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STREAM FISHERIES INVESTIGATIONS

JOB PROGRESS REPORT

PROJECT F-51-R-7

by

R. Barry Nehring, Wildlife Researcher

Richard Anderson, Wildlife Researcher

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Federal Aid in Fish and Wildlife Restoration
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Colorado Division of Wildlife
Fish Research Section
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JOB PROGRESS REPORT

State Colorado

Project No. F-51-R-7 Name: Stream Fisheries Investigations

Job No. 1 Title: Taylor River Flow Investigations

Inclusive dates: May 1, 1981 - April 30, 1982

INTRODUCTION

This project began in 1973 as the "Upper Gunnison River Investigations." In 1975, the title was changed to "Stream Fishery Investigations" (F-51-R). At that time the project included Job 1, "Taylor River Flow Investigations" and Job 2, "Influence of Artificial Stream Flow Alterations on Trout Populations." Job 1 involved studies done from 1973-1975 to determine the status of the fishery under the existing Taylor River flow regime. These results were reported by Burkhard (1977).

The pattern of discharge resulted in abnormally high flows during the fall spawning period of brown trout (October-November) followed by extremely low flows during the winter months (December-March). Fall spawning flows ranged up to 18 m^3/sec (600 ft^3/sec) and were followed by rapid flow reduction to as low as 0.6 m^3/sec (20 ft^3/sec) and were rarely above 1.8 m^3/sec (60 ft^3/sec) during the winter incubation period for brown trout. Burkhard's (1977) hypothesis was that abnormally high fall spawning flows followed by extremely low winter (incubation period) flows could seriously limit the brown trout population by leaving brown trout redds high and dry, frozen in the gravel, with very detrimental effects on the reproductive success.

Commencing with the 1976-77 water year (October 1976-September 1977) the flow regime was altered so that fall-winter flows would remain relatively constant. This flow pattern has been maintained quite well, within the confines of the needs for irrigation and variations in precipitation between water years. The study was reactivated in the fall of 1979 after 3 years. Population estimations were completed in the fall of 1979, 1980, and 1981 to determine if a significant change had occurred in the Taylor River brown trout population that could be attributed to this stabilized fall-winter flow regime.

METHODS AND MATERIALS

Methodologies used and experimental design employed in the early years (1973-1975) of the study was described by Burkhard (1977). Methods, techniques, and experimental design used in the later years (1979-1981) of the study were described by Nehring (1980).

The methods, techniques, and experimental design used by Nehring and Burkhard were the same except for the changes noted below. First, Burkhard (ibid.) used 1-in. mesh chicken wire to screen off the top and bottom sections of the areas to be electroshocked during his segment of the study. However, floating ice in the spring and floating leaves in the fall quickly plugged most of the holes in the chicken wire causing water to put pressure on the wire and force down the "barrier" making it ineffective in preventing the emigration of resident fish out of the study area during the electroshocking procedure. Studies by Bjornn (1978), Timmermans (1974) and Nehring (1980) indicated that barriers were not necessary in preventing the emigration of marked fish out of electroshocking study areas. Therefore, chicken wire barriers were not used in the 1979-1981 study period. Furthermore, the small size of the brown trout in the Taylor River (the vast majority being 25 cm long or less) meant that any trout wishing to emigrate could in a high probability do so with ease. The 1-in. mesh chicken wire would be readily "porous" to the majority of the trout.

The second modification of Burkhard's (1977) experimental design was in the sampling sections. Burkhard's electroshocking sections were selected in the following manner. The Taylor River was first divided into 33 1-km sections which were, in turn, segmented into ten 100-m subsections within each kilometer. Four different 1-km electroshocking areas (two on public land and two on private land) were first selected. Then, three 100-m subsections were randomly selected in three of the four 1-km sections, and two 100-m subsections were from the fourth 1-km section. This sampling scheme was recommended by statisticians from the Colorado State University Statistics Department as a means of increasing the sample size and statistical reliability of the data. However, after the first 2 yrs of population data were collected (1974-75) it was discovered the population estimates varied so widely, within and between sections and years, the data was not suited to statistical analyses that would yield significant results. Therefore, Burkhard pooled the data from the subsection and expanded it to represent numbers of brown trout/km. Not only was the original design (three 100-m subsections per 1-km section) a disaster from a statistical standpoint, it also increased the "set-up" and "break-down" time on the equipment from 10 times to 22 times. This probably resulted in twice as much time being spent in the field on a population estimation procedures as was really necessary, a considerable expense when the procedure required a field crew of at least 10 people fulltime for a full week.

In light of the above inadequacies in the experimental design and in the interest of minimizing the cost, the author modified Burkhard's sampling scheme as outlined in Table 1 below.

Table 1. Taylor River electroshocking scheme.

	1974-75		1979-1981	
Station name	section number	subsection (100 m)	section number	subsection (100 m)
Almont	1	1	1	1
Almont	1	3	1	2
Almont	1	7	1	3
Elsinore	2	1	2	1
Elsinore	2	2	2	2
Elsinore	2	6	2	3
One Mile	3	1	3	1
One Mile	3	3	3	2
One Mile	3	10	3	3
Lower Sams	5	1	5	1
Lower Sams	--	--	5	2
Upper Sams	5	2(7)[a]	5	7
Upper Sams	--	--	5	8
Upper Sams	--	--	5	9

[a] Burkhard (1977) designated the Upper Sams 5-2. In order to be consistent with the system at the other four stations, the proper designation is 5-7.

Burkhard's estimates were done on individual 100-m subsections, then pooled within a 1-km section, and finally expanded to numbers of brown trout/km.

Commencing in 1979 the author reported a single population estimate for each section number which was then expanded to numbers of brown trout/km.

Finally, Burkhard electroshocked the Taylor River in both the spring and fall of 1974-75. The spring electroshocking was not done in the 1979-1981 segments for several reasons. First, it would have doubled the costs. Second, electroshocking the Taylor River in April is very difficult because of snow depths which were enormous in 1979 and 1980. Third, spring population estimates do not really yield much additional information (over fall-only estimates) other than give a good indication of what the overwinter mortality was. Therefore, the author concluded a good evaluation could still be completed with fall-only population estimates with a considerable saving in time and manpower costs.

RESULTS

Fall brown trout population estimates for the 5 years of electroshocking are presented in Table 2 below.

Table 2. Taylor River brown trout population estimations from October 1974, 1975, 1979, 1980, and 1981. (Estimates in no./km).

Sample station	1974	1975	1979	1980	1981
Almont	1775	1482	2975	2823	2728
Elsinore Cattle Company	2156	1866	2460	2531	2013
One Mile Campground	2384	1829	3641	3741	2784
Perkins Sam	1817	1974	2825	3575	4032

A paired t-test evaluation of all possible pairings of the data (between years) presented in Table 2 is presented in Table 3 below.

Table 3. Statistical evaluation of brown trout populations in the Taylor River from October 1974, 1975, 1979, 1980, and 1981.

Years tested	df	Calculated t value	t percentile	t value
1974 vs 1975	3	1.662	nsd[a] 0.90	1.638
1974 vs 1979	3	-4.296	*** 0.95	2.353
1974 vs 1980	3	-3.886	*** 0.975	3.182
1974 vs 1981	3	-1.694	* 0.990	4.541
1975 vs 1979	3	-4.242	*** 0.995	5.841
1975 vs 1980	3	-5.224	****	
1975 vs 1981	3	-2.782	**	
1974 /75 av. vs 1981	3	-2.184	*	
1979 vs 1980	3	-0.990	nsd	
1979 vs 1981	3	+0.191	nsd	
1980 vs 1981	3	+0.923	nsd	

[a]nsd = No significant difference
* Level of significance between 0.90 and 0.95
** Level of significance between 0.95 and 0.975
*** Level of significance between 0.975 and 0.99
**** Level of significance between 0.99 and 0.995

Table 4 indicates the percent change in the Taylor River brown trout population in 1979, 1980, and 1981 as compared to the average population size for the fall 1974-75.

Table 4. Percent increase in Taylor River brown trout populations (no./km) for October 1979, 1980, and 1981 over the October 1974-75 average.

Sample station	1974-75 average	1979	% inc.	1980	% inc.	1981	% inc.
Almont	1629	2475	83.0	2823	73.0	2728	67
Elsinore Cattle Co.	2011	2460	22.0	2531	26.0	2013	0
One Mile Campground	2112	3641	72.0	3741	77.0	2784	32
Perkins Sam	1896	2825	49.0	3575	89.0	4032	113
Average increase	--	--	56.5	--	66.3	--	53

DISCUSSION

The data presented in Tables 2-4 in the Results section give a very strong indication that a significant increase has occurred in the brown trout population of the Taylor River. It is also quite certain that this increase has been largely due to the stabilization of water release patterns out of Taylor Park Reservoir in the fall-winter (November - March) months.

Earlier (Nehring 1980, Nehring and Anderson 1981) we indicated the increases measured in 1979 and 1980 could have easily been the result of near-record-low water years in the summer of 1977 and 1978. We have demonstrated that recruitment of brown trout in some streams in Colorado is inversely proportional to the maximum levels of run-off each year (Nehring and Anderson 1980). Thus, the large increases in the Taylor River brown trout population in the fall of 1979-80 (compared to 1974-75) could have been the result of unusually high levels of recruitment in 1977 and 1978. Therefore, we recommended the continuation of this study through the fall of 1982. In so doing, we would be able to determine if the near-record high run-off years in 1979-80 in the Taylor River Basin would once again reduce the brown trout populations to the levels observed in 1974-75, at a time prior to the stabilization of the fall-winter flow regime.

Our results in the fall of 1981 indicate the Taylor River brown trout populations is still 53% higher than the levels observed in 1974-75. Assuming the levels observed in the fall of 1982 are still significantly higher than the 1974-75 fall population estimates, we will have eliminated the possibility that maximum run-off levels are the controlling factor.

To get a better indication of the relationship between year class strength and the water flow regime a series of regression analyses were conducted. The data in Table 5 below is presented to give the reader (unfamiliar with the study) a better visual idea of how these regression analyses were carried out.

Table 5. Example of a regression analysis of year class strength of brown trout versus mean monthly flow in the Taylor River.

Station	Year class (yr)	Age (yrs)	Year class size no./ha	Sample period	Flow period	Mean monthly flow (ft^3/sec)
Almont	1973	1+	106	Oct 74	Dec 72	94
Almont	1974	1+	57	Oct 75	Dec 73	90
Almont	1978	1+	143	Oct 79	Dec 77	133
Almont	1979	1+	79	Oct 80	Dec 78	150
Almont	1980	1+	338	Oct 81	Dec 79	182

Year class size (no./ha) was regressed against the mean monthly flow (for the month of December) in ft^3/sec. The correlation coefficient (r) in this regression was +0.7796. This same sort of regression of year class size (no./ha) for age 1+ browns at the Almont station was run against mean monthly flows for all 12 months of the year. Since we had five electroshocking stations and 12 months of flows, we were able to calculate 60 individual regressions. Forty-eight of the 60 regressions revealed a positive correlation between year class strength of age 1+ browns and mean monthly flow. For the brown egg incubation and hatching period (November through April) 28 out of the 30 correlations were positive, which shows a strong positive relationship between brown trout recruitment and flow in the Taylor River.

Dr. Dave Bowdèn, Statistician at Colorado State University, reports (personal communication) that we really do not have 60 true correlations because of the high correlation in flows between the five electroshocking stations within a given year; i.e., the flow out of Taylor Park Reservoir is going to have a significant impact on any electroshocking station in the Taylor River. Therefore, Dr. Bowden suggests a regression analysis between year class strength (for all four electroshocking areas) and the difference between the maximum sustained 7-day flow and the minimum sustained 7-day flow during the brown trout spawning and incubation period. The assumption is that the greater the difference between the maximum and minimum 7-day flows during the brown trout spawning and incubation period the more the brown trout age class for that year would be depressed. In other words, we would anticipate a negative correlation coefficient. We completed the correlation on the year class at the end of the third summer of life (2+) for consistent electroshocking results and to minimize the impacts of angler harvest on the year class, thereby biasing the data. The correlations were negative as anticipated (see Table 6 below).

Close scrutiny of the life table data for the Taylor River reveals that large increases in year class occur at all stations and in all years between the second summer (age 1+) and third summer (age 2+) of life. In four instances the increase was less than 100%, or a doubling. But in eleven cases out of fifteen the increase was from two times to near 20 times. This indicates that year class augmentation occurs between the second summer and third summer of life and apparently comes from the side tributaries. Four major tributaries (Spring, Beaver, Crystal and Lottis Creeks) empty into the Taylor River between Taylor Park Reservoir and the town of Almont and all contain thriving brown trout populations.

We hypothesize that year class strength on the side tributaries is likely to be inversely proportional to the maximum levels of spring run-off, as it is on the South Fork of the Rio Grande (Nehring and Anderson 1981). Drummond (1966) found a similar relationship between recruitment of cutthroat trout and stream discharge into Trapper's Lake, Colorado. Density-independent mortality on young-of-the-year trout appears to be almost directly proportional to increasing levels of spring run-off

Table 6. Correlation between brown trout year class strength (n/ha) and the difference between maximum and minimum 7-day flows during the brown spawning and incubation period October 1 - April 30.

Flow (ft 3/5)	Flow period	Brown year class[a]	Almont	Elsinore	One Mile	Upper Sams	Lower Sams
453	10/1/72 - 4/30/72	1972	322	263	433	65	124
464	10/1/72 - 4/30/73	1973	296	262	334	166	137
35	10/1/76 - 4/30/77	1977	713	684	1066	566	711
20	10/1/77 - 4/30/78	1978	438	447	855	288	603
189	10/1/78 - 4/30/79	1979	385	318	397	170	659
Correlation coefficient (r)			-0.7615	-0.8054	-0.8379	-0.7598	-0.9395

[a] Year class strength determined at the end of the third summer of life, i.e., October 1974, 1975, 1979, 1980, 1981 by electroshocking.

on uncontrolled streams in Colorado, the situation with the tributaries of the Taylor River. Therefore, we would anticipate an inverse relationship between year class strength of third summer (age 2+) browns and discharge in the Taylor River since most of those trout are apparently immigrants to the Taylor River from the side tributaries.

Once again we completed 60 regressions between year class strength over 5 years at the five electroshocking stations and mean monthly flow in the Taylor River. In this case, 54 of the 60 regressions were negative, supporting the above hypotheses. Furthermore, the strongest consistently negative correlations came in the period from May through October, during the first 6 months of life for young-of-the-year brown trout.

No effort was made to actually count numbers of dead brown trout (lost to winterkill) in the electroshocking sections in the spring of 1974-75, during Burkhard's portion of the study. Yet, three biologists who electroshocked the Taylor River in those years all remember many dead brown trout in the spring of 1974 and 1975. Flow records in November-December of 1973 and 1974 indicate flows were dropped from as high as 500 ft^3/sec to as low as 50 ft^3/sec in a matter of days. Rapid drastic decreases in stream discharge would tend to strand larger trout in dewatered areas of the channel as the flow receded and result in significant losses of large numbers of brown trout. The three biologists indicated from 10 to 30 dead browns were observed in 100-m electroshocking sections. Overwinter losses were 40% from the fall of 1974 to the spring of 1975 according to Burkhard (1977), probably about 27,000 brown trout.

A creel census was conducted on the Taylor River from June through September 1981, from Taylor Park Dam to the town of Almont. Total brown trout catch was estimated at 7,400 and the harvest (browns kept) was 5,500. Our brown trout population estimates in the fall of 1981 expanded over the entire 33 km of river was over 95,000 brown trout. Thus, the exploitation rate was about 7%. We define exploitation rate as follows:

$$\text{Exploitation rate} = \frac{\text{total catch}}{\text{population estimate + total catch}} \times 100$$

An exploitation rate this low (7%) is quite typical for a brown trout fishery in southwestern Colorado where the vast majority of anglers are non-resident novice trout fishermen. Non-residents made up 65% of the angling public on the Taylor River in 1973. On the South Fork of the Rio Grande, creel census has consistently shown a brown exploitation rate between 3% and 10% over the last decade. Non-resident fishermen make up more than 70% of the angling public there as well. Brown catch-per-man-hour (CPMH) averaged 0.317 in 1981 on the Taylor River and total CPMH averaged 0.672.

RECOMMENDATIONS AND CONCLUSIONS

Brown trout populations observed during the falls of 1979-1981 have been significantly higher (5% level) than the populations observed in the fall of 1974-75. The data presented indicates this increase is probably due to the stabilized fall-winter flow regime that went into effect in 1976. However, near-record discharge levels in the spring of 1979 and 1980 may have had a negative impact on brown trout recruitment during those 2 yrs. If so, this decreased recruitment in 1979 and 1980 should be manifested as decreased population levels in the fall of 1981 and 1982.

We recommend a continuation of the Taylor River flow study through the fall of 1982 in order to determine the relationship between annual discharge patterns and levels of brown trout recruitment. We will conduct cross-sectional analysis of the Taylor River and complete a habitat evaluation by trout life stage to see if changes in the brown trout population (1974-75 vs 1979-1981) can be correlated with flow-induced changes in trout habitat.

State Colorado

Project No. F-51-R-7 Name: Stream Fisheries Investigations

Job 3 Title: Special Regulations Evaluations

Inclusive dates: May 1, 1981 - April 30, 1982

INTRODUCTION

Background

This job began in 1979. The study has been on-going since that time with several new streams incorporated into the study in both the 1980-81 and 1981-82 segments. We initiated the study in 1979-80 with eight streams. During the 1980-81 segment with the addition of another person (Richard Anderson) to the project we added three more rivers to the evaluation, for a total of eleven study streams. In the 1981-82 segment, three new streams were added and three others were dropped, keeping the total under evaluation at eleven. Table 7 indicates the sequence of the additions to and deletions from the study over the past 3 years.

Segment objectives for the 1981-82 segment were:

1. Determine the effects of special regulations on trout population parameters in selected sections of 11 Colorado trout streams.

2. Determine the effects of special regulations on fisherman use and catch on the Fryingpan, South Platte and Arkansas rivers.

3. Determine the degree of acceptance of special regulations by fishermen and their satisfaction with the fishery on the Fryingpan, South Platte and Arkansas rivers.

4. Compare the results from experimental and control stream sections by species as well as between different study streams and make recommendations for further study and management implementation of results.

5. Work with regional management personnel to evaluate the need for similar investigations to be incorporated into the study in future years.

Table 7. Special regulations study streams in F-51-R.

Stream name	County	Important species	Segment period in study 79-80	80-81	81-82
Arkansas	Chaffee/ Fremont	Brown		X	X
Cache la Poudre	Larimer	Brown, Rainbow		X	X
Cochetopa	Saguache	Brook, Brown, Rainbow	X	X	X
Colorado	Grand	Rainbow, Brown			X
Conejos	Conejos	Brown, Brook	X	X	
Conejos, Lake Fork	Conejos	Rio Grande Cutthroat	X	X	X
Eagle	Eagle	Brown, Rainbow			X
Fryingpan	Eagle	Brown, Rainbow, Brook	X	X	X
Gunnison [a]	Montrose/ Delta	Brown, Rainbow			
Los Pinos	Saguache	Brook, Brown	X	X	X
Middle Fork	Park	Brown	X	X	X
North Platte	Jackson	Brown, Rainbow		X	
Roaring Fork	Pitkin	Rainbow, Brown Brook	X	X	
Rio Grande [a]	Mineral/ Rio Grande	Brown, Rainbow			
South Platte	Douglas/ Jefferson	Rainbow, Brown	X	X	X
St. Vrain	Boulder	Brown			X

[a] These streams were electroshocked in 1981 at the request of regional biologists and are to be added to the study in the 1982-83 segment.

Table 8 lists the streams included in the 1981-82 project segment with the harvest restrictions and terminal tackle limitations imposed on the study streams during the 1981-82 calendar years.

The expected completion date of this project when it was initiated in 1979 was to be at the end of the 1981-82 project segment. However, as new areas have been added to the study over the previous segments, we have not yet completed the evaluation. Furthermore, trout populations in high altitude areas such as the Middle Fork of the South Platte have responded slowly to changes in management through special regulations. We feel we need several more years of study to clearly evaluate the responses of stream trout populations to special regulations management. Therefore, we will continue this study under new documentation and a final report will be written at the end of the 1986-87 segment.

Table 8. F-51-R-7 (Job 3) Study Streams - 1981-82 Segment.

Name	County	Important species	Harvest restrictions	Terminal tackle
Arkansas	Chaffee/ Fremont	Brown	Catch & Release 2 fish bag over 16 in.	Flies & Lures
Cache la Poudre	Larimer	Brown, Rainbow	None	Flies & Lures
Cochetopa	Saguache	Brook, Brown Rainbow	Catch & Release	Flies & Lures
Colorado	Grand	Rainbow, Brown	Catch & Release Between 12 in. & 20 in. 2 fish bag limit	None
Conejos, Lake Fork	Conejos	Rio Grande Cutthroat	Catch & Release	Flies & Lures
Eagle	Eagle	Brown, Rainbow	Catch & Release Between 10 in. & 14 in. 8 fish bag limit	None
Fryingpan	Eagle	Brown, Brook Rainbow	Catch & Release	Flies & Lures
Los Pinos	Saguache	Brook, Brown	Catch & Release	Flies & Lures
Middle Fork S. Platte	Park	Brown	Catch & Release Between 8 in. & 16 in. 8 fish bag limit only two 16 in. and over	Flies & Lures
S. Platte	Douglas/ Jefferson	Brown, Rainbow	Catch & Release	Flies & Lures
St. Vrain, Middle Fork	Boulder	Brown	Catch & Release	Flies & Lures

METHODS AND MATERIALS

The methodologies and techniques used in fish population sampling, population estimation, biomass estimation, age and growth analyses, mortality estimates, creel censuses, and angler preferences have all been outlined previously (Nehring 1980, Nehring and Anderson 1981).

The boat electroshocking method was used on the Arkansas, Colorado, Animas, Gunnison, and Rio Grande rivers during the 1981-82 segment. The latter three streams were electroshocked at the request of regional personnel.

RESULTS AND DISCUSSION

Fish Populations

Except where specifically noted below, all population and biomass estimates were completed on trout over 10 cm total length. All study streams will be presented alphabetically in this section, except for those streams investigated as potential additional study areas under Objective 5, Job 3. This objective states: "Work with regional management personnel to evaluate the need for similar investigations to be incorporated into the study in future years". These areas, (Animas, Gunnison, and Rio Grande rivers) are presented in alphabetical order in the Results and Discussion section, immediately after the sections dealing with the 1981-82 segment streams.

Arkansas River

In 1981 a catch and release regulation for all trout less than 16 in. (40 cm) went into effect for two sections on the Arkansas River. Descriptions of the sampling stations are given in the 1981 report. As was found in 1981 the species composition in March 1982 was 99.6% brown trout, 0.3% Snake River cutthroat and 0.1% rainbow. The density and biomass estimates for 1980 and 1981 are presented in Table I-1 and Table I-2 of Appendix I.

Brown trout recruitment was good in 1981. Density of trout <20 cm (primarily age 1) increased in all stations from 1981. The Salida station which had a poor recruitment year in 1980 had the greatest increase of 1,965% (17 trout/ha, 1981; 351 trout/ha, 1982) followed by Loma Linda at 323% (128 trout/ha, 1981; 414 trout/ha, 1982), Coaldale at 94% (128 trout/ha, 1981; 249 trout/ha, 1982) and the Tezak station at 16% (243 trout/ha, 1981; 281 trout/ha, 1982). The large increase in young trout coincides with the mild winter that produced a very low 1981 spring run-off and may be responsible for the increased YOY survival.

Estimates of trout $\geq$ 20 cm (8 in.) were up at two of the stations from last year. The Tezak station was up 23% (292 trout/ha, 1981; 358 trout/ha, 1982) and the Loma Linda station was up 51% (239 trout/ha, 361 trout/ha 1982). The Tezak station is privately owned property that is closed to the general public where angling mortality has probably been moderate and not likely to vary much between years. The Loma Linda station includes

1.6 mi of newly designated catch and release fishing and 0.9 mi of the river that traverses the KOA Campground (fishing restricted to KOA campers only). Angler harvest was sharply cut back on this station in 1981 due to the implementation of the size limit. The Coaldale station, located in the standard regulation area of 8 trout/day, was down 11% in density for trout $\geq$ 20 cm from 1981 (274 trout/ha, 1981; 244 trout/ha, 1982); and trout $\geq$ 20 cm in the Salida station declined by 7% (378 trout/ha, 1981; 351 trout/ha, 1982) in spite of the fact that a catch and release regulation was in effect for this station.

Biomass estimates were up for all stations. The brown biomass for trout less than 20 cm was up 49%, 300%, 123%, and 96% for the Tezak, Loma Linda, Coaldale, and Salida stations, respectively. The greatest increase in biomass for trout $\geq$ 20 cm was at the Loma Linda station (174%). Much of the improvement at this station is due to the large density increase. The Tezak, Coaldale, and Salida stations were up by 46%, 27%, and 16% in biomass for browns $\geq$ 20 cm, respectively. The fact that biomass increased at both stations where density declined indicated that the size structure of the brown population in 1982 is composed of a higher proportion of large fish. Indeed, average trout length (for trout $\geq$ 20 cm) was 26.7 cm in 1981 and 28.8 cm in 1982. It appears that if density had remained constant between years, biomass would have increased by 23% to 38% for browns $\geq$ 20 cm.

Length-frequency histograms are presented in Appendix II. The peaks for the age 1 trout occurred at 16 cm in March 1982. This was 2 cm greater than that observed for March 1981. Better growth in the 1981 season is correlated with the mild winter of that year and an extension of the growing season. Although the 1982 sample of trout scales have not yet been analyzed, it appears growth was also better for larger fish. For example at the Tezak station the age 2 group peaked at 25 cm in March 1981, but at 27 cm in March 1982. The size structure of the trout population for Tezak and Loma Linda are nearly identical to that of 1981 except that they are shifted 2 cm to the right. The Coaldale and Salida stations size structure do not match so closely when superimposed because a prominent peak for age 2 trout is missing. Poor recruitment was identified for the Salida station in 1979. Consequently, there were fewer age 2 trout in the population this year compared to last. Table 9 shows that the reduced number of trout < 30 cm at the Salida and Coaldale station account for the decline in total density at these stations. The number of trout $\geq$ 30 cm is up at all stations. The better growth accounts for much of this.

Table 9. Arkansas River brown trout densitites (no./ha) size groups comparisons for March 1981 and March 1982.

	20 - 30 cm			31 cm & larger		
	1981	1982	% Δ	1981	1982	% Δ
Tezak	236	266	+13	56	93	+ 66
Loma Linda	201	275	+37	38	87	+128
Coaldale	238	154	-35	36	90	+151
Salida	311	217	-30	67	134	+100

Age/back-calculated lengths determined by scale analysis are presented in Table III-1 of Appendix III for trout scale samples from March 1981. Scale samples taken in March 1982 will be analyzed and presented along with life tables in next year's report. In 1981 age 1 and 2 were the predominate age groups. Three-year-olds comprised only 18% of the $\geq$ 20 cm population in the three lower stations, but were 47.5% at Salida. Four-year-olds were limited to a few individuals at all stations. As mentioned above, length frequency analysis indicated that growth was better in 1981 than in the previous year. The average mean length of age 1 trout at the Loma Linda station in March 1981 was 14.2 cm and 15.4 cm in March 1982.

The enigma of few age 4 or older trout in the population was brought out in the 1981 report. Reports of brown trout $\geq$ 16 in. being caught from the Arkansas were fairly common prior to 1977, but not in recent years. The last year that catchable size rainbow were stocked in the Arkansas River was 1976. The fact that the hatchery trout are easier to catch than wild trout means that the stocking program may reduce the impacts of angler mortality on the wild population. Perhaps the elimination of stocking was an indirect factor resulting in the reduction in trophy size brown trout. The catchable rainbow stocking program may have provided a forage base for large predatory brown trout in the early 1970's.

Mean density for trout $\geq$ 20 cm for the four stations was 296 trout/ha in March 1981, and 329 trout/ha in March 1982, reflecting only a modest trout population. It appears that a primary factor limiting the brown trout is the quality of the habitat. The Arkansas River is characterized be wide sandy-bottomed runs, deep open pools, and interspersed riffles. Scattered boulders provide most of the trout cover. Electrofishing efforts have found that most brown trout were collected from areas of cover or in deep riffles and that most deep pools and runs though containing many suckers, were devoid of trout. It is believed that the introduction of rainbow trout which are commonly electrofished from deep fast runs in the Colorado, Gunnison, and South Platte rivers, would exploit these under-utilized habitats and greatly add to the total trout standing crop and enhance angling opportunities. In order to test this hypothesis, wild rainbow trout spawn were taken from the Colorado River and the 15,000 resulting fry were introduced into the Arkansas River in October 1981. Although some of these fingerling rainbow trout were collected, due to the small size of the rainbow trout in March 1982 it was not possible to effectively determine their overwinter survival. However, this experiment will be continued through 1984.

The 1981 creel census data is tabularized in Tables V-1 and V-2 of Appendix V. Creel and pressure counts were made from May through October 1981. The study sections were the same as in 1980 except that the catch and release section (Loma Linda) was broken out. A total of 2,045 fisherman contacts were made in 1981, 557 in the upper study area (Coaldale to KOA Campground) and 1,237 in the lower study area (Texas Creek to Parkdale), and 240 in the catch and release area. The majority (86.8%) of anglers on the Arkansas River were residents of the state, similar to 88.5% found in 1980.

The upper study area received higher per unit area use in 1981, 249.8 hr/ha. The lower study area had 155.7 hr/ha in 1981 compared to 180 hr/ha in 1980. Even though pressure was fairly consistent between the 2 yrs in both areas, the monthly distribution of pressure was much different in 1981 (Table 10).

Table 10. Monthly use in hours on the Arkansas River for 1980 and 1981.

Month	Lower 1980	Lower 1981	Upper 1980	Upper 1981
May	NC[a]	5,381	NC[a]	1,361
June	1,282	2,073	748	1,557
July	3,715	1,971	2,994	1,640
August	5,477	1,549	3,516	1,412
September	3,528	1,031	2,414	915
October	NC[a]	831	NC[a]	679
Total	14,003	12,825	9,672	9,417

[a]NC = No counts made

In 1980 the magnitude of the spring run-off discouraged fishing in May and June, but pressure was heavy throughout the summer and fall. The reverse situation existed in 1981. Spring run-off was very light in 1981 and pressure was heaviest in May. This was also observed at the Tomahawk property on the Middle Fork of the South Platte. Late summer and fall rains were frequent and severe enough to increase turbidity which discouraged fishing at that time. Because of its elevation and temperature regime, good fishing can extend into November on the Arkansas River. Also many anglers were observed in March 1981 during our sampling. Therefore use and harvest may be underestimated by 15-25% of 1981 and even more for 1980.

Angler success was significantly better in the upper study area than in the lower in 1981. The CPMH in 1981 for the upper was 0.651 and similar to that found in 1980 (0.696). CPMH in the lower study area declined in 1981 to only 0.285 from 0.448 found in the same area in 1980. The CPMH in the catch and release area, intermediate to the other sections, was 0.451 for 1981. The CPMH in the upper area with the C&R area not included is 0.706.

The large increase in trout density at the Loma Linda corresponded to the implementation of the catch and release regulation. Use in the catch and release area (248 hrs/ha) was very similar to the upper creel study area in 1981 (251 hrs/ha) and in 1980 (284 hrs/ha). There was a light harvest in the catch and release area of 18.5 trout/ha. All trout checked there were illegal (smaller than the 16 in. minimum legal size), but considering that this was the first year of the regulation, violations were not uncommonly high. The upper study area had a harvest of 117 trout/ha in 1981, not significantly different than that found in 1980 (124 trout/ha, $P < 0.05$), and equates to an annual exploitation rate of 42.7% of the spring, 1981 population estimate for trout $\geq$ 20 cm. The fact that harvest and population size did not differ significantly between 1980 and 1981 at the Coaldale station, while numbers significantly increased at the Loma Linda station (catch and release), suggests that harvest is a factor in regulating population size.

In 1981, 74% of the trout checked were caught by only 9.6% of the anglers. Table 11 summarizes the creel catch per fisherman checked and predicts what harvest would be if the daily bag would be reduced to one or two trout. These data along with those from the South Platte and Fryingpan rivers creel studies, illustrate the fact that reducing the size of the bag limit is not an effective method of reducing total harvest unless the bag limit is reduced to very low levels. In this example, a 2 fish per day bag would have reduced harvest by only 32% and a 1 fish per day bag by 53%.

Table 11. Harvest distribution within the angling community on the Arkansas River 1981.

No. fish caught	Number fishermen	Brown harvest	Projected brown harvest 1 trout/day	Projected brown harvest 2 trout/day
0	1,272	0	0	0
1	195	195	195	195
2	55	110	55	110
3	43	129	43	86
4	16	64	16	32
5	22	110	22	44
6	9	54	9	18
7	5	35	5	10
8	7	56	7	14
Total	1,624	753	352 (47%)	509 (68%)

Of 1551 fishermen contacted in standard regulations areas between May and October 1981, 43% fished exclusively with bait, 34% with lures, and 13% with flies. In the catch and release area where bait was prohibited, 47% of the 32 fishermen checked used flies exclusively. Even though bait fishermen were the largest tackle-type group, it was the lure group that had the greatest impact (harvest) on the fishery. Total trout harvest was distributed among the angling community by 30%, 52%, and 16% for bait, lure, and flies, respectively. CPMH for bait, lure, and fly fishermen was 0.221, 0.619, and 0.781, respectively. Marshall (1973) reported that fly fishermen were the most successful group on the Poudre River in wild trout waters. On the Arkansas River, fly fishermen as a group were also found to be the group most apt to release caught fish. Outside the C&R area fly fishermen released 60.4% of their fish, compared to 39% for lure fishermen, and 8.3% for bait users.

The reliability of a volunteer postcard mail-back system was again evaluated for fishermen on the Arkansas River (Tables V-1 and V-2, Appendix V). Of self-addressed, stamped postcards distributed to fishermen, 40.7% were returned. Estimates computed from the postcard were very similar to the interview method in 1980 (Nehring and Anderson 1981). However, it was more variable in 1981. Most of the divergence appears in the latter summer months when pressure was low which resulted in a small sample size. The opinion question, which asked the anglers if they would favor a catch and release regulation on rainbow trout if the Division of Wildlife made an effort to establish a wild population resulted in 60% in favor, 30% opposed and 10% no opinion (N = 219), Table V-12, Appendix V.

Cache la Poudre

Studies on the Poudre River were the state's first attempt at evaluating special regulations. Klein's (1974) investigations ran from 1962 to 1973. He concluded the regulation in the "wild trout water" had more influence on the angling community than on the trout population. The 12-in. minimum size limit on rainbow trout, which ran from 1963-1969, did not significantly increase their mean size, density, or biomass. However, Poudre River trout are typically slow growing due to low water temperature, and can be subjected to severe winter mortality. Klein (1974) found that excess trout biomass built-up over the summer of 1963 was lost over winter. A 12-in. maximum size limit would probably have been more effective on this stream since it protects larger trout from harvest, but still allows harvest of small fish which may die during the winter. Marshall (1973) found the fly and lure only requirement resulted in reduced pressure (one-third) of that found in Kelly Flat Campground, but it also attracted a more adroit angler, (CPMH was three times higher than in the campground) who was more apt to release trout. Summarizations of Klein's (1974) and Marshall's (1973) trout population data are given in the 1981 report (Nehring and Anderson 1981).

Evaluations of the wild trout water on the Poudre River were reactivated in the fall of 1980. Sampling stations were selected to correspond with those of Klein (1974) and Marshall (1973) and their locations are given in the 1981 report. Of the five sampling stations (Big Bend, Wild Trout Water, Lower Control, Indian Meadows, and Kelly Flats: upstream to downstream) on the "upper" Poudre only one lies within the restricted (fly and lure only) area. This is the Upper Wild Trout Water (UWTW); trout are not stocked, terminal tackle is restricted to artificial flies and lures only, but the bag limit is the standard 8 trout/day. The Big Bend and Kelly Flats stations are located on Forest Service campgrounds. Indian Meadows is a little known section of public land, and the lower control has private property on one side and Highway 14 (public access) on the other. Due to modifications in equipment, the length of the sampling stations in 1981 were expanded to 800-1,000 ft. They were all 500 ft in 1980. 1981 electrofishing results for trout 15 cm and larger are given in Table I-3 of Appendix I.

Species composition was similar to that reported by Klein (1974), Marshall (1973), and the 1980 findings. For trout > 15 cm, rainbow comprised 20%, 51%, 59%, 76%, and 61% of the population at the Big Bend, UWTW, Lower Control, Indian Meadows, and Kelly Flats stations, respectively.

Two stations exhibited significant increases in density and biomass in 1981 from those found in 1980. 1981 estimates for density and biomass were 892 trout/ha and 133.5 kg/ha, respectively, at the UWTW and 870 trout/ha and 124 kg/ha at the Lower Control, representing an average density and biomass increase of 102% and 106%, respectively, from the previous year. This increase may be biased due to sampling variation. The shorter station lengths and reduced sampling efficiency caused by blowing snow in 1980 probably resulted in estimates that were somewhat low at these stations that year. In any event, the 1981 estimates for the UWTW and Lower Control significantly exceed those reported by Klein (1974) and Marshall (1973) in all 6 yrs of their samples (1962, 1963, 1964, 1970, 1971, 1972). The most likely explanation for the inflated population in 1981 is the good survival through the unusually mild winter, the low run-off, and production that was added to the standing crop over the summer.

The other three "upper" stations also increased in density from the 1980 estimates, but not significantly ($P < 0.05$). Density was up at the Big Bend, Indian Meadows, and Kelly Flats stations by 47%, 17% and 14%, respectively. The fact that biomass was up by a lesser amount 42%, 8%, and 11% for the same sections, respectively, indicates that smaller trout are more common in the population this year. Since density changes were not significant at these stations, but were at the UWTW and Lower Control, it is tempting to postulate that there may be some differences in summer mortality rates between these areas due to angler harvest.

Size structure for all five stations was poor with very few trout sampled over 30 cm length. Kelly Flats Campground had the poorest size structure for both browns and rainbows for the five stations. Mean length was only 22.1 cm for brown and 19.3 cm for rainbow at Kelly Flats and only 17% of that population was $\geq$ 25 cm (9.8 in.) in length (Table 12). Marshall considered fishing pressure at Kelly Flats to be extremely high (1,898 hr/ha, 1971) and has probably increased in fishing pressure over the last 9 yrs. It has been demonstrated that high fishing pressure depresses the size structure of a population. The UWTW had the highest number of trout $\geq$ 30 cm of the five stations (Table 12), suggestive that anglers in the wild trout area are voluntarily releasing more of their catch. The Big Bend Campground had the greatest proportion of trout $\geq$ 30. However, this population is 80% brown trout, has the lowest overall density, and the few areas of cover at this station were dominated by larger fish.

Age and growth data for trout sampled in 1981 are given in Table III-1 and life table analysis in Table III-2 of Appendix III. In 1981, back-calculated lengths for rainbow trout were about 2 cm greater in age group 1, 2, 3, and 4 than found in 1980 and also greater than those reported by Klein (1974) for 1963, 1967, 1969, and 1970. Brown trout back-calculated lengths were also greater in 1981 than those reported by Klein (1974). Better growth in 1981 is attributed to the mild winter and earlier seasonal warm-up. Mean size and number of young-of-the-year increased in 1981 over 1980 and previous years as reported by Klein (1974). Mean length for YOY rainbow trout was 7.3 cm (n = 51) and 7.9 cm (n = 208) in 1980 and 1981, respectively, and 9.5 cm (n = 30) and 9.7 cm (n = 125) for brown trout in 1980 and 1981, respectively. Mean size (cm) of YOY by fall 1981 in other streams is generally less on the Poudre River than on other Front Range streams (St. Vrain, 10.9; South Platte, 12.8; Middle Fork of South Platte, 7.9; Arkansas River, 15.0).

Table 12. Density and percentage of trout ≥ 25 cm (10 in.) and ≥ 30 cm for sampling stations in the Cache la Poudre River, October 1981.

Station	Minimum size	Browns no./ha	Browns %	Rainbows no./ha	Rainbows %	Total no./ha	Total %
Big Bend	≥ 25	177	50.0	48	56.0	225	51.2
	≥ 30	65	18.5	14	16.0	79	18.0
UWTW	≥ 25	218	49.4	194	41.4	412	45.3
	≥ 30	70	15.7	37	7.9	107	11.8
Lower Control	≥ 25	177	50.6	182	35.5	359	41.4
	≥ 30	40	11.2	30	5.9	70	8.1
Kelly Flats	≥ 25	89	29.0	45	9.3	134	17.0
	≥ 30	15	5.0	0	0	15	1.9
Indian Meadows	≥ 25	70	44.0	124	24.8	194	29.3
	≥ 30	20	13.0	29	5.8	49	7.4

Two other stations were resampled in 1981. The "lower" wild trout water (LWTW), located 15 km west of Fort Collins (elevation 5,600 ft) has the same regulation as the "upper" wild trout area in that tackle is restricted to artificial flies and lures only, but the standard 8 trout/day bag limit is in effect.

Brown trout are dominate, comprising 91% of the population at both the LWTW and the upstream control station. Density and biomass estimates were substantially down in 1981 from 1980 (Table I-3, Appendix I). Density was 621 trout/ha and biomass was 68 kg/ha at the control station, while 909 trout/ha and 88.3 kg/ha at the LWTW in 1981, representing declines of 40% and 17%, and 33% and 16% for density and biomass estimates for the control and LWTW, respectively. As was the case last year, the population did not differ significantly (P >0.05) between these two stations. It appears that the main reason for the decline in number in 1981 was due to lowered recruitment from the age 1+ group (1980 year class). Also the lower flows of 1981 may have made trout more susceptible to anglers. It is also interesting to note that rainbows were slightly more abundant in the wild trout station than in the control area where they are stocked at a rate of about 280/km.

No trout collected in the control section was over 12 in. (> 30 cm) and only one was found in the LWTW. As suggested last year, these population structures are typical of ones that have been over-harvested. Since this portion of the river is fairly close to Fort Collins, fishing pressure here is probably greater than further upstream.

Scale analysis (Table III-1, Appendix III) also indicates that even though the growth rate was somewhat faster (2-3 cm/season), the "lower" stations had smaller mean sizes for trout and far less age 3+ or older trout in the population than were found in the "upper" stations. Drastic reductions of the older age groups from a population can result from poor winter habitat or, as was found to be the cause on the South Platte River near Deckers, high summer mortality due to harvest. In the case of the "lower" Poudre it may be a combination of the two, but probably mostly due to angler harvest.

