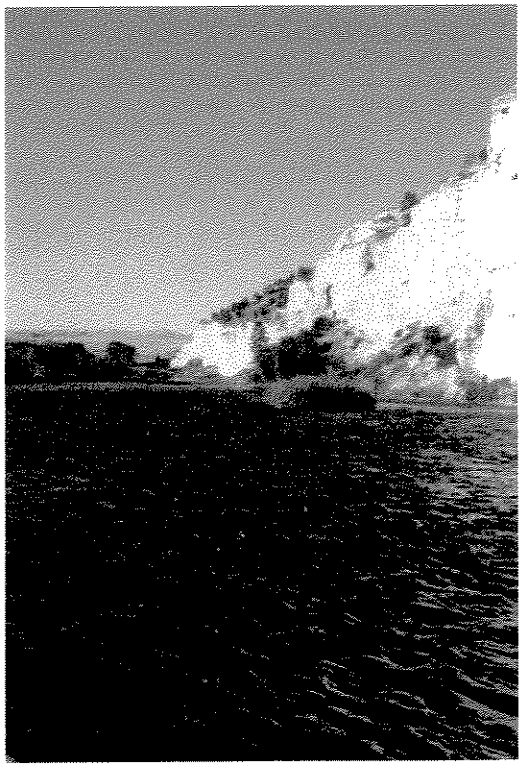
An Examination of 1995 and 1996 Creel Survey Data for the Madison River, Montana and Evidence of Possible Effects due to Whirling Disease

Prepared for:

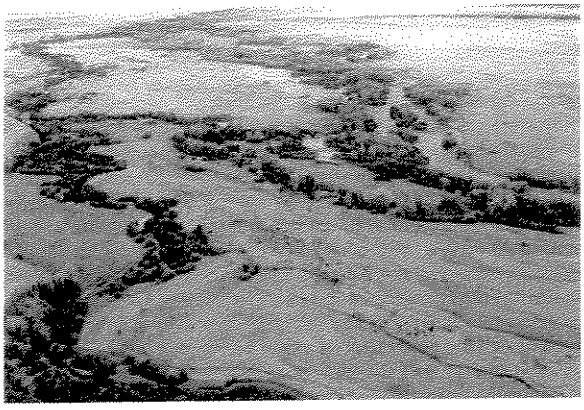
Montana Fish, Wildlife & Parks
Region 3 Headquarters
1400 South 19th Avenue
Bozeman, MT 59718



Prepared by:

Leanne Hennessey Roulson

March 12, 2002



An Examination of 1995 and 1996 Creel Survey Data for the Madison River, Montana and Evidence of Possible Effects due to Whirling Disease

Prepared for:

Montana Fish, Wildlife & Parks
Region 3 Headquarters
1400 South 19th Avenue
Bozeman, MT 59718

Prepared by:
Leanne Hennessey Roulson
808 Oregon Street
Belgrade, MT 59714
406-388-6194
lhroulson@garciaandassociates.com

March 12, 2002

Table of Contents

List of Tables

List of Figures

List of Appendices

Executive Summary

The parasite that causes whirling disease was first discovered in Montana in rainbow trout in the Madison River in December 1994. It was discovered during an investigation into the cause of a major decline in the rainbow trout population in the upper Madison River. Part of FWP's response to these findings was an intensive creel survey in 1995 and 1996. In 1995, the creel survey covered the entire Madison River from Quake Lake downstream to the headwaters of the Missouri River at Three Forks; and in 1996, the section from Slide Inn downstream to Windy Point (approximately 20 river miles) was surveyed. The results from these two surveys, when compared with historical creel surveys, provide a great deal of insight into the effects of the disease on the fishery.

The Madison River rainbow trout fishery declined significantly from the late 1970's and early 1980's to the period after whirling disease was first diagnosed in 1994. The decline is evident in angler catch rate data, trout population estimates, and angler use surveys. Catch rates for rainbow trout were much lower in 1995 than in earlier surveys, but the catch rates for brown trout did not show a similar pattern, and actually increased from 1977 to 1995. It appears that as whirling disease was reducing the numbers of rainbow trout, the brown trout population became proportionately more available for capture by anglers. Changes in FWP's annual population abundance estimates for rainbow and brown trout have mirrored changes in catch rates in the upper Madison River over the years, and the 1995 and 1996 surveys were no exception. Rainbow trout population declines as measured by the annual electrofishing surveys paralleled the rinbow trout catch rate declines recorded in the creel surveys.

Despite these declines, the anglers who chose to fish the Madison River were generally satisfied with their fishing experience according to the 1995 angler satisfaction survey. However, FWP's biennial mail-in surveys showed a slight decrease in angler use of the Madison River in the mid-1990's. Nearly 90% of all anglers surveyed on the Madison in 1995 and 1996 were non-residents, which may explain why many anglers also responded that they had fished the area for one year or less. The upper reach of the river was frequented almost exclusively by fly anglers, and had a higher proportion of guided trips than the lower reach. In addition, the upper river

experienced much higher fishing pressure than the lower sections, which may have important management implications.

The economic and ecological impacts of whirling disease affect both anglers and non-anglers within the Montana community. The Madison generates a significant amount of income for the surrounding area, and for the state. This report provides a thorough examination of how whirling disease has affected the Madison River fishery in terms of angler perceptions and trout population trends using existing data.

1.0 Introduction

Montana Fish, Wildlife and Parks (FWP) monitors trout populations annually on the Madison River. When these surveys revealed that one-year old rainbow trout were disappearing from their annual Madison River population estimates in 1991, there was an intensive investigation to discern why young-of-the-year (YOY) survival, and potential recruitment appeared to have plummeted. Population declines were eventually attributed to the myxozoan parasite *Myxobolus cerebralis* which causes whirling disease. The Madison River is a renowned fishery and the presence of whirling disease raised concern for the trout populations and associated fishery.

Annual population estimates have been examined by Vincent and Byorth (1999) to determine the impact of whirling disease on the Madison River fishery. While trout population declines were well documented, the impacts of whirling disease on angling were unclear. Creel surveys were undertaken in 1995 and 1996 to document angling pressure, catch rates, and angler satisfaction in the presence of whirling disease. This report summarizes the 1995 and 1996 creel surveys and compares them with historic creel survey data from pre-whirling disease years; 1976, 1977, and 1981.

The specific objectives of this report are to:

1. Document fishing pressure, catch rates, and angler characteristics on the Madison River in 1995 and 1996.
2. Examine creel survey results from 1996 by section, focusing on the FWP study sections, Pine Butte and Snoball.
3. Compare the 1995 and 1996 results with historical creel data.
4. Assess the effects of whirling disease on the fishery and its implications for future fisheries management.

2.0 Whirling Disease and the Madison River

2.1 Mechanism and Biology of the Disease

"Whirling disease" is a disease of Salmonid fish (trout, salmon, whitefish) caused by a myxozoan parasite known as *Myxobolus cerebralis*. This tiny parasite has a fairly complicated life cycle which involves two hosts; a small aquatic worm (*Tubifex tubifex*) and a fish. The fish becomes infected after the triactinimyxon form of the parasite (the TAM stage) emerges from the worm and enters the water column. The parasite finds a salmonid fish, attaches to the fish and penetrates the skin. The parasite eventually finds its way to the cartilage of the fish where it develops into a mature spore. Spores remain in the cartilage and bone until the fish dies, releasing spores into the water, which ultimately are ingested by the tubificid worms and the life cycle starts all over (MTWDTF 2000).

Once ingested, the parasite can affect nerves and damage cartilage which results in the abnormal whirling or tail-chasing behavior exhibited by some infected fish. The neural damage and pressure on nerves from inflammation due to the parasitic infection cause these and other symptoms, which may include a black tail in younger fish. In older fish symptoms sometime include deformities to the head or body (MTWDTF 2000). Table 1 lists the fish species in Montana that have been found infected with the whirling disease parasite.

Table 1. Salmonid species occurring in Montana that have tested positive for whirling disease (MTWDTF 2000).

Common Name	Scientific Name	Susceptibility	Found in Madison?
Rainbow trout	Oncorhynchus mykiss	All strains of rainbow trout tested to date are susceptible	X
Mountain whitefish	Prosopium williamsoni	Susceptible	X
Yellowstone cutthroat trout	Oncorhynchus clarki bouvieri	Susceptible	X
Westlope cutthroat trout	Oncorhynchus clarki lewisi	Susceptible	X
Bull trout	Salvelinus conluentus	Partial resistance	
Brown trout	Salmo trutta	Partial resistance	X

Common Name	Scientific Name	Susceptibility	Found in Madison?
Chinook Salmon	Oncorhynchus tshawytscha	Very susceptible	
Coho Salmon	Oncorhynchus kisutch	Quite resistant	
Grayling	Thymallus arcticus montanus	Very resistant	X

Most species of trout and salmon can be infected with the parasite but not all will develop whirling disease. Scientists have found that the age of the fish when first exposed to the parasite is very important (Ryce, MacConnel and Zale 1999). Very young fish are highly susceptible but after a fish is nine weeks old it becomes resistant to whirling disease (Ryce, MacConnel and Zale 1999, E. Ryce, pers. comm. 2002). Newly hatched rainbow trout fry (one week old) had significantly lower survival rates at any exposure than older fish (Ryce, MacConnel and Zale 1999). Other members of the trout and salmon family, such as mountain whitefish may be at risk; however, rainbow trout appear to be the most susceptible trout species. Brown trout become infected with the parasite, but they appear to have immunity to the parasite and have not been as heavily impacted as rainbow trout (Opitz and Zale 1998).

2.2 History of Whirling Disease on the Madison River

The parasite that causes whirling disease was first discovered in Montana in rainbow trout in the Madison River in December 1994. It was discovered during an investigation into the cause of a major decline in the rainbow trout population in the upper Madison River. Prior to December of 1994 this parasite had never been detected in any fish in Montana. Monitoring of hatchery stocks and limited inspections and testing of wild populations for this parasite had taken place for many years prior to its discovery in the Madison River. These monitoring efforts increased dramatically after the 1994 discovery of the parasite and a state-wide survey was initiated. As of early 1998 nearly 300 individual waters have been tested and the parasite has been detected in more than 85 individual sites in Montana (MTWDTF 2000).

