Madison River/Ennis Reservoir Fisheries

1995 Annual Report
to
Montana Power Company
Environmental Division
Butte

from
Montana Fish, Wildlife, & Parks
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Ennis
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INTRODUCTION

During 1995, the Montana Power Company (MPC) and Montana Fish, Wildlife, & Parks (MFWP) continued the cooperative agreement they began in 1990. As developed in 1990, MPC provided funding to MFWP for a biologist to study the Madison River/Ennis Reservoir arctic grayling (Thymallus arcticus) population (Montana Fish, Wildlife, & Parks 1995). Additional duties and money have been added to the contract to assist MPC in gathering information for relicensing of MPC's Madison/Missouri hydropower system, and to carry out protection, mitigation, and enhancement (P,M & E) activities. The Federal Energy Regulatory Commission (FERC) is expected to release a Draft Environmental Impact Statement (DEIS) on the relicensing in the spring of 1996. MPC owns and operates nine dams on the Madison and Missouri Rivers (Figure 1). These nine dams collectively are called the 2188 Project, refering to the FERC license number that authorizes their operation.

Many of the tasks that were conducted in 1994 were continued in 1995, and additional tasks were added after the discovery of whirling disease in the Madison River in December, 1994. Whirling disease is caused by a parasitic organism (Myxobolus cerebralis) that attacks primarily the cranial cartilege of young fish prior to ossification. It may cause death directly, or lead to physical deformities and behavioral abnormalities that inhibit the young fish's ability to avoid predators and feed efficiently. Populations of rainbow trout in the Madison River between Quake Lake and Ennis have decreased as much as 90 percent, attributable to the invasion of whirling disease.

METHODS

Electrofishing with a driftboat mounted mobile anode system remains the principle method used to capture trout and grayling for population estimates and sampling. Fish captured for population estimates are weighed and measured, marked with a fin clip and/or tagged with a Visual Implant (V.I.) tag posterior to one or both eyes, and released. A log-liklihood statistical analysis (Montana Fish, Wildlife, & Parks 1994) is used to estimate trout populations throughout the Madison River (Figure 2).

To monitor grayling use of Meadow Creek and a preferred channel of the main river, upstream and downstream box traps were installed in late March and early April (Figure 3). The traps were removed in early May.

Young-of-the-year (yoy) grayling in Ennis Reservoir are sampled using a beach seine. To beach seine, two people are let off a boat in water up to five feet deep. They stretch a 125 beach seine between them, and proceed to walk directly into the

shoreline, pulling the seine into a large arc behind them. The seine is pulled up onto the shoreline and captured fish are

Figure 1. Locations of Montana Power Company dams on the Madison and Missouri Rivers.

Figure 2. Locations of Montana Fish, Wildlife, & Parks trout population estimate sections.

Figure 3.Locations of gillnet sites in Ennis Reservoir, and trap sites in Meadow Creek and the Madison mainstem.

enumerated by species. Dimensions of the beach seine are 125 feet by 5 feet, with 1/4 inch mesh netting. A 5'x5'x5' bag is constructed into the middle of the seine. Purse seining was not conducted in 1995.

Gill nets are used to sample fish from Ennis Reservoir. Netting is conducted seasonally, in June, August, and October. Nets for this task were not obtained until mid-summer, 1995, so the spring (June) sampling was not conducted. Experimental nets, composed of five 25 foot panels of progressively larger mesh, are set at four locations in Ennis Reservoir and left to fish overnight (Figure 3). The smallest mesh panel is set in the most shallow water, near the shoreline, and the largest mesh in the deepest water. Nets are set perpendicular to the shoreline. Sites selected for netting were chosen partly in an effort to avoid sampling grayling, since netting mortality of salmonids is usually high. Floating nets are used at the shallow south end of the reservoir, and one floating net and one sinking net are used near the county bridge at the north end of the reservoir. Because the south end of the reservoir is so shallow, floating nets are able to sampling the entire water column. At the deeper north end of the reservoir, a sinking net and a floating net are required to sample benthic and pelagic areas, respectively. Captured fish are removed from the nets, separated by species, weighed, measured, and released. If a large number of one species is captured in a given net, generally 25 are weighed and measured and the remainder are simply enumerated. Game fish which do not survive are offered to the local Meals-on-Wheels Program.

Spring and fall population estimates were conducted in the Pine Butte and Snoball sections of the Madison River to determine the effects of angling on trout infected with whirling disease (Figure 2). The Pine Butte section remained open to catch-and-release angling, while the Snoball section was closed to all angling. Other sections where population estimates are routinely conducted are the Varney and Norris sections. The Bypass section, between Ennis Dam and Powerhouse, has recently been incorporated into MFWP population estimate efforts, and an estimate is conducted on the Greycliff section when time and personnel are available.

Young-of-the-year rainbow and brown trout are sampled from

areas throughout the Madison River to determine the timing of whirling disease infection, infection rate, and the effects of the disease. To accomplish these tasks, two methods are used to collect yoy trout. From June through November, the drift boat system is modified by adding a 75 foot electrical cord to the anode. This system is then used to sample selected 150 foot sections of the riverbank within the Pine Butte and Snoball sections. The boat is anchored within a few feet of the river bank, the 75-foot anode carried downstream, and electrofishing proceeds in an upstream direction past the boat. Three passes are conducted at each location, with captured fish enumerated by species after each run. The Zippin Removal Method (Zippin 1958) is used to derive a numeric estimate of yoy for that 150 feet of river bank. Generally, areas that look most likely to hold yoy are selected for sampling, so the numbers generated should not be extrapolated to arrive at yoy estimates for larger sections of the river. Abnormalities potentially caused by whirling disease are noted. Fish are held in water-filled buckets until the sampling is completed, then released. Up to ten individuals of each species are preserved in Davidson's Solution or by freezing for examination for whirling disease spores.

Additionally, a backpack mounted shocker is used to collect yoy trout from a series of locations throughout the Madison River drainage in early winter (Figure 4). These fish are collected solely for determining the presence and incidence of whirling disease in a given area.

Water temperature is recorded throughout the Madison River from the Quake Lake outlet to the Headwaters State Park (Figure 5). StowAway and Optic StowAway temperature loggers are programmed to record every 15 or 30 minutes, in Fahrenheit.

As part of its relicensing effort, MPC has initiated a water quality monitoring program. In this program, personnel from MPC and several agencies, including MFWP, collect samples for biological and biocontaminant monitoring at locations within the Madison/Missouri System (Appendix Figures 1 and 2). Aquatic invertebrate and periphyton samples are collected for biological monitoring at seven sites from within Yellowstone National Park (YNP) to below Morony Dam. Additionally, surface and bottom feeding fish are collected at four locations for metals and contaminant testing. Samples are analyzed by a variety of consultants and reported to the MPC Environmental Division.

RESULTS AND DISCUSSION

Madison Grayling

During spring electrofishing, only eleven adult grayling were captured in four electrofishing runs through the Channels section.

As in previous years, inconsistantly available manpower hindered the ability to thoroughly work the area. In general, spring was "late" due to cold air temperatures and high spring runoff. None of the grayling captured were recaptures from previous years.

The box traps installed in Meadow Creek and a channel of the mainstem captured brown trout, rainbow trout, whitefish, suckers, and chubs, but no grayling. The lead across the channel in the mainstem was subject to high flows, which at times may have rendered it less than fully effective.

Figure 4.Collection sites of young-of-the-year trout for whirling disease testing in 1995.

Figure 5. Locations of Fish, Wildlife, & Parks 1995 temperature monitoring sites. Names of air temperature sites are underlined.

