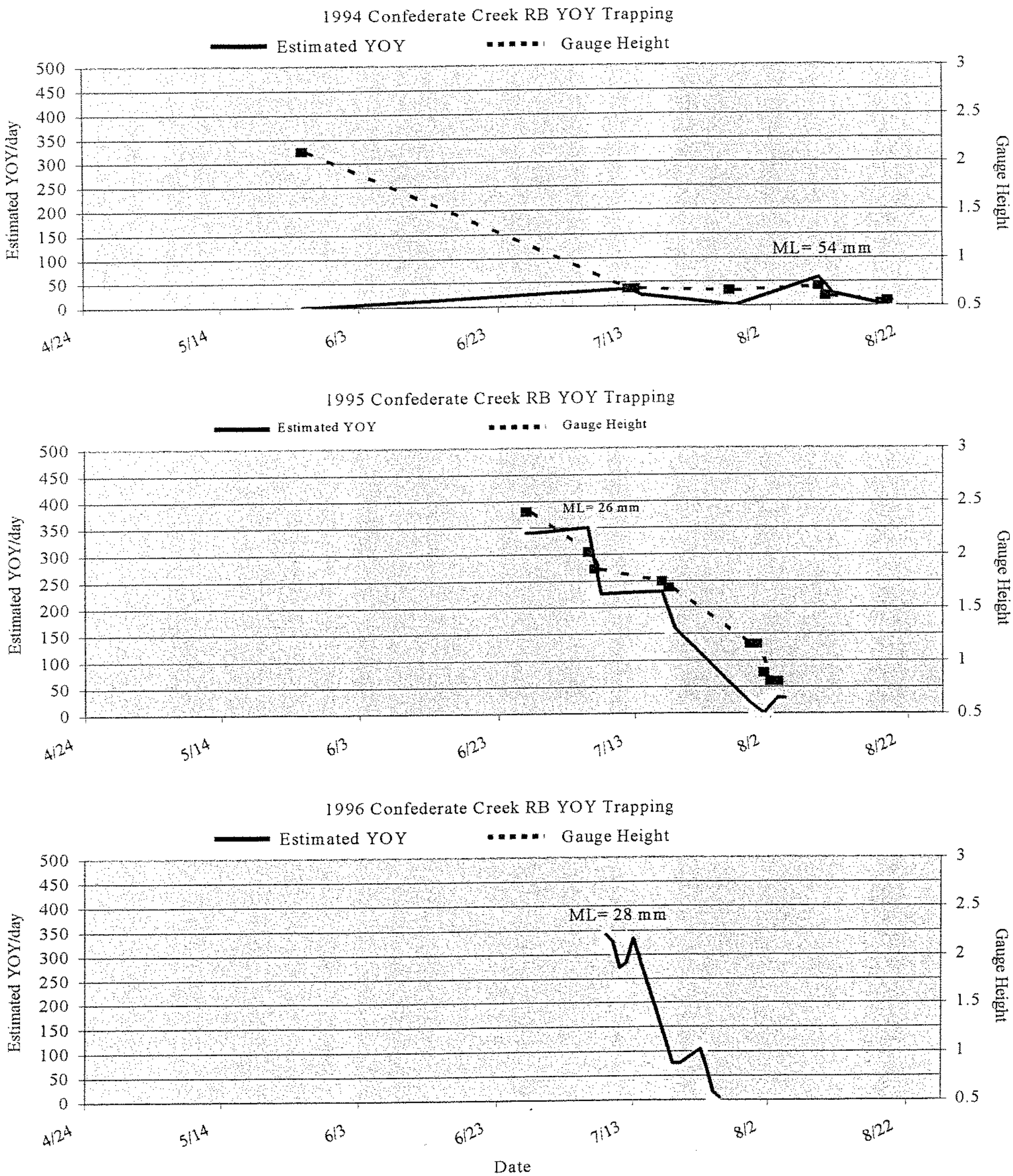


Figure 7. Number of RB YOY trapped in Confederate Creek within enhancement area, 1997 - 1999.

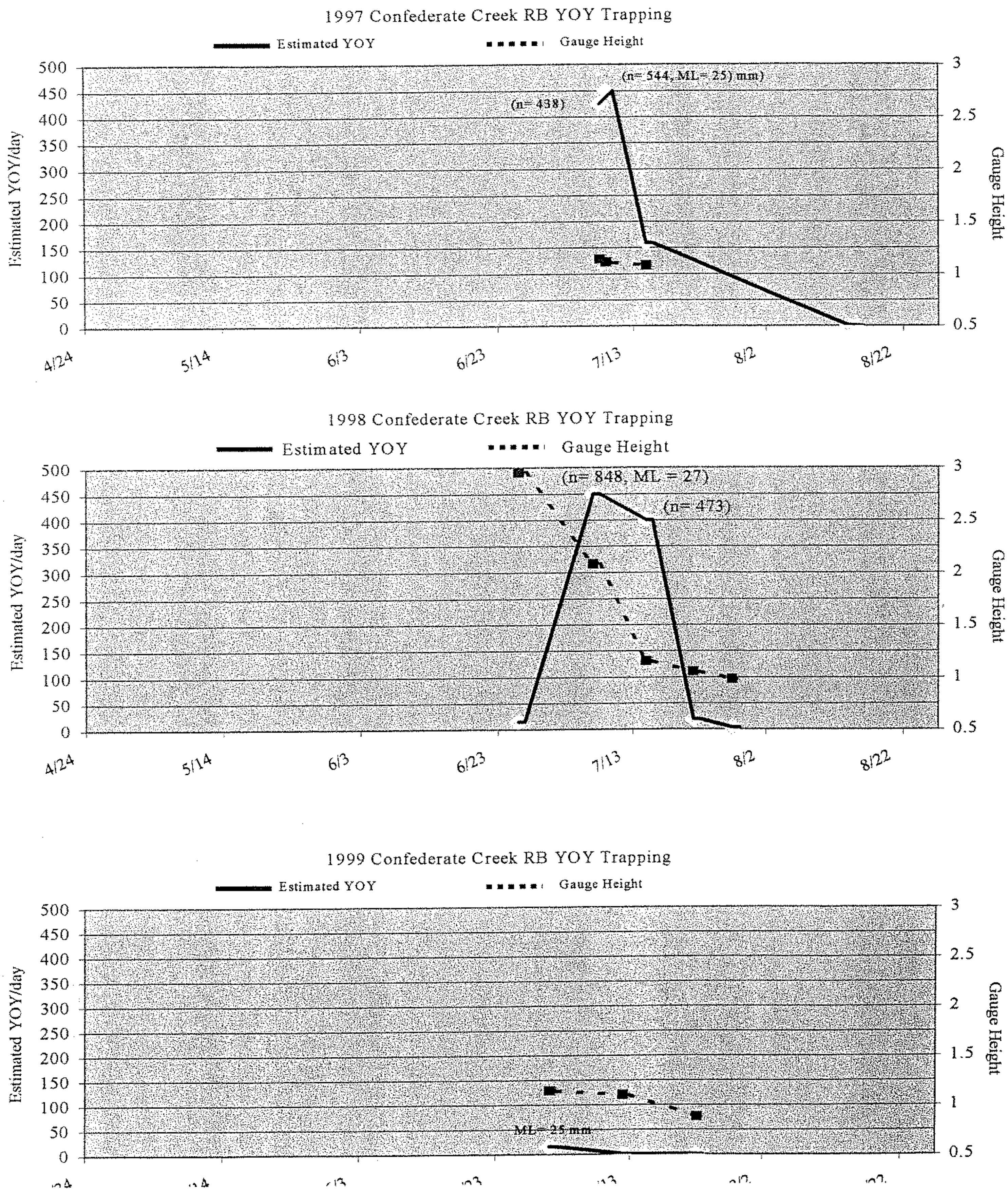
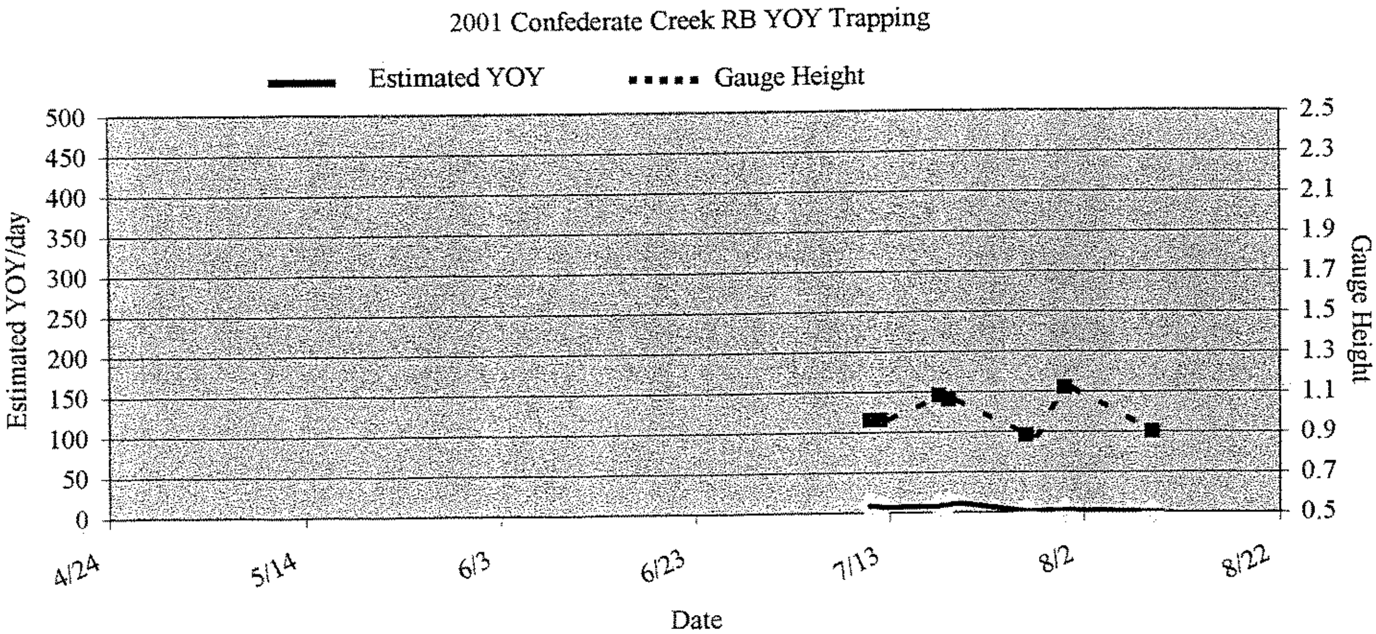


Figure 8. Number of Rb YOY captured in the enhancement area 2001.



Appendix B
Deep Creek Watershed and Spawning Enhancement Project
Supplemental Data

Table 1. Target conditions for Watershed Monitoring in Deep Creek

Monitoring Parameter	Target Condition
Total Suspended Solids	Slope of Total Suspended Solids Vs. Flow at Montana Ditch less than 0.79 in 4 out of 5 years.
Eroding Banks	50% Reduction in area (square feet) of eroding banks (112008 sq ft)
Maximum Water Temperature	Maximum water temperature less than 73 °F no more than 10 days/ year at Montana Ditch in 4 out of 5 years
Minimum Stream Discharge	Greater than 9 cubic feet per second from the Montana Ditch to the mouth and above Clopton Lane.

Table 2. Abiotic Monitoring Results Deep Creek.

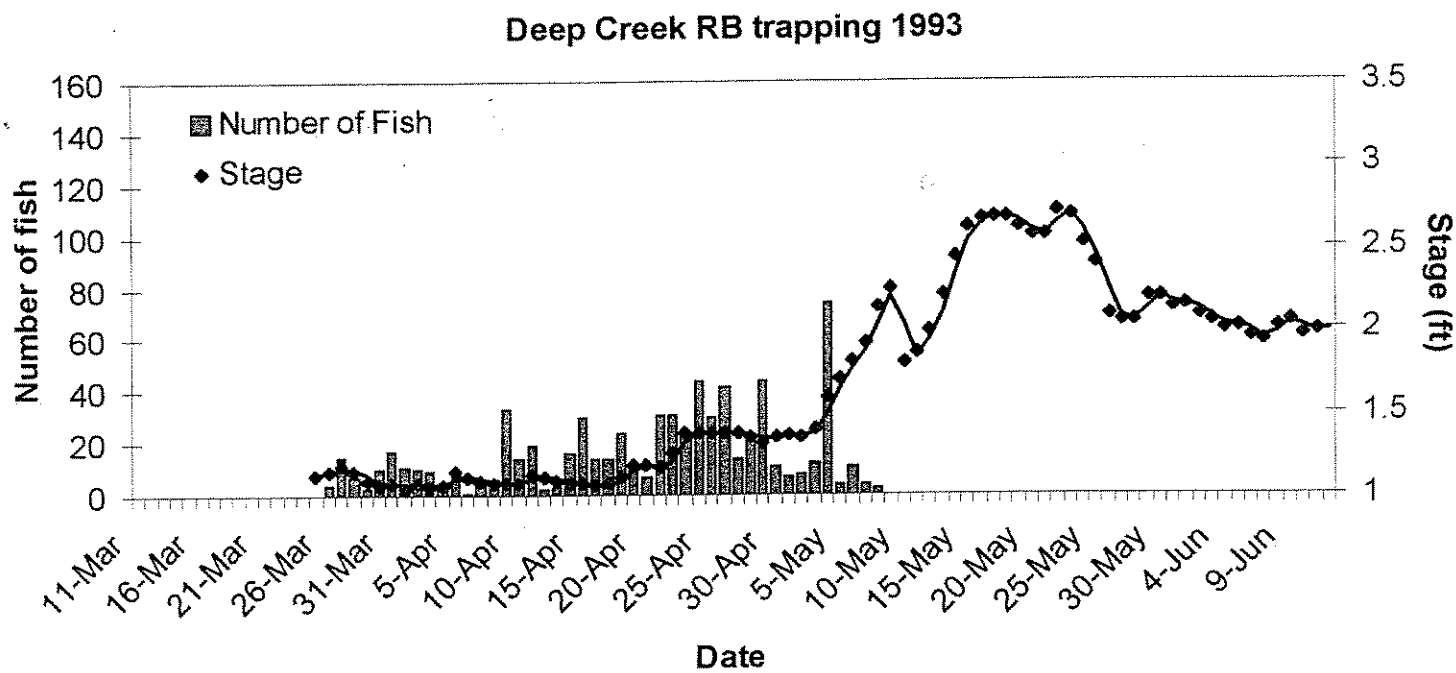
Monitoring Parameter	Baseline Condition	1997	1998	1999	2000	2001
Total Suspended Solids	TSS vs flow regression 1.58	2.89	1.42	2.9	0.51	N/A
Eroding Banks	224,016 Ft^2 eroding banks	N/A	139,840	132,241	131,391	N/A 132,427
Maximum Water Temperature	1993 0 days > 73 °F 1994 42 days > 73 °F	N/A	1 day	33 days	40 days	63 days
Minimum Stream Discharge	1993 0 days < 9 cfs at Montana Ditch 1994 12 days < 9 cfs at Montana Ditch	N/A	8 days	27 days	N/A	37 days

N/A = Not Available

Table 3. Catch per 100 electrofishing seconds for wild rainbow and brown trout at locations on Deep Creek.

Date	Location	**Number of per 100 sec shocking**	
		RB < 120 mm	LL < 130 mm
10/8/92	Below trap (280 ft, 576 sec)	0.5	1.2
10/20/92	Below trap (443 sec)	1.1	1.4
10/5/95	Below trap (1257 ft, 3247 sec)	1.8	0.3
8/19/96	Below trap (475 sec)	0.8	2.9
10/30/98	Below trap (200 ft, 929 sec)	3.9	1.5
10/28/99	Below trap (250 ft, 500 sec)	3.0	1.4
10/11/01	Below Trap (127 ft 250 sec)	0	.8
8/7/92	Above trap (174 ft, 878 sec)	1.5	1.0
10/20/92	Water quality site (1st pass of estimate, 300 ft, 2325 sec)	0.6	0.3
11/11/93	Water quality site (1st pass of estimate: 330 ft, 900 sec)	0	0.1
9/19/93	Weir to highway (1st pass of estimate, 3600 sec)	0.1	0.1
10/12/94	Water Quality site (3300 sec)	0.7	0.7
10/8/96	Above trap (1500 ft, 5636 sec)	0.7	0.3
10/17/97	Fence to gauge (3277 sec)	< 0.1	0.3
7/18/00	Montana Ditch (195 ft 490 sec)	8.2	0
8/14/92	Above BM ditch (120 ft, 541 sec)	0.6	0.2
11/3/92	John Hahns (1st pass of estimate, 300 ft, 1604 sec)	1.1	0.2
8/18/93	John Hahns (1st pass of estimate: 1920 sec)	0.4	0.3
11/11/93	Carson Lane (1st pass of estimate: 330 ft, 720 sec)	0.6	0
10/10/96	Dagnalls (2426 sec)	2.5	0.8
10/29/99	Dagnalls (145 ft, 566 sec)	1.8	1.1
7/18/00	Clopton Lane (130 ft 785 sec)	0.25	1.1
7/18/00	Horse Pasture (100 ft 503 sec)	5.7	.9
9/6/00	Horse Pasture (160 ft 656 sec)	4.1	2.59
10/25/00	Horse Pasture (160 ft 732 sec)	3.2	1.9
7/27/01	Horse Pasture (154 ft 805 sec) 1st pass	0.2	0.1
7/27/01	Horse Pasture (154 ft 604 sec) 2nd pass	.0.2	0.5

Figure 1. Rainbow Trout and stage readings by day Deep Creek Weir 1993-1994



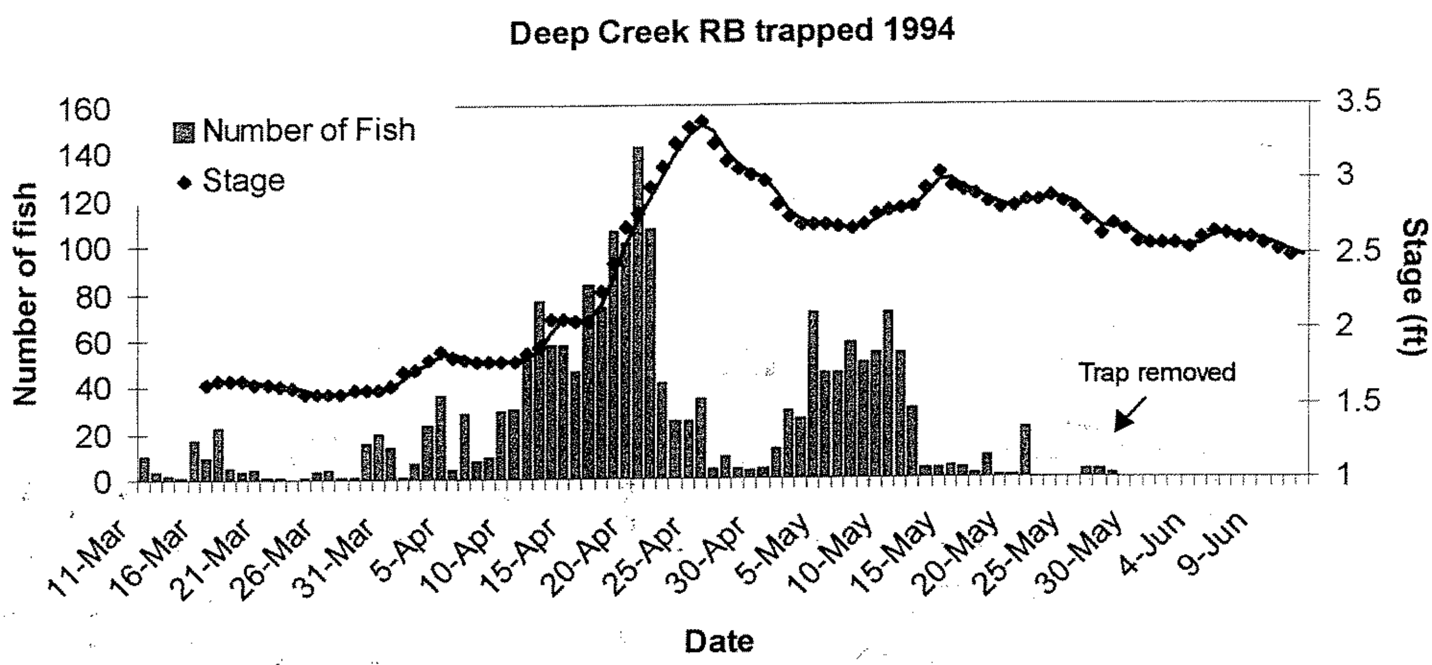
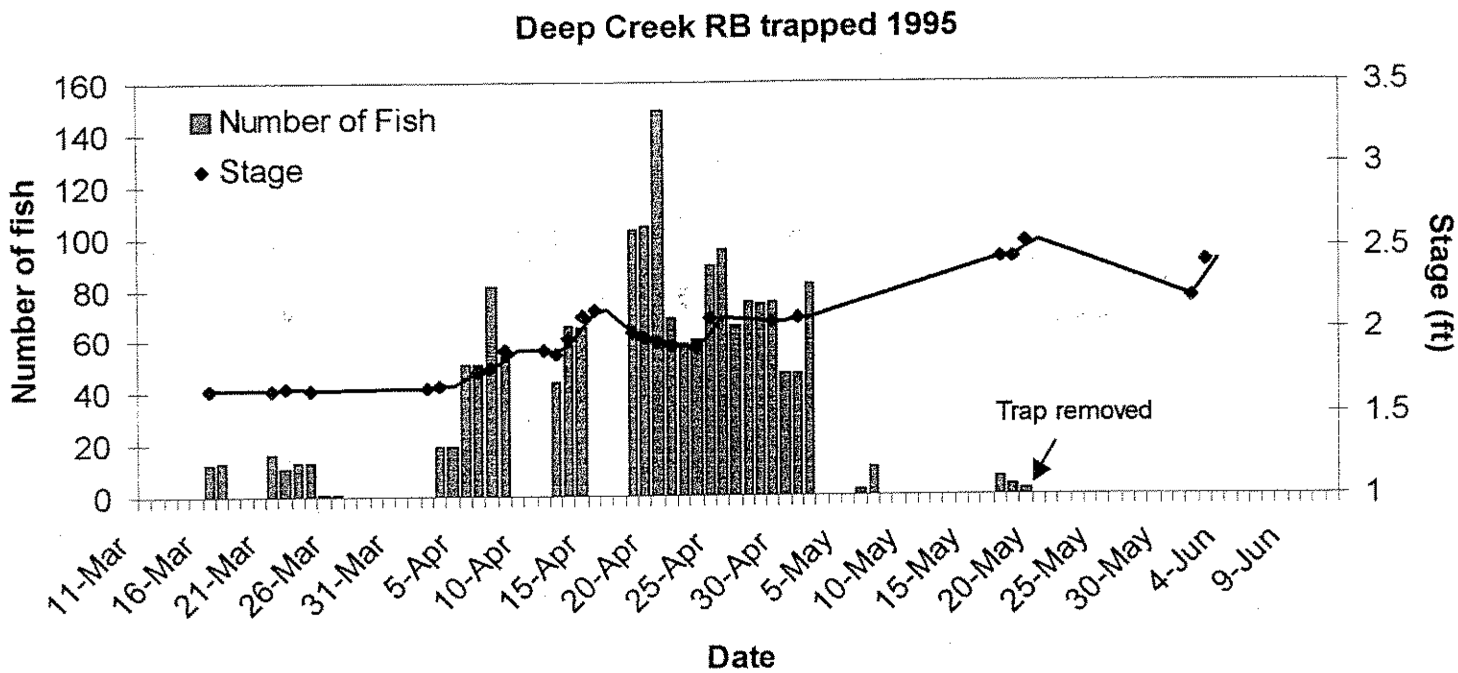


