WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

AMMENDED ADMINISTRATIVE REPORT

TITLE: Medicine Lodge Creek Instream Flow Report

PROJECT: IF-2289-07-8902

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INTRODUCTION

Data were collected during the 1989 field season to conduct instream flow analyses for a segment of Medicine Lodge Creek located near the town of Hyattville, in north-central Wyoming. The study and this report were prepared in compliance with instream flow legislation to support a Wyoming Water Development Commission application for an instream flow water right.

METHODS

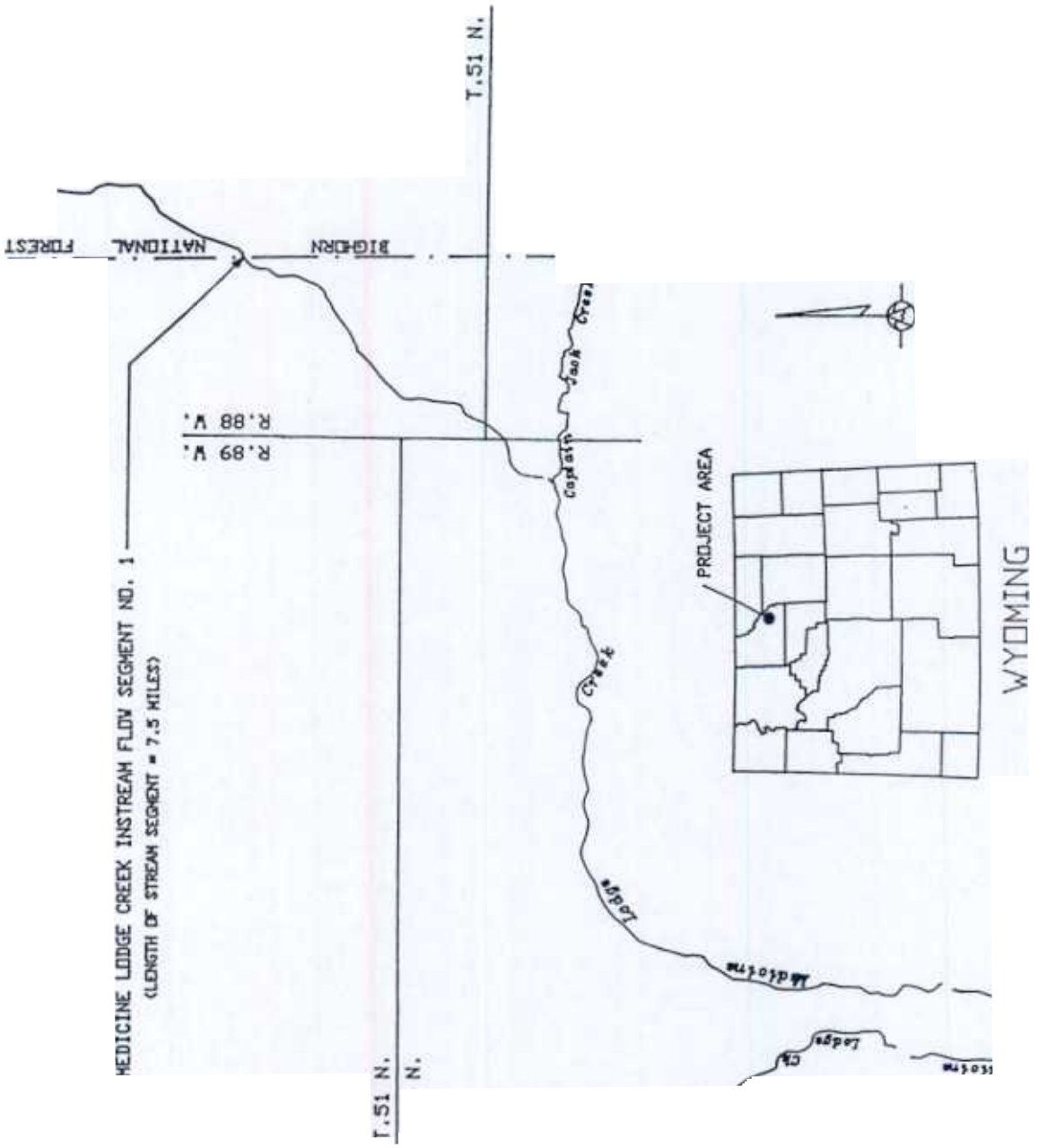
Study Area

Medicine Lodge Creek is considered a Class 2 trout stream by the Wyoming Game and Fish Department (WGFD). Trout stream classifications throughout Wyoming range from Class 1 (highest rating) to Class 5 (lowest rating). Class 2 trout streams are generally considered important trout fisheries on a statewide basis. Less than 6% of all streams in the state are Class 2 or better streams.

