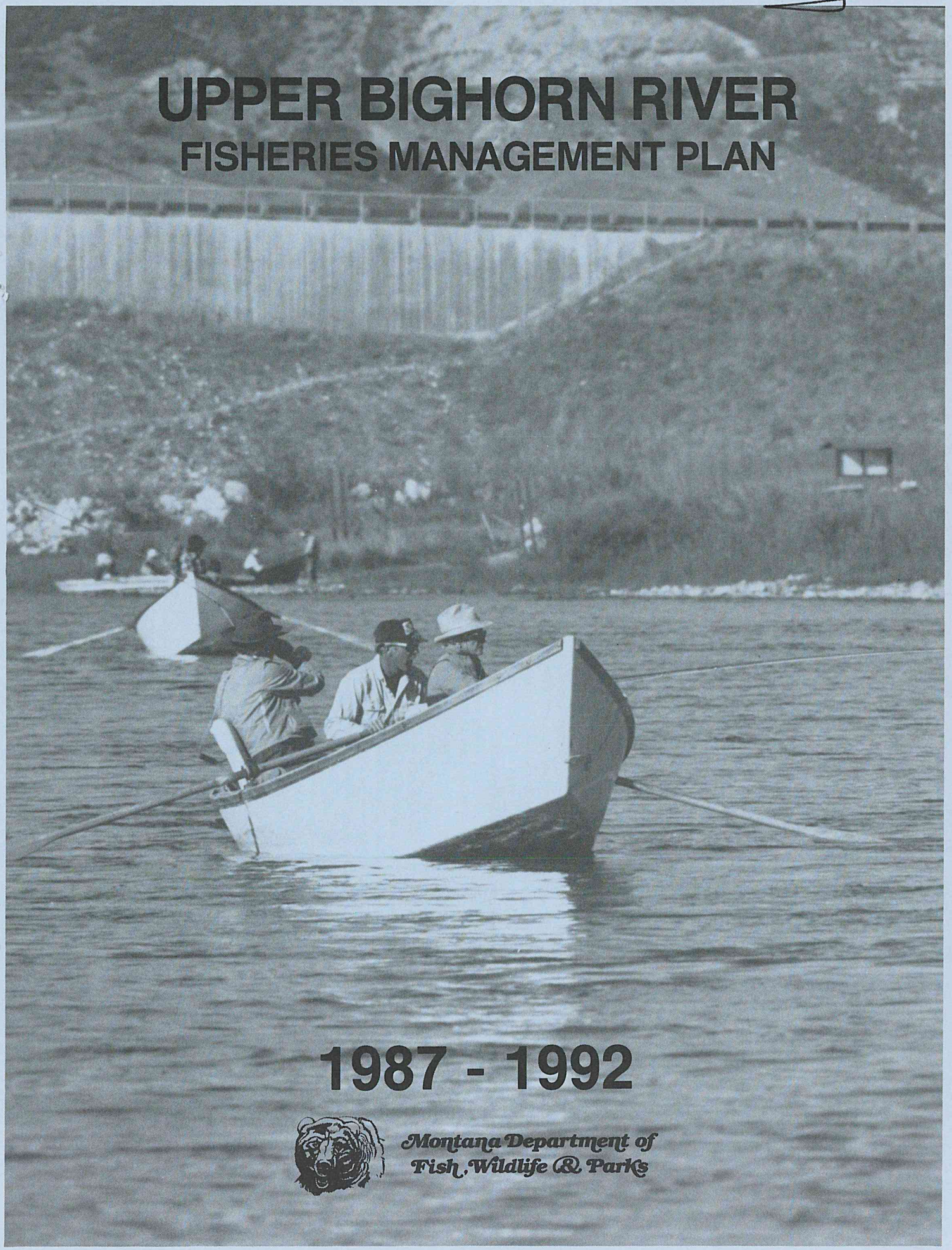
Tim Gallagher

UPPER BIGHORN RIVER
FISHERIES MANAGEMENT PLAN



1987 - 1992

Montana Department of
Fish, Wildlife & Parks

UPPER BIGHORN RIVER

FISHERIES

MANAGEMENT PLAN

AUGUST 1987

SUMMARY

The Bighorn River is one of the world's finest trout streams. Since the river was reopened to fishing in 1981 (following a closure by the Crow Indian Tribe), use of the river has been heavy and increasing. A rapid increase in fishing pressure in 1986 generated much concern among managers and users of the river. Concerns were centered around effects of increased fishing pressure on the Bighorn's fish populations and the quality of the fishing experience. This management plan is designed to review the current situation, address public and agency concerns, and suggest management strategies for the next five years to ensure that the Bighorn River remains one of the world's premier trout streams.

Brown trout and rainbow trout population trends in the Bighorn River have varied markedly over the years. Optimum management of the river requires different strategies for the two species. Brown trout populations have closely mirrored flow conditions since 1981. Population density has been high when flows are high and lower when flows decrease. The September, 1986 brown trout population density was slightly lower than the highest recorded levels. Rainbow trout populations have traditionally reflected stocking levels. No rainbow trout have been stocked in the river since 1983. Many wild rainbows appeared in the population for the first time in 1985 and 1986.

Estimates of trophy (18+ in) brown trout population density in September 1986 were the lowest on record. A substantial decrease between 1984 and 1986 was caused by low flows during the summer drought of 1985, and water temperatures in 1985 that were much colder than average. Growth rates of trout were substantially reduced due to the colder water temperatures. Trophy rainbow trout population density, which was relatively high in September 1986, is expected to drop temporarily as fish planted in 1983 disappear from the population.

Fishing pressure increased slowly between 1981 and 1985. A dramatic increase occurred between 1985 and 1986, particularly during the peak use season (June through September). Complaints about crowded fishing conditions were common in 1986.

The goal of fisheries management on the upper Bighorn River is to meet public demand for a high quality wild trout fishing experience, with a management emphasis on maximizing the opportunity to catch large trout. Specific objectives designed to meet that goal are as follows:

1. To maintain average population densities of 5,000 to 7,000 age one and older brown trout per mile and at least 500 18-in and longer brown trout per mile in the upper 12 miles of the Bighorn River.

2. To maintain average population densities of 1,500 to 2,500 age one and older brown trout per mile in the

Bighorn River between Bighorn Fishing Access and Two Leggins Access.

3. To maintain average population densities of at least 1,000 age one and older rainbow trout per mile and at least 150-18 in and longer rainbow trout per mile in the upper 12 mi of the Bighorn River.

4. To maintain average population densities of at least 500 age one and older rainbow trout per mile in the Bighorn River between Bighorn Fishing Access and Two Leggins Fishing Access.

Brown trout population objectives are slightly higher than the average fall population density during the 1981-86 period. Rainbow trout population objectives are sig nificantly higher than average fall population density during the 1981-86 period.

Strategies to achieve the stated objectives are grouped into three categories: fish habitat, fish populations and angler use. Fish habitat strategies include:

1. To establish minimum flow targets in cooperation with the U.S. Bureau of Reclamation (USBR) to provide optimum habitat conditions, given water supply constraints,

2. To assist the USBR, other agencies and private entities in solving the gas supersaturation problem at the Afterbay Dam, and

3. To determine the contribution of Soap Creek rainbow spawners to the total Bighorn River rainbow trout population, factors affecting rainbow trout production in Soap Creek and strategies to improve production (if necessary).

Fish population strategies for brown trout include:

1. To continue to place management emphasis on providing high quality habitat,

2. To continue with present regulations and annual evaluation of effectiveness of regulations,

3. To increase monitoring of fishing pressure and angler success,

4. To increase information and education efforts regarding status of the fishery, proper methods of releasing fish, use of barbless hooks and river etiquette, and

5. To artificially enhance the brown trout population of the St. Xavier area by transplanting age one brown trout from the upper river.

