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MONTANA FISH AND GAME DEPARTMENT
FISHERIES DIVISION
HELENA, MONTANA

JOB COMPLETION REPORT
RESEARCH PROJECT SEGMENT

State of Montana

Project No. F-20-R-13 Name: South Central Montana Fishery Study

Job No. III Title: Stream Sediment Investigation

Period Covered: October 1, 1967 through September 30, 1968

Abstract:

This report describes findings of data gathered during the report period and compares current data with data collected before completion of three stream habitat improvement projects on Bluewater Creek. Maximum and minimum water temperatures, mean monthly discharge and mean sediment data are tabled and discussed for the report period.

Mean monthly sediment concentrations and loads were lowest at Station 1 and progressively increased downstream. Average suspended sediment load has been reduced by 1.9 tons/day or 32% at Station 2, 14.0 tons/day or 52% at Station 3 and 10.5 tons/day or 44% at Station 4 following the three streambank improvement projects located near Station 2.

Trout composition at all stations on Bluewater Creek represented 37% of the fish sampled in 1968 compared to 13% in 1963 prior to habitat improvement. Trout:rough fish ratios were not appreciably altered following a 32% reduction in sediment load at Station 2. Corresponding with a 52% reduction in sediment load at Station 3, there has been a change in weight ratios of trout:rough fish from 39:61 in 1963 to 63:37 in 1967 to 78:22 in 1968. At Station 4 the trout:rough fish weight ratio has changed from 12:88 in 1963 to 34:66 in 1967 to 51:49 in 1968.

Recommendations:

The detrimental effects of sediment to a trout population in a stream has been clearly shown in the eight years of this study. A continued attempt should now be made to evaluate the major factors causing sedimentation in Bluewater Creek, and to take corrective steps to reduce this sediment. These corrective steps should be evaluated through continued sediment and fish population sampling; if no corrective steps are achieved, sediment analysis should be terminated until corrective steps are achieved. The most effective means of reducing the sediment load in Bluewater Creek appears to be streambank fencing and lining of waste-water ditches.

Objectives:

One objective of the study is to determine the relationships between the sedimentation in a stream and trout production. Specifically, the effects of sediment

on the trout population, egg incubation and bottom fauna are being measured plus the effects of discharge and water temperature on the trout population. Another objective is to evaluate the important factors causing sedimentation and to initiate corrective steps to reduce this sediment.

Techniques Used:

The experimental design and method to obtain sediment, discharge and temperature data are described in F-20-R-5, Job No. III. There are five sampling stations numbered, consecutively, 1 through 5 with 1 designating the upstream station and 5 the farthest downstream station. A depth-integration sampler (DH-48 hand-suspended sediment sampler developed by the U. S. Geological Survey) holding a 1-pint bottle is used to sample the water-sediment mixture. Two bottles are filled per station by submerging the sampler and attached bottle at an equal rate across the stream, thus securing an increment of sample from surface to bottom at 1-foot intervals across the stream. A current meter, a staff gauge and a water-level recorder are used to measure discharge. Water temperatures are obtained from Dickson Minicorder and Ryan recording thermometers, and by pocket thermometers. Landowners adjacent to Bluewater Creek are being contacted in an attempt to develop corrective land-use practices such as streambank fencing, riprapping and lining of waste-water ditches. Fish populations are sampled by electrofishing three 4,000 square-foot sections per station.

Findings:

Data gathered on maximum and minimum water temperatures, mean monthly discharge, and mean sediment concentrations and loads are presented in Tables 1, 2 and 3, respectively. These data are presented for the period, October 1, 1967 through September 30, 1968, to coincide with the 1968 water year designated by the U. S. Geological Survey.

Mean monthly water temperatures on Bluewater Creek varied from a high of 71°F during July at Station 4 to a low of 33°F in January at Station 5. Annual discharge averaged 11, 30, 26, 24 and 52 cfs at Stations 1, 2, 3, 4 and 5, respectively. Flows at Stations 2, 3 and 4 were slightly above the 1960-1967 average. Mean monthly discharge ranged from 8 cfs at Station 4 in July to 76 cfs at Station 5 in October. Mean monthly sediment concentrations and loads were lowest at Station 1 and progressively increased downstream.