In order for this section of the Poudre to produce even moderate numbers of 12-in. trout, it is apparent that the trout population needs protection from the impacts of harvest by more restrictive regulations. Size limits and reduced bag limits would be most appropriate for this area. Evidence has been presented in other sections of this report that bag limits of two or more trout are not effective in reducing total angling mortality (see discussion on Arkansas, Fryingpan, and South Platte rivers). Data taken from Marshall (1973) lends support to this contention. From 1,047 and 558 completed trip interviews made on Kelly Flats Campground in 1971 and 1972, respectively, Marshall found that only 3% in 1971 and 2% of the fishermen in 1972 caught three or more wild trout (Table 13). A bag limit of two trout would have reduced total harvest by only 21% in 1971 and 15% in 1972. These levels of reduction in total harvest would not be nearly enough to improve the size structure of the "lower" Poudre trout population.

A higher percentage of fishermen were able to harvest catchables, probably due to their high catchability and to the practice of "truck following" by many fishermen who are on the stream at the time of the plants. In 1971, 10% of the anglers and 22% in 1972 took three or more trout (Table 13). These represent 29% and 50% of the total harvest in 1971 and 1972, respectively. However, there is no concern about over-harvest of "catchables" and they are not usually stocked in restrictive areas anyway.

Marshall (1973) also found that only 44% and 43% of the anglers were able to catch a trout in his campground study area in 1971 and 1972, respectively (Table 13). This left a fairly large reservoir of anglers, 56% in 1971 and 57% in 1972 who did not catch anything. It is possible that a creel limit of two trout would allow for some compensatory re-action in that fewer anglers would be unsuccessful thus resulting in no reduction at all in total fishing mortality. Also the added publicity from wild trout and catch and release fishing usually attracts more anglers into the area.

Table 13. Summary of 1,047 and 558 completed trip interviews conducted in the campground study areas of the Cache la Poudre River between 2 May and 15 September 1971 and 1972, respectively. Taken from Marshall (1973).

	1971		1972	
Percentage of anglers keeping:	wild trout	stocked trout	wild trout	stocked trout
0	80	68	82	67
1+	20	32	18	33
2+	7	17	5	27
3+	3	10	2	22
4+	2	5	1	19
1+ wild or 1+ stocked trout	44		43	
1+ wild and 1+ stocked trout	8		8	
1+ stocked trout and no wild trout	(32-8) = 24		(33-8) = 25	
1+ stocked trout as a percentage of anglers keeping no wild trout	(24/80) = 30		(25/82) = 30	

Cochetopa, Archuleta and Los Pinos Creeks - Coleman Easement

Archuleta Creek has been electroshocked each fall since 1977 and as a part of this study since 1979. Results of the electroshocking are summarized in Table 14 below. For detailed population statistics see Table I-4 in Appendix I as well as previous reports (Nehring 1980, Nehring and Anderson 1981).

Table 14. Population estimates and biomass data, Archuleta Creek (1977-1981).

Year	Brook n/ha	Brook kg/ha	Brown n/ha	Brown kg/ha	Rainbow n/ha	Rainbow kg/ha	Cutthroat n/ha	Cutthroat kg/ha
1977	2,086	249	543	71	--	--	--	--
1978	615	60	548	108	47	3	30	5
1979	3,762	144	417	47	18	4	12	1
1980	3,047	124	262	41	6	1	--	--
1981	3,863	141	387	40	6	1	6	1

Brook trout have predominated throughout the entire period of the study. The precocious nature of brook trout will usually give them a competitive edge over other trouts on small streams if there are no other limiting factors. The catch and release angling regulation, implemented in 1979, would tend to further tip the balance in favor of the brook trout. Brown, rainbow and cutthroat all require at least 3 yrs to attain sexual maturity and would be subject to the processes of natural mortality for an additional 1 or 2 yrs when compared to brook trout. The population data above indicates the brook trout population is continuing to expand (numerically) probably to the disadvantage of the brown trout component in the population. The data in Table 15 definitely indicates the brook trout population is stunting with brook trout over 25 cm (10 in.) making up a decreasingly smaller percentage of the population each year. The fluctuations in numbers of brown trout over 25 cm (10 in.) may be purely the result of variations in annual recruitment.

Table 15. Brook and brown trout 25 cm and larger in Archuleta Creek.

Year	Brooks ≥ 25 cm %	Brooks ≥ 25 cm n/ha	Browns ≥ 25 cm %	Browns ≥ 25 cm n/ha
1977	6.8	142	10.5	57
1978	5.7	35	42.4	232
1979	2.8	105	19.3	80
1980	1.5	46	27.1	71
1981	1.7	66	27.3	106

Cochetopa Creek has been a part of this study since 1979. Large increases in brown trout numbers and biomass in the catch and release area observed between 1979 and 1980 are still occurring (Table 16).

Table 16. Brown, brook and rainbow trout populations on Cochetopa Creek in the catch and release area.

Year	Browns n/ha	Browns kg/ha	Brooks n/ha	Brooks kg/ha	Rainbows n/ha	Rainbows kg/ha
1979	188	28	9	1	107	24
1980	588	62	64	4	167	25
1981	653	100	44	6	138	24

In contrast, no changes were found in a section of Cochetopa Creek outside the catch and release area electroshocked in 1980 and 1981. Standard statewide (8 trout/day bag limit) regulations remain in effect on this section of stream. Despite stocking of catchable size rainbows to ameliorate some of the angling pressure on the wild browns, the brown trout population has remained very low. Harvest is the reason in our estimation. A consistent 1,000% difference in numbers and biomass between the catch and release area and the standard regulations section cannot be explained on any other basis than angler harvest. A habitat comparison would probably reveal better habitat where anglers can harvest 8 trout/day. The electroshocking results for the 1980-81 seasons in the standard regulations section are summarized in Table 17. See Table I-4 in Appendix I for details.

Table 17. Brown, brook and rainbow trout density and biomass on Cochetopa Creek, 8 trout/day bag limit.

Year	Browns n/ha	Browns kg/ha	Brooks n/ha	Brooks kg/ha	Rainbows[a] n/ha	Rainbows[a] kg/ha
1980	60	7	--	--	149	9
1981	48	10	16	2	191	22

[a]Rainbows are stocked as catchables.

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The difference in number of brown trout over 25 cm (10 in.) in length is also 800% to 1,000% between the catch and release and standard regulations section (Table 18).

Table 18. Brown trout/ha $\geq$ 25 cm in the catch and release and 8 trout/day bag areas on Cochetopa Creek.

Year	Catch and release	8 trout/day
1979	93	no data
1980	105	10
1981	316	43

The trout population in Los Pinos Creek has been largely brook trout since electroshocking surveys began in 1978. The population is quite dense and no brook trout have been taken over 30 cm during that time period. The density and biomass estimates are summarized in Table 19.

Table 19. Trout population density and biomass estimates for Los Pinos Creek (catch and release).

	Browns		Brooks	
Year	n/ha	kg/ha	n/ha	kg/ha
1978	130	20	3,098	226
1979	58	8	1,364	138
1980	66	9	1,868	181
1981	41	8	2,207	179

Brown trout density and biomass estimates for Los Pinos Creek (Table 19) are far below those for Archuleta Creek (Table 15) in all years. This is probably a reflection of the poor spawning habitat, heavy siltation, and stream bank erosion due to heavy cattle grazing on the riparian zones bordering Los Pinos Creek. Brook trout numbers are generally lower but biomass estimates are higher than for Archuleta Creek in most years again reflecting the poorer spawning habitat in Los Pinos Creek. Brook trout size in Los Pinos Creek is better, reflecting the less crowded condition.

Colorado River

Portions of the Colorado River have been electroshocked since 1979. In 1981 a catch and release regulation was instituted on a 5.6 km (3.5 mi) section of the Colorado River from the Parshall Bridge downstream through the Sunset Ranch. The bag limit was reduced to two trout and all trout between 12 in. and 20 in. must be returned to the water immediately. Table 20 contains a summary of the results of the electroshocking studies to date, by station and species. The stations are arranged from downstream to upstream. The inverse relationship between population statistics and relative fishing pressure is quite obvious. Limited access and restricted harvest areas (Con Ritschards Ranch, Skylark Ranch, Parshall-Sunset catch and release area, and Thompson Ranch) all have the higher population density and biomass estimates. Conversely, in the public access areas with liberal bag limits (State Ranch at Lone Buck and Paul Gilbert Wildlife areas and Pioneer Park in Hot Sulphur Springs), population densities and biomass estimates are much lower.

A comparison of the numbers of rainbow trout over certain sizes in the fall of 1981 is even more revealing. The details are presented in Table 21. These data are arranged from the most downstream (Con Ritschards) to the most upstream (Thompson Ranch) stations. The Williams Fork River which meets the Colorado just upstream of the Parshall-Sunset Ranch Section is the only tributary of any consequence which flows into the Colorado within the study section. Therefore with excellent numbers of rainbow trout over 30 cm (12 in.) and 40 cm (16 in.) at both the two lower stations and the uppermost station as well, we conclude that environmental variability is not an important factor in regulating the numbers of quality size rainbow between the stations.

Table 20. Colorado River trout population density and biomass estimates, 1979-1981. (station name - regulation).

Year	Rainbows n/ha	Rainbows kg/ha	Browns n/ha	Browns kg/ha
Skylark Ranch - Limited Harvest - Private				
Fall 1979	57	34	5	1
Fall 1981	162	60	13	2
Con Ritschards Ranch - Private Limited Harvest				
Fall 1979	220	138	54	15
Spring 1980	157	138	14	9
Fall 1980	208	118	32	9
Spring 1981	101	65	105	44
Fall 1981	284	105	42	15
Parshall-Sunset Ranch - Catch & Release 12 in. - 20 in. - 2 trout/day				
Fall 1979[a]	104	23	44	8
Fall 1979[a]	146	69	32	8
Fall 1981	889	231	294	82
State Ranch - Lone Buck Wildlife Area - 8 trout/day				
Fall 1979	230	148	30	15
Fall 1980	90	36	6	3
Spring 1981	92	57	12	3
Fall 1981	98	31	23	14
State Ranch - Paul Gilbert Wildlife Area - 8 trout/day				
Fall	29	4	12	1
Hot Sulphur Springs - Pioneer Park - 8 trout/day				
Fall 1981	78	9	56	10
Thompson Ranch - Private - Limited Harvest				
Fall 1980	143	101	59	28
Fall 1981	224	117	118	64

[a]Not catch and release until 1981.

Table 21. Number of rainbow trout/ha in the Colorado River in the fall of 1981.

Station	Access/ Harvest restrictions	Rainbows per size groups $\geq$ 25 cm	$\geq$ 30 cm	$\geq$ 40 cm
Con Ritschards	Private/Limited	160	129	44
Parshall-Sunset	Public & Private/ Catch & Release	516	314	86
State Ranch	Public/Standard Regulations	76	58	4
State Ranch	Public/Standard Regulations	6	4	0
Pioneer Park	Public/Standard Regulations	28	0	0
Thompson Ranch	Private/Limited	187	181	49

Fish Management personnel from the Northwest Region censused a 1.2 km (0.75 mi) section of the Colorado River from April through October of 1979. The 1979 run-off year was one of the highest in recent years which would tend to shorten the fishing season and reduce angler harvest. The censused section has not been stocked in many years. Therefore, the 1979 angler harvest is an indication of the impact on the wild trout population. Angler harvest rate or exploitation rate of the rainbow population was 60% between April and October 1979. Exploitation rate is defined as:

$$\text{Exploitation rate (\%)} = \frac{\text{Angler Harvest}}{\text{(Angler Harvest + Population Estimate)}} \times 100\%$$

Exploitation rates in excess of 35% to 40% will rapidly deplete a wild trout population. Gerald Bennett (NW Region Fisheries Biologist) indicated that by August 1979 anglers were harvesting trout in the 20-30 cm (8-12 in.) size group. Earlier in the spring the harvest was primarily 30-40 cm (12-16 in.) trout. The brown exploitation rate was 38% for the April - October 1979 period.

Three thousand angling hours were expended on this section of river from April through October 1979. We had an estimated 2,000 angling hours on the same section just during the months of May and June 1981. During 1979, angling pressure was 691 hrs/ha (280 hrs/ac). With 2,000 hrs of angling during May - June 1981, it is quite possible total angling pressure may have been up to 1,600 hrs/ha (650 hrs/ac) in 1981.

Age and growth data and life tables for rainbow and brown trout in the Colorado River are contained in Tables III-1 and III-2 in Appendix III. The life table data supports the evidence above that indicates angler harvest is having a major impact on stocks of rainbows over 30 cm (12 in.) in size.

Conejos River, Lake Fork

This stream was chemically reclaimed in 1977 and restocked with both fingerling and adult Rio Grande cutthroat trout (<u>Salmo</u> <u>clarki</u> <u>virginalis</u>) in the fall of 1977. The population has been increasing almost exponentially since 1978 and has probably about reached maximum carrying capacity. The data summarized in Table 22 is a graphic indication of the status of this population. Station 1 is the most downstream and station three the farthest upstream, just below the outlet of Big Lake. No trout were electroshocked above Big Lake in 1980 and only one was taken there in 1979. However, the numerical and distributional expansion of this population will soon insure that trout appear above Big Lake and populate the headwaters.

Trout condition factor appears to be deteriorating from overcrowding and it would be wise to (1) open the Lake Fork to limited harvest, or (2) remove some of the trout for transplant to other Rio Grande basin streams, or (3) both. Length-frequency histograms for the Lake Fork of the Conejos trout populations are found in Appendix II.

Table 22. Lake Fork of the Conejos Rio Grande cutthroat trout population density and biomass estimates 1979-1981.

Year	Station 1 n/ha	Station 1 kg/ha	Station 2 n/ha	Station 2 kg/ha	Station 3 n/ha	Station 3 kg/ha
1979	976	--	400	--	0	--
1980	14,530	146	5,038	81	688	6
1981	6,667	198	5,019	222	1,803	105

Eagle River

The Eagle River was added to this study during this segment. Preliminary electroshocking data was collected in the spring and fall of 1980 and the fall of 1981. Population estimates and biomass data collected to date are summarized in Table 23 below. For details see Table I-7 in Appendix I.

Table 23. Eagle River trout population density and biomass data, 1980-81.

Station	Date	Browns n/ha	Browns kg/ha	Rainbows n/ha	Rainbows kg/ha
Wolcott	March 1980	278	63	54	23
Wolcott	November 1980	254	64	99	26
Wolcott	September 1981	133	58	9	4
Highway 6	September 1981	11	5	6	2
Upper Catch & Release[a]	September 1981	118	45	39	12
Lower Catch & Release[a]	September 1981	129	35	116	25
Dumpsite	November 1980	75	24	66	42
Dumpsite	September 1981	0	0	3	1

[a] Stations have been under a slot size catch and release regulation during 1981-82. All trout between 10 in. and 14 in. must be returned to the water. All other stations are under standard statewide regulations.

A lengthy section of the Eagle River on the Horn Ranch was first leased by the Division of Wildlife in 1979. Population evaluations in 1978 and 1980 indicated a low trout density. While growth rates for both rainbow and brown trout are very good, spawning success and recruitment of young-of-the-year (YOY) trout is severely limited by heavy siltation of the Eagle River from Milk Creek confluence about 1.6 km (1 mi) downstream from Wolcott, Colorado. This puts the trout population in a precarious position. Relatively light angling pressure will rapidly overexploit both the rainbow and brown trout components of this population. Our electroshocking surveys in the fall of 1981 indicate severe overexploitation has already occurred outside the catch and release area. The trout population at the Dumpsite station (under statewide angling regulations in 1981-82) was virtually eliminated between November 1980 and September 1981.

Creel-size rainbow trout were inadvertently stocked in 1981 in the Eagle River between Eagle and Wolcott where our studies have been taking place. Despite this infusion of hatchery fish, exploitation rates for both rainbow and brown trout were very high during 1981. Table 24 contains a summary of the estimated exploitation rates.

Table 24. Angler exploitation rates on three sections of the Eagle River in 1981.

	Exploitation rates (%)			
	Browns		Rainbows	
Study section	1980[a]	1981	1980[a]	1981
Milk Creek/ Wolcott 8 trout/day	26	33	120	93
Catch & Release	19	27	53	62
Horn Lease 8 trout/day	39	72	217	97

[a] 1981 exploitation rate calculated using population estimate from November 1980.

The two exploitation rates for 1980 and 1981 can be explained in the following manner. The 1980 column for each species is the 1981 exploitation rate calculated using our November 1980 population estimates. When exploitation rates occur in excess of 100%, that percentage over 100% is due to the catchable rainbow stocking and harvest. The 1981 exploitation rate is based on our September 1981 population estimate (that portion of the population remaining after the 1981 angling season). These percentages clearly indicate why there are no rainbows left in the population outside the catch and release areas. When 93% to 97% of the population goes into the angler's creel between May 1st and Labor Day, it is not too difficult to understand. And in areas where the stocking could not be easily accomplished (as at the Dumpsite Station) both rainbow and brown trout were virtually eliminated in 1981. Even where it was possible to stock the river, the trout population has been greatly decimated where the bag limit is 8 trout/day.

Fish researchers in Montana feel that annual exploitation rates in excess of 35% will quite rapidly deplete a wild trout population, leaving only subcatchable size trout in the stream (Dick Vincent, personal communication). Sexually mature trout cannot be maintained in a stream trout population when total annual mortality on all age classes (angling mortality and natural mortality) exceeds 50%. Natural mortality in streams well below carrying capacity will usually be about 15-20% annually. As the carrying capacity of the stream is approached natural mortality increases, up to 50% annually in unfished populations. When exploitation rates exceed 50% (as was the case on rainbows in the catch and release area and on browns on the Horn lease in 1981) it is time for even more restrictive angling regulations. When exploitation rates exceed 90% (rainbows outside the catch and release area) it is high time for radical management procedures, probably total catch and release for at least 2 yrs.

Some investigators (Avery and Hunt 1981) have concluded angler exploitation rates in excess of 50%/yr on sexually mature brown trout were not having a negative impact on recruitment of young brown trout to the population. However, they were working with slow growing brown trout that were attaining sexual maturity at about the time and size the trout were of an acceptable size to anglers. Thus, enough sexually mature trout were escaping angler harvest to maintain a very high rate of exploitation without a drastic reduction in standing crop. However, this study (ibid.) and another (Hunt, Brynildson and McFadden 1962) both showed that exploitation rates were inversely related to adult trout stock density. More simply put, the lower the density of trout the higher the exploitation rate and the greater the danger of overharvest. This is definitely the case on the Eagle River.

Both of the creel census methods (postcard and count/interview) conducted on the Eagle River with the cooperation of Marv Smith, Bill Heicher and Dave Hoart indicated rainbows and browns between 9 in. and 15 in. (23-38 cm) comprised the vast majority of the angler harvest. It is also these stocks we are most interested in preserving. Angling pressure varied between 526 hrs/ha (213 hrs/ac) and 655 hrs/ha (265/ac) for the period May 1 through September 7, 1981. These pressure levels are similar to those on the Fryingpan in the standard regulation areas.

The life tables and age-growth data for rainbow and brown trout on the Eagle River are found in Appendix III. These data indicate both rainbow and brown trout reach about 30 cm (12 in.) by the end of the third year of life. The growth rate is considerably better than that for trout on the Fryingpan River. Browns on the Fryingpan River reach about 20 cm (8 in.) by the end of the third year of life compared to near 30 cm (12 in.) for 3-year-old browns on the Eagle.

Fryingpan River

This river (below Ruedi Dam) probably has been the most intensively studied stream in Colorado in the last decade (Finnell 1972 and 1978, Finnell and Bennett 1973 and 1974, Nehring 1979 and 1980, Nehring and Anderson 1981). It has been the subject of intensive fisheries investigations in previous decades as well (Hunter and Parsons 1943, Weberg 1954, Burkhard 1966 and 1967, and Clary 1969).

The data in Table 25 is a summarization of all electroshocking data from the two most intensively studied stations on the Fryingpan River. For details on population density and biomass at all stations, see Tables I-8, I-9, I-10 in Appendix I. Stocking of catchable size rainbow trout was terminated at both of these stations in September 1978. Stocking of all sizes of trout was eliminated to ascertain the impacts of angler harvest on wild trout populations. Now, after 4 yrs of intensive study it is vividly clear what impacts angler harvest is having on wild rainbow and brown trout populations.

Brown trout no./ha have increased or remained the same at the Ruedi Dam and Taylor Creek stations (Table 25). In contrast, rainbow numbers and biomass have fallen after 1979 in both the catch and release and 8 trout/day bag limit areas. There are two reasons for this. First, rainbow spawning and recruitment is nil in the catch and release area below Ruedi Dam. The trophy size rainbows in the catch and release area in 1979 and 1980 are now rapidly dying of old age and the population estimates for 1981 reflect this loss. The 1976 and 1977 year classes of rainbows which maintained the rainbow fishery in the catch and release area in 1979 and 1980 have mostly succumbed to old age by September of 1981. This is borne out by the life table data for Fryingpan rainbows in Appendix III. The length-frequency histograms in Appendix II also support this conclusion. The three electroshocking stations in the catch and release area do not show a pulse or peak in the rainbow histograms for any year between 1978 and 1981. In contrast, the histograms for rainbow trout at Taylor Creek 11 km (7 mi) downstream from Ruedi Dam show good to moderate pulses or peaks between 10 cm and 15 cm for 1979, 1980 and 1981. These "peaks" represent the 1978, 1979 and 1980 year classes of rainbows for the Fryingpan River. Secondly, overharvest is the reason the rainbow component of the population is falling in the 8 trout/day harvest areas of the Fryingpan River. Table 26 summarizes the rainbow creel census statistics for 1979 through 1981 for those sections of the Fryingpan River under standard regulation management.

Table 25. Fryingpan River trout biomass estimates, 1972-1981.

Month	Year	Brown		Rainbow	
		no./ha	kg/ha	no./ha	kg/ha
Ruedi Dam Station					
September	1972	161	48	368	45
October	1973	180	44	358	82
September	1977	340	60	680	220
October	1978	401	91	416	112
September	1979	466	101	220	88
September	1980	431	87	241	73
September	1981	461	70	138	15
Taylor Creek Station					
September	1972	704	172	891	181
October	1973	432	110	889	186
September	1977	320	--	320	--
October	1978	462	93	486	69
September	1979	724	75	635	61
September	1980	504	78	280	30
September	1981	591	91	349	31

Creel census statistics were modified from those shown in Appendix V, Table V-4 because of erroneous computer data expansion for Section 1 in the May 1981 census period. The expansion showed a rainbow catch for weekdays in May of over 1,800 rainbow trout, more than the total rainbow catch for 1979 and 1980. Therefore, to arrive at comparable statistics for Section 1 between years we eliminated the May creel census data for Section 1.

Table 26. Fryingpan River rainbow creel census statistics in sections with 8 trout/day regulation.

Section	Statistic	1979	1980	1981
1[a]	Total Catch	1,791	1,430	842
1[a]	Harvest	1,572	1,110	--
1[a]	CPMH	0.66	0.45	0.39
2	Total Catch	2,285	1,917	1,941
2	Harvest	1,769	1,318	--
2	CPMH	0.33	0.26	0.31
3	Total Catch	2,737	2,615	2,092
3	Harvest	2,045	1,110	--
3	CPMH	0.50	0.40	0.28

[a]Statistics are for June-September, 1979 and June-October 1980-81. Other statistics are for May-September 1979, May-October 1980-81.

The statistics in Table 26 show decreasing catch, declining harvest and falling catch rates for the past 3 yrs. Rainbow exploitation rates have been increasing over the past 3 yrs in those sections under an 8 trout/day bag limit. These figures are presented in Table 27. Avery and Hunt (1981) and Hunt, Brynildson and McFadden (1962) demonstrated that as trout populations decline exploitation rates increase, driving the trout population to lower and lower levels. Once exploitation rates exceed about 35% per annum, the quality size trout (14 in. and larger) will become increasingly scarce in the population. The length-frequency histograms for rainbow and brown trout for the Fryingpan River in Appendix II present this phenomenon in graphic form. The depletion of rainbows larger than 30 cm (12 in.) has been especially acute; however, the larger brown trout stocks are also showing the impacts of angler harvest.

Table 27. Fryingpan River rainbow trout exploitation rates in the 8 trout/day bag limit sections, 1979-1981.

	Rainbow exploitation rates (%)		
Section number	1979	1980	1981
1	38.6	20.4	69.7
2	27.5	39.2	43.2
3	32.9	65.8	72.8

The decrease in numbers of quality size trout in the population as shown by our electroshocking studies is reflected in the numbers of trout over 38 cm (15 in.) and 46 cm (18 in.) caught by anglers in the 8 trout/day area on the Fryingpan River. These statistics are summarized in Table 28.

Thus far in the discussion of the Fryingpan we have been dwelling on the severity of the overharvest in the 8 trout/day areas, the inadequate rainbow reproduction and loss of trophy size fish to old age in the catch and release areas. Should the reader infer from this that catch and release angling has been unsuccessful on the Fryingpan River? On the contrary, the results of this management technique have been spectacular. The catch of trophy size (15 in. - 18 in. and larger) trout has been four times to 12 times higher in the catch and release areas (2.2 mi of river) as in the 8 trout/day bag limit areas (12 mi of river). Hours of angling effort increased 47% in the 2.2 mi catch and release section while it only increased 7.5% in the 12 mi 8 trout/day bag area between 1979 and 1981. This is a strong indication of the demand for and appreciation of a quality stream fishing experience in Colorado. Catch and release angling allows trophy size rainbow and brown trout to be recycled many times over.

Table 28. Total catch of trophy size trout in the Fryingpan River for 1980 and 1981.

Regulation (section length)	Catch ≥ 15 in. 1980	Catch ≥ 15 in. 1981	Catch ≥ 18 in. 1980	Catch ≥ 18 in. 1981
8 trout/day (12 mi)	392	351	25	0
Catch & Release (2.2 mi)	1,279	4,064	206	673

However, if quality angling for trophy size trout is to be maintained in the Fryingpan River without stocking of catchable size trout, management must find solutions to two problems. The first problem is excessive angler harvest of stocks over 20 cm (8 in.) in size. The second is a lack of rainbow recruitment in the upper portion of the Fryingpan, primarily in the catch and release section.

The first problem, i.e., overharvest of rainbow and brown trout under an 8 trout/day bag limit can only be solved by drastic reductions in the angler harvest. Table 29 summarizes the results of our 1980 creel census on the Fryingpan River and also sets forth some statistics on what the harvest would have been with one or two trout bag limit on rainbows and browns.

It is readily apparent that the vast majority of the trout are harvested by anglers that harvest one, two or three trout. The census indicated 77% of the rainbow harvest and 82.3% of the brown harvest was taken by anglers harvesting one to three trout. Thus, a four trout bag limit would do very little to reduce angler harvest. Cutting the bag limit back to 2 rainbow and 2 brown trout per angler-day would only reduce the rainbow harvest 21% and the brown harvest by 14%. This reduction would do very little good in restoring the depleted trout populations in the Fryingpan River. Setting the bag limit at one rainbow and one brown trout per

Table 29. Creel census and harvest statistics, Fryingpan River 1980.

No. fm with no. trout kept	8 trout/day bag limit actual harvest data		4 trout/day(2 rbw & 2 brn) theoretical harvest		2 trout/day(1 rbw & 1 brn) theoretical harvest	
	rainbow harvest	brown harvest	rainbow harvest	brown harvest	rainbow harvest	brown harvest
0 - 289	0	0	0	0	0	0
49 - 1 Rainbow	49	--	49	--	49	--
29 - 1 Brown	--	29	--	29	--	29
26 - 2 Rainbow	52	--	52	--	26	--
16 - 2 Brown	--	32	--	32	--	16
14 - 3 Rainbow	42	--	28	--	14	--
3 - 3 Brown	--	9	--	6	--	3
4 - 4 Rainbow	16	--	8	--	4	--
1 - 4 Brown	--	4	--	2	--	1
3 - 5 Rainbow	15	--	6	--	3	--
1 - 5 Brown	--	5	--	2	--	1
2 - 6 Rainbow	12	--	4	--	2	--
1 - 6 Brown	--	6	--	2	--	1
0 - 7 or more	0	0	0	0	0	0
Total	186	85	147	73	98	51

angler-day would reduce the rainbow harvest by 47% and the brown harvest by 40%. This is the level of harvest reduction that will be required to restore some quality-size trout (14 in. and larger) to the Fryingpan River trout populations.

The second problem, a severe lack of rainbow recruitment in the upper Fryingpan below Ruedi Dam will be difficult to resolve. Since both brook and brown trout spawn successfully in the catch and release area we can probably conclude that substrate (spawning gravel), water volume, and velocity (providing oxygen for successful egg incubation) are not limiting factors. Brown and brook trout eggs incubate very well in water temperatures at or near 32 F. Rainbow trout eggs incubate most successfully in water temperatures between 45 F and 55 F. As the water temperatures approach the low 40's (F) embryo development becomes excessively slow and egg mortalities increase. At temperatures below 42 F egg mortality becomes excessive (McAfee 1966). Egg mortality for rainbow trout approaches 100% at water temperatures around 38 F. During May 1980 the maximum water temperature below Ruedi Dam was 40.1 F, the minimum was 35.5 F and the average was 37.9 F. The average water temperature in the Fryingpan below Ruedi Dam in April and May 1981 (rainbow spawning and incubation period) was 39.4 F and 40.5 F, respectively. Excessively cold water temperatures are probably responsible for poor rainbow recruitment in the Fryingpan River for the first 4-5 km below Ruedi Dam.

The most practical solution to the problem would seem to be the stocking of advanced fingerling (4 in. or 10 cm) rainbow in the upper portion of the river below Ruedi Dam. This approach is being evaluated at the present time. Approximately 30,000 fingerling rainbow averaging 4.5 in. (11.4 cm) were stocked in the Fryingpan in October 1981. An additional plant of that size will probably be made in the fall of 1982. Hopefully, these fish will augment the rainbow population in the Fryingpan River by 1983 or 1984. The spring 1982 population surveys indicated good survival on the rainbow fingerling plant.

The most ideal solution (from a fisheries standpoint) to the problem would be a multi-stage outlet on Ruedi Dam for better regulation of the thermal regime in the river below the dam. The problem that this bottom release has caused on the Fryingpan should be borne in mind when the Division evaluates future requests for dam construction on Colorado's trout streams. If Ruedi Dam is modified for hydro-electric power generation, the possibility of a multi-stage outlet ought to be examined.

Middle Fork of the South Platte

The Division of Wildlife purchased the Tomahawk Wildlife Area in 1978 along with a fishing rights lease on the property immediately upstream. From 1978 to 1980 fishing was restricted to artificial flies only with an 8 trout/day bag limit. Data presented in the 1980 and 1981 reports suggested that high angler exploitation was responsible for the low density of trout over 20 cm in the population. In order to protect "creel-size" trout, a slot limit went into effect January 1, 1981, for the state-owned Tomahawk area where all trout between 8 and 16 in. (20-40 cm) must be released and only two trout over 16 in. can be included in a total creel of 8 trout. The sampling stations in this area are: 1 mi below, 2 mi below, and 3 mi below the gage. The lease portion (control) was without the slot limit and the sampling stations include the Highway Bridge and Gaging Station. Artificial flies and lures only are required for both areas.

Population estimates for October 1981 are presented in Table I-11 of Appendix I. Total density for trout $\geq$ 12 cm was significantly down ($P < 0.05$) at the Highway Bridge Station (Table 30). This decline was due to a much reduced number of age 1+ trout (13-19 cm) compared to what was found in 1980. The Gaging and 1 Mile stations did not differ significantly between years. The 2 and 3 mile stations displayed significant ($P < 0.05$) increase in density in 1981 (Table 30).

Table 30. Density estimates for brown trout $\geq$ 12 cm for the Middle Fork of the South Platte, October 1979, 1980, 1981.

Year	Highway Bridge no./ha	Gaging Sta. no./ha	1 Mile no./ha	2 Mile no./ha	3 Mile no./ha
1979	1,526	950	1,436	--	--
1980	1,776	993	1,763	1,265	1,330
1981	1,310[a]	1,151	1,735[b]	1,614[ab]	1,745[ab]

[a] Significant at 5% from previous year

[b] Slot limit in effect

Biomass estimates ranged from 111 to 246 kg/ha at the Gaging Station and 3 Mile Station, respectively. Biomass estimates did not significantly differ from 1980 except at the 3 Mile Station.

Length-frequency histograms (Appendix II) show that the 1981 brown trout size structure is primarily composed of smaller fish, the same situation occurring in 1979 and 1980. There were increases in the number of trout within the slot limit size range (8-16 in.) at all electroshocking stations. The life tables (Table III-2, Appendix III) reveal much better survival for the 1976, 1977 and 1978 year classes at the stations in the catch and release area than in the 8 trout/day control stations.

The fact that the number of trout in the 8-16 in. size range increased at all stations is encouraging and coincides with a big decrease in harvest. In 1981 harvest of trout on the Tomahawk property (slot limit area) was down to 84 trout/ha and was only 106 trout/ha in the state lease area (control stations). In 1980 the harvest for both areas combined averaged 509 trout/ha. It appears that the slot limit not only reduced harvest in the study area, but also albeit indirectly the harvest in the nonslot area.

Total use in hrs/ha was nearly identical the summers of 1980 and 1981, 826 hrs/ha and 801 hrs/ha, respectively. The Tomahawk property received heavier use in 1981 (1,003 hrs/ha) than the lease area (634 hrs/ha). Catch rate was excellent though slightly less in 1981 from 1980, with rates of 2.04 and 2.48 fish/hr, respectively. In 1980, 76.4% of the trout caught were released, a high rejection rate based on the high proportion of small trout. In 1981 the throwback rate was 90.8% in the lease and 96.2% in the Tomahawk property. Creel data collected in 1981 is tabulated in Table V-8 of Appendix V. Using the amount of summer use as an indicator, the popularity of the Tomahawk area for fishing was unaffected by the implementation of the slot limit. Prior to 1981, this area was restricted to flies only and fly fishermen, who generally release more of their catch than other groups, were not put off by the regulation. Apparently, the size limit gave them an excuse to release most of their fish in the control area also.

Age and growth data is given in Table III-1 of Appendix III. Trout growth is fairly typical of streams at 9,000 ft. Young-of-the-year averaged 9.1 cm; age 1+, 15.8 cm; age 2+, 22.6 cm and age 3+, 30.9 cm at time of capture.

Creel studies have shown that overharvest generally has more severe impacts on the larger (> 30 cm) fish of a trout population. On the Middle Fork of the South Platte after 1 yr of protective regulations the age group 2 trout displayed big increases in no./ha and the older age groups responded as well. Hopefully, the 1979 year class will have good survival and carry over into 1982 and 1983. If this does not occur, it would be attributed to natural mortality which may be independent of angling mortality. The U.S.G.S. gage near Hartsel reveals that winter water levels can be very low. Flows ranged from 9 to 12 ft^3/sec from October 3, 1979 to April 18, 1980 (U.S.G.S. 1979). Flows were worst in the previous winter. From early December 1979 to early March 1980 flow ranged from 1 to 3 ft^3/sec and was below 2 ft^3/sec for a period of 35 days in January and February (U.S.G.S. 1980). Low flows necessitate good winter habitat and the lack of winter habitat can be a limiting factor for a trout population (Chapman and Bjornn 1969). Completion of the stream fencing on the Tomahawk property should help improve winter habitat by stabilizing the stream banks, increasing the number of undercut banks and reducing siltation.

South Platte River

The catch and release area in Cheesman Canyon on the South Platte River is the oldest zero bag area in Colorado (1976). The response of the trout population in this area has been dramatic, making this area a prime example of what special regulation management can achieve. Catch rates and trout sizes are outstanding even though fishing pressure has been extremely heavy. Presently there are 3 yrs of data on the South Platte. Population estimates for the spring and fall of 1981 and spring of 1982 are given in Tables I-12, I-13, and I-14 of Appendix I.

Over the 3 yrs of the study, total trout density and biomass have been exceptionally high in the catch and release area on the South Platte. Density has ranged from 1,390 to 2,380 trout/ha and biomass from 466 to 667 kg/ha (Table 31). Trout biomass of Cheesman Canyon has been well above those found in other excellent trout streams in Colorado: 300 kg/ha on the Gunnison, 313 kg/ha on the Colorado, 333 kg/ha on the Fryingpan, 100 kg/ha on the Poudre and 90 kg/ha in the Arkansas.

Rainbows have dominated the trout population in Cheesman Canyon at all sampling periods (Table 31). The average of the samples from October 1979 to March 1982 shows rainbow trout have comprised 61.5% of the population there. In March 1982, the latest sample, rainbows comprised 55.9%. In contrast, browns have dominated in the population in the standard regulation areas which include Deckers and Scraggy View, averaging 82.5% from fall 1979 to spring 1982 (6 sampling periods) and 89.4% in March 1982. The difference in species composition between the catch and release and harvest areas demonstrates the rainbow's specific vulnerability to angling exploitation. In Cheesman Canyon rainbow have been the better competitor because of minimal angling mortality. However, in the harvest area rainbow have been harvested at a faster rate, giving the advantage to browns.

From October 1979 to March 1982, Cheesman Canyon has supported a higher trout density (15% to 62%) and biomass (113% to 227%) than found in the control stations (Table 31). The rainbow component of the trout population accounts for the difference. Rainbows averaged 6.3 times more numerically and 13.7 times more in biomass in the catch and release area than the harvest stations. In contrast, the browns of the Canyon have generally been less numerous (mean = 0.76) while biomass was slightly greater (mean = 1.2 times) than of that in the control area.

Table 31. South Platte River trout density and biomass estimates.

Sampling period	Year	Upper and Lower Cheesman Canyon (C & R) no./ha	kg/ha	percent	Deckers and Scraggy View (8 trout/day) no./ha	kg/ha	percent
		Rainbow Trout					
Fall	1979	1,412	451	62.7	335	55	24.2
Spring	1980	1,512	489	65.0	140	26	12.5
Fall	1980	1,344	462	56.3	325	42	20.6
Spring	1981	1,633	586	67.8	137	20	14.4
Fall	1981	818	327	58.9	204	39	16.9
Spring	1982	958	385	55.9	75	15	10.6
		Brown Trout					
Fall	1979	839	199	37.3	1,050	144	75.8
Spring	1980	814	178	35.0	984	140	87.5
Fall	1980	1,036	205	43.7	1,256	149	79.4
Spring	1981	777	161	32.2	818	109	85.4
Fall	1981	572	139	41.1	1,006	180	83.1
Spring	1982	757	160	44.1	636	96	89.4

A consistent trend in the population data is that spring estimates for rainbow trout in Cheesman Canyon have exceeded the estimates of the previous fall (Table 31). This is probably a reflection of winter migration of rainbows into better winter habitat areas, primarily the lower canyon station. Also, in the control areas (Deckers and Scraggy View) overwinter losses have been significant for both brown and rainbow trout over the 3 yrs of the study. Low flow releases during the winter from Cheesman Dam probably results in larger overwinter mortality as distance from the dam increases.

Total density estimates in October 1981 of 793 and 843 trout/ha were 45.7% and 31.3% less in the upper and lower canyon stations, respectively, as compared to the fall of 1980. Rainbows exhibited the greatest decline. From October 1979 to October 1981 rainbows are down 46.6% while browns only 12.2% (Table 31). Attrition of older (1976 and 1977 year class) age groups along with poor recruitment rates appear responsible for the reduction in rainbow density. Year class strength has been shown to be negatively correlated with discharge during egg incubation and fry emergence periods on other streams in this study with best fry survival during years that have lower flows (Nehring and Anderson 1981). This appears to be the case with the rainbows. Trout recruitment has been less in

Cheesman Canyon than at the control stations and rainbow recruitment less than browns (Table 32). Rainbow emerge in June at times of higher flows. The high trout density of Cheesman Canyon also means that fry are subjected to high levels of predation and competition. In the control area adult trout numbers are much lower and brown recruitment has been very good there, apparently due to reduced competition.

Table 32. Number of age 1+ trout/ha (14-23 cm) in fall samples representing the previous year recruitment for rainbow and browns on the South Platte River.

Year	Discharge March (brown)	Discharge June (rainbow)	Cheesman Canyon rainbow age 1+	Cheesman Canyon browns age 1+	Control area browns age 1+
1978	29	300	106	97	380
1979	36	620	44	275	772
1980	90	1,100	18	92	436

Another consistent difference between the trout populations of the special regulation and control areas has been their respective size structure. Length-frequency histograms for fall 1981, given in Appendix II, are typical of prior years. In 1979, 54% of the rainbows and 34% of the browns in the canyon population exceeded 30 cm (12 in.) total length, compared to only 7% and 5% of the rainbow and browns, respectively, in the control stations. By March 1982 rainbows and browns over 30 cm were 84.4% and 33.9%, respectively, in Cheesman Canyon but only 25.6% and 10.2%, respectively, in the control area. Obviously, the size structure of the catch and release area could not be maintained except under a zero bag limit regulation.

Back-calculated lengths, determined by scale analysis, and life tables for rainbow and brown trout on the South Platte, are given in Tables III-1 and III-2 of Appendix III. Growth rates for South Platte trout compare favorably with other streams. In the control stations young-of-the-year brown range in size from 7 to 14 cm by October and age 1+ from 15 to 24 cm after two summers. Age 2+ browns usually range in size from 23 to 29 cm and 3+ trout usually exceed 30 cm. The fact that there are few trout $\geq$ 30 cm in the Deckers and Scraggy View stations indicates their age structure is heavily skewed toward younger fish. Harvest is primarily responsible for this. Summer mortality was determined by age groups in 1980 and 1981 for the brown populations for the control station and it was found that the older trout (age 3+ and up) have much higher mortality rates. In 1980, total summer mortality was determined to be 58% for browns in the harvest stations. A 45% summer loss was found in age group 2 trout (1977 year class), while the 3-year-olds had an 89% summer mortality (Table 33). The creel census for that period indicated a removal of 722 browns/ha in this area for an exploitation rate of 57%. Therefore, all of the summer mortality observed can be explained by harvest over the fishing season. In 1981, the summer mortality of 3-year-olds was again disproportionately higher than for the younger age groups. Creel census indicated that fishing pressure and brown catch was less in 1981 than in 1980 which was reflected in the decreased summer mortality of 62% for 3+ browns and only 8% for the 2+ group. The designation of the South Platte to Gold Medal Stream status which entails special regulations for the Deckers and Scraggy View areas should allow for improvement in age and size structures for the trout populations there.

