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Dept

MONTANA FISH AND GAME DEPARTMENT
ENVIRONMENT AND INFORMATION DIVISION

JOB PROGRESS REPORT

State Montana

Project No. FW-2-R-1 Title Beartooth-Absaroka Wildlife-Mining Research

Job No. 1-b Title Planning Inventory, Fisheries

Period Covered July 1, 1971 to June 30, 1972

Contract Report Period July 1, 1971 to December 31, 1972

ABSTRACT

Chemical and biological investigations were undertaken in streams draining an area of southcentral Montana where mining development is expected. Water quality was generally good. Waters are mostly soft and low in dissolved materials. Standing crops of stream bottom fauna were variable, both in time and location. At most stations groups of organisms considered sensitive to pollution were dominant. Fish population estimates were made on 15 sections of 13 streams. Standing crops were moderately low in larger streams, but moderately high in some brushy, meandering tributaries. Fish growth was somewhat less than state averages. Limited data on fish stomach contents suggests fish cropped a wide variety of aquatic organisms. Survival to hatching of trout eggs placed in artificial redds averaged less than 50 percent, probably because of low water temperatures during early incubation. Limited data is given on spawning trout and egg survival in the Goose Lake inlet stream. Acid mine drainage at the head of the Stillwater River affects the river for several miles downstream.

BACKGROUND

Several thousand acres of mining claims are located along or near the north edge of the Beartooth-Absaroka Mountain Range in southcentral Montana (Figures 1 and 2). Extensive mining in this area seems likely in the near future. Chemical and biological data on waters draining the area were mostly lacking. The overall goal of protecting aquatic resources was undertaken initially by chemical and biological surveys at stations both upstream and downstream from mining claims. Although separated from the main block of mining claims, information was also collected relative to mining claims bordering Goose Lake and to acid mine drainage entering the Stillwater River near its head, below Daisy Pass (Figure 1).

OBJECTIVES

Job objectives were to obtain the following information at stations upstream and downstream from the complex of mining claims:

1. Basic water quality data
2. Numbers per square foot and species present in stream bottom fauna samples
3. Fish population estimates
4. Metal concentrations in fish tissues
5. Information on organisms present in fish stomachs
6. Survival of hatching of trout eggs placed in artificial redds
7. Limited biological data related to acid mine drainage near the head of the Stillwater River, and to mining claims near Goose Lake.

PROCEDURES

To facilitate and simplify data compilation the report period includes data collected from the beginning of this project, July 1, 1971 to December 31, 1972, a period of 18 months. Future reports will include data presentation on a calendar year basis instead of a fiscal year basis. A calendar year report is more meaningful from the biological standpoint and conforms better to field collection periods.

Sampling Stations

Sampling stations were established at points downstream and upstream from the mining claim complex. Station locations are given in Table 1.

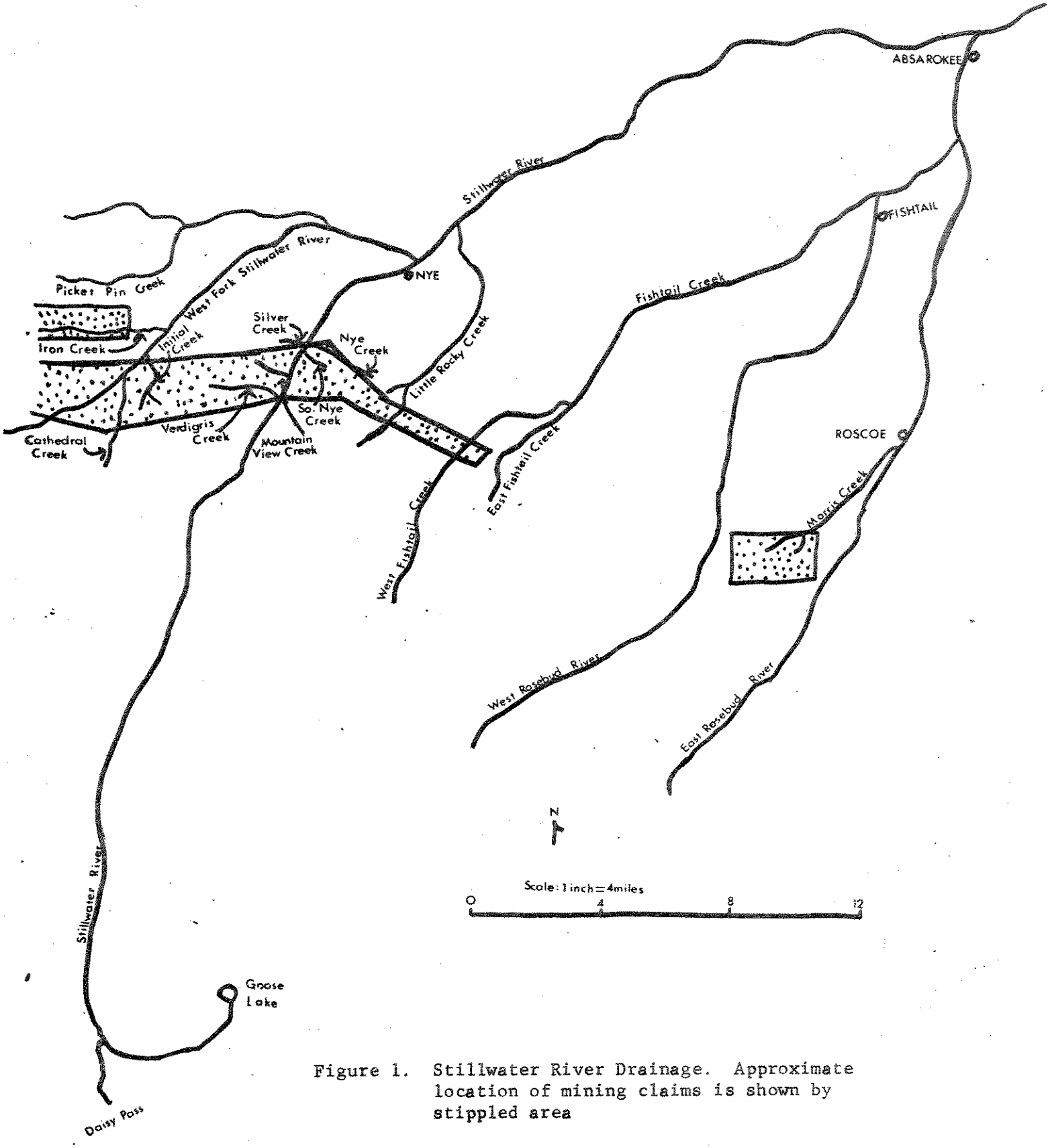

Figure 1. Stillwater River Drainage. Approximate location of mining claims is shown by stippled area

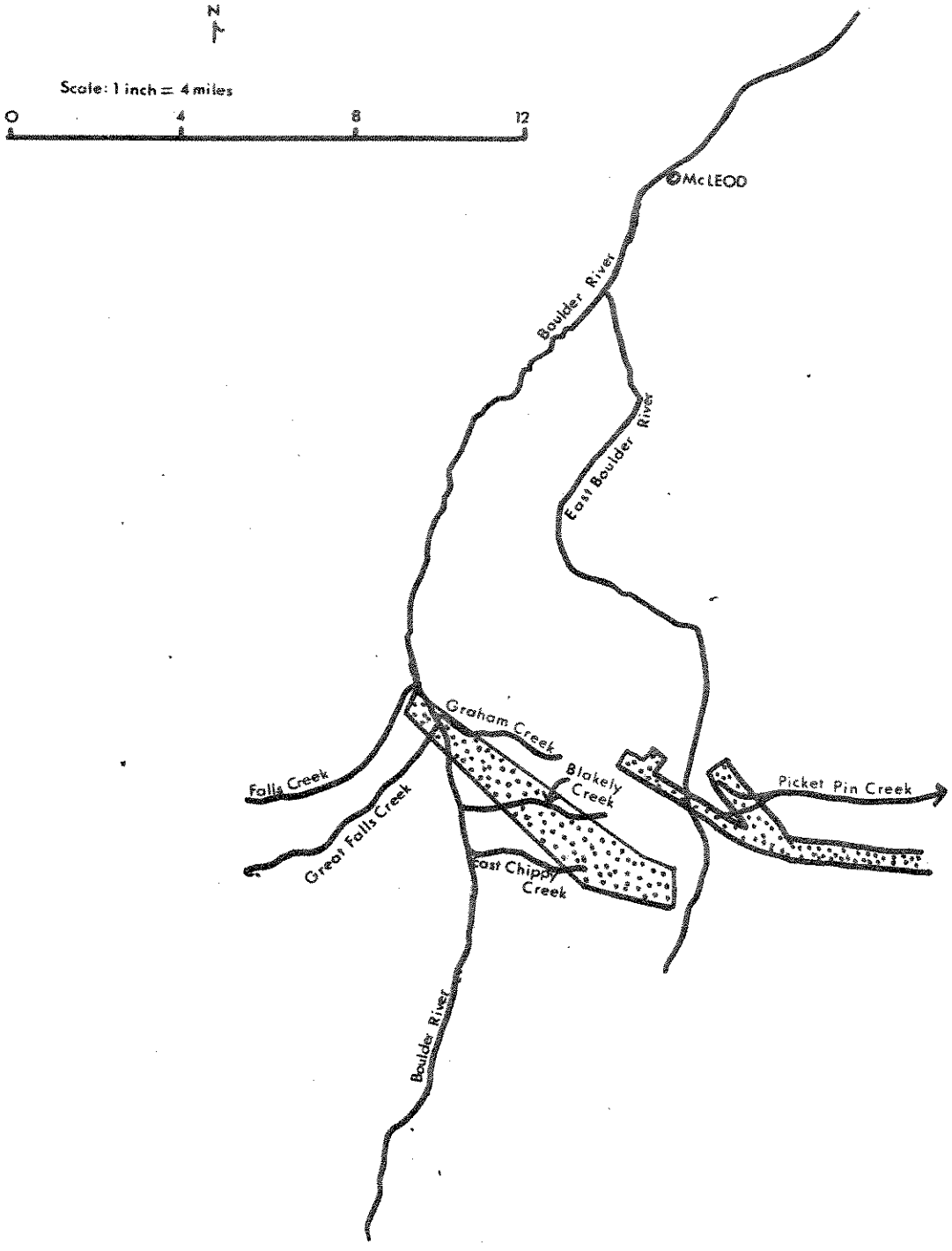

Figure 2. Boulder River Drainage. Approximate location of mining claims is shown by stippled area.

