MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS
FISHERIES DIVISION

JOB PROGRESS REPORT

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Job. No:	I-h	**Job Title:**	UPPER BIGHORN RIVER INVESTIGATIONS

Project Period: April 1, 1990 - March 31, 1991

ABSTRACT

Bighorn River flows and water temperatures improved in 1990 from drought levels experienced in 1988 and 1989. A river ranger position was initiated on the Bighorn in the spring of 1990. This river ranger interviewed over 4,500 anglers between May and October and an additional 500 anglers during the winter months. Fishing pressure in 1990 was similar to the high levels recorded in 1988 and 1989. Average catch rates declined from record levels but were still very good. The angling population on the Bighorn continued to shift toward nonresident, catch-and-release fishermen. Nonresidents comprised 78% of the anglers surveyed between May and October. Anglers kept just over 2% of the fish caught during this time.

The brown trout population started to rebound from the low levels recorded at the end of 1989. Most of the improvement in populations in both shocking sections was due to a strong age 1 year class. High mortality rates observed for older brown trout in both sections accounted for a significant decline in older brown trout in the upper river between 1989 and 1990. Movement of 3 year old fish into the lower section kept the population of 3 year old and older brown trout fairly constant in the lower river. The decline of large predatory brown trout apparently allowed excellent survival of small brown trout even with marginal summer flows. The continued loss of older brown trout along with the strong age 1 year class resulted in a complete shift in the brown trout population structure in the upper river.

The rainbow trout population in the Bighorn continued to grow in 1990. The total population in the upper 12 miles of river declined from record 1989 levels due to a poor age 2 year class and downstream movement of 1 year old fish. Rainbow from the 1987 year class, which appeared to be a weak year class in both 1988 and 1989, moved into both shocking sections in 1990 and became a dominant year class. A record age 1 year class in the lower section, combined with the strong 1987 year class to produce a rainbow population almost twice as large as the next highest estimate. For the first time, the number and biomass of age 1 and older rainbow exceeded the number and biomass of brown trout in the lower shocking section.

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OBJECTIVES AND DEGREE OF ATTAINMENT

1. To maintain a year around minimum flow in the upper Bighorn River of at least 2,000 cfs in eight out of 10 years and at least 2,500 cfs in five out of 10 years.

   Flow conditions improved in 1990 over the poor flows seen in 1988 and 1989. Flows remained very near or above the minimum recommended flow of 2,000 cfs throughout the period.

2. To eliminate gas bubble trauma as a significant cause of trout mortality.

   Continued to work with the Bureau of Reclamation on this problem. Some renewed interest in fitting the Afterbay with a hydropower generator which would also reduce supersaturation.

3. To maintain average population densities of 5,000 to 7,000 age one and older brown trout and at least 500 18-inch and longer brown trout per mile in the Bighorn River upstream of Bighorn Fishing Access Site (FAS), and to maintain 1,500 to 2,500 age one and older brown trout per mile between Bighorn FAS and Two Leggins FAS.

   Brown trout populations improved in both sections in 1990. The desired population level of brown trout was reached in the upper section, but populations remained below the desired level in the lower section. The number of 18-inch and longer brown trout declined in the upper section.

4. To maintain average population densities of at least 1,000 age one and older rainbow trout and 150 18-inch and longer rainbow trout per mile in the Bighorn River upstream of Bighorn FAS, and to maintain at least 500 age one and older rainbow trout per mile between Bighorn FAS and Two Leggins FAS.

   The rainbow fishery continued to improve in the Bighorn River. The rainbow population dropped below the desired level in the upper section due to downstream movement of age 1 fish, but a strong population of age 1 fish in the lower section brought the population density in this section well above the desired management level. The management objective of 150 18-inch and longer rainbow per mile was exceeded in both shocking sections with the upper section containing four times this number.

5. To redistribute angler use to achieve use levels of no more than 3,000 angler-days per month above Bighorn FAS and at least 10,000 angler-days annually between Bighorn and Two Leggins FAS (state funded).

Angler use appeared to level off some in 1990, but use continued to exceed 3,000 angler-days per month during late summer. Little increased use was documented at the lower fishing access site.

6. To make at least 750 creel census contacts per year to assess angler success and opinions (state funded).

   Over 4,500 anglers were contacted on the Bighorn River in 1990. Complete creel census data were collected from each contact.

PROCEDURES

The study area, consisting of the Bighorn River in south central Montana from Yellowtail Afterbay Dam downstream to Two Leggins Fishing Access Site, has been described previously (Fredenberg 1984) (Figure 1). River miles (RM) denoted in this report refer to distance downstream from the Afterbay Dam.

Fishing pressure estimates for the Bighorn River were calculated from car counter data taken at Bighorn FAS according to methods developed during the Bighorn River creel census (Fredenberg 1985b). Fishing pressure in the upper 12 mi of the river was estimated using the equation $y + 1.09x - 55.57$, where y = angler-days of use and x = 1/2 the car count. Pressure was calculated for monthly intervals.

A river ranger position was initiated on the Bighorn River in the spring of 1990. This position had two major objectives: 1) to be a highly visible representative of the Department while he collected attitude and opinion information from the anglers on the river; and 2) to conduct a general creel census.

The ranger used a 17 foot square-end canoe equipped with an electric trolling motor to float from Afterbay access to Bighorn access, and interviewed as many anglers as possible. Floating dates were randomly selected by choosing four weekdays and three weekend or holidays out of each two-week period. Thirty-nine week days and 29 weekend and holidays were sampled between May 8 and October 25.

Each angler was interviewed on an individual basis, and asked a number of standard questions concerning time fished, number of fish caught and released, residence, access areas used and if the trip was guided or not. Appendix A contains a sample of the questionnaire used and a key for the different questions. In addition to the standard questions, each new angler was asked one open question designed to give them an opportunity to comment on anything they wanted to about fishing on the Bighorn. All data collected by the river ranger was entered into a computer and analyzed using D-Base III+.

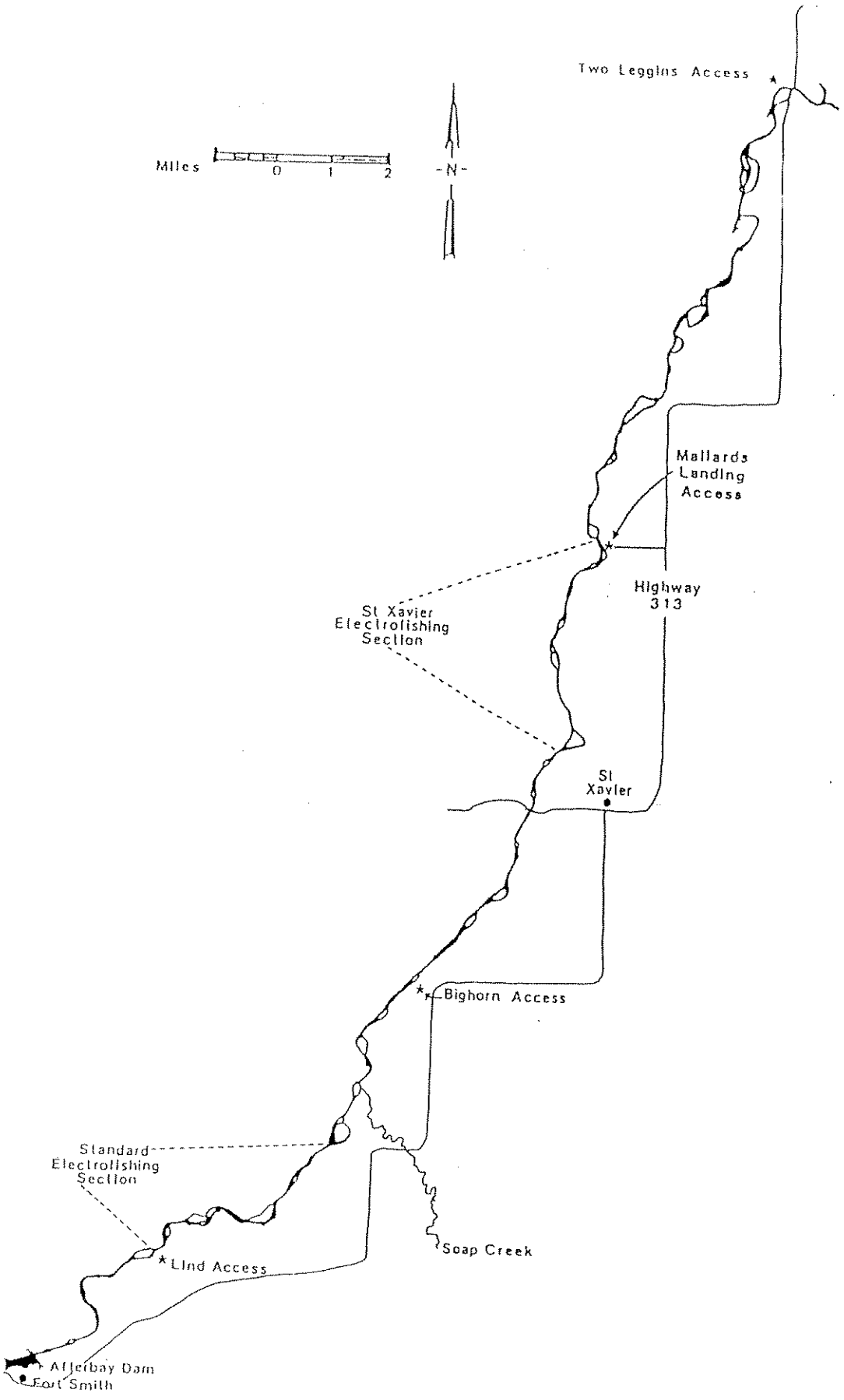

Figure 1. Map of the upper Bighorn River showing location of electrofishing sections.

In addition to the standard May-October field season, anglers were interviewed on 17 days during the winter and early spring using the same survey format. During this period, the river ranger was paid with outside funds provided by the local chapter of Trout Unlimited (Magic City Fly Fishers) and two fly shops located in Fort Smith, Quill Gordon and the Bighorn Trout Shop. Survey days were selected based on weather, and most surveys were conducted on weekends. Most of these surveys were conducted at Three Mile or Bighorn accesses as anglers were completing their trips.

Boater registration stations were installed at Afterbay, Lind Ranch and Bighorn accesses on June 12, 1990 and maintained through the rest of the year. Each station had a sign asking floaters to fill out a voluntary registration form before starting their float. The questionnaire asked the launch and take out points for the trip, if the trip was guided and the number of days the party planned to spend on the Bighorn. A question on the river ranger's survey was used to determine what percent of the floaters actually registered.

