WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

ADMINISTRATIVE REPORT

TITLE: Laramie River Instream Flow Report

PROJECT: IF-5089-07-8902

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DATE: June 1989

INTRODUCTION

Data were collected during the 1981 field season to conduct instream flow analyses for a segment of the Laramie River located near the town of Woods Landing, 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

The Laramie River is considered a Class 2 stream by the Wyoming Game and Fish Department (WGFD). Stream classifications throughout Wyoming range from Class 1 (highest rating) to Class 5 (lowest rating). Class 2 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.

The Laramie River contains a naturally reproducing population of brown trout and a small population of rainbow trout. The stream is currently managed as a wild fishery for brown trout, and future emphasis will include management of wild rainbow trout. This stream segment is not currently stocked by the WGFD. The segment of the Laramie River identified as the instream flow reach passes through land owned by the WGFD and private land on which the WGFD has secured access for public fishing and is highly accessible to the public. Because this section of the Laramie River 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 393 foot long study site located within a WGFD public fishing area in the northeast quarter of Section 15, Township 13 North, Range 77 West. This site is located approximately 1.5

miles upstream from the town of Woods Landing (Figure 1). 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 the east boundary of the S 1/2 NE 1/4 SE 1/4 of Section 10, T13N, R77W upstream to the south boundary of W 1/2 NW 1/4 of Section 26, T13N, R77W. This is a distance of approximately 3.9 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 physical habitat for rainbow trout spawning during the spring, 2) maintain or improve physical habitat for brown trout spawning during the fall, 3) maintain or improve hydraulic characteristics in the winter that are important for survival of trout, fish passage and aquatic insect production and, 4) maintain or improve adult trout production during the late summer months. Three habitat models were used to make these determinations.

Models

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 rainbow and brown 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 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 rainbow and brown trout was simulated for flows ranging from 10 to 400 cubic feet per second (cfs) using calibration and modeling techniques outlined in Milhous et al. (1984).

Table 1. Dates and discharges when instream flow data were collected at the Laramie River instream flow segment.