3.0 Methods

The Madison River stretches 115 miles from Quake Lake near Yellowstone National Park to where it joins the Gallatin and Jefferson rivers to form the headwaters of the Missouri River (Figure 1). Two study sections of the upper Madison River are covered in this report, Snoball and Pine Butte. FWP collected creel survey data on the Madison River as early as the 1960's, and currently assesses trout populations in the Madison regularly. The Snoball section, named after an historic inn, lies between Squaw Creek and Windy Point, approximately 16.5 miles downstream from Quake Lake. The Snoball section, which is approximately 4.5 miles long, has been electrofished intermittently since 1975. The section was shortened to 4.0 miles in 1994. The Madison River in this reach has many small tributaries, but fewer side channels than the second study section, Pine Butte. Snoball is a popular fishing section and has been managed under restricted regulations or closures in the past due to fluctuations in the trout population, and for research purposes (Table 2). Snoball provided a laboratory to study the impacts of angling, regulations, and disease since 1977 when it was closed to all fishing. It was opened to catch-and-release fishing for trout and fishing from boats in March 1983 (M. Lere personal comm. and FWP Files). To study the impacts angling and whirling disease, it was closed to fishing again between March 1995 and February 1997.

The Pine Butte section lies approximately 12.0 miles below Quake Lake (Figure 1). It is 3.0 miles long, extending from Pine Butte Creek to Lyons Bridge (river mile (RM) 89 to RM 92) consistently as a research section since 1977. The Madison River through the Pine Butte reach has a fairly uniform gradient run habitat, with a network of side channels that influence spawning and recruitment. The West Fork Madison River, the largest tributary in the upper Madison basin, enters the Pine Butte Section approximately 0.6 miles above Lyons Bridge.

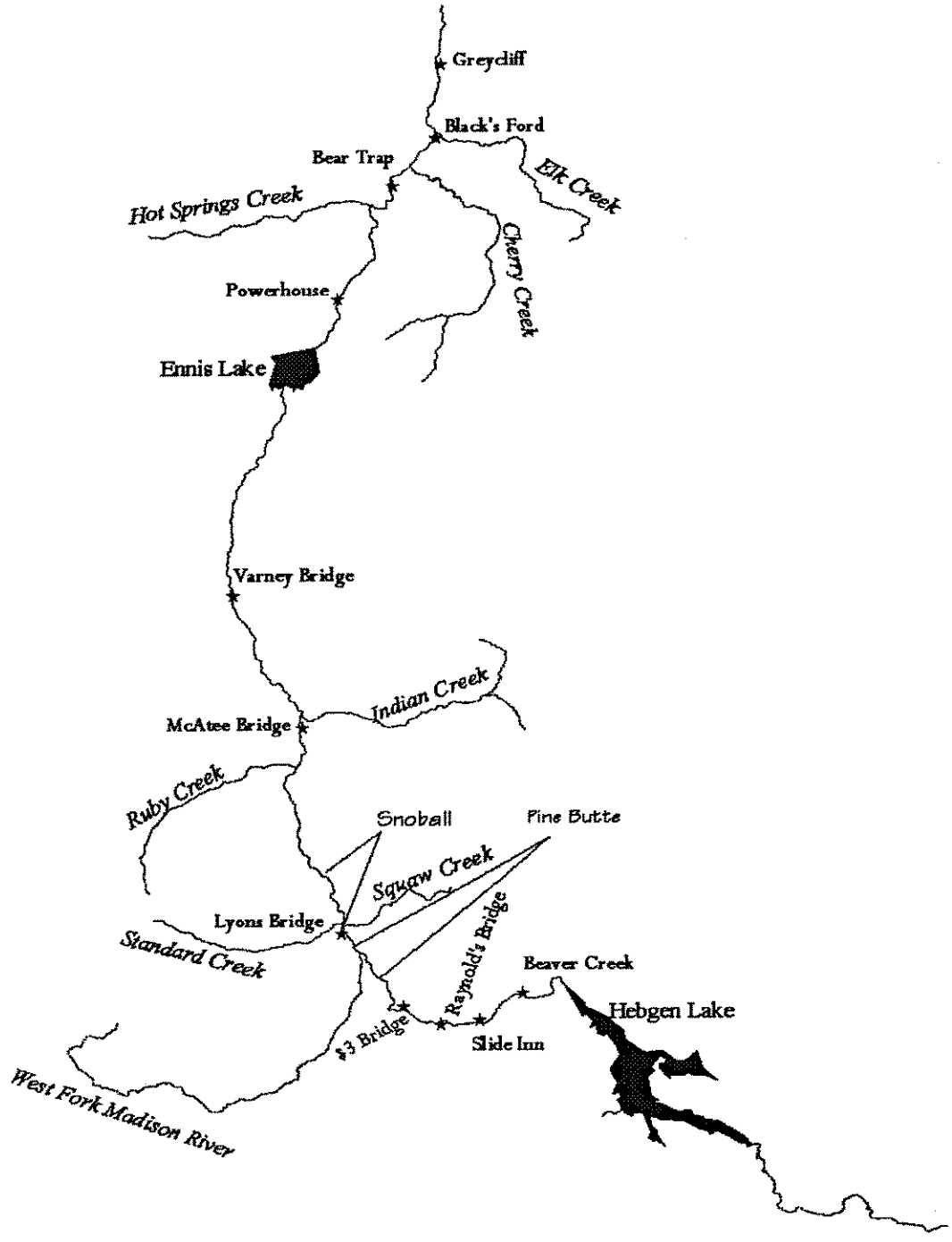


Figure 1. Map of the Madison River from Hebgen Reservoir to Greycliff access, Montana showing the study sections, tributaries mentioned in this report, and fishing access sites (*).

Fishing regulations on this reach have been catch-and-release only for trout since 1978 and no fishing was allowed from boats since 1974 (Table 2). Since 1995, angling was restricted to after the third Saturday in May above McAtee Bridge to protect spawning rainbow trout. Population estimates have been conducted on the Pine Butte Section since 1977.

Angler interviews from each creel survey were summarized by FWP staff and provided to the author along with annual Fisheries Division Job Progress Reports where available, original creel data sheets, and creel method summaries for each year. Table 2 provides a brief summary of the number of creel responses, the pressure estimate reported, the dates the creel survey was conducted, and any pertinent regulations. In the years when no progress report was available, exact dates for the creel period are estimated based on the creel summary data sheets. Some of the inherent problems in making comparisons among years using the existing data include the lack of standardization in the number of interviews performed, the fact that Snoball was closed to fishing partially or entirely during some years, and an increase in survey effort in 1995 and 1996 both in interviews performed and area covered. The author has attempted to note when these inconsistencies may affect comparisons, and to address the implications accordingly.

Table 2. Creel survey data collection for the Madison River, Montana from 1975 to 1996. Pressure estimates in angler hours, were taken from original data summary sheets or final annual fisheries division job progress reports (Appendix A). Sections are open to boat and shore fishing unless noted otherwise.

Year	Section	Number of responses	Pressure (hours)	Creel Period	Notes
1975	Snoball	1006	3,238[a]	May to September[b]	Closed to boat fishing
1976	Snoball	1638	7,867[a] (1,437 s/ 6,430 b)	May 15 to September 15	Open to boat (b) and shore (s) fishing
1977	Pine Butte	1147	7,111[c]	May 22 to September 30	First year for sampling this section. Closed to boat fishing (since 1974).
1977	Snoball	–	–	May 22 to September 30	Closed to fishing due to high summer mortalities in 1976.
1981	Pine Butte	NA	6,897[d]	May to September[b]	Catch and release only (since 1978) and closed to boat fishing (since 1974).
1981	Snoball	887	2,009[e]	May to September[b]	
1995	Pine Butte	1450	19,853[f]	June 4 to September 30[b,g]	Catch and release only (since 1978) and closed to boat fishing (since 1974).

Year	Section	Number of responses	Pressure (hours)	Creel Period	Notes
1995	Snoball	—	—	June 4 to September 30 [b,g]	Closed to fishing.
1996	Pine Butte	668	6,590[h]	June 1 to September 26 [b,i]	Catch and release only (since 1978) and closed to boat fishing (since 1974).
1996	Snoball	—	—	June 1 to September 26 [b,i]	Closed to fishing.

[a] Vincent 1977
[b] No annual fisheries division job progress reports were completed in 1975,1981, 1995, or 1996.
[c] Vincent 1978
[d] Original data summary sheet provided by FWP for the Pine Butte Creel 1981 and 1995
[e] Original data summary sheets for the 1981 creel survey provided by FWP
[f] Estimate listed in the original data summary sheets provided by FWP for the Pine Butte creel 1981 and 1995. 1995 estimate derived from applying the proportion 0.342 to the total pressure estimate for Section1.
[g] Lere 1995a
[h] Estimate listed in the computer data provided by FWP for Section 4 of the 1996 creel.
[i] Lere 1996

3.1 Creel Methods, 1995

The entire Madison River from Quake Lake to the headwaters of the Missouri River at Three Forks was creeled from June 4 to September 30, 1995 (Lere 1995a). Angler counts were stratified weekly with one randomly selected weekend day and two random weekdays. Angler counts were made by airplane, and broken down by number of boats and number of shore anglers. Flight times were chosen randomly from eight 2-hour periods from 9 am to 7 pm. Ten sections were monitored twice each flight day. The first counts were made beginning in Three Forks and proceeding upstream to West Yellowstone, and then a second count was made traveling in the opposite direction. Anglers from a boat that was beached, with all anglers fishing from shore when counted, were recorded as shore anglers. Missed flights were rescheduled within the same week if possible, but if a "make-up" flight could not be scheduled within the same week it was dropped from the survey (Lere 1995b). Pressure estimates and catch rates were analyzed using FWP's Creel Survey Program (McFarland and Roche 1987).

Anglers were interviewed by two creel clerks, one in each of two sections, Quake Lake Dam to Ennis Dam (upper river) and Ennis Dam to Three Forks (lower river). Creel clerks interviewed anglers on the same days as flight monitoring, with an additional randomly selected interviewing

day each week to make four total interview days per week. Survey sections were numbered 1-4 in the upper river and 1-3 in the lower section.

Upper river sections were:

1. Quake Lake to Lyons (12.5 miles)
2. Lyons to Ruby Creek (17.3 miles)
3. Ruby Creek to Varney (11.9 miles)
4. Varney to Ennis Lake (13.9 miles)

Lower River sections were:

1. Ennis Dam to Hot Springs (9.7 miles)
2. Hot Springs Creek to Elk Creek (7.0 miles)
3. Elk Creek to Three Forks (20.6 miles)

The first section surveyed each week was chosen randomly and the survey progressed through the remaining sections in numerical order. In the lower river, the section monitored on the last day of the four-day cycle was chosen randomly from the three sections. Interviews were completed in two sections per day, with one survey during the morning hours and one in the evening. Morning and evening sampling times were alternated on the next sampling day for the chosen sections. Creel clerks ground-truthed airplane counts for section 2 on the lower river on days when section 2 was scheduled for interviews.

