Bighorn River Creel Census

March, 1982 - October, 1983

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ABSTRACT

A creel census study was conducted on the Bighorn River from the Afterbay Dam 31 miles downstream to two Leggins Access during March, 1982 through September, 1983. Estimated total pressure for the one-year period from October, 1982 through September, 1983 on the heavily fished 12-mile reach between the Afterbay Dam and Bighorn Access was 11,840 man-days (73,574 hours). Total catch was estimated at 25,626 brown trout and 9,197 rainbow trout within that reach with a harvest of 5,162 brown trout and 2,307 rainbow trout. Catch rates averaged 0.34 brown trout and 0.12 rainbow trout per hour.

Overall, a total of 10,707 fishermen were interviewed and characteristics of the angler population and fishery in three stream sections are presented. The Bighorn River is characterized as a high-quality, float-fishing stream with a diverse user group. The heavily used 12-mile special regulation reach attracts heavy use by nonresidents and professional guides. Reaches upstream and downstream where bait use is not restricted are dominated by Billings anglers. Rainbow trout catch rates are much higher in sections where bait use is allowed. Nearly three-fourths of all anglers caught at least one trout and about 40% caught a limit of three trout. Nearly 60% of the anglers did not keep any fish and 8% kept a limit of three trout. The average length of fish harvested was 15.7 inches for brown trout and 15.5 inches for rainbow. About 18% of the trout harvested were over 18 inches long.

Comparison to a 1973 census on the Bighorn shows the fishery has evolved into a wild brown trout fishery from one that was dominated by stocked rainbow trout in 1973. Angler use by nonresidents has increased dramatically, but total pressure has changed little. Regulation changes were implemented in May, 1984 in order to reduce exploitation of the rainbow trout population which is experiencing heavy angler-induced mortality. Angler-induced mortality is a minor factor in controlling brown trout population levels.

ACKNOWLEDGEMENTS

Anita Dalton was the creel clerk who so ably collected and coded the data through 18 months of long hours, missed weekends, and sometimes difficult weather. For enduring the stories of 10,707 fishermen she deserves a lot of credit.

Bob McFarland used his creative computer wizardry to manipulate the raw data into the meaningful results presented here. Mark Schollenberger assisted in the data preparation.

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INTRODUCTION

From 1975 through August 19, 1981, the 44 miles of the Bighorn River on the Crow Indian Reservation were closed to fishing by nontribal members. During most of that period, the Montana Department of Fish, Wildlife and Parks did not do any work on the Bighorn River within the reservation boundary. Prior to 1975, work was mainly limited to a creel census conducted during 1972 and 1973 (Stevenson 1975). Comparisons with that data indicate that the brown trout population has expanded considerably through natural reproduction since the early 1970's.

On March 24, 1981, the U. S. Supreme Court ruled that the bed of the Bighorn River belonged to the State of Montana, and not the Crow Indian Tribe. The Department of Fish, Wildlife and Parks (DFWP) was faced with managing a very valuable high-use fishery with an almost total absence of biological information. The regulations adopted on the upper 12 miles of the Bighorn for the season which began August 20, 1981 consisted of a three-fish slot limit which allowed anglers to keep one trout over 22 inches and two under 18 inches. For the succeeding two seasons which ran from May 1, 1982 through April 30, 1984, this was relaxed to a limit of three trout, only one of which could exceed 18 inches in length. Beginning May 1, 1984 to the present, the regulations allow anglers to keep five fish, only one of which may exceed 18 inches and only one of which can be a rainbow trout.

During the entire period since the 1981 reopening, there has been a special regulations section on the upper 12 miles of the Bighorn River from 600 feet downstream of the Afterbay Dam to Bighorn Fishing Access Site. In that special regulation section, the use of bait and motorized boats are banned.

Major management problems on the Bighorn River at present include poor recruitment of rainbow trout and poor condition factor of large brown trout. Gas bubble disease affects trout in the upper river seasonally as a result of a nitrogen supersaturation problem associated with the Afterbay Dam. An annual fall drawdown to inspect the seepage flow around the main Yellowtail Dam reduces flow in the river to 400 cfs and causes major fish stranding and fish kill problems. Future research efforts will focus on these areas of concern (Fredenberg 1984, 1985).

The need for creel census to delineate certain parameters of angler use was recognized many years ago. A paper written by Charles K. Phenicie and Clinton G. Bishop, published by the Montana Fish and Game Commission in 1950 and entitled "Why Creel Census" included this whimsical discussion between two anglers about the meaning of creel census (Phenicie and Bishop 1950):

> "Say, Bill, Joe and I've been talkin' over this creel census program of the Fish and Game Department. We think it's about the craziest thing we've heard of. Why, heck, here they're spendin' sportsmen's hard earned cash to count fish when I could tell 'em all there is to know about this stream and a dozen others like it. They could do a lot better with the money buyin' more fish food to raise more fish in the hatcheries."

"Now wait a minute, Tom," Bill drawled as he leaned back on a boulder ready for a long verbal battle, "You sound just like I did when I first heard about creel census. I've given it a lot of thought. You and Joe should too, before you condemn it...

"...since I been here, our fish 'n' game has dwindled as more and more people moved in. Regulations and bag limits helped some, but Montana kept gettin' more and more people so's there just ain't the fish and game to go 'round. Somethin' else's got to be done! We need to know how to take care of fish 'n' game so we can all get our share of sport and yet have enough left for breedin' and spawnin'. It looks to me like creel census is one step toward gettin' this done."

"The Department can't prepare a better plan until it knows as accurately as possible the yield of our streams and lakes. They can't go on hunches, and they can hardly 'spect accurate information from guesses by people busy at other jobs. This is a job that requires careful examination of catches. There's a lot of this wildlife work that's easy to criticize, but let's give the Department a chance before rantin' and ravin' too much."

The lack of sound biological information about the Bighorn River fish population and concerns about potential overharvest and user conflicts necessitated the institution of a special creel census effort to evaluate these concerns. The creel census results combined with population data were instrumental in assessing the desirability and need for the special regulations that have evolved.

This partial creel census was conducted March 19, 1982 through September 30, 1983. It served as a valuable tool to disseminate information, evaluate user concerns, coordinate and highlight enforcement efforts, and most importantly to evaluate the characteristics of the fishery. The following report summarizes the results of that census.

DESCRIPTION OF THE STUDY AREA

The Bighorn River headwaters lie in the Absaroka, Bighorn and Wind River mountain ranges of northwest and north central Wyoming (Figure 1). It flows in a northerly direction into Montana where it is impounded at Fort Smith, Montana by the 525-foot high Yellowtail Dam. Water is backed up some 41 miles in Montana and 30 miles in Wyoming in what is now called Bighorn Lake. Bighorn Lake has a capacity of 1.4 million acre-feet and a surface area of 17,300 acres at full pool. Flows into Bighorn Lake are partially regulated by Buffalo Bill Reservoir on the Shoshone River and Boysen Reservoir on the Bighorn River in Wyoming.

Yellowtail Dam was completed in 1965 and changed a good warm water fishery into a high quality tailwater trout fishery. The change in character of the fishery was accompanied by a surge in fisherman use. Unpublished data collected by the Department mail survey in 1965-66 estimated 446 man-days of pressure on the entire Bighorn River, less than 1% of the total stream fishing pressure in the Billings region (Region 5). The most recent mail survey in 1983-84 shows 37,000 fisherman days were expended on the Bighorn which was about 20% of the regionwide total stream pressure. Total stream pressure in the region grew about 150% during the 17 years between the two surveys, while pressure on the Bighorn increased by a factor of nearly 100 times.

Yellowtail Dam is used for peaking power with the Yellowtail Afterbay Dam 2 miles downstream functioning as a reregulating facility. As a consequence, stream flow in the river is relatively stable with little daily fluctuation.

The Bighorn River flows north for 84 miles from the Afterbay Dam to the Yellowstone River at Bighorn, Montana. Fishing pressure and trout fishing quality decreases in downstream progression from the Afterbay Dam. The upper 41 miles above Hardin are considered high-quality trout fishing water. While trout are caught all the way to the mouth, the lower reaches from Hardin downstream generally provide only fair-quality trout fishing. Some channel catfish, sauger and burbot are also taken.

This report focuses on the uppermost 32 miles of the river from the Afterbay Dam to Two Leggins Fishing Access. Three sections of stream are discussed, a 600-foot reach immediately downstream from the Afterbay Dam, a 12.0-mile reach from that point downstream to Bighorn Access, and a 20-mile reach from Bighorn Access to Two Leggins Access (Figure 2). These sections are subsequently referred to as sections 1, 2 and 3 in downstream order.

There are four public accesses in the 32-mile stream reach under consideration. The uppermost two are immediately below the Afterbay Dam and 3 miles downstream and are referred to as Afterbay and Lind Access, respectively. Both of these are maintained by the National Park Service. Bighorn Access 12 miles downstream and Two Leggins Access 32 miles downstream from the Afterbay Dam are maintained by the DFWP (Figure 2). Several private take-out points exist up and down the river.

Mean annual stream flow of the Bighorn River at the Afterbay Dam for the past 10 years was about 3,500 cfs. Tributary inflow is minor above Hardin except during spring runoff. Soap Creek which enters the river from the east about 10 miles downstream from the Afterbay is the largest tributary with a

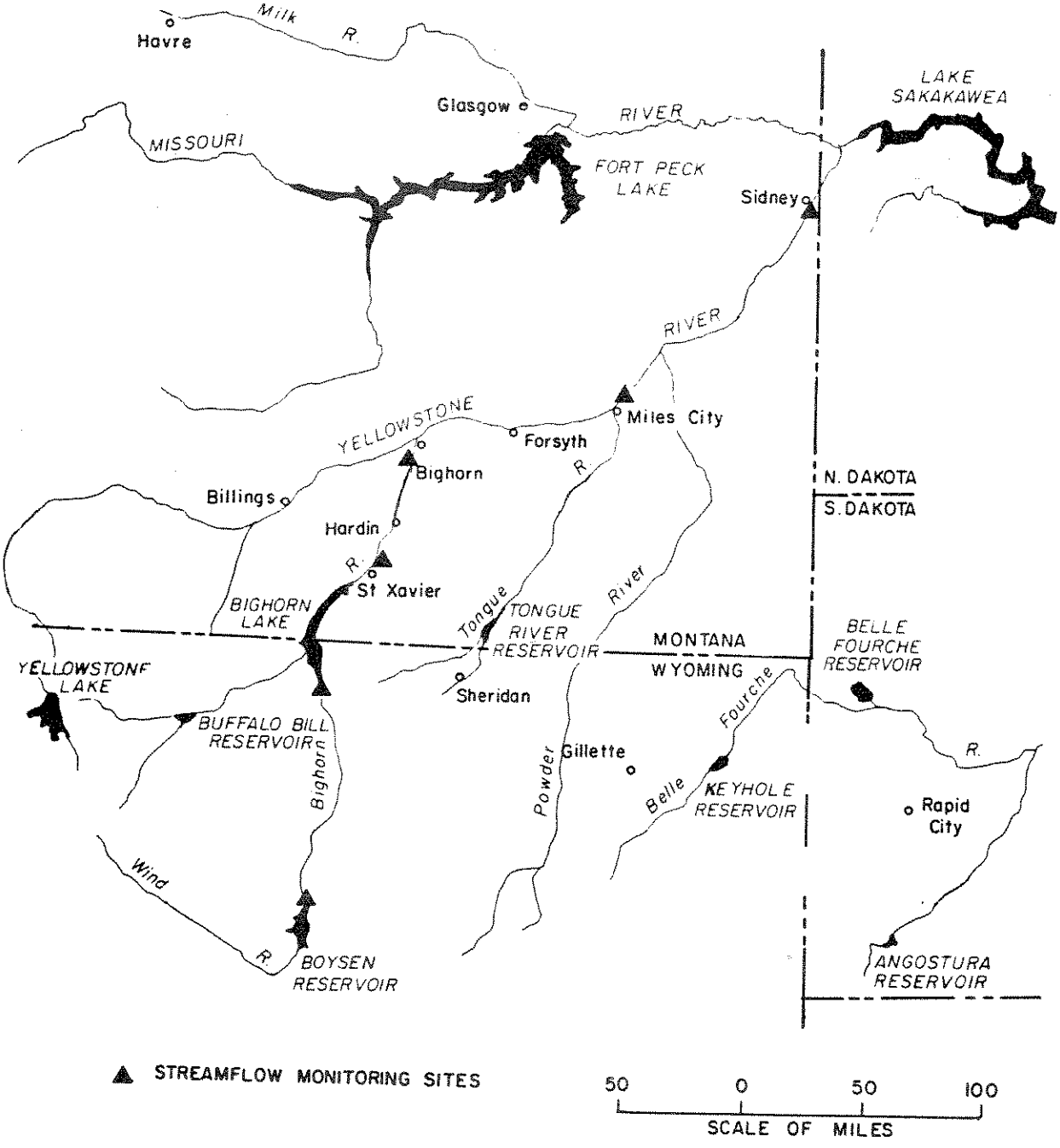

Figure 1. General location map of the Bighorn River showing stream flow gauging sites.