Fish population strategies for rainbow trout include:

1. To continue present emphasis on wild trout management.

2. To implement catch and release regulations on rainbow trout in the river from the Afterbay Dam to Bighorn Fishing Access beginning in 1988, and

3. To close key mainstem river rainbow trout spawning areas to fishing from March 1 through June 30, beginning in 1988.

Angler use strategies include:

1. To purchase additional access sites to increase angling opportunities and more evenly distribute fishing pressure,

2. To review regulations annually to ensure that angler use and harvest do not prevent attainment of fish population objectives,

3. To increase monitoring of the fishery and enforcement efforts during the peak use season, June through September,

4. To prepare a project proposal for the 1989 Montana Legislature to fund a river ranger position, and

5. To conduct a comprehensive creel, recreation and angler opinion survey in 1990.

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INTRODUCTION

The Bighorn River has been called the world's finest trout stream. While there are many streams that could lay claim to the "best" title, there is no doubt the Bighorn is a trout stream of national significance. Because of its abundant trout, dense insect hatches, easy accessibility and much attention in regional and national press, the Bighorn is one of those trout streams that nearly every ardent trout angler dreams of fishing. In 1986, many anglers realized that dream, some of those went home disappointed with crowded conditions and smaller fish than they expected. Fisheries personnel in the Montana Department of Fish, Wildlife and Parks (MDFWP) received many inquiries from anglers worried that the Bighorn River was in danger of becoming "just another trout stream." This management plan is designed to review the current situation, address public and agency concerns, and suggest management strategies for the next five years to ensure that the Bighorn River remains one of the world's premier trout streams.

Background

Prior to 1965, the Bighorn River was a silty stream that emerged from the spectacular Bighorn Canyon on a northward course to meet the Yellowstone River in the eastern Montana prairie. The majority of its sauger, catfish, burbot, goldeye, and many Cyprinid species had never seen an angler's hook. A 1965 MDFWP survey estimated less than 500 man-days of fishing were spent on the entire river. With the completion of Yellowtail Dam, most of the river's silt load was trapped in Bighorn Reservoir. A new, clear-water river emerged from Bighorn Canyon. Released from deep below the surface of Bighorn Lake, the river water was much cooler in summer and warmer in winter than before dam construction. The river had been transformed from a warm, silty, prairie river into a cold, clear tailwater, much like a giant spring creek - an ideal habitat for trout.

Rainbow trout planted in the river grew rapidly, and the Bighorn gained a reputation for producing trophy fish. By 1973, fishing pressure on the 12 miles of river immediately below the Afterbay Dam (Figure 1) had grown to 13,000 man-days, roughly the same intensity of use seen on the Madison River. That came to an end in 1975, when the Crow Tribe closed its entire reservation to hunting, fishing and trapping to all but tribal members. A lengthy series of court battles ensued before the U.S. Supreme Court ruled the Bighorn River was navigable. That decision meant title to the streambed lay with the state of Montana from the date of statehood (1889).

With the court battles over, the river was reopened to fishing in August 1981. In the midst of much fanfare, fishing pressure picked up where it had left off in 1975. Angler success was excellent on the previously lightly fished population of trout. The MDFWP published a management plan for the Bighorn River in 1982. Since then, fish populations and the fishery on

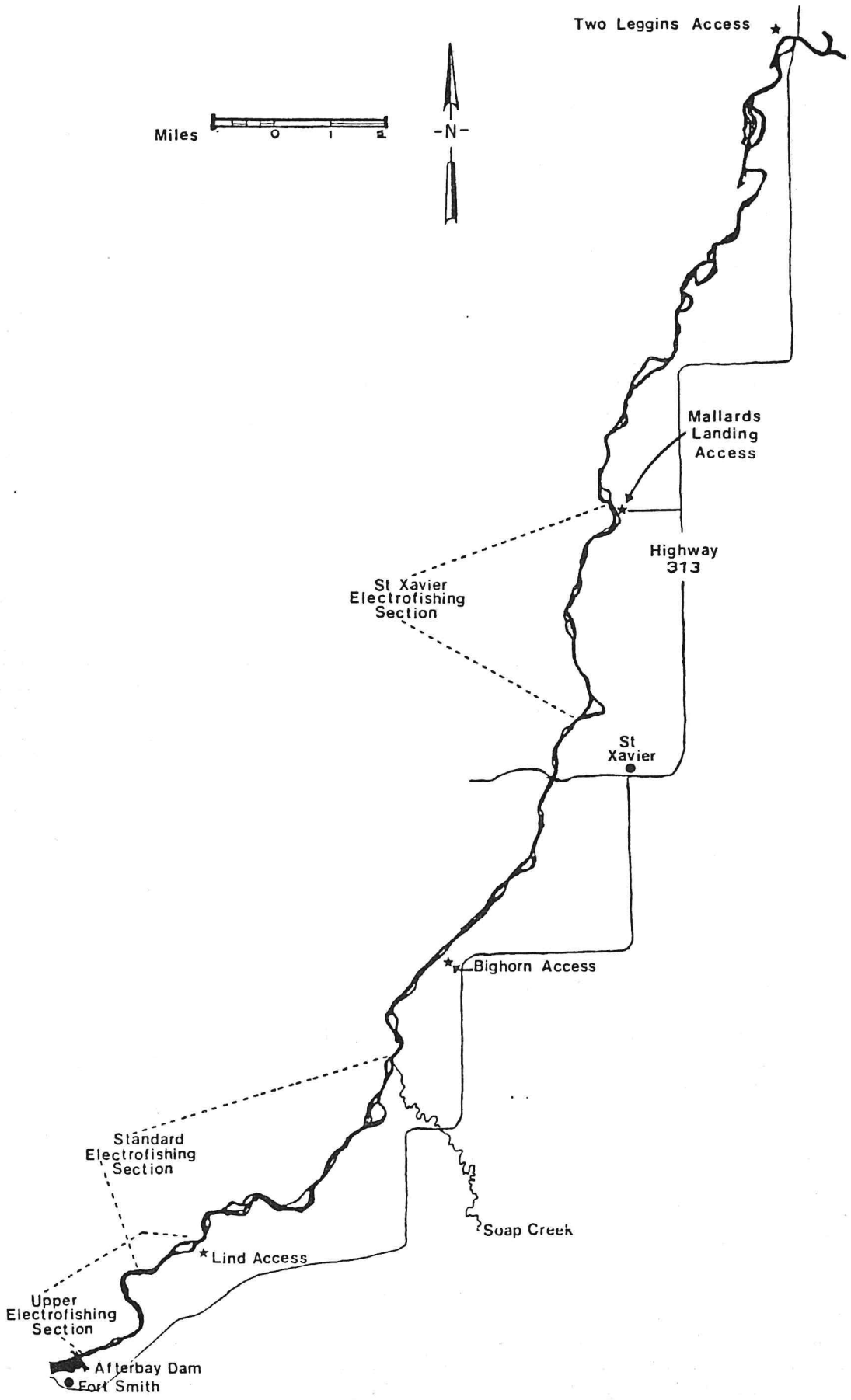

Figure 1. The upper Bighorn River.

the Bighorn have changed dramatically. A rapid increase in fishing pressure in 1986 generated much concern among managers and users alike. Concerns were centered around effects of increased fishing pressure on the Bighorn's fish populations and the quality of the fishing experience.

In response to these concerns, this management plan was designed to accomplish the following:

1. Summarize the findings of five years of fisheries research and management,

2. Identify goals, objectives and suggested management strategies for the period 1987-92, and

3. Serve as a vehicle for maximizing public participation in the management process.

THE BIGHORN RIVER FISHERY
1981-86

The Bighorn River fishery has two principal components - fish populations and angling use. Each of these components will be discussed in separate sections. Because the biology and management of brown trout and rainbow trout are quite different, they are discussed separately in the fish population section.

Fish Populations

Brown Trout

In July 1981, MDFWP biologists sampled the Bighorn River's trout populations to determine their status prior to opening the river to fishing. The first sampling yielded a population estimate of 3,918 age one and older (six inches and longer) brown trout per mile in a seven-mile long reach of the upper river. It was a typical unfished population, containing a high proportion of old, large fish (Figure 2). In spite of fairly restrictive regulations (limit of three fish, all fish between 18 and 22 inches released), the brown trout population declined to 2,218 per mile by December 1981 (Table 1). A gradual increase resulted in a peak of 9,660 browns per mile in May 1985. Summer mortality was high, however, during the 1985 drought. By September 1986, it was apparent the brown trout population had rebounded substantially.

Five years of monitoring the Bighorn's brown trout have demonstrated that environmental factors are more important than fishing pressure in controlling population levels. Mortality of age three and older brown trout during summer is closely related to flows. Mortality is high when flows are low, and is low when flows are high. Numbers of trophy sized brown trout (18 in and larger) declined significantly during periods of low flow and generally increased during periods of higher flow (Table 2). The largest decrease in trophy trout occurred when fishing regulations were most restrictive. Peak numbers of trophy trout occurred following a period of progressive liberalization of regulations.

