WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

ADMINISTRATIVE REPORT

TITLE: Middle Piney Creek Instream Flow Report

PROJECT: IF-4090-07-8806

AUTHOR: William H. Bradshaw

DATE: November 1990

INTRODUCTION

Studies were conducted to obtain instream flow information from a segment of Middle Piney Creek west of Big Piney, Wyoming. These studies were designed to provide the basis for determining instream flows which would maintain or improve the existing fishery in the candidate section of Middle Piney Creek. Results of these studies apply to the stream segment extending upstream from the U.S. Forest Service boundary in Section 12, Range 115 West, Township 30 North, to the point where Middle Piney Creek crosses the west boundary of Section 3, Range 115 West, Township 30 North. This stream section is 3.6 miles long.

This section of Middle Piney Creek is designated by the Wyoming Game and Fish Department (WGFD) as a Class 3 trout stream. Class 3 streams generally support regionally important fisheries. The stream is managed as a wild fishery for brook trout. This section of Middle Piney Creek supports significant recreational fisheries opportunities for resident anglers (R. Remmick, WGFD, Personal communication), and is highly accessible through public lands. For these reasons, this segment of the river is considered a critical stream segment.

The management goal of the WGFD is to maintain or improve the existing stream fishery in Middle Piney Creek. Two time periods are considered critical for realizing this goal. October 1 to March 31 is considered critical because this is a time period when low flows can cause degradation of hydraulic characteristics necessary for trout survival, fish passage and aquatic insect production. Brook trout spawning also occurs during this time period. From July 1 to September 30 it is critical to provide flows adequate for maintaining existing levels of adult trout production.

To address the management goal, objectives of this study were to 1) determine instream flows necessary to maintain hydraulic characteristics that are important for survival of trout, fish passage and aquatic insect production, 2) maintain or improve physical habitat for brook trout spawning and, 3) maintain or improve adult trout production during the late summer months.

1

METHODS

Data for these studies were collected from a site located approximately 1/4 mile upstream from the confluence of Middle Piney and Bird Creeks, in Section 2, Range 115, West, Township 30 North (Figure 1). These studies were conducted between June and August 1988 within a 291 foot long study site that contained trout habitat typical of that found throughout the candidate section of Middle Piney Creek. Data were collected after peak runoff from a range of discharge rates (Table 1).

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

Date	Discharge (cfs)
06-09-88	102
06-03-88	48
08-24-88	15

The Habitat Retention method (Nehring 1979) 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. Based on extensive research by Annear and Conder (1984), the maintenance flow is specifically defined as the discharge at which two of three hydraulic criteria are met for all riffles in the study area (Table 2). Meeting these criteria provides passage for all life stages of trout between different habitat types and maintains survival of trout and aquatic macroinvertebrates at all times of year.