Figure 2. Rainbow Trout and stage readings by day Deep Creek Weir 1995-1996



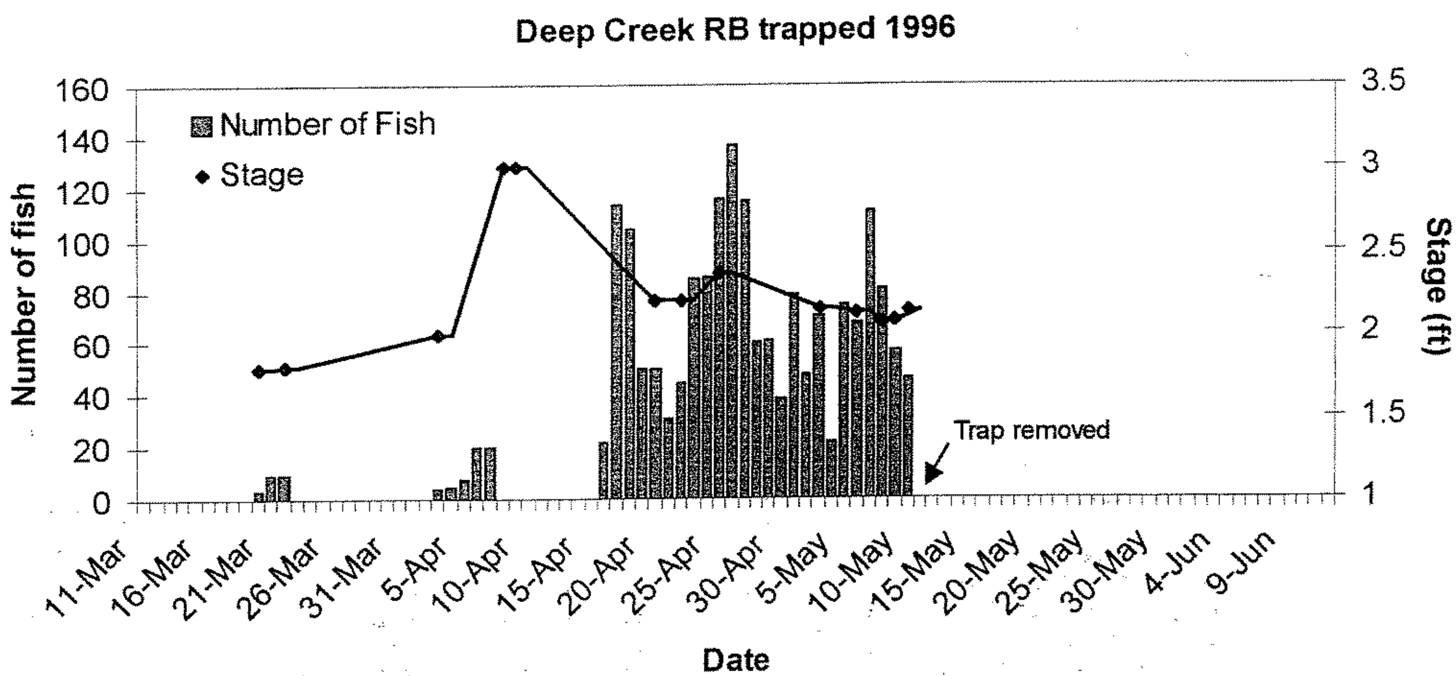
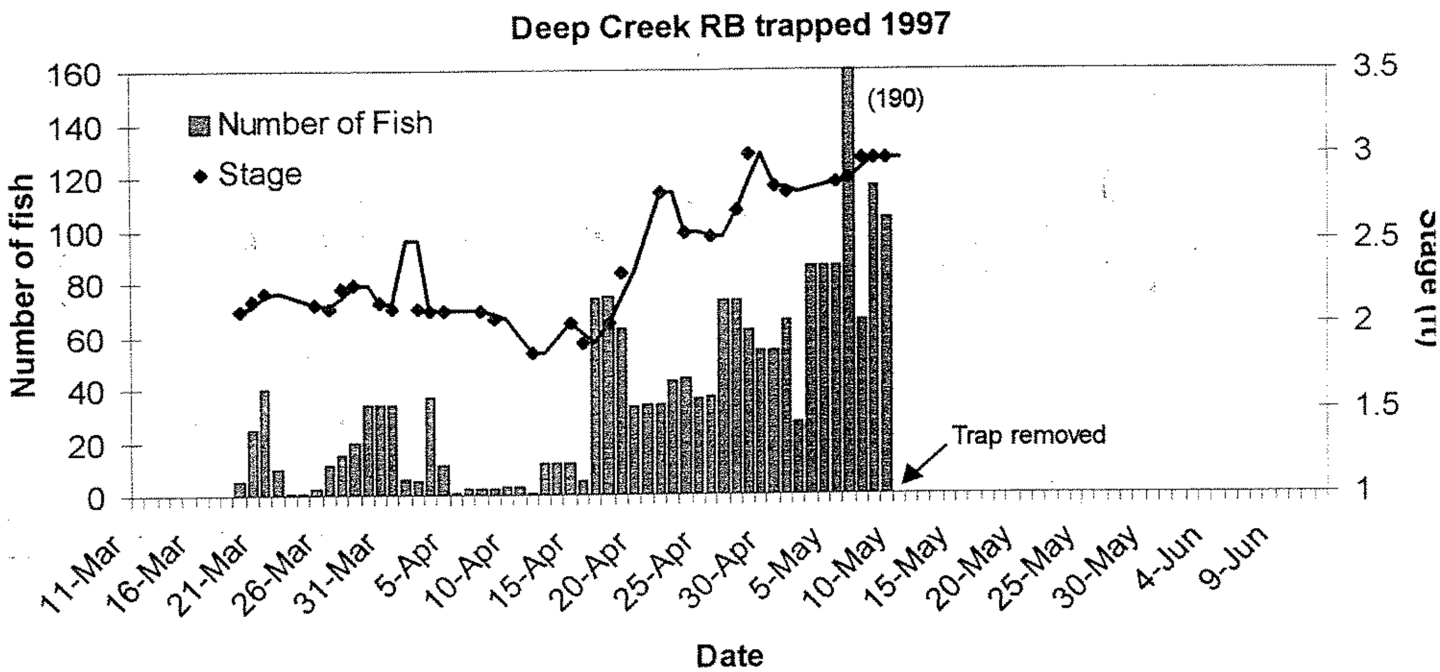


Figure 3. Rainbow Trout and stage readings by day Deep Creek Weir 1997-1998



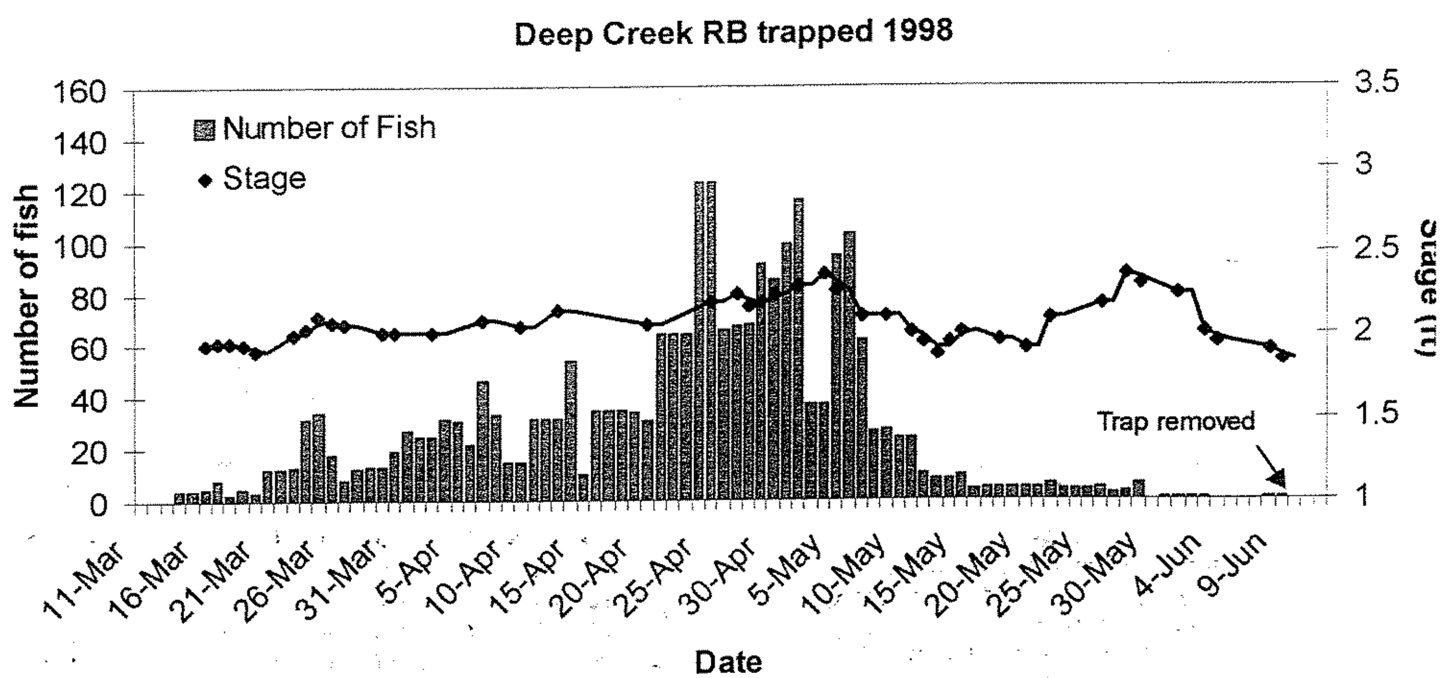
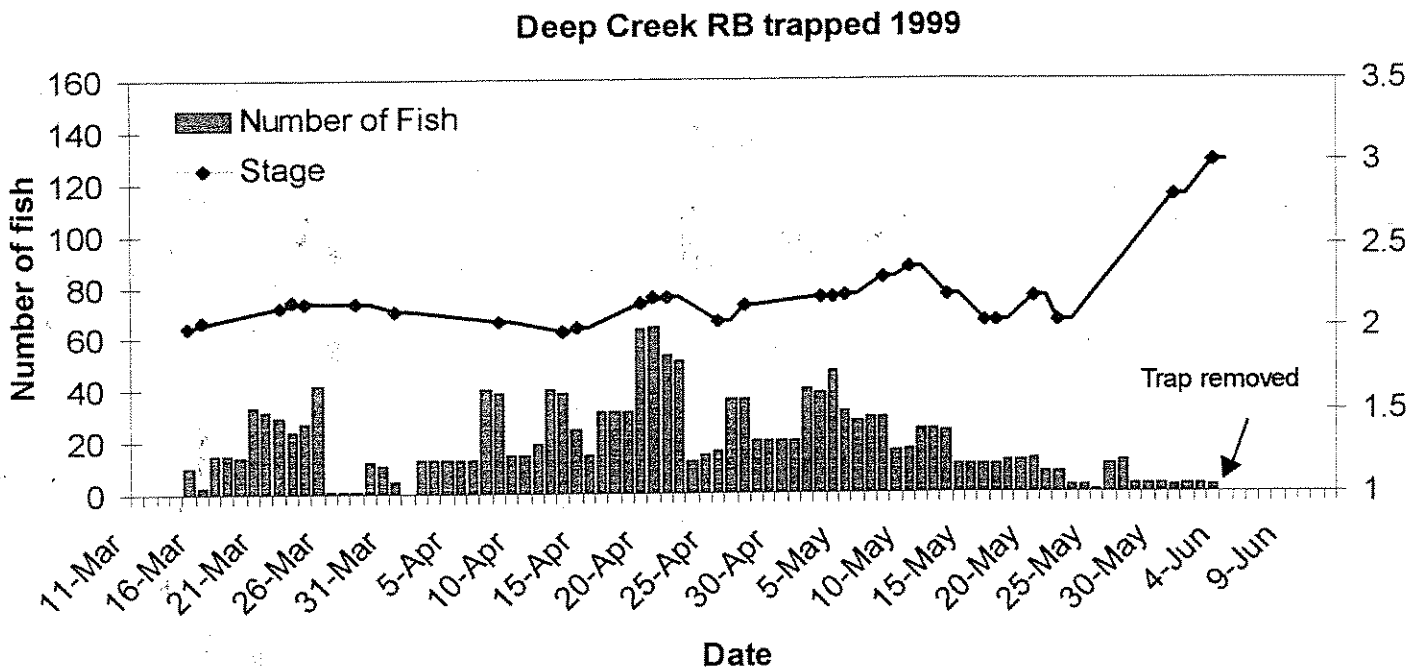


Figure 4. Rainbow Trout and stage readings by day Deep Creek Weir 1999-2000



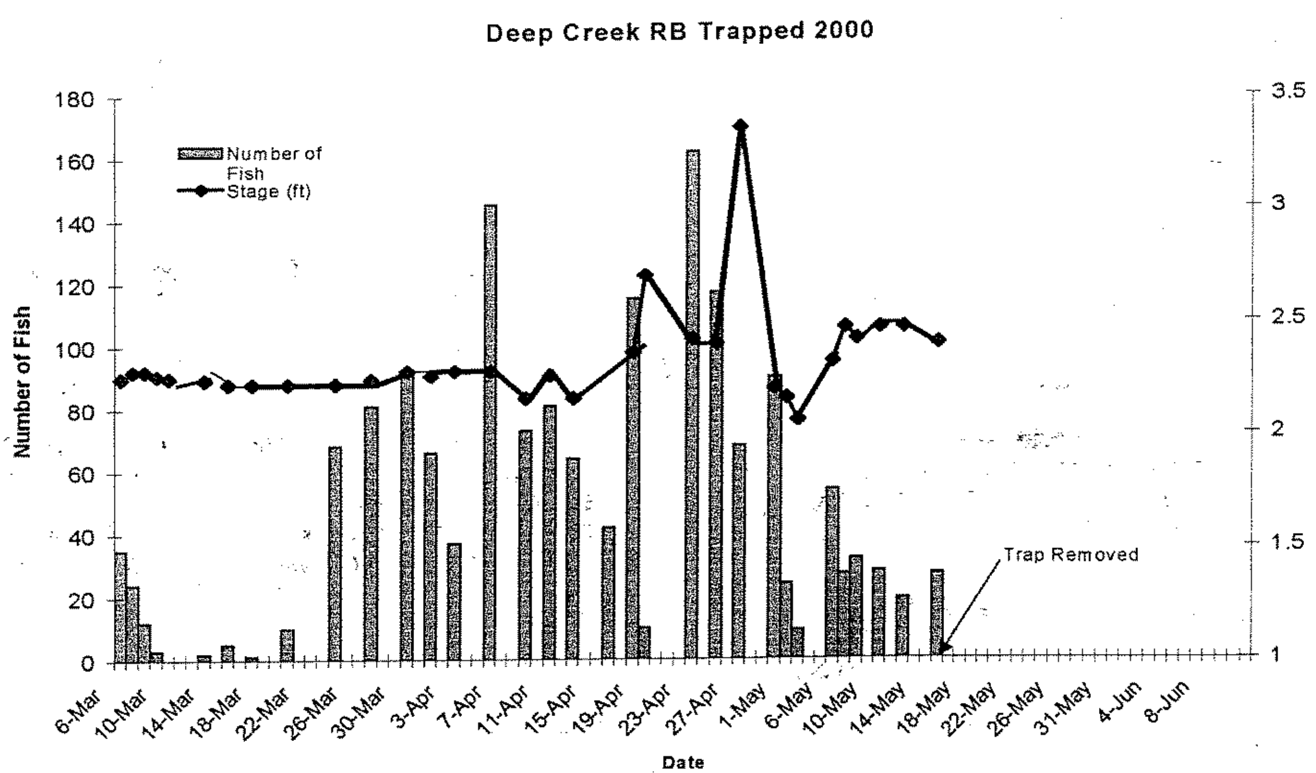
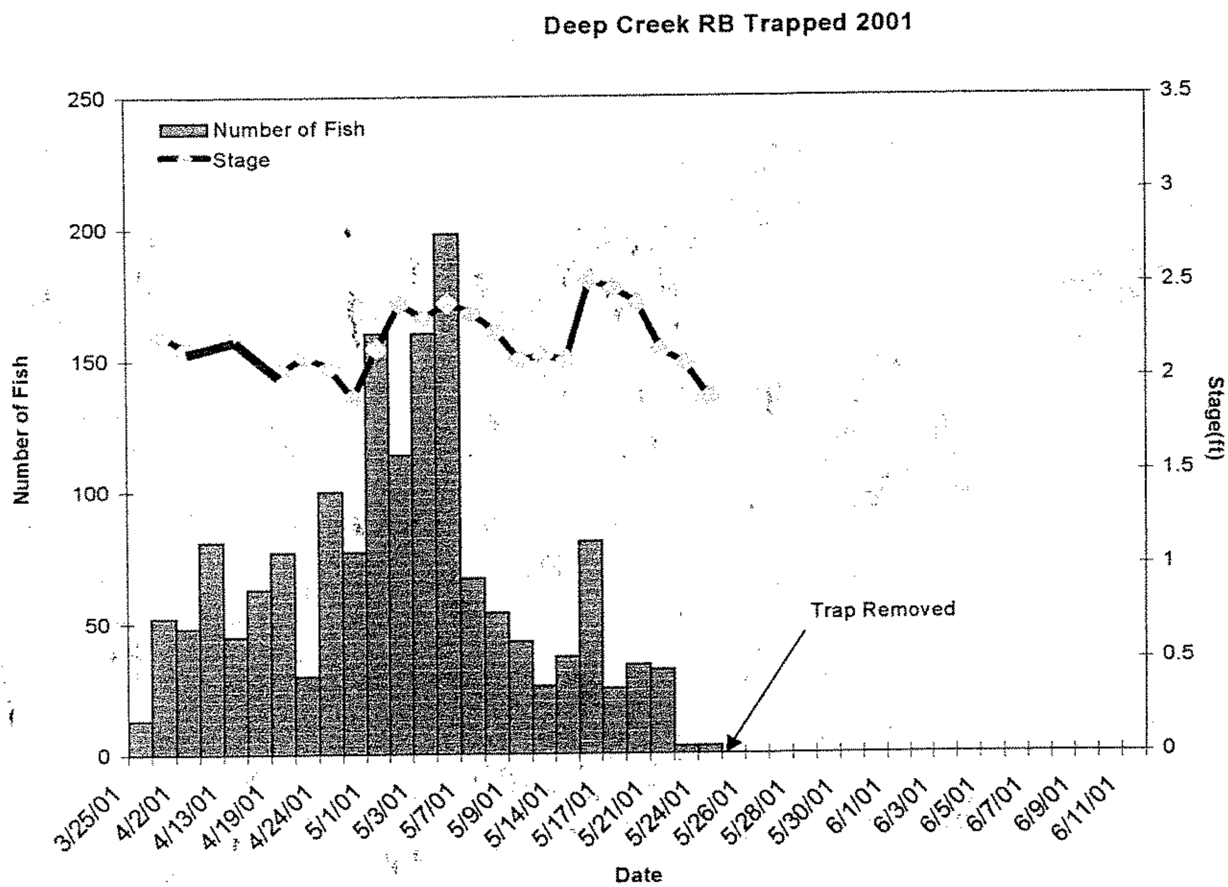


Figure 5. Rainbow Trout and stage readings by day Deep Creek Weir 2001



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Established in 1923

DEEP CREEK WATERSHED AND SPAWNING ENHANCEMENT PROJECT

2001
PROJECT MONITORING REPORT

Prepared For
Broadwater Conservation District
(Project Sponsor)

By
Hydrotech Water Resource Consultants
(Project Monitoring Coordinator)

January 2002

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INTRODUCTION/BACKGROUND

Prior to implementation of the Deep Creek Watershed and Spawning Enhancement Project, Deep Creek was listed by the Montana Department of Environmental Quality (MDEQ) as "water quality limited". This meant Deep Creek was not fully supporting it's designated beneficial uses. In this case the "impaired" beneficial uses were cold water aquatic life (mainly fish and macroinvertebrates). Pre-project monitoring conducted in 1991 - 93 indicated that Deep Creek was impaired due to excessive sedimentation, dewatering and elevated water temperature primarily related to bank erosion, localized decline or loss of riparian vegetation and irrigation withdrawals.

In 1996 a plan was formulated to address these problems and restore full support to beneficial uses in Deep Creek. This plan was called a Total Maximum Daily Load or "TMDL". The TMDL identified the problems, recommended solutions to correct the problems and established targets meant to achieve full support of beneficial uses in Deep Creek and ultimately remove it from the impaired list. The solutions recommended in the TMDL Plan were incorporated into the Deep Creek Watershed and Spawning Enhancement Project developed in 1996.

This project was designed to implement watershed restoration, stream stabilization and habitat enhancement activities that addressed water quality and fisheries concerns in Deep Creek. Restoration activities began in 1996 and were completed in 1999. Monitoring is an integral part of the Deep Creek Project and critical to determine the success of restoration activities in meeting TMDL targets.

The Deep Creek Final Monitoring Plan (May 1999) outlines project monitoring strategy, and describes all monitoring parameters, targets, sampling techniques/methods, sample sites and responsibilities. This information in summarized in Appendix A, Tables 1, 2 and 3. Project monitoring began in 1997 and continued annually through 2001. Monitoring is planned to continue through 2003, however, monitoring funds have not been secured for 2002-03.

