



The benthic macroinvertebrates of the Musselshell River, Montana  
by Mark William Gorges

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE  
in Fish and Wildlife Management

Montana State University

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**Abstract:**

The benthic macroinvertebrates and water quality of the Musselshell River were studied from June 1974 through June 1975 prior to anticipated alteration of flows in the river. Ephemeroptera, Trichoptera and Diptera combined accounted for over 98% of the organisms taken from modified Hester-Dendy plates recovered from riffles at six stations. ChoroterPes, Baetis, Simuliidae and Hydropsyche together comprised about 80% of the organisms collected. The ranges of dissolved oxygen, pH and temperature were similar, at all stations. Conductivity, turbidity, alkalinity, calcium and total hardness, chloride, and sulfate levels increased progressively downstream.

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MARK WILLIAM GORGES

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Approved:

William R. Gould  
Chairman, Examining Committee

James M. Pickett  
Head, Major Department

Henry L. Parsons  
Graduate Dean

MONTANA STATE UNIVERSITY  
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## ABSTRACT

The benthic macroinvertebrates and water quality of the Musselshell River were studied from June 1974 through June 1975 prior to anticipated alteration of flows in the river. Ephemeroptera, Trichoptera and Diptera combined accounted for over 98% of the organisms taken from modified Hester-Dendy plates recovered from riffles at six stations. *Choroterpes*, *Baetis*, Simuliidae and *Hydropsyche* together comprised about 80% of the organisms collected. The ranges of dissolved oxygen, pH and temperature were similar at all stations. Conductivity, turbidity, alkalinity, calcium and total hardness, chloride, and sulfate levels increased progressively downstream.

## INTRODUCTION

The Musselshell River flows through the Bull Mountains Coal Field which contains some of the most important coal deposits in Montana. The increasing development of coal reserves in Montana makes it likely coal production from this area will be expanded. Additional development of the Bull Mountains Coal Field could cause an increased demand for water resulting in alteration of the river's flow and water quality.

Little information on the biota and water chemistry of the Musselshell River is presently available. I conducted field research from 12 June 1974 through 30 June 1975 to obtain baseline information on the benthic macroinvertebrates and the water quality of the Musselshell River prior to increased coal development. The data collected should facilitate the monitoring of these parameters.

## DESCRIPTION OF THE STUDY AREA

The Musselshell River is located in Central Montana (Figure 1). It rises from the junction of the North and South Forks of the Musselshell River in Wheatland County, flows easterly through Wheatland, Golden Valley and Musselshell Counties, northward along the east side of Petroleum County and empties into Fort Peck Reservoir on the Missouri River.

Most of the Musselshell Valley was not glaciated during the Pleistocene (Perry, 1933). It is a relatively narrow valley filled, in places, to depths of over 50 feet with interbedded silt, clay, sand and gravel typical of deposits formed by ordinary stream action (Perry, 1933).

Flows of the Musselshell River have been monitored by the U.S.G.S. at four stations in the study area for over 27 consecutive years. A summary of the flows at these stations during the period of record and the study period is presented in Table 1. Subsurface flows in the riverbed gravel are usually maintained even when surface waters dry up (Perry, 1933).

Six collecting sites were established over the approximately 300 km of the river flowing in an easterly direction (Figure 1). The locations of stations and distances between stations are given in Table 2. Stations 1, 2 and 3 lie in a portion of the river supporting