In 1995, FWP added an angler satisfaction survey to its creel form. The survey attempted to measure how happy anglers were with the size and number of fish caught, the overall fishing experience, and to gather some additional information on age, experience and origin of the anglers on the Madison River. Anglers were asked to rank their level of satisfaction with the number of trout caught, size of trout, and species of trout on a scale of –2 (very dissatisfied) to +2 (very satisfied). Anglers were also asked to rank their top three reasons, out of a list of 11 options, for choosing the Madison River for their trip that day. Finally, anglers were asked to list any major problems they had with fishing on the Madison. The last question was free response, and comparable answers were categorized and tallied (Appendix B).

3.2 Creel Methods, 1996

A portion of the upper Madison River from Slide Inn to Windy Point (approximately 20 river miles) was creeled from June 1 to September 26, 1996 by a single on-the-ground creel clerk

(Lere 1996). The majority of the area creeled in 1996 falls within the region identified as Section 1 (Quake Lake) in the 1995 creel survey (Figure 1). Both angler counts and individual interviews were conducted. The study reach was divided into five sections as follows:

1. Slide Inn to Raynold's Bridge
2. Raynolds to $3 Bridge
3. $3 Bridge to Pine Butte
4. Pine Butte to Squaw Creek
5. Squaw Creek to Windy Point

Angler counts were stratified weekly, with counts on one weekend day and three random weekdays, selected without replacement. Start times for the first count were selected randomly from the following set; 7 am, 8 am, 9am, 10 am, 11 am, 12 noon, and 1 pm. Four successive counts were completed at two hour intervals throughout the rest of the day. The single creel clerk counted anglers the entire stretch on each survey day. The direction of survey was chosen randomly on the first survey day for each week and then alternated as the week progressed. Counts were conducted from pre-determined vantage points along the highway and at river crossings such as Lyons Bridge. An additional count was made between Squaw Creek and Windy Point, a section closed to fishing, in order to measure compliance with the closure.

Between count times the creel clerk interviewed anglers. Because of time constraints, both completed and uncompleted fishing trips were tallied. However, obtaining as many "completed" trip interviews as possible took precedence. In addition, interviews from the Pine Butte section were prioritized. Raw count and interview data were keypunched into PC computer files. Pressure estimates and catch rates were analyzed using FWP's Creel Survey Program (McFarland and Roche 1987).

3.3 Creel Methods 1975, 1976, 1977, and 1981

Information on exact creel methods for the earlier surveys was limited to fisheries division reports for 1976 and 1977 (Vincent 1977, 1978). In both 1976 and 1977 the upper 30 miles of the Madison from Hebgen Reservoir to McAtee Bridge was creeled using creel checks and angler

counts. The creel period began on the first day of fishing season in both years as well (Table 2). However, in 1976 an emphasis was placed on the Snoball section, and in 1977, Pine Butte was the focus (Vincent 1977, 1978). Creel survey computations were completed using a computer program modeled after Neuhold and Lu (1957). No information was available concerning specific methods for 1975 or 1981. The reported creel period was determined by the summary data sheets provided by FWP.

4.0 Results

4.1 Creel Results for 1995

4.1.1 Catch Rates

Catch rates on the upper river sections averaged 0.20 fish per hour for rainbow trout (Figure 2). To put this in perspective, catch rates of 0.33 would be considered "good quality" for most trout fisheries (P. Byorth, pers. comm. 2001). Brown trout were caught more frequently than rainbows in all sections except for Quake Lake on the upper river (Figure 2). A total of 1,460 anglers were interviewed on the upper river during the 1995 creel.

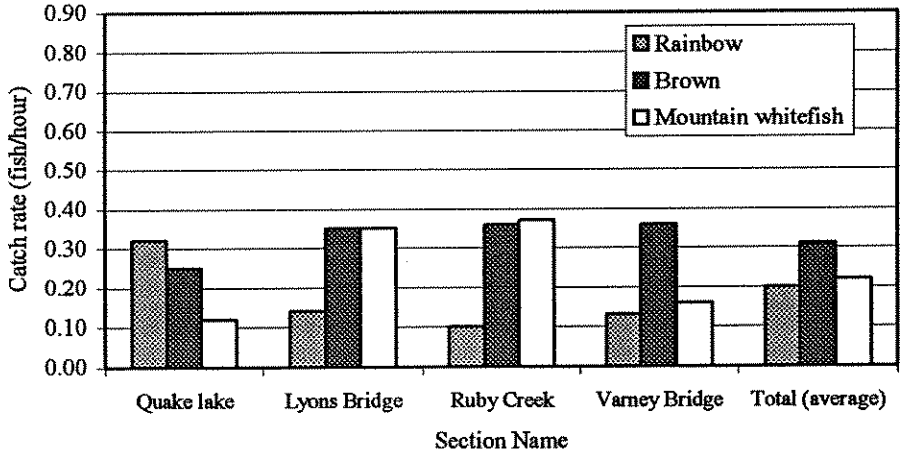


Figure 2. Catch rates in fish per hour for the four sections surveyed on the upper Madison River during the 1995 creel survey.

In contrast, catch rates on the lower river sections were higher in some sections for rainbow trout, and were much higher for brown trout in all four sections surveyed. Catch rates averaged 0.58 fish per hour for brown trout, and 0.24 fish per hour for rainbow trout in the lower river (Figure 3). However, catch rates also varied more from section to section than in the upper river. A total of 970 anglers were interviewed on the lower river during the 1995 creel.

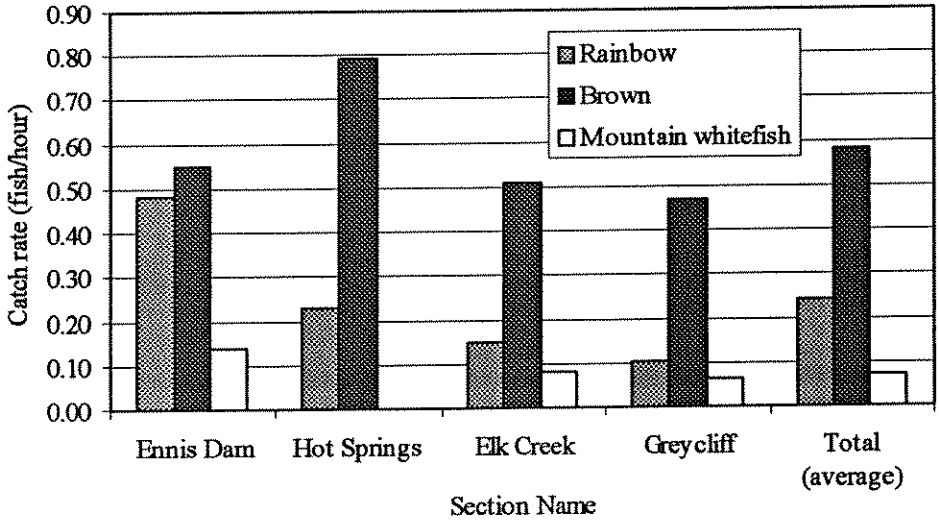


Figure 3. Catch rates in fish per hour for the four sections surveyed on the lower Madison River during the 1995 creel survey.

4.1.2 Angling Pressure

Angling pressure was heaviest in the Quake Lake section of the upper river, where almost all of the anglers were shore anglers. Angling pressure in the Quake Lake section was almost twice that of any other upper river section (Figure 4). In the other three upper sections angling appears to have been evenly split between shore and boat fishing.

Angling pressure was much lighter in the lower sections of the Madison River during 1995. Two sections, Elk Creek and Greycliff, displayed a similar split between shore and boat fishing, but the first two sections downstream of the Ennis Dam recorded no boat anglers all summer (Figure 5).

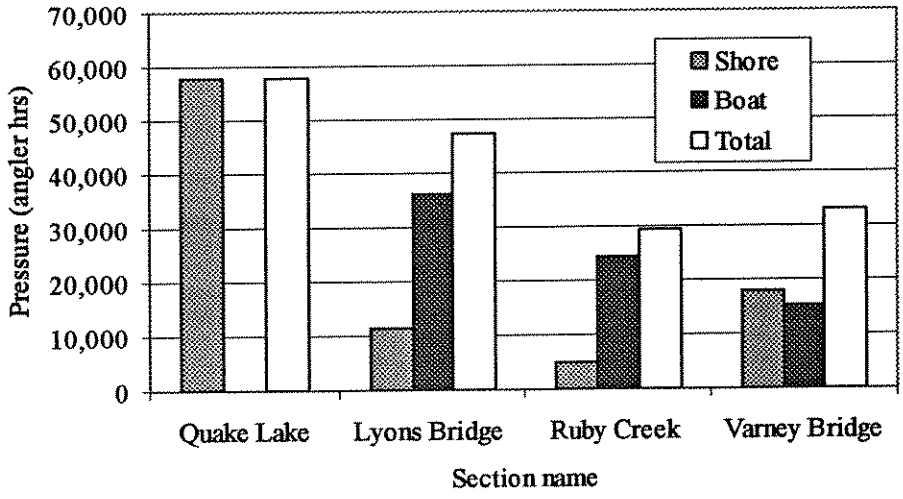


Figure 4. Angling pressure in total angler hours fished for the four sections of the upper Madison River surveyed during the 1995 creel survey.

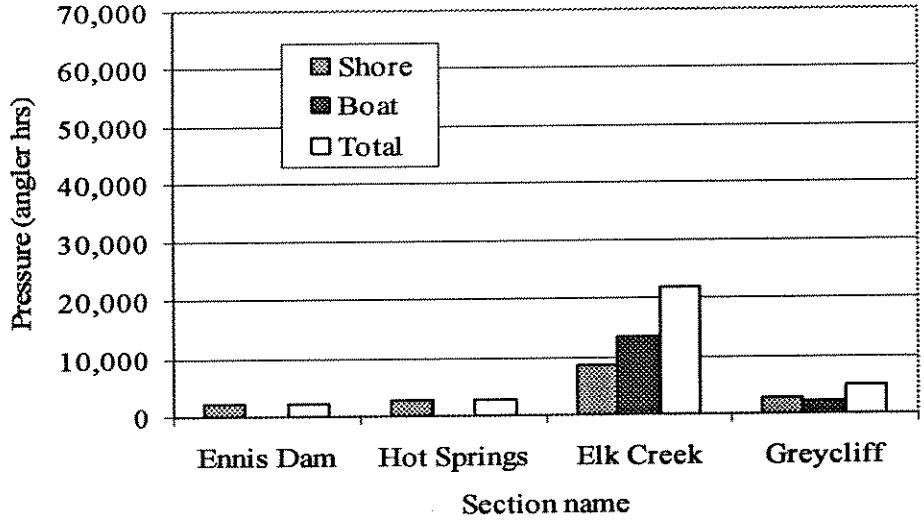


Figure 5. Angling pressure in total angler hours fished for the four sections of the lower Madison River surveyed during the 1995 creel survey.

