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MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS

FISHERIES DIVISION

JOB PROGRESS REPORT

STATE:	Montana	TITLE:	Southwestern Montana Fisheries Investigations
PROJECT NO.:	F-9-R-28		
JOB NO.:	I-c	TITLE:	Inventory and Survey of Waters of the Upper Yellowstone Drainage

PERIOD COVERED: July 1, 1979 through June 30, 1980

REPORT PERIOD : April 1, 1979 through March 31, 1980

ABSTRACT

Fish population estimates are presented for Yellowstone cutthroat trout (*Salmo clarki*), brown trout (*Salmo trutta*) and rainbow trout (*Salmo gairdeneri*) from one study section of the Yellowstone River during spring, 1978.

Analysis of growth patterns of tagged brown and rainbow trout from the Yellowstone River revealed a similar length-weight growth rate relationship of slower growth with increased size of fish.

A summary is presented of U.S.G.S. flow data collected from the Yellowstone River between 1968 and 1979 coinciding with the high and low flow periods of the Department of Fish, Wildlife and Parks water reservation.

Water temperature data collected from the Yellowstone River between 1967 and 1979 showed the highest maximum water temperatures were recorded during the "high flow period" of 1977 when the lowest flows for that period occurred.

Fish population estimates from 1978 and 1979 are presented for brown trout, rainbow trout and mountain whitefish (*Prosopium williamsoni*) from two study sections of the Shields River.

The mean daily flow of the Shields River, near Wilsall, from October, 1978 to September 30, 1979 (354 days) was 128 cfs. A record peak flow of 5,410 cfs was recorded on June 20, 1979 near the mouth of the Shields River.

The maximum water temperatures of the Shields River, 72°F at Convict Grade and 65°F at Zimmerman, coincide with the lowest flow recorded (21 cfs at Zimmerman) during the summer months.

Generally, patterns of flow, turbidity and conductivity of the Shields River were similar showing increased readings with downstream progression. However, conductivity patterns were less consistant and indicate activities at the downstream reaches may be altering normal water quality patterns.

Two years following partial rehabilitation of Dailey Lake, the average size of yellow perch (Perca flavescens) collected increased 2.1 inches, and rainbow trout increased 4.9 inches.

In Armstrong Spring Creek, wild brown trout were predominant during spring, 1971 and 1972, making up 77 and 84 percent, respectively, of the trout population. Following the operation of a commercial hatchery, spring, 1978 population estimates showed that rainbow trout made up 73 percent of the population and that brown trout made up 27 percent of the trout population.

BACKGROUND

Existing water rights held by the Department of Fish, Wildlife and Parks since 1969 on certain reaches of "blue ribbon" streams, including the upper 123 miles of the Yellowstone River mainstem in Montana, must be refiled before January 1, 1982 due to an act of the 1978 Montana Legislature.

In addition, substantial water reservations granted to the Department on December 16, 1978 for maintenance of fish and wildlife habitat in the Yellowstone River Basin by the Board of Natural Resources requires certain conditions to be met to keep the reservations valid.

Study is necessary to continue to substantiate these rights and also important for making sound management decisions in the face of increasing recreational demands being placed on the Upper Yellowstone drainage.

OBJECTIVES AND ATTAINMENT

The objectives were as follows:

1. To determine fish populations on at least one study section of the Yellowstone River and two established study sections of the Shields River. Data collected from the Yellowstone River and Shields River are presented in this report.

2. To monitor flows at two Shields River sites. Data included in this report.

3. To determine water temperature regimes at one site on the Yellowstone River and two sites on the Shields River. Data included in this report.

4. To monitor certain water quality parameters on the Shields River. Turbidity and conductivity data are included in this report.

PROCEDURES

Fish populations were sampled in the Yellowstone River using 0-600 variable voltage pulsed direct/alternating current electrofishing equipment. Sampling was conducted from an 18 foot aluminum boat with an 80 horsepower outboard jet motor. A fixed double boom positive electrode system was used with negative electrodes fixed to the gunwales of the boat.

Fish populations were sampled in the Shields River and Armstrong Spring Creek using 0-500 variable voltage pulsed direct current electrofishing equipment. Sampling in the Shields River was conducted from motorless 13 and 14 foot fiberglass and aluminum boats, respectively. A 10 foot fiberglass boat was used on Armstrong Spring Creek. A mobile positive electrode system was used with negative electrodes fixed to the bottom of the boat.

Fish population sampling procedures were those described by Vincent (1971 and 1974). Fish population estimates were computer calculated by 0.5 inch groups.

Captured fish were anesthetized, measured, weighed and marked with a partial fin clip or Floy T tags. Scale samples were collected, and the fish were released near the capture site.

Growth rate analysis of trout was done using data from trout captured during spring electrofishing and identified with numbered Floy T tags and recaptured by the same method in subsequent years.

Instream flows were monitored at two U.S.G.S. sites on the Yellowstone River.

The U.S.G.S. was contracted to install and service a continuous recording guage in the Shields River near its mouth. Flows at three other sites were monitored using a hand held rod with a currentmeter, stage measurements and flow rating tables.

Water temperatures were monitored at one site on the Yellowstone River using a continuous recording 30-day thermograph. In addition, water temperatures were monitored by the U.S.G.S. at two sites on the Yellowstone River.

Water temperatures were monitored on the Shields River using a continuous recording 30-day thermograph and max/min thermometers.

Turbidity and conductivity were monitored at four sites on the Shields River using a Hach Model 2100 A turbidmeter and a YSI Model 33 S-C-T meter, respectively.

Flow, water temperature, turbidity and conductivity of the Shields River were monitored on the same weekly schedule from March through mid-November and bi-weekly from mid-November through February.

Fish populations in Dailey Lake were sampled using experimental (3/4-2 inch square) gill nets.

RESULTS

Yellowstone River

Fish Populations

Electrofishing data have been collected from the Yellowstone River from spring, 1970 through fall, 1979. During this time period, populations from five study sections have been monitored beginning 10 miles downstream from Livingston at Sheep Mountain and spanning about 60 miles of the Yellowstone River upstream to Corwin Springs (Figure 1).

The Sheep Mountain study section is 4.4 miles long and begins six miles downstream from Livingston at the Highway 89 bridge. The Ninth Street and Carter's Bridge study sections are adjacent encompassing approximately nine miles of the Yellowstone River at Livingston. The Carter's Bridge section begins at Carter's Bridge and extends downstream 4.3 miles to the Ninth Street Island Bridge in Livingston. The Ninth Street section begins at

UPPER YELLOWSTONE RIVER DRAINAGE

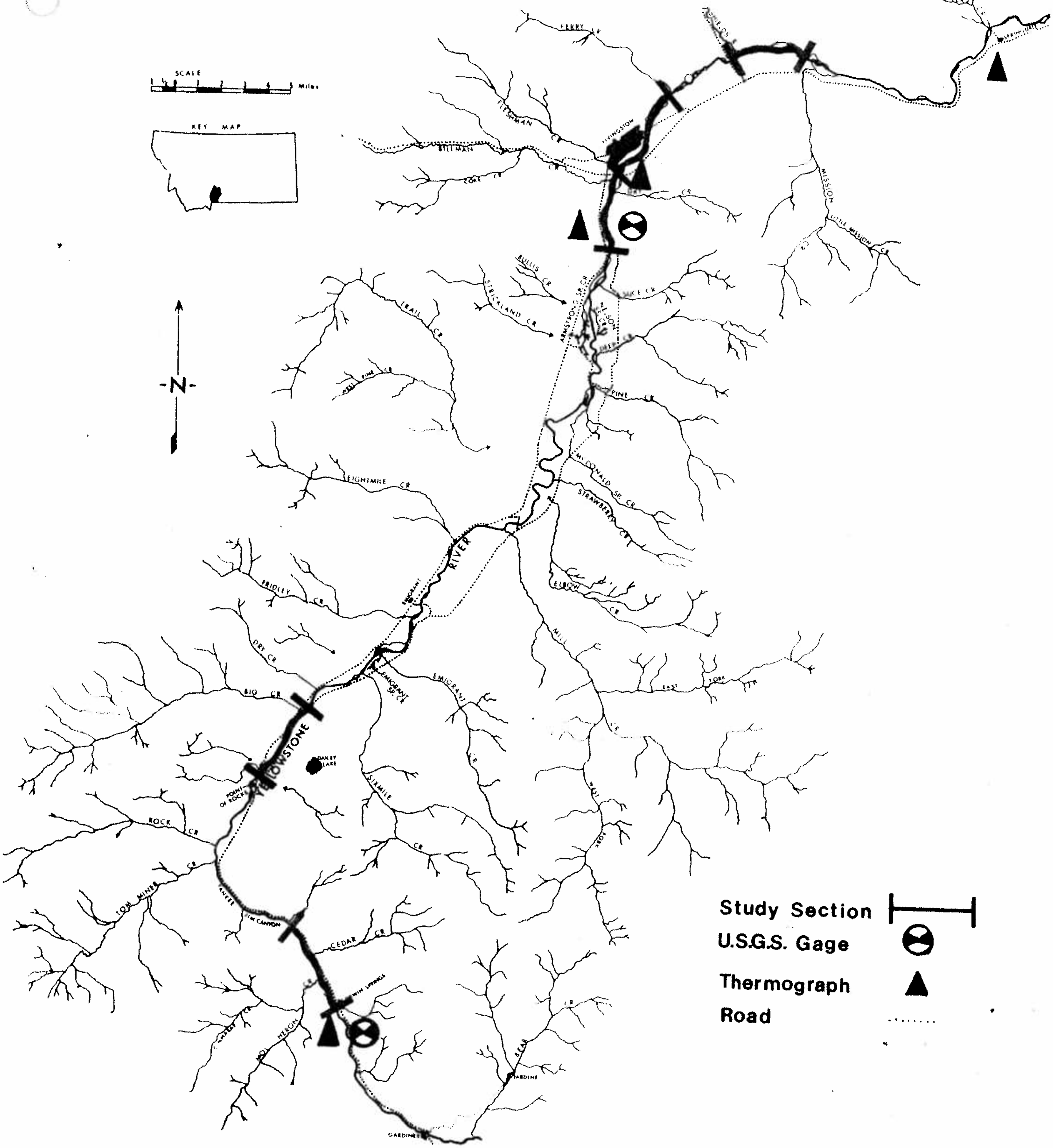

Figure 1. Map of Upper Yellowstone River Drainage.

Ninth Street Bridge and extends downstream 4.6 miles. The Point of Rocks study section is 4.0 miles long beginning at the Highway 89 Bridge at Point of Rocks located approximately 38 miles upstream from Livingston. The Corwin Springs section is located approximately 52 miles upstream from Livingston. This study section begins at the first riffle upstream from the Corwin Springs Bridge and extends downstream 5.2 miles to the last riffle upstream from Yankee Jim Canyon.

Mark and recapture data collected from the Corwin Springs study section during spring, 1979 were used to compute fish population estimates by length groups of trout 6.0 inches and larger (Table 1). In this study section, brown trout made up 55 percent, rainbow trout 29 percent, and cutthroat trout 17 percent of the total number. Brown trout made up 80 percent of the total number of trout 14.0 inches and larger, rainbow trout 20 percent and cutthroat trout less than 1 percent. Within the brown trout population, 32 percent were 14.0 inches or larger. Within the rainbow trout and cutthroat trout populations 15 and 0.3 percent respectively were 14.0 inches or larger.

There is no apparent difference in growth rate between these three species of trout in the Yellowstone River (Stevenson, 1978). Therefore, the relative absence of older rainbow trout and cutthroat trout may be due to greater vulnerability of these species to fishermen compared to brown trout or due to other unknown interactions within the fish populations and their environment.

