MONTANA DEPARTMENT OF FISH AND GAME
FISHERIES DIVISION
JOB PROGRESS REPORT

STATE: Montana TITLE: Southwestern Montana Fisheries Investigations

PROJECT NO.: F-9-R-26 TITLE: Inventory and Survey of Waters of the

JOB NO.: I-c Project Area

PERIOD COVERED: July 1, 1977 through June 30, 1978

REPORT PERIOD: February 1, 1977 through January 31, 1978

ABSTRACT

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

Photo points monitored on the Yellowstone River illustrate the dominant discharge and how quantity of stream flow affects food producing area and living space for fish.

The flow regime of the Yellowstone River during the spawning and incubation periods of brown (Salmo trutta) and rainbow (Salmo gairdneri) trout are illustrated for the years 1968 through 1976.

Spring population estimates of trout in the Yellowstone River for 1970 through 1977 showed the maximum fluctuations in numbers of trout between years and within study sections was approximately 200 percent for both brown and rainbow trout.

Correlation between the numbers of brown trout 6.0 inches and larger per 1000 feet and the mean daily flow between the last recapture dates of the estimates suggests that a relationship exists between incremental changes in flow and changes in brown trout populations of the upper Yellowstone River.

Analysis of the growth of 469 tagged trout in the Yellowstone River revealed similar patterns of growth between species, study sections and years. Growth patterns also showed a marked progressive decrease of annual growth increment with increased length and a wide range of annual growth increment within inch groups.

One year following partial rehabilitation of Dailey Lake, the average size of yellow perch (Perca flavescens) collected increased 1.1 inches, rainbow trout 1.1 inches, and kokanee (Oncorhynchus nerka) 4.4 inches.

BACKGROUND

In the face of increasing demands for energy and food production, the consuming public is turning to certain western states that offer relatively clean air, expanses of irrigable lands, large reserves of stripable coal, and an apparent abundant supply of high quality water. Parallel with this demand is the growing demand for water based recreation.

Both demands can be satisfied to a point, however, water is a finite commodity and this point has already been passed in many Yellowstone basin tributaries.

The Yellowstone mainstem, presently 20-27% depleted, is threatened by pending diversionary and consumptive water use permits and applications for reservation of water that would result in severe dewatering if implemented.

Legislation introduced into the 1977 Montana Legislature in an attempt to place preference of uses on the Yellowstone Basin Water, with fish and wildlife placed at the bottom of the list in alarming evidence of the immediate and profound need to quantify the aquatic biological requirements of the fish and wildlife resource. We are being asked today...."how much water is needed to maintain our fisheries?" It is imperative that we respond with information adequate to document these needs.

OBJECTIVES AND ATTAINMENT

The objectives were as follows:

1. To monitor fish populations at one established study section of the Yellowstone River and three study sections of the Shields River. Data for the Yellowstone is presented in this report.

2. To monitor flows and measure selected habitat parameters on three study sections of the Shields River. Work not accomplished. Additional emphasis was placed on Yellowstone flow-fishery relationships. Data included in this report.

3. To determine fisherman harvest of game fish from a section of the Yellowstone River. Work not accomplished.

4. To document temperature regimes of the Yellowstone River. Data included in this report.

PROCEDURES

Water temperatures were monitored on the Yellowstone River using Foxboro and Taylor 30-day thermographs. These data and past temperature data collected from the Yellowstone River were summarized using a computer program at the Civil Engineering Department at Montana State University.

Flow photo points were monitored on the Yellowstone River using a 35mm camera and flow information from U.S.G.S. gaging stations at Livingston and Corwin Springs. Flow data was obtained from U.S.G.S. records (1968-1977) and summarized.

Fish populations were sampled in the Yellowstone River using 0-500 variable voltage direct current electrofishing equipment. Sampling was conducted from a fiberglas boat equipped with a 40 horsepower outboard jet motor. A mobile positive electrode system was used with negative electrodes fixed to the bottom of the boat. Fish polulation estimates were hand calculated by inch groups (Vincent, 1971 and 1974).

Instream flow/fish population linear regression analysis was done using a model TI-55 Texas Instruments calculator and verified at the Montana State University Computer Center.

Growth rate analysis of trout was done using data from trout captured during spring electrofishing and identified with numbered Floy anchor tags from 1970 through 1976 and recaptured by the same method in subsequent years.

Fish populations in Dailey Lake were sampled using experimental (3/4 - 2 inch square) gill nets. Dailey Lake was partially rehabilitated using a rotenone base fish toxicant (Pro-Nox-Fish).

RESULTS

A general map of the study area is presented in Figure 1.

Yellowstone River

Water Temperatures

Water temperature data collected from five locations on the Yellowstone River between 1967 and 1977 are summarized in Table 1. These data were summarized by average, minimum and maximum water temperatures (^{o}F) during the high flow and low flow periods of the Yellowstone River.

These data indicate that water temperature fluctuations are 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 that time the average and maximum temperatures, respectively, were 55.4 and 70.9^{o}F at Corwin Springs, 58.3 and 70.5^{o}F at Livingston, and 60.1 and 71.5^{o}F at the Grey Bear site near Big Timber. Maximum temperatures for all other years of record were always less than 70^{o}F.

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

Yellowstone River Flows

Flow photo points were monitored on the Yellowstone River at Mallards Rest Fishing Access (15 miles south of Livingston) and at Point of Rocks (30 miles south of Livingston).

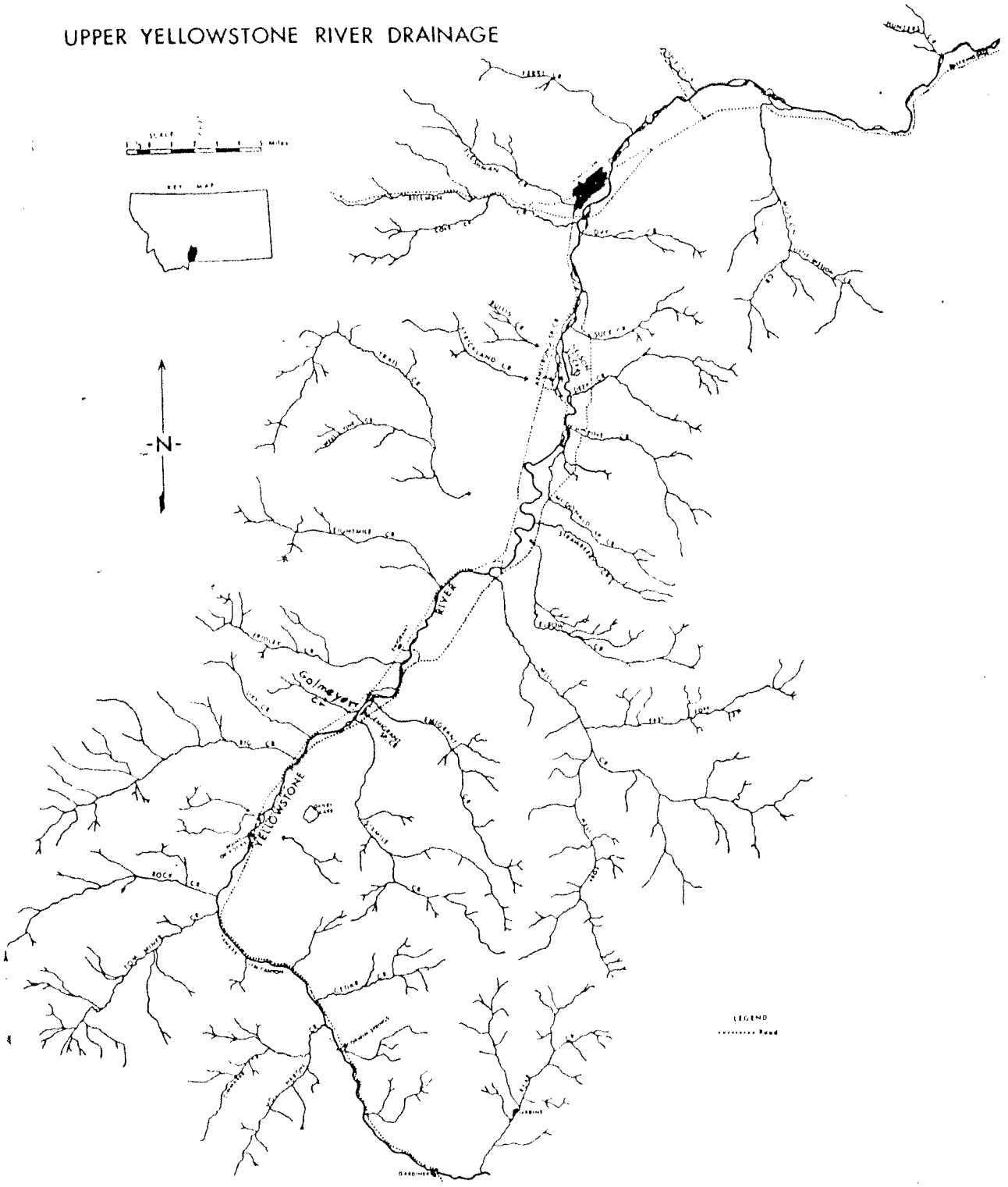

Figure 1. Map of Upper Yellowstone River drainage.

TABLE 1. Average, minimum and maximum water temperatures (°F) at five locations on the Yellowstone River.

Location	High Flow Period May 11 - August 10					Low Flow Period August 11 - May 10				
	Dates	Ave. (°F)	Ave. (°F)	Ave. (°F)	No. Days No Temp. Recorded	Dates	Ave. (°F)	Ave. (°F)	Ave. (°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
					26	1976-77 Aug.11-May 10	51.7	33.9	67.0	0
										7
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					
					43					
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					
					45					
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					
					1					
Grey Bear Fishing Access	1976 May 11-Aug.10	56.2	44.4	69.1	4	Mar.12-Apr.30				
	1977 May 11-Aug.10	60.1	45.2	71.5	0	1976 Sep.01-Nov.27	47.3	38.4	55.2	0
					4	1977 Sep.01-Nov.29	49.0	44.5	53.4	0

Photo points at Mallards Rest are presented in Figures 2 through 5 and at Point of Rocks in Figures 6 through 9. Photos were taken at a low flow (Figures 2 and 6), the dominant discharge flow (Figures 5 and 9), and two intermediate flows (Figures 3, 4, 7 and 8).

These photos illustrate how quantity of stream flow affects food producing area and living space for fish. It is apparent that low flows as shown in Figures 2 and 6 substantially reduce these parameters compared to the higher flows shown in the remaining figures.

Figures 5 and 9 illustrate the dominant discharge or bankful concept as outlined in the Department of Fish and Game Application for Reservation of Water in the Yellowstone River basin (Montana Fish and Game, 1976). In the application, the dominant discharge requested was 18,200 cfs from Big Creek to the Boulder River (includes Mallards Rest) and 15,000 cfs from the town of Gardiner to Big Creek (includes Point of Rocks).

The flow regime of the Yellowstone River during the spawning (September 15-December 15) and incubation and spawning periods (September 15 - March 30) of brown trout are illustrated in Appendix Figures 1 and 2, respectively. The flow regime during the spawning (February 1 - April 30) and incubation and spawning periods (March 1 - June 30) of rainbow trout are illustrated in Appendix Figures 3 and 4, respectively. Evaluation of these important periods of the life history of trout is planned for a later report.

U.S.G.S. flow data from gage stations located in the Yellowstone River "at Corwin Springs" and "near Livingston" 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).