4.1.3 Angler Characteristics and Satisfaction

The 1995 attitude survey was completed by 833 anglers. In general, anglers were satisfied with their experience (Figure 6). Within the "dissatisfied" and "satisfied" responses were evenly split,

with those being "very satisfied" or "very dissatisfied" making up about ½ of each category's responses.

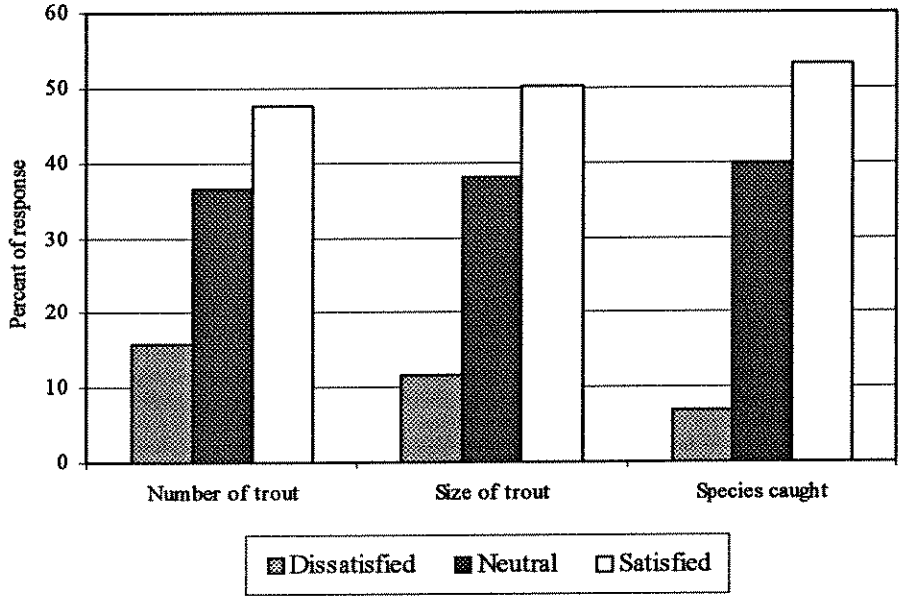


Figure 6. Results of the 1995 angler satisfaction survey for the Madison River, Montana with regards to the type, size, and quantity of fish caught.

The most commonly cited reasons for fishing on the Madison were the catch and release regulation limitation (47%), the large fish found in the area (45.7%), and the restrictions for artificial lures only (27.1%). The only other responses that garnered popular support had to do with the ease and ability to boat fish on the river (15% and 13%, respectively). Since anglers were allowed to rank three responses, and many ranked four, the percentages do not add up to 100. Only 3% chose the lack of whirling disease as a reason to fish on the Madison River. Of those who chose "other ", the most common reason written in was that the river had been recommended by a guide.

When asked to name problems on the Madison, an overwhelming 54% said that they did not feel there were any problems with fishing the river (Table 3). The second most common response was that the river was crowded (14%). No other single problem was noted by more than 10% of

the anglers. The presence or threat of whirling disease (7%) was the 5th most common problem cited.

Table 3. Six most common problems perceived by anglers during the 1995 Madison River angler satisfaction survey. The question was free response. A total of 904 distinct responses were tallied for the 833 respondents to the survey.

Problem	Number of responses	Percent of the 904 responses
No problems	489	54.0
Crowding on river	124	13.7
Poor or degraded conditions	58	6.4
Presence or threat of whirling disease	54	6.0
Lack of fish, few fish	35	3.7
Too many boats, presence of boats	28	3.1
Totals	**788**	**86.8**

Other responses that were listed in the report included regulations (2.7 %), development (2.1%), access (1.9%), water levels (1.5%), outfitters (1.3%), anchor drag (0.4%), and grazing (0.3%). An additional 1.7% of respondents cited a variety of "other" concerns. A total of 904 distinct responses were tallied out of the 833 surveys completed.

Anglers were also asked how long they had been fishing the Madison River. This question, along with the results from previous years of resident versus non-resident use, shed light on who uses the river. The largest group of respondents had fished the Madison for one year or less (41%) (Figure 7). Residency data were collected in 1981, 1995, and 1996. In all three years, nearly 90% of all anglers were non-residents, which may explain the many "one year or less" respondents. However, the resident- non-resident composition was markedly different in the upper river, with 89% non-residents compared with only 59% in the lower river. The upper river also had a higher proportion of guided anglers (26%) than the lower river (17%).

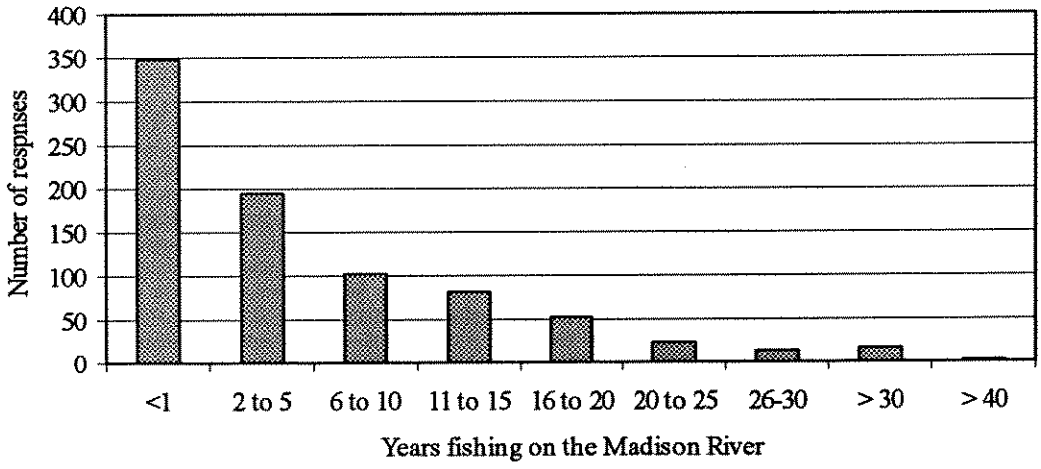


Figure 7. Number of years that respondents had fished on the Madison River, Montana from the 1995 angler satisfaction survey. A total of 833 responses were tallied for this question.

The type of gear used in all stretches of the river was predominately flies with lures coming in a distant second. Again, there was a difference between the anglers of the upper versus the lower river with upper river anglers choosing flies 90% of the time and lower river anglers choosing flies only 60% of the time. Upper river anglers used lures (5.6%) and bait (1.9%) much less frequently than lower river anglers did (15% lures and 14.79% bait). In both sections the remaining percent was attributed to "any combination of gear".

When asked what type of fish was their "target" species, the vast majority of lower river anglers were fishing for trout (93%), with the next most frequent response being "any fish" (3%). Among upper river anglers, results were similar, but less specific, with trout receiving 71% of responses and "any fish" getting 23% of responses. However, of those anglers wanting to catch a specific type of fish, upper and lower river anglers were looking for brown trout (4% and 2%, respectively) more often than rainbows (<1% both regions). Interestingly no anglers were looking to catch the native cutthroat or grayling in either region of the river.

4.2 Creel Results for 1996

4.2.1 Catch Rates

In 1996 a much shorter section of the Madison River was creeled due to budgetary restraints; therefore, it is difficult to do direct comparisons between this year's creel and 1995. However, a general comparison does suggest that catch rates for rainbow trout were slightly higher in 1996 than those recorded in 1995 on the upper or lower river sections (Figure 8). Catch rates for brown trout were much lower in 1996 than those seen in 1995, and were much lower than catch rates for rainbow trout in three of the five sections surveyed. A total of 1,444 interviews were completed during the 1996 creel survey, a number comparable to the total surveyed during the upper river work in 1995.

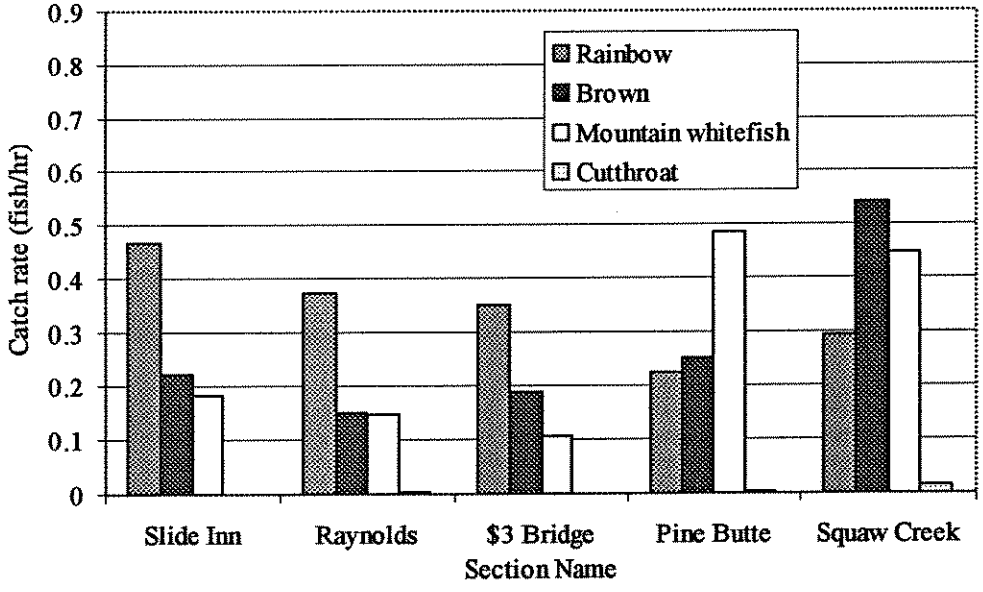


Figure 8. Catch rates in fish per hour for the five sections surveyed between Slide Inn and Windy Point on the Madison River during the 1996 creel survey.

