WYOMING GAME AND FISH DEPARIMENT

FISH DIVISION

ADMINISTRATIVE REPORT

TITLE: Fish Creek Instream Flow Report

PROJECT: IF-4090-07-8803

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INTRODUCTION

Studies were conducted to obtain instream flow information from a segment of Fish Creek west of Big Piney, Wyoming. These studies were designed to provide the basis for determining instream flows which would maintain or improve the existing fishery in this candidate section of Fish Creek. Results of these studies apply to the stream segment extending upstream from the U.S. Forest Service boundary on the east side of Section 36, Range 115 West, Township 30 North, to the road crossing in the SE1/4 NW1/4 Section 28, Range 115 West, Township 30 North. This stream section is 4.2 miles long.

This section of Fish Creek is designated by the Wyoming Game and Fish Department (WGFD) as a Class 3 trout stream. Class 3 streams generally support regionally important fisheries. This stream segment is managed under the species concept for Colorado River cutthroat trout. Other species present include brook trout and rainbow trout.

Colorado River cutthroat trout were historically distributed throughout the Green River drainage, but are currently found only in headwater streams. The U.S. Fish and Wildlife Service considers the Colorado River cutthroat trout a Category 2 taxa which may be appropriate for Federal listing as threatened or endangered (USFWS 1985). The Wyoming Game and Fish Department considers this trout to be a "sensitive" species which requires special attention to prevent population reductions to threatened or endangered levels (WGFD 1987). The Comprehensive Management and Enhancement Plan for Colorado River Cutthroat Trout in Wyoming (WGFD 1987) provides a framework for management of Colorado River cutthroat trout populations and includes the need to obtain adequate instream flow protection for streams inhabited by this species. For these reasons, this stream segment is considered a critical reach.

The management goal of the WGFD is to maintain or improve the existing stream fishery in Fish Creek. Three time periods are considered critical for realizing this goal. October 1 to May 14 is considered critical because this is a time period when low flows can cause degradation of hydraulic characteristics necessary for trout survival, fish passage and aquatic insect production. May 15 to June 30 is a critical period for maintaining spawning habitat for Colorado River cutthroat trout;

and from July 1 to September 30 it is critical to provide flows adequate for maintaining existing levels of adult trout production.

To address the management goal, objectives of this study were to 1) determine instream flows necessary to maintain hydraulic characteristics that are important for survival of trout, fish passage and aquatic insect production, 2) maintain or improve physical habitat for Colorado River cutthroat trout spawning and, 3) maintain or improve adult trout production during the late summer months.

METHODS

Data for these studies were collected from a site located in Section 27, Range 115 West, Township 30 North (Figure 1). These studies were conducted between June and August 1988 within a 305 foot long study site that contained trout habitat typical of that found throughout the candidate section of Fish Creek. Data were collected after peak runoff from a range of discharge rates (Table 1).

Table 1. Dates and discharge rates when instream flow data were collected from Fish Creek during 1988.

Date	Discharge Cubic Feet Per Second (cfs)
06-11-88	71
07-03-88	29
08-23-88	8

The Habitat Retention method (Nehring 1979, Annear and Conder 1984) was used to identify a maintenance flow. A maintenance flow is defined as a continuous flow needed to maintain minimum hydraulic criteria at riffle areas in a stream segment. Based on extensive research by Annear and Conder (1984), the maintenance flow is specifically defined as the discharge at which two of three hydraulic criteria are met for all riffles in the study area (Table 2). Meeting these criteria provides passage for all life stages of trout between different habitat types and maintains survival of trout and aquatic macroinvertebrates at all times of year.

Data were collected from transects placed across three riffles within the study area and analyzed using the IFG-1 computer program (Milhous 1978). Instream flow recommendations derived from this method are applicable throughout the year except when higher instream flows are required to meet other fishery management purposes.