Electrofishing on two sections (Figure 1) of the Bighorn River was conducted during daylight using a fixed-boom electrofishing boat powered by an outboard jet engine. The electrofishing apparatus was a Coffelt VVP-15 powered by a 6,500 watt Onan generator. Generally, the controls were set on mid-range at about 100 pulses per second and 50% pulse width, producing about 2,500 W of power at an output of 250 V and 10 amps.

Generally, four marking and four recapture runs were completed by alternating daily between the left and right banks. Flows were too low during 1990 to work most of the side-channels. Both banks were occasionally electrofished on the same day in the lower (Saint Xavier) section. About 10 days were allowed between mark and recapture.

Typically, in all sections 300-1,000 trout were handled in a day of electrofishing. All fish were measured to the nearest 0.1 in and weighed on a standard spring platform scale. Ten fish scale samples were taken per 1/2 in size group, from an area above the lateral line posterior to the dorsal fin. Samples were mounted on acetate sheets with the impressions read on a microfiche reader at 43X.

Population estimates were obtained using a computer program developed by the MDFWP which utilizes standard Petersen mark-recapture calculations.

Bighorn River water temperatures were monitored with a Taylor 30-day recording thermograph located in the U.S. Geological Survey (USGS) gauge house on the right bank 200 yards downstream from the Afterbay Dam. Flow records from the site were obtained from the USGS.

RESULTS AND DISCUSSION

Stream Flow

Flows in the Bighorn river in 1990 were considerably better than those seen in 1988 or 1989, but were still near the lower end of the flow levels recorded in the past (Table 1). Mean daily flows fluctuated between 1,950 cfs and 2,000 cfs during most of June and the first half of July. Mean daily flows dropped below 1,600 cfs for about 10 days in late September. Otherwise flows remained above the minimum target flow of 2,000 cfs. The highest flows occurred in January with a mean monthly flow of 3,135 cfs.

Water temperatures

Average summer water temperatures in the Bighorn River remained slightly colder than normal in 1990, but improved considerably from the low levels recorded in 1988 and 1989 (Table 1). Water temperatures reached 57°F the last three days of August and remained at or above this temperature through most of October. The maximum temperature of 60°F was only reached for three days during the first week of October.

Gas Supersaturation

Gas supersaturation levels remained low during 1990 and visible symptoms of gas bubble trauma were rare. The Bureau of Reclamation continued to use the radial gates in the afterbay dam as much as possible to keep supersaturation levels down.

Fishing Pressure

Fishing pressure continued to be very heavy on the Bighorn in 1990; however, no good estimates of total pressure were obtained. According to data collected at the Bighorn Access car counter and the formula developed from the 1982-1983 creel census data (Fredenberg 1985b), there were 16,549 angler-days of use on the upper 12 miles in 1990. This estimate was very close to the use levels calculated from this car counter in both 1988 and 1989 (Frazer 1990). Although these estimates are no longer accurate, they do provide trend data that can be compared to previous years.

Table 1. Maximum summer water temperature, mean summer water temperature (July-September), and mean daily summer discharge (July-September) at the Afterbay Dam on the Bighorn River during 1966-1990.

Year	Maximum Summer Temperature (°F)	Mean Summer Temperature (°F)	Mean Daily Summer Discharge(cfs)
1966	62	55.2	1,241
1967	69	64.0	8,713
1968	62	58.3	2,990
1969	61	52.5	3,869
1970	62	54.0	3,754
1971	64	60.7	3,972
1972	62	60.2	3,434
1973	58	52.3	3,400
1974	65	60.6	4,334
1975	65	60.0	5,932
1976	60	57.7	3,017
1977	50	43.8	1,896
1978	65	60.0	6,745
1979	59	51.5	2,950
1980	62	56.2	3,740
1981	60	57.0	2,751
1982	65	58.0	4,747
1983	67	63.1	5,879
1984	64	59.3	3,876
1985	53	46.9	1,999
1986	67	63.5	4,306
1987	60	67.5	2,112
1988	56	47.9	1,766
1989	59	50.9	1,572
1990	60	53.1	2,036
MEAN	61.5	56.6	3,641

Frazer (1990) discussed in detail the problems associated with using this car counter data, especially the establishment of additional accesses since the formula was calculated. Many anglers continued to use private accesses in 1990. They were not counted in the car-counter estimates. Over 49% of the guided anglers and almost 23% of the non-guided anglers interviewed by the river ranger during the spring, summer and fall indicated they were pulling out at one of the three private accesses upstream of Bighorn Access. Overall, 34.9% of the boat fishing anglers that were interviewed by the river ranger and 34.6% of the anglers that filled out boater registration forms indicated they were pulling out at one of these three accesses.

If the angler use value calculated from the car counter data was expanded by 35% it would give an estimated use of 22,341 angler-days for 1990. Although still unreliable, this estimate is closer to the true use value than the estimate calculated from the Bighorn car counter data.

Overall use in 1990 appeared to be comparable to levels seen in 1989. August and September were again peak use months with 3,176 angler-days calculated from the Bighorn car counter in September. This compares to 3,205 angler-days in August and 3,098 angler-days for September calculated in 1989. October use appeared to be down from 1988 and 1989. A peak of 1,771 angler-days was calculated for October 1989 using the Bighorn car counter. In 1990 this level dropped to 1,310 angler-days.

River Ranger Survey and Creel Census

During 1990 the river ranger interviewed 4,598 anglers from 2,250 parties during 68 days between May 8 and October 25. These anglers fished 19,357.5 total hours for an average of 4.2 hours per angler. Since most of these interviews were conducted while floating the river, very few were completed trips.

Interviewed anglers caught 11,329 brown trout and 3,234 rainbow trout for an overall catch rate of 0.75 fish per hour. This rate was down over 25% from the maximum average catch rate of 1.02 fish per hour recorded in 1988. Guided anglers caught an average of 0.88 fish per hour compared to 0.69 fish per hour for non-guided anglers.

The trend continued towards an increasing percentage of nonresident, catch-and-release fly fisherman. Of 14,563 trout reported caught, only 309 or 2.2% were kept. The average angler kept less than 0.07 fish. This compared to an average harvest rate of 0.54 fish per angler reported in 1988 (Frazer 1990). In 1990, 1,011 resident anglers kept 8.3% of the fish they caught compared to 0.89% kept by 3,587 nonresident anglers.

Nonresident anglers accounted for 78% of the anglers surveyed in 1990 (Table 2), as compared to 64% nonresidents recorded in 1988. Figure (2) shows the distribution of angler residence by month for 1990. Nonresident anglers comprised 73.7% of the anglers in June and 81.3 % of the anglers in August. Sixty-seven percent of the nonresident anglers came from 12 states. These states in order of most participation were: CO, CA, PA, WY, MN, WI, NY, NJ, ID, SD, AZ, and NM.

Table 2. Residency of anglers interviewed on the Bighorn River between May 8, 1990 and October 25, 1990.

Angler Residence	Number Of Anglers	Percent of total	Percent Resident vs Non-Resident
Local (Ft Smith-Hardin area)	139	3.0	
Billings (area)	539	11.7	22
Resident (rest of state)	333	7.2	
Non-resident (From U.S.)	3,538	76.9	78
Non-resident (Outside U.S.)	49	1.1	
Total	4,598		

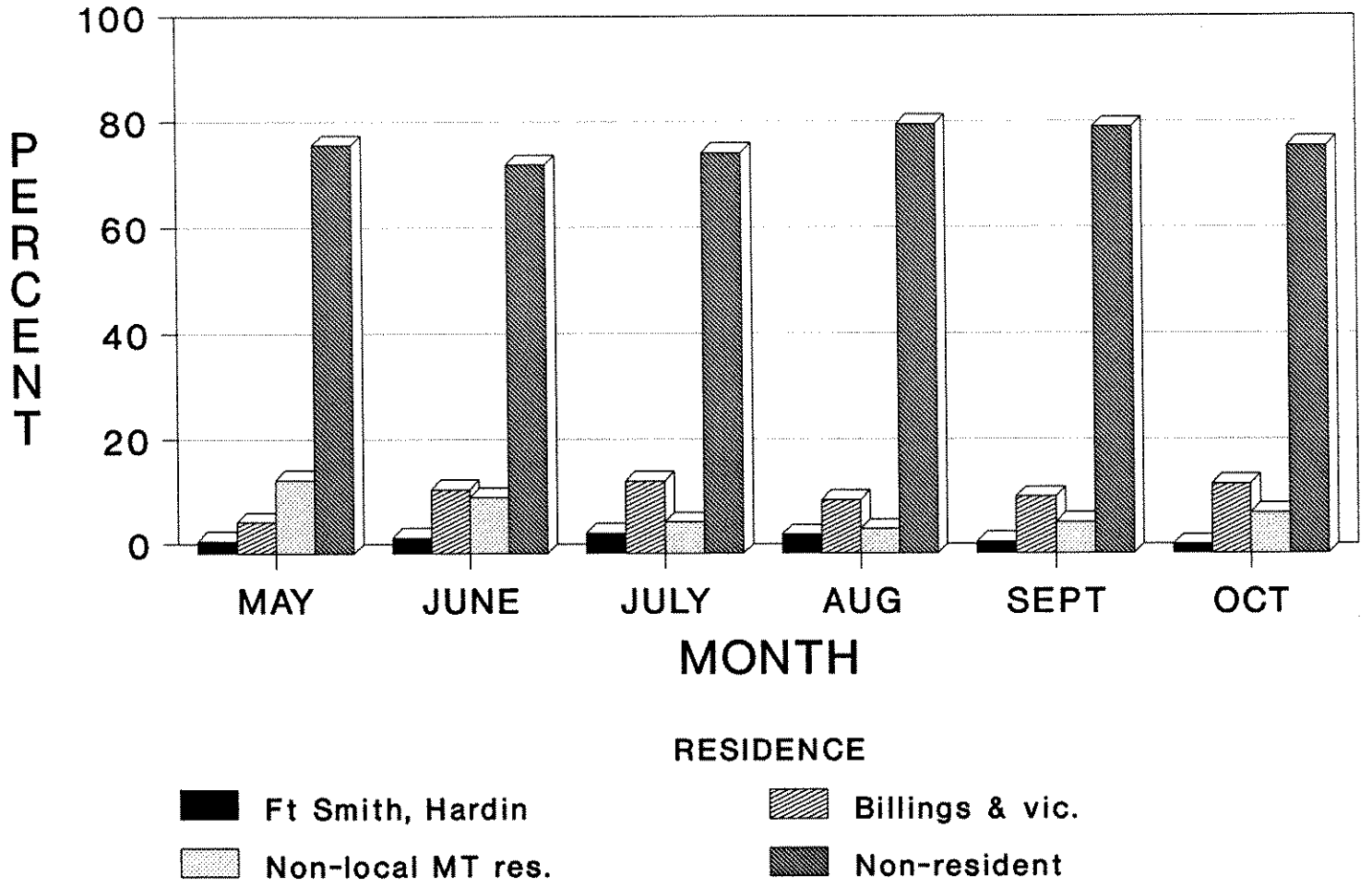

Figure 2. Monthly distribution of angler residence for anglers fishing the Bighorn River during 1990.