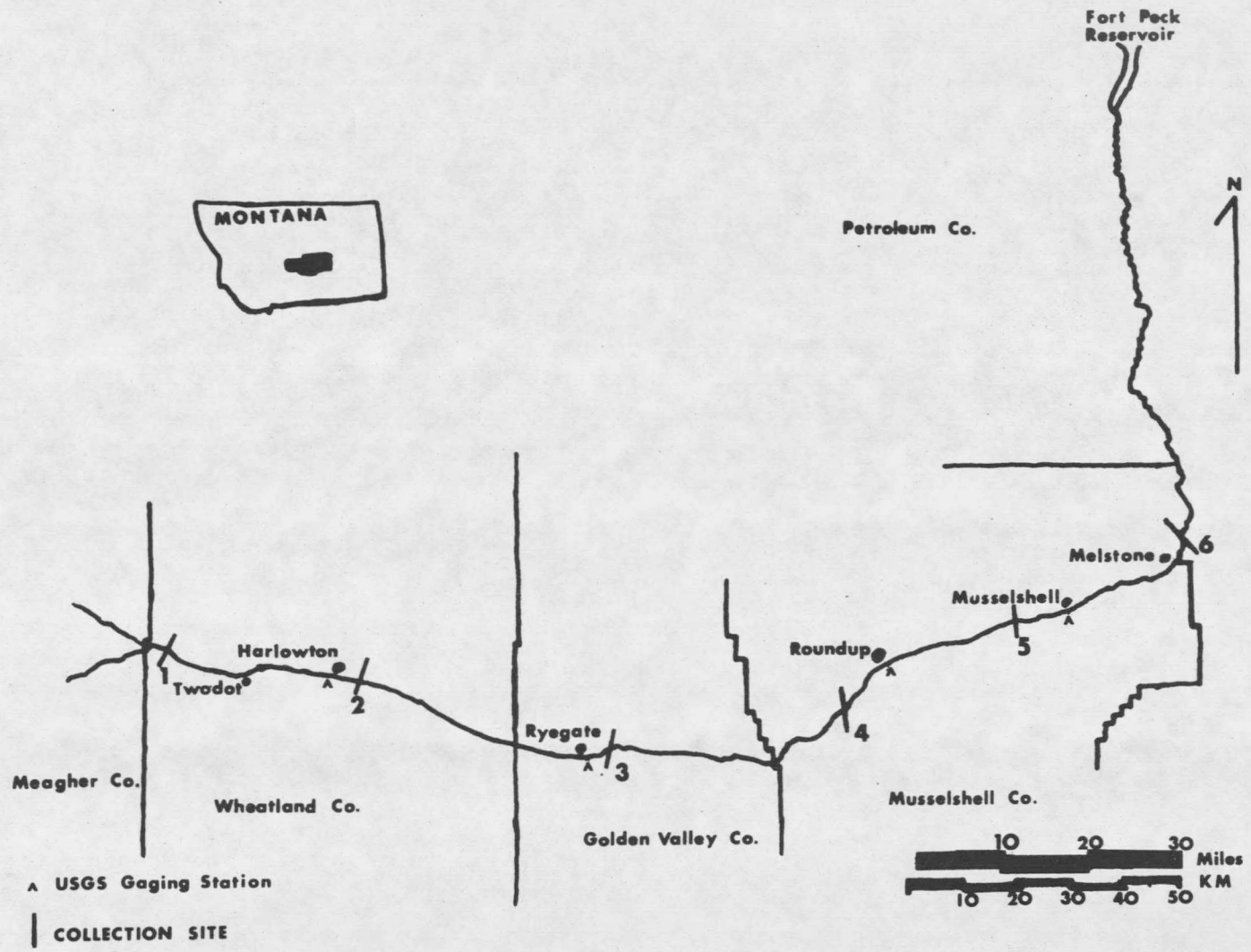


FIGURE 1. Map of the study area showing location of collection sites.

TABLE 1. AVERAGE, MAXIMUM AND MINIMUM FLOWS (in cfs) OVER THE PERIOD OF RECORD AND THE STUDY PERIOD AT FOUR STATIONS ON THE MUSSELSHELL RIVER (USGS, 1975 and 1976\*).

Station	Period of Record			Period of Study		
	Avg.	Max.	Min.	Avg.	Max.	Min.
Harlowton	158	6,200	0	372	6,200	40
Ryegate	163	9,500	0	445	7,550	25
Roundup	196	9,610	0.6	479	6,600	25
Musselshell	185	9,850	0	485	6,800	30

\*Preliminary data subject to revision.

TABLE 2. LOCATIONS OF COLLECTING SITES AND DISTANCE (in river km) BETWEEN STATIONS.

Station #	Township	Range	Section	Distance from Last Upstream Station
1	T8N	R12E	5	--
2	T8N	R16E	34	54
3	T6N	R20E	2	55
4	T7N	R25E	8	69
5	T9N	R28E	28	56
6	T10N	R31E	21	61

trout while Stations 4, 5 and 6 lie in a section containing warmwater fish.

The bottom types varied at sampling sites. The substrate at Station 1 was gravel. At Station 2 the gravel bottom was interspaced with silt. The substrate at Station 3 was silty mud over broken sandstone slabs. The bottom at Stations 4, 5 and 6 was gravel embedded in a layer of silty mud.

## METHODS

Benthic macroinvertebrates were sampled with artificial substrates similar to Hester-Dendy samplers (APHA, 1971) but with 11 x 11 cm plates giving a total surface area of 0.2 m<sup>2</sup> per sampler. Four samplers were used at each station. All plates were anchored in areas of visually similar current and positioned just above the substrate with plates lying parallel to the bottom. Macroinvertebrates were collected after a colonization period of approximately four weeks. In August 1974, four additional samplers were installed at both Stations 1 and 6; two of these samplers were collected from each station after two and six weeks of colonization.

