



Potential impacts of altering discharge pattern from Hauser Dam, Missouri River, on young-of-the-year brown trout and rainbow trout
by Daniel Gregory Carty

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management
Montana State University
© Copyright by Daniel Gregory Carty (1985)

Abstract:

Daily flow fluctuations would occur in the Missouri River between Hauser Dam and Holter Reservoir if Hauser Dam were converted to a hydroelectric peaking facility.

To address potential impacts of fluctuating flows on free-swimming young-of-the-year (YOY) brown trout (*Salmo trutta*) and rainbow trout (*S. gairdneri*) emergence, growth, abundance, distribution, movement, and habitat use were investigated. During reduced-flow tests stranding, isolation, displacement, and habitat changes were evaluated. Hydraulic modeling was used to predict changes in the quantity of usable habitat at different discharges. Recruitment from a tributary into the river was also monitored. Field data were collected between April 1982 and November 1983. Young-of-the-year brown trout were first observed in early April while YOY rainbow trout were first found in mid-June. Both species used relatively shallow, low-velocity water near shore where cover was abundant. Reduced-flow tests in August of each year revealed little stranding or isolation, and YOY trout were not permanently displaced from temporarily dewatered habitat. Hydraulic modeling predicted an increase in the quantity of habitat as discharge decreased, but field observations indicated a reduction in habitat quality.

The tributary was found to be a relatively important source of recruitment to the river rainbow trout fishery but rather unimportant to the river brown trout fishery.

POTENTIAL IMPACTS OF ALTERING DISCHARGE PATTERN FROM
HAUSER DAM, MISSOURI RIVER, ON YOUNG-OF-THE-YEAR
BROWN TROUT AND RAINBOW TROUT

by

Daniel Gregory Carty

A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Fish and Wildlife Management

MONTANA STATE UNIVERSITY
Bozeman, Montana

August 1985

N378
C249
C.2

APPROVAL

of a thesis submitted by

Daniel Gregory Carty

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.

29 July 1985 Robert S. White
Date Chairperson, Graduate Committee

Approved for the Major Department

29 July 1985 Kate F. Brunson
Date Head, Major Department

Approved for the College of Graduate Studies

7-29-85 M. Maloe
Date Graduate Dean

STATEMENT OF PERMISSION TO USE

In presenting this thesis in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the Library shall make it available to borrowers under rules of the Library. Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgement of source is made.

Permission for extensive quotation from or reproduction of this thesis may be granted by my major professor, or in his absence, by the Director of Libraries when, in the opinion of either, the proposed use of the material is for scholarly purposes. Any copying or use of the material in this thesis for financial gain shall not be allowed without my written permission.

Signature Dan Coity

Date July 29, 1985

ACKNOWLEDGMENT

My sincere thanks to those who assisted in all phases of this study. Dr. Robert White directed the investigation and assisted in preparation of the manuscript. Drs. Calvin Kaya and Ray White critically reviewed the manuscript. George Liknes supervised field operations. Ron Spoon assisted in much of the field work and offered valuable professional advice. Frank Pickett and Chris Vitello of Montana Power Company provided logistical support and field assistance on important occasions; they also reviewed a prior version of the written material. Other Montana Power Company personnel extended their technical expertise. A number of Montana State University graduate students occasionally assisted in field operations.

My thanks, also, to my parents, for their constant encouragement, to Bob Gresswell, for his professional insight and personal friendship, and to Michele D'Arcy, for "being there" while this project was in progress.

This study was funded by Montana Power Company through grants to the Montana Cooperative Fishery Unit, Montana State University, Bozeman, Montana.

TABLE OF CONTENTS

	Page
APPROVAL.....	ii
STATEMENT OF PERMISSION TO USE.....	iii
VITA.....	iv
ACKNOWLEDGMENT.....	v
TABLE OF CONTENTS.....	vi
LIST OF TABLES.....	viii
LIST OF FIGURES.....	xii
ABSTRACT.....	xv
INTRODUCTION.....	1
DESCRIPTION OF STUDY AREAS.....	4
Missouri River Below Hauser Dam.....	4
Beaver Creek.....	6
METHODS.....	14
Missouri River Fish and Habitat Sampling.....	14
Emergence, 1982 and 1983.....	16
Growth, Abundance, Distribution, and Movement, 1983.....	16
Habitat, 1982 and 1983.....	18
Reduced-Flow Test, 1982.....	21
Reduced-Flow Test, 1983.....	23
Physical Habitat Simulation, 1982.....	24
Beaver Creek Fish Sampling.....	25
Discharge and Temperature Monitoring.....	27

