Ref ID:85822

MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS

FISHERIES DIVISION

JOB PROGRESS REPORT

State:	Montana	Title:	Southwestern Montana Fisheries Study
Project No.:	F-9-R-34	Title:	Investigation of the Influence of Clark Canyon Reservoir on the Stream Fishery of the Beaverhead River
Job No.:	II-a		

Project Period: July 1, 1985 through June 30, 1986

Report Period: July 1, 1985 through June 30, 1986

ABSTRACT

Brown trout populations in the Hildreth section have remained relatively stable at high densities since 1980. Brown trout growth declined as densities increased since 1974. This decline appears to have stabilized. Rainbow trout have also undergone a decline in growth rate from pre-1974 levels; however, fluctuating reproductive success has resulted in low enough densities to maintain numbers of trophy trout. Non-irrigation season flows in 1983-84 greatly exceeded over-winter survival criteria, while irrigation season flows in 1984 resulted in persistent flooding and channel alterations.

Gas bubble disease was monitored in brown trout populations in the Hildreth section. Symptoms of the disease appeared in 10% of the brown trout sampled. The primary symptom observed was exopthalmy. Fish exhibiting symptoms displayed a condition factor which averaged 10% lower than all brown trout sampled.

While brown trout in the Pipe Organ section maintained high densities, a general decline in the numbers of larger (age IV+) fish was evident. Comparative brown trout data from the Henneberry section (closed to winter fishing) indicated the presence of substantially higher numbers of larger size classes of fish per mile than were found in the Pipe Organ section which is open to year-long fishing.

BACKGROUND

Effects of flow releases from Clark Canyon Reservoir on trout populations in the Beaverhead River have been monitored by the Montana Department of Fish, Wildlife and Parks since 1966. These studies have shown that the Beaverhead River supports exceptional populations of trophy (greater than 5.0 lbs.) rainbow trout and larger (2.0 to 4.0 lb.) brown trout in its upper tailwater reaches. The extreme productivity of the tailwater fishery is the product of a chemically rich upper watershed, production in Clark Canyon Reservoir and the bottom-draw outlet which forms the modern source of the Beaverhead River. These factors have combined to form a low sediment, nutrient rich tailwater with near optimal thermal regime for trout growth (Berg 1974, Smith 1973). The Beaverhead River also provides excellent trout habitat in the form of riffle-pool habitat from an average sinuosity of 1.40 and dense willow bank cover vegetating up to 77% of a given stream reach (Nelson 1978). Volume of flow and annual flow regimes in the upper Beaverhead River are controlled almost exclusively by flow releases from the outlet of Clark Canyon Dam. Nelson (1978) demonstrated that non-irrigation season (October 16 to April 15) flows of less than 250 cfs adversely affected numbers of trophy trout. The study further demonstrated that extreme flow fluctuations during brown and rainbow trout spawning seasons severely depressed recruitment of both species. Wells (1981) showed that outbreaks of the bacterial disease furunculosis and subsequent fish kills were correlated with mid-summer drops in flow. More recently, Oswald (1984) presented data suggesting a link between volume of the flow release and gas bubble disease in Beaverhead River trout.

Trout populations in the Hildreth section of the Beaverhead River were depressed prior to 1974. Changes in the operation of Clark Canyon Dam, resulting in more favorable winter and spawning period flow regimes, resulted in dramatic increases in rainbow trout abundance between 1974 and 1977 and brown trout numbers between 1975 and 1977 (Wells 1981). Brown trout populations remained stable at high levels between 1977 and 1983, while rainbow trout populations have fluctuated with sporadic recruitment over the same period. Growth rates of both species and numbers of trophy brown trout have declined with increased densities since 1974; however, total trout biomass has increased markedly (Wells 1979). The Hildreth section was not sampled in 1981 and 1982 due to landowner conflicts. Sampling was resumed in 1983 but did not occur in the fall of 1984 due to flood flows which persisted from June through November of 1984.

Trout populations in the Pipe Organ section were monitored between 1967 and 1976. Sampling was resumed in 1981 and continued through the present. Trout populations in the Pipe Organ section have exhibited a response to critical flow management similar to populations in the Hildreth section (McMullin 1982). While recent data indicate marked increases in both brown and rainbow trout numbers over pre-1974 levels, numbers of larger fish (age IV+), especially brown trout, have declined (Oswald 1984). The Beaverhead River downstream from the beginning of the Pipe Organ section is open to year-round angling, while the reaches upstream from Pipe Organ Bridge are closed to fishing from December 1 to mid-May.

In order to more thoroughly investigate the possibility that the decline in numbers of large fish in the Pipe Organ section was related to year-round fishing pressure, a new study section was initiated in spring of 1984. The Henneberry section (7920 feet) is bounded upstream at the Henneberry Bridge and is bounded downstream at an irrigation canal outlet, approximately 1200 feet upstream from the Pipe Organ Bridge. The section was located to represent similar habitat and downstream distance from the dam to approximate conditions in the Pipe Organ section while located in the reach of river closed to winter fishing. Due to the preponderance of brown trout in both sections and strong indications that larger brown trout have declined in number in the Pipe Organ section, the Henneberry section is electrofished in spring to gather comparable data on stable brown trout populations. No fall data collection will occur in the Henneberry section at present.

