The long term effectiveness of three types of stream improvement structures installed in Montana streams

by Mark Edmond Lere

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 long term effectiveness and durability of random boulders, rock jetties, and log step dams installed as improvement structures in three Montana streams were evaluated in 1979 and 1980. Random boulders and rock jetties placed in channelized sections of the St. Regis River appeared to have restored habitat for cutthroat trout (Salmo clarkI) and brook trout (Salvelinus fontinalis) populations. Total numbers of trout were least in a partially altered control, greatest in a section mitigated with random boulders, and intermediate in a section mitigated with rock jetties. Total biomass of trout was similar in the control and jetty sections, but was greater in the boulder section. Total densities of trout in the control and jetty sections were less than estimates obtained 5 years previously. Sections with mitigative structures had greater pool frequencies than the control, Pool-riffle periodicity was significantly related to the total numbers of trout among sections ($P<0.01$). A majority of the boulders were functionally intact 8 years following installation.

Twelve of 18 rock jetties were functionally intact 7 years following installation. Rock jetties placed in a channelized section of Little Prickley Pear Creek appeared to have restored habitat for a rainbow trout (Salmo gairdneri) population, but were ineffective in restoring habitat for a brown trout (Salmo trutta) population, The biomass of rainbow trout was similar in a control and a section mitigated with rock jetties, but was less in a channelized section that was unmitigated. Brown trout densities were greatest in the control and similar in the jetty and unmitigated sections. Brown trout densities and rainbow trout biomass in the control were less than estimates obtained 14 years previously. The jetty section had a pool frequency that was similar to that in the control. Pools were absent in the unmitigated section. Individual physical characteristics were not significantly related to the densities of trout among study sections ($P>0.10$). Fourteen of 16 rock jetties were functionally intact 16 years following installation. Log step dams placed in Sheep Creek were ineffective in enhancing habitat for a rainbow trout population. Densities of rainbow trout in a section containing step dams and a control were not different. Pool frequencies in the step dam section were greater than the control. Eight log step dams were functionally intact 19 years following installation.

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by

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ABSTRACT

The long term effectiveness and durability of random boulders, rock jetties, and log step dams installed as improvement structures in three Montana streams were evaluated in 1979 and 1980. Random boulders and rock jetties placed in channelized sections of the St. Regis River appeared to have restored habitat for cutthroat trout (*Salmo clarki*) and brook trout (*Salvelinus fontinalis*) populations. Total numbers of trout were least in a partially altered control, greatest in a section mitigated with random boulders, and intermediate in a section mitigated with rock jetties. Total biomass of trout was similar in the control and jetty sections, but was greater in the boulder section. Total densities of trout in the control and jetty sections were less than estimates obtained 5 years previously. Sections with mitigative structures had greater pool frequencies than the control. Pool-riffle periodicity was significantly related to the total numbers of trout among sections ($P<0.01$). A majority of the boulders were functionally intact 8 years following installation. Twelve of 18 rock jetties were functionally intact 7 years following installation. Rock jetties placed in a channelized section of Little Prickley Pear Creek appeared to have restored habitat for a rainbow trout (*Salmo gairdneri*) population, but were ineffective in restoring habitat for a brown trout (*Salmo trutta*) population. The biomass of rainbow trout was similar in a control and a section mitigated with rock jetties, but was less in a channelized section that was unmitigated. Brown trout densities were greatest in the control and similar in the jetty and unmitigated sections. Brown trout densities and rainbow trout biomass in the control were less than estimates obtained 14 years previously. The jetty section had a pool frequency that was similar to that in the control. Pools were absent in the unmitigated section. Individual physical characteristics were not significantly related to the densities of trout among study sections ($P>0.10$). Fourteen of 16 rock jetties were functionally intact 16 years following installation. Log step dams placed in Sheep Creek were ineffective in enhancing habitat for a rainbow trout population. Densities of rainbow trout in a section containing step dams and a control were not different. Pool frequencies in the step dam section were greater than the control. Eight log step dams were functionally intact 19 years following installation.

INTRODUCTION

Randomly placed boulders, rock jetties, and log step dams are common types of stream improvement structures that have been utilized to restore or enhance trout habitat. These structures have been shown to produce changes in channel configuration that have enhanced trout populations in Montana streams (Swedberg 1964; Elser 1968; Schaplow 1976). However, these evaluations were made within 2 years following installation. This 2 year interval between installation and assessment is not adequate for evaluating the effectiveness of these structures to enhance trout populations (White 1975). Hunt (1976) found that the maximum response of a brook trout population did not occur until 5 years following habitat development of Lawrence Creek, Wisconsin. Furthermore, evaluations of these structures within 2 years of installation do not provide an assessment of their ability to remain intact and functional over a long term.