Beach seining in Ennis Reservoir was conducted in late July and early September. In July, 11 yoy grayling were captured, ranging in length between 2.5"-2.9". Additionally, 177 yoy whitefish were captured, as well as dace, yoy suckers, chubs, and trout. In September, 23 yoy grayling were captured, ranging between 4.5"-5.0". Eighty-five yoy whitefish, as well as yoy trout and suckers were captured. All yoy grayling captured in 1995, except one, were in shoreline areas of Meadow Creek Bay, in the vicinity of at least some macrophyte development. Grayling were not captured in all areas where macrophytes were present. In 1994, yoy grayling were captured along the south shoreline of the reservoir as well as in Meadow Creek Bay. Locations of seining sites and catch for each date are described in Appendix A.

In early August, with the assistance of Turner Ranch employees, a portion of the Butler Reach of Cherry Creek was sampled to monitor the fate of 1450 Madison grayling introduced in July, 1994, as yearlings. No grayling were captured or sighted in two passes through a 1050 foot section of the reach. However, in late August, Turner personnel reported catching an 11 inch grayling during recreational angling in lower Cherry Creek, below the waterfall that is the downstream boundry of the Butler Reach. As previously reported (MFWP 1995), no grayling were captured in a downstream trap installed in Cherry Creek from July 25-August 29, 1994, approximately 3-4 miles below the waterfall.

Additional work intended for 1995 was to monitor the use of the upper river by adult grayling to determine if a fluvial component exists in the Madison population. In previous years, fishing guides reported routinely catching grayling as late as September as far as 30 miles upstream of Ennis Reservoir. To monitor use of the upper Madison by grayling, guides who previously reported catching grayling were routinely queried about the presence and location of grayling, and radio tags were to be

implanted in grayling caught in the upper river. The movements and duration of grayling use of the upper river would be closely followed. However, contacts with these guides revealed that they were catching no grayling in the upper river in 1995, so no radio tags were deployed.

Population Estimates

Seasonal population estimates of rainbow and brown trout continued in 1995. Historically, estimates have been conducted primarily for management purposes. With the invasion of whirling disease, the estimates take on additional value, namely to document the on-going effects of the disease, and to provide evidence on the effectiveness of efforts developed and implemented to mitigate the effects of whirling disease. Figures 6-16 illustrate historic population levels (number/mile) of rainbow and brown trout in sections of the Madison River (Figure 2). One year old fish are separated from two year old & older fish because of the natural fluctuations that occur within yearling numbers from year to year. Generally, the number of two year old & older fish is a better indicator of population trends. The Bypass, Norris, and Greycliff sections, in which estimates are conducted in the spring, show only two year old and older trout. Generally, too few yearling fish are captured in the spring to conduct an estimate on them. Aging of fish has not been completed for Varney in 1995, so fish greater than 10" are substituted for two year old & older fish. The actual number of yearlings and two year old & older will most likely change once aging is completed. Appendix B contains historic population levels (total number) of two year old & older rainbow and brown trout ($\pm$ 80% C.I.) in each section.

Rainbow trout populations remain low in those sections previously affected by whirling disease, and brown trout numbers remain steady.

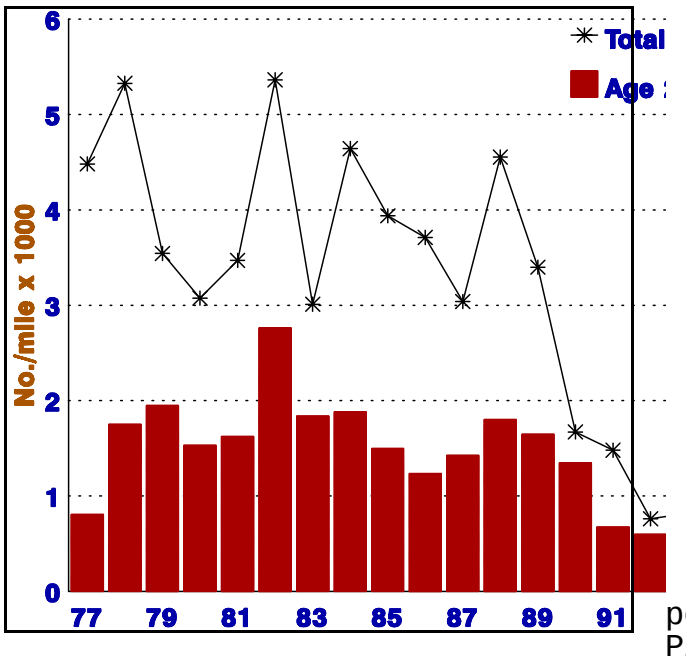


Figure 6. Rainbow trout populations in the Pine Butte section of the Madison River, 1977-95, fall estimates.

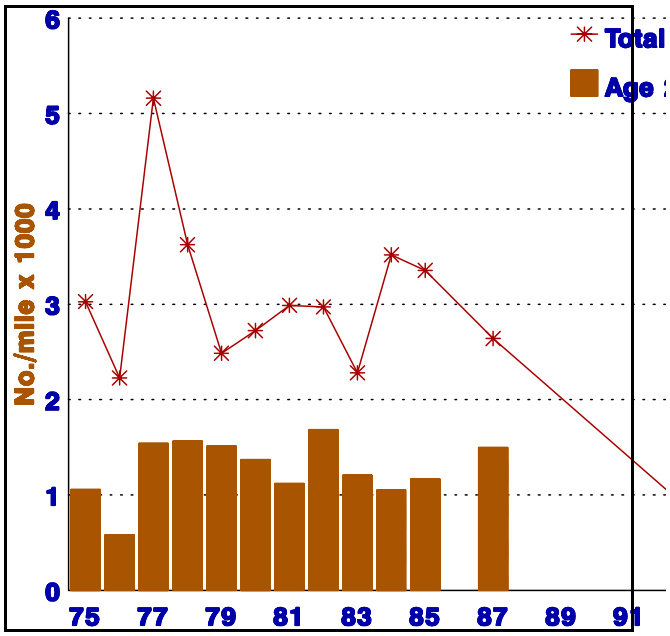


Figure 7.Rainbow trout populations in the Snoball section of the Madison River, 1975-95, fall estimates.

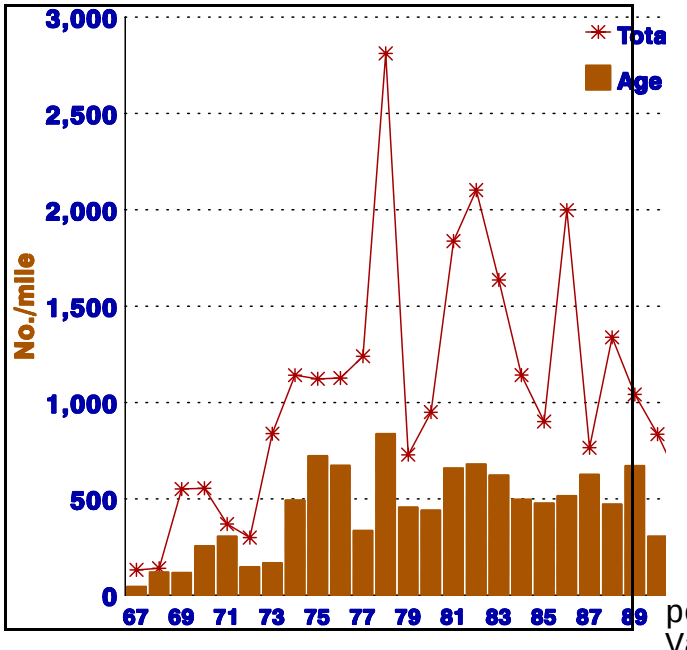


Figure 8.Rainbow trout populations in the Varney section of the Madison River, 1967-95, fall estimates.