Mark and recapture data were also processed from the other four study sections from spring, 1970 through spring, 1979. Due to technical problems, these data are not presented here but will appear in a later report.

TABLE 1. Spring population estimates of trout 6.0 inches and larger (80 percent confidence limits in parenthesis) expressed in numbers per 1,000 feet of stream for the Corwin Springs section of the Yellowstone River.

Section and Date	Length Group (inches)				
	6.0-9.9	10.0-13.9	14.0-17.9	18.0+	6.0+
Corwin Springs					
			Rainbow Trout		
1979	16	39	10	0	65(± 22)
			Brown Trout		
1979	28	56	38	2	124(± 23)
			Yellowstone Cutthroat Trout		
1979	15	23	0[1/]	0	38(± 10)

1/ 0.3 per 1,000 ft.

Growth Rate of Trout

The annual growth in length of tagged trout was determined from fish measured and tagged during spring electrofishing in the Yellowstone River and recaptured by the same method in following years (Stevenson, 1978).

Using the same sample of data, corresponding increments of growth by weight were plotted against length frequencies of recaptured fish for this report period (Appendix A).

The mean annual weight increment compared to the mean annual length increment by one inch groups for Ninth Street brown and rainbow trout are illustrated in Figures 2 and 3, respectively.

Similar length and weight growth patterns were observed for both brown and rainbow trout. The relationship between mean length increment and mean weight increment was examined using linear regression. The regression analysis was limited to brown trout from 8 to 18 inches and rainbow trout from 8 to 17 inches because sample size of smaller and larger trout was small. Annual length increment per inch group was regressed on annual weight increment. Correlations were tested at the 90% level of probability. A correlation between length and weight increments of brown trout gave an r value of 0.95 (p = .001) and for rainbow trout an r value of 0.80 (p = .01) showing a definite length-weight relationship for both species.

Flow

U.S.G.S. flow data from gauge stations located in the Yellowstone River "at Corwin Springs" and "near Livingston" (Figure 1) were summarized for this report period. Flows were broken down to coincide with the high and low flow dates of the Department of Fish and Game Application for Water Reservation on the Upper Yellowstone River from Gardiner to the mouth of the Boulder River and to coincide with the period of time between population estimates. All flow data is expressed as mean daily flow in cubic feet per second (cfs).

Summaries of the mean daily flow (cfs) from 1968 to 1979 during the high flow (May 11-August 10) and low flow (August 11-May 10) periods and the mean daily flow during the time interval between dates of fish population estimates are presented for the gauges "at Corwin Springs" and "near Livingston" in Tables 2 and 3, respectively.

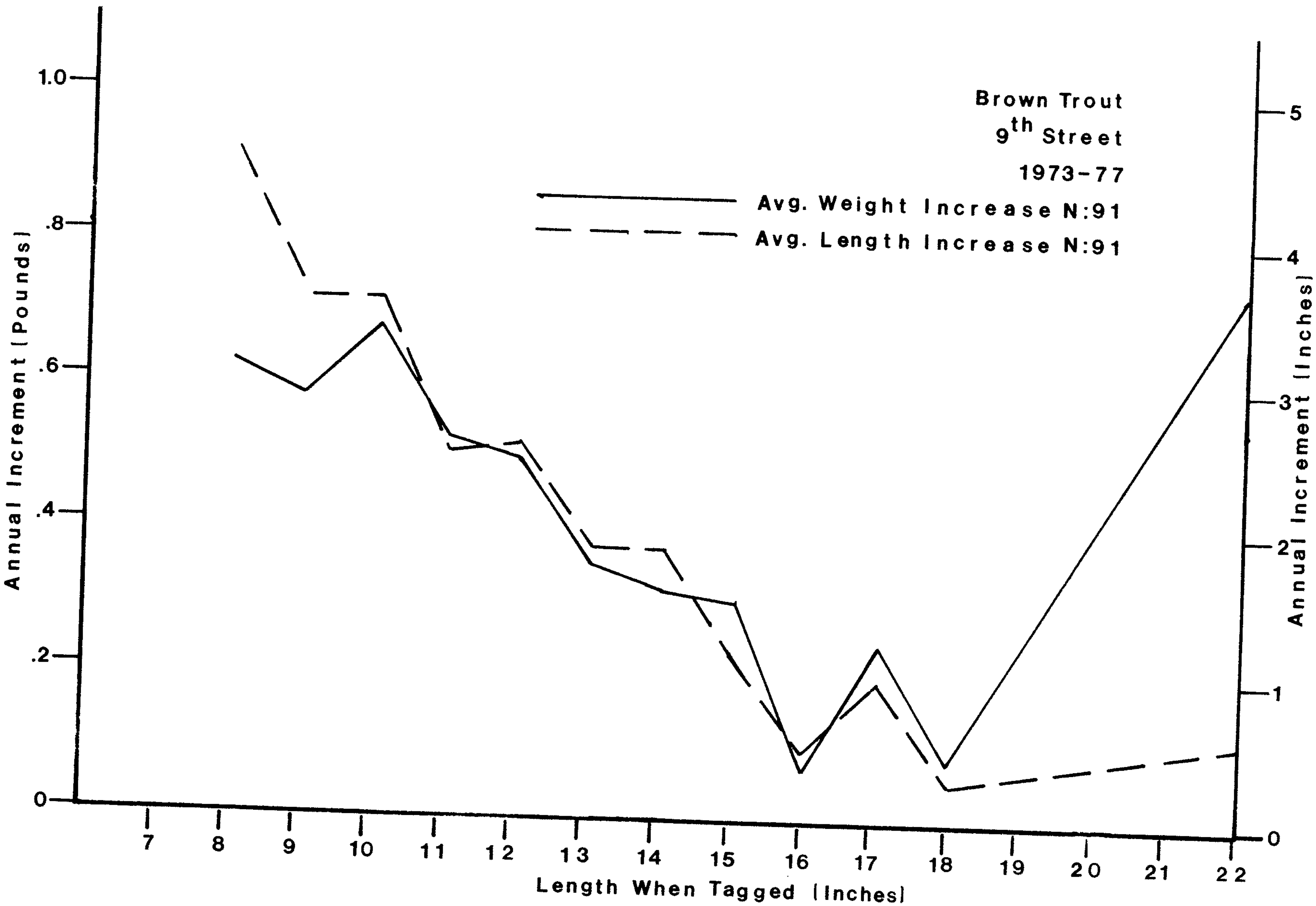

FIGURE 2. Mean annual weight increment compared to mean annual length increment of brown trout in the Ninth Street study section.

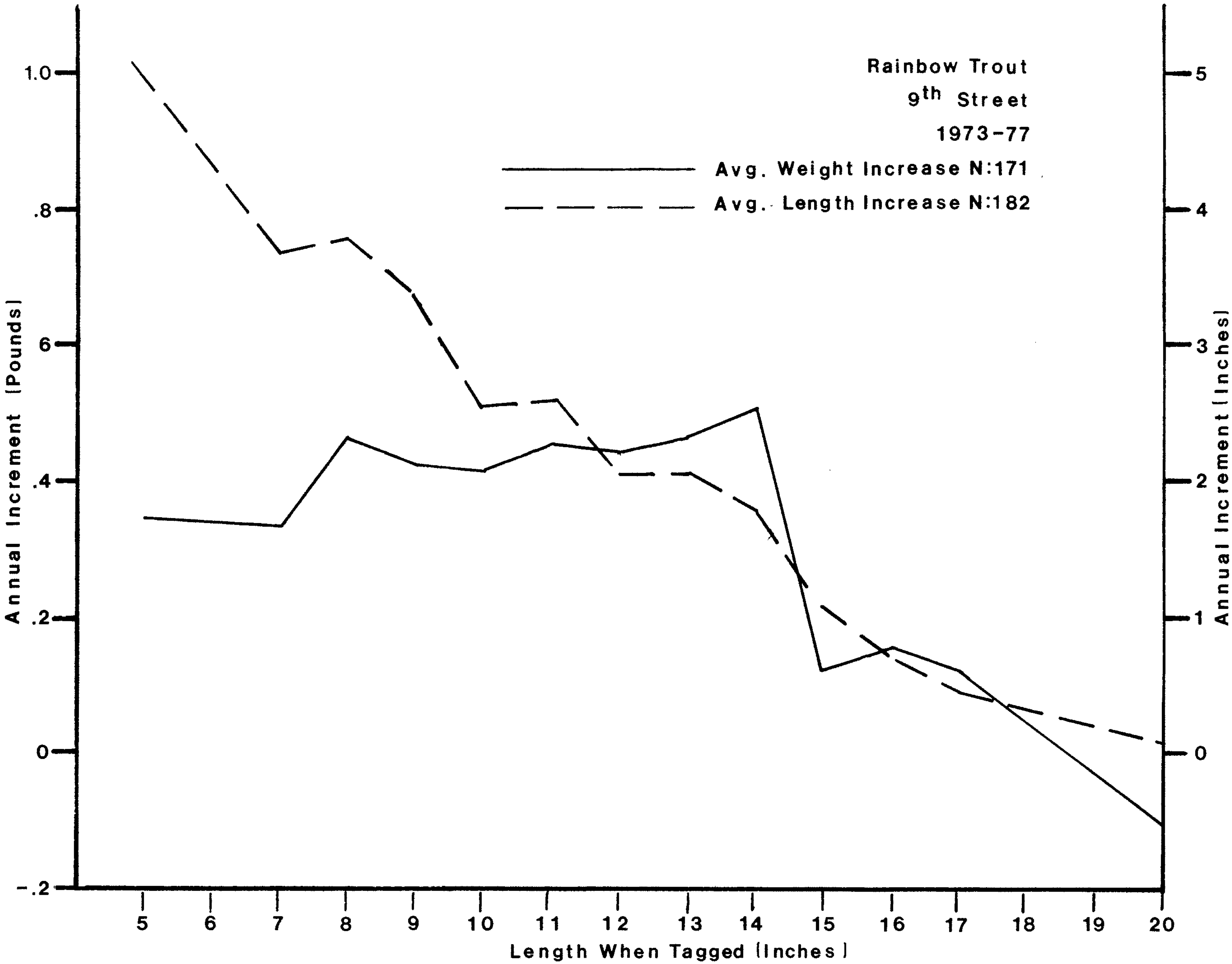

FIGURE 3. Mean annual weight increment compared to mean annual length increment of rainbow trout in the Ninth Street study section.

TABLE 2. Mean daily flow (cfs) during high flow (May 11-August 10) and low flow (August 11-May 10) periods and mean daily flow during the interval between dates of fish population estimates. (U.S.G.S. gauge at Corwin Springs).

Year	High Flow	Low Flow	Between Estimates[1/]
1968	8,667		
1968-69		2,109	
1969	8,695		
1969-70		1,246	
1970	9,919		
1970-71		1,603	3,590
1971	11,782		
1971-72		1,684	4,068
1972	10,536		
1972-73		1,701	3,906
1973	6,569		
1973-74		1,408	2,639
1977[2/]	4,225		
1977-78[2/]		1,136	1,925
1978[2/]	9,416		
1978-79[2/]		1,449	3,459
1979[2/]	7,216		

[1/] Mean flow one year preceding last recapture data for population estimate.

[2/] Provisional, unpublished U.S.G.S. data.

TABLE 3. Mean daily flow (cfs) during high flow (May 11-August 10) and low flow (August 11-May 10) periods and mean daily flow during the interval between dates of fish population estimates. (U.S.G.S. gauge near Livingston).