Table 33. South Platte River brown trout summer mortality per age group (year class) per hectare in the standard regulation sections.

Sampling period	2+	3+	Total	Angler harvest/ha
	1978	1977		
Spring 1980	793	349	1,142	
Fall 1980	436	38	474	
May-Oct. 1980				722
Percent mortality	45	89	58	57
	1979	1978		
Spring 1981	499	268	767	
Fall 1981	462	103	565	
May-Oct. 1981				450
Percent mortality	8	62	26	41

Creel surveys were run from 1979 to 1981 in the standard regulation area (Deckers) and in the catch and release area. The South Platte in the Deckers area (8.1 ha) parallels the highway and was stocked at a rate of 1,000 trout/ha in all 3 yrs. In contrast, a 20-min walk is required to reach the river in Cheesman Canyon and trout have not been stocked since 1959. From 1979 to 1981 creel studies have shown that fishing opportunities were greatly improved in the Cheesman Canyon area (8.1 ha) compared to the Deckers study area. The creel census data is summarized in Tables V-9, V-10 of Appendix V.

As was the case in 1979 and 1980, fishing pressure in 1981 was greater in the Deckers area (3,348 hr/ha) than in Cheesman Canyon (2,919 hr/ha). Not only does this tremendous amount of pressure indicate that the South Platte is an extremely popular trout stream, but also illustrates that the catch and release regulation is basic to the maintenance of the high trout standing crop in Cheesman Canyon. In the catch and release area, total CPMH averaged 48% higher for the 3 yrs of the study and was 1.857 in 1981 compared to 0.714 in the Deckers study area. Rainbow CPMH averaged 2.9 times greater in the Canyon than in the standard regulation section that had the benefit of the stocking of catchable rainbows. In 1981 rainbow CPMH was 1.412 and 0.323 in the catch and release area and Deckers area, respectively. Brown CPMH was 0.445 and 0.389 for the C & R and control areas, respectively, in 1981. An even more impressive statistic is that the CPMH for trophy-sized trout (over 38 cm) averaged 28 times more in the catch and release than in the control area.

The resident brown population in the control area appears to be afforded some protection from angling by the catchable stocking program. An independent and supplemental creel study was made in 1980 to determine the return rate to the creel for a plant of catchable rainbows. Seventy-five percent of the catchables were harvested within 5 days of the plant. Over this 5-day period, rainbow CPMH jumped from 0.165 to 0.715 and brown CPMH dropped from 0.265 to 0.156 (Table 34). The rainbow CPMH doubled while the brown CPMH fell by half the 1980 season average. Within this 5-day period, rainbow comprised 80% of the harvest compared to only 42% for the entire season. It appears that the catchables at least partially buffer the resident trout population from an even greater angler exploitation if stocking did not take place.

The percentage of fishermen who favored the catch and release regulation in Cheesman Canyon were 73.0% and 69.2% in 1980 and 1981, respectively (Table V-12, Appendix V).

Overharvest is clearly a problem on the Deckers Area of the South Platte and the need for protective regulations is obvious if this stream segment is to achieve the intent of a Gold Medal Stream. Examples from the Arkansas and Cache la Poudre rivers illustrate that a 2 or 1 trout bag limit would reduce angling mortality by less than 50%. A 50% reduction in harvest would still result in an overexploited trout population on the South Platte. In 1980 fishermen caught 13,905 browns from the

Deckers area, which equates to 140% of the brown population (Table 35). Fifty-eight percent of the browns caught were throwbacks, reflecting that most of these fish were undersized, and the total harvest was 722 trout/ha for a 60% exploitation of the spring brown density (Tables 33 and 35). If harvest were cut in half to 361 trout/ha or a 30% rate, this would still be enough to harvest most of the 3-year-old trout (433/ha, 1980; 389/ha, 1981, see Life Table III-2, Appendix III). Also rainbow harvest at Deckers was 980/ha, most of which were hatchery plants. A cutback in rainbow plants would result in more pressure on the wild brown population assuming that angling pressure remained constant.

Table 34. South Platte River CPMH following a plant of catchable rainbow compared to previous and seasonal catch rates at Deckers, Colorado, July 15-19, 1980.

Period	CPMH rainbow	CPMH brown	CPMH total
July 14, 1980	0.165	0.265	0.430
July 15-19, 1980	0.705	0.156	0.861
May - Oct., 1980	0.265	0.360	0.625

Table 35. South Platte River brown and rainbow trout harvest and exploitation rates, Deckers, Colorado, May - October 1980.

Species	Total catch	Catch per ha	Spring density	% pop. caught	% kept	Creel harvest
Brown	13,905	1,717	1,198	1.4	0.421	722
Rainbow	10,237	1,264	166 (1,000)[a]	1.1	0.775	980

[a] 1,000 rainbow/ha stocked in the 1980 season.

Species-specific regulations could eliminate many of the inadequacies of a blanket trout regulation. Species management allows for the option of more liberal harvest on one species while protecting another. Table 36 shows how harvest would be reduced in a situation where the bag limit was restricted to two rainbow and two browns and for one trout of each species.

In this format it is possible to estimate harvest reduction in a species management system. A bag limit of two or one brown trout only reduces harvest by 17.8% and 47.5%, respectively, and by only 7.6% and 36.8% for rainbows. Because the amount of fishing pressure is so great on the South Platte, it would probably take a zero bag limit or minimum size limit to give the trout population enough protection for it to achieve Gold Metal objectives. When a limited amount of harvest is desirable in a population, then a reduced bag in conjunction with a size limit, i.e., minimum, maximum or slot limit, is the best approach in an area of heavy fishing pressure.

Table 36. Creel census and theoretical harvest statistics for the South Platte River, Deckers area, May - October 1980.

	8 trout/day bag limit		4 trout/day (2 rbw & 2 brn)		2 trout/day (1 rbw & 1 brn)	
No. fm with no. trout kept	rainbow harvest	brown harvest	rainbow harvest	brown harvest	rainbow harvest	brown harvest
50 - 0	0	0	0	0	0	0
40 - 1 Rainbow	40	--	40	--	40	--
27 - 1 Brown	--	27	--	27	--	27
26 - 2 Rainbow	52	--	52	--	26	--
15 - 2 Brown	--	30	--	30	--	15
7 - 3 Rainbow	21	--	14	--	7	--
6 - 3 Brown	--	18	--	12	--	6
1 - 4 Rainbow	4	--	2	--	1	--
1 - 4 Brown	--	4	--	2	--	1
3 - 5 Brown	--	15	--	10	--	3
1 - 7 Brown	--	7	--	2	--	1
Total	117	101	108	83	74	53
% reduction in harvest			7.6%	17.8%	36.8%	47.5%

St. Vrain River

Of the four trout sampling stations established in 1980 (pre-catch and release regulation), only two (Meadow Park and Gaging Station) were usable for comparison in the fall of 1981. The trout population at the Martin Marietta Station (lower control) was greatly reduced due to a fish kill earlier in the summer. The Ideal Concrete Station, which had the largest trout density in 1980, had stream improvements constructed earlier in the summer. Apparently, the dredging and equipment operations displaced most fish from the area, since very few were collected there in the fall. The electrofishing results for the two remaining stations are given in Table I-15 of Appendix I.

Density and biomass for trout larger than 15 cm was down 32% and 19%, respectively, at the Meadow Park Station and down 60% and 39%, respectively, at the Lyons Gaging Station from estimates made in 1980. The 1981 population had much fewer trout in the 14 to 21 cm size range than was found in 1980. This size range represents the 1980 year class which was poor due to heavy spring run-off of that year. Life Tables (see Table III-2 of Appendix III) show that the number of 2-year-old trout were very similar in the 1980 and 1981 population samples.

Length frequency histograms for brown trout are given in Appendix II. Size distribution did not improve at the Lyon's Gaging Station which is located within the catch and release area. The largest trout taken was 31 cm, the only trout over 12 in. in the station.

Back-calculated lengths for brown trout are given in Table III-1 of Appendix III and indicate no change in growth rate from last year. No age 3+ trout were found in either the Meadow Park or Lyons Gaging Station; the same was true in 1980. A prerequisite for special regulations to be effective is that the habitat of the stream must be of suitable quality so that the stream can raise quality size trout. The failure of older trout to accumulate in the St. Vrain population reflects the poor quality of the habitat. Hopefully, the stream improvement projects planned for this river will produce the desired results.

Animas River

This river was electroshocked during December 1981 - January 1982 using the boat and mobile electrode technique. This effort was accomplished at the request of Mike Japhet, Wildlife Biologist in Durango, with the approval of the Regional Fisheries Biologist, Lloyd Hazzard. This type of cooperative effort is provided for under Segment Objective 5 of Job 3.

Two sections of the Animas River were electroshocked. The upper section began at the DOW rearing unit in Durango and ended near the Highway 160 Bridge (to Cortez) about 1.2 mi (2 km) downstream. The lower section, 2.4 mi long, ran from a point immediately behind a local business on Highway 160 called Pueblo Paving, to an area along the river known as Purple Cliffs.

The total trout biomass on a unit area basis was 2.2 times as high in the Purple Cliffs section as it was in the town of Durango, 51.6 kg/ha and 23.4 kg/ha, respectively. Numerical density was 122/ha and 93/ha at Purple Cliffs and in Durango, respectively. Similar numerical densities between the stations but a much higher biomass at the Purple Cliffs Station tends to indicate fishing pressure has reduced the population through the town of Durango. Creel census studies were carried out by the DOW (Smith 1976) in 1975 and 1976 between the New Mexico state line and Bakers Bridge upstream from Durango, a 40 mi (64.5 km) section of the Animas River. These studies indicated 83% and 93% of the angling pressure in 1975 and 1976 occurred on the 6-mile (9.7 km) section of the Animas River between the 32nd Street Bridge at the north end of Durango and the Purple Cliffs, just south of Durango. Furthermore, Smith's studies (ibid.) indicated that if the angling pressure on this section of the Animas River is again divided into two sections, the vast majority of the angling pressure is expended between the Highway 160 Bridge to Durango upstream to the 32nd Street Bridge and much less angling pressure exists from the Highway 160 Bridge downstream to Purple Cliffs. During 1975 fishing pressure was 50% higher on the Highway 160 - 32nd Street section than on the Purple Cliffs - Highway 160 section. In 1976 fishing pressure was 330% higher on the Highway 160 - 32nd Street section. This probably explains why the trout population density and biomass is lower in the section of river through Durango as shown in our population estimates this past winter (1981-82).

Stocking records and creel census data compiled over the past 30 yrs indicates a very strong correlation between brown trout stocked as fingerlings and the percentage of brown trout composition in the catch. This relationship is demonstrated in Table 37.

There is always a year or two lag between the time the fingerlings are planted and when they begin to show up in the catch. After several years of stocking between 1964 and 1969, the creel checks in 1970 indicated browns made up 41% of the harvest. Again, in 1980 and 1981 an intensive creel census indicated browns made up 37% and 30% of the angler catch, respectively. Conversely, between 1970 and 1976 when browns were not regularly stocked (only once in 1971) the percentage of browns in the harvest ranged between 3% and 10%. Furthermore, the average size decreased throughout that period. This information indicates quite strongly that very little brown trout reproduction occurs in the Animas River.

Our electroshocking surveys of the Animas River in 1981-82 revealed no evidence of natural reproduction by brown trout. The smallest browns collected were 15 cm (6 in.) in length. Scale age and growth analysis indicated a false annulus (planting check) that back-calculated to around 7-10 cm (3-4 in.) on all scales samples. This same false annulus was visible on scale samples of 2- and 3-year-old brown trout as well. This corresponds well with the size of brown trout stocked in the Animas River since 1977. DOW electroshocking surveys in the Animas River in December 1975 turned up no brown trout less than 28 cm (11 in.) between Purple Cliffs and the State Line. Only four brown trout less than 25 cm (10 in.) were collected farther upstream during that survey (Smith 1976). Many

Table 37. Relationship between fingerling brown trout stocked and percent brown trout composition in the catch in the Animas River.

Year	Brown stocked	Percent brown in catch	Average size (in.)
1958	51,040	3	14.0
1959	--	0	--
1960	--	2	12.0
1961	20,000	0	--
1962	27,000	4	13.0
1963	--	18	12.0
1964	20,000	12	16.5
1965	100,000	8	17.0
1966	30,000	NC[a]	--
1967	25,000	NC	--
1968	40,000	NC	--
1969	28,000	NC	--
1970	--	41.0	10.0
1971	13,320	9.0	16.0
1972	--	NC	--
1973	--	9.0	16.0
1974	--	10.0	14.0
1975	--	3.0	13.0
1976	--	3.0	12.0
1977	10,000	NC	--
1978	16,200	NC	--
1979	20,400	NC	--
1980	20,200	37.0	14.0
1981	21,750	30.0	--

[a] NC - No fishermen contacts

brown trout collected on that survey were between 43 cm (17 in.) and 53 cm (21 in.) with the largest specimen being 78 cm (31 in.) long. Most of the brown trout electroshocked that were over 43 cm in 1975 probably came from the 1971 stocking. Age and growth analysis of scale samples collected in December 1981 - January 1982 indicate that the 1977 and 1978 brown year classes were over 43 cm when sampled in January 1982. This is approximately the same time span between the 1971 plant and the December 1975 electroshocking studies.

The growth rates of these brown trout in the Animas River are the fastest we have documented in a stream environment in Colorado. Table 38 contains the average sizes of brown trout from the Animas River for the year classes 1977-1981.

Table 38. Average length of brown trout by year class from the Animas River, January 1982.

Year class	Age	N	$\overline{X}$ (cm)
1981	0+	5	17.2
1980	1+	40	33.6
1979	2+	40	44.4
1978	3+	3	48.0
1977	4+	2	54.5

Rainbow and Snake River strain cutthroat trout are also found in the Animas River as a result of stocking. The cutthroat are stocked as fingerlings and rainbows as catchables. However, the rainbows are virtually all harvested by anglers the same year they are stocked (Smith 1976) and most of the cutthroats appear to be harvested as soon as they reach an acceptable size for fishermen, probably about 9-10 in. (23-25 cm). Of 122 cutthroat collected during the electroshocking only three were 30 cm (12 in.) or larger.

Detailed population information on the Animas River can be found in Table I-17 in Appendix I. The detailed age and growth information with back-calculated lengths can be found in Appendix III.

When one realizes that the growth of rainbow, brown and cutthroat trout in the Animas River is excellent the question arises, "Why is there apparently no natural reproduction in the Animas River?" The most plausible explanation lies in the severe chronic heavy metal pollution found in the Animas River basin above and below the town of Silverton, Colorado. Heavy metal concentrations are so high in the Animas River at Silverton that the river is almost devoid of trout except for a few hardy brook trout, the salmonid species most resistant to heavy metal toxicity (Nehring and Goettl 1974). The Animas River is known to be polluted with zinc, lead, copper, silver and cadmium at Silverton, Colorado (Goettl and Davies 1975). It is quite likely that an intensive sampling and analysis of the Animas River, using the "state-of-the-art" analytical techniques would reveal heavy metal pollution (possibly silver) as the factor limiting salmonid reproduction (John Goettl and Patrick Davies, personal communication). Silver is extremely toxic to rainbow trout, especially in the embryonic developmental states, causing premature hatching of the eggs (Goettl, Sinley and Davies 1973). Analyzed levels of silver in the Animas River at Silverton are not far below those levels known to be toxic to rainbow trout.

The rapid growth, good survival and large size of brown trout in the Animas River makes it the best stream fishery for trophy size brown trout known in Colorado at the present time. The 1980 creel census revealed an average CPMH of 0.71 and 28% of the brown trout population over 20 cm (8 in.) is over 40.6 cm (16 in.) putting the Animas River well within the criteria prescribed for Gold Medal waters. However, the fact that the trout are all stocked detracts from the idea of a Gold Medal water. Also, severe organic pollution occurs from ineffective sewage treatment and this also detracts from the Gold Medal connotation. The decision as to whether or not the Animas River deserves a Gold Medal designation should be made by administrative personnel. However, it is clear that once the Animas River receives notoriety as a trophy brown trout fishery it will not be long until overharvest becomes a chronic problem and some sort of protective regulation will be required to maintain a trophy brown trout population.

Gunnison River

Three sections of the Gunnison River were electroshocked using the boat shocking method during August - September 1981. This was accomplished under Segment Objective 5 of Job 3, which provides for cooperative work with the regional fisheries staff. Helicopter time, supplied by the S.W. Region, was required to lift our boat and shocking equipment into and out of the Black Canyon of the Gunnison at the upper station.

Population estimates were completed for a 2-mi (3.2 km) section of the Gunnison Gorge between the Duncan and Ute trails and a 4-mi (6.5 km) section between the Smith Fork and North Fork confluences with the Gunnison River. One electroshocking pass was made on the Gunnison from the North Fork confluence to the Austin Bridge to obtain an approximation of species composition and diversity as well as document the presence or absence of trout down to the Austin Bridge. This latter section was a 9.3 mi (15 km) reach of the river.

Colorado-Ute Electric Association acquired the services of R.W. Beck and Associates to complete a terrestrial and aquatic faunal inventory of the Gunnison River in an area to be impacted by the proposed Tri-County Reservoir and Hydroelectric Project. Mr. George Kidd, fisheries consultant, Grand Junction, Colorado, was hired as a subcontractor to complete the aquatic faunal survey, which was completed in August 1981. Four stations (each consisting of a pool and riffle) were surveyed and only the upper two stations supported trout according to the data summary provided by Colorado-Ute Electric Association. Station 1 (just downstream from the proposed damsite) and Station 2 (approximately 3 mi downstream from the North Fork confluence) purportedly contained no trout. A small number of rainbow and brown trout were collected at Stations 3 and 4. Station 3 was located just downstream from the North Fork confluence and Station 4 was about 1.5 mi upstream from the North Fork confluence on the mainstem of the Gunnison. These trout ranged from 95 to 335 mm total length.

Fishermen consistently report catching rainbow and brown trout in excess of 45 cm total length between the North Fork confluence and the Austin Bridge on the Gunnison River. The boat electroshocking method (with a mobile-throw electrode) was used on our survey. Using U.S.G.S. topographic maps we kept track of all species of fish collected by section, range and township as we worked downstream. Thirteen sections in two ranges and two townships were traversed during the sampling. Rainbow and/or brown trout were collected in all thirteen sections. Trout comprised 21.9% of the total sample. The species composition is probably biased towards suckers and sucker hybrids as they respond more positively to DC voltage (used in electroshocking) than rainbow and brown trout. Sampling of the smaller species (sculpins, dace, minnows and roundtail chubs) was probably negatively biased when compared to real species composition because of smaller body size.

Summer water temperatures in the Gunnison River during 1981 were unusually warm due to near minimum releases from Crystal Reservoir. Water temperatures exceeded 20 C below the North Fork during the months of July and August 1981 much of the time. Nonetheless, rainbow and brown trout over 45 cm were in robust condition below the proposed Tri-County Damsite. Growth of stocked fingerling rainbow trout below the North Fork averaged about 1 in. (2.5 cm) a month during the summer of 1981 attesting to the excellent food resources and growth potential in this section of the Gunnison River. However, very little evidence of brown or rainbow trout reproduction was seen in the Gunnison River below the North Fork confluence. The electroshocking data summary for this section of the Gunnison River is presented in Appendix I, Table I-18.

Population estimates of trout were completed on the North Fork to Smith Fork section and the Duncan to Ute trail section of the Gunnison River. Population estimates and confidence intervals for rainbow and brown trout 6 in. (15 cm) and over, 12 in. (30 cm) and over, and 16 in. (40 cm) and over were completed. This data is presented in Table I-19 of Appendix I. The Duncan to Ute section was 2 mi long and the Smith Fork to North Fork sections was 4-mi long. Despite the disparity in section length, the Duncan to Ute trail section supported many more trout in most categories as shown in Table 39. The only reason rainbows over 6 in. were higher in the Smith Fork/North Fork section was that 50,000 4-in. fingerling were stocked at the North Fork in April 1981 and these trout averaged almost 8 in. and were very abundant in the first mile of river above the North Fork confluence in August 1981. Above this point brown trout were the predominant trout species as was the case in the Duncan/Ute trail section.

Table 39. Gunnison River trout population estimates, August - September 1981.

Species	Size category (in.)	Smith Fork/ North Fork	Duncan/ Ute
Browns	$\geq$ 6	2,297	8,659
Browns	$\geq$ 12	323	1,903
Browns	$\geq$ 16	87	54
Rainbows	$\geq$ 6	7,082	3,388
Rainbows	$\geq$ 12	489	1,415
Rainbows	$\geq$ 16	235	678

Creel census information (Wiltzius 1977) indicates fishing pressure on the North Fork/Smith Fork section of the river was about double that in the section from the Chukar to the Ute trail (includes Duncan/Ute section). Angling pressure was 106 hrs/ac on the Smith Fork/North Fork section and 54 hrs/ac on the Chukar/Ute trail section in 1977. By combining the population estimates from 1981 and Wiltzius' creel census data from 1977, we were able to make some "educated guesses" as to the probable exploitation rates on rainbows and browns in the Smith Fork/North Fork and Duncan/Ute sections of the Gunnison River for 1977 and 1981. Exploitation rates were previously defined in the section on the Colorado River. These estimates are presented in Table 40.

Table 40. Projected rainbow and brown trout exploitation or harvest rates for two sections of the Gunnison River.

Year	Species	Duncan/Ute	Smith/North Fork
1977	Rainbow	24.1%	30.9%
1977	Brown	10.5%	17.3%
1981	Rainbow	33.4%	43.8%
1981	Brown	15.8%	26.2%

Once again these data show the rainbow as the most vulnerable to angler harvest as was the case on the Fryingpan, South Platte and Eagle rivers. Examination of the histograms in Appendix II for the Gunnison River reveals the great majority of rainbow and brown trout in the Smith Fork/North Fork section are less than 30 cm (12 in. total length). In contrast, in the Duncan/Ute trail section where access is more difficult and angler pressure is less we find more trout over 30 cm and 40 cm total length. We feel this information clearly demonstrates the need for protective restrictive regulations implemented by the Wildlife Commission on the Gunnison Gorge in October 1981.

Growth rates determined by age-scale analysis and back-calculated lengths reveal that rainbows in the Gunnison River average 40.8 cm in their fourth summer of life and 44.6 cm in their fifth summer. Details on age and growth for rainbow and brown trout from the Black Canyon of the Gunnison can be found in Table III-1 in Appendix III.

Life table information on rainbow and brown trout from the Black Canyon of the Gunnison (Table III-2, Appendix III) reveal four times as many rainbows and ten times as many browns from the 1978 year class (fourth summer trout in 1981) were found in the Duncan/Ute trail section as in the Smith Fork/North Fork section on a unit area basis. This data further supports our contention that the heavier angling pressure is having severe impacts on this Gold Medal wild trout fishery. Protective angling regulations will definitely be required to maintain trophy size trout in this fishery.

Rio Grande River

The Rio Grande River was electroshocked at the request of regional staff and accomplished under Segment Objective 5, Job 3. The boat shocking method was used on two sections of the Rio Grande River. A 2.1 mi section of the Rio Grande known as the Coller fly and lure water was electrofished four times to acquire population estimates and a 6.8 mi section from State Bridge (approximately 10 mi east of South Fork) to Del Norte, Colorado, and was also sampled four times.

Total biomass for brown trout in each section was similar, 42.9 kg/ha (38.3 lb/ac) and 39.3 kg/ha (35.1 lb/ac) for the Coller and State Bridge sections, respectively. Brown trout were more numerous in the Coller section, 223/ha (90.1/ac) as compared to the State Bridge section, where the brown density was 97/ha (39.4/ac).

Growth rates differed slightly between the sections. Second summer brown trout (1+) on the Coller section averaged 15 cm (6 in.) as compared to 19 cm (7.5 in.) on the State Bridge area. Third summer browns (2+) averaged 24 cm (9.5 in.) on the Coller and 28 cm (11 in.) on the State Bridge section. This difference in growth rate is probably due to warmer water temperatures throughout the summer growth period on the State Bridge section as it is about 24 km (15 mi) downstream from the Coller study area.

Despite the differences in growth related to water temperature, we would not anticipate the tremendous difference in numbers of large brown trout between the two areas. The largest brown we sampled on the Coller section was 39 cm (15.3 in.) out of more than 900 browns collected. On the State Bridge study section of more than 1,100 browns sampled, 136 brown trout were over 40 cm (16 in.). Our estimate of brown trout 40 cm and larger was 425 for the State Bridge section and zero for the Coller study section.

Fishing pressure is the only logical explanation for the differences in the number of large brown trout between the two areas. Our observation of fishing pressure in the two study areas would seem to bear this out. Each section was electroshocked four times between July 13 and August 14, 1981. We observed upwards of 30 anglers on the Coller section (2 mi) during each electroshocking pass. We did not observe a single angler on the 6.8 mi State Bridge section on any of the four electroshocking runs. DWM Dave Kenvin verifies the vast differences in angler use patterns between the two areas.

Fish biologists have suspected for a long time that the fastest-growing, most-aggressive trout are the most vulnerable to angler harvest. However, very few studies have been done on the long term impacts and implications of this phenomenon on wild trout populations and trout growth rates. Our age and growth data (using back-calculated lengths) indicates not only do we have more larger and older trout in the State Bridge section, but also the average size of brown trout for a given year class is increasingly greater with increasing age in the State Bridge section as compared with the Coller section. The data presented in Table 41 illustrates this.

Although the difference in average size for the 1980 and 1979 year class is only about 3 cm (1.4 in.) or less, as the trout get progressively older the average size disparity increases between the two areas. The difference is 7.5 cm (3 in.) for the 1978 year class, 16.6 cm (6.5 in.) for the 1977 year class, and 9 cm (3.5 in.) for the 1976 year class. We believe this quite clearly demonstrates that anglers in the more heavily used Coller section are cropping off the fastest-growing, more-aggressive brown trout first and we are left with the slower-growing, less-aggressive brown trout in the population. While some studies have implied that this sort of unnatural selection process can have long-term detrimental impacts on the genetics of the wild trout population as a whole (Favro, Kuo and MacDonald 1979), another expert (Robert Behnke, personal communication) seriously questions the assumptions and methodologies used in that study. Behnke also disagrees with the results of that study, indicating that other factors (besides angler harvest) were probably responsible for decrease in growth rate of same age fish over time. Studies done on cutthroat trout in Yellowstone National Park on the Yellowstone River indicate that depressed growth rates and average size of trout will again increase if a trout population is given adequate protection from overharvest by anglers. It is our contention that all of this information overwhelmingly supports the immediate need for restrictive harvest regulations on many of our "gold medal" trout waters in Colorado. It is not possible to manage for trout from 4 to 6 yrs in age under either the present 8 trout/day harvest regulation, or a single limited kill regulation. Management needs several options to optimize the production of trophy-size trout under varying species composition, levels of angling pressure and environmental limitations.

Table 41. Average size (cm) of year classes of brown trout from two sections of the Rio Grande River, 1981.

Year class	Age	Coller N	Coller $\bar{X}$ (cm)	State Bridge N	State Bridge $\bar{X}$ (cm)
1980	1+	27	15.7	37	18.3
1979	2+	23	22.0	34	25.6
1978	3+	21	26.6	48	34.1
1977	4+	35	28.2	9	44.8
1976	5+	4	35.8	18	44.8
1975	6+	0	--	5	49.6

Length-frequency histograms for the brown trout populations in the Coller and State Bridge sections of the Rio Grande are found in Appendix II. Specific information on popultion densities, species and confidence intervals are found in Table I-20, Appendix I. Back-calculated length and life tables data are found in Tables III-1 and III-2 of Appendix III.

Determination of Need for an Expected Response to Special Regulations Management

Several physical, environmental, biological, social and cultural parameters must be evaluated to determine the need for special regulations management. These same parameters will also dictate or control to a large degree the response of a stream trout population to special regulations management. Some of the most obvious (but certainly not all inclusive) parameters that must be considered for their possible impacts are as follows:

(1) Reproductive potential of the species and stream in question

(2) Stream hydrographic patterns and habitat suitability

(3) Stream elevation

(4) Daily and seasonal water temperature patterns

(5) Species composition and vulnerability

(6) Fishing pressure and harvest

Each of these six parameters will be briefly discussed and at least one example of a Colorado stream given where the parameter in question is deemed to be a limiting factor.

When the reproductive potential of the species and/or stream in question is believed to be one of the primary factors limiting the population, special restrictive harvest regulations can be effectively used to maintain greater numbers of mature trout in the population. Rainbow and brown trout reproduction is seriously limited on the Eagle River below Wolcott, Colorado, because of heavy silt-loads which smother the eggs. Rainbow reproduction in the first 3 miles of the Fryingpan River below Ruedi Dam is virtually nonexistent almost certainly due to the extremely cold (less than 42 F) water release from Ruedi Reservoir. Severe fluctuations in release patterns from Cheesman Reservoir into the South Platte River during brown and rainbow spawning and incubation periods appear to adversely affect rainbow and brown recruitment. Catch-and-release regulations have been successfully used on all three of these streams to maintain higher standing stocks of brown and rainbow trout and ameliorate the impacts of the problems with limited or nonexistent reproductive potential.

Severe fluctuations in stream hydrographic patterns during the critical spawning, incubation, hatching and fry life stages of trout can all but wipe out a single year class of trout. If such a catastrophe occurs several years in a row a species may be virtually eliminated from the stream. These problems, whether natural (in the case of heavy snow packs or drought years) or man-made (in the case of streams below irrigation and hydro-electric dams) can again be ameliorated with special restrictive harvest regulations which will maintain sexually mature stocks in the population over a period of several years and hopefully result in successful reproduction of the species. Instances where stream hydrographic patterns have had severe impacts on reproductive success include the South Fork of the Rio Grande, Taylor, South Platte and Colorado rivers. Restrictive harvest regulations have helped control these problems on the South Platte and Colorado rivers.

Stream elevation greatly controls the daily and seasonal temperature regime of a stream. Unless a stream has a thermal regime of the proper range and duration, the growth rate and/or survival of trout in the stream will be poor. Streams between 6,000 ft and 8,000 ft elevation will generally respond the best to special regulations management on salmonids in Colorado. Streams much in excess of 9,000 ft elevation will probably respond poorly to special regulations management as the water temperature is too cold and the growing season too short to produce trophy size trout in large numbers. Except in areas immediately below coldwater release reservoirs, trout will usually not survive well much below 6,000 ft elevation in Colorado. High summertime water temperatures will severely restrict growth and survival of trout. At elevations below 5,000 ft even coldwater releases from reservoirs will have very little positive impact on the thermal regime of a stream in Colorado. Summertime water temperatures will just be too high.

Species composition and species vulnerability to angling pressure create great difficulties for fish biologists from a management standpoint. This is especially true where two or more salmonid species exist sympatrically in a stream. The order of angling vulnerability (from most vulnerable to least vulnerable) among the four most common stream salmonids in Colorado is cutthroat, rainbow, brook and brown trout. Sympatric rainbow and brown populations are the most common combination confronting fisheries managers of the stream environment in Colorado. Our studies have shown rainbow and brown trout populations have been decimated by overharvest in stream situations. Rainbows managed with restrictive regulations have responded very positively in the South Platte, Roaring Fork, Fryingpan and Colorado rivers. Brown trout managed under restricted harvest or access limitations have responded positively on the South Platte, Fryingpan, Roaring Fork and Rio Grande rivers as well as on Cochetopa Creek. However, for most effective management of stream populations where two or more salmonids exist sympatrically, biologists need the option of species management or species bag limits. Without that option our management flexibility and effectiveness will be greatly restricted.

Fishing pressure and harvest is probably thought to be the easiest parameter to assess. However, it is probably the most costly and most labor intensive aspect of fisheries management. It definitely requires the most time to complete. Formerly, biologists were so convinced that wild brown trout could not be hurt by overharvest the premise became almost an axiom of fisheries management. However, our studies over the past 3 to 4 yrs definitely indicate this is not the case. Our studies reveal that fishing pressure levels as low as 100 hrs/ac/season has resulted in overexploitation of brown trout stocks on rivers as large as the Arkansas, Rio Grande and the Gunnison in Black Canyon. Rainbows, more vulnerable to angling than browns, have been even more heavily exploited; in many cases wild rainbow stocks have been decimated. The South Platte, Fryingpan, Eagle and Roaring Fork rivers are prime examples of streams where wild rainbow populations cannot thrive under standard statewide angling regulations. Smaller streams, those that average less than 20 to 30 ft in width, are especially vulnerable to overexploitation by angling pressure probably at levels considerably below 100 hrs/ac/season. When seasonal angling pressure estimates exceed more than 200 to 300 hrs/ac on even the largest of streams it can be assumed that overexploitation of stream trout populations is almost axiomatic without restrictive angling regulations. Unrestricted angling (8 trout/day bag limits) at these levels will reduce trout stocks in excess of 30 cm (12 in.) total length to almost nothing in 3-yrs time and even severely reduce numbers of trout 25 cm (10 in.) and larger. Furthermore, our studies have shown that setting the bag limit at two trout (without species bag limits) will do nothing to reduce harvest from current levels.

Guidelines for Evaluation of Special Regulation Stream Fisheries

We have been evaluating stream trout populations managed with special regulations for almost 4 yrs now. Initially our procedure was to conduct a population estimation, collect scale samples for age and growth analysis, and in a few instances carry out a creel census. In the last 2 yrs, our analysis and manipulation of the data has become more intense as we saw the need to answer more and more questions that were arising as the result of the dynamic interactions between the trout population, the fishing public, and the regulations impacting both fish and fishermen. It is becoming increasingly clear that management of wild trout populations to produce a trophy trout or "gold medal" trout population cannot be accomplished with a once-through electroshocking survey and subsequent application of a "special regulation." Effective management of stream trout populations for production of larger older trout will require long-term (3-5 yrs) intensive studies to determine the impacts of the regulation on the trout population and the angling public. Without this sort of time and manpower commitment on the part of field personnel and administrators alike, trophy trout management or "gold medal" management as it is to be called in Colorado, will be a dismal failure.

However, we feel the demand for trophy trout angling is increasing and the time and manpower commitments should be made to implement "gold medal" management in Colorado. In the following paragraphs, we will attempt to set forth guidelines necessary for the effective evaluation and implementation of special regulation stream fisheries. The list below is a compilation of the types of data and analysis techniques we feel are necessary components for an effective evaluation of a stream fishery under special regulations management.

(1) Population Estimations
(2) Biomass Estimates
(3) Age and Growth Analysis (from scale reading)
(4) Life Tables and Mortality Estimates
(5) Creel Census
(6) Determination of Exploitation Rates (from 1, 4 and 5)

The population estimation, conducted at least once each year, is the backbone of the evaluation process. The data (density and biomass) from this step forms the basis for every other step in the analysis process. Thus far, we have used three different estimation procedures that employ three different field approaches. The method used depends primarily upon stream size, crew size, and crew (and equipment) efficiency.

The procedure most commonly used is the Peterson Mark and Recapture method. We use this on streams from about 20 ft up to 100 ft in width where a crew of six to ten or more people is available and we are quite certain the efficiency of the crew will result in the capture of 15% to 50% or more of the trout population in one pass through the stream.

We use the two-catch method, described by Seber and LeCren (1967), on small streams under 20 ft average width, and in special instances on streams up to 60 to 80 ft in width, where we are virtually certain (as known from past experience) of capturing at least 70% or more of the entire trout population in one pass through the stream. This is a great method from an efficiency standpoint as only one equipment set-up is required, the fish are not marked or shocked more than once, and the estimates are very precise with very narrow 95% confidence intervals. Ninety-five percent confidence intervals generally average between 1% and 10% of the mean estimate. However, if shocking efficiency drops much below 70% then the confidence intervals become exceedingly poor in an almost exponential manner and the estimation also becomes less precise. A shocking efficiency of 50% in essence results in an infinite population estimate and infinite confidence intervals. Fish captured in the first pass are held in a holding pen until after the second pass has been completed.

The third method we use has been referred to as the Schnabel, Running Peterson, or Multiple Mark and Recapture Method. This method requires two, three, four, or more passes through a section of stream and is usually carried out on a section of stream from 2 to 6 mi long over a period from 1 to 4 weeks. It is used on large rivers, generally more than 100 ft average width and too fast and deep for effective shocking by the walk shocking method. Shocking efficiency with this method usually ranges from 5% or less to a maximum of about 15% for a single pass.

Boat shocking equipment is a necessity with this method. We find the mobile-electrode method as pioneered by Dick Vincent in Montana and previously described by Nehring and Anderson (1981) as most effective. This method has been successfully used on the Colorado, Arkansas, Gunnison, Rio Grande and Animas rivers in Colorado. Ninety-five percent confidence intervals after two or three marking runs and a final recapture run have ranged between 10 and 20% of the mean estimates. If different marks are used on each marking run it is possible to begin the population estimation procedure on the second run. With four passes (3 marking runs and a final recapture) three individual Peterson estimates are derived plus a final Schnabel estimate. These four estimates give a check on the precision of the estimates.

We feel quite strongly that proper formating and collection of data in the field will greatly facilitate data tabulation and analysis back in the office. Number "crunching" in the office is a long, arduous, dreary process. With proper data formating in the field we feel the time spent on this task can be reduced by as much as 50% or more. We use a commercially available data pad made by Ampad, Stock Number 636-P which has 10 vertical columns and 50 horizontal lines numbered from 1 to 50. The numbers from 1 to 50 correspond to total fish lengths in centimeters. A vertical mark or "hash" mark is made in the appropriate cm category for each fish. When recorded in this manner, group totals of fish can be quickly made as well as rapid biomass calculations. Using programs we have written for commercially available programmable pocket calculators such as Hewlett Packard's HP-33E, HP-34C, or HP-67, we can complete a day's population and biomass estimates in a matter of minutes. This same data sheet is also used in the data reduction process for constructing life tables. Examples of how the data is formated for population estimations, biomass calculations, and life table construction are presented in Appendix IV.

Biomass estimation can be done in several ways. The most tedious time-consuming method is to weigh each and every fish. In most cases, on our first trip to the study area we collected empirical length-weight data on a minimum of five trout (by species) per cm group. From that data, length-weight regressions were determined for each species on each stream and/or study area. These regressions have been used in subsequent years for biomass determination without collecting additional weight (by cm group) data. We acknowledge that the length-weight regression can vary somewhat with changes in population density between years, temperature regime variation between years, alterations in the food supply, habitat alterations and the like. But we contend that for a given stream and trout species the length-weight regression does not change enough between years, despite the potential variations already alluded to, to warrant determination of new length-weight regressions each year. The biomass calculation is much more accurate than the population estimate which can be ±20% of the mean or more at the 95% confidence level. Thus, if the population estimate is only accurate to ±20% or worse, we see little reason to expend the additional time for a biomass determination that is accurate to ±1% each year. Changes in the age and growth relationship between years (induced by one or more of the variables alluded to above) can be readily determined from population age structure and length-frequency distributions over time and sampling periods. An example of our biomass calculation process can be seen in Appendix IV and is also described mathematically by Nehring (1980).

Age and growth analysis is completed by reading scales and drawing the annuli on paper through the use of a micro-projector. Back-calculated lengths at each annulus allow us to classify the length-frequency data into age classes and then subsequently into year classes. We collect five scale samples for each centimeter group (by species) up to a size of 40 cm total length. We take scale samples on all trout over 40 cm as the tendency towards more regenerated unreadable scales tends to increase with the age and size of the fish.

Life tables and mortality estimates are prepared using the data from the age and growth analysis together with the population estimation. The length-frequency distribution for the entire population is broken down by age class and year class by the percentages of each age class at each centimeter group in this length-frequency distribution. Percentages for each year class (or age class) are then totaled and multiplied by the total population estimate (in no./ha/species) to break the year classes out on a no./ha basis. This procedure allows us to easily compare on a unit-area basis both within and between species, years, study sections and rivers. An example of the life table construction process is given in Appendix IV.

Creel census is a very important part of the evaluation process. Information gleaned on size and species composition in the harvest can be put together with population estimation data to determine what portions of the population, by species and/or age group, are being most subjected to angling pressure. Our evaluations have shown the voluntary creel census, using mail-back postcard questionnaires, to be a viable alternative method to the count-interview system described by Neuhold and Lu (1957). The reliability, comparability, and precision of the postcard method has been checked in eight different sections of three streams over the past 3 yrs and found to be quite reliable. For further details the reader is referred to Nehring (1980), Nehring and Anderson (1981), and the sections of this report dealing with the Fryingpan, Arkansas and South Platte rivers.

The postcard method involves the distribution of postcards to vehicles or fishermen, plus the counting of those vehicles and/or fishermen at periodic times and days throughout the census period. The postcard return provides all the information normally acquired from the personal interview without going through the interview process. Return rates on cards have generally been between 30% and 40%.

Determination of exploitation rates is one of the most important parts in the analysis process and it cannot be accomplished without population estimations and creel census as a minimum data base. Life tables are also helpful. Exploitation rate has already been defined in this report. For continuity of thought it is redefined here:

$$\text{Exploitation rate (\%)} = \frac{\text{Angler Harvest}}{(\text{Angler Harvest} + \text{Population Estimate})} \times 100\%$$

This statistic can be used to determine the rate of angler harvest on the total population or on the most vulnerable size groups of trout in the population. Single season angler exploitation rates in excess of 35% will usually result in depletion of trophy-size trout stocks in a stream population in a short period of time. When total annual mortality (natural plus angling) exceeds 50% trophy-size trout stocks will be rapdily depleted. During 1982 we had several streams in Colorado where the exploitation rate was 75% to 90% and higher!

These pieces of information (population and biomass estimates, age and growth analysis, life tables and mortality estimates, creel census, and exploitation rates) are like pieces of a puzzle or a mosaic. Individually, a single piece of information doesn't tell much about what's happening with the trout population and the angling public. When viewed over time (3 or more years) trends will become very clear that may dictate the need for radical management procedures.