The present study was undertaken to evaluate randomly placed boulders, rock jetties, and log step dams that have been in Montana streams for at least 5 years. The objectives of this study were to evaluate: (1) the changes in physical habitat associated with these improvement structures; (2) the persistance and integrity of these structures; (3) the response of trout populations to the habitats created by these structures. Field studies were carried out from

July through September 1979 and July through October of 1980 on the St. Regis River, Little Prickley Pear Creek, and Sheep Creek.

DESCRIPTION OF STUDY AREAS

St. Regis River

The St. Regis River originates on the east slope of the Bitterroot Mountains in the northwest corner of Mineral County, Montana (Figure 1). It arises at an elevation of 1,707 meters (m) above mean sea level (msl) and flows southwesterly for approximately 60 kilometers (km) to its confluence with the Clark Fork River at an elevation of 805 m (msl). The mean gradient of the stream is about 1.5%. Mean, minimum, and maximum discharges measured near the town of St. Regis over a 17 year period ending in 1975 were 16.4, 1.16, and 273 m^3/second (sec), respectively (U. S. Geological Survey 1976).

The narrow valley of the St. Regis River has been used as a transportation route since the late 1800s. Much of the river has been channelized or encroached upon as a result of railroad and state highway construction. Additional alterations to the river have resulted from construction of Interstate Highway 90 which began in 1971. Rock step dams, random boulders, and rock jetties were installed in sections of the river above the town of Saltese in 1972 and 1973 to mitigate the destructive effects of the Interstate construction (Schaplow 1976).

Three study sections were established on the St. Regis River. They were located between the confluence of Dominion Creek and Saltese. Section 1 was located approximately 3.0 river km above Saltese at an elevation of about 1,078 m (msl). It began at a railroad trestle and