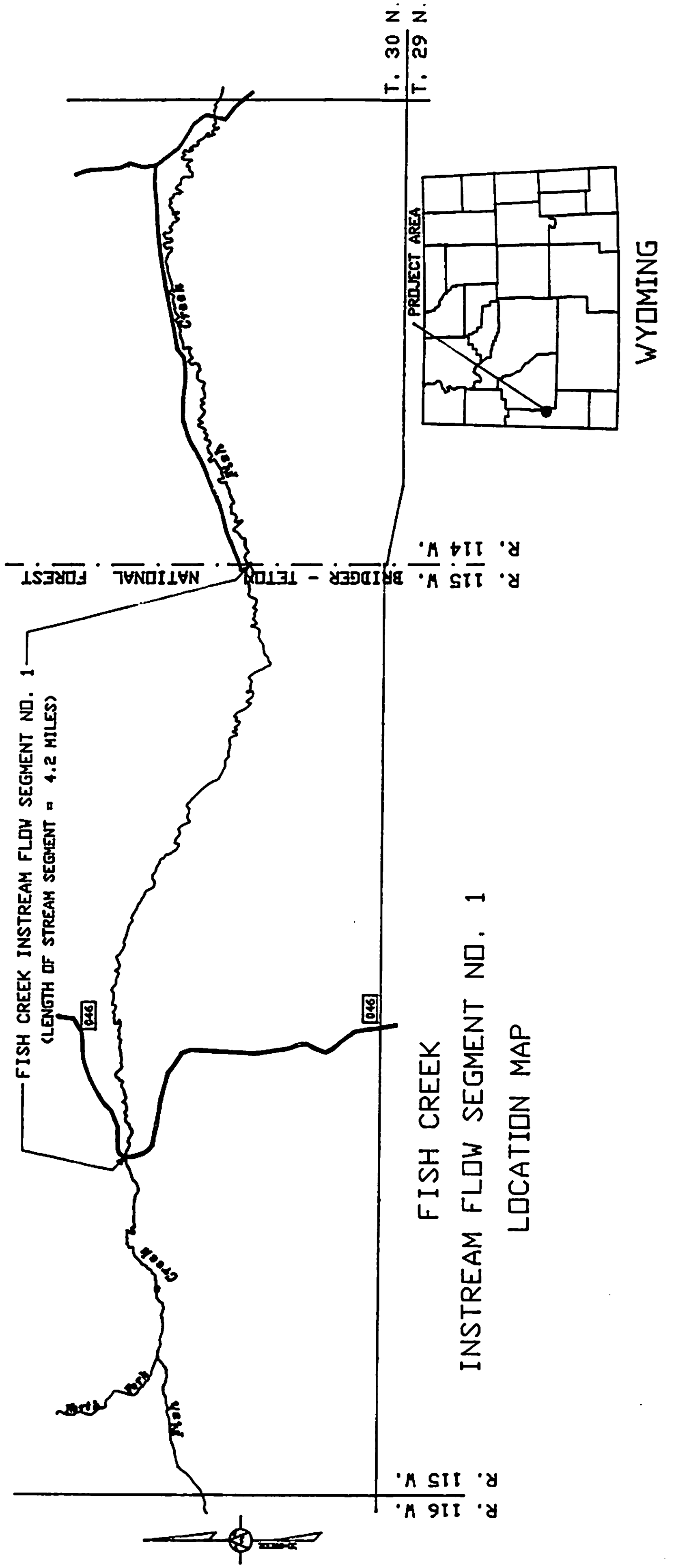

Figure 1. Location of Instream Flow filing reach on Fish Creek.

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

Category	Criteria
Average Depth (ft)	Top width[1] X 0.01
Average Velocity (ft per sec)	1.00
Wetted Perimeter (percent)[2]	60

1 - At average daily flow
2 - Compared to wetted perimeter at bankfull conditions

A physical habitat simulation model (PHABSIM) developed by the Instream Flow Service Group of the U.S. Fish and Wildlife Service (Bovee and Milhous 1978) was used to examine incremental changes in the amount of physical habitat available for cutthroat trout spawning at various discharge rates. This model is generally regarded as state-of-the-art technology and is the most commonly used method in North America for quantifying changes in physical habitat with changes in discharge (Reiser et al. 1989).