A case in point. Successive population estimates over 2 yrs may show a large decline the second year. It could be due to large overwinter losses, followed by poor recruitment in the last year, all a part of the normal cycle of things. A creel census may show a decline in catch rate over two successive summers. Again overwinter loss (normal) of older larger trout stocks could be the culprit. Scale analysis and mortality tables indicate a 90% loss in a single age class between one season and the next. Again, natural mortality may be the cause. However, when all of these same individual observations are put together on a single population or stream and the trends are maintained over a 2 - 3-yr period despite probable changes for the better in natural environmental variables, fishing pressure may be suspected as the culprit. Some experimentation with regulation changes (to restrict angler harvest and impacts) will usually quickly determine (2-3 yrs) if angling pressure was the operative mechanism. The six pieces of information listed in the preceding paragraph may seem like a very costly, labor-intensive process.

In actuality the only field work required is the population estimation and a creel census (assuming scale samples were collected during one or both procedures). All of the rest of the analysis can be completed in the office without the use of awesome computer programs or computer analysis techniques.

RECOMMENDATIONS AND CONCLUSIONS

Fish Populations

Arkansas River

Results after 1 yr of catch and release fishing (minimum size of 16 in.) on the Loma Linda and Salida stations are encouraging, but not definitive. Total trout density was higher at Loma Linda while harvest was significantly less than 1980. At the same time trout numbers were slightly less at the control station (Coaldale) where harvest was still high. The role that the regulation played in the population changes of these two areas is unclear, but should be better understood after trout scales are read and life tables have been constructed. Total number of trout over 31 cm was fairly similar at the Loma Linda and Coaldale stations in both 1981 and 1982. This indicates that total mortality for trout of this size range was similar even though angling mortality was greater at the Coaldale station in 1981. The big difference in density for the Loma Linda and Coaldale stations was in the number of trout from 20-30 cm (121 trout/ha), which are primarily age 2 trout. This was unexpected since the Loma Linda and Coaldale stations appeared to have equal numbers of age 1 trout in March 1981. Two-year-olds made up about 35% of the 1981 creel harvest which equates to a removal of about 35-55 trout/ha. Some other unknown source of mortality may have been operating on the 1979 year class at Coaldale, but the most likely explanation for the disparity in numbers of age 2 trout between these two areas is that age 1 trout were underestimated at Loma Linda in 1981.

It was also hoped that the number of trout larger than 16 in. would be noticeably improved in 1982. This did not occur. The 16-in. minimum size limit does not protect trout of this size. In the future it may be decided that it is more desirable to give total protection to the larger trout over 12 in. and allow harvest to be absorbed by smaller trout. However, no recommendations for regulation changes are given at this time.

The recommendation was given last year to try to increase trout production by introducing a wild strain of rainbow that would hopefully utilize unoccupied trout habitat. This has been incorporated into the research project and will be pursued through 1985.

Cache la Poudre

Undoubtedly the Cache la Poudre is one of the most popular trout streams in Colorado, and this is in spite of the fact that it does not have notoriety as a quality fishery. Very high harvest rates have been found in the "upper" Poudre, the vicinity of Rustic, Colorado (exploitation rate of 46% in 1971, and 52% in 1972 in the wild trout section and 56% and 57% in the campground in 1972 [Marshall 1973]). Slow-growing trout in the Poudre, due to low temperatures is a factor; Klein (1974) found only three of 16 paired samplings had a significantly lower spring estimate than was found the previous fall. The greatest fall and spring reduction was 53% in the 1973-74 winter, but harvest seems to be a primary reason for the poor size structure of the Poudre. Only 5% and 4% of the trout sampled were over 12 in. in 1980 and 1981, respectively. Obviously, a 12-in. or larger trout is a rare and precious individual that should be protected from the creel so that other anglers can have the opportunity to catch such a fish. Regulations that protect larger trout include zero bag, maximum size and slot limits. A total catch and release would be desirable from a research standpoint because it will give us the opportunity to determine natural mortality without having to isolate angling mortality (a costly process requiring a creel census). Another possibility for the upper wild trout water would be a 10-in. maximum size limit with a 2-trout bag limit. Since winter mortality is fairly random, larger trout may stand a better chance of overwintering if there is some harvest on smaller trout.

The same rationale applies to the lower wild trout water. There, only 0.2% of the trout handled were over 12 in. in 1981. There was no difference between the density or size structure of the lower wild trout water and its control. Harvest is apparently at such a high magnitude that the only trout extant there are those that are too small for most fishermen to keep. Because of the 2,000 ft lower elevation, which may lessen winter mortality and its closeness to front range metropolitan area, we feel a total catch and release regulation is required in order to improve the population of this area.

Evaluation of the Poudre will continue through 1984 and instream flow (IFG4) evaluations will be incorporated into the study.

Cochetopa, Archuleta and Los Pinos Creeks

Cochetopa and Los Pinos creeks are both candidates for easy overexploitation under a 8 trout/day harvest limit. Easy access and limited reproductive success due to habitat problems induced by cattle grazing are two reasons why these streams should remain under catch and release management. Archuleta Creek has good brown and brook trout reproduction and could support substantial harvest pressure; however, the stream is less than 1-km long on the Coleman Wildlife Easement Area below Dome Lakes. Therefore, from a regulation simplification standpoint, Archuleta Creek on the Coleman Easement should remain under catch and release management.

The response of the Cochetopa Creek brown trout population to catch and release management has been phenomenal. Brown trout density increased 347% and brown biomass increased 357% between the fall of 1979 (the first year of catch and release management) and the fall of 1981. The number of brown trout over 25 cm in length has increased 340% between 1979 and 1981 as well. Brown trout over 25 cm have been 800% and 1,000% more numerous under catch and release management as under the 8 trout/day bag limit on another section of Cochetopa Creek.

We recommend Cochetopa, Archuleta and Los Pinos creeks be officially dropped as study streams during the 1981-82 segment. We recommend regional biologists continue to monitor Cochetopa Creek for 1 or 2 more years to determine how long the brown population will continue to expand in numbers, biomass and trout growth rate before it finally tops out or stabilizes.

Colorado River

When first electroshocked in the fall of 1979 our results seemed to indicate that rainbow trout stocks were in excellent shape in the public sections of the Colorado River as well as in the private sections with reduced angling pressure and limited access. However, the 1979 run-off year was a near record year with the 1978-79 snow pack being 200 to 300% of normal in many areas of Colorado. This heavy run-off seriously limited fishing pressure and harvest levels in 1979. The 1980 run-off year was above normal but not the near record run-off of 1979, and the 1981 run-off year was far below normal, thereby extending the length of the angling season and giving fishermen a much greater chance to harvest larger trout. Fall 1981 electroshocking results revealed virtually all rainbow over 30 cm (12 in.) in length had been removed from the public access - standard regulations sections of the Colorado River. In contrast, where restrictive angling regulations and limited angler access was in effect, excellent numbers of rainbow and brown trout 30 to 40 cm and larger in size remained in the population.

A section of the Colorado River from Windy Gap Dam (under construction) to the confluence with Troublesome Creek has been designated as one of Colorado's Gold Medal trout streams. Maintenance of trophy-size rainbow and brown trout stocks in this section of the Colorado River will require a restricted bag limit, preferably not more than two trout, one brown, and one rainbow each. Evaluation of this section of the Colorado River should remain a part of this research project for a number of years for an effective evaluation of any new regulations that go into effect in 1983.

Conejos River, Lake Fork

The Lake Fork of the Conejos River population of Rio Grande cutthroat trout has been expanding in a near exponential fashion since chemical reclamation and restocking in the fall of 1977. This population is firmly established with standing crop estimates over 200 kg/ha in some sections. All sections of the Lake Fork between Rock and Big Lakes support a standing crop in excess of 105 kg/ha (93 lb/ac).

The body condition of the cutthroat trout is deteriorating due to overcrowding and we feel it would be wise to (1) open the stream to limited harvest, or (2) remove some of the juvenile cutthroat for transplants to other Rio Grande Basin streams, or (3) both. This stream is heavily overpopulated at the present time. We recommend the Lake Fork of the Conejos River be dropped as a study stream during the 1981-82 segment.

Eagle River

Notoriety of the Eagle River has increased through the mass media as well as word of mouth over the past 2 yrs. Fishing pressure has increased dramatically in the past 2 yrs as the angling public became more aware that a 7-mi section of the Eagle River was open to public fishing through a lease agreement with the owners of the Horn Ranch, between Eagle and Wolcott, Colorado. Biologists have known for several years that although the growth rate of rainbow and brown trout in the Eagle River is very good the population has always been in a precarious position because of very poor reproductive success. Two silt-laden streams empty into the Eagle River just west of Wolcott bringing in tremendous silt loads during the spring runoff period and in the fall low-flow period when fall rains begin. These surges in the silt load come during the rainbow and brown trout spawning and incubation periods. The end result is very limited recruitment of young trout to the population. Thus, when angler pressure levels reached 200-265 hrs/ac in 1981 between May 1st and Labor Day, the result was a decimated trout population, a 97% exploitation of rainbow trout stocks. Biomass estimates outside the catch and release area plunged from 42 kg/ha in November 1980 to 1 kg/ha in September 1981! Even in the catch and release section (all fish between 10.0 in. and 14.0 in. must be returned to the water) stocks were reduced due to excessive harvest on trout under 10 in. and over 14 in. total length. A recommendation of a limit of one trout (in the aggregate of eight) over 14 in. total length was not accepted in 1980.

The Eagle River trout fishery is severely decimated at present between Eagle and Wolcott and should be put under total catch and release with a flies and lures only terminal tackle restriction for at least 2 yrs, probably 4 or 5. Past experience (on Cochetopa Creek and the South Platte River) has shown that it will require 3 to 5 yrs for an overexploited trout population to recover fully.

Fryingpan River

The upper 3 to 7 mi of the Fryingpan River (downstream from Ruedi Dam) suffers from a lack of rainbow trout reproduction apparently due to water temperatures below 42 F and often lower than 38 F. Water temperature at these levels results in massive losses of incubating rainbow trout eggs due to thermal shock. Fall spawning brown and brook trout reproduce very successfully in this portion of the Fryingpan River. Low temperature thermal shock is not a problem with these species. Rainbow trout stocks have fallen drastically in that portion of the Fryingpan River under an 8 trout/day bag limit. Overharvest of rainbows larger than 20-25 cm in size has been the culprit. Even numbers of brown trout in excess of 30 cm (12 in.) have begun to decline under the 8 trout/day bag limit in the past 2 yrs.

Management of the Fryingpan River below Ruedi Dam as either a wild trout fishery or a Gold Medal trout water cannot be accomplished under the present 8 trout/day bag limit. Our creel surveys and population studies over the past three summers (1979-1981) indicate that the bag limit must be reduced to one rainbow and one brown trout in that portion of the Fryingpan River from the catch and release area down to the town of Basalt if the Fryingpan River is to be managed as a Gold Medal trout water. Any harvest limit higher than this will not restore the numbers of trout over 14 in. in sufficient numbers to meet the criteria for a Gold Medal water.

Stocking of fingerling rainbow trout (4 in.) has begun in that portion of the Fryingpan presently under catch and release management. Our spring 1982 electroshocking results reveal that rainbow trout are once again the dominant species (numerically) in the upper catch and release area for the first time since September 1978. Rainbows that were stocked at an average size of 10 cm in October 1981 averaged 15-16 cm in April 1982 with the largest of the plant ranging up to 20 cm (8 in.) in size. These stocked fingerling rainbow made up 50 and 86% of the rainbow component of the population at the upper two electroshocking stations. We recommend this stocking program continue on an annual basis to maintain the rainbow component of the population in the catch and release section of the Fryingpan River.

Middle Fork of the South Platte

Results have shown that the Middle Fork of the South Platte is very productive small trout stream. Two factors have been identified that may be a problem for survival of larger trout, overharvest and low-winter flows. The Tomahawk would be a fairly easy stream to overexploit, mainly because it is easy to fish. The channel is narrow, there are no obstructions from vegetation, and the gradient is low. It would take only 250 fishermen, each taking four larger trout, to eliminate the population over 12 in. Also the current slot limit will have been in effect for 2 yrs by September 1982, the next sampling period. We feel that this is too short a time to evaluate this stream. By 1984 we will have a good data on natural mortality and will be able to recommend optimal harvest levels. We will do this by following the survival of the 1979 year class. Life tables show that survival drops off quickly for trout between 2 and 3 yrs of age. If this is primarily due to harvest, survival for this year class should be improved. We also intend to do spring electrofishing in April 1983, and possibly 1984 to determine the winter loss for older age groups.

Low flows during winter are a potential hazard because there is little or no winter habitat for large trout. These fish would have to emigrate to find better holes. The best way to improve winter habitat is by stream fencing. We also plan to include the Tomahawk area in our instream flow requirements study which will begin in 1983. By taking stream cross sections and discharge measurements we will be able to precisely determine the amount of winter habitat available at various flows.

Because of the above considerations, we recommend the current regulations remain in effect through 1984.

South Platte River

Cheesman Canyon, on the South Platte River, is Colorado's best example of what catch and release fishing can do for a trout population. Rainbow density, biomass, average size and fishermen success has been far superior there than in the standard regulation area. Cheesman Canyon is also a good indicator of the popularity of special regulations management. Use in the canyon was just slightly less then around Deckers which is a very popular area for fishermen, tourists and weekend outdoor parties. With the advent of Gold Medal Stream designation, it is apparent that the zero bag limit should remain in effect for Cheesman Canyon and be implemented on the other segments of the South Platte that will come under this title.

The underlying reason for this recommendation has to do with the enormous amount of fishing pressure observed in this area over the last 3 yrs. In 1980, with 4,000 hr/ha of pressure, 140% of the brown population were caught by anglers in the Deckers area with 57% of the catch throwbacks. The browns found in the population in the fall were either undersized or had evaded the hook and line. A 1 trout/day bag limit which may allow for about a 50% reduction in harvest, may not be enough to protect the larger trout from overexploitation. Also, the termination of stocking "catchable" rainbow will result in additional angling pressure on the wild trout. "Catchables" made up about 60%, 40% and 45% of the total catch in 1979, 1980 and 1981, respectively. The hatchery trout are much easier to catch than wild fish and actually help insulate the wild population from harvest. It is likely that without stocking a 1 trout/day bag limit would reduce harvest by much less than 50%. Pressure would probably have to drop to the 1,000-2,000 hr/ha range before a limited harvest would be advisable if the South Platte were to produce a Gold Medal fishery.

St. Vrain River

No change was found in the St. Vrain brown trout population after 1 yr of catch and release fishing. Size and age structure were still very poor in 1981 at the gaging station. The impacts that the stream improvement structures have on the trout will be determined in fall sampling of 1982 and 1983.

Natural reproduction was very good in the St. Vrain in 1981, but habitat deficiencies are restricting the production of large trout. The St. Vrain will be included in the discharge evaluation study that will begin in 1983. The trout population will continue to be monitored for at least 2 more years.

Animas River

Electroshocking surveys of the Animas River through and downstream of the town of Durango in December 1981 and January 1982 revealed a moderate population of trout. Brown trout were the dominant species in both areas studied. Snake River cutthroat trout were found in moderate numbers followed by a few rainbows and an odd brook trout or two. Age and growth analysis (back-calculated lengths) indicated all four species of salmonids found were from hatchery stock. No evidence was found that would suggest brown trout were reproducing in the Animas River. Stocking records and catch composition of the angler harvest over the past 20 yrs strongly suggests that brown trout thrives in the Animas River only as a result of annual fingerling brown plants. Growth of brown trout in the Animas River is by far the best observed in Colorado streams. Third summer browns average 17.5 in., fourth summer browns average 19 in. and fifth summer browns average 21.5 in. in length.

Gunnison River

Population estimations were completed on two sections of the Gunnison River at the lower end of the Black Canyon of the Gunnison, upstream from the confluence with the North Fork of the Gunnison. These estimates indicated angler harvest has made heavy inroads on the rainbow and brown trout populations on the Smith Fork to North Fork section of the Gunnison. Angler access is easy in this section, especially during low-flow periods as was the case during all of 1981. Angler access is much more difficult on the Duncan to Ute Trail section of the Gunnison River and both brown and rainbow trout population estimates reflected this. Numerical density of brown and rainbow trout 40 cm (16 in.) and larger was much higher in this section as compared to the Smith Fork/North Fork section.

A single-pass electroshocking survey from the North Fork confluence downstream 9.3 mi to the Austin Bridge revealed the presence of rainbow and brown trout throughout the reach with some rainbow and brown trout from 16 to 19 in. in length taken below the proposed Tri-County damsite.

Growth rates of rainbow and brown trout in the Black Canyon of the Gunnison River are almost as good as the growth of the brown trout in the Animas River. Both rainbow and brown trout reproduce in the Black Canyon of the Gunnison. This river has been added to this research project as a study stream for the 1982-83 segment.

Rio Grande River

Electroshocking surveys of two sections of the Rio Grande River revealed that angling pressure is making serious inroads on the brown trout population. The population estimate on the Coller fly and lure section revealed a population devoid of brown trout 40 cm (16 in.) in length. In contrast, on the section of the Rio Grande between State Bridge and Del Norte we estimated a population of 425 browns 40 cm and larger. Angler access is severely restricted (private property) on this section of the river and angler pressure is very light. Growth rates of brown trout in the State Bridge section were somewhat better than on the Coller section; however, the major difference was in the number of 5-, 6- and 7-year-old brown trout. The State Bridge section harbored many brown trout from 5 to 7 yrs in age. The Coller section had few trout in the fifth and sixth years of life and none in the seventh year. A 2 brown trout bag limit has been recommended for the Coller section of the Rio Grande with a maximum permitted size limit of 14 in. The Rio Grande has been added to this research project beginning in the 1982-83 segment.

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APPENDIX I

Trout population density and biomass estimates from study streams.

Table I-1. Arkansas River standing crop and biomass estimates, March 1981.

Study section location	Study section size length (km)	width (m)	area (ha)	Species	Population statistics $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Tezak[a]	4.34	36.6	15.9	Brown				
				<20 cm	3,859	±2,773	242.7	9.0
				≥20 cm	4,645	± 836	292.0	66.3
Loma Linda	4.34	36.6	15.9	Brown				
				<20 cm	2,032	±1,175	128.0	4.6
				≥20 cm	3,805	± 721	239.0	53.5
Coaldale	4.18	36.6	15.3	Brown				
				<20 cm	1,955	±1,870	128.0	5.2
				≥20 cm	4,191	± 709	274.0	54.8
Salida	4.02	36.6	14.7	Brown				
				<20 cm	246	± 171	17.0	0.8
				≥20 cm	5,552	± 898	378.0	84.7

[a]December 1980

Table I-2. Arkansas River standing crop and biomass estimates, March 1982.

Study section location	Study section size: length (km)	width (m)	area (ha)	Species	Population statistics: $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Tezak	4.34	36.6	15.9	Brown				
				<20 cm	4,461	±1,176	281	13.4
				≥20 cm	5,698	± 761	358	96.8
				Snake R.	39	± 28		
Loma Linda	4.34	36.6	15.9	Brown				
				<20 cm	6,590	±2,791	414	18.4
				≥20 cm	5,745	±1,075	361	93.0
				Snake R.	29	± 21		
Coaldale	4.18	36.6	15.3	Brown				
				<20 cm	3,803	± 862	249	11.6
				≥20 cm	3,736	± 759	244	69.7
				Snake R.	11	± 8		
Salida	4.02	36.6	14.7	Brown				
				<20 cm	3,190	±1,326	217	8.5
				≥20 cm	5,164	± 818	351	98.1
				Snake R.	3	± 2		
				Rainbow	18	± 13		

Table I-3. Cache la Poudre River standing crop and biomass estimates, October 1981.

Study section location	Study section size length (m)	width (m)	area (ha)	Species	Population statistics $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Big Bend Campground	243.8	18.3	0.446	Brown	158	± 50	354	60.2
				Rainbow	38	± 18	85	13.0
				Total Trout	198	± 52	444	73.2
Wild Trout Water 5 mi above Rustic	274.3	18.3	0.502	Brown	224	± 53	442	71.0
				Rainbow	237	± 35	467	62.5
				Total Trout	452	± 58	892	133.5
Lower Control 2 mi above Rustic	304.8	18.3	0.558	Brown	197	± 59	353	56.2
				Rainbow	287	± 85	514	68.6
				Total Trout	486	±103	870	124.8
Indian Meadow 1 mi above Rustic	243.8	18.3	0.446	Brown	72	± 22	161	25.2
				Rainbow	244	± 57	502	58.3
				Total Trout	313	± 58	702	83.5
Kelly Flat Campground	243.8	18.3	0.446	Brown	137	± 34	307	37.1
				Rainbow	214	± 43	480	39.8
				Total Trout	351	± 55	787	76.9
Lower Wild Trout control above Greeley Diversion	243.8	19.8	0.483	Brown	264	± 78	547	61.3
				Rainbow	33	± 24	68	6.7
				Total Trout	300	± 83	621	68.0
Lower Wild Trout water below Greeley	243.8	19.8	0.483	Brown	377	± 98	780	78.4
				Rainbow	51	± 33	106	10.4
				Total Trout	439	±108	909	88.3

Table I-4. Cochetopa, Archuleta, and Los Pinos creeks population and standing crop estimates, August 1981.

Study section description	Study section size length (m)	width (m)	area (ha)	Species	Population statistics $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Cochetopa Creek (Catch & Release Area)	335	6.7	0.224	Brown	147	± 16	653	100
				Rainbow	31	± 5	138	24
				Brook	10	± 1	44	6
				Cutthroat	1	--	4	1
				Total Trout	188	± 15	836	131
				WWS[a]	63	± 46	280	--
				LNS[b]	4	--	18	--
				Total Sucker	73	± 60	324	--
Cochetopa Creek (Standard Regulations Area)	213	8.8	0.187	Brown	9	± 1	48	10
				Rainbow	36	± 8	191	22
				Brook	3	--	16	2
				Total Trout	47	± 6	250	34
				WWS	64	±425	340	--
				LNS	69	± 20	367	--
				Total Sucker	96	± 35	511	--
Los Pinos Creek (Catch & Release Area)	305	4.0	0.121	Brown	5	± 4	41	8
				Brook	267	± 33	2207	179
				Total Trout	271	± 33	2240	187
Archuleta Creek (Catch & Release Area)	305	5.5	0.168	Brown	65	± 40	387	40
				Brook	649	± 68	3863	141
				Rainbow	1	--	6	1
				Cutthroat	1	--	6	1
				Total Trout	712	± 73	4238	183
				WWS	110	± 25	655	--
				LNS	1	--	6	--

[a] Western white sucker

[b] Longnose sucker

Table I-5. Colorado River population and standing crop estimates, October 1981.

Study section description	Study section size: length (m)	width (m)	area (ha)	species	Population statistics: $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Con Ritschards Ranch (Catch & Release Area)	183	26.0	0.476	Brown	20	± 1	42	15
				Rainbow	135	± 3	284	105
				Total Trout	155	± 4	326	120
State Ranch - Lone Buck Wildlife Area (Standard Regulations Area)	183	28.0	0.512	Brown	12	± 1	23	14
				Rainbow	50	± 1	98	31
				Total Trout	62	± 1	121	45
Thompson Ranch (Catch & Release Area)	183	19.5	0.357	Brown	42	± 6	118	64
				Rainbow	80	± 11	224	117
				Total Trout	121	± 12	339	181
Parshall (Catch & Release Area)	3220	36.0	11.6	Brown	3,415	±1335	294	82
				Rainbow	10,300	±1635	889	231
				Total Trout			1183	313

Table I-6. Colorado River catch and release area population estimates, October 1981.

Estimate	6 inches and up N	6 inches and up 95% C.I.	12 inches and up N	12 inches and up 95% C.I.	16 inches and up N	16 inches and up 95% C.I.
			Browns			
First	2,462	± 1,478	714	± 675	5	± 6
Second	3,415	± 1,335	914	± 466	95	±176
Schnabel[a]	2,331 ≤ 3,126	≤ 4,746	614 ≤ 915	≤1,793	83	--
			Rainbows			
First	9,200	± 1,990	1,853	± 556	508	±294
Second	10,326	± 1,635	2,379	± 442	543	±196
Schnabel[a]	8,725 ≤ 9,916	≤11,484	1,891 ≤2,223	≤2,696	403 ≤545	≤842

[a]Schnabel Population Estimate w/95% C.I. - P (-95% C.I. ≤ N ≤ + 95% C.I.)

Table I-7. Eagle River population and standing crop estimates, September 1981.

Study section description	Study section size: length (m)	width (m)	area (ha)	Species	Population statistics: $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Wolcott Station (Standard Regulations above Milk Creek)	213	31.4	0.669	Rainbow	6	--	9	4
				Brown	89	± 79	133	58
				Total Trout	109	± 98	163	62
Below Highway 6 Bridge (Standard Regulations)	183	19.8	0.362	Rainbow	2[a]	--	6	1.7
				Brown	4[a]	--	11	4.9
				Total Trout	6[a]	--	17	6.6
Pullout Station (Upper end of Catch & Release Area)	244	19.8	0.483	Rainbow	19	--	39	12
				Brown	57	± 40	118	45
				Total Trout	81	± 58	168	57
Irrigation Diversion Station (Catch & Release Area)	305	19.8	0.604	Rainbow	70	± 92	116	25
				Brown	78	± 81	129	35
				Total Trout	179	±166	296	60
Dumpsite - Lower Control (Standard Regulations)	183	19.8	0.362	Rainbow	1[a]	--	3	1
				Brown	--	--	--	--
				Total Trout	1[a]	--	3	1

[a]Fish in one electroshocking pass - not enough for a real estimate.

Table I-8. Fryingpan River population and standing crop estimates, April 1981.

Study section description	Study section size: length (m)	width (m)	area (ha)	Population statistics: Species	$\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Station 1 at Ruedi Dam Gage (Catch & Release)	152	15.2	0.231	Brown	160	± 54	693	211
				Brook	100	± 35	433	65
				Rainbow	72	± 61	312	181
				Cutthroat	1	--	4	1
				Total Trout	326	± 78	1411	458
Station 2 - below Gaging Station (Catch & Release)	305	15.2	0.464	Brown	162	± 49	349	79
				Brook	170	± 47	366	55
				Rainbow	121	± 27	261	114
				Cutthroat	2	--	4	1
				Total Trout	448	± 68	966	249
Station 3 - Old Faithful, lower end (Catch & Release)	320	18.9	0.605	Brown	417	±102	689	107
				Brook	41	± 19	41	5
				Rainbow	124	± 34	205	72
				Cutthroat	2	--	3	1
				Total Trout	573	±100	947	185
Station 4 - Upper Control (upper terminus - Standard Regulations)	366	18.6	0.681	Brown	159	± 53	233	32
				Brook	15	± 17	22	3
				Rainbow	51	± 52	75	16
				Cutthroat	1	--	1	Trace
				Total Trout	234	± 78	344	51
Station 5 - Taylor Creek (Standard Regulations)	305	15.2	0.464	Brown	404	±115	871	138
				Rainbow	205	±107	442	46
				Total Trout	601	±150	1295	184
Station 6 - Big Pullout (Standard Regulations)	213	15.2	0.324	Brown	37	± 23	114	27
				Rainbow	98	± 65	302	62
				Total Trout	136	± 66	420	89

Table I-9. Fryingpan River population and standing crop estimates, September 1981.

Study section description	Study section size: length (m)	width (m)	area (ha)	Species	Population statistics: $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Station 1 - at Ruedi Dam Gage (Catch & Release)	152	15.2	0.231	Brown	167	± 91	723	218
				Brook	83	± 66	359	45
				Rainbow	39	± 28	168	85
				Total Trout	333	±144	1442	348
Station 2 - below Gaging Station (Catch & Release)	305	15.2	0.464	Brown	214	± 95	461	70
				Brook	138	± 48	297	32
				Rainbow	64	± 24	138	15
				Cutthroat	1	--	2	Trace
				Total Trout	396	± 90	853	117
Station 3 - Old Faith (Catch & Release)	320	18.9	0.605	Brown	528	±184	873	147
				Brook	45	± 32	74	11
				Rainbow	56	± 20	93	26
				Cutthroat	8	± 14	13	3
				Total Trout	588	±151	972	187
Station 4 - Upper Control, upper terminus (Standard Regulations)	366	18.6	0.681	Brown	292	±173	429	59
				Brook	24	± 44	35	4
				Rainbow	44	± 82	65	9
				Total Trout	427	±258	627	72
Station 5 - Taylor Creek (Standard Regulations)	305	15.2	0.464	Brown	274	±115	591	91
				Rainbow	162	±216	349	31
				Total Trout	408	±172	879	122
Station 6 - Big Pullout (Standard Regulations)	213	15.2	0.324	Shocked once but not enough fish for an estimate - floods and siltation have severely reduced populations.				

Table I-10. Fryingpan River population and standing crop estimates, April 1982.

Study section description	Study section size length (m)	width (m)	area (ha)	Species	Population statistics $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Station 1 at Rudei Dam Gage (Catch & Release)	152	15.2	0.231	Brown	165	± 68	714	165.5
				Brook	87	± 72	377	44.7
				Rainbow[a]	29	± 21	125	--
				Rainbow[b]	248	± 99	1074	--
				Rainbow[c]	290	±106	1255	168.6
				Cutthroat	3	--	13	2.0
				Total	556	±147	2407	380.8
Station 2 - below Gaging Station (Catch & Release)	305	15.2	0.464	Brown	237	± 73	511	83.0
				Brook	224	± 88	483	85.5
				Rainbow[a]	105	± 38	226	--
				Rainbow[b]	108	± 41	233	--
				Rainbow[c]	216	± 57	466	--
				Cutthroat	6	± 5	13	2.0
				Total	674	±120	1453	343.9
Station 3 - Old Faithful (Catch & Release)	320	18.9	0.605	Brown	428	±110	712	114.0
				Rainbow	83	± 33	137	45.1
				Brook	14	± 11	23	2.4
				Cutthroat	4	± 5	7	1.0
				Total	534	±113	883	162.5
Station 4 - Upper Control, upper terminus (Standard Regulations)	366	18.6	0.681	Brown	431	±201	633	78.1
				Rainbow	137	±122	201	21.0
				Brook	15	± 24	22	2.1
				Total	632	±271	928	101.2
Station 5 - Taylor Creek (Standard Regulations)	213	15.2	0.324	Brown	325	±110	703	131.2
				Rainbow	176	± 90	379	33.5
				Total	501	±142	1080	164.7

[a]Wild Rainbows

[b]Stocked Rainbows

[c]Total Rainbows

Table I-11. Middle Fork of the South Platte River population and standing crop estimates, September 1981.

	Study section size			Population statistics				
Study section description	length (m)	width (m)	area (ha)	Species	$\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Highway 9 Bridge (8 trout/day bag area)	183	6.10	0.116	Brown				
				≤12 cm	38	±36	323	4
				>12 cm	152	±12	1310	150
				Rainbow	5	0	43	4
				Total Trout[a]	156	±11	1345	158
Gaging Station Bridge (8 trout/day bag area)	183	7.62	0.139	Brown				
				≤12 cm	36	±24	259	3
				>12 cm	160	±40	1151	111
				Rainbow	4	± 7	29	2
				Total Trout[a]	164	±41	1179	116
1 mile below Gage (Catch & Release between 8 & 16 in.)	183	6.40	0.117	Brown				
				≤12 cm	63	±15	538	7
				>12 cm	203	±65	1735	186
				Rainbow	16	±62	137	13
				Total Trout[a]	216	±70	1846	206
2 miles below Gage (Catch & Release between 8 & 16 in.)	183	7.20	0.132	Brown				
				≤12 cm	93	±98	705	9
				>12 cm	213	±42	1614	164
				Rainbow	7	--	53	3
				Total Trout[a]	220	±45	1667	176
3 miles below Gage (Catch & Release between 8 & 16 in.)	244	7.60	0.185	Brown				
				≤12 cm	400	--	2162	24
				>12 cm	323	±48	1746	246
				Rainbow	11	--	59	6
				Total Trout[a]	334	±51	1805	276

[a]Total trout greater than 12 cm.

Table I-12. South Platte River standing crop and biomass estimates, March 30-31, 1981.

Study section location	Study section size: length (m)	width (m)	area (ha)	Species	Population statistics: $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Upper Canyon - 1.5 mi. above Wigwam Club (Catch & Release)	183	14.0	0.256	Brown	139	± 6	543	97.7
				Rainbow	299	± 9	1167	423.7
				Total Trout	438	± 11	1711	521.4
Lower Canyon - 0.2 mi. above Wigwam Club (Catch & Release)	183	17.1	0.313	Brown	259	± 9	1012	224.5
				Rainbow	496	± 11	1938	748.4
				Total Trout	765	± 14	2988	973.9
Deckers Bridge - stocked rainbow (Standard Regulations)	183	17.1	0.313	Brown	303	± 17	968	136.3
				Rainbow	37	± 4	118	19.3
				Total Trout	336	± 17	1073	255.4
Lower Swayback - low pressure, low harvest, no stocking	183	17.1	0.313	Brown	195	±115	625	96.7
				Rainbow	27	± 46	86	12.8
				Total Trout	222	±124	709	109.5
Scraggy View Picnic Area - rainbow stocked (Standard Regulations)	183	17.1	0.313	Brown	209	± 76	668	82.6
				Rainbow	52	± 19	169	21.7
				Total Trout	258	± 70	824	104.3

Table I-13. South Platte River standing crop and biomass estimates, October 6-7, 1981.

Study section location	Study section size length (m)	width (m)	area (ha)	Species	Population statistics $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Upper Canyon - 1.5 mi. above Wigwam Club (Catch & Release)	183	14.0	0.256	Brown	112	± 76	438	100
				Rainbow	203	± 36	793	311
				Total Trout	304	± 57	1188	411
Lower Canyon - 0.2 mi. above Wigwam Club (Catch & Release)	183	17.1	0.313	Brown	221	± 22	706	178
				Rainbow	264	± 35	843	342
				Total Trout	485	± 40	1543	519
Deckers Bridge - stocked rainbow (Standard Regulations)	183	17.1	0.313	Brown	396	±174	1265	244
				Rainbow	88	±134	281	53
				Total Trout	481	±206	1537	297
Scraggy View Picnic Area - rainbow stocked (Standard Regulations)	183	17.1	0.313	Brown	234	± 30	748	115
				Rainbow	40	± 9	128	25
				Total Trout	273	± 31	872	140

Table I-14. South Platte River standing crop and biomass estimates, March 8-10, 1982.

Study section location	Study section size: length (m)	width (m)	area (ha)	Species	Population statistics: size (cm)	$\hat{N}$	95% C.I.	fish/ha	kg/ha
Upper Canyon - 1.5 mi. above Wigwam Club (Catch & Release)	183	14.0	0.256	Brown	>14	138	± 4	539	108.8
				Rainbow	>14	209	± 3	817	314.9
				Total Trout	>14	347	± 4	1355	418.7
Lower Canyon - 0.2 mi. above Wigwam Club (Catch & Release)	183	17.1	0.313	Brown	>14	305	± 20	975	216.3
				Rainbow	>14	344	± 19	1099	454.5
				Total Trout	>14	649	± 27	2073	670.8
Deckers Bridge - stocked rainbow (Standard Regulations)	183	17.1	0.313	Brown	≤14	529	±182	1690	36.5
					>14	205	± 20	655	101.4
				Rainbow	<14	24	± 4	37	0.7
					≥14	17	± 2	54	7.5
				Total Trout	≥14	221	± 19	706	108.9
Bridge between Deckers & Trumbull (8 trout/day)	183	17.1	0.313	Brown	≤14	494	±150	1578	35.0
					>14	284	± 25	907	152.4
				Rainbow	≤14	16	± 4	51	0.5
					>14	64	± 6	204	40.7
				Total Trout	>14	345	± 24	1105	201.1
Scraggy View (8 trout/day)	183	17.1	0.313	Brown	≤14	239	± 29	764	18.0
					>14	218	± 8	696	95.3
				Rainbow	≤14	57	± 20	182	2.6
					>14	30	± 9	96	22.3
				Total Trout	>14	247	± 9	789	117.6
Twin Cedars (8 trout/day)	183	17.1	0.313	Brown	≤14	233	± 31	744	17.0
					>14	351	± 40	1121	146.9
				Rainbow	≤14	35	± 7	112	1.5
					>14	78	± 20	249	41.4
				Total Trout	>14	429	± 45	1371	287.3

Table I-15. St. Vrain standing crop and biomass estimates, September 1981.

Study section location	Study section size length (m)	width (m)	area (ha)	Species	Population statistics $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
City Park, Lyons	183	7.6	0.139	Brown	217	28	1561	139.7
Lyons' Gaging Station	183	12.2	0.223	Brown	99	10	444	52.5
Ideal Concrete Lyons	137	13.7	0.188	Brown	-no estimates-			
Martin Marrita, Lyons	157	7.7	0.116	Brown	-no estimates-			

Table I-16. Taylor River population and standing crop estimates, October 1981.

Study section description	Study section size length (m)	width (m)	area (ha)	Species	Population statistics $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Upper Sams	305	25.9	0.868	Brown	971	±135	1229	221
				Rainbow	182	± 75	230	70
				Kokanee	1	--	1	Trace
				Cutthroat	5	± 6	6	3
				Total	1138	±150	1441	294
Lower Sams	183	19.8	0.362	Brown	893	±185	2467	315
				Kokanee	1	--	3	2
				Rainbow	53	± 20	146	42
				Cutthroat	2	--	5	3
				Total	918	±170	2536	362
One Mile Campground	305	20.4	0.622	Brown	849	±102	1365	162
				Cutthroat	3	--	5	1
				Rainbow	8	± 11	13	2
				Kokanee	12	± 19	19	1
				Total	871	±104	1400	166
Elsinore Cattle Company	305	21.3	0.650	Brown	614	±113	945	138
				Kokanee	3	± 3	5	1
				Rainbow	9	± 11	14	3
				Cutthroat	4	± 4	6	1
				Brook	1	--	2	--
				Total	634	±114	975	143
Almont	305	26.8	0.817	Brown	832	± 95	1018	151
				Rainbow	95	± 32	116	30
				Cutthroat	8	± 13	10	2
				Kokanee	--	--	--	--
				Total	939	±102	1149	183

Table I-17. Results of Animas River electroshocking, December 15-18, 1981 - January 26, 1982.

Species	$\hat{N}$	95% C.I.	Fish/ha	Kg/ha
Durango Hatchery to 9th Street Bridge (1.2 mi.)				
Browns (all)	168	±154	29	15.4
Browns over 38 cm (15 in.)	24	± 67	4	8.5
Rainbows	95	± 95	16	2.8
Cutthroat	276	±361	47	5.2
Brook	1	--	1	Trace
Pubelo Parving to Purple Cliffs (2.4 mi.)				
All Browns				
1st Est.	727	±273	62	40.0
2nd Est.	651	±146	55	36.0
Schnabel Est.[a]	549 $\leq$677 $\leq$882	--	57	
Browns over 40 cm (16 in.)	120	± 58	10	21.4
2nd Est.	121	± 35	10	19.4
Schnabel Est.[a]	90 $\leq$121 $\leq$192	--	10	--
Rainbows				
1st Est.	110	±138	9	4.2
2nd Est.	102	±119	9	4.0
Schnabel Est.[a]	179	--	15	--
Cutthroat				
1st Est.	288	±266	24	5.2
2nd Est.	672	±885	57	11.6
Schnabel Est.[a]	297 $\leq$587 $\leq$29,362	--	50	--

[a]Schnabel Population Estimate w/95% C.I. - P (-95% C.I. $\leq$ N $\leq$ + 95% C.I.)

Table I-18. Results of electroshocking survey of the Gunnison River (North Fork of the Gunnison to Austin Bridge) September 4 and 9, 1981.

Species	Section number												Total	%
	[illegible]1	36	1	2	11	10	3&4	9	4	5	6	1		
Rainbow Trout	53	74	29	2	0	4	3	6	6	17	1	8	203	16.7
Brown Trout	16	9	4	4	2	1	0	5	2	13	5	2	63	5.2
Flannelmouth Sucker (FMS)	9	76	39	5	0	14	13	16	5	23	15	11	226	18.6
Bluehead Sucker (BHS)	49	57	65	3	5	24	21	29	17	25	10	3	308	25.3
Western White Sucker (WWS)	9	40	23	4	1	16	7	17	41	30	15	10	213	17.5
Longnose Dace	4	2	6	0	1	12	2	3	10	17	11	1	69	5.7
Mottled Sculpin	2	2	2	0	1	0	0	1	0	0	0	1	9	0.7
Longnose Sucker (LNS)	3	0	1	0	0	0	0	0	0	0	0	0	4	0.3
Fathead Minnow	0	0	0	0	0	0	0	0	29	1	0	0	30	2.4
Carp	0	2	2	0	0	0	1	2	26	4	4	3	44	3.6
Roundtail Chub	0	0	0	0	0	0	0	0	2	0	1	0	3	0.2
Sucker Hybrids														
WWS X BHS	12	5	2	0	0	0	1	1	0	3	0	0	24	2.0
WWS X FMS	0	1	7	3	0	5	2	1	0	0	0	0	19	1.6
BHS X FMS	1	1	1	0	0	0	0	0	0	0	0	0	3	0.2
Total All Species													1218	100.0
	R94W, T15S	R94W, T14S	R94W, T15S	R94W, T15S	R94W, T15S	R94W, T15S	R94W, T15S	R94W, T15S	R94W, T15S	R94W, T15S	R94W, T15S	R95W, T15S		

Table I-19. Gunnison River trout population estimates, August - September 1981.

	Total Browns 6 in. & up			Browns 12 in. & up			Browns 16 in. & up			Total Rainbows 6 in. & up			Rainbows 12 in. & up			Rainbows 16 in. & up		
Estimate	Est.	80%[a]	95%[b]	Est.	80%	95%	Est.	80%	95%	Est.	80%	95%	Est.	80%	95%	Est.	80%	95%
Gunnison River - Smith Fork to North Fork Confluence (4 mi.) (49.5 ac)																		
First	1808	± 929	±1420	225[c]	± 279	± 426	10[c]	± 9	± 14	9331	±6872	±10,506	468[c]	± 588	± 899	80[c]	± 97	±150
Second	2331	± 789	±1206	135	± 88	± 136	30[c]	±34	± 53	8190	±2841	± 4,345	225	± 130	± 199	187[c]	±229	±349
Third	2243	± 499	± 764	280	± 166	± 254	80[c]	±95	±147	6067	±1414	± 2,162	420	± 287	± 440	162	±134	±205
Schnabel[d]	1778	≤ 2,297	≤3246	172	≤ 323	≤2613	87[c]	--	--	5445	≤7092	10,167	261	≤ 489	≤3961	509	--	--
Average	2170	--	--	241	--		52	--	--	7670	--	--	401	--	--	235	--	--
Gunnison River - Duncan Trail to Ute Trail (2 mi.) (24.7 ac)																		
First	7987	± 2,507	±3833	1278	± 709	±1085	35[c]	±41	± 64	2482	±1090	±1667	865	± 534	± 817	335	±291	±446
Second	9427	± 3,107	±4751	1820	±1116	±1707	22	±14	± 21	3571	±1794	±2743	1292	± 913	±1396	400	±339	±519
Schnabel[d]	6377	≤ 8,659	≤13,484	1093	≤1903	≤7342	54	--		2164	≤3388	≤7803	754	≤1415	≤1464	678	--	--
Average	8691	--	--	1667	--	--	37	--	--	3147	--	--	1190	--	--	471	--	--

[a]80% Confidence Levels

[b]95% Confidence Interval

[c]These numbers are only "best approximations" since no recaptures were actually made; however, a recapture of one trout was assumed to get a minimal estimate for that segment of the population.