Year	High Flow	Low Flow	Between Estimates[1]
1968	10,766		
1968-69		2,646	
1969	10,202		
1969-70		1,739	3,972
1970	11,942		
1970-71		2,154	4,561
1971	14,060		
1971-72		2,263	5,339
1972	12,185		
1972-73		2,244	4,680
1973	7,770		
1973-74		1,742	3,335
1974	13,667		
1974-75		1,844	4,809
1975	11,219		
1975-76		2,243	4,459
1976	12,376		
1976-77[2]		2,076	4,673
1977[2]	5,199		
1977-78[2]		1,532	2,445
1978[2]	12,177		
1978-79[2]		2,068	
1979[2]	8,202		

1/ Mean flow one year preceding last recapture date for population estimate.

2/ Provisional unpublished U.S.G.S. data.

Water Temperatures

Water temperature data collected from five locations on the Yellowstone River (Figure 1) between 1967 and 1979 are summarized in Table 4. These data were summarized by average, minimum and maximum water temperatures (°F) during the "high flow" and "low flow periods" of the Yellowstone River.

These data indicate that water temperature fluctuations were dependent, at least in part, on discharge. The highest average and maximum water temperatures were recorded during the "high flow period" of 1977 when the lowest flows for that period occurred. During the "high flow period" of 1977, the average and maximum temperatures, respectively were 55.4 and 70.9°F at Corwin Springs, 58.3 and 70.5°F at Livingston, and 60.1 and 71.5°F at the Grey Bear site near Big Timber. During the "high flow period" of 1979, a relatively low water year, the average and maximum water temperatures were 57.8 and 70.5°F, respectively at the Grey Bear site. Maximum temperatures observed were less than 70°F during the "high flow period" for all other years of record.

The average temperature during the "high flow period" of 1977 ($\bar{x}$ = 5,199 cfs) increased 4.7°F from Corwin Springs to Grey Bear (84 river miles) while during 1976, a relatively high water year ($\bar{x}$ = 12,376 cfs) the increase was only 1.8°F. During the 1975 high flow period ($\bar{x}$ = 11,219 cfs) average water temperatures increased 2.8°F from Corwin Springs to Springdale, about 75 river miles.

Shields River

Fish Populations

Spring and fall fish populations were monitored at the Convict Grade and Zimmerman study sections of the Shields River during this report period (Figure 4).

The Convict Grade section is located about two miles upstream from the mouth of the Shields River. This section begins at the second bridge upstream from the mouth of the Shields River and extends 7,900 feet downstream to the first bridge. The Zimmerman section is located about 35 miles upstream from the mouth of the Shields River. This section begins at the first bridge upstream from the mouth of Elk Creek and extends downstream 3,600 feet to the mouth of Elk Creek.

Fish population estimates of brown trout, rainbow trout and mountain whitefish from the Convict Grade study section and of brown trout and mountain whitefish from the Zimmerman study section are presented in Table 5.

In the Convict Grade study section during fall, 1978, there were 74 (8 percent) brown trout, 53 (5 percent) rainbow trout and 877 (87 percent) mountain whitefish 6.0 inches and larger per 1,000 feet of stream. Twenty-one percent of the brown trout, 13 percent of the rainbow trout and 4 percent of the mountain whitefish were 14.0 inches or larger.

TABLE 4. Average, minimum and maximum water temperatures (^{o}F) at five locations on the Yellowstone River.

Location	High Flow Period May 11 - August 10 Dates	Ave. (^{o}F)	Min. (^{o}F)	Max. (^{o}F)	No. Days No Temp. Recorded	Low Flow Period August 11 - May 10 Dates	Ave. (^{o}F)	Min. (^{o}F)	Max. (^{o}F)	No. Days No Temp. Recorded
Corwin Springs	1968 May 23-Aug.25	48.7	43.9	58.9	9	1967 Aug.08-Nov.02	51.3	44.5	58.2	4
	1969 May 11-Aug.10	50.7	38.8	64.0	15	1968 Sep.05-Oct.06	49.1	41.8	55.2	3
	1975 May 11-Aug.10	51.5	38.4	66.1	0	1969 Mar.17-Apr.30				
	1976 May 11-Aug.10	54.4	43.1	67.2	0	1969 Sep.01-Sep.18	48.0	41.9	53.3	0
	1977 May 11-Jul.18	55.4	41.1	70.9	2	1975-76 Aug.11-May 10	42.9	30.9	64.4	0
	1978 May 11-Aug.10	51.8	39.4	66.4	0	1976-77 Aug.11-May 10	51.7	33.9	67.0	0
	1979 May 11-Aug.10	49.4	39.0	69.0	39	1977-78 Oct.01-May 10	41.5	32.0	52.9	65
						1978-79 Aug.11-May 10	42.9	32.0	67.2	49
Carter's Bridge	1968 May 14-Aug.09	50.9	41.4	63.4	26					
	1969 May 11-Aug.10	53.9	41.3	66.2	17					
	1978 May 11-Aug.10	52.9	41.0	67.1	0	1977-78 Oct.01-May 10	39.6	32.0	53.6	0
	1979 May 31-Aug.10	54.1	41.2	68.9	0	1978-79 Aug.11-May 06	43.3	32.0	65.5	32
9th Street	1975 May 19-Aug.08	56.2	40.6	67.7	45	1975-76 Sep.07-May 03	42.8	32.9	62.8	0
	1976 May 11-Aug.10	55.1	42.6	68.3	0					
	1977 May 11-Aug.10	58.3	44.2	70.5	0					
Springdale	1973 May 10-Aug.10	56.7	43.6	68.6	0	1973-74 Aug.11-May 10	46.2	31.3	67.9	0
	1974 May 11-Aug.10	55.7	41.9	68.1	1	1974-75 Aug.11-May 10	44.9	31.8	64.9	0
	1975 May 11-Aug.10	54.3	41.2	67.7	0					
Grey Bear Fishing Access	1976 May 11-Aug.10	56.2	44.4	69.1	4	1976 Mar.12-Apr.30, Sep.01-Nov.27	47.3	38.4	55.2	0
	1977 May 11-Aug.10	60.1	45.2	71.5	0					
	1978 May 11-Aug.10	59.6	47.8	69.4	35	1977-78 Sep.01-May 10	45.0	31.6	53.4	60
	1979 May 11-Aug.10	57.8	38.5	70.5	0	1978-79 Aug.11-May 10	44.2	31.5	68.6	25

SHIELDS RIVER DRAINAGE

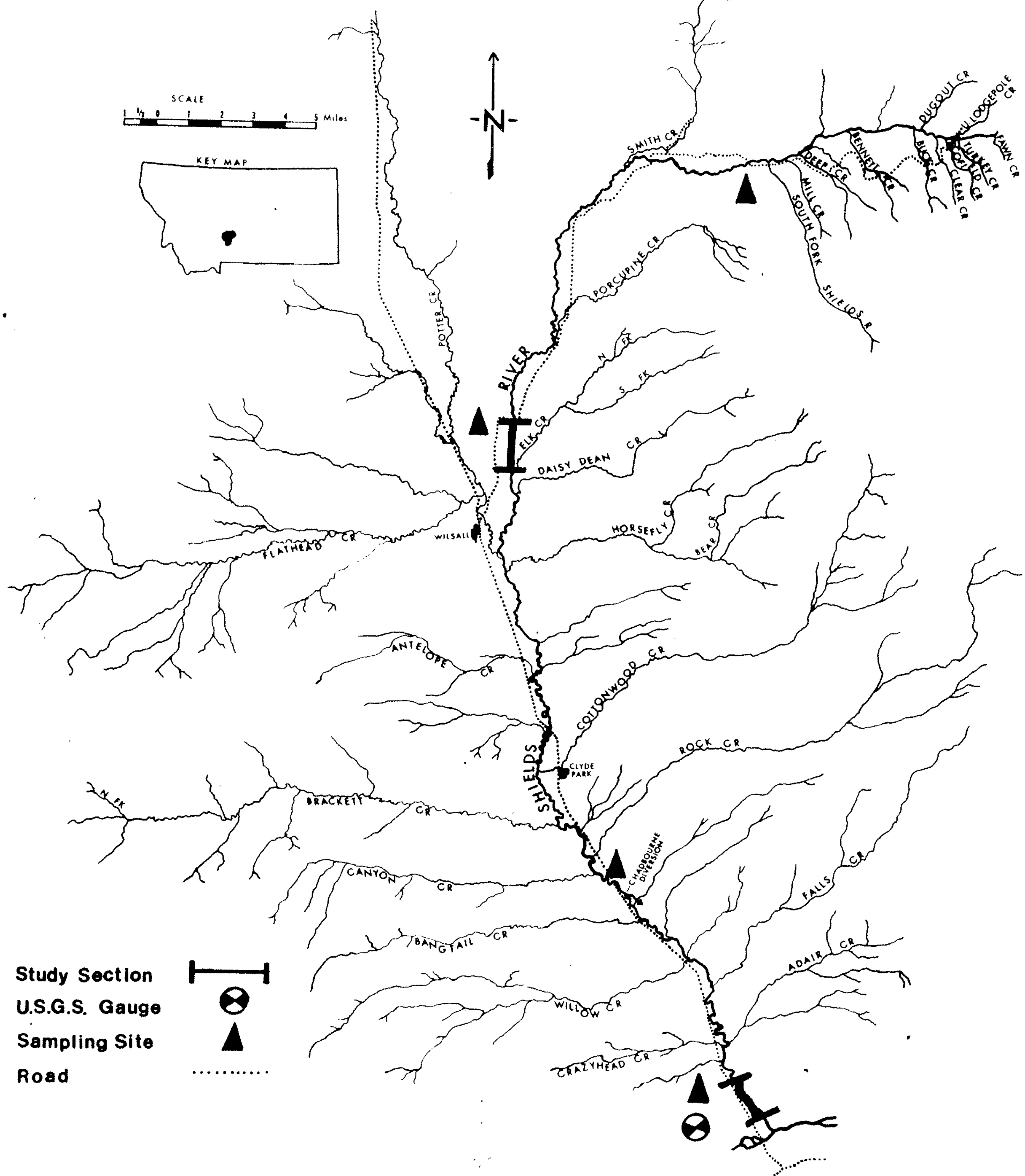

Figure 4. Map of Shields River Drainage.

TABLE 5. Population estimates of trout and mountain whitefish 6.0 inches and larger (80 percent confidence limits in parenthesis, 6.0+) expressed in numbers per 1,000 feet of stream for the Shields River.

Section and Date	Length Group (inches)				
	6.0-9.9	10.0-13.9	14.0-17.9	18.0+	6.0+
Zimmerman					
		Brown Trout			
F 1978	63	29	46	5	143(± 35)
S 1979	18	25	28	1	72(± 12)
		Whitefish			
F 1978	136	267	19	0	422(±103)
S 1979	74	270	21	1	366(±103)
Convict Grade					
		Rainbow Trout			
F 1978	26	20	7	0	53(± 18)
S 1979	3	7	3	0	13(± 5)
		Brown Trout			
F 1978	39	20	15	1	75(± 14)
S 1979	16	25	10	1	52(± 13)
		Whitefish			
F 1978	553	288	37	0	877(±215)
S 1979	391	274	14	0	679(±185)
F 1979	412	602	91	1	1,106(±341)

F - Fall estimate
S - Spring estimate

Overall mortalities of brown trout (30 percent) and mountain whitefish (23 percent) 6.0 inches and larger during the winter of 1978-79 are not considered excessive. However, high mortalities were observed in the 6.0 to 9.9 inch length group of brown trout (59 percent) and in the 14.0 to 17.9 inch length group of mountain whitefish (62 percent).

Very high mortalities were experienced by the rainbow trout population between fall, 1978 and spring, 1979. The overall mortality rate of rainbow trout 6.0 inches and larger was 75 percent with an 88 percent mortality in the 6.0 to 9.9 inch length group.

