ATTACHMENT A – EVALUATION OF FISHERY TRENDS IN THE JEFFERSON RIVER DRAINAGE RELATED TO CHANGES IN STREAMFLOW PATTERN AND HABITAT RESTORATION ACTIVITIES

EVALUATION OF FISHERY TRENDS IN THE JEFFERSON RIVER DRAINAGE RELATED TO CHANGES IN STREAMFLOW PATTERN AND HABITAT RESTORATION ACTIVITIES

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ACKNOWLEDGEMENTS

Information in this report is a product of over 20 years of attention provided to one of Montana's great rivers. Compiling information to better understand the water and fishery resource is intended to help citizens in the valley make decisions on the fate of the Jefferson River. Once dubbed the "Forgotten Fork" of the headwaters of the Missouri, the past eight years of citizen involvement to protect and improve habitat have raised the profile of the river, and it is clear that the river can no longer be considered forgotten or dismissed. The commitment of volunteers in watershed groups, water user associations, Trout Unlimited boards, Conservation Districts, and other numerous landowners and citizens has made the Jefferson Valley a better and healthier place. Since 1979, a handful of fishery technicians have helped collect the information presented in this report. Their skill and hard work has been critical for improving our understanding of the river.

INTRODUCTION

CHAPTER I

FISHERY AND STREAMFLOW TRENDS IN THE JEFFERSON RIVER – 1979 TO 2007

Evaluation of annual stream flow and fishery trends in the Jefferson River demonstrate that the fishery is influenced by low flow conditions during periods of drought. Population estimates for brown trout in three sections of the river from 1979 to 2007 indicate that the fishery declined during low flow periods, and surveys of other fish species also show that drought conditions impact all fish species resident to the Jefferson River. Monitoring of fish response to tributary enhancement projects from 1986 to 2007 indicate that such projects have significant potential to improve the trout population of the Jefferson River if adequate seasonal flow is maintained in the mainstem Jefferson River.

The Jefferson River is approximately 80 miles in length. The river originates at the confluence of the Big Hole and Beaverhead Rivers near Twin Bridges, and joins with the Madison River near Three Forks, Montana (Figure 1). The average width of the Jefferson River is about 197 feet, and the gradient averages 7.3 feet per mile. The river substrate is primarily composed of gravel and cobble, and the river typically meanders throughout a broad floodplain dominated by cottonwood.

Throughout its length, the Jefferson River and associated tributaries are extensively used as a source of irrigation water. Streamflow gaging near the headwaters show a mean annual flow of 2,014 cfs. Mean monthly flow ranges from 856 cfs (August) to 6,050 cfs (June). Base winter flow averages 1,070 cfs. Stream flow gaging reflects the severe summer dewatering of the Jefferson River, and flow depletion is considered one of the primary limiting factors for maintaining a desirable sport fishery for trout.

Another factor that significantly influences the sport fishery is the relative scarcity of healthy tributaries providing cold, clean water to the mainstem Jefferson River. The shortage of healthy tributaries results in few locations for successful trout spawning and juvenile trout rearing areas needed to provide recruitment of new fish to the system.

Since mainstem flow depletion and a shortage of quality tributaries are believed to be the primary limiting factors for the Jefferson River trout fishery, evaluation of flow enhancement and tributary restoration projects are the primary topics of investigation in this report. The Jefferson River Watershed Council and Trout Unlimited began an important partnership with MDFWP for this evaluation and restoration project beginning in 1999 and 2001, respectively.

METHODS

Fish Sampling

JEFFERSON RIVER

Fish sampling in the Jefferson River was primarily conducted during the spring when flow was sufficient to operate a boom-mounted electrofishing unit and a jet boat. A Coffelt Model VVP-15 electrofisher powered by a 4500 watt generator was used to create an electric field with direct current. Captured fish received a fin clip for Mark/Recapture identification, and were weighed, measured, and released. Marking fish for conducting Mark/Recapture estimates was typically conducted by making at least three downstream passes of the electrofishing boat: left bank, right bank, and mid channel to attempt to obtain a complete and unbiased sample of the entire river channel. Recapture runs for a sampling section were conducted at least seven days after the marking runs to allow for fish re-distribution, and when multiple recapture runs were needed to obtain population estimates, sampling was conducted with replacement of marked fish (ie. no fin clipping was conducted during recapture runs to ensure that fish were not included in subsequent runs).

Sampling time was recorded at each electrofishing stop to the nearest minute using a watch or stop watch. Recording actual electrofishing time (not including travel time) allowed estimation of catch-per-unit-effort (CPUE) for various species of fish during the population estimate procedure. In addition to recording the number of trout captured by the netter at each stop, the netter also estimated the number of other fish species observed in the electrofishing field and provided the information to the boat operator using hand signals. Thus, CPUE for trout was based on number of trout netted and delivered to the live well and CPUE for other species (typically mountain whitefish, suckers, and other species) was based on number of fish observed but not captured by the netter.

TRIBUTARIES

Evaluation of spawning and juvenile trout rearing in tributaries were primarily based on counting redds and conducting one-pass CPUE surveys using a backpack electrofishing unit. Determining spawning use of a tributary was conducted by walking upstream and recording the number of redds counted near the expected end of spawning activity. Streams with extensive spawning or concentrated redd construction received multiple redd counts to help identify occupied (new) redds or unoccupied (old redds) to provide a more accurate redd count.

Juvenile trout CPUE surveys were typically conducted with one electrofishing pass of the entire stream channel. The survey attempted to capture all trout to obtain a count and to measure length of fish. Non-game fish were generally not captured and classified as abundant, common, or rare. The number of young-of-the-year (YOY) trout captured per 100 seconds of shocking time was calculated by simply dividing the number of rainbow trout <120 mm and brown trout <130 mm by the shocking time.

Streamflow Measurement:

Streamflow data presented in this report were generally obtained from United States Geological Survey (USGS) records. Long-term USGS gage records prior to 1999 for the Jefferson are available for two sites: Jefferson River near Twin Bridges (06026500) is located near the headwaters and Jefferson River near Three Forks (06036650) is located near the mouth of the river. Additional flow monitoring was conducted by MDFWP near the most severely dewatered reach of the Jefferson River below Parson's Bridge (Waterloo). Flow monitoring near Waterloo was conducted using standard USGS methods and flow readings were related to staff gage elevations during low flow periods (mid-July through September). Stage readings gradually became more continuous when an Aqua-Rod was installed from 2000 to 2005. Flow monitoring at Waterloo was conducted by USGS (06027600) starting in 2006, and seasonal data is available for low flow periods in July, August and September.

In 1996, the Twin Bridges gage was reactivated by MDFWP, USGS and DNRC to improve understanding of inflow patterns of the Upper Jefferson Basin. Continuous flow monitoring is conducted near the mouth of the Jefferson River at Three Forks since 1979. Occasional stream flow measurements were gathered by MDFWP near the most severely dewatered reach of the river near Waterloo during the 1990's. Additional streamflow and water temperature measurements are presented in this report. Data were collected using standard cross section methods and a Marsh-McBirney Flow Meter.

Jefferson River Study Area

The Jefferson River flows for about 80 miles from the confluence of the Big Hole and Beaverhead Rivers near Twin Bridges to its mouth near Three Forks (Figure 1). The average width of the river is about 197 feet, and the gradient averages 7.3 feet per mile. River substrate consists primarily of gravel and cobble.

The drainage area of the Jefferson River Basin above the USGS gage at Three Forks is over 9,500 square miles (USGS, Gustofson 2003). The drainage area of the Big Hole River, Beaverhead River (including Red Rock River), and Ruby River is 2802 sq. miles, 3,783 sq. miles, and 989 sq. miles, respectively. The Big Hole River basin has no large impoundments for water storage, the Ruby River basin is influenced by Ruby Reservoir, and the Beaverhead River basin contains Lima Reservoir and Clark Canyon Reservoir. The Jefferson Basin HUC contains 1340 sq. miles and 893 miles of perennial steam, with a mean elevation of 5640 ft (Gustofson 2003).

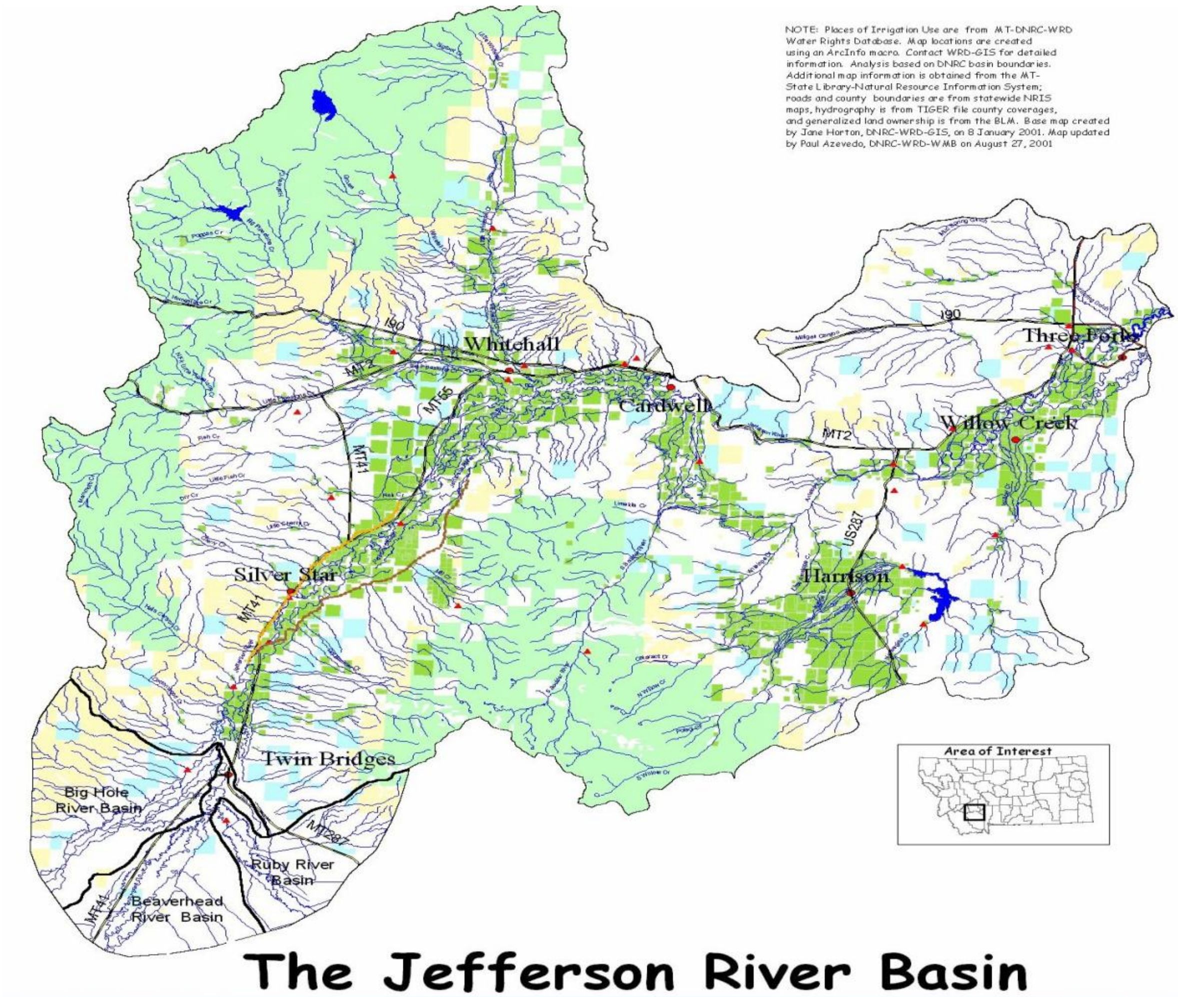


Figure 1. Map of the Jefferson Basin.

RESULTS

Based on long term streamflow monitoring of the Jefferson River at two USGS gaging stations and one seasonal station at Parson's Bridge (Waterloo), it is clear that drought conditions beginning in 1999 or 2000 have resulted in significantly reduced flows at all monitoring locations in the Jefferson Basin compared to earlier records. During the period 1979 to 2007, mean annual flow and mean August flow of the Jefferson River at Three Forks was generally above average from 1979 to 1984 and 1996 to 1998, and well below average from 1985 to 1995 and from1999 through 2007 (Figure 2). The trend for mean annual flow is mirrored by the trend of mean August flow near the mouth of the Jefferson River at Three Forks, indicating that a poor water year generally results in both lower peak flows during spring and lower base flow during summer.

The flow trend near the headwaters of the Jefferson River near Twin Bridges provides a longer period of record compared to the Three Forks Gage, but has periods with data gaps. The mean August flow for the Twin Bridges gage was estimated to be 788 cfs. From 2000 to 2007, the mean August flow was generally about 50% (about 400 cfs) less than the long term average, and the unusual pattern of continuous low flow years is apparent (Figure 3). Occasional years of extremely low flow during the period of record can be expected, but the 8 consecutive years of low flow from 2000 to 2007 appear to be unprecedented.

Flows at all measurement locations of the Jefferson River reflect the severe dewatering that occurs during summer seasons. The lowest flow in the river generally occurs in the general area between Silver Star and Waterloo. When summer flow is less than about 400 cfs at Twin Bridges, flow near Waterloo is often less than 100 cfs and sometimes less than 20 cfs. The drought plan established for the Jefferson River, which was written in 1999, attempts to maintain streamflow over 50 cfs at the Waterloo gaging station (See Chapter V for a discussion of the drought plan and an evaluation of flow trends during the 2000 to 2007 period).

The health of the Jefferson River is severely impacted during periods of drought when inflows to the river near Twin Bridges (the approximate confluence of the Big Hole, Ruby, and Beaverhead Rivers) fall below 400 to 500 cfs. The reach of the Jefferson River located between Twin Bridges and Waterloo contains about 800 cfs of water right claims, and four large canals routinely monitored in this area frequently divert about 350 cfs during the irrigation season. The frequent occurrence of low flow throughout the Jefferson River is a product of the significant appropriation of water for irrigation in the upper 20 miles of river, and the additional irrigation withdrawals spaced throughout the remaining 60 miles of river.

The quantity of water needed to maintain a healthy aquatic community and an abundant sport fishery was quantified in MDFWP's *Application for Reservations of Water in the Missouri River Basin above Fort Peck Dam* in 1989. The wetted perimeter method was used to recommend a minimum flow request of 1,100 cfs. Based on this method of surveying cross-sectional measurements to develop the relationship between streamflow and the quantity of river channel covered with water, there were two flows identified where rapid loss of river channel area occurs when flows decrease: upper inflection point was 1,100 cfs and lower inflection point was 550 cfs. Thus, flows decreasing below 1,100 cfs result in the increased exposure of the river channel, and flows decreasing below 550 cfs result in a very rapid loss of aquatic habitat. During "normal" flow years, there is typically enough water to maintain a recommended flow of 1,100 cfs at many locations in the Jefferson River, but during drought years, flow is often well below recommended levels.

Flow trends for the Jefferson River presented in Figures 2 and 3 indicate that the recent drought is severe based on relatively recent data of the past 30 to 40 years. Gaging data for the Jefferson River, however, do not extend back to the 1930's when drought conditions were generally considered to be most severe. Long term gaging stations in the lower Big Hole (Melrose) and the Upper Missouri River (Toston) indicate that the current flow trend since 2000 is more severe than previous drought years experienced in the upper Missouri River basin (Figure 4).

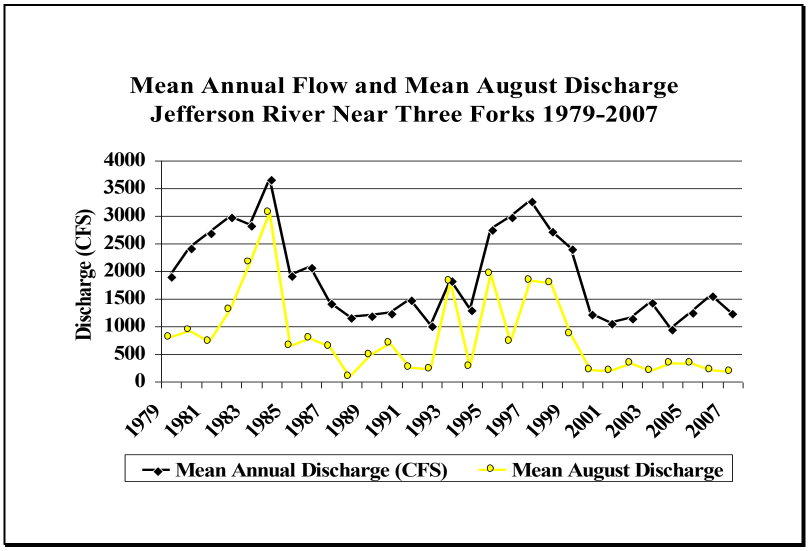


Figure 2. Comparison of mean annual flow and mean August flow of the Jefferson River at the Three Forks USGS gaging station near Three Forks.

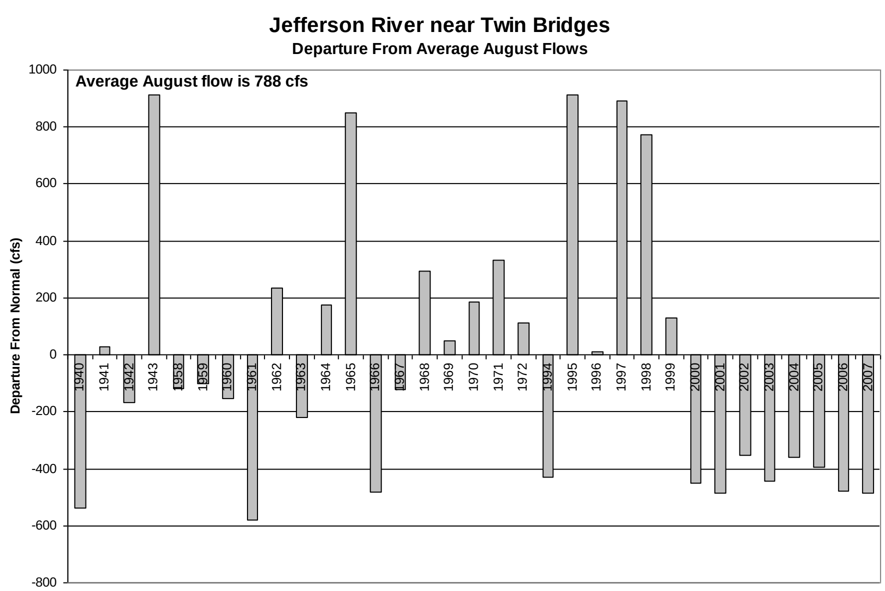


Figure 3. Departure from "normal" stream flow of the Jefferson River at the USGS gaging station near Twin Bridges.

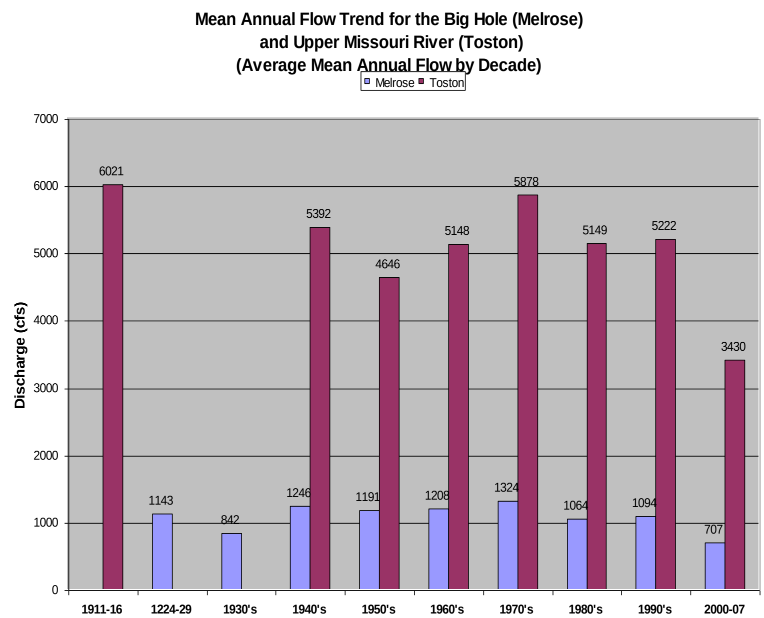


Figure 4. Comparison of long term mean annual flow above and below the Jefferson River (Average Mean Annual Flow by Decade).

Stream flow in the upper Jefferson River have been monitoried at the Twin Bridges gaging station for 33 years since the beginning of the period of record in 1940. Flow monitoring at Waterloo was only been monitored during occasional years during 1988 and a few select water years in the 1990's to confirm the extent of dewatering at this critical location. Daily flow records have been collected at Waterloo from 2000-2007 and a comparison of stream flow at Twin Bridges and Waterloo during 2000 illustrates the significant irrigation withdrawl between these two locations (Figure 5). In addition, Figure 5 illustrates the extreme departure between the desirable instream flow recommendation of 1,100 cfs and the flow level during drought conditions at both Twin Bridges and Waterloo gaging locations.

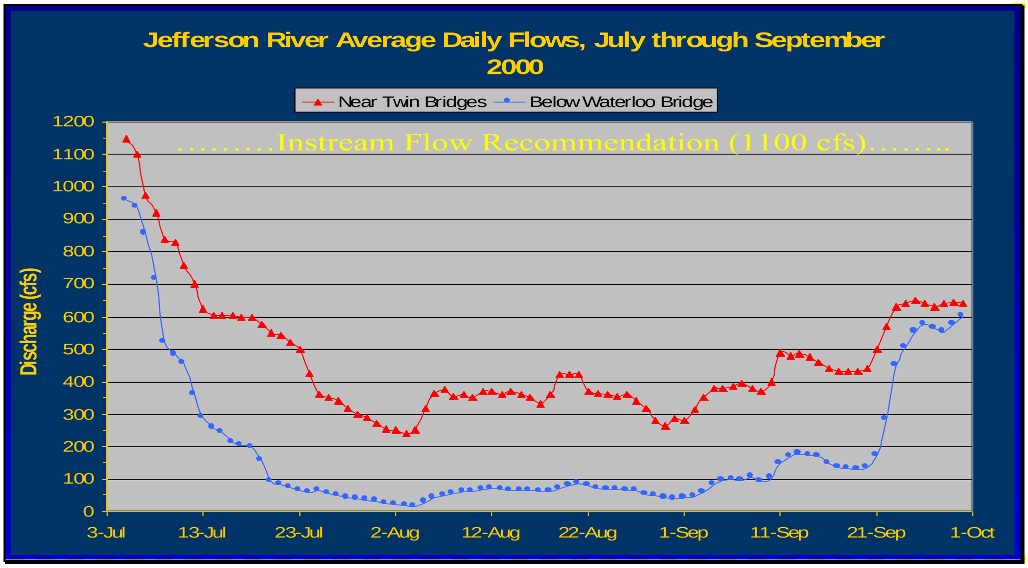


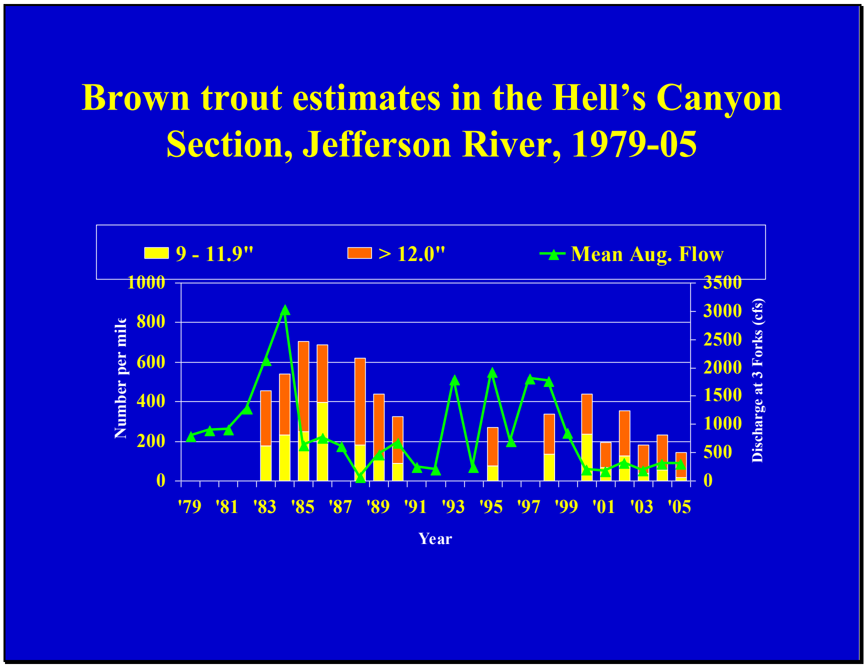
Figure 5. Summer flow trend of the Jefferson River at Twin Bridges and Waterloo during 2000 in relation to the instream flow recommendation of 1,100 cfs.

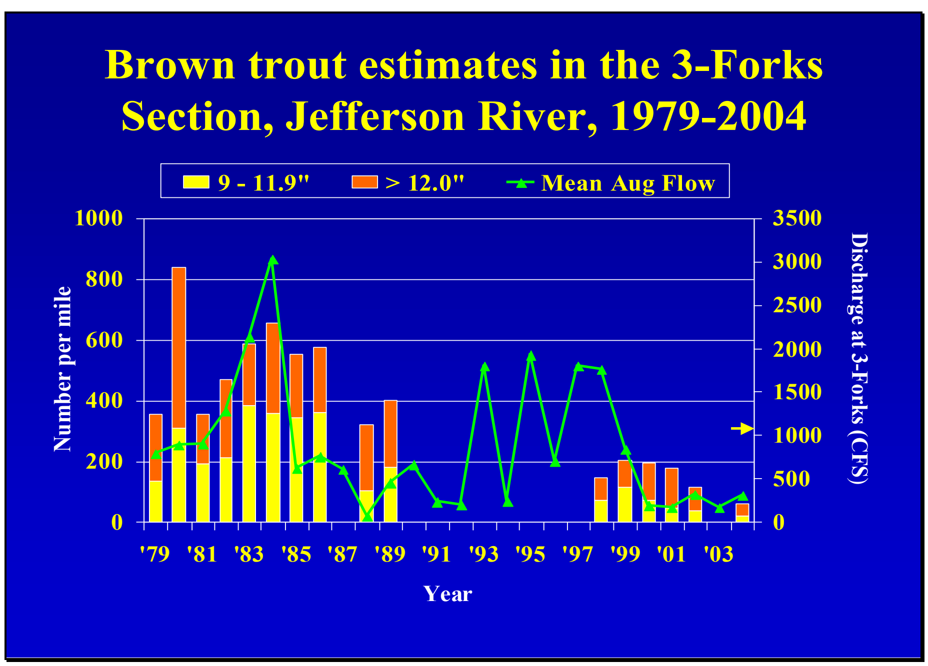
Fishery Trends in the Jefferson River

Fisheries data presented in subsequent sections of this report indicate that trout and other species of fish have declined significantly during these extreme flow conditions observed since 2000. Other variables such as spawning habitat limitations, water quality, fish mortality due to angling, impacts on physical habitat quality, bird predation on fish, and others probably influence the fishery of the Jefferson River, but the loss of flow during the summer period appears to have the most significant impact on the fishery.

Spring electrofishing surveys provide reliable brown trout population estimates for two long-term study sections established in the late 1970's (Hells Canyon Section and Three Forks Section). An additional section was added in 2000 in the mid-section of the river where flow depletion is most severe (Waterloo Section) (Figure 6; page 16). In addition, a fourth section was added in 2006 near the Sappington Springs to monitor fish response to habitat improvements in the lower segment of the Jefferson River.

Long-term study sections near Hells Canyon (upper river) and Three Forks (lower river) demonstrated declining brown trout populations in response to drought conditions in the mid to late 1980's (Figures 7 and 8). Brown trout abundance increased in the Hells Canyon Section in response to improved flow conditions in the mid-1990's, but brown trout abundance did not increase in the lower river during this time frame. The absence of a positive population response to increasing flow from 1993 to 1998 at Three Forks indicates that other factors such as recruitment limitations are affecting this reach of the Jefferson River.