[d]Schnabel Population Estimate w/95% C.I. - P (-95% C.I. ≤ N ≥ + 95% C.I.)

Table I-20. Rio Grande River trout population estimates, August 1981.

Estimate	Browns 6 in. & up Est.	80%[a]	95%[b]	Browns 12 in. & up Est.	80%	95%	Browns 16 in. & up Est.	80%	95%	Rainbows Est.	80%	95%	Snake Rivers Est.	80%	95%	Total Trout Est.	95%
Coller Fly and Lure Water (2.12 mi. section = 40.3 ac)																	
First	3695	±1750	±2675	568	± 400	± 611	0	--	--	2223	±1989	±3041	--	--	--	6611	±4502
Second	3234	± 881	±1347	394	± 159	± 243	0	--	--	2527	±1577	±2410	--	--	--	5569	±2182
Third	3971	± 666	±1019	427	± 103	± 157	0	--	--	2421	± 767	±1172	32	±24	±37	6259	±1411
Schnabel[c]	3108	≤3802	≤4895	334	≤ 454	≤ 707	--	--	--	1834	≤2659	≤4832	--	--	--	5096	≤6115 ≤7644
Average	3633	--	--	463	--	--	0	--	--	2390	--	--	--	--	--	6146	--
State Bridge to Farmers Union Canal Outtake (6.8 mi. = 124.5 ac)																	
First	4536	±1912	±2924	1640	± 728	±1113	215	±155	±233	68	± 57	± 87	--	--	--	4533	±2768
Second	4772	±1082	±1654	2104	± 566	± 865	411	±244	±372	--	--	--	--	--	--	5206	±1808
Third	5399	± 876	±1339	2155	± 394	± 603	425	±139	±213	118	± 91	± 139	2	--	± 3	5551	±1351
Schnabel[c]	4512	≤5168	≤6047	1699	≤2106	≤2770	289	≤426	≤812	123	≤ 295	≤ 763	--	--	--	4518	≤5436 ≤6823
Average	4902	--	--	1966	--	--	350	--	--	93	--	--	--	--	--	5097	--

[a] 80% Confidence Levels

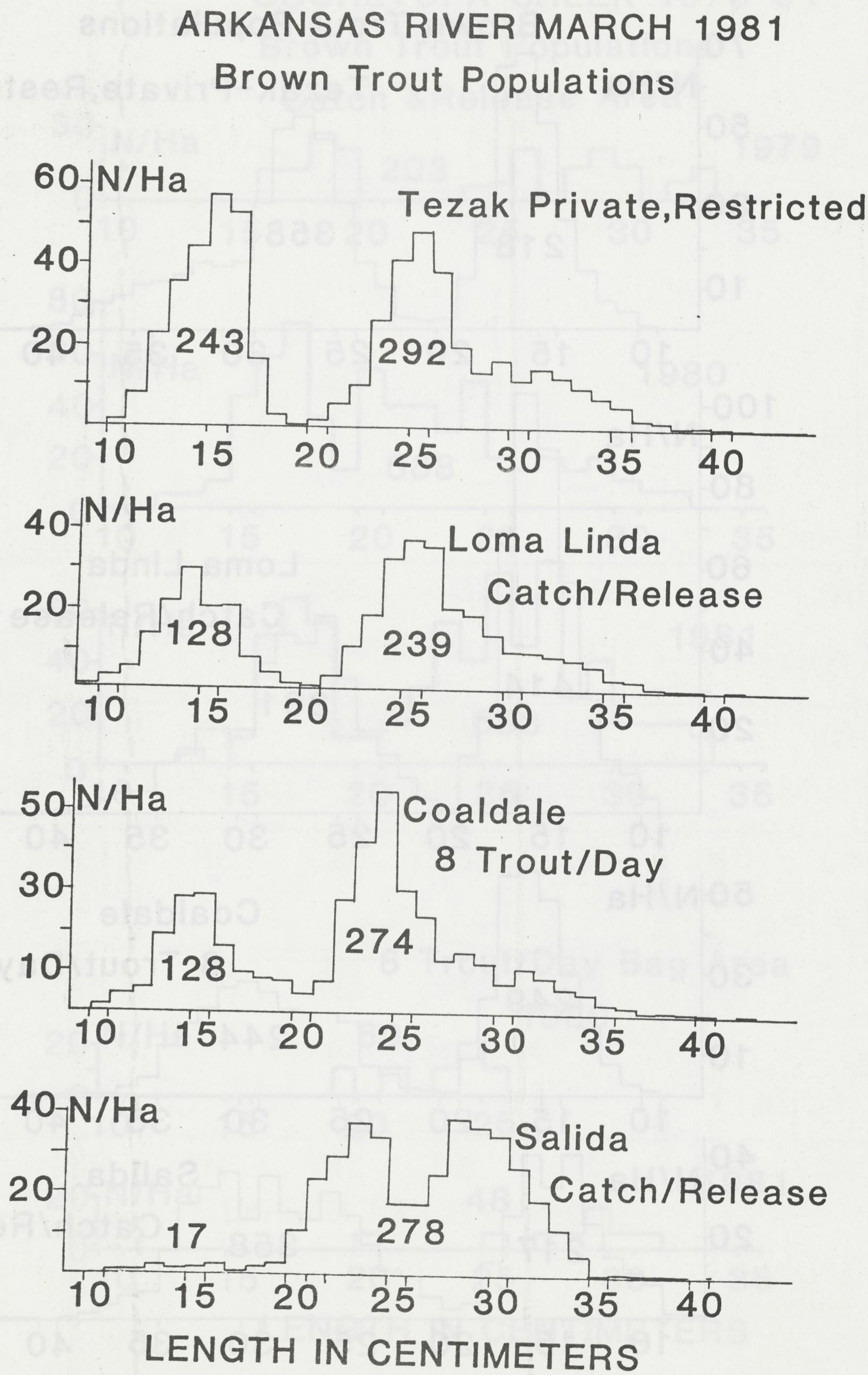
[b] 95% Confidence Levels

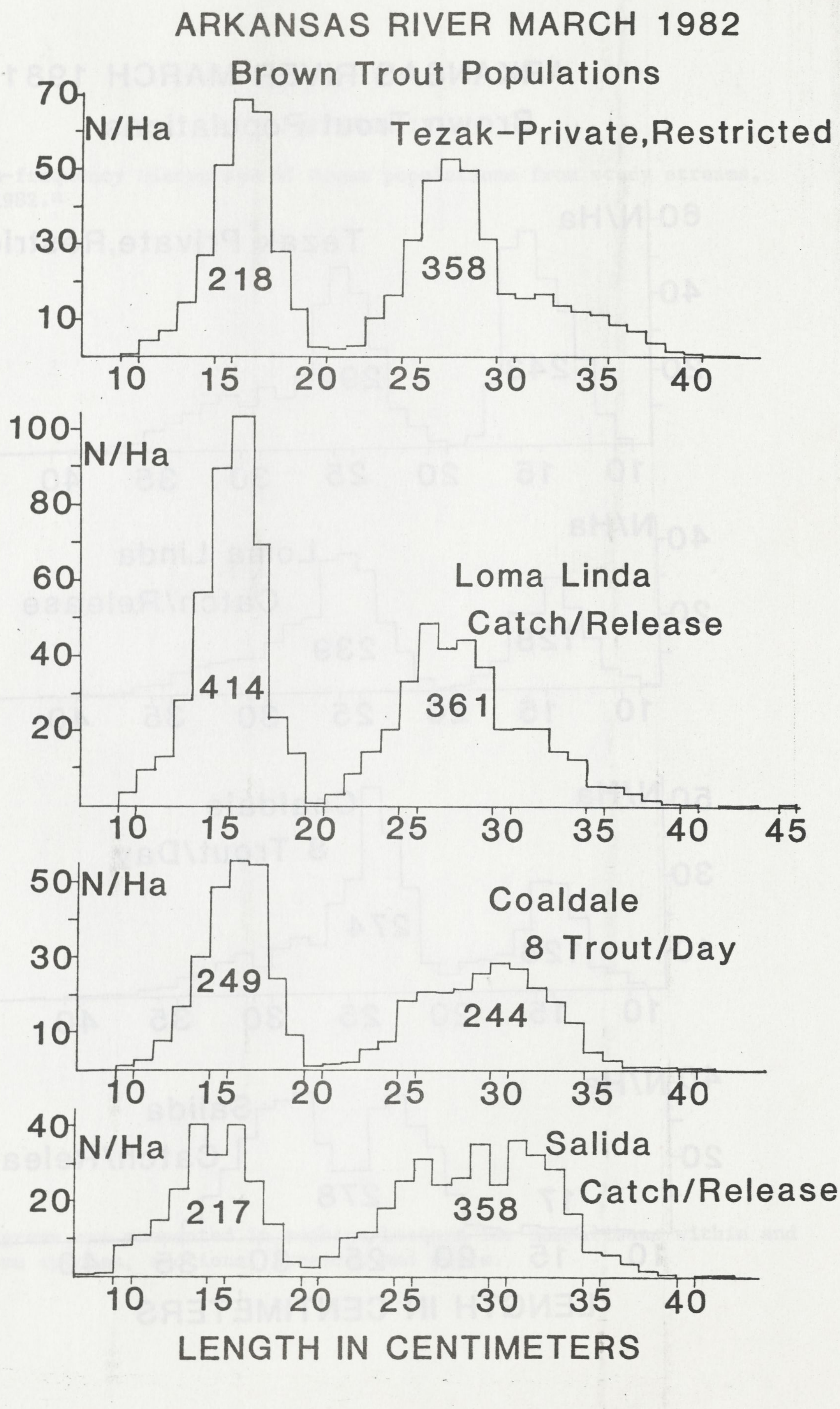
[c] Schnabel Population estimate w/95% C.I. - P (-95% ≤ N ≤ + 95%)

APPENDIX II

Length-frequency histograms of trout populations from study streams, 1978-1982.[a]

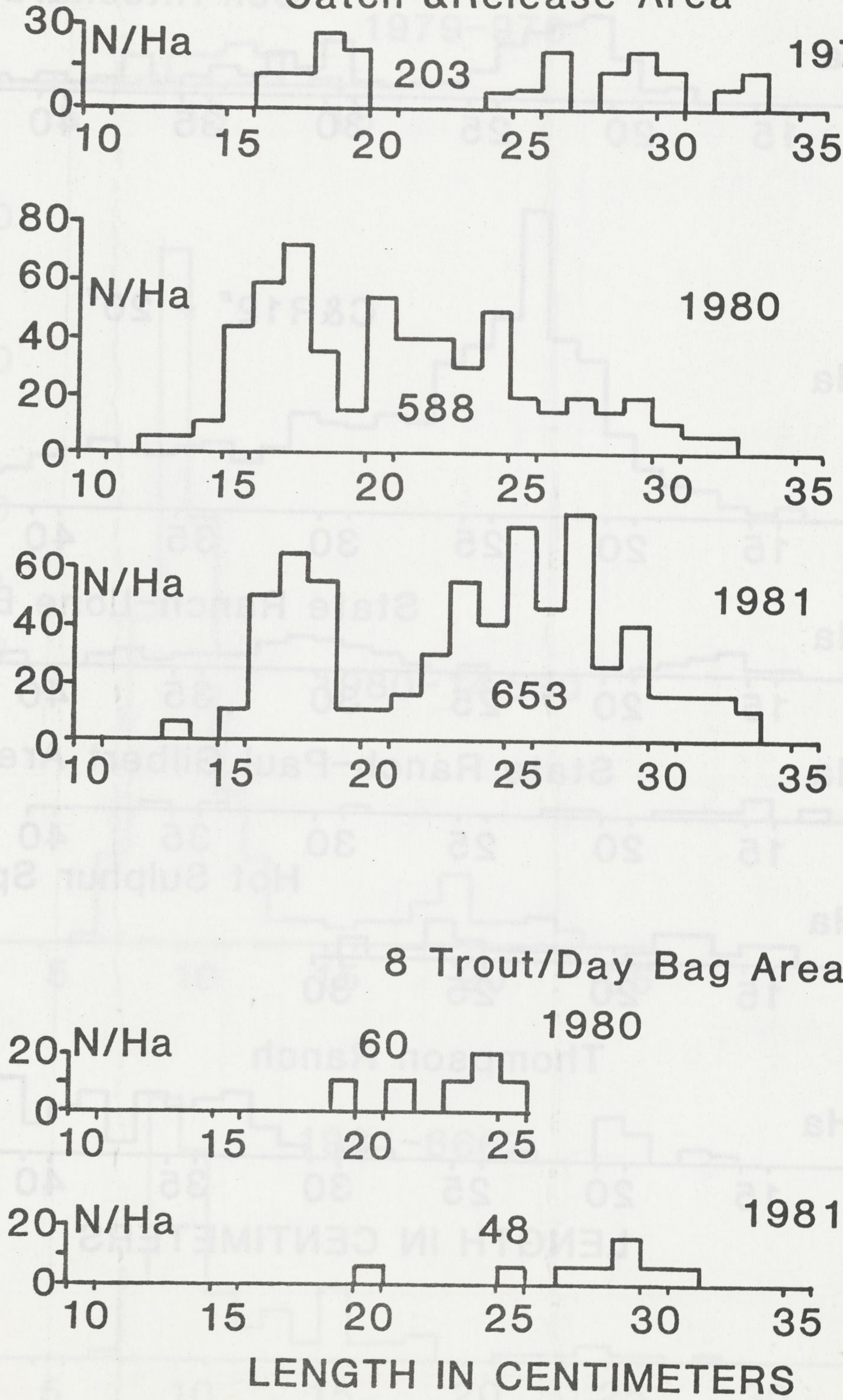
[a]Histograms are presented in numbers/hectare for comparisons within and between species, sections, streams, and years.


ARKANSAS RIVER MARCH 1981
Brown Trout Populations
60
40
20
N/Ha
Tezak Private,Restricted
243
292
10 15 20 25 30 35 40
40
20
N/Ha
Loma Linda
Catch/Release
128
239
10 15 20 25 30 35 40
50
30
10
N/Ha
Coaldale
8 Trout/Day
128
274
10 15 20 25 30 35 40
40
20
N/Ha
Salida
Catch/Release
17
278
10 15 20 25 30 35 40
LENGTH IN CENTIMETERS

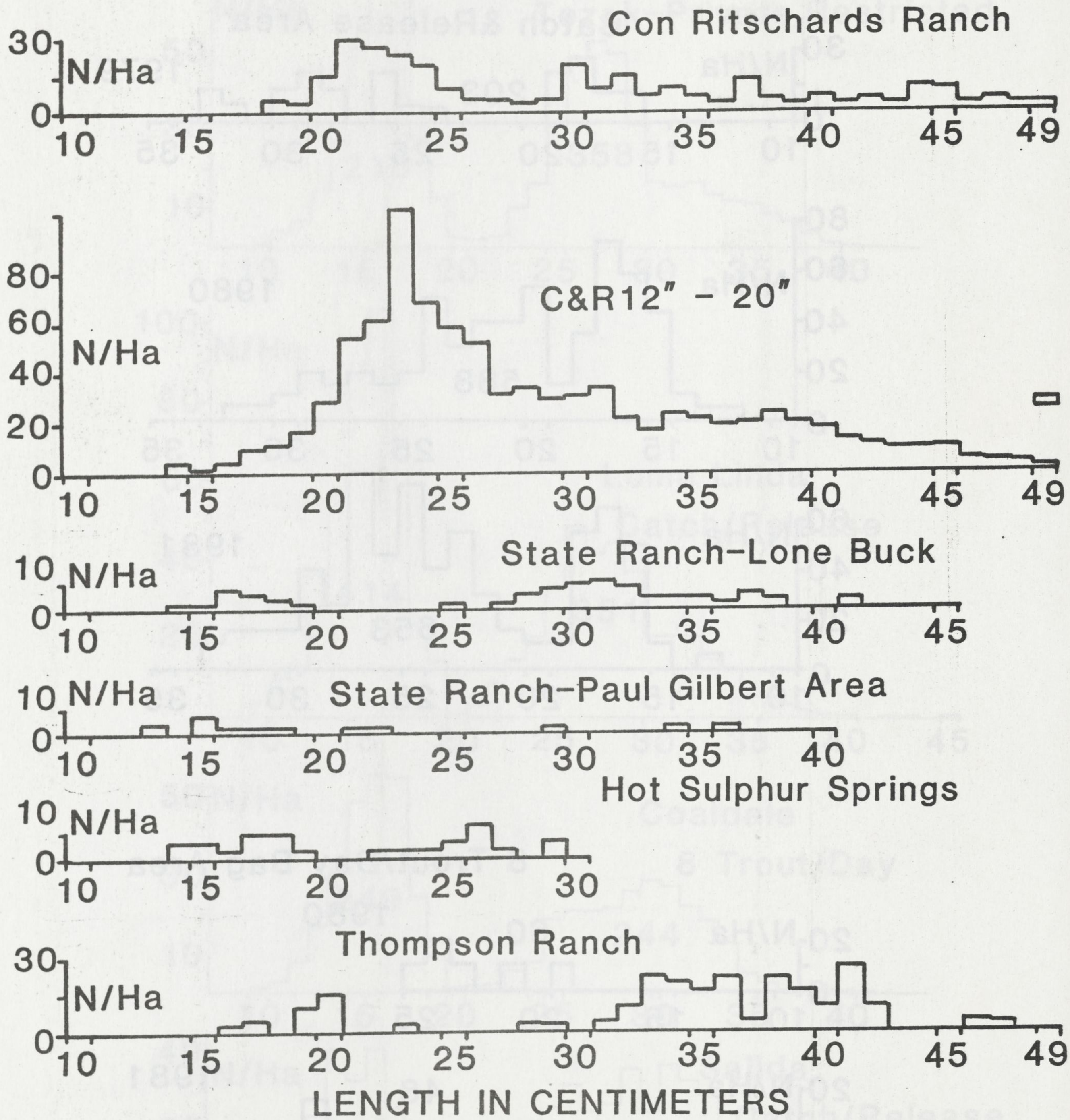


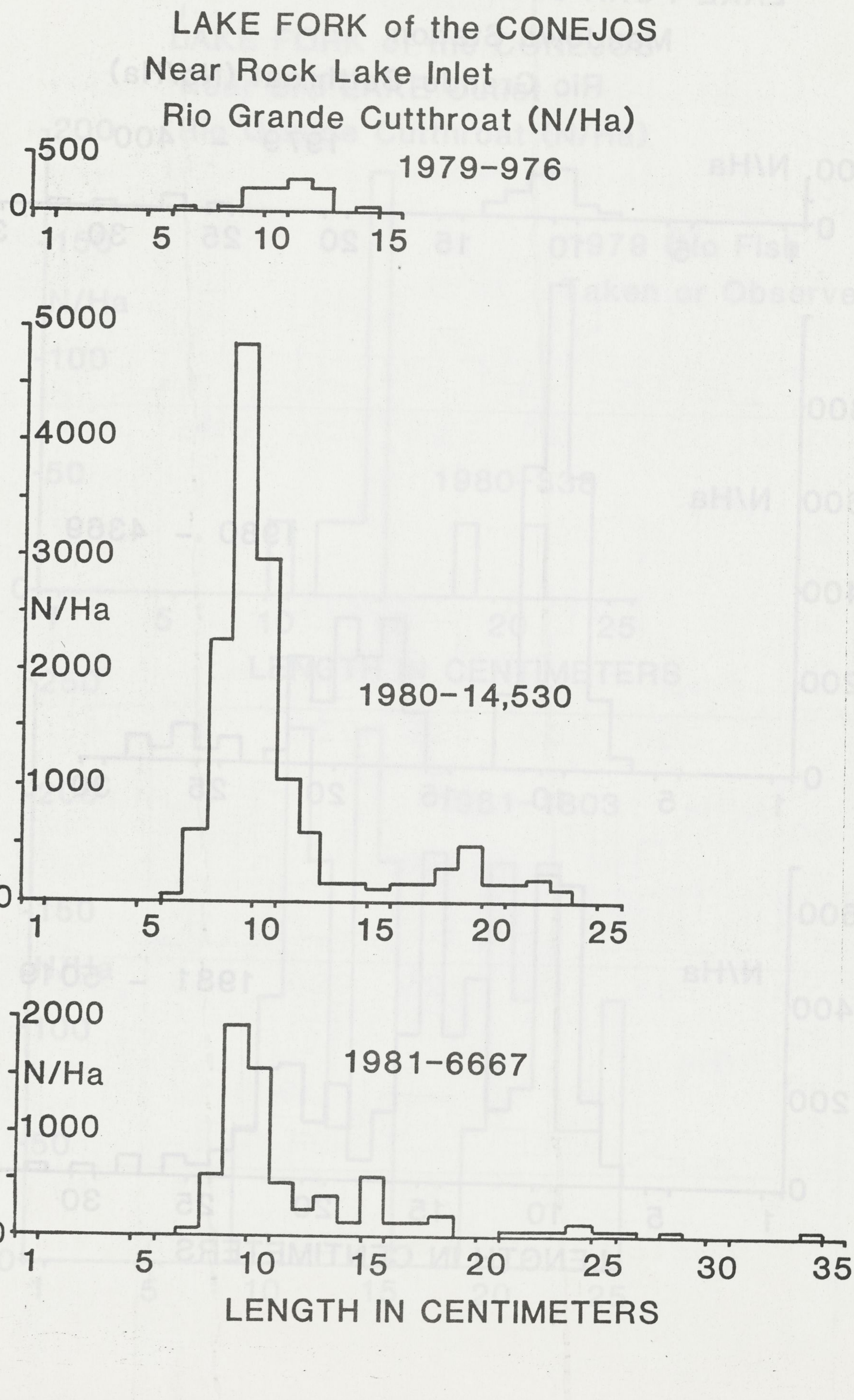
ARKANSAS RIVER MARCH 1982
Brown Trout Populations
N/Ha
Tezak-Private,Restricted
218
358
Loma Linda
Catch/Release
414
361
Coaldale
8 Trout/Day
249
244
Salida
Catch/Release
217
358
LENGTH IN CENTIMETERS

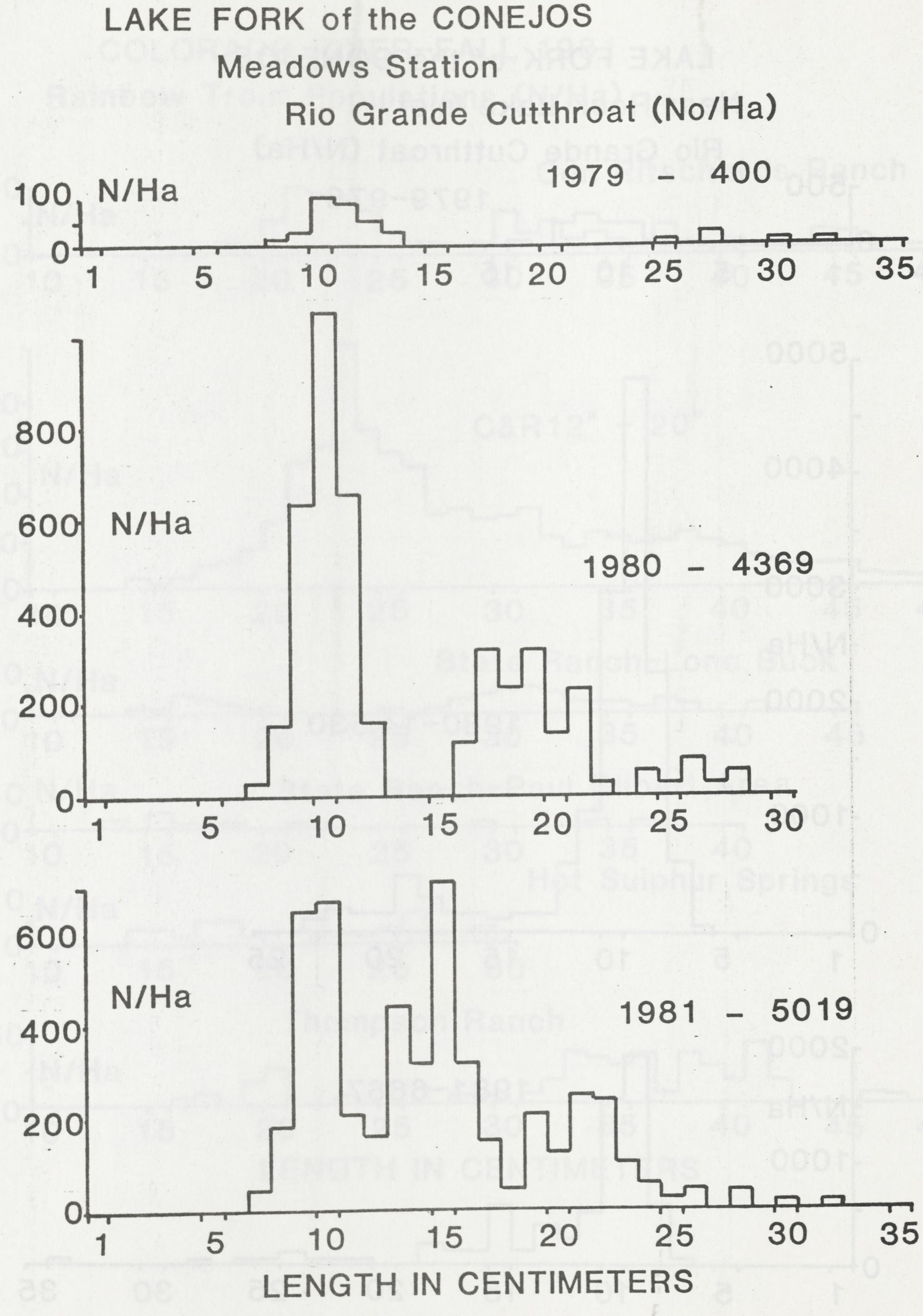
COCHETOPA CREEK 1979-81
Brown Trout Populations
Catch &Release Area



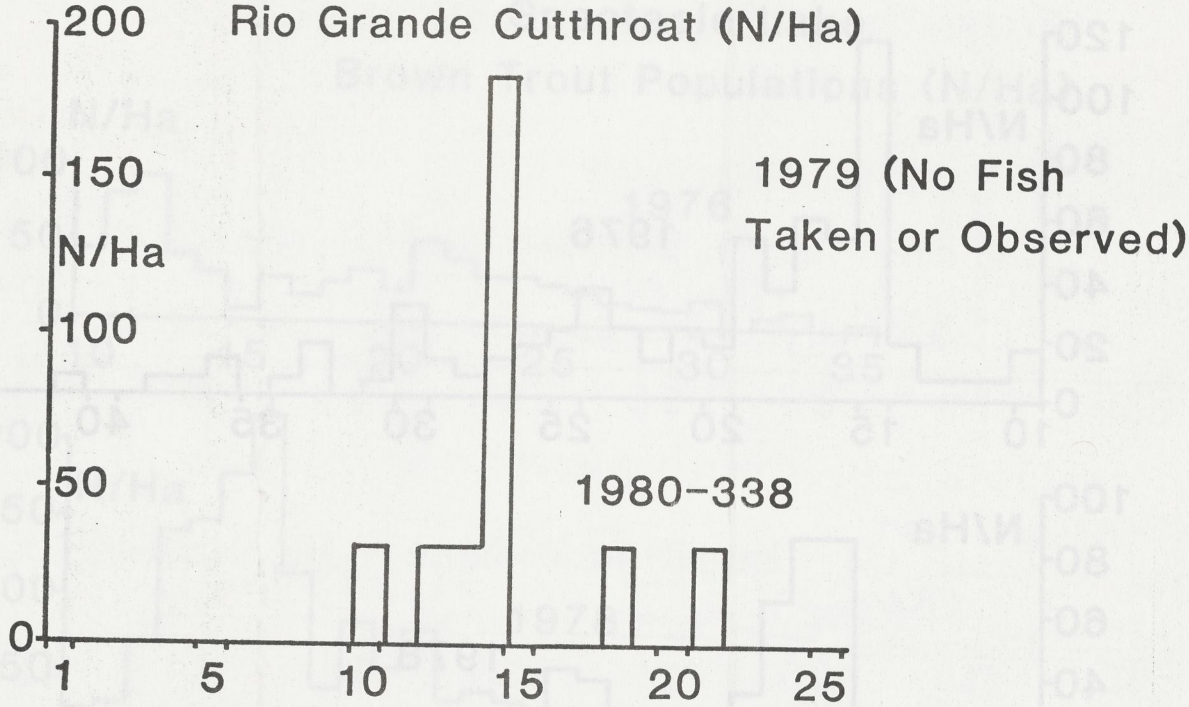
COLORADO RIVER-FALL 1981
Rainbow Trout Populations (N/Ha)



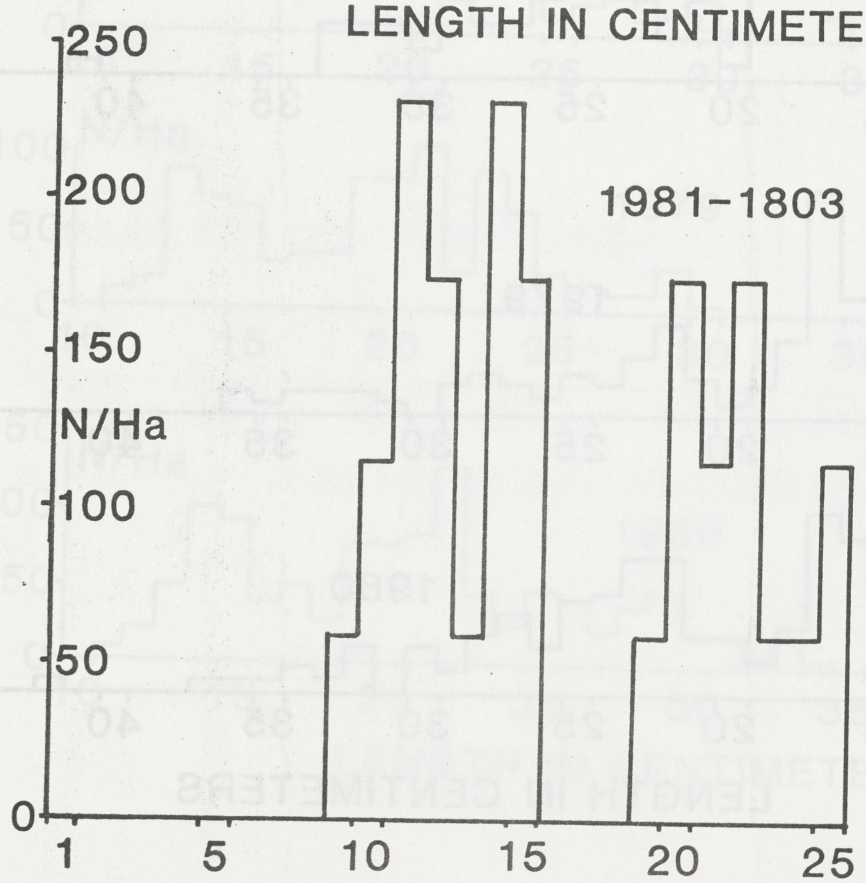

LAKE FORK of the CONEJOS
Near Rock Lake Inlet
Rio Grande Cutthroat (N/Ha)
500
0
1979-976
1
5
10
15
5000
4000
3000
N/Ha
2000
1000
0
1980-14,530
1
5
10
15
20
25
2000
N/Ha
1000
0
1981-6667
1
5
10
15
20
25
30
35
LENGTH IN CENTIMETERS


LAKE FORK of the CONEJOS
Meadows Station
Rio Grande Cutthroat (No/Ha)
N/Ha
1979 - 400
100
0
1 5 10 15 20 25 30 35
N/Ha
1980 - 4369
800
600
400
200
0
1 5 10 15 20 25 30
N/Ha
1981 - 5019
600
400
200
0
1 5 10 15 20 25 30 35
LENGTH IN CENTIMETERS

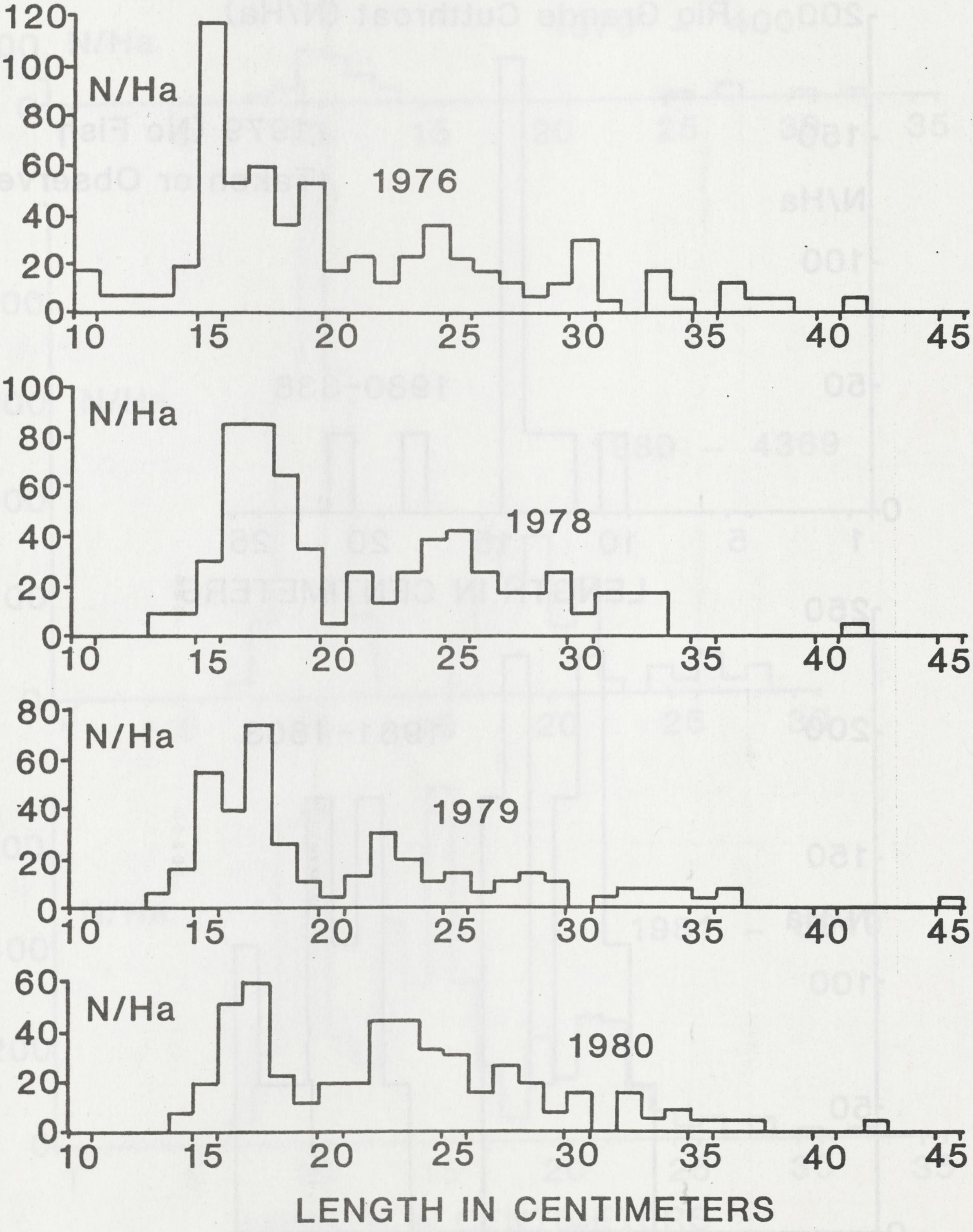
LAKE FORK of the CONEJOS
Near BIG LAKE Outlet
Rio Grande Cutthroat (N/Ha)

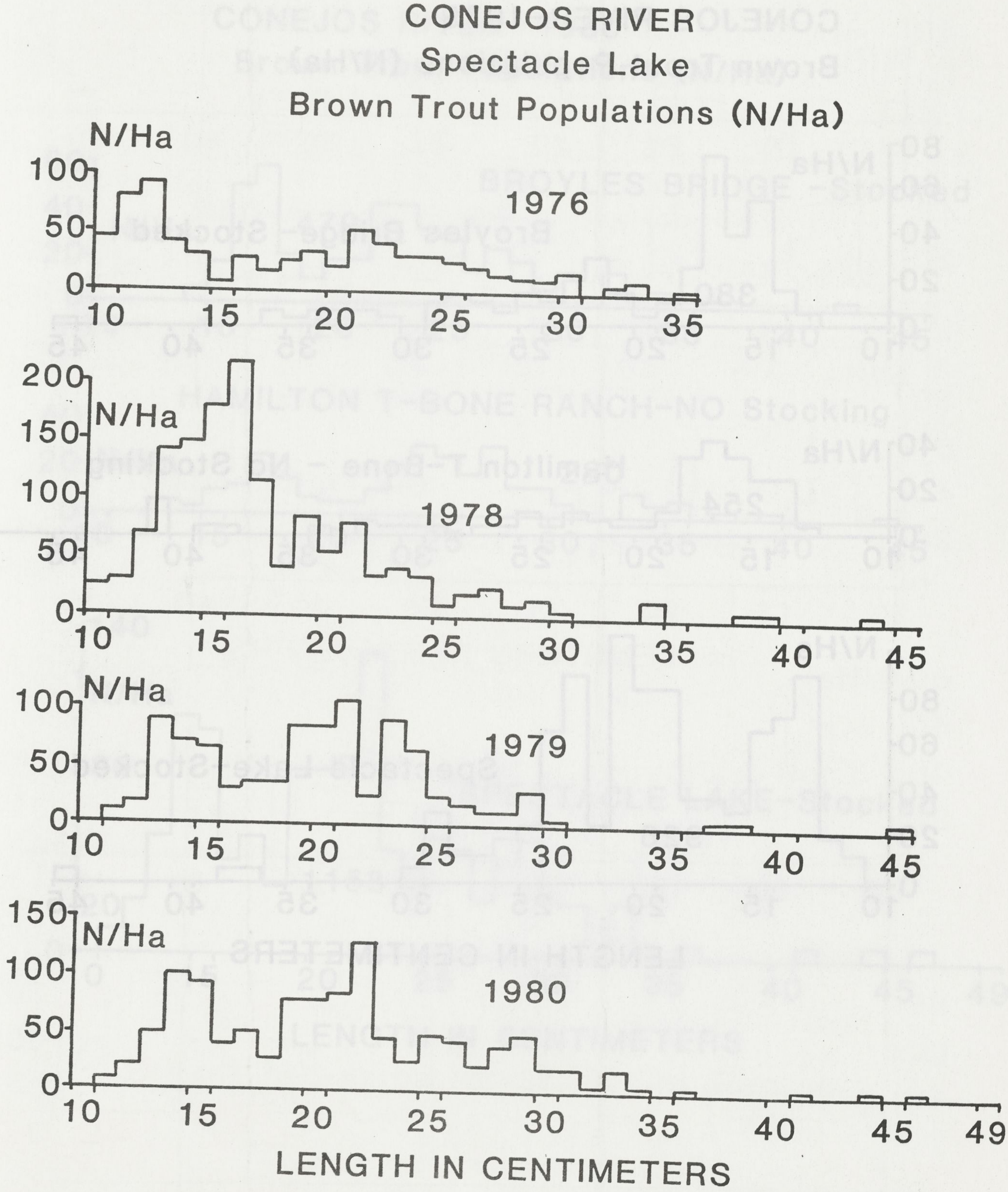


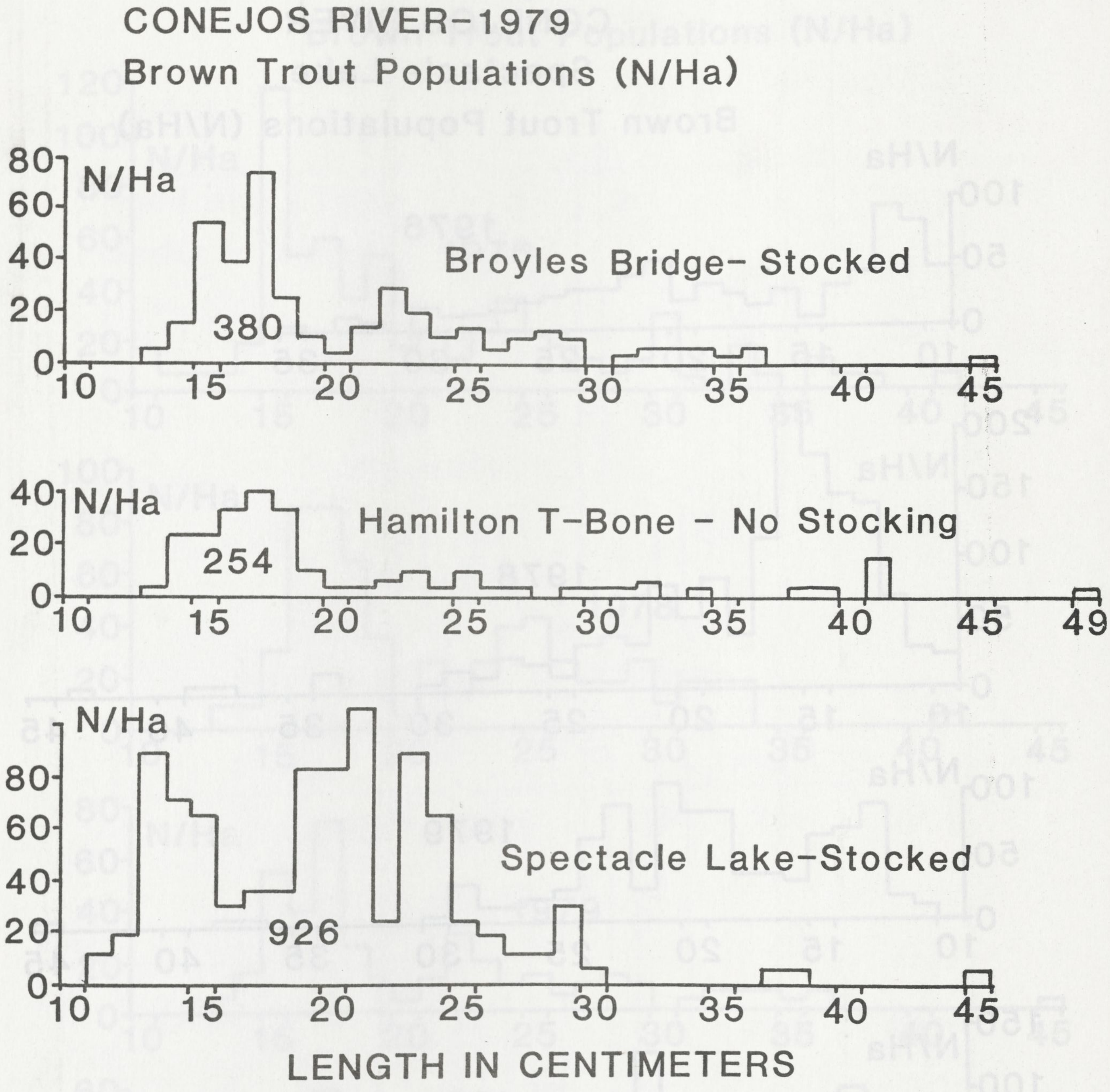
LENGTH IN CENTIMETERS

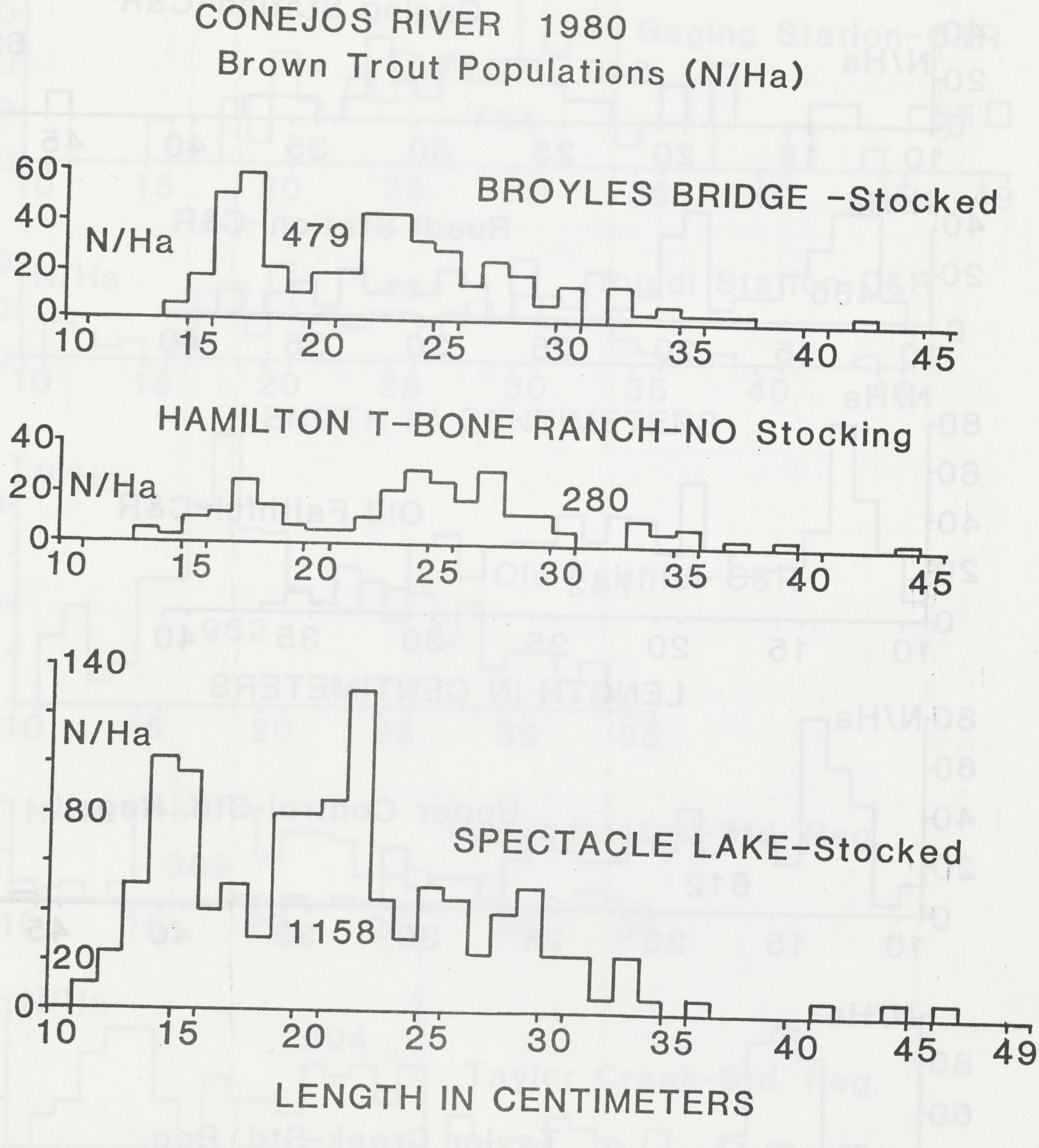


CONEJOS RIVER
Broyles Bridge
Brown Trout Populations (N/Ha)