Thirty-four percent of all interviewed anglers were fishing with a guide in 1990. Forty-one percent of nonresident anglers were fishing with a guide. In 1988, 25% of the parties interviewed were fishing with a guide (Frazer 1990). The number of anglers using a guide during part of their trip was undoubtedly higher than this, because many anglers hired a guide for a day or two then fished several more days without a guide. If these anglers were interviewed during the later part of their trip they were counted as non-guided.

Almost 92% of all interviewed anglers were strictly fly fishermen, with over 98% of guided anglers being fly fishermen.

The open question "If you could change one thing about fishing on the Bighorn River, what would you change?" was asked to each angler the first time they were contacted by the river ranger. This question was designed to give each angler a chance to comment on anything he wanted concerning fishing on the Bighorn. Of the 3,577 anglers asked this question, 1,572 (44.1%) had no comment. The most common response from the 1,995 anglers who did answer the question (762 anglers or 38%) was that they wouldn't change a thing. For the second most common answer, 459 anglers (23%) said they would like to see fewer people on the river. Another 7.4% (149 anglers) said we should limit the number of guides and outfitters on the river or limit the number of boats on the river. The other common response was a request for stricter regulations. Two hundred and nineteen anglers (10.9%) said they would like to see catch-and-release only or reduced limits or slot limits on brown trout.

Slightly different results were obtained during the winter interviews. The river ranger interviewed 497 anglers during 17 days between November 12, 1990 and April 27, 1991. Most of these interviews were conducted at the boat ramp at the end of completed trips. These anglers fished a total of 2,308 hours. They caught 1,205 brown trout and 386 rainbow. The overall catch rate was 0.69 fish per hour, the same as was calculated for non-guided anglers during the summer. Anglers interviewed during the winter kept a total of 241 fish or 15% of the fish caught.

A majority of the anglers interviewed during the winter were Montana residents. Forty-two percent were from the Billings, Hardin, Fort Smith area. Another 27% were from other parts of Montana. Only 31% were non-resident anglers, yet anglers from 20 different states, besides Montana, were interviewed during the 17 days. Only 21 anglers (4.2%) were using guides the day they were interviewed.

Of the 377 anglers who were asked the open question concerning fishing the Bighorn, 63% had no comment and another 13% said they wouldn't change a thing. Just over 14% responded they wanted to see fewer people, or that the number of guides and outfitters or boats should be limited.

Brown Trout

Standard Section

The brown trout population in the standard electrofishing section (Figure 1) increased slightly in 1990 to 5,732 age 1 and older fish per mile, up from 4,601 per mile in 1989. This increase was entirely due to a very strong age 1 year class in 1990. The lingering effects of the low flows experienced in 1988 and 1989 combined with the strong 1989 year class resulted in a complete shift in the brown trout population structure in 1990 (Figure 3). Since sampling began in 1981 there has been a trend towards increasing dominance of age 2 and 3 brown trout in the population (Table 3). Both 1988 and 1989 brown trout populations were dominated by age 3 fish with few 1 year old fish. This trend reversed in 1990. While weak 1987 and 1988 year classes resulted in low numbers of 2 and 3 year old fish, a strong 1989 year class produced a dominant age 1 population. Age 2 and older fish comprised over 77% of the brown trout population in the standard section in 1989. In 1990 68% of the brown trout population consisted of age 1 fish.

Table 3. Estimated number of brown trout per mile in the standard electrofishing section (RM 3.8-8.0)* of the Bighorn River during fall 1981-1990.

Age	12/81	12/82	9/83	9/84	9/85	9/86	9/87	9/88	9/89	9/90
0	7,198	4,952	7,312	--	--	--	--	--	--	--
1	922	1,957	2,526	4,468	2,294	2,787	1,537	685	873	3,905
2	870	954	1,024	2,103	1,615	2,948	3,518	1,861	1,002	808
3	183	267	519	871	909	1,036	3,219	2,585	2,550	1,004
4+	243	190	117	203	428	260	184	97	156	15
Total (1+)	2,218	3,368	4,186	7,645	5,246	7,031	8,458	5,228	4,601	5,732

*RM 2.4-9.6 for 1981-1987.

The composition of the brown trout population has gone through a complete cycle since annual sampling began in 1981 (Figure 4). In the early to mid 80's, age 1 brown trout dominated the population. As these fish matured, dominance shifted to age 2 and then age 3 fish. In 1990 dominance shifted back to age 1 fish.

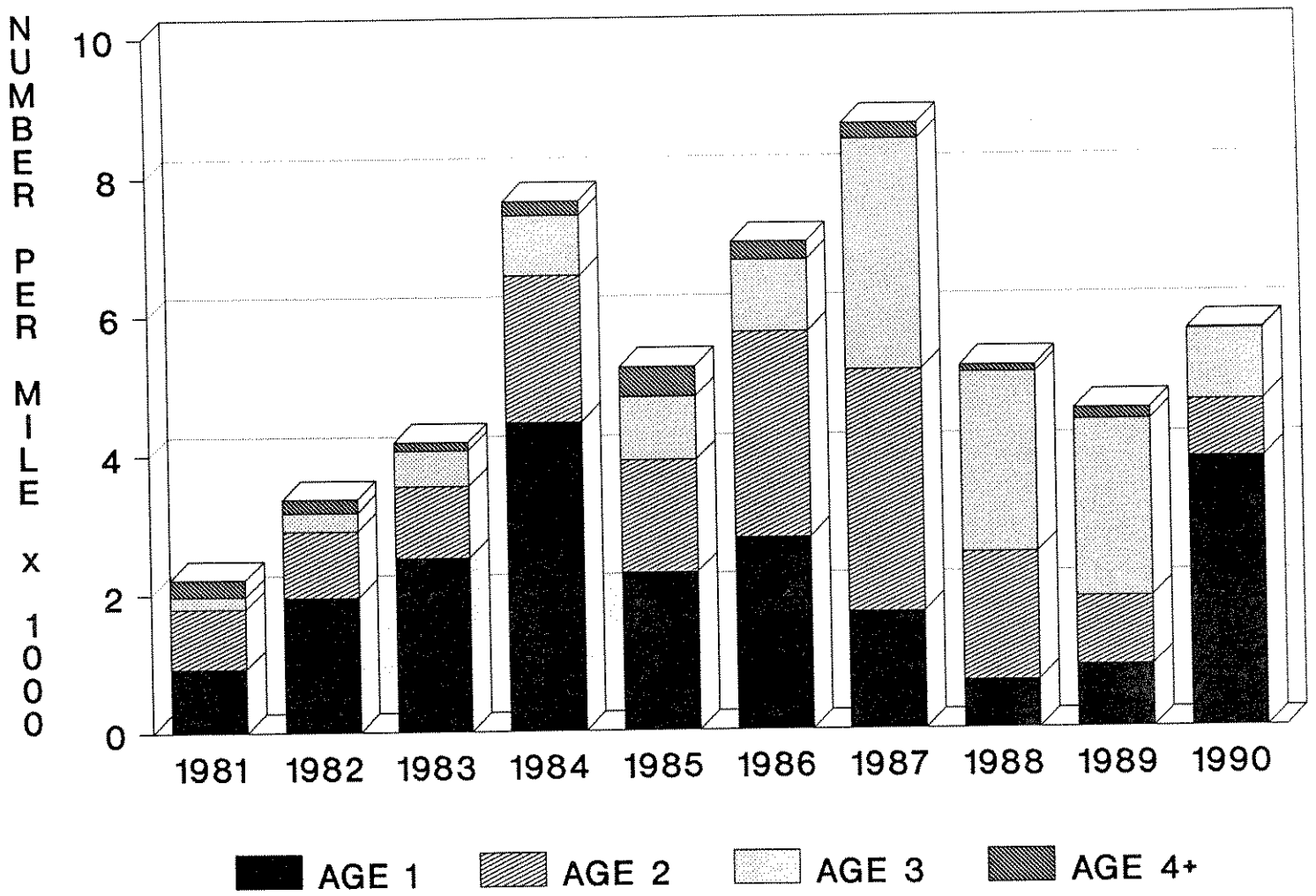

Figure 3. Estimated number (and age composition) of brown trout in the standard electrofishing section RM 3.8-8.0* of the Bighorn River during fall 1981-1990.