Gas supersaturation, which causes gas bubble trauma in trout, is another environmental factor affecting Bighorn River trout populations. The problem originates at the Afterbay Dam, and its effects are most severe in the uppermost two miles of the river. Ongoing studies suggest that gas bubble trauma is a major cause of mortality in some years. It appears that large fish are more severely affected than small fish.

Fall 1986 population monitoring resulted in an estimate of 7,031 brown trout per mile, the second highest fall estimate since monitoring began in 1981 (Figure 3). Trophy trout numbers were the lowest on record (Table 2), largely due to cold water temperatures slowing trout growth during the 1985 drought. Water

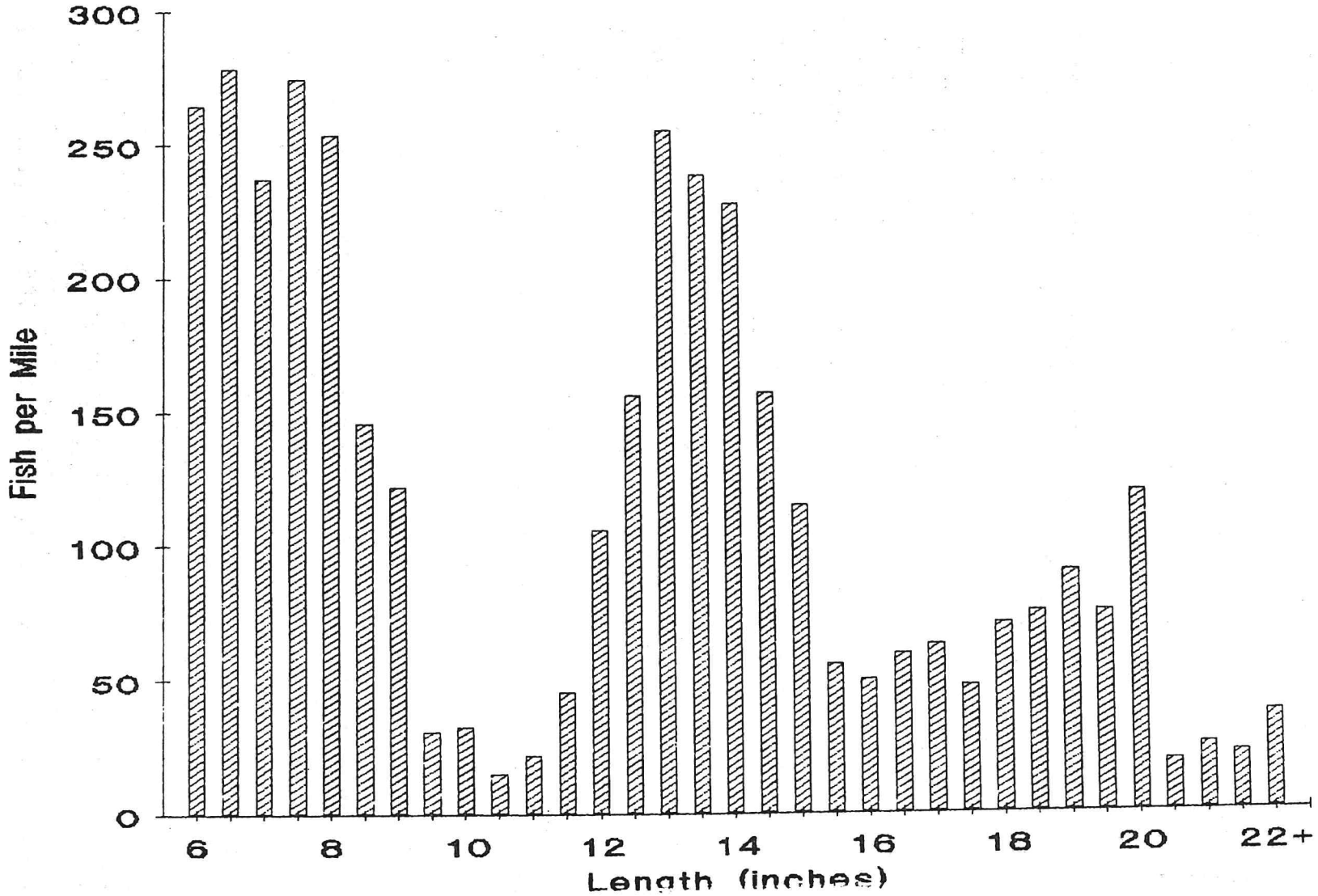

Figure 2. Estimated length-frequency of the brown trout population in the standard electrofishing section of the upper Bighorn River during July 1981. Total population estimate = 3,918 per mile.

Table 1. Estimated number per mile of age one and older brown trout in a 7.2 mile section of the Bighorn River between the Afterbay Dam and Bighorn Fishing Access.

Date	Brown Trout Per Mile
July 1981	3,918
December 1981	2,218
May 1982	5,107
December 1982	3,368
May 1983	5,627
September 1983	4,193
May 1984	5,925
September 1984	7,645
May 1985	9,660
September 1985	5,246
March 1986	*
September 1986	7,031

*Estimate of age one fish is invalid.

Table 2. Estimated number of brown trout of various size groups per mile of the Bighorn River, and minimum summer flows in the interval between population estimates from 1981 through 1986.

	Brown Trout per Mile				Lowest 30-day Average Flow (cfs)
	18"+	18-20"	20-22"	22"+	
July 1981	533	311	185	37	1,792
December 1981	322	163	123	36	1,953
December 1982	327	197	112	18	3,032
September 1983	331	258	66	7	3,610
September 1984	546	434	101	11	1,461
September 1985	402	331	66	5	3,005
September 1986	288	234	49	5	

temperatures in the Bighorn River during summer 1985 were colder than during any previous summer (except 1977) since construction of Yellowtail Dam in 1965. As a result, trout of all ages were one to two inches shorter than average. The smaller average size of fish carried over into 1986 and should be noticeable in the population for at least two more years. Estimates of the age class composition of the fall 1986 brown trout population indicate numbers of age three and older fish (the fish that comprise the trophy trout population) are higher than ever. However, age three fish in fall, 1986 averaged 15-17 in in length instead of 17-18 in as they have in past years.

Population monitoring in three sections of the Bighorn River has demonstrated that numbers of brown trout decrease rapidly with distance from the Afterbay Dam. Food may be abundant nearer the dam, or brown trout may concentrate in the spawning grounds there, resulting in higher recruitment levels. Regardless, in fall 1986, nearly twice as many brown trout were found in the reach from the Afterbay Dam to 3.8 mi downstream compared to the standard monitoring section (2.4 to 9.6 mi below the Afterbay Dam). A section near St. Xavier (17.6 to 21.6 mi below the Afterbay Dam) has consistently yielded estimates of one-third to one-fourth the population found in the standard monitoring section (Figure 4). The number of brown trout age three or older, however, was approximately the same in both sections. Additionally, growth rates tend to be slowest near the Afterbay Dam where water temperatures are coldest.

Rainbow Trout

Unlike the naturally reproducing brown trout, rainbow trout populations in the upper Bighorn River have been dominated by hatchery fish. Over 263,000 rainbows have been planted in the upper river since 1966 (Table 3). The most recent plant was in October 1983. Large plants made in 1979, 1981, and 1983 have accounted for the bulk of the rainbow population since the river was reopened to fishing.

MDFWP personnel were unable to recapture enough fish to obtain a quantitative estimate of the rainbow trout population in the upper river in July 1981. According to angler reports, large rainbows were plentiful when the river was reopened to fishing in 1981. It is likely that many were harvested during the first season of fishing. In December 1981, only 39 rainbows per mile greater than 18 in long were found. Since then, peak numbers of trophy rainbows have occurred in 1983 and 1985 (Table 4). Each of the peaks occurred four years following large plants.