Data were collected from transects placed across two riffles within the study area and analyzed using the IFG-1 computer program (Milhous 1978). Instream flow recommendations derived from this method are applicable throughout the 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 brook trout spawning, incubation and fry at various discharge rates. This model is generally regarded as state-of-the-art technology and is the most commonly used method in North America for quantifying changes in physical habitat with changes in discharge (Reiser et al. 1989).
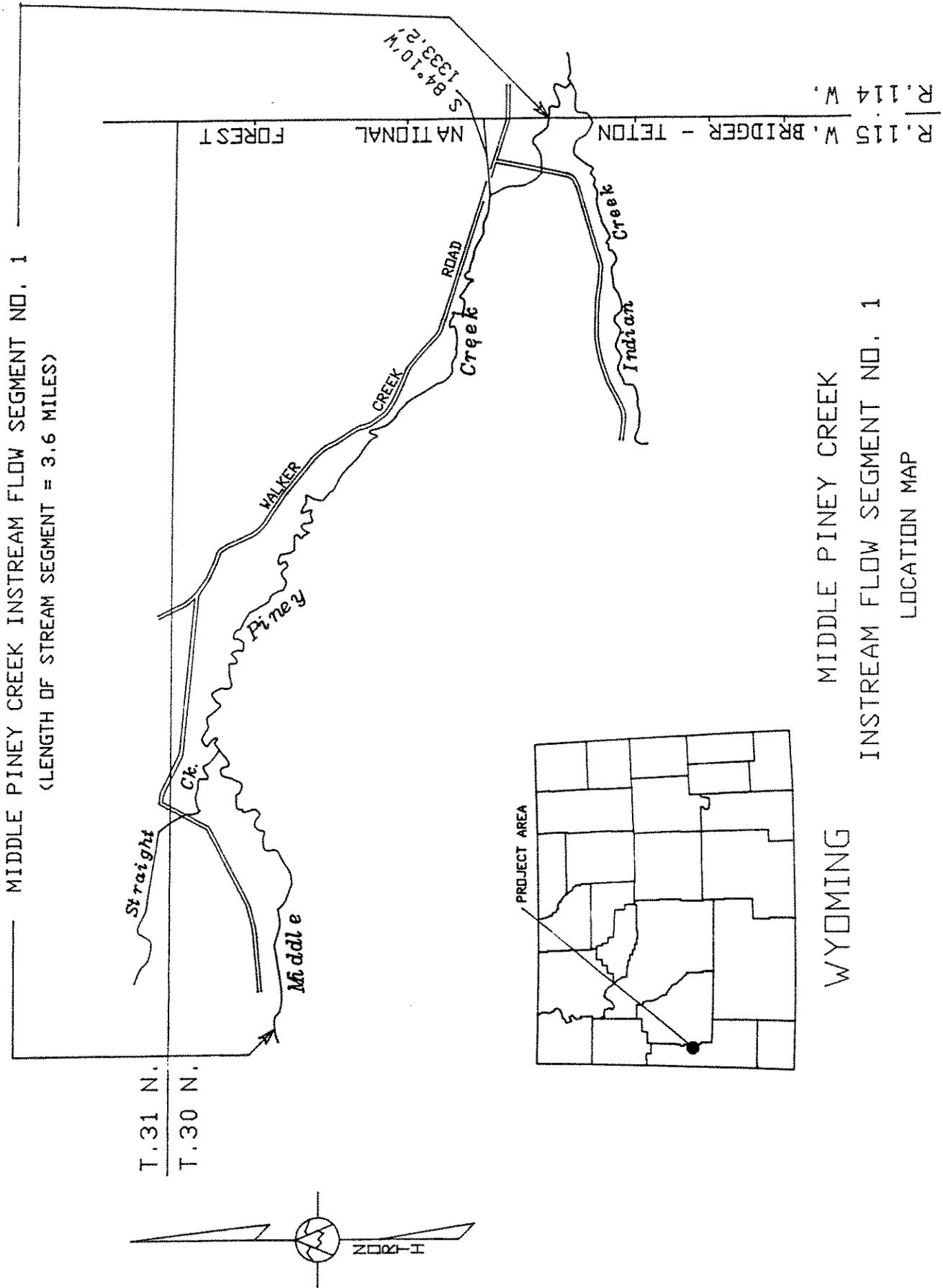
2

Figure 1. Location of Instream Flow filing reach on Middle Piney Creek.

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 four transects in accordance with guidelines given by Bovee and Milhous (1978).

Because this fishery depends upon natural reproduction for continuation, it is important to maintain physical habitat for spawning that occurs in October and November. Maintenance of suitable physical habitat for this life stage is a critical part of ensuring adequate recruitment to this fishery. The WUA for brook trout spawning was simulated for flows ranging from 5 to 125 cfs using calibration and modeling techniques outlined in Milhous (1984) and Milhous et al. (1984).

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 production over a range of late summer flow conditions. The model incorporates seven attributes that address chemical, physical and biological components of trout habitat. Results are expressed in habitat units (HU), with one HU defined as the amount of habitat quality which will support approximately 1 pound of trout. 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 habitat unit gains or losses associated with projects that modify instream flow regimes.

By measuring habitat attributes at various flow events as if associated habitat features were typical of late summer flow conditions (Conder and Annear 1987), HU estimates were made for hypothetical summer flows ranging from 5 to 125 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 of the HQI model apply to the time of year that determines trout production. For Middle Piney Creek this period is from July 1 to September 30.

RESULTS AND DISCUSSION

The Habitat Retention method was developed to identify a flow that would maintain existing survival rates of trout, provide passage for trout between different habitat types in streams, and maintain survival rates of aquatic insects in riffle areas. 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 showed that flows of 3 and 4 cfs are necessary to maintain aquatic insect production and fish passage at riffles 1 and 2 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. Based on this criteria, the maintenance flow for this segment of LaBarge Creek is 4 cfs.