Although monitoring has occurred on Deep Creek since 1997, the first annual project monitoring report wasn't completed until 2000. Prior to 2000, project monitoring results for 1997 through 1999 were presented and discussed under project Task 8 (monitoring) in parts One and Two of the Final Project Report. These reports dated December 1998 and September 1999 respectively are available through the Broadwater Conservation District. Pre-project/baseline monitoring (1991 -1993) information is summarized in the Deep Creek TMDL Report dated March 1996 and available through the MDEQ.

This 2001 Annual Deep Creek Monitoring Report summarizes monitoring results from the 2001 season as well as providing a review of past monitoring results including pre-project monitoring and project monitoring prior to 2001 (1997 - 2000). Parameter specific monitoring results are presented by year and site where applicable, followed by general trend comparisons and discussion. The recommendations section at the end of the report provides options for improving monitoring and resolving undesirable conditions observed on the stream.

The Deep Creek TMDL, Project Work Plans, Monitoring Plan, and Final Reports provide comprehensive, in-depth information on the Deep Creek Project and are available through the Broadwater Conservation District. Although the reader is encouraged to review these documents for a thorough understanding of the whole project, it is hoped that this monitoring report contains enough information to put the monitoring results into an understandable perspective without having to read the other documentation. For this reason this report repeats some of the information contained in previous Deep Creek documents.

MONITORING RESULTS

Targets have been established for all monitoring parameters except photo points. Target values serve as the basis to compare monitoring results by parameter to determine the success of the watershed improvement efforts in meeting project objectives. Table 1 lists all project monitoring parameters and associated targets and summarizes all monitoring results by year through 2001.

1) TOTAL SUSPENDED SOLIDS (TSS)

Sediment, primarily from eroding stream banks was identified as a major concern in Deep Creek. Project activities included extensive bank stabilization to reduce this sediment source. TSS is the primary monitoring parameter used to determine the effectiveness of stabilization activities in reducing suspended sediment in Deep Creek.

The target for this parameter is to decrease the slope of the regression between discharge and TSS by half of the baseline value in four out of five years (from 1.58 to 0.79). Simply speaking this means that for a given stream discharge (particularly discharges greater than base flow) TSS concentrations will be reduced by approximately 50 percent compared to pre-project levels. This target is set for the lower sample site near the mouth of Deep Creek (just above the Montana Ditch siphon). Although no other targets are set, additional TSS analysis looks at trends in TSS concentrations and loading between years and sites.

TSS monitoring has occurred annually during runoff at three sites since implementation of this project (1997 - 2001). The three TSS monitoring sites are lower (near the mouth and Montana Ditch), mid or intermediate (Clopton Lane) and upper (Horse Pasture) (see Figure 1 for map). Samples are collected five to eight times at each site between mid May and early July.

Lower Monitoring Site

Many acres of burned timber in the upper watershed and continued drought contributed to unusual flow and sediment conditions on Deep Creek in 2001. Flows were very low yet TSS concentrations were high relative to the flow. At the downstream monitoring site the relationship between TSS and discharge tended toward the opposite of what would "normally" be expected. Some of the lower TSS values occurred during the highest flows. Two identical TSS values occurred at very different flows and two identical flow values resulted in significantly different TSS values (Figure 2)

Regression analysis of TSS and discharge returned a negative slope value (-0.16) in 2001 indicating a potential inverse relationship between the two factors. The correlation between TSS and discharge was so poor (Rsq = .20) at this site that a determination of slope based on regression analysis is not valid for 2001. Therefore this TMDL target was eliminated for 2001.

Table 1 Monitoring Results Summary

DEEP CREEK MONITORING RESULTS SUMMARY (PRE-PROJECT through 2001)							
MONITORING PARAMETER	**TARGET**	**PRE-PROJECT / BASELINE**	**1997**	**1998**	**1999**	**2000**	**2001**
TOTAL SUSPENDED SOLIDS (TSS)	Slope of TSS vs. Dschg. <= 0.79 at lower sample site	1.58	2.89	1.42	2.9	0.51	N/A
CHANNEL CROSS-SECTIONS	Consistent with Rosgen "C" channel type (W:D ratio >= 12, Entrenchment >= 2.2)	N/A	N/A	N/A	80% consistent	85% consistent	**55% consistent**
PHOTO POINTS	Not applicable						
PEBBLE COUNTS	D50 >6.3 mm.	12 - 39 mm.	Avg. 22.4mm. (range 14-33)	Avg. 19.7mm. (range 16-23.5)	Avg. 21mm. (range 14-28.5)	26.5mm. (14-30)	**27 mm. (Range 11.3-38)**
BANK EROSION	50% Reduction in eroding bank area. (>112,008 sq.ft.reduction)	224,016 sq. ft. (1996)	N/A	62% reduction (139,840 sq. ft.)	59% reduction (132,241 sq. ft.)	59%(131,391sqft)	**59% reduction (132,127 sq ft)**
MAXIMUM WATER TEMPERATURE	Max. temp. 73 *F <10 days in 4 out of 5 yrs.	# Days Exceeding 73* F					
	Abv. Mt. Ditch	1993 - 0 days, 1994 - 42 days	?	1 day	33 days	40 days	**50 days**
	Abv. B-M Ditch	N/A	N/A	3 days	27 days	42 days	**N/A**
	Clopton Ln.	N/A	N/A	0 days	0 days	0 days	**14 days**
MINIMUM STREAM DISCHARGE	Reach 1 - 4 & 10 - 11 **>=9CFS**	# Days Below Minimum Flow Recommendations					
	Mt. Ditch	1993 - 0 days, 1994 - 12 days	N/A	**est 8 days**	27 days	N/A	**70 days (est)**
	Clopton Lane	N/A	N/A	est 30 days	60 days	N/A	**79+ days (est)**
	Reach 5 - 9 **>= 3CFS**						
	B/M Ditch	N/A	N/A	N/A	54 days	N/A	**89+days (est)**
MACROINVERTEBRATES	Biointegrity score >= 75% of ref. conditions						
	Mt. Ditch (lower project area)	Score = 50% - 75%	N/A	N/A	Score = 63%	N/A	**N/A**
	B/M Ditch (mid project area)	Score = 81% - 92%	N/A	N/A	Score = 67%	N/A	**N/A**
	Near Lippert Gulch (upper project area)	Score = 63% - 96%	N/A	N/A	Score = 96%	N/A	**N/A**
MIGRANT FEMALE RAINBOW TROUT	3000 females (By 2008)	Est. 1500	Est. 1119	1384	1041	950	**664**
STREAM BANK INVENTORY	optional monitoring parameter, no established target		N/A	N/A	N/A	N/A	**N/A**
BROWN TROUT REDD COUNTS	Increase over pre-project numbers	76	N/A	N/A	**190**	N/A	**146**
N/A = Not Available							

Figure 1 - MAP

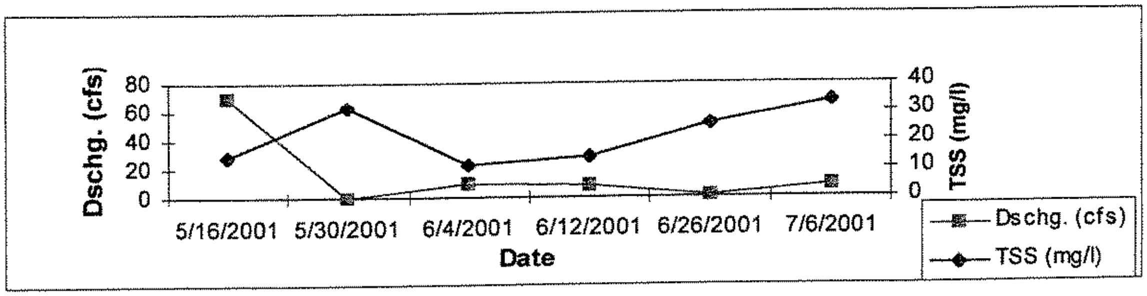

Figure 2 TSS Discharge @ Montana Ditch

In looking at average values for 2001 at the lower monitoring site, average TSS concentration was lower but similar to 2000 and much lower than 1997 through 99. Average flow and sediment loading were much lower in 2001 than all past years (Figure 3). These trends indicate a continued reduction in sediment over preproject levels but reasons for the reduction are less evident than in 2000.

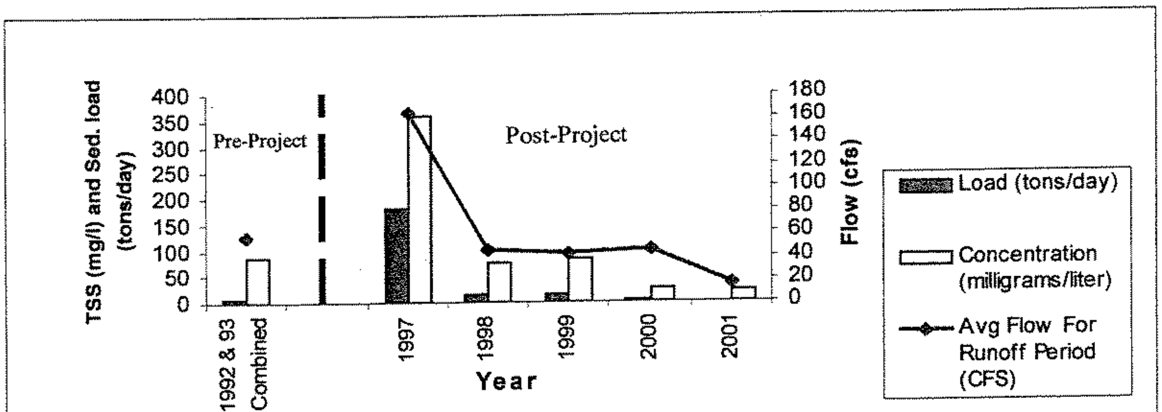

Figure 3 - Pre & Post Project Avg. TSS & Flow Values @ Lower Deep Cr. Monitoring Site

Regression analysis on the other hand has thus far been inconclusive regarding trends in sediment reduction. The slope of regression between TSS and discharge increased over pre-project levels in 1997 and 1999 and decreased in 1998 and 2000. In 2000 the slope of regression fell below the target of 0.79 for the first time since project implementation (Figure 4) . Despite falling below the target slope value in 2000 the percentage of time this target has been met thus far is still well below the project target of 80 percent or four out of five years. However, the slope has been reduced under pre-project levels in two out

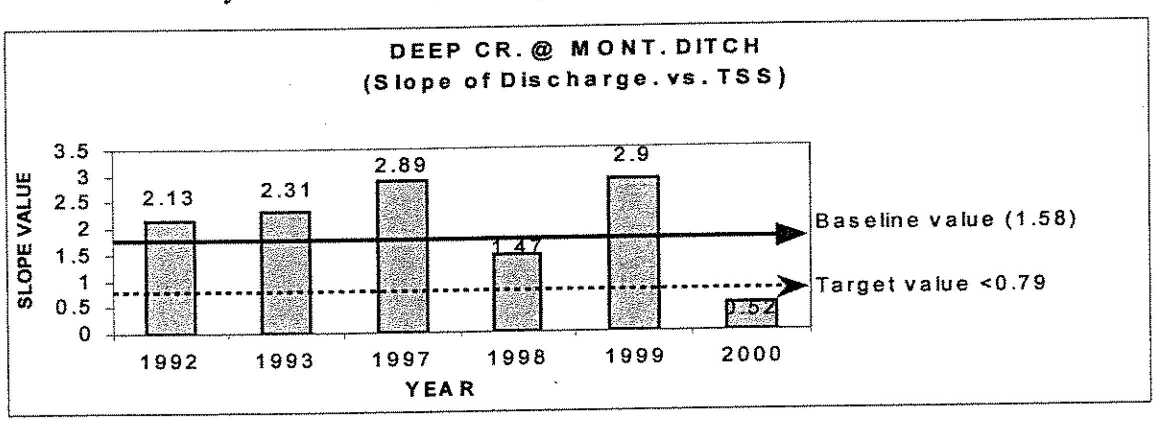

Figure 4 - Slope of Discharge vs. TSS @ Montana Ditch

of four years.

Although no project TSS targets have been set for the middle monitoring site (Clopton Lane) and the upper monitoring site (Horse Pasture), TSS has also been evaluated at these sites. The middle monitoring site at Clopton Lane separates reaches 10 and 11 from the rest of the project stream reaches below. Over fifty percent of the project channel work occurs directly above this monitoring site, therefore, this site is potentially better suited to directly evaluate project activities on TSS than the lower monitoring site located further downstream from restoration activities. In 2001 the middle and upper monitoring sites showed much greater sediment response related to erosion from the 2000 forest fire than the lower site.

Middle Monitoring Site

In general, TSS values at the middle monitoring site in 2001 continued declining trends exhibited in recent years. The exception was an extreme sediment spate documented by a TSS sample collected on July 6, 2001. This event, prompted by rainfall in the burned areas of the upper watershed resulted in a TSS concentration of 6594 mg/l. This is the highest recorded TSS concentration on Deep Creek since monitoring began in 1991. It represents an approximate 1500-fold increase in TSS concentration over the previous sample collected at this site on June 26, 2001.

While the July 6 sample was a significant indicator of fire effects in the drainage it is an extreme outlier compared to the other five samples collected at this site in 2001. Consequently this single sample was not included in TSS trend analysis at this site. Trend analysis here consists comparing annual average TSS concentration, loading and flows over the years. Weak correlation between discharge and TSS precludes meaningful regression analysis for this site.

Excluding the July 6 sample, average TSS concentration, loading and stream flow continued the downward trend exhibited at this site since 1998 (Figure 5). Average values for each of these parameters in 2001 was slightly less than 2000. Average TSS concentration values between 1998 and 2001 are below pre-project levels. Pre-project TSS loading values are unavailable. Despite a general downward trend in TSS, similar flow reductions make it is difficult to infer whether TSS reductions were related to reduced flows or upstream channel improvements. This inference will become even more difficult as fire related erosion in the upper watershed continues influence sedimentation in Deep Creek.

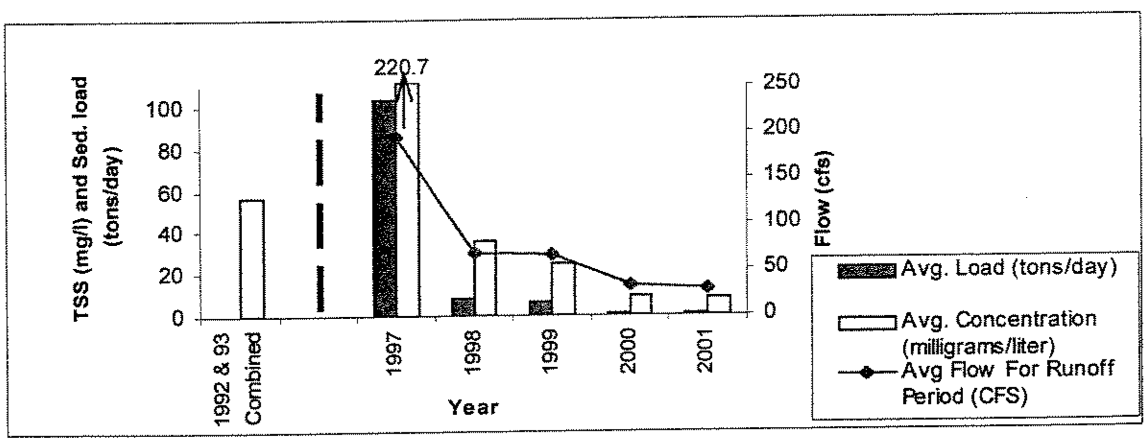

Figure 5 - Pre & Post Project Avg. TSS & Flow Values @ Middle Monitoring Site

A prelude to the effects of fire erosion was documented on July 6, 2001. This event was related to rainfall causing extreme channel erosion in Sulfur Bar Creek, a tributary to Deep Creek located upstream of all project activity. The TSS concentration on this date at the mid monitoring site equated to a sediment loading level of over 500 tons per day. Interestingly, stream flows did not significantly increase on this date.

Upper Monitoring Site

The upper monitoring site is located upstream of all project activity and serves as a control of sorts. Following the fires of 2000 this site also serves as a monitoring site located centrally in the burned upper watershed. As observed at the middle monitoring site, rainfall in the burn area prompted a significant spike in TSS concentration at the upper site on July 6, 2001. While the increase in sediment concentration was not as dramatic as the middle monitoring site, the TSS concentration of 363 mg/l was a 27-fold increase over the previous sample and much higher than any concentration recorded previously at this site. Stream flow did not increase on July 6, in fact this sediment spike occurred during the lowest flow recorded in 2001.

As with the middle monitoring site the July 6 TSS sample was extreme relative to other 2001 TSS values at this site, consequently it was considered an outlier and not used for 2001 trend analysis at the upper site. Again, due to poor correlation between discharge and TSS at this site, trend analysis consisted only of comparing annual average TSS concentration, loading and flow between years.

Unlike the lower two monitoring sites, the trend in average TSS concentration did not continue to decline in 2001 as in the previous three years at the upper site (Figure 6). Average TSS concentration in 2001 was twice to five times higher than any other year between 1998 to 2000. Average TSS concentration in 1997 (a very high water year) was higher than 2001, however, maximum TSS concentration in 2001 (excluding the outlier) was similar to 1997. Average flow during the 2001 sampling period was slightly lower than 2000 while average sediment loading was significantly higher in 2001 than 2000. No other trends in average flow or sediment loading are apparent when comparing 2001 to previous years.

The July 6 spike in TSS in the absence of increased flow combined with increase in the average TSS concentration at this site confirms the obvious effect of fire erosion on sedimentation in Deep Creek at this site.

The effects of fire erosion on water quality were clearly documented by the spike in TSS concentrations at the upper and middle monitoring sites on July 6, 2001. Although no TSS monitoring occurred after July 6, extreme grey/black colored turbidity was observed in Deep Creek on July 17, 2001. These observation

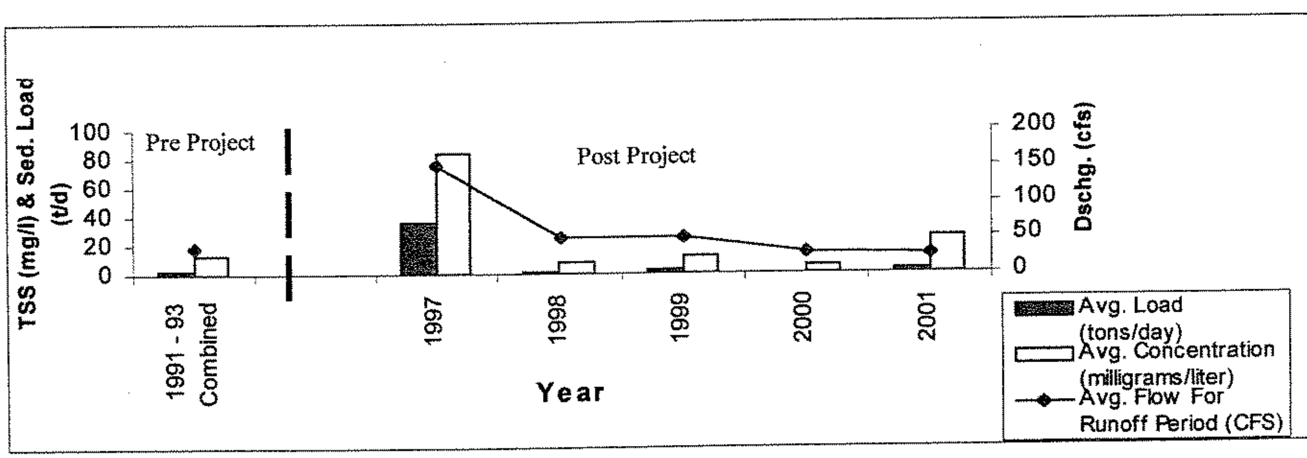

Figure 6 - Pre & Post Project Avg. TSS & Flow Values & Upper Monitoring Site

coincided with moderate to heavy rain storms in the Deep Creek area. Isolated but significant amounts of black sediment deposition on the stream bottom was also noted during cross section surveys conducted between July 17 and 20th. These conditions were much more evident in upstream reaches 6 through 11 than is Reach 3 below.

Interestingly TSS concentration did not significantly increase at the lower monitoring site on July 6. It is suspected that much of the suspended sediment load documented upstream on this date was subsequently carried out of Deep Creek via irrigation diversions before it reached the downstream monitoring site.

2) STREAM CHANNEL CROSS SECTION SURVEYS

Another important goal of this project was to reestablish proper (i.e., stable) channel morphology in many of the treated stream areas. Channel cross section surveys are used to determine if the modified channel sections remain stable over time. Seventeen permanent cross sections have been established in all but one reach of the restored stream areas. These cross sections are located to represent the individual stream reaches and a variety of the bank stabilization techniques employed on the project. Most cross sections were initially surveyed prior to the first runoff following construction. Subsequent surveys are then done annually following runoff. Cross section surveys began in 1997 on reaches 3 and 11, in 1998 on reach 10 and in 1999 on reaches 6, 7, and 8. Cross section surveys are not done on reach 9 due to the limited number of sites treated in that reach.

Analysis of survey data initially consisted of simple visual comparison of plotted cross sections from year to year to determine if the channel shape was changing. Beginning in 1999 analysis also included calculation of entrenchment (degree of channel incision relative to valley floor) channel width to depth ratios and water slopes at selected cross sections. The target for these parameters is to maintain channel morphology consistent with Rosgen C channel type. The exception to this is one cross section in Reach 3 where a Rosgen B channel type was established.

Visual comparisons of all plotted cross sections with multiple surveys generally indicate only minor changes since the cross sections were established. Changes observed on a few cross sections included outer bank steepening that appears consistent with lower bank scour to the approximate bank full elevation; minor channel incision and minor widening. Substantial sediment deposition along one bank results in a very minor change in the channel cross section in Reach 10.

Appendix B contains plots of all cross sections. It should be noted that the darkest/heaviest line on each plot represents the first or "new"channel cross section survey following restoration activity. The 1997 cross-sections are often slightly different (offset) than the other cross-sections. Some of this difference is attributable to channel changes, however, most of the difference is related to slight survey discrepancies between 1997 and subsequent years. Figure 6 represents differences influenced by both factors. ???