Figures 7 and 8. Brown trout population trends related to mean August flow at the Three Forks Gaging Station (1979 to 2005).

Brown Trout Response to Low Flow Conditions – 2000-2007

Brown trout abundance has declined in each of the three population monitoring sections in response to the severe summer flow depletions beginning in the late 1990's. Adult brown trout populations (fish over 12" total length) at Hells Canyon, Waterloo, and Three Forks sections have declined by about 40 to 60% percent between 2000 and 2007 (Figure 9). The Hells Canyon and Three Forks Sections were last sampled in 2005 and 2004, respectively.

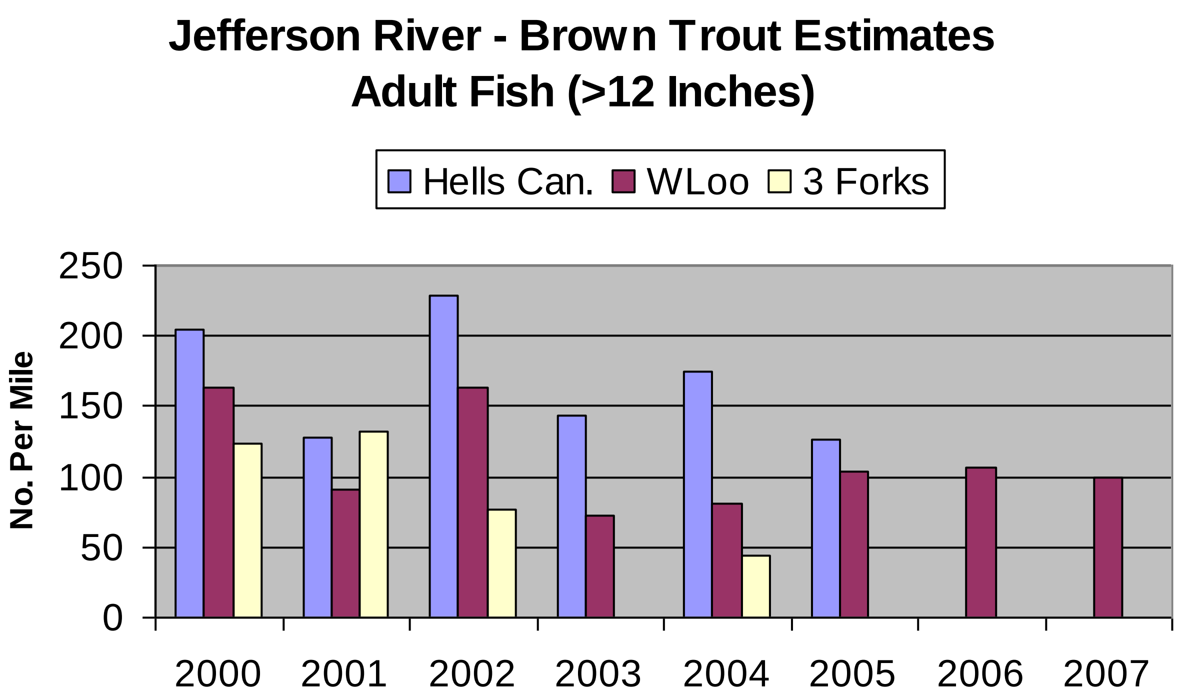


Figure 9. Comparison of adult brown trout population trends in three sections of the Jefferson River during the severe drought period of 2000 to 2007.

Young brown trout (age II fish between 9 and 11.9") also declined at each of the three sampling sections, and the reduction in numbers appears to be more severe than the adult fish over 12" in length (Figure 10). It appears that low stream flow during drought impacts juvenile brown trout in the Jefferson River more than it impacts the adult population. Improved flow during the 1993-1998 period indicates that juvenile trout abundance recovered in the Hell's Canyon Section more quickly than adult brown trout after favorable summer flow conditions (Figure 7).

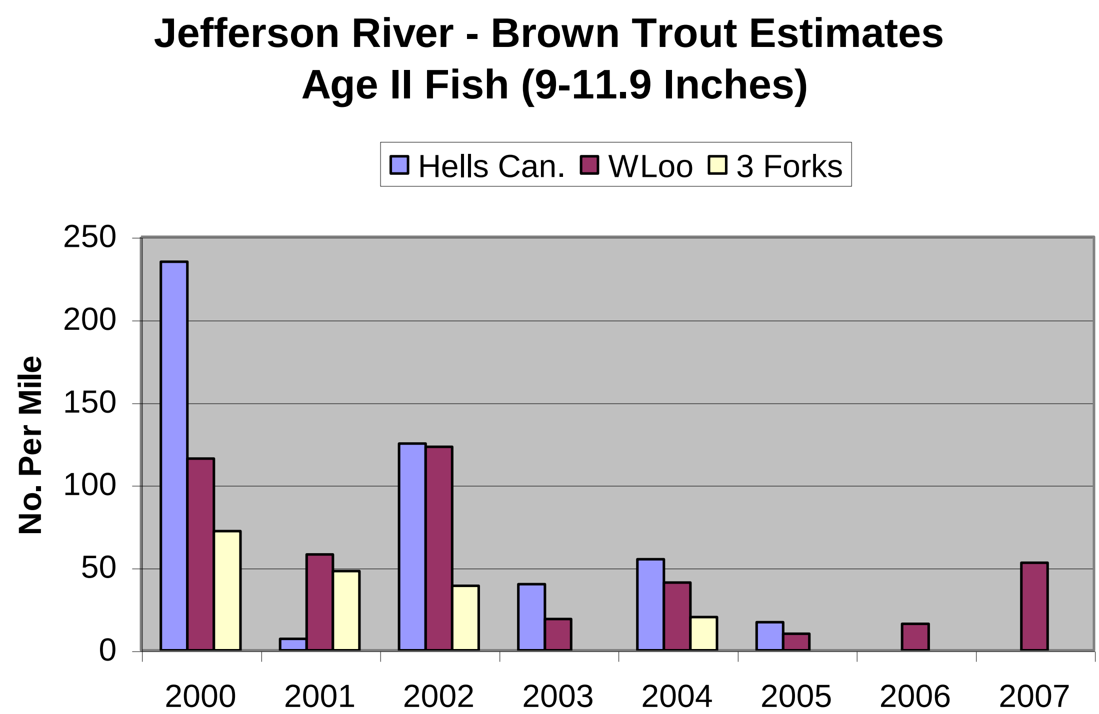


Figure 10 . Comparison of age II brown trout population trends in three sections of the Jefferson River during the severe drought period of 2000 to 2007.

Although the direct causes of reduced survival of young fish is not known, it is possible that young brown trout dependant on shoreline cover are forced to move into concentrated pool habitat during drought conditions and may be subjected to predation or other sources of mortality. After the extremely low flow year of 1988, the number of adult brown trout at the Hells Canyon Section was relatively unchanged, but the number of fish less than 12" was significantly reduced (Figure 7).

The instream flow recommendation of 1,100 cfs maintains a desirable wetted perimeter with water in contact with shoreline cover, which is important for brown trout survival. Summer streamflow in the upper river near Hells Canyon was often below 400 cfs, and flow near Waterloo was often less than 100 cfs from 2000 to 2007. Shoreline rearing habitat was very limited during each of these years.

Although a general decline has been observed throughout all sections during the severe drought period representing the upper, middle, and lower river, it is noteworthy that the most severe dewatering of the middle river near Waterloo has not experienced continued declines in numbers in the past three years (since 2005). Implementation of the drought plan, which attempts to maintain critical flows near Waterloo has been effective at preventing complete dewatering of this reach of the river. See Chapter V for a summary of the drought plan, and Appendix A for a table of discharge measurements near Waterloo.

Rainbow Trout Population Estimates

Spring-time population surveys provide reliable indices of brown trout abundance because movement of fish appears to be minimal during the population estimate procedure, which takes 10 to 14 days to complete. Spring estimates for rainbow trout are influenced by spawning movements of adult rainbow trout, and these data have a known bias resulting from adult fish moving to and from spawning areas during the population estimate process. Therefore, population estimate results for adult rainbow trout are not included in this report.

Despite movements of adult and some sub-adult rainbow trout, there is some useful trend information that can be obtained from these population surveys at the Hells Canyon Section (upper river) and the Waterloo Section (middle river). Rainbow abundance in the Three Forks Section (lower river) is not sufficient to show meaningful trends.

Population estimates for rainbow trout less than 12.0 inches in length (mostly non-spawning fish) in the Waterloo Section declined after the beginning of the severe drought conditions starting in 2000 and began to rebound in 2004 (Figure 11). A reduction in the rainbow trout population after 2000 was similar to that observed for brown trout, but the improved numbers of rainbow trout after 2003 indicates that rainbow trout abundance can be improved during years with low summer streamflow. Projects to enhance two spawning/rearing tributaries in this monitoring section were completed from 2004 to 2007.

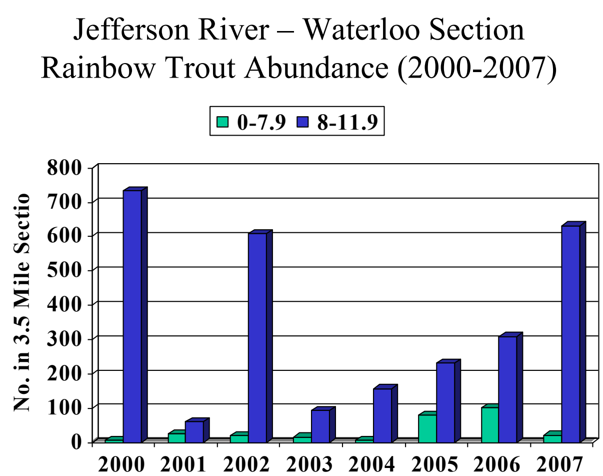


Figure 11. Rainbow trout population trend in the Waterloo Section during consecutive years of severe drought (2000-2007). Number of rainbow trout in size group (0-8.9") is the total numbered captured; the number (8-11.9 inches) is a mark recapture population estimate.

Rainbow trout abundance for fish less than 12 inches in the Hells Canyon Section also show a significant decline between 2000 and 2004, presumably due to the flow decline during this period (Figure 12). Although current rainbow trout abundance appears reduced due to drought conditions, rainbow trout were not abundant during the improved flow conditions of the 1980's. There was an apparent increase in the rainbow fishery from the mid-1980's to the late 1990's. Some factors influencing the rainbow trout fishery in this reach during this increase is the implementation of a catch and release fishing regulation, implementation of the Hells Canyon Water Lease and Fish Screen Project in 1996, and relatively good flow conditions in the Jefferson River.

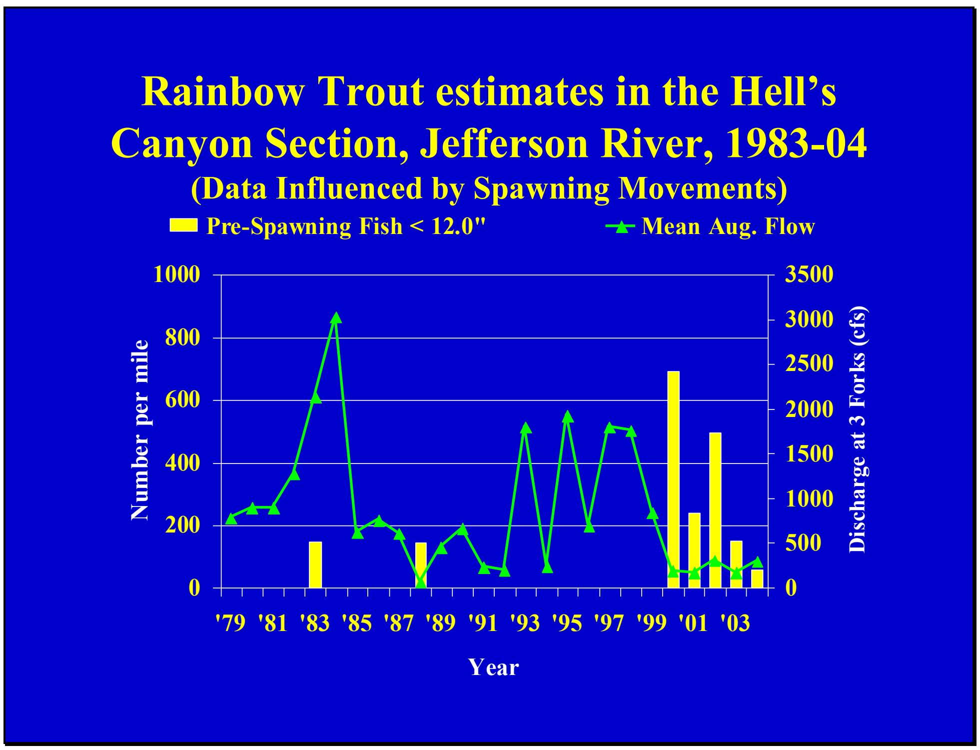


Figure 12. Long term trend of rainbow trout abundance in the Hells Canyon Section of the Jefferson River related to mean August flow.

Brown trout have been the dominant trout species in the Jefferson River during the 1980's and 1990's. Although it appears that both brown and rainbow trout are impacted by low flow conditions, the improved recruitment of rainbow trout due to tributary enhancement projects provides a new component to the trout fishery that may buffer the fishery from severe population declines during periods of change. The positive population response of the rainbow fishery in the Waterloo Section during low flow conditions is an example of the benefits of developing an alternative trout fishery (Figure 11).

Catch-Per-Unit-Effort Surveys

Population estimates at defined locations over a period of time are useful for determining population trends at specific locations, but these data can miss important dynamics of the fishery at other locations throughout the river. In 2000, FWP conducted an extensive survey of other reaches of the river using one electrofishing pass and determining the number of fish captured per unit time of sampling.

Catch-per-effort (CPUE) surveys in 2000 provide a wide view of fish distribution throughout the Jefferson River, and this sampling occurred in reaches of the river that had no previous fish inventory information (Figure 6). The longitudinal fishery trend from CPUE data show that rainbow trout abundance appears to be linked to recruitment from two spawning tributaries. The largest number of rainbow captured per unit effort was observed near the mouths of Hells Canyon and Willow Springs, which are the two primary spawning and rearing tributaries for rainbow trout in the Jefferson basin (Figure 13).

Observations for other fish species were also obtained during the CPUE survey. Mountain whitefish were the most common fish observed during this sampling in 2000, followed by sucker species, brown trout and rainbow trout (Figure 14).

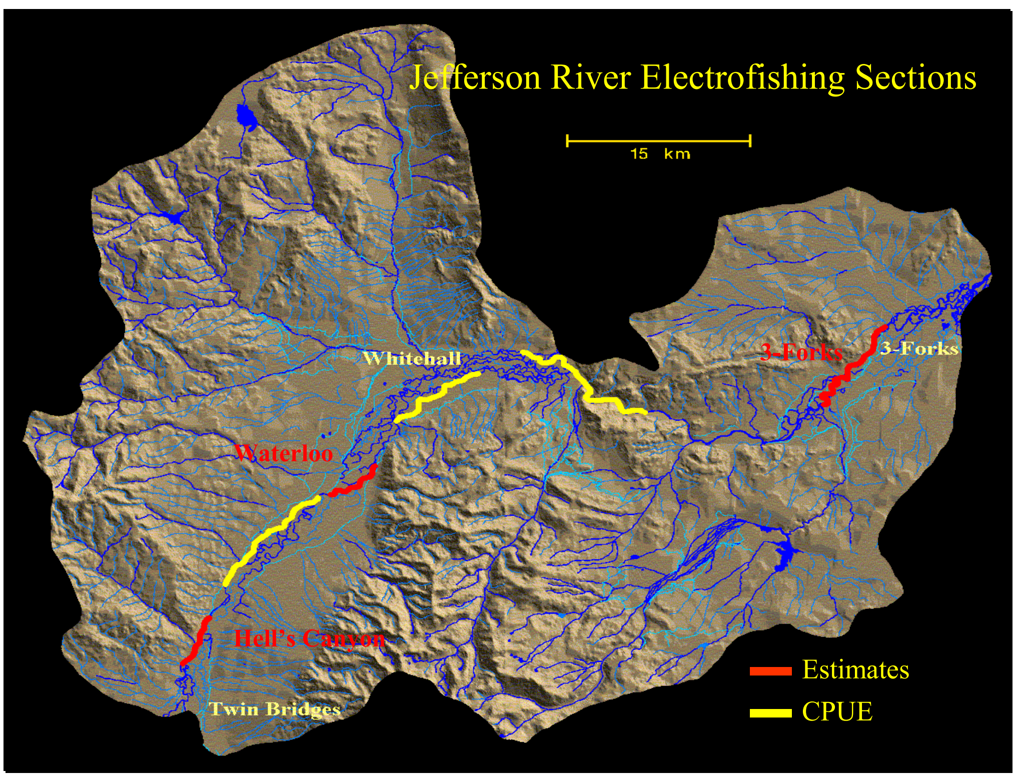
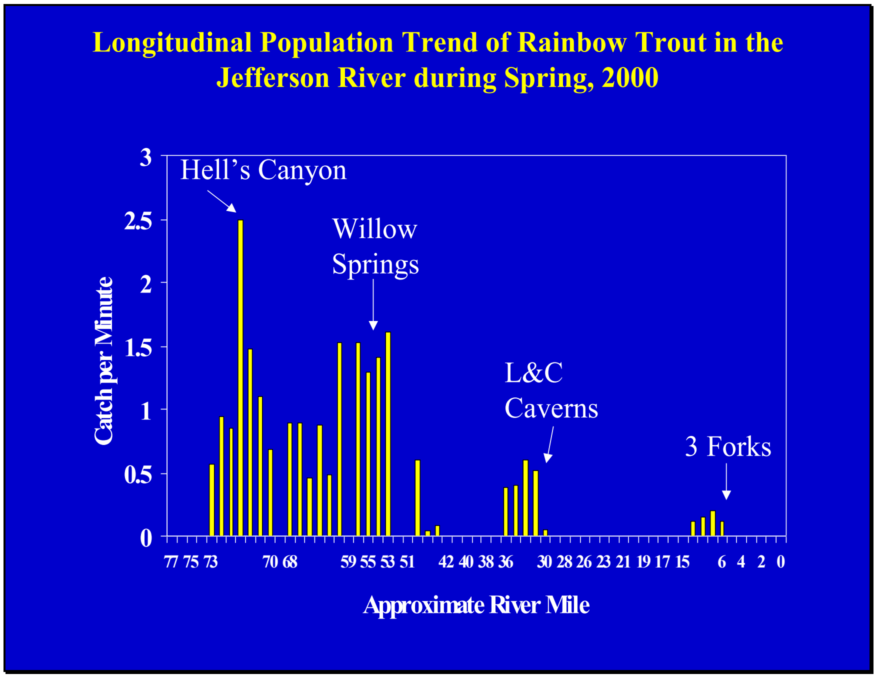
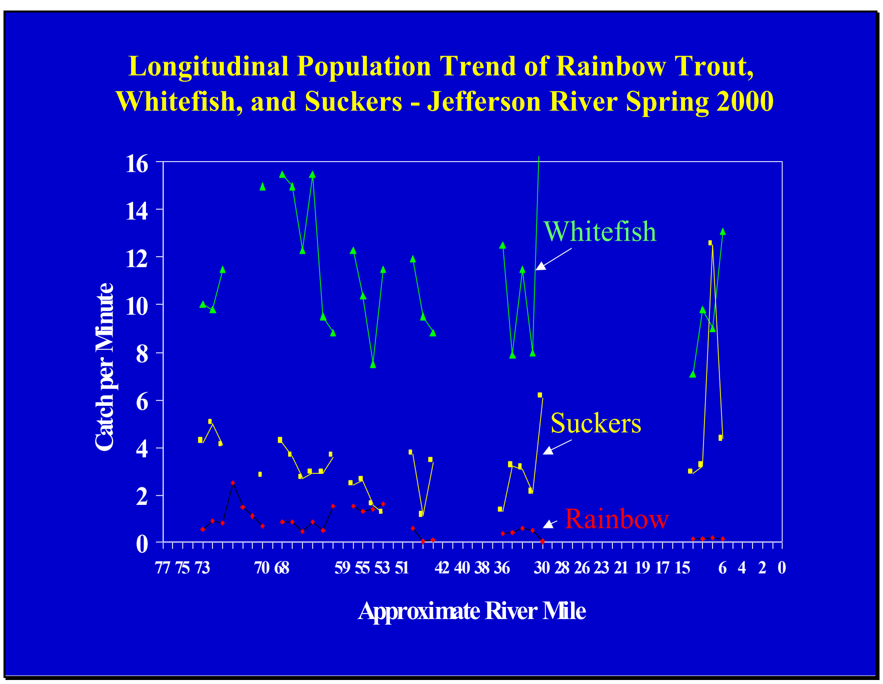


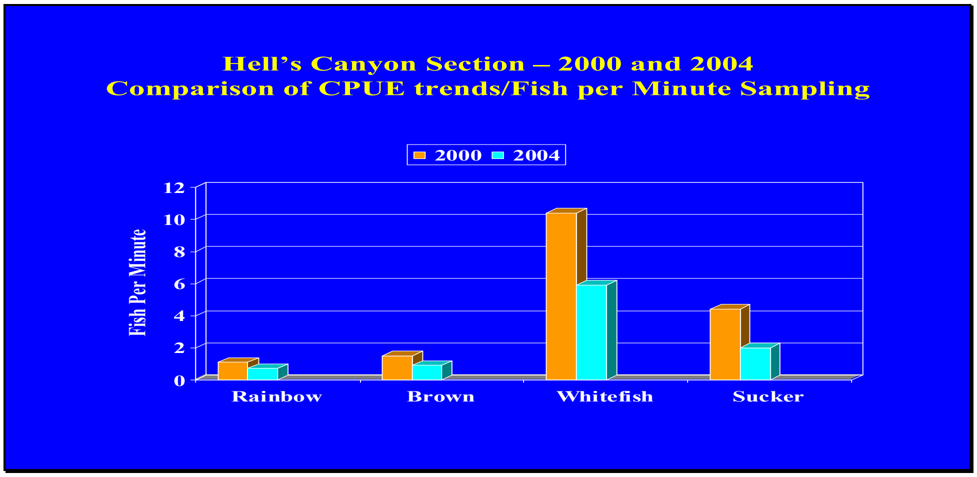
Figure 6. Map showing three long-term population estimate sections and three reaches of the Jefferson River where single pass, CPUE data was collected during 2000.

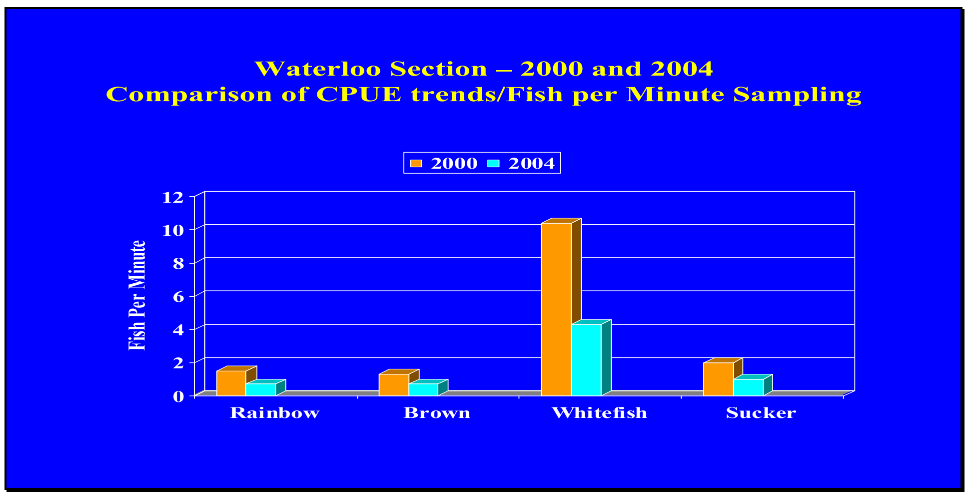
Although CPUE sampling techniques do not provide estimates of fish abundance, these surveys do provide a relative measure of abundance that appears to be sensitive to drought impacts. A comparison of CPUE results for brown and rainbow trout show a decline in numbers using population estimate techniques (Figures 7 and 8). Declining abundance of mountain whitefish and sucker species were also documented in all there study sections using CPUE sampling between 2000 and 2004 (Figures 15, 16, 17).

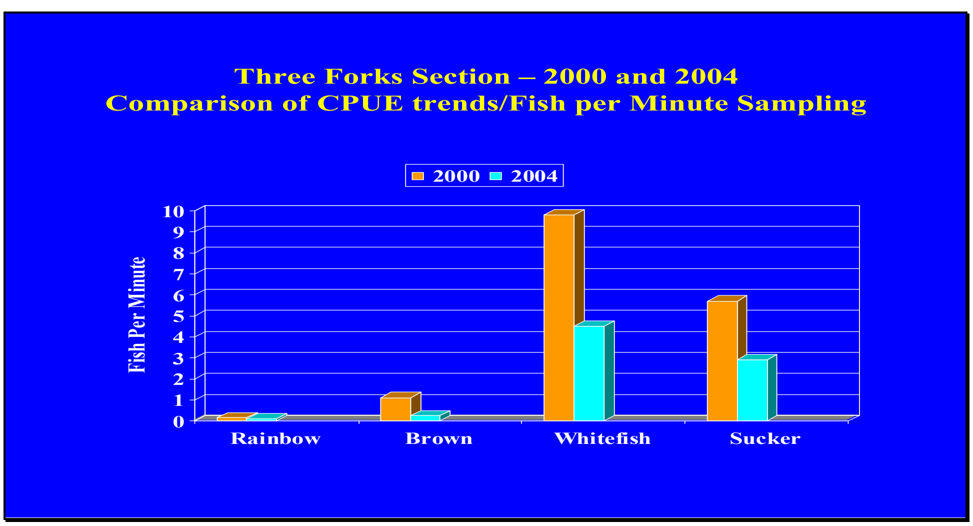




Figures 13 and 14. CPUE sampling results in the Jefferson River during 2000.







Figures 15, 16 and 17. Comparison of CPUE trends for four fish species in three Study Sections of the Jefferson River (2000-2004).

CPUE data improved understanding of important recruitment sources of brown and rainbow trout in the Jefferson River, and provided quantitative data for non-trout species during the drought event beginning in 2000. Flow conditions resulting in reductions of brown and rainbow trout populations were documented with population estimate data, but CPUE data indicated that these conditions were also resulting in population effects on mountain whitefish and sucker populations (Figures 15, 16, and 17). Since mountain whitefish and sucker species are not likely to have significant angling- related mortality, documentation of declines in whitefish and sucker abundance from 2000 to 2004 further reflect the cause of fish population reductions to be largely related to drought impacts.

COMPARISON OF CPUE AND POPULATION ESTIMATE TRENDS

Comparing results of population estimates conducted in the Waterloo Section to CPUE trends determined concurrently with population estimate sampling indicated that CPUE reliably assessed basic fish population trends (Figure 18). With the possible exception of an outlier in 2002, CPUE and population estimate results closely mirror the trends and relative magnitude of population response during the 2000 to 2007 period. Raw numbers used in the population estimate and CPUE procedure are presented in Table 1. The relatively high recapture rate in the population estimate procedure (R/C ratio for brown trout over 12” averaged 29%) probably accounts for the trend of CPUE closely matching the population estimate result. Relatively low electrofishing efficiency (R/C ratios of less than 10%) would likely result in a poor relationship between mark-recapture estimates of fish abundance and CPUE results.