TABLE 1. Location of water, bottom fauna and egg bioassay stations

Station Number	Stream	T	R	S*	Description
001	E. Rosebud River	7S	17E	11	Adjacent to Jimmie Joe Campground
002	E. Rosebud River	6S	18E	16	At Bridge
003	W. Rosebud River	6S	17E	28	At Pine Grove Campground
004	W. Rosebud River	6S	17E	2	At Bridge
005	Stillwater River	5S	15E	32	East channel 200 yards upstream from bridge at Woodbine Campground
006	Stillwater River	5S	15E	15	East channel 1.4 road miles south of the Mouat Mill
007	West Fork Stillwater River	4S	15E	33	At Bridge
008	E. Boulder River	3S	13E	29	At Anderson Springs resort
009	E. Boulder River	2S	13E	33	At Ewan Campground 200 yards above mouth
010	Boulder River	4S	12E	15	At Falls Creek Campground
011	Boulder River	5S	12E	13	At Flemming Bridge
012	E. Fishtail Creek	5S	16E	19	At Mouth
013	W. Fishtail Creek	5S	16E	19	At Mouth
014	Morris Creek	6S	18E	8	200 yards downstream from MacKay Ranch house
015	Little Rocky Creek	5S	16E	21	At road crossing near Little Rocky Campground
016	Nye Creek	5S	15E	15	At road crossing 100 yards upstream from mouth
017	Initial Creek	5S	14E	14	At road crossing

* Township, Range and Section

TABLE 1. (Con'd)

Station Number	Stream	T	R	S	Description
018	Cathedral Creek	5S	14E	14	At Road crossing near mouth
019	Iron Creek	5S	14E	12	At mouth
020	Picket Pin Creek	5S	14E	3	At road crossing
023	East Chippy Creek	4S	12E	1	At road crossing near mouth
024	Blakely Creek	4S	12E	25	At road crossing near mouth
025	Graham Creek	4S	12E	23	At road crossing near mouth
026	Great Falls Creek	4S	12E	23	At mouth
027	Falls Creek	4S	12E	23	West channel at road crossing
028	E. Rosebud River	5S	18E	34	At Roscoe bridge
029	W. Rosebud River	5S	17E	23	At bridge
030	Fishtail Creek	5S	17E	19	At bridge
031	Little Rocky Creek	5S	16E	3	At crossing of Highway 419
032	Stillwater River	4S	16E	32	at USGS station 200 yards below mouth of West Fork
033	Stillwater River	4S	16E	28	At Moraine Fishing Access
034	Stillwater River	4S	17E	18	At Midnight Canyon Bridge
035	Stillwater River	3S	18E	35	At Johnson Bridge
036	West Fork Stillwater River	4S	16E	31	At Nye Bridge, South channel
037	West Fork Stillwater River	5S	14E	14	At Initial Creek Campground
038	East Boulder River	5S	13E	11	0.5 miles upstream from road crossing
039	Boulder River	2S	13E	33	At Ewan Campground 50 yards downstream from bridge
040	Boulder River	2S	13E	1	At bridge

TABLE 1. (Con'd)

Station Number	Stream	T	R	S	Description
041	West Boulder River	2S	13E	15	At McLeod Bridge
042	Silver Creek	5S	15E	15	At crossing of Highway 419
043	Verdigris Creek	5S	15E	28	At crossing of Highway 419
044	Mountain View Creek	5S	15E	21	At crossing of Highway 419
045	Fishtail Creek	5S	17E	9	At bridge 100 yards upstream from mouth of Sheep Creek
046	East Rosebud River	5S	18E	15	At bridge
047	South Nye Creek	5S	15E	15	At trail crossing 200 yards upstream from mouth
049	East Rosebud River	6S	18E	30	1 road mile downstream from TO Bar Ranch buildings
050	Boulder River	4S	12E	25	At Clydehurst Ranch buildings

Chemical Water Quality Sampling

Water samples at Stations 001-010 were collected at irregular time intervals by other Department personnel until October 1971. Samples at Stations 005-011 were collected monthly from October 1971 to September 1972 and in November 1972. Samples at Stations 001-004 were collected quarterly from Movember 1971 to November 1972. Other stations were sampled two to four times per year in February, May or June, August and November 1972. Stations 001 and 011 were inaccessible during winter and were not sampled then for that reason.

Values for temperature, turbidity, pH, and dissolved oxygen were obtained in the field. Temperature was measured with a pocket mercury thermometer. Turbidity and pH were measured colorimetrically (Hach Chemical Co., field unit model DR-EL). Dissolved oxygen was measured by the Winkler method.

Laboratory parameters (Table 2), were analyzed at the Montana Bureau of Mines and Geology laboratory in Butte under contract agreement with the Montana Fish and Game Department. Field procedures used were suggested by laboratory personnel. Samples were collected in plastic bottles and rinsed three times with river water at the sampling site. Bottles for non-metals analysis were filled to capacity to prevent air contact. Two milliliters of concentrated nitric acid were added in the field to bottles of water for metals analysis.

Stream Bottom Fauna

Bottom fauna were sampled with a square foot sampler slightly modified from that described by Waters and Knapp (1961). One riffle sample per station was collected in August or October 1970 and in April 1971. Three samples per station were collected in October 1971, and February, May, and August, 1972 from stations on larger streams. Samples from stations on tributary streams were collected in August 1972.

Various non-riffle habitat types were sampled with a Needham hand screen to collect species not present in riffle samples. Samples of this type were collected in May and November from stations on major streams and in August from tributary streams.

Samples were preserved in the field in 10 percent formalin and sorted to order (insects) or other taxonomic group for non-insect organisms at the Department of Fish and Game laboratory in Helena. The number and volume of organisms were obtained for each taxonomic group in each sample. Samples were preserved for future work.

TABLE 2. Summarization of water quality for stations on major streams*

	East Rosebud River Station 001				East Rosebud River Station 002			
	Mean	Max.	Min.	No. of Samples	Mean	Max.	Min.	No. of Samples
Calcium	4.1	5.7	2.0	9	5.6	8.6	2.6	9
Magnesium	1.1	1.5	0.6	9	1.4	1.8	0.7	9
Sodium	0.9	1.3	0.5	9	1.4	2.4	0.6	9
Potassium	0.8	1.4	0.5	9	0.8	1.7	0.6	9
Silica	2.2	3.0	1.0	9	3.5	6.0	1.3	9
Bicarbonate	17.1	24	10	9	24	36	11	9
Carbonate	0	0	0	9	0	0	0	9
Hydroxide	0	0	0	9	0	0	0	9
Chloride	0.3	1.0	0.0	9	0.5	1.4	0.1	9
Sulfate	3.6	6.0	1.8	9	3.9	5.6	2.6	9
Nitrate	0.3	0.7	0.0	9	0.4	0.9	0.0	9
Flouride	0.0	0.1	0.0	9	0.0	0.1	0.0	9
pH (lab)	6.74	7.15	6.19	9	6.90	7.18	6.33	9
pH (field)	8.3	8.4	8.2	6	8.2	8.4	8.1	6
Temperature (°F - field)	43	57	32	8	43	60	32	9
Dissolved Solids (calculated)	30.5	38.4	18.6	9	41.8	59.6	21.7	9
Total Hardness (as $CaCO_3$)	14	20	9	9	20	28	10	9
Total Alkalinity (as $CaCO_3$)	14	20	8	9	20	30	9	9
Dissolved Oxygen (field)	11.2	13.0	8.5	5	11.3	13.0	8.5	6
Turbidity (JTU-field)	1	4	0	4	2	3	0	4
Zinc	<0.01	0.01	<0.01	9	<0.01	0.01	<0.01	9
Cadmium	<0.01	<0.01	<0.01	9	<0.01	<0.01	<0.01	9
Copper	<0.01	<0.01	<0.01	9	<0.01	<0.01	<0.01	9
Nickel	<0.02	<0.02	<0.02	9	<0.02	<0.02	<0.02	9
Iron	0.02	0.08	0.00	9	0.12	0.41	<0.02	9
Manganese	0.00	0.00	0.00	9	0.00	0.01	0.00	9

*Units are milligrams per liter except as indicated

TABLE 2. (Con'd)

	West Rosebud River Station 003				West Rosebud River Station 004			
	Mean	Max.	Min.	No. of Samples	Mean	Max.	Min.	No. of Samples
Calcium	4.3	10.5	2.6	9	5.2	8.6	3.3	9
Magnesium	0.9	1.3	0.4	9	0.9	1.4	0.6	9
Sodium	1.0	1.3	0.7	9	1.3	1.9	0.8	9
Potassium	0.8	1.1	0.4	9	0.8	1.2	0.6	9
Silica	2.5	4.3	0.0	9	3.6	7.0	1.0	9
Bicarbonate	17	34	10	9	20	27	15	9
Carbonate	0	0	0	9	0.1	1.0	0.0	9
Hydroxide	0	0	0	9	0	0	0	9
Chloride	0.5	1.4	0.1	9	0.4	1.0	0.1	9
Sulfate	3.2	6.2	2.0	9	4.4	7.4	2.2	9
Nitrate	0.3	0.8	0.0	9	0.2	0.7	0.0	9
Flouride	0.0	0.1	0.0	9	0.0	0.1	0.0	9
pH(lab)	6.70	7.22	6.24	9	6.91	8.42	6.34	9
pH(field)	8.1	8.3	7.9	6	8.2	8.4	7.9	6
Temperature (°F - field)	43	57	32	8	44	60	32	8
Dissolved Solids (calculated)	30.3	57.6	19.6	9	36.8	48.5	28.1	9
Total Hardness (as $CaCO_3$)	15	31	10	9	17	26	12	9
Total Alkalinity (as $CaCO_3$)	14	28	8	9	17	26	12	9
Dissolved Oxygen (field)	11.1	12.0	8.6	6	10.9	12.0	8.3	5
Turbidity (JTU-field)	3	8	0	4	2	3	0	4
Zinc	<0.01	0.01	<0.01	9	<0.01	0.01	<0.01	9
Cadmium	<0.01	<0.01	<0.01	9	<0.01	<0.01	<0.01	9
Copper	<0.01	<0.01	<0.01	9	<0.01	<0.01	<0.01	9
Nickel	<0.02	<0.02	<0.02	9	<0.02	<0.02	<0.02	9
Iron	0.02	0.07	0.02	9	0.03	0.12	0.00	9
Manganese	0.00	0.01	0.00	9	0.00	0.01	0.00	9

TABLE 2. (Con'd)

	Stillwater River Station 005				Stillwater River Station 006			
	Mean	Max.	Min.	No. of Samples	Mean	Max.	Min.	No. of Samples
Calcium	4.9	7.1	2.6	16	8.4	16.4	3.6	16
Magnesium	1.1	1.8	0.6	16	2.0	3.1	0.7	16
Sodium	1.4	2.5	0.6	16	1.6	2.7	0.6	16
Potassium	0.7	1.6	0.4	16	0.8	1.5	0.4	16
Silica	4.6	7.3	1.3	16	5.0	9.0	1.3	16
Bicarbonate	19	26	13	16	28	51	13	16
Carbonate	0	0	0	16	0	0	0	16
Hydroxide	0	0	0	16	0	0	0	16
Chloride	0.5	1.5	0.2	16	0.5	1.4	0.0	16
Sulfate	4.5	7.4	2.0	16	8.3	14.0	2.8	16
Nitrate	0.3	1.0	0.0	16	0.3	1.0	0.0	16
Flouride	0.0	0.1	0.0	16	0.0	0.1	0.0	16
pH(lab)	6.81	7.24	6.32	16	6.88	8.12	6.04	16
pH(field)	8.3	8.4	7.8	13	8.2	8.5	7.0	13
Temperature (°F - field)	41	55	32	15	43	56	32	15
Dissolved Solids (calculated)	37.0	48.6	23.4	16	54.3	92.0	26.8	16
Total Hardness (as $CaCO_3$)	17	21	11	16	28	51	12	16
Total Alkalinity (as $CaCO_3$)	15	22	10	16	23	42	10	16
Dissolved Oxygen (field)	11.4	16.0	9.5	12	10.9	13.4	9.4	13
Turbidity (JTU-field)	2	10	0	9	2	8	0	9
Zinc	<0.01	0.01	<0.01	16	<0.01	0.02	<0.01	16
Cadmium	<0.01	<0.01	<0.01	16	<0.01	<0.01	<0.01	16
Copper	<0.01	0.01	<0.01	16	<0.01	0.02	<0.01	16
Nickel	<0.02	<0.02	<0.02	16	<0.02	<0.02	<0.02	16
Iron	0.06	0.20	0.00	16	0.06	0.24	0.00	16
Manganese	0.00	0.01	0.00	16	0.00	0.01	0.00	16