Medicine Lodge Creek contains a naturally reproducing population of brown trout and is managed as a wild fishery for that species. A small section of the stream at the Medicine Lodge State Park is stocked with catchable rainbow trout by the WGFD. However, these fish do not overwinter nor do they reproduce in Medicine Lodge Creek. The segment of Medicine Lodge Creek identified as the instream flow reach passes through land owned by the WGFD and federally owned lands administered by the Bureau of Land Management; it is highly accessible to the public. Because this section of Medicine Lodge Creek supports an important trout fishery and has public access, this segment was identified as a critical reach.

Data Collection

All of the field data used in this study were collected from a 309 foot long study site located on land owned by the WGFD in the SW 1/4 of Section 15, Township 50 North, Range 89 West. This site is located approximately 6 miles Northeast of the town of Hyattville (Figure 1). The study 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



Location of Instream ; reach on Medicine Lodge Creek

a portion of the stream extending from the north boundary of the south 1/2 of the southeast 1/4 Section 21, Township 50 North, Range 89 West upstream to the Bureau of Land Management-U.S Forest Service boundary in the southeast 1/4 of the southwest 1/4 Section 28, Township 51 North, Range 88 West. This is a distance of approximately 7.5 stream miles.

In accordance with the 1986 instream flow legislation, the goal of this study was to determine instream flows necessary to maintain or improve the existing trout fishery. The specific objectives of this study were to determine instream flows necessary to 1) maintain or improve hydraulic characteristics year-round that are important for survival of trout, fish passage and aquatic insect production, 2) maintain or improve physical habitat for brown trout spawning during the fall, and 3) maintain or improve adult trout production during the late summer months. Three habitat models were used to make these determinations.

Models

A Habitat Retention method (Nehring 1979; Annear and Conder 1984) was used to identify a maintenance flow. A maintenance flow is defined as the lowest continuous flow that will maintain minimum hydraulic criteria at riffle areas in a stream segment. These criteria are important at all times of year to maintain passage between different habitat types for all life stages of trout. These criteria are also important for maintaining survival rates of fish and aquatic macroinvertebrates during the winter that approximate rates observed under natural stream flow conditions.

Data from single transects placed across three riffles within the study area were analyzed with the IFG-1 computer program (Milhous 1978). Flow data were collected at three different flow levels (Table 1). Based on comparison of instream flow methods on Wyoming streams by Annear and Conder (1984), the maintenance flow is specifically defined as the discharge at which two of the three criteria in Table 2 are met for all riffles in the study area. Maintenance flows apply to all times of the year except when higher stream flows are required to meet other fishery management objectives.

Table 1. Dates and discharges when instream flow data were collected at Medicine Lodge Creek instream flow segment.

DATE	DISCHARGE (cfs)
June 7, 1989	110
June 30, 1989	53
August 17, 1989	

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 quantify incremental changes in the amount of physical habitat available for brown trout spawning at various discharge rates. This model is generally considered to reflect state-of-the-art technology for evaluating fisheries physical habitat changes with changes in stream flows and is the most commonly used instream flow model in North America (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 at seven transects as described in Bovee and Milhous (1978). Dates and

discharge rates when data were collected are given in Table 1. The WUA for brown trout spawning was simulated for flows ranging from 10 to 250 cubic feet per second (cfs) using calibration and modeling techniques outlined in Milhous (1984) and Milhous et al. (1984).

Because this brown trout fishery depends upon natural reproduction for continuation, it is important to maintain physical habitat for spawning that begins in October and continues into late fall. Maintenance of suitable physical habitat for this life stage is a critical part of ensuring adequate recruitment to this fishery. Results from the PHABSIM analysis were used to identify a flow from October 1 to March 31 which would maintain or improve physical habitat for brown trout spawning.

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

CATEGORY	CRITERIA
Average Depth (feet)	(Top Width[1]) X (0.01)
Average Velocity (feet per second)	1.00
Wetted Perimeter (percent of bank full)	

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

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 standing crops over a range of average late summer flow conditions. 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 HU gains or losses associated with projects that modify instream flow regimes. This model incorporates seven attributes that address chemical, physical and biological components of trout habitat. Results are expressed in habitat units (HU). One HU is defined as the amount of habitat quality which will support 1 pound of trout. Analyses obtained from this method apply to the time of year that governs trout production. On Medicine Lodge Creek this time period is between July 1 and September 30.

