WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

ADMINISTRATIVE REPORT

TITLE: Middle Fork Powder River Instream Flow Report

PROJECT: Contract Number YA-512-CT9-226

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DATE: February 1987

Studies were conducted during the 1981 field season to obtain instream flow information from a portion of the Middle Fork Powder River near the community of Barnum. The studies were designed to provide results which could be used to determine instream flow needs for trout as well as to evaluate potential flow-related impacts of future water development activities.

METHODS

All of the field data used in this study were collected from a 296 foot long study site located in the southwest corner of section 14, township 42 north, range 84 west. This site contained a combination of pool and riffle habitat for trout that was representative of trout habitat features found throughout this portion of the stream. Results and recommendations were applied to a portion of the stream extending from a downstream boundary at R84W, T42N, S23, NW¼ upstream to the west section line of section 28, T42N, R85W. This is a distance of 10.01 stream miles.

A physical habitat simulation (PHABSIM) model developed by the Instream Flow Service Group of the U.S. Fish and Wildlife Service (Bovee and Milhous 1978) was used to identify incremental changes in the amount of physical habitat for rainbow trout with changes in flow. Data were collected at six transects which were placed across each habitat type within the study segment. Velocities and depths were measured at 1 to 2 foot intervals across each transect during four different flow events (Table 1). These data permitted simulation of physical habitat over a range of flows between 6 and 415 cfs.

Table 1. Dates and discharges when instream flow data were collected.

Date	Discharge (cfs)
05-28-81	166
05-04-81	57
06-16-81	46
09-18-81	15

The PHABSIM model can be used to quantify habitat changes for a variety of species of fish and up to five life stages of fish. For the above-defined stream segment, analyses were made of habitat changes for rainbow trout adult, juvenile and fry life stages (combined) as well as for spawning and incubation habitat (combined). The model was used for rainbow trout since the stream is dominated by this species.

The Habitat Retention method (Nehring 1979) was used to identify a flow for maintaining adequate levels of aquatic insect production and fish passage through riffle areas. Data from single transects placed across two riffles within the study area were analyzed in the IFG-1 computer program (Milhous 1978). Flow data were collected on the same dates shown in Table 1. The flow recommendation for this method was determined by identifying the discharge at which two of the three hydraulic criteria in Table 2 were met at both riffle cross-sections.

Table 2. Hydraulic criteria used to obtain an instream flow recommendation using the Habitat Retention method for the Middle Fork Powder.

Category	Criteria
Average Depth (feet)	0.50
Average Velocity (Feet per second)	1.00
Wetted Perimeter (Percent)*	50

* - Compared to wetted perimeter at bank full conditions.

The Habitat Quality Index (HQI) developed by the Wyoming Game and Fish Department (Binns and Eiserman 1978) was used to estimate potential changes in trout standing crops under various levels of late summer flow conditions. This model incorporates seven attributes that address chemical, physical as well as biological components of trout habitat. Results are expressed in habitat units (HU) per acre.

Results from the HQI, Habitat Retention, and PHABSIM (Adult, juvenile and fry life stages) models were combined to identify the flow needed to maintain existing levels of trout production between July 1 and September 30. Results from the Habitat Retention and PHABSIM (adult, juvenile and fry life stages) models were used to identify a preferred flow from October 1 to March 31 which would maintain or improve trout survival. Natural undepleted flows during this time period that are less than the recommended discharge will maintain trout survival at its current level since the existing trout population has evolved under these conditions. The results presented here are useful to illustrate the critical nature of those flows for trout survival. Results from the PHABSIM model for spawning and incubation life stages were used to identify a flow which would improve rainbow trout reproductive success. This time period extends from April 1 to June 30.

RESULTS

Results from the habitat retention model showed that flows of 12 and 10 cfs are necessary to maintain aquatic insect production and fish passage at riffles 1 and 2 respectively (Table 3). The maintenance flow derived from this method is defined as the flow at which two of the three hydraulic criteria are met for all riffles in the study site which in this case is 12 cfs.

