WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

ADMINISTRATIVE REPORT

TITLE: Encampment River Instream Flow Report

PROJECT: IF-5088-07-8801

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INTRODUCTION

Data were collected during the 1981 field season to conduct instream flow analyses for a segment of the Encampment River located approximately 2 miles upstream from the Town of Encampment, Wyoming. The study was 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 stream flow modifications to the stream fishery.

METHODS

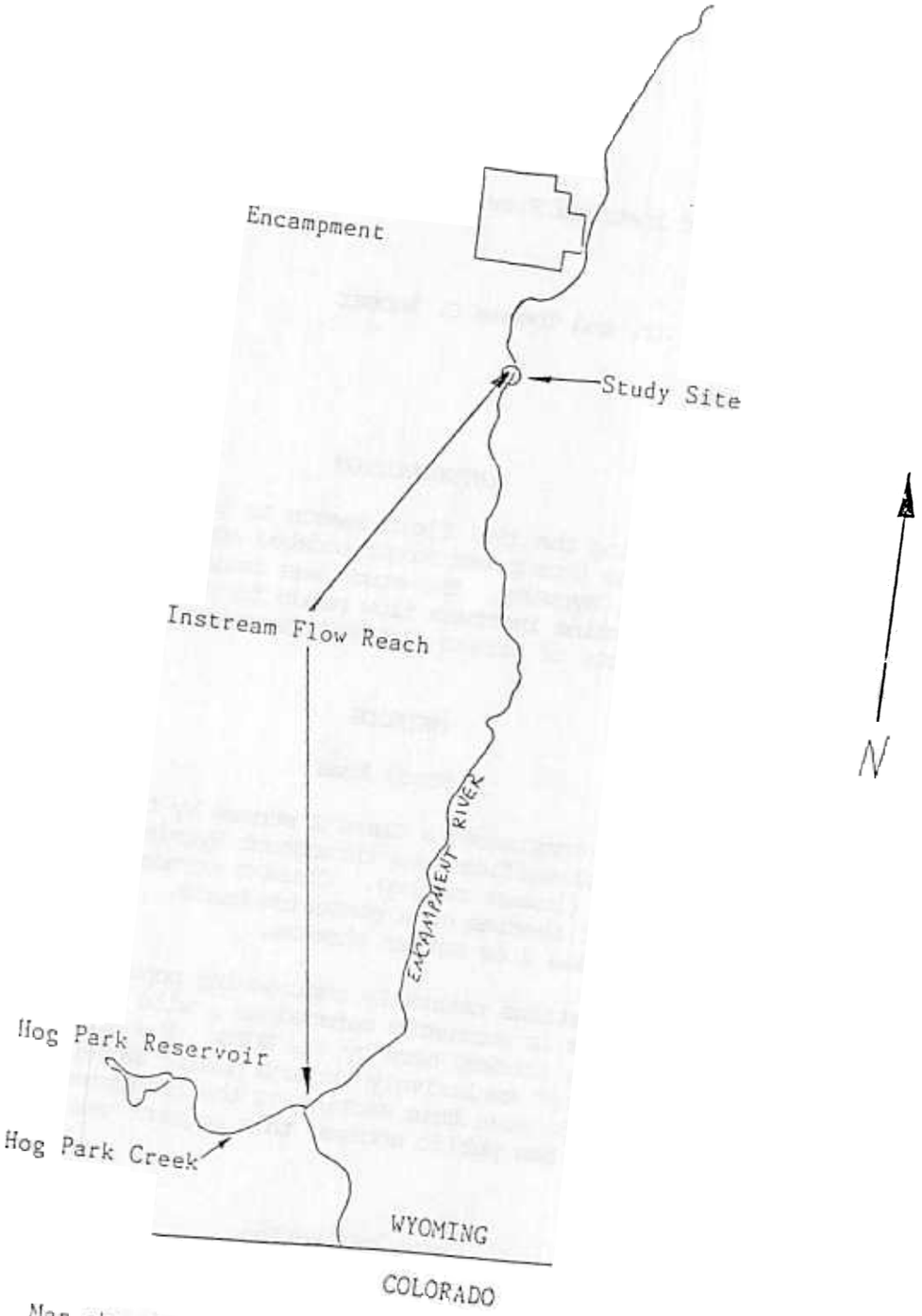
Study Area

The Encampment 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 Encampment River contains naturally reproducing populations of rainbow, brown and brook trout. The stream is currently managed as a wild fishery for rainbow trout; therefore no fish are stocked here by the WGFD. The study segment of the Encampment River passes almost exclusively through public lands making it generally accessible to the public. Because this section of the Encampment 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 339 foot long study site located on Bureau of Land Management property in the southwest quarter of S13, T14N, R84W. This site is located approximately 2 miles upstream from the town of Encampment (Figure 1). This site contained a combination of pool and riffle habitat for trout that was representative of trout habitat features found throughout



igure Map showing location of 1981 study te the Encampment near Encampment

this portion of the stream. Results and recommendations were applied to a portion of the stream extending from the north boundary of the NW 1/4, NW 1/4 of S13, T14N, R84W upstream to the mouth of Hog Park Creek in the NE 1/4, NW 1/4, S10, T12N, R84W.

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 in the above segment of Encampment River. 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 hydraulic characteristics in the winter that are important for survival of trout, fish passage and aquatic insect production, and 3) 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 trout spawning and incubation 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 six 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 trout was simulated for flows ranging from 10 to 500 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

Date	Discharge (cfs)
04-15-81	115
05-14-81	210
08-26-81	44