4.2.2 Angling Pressure

Angling pressure was significantly lower in 1996 than in 1995. However, it is important to remember that the 1995 survey was much more comprehensive and derived its pressure estimates from air-based counts as well as on-the-ground interviews, while the 1996 survey used

vantage point counts along with the interviews to estimate the number of anglers (Lere 1997). In addition, two creel clerks were used in 1995, compared to one in 1996. Because of these differences, the 1995 survey may represent a much larger sample of the angling community and comparisons between 1995 and 1996 pressure estimates may be less than robust.

The five-section area surveyed in 1996 was comparable to the portion of the 1995 creel survey identified as "Section 1: Quake Lake to Lyons". Therefore, a comparison of the pooled 1996 data to the 1995 Section 1 data may be the most sound. Figure 9 depicts angling pressure in angling hours for the Quake Lake Section surveyed in 1995 and the pooled data for 1996. Angling pressure totaled 58,049.06 angler hours in 1995 for the Quake Lake section, with only 121.33 of these hours attributed to boat anglers (Figure 9) (FWP 1995b). In 1996, angling pressure for the five sections surveyed totaled 22,868.13 angler hours (Figure 9)(FWP 1996b). Only seven boat anglers were interviewed in 1996, and only one boat-based party was recorded.

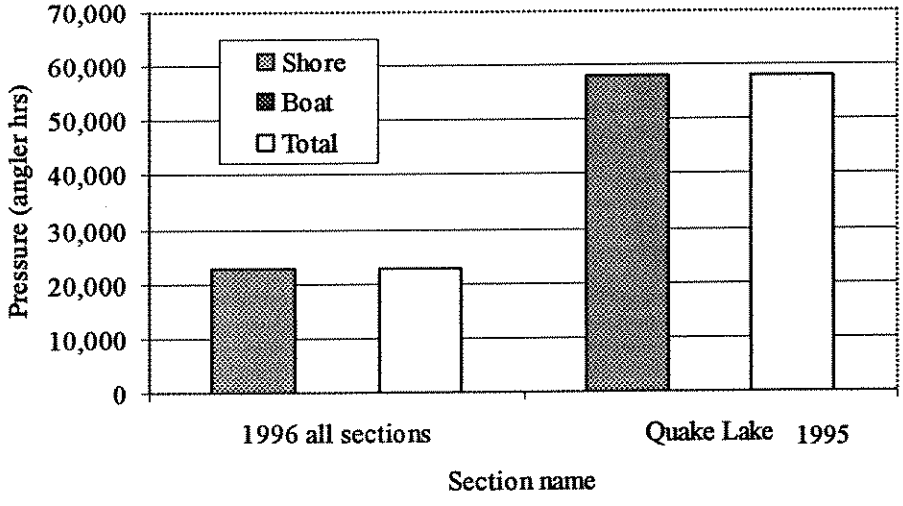


Figure 9. A comparison of angling pressure in angler hours from the 1995 Quake Lake section and the 1996 (all sections) Madison River creel survey surveys. All sections from 1996 were pooled as they cover an area comparable to the "Quake Lake" section surveyed in 1995.

4.2.3 Angler Characteristics

Although no detailed survey was conducted regarding angler satisfaction in 1996, the standard data concerning experience, origin, and gear were collected. As stated above, the majority of anglers were non-residents in 1996, with only 6% of interviewees being from Montana. Out of the residents, approximately 57% were from Gallatin or Madison County. Most anglers were self-guided in 1996 (85%), approximately 10% fewer than in 1995.

The type of gear used in all surveyed sections of the river was predominately flies with lures coming in a distant second. Anglers chose flies an overwhelming 97% of the time. Anglers used lures only 2.7% of the time, and no anglers surveyed were using bait. As in 1995, the remaining percent (0.3%) was attributed to "any combination of gear".

When asked what type of fish was their "target" species, the vast majority were fishing for trout (88%), with the next most frequent response being "any fish" (6%). A small number of anglers were fishing specifically for rainbow or brown trout (2% each). Interestingly, no anglers were looking to catch the native cutthroat trout or grayling. Since the 1996 creel covered an area within the upper region of the Madison, it is not surprising that much of these results are comparable with the 1995 "upper river" results.

5.0 Discussion

Available creel survey data from the 1970's and 1981 allow some comparisons among these years and the more recent 1990's data for the Madison River fishery. In addition, the introduction of whirling disease increases the importance of the early data in evaluating the status of Madison River fish populations. Historic creels were not as exhaustive as the 1995 full-river creel, but catch rate and pressure information are comparable and are examined in relation to the more recent data with some caveats. Much of the earlier creel data were limited to the Pine Butte and Snoball sections; therefore, these sections have been used whenever possible when making direct comparisons. The intent is not to focus just on these sections, but to take advantage of the continuity in data and use them as an index to the overall fishery on the Madison River.

5.1 Historic Creel Comparisons

The Madison River rainbow trout population declined significantly after whirling disease was first diagnosed in 1994. The decline is evident in catch rate data, population estimates, and angler satisfaction surveys. The changes in the proportion of each species in the fish assemblage also indicate an unequal effect consistent with the relative resistance of rainbow trout, brown trout, and mountain whitefish to whirling disease.

5.1.1 Catch Rates and Composition

Catch rates for the two primary game fish in the Madison, rainbow and brown trout, were lower at both Snoball and Pine Butte sections in 1996 than in 1975 (Figures 10 and 11). For the years examined on the Snoball section, rainbow trout catch rates peaked in 1976 at 1.09 fish per hour and declined to 0.74 fish per hour in 1981, the last year for creel data in this section (Figure 10). However, Snoball was also open to both boat and shore fishing in 1976, and the catch rate for 1981 and 1975 may be skewed by the limitation to shore fishing for those years. Catch rates were higher in 1976 and 1981 than 1975, when rainbow trout were caught at 0.55 fish per hour (Figure 10).

Catch rate trends for brown trout and mountain whitefish paralleled those for rainbow trout in the Snoball section; although they were consistently lower (Figure 10). Proportion of catch by species was consistent in Snoball during pre-whirling disease years in contrast with post-whirling disease data for the Pine Butte section. However, this data should be viewed with the caveat that catch rates can be affected by factors such as weather, flows, and other climatic conditions that may not be reported as part of the creel survey. The Snoball section is not as valuable for examining the impact of whirling disease because of a lack of post-whirling disease catch rate data, but is included as a reference for comparison with earlier Pine Butte data.

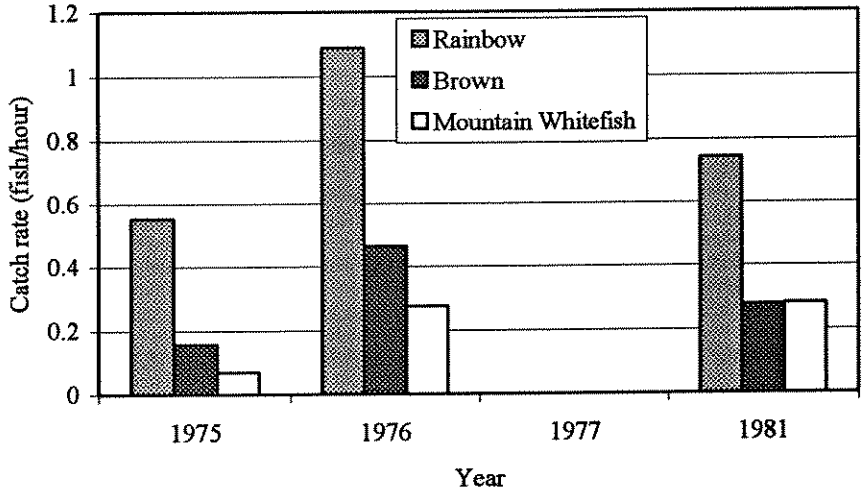


Figure 10. Catch rates in fish per hour for the Snoball section of the Madison River, Montana from 1977 to 1981. The Snoball section was closed to boat fishing in 1975 and closed to all fishing in 1977.

Catch rates for rainbow trout in the Pine Butte section were much lower in 1995 (0.19 fish per hour) than in 1981 (0.63 fish per hour) (Figure 11). The catch rates for brown trout did not show a similar pattern, and actually increased from 0.12 fish per hour in 1977 to 0.33 fish per hour in 1995 (Figure 11). It appears that as whirling disease was reducing the numbers of rainbow trout, the brown trout population became proportionately more available for capture by anglers. The data for mountain whitefish is less complete, but does show a slight increase from 0.19 fish per hour in 1977 to 0.24 fish per hour in 1995, the only two years with data available (Figure 11). Again this increase may reflect a shift in the proportion of each species available in the Madison,

and should not be taken as an indicator of an overall increase in the number of whitefish or brown trout present.

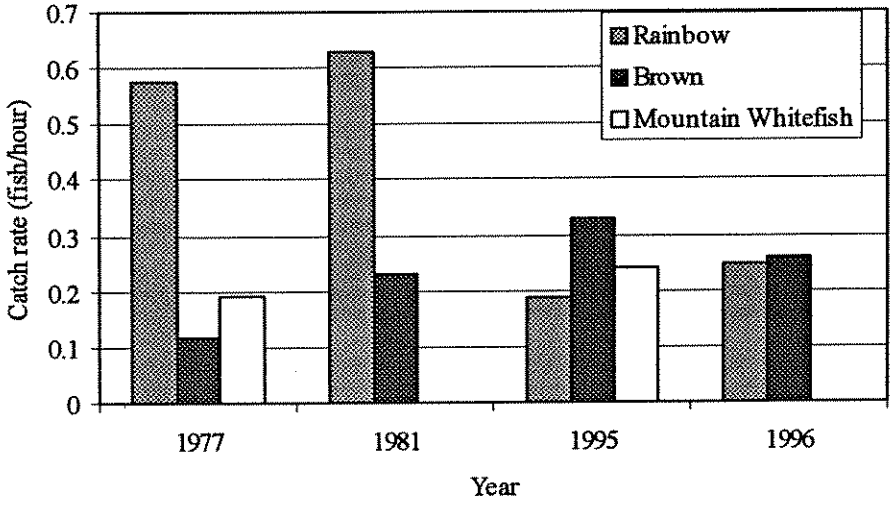


Figure 11. Catch rates in fish per hour for the Pine Butte section of the Madison River, Montana from 1977 to 1996.

Figures 12 and 13 show how the proportion of the total catch changed from 1977 to 1996 in the Pine Butte and in Snoball sections. Although 1981 is the only year with data for both sections, it is interesting to note that rainbow trout shift from being the most common fish caught in 1977 and 1981 to less than 30% of the catch in 1995 in the Pine Butte section. The proportions of brown, rainbow, and cutthroat trout, and mountain whitefish remain relatively consistent in the Snoball section despite different fishing restrictions from year to year. Very few cutthroat trout were caught in either section in any year surveyed.