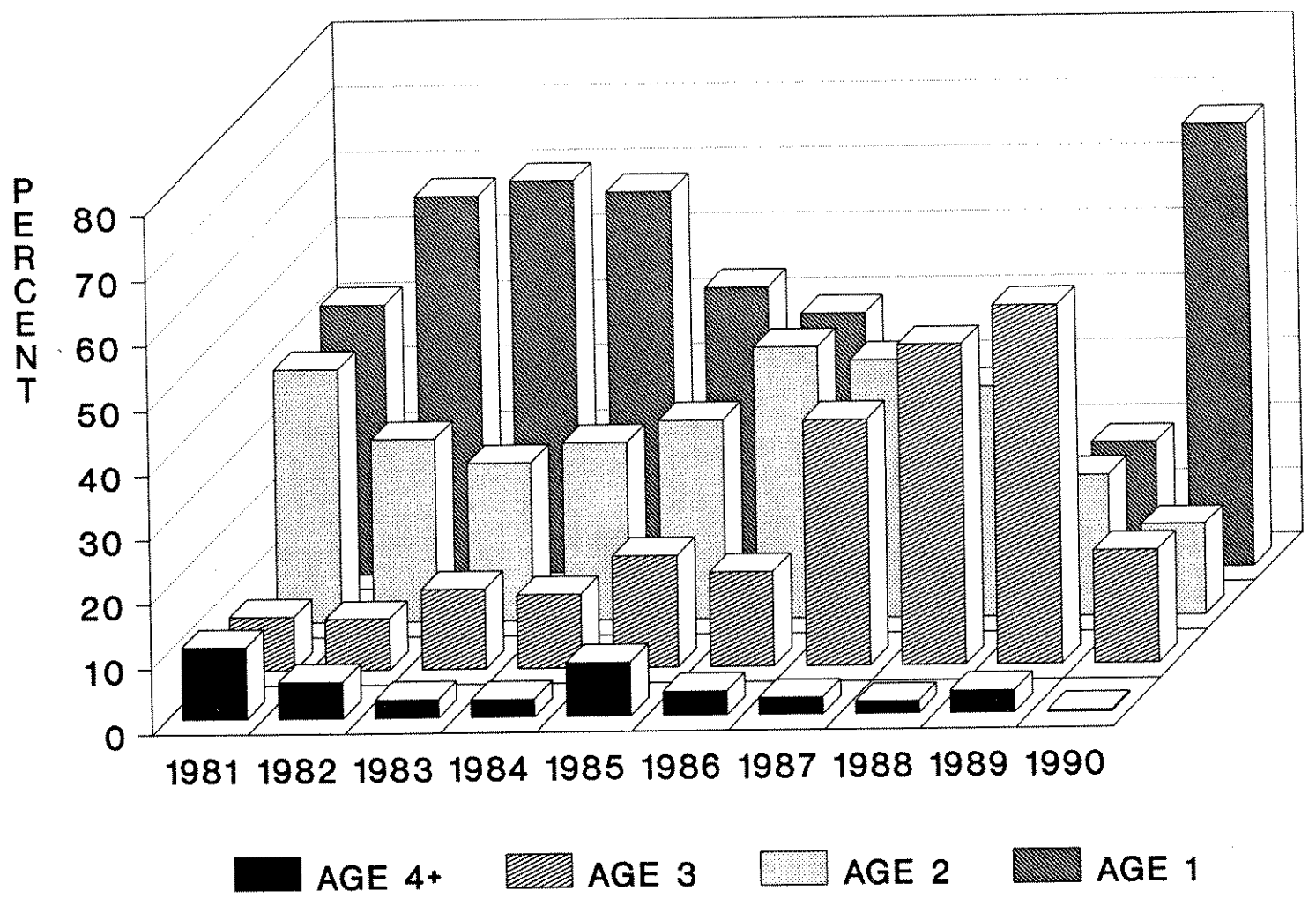

Figure 4. Percent age composition of the brown trout population sampled in the standard electrofishing section of the Bighorn River during the fall 1981-1990.

Mortality rates of age 3 and older brown trout were very high between 1989 and 1990 (Table 4). Over 99% of the age 3 fish were lost between September 1989 and September 1990, and no brown trout over 4 years old were sampled in 1990. On the other hand, the populations of age 1 and 2 brown trout remained almost constant from 1989 to 1990. Frazer (1990) discussed the probability that 1 and 2 year old brown trout moved into the shocking section between sampling periods in 1988 and 1989. This type of movement may have been responsible for masking any mortality that did occur in these younger age classes between 1989 and 1990. The combined mortality for all age classes was 60.3% between September 1989 and September 1990. which was quite high when compared to historic records (Table 4). Without the strong age 1 year class in 1990, the brown trout population would have continued to decline below the low level recorded in the fall of 1989.

Table 4. Comparison of estimated annual mortality rates (percent change) for brown trout in the standard electrofishing section (RM 3.8-8.0)* of the Bighorn River from 1981-1990. Age class indicated is age at beginning of time interval.

Age Class	12/81-12/82	12/82-9/83	9/83-9/84	9/84-9/85	9/85-9/86	9/86-9/87	9/87-9/88	9/88-9/89	9/89-9/90
1	+ 3.4	-47.7	-16.7	-63.7	+28.5	+26.2	+21.1	+46.3	-10.0
2	-69.3	-45.6	-14.9	-56.8	-35.9	+ 9.2	-26.5	+37.0	+ 0.2
3	-42.4	-69.7	-63.4	-58.8	-75.7	-92.9	-97.0	-94.0	-99.4
4 and Older	-65.3	-81.2	-88.5	-68.0	-90.8	-97.6	-92.4	-73.0	- 100
Total	-36.4	-50.7	-24.1	-61.4	-75.2	- 1.6	-46.3	-29.1	-60.3

*RM 2.4-9.6 for 1981-1987.

As in the past, environmental factors such as flow, available habitat, population densities and predation appeared to be the major factors controlling the brown trout population levels in the Bighorn River in 1990. Previous reports have discussed the effects of many of these environmental factors (Frazer 1990; Fredenberg 1985a, 1987). The interaction of several of these factors were responsible for the shift seen in the brown trout population in 1990.

Despite record low flows during the summer of 1989, flow conditions were near optimum for brown trout production during the fall of 1989 and spring of 1990. Flows began to improve by late October when brown trout were starting to spawn, and by mid-November, the flows were above the minimum optimum flow of 2,500 cfs. Flows stayed at or above 2,500 cfs through the peak of emergence in mid-April 1990.

A second factor contributing to the strong age 1 year class was the major decline in numbers of larger brown trout between 1989 and 1990. Frazer (1990) discussed the problem of predation during 1988 and 1989 when low flows forced small brown trout into the main channel habitat with a large population of big brown trout. Along with a reduced number of larger brown trout in 1990, improved flows provided more rearing habitat in shallow shoreline and side channel areas where small brown trout could escape predation.

There appears to be some flow dependent level at which the number of large brown trout becomes a controlling factor on the survival rate of small brown trout in the Bighorn River. Figure 3 (p18) helps illustrate this relationship. Between 1981 and 1984 the number of age 1 brown trout continued to increase each year along with increasing numbers of larger brown trout. Up to this point, increasing numbers of larger browns meant more spawners, but flows were good and the small brown trout had plenty of rearing habitat where they could avoid predation. The number of age 2 and older brown trout remained almost constant between 1984 and 1985. Flows remained excellent for spawning and emergence during the fall of 1984 and the spring of 1985, but then summer flows dropped to under 1,500 cfs, forcing small brown trout into the main channel with the larger fish. The population of age 1 brown trout was down in the fall of 1985. Since spawning and emergence flows were excellent, it appears that predation had a major impact on the 1984 year class during the low flow period. Spawning and emergence flows for 1986 were fair, but not nearly as good as in 1985, but 1986 summer flows were excellent. The number of large brown trout increased significantly between 1985 and 1986, yet the 1986 age 1 population was larger than the 1985 population. Even though the number of large brown trout had increased, summer flows apparently were high enough to disperse fish, and predation on small brown trout was low. Spawning and emergence flows as well as summer flows were good in 1987, but the fall estimate of age 1 brown trout declined to the second lowest level recorded since shocking began. Apparently the population of large brown trout had reached the critical level where predation became a major problem even with good summer flows. During 1988 and 1989 the population of large brown trout remained high and summer flows were low. This again forced the small brown trout into the main channel with a large population of predators. Fall estimates of age 1 fish were very low both years. The 1989 - 1990 spawning and emergence flows were very good but summer flows were only fair, yet the age 1 population in 1990 was the second largest population of 1 year old fish estimated since sampling began. Apparently the population of larger brown trout declined to a level where predation was no longer a serious problem even with marginal summer flows.

The relationship between density of smaller (especially age 2) brown trout and the mortality rate of age 4+ fish was discussed in detail in Frazer (1990). This relationship became more complicated in 1990. The numbers of age 2 and 3 brown trout decreased significantly between 1989 and 1990 yet the mortality of age 4+ brown trout increased to near 100%. Although natural mortality has

always been quite high in the Bighorn once brown trout reached 4 years of age, it appeared the strong 1989 year class may have played a role in the extremely high mortality observed in 1990. These fish averaged 7.6 inches long in the fall and were capable of competing with the larger brown trout for the small insects that provide the major food base on the upper Bighorn River. Even these smaller fish, when present in high enough numbers, can apparently have a major impact on the survival rate of large brown trout. Another factor to be considered in this relationship was the increasing rainbow population in the river during the past couple of years.

Despite the major shift towards younger fish, the number of "trophy" sized (18 inches and greater) brown trout remained quite high in 1990 at 324 per mile. This number was well below the management goal of 500 per mile, down from 412 per mile recorded in 1989, but still higher than the number found in 1988. This was due primarily to good growth rates observed in 3 year old fish. Their average length of 18 inches put many of them in the trophy size category.

Past reports have discussed the role of angler harvest on brown trout mortality in the Bighorn River (Frazer 1990; Fredenberg 1985a, 1987). Environmental factors such as flow, water temperature and fish population levels appear to have a much greater influence on population changes than does angler harvest. The 1990 river ranger data helped reinforce this idea. Based on interviews, only 3.4% of the 16,154 fish reported caught between May 1990 and April 1991 were actually kept by anglers. Concern has been expressed that local anglers fishing during the off season harvest large numbers of fish from the Bighorn River. Harvest rates did increase during the winter, but still remained quite low. Only 15% of 1,591 trout reported caught by anglers interviewed between November 12, 1990 and April 27, 1991 were kept. During the peak months of May through October, only 2.2% of the trout caught were kept. This was despite a daily limit of five brown trout. Electrofishing data indicated a combined annual mortality of over 60% for age 1 and older brown trout between September 1989 and September 1990.

Brown trout growth rates were influenced by both water temperature and population densities in 1990. Summer water temperatures were warmer than in 1988 or 1989, but were still below the mean summer water temperatures recorded since the dam was closed (Table 1). These warmer temperatures, combined with the lower densities of older brown trout resulted in excellent growth rates for age 2 and 3 fish (Table 5). Age 2 fish started at a record low average length in 1989, yet their 1990 average length

was the largest recorded since 1984. The average size of 3 year old fish in 1990 was 0.1 inch shorter than the record average length for that age group recorded in 1981. The average length of 4 year old fish was within the normal range found over the past seven years. The 1 year old brown trout did not follow the same trend as the older fish. The average length of age 1 fish in 1990 was the shortest yet recorded. Competition between the large number of fish in this age group was probably a major factor in this slower growth. The estimated population of age 1 fish in 1984 was even larger than the 1990 population, yet these fish had a much better average length in the fall. The main difference appeared to be flow and water temperature. Flows in 1984 were much higher than in 1990 which provided more habitat, spread fish out, and reduced the problem of competition. The relationship between flow and water temperature has been discussed in detail in the past (Fredenberg 1986). The higher flows in 1984 resulted in warmer summer water temperatures which improved growth rates for the 1984 fish.

Table 5. Average length (in) by age class of brown trout from the standard electrofishing section (RM 3.8-8.0)* of the Bighorn River during September 1981-1990.

Year/Age	0	1	2	3	4	5+
1981	5.8	11.6	15.4	18.1	19.8	21.2
1982	5.1	11.0	15.4	17.8	20.0	20.8
1983	4.3	9.5	14.8	17.4	20.0	20.8
1984	-	9.4	14.3	17.6	19.2	21.9
1985	-	8.0	13.5	16.2	18.6	19.9
1986	4.1	8.0	13.0	16.8	19.4	21.2
1987	3.6	8.9	12.6	15.9	18.9	22.3
1988	-	9.8	13.6	16.8	18.1	21.3
1989	-	7.8	13.6	16.7	19.4	21.7
1990	-	7.6	13.7	18.0	18.9	-

*RM 2.4-9.6 for 1981 through 1987.