Date	Discharge (cfs)
04-13-81	52
04-30-81	194
05-13-81	103

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

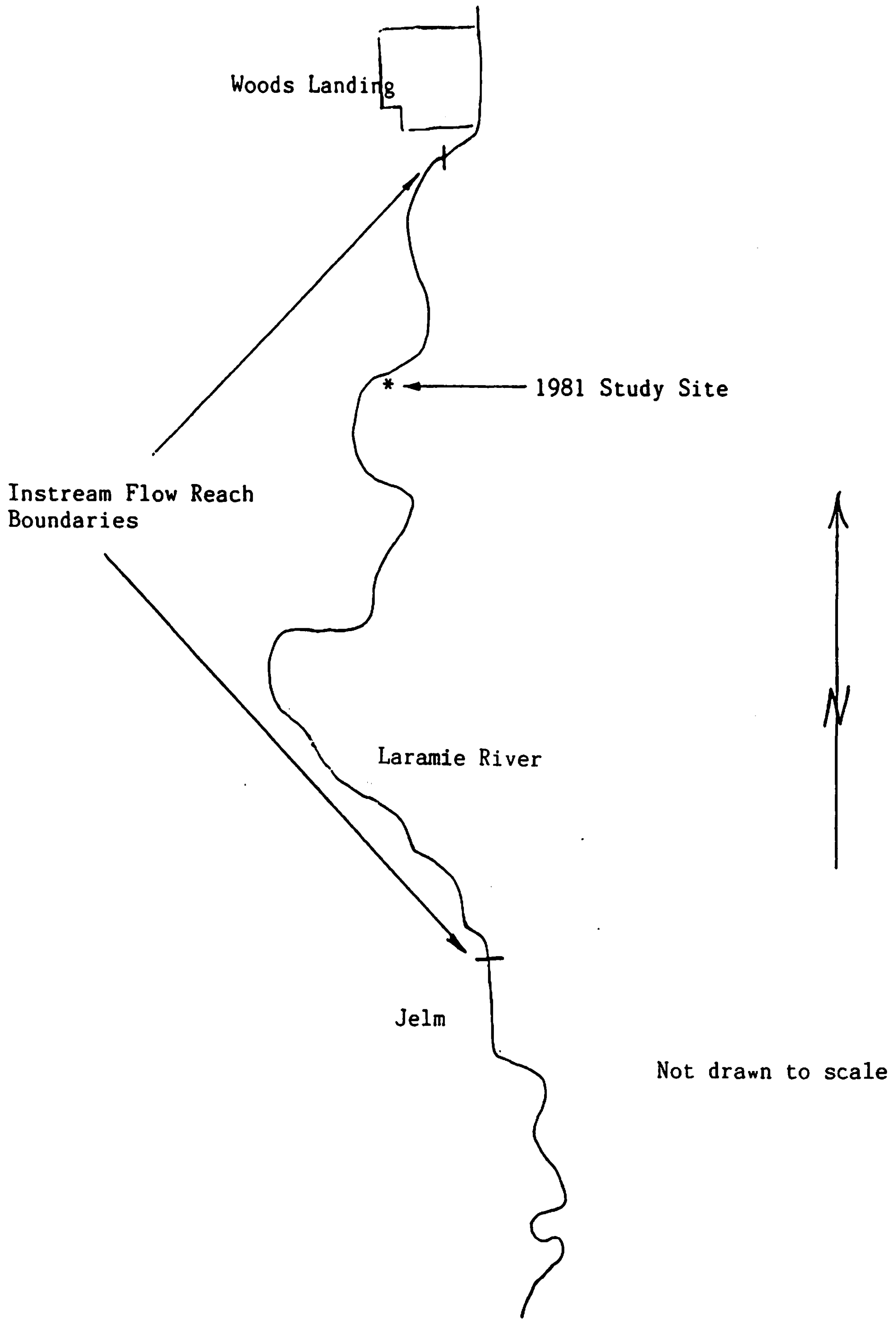

Figure 1. Location of the 1981 study site and the Instream Flow reach on the Laramie River near Woods Landing, Wyoming.

collected at three different flow levels (Table 1). The maintenance flow is identified as the discharge at which two of the three criteria in Table 2 are met for all riffles in the study area.

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/sec)	1.00
Wetted Perimeter (percent)[2]	60

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 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 the Laramie River 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. Habitat attributes on the Laramie River 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 the Laramie River immediately upstream from the Pioneer Canal for the period 1912 to 1987 (with some missing years) for determining the annual stream flow variation and critical period stream flow at the study site.

Instream flow recommendations derived from the Habitat Retention method are applicable to all times of year except when higher instream flows are required to meet other fishery management purposes.

Rainbow trout begin spawning in early April and their eggs incubate through June. Results from the PHABSIM analysis were used to identify the flows needed to maintain or improve physical habitat for the rainbow trout spawning from April 1 to June 30. Brown trout spawning begins in early October and continues into late fall. Their eggs incubate in the gravel until late March. Results from the PHABSIM analysis were also used to identify a flow from October 1 to March 31 which would maintain or improve physical habitat for brown trout spawning.

Results from the HQI model were used to identify the average flow needed to maintain or improve existing levels of trout production between July 1 and September 30.

RESULTS

Results from the Habitat Retention model showed that the hydraulic criteria in Table 2 are met at flows of 50, 37, and 35 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 50 cfs.

Table 3. Simulated hydraulic criteria for three riffles on the Laramie River. Estimated average daily flow = 177 cfs. Bank full discharge = 1145 cfs.