4

Table 3. Results from IFG-1 modeling at the Middle Piney Creek study site during 1988.

Discharge (cfs)	Average Depth (ft)	Average Velocity (ft/sec)	Wetted Perimeter
		Riffle 1	
1.9	0.10	4.71[1]	4.0
2.8[2]	0.15[1]	3.75	5.0
3.8	0.21	2.61	7.2
5.2	0.23	2.27	10.6[1]
6.8	0.25	1.88	14.5
11.3	0.45	1.74	14.9
14.0	0.53	1.80	15.1
16.6	0.61	1.86	15.3
26.7	0.83	2.16	15.9
37.5	0.99	2.48	16.3
54.7	1.19	2.97	16.9
75.2	1.37	3.48	17.3
90.6	1.47	3.80	17.7
		Riffle 2	
1.5	0.15	0.78	13.1
3.8	0.21	1.00[1]	15.7
3.9[2]	0.21[1]	1.01	15.8
4.3	0.22	1.05	16.3[1]
6.3	0.27	1.24	18.5
10.4	0.36	1.50	19.1
14.0	0.39	1.70	21.6
23.1	0.49	2.06	23.1
32.0	0.57	2.36	23.9
46.5	0.66	2.78	25.6
55.8	0.72	3.01	26.2
70.9	0.81	3.36	26.6
90.6	0.90	3.76	27.1

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. Because any reduction of natural

winter stream flows would increase trout mortality and effectively reduce the number of fish that the stream could support, maintenance of natural flows is considered critical. As a consequence, the fishery management objective for the time period from October 1 to March 31 is to protect all available natural stream flows in the instream flow segment up to the maintenance flow. For Middle Piney Creek, the maintenance flow is 4 cfs.

Stream flow data are unavailable for this section of Middle Piney Creek and it is possible that the discharge of 4 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 4 cfs, in order to maintain existing survival rates of trout populations.

The candidate section of Middle Piney Creek is managed for wild brook trout, and as such, is dependent on spawning and egg survival for perpetuation of the trout fishery. Brook trout generally spawn in October and November. Results from the PHABSIM model for spawning were used to determine flows necessary to maintain or improve brook trout reproductive success during this time period. Although Habitat Suitability Index curves are unavailable for juvenile and fry brook trout, physical habitat at flows recommended for adults was considered adequate for survival of these life stages.

The brook trout spawning and incubation period coincides with the time of year when the management objective is to preserve all natural stream flows (October 1 to March 31). Results from the PHABSIM analysis show that meeting this objective with the discharge identified by the Habitat Retention method (4 cfs) will maintain approximately 100% of the available physical habitat for brook trout spawning (Figure 2). Physical habitat for brook trout spawning declines markedly at flows below 4 cfs.
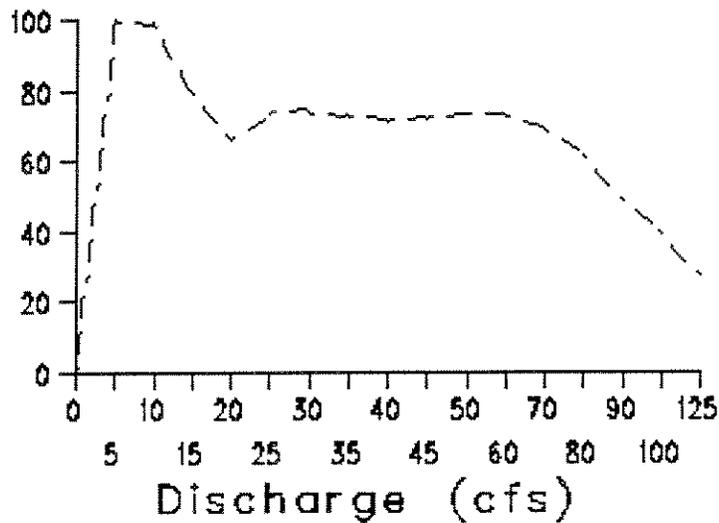
6

Figure 2. Percent of maximum weighted usable area (MUA) for brook trout spawning at the Middle Piney Creek study site as a function of discharge.