TABLE 2. (Con'd)

Station 007 - West Fork Stillwater River

	Mean	Max.	Min.	No. of Samples
Calcium	13.0	21.0	5.0	16
Magnesium	4.0	6.7	0.5	16
Sodium	1.6	2.4	0.8	16
Potassium	0.9	1.8	0.5	16
Silica	6.8	10.0	2.0	16
Bicarbonate	57	94	22	16
Carbonate	0	1	0	16
Hydroxide	0	0	0	16
Chloride	0.4	1.1	0.2	16
Sulfate	5.9	8.6	2.2	16
Nitrate	0.2	1.0	0.0	16
Fluoride	0.0	0.1	0.0	16
pH (lab)	7.29	8.32	6.38	16
pH (field)	8.3	8.6	6.9	13
Temperature (°F-field)	42	53	32	15
Dissolved solids (calculated)	90.1	133.1	40.0	16
Total Hardness (as $CaCO_3$)	48	76	21	16
Total Alkalinity (as $CaCO_3$)	47	76	21	16
Dissolved Oxygen (field)	10.8	12.8	9.0	12
Turbidity (JTU-field)	0	2	0	10
Zinc	<0.01	0.02	<0.01	16
Cadmium	<0.01	<0.01	<0.01	16
Copper	<0.01	0.02	<0.01	16
Nickel	<0.02	<0.02	<0.02	16
Iron	0.10	0.92	0.00	16
Manganese	0.00	0.01	0.00	16

TABLE 2. (Con'd)

	East Boulder River Station 008				East Boulder River Station 009			
	Mean	Max.	Min.	No. of Samples	Mean	Max.	Min.	No. of Samples
Calcium	23.8	32.0	10.4	16	41.6	55.0	17.9	16
Magnesium	5.7	6.9	2.0	16	9.5	15.3	3.2	16
Sodium	1.4	2.0	0.8	16	4.8	12.7	1.6	16
Potassium	0.5	1.0	0.2	16	1.2	2.5	0.5	16
Silica	6.7	10.0	2.6	16	7.1	11.0	3.2	16
Bicarbonate	89	122	36	16	141	178	59	16
Carbonate	0	2	0	16	0	5	0	16
Hydroxide	0	0	0	16	0	0	0	16
Chloride	0.3	1.0	0.0	16	1.4	3.3	0.3	16
Sulfate	7.0	12.2	1.8	16	44.0	63.0	9.4	16
Nitrate	0.1	0.8	0.0	16	0.3	1.00	0.00	16
Fluoride	0.0	0.01	0.0	16	0.0	0.2	0.0	16
pH (lab)	7.65	8.41	6.82	16	7.92	8.48	7.00	16
pH (field)	8.5	8.6	8.0	13	8.4	8.7	7.6	13
Temperature (°F-field)	40	52	32	16	42	58	33	16
Dissolved solids (calculated)	142.0	180.1	63.0	16	253.2	324.9	97.7	16
Total Hardness (as $CaCO_3$)	82	105	35	16	150	196	57	16
Total Alkalinity (as $CaCO_3$)	78	104	29	16	116	158	48	15
Dissolved oxygen (field)	11.0	12.1	9.2	12	11.1	12.4	9.3	12
Turbidity (JTU-field)	1	5	0	10	4	20	0	10
Zinc	<0.01	0.01	<0.01	16	<0.01	0.015	<0.01	16
Cadmium	<0.01	<0.01	<0.01	16	<0.01	<0.01	<0.01	16
Copper	<0.01	<0.01	<0.01	16	<0.01	<0.01	<0.01	16
Nickel	<0.02	<0.02	<0.02	16	<0.02	<0.02	<0.02	16
Iron	0.02	0.17	0.00	16	0.11	0.55	0.00	16
Manganese	0.00	0.01	0.00	16	0.00	0.02	0.00	16

TABLE 2. (Con'd)

	Boulder River Station 010				Boulder River Station 011			
	Mean	Max.	Min.	No. of Samples	Mean	Max.	Min.	No. of Samples
Calcium	9.0	13.2	4.8	16	8.7	14.2	4.8	11
Magnesium	2.2	3.5	0.8	16	2.2	2.8	1.4	11
Sodium	2.0	2.8	1.0	16	2.0	2.8	1.0	11
Potassium	1.2	2.1	0.6	16	1.0	1.5	0.6	11
Silica	7.7	11.0	3.0	16	9.0	11.0	3.2	11
Bicarbonate	37	54	23	16	36	47	24	11
Carbonate	0	1	0	16	0	0	0	11
Hydroxide	0	0	0	16	0	0	0	11
Chloride	0.5	1.5	0.1	16	0.4	0.6	0.1	11
Sulfate	6.5	11.4	2.6	16	5.8	10.4	2.6	11
Nitrate	0.2	0.8	0.0	16	0.3	0.7	0.0	11
Fluoride	0.02	0.13	0.00	16	0.01	0.12	0.00	11
pH (lab)	7.06	8.34	6.53	16	7.17	7.94	6.46	11
pH (field)	8.4	8.7	8.3	13	8.4	8.7	8.2	11
Temperature (°F-field)	40	54	32	16	41	52	31	10
Dissolved solids (calculated)	69.9	89.9	40.6	16	65.3	86.0	44.8	11
Total hardness (as $CaCO_3$)	31	46	20	16	31	44	20	11
Total Alkalinity (as $CaCO_3$)	30	44	19	16	30	39	20	11
Dissolved oxygen (field)	11.1	12.0	8.9	13	10.7	12.0	9.1	11
Turbidity (JTU-field)	3	8	0	9	1	7	0	8
Zinc	<0.01	0.01	<0.01	16	<0.01	0.01	<0.01	11
Cadmium	<0.01	<0.01	<0.01	16	<0.01	<0.01	<0.01	11
Copper	<0.01	<0.01	<0.01	16	<0.01	<0.01	<0.01	11
Nickel	<0.02	<0.02	<0.02	16	<0.02	<0.02	<0.02	11
Iron	0.10	0.68	0.00	16	0.07	0.27	0.00	11
Manganese	0.00	0.03	0.00	16	0.00	0.01	0.00	11

Fish Studies

Population estimates were made using methods described by Vincent (1971). This technique involves capturing fish by electrofishing in a stream section and marking them in a manner recognizable at a future date. Several days later fish are again captured in the stream section, noting whether or not each fish is marked. Fish in each stream section were given a distinctive fin clip (shown in Table 9). Fish were aged from scale impressions.

Fish stomachs and fish for metals analysis were collected during the last recapture run. Fish stomachs were preserved in formalin and stomach contents were identified to order. Fish collected for metals analysis were frozen the same day of collection and later shipped on dry ice by air freight to the Environmental Protection Agency laboratory in Denver, Colorado.

Egg Bioassays

Eyed cutthroat trout eggs were buried in artificial redds to determine survival rates during the incubation period. Redds were built by excavating the stream bottom in riffle areas to a depth of 12 to 14 inches, leaving a semi-spherical depression 2.5 feet in diameter. This was filled with clean gravel from 0.5 to 1.0 inches in diameter. Redds were allowed to settle and stabilize at least two weeks before egg placement.

Eggs were obtained from the Montana Fish and Game Department Yellowstone River Trout Hatchery at Big Timber, placed in egg trays, covered with crushed ice, and transported directly to artificial redds.

Two different types of egg containers were used. A few eggs were placed in small perforated plastic vials, which were removed periodically to determine when hatching had occurred. Three containers made of plastic screening were filled with 100 eggs each and buried six inches deep in each redd. Both types of containers were constructed to retain fry after hatching.

All eggs were in redds within five and a half hours after leaving the hatchery. Eggs were placed in redds on April 19 and 20, and were removed on May 15, 16 and 17, 1972.

Stillwater River Headwaters Area

Fish were seined from the Goose Lake inlet stream in July, 1972. Fish eggs were removed from natural redds by loosening the gravel with a shovel. A hand screen was held downstream from the redd to capture eggs removed. Other procedures in this area were with methods and equipment previously described.

FINDINGS

Chemical Water Quality

Water quality data is presented in Tables 2 through 6. Locations of sampling stations are given in Table 1. Locations of streams are indicated in Figures 1 and 2.

Waters are of the calcium bicarbonate type (typical of fresh water), very soft to moderately soft, and generally low in dissolved material. Exceptions are the East Boulder River and Silver Creek in the Stillwater River Drainage. These two streams have moderate levels of dissolved material and are moderately hard. Silver Creek originates from springs and is less than a mile in length. In general, human activities have probably modified water quality very little. A few notable exceptions exist.

Turbidity at all stations was low, even during highwater flows. Dissolved oxygen was at or near saturation values. Water temperatures usually did not exceed 60° F. Daytime water temperatures in the 40 to 50° F. range were common during cool periods in summer.

Tables 2 through 6 indicate discrepancies between field and laboratory pH measurements of 1.0 to 2.0 units. Laboratory values were always lower. Laboratory measurements were made one to two months following sample collection while field pH was measured within a few minutes after sample collection. To find out which set of pH values was correct, a simultaneous comparison of laboratory and field pH meters was made on water that had been collected the day before (Table 7). Samples were collected January 24, 1973 and measurements made on January 25, 1973. There was good agreement between the two meters when measurements were made at the same time and soon after sample collection. Values of pH were in the range 7.9 - 8.5, agreeing with previous field measurements. Apparently pH values decreased considerably between time of collection and time of laboratory measurements. The conclusion is that of the pH values in Tables 2 through 6, the field measurements rather than the laboratory measurements indicate true pH values in streams.

The metals cadmium, copper, manganese, nickel and zinc rarely exceeded 0.02 mg/liter, and were usually below detection limits except in Verdigris Creek (Table 3). Nickel and copper were as high as 0.59 and 0.14 mg/liter, respectively. The stream passes through a gossan (area of decomposed rock of rusty color due to oxidized metal pyrites), but the watershed has been considerably disturbed by road building. The relative contribution of metals from these sources to Verdigris Creek cannot be assessed.

Both Nye and South Nye Creeks are filled with Mill tailings which have blown in from the Mouat tailings pond located a few hundred yards upstream. This has had no obvious effect on water chemistry in these two streams, but the natural stream bottoms have been almost completely destroyed in the lower 0.5 to 0.75 miles of these streams.