A 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 that is needed to 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 four 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). 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 per 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 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 Encampment 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 late summer flow conditions, HU estimates can be made for a range of theoretical summer flows. Habitat attributes on the Encampment 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 potential impact of other late summer flow levels on trout production, some attributes were derived mathematically or obtained from existing gage data. Gage data were obtained from a U.S. Geological Survey gage located on the Encampment River upstream from the mouth of Hog Park Creek for the period 1965 to 1986. A regression equation was developed to relate the discharges at the USGS gage with discharges measured at the study site. This equation was used to determine the annual stream flow variation and critical period stream flow, two variables of the HQI, at the study site.

Results from the PHABSIM analysis were used to identify the flows needed to maintain or improve physical habitat for the rainbow trout spawning and incubation period. This period extends from April 1 to June 30.

Results from the Habitat Retention model were used to identify a flow from October 1 to March 31 which would maintain trout survival and passage and aquatic insect survival.

Results from the HQI model were used to identify the flow needed to maintain 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 54.1, 48.8, 22.6 and 25.0 cfs for riffles 1, 2, 3 and 4, 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 54.1 cfs. Maintenance of this flow at all times of

year except when higher flows are needed for other fishery purposes will maintain this stream fishery.

Table 3. Simulated hydraulic criteria for four riffles on the Encampment River. Average daily flow = 246 cfs. Bank full discharge = 1592 cfs.

Riffle 1

Average Depth (ft)	Average Velocity (ft/sec)	Wetted Perimeter (ft)	Discharge (cfs)
2.25	6.2	110.0	1591.6
1.28	2.5	92.6	246.0
1.20	2.3	91.8	198.8
1.00	2.1	91.2	162.5
0.85	1.8	90.0	112.6
0.76[1]	1.7	87.1	93.1
0.71	1.6	89.1	82.9
0.64	1.5	78.1	66.4
0.63	1.4	65.8[1]	54.1[2]
0.53	1.0[1]	41.8	22.1

Riffle 2

1.90	6.9	85.1	1591.6
1.40	4.4	68.7	401.6
1.10	3.5	66.0	246.0
1.00	3.3	64.9	204.4
0.70	2.6	59.8	113.8
0.64[1]	2.4	58.0	91.7
0.60	2.2	56.7	70.2
0.46	2.0	51.1[1]	48.8[2]
0.30	1.7	39.8	21.7
0.03	1.0[1]	0.0	0.0

Riffle 3

2.60	5.5	82.3	1591.6
1.90	2.6	73.7	363.9
1.70	2.1	71.1	246.0
1.60	1.9	69.9	200.2
1.30	1.3	64.8	108.3
1.00	1.0[1]	62.2	66.1
0.90	0.8	60.7	43.5
0.80	0.6	58.6	30.7
0.71[1]	0.5	55.3	22.6[2]
0.56	0.4	49.4[1]	11.0