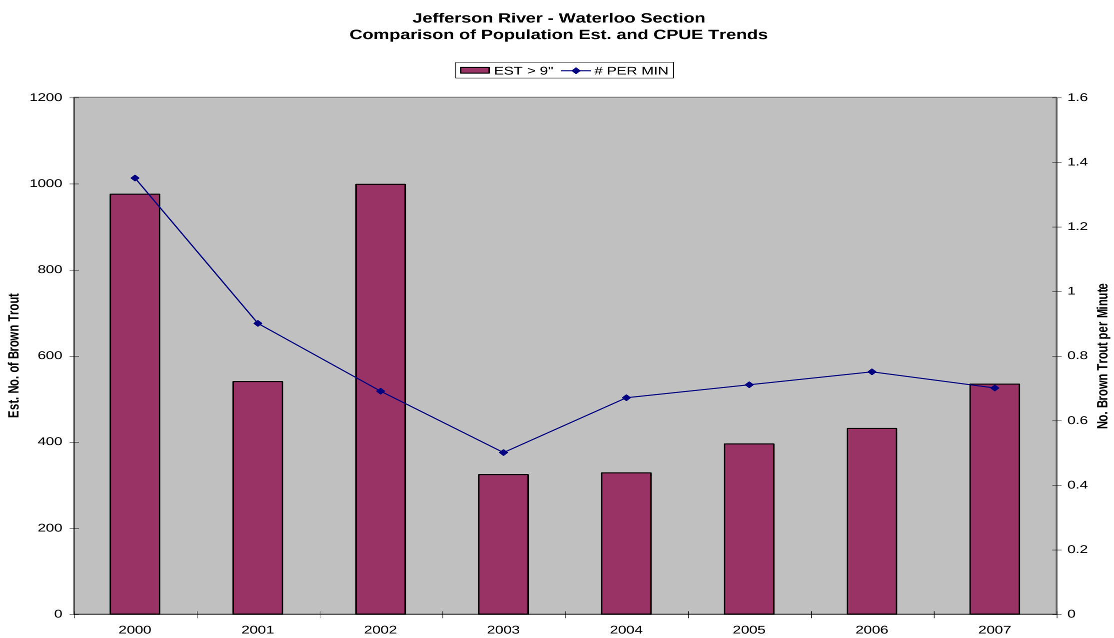


Figure 18. Comparison of Population Estimate and CPUE trends for brown trout in the Waterloo Section of the Jefferson River (2000-2007).

Table 1. Raw data for population estimate and CPUE comparisons at the Waterloo Section of the Jefferson River (2000-2007).

JEFFERSON RIVER AT WATERLOO; 3.5 MILE SECTION; SPRING SAMPLING FOR BROWN TROUT

YEAR	SIZE	POP EST	SD	CPUE	MARK	CAP	RECAP	R/C	# NEW
2000	0-8.9				17	10	0		27
	9-11.9	405	72		123	58	17	29%	
	>12.0	570	56		220	123	47	38%	
	ALL BNT			1.35/MIN					
2001	0-8.9	779	293		64	59	4		119
	9-11.9	203	63		48	24	5	21%	
	>12.0	337	38		114	76	32	42%	
	ALL BNT			0.90/MIN					
2002	0-8.9	83	40		7	20	1		26
	9-11.9	431	174		35	47	3	6%	
	>12.0	567	98		93	126	20	16%	
	ALL BNT			0.69/MIN					
2003	0-8.9	179	93		14	23	1		36
	9-11.9	74	36		14	9	1	11%	
	>12.0	250	25		90	101	36	36%	
	ALL BNT			0.50/MIN					
2004	0-8.9	62	27		4	24	1		27
	9-11.9	144	40		34	28	6	21%	
	>12.0	284	28		101	108	38	35%	
	ALL BNT			0.67/MIN					
2005	0-8.9	219	97		21	29	2		48
	9-11.9	35	6		18	14	7	50%	
	>12.0	360	49		118	81	26	32%	
	ALL BNT			0.71/MIN					
2006	0-8.9	747	309		40	72	3		109
	9-11.9	56	15		18	17	5	29%	
	>12.0	375	90		68	59	10	17%	
	ALL BNT			0.75/MIN					
2007	0-8.9	164	108		10	14	0		24
	9-11.9	184	45		48	33	8	24%	
	>12.0	350	79		68	60	11	18%	
	ALL BNT			0.70/MIN					

CHAPTER II
Projects to Enhance Trout Spawning and Rearing Habitat

Based on prior observations of the importance of tributary spawning and rearing and monitoring of fish trends throughout the river, a primary goal of enhancing spawning habitat received increased focus from 2000 to 2007. Spawning and juvenile rearing habitat in tributaries of the Jefferson River are most often limited by flow limitations, over-widened channels due to land use, high sediment impacting spawning substrate, and fish passage problems. Spawning habitat enhancement projects intended to correct these problems were conducted for the following tributaries from 2000 to 2007:

Willow Springs	Antelope Creek	Sappington Springs
Parson's Slough	Hamilton Spring Creek	Fish Creek
Boulder River	Hell's Canyon Creek	

An example of one tributary enhancement project is shown in Figure 19. The design considerations for tributary enhancement are primarily based on providing increased areas with clean gravel for trout egg deposition and providing suitable streamflow during egg incubation and juvenile out-migration. Although improved habitat for resident fish also occurs in some of these projects, creation of numerous pools and adult holding water habitat is intentionally minimized during design of most projects to maximize spawning/rearing benefits.

Implementing habitat enhancement projects requires significant effort to identify willing landowners, write grants, prepare stream enhancement designs, apply for permits, review water rights, conduct before and after project monitoring, and others. Trout Unlimited and FWP shared many of the tasks and few projects would have been completed between 2001 and 2007 without the partnership between these two entities.

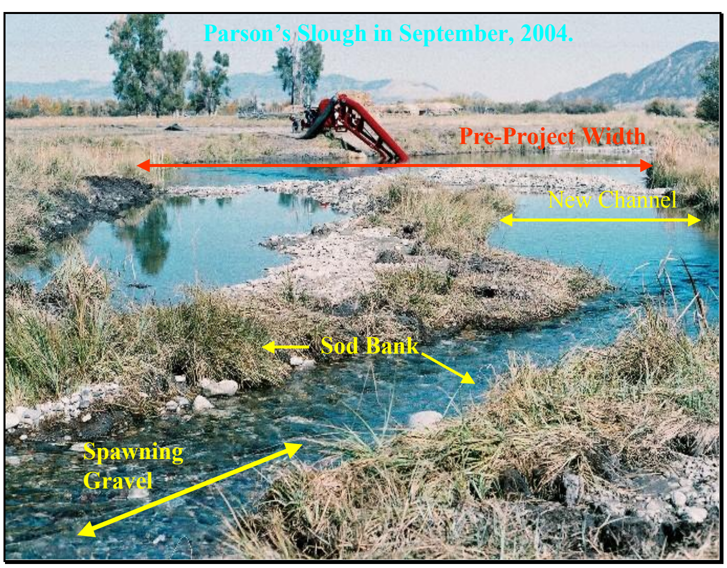


Figure 19. Example of project to enhance trout spawning/rearing habitat.

CHAPTER III

EVALUATION OF FISHERY TRENDS IN TRIBUTARIES TO THE JEFFERSON AND UPPER MISSOURI RIVER RELATED TO CHANGES IN STREAMFLOW PATTERN AND HABITAT RESTORATION ACITITIES (1990-2007)

Both the Jefferson and Missouri Rivers are impacted by low summer streamflow, and monitoring of the mainstem fisheries generally show a relationship between fish numbers and major shifts in summer flow. Another factor that significantly influences the sport fishery is the relative scarcity of healthy tributaries providing cold, clean water to the mainstem Jefferson River. The shortage of healthy tributaries results in few locations for successful trout spawning and juvenile trout rearing areas needed to provide recruitment of new fish to the system. Since mainstem flow depletion and a shortage of quality tributaries are believed to be the primary limiting factors for the Jefferson and Upper Missouri River trout fisheries, these aspects of the fishery and the associated habitat are the primary topics of interest for fisheries monitoring.

This report summarizes results from electrofishing surveys on 16 spawning tributaries of the Missouri River and Jefferson River. The relatively simple and inexpensive technique of making a one pass electrofishing run and calculating the Catch-Per-Unit-Effort (CPUE) was used to determine basic trends in the number of juvenile trout residing in these spawning and nursery tributaries.

Monitoring results of fish response to tributary enhancement projects from 1986 to 2007 indicate that such projects have significant potential to improve the trout population of the Jefferson River. Results of Catch-Per-Unit-Effort (CPUE) electrofishing surveys are presented for nine tributaries of the Jefferson River. Similar monitoring of seven tributaries of the Missouri River is also included in this report to provide an expanded sample size to evaluate broad trends in juvenile trout abundance.

METHODS

This report summarizes results from 16 tributaries over a number of years beginning in 1992. A single pass using a backpack electrofishing unit was used to collect fish and the distance and time sampled was recorded. Fish were captured using a dip net and a measurement of total length was recorded. In most cases, a two-person crew (electrofisher and dip netter) was used to sample the entire channel during the summer or fall period.

Sampling sections were generally located near the mouths of streams or near typical spawning locations of fish migrating from the mainstem river. The sections were typically 100 to 300 feet in length, and sampling time was generally 800 to 2000 seconds in duration. The technique generally took minimal effort, and 2 or 3 streams could be surveyed per day. The same location was sampled each year (Figure 12; page 37).

The streams selected for sampling was based on known observations of spawning fish migrating into these tributaries from the mainstem rivers, or to evaluate the number of juvenile trout present in the section before and after projects were implemented to enhance spawning attributes of tributaries. The basic assumption of this sampling method is that CPUE trends determined in the late summer and fall reflect the relative quality of these streams related to spawning and rearing potential.

An example of the potential use of this sampling technique is to determine abrupt changes in juvenile density due to major changes in habitat or fish survival (eg. dewatering due to drought, rainbow trout mortality due to disease, or fish response due to habitat improvements and imprinting of eggs or fry). The technique was not assumed to be appropriate for detecting small changes in fish populations or year class strength. Since fall electrofishing surveys for juvenile trout (young-of-the-year) reflect success of spawning activity, egg incubation success, and rearing conditions during summer after fry emerge from redds, this technique provides a broad assessment of the suitability of the spawning stream for a portion of the year. Since rainbow trout spawn from March through April in most of these streams, CPUE of rainbow trout juveniles during November provide an assessment of the stream's ability to support reproduction from March through November of a given year. Since brown trout spawn in October and November, CPUE trends for juvenile brown trout during the following November provide an assessment of the suitability of the stream for spawning and rearing for approximately the previous 12 months.

The abundance of juvenile trout determined near the mouth of these 16 spawning tributaries is generally considered to reflect hatching and survival of fish produced in the tributary, and not a result of juvenile trout migrating into a specific tributary from a mainstem river. However, it is known that juvenile trout from the mainstem river can migrate into these tributaries and influence the CPUE trend. For example, an electrofishing survey of an artificial spawning channel of the Missouri River (Crow Creek Spawning Channel) found more brown trout juveniles than rainbow trout despite the fact that the channel was dry during the brown trout spawning period. These fish presumably migrated into the channel from the Missouri River during the summer.

Both the Jefferson and Missouri Rivers are impacted by low summer streamflow, and monitoring of the mainstem fisheries generally show a relationship between fish numbers and major shifts in summer flow. Another factor that significantly influences the sport fishery is the relative scarcity of healthy tributaries providing cold, clean water to the mainstem Jefferson River. The shortage of healthy tributaries results in few locations for successful trout spawning and juvenile trout rearing areas needed to provide recruitment of new fish to the system.

RESULTS

CATCH-PER-UNIT-EFFORT ELECTROFISHING

Electrofishing surveys were conducted in several trout spawning tributaries (16 streams) of the Missouri River and Jefferson River from 1992 through 2007. A single pass using a backpack electrofishing unit during the late summer or fall provides a relative index of the number of juvenile trout residing in each tributary. The technique does not provide an estimate of total numbers of fish, but can provide general trends in response to changes in habitat, flow and species composition. Significant changes in fish numbers resulting from habitat enhancement can be detected using this technique, and tables showing trends of brown trout and rainbow trout are presented in this summary. Based on general observations in several streams over a number of years, it appears that catch rates of 0 to 1.0 juvenile fish per 100 seconds indicates low spawning/rearing success. Catch rates of 1.0 to 3.0 fish per 100 seconds indicates moderate spawning/rearing success, and catch rates exceeding 3.0 fish per 100 seconds indicates that significant spawning and rearing occurred in the stream during a specific year. The best spawning/rearing tributaries in the study area occasionally yielded 8 to 10 trout per 100 seconds during exceptional production years.

Several tributaries of the Missouri River show a trend of decreasing abundance of rainbow trout juveniles after the severe drought beginning in about 2000 (Table 1). Another finding of this evaluation was that the abundance of rainbow trout juveniles increased after imprinting fish and or eggs and conducting enhancement of spawning habitat in at least three of the streams sampled. Examples of this response to imprinting and/or habitat enhancement are presented in this summary. In addition, trout population estimate information for the Waterloo Section of the Jefferson River indicated that improved recruitment of juvenile rainbow trout provided potential benefits of tributary restoration to the fishery in the mainstem river where rainbow trout estimates showed an increasing population (Figure 6). The increased numbers of rainbow trout was most apparent for small fish less than 8 inches in length (Figure 7). Both Willow Springs and Parson's Slough enter the Jefferson River in the Waterloo monitoring section (Figure 3).

Since the ratio of brown trout to rainbow trout juveniles is an unbiased result of the CPUE survey (electrofishing efficiency is likely very similar for the two species), relatively small changes in the ratio of brown trout and rainbow trout are likely to be detected. Two streams with long term CPUE trends of both brown and rainbow trout show relatively stable brown trout numbers during periods of changing rainbow trout abundance (Figures 8 and 9). One stream (Confederate Creek) experienced a near complete loss of brown trout during the period (Figure 10), and one stream showed a significant decline of both trout species since 1992 (Figure 11).

Table 1. Summary of catch-per-unit-effort (CPUE) electrofishing surveys of juvenile **rainbow trout** in selected spawning tributaries of the Jefferson River and Missouri River. The CPUE value for each stream represents the number of age 0 **rainbow trout** (<120 mm) captured per 100 seconds of electrofishing during the period, 1992 to 2006.

Creek Name	‘92	‘93	‘94	‘95	‘96	‘97	‘98	‘99	‘00	‘01	‘02	‘03	‘04	‘05	‘06	‘07
Willow Springs	1.5	---	2.4	5.0	---	---	6.1	9.1	---	9.8	4.3	1.8	3.1	6.3	3.8	10
Hells Canyon	5.6	---	---	3.0	3.8	4.0	2.6	1.6	---	3.3	4.7	6.2	5.5	7.2	3.0	2.9
Parson’s Slough												0.0	1.6	0.2	9.4	2.4
Sappington Spring															2.4	2.6
Antelope Creek													0.2		0.2	0.1
Hamilton Spring														0.1	0	--
Fish Creek														0.1		
Sl. House Slough														0.0		
Willow Creek																0.0
Missouri River Tributaries:																
Beaver Creek	0.3	---	---	5.8	2.2	6.7	2.5	2.1	---	3.5	---	---	1.2	0.6		1.1
Deep Creek	0.8	---	---	1.8	0.8	---	3.9	3.0	---	0.0	0.3	---	0.6	0.1	0.1	0.1
Dry Creek	---	---	---	2.2	---	---	3.6	0.0	---	0.0	---	---	2.5	0.4	0.0	0.0
Magpie Creek	---	---	---	4.7	2.6	---	---	---	--	---	0.1	---	0.16	0.0	9.8	--
Confederate Creek	7.4	4.4	---	6.6	3.8	2.6	2.8	3.0	---	11.4	2.1	2.6	3.0	0.3	0.4	2.2
Marsh Creek				1.1				0.2				0.0			0.1	0.6
Big Springs				1.9											2.1	5.1

Table 2. Summary of catch-per-unit-effort (CPUE) electrofishing surveys of juvenile **brown trout** in selected spawning tributaries of the Jefferson River and Missouri River. The CPUE value for each stream represents the number of **brown trout** (<130 mm) captured per 100 seconds of electrofishing during the period, 1992 to 2005.

Creek Name	‘92	‘93	‘94	‘95	‘96	‘97	‘98	‘99	‘00	‘01	‘02	‘03	‘04	‘05	‘06	‘07
Willow Springs	1.5	---	1.3	0.9	---	---	2.5	0.5	---	3.2	0.6	0.5	0.4	0.1	0.9	2.2
Hells Canyon	3.4	---	---	1.4	0.5	0.7	0.7	1.8	---	0.6	2.4	0.4	0.6	2.0	2.4	1.1
Parson’s Slough												0.08	1.2	0.4	0.3	2.1
Sappington Spring															3.1	2.6
Antelope Creek													1.3		1.5	0.9
Hamilton Spring														0.1	0.1	--
Fish Creek														1.0		
Sl. House Slough														2.2		
Willow Creek																0.1
Missouri River Tributaries																
Beaver Creek	0.2	---	---	0.0	0.5	0.04	0.07	0.0	---	0.2	---	---	0.9	0.0	--	0.0
Deep Creek	3.6	---	---	0.3	0.3	---	0.3	1.4	---	0.0	0.3	---	0.7	0.6	0.1	0.0
Dry Creek	---	0.0	0.0	---	---	0.0	0.0	0.0	---	0.0	0.0	---	0.0	1.0	0.0	0.0
Magpie Creek	---	---	0.0	---	0.0	---	---	---	--	---	0.0	---	0.0	0.0	0.0	--
Confederate Creek	3.9	3.5	---	0.2	0.06	0.1	0.3	0.6	---	0.0	0.8	0.1	0.0	0.2	0.2	0.0
Marsh Creek				0.1		0.1		1.8				0.9			0.6	4.6
Big Springs				1.2											0.2	0.5

TABLE SUMMARY: Jefferson River Tributaries

Willow Springs: Initial habitat improvement took place in 1987 and additional improvements were made in April 2005. No rainbow trout were observed in this tributary in the mid-1980's, and the first spawning took place in 1991 (three years after imprinting rainbow trout from Hell's Canyon Creek). Fry production after habitat improvement and imprinting was significantly improved by the project, and an increase in the number of rainbow trout residing in the Jefferson River near Willow Springs was observed throughout the 1990's. Redd counts for rainbow trout spawning in Willow Springs show a progressive increase since 1991 (Figure 2) and a general increase in juvenile rainbow trout accompanied the increased number of redds (Figure 8). The abundance of age 0 rainbow trout frequently exceeded 3.0 fish per 100 seconds, which was among the highest density of all tributaries surveyed. Four years of egg collection (approximately 10,000 eggs per year) from the Willow Springs spawning run (2004 – 2007) have not impacted juvenile rainbow trout abundance based on CPUE result.

Hells Canyon: Prior to 1991, when rainbow trout began spawning in Willow Springs (see above), Hells Canyon Creek was the only major rainbow trout spawning tributary for the upper Jefferson River. Abundance of juvenile rainbow trout appeared to decline in the late 1990's during early observations of Whirling Disease effects, but numbers recovered from 2000 to 2005 (Figure 9). A project to install a fish screen and to implement a water lease on an irrigation canal was completed in the fall of 1996 after dewatering impacts and fish loss to the irrigation system was documented. Water lease requirements have been met since project was implemented in 1996. Rainbow trout fry numbers have maintained a level near the long-term average despite Whirling Disease and the severe drought of 2000-2006. The water lease has maintained sufficient flow in the stream to allow rearing of large numbers of young rainbow trout as shown by the catch-per-unit-effort table. Installation of a fish screen has prevented the loss of thousands of juvenile trout each year. Information on this evaluation, including flow measurements, is presented in the water leasing report. The abundance of brown and rainbow trout juveniles have fluctuated since 1992, but numbers have not significantly declined despite drought conditions, in part, because of the water lease agreement.

Parson's Slough: Habitat improvement and imprinting rainbow trout eggs resulted in the first juvenile rainbow trout observed in this spring creek in 2004. Successful imprinting of rainbow trout eggs from Willow Springs in 2006 resulted in one of the highest catch rates of juvenile rainbow trout observed in any tributary surveyed in the Missouri River and Jefferson River. Additional habitat improvement was conducted during 2007 in Parson's Slough using funds from FFIP and other sources. The trend for brown trout is positive, and rainbow trout returning to Parson's Slough after imprinting was first documented in 2006. See pages 29-33 for more detailed results.

Sappington Spring: This small (<5 cfs) spring was constructed during fall 2005 to provide spawning and rearing habitat for brown and rainbow trout resident to the Jefferson River. One brown trout redd was observed soon after construction in 2005 and

5 redds were observed in 2006. No rainbow trout redds were observed in spring 2006. Rainbow trout eggs from Willow Springs were imprinted in 2006 and 2007, and moderate abundance of juvenile brown and rainbow trout was observed in the fall CPUE survey (Tables 1 and 2).

Antelope Creek: Elimination of an irrigation canal and habitat enhancement were implemented in fall/winter of 2005. Five brown trout redds were observed in the project area in 2006. CPUE survey results before and after the project showed similar numbers of brown and rainbow trout after the first two years (2006 and 2007) of project completion (Table 1 and 2).

Fish Creek: Brown trout fry were present, but not common, in the proposed enhancement reach and rainbow trout fry were rare prior to restoration (2005). Brown trout spawning was documented in the enhancement reach during fall 2007, and post project CPUE sampling in 2008 will be conducted to evaluate fish survival.

Slaughterhouse Slough: Brown trout fry were present in this slough (side channel) near the Piedmont Bridge crossing in 2005, but no rainbow trout fry were observed. Continued restoration of Fish Creek and improved flow conditions in Slaughterhouse Slough is expected to provide improved habitat for rainbow trout. Continued monitoring will determine the need for rainbow trout imprinting.

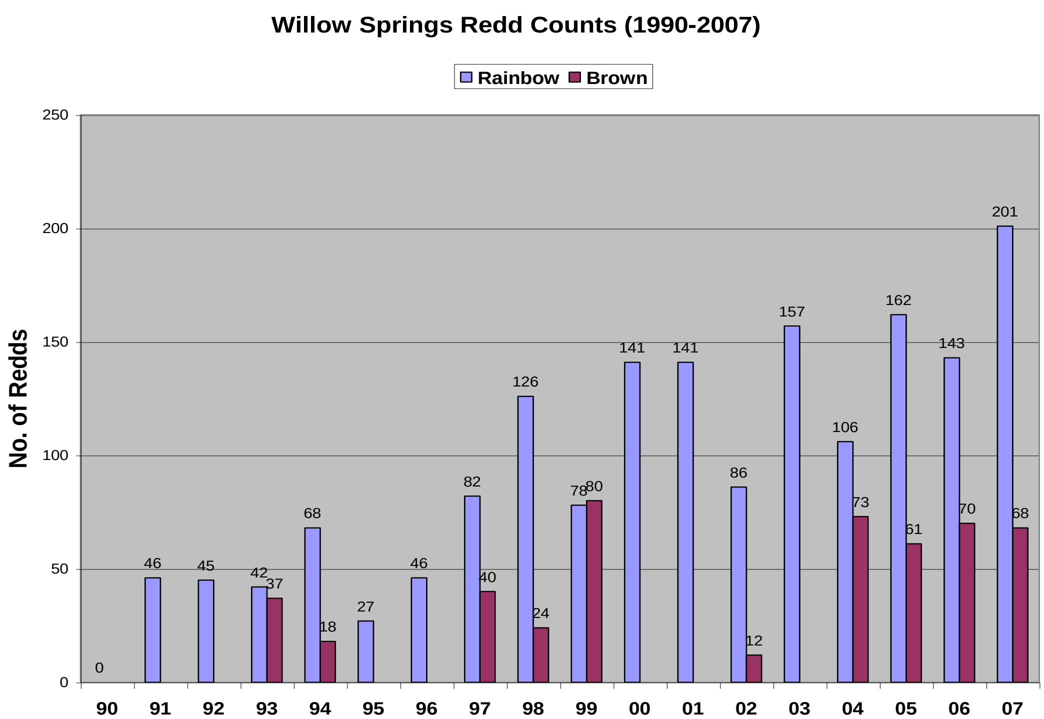


Figure 1. Brown and rainbow trout redd counts in Willow Springs from 1990 to 2007.

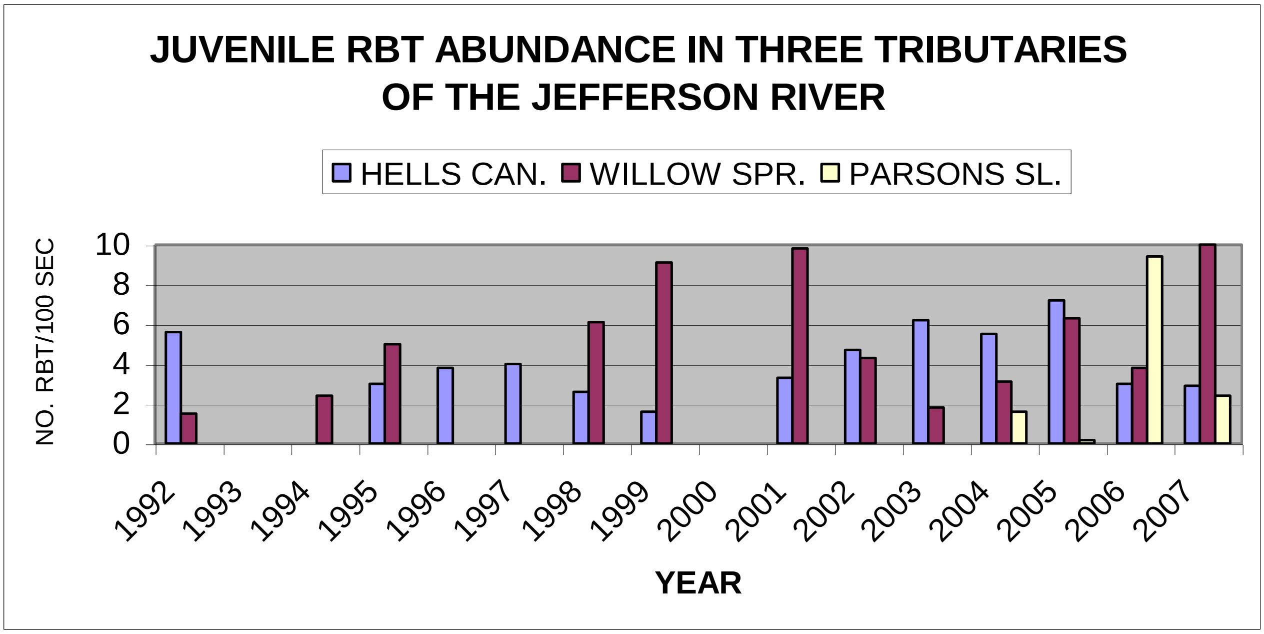


Figure 2. Juvenile rainbow trout Catch-per-Unit-Effort trends for three tributaries to the Jefferson River (HCAN=Hells Canyon Creek, WSPR=Willow Springs, PARS=Parson's Slough).

Willow Creek: The first CPUE survey was conducted in 2007. Low density of brown trout juveniles and no rainbow trout juveniles were observed. Willow Creek is influenced by seasonal flow releases from Harrison Lake, and future sampling will determine the potential recruitment value of this tributary.

Hamilton Spring Creek: Low densities of both trout species were observed in 2005 and 2006 after imprinting rainbow trout eggs. High sediment loading appears to impact egg survival and future monitoring is needed to evaluate benefits from a riparian fence installation.

THE PARSON'S PROJECT

Parson's Slough enters the Jefferson River about one mile downstream of Parson's Bridge. Habitat enhancement work to improve spawning and rearing attributes of this small tributary was initiated by a private landowner, Trout Unlimited, and MDFWP in 2003.

A fall electrofishing survey was conducted above Loomont Lane was initiated during fall 2003. A very low number of brown trout juveniles and no rainbow trout were observed in 2003. This sampling confirmed the need for initiating rainbow trout imprinting of the spring creek in a similar manner to work conducted in Willow Springs in the late 1980's. Both Willow Springs and Parson's Slough are streams heavily influenced by groundwater and spring seepage, and the streams were wide, shallow and the stream bottom was dominated by large amounts of fine sediment. Both streams were modified to narrow the channel, protect streambanks from livestock, and in some cases appropriately sized gravel was added to the system.