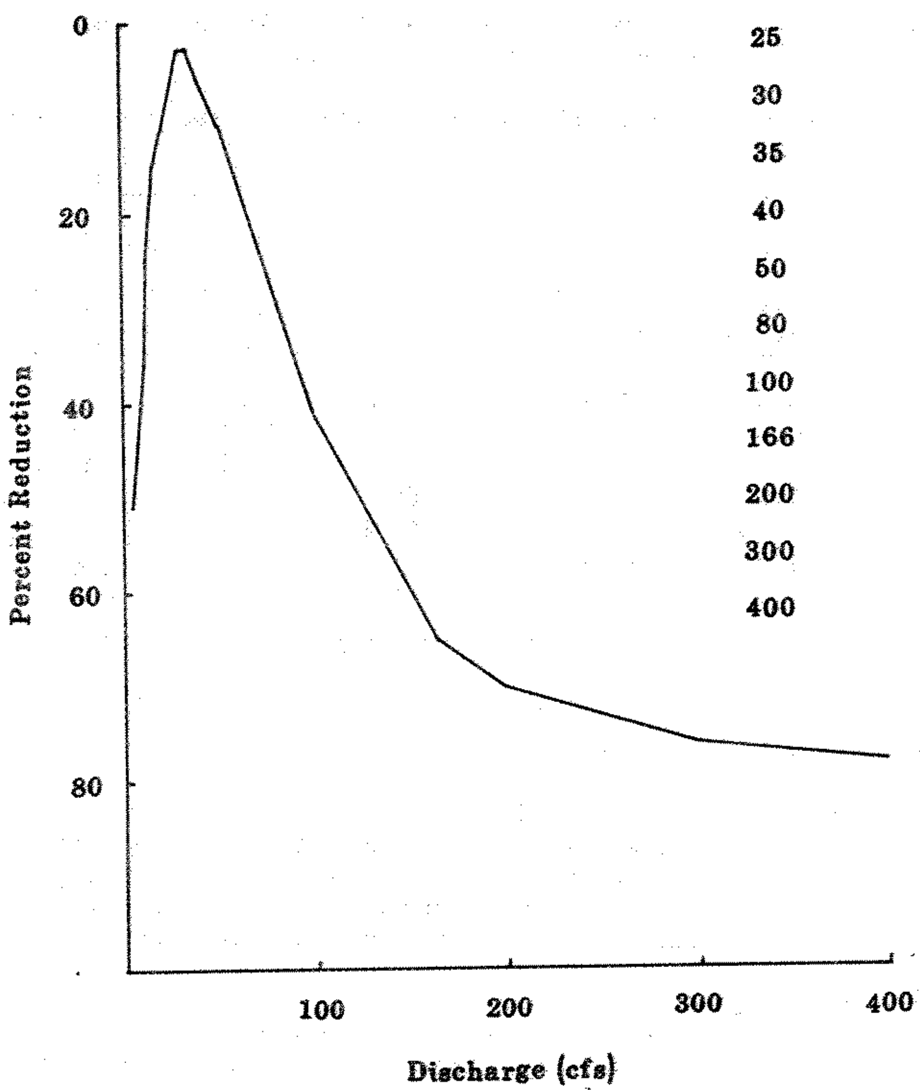
Table 3. Simulated hydraulic criteria for two riffles on the Middle Fork Powder.

Riffle No. 1				Riffle No. 2			
Disch[a]	Avg Dep[b]	Avg Vel[c]	Wet Per[d]	Disch	Avg Dep	Avg Vel	Wet Per
7.4	0.37	0.83	25.0	5.8	0.42	0.62	23.1
11.2	0.45	0.98	26.7	9.0	0.49	0.76	24.8
11.8	0.46	1.00	27.0	10.0	0.50	0.80	25.6
13.6	0.47	1.06	27.9	11.0	0.51	0.84	26.4
16.3	0.50	1.15	29.2	13.2	0.55	0.92	27.0
19.4	0.53	1.24	30.4	15.8	0.59	1.00	27.4
22.9	0.56	1.34	31.6	18.6	0.64	1.09	27.8

a - Discharge (cfs)
b - Average Depth (feet)
c - Average Velocity (feet per second)
d - Wetted Perimeter (percent of bank full)

Results from the PHABSIM analysis for adult, juvenile and fry rainbow trout showed that usable area in the stream is maximized at 30 cfs for the range of flows considered (Figure 1). The average percent reduction in usable area for these three life stages at the 12 cfs maintenance flow increases from 3% at 30 cfs to 25%. At flows less than 12 cfs, usable area for rainbow trout decreases rapidly.

August and September stream flows usually approximate the 15 cfs flow that was measured on September 18 (Table 1). Therefore, the management objective is to maintain the 168 habitat units per acre which were determined to presently exist in the study area (Figure 2). Although actual field measurements were not taken at flows less than 15 cfs, the data in Figure 2 suggest that late summer flows less than this level would decrease the habitat quality and standing crop



Discharge (cfs)	Percent Reduction
6	51
9	36
12	25
15	18
18	15
21	11
25	7
30	3
35	3
40	6
50	11
80	29
100	41
166	65
200	70
300	76
400	78

Figure 1. Percent reduction from the optimum flow for adult, juvenile and fry life stages of rainbow trout in the Middle Fork Powder River.