Symptoms of gas bubble disease were first observed in trout in the Hildreth section in September 1983 (Oswald 1984). Subsequent saturation measurements have resulted in observations of total gas saturations as high as 119% from dam outlet release and 129% from dam spillway flow. External symptoms of gas bubble disease, primarily exopthalmy, were observed in 8.8% of all brown trout handled in the Hildreth section in the fall of 1983. In order to more completely describe the problem of gas supersaturation in the Beaverhead River, observations of affected fish have been recorded in the three population study sections.

OBJECTIVES AND DEGREE OF ATTAINMENT

1. To determine spring and fall trout populations in at least two study sections of the Beaverhead River. Data are presented for the spring of 1984. Fall collections could not be made in 1984 due to flood flows which persisted from June through November. Spring and fall data collections were completed in 1985. Due to reorganization of the MDFWP data processing system, this data is not available at the writing of this report and will appear in a subsequent report.

2. To evaluate the effect of flow releases from Clark Canyon Dam on trout populations. Data are presented through 1984. Data collections have been made for 1985 but will be presented in the subsequent report for reasons stated above.

3. To evaluate the effects of population density on trout growth. Data are presented through 1984. Data collections have been made for 1985 but will be presented in a subsequent report for reasons stated above.

PROCEDURES

Trout populations were sampled by using boat-mounted mobile anode electrofishing equipment. Standing crop, number by length group and age group estimates were calculated by using methods described by Vincent (1971 and 1974) and adapted for computer analysis (Holton, et al 1981). Selection of length groups on which population estimates were based was determined by analysis of recapture-capture efficiency curves at one and two inch intervals. Fish were aged by using the scale method. Stream discharges were measured by the U.S. Bureau of Reclamation at the dam outlet because the U.S.G.S. gage site near Grant was abandoned after water year 1983.

FINDINGS

Hildreth Section

Brown Trout

Estimated numbers, standing crops and mean lengths are given for age groups of brown trout in the Hildreth section, March, 1984 in Table 1. The 1984 brown trout standing crop was the heaviest observed in the sampling history of the Hildreth section, dating back to 1966. Estimated numbers of brown trout were second only to the 1977 estimate; however, the 1977 population was dominated by age II fish which composed 49% of the estimated numbers (Table 2). Numbers of age III brown trout were exceptionally high in 1984. While the 1983 sample indicated good recruitment into age II ranks (Oswald 1984), the 1984 age III estimate indicates a substantial increase within the year class. This might be due to an underestimate of age II fish in 1983, movement of age III fish into the section or error associated with scale analysis and aging.

The 1984 estimate demonstrated a continuation of the trend of stable high-density brown trout populations that has persisted from 1977 (Table 2). This population stability has been marked by excellent recruitment of age II fish and over-winter survival of large (age IV+) fish. Both of these parameters have been correlated with river flow regimes controlled at Clark Canyon Dam. Stable flow regimes during the peak brown trout spawning period, October 15-November 15, have resulted in dramatically increased numbers of brown trout in the Beaverhead River since 1977 (Nelson 1978, Wells 1981, McMullin 1982, Oswald 1984). Good recruitment of age II brown trout in 1984 was indicative of stable spawning period flows in 1982. The 1982 spawning flows were high, averaging 322 cfs over the period (USGS 1983). The first week of the peak spawning period was marked by fluctuating flows (240-373 cfs), but the remainder of the period was extremely stable (299-340 cfs). Non-irrigation season flows of less than 250 cfs have been shown to have an adverse effect on the numbers of large trout, particularly trophy (over 5 lbs.) sized trout (Nelson 1978). While numbers of trophy brown trout have declined since 1974-75 with increased brown trout densities (Table 8), numbers of 18 inch and larger brown trout achieved the highest observed density (419 per mile) in the sampling history of the section. The previous observed maximum density of 18 inch and larger brown trout occurred in 1983 (393 per mile). Non-irrigation season (Oct. 16-Apr. 15) flow releases were excellent for large trout over-winter survival in 1982-83 (Oswald 1984) and in 1983-84 (Table 3). During the 1983-84 non-irrigation season, average daily flow (ADF) attained a maximum monthly average of 672 cfs in November and a minimum average of 360 cfs in March. Flow did not drop below 250 cfs over the entire non-irrigation period and attained a minimum ADF of 300 cfs in March.