TABLE 3. Summarization of water quality data for stations on Rosebud tributaries[A]

	East Fishtail Creek Station 012[B]		West Fishtail Creek Station 013[C]			Morris Creek Station 014[C]		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
Calcium	10.8	10.2	5.1	8.7	3.0	16.5	20.0	10.8
Magnesium	3.8	3.8	1.1	1.6	0.6	3.6	4.9	2.2
Sodium	3.7	2.5	1.9	2.5	1.0	12.0	17.0	7.0
Potassium	0.71	0.61	0.69	0.90	0.60	1.0	1.4	0.7
Silica	11.4	8.7	7.9	11.0	5.0	16	18	14
Bicarbonate	55	52	22	32	15	92	115	66
Carbonate	0	0	0	0	0	0	0	0
Hydroxide	0	0	0	0	0	0	0	0
Chloride	0.5	0.4	0.3	0.6	0.1	0.8	1.3	0.3
Sulfate	6.0	4.2	4.4	5.6	2.6	6.6	9.6	2.0
Nitrate	0.7	0.0	0.4	0.8	0.0	0.4	1.0	0.2
Fluoride	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0
pH (lab)	6.75	6.65	6.64	7.18	6.40	7.08	7.11	6.90
pH (field)	8.5	8.4	8.3	8.5	8.1	8.4	8.4	8.3
Temperature (°F-field)	41	32	40	52	32	45	70	32
Dissolved solids (calculated)	89.2	86.0	43.9	61.7	28.3	150.4	187.4	105.8
Total Hardness (as $CaCO_3$)	43	41	17	25	10	56	70	39
Total Alkalinity (as $CaCO_3$)	45	43	18	27	12	75	84	54
Dissolved oxygen (field)	11.5	10.4	10.7	11.6	9.6	10.7	12.1	7.1
Turbidity (JTU-field)	12	5	1	5	0	18	35	8
Zinc	0.01	<0.01	<0.01	0.015	<0.01	<0.01	0.01	<0.01
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nickel	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Iron	0.21	0.06	0.02	0.05	0.00	0.71	1.10	0.46
Manganese	0.00	0.00	0.00	0.00	0.00	0.10	0.36	0.00

[A] Units are milligrams per liter except as indicated

[B] 2 samples

[C] 4 samples

TABLE 4. Summarization of water quality data for stations on Stillwater River tributaries[A]

	Little Rocky Creek Station 015[B]			Nye Creek Station 016[B]			Silver Creek Station 042[C]	
	Mean	Max.	Min.	Mean	Max.	Min.	Max.	Min.
Calcium	14.3	18.2	11.2	9.4	10.4	8.7	50	49
Magnesium	4.5	5.6	3.7	7.6	7.7	7.5	18.0	17.8
Sodium	1.9	2.4	1.5	2.0	2.2	1.8	2.3	1.9
Potassium	0.50	0.60	0.38	0.45	0.60	0.31	0.70	0.59
Silica	10.5	12.8	8.7	17	18	16	12.8	8.6
Bicarbonate	67	80	54	67	69	64	147	143
Carbonate	0	0	0	0	0	0	0	0
Hydroxide	0	0	0	0	0	0	0	0
Chloride	0.2	0.4	0.0	0.1	0.1	0.1	0.4	0.1
Sulfate	4.8	7.9	2.0	6.9	7.9	6.4	74	74
Nitrate	0.4	0.7	0.0	0.7	1.0	0.0	0.9	0.2
Fluoride	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
pH (lab)	6.73	6.77	6.69	6.97	7.16	6.78	8.42	7.28
pH (field)	8.3	8.5	8.1	8.5	8.5	8.4	8.6	8.6
Temperature (°F-field)	41	54	32	42	51	32	60	50
Dissolved solids (calculated)	103.9	128.6	86.3	111.2	115.1	105.1	304.5	300.6
Total hardness (as $CaCO_3$)	55	68	44	56	57	53	199	195
Total Alkalinity (as $CaCO_3$)	55	66	44	55	57	52	126	121
Dissolved oxygen (field)	10.6	12.9	8.2	10.4	12.1	9.2	9.6	8.6
Turbidity (JTU)	2	7	0	2	5	0	0	0
Zinc	0.01	0.01	<0.01	<0.01	0.01	<0.01	0.01	0.01
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nickel	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Iron	0.05	0.11	0.00	0.21	0.53	0.00	0.04	0.03
Manganese	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.00

[A] Units are milligrams per liter except as indicated

[B] 3 samples except for lab pH which is 2

[C] 2 samples

[D] 3 samples

[E] 2 samples except for lab pH which is 1

TABLE 4. (Con'd)

	Verdigris Creek Station 043[D]			Mountain View Creek Station 044[E]		South Nye Creek Station 047[C]	
	Mean	Max.	Min.	Max.	Min.	Max.	Min.
Calcium	7.6	9.9	3.4	17.4	15.0	17.9	8.8
Magnesium	10.8	14.9	4.3	17.9	12.2	9.8	6.8
Sodium	2.3	3.0	1.5	4.0	2.9	3.5	1.8
Potassium	0.7	1.1	0.5	0.70	0.70	0.52	0.46
Silica	13.8	16.0	11.0	0.21	0.16	18.5	16.0
Bicarbonate	34	43	21	136	102	101	58
Carbonate	0	0	0	0	0	0	0
Hydroxide	0	0	0	0	0	0	0
Chloride	0.6	1.0	0.1	2.0	0.0	0.8	0.5
Sulfate	40.1	61.0	7.2	11.0	7.2	9.0	4.8
Nitrate	0.5	1.0	0.0	2.2	0.3	0.8	0.0
Fluoride	0.0	0.0	0.0	0.0	0.0	0.0	0.0
pH (lab)	6.66	6.70	6.61	7.00	---	7.64	7.26
pH (field)	8.4	8.5	8.3	8.5	8.5	8.4	8.4
Temperature (°F-field)	46	57	32	52	36	49	37
Dissolved solids (calculated)	110.7	149.8	49.6	208.8	157.0	163.1	97.8
Total hardness (as $CaCO_3$)	64	87	26	118	88	85	50
Total Alkalinity (as $CaCO_3$)	28	35	18	112	84	83	48
Dissolved oxygen (field)	9.6	10.6	8.7	11.2	9.0	10.8	9.7
Turbidity (JTU)	3	5	0	10	0	12	5
Zinc	0.01	0.015	0.01	0.01	0.01	0.01	0.01
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	0.10	0.14	0.08	<0.01	<0.01	<0.01	<0.01
Nickel	0.39	0.59	0.09	<0.02	<0.02	0.02	<0.02
Iron	0.33	0.58	0.17	0.21	0.16	1.28	0.08
Manganese	0.04	0.06	0.01	0.00	0.00	0.03	0.00

TABLE 5. Summarization of water quality data for stations on West Fork Stillwater River tributaries[A,B]

	Initial Creek Station 017		Cathedral Creek Station 018		Iron Creek Station 019		Picket Pin Creek Station 020	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Calcium	34	23	4.1	3.5	21.0	10.7	15.0	10.7
Magnesium	11.3	8.2	2.9	2.8	4.5	2.9	3.0	1.4
Sodium	2.1	1.4	2.1	1.6	1.7	1.0	1.7	1.3
Potassium	0.41	0.33	0.48	0.33	0.78	0.28	0.19	0.16
Silica	11.4	10.0	10.0	8.6	10.0	8.7	8.7	8.6
Bicarbonate	154	112	28	27	87	48	55	40
Carbonate	0	0	0	0	0	0	0	0
Hydroxide	0	0	0	0	0	0	0	0
Chloride	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3
Sulfate	7.8	1.6	3.9	2.4	5.4	2.6	4.7	2.0
Nitrate	0.1	0.0	0.2	0.0	0.2	0.0	0.3	0.0
Fluoride	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
pH (lab)	7.46	---	6.45	---	6.55	---	6.50	---
pH (field)	8.6	8.6	8.3	8.3	8.3	7.7	8.6	8.2
Temperature (°F-field)	36	32	36	32	39	36	36	32
Dissolved solids (calculated)	220.4	156.5	50.4	48.2	171.1	74.6	88.7	64.6
Total hardness (as $CaCO_3$)	130	90	22	20	70	39	49	32
Total Alkalinity (as $CaCO_3$)	126	92	23	22	72	39	45	33
Dissolved oxygen (field)	10.8	9.7	10.8	8.7	10.0	5.0	10.3	9.7
Turbidity (JTU)	4	0	2	0	7	0	7	0
Zinc	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.015	<0.01
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nickel	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Iron	0.06	0.02	0.06	0.00	0.06	0.06	0.05	0.02
Manganese	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.00

[A] Units are milligrams per liter except as indicated

[B] 2 samples per station except for lab pH which is 1

TABLE 6. Summarization of water quality data for stations on Boulder River tributaries.[A,B]

	East Chippy Creek Station 023		Blakely Creek Station 024		Graham Creek Station 025		Great Falls Creek Station 026		Falls Creek Station 027	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Calcium	10.8	8.3	12.2	9.9	13.7	9.9	6.4	4.2	7.9	4.6
Magnesium	4.1	3.0	8.0	4.9	3.8	1.9	0.8	0.0	1.2	1.0
Sodium	0.83	0.83	1.4	1.0	2.2	1.3	2.1	1.1	3.0	1.1
Potassium	0.67	0.64	0.32	0.26	0.20	0.18	0.9	0.9	1.0	0.9
Silica	10.0	9.5	11.4	9.5	11.4	8.3	8.6	5.9	7.1	5.9
Bicarbonate	42	33	74	50	61	38	16	14	22	17
Carbonate	0	0	0	0	0	0	0	0	0	0
Hydroxide	0	0	0	0	0	0	0	0	0	0
Chloride	0.4	0.3	0.7	0.6	0.7	0.5	0.3	0.2	1.5	0.2
Sulfate	14.3	6.8	6.3	4.4	5.4	3.2	11.6	6.6	12.0	4.0
Nitrate	0.8	0.1	0.2	0.1	0.4	0.0	0.6	0.0	0.8	0.2
Fluoride	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
pH (lab)	6.82	--	7.08	--	6.79	--	6.66	6.37	7.17	6.37
pH (field)	8.5	8.2	8.5	8.3	8.5	8.1	8.4	7.8	8.4	8.4
Temperature (°F-field)	40	32	43	32	40	32	40	32	40	32
Dissolved solids (calculated)	84.0	53.9	114.3	80.7	98.6	40.0	46.9	33.8	56.2	35.4
Total hardness (as $CaCO_3$)	44	33	63	45	49	32	16	14	24	15
Total Alkalinity (as $CaCO_3$)	34	27	61	41	50	31	13	11	18	14
Dissolved oxygen (field)	12.1	10.5	11.9	10.2	11.6	10.3	10.6	10.1	11.8	10.5
Turbidity (JTU)	1	0	0	0	1	0	2	0	2	0
Zinc	0.015	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
Nickel	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Iron	0.02	0.02	0.02	0.02	0.50	0.02	0.08	0.02	0.09	0.02
Manganese	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00

[A] Units are milligrams per liter except as indicated

[B] 2 samples per station except for lab pH at stations 023,024 and 025, which is 1

Stream Bottom Fauna

Variability in numbers and volume of bottom fauna at most stations was high (Table 8). This was true in comparing samples from different seasons and also with samples from the same riffle on the same day. Needham and Usinger (1956) took 100 one square foot samples over a two day period from a single riffle. Numbers of organisms per sample ranged from 2 to 198 and weights of organisms per sample from 0.015 to 2.31 grams. Data of this study is probably somewhat less variable than that reported by Needham and Usinger (1956), and so should not be considered any more variable than is characteristic of bottom fauna populations.