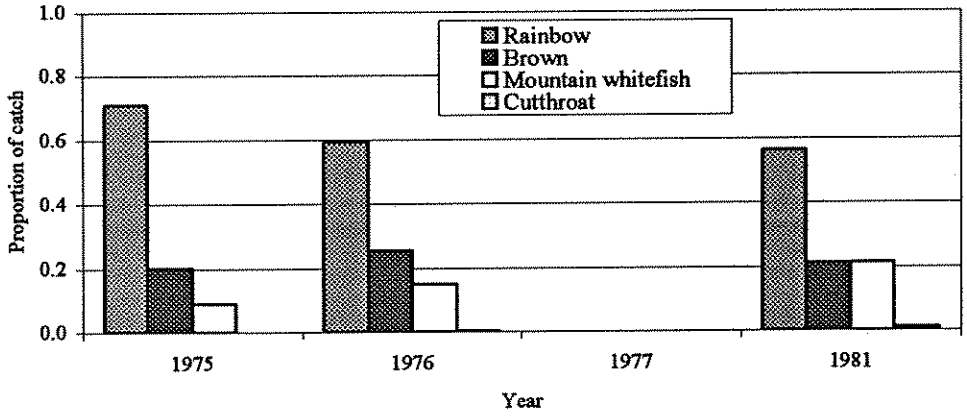


Figure 12. Proportion of the catch for each salmonid species in the Snoball section of the Madison River, Montana, based on creel survey data from 1975 to 1981. This section was closed to fishing in 1977.

In addition to official FWP creel survey data, some anecdotal data was provided by an angler who has fished the Madison consistently since 1974 and has kept a detailed fishing log since 1986. His information displays the same pattern in the proportion of catch changes (Figure 14). Although this data is not official, it does have the added benefit of somewhat controlling for the skill of the angler, which is often a confounding factor in creel analysis.

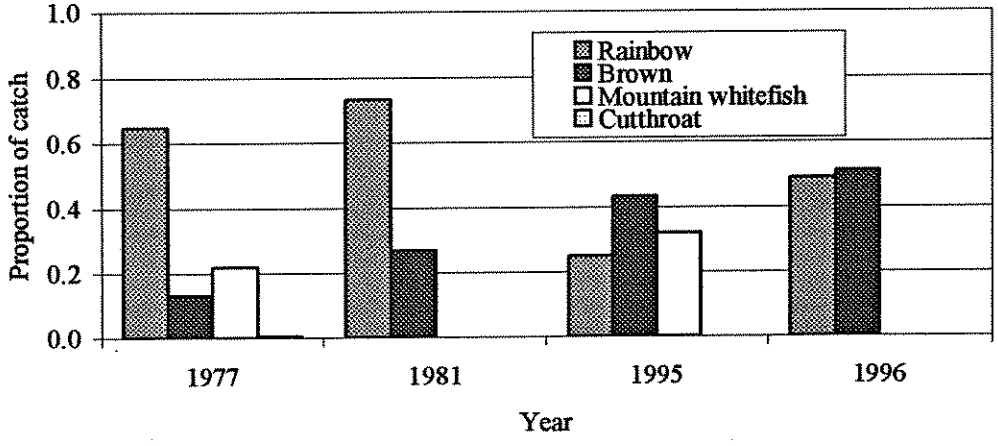


Figure 13. Proportion of the catch for each salmonid species in the Pine Butte section of the Madison River, Montana, based on creel survey data from 1977 to 1996. No data were collected in 1981 or 1996 for mountain whitefish.

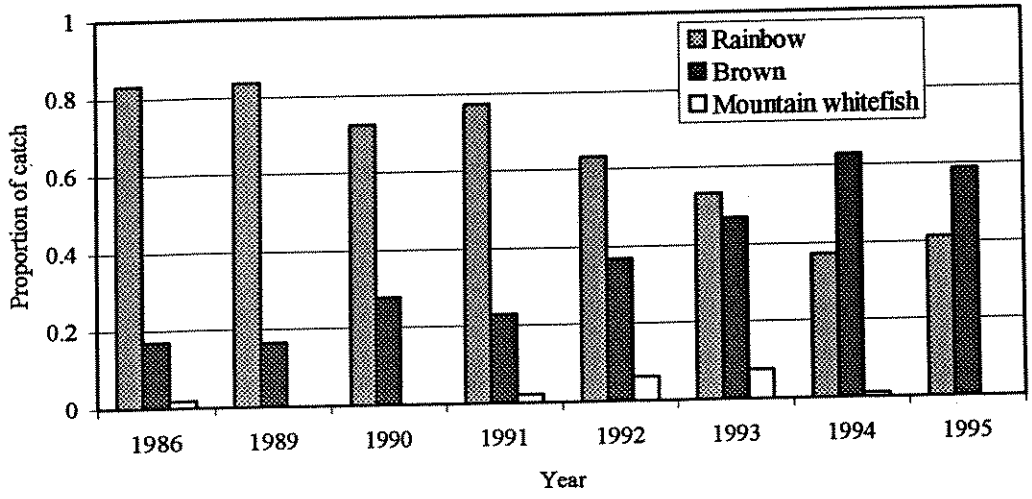


Figure 14. Proportion of catch from anecdotal data provided by a Madison River angler based on his fishing log from 1986 to 1995. No information was provided for cutthroat trout.

5.1.2 Angling Pressure

Angling pressure is used as an index of how much "pressure" is applied to a fishery. However, because methods used in 1995 and 1996 creel surveys were so different in terms of the level of effort and the types of surveys used comparing these pressure estimates may not be the a robust way to examine angler use. A more continuous and consistent set of data exists in the biennial mail-in angler surveys collected by FWP. Figure 15 depicts data from responses to mail-in surveys from 1968 to 1999 for the section from Ennis Lake to Hebgen Reservoir which encompasses much of the area surveyed in 1995, 1996, and the creel surveys from earlier years.

Angling pressure generally appears to have increased from the 1960's to the present, but has fluctuated since an initial 28% increase from 1984 to 1985. It is difficult to know what caused the fluctuations in angler use from 1985 to 1997, but the declines in 1995 and 1997 may be attributable to anglers avoiding the Madison River due to reports of the impact of whirling disease on the fishery. Since the discovery of whirling disease in the Madison was first reported in the mass media in December of 1994, it would be reasonable to assume that some of the 25% decline in angler use from 1993 to 1995 might be due to anglers avoiding the area either because

they did not want to spread the disease or because they were concerned that might not catch many fish.

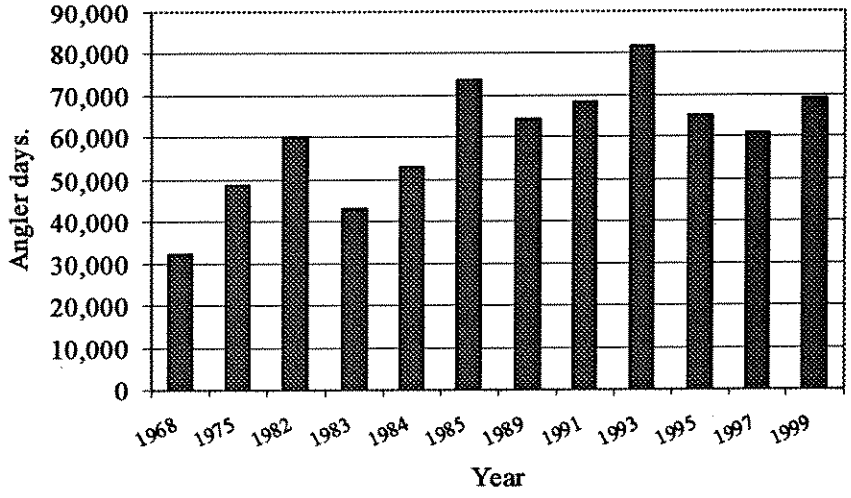


Figure 15. Angler days fished from 1968-1999 on the section of the Madison River from Ennis Lake to Hebgen Reservoir, Montana. Data were collected via mail-in surveys distributed by FWP to randomly selected Montana fishing license holders.

5.2 Population Estimates

Changes in rainbow and brown trout population abundance have mirrored changes in catch rates in the upper Madison River over the years. FWP conducts annual electrofishing and Peterson-type mark-recapture population estimates to assess the fishery and estimate trout species populations. Three marking runs are followed by three recovery runs, 10 to 14 days after marking. The ratio of marked to unmarked fish in the recovery sample is used to estimate abundance according to FWP's computerized Mark-Recapture Log-likelihood Model.

Population assessments are completed each fall and occasionally in the spring. Fall estimates were used in this report to evaluate how the actual number of fish present compared with the number of fish being caught by anglers because the data set is continuous, and fall estimates are

considered a better indicator of the overall trout population trends (P. Byorth, pers. comm.. 2001).

Figure 16 illustrates that the decline of the rainbow trout abundance coincided with the declining catch rates in 1995 and 1996 creel surveys. Mean rainbow trout abundance declined 77% in 1991, suggesting that whirling disease was beginning to affect the fishery (Figure 16). Rainbow trout populations fell from a mean of 3,944 fish per mile (1975 to 1990) to a mean of 903 fish per mile (1991 to 1996)(Figure 16). This decline is echoed in the greater than 60% decrease in catch rates in post-whirling disease creel surveys as compared to earlier surveys from the 1970's and 1981 (Figure 10 and 11).

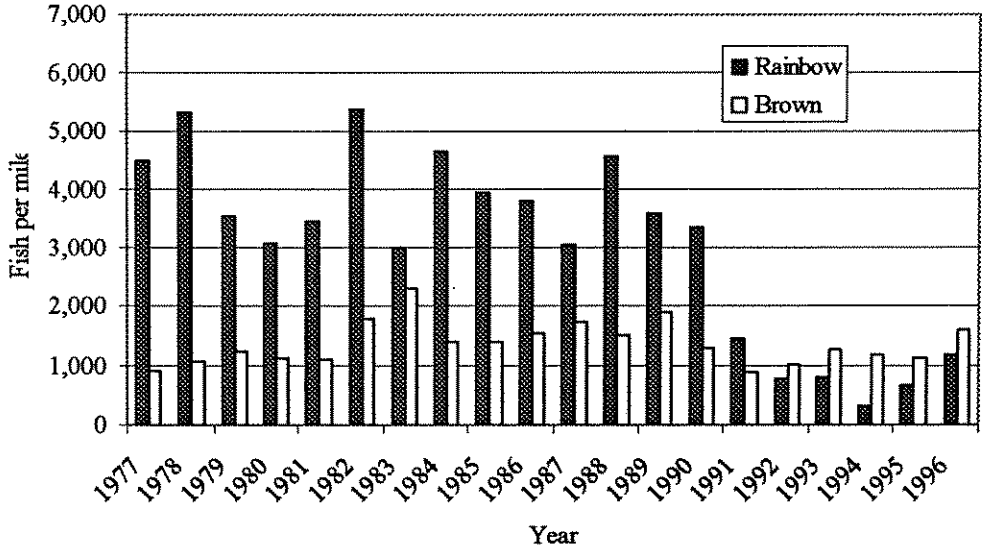


Figure 16. Fall population estimates for the Pine Butte section of the Madison River, Montana from 1977 to 1996. Estimates are derived from mark-recapture data for electrofishing runs, and include age 1 and older trout (FWP 1995d, 1996c).