The average brown trout condition factor was up about half a point between 1989 and 1990, from 42.66 to 43.21. The majority of this increase was in fish from about 9 to 16 inches long. There was a slight decrease in the condition factor of the smaller fish, and the average condition factor of fish greater than 18 inches long was about the same both years.

Brown trout biomass in the standard section declined 41% between 1989 and 1990 from 7,049 to 4,168 pounds per mile. This reflected the shift in the composition of the brown trout population. In 1989 the age 3 fish comprised 69% of the total biomass with age 1 and 2 fish providing 25% of the biomass. In comparison, 47% of the estimated biomass in 1990 was age 1 and 2 fish. The 1990 biomass estimate was less than half the peak biomass level of 9,600 pounds of brown trout per mile reached in 1987. Frazer (1990) discussed the relationship between summer flows and biomass in the Bighorn River. A given volume of water will only support some maximum level of fish biomass. Declining water levels during the drought years of 1988 and 1989 resulted in a corresponding decline in biomass in the river. Due to the annual sampling schedule on the Bighorn, a change in biomass does not show up until the year following a change in flow (Figure 5). Based on this relationship, Frazer (1990) predicted one more year of declining biomass before any recovery was observed. This decline was evident in the fall of 1990. Looking at Figure 5 it appears there should be a significant increase in brown trout biomass by the fall of 1991 if conditions remain near normal.

Lower Section

The brown trout population in the St. Xavier shocking section (Figure 1) improved slightly from 1989 levels to 818 age 1 and older brown trout per mile (Table 6). This population level is still well below our management goal of 1,500 to 2,500 age one and older brown trout per mile. The 1990 estimate was the second lowest brown trout population estimate for this section since sampling began in 1984. The brown trout population level in this section has always been dependent upon the year class strength of age 1 fish. The major reason for the expanded population observed in the fall of 1990 was the improvement in the age 1 population (Figure 6). Two years of very poor flows in 1988 and 1989 resulted in a poor population of age 1 fish in the fall of 1989, which in turn resulted in the poorest age 2 population yet recorded in 1990.

Table 6. Estimated number of brown trout per mile in the lower (Saint Xavier) electrofishing section (RM 17.6-21.6) of the Bighorn River during September 1984-1990.

Age	9/84	9/85	9/86	9/87	9/88	9/89	9/90
1	1,538	698	1,046	633	767	168	477
2	558	622	409	488	366	143	80
3	234	185	212	221	208	199	244
4+	42	63	40	49	75	63	17
Total (1+)	2,372	1,568	1,707	1,391	1,416	573	818

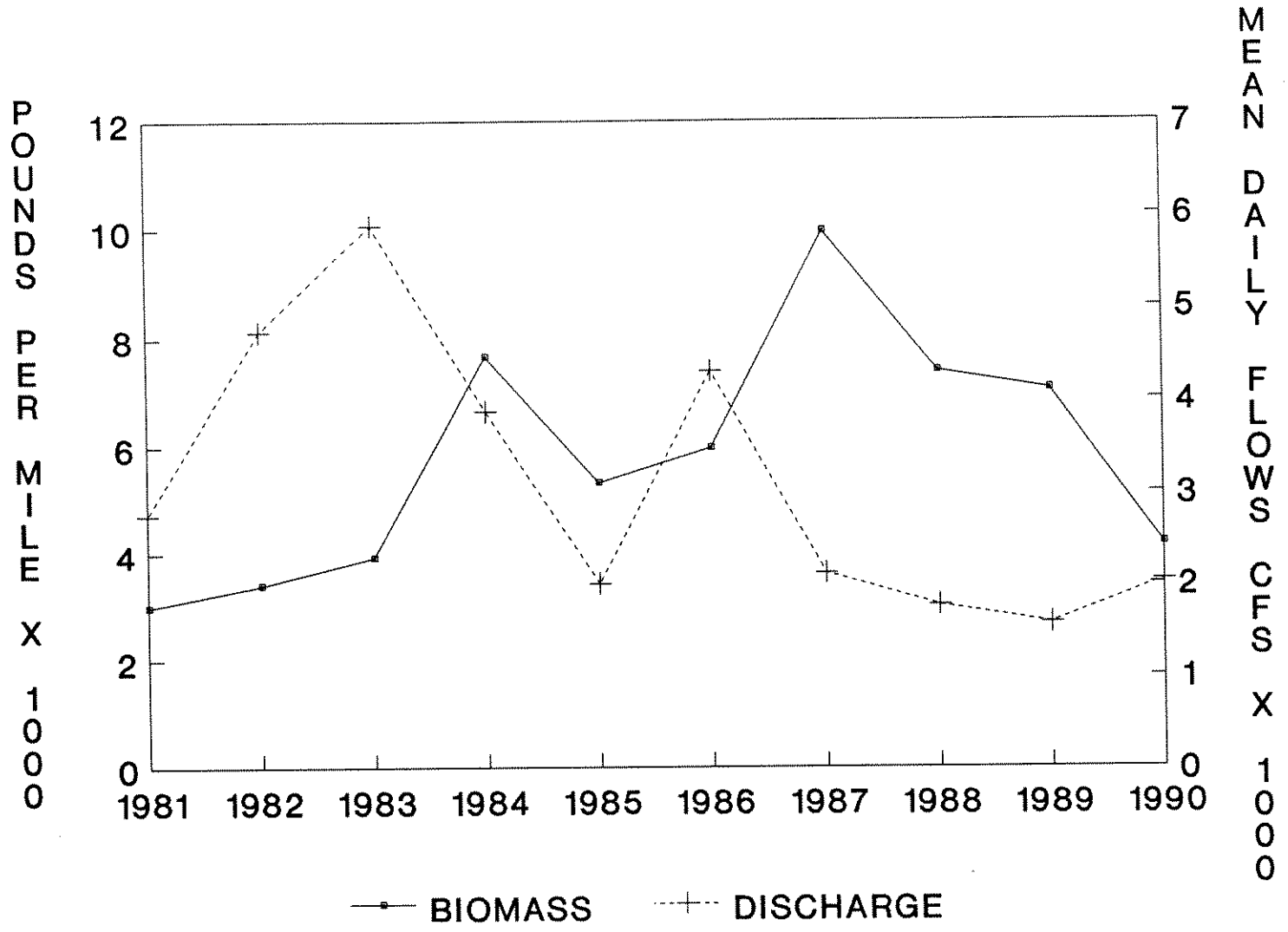

Figure 5. Biomass of brown trout estimated in the standard electrofishing section of the Bighorn River during fall 1981-1990 compared to mean daily summer (July-September) flows recorded in the Bighorn River for the same period.

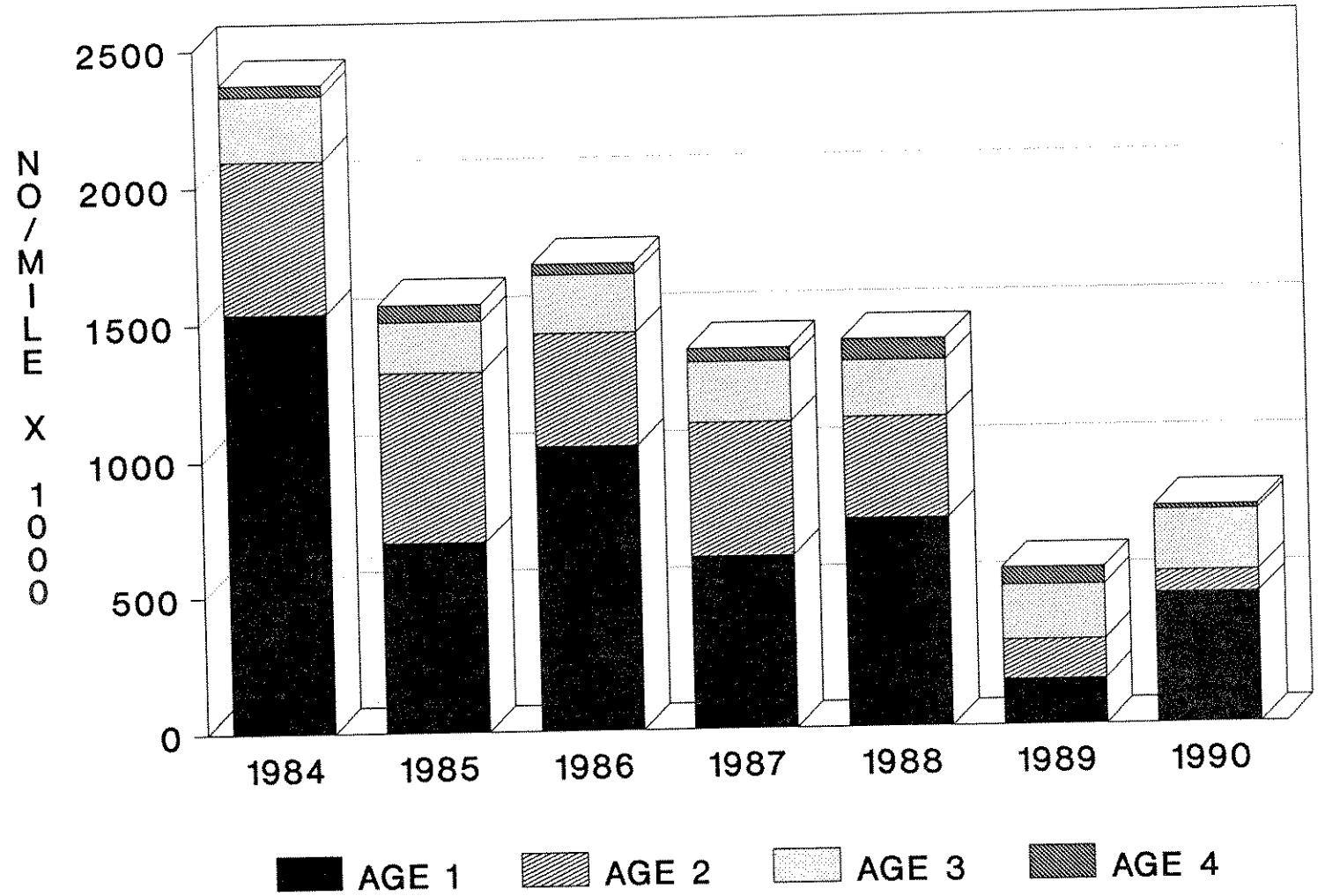

Figure 6. Estimated number (and age composition) of brown trout per mile in the lower (Saint Xavier) electrofishing section (RM 17.6-21.6) of the Bighorn River during fall 1984-1990.

Despite considerable fluctuations in age 1 and 2 populations in the lower section, the population of age 3 and older brown trout has remained fairly consistent. This trend continued in 1990 (Figure 6).