Fall 1986 rainbow population estimates ranged from 740 per mile in the uppermost section of river, to 689 per mile in the standard monitoring section, to 432 per mile in the St. Xavier area. Numbers of trophy rainbows were lower than in fall 1985, but were still relatively high. Although total numbers were

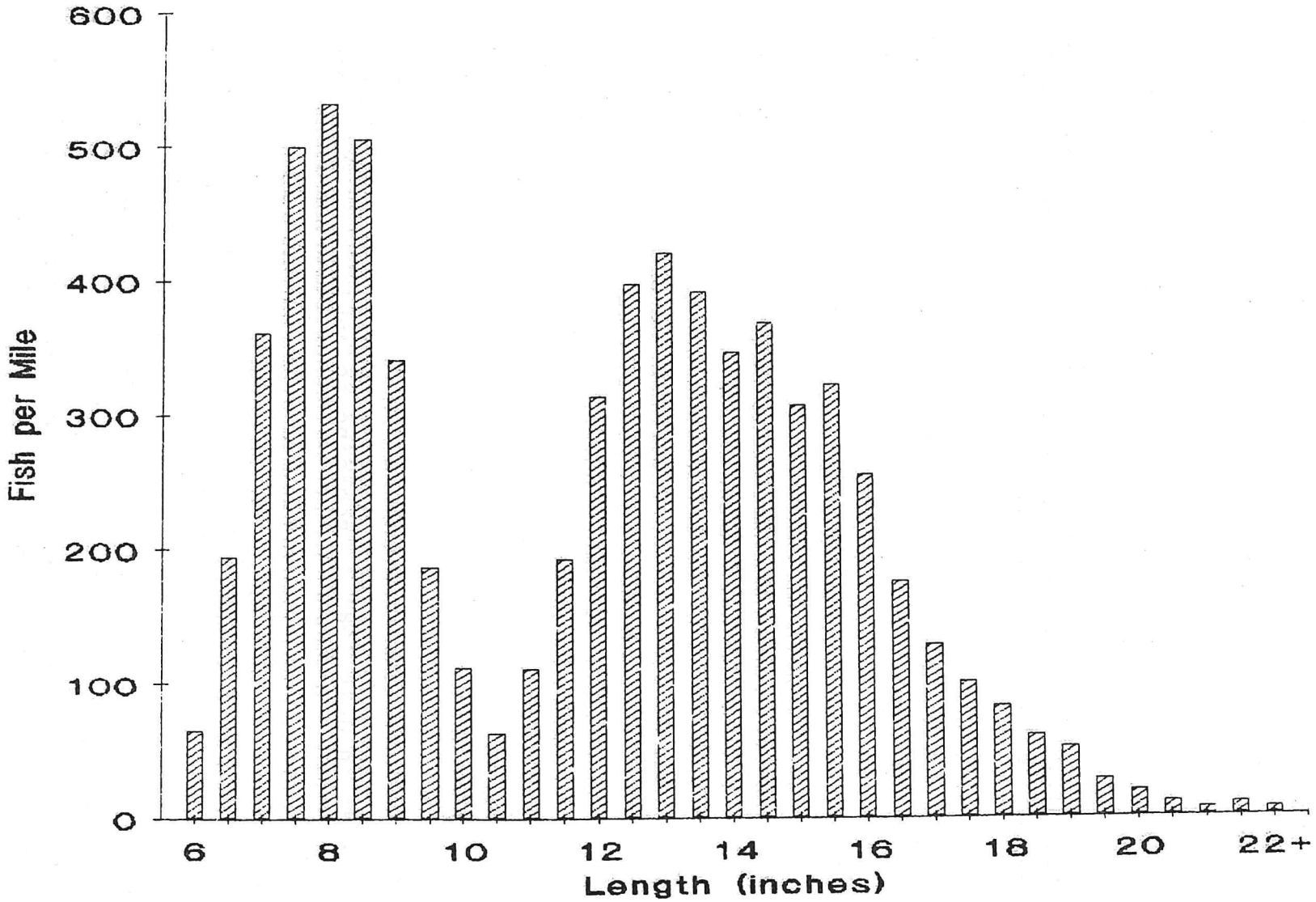

Figure 3. Estimated length-frequency of the brown trout population in the standard electrofishing section of the upper Bighorn River during September 1986. Total population estimate = 7,031 fish per mile.

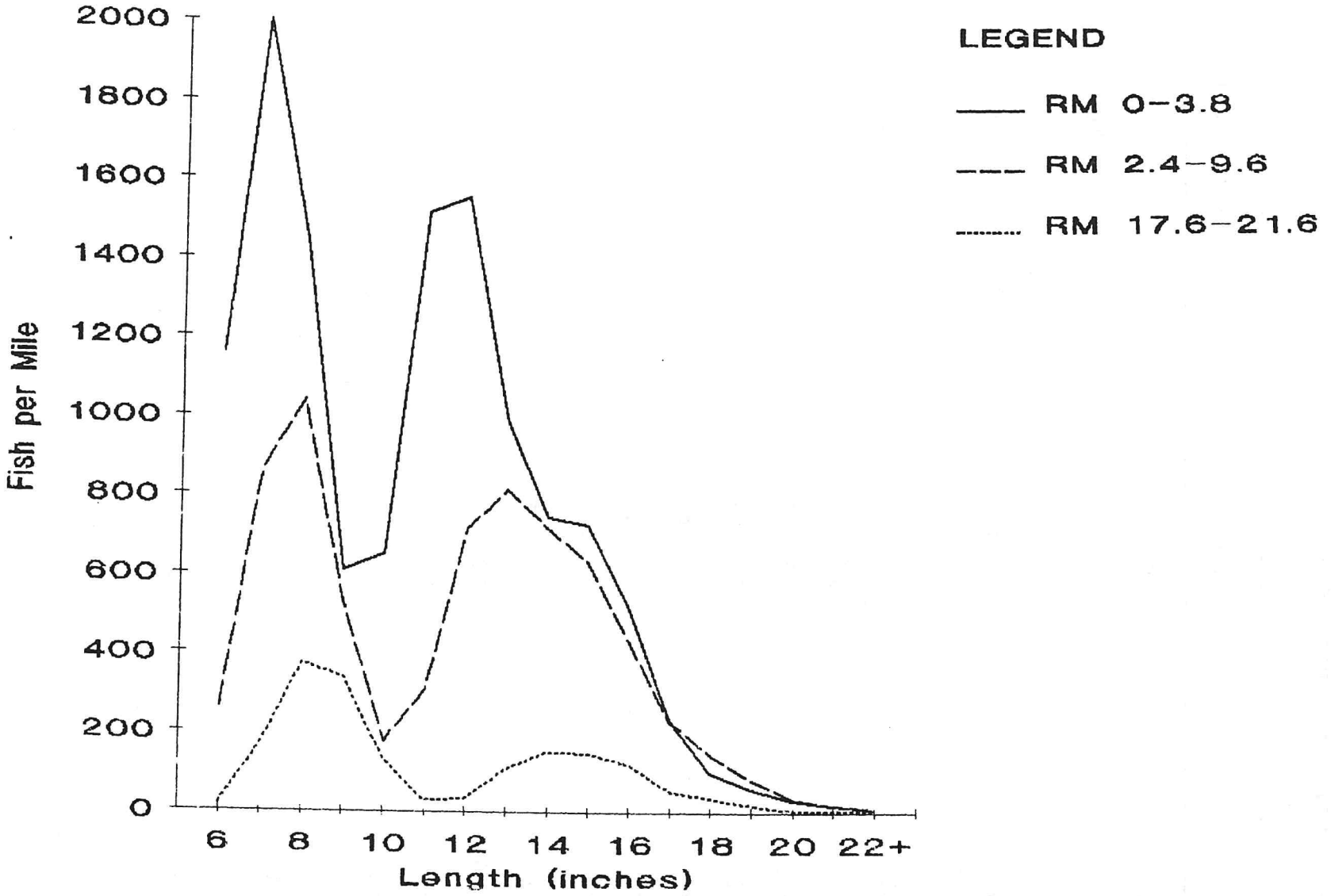

Figure 4. Comparative estimated length-frequencies of brown trout populations during September 1986 in the upper (RM 0-3.8), standard (RM 2.4-9.6), and St. Xavier (RM 17.6-21.6) electrofishing sections of the upper Bighorn River.

Table 3. Rainbow trout planted in the Bighorn River above Two Leggins Diversion since 1966.