In 2001 entrenchment ratio, width to depth ratios and slopes were calculated for 14 of 16 surveyed channel cross sections. Of these 14 cross sections eight or 57 percent fell within the ranges expected for the restored channel types. The exceptions occurred in reaches 3 (X-S L3&L4), 6 (X-S 1), 7 (X-S 2) and 8 (X-S 1 & 2). Reach 11 cross section D6, the exception noted in 1999 and 2000 was not included in 2000. Of the cross sections analyzed in 1999 and 2000, 92 percent and 85 percent respectively fell within the expected ranges for restored channel types. 2001 represents a substantial reduction in cross sections of meeting the criteria expected for these parameters.

Entrenchment ratio was the criteria most commonly "off" in 2001. In all cases where the entrenchment ratio was off it fell into a lower range than would be expected. A lower entrenchment ratio indicates that the channel is more incised into the flood plain. In one case (Reach 8 X-S 3) the width:depth ratio was higher than it should be indicating that the channel may be wider and shallower than desirable. There was also one instance (Reach 3 X-S L3) where the channel slope is flatter than desirable. Minor deposition is beginning to occur at the site.

Most of the changes in channel morphology occurring in 2001 are based on changes in calculations rather than actual physical channel changes. There has been no significant runoff, or, other than beaver dams, no major channel changing events for four years on Deep Creek. The physical channel surveys verify this. The changes in calculated channel morphology, mostly entrenchment ratios, are related to discrepancies in estimated bankfull (BF) elevations between 2001 and past years. In five of six cross-sections exhibiting reduced entrenchment ratios, field determined BF elevations were less in 2001 than in previous years.

The discrepancies in estimating BF elevations are related continued lack of "normal" runoff flow and subsequent vegetational encroachment into the stream channel due to lack scouring stream flows. Because channel dimensions at most cross section was significantly modified during restoration most bank full indicators have evolved in the last four years. Since this evolution has occurred only during very low runoff years true bank full flow events (i.e., ≈1.5 yr. return interval) and associated field indicators are not present.

Deep back water pools created by numerous beaver dams on Deep Creek have and will continue to necessitate occasional cross section alterations. Thus far one cross section has been abandoned and relocated and several others are threatened due to beaver activity. In 2001 beaver dams caused backwater at five cross sections in reaches 10 and 11. Cross section D1 in reach 11 was unmeasurable in 2001 due excessive water depth caused by beaver ponding.

3) PHOTO POINTS

Photo points provide consistent annual photo documentation to visually evaluate the success of restoration activities in maintaining stable channel and banks and reestablishing riparian vegetation. While other monitoring parameters evaluate channel and bank stability, this is the only project monitoring technique applied to vegetation. Other than photo documentation depicting relative degree of restoration success, no specific targets have been established for photo points.

A total of ten documented photo points were established in reaches 3, 8, and 11 plus each of the 17 permanent channel cross sections also serve as photo points. Photos are taken annually when cross sections are surveyed. Photos were taken during early spring (March) and late fall (Oct. -Dec.) in 1997 and 1998 and during July in 1999, 2000 and 2001. See Appendix C for examples of project photos.

In 2001 photo points continued to generally depict stable channel and banks and mixed success of revegetation efforts. Bank erosion and channel deposition are evident at several photos points, however, this condition is not prevalent throughout the project area (see Bank Erosion Inventory discussion below).
Initial photos plus observations of vegetation in 1997 and 1998 indicated that grass and shrub take was fair to poor with many sites dominated by weeds. It should be noted however, that photos were taken when plants were dormant in each of those years.

Photos/observations taken during the growing season in 1999 and 2000 indicated a better vegetational take and ground cover than 1998. Although there were still a lot of weeds on treated banks it appears that desirable vegetation was beginning to compete with the weeds. In 2000 vegetative colonization of gravel point bars was particularly evident. Also in 2000, vegetation on stream banks, especially within the juniper revetments, appeared thicker and more vigorous, than in past years.

Dry weather patterns and vegetational trends observed in 2000 generally continued into 2001. In the continued absence of scouring stream flows and a reduction in grazing, vegetation establishment on gravel bars appeared to improve for both weeds and desirable vegetation such as grass and willow. In places where the grass and shrub component is particularly thick the vegetation is beginning to encroach on the design channel width. Desirable vegetation on stream banks is holding its own but weeds still dominate many of the upper banks and bank tops. With one exception, it appeared that landowner compliance with grazing exclusions along the stream corridor improved in 2001. Where grazing pressure was reduced vegetation appeared to respond favorably and look better than in 2000. In areas where grazing had little or no influence on stream side vegetation no obvious improvement in vegetation was observed. It is likely that extended drought continues to have a negative effect on vegetation establishment in the project area. Another factor influencing stream bank vegetation particularly in reaches 10 and 11 is beaver dams. Moisture wicking into the upper banks behind beaver ponds has helped the herbaceous vegetation higher on the banks, but continuous inundation of the lower banks has drowned many shrubs out.

Cursory sprig and shrub transplant survival counts conducted in 2001 revealed a sprig survival rate of 12 to 50 percent. Transplant survival was better at 46 to 69 percent. When compared to 2000, sprig survival decreased and transplant survival remained about the same. Leader growth on planted shrubs was not evaluated in 2001 however, as much as 6 to 7 feet of leader growth was observed on well established sprigs planted in Reach 11 in 1997. Shrub survival rates are summarized in Table 2.

Table 2. Shrub Survival Trends on Deep Creek

	2000	2001
Sprig Survival Rate (Range.)	53% (30 - 67%)	31% (12 - 50%)
Transplant Survival Rate (Range.)	67%	58% (46 - 69%)

4) PEBBLE COUNTS

The purpose of this monitoring parameter is to track changes in channel bottom material and determine if it remains consistent with a Rosgen gravel bottom channel type (e.g., C4) which covers the majority stream work completed on Deep Creek. Gravel particles range from approximately 0.1" dia (3mm) to 2.5" dia (64mm). Sand and silt falls below and cobble and boulder above these size ranges. The target for this parameter is to maintain a particle size distribution consistent with a Rosgen C4 (gravel bottom) channel type.

Channel substrate size directly reflects habitat suitability for aquatic organisms, and indirectly reflects channel stability characteristics. For example, changes in substrate toward finer particles may be indicative of excessive aggradation (deposition) and shifts toward larger material could reflect scour or channel incision. Substrate dominated by gravel material greater than 1/4" diameter (approx. 6mm) provides the best habitat for trout spawning and larger gravel and cobble size material provide nooks and crannies necessary macroinvertebrates (bugs) and rearing of trout fry.

A total of nine pebble count sites are currently established in the treated reaches of Deep Creek. With the exception of Reach 9, there are one or two sites located at existing cross section in each reach. Like cross sections, pebble counts were generally conducted prior to the first runoff following construction and then annually following runoff. Pebble counts began in 1997 on reaches 3 and 11, 1998 on reach 10 and 1999 in reaches 6, 7, and 8.

Medium to course gravels have and continue to dominate the channel bottom substrate in Deep Creek. Between 1997 and 1998 pebble counts in reach 3 revealed a minor shift toward smaller gravel, possibly due to increased deposition related to erosion from extreme flows during the 1997 runoff. Pebble counts conducted in 1999 indicated a slight increase in gravel size and were very consistent to sizes found in 1997. In 2000 gravel size continued to increase slightly over previous years.

With the exception of Reach 3 the gravel size on the stream bottom continued to increased in 2001. At these sites coarse to very coarse gravel dominates. In Reach 3 the diameter of the channel bottom material decreased but stayed in the medium to coarse gravel size. At cross-section L3 in Reach 3 finer substrate material in the "very fine gravel/sand" categories became much more common than in past years. Aquatic plant growth is common in cross-section L3. This plant growth is trapping silt/sand size materials and appears to be the reason fine sediment is increasing at this site. Figure 7 summarizes trends in stream bottom substrate composition relative to the median particle size diameter (D-50).

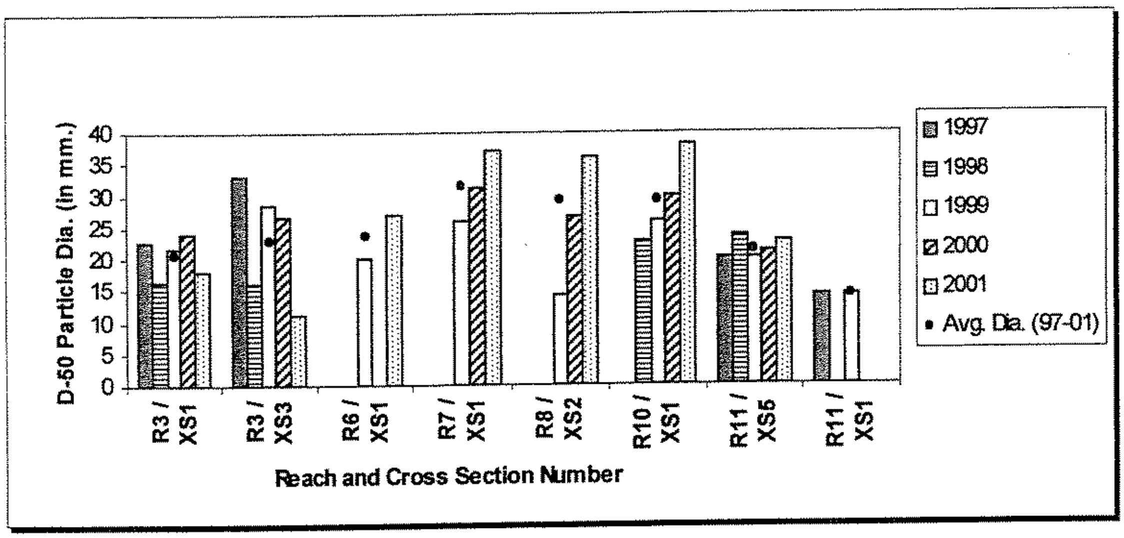

Figure 7 - Deep Creek Substrate Trend (1997-2001)

5) BANK EROSION

This parameter involves post restoration evaluation of all treated stream banks. The target for reduction of eroding stream banks in Deep Creek project area is 50 percent of pre-project levels as determined during a 1996 inventory. This figure applies to area of eroding bank rather than lineal distance. Project restoration activities treated 62 percent of the pre-project eroding bank area.

Since 1999 bank erosion monitoring has been conducted at all project sites to determine the success of restoration efforts in long term stabilization of eroding banks. Monitoring consists of visual assessment of all treated banks to identify and quantify areas of new erosion. Potential causes of and solutions for erosion problems are also evaluated.

Figure 8 illustrates trends in bank erosion on treated reaches since the inception of this project. In this figure 1996 represent pre-project conditions and 1998 represent the reduction in eroding bank area as a result of all project channel restoration activity. Erosion levels beginning in 1999 track any erosion damage that has occurred to treated sites.

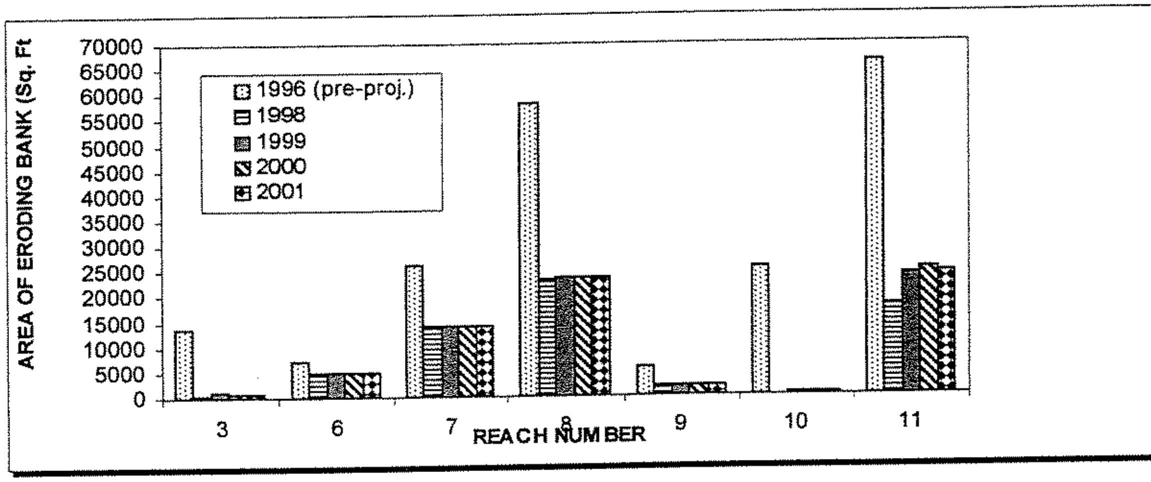

Figure 8 - Deep Cr. Bank Erosion Trends 1996 - 2001 (Treated Reaches Only)

In 2001 bank erosion followed similar trends to 1999 and 2000 in that very little new bank erosion was observed. Three new eroding sites were added in 2001 to bring the total to 49. This figure indicates that some level of erosion is occurring at 28 percent of the 146 sites originally treated. The average size of eroding bank increased slightly in 2001 because the average height increased. Although the amount of eroding bank increased slightly in 2001, total eroding bank on Deep Creek remains at 59% less than pre-project levels. This figure well exceeds the project target of a 50 percent reduction in eroding bank. Table 3 provides a summary review of stream bank inventories conducted since 1999.

Table 3 - Summary of Bank Erosion Inventories	1999	2000	2001
Number/Percentage of Treated Banks Exhibiting Erosion	44 sites/23%	46 sites/26%	49 sites/28%
Percentage of Area Treated Exhibiting Erosion	5%	6%	5.5%
Average Size Eroding Bank (Length x Height)	30'x 3'	23.6'x 3.1'	22'x3.8'
Number of sites with high priority for maintenance	8	7	7
Percent reduction of Eroding Bank over PreProject levels	59%	59%	59%

While the average height of eroding banks increased slightly in 2001 the average length was reduced. Banks heights increased primarily due to sloughing on banks that were over- hanging in the past. Colonization of bank toes by vegetation contributed to the decreased length of erosion observed in 2001. Seven of the 49 sites exhibiting erosion are at risk of failure and are considered high priority for maintence/repair. Half of these sites occur in Reach 11. When compared to 2000 there was a 3 percent reduction in eroding bank in Reach 11 and a 4 percent increase in erosion in Reach 3 in 2001. Eroding bank area in all other reaches remained the same.

Types and locations of bank erosion 2001 remained consistent with past years. Erosion was present on some of the revetted stream banks, but was generally limited to minor undercutting to the bankfull elevation or confined to small areas where the revetments had washed away. Physical livestock damage, stream flow around beaver dams and bank saturation around beaver ponds also contributed to bank erosion to a limited extent. Livestock damage was less in 2001 than in past years.

Beaver ponds continue to effect the ability to see many banks on Deep Creek. This was particularly true in reaches 10 and 11 where nearly 50 percent of the treated sites are influenced by beaver ponds. In cases where it was impossible to see the banks in 2001, information collected in 2000 was carried forward.

6) WATER TEMPERATURE

Monitoring conducted in the early 1990's indicated that summer stream temperatures in Deep Creek often exceeded the tolerance threshold for trout of 73° F. This was particularly true in some of the lower dewatered reaches of Deep Creek. Project tasks that addressed this issue were improved irrigation and riparian management. A target of maximum daily temperatures of 73° F for no more than ten days in four out or five years has been established for Deep Creek. Annual daily temperature monitoring occurs near the mouth of Deep Creek (Montana Ditch), just above the Broadwater-Missouri (B-M) Canal (between reaches 4 & 5) and at Clopton Lane (between reaches 9 & 10). The summer of 1997 was cool and wet so temperature monitoring was not conducted. Annual automated daily temperature monitoring began in 1998 and results are summarized in figures 9, 10, 11.

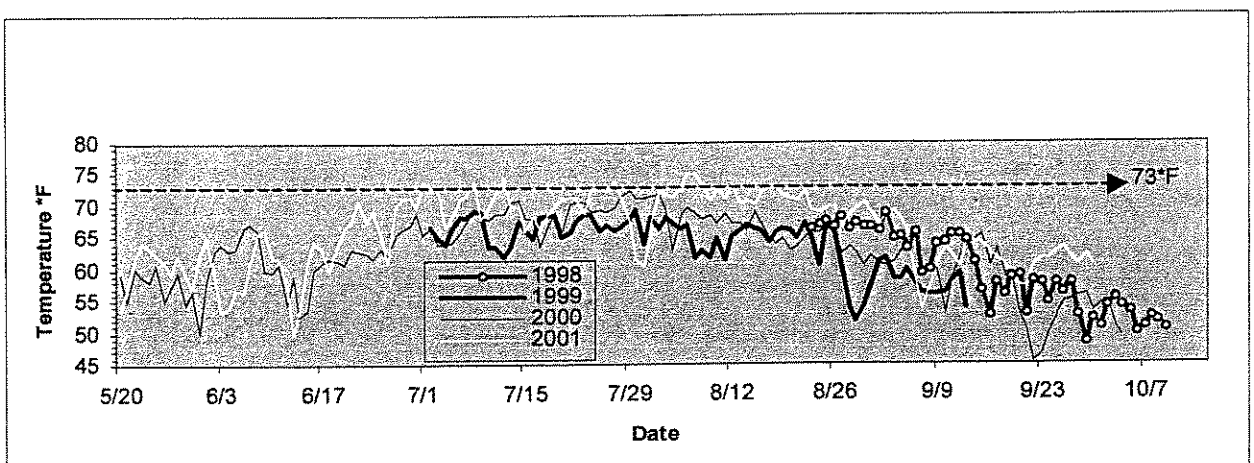

Figure 9 - Deep Creek @ Clopton Lane; water temperatures 1998-2001

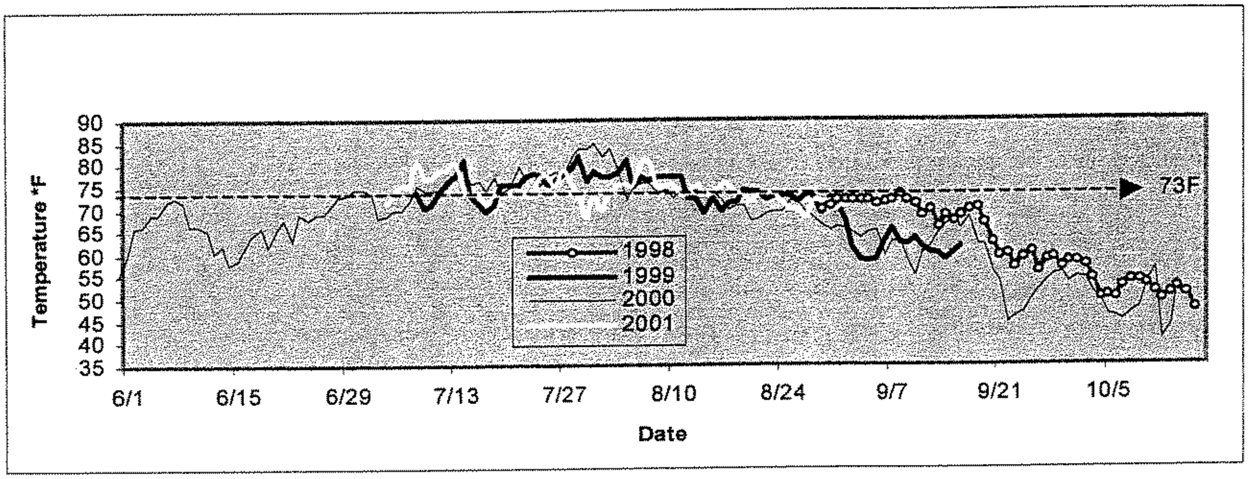

Figure 10 - Deep Creek Near Montana Ditch; water temperatures 1998-2001

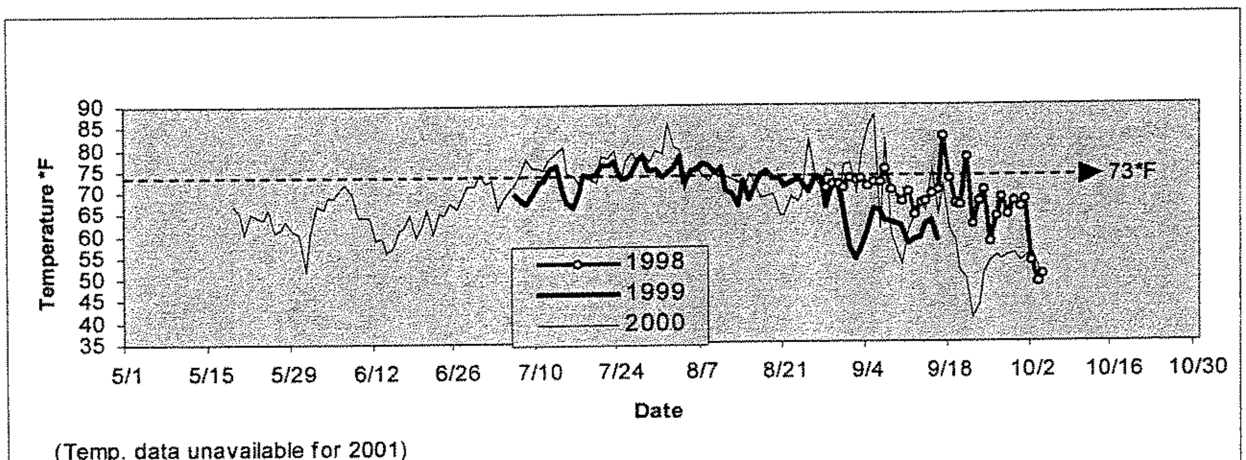

Figure 11 - Deep Creek Near Broadwater/Missouri Ditch; water temperatures 1998-2001

Between 1998 and 2000 low stream flows and dry, warm weather adversely influenced water temperatures in lower Deep Creek. Water temperature targets were greatly exceeded in 1999 and 2000 at the Montana Ditch and B-M Canal sites. It is suspected that targets were exceeded at these two sites in 1998 also, however there were not enough data to verify it. The water temperature target was not exceeded at the Clopton Lane monitoring site during this three year period. Maximum documented water temperatures for the 1998 to 2000 period were 84.7 at Montana Ditch and 87.2 and the B-M Canal site. Both occurred during 2000. Flow data corresponding to maximum water temperatures are limited during this period, however, the available data do not necessarily corroborate that maximum temperatures occurred during minimum flows.

Hot, dry weather and low flows persisted into the summer of 2001. Stream temperatures reflected this and project targets were exceeded again in 2001 at the Montana Ditch and Clopton Lane sites. Temperature monitoring data for the B-M Canal was unavailable for this report.