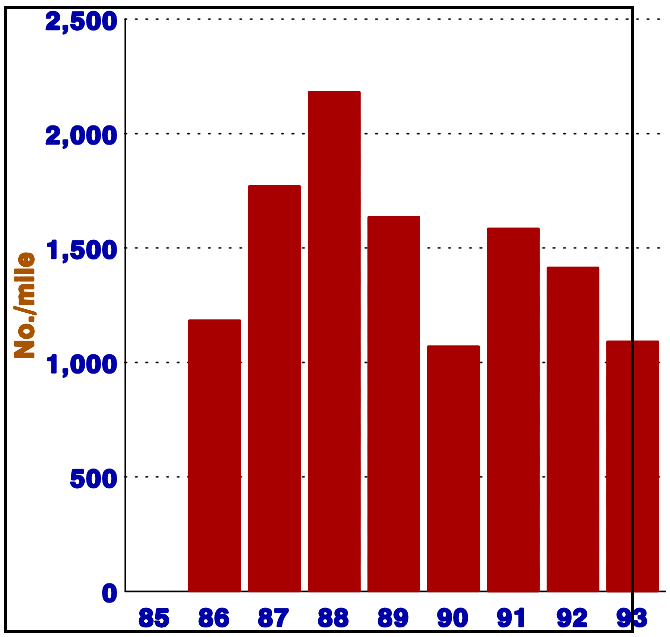


Figure 9.Rainbow trout populations in the Norris section of the Madison River, 1986-95, spring estimates.

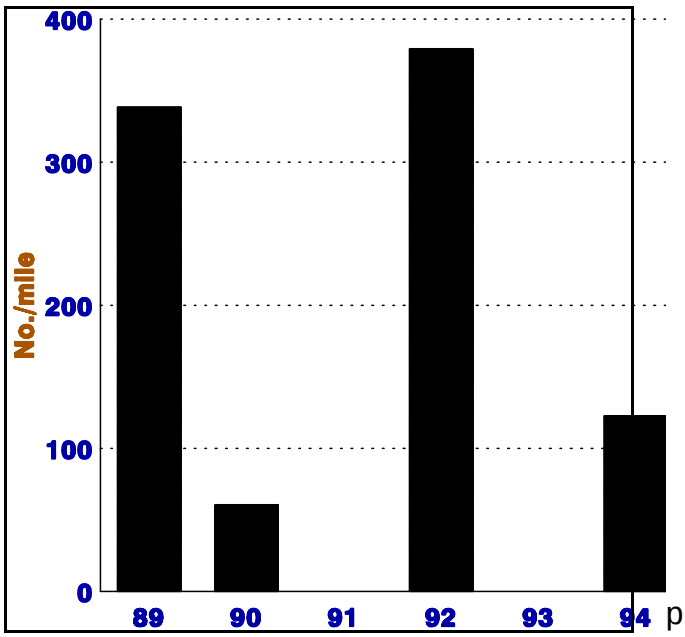


Figure 10.Rainbow trout populations in the Greycliff section of the Madison River, 1989-95, spring estimates.

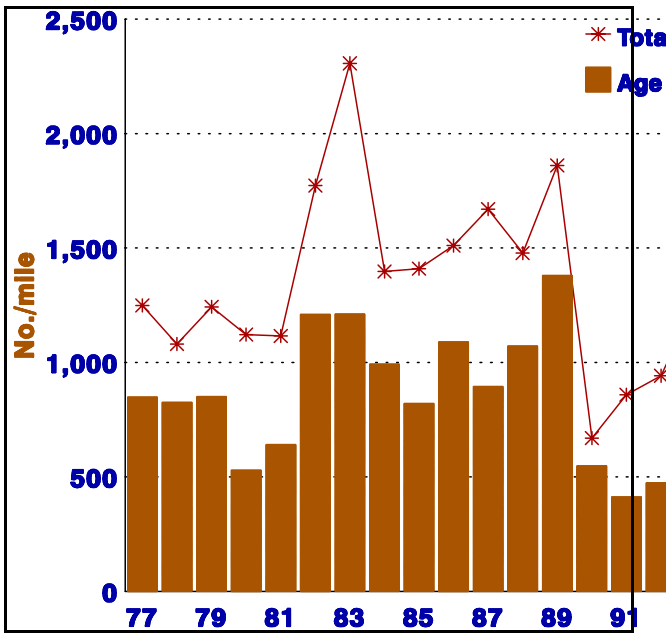
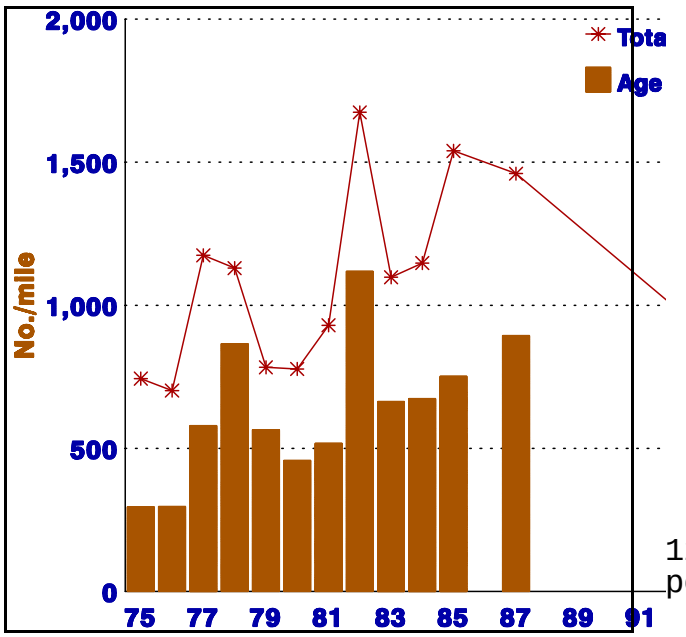


Figure 11.Brown trout populations in the Pine Butte section of the Madison River, 1977-95, fall estimates.

Figure 12.Brown trout populations in the Snoball section of the Madison River, 1975-95, fall estimates.



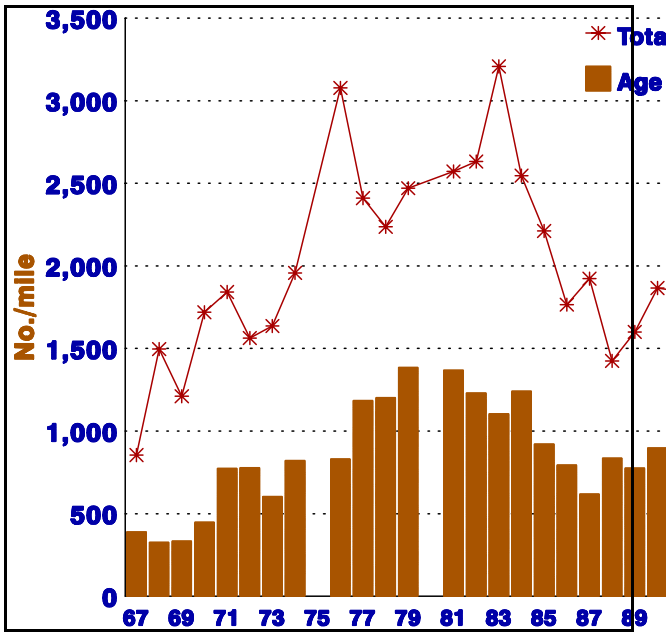


Figure 13.Brown trout populations in the Varney section of the Madison River, 1967-95, fall estimates.