Flows were summarized as the number of days the mean daily flow (cfs) was less than 0, 20, 50, 70, and 90 percent exceedance flows based upon a U.S.G.S. 39 year period of record near Livingston and a 49 year period of record at Corwin Springs (Appendix Table 1).

Summaries of the 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 time interval between dates of fish population estimates are presented for the gages at Corwin Springs (Appendix Table 2) and near Livingston (Appendix Table 3).

Fish Populations

Electrofishing data used in this report were collected in the Point of Rocks, Carter's Bridge, and Ninth Street Study Sections. The Point of Rocks Study Section is 4.0 miles long and located about 30 miles south of Livingston (Figure 1). The Carter's Bridge and Ninth Street 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 Ninth Street Bridge and extends downstream 4.6 miles.

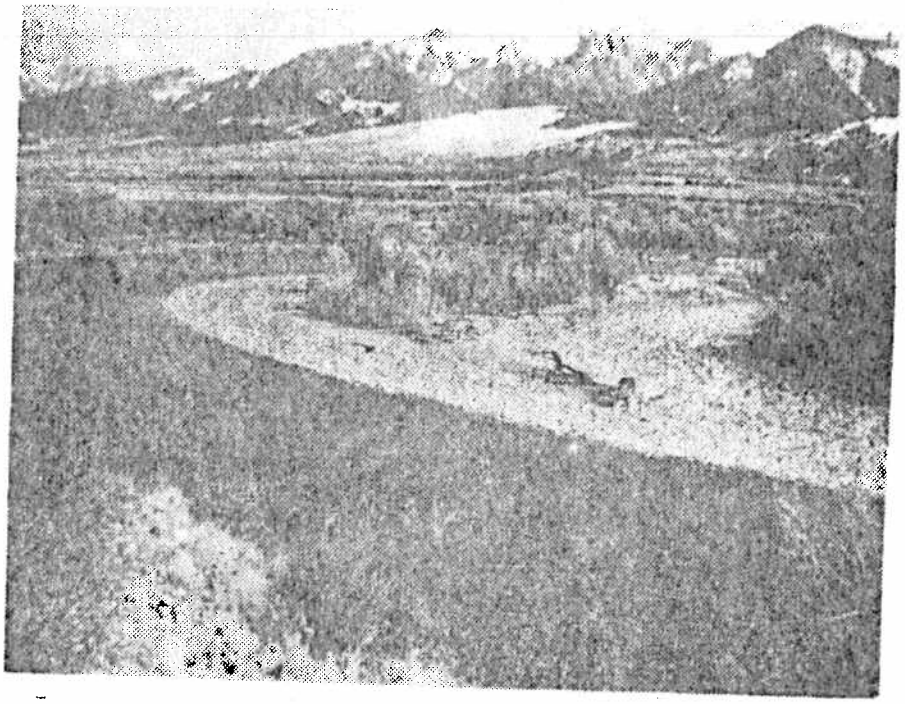

FIGURE 2. Yellowstone River just below Mallards Rest Fishing Access March 29, 1978 when flow was 1,295 cfs at U.S.G.S. gaging station near Livingston.

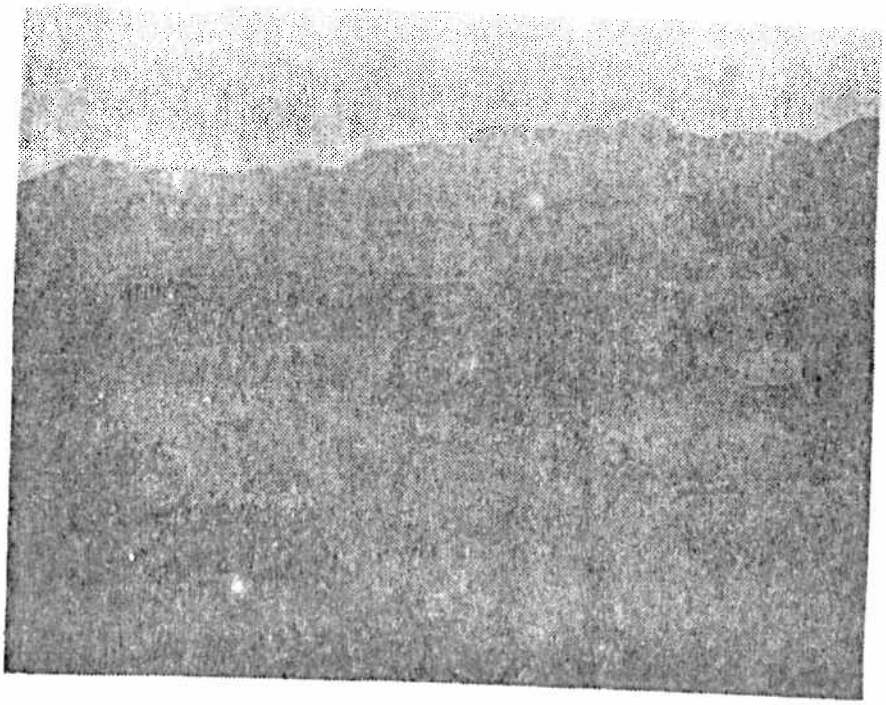

FIGURE 3. Yellowstone River just below Mallards Rest Fishing Access June 20, 1977 when flow was 6,400 cfs at U.S.G.S. gaging station near Livingston.

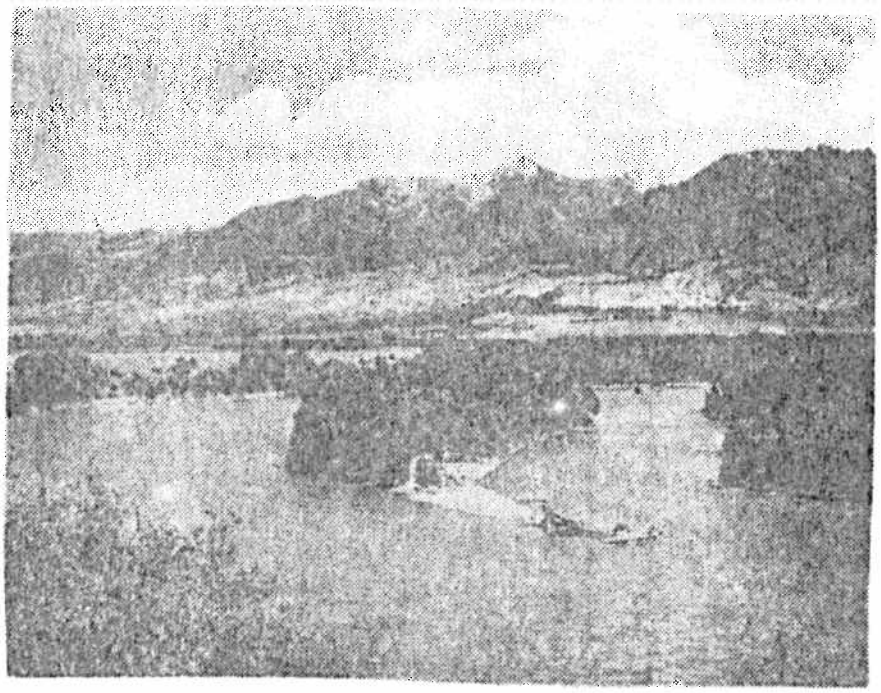

FIGURE 4. Yellowstone River just below Mallards Rest Fishing Access June 7, 1977 when flow was 12,600 cfs at U.S.F.S. gaging station near Livingston.

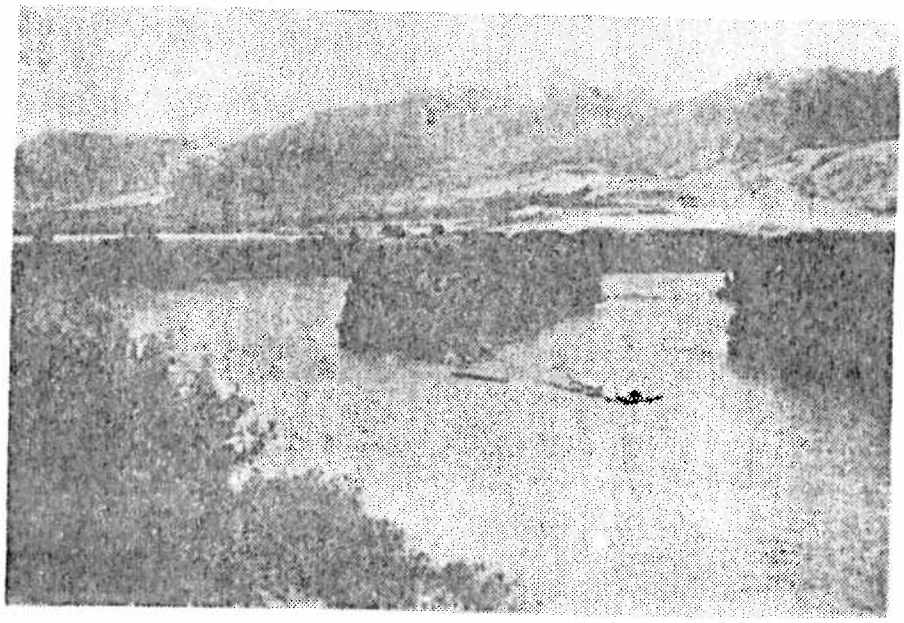

FIGURE 5. Yellowstone River just below Mallards Rest Fishing Access June 30, 1978 when flow was 18,980 cfs at U.S.G.S. gaging station near Livingston.

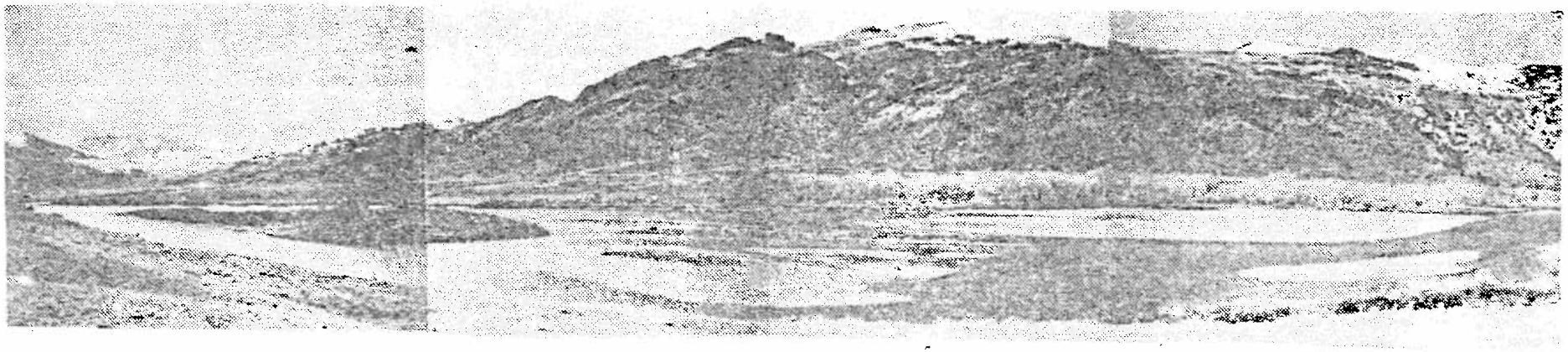

FIGURE 6. Yellowstone River just below Point of Rocks March 29, 1978 when flow was 1,100 cfs at U.S.G.S. gaging station near Corwin Springs.

