INVENTORY AND SURVEY OF THE SALMONID POPULATIONS OF THE BIG HOLE RIVER OF SOUTHWEST MONTANA, 2000 - 2001.

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June 2002
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ABSTRACT

River discharge and thermal data are summarized for the Big Hole River at the USGS Melrose Gage site for water years 2000 and 2001. A relatively severe period of drought dominated flow and temperature regimes over the 1999 through 2001 period. Despite extremely low water yields recorded in 2000 and 2001, summer minimum flows were mitigated through components of a Big Hole River Drought Plan administered by the Big Hole River Watershed Committee. Rainbow trout population studies were limited by drought conditions to fall estimates in the Jerry Creek Study Section while brown trout population studies were conducted from spring estimates in the Maiden Rock, Melrose, and Hog Back Study Sections. Analysis of rainbow trout populations demonstrated relatively strong recruitment and high population density despite prevailing drought conditions. This was associated with mitigating components of the Big Hole River Drought Plan. Brown trout populations in the Hog Back Section exhibited a tendency to decline following extremely low summer flow regimes and high summer water temperatures in 2000 and 2001.The declines were most severely manifest via brown trout standing crop and densities of large, mature fish. Brown trout populations in the Maiden Rock and Melrose Study Sections fared well despite prevailing drought conditions. Comparative data with past drought episodes strongly suggest that components of the Big Hole Drought Plan have benefitted brown trout populations in the Melrose and Maiden Rock Sections.

ACKNOWLEDGMENTS

The author would like to gratefully acknowledge the able assistance of the following individuals in the collection of field data under often arduous conditions; Greg Gibbons, Tim Mosolf, Scott Lula, and Jim Magee. The author would also like to thank Dick Vincent, Jeff Bagdanov and Jody Hupka for assistance in the analyses of Whirling Disease samples. Finally, the author would like to acknowledge the assistance of Bob McFarland, Wayne Black, and Deanna Meredith in data preparation and analysis techniques.

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INTRODUCTION

The Big Hole River is a major tributary of the upper Missouri River drainage in southwest Montana. It merges with the Beaverhead River near Twin Bridges, Montana to form the Jefferson River, one of the three major forks of the Missouri River named by Lewis and Clark. The Big Hole drainage supports native populations of westslope cutthroat and lake trout; Arctic grayling; mountain whitefish; burbot; white, longnose, and mountain sucker; longnose dace; and mottled sculpin. The sport fisheries of the drainage, however, are dominated by introduced populations of rainbow, brown and brook trout which were stocked into the drainage in the late 1930's and early 1940's. Stocking of hatchery rainbow trout into the Big Hole River and its tributaries was ceased in 1974 in favor of management for wild trout populations.

While the sport fishery of the Big Hole River is dominated by the introduced rainbow and brown trout populations, recent interest in the conservation of native salmonids has expanded research within the drainage. Extensive genetic research has been conducted on tributary populations of native westslope cutthroat trout by Montana Department of Fish, Wildlife and Parks and the Beaverhead National Forest. A native glacial relict population of lake trout in Twin Lakes was studied extensively (Oswald and Roberts 1998) and subjected to genetic testing to confirm its native origins (Oswald 2000c). Liknes (1981) and Oswald (1984) initiated research on the fluvial arctic grayling population of the Big Hole River. Since Oswald (Vincent et al 1989) last reported on the status of the arctic grayling population, arctic grayling research has been conducted under the auspices of the grayling recovery program and reported by Byorth (1991 - 1996) and, more recently, Magee and Byorth (1998) and Magee (1999 and 2002). For this reason, arctic grayling population data will not be included in this report.

The wild brown and rainbow trout populations of the Big Hole River were last described by Oswald (2000a) for the Jerry Creek, Maiden Rock, Melrose, and Hog Back study sections. Since that time, Big Hole River flow regimes have been dominated by severe drought conditions which have persisted through the winter and spring of 2002. This most recent drought episode followed a very wet climatic period which resulted in extremely high flow regimes during the 1995 - 1997 period. High amplitude and duration of runoff events during this period significantly modified the geomorphology of the Big Hole River channel and trout habitat niche provided therein, at least on a localized basis. Abundant flow regimes also maximized trout habitat niche quantity and quality resulting in brown and rainbow trout populations marked by high standing crops and high densities of older, larger fish (Oswald 2000a). Drought conditions in the late 1980's and early 1990's precipitated a cooperative effort between sportsmen and irrigators under which irrigation withdrawal was mitigated and the river was closed to angling as defined low flow triggers were encountered. Subsequent efforts of the Big Hole River Watershed Committee, a citizen based advocacy group, have expanded and refined drought mitigation efforts into a drought response plan which was adopted for use under future drought conditions. Montana Fish, Wildlife and Parks currently cooperates with the Big Hole Watershed Committee in the application of this drought response plan throughout three defined river reaches.

Whirling disease, caused by infections of the protozoan parasite, *Myxobolus cerebralis*, was discovered in yearling rainbow trout from the Big Hole River in 1996. Subsequent research suggests that the disease has remained present at a relatively low frequency of infectivity within

the trout populations and relatively low grade of infection among individual fish (MFWP Unpub. Data).

Angler use of the Big Hole River increased markedly during the 1990's. Angling pressure increased from an estimated 51,203 angler days in 1991 to an estimated 83,408 angler days in 1997 and 79,747 angler days in 1999 (MFWP 1991, 1997 and 1999). While resident angler pressure increased 22.6% between 1991 and 1997, nonresident angler use increased 158%. Nonresident anglers composed 47.1% and 39.0% of the estimated use in 1997 and 1999, respectively. This rapid increase in pressure led to the 1999 formation of a citizens advisory committee which studied the issue of crowding on the Big Hole River at the request of the Montana Fish, Wildlife and Parks Commission. One aspect of study included summer user surveys in 1999 and 2000 which gathered data on the demographics and use patterns of anglers and other users of the Big Hole River. As a result of these studies and recommendations from the citizen's advisory committee, the Commission enacted a "Biennial Rule" which placed restrictions and limitations on anglers, commercial outfitters, and other recreational users of the Big Hole River in 2001 and 2002.

METHODS

Trout populations were sampled through the use of electrofishing techniques based on mark-recapture methodologies described by Vincent (1971). Electrofishing was conducted via boat mounted, mobile anode techniques which utilize a 3500 watt generator and Leach type rectifying box. A straight or continuous wave DC current was used at 1,000 to 1,500 watts. Fish captured within the field were drawn to the boat, netted, and deposited into a live car. Individual fish captured were anesthetized, segregated by species, measured for length and weight, marked with a small identifying fin clip, and released. Arctic grayling captured during the sampling are also implanted with an individually numbered Visual Implant (VI) Tag for future identification. Scale samples for age determination were collected from a representative subsample by length. Multiple marking runs and recaptures runs were made through each of the study sections until predetermined goals were achieved in mark and capture totals.

Trout population statistics were analyzed under a log-likelihood methodology developed and described by Montana Fish, Wildlife and Parks (1994) under guidelines presented by Brittain, Lere, and McFarland (1998). Population estimates were calculated for brown trout from March samples collected from the Maiden Rock, Melrose, and Hog Back study sections while rainbow trout population estimates were calculated from September samples collected from the Jerry Creek, Maiden Rock, and Melrose study sections. The seasonal segregation of brown and rainbow trout population estimates was applied to avoid estimate bias due to spawning movements and migrations.

Flow and temperature data were gathered at the Melrose Gage (USGS 2000-2001), by water year, for the report period. Additional stream gages have recently been installed through the Big Hole Watershed Committee's actions to gather additional data on summer stream flow characteristics. Data presented in this report, however, were limited to the Melrose Gage site because it has been operated from 1923 through the present.