Irrigation season flow releases have been correlated with outbreaks of the bacterial disease, furunculosis. Wells (1981) documented furunculosis outbreaks in 1978, '79 and '80 following flow reductions in early July. Flow reductions resulting in disease outbreaks produced river discharges of 400 to 620 cfs. No outbreak of the disease was observed in 1982 or 1983 when minimum July flows were 813 and 759 cfs, but a disease outbreak occurred in 1983 following a reduction to 476 cfs. The 1984 irrigation season failed to result in a disease outbreak and was marked by extremely high flows (Table 4). The 1984 flow regime can be contrasted with the prior ten year average in Table 5. Flows during the 1984 irrigation season were marked by a 100 year flood event and a 500 year volume of discharge event (U.S. Bureau of Reclamation data 1984). Mean monthly ADF in 1984 represented a 74% to 275% increase over values representing the previous ten year average through the irrigation season, while the prior ten year maximum of 1225 cfs was exceeded by the minimum ADF for June through September, 1984 (Tables 4 and 5). The prolonged flooding of 1984 resulted in many changes in channel morphology, reduced fishing pressure, fish distribution and gas supersaturation (Oswald 1984) which will be acknowledged in future sampling. The persistent flood flows also precluded any sampling program in the Beaverhead River in the fall of 1984.

The effect of brown trout density on age-growth relationships in the Hildreth section was described by Wells (1981). This relationship has been expanded to demonstrate effects of brown trout densities on mean weight and mean length at age in Tables 6 and 7. Wells (1981) was able to demonstrate that steadily declining brown trout mean weight at age was significantly correlated with increased brown trout density for all age groups through the 1980 sample. The same trend appears to apply to mean length at age (Table 7), although it is not as marked a difference as is the case with mean weight. Data indicate that 1977 was the year in which brown trout density and biomass attained approximate modern levels of abundance. Comparison of the pre-1977 era with the post-1977 era revealed significant decline in the mean weights of age II (15.2%), age III (8.3%) and age IV and older (17.4%) brown trout, while the same comparison with mean length revealed 5.4%, 3.6% and 6.8% declines for the respective age groups. Comparison of the pre-1977 period with the post-1977 period show a 200% increase in mean brown trout numbers and a 137% increase in mean biomass over the same period as the growth decline. Data from 1983 and 1984 suggest that overall declines in brown trout growth have stabilized with brown trout populations. A significant result of the decline in brown trout growth with increased density is the diminished capability of the section to sustain trophy (over 5 lbs.) brown trout (Table 8). Numbers of trophy brown trout have exhibited a steady decline in the Hildreth section since maximum abundance was attained in 1974 and 1975.

Rainbow Trout

Spring numbers, mean lengths and standing crops are presented by age group for rainbow trout in Table 1. Spring rainbow trout estimates in the Beaverhead River are generally not reliable due to estimate inflation from spawning movements. This relationship has been tested by the analysis of electrofishing recapture/capture efficiency curves and mark-capture percent of sample curves. Table 1 indicates a balance in population between age II, III and IV+ fish. This is indicative of good recruitment from the 1982 spawning season (Oswald 1984) and deviates from the 1983 spring estimate which was dominated by age IV+ fish and indicated a population of age II fish of 263.

The fall 1983 rainbow trout sample yielded the highest total numbers of trophy rainbow trout observed in the sampling history of the section (Oswald 1984). The high numbers of trophy rainbow trout followed high non-irrigation season flows in 1982-83. The 1983-84 non-irrigation season (Table 3) was again marked by high flows which averaged 360 to 672 cfs ADF on a monthly basis and never dropped below 300 cfs.

The effect of rainbow trout density on age-growth relationships in the Hildreth section was described by Wells (1981). The described relationship between density and mean weight showed a marked difference between low density (1973-74) and high density (1978-79) periods but could not demonstrate a linear relationship between mean weight at age and density over the sample period. This was in contrast to the linear decline in mean brown trout weight with increased density resulting from stable recruitment. Analysis of rainbow trout growth and density relationships has been expanded to include mean weight and mean length at age data (Tables 9 and 10). While mean weight and length at age have declined over the 1971-1983 period for rainbow trout, this decline has not been linear with density or standing crop increases. In contrast with brown trout, rainbow trout density and, to a lesser extent, biomass have fluctuated over the period. The data indicate that 1974 was the year in which rainbow trout density and biomass achieved modern levels of abundance over previously depressed populations. Comparison of the pre-1974 era with the post-1974 era revealed significant decline in the mean weights of age I (19.8%), age II (17.1%), age III (26.8%) and age IV+ (14.3%) rainbow trout, while the same comparison with mean length revealed 7.7%, 5.7%, 3.5% and 0.5% declines for the respective age groups. While rainbow trout growth in the Hildreth section has declined from the early 1970's, it is still exceptional. During the 1979-1983 period, fall weights of age IV+ fish averaged in excess of four pounds and Oswald (1984) reported that five pound and larger rainbow trout attained their highest observed abundance in section history in 1983. This abundance of very large rainbow trout may be due, in part, to fluctuating rainbow trout recruitment which has held rainbow trout densities to less than half the numbers attained by brown trout in the Hildreth section.