Riffle 4

2.10	9.2	88.7	1591.6
1.30	4.0	72.1	375.0
1.10	3.1	69.4	246.0
1.00	2.4	67.8	157.1
0.90	2.1	67.3	124.5
0.70	1.8	66.3	85.0
0.68[1]	1.7	66.1	74.4
0.60	1.4	64.4	48.9
0.45	0.9	53.2[1]	25.0[2]
0.40	1.0[1]	58.6	23.4

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

Results of the PHABSIM analysis indicate that under existing flow conditions during the month of April (average daily flow of approximately 52 cfs), physical habitat for rainbow trout spawning is approximately 10% of the maximum amount available, which occurs at a discharge of 400 cfs (Figure 2). Further reductions in physical habitat for spawning occur at flows lower than 52 cfs. Flows greater than 100 cfs result in substantial increases in physical habitat for spawning.

Physical habitat for rainbow trout incubation is maximized at a discharge of 250 cfs. This analysis indicates that at flows between 30 and 200 cfs, physical habitat for incubation is only slightly reduced; however, at flows less than 30 cfs and greater than 300 cfs, physical habitat is greatly reduced. Since gage records indicate that existing flows during May and June often exceed 500 cfs, any fairly stable flow between 30 and 450 cfs will maintain or improve the existing physical habitat for rainbow trout incubation. However, flows less than 52 cfs will reduce the existing amount of physical habitat for trout that may still be spawning during May and June.

Although PHABSIM results indicate that an instream flow of 52 cfs will maintain or improve physical habitat for rainbow trout spawning and incubation between April 1 and June 30, this flow is below the fishery maintenance flow (54 cfs). To meet the dual objective of maintaining or improving existing physical habitat for rainbow trout spawning and incubation, and maintenance flow criteria, a flow of 54 cfs is recommended for the period April 1 to June 30.

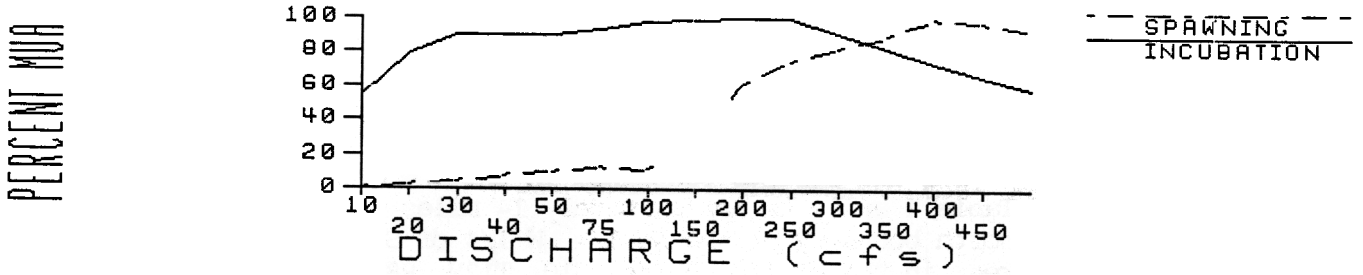


Figure 2. Percent of maximum usable area (MUA) for spawning and incubation life stages of rainbow trout.

Results from the HQI analyses (Figure 3) indicate that under existing late summer conditions, the stream presently supports approximately 46 HUs. According to the model, 46 HUs would be realized at a late summer flow of 60 cfs. The current fishery management objective is to maintain or improve the existing number of HUs, and a discharge of 53 cfs is the minimum flow that will accomplish this objective. At late summer flows below 53 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 increased annual stream flow variation. Increases in stream flow from 60 cfs to 210 cfs would increase trout HUs over present conditions. The model indicates that flows above 210 cfs would result in large reductions in trout HUs, as would reductions in discharge below 53 cfs (Figure 3).

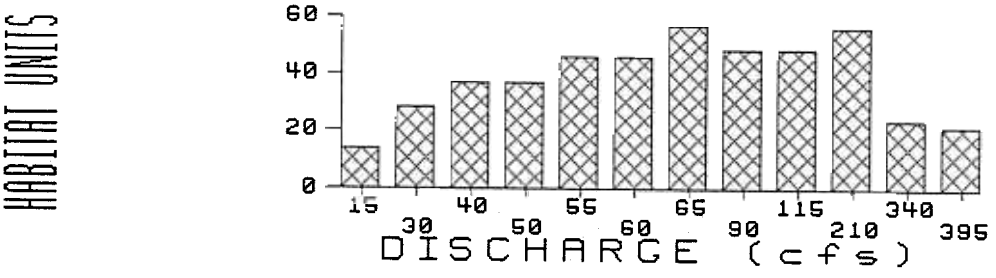


Figure 3. Number of potential trout habitat units at several late summer flow levels in the Encampment River.

