WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

ADMINISTRATIVE REPORT

TITLE: Instream Flow Report for the Green River, Segment 1

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## INTRODUCTION

Studies were conducted to obtain instream flow information from the Green River near Warren Bridge from May through October of 1987. The studies were designed to provide the basis for determining instream flow needs for maintaining or improving the existing fishery. The results of these studies are applicable to the section of the Green River extending from a point located 200 feet upstream from the Horsefly Ditch headgate (NW1/4, NW1/4, S9, T35N, R111W), to a point ending at the east section line of the NE1/4, NE1/4, S11, T36N, R111W. Public access is available throughout this river section which is 9.84 miles long.

This section of the Green River is designated by the Wyoming Game and Fish Department (WGF) as a Class 3 trout stream and is managed for rainbow trout. Brown trout and brook trout are also present. Class 3 waters are generally considered to be regionally important recreational resources. This section of the Green River is of exceptional value because it is highly accessible through public land and Game and Fish Department easements, and because as much as 62% of the angling effort is from non-resident anglers (Kurtz 1987). This fishery provides a significant contribution to the local economy through resident and non-resident anglers. For these reasons, this segment of the river is considered a critical stream segment.

The objectives of this study were to determine instream flows necessary to 1) maintain or improve physical habitat for rainbow trout juveniles 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.

## METHODS

The data for these studies were collected from a study site 638 feet long located about 1.5 miles upstream from Warren Bridge in the east half of S4, T35N, R111W. The trout habitat found within the study site is typical of that found throughout the candidate section of the Green River.

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 juvenile rainbow trout 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 eight transects after peak runoff in accordance with guidelines given by Bovee and Milhous (1978). Dates and discharge rates when data were collected are given in Table 1. Using calibration and modeling techniques outlined in Milhous (1984) and Milhous et al. (1984), the WUA for rainbow trout was simulated for flows ranging from 50 to 800 cubic feet per second (cfs).

Table 1. Dates and discharge rates when data were collected for PHABSIM, HQI and IFG-1 modeling on the Green River at Warren Bridge during 1987.

| Date | Discharge (cfs) |
|---|---|
| 07-01-87 | 775 |
| 08-01-87 | 605 |
| 09-13-87 | 260 |
| 10-22-87 | 128 |

The Habitat Quality Index (HQI) model developed by Binns and Eiserman (1979) was used to assess late summer habitat conditions for adult trout. Results of the HQI model are expressed as habitat units (HU), with one habitat unit 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 Wyoming trout streams, this period is from July 1 to September 30.

The data required for the HQI model were collected concurrently with PHABSIM data (Table 1). By collecting HQI data at several flows and analyzing those data as if they reflected late summer conditions, the number of habitat units available over a range of flows between 100 and 800 cfs was estimated. Results from the HQI model were used to identify the flow needed to maintain or improve existing levels of trout production between July 1 and September 30.

The Habitat Retention method (Nehring 1979, Annear and Conder 1983) 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. 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 the three criteria in Table 2 are met for all riffles in the study area.

Data were collected from two riffles on the dates and at the discharges shown in Table 1. Data were analyzed using the IFG-1 computer program (Milhous 1979). 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)[1] | Top width X 0.01 |
| Average Velocity (ft per sec) | 1.00 |
| Wetted Perimeter (percent)[2] | 70 |

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

## RESULTS AND DISCUSSION

Results of the PHABSIM analysis indicate that there is no usable area for rainbow trout spawning within the study site over the range of simulated flows (WUA = 0). This lack of spawning area reflects the absence of suitable substrate materials. Since usable area for spawning is generally lacking in this section of the Green River, no spawning or incubation flows are recommended.

Although usable area for spawning is absent from the study area, it is important to maintain physical habitat for the juvenile rainbow trout that recruit to the fishery from the river and tributaries upstream. The PHABSIM analysis shows that physical habitat for rainbow trout juveniles is maximized at 175 cfs (Figure 1). Increasingly rapid reductions in physical habitat for juveniles occur outside the range of flows from 75 to 200 cfs. In order to maximize habitat for juvenile rainbow trout during the period when this life stage is present in the river, a flow of 175 cfs is recommended. For this segment of the Green River, this period extends from April 1 through June 30.

Preliminary analyses indicate that, under existing conditions, this recommended flow is always exceeded. Maintaining the present flow regime will consequently maintain current levels of recruitment and survival of juvenile rainbow trout.

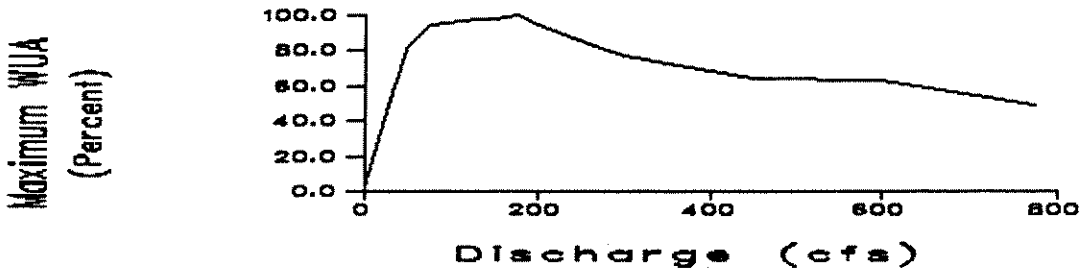


Figure 1. Percent of maximum weighted usable area (WUA) for juvenile rainbow trout at the Warren Bridge study site as a a function of discharge.