Date	Number	Length (inches)
5/5/66	8,010	4
5/5/66	1,580	10
4/7/67	10,080	3
5/8/68	10,080	4
7/3/69	11,300	6
9/29/69	2,250	10
7/16/70	18,000	6
8/6/71	9,989	7
7/26/72	15,504	7
7/27/72	2,240	7
7/26/73	13,000	4
7/8/75	15,600	5
7/14/76	13,200	6
11/10/76	20,125	3
5/14/79	24,700	5
8/24/81	17,993	6
8/27/81	11,750	6
8/28/81	10,771	6
5/5/82	1,325	7
10/24/83	45,591	5
TOTAL	263,088	

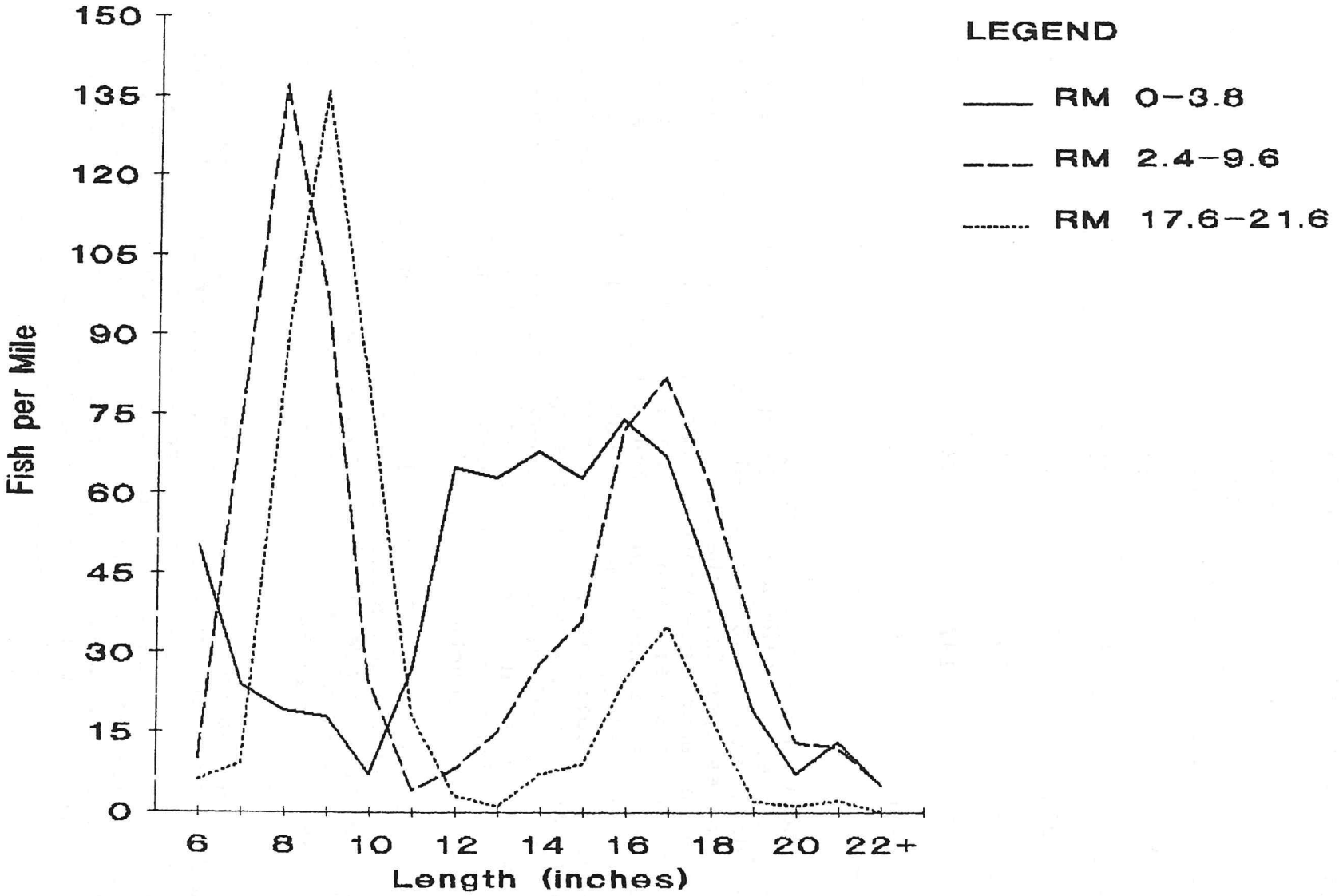

Figure 5. Comparative estimated length-frequencies of rainbow trout during September 1986 in the upper (RM 0-3.8), standard (RM 2.4-9.6) and St. Xavier (RM 17.6-21.6) electrofishing sections of the upper Bighorn River.

Table 4. Estimated number of rainbow trout of various size groups per mile of the Bighorn River, 1981-86.

	18"+	18-20"	20-22"	22"+
December 1981	39	18	13	8
December 1982	34	19	11	4
September 1983	147	108	35	4
September 1984	135	95	37	3
September 1985	197	126	49	22
September 1986	120	92	24	4

similar, the rainbow populations in the various sections were distinctly different (Figure 5). The uppermost section (Afterbay to 3.8 mi downstream) was composed almost entirely of hatchery rainbows that escaped from the Afterbay reservoir. Few rainbows in the 6-10 in range were found in the uppermost section in fall 1986. In the standard and St. Xavier monitoring sections, numerous 6-10 in rainbows were found (Figure 5). These were nearly all wild fish, hatched in 1985. Few fish in the 10-14 inch range were found in the lower two sections, while fish in that size range were common in the uppermost section, having escaped from the 1985 plant in Afterbay reservoir. Consequently, it is expected that numbers of trophy rainbows will decline in the lower sections over the next two years until the 1985 year class of wild fish reaches trophy size.

Observations of age 0 fish collected in September indicated rainbow spawning was again successful in 1986. The 1985 and 1986 rainbow year classes are the first to show significant numbers of wild fish. A similar pattern of increased natural reproduction after stocking of hatchery fish ceased has been noted in other Montana Rivers.

More conservative fishing regulations were implemented in 1984 to further protect rainbow trout. Prior to 1984, rainbow and brown trout were included in the same limit. Rainbows tend to be more susceptible to angling and are usually caught at a disproportionate rate. For example, brown trout were seven times more abundant than rainbows in September 1983 but were caught only 2.8 times as often. Since the regulations were changed to allow harvest of only one rainbow per day in 1985, harvest rates have been more proportional to population levels of the two species.

Angler Use

A comprehensive creel census conducted from October, 1982 through September 1983 resulted in an estimated 11,840 man-days of fishing pressure on the Bighorn River from the Afterbay to Bighorn Fishing Access. A similar census from 1973 estimated 13,000 man-days on the same section. In the interim, however, the Bighorn's reputation had grown, and the anglers fishing the river changed from mostly Montana residents to over one-third nonresidents.

Since 1983, fishing pressure on the upper 12 mi of the Bighorn River has been continuously monitored through use of a car counter at Bighorn Fishing Access. The counter was in place during the comprehensive 1982-83 creel census. The car counter yielded an estimate of 11,667 man-days of use in calendar year 1983 (Table 5). Fishing pressure dropped slightly in 1984, probably due to adverse publicity regarding a fish kill that occurred in July 1984. A marked increase to a total of 14,943 man-days occurred in 1985, but in 1986 fishing pressure leaped to nearly 22,000 man-days. Pressure during the peak use period (June through September) increased only 15 percent from 1983 to 1985 but jumped by 85 percent from 1985 to 1986 (Figure 6).

Prior to 1986, MDFWP received few complaints about crowded fishing conditions on the Bighorn. In 1986, however, complaints about too many fishermen were common. Heavy fishing pressure also generated much concern among users regarding its effects on fish populations. In October 1986, MDFWP fisheries personnel met with concerned sportsmen at public meetings in Billings and Fort Smith to discuss fisheries management of the river. At both meetings, sportsmen were asked for their opinions concerning goals, objectives, and management strategies for the upper Bighorn River. Additional input was obtained from letters.

Public comments received to date indicate anglers are interested in managing the Bighorn River to produce large trout rather than large numbers of trout. In spite of evidence suggesting habitat factors are more important in controlling fish populations (particularly brown trout), most public concern has centered around regulations. Suggested regulation strategies have included:

1. Opening the entire river to bait fishing,
2. Eliminating use of bait in the reach from the Afterbay Dam to the aerial cable 600 feet downstream,
3. Reducing the current five fish limit,
4. Changing the current size restriction of one fish over 18 inches to afford more protection for large fish,
5. Imposing more restrictive regulations such as a slot limit or catch and release, and
6. Requiring the use of single and/or barbless hooks.

Table 5. Estimated fishing pressure (man-days) on the upper 12 miles of the Bighorn River, 1983-86.