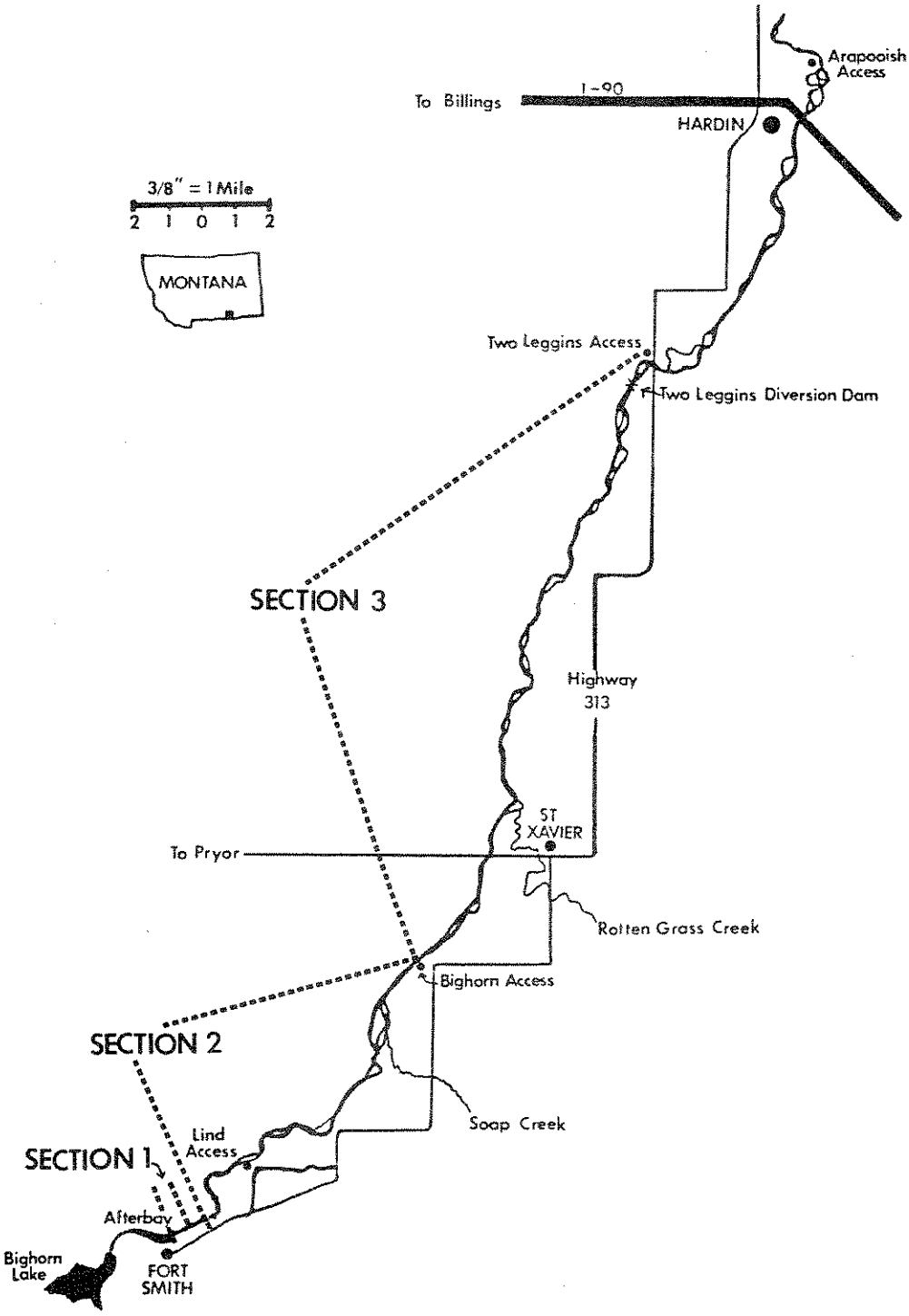

Figure 2. Map of the study area showing access sites and location of stream sections.

mean annual flow of about 35 cfs (U.S.G.S. 1973). Soap Creek and other smaller tributaries contribute high sediment loads during the spring, making the river downstream from Soap Creek turbid during runoff events.

Stream flow conditions during the census period were above average. The average monthly flow for the 19-month period was 4,323 cfs. Mean monthly flows in the Bighorn River at the Afterbay Dam for the period were as follows:

1982		1983	
March	- 3,537 cfs	January	- 3,900 cfs
April	- 3,524	February	- 3,939
May	- 2,020	March	- 3,981
June	- 2,556	April	- 3,060
July	- 6,005	May	- 4,161
August	- 4,547	June	- 5,793
September	- 3,690	July	- 9,824
October	- 4,009	August	- 3,967
November	- 5,151	September	- 3,845
December	- 4,632		

Major diversions for irrigation exist at the Afterbay Dam (up to 500 cfs) and at Two Leggins. More detailed maps of the river and side-channel configurations with a river-mile index were presented previously (Fredenberg 1984).

METHODS

A partial creel census was conducted on the Bighorn River from March 19, 1982 through September 30, 1983. A semi-permanent check station was installed at the junction of Highway 313 and the road into Bighorn Access, 12 river miles downstream from the Afterbay Dam (Figure 2). Two large signs were set up on the highway telling all fishermen coming from the south (upriver) to stop at the check station. All traffic leaving Bighorn Access was closely monitored during the hours the check station was operated, with nearly 100% compliance by anglers leaving the river from that point.

Electronic car counters were installed at the three major access points (Afterbay Dam, Lind Access and Bighorn Access) and two 16mm movie cameras were utilized in order to better assess the rate of noncompliance by anglers departing from the upper two access points. The two movie cameras were mounted on the Afterbay Dam and in a tree upstream from Lind Access. Photoelectric eyes turned them on and off during day and night. The cameras were set to expose one frame every 5 and 2 1/2 minutes at the upstream and downstream sites, respectively. Films were changed every 7 to 21 days as necessary, and following development the films were examined frame by frame on a microfilm reader and the number of boats counted.

Stratified random sampling was used in the design to select census days with weekends and weekdays separated (Neuhold and Lu 1957). During March through October, 1982 and April through September, 1983, the sampling was scheduled to census approximately half of all weekdays and three-fourths of all weekend days. During the period November, 1982 through March, 1983,

approximately half of all weekend days and one-fifth of weekdays were sampled. This sampling schedule was used in an attempt to focus heaviest sampling during the periods of highest fisherman use (Neuhold and Lu 1957).

On each sample, day census was conducted from the check station during the last nine daylight hours and first hour of darkness in order to census the greatest number of fishermen possible in a 10-hour shift. Census hours were adjusted throughout the season with typical winter hours from 10:00 a.m. to 8:00 p.m., and typical summer hours from 12 Noon to 10:00 p.m. Generally, the creel clerk worked into the evening until all fishermen had vacated the Bighorn Access Site which was visible from the census station. During most of the survey period, only one creel clerk was used. Two were employed during late summer and early fall, 1982.

The creel clerk interviewed fishermen on an individual basis with a separate report for each angler. All data were coded directly onto a coding form for later keypunching. Anglers were assigned individual I.D. numbers with month, day, year, day of the week, number in the party, area fished, access site(s) used, angler sex and origin, and tribal status all determined from observation and/or questioning. Anglers were then asked whether they fished from shore or used a boat. All anglers using boats were called boat fishermen, even though all their fishing may have been done from shore. Each angler was asked what type of terminal tackle he or she used (bait, fly, lure, or some combination of the three) and how many hours they actually fished. All trips were completed trips. Information was also kept on the number of licensed guides working on the river and the proportion of fishermen utilizing guides.

Each angler was asked how many fish they caught and of what species. Any fish kept were measured if head and tail were intact and weighed if they had not been eviscerated. Each angler was also asked how many trout of each species (brown and rainbow) they had released that were longer than 18 inches.

Keypunched data from the interview forms was then summarized by computer. Due to the nature of the information collected, most of it is presented as summarized with no attempt to formulate estimates.

The census operation was refined as time went on. Beginning October 1, 1982 all changes were complete, and the information collected from October 1, 1982 through September 30, 1983 provided the best data to use in formulating estimates of annual fishing pressure and fish harvest. After studying the results, it was determined that only the information collected on the Bighorn River from the cable 600 feet below from the Afterbay Dam downstream 12 miles to Bighorn Access could be used to formulate valid estimates. Information collected in the 600-foot section immediately downstream from the Afterbay and downstream from Bighorn Access is useful in comparing angler characteristics and catch rates, but no harvest or pressure estimates are available. The same is true for information collected between March 19 and September 30, 1982 on the river. Creel information for Bighorn Lake and Yellowtail Afterbay was presented in previous reports (Fredenberg 1984, 1985).

Formulas used in calculating estimated fishing pressure and harvest are presented (Appendix). Pressure was calculated separately for weekends and weekdays, and then added to produce total pressure estimates by month. Total

monthly pressure was adjusted by an inflation factor, based on results of camera counts of boats in order to account for anglers either passing the check station during noncensus hours or failing to stop. Failure to stop at a check station is a violation of state law, and several arrests were made in order to improve compliance with the census. Adjusted monthly pressure was added to achieve an annual total pressure estimate.

Average catch rates for each month were calculated as the number of fish caught divided by the total number of hours fished for the group of anglers interviewed. Harvest estimates were obtained by multiplying the average number of fish per angler times the estimated number of anglers each month. Many of the calculations were performed on the computer. These include $\bar{f}$ (average number of fish per angler per trip) and $\bar{h}$ (average hours fished per trip). Pressure and harvest were calculated by hand calculator.

Total catch rate as used in comparing catch and harvest rates between different fisherman groups (e.g., shore vs. boat; fly vs. lure, etc.) and between sections was calculated differently than average monthly catch rates used to determine catch and harvest. Total catch rate was the sum of individual catch rates for each angler divided by the total number of anglers interviewed. Average and total catch rates were nearly identical even though derived by different methods.

RESULTS

Distribution of interviews and characteristics of anglers

Interview distribution and party size

A total of 10,707 fishermen were interviewed during the 19 months of this study. Seventy-four percent of those interviews were with anglers fishing in Section 2 (from the Afterbay cable to Bighorn Access), 15% fished downstream in Section 3, and the remaining 11% fished in Section 1 between the Afterbay Dam and the cable 600 feet downstream (Table 1). There were a total of 4,324 angler parties interviewed for an average party size of 2.5 anglers per party. Party size increased from an average of 2.2 in Section 1 to 2.5 in Section 2 and 2.7 in Section 3 (Table 2) Party size varied little from month to month.

Parties of up to 12 anglers were encountered. Overall, 14% of anglers interviewed fished alone, 46% were in parties of two, 26% in parties of three, 10% in parties of four and only 4% were in parties of five anglers or more. There was little difference between stream sections, except that in Section 1 about one-fourth of all anglers fished alone, which contributed to the lowest average party size occurring in this section.

Weekends versus weekdays

Forty percent of the total interviews were conducted on weekdays and 60% on weekends. This varied month by month, depending on the sampling schedule. During winter months (November, 1982-April, 1983), 63-89% of the interviews in Section 2 were conducted on weekends. During the higher-use period of May, 1983-October, 1983, this fell to 46-66%. In general, Sections 1 and 3 received heavier weekend increases in pressure than Section 2. This was reflected in the fact that only 34 and 32% of the interviews in Sections 1 and

Table 1. Total number of angler interviews conducted on the Bighorn River during 1982-1983 and their distribution by month and stream section.

Month	Stream Section 1	2	3	Total
March, 1982	2	15	13	30
April	76	207	62	345
May	97	208	88	393
June	147	68	5	220
July	165	202	54	421
August	72	805	191	1,068
September	67	1,081	208	1,356
October	97	760	118	975
November	28	136	24	188
December	25	108	27	160
January, 1983	68	171	44	283
February	66	245	61	372
March	22	191	45	258
April	40	574	91	705
May	58	602	34	694
June	34	620	75	729
July	69	489	103	661
August	56	792	186	1,034
September	29	662	124	815
Total	1,218	7,936	1,553	10,707

Table 2. Total number of parties interviewed on three sections of the Bighorn River during 1982-1983 with average party size (number of anglers per party) in parentheses.