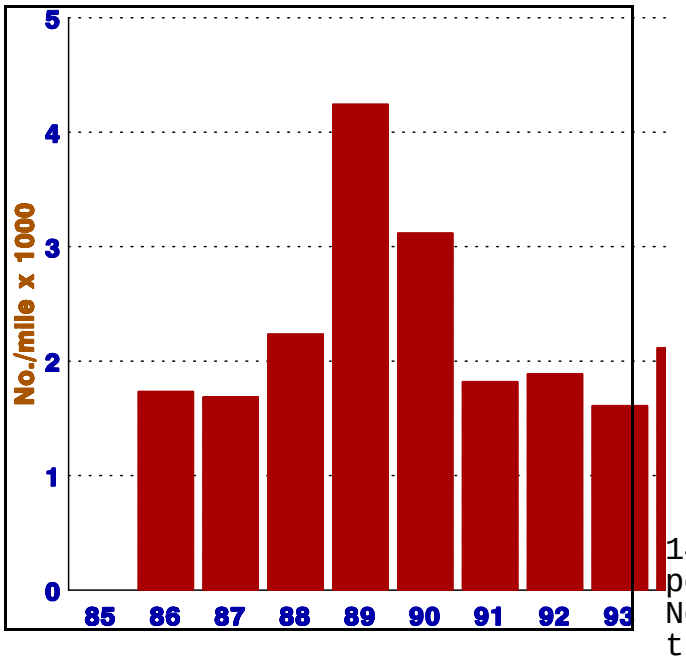


Figure 14.Brown trout populations in the Norris section of the Madison River, 1986-95, spring estimates.

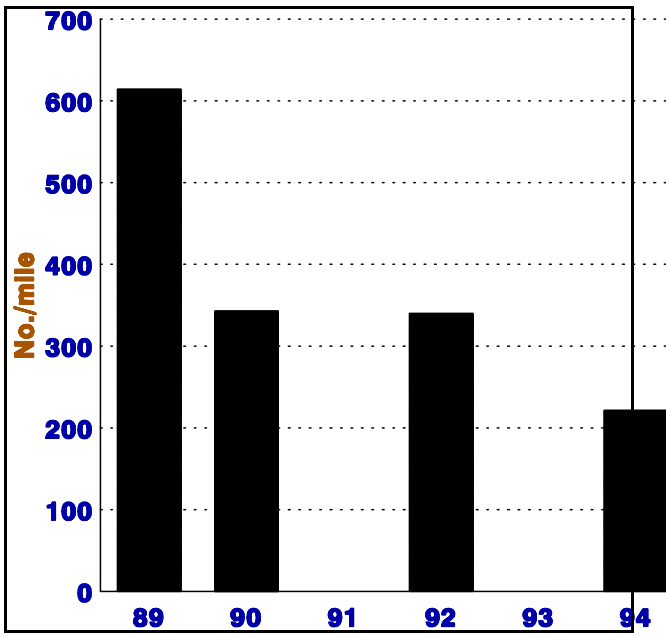


Figure 15.Brown trout populations in the Greycliff section of the Madison River, 1989-95, spring estimates.

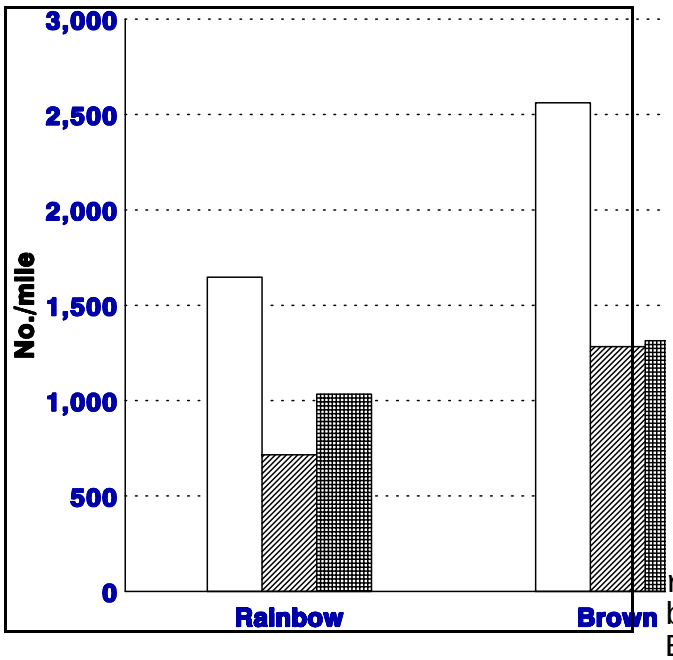


Figure 16.Populations of rainbow and brown trout in the Bypass section of the Madison River, spring estimates. Bypass flows during the estimates were as follows: 1992, 1118-1685 cfs; 1994, 90 cfs; 1995, 355-560 cfs.

Brown trout in the Pine Butte section exhibited a noticeable decrease in 1990, one year prior to the onset of the decline in rainbow trout. Four of the lowest counts of brown trout in Pine Butte since 1977 have occured since 1990. Since 1989, the strength of the yearling cohort is predictive of the trend shown by the age 2 and older fish the following year (Figure 11). Brown trout numbers in the Snoball and Varney sections remain within their historic range.

Gill netting

Statistics of fish captured during gill netting in Ennis Reservoir are presented in Table 1. As expected, relatively few trout and grayling were captured in 1995, together accounting for 6 percent and 4 percent of the total catch in August and October, respectively.

- Table 1.Summary of gill net catch in Ennis Reservoir, 1995. Length is in inches, weight in pounds.

	UC[1]	WSu	LnSu	MWF	Rb	LL	AG
August							
Av.length	9.6	12.2	11.1	--	8.5	17.0	--
Av.weight	--	--	--	--	0.3	1.8	--
# measured	70	52	7		1	16	
total catch	178	94	7	0	1	16	0
October							
Av.length	10.4	13.3	14.5	12.4	--	11.3	11.5
Av.weight	0.5	1.0	1.3	0.7	--	0.6	0.5
# measured	75	62	10	6	0	9	2
total catch	138	99	10	6	0	9	2

[1]UC= Utah Chub, WSu= white sucker, LnSu= Longnose sucker, MWF= Mountain whitefish, Rb= Rainbow trout, LL= Brown trout, AG= Arctic grayling

Whirling Disease

Summertime mortality of rainbow trout appears to be higher in the Pine Butte section, which remains open to catch-and-release angling, than in the Snoball section, which is closed to all fishing (Figure 17). Summer mortality of rainbows is most likely a result of the pressures of catch-and-release on a small population, not necessarily an effect of angling on a population infected with whirling disease. If approved by the Fish, Wildlife, & Parks Commission, this experiment will be repeated in 1996. An intensive creel survey conducted by MFWP throughout the Madison River, from June 1 through September 30, 1995, indicates that angling pressure is greater between Quake Lake and Lyons Bridge, including the Pine Butte section, than in any other section of the river (M. Lere, MFWP, pers.comm.).

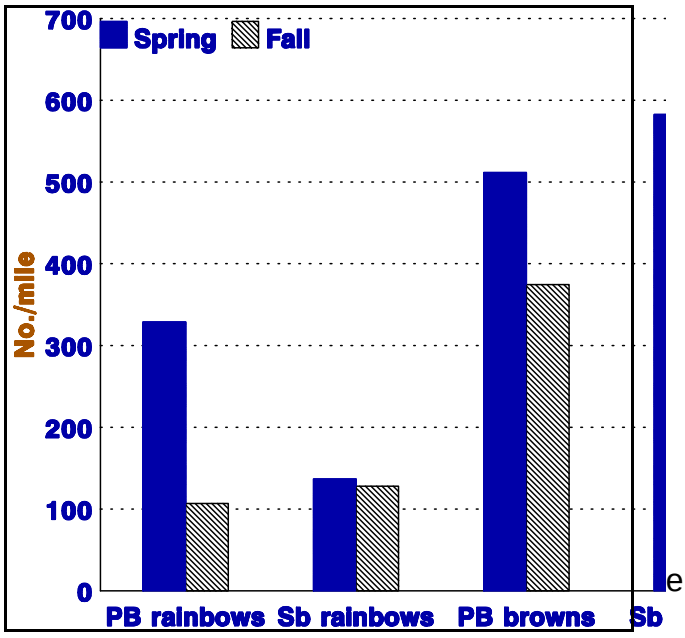


Figure 17.Population estimates for

three year old & older rainbow and brown trout in Spring (March) and Fall (September), 1995, in the Pine Butte and Snoball sections.