Fall, 1979 mountain whitefish population estimates showed a significant gain in all length groups for an overall recruitment of 63 percent over the spring, 1979 population estimate and a 26 percent gain over the fall, 1978 estimate. The net effect being the summer gain effectively replaced the winter mortality.

Rainbow trout numbers were too small to obtain a fall, 1979 population estimate in the Convict Grade study section. Technical problems prevented the inclusion of the fall, 1979 brown trout population estimate from the Convict Grade study section and this estimate will be presented in a later report.

A very good population of brown trout and mountain whitefish 6.0 inches and larger was found in the Zimmerman study section. During fall, 1978 there were 143 (25 percent) brown trout and 422 (75 percent) whitefish per 1,000 feet of stream. Rainbow trout were not present in large enough numbers to obtain a population estimate. Thirty-six percent of the brown trout and 5 percent of the mountain whitefish were 14.0 inches or larger.

A heavy mortality (49 percent) of brown trout 6.0 inches and larger was observed during the winter of 1978-79. The greatest mortalities were sustained by the 6.0 to 9.9 inch length group (71 percent) and the 18.0 inch and larger length group (80 percent). Movement may have been a factor in the loss of the larger fish.

The mountain whitefish population experienced a loss only in the 6.0 to 9.9 inch length group (46 percent) with a small gain in numbers of fish 10.0 inches and larger.

Flood waters in June, 1979 deposited debris in the river channel and rendered the Zimmerman study section impassable so fall, 1979 population estimates could not be made.

Mortalities of fish populations from the Convict Grade and Zimmerman study sections were calculated for length groups based on the assumption that little recruitment occurred between length groups due to growth during the winter season.

<u>Flow</u>

Instream flows of the Shields River were monitored at four sites during this study period (Figure 4).

Gauging sites were located at the two fish population study sections (Convict Grade and Zimmerman). The third location was between the two fish population study sections at Cowan School about twelve miles upstream from the mouth of the Shields River. The fourth Shields River gauge site was located about 48 miles upstream from its mouth just downstream from the South Fork of the Shields River.

Flows at the Zimmerman gauge site from October 12, 1978 to September 30, 1979 are presented in Figure 5. The mean daily flow for this 354 day period was 128 cfs. During the "high flow period," corresponding to the Montana Department of Fish, Wildlife and Parks water reservation "high flow period" (April 16 to July 20), the mean daily flow was 363 cfs. A continuous "low flow period" (July 21 to April 15) had not been observed at this writing. The lowest flow observed at the Zimmerman site was 19 cfs on September 25, 1979.

Peak flows occurred on May 30 (1650 cfs) and June 20 (5410 cfs) as measured by the U.S.G.S. at the Convict Grade site. The peak flow of June 20 is the highest flow on record for the Shields River. Flow was estimated at 725 cfs on May 29 at the Zimmerman site. No estimate was made on June 20 at this site but flows probably exceeded 3000 cfs.

Flow rating tables have not been completed for the Cowan and South Fork gauge sites. However, stage measurements are presented for the Cowan (May 2, 1979 to November 30, 1979) and South Fork (April 24, 1979 to November 30, 1979) sites in Figures 6 and 7 respectively. Flow patterns at the South Fork, Cowan, and Zimmerman sites were similar with the high flow period beginning in April and ending in July. Complete flow data at the Convict Grade site was not available from the U.S.G.S. at this writing.

Water Temperature

Water temperature data for the Shields River was collected from the Convict Grade site (Figure 8) and Zimmerman site (Fiture 9) during this report period.

The maximum water temperatures, 72°F at Convict Grade and 65°F at Zimmerman, were recorded on August 20 at both sites and coincide with the lowest flow recorded (21 cfs at Zimmerman) during the summer months.

Maintenance difficulties with the thermograph at Convict Grade and with max/min thermometers prevented the collection of meaningful data from the Cowan and South Fork sites and resulted in some missing data at the Convict and Zimmerman sites.

Turbidity

Turbidity data was collected from the Convict Grade, Cowan, Zimmerman and South Fork sites (Figure 4). Turbidity data from the four sites are presented in Figures 10 and 11.

Turbidity readings consistently increased with downstream progression with the South Fork site being much less turbid than the downstream sites suggesting that greater amounts of silt come from the valley floor or from downstream tributaries than from the headwaters.

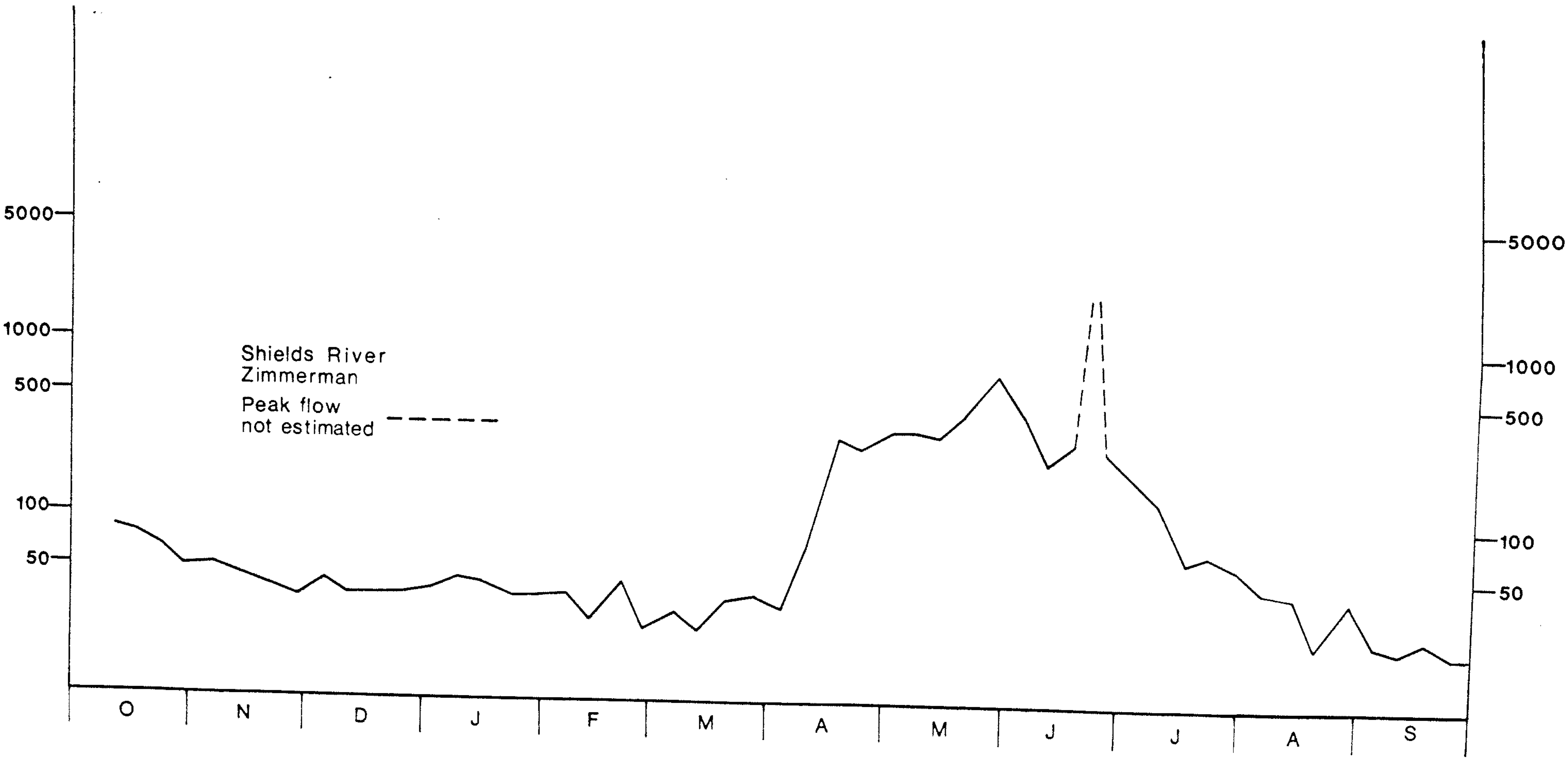

FIGURE 5. Flow of the Shields River at the Zimmerman gauge site from October 12, 1978 to September 30, 1979.

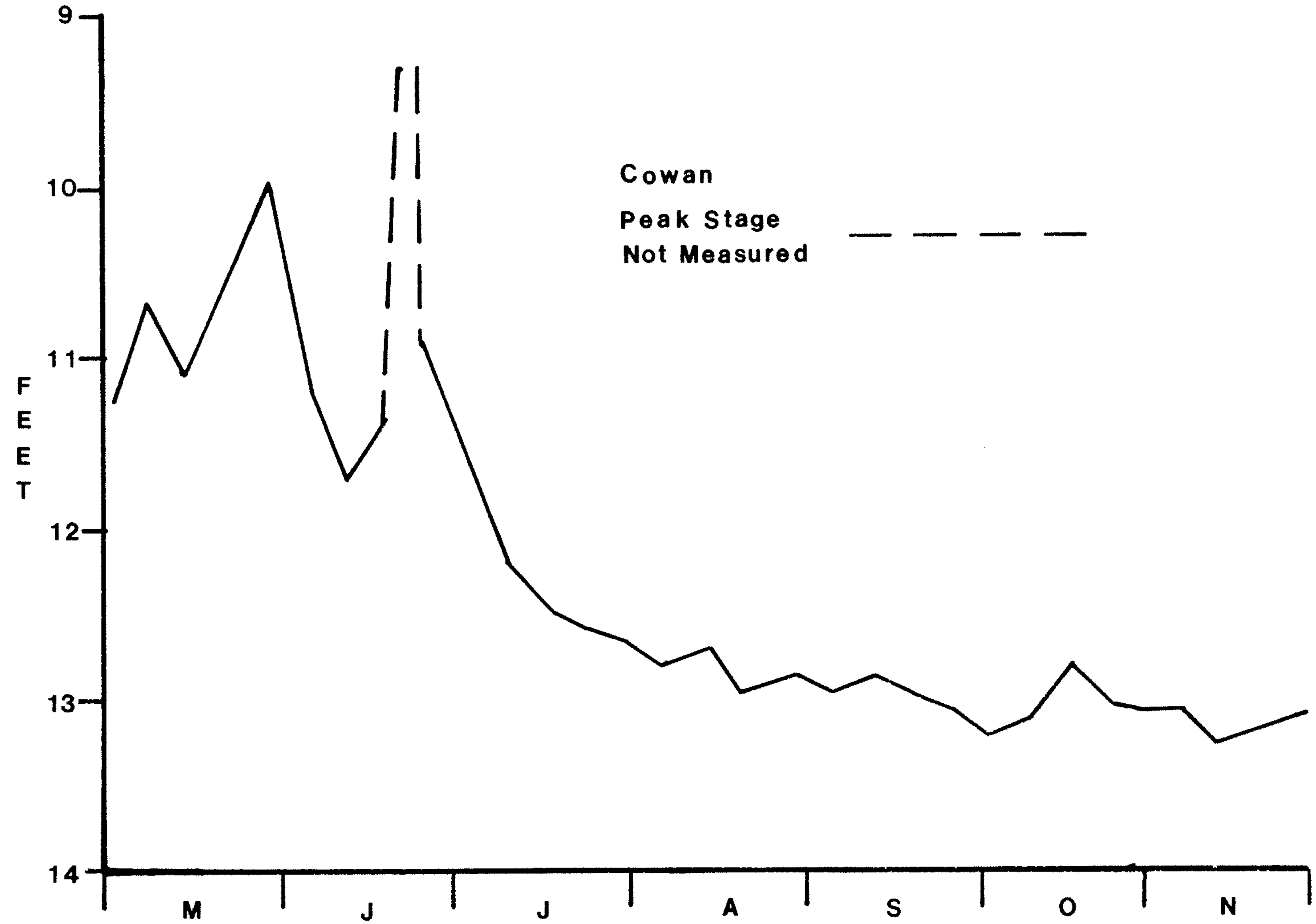

FIGURE 6. Stage measurements of the Shields River at the Cowan site from May 2, 1979 to November 30, 1979.

