The effects of controlled dewatering on a trout stream

by Melvin Earl Kraft

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Fish and Wildlife Management
Montana State University

Abstract:
The effect of controlled flow-reductions on the physical characteristics and fish populations of Blacktail Creek, Montana, were studied from June, 1965, through September, 1967. Three test sections (designated A, B, and C) were dewatered 75%, 50%, and 25% respectively for about 3 months during the summers of 1965 and 1966 and all three sections, were dewatered 90$ during 1967. Two additional sections were designated as controls.

A pool and run in each section were mapped and their fish populations sampled. About 90% of the fish were eastern brook trout. During 1965 and 1966 catchable trout were jaw-tagged while in 1967 they were cold-branded. Average current velocity was the most effected physical parameter with over 70% reduction when flows were reduced 90%. Area and average depth were least effected. Fast water types which comprised over 60% of the area at normal flows were reduced to 15% or less while slow-shallow water types increased from about-35% at normal flows to about 85% when flows were reduced 90%. During 1965 and I966 no substantial changes in numbers or weights of fish could be attributed to flow reductions. The standing crop of eastern brook trout in two runs were most effected during 1967. Number decreased about 75% and weight over 58%. Movement of marked fish was greatest from section B and C runs which was consistent with low standing crops in these areas. A multiple linear regression with physical parameters as independent variables and fish numbers as dependent variables accounted for 77% and 83% of the variation in the number of age I and older brook trout in runs and pools and was significant at the 0.01 level.

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Approved:

Head, Major Department

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Bozeman, Montana

March, 1968

ACKNOWLEDGMENT

The author wishes to thank the following for their contributions to the study: Dr. Richard J. Graham directed the study and aided in preparation of the manuscript; Mr. Al Wipperman and Mr. John Gaffney of the Montana Fish and Game Department set up the dewatering system and gave suggestions and aid; Dr. William Gould, William McClay, Allen Elser, and Steve Lewis of the Montana Cooperative Fishery Unit for help with the field work; the Rock Island Ranch permitted the use of their property for a study area; Dr. W. E. Booth identified plants; David Jacobson assisted with statistical analyses; and my wife Carol, for aid and encouragement. The investigation was financed by the Montana Cooperative Fishery Unit and the Montana Fish and Game Department under Federal Aid to Fish Restoration Projects F-9-R.

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ABSTRACT

The effect of controlled flow reductions on the physical characteristics and fish populations of Blacktail Creek, Montana, were studied from June, 1965, through September, 1967. Three test sections (designated A, B, and C) were dewatered 75%, 50%, and 25% respectively for about 3 months during the summers of 1965 and 1966 and all three sections were dewatered 90% during 1967. Two additional sections were designated as controls. A pool and run in each section were mapped and their fish populations sampled. About 90% of the fish were eastern brook trout. During 1965 and 1966 catchable trout were jaw-tagged while in 1967 they were cold-branded. Average current velocity was the most effected physical parameter with over 70% reduction when flows were reduced 90%. Area and average depth were least effected. Fast water types which comprised over 60% of the area at normal flows were reduced to 15% or less while slow-shallow water types increased from about 35% at normal flows to about 85% when flows were reduced 90%. During 1965 and 1966 no substantial changes in numbers or weights of fish could be attributed to flow reductions. The standing crop of eastern brook trout in two runs were most effected during 1967. Number decreased about 75% and weight over 58%. Movement of marked fish was greatest from section B and C runs which was consistent with low standing crops in these areas. A multiple linear regression with physical parameters as independent variables and fish numbers as dependent variables accounted for 77% and 83% of the variation in the number of age I and older brook trout in runs and pools and was significant at the 0.01 level.

INTRODUCTION

The normal flows of many streams are altered when water is used or controlled for hydroelectric production, irrigation, flood control, or municipal water supplies. Pfitzer (1954), Irving and Cuplin (1956), Powell (1958), Abdurakhmanov (1958), Dyuzhikov (1961), and Sharonov (1963), reported that reduced and fluctuating flows below reservoirs adversely affected fish growth and reproduction and caused certain species to disappear. Work by Weber (1959) and Curtis (1959) showed the effects of reduced flows on the physical characteristics of rivers. Schieminz (1960) showed fish movement at changing flows and stated that the variation in the local living space depending on the level of the water appeared to be a substantial cause for fish movement. Clothier (1954) reported upstream movement of fish coincident with water reductions in irrigation canals. It is possible that decreased cover and increased competition brought about by reduced water levels caused the fish to move.