The material on each recovered sampler was scraped into a separate jar and preserved in 10% formalin. Samples were taken to Montana State University where they were individually washed on a US Series Number 30 screen. The aquatic macroinvertebrates from each sample were hand picked from the material retained by the screen and preserved in 50% isopropyl alcohol. These organisms were identified to the lowest practical taxon using Ward and Wipple (1959) and counted.

The individual diversity based on Brillouin's interpretation of the information theory and the redundancy of the collection for each site on each collecting date were calculated using the formulae of Pielou (1969). Data were calculated at the Montana State University

Computer Center utilizing a computer program written by personnel of the Department of Mathematics, Montana State University.

Conductivity, turbidity, pH, alkalinity, calcium hardness, total hardness, chloride, sulfate and dissolved oxygen were measured with a Hach DR/EL2 with Conductivity kit. Measurements were made monthly from July 1974 through June 1975, conditions permitting, at streamside on dates scheduled for collecting macroinvertebrates. The range of water temperatures at each station during each colonization period was recorded with a Taylor Max-Min thermometer. The water temperature at the time of each collection was taken with a pocket thermometer.

## RESULTS

### Biotic

#### 4 Week Sampling

*Ordinal Composition.*-- During the monthly sampling, 192 samplers were installed. Ice, floods and shifting substrates prevented the recovery of 60 samplers. The numbers and kinds of benthic macro-invertebrates collected from each sampler retrieved are presented in Appendix Tables 6 to 11. During the study, 25,088 organisms belonging to nine orders were taken. Ephemeroptera comprised 43% of the number collected and contained representatives of 11 genera. Trichoptera accounted for 37% of the total number and contained 5 genera. Diptera made up 18% of the collection and consisted of three families. Odonata, Plecoptera, Hemiptera, Neuroptera, Pulmonata and Coleoptera each made up 1% or less of the total number. These orders contained 4, 3, 1, 1, 1 genera and 1 family, respectively.

The average number and ordinal composition of organisms collected at each station is presented in Table 3. Over six times as many organisms per sampler were taken from Station 6 as from Station 5. Mayflies and caddisflies combined accounted for 80% or more of the macroinvertebrates collected at each station except Station 1 where they made up 59%. In bottom samples taken by the Montana State Board of Health (1960), caddisflies and dipterans at a site near Station 2



TABLE 3. AVERAGE NUMBERS<sup>+</sup> PER SAMPLER AND PERCENT<sup>+</sup> COMPOSITION  
(in parentheses) OF BENTHIC MACROINVERTEBRATES BY ORDER  
FROM MONTHLY COLLECTIONS. Hyphens indicate zero counts.

Station # of Samplers	1 28	2 21	3 17	4 23	5 17	6 26
Order						
Ephemeroptera	43 (25)	65 (32)	51 (53)	93 (71)	38 (64)	155 (41)
Diptera	62 (36)	39 (19)	11 (11)	7 (5)	2 (3)	71 (19)
Trichoptera	57 (34)	101 (49)	31 (32)	30 (23)	17 (30)	152 (40)
Plecoptera	3 (2)	>1 (>1)	1 (1)	>1 (>1)	>1 (>1)	>1 (>1)
Odonata	-	-	>1 (>1)	>1 (>1)	>1 (>1)	>1 (>1)
Coleoptera	1 (1)	1 (>1)	1 (1)	1 (1)	1 (2)	3 (1)
Hemiptera	-	>1 (>1)	1 (1)	-	-	-
Neuroptera	-	-	-	>1 (>1)	-	-
Pulmonata	4 (2)	>1 (>1)	1 (1)	>1 (>1)	-	-
Totals	170 (100)	206 (100)	97 (100)	131 (100)	59 (99)*	381 (101)*

<sup>+</sup>Rounded to the nearest whole number.

\*Rounding gave numbers unequal to 100%.

and caddisflies and gastropods at a location near Station 4 made up 80% or more of the organisms collected.

Not all stations were sampled during the same months. However, all stations were sampled during the months of July, August, October and November. During these months, the relationships between numbers and ordinal composition were similar to those presented in Table 3.

*Generic Composition.*-- The composition of the taxa within each order is presented in Table 4. The mayfly *Choroterpes*, the dipteran Simuliidae and the caddisfly *Hydropsyche* were the dominant taxa, with each contributing over twice as many organisms per sampler as any other taxon. Each form accounted for over 50% of the numbers within its order and was most abundant at Station 6.