TABLE OF CONTENTS (continued)

	Page
RESULTS.....	29
Missouri River.....	29
Emergence, 1982 and 1983.....	29
Growth, 1983.....	29
Abundance and Distribution, 1983.....	30
Movement, 1983.....	33
Habitat, 1982.....	37
Reduced-Flow Test, 1982.....	41
Reduced-Flow Test, 1983.....	45
Physical Habitat Simulation, 1982.....	53
Beaver Creek.....	60
DISCUSSION.....	63
REFERENCES CITED.....	75
APPENDIX.....	80

LIST OF TABLES

Table	Page
1. Fish species known to occur in the Missouri River between Hauser Dam and Holter Reservoir (White et al. 1984).....	9
2. Fish species known to be resident in Beaver Creek.....	12
3. Classification of substrates used in the study of YOY brown trout and rainbow trout habitat in the Missouri River between Hauser Dam and Holter Reservoir 1982-1983.....	19
4. Classification of cover components used in the study of YOY brown trout and rainbow trout habitat in the Missouri River between Hauser Dam and Holter Reservoir 1982-1983.....	20
5. Discharge and YOY brown trout and rainbow trout sampling schedule in the Missouri River between Hauser Dam and Holter Reservoir, 1983.....	21
6. Flow schedule for the reduced-flow test, Missouri River at Hauser Dam, 16-17 August 1982.....	22
7. Flow schedule for the reduced-flow test, Missouri River at Hauser Dam, 4 August 1983.....	24
8. Example of the Physical Habitat Simulation System (PHABSIM) output from one transect location on the Missouri River between Hauser Dam and Holter Reservoir, 1982.....	26
9. Distribution of YOY brown trout captured by electrofishing in shallow-water areas along the banks of the Missouri River between Hauser Dam and Holter Reservoir, 1983.....	34

LIST OF TABLES (continued)

Table	Page
10. Distribution of YOY rainbow trout captured by electrofishing in shallow-water areas along the banks of the Missouri River between Hauser Dam and Holter Reservoir, 1983.....	35
11. Movement of marked YOY brown trout and rainbow trout in the Missouri River between Hauser Dam and Holter Reservoir, 1983.....	36
12. Number of stranded fish observed, by area and species, during the 17 August 1982 reduced-flow test on the Missouri River between Hauser Dam and Holter Reservoir.....	44
13. Number of fish observed isolated in pools, by area and species, during the 17 August 1982 reduced-flow test on the Missouri River between Hauser Dam and Holter Reservoir.....	46
14. Number of YOY trout (brown trout and rainbow trout combined) observed at four sampling stations during three sampling periods in the Missouri River between Hauser Dam and Holter Reservoir, 1983.....	46
15. Discharge, change in discharge, and area dewatered for four sampling stations during two sampling periods (29 June-2 July <u>vs.</u> 4 August) in the Missouri River between Hauser Dam and Holter Reservoir, 1983.....	48
16. Means and ranges of fish length and habitat parameters for YOY brown trout captured by electrofishing during selected periods of normal seasonal discharges (29 June-2 July, 26-29 July, and 23-25 August) and reduced discharges (4 August) in the Missouri River between Hauser Dam and Holter Reservoir, 1983.....	54
17. Means and ranges of fish length and habitat parameters for YOY rainbow trout captured by electrofishing during selected periods of normal seasonal discharges (29 June-2 July, 26-29 July, and 23-25 August) and reduced discharges (4 August) in the Missouri River between Hauser Dam and Holter Reservoir, 1983.....	55

LIST OF TABLES (continued)

Table	Page
18. Catch statistics for trout emigrating from Beaver Creek into the Missouri River, 1983.....	61

LIST OF TABLES (continued)

Appendix Table	Page
1. Schedule for monitoring growth, abundance, distribution, and movement of YOY brown trout and rainbow trout in the Missouri River between Hauser Dam and Holter Reservoir, 1983...	81
2. Schedule for sampling habitat used by YOY brown trout and rainbow trout in the Missouri River between Hauser Dam and Holter Reservoir, 1982...	82
3. Mean lengths and length ranges of YOY brown trout captured by electrofishing on selected sampling dates in the Missouri River between Hauser Dam and Holter Reservoir, 1983.....	83
4. Mean lengths and length ranges of YOY rainbow trout captured by electrofishing on selected sampling dates in the Missouri River between Hauser Dam and Holter Reservoir, 1983.....	84