Riffle 1

Average Depth (ft)	Average Velocity (ft/sec)	Wetted Perimeter (ft)	Discharge (cfs)
2.23	5.6	92.5	1145
1.95	4.1	88.1	688
1.50	2.6	85.4	330
1.19	1.8	81.7	177
0.95	1.3	77.9	97
0.83	1.0[1]	68.8	57
0.81[1]	0.9	66.6	50[2]
0.70	0.6	55.5[1]	25
0.54	0.4	49.4	11
0.34	0.2	43.1	4

Riffle 2

Average Depth (ft)	Average Velocity (ft/sec)	Wetted Perimeter (ft)	Discharge (cfs)
2.26	5.9	81.6	1145
1.93	4.3	79.0	642
1.18	2.1	73.4	177
1.05	1.8	72.5	133
0.86	1.4	71.2	88
0.72[1]	1.2	69.6	60
0.60	1.1	67.3	42
0.57	1.0[1]	65.8	37[2]
0.35	0.7	49.0[1]	12
0.23	0.5	24.2	3

Riffle 3

2.61	5.2	85.6	1145
2.29	3.7	82.6	689
1.84	2.4	80.4	343
1.46	1.5	79.1	177
1.27	1.2	78.5	118
1.13	1.0[1]	78.0	89
0.98	0.8	77.5	59
0.78[1]	0.6	76.0	35[2]
0.55	0.3	69.5	13
0.19	0.1	51.4[1]	2

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

Results of the PHABSIM analysis indicate that physical habitat is maximized at 125 cfs (Figure 2). Under existing flow conditions during the month of April (average daily flow of 130 cfs), physical habitat for rainbow trout spawning is near the maximum amount available. This amount of physical habitat is also provided by stream flows of 100 cfs; however, increasingly rapid reductions in existing physical habitat for spawning occur at flows lower than 100 cfs. Though more gradual, similar reductions in physical habitat also occur at flows exceeding 130 cfs.

Gage data indicate that existing streamflows in the Laramie River often exceed 500 cfs during the months of May and June. Since the PHABSIM analysis was limited to simulations of flows up to 400 cfs, physical habitat at flows in excess of 500 could not be precisely determined. However, it appears that flows higher than 400 cfs will provide less physical habitat than is available at 100 cfs. Therefore, an instream flow of 100 cfs will improve physical habitat for rainbow trout spawning during the months of May and June. This is consistent with the objectives established in the Instream Flow Legislation.

Based on this analysis, an instream flow of 100 cfs is the minimum discharge which will maintain or improve the existing amount of physical habitat for rainbow trout spawning during the spring. Therefore, an instream flow of 100 cfs is recommended for the period April 1 to June 30.

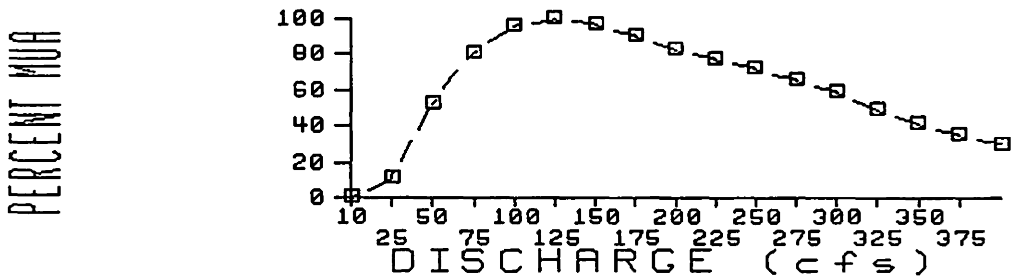

Figure 2. Percent of maximum usable area (MUA) for spawning life stage of rainbow trout.

Gage data indicate that existing mean daily flows during the fall and winter (October 1 - March 31) are approximately 50 cfs. At this discharge, PHABSIM analyses indicate that physical habitat for brown trout spawning is approximately 63% of the maximum amount available, which occurs at a discharge of 150 cfs (Figure 3). Large reductions in existing physical habitat for brown trout spawning occur at discharges below 50 cfs. The fishery maintenance flow identified by the Habitat Retention Method (50 cfs) will maintain the existing amount of physical habitat for brown trout spawning during the fall and winter, as well as meet minimum hydraulic criteria for fish passage and survival.