Of major importance in the western United States is the reduction of summer stream flows when water is used for irrigation. Spindler (1955) and Clothier (1953, 1954) discussed fish losses in irrigation diversions and methods of reducing such losses but little is known about how this dewatering affects the stream.

The Montana Fish and Game Department began a study in 1964 to determine if reduced stream flows affect a trout population, and if so, what flows are required to sustain a population sufficient for recreational fishing (Wipperman, 1966). In conjunction with the above study

I undertook an investigation to determine how different amounts of dewatering affected the physical characteristics of specific pools and runs and their fish populations. Field studies were made on Blacktail Creek, Montana, from June, 1965, through September, 1967.

DESCRIPTION OF AREA

Blacktail Creek drainage (312 sq. miles) lies in Beaverhead County in southwestern Montana. The major tributaries rise on the southwest slopes of the Snow Crest Mountains about 8,600 feet msl (mean sea level) and flow about 18 miles before joining to form Blacktail Creek at approximately 6,500 feet msl. At higher elevations they flow through coniferous forests which gradually give way to sagebrush or grassland hills. Blacktail Creek meanders about 28 miles to join the Beaverhead River at about 5,100 feet msl at Dillon, Montana. The upper half of Blacktail Creek flows through a broad valley with grass covered collescent alluvial fans bordering both sides of the 1.4 mile wide flood plain. The valley is cut in Tertiary deposits of glacial outwash, sand, and gravel (Alder, 1953). The major land use in this area consists of livestock grazing and haying of native grasses in meadows. The lower half of the creek cuts across the Beaverhead valley and is severely dewatered for irrigation during summer months. The study area was located in the upper half of Blacktail Creek, above irrigation diversions, where the stream gradient was 41 feet per mile.

Flows of Blacktail Creek are characterized by high spring runoffs and low flows the remainder of the year. Flow records from a United States Geological Survey gage station about 8 miles below the study area showed that from 1948 through 1965 a peak mean monthly discharge of 237 cfs (cubic feet per second) occurred in June, 1964, and the low monthly discharge of 16 cfs occurred in the winters of 1964 and 1959. Mean monthly discharges for 1965, 1966, and the 18 year average are shown in Figure 1.