Month	Stream Section 1		2		3		Total	
March, 1982	1	(2.0)	8	(1.9)	5	(2.6)	14	(2.1)
April	39	(1.9)	86	(2.4)	27	(2.3)	152	(2.3)
May	46	(2.1)	83	(2.5)	34	(2.6)	163	(2.4)
June	64	(2.3)	31	(2.2)	3	(1.7)	98	(2.2)
July	81	(2.0)	75	(2.7)	18	(3.0)	174	(2.4)
August	35	(2.1)	347	(2.3)	62	(3.1)	444	(2.4)
September	29	(2.3)	414	(2.6)	72	(2.9)	515	(2.6)
October	43	(2.3)	327	(2.3)	38	(3.1)	408	(2.4)
November	13	(2.2)	52	(2.6)	10	(2.4)	75	(2.5)
December	10	(2.5)	53	(2.0)	10	(2.7)	73	(2.2)
January, 1983	29	(2.3)	80	(2.1)	18	(2.4)	127	(2.2)
February	29	(2.3)	101	(2.4)	26	(2.3)	156	(2.4)
March	10	(2.2)	79	(2.4)	17	(2.6)	106	(2.4)
April	22	(1.8)	215	(2.7)	34	(2.7)	271	(2.6)
May	25	(2.3)	254	(2.4)	14	(2.4)	293	(2.4)
June	18	(1.9)	244	(2.5)	30	(2.5)	292	(2.5)
July	30	(2.3)	192	(2.5)	35	(2.9)	257	(2.6)
August	21	(2.7)	291	(2.7)	65	(2.9)	377	(2.7)
September	16	(1.8)	266	(2.5)	47	(2.6)	329	(2.5)
Total	561	(2.2)	3,198	(2.5)	565	(2.7)	4,324	(2.5)

3, respectively, were conducted during the week, but about 42% of the views in Section 2 occurred on weekdays.

Angler origin and sex

Nearly half of all anglers were either local or from the Billings area (Table 3). Out-of-state anglers made up about one-third of the anglers surveyed. On a monthly basis, out-of-state anglers used the river primarily during the May-October period with Billings anglers dominant during the November-April period. Local anglers comprised a fairly steady 4-10% of the total interviews each month and other Montana residents generally made up 12-20%. Only 27 interviews were conducted with Crow tribal members during the entire 19-month census period.

In stream Section 1 immediately downstream from the Afterbay Dam, the breakdown was 56% Billings anglers, 17% each from other areas of Montana and from out of state, and 10% local. Stream Section 2 was heavily used by nonresidents (41%) with 35% from Billings, 18% other Montanans and 6% local anglers. Billings anglers made up nearly two-thirds (65%) of all those fishing in Section 3 followed by 14% nonresidents, 11% other Montanans, and 10% locals. Nonresident anglers seemed to show a strong preference for the 12-mile special regulations section of the river (Section 2), while Billings anglers fished stream Sections 1 and 3 more often.

There is a strong tendency for Billings anglers to fish the Bighorn River on weekends. During weekends, the distribution of angler interviews was 48% Billings residents, 26% nonresidents, 19% other Montanans and 7% locals. This changed dramatically for interviews conducted on weekdays when the breakdown was 46% nonresidents, 32% Billings, 15% other Montanans and 8% local anglers.

Anglers fishing in stream Section 1 at the Afterbay Dam were 67% adult men, 14% adult women, 10% juveniles (under age 15) and 9% pioneers (over age 62). In stream Section 2 the interviews conducted were comprised of 82% adult males, 8% adult women, 5% juveniles and 5% pioneers. In stream Section 3 totals were 79% adult men, 8% women, 7% juveniles and 6% pioneers. The highest proportion of women, children and older anglers occurred in Section 1 where access is easy and bait fishing is allowed. Overall, 80% of all anglers interviewed were men between the ages of 15 and 62.

Boat versus shore fishermen

In Section 1, about 93% of all anglers fished from shore. In Sections 2 and 3, 84% of all anglers used boats. Anglers were considered to be boat fishermen if they floated, even though they may have used the boat only to float between fishing spots but fished exclusively from shore. Boat use peaked in midsummer (July-September) when 90% of all anglers used boats in Sections 2 and 3. During winter months, boat use was lowest with about half of all anglers fishing from shore in Sections 2 and 3 during December, 1982 and January, 1983.

Types of tackle

Bait fishing was the most popular fishing method in Sections 1 and 3 where regulations allowed bait use. In Section 1, 43% of all anglers used

Table 3. Residency of anglers fishing the Bighorn River during 1982-1983.

Month	No. of Anglers	Percent of Total			
		Local	Billings	Other Montanans	Nonresident
March, 1982	30	17	53	27	3
April	345	13	57	15	15
May	393	5	60	17	18
June	220	6	47	12	35
July	421	8	50	13	29
August	1,068	8	41	19	32
September	1,356	5	33	19	43
October	975	7	34	15	44
November	188	10	55	19	15
December	160	6	78	7	9
January, 1983	283	5	73	16	6
February	372	10	57	20	13
March	258	4	57	22	17
April	705	5	41	20	34
May	694	6	34	20	40
June	729	8	41	16	35
July	661	5	43	19	33
August	1,034	8	38	13	41
September	815	7	28	16	49
Total	10,707	7	42	17	34

bait, 25% used flies, 21% used lures and 11% used some combination three during the day. In Section 3, about 36% of all anglers used ba used combinations, 21% used lures and only 9% used flies. Fly fis comprised nearly half of all anglers fishing in Section 2 (Table 4). ally, fly fishermen made up the major group of fishermen interviewed each month, except during the winter (November-March) when fly and lure fishermen were approximately equal. About one of every five anglers used both flies and lures during the course of the day.

Fly fishermen showed a strong tendency to fish on weekdays, while other groups fished more heavily on weekends. While about 60% of all interviews occurred on weekends, only 54% of fly fishermen interviewed were on weekends vs. 77% for bait fishermen, 68% for lure fishermen and 69% for those using combinations. This tendency was most pronounced in Section 2 where weekday anglers used 59% flies, 26% lures and 16% combinations, but weekend anglers used 43% flies, 35% lures and 22% combinations.

Shore fishermen had a much higher tendency to use bait than did boat anglers. This was due mostly to the large number of shore-fishing bait fishermen in Section 1 immediately below the Afterbay Dam. Overall, shore anglers used bait 27% of the time, flies 33%, lures 26% and combinations 14%. Correspondingly, float fishermen used flies (43%), lures (27%), combinations (25%) and bait (5%) in that order. In Section 3, the only section where shore and boat anglers had equal opportunity to bait fish, 52% of shore anglers used bait, while only 34% of boat fishermen did so.

There were distinct differences between the type of tackle used by anglers from three of the four different areas of origin (Table 5). Generally, local anglers fished with much the same gear as Billings residents. Other Montanans had a greater tendency to use flies, and this tendency was more extreme for nonresidents. Billings anglers preferred lures, especially in Section 2 where bait was illegal. Nonresidents used flies nearly three times as often as Billings anglers (Table 5).

locals

Access use

During the final 12 months of the census (October, 1982-September, 1983) information was gathered on the distribution of anglers in Section 2 as to which accesses they used. The three public accesses (Figure 2) allowed anglers to float either the upper 3 miles, the lower 9 miles, or all 12 miles from the Afterbay to Bighorn Access. About two-thirds of all floating anglers interviewed floated the entire 12-mile reach with the other one-third equally divided between using only the upper 3 or lower 9 miles (Table 6). There was a very pronounced trend toward shorter floats during the harsher weather months of November through March, which may have been also related to shorter day-length. During December, this trend reached an extreme when only 19% of all floaters used the entire 12 miles with 46% floating only the upper 3 miles and the remaining 35% floating only the lower 9 miles (Table 6).

Float fishermen who fished only the upper 3 miles or the lower 9 miles exclusively used essentially the same tackle (i.e., 57 and 58% flies, 29 and 31% lures and 14 and 11% combinations, respectively). However, of anglers who floated the entire 12-mile reach, fewer used flies (46%) and more used

Table 4. Proportion of anglers using various tackle types on Section 2 of the Bighorn River during March, 1982-September, 1983.

Month	Percent of Anglers Interviewed		
	Fly Fishermen	Lure Fishermen	Combination Fishermen
March, 1982	60	27	13
April	50	46	4
May	50	49	1
June	62	38	0
July	36	62	2
August	42	30	28
September	56	25	19
October	62	21	17
November	45	40	15
December	52	42	6
January, 1983	39	43	18
February	33	49	18
March	42	39	18
April	48	29	23
May	61	21	18
June	53	30	18
July	43	35	22
August	44	38	19
September	46	28	26
Total	49	32	19

Table 5. Type of tackle used by anglers from four different areas of origin on three sections of the Bighorn River during March, 1982-September, 1983.

Stream Section	Local %	Billings %	Other Montanans %	Nonresident %
Section 1				
Bait	40	46	49	27
Fly	23	24	16	40
Lure	21	19	22	24
Combination	12	11	13	9
Section 2				
Fly	44	28	47	69
Lure	40	50	32	16
Combination	16	22	21	15
Section 3				
Bait	29	38	32	38
Fly	9	7	7	19
Lure	25	22	22	14
Combination	37	33	39	29
Total Combined				
Bait	15	16	9	4
Fly	33	23	40	64
Lure	33	38	30	16
Combination	19	23	21	16

Table 6. Distribution of float fishermen using Section 2 during October, 1982 through September, 1983.

	Upper 3 Miles		Lower 9 Miles		Both Reaches		Total Anglers
	#	%	#	%	#	%	
October, 1982	102	13.5	109	14.4	545	72.1	756
November	32	23.5	37	27.2	67	49.3	136
December	50	46.3	38	35.2	20	18.5	108
January	64	37.4	52	30.4	55	32.2	171
February	56	23.0	62	25.5	125	51.4	243
March	56	29.6	50	26.5	83	43.9	189
April	137	14.1	112	19.7	319	56.2	568
May	128	21.5	82	13.8	385	64.7	595
June	79	12.8	101	16.3	439	70.9	619
July	36	7.4	36	7.4	416	85.2	488
August	46	5.9	144	18.4	594	75.8	784
September	49	7.5	121	18.4	487	74.1	657
Total	835	15.7	944	17.8	3,535	66.5	5,314

combinations (24%). About 30% still used lures. The longer float time may have resulted in greater experimentation by anglers.

Guided fishermen profiles

During October, 1982 through September, 1983, information was also collected on the numbers and distribution of anglers employing professional fishing guides. A total of 842 guided anglers were interviewed during the 1-year period. Nearly all (99.4%) fished in Section 2 on the river. All were float fishermen. The proportion of guided anglers ranged from 0% during January and February to 28.6% during October (Table 7). Overall, nearly one of every six float fishermen in river Section 2 employed a guide with most of that use occurring during May-October.

Only 1.2% of Billings fishermen employed guides during the period surveyed and 4.1% of local anglers hired guides. This rose to 10.2% for other Montana residents and 32.3% for nonresidents. Of 837 guided anglers interviewed in Section 2, 84% were nonresidents, 12% were other Montana residents, 3% were from Billings and 1% were locals.

The 837 guided anglers interviewed were mostly fly fishermen. Nearly 88% used flies exclusively, 4% used lures and 8% used some combination. Guided anglers are accurately categorized as nonresident fly fishermen who fish in the special regulations section of the Bighorn River during the months of May-October.

Catch rates, distribution and composition of catch and harvest

Monthly catch rates by area and species

Catch and harvest rates for Section 1 on the Bighorn River for the period October, 1982 through September, 1983 were dominated by rainbow trout (Table 8). Overall, anglers caught and kept about two rainbow for every brown trout in this section with a high degree of variability by month. Catch rates were generally highest in October through January. Brown trout catch rates in Section 1 were the lowest of the three sections surveyed.

River Section 2 produced catch rates strongly different than those in Section 1 (Table 9). In Section 2, brown trout were dominant by nearly three to one in the catch and harvest. It is noteworthy that bait use was not allowed in this section. Generally, catch rates in Section 2 were highest during October through December, and lowest in March through July with intermediate success in the intervening months.

Catch rates in Section 3, where bait use was allowed, were most similar to Section 1 (Table 10). The catch and harvest was about equally divided between brown and rainbow trout with highest catch rates again experienced in the fall and early winter fishery.

Harvest rates for brown trout were similar in all three sections (0.07 to 0.10 fish per hour). Rainbow trout harvest rates were similar in Sections 1 and 3 (0.16 and 0.12 fish per hour, respectively), but much lower in Section 2 where anglers kept only 0.03 rainbow trout per hour fished.

Table 7. Proportion of float fishermen in Section 2 of the Bighorn River who were guided by professional fishing guides (by month) during October, 1982 through September, 1983.

