An evaluation of habitat improvement structures in the Boulder River, Montana
by Jon Michael Streu

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management
Montana State University

Abstract:
The trout biomasses and selected physical parameters associated with five types of habitat improvement structures (HIS) were measured in a section of the Boulder River near Basin, Montana in 1987 - 1989. The study sites consisted of three log jetties, three check dams and their plunge pools, three boulder clusters, three log bank hides, four shore anchored habitat structures (SAHS), and two control sections (no structures). During the summer and fall seasons, sections with all types of HIS had mean total salmonid and rainbow trout biomasses that were significantly greater ($p<0.10$) than the means for the control sections, indicating HIS provided some improvement . Of the five structure types, check dams and log bank hides had the highest mean total salmonid and rainbow trout biomasses during the summer and fall seasons. Simple and stepwise regression procedures indicated that maximum associated depth (MAD), a measure of pool presence and depth, was the most important physical parameter explaining variation in both total salmonid biomasses. Check dams, bank hides, and boulder piles were the least expensive structure types to install. Check dams and bank hides were also the most physically durable of the five HIS types. The high relative attraction to salmonids, relatively low construction cost, and high physical durability indicate that check dams were the most advantageous form of habitat improvement structure.

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APPROVAL

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Jon Michael Streu

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

11/6/90 — Date

William R. Gould — Chairperson, Graduate Committee

Approved for the Major Department

5 November, 1990 — Date

Robert E. Moore — Head, Major Department

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11/16/90 — Date

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Date 11-8-90

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ABSTRACT

The trout biomasses and selected physical parameters associated with five types of habitat improvement structures (HIS) were measured in a section of the Boulder River near Basin, Montana in 1987 - 1989. The study sites consisted of three log jetties, three check dams and their plunge pools, three boulder clusters, three log bank hides, four shore anchored habitat structures (SAHS), and two control sections (no structures). During the summer and fall seasons, sections with all types of HIS had mean total salmonid and rainbow trout biomasses that were significantly greater ($p<0.10$) than the means for the control sections, indicating HIS provided some improvement . Of the five structure types, check dams and log bank hides had the highest mean total salmonid and rainbow trout biomasses during the summer and fall seasons. Simple and stepwise regression procedures indicated that maximum associated depth (MAD), a measure of pool presence and depth, was the most important physical parameter explaining variation in both total salmonid biomasses. Check dams, bank hides, and boulder piles were the least expensive structure types to install. Check dams and bank hides were also the most physically durable of the five HIS types. The high relative attraction to salmonids, relatively low construction cost, and high physical durability indicate that check dams were the most advantageous form of habitat improvement structure.

INTRODUCTION

In 1983, the Montana Department of Highways (MDH) moved portions of the Boulder River above the town of Basin, Montana (Figure 1) from its natural channel into sections of artificially constructed channel. This was done to facilitate the construction of U.S. Interstate 15 through the Bernice - Basin canyon.

To enhance fish habitat in the artificial channel, the MDH installed a variety of habitat improvement structures (HIS). HIS are used to enhance the cover, depth, velocity, and pool-to-riffle ratios in a stream, thus improving the habitat for fish populations (Hunt 1971; Binns and Eisermann 1979; Wesche 1980).

Five different types of structures were installed. Log bank hides and shore anchored habitat structures (SAHS) were built to provide overhead cover by simulating undercut stream banks. Log and rock check dams were installed to create pools and thereby increase the stream's pool to riffle ratio. Log jetties and boulder clusters were installed primarily as current deflectors to increase channel depth, but also to function as HIS.

The performance of HIS have varied substantially on improving both physical habitat and fish populations. Babcock (1982) reported that rock dams, log dams, log deflectors, and boulder deflectors in Tenmile Creek,