RESULTS

Flow and Temperature Regimes

Summary statistics for dominant flow regimes (Table 1) adequately depict the drought conditions which began to influence summer flows in 1999 and dominated the Big Hole River for the 2000 and 2001 water years. Low mountain snowpack and summer precipitation resulted in low runoff peaks which were generally of short duration while annual water yield barely exceeded 400,000 acre feet per year. In comparison, the extremely dry years of 1987 and 1988 yielded 424,400 and 426,800 acre feet per respective water year. Despite these extremely low annual output values, minimum summer flows did not drop to levels similar to those observed in 1987 and 1988. Minimum July and August streamflow fell far below the respective long term averages of 1,340 cfs and 477 cfs for those two months and also dropped below the recommended minimum instream flow in August of 1999, 2000, and 2001 as well as in July of 2000. Instream flow requirements for aquatic organisms have been calculated at 650 cfs to maintain optimum habitat and 260 cfs to maintain minimum habitat conditions (MFWP 1989).

Table 1. Average daily flow statistics for the Big Hole River at the USGS Melrose Gage for the 1989 - 1999 period of record.

Water Year	Runoff Peak Flow (Cfs)	July Minimum Flow (Cfs)	August Minimum Flow (Cfs)	Annual Water Yield (Acre - feet)
1989	3,660	441	185	486,700
1990	3,130	385	228	518,100
1991	9,710	450	175	646,500
1992	1,710	421	178	393,900
1993	4,910	982	674	716,200
1994	3,150	272	152	439,800
1995	11,300	983	342	954,200
1996	11,600	606	320	1,199,000
1997	12,800	1,010	514	1,352,000
1998	4,980	866	299	934,400
1999	6,830	407	228	767,900
2000	2,420	192	126	407,700
2001	2,440	280	151	408,800

Low flow regimes during the recent drought influenced 2000 - 2001 period were often accompanied by elevated daily thermal regimes (Table 2). July maxima exceeded 21.1 degrees C. (70 degrees F.) at the USGS Melrose Gage on 9 days in 2000 and 8 days in 2001, however, mean daily temperatures averaged about 17.5 degrees in both years. These data can be contrasted with July temperatures in 1988 which averaged 18.5 degrees and yielded 22 days in which temperatures exceeded 21.1 degrees. August maxima were relatively high in 2001, revealing 10 days in which maximum daily temperatures exceeded 21.1 degrees resulting in a mean daily temperature of 18.2 degrees for the month. The low late summer flow regimes of 2001 exhibited the warmest August thermal regime observed during the 1987 - 2001 period at the Melrose Gage.

Table 2. Temperature range and mean daily temperature in degrees Centigrade for July and August measured at the USGS Melrose Gage for the 1989 - 1999 period of record.

	JULY				AUGUST		
Year	Max.	Min.	Mean		Max.	Min.	Mean
1989	23.5	13.0	18.0		21.5	10.5	16.5
1990	23.0	13.0	17.5		22.5	12.0	16.5
1991	23.0	12.5	18.0		21.5	14.0	18.0
1992	22.5	12.5	16.5		23.0	8.0	17.0
1993	19.5	10.5	14.0		20.5	10.0	15.0
1994	24.0	10.5	17.5		22.5	11.5	17.5
1995	20.5	11.5	16.1		21.0	12.0	16.4
1996	23.0	13.5	17.7		21.0	11.0	16.5
1997	21.5	10.0	16.5		21.0	13.0	16.5
1998	23.5	15.0	18.5		23.0	13.0	17.1
1999	21.5	11.0	16.5		21.5	13.0	17.5
2000	23.0	11.5	17.5		22.5	12.5	17.0
2001	23.2	12.7	17.6		23.2	12.8	18.2

Relatively high thermal regimes observed at the Melrose gage were often exceeded in downstream environments. Thermal loggers placed at Notch Bottom and Pennington Bridge in July and August 2000 revealed thermal daily maxima of 29.5 degrees and 28.3 degrees,

respectively, in late July. Moreover, late July recordings revealed temperatures in excess of 21.1 degrees, up to a maximum of 24.0 degrees, persisting for up to 12 consecutive hours within a 24 hour period at Pennington Bridge. Oswald, in Vincent et al. (1989), reported the 1988 occurrence of thermally induced fish kills affecting mountain whitefish and brown trout in lower reaches of the Big Hole River near Pennington Bridge while Byorth (1995) observed a fish kill which affected mountain whitefish, arctic grayling and brook trout in July near the mouth of Pintler Creek in 1994. Despite the relatively high water temperatures characteristic of the summers of 2000 and 2001, no major fish kills were reported or observed in the Big Hole River.

Rainbow Trout Populations

Jerry Creek Section: Rainbow trout studies were initiated in the Jerry Creek study section in the fall of 1986. Trends in estimated rainbow trout density and standing crop for Age I and older fish are presented in Figure 1 for the 1986-2001 period. No electrofishing was conducted in 1994 and 2000 due to low flow and high water temperature in keeping with the Big Hole River Drought Plan and subsequent closure of angling. Despite recent drought conditions, the 2001 rainbow trout population in the Jerry Creek Section expanded to a relatively high density of 2,119 fish per mile and an extremely high standing crop of 1,190 pounds per mile. Population densities exceeding 2,000 Age I and older fish per mile were observed in 1987, 1990, 1991, and 1993. These peaks in population were not associated with dramatic rises in standing crop which tended to remain very stable at approximately 1,000 pounds per mile. The 2001 standing crop was the highest observed in the sampling history of the Jerry Creek Study Section and obviously combined a relatively strong recruitment class with strong survival of high numbers of older, larger fish in the population despite persistent drought conditions. Peaks in rainbow trout population have typically been associated with strong recruitment cohorts of Age I rainbow trout (Figure 2). Recruitment in 2001 was relatively strong, continuing a trend which began in 1999. The strong recruitment cohorts of 1987, 1990, 1991, and 1993 were associated with moderate runoff peaks (Table 1) observed in the prior year when the fish were incubating or hatching. Conversely, poor recruitment of yearling rainbow trout observed in 1992, and 1996-1998 was associated with runoff peaks of 9,700 cfs and higher. Poor recruitment of yearling rainbow trout into the population between 1995 and 1998 was directly correlated with rainbow trout population declines over that period. Good recruitment classes observed in 1999 and 2001 were also associated with moderate runoff peaks in the prior years and resulted in expanding rainbow trout populations observed in 1999 and 2001.

Prior population analyses (Oswald 1984 and 1986, Vincent et al. 1989, and Oswald 2000a) considered 13 inch and larger and 16 inch and larger rainbow trout numbers as valid parameters for the assessment of the special angling regulations which have been in affect in the river reach which encompasses the Jerry Creek Section since 1988. The two length groups also roughly describe the Age III and older and Age V and older segments of the rainbow trout population. Numbers of 13 inch and larger rainbow trout (Figure 3) increased steadily throughout the 1986-1997 period but declined in 1998 and 1999 following the poor yearling recruitment observed in the 1995 - 1998 period. The 2001 sample revealed high numbers of 13 inch and larger rainbow trout exceeding 600 fish per mile. This high density resulted directly from strong yearling

recruitment in 1999 and relatively strong subsequent survival despite severe drought conditions. The 2001 density of 13 inch and larger fish compared favorably with prior highs observed in 1996 and 1997. Densities of 16 inch and larger rainbow trout are depicted in Figure 4. Numbers of these larger fish appear somewhat limited in the Jerry Creek section and appear maximized, with the exception of 1987, at approximately 40 per mile. The 2001 estimate for these older, larger rainbow trout was 40 per mile despite persistent drought conditions.