At the Montana Ditch site temperature monitoring began on July 4. During the period of July 5 through August 23 the 73° F temperature threshold was exceeded on approximately 50 days. Water temperature stayed below the threshold from August 24 until monitoring ended on September 5. The maximum water temperature for this period was 80.6° F. This high occurred on three separate occasions (7/17, 8/6, 8/7). The average maximum temperature for this period was 74° F. As illustrated in Figure 12 there was a general trend toward increased water temperatures during periods of low flow, however, there were a number of exception to this. For example maximum and minimum water temperatures for 2001 occurred as flow steadily dropped between July 19 and August 20.

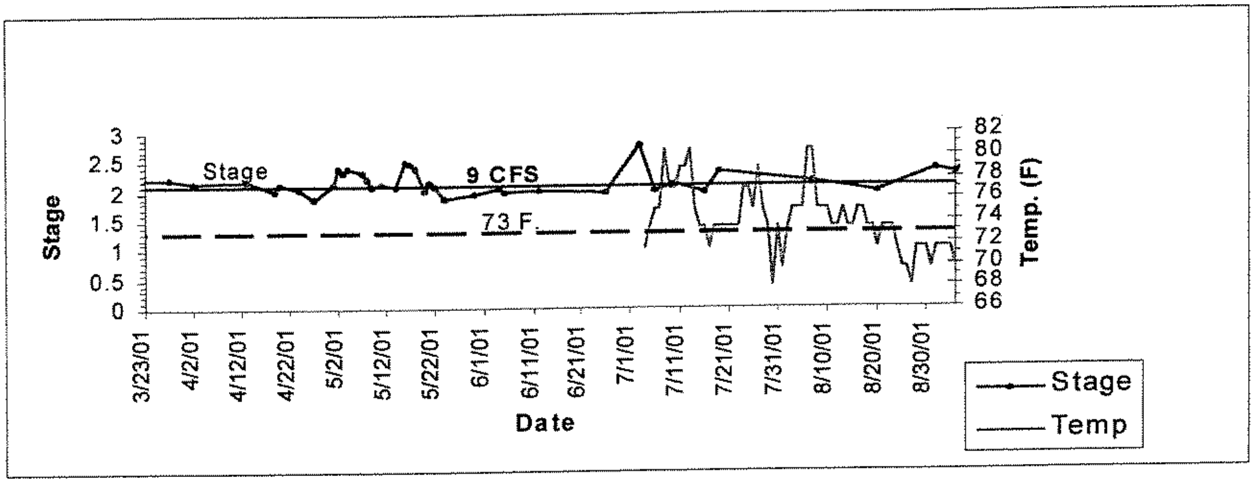

Figure 12 - Temperature & Discharge near Montana Ditch 2001

Temperature monitoring began at Clopton Lane in late May and continued until the end of September. For the first time since monitoring began in 1998 water temperature exceed the 73°F threshold at Clopton Lane. Between July 1 and August 18 the temperature threshold was exceed on 14 days. The maximum temperature at this site was 75.1°F on August 18. Average daily maximum temperature for the time period was 66.1°F. There was a better relationship between increased water temperature and decreased flow at this site than there was at the Montana Ditch.

7) STREAM DISCHARGE

This parameter focuses on summertime low flow. Similar to excessive stream temperatures, monitoring in the early 1990's identified stream dewatering as a concern to fisheries in portions of Deep Creek below Clopton Lane. Voluntary water releases out of the Broadwater-Missouri Canal have greatly improved flows in the lower four reaches of Deep Creek. It is anticipated that other project irrigation improvements will reduce dewatering concerns in reaches 5 through 9. Minimum flow targets of 9 cubic feet per second (cfs) have been established in reaches 1 through 4,10 and 11, and 3 cfs in reaches 5 through 9.

The Deep Creek Monitoring Plan calls for weekly stream flow monitoring at the same sites where temperature monitoring occurs (above Montana Ditch, above B-M Canal and at Clopton Lane). To date summertime low flow monitoring has generally been limited and sporadic on Deep Creek. Due to an abundance of water, flow monitoring was not conducted during the late summer of 1997. Figures 13, 14, 15 summarizes 1998 through 2001 stream stage information relative to the target flow for each monitoring site.

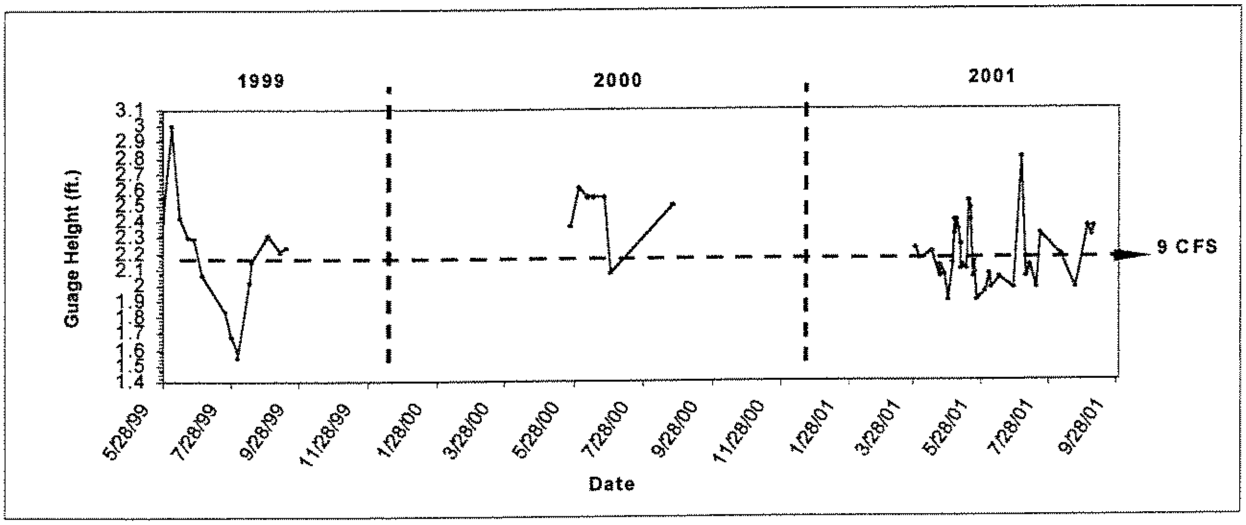

Figure 13 - Staff Guage Heights Near Montana Ditch (1999 - 2001)

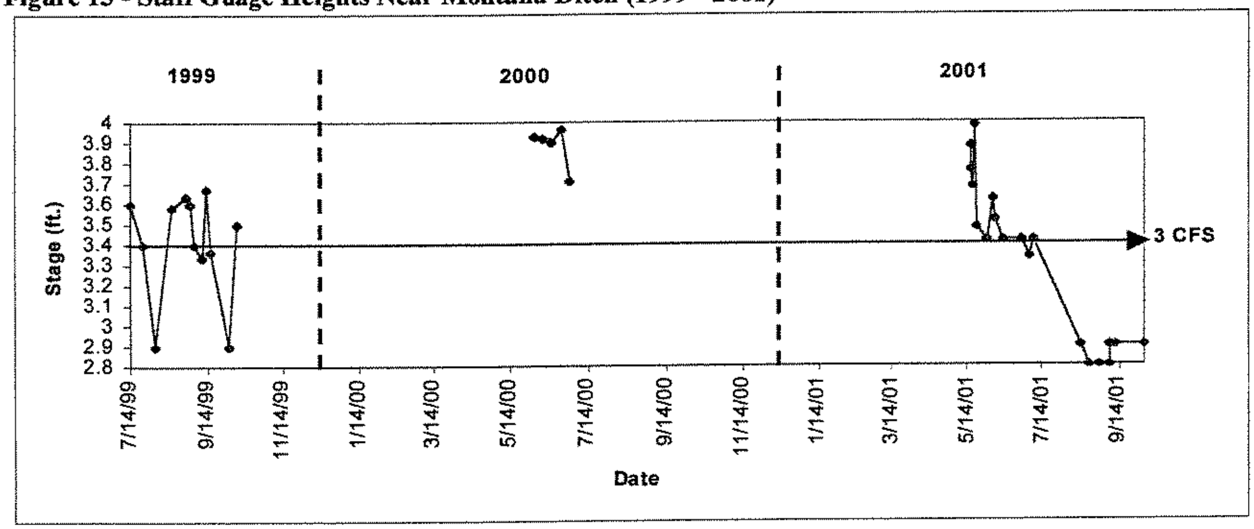

Figure 14 - Staff Guage Heights Near B-M Canal (1999-2001)

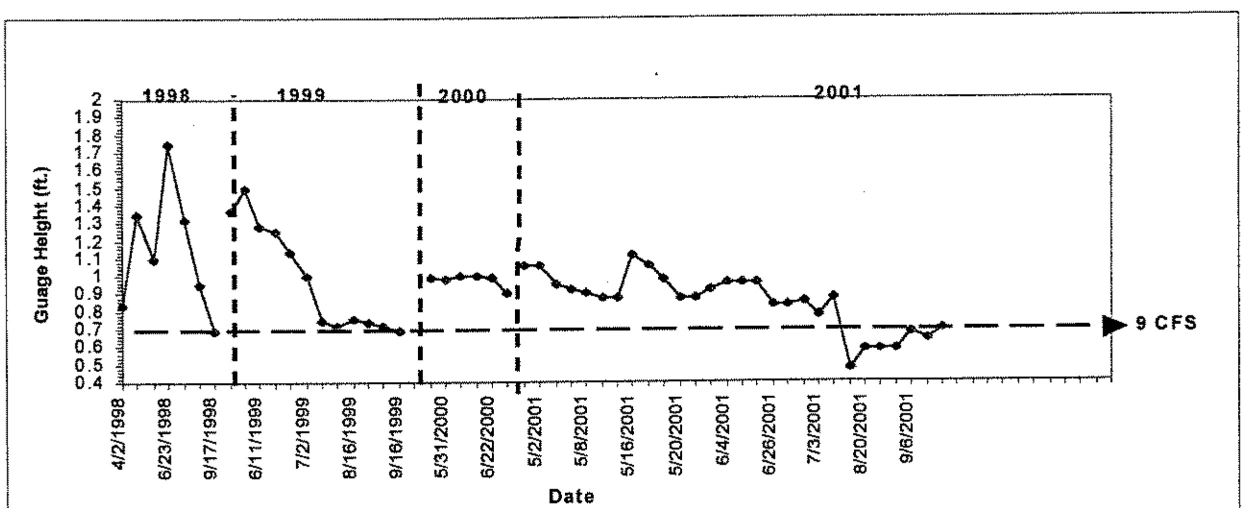

Figure 15 - Staff Guage Heights Near Clopton Lane (1999-2001)

Based on the available data in 1998, minimum stream flows went the below the project target of 9 cfs for eight days in July at the Montana Ditch site and for an estimated 30 days beginning in mid August at the Clopton site. Flow data for the B-M Canal Site were unavailable for 1998. Stream flow data increased in 1999 as did the incidence of flows below minimum targets. In 1999 it is estimated that stream flow went below the project target for 27 days at the Montana Ditch site, 60 days at the Clopton Lane site and for 54 days at the B-M Canal site. Low flow data was almost non existent in 2000. Casual observations plus one stage readings that occurred after June 30 suggest that dewatering was not a problem at the Montana Ditch site. Based on one stage reading obtained at the B-M Canal site, stream flow dropped below the minimum target of 3 CFS in late September of 2000.

Stream discharge monitoring improved again in 2001. The drought influence on flows in Deep Creek was particularly evident in 2001. Stream flows began to diminish in early spring and portions of the stream went dry during the summer.

At the Montana Ditch monitoring site stream flow went below the minimum target for 70 days through the period of April 17 to approximately August 23. Flows were up and down during this period and the longest continuous stretch below target was 33 days between May 23 and June 24. A maximum flow of 115 cfs occurred at this site on July 3 and was probably associated with a rainstorm. The minimum recorded flow was 4.1 cfs on July 16. September stage readings indicate that adequate flows were maintained at this site after August 23.

Stream flow at the B-M Canal site dropped below the minimum target of 3cfs on approximately July 7 and is presumed to have stayed there for 89 days until the last stage reading on October 3. It should be noted the starting date of minimum flow at this site was extrapolated from the plotted data. There was a 37 day gap in stage readings between July 7 and August 12 therefore it is possible that minimum flows began later than estimated. **Minimum flow at this site was zero and occurred for a period of 17 days between August 20 and September 5.** The estimated maximum flow for 2001 at this site was 14.5cfs.

As with the B-M Canal site there is a 25 day data gap at the Clopton site between July 17 and August 12. Flows are estimated to have dropped below the 9cfs target on approximately July 18 and remained below the target for 77 days until the last stage reading on October 3, 2000. Based on staff readings the estimated minimum discharge for this site was <1cfs on August 13. The maximum discharge was 50.4 cfs on May 16.

Since the last recorded stage on October 3 was below the minimum for the B-M Canal and Clopton sites it is assumed that minimum flows continued for some time afer that date.

8) MACROINVERTEBRATES

Macroinvertebrates are insects that live in the stream. Population characteristics of these organisms can provide clues to impacts occurring in a stream. Aquatic biological health of Deep Creek was evaluated in 1991, 1992 and 1996 using EPA Rapid Bioassessment Protocols (RBP) for macroinvertebrates. These pre-project monitoring results indicated slight to moderate impairment particularly in the lower reach of Deep Creek.

To evaluate the effects of project restoration efforts on the biotic health of Deep Creek, macroinvertebrate sampling using RBP methodology has continued at three previously sampled locations (**a.** at Hahn's near the confluence with the Missouri River, **b.** above the Broadwater Missouri Canal, and **c.** in reach 11 above Lippert Gulch). A project target of "not/least impaired" as determined by the aquatic life support decision criteria developed by Montana Department of Environmental Quality (MDEQ) is used for macroinvertebrates. Aquatic impairment values are determined by comparing biotic conditions at the sample sites to best or reference conditions within Deep Creek or outside of the drainage but within the same ecological region. A biological integrity (biointegrity) score of 75 percent or more of the references is considered "not impaired".

Macroinvertebrate samples were last collected from Deep Creek in August of 1999. This was the first sample collected since implementation restoration work. Biointegrity scores from 1999 indicated Deep Creek was moderately impaired (e.g., partially supporting aquatic uses) at the Hahn (lower) site and Broadwater-Missouri Canal (middle) site and not impaired at the Lippert Gulch (upper) site. Based on species composition in the samples, dewatering and sediment deposition were identified as potential stressors to the macroinvertebrates.

Sample analysis and reporting in 1999 was completed by a subcontractor hired by the MDEQ. That report is contained in Appendix B of the Deep Creek Watershed and Spawning Enhancement 2000 Project Monitoring Report available through the Broadwater Conservation District.

Macroinvertebrate monitoring was not conducted in 2000 or 2001. The next sampling is scheduled for the summer of 2002.

9) FISH

The primary driving force of the Deep Creek restoration project is spawning enhancement for migratory trout. Annual migratory rainbow trout trapping has been conducted by the Montana Department of Fish, Wildlife and Parks since 1991 near the mouth of Deep Creek. Number of female rainbow trout captured at the trap is the only biological component specifically listed as a target in the Deep Creek TMDL Consequently, fish monitoring is an important component of this monitoring plan.

The target for this parameter is 3000 female rainbow trout captured annually at the trap within ten years of implementation of restoration activities (2008). This number is based on a doubling of the approximate pre-project migrant trout numbers.

Trends in annual migrant rainbows numbers in Deep Creek have been mixed since project implementation began in 1996 (Figure 16).

Since trapping began in 1993, the first and third highest number of trout through the trap occurred after project implementation in 1998 and 1997 respectively. Following 1998 however, rainbow trout numbers came down to the sixth lowest in 2000 and seventh lowest in 1999 recorded in eight years of trapping. Rainbow trout trapped in 2001 continued to decline to the eighth lowest number of fish in now nine years of trapping. Based on the last three years of trapping (99 - 01) there is a downward trend in rainbow numbers. However, when comparing the post to pre-project averages, the total number and total number of female rainbow trout have increased since project implementation (Table 4). This attributable to the high number of fish in 1997 and 1998.

Table 4 Average Numbers of Migrant Rainbow

Number of Rainbow Trout	Pre Project Avg. 93 - 96	Post Project Avg. 97 - 01	Average 93 - 01
Total	1572	1758	1676
Total Female	878 (56%)	1031 (59%)	963 (57%)

Any number of interrelated factors may be influencing trout numbers in Deep Creek. Some of these include sedimentation from project construction, whirling disease, fishing pressure in the Missouri River and in Canyon Ferry Reservoir, trapping efficiencies and spring runoff characteristics in Deep Creek. Of these factors, the project fisheries biologist suspects relatively low and early receding runoff may be the largest factor influencing migratory rainbow trout numbers in Deep Creek.

It appears that the majority of the 2000 forest fire related sediment in Deep Creek came out in July after rainbow would have spawned in 2001. However, it quite possible that sediment impacts from the fire may impact fish numbers in the future.

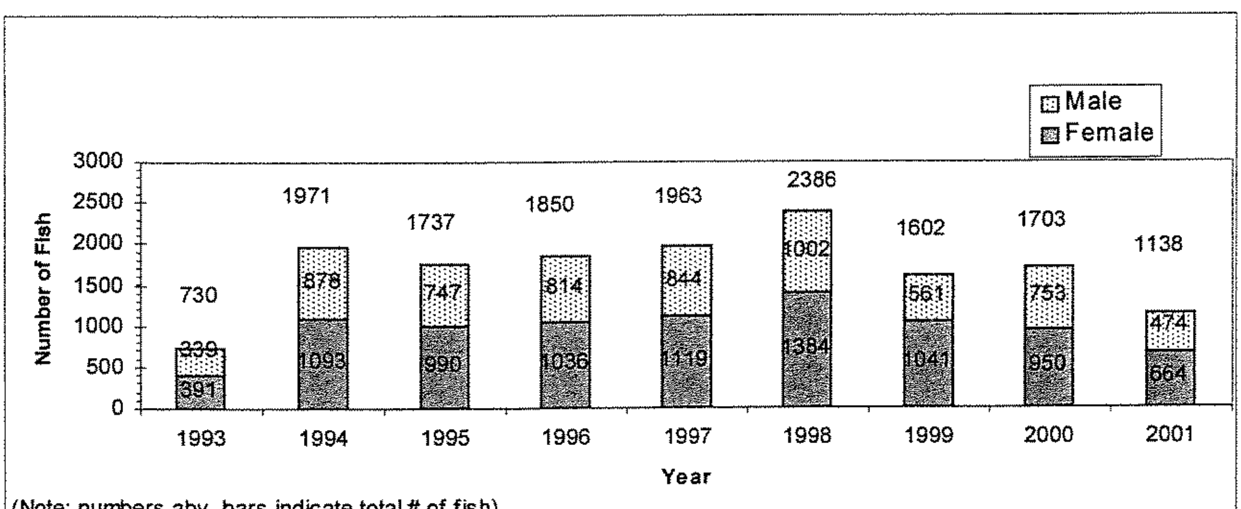

Figure 16 - Number of Rainbow Trout Caught at Trap 1993 - 2001

Brown Trout Redd Counts
Another fisheries monitoring technique that is considered an optional component of the monitoring plan is fall surveys of brown trout redds. "Redds" are basically fish spawning nests consisting of a mound of cleaned stream gravel downstream of a depression in the stream bottom. Since the majority of the restoration activities occurred in spawning areas, periodic fall redd counts may provide useful information to evaluate post-restoration trends in resident and migratory brown trout fisheries populations. Pre-project brown trout redd counts were conducted in Deep Creek in 1991 and possibly 1993. Post-project counts occurred in 1999 and 2001. Redd counts are conducted in the upper project area (reaches 10 and 11) between Clopton Lane and highway 2. The desired target for this parameter is simply an increasing trend in redd numbers over pre-project counts.

A comparison of pre-project redd counts conducted in 1991 and post-project counts conducted in 1999 and 2001 indicates a large increase in brown trout redds since restoration activities were implemented (Table 5). Redd count data for 1993 is currently unavailable. The surge in post-project redds indicates a probable increase in adult brown trout which suggests that habitat improvements implemented with this project may be helping. Another positive influence on fish numbers is the increase in rearing, holding and winter habitat offered by the numerous beaver ponds in the redd survey reach. The decline between 1999 and 2001 counts may be attributable later timing of the counts in 2001 rather than reduction in fish numbers.

Table 5 - Summary of Brown Trout Redd Counts

	Dec 1991	Nov. 1999	Nov. 2001
Number of Redds Observed	76	206	146

Electrofishing

Another fish monitoring technique sporadically applied in Deep Creek since 1992 is electrofishing. This method has established trends in catch per unit effort (number fish per 100 sec. shocking) for wild rainbow trout and brown trout at a variety of locations. Although the electrofishing trends are not identified as project fisheries monitoring targets they provide supporting information.

Electrofishing data is available for two sites on Deep Creek in 2001. These sites are below the trap near the mouth of Deep Creek and at Horse Pasture in the upper watershed. The most recent previous samples are 1999 for the near trap site and 2000 for the Horse Pasture site. When compared to 1999 rainbow and brown trout numbers dropped significantly below the trap in 2001. A drastic decline also occurred in rainbow at the Horse Pasture site in 2001. The brown trout catch was less at Horse Pasture in 2001 than 2000 but the decline was less dramatic than in rainbow.

RECOMMENDATIONS

The following recommendations are broken into two categories, management and monitoring. The recommendations are based on the most comprehensive analysis of project monitoring information to date. Many of these recommendations are basically repeats from previous years that still apply, however, new recommendations are included.

Management Recommendations

1. At present the majority of the eroding bank sites in the project area do not require repair; however, most of these sites would benefit greatly from maintenance consisting of a light overseeding of grass and additional willow sprigging. Maintenance/repair is strongly recommended at the seven high priority sites because they are subject to failure. Most of this repair could be accomplished by hand installation of juniper revetments. Table 6 identifies these high priority sites.

Table 6 High Priority Sites for Repair (Based on 2001 Inventory)

Reach Number	Site Number
3	8
7	90A, 105
8	45
11 (above Lippert Gul.)	3, 16
11 (below Lippert Gul.)	6

2. Weed infestation, noxious and other, is common throughout the Deep Creek drainage. Despite an aggressive project revegetation effort, including heavy grass seeding, ground disturbance from restoration activities has probably played a role in making the weed situation worse. Although it appears that desirable species are starting to out-compete some of the initial weed invaders, additional action is recommended to promote desirable vegetation and reduce the spread of weeds. These actions should include additional overseeding in areas where grass take is poor, active weed control where necessary and monitoring. Additional financial and technical assistance would be needed to accomplish this.