The amount of physical habitat available at a given discharge is expressed in terms of weighted usable area (WUA) and reflects the composite suitability of depth, velocity and substrate at a given flow. Depth, velocity and substrate data were collected from seven transects in accordance with guidelines given by Bovee and Milhous (1978). The WUA for cutthroat trout spawning was simulated for flows ranging from 5 to 125 cfs using calibration and modeling techniques outlined in Milhous (1984) and Milhous et al. (1984). Because Colorado River cutthroat trout generally spawn between May 15 and June 30, the results of this model were applied to this time period.

The Habitat Quality Index (HQI) developed by the Wyoming Game and Fish Department (Binns and Eiserman 1979) was used to estimate potential changes in trout production over a range of late summer flow conditions. The model incorporates seven attributes that address chemical, physical and biological components of trout habitat. Results are expressed in habitat units (HU), with one HU defined as the amount of habitat quality which will support 1 pound of trout. This model was developed by the WGFD after several years of testing and model refinement. The HQI has been reliably used on many Wyoming streams to assess habitat unit gains or losses associated with projects that modify instream flow regimes.

By measuring habitat attributes at various flow events as if associated habitat features were typical of late summer flow conditions (Conder and Annear 1987), HU estimates were made for hypothetical summer flows ranging from 5 to 100 cfs. To better define the potential impact of these other late summer flow levels on trout production, some attributes were derived mathematically for flows other than those which were measured. Results of the HQI model apply to the time of year that determines trout production. For Fish Creek this period is from July 1 to September 30.

RESULTS AND DISCUSSION

The Habitat Retention method was developed to identify a flow that would maintain survival rates of aquatic insects in riffle areas, maintain existing survival rates of trout, and provide passage for trout between different habitat types in streams. Maintenance of these features is important year round except when higher flows are needed at specific times to meet other requirements.

Results from the Habitat Retention model show that flows of 6, 5 and 2 cfs are necessary to maintain aquatic insect production and fish passage at riffles 1, 2 and 3 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. Based on this criteria, the maintenance flow for this segment of Fish
Creek is 6 cfs.

Table 3. Results from IFG-1 modeling at the Fish Creek study site.

Discharge (cfs)	Average Depth (ft)	Average Velocity (ft/sec)	Wetted Perimeter
	Riffle 1		
1.6	0.18[1]	0.58	14.9
3.0	0.25	0.74	16.1
5.5	0.34	0.97	16.7
5.9[2]	0.35	1.00[1]	16.8
8.7	0.42	1.20	17.2
13.9	0.52	1.53	17.9
16.1	0.54	1.64	18.4
20.2	0.58	1.85	19.2
31.6	0.65	2.30	21.2[1]
37.9	0.69	2.53	22.2
49.7	0.75	2.88	23.6
63.6	0.79	3.24	25.3
98.9	0.75	3.91	34.3
104.1	0.75	3.97	35.4
	Riffle 2		
1.2	0.09	1.05	11.9
3.4	0.17	0.94	20.8[1]
4.8[2]	0.22[1]	0.98	21.8
5.2	0.23	1.00[1]	21.8
7.9	0.32	1.11	22.2
12.0	0.42	1.30	22.5
16.1	0.49	1.46	22.8
17.3	0.51	1.51	22.9
19.2	0.54	1.58	23.1
32.1	0.67	1.99	24.6
53.0	0.78	2.49	28.1
77.8	0.86	2.94	31.8
104.1	0.92	3.27	34.7

Table 3. (continued).