Three projects were completed in the spring of 1966 in an attempt to reduce the sediment load in Bluewater Creek. The projects were: (1) Uncontrolled water from an artesian well was obviously contributing suspended sediment at its confluence with Bluewater Creek. This water was placed into a series of pipes and controlled channels and delivered to Bluewater Creek. (2) Several small areas of streambank were sloughing into Bluewater Creek adding to the sediment load. These areas were sloped and rock riprap was added to stablize these banks. (3) Bluewater Fishing Access Site was fenced to control grazing by cattle. The location of these improvements are shown in Figure 1.

The suspended sediment load in tons/day has been measured almost continuously since April 1, 1960. A summary of suspended sediment load data is shown in Table 5. Analysis of the sediment load occurring in Bluewater Creek before and after completion of the streambank improvement projects reveals a marked reduction of suspended sediment for the period (1966-1968) following completion of the three improvements. Abnormally high flows occurred in the spring of 1964 and the sediment load was correspondingly high. Averaging the annual sediment load occurring from April 1960

Table 1. Mean monthly maximum and minimum temperature (^{o}F) at each station on Bluewater Creek from October 1, 1967 through September 30, 1968

Period	Stations									
	1		2		3		4		5	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1967										
October	56	55	57	47	54	50	51	47	50	47
November	54	54	52	47	46	44	44	42	42	39
December	52	52	49	44	46	44	37	35	35	34
1968										
January	51	50	49	45	47	43	36	34	36	33
February	53	50	52	44	48	46	-	-	42	40
March	52	51	55	47	51	46	52	48	47	44
April	54	52	57	50	53	47	52	49	50	47
May	56	54	59	49	59	53	58	54	57	54
June	57	56	61	53	63	57	63	59	64	60
July	59	58	63	50	69	58	71	62	68	62
August	58	57	63	53	61	58	65	59	62	59
September	57	56	59	53	58	56	59	55	60	58
$\bar{X}$	55	54	56	49	55	50	53	49	51	48

Table 2. Mean monthly discharge (cfs) at each station on Bluewater Creek from October 1, 1967 through September 30, 1968

Period	Stations				
	1	2	3	4	5
1967					
October	11	30	27	23	76
November	11	32	31	29	55
December	11	31	27	28	42
1968					
January	11	31	27	27	41
February	11	30	31	29	42
March	11	29	30	30	43
April	10	30	29	31	61
May	10	29	29	25	59
June	11	30	32	24	60
July	11	28	9	8	40
August	11	28	14	11	42
September	11	29	28	21	62
$\bar{X}$	11	30	26	24	52

Table 3. Mean monthly sediment concentrations (ppm) and sediment loads (tons/day) at each station on Bluewater Creek from October 1967 through September 1968

Period	Mean Sediment Concentrations Stations					Mean Sediment Loads Stations				
	1	2	3	4	5	1	2	3	4	5
1967										
October	20	35	104	240	342	0.6	2.8	7.6	14.8	71.1
November	18	33	101	169	178	0.5	2.9	8.3	14.0	27.4
December	19	48	127	204	148	0.5	4.0	9.1	15.5	17.2
1968										
January	8	43	155	295	163	0.2	3.5	11.4	21.8	18.1
February	9	41	212	274	282	0.3	3.4	17.8	21.2	33.2
March	19	50	154	197	266	0.4	4.0	12.7	16.6	31.1
April	17	62	106	78	251	0.5	5.0	8.5	6.4	57.4
May	25	51	435	205	504	0.7	4.0	35.7	13.8	86.6
June	23	70	364	519	1,115	0.7	5.9	118.1	111.8	271.1
July	27	43	85	116	193	0.8	3.2	23.2	14.6	223.4
August	22	44	174	406	1,813	0.7	3.3	11.4	24.2	225.8
September	12	65	149	206	340	0.4	5.2	14.3	13.2	59.8
$\bar{X}$	18	49	180	242	466	0.5	3.9	23.2	24.0	93.5