Gas Bubble Disease

Symptoms of gas bubble disease were first observed in the Hildreth section during the fall, 1983 sample season (Oswald 1984). These symptoms were primarily manifest as exopthalmy (emphysema in the eyes) and, to a much lesser extent, external emphysema on the opercles, abdomens or fins. A series of gas saturation measurements in 1983 and 1984 indicated that supersaturation increased with increased discharge at Clark Canyon Dam (Oswald 1984). Due to damage and temporary loss of the saturometer, a single measurement was obtained in October 1984 which revealed a saturation of 126% at 950 cfs discharge. Measurements of supersaturation will continue in the future with the attainment of another saturometer.

Data expressing the percentages of brown trout exhibiting external symptoms of gas bubble disease, by inch group, are expressed for spring, 1984 in Table 11. Ten percent of all of the brown trout handled in 1984 exhibited symptoms compared with an 8.8% incidence of symptoms in fall, 1983 (Oswald 1984). As was the case in 1983, the 13 inch and larger brown trout exhibited the highest incidence of symptoms (7-15% affected). Rainbow trout in the section appear to be less susceptible than brown trout with an overall incidence of 2.0% of the disease. Brown trout farther downstream from the dam in the Henneberry section (4.2 miles) exhibited an incidence of symptoms of only 0.5%, while no fish exhibiting symptoms were collected in the Pipe Organ section (5.7 miles).

Brown trout exhibiting symptoms of gas bubble disease have exhibited a marked decrease in condition factor (K) compared with fish lacking symptoms. Data presented by inch group in Table 12 compare mean condition of affected brown trout with mean condition of all brown trout in the sample. These data reveal that brown trout exhibiting gas bubble disease symptoms have sustained an average 10% decline in condition in the Hildreth section.

Pipe Organ Section

Brown Trout

Estimated numbers, biomass and mean length of brown trout are presented by age group for the spring 1984 sample in the Pipe Organ section (Table 13). Brown trout density attained its highest observed level in sampling history in 1984 (Table 14) based primarily on excellent recruitment of age II fish. Recent levels of abundance of brown trout (1984-1984) continued to remain much higher than those observed during the 1970's. Oswald (1984) observed that most of the numerical gains of the 1980's were due to increased abundance of age II fish and that these gains were not resulting in increased numbers of age III or age IV+ fish. While the 1984 sample does indicate an increase in the numbers of age III and age IV+ fish, this increase was not substantial in comparison with numbers of age II fish nor do 1984 numbers of age IV+ fish compare favorably with numbers of these older fish from the 1970's. Data presented in Table 15 indicate that age IV+ brown trout continue to account for low percentages of the total brown trout biomass when compared with data from the 1970's as discussed previously (Oswald, 1984). The 1984 estimate in which age IV+ brown trout account for 9% of the standing crop can be compared with results from the Hildreth and Henneberry sections where these older fish accounted for 36% and 18% of the standing crop, respectively.

Rainbow Trout

Spring rainbow trout population data are presented for the Pipe Organ section in Table 13. While spring rainbow trout estimates are not considered reliable due to spawning movements, numbers of age II fish, from the 1982 spawning season, remained high. These results are similar to those in the Hildreth section and indicate that 1982 produced good rainbow trout recruitment in the Beaverhead River. Flood flows in the river in the fall of 1984 precluded sampling and a reliable rainbow trout estimate.

Henneberry Section

Brown Trout

In order to more accurately assess the effects of year-long angling pressure on the decline of larger brown trout in the Pipe Organ section (Oswald 1984) the Henneberry section was established in spring, 1984. The Henneberry section is located immediately upstream from the Pipe Organ section in the reach of river (dam to Pipe Organ Bridge) that is closed to winter fishing (Dec. 1 to the 3rd Saturday in May). The Henneberry section has been closed to year-long fishing since the 1975-76 fishing season. Both sections contain extremely similar habitat and originate 4.2 miles (Henneberry) and 5.7 miles (Pipe Organ) downstream from Clark Canyon Dam. The Henneberry section is sampled only in spring to compare brown trout numbers.

Estimated numbers, standing crop and mean length of brown trout are presented by age group for spring 1984 in Table 16. Estimated numbers of brown trout in the Henneberry section are high and compare favorably at 1613 per mile with Hildreth section (1425 per mi.) and Pipe Organ section (1339 per mi.). Brown trout biomass at 1779 lbs. per mi. was intermediate between Hildreth section (2268 lbs. per mi.) and Pipe Organ section (1202 lbs. per mi.).