LIST OF FIGURES

Figure	Page
1. Map of Missouri River showing Hauser Dam and study area.....	5
2. Mean monthly discharge of the Missouri River at Hauser Dam for the periods 1954-1976 and 1982-1983.....	7
3. Mean monthly water temperature of the Missouri River at Hauser Dam for the period 1982-1983..	8
4. Mean monthly discharge of Beaver Creek, April to November, for the period 1982-1983.....	11
5. Mean monthly water temperature of Beaver Creek for the period 1982-1983 (no data for February).....	13
6. Map of study area showing YOY trout electrofishing sections (1-14), stranding sampling areas (1-4), and Beaver Creek emigration trap.....	15
7. Mean lengths of YOY brown trout and rainbow trout captured by electrofishing on selected sampling dates in the Missouri River between Hauser Dam and Holter Reservoir, 1983.....	31
8. Numbers of YOY brown trout and rainbow trout captured by electrofishing during 14 sampling periods in the Missouri River between Hauser Dam and Holter Reservoir, 1983.....	32
9. Length frequencies of YOY brown trout and rainbow trout captured by electrofishing in the Missouri River between Hauser Dam and Holter Reservoir, April-October, 1982.....	38
10. Distribution, by depth and mean water velocity, of YOY brown trout and rainbow trout captured by electrofishing in the Missouri River between Hauser Dam and Holter Reservoir, April-October 1982.....	39

LIST OF FIGURES (continued)

Figure	Page
11. Distribution, by distance to shore and dominant substrate type, of YOY brown trout and rainbow trout captured by electrofishing in the Missouri River between Hauser Dam and Holter Reservoir, April-October, 1982.....	40
12. Distribution, by number of cover components and cover type, of YOY brown trout captured by electrofishing in the Missouri River between Hauser Dam and Holter Reservoir, April-October, 1982.....	42
13. Distribution, by number of cover components and cover type, of YOY rainbow trout captured by electrofishing in the Missouri River between Hauser Dam and Holter Reservoir, April-October, 1982.....	43
14. Water depth profiles of four sampling stations at different discharges in the Missouri River between Hauser Dam and Holter Reservoir, 29 June-2 July <u>vs.</u> 4 August, 1983.....	50
15. Mean water velocity profiles of four sampling stations at different discharges in the Missouri River between Hauser Dam and Holter Reservoir, 29 June-2 July <u>vs.</u> 4 August, 1983.....	52
16. Probability-of-use curves for YOY brown trout and rainbow trout in the Missouri River between Hauser Dam and Holter Reservoir, 1982.....	56
17. Young-of-the-year brown trout and rainbow trout habitat at different discharges as predicted by the PHABSIM model, Transect Set No. 1, in the Missouri River between Hauser Dam and Holter Reservoir, 1982.....	58
18. Young-of-the-year brown trout and rainbow trout habitat at different discharges as predicted by the PHABSIM model, Transect Set No. 2, in the Missouri River between Hauser Dam and Holter Reservoir, 1982.....	59

LIST OF FIGURES (continued)

Figure	Page
19. Weekly counts of rainbow trout emigrants from Beaver Creek into the Missouri River, June-August 1983.....	62

ABSTRACT

Daily flow fluctuations would occur in the Missouri River between Hauser Dam and Holter Reservoir if Hauser Dam were converted to a hydroelectric peaking facility. To address potential impacts of fluctuating flows on free-swimming young-of-the-year (YOY) brown trout (Salmo trutta) and rainbow trout (S. gairdneri) emergence, growth, abundance, distribution, movement, and habitat use were investigated. During reduced-flow tests stranding, isolation, displacement, and habitat changes were evaluated. Hydraulic modeling was used to predict changes in the quantity of usable habitat at different discharges. Recruitment from a tributary into the river was also monitored. Field data were collected between April 1982 and November 1983. Young-of-the-year brown trout were first observed in early April while YOY rainbow trout were first found in mid-June. Both species used relatively shallow, low-velocity water near shore where cover was abundant. Reduced-flow tests in August of each year revealed little stranding or isolation, and YOY trout were not permanently displaced from temporarily dewatered habitat. Hydraulic modeling predicted an increase in the quantity of habitat as discharge decreased, but field observations indicated a reduction in habitat quality. The tributary was found to be a relatively important source of recruitment to the river rainbow trout fishery but rather unimportant to the river brown trout fishery.