Relative abundance of brown trout increased from 1977 to 1996 in the Pine Butte section (Figure 16). Brown trout numbers have not varied substantially throughout most of the years surveyed, but appear to be increasing recently in the Pine Butte section (Figure 16).

Fall population estimates for the Snoball section have not been collected as consistently as in Pine Butte. There are no data for 1986, or 1988 to 1993 for the Snoball section. However, population comparisons may still be made between the two study sections. Relative abundance shifts in the mid-1990's from a predominance of rainbow to brown trout in the Snoball section just as it did in the Pine Butte section (Figures 16 and 17). The dramatic decline in rainbow trout numbers is also apparent in the Snoball section where populations fell 83% from a mean of 3,304 fish per mile (1975 to 1987) to a mean of 571 fish per mile (1994 to 1997)(Figure 17).

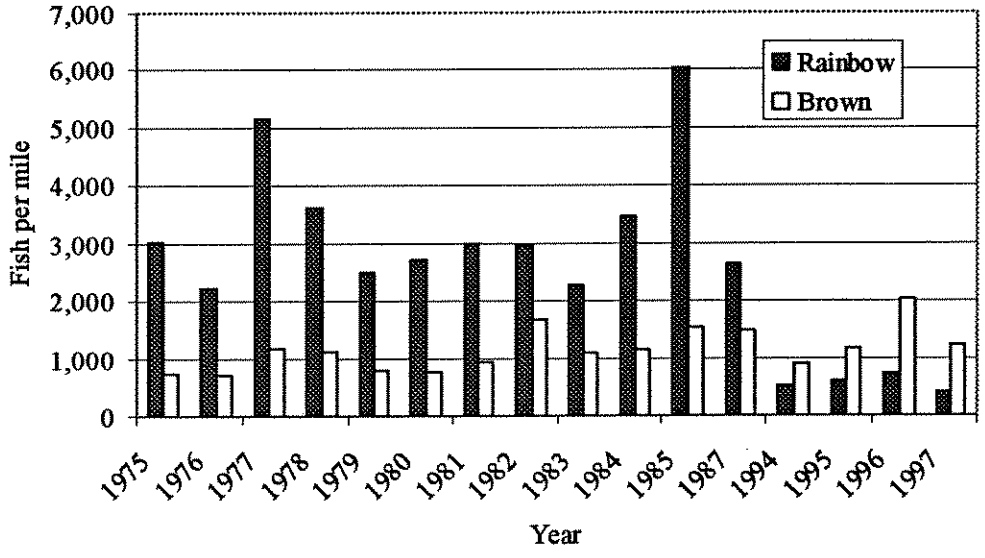


Figure 17. Fall population estimates for the Snoball section of the Madison River, Montana from 1975 to 1985, 1987, and 1994 to 1997. Estimates are derived from mark-recapture data for electrofishing runs, and include all age classes of fish (FWP 1995d, 1996c).

5.3 Impacts of Whirling Disease and Management Implications

The declines in catch rates documented by the 1995 and 1996 creel surveys, when examined with the coincident declines in rainbow trout populations as measured by FWP annual surveys provide a strong argument that whirling disease has had a heavy biological impact on the Madison River fishery. The declines in the rainbow trout population are the most extreme, but

their ramifications to overall Madison River ecology should be noted as well. Rainbow trout are a food source for osprey, otters, and other predators that live in the area. Although the proportion of brown trout has increased within the fish assemblage, total numbers of fish have not; therefore, the available prey base has decreased. Although predators may choose to move to better foraging areas, fewer fish in the Madison may translate into proportionally heavier predation on remaining fish which may also be weakened by whirling disease. The fishery also plays a role in the larger ecosystem, and changes within the river will have an effect on the surrounding biological community.

Although not as dramatic as the trout population declines, the decrease in angler use recorded in the FWP mail-in survey suggest that anglers have avoided the Madison River because of lower fishing success and/ or a perceived decline in the river's overall merit as a fishing destination. This translates into a potentially large economic impact due to the disease.

The Madison River is an important sport fishery and recreational resource for the state and generates considerable income annually from guided and independent fishing trips and associated recreation. According to Duffield (1990) the Madison River produces the highest non-market fishery value per mile (annual basis) in the state at $184,000 per mile. This estimate is based on value per angler day (derived from travel cost model estimates) times the total angler use quantified for each Montana stream (Duffield 1990). As a point of reference, the total economic value of each stream in 1985 ranged from $17.5 million per year on the Madison to $531,000 on the Swan (Duffield 1990). It should be noted that these estimates were for a period prior to the noticeable impact of whirling disease. Dr. Duffield has examined post-1990's data to estimate the economic effect of whirling disease and found that the existence of the brown trout fishery may have diminished the overall economic impact (Duffield et al. 1999). In his 1999 report he states that, " the combined (rainbow and brown) trout population, while about one-third below the 1983- 1990 population, still places the Madison among the very top rivers in the state".

In addition to the possible economic impact due to whirling disease, the Madison is a large tributary to the Missouri River and provides a connection with the Jefferson and Gallatin rivers

with the potential to act as a corridor for transmission of whirling disease. Other tributaries to the Missouri have recently tested positive for whirling disease, and its downstream progression will create similar concerns throughout the state's trout waters (Liknes et al. 1999).

Stocking has been suggested as a remedy to the whirling disease dilemma. If very young fish are the most susceptible, then stocking adult or sub-adult fish seems an attractive option for avoiding infection. However, Montana ceased stocked its river fish populations as early as the 1970's because FWP had collected data suggesting that stocking trout on top of natural populations actually decreased overall fishery strength (Vincent 1996, 1987). Vincent (1987) cited differences in behavior between hatchery and wild trout, lower overall health and vigor of hatchery fish, and the potential for introducing other diseases as reasons for not returning to a river stocking program in Montana. Other studies have confirmed these findings, and suggest that hatchery fish, due to their homogeneous genetic makeup, may degrade the overall quality of wild salmonid populations (Hindar, Ryman and Utter 1991). The argument against stocking generally stresses the concept of "local adaptation" by which it is reasoned that as populations evolve and adapt to an area, the progeny of that population become better able to cope with conditions specific to that river, stream or lake (Hindar, Ryman and Utter 1991). Trout do not rear their young, and many of their behavioral adaptations are genetically based and environmentally influenced (Allendorf, Ryman, and Utter 1987). When hatchery fish with their non-local gene complement are stocked on top of wild populations, the hybrids may experience lower spawning success, lower survival, and reduced health (Hindar, Ryman and Utter 1991). Therefore, stocking hatchery rainbow trout in the Madison River might actually compound the impact of whirling disease rather than remedy its effects.

The potential for lasting ecological damage from whirling disease is high, and the long term preservation and enhancement of the fishery is FWP's primary concern. Therefore, FWP wants to quantify the impact that whirling disease has had on the Madison River in terms of angler catch rates, fishing pressure, and social perception of the river and its fishery. By fully understanding how whirling disease has affected the Madison River fishery, FWP hopes to determine the best management strategy to facilitate recovery.

6.0 References Cited

Allendorf, F.W., N. Ryman, and F.M. Utter. 1987. Genetics and fisheries management. Pages 1-20 *in* N. Ryman and F.M. Utter, eds. Population genetics & fishery management. Washington Sea Grant Program, University of Washington Press, Seattle.

Duffield, J. 1990. Economic value of fisheries: nonmarket studies in the Clark Fork Basin. Presented at the 1990 Clark Fork Symposium, University of Montana, Missoula. Available online at: http://ibscore.dbs.umt.edu/clarkfork/Past_Proceedings/1990_proceedings/duffield/Duffield.htm

-----, D.A. Patterson, C. J. Neher, and J.B. Loomis. 1999. Economic consequences of whirling disease in Montana and Colorado trout fisheries. Presented at the 5th Annual Whirling Disease Symposium for Research and Management Perspectives. Missoula, Montana. February 18-20, 1999.

Hindar, K., N. Ryman, F. Utter. 1991. Genetic effects of cultured fish on natural fish populations. Canadian Journal of Fisheries and Aquatic Sciences. 48: 945-957.

Lere, M. 1995a. 1995 Madison River creel survey documentation, May 1995. Montana Fish, Wildlife and Parks, Bozeman.

-----, 1995b. 1995 Madison River pressure estimate, May 1995. Montana Fish, Wildlife and Parks, Bozeman.

-----, 1996. 1996 Madison River creel census documentation. Montana Fish, Wildlife and Parks, Bozeman.

-----, 1997. Letter to Robin Cunningham dated July 11, 1997. Montana Department of Fish, Wildlife and Parks, Bozeman.

Liknes, G.A., G. Grisak, E. R. Vincent, and S. Leathe. 1999. The progression of whirling disease in the Missouri River and its tributaries in central Montana. Presented at the 5th Annual Whirling Disease Symposium for Research and Management Perspectives. Missoula, Montana. February 18-20, 1999.

McFarland, B. and R. Roche. 1987. Montana Fish, Wildlife and Parks (FWP) user manual for the creel survey program running on an IBM compatible microcomputer. Montana Fish, Wildlife and Parks, Bozeman.

Montana Whirling Disease Task Force (MTWDTF) 2000. Montana Whirling Disease Task Force web page, frequently asked questions about whirling disease. Last updated October 25, 2000. Available at: http://www.whirlingdisease.org/faq.htm

Neuhold, J. M. and K. H. Lu. 1957. Creel census method. Publication number 8 of the Utah State Department of Fish and Game. Contribution of F-1-R and F-4-R. Utah State Department of Fish and Game, Salt Lake City.