In order to investigate the effects of fishing pressure applied through the year, and subsequent harvest of fish, numbers of brown trout per mile are presented by ascending length group for the Pipe Organ and Henneberry sections in Table 17. The data suggest that little difference exists between the two sections in numbers of fish less than 14 inches in length. Slightly more of these smaller fish occupy the Pipe Organ section. As numbers of larger fish are compared, the difference between the two sections becomes more marked. For example, the difference between the two sections for 14.0-15.9 inch fish represents a 15% increase in the Henneberry section, while the difference for 16.0-17.9 inch fish represents a 133% increase in the Henneberry section, and 20.0 inch and larger fish represent a 430% increase in the Henneberry section over numbers present in the Pipe Organ section. The data, in conjunction with declining numbers of larger brown trout in the Pipe Organ section (Oswald, 1984), suggest that year-long angling pressure and size selective harvest could account for the difference between the two sections.

Rainbow Trout

Despite the fact that the Henneberry section was initiated to compare spring brown trout populations, certain comparisons can be made from the spring rainbow trout estimate (Table 16). Numbers of larger (age IV+) rainbow trout in the spring 1984 estimate were calculated at 89 per mile in the Henneberry section compared with a calculated abundance of 37 per mile in the Pipe Organ section. Data presented by Oswald (1984) showed that age IV and older rainbow trout accounted for only four percent of the estimated rainbow trout population during fall sampling in 1982 and 1983 in the Pipe Organ section. Estimated numbers of these larger rainbow trout were 15 per mile in 1982 and 36 per mile in 1983.

DISCUSSION

Brown trout numbers have remained relatively stable at high (1358 age II and older per mile) densities in the Hildreth section since 1977. Concurrently, no decline in standing crop has occurred with a 1984 estimate of 2700 lbs. (age II+) compared to an average estimate of 2507 lbs. for the 1977-1984 period. Brown trout populations have attained current levels of stability and density through the stabilization of fall spawning flows, which has resulted in consistently good annual recruitment (Wells 1981, McMullin 1982, Oswald 1984). Increased density of brown trout over pre-1977, and especially pre-1974, levels has resulted in a decline in growth rate over the period. This decline is evident in mean length at age and, to a much greater extent, mean weight at age. Well, 1981, demonstrated that declines in mean weight were linearly related to increased brown trout density for the 1974-1980 period. Current data indicate that declining growth rates have stabilized with stable brown trout populations in the 1980's. Data also indicate a dramatic decline in the numbers of trophy (≥5.0 lbs.) brown trout in the section, while numbers of large (2.0 to 4.0 lb.) brown trout have maintained high levels of abundance. Data strongly suggest that brown trout populations, particularly size distribution, are density dependent and a product of stable recruitment.

Rainbow trout populations in the Hildreth section have fluctuated with recruitment success (McMullin 1982, Oswald 1984). Rainbow trout populations have shown a dramatic increase over pre-1974 levels in response to stable spawning period flows. Unlike the brown trout, however, rainbow trout have suffered poor recruitment from years marked by apparently good spawning flows (Oswald 1984). While rainbow trout have shown a growth decline similar to the brown trout, this decline was not linear with density (Wells 1981) and constitutes a difference between depressed populations (pre-1974) and current levels of abundance. Overall, the rainbow trout of the Hildreth section have maintained high numbers of trophy (≥5.0 lbs.) sized fish (Oswald 1984) probably related to densities which approximate one-half current brown trout densities. Data strongly suggest that rainbow trout populations are not density limited to the same degree as brown trout and fluctuate with reproductive success from year to year.

Over-winter flows in the Beaverhead River were optimal in terms of survival criteria for large trout during the 1983-84 non-irrigation season. Irrigation season flows were the highest of record since the construction of Clark Canyon Dam and resulted in a 500 year volume event (USGS 1964-1983, U.S. Bureau of Reclamation 1984). This high flow precluded an outbreak of the bacterial disease, furunculosis, which has been observed when early July streamflow is reduced below 650 cfs (Wells 1981). Spillway flow, however, produced gas saturations which exceeded 120% to a maximum observed saturation of 129% between June 6 and July 14, 1984. Effects of the prolonged flooding with concomitant flow velocities, bed load movement and changes in channel morphology will have to be accounted for in future analysis of recruitment, survival and distribution of trout in the Beaverhead River.

Symptoms of gas bubble disease in trout in the Beaverhead River were observed in the fall of 1983 (Oswald 1984). Subsequent measurements of gas saturations suggested a link between supersaturation and volume of discharge from the Clark Canyon Dam; however, this relationship was modified by season.

Supersaturated conditions generally result from rapid temperature increases, gas injection by pressurized pumping or turbulent injection in falling water (D'Aoust and Clark 1980) or, in some cases, from extreme photosynthetic activity (Mathias and Barica 1985). Because Clark Canyon Dam contains a bottom draw outlet, the supersaturations in the Beaverhead River do not conform to the usual explanations. More saturation measurements will be required to further attempt to explain the source of supersaturated conditions in the Beaverhead River.