Despite low summer flow regimes and high water temperatures associated with drought conditions prevalent throughout the 1999 - 2001 period, rainbow trout populations in the Jerry Creek Section fared better in 2001 than those observed during the relatively severe 1987 - 1989 drought period. Figures 5, 6 and 7 demonstrate that rainbow trout standing crop and numbers of older, larger rainbow trout fared far better in 2001, under the Big Hole River Drought Plan than prior populations in the 1987 - 1989 period. Components of the Drought Plan include voluntary flow contributions by irrigators, mandatory angling closure, and no electrofishing sampling as average daily flow at the Melrose Gage drops below a 150 cfs trigger.

Brown Trout Populations

Maiden Rock Section: Brown trout population studies were initiated in the spring of 1981 to assess the affects of special angling regulations which included implementation of a "slot limit" and gear restrictions. Affects of the special regulations have been previously evaluated by Oswald (1986), Vincent et al. (1989), and Oswald (2000a). Brown trout populations and standing crops (Figure 8) have demonstrated an expanding trend since 1981. Populations increased markedly after 1984, declined somewhat during the 1989-1992 drought influenced period, and recovered to observed high densities over the 1993-1998 period. The recent population sample in 2001, coupled with the 1998 sample, represented observed highs for the study section in both density and standing crop.

Numbers of 13 inch and larger brown trout (Figure 9) increased markedly to exceed 1,000 fish per mile in 1998 following abundant water years in the 1995 - 1997 period. Despite recent drought conditions, densities of 13 inch and larger fish remained above 1,000 fish per mile in 2001. In contrast, numbers of 18 inch and larger brown trout (Figure 10) declined markedly between the 1998 and 2001 samples. Numbers of these larger brown trout, however, remained well above those observed in drought affected years between 1988 and 1996. Similar to the rainbow trout analysis, these spring length analysis groupings correspond roughly to Age III and older fish and Age V and older fish in the brown trout population.

Melrose Section: Age II and older brown trout population densities and standing crops of the Melrose section are exhibited in Figure 11 for the 1981-2001 period. Brown trout populations in the Melrose section have fluctuated between an observed low of 526 and high of 1,569 per mile but have generally varied between 800 and 1,000 per mile in most of the sample years. The 2000 and 2001 samples exhibited some of the highest observed populations in the sampling history of the study section with both density and standing crop approaching 1,400 fish

and 1,400 pounds per mile. Similar to the case in the Maiden Rock Section, brown trout populations in 2000 and 2001 flourished despite prevailing drought conditions.

Numbers of 13 inch and larger brown trout (Figure 12) also increased dramatically in the 2000 and 2001 samples. Both years exhibited recorded highs in densities of these Age III and older fish exceeding 800 fish per mile. While numbers of 18 inch and larger brown trout exhibited a decline in the Maiden Rock Section, densities of these older, larger fish flourished in the 2000 - 2001 samples in the Melrose Section (Figure 13). The trend from 1991 through 2000 had been a steadily increasing density followed by a slight decline in 2001. While numbers of 18 inch and larger fish declined in 2001, this density remained in excess of 100 fish per mile, and, with the 2000 sample, represented the highest observed sample densities of these large brown trout for the period of record.

Hog Back Section: The Hog Back study section was initiated in the spring of 1987 in order to monitor the brown trout dominated lower reaches of the Big Hole River (Vincent et al 1989). Brown trout population trends for the Hog Back Section were last discussed by Oswald (2000a). Estimated spring densities and standing crops of Age II and older brown trout are presented in Figure 14. Following recorded highs in density and standing crop observed in 1997 and 1998, brown trout populations generally declined over the 1999 - 2001 period. Although brown trout density increased slightly in 2001 based on a relatively strong class of 504 Age II fish per mile, standing crop declined steadily with declining flow regimes from the observed high in the 1998 sample. This same decline was observed with drought influenced streamflow in the 1987 - 1990 period and the 1991 - 1995 period. Conversely, observed highs in standing crop occurred following abundant flows in the 1995 - 1998 and 1982 - 1986 periods and relatively ample flows in the 1990 and 1991.

Estimated densities of 13 inch and larger brown trout in the Hog Back section (Figure 15) have varied over the study period in a manner quite similar to the trends of the brown trout population. Estimated densities of 13 inch and larger brown trout in 2000 and 2001 generally exhibit a declining trend symptomatic of the continuing drought conditions. Similarly, numbers of 18 inch and larger brown trout (Figure 16) have steadily declined since the observed high was recorded in the 1998 sample. This trend is substantially different from those observed in the Maiden Rock and Melrose Sections where densities of these larger fish remained high despite drought influenced flows. While numbers of both 13 inch and 18 inch and larger fish have declined, numbers of 13 inch and larger fish have maintained near 600 per mile and numbers of 18 inch and larger fish have continued to exceed 40 per mile.

Brown Trout Drought Comparison: Brown trout population dynamics characteristic of the recent drought episode can be compared with similar statistics from the 1987 - 1989 drought period prior to the implementation of the Big Hole River Drought Plan. Under the Drought Plan, certain voluntary actions are implemented at discreet flow and temperature triggers specific to three defined reaches of the Big Hole River. The Jerry Creek, Maiden Rock, Melrose, and Hog Back Study Sections all lie within the Lower Reach which extends from Dickie Bridge to the mouth of the river for a distance of approximately 74 river miles. Under the Drought Plan, a trigger flow of 150 cfs at the USGS Melrose Gage initiates voluntary irrigation cutbacks by

ranchers, mandatory closure of fishing, cessation of diversion of domestic water by the City of Butte, Montana, and suspension of electrofishing sampling by FWP. Once the 150 cfs trigger flow is encountered, all voluntary and mandatory restrictions remain in affect until flows exceed 200 cfs for seven consecutive days. In August 2000 the Drought Plan actions were initiated as flows declined to an August low of 126 cfs at the Melrose Gage. In 2001, the full application of the Drought Plan was narrowly avoided via irrigator efforts and timely precipitation as flows dropped to an August minimum of 151 cfs. Brown trout standing crop was analyzed to compare differences between the 1987 - 1989 drought episode and the current 1999 - 2001 episode for the Maiden Rock, Melrose, and Hog Back Study Sections in Figures 17, 18, and 19. Within the Maiden Rock and Melrose Study Sections, brown trout standing crop clearly fared better under the Drought Plan than was the case in the 1987 - 1989 period. Moreover, brown trout standing crop in the Melrose Section (Figure 19) actually demonstrated an increase despite continuing low flows. In the Hog Back Section, however, (Figure 17) standing crops were very similar between the two drought periods and were products of a clearly declining trend in both instances (Figure 14). Numbers of older, larger fish were also analyzed to compare brown trout population responses to the two drought episodes (Figures 20 and 21). Again, numbers of larger brown trout in the Melrose Section demonstrated an improved trend despite drought conditions and maintained density levels far in excess of those observed in 1989. In the Hog Back Section (Figure 21), numbers remained well above those observed in the 1987 - 1989 period but evidenced a steadily declining trend similar to that exhibited by standing crop. Different responses to the drought impacted flows and the Drought Plan among the three brown trout study sections could be associated with subtle differences in flow or temperature regime. While flow regimes in 2000 differed little between the Melrose and Glen USGS Gages in 2000, water temperatures recorded at the Glen Gage site clearly exhibited an elevated thermal regime in the vicinity of the Hog Back Study Section and downstream reaches. In 2001, elevated thermal regimes and lower flows influenced the Hog Back Section much more substantially than the Melrose or Maiden Rock Study Sections. While August flows at the Melrose and Maiden Rock Gage sites did not drop below 150 cfs in 2001, flows at the Glen Gage dropped below 150 cfs for 14 consecutive days to a minimum of 124 cfs.