Trout Habitat Units	Discharge (cfs)
168	15
289	50
26	165

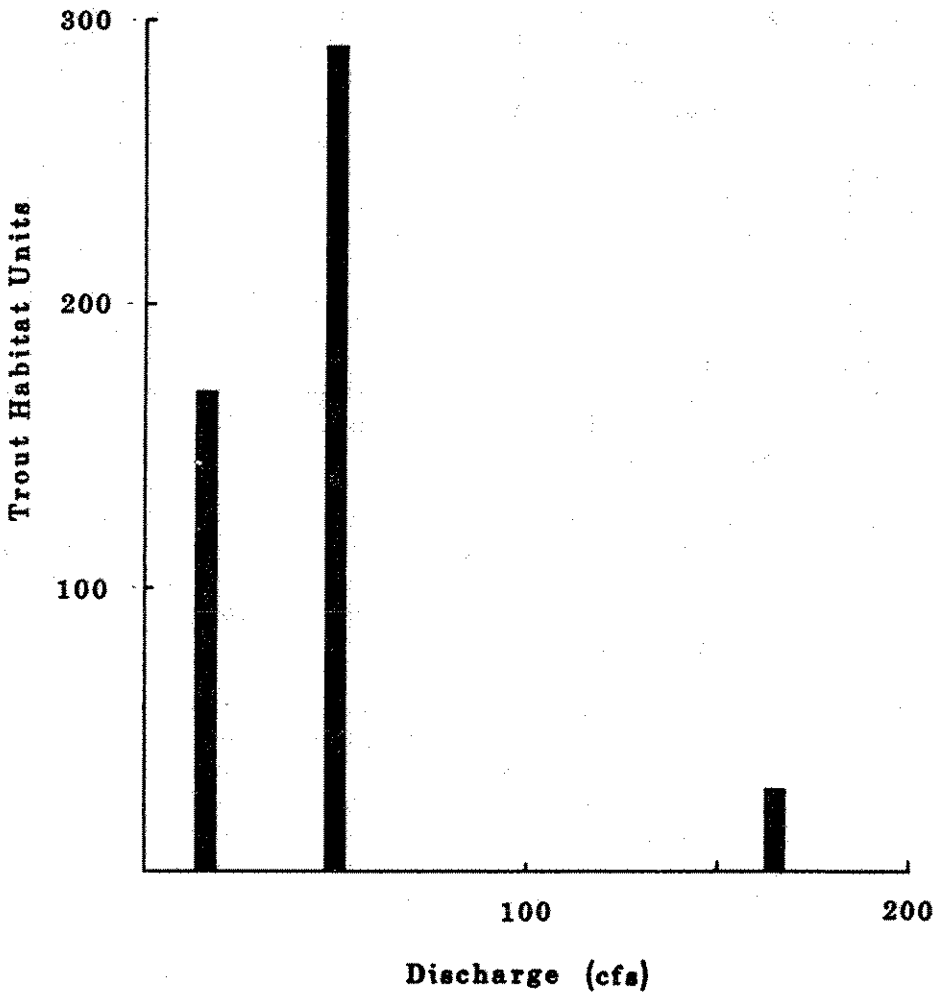


Figure 2. Trout habitat unit dynamics with change in flow for the Middle Fork Powder River.

of trout presently found in this portion of the Middle Fork. To better define this trend, data for an HQI at 8 cfs were simulated and run through the model. The results from this analysis indicate that this trend does continue and that trout habitat units would decrease to about 124.0 HU's per acre. If July to September flows were to be increased above existing levels, potentially significant gains in trout densities would be observed.