3. Due to the fragile nature of initially restored stream areas and the importance of reestablishing proper streamside vegetation, control of livestock grazing along the stream was a very critical component of the project. Exclusionary fencing was the selected control method and many miles of new fence were installed.

   Observation in 2000 indicate that the fencing had helped to improve vegetation in some areas, but there were essentially no instances where livestock was excluded from the stream as planned. In 2001 landowner compliance improved resulting in even more improvement in vegetation, however, there were still exceptions. Most notably electric fencing installed in lower Reach 10 was down and livestock had full access to the stream channel. The six restoration sites in this area were heavily grazed and trampled. Although no grazing use was observed, riparian fencing in Reach ll was still incomplete in October 2001. In Reach 8 no stock was observed inside fences, but light grazing had occurred and several gates were inadvertently left open.

If not already done, it is recommended that fencing in reach 11 be completed as soon as possible. It is also recommended that landowners exercise due diligence on fence repair and maintenance where necessary to keep stock out of the riparian areas in reaches 7, 8, 9 and 10.

4 At site one in Reach 10 moderate gullying is occurring on the upper bank of this high terrace and causing a significant amount of sediment to enter the stream. It appears that runoff from the hay field above this site is concentrating onto the poorly vegetated bank. Bank protection consisting of erosion cloth and revegetation should be installed and field runoff evaluated and controlled as necessary at this site.

Monitoring Recommendations

1. Late season flow monitoring (after ≈ July 15) has been limited and sporadic. Additional flow monitoring would improve summer/fall flow estimates and assist in correlating the relationship between water temperature and flow. A minimum of weekly flow readings should occur at the three existing monitoring sites between July 1 and October 15.

2. Summer stream flows drop significantly between the Clopton Lane sample site and the Broadwater-Missouri (B-M) canal site. Deep Creek is often substantially dewatered at the B-M canal site during the summer/fall. There are at least nine irrigation diversions (pump or ditch sites) between Clopton Lane and the B-M canal site, but it is unknown where the stream becomes significantly dewatered. In order to better understand the extent of dewatering in these reaches of Deep Creek, additional periodic flow monitoring should be implemented below Clopton Lane when irrigation is occurring. This could be accomplished with one or two reconnaissance level flow monitoring visits.

3. There is a poor correlation between TSS and discharge at the Montana Ditch monitoring site. This suggests that to the extent practical, additional sampling is needed to improve the correlation. Or if additional sampling is not practical, perhaps the project TSS target using slope of regression between TSS and Discharge is no longer valid. If this is the case additional sediment monitoring parameters and targets should be examined.

4 Erosion from burned areas in the upper Deep Creek watershed is a significant new sediment source to the stream. In 2001 TSS monitoring only documented one major spike in sediment from the fire and missed additional episodes that occurred later in the summer. Until ground cover is reestablished and erosion controlled in areas like the Sulphur Bar drainage it is probable that effects of restoration activities on sediment will be masked by sedimentation from the burn. This situation suggests two potential and very different courses of action.

First, in order to better determine the fire effects on sediment in Deep Creek additional late and possibly early season monitoring should occur. This would require more resources and extend beyond the scope of the restoration project. The second course of action is to drop project sediment monitoring and accept the possibility that fire sediment may impact the Deep Creek system for a number of years and mask any project related improvements.

5. Deep Creek has not experienced a true bankfull discharge since 1997. Consequently true bank full indicators have not developed where restoration significantly modified the original channel. This has led to underestimation of bankfull elevations which has produced morphological calculations that are inappropriate for the original ("normal" bankfull discharge) design channel. Morphology should be discontinued until such time as true bankfull flow indicators are reestablished. Annual channel cross-section surveys should suffice to determine if restored channels remain stable.

6. Based on current water temperature monitoring in Deep Creek we know that excessive temperatures generally are not as big a problem above Clopton Lane in reaches 10 and 11 as they are below. Excessive temperatures at the two sample sites below Clopton Lane suggest temperatures could be a problem from Clopton to the mouth of Deep Creek. What we don't know is how far below Clopton Lane cooler water temperatures extend, nor do we know how far the influence of periodic flow augmentation from the B-M Canal extends downstream. In order to better pinpoint thermal problems for fisheries and factors influencing water temperatures a minimum of two additional temperature monitoring sites are recommended. One site would be at the lower boundary of Reach 8 and the other site could be just above or below reach 3. An additional cost of approximately $200.00 would be required to purchase two more temperature data loggers if loaners couldn't be found..

7. Calibrated staff gauges are currently installed at four flow monitoring sites on Deep Creek. The calibration for these gauges is based on a stage - discharge relationship established for the channel cross section when flow measurements occurred. Once this relationship is established flow determinations are based on reading the water level (stage) on the staff gauge. This greatly facilitates the collection of flow data.

   Unfortunately, if channel cross sections change very much the stage-discharge relationship is no longer accurate and must be reestablished before flow can be determined from reading the staff gauge. It is recommended that flows be periodically measured at each monitoring site, particularly after channel altering events (i.e., large runoff, beaver dam construction or blow out, etc.). Currently the upper site at Horse Pasture is most vulnerable and should be checked annually. A beaver dam failure in 1998 changed this site. The Clopton Lane and B-M Canal sites are on bridge abutments and are less vulnerable, however, beaver dams above and below the Clopton site threaten the accuracy of this gauge. These sites should also be checked on an annual basis.

8. Reestablishing vegetation on streambanks is a critical component of the Deep Creek Project. Project vegetative monitoring is limited primarily to general and subjective observations. Objectivity in vegetation monitoring could be improved by adding limited quantitative measurements. One measurement that has periodically occurred is shrub/sprig survival counts. Where thick vegetation does not preclude getting a good mortality count, a couple of sprig and transplanted shrub survival counts should be conducted annually in each reach. In addition, average leader growth should be measured for sprigs to get an idea how fast living sprigs are growing.

9. Lower priority eroding stream banks that were not treated but were within the restored stream reaches where not evaluated during the bank erosion inventories nor were areas outside the restored reaches. Further evaluation of these areas could provide a useful comparison in trends of bank erosion between treated and untreated portions of the project area and should be pursued. This evaluation could be accomplished using the stream bank inventory procedure conducted on Deep Creek in 1991 and 1996. This procedure is described in the monitoring plan but listed as an optional bank monitoring parameter.

APPENDIX A

TABLE 1 DEEP CREEK MONITORING TARGETS

MONITORING PARAMATER	TARGET
TSS	Slope of TSS vs discharge ≤ 0.79 in 4 out of 5 years
Cross Section Surveys	W:D and entrenchment ratios consistent with Rosgen C channel type
Wolman Pebble Counts	Maintain substrate particle size distribution consistent with Rosgen C4 channel type
Photo Points	Banks and channel remain stable - Restored areas colonized by desirable vegetation (i.e., characteristic of natural riparian vegetation on Deep Creek)
Bank Erosion	50% reduction in total surface area as compared 1996 inventory
Stream Bank Inventory (Optional)	N/A
Water Temperature	Maximum daily water temp of 73°F $\leq$ 10 day per year, in 4 out of 5 years
Stream Discharge	Minimum 9cfs in Reaches 1-4, 10-11 minimum 3 cfs in Reaches 5-9
Macroinvertebrates	Aquatic life support = "not/least impaired" as compared to Montana Valley & Foothill Ecoregion ref..
Migrant Trout	3000 female rainbow trout captured at trap within 10 years
Fall Brown Trout Redd Counts (Optional)	Increase in redd numbers of pre-project counts

TABLE 2 DEEP CREEK MONITORING RESPONSIBILITIES AND ANNUAL COSTS

	RESPONSIBLE PARTIES			ESTIMATED ANNUAL COST[1]		
MONITORING PARAMATER	**COLLECTION**	**ANALYSIS**	**REPORTING**	**COLLECTION**	**ANALYSIS & REPORTING**	**PROJECT TOTAL**
TSS	FWP	USFS-Helena NF	BCD	N/C	$285	$285
Cross Section Surveys	BCD/NRCS	BCD	BCD	$650	$685	$1,335
Wolman Pebble Counts	BCD	BCD	BCD	$250	$485	$735
Photo Points	BCD	N/A	BCD	$250	$285	$535
Bank Erosion	BCD	BCD	BCD	$800	$385	$1,185
Stream Bank Inventory (Optional)	BCD/Volunteers	BCD	BCD	$250[2]	$535[2]	$785
Water Temperature	FWP	FWP/BCD	BCD	N/C	$385	$385
Stream Discharge	BCD/FWP/volunteers	BCD	BCD	$250	$335	$585
Macroinvertebrates	BCD/DEQ	DEQ/Contracted	DEQ/Contracted	$100[2]	$400[2]	$500
Migrant Trout	FWP	FWP	FWP	N/C	N/C	N/C
Fall Redd Counts (Optional)	FWP	FWP	FWP	N/C	N/C	N/C
					TOTAL	$6,330

Abbreviations: FWP = Montana Dept. of Fish, Wildlife & Parks, NRCS = Natural Resource Conservation Service, DEQ = Montana Department of Environmental Quality, BCD = Broadwater Conservation District

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[1]Incidental cost for supplies not included

[2]Prorated over life of project

TABLE 3 SUMMARY OF DEEP CREEK MONITORING ACTIVITIES

	RESPONSIBLE PARTIES			SAMPLE FREQUENCY BY MONTH						
MONITORING PARAMATER	TIMING	NUMBER OF SAMPLES	SAMPLING SITES	Apr	May	June	July	Aug	Sept	Oct
TSS	Annual (brackets runoff)	8-12	MD,C,HP		2 - 4	4	2 - 4			
Cross Section Surveys	Annual (after runoff) [3]	15	R3, R6, R7, R8, R9, R10, R11				X	X	X	X
Wolman Pebble Counts	Annual (after runoff) [1]	7-14	R3, R5 through 11				X	X	X	X
Photo Points	Annual	Approx. 30	R3, R5 through 11				X	X	X	
Bank Erosion	Annual (after runoff) [1]	N/A	R3, R5 through 11				X	X	X	X
Stream Bank Inventory (Optional)	Once Prior to 2003 (2001 recommended)	N/A	Project Length				X			
Water Temperature	Annual (summer/fall)	Continuous recorder	MD, BMD, C + variable			X	X	X	X	X
Stream Discharge	Annual (summer/fall)	14	BMD, C				4	4	4	2
Macroinvertebrates	Periodic 1999 & 2003 (summer)	6	MD, BMD, R11			X	X	X	X	
Migrant Trout	Annual (spring/summer)	N/A	BMD	X	X	X	X			
Fall Redd Counts (Optional)	Periodic (fall)	N/A	R7 through R11							X

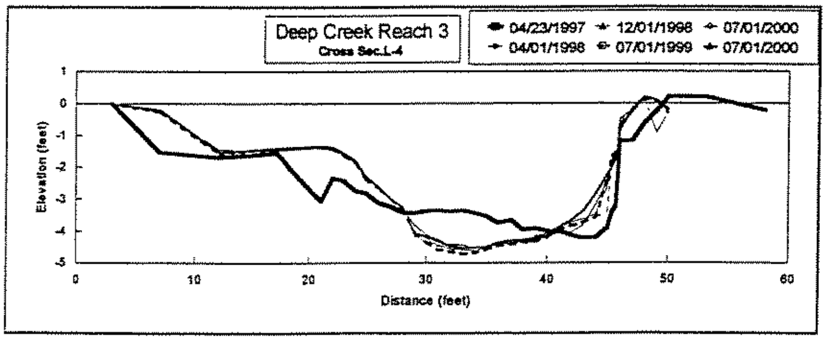
Abbreviations: MD = Montana Ditch BMD = Broadwater - Missouri Ditch R = Reach + number
C = Clopton Lane HP = Horse Pasture

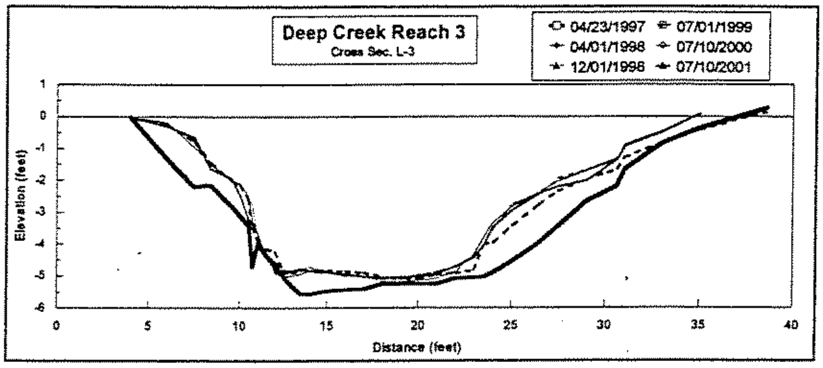
[3]Initial Monitoring will be conducted prior to first runoff following restoration. Subsequent annual monitoring will occur following runoff.

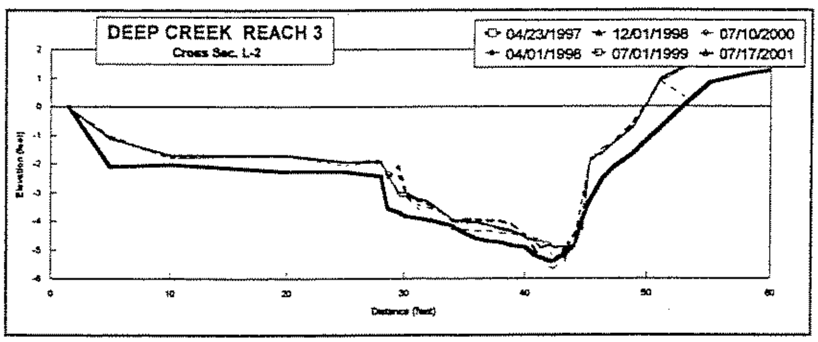
APPENDIX B

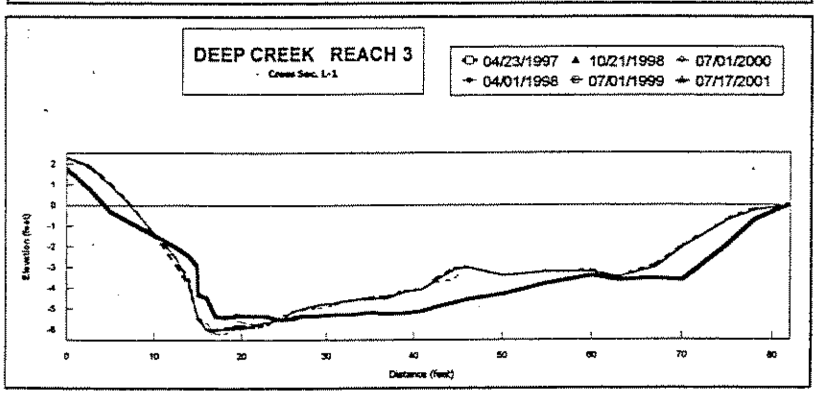
Deep Creek Cross Section Plots

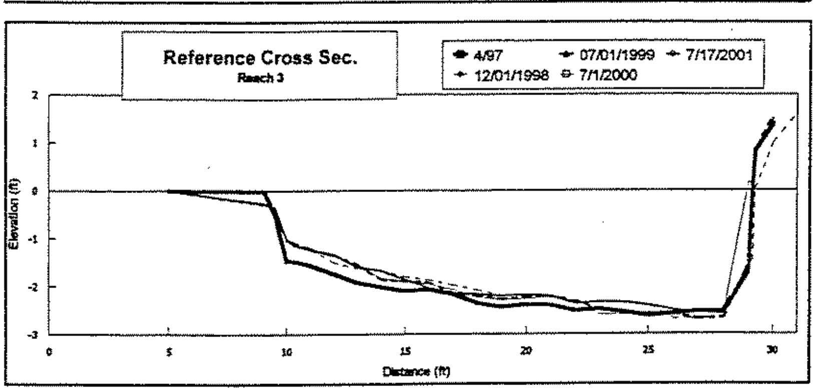
DEEP CREEK CHANNEL CROSS SECTIONS FOR REACH 3 1996 - 2001



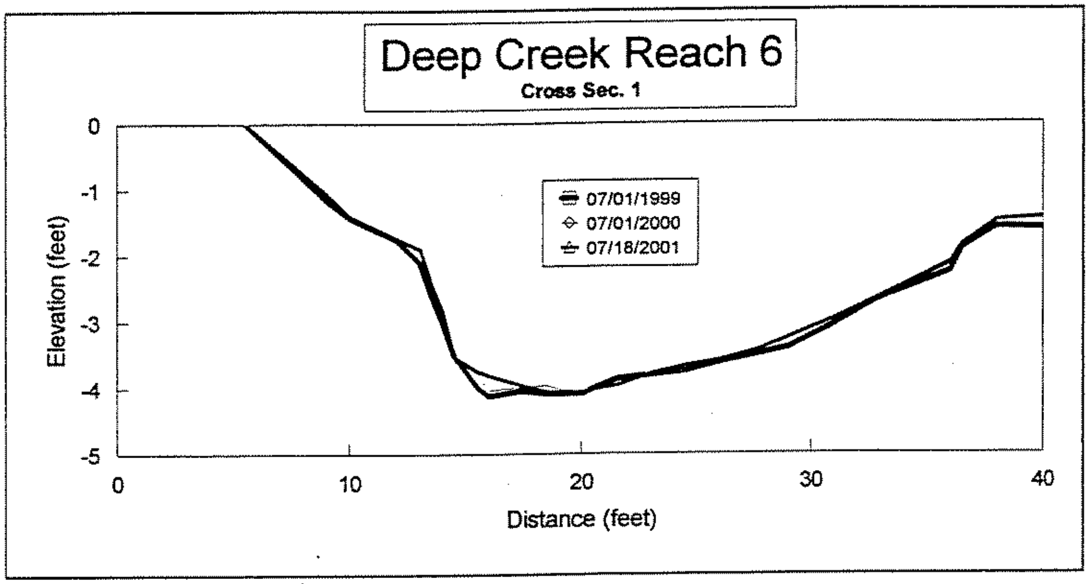


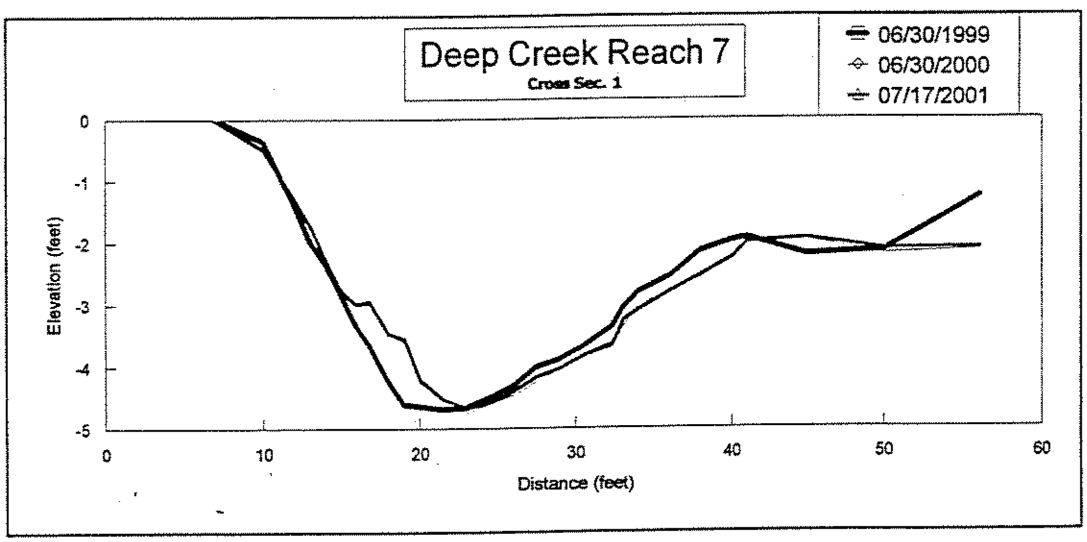


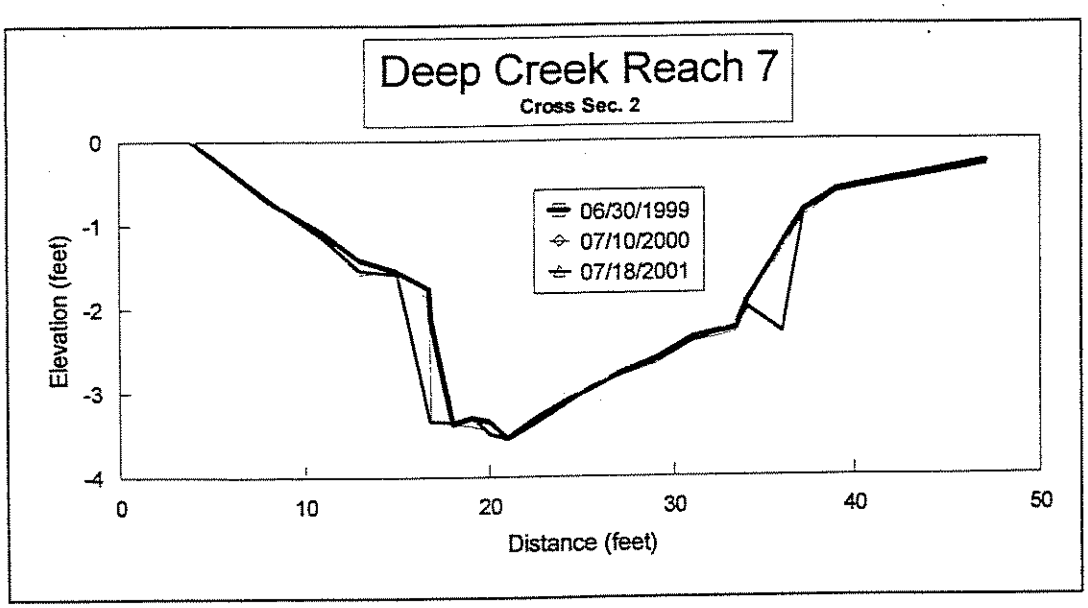




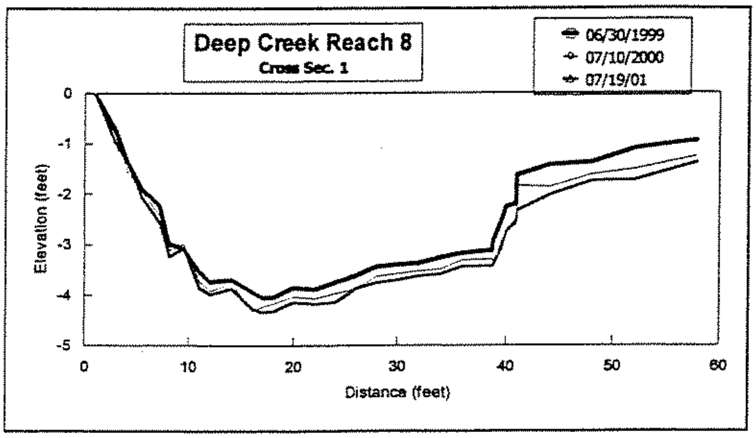
DEEP CREEK CROSS SECTIONS FOR REACHES 6 AND 7 (1998-2001)