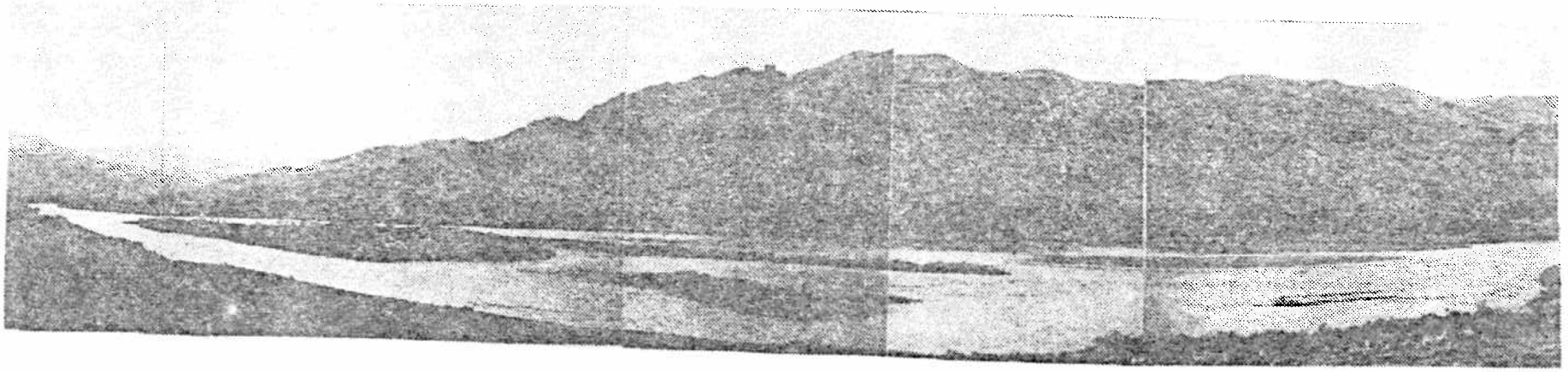

FIGURE 7. Yellowstone River just above Point of Rocks June 20, 1977 when flow was 5,500 cfs at U.S.G.S. gaging station near Corwin Springs.

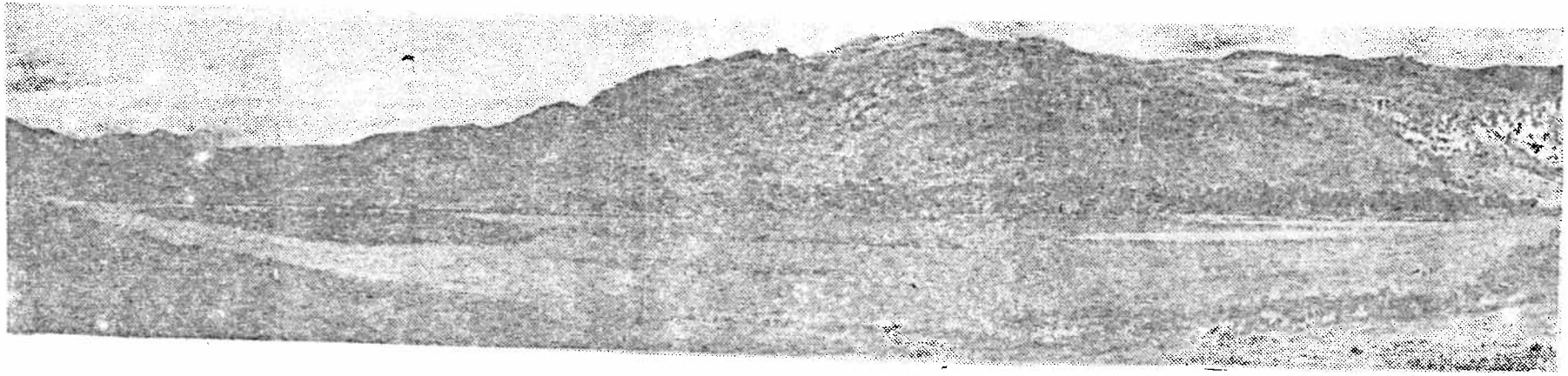

FIGURE 8. Yellowstone River just above Point of Rocks June 7, 1977 when flow was 9,980 cfs at U.S.G.S. gaging station at Corwin Springs.

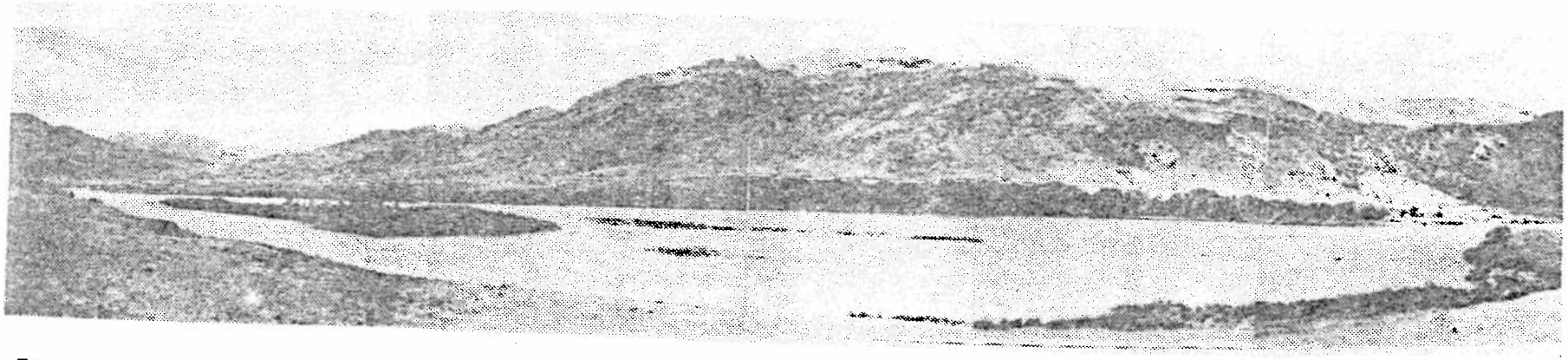

FIGURE 9. Yellowstone River just above Point of Rocks June 30, 1978 when flow was 14,800 cfs at U.S.G.S. gaging station at Corwin Springs.

Spring mark and recapture data collected from the above study sections from 1970 through 1977 were used to hand calculate population estimates of trout 6.0 inches and larger (Table 2). In some cases, estimates were calculated by length groups.

Maximum fluctuations in numbers of trout between years and within study sections for both rainbow and brown trout was approximately 200 percent. The largest number estimate of a trout species was 436 rainbow per 1000 feet in the Ninth Street Study Section the spring of 1975. The smallest estimate was 43 brown trout per 1000 feet in the Point of Rocks Study Section the spring of 1972.

Fish Populations and Flow

Preliminary analysis of fish population/flow relationships was done using linear regression methods. Population estimates of brown and rainbow trout from Table 2 were used in the regressions. Flow data from the U.S.G.S. gage station at Corwin Springs (Appendix Table 2) were regressed on the Point of Rocks population estimates and flow data from the U.S.G.S. gage near Livingston (Appendix Table 3) were regressed on the Carter's Bridge and Ninth Street population estimates. Correlations were tested at the 80% level of probability.

A significant relationship was found for brown trout in the Ninth Street, Carter's Bridge and Point of Rocks Study Section between 1970 and 1977. Correlation between the numbers of brown trout 6.0 inches and larger per 1000 feet and the mean daily flow between the last recapture dates of the estimates gave an r value of 0.453 ($P = 0.14$) suggests that a relationship exists between incremental changes in flow and changes in brown trout populations of the upper Yellowstone River (Figure 10).

However, these statistics indicate that only 21% of the variation of brown trout numbers is accountable to variations of flow. Other variables that may affect the estimate of trout numbers must be investigated including fish biomass, species and age class interactions, recruitment, habitat, water quality, fishing pressure and sampling error.

No significant correlation was found between numbers of rainbow trout and flow.

Improved documentation of the instream flow needs of trout in the upper Yellowstone River is expected to be found with more intensive data analysis including computor processed fish population estimates by age groups, refinement of flow data, and multilinear regression techniques.

TABLE 2. Spring population estimates of trout 6.0 inches and larger expressed in numbers per 1000 feet of stream for the Yellowstone River.

Section and Year	Length Group (inches)				
	6.0 - 12.9	13.0 - 14.9	13.0+	15.0+	6.0+
Ninth Street					
		Rainbow Trout			
1973	132	22	63	41	195
1974	259	42	109	67	368
1975	342	57	94	37	436
1976	192	58	96	38	288
1977	209	79	146	67	355
		Brown Trout			
1973	41	39		13 1/	93
1974	60	17		21	99
1975	78	25		17	120
1976	51	30		11	92
1977	45	7		11	63
Carter's Bridge					
		Rainbow Trout			
1970	236	28	64	36	300
1971	273	48	121	73	394
1972	216	46	93	47	309
		Brown Trout			
1970					161
1971					161
1972					186
Point of Rocks					
		Brown Trout			
1971					75
1972					43
1973					55
1974					77

1/ Brown trout 16.0 inches and larger

Growth Rate of Trout

A new technique using tagging information was investigated as an aid in determining the age and growth of trout. This technique assumes no differential growth rates between tagged and untagged fish.

The annual growth of tagged fish of varying lengths was determined from trout measured and tagged during spring electrofishing and recaptured by the same method in following years. These data are presented for brown, rainbow and cutthroat (Salmo clarki) trout tagged and recaptured from three study sections of the Yellowstone River between 1970 and 1977 (Appendix Table 4).

Lengths of recaptured fish were arranged in length frequencies and plotted against corresponding annual increments of growth for this report period.

Growth rates of trout between years, species, and reach were similar in the upper Yellowstone River sections. The mean annual growth of brown trout between four years in the Ninth Street Study Section are compared in Figure 11. Figure 12 shows growth of rainbow, brown, and cutthroat in the Ninth Street Study Section. The growth of brown trout between the Ninth Street, Carter's Bridge, and Point of Rocks Study Sections are shown in Figure 13.

The mean and range growth rates of trout by one inch groups for Ninth Street brown and rainbow trout are illustrated in Figures 14 and 15, respectively. These figures show a marked decrease of annual growth rate with increased length. It is important to note that the average annual growth of trout 15.0 inches and larger is only about one inch or less. It can also be seen that there is a wide range of annual growth increment within inch groups. This implies a wide overlap between age groups.

Figure 16 is a projection of the median and range of lengths for age groups of rainbow trout in the Ninth Street Study Section. Data points for this figure were derived by reading fish scales to determine the range of age group II fish and the smallest age group III fish. The remaining data points (upper limit of age group III and the range of age groups IV through X) were projected by adding the annual increment (of the corresponding inch group) of the slowest and fastest growing tagged fish to the lower and upper limits of the preceding age groups. Although this may not duplicate the actual range of age groups in the population it is probably very close and in general represents the pattern of growth for rainbow trout in the upper Yellowstone River.

This kind of analysis can be a useful decision making tool when reading scales to calculate population estimates by age group. For example, Figure 16 shows that fish in the two inch group from 12.0 to 13.9 inches encompasses five age groups from III to VII. Further, the larger portion of these fish can be expected to be in age group IV with progressively smaller numbers in age groups V, III, VI, and VII.

It should also be noted that the younger, faster growing age groups are relatively distinct. For example, fish 4.4 to 7.9 inches, in Figure 16, are exclusively age group II fish while 8.0 - 8.9 inch fish include two age groups, 9.0 - 12.5 inch fish three age groups, and fish from 12.6 - 15.0 inches include eight or more age groups.