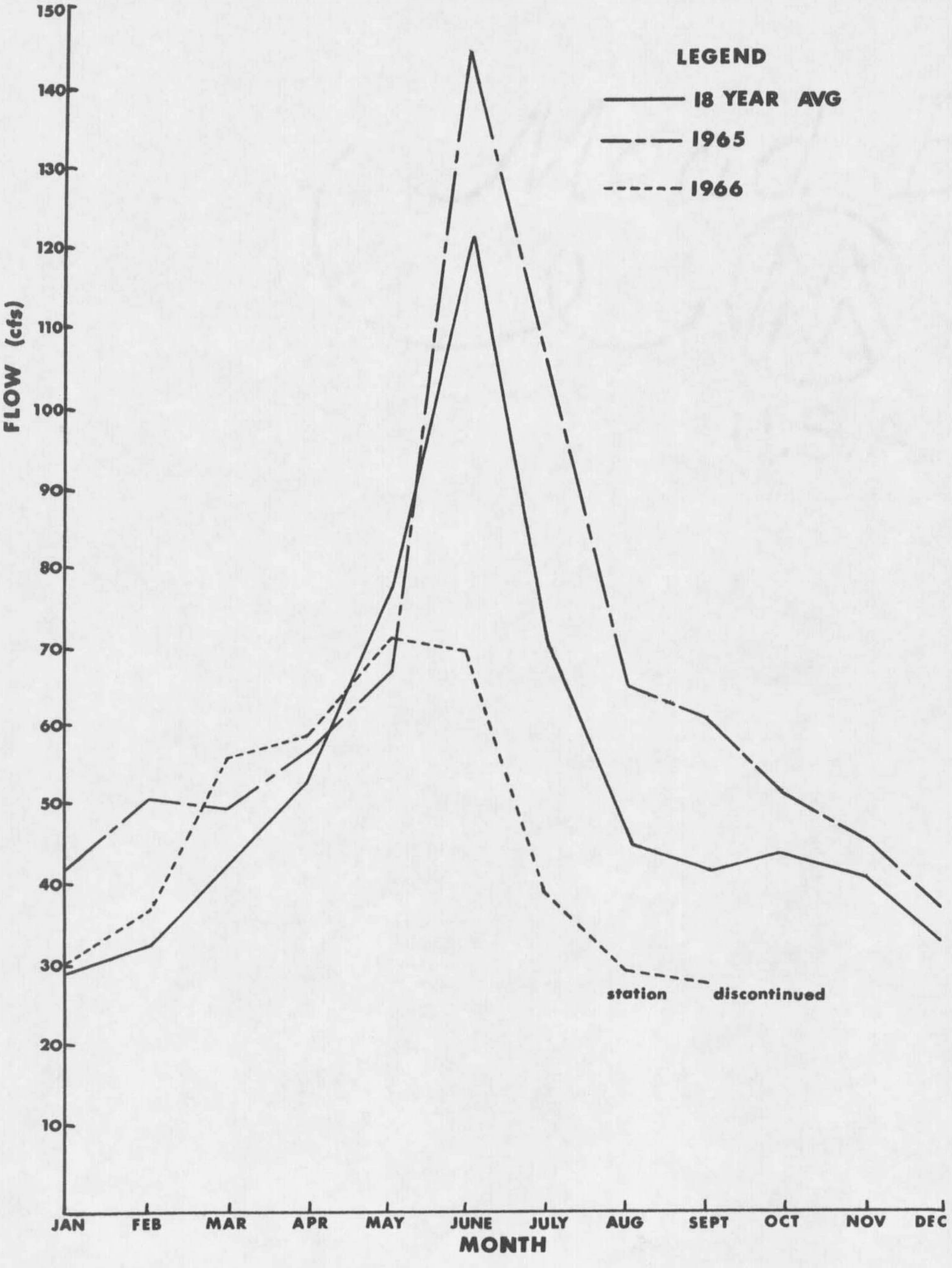

Figure 1: Mean monthly discharges for 1965, 1966, and the 18 year average.

No tributaries occurred between the study area and the gage station but flows increased progressively downstream due to accretions from springs and ground water. The gage station was discontinued in September, 1966, but a flow recorder at the study area showed 1967 flows to be near average.

Blacktail Creek flows in a well defined channel and bank erosion or flooding are uncommon. Shrubs comprised 57% of the stream bank vegetation and open meadows 43%. Willow (Salix sp.) was predominant in shrub areas being interspersed with water birch (Betula sp.), wild rose (Rosa sp.) and wild gooseberry (Ribes sp.) (Figure 4). Meadow vegetation was primarily sedges (Carex sp.), and grasses (Agrostis sp. and Phleum sp.). Slender pondweed (Potamogeton filiformis) and aquatic buttercup (Ranunculus aquatilis) were present in the stream.

Temperature ranges for July through September were: 30.5 - 63.5 F, 31.5 - 68.0 F, and 42.5 - 66.5 F for 1965, 1966, and 1967 respectively. Chemical analyses made in the study area during August, 1965, gave the following: total alkalinity 202 ppm, total hardness 237 ppm and specific conductance 284 microhms.

Species of fish taken in order of decreasing abundance were brook trout (Salvelinus fontinalis), rainbow trout (Salmo gairdneri), and mountain whitefish (Prosopium williamsoni). Mottled sculpins (Cottus bairdi) while abundant were not collected efficiently.

METHODS

A 1,700 foot portion of Blacktail Creek was divided into three sections of about equal length and designated section A, B, and C progressing downstream (Figure 2). A diversion canal was dug around the sections with short returns entering the upper end of section B and C. Steel structures for regulating flows were installed in May, 1965, at the head of section A, the head of the canal, and in the canal and at the head of each return to section B and C. Fish traps were installed at the lower end of section C and at the upper end of section A in April, 1966. Two control sections were established, one about one-half mile above and the other one-fourth mile below the dewatered sections. A "pool" and "run" in each of these five sections were selected for intensive study. A pool was defined as a deep-slow portion of the stream, usually in a bend and with associated cover. A run was generally a straight portion of stream with average depth, average velocity and some cover. The stream was closed to fishing from one mile above to one mile below the study sections.