	1983	1984	1985	1986
January	474	174	349	795
February	586	489	643	378
March	577	661	728	1,349
April	549	804	1,150	1,129
May	1,128	946	1,914	1,647
June	1,204	1,089	1,249	2,164
July	1,334	944	1,472	3,458
August	2,156	1,525	2,381	4,973
September	1,516	1,282	2,034	2,593
October	1,210	974	1,549	1,709
November	364	603	630	665
December	269	360	844	874
Total	11,667	9,851	14,943	21,724

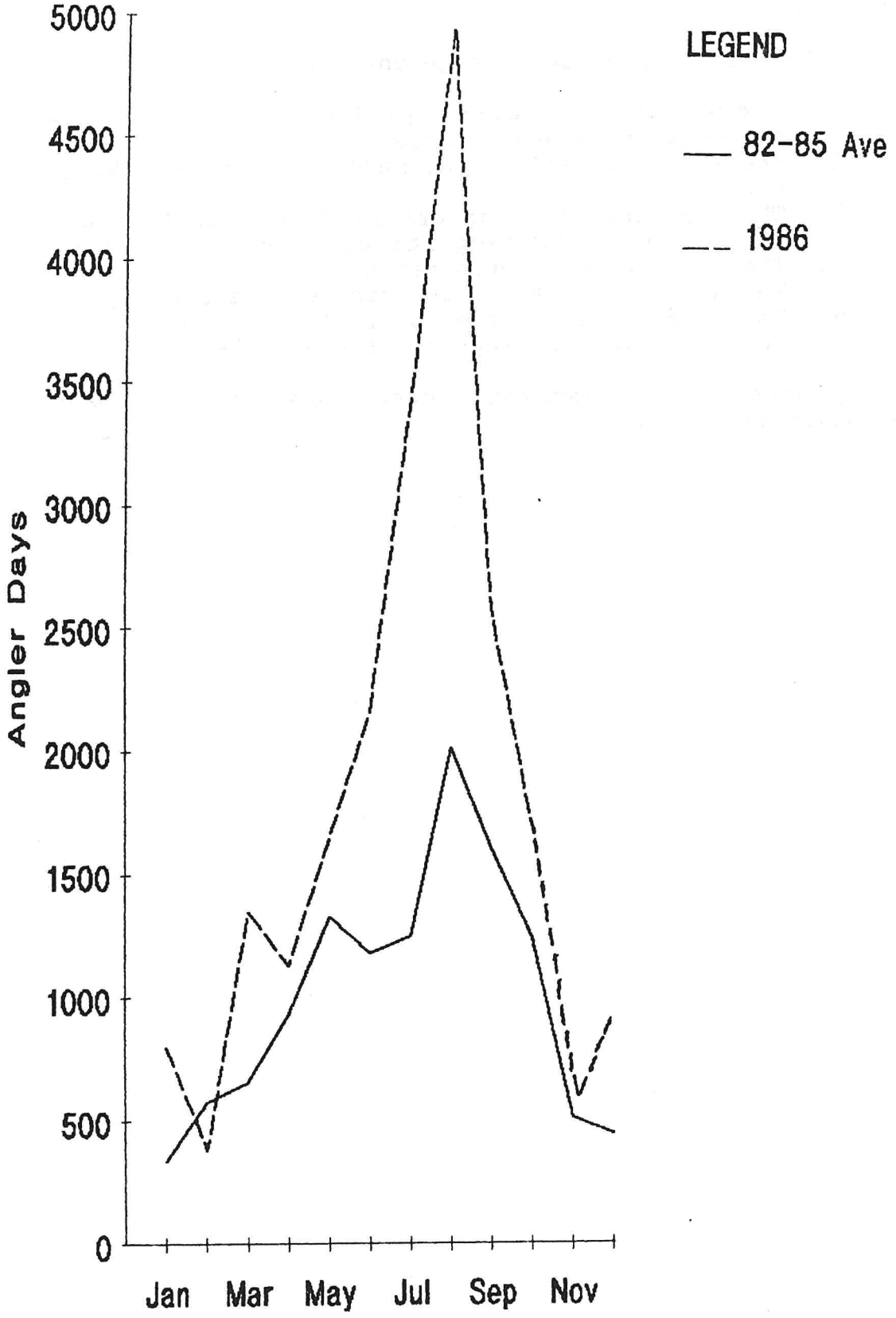

Figure 6. Comparative monthly fishing pressure on the upper 12 miles of the Bighorn River from October 1982 through December 1985 (average values) and during calendar year 1986.

Other fish population management concerns raised, included:

1. A need for increased protection of rainbow trout spawners and spawning sites,
2. The merits of wild trout management vs. stocking rainbow trout,
3. The practice of "high grading," or releasing of smaller fish in order to keep larger ones as they are caught,
4. The need for more enforcement,
5. The need for more fishing access sites, and
6. The need for increased information and education efforts regarding various aspects of the fishery.

The strategies and concerns listed above are addressed in the following sections.

GOALS, OBJECTIVES AND STRATEGIES

Fisheries Management Goal

To meet public demand for a high quality, wild trout fishing experience on the upper Bighorn River with a management emphasis on maximizing the opportunity to catch large trout.

Objectives

1. To maintain average population densities of 5,000 to 7,000 age one and older brown trout per mile, and at least 500 18-in and larger brown trout per mile, in the upper 12 mi of the Bighorn River.

2. To maintain average population densities of 1,500 to 2,500 age one and older brown trout per mile in the Bighorn River between Bighorn Fishing Access and Two Leggins Access (Figure 1).

3. To maintain average population densities of at least 1,000 age one and older rainbow trout per mile and at least 150 18-in and larger rainbow trout per mile in the upper 12 mi of the Bighorn River.

4. To maintain average population densities of at least 500 age one and older rainbow trout per mile in the Bighorn River between Bighorn Fishing Access and Two Leggins Access (Figure 1).

5. To develop a framework for regulating and redistributing fishing pressure on the upper Bighorn River to maintain use at acceptable levels.

Brown trout population objectives are slightly higher than the average fall population density during the 1981-86 period. Rainbow trout population objectives are significantly higher than the average fall population density during the 1981-86 period.

Strategies

Management strategies designed to attain the objectives listed above can be grouped into the following three categories: fish habitat, fish populations, and angler use.

Fish Habitat

Fish habitat strategies include:

1. To establish minimum flow targets in cooperation with the U.S. Bureau of Reclamation (USBR) designed to maintain optimum trout habitat conditions, given water supply constraints,

2. To assist the USBR, other agencies and private entities

in solving the gas supersaturation problem at the Afterbay Dam, and

3. To determine the contribution of Soap Creek rainbow spawners to the total Bighorn River rainbow trout population, factors affecting rainbow trout production in Soap Creek, and strategies to improve production (if necessary).

Flows

The USBR will strive to meet the following minimum flow targets established by MDFWP:

Optimum flow - 2,500 cfs
Standard flow - 2,000 cfs
Minimum flow - 1,500 cfs

MDFWP studies indicate summer mortality of brown trout in the upper Bighorn River is highly correlated with minimum flows. Mortality decreases as flow increases. In general, the brown trout population can be expected to increase over the long term when flows remain above 2,500 cfs and decrease when flows drop below 2,000 cfs. The population should remain stable at flows between 2,000 cfs and 2,500 cfs.

The USBR estimates a minimum flow of 2,000 cfs can be maintained year around approximately seven to eight out of 10 years with no adverse effects on power generation or recreation opportunities in Bighorn Lake. The 2,500 cfs optimum flow could be maintained in four to five years out of 10. The minimum flow of 1,500 cfs could be maintained nine out of 10 years. Flows below 1,500 cfs might occur if two or more consecutive years of drought occur. The USBR's minimum operating criteria for Yellowtail Dam include a minimum flow level of 1,000 cfs. An annual one-day drawdown to 400 cfs is required during October by the USBR to measure flows from springs near the left abutment of Yellowtail Dam.

The USBR is most likely to encounter problems in meeting minimum flow targets during April and May. Depending on snowpack and weather conditions, inflow to the reservoir may be lower than minimum flow targets during the early spring period. The USBR attempts to hold Bighorn Lake water levels stable or rising in the spring to benefit walleye spawning and recreational access to the reservoir.

USBR studies indicate the 1,500 cfs minimum flow could be met during a single severe drought year without notable adverse effect on summer and fall recreational use of the reservoir. There would be a loss of powerplant capability, however, due to loss of head in the reservoir. MDFWP and the USBR will continue to work together to identify economic costs and benefits of providing minimum instream flows.