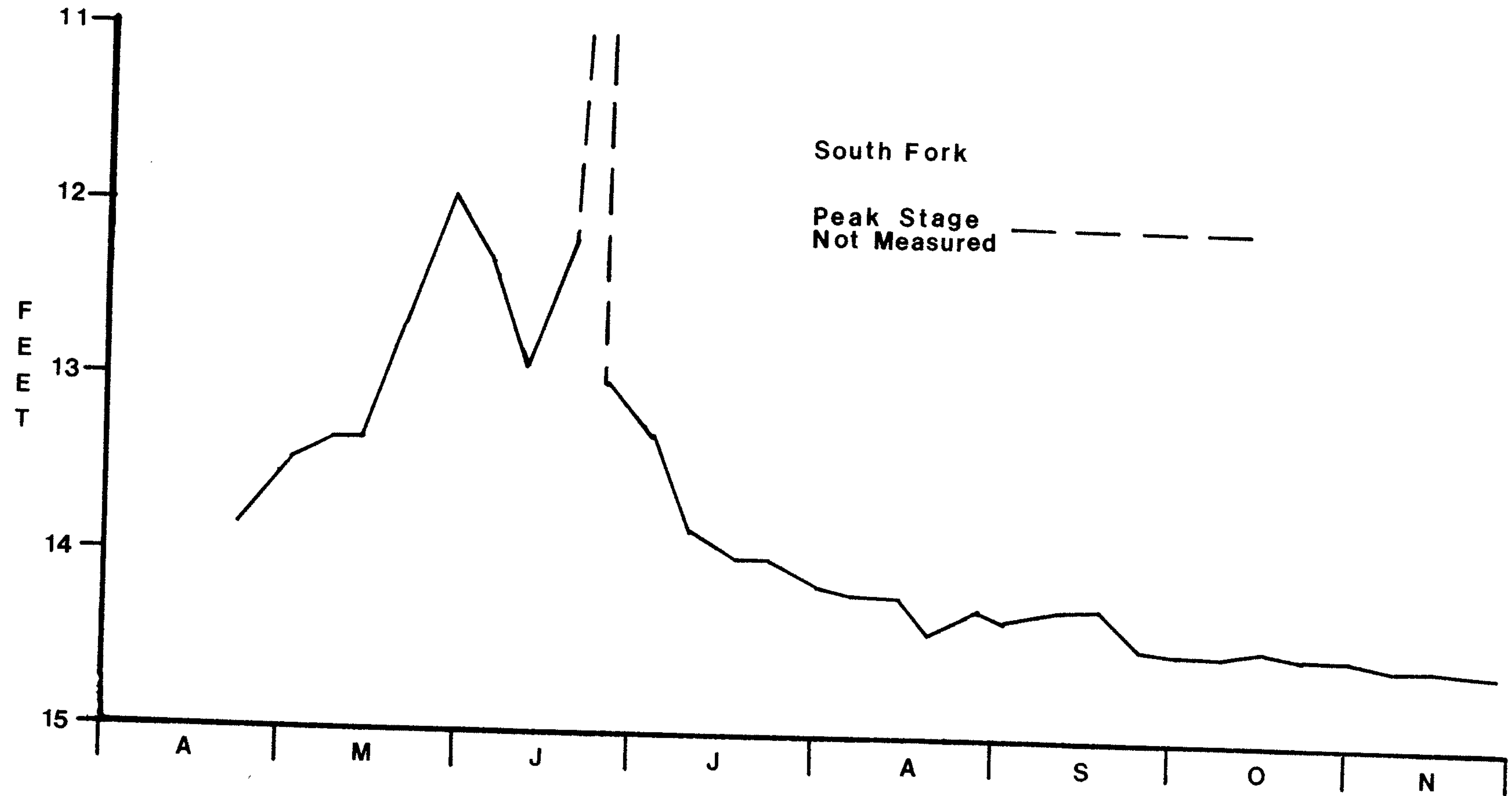

FIGURE 7. Stage measurements of the Shields River at the South Fork site from April 24, 1979 to November 30, 1979.

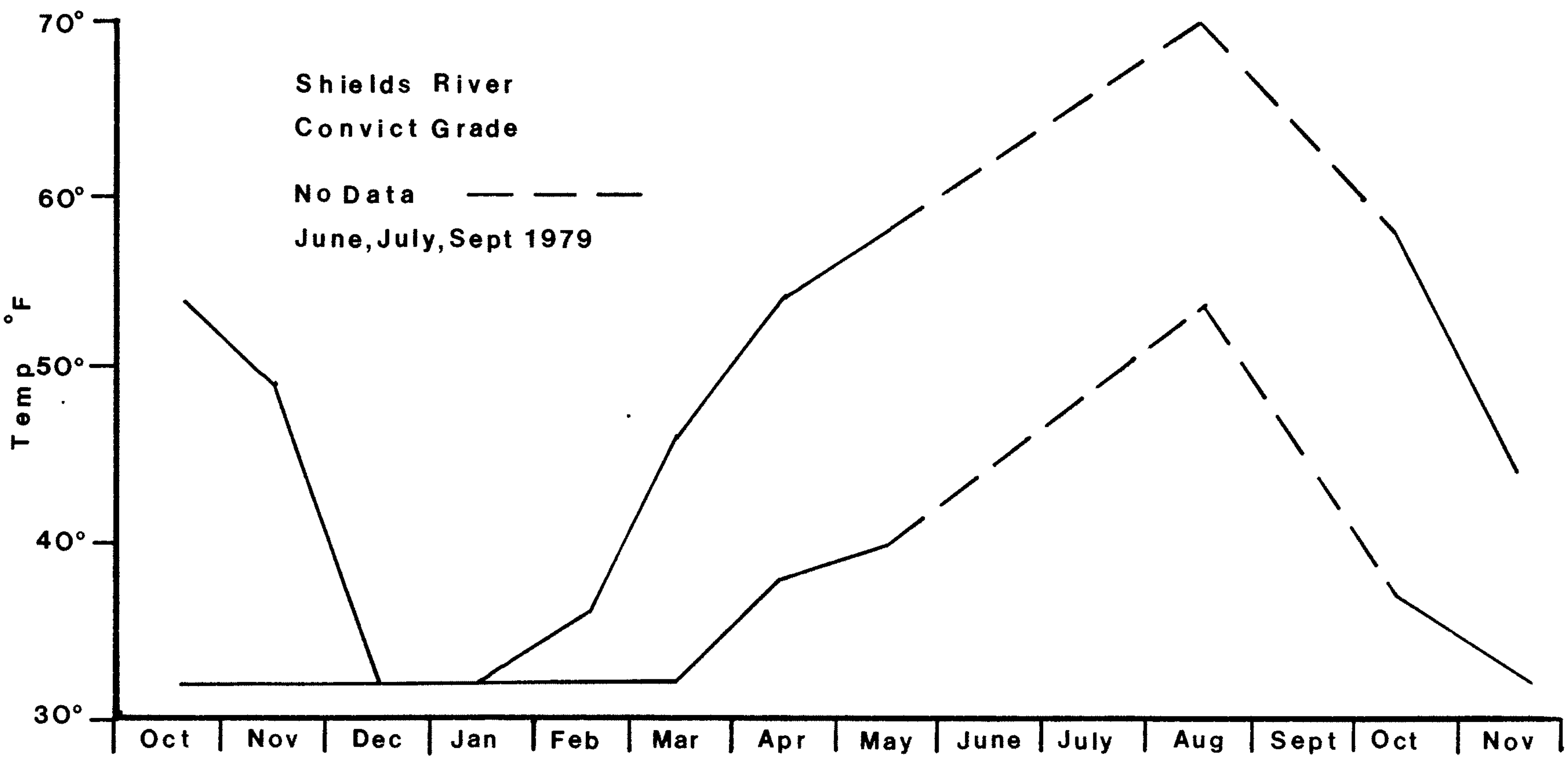

FIGURE 8. Water temperature of the Shields River at the Convict Grade site from October, 1978 through November, 1979.

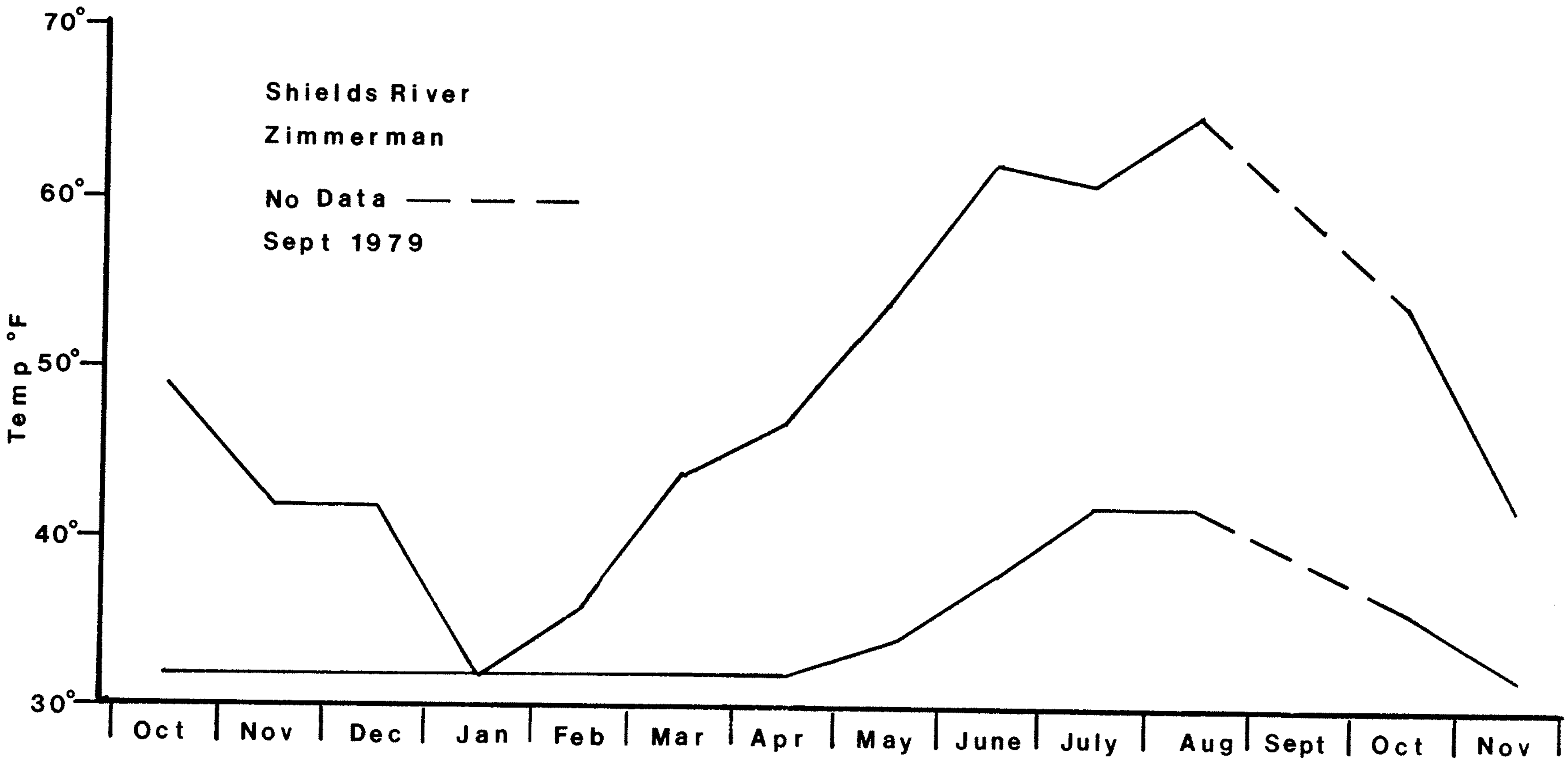

FIGURE 9. Water temperature of the Shields River at the Zimmerman site from October, 1978 through November, 1979.