DISCUSSION

Flow and Temperature Regimes

Summer flow and temperatures in the Big Hole River, over the current portions of this report period, were dominated by drought conditions marked by below average mountain snowpack, below average spring and summer precipitation, and high ambient summer air temperatures. Drought influenced conditions on the Big Hole River persisted over the 1999 through 2001 period resulting in a below average flow pattern which exhibited some of the lowest annual water yields observed for the period of record at the USGS Melrose Gage. Despite the

exceptionally low water yields in 2000 and 2001, summer minimum flows have been substantially improved when compared with other severely impacted drought years such as 1987, 1988, and 1994. Summer flows in 1988 dropped to a minimum of 53 cfs at the Melrose Gage while minimum flows of 126 cfs in 2000 and 151 cfs in 2001 were maintained despite annual water yields which dropped below that observed in 1988. This improvement can be directly correlated with components of the Big Hole River Drought Plan such as the voluntary irrigation cutbacks and the restriction of domestic diversion as the 150 cfs flow trigger is encountered. Trout population data for the Big Hole River strongly suggest that the limited flow regimes characteristic of drought periods have resulted in substantial reductions in trout standing crop and numbers of large trout (Vincent et al. 1989 and Oswald 2000a). Similar reductions in biomass and large trout numbers were also observed on the Beaverhead and Ruby Rivers (Oswald and Brammer 1993, Oswald 2000c). Data also suggest, however, that the moderate runoff events of the drought periods often resulted in strong, if not exceptional recruitment of juvenile rainbow trout into the population (Oswald 2000a).

High summer water temperatures also marked the 2000 - 2001 drought period. Maximum July water temperatures recorded at the USGS Melrose Gage ranged between 23.0 and 23.2 degrees C. while August temperatures in 2001 recorded the highest maximum and mean temperatures observed over the 1987 - 2001 period of study. Thermal recorders placed in lower reaches of the river near the Glen USG Gage and at Pennington Bridge revealed extremely high July water temperatures approaching 30 degrees C., often remaining in excess of 21.1 degrees C. (70 degrees F.) up to 12 hours per day. This additional thermal input, despite flow mitigation efforts of the Big Hole River Drought Plan, could be associated with declining brown trout standing crop and declining numbers of older larger brown trout in the Hog Back Section. No thermally induced localized fish kills were documented in the Big Hole River in 2000 - 2001 despite the relatively high observed thermal regimes. Such kills accompanied prior drought episodes in 1988 (Vincent et al. 1989) and in 1994 (Byorth 1995). Oswald (2000a) noted other indications of stress such as reduced yearling rainbow trout growth, reduced condition factor in mature brown and rainbow trout, and fungal disease outbreaks during prior drought episodes. Some of these indications of stress, particularly reduced condition factor, were also noted during the 2000 - 2001 sample period.

Rainbow Trout Populations

Rainbow trout population data for the 2000 - 2001 sample period was limited to a 2001 sample in the Jerry Creek Section. No fall electrofishing sampling was conducted in 2000 per the Big Hole River Drought Plan agreements which preclude electrofishing when flows for the Lower Reach drop below the 150 cfs trigger at the Melrose Gage. Electrofishing sampling and public angling are both suspended when the 150 cfs trigger is encountered and do not resume unless flows exceed 200 cfs for seven consecutive days. In August and September of 2000, flows at the Melrose Gage dropped below 150 cfs on August 16 and did not complete seven consecutive days over 200 cfs until September 30. While flows did not drop below 150 cfs in 2001, flows remained between the minimum instream flow recommendation of 260 cfs and 151 cfs at the Melrose Gage throughout most of August and all of September. For this reason and the persistent nature of the

drought, it was decided to sample rainbow trout only in the Jerry Creek Section which maintained higher flows than those in either the Maiden Rock or Melrose Study Sections. This component of the Drought Plan, in conjunction with the angling closure, is aimed at reducing stress to the trout populations, as well as other fish species, already under substantial stress from low flows.

The rainbow trout population of the Jerry Creek Study Section demonstrated an increasing trend in the 2001 sample in terms of population density and standing crop, juvenile recruitment, and densities of older, larger fish despite prevailing drought conditions. Direct comparisons with prior drought episodes strongly suggest that components of the Big Hole River Drought Plan have significantly benefitted rainbow trout populations. These benefits have been most substantially manifest as improvements in standing crop and densities of older, larger fish in the population. Oswald (2000a and 2000c) noted numerous examples of expansion of brown and rainbow trout standing crops and densities of mature fish in populations in the Big Hole, Beaverhead, and Ruby Rivers under conditions of ample streamflow. He also noted the decrease in these key parameters under conditions of low flow regimes associated with drought conditions. Rainbow trout populations benefited from relatively strong recruitment of Age I fish over the 1999 - 2001 period. While drought reduced summer flows influenced trout populations over the recent period, moderate spring runoff flows ranging between 2,420 and 4,980 in 1998 and 2000 were associated with relatively strong recruitment classes of yearling rainbow trout in 1999 and 2001. Oswald (2000a) suggested that high runoff peaks ranging between 11,300 and 12,800 cfs during the 1995 - 1997 period resulted in very poor recruitment of yearling rainbow trout into the population over the 1996 - 1998 period.

Numbers of larger rainbow trout in the Jerry Creek Study Section maintained at relatively high levels compared with other prior years over the sampling history of the section despite various angling regulations which were in affect over the period. Numbers of 16 inch and larger rainbow trout estimated at 40 per mile in the Jerry Creek Section in 2001 did not approach highs observed in the Melrose Section over the same period despite a lack of special regulations in the Melrose Section. Special regulations including a restriction to artificial lures and flies and a "slot limit" which mandated the release of trout between 13 and 22 inches in length were implemented on the Big Hole River in 1981 on the Divide to Melrose reach which included the Maiden Rock study section. The special regulations were extended upstream to Dickie Bridge, the reach incorporating the Jerry Creek study section, in 1988 but the "slot limit" stipulation was removed in the 1996 fishing season over concern for arctic grayling management and data analyses which indicated that the regulation was ineffective regarding rainbow trout, the dominant sport fish of the reach. The regulations were implemented in response to angler's concerns that numbers of larger trout, particularly large brown trout, were being limited by angler harvest. While Kozakiewicz (1979) indicated that angler harvest was not a limiting factor for Age IV and older brown trout in the Big Hole River, Wells and Decker-Hess (1980) suggested that angler harvest might have been limiting the 18 inch and larger segment of this age group. Avery and Hunt (1981) cited selective harvest of larger fish as the major factor limiting numbers of large brown trout in central Wisconsin streams. Oswald (1986) reported on the apparent early success of the special regulation in increasing numbers of larger brown trout but suggested that improvement in numbers of larger rainbow trout was not significant and further documented declines in numbers of the large brown trout entering the drought period (Vincent et al. 1989). Recent comparative

analysis of biomass composition among the three study sections strongly suggests that the special regulations have had no affect in improving the contribution of 13 inch and larger or 16 inch and larger rainbow trout (Oswald 2000a). The rainbow trout populations appear to be strongly driven by recruitment class strength and density dependant factors. Data further suggest that the prevailing practice of anglers on most of the major river fisheries of Montana has become voluntary catch and release despite angling regulations allowing harvest. This suggests that carrying capacity and natural mortality rates, under varying habitat conditions, probably are more important in dictating recent population trends than special restrictive regulations on the Big Hole River.

The recent discovery of whirling disease in Big Hole River trout has raised concern over the future of the river's rainbow trout populations. Data collected to date are indicative of a low frequency of infected fish within the population and a low grade of infection in the fish that have been infected (MFWP Unpub. Data). Random samples of yearling rainbow and brown trout have been collected from the wild populations in the four study sections and sentinel cages of juvenile rainbow trout have been placed into the Big Hole River for later analysis. Future sampling will determine if the disease ultimately results in deleterious effects on the rainbow trout population or remains present at low levels of infectivity.