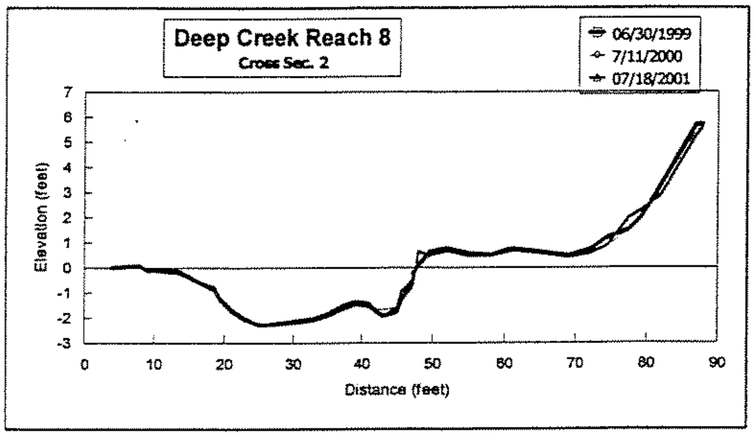


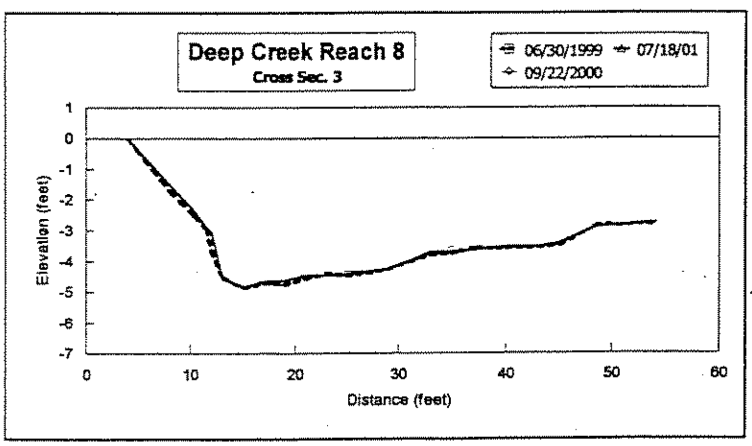


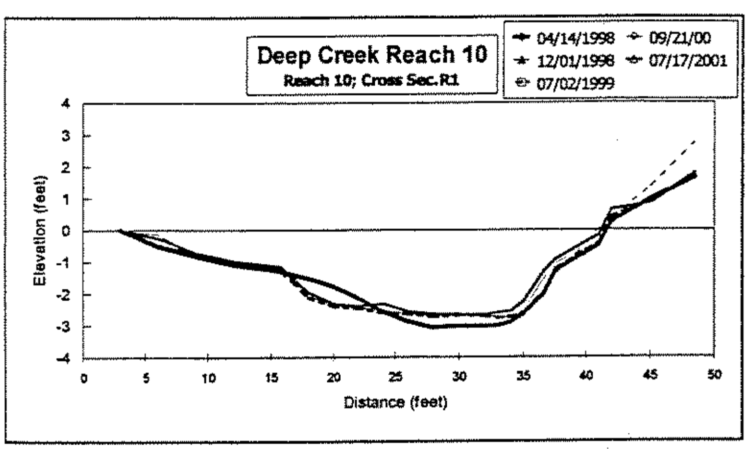


DEEP CREEK Reach 8 (1999-2001)
& Reach 10 Cross Section (1998-2001)

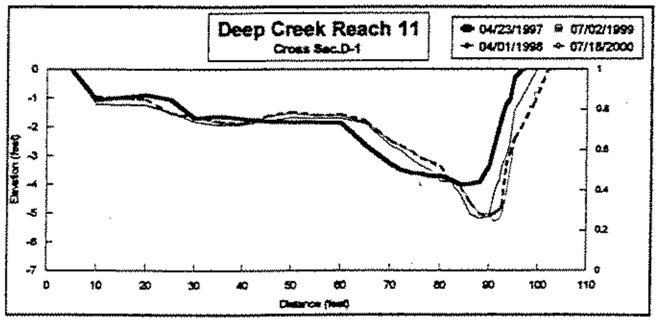


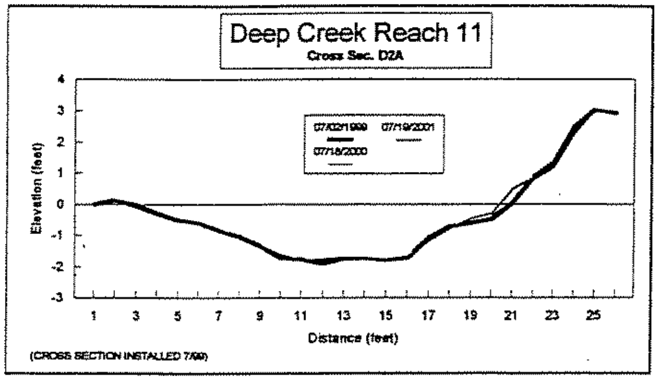


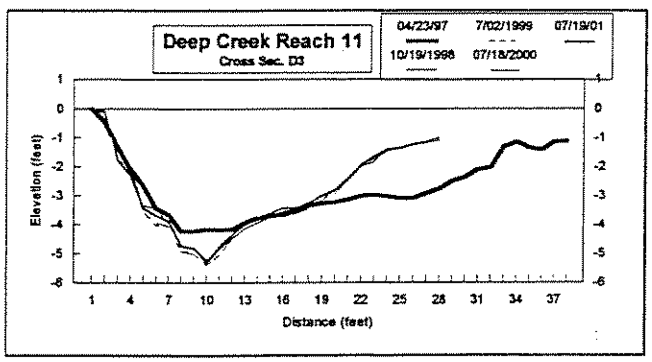


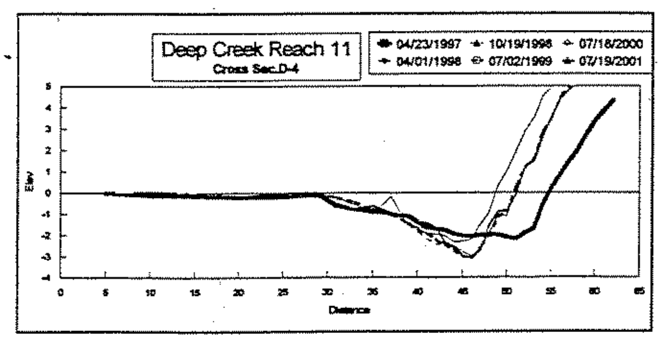


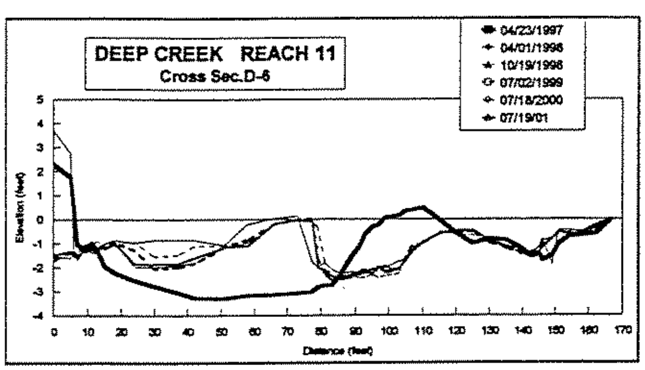
DEEP CREEK REACH 11 CROSS SECTIONS 1997 - 2001