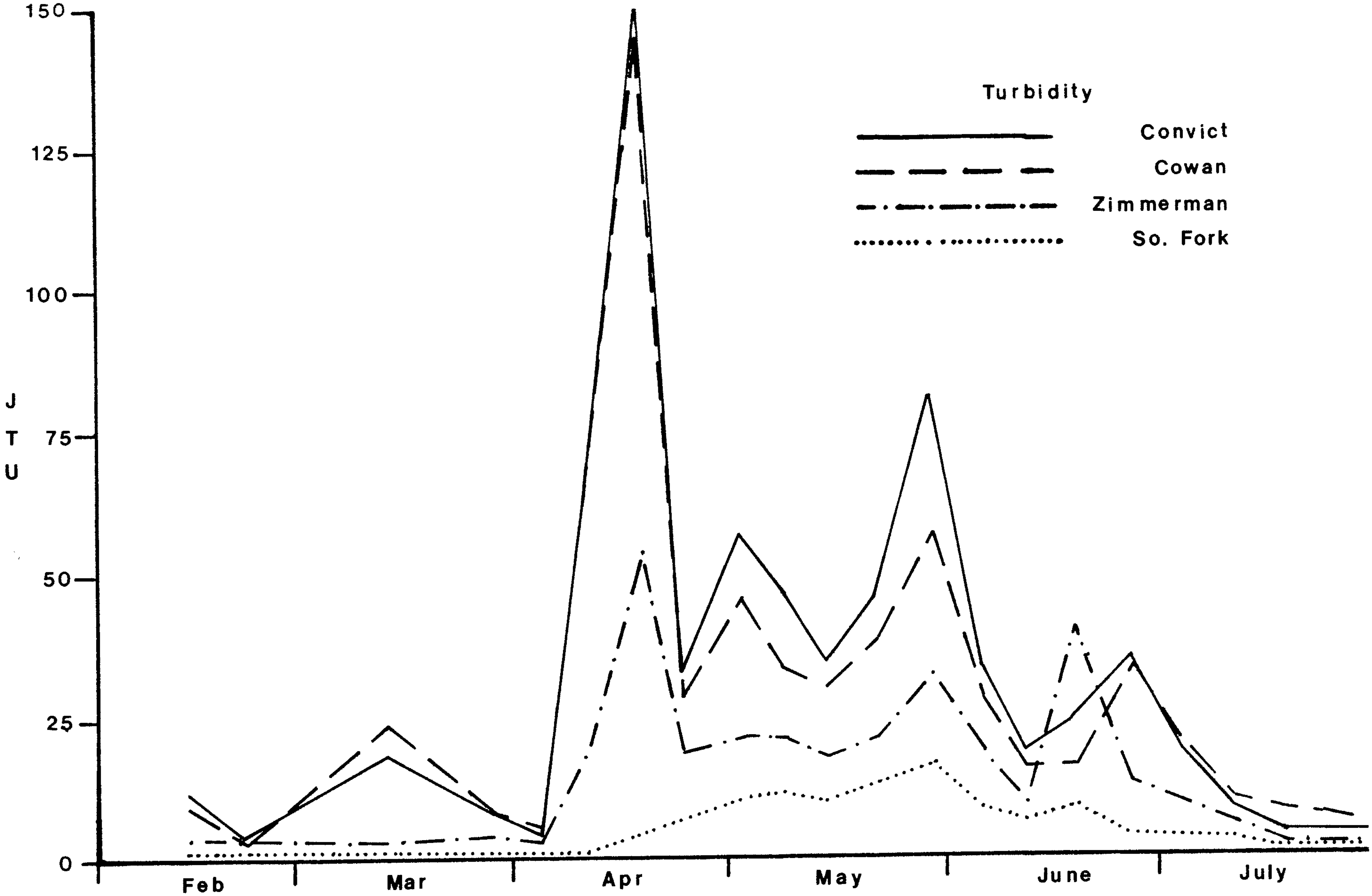

FIGURE 10. Turbidity of the Shields River at four sampling sites from February 13, 1978 through July 1979.

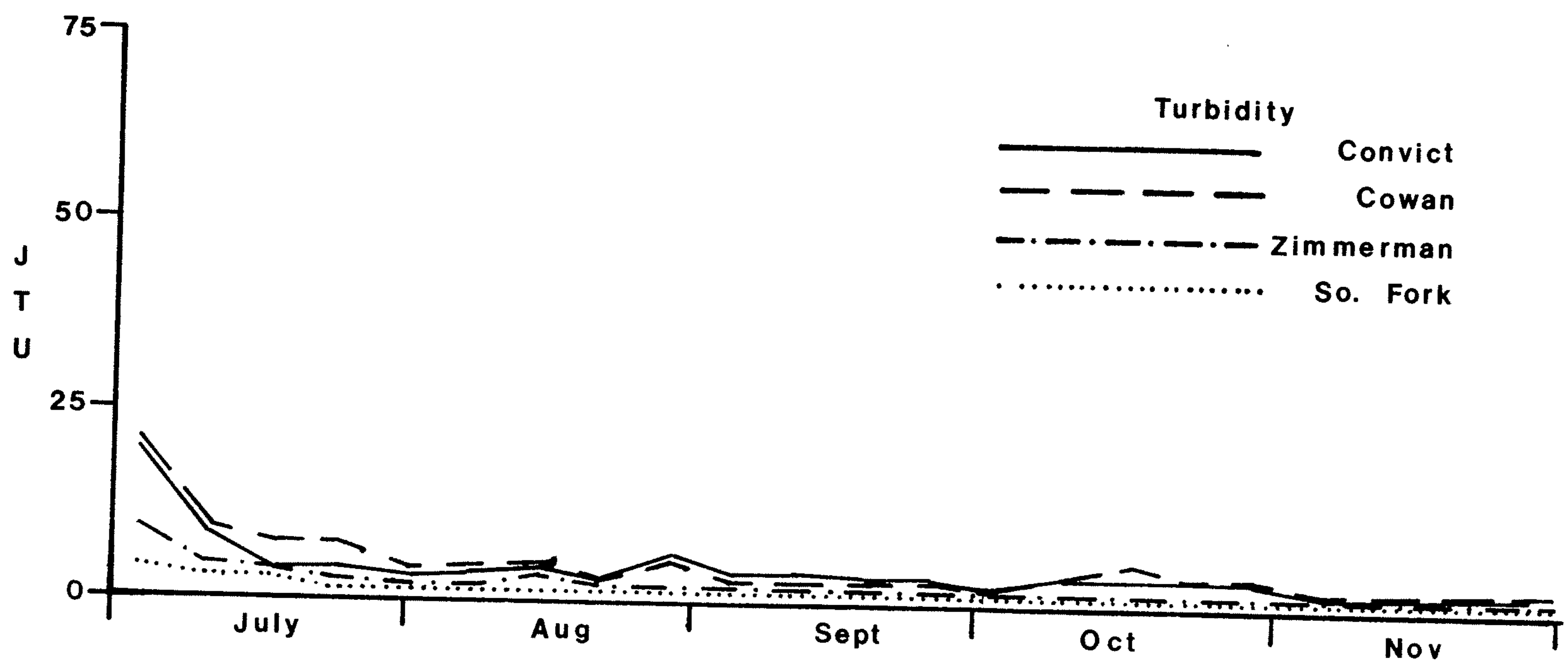

FIGURE 11. Turbidity of the Shields River at four sampling sites from July, 1979 to November 27, 1979.

The most prominent turbidity peaks occurred in April and coincided with the first high flow of the water year. Subsequent peak turbidities also coincided with peak flow but were less prominent even though flows were much higher. Although dilution at higher flows may have been a factor, early May flows approximately equal to flows that produced the April peak, resulted in much lower turbidities. This phenomenon suggests that the early lowland runoff carried greater amounts of silt than did the high country runoff. The flushing action of the first high flow may also have been a factor.

Conductivity

Conductivity data collected from the Convict Grade, Cowan, Zimmerman and South Fork sites are presented in Figures 12 and 13.

Generally, conductivity patterns were similar to flow and turbidity patterns showing increased readings with downstream progression. However, conductivity patterns were less consistent and indicate activities at the downstream sites may be altering normal water quality patterns.

For example, there were unexplained peaks in conductivity at all but the South Fork site. These peaks could be related to a number of variables including: weather phenomena of short duration, agricultural/domestic activities, or sampling error.

Also, conductivity at the South Fork site increased following spring runoff while it decreased at the other sites. Normally, lower flow results in higher conductivity. The South Fork data best fits this pattern.

Dailey Lake

Dailey Lake is located approximately 28 miles south of Livingston in the foothills of the Absaroka Mountain Range at an elevation of 5,200 feet mean sea level (Figure 1). It has a surface area of 204 acres and maximum depth of 24 feet. Inlets are located at its north and south shores with an irrigation outlet on its north shore. The lake is fed by a canal that diverts water from Sixmile Creek and by springs and runoff. A 1945 Department of Fish, Wildlife and Parks filing for 500 miners inches of water (12.5 cfs) to flow from Sixmile Creek to Dailey Lake is on record at the Park County Courthouse. A decreed water right is on file to enter the south shore of Dailey Lake for irrigation storage.

Frequent strong winds preculde thermal stratification of Dailey Lake. Maximum and minimum water temperatures recorded were 71°F (21°C) and 41°F (6°C), respectively, during June through September of 1960 and 1961. During the same period, chemical analysis showed the following: Methal orange alkalinity, 320-360 ppm; ph 8.2-8.6 and total dissolved solids, 403 ppm (one sample). Abundant emergent and submergent (Chara) vegetation is present in the lake (Johnson, 1965).