Brown Trout Populations

The brown trout populations of the Big Hole River proliferated with the ample flow regimes that predominated from 1995 through 1998. Oswald (1986), Vincent et al. (1989), and Oswald (2000a) all discussed the affects of flow on brown trout populations and Oswald and Brammer (1993), and (Oswald 2000c) documented the affects of low flows on numbers of large brown trout in the Beaverhead and Ruby Rivers. The 1995 - 1998 high flow regimes resulted in extremely high standing crops of brown trout as well as high densities of 13 inch and larger brown trout and extremely high densities of 18 inch and larger brown trout in all three of the study sections. In fact, the 1999 estimates for 18 inch and larger brown trout in the Melrose and Hog Back study sections resulted in the highest observed densities of these large fish in the period of study. In contrast with the rainbow trout, the high spring runoff events of the 1995-1997 period did not hamper brown trout recruitment. The 1999 - 2001 period, however, exhibited limited brown trout population declines accompanying drought related low flows and elevated water temperatures. While brown trout population parameters such as standing crop and density of older, larger fish declined steadily from 1998 through 2001 in the Hog Back Section, declines in the Maiden Rock and Melrose Sections were not as apparent. When compared with prior drought episodes, brown trout population parameters exhibited substantial improvement in all three study sections, and particularly, in terms of standing crop and densities of large fish in the Melrose Study Section. This improved brown trout population response was attributed to beneficial components of the Big Hole River Drought Plan, particularly improvement of low flow regimes and reduction of human caused stress to the population. More substantial population reductions observed in the Hog Back Section were believed to be associated with slightly reduced flow regimes and elevated thermal regimes in lower reaches of the river.

The previously discussed special regulations applied within the Divide to Melrose reach in

1981 were assessed in detail for brown trout by Oswald (2000a). He reported on early increases in the number of 13 inch and 18 inch and larger brown trout following implementation of the special regulations but, in 1989, observed that little difference existed between the two sections in terms of 13 inch and larger fish (Vincent et al. 1989). Oswald (2000a) further noted that any differences for 18 inch and larger brown trout among study sections, with or without special regulations, had become virtually undetectable since 1995. Clark and Alexander (1984) noted a decline in total brown trout numbers and a decline in the numbers of brown trout protected under a "slot limit" regulation on the Au Sable River in Michigan but did not observe a concomitant increase in large fish. The 2000 and 2001 samples in the Melrose Section continued to exhibit high densities of 18 inch and larger brown trout in excess of those observed in the Maiden Rock Section in 2001 despite the continuation of special "slot limit" regulations in effect throughout the Maiden Rock reach. Comparative data suggest that this response was associated with favorable components of the Big Hole Drought Plan but could also be associated with the continued affects of habitat conditions favorable to brown trout which influenced the system with ample flow regimes over the 1995 - 1998 period. Similar increases in numbers of large brown trout were observed in the Beaverhead and Ruby Rivers under ample flow regimes of the 1995-1999 period despite differing angling regulations in effect (Oswald 2000c). It could also be the result of voluntary catch and release practices adopted by most anglers utilizing the major rivers of southwest Montana in recent years (MFWP Unpub. Data). In lieu of significant harvest or substantial release mortality, brown trout populations would be subject to habitat limited carrying capacity and natural mortality factors and likely would not be influenced by differences in regulations.

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Report Prepared By: Richard A. Oswald, MFWP, Region 3, Bozeman June 2002

All Work Included in this Report in Conjunction with Federal Aid in Fish and Wildlife Restoration Acts:
Project Numbers: F-78-R-6 and F-113-R-1

Montana Fish, Wildlife & Parks Project Number 3320

APPENDIX OF FIGURES

Figure 1. Estimated fall density and standing crop of Rainbow Trout in the Jerry Creek Section of the Big Hole River, 1986 - 2001.

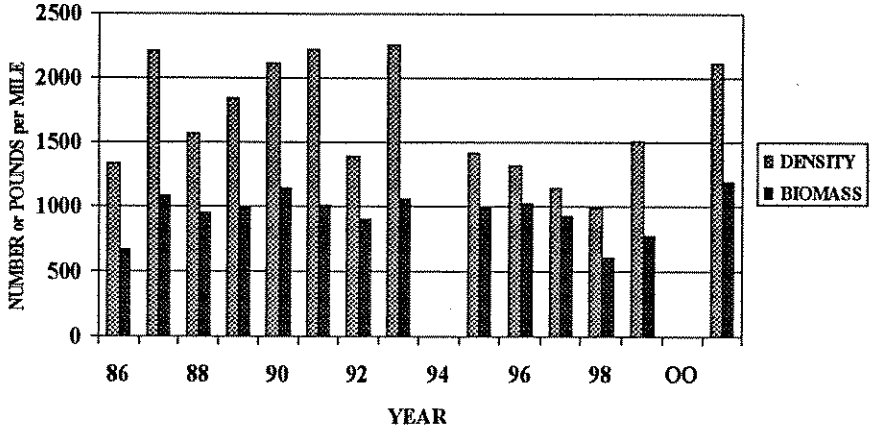

Figure 2. Estimated fall density of Age I Rainbow Trout in the Jerry Creek Section of the Big Hole River, 1986 - 2001.

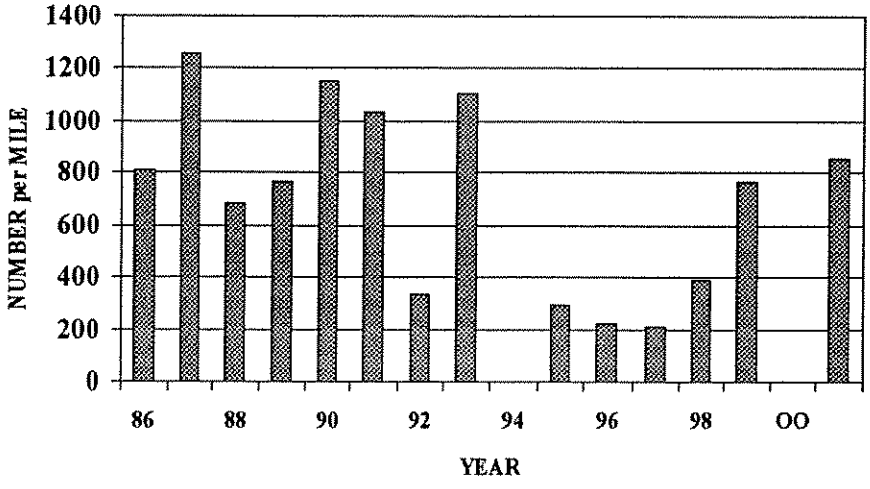

Figure 3. Estimated fall density of 13 inch and larger Rainbow Trout in the Jerry Creek Section of the Big Hole River 1986 - 2001.

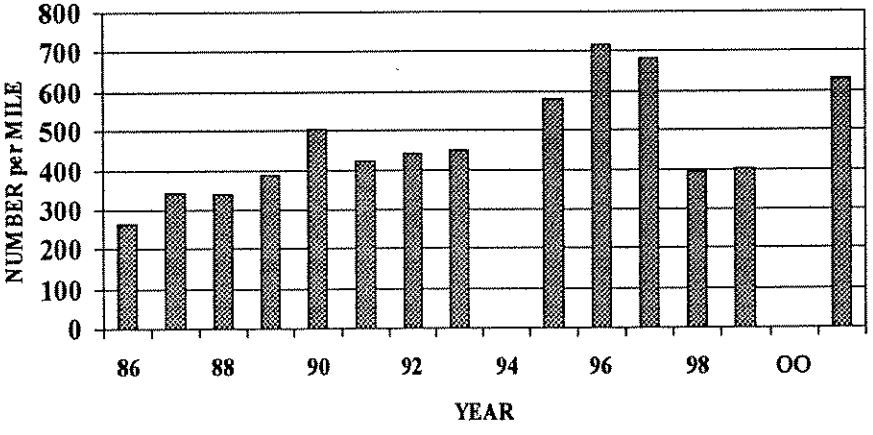

Figure 4. Estimated fall density of 16 inch and larger Rainbow Trout in the Jerry Creek Section of the Big Hole River, 1986 - 2001.