Under existing average late summer conditions, the candidate section of the Green River supports approximately 22 habitat units. Results of the HQI analyses (Figure 2) indicate that a flow of 350 cfs is the minimum amount needed to maintain this existing level of HU's.

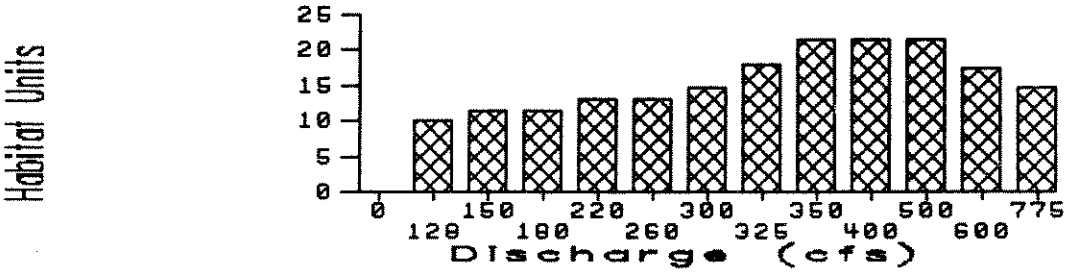


Figure 2. Adult trout habitat units (HU) at the Warren Bridge study site as a function of discharge.

Trout production in this section of the Green River is generally limited by the availability of adult habitat (Kurtz 1980). The management objective is to maintain the maximum amount of trout habitat units. Based on results from the HQI model, the minimum flow that will accomplish this objective during the late summer is 350 cfs. This flow is recommended for the period from July 1 to September 30.

Preliminary analyses indicate that a flow of 350 cfs is often exceeded from July through September. Depending on the extent to which the recommended flow is exceeded, the number of HU's may be reduced. This does not indicate a need for storage since the existing rainbow trout population is adapted to the current flow regime. Maintenance of the present flow regime (down to 350 cfs) will maintain the fishery at its present level of production.

Results from the Habitat Retention model (Table 3) show that flows of 95 and 101 cfs will maintain hydraulic criteria for aquatic insect production and fish passage at the two riffles in the study area. The flow which meets the hydraulic criteria for both riffles is 101 cfs.

Table 3. Results from IFG-1 modeling at the Warren Bridge study site during 1987.

| Discharge (cfs) | Average Depth (ft) | Average Velocity (ft/sec) | Wetted Perimeter |
|---|---|---|---|
| | | Riffle 1 | |
| 22 | 0.40 | 0.77 | 76.8 |
| 30 | 0.45 | 0.83 | 79.7 |
| 40 | 0.54 | 0.90 | 82.6 |
| 51 | 0.62 | 0.97[1] | 85.5 |
| 64 | 0.69 | 1.04[1] | 84.9 |
| 79[2] | 0.76 | 1.12 | 92.4[1] |
| 95[2] | 0.81 | 1.20 | 98.9[1] |
| 113 | 0.87 | 1.26 | 104.2 |
| 133 | 0.95[1] | 1.33 | 105.7 |
| 294 | 1.32[1] | 1.75 | 128.4 |
| | | Riffle 2 | |
| 7 | 0.16 | 0.67 | 58.7 |
| 16 | 0.33 | 0.70 | 70.0 |
| 23 | 0.37 | 0.75 | 83.1 |
| 31 | 0.44 | 0.80 | 88.9 |
| 41 | 0.52 | 0.86 | 92.4 |
| 53 | 0.61 | 0.93[1] | 94.4 |
| 67 | 0.70 | 1.00[1] | 96.4 |
| 83[2] | 0.78 | 1.08 | 98.4[1] |
| 101[2] | 0.86 | 1.16 | 100.4[1] |
| 137 | 0.99[1] | 1.31 | 104.7 |
| 280 | 1.31[1] | 1.73 | 118.8 |

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

Natural winter mortality 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 this section of the Green River. Mortality approached 90% during some years of this study. 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. The fishery management objective for the time period from October 1 to March 31 is subsequently to protect all available natural stream flows in the instream flow segment up to the identified instream flow recommendation.

The discharge of 101 cfs identified by the Habitat Retention method will maintain hydraulic criteria for fish passage and aquatic insect survival. It will also maintain the existing survival rates of trout populations. A flow of 101 cfs is consequently recommended from October 1 to March 31 for this section of the Green River.

Preliminary analyses indicate that this recommended winter instream flow is occasionally unavailable in the portion of the Green River addressed by these studies. This does not indicate a need for storage to provide the recommended flow but instead shows that the entire available natural flow (up to 101 cfs) is needed through the winter to maintain trout survival at its present level.

## SUMMARY

Based on the results of analyses contained in this report, the instream flow regime shown in Table 4 is recommended for maintenance or improvement of the existing rainbow trout fishery in the Green River from a point 200 feet upstream of the Horsefly Ditch headgate in the NW1/4, NW1/4 of S9, T35N, R111W upstream through the WGF public easement to the east boundary line of the NE1/4, NE1/4, S11, T36N, R111W. These recommendations are applicable to 9.84 miles of the Green River.

Table 4. Summary of instream flow recommendations for the Green River above Warren Bridge.

| Time Period | Instream Flow Recommendation (cfs) |
|---|---|
| July 1 to September 30 | 350 |
| October 1 to March 31 | 101 |
| April 1 to June 30 | 175 |

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