Considering all 27 stations reported in Table 7, relative richness of the bottom fauna is intermediate. Using a "richness index" developed by Lagler (1956) which considers numbers and volume of organisms, seven stations rate "poor", fourteen "average richness" and six "exceptional richness". Numbers and volume of organisms tend to increase in a downstream direction.

The insect orders Plecoptera, Tricoptera and Ephemeroptera are made up largely of forms considered pollution sensitive. These three orders typically made up 60 to 90 percent of organisms in samples.

Dent (1971) has also sampled bottom fauna in the same streams and at some of the same stations reported in this study. He used a Surber sampler and reported consistently fewer numbers of organisms per square foot than found in this study. For comparison, the following are average number of organisms per square foot in October 1971 for stations on similar portions of the Stillwater, West Fork Stillwater, East Boulder and Boulder Rivers, respectively (data of Dent, 1971, given first): 83 and 267, 84 and 246, 91 and 739, 106 and 402. At the same station (031) on Little Rocky Creek, the corresponding numbers are 36 and 156. Dent's (1971) data is similar to that of this study in proportions of insect orders present in the various samples.

In personal correspondence with Mr. Dent, he stated that he felt his Surber sampler had failed to capture many of the organisms present in each square foot covered by the sampler. Waters and Knapp (1961) and Needham and Usinger (1956) both felt the Surber sampler had considerable shortcomings.

Bottom fauna samples were also collected in the spring, summer, and fall during 1972 and from additional stations on tributary streams in August, 1972. These samples have yet to be sorted and tabulated. Results will be given in a future report. Identification of bottom fauna to species and development of diversity indices are planned for the near future.

TABLE 7. Comparison of pH measurements made simultaneously with laboratory and field instruments.

Stream	Station	Field Instrument	Laboratory Instrument	Difference
West Rosebud	004	7.98	7.91	+0.07
Stillwater	006	8.12	8.13	-0.01
West Fork Stillwater	007	8.45	8.24	+0.21
East Boulder	009	8.53	8.46	+0.07
Boulder	010	8.05	8.11	-0.06

TABLE 8. Number and volume (in parentheses) of organisms collected in one square foot stream bottom samples

Date	Plecoptera	Tricoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Nematoda	Other [A]	Total
East Rosebud River - Station 001 - Jimmie Joe Campground									
8-70	46	17	93	29	0	0	0	0	185
4-71	66(.5)	2(T)[B]	143(.2)	7(T)	0	0	0	0	218(.7)
10-71	39(.2)	1(T)	132(.5)	9(.1)	0	0	1(T)	0	151(.8)
10-71	8(.4)	8(.2)	43(.1)	1(T)	0	0	0	0	60(.7)
10-71	72(.2)	3(.1)	141(.6)	4(T)	0	0	0	0	220(.9)
East Rosebud River - Station 049 - 1 mile below TO Bar Ranch									
8-70	47	0	95	17	0	0	0	0	159
4-71	23(.3)	57(.2)	149(.5)	12(T)	2(T)	0	0	0	243(1.0)
10-71	5(.1)	16(T)	83(.2)	5(T)	0	0	0	0	109(.3)
10-71	9(.2)	10(T)	189(.5)	1(T)	2(T)	0	1(T)	0	212(.7)
10-71	18(.5)	12(.1)	106(.3)	6(T)	0	0	1(T)	0	143(.9)
East Rosebud River - Station 028 - Town of Roscoe Bridge									
2-72	20(.2)	100(.7)	187(.7)	39(.2)	2(T)	9(T)	0	0	357(1.8)
2-72	30(.1)	92(1.0)	172(2.0)	11(.2)	1(T)	10(T)	0	1(T)	317(3.3)
2-72	6(T)	33(.5)	191(.4)	2(T)	0	1(T)	0	0	233(.9)

[A] Mostly Hydracarina and Turbellaria [B] Trace

TABLE 8. (Con'd)

Date	Plecoptera	Tricoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Nematoda	Other	Total
East Rosebud River - Station 046 - Bridge 4 miles below Roscoe									
10-71	17(.1)	62(.2)	87(.3)	10(.1)	8(T)	0	26(T)	0	210(.7)
10-71	14(.3)	67(.7)	94(.2)	17(.2)	10(T)	0	35(T)	0	237(1.4)
10-71	25(.2)	99(1.1)	137(.5)	16(.2)	8(T)	0	29(T)	0	314(2.0)
2-72	13(.1)	25(.1)	86(.5)	2(.1)	0	0	0	0	126(.8)
2-72	28(.1)	50(.2)	272(1.1)	2(T)	0	0	0	0	352(1.4)
2-72	14(T)	71(.3)	229(.7)	1(T)	0	0	0	0	315(1.0)
West Rosebud River - Station 003 - Pine Grove Campground									
8-70	50	3	102	31	4	5	0	2	197
4-71	18(.1)	17(.3)	103(.3)	13(T)	2(T)	0	63(T)	0	216(.7)
10-71	37(.1)	8(.1)	106(.3)	4(T)	3(T)	18(T)	0	0	318(.8)
10-71	59(.4)	16(.1)	260(.2)	9(.1)	5(T)	71(T)	0	0	420(.8)
10-71	62(.3)	27(.2)	249(.3)	5(.1)	1(.1)	15(T)	0	0	359(1.0)
2-72	60(.7)	41(.7)	288(.7)	15(T)	4(.1)	20(T)	4(T)	0	432(2.2)
2-72	155(.3)	32(.4)	400(.8)	49(.1)	7(T)	54(T)	0	0	697(1.6)
2-72	24(.2)	23(.3)	350(.6)	4(.1)	5(T)	3(T)	0	0	409(1.2)

TABLE 8. (Con'd)

Date	Plecoptera	Tricoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Nematoda	Other	Total
West Rosebud River - Station 004 - First bridge below Pine Grove Campground									
8-70	28	64	62	49	4	16	0	1	224
4-71	39(.4)	123(1.0)	219(.7)	6(T)	4(T)	0	62(T)	0	453(1.2)
10-71	6(.1)	12(.1)	48(.1)	3(T)	1(T)	11(T)	0	0	81(.3)
10-71	7(T)	14(.1)	36(.1)	5(T)	0	4(T)	0	0	66(.2)
10-71	34(T)	20(.2)	97(.2)	10(.1)	3(.1)	9(T)	0	0	173(.6)
2-72	14(.1)	23(.1)	162(.5)	2(T)	4(T)	29(T)	0	0	234(.7)
2-72	18(.1)	28(.2)	107(.5)	2(T)	2(T)	25(T)	0	0	182(.8)
2-72	16(.7)	108(.5)	214(.8)	2(.1)	1(T)	11(T)	0	0	352(1.6)
West Rosebud River - Station 029 - Wigwam Ranch Bridge									
8-70	5	18	127	59	10	0	0	0	219
4-71	29(.1)	53(.3)	190(.4)	22(T)	11(T)	1(T)	44(T)	0	350(.8)
10-71	52(.4)	76(2.0)	167(.7)	43(.1)	5(T)	41(T)	0	0	384(3.2)
10-71	27(.3)	101(.4)	134(.3)	38(T)	7(T)	35(T)	0	0	342(1.0)
10-71	43(.2)	57(.5)	172(.4)	29(.1)	6(T)	51(T)	0	0	358(1.2)
2-72	27(.2)	152(1.1)	117(.4)	5(.1)	2(T)	7(T)	0	0	310(1.8)
2-72	25(T)	59(.5)	76(.2)	19(T)	3(T)	13(T)	0	1(T)	196(.7)
2-72	24(.4)	82(.2)	98(.5)	20(.1)	7(T)	1(T)	0	1(T)	233(1.2)

TABLE 8. (Con'd)

Date	Plecoptera	Tricoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Nematoda	Other	Total
				Fishtail Creek - Station 030 - Bridge near 4K Ranch					
10-71	48(.4)	90(1.3)	155(.5)	5(T)	1(T)	104(T)	0	49(.2)	452(2.4)
10-71	41(.1)	50(.1)	96(.2)	21(T)	9(T)	75(T)	0	16(.1)	308(.5)
10-71	27(.2)	44(.2)	166(.2)	8(T)	8(T)	91(T)	0	29(.1)	373(.7)
2-72	20(.7)	189(.4)	211(.5)	18(T)	3(T)	18(T)	0	16(T)	475(.6)
2-72	12(.1)	250(.7)	103(.2)	4(.1)	11(.1)	92(.1)	1	33(T)	506(1.4)
2-72	29(.1)	76(.2)	96(.3)	4(T)	7(.1)	45(T)	0	13(T)	270(.7)
				Fishtail Creek - Station 045 - Mouth of Sheep Creek					
10-71	54(.6)	102(1.2)	140(.3)	27(.3)	11(.1)	94(.1)	0	2(T)	448(2.5)
10-71	28(.1)	111(1.1)	139(.2)	78(.1)	15(T)	146(.1)	0	1(T)	518(1.6)
10-71	41(.8)	102(1.1)	111(.2)	23(.1)	10(T)	88(T)	0	0	375(2.2)
2-72	35(.5)	233(.5)	222(.6)	80(.1)	15(.1)	97(.1)	0	0	682(1.9)
2-72	33(.3)	215(.4)	172(.5)	21(.5)	8(T)	46(T)	0	0	495(1.3)
2-72	6(.1)	34(.2)	62(.2)	9(.1)	6(T)	16(T)	0	0	133(.6)
				Little Rocky Creek - Station 031 - Highway 419 Crossing					
10-71	34(T)	4(T)	71(.1)	72(1.1)	12(T)	3(T)	0	0	196(1.2)
10-71	14(T)	1(T)	19(.1)	20(2.1)	7(T)	2(T)	0	0	63(2.2)
10-71	38(.1)	15(.1)	85(.1)	59(1.3)	11(.1)	2(T)	0	0	210(1.7)
2-72	17(.3)	51(T)	119(.3)	322(1.9)	40(T)	1(T)	0	52(.1)	602(2.6)
2-72	26(T)	78(.1)	126(.2)	424(3.5)	103(.1)	0	3(T)	23(T)	783(3.9
2-72	8(T)	78(.1)	113(.2)	826(.4)	80(T)	0	0	31(T)	1140(.7)

TABLE 8. (Con'd)

Date	Plecoptera	Tricoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Nematoda	Other	Total
				Stillwater River - Station 005 - Woodbine Campground					
8-70	43	18	74	168	4	2	0	0	309
4-71	15(.1)	9(.1)	163(.2)	5(T)	1(T)	0	10(T)	0	203(.4)
10-71	30(.1)	14(.3)	85(.1)	22(T)	2(T)	27(T)	0	0	180(.5)
10-71	24(.1)	22(.3)	84(.1)	40(T)	3(T)	39(T)	0	0	212(.5)
10-71	5(T)	5(T)	48(.1)	3(T)	1(T)	5(T)	0	0	67(.1)
2-72	61(.2)	14(.2)	329(.5)	7(T)	1(T)	0	1(T)	0	413(.9)
2-72	39(.1)	11(.2)	344(.7)	5(.1)	0	1(T)	0	0	400(1.1)
2-72	69(.5)	6(T)	215(.3)	7(T)	1(T)	0	2(T)	0	300(.8)
				Stillwater River - Station 006 - 1.4 miles below Mouat Mill					
8-70	11	4	145	41	2	0	0	0	203
4-71	92(.4)	83(.3)	300(.1)	65(T)	0	0	0	0	540(.8)
10-71	30(.3)	52(.6)	254(.3)	63(.2)	0	1(T)	0	0	400(1.4)
10-71	10(.1)	2(.4)	135(.3)	8(.4)	0	4(T)	0	0	159(1.2)
10-71	19(.1)	12(.3)	71(.2)	5(.1)	0	0	0	0	107(.7)
2-72	126(.3)	51(.9)	409(.9)	105(.1)	1(T)	23(T)	0	1(T)	716(2.2)
2-72	29(T)	26(.2)	339(.8)	41(.1)	0	2(T)	0	1(T)	438(1.1)
2-72	100(.6)	39(.4)	456(.8)	45(T)	0	7(T)	0	1(T)	648(1.8)