Phase I of Parson's Slough habitat enhancement took place during summer/fall 2004 above Loomont Lane. Imprinting of rainbow trout eggs from the Willow Springs spawning run was initiated in 2004. Imprinting was conducted in 2004, 2005, and 2006. Phase II of the habitat enhancement project was conducted during February and March of 2007 from Loomont Lane to the mouth of Parson's Slough. About 0.27 miles of habitat is located below Loomont Lane and 0.85 miles of habitat is located above Loomont Lane.

Rainbow Trout Spawning Observations:

No rainbow trout redds were observed in 2004 and 2005. In 2006, the first documented rainbow trout spawning occurred when nine redds were counted: 3 redds below Loomont Lane and 6 redds above Loomont Lane. A total of 32 redds were counted in 2007: 14 redds below Loomont Lane and 18 redds above Loomont Lane.

Brown Trout Spawning Observations:

On 1 December 2004, we counted 16 brown trout redds (6 below Loomont Lane, and 10 within the newly constructed habitat above Loomont Lane). On 23 November 2005, we counted 26 total redds in Parson's Slough (11 below Loomont Lane, and 15 above Loomont Lane). In 2006, 51 brown trout redds were counted: 13 redds below Loomont Lane and 38 above Loomont Lane). Three counts during November 2007 found a total of 64 brown trout redds (29 below Loomont Lane and 35 redds above Loomont Lane.

Fall Electrofishing to monitor fry production:

Rainbow trout fry were not present prior to imprinting based on sampling in 2003. During fall 2004, significant numbers of rainbow trout fry were observed indicating the imprint planting during the summer was very successful. This success was evident during Jefferson River electrofishing in April 2005, when rainbow trout yearlings were about 4 times more abundant than previously observed in the Waterloo Section. Rainbow trout fry were present, but not common in 2005, indicating that 2005 imprinting was not very successful as suspected when observing high fry mortality in hatching boxes. The successful imprint of rainbow trout fry in 2006 resulted in a very high density of YOY rainbow trout during the fall survey (Table 3). As a result of the high number of juvenile rainbow trout observed in 2006 and the presence of the first documented rainbow trout spawning during 2006, no additional imprinting of rainbow trout eggs from Willow Spring was conducted in 2007. The relatively high number of juvenile rainbow trout observed during fall 2007 was a product of natural reproduction with no supplementation of imprinted fish.

Brown trout fry above Loomont Lane was very low in 2003. Sampling in 2004 and 2005 was conducted below Loomont Lane and brown trout fry abundance was similar during the two years (Table 3). After additional channel modification was conducted in 2007, the number of brown trout fry observed during the fall was the highest observed during the study period.

Table 3. Juvenile trout abundance in Parson's Slough during the fall (2003-07).

	Brown Trout/100 Seconds	Rainbow/100 Seconds
2003	0.16	0
2004	1.6	1.9
2005	1.5	0.2
2006	0.3	9.4
2007	2.1	2.4

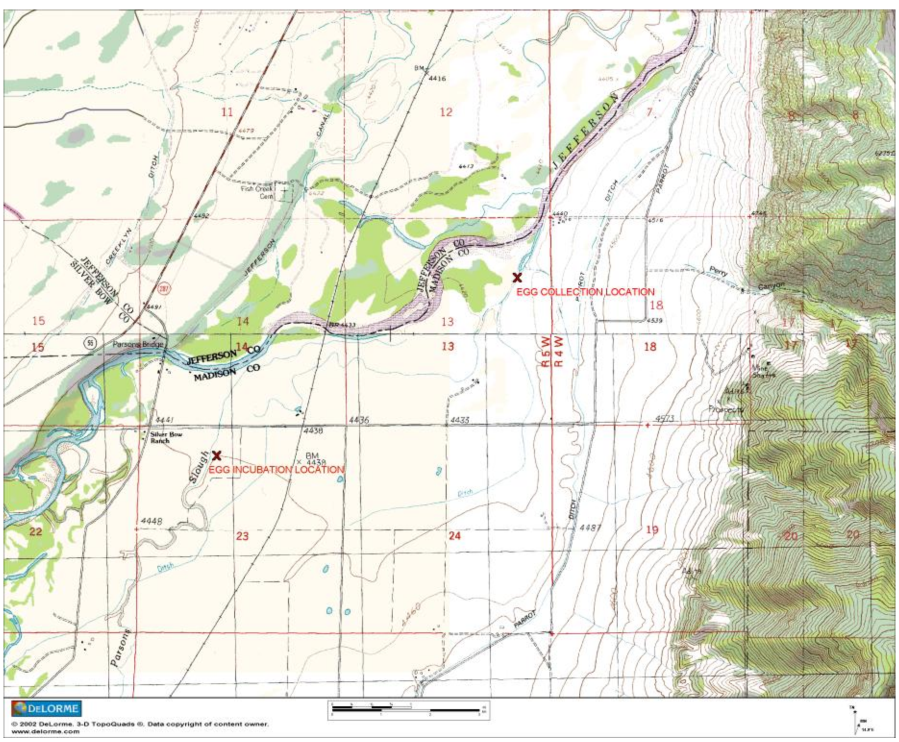
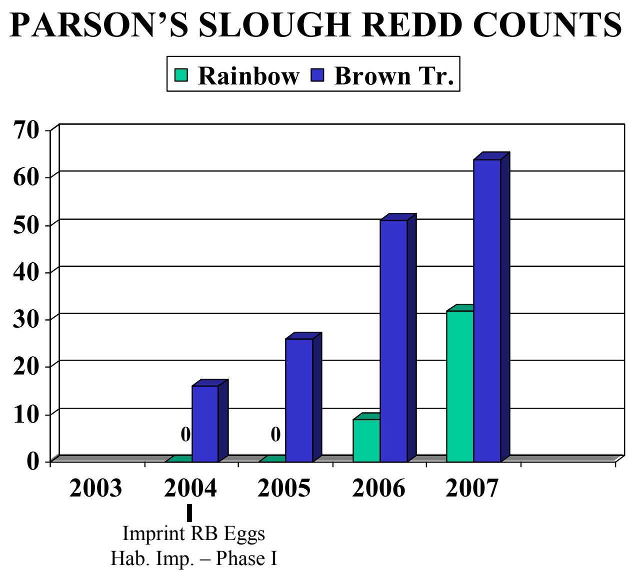
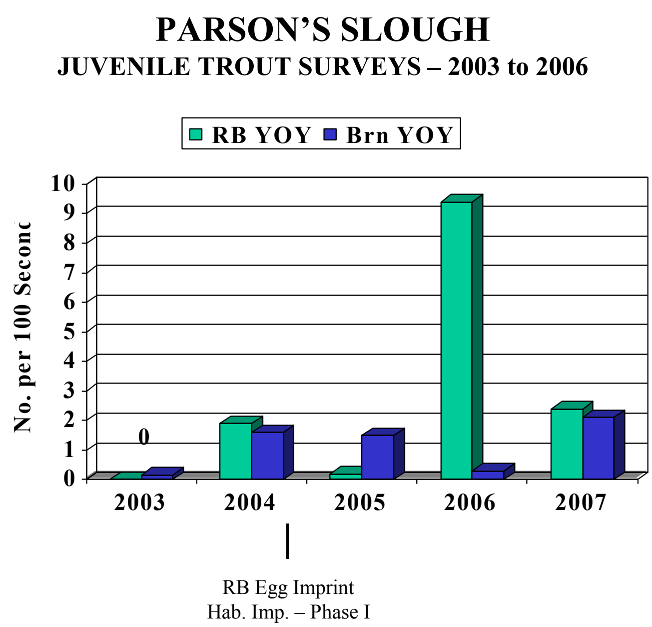


Figure 3. Map of Parson's Slough and Willow Springs showing rainbow trout egg collection location (Willow Springs) and egg incubation location (Parson's Slough).





Figures 4 and 5. Brown and rainbow trout redd count results and juvenile trout CPUE trends (2003-2007).

Rainbow Trout Population Trend in the Waterloo Section, Jefferson River (2000 to 2007)

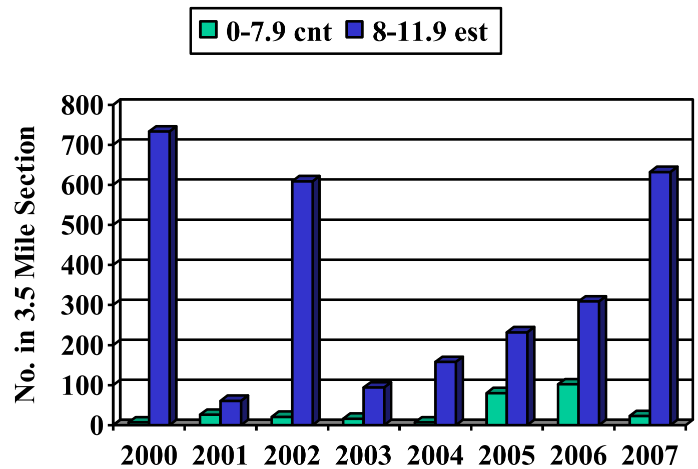


Figure 6. Rainbow trout abundance in the Waterloo Section of the Jefferson River during springtime electrofishing. Yearling rainbow trout (0 to 7.9 inches) represent the total number captured during the survey and age II trout (8 to 11.9 inches) represent the estimated number using Mark/Recapture techniques. Rainbow trout over 12 inches were not included due to bias resulting from spawning movements.

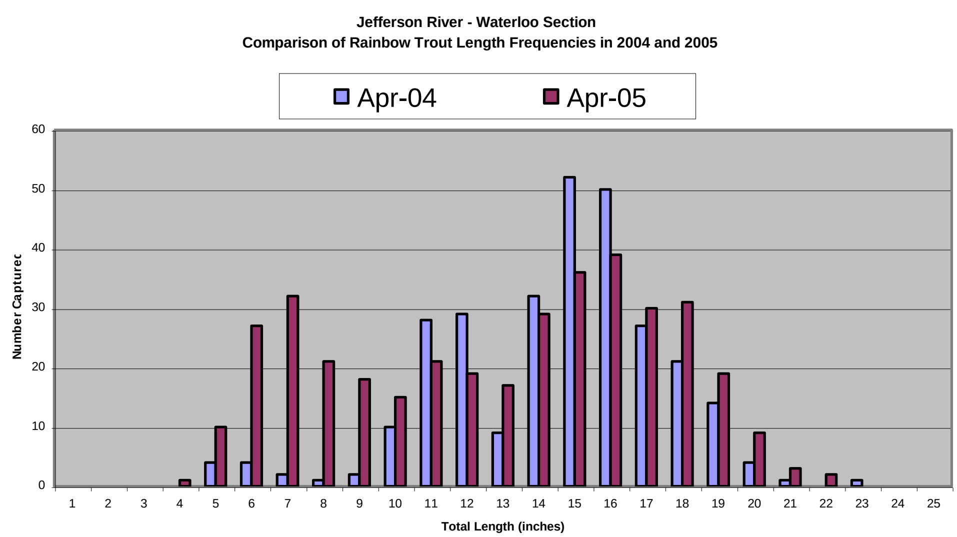


Figure 7. Length frequency of rainbow trout in the Waterloo Section (2004-05).

Missouri River/Canyon Ferry Reservoir Tributaries

Catch rates of juvenile trout were also monitored for several tributaries in the Missouri River/Canyon Ferry Reservoir complex to evaluate spawning and rearing success. See Tables 1 and 2 to review trends in abundance. The most extensive fishery monitoring of Missouri River tributaries was conducted in Deep Creek and Confederate Creek and these results are presented in more detail in the Toston Mitigation report.

Beaver Creek: Severe flow limitations have reduced rainbow fry abundance during the recent drought (no habitat or flow improvement has been conducted). The CPUE tables show catch rates of less than 1 trout per 100 seconds of sampling during most years after 2000 and fish abundance was generally reduced compared to the pre-2000 sampling.

Deep Creek: Fry migration and adult spawning surveys have also been conducted (see a more detailed evaluation of Deep Creek in this report). Low streamflow has reduced rainbow trout fry abundance compared to the mid-1990's, and effects of Whirling Disease also appear to impact spawning success based on the declining trend in CPUE and the frequent observations of fish with deformities.

Dry Creek: Juvenile rainbow trout are completely absent during some years, and at moderate levels during other years. Supplemental water delivered for egg incubation has variable success in this stream. Streamflow is very low during fall and winter and brown trout generally do not spawn successfully in Dry Creek.

Magpie Creek: Rainbow spawners pass upstream of the fish ladder in most years. Abundance of juvenile rainbow trout above the ladder is much reduced from levels observed in the mid-1990's and no rainbow trout were observed in 2005. Surprisingly, an extremely high number of juvenile rainbow trout were observed above the fish ladder in 2006, indicating favorable fish passage and high spawning success (Table 1).

Confederate Creek: Juvenile rainbow trout abundance has maintained a level near the long-term average in recent years, despite the severe drought. Brown trout abundance has declined in recent years and virtually no brown trout redds have been observed in this stream in the past five years. Habitat improvement was conducted in 1991.

Marsh Creek: Juvenile brown and rainbow trout abundance has remained low throughout the years of sampling. No habitat improvement has been conducted in this stream, but future potential exists to provide spawning and rearing for trout due to a spawning run that occasional enters the system.

Big Springs: An artificial spawning channel was constructed at Big Springs in September 1994. About 20 to 40 brown trout redds and over 50 rainbow trout redds have been counted annually for the past 13 years. CPUE surveys were conducted during three years: juvenile rainbow trout were common with an increasing trend and brown trout were less abundant with a decreasing trend.

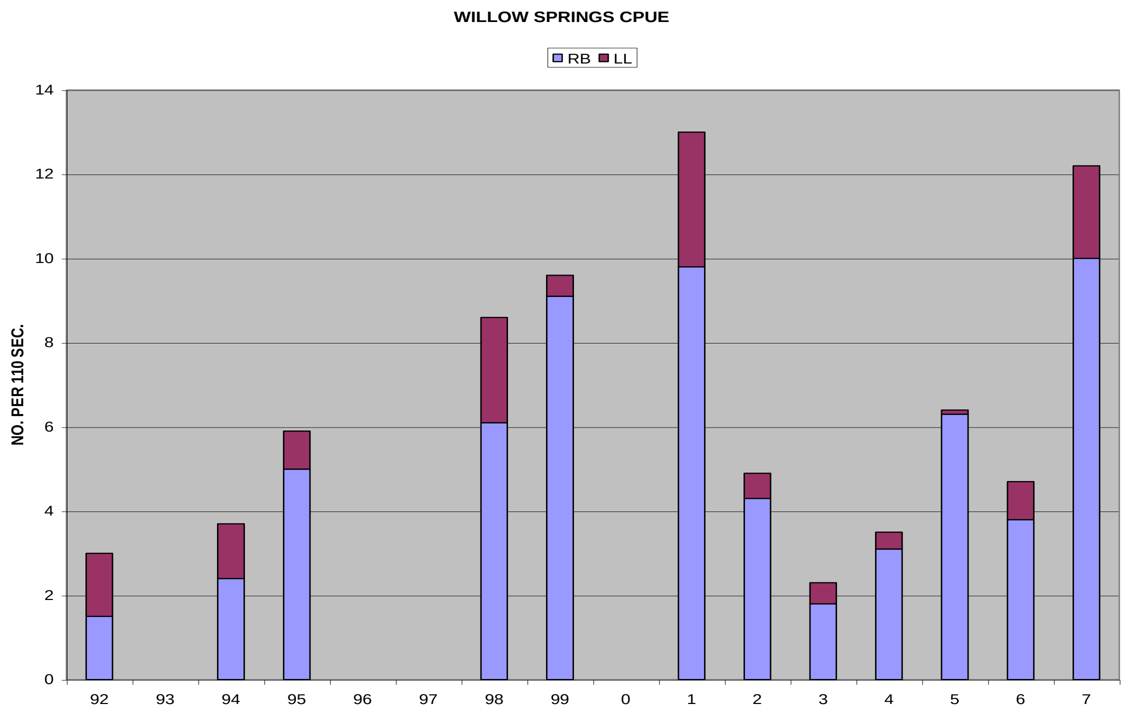


Figure 8. Brown and rainbow trout CPUE trend in Willow Springs (1992-2007).

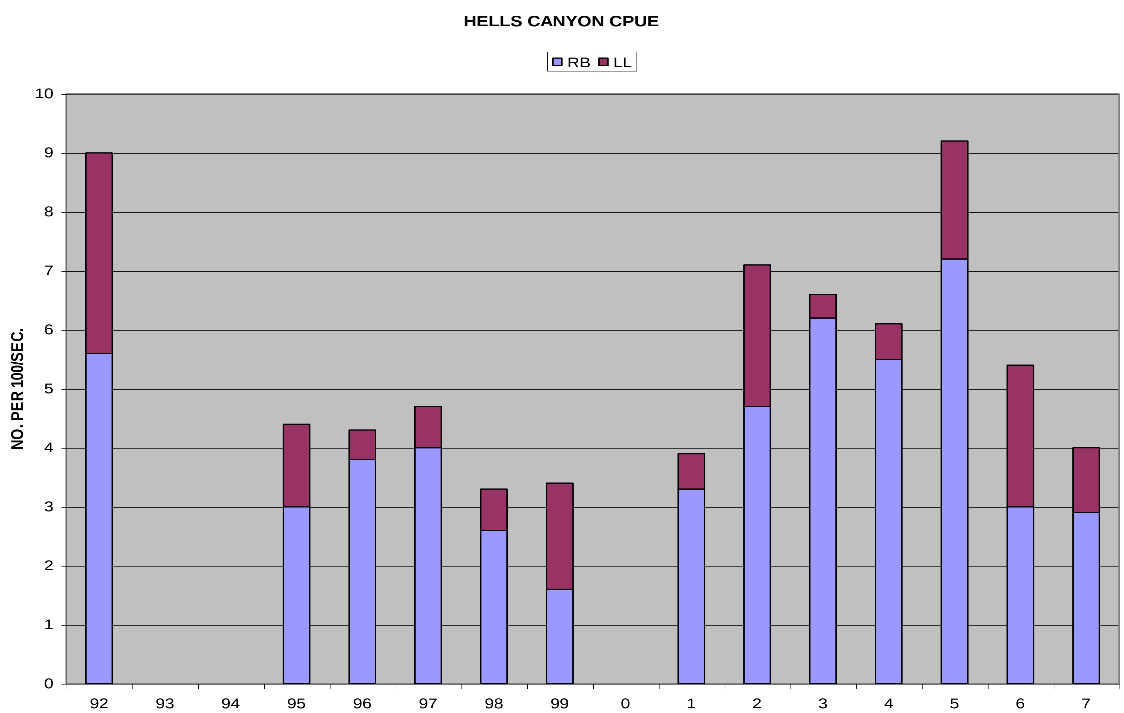


Figure 9. Brown and rainbow trout CPUE trend in Hells Canyon Creek (1992-2007).

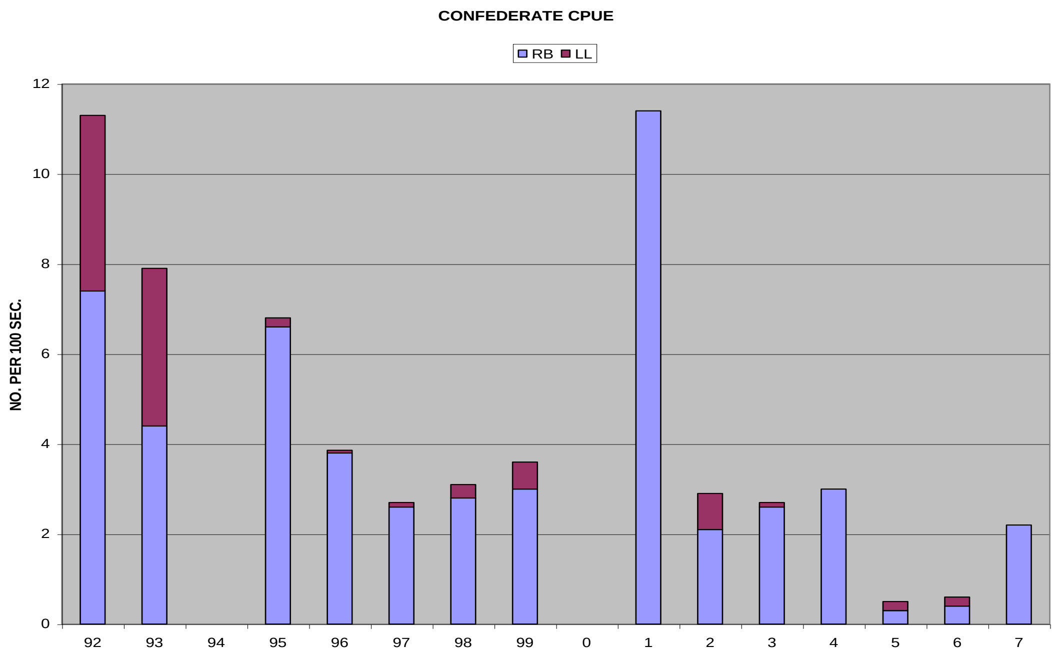


Figure 10. Brown and rainbow trout CPUE trend in Confederate Creek (1992-2007).

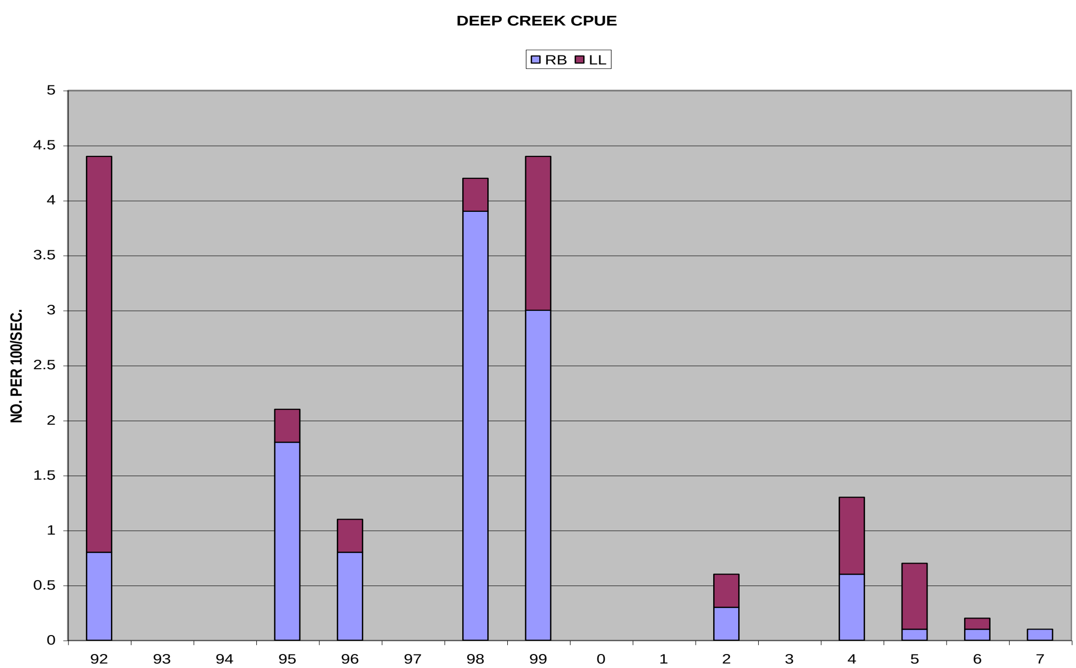


Figure 11. Brown and rainbow trout CPUE trend in Deep Creek (1992-2007).

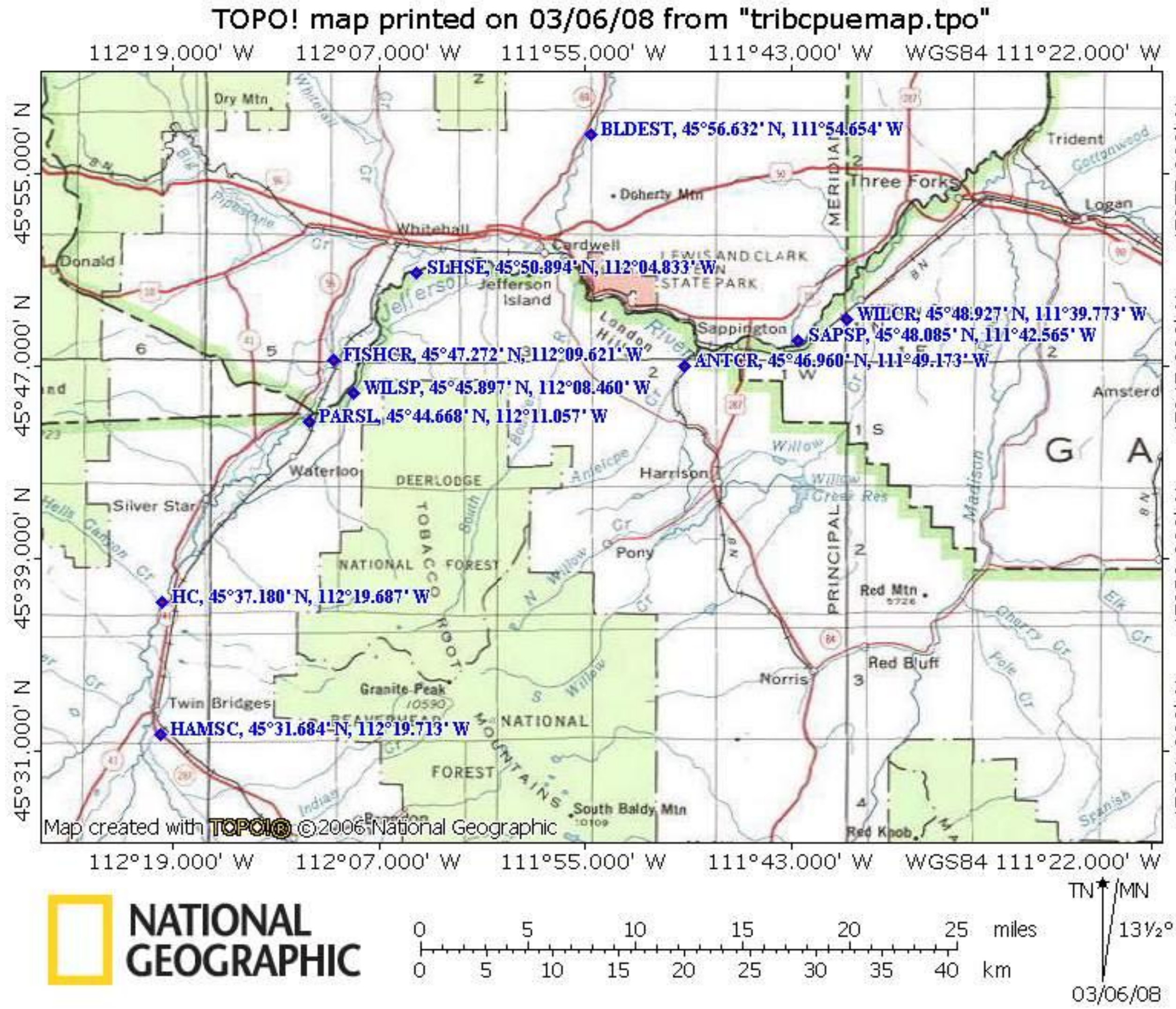


Figure 12. Location of CPUE sampling sections for tributaries of the Jefferson River.

Summary of Tributary Evaluations

Catch-per-unit-effort (CPUE) sampling of several tributaries over a long period of time provided information to assess the spawning and nursery function of streams. Some streams showed a measurable decline in juvenile abundance due to low flow conditions (Deep Creek, Beaver Creek). Hells Canyon Creek and Willow Springs did not experience similar declines in juvenile trout abundance during the same period. The water lease in Hells Canyon Creek and the relatively stable flow regime of Willow Springs may have helped avoid fish loss during the series of low flow years starting in 2000. CPUE sampling was effective for evaluating success of imprint planting at Willow Springs, Parson's Slough, and Sappington Springs, and the sampling method established a baseline of juvenile trout abundance for several other streams in the project area.