Based on the results from the HQI analysis, the fishery maintenance flow of 54 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.

CONCLUSIONS

Based on the analyses and results contained in this report, the instream flow recommendations in Table 4 apply to approximately 14 miles of the Encampment River extending from the north boundary of the NW 1/4 NW 1/4 of S13, T14N, R84W to the mouth of Hog Park Creek in the NE 1/4, NW1/4, S10, T12N, R84W.

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

Time Period	Instream Flow Recommendation (cfs)
April 1 to June 30	54
July 1 to September 30	54[1]
October 1 to March 31	54

1 - Feasibility determined by availability at the 50% exceedence level during the specified time period

LITERATURE CITED

Bovee, K. and R. Milhous. 1978. Hydraulic simulation in instream flow studies: theory and technique. Instream Flow Information Paper 5, FWS/OBS-78/33, Cooperative Instream Flow Service Group, U.S. Fish and Wildlife Service. Fort Collins, Colorado.

Binns, N. and F. Eiserman. 1979. Quantification of fluvial trout habitat in Wyoming. Transactions of the American Fisheries Society 108:215-228.

Milhous, R.T., D.L. Wegner, and T. Waddle. 1984. User's guide to the Physical Habitat Simulation System. Instream Flow Paper 11, FWS/OBS-81/43, U.S. Fish and Wildlife Service, Fort Collins, Colorado.

Milhous, R.T. 1984. PHABSIM technical notes. Unpublished. U.S. Fish and Wildlife Service, Fort Collins, Colorado.

Milhous, R.T. 1978. A computer program for the determination of average hydraulic and shape parameters of a stream cross section. Washington State Dept of Ecology, Olympia.

Nehring, R. 1979. Evaluation of instream flow methods and determination of water quantity needs for streams in the state of Colorado. Colorado Division of Wildlife, Fort Collins.

APPENDIX A

Documentation of Model Calibration and Selection

The original IFG-4 data deck containing the 3 measured discharges (Table A-1) was modified into data decks for calibrating with the one-flow IFG-4, and WSP hydraulic models. An additional three-flow IFG-4 data deck with 7 discharges was also created. The latter three data decks are shown in Tables A-2 - A-4.

There were no differences in the predicted water surface elevations produced by the three- and one-flow IFG-4 methods (Table A-5), since these models both use the same stage-discharge relationship. The water surface elevations predicted by the WSP model were very similar to those predicted by the IFG-4 model, except for transect 5. I had a little trouble calibrating the WSP model for this transect, probably because transect 5 was a hydraulic control.

Examination of the velocity adjustment factors (Table A-6) and velocity prediction errors (Table A-7) indicated that the predictions of cell velocities by the three-flow method were good, even though the velocity prediction errors produced by this method were in the "marginal" category. All but one of the velocity adjustment factors from this run were in the "good" category. The VAF plot for the one-flow IFG-4 model indicates that this model also adequately predicts cell velocities, and that the model starts to break down at discharges greater than about 500 cfs, as indicated by the spread of points on the plot (Figure A-1). Figure A-2 shows that the WSP model also does a good job of simulating velocities over the same range of flows.

I selected the three-flow IFG-4 method for the production run, since it did a good job of predicting water surface elevations and velocities, and since I had some trouble calibrating the WSP model. The production data deck is shown in Table A-8. Since the VAF plot for the one-flow method indicated that this stage-discharge relationship broke down at around 500 cfs, I only simulated flows up to 500 cfs in the production run.

I ran the habitat simulation for brown, rainbow and cutthroat trout. For each species, I used the curves for the adult, juvenile, spawning, incubation, and fry life stages. For the final analysis, the incubation curve with slope = 0.004 was used, since this was the slope I calculated for the study reach. Nehring's fry curves for brown and rainbow trout were used in this analysis.