Controlled experiments conducted by the USFWS and MFWP tested the affects of whirling disease on yoy grayling of Big Hole River stock. Tests conducted by MFWP were carried out in Willow Creek upstream from Willow Creek (Harrison) Reservoir. Grayling were place in holding boxes August 15 and removed in early November. Tissue analyses detected no infection by whirling disease. However, it is suspected that the grayling were introduced to the experiment too late in the season, and consequently did not become infected. Experiments to be conducted in 1996 will introduce grayling of Big Hole River stock into the holding boxes early enough in the season to insure adequate exposure to whirling disease spores.

Experiments by the USFWS were conducted in Blaine Spring Creek, a tributary to the Madison River near Varney, and in a side channel of the river near Varney. These fish were introduced into the experiment in July and sampled weekly for 15 weeks. Grayling were used only in the spring creek, and showed "light" infection by whirling disease spores, cartilege destruction, and immune system inflammation, but no external clinical signs of the disease. Blaine Spring Creek is thought to be only lightly infected with whirling disease because rainbow trout used in the same experiment were only lightly infected. Rainbow trout tested in the river side channel and from other locations in the Madison River have shown extremely heavy infections of the disease (MacConnell pers.comm.). These experiments will be repeated in 1996, and grayling will be used in the river side channel to determine if they are susceptible to heavy infections of whirling disease.

Approximately every two weeks from late June through mid-November, 150 foot sections of riverbank that looked likely to be hospitable to yoy trout were sampled to monitor numbers of yoy trout and to document the onset and incidence of clinical signs of whirling disease. Once a particular section was sampled, it was not repeated at any time later in the season. Numbers of rainbow and brown trout yoy, as derived by the Zippin Removal Method (Zippin 1958), are illustrated in Figure 18. In the June sampling, yoy trout were too small to distinguish species, so are not included in these data. Rainbow trout yoy populations decreased from an average of 116/150 feet to 18/150 feet over the period between late July and mid November, while brown trout decrease from an average of 36/150 feet to 19/150 feet. A significant portion of the yoy rainbow trout captured during these efforts exhibited clinical signs of whirling disease (Table 2).

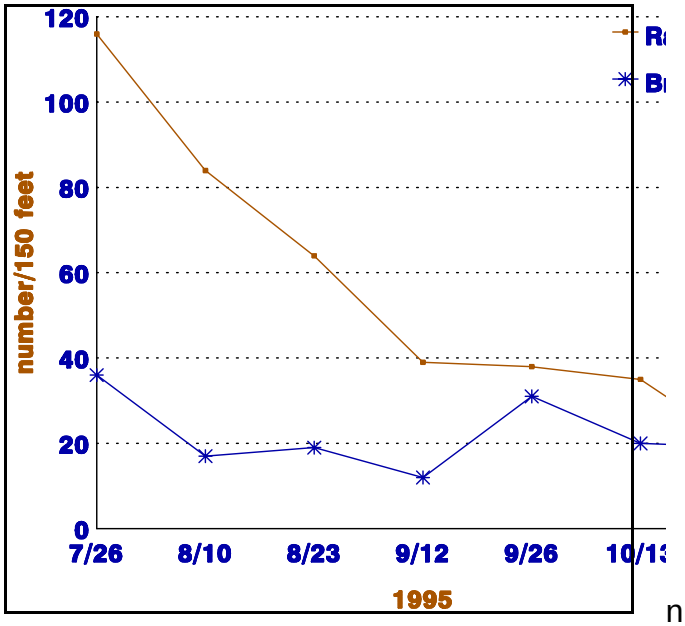


Figure 18. Average number of young-of-the-year rainbow and brown trout per 150 feet of riverbank, Pine Butte and Snoball sections, Madison River, July-November, 1995.

In the late fall-early winter, a backpack shocker is used to collect yoy trout from selected sites along the Madison River to determine the range and infection rate of whirling disease (Figure 4). Up to 25 rainbow trout and brown trout are collected from each location and provided to the U.S. Fish & Wildlife Service Fish Technology Center in Bozeman for analyses of presence and degree of infection of whirling disease. Due to the number of samples collected from this and other locations across the state, histological examinations of yoy fish collected during MFWP monitoring throughout the river are not yet complete. Preliminarily, it appears that whirling disease is not yet affecting trout populations below the Bypass section of the river.

Though data collected during the creel survey are not yet thoroughly analyzed, it appears that anglers are satisfied with their angling experiences, despite the impacts of whirling disease on the rainbow trout population of the Madison (MFWP, M. Lere, pers.comm.).

Table 2. Incidence of deformity among young-of-the-year rainbow trout monitored in the Madison River, 1995.

Date	Number sampled[1/]	Normal (%)	Exopthalmia/ cranial deform.	Caudal Blacktail	deform.	Whirling
7/25,26	770	769 (99.9)		1		

8/9,10	609	607 (99.7)	1	1		
8/22,23	472	460 (97.5)	12			
9/11,12	282	181 (64.2)	95	5	4	1
9/25,26	296	160 (54.1)	117	16	11	
10/11,13	261	189 (72.4)	67	4	4	1
10/26,27	125	99 (79.2)	24	3	2	
11/13,14	134	120 (89.6)	14	2		

[1/]An individual fish may exhibit more than one clinical symptom, so the number sampled may be exceeded by the summation of the other categories.

Water Temperatures

StowAway and Optic StowAway temperature recorders are deployed throughout the Madison River to document water and air temperatures (Figure 5). Table 3 summarizes the data collected at each location in 1995, and Appendix C contains thermographs for each location. Recorders deployed to monitor air temperatures were located in areas that were shaded 24 hours per day.

Examination of thermographs in Appendix C illustrates that the Madison River is very reactive to ambient air temperature. In mid September, all monitored sites, except Quake Lake outlet, simultaneously exhibited a noticeable stepdown of water temperatures. This stepdown occurred on September 19 and 20 in both the upper and lower river (Appendix Table C1). The same trend is noticeable in air temperatures recorded at various locations along the river. At all monitored water temperature locations above Ennis Reservoir, except Quake Lake outlet, the maximum water temperature increased from September 17th to the 18th, while at all monitored locations below Ennis Reservoir, the maximum water temperature decreased during that time (Appendix Table C1). A similar simultaneous stepdown occurred in early October, 1994, at all locations monitored (MFWP 1995).

Table 3.Maximum and minimum temperatures (^{o}F), the dates of each, period monitored, and number of readings at monitored locations in the Madison River drainage. Charts for each location are in Appendix C.

Site	Maximum	Minimum	Period	# readings

Quake Lake outlet	64.4 (8/23)	44.8 (7/26)	7/25-10/10	7458
Slide Inn Store air	86.9 (8/6)	36.8 (8/30,31)	8/3 - 9/5	1623
	77.2 (9/15,16)	23.26[2/]	9/6 -10/10	1667
		(9/21,24 10/2)		
Kirby	68.0 (8/22)	48.2 (7/27, 10/4)	7/26-10/10	7360
West Fork Madison	65.0 (8/6)	37.4 (10/2,8)	7/26-10/10	7360
West Fork Camp air temp	87.3 (8/6)	31.6 (8/19)	8/3 - 9/5	1622
	80.0 (9/15)	23.26[2/] (9/21,22,24 10/2,8)	9/6 -10/10	1667
McAtee Bridge	68.2 (8/22)	44.0 (10/8)	7/25-10/10	7453
Ennis Bridge	69.7 (8/23)	43.7 (10/8)	7/25-10/10	7211
Ennis air temp	93.2 (7/28 8/6)	36.2 (8/9)	6/7/25- 8/28	1647
	90.7 (9/2)	23.26[2/] (9/21 10/2)	8/28-10/4	1800
Eagles' Nest	70.5 (8/5)	41.3 (9/21)	7/25-10/10	7449
Inlet	71.4 (8/5,11)	41.8 (9/21, 10/8)	7/25-10/10	7448
Ennis Dam[1/]	70.8	62.4	7/25- 8/31	1800
	67.8 (7/25,26)	44.9 (10/8,9,10)	8/24-10/10	4517

Table 3 continued.