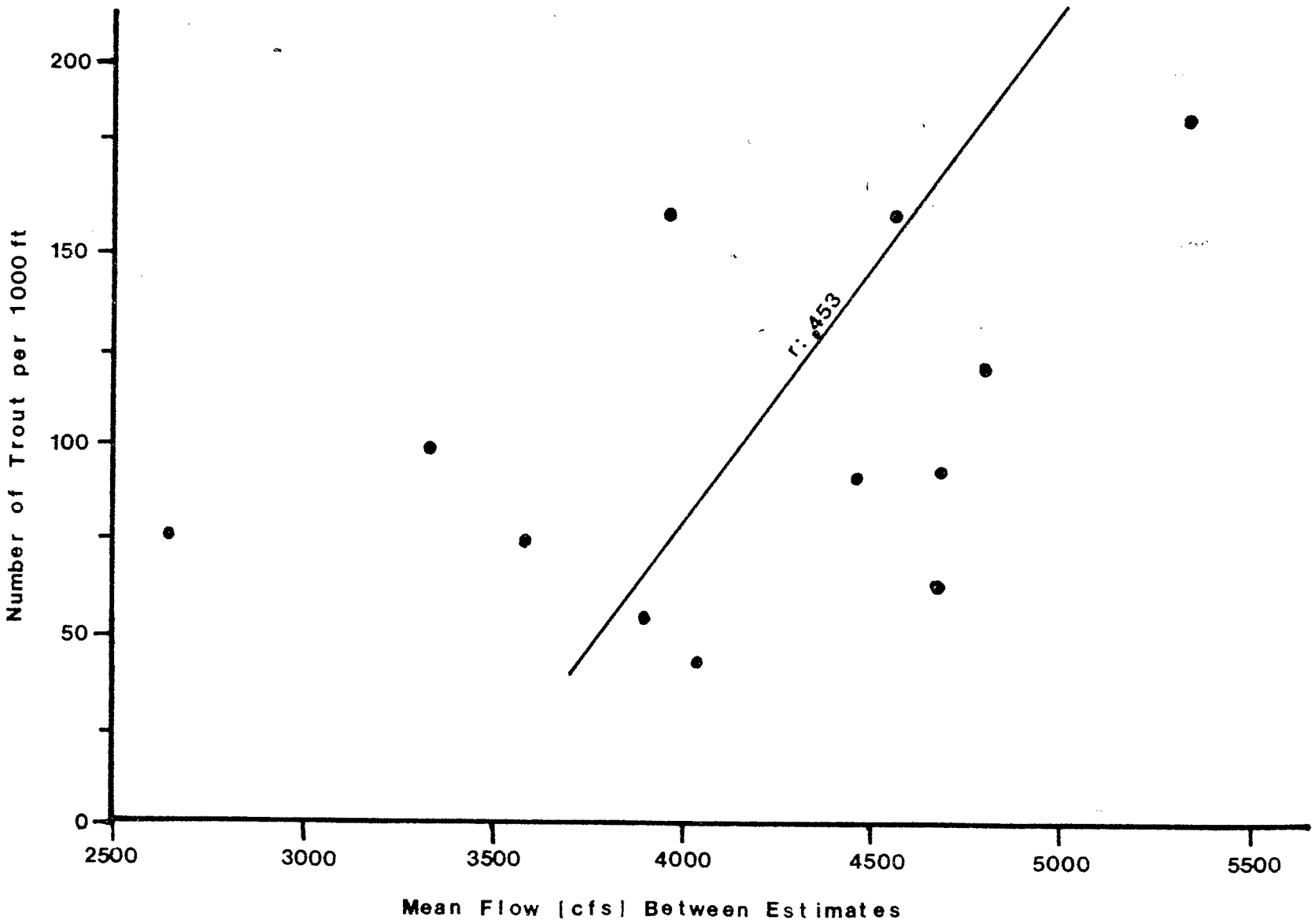

FIGURE 10. Relationship between the number of brown trout 6.0 inches and larger and the mean daily flow between the last recapture dates of the estimates.

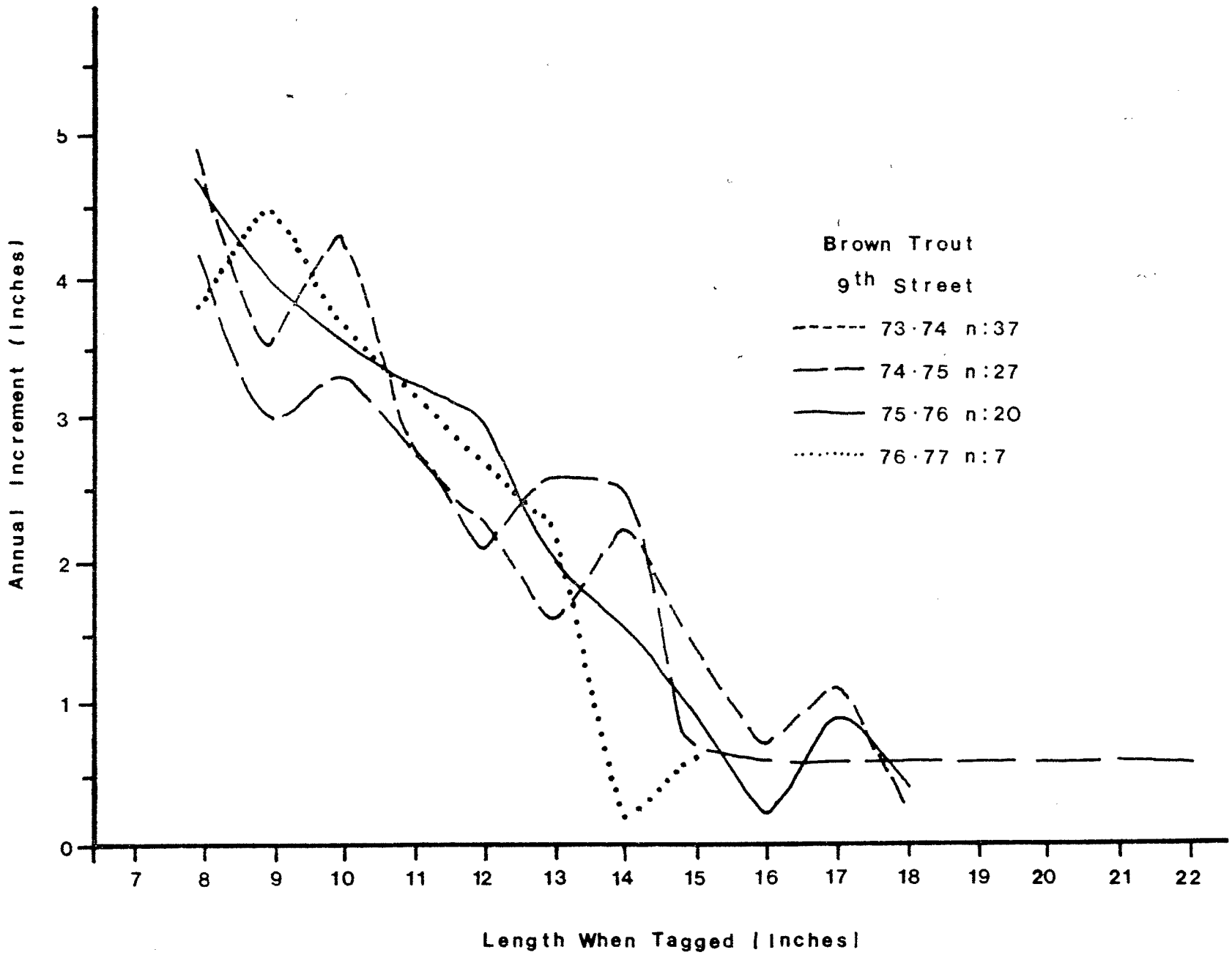

FIGURE 11. Mean annual growth of brown trout between four years in the Ninth Street Study Section.

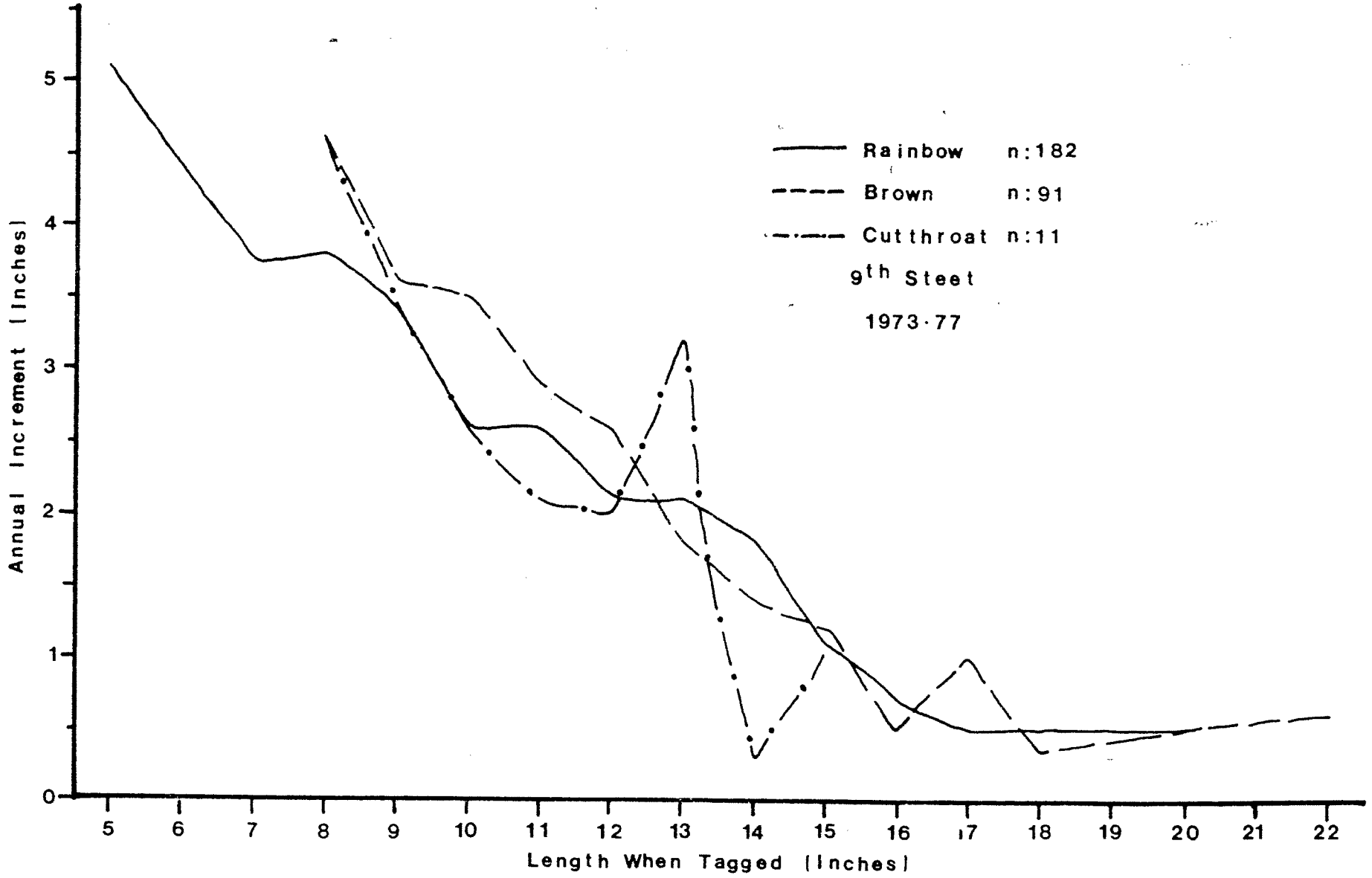

FIGURE 12. Mean annual growth of rainbow, brown, and cutthroat trout from 1973 to 1977 in the Ninth Street Study Section.