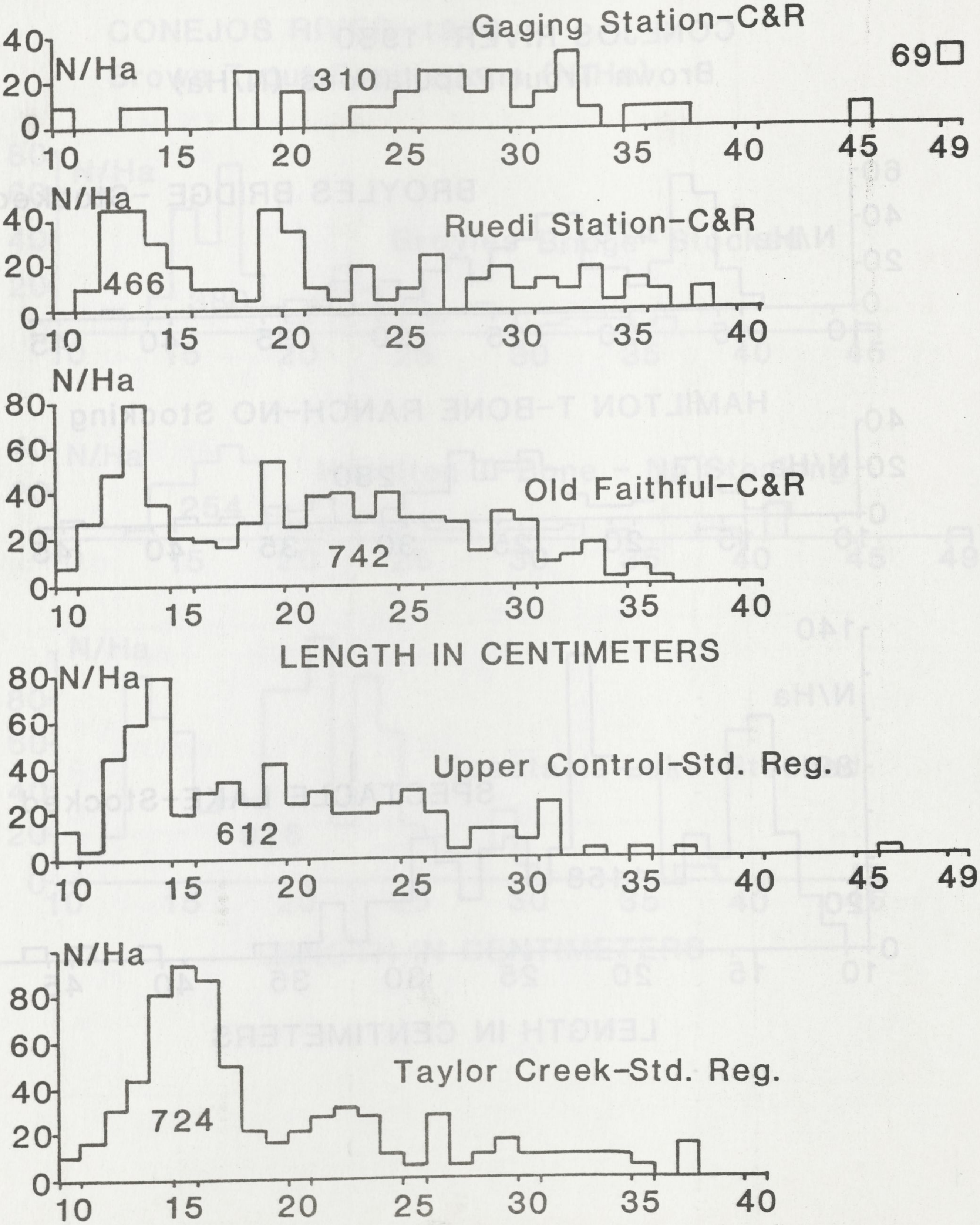



CONEJOS RIVER
Spectacle Lake
Brown Trout Populations (N/Ha)
N/Ha
1976
1978
1979
1980
LENGTH IN CENTIMETERS


CONEJOS RIVER-1979
Brown Trout Populations (N/Ha)
N/Ha
Broyles Bridge- Stocked
380
N/Ha
Hamilton T-Bone - No Stocking
254
N/Ha
Spectacle Lake-Stocked
926
LENGTH IN CENTIMETERS

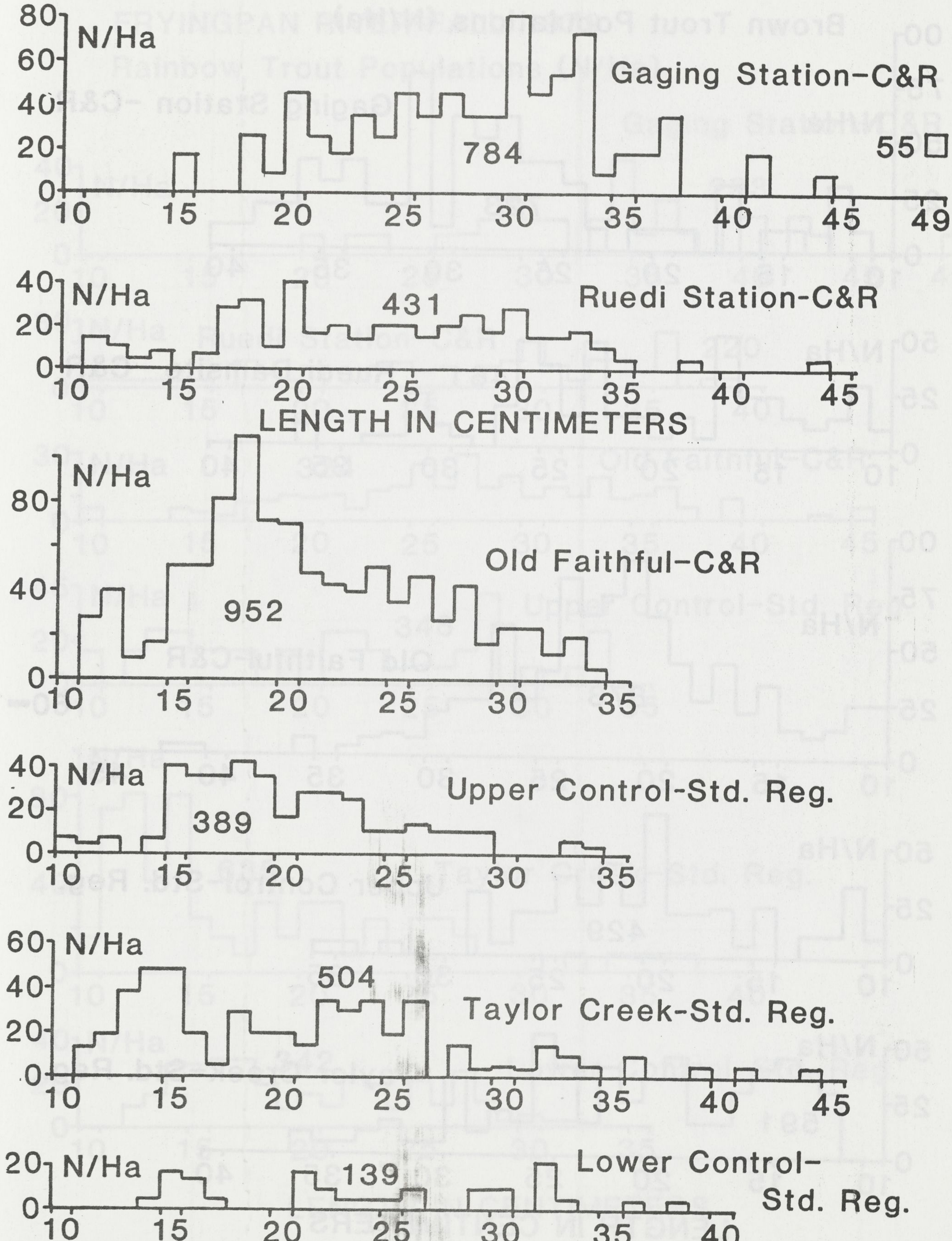

CONEJOS RIVER 1980
Brown Trout Populations (N/Ha)
BROYLES BRIDGE -Stocked
N/Ha
479
60
40
20
0
10
15
20
25
30
35
40
45
HAMILTON T-BONE RANCH-NO Stocking
N/Ha
280
40
20
0
10
15
20
25
30
35
40
45
SPECTACLE LAKE-Stocked
N/Ha
1158
140
80
20
0
10
15
20
25
30
35
40
45
49
LENGTH IN CENTIMETERS

FRYINGPAN RIVER-FALL 1979
Brown Trout Populations (N/Ha)

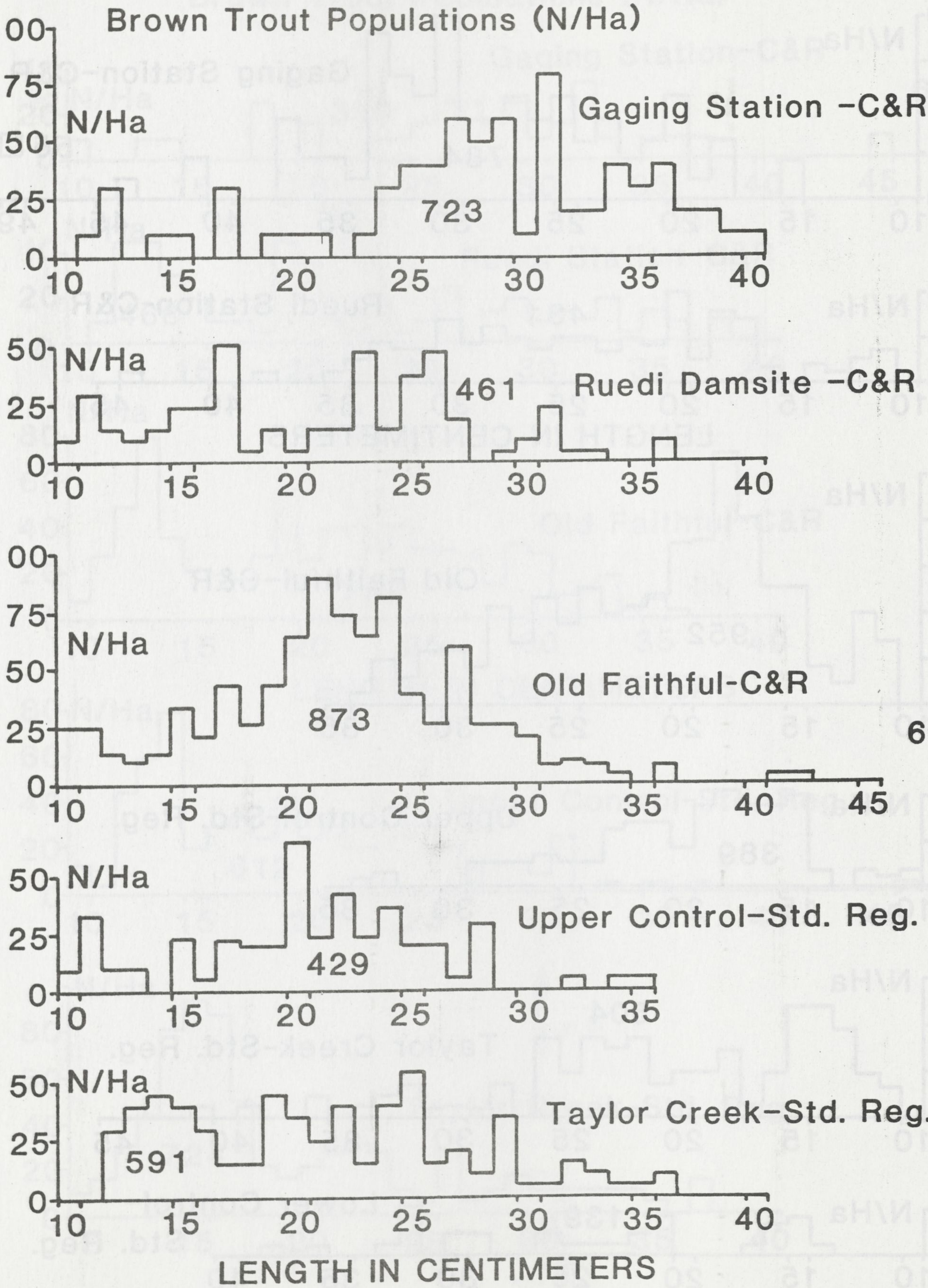


FRYINGPAN RIVER FALL 1980

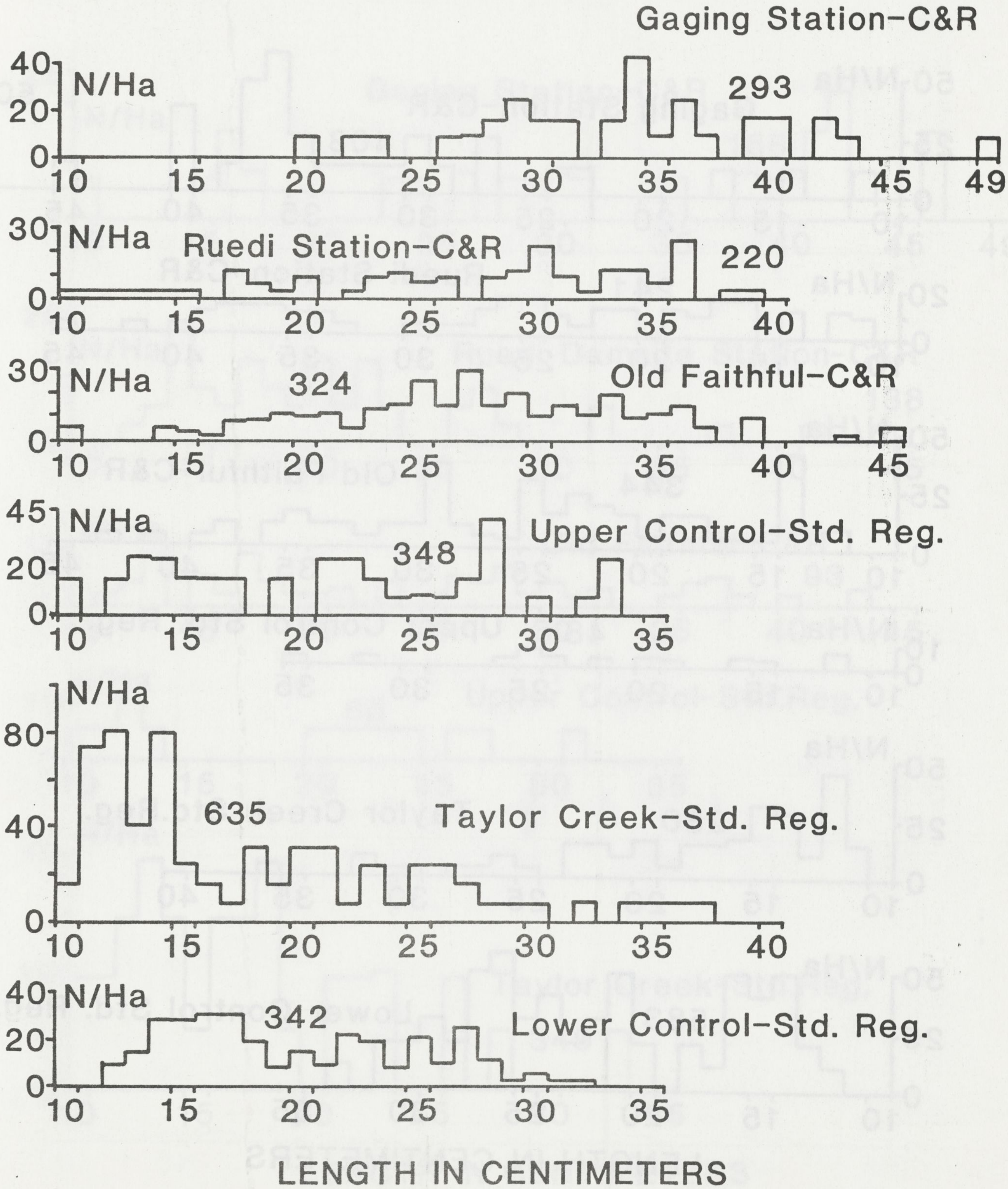
Brown Trout Populations (N/Ha)

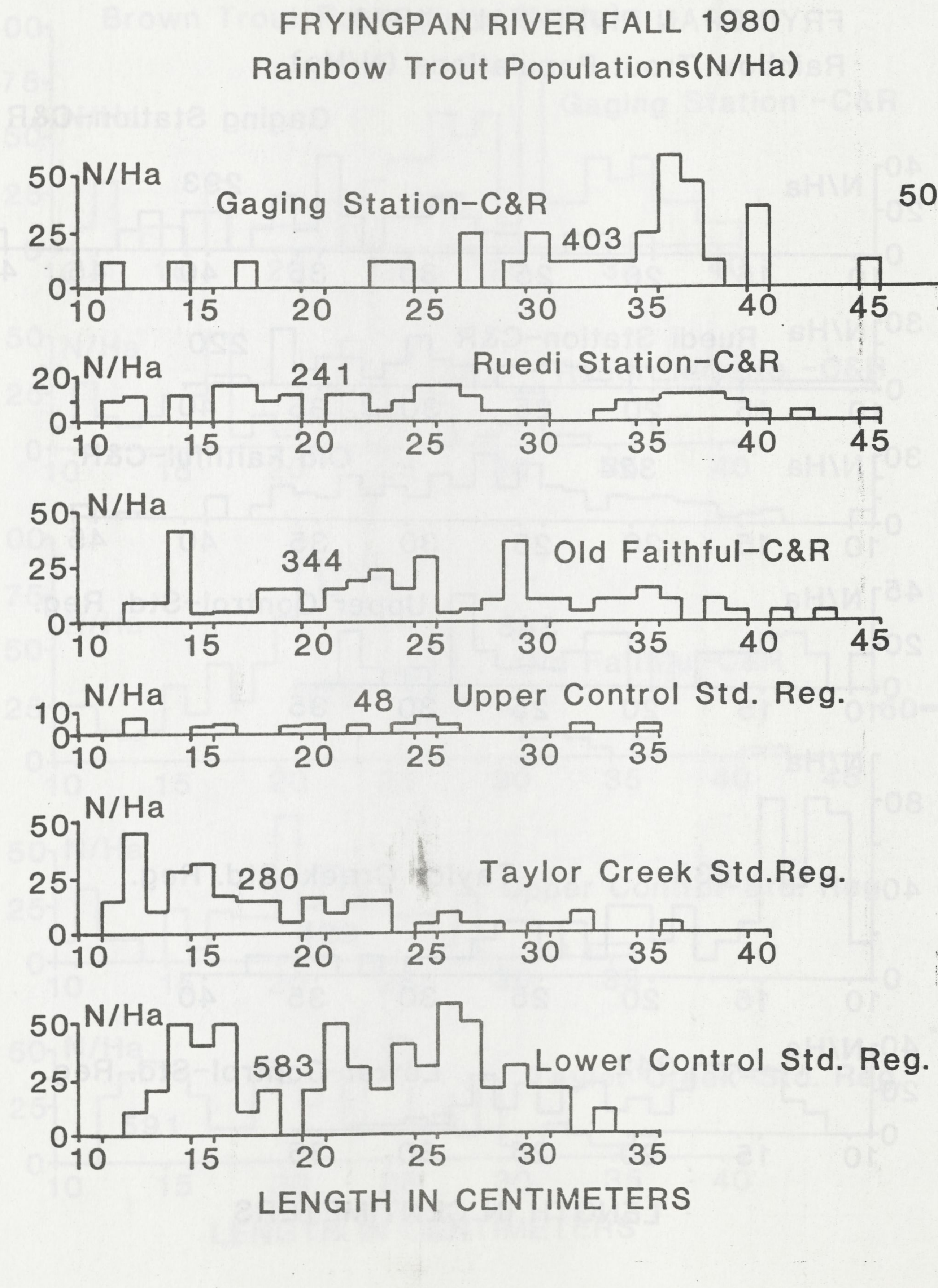


FRYINGPAN RIVER-FALL 1981
Brown Trout Populations (N/Ha)

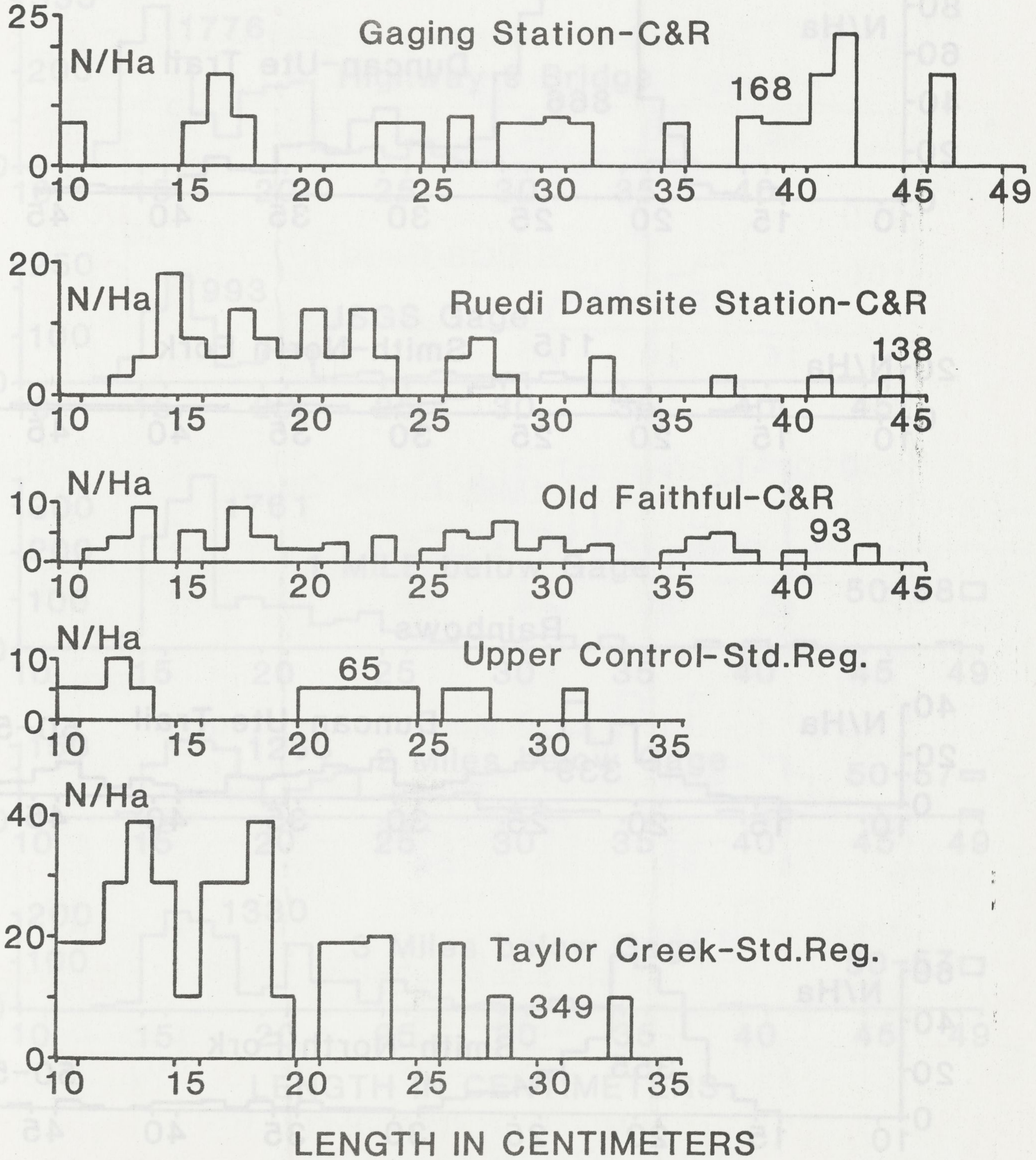


FRYINGPAN RIVER-FALL 1979
Rainbow Trout Populations (N/Ha)

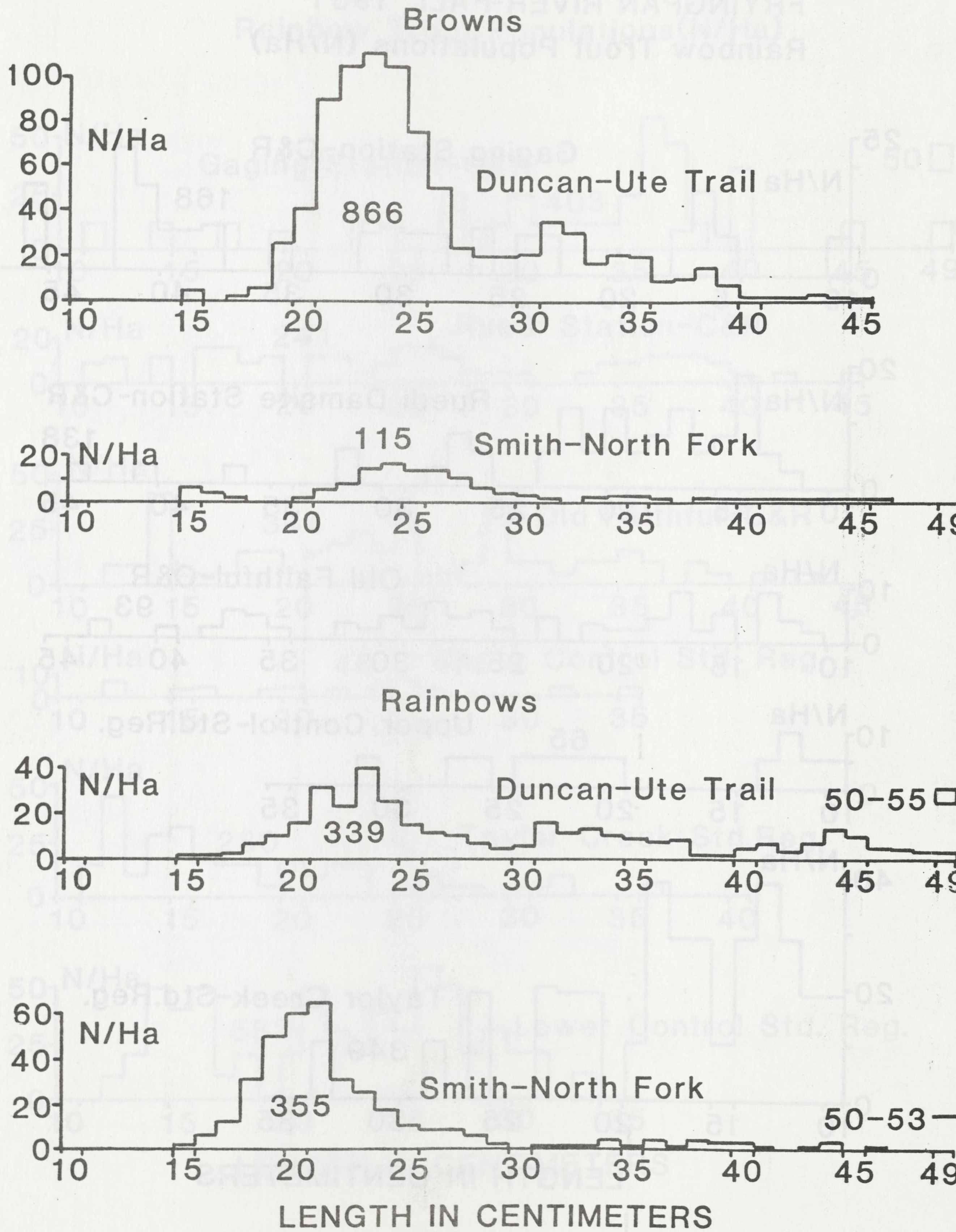



FRYINGPAN RIVER FALL 1980
Rainbow Trout Populations(N/Ha)
N/Ha
Gaging Station-C&R
403
50
N/Ha
Ruedi Station-C&R
241
N/Ha
344
Old Faithful-C&R
N/Ha
48
Upper Control Std. Reg.
N/Ha
280
Taylor Creek Std.Reg.
N/Ha
583
Lower Control Std. Reg.
LENGTH IN CENTIMETERS

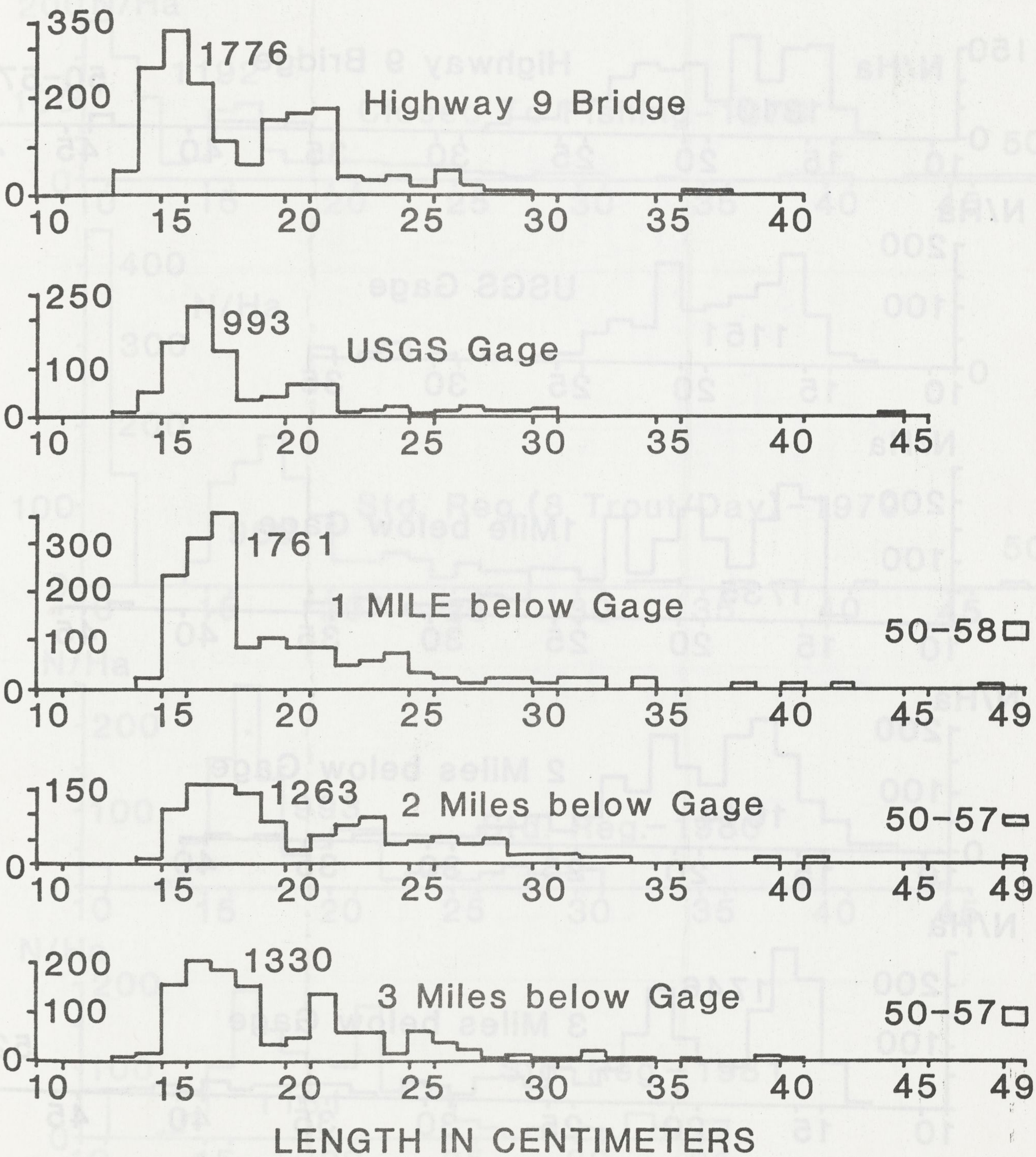
FRYINGPAN RIVER-FALL 1981
Rainbow Trout Populations (N/Ha)

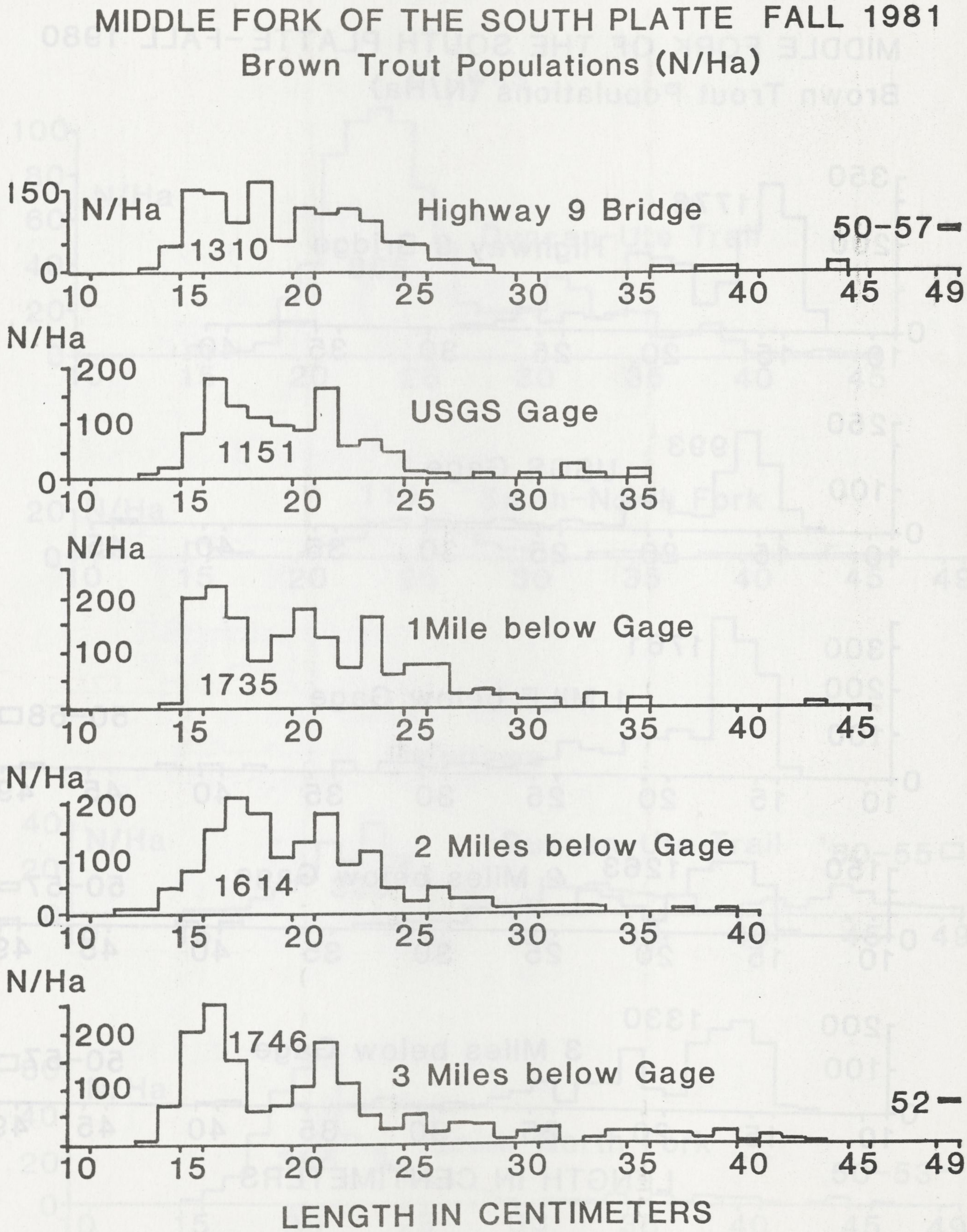


GUNNISON RIVER AUGUST 1981 (N/Ha)



MIDDLE FORK OF THE SOUTH PLATTE - FALL 1980
Brown Trout Populations (N/Ha)