Opitz, S.T., and A.V. Zale. 1998. Brown Trout Recruitment and Whirling Disease in the Ruby River and Poindexter Slough, Montana. *In*: Whirling Disease Symposium: Research in Progress. Whirling Disease Foundation. pp. 59-71.

Ryce, E., E. MacConnell, and A. Zale. 1999. Effects of age and dose on the development of whirling disease in rainbow trout. Presented at the 5th Annual Whirling Disease Symposium for Research and Management Perspectives. Missoula, Montana. February 18-20, 1999.

Vincent, E.R. 1987. Effects of stocking catchable-size hatchery rainbow trout on two wild trout species in the Madison River and O'Dell Creek, Montana. North American Journal of Fisheries Management. 7: 91-105.

-----, 1996. History of fisheries management in Montana, with an emphasis on the Madison River. Presentation made to the Fisheries Management graduate level course at Montana State University, November 12, 1996. Bozeman.

Vincent, E. R. and P. Byorth. 1999. Chronology of whirling disease epizootic in the Madison River. Presented at the 5th Annual Whirling Disease Symposium for Research and Management Perspectives. Missoula, Montana. February 18-20, 1999.

Appendices

Appendix A:

Primary Data Sources and Reports Used in the Preparation of this Report

The following fisheries division reports and unpublished data were used in the compilation of this report. The author attempted to reconcile any discrepancies between reports and other data sources with FWP personnel before inclusion in the report. In general, the final FWP report was used as the standard when evaluating data, and any deviations from this policy are noted in the body of the report.

Byorth, P. Unknown. Unpublished data summaries of creel census estimates, 1975, 1976, 1977, 1981, 1995, and 1996. Montana Department of Fish, Wildlife and Parks, Bozeman.

Lere, M. 1995a. 1995 Madison River creel census documentation. Montana Fish, Wildlife and Parks, Bozeman.

------ 1995b. 1995 Madison River pressure estimate, May 1995. Montana Fish, Wildlife and Parks, Bozeman.

------ 1995c. Memorandum to Dick Vincent dated 10/12/1995. Preliminary creel summary for Madison River for June through September, 1995. Montana Fish, Wildlife and Parks, Bozeman.

------ 1996. 1996 Madison River creel census documentation. Montana Fish, Wildlife and Parks, Bozeman.

M. R.W.(author's full name confidential) 1996. Madison River yearly statistics, 1974 to 1995. Unpublished data provided to Montana Fish, Wildlife and Parks, Bozeman.

Montana Fish, Wildlife and Parks (FWP). 1995a. Original data sheets for the 1995 Madison River creel survey. Montana Fish, Wildlife and Parks, Bozeman.

------ 1995b. Data output from FWP's Creel Survey Program for the 1995 Upper Madison River creel survey. Montana Fish, Wildlife and Parks, Bozeman.

------ 1995c. Data output from FWP's Creel Survey Program for the 1995 Lower Madison River creel survey. Montana Fish, Wildlife and Parks, Bozeman.

------1995d. Montana Fish, Wildlife and Parks population statistics by age class for the Madison River, Pine Butte and Snoball sections, 3/07/95. Unpublished data. Montana Fish, Wildlife and Parks, Bozeman.

------ 1996a. Original data sheets for the 1976 Madison River creel survey. Montana Fish, Wildlife and Parks, Bozeman.

------ 1996b. Data output from FWP's Creel Survey Program for the 1996 Madison River creel survey. Montana Fish, Wildlife and Parks, Bozeman.

------ 1996c. Montana Fish, Wildlife and Parks population statistics by age class for the Madison River, Pine Butte and Snoball sections, 3/15/96. Unpublished data. Montana Fish, Wildlife and Parks, Bozeman.

Vincent, R. E. 1977. Montana Department of Fish and Game Fisheries Division job progress report. Project number F-9-R-25, job number IIb. Southwest Montana fisheries investigation, Madison River trout harvest study. March 16, 1976 through March 31, 1977. Montana Department of Fish and Game, Bozeman.

------ 1978. Montana Department of Fish and Game Fisheries Division job progress report. Project number F-9-R-26, job number IIb. Southwest Montana fisheries investigation, Madison River trout harvest and study. April 1, 1977 through March 31, 1978. Montana Department of Fish and Game, Bozeman.

Woolwine, D.J. 1996. Statistical significance of corrections to historic Madison River creel survey data 1975-1976. Project number 520-11-9381. Completed as part of FWL 470 at Montana State University, Bozeman.

Appendix B:

Copies of Forms Used During the 1995 and 1996 Creel Surveys

MADISON RIVER CREEL CENSUS FORM (5/96)
(Individual Interviews)

Interview Number:_____ Date:_____

Day of Week:____ (1-5, Mon-Fri; 6-Sat.;7-Sun.;8-Holiday)

Area Fished:____
1:Slide Inn
2:Raynolds
3:$3 Bridge
4:Pine Butte
5:Squaw Creek

Type of Fishing:____ 1:Boat 2:Shore

Number of Anglers in Party:_____ (Note:record for only one member in each party and exclude all non-anglers)

Time Started Fishing:_____ AM PM

Time of Interview:_____ AM PM

Hours Fished:____.____ Time spent not Fishing (hrs):_____
(ie. time rowing, eating lunch)

Done Fishing for the Day: Yes No

Guided Trip: Yes No

Angler Origin:_____
1:Madison Co.
2:Gallatin Co.
3:Other Montana
4:Non-resident (USA)
5:Foreign

Target Species:_____
1:Rainbow
2:Brown
3:Cutthroat
4:Trout (general)
5:Grayling
6:Whitefish
7:Trout & whitefish
8:Any fish

Bait Type:_____ 1:Flies 2:Lures 3:Bait 4:Any Combination

Catch Data: (For each individual angler)

	Rainbow	Brown	Cutthroat	Whitefish	Grayling
# Kept					
# Released					
TOTAL					

ANGLER SURVEY - MADISON RIVER

INTERVIEW NUMBER:_____ DATE:_____

1. How many years have you been fishing the Madison River?

   _____ years (Note: If less than 1 but not 0 enter 1)

2. Please indicate your level of satisfaction with your fishing experience on this trip to the Madison River? (Please circle one choice each for number; size and species)

	Very Dissatisfied		Neutral		Very Satisfied
Number of trout caught	-2	-1	0	+1	+2
Size of trout caught	-2	-1	0	+1	+2
Species of trout caught	-2	-1	0	+1	+2

3. Please indicate the reasons why you selected to fish this site on the Madison River rather than another Madison River site? Please rank the top three choices (if appropriate) with 1 being most important.

   _____ good place to launch or take out a boat
   _____ regulations allow fishing from boat
   _____ regulations do not allow fishing from boat
   _____ regulations allow artificial lures only
   _____ regulations allow the use of bait
   _____ regulations allow catch and release only
   _____ regulations provide ability to keep fish
   _____ this is a section of river where whirling disease is not present
   _____ size of trout found in this section of river
   _____ a certain species of trout is more abundant
   _____ no particular reason
   _____ other _____

4. What do you think are the major problems (if any) with fishing on the Madison River?

MADISON RIVER CREEL CENSUS FORM (5/95)
(Individual Interviews)

Interview Number:_____ Date:_____

Day of Week:____ (1-5, Mon-Fri; 6-Sat.;7-Sun.;8-Holiday)

Area Fished:____
1:Quake-Lyons
2:Lyons-McAtee
3:McAtee-Varney
4:Varney-Ennis Lake
5:Dam-P.House
6:P.House-Hot Springs
7:Hot Springs-Elk Cr.
8:Elk Cr.-Greycliff
9:Greycliff-Cobblestone
10:Cobblestone-3 Forks

Type of Fishing:____ 1:Boat 2:Shore

Number of Anglers in Party:_____ (Note:record for only one member in each party and exclude all non-anglers)

Time Started Fishing:_____ AM PM

Time of Interview:_____ AM PM

Hours Fished:____.____ % of Time not Fishing:_____
(ie. time rowing, eating lunch)

Done Fishing for the Day: Yes No

Guided Trip: Yes No

Angler Origin:_____
1:Madison Co.
2:Gallatin Co.
3:Other Montana
4:Non-resident (USA)
5:Foreign

Target Species:_____
1:Rainbow
2:Brown
3:Cutthroat
4:Trout (general)
5:Grayling
6:Whitefish
7:Trout & whitefish
8:Any fish

Bait Type:_____ 1:Flies 2:Lures 3:Bait 4:Any Combination

Catch Data: (For each individual angler)

	Rainbow	Brown	Cutthroat	Whitefish	Grayling
# Kept					
# Released					
TOTAL					

PRESSURE ESTIMATE GROUND TRUTH
LOWER MADISON (Hot Springs Cr. to Elk Cr.)

DATE	TIME	NUMBER OF SHORE ANGLERS	NUMBER OF BOATS
6/8	2PM		
	4PM		
6/13	4PM		
	6PM		
6/17	1PM		
	3PM		
6/25	11AM		
	1PM		
7/4	11AM		
	1PM		
7/8	2PM		
	4PM		
7/18	11AM		
	1PM		
7/20	NOON		
	2PM		
7/28	1PM		
	3PM		
8/4	2PM		
	4PM		
8/11	NOON		
	2PM		

PRESSURE ESTIMATE GROUND TRUTH
LOWER MADISON (Hot Springs Cr. to Elk Cr.)

DATE	TIME	NUMBER OF SHORE ANGLERS	NUMBER OF BOATS
8/15	2PM		
	4PM		
8/23	4PM		
	6PM		
8/26	9AM		
	11AM		
9/8	11AM		
	1PM		
9/10	NOON		
	2PM		
9/21	1PM		
	3PM		
9/25	9AM		
	11AM		
9/29	2PM		
	4PM		

MADISON RIVER PRESSURE DATA (5/95)

Date:_____ Time:_____

	Number of Shore Anglers	Number of Boats
Quake-Lyons		
Lyons-McAtee		
McAtee-Varney		
Varney-Ennis Lake		
Dam-P. House		
P. House-Hot Springs		
Hot Springs-Elk Cr.		
Elk Creek-Greycliff		
Greycliff-Cobblestone		
Cobblestone-3 Forks		

Time:_____

	Number of Shore Anglers	Number of Boats
Quake-Lyons		
Lyons-McAtee		
McAtee-Varney		
Varney-Ennis Lake		
Dam-P. House		
P. House-Hot Springs		
Hot Springs-Elk Cr.		
Elk Creek-Greycliff		
Greycliff-Cobblestone		
Cobblestone-3 Forks		