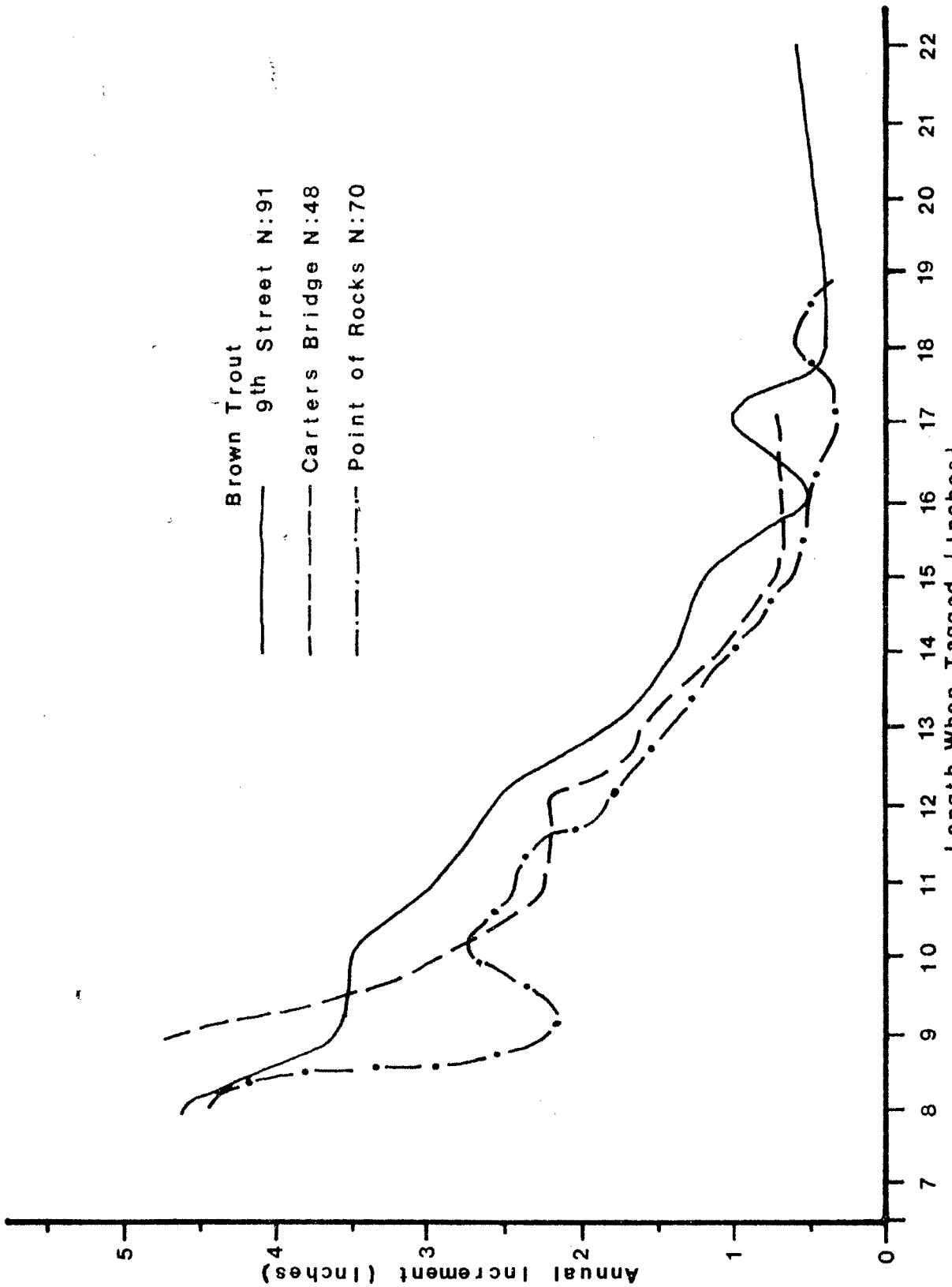

FIGURE 13. Mean annual growth of brown trout between the Ninth Street, Carter's Bridge and Point of Rocks Study Section.

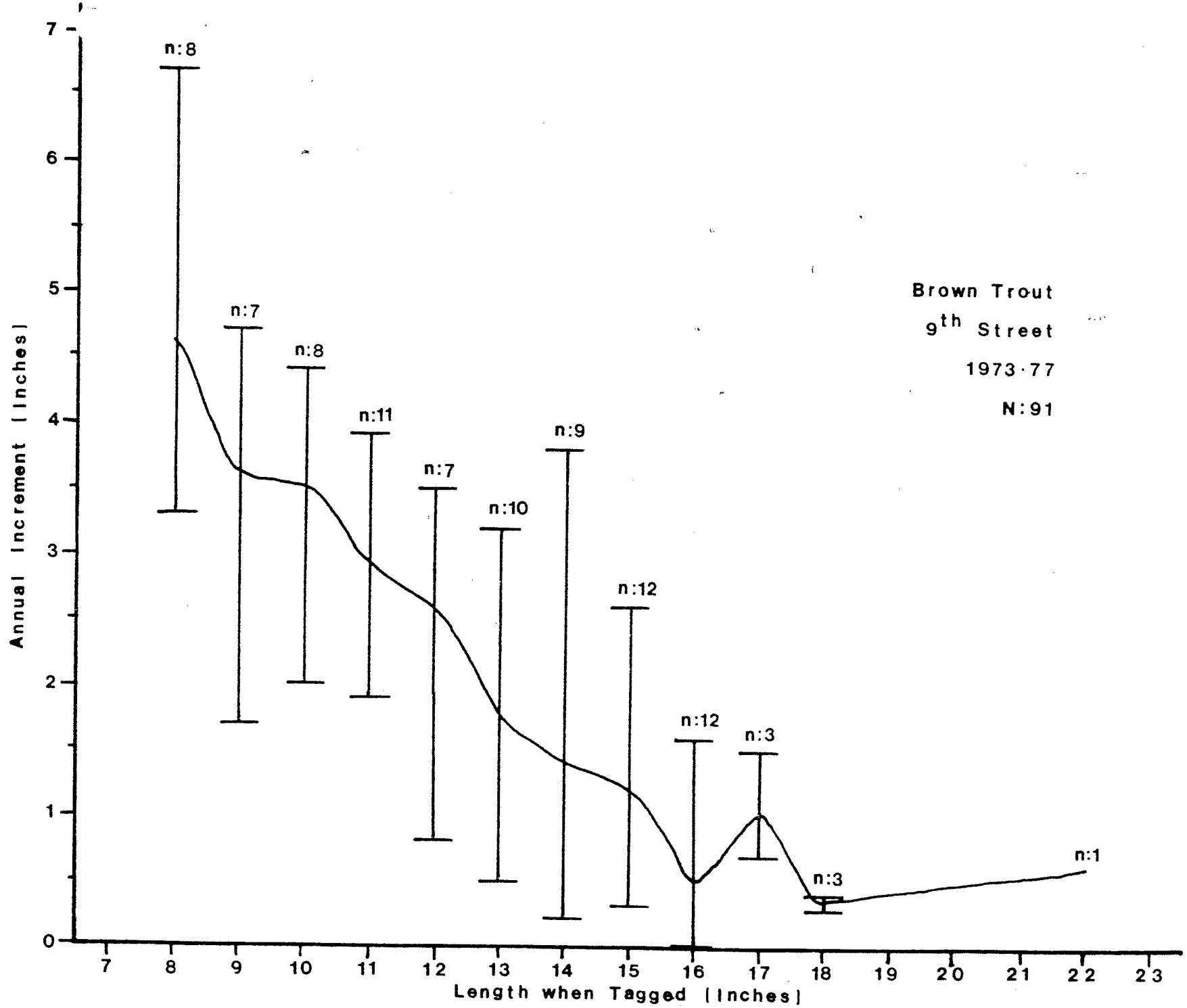

FIGURE 14. Mean and range of the annual growth of brown trout from the Ninth Street Study Section.

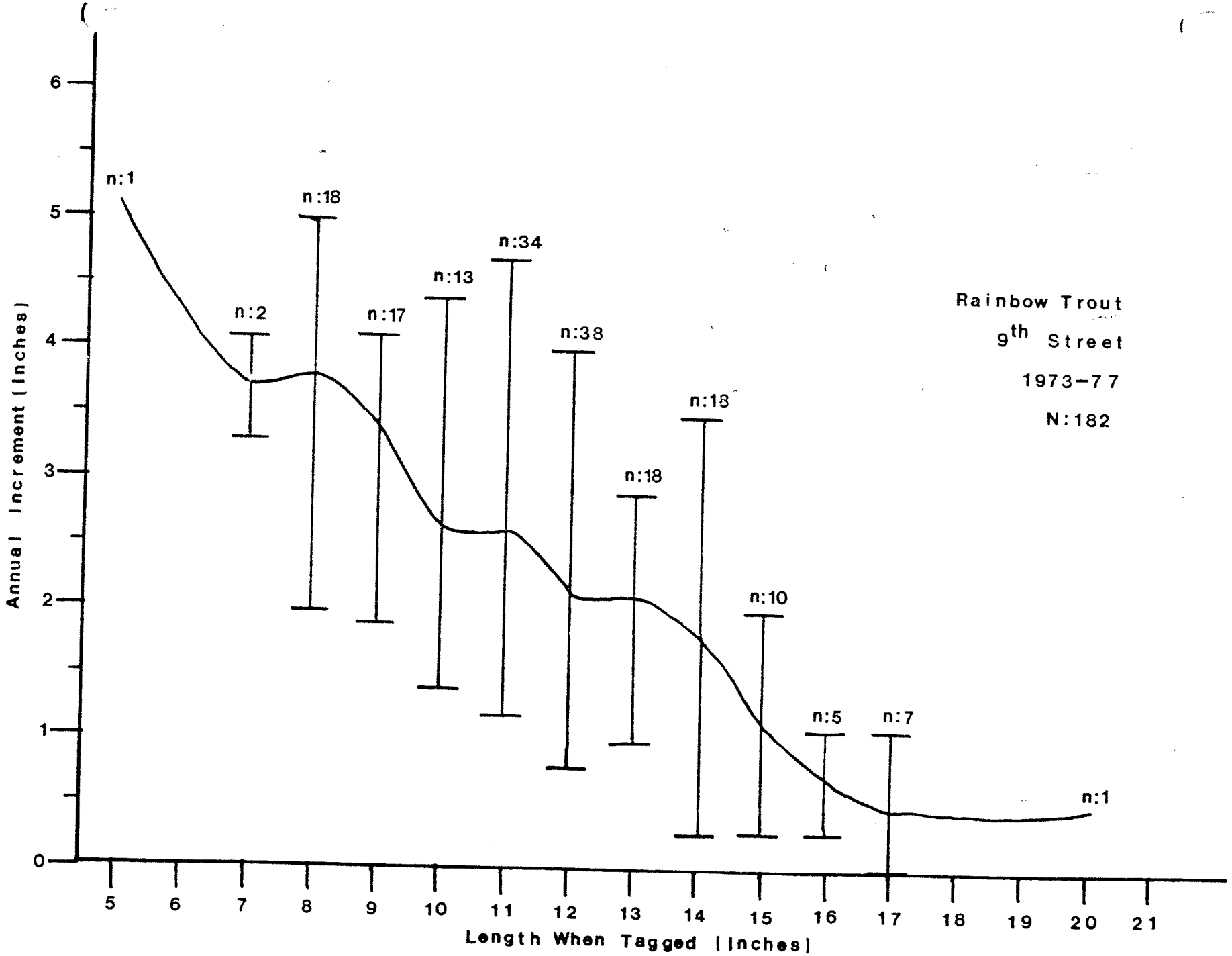

FIGURE 15. Mean and range of the annual growth of rainbow trout from the Ninth Street Study Section.