Beartrap Mouth	73.4 (7/29, 8/5,6)	44.3 (10/8)	7/25-10/10	7442

Norris	73.5 (7/29, 8/5,6)	43.9 (10/8)	7/25-10/10	7441
Blacks' Ford	74.9 (8/5)	42.9 (10/8)	7/25-10/10	7440
Greycliff	76.9 (8/4)	42.5 (10/8)	7/25-10/10	7438
Cobblestone	74.6 (9/3)	42.3 (10/8)	8/22-10/12	4946
Headwaters (Madison mouth)	74.0 (8/23)	42.6 (10/8)	8/22-10/10	4745

[1/]Two separate measuring units were used at the dam, the time periods measured overlapped for one week.

[2/]Air temperatures were lower than 23.26°F, but this is the lowest tem

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Biological and Biocontaminant Monitoring

Final results of the biological and biocontaminant monitoring conducted in 1995 are not yet available. The most notable finding of the 1994 monitoring is the discovery of the New Zealand Mud Snail (NZMS) (Potamopyrgus antipodarum) in the Madison River inside Yellowstone National Park (McGuire 1995). Previously, this organism had not been found in North America outside the middle Snake River, Idaho. The NZMS has proliferated in the middle Snake since its unintended introduction, probably as a hitchhiker with rainbow trout imported from New Zealand for Idaho's commercial trout farms. It was initially identified from Snake River samples in 1987. The NZMS is competing with and displacing native molluscan fauna of the Snake River due to its ability to withstand a wide range of environmental conditions (Bowler 1989). The NZMS may be of little value for salmonids and other fish species that attempt to feed on them. Pack and Jellyman (1988) interpret the results of a study by McCarter (1986) and state that brown trout receive less than two percent of the available energy from the NZMS unless the shell is broken. Individual NZMS are extremely small, so may be difficult for fish to chew to break the shell. McGuire (pers.comm.) states that the NZMS has been found in the Snake River to densities as high as 500/in^2.

CONCLUSIONS AND FUTURE PLANS

It is unlikely that an adequate fluvial component exists within the genetics of the Madison grayling population to enhance

the fluvial nature of the population through selective breeding. In recent years, as the population recovered from the 1983 drawdown of Ennis Reservoir, anglers infrequently, but regularly, reported catching grayling upstream of McAtee Bridge as late as September. This lent credence to the idea of a fluvial component in the population. If grayling are negatively affected by whirling disease, chances of recovering and exploiting any fluvial component of the population are greatly reduced, if not eliminated.

Ongoing studies are designed to determine if grayling are susceptible to whirling disease. Initial studies indicate that whirling disease will affect grayling. This is supported by the apparent lack of adult grayling in the 1995 spring spawning run, and from the absence of grayling in the upper Madison River in the fall, as reported by anglers.

Progeny of Big Hole River fluvial grayling will be introduced into Cherry Creek, a tributary of the lower Madison River, if the landowner accepts the proposal of the Montana Fluvial Grayling Technical Committee. At least one graduate student will be assigned to closely monitor the fate of these fish, with assistance from MFWP.

Management actions designed to address the problems associated with whirling disease will probably be developed and distributed for public comment sometime after the 1996 field season. The initial year of study suggests that summertime rainbow trout survival is higher in the Snoball section with elimination of angling pressure than in the Pine Butte section, which remains open to catch-and-release angling (Figure 17).

Monitoring of yoy trout will continue in 1996 as well. Additional sections of the river, perhaps one yet uninfected with whirling disease, may be incorporated into the monitoring.

Water temperatures will also continue to be collected throughout the drainage to monitor measures implemented to address thermal issues and to provide data to update the MPC Thermal Model, or other models, if required.

Biological and biocontaminant monitoring will be conducted again during 1996. After 1996, these tasks will be conducted every 3-5 years.

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APPENDIX FIGURES 1 AND 2

BIOLOGICAL AND BIOCONTAMINANT MONITORING LOCATIONS IN THE MADISON AND MISSOURI RIVERS, MONTANA.

Figures provided by Montana Power Company, Environmental Division

APPENDIX A.

DESCRIPTION OF YOY GRAYLING BEACH SEINING LOCATIONS IN ENNIS RESERVOIR, AND CATCH AT EACH SITE.

July 27, 1995

Site seined/time	AG[1/]	MWF[2/]	Other[3/]	Note
west side of willow patch between Meadow Creek FAS and Peterson property ($1000 house) 1040 hrs.	0	0	0	no
east side of willow patch between Meadow Creek FAS and $1000 house 1110 hrs.	4	14	2 LND	macrophytes present
West of willows at Meadow Creek boat launch- 1144 hrs.	3	52	1 juv. UC 2 yoy suckers 2 juv. suckers	macrophytes present
Mouth of Meadow Creek, left bank 1215 hrs.	0	0	3 yoy LL	along shoreline vegetation
cattail patch imm. north of Meadow Creek 1235 hrs.	4	33	1 LND 1 UC adult	macrophytes present
southwest corner of reservoir- 1st point west of Fletchers mouth 1344 hrs.	0	0	1 2-yr-old RB	no veg.
immediately east of Fletchers 1406 hrs.	0	16	2 yoy UC	macrophytes present
between Fletchers & main channel mouth 1406 hrs.	0	58	1 yoy LL 2 yoy UC	macrophytes present
point .25 mile east of main channel	1	4		

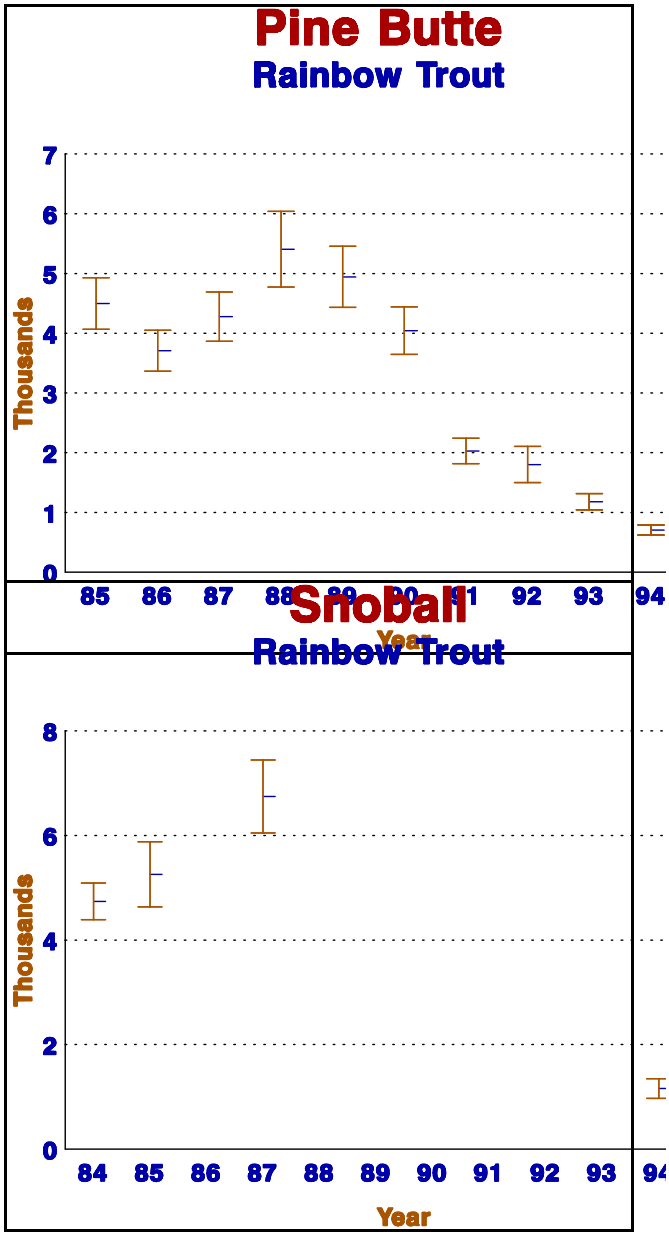
[1/] AG= arctic grayling
[2/] MWF= mountain whitefish
[3/] LND= longnose dace; UC= Utah Chub; LL= brown trout; Rb= rainbow trout

