WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

ADMINISTRATIVE REPORT

TITLE: North Cottonwood Creek Instream Flow Report

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INTRODUCTION

Studies were conducted to obtain instream flow information from a segment of North Cottonwood Creek west of Daniel, 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 North Cottonwood Creek. Results of these studies apply to the stream segment extending upstream from the east boundary of Section 20, Range 114 West, Township 33 North, to the west boundary of Section 13, Range 115 West, Township 33 North. This stream section is 8.9 miles long.

This section of North Cottonwood Creek is designated by the Wyoming Game and Fish Department (WGF) as a Class 3 trout stream. Class 3 streams generally support regionally important fisheries. The stream is managed under the species concept for Colorado River cutthroat trout. Other species present include rainbow and brook 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 (WGF 1987). The Comprehensive Management and Enhancement Plan for Colorado River Cutthroat Trout in Wyoming (WGF 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.

Objectives of this study were to determine instream flows necessary to 1) 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 approximately 0.4 miles upstream from the U.S. Forest Service boundary in the NW1/4, SW1/4 of Section 29, Range 114 West, Township 33 North. These studies were conducted between June and August 1988 within a 367 foot long study site that contained trout habitat typical of that found throughout the candidate section of North Cottonwood Creek. Data were collected from a range of discharge rates after peak runoff (Table 1).

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

Date	Discharge Cubic Feet Per Second (cfs)
06-13-88	59
07-05-88	24
08-26-88	12

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. Meeting these criteria provides passage for all life stages of trout between different habitat types and maintains survival of trout and aquatic macroinvertebrates. The maintenance flow is identified as the discharge at which two of three criteria (Table 2) are met for all candidate riffles in the study site. 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 to all times of year except when higher instream flows are required to meet other fishery management purposes.

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.

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). Using calibration and modeling techniques outlined in Milhous (1984) and Milhous et al. (1984), the WUA for cutthroat trout spawning was simulated for flows ranging from 5 to 75 cfs.

The Habitat Quality Index (HQI) model (Binns and Eiserman 1979) was used to estimate the number of habitat units (HU) that the stream supports under average stream flow conditions, as well as to evaluate the effect of other late summer flow patterns on HU's. One habitat unit is defined as the amount of habitat quality capable of supporting one pound of trout. The results of the HQI model apply to the time of year that determines trout production. For North Cottonwood Creek this period is from July 16 to September 30.

By measuring habitat attributes at various flow events as if associated habitat features were typical of late summer flow conditions, HU estimates were made for hypothetical summer flows ranging from 5 to 75 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 from the HQI model were used to identify the flow needed to maintain existing levels of trout production between July 16 and 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 during the winter. 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 9, 16 and 4 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. For this segment of North Cottonwood Creek, this stream flow is 16 cfs.

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

Discharge (cfs)	Average Depth (ft)	Average Velocity (ft/sec)	Wetted Perimeter
		Riffle 1	
1	0.17	0.62[1]	10.0
4[2]	0.24[1]	1.00[1]	14.6
9[2]	0.30[1]	1.27	21.1
11	0.33	1.38	24.9
25	0.52	1.72	27.7
40	0.67	2.02	29.5[1]
48	0.72	2.16	30.6[1]
58	0.79	2.34	32.0
88	0.88	2.71	37.3
121	0.97	3.00	41.9
312	1.52	4.08	51.0
		Riffle 2	
1	0.10	0.92[1]	11.0
5	0.19	1.00[1]	26.2
11[2]	0.33[1]	1.25	29.4
16[2]	0.38[1]	1.37	30.2[1]
22	0.45	1.56	31.6[1]
48	0.58	2.15	39.1
60	0.62	2.36	41.9
89	0.72	2.76	45.9
167	0.96	3.60	49.2
312	1.26	4.80	52.6
		Riffle 3	
1	0.14[1]	0.58	9.7
2[2]	0.19[1]	0.76[1]	12.2
4[2]	0.27	1.00[1]	15.0[1]
9	0.40	1.32	16.5[1]
11	0.46	1.48	17.1
18	0.58	1.82	17.9
24	0.65	2.05	18.3
48	0.87	2.84	19.7
77	1.03	3.55	21.6
147	1.22	4.80	25.8
312	1.75	6.78	27.6

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. The maintenance flow for this stream segment is 16 cfs.