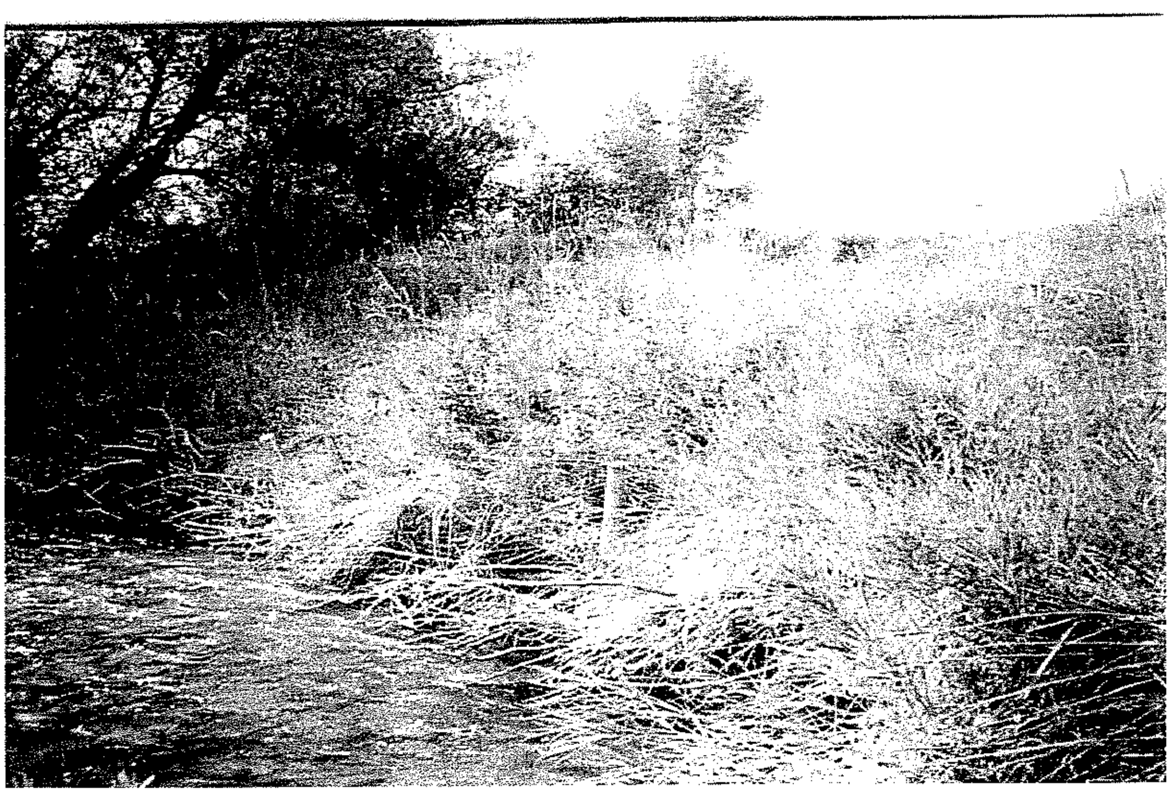
Appendix C

Project Photos

Reach 3 site 4 Sept 1996

Reach 3 site 4 10/01

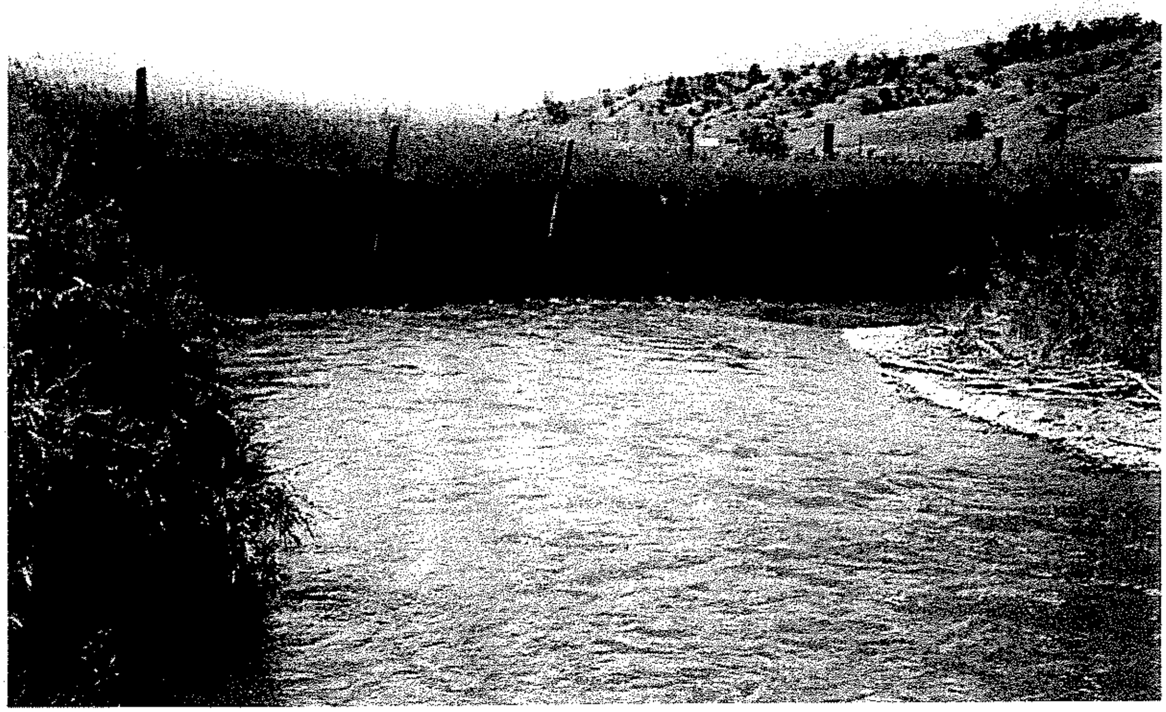
Reach 3 Site 4 Sept 1996



Reach 3 Site 4 Oct 2001

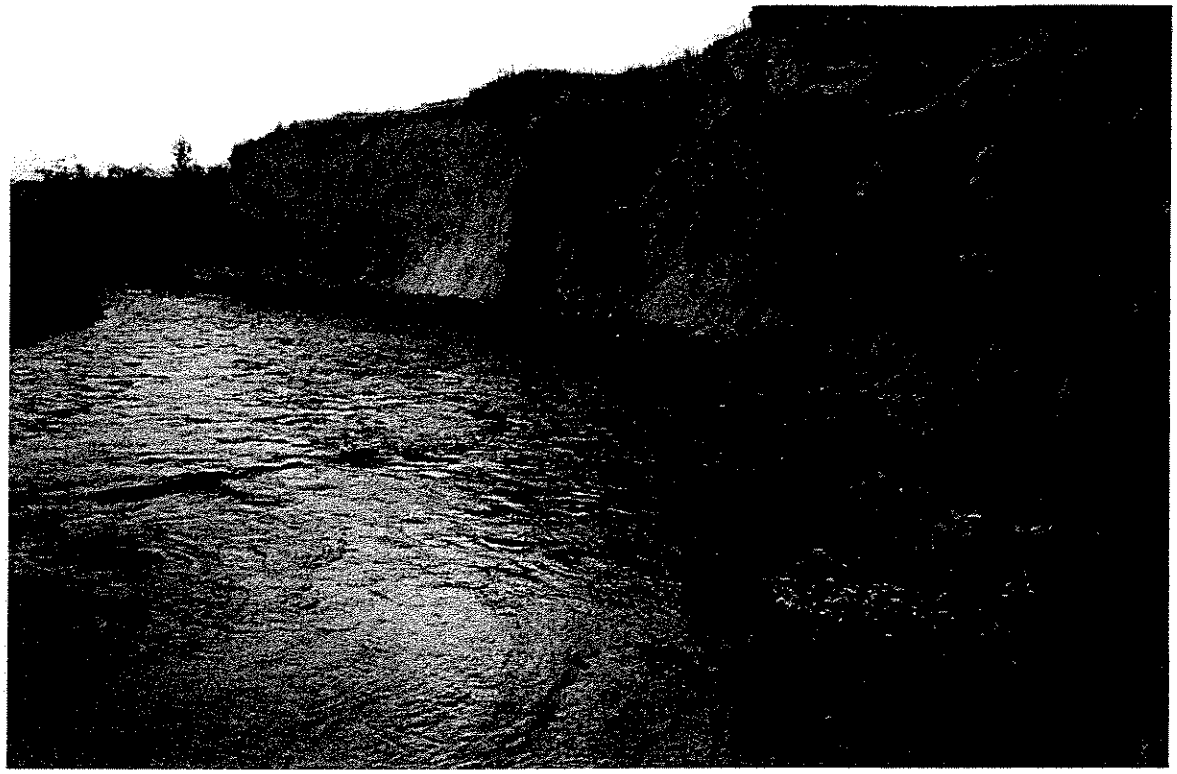
Reach 3 Site 1   7-1999

Deep Creek Reach 3 site 1   7-2001

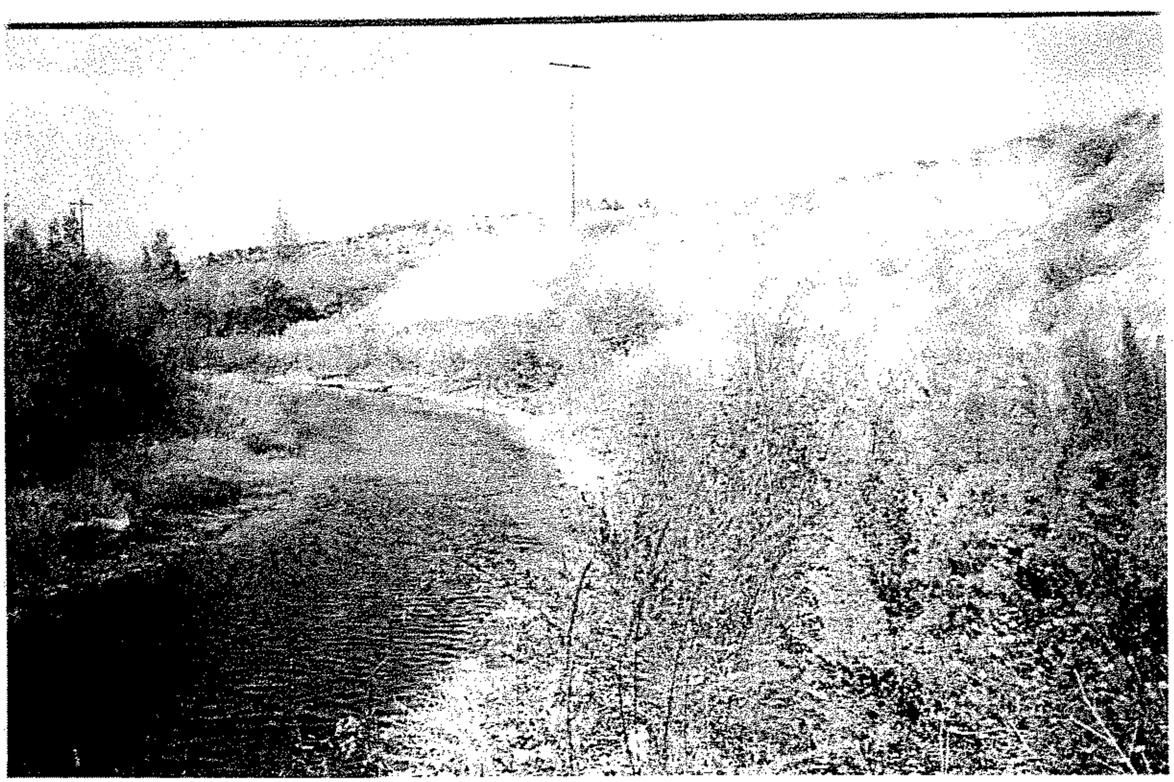


Reach 10 Site 10 **1997**

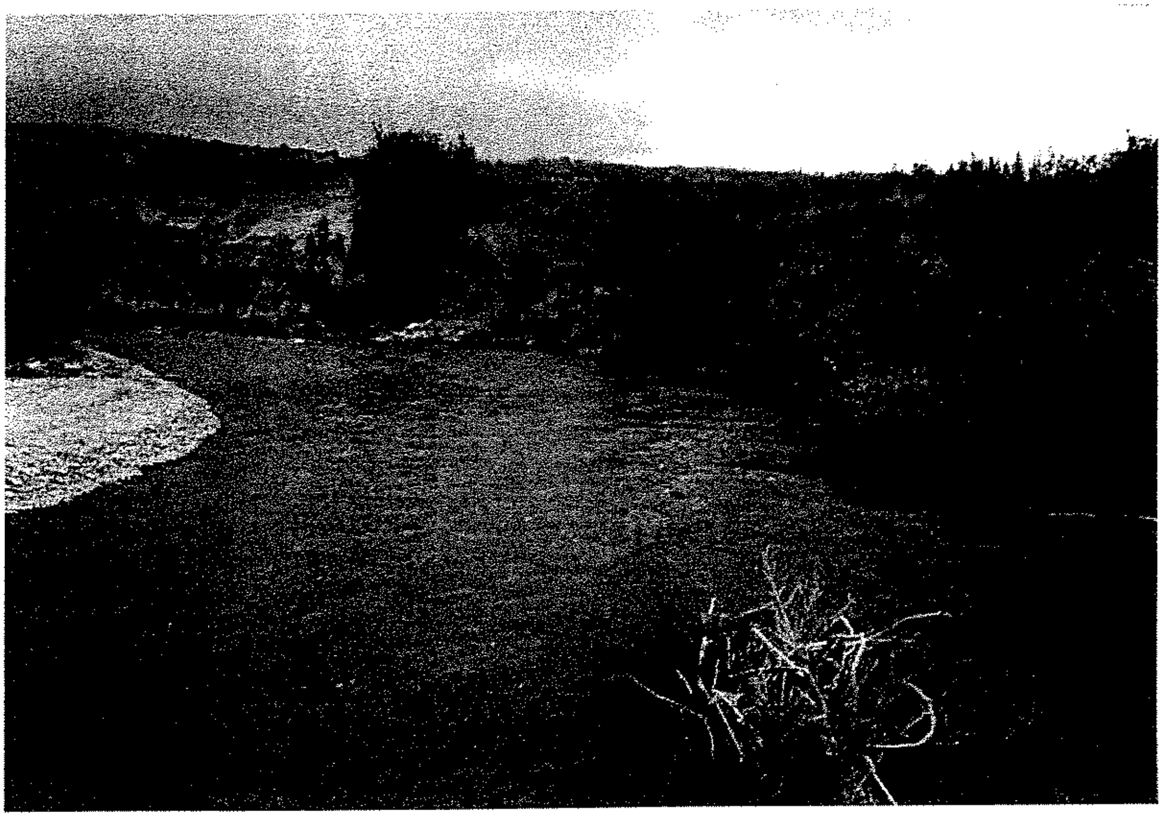
Reach 10 Site 10 **10-2001**



Reach 10 Site 1 7-1997



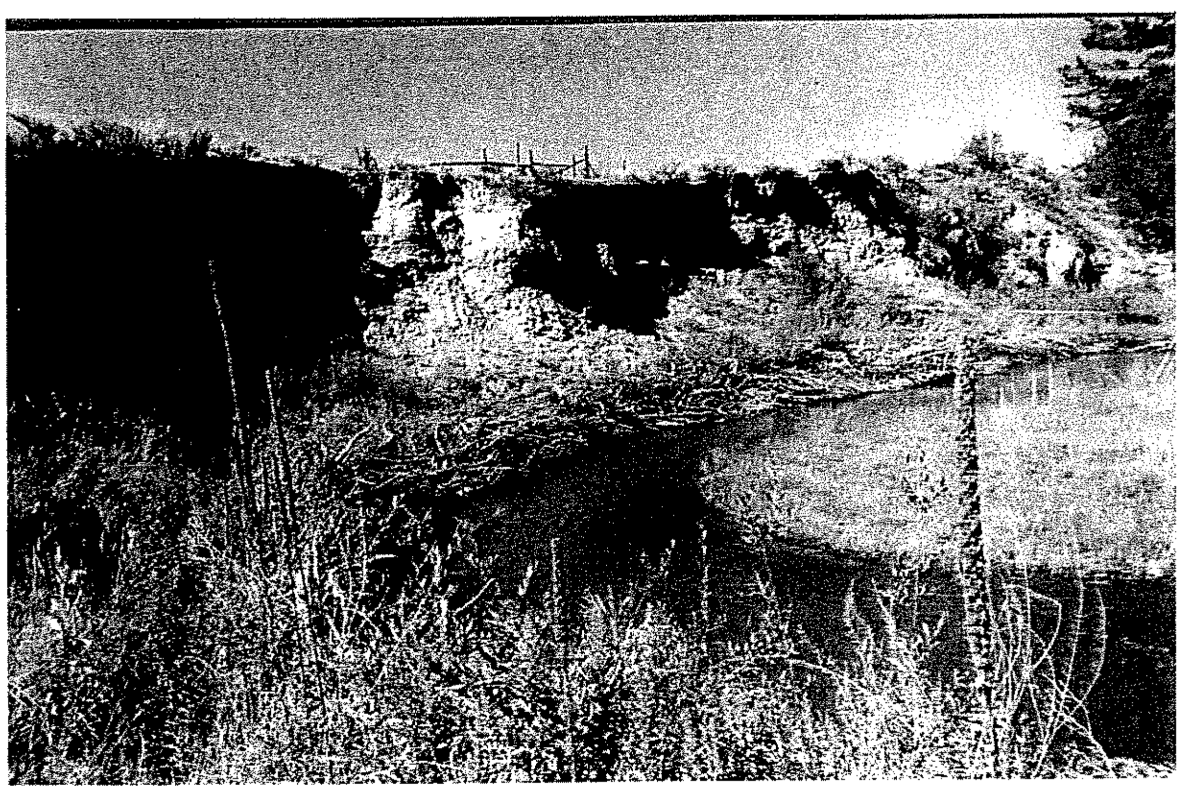
Reach 10 Site 1 Site Inventory 10-2001



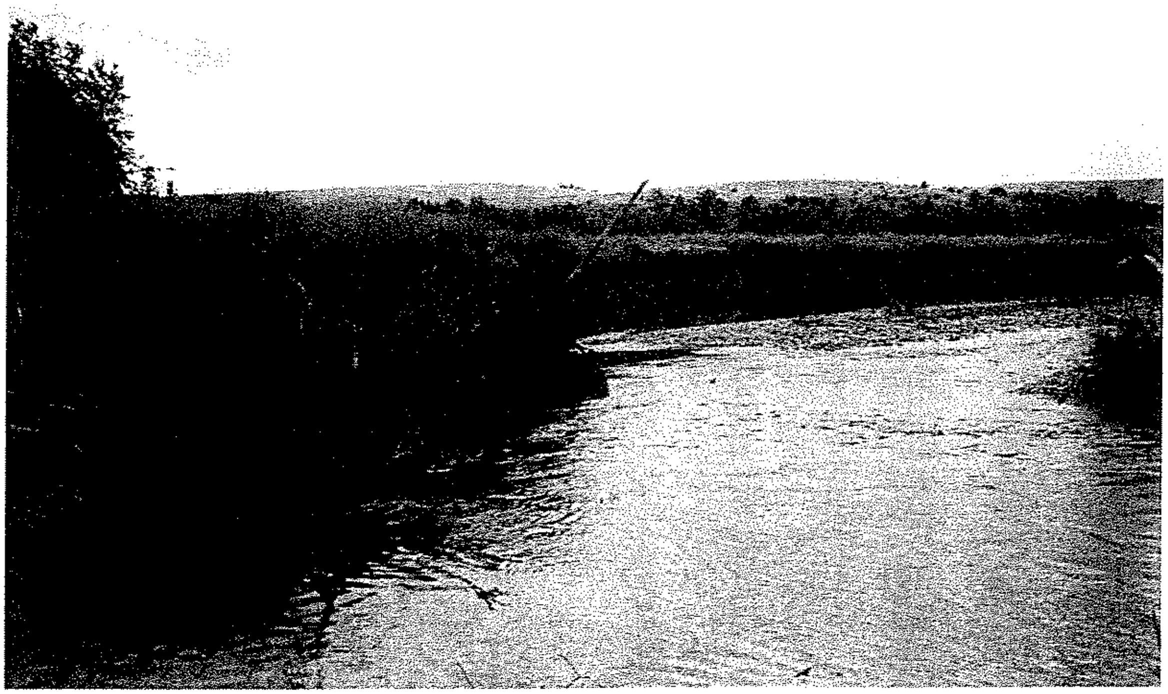
Reach 10 Site 1 7-1997

Reach 10 Site 1 Site Inventory   10-2001

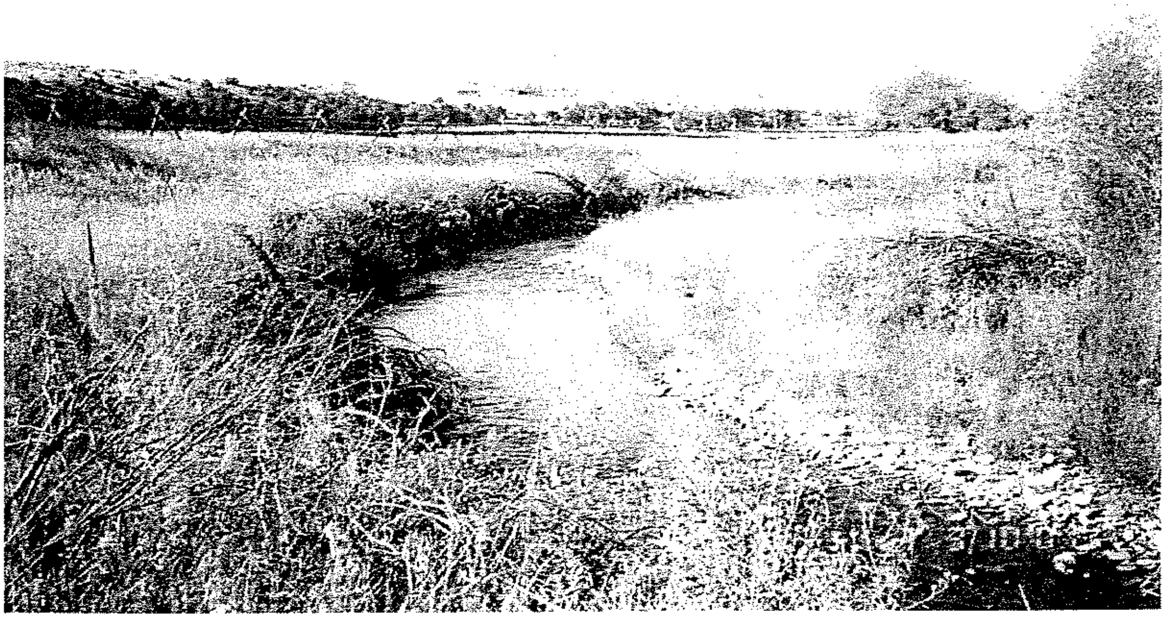
Reach 8 site 20   7-1997



Reach 8 Site 20 7-2001



Reach 9 Site 6   7-1997



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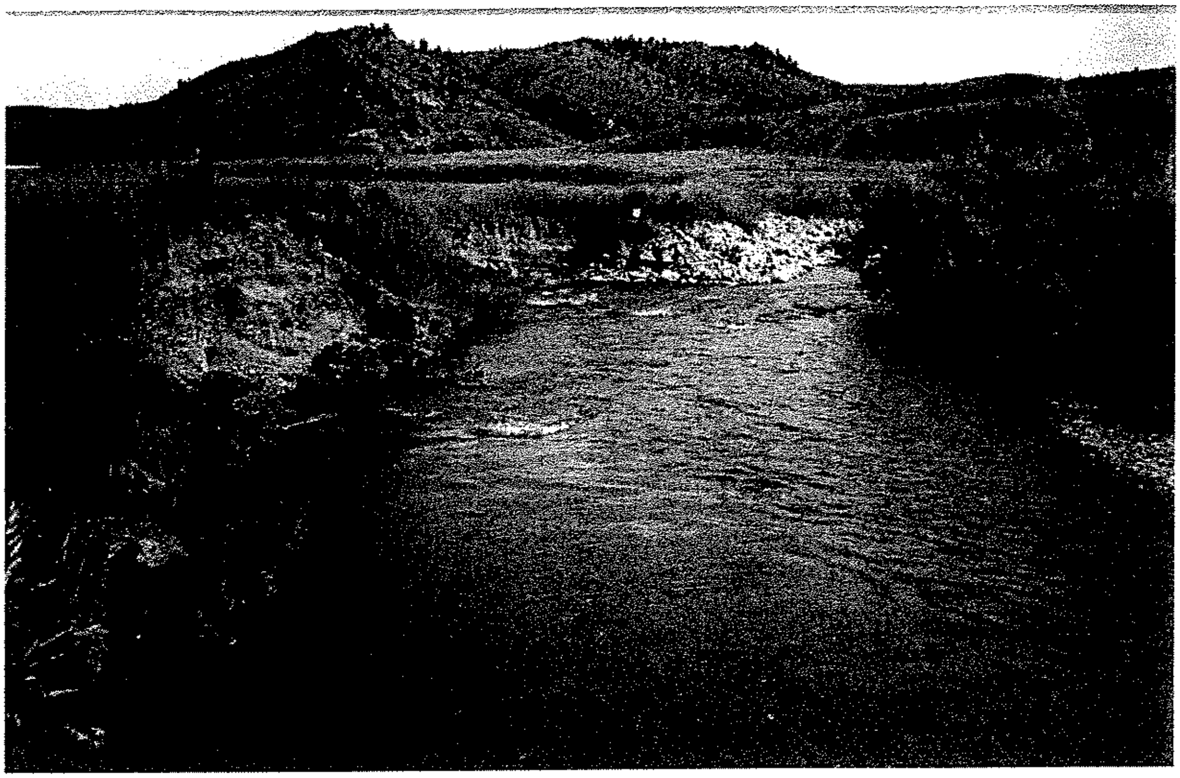
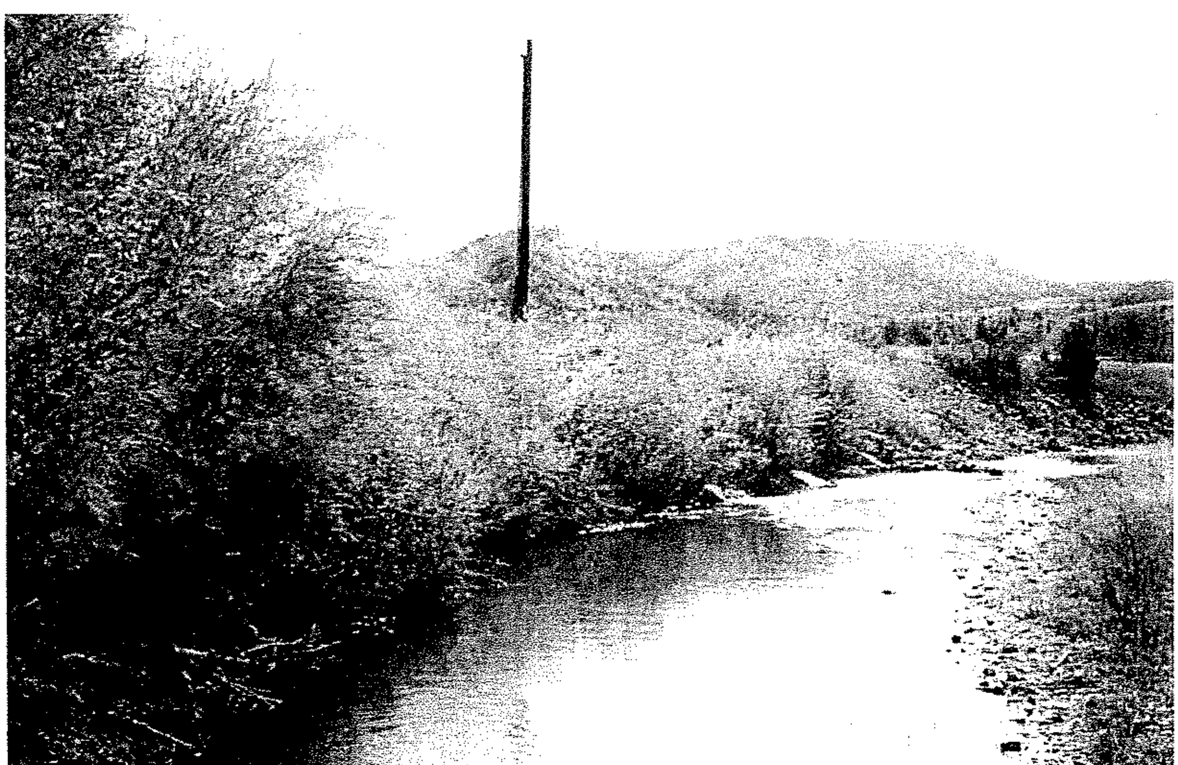
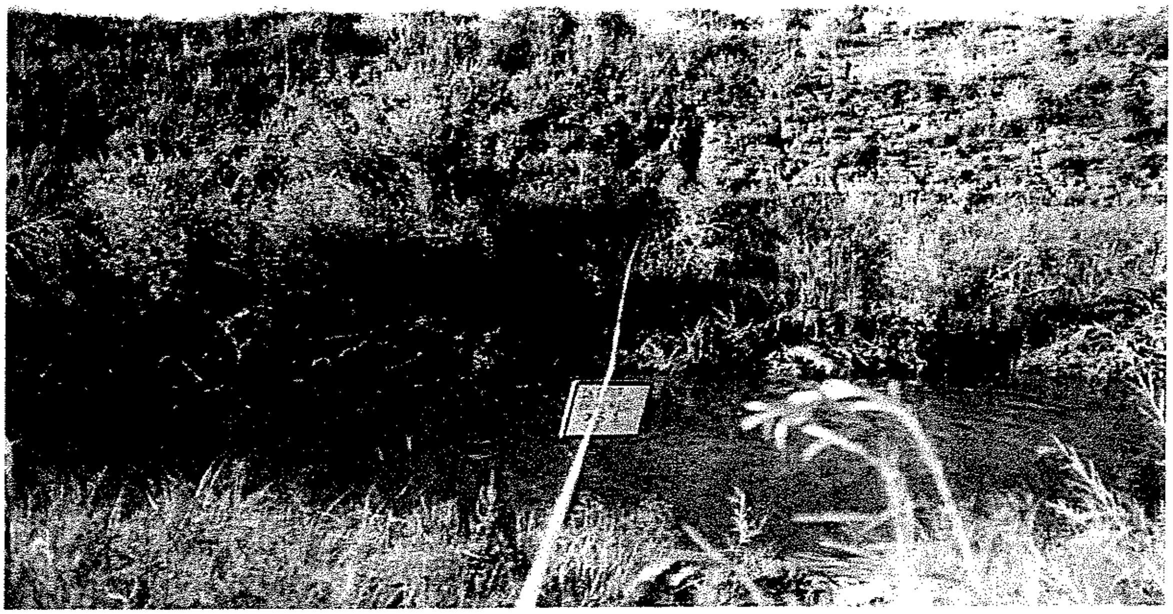


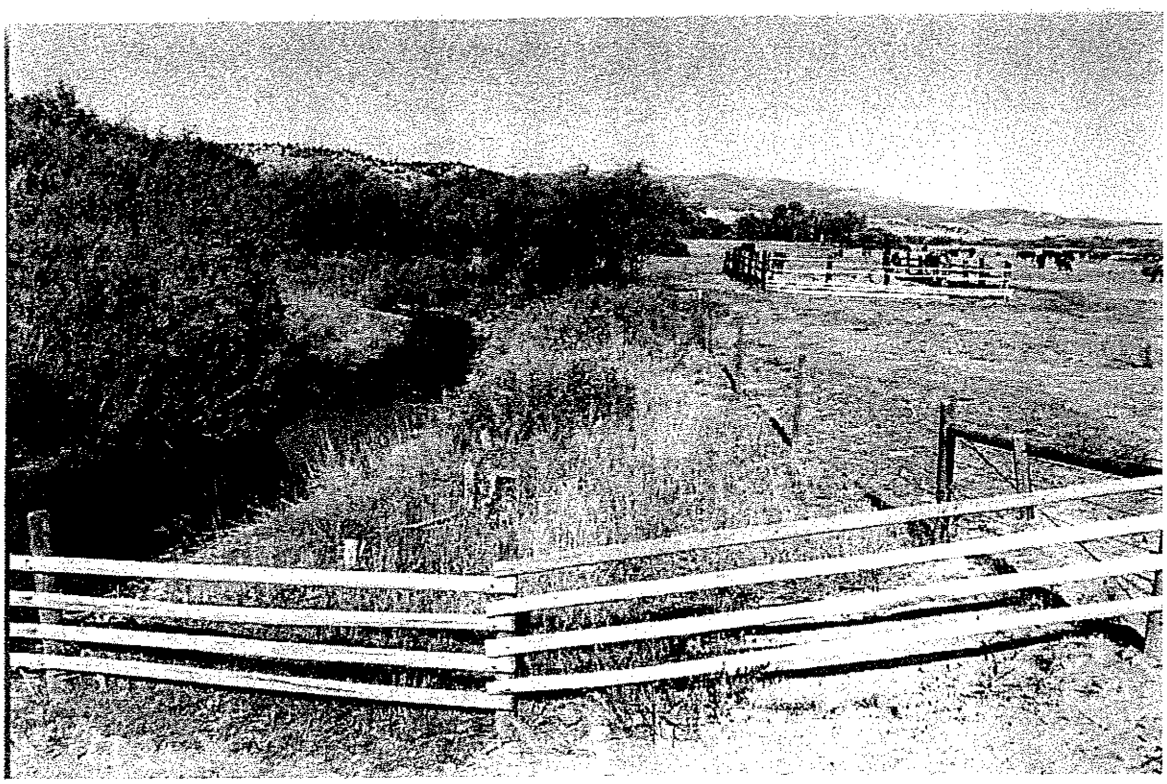
Reach 11 Site 36 7-1997



Reach 9 Site 36 10-2001



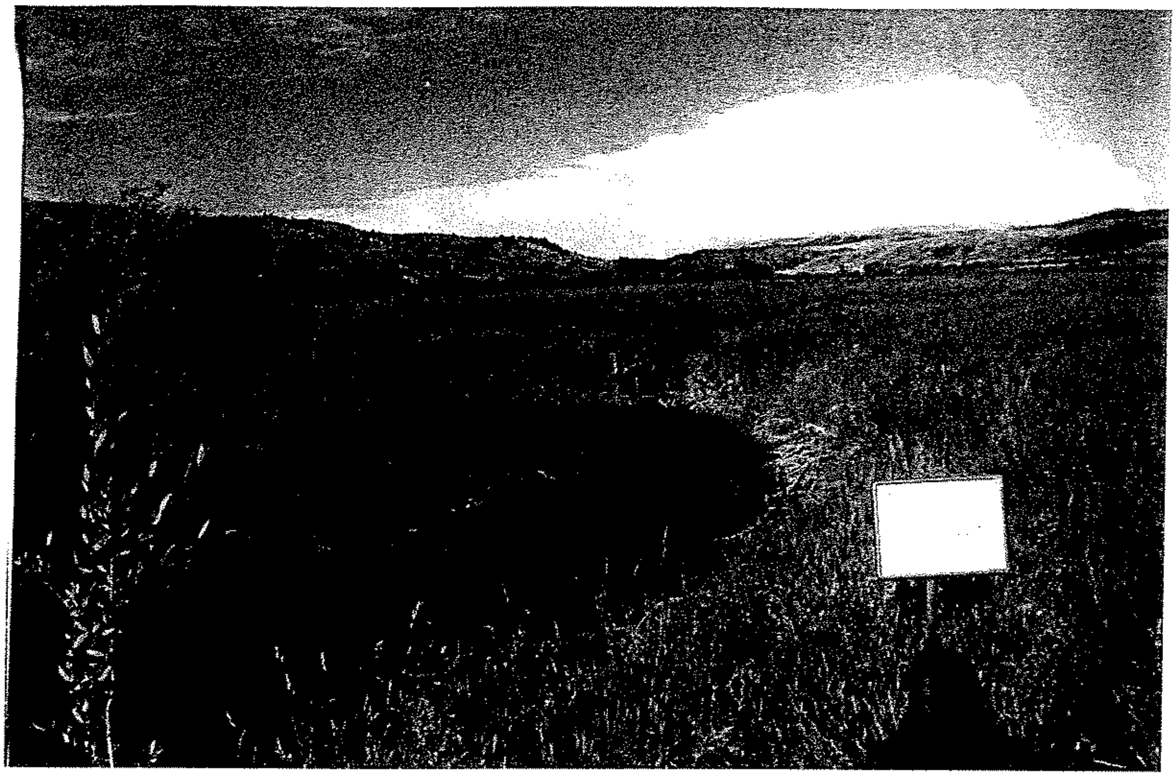
Reach 10 Site 1 7-2001



Reach 7   09-2000

Reach 10 10-2001

Reach 8 09-2001



Reach 11 7-2001

Reach 10 10-2001