Month	Unguided		Guided		Total
	#	%	#	%	
October, 1982	543	71.4	217	28.6	760
November	129	94.9	7	5.1	136
December	103	95.4	5	4.6	108
January, 1983	171	100.0	0	0	171
February	245	100.0	0	0	245
March	189	99.0	2	1.0	191
April	563	98.1	11	1.9	574
May	543	90.2	59	9.8	602
June	515	83.1	105	16.9	620
July	380	77.7	109	22.3	489
August	643	81.2	149	18.8	792
September	489	73.9	173	26.1	662
Total	4,513	84.4	837	15.6	5,350

Table 8. Catch and harvest rates (fish per hour) in stream Section 1 of the Bighorn River for the period October, 1982 through September, 1983.

Month	No. of Anglers	Hours Fished	Rainbow Caught	Rainbow Kept	Brown Trout Caught	Brown Trout Kept
October, 1982	98	388.0	0.68	0.30	0.15	0.06
November	28	102.5	0.61	0.20	0.32	0.14
December	26	103.5	0.75	0.33	0.44	0.06
January, 1983	66	248.5	0.33	0.16	0.22	0.12
February	66	241.5	0.07	0.04	0.14	0.10
March	21	59.25	0.08	0.03	0.19	0.10
April	42	191.0	0.11	0.08	0.28	0.13
May	58	186.75	0.13	0.09	0.11	0.07
June	36	120.5	0.07	0.06	0.16	0.05
July	70	275.0	0.15	0.12	0.03	0.03
August	57	211.25	0.36	0.25	0.26	0.06
September	28	99.25	0.18	0.13	0.05	0.03
Total	596	2,227.0	0.31	0.16	0.18	0.08

Table 9. Catch and harvest rates (fish per hour) in stream Section 2 of the Bighorn River for the period October, 1982 through September, 1983.

Month	No. of Anglers	Hours Fished	Rainbow Caught	Rainbow Kept	Brown Trout Caught	Brown Trout Kept
October, 1982	760	5,440.5	0.19	0.03	0.48	0.07
November	136	687.0	0.17	0.07	0.53	0.20
December	108	435.0	0.27	0.09	0.68	0.22
January, 1983	171	848.75	0.13	0.07	0.36	0.15
February	245	1,194.5	0.08	0.03	0.30	0.14
March	191	992.25	0.07	0.03	0.26	0.13
April	574	3,642.75	0.07	0.01	0.25	0.06
May	602	3,737.0	0.09	0.01	0.29	0.04
June	620	3,857.5	0.09	0.02	0.24	0.05
July	489	2,947.0	0.13	0.04	0.27	0.04
August	792	5,113.0	0.15	0.04	0.34	0.06
September	662	4,683.75	0.10	0.02	0.39	0.04
Total	5,350	33,579.0	0.12	0.03	0.34	0.07

Table 10. Catch and harvest rates (fish per hour) in stream Section 3 of the Bighorn River for the period October, 1982 through September, 1983.

Month	No. of Anglers	Hours Fished	Rainbow Caught	Rainbow Kept	Brown Trout Caught	Brown Trout Kept
October, 1982	118	665.25	0.37	0.13	0.31	0.09
November	24	105.0	0.59	0.23	0.63	0.11
December	28	121.25	0.32	0.18	0.37	0.22
January, 1983	40	169.5	0.23	0.14	0.34	0.19
February	61	337.0	0.19	0.08	0.28	0.12
March	45	167.25	0.08	0.05	0.29	0.17
April	91	421.5	0.06	0.03	0.14	0.09
May	34	203.5	0.10	0.05	0.16	0.03
June	75	384.5	0.09	0.07	0.17	0.12
July	103	539.0	0.18	0.12	0.16	0.06
August	185	1,138.25	0.33	0.17	0.29	0.09
September	124	713.5	0.24	0.12	0.24	0.08
Total	928	4,965.5	0.24	0.12	0.26	0.10

Average catch rate, for both species of trout combined for the 1-year period, was remarkably consistent between the three sections. The average combined catch rate was 0.49 fish per hour in Section 1, 0.46 fish per hour in Section 2 and 0.50 fish per hour in Section 3. Monthly catch rates exceeded one trout per hour during the fall peak in some sections, and the lowest average catch rates in early summer were around one-fourth of a trout per hour.

Total catch rate comparisons by user group

Comparison of total catch rates, consisting of the average of individual catch rates for each angler, provide some useful comparisons between user groups. All total catch rate comparisons are for the 1-year period from October, 1982 through September, 1983.

Access

Anglers fishing only the upper 3 miles of the Bighorn River from Afterbay to Lind Access experienced higher total catch rates than anglers fishing from Lind Access to Bighorn Access (Table 11). Both groups caught fish at a faster rate than anglers who fished the entire 12-mile reach. The reasons for this are unclear, but may be due to more time spent fishing and less time floating. The relationship was consistent for both trout species (rainbow and brown) as well as for larger fish over 18 inches (Table 11).

Angler origin

Total catch rates by anglers from various areas of residence differed little. Nonresidents and local anglers each caught 0.50 trout per hour vs. 0.48 for Billings anglers and 0.42 fish per hour for other Montanans. There were, however, substantial differences in the harvest rates for those anglers. Overall, Billings area fishermen kept 43% of the fish they caught and local anglers kept 41% (Table 12). This was a much more consumptive orientation than for other Montanans and nonresident anglers who kept 28 and 14% of their catch, respectively.

There was also a substantial difference between sections. In river Sections 1 and 3 where there were not any bait restrictions, anglers kept 49 and 46% of the trout they caught, respectively (Table 12). In Section 2, where the regulations allow artificial lures only, anglers kept only 25% of their catch. Nonresident anglers in area 2 kept only 12% of their catch.

For trout over 18 inches in length, results were similar, except anglers kept a higher proportion of those larger fish. Local area fishermen kept 58% of the trout they caught over 18 inches vs. 51% for Billings anglers, 36% for other Montanans and 16% for nonresidents. In river Sections 1 and 3 anglers kept 75% of trout over 18 inches that they caught, but in the restricted Section 2 where no bait was allowed only 31% were kept.

Types of tackle

Catch rate comparisons for anglers using various types of tackle show that the highest catch rates were achieved by fly fishermen, with a total catch rate of 0.58 trout per hour. Bait fishermen were second at 0.47, lure

Table 11. Comparison of total catch rate (fish per hour) in the Bighorn River for anglers fishing from Afterbay to Lind Access, Lind Access to Bighorn Access and Afterbay to Bighorn Access during October, 1982 through September, 1983.

	Afterbay to Lind Access	Lind Access to Bighorn Access	Afterbay to Bighorn Access
Rainbow caught	.22	.13	.11
Brown trout caught	.49	.38	.31
Total trout caught	.71	.51	.42
Rainbow >18" caught	.03	.02	.02
Brown trout >18" caught	.05	.06	.04
Total trout 18" caught	.08	.08	.06
Rainbow kept	.06	.04	.03
Brown trout kept	.13	.11	.06
Total trout kept	.19	.15	.09
Rainbow >18" kept	.01	.01	.01
Brown trout >18" kept	.02	.02	.01
Total trout >18" kept	.03	.03	.02

Table 12. Percent of catch kept by anglers from various areas of origin in three different reaches of the Bighorn River during October, 1982 through September, 1983.

Angler Origin	Proportion of Catch Kept (All Trout) Area 1	Area 2	Area 3	Total
Local	68	35	54	41
Billings	44	41	37	43
Other Montanans	65	23	43	28
Nonresident	53	12	30	14
Total	49	25	46	30

Table 13. Percent of catch kept by anglers using various types of tackle in three different sections of the Bighorn River during October, 1982 through September, 1983.

River Section	Proportion of Catch Kept (All Trout) Bait	Fly	Lure	Combination	Total
1	54	25	42	74	49
2	-	14	44	33	25
3	54	26	40	43	47
Total	54	16	43	39	31

fishermen caught 0.44 trout per hour and anglers using various combinations caught only 0.36 trout per hour. These results were consistent between stream sections, except in Section 2 where bait was illegal.

There were distinct differences in success rates of various tackle types between species. Total catch rates for rainbow trout were much higher on bait than anything else. Bait fishermen caught 0.31 rainbow and 0.16 brown trout per hour. Fly fishermen showed the opposite relationship, with a total catch rate of 0.42 brown trout and only 0.16 rainbow per hour. Lure fishermen were similar to fly fishermen, catching 0.31 brown trout and 0.12 rainbow per hour. Anglers using combinations caught 0.23 brown trout and 0.13 rainbow per hour.

Harvest characteristics also differed substantially between groups (Table 13). Bait fishermen kept 54% of the fish they caught vs. 43% for lures, 39% for combinations and only 16% for flies. These percentages increased for larger fish (Table 14). About 38% of all trout over 18 inches that were caught were kept, including 32% of the brown trout and 50% of the rainbow. With the exception of fly fishermen, who kept only 16% of the 18-inch fish they caught, anglers using all other types of tackle kept more than half of the larger fish they caught. Anglers using all four tackle types showed a greater inclination to keep large rainbow than large brown trout.

Guided anglers

Total catch rates for anglers who fished with professional guides were 30% higher than for nonguided anglers at 0.60 and 0.46 trout per hour, respectively. Guided anglers kept only 3% of the fish they caught vs. 30% for nonguided anglers. Guided anglers reported catching 0.11 18-inch and larger fish per hour, nearly double the .06 rate for nonguided anglers. Guided anglers kept 4% of the 18-inch fish they reported catching vs. 41% for nonguided anglers.

Distribution of the catch and harvest

Nearly three-fourths of all anglers (73%) caught at least one trout on their trip on the Bighorn River between March, 1982 and September, 1983 (Table 15). Nearly 4 out of 10 anglers (38.8%) caught three or more trout which would have been the legal limit had they chosen to keep them. Almost 6% of the anglers caught 10 trout or more. About 58% of the 10,707 anglers interviewed caught one or more brown trout, but only 43% caught one or more rainbow trout. Two-thirds of all anglers in Section 1, immediately downstream from the Afterbay Dam, did not catch a single brown trout. The average angler in both Sections 1 and 3 caught more rainbow than brown trout, while in Section 2 the catch was much more heavily skewed toward browns. Anglers fishing in river Sections 2 and 3 were much more likely to make large catches of five or more fish than were anglers in Section 1.

Overall, 64% of all fish caught were caught by the 22% of the anglers who landed five or more fish each (Table 15). The nearly 39% of all anglers who "caught their limit" of three or more trout accounted for 84% of the total catch.

The 10,707 anglers surveyed kept 7,645 trout for an average of 0.71 fish per angler. About 58% of the anglers kept no fish, 22% kept one, 12% kept two

Table 14. Percent of 18-inch and longer rainbow, brown trout and total trout caught that were kept by anglers using various types of tackle on the Bighorn River during October, 1982 through September, 1983.

Tackle Type	Brown Trout Over 18 Inches	Rainbow Over 18 Inches	Total Trout Over 18 Inches
Bait	80	83	82
Fly	15	21	16
Lure	63	75	67
Combination	55	71	61
Total	32	50	38

Table 15. Distribution of fish caught amongst 10,707 anglers fishing the Bighorn River from March, 1982 through September, 1983. Numbers are percent of total in each column.

No. of Fish	Section 1			Section 2			Section 3			Total		
	Rainbow Caught	Browns Caught	Total Caught	Rainbow Caught	Browns Caught	Total Caught	Rainbow Caught	Browns Caught	Total Caught	Rainbow Caught	Browns Caught	Total Caught
0	55.2	67.4	39.5	59.5	35.8	25.4	43.3	51.3	25.7	56.8	41.7	27.0
1	18.2	18.0	21.7	18.7	21.2	10.3	20.1	20.4	20.1	18.8	20.7	20.4
2	9.7	6.6	11.5	9.9	14.0	14.1	12.4	11.3	13.6	10.2	12.8	13.8
3	6.5	2.5	8.5	5.2	9.0	10.2	8.2	6.6	11.0	5.8	7.9	10.1
4	4.1	2.0	5.6	2.8	6.2	7.4	5.3	3.4	6.5	3.3	5.3	7.1
5	2.1	1.1	3.9	1.4	4.3	5.8	3.9	2.4	5.8	1.8	3.6	5.6
6	1.3	0.4	2.5	0.9	2.7	4.0	2.2	0.8	4.4	1.1	2.2	3.9
7	1.1	0.3	1.8	0.5	1.7	2.9	1.0	1.2	2.9	0.6	1.5	2.7
8	0.2	0.5	1.0	0.4	1.4	2.1	0.9	0.8	3.0	0.5	1.2	2.1
9	0.7	0.2	1.1	0.2	0.8	1.8	0.7	0.6	1.6	0.3	0.7	1.7
10-19	1.0	0.7	2.3	0.5	2.6	5.2	1.7	1.2	4.6	0.7	2.2	4.8
20-39		0.3	0.7	<0.1	0.2	0.7	0.2		0.8	<0.1	0.2	0.7
30-39				<0.1	0.1	0.2			0.1	<0.1	0.1	0.1
40+						<0.1						<0.1

and 8% kept the limit of three (Table 16). This varied widely between sections. In Section 2, only 38% of all anglers kept fish, but in Section 1, 48% kept fish and in Section 3, 62% kept at least one trout. Anglers in Sections 1 and 3 kept at least one rainbow 35 and 46% of the time, respectively; whereas in Section 2 only 17% kept one or more rainbow trout. Nearly 20% of the anglers in Section 3 kept their limit of three trout vs. 9% in Section 1 and only 6% in Section 2.