Twenty-six of the thirty-two taxa collected during this study have been reported from either the Yellowstone River (Newell, 1975) or the Tongue River (Gore, 1975) in Montana. Of the organisms I collected, the mayfly *Caenis*, the caddisflies *Mystacides* and *Helicopsyche*, the damselflies *Ishmura* and *Calopteryx* and the neuropteran *Sialis* were not found in their studies.

*Distribution.*-- The distribution of the taxa taken in monthly collections throughout the study area is graphically displayed in Figure 2. The mayflies *Heptagenia*, *Choroterpes*, *Tricorythodes* and *Baetis*, the dipterans Simuliidae and Tendipedidae, the caddisflies *Hydropsyche*, *Mystacides* and *Brachycentrus* and the beetle Elmidae were

TABLE 4. AVERAGE NUMBERS<sup>+</sup> PER SAMPLER AND PERCENT<sup>+</sup> COMPOSITION (in parentheses) OF EACH TAXA WITHIN EACH ORDER FROM MONTHLY COLLECTIONS. Hyphens indicate zero counts.

Station	1	2	3	4	5	6	Average
TAXA							
Ephemeroptera							
Ephemeridae							
<i>Ephoron</i>	-	<1 (<1)	<1 (1)	<1 (<1)	2 (5)	1 (1)	1 (1)
Heptagenidae							
<i>Heptagenia</i>	7 (14)	5 (7)	11 (22)	6 (6)	2 (4)	6 (4)	6 (8)
Baetidae							
<i>Isonychia</i>	-	<1 (<1)	7 (14)	8 (7)	4 (9)	6 (4)	4 (5)
<i>Choroterpes</i>	2 (5)	7 (11)	16 (30)	71 (76)	29 (72)	131 (84)	43 (56)
<i>Traverella</i>	-	-	2 (3)	3 (3)	2 (5)	2 (1)	2 (3)
<i>Paraleptophlebia</i>	4 (8)	<1 (<1)	-	-	-	-	1 (1)
<i>Ephemerella</i>	5 (12)	<1 (<1)	-	-	-	-	1 (1)
<i>Tricorythodes</i>	6 (14)	13 (20)	6 (12)	4 (4)	1 (2)	1 (1)	5 (6)
<i>Caenis</i>	-	<1 (<1)	-	-	-	-	<1 (<1)
<i>Brachycercus</i>	-	-	<1 (<1)	<1 (<1)	<1 (1)	-	<1 (<1)
<i>Baetis</i>	22 (48)	39 (60)	9 (17)	1 (1)	1 (3)	9 (5)	14 (18)
Diptera							
Simuliidae							
	51 (83)	31 (78)	7 (67)	4 (61)	1 (62)	81 (96)	29 (85)
Tendipedidae							
	10 (14)	8 (21)	4 (33)	3 (37)	1 (38)	3 (4)	5 (15)

TABLE 4. Continued.

Station	1	2	3	4	5	6	Average
TAXA							
Diptera (continued)							
Tipulidae	<1 (<1)	<1 (<1)	-	<1 (<1)	-	<1 (<1)	<1 (<1)
Trichoptera							
Hydropsychidae							
<i>Hydropsyche</i>	20 (36)	98 (96)	30 (97)	31 (99)	17 (98)	151 (100)	58 (91)
Leptoceridae							
<i>Oecetis</i>	1 (2)	<1 (<1)	-	<1 (<1)	-	-	<1 (<1)
<i>Mystacides</i>	<1 (<1)	<1 (<1)	<1 (<1)	<1 (<1)	<1 (1)	<1 (<1)	<1 (<1)
Brachycentridae							
<i>Brachycentrus</i>	28 (52)	2 (2)	<1 (3)	<1 (1)	<1 (1)	<1 (<1)	5 (8)
Helicopsychidae							
<i>Helicopsyche</i>	5 (10)	1 (1)	-	-	-	-	1 (2)
Plecoptera							
Pteronarcidae							
<i>Pteronarcella</i>	<1 (12)	-	-	-	-	-	<1 (9)
Perlodidae							
<i>Isoperla</i>	3 (81)	<1 (100)	-	<1 (25)	-	-	1 (68)
Perlidae							
<i>Acroneuria</i>	<1 (7)	-	1 (100)	<1 (75)	<1 (100)	<1 (100)	<1 (23)
Odonata							
Gomphidae							
<i>Gomphus</i>	-	-	<1 (13)	-	-	-	<1 (5)
Coenagrionidae							
<i>Argia</i>	-	-	<1 (75)	<1 (44)	<1 (100)	<1 (33)	<1 (57)



















