Applicable gage data are unavailable for this section of North Cottonwood Creek and it is possible that the discharge of 16 cfs identified by the Habitat Retention method may not be present at times during the winter. Occasional periods of shortfall during the winter do not imply the need for storage to supply winter flows, but illustrate the need to maintain all natural winter streamflows, up to 16 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 (WGF 1984, WGF 1987). This segment of North Cottonwood Creek is managed for wild cutthroat trout and is dependent on spawning and egg survival for perpetuation of the fishery. Colorado River cutthroat trout spawn in the spring, during or shortly after peak runoff, and their eggs 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 July 15.

Results from the PHABSIM analysis (Figure 1) show that flows of 35 and 10 cfs will both maintain 100% of the maximum amount of physical habitat available for cutthroat trout spawning, but rapid reductions in available physical habitat occur between the two flows down to 20 cfs. The two peaks are a reflection of channel characteristics that result in equal amounts of physical habitat for spawning in different parts of the channel at different flows. Although the PHABSIM model indicates that physical habitat for spawning is high at a flow of 10 cfs, this lower flow is less than the maintenance flow identified by the Habitat Retention method (16 cfs), and will not maintain important hydraulic criteria necessary to maintain fish passage, trout survival and aquatic insect production. In order to maintain or improve spawning success and maintain important hydraulic conditions, a flow of 35 cfs is recommended from May 15 to July 15.

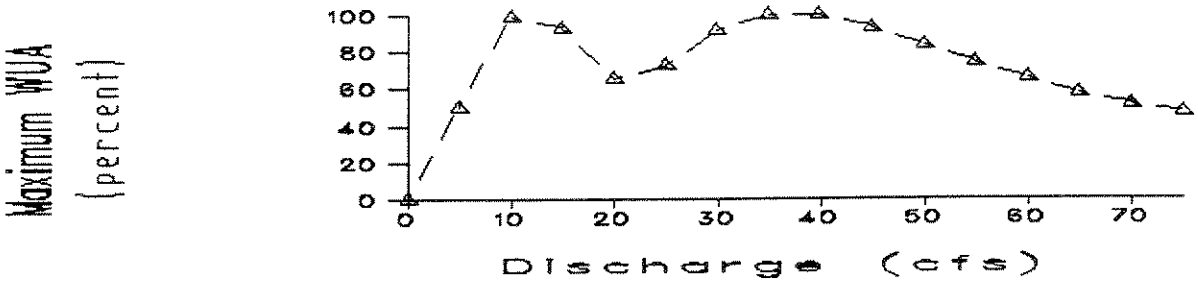

Figure 1. Percent of maximum weighted usable area (MUA) for cutthroat trout spawning at the North Cottonwood Creek study site as a function of discharge.

Results from the HQI model indicate that under existing average late summer conditions, this segment of North Cottonwood Creek supports approximately 105 trout Habitat Units (Figure 2). Results from this analysis indicate that 25 cfs is the minimum streamflow that will maintain this existing level of HU's. At lower flows, trout habitat units would be reduced by approximately 60% 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 25 cfs is recommended for the period from July 16 through September 30.

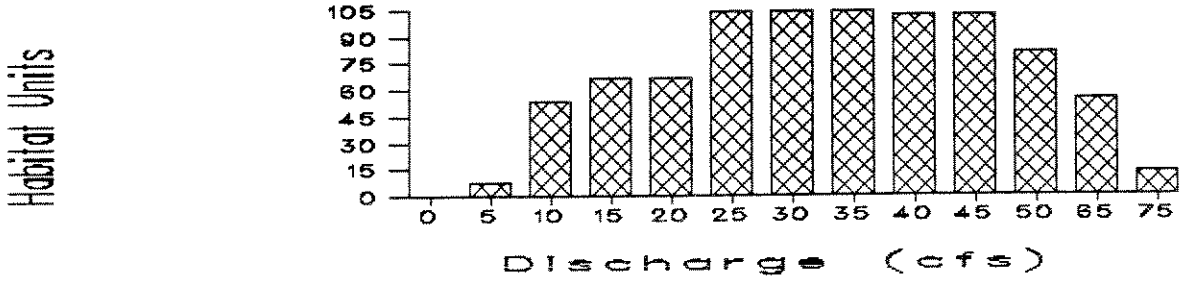

Figure 2. Adult trout habitat units (HU) as a function of discharge at the North Cottonwood Creek study site.

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 North Cottonwood Creek from the east boundary of Section 20, Range 114 West, Township 33 North upstream to the west boundary of Section 13, Range 115 West, Township 33 North. These recommendations are applicable to 8.9 miles of North Cottonwood Creek.

Table 4. Summary of instream flow recommendations for North Cottonwood Creek west of Daniel.

Time Period	Instream Flow Recommendation (cfs)
October 1 to May 14	16 *
May 15 to July 15	35
July 16 to September 30	25

* - To maintain existing natural flows.

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