Limitations to a rainbow trout population in north-central Montana
by Robert William Hitchcock

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

Abstract:
Environmental limitations of Beaver Creek trout populations were studied from August 1981 to March 1983.

I attempted to identify primary limiting factors and to determine if timing and quantity of flow released from an upstream storage reservoir (Bear Paw Lake) would improve habitat conditions.

Major limiting factors appeared to be streambed composition, quantity of streamflow, and water temperature. Angling, channel alterations, livestock grazing, and beaver activity contributed to the low rainbow trout abundance below Bear Paw Lake, but did not appear to be major limiting factors.

Throughout the study area, high percentages (>20%) of fine particles (<0.85 mm) were found in streambed materials, reducing quality and quantity of suitable spawning habitat for rainbow trout. Predicted rainbow trout embryo survival to emergence ranged from 0-30% in the study area. Geology of the lower two-thirds of the study section prevents improvement of spawning substrate by manipulating quantity of water released from Bear Paw Lake.

With water temperatures as high as 26 C during summer low flows, Beaver Creek is considered thermally marginal for rainbow trout. Temperature model predictions indicated that releasing 4.4-13.9 C water from the bottom of Bear Paw Lake at a rate of 0.028-1.36 m^/s, would maintain an average-maximum temperature of 16 C or less for 3.2 km downstream, providing near optimum water temperature for the rainbow trout during most summer months. Releases exceeding the base flow of Beaver Creek by 0.065 mr/s/day for 60 days, could reduce the recreational value of Bear Paw Lake by exposing 22% (4 ha) of the lake bottom.

Physical habitat simulation model predicted flows of less than 0.34 m^3/s would greatly reduce available adult and juvenile rainbow trout habitat. A discharge range of 0.34-0.86 m^3/s would produce "preferred" velocities and depths for adult rainbow trout in 51-53% of the channel in the 3.2 km section below Bear Paw Lake. In relation to rainbow trout habitat and optimum water temperature, a minimum flow of 0.28 m^/s released from the bottom of Bear Paw Lake throughout the year, is recommended• The 1.6 km of Beaver Creek immediately downs t ream from Bear Paw Lake was the most heavily fished area on the stream. Rainbow trout of hatchery origin were dominant in this section, having moved down from Bear Paw Lake. By stocking rainbow trout in this 1.6 km section, 99% of the recreational fishing needs for Beaver Creek below Bear Paw Lake would be met.

LIMITATIONS TO A RAINBOW TROUT POPULATION IN NORTH-CENTRAL MONTANA

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Robert William Hitchcock III

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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.

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ABSTRACT

Environmental limitations of Beaver Creek trout populations were studied from August 1981 to March 1983. I attempted to identify primary limiting factors and to determine if timing and quantity of flow released from an upstream storage reservoir (Bear Paw Lake) would improve habitat conditions.

Major limiting factors appeared to be streambed composition, quantity of streamflow, and water temperature. Angling, channel alterations, livestock grazing, and beaver activity contributed to the low rainbow trout abundance below Bear Paw Lake, but did not appear to be major limiting factors.

Throughout the study area, high percentages (>20%) of fine particles (<0.85 mm) were found in streambed materials, reducing quality and quantity of suitable spawning habitat for rainbow trout. Predicted rainbow trout embryo survival to emergence ranged from 0-30% in the study area. Geology of the lower two-thirds of the study section prevents improvement of spawning substrate by manipulating quantity of water released from Bear Paw Lake.

With water temperatures as high as 26 C during summer low flows, Beaver Creek is considered thermally marginal for rainbow trout. Temperature model predictions indicated that releasing 4.4-13.9 C water from the bottom of Bear Paw Lake at a rate of 0.028-1.36 m^3/s, would maintain an average-maximum temperature of 16 C or less for 3.2 km downstream, providing near optimum water temperature for the rainbow trout during most summer months. Releases exceeding the base flow of Beaver Creek by 0.065 $m^3/s/day$ for 60 days, could reduce the recreational value of Bear Paw Lake by exposing 22% (4 ha) of the lake bottom.

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rainbow trout habitat and optimum water temperature, a minimum flow of 0.28 m^3/s released from the bottom of Bear Paw Lake throughout the year, is recommended.