Discharge (cfs)	Average Depth (ft)	Average Velocity (ft/sec)	Wetted Perimeter
		Riffle 3	
1.7	0.21[1]	0.60	13.3
2.4[2]	0.23	0.70	14.5[1]
3.7	0.26	0.88	16.7
5.1	0.29	1.00[1]	17.7
6.9	0.32	1.15	19.0
9.0	0.34	1.28	20.9
16.1	0.46	1.65	21.4
17.4	0.48	1.72	21.5
23.5	0.55	1.99	21.8
35.0	0.66	2.42	22.3
77.8	0.92	3.66	23.6
104.1	1.03	4.26	24.1

1 - Hydraulic criteria from Table 2 met
2 - Flow meets two of three criteria for individual transect

Natural mortality that occurs during the winter can often be a significant factor limiting a trout population. Kurtz (1980) found that the loss of winter habitat due to low flow conditions was an important factor affecting mortality rates of trout in the upper Green River, with mortality approaching 90% during some years. Needham et al. (1945) documented average overwinter brown trout mortality of 60% and extremes as high as 80% 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 as the primary causes of winter trout mortality.

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 May 14 is subsequently to protect all available natural stream flows in the instream flow segment up to the maintenance flow (6 cfs).

Gage data are unavailable for this section of Fish Creek and it is possible that the discharge of 6 cfs identified by the Habitat Retention method may not be present at times during the winter. Because the existing fishery is adapted to natural conditions, occasional periods of shortfall during the winter do not imply the need for storage. Rather, such shortfalls illustrate the need to maintain all natural winter streamflows, up to 6 cfs, in order to maintain existing survival rates of trout populations.

Current management objectives are aimed at maintaining or improving populations of Colorado River cutthroat trout (WGFD 1984; WGFD 1987). This segment of Fish Creek is managed for wild cutthroat trout and is dependent on spawning and egg survival for

maintenance of the fishery. Colorado River cutthroat trout spawn in the spring, during or shortly after peak runoff, and their eggs normally incubate until early to mid summer. Results from the PHABSIM model were used to determine flows necessary to maintain or improve Colorado River cutthroat trout reproductive success by maintaining spawning habitat from May 15 to June 30.

Results from the PHABSIM analysis show that a flow of 10 cfs will maintain 100% of the maximum amount of physical habitat available for cutthroat trout spawning (Figure 2). Rapid reductions in physical habitat available for spawning occur at flows below 5 cfs, and above 10 cfs. Because Colorado River cutthroat trout are considered a "sensitive" species by the WGFD and their perpetuation in Fish Creek is dependent upon natural reproduction, it is important to maximize spawning opportunities. To accomplish the current fishery management objective of maintaining or improving reproductive success for Colorado River cutthroat trout, and at the same time, protecting the habitat features addressed by the Habitat Retention method, a flow of 10 cfs is recommended for the period from May 15 to June 30.