Mortality in the lower section followed a pattern similar to the standard section in 1990. The mortality rate for age 3 fish was the highest yet recorded for the lower shocking section at 91.5% (Table 7). As in the standard section, no age 5 or older brown trout were collected in 1990. The mortality rate for age 1 fish was down considerably from 1989, but was within the normal historic range. The low age 1 population in 1989 produced a very poor age 2 population in 1990. Like the standard section, but to a much greater extent, there appeared to be considerable movement of age 2 brown trout into the lower shocking section. This resulted in the best population of 3 year old fish estimated for this section so far (Table 6), and helped keep the estimate for age 3 and older fish in line with past levels. The large influx of 2 year old fish into the section between 1989 and 1990 helped keep the overall brown trout mortality at the lowest level yet recorded.

Table 7. Comparison of estimated annual mortality rate (percent change) for brown trout in the lower (Saint Xavier) electrofishing section (RM 17.6-21.6) of the Bighorn River from 1984-1990. Age class indicated is age at beginning of time interval.

Age Class	9/84-9/85	9/85-9/86	9/86-9/87	9/87-9/88	9/88-9/89	9/89-9/90
1	-59.6	-41.4	-53.3	-42.2	-81.3	-52.4
2	-66.8	-65.9	-46.0	-57.4	-45.6	+70.6
3	-74.9	-82.7	-82.5	-66.1	-69.7	-91.5
4 & Older	-90.5	- 87.3	-70.0	-97.9	-100.0	-100.0
Total	-63.3	-57.8	-55.6	-53.3	-71.4	-40.5

The brown trout biomass in the lower section recovered slightly from the record low level of 767 pounds per mile recorded in 1989. The 1990 biomass estimate was 866 pounds per mile. The strong age 3 year class was responsible for the majority of this improvement accounting for 53% of the total estimated biomass.

Brown trout growth rates in the lower section were comparable to those seen in 1988 and 1989. In September 1990 age 1 through 4 fish averaged 9.1, 13.9, 17.7 and 19.5 inches, respectively. Age 1 brown trout in the lower section averaged 1.5 inches longer than the same age class in the upper section, but this was still one of the shortest average lengths seen for age 1 fish in the lower section. The poor growth rate of age 1 fish in the standard

section was related to competition and water temperature. In the lower section the slower growth may have been partially due to competition with a strong age 1 year class of rainbow (see rainbow section). The average length of 3 year old fish was 0.6 inches longer than in 1989, but was still below the excellent average size recorded for age 3 fish in the standard section in 1990.

The average condition factor for brown trout in the lower section improved by over 3.5 points in 1990 to 45.29. This was about the same as the average condition factor recorded in 1988. The condition factor improved for all fish over about 10 inches in length. This average condition factor was almost 2 points higher than the 1990 average condition factor for the standard section. One possible explanation for the improved brown trout condition seen in the lower section was the abundance of small rainbow in this section in 1990. The forage value of these small fish apparently outweighed any competition they exerted on the larger brown trout.

Summary and Discussion - Brown Trout

The brown trout populations in both the upper and lower shocking sections began rebuilding in 1990 following two drought years that had caused a major decline in brown trout. The improved populations in both sections were due almost entirely to good populations of age 1 fish. This was especially true in the standard section where the age 1 population was the second highest ever recorded. Several factors contributed to this rebound. There was a good population of spawning age brown trout in the fall of 1989, and spawning and emergence flows were good during the fall of 1989 and spring of 1990, so spawning success was high. Flows remained good through the summer in 1990, providing good rearing conditions for small fish. At the same time, the population of large brown trout declined significantly reducing the number of large predators in the river. Evaluation of past trends indicates that predation by large brown trout is probably a major factor controlling the age 1 brown trout population, especially during poor water years.

The effects of low flows experienced in 1988 and 1989 were still evident in 1990. The poor populations of young brown trout produced during those years carried through as low numbers of older fish in 1990. Natural mortality rates of larger brown trout have always been quite high in the Bighorn River, but they reached extreme levels in both shocking sections in 1990. Several environmental factors contributed to these observed mortalities. The effects of flow fluctuations on the biomass of trout the river would support have been discussed in the past (Frazer 1990). Fluctuations in flows are followed by a corresponding fluctuation in total brown trout biomass. Due to the sampling schedule on the Bighorn, the change in biomass usually lags behind the change in flow by one year. The 1990 data showed the effects of a major decline in biomass following the poor flow conditions in 1989.

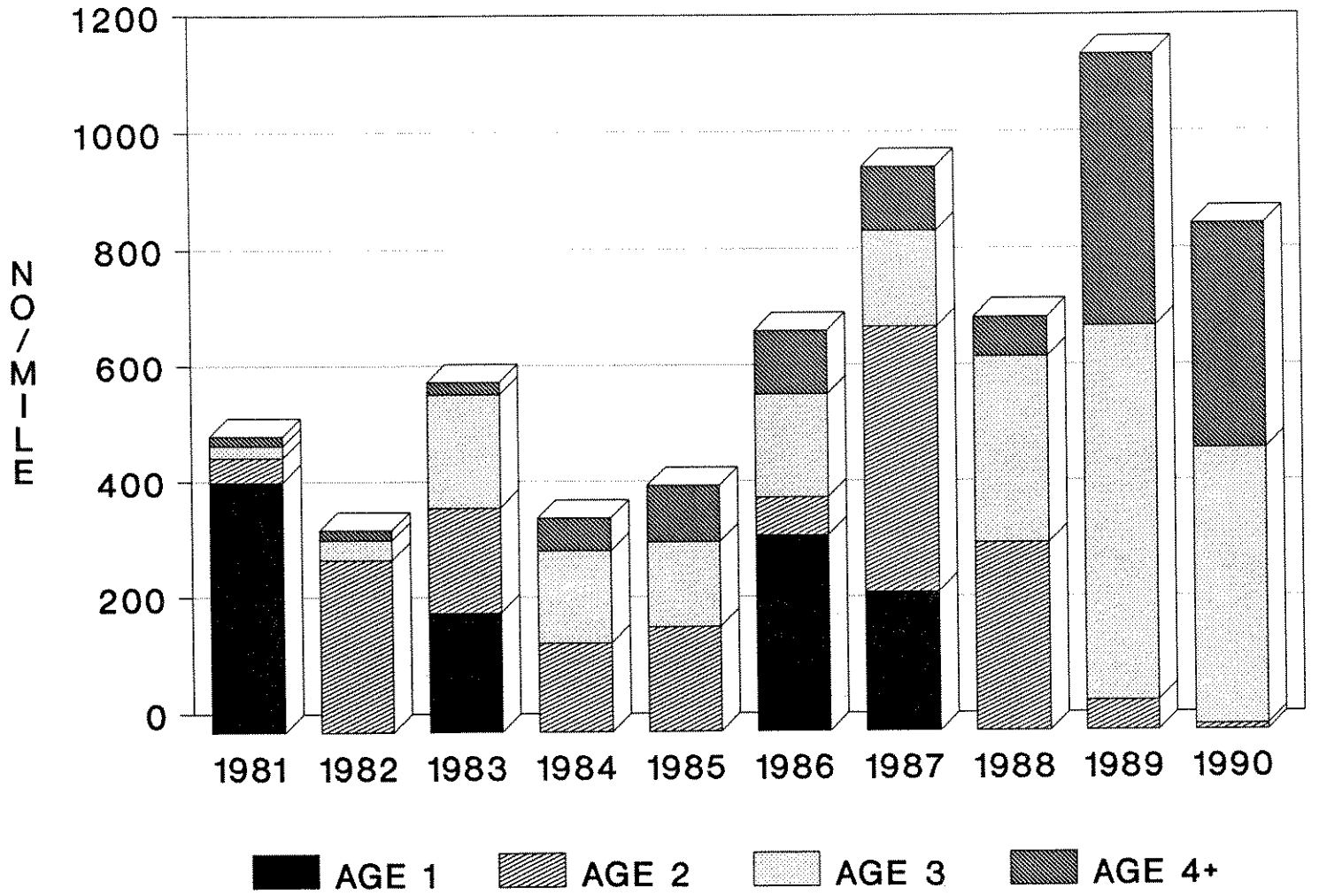

Figure 7. Estimated number (and age composition) of rainbow trout per mile in the standard electrofishing section (RM 3.8-8.0)* of the Bighorn River during fall 1981-1990.

Angling mortality may have also had a part in the high mortalities observed, but not in the normal sense. Results of the creel census conducted in 1990 showed that angler harvest is insignificant on the Bighorn. However , the impacts of angler mortality on released fish is not well understood. Angler pressure was heavy during the low flow years of 1988 and 1989 and this pressure continued in 1990. During the low flow conditions, all anglers as well as all fish were crowded into a relatively small volume of water. A majority of the larger brown trout handled during fall shocking in the standard section had one to several hooking scars indicating many of these fish were probably hooked and released several times. The presence of scars showed that these fish had survived being caught and released, but the cumulative impacts of catch-and-release fishing on this population of fish, already stressed by low flows, may have been severe. Angler-caused mortality of released fish may have been an important part of the high mortality observed between 1989 and 1990.

The relationship between the density of small fish and the mortality rate of large brown trout has been discussed in the past (Frazer 1990). This relationship appeared to be a factor again in 1990, especially in the upper river where a large population of age 1 fish were competing against the older brown trout.

Last year's report anticipated a rebound in the brown trout population as soon as the flows improved, but stated that this rebound would be at the expense of the larger brown trout (Frazer 1990). This appeared to be the case in 1990. The population of young-of-year brown trout appeared to be very good in the fall of 1990. The number of large predatory brown trout was down, and flows were up, so another strong year class of age 1 fish is anticipated in the fall of 1991. If flow conditions remain good as these strong 1989 and 1990 year classes mature, another brown trout population increase, such as occurred between 1984 and 1987, is expected. As the population of brown trout builds, there will be another factor involved that wasn't nearly as significant the last time; i.e., the strong rainbow population that is currently present in the river. It is not known what effects this may have on the rebuilding of the brown trout population.

Rainbow Trout

Standard Section

The rainbow trout population in the standard shocking section declined from the record level recorded in 1989. The number of age 2 and older rainbow per mile dropped from 1,163 in 1989 to 872 in 1990. Almost 99% of the rainbow population in the standard section in 1990 was age 3 and older fish. Too few age 1 fish were present to accurately estimate, and only 10 age 2 rainbow were estimated per mile (Table 8). The poor age 2 estimate followed a very poor age 1 year class seen in both shocking sections in 1989.

Table 8. Estimated number of rainbow trout per mile in the standard electrofishing section of the Bighorn River (RM 3.8-8.0)* during fall 1981-1990.