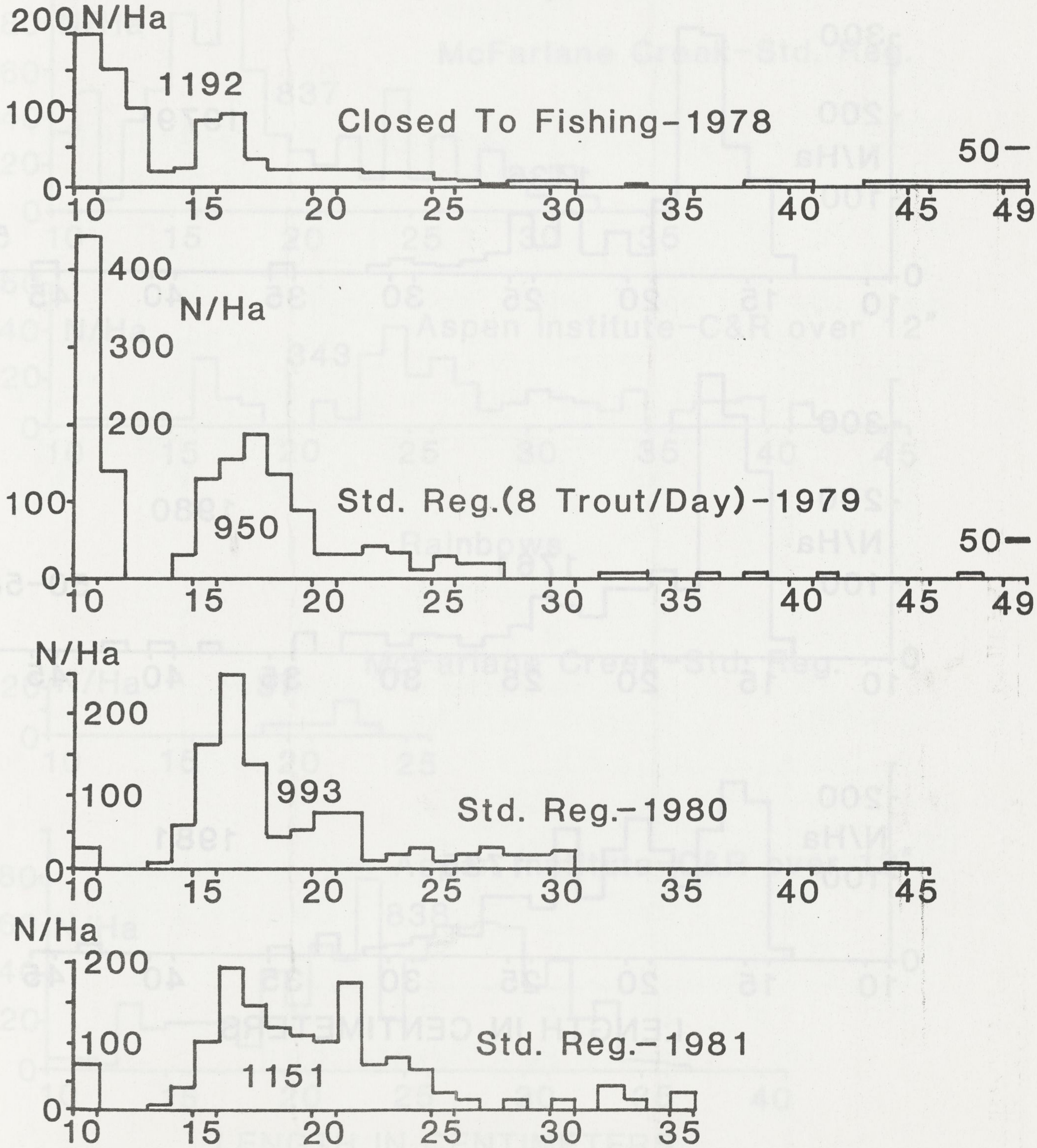




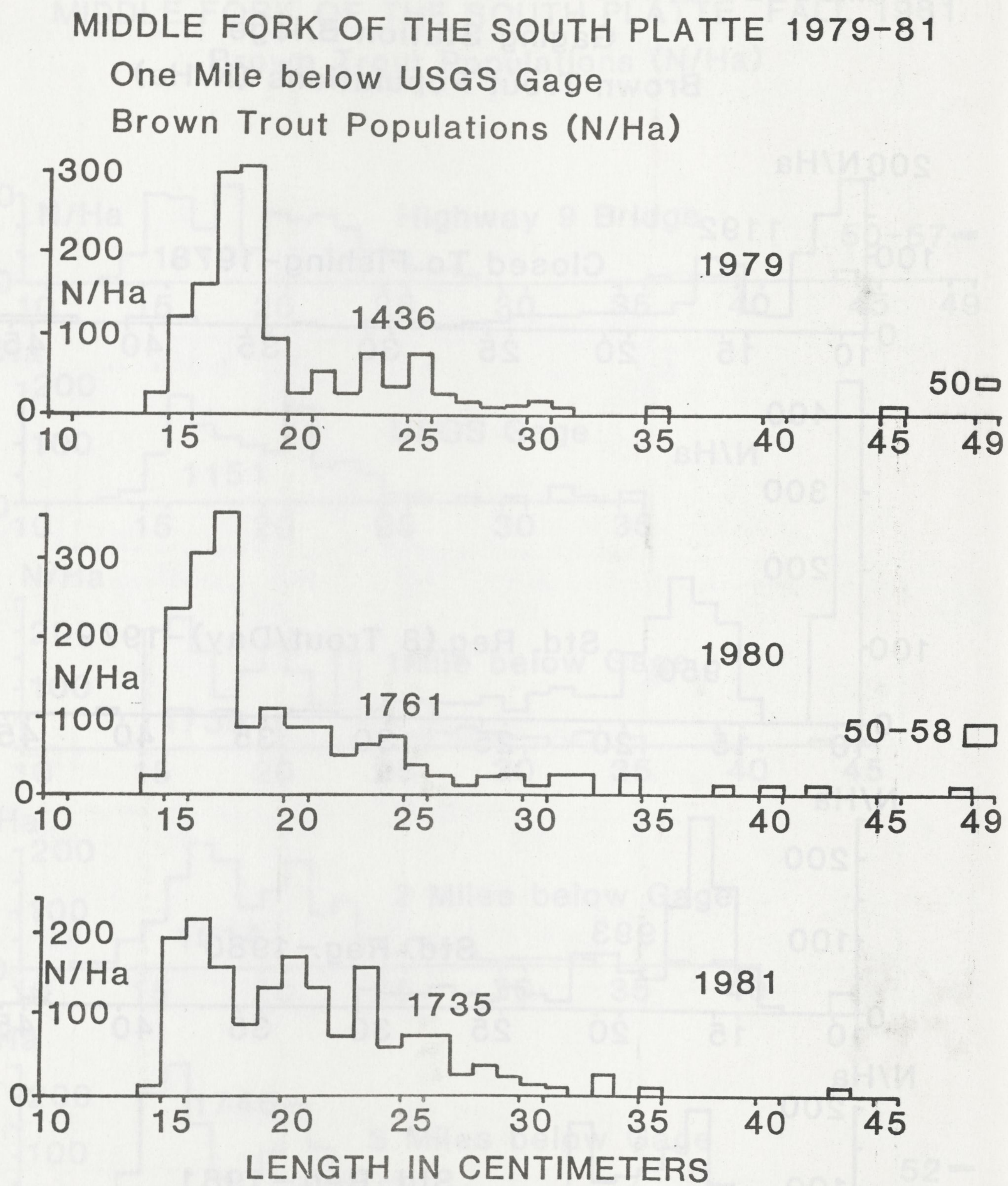
MIDDLE FORK OF THE SOUTH PLATTE FALL 1981
Brown Trout Populations (N/Ha)
150
0
N/Ha
1310
Highway 9 Bridge
50-57
10 15 20 25 30 35 40 45 49
N/Ha
200
100
0
1151
USGS Gage
10 15 20 25 30 35
N/Ha
200
100
1735
1Mile below Gage
10 15 20 25 30 35 40 45
N/Ha
200
100
0
1614
2 Miles below Gage
10 15 20 25 30 35 40
N/Ha
200
100
1746
3 Miles below Gage
52
10 15 20 25 30 35 40 45 49
LENGTH IN CENTIMETERS

MIDDLE FORK OF THE SOUTH PLATTE -1978-1981

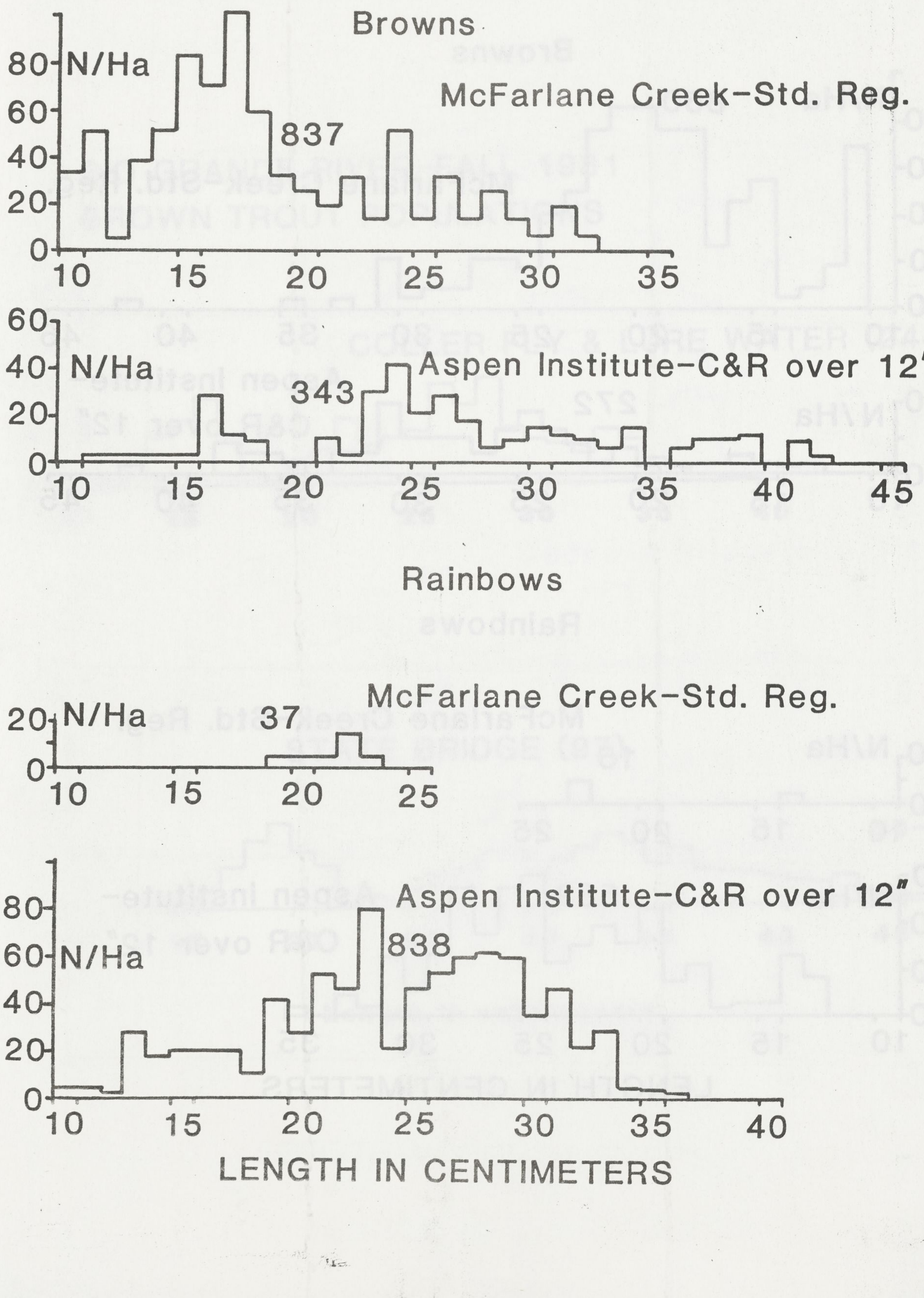
Gaging Station Bridge
Brown Trout Populations (N/Ha)



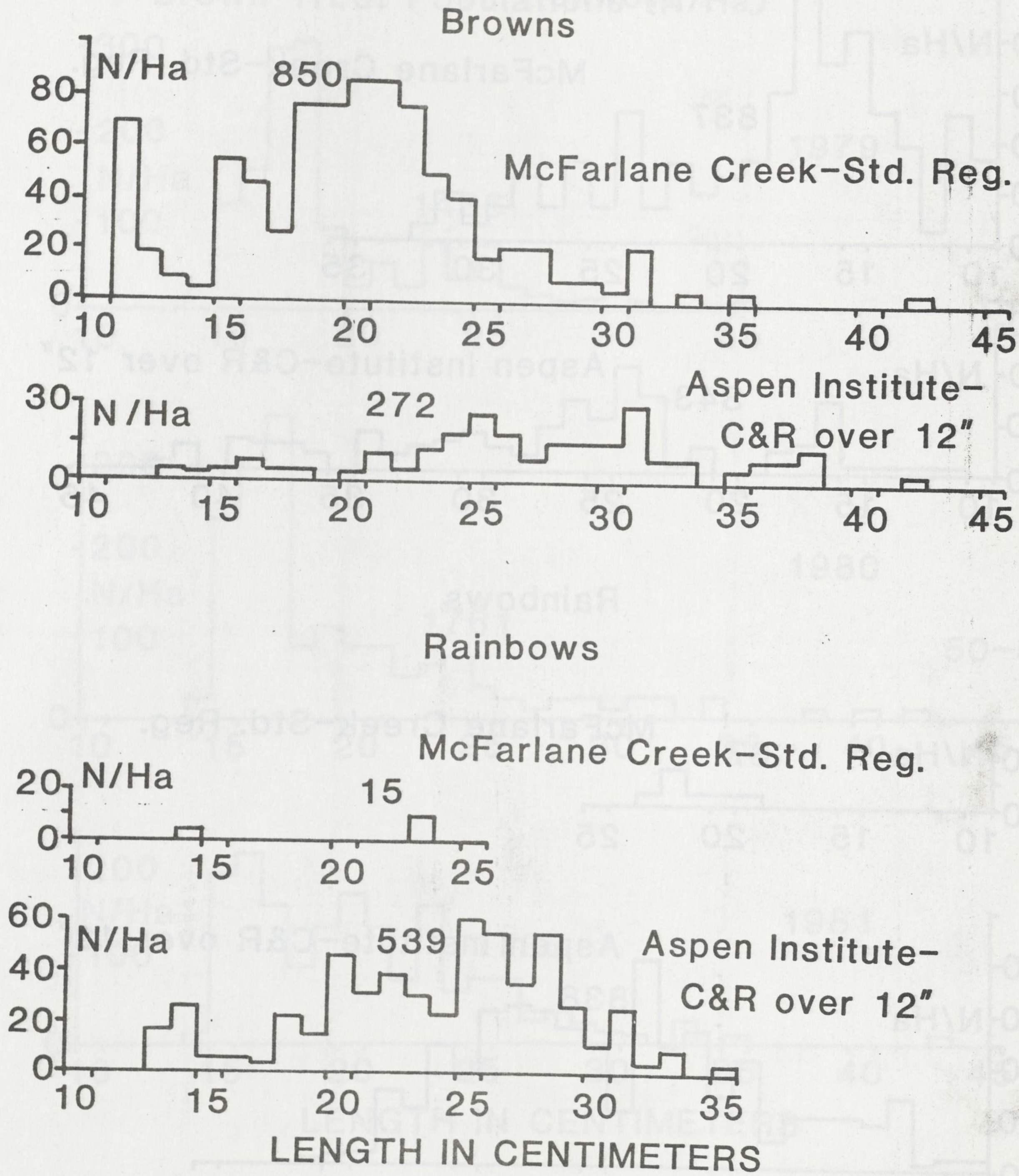
LENGTH IN CENTIMETERS


MIDDLE FORK OF THE SOUTH PLATTE 1979-81
One Mile below USGS Gage
Brown Trout Populations (N/Ha)
300
200
N/Ha
100
0
1436
1979
50
10
15
20
25
30
35
40
45
49
300
200
N/Ha
100
0
1761
1980
50-58
10
15
20
25
30
35
40
45
49
200
N/Ha
100
0
1735
1981
10
15
20
25
30
35
40
45
LENGTH IN CENTIMETERS

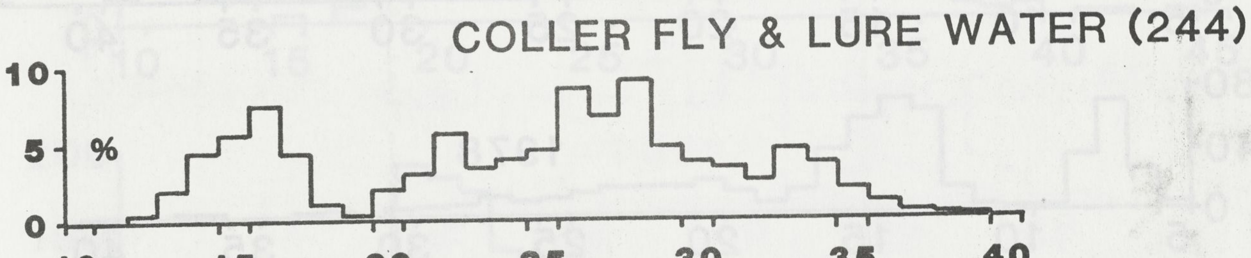
ROARING FORK RIVER -FALL 1979 (N/Ha)

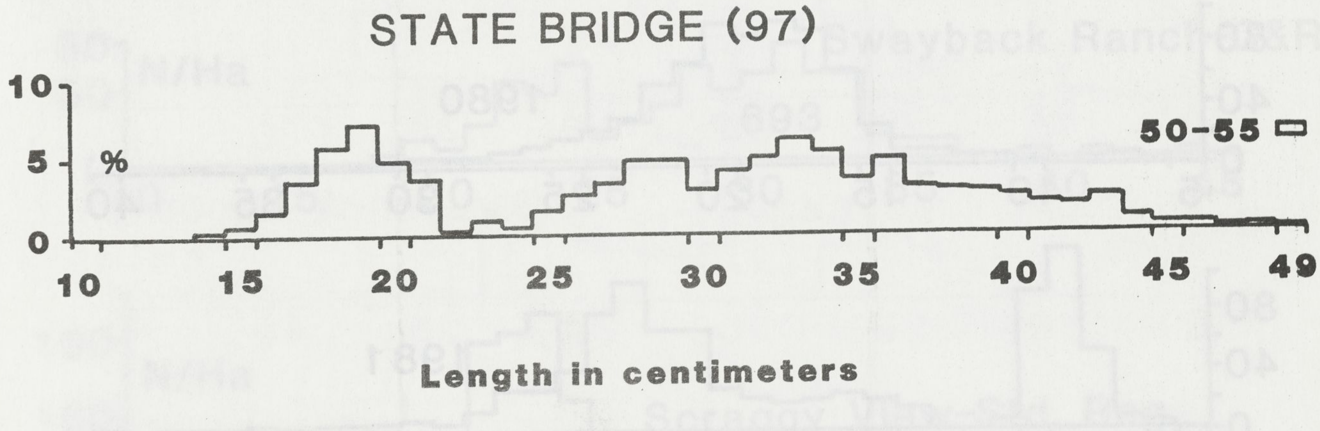


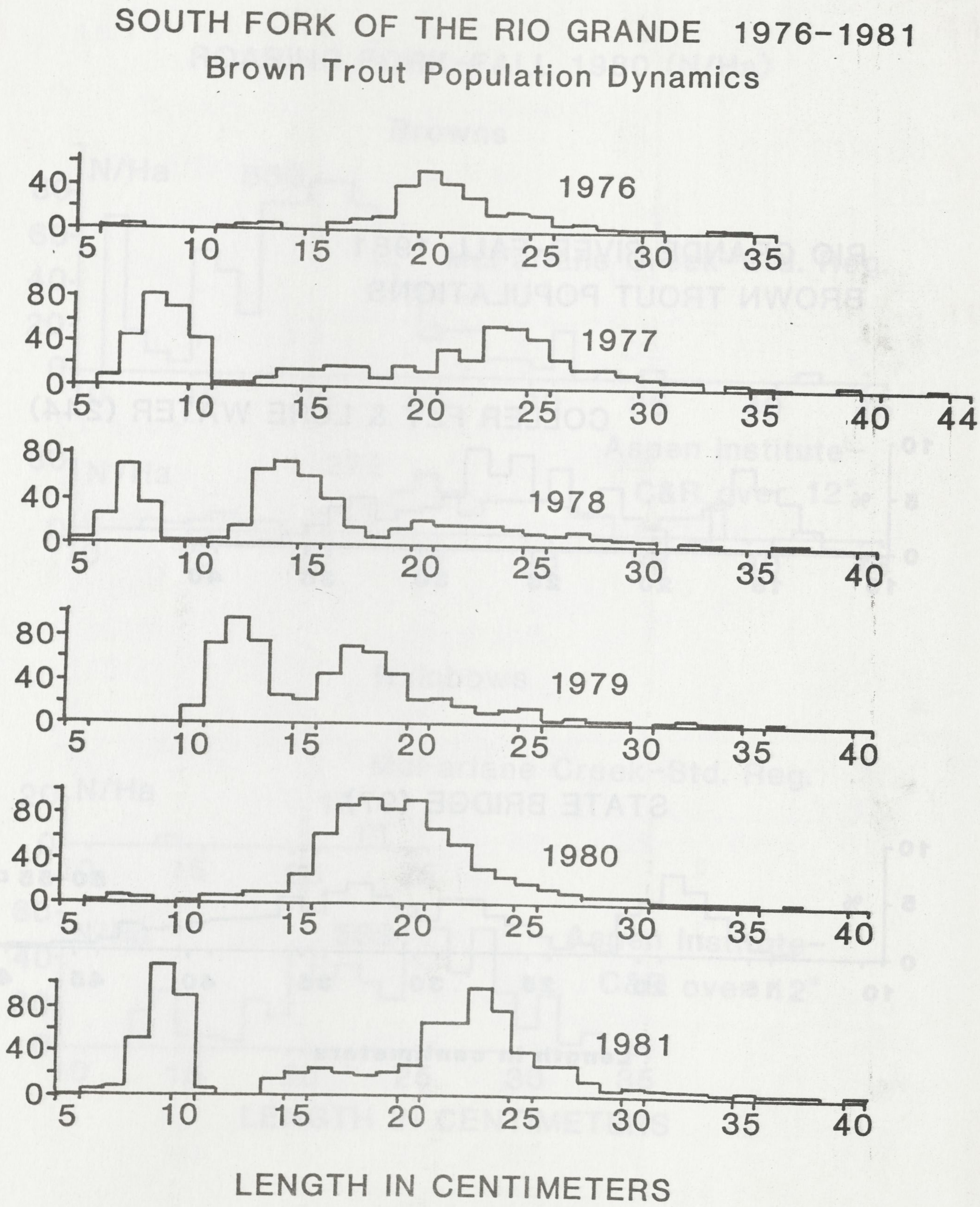
ROARING FORK-FALL 1980 (N/Ha)



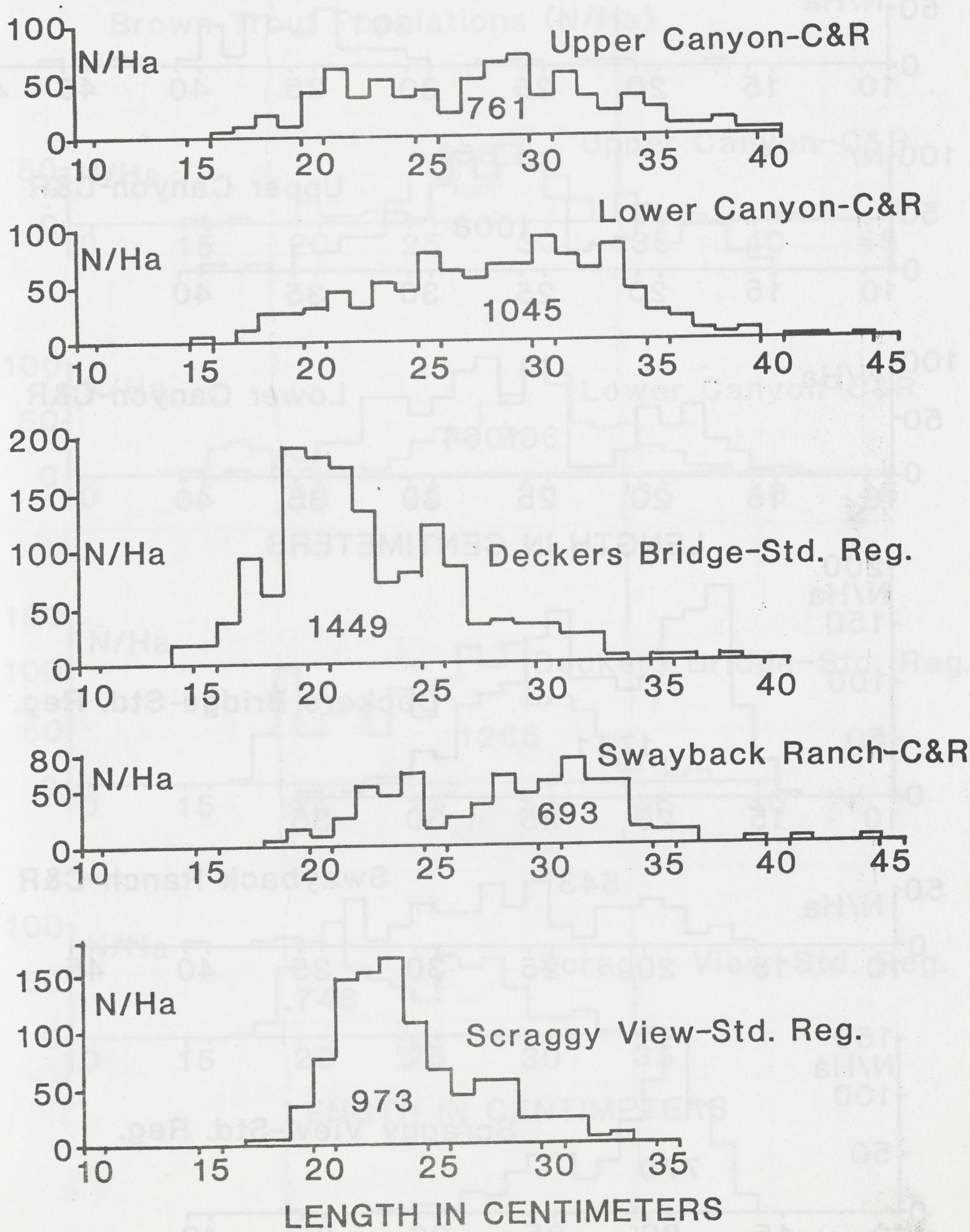
RIO GRANDE RIVER-FALL 1981
BROWN TROUT POPULATIONS



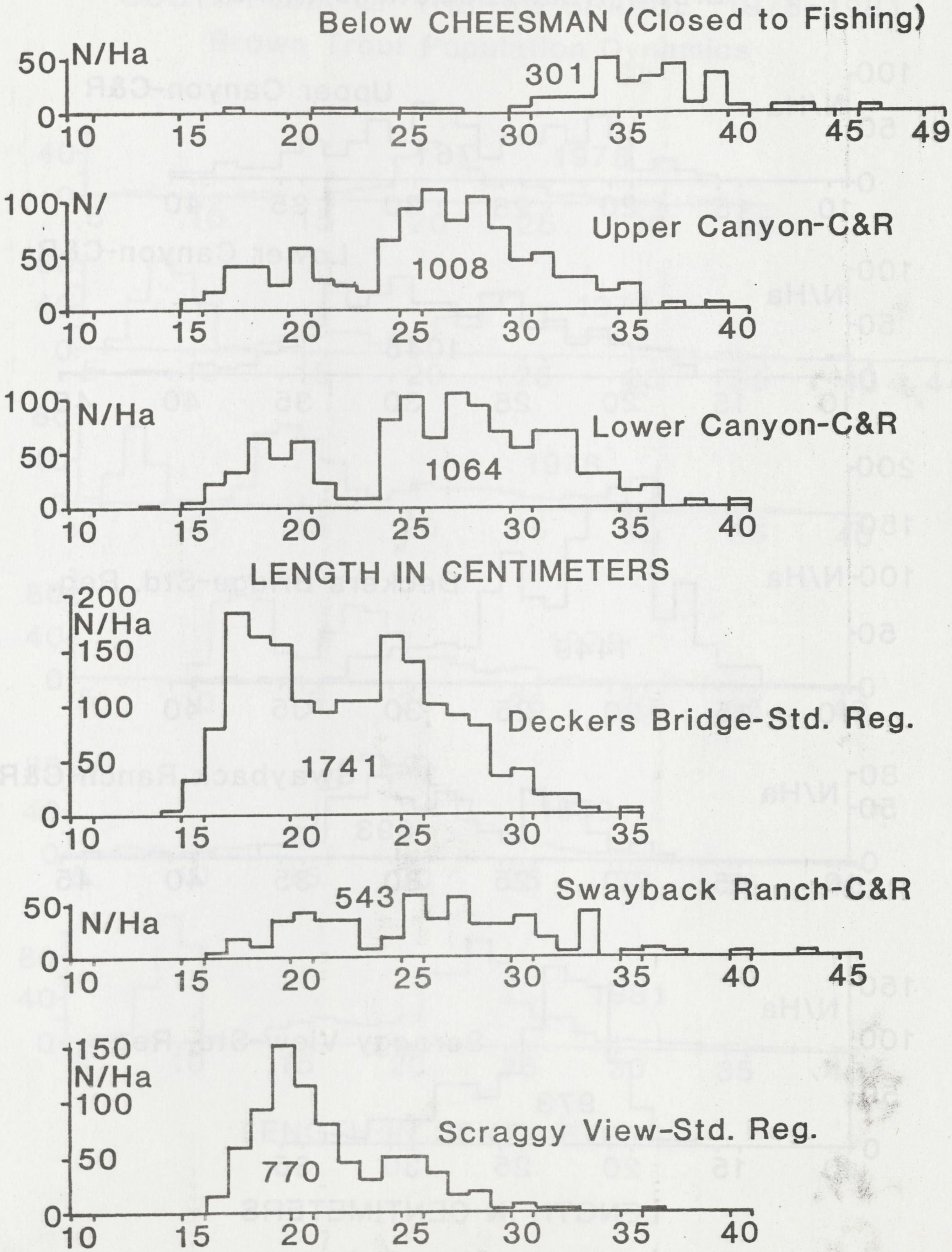


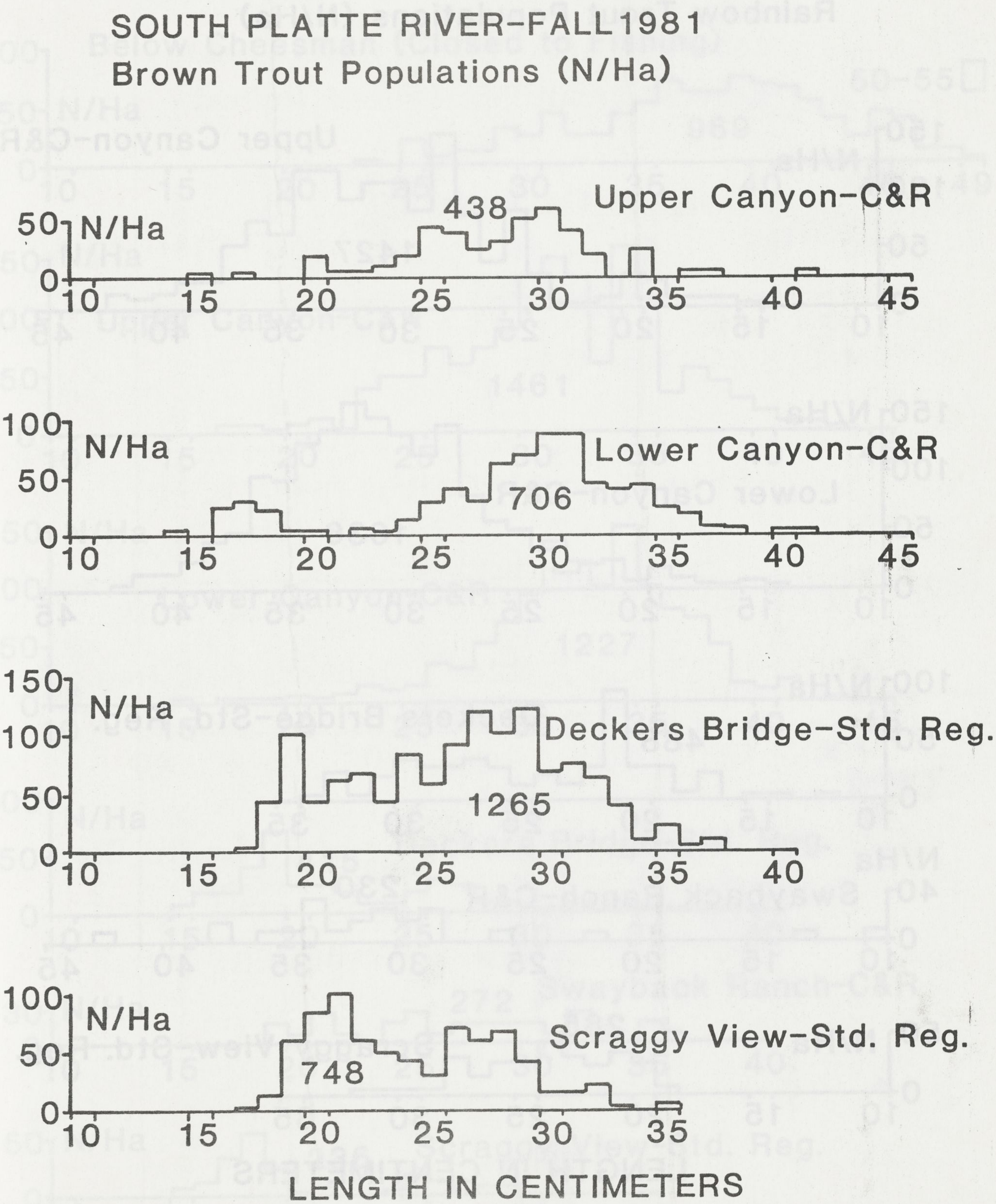

SOUTH FORK OF THE RIO GRANDE 1976-1981
Brown Trout Population Dynamics
1976
1977
1978
1979
1980
1981
0
40
80
5
10
15
20
25
30
35
40
44
LENGTH IN CENTIMETERS

SOUTH PLATTE RIVER-FALL 1979
Brown Trout Populations (N/Ha)



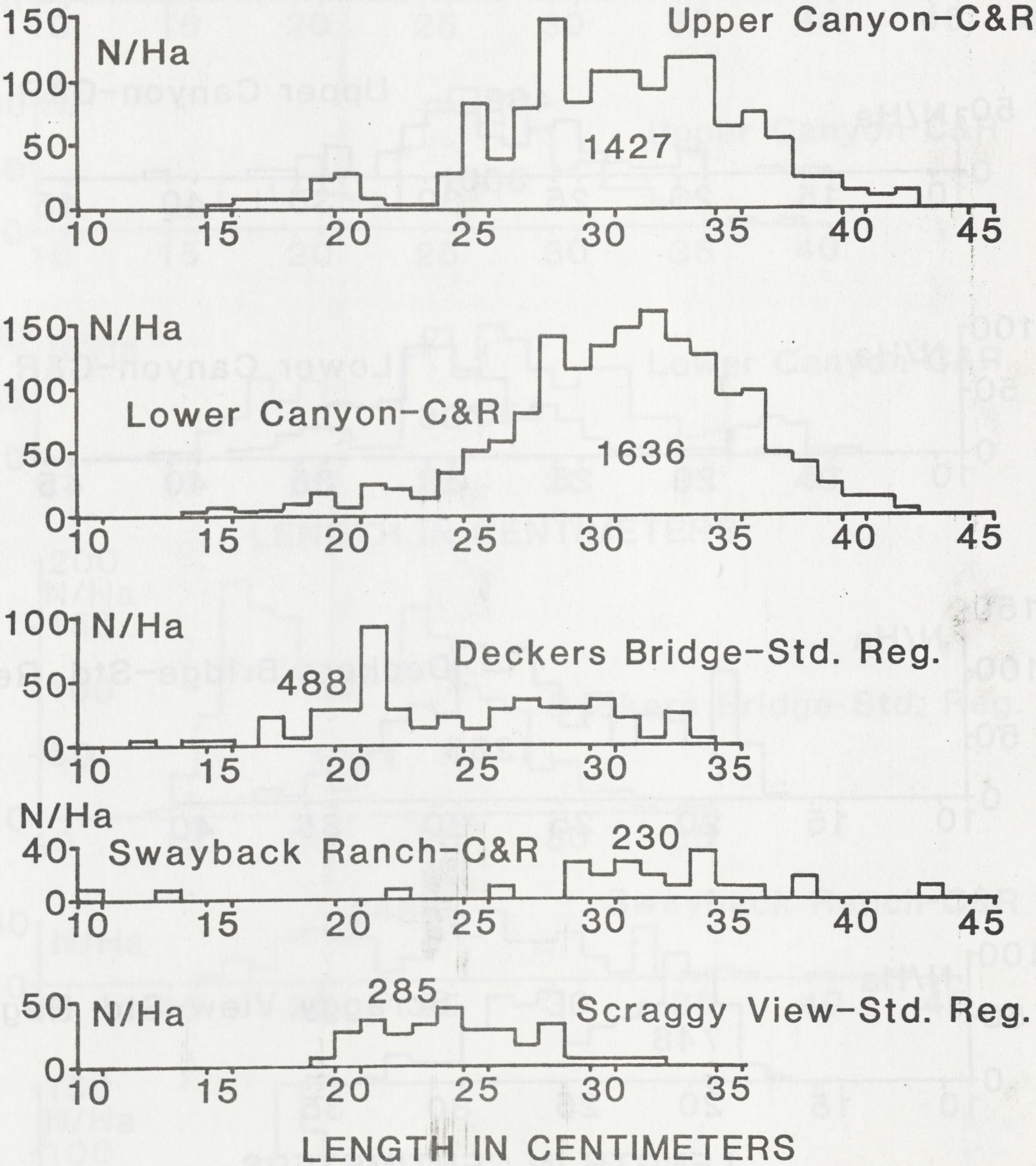
SOUTH PLATTE RIVER-FALL 1980
Brown Trout Populations (N/Ha)



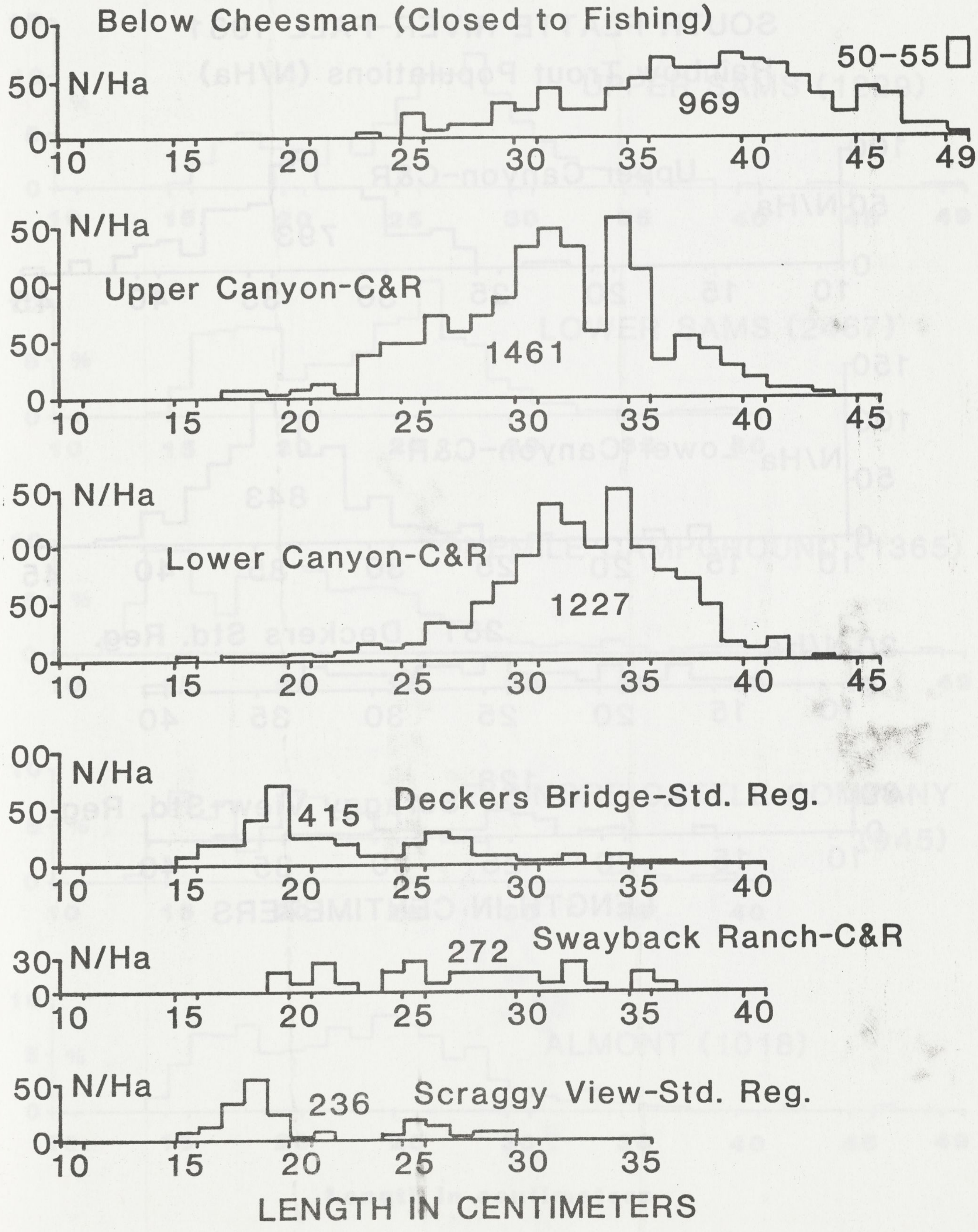

SOUTH PLATTE RIVER-FALL 1981
Brown Trout Populations (N/Ha)
Upper Canyon-C&R
438
N/Ha
Lower Canyon-C&R
706
Deckers Bridge-Std. Reg.
1265
Scraggy View-Std. Reg.
748
LENGTH IN CENTIMETERS