TABLE 8. (Con'd)

Date	Plecoptera	Tricoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Nematoda	Other	Total
			Stillwater River - Station 032 - USGS gaging station						
4-71	31(.1)	131(1.5)	505(.7)	120(.1)	3(.1)	0	0	0	790(2.5)
10-71	30(.2)	13(.1)	89(.2)	13(.1)	2(T)	0	0	0	147(.6)
10-71	20(.1)	15(.1)	57(.3)	20(.1)	2(T)	3(T)	1(T)	1(T)	119(.6)
10-71	24(T)	4(T)	61(.2)	1(T)	0	0	0	0	90(.2)
2-72	30(.2)	58(.3)	225(.8)	47(.3)	4(T)	24(T)	0	0	388(1.6)
2-72	44(.1)	86(.8)	201(1.0)	32(.3)	0	25(T)	0	0	388(2.2)
2-72	32(.1)	18(.1)	125(.5)	28(.1)	3(T)	46(T)	0	0	252(.8)
			Stillwater River - Station 033 - Moraine Fishing Access						
8-70	47	31	163	26	3	3	0	2	275
4-71	25(.1)	101(.9)	154(.6)	3(T)	3(.1)	18(T)	0	0	304(1.7)
10-71	91(.5)	105(1.1)	388(1.3)	64(.3)	1(T)	2(T)	0	0	651(3.2)
10-71	67(.2)	179(1.0)	197(.7)	39(.6)	1(T)	8(T)	0	0	491(2.5)
10-71	57(.3)	91(1.0)	177(.9)	229(.5)	4(T)	23(T)	0	1(T)	582(2.7)
2-72	89(.5)	156(1.8)	401(.9)	185(.4)	18(.1)	70(T)	2(T)	0	921(3.7)
2-72	93(1.1)	125(.8)	465(1.5)	99(.4)	5(T)	114(.1)	0	2(T)	903(3.9)
2-72	68(.7)	122(.7)	297(2.2)	65(.3)	3(T)	54(T)	0	1(T)	610(3.9)

TABLE 8. (Con'd)

Date	Plecoptera	Tricoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Nematoda	Other	Total
				Stillwater River - Station 034 - Midnight Canyon Bridge					
8-70	21	41	159	30	7	0	0	0	258
4-71	45(.3)	198(.7)	577(1.0)	48(.2)	10(T)	0	0	0	878(2.2)
8-71	41(.6)	51(.2)	112(.8)	121(.4)	13(T)	0	0	0	338(1.8)
8-71	47(1.6)	425(2.1)	191(.5)	46(.3)	9(T)	67(T)	0	0	785(4.5)
8-71	36(1.5)	197(3.3)	151(.7)	101(.4)	19(T)	0	9(T)	0	513(5.9)
2-72	156(.6)	216(.6)	320(1.3)	228(.7)	7(T)	84(T)	14(.1)	2	1027(3.3)
2-72	66(.6)	168(.7)	210(.3)	142(.5)	6(T)	22(T)	0	0	614(2.1)
2-72	112(.7)	276(1.0)	238(.6)	167(.4)	10(.1)	98(T)	3(T)	1(T)	905(2.8)
				Stillwater River - Station 035 - Johnson Bridge					
8-70	29	74	64	324	1	2	0	0	494
10-71	41(.4)	524(8.8)	156(.2)	28(T)	19(T)	0	29(T)	0	797(9.4)
10-71	39(.2)	533(9.1)	109(.5)	42(.3)	24(T)	0	20(T)	0	767(10.1)
10-71	32(.1)	242(3.1)	205(.4)	60(.6)	14(T)	0	30(T)	0	583(4.2)
2-72	51(.5)	190(1.3)	119(.8)	13(.2)	17(T)	18(T)	1(T)	0	409(2.8)
2-72	22(.4)	82(.7)	112(.3)	10(T)	5(T)	9(T)	0	0	240(1.4)
2-72	26(.2)	248(1.7)	162(.2)	31(.5)	19(.1)	41(T)	2(T)	0	529(2.7)

TABLE 8. (Con'd)

Date	Plecoptera	Tricoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Nematoda	Other	Total
	West Fork Stillwater River - Station 037 - Initial Creek Campground								
8-70	19	18	208	20	0	0	0	0	265
10-71	53(.1)	47(.1)	94(.4)	3(T)	0	24(T)	0	0	221(.6)
10-71	65(T)	35(.2)	137(.4)	3(T)	2(T)	39(T)	0	0	281(.6)
10-71	43(T)	28(.1)	74(.2)	7(.4)	1(T)	17(T)	0	0	170(.7)
	West Fork Stillwater River - Station 007 - Henry Grant's Cabin Bridge								
8-70	18	15	224	8	4	3	0	0	272
4-71	69(.1)	14(.1)	228(1.2)	5(T)	8(T)	0	23(T)	0	347(1.4)
10-71	90(.2)	13(T)	64(.1)	3(.3)	36(T)	99(T)	0	0	305(0.6)
10-71	71(.4)	25(.1)	138(.3)	18(.3)	11(T)	3(T)	0	0	266(1.1)
10-71	103(.2)	20(.4)	70(.3)	2(.4)	1(T)	27(T)	0	0	233(1.3)
2-72	186(.2)	22(.2)	89(.5)	13(.3)	0	17(T)	4(T)	3(T)	334(1.2)
2-72	170(.4)	37(.2)	115(.6)	64(2.5	0	36(T)	0	4(T)	426(3.7)
2-72	230(.5)	25(.2)	196(1.1)	59(2.5)	2(T)	13(T)	1(T)	2(T)	528(4.3)
	West Fork Stillwater River - Station 036 - Nye Bridge, South Channel								
8-70	26	27	207	16	3	18	0	1	298
10-71	85(.4)	17(.3)	182(1.1)	80(.2)	8(T)	0	34(T)	0	406(2.0)
10-71	26(.1)	58(.5)	93(.6)	13(T)	9(T)	0	24(T)	0	223(1.2)
10-71	40(.3)	26(.4)	136(1.1)	82(.3)	5(T)	0	8(T)	0	297(2.1)
2-72	153(.5)	23(.1)	348(1.6)	180(.3)	8(T)	242(.1)	0	1(T)	955(2.6)
2-72	161(.7)	38(.6)	441(2.4)	80(.6)	13(T)	187(.1)	1(T)	4(T)	925(4.4)
2-72	83(.2)	39(.3)	136(.6)	31(.1)	9(.1)	52(T)	0	1(T)	351(1.3)

TABLE 8. (Con'd)

Date	Plecoptera	Tricoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Nematoda	Other	Total
East Boulder River - Station 008 - Anderson Springs									
10-70	63	52	239	64	24	1	0	7	450
4-71	54(.1)	8(T)	120(.3)	1(T)	12(T)	0	22(T)	0	217(.4)
10-71	12(T)	8(.2)	55(.3)	0	5(T)	0	5(T)	0	85(.5)
10-71	83(.3)	43(.3)	135(.8)	13(T)	16(T)	1(T)	18(T)	0	309(1.4)
10-71	89(1.0)	33(1.2)	118(.6)	9(T)	7(T)	0	2(T)	0	258(1.8)
2-72	106(.5)	8(.1)	174(1.0)	10(.3)	6(T)	28(T)	0	7(T)	339(1.9)
2-72	103(.5)	12(.1)	171(.8)	13(.1)	2(T)	11(T)	0	5(T)	317(1.5)
2-72	107(.5)	11(T)	111(.5)	4(T)	5(T)	10(T)	0	1(T)	249(1.0)
East Boulder River - Station 009 - Ewan Campground near Mouth									
10-70	98	162	152	261	4	0	0	0	677
4-71	82(.1)	217(2.0)	585(1.0)	790(.9)	10(T)	0	10(T)	0	1694(4.9)
10-71	44(1.1)	279(3.2)	142(1.8)	124(1.7)	4(T)	0	51(T)	0	644(7.8)
10-71	64(.7)	307(4.1)	146(1.4)	138(.5)	4(T)	0	23(T)	0	682(6.7)
10-71	76(1.3)	385(5.4)	142(1.0)	236(1.5)	2(T)	0	49(T)	0	890(9.2)
2-72	226(.6)	353(2.5)	599(.8)	1077(.8)	5(T)	166(T)	2(T)	2(T)	2430(4.7)
2-72	207(2.5)	104(.4)	320(.4)	1176(.8)	10(T)	269(T)	3(T)	0	2089(4.1)
2-72	70(.2)	184(.9)	194(.2)	337(.5)	4(T)	102(T)	0	2(T)	893(1.7)
Boulder River - Station 011 - Flemming Bridge									
10-70	31	67	103	16	0	33	0	0	250
4-71	127(1.2)	29(.4)	131(1.4)	34(T)	0	0	37(T)	0	358(3.0
10-71	51(.1)	18(.2)	39(.1)	6(T)	0	0	6(T)	0	120(.4)
10-71	75(.2)	33(.7)	292(.9)	2(.4)	0	0	34(T)	0	436(2.2)
10-71	19(.1)	18(.7)	101(.4)	0	0	0	8(T)	0	146(1.2)

TABLE 8. (Con'd)

Date	Plecoptera	Tricoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Nematoda	Other	Total
				Boulder River - Station 050 - Clydehurst Ranch					
10-70	35	28	138	5	3	13	0	0	222
4-71	48(.1)	76(1.0)	118(.3)	31(T)	0	0	0	0	273(1.4)
10-71	154(.2)	94(.4)	153(.6)	4(T)	2(T)	62(.1)	0	0	469(1.3)
10-71	77(.2)	66(.3)	130(.5)	4(.1)	1(T)	69(T)	0	0	347(1.1)
10-71	169(.2)	141(1.1)	255(1.0)	13(.1)	0	24(T)	0	0	602(2.4)
				Boulder River - Station 010 - Falls Creek Campground					
10-70	40	29	99	4	5	21	0	0	198
4-71	38(.2)	14(.1)	93(.8)	7(T)	0	0	74(T)	0	226(1.1)
10-71	116(.3)	62(.4)	172(.6)	9(.1)	0	3(T)	3(T)	0	365(1.4)
10-71	50(.1)	55(.3)	121(.4)	11(.2)	0	4(T)	0	0	241(1.0)
10-71	109(.3)	86(.5)	150(.4)	7(.2)	1(T)	37(T)	0	0	390(1.4)
2-72	70(.4)	25(.1)	117(.7)	13(T)	4(T)	69(.1)	0	1(T)	299(1.3)
2-72	73(.6)	12(.2)	136(.9)	9(.1)	2(T)	61(.1)	0	0	293(1.9)
2-72	17(.1)	2(T)	44(.4)	3(T)	2(T)	10(T)	0	0	78(.5)
				Boulder River - Station 039 - Ewan Campground					
10-70	8	84	49	33	1	0	0	2	177
4-71	48(.2)	288(.3)	337(1.2)	271(.2)	9(.1)	0	0	0	953(2.0)
10-71	10(T)	129(2.3)	79(.7)	11(.1)	2(T)	0	3(T)	0	234(3.1)
10-71	4(T)	90(.5)	37(.2)	30(.4)	4(T)	0	2(T)	0	167(1.1)
10-71	1(T)	23(.1)	42(.3)	17(.2)	1(T)	0	0	0	84(.6)
2-72	55(.2)	34(.3)	180(.5)	969(.5)	3(T)	25(T)	1(T)	3(T)	1270(1.5)
2-72	41(.1)	126(.8)	157(.7)	53(3.5)	0	57(T)	0	9(T)	443(5.1)
2-72	18(.1)	31(.1)	65(.3)	3(T)	0	17(T)	1(T)	0	135(.5)