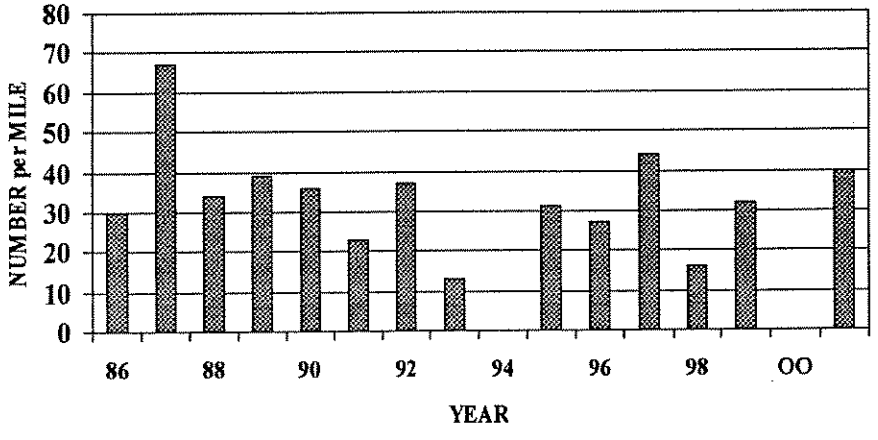

Figure 5. Estimated standing crop of Age I and older rainbow trout in the Jerry Creek Study Section of the Big Hole River; 1987 - 1989 compared with 2001.

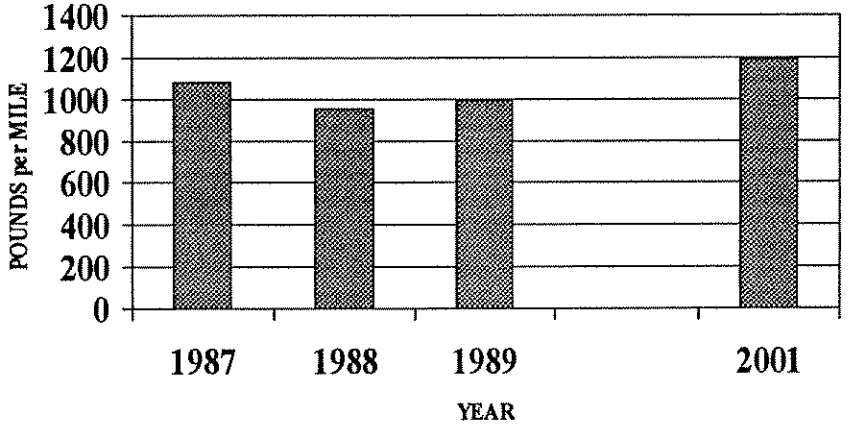

Figure 6. Estimated density of 13 inch and larger rainbow trout in the Jerry Creek Study Section of the Big Hole River; 1987 - 1989 compared with 2001.

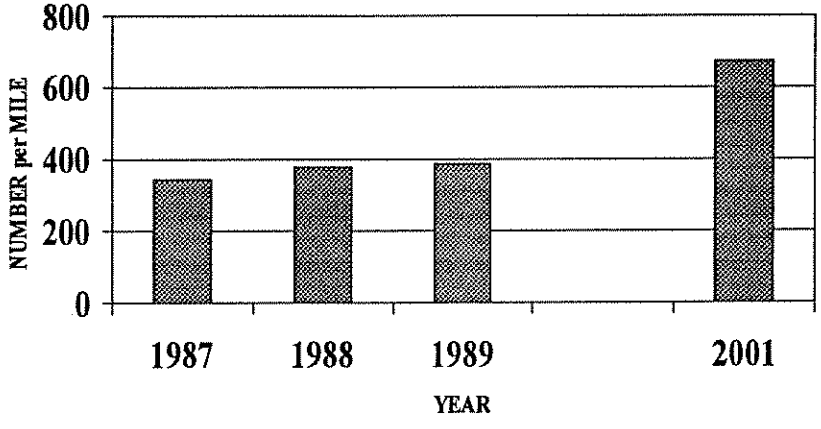

Figure 7. Estimated density of 15 inch and larger rainbow trout in the Jerry Creek Study Section of the Big Hole River; 1987 - 1989 compared with 2001.

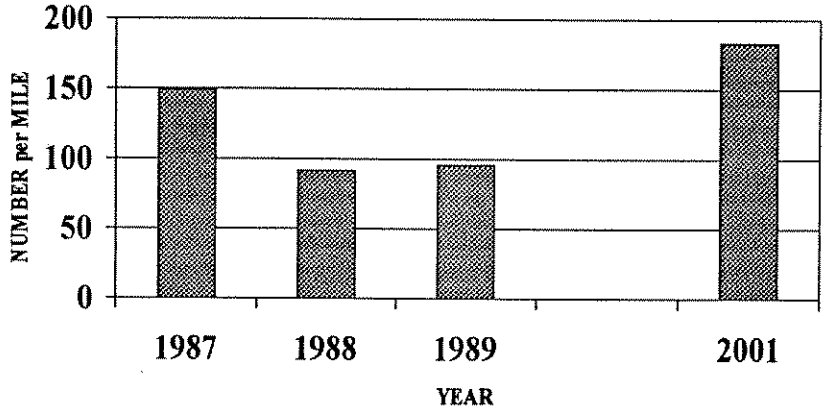

Figure 8. Estimated spring density and standing crop of Brown Trout in the Maiden Rock Section of the Big Hole River 1981 - 2001.

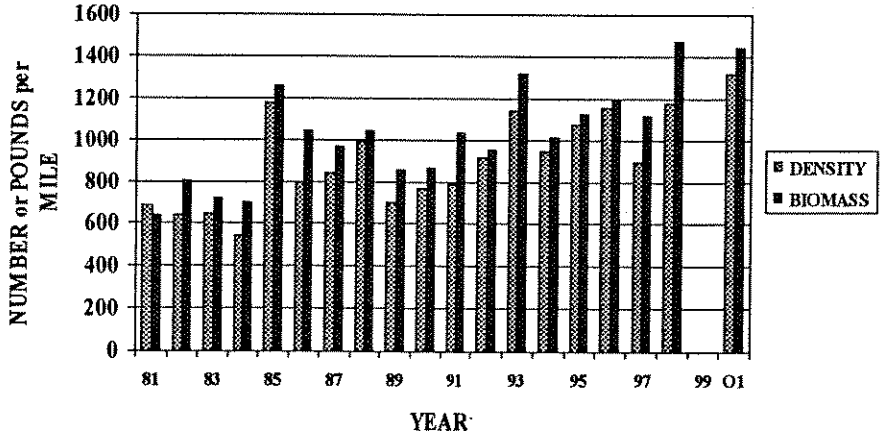

Figure 9. Estimated spring density of 13 inch and larger Brown Trout in the Maiden Rock Section of the Big Hole River, 1981 - 2001.

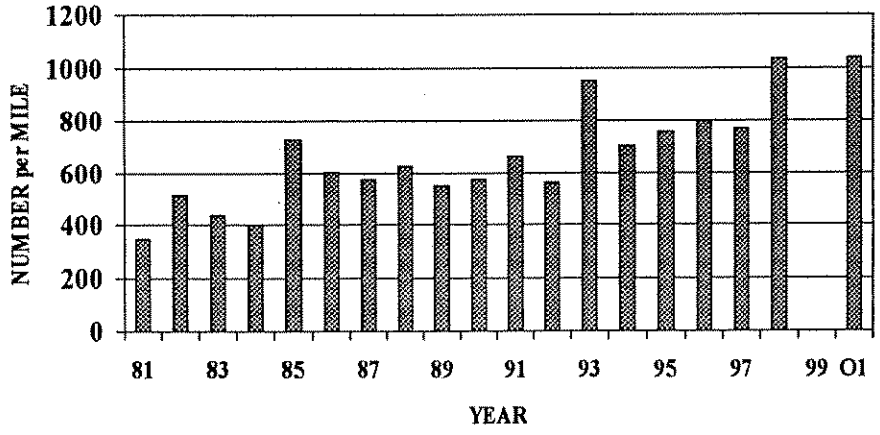

Figure 10. Estimated spring density of 18 inch and larger Brown Trout in the Maiden Rock Section of the Big Hole River, 1981 - 2001.