By measuring habitat attributes at various flow events as if associated habitat features were typical of average late summer flow conditions, HU estimates can be made for a range of theoretical summer flows (Conder and Annear 1987). Habitat attributes on Medicine Lodge Creek were measured on the same dates and flow levels that data were collected for the PHABSIM and Habitat Retention models (Table 1). To better define the relationship of discharge and trout production, some attributes were derived mathematically or obtained from existing gage data for flows in addition to those shown in Table 1. Other data were obtained from a U.S. Geological Survey gage located on Medicine Lodge Creek for the period 1942 to 1973 (with some missing years).

RESULTS/DISCUSSION

Results from the Habitat Retention model showed that the hydraulic criteria in Table 2 are met at flows of 8.9, 7.4, and 7.6 cfs for 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 which in this case is 8.9 cfs.

Table 3. Simulated hydraulic criteria for three riffles on Medicine Lodge Creek. Estimated average daily flow = 34 cfs. Bank full discharge = 220 cfs.

RIFFLE 1

Average Depth (feet)	Average Velocity (feet/second)	Wetted Perimeter (percent)	Discharge (cfs)
0.94	5.2	44.5	220
0.86	4.4	44.2	164
			87
	[1]	27.1	8.9[2]
		22.2[1]	4

RIFFLE 2

Average Depth (feet)	Average Velocity (feet/second)	Wetted Perimeter (percent)	Discharge (cfs)
1.33	5.8	30.7	220
1.27	5.5	30.5	196
		27.1	
1.08	3.5		
0.90	2.5		
0.91	2.3	15.4[1]	
0.93	1.5	10.4	12
0.83	1.0[1]	8.7	7.4[2]
0.15[1]	0.0	2.3	0

RIFFLE 3

Average Depth (feet)	Average Velocity (feet/second)	Wetted Perimeter (percent)	Discharge (cfs)
1.06	5.9	34.8	220
1.03	5.4	34.7	189
0.93			
0.84			
0.74			
0.56			
0.45			20
0.38			13
0.33[1]	0.8	29.6	7.6[2]
0.10	0.2		

1 - Minimum hydraulic criteria met

2 - Discharge at which 2 of 3 hydraulic criteria are met

The maintenance flow is defined as a continuous flow that will maintain minimum hydraulic criteria in riffle areas within a stream segment. These criteria are important at all times of year to maintain passage between different habitat types for all life stages of trout. These criteria are also important for maintaining survival rates of fish and aquatic macroinvertebrates during the winter that approximate rates observed under natural stream flow conditions.

Low flow conditions during winter months (October through March) naturally limit the survival and growth of many trout populations (Cunkak 1996). The extent of these impacts is dependent upon several factors including but not limited to snow fall, cold intensity and the duration of intense cold periods. These factors vary from year to year and affect fish populations depending on the amount of frazile ice and anchor ice formation (which can plug the gills of fish), the extent of snow bank collapse (and stream damming) and increased metabolic demands on fish (and increased stress).

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.

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. Therefore protection of natural winter stream flows up to the recommended maintenance flow for each stream segment is necessary to maintain existing survival rates of trout populations.

It is possible that the discharge of 8.9 cfs identified by the Habitat Retention method may not be present at times during the winter. Because the existing fishery is adapted to natural flow patterns, occasional periods of shortfall during the winter do not necessarily imply the need for storage. Instead, they illustrate the need to maintain all natural winter streamflows, up to 8.9 cfs, in order to maintain existing survival rates of trout populations.

Gage data indicate that existing mean daily flows during October and November approximate 15 cfs. The majority of the brown trout spawning occurs during this time. At a discharge of 15 cfs, PHABSIM analyses indicate that physical habitat for brown trout spawning is just over 60% of the maximum amount available, which occurs at a discharge of 30 cfs (Figure 2). Reductions in flows below 15 cfs would result in reductions in existing levels of WUA for brown trout spawning. Increases in discharge up to about 80 cfs would result in increases in WUA for brown trout spawning from existing conditions; however, WUA is reduced below existing levels at flows higher than 80 cfs.