Age	12/81	12/82	09/83	09/84	09/85	09/86	09/87	09/88	09/89	09/90
1	431	-	205	-	-	338	240	-	-	-
2	42	295	181	153	180	65	457	324	61	10
3	20	35	195	158	146	177	164	321	646	476
4+	17	17	22	47	98	110	100	68	466	386
Total	79	347	398	368	424	352	721	713	1,163	872

*RM 2.4-9.6 for 1981-1987

The rainbow trout population has increased since stocking was discontinued, it has been dominated by fish from two strong year classes produced in 1985 and 1986. These year classes continued to be important in 1990. Over 44% of the estimated rainbow population was age 4 and older fish (the 1986 and older year classes). The 1987 year class of rainbow did not show up as a strong year class in either shocking section in 1988 or 1989, but they constituted 54% of the estimated rainbow population in the standard section in 1990 (Figure 7).

Previous reports have discussed the problem with movement of rainbow trout in and out of the shocking sections (Frazer 1990). It appears that especially during years of poor flow, most young-of-year rainbow migrate downstream for rearing. They then move back upstream as 2 or 3-year-old fish. Frazer (1990) discussed the apparent movement of age 2 and 3 rainbow into the standard shocking section between 1988 and 1989. There was a major movement of age 2 fish into this section between September 1989 and September 1990. The estimated population of the 1989 age 2 rainbow increased 780% in the standard section by 1990. Fish from this age group also moved into the lower shocking section between 1989 and 1990 (Table 11). The fact that an apparent weak year class in both 1988 and 1989 could become a dominant year class in 1990 shows that fall shocking results give a poor indication of the number of small rainbow that are really in the river.

Mortality rates for both 3 and 4 year old rainbow from the dominant 1985 and 1986 year classes, increased in 1990 (Table 9). As these fish are lost from the population, there appears to be a strong 1987 year class filling in behind them. Based on 1989 and 1990 shocking results, the 1989 year class appears to be very poor. If this is true it could leave a gap in the rainbow population in the future. However, these fish may show up as age 3 fish in the fall of 1991 like the 1987 year class did in 1990.

Table 9. Comparison of estimated annual mortality rate (percent change) for rainbow trout in the standard electrofishing section (RM 3.8-8.0)* of the Bighorn River from 1981-1990. Age class indicated is age at beginning of time interval.

Age Class	12/81 - 12/82	12/82 - 09/83	09/83 - 09/84	09/84 - 09/85	09/85 - 09/86	09/86 - 09/87	09/87 - 09/88	09/88 - 09/89	09/89 - 09/90
1	-31.6	-	-25.4	-	-	+35.2	+35.0	(+)	-
2	-16.7	-33.9	-12.7	4.6	-1.7	+152.3	-29.8	+99.4	+78.0
3 & Older	-54.1	-57.7	-73.7	-54.4	-54.9	-49.7	-61.0	+33.3	-47.5
4 & Older	-	-	-	-	-	-88.2	-96.6	-44.1	-89.9
TOTAL (2+)	-34.2	-37.5	-50.0	-33.7	-32.3	-25.0	-46.8	+56.0	-26.5

*RM 2.4-9.6 for 1981-1987.

With an increased mortality in the dominant 1985 year class there was a slight decline in the number of "trophy sized" rainbow in the standard section in 1990. This number dropped from a record high of 612 per mile down to 571 per mile. The 1990 level is still almost four times the stated management goal of 150 18-inch and longer rainbow per mile (Montana Department of Fish , Wildlife and Parks 1987). The strong 1987 year class of rainbow should help maintain a good population of large rainbow for the next couple of years.

Warmer water temperatures and reduced competition from larger brown trout resulted in slightly better growth rates for 2 year old and older rainbow in the standard section in 1990 (Table 10). The average length of the age 1 rainbow was the shortest yet recorded. This same pattern was seen for brown trout in this section and was related to the large population of age 1 brown trout. It appears the large numbers of small brown trout also affected growth rates of small rainbow.

Table 10. Average length (in) by age class of rainbow trout from the standard electrofishing section (RM 3.8-8.0)* of the Bighorn River during September from 1983-1990.

Year/Age	0	1	2	3	4	5+
1983	5.0	10.3	15.9	18.3	20.3	21.1
1984	-	11.4	15.1	18.1	19.1	21.1
1985	-	9.3	15.2	17.7	19.4	21.1
1986	3.8	8.6	13.8	16.9	19.3	21.3
1987	-	10.1	13.9	16.6	18.9	20.8
1988	-	-	15.0	17.4	19.6	20.5
1989	-	-	14.7	17.1	19.5	20.4
1990	-	7.6	15.2	17.8	19.7	20.5

*RM 2.4-9.6 for 1983 through 1986

Lower Section

The 1990 rainbow trout estimate for the Saint Xavier section was almost twice the next highest estimate made since rainbow stocking was discontinued (Figure 8). The 1990 estimate was 852 age 1 and older rainbow per mile compared to an estimate of 432 age 1 and older per mile in 1986; and an estimate of 298 age 1 and older rainbow per mile in 1989. Over 75% of the strong 1986 population was 1 year old fish from the 1985 year class. Age 1 fish comprised 62% of the 1990 population, but even without this year class there were still 320 age 2 and older rainbow per mile. This estimate was the second highest for age 2 and older fish since sampling was initiated in 1984 (Table 11). The other good population of age 2+ rainbow in 1985 was dominated by hatchery fish from a plant in 1983. The 1987 population was dominated by the strong 1985 year class. The population of age 1 rainbow was too low to estimate in either of these years. The 1990 estimated population of age 1 fish (532 per mile) was greater than the total estimated population of rainbow in this section during any previous year.

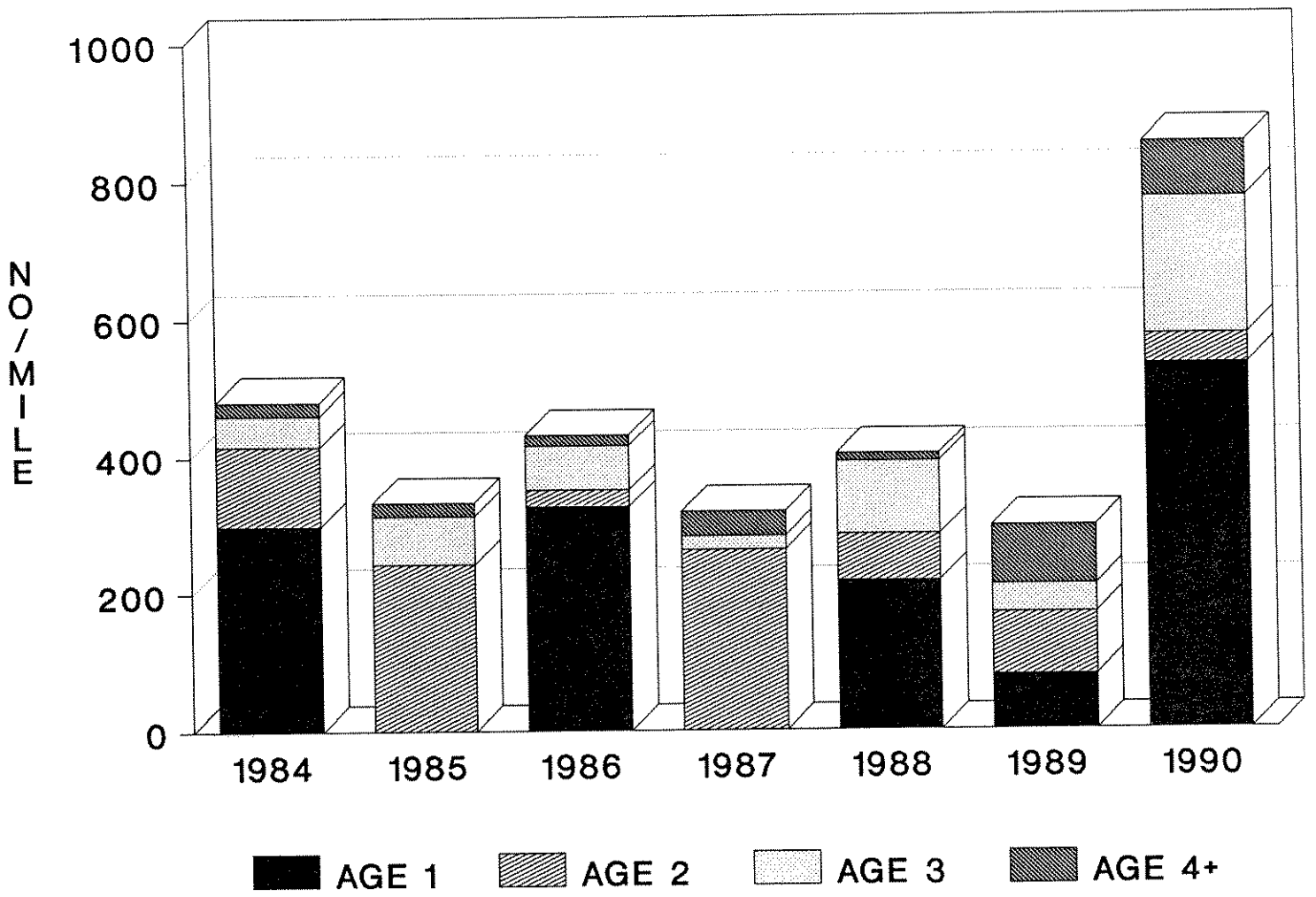

Figure 8. Estimated number (and age composition) of rainbow trout per mile in the lower (Saint Xavier) electrofishing section (RM 17.6-21.6) of the Bighorn River during fall 1984-1990.

Table 11. Estimated number of rainbow trout (per mile) in the lower (Saint Xavier) electrofishing section (RM 17.6-21.6) of the Bighorn River during September 1984-1990.

AGE	SEPTEMBER 1984	SEPTEMBER 1985	SEPTEMBER 1986	SEPTEMBER 1987	SEPTEMBER 1988	SEPTEMBER 1989	SEPTEMBER 1990
1	299	--	327	--	218	80	532
2	117	243	24	263	67	91	42
3	46	70	65	20	107	41	198
+4	20	20	16	36	11	86	80
TOTAL (2+)	183	333	105	319	185	218	320

Movement of rainbow was again very evident in 1990. Numbers of age 1 rainbow were too low to estimate in the upper river where almost all the rainbow spawning occurs, but there was a very large population in the lower section. The population of age 2 rainbow in 1990 followed the worst age 1 year class yet recorded, but even these fish were four times as abundant in the lower section as in the standard section. Frazer (1990) discussed the apparent movement of small rainbow downstream for rearing during poor water years. There was a substantial movement of fish from the 1987 year class into the lower section between 1989 and 1990. The estimated population of this age class in the shocking section increased by 117% between these two years. This increase was much smaller than was seen in the standard section, but still resulted in an estimated population of 3-year-old rainbow almost twice as large as the next highest estimate made in 1988 (Table 11). There also appeared to be movement of 4-year-old fish from the 1986 year class into the lower shocking section between 1989 and 1990, as this group increased by 95%. A high mortality of this age group was noted in the standard section.