About 35% of the total trout harvest was by the 8% of the anglers who kept the limit of three fish (Table 16). Nearly 70% of the harvest was by the 20% of anglers who kept two or more fish. Only 42% of all anglers kept fish. In river Section 2 where there was a high rate of release, nearly two-thirds of the harvest was by the 16.6% of anglers who kept two or more trout.

Length frequency of harvested Fish

Length data was gathered from 3,750 brown trout and 3,216 rainbow harvested by fishermen between March, 1982 and September, 1983. Length frequencies for both species were bell-shaped with means of 15.7 inches for brown trout (Figure 3) and 15.5 inches for rainbow trout (Figure 4).

The longest trout measured was a 27.5-inch rainbow. Overall, 16.5% of the rainbow trout and 19.3% of the brown trout measured exceeded 18 inches in length (Table 17). Fifty-seven percent of the rainbow and 55.2% of the brown trout kept were between 14 and 18 inches long. Only 26% of both species in the harvest were less than 14 inches long.

Length frequencies differed between river sections (Table 17). Rainbow trout from Section 1 were much smaller than average, with 47% of the harvest less than 14 inches in length and an average of 14.5 inches. Average length of rainbow from Section 2 was 15.7 inches, with only 19.3% less than 14 inches in length. Rainbow trout from Section 3 averaged 15.7 inches as well, with 18.8% less than 14 inches.

Brown trout showed the same pattern as rainbow (Table 17). In Section 1, 46% of the brown trout harvested were less than 14 inches, 15% were over 18 inches, and the average length was 14.6 inches. In river Section 2, 25% of the harvest was less than 14 inches, 19% was over 18 inches, and the average length was 15.6 inches. River Section 3 was similar to Section 2, with 21% of the harvest less than 14 inches, 19% over 18 inches, and an average length of 16.1 inches.

Estimated pressure, catch and harvest in Section 2.

Estimated pressure October, 1982-September, 1983

Total estimated fishing pressure for Section 2 of the Bighorn River was 11,840 man-days for the period October, 1982 through September, 1983 (Table 18). Pressure peaked in August, 1983 at 6.1 man-days per mile per day in this reach of stream. Other heavy use months in order were October, 1982 and September, April, May and June, 1983 which all exceeded 1,000 fisherman days during the month. Lowest use occurred during November and December, 1982.

Table 16. Distribution of the harvest amongst 10,707 anglers fishing the Bighorn River from March, 1982 through September, 1983. Numbers are percent of total in each column.

No. of Fish	Section 1			Section 2			Section 3			Total		
	Rainbow Kept	Browns Kept	Total Kept	Rainbow Kept	Browns Kept	Total Kept	Rainbow Kept	Browns Kept	Total Kept	Rainbow Kept	Browns Kept	Total Kept
0	65.1	80.3	52.1	83.4	71.9	62.2	54.4	68.0	37.9	77.1	72.3	57.6
1	20.0	14.5	25.0	12.7	19.4	21.1	23.9	21.3	24.2	15.1	19.1	22.0
2	10.4	4.5	14.2	3.1	6.9	11.0	14.4	7.9	18.1	5.6	6.8	12.4
3	4.3	0.7	8.7	0.8	1.0	5.5	7.3	2.7	19.5	2.1	1.8	7.9
4+	0.2	0	<0.1	<0.1	<0.1	0.1	0.1	0	0.3	<0.1	<0.1	0.1

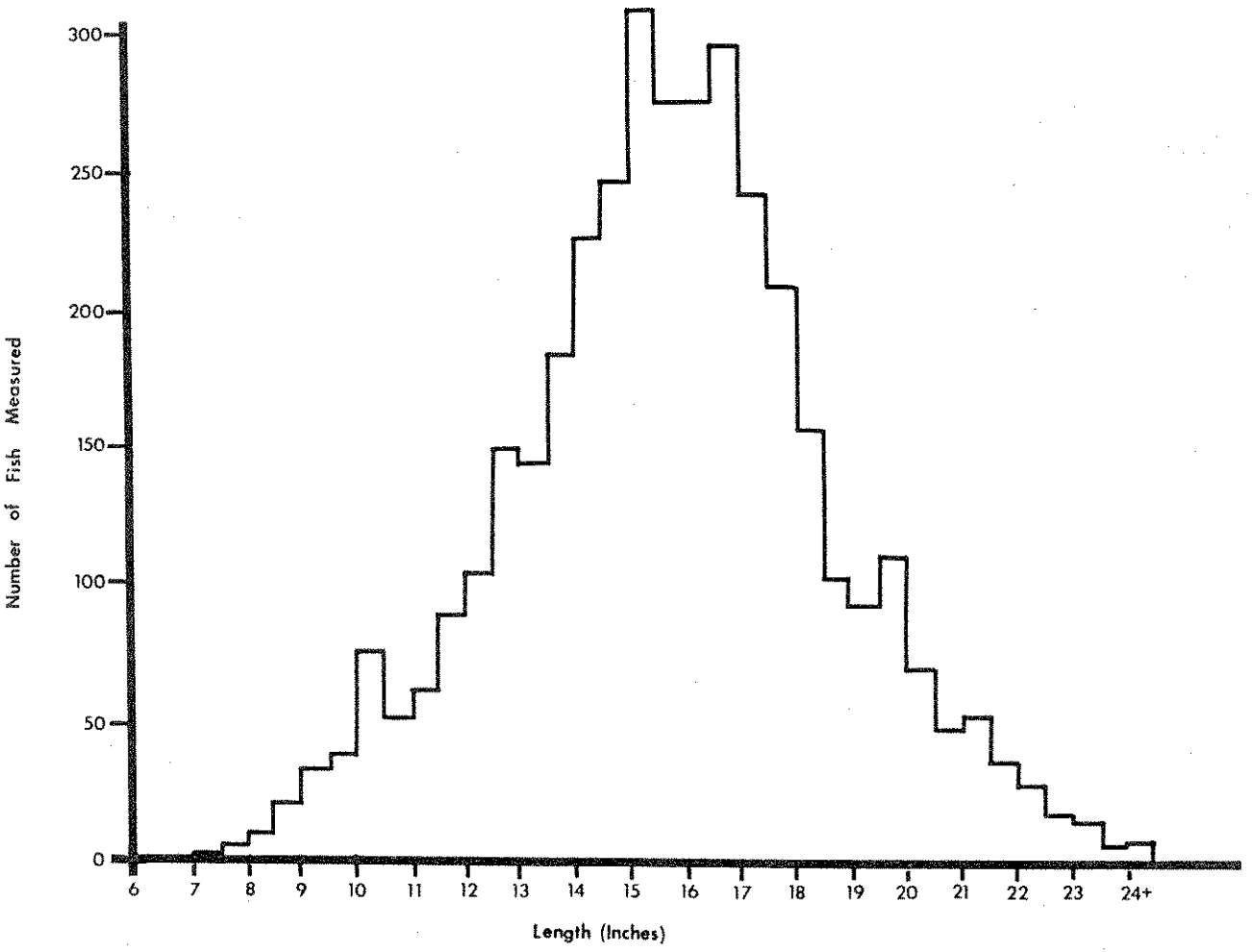

Figure 3. Length frequency distributon of 3,750 brown trout harvested from the Bighorn River during March, 1982 through September, 1983.

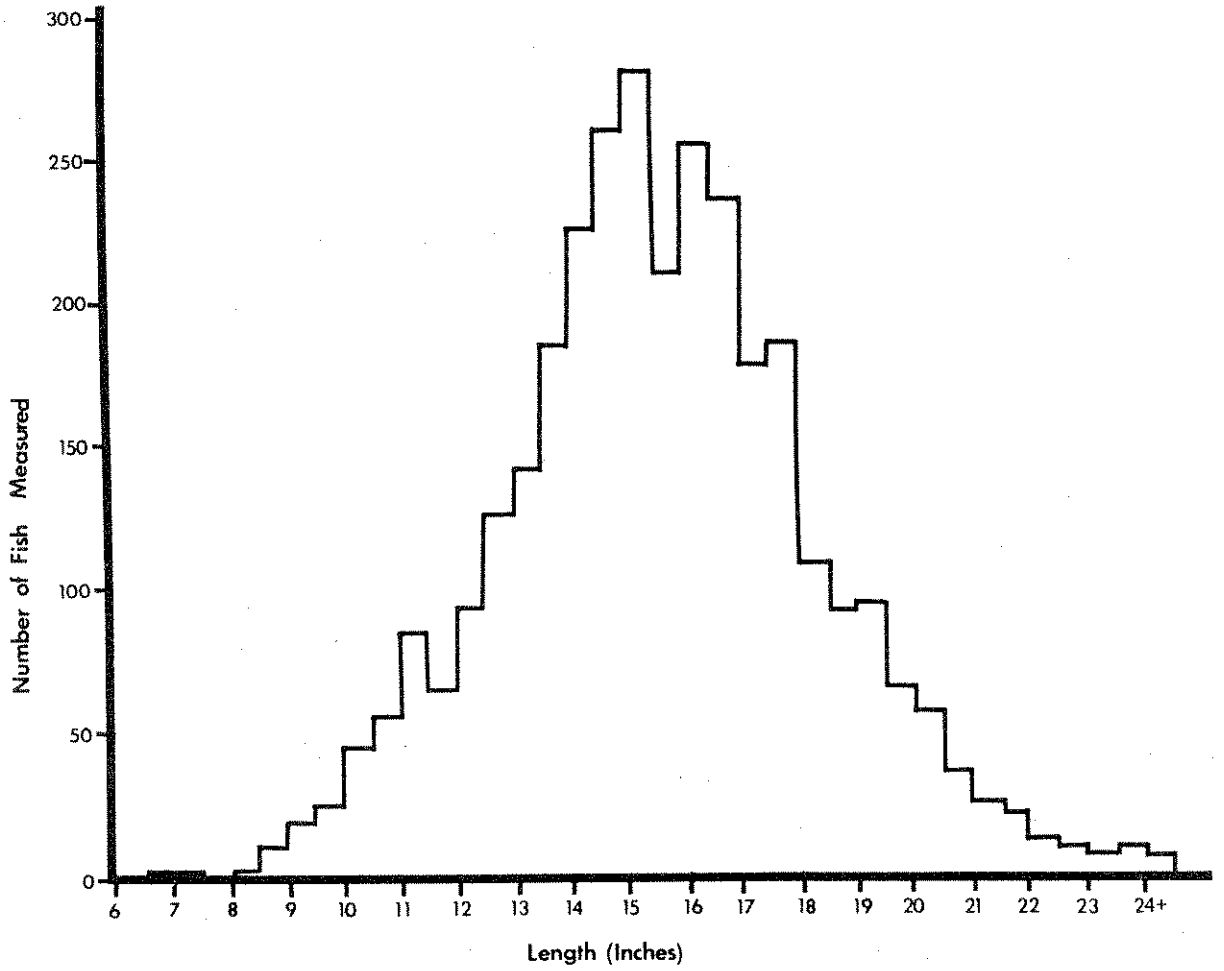

Figure 4. Length frequency distribution of 3,216 rainbow trout harvested from the Bighorn River during March, 1982 through September, 1983.

Table 17. Lengths of trout measured at the Bighorn River creel census station from March, 1982 through September, 1983. Numbers are percent of total in each column.