TABLE 8. (Con'd)

Date	Plecoptera	Tricoptera	Ephemeroptera	Diptera	Coleoptera	Annelida	Nematoda	Other	Total
				Boulder River - Station 040 - Fuller Draw Bridge					
10-71	17(1.2)	103(.3)	91(.2)	20(T)	4(T)	0	0	0	234(1.7)
10-71	5(T)	44(.1)	30(.1)	3(.1)	0	13(T)	0	0	97(.3)
10-71	28(.2)	210(1.1)	102(.3)	1(T)	1(T)	19(T)	0	0	366(1.6)
2-72	84(.4)	282(.9)	461(1.1)	96(2.1)	6(T)	425(.1)	0	0	1354(4.6)
2-72	74(.6)	375(1.0)	651(1.7)	34(.6)	4(T)	736(.2)	1(T)	0	1875(4.1)
2-72	158(.3)	290(1.0)	648(2.4)	29(.5)	4(T)	855(.3)	0	0	1984(4.5)
				West Boulder River - Station 041 - McLeod Bridge					
10-70	18	10	139	6	5	56	0	2	236
4-71	7(.1)	5(.1)	55(.2)	21(T)	1(T)	0	1(T)	0	89(.4)
10-71	29(.2)	21(.4)	178(.6)	10(T)	4(T)	0	18(T)	0	260(1.2)
10-71	25(.7)	34(.7)	126(.4)	3(T)	2(T)	125(T)	0	0	315(1.8)
10-71	33(.1)	6(T)	96(.4)	7(T)	1(T)	28(T)	0	0	171(.5)
2-72	54(.2)	10(T)	91(.2)	4(T)	2(T)	52(T)	2(T)	0	215(.4)
2-72	75(.2)	10(T)	123(.2)	9(T)	3(T)	0	2(T)	1(T)	223(.4)
2-72	62(.1)	12(.1)	113(.2)	10(T)	1(T)	30(T)	3(T)	0	231(.4)

Fish Populations

Data in Table 9 is a summary of physical characteristics, fish species captured, and fin clips made on fish in stream sections. These sections were used for estimation of fish population parameters.

No hatchery fish were captured in any of the stream sections, despite the fact that they are stocked in all of the larger streams.

Fish population data is given in Tables 10 through 12. Only one estimate (Table 10) was made for whitefish, and this estimate was not specific for fish age. I was unable to age whitefish from scales and this species sustained considerable handling mortality. Age specific estimates or overall population estimates were not made for species captured infrequently. Underyearling and yearling fish were often captured in insufficient numbers to be estimated.

Fish ages shown in Tables 10 and 11 are equal to numbers of annuli on scales. Except for fish captured in June when annuli were formed, fish had experienced some portion of a growing season beyond the indicated age. Growth rates were generally slightly less than state averages reported by Brown (1971). Growth rates are commensurate with the relatively low summer water temperatures and resultant short growing seasons.

Standing crops of trout in pounds per acre (Tables 10, 11, 12) on larger streams are somewhat lower than those reported by Vincent (1969) for rivers in southwestern Montana. Some of the tributary streams had moderately high standing crops of trout (Table 11). Carlander (1953) reports standing crop values for trout streams across North America. Most streams were in the range of 10 to 150 pounds per acre, with an approximate median of 60 pounds per acre. Compared to Carlander's (1953) data, standing crops of trout in streams in the study range from moderately low to high.

Relative numbers of fish per age group were mostly typical (fewer numbers of older fish). For sections on the East Rosebud (F-14) and the Boulder (F-4), low proportions of the youngest age group may be caused by eroding banks which have deposited sediment in spawning gravels. The high percentage of older rainbow trout in Section F-4 is probably due to numerous deep pools and runs, which is the habitat type required by large fish.

No fish were found in approximate 2,000 feet sections of South Nye, Verdigris, and Initial Creeks. Only one small rainbow trout was captured in a similar portion of Cathedral Creek. These streams are very small with only marginal fish habitat. South Nye and Initial Creeks may occasionally dry up. Verdigris Creek has sporadic high concentrations of metals (Table 4), and the stream bottom is covered with iron precipitates. Acute or chronic toxicity of metals probably prevents the establishment of a fish population in Verdigris Creek.

TABLE 9. Physical Data for Electrofishing Sections and Fish Species Captured.

Stream	Section No.	Location T	R	S	Length (feet)	Mean Width (feet)	Species* Captured	Fin Clip
East Rosebud	F-14	6S	18E	19,20	6283	77.6	Rb, LL, Wf, Catostomus sp	none
Morris Creek	F-12	6S	18E	8	1347	8.4	Eb, LL, Ct, unidentified cyprinid	left pelvic
West Fishtail	F-10	5S	16E	19	2270	20.3	Rb, Eb, LL	right pelvic
East Fishtail	F-9	5S	16E	19	2073	14.8	Rb, Eb, LL	right pectoral
Fishtail	F-11	5S	17E	8,17,18	3948	27.5	Rb, Eb, LL, Wf	adipose
Stillwater	F-1	5S	15E	28	2986	109.5	Rb, Eb, LL, Wf, Catostomus sp unidentified cyprinid	right pelvic
Stillwater	F-2	5S	15E	10,11,15	6710	91.6	Rb, Eb, LL, Wf, Catostomus sp unidentified cyprinid	adipose
Stillwater	F-3	5S	15E	1,2	5578	82.5	Rb, Eb, LL, Wf, Catosomus sp	none
Silver Creek	F-7	5S	15E	15	1289	6.4	Rb, Eb, LL	left pectoral
Nye	F-6	5S	15E	15	1453	5.0	Rb, Eb, LL	right pectoral
Mountain View	F-5	5S	15E	21	2589	4.8	Rb, Eb, LL, unidentified cyprinid	adipose plus left pelvic
Little Rocky	F-8	5S	16E	3,4	2590	13.9	Ct, LL	adipose plus right pelvic
Picket Pin	F-16	4S	14E	25	2059	13.5	Ct, Eb, LL	adipose
Boulder	F-4	3S	12E	26,35	5236	81.4	Rb, Eb, unidentified cyprinid	adipose
East Boulder	F-13	4S	13E	2,11	2410	28.2	Rb, Ct, LL	adipose

* Abbreviations are: Rb=Rainbow Trout; Ct=Cutthroat Trout; Eb= Brook Trout; LL=Brown Trout; Wf=Mountain Whitefish

TABLE 10. Fish Population Estimates for Major Stream Sections

Age Class	Mean length (inches)	Mean weight (pounds)	Estimated number (95% confidence interval in parentheses)	Estimated weight (pounds)	Pounds per acre
East Rosebud River-Section F-14-Brown Trout-November 1971					
I	5.8	0.07	136	9	
II	9.2	0.25	153	39	
III	12.0	0.57	119	68	
IV	16.9	1.51	53	79	
		Total	460(±101)	195(±55)	17.4
Fishtail Creek-Section F-11-July 1972					
			Brown Trout		
II	6.9	0.14	95	13	
III	9.9	0.39	58	23	
IV	12.8	0.83	50	41	
		Total	203(±47)	77(±19)	30.9
			Rainbow Trout		
I	3.6	0.02	405	8	
II	5.5	0.08	188	14	
III	8.1	0.22	42	10	
IV and older	10.8	0.51	31	15	
		Total	666(±318)	47(±14)	18.9
		Grand Total (2 species)	869	124	49.8

TABLE 10. (Con'd)

Age Class	Mean length (inches)	Mean weight (pounds)	Estimated number (95% confidence interval in parentheses)	Estimated weight (pounds) (95% confidence interval in parentheses)	Pounds per acre
Stillwater River-Section F-1-May 1972					
Rainbow Trout					
0	2.6	0.01	163	1	
I	4.6	0.03	244	8	
II	7.6	0.17	174	29	
III	9.5	0.34	28	10	
IV and older	12.9	0.83	8	7	
		Total	617(±322)	55(±31)	7.3
Brook Trout					
0	3.9	0.02	319	6	
I	5.8	0.07	115	8	
II	8.2	0.18	39	7	
		Total	473(±259)	21(±7)	2.8
Brown Trout					
I	5.9	0.08	34	3	
II	8.9	0.23	40	9	
III	12.0	0.57	21	12	
IV	14.9	1.23	13	16	
		Total	108(±63)	40(±13)	5.3
Mountain Whitefish					
all	--	--	336(±195)	167(±97)	22.0
GRAND TOTAL (4 species)			1534	283	37.4

TABLE 10. (Con'd)

Age Class	Mean length (inches)	Mean weight (pounds)	Estimated number (95% confidence interval in parentheses)	Estimated weight (pounds)	Pounds per acre
Stillwater River-Section F-2-March, April 1972					
			Brown Trout		
I	6.0	0.08	379	30	
II	9.0	0.26	260	67	
III	12.0	0.56	192	107	
IV	14.8	1.08	78	84	
V	23.1	4.15	1	6	
		Total	909(±175	293(±32)	20.8
			Brook Trout		
all	--	--	316(±146)	32(±15)	2.3
			Rainbow Trout		
all	--	--	214(±109)	102(±52)	7.2
		Grand Total (3 species)	1439	427	30.3
Stillwater River-Section F-3-November 1971					
			Brown Trout		
I	6.0	0.06	984	63	
II	9.0	0.26	400	104	
III	12.3	0.65	222	144	
IV	15.0	1.16	139	161	
V	19.6	2.75	10	26	
		Totals	1755(±774)	498(±101)	48.3

TABLE 10. (Con'd)

Age Class	Mean length (inches)	Mean weight (pounds)	Estimated number (95% confidence interval in parentheses)	Estimated weight (pounds) (95% confidence interval in parentheses)	Pounds per acre
			Boulder River-Section F-4-April 1972		
			Rainbow Trout		
0	2.5	0.01	43	0.4	
I	5.5	0.07	109	8	
II	8.8	0.26	87	23	
III	13.3	0.79	64	51	
IV and older	16.8	1.67	252	419	
		Total	555(±199)	501(±253)	51.2
			Brook Trout		
0	3.5	0.01	1788	23	
I	6.0	0.08	980	75	
II	8.7	0.21	115	24	
III	12.7	0.67	9	6	
		Total	2892(±940)	128(±24)	13.1
		Grand Total	3447	629	64.3

TABLE 10. (Con'd)

Age Class	Mean length (inches)	Mean weight (pounds)	Estimated number (95% confidence interval in parentheses)	Estimated weight (pounds)	Pounds per acre
East Boulder River-Section F-13-July, August 1972					
Brown Trout					
II	4.1	0.02	12	0.3	
III	6.2	0.09	49	4	
IV	7.5	0.16	18	3	
V and older	10.9	0.52	7	4	
		total	87(26)	12(3)	7.9
Rainbow Trout					
I	4.0	0.02	31	1	
II	5.2	0.05	128	7	
III	6.1	0.09	263	24	
IV	8.2	0.21	61	13	
V	10.1	0.34	8	3	
		Total	493(69)	47(6)	31.1
		Grand Total	580	59	39.0

TABLE 11. Fish Population Estimates for Tributary Stream Sections in Which age Specific Estimates were made.