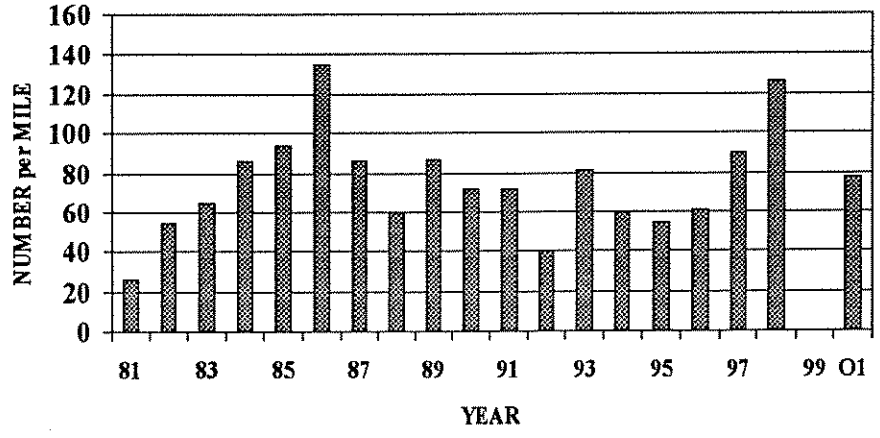

Figure 11. Estimated spring density and standing crop of Brown Trout in the Melrose Section of the Big Hole River, 1981 - 2001.

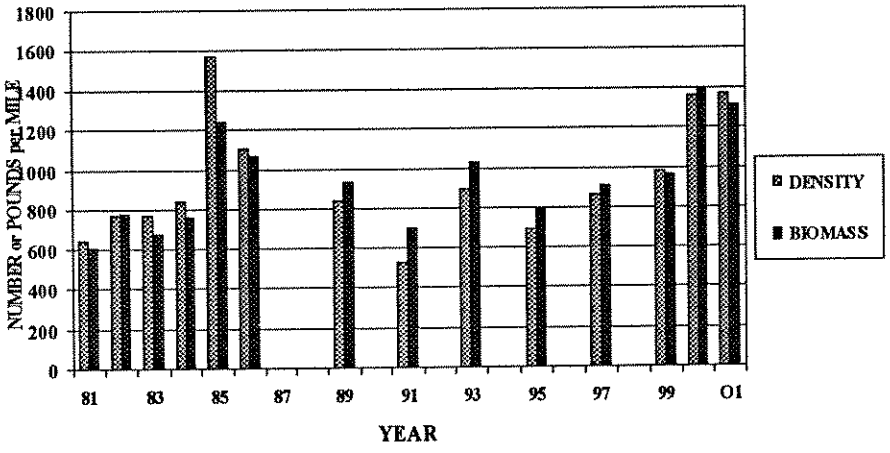

Figure 12. Estimated spring density of 13 inch and larger Brown Trout in the Melrose Section of the Big Hole River 1981 - 2001.

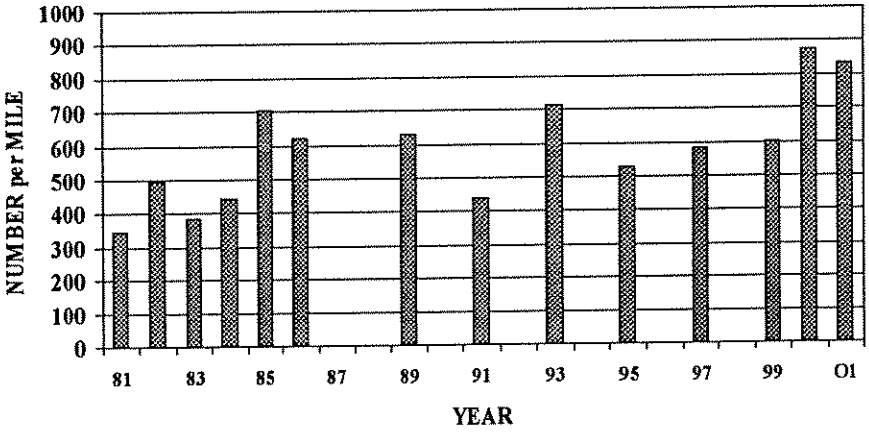

Figure 13. Estimated spring density of 18 inch and larger Brown Trout in the Melrose Section of the Big Hole River, 1981 - 2001.

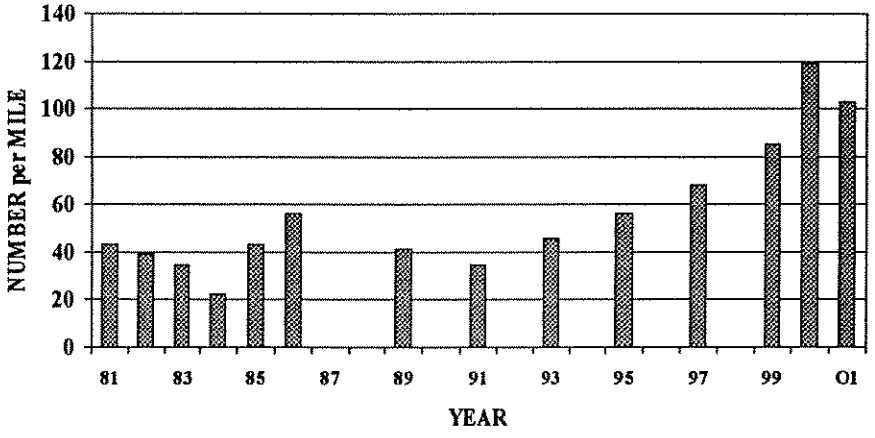

Figure 14. Estimated spring density and standing crop of Brown Trout in the Hog Back Section of the Big Hole River, 1987 - 2001.

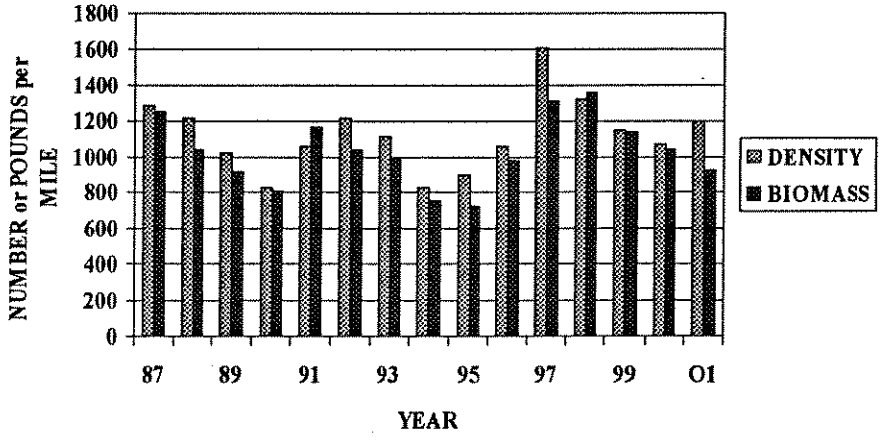

Figure 15. Estimated spring density of 13 inch and larger Brown Trout in the Hog Back Section of the Big Hole River, 1987 - 2001.