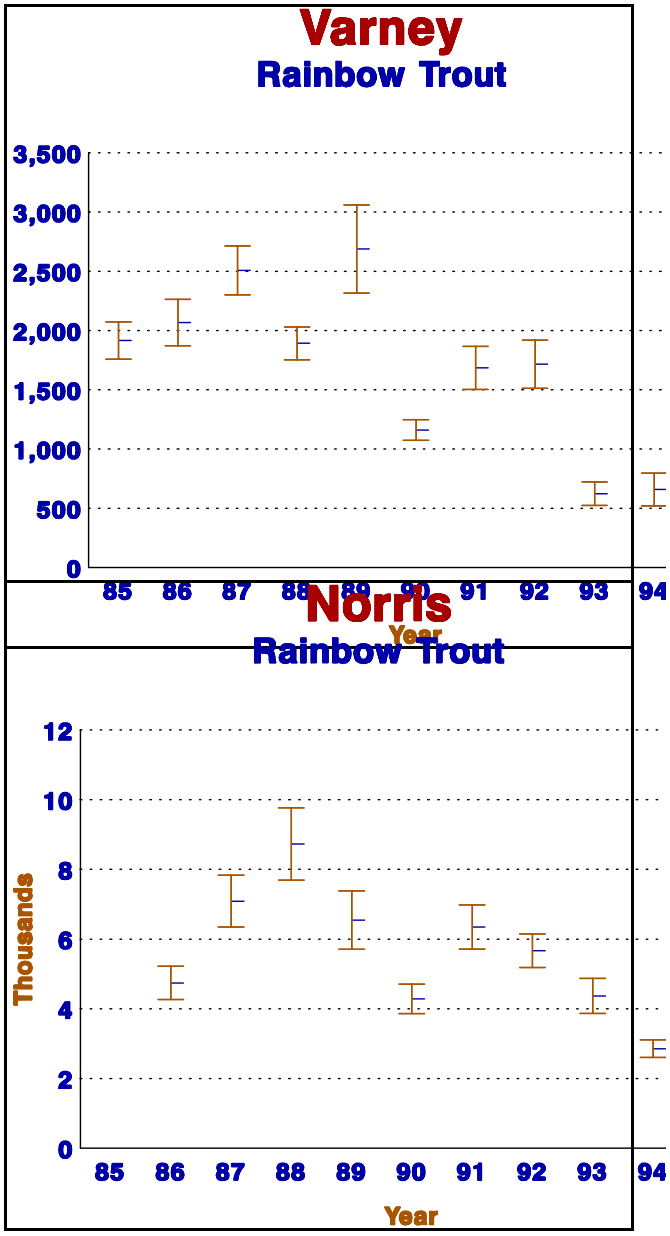
September 1, 1995

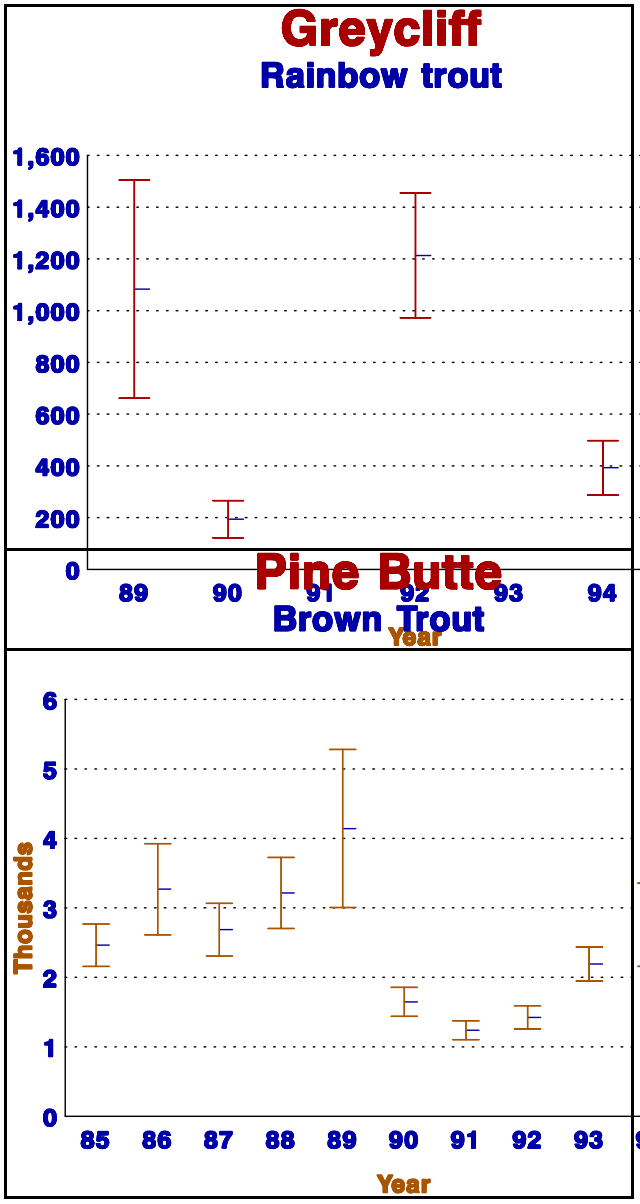
Site seined/time	AG	MWF	Other	Note
west of willows- $1000 house 1032 hrs.	0	9	3 yoy LL	
east of willows- $1000 house 1102 hrs.	22	66	2 yoy suckers	
Meadow Cr. boat launch 1121 hrs	1	4	many yoy suckers	
Klutz boat ramp 1151 hrs.	0	3	1 yoy LL 1 yoy sucker	
west side of Fletchers mouth 1237 hrs.	0	5	many yoy suckers	macrophytes
east side of Fletchers mouth 1256 hrs.	0	2		macrophytes present
big cove between Fletchers & river mouth 1320 hrs.	0	0		
big cove east of main channel 1402 hrs.	0	0		
Klutz- parallel to shore from shrubs south of ramp to ramp 1430 hrs.	0	0		
Klutz- from ramp north to private boat ramp 1458 hrs.	0	0		