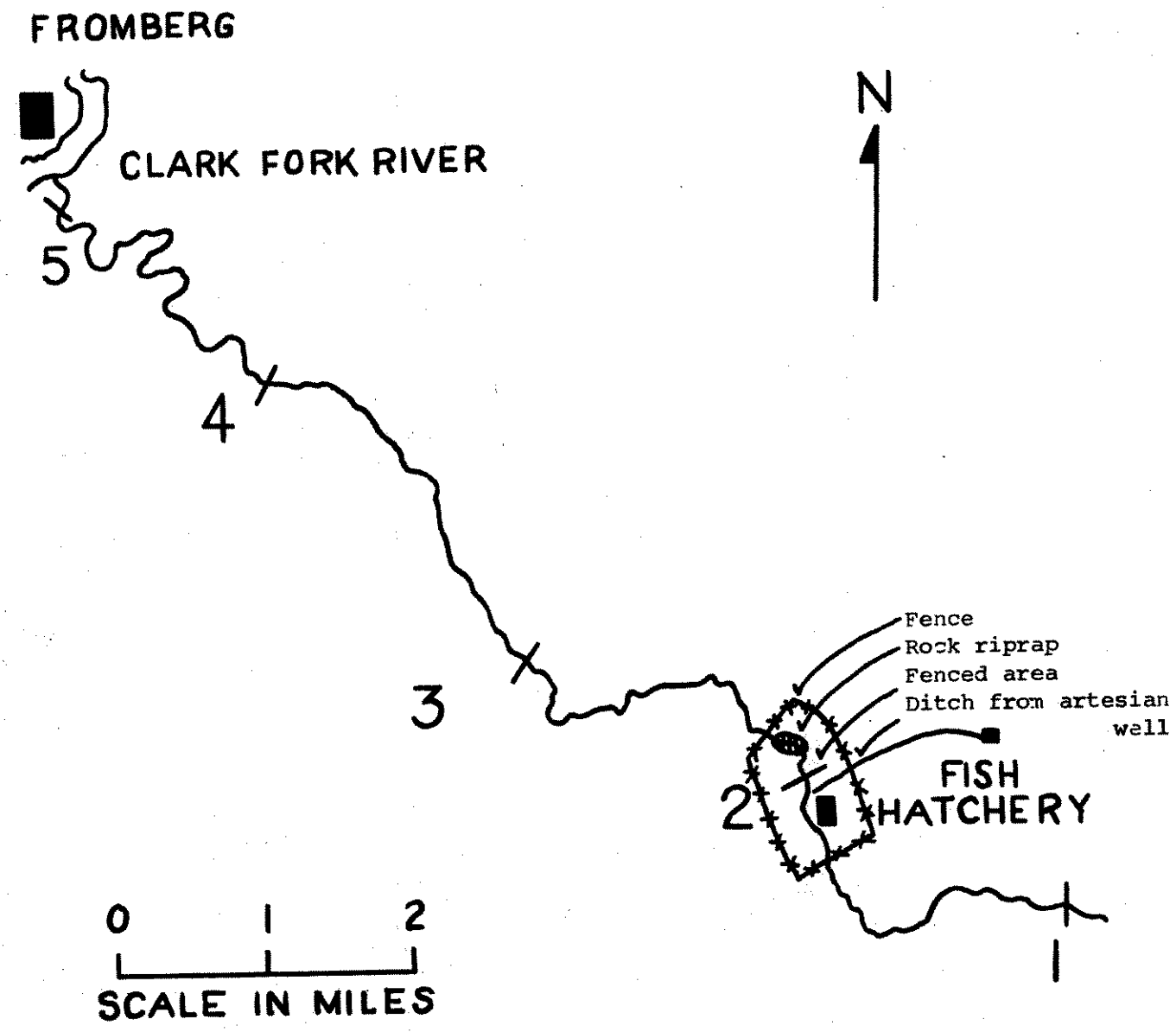

Figure 1. Bluewater Creek, showing sampling stations and improvement areas.