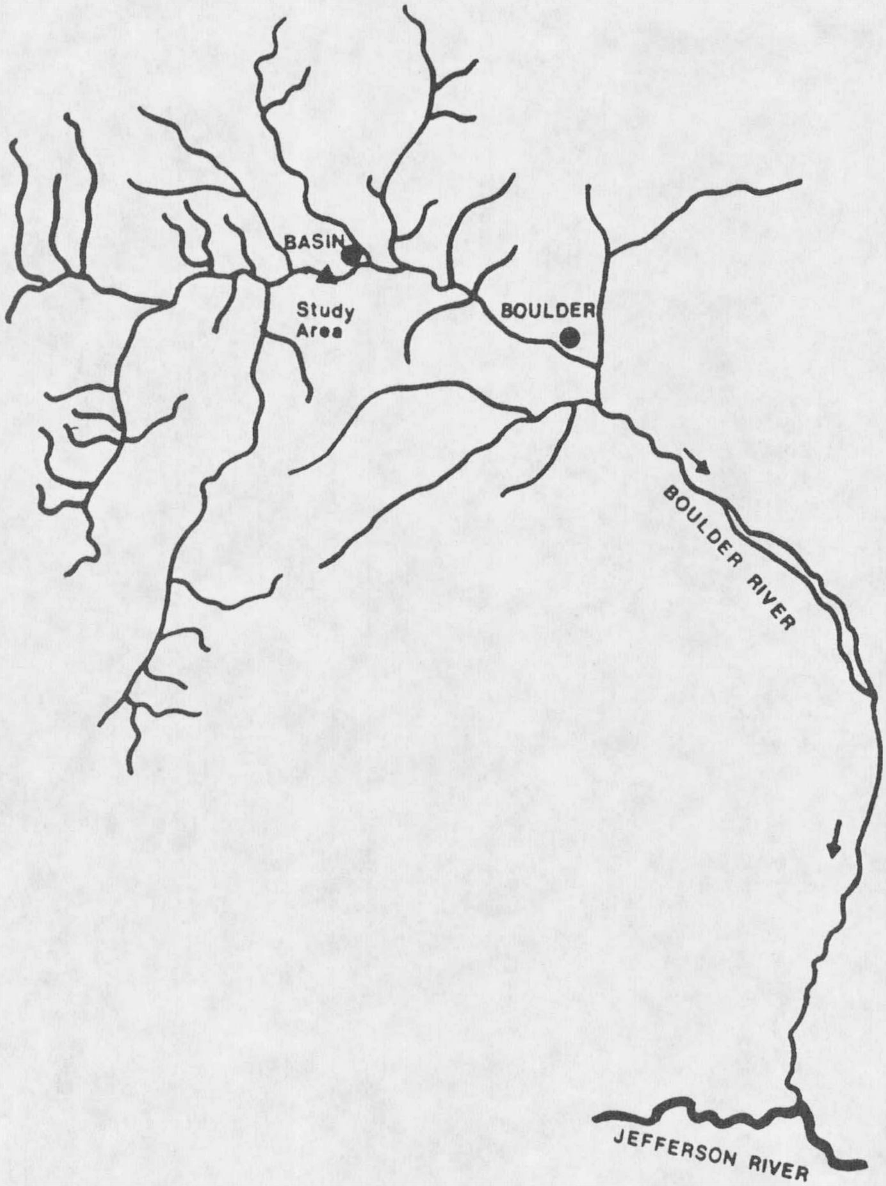

Figure 1. Map showing the location of the Boulder River study area (arrows indicate direction of flow).

Colorado, were providing little suitable physical habitat after 2 years. Elser (1970) found that rock jetties installed in altered portions of Prickley Pear Creek and the East Gallatin River, Montana provided physical habitat similar to that present in the prealteration channels of those streams although fish populations and biomasses showed marked postalteration reductions. In contrast, Schaplow (1976) found that trout populations and biomass in sections of the St. Regis River of Montana altered with step dams, random rocks, and jetties, were similar to those of unaltered sections. Lere (1982) noted varied results among three Montana streams improved with the emplacement of boulders and rock jetties. Trout biomasses and populations increased in altered sections of the St. Regis River but not in altered sections of Sheep Creek and Prickley Pear Creek (Lere 1982).

The purpose of this study was to evaluate the performance and characteristics of HIS types and of individual HIS in the Boulder River. Evaluation involved measuring the fish biomass, water depth, water velocity, and overhead cover associated with each of 16 study structures during spring, summer, and fall seasons. Of the five types of HIS constructed in the Boulder River, SAHS, log jetties, and log bank hides, have not been evaluated in Montana, previously. Analyses were implemented to identify the most productive HIS type and individual HIS and to identify the particular habitat features that made structures attractive or unattractive to fish. In addition, the durability and cost effectiveness of the structures were evaluated.

STUDY SITE

The Boulder River originates in the Boulder Mountains of Jefferson County in southwestern Montana at an approximate elevation of 2,200 m (Figure 1). It flows north for approximately 17 km then turns southeast near the town of Basin and enters the Jefferson River near the town of Cardwell. The average discharge of the Boulder River near the town of Boulder, for a 58 year period ending in 1988, was 11.8 m^3/s (U.S. Geological Survey 1988). Maximum and minimum discharges for that period were 98.8 m^3/s and 0.0 m^3/s, respectively. Annual precipitation averages approximately 90 cm at the town of Basin (North Boulder Drainage and Jefferson Conservation District 1975).

The study structures are located in two areas situated approximately 2.1 to 5.1 km upstream from Basin (Figure 1). Both areas are located above the section of river influenced by heavy metals (Nelson 1976). The lower area lies adjacent to U.S. Interstate 15. Its entire highway side consists of riprap, while the far side consists mainly of a narrow riparian zone and steep rock walls. There is no vegetative overhead cover. Stream width in this area varied from 12.2 m in June of 1988 to 3.2 m in August of 1987.

The upper study site has steep stream banks and lies in a flood plain containing greater amounts of riparian vegetation than the lower site. The dominant floodplain vegetation consisted of conifers and alders (Alnus spp.), but these provided little overhead cover. Stream width varied from 8.7 m in June of 1987 to 2.6 m in August of 1988.

Mean, maximum, and minimum measured discharges during the three study seasons were 0.71 m^3/s, 1.42 m^3/s, and 0.30 m^3/s, respectively. Seasonal discharges are presented in Figure 2. Dissolved oxygen concentrations, conductivity, and pH (Table 1) were similar to those found in the area by Nelson (1976). Alkalinity for this section of the Boulder River averaged a relatively low 40.6 mg/l $CaCO_3$ (Gardner 1977).

Table 1. Water chemistry measurements of the Boulder River during 1989. Number of measurements are in parentheses.

Characteristic	Upper section	Lower section
pH	6.96-7.22 (3)	6.85-6.86 (3)
Specific conductivity (umhos/cm)	150 (2)	148 (2)
Dissolved oxygen (mg/l)	10.0 (2)	10.0 (2)

Rainbow trout (Oncorhynchus mykiss) were the most