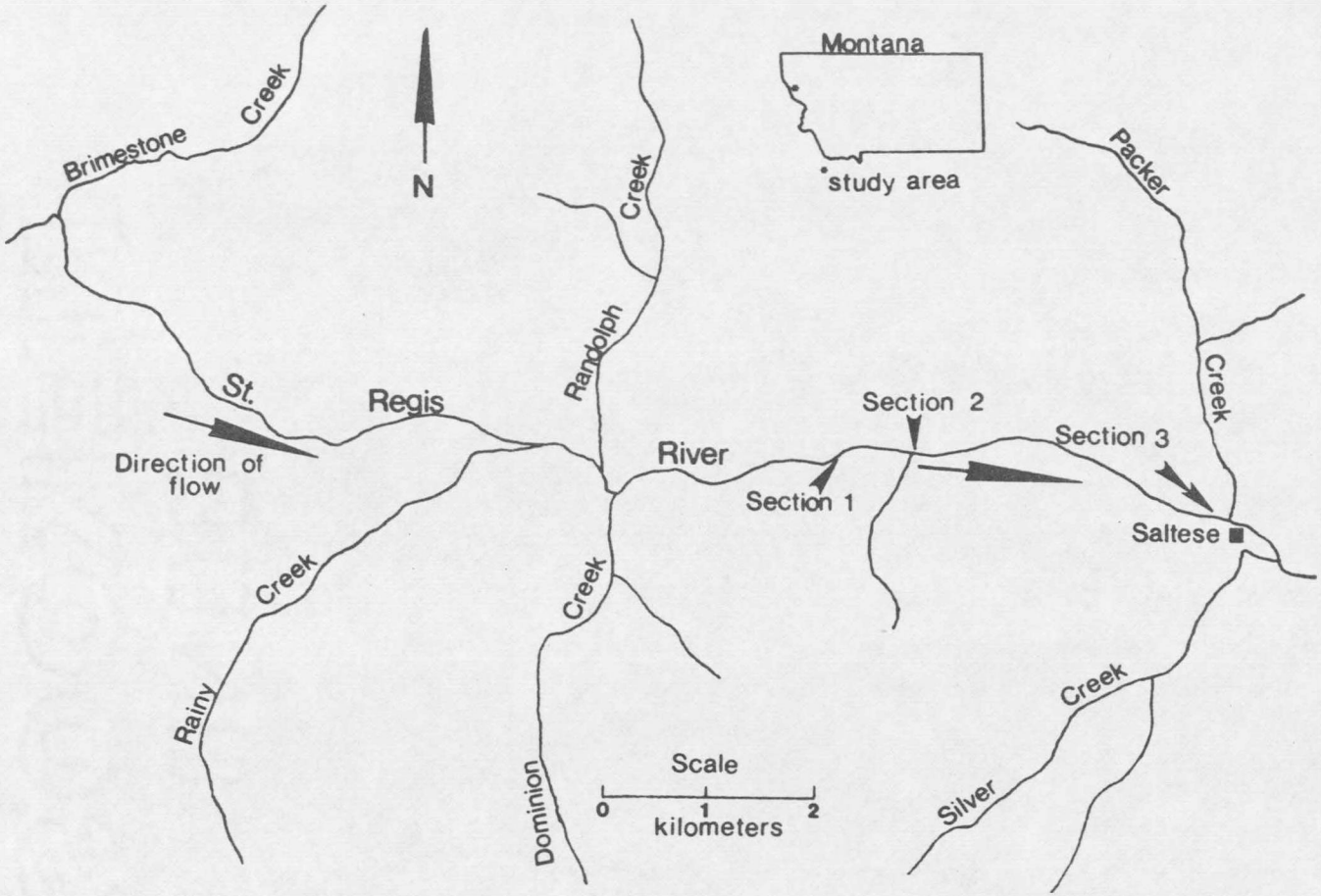

Figure 1. Map of the St. Regis River showing locations of study sections.

extended 510 m downstream. Construction of Interstate Highway 90 altered approximately 35% of this section (Schaplow 1976). Willow (*Salix* spp.) and red dogwood (*Cornus stolinifera*) dominated the riparian zone. This vegetation provided a moderate amount of cover overhanging the stream. This section served as a partially altered control.

Section 2 began about 2,5 river km above Saltese and extended 455 m downstream. The approximate elevation of the section was 1,057 m (msl). This section of stream was rechanneled and confined between Interstate Highway 90 and the roadbed of the railroad as a result of highway construction. Random boulders were installed as a mitigative device in 1972. The riparian zone was practically devoid of vegetation because of the placement of rock revetment at the time of construction. This section served as an altered stream reach mitigated with random boulders.

Section 3 began approximately 0.5 river km above Saltese at an elevation of 1,042 m (msl) and extended 387 m downstream. This section was situated in a relocated channel which was built to facilitate the construction of Interstate Highway 90. Nine pairs of offset rock jetties were installed at intervals of approximately 40 m within the section in 1973. Rock revetment was used to stabilize the stream channel which limited vegetation in the riparian zone to sparse patches of willow. This vegetation provided almost no cover overhanging the

stream. This section served as an altered stream reach mitigated with rock jetties.

The three study sections established on the St. Regis River corresponded with sections studied by Schaplow (1976). The legal description of each study section is given in Appendix Table 1.

Water temperatures were measured in the first 2 weeks of September, 1980. Ranges for stations in Sections 1, 2, and 3 were 5.0-15.0, 5.0-16.0, and 8.0-15.0 Celsius (C), respectively. The mean diel difference between maximum and minimum temperatures for Sections 1, 2, and 3 were 8.8, 8.0, and 5.3 C, respectively.

Selected chemical and physical analyses of water made within the three study sections are presented in Table 1. Similar values of pH (7.0-7.3), hardness [20-34 milligrams/liter (mg/l)], alkalinity (21-35 mg/l), and conductivity [42-86 micromhos/centimeter (μmhos/cm)] have been reported for the St. Regis River near Saltese by Lund (1976).

Cutthroat trout (*Salmo clarki*) was the dominant game fish in the study area. Brook trout (*Salvelinus fontinalis*), mountain whitefish (*Prosopium williamsoni*), longnose dace (*Rhinichthys cataractae*), slimy sculpin (*Cottus cognatus*), and shorthead sculpin (*C. confusus*) were also present. No hatchery fish were stocked in the area during the study.

Table 1. Mean and range (in parentheses) of selected chemical and physical properties of water in study sections on the St. Regis River from September 2 through September 12, 1980.

Study Sections	pH	Total Hardness (as mg/l $CaCO_3$)	Total Alkalinity (as mg/l $CaCO_3$)	Conductivity (µmhos/cm at 25 C)
1	7.1 (7.0-7.2)	40 (40)	38.5 (35-40)	88.8 (85-90)
2	7.2 (7.1-7.3)	37.5 (35-40)	38.5 (35-40)	83.8 (80-85)
3	7.2 (7.0-7.3)	37.5 (35-40)	38.5 (35-40)	80 (80)

Little Prickley Pear Creek

Little Prickley Pear Creek is located in Lewis and Clark County in central Montana (Figure 2). It originates on the east slope of the Continental Divide and flows northeasterly for approximately 50 km to its confluence with the Missouri River. The elevation of the stream ranges from 1,475 m (msl) at the headwaters to 1,058 m (msl) at the mouth. The mean gradient of the stream is about 0.85%. Mean, minimum, and maximum discharges measured near the town of Wolf Creek over a 5 year period ending in 1967 were 3.65, 0.40, and 88.01 m^3/sec, respectively (U. S. Geological Survey 1968).

The lower 18 km of Little Prickley Pear Creek flows through Wolf Creek Canyon. This portion of the stream has been extensively altered for the construction of Interstate Highway 15. Eighty-eight rock jetties were installed at intervals of approximately 60 m in this reach