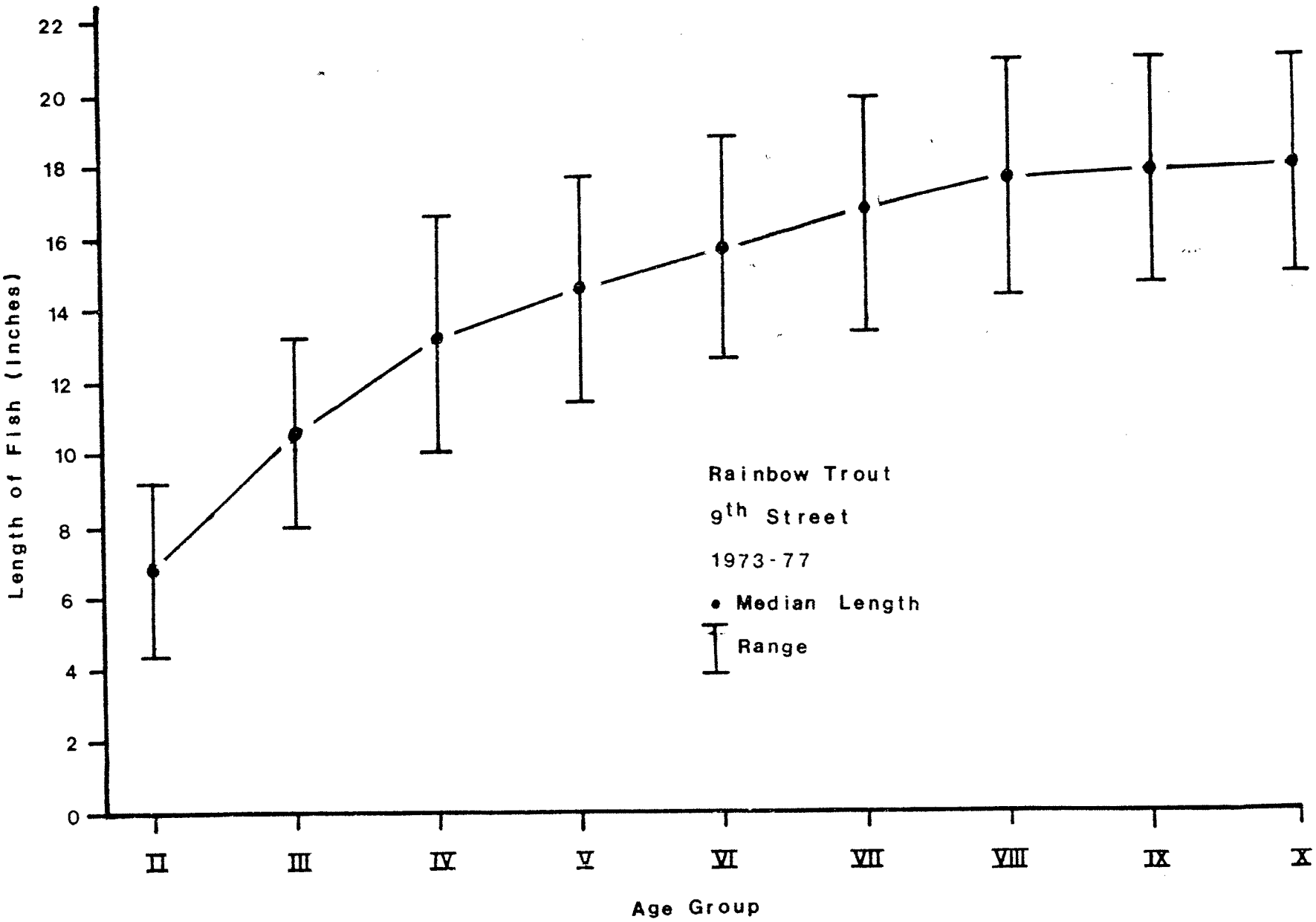

FIGURE 16. Projected median and range of lengths for age groups of rainbow trout from the Ninth Street Study Section.

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 a maximum depth of 24 feet. Both the inlet and outlet are located at its northern shore. The lake is fed by a canal that diverts water from Six Mile Creek and by springs and run-off. Frequent strong winds preclude thermal stratification. 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 this same period, chemical analysis showed the following: Methyl orange alkalivity, 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).

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

The yellow perch population in Dailey Lake has increased to the point that stunting has severely reduced the size of perch and may be the cause of the small size of rainbow trout and kokanee observed in the fisherman's catch.

As a result, a management program was begun in 1977 to reduce the number of perch in the lake by poisoning the south third of the lake and to introduce walleye (Stizostedion vitreum) as a predator on perch.

The lake was surveyed using experimental gill nets before the poisoning in 1977 and again in 1978 one year 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 3.

TABLE 3. Mean length and number (in parenthesis) of yellow perch, rainbow trouth, kokanee, and longnose sucker collected from Dailey Lake during 1977 and 1978.

Year	Yellow Perch	Rainbow Trout	Kokanee	Longnose Sucker
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)

From 1977 to 1978, following partial rehabilitation, the average size of yellow perch collected increased 1.1 inches, rainbow trout 1.1 inches, and kokanee 4.4 inches.

The largest rainbow and kokanee netted during 1977 were 14.9 and 10.8 inches, respectively. During the 1978 netting, six rainbow were collected between 16.5 and 17.4 inches along with five kokanee from 11.6 to 14.8 inches.

The introduction of adult walleye during the fall of 1978 and fry in the spring of 1979 is planned to complete the management program for Dailey Lake.

APPENDIX

TABLE 1. Number of days the mean daily flow (cfs) was less than 0, 20, 50, 70, and 90 percent exceedence at the near Livingston and Corwin Springs U.S.G.S. guage sites.

Date of Estimates	Gage Station	0%	20%	50%	70%	90%
4/30/70 - 4/28/71	Livingston 1/	320	125	28	16	5
4/28/71 - 4/19/72	"	294	53	15	5	0
4/19/72 - 5/02/73	"	286	139	30	6	0
5/02/73 - 4/19/74	"	346	272	117	74	6
4/17/74 - 5/05/75	"	340	228	69	31	6
5/05/75 - 4/30/76	"	296	105	40	27	13
4/30/76 - 5/16/77	"	380	181	20	1	0
4/06/71 - 5/01/72	Corwin Springs 2/	339	172	21	4	0
5/01/72 - 5/09/73	"	319	148	40	20	3
5/09/73 - 4/17/74	"	344	315	220	83	0

1/ U.S.G.S. 39 year period of record between water years 1901 and 1967.

2/ U.S.G.S. 49 year period of record between water years 1926 and 1974.

TABLE 7. 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. gage at Corwin Springs.)

Year	High Flow	Low Flow	Between Estimates
1968	8,667		
1968-69		2,109	
1969	8,695		
1969-70		1,246	
1970	9,919		
1970-71		1,603	3,590 1/
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

1/ Mean flow one year preceding last recapture date 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-May10) periods and mean daily flow during the interval between dates of fish population estimates. (U.S.G.S. gage near Livingston).

Year	High Flow	Low Flow	Between Estimates
1968	10,766		
1968-69		2,646	
1969	10,202		
1969-70		1,739	3,972[1/]
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

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

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

TABLE 4. Sample size, mean, and range of annual growth increment of three trout species tagged and recaptured in the upper Yellowstone River from 1970 to 1977.