INTRODUCTION

The flowing portion of the Missouri River between Hauser Dam and Holter Reservoir is a high quality fishing and recreation area. Sportfishing in this reach focuses on brown trout (Salmo trutta), rainbow trout (S. gairdneri), and mountain whitefish (Prosopium williamsoni). Longnose sucker (Catostomus catostomus) and white sucker (C. comersoni) are commonly caught, but not actively harvested. Walleye (Stizostedion vitreum), though rarely taken, are a prized addition to the creel. Brown trout, mountain whitefish, longnose sucker, white sucker, and walleye populations are entirely self-sustaining. The rainbow trout population is augmented by annual stocking of hatchery-reared fish into Canyon Ferry, Hauser, and Holter Reservoirs.

Hauser Dam has been operated by Montana Power Company as a run-of-the-river hydroelectric power plant, i.e. when the reservoir is full, all water which cannot pass through the turbines must be spilled over the dam. Recent engineering studies by Montana Power Company indicated that construction of a new powerhouse, coupled with hydroelectric peaking, would maximize the operational benefit:cost ratio. Hydroelectric peaking would alter

discharge patterns that have been in effect since 1954 (when the U.S. Bureau of Reclamation initiated hydroelectric power generation at Canyon Ferry Dam located approximately 24 km upstream) and daily flow fluctuations in the river downstream of the dam would occur during one or more seasons of the year.

This study was part of a larger investigation designed to predict potential impacts of altering discharge patterns from Hauser Dam on fish populations (White et al. 1984). Due to the importance of the brown trout and rainbow trout fisheries, research emphasis was placed on these species. Specifically, my study concerned potential impacts of fluctuating flows associated with hydroelectric peaking on young-of-the-year brown trout and rainbow trout.

Effects of fluctuating flows due to hydroelectric peaking, experimental drawdowns, and dam inspections on juvenile salmonids have been reported since the 1950's. Lindroth (1956) observed lateral displacement of age-0 anadromous brown trout during daily fluctuations below a hydroelectric plant on a large Swedish river. A number of investigators have reported stranding of fry and fingerlings of chinook salmon (Oncorhynchus tshawytscha), chum salmon (O. keta), coho salmon (O. kisutch), steelhead trout (Salmo gairdneri), and rainbow trout on dewatered substrate (Phillips 1969; Phinney 1974; Witty and Thompson

1974; Bauersfeld 1977,1978; Becker et al. 1981). Others have observed that juvenile fish may become isolated in pools during reduced discharges and exposed to increased water temperatures, decreased dissolved oxygen levels, and increased predation (Bauersfeld 1978; Becker et al. 1981).

I know of no information on potential impacts of fluctuating flows on young-of-the-year brown trout or rainbow trout under flow regimes similar to those tested by Montana Power Company at Hauser Dam. The following objectives were established for investigating potential impacts on young-of-the-year of both species: 1. determine date of earliest emergence; 2. monitor growth, abundance, distribution, and movement; 3. locate and describe habitat used by young-of-the-year trout; 4. evaluate stranding, isolation, and displacement during reduced-flow tests; 5. observe and predict habitat changes at different discharges; and 6. determine the importance of Beaver Creek as a source of recruitment to the river fishery.

Field research for this study was conducted between April 1982 and November 1983.

DESCRIPTION OF STUDY AREAS

Missouri River Below Hauser Dam

Hauser Dam is located on the Missouri River approximately 23 km northeast of Helena, Montana. The dam, in operation since 1911 as a run-of-the-river hydroelectric power generating facility, is a concrete structure with a height of 39.6 m, length of 135.6 m, and a spillway crest elevation of 1,103.7 m above mean sea level. Present intake capacity of the turbines is 121.8 m³/sec; surplus water exceeding this capacity is spilled (White et al. 1984).

The Missouri River study area extended from Hauser Dam downstream to American Bar Gulch near the head of Holter Reservoir, a river distance of about 6.8 km (Figure 1). From the dam to the mouth of Beaver Creek, the river flows in a confined channel through a high-walled, rugged canyon. It continues through a narrow floodplain bordered by several benches and bars until reaching Upper Holter Reservoir.

A ponderosa pine (Pinus ponderosa)-grassland vegetation type is dominant along the banks of the river; patches of red osier dogwood (Cornus stolonifera) and willow (Salix sp.) are also present (White et al. 1984).