Data describing the effects of gas supersaturation on Beaverhead River trout were collected in fall 1983 and spring 1984. The data indicate that while no acute mortality in the form of fish kills has been observed to date, approximately 9-10% of the brown trout in the Hildreth section exhibit symptoms of gas bubble disease. Rainbow trout, present at approximately one-half of the density of brown trout, exhibited symptoms of the disease at an incidence of 2-3%. Symptoms exhibited by trout sampled were primarily manifest as exopthalmy but also occurred as external emphysema on the opercles and abdomen and, in rare cases, on fins. While exopthalmy is a common symptom of gas bubble disease, particularly in salmonids, emphysema under the skin and between fin rays is a more commonly reported symptom (Weitkamp and Katz 1980). Data suggest that brown trout which bear external symptoms of gas bubble disease have undergone an average decline of 10% in condition (K) in the Hildreth section.

It is difficult to ascertain the link between gas supersaturation level and its effect on the trout populations of the Beaverhead River at this time. Limits of gas supersaturation and effects on fish depend on species tolerance and factors that differ among streams, between length of exposure time and across ranges in salinity and temperature (Bouk 1980). Furthermore, it has been demonstrated that fish can detect and avoid gas supersaturations by utilizing water depth, while most bioassay information has been collected in shallow water (Weitkamp and Katz 1980). More information on cause and effect relationships will become available through the continued collection of gas saturation data on the Beaverhead River.

Brown trout populations in the Pipe Organ section have responded to critical flow management in a manner similar to populations in the Hildreth section (McMullin 1982, Oswald 1984). While current brown trout populations have remained stable at high densities, the data strongly suggest a decline in the numbers of larger (age IV+) brown trout. Oswald (1984) suggested that declining numbers of larger brown trout could be due to year-long fishing pressure and subsequent selective harvest which began during the 1975-76 fishing season. A comparative study section, Henneberry, was sampled in spring 1984. The Henneberry section is located immediately upstream from Pipe Organ and is located within the reach of the Beaverhead River which has maintained a winter angling closure. Comparison of the Henneberry section with the Pipe Organ section revealed significantly higher densities of large trout in the Henneberry section. The percent difference between the two sections increased with increasing brown trout size, which strongly suggests size selective mortality or angler harvest. Selective harvest of larger trout has proven to be a factor in the decline of larger brown trout in other studies (Avery and Hunt 1981, Oswald 1984b). Continued comparative analysis of the two sections should provide more information on the effects of year-long angling pressure on Beaverhead River trout populations.

RECOMMENDATIONS

This project should continue. Further investigations into brown and rainbow trout population dynamics, rainbow trout recruitment, effects of flows on trout mortality and recruitment and effects of gas supersaturation should be studied in the Hildreth section. Brown trout population dynamics and age structure and rainbow trout recruitment should be studied in the Pipe Organ section. Brown trout population dynamics and age structure should be studied in the Henneberry section to assess effects of year-long fishing versus winter fishing closure.

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Date: July 27, 1986

Waters Referred To: Beaverhead River, Sec. 4, 3-01-0500-01

Key Words: Rainbow Trout, Population Dynamics, Flow Releases, Age and Growth, Brown Trout, Recruitment, Gas Bubble Disease

TABLES

Table 1. Estimated numbers, biomass and mean length of brown and rainbow trout in the Hildreth section (6250 ft) of the Beaverhead River, spring 1984 (standard deviations [80% confidence interval] are in parentheses).

Age	Mean Length (in)	Number	Biomass (lbs)
		Brown Trout	
II	11.9	520	355
III	16.6	801	1358
IV+	19.7	360	963
		1681 (±141)	2676 (±222)
		Rainbow Trout	
II	12.3	446	385
III	17.0	398	861
IV+	20.8	424	1566
		1268 (±153)	2812 (±384)

Table 2. Estimated spring number and biomass of age II and older brown trout in the Hildreth section of the Beaverhead River 1974-1984.

Year	Age Group II	Age Group III	Age Group IV+	Total No.	Total Biomass (lbs)
1974	32	90	195	317	846
1975	467	61	142	670	1030
1976	624	420	139	1183	1681
1977	864	410	475	1752	2624
1978	565	791	338	1694	2536
1979	329	536	442	1307	2213
1980	733	370	504	1607	2531
1983	668	528	361	1557	2439
1984	527	807	360	1698	2700

Table 3. Average daily flow (ADF) and numbers of days per month that flow was less than 250 cfs (parentheses) for the non-irrigation period (Oct. 16-April 15) 1980-1985 in the Beaverhead River below Clark Canyon Dam.

Time Period	Month						
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1980-81	289 (15)	384 (2)	312 (0)	262 (0)	211 (23)	188 (31)	183 (15)
1981-82	140 (15)	144 (30)	168 (31)	196 (31)	228 (28)	196 (31)	227 (15)
1982-83	402 (1)	334 (0)	344 (0)	359 (0)	373 (0)	446 (5)	446 (4)
1983-84	406 (0)	672 (0)	609 (0)	470 (0)	441 (0)	360 (0)	473 (0)
1984-85	877 (0)	685 (0)	511 (0)	405 (0)	353 (1)	222 (31)	215 (15)

1980-83 flows measured in cfs at U.S.G.S. gage near Grant, MT.