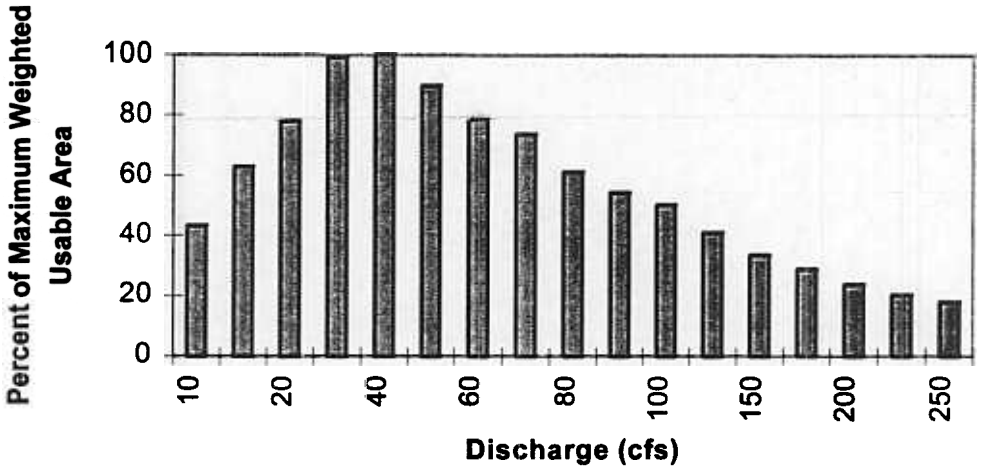


Figure 2 Percent of maximum weighted usable area for spawning life stage of brown trout.

Mean daily flows during the remainder of the winter (December through March) are reduced from flow levels in October and November and are fairly stable throughout that time period. During this time, some late brown trout spawning occurs, as well as the incubation of eggs deposited in October and November. Although flows less than 10 cfs were not simulated for this analysis, it appears that the maintenance flow recommendation of 8.9 cfs would provide about 40% of the maximum amount of WUA available at 40 cfs. Reductions in flow below 8.9 cfs would probably further reduce WUA.

Based on this analysis, an instream flow of 15 cfs is the minimum discharge which will maintain or improve the existing amount of physical habitat for brown trout spawning during October and November. Similarly, 8.9 cfs is the minimum discharge which will maintain or improve the existing amount of physical habitat for brown trout spawning during the remainder of the winter (December through March) while meeting the hydraulic criteria necessary for maintaining trout survival and passage at existing levels.

Results from the HQI analyses (Figure 3) indicate that under existing average late summer conditions (about 10 cfs), the stream presently supports about 109 HU's. The current fishery management objective is to maintain or improve the existing number of HU's. Although the existing number of habitat units would be maintained at this level at lower flows, the Habitat Retention method indicates that 8.9 cfs is the lowest flow that will maintain important channel characteristics. As a consequence a discharge of 8.9 cfs is the minimum flow that will accomplish the dual objectives of maintaining both trout habitat units and channel characteristics.

Supplemental late summer flows of 20 cfs would increase the number of trout HU's in the segment. Increases in stream flow above 30 cfs would reduce trout HU's over present conditions.

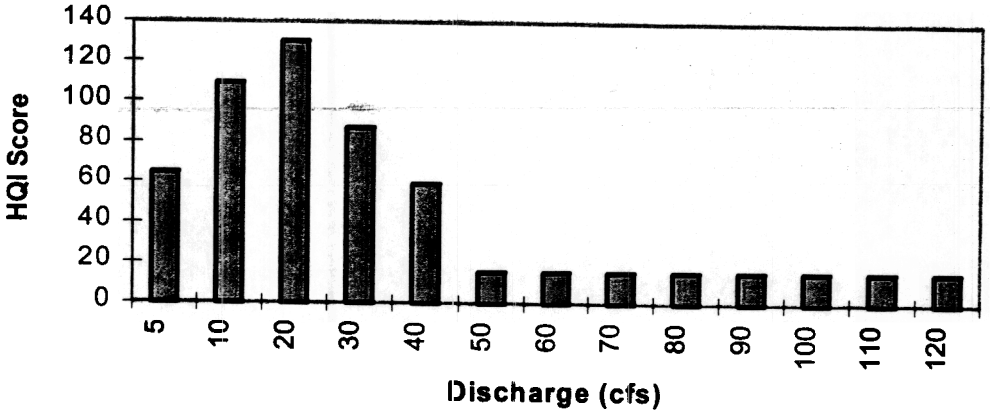


Figure 3. Potential trout habitat units at several average late summer flow levels in Medicine Lodge Creek instream flow segment.

Based on the results from the HQI analysis, a late summer flow of 8.9 cfs will maintain existing levels of trout production between July 1 and September 30 and will meet or exceed the hydraulic criteria addressed by the Habitat Retention Method.

CONCLUSION

Based on the analyses and results contained in this report, the instream flow recommendations (Table 4) apply to a 7.5 mile segment of Medicine Lodge Creek extending from the north boundary of the south 1/2 of the southeast 1/4 Section 21, Township 50 North, Range 89 West upstream to the Bureau of Land Management-U.S. Forest Service boundary in the southwest 1/4 Section 28, Township 51 North, Range 88 West.

Table 4. Summary of instream flow recommendations to maintain the existing trout fishery in Medicine Lodge Creek.

Time Period	Instream Flow Recommendation (cfs)
October 1 to November 30	15
December 1 to June 30	8.9
July 1 to September 30	8.9

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