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INTRODUCTION

In north-central Montana, few streams support recreational trout fisheries. Although most streams in this area do not have large trout populations, streams such as Beaver Creek are an important source of recreation.

A study by personnel of Montana Department of Fish, Wildlife and Parks (Needham and Gilge 1980) found large annual variations in rainbow trout (Salmo gairdneri) age class structure in Beaver Creek, suggesting the existence of less than optimum conditions. By monitoring trout abundance and various physical parameters of the stream, I attempted to identify factors that are limiting the trout population.

Numerous limiting factors to trout populations have been identified (Burton and Odum 1945, Call 1970, Raleigh et al. 1984). Those which I hypothesized were the most important in Beaver Creek were streambed composition, reduced stream discharge during late summer, fall, and winter, and high summer water temperatures.

Bear Paw Lake, an impoundment on Beaver Creek, is owned and operated by Montana Department of Fish, Wildlife and Parks and provides a major source of recreation in

Hill County Park. A spillway and penstock provide a means for controlling discharge from the dam and provide opportunity to modify flow and water temperature in Beaver Creek.

Several researchers have demonstrated a good relationship between flow and standing crop of trout (Wesche 1974, Binns and Eiserman 1979, and Schlosser 1982). I sought to identify limiting factors for rainbow trout in Beaver Creek and to determine the extent to which these limitations could be controlled through timing and quantity of flow released from Bear Paw Lake.

The objectives of the study were to:

1. Determine species composition, distribution, and abundance of fish in Beaver Creek between Beaver Creek Reservoir and Bear Paw Lake.

2. Evaluate potential factors limiting the rainbow trout population.

3. Determine recreational use and angler attitudes on Beaver Creek and Bear Paw Lake.

4. Develop a water release plan for Bear Paw Lake, for the purpose of enhancing rainbow trout habitat in Beaver Creek, within the constraints of downstream water rights and recreational demands of Bear Paw Lake.

DESCRIPTION OF STUDY AREA

Beaver Creek is located in north-central Montana, approximately 16 km south of the city of Havre. Mean annual precipitation is 31.95 cm, half of which occurs between May and August (NOAA 1981). Average number of frost-free days is 138, occurring between May and mid-September. Winters are cold with sub-zero temperatures common. Summer air temperatures are warm but seldom hot (less than 35 C). Warmest months are July and August, with mean air temperatures of 20.1 and 19.7 C, respectively. The mean annual air temperature is 5.9 C (NOAA 1981).

Beaver Creek is the main drainage of the Bear's Paw Mountains, which range in elevation from 762 to 1,829 m. The stream drains 127 ha, channeling the water 48 km to its intersection with the Milk River. Beaver Creek runs through the 4,047 ha Hill County Park, reportedly the largest county park in the continental United States. The parkland was placed under stewardship of the county for the purpose of providing a recreation area for visitors and residents of the region. Haying, grazing, and fur trapping in the park help to provide an economic base for the park.

Two reservoirs exist in Hill County Park (Figure 1). Completed in 1973, Beaver Creek Reservoir, located at the northern (downstream) end of the park, is the largest impoundment with a surface area at full pool of 48 ha. The reservoir functions mainly as an irrigation and flood control structure, with a growing potential for recreation. Beaver Creek Reservoir does not influence conditions in the study area, except to block immigration from downstream. The second reservoir, Bear Paw Lake (18 ha), is located 10.0 km upstream. It was constructed in 1952 and serves as one of the area's major recreation sites. Bear Paw Lake has a good trout fishery, supported by stocking of hatchery fish by the Montana Department of Fish, Wildlife, and Parks.

The study area was designated as the 10.0 km of stream between the two reservoirs, as well as 1.6 km upstream from Bear Paw Lake and a similar distance below Beaver Creek Reservoir. Five sections were selected for comparative purposes (Figure 1). All study sections are highly affected by the geology of the region (Figure 2).

Study section 1 is 1.6 km long and is located immediately downstream from Beaver Creek Reservoir (Figure 1; Table 1). In this section, the stream cuts through a thick bed (60 m deep) of ground moraine. This fine-grained glacial deposit makes up much of the substrate in depositional areas of this stream segment. More recent