CHAPTER IV
Boulder River Fishery Evaluation

Monitoring of fish population abundance, spawning movements of brown trout, and redd construction by brown trout was conducted in the Boulder River in 2007. The Boulder River from Cold Springs to the confluence with the Jefferson River (about 13 miles) contains a resident brown trout fishery and provides significant spawning habitat for a migratory run of spawning brown trout resident to the Jefferson River. Monitoring of this reach of the Boulder River was conducted in 2007 to evaluate the status of this fishery and determine feasibility of improving the fishery using habitat enhancement methods.

A mark recapture population estimate was conducted in a 1.66 mile reach of the river on 11 April 2007 (Figure 1). Ninety-one percent of trout fishery was comprised of brown trout, with total of 296 brown trout and 28 rainbow trout were captured during the survey. The sampling section contained 328 brown trout per mile of stream for fish over 9.0 inches in total length (age II and older fish). No estimate of rainbow trout was calculated due to small sample size and the presence of spawning fish presumed to be migrating through the sampling section.

Evaluation of the Brown Trout Spawning Run

Fish Trapping at Shaw Diversion

The Shaw Diversion is located about 4 miles upstream of the mouth of the Boulder River. This diversion is a seasonal barrier to upstream fish movement due to the placement of boards on the concrete diversion, and a fish ladder was placed in the diversion in 2001. Capture of spawning brown trout was attempted during 2007 to document fish passage around the diversion and to determine the timing and extent of the brown trout spawning run during the fall migration period.

Trapping began on 9 September 2007, and the first fish was captured on 27 September. The majority of brown trout moved through the trap between 9 October and 31 October, and no fish entered the trap after 10 November. The trap was operated for 50 days, and 45 brown trout and 4 mountain whitefish were captured during the effort. A total of 38 brown trout received floy tags inserted behind the dorsal fin for future evaluation of spawning movements. Size of brown trout entering the trap ranged from 9.7 to 22.5 inches total length. The sex ratio of brown trout was 21 males: 21 females and 3 non-spawning fish.

Irrigation boards were removed from the structure in early October and an unknown percentage of fish were able to move through the diversion without entering the fish trap. Thus, the capture of 45 brown trout only represents a small, unknown percentage of the spawning run. An extensive survey of brown trout redd construction was conducted following the trapping operation to determine the size of the spawning run migrating into the Boulder River.

Boulder River Redd Count--2007

Ten reaches of the Boulder River was walked during November to count brown trout redds and estimate the total number of redds in the lower 13 miles of the river (Table 1).

Table 1. Boulder River Redd Count During November, 2007.

SECTION	RIVER MILES	# of REDDS	REDDS/MILE
Cold Spr to Ford	0.0-0.71 (0.71 Miles)	80	112.7 Redds/Mile
Ford to Gavin Bridge	0.71-1.56 (0.85 Miles)	30	**35.3*** Redds/Mile
Bridge to Gavin Cabin	1.56-2.11 (0.55 Miles)	20	**36.4*** Redds/Mile
Cabin to Rt Bank Slough	2.11-2.90 (0.79 Miles)	45	**57.0*** Redds/Mile
Slough to County Bridge	2.90-5.33 (2.43 Miles)	---	No Count (Est. 43.6/Mile)
County Bridge to Diversion	5.33-9.13 (3.8 Miles)	---	No Count (Est. 43.6/Mile)
Diversion to Ctwd Bridge	9.13-9.48 (0.35 Miles)	16	**45.7*** Redds/Mile
Ctwd Bridge to Old Highway	9.48-11.10 (1.62 Miles)	28	17.3 Redds/Mile
Old Highway to Railroad	11.10-12.33 (1.23 Miles)	22	17.9 Redds/Mile
Railroad to Jefferson R.	12.33-13.13 (0.80 Miles)	0	Low Gradient (0 Redds/Mile)
Cold Springs to Mouth of Boulder River	0- 13.13 Miles	241 Counted + 272 Estimated = **513 Total Redds**	Redd Cnt. Estimated from Mile 2.9 to 9.13

- Average Redds Per Mile based on these four reaches to estimate number of redds per mile in 6.23 miles of river where a redd count was not conducted in 2007.

The redd count survey found that a total of 513 brown trout redds were constructed in the 13.1 mile reach of the Boulder River between Cold Springs and the confluence with the Jefferson River. About 7 miles of river was walked during the redd count, and redd counts were extrapolated for the remaining 6.2 miles that was not walked during the survey. Based on redd counts in nearby reaches, it was assumed that 43.6 redds per mile were constructed in the reaches not surveyed.

Relatively few redds were observed in the lower 3 miles of the river near the confluence with the Jefferson River, with a maximum of 17.9 redds per mile observed in this area. From the I-90 crossing to about 0.7 miles below Cold Springs, the number of redds per mile ranged from 45.7 to 57.0 redds per mile. The largest concentration of brown trout redds were observed in the 0.7 mile reach below Cold Springs, where 112.7 redds per mile were observed. The spring water entering the Boulder River appears to be the most desirable location for spawning fish.

Comparison of Fish Abundance in 1974 and 2007

Fish sampling was conducted in four sections of the Boulder River in 1974. Low numbers of brown trout were observed near Elkhorn Bridge, the Carey Ranch, and near Negro Hollow Bridge, ranging from 39 to 52 brown trout per 1000 feet of stream (7 to 10 brown trout per mile). Brown trout abundance increased below Cold Springs, and an estimate section at Shaw Ranch showed 242 brown trout per 1000 feet (46 brown trout per mile) for age I fish and older. Estimates were conducted in late summer and no mention of rainbow trout was found in the previous records.

The population estimate conducted in April of 2007 was not conducted precisely at the previous Shaw Ranch section due to access issues and the uncertain boundaries of the previous population estimate section. Since the 2007 population estimate was conducted in the spring to eliminate potential spawning movement bias, the late summer estimate of 1974 cannot be directly compared to results from 2007 sampling. Despite the potential errors from section boundaries and seasonal timing, it appears that brown trout abundance has increased from about 46 brown trout per mile in 1974 to 328 brown trout per mile in 2007.

Rainbow trout observations in the lower Boulder were not recorded in the 1974 fishery summary for the Boulder River, and it is assumed that either no rainbow trout were present at this time, or relatively few fish were present and no population estimate was conducted due to low sample size. Therefore, it is not known whether the capture of 28 rainbow trout captured in the 1.66 mile section in 2007 represents a significant change in the population of rainbow trout.

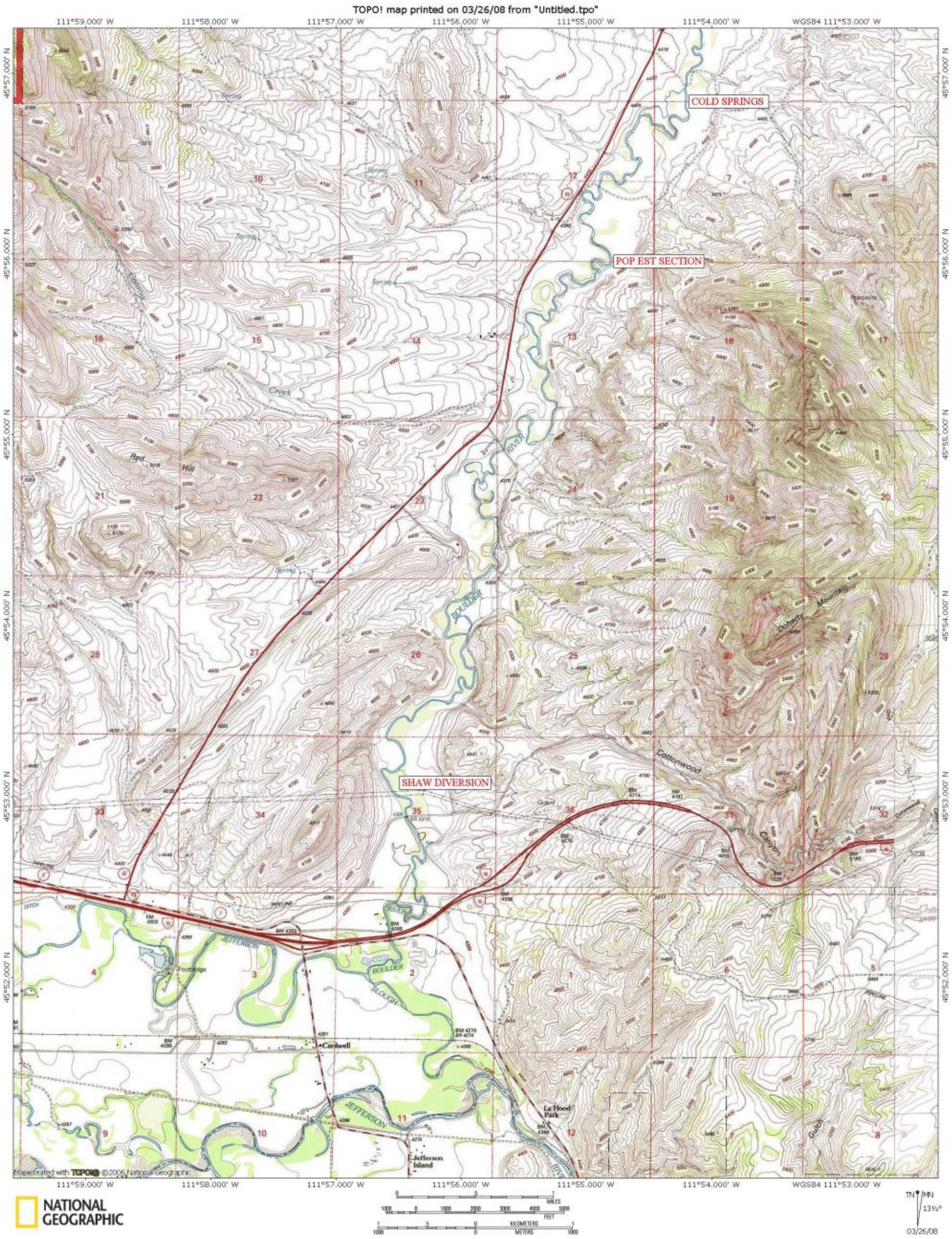


Figure 1. Map of lower Boulder River showing trap location at Shaw Diversion, the population estimate section, and the Cold Springs, which is the upper extent of the redd count conducted in 2007.

CHAPTER V
STREAMFLOW PROTECTION AND ENHANCEMENT EFFORTS FOR THE JEFFERSON RIVER

The Jefferson River is designated as a Chronically Dewatered stream by MDFWP because of the frequent occurrence of low stream flow during the summer irrigation season. Relatively low summer stream flow of the lower Big Hole, Ruby and Beaverhead Rivers often results in low stream flow of the Upper Jefferson River, and the appropriation of approximately 800 cfs of water right claims in the upper 25 miles of the Jefferson River can result in very low flows during years with below average snowpack and rainfall. During the extreme drought conditions of 1988, the Jefferson River had almost no water flowing over riffles, and the USGS measured about 3 cfs of flow near Waterloo below Parson's Bridge.

At least four important steps have been taken to attempt to resolve the chronic dewatering of the Jefferson River.

1. The upper Missouri River Basin was closed to new appropriation of water claims in 1993. This action provided protection for instream flow and for existing water users by reducing or eliminating new and competing claims for additional water use in the basin;

2. A drought management plan for the Jefferson River was written in 1999 to attempt to voluntarily share the burden of water shortages during drought years. Existing water users attempt to coordinate withdrawals to informally share the remaining water and leave a portion of the water savings in the Jefferson River to protect aquatic life;

3. A cooperative effort between MDFWP, DNRC, JRWC and Trout Unlimited was initiated in 2001 to improve understanding of irrigation canal infrastructure to improve efficiency of water use to benefit both water users and the instream flow of the Jefferson River;

4. A study groundwater resources in the Waterloo area was conducted in 2004 and 2005 to improve understanding and management of groundwater resources in a portion of the Jefferson Valley. Protection of groundwater resources is believed to be key in the future recovery of aquatic resources in the Jefferson River Basin.

JEFFERSON RIVER DROUGHT MANAGEMENT PLAN (ABSTRACT)

Purpose:

The purpose of the Drought Management Plan is to reduce resource damage and to aid in the equitable distribution of water resources during water critical periods. The plan is a voluntary effort involving local interests including agriculture, conservation groups, anglers, municipalities, businesses, and government agencies.

The first Drought Management Plan was prepared and approved by the Jefferson River Watershed Council on 25 July, 2000. The plan was implemented for five years (2000 through 2004) and increased flow at the target location (Waterloo Gage below Fish Creek Canal) was documented by monitoring river and irrigation canal flows during the period. The drought management plan goal of maintaining at least 50 cfs at Waterloo was not always met during these years, but cooperation by water users helped improve flows at this critical location. Prior to developing the drought plan, the Jefferson River was severely dewatered at this location during dry years, and in 1988, only 5 cfs was measured at the Waterloo Gage location.

Drought Management Plan Triggers:

The 2000 version of the Drought Management Plan established flow triggers for directing actions of anglers, water users, and government agencies. The triggers were revised in February 2005 based on observations of the previous 5 years of plan implementation. As of 2007, the current drought plan triggers are listed below.

Triggers: The following prescribed actions are to occur when the river flow drops below the following levels or when maximum daily water temperature exceeds 73 degrees F for three consecutive days at the Twin Bridges Gaging Station (06026500):

600 cfs: The 600 cfs trigger flow at the Twin Bridges Gage serves to alert water users and anglers of declining flow conditions and requests voluntary water conservation measures and angler awareness of stress caused by fishing during periods of low flow and high water temperature. A press release will be issued to inform the public of low flow conditions on the Jefferson River.

280 cfs: Montana Dept. of Fish, Wildlife & Parks will evaluate the need for a mandatory fishing closure throughout the Jefferson River at this flow level at the Twin Bridges Gage. Voluntary reduction of irrigation and municipal water use is also initiated when the river drops below 280 cfs, and weekly meetings with water users will be coordinated by JRWC. The meetings will update water users on inflows to the river, ditch withdrawals, and status of the flow at the Waterloo Gage to attempt to maintain a minimum flow of 50 cfs at Waterloo. The angling closure will remain in effect until flows reach or exceed 300 cfs for seven consecutive days at the Twin Bridges Gage.

73 Degrees F: Independent of stream flow level, Montana Dept. of Fish, Wildlife & Parks can implement a mandatory time of day closure to prohibit angling throughout the Jefferson River between the hours of 2:00 PM to 12:00 AM (midnight) when maximum daily water temperature equals or exceeds 73 degrees F (23 degrees C) for three consecutive days. Lifting of summer temperature restrictions will be conducted on September 15 unless an earlier/later date is designated by the FWP Commission.

DROUGHT PLAN EVALUATION (2000-2008)

The evaluation of the effectiveness of the Drought Management Plan was conducted throughout the first eight years of implementation (2000 – 2008). Monitoring flow of four large irrigation canals and several locations of the Jefferson River was used to determine the ability to maintain critical stream flow in the river while providing sufficient irrigation water to water users. Implementation of the plan was challenged by the unprecedented drought conditions from 2000 to 2008. Long term flow records were not available for stations located on the Jefferson River, but flow records for the Big Hole (Melrose Gage) and the Upper Missouri River (Toston Gage) indicate that the eight consecutive drought years starting in 2000 were the lowest on record when compared to previous averages (Figure 1).

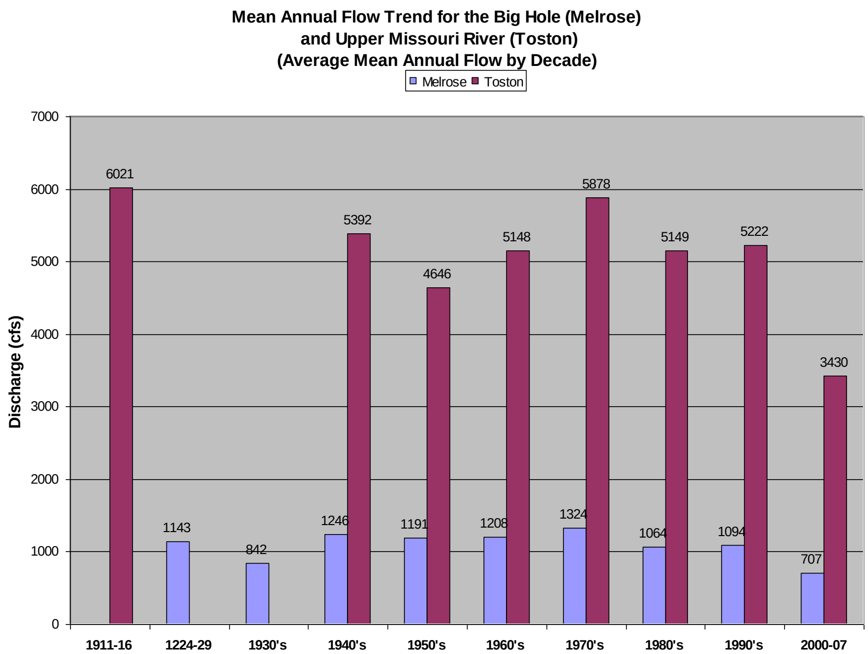


Figure 1. Long term trend of mean annual flow for the Big Hole and Missouri River USGS gaging stations located at Melrose and Toston.

The primary method for attempting to coordinate water use by the four major irrigation canals in the upper Jefferson River was to conduct weekly meetings during the summer months when flow at the USGS gage at Twin Bridges was critically low (less than 280 cfs). The purpose of the weekly meetings was to attempt to maintain 50 cfs at the Drought Management Plan (DMP) target location at Waterloo (below Parson's Bridge). Four major canals (Creeklyn Ditch, Parrot Ditch, Fish Creek Canal, and Jefferson Canal) and several small ditches withdraw water between the mouth of Hell's Canyon Creek and Parson's Bridge (Figure 2).

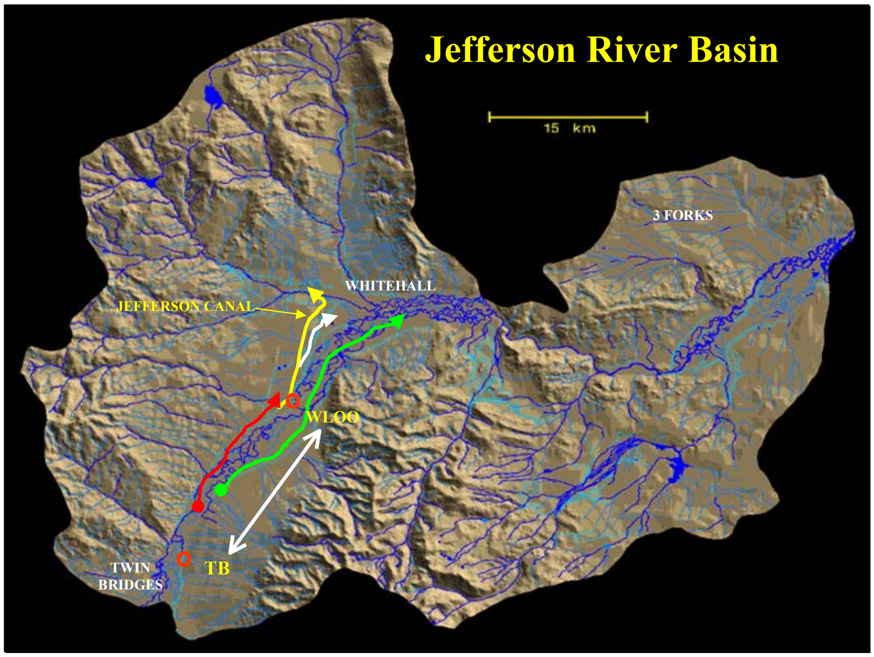


Figure 2. Map of the four major canals participating in the Drought Management Plan (Creeklyn Ditch: Red, Parrot Ditch: Green, Jefferson Canal: Yellow, and Fish Creek Canal: White).

Maintenance of the flow target of 50 cfs at Waterloo was not accomplished for several days during most years between 2000 and 2007 (Figure 3). Weekly meetings held with water users, agency representatives and Trout Unlimited during periods when flow was less than 280 cfs at Twin Bridges and often less than 100 cfs at Waterloo were conducted to attempt to voluntarily reduce ditch withdrawals to maintain the flow above 50 cfs at the Waterloo Gage.

When one or more of the ditches were able to provide some water to improve flow in the Jefferson River, other ditches attempted to lower headgates to attempt to pass the water downstream to the Waterloo Gage. Another example of actions taken during weekly water user meetings, was to agree to modify irrigation diversion structures to attempt to improve ditch flows for a specific period, and to refrain from additional measures to obtain water later in the summer.

During periods when the Jefferson River was extremely low (less than 280 cfs at Twin Bridges and less than 50 cfs at Waterloo), and air temperature was high during critical growing periods, the result of the weekly meeting often resulted in no possible action to improve flow at Waterloo. Weather forecasts and summaries of flow trends from upstream sources were discussed during such meetings. During the eight years of DMP meetings with water users, irrigation withdrawal was never increased when flow at Waterloo was less than 50 cfs.

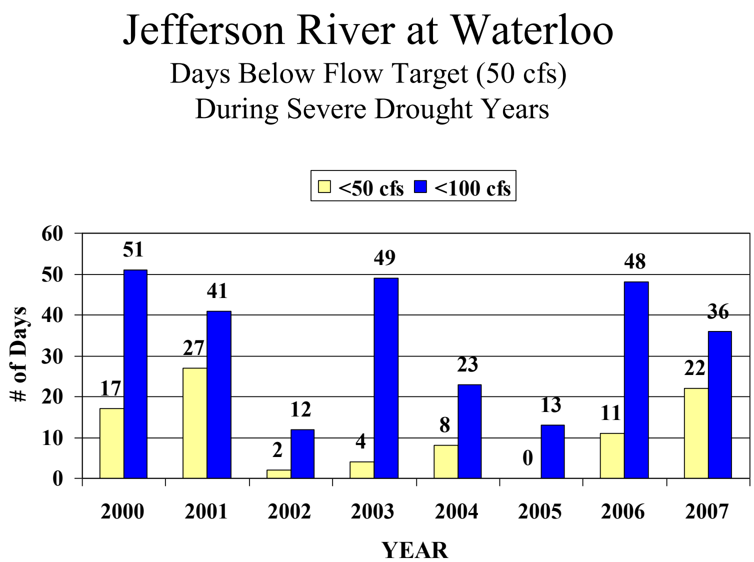


Figure 3. Number of days that Waterloo flow target of 50 cfs was not reached from 2000 to 2007. Days less than 100 cfs also included for reference.

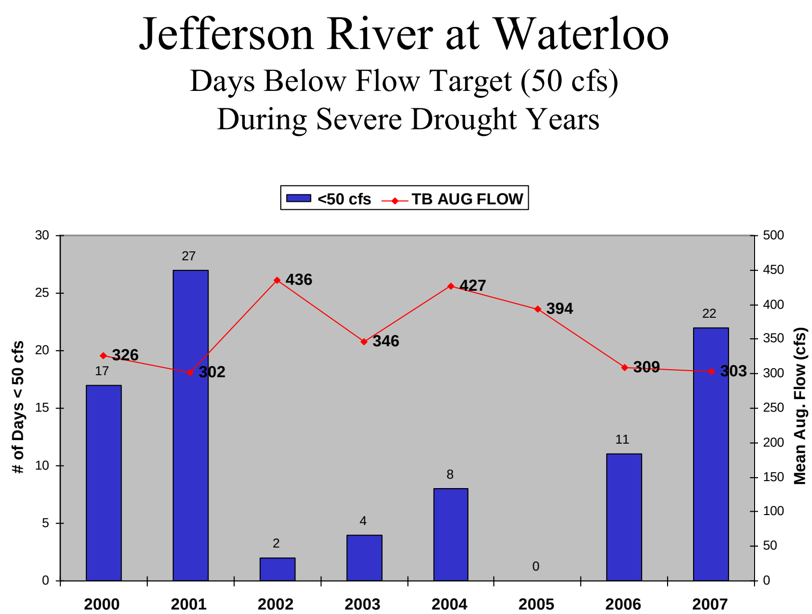


Figure 4. Number of days that Waterloo flow target of 50 cfs was not reached compared to mean August flow at the USGS gage near Twin Bridges.

The number of days that flow at Waterloo was less than 50 cfs ranged from 11 to 27 days during years when mean August flow at Twin Bridges was approximately 300 cfs (Figure 4). When mean August flow at Twin Bridges was near or above 400 cfs, the number of days that flow at Waterloo was less than 50 cfs ranged from 0 days and 8 days.

When mean August flow at Twin Bridges exceeded 400 cfs from 2000 to 2007 the number of days that flow was less than 50 cfs at Waterloo was relatively low, and the percentage of water at Twin Bridges that reached the target at Waterloo was relatively high (Figure 5). A relatively constant percentage of 16 to 17 % of the Twin Bridges flow was observed during 5 years when the Twin Bridges flow was about 300 to 350 cfs. During the three years when mean August flow at Twin Bridges was approximately 400 cfs, the percentage of water that reached Waterloo was 32 to 34 %.

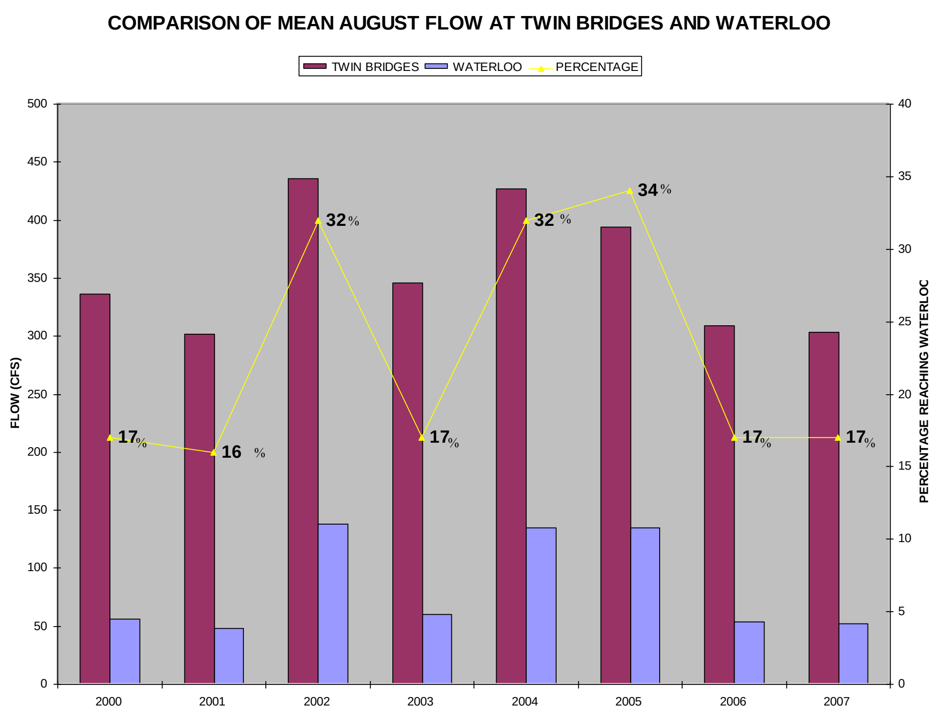


Figure 5. Comparison of mean August flow at Twin Bridges and Waterloo and the percentage of flow reaching Waterloo (2000-2007).

Based on evaluations of flow trends at Twin Bridges and Waterloo from 2000 to 2007, it appears that a flow of approximately 400 cfs at Twin Bridges is a critical stage for preventing dewatering of the upper Jefferson River. When flow at Twin Bridges exceeds 400 cfs, a relatively high percentage of flow reaches Waterloo and the risk of dewatering the river between Silver Star and Waterloo is reduced.

An important component of the implementation of the DMP from 2000 to 2007 was monitoring withdrawals by irrigation canals. Staff gages were placed near the headgate of Creeklyn Ditch, Parrot Ditch, and the combined headgate of Fish Creek and Jefferson Canal. Rating curves were established for each canal and staff gage readings were collected at least once per week during the mid-July to late September period.