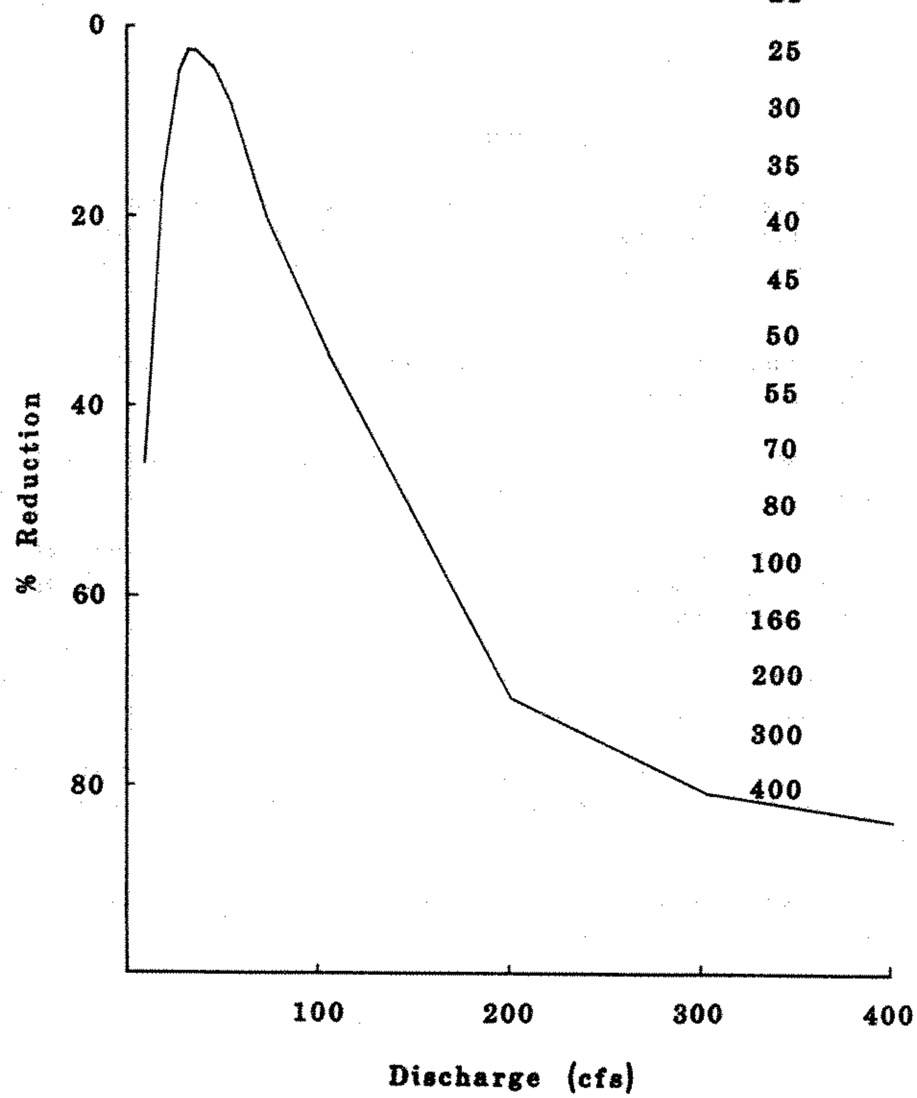
On this basis an instream flow of 12 cfs is recommended to maintain existing levels of trout production between July 1 and September 30.

It is a well documented fact that substantial losses of wild trout occur in the winter, particularly in relatively high elevation streams like those found throughout Wyoming. Needham et al. (1945) documented overwinter losses of brown trout ranging up to 85% and averaging over 60% in a California stream. Butler (1979) reported significant trout and aquatic insect losses caused by anchor ice formation. Reimers (1957) considered anchor ice, collapsing snow banks and fluctuating flows resulting from the periodic formation and breakup of ice dams to be the primary causes of trout winter mortality. These studies were all conducted on unregulated streams and illustrate the severe conditions that trout are exposed to naturally during the winter. The causes of winter mortality discussed above are all greatly influenced by the quantity of winter flow in terms of its ability to minimize anchor ice formation (increased velocity and temperature loading) and dilute and prevent snow bank collapses and ice dam formation respectively. Any reduction of natural winter stream flows would increase trout mortality and effectively reduce the number of fish that the stream could support. The fishery management objective for the time period from October 1 to March 31 is subsequently to protect all available natural stream flows in the instream flow segment.

The habitat retention method was developed to identify a flow that would provide adequate survival of aquatic insects in riffle areas and provide passage for trout between different habitat types in the stream. Maintenance of these features is as important during the winter as it is during the summer and, as a consequence, the recommendation derived from this method (12 cfs) is applied to the period between October 1 and March 31.

Preliminary analyses indicate that the recommended winter instream flow is seldom found in the portion of the Middle Fork addressed by these studies. This does not indicate a need for storage to provide the recommended flow but instead shows that the entire available natural flow is needed throughout the winter to maintain trout survival at its present level.

Results from the PHABSIM model for rainbow trout spawning and incubation habitat (Figure 3) show that a flow of 25 cfs would provide the maximum amount of habitat for this species. Natural flows during the period when rainbow trout spawn (April 1 to June 30) significantly exceed this flow under normal conditions. The present flow regime provides adequate recruitment to support the existing stream fishery; however, as the data in Figure 3 show, reductions in flow to 25 cfs would improve spawning success and standing crop in the stream.



Discharge (cfs)	Percent Reduction
6	46
9	30
12	19
15	12
18	7
21	4
25	2
30	2
35	3
40	4
45	5
50	7
55	11
70	20
80	25
100	34
166	61
200	70
300	80
400	83

Figure 3. Percent reduction from the optimum spawning flow for rainbow trout in the Middle Fork Powder River.

CONCLUSIONS

Based on the analyses and results contained in this report, the instream flow recommendations in Table 4 apply to a 10 mile segment of public lands on the Middle Fork Powder River upstream from the NW¼, NW¼, S23, T42N, R84W:

Table 4. Summary of instream flow recommendations for the Middle Fork Powder River.

Time Period	Instream Flow Recommendation (cfs)
July 1 to September 30	12
October 1 to March 31	12
April 1 to June 30	25

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