1983-85 flows measured in cfs at U.S. Bureau of Reclamation gage at dam outlet.

Table 4. Minimum, maximum and mean flow (cfs) per month during the 1984 irrigation season (Apr. 16-Oct. 15) in the Beaverhead River below Clark Canyon Dam.

	April	May	June	July	August	Sept.	Oct.
Minimum	325	625	1500	1900	1771	1384	1050
Maximum	625	1500	2586	2202	1900	1750	1350
Mean	550	879	1925	2048	1876	1599	1076

Flows measured in cfs at U.S. Bureau of Reclamation gage at Clark Canyon Dam outlet.

Table 5. Average daily flow (ADF) per month during the irrigation season (Apr. 16-Oct. 15) in the Beaverhead River for the ten year period 1974-1983.

	Month						
Year	April	May	June	July	August	Sept.	Oct.
1974	374	782	809	772	699	367	161
1975	73	229	694	938	1225	1003	613
1976	291	621	792	881	853	511	440
1977	100	336	498	565	499	152	87
1978	188	637	765	577	622	283	210
1979	193	401	861	749	508	202	119
1980	97	293	565	684	722	420	289
1981	183	559	762	887	761	453	148
1982	227	498	738	819	854	528	402
1983	446	701	669	712	852	614	406
Ten Year Average	217	506	715	758	760	453	288

Table 6. Mean spring weights (pounds) by age group for brown trout and estimated spring brown trout biomass in the Hildreth section of the Beaverhead River, 1970-1984.

	Age Group			
Year	II	III	IV+	Total Biomass (lbs)
1970	0.94	1.89	2.98	959
1971	0.87	1.73	2.65	873
1972	0.94	1.82	3.07	933
1974	1.06	1.87	3.30	846
1975	0.87	1.98	3.55	1030
1976	0.81	1.59	3.68	1681
1977	0.77	1.63	2.71	2624
1979	0.90	1.61	2.39	2213
1980	0.79	1.65	2.67	2531
1983	0.78	1.70	2.82	2439
1984	0.68	1.70	2.67	2700
Period Average	0.86	1.74	2.95	1712
Pre-1977 Average	0.92	1.81	3.21	1054
Post-1977 Average	0.78	1.66	2.65	2501

Table 7. Mean spring length (inches) by age group for brown trout and estimated fall numbers of brown trout in the Hildreth section of the Beaverhead River, 1970-1984.

Year	Age Group II	III	IV+	Total Biomass (lbs)
1970	13.2	17.2	20.6	500
1971	12.7	16.6	19.6	535
1972	13.2	16.8	20.5	404
1974	13.7	17.0	20.5	846
1975	12.7	17.1	21.1	1030
1976	12.4	16.1	22.0	1681
1977	12.3	16.2	19.4	2624
1979	12.9	16.0	18.6	2213
1980	11.9	15.8	19.2	2531
1983	12.5	16.5	19.7	2439
1984	11.9	16.6	19.7	2700
Period Average	12.7	16.5	20.1	1591
Pre-1977 Average	13.0	16.8	20.7	833
Post-1977 Average	12.3	16.2	19.3	2501

Table 8. Numbers of brown trout ≧ 5.0 lbs. captured per electrofishing trip in the Hildreth section of the Beaverhead River, 1967-1984 during spring sampling periods.

Year	No. Caught	No. Trips	No. Per Trip	Year	No. Caught	No. Trips	No. Per Trip
1967	0	2	0.0	1976	5	4	1.3
1968	0	3	0.0	1977	5	4	1.3
1969	0	4	0.0	1978	5	4	1.3
1970	0	3	0.0	1979	1	4	0.3
1971	4	4	1.0	1980	6	4	1.5
1972	3	4	0.8	1981	-	-	-
1973	-	-	-	1982	-	-	-
1974	10	4	2.5	1983	2	4	0.5
1975	19	5	3.8	1984	2	4	0.5

Table 9. Mean fall weights (pounds) by age group for rainbow trout and estimated fall rainbow trout biomass in the Hildreth section of the Beaverhead River, 1971-1983.

Year	Age Group I	II	III	IV+	Biomass (lbs)
1971	0.93	2.47	3.93	5.01	510
1972	1.05	-	-	5.02	480
1973	1.20	2.68	4.06	6.09	903
1974	1.19	2.24	4.94	5.23	1857
1975	0.91	2.40	3.26	5.64	1504
1977	0.89	2.42	3.35	4.56	1477
1978	0.73	1.86	2.65	3.94	1727
1979	0.65	2.01	2.93	4.19	1500
1980	0.96	2.12	3.37	4.24	2665
1983	0.60	1.94	2.90	4.39	1544
Period Average	0.91	2.24	3.49	4.83	1417
Pre-1974 Average	1.06	2.58	4.00	5.37	631
Post-1974 Average	0.85	2.14	2.93	4.60	1753

Table 10. Mean fall lengths (inches) by age group for rainbow trout and estimated fall numbers of rainbow trout in the Hildreth section of the Beaverhead River, 1971-1983.