Data for individual canals were not published during the evaluation to maintain the privacy of water users, but total flow of the combined ditch withdrawals of all four canals range from about 250 cfs to 400 cfs (Figure 6). Despite the extremely dry conditions and hot temperatures of 2007, the total ditch withdrawal in 2007 was lower than previous years indicating that effectiveness of the DMP coordination was relatively high after several years of effort implementing the plan (Figure 6).

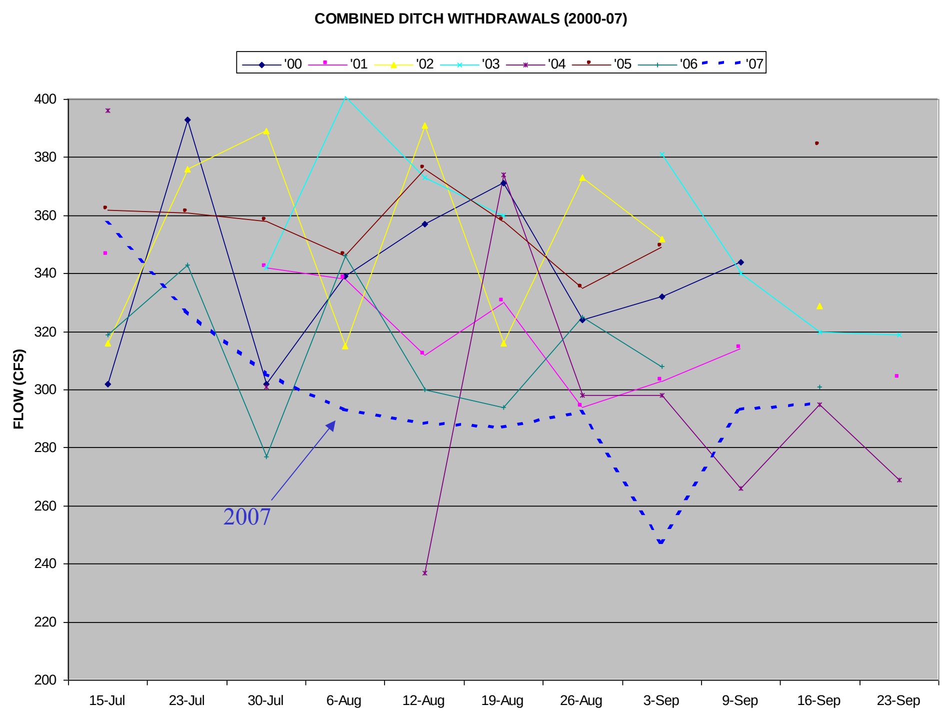


Figure 6. Combined ditch withdrawals from four irrigation canals participating in the DMP from 2000 to 2007.

Averaging weekly data from 2000 to 2007 for all canals indicated that the trend for irrigation withdrawal through the mid-July to late September period was relatively stable (Figure 7). Thus, water diversion during the relatively high demand by plants in mid-July was similar (about 350 cfs) to water diversion in September (about 300 cfs). The weekly withdrawals of canals during 2007 showed reduced late season water diversion compared to the average diversion of water from 2000 to 2007 (Figure 8).

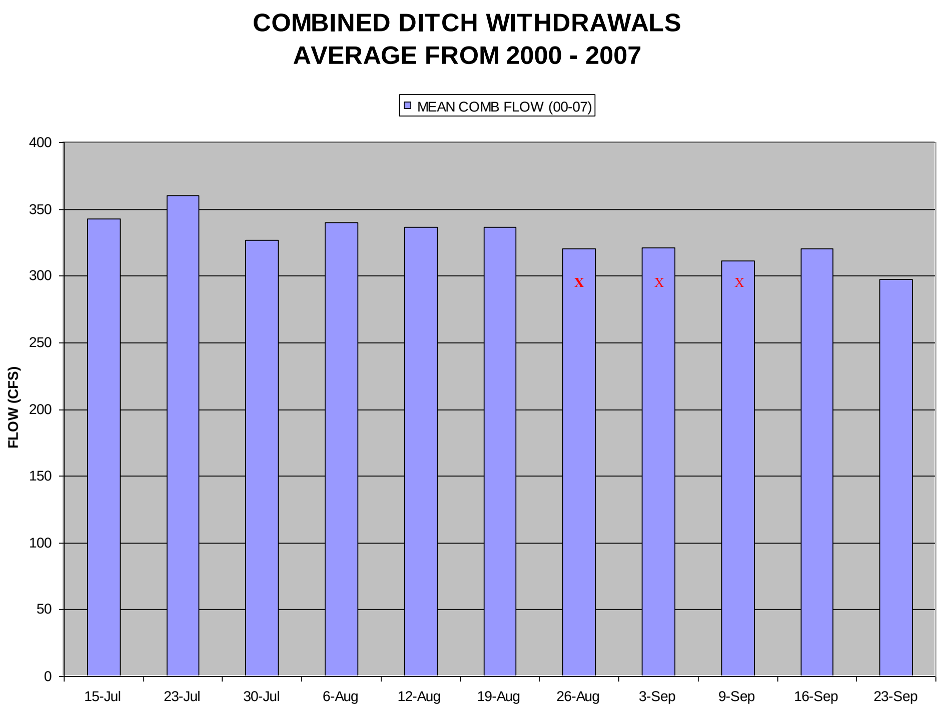


Figure 7. Average water diversion for four canals during eight years of monitoring during 11 weeks of the irrigation season.

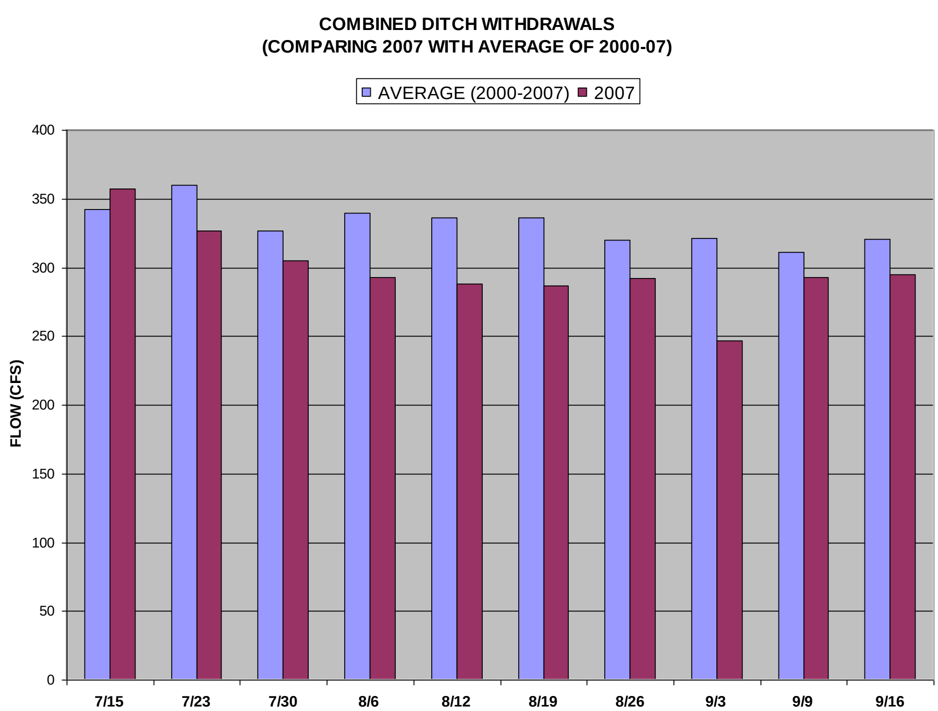


Figure 8. Comparison of average weekly water diversion for four canals during 8 years of monitoring (2000-2007) compared to weekly withdrawals during 2007.

The canal withdrawal trend in 2007 indicated a potential improvement in the ability of the DMP to maintain the 50 cfs flow target at Waterloo during years when the late season flow shortage was severe. From 2000 to 2007, most years experienced continued flow shortage in late August and early September, which resulted in additional days of flow less than 50 cfs at Waterloo despite reduced water demand by irrigated crops. For example, in 2000 flow at Twin Bridges remained above 350 cfs during most of August and a late season decline in late August created concern that the river would be dewatered after several weeks of attempting to maintain 50 cfs at the target (Figure 9). A similar pattern was observed during most years between 2000 and 2007.

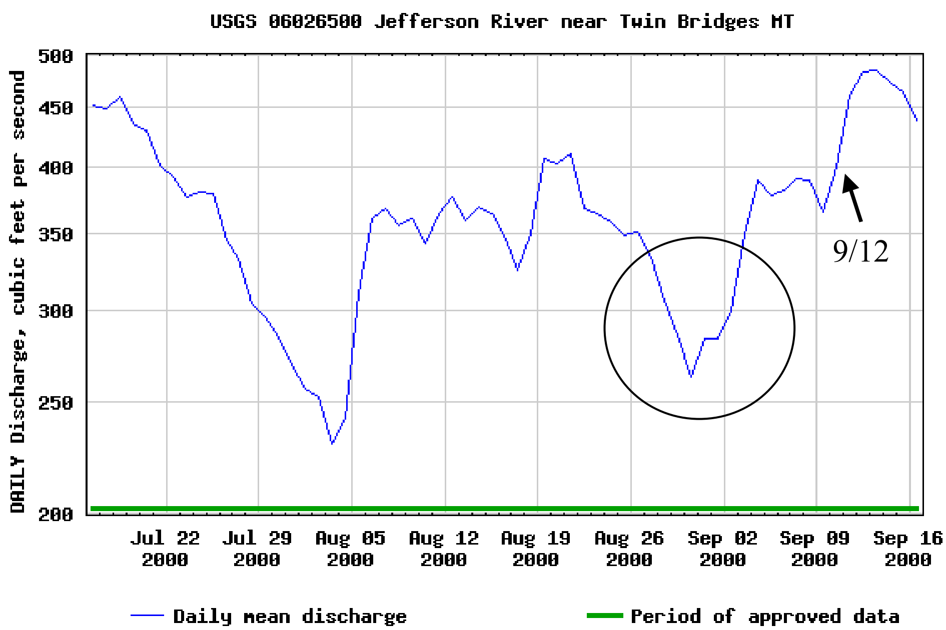


Figure 9. An example of the late August "hole" in the summer hydrograph of the Jefferson River near Twin Bridges (2000). September 12th was the date that flow recovered to at least 400 cfs.

A review of the summer hydrograph of the Jefferson River at Twin Bridges showed that the date that flows recover to at least 400 cfs was relatively consistent from 2000 to 2007 (Table 1). The predictable increase in flow in September always resulted in at least 400 cfs by 16 September. The reliable flow in September may be important to water users voluntarily reducing withdrawals during the summer and having the flexibility to increase withdrawals after mid-September for fall irrigation of pasture..

Table 1. Date range that flow of the Jefferson River at Twin Bridges exceeded 400 cfs (2000-2007).

Year	2000	2001	2002	2003	2004	2005	2006	2007
Date flow > 400 cfs	9/12	9/7	8/28	9/15	8/23	9/12	9/15	9/16

Daily flow was monitored at Waterloo (below Parson's Bridge) during the summer low flow period from 2000 through 2007 to evaluate the success of the DMP in maintaining the 50 cfs flow target (Figure 10). Flow monitoring was conducted by the JRWC from 2000 through 2005, and by USGS in 2006 and 2007. Daily data for this site is tabulated in Appendix A.

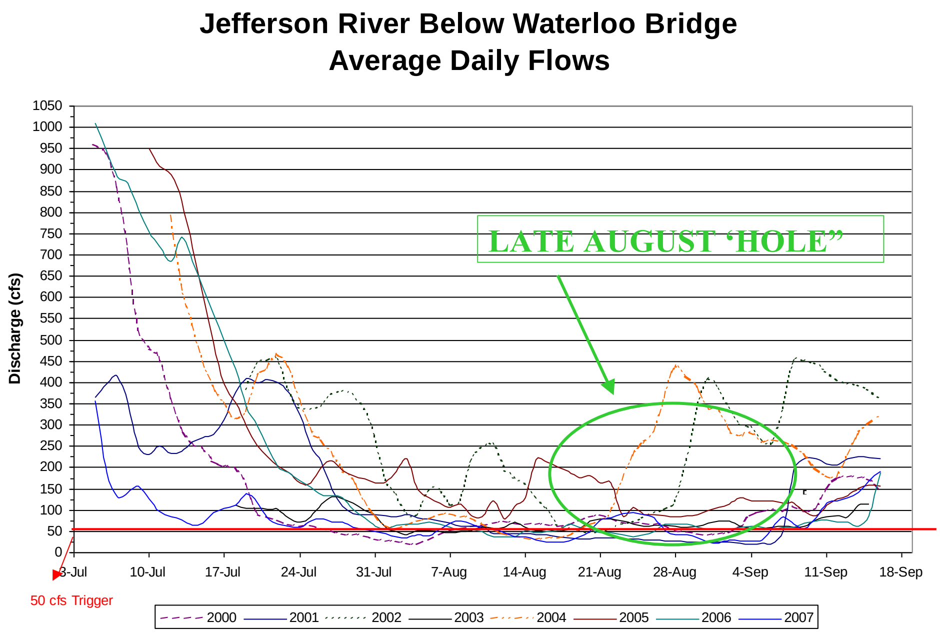


Figure 10. Average daily flow of the Jefferson River at Waterloo compared to the 50 cfs flow target (2000-2007).

The DMP has also monitored flow at several other locations to attempt to document the current flow situation and look for new opportunities to enhance water supply in the Jefferson River. Flow monitoring of the Big Hole, Ruby and Beaverhead Rivers was conducted to better understand the sources of water reaching the headwaters of the Jefferson River. In 2007, flow monitoring of inflows to the Jefferson River was conducted at four locations: Mouth of the Big Hole (USGS gage), Mouth of Beaverhead River (JRWC aqua-rod), Ruby River at Seyler Lane (JRWC staff gage), and the Beaverhead River at Twin Bridges (USGS gage) (Figure 11).

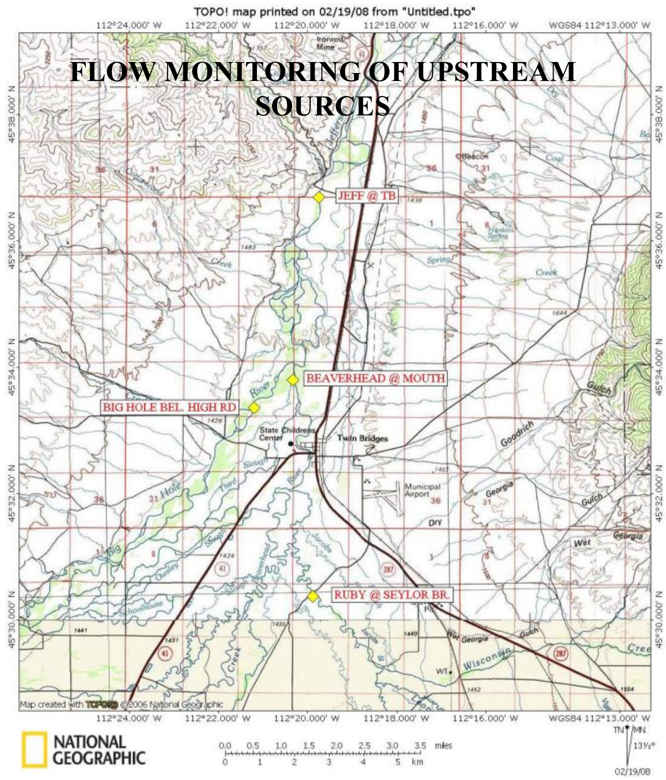


Figure 11. Location of flow monitoring stations above the Jefferson River in 2007.

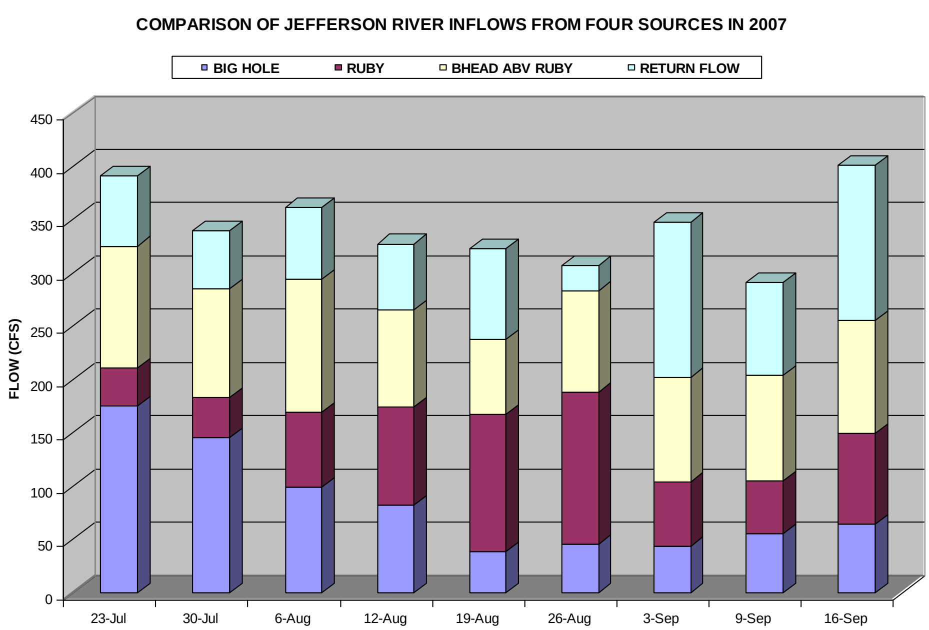


Figure 12. Comparison of Jefferson River inflow from four sources in 2007.

Flow data collected in 2007 indicated that, despite the small size of the drainage area, the Ruby River provided important flow for the upper Jefferson River during the critical period of late August (Figure 12). The Big Hole River near the mouth provided relatively little water to the Jefferson River in late August, but the ditches and sloughs entering the Beaverhead River near Twin Bridges (identified as "return flow") provided significant flow for the lower Beaverhead River. Flow of the Beaverhead River above the confluence with the Ruby River was relatively low considering the large size of the watershed and the presence of Clark Canyon Reservoir.

Monitoring of the Jefferson River stream flow downstream of the Waterloo Gage was intermittently sampled during the 2000 to 2007 period. In 2007, flow at Kountz Bridge and Cardwell was significantly higher than the low flow measured at Waterloo on August 22 (Figure 13). The increased flow downstream of Waterloo was a result of groundwater inflow, spring creek tributaries, and return flow from Parrot Canal, and these sources of water appeared to allow fish survival in the most severely dewatered reach of the Jefferson River. Brown and rainbow trout population estimates conducted during April in this reach of the river indicated that fish numbers declined after the 2000 flow event and have remained stable or increased in recent years (Figures 14 and 15). Mountain whitefish and suckers have also declined in this area since 2000 (Figure 16).

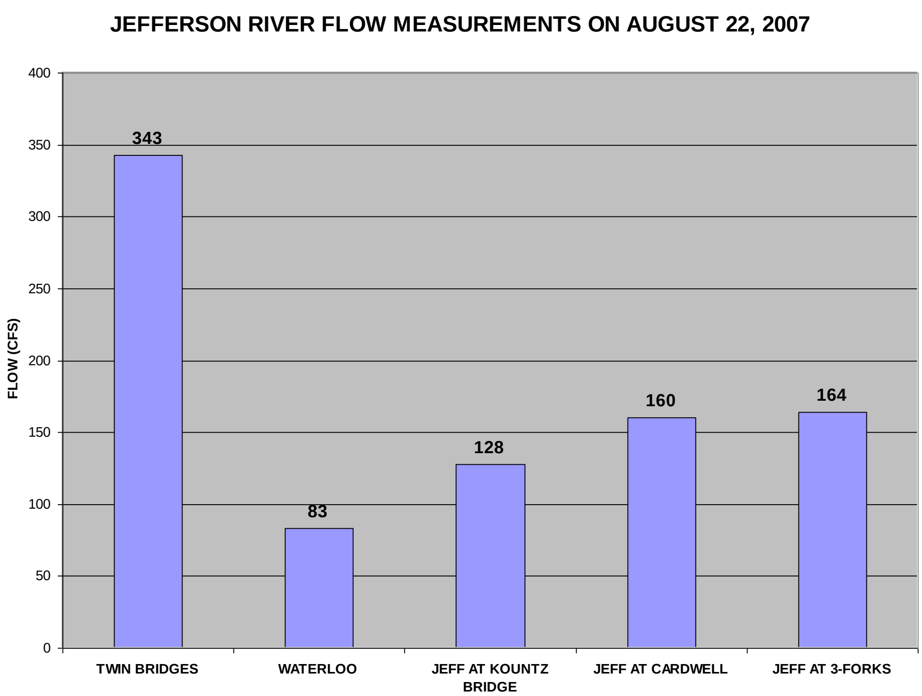
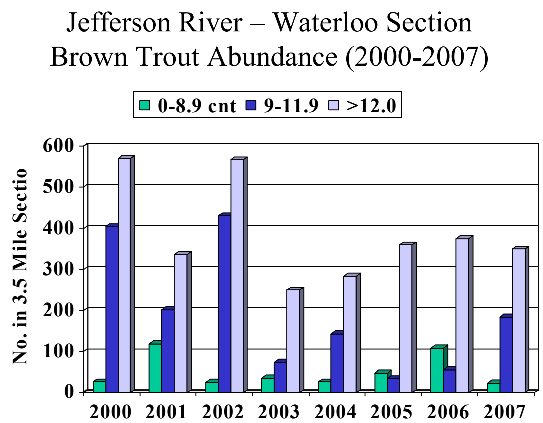
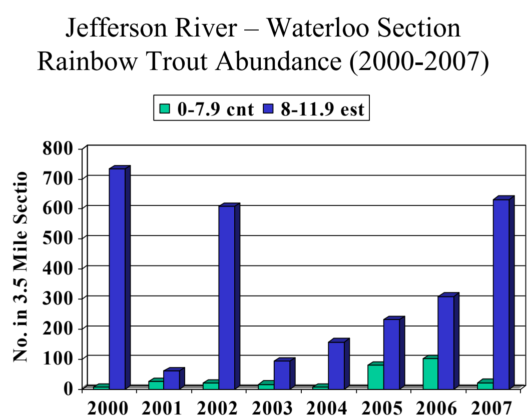


Figure 13. August 22, 2007 flow measurements at 5 locations of the Jefferson River.





Figures 14 and 15. Brown and rainbow trout population estimates in the Waterloo Section of the Jefferson River (2000 – 2007).

Jefferson River – Waterloo Section
Sucker and Whitefish CPUE Trend (2000-2007)

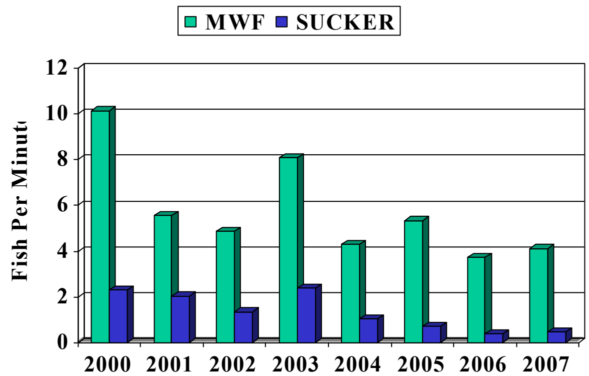


Figure 16. Mountain Whitefish and Sucker trend in the Waterloo Section of the Jefferson River (2000-2007) based on catch per minute of sampling.

Summary of Drought Plan Evaluation

Extensive flow monitoring of the Jefferson River and irrigation canals participating in the drought plan show that water supply during the 2000 to 2007 implementation period was the lowest on record and probably represents the worst case scenario for water supply. Despite the challenging conditions, the Jefferson River did not experience the degree of dewatering experienced in past drought years (particularly 1988), when little or no coordination was attempted to maintain critical summer flows in the Jefferson River.

Although the flow target of 50 cfs at Waterloo was frequently not met during the 2000 to 2007 irrigation seasons, it appears that drought plan implementation resulted in more water at Waterloo than would have been present without the weekly coordination with water users dictated by the DMP. It is not precisely known how much water was "donated" voluntarily by water users, but previous comparisons of water diversion before and after 2000 by DNRC indicate that four major canals diverted about 30 to 50 cfs less water after the DMP was implemented in 2000.

The fishery declined abruptly in the Waterloo Section after the initial summer of severe drought in 2000. Stable or increasing numbers of brown and rainbow trout in the Waterloo Section (the most severely dewatered reach of the Jefferson River) indicate that average August flow at Waterloo is adequate to prevent major fish kill events and continued loss of the fishery.

Coordination with existing water users has been the most effective activity for improving stream flow in the Jefferson River. Improving irrigation efficiency by lining canals for long term improvements in efficiency or temporarily sealing the canals with Canal Seal continues to have potential for reducing ditch withdrawals during critical periods. Other improvements of ditch infrastructure to improve canal management, such as replacing headgates or blow-off structures also have potential to improve flows in the river. In 2008, several projects to improve irrigation structures on the Parrot Canal are being implemented to improve ditch operation. Fund raising, project coordination, and project oversight of this work is being coordinated by Trout Unlimited.

The Jefferson River Drought Management Plan has evolved in the past 8 years. The most recent review of the DMP occurred in February and March, 2008. The proposed modifications to the drought plan that resulted from public meetings in 2008 included:

- Continue to coordinate with upstream watershed groups to enhance inflows to the upper Jefferson River from the Ruby, Big Hole, and Beaverhead River;
- Increase scrutiny of new or expanded water use in the Jefferson Valley by improving understanding of the DNRC water right process;
- Expand the extent of the Drought Plan Reach from Waterloo to Cardwell to attract new, downstream interests into the DMP process;
- Review fishing closure triggers and examine potential for splitting fishing closures into selected reaches of the river rather than the entire Jefferson.
- Continue to attempt to maintain a flow target of 50 cfs at Waterloo and examine methods to reduce the number of days that flow is less than 50 cfs.

CHAPTER VI
FISH LOSS TO IRRIGATION CANALS

Introduction

It is widely known that fish move into various irrigation canals of the Jefferson River during the irrigation season. Prior to 2001, the extent of fish entrainment in canals was not well understood, and sampling of the Creeklyn Ditch was initiated from 2001 to 2007 to better understand the significance of fish loss in one irrigation canal.

The Creeklyn Ditch diverts water from the Jefferson River approximately 4 miles south of Silver Star Montana (T2S R6W S 23) and terminates near Fish Creek (T1S R5W S 11). Total length of the Ditch is approximately 11 miles and flow rate ranges from 60 to 90 cubic feet per second (cfs). The ditch operates from April through November and is usually shut down for one week in early July for control of aquatic vegetation.

Creeklyn Ditch was selected to begin evaluation of fish loss because of its proximity to a major spawning tributary and the fact that no screening devices are in place to prevent fish from entering the ditch. The intake of Creeklyn Ditch is about 2 miles downstream of Hells Canyon Creek, which is a major spawning tributary to the Jefferson River. The proximity of this canal to an important trout spawning and rearing tributary made it likely that Creeklyn Ditch would have a relatively high rate of fish entrainment.

Two fish sampling methods were used to capture fish in Creeklyn Ditch. Use of a backpack electrofishing unit was used to capture fish in the canal during periods when ditch flow was significantly reduced, and operation of a screw trap was used to count downstream migration of fish during normal ditch operations. Electrofishing was occasionally conducted during the early July shut down, and was done within a week of the November shut down at the end of the irrigation season. The screw trap was operated from 26 June to 20 September, 2001. Temperature was also monitored in two locations of the canal from 17 July to 18 October, 2001.

Fish Captured Using the Screwtrap

The screwtrap was placed approximately 600 feet downstream of the headgate and efficiency tests revealed that the trap sampled about 30-40% of the flow. Several checks revealed that the cone rotated at 4 revolutions per minute (RPM), and since little variation was noted in this rate therefore further checks were not done. The trap was checked 32 times between 6/26-9/20 2001. Flow to the ditch was shut off from 1 July to 8 July to control aquatic vegetation. On 9 occasions the trap was found to be jammed with debris and not operational.

Species captured at the trap included rainbow trout, brown trout, redside shiners, longnose dace, sucker spp and mountain whitefish. Total numbers of each species captured is presented in Table 1.