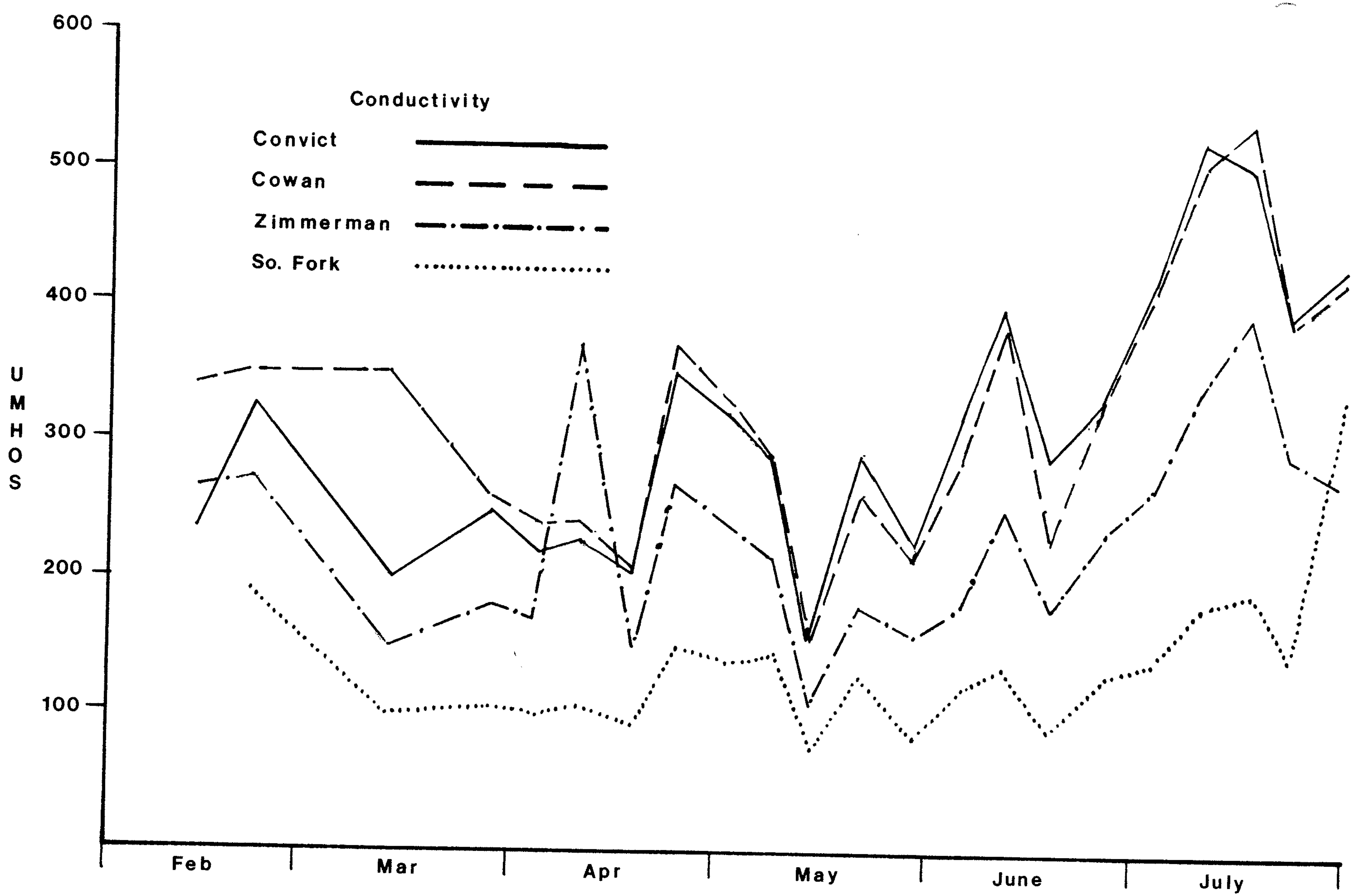

FIGURE 12. Conductivity of the Shields River at four sampling sites from February 13, 1978 through July, 1979.

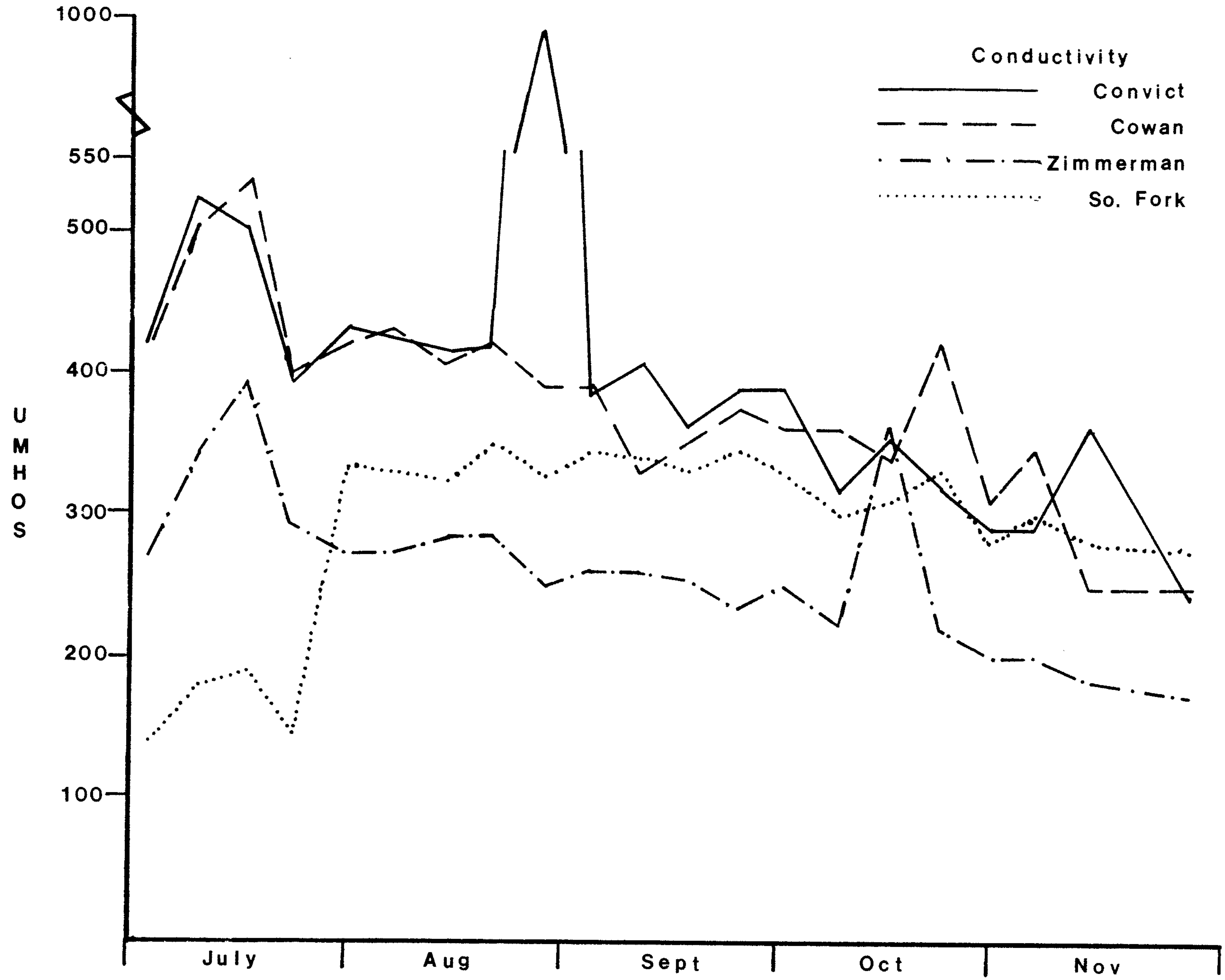

FIGURE 13. Conductivity of the Shields River at four sampling sites from July, 1979 through November 27, 1979.

Currently, the dominant fish species in the lake are yellow perch, rainbow trout, kokanee, walleye (*Stizostedion vitreum*), and longnose sucker (*Catostomus catostomus*).

During the late 1960's and 1970's, the yellow perch population in Dailey Lake increased to the point that stunting severely reduced the size of perch and may have been the cause of the small size rainbow trout and kokanee observed in the fisherman's catch.

As a result, a management program was implemented to reduce the number of perch. During the summer of 1977 the south third of the lake was poisoned and adult and fingerling walleye were introduced during the spring and summer, respectively, of 1979.

The lake was surveyed using experimental gill nets before the poisoning in 1977 and again in 1978 and 1979, one and two years following the poisoning. Gill nets were placed at four of eight locations (#2, #3, #6 and #7) used by Johnson (1965). The results of the netting surveys are presented in Table 6.

TABLE 6. Mean length and number (in parenthesis) of yellow perch, rainbow trout, kokanee, walleye, and longnose sucker collected from Dailey Lake from 1977 to 1979.

Year	Yellow Perch	Rainbow Trout	Kokanee	Longnose Sucker	Walleye
1977	6.2 (586)	8.0 (57)	9.5 (19)	16.3 (23)	
1978	7.3 (425)	9.1 (72)	13.9 (5)	15.6 (19)	
1979	8.2 (659)	12.9 (47)	17.1 (2)	17.7 (22)	19.2 (8)

From 1977 to 1979 the average size of perch collected increased 2.1 inches, rainbow trout 4.9 inches and kokanee 7.6 inches. However, kokanee were last planted in 1976 so a direct comparison between years cannot be made.

Armstrong Spring Creek

Armstrong Spring Creek is a tributary to the Yellowstone River located approximately six miles upstream from Livingston (Figure 1). The stream is fed by springs arising from the bottomland of Paradise Valley and is 2.8 miles in length with an average width of 30 feet (Berg, 1975).

Flows measured September 12, 1977 were 38 cfs upstream from the "Big Springs" and 73 cfs below. However, 1977 was a very low water year in the Upper Yellowsonte Drainage and higher flows can be expected during normal years.

Armstrong Spring Creek is a highly productive stream. It derives its high productivity from high chemical fertility and relatively constant flow and temperature, characteristic of spring creeks.

Armstrong Spring Creek is nationally acclaimed for its unique and outstanding wild trout fishery. Apopulation study of the creek was begun when Trout Unlimited obtained a five year lease of the fishing rights on the stream from 1969 through 1974 (Elser and Marcoux, 1971, and Workman, 1974).

Near the end of the lease, a commercial rainbow trout hatchery was constructed on the creek. Presently, Armstrong Spring Creek serves 31 raceways and fishermen pay a trespass fee to private landowners to fish on the creek.

Further study was initiated in 1977 when an additional twenty raceways were proposed on the creek.

Spring population estimates of brown and rainbow trout during 1971 and 1972 before the hatchery was in operation and during 1978 following operation are presented in Table 7. Total trout numbers per 1,000 feet ranged from 1,577 and 1,192 in 1971 and 1972 respectively to 1,503 in 1978.

Wild brown trout were predominant during spring,1971 and 1972 making up 77 and 84 percent, respectively, of the trout population in Armstrong Spring Creek with wild rainbow trout making up the remainder. Spring, 1978 population estimates showed that rainbow trout made up 73 percent of the population and that wild brown trout were the minority making up 27 percent of the trout population.

During spring, 1978, 49 percent of all rainbow trout captured had observable fin erosion and orginated from the hatchery raceways. A greater percentage may have been hatchery fish. Stevenson, 1975, found that up to 66.7 percent of marked hatchery trout planted in the wild showed no observable fin erosion and appeared to be wild fish.

The rainbow trout population of Armstrong Spring Creek appeared to be more vulnerable to fishermen than the brown trout population of 476 rainbow trout observed, 113 (24%) had hooking scars while only 25 (6%) of 397 brown trout observed had hooking scars.

The influx of hatchery rainbow trout into Armstrong Spring Creek appears to have been detrimental to wild brown trout between 6.0 and 13.9 inches and those larger than 18.0 inches. A 258 percent increase of rainbow trout in the 6.0 to 13.9 inch length group from 1971 to 1978 corresponds to a 75 percent decrease of brown trout in the same length group with a 91 percent decrease of brown trout from 6.0 to 9.9 inches. There also appears to be a loss of trophy size trout (18.0+) of both species. In contrast, there was a three-fold increase in numbers of trout in the 14.0 to 17.9 inch length group from 1971 to 1978 with rainbow trout increasing 745 percent and brown trout increasing 147 percent.

TABLE 7. Spring population estimates of trout 6.0 inches and larger (80 percent confidence limits in parenthesis, 6.0+) expressed in numbers per 1,000 feet of stream for Armstrong Spring Creek.