Results from the HQI model indicate that under existing average late summer conditions, this segment of Middle Piney Creek supports approximately 80 trout Habitat Units (Figure 3). A flow of 15 cfs will maintain this existing level of HU's, but at lower flows, trout habitat units would be reduced by almost 50% 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 15 cfs is recommended for the period from July 1 through September 30.

7

Habitat Units

100
80
60
40
20
0

0   10   20   30   40   50   100

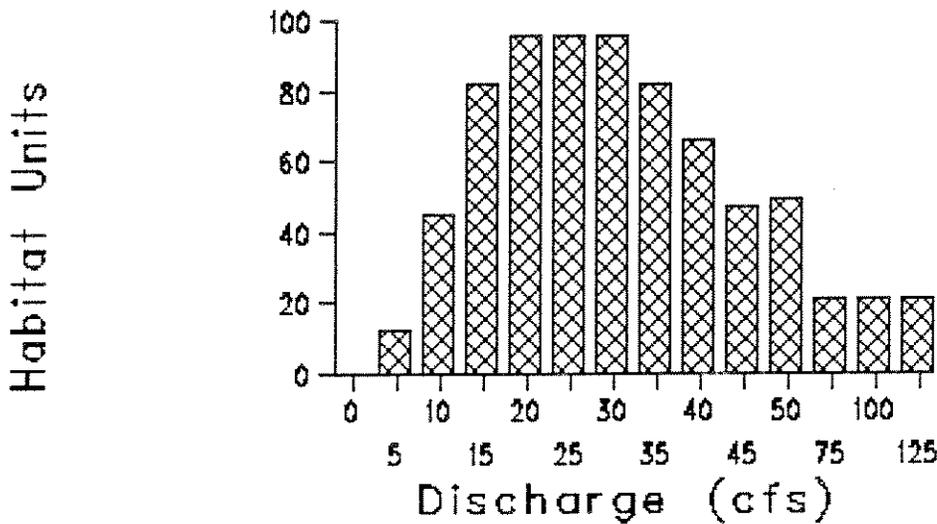5   15   25   35   45   75   125

Discharge (cfs)

Figure 3. Adult trout habitat units (HU) as a function of discharge at the Middle
Piney Creek study site.

SUMMARY

The instream flow regime in Table 4 is based on results from the Habitat
Retention, HQI and PHABSIM models, and displays the minimum stream flows needed to
maintain or improve existing trout production levels in a section of Middle Piney
Creek at critical times of year. This stream section extends for a distance of 3.6
miles; from the U.S. Forest Service boundary in Section 12, Range 115 West, Township
30 North upstream to the point where Middle Piney Creek crosses the west boundary of
Section 3, Range 115 West, Township 30 North.

Table 4. Summary of instream flow recommendations for Middle Piney Creek west of
Big Piney.

Time Period	Instream Flow Recommendation (cfs)
October 1 to March 31	4 *
April 1 to June 30	4
July 1 to September 30	15

* — To maintain existing natural flows

8

REFERENCES

Annear, T.C. and A.L. Conder. 1984. Relative bias of several fisheries instream flow methods. North American Journal of Fisheries Management 4:531-539.

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.

Butler, R. 1979. Anchor ice, its formation and effects on aquatic life. Science in Agriculture, Vol XXVI, Number 2, Winter, 1979.

Conder, A.L. and T.C. Annear. 1987. Test of weighted usable area estimates derived from a PHABSIM model for instream flow studies on trout streams. North American Journal of Fisheries Management 7:339-350.

Kurtz, J. 1980. Fishery management investigations - a study of the upper Green River fishery, Sublette County, Wyoming (1975-1979). Completion Report. Wyoming Game and Fish Department, Fish Division, Cheyenne.

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.

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

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, Cooperative Instream Flow Service Group, U.S. Fish and Wildlife Service, Fort Collins, Colorado.

Needham, P., J. Moffett, and D. Slater. 1945. Fluctuations in wild brown trout populations in Convict Creek, California. Journal of Wildlife Management 9(1):9-25.

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.

Reimers, N. 1957. Some aspects of the relation between stream foods and trout survival. California Fish and Game 43(1):43-69.

Reiser, D.W., T.A. Wesche, and C. Estes. 1989. Status of instream flow legislation and practices in North America. Fisheries 14(2):22-29.