The base flow for dewatering was determined by considering August flows for the six years preceding 1965 and the lowest three years (1959, 1961, and 1963) were averaged to give 32 cfs. Section A was dewatered to 8 cfs, section B to 16 cfs, and section C to 24 cfs during 1965 and 1966. All three sections were dewatered about 90% to a flow of 3 cfs in 1967 (Figures 3 - 6). Ground water accretions were not sufficient to alter flows in the dewatered sections. The dewatering period was selected to

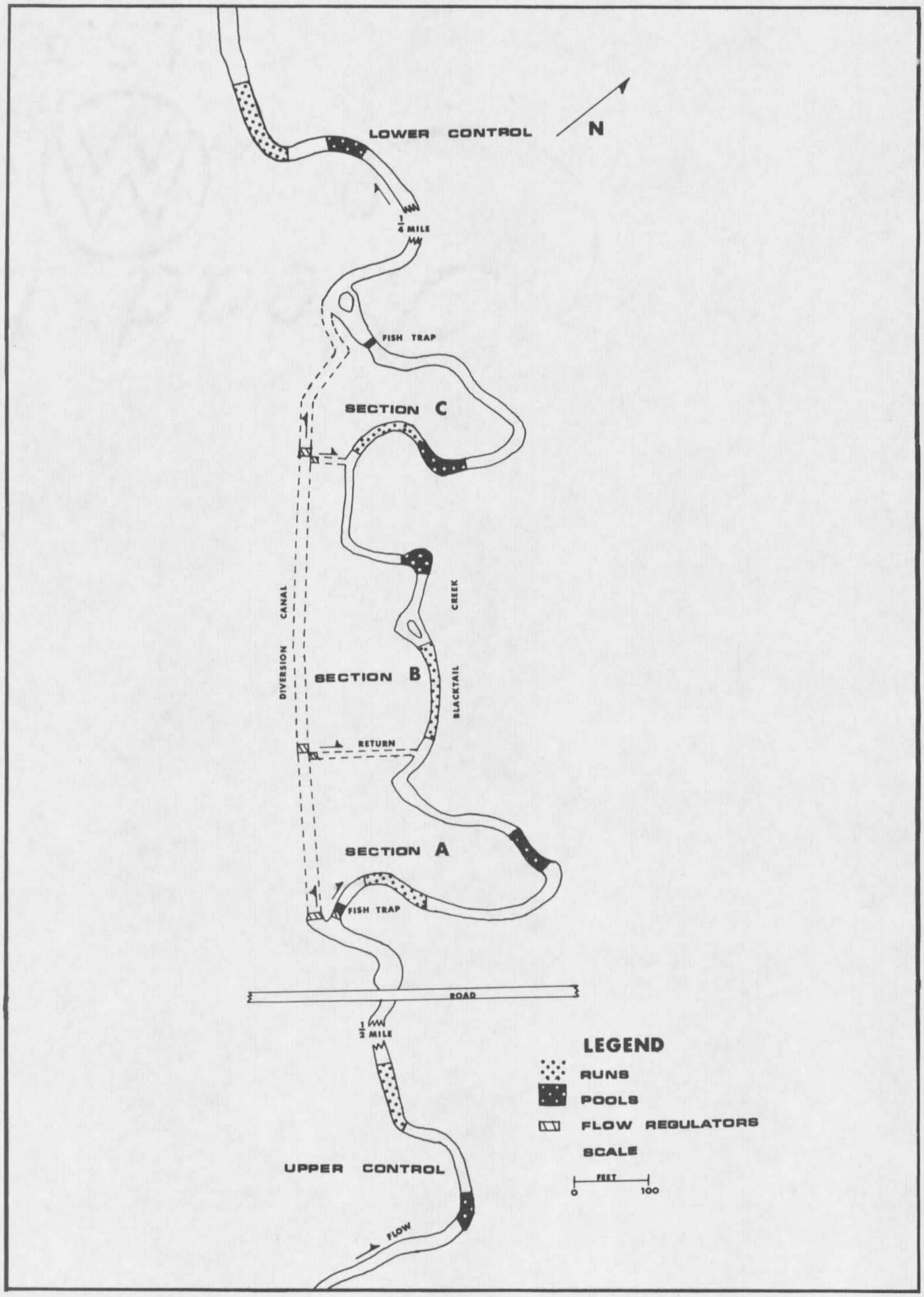

Figure 2: Map of study area showing location of study sections and diversion canal.