Up to 240,000 acre-feet of water in Yellowtail Reservoir is available for purchase. It may be possible to purchase water to augment instream flows during drought years. This purchase would require development of a funding source (most likely from private rather than state sources) and negotiation of price and delivery conditions with the USBR. Any changes in operations may affect several interests and should be coordinated between USBR, MDFWP, National Park Service, and Wyoming Game and Fish Department.

Gas Supersaturation

The gas supersaturation problem originates at the Afterbay Dam where water plunges over the sluiceway and spillway gates. Air bubbles are trapped in the water and forced into solution by increased pressure as the water plunges into the stilling basin. Construction of a powerplant and bypass system would eliminate the gas supersaturation problem by routing water through penstocks rather than over the dam.

MDFWP will continue to assist and encourage USBR, other agencies, and private interests in their attempt to build a powerplant and bypass system in the Afterbay Dam. MDFWP will also continue to assist researchers from the Montana Cooperative Fisheries Research Unit (MCFRU) in their study of the effects of gas supersaturation on fish populations in the Bighorn.

Previous research suggests that gas bubble trauma is at times a major cause of mortality in the fish population of the uppermost reach of the Bighorn River. The ongoing study is designed to determine physiological and behavioral responses of fish to gas supersaturation. Information collected by the researchers will be valuable to MDFWP in refining management strategies to deal with gas supersaturation until the problem can be eliminated.

MDFWP fully supports construction of a powerhouse in the Afterbay Dam if the following conditions are met:

1. A bypass system with a capacity of at least 2,500 cfs is included in the project,

2. Penstocks and the bypass system are screened to prevent entrainment of fish,

3. Sportsman access to the river is maintained during the construction process, and

4. Daily and seasonal flow patterns in the Bighorn River are not altered from the present regime.

Elimination of the gas supersaturation problem would have other benefits in addition to reducing trout mortality. More fish should be available to anglers with fewer fish suffering from sublethal effects of gas bubble trauma. Trophy trout

management options would also increase if gas supersaturation were eliminated. Potential forage fish for large trout such as mountain whitefish would become more abundant without supersaturation. The introduction of sculpins for forage would likely fail under the present conditions, but may be possible once the gas problems were eliminated.

Rainbow Trout Spawning Habitat

Bighorn River rainbow trout spawn either in the mainstem river or Soap Creek, a tributary that enters the river approximately nine miles below the Afterbay Dam. Mainstem spawners are affected by river flows and gas supersaturation, both of which have already been addressed. Effects of anglers on mainstem spawners will be addressed later. Soap Creek spawners are affected by water quality and a major irrigation diversion on the creek.

Turbidity and sulfide discharge are the major water quality problems affecting Soap Creek. Turbidity is caused mainly by naturally erosive soils. Sediment contributions from eroding stream banks could be reduced if the banks were stabilized but the cost would probably be prohibitive. Sulfide discharge from the oil fields on upper Soap Creek has been reduced.

Adult rainbow trout ascending Soap Creek to spawn have trouble negotiating the Soap Creek diversion dam. Although some fish get over the dam, it appears many do not. Some adults that are successful in getting over the dam and many juvenile rainbows may be lost in the irrigation canal on their downstream trip to the river. Eliminating the barrier and screening the canal should increase recruitment of wild rainbow trout to the Bighorn River.

Fish Populations

Montana's trout streams are managed with the goal of providing a high quality wild trout fishing experience. The key elements of wild trout management are preservation of quality trout habitat and regulating the fishery to prevent overharvest. Montana has some of the most progressive habitat protection legislation in the nation including laws granting instream flows, stream bank and bed protection and water quality standards. On some of the state's more popular streams, special restrictive fishing regulations have been implemented to protect wild trout populations. Keeping a few fish for the frying pan is a time honored and legitimate use of the fishery resource. However, it is the policy of MDFWP that recreation, not harvest, is the prime benefit derived from the wild trout resource in Montana's streams.

Brown Trout

The following strategies are recommended for management of brown trout in the upper Bighorn River:

1. Continue to place management emphasis on providing high quality habitat,
2. Continue with present regulations structure and annual evaluation of effectiveness of regulations,
3. Increase monitoring of fishing pressure and angler success,
4. Increase information and education efforts regarding status of the fishery, proper methods of releasing fish, use of barbless hooks and river etiquette, and
5. Artificially enhance the brown trout population of the St. Xavier area by transplanting age one brown trout from the upper river.

Habitat factors appear more important than regulations in controlling the Bighorn River brown trout population. Management of flows is the most important of the habitat factors. The USBR is committed to incorporating the minimum flow targets established by MDFWP in their operating goals for Yellowtail Dam. The USBR's ability to meet the flows will, of course, be contingent upon hydrologic conditions.

It is unlikely that imposition of more restrictive fishing regulations would result in a significant increase in the brown trout population, or the proportion of trophy fish in the population at this time. Numbers of trophy brown trout have fluctuated in response to flows and water temperatures. A rapid decline in trophy brown trout numbers occurred when regulations were much more restrictive than now. The underlying assumption for restrictive regulations is that angler harvest is the major factor controlling the fish population. This is apparently not the case with brown trout in the Bighorn River.

A reduction of the overall limit or the size restriction now imposed would likely result in increased "high grading," i.e., replacing smaller fish on a stringer with larger as they are caught. An education program is planned to encourage those anglers wishing to keep fish to focus on keeping smaller fish. The practice of "high grading," while not illegal, is nevertheless undesirable. Fish that are held on a stringer and then released are less likely to survive than if they had been released immediately.

The slot limit and catch-and-release are the most restrictive forms of regulations. These regulations have been very successful in increasing trout populations in other Montana streams where angler harvest was a major factor. A slot limit was not effective while in effect on the Bighorn River. Imposition of either of these regulations on the Bighorn would restrict recreational opportunity for that segment of the angling public wishing to harvest fish without providing additional benefits to other anglers.

Use of bait is currently prohibited from the cable below the Afterbay Dam to Bighorn Fishing Access. Regulations in effect

require the release of many brown trout over 18 in in length, as as well as many rainbow trout. Several studies have shown that mortality of fish caught and released on bait is significantly higher than those caught on flies or lures. For that reason, a change to allow bait fishing in this reach is not recommended. The bait fishing section between the Afterbay Dam and the cable 600 feet downstream is extremely popular and receives heavier use than any other reach of the river. While the same regulations are in effect for the entire upper 12 mi of river, there are fewer trophy brown trout in the upper 3 mi, and nearly all rainbows are hatchery fish that have escaped from the Afterbay reservoir. Bait fishing in this short reach has a negligible effect on the Bighorn River trout population. Elimination of bait fishing would restrict recreational opportunity for many anglers without serving any useful purpose biologically.

Use of barbless hooks has been suggested as a method of reducing mortality and the incidence of missing maxillaries (the small bone on the upper jaw on either side of a fish's mouth). Numerous studies have shown no difference in mortality of fish caught and released on barbed or barbless hooks. However, removing a barbless hook from a fish's mouth is much easier than removing a barbed hook. Less damage to the mouth, gills and maxillary is likely to occur. Blindness caused by hook penetration of the eye may actually increase slightly with barbless hooks, because they tend to penetrate deeper than barbed hooks.

Because the majority of anglers on the Bighorn release some if not all the fish they catch, use of barbless hooks is desirable. An information and education program to encourage their use will be initiated. The program will also focus on proper methods of catching and releasing fish. A brochure summarizing Bighorn River management objectives, describing how to properly release fish, the desirability of using barbless hooks, and river etiquette will be published.

Artificial enhancement of the St. Xavier area brown trout population would be an experimental program carried out over a period of several years. The program would not be implemented until the MCFRU gas supersaturation study is completed. Population monitoring in the upper electrofishing section during 1985 and 1986 indicated mortality rates of age one brown trout were significantly higher than in the standard or St. Xavier sections. Excellent spawning conditions in the upper three miles of the river may be creating an oversupply of young fish. The high mortality rates may be nature's way of compensating for an oversupply. On the other hand, recruitment of young brown trout in the St. Xavier area may be limited by poor spawning habitat. Sediment levels in the St. Xavier area are much higher, reducing the quality of spawning gravels. In other respects, the St. Xavier area appears to be capable of producing more fish.