Species	Length Group (inches)				
	6.0-9.9	10.0-13.9	14.0-17.9	18.0+	6.0+
			1971		
Rainbow Trout	117	219	31	1	368(± 97)
Brown Trout	680	449	76	4	1,209(± 85)
Total	797	668	107	5	1,577(+182)
			1972		
Rainbow Trout	29	131	29	1	190(± 28)
Brown Trout	516	448	34	4	1,002(±144)
Total	545	579	63	5	1,192(±172)
			1978		
Rainbow Trout	267	601	231	0	1,099(±346)
Brown Trout	64	228	112	0	404(± 75)
Total	331	829	343	0	1,503(±421)

It appears that the inadvertant introduction of hatchery rainbow trout into Armstrong Spring Creek has replaced a large portion of the outstanding wild trout population of Armstrong Spring Creek. Hatchery fish apparently escape over the screens as a result of algae accumulation on the screens or when insufficient precautions are taken by hatchery workers during transfer of hatchery fish and raceway maintenance.

APPENDIX

APPENDIX A. Sample size, mean, and range of annual growth increment by weight of three trout species tagged and recaptured in the Upper Yellowstone River from 1970 to 1977.

Point of Rocks

udy Section / Inch Group	1971-72 N	1971-72 ā	1971-72 Range	1972-73 N	1972-73 ā	1972-73 Range	1973-74 N	1973-74 ā	1973-74 Range	1974-75 N	1974-75 ā	1974-75 Range	1971-75 N	1971-75 ā	1971-75 Range
8.0- 8.9							2	.66	.60-.72				2	.66	.60-.72
9.0- 9.9				2	.19	.09-.28	1	.62	-------				3	.33	.09-.62
10.0-10.9							5	.47	.30-.67				5	.47	.30-.67
11.0-11.9	1	.31	-------				1	.34	-------				2	.33	.31-.34
12.0-12.9	1	.64	-------	4	.35	.24-.46	2	.48	.08-.87				7	.42	.08-.87
13.0-13.9	2	.19	.10-.29	1	.53	-------	2	.25	.14-.35				5	.28	.10-.53
14.0-14.9	5	.24	-.13-.86	7	.15	-.03-.40	3	.22	-.15-.42	1	.20	-----	15	.21	-.13-.86
15.0-15.9	3	.03	-.27-.20	1	-.17		1	.23	-------				5	.03	-.27-.23
16.0-16.9	4	-.04	-.14-.08	6	.12	-.12-.50	7	.13	-.10-.52				17	.09	-.14-.52
17.0-17.9	1	-.37	-------	3	-.01	-.15-.09	1	.20	-------				5	-.04	-.37-.20
18.0-18.9							1	.47	-------				1	.47	-------
19.0-19.9				1	-.29	-------							1	-.29	-------
20.0-20.9															
21.0-21.9															
22.0-22.9															
TOTAL	17	.20	-.27-.86	25	.14	-.29-.53	26	.33	-.[illegible]-.87	1	.20	-----	69	.21	-.29
5.0- 5.9															
6.0- 6.9															
7.0- 7.9															
8.0- 8.9															
9.0- 9.9															
10.0-10.9															
11.0-11.9															
12.0-12.9															
13.0-13.9										1	.03	-----	1	.03	-------
14.0-14.9															
15.0-15.9	1	-.17	-------	1	.04	-------							2	-.07	-.17-.04
16.0-16.9															
17.0-17.9															
18.0-18.9															
19.0-19.9															
20.0-20.9															
TOTAL	1	-.17	-------	1	.04	-------				1	.03	-----	3	-.03	-.17-.04
8.0- 8.9							1	.49	-------				1	.49	-------
9.0- 9.9															
10.0-10.9	1	.40	-------				1	.13	-------				2	.27	.13-.40
11.0-11.9				1	.15	-------	1	.29	-------				2	.22	.15-.29
12.0-12.9															
13.0-13.9															
14.0-14.9				1	.11	-------							1	.11	-------
15.0-15.9															
TOTAL	1	.40	-------	2	.13	.11-.15	3	.30	.13-.49				6	.26	.11-.49

Carter's Bridge

udy Section / Inch Group	1970-71 N	1970-71 ā	1970-71 Range	1971-72 N	1971-72 ā	1971-72 Range	1970-72 N	1970-72 ā	1970-72 Range
8.0- 8.9									
9.0- 9.9	1	.70	-------				1	.70	-------
10.0-10.9	9	.44	.19-.63	5	.58	.34-.79	14	.49	.19-.79
11.0-11.9	3	.39	.36-.44	5	.46	.10-.73	8	.43	.10-.73
12.0-12.9	1	.38	-------	1	.36	-------	2	.37	.36-.38
13.0-13.9	2	.12	.11-.13	2	.21	.19-.23	4	.17	.11-.23
14.0-14.9	3	.26	.06-.50	1	-.02	-------	4	.19	-.02-.50
15.0-15.9	4	.15	.01-.25	3	.05	-.05-.14	7	.10	-.05-.25
16.0-16.9	1	.24	-------	3	.11	-.11-.30	4	.14	-.11-.30
17.0-17.9	2	.21	.01-.41	1	.08	-------	3	.16	.01-.41
18.0-18.9									
19.0-19.9									
20.0-20.9									
21.0-21.9									
22.0-22.9									
TOTAL	26	.33	.01-.63	21	.31	-.11-.79	47	.32	-.11-.79
5.0- 5.9									
6.0- 6.9									
7.0- 7.9									
8.0- 8.9									
9.0- 9.9									
10.0-10.9	3	.33	.21-.51	3	.33	.21-.51	3	.33	.21-.51
11.0-11.9	5	.25	.14-.42	1	.17	-------	6	.23	.14-.42
12.0-12.9	9	.41	.20-.57	2	.49	.43-.54	11	.42	.20-.57
13.0-13.9	4	.21	.03-.54	3	.22	.06-.40	7	.22	.03-.54
14.0-14.9	5	.07	-.24-.29	4	.20	-.9 -.37	9	.13	-.24-.37
15.0-15.9	6	.09	-.20-.29	4	.13	-.05-.26	10	.10	-.20-.29
16.0-16.9	3	-.06	-.19-.11	3	-.19	-.44-.09	6	-.12	-.44-.11
17.0-17.9									
18.0-18.9				1	-.39	-------	1	-.39	-------
19.0-19.9									
20.0-20.9									
TOTAL	35	.21	-.24-.57	18	.12	-.44-.54	53	.18	-.44-.57
8.0- 8.9									
9.0- 9.9									
10.0-10.9									
11.0-11.9									
12.0-12.9	1	.02	-------				1	.02	-------
13.0-13.9									
14.0-14.9	1	.36	-------				1	.36	
15.0-15.9									
TOTAL	2	.19	.02-.36				2	.19	.02-.36

Ninth Street

udy Section / Inch Group	1973-74 N	1973-74 ā	1973-74 Range	1974-75 N	1974-75 ā	1974-75 Range	1975-76 N	1975-76 ā	1975-76 Range	1976-77 N	1976-77 ā	1976-77 Range	1973-77 N	1973-77 ā	1973-77 Range
8.0- 8.9	1	.57	--------	1	.68	-------	5	.66	.37-1.16	1	.47	-------	8	.63	.37-1.16
9.0- 9.9	3	.60	.15-1.08	2	.41	.36-.45	1	.53	--------	1	.94	-------	7	.59	.15-1.08
10.0-10.9	2	.84	.66-1.02	5	.61	.34-.89				1	.73	-------	8	.68	.34-1.02
11.0-11.9	3	.51	.34- .61	8	.54	.22-.83							11	.53	.22- .83
12.0-12.9	3	.43	-.02- .81	1	.31	-------	3	.63	.58- .70				7	.50	-.02- .81
13.0-13.9	5	.31	-.05- .84	1	.52	-------	3	.32	.20- .49	1	.52	-------	10	.36	-.05- .84
14.0-14.9	4	.27	.13- .50	2	.67	.48-.87	2	.26	.23- .29	1	-.03	-------	9	.32	-.03- .87
15.0-15.9	7	.32	-.05- .63	2	.20	.14-.25				2	.39	.23-.54	11	.31	-.05- .63
16.0-16.9	4	.13	-.02- .34	4	.16	-.01-.25	4	-.09	-.16-0.0				12	.07	-.16- .34
17.0-17.9	2	.49	.17- .81				1	-.14	-------	1	.14	-------	4	.25	-.14- .81
18.0-18.9	2	.12	-.04- .28				1	.04	-------				3	.09	-.04- .28
19.0-19.9															
20.0-20.9															
21.0-21.9															
22.0-22.9				1	.74	-------							1	.74	--------
TOTAL	36	.37	-.05-1.08	27	.47	-.01-.89	20	.34	-.16-1.16	8	.45		91	.40	-.16-1.16
5.0- 5.9															
6.0- 6.9							1	.35	--------				1	.35	--------
7.0- 7.9															
8.0- 8.9							2	.34	.22- .46				2	.34	.22- .46
9.0- 9.9	5	.63	.44- .88	4	.35	.31-.39	7	.39	.17- .57	1	.68	-------	17	.47	.17- .88
10.0-10.9	3	.62	.59- .65	2	.34	.32-.36	8	.34	.21- .47	4	.53	.39-.60	17	.43	.21- .65
11.0-11.9	1	.81	--------				6	.28	.09- .35	6	.50	.38-.70	13	.42	.09- .81
12.0-12.9	6	.71	.50- .84	7	.44	.22-.68	8	.34	.20- .47	7	.40	.13-.64	28	.46	.13- .84
13.0-13.9	14	.62	.19-1.06	6	.34	.20-.46	10	.27	.14- .43	7	.52	.38-.75	37	.45	.14-1.06
14.0-14.9	6	.64	.37- .83	3	.46	.37-.52	4	.27	.16- .37	5	.46	.17-.88	18	.47	.17- .88
15.0-15.9	9	.70	.42-1.34	3	.46	.38-.61	5	.19	.08- .47	1	.60	-------	18	.51	.08-1.34
16.0-16.9	5	0.0	-.18- .34	3	.11	-.27-.36	2	.36	.12- .60				10	.13	-.27- .60
17.0-17.9	2	.28	.08- .47				2	.04	-.01- .09				4	.16	-.01- .47
18.0-18.9	5	.15	.00- .62	1	.02								6	.13	.00- .62
19.0-19.9															
20.0-20.9										1	-.10		1	-.10	
TOTAL	56	.54	-.18-1.34	29	.36	.02-.68	55	.30	-.01- .57	32	.47	-.10-.88	172	.42	-.27-1.34
8.0- 8.9															
9.0- 9.9										1	.47	-------	1	.47	--------
10.0-10.9	1	.36	--------							1	.77	-------	2	.57	.36- .77
11.0-11.9	1	.45	--------										1	.45	--------
12.0-12.9	2	.30	.17- .42							1	.39	-------	3	.33	.17- .42
13.0-13.9	1	1.29	--------				1	.52	--------				2	.91	.52-1.29
14.0-14.9	1	.06											1	.06	--------
15.0-15.9				1	.34								1	.34	
TOTAL	6	.46	.06-1.29	1	.34	-------	1	.51	--------	3	.54	.39-.77	11	.48	.06-1.29

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Prepared By: H. R. Stevenson

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Waters Referred To:

Dailey Lake	3-22-7644-03
Armstrong Spring Creek	3-22-0140-01
Shields River	3-22-5362-01
Shields River	3-22-5348-01
Shields River	3-22-5334-01
Yellowstone River	5-22-7056-01
Yellowstone River	3-22-7070-01
Yellowstone River	3-22-7084-01

Key Words: Rainbow trout - length - weight relationship
Brown trout - length - weight relationship
Partial rehab - fish population
Species supplantation
Trout - numbers
Mountain whitefish - numbers
Trout - population dynamics
Stream temperatures
Turbidity
Conductivity
Mountain whitefish - population dynamics