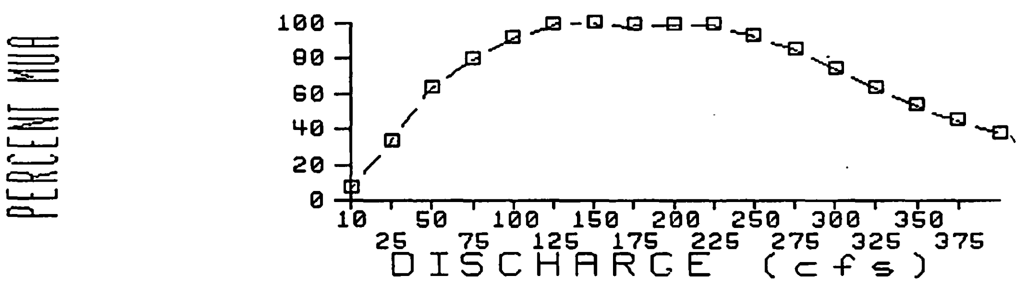

Figure 3. Percent of maximum usable area (MUA) for spawning life stage of brown trout.

Results from the HQI analyses (Figure 4) indicate that under existing average late summer conditions (approximately 75 cfs), the stream presently supports approximately 36 HUs. The current fishery management objective is to maintain or improve the existing number of HUs. A discharge of 50 cfs is the minimum flow that will accomplish this objective. At average late summer flows below 50 cfs, the model indicates that reductions in the present fishery would occur. These reductions would largely be the result of lower critical period flow and lower water velocities. Increases in stream flow above 75 cfs would increase trout HUs over present conditions.

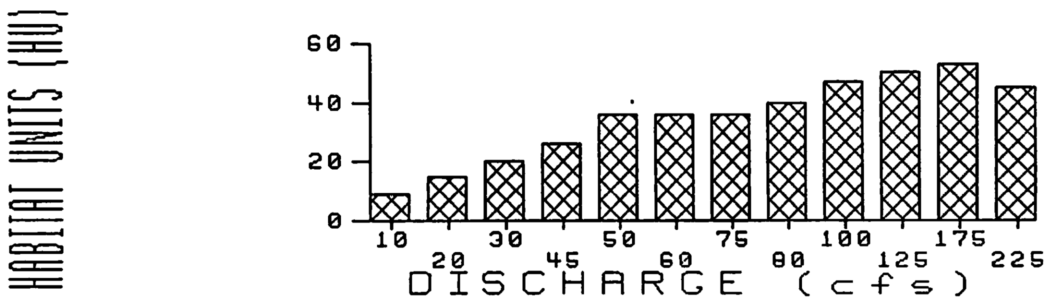

Figure 4. Number of potential trout habitat units at several average late summer flow levels in the Laramie River instream flow segment.

Based on the results from the HQI analysis, the fishery maintenance flow of 50 cfs will maintain existing levels of trout production between July 1 and September 30. In addition, this discharge will maintain minimum hydraulic criteria that allow fish passage between different habitat types and provide adequate substrate for production of aquatic insects.

CONCLUSIONS

Based on the analyses and results contained in this report, the instream flow recommendations (Table 4) apply to a 3.9 mile segment of the Laramie River extending from the east boundary of the S 1/2 NE 1/4 SE 1/4 of Section 10, T13N, R77W upstream to the south boundary of W 1/2 NW 1/4 of Section 26, T13N, R77W.

Table 4. Summary of instream flow recommendations to maintain the existing trout fishery in the Laramie River.

Time Period	Instream Flow Recommendation (cfs)
April 1 to June 30	100[1]
July 1 to September 30	50[2]
October 1 to March 31	50

1 - Feasibility determined by availability at the 50% exceedence level during the specified time period
2 - To maintain existing natural stream flows

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