The proposed program would involve electrofishing and removal of 4,000 to 6,000 age one brown trout from the upper three mi of the Bighorn River. These fish would be transplanted

to the four-mile long St. Xavier electrofishing section. Justification for the population manipulation is based on the theory that natural mortality rates in the upper section would be reduced so that no noticeable reduction in the fish population would occur. The fish population in the St. Xavier area could be significantly enhanced, thereby serving to attract more anglers to the area below Bighorn Fishing Access. Total biomass in the upper river may shift more towards adult fish, the goal of fisheries management in the river. Populations in both sections would be monitored twice annually to evaluate success or failure of the experiment.

Rainbow Trout

The following strategies are recommended for management of rainbow trout in the upper Bighorn River:

1. Continue present emphasis on wild trout management.

2. Implement catch and release regulations on rainbow trout in the river from the Afterbay Dam to Bighorn Fishing Access beginning in 1988, and

3. Assess the feasibility of closing key mainstem rainbow trout spawning areas to fishing on an experimental basis.

Fall 1986 fish population monitoring indicated natural reproduction of rainbow trout has increased since stocking of rainbow trout ceased in 1983. A notable exception is the upper three miles of the river, where virtually the entire rainbow population is made up of fish that escaped from the Afterbay reservoir. Population studies in several other Montana rivers have shown a similar trend of increased natural reproduction after stocking ceased.

A commitment to managing the Bighorn River rainbow fishery for wild fish will require more protection than is afforded under the current regulation structure. The intense fishing pressure occurring on the upper 12 mi of the river, combined with high vulnerability to angling and low population densities could halt or significantly impede wild rainbow population growth. The one fish limit on rainbows encourages "high grading." Since a short term decline in trophy rainbow trout is expected as older hatchery fish die; therefore, additional protection through catch and release regulations for the reproducing segment of the population is warranted. If the wild rainbow trout population continues to grow, a limited harvest may be possible in the future.

Closure of key spawning areas would protect a large proportion of the rainbow trout spawning population from the stress of being caught and released during the spawning season. Many rainbows are highly vulnerable to angling as they spawn in shallow side-channel areas. Recent studies conducted on Nelson

Spring Creek indicate egg mortality was significantly increased in heavily fished spawning areas as a result of trampling by wading anglers. Closure of key spawning areas would prevent mortality due to trampling by anglers and should increase production.

Identification of spawning areas will lead to some enforcement problems even if the areas are closed. Crow tribal members are not bound by Montana fishing regulations on the reservation. Some anglers may find it difficult to resist the temptation to fish in a closed area. Spawning area closures should be made on a limited trial basis. They should be closely evaluated to determine if increased production occurs and whether or not the increases outweigh any enforcement problems encountered.

Each of the closed areas would be posted with temporary signs and patrolled regularly. The closure period would include the entire rainbow trout spawning season. Although eggs would remain in the gravel for up to a month after the closure ends, this generally occurs during the period of peak flows when wading in these areas would be difficult and spawners would no longer be present.

Angler Use

Recommended strategies for management of angler use on the upper Bighorn River include:

1. Purchasing of additional access sites to increase angling opportunities and more evenly distribute fishing pressure,

2. Reviewing regulations annually to ensure that angler use and harvest do not prevent attainment of fish population objectives, including development of a progressive, multi-stage framework for regulating recreational use,

3. Increasing monitoring of the fishery and enforcement efforts during the peak use season, June through September,

4. Preparing a project proposal for the 1989 Montana Legislature to fund a river ranger position, and

5. Conducting a comprehensive creel, recreation and angler opinion survey in 1990.

The reach between Bighorn Fishing Access and Two Leggins Fishing Access receives light fishing pressure primarily due to the long float distance between access points (20 mi). MDFWP efforts have been focused on purchasing another access area between Bighorn and Two Leggins. The effort has culminated in the acquisition of the Mallards Landing Access Site. Efforts should be made to eventually acquire additional access areas near

St. Xavier and in the reach between Lind and Bighorn Access Areas. Increasing the number of options available to anglers should spread use more evenly. It is particularly important to try to reduce pressure on the upper 12 miles of river.

Fishing pressure will likely continue to increase on the Bighorn River. While redistribution of pressure may alleviate some of the problems encountered in 1986, more restrictive measures will probably be necessary in the long run. Restrictive fishing regulations have been suggested as a means of reducing pressure. Catch and release or other restrictive regulations often serve to attract anglers, however, and pressure usually increases on these sections in the long run.

Regulations on boat use, such as float closures, prohibiting fishing from boats, reservation systems, and boat quotas have also been suggested. Bank access is restricted along most of the river. Consequently, floating is the only means of access for most anglers. A float closure would be too restrictive. Fishing from boats has been prohibited on sections of other Montana rivers, most notably the Madison. This would have little effect on fishing pressure on the Bighorn, because most anglers use a boat primarily for transportation and fish from shore.

Presently, MDFWP has no authority to limit recreational use other than for public safety on navigable streams like the Bighorn River. On smaller streams, MDFWP can regulate recreational use where a clear threat to property or fish populations exists. Unless the Montana Legislature grants MDFWP authority to regulate the amount of recreational use on the Bighorn, a reservation or quota system cannot be implemented. However, a progressive, multi-stage framework for regulating recreational use will be developed. It could include measures such as voluntary reservations, mandatory reservations or quotas and permits. The program would be implemented only if present MDFWP authority is expanded.

One concern is the possible effect of recreation on the security of the upper Bighorn for resting waterfowl. Since 1981, the number of waterfowl overwintering on the upper Bighorn has declined noticeably and faster than the mallard population. The disturbance of resting ducks and geese on favorite loafing sites may be a major factor in these declines. Should these declines continue or worsen as fishing pressure and other use of the upper river increases, some restriction on boat travel may be considered. As additional access areas are acquired, the potential for disturbance further increases, but so do the options for closing short reaches of the river between two access points to establish secure resting areas. Despite the decline in wintering waterfowl numbers, hunters are presently satisfied with the hunting. Until hunters perceive a need for a use restriction, none will be recommended.

Monitoring of fishing pressure and angler attitudes should continue. The fishery may be self-regulating, i.e., anglers may

voluntarily redistribute fishing pressure due to crowded conditions. A study should be initiated to assess angler attitudes and opinions regarding management of the Bighorn River fishery and assist in developing the phased approach to implementing control of recreational use discussed above.

The proposed river ranger position would serve several functions. The person hired for the position would have a biological background and be trained as an ex-officio game warden. The river ranger would be on the river full time during the peak use season and part time during the remainder of the year. Duties of the position would include collection of creel and angler attitude and opinion information, enforcement of fishing regulations including frequent patrol of areas posted for fishing closures, maintenance at MDFWP fishing access sites, and assisting MDFWP biologists and wardens as necessary. Creation of a new position and funding would require approval of the Montana Legislature. If approved, the position would not be filled until after July 1, 1989.

A comprehensive creel and angler opinion survey should be conducted in 1990, prior to preparation of a management plan for the 1992-97 period. The study should be designed to determine maximum use levels acceptable to users. The last comprehensive creel census was conducted in 1982-83. Increased fishing pressure, redistribution of recreational use, and difficult choices for alternative management strategies dictate the need for a comprehensive user survey. Conducting the survey in 1990 would allow enough time for new recommended management strategies to take effect, and allow time for analysis prior to writing the 1992-97 management plan.

REVIEW OF DRAFT PLAN

A total of 104 responses to a questionnaire concerning the draft "Upper Bighorn River Fisheries Management Plan" were received. In general, those who replied felt the draft plan improved their understanding of the Bighorn and its fishery (Table 6). The majority agreed with the fish habitat, fish population, and angler use objectives and recommended strategies.

Additional comments received from respondents were incorporated into this final management plan for 1987-92.

Table 6. Responses to the Upper Bighorn River Management Questionnaire. (Percent recorded under each opinion category is based on a total of 104 responses.)

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
The management plan improved my understanding of the Bighorn River and its fishery.	39.4	53.8	4.8	2.0	0.0
I agree with the fish habitat objectives and recommended strategies.	37.5	45.2	5.8	7.7	3.8
I agree with the fish population objectives and recommended strategies.	27.9	47.1	6.7	12.5	5.8
I agree with the angler use objectives recommended strategies.	24.0	45.2	7.7	16.3	6.8
My opinion of how the Bighorn River should be managed/changed as a result of reading the plan.	8.7	41.3	23.0	23.1	2.9