The extensive movement of rainbow in the Bighorn River makes it very difficult to draw any conclusions about mortality rates of different age classes. The only age group of rainbow showing any mortality between 1989 and 1990 was the weak 1989 age 1 year class. These fish showed a 47.5% mortality rate between 1989 and 1990. Part of this mortality may have been due to movement out of the shocking section. Overall there was a 47% increase in the population of 1989 age 1 and older rainbow in the lower section between 1989 and 1990.

For the first time since sampling was initiated in 1984, the estimated population of age 1 and older rainbow in the lower section (852 per mile) was greater than the estimated population of age 1 and older brown trout (818 per mile). The estimated biomass

of rainbow trout in the lower shocking section more than doubled between 1989 and 1990 from 421 pounds per mile to 1,051 pounds per mile. Estimated biomass for brown trout in 1990 was 866 pounds per mile.

As in the past, angler harvest did not have any apparent impact on the rainbow population in the lower section in 1990. This area is open to bait fishing and anglers can harvest one rainbow per day, yet the populations of all larger rainbow actually increased between 1989 and 1990.

Growth rates in the lower section continued to exceed those in the standard section as they have in the past, due to warmer temperatures and more abundant food. Age 1 rainbow were almost 2 inches longer in the lower section than in the standard section. The average lengths of age 1, 2, 3, and 4+ rainbow in the lower section in 1990 were 9.5, 15.6, 18.6, and 19.7 inches respectively.

Summary and Discussion - Rainbow Trout

The wild rainbow fishery in the Bighorn River continued to improve in 1990. The population in the standard section declined from the record high level observed in 1989, but still remained very strong. Up until this year, the wild rainbow population has been dominated by two strong year classes produced in 1985 and 1986. The 1985 year class was 5 years old in 1990 and began to show some significant natural mortality. At the same time, fish from the 1987 year class of rainbow which had appeared to be very weak the past two years, moved into both shocking sections and became the dominant older age class in both sections.

Besides having a very strong population of 3-year-old fish from the 1987 year class, the lower shocking section contained a tremendous population of age 1 rainbow. For the first time, the number and biomass of rainbow trout in the lower shocking section was greater than the number and biomass of brown trout.

Movement of rainbow in and out of the shocking sections continued to cloud conclusions about actual rainbow populations. If anything, electrofishing data may under-estimate rainbow numbers, especially for younger fish.

Overall the wild rainbow population appeared to be coming on very strong in the Bighorn River. Based on past trends, it may be even stronger than indicated by the sampling results. As this population continues to grow, its impact on the brown trout population in the river will too.

CONCLUSIONS

Both rainbow and brown trout estimates in 1990 showed the Bighorn River fishery was recovering from the effects of the drought experienced in 1988 and 1989. The mortality rate of older brown trout remained high in 1990, but there was a good population of young fish filling in behind them. A major increase in the brown trout population over the next several years is likely.

The rainbow trout population has been improving each year since stocking was discontinued in 1983. This improvement continued in 1990. Mortality rates increased as the dominant 1985 year class reached 5 years of age, but the population of younger fish continued to increase. The 1989 year class of rainbow was extremely strong and should make a major contribution to the rainbow fishery as these fish mature. The population of "trophy-sized" rainbow remained well above management goals. Extensive movement of rainbow within the river continued to make it difficult to accurately estimate the rainbow population in the river.

Angling pressure remained very heavy on the Bighorn in 1990. The angler population continued to shift more towards the nonresident, catch-and-release, fly fishermen. Catch rates were down from 1989, but still very good. Harvest rates were way down from the low levels reported in 1989. Crowding was a problem, but not a serious problem to the majority of anglers fishing the Bighorn in 1990. The river ranger data indicated that many Montana resident anglers, who were more likely to be affected by the crowded conditions, have quit fishing the Upper Bighorn River altogether.

The continued shift towards catch-and-release fishing on the Bighorn may have serious implications for future management of brown trout in the river. The relationship between the densities of small brown trout and the survival and condition of large brown trout has been discussed in the past (Frazer 1990). One of the best ways to establish a balance that would maintain brown trout populations at a level necessary to provide good fishing, but still maintain reasonable survival of larger brown trout, would be to continually harvest some of the smaller fish. With the shift in the angler population, this harvest is not occurring. Fish loss due to handling mortality is probably more significant than angler harvest on the Bighorn. Handling mortality is greatest on the large fish we are trying to manage for rather than the small fish that need to be removed. If this trend continues, it may be necessary to look at using flow manipulation or some other method to try and maintain this balance. Another factor that could change the whole balance on the Bighorn is the continually expanding rainbow fishery. At some point the rainbow population will reach a level where it will start having a direct impacts on the brown trout fishery. The 1990 rainbow population was probably close to this level.

MANAGEMENT RECOMMENDATIONS

1. Continue efforts to maintain target flow levels of at least 2,000 cfs in the Bighorn River year-round.

2. Continue to work with the Bureau of Reclamation to resolve the gas supersaturation problems in the river.

3. Continue the river ranger program shifting emphases to collect data necessary to recalibrate car counters so actual angler-use can be calculated.

4. Solicit the guides, outfitters and anglers using the Bighorn for ideas on ways to better manage the overcrowding problem on the upper 12 miles of river.

5. Continue to monitor the expanding rainbow population and its effects on the brown trout population. Explore new sampling and/or tagging methods that could provide additional data on rainbow movement.

6. Continue to promote some harvest of smaller brown trout to try and achieve a population balance that will provide enough fish to maintain good catch rates, yet be low enough to allow the maintenance of a good population of "trophy" sized brown trout.

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Fredenberg, W. 1985a. South central Montana fisheries investigations, Bighorn Lake and Bighorn River post-impoundment study. Montana Department of Fish, Wildlife and Parks Job Progress Report F-20-R-29-IV-a.

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Montana Department of Fish, Wildlife and Parks, 1987. Upper Bighorn River Fisheries Management Plan.

Prepared by Ken Frazer

Date August 26, 1991

Waters referred to:

22-0490 Bighorn River, Sec. 1
22-0495 Bighorn River, Sec. 2

APPENDIX A
BIGHORN RIVER SURVEY FORMS AND RESPONSE KEY

REGION 5 CREEL CENSUS - BIGHORN RIVER
CREEL LEGEND

ID#: Each fishing party will be assigned a unique number in sequential order. Therefor each person in a party will be assigned the same number.

BOATER REGISTRATION: Enter **1** if angler filled out registration form proir to trip and **2** if no registration form was filed. (Leave blank if party is not floating)

REPEAT INTERVIEW: Enter **1** if angler has been interviewed in creel census year and **2** if she has not been interviewed.

IN PARTY: Enter total number of persons in party.

OF ANGLERS: Enter only number of anglers in party.

ORIGIN:
1- Resident (Ft. Smith, St. X, Hardin, Pryor)
2- Resident (Billings area)
3- Resident (Rest of State)
4- Nonresident (U.S.- Comment State)
5- Nonresident (Outside U.S. - Comment Country)

LICENCE TYPE:
1- Resident Season (Including Sportsman)
2- Resident Senior, Juvenile or Disabled
3- Nonresident Tempoary
4- Nonresident Seasonal

TIMES FISHED:
1 - one day
2 - 2-5 days
3 - 6-10 days
4 - 11-20 days
5 - >20 days

TACKLE TYPE:
1- Flies
2- Artificial lures other than flies
3- Bait (Comment if live minnows are used)
4- Combination

BOAT/SHORE:
1- Boat (Person floating any part of trip is considered a boater)
2- Shore

AREA IN/ OUT:
1- Afterbay
2- Lind (3 Mile)
3- Schneiders
4- Craig
5- Bighorn
6- Mallard
7- Two Leggins
8- Other(Comment)

HOURS FISHED : Record only hours fished to the nearest $1/2$ Hr.

GUIDED:
1- Angler is guided
2- Non-guided

GUIDE RES.:
1- Resident Local (Same as definition above)
2- Resident Billings
3- Resident (Rest of State)
4- Out of State (Comment)

Completed Trip:
1- Done Fishing for the day
2- Not Done

Final Question*: If you could comment on one thing about fishing on the Bighorn River, what would it be? - Record in comments.
*Answers will be coded following a preliminary period in which a general classification of responses will be made.

MONTANA DEPT. FISH, WILDLIFE & PARKS

Water Name: Bighorn River

Creel Clerk: ____________

Date: (D/M/Y/DOW) ____________

ID	B. Regist.	R. Interview	# in Party	# of Anglers	Origin	Licence Type	Times Fished	Tackle Type	Boat/Shore	Area in/out	Hours fished	Guided	Guide Res.	Completed	RAINBOW			BROWN TROUT		
															Kept	Ret'd	>18"	Kept	Ret'd	>18"

Comments: ____________

Question: ____________

ID	B. Regist.	R. Interview	# in Party	# of Anglers	Origin	Licence Type	Times Fished	Tackle Type	Boat/Shore	Area in/out	Hours fished	Guided	Guide Res.	Completed	RAINBOW			BROWN TROUT		
															Kept	Ret'd	>18"	Kept	Ret'd	>18"

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Comments: ____________

Question: ____________

Montana Dept. Fish, Wildlife & Parks
Boater Registration Form

Please fill out one per boat per day- (Circle Answer)

Please keep track of the number of fish caught/released and the hours fished as you may be contacted by a creel clerk on the river.

DATE: ______________________________

Number of persons in boat: 1 2 3 4 ___

Number of persons fishing: 1 2 3 4 ___

PLANNED FLOAT:

Launch Point: Afterbay Lind Ranch Schneiders Bighorn Access Mallards Landing Other_____________

Take Out Point: Lind Ranch Schneiders Bighorn Access Mallards Landing Two Leggins Other_____________

Number of days of fishing planned on the Bighorn River this trip:

1 2 3 4 5 6 7 More_________

Privite Party or Guided Party

DATE: ______________________________

Number of persons in boat: 1 2 3 4 ___

Number of persons fishing: 1 2 3 4 ___

PLANNED FLOAT:

Launch Point: Afterbay Lind Ranch Schneiders Bighorn Access Mallards Landing Other_____________

Take Out Point: Lind Ranch Schneiders Bighorn Access Mallards Landing Two Leggins Other_____________

Number of days of fishing planned on the Bighorn River this trip:

1 2 3 4 5 6 7 More_________

Privite Party or Guided Party

DATE: ______________________________

Number of persons in boat: 1 2 3 4 ___

Number of persons fishing: 1 2 3 4 ___

PLANNED FLOAT:

Launch Point: Afterbay Lind Ranch Schneiders Bighorn Access Mallards Landing Other_____________

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Privite Party or Guided Party