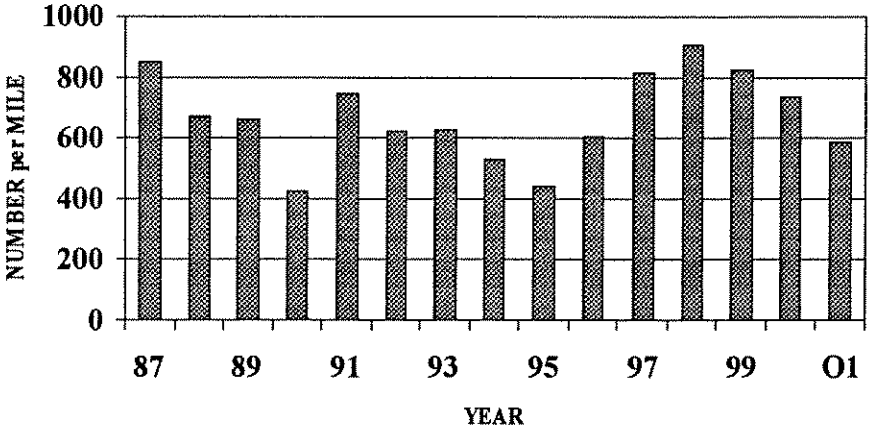

Figure 16. Estimated spring density of 18 inch and larger Brown Trout in the Hog Back Section of the Big Hole River, 1987 - 2001.

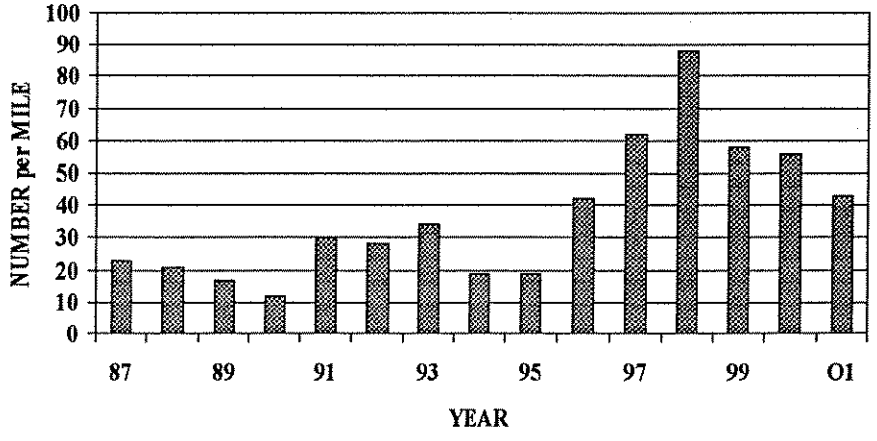

Figure 17. Comparison of estimated brown trout standing crops in the maiden Rock, Melrose, and Hog Back Study Sections of the Big Hole River; 1989 versus 2001.

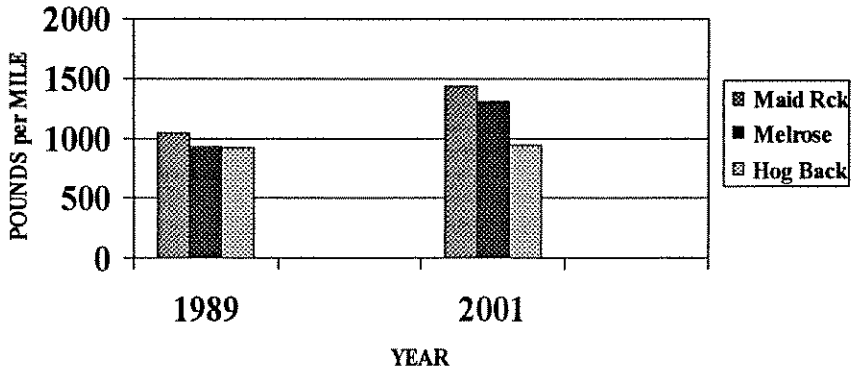

Figure 18. Estimated brown trout standing crop in the Maiden Rock Study Section of the Big Hole River; 1987 - 1989 compared with 2001.

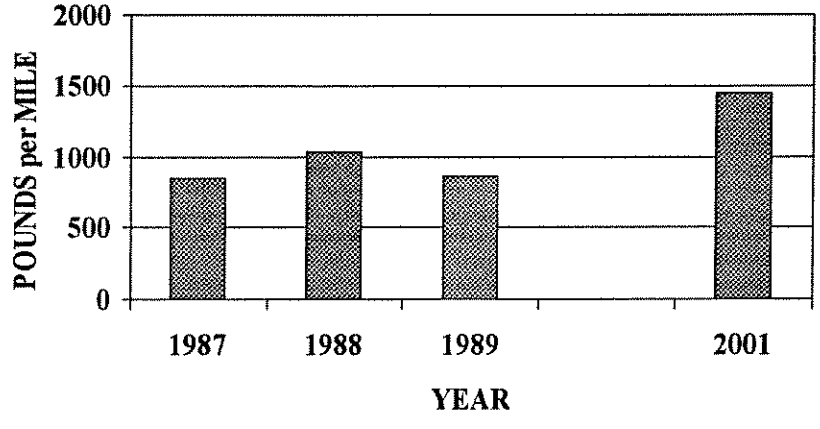

Figure 19. Estimated brown trout standing crop in the Melrose Study section of the Big Hole River; 1989 compared with 1999 - 2001.

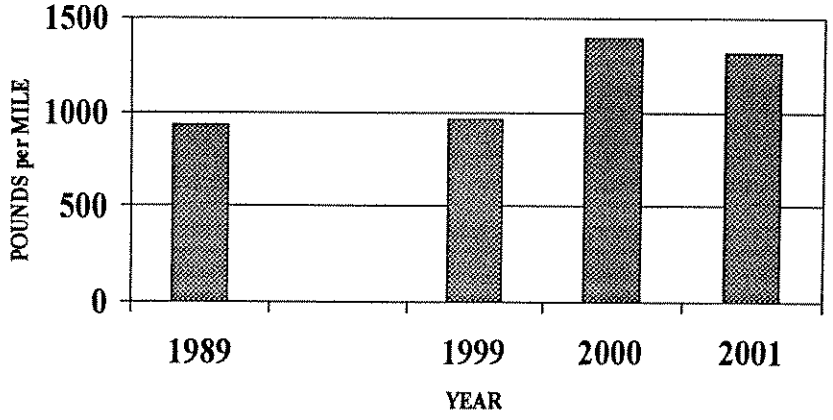

Figure 20. Comparison of the estimated densities of 16 inch and 18 inch and larger brown trout in the Melrose Study Section of the Big Hole River 1989 versus 1999 - 2001.

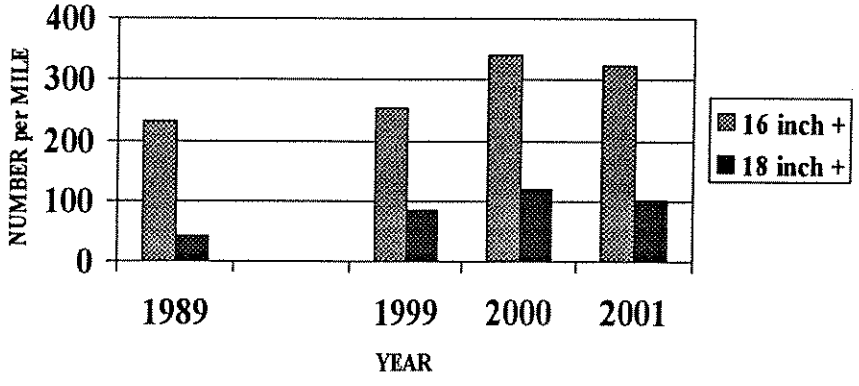

Figure 21. Comparison of the estmated densities of 16 inch and 18 inch and larger brown trout in the Hog Back Study Section of the Big Hole River; 1987 - 1989 versus 1999 - 2001.