Kind of Trout	Inch Group	Point of Rocks																Carter's Bridge												Ninth Street																	
		1971-72			1972-73			1973-74			1974-76			1971-75				1970-71			1971-72			1970-72				1973-74			1974-75			1975-76			1976-77			1973-77					
		N	$\bar{a}$	Range	N	$\bar{a}$	Range	N	$\bar{a}$	Range	N	$\bar{a}$	Range	N	$\bar{a}$	Range		N	$\bar{a}$	Range	N	$\bar{a}$	Range	N	$\bar{a}$	Range		N	$\bar{a}$	Range	N	$\bar{a}$	Range	N	$\bar{a}$	Range	N	$\bar{a}$	Range	N	$\bar{a}$	Range			
BROWN TROUT	8.0- 8.9							2	4.4	4.1-4.6				2	4.4	4.1-4.6												1	4.9	-------	1	4.2	------	5	4.7	3.3-6.7	1	3.8	-------	8	4.6	4.2-6.7			
	9.0- 9.9				2	1.2	0.4-2.0	1	3.8	-------				3	2.1	0.4-2.0		1	4.7	-------	1	4.7	-------	1	4.7	-------		3	3.5	1.7-4.7	2	3.0	2.9-3.2	1	4.0	-------	1	4.5	-------	7	3.6	1.7-4.7			
	10.0-10.9							5	2.7	2.6-3.8				5	2.7	2.6-3.8		9	2.8	2.2-3.3	6	3.3	2.1-4.2	15	3.0	2.1-4.2		2	4.3	4.2-4.4	5	3.3	2.0-3.7				1	3.7	-------	8	3.6	2.0-4.4			
	11.0-11.9	1	2.5	-------				1	2.3	-------				2	2.4	2.3-2.5		3	1.9	1.8-2.0	5	2.3	1.9-3.5	8	2.2	1.8-3.5		3	2.8	2.8-3.1	8	2.8	1.9-3.9							11	2.6	1.9-3.9			
	12.0-12.9	1	2.5	-------	4	1.3	0.7-1.5	2	2.4	1.2-3.5				7	1.8	0.7-3.5		1	2.0	-------	1	2.3	-------	2	2.2	2.0-2.3		3	2.3	0.8-3.5	1	2.1	-------	3	3.0	2.4-3.4				7	2.6	0.8-3.5			
	13.0-13.9	2	0.9	0.3-1.5	1	2.4	-------	2	1.5	0.8-2.2				5	1.4	0.3-2.4		2	0.9	0.6-1.2	2	1.3	0.8-1.7	4	1.6	0.6-1.7		5	1.6	0.5-3.2	1	2.6	-------	3	2.0	1.2-2.3	1	2.3	-------	10	1.9	0.5-3.2			
	14.0-14.9	5	1.5	0.1-2.8	7	0.7	0.3-1.2	3	0.8	0.1-1.2	1	0.6	1/	15	1.0	0.1-2.8		3	1.4	0.6-2.8	1	0.3	-------	4	1.1	0.6-2.8		4	2.2	1.1-3.8	2	2.5	2.3-2.8	2	1.6	1.5-1.7	1	0.2	-------	9	1.9	1.1-3.8			
	15.0-15.9	3	0.6	0.1-1.0	1	0.2	-------	1	0.9	-------				5	0.6	0.1-1.0		4	0.8	0.4-1.0	3	0.6	0.2-1.2	7	0.7	0.2-1.2		8	1.4	0.4-2.6	2	0.7	0.31.1				2	0.6	0.5-0.8	12	1.2	0.3-2.6			
	16.0-16.9	4	0.2	0.2-0.4	6	0.4	0.0-1.4	8	0.7	0.3-1.4				18	0.5	0.0-1.4		1	1.3	-------	3	0.5	0.1-0.7	4	0.7	0.1-1.3		4	0.7	0.2-1.6	4	0.6	0.2-0.8	4	0.2	0.0-0.6				12	0.5	0.0-1.6			
	17.0-17.9	1	0.2	-------	3	0.2	0.1-0.5	1	1.0	-------				5	0.3	0.1-0.5		2	0.6	0.2-1.0	1	0.8	-------	3	0.7	0.2-1.0		2	1.1	0.7-1.5				1	0.9	-------				3	1.0	0.7-1.5			
	18.0-18.9	1	0.3	-------				1	1.8	-------				2	0.6	0.3-0.8												2	0.3	-------				1	0.4	-------				3	0.3	-------			
	19.0-19.9													1	0.3	-------																													
	20.0-20.9																																												
	21.0-21.9																																												
	22.0-22.9																																												
	TOTAL	18	0.9	0.1-2.8	25	0.7	0.4-2.0	27	1.7	0.1-4.6	1	0.6	-----	70	1.2	0.0-4.6		26	1.9	0.2-3.3	22	1.9	0.1-4.2	48	1.9	0.1-4.2		37	2.0	0.2-4.7	27	2.3	0.2-3.9	20	2.4	0.0-6.7	7	2.2	0.2-4.5	91	2.2	0.0-6.7			
RAINBOW TROUT	5.0- 5.9																																												
	6.0- 6.9																											1	5.1											1	5.1	-------			
	7.0- 7.9																																												
	8.0- 8.9																											2	3.7	3.3-4.1										2	3.7	3.3-4.1			
	9.0- 9.9																											6	4.3	3.8-4.5	4	3.2	3.0-3.6	7	3.6	2.0-4.6	1	5.1	-------	18	3.8	2.0-4.6			
	10.0-10.9																	3	2.7	2.0-3.7				3	2.7	2.0-3.7		3	3.7	3.6-3.8	2	3.0	2.9-3.2	8	2.8	1.9-3.7	4	3.6	3.3-4.1	17	3.4	1.9-4.1			
	11.0-11.9																	6	1.9	1.7-2.3	1	1.4	-------	7	1.8	1.4-2.3		1	4.4	-------				6	2.0	1.4-3.0	6	2.9	2.4-3.3	13	2.6	1.4-3.9			
	12.0-12.9																	9	2.3	1.7-3.2	2	2.5	2.0-3.0	11	2.3	1.7-3.2		11	3.7	2.8-4.7	7	2.4	1.7-3.4	9	2.0	1.3-2.9	7	2.0	1.2-3.4	34	2.6	1.3-4.7			
	13.0-13.9																	4	1.8	0.9-2.6	3	1.4	1.0-2.3	7	2.3	0.9-2.6		14	2.5	0.8-4.0	6	1.9	1.5-2.3	11	1.5	1.1-2.2	7	2.5	1.4-3.3	38	2.1	0.8-4.0			
	14.0-14.9										1	0.8	-----					5	0.9	0.0-1.8	4	1.2	0.5-1.8	9	1.0	0.0-1.8		6	2.4	2.0-3.4	3	2.3	2.1-2.6	4	1.4	1.0-2.0	5	2.1	1.4-3.0	18	2.1	1.0-3.4			
	15.0-15.9	1	0.0	-------	1	0.3	-------											6	1.0	0.7-1.8	4	0.8	0.2-1.9	10	0.9	0.2-1.9		9	2.3	1.7-3.5	3	1.9	1.5-2.3	5	0.9	0.3-2.4	1	1.8	-------	18	1.8	0.3-3.5			
	16.0-16.9																	3	0.6	0.3-0.9	3	0.4	0.1-0.8	6	0.5	0.1-0.9		5	1.0	0.3-1.7	3	1.0	0.3-2.0	2	1.5	1.1-1.9				10	1.1	0.3-2.0			
	17.0-17.9																											3	0.9	0.7-1.1				2	0.4	0.3-0.5				5	0.7	0.3-1.1			
	18.0-18.9																				1	0.1	0.1	1	0.1	-------		6	0.4	0.0-1.1	1	1.0	-------							7	0.5	0.0-0.1			
	19.0-19.9																																												
	20.0-20.9																																												
	TOTAL	1	0.0	-------	1	0.3	-------				1	0.8	-----					36	1.7	0.0-3.7	18	1.4	0.1-3.0	54	1.6	0.0-3.7		64	2.5	0.0-4.7	29	2.2	0.3-3.6	57	2.1	0.3-4.6	32	2.5	0.1-4.1	182	2.3	0.0-4.6			
CUTTHROAT TROUT	7.0- 7.9																																												
	8.0- 8.9							1	3.7	-------				1	3.7	-------																													
	9.0- 9.9																																					1	4.1		1	4.1	-------			
	10.0-10.9	1	3.0	-------				1	1.8	-------				2	2.4	1.8-3.0												1	3.0	-------							1	4.7		2	3.9	3.0-4.7			
	11.0-11.9				1	1.5	-------	1	1.7	-------				2	1.6	1.5-1.7												1	3.4	-------										1	3.4	-------			
	12.0-12.9	1	2.0											1	2.0	-------		1	1.3	-------																									
	13.0-13.9																											2	2.0	1.5-2.4							1	2.2		3	2.0	1.5-2.4			
	14.0-14.9				1	-.5	-------							1	-.5	-------		1	-1.1	-------								1	4.2	-------				1	1.9	-------				2	3.1	1.9-4.2			
	15.0-15.9																											1	0.3	-------	1	-0.1	-------							2	0.2	0.3-0.1			
	16.0-16.9																														1	1.0	-------							1	1.0	-------			
	17.0-17.9																																												
	18.0-18.9																																												
	19.0-19.9																																												
	20.0-20.9																																												
	TOTAL	2	2.5	2.0-3.0	2	.5	1.5- -.5	3	2.4	1.7-3.7				7	1.4	-.5-3.0		2	0.1	-1.1-1.3				2	0.1	1.1-1.3		6	2.5	0.3-4.2	2	.05	-------	1	1.9	-------	3	3.7	2.2-4.7	12	1.5	-.01-4.7			

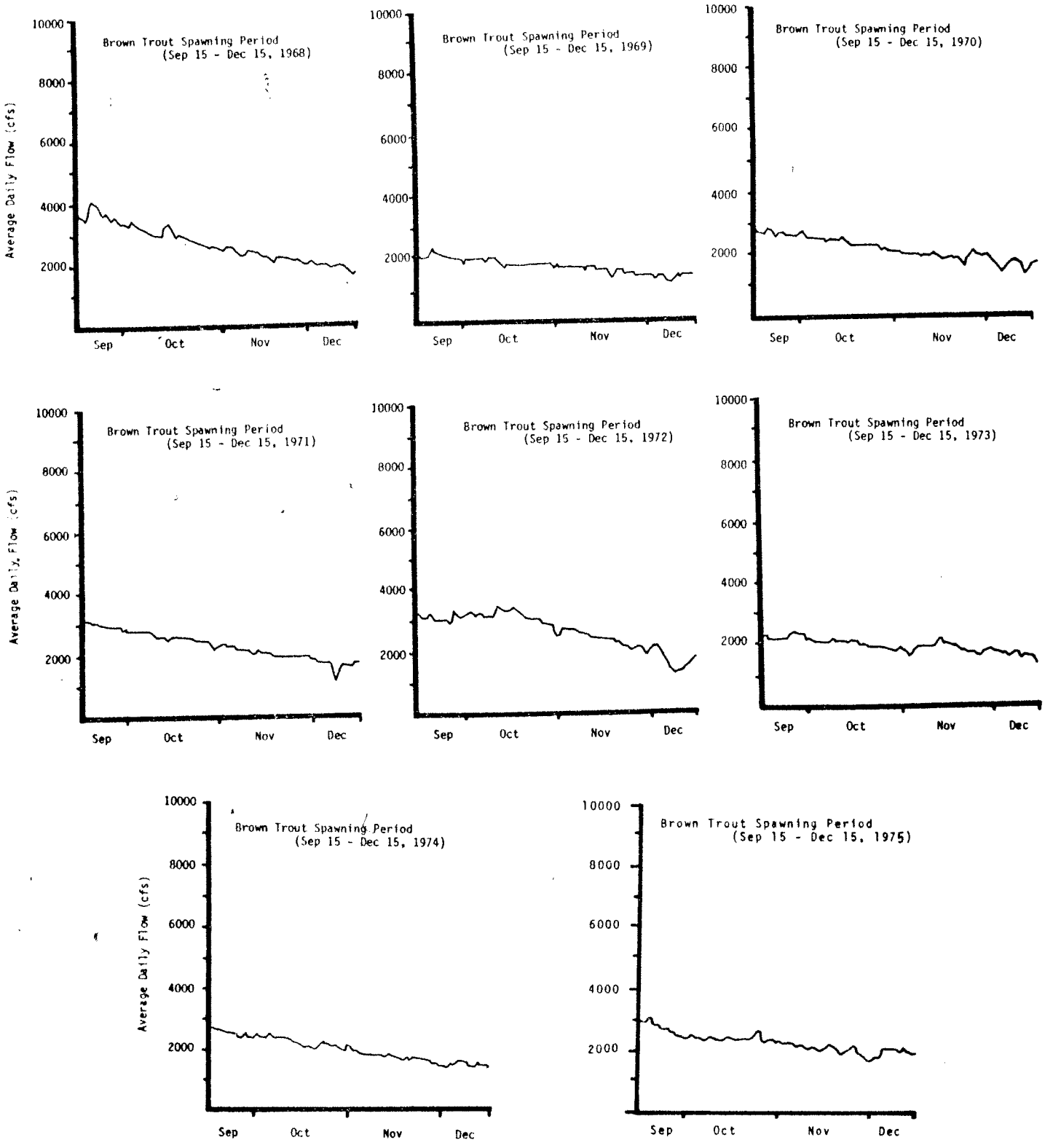

FIGURE 1. Yellowstone River flows near Livingston during the brown trout spawning period from 1968 to 1975.