Table 1. Species and number of fish captured in the screw trap at Creeklyn Ditch in 2001.

Species	Total Captured
Rainbow Trout	110
Brown Trout	9
Longnose Dace	1740
Sucker spp.	2000
Mottled Sculpin	28
Redside Shiner	46

Electrofishing Surveys

Electrofishing was conducted on 2 July 2001 and in the fall on 12 and 15 October and 2 November. This was done to evaluate longitudinal distribution of fish in the Creeklyn ditch, further evaluate fish loss, and attempt to rescue fish and return them to the Jefferson River.

Summer Sampling during Drawdown

Four sections of the Creeklyn Ditch were sampled with backpack electrofishing gear on July 2, 2001 one day after ditch drawdown. The headgate section extended from the headgate downstream to the screwtrap. The highway section extended from the screwtrap to the highway crossing. Silver Star and Highway JCT 55/41 were 4.3 and 8.5 miles below the headgate, respectively. The majority of fish captured or observed died due to high air and water temperature. The highest concentration of fish was captured in the 1800 ft section below the headgate, and no fish were captured in the 55/41 Highway Junction. The lack of observed fish near the Highway 55 Junction (8.5 miles below the headgate) may have been influenced by the rapid loss of water during drawdown and the abundant vegetation in the canal (Table 2).

Table 2. Total numbers of fish captured in four sections of the canal on 2 July 2001.

Species	**Headgate 1800 feet 2519 seconds**	**Highway 1200 feet 1728 seconds**	**Silver Star 3600 feet 1241 seconds**	**55/41 JCT 450 feet 240 seconds**
Brown	27	23	7	0
Rainbow	12	4	12	0
MWF	14	7	427	0
Dace	1310	420	80	0
Suckers	410	180	50	0
Red Side	1040	550	0	0
Sculpin	340	100	0	0
Total Fish	3153	1284	576	0

Total fish numbers decreased steadily as distance from the headgate increased, which may be due to fish swimming upstream as flow decreased in the ditch. The notable exception was mountain whitefish, which were observed in large numbers in the Silver Star Section, which was about 4 miles below the headgate

Fall Sampling-- End of Season Shutdown

Headgate and highway sections of Creeklyn Ditch were sampled on Oct-12, Oct-15 and Nov-2. Emphasis on this shocking effort was placed on rainbow and brown trout. A total of 276 rainbow trout and 64 brown trout were captured during the 3 sampling days between the highway and the headgate. Rainbow trout ranged in length from 62-249 mm in length, 92% of rainbow trout captured were young of the year (< 120 mm). Brown Trout ranged from 68-490 mm in length and 40% of those captured were YOY (<130 mm).

Water Temperature

Temperatures were monitored with electronic continuous recording temperature probes at the screw trap and the Highway 55-41 Junction from July 17 through October 18, 2001. Temperatures exceeded 65 F on 48 days at the lower site and 51 days at the upper site. Temperatures did not appear to differ significantly between the two sites..

Annual Comparisons of Fall Sampling

From 2001 through 2007, evaluation of fish loss at Creeklyn Ditch was continued by sampling the 3100 ft reach of the canal from the headgate to the highway crossing with the backpack electrofishing unit during the fall shutdown. Trout were collected during this sampling effort to determine trends in abundance through the 7 year period, and to return fish to the Jefferson River.

Rainbow trout were more abundant in the canal than brown trout during most years, and the number of trout captured in the relatively short reach of the canal below the headgate appeared to be significant (Table 3). The large number of trout near the headgate, however, should not be extrapolated over the 11 miles of ditch in order to estimate total fish loss because fish appeared to concentrate near the headgate during reduced flow.

Considering the difficulty in determining the total number of fish moving into the canal, another approach was used to assess the impacts of fish loss. This approach was to rescue fish from the canal and mark the fish released back to the river to determine the percentage of the river fishery that was comprised of "rescued" fish. In the past 3 years (2005-2007), all trout were given a permanent mark by clipping the entire adipose fin for later identification in the Jefferson River. A total of 1025 rainbow trout and 368 brown trout were marked during this effort. Sampling of the Jefferson River near the release location of fish rescued from Creeklyn Ditch during April 2007 indicated that about 5% of the rainbow trout in the 2 mile reach of the river near the release site were marked with an adipose clip. Since the majority of the rainbow trout rescued and marked with an adipose clip were age 0 at the time of the rescue, most fish captured in the river with adipose clips were 9.0 to 10.9 inches long in 2007. We observed 5 clipped fish in the Jefferson River out of a sample of 50 rainbow trout between 9 and 10.9 inches in length in 2007, indicating that 10% of this size group was comprised of fish rescued from Creeklyn Ditch. More detailed results of this evaluation will be presented in a future report. Preliminary findings indicate that the fish rescue effort may be a benefit to the river population and that the loss of fish to Creeklyn Ditch reduces the trout population within about 2 miles of the headgate.

The size of brown and rainbow trout captured in the canal each fall provided a consistent measure of the growth of YOY fish during the sampling period (2001-2007). The mode length for rainbow trout decreased over the period for rainbow trout from about 95 mm (3.7 inches) in 2001 to about 80 mm (3.1 inches) in 2007 (Table 4). The mode for YOY brown trout 125 mm (4.9 inches) remained consistent throughout the sampling period (Table 5). Growth and condition of YOY trout captured during the fall was favorable, indicating that the ditch provided a favorable rearing environment.

The number of rainbow trout over 300 mm (11.8 inches) captured in the ditch during the fall rescue was always less than 3 fish per year. Larger brown trout were more common than rainbow trout with 0 to 12 brown trout over 300 mm (11.8 inches) captured from 2001 to 2007. Two of the six larger brown trout (>300 mm) captured in Creeklyn Ditch in 2007 were recaptured adipose clipped fish from 2005 or 2006.

Table 3. Fish rescue in Creeklyn Ditch (3100 ft from Highway to Headgate) during October/November 2001 – 2007.

YEAR	Effort (seconds)	No. Rainbow	No. Brown Trout
2001	3155	184	39
2002	4423 (1st pass) 3121 (2nd pass)	80 25	15 48
2003	4323	100	46
2004	6800	346	28
2005	7710	422 (ad.clip)	174 (ad.clip)
2006	5708	242 (ad.clip)	78 (ad.clip)
2007	6995	361 (ad.clip)	116 (ad.clip)

Note: Other Species sampled in ditch.
Longnose dace (abundant)
Sculpin (abundant)
Sucker spp. (common)
Redside Shiner (common)
Mountain Whitefish (present)
Carp (rare)

Table 4. Length Frequency of Rainbow Trout Captured during November fish sampling in Creeklyn Ditch (2001-2007).

Min. Length	Max. Length	2001	2002	2003	2004	2005	2006	2007
0	9							
10	19							
20	29							
30	39							
40	49							2
50	59		2	3		6	3	5
60	69	6	0	10	8	32	35	35
70	79	39	12	19	34	79	85	91
80	89	43	21	23	68	120	47	104
90	99	49	28	24	61	102	31	48
100	109	40	12	5	58	42	9	20
110	119	14	13	1	51	16	4	12
120	129	8	2	2	24	6	0	14
130	139	0	4	1	8	1	0	4
140	149	1	0	1	12	0	2	4
150	159	1	1	1	4	1	4	1
160	169	0	0	2	2	1	4	2
170	179	1	1	2	0	5	2	7
180	189	0	3	1	1	4	4	3
190	199	0	0	1	6	2	1	1
200	209	0	0	1	1	0	2	4
210	219	1	0	3	1	2	4	0
220	229	3	0		2	0	2	1
230	239	0	2		2	0	0	3
240	249	2	0		0	0	0	0
250	259	0	0		0	0	0	0
260	269	0	0		0	1	0	0
270	279	1	0		1	0	1	0
280	289	0	0		0	0	0	0
290	299	0	4		0	1	0	0
300	499	1	0		2	1	2	0

Table 5. Length Frequency of Brown Trout Captured during November fish sampling in Creeklyn Ditch (2001-2007).

Min. Length	Max. Length	2001	2002	2003	2004	2005	2006	2007
0	9							
10	19							
20	29							
30	39							
40	49							
50	59							
60	69							1
70	79					2	1	1
80	89	2		2	1	6	1	4
90	99	1		2		4	5	14
100	109	3	3	2		6	7	15
110	119	7	10	8	3	25	8	21
120	129	8	12	6	6	47	6	27
130	139	5	7	7	4	34	8	14
140	149	3	8	3	7	31	4	9
150	159	1	9	3	4	7	3	2
160	169		3		2	3	1	2
170	179		1		1			
180	189							
190	199						1	
200	209							
210	219			1				
220	229						2	
230	239	1		1		1	2	
240	249	2		2			2	
250	259						2	
260	269					1	1	
270	279	1	1	1			2	
280	289	1		1			7	
290	299	3		1		1	5	
300	399	10	8	4		3	6	6
400	499	2	1	1			3	

CHAPTER VII

Water Temperature Measurements in the Jefferson River and Associated Tributaries on July 31, 2007

On July 31, 2007 water temperature was measured at a variety of locations in the Jefferson River and tributaries to determine site-specific water temperature trends from approximately Sappington Springs to Hell's Canyon Creek. Water temperature was recorded using a Taylor thermometer. The survey began near Sappington Springs and proceeded upstream during the day. Water temperature measurements near Sappington Springs were first recorded at approximately 1200 hrs and the last measurement of the day was recorded at 1900 hours. Therefore, measurements between Sappington and approximately Whitehall were taken before daily maximum temperature was reached (about 1800 hrs), and measurements upstream of Whitehall were taken after the daily maximum temperature was reached.

This day was selected for the survey because the date is generally near the maximum water temperature of the Jefferson River, which generally occurs in late July/early August, and because the day was typical of hot, sunny conditions with above average conditions. Thus, these results provide a general view of near maximum water temperatures for several locations of the Jefferson River.

In addition to collecting water temperature readings in flowing riffle areas where water mixing has occurred, some additional measurements of the water surface or the bottom of pools were also taken to determine general trends for water temperature in various locations of the river. Multiple water temperature measurements were also taken at established USGS gaging stations to verify results of continuous water temperature measurement stations.

JEFFERSON RIVER WATER TEMPERATURE AND FLOW TREND

Data collected at three USGS gaging stations located near the headwaters (Twin Bridges Gage), at the most severely dewatered location upstream of Whitehall (Parson's Bridge Gage), and near the mouth of the Jefferson (Three Forks Gage), confirm the general understanding that water temperature increases from the headwaters to the mouth of the Jefferson River (Table 1). Data collection to identify more specific trends in water temperature have not been conducted in a systematic manner in the past. During 2008, more detailed evaluations of water temperature trends in the Jefferson River will be conducted as a part of the ongoing TMDL program for the Jefferson River, and the data gathered in 2007 was intended to help guide the upcoming temperature evaluation.

Table 1. Temperature and flow data at three USGS gaging stations for July 31, 2007.

LOCATION	FLOW (CFS)	MAX. TEMP.	MIN. TEMP	MEAN TEMP
TWIN BR.	319	24.5 (76.1)	18.5 (65.3)	21.4 (70.5)
PARSON'S BR	51	26.4 (79.5)	18.7 (65.7)	N/A
THREE FORK	168	26.8 (80.2)	21.6 (70.9)	23.8 (74.8)

A general pattern of reduced stream flow and elevated water temperature since 2000 is apparent by looking at data from the USGS gaging station for the Jefferson River at Twin Bridges. From 1995 through 1999, the Jefferson River experienced higher peak flows and higher summer flows compared to the past eight years of severe drought (2000 to 2007) (Figure 1).

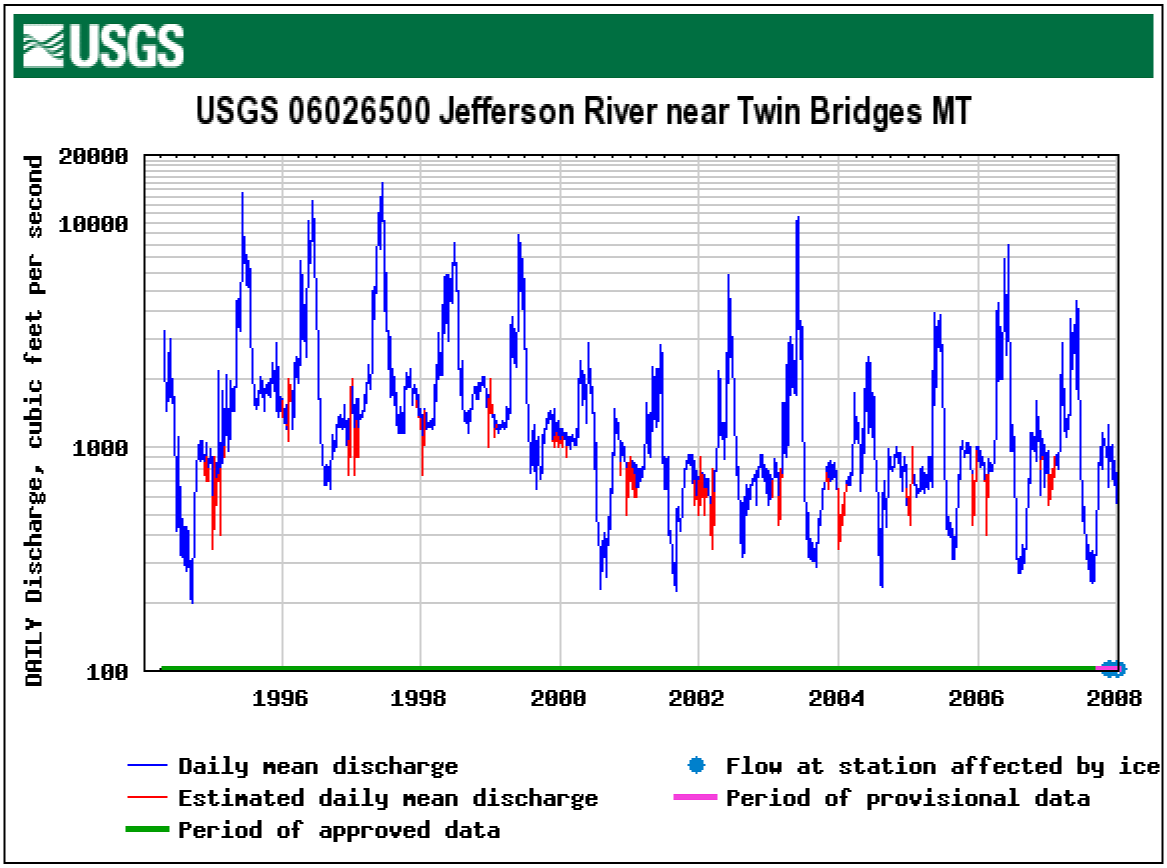


Figure 1. Stream flow pattern of the Jefferson River near Twin Bridges from 1994 to 2008.

Water temperature data from 1996 through 2007 at the Twin Bridges gage appears to closely reflect the reduced stream flow pattern, and years with relatively low flow generally result in relatively high water temperature. Daily maximum water temperature rarely exceeded 23 to 24 C (73.4 to 75.2 F) during the summers of 1996 to 1999 (Figure 2). Compared to the late 1990's, an increase in daily maximum water temperature was observed from 2000 to 2007 with readings sometimes exceeding 24 to 25 C (75.2 to 77.0 F).

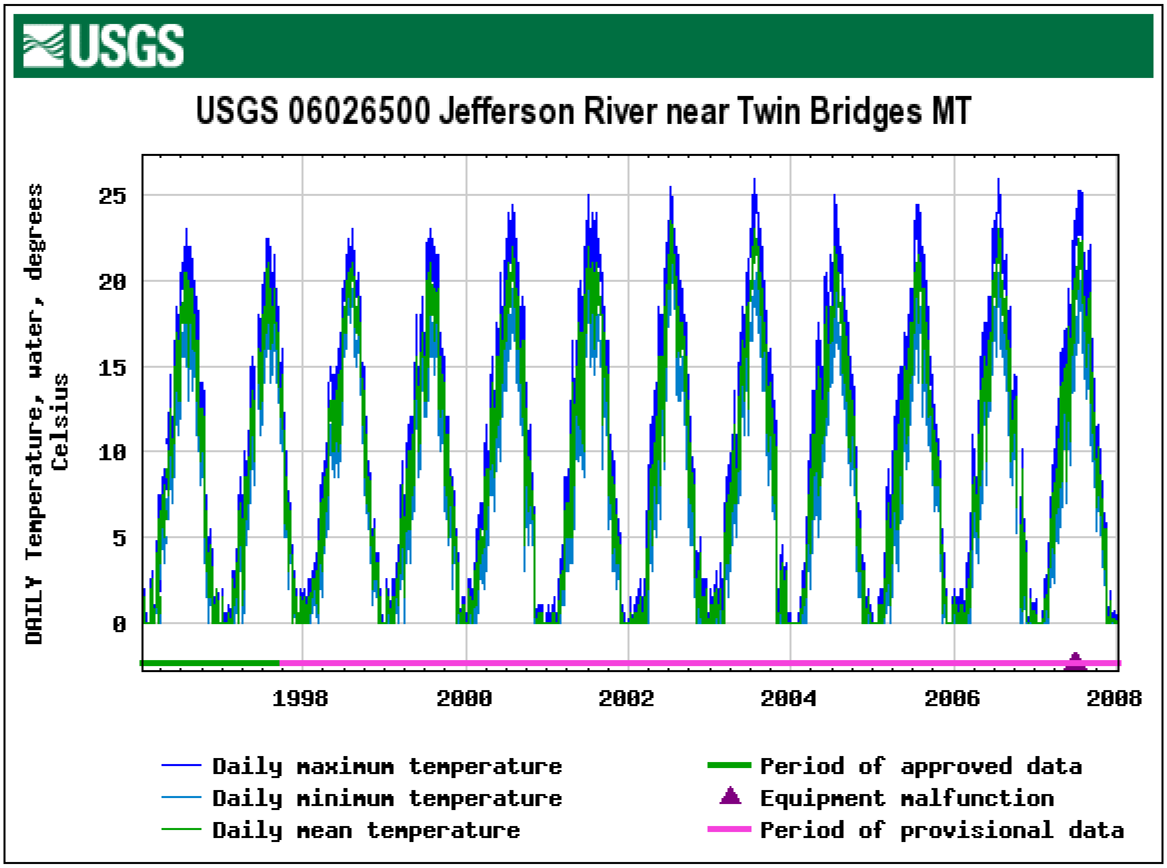


Figure 2. Daily maximum, minimum and mean water temperature of the Jefferson River near Twin Bridges.

RESULTS OF 2007 FIELD SURVEY OF WATER TEMPERATURE

During the summer of 2007, a more detailed understanding of the water temperature status of the Jefferson River was initiated. This survey was intended to expand knowledge of temperature trends beyond the three gaging stations established on the Jefferson River and to prepare for a more detailed evaluation of water temperature planned by DEQ, JRWC, TU and FWP during 2008.

Thirty measurements of water temperature between Sappington Springs and Hell's Canyon Creek on July 31, 2007 clearly show that some springs, sloughs and tributaries entering the Jefferson River provide water that is cooler than the mainstem Jefferson River (Figure 3). Sappington Springs, Willow Springs, Parson's Slough, the North Boulder River, and Hell's Canyon Creek represent the five coolest water temperature measurements during the survey. The warmest water temperature measurements were also obtained away from the mainstem Jefferson River, with Pipestone Creek and the mouth of Jefferson Slough being the two highest recorded measurements. Whitetail Creek was dry and no measurement was obtained at this relatively warm source of water.

On 31 July, temperature of the Jefferson River mainstem ranged from about 72 F to 78 F. The coolest measurement was observed near Cardwell FAS (72.1 F at 1326 hrs) and the warmest measurement was observed near Waterloo and Silver Star (over 78 F at 1700 to 1800 hrs).

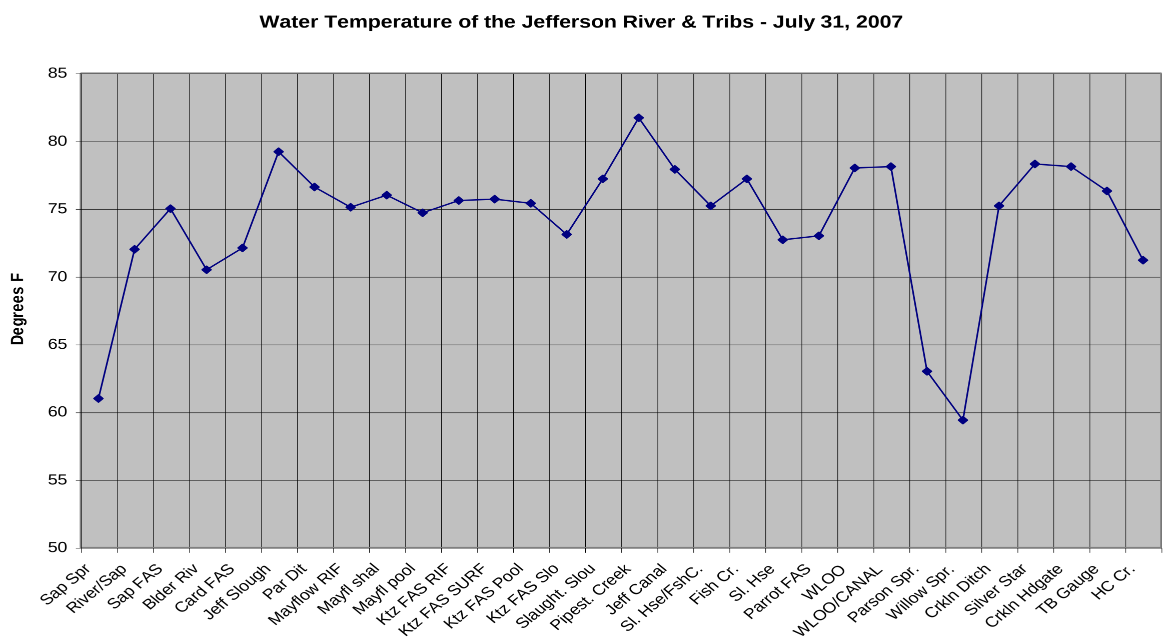


Figure 3. Water temperature measurements at 30 locations along the Jefferson River and associated tributaries and irrigation canals on July 31, 2007.

Water temperature at major canals was also measured during during the survey. The lower end of Parrot Ditch (near Kountz Road) was 76.6 F at 1359 hrs, the lower end of Jefferson Canal (near Whitehall) was 77.9 at 1555 hrs, the lower end of the Fish Creek Canal was 77 F at 1615, and the lower end of Creeklyn Ditch was 75.2 F at 1757. Creeklyn Ditch appeared to be cooler at the bottom of the ditch compared to temperature at the point of diversion. The lower canal temperature measured at 75.2 F (1757 hrs), and the temperature at the headgate measured at 78.1 F (1820) (Figure 4).

The finding at Creeklyn Ditch indicates that the narrow cross-section of canals can sometimes result in less thermal input, which may help maintain cooler temperature. Wide cross-sections, low velocity, and poor riparian growth along canals may increase thermal input and result in elevated water temperature at points of return flow.

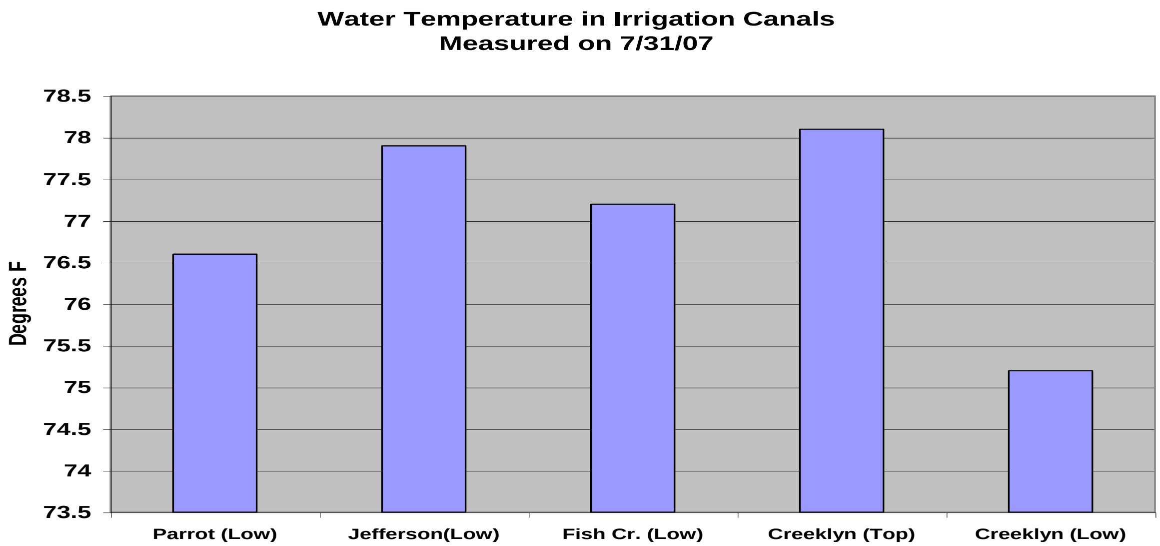


Figure 4. Water temperature measurements in four irrigation ditches on July 31, 2007.

COMPARISON OF USGS GAGING DATA TO FIELD MEASUREMENTS

Three USGS gaging stations record water temperature of the Jefferson River: Three Forks Gage, Parson's Bridge (Waterloo) Gage, and Twin Bridges Gage. Field measurements collected on July 31, 2007 were conducted at the gaging stations to determine the consistency of water temperature measurements of field measurements and gaging station recorders, and determine whether gaging station temperature "probes" reflected water temperature trends throughout the river channel.

Maximum water temperature of the Twin Bridges gage on 31 July was recorded at 76.1 F. The temperature probe was located approximately 3 inches below the water surface in moving water. Field measurements at this location were very similar to the USGS reading. A water temperature measurement of 76.7 F adjacent to the probe was obtained at 1845 hours. The Twin Bridges gage is used to determine the flow and temperature fishing restrictions in the Jefferson River Drought Management Plan. When daily maximum water temperature exceeds 73 F at the Twin Bridges Gage for three consecutive days, fishing may be restricted to morning hours.

Maximum water temperature of the Parson's Slough (Waterloo) Gaging Station on 31 July was recorded at 80.6 F at 1600 hours. Hourly readings from 1300 hours to 2000 hours are presented in Table 1. The USGS temperature probe was located 6 inches below the water surface.

Table 2. Comparison of water temperature recorded at Parson's Slough Gaging Station, Jefferson River, to Field Check (F.C.) measurements at three locations near the gage (near the temperature probe, surface of pool near the probe, and a the bottom of river channel).

TIME	USGS GAGE (DEGREES F)	F.C. AT GAGE (DEGREES F)	F.C. WATER SURFACE (DEGREES F)	F.C. POOL BOTTOM (DEGREES F)
1300	74			
1400	76.3			
1500	78.3			
1600	80.6			
1700	80.2	77.7	78.4	74.3
1800	77.9			
1900	75.9			
2000	75.7			

The USGS gage recording was 2.5 degrees higher than the field check measurement taken near the probe. The field check measurements also indicated that the water surface temperature was elevated as expected, but also indicated that the bottom of the pool (approximately 5 ft depth) was significantly cooler than readings at waters surface or near the gaging station temperature sensor.

AIR TEMPERATURE DURING JULY 31, 2007 SURVEY

Air temperature recorded during the survey with the Taylor thermometer was 90 F at 1200 hours, 92 F at 1600 hours, and 80.6 F at 1900 hours. Temperature Data for surrounding areas (Dillon, Helena, Bozeman) from the NOAA Online Weather Data Website confirm that the date of the survey represented relatively hot conditions for assessing the near maximum water temperatures for the Jefferson River (Table 3).

Table 3. Air temperature data for July 31, 2007 obtained from NOAA.