Table 4. Summary of suspended sediment loads (tons/day) at each station on Bluewater Creek occurring before June 1966 and after streambank improvements (1966-1968)

Period	Stations				
	1	2	3	4	5
1960-1966	3.2	9.7	40.2	39.2	88.0
1960-1966 Less abnormal 1963-1964	0.7	6.0	26.9	23.6	75.8
1966-1968	0.7	4.1	12.9	13.1	78.0

Table 5. Number and size distribution of fish captured in Bluewater Creek in July 1968

Stations		Total No.	Av Length 0.1 Inch	Av Weight .01 Lb	Total Weight .01 Lb	Size Range 0.1 Inch	Fish ≤ 7 Inches	Fish > 7 Inches
1	Trout	311	6.4	.12	37.18	2.4 - 12.6	168	143
	Rough fish	0	-	-	-	-	-	-
2	Trout	519	5.6	.10	58.91	2.6 - 17.2	344	175
	Rough fish	15	13.8	1.14	17.11	9.1 - 17.6	0	15
3	Trout	142	6.4	.14	19.76	2.8 - 14.9	81	61
	Rough fish	83	4.6	.07	5.46	2.0 - 12.8	69	14
4	Trout	95	10.6	.41	39.43	2.5 - 18.5	19	76
	Rough fish	642	4.1	.06	38.11	1.6 - 14.5	558	84
5	Trout	9	9.6	.48	4.28	3.2 - 15.5	3	6
	Rough fish	1,096	4.1	.04	39.40	1.5 - 15.5	1,067	29

Table 6. Percentage of total weight and numbers of fish captured from three 4,000 square-foot sections at each of five stations on Bluewater Creek, 1968

Period		Stations				
		1	2	3	4	5
1963	Trout	66 (96)	69 (94)	39 (12)	12 (2)	2 (1)
	Rough fish	34 (4)	31 (6)	61 (88)	88 (98)	98 (99)
1967	Trout	100 (100)	80 (98)	63 (40)	34 (16)	2 (1)
	Rough fish	0 (0)	20 (2)	37 (60)	66 (84)	98 (99)
1968	Trout	100 (100)	77 (97)	78 (63)	51 (13)	1 (1)
	Rough fish	0 (0)	23 (3)	22 (37)	49 (87)	99 (99)

Number in parenthesis is a percentage of total number.

to May 31, 1966, excluding the abnormal 1963-1964 data, still reveals a marked reduction in the sediment load of Bluewater Creek. The sediment load was reduced 1.9 tons/day at Station 2, 14.0 tons/day at Station 3 and 10.5 tons/day at Station 4. This represents a 32% reduction of the sediment load at Station 2, 52% reduction at Station 3 and 44% reduction at Station 4. The load at the control station (1) near the headwaters remained the same for periods before and after improvements. Station 5, the station farthest downstream, is influenced by waste water returns from the Clarks Fork of the Yellowstone River and the sediment load was not altered.

Table 5 shows the abundance, distribution and size of 2,912 fish sampled by electrofishing in 1968. Trout represented 37% of the sample of all fish collected in 1968. In 1963, before streambank improvements, trout consisted of 13% of the total fish sampled. Station 4 revealed a much improved trout:rough fish ratio compared to all previous sampling at this station. The average weight of 95 brown trout was 0.41 pounds and 80% were over 7 inches.

Trout:rough fish ratios occurring before and after completion of streambank improvement projects is presented in Table 6. Stations 1, 2 and 5 show no appreciable change in population structure. Increases of trout over rough fish appear most dramatically by analyzing percentage of total fish weight in Table 6. At Station 3 trout comprised 39% of the total weight of all fish sampled in 1963 before habitat improvement compared to 63% in 1967 and 78% in 1968, one and two years after habitat improvement. Increased weight of trout at Station 3 is attributed to large reductions of rough fish and slightly increased average size of trout. At Station 4 weight ratios of trout:rough fish have changed from 12:88 in 1963 to 34:66 in 1967 to 51:49 in 1968. Increased trout biomass at Station 4 can be attributed to increased numbers, larger average size and a reduction of rough fish.

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