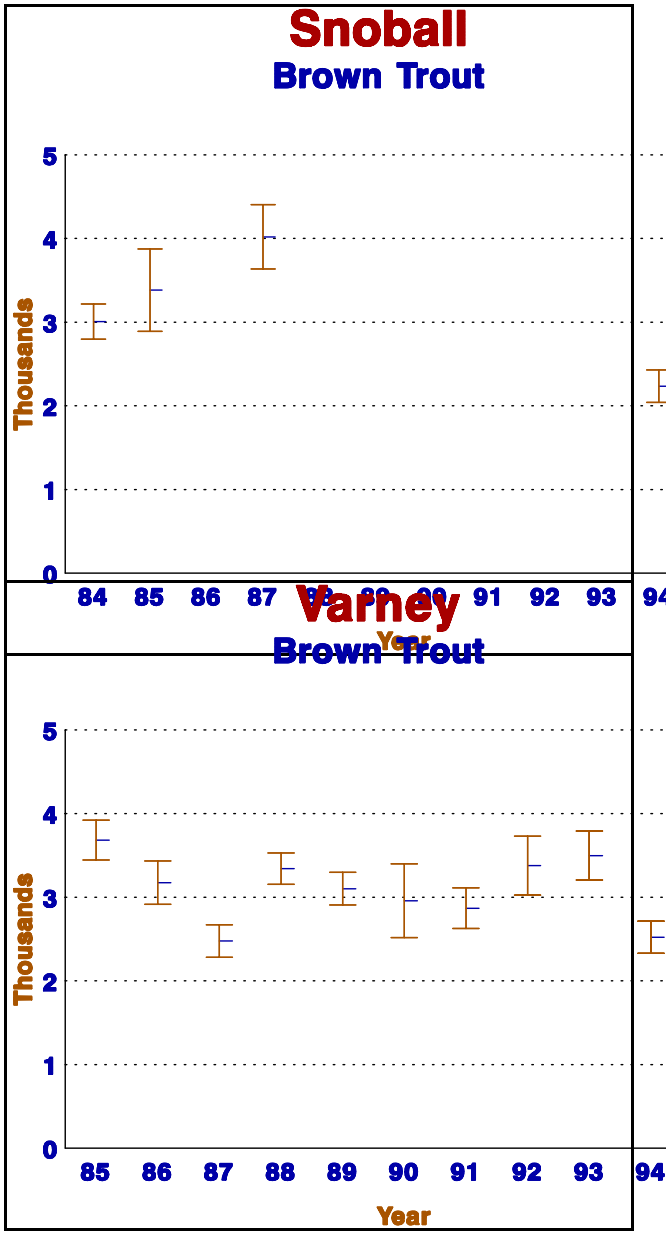
APPENDIX B.

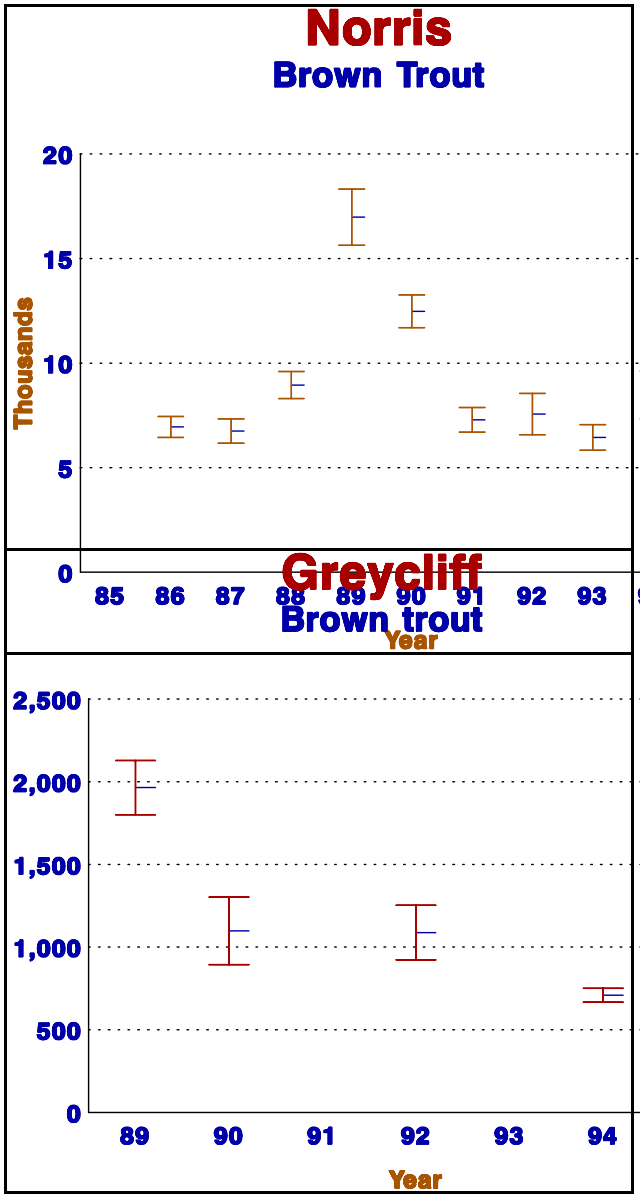
POPULATION ESTIMATES OF AGE 2 & OLDER RAINBOW TROUT AND BROWN TROUT IN THE MADISON RIVER ±80 PERCENT CONFIDENCE INTERVALS.


Pine Butte
Rainbow Trout
Thousands
0
1
2
3
4
5
6
7
85
86
87
88
89
90
91
92
93
94
Year
Snoball
Rainbow Trout
Thousands
0
2
4
6
8
84
85
86
87
88
89
90
91
92
93
Year


Varney
Rainbow Trout
3,500
3,000
2,500
2,000
1,500
1,000
500
0
85
86
87
88
89
90
91
92
93
94
Year
Norris
Rainbow Trout
Thousands
12
10
8
6
4
2
0
85
86
87
88
89
90
91
92
93
94
Year


Greycliff
Rainbow trout
1,600
1,400
1,200
1,000
800
600
400
200
0
89
90
91
92
93
94
Year
Pine Butte
Brown Trout
Thousands
6
5
4
3
2
1
0
85
86
87
88
89
90
91
92
93
94
Year


Snoball
Brown Trout
Thousands
5
4
3
2
1
0
84
85
86
87
91
92
93
Year
Varney
Brown Trout
Thousands
5
4
3
2
1
0
85
86
87
88
89
90
91
92
93
94
Year


Norris
Brown Trout
Thousands
20
15
10
5
0
85
86
87
88
89
90
91
92
93
94
Year
Greycliff
Brown trout
2,500
2,000
1,500
1,000
500
0
89
90
91
92
93
94
Year

APPENDIX C.

TEMPERATURE RECORDINGS FROM MONITORED SITES ALONG THE MADISON RIVER.

Appendix Table C1. Maximum daily temperature (°F) during fall stepdown, Madison River drainage, September 17-21, 1995.

Site	9/17	9/18	9/19	9/20	9/21
Quake outlet[1/]	60.40	59.83	58.42	57.85	57.29
Slide Store[3/]	61.79	62.65	51.11	39.09	49.72
Kirby	60.76	61.61	58.49	55.97	58.20
West Fork	53.66[2/]	55.06	51.71[2/]	47.52[2/]	46.69
WF Camp[3/]	67.57	59.50	50.28	39.09	50.56
McAtee Bridge	60.15	61.85	57.32	52.03	57.04
Ennis Bridge	60.12[2/]	60.41	54.52[2/]	51.17[2/]	54.52
Ennis[3/]	73.22	62.36	51.39	46.93	56.41
Nest	60.05	60.34	53.05[2/]	50.27	53.33
Inlet	60.30	60.58	53.56[2/]	50.50	53.56
Dam[1/]	61.75	61.46	60.89	56.36	53.57
Powerhouse[4/]	70.82	62.66	47.81	46.15	56.43
Beartrap	62.82	61.97	59.13[2/]	55.47[2/]	55.20
Norris	62.65	61.50	58.66	55.04	55.32
Norris[4/]	69.91	62.64	48.05	45.00	51.39
Black's Ford	63.36	61.64	57.95	54.88	56.26
Greycliff	63.50	62.07	57.82	55.04	56.70
Cobblestone	63.64	61.92	57.94	55.16	56.54
Three Forks[4/]	79.91	64.84	51.30	52.69	65.71
Headwaters	63.06[2/]	61.35[2/]	56.82[2/]	54.04[2/]	54.85

[1/] The Quake Lake outlet and Ennis Dam sites showed relatively continuous declines over the period, not exhibiting a diurnal cycle.

[2/] Higher temperatures were measured in the early morning hours (0000-0200 hrs), but were "residual" from the previous day.

[3/] FWP air temperature monitoring locations

[4/] MPC air temperature monitoring locations. Data provided by MPC Environmental Division.