Length (inches)	Rainbow Trout				Brown Trout			
	Sec. 1	Sec. 2	Sec. 3	Total	Sec. 1	Sec. 2	Sec. 3	Total
6		0.1		<0.1				
7		0.1		<0.1		0.2		0.2
8	1.0	0.3		0.3	1.0	0.9		0.8
9	3.8	1.1		1.3	1.4	2.2	0.3	1.9
10	10.9	1.7	0.5	3.1	8.2	3.2	1.6	3.4
11	10.3	3.4	3.0	4.6	8.6	3.5	4.2	4.0
12	11.1	6.1	5.3	6.8	14.0	6.2	5.7	6.7
13	10.9	10.0	10.0	10.2	12.3	8.3	8.9	8.7
14	9.2	16.1	17.4	15.2	12.0	12.3	13.9	12.6
15	9.0	15.5	19.0	15.3	11.0	15.8	16.6	15.5
16	9.2	15.8	18.1	15.2	7.5	16.0	15.0	15.2
17	7.7	11.5	13.2	11.3	9.2	12.5	10.5	11.9
18	5.9	6.4	6.1	6.2	5.5	6.8	7.5	6.8
19	5.4	5.3	4.2	4.9	5.1	5.6	4.4	5.4
20	2.1	3.7	1.8	2.8	2.4	2.9	4.0	3.1
21	2.5	1.5	0.6	1.4	0.7	2.2	3.5	2.3
22	0.7	0.6	0.5	0.6	1.0	0.8	2.4	1.1
23	0.3	0.7		0.4		0.3	1.2	0.4
24+	0.2	0.1	0.2	0.2		0.1	0.3	0.2

The average hours fished per day by anglers ranged from 4.1 in December to 7.2 in October. Generally, anglers fished longest in the late summer and fall (August-October) and fishing trips were shortest in winter (November through March). This is undoubtedly related to shorter day length and harsher weather conditions during the winter months. Overall, anglers fished an average of 6.2 hours per trip.

Total fisherman hours were estimated by multiplying pressure (fisherman days) by average hours fished. The total hours expended by anglers on Section 2 of the Bighorn River during October, 1982 through September, 1983 was estimated at 73,574 (Table 18). Due to the longer average trips occurring in August through October, these three months become even more dominant as the three highest pressure months of the year. Slightly over 49% of the total fishermen hours on the river occurred during those three months.

Fisherman pressure in Section 2 was about equally divided between weekdays, weekends and holidays (Table 19). Generally, weekend pressure was a higher proportion of the total during winter months, while weekday use was more intense during the rest of the year when overall pressure was higher. Weekday pressure was about 60% of the total pressure during the highest use period of August through October, but made up only 45% of the total mandays of use during the other 9 months of the year.

Projections - October, 1983-September, 1985

During the period October, 1982 through September, 1983, electronic car counters were monitored on roads leading into the three main access points (Afterbay, Lind and Bighorn). Linear regression analysis of monthly car counts (independent variable) vs. estimated monthly fishing pressure (dependent variable) in Section 2 produced highly significant correlations (99.9% confidence) at all three sites. The highest correlation occurred for the Bighorn Access Site and was described by the equation [$y = 1.09 (x) - 55.57$] where x = car count divided by 2 (to account for one trip in and out) and y = fishermen days of pressure. The line has a slope of 1.092 and $r = 0.93$.

The car counter at Bighorn Access was maintained from October, 1982 to the present. Since no appreciable changes have been observed in use pattern of river access sites over the intervening period, the regression equation was used to predict fisherman pressure in Section 2 (Table 20). During the 12 months the census was run, the regression equation produced predicted pressure values that were generally within 20% of values estimated by census techniques, with three exceptions. Consequently, this is believed to be an inexpensive and effective technique for monitoring changes in fishing pressure on the upper Bighorn River.

Comparison of the estimated pressure for the 36-month period that data are available suggest a relatively stable trend in fisherman numbers (Figure 5). Monthly variation from year-to-year may be strongly related to weather conditions and other factors such as guide availability, flow conditions, and real or perceived angling quality.

During the period from July 20-September 30, 1984, the Bighorn River was restricted to catch and release fishing only, due to the aftermath of a

Table 18. Estimated total pressure in fisherman days, average hours fished and total fisherman hours expended on Section 2 of the Bighorn River during October, 1982 through September, 1983. Section length is 12.0 miles (80% confidence intervals in parentheses).

Month	Fisherman Days		Average Hours Fished		Total Fisherman Hours	
October, 1982	1,582	(±51)	7.2	(±.1)	11,388	(±406)
November	351	(±55)	5.0	(±.3)	1,760	(±290)
December	341	(±45)	4.1	(±.3)	1,414	(±206)
January, 1983	486	(±65)	4.9	(±.2)	2,384	(±334)
February	562	(±64)	4.9	(±.2)	2,774	(±332)
March	527	(±86)	5.2	(±.2)	2,723	(±461)
April	1,206	(±53)	6.3	(±.1)	7,611	(±376)
May	1,104	(±45)	6.2	(±.1)	6,819	(±317)
June	1,095	(±39)	6.2	(±.1)	6,834	(±284)
July	825	(±32)	6.0	(±.2)	4,982	(±231)
August	2,284	(±111)	6.4	(±.1)	14,709	(±759)
September	1,477	(±81)	6.2	(±.1)	10,176	(±581)
Total	11,840	(±223)	6.2	(±.1)	73,574	(±1,420)

Table 19. Estimated fishing pressure (fisherman days) on Section 2 of the Bighorn River broken down by weekdays vs. weekends and holidays (percentages for each month in parentheses).

Month	Weekday Pressure		Weekend Pressure	
October, 1982	984	(62)	599	(38)
November	121	(34)	230	(66)
December	201	(59)	140	(41)
January, 1983	196	(40)	290	(60)
February	130	(23)	432	(77)
March	253	(48)	274	(52)
April	608	(50)	598	(50)
May	452	(41)	652	(59)
June	585	(53)	510	(47)
July	392	(48)	433	(52)
August	1,482	(65)	802	(35)
September	734	(50)	744	(50)
Total	6,138	(52)	5,704	(48)

Table 20. Estimated fishing pressure (fisherman days) on Section 2 of the Bighorn River (12.0 miles) as predicted by the regression equation [y = 1.09(x)-55.57] where x = 1/2 car count at Bighorn Access and y = fisherman days.

Month	Bighorn Access Car Count - 2	Estimated Pressure (Fisherman Days) Y = 1.09(x)-55.57	Estimated Pressure (Fisherman Days) Bighorn Creel Census	% Difference
October, 1982	1,208	1,261	1,582	+25.5
November	445	429	351	-18.2
December	329	303	341	+12.5
January 1983	486	474	486	+2.5
February	589	586	562	-4.1
March	580	577	527	-8.7
April	830	849	1,206	+42.1
May	1,086	1,128	1,104	-2.1
June	1,156	1,204	1,095	-9.1
July	1,275	1,334	825	-38.2
August	2,029	2,156	2,284	+5.9
September	1,442	1,516	1,477	-2.6
October	1,161	1,210		
November	385	364		
December	No data	-		
January, 1984	211	174		
February	500	489		
March	657	661		
April	No data	-		
May	919	946		
June	1,050	1,089		
July	917	944		
August	1,450	1,525		
September	1,227	1,282		
October	945	974		
November	604	603		
December	381	360		
January, 1985	371	349		
February	641	643		
March	719	728		
April	1,106	1,150		
May	1,807	1,914		
June	1,197	1,249		
July	1,401	1,472		
August	2,235	2,381		
September	1,917	2,034		

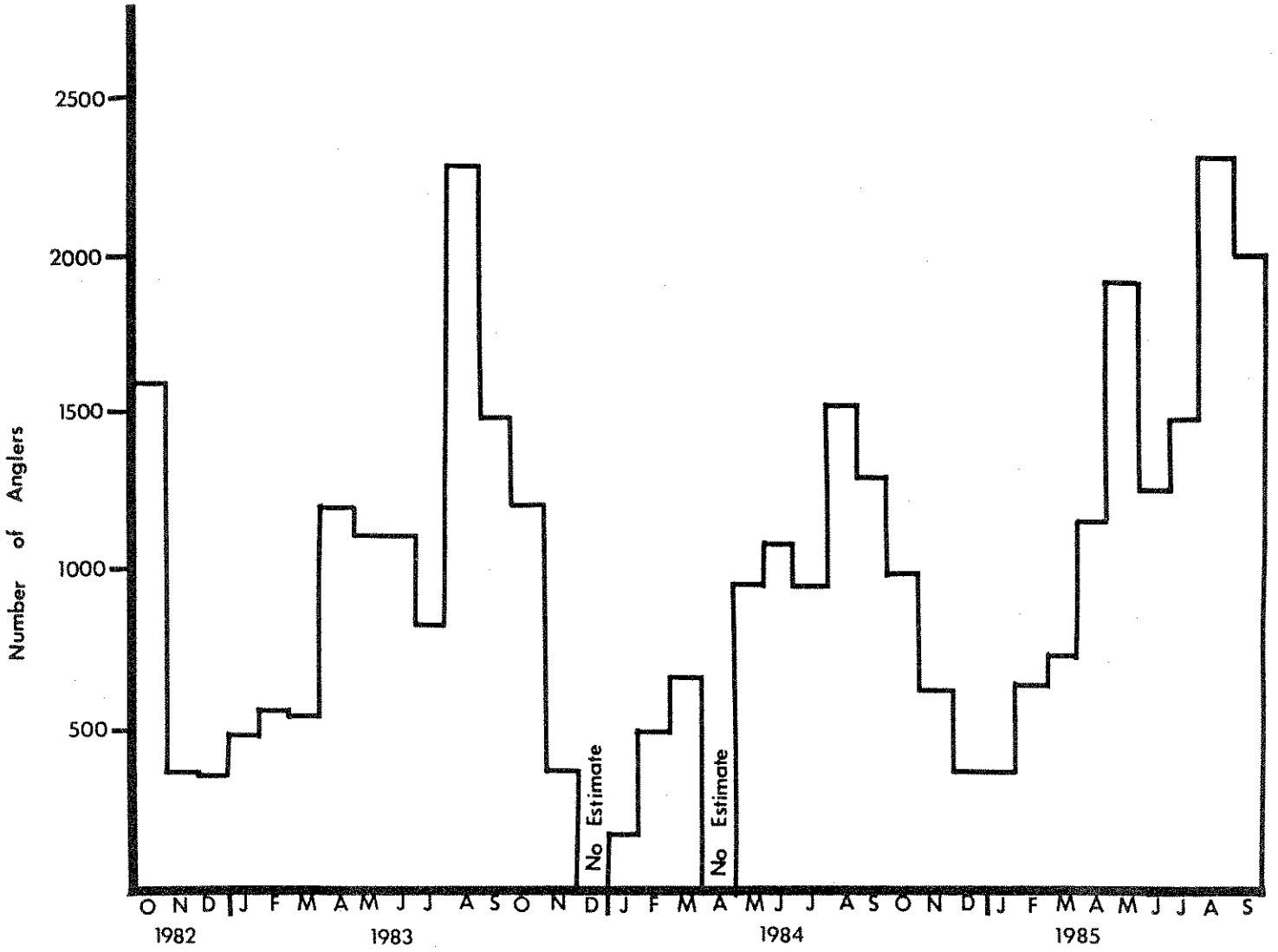

Figure 5. Monthly trend in estimated fisherman numbers on Section 2 of the Bighorn River (12.0-mile reach) during October, 1982-September, 1985. October, 1982-September, 1983 is based on the Bighorn creel estimates. October, 1983-September, 1985 is based on predicted values.

serious fish kill (Fredenberg 1985). This closure and accompanying uncertainties may have been partially responsible for decreased fishing pressure seen during the summer and fall, 1984.

Estimated catch and harvest

Estimated angler catch was approximately 34,800 trout in 11,840 angling days for an average of 2.9 fish per angler per day and 0.47 trout per angler per hour (Table 21). The catch was 74% brown trout and 26% rainbow trout. Anglers kept nearly 7,500 of the trout they caught. Twenty percent of the brown trout caught and 25% of the rainbow caught were kept. Anglers harvested an average of 0.63 fish per angler per day and 0.10 fish per angler per hour. Sixty-nine percent of the trout harvested were brown trout and 31% were rainbow trout.

Nearly 57% of the brown trout caught and 58% of the rainbow trout caught were taken during only 3 months - August, September and October (Table 21). The lowest catch of both species was during November through March, when only 17% of the brown trout and 15% of the rainbow catch occurred.

Estimated harvest trends followed similar patterns to catch, but were not nearly as skewed to the heavy pressure months (Table 21). Only 41% of the brown trout and 52% of the rainbow trout that were harvested were taken during the August-October heavy-use period. Harvest was heavily skewed toward brown trout during February-June, 1983 when about 80% of all trout harvested were brown trout. During October, 1982 through January, 1983, brown trout comprised 70% of the harvest. Heavy rainbow trout harvest occurred during July and August, 1983, when 44% of all trout harvested were rainbow. Nearly 40% of the total rainbow trout harvest occurred during just those 2 months.

Tag returns

A total of 1,668 brown trout and 372 rainbow were tagged with Floy anchor tags in 1980-81. Fish tagged in 1980 and early 1981 (February-July 20) were tagged by the U. S. Fish and Wildlife Service as part of a gas supersaturation study. The rest of the tagging was done by DFWP to study movement information and return rates. All tags were inserted in catchable-sized trout, most of which were 14 inches or larger.