Location	Max. Temperature on 7/31 (Observed 7/31/07)	Normal Max. Temperature for 31 July
Dillon	89	83
Bozeman	100	86
Helena	96	85

TEMPERATURE CRITERIA FOR ANGLING RESTRICTIONS

Beginning in 2005, FWP and JRWC began using water temperature criteria to restrict angling during warm conditions (afternoon and evening). FWP can implement the temperature restriction when daily maximum water temperature exceeds 23 C (73 F) for three consecutive days. Prior to the 2000 to 2007 drought, temperature rarely exceeded the criteria for three consecutive days (Table 4). In contrast, during the low flow period of the past eight years, the criteria was frequently met during the last two weeks of July.

Table 4. Water temperature trends relative to criteria for drought-related fishing closures. Data was provided by the USGS gaging station at Twin Bridges.

DATE	# DAYS > 23 C	RANGE OF DATES MAX TEMP > 23C	Tmax
1995	0	N/A	18.5
1996	2	27, 28 July	23.0
1997	0	N/A	22.5
1998	2	12, 13 August	23.0
1999	3	27, 28, 30 July	23.0
2000*	16	July 12, 13, 14, 16, 21, 22, 23, 24, 25, 27, 28, 29, 30, 31, August 1, 2	24.5 (7/28-31)
2001*	17	June 28, 29, July 1, 2, 3, 8, 9, 11, 12, 24, 25, 26, 27, August 5, 6, 7, 8	24.5 (7/8)
2002*	16	June 25, 26, 27, July 8, 9, 10, 11, 12 13, 14, 15, 17, 18, 21, 23, 24	25.5 (7/12)
2003*	32	July 7, 10, 11,12,13, 14, 15, 16, 17, 18,19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, August 1, 2, 3, 4, 7, 9, 10, 13, 20	26.0 (7/23-24)
2004*	7	July 14, 15, 16, 17….19, 20, 21	25.0 (7/17)
2005*	13	July 12..14, 15..18, 19, 20, 21..23, 24..Aug 4, 5, 6, 7	24.5 (7/21-23)
2006*	18	July 4..8..15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25..26, 27, 28, 29, 30	26.0 (7/23,24)
2007*	30	July 1, 2, 3, 4, 5, 6, 7, 8, 9..12, 13 14, 15, 16, 17, 18, 19, 20, 21, 22, 23.. 25, 26, 27, 28, 29, 30, 31..Aug 2, 3	25.3 (7/22)

* FWP drought fishing closure policy would be implemented during these years due water temperature exceedence of threshold of 23 C (73 F) for three consecutive days. In 1999, the three days exceeding 23.0 were not consecutive.

DISCUSSION

Based on data collected at existing USGS gaging stations, it is clear that water temperature has increased during the low flow period beginning in about 2000. Brown trout populations have declined in the Jefferson River during the same period and it is not known whether loss of habitat, elevated water temperature, or other causes are responsible for reduced brown trout numbers. Events where significant fish mortality was observed due to high temperature and associated low dissolved oxygen have been rare based on casual observations of the river during hot summer conditions. One large fish kill observed in 2003 between Sappington Bridge and Williams Bridge occurred during very warm conditions in late July indicated that primarily mountain whitefish were affected by the warm conditions. A few hundred mountain whitefish were observed near Sappington Bridge and a few dozen mountain whitefish were observed near Williams Bridge on July 22, 2003. No dead trout were observed on this date, but the survey was not extensive and other species were likely affected to some degree.

Since fish have the ability to migrate to deep pools or other areas of refuge during the severe conditions, it is important to identify areas where fish can survive drought conditions during the most severe period of the summer (approximately July 15 to Aug 15). Knowledge of such areas may help direct management practices by water users to rely on relatively warm sources of water for irrigation, and attempt to maximize instream use of relatively cool water sources.

For example, previous work on the Jefferson River has shown that springs in the Waterloo area (eg. Parsons Slough and Willow Springs) provide cool water for the Jefferson River in the most severely dewatered reach of the river. These sources are approximately 15 degrees F cooler than the Jefferson River. The 2007 survey identified a few other sources of tributary or slough inflows that had different temperature regimes compared to the Jefferson River. A small slough entering the river near Kountz bridge was 2 degrees F cooler than the river. The mouth of the Jefferson Slough was approximately 4 degrees F warmer than the Jefferson River. Some tributaries are cooler than the river (Hells Canyon, North Boulder River) and some are warmer than the river (Pipestone Creek) (Figure 3).

Each of the above examples provide some management possibilities to improve conditions in the Jefferson River. Relatively cool sources of water should receive protection from additional irrigation use, and relatively warm sources of water need to be evaluated for potential improvements of channel morphology to reduce thermal input (the Jefferson Slough channel is very wide with low gradient and relatively high water temperature was measured near the mouth).

Site specific temperature refuge for fish was sometimes apparent from the 2007 survey. Water temperature at the Parson's Slough gage (Waterloo) varied by approximately 4 degrees F when comparing surface, riffle, and pool substrate temperature. The pool was 5 ft deep and about 4 degress F cooler than the water surface. In contrast to the Waterloo observation, temperature readings near Kountz Bridge found the surface water to be very similar to the pool substrate temperature. It is not known if the lack of temperature stratification near Kountz Bridge was due to water mixing, lack of groundwater inflows, or other variables.

The proposed study by DEQ to evaluate infra-red temperature readings on a large scale basis along the Jefferson River will be very helpful for determining opportunities to improve water temperature in the Jefferson River.

CHAPTER VIII
FISHING PRESSURE AND ANGLER USE OF THE JEFFERSON RIVER

Information presented in this report regarding fish population trends indicate that insufficient streamflow is the likely limiting factor for fish abundance in the Jefferson River. An unknown number of fish are also lost or removed from the population due to angling mortality during both high flow years and drought years. Some portion of fish mortality is due to direct harvest by anglers, and some unknown percentage of fish mortality is due to catch and release mortality. To date, there has never been a formal, comprehensive creel census evaluation on the Jefferson River to better understand these sources of fish mortality.

Mortality of fish during drought years is generally believed to be higher than years with normal or high flow due to habitat loss, stress on fish due to elevated temperature and reduced habitat quality, and increased predation loss to a variety of predators (birds, fish, mammals, etc.). Likewise, angling during low flow conditions probably has more potential to impact the fishery due to high water temperature and the concentration of fish during the declining available habitat as the river shrinks in size. See Figure 1 for an example of fishing during drought conditions.

Figure 1. Photograph of an angler fishing in a concentrated pool habitat in the Jefferson River near Waterloo on August 4, 2000.

Angling restrictions imposed during implementation of the Drought Management Plan (2000-2007) were intended to reduce angler-related mortality during stressful drought conditions. Complete fishing closures implemented when flow is less than 280 cfs (90% exceedence flow for August) at Twin Bridges apply to the entire river, and time-of-day restrictions based on elevated water temperature (maximum daily water temperature exceeds 73 F for three consecutive days) also results in closing fishing for the entire Jefferson River from 2 pm to midnight. The rationale for applying fishing restrictions to the entire river was to reduce stress on the fishery in both severely dewatered areas as well as relatively healthy reaches of river where fish may congregate during severe conditions.

Fishing regulations for trout in the Jefferson River have become progressively more restrictive in the past 20 years (Table 1). Catch and release fishing for rainbow trout was initiated in 1986 in an attempt to improve the rainbow trout fishery by restricting harvest. Compared to other catch and release regulations in Montana, which generally restrict gear to artificial lures, the Jefferson River catch and release regulation was a relatively rare format that allowed continued use of bait. Based on an evaluation of rainbow trout and brown trout with visible hook scars during selected years before and after the catch and release regulation was implemented, there appeared to be more trout with hook scars after the regulation was imposed (Figure 2). There was a general trend of higher hook scar percentages for rainbow trout compared to brown trout, which may be due to the catch and release regulation for rainbow trout, the higher catch rates of rainbow trout, or a combination of factors.

"Hoot-owl" fishing restrictions based on reducing fishing activity during warm, afternoon hours typically prohibited fishing from noon to midnight from 2000 to 2006. In 2007, the temperature restriction was changed to prohibit fishing from 2 pm to midnight, which provided an additional two hours of fishing opportunity during low water conditions (Table 1).

Table 1. Summary of Fishing Regulation Changes from 1986 to 2007.

YEAR	CHANGE IN FISHING REGULATION
1986	Catch and Release Regulation for rainbow trout. Allows use of bait.
1998	Catch and release for rainbow trout in spawning streams due to Whirling Disease (statewide issue)
2000	First implementation of fishing closure due to drought plan
2002	Reduction of brown trout limit from 5 to 3 (only 1 over 18") due to drought impacts.
2003	Catch/Release Regulation for rainbow trout maintained despite an effort to allow youth anglers to harvest one fish.
2004	Refine drought plan to close fishing at 280 cfs rather than 250 cfs, and add temperature trigger of 3 days over 73 F.
2007	Extend hours of hoot-owl closure from noon to 2 pm allowing two additional hours of fishing during temperature restriction.

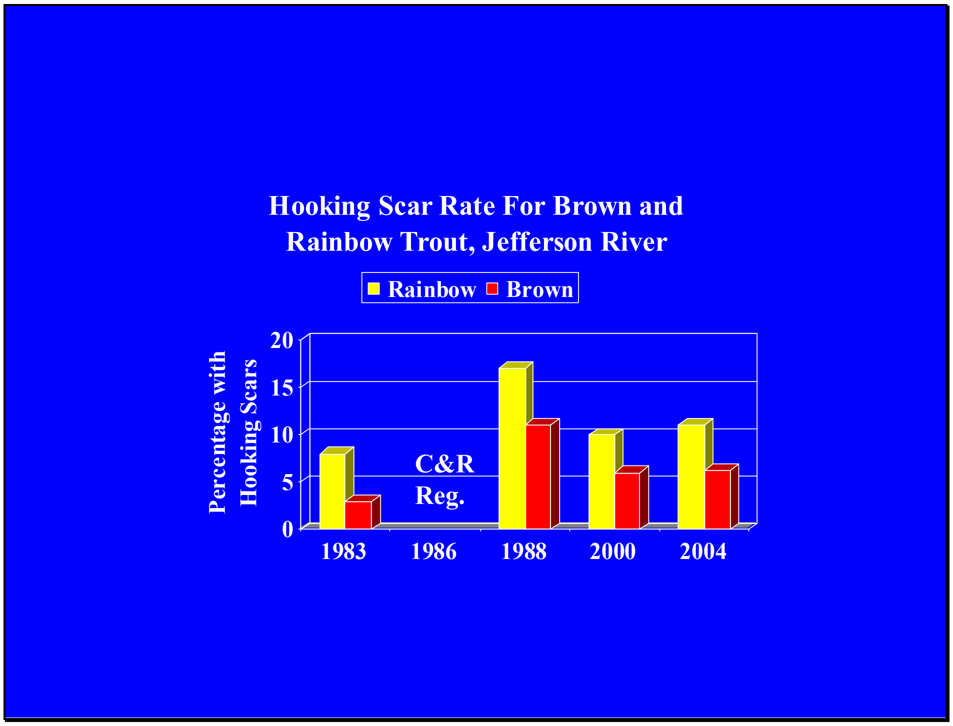


Figure 2. Percentage of brown and rainbow trout with visible hook scars in the Jefferson River before and after 1986 when catch and release fishing regulation was initiated for rainbow trout

CREEL CENSUS

Formal creel census work and angler surveys have not been conducted during the duration of this study. During March 1999, the local Game Warden conducted an informal survey of anglers during routine enforcement patrols. He conducted 38 interviews with anglers, and observed that 24 brown trout and 9 rainbow trout were caught. About 58% of the brown trout were kept by anglers, and due to catch and release regulation for rainbow trout, no rainbow were kept. A total of 64 hours of angling was included in the 38 interviews resulting in a catch rate of 0.38 brown trout per hour and 0.14 rainbow trout per hour.

The informal census in March of 1999 does not give a broad picture of angling success in the Jefferson River because it did not provide a large sample size of interviews throughout the river, or throughout the fishing season. A more detailed creel census would be needed to determine the potential effects of angler harvest on trout populations. Another factor affecting the magnitude of angling mortality of trout in the Jefferson River is fishing pressure. Angling pressure surveys conducted by MDFWP shows that fishing pressure declined from a high of about 25,000 angler days in the mid-1980's to a low of about 5000 anglers days in 2005 (Figure 3). Comparing fishing pressure to mean annual flow of the Jefferson River indicates that years with low stream flow tend to result in fewer angler days. The reduced angling pressure in response to lower stream flow is likely due to a combination of lower stream flow causing reduced fish populations, and the fact that lower stream flow levels during the summer fishing season results in less desirable conditions for floating and fishing the river.

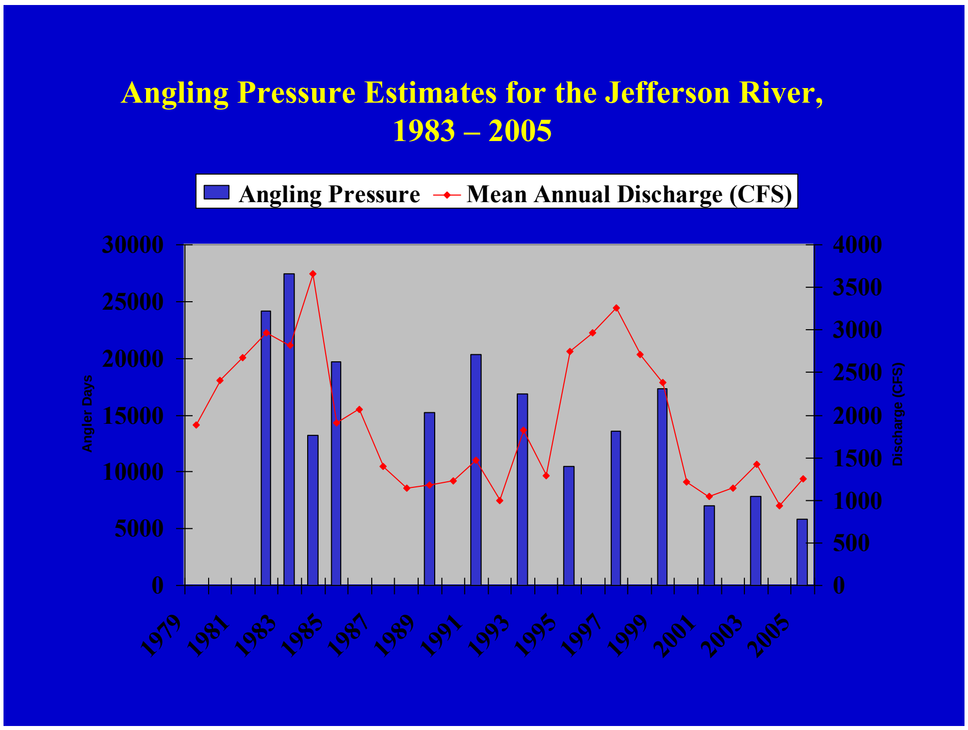
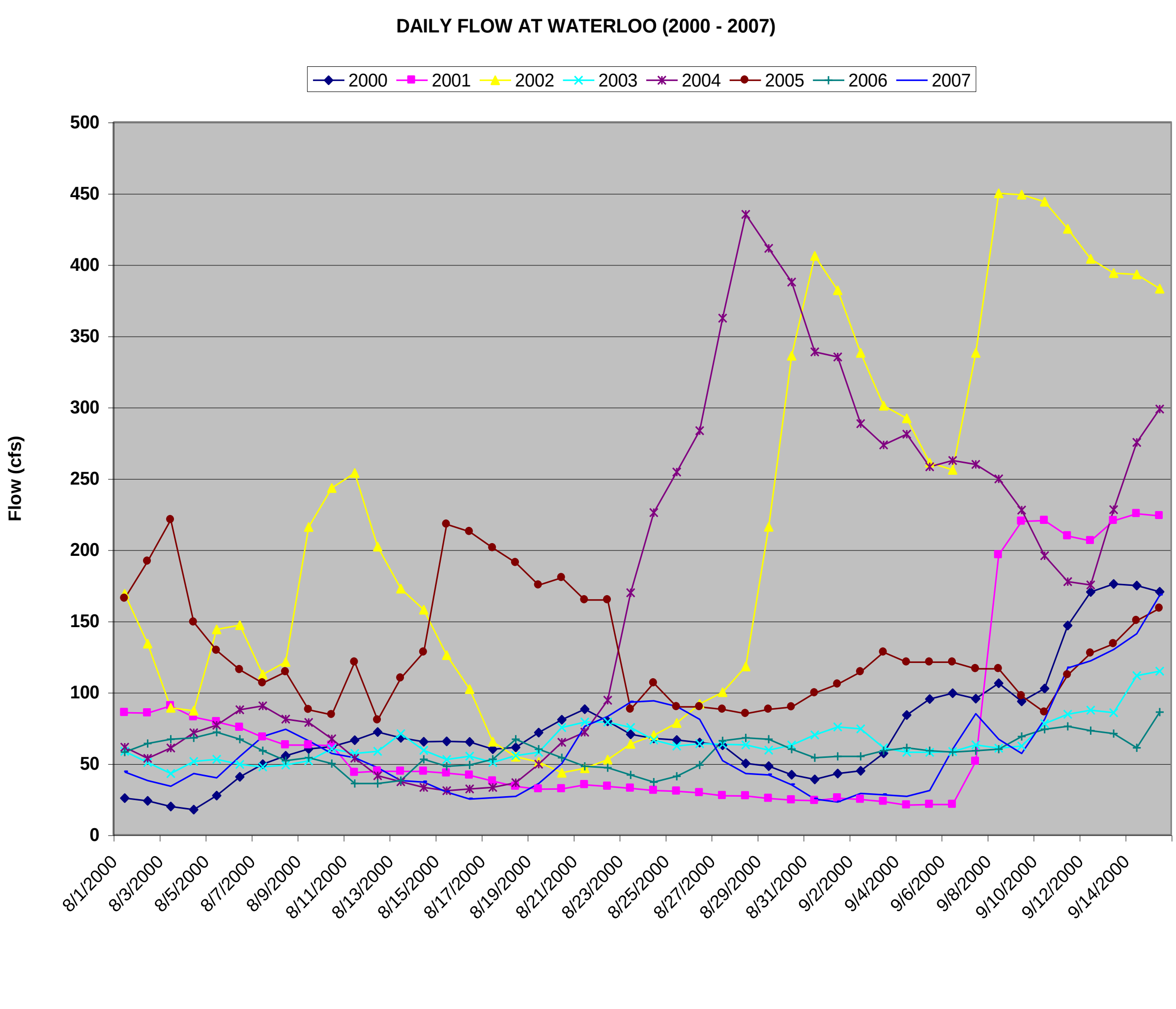


Figure 3. Mean annual flow and angling pressure trends for the Jefferson River.

Appendix A: Daily Flow Records at Waterloo (2000-2007)

SEASONAL DATA COLLECTED BY JRWC FROM 2000 THROUGH 2005
AND BY USGS IN 2006 AND 2007



DAILY FLOW DATA AT WATERLOO
(July through August 8th)

Jefferson River below Waterloo Bridge, Days below benchmarks:

	2000	2001	2002	2003	2004	2005	2006	2007
Days < 100	51	41	12	49	23	13	48	36
Days < 50	17	27	2	4	8	0	11	22
Low Flow	17.6	20.8	43.5	43	30.9	85	36	23

Average Daily Flows Below Waterloo Bridge

	2000	2001	2002	2003	2004	2005	2006	2007
25-Jun								821
26-Jun								746
27-Jun								672
28-Jun								621
29-Jun		331.20						576.0
30-Jun		365.52						545.0
1-Jul		337.11					979.0	530.0
2-Jul		311.61					1130.0	539.0
3-Jul		282.14					1080.0	487.0
4-Jul		287.49					1030.0	456.0
5-Jul	958.24	365.87					1010.0	357.0
6-Jul	936.96	396.00					943.0	188.0
7-Jul	855.58	413.42					884.0	131.0
8-Jul	712.88	351.50					870.0	141.0
9-Jul	520.78	247.95					807.0	156.0
10-Jul	482.31	229.85				**950.8**	754.0	126.0
11-Jul	456.23	251.89				**909.2**	721.0	98.0
12-Jul	358.95	233.87			790.60	**888.40**	684.0	85.0
13-Jul	289.74	238.42			628.20	**825.90**	741.0	76.0
14-Jul	256.58	260.22			534.50	**718.60**	686.0	65.0
15-Jul	243.09	270.02			448.00	**605.10**	623.0	70.0
16-Jul	212.89	277.44			390.90	**494.80**	561.0	94.0
17-Jul	201.80	313.67			351.20	**398.00**	500.0	104.0
18-Jul	196.30	378.48		112.20	312.40	**353.20**	431.0	111.0
19-Jul	158.74	409.11	381.80	104.40	330.90	**297.00**	343.0	138.0
20-Jul	92.23	400.18	441.20	103.60	407.50	**253.20**	301.0	119.0
21-Jul	82.16	406.74	450.00	101.00	431.60	**225.10**	247.0	82.0
22-Jul	74.70	399.15	450.90	102.20	464.60	**204.30**	201.0	66.0
23-Jul	64.82	376.70	378.60	83.00	433.70	**189.70**	189.0	63.0
24-Jul	59.14	322.39	340.40	71.30	356.30	**162.60**	168.0	59.0
25-Jul	63.28	251.38	335.10	85.60	289.30	**164.70**	154.0	74.0
26-Jul	53.77	214.28	342.50	114.70	261.40	**202.20**	136.0	80.0
27-Jul	48.73	148.26	368.70	131.50	233.10	**216.80**	134.0	73.0
28-Jul	42.46	109.77	377.20	125.80	196.20	**193.90**	128.0	71.0
29-Jul	39.00	90.87	369.80	117.40	171.40	**181.40**	102.0	60.0
30-Jul	36.10	88.32	335.00	98.40	118.00	**173.10**	83.0	54.0
31-Jul	30.88	88.19	271.00	86.70	83.40	**163.70**	62.0	50.0
1-Aug	25.67	85.65	169.00	58.50	61.40	**165.80**	58.0	44.0
2-Aug	23.76	85.35	134.00	50.70	53.60	**191.80**	64.0	38.0
3-Aug	19.84	90.37	89.00	43.00	60.90	**220.90**	67.0	34.0
4-Aug	17.60	82.51	87.00	51.50	71.50	**149.10**	68.0	43.0
5-Aug	27.47	79.14	144.00	52.90	76.90	**129.30**	72.0	40.0
6-Aug	40.63	75.29	147.00	49.40	87.70	**115.80**	67.0	55.0
7-Aug	49.49	68.44	112.50	47.60	90.40	**106.40**	59.0	69.0
8-Aug	55.46	62.98	121.20	49.00	81.10	114.20	52.0	74.0

Note: Bold - Data correlated w/Twin USGS Flows
Aquarod Down During This Time
2006-07 Based on USGS Gauge installed J
2001-2005: DNRC Stilling Well/Staff Gauge

DAILY FLOW DATA AT WATERLOO CONTINUED.

5-Aug	27.47	79.14	144.00	52.90	76.90	**129.30**	72.0	40.0
6-Aug	40.63	75.29	147.00	49.40	87.70	**115.80**	67.0	55.0
7-Aug	49.49	68.44	112.50	47.60	90.40	**106.40**	59.0	69.0
8-Aug	55.46	62.98	121.20	49.00	81.10	114.20	52.0	74.0
9-Aug	60.13	62.90	215.90	51.80	78.80	87.70	54.0	66.0
10-Aug	61.79	62.69	243.20	60.30	67.30	84.10	50.0	57.0
11-Aug	66.29	43.59	253.70	57.00	53.70	121.00	36.0	54.0
12-Aug	72.12	44.55	202.00	58.60	41.50	80.50	36.0	47.0
13-Aug	68.05	44.44	172.60	70.90	37.20	109.80	38.0	38.0
14-Aug	65.22	44.44	157.90	59.20	33.30	128.00	53.0	37.0
15-Aug	65.46	43.19	126.00	52.80	30.90	**217.80**	48.0	30.0
16-Aug	65.11	41.71	102.20	55.10	32.20	**212.60**	49.0	25.0
17-Aug	60.06	37.59	65.20	50.80	33.20	**201.20**	53.0	26.0
18-Aug	61.30	33.95	54.70	55.60	36.50	**190.80**	67.0	27.0
19-Aug	71.63	32.03	51.00	57.90	49.50	**175.10**	60.0	36.0
20-Aug	80.69	32.12	43.50	75.20	64.90	**180.30**	54.0	50.0
21-Aug	88.10	34.96	46.70	79.10	71.90	**164.70**	48.0	76.0
22-Aug	79.65	33.86	52.70	79.10	94.40	**164.70**	47.0	83.0
23-Aug	70.50	32.62	63.80	75.20	169.70	**88.00**	42.0	93.0
24-Aug	67.55	31.10	69.80	66.50	226.00	**106.40**	37.0	94.0
25-Aug	66.45	30.49	78.40	62.20	254.50	**89.70**	41.0	90.0
26-Aug	64.74	29.35	91.80	63.90	283.40	**89.70**	49.0	81.0
27-Aug	62.80	27.40	100.00	63.50	362.40	**87.90**	66.0	52.0
28-Aug	50.06	27.24	118.00	63.10	435.10	**85.00**	68.0	43.0
29-Aug	48.15	25.39	216.00	59.40	411.30	**87.90**	67.0	42.0
30-Aug	42.09	24.40	336.00	62.90	387.70	89.60	60.0	35.0
31-Aug	38.82	23.96	406.00	70.00	338.70	99.40	54.0	25.0
1-Sep	42.99	25.75	382.00	75.70	335.10	105.60	55.0	23.0
2-Sep	44.84	24.70	338.00	74.30	288.40	114.20	55.0	29.0
3-Sep	57.19	23.21	301.00	61.00	273.40	128.00	59.0	28.0
4-Sep	83.96	20.80	292.00	57.90	281.00	121.00	61.0	27.0
5-Sep	95.24	21.22	261.00	57.80	258.10	121.00	59.0	31.0
6-Sep	99.30	21.19	256.00	58.40	262.50	121.00	58.0	60.0
7-Sep	95.55	51.49	338.00	63.00	259.80	116.40	59.0	85.0
8-Sep	106.31	196.32	450.00	60.70	249.60	116.40	60.0	67.0
9-Sep	93.55	219.82	449.00	62.30	227.80	97.40	69.0	57.0
10-Sep	102.62	220.43	444.00	78.00	195.70	85.90	74.0	81.0
11-Sep	146.75	209.52	425.00	84.50	177.50	112.00	76.0	117.0
12-Sep	170.32	206.11	404.00	87.40	175.20	127.40	73.0	122.0
13-Sep	175.96	220.26	394.00	85.60	228.00	133.90	71.0	130.0
14-Sep	174.83	225.23	393.00	111.60	275.20	150.20	61.0	141.0
15-Sep	170.50	223.66	383.00	114.80	298.60	158.80	86.0	168.0
16-Sep	146.74	221.07	359.00		319.50	157.10	189.0	191.0
17-Sep	135.41	222.93	373.00		324.80	161.20	264.0	188.0
18-Sep	132.41	219.43	469.00		314.80	187.60	272.0	208.0
19-Sep	129.97	212.81	477.00		352.00	207.30	293.0	241.0
20-Sep	136.23	208.42	457.00		512.80	222.00	313.0	298.0
21-Sep	173.44	210.14	453.00		792.20	238.20		382.0
22-Sep	282.72	203.20	424.00		883.80	258.00	386.0	415.0
23-Sep	451.48	206.53	416.00		871.40	265.10	438.0	440.0
24-Sep	504.57	205.92	404.00		827.90	376.70		532.0
25-Sep	554.58	208.58	410.00		825.30	459.90	466.0	614.0
26-Sep	575.90	196.16	427.00		789.90	469.80	471.0	641.0
27-Sep	564.03	187.78	447.00		797.20	483.80	462.0	
28-Sep	554.16	190.57	472.00		757.30	467.10	475.0	
29-Sep	576.59	207.94	468.00		740.90	464.90	469.0	
30-Sep	600.92	223.04	474.00		729.60	452.10	477.0	
Average Seasonal Flow	149.6	150.5	249.7	73.7	231.6	215.6	206.9	77.7