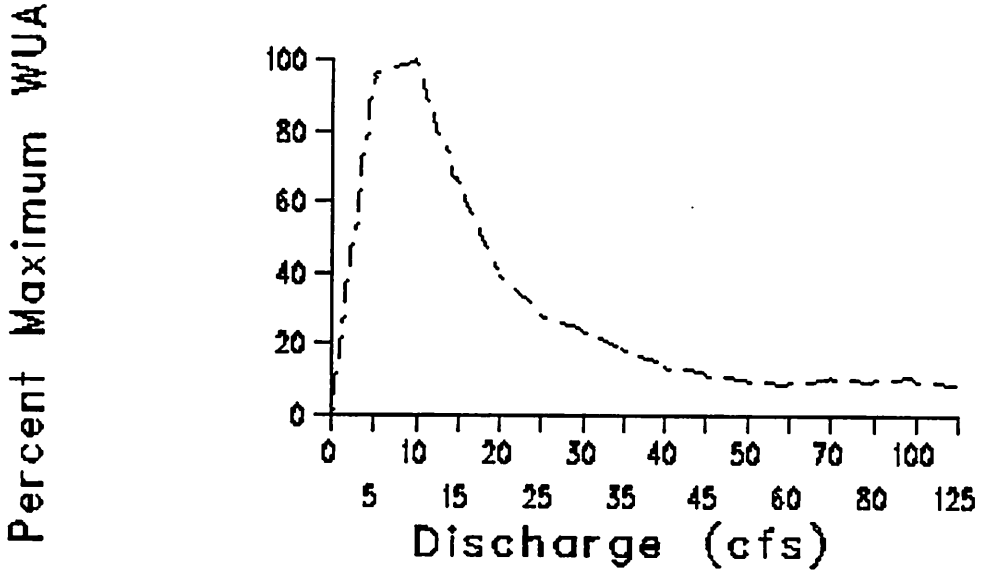

Figure 2. Percent of maximum weighted usable area (WUA) for cutthroat trout spawning at the Fish Creek study site as a function of discharge.

Results from the HQI model indicate that under existing average late summer conditions, this segment of Fish Creek supports approximately 55 trout Habitat Units (Figure 3). A flow of 10 cfs will maintain this existing level of HU's. At lower flows, trout habitat units would be reduced by about 27% or more. Fishery management objectives for the late summer are to maintain the existing number of habitat units, and meet or exceed the hydraulic criteria addressed by the Habitat Retention method. In order to accomplish these objectives a flow of 10 cfs is recommended for the period from July 1 through September 30.

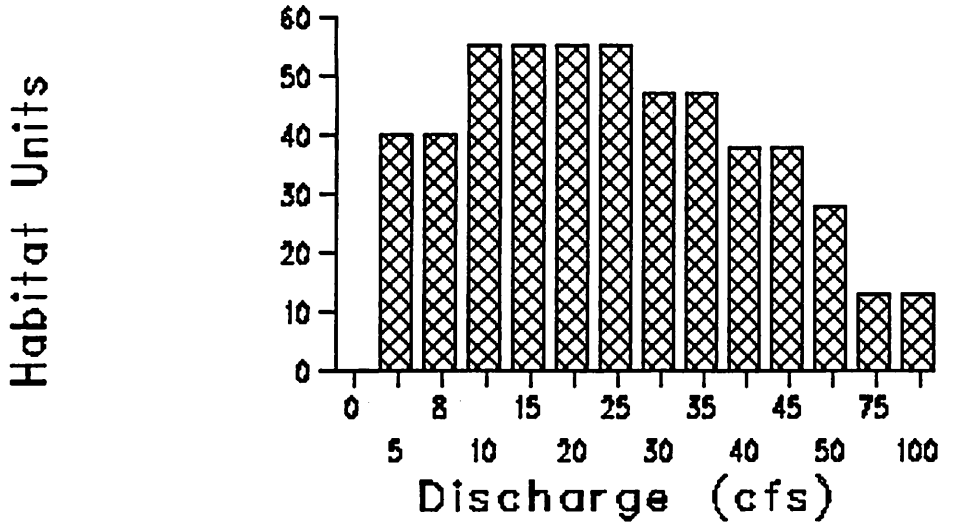

Figure 3. Adult trout habitat units (HU) as a function of discharge at the Fish Creek study site.

SUMMARY

Based on results from the Habitat Retention method and PHABSIM and HQI modeling, the instream flow regime shown in Table 4 is recommended to maintain or improve existing trout production levels in Fish Creek from the east boundary of Section 36, Range 115 West, Township 30 North upstream to the road crossing in the SE1/4 NW1/4 Section 28, Range 115 West, Township 30 North. These recommendations are applicable to 4.2 miles of Fish Creek.

Table 4. Summary of instream flow recommendations for Fish Creek west of Big Piney.

Time Period	Instream Flow Recommendation (cfs)
October 1 to May 14	6*
May 15 to June 30	10
July 1 to September 30	10

* - To maintain existing natural flows

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