Anglers returned 2.6% of all brown trout tags and 5.6% of rainbow tags distributed (Table 22). Total returns from electrofishing operations were 8.5% for brown trout and 3.8% for rainbow. This disparity between angler and electrofishing catch rates for the two species follows what would be expected since population estimates compared to harvest indicate anglers are harvesting the rainbow population at a higher rate than for brown trout (Fredenberg 1984, 1985). A higher proportion of rainbow tags were returned by anglers and a lower proportion remained in the population to be gathered by electrofishing in comparison to brown trout.

Little effort was made during the period to encourage tag returns from anglers and, consequently, it is believed that the rate of compliance was quite low, probably less than 50%. Nevertheless, the rate of exploitation by anglers, based on tag returns, is relatively low for both species.

Table 21. Estimated catch and harvest of brown and rainbow trout from Section 2 of the Bighorn River (12.0 miles) during October, 1982 through September, 1983 (80% confidence intervals in parentheses).

Month	Brown Trout Caught		Brown Trout Kept		Rainbow Trout Caught		Rainbow Trout Kept	
October, 1982	5,470	(+323)	774	(+66)	2,137	(+165)	333	(+40)
November	935	(+179)	343	(+66)	297	(+68)	115	(+32)
December	959	(+186)	306	(+58)	384	(+86)	124	(+34)
January, 1983	851	(+156)	357	(+64)	315	(+66)	174	(+39)
February	838	(+151)	397	(+60)	218	(+50)	91	(+24)
March	711	(+148)	360	(+74)	187	(+57)	71	(+23)
April	1,876	(+208)	474	(+49)	518	(+111)	105	(+21)
May	2,009	(+203)	243	(+33)	622	(+81)	69	(+15)
June	1,614	(+154)	360	(+38)	647	(+79)	135	(+22)
July	1,332	(+126)	183	(+25)	649	(+82)	220	(+31)
August	5,057	(+367)	909	(+83)	2,184	(+184)	653	(+67)
September	3,974	(+333)	456	(+52)	1,039	(+104)	217	(+35)
Total	25,626	(+777)	5,162	(+201)	9,197	(+354)	2,307	(+119)

Table 22. Summary of tagging and return information for brown and rainbow trout on the Bighorn River during 1980-1984.

Date Tagged	Area (River Mile)	Trout Species	No. Tagged	Length Range (Inches)	No. of Fishermen Returns	Percent Fishermen Return	No. of Electrofishing Returns	Percent Electrofishing Return
7/24-9/22/80	0-15	Brown	423	6-22	9	2.1	21	5.0
2/17-7/20/81	0-5.5	Brown	215	11-22	11	5.1	34	15.8
7/23-8/13/81	3.5-9.0	Brown	1,030	8-24	23	2.2	66	6.4
Total	0-15	Brown	1,668	6-24	43	2.6	121	7.3
7/24-9/22/80	0-15	Rainbow	122	8-22	2	1.6	2	1.6
2/17-7/20/81	0-5.5	Rainbow	55	12-25	4	7.3	0	0
7/23-8/13/81	3.5-9.0	Rainbow	195	13-24	15	7.7	12	6.2
Total	0-15	Rainbow	372	8-25	21	5.6	14	3.8

DISCUSSION

Fisherman impacts on the trout population

Fish population estimates were conducted on the Bighorn River during December, 1982 and May and September, 1983 in a 7.2-mile reach of stream midway between the Afterbay Dam and Bighorn Access (Fredenberg, 1985). By comparing monthly length frequencies of harvested fish to known age and growth parameters from population sampling, a reconstruction of the age distribution of the harvest in Section 2 was created.

Peak estimated brown trout harvest occurred in Age Class 3 fish which contributed 42% of the total harvest (Table 23). Age Class 2 contributed 38%, Age 4 and older 14% and Age 1 only 6%. The relative contribution of each age class varied somewhat by month, with Age 2 fish the most important from August through December. On January 1, all fish advanced one age class, and consequently Age 3 fish dominated the January through July harvest.

The effects of this harvest on the brown trout populations are minimal (Table 24). Only 19% of the total mortality during the census period was due to angler harvest. The bulk of this occurred in the Age 2 class where 40% of the mortality was due to angler harvest. In the Age 3 and older class, only one in seven brown trout that died (14%) were creeled by anglers.

On the Big Hole River, direct harvest accounted for 70% of the total Age 2 and older brown trout mortality between October, 1977 and October, 1978 (Kozakiewicz 1979). Total annual mortality rate was 43% but angling was not considered to be a limiting factor. On the Bighorn River in this study, annual mortality rates of 55% occurred for Age 2 and older brown trout, but only 29% of that was directly due to angling harvest. Angling was not the major factor controlling brown trout mortality during the course of this study.

Similar analysis of rainbow population and mortality is less dependable. Population estimates are not as accurate, due to lower population levels and wider confidence intervals. This is compounded by difficulty in aging scales and known heavy escapement of stocked fish from the Afterbay downstream into the Bighorn River.

Ages 2 and 3 rainbow trout each made up nearly 40% of the estimated harvest (Table 25). This was followed by Age 4+ at 12% and Age 1 fish at 9%. Rainbow harvest was more evenly split between age classes on a monthly basis than was the brown trout harvest, perhaps indicating a greater inclination by anglers to keep rainbow trout regardless of size.

Unlike brown trout, the potential effects of harvest on the rainbow population are serious. Age 1 figures were not usable, probably because of downstream escapement from the Afterbay which resulted in a net gain in the population of Age 1 fish between December, 1982 and September, 1983. Despite relatively low total mortality rates for Age 2 and older rainbow of 37% during the period, a very high proportion of that mortality was due to angler harvest (Table 26). Anglers creeled 27% of the population of Age 2+ rainbow between December, 1982 and September, 1983, and were directly responsible for 72% of the total mortality.

Table 23. Estimated breakdown of the brown trout harvest by age group from Section 2 of the Bighorn River during October, 1982 through September, 1983. Reconstructed from length frequency and known age and growth data.

Month	Age 1	Age 2	Age 3	Age 4+	Total Harvest
October, 1982	95	372	178	129	774
November	35	207	59	42	343
December	32	194	45	35	306
January, 1983	0	92	197	68	357
February	0	100	230	67	397
March	0	85	229	45	359
April	0	90	290	94	474
May	0	62	153	28	243
June	0	108	213	39	360
July	9	72	75	26	182
August	65	407	349	88	909
September	94	149	173	40	456
Total	330	1,938	2,191	701	5,160

Table 24. Brown trout population estimates (Fredenberg 1985) as compared to estimated harvest in the upper 12.0 miles of the Bighorn River during December, 1982 through September, 1983.

Age Group (Dec., 1982)	Total Population/12 Miles		Total Mortality	Percent Mortality	Total Angler Harvest	% of Dec., 1982 Population Harvested by anglers	% of Total Mortality Due to Angler Harvest
	Dec., 1982	Sept., 1983					
1	23,484	12,288	11,196	47.7	1,197	5.1	10.7
2	11,448	6,228	5,220	45.6	2,103	18.4	40.3
3+	5,484	1,404	4,080	74.4	575	10.5	14.1
Total	40,416	19,920	20,496	49.3	3,875	9.6	18.9

Table 25. Estimated breakdown of the rainbow trout harvest by age group from Section 2 of the Bighorn River during October, 1982 through September, 1983. Reconstructed from length frequency and known age and growth data.

Month	Age 1	Age 2	Age 3	Age 4+	Total Harvest
October, 1982	104	137	80	13	334
November	12	59	32	12	115
December	25	61	34	4	124
January, 1983	2	43	82	48	175
February	0	17	50	24	91
March	0	15	36	30	71
April	2	40	33	30	105
May	0	23	19	27	69
June	8	56	52	19	135
July	3	68	113	36	220
August	20	293	300	41	654
September	21	105	84	8	218
Total	197	917	915	282	2,311

Table 26. Rainbow trout population estimates (Fredenberg 1985) as compared to estimated harvest in the upper 12.0 miles of the Bighorn River during December, 1982 through September, 1983.

Age Group (Dec., 1982)	Total Population/12 Miles		Total Mortality	Percent Mortality	Total Angler Harvest	% of Dec., 1982 Population Harvested by Anglers	% of Total Mortality Due to Angler Harvest
	Dec., 1982	Sept., 1983					
2	3,540	2,340	1,200	33.9	830	23.4	69.2
3+	624	276	348	55.8	291	46.6	83.6
Total	4,164	2,616	1,548	37.2	1,121	26.9	72.4

Estimated rainbow catch in Section 2 of the Bighorn River from December, 1982 through September, 1983 was about 6,800 fish (Table 21). The estimated rainbow trout population in December, 1982 of Age 1 and older fish (approximately 10+ inches) was only 5,016 fish in this 12-mile reach. This means that not counting mortality every fish was caught an average of 1.3 times. Subtracting those that were harvested and considering natural mortality the actual figure would be much higher than this. Angler-induced mortality may be the major factor controlling the rainbow trout population.

On the Snoball and Pine Butte study sections of the Madison River, Age 3 and older rainbow trout experienced 71-75% summer mortality rates under a general 10-trout limit (Vincent 1983). A total fishing closure reduced this to 18-27% mortality on the Snoball section, and catch and release regulations resulted in 45-50% mortality rates in the Pine Butte section. In the Pine Butte section, the rainbow trout catch was approximately equal to the spring population (Vincent 1983), while on the Bighorn the catch exceeded the spring population, due largely to the more year-round nature of the Bighorn fishery which allowed for heavier winter use.

Comparison to other censuses on the Bighorn River

Limited contact creel survey was conducted on the Bighorn River by DFWP field personnel from 1967-1976 and in 1981. Results of those surveys (Swedberg 1969-1983) showed that during the 1967-1976 period the fishery was heavily dependent on hatchery-reared rainbow trout. Hatchery fish generally made up about 90% of the trout catch prior to 1975, with catch rates averaging about 0.4 fish per hour (Table 27). Between 1975 and 1981, brown trout became a major contributor to the fishery. The average length of rainbow trout in the harvest ranged from 12.4 to 16.7 inches during 1967-1981.

An intensive creel census was conducted in 1972 and 1973 (Stevenson 1975). Information collected during that census provides the best data for comparison to the current census. Estimated fishing pressure in a 10.3-mile reach of the river beginning 1.7 miles downstream from the Afterbay Dam was 631 man-days per mile during April 28-September 9, 1973. In 1973, 52-57% of the pressure occurred on weekends, while in the same period of 1983 about 58% of the pressure was on weekends.

During the 1973 census, 59% of the anglers were from Billings with 15% nonresidents, 14% other Montanans and 11% local residents. In 1983, Billings anglers made up only 35% of the total in Section 2, while nonresidents were the largest group at 41%. About 18% were other Montanans and 6% were local anglers. Average party size in 1973 of 2.66 anglers was about the same as the 2.5 found in 1983.

During 1973, about 88% of all anglers in the 10.3-mile reach above Bighorn Access used boats, but only 21% did so at the Afterbay Dam. Comparable figures were found in 1983, with 84% of all anglers floating in Section 2, but only 7% in Section 1. The average float fisherman fished 5.2 hours per day in 1973 and about 6.2 hours per day in 1983. No information on types of tackle or use of professional guides was available from the 1973 census.

Catch rates in 1972 and 1973 ranged from 0.31 to 0.74 fish per hour, depending on the section and whether the angler was fishing from shore or a

Table 27. Summary of creel survey results collected by angler contacts on the Bighorn River downstream from the Afterbay Dam during 1967-1981.

Time Period	Catch Rate (Trout/Hour)	Catch % Rainbow	Catch % Brown Trout	Avg. Length Rainbow (Inches)	Avg. Length Brown Trout (Inches)	Source
Aug., 1967-Jan., 1968	1.14	81-91	-	12.4	12.0	Swedberg 1969
May-Aug., 1968	0.72	90	-	13.8	-	Swedberg 1970
May-Sept., 1969	0.26	90	-	13.7	-	Swedberg 1971
June-Oct., 1970	0.23	85	12	15.2	-	Swedberg 1972
June-Sept., 1971	0.48	98	-	14.4	-	Swedberg 1973
June-Sept., 1972	0.40	85	8	13.6	14.1	Swedberg 1973
June-Sept., 1974	0.4	97	2	12.9	-	Swedberg 1975
April-Dec., 1975	0.4	66	34	16.6	16.2	Swedberg 1976
April-Sept., 1976	0.4	78	22	12.3	15.0	Swedberg 1977
Aug.-Sept, 1981	0.16	51	49	16.7	15.3	Swedberg 1983

Table 28. Comparison of the Bighorn River to other major Montana rivers where extensive creel census and survey work has been conducted.