Age Class	Mean length (inches)	Mean weight (pounds)	Estimated number (95% confidence interval in parentheses)	Estimated weight (pounds) (95% confidence interval in parentheses)	Pounds per acre
Silver Creek-Section F-7-June 1972					
			Brown Trout		
0	2.6	0.01	208	2.00	
I	5.0	0.05	100	5.00	
II	7.2	0.13	80	11	
III	9.2	0.28	24	6	
		Total	412(±152)	24(±4)	132
Little Rocky Creek-Section F-8-June 1972					
			Brown Trout		
II	6.7	0.13	77	10	
III and older	11.1	0.61	67	41	
		Total	144(±18)	51(±6)	61.7
Morris Creek-Section F-12-June 1972					
			Brook Trout		
I	5.0	0.05	467	23	
II	7.7	0.18	102	18	
III	8.9	0.28	83	24	
		Total	652(±86)	65(±7)	250

TABLE 11. (Con'd)

Age Class	Mean length (inches)	Mean weight (pounds)	Estimated number (95% confidence interval in parentheses)	Estimated weight(pounds) (95% confidence interval in parentheses)	Pounds per acre
Picket Pin Creek-Section F-16-August, September 1972					
			Brook Trout		
I	5.3	0.06	49	3	
II and older	8.8	0.30	47	14	
		Total	96(±13)	17(±1)	26.6
			Brown Trout		
I	4.4	0.04	24	1	
II	6.4	0.10	41	4	
III	9.4	0.34	36	12	
IV	11.6	0.59	8	5	
		Total	109(±14)	22(±3)	34.4
			Cutthroat Trout		
I	5.0	0.04	28	1	
II	7.3	0.14	14	2	
III	9.5	0.30	10	3	
		Total	52(±13)	6(±1)	9.4
		Grand Total (3 species)	257	45	70.4

TABLE 12. Fish Population Estimates for Tributary Stream Sections in Which age Specific Estimates were not made.

Species	Length range (inches)	Estimated number (95% confidence interval in parentheses)	Estimated Weight (pounds) (95% confidence interval in parentheses)	Pounds per acre
West Fishtail Creek-Section F-10-July 1972				
Brook Trout	1.5 - 9.3	150(±73)	10(±5)	9.4
East Fishtail Creek-Section F-10-July 1972				
Rainbow Trout	2.1 - 11.5	124(±59)	7(±3)	10.0
Brook Trout	4.0 - 10.1	42(±27)	6(±4)	8.6
	total	166	13	18.6
Nye Creek-Section F-6-June 1972				
Brook Trout	3.8 - 7.4	32(±15)	2(±1)	12.0
Brown Trout	2.9 - 7.1	16(±6)	1(±0)	6.0
	total	48	3	18.0
Mountain View Creek-Section F-5-June 1972				
Brook Trout	3.2 - 10.0	112(±64)	7(±4)	24.1
Brown Trout	2.7 - 9.6	39(±28)	2(±1)	6.9
	total	151	9	31.0

Other Fish and Game Department personnel electrofished a portion of the East Boulder River in Placer Basin (T5S; R13E; Section 11) in the summer of 1971. No fish were found and hatchery cutthroat trout were subsequently stocked. A 1600 feet section in the same location was electrofished in the summer of 1972. Four of the stocked fish were captured. These ranged in length from 6.3 to 7.5 inches.

Metals Concentrations in Fish Tissue

Representative samples of fish populations from five sections on the larger streams have been sent to the U. S. Environmental Protection Agency laboratory in Denver, Colorado. Analysis is under way, but no results have been reported.

Fish Stomach Contents

Approximately 12 fish stomachs per stream section were examined from sections of the Stillwater, Boulder and East Boulder Rivers. This analysis was made to find organisms, if any, which were of overwhelming importance as fish food. A wide variety of organisms were found in stomachs and no particular bottom fauna species appeared to be of great significance as fish food. In stomachs containing several organisms two or more species were always present. Many more fish stomachs would have to be examined to reach any firm conclusion concerning fish foods.

Egg Bioassays

Percentage survival to hatching of eyed cutthroat trout eggs placed in artificial redds is found in Table 13. Spring runoff began the last few days that eggs were in redds, causing complete loss of eggs and fry at Stations 010 and 011 (Boulder River) and partial loss at three other stations.

Survival of eggs to hatching averaged less than 50 percent. Over 90 percent of eggs which received the same treatment as those placed in redds, and were returned to the hatchery as controls, survived to hatching.

Water temperatures, measured when eggs were placed in redds, were lower than optimum for cutthroat trout embryo development. Peters (1965) reported survival of rainbow trout eggs to be as high as 95 percent, under conditions which were similar to those of this study except for water temperature.

Stillwater River Headwaters Area

On July 27, 1972 cutthroat trout spawners were sampled with a seine in the inlet stream to Goose Lake (Figure 2). This stream is approximately 1000 feet long and connects Goose Lake with Little Goose Lake. Eighty fish were captured. This number appeared to be about half the fish present in the stream on that day. Fish ranged in length from 6.9 to 16.2 inches and from 0.11 to 1.35 pounds. Most females were ripe and some were spawned out.

TABLE 13. Percentage survival to hatching of eyed cutthroat trout eggs placed in artificial redds.

Station No.	Date Eggs placed in redds	Date Eggs removed from redds	Egg Containers 1	2	3	Mean Survival
Stillwater River						
005	4-19-72	5-16-72	42	47	51	46
006	4-19-72	5-16-72	7	--	--	--
West Fork Stillwater River						
007	4-19-72	5-16-72	50	59	51	53
East Boulder River						
008	4-19-72	5-17-72	40	--	--	--
East Rosebud Creek						
001	4-20-72	5-15-72	51	39	33	41
028	4-20-72	5-15-72	43	--	--	--
West Rosebud Creek						
003	4-20-72	5-15-72	27	34	34	32
004	4-20-72	5-15-72	69	63	62	65

Scales were collected, but could not be aged with any confidence because scale circuli did not form recognizable annuli in many instances.

Redds in the inlet stream were sampled on September 6, 1972. All live eggs had hatched but fry were still in the gravel. No redds were found in the lower half of the stream. Drainage from a pit dug on an adjacent mining claim had contributed silt to the lower portion of the stream, but fine material was also present in gravels in the upper portion. A total of 1168 dead eggs and sac fry were removed from three redds. Overall survival to hatching of sac fry and dead eggs recovered from redds was 54 percent and varied from 1 percent to 84 percent for the three redds. No reason for the large variability in survival was apparent.

Acidic mine drainage originates from Daisy Pass area (Figure 1). Water from many seeps and springs in the disturbed area has pH values of approximately 2.5 to 4.0, with some concentrations of over one hundred milligrams per liter of metals such as aluminum, copper, iron, and zinc (unpublished data, Custer National Forest, U. S. Forest Service). Little or no data is available, however, on affects of acid drainage on the upper Stillwater River.

Results of work done in this area in August 1972 are shown in Table 14. The pH had reached 5.6 at the mouth of the unnamed creek (here called Daisy Creek) which drains the area disturbed by mining activities. Values of pH in the Stillwater downstream from this point were above 8.0 (Table 14). Metal concentrations had dropped to values probably not acutely toxic to organisms at a distance of 0.4 stream miles below Daisy Creek. Quantitative bottom fauna samples were collected, but have not been analyzed.

From observations, bottom fauna is depressed severely for at least 1.5 miles, below the mouth of Daisy Creek and for an undetermined distance below this point. The iron precipitate on the stream bottom and metals in the stream interferes with establishment of bottom fauna.

Fish were not found in the Stillwater River upstream from the acid drainage, nor in Goose Creek before it empties into the Stillwater River. This apparent lack of fish cannot be explained. The only fish captured in the area of the Stillwater was 6.5 stream miles below the mouth of Daisy Creek (Table 14). Fish may be present farther up the Stillwater River, but numbers are probably extremely low. Fish may not survive in many streams in this area because of the high elevation, severe winter conditions, and unknown but possibly very low water flow rates in winter.

RECOMMENDATIONS

At least four or five additional years will be required to obtain precise pre-mining chemical and biological data over all of the streams that could possibly be affected.

TABLE 14. Summary of physical, chemical, and biological conditions in the Stillwater River downstream from the Daisy Pass headwaters area.

Distance from mouth of Acid Stream	pH	Cu (mg/liter)	Mn (mg/liter)	Zn (mg/liter)	Condition of Stream Bottom	Bottom Fauna	Fish
50 feet upstream	8.5	--	--	--	Clean gravel	Plentiful diverse	None captured
150 feet downstream	8.1	--	--	--	Heavy Iron precipitate	Some present	None captured
0.4 miles downstream	8.4	0.05*	0.16*	0.02*	Iron Precipitate	Very few present	None captured
1.5 miles downstream	8.5	--	--	--	Iron Precipitate	None visible	None captured
2.7 miles downstream above Goose Creek	8.5	0.07	0.06	0.015	Iron Precipitate	Present	None captured
below Goose Creek	8.4	0.02	0.02	0.015	Faint Iron Precipitate	Present	None captured
6.5 miles downstream	--	--	--	--	--	--	One brook trout captured by hook and line
8.5 miles downstream	--	--	--	--	--	--	Several fish seen in river

* unpublished data - Custer National Forest - U. S. Forest Service

Additional work similar to that reported here is planned for 1973. Data on general water quality parameters is sufficient for now except for a few tributary streams which have yet to be sampled. These streams will be sampled in 1973. Detailed sampling for metals will also be done this year. This will consist of analysis for suspended metals and metals in stream sediments, as well as dissolved metals. Additional collections of fish for metals analysis are also planned. Collection of bottom fauna samples will continue in order to better define the variability in standing crops. Species lists and diversity indices will be developed for the various sampling stations after species identification of stream bottom fauna is begun. Fish egg bioassays will be repeated in early fall this year. Early fall water temperatures should be more suitable than spring water temperatures. Fish population estimates will be repeated and estimates will be made on additional sections as time allows. Fish populations in each of these sections should be estimated in at least three years to measure yearly changes and to allow calculations of mortality and production rates.

No further work with fish stomach contents is planned. The time required to obtain precise information is probaly not justified at this time. It would be desirable to further evaulate spawning success in the Goose Lake inlet stream, but no additional work is planned because the situation appears very delicate and an entire year class of fish could easily be destroyed with only minimal redd sampling.

Information is needed on the size composition of stream bottom materials. Increased sediment is likely when mining actually takes place and much of this sediment would probably deposit in stream gravels. No work of this sort is planned at this time because of the large amount of time required. Hopefully, another investigator or agency might undertake this project.

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