Year	Age Group I	II	III	IV+	Number
1971	12.5	17.3	19.9	21.9	137
1972	12.9	-	-	21.6	214
1973	13.7	17.8	19.8	22.5	331
1974	13.3	16.7	20.9	23.0	1210
1975	12.6	17.7	19.6	21.7	1107
1977	12.5	17.5	19.6	21.7	700
1978	11.5	15.9	18.2	20.5	1338
1979	10.9	16.0	18.3	20.8	865
1980	12.5	16.1	18.9	20.6	1051
1983	10.8	16.1	18.7	21.3	932
Period Average	12.3	16.8	19.3	21.9	789
Pre-1974 Average	13.0	17.6	19.9	22.0	227
Post-1974 Average	12.0	16.6	19.2	21.9	1029

Table 11. Numbers and percentages, by inch group, of brown trout exhibiting symptoms (primarily exopthalmy) of gas bubble disease in the Hildreth section of the Beaverhead River, March 1984.

Inch Group	Affected/Handled	Percent Affected
7.0-7.9	0/5	0
8.0-8.9	0/6	0
9.0-9.9	1/16	6
10.0-10.9	2/46	4
11.0-11.9	3/55	5
12.0-12.9	2/76	3
13.0-13.9	4/28	14
14.0-14.9	6/59	10
15.0-15.9	13/86	15
16.0-16.9	13/84	15
17.0-17.9	11/95	12
18.0-18.9	9/117	8
19.0-19.9	11/83	13
20.0+	6/86	7
Total	81/805	10.0%

Table 12. Average condition factor (K) for brown trout exhibiting symptoms of gas bubble disease compared with average condition factor for all brown trout captured in the Hildreth section, spring 1984, by inch group.

Inch Group	Mean K With Symptoms	Mean K Total Sample
13.0-13.9	34.43	39.26
14.0-14.9	33.11	37.60
15.0-15.9	33.58	37.75
16.0-16.9	32.40	36.96
17.0-17.9	32.93	35.81
18.0-18.9	33.44	35.47
19.0-19.9	31.72	35.07
20.0-22.4	30.23	33.18

Table 13. Estimated numbers, biomass and mean length of brown and rainbow trout in the Pipe Organ section (13125 ft) of the Beaverhead River, spring 1984 (standard deviations [80% confidence interval] are in parentheses).

Age	Mean Length (in)	Number	Biomass (lbs)
		Brown Trout	
II	11.5	2156	1314
III	15.4	1049	1401
IV+	18.6	129	277
		3334 (±567)	2992 (±414)
		Rainbow Trout	
II	11.8	832	602
III	15.9	463	780
IV+	18.1	91	216
		1386 (±320)	1598 (±330)

Table 14. Estimated spring numbers per mile of age II and older brown trout in the Pipe Organ section of the Beaverhead River, 1968-1984.

Year	Age Group II	III	IV+	Total
1968	269	127	90	507
1970	338	285	21	644
1971	169	391	169	729
1972	380	227	269	876
1974	63	232	153	449
1976	491	459 (III+)	-	950
1981	792	306	90	1188
1982	824	422	63	1309
1983	719	333	21	1073
1984	866	421	52	1339

Table 15. Percentage of brown trout standing crop (biomass) accounted for by age group in the Pipe Organ section of the Beaverhead River, 1970-1983.

Year	Age II % of Total Biomass	Age III % of Total Biomass	Age IV+ % of Total Biomass
1970	33	59	7
1971	14	54	32
1972	22	27	51
1974	6	47	46
1981	50	34	17
1982	45	43	11
1983	52	43	5
1984	44	47	9

Table 16. Estimated numbers, biomass and mean length of brown and rainbow trout in the Henneberry section (7920 ft) of the Beaverhead River, spring 1984 (standard deviations [80% confidence interval] are in parentheses).

Age	Mean Length (in)	Number	Biomass (lbs)
		Brown Trout	
II	12.2	1491	1069
III	16.1	747	1129
IV+	19.9	181	470
		2419 (±283)	2668 (±229)
		Rainbow Trout	
II	11.7	452	318
III	16.3	243	445
IV+	19.1	134	357
		829 (±198)	1120 (±221)

Table 17. Estimated numbers of brown trout per mile, compared by arbitrary length group selection, in the Henneberry and Pipe Organ sections of the Beaverhead River, spring 1984.

Length (in)	Pipe Organ Number/Mile	Henneberry Number/Mile
8.0-13.9	820	783
14.0-15.9	344	397
16.0-17.9	116	270
18.0-19.9	51	108
20.0+	10	53
Total	1341	1611