Stream	Section	Length (Miles)	Source	Date of Census	Pressure (Fisherman Days/Mile)	Catch Rates: Brown Trout	Rainbow Trout	Cutthroat Trout	Total Trout	% of Catch Rept	Avg. Length of Trout Kept (Inches)	% Guided Floaters	Tackle Type (% Using): Bait	Fly	Lure	Combination	Angler Origin: Montana	Nonresident
Bighorn River	Afterbay to Bighorn Access	12.0	Fredenberg 1985	Oct., 1982-Sept., 1983	987	.34	.12	-	.46	21	15.6	16	-	49	32	19	59	41
Bighorn River	1.7 miles downstream from Afterbay to Bighorn Access	10.3	Stevenson 1975	April 28-Sept. 9, 1973	631	.07	.26	.01	.34	57	12.6	-	-	-	-	-	85	15
Missouri River	Holter Dam to Smith River	61.5	Berg 1982	April-Nov., 1981	-	.02	.39	-	.41	78	-	-	63	8	6	23	89	11
Madison River	Quake Lake to Greycliff	67.0	Vincent 1969	May-Sept., 1967	580	.20	.60	-	.80	-	-	-	40	25	17	18	38	62
Madison River	Snoball	4.5	Vincent 1977, 1978	May-Sept., 1976	546	-	-	-	.95	26	12.6	77	12	60	7	21	9	91
Bichole River	Melrose to Glen	9.9	Kozakiewicz 1979	May-Sept., 1978	403	.43	.15	-	.58	48	14.1	11	22	46	16	16	73	27
Yellowstone River	Corwin Springs to Yankee Jim Canyon	5.0	Vincent & Clancy 1980	Oct., 1978-Oct., 1979	≈ 250	.30	.18	.24	.72	16	12.6	-	32	42	20	6	77	23
Yellowstone River	Mill Creek Bridge to Loch Leven Access	5.7	Javorsky 1984	March-Sept., 1982	384	.35	.16	.13	.64	41	-	29	27	27	23	23	73	27
W. Gallatin River	Yellowstone Park to Canyon Mouth	41.0	Lyden 1973	May-Sept., 1972	246	.01	.45	.02	.48	73	-	-	-	-	-	-	55	45
Flathead River	Junction of North & Middle Forks to Flathead Lake	55.0	Fredenberg & Graham 1983	May 15-Nov., 1981	653	-	-	.18	.23	56	11.0 Cutthroat only	-	57	7	21	15	93	7

boat. Catch rates in 1983 were similar. In both censuses, the catch rates were seen to increase from May through September as the season progressed. There were, however, dramatic differences in the composition of the catch and harvest. Anglers fishing in 1973 in the 10.3-mile reach upstream from Bighorn Access caught 0.26 rainbow trout, 0.07 brown trout and 0.01 cutthroat trout per hour for a total catch rate of 0.34 trout per hour (Stevenson 1975). During the same period of 1983, anglers in Section 2 caught 0.12 rainbow and 0.30 brown trout per hour for a total trout catch rate of 0.42 fish per hour.

In 1973, anglers in the 10.3-mile reach above Bighorn Access harvested 8,157 rainbow, 2,234 brown trout and 71 cutthroat for a total of 10,462 trout between April 28 and September 9, 1973. For a comparable period of 1983, the harvest was only 1,879 brown trout and 1,153 rainbow for a total of 3,032 trout. Brown trout harvest in 1983 was about equal to 1973, but rainbow trout harvest in 1983 was only 14% of the 1973 total. In 1973, anglers kept about 57% of their catch vs. only 19% in 1983. In 1973, the average angler kept two fish per day vs. only about 0.5 fish per man per day in 1983 despite a higher catch rate.

The average length of fish creeled in 1973 was 11.9 inches for rainbow trout and 15.2 inches for brown trout. This had increased in the 1983 census to 15.5 inches for rainbow trout and 15.7 inches for brown trout. There is some evidence, however, that fewer trophy fish were being caught in 1983. During 1973, about 23% of the brown trout harvested were over 18 inches, 14% were over 20 inches, 7% were over 22 inches and 2% were over 24 inches. Comparable percentage values for 1983 were 19% over 18 inches, 6% over 20, 1% over 22 and only 0.1% over 24 inches.

From the foregoing comparison, it is obvious that the Bighorn River fishery has changed immensely between 1973 and 1983. It has shifted from a rainbow trout fishery heavily dependent on stocking to a brown trout-dominated fishery dependent on natural reproduction. The current fishery is much more heavily used by nonresident anglers, and is much less consumptive with a high voluntary rate of release. Overall catch rates and average sizes of fish have probably improved, but trophy trout potential has declined.

The DFWP has conducted mail surveys periodically which have been used to formulate fishing pressure estimates (MDFWP unpublished). The 1965 mail survey estimated total pressure on the Bighorn River in Montana at 446 man-days. This increased to 10,970 man-days in 1968-69 on the 84 miles of the river downstream from the dam and had ballooned to nearly 25,000 man-days by 1975-76 for a 1-year period. The most recent estimate was 30,000 man-days between March, 1984 and February, 1985 for the entire Bighorn River.

The estimated pressure presented in this report, of about 12,000 man-days, is a minimum estimate for only the uppermost 12.0-mile reach downstream from the Afterbay, which is the most heavily floated section of the river. It does not include the intense use in the short section immediately downstream from the Afterbay (Section 1), nor the less-intensively used Section 3 further downstream. A ball park estimate of total man-days of use in the upper 40 miles of the Bighorn River upstream from Hardin would lie in the range of 20,000-25,000 man-days. The DFWP mail survey estimated 20,000 man-days of use in this upper 40 miles of river between March, 1984 and February, 1985.

Comparison to other Montana Rivers

A number of intensive creel census efforts have been conducted on major Montana rivers during the past. A summary view of some of those other censuses and surveys is presented in order to bring the Bighorn River fishery into perspective (Table 28).

The Bighorn River can be characterized as an extremely high-use fishery in the upper 12 miles. Catch rates average lower than most other streams, but the average size of the fish kept is the highest encountered in any of the streams examined (Table 28). Catch rates are heavily dependent on brown trout. There is a very high rate of voluntary release by anglers fishing on the Bighorn. Nonresidents and guided trips are a major component of the fishery, but do not approach levels found on the Snoball section of the Madison River. Overall, the Bighorn River has remained a high-quality trout stream because of its tremendous productivity and despite heavy fishing pressure. Future management direction must maintain this level of quality.

Management implications

Heavy angling pressure dictates that the upper reaches of the Bighorn River be carefully monitored to detect any signs of overuse. The three-fish limit with only one over 18 inches that was in effect during this creel census appeared to be allowing effective utilization of the brown trout population by encouraging harvest of the abundant Age Class 2 and 3 fish. It did not, however, afford adequate protection to the rainbow trout population which showed signs of overutilization.

Partially as a result of this census, a regulation change was initiated effective May 1, 1984, which allowed anglers to keep five fish, but only one over 18 inches and only one rainbow trout. The total limit was increased to five fish to encourage greater utilization of the expanding brown trout population. The one fish over 18 inch restriction was maintained to preserve the quality fishery the Bighorn has become famous for.

For the first time in 1984, a species regulation was adopted which allowed anglers to keep only one rainbow trout. The goal of this restriction is to protect this segment of the trout population. Rainbow trout in the Bighorn produce a better opportunity for anglers to catch trophy trout than do brown trout. A limit of one rainbow, had it been in effect from October, 1982 through September, 1983, would have reduced the rainbow trout harvest by those anglers surveyed by 28%, dropping the total estimated take from 1,939 down to 1,401 rainbow. The restriction would have reduced rainbow harvest by 38% in Section 1, 33% in Section 2 and 21% in Section 3. An aggressive program to encourage anglers to release rainbow trout could reduce harvest numbers even more.

Results of this census have been used in conjunction with fish population trend information to dictate past managememnt policy. Brown trout populations appear to be regulated by streamflow and environmental factors with very little impact from fishing. If future monitoring continues to indicate this same relationship, then fishing regulations will likely remain as liberal as possible for this species.

The present restrictions placed on the fishery for the protection of rainbow trout should remain in effect until data indicates the population has responded. If the current attempts to enhance the self-sustaining rainbow trout population fail after an adequate evaluation period of about 5 years, a return to stocking should be considered. Under that scenario, special species regulations may no longer be necessary. The preferred course of action, however, would be to do everything possible to enhance a self-sustaining rainbow population. Current restrictions may need to be tightened even further to achieve that goal if population and creel information continue to indicate high mortality due to angling.

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APPENDIX

Statistical formulas used to calculate pressure and harvest:

n = number of fishermen interviewed

h_i = number of hours fished by the i'th fisherman interviewed; i = 1,...n

$\bar{h}$ = average hours fished per completed trip

P - pressure - denotes the number of fisherman trips

P_{adj} = adjusted pressure inflated for missed trips

TMH = total man-hours expended

fi = number of fish caught (or kept) by the i'th fisherman interviewed; i = 1,...n

$\bar{f}$ = average number of fish per angler per trip

f/h = average fish per hour for a given stratum

Var( ) = denotes the variance of the variable within parentheses

$\bar{}$ = the average of the variable considered, calculated by dividing the sum by the number of all sampled units

SE = standard error, equal to the square root of the variance

M = total number of days in a stratum

m = number of days sampled in a stratum

Q = adjustment factor based on camera counts;

$$Q = \frac{\text{boat-count-by camera}}{\text{boat count by creel clerk}} \Big\} \text{ for selected days}$$

TFH = total fish harvested (or caught)

To calculate pressure:

1.) $$P = \frac{\sum_{i=1}^{n} (n)}{m/M}$$ = man-days pressure in a given stratum

$$Var(P) = \frac{\sum n_i^2 - \frac{(\sum n_i)^2}{n}}{\frac{n-1}{(m/M)^2}} = \frac{\sum n_i^2 - \frac{(\sum n_i)^2}{n}}{(n-1)(m/M)^2}$$ = variance of pressure

2.) Adjustment of pressure for camera counts:

$P_{adj} = P \times Q$ = adjusted pressure

$Var\ (Padj) = Var(P) \times Q^2$ = variance of adjusted pressure

3.) Calculation of average hours fished:

$$\bar{H} = \frac{\sum_{i=1}^{n} h_i}{n} = \text{average hours fished}$$

$$Var(\bar{H}) = \frac{\sum_{i=1}^{n} (h_i - \bar{h})^2}{n(n-1)} = \text{variance of average hours fished}$$

4.) Calculation of total man-hours:

$TMH = P_{adj} \times \bar{H}$ = total man-hours

$Var(TMH) = \bar{H}^2 x Var(P_{adj}) + P_{adj}^2 x Var\ \bar{H}$ = variance of total man-hours

5.) Calculation of fish per angler:

$$\bar{f} = \frac{\sum_{i=1}^{n} fi}{n} = \text{fish per angler per trip}$$

$$Var\ (\bar{f}) = \frac{\sum_{i=1}^{n} (f_i - \bar{f})^2}{n(n-1)} = \text{variance of fish per angler}$$

6.) Calculation of catch rate:

$(f/h) = (\bar{f}/\bar{h})$ = catch rate for a given stratum

Variance of catch rate was not calculated, due to complexity of the formula and lack of need for this statistic in this report.

7.) Calculation of total fish harvested (or caught):

$TFH = \bar{f} \times P$ = total fish harvested (or caught)

$Var(TFH) = (\bar{f})^2\ Var(P) + (P)^2\ Var(\bar{f})$

These equations will yield the estimates of pressure, man-hours and harvest and each of their variances for any one stratum. To indicate the procedure for deriving estimates pertinent to the entire season, assume that everything in these equations has an additional subscript, say k, which denotes the stratum under consideration (k = 1, 2 or 3).

The totals can be derived as the sum of the stratum totals and the variance of such a total is, due to the nature of stratified sampling, simply the sum of the variances from the strata.

An average for the entire season ($\bar{f}$ or $\bar{h}$) is derived as the weighted average of the stratum averages where the weight assigned to any stratum is proportionate to a measure of its respective size.

The average fish per hour (f/h) is the ratio of two random variables and cannot be considered as an average over sampling units. Rather, the estimate is derived for the sason exactly the same as it was derived within each stratum:

$$f/h = \frac{\bar{f}}{\bar{h}}$$

The standard error of estimate can be derived in all cases as the square root of the variance. Approximately 95% confidence limits can be computed as the point estimate plus or minus two standard errors. Approximately 80% confidence limits can be computed as the point estimate plus or minus 1.28 standard errors.