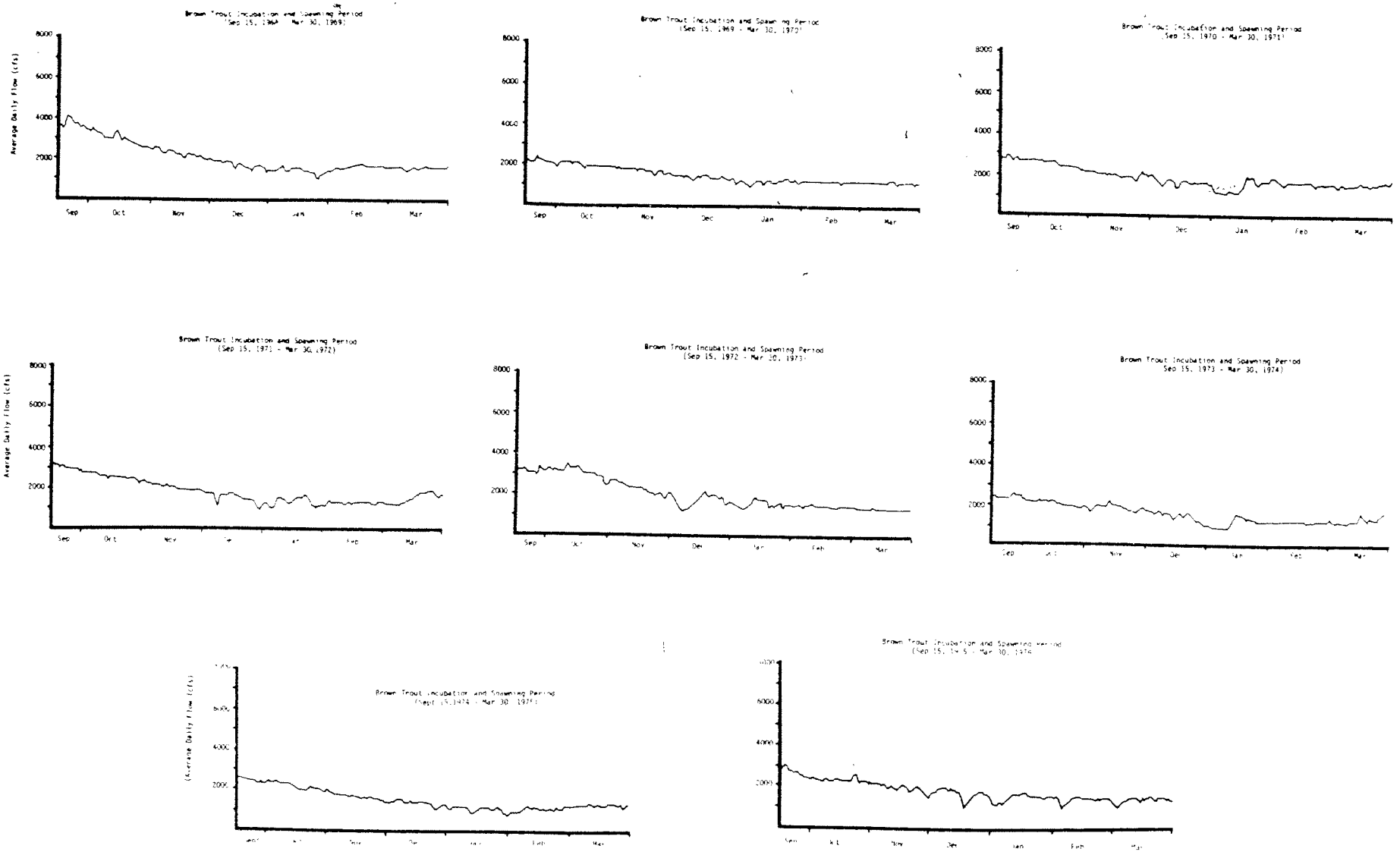

FIGURE 2. Yellowstone River flows near Livingston during the brown trout incubation and spawning period from 1968 to 1976.

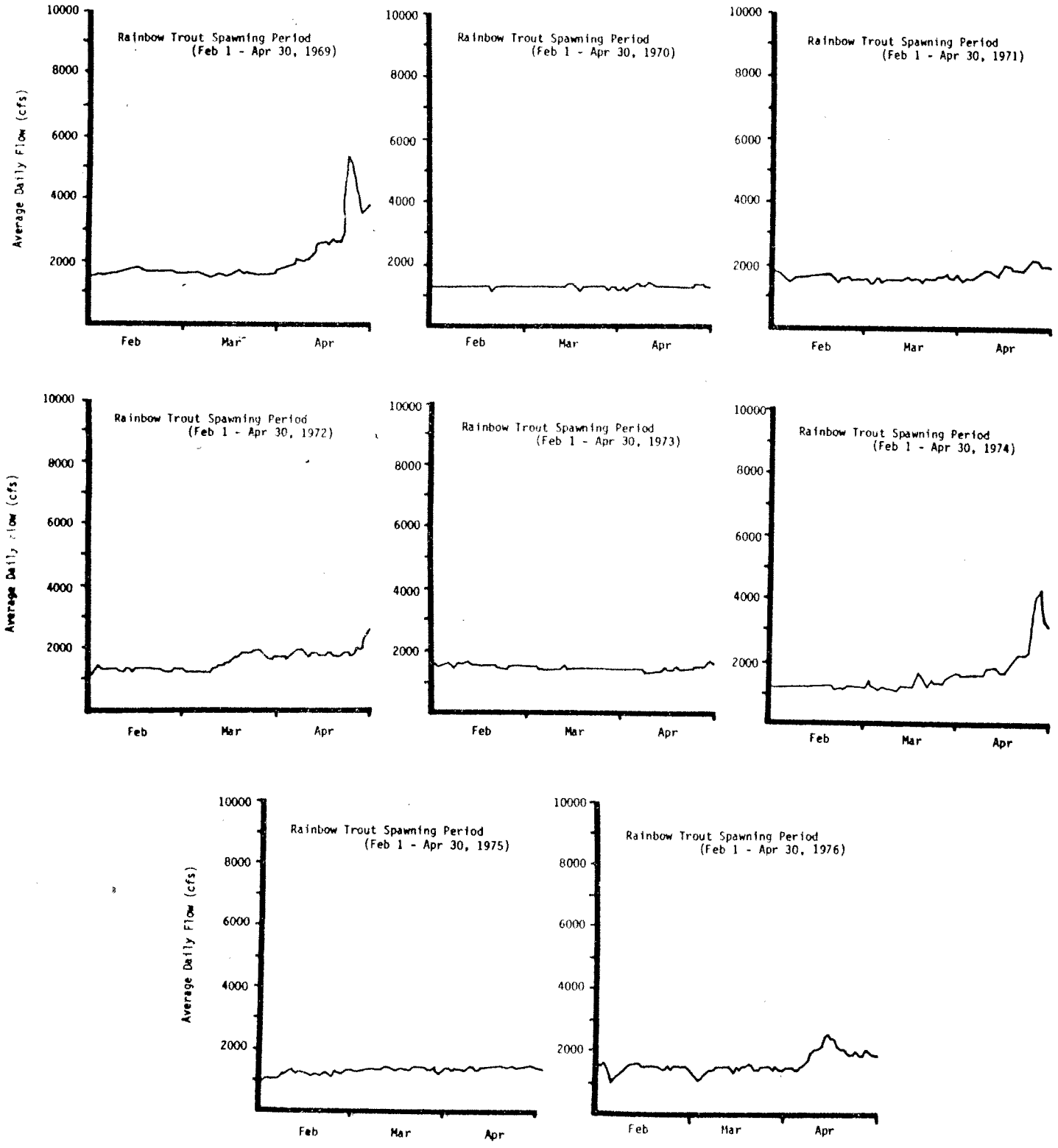

FIGURE 3. Yellowstone River flows near Livingston during the rainbow trout spawning period from 1969 to 1976.

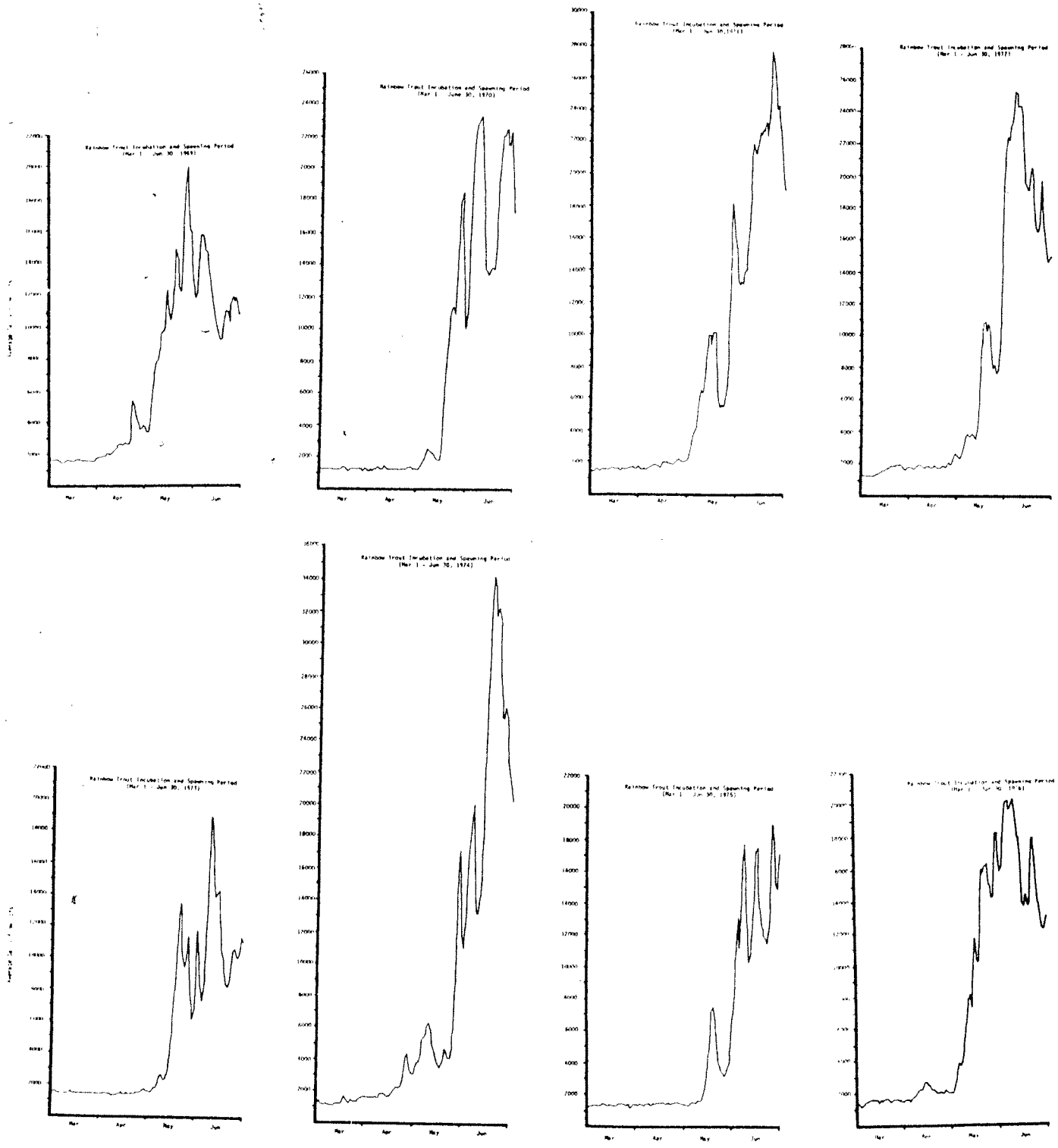

FIGURE 4. Yellowstone River flows near Livingston during the rainbow trout incubation and spawning period from 1969 to 1976.

LITERATURE CITED

Berg, R. K. 1975. Fish and Game Planning, Upper Yellowstone and Shields River Drainages. Fisheries inventory and planning, Federal Aid in Fish and Wildlife Restoration Acts, Mont. Proj. No. FW-3-R, Job I-a, pp. 1-125.

Elser and R. G. Marcoux. 1971. Inventory of waters of the project area. Job Completion Report, Federal Aid in Fish and Wildlife Restoration Acts, Mont. Proj. No. F-9-12, Job No. II, 4 pp.

Johnson, R. L. 1965. The yield and standing crop of fish in Dailey Lake, Montana. Proceed. Mont. Acad. Sci., 25:5-19.

Montana Fish and Game Commission. 1976. Application for Restoration of Water in the Yellowstone River Basin. Helena, Mont. 300 pp.

U.S. Dept. of Interior, Geological Survey, 1968-76, Water Resources Division, Water Resource Data for Montana. Part I: Surface Water Records, U.S. Geol. Survey, 421 Federal Bldg., Helena, Montana.

Vincent, R. E. 1971. River electrofishing and fish population estimates. Prog. Fish Cult., Vol. 33(3):163-169.

_____ 1974. Addendum to river electrofishing and fish population estimates. Prog. Fish Cult., Vol. 36(3):182.

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Waters referred to:

Dailey Lake	3-22-7644-03
Yellowstone River	5-22-7056-01
Yellowstone River	3-22-7070-01
Yellowstone River	3-22-7084-01