SOUTH PLATTE RIVER - FALL 1979

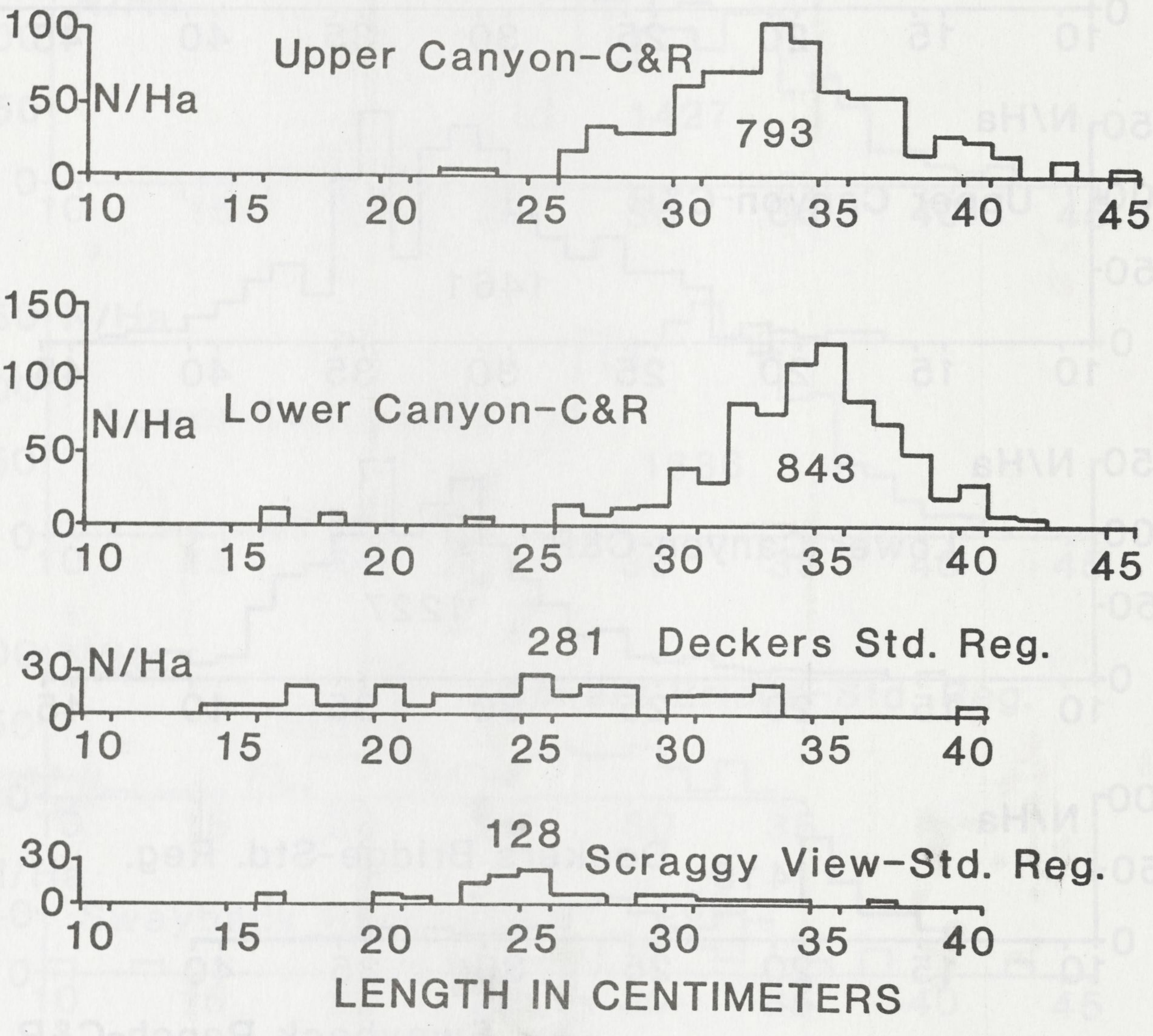
Rainbow Trout Populations (N/Ha)



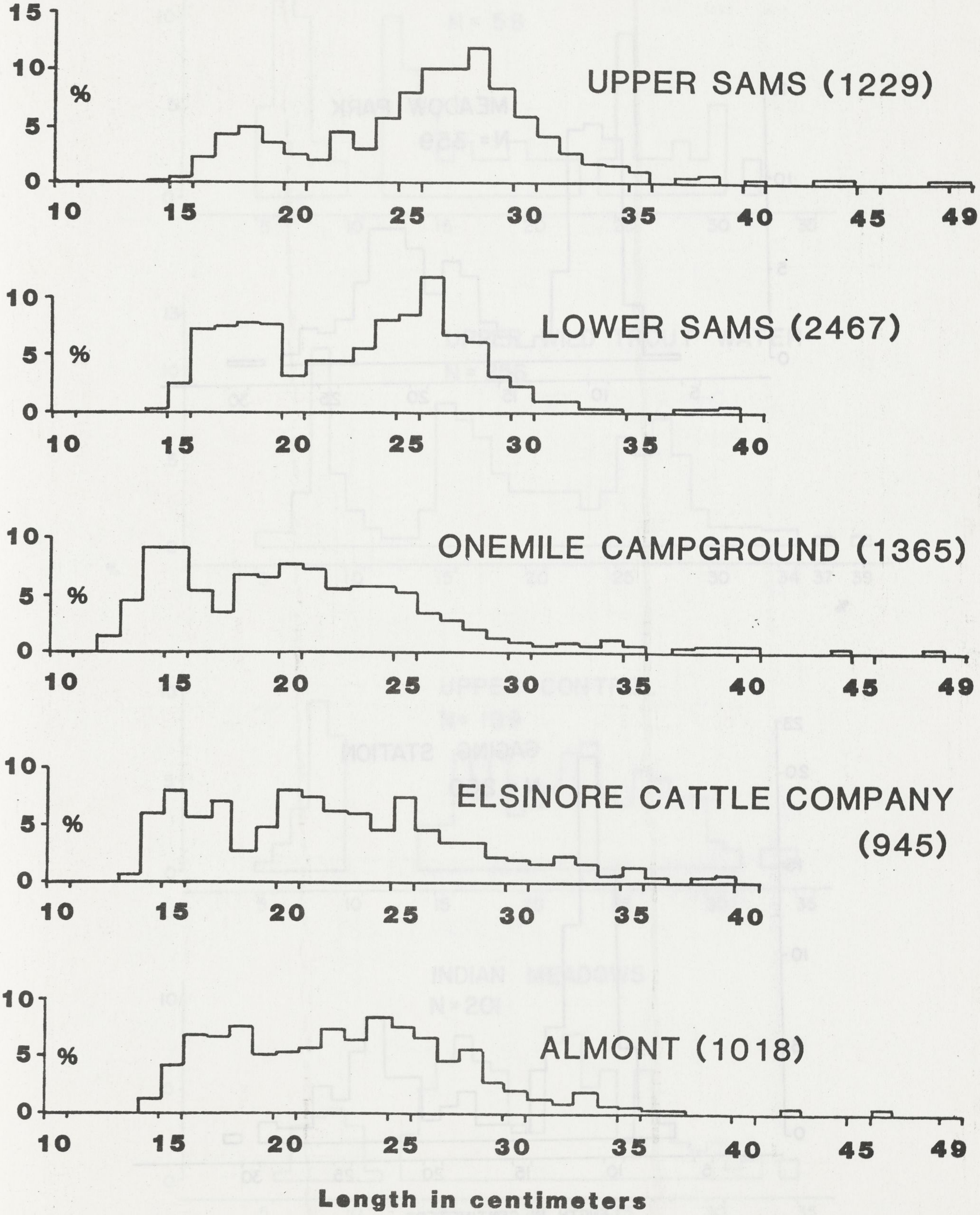
SOUTH PLATTE RIVER-FALL 1980
Rainbow Trout Populations (N/Ha)



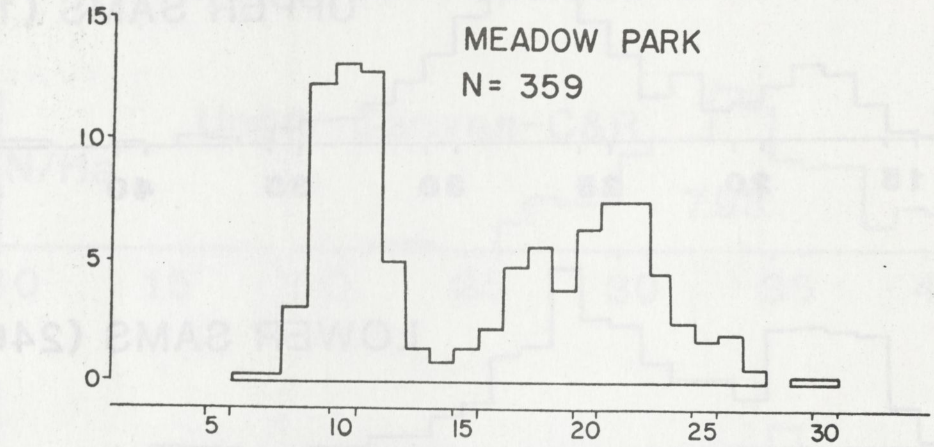
SOUTH PLATTE RIVER-FALL 1981
Rainbow Trout Populations (N/Ha)

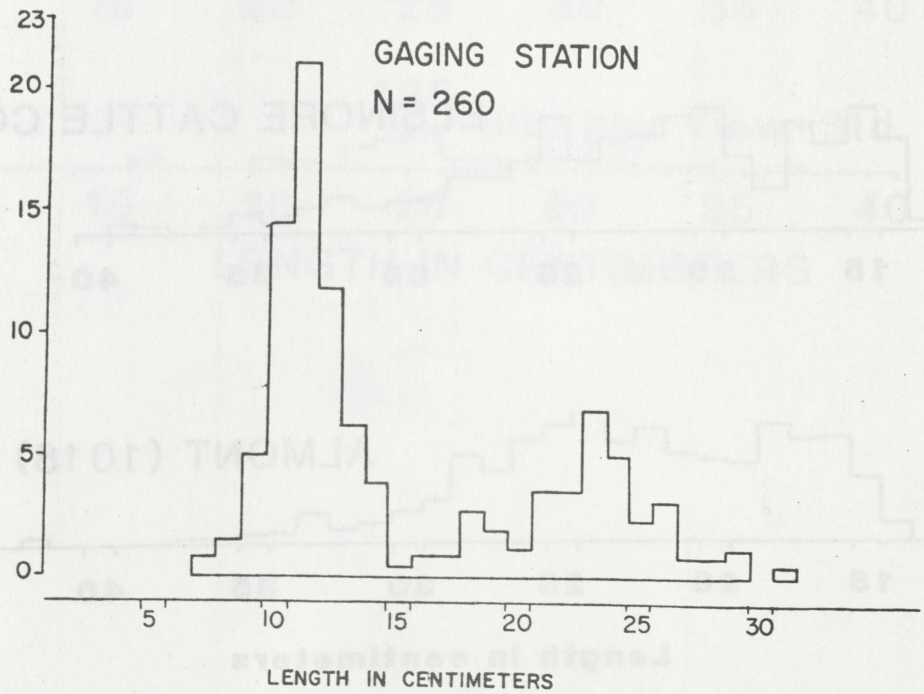


TAYLOR RIVER-FALL 1981
BROWN TROUT POPULATIONS

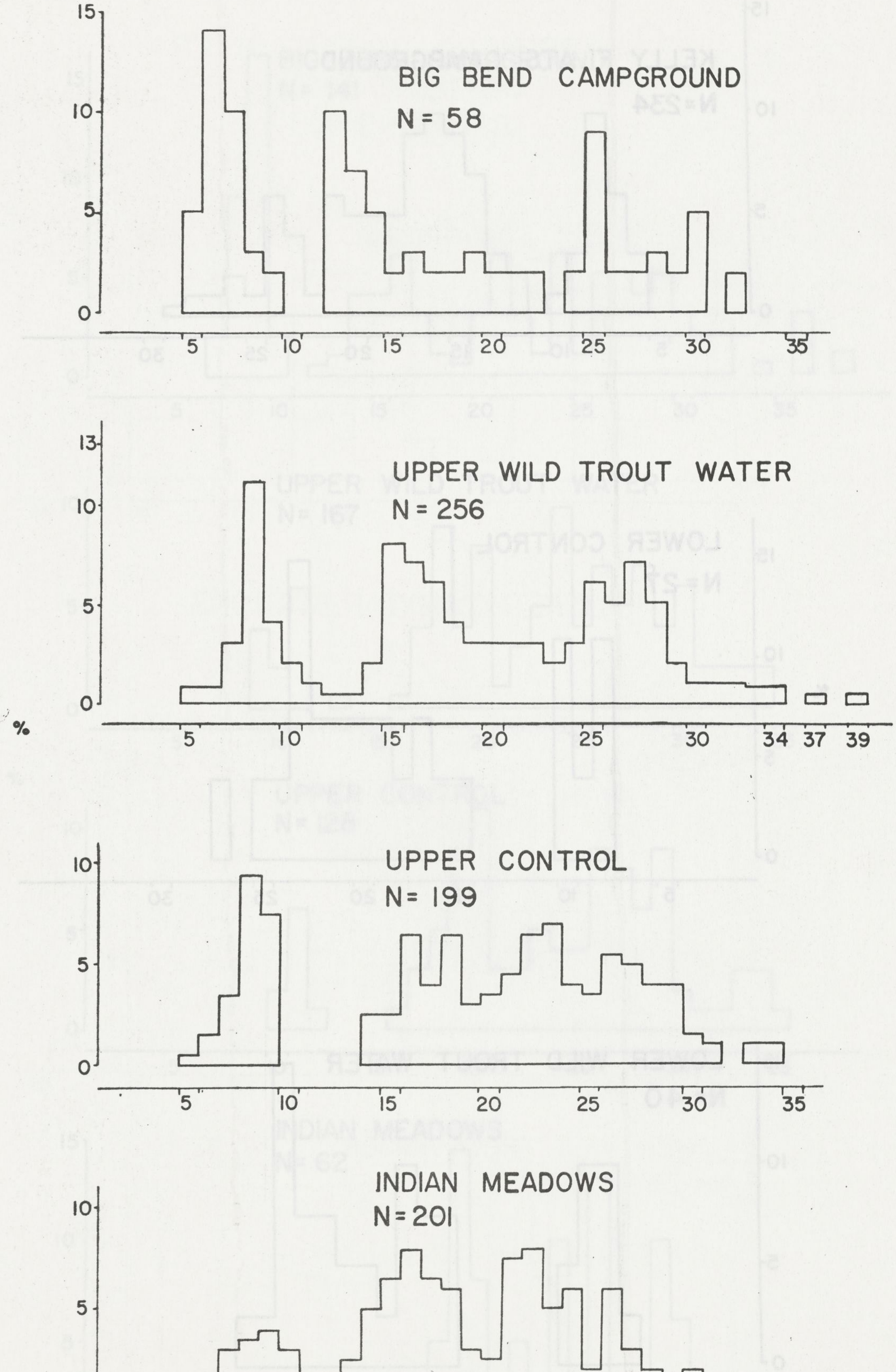


ST VRAIN RIVER
SEPTEMBER 1981
BROWN TROUT

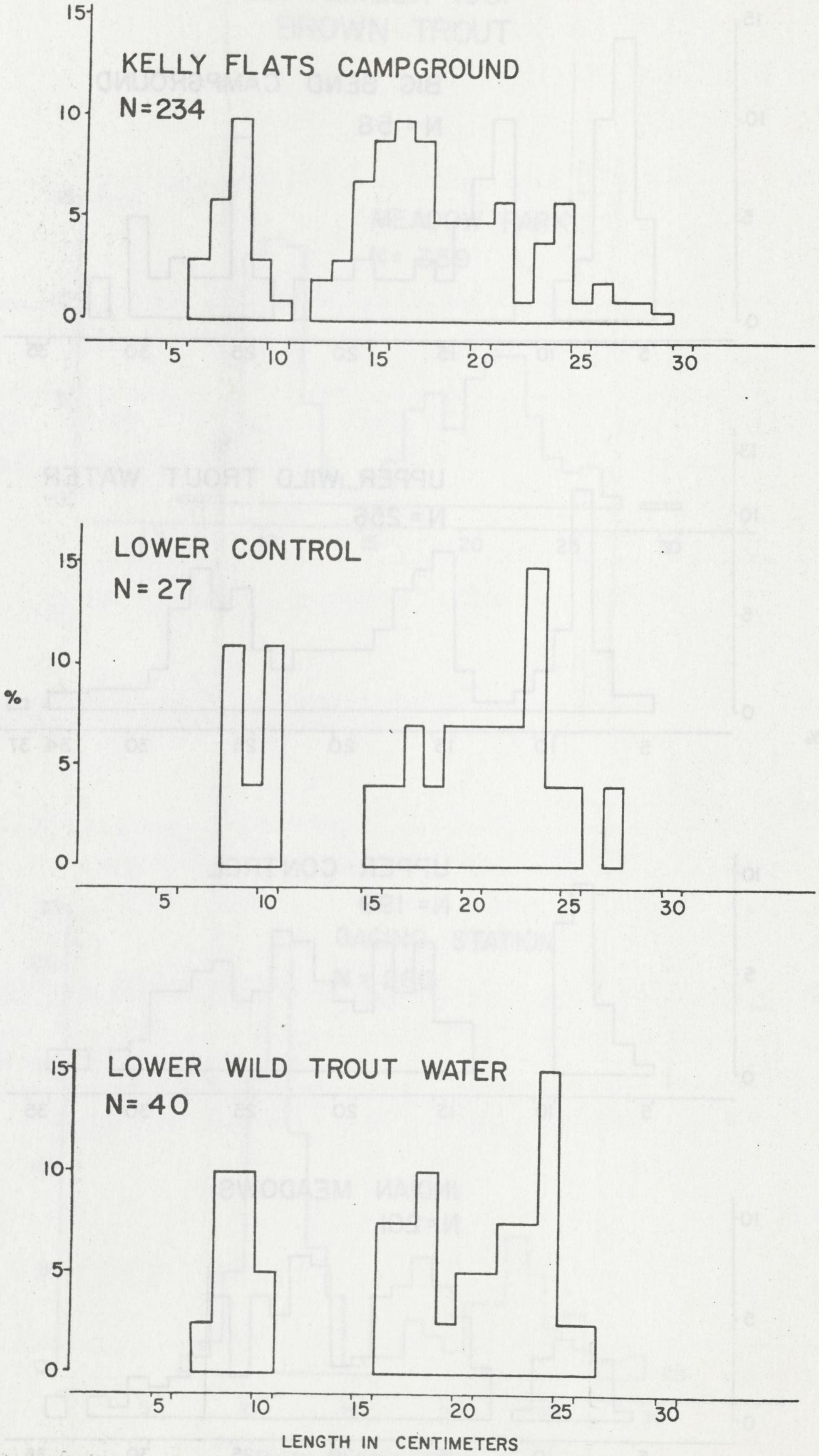




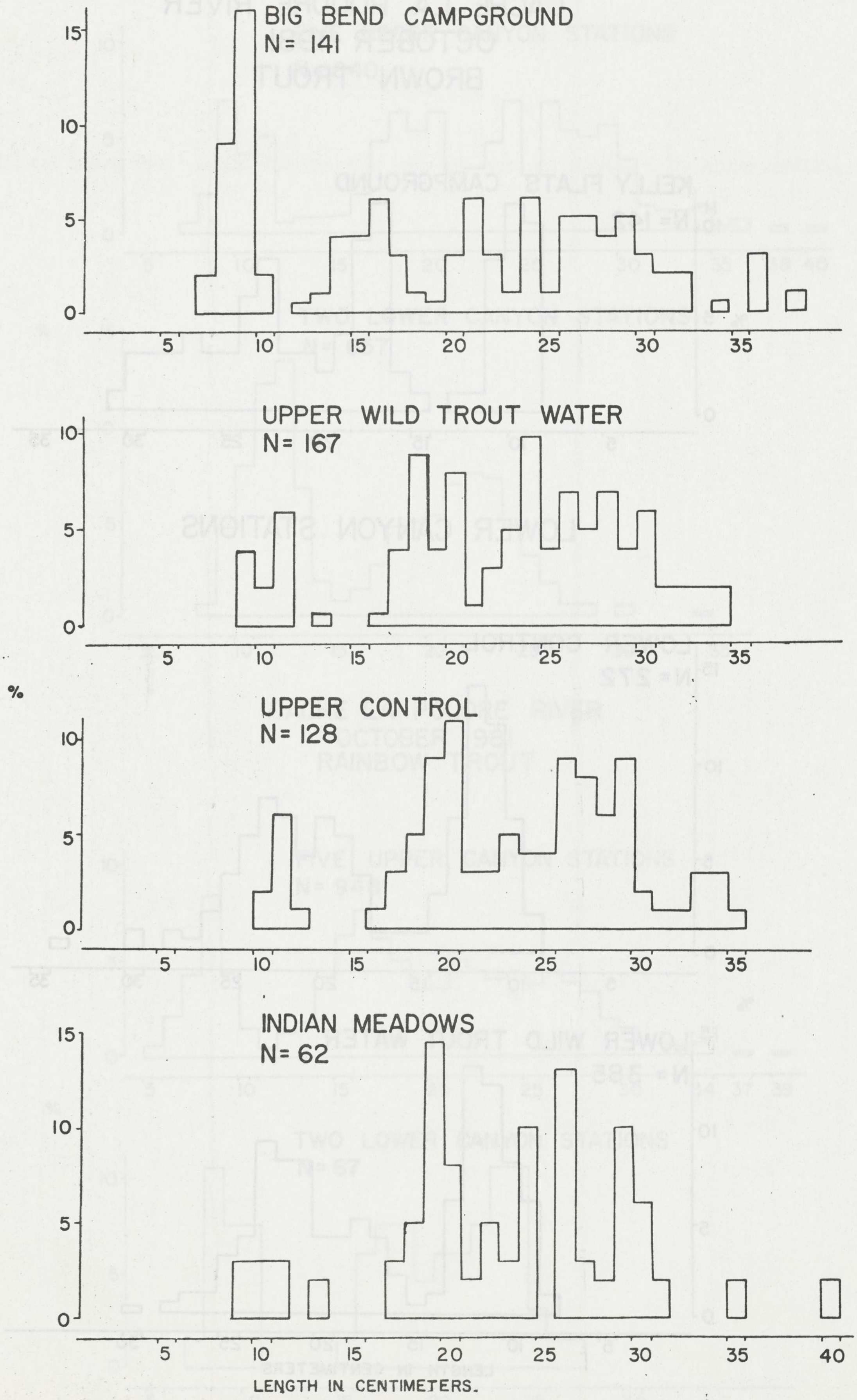
CACHE LA POUDRE RIVER
OCTOBER 1981
RAINBOW TROUT



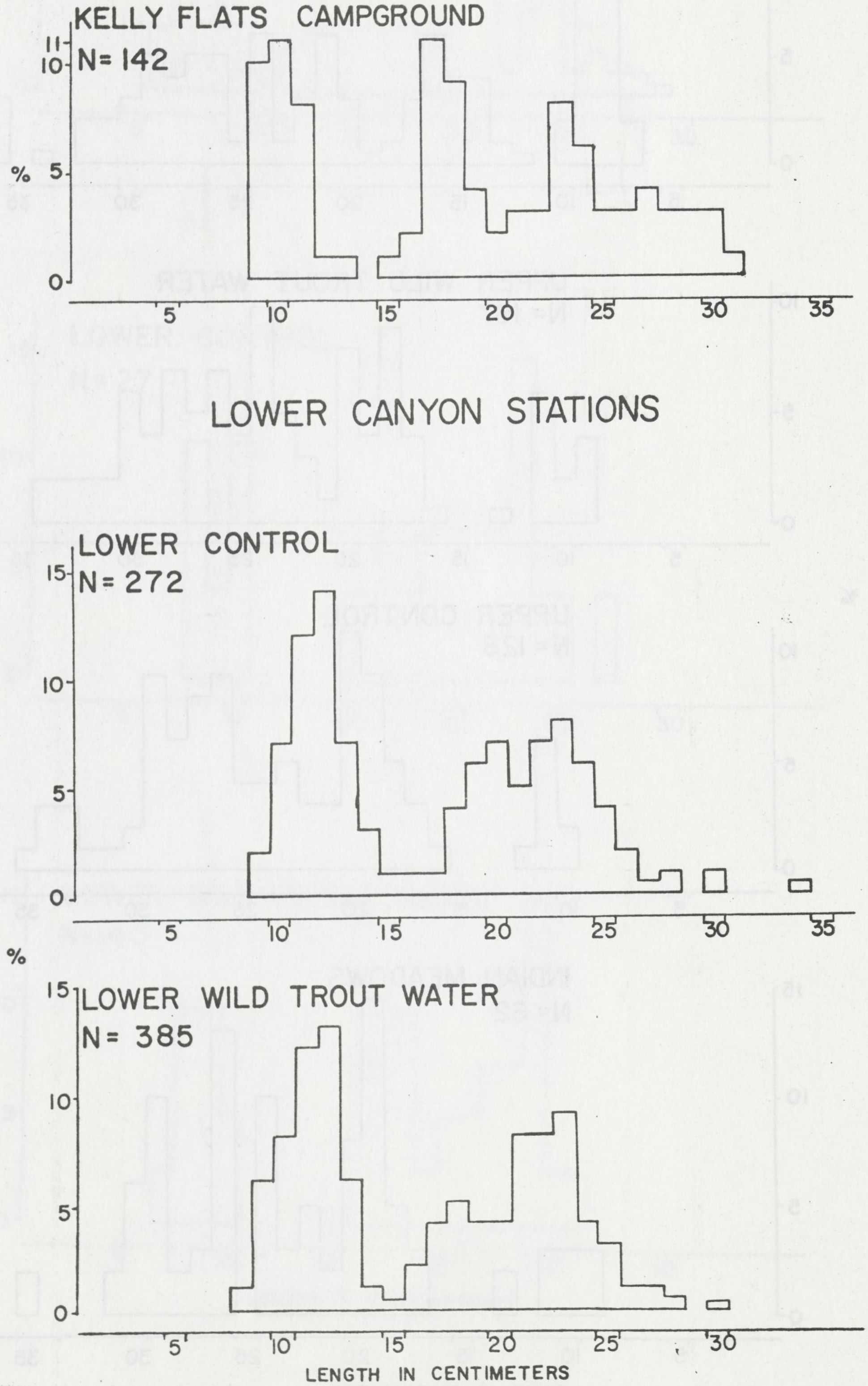
CACHE LA POUDRE RIVER
OCTOBER 1981
RAINBOW TROUT



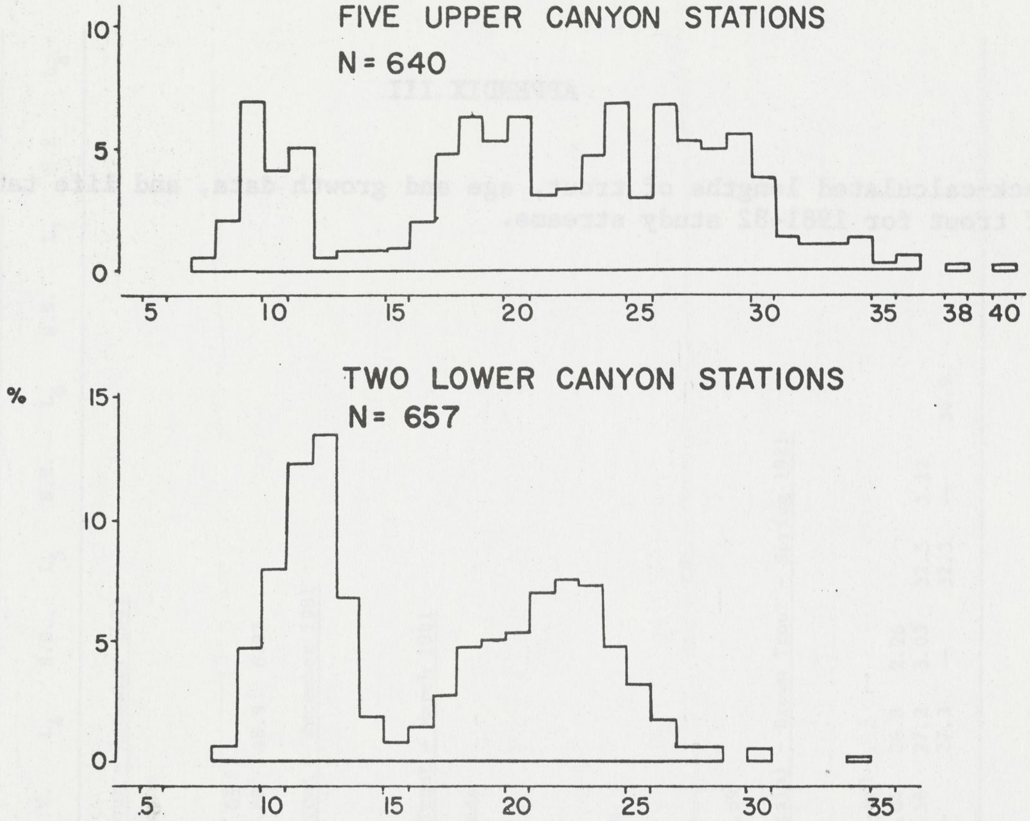
CACHE LA POUDRE RIVER
OCTOBER 1981
BROWN TROUT



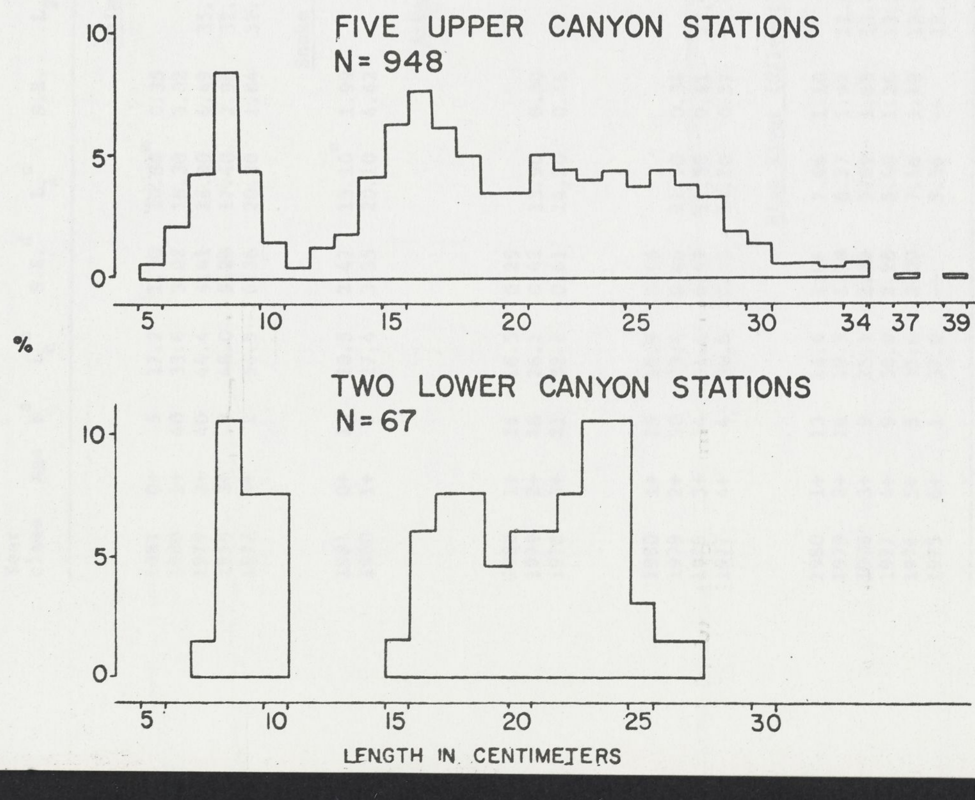
CACHE LA POUDRE RIVER
OCTOBER 1981
BROWN TROUT



CACHE LA POUDRE RIVER
OCTOBER 1981
BROWN TROUT



CACHE LA POUDRE RIVER
OCTOBER 1981
RAINBOW TROUT



APPENDIX III

Back-calculated lengths of trout, age and growth data, and life tables of trout for 1981-82 study streams.

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1980-81.

Year class	Age	N[a]	L_c[b]	S.E.[d]	L_1[c]	S.E.	L_2	S.E.	L_3	S.E.	L_4	S.E.	L_5	S.E.	L_6	S.E.	L_7	S.E.	L_8
Animas River - Brown Trout - December 1981																			
1981	0+	5	17.2	1.30	10.80[e]	0.35													
1980	1+	40	33.6	3.02	18.30	3.02													
1979	2+	40	44.4	4.41	18.80	6.49	35.7	5.12											
1978	3+	3	48.0	5.20	17.40	2.98	32.3	2.75	38.6	3.65									
1977	4+	2	54.5	6.36	20.20	1.84	32.4	0.50	43.0	4.88	48.9	6.93							
Snake River - Cutthroat Trout - December 1981																			
1981	0+	13	20.5	2.47	13.10[e]	1.99													
1980	1+	7	27.4	3.55	20.10	4.42													
Arkansas River - Brown Trout - March 1981																			
Loma Linda																			
1980	1+	16	16.5	0.29															
1979	2+	48	26.1	0.42	13.90	0.30													
1978	3+	21	32.2	0.61	14.20	0.46	25.0	0.53											
Salida																			
1980	1+	15	15.9	0.46															
1979	2+	50	23.4	0.46	11.70	0.34													
1978	3+	34	31.4	0.57	12.50	0.41	23.4	0.62											
1977	4+	4	36.8	0.25	14.20	0.37	24.4	1.27	30.7	0.69									
Blue River (Silverthorne to Green Mountain) - Brown Trout - Spring 1981																			
1980	1+	13	14.6	1.04	7.66	1.10													
1979	2+	16	19.3	1.98	6.27	1.92	12.9	1.79											
1978	3+	9	25.1	2.32	5.89	1.63	13.3	2.51	19.8	2.11									
1977	4+	9	30.8	2.28	5.68	1.26	13.5	3.04	20.1	2.04	26.8	2.26							
1976	5+	5	35.0	2.00	7.16	1.10	13.4	1.90	18.7	1.58	27.2	3.03	32.5	3.12					
1975	6+	1	37.0	--	5.36	--	12.3	--	18.2	--	27.3	--	32.3	--	34.9				

[a] N = Number of samples
[b] L_c = Length of time of collection
[c] L_n = Back-calculated length at Age N
[d] S.E. = Standard Error
[e] Planting check - not annulus

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1980-81 (continued).

Year class	Age	N	L_c	S.E.	L_1	S.E.	L_2	S.E.	L_3	S.E.	L_4	S.E.	L_5	S.E.	L_6	S.E.	L_7	S.E.	L_8
Cache la Poudre River (Upper Station) - Rainbow Trout - Fall 1981																			
1981	0+	208	7.9	0.09															
1980	1+	26	16.1	0.33	7.50	0.30													
1979	2+	23	22.5	0.44	6.30	0.20	15.7	0.40											
1978	3+	18	26.4	0.56	7.30	0.38	15.5	0.59	21.8	0.59									
1977	4+	12	30.2	0.63	6.80	0.21	15.3	0.51	21.5	0.64	25.2	0.83							
Cache la Poudre River (Upper Station) - Brown Trout - Fall 1981																			
1981	0+	123	9.7	0.11															
1980	1+	23	16.8	0.45	7.60	0.20													
1979	2+	34	23.1	0.33	7.40	0.19	16.0	0.34											
1978	3+	25	27.7	0.25	7.70	0.25	16.5	0.49	22.8	0.47									
1977	4+	12	30.5	0.73	7.80	0.23	14.9	0.76	26.6	0.87									
Cache la Poudre River (Lower Station) - Rainbow Trout - Fall 1981																			
1981	0+	18	8.8	0.23															
1980	1+	14	18.0	0.57	7.90	0.23													
1979	2+	13	23.8	0.43	8.10	0.51	18.9	0.56											
Cache la Poudre River (Lower Station) - Brown Trout - Fall 1981																			
1981	0+	313	11.3	0.08															
1980	1+	24	18.9	0.39	8.70	0.28													
1979	2+	28	23.6	0.42	9.20	0.27	18.7	0.36											
Colorado River (Hot Sulphur Springs) - Rainbow Trout - April 1981																			
1980	1+	4	22.8	0.96	8.47	1.09													
1979	2+	11	25.8	2.44	8.14	1.22	17.6	2.60											
1978	3+	20	33.2	3.98	7.80	1.48	19.7	2.55	27.7	3.62									
1977	4+	22	39.7	4.34	8.13	1.03	18.4	3.40	27.0	4.43	33.8	3.88							

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1980-81 (continued).

Year class	Age	N	L_c	S.E.	L_1	S.E.	L_2	S.E.	L_3	S.E.	L_4	S.E.	L_5	S.E.	L_6	S.E.	L_7	S.E.	L_8
Colorado River (Hot Sulphur Springs) - Rainbow Trout - Fall 1981																			
1980	1+	11	16.4	1.69	7.12	1.10													
1979	2+	5	26.2	2.95	8.56	1.32	17.7	1.45											
Colorado River (Chimney Rock Ranch) - Rainbow Trout- Fall 1981																			
1980	1+	2	17.0	--	8.36	0.61													
Colorado River (Windy Gap Ranch) - Rainbow Trout - Fall 1981																			
1980	1+	1	18.0	--	6.17	--													
1978	3+	3	29.0	--	16.40	--	22.1	--											
Colorado River (Chimney Rock Ranch) - Brown Trout - Fall 1981																			
1980	1+	1	18.0	--	8.78	--													
1979	2+	3	29.3	5.51	8.61	0.87													
1978	3+	1	36.0	--	7.83	--	21.9	--	30.8	--									
Colorado River (Windy Gap Ranch) - Brown Trout - Fall 1981																			
1980	1+	2	23.5	3.53	13.60	1.84													
1979	2+	4	30.3	4.11	8.39	3.76	20.4	3.96											
1978	3+	2	30.5	0.71	7.52	0.61	17.4	1.56	23.8	2.62									
Colorado River (Hot Sulphur Springs) - Brown Trout - Fall 1981																			
1980	1+	10	20.1	1.73	8.72	1.29													
1979	2+	5	24.8	2.28	9.32	1.68	19.3	2.58											
1978	3+	1	33.0	--	12.20	--	23.9	--	28.9	--									

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1980-81 (continued).

Year class	Age	N	L_c	S.E.	L_1	S.E.	L_2	S.E.	L_3	S.E.	L_4	S.E.	L_5	S.E.	L_6	S.E.	L_7	S.E.	L_8
						Colorado River (Below Williams Fork) - Brown Trout - Fall 1981													
1980	1+	2	15.0	2.83	6.49	2.84													
1979	2+	26	28.7	4.04	8.74	0.99	20.3	3.58											
1978	3+	23	35.7	3.21	9.16	1.67	22.5	3.16	30.3	3.09									
1977	4+	5	40.0	3.00	10.70	1.87	18.0	0.28	28.8	2.38	33.7	1.89							
1976	5+	1	42.0	--	7.00	--	19.0	--	24.0	--	30.5	--	37.5	--					
1975	6+	1	57.0	--	11.80	--	25.9	--	43.4	--	47.4	--	50.4	--	54.4	--			
						Colorado River (Below Williams Fork) - Rainbow Trout - Fall 1981													
1981	0+	5	8.2	0.45															
1980	1+	25	17.5	1.92	7.12	1.16													
1979	2+	41	23.8	4.33	7.08	1.57	17.6	2.39											
1978	3+	54	35.7	4.51	7.51	1.60	19.8	3.92	29.5	3.36									
1977	4+	57	41.1	4.22	7.10	1.55	19.5	3.82	28.6	4.16	36.2	3.80							
1976	5+	6	46.5	4.76	6.41	0.48	19.7	4.40	27.6	4.93	34.6	5.21	40.9	3.86					
1975	6+	1	47.0	--	4.27	--	19.0	--	26.1	--	31.8	--	38.9	--	42.7				
						Eagle River (Wolcott to Eagle) - Rainbow Trout - Fall 1981													
1981	0+	1	10.0	--															
1980	1+	23	22.9	2.10	8.31	1.37													
1979	2+	10	27.6	5.15	8.75	3.60	21.0	4.99											
1978	3+	2	37.0	28.3	--	--	--	--	--	--									
1977	4+	1	43.0	--	--	--	--	--	--	--	--	--							
						Eagle River (Wolcott to Eagle) - Brown Trout - Fall 1981													
1981	0+	2	12.5	3.00															
1980	1+	24	19.3	3.24	7.69	1.79													
1979	2+	35	28.8	5.86	9.57	2.14	22.1	3.09											
1978	3+	26	33.8	2.21	9.45	2.48	20.8	4.28	29.1	2.82									
1977	4+	1	36.0	--	5.26	--	11.9	--	26.3	--	32.5	--							
1976	5+	1	43.0	--	10.70	--	--	--	27.9	--	35.0	--	38.2	--					

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1980-81 (continued).

Year class	Age	N	L_c	S.E.	L_1	S.E.	L_2	S.E.	L_3	S.E.	L_4	S.E.	L_5	S.E.	L_6	S.E.	L_7	S.E.	L_8
Fryingpan River (Catch & Release Area) - Rainbow Trout - Fall 1980																			
1980	0+	1	10.0	--															
1979	1+	8	13.9	0.99	10.10	1.99													
1978	2+	16	20.8	3.00	8.51	2.44	15.9	2.15											
1977	3+	15	29.8	4.59	8.68	2.07	16.7	3.02	24.5	4.20									
1976	4+	17	33.4	4.51	8.19	2.11	14.0	3.92	21.2	4.86	28.5	4.95							
1975	5+	7	35.1	5.79	7.96	1.68	14.5	2.46	20.1	2.72	25.7	4.69	30.8	5.08					
1974	6+	2	40.0	1.41	7.69	1.85	15.0	0.21	19.4	0.21	22.7	0.05	28.6	3.14	35.6	0.60			
Fryingpan River (8 Trout/Day Harvest Area) - Rainbow Trout - Fall 1980																			
1979	1+	21	13.8	3.25	7.20	2.10													
1978	2+	16	20.1	2.82	8.42	1.98	15.6	2.31											
1977	3+	10	26.0	3.56	7.36	1.68	14.3	4.18	21.5	4.15									
1976	4+	4	31.0	3.56	5.57	1.20	13.1	1.84	21.2	2.57	26.6	1.98							
1975	5+	0																	
1974	6+	1	31.0	--	5.17	--	9.5	--	13.4	--	20.7	--	26.3	--	29.3	--			
Fryingpan River (Catch & Release Area) - Brown Trout - Fall 1980																			
1980	0+	1	11.0	--															
1979	1+	14	11.7	1.94	6.76	1.25													
1978	2+	30	20.9	2.36	7.26	2.06	15.8	2.17											
1977	3+	37	28.5	3.02	7.44	1.67	16.2	2.73	23.9	2.95									
1976	4+	16	35.4	3.30	7.89	2.01	14.6	3.56	24.0	2.85	30.6	3.46							
Fryingpan River (8 Trout/Day Harvest Area) - Brown Trout - Fall 1980																			
1979	1+	22	13.8	1.88	7.20	1.29													
1978	2+	9	18.8	3.31	6.82	1.43	15.2	3.26											
1977	3+	1	21.0	--	6.42	--	14.6	--	18.1	--									
1976	4+	2	37.5	2.12	7.13	0.11	19.2	1.36	27.5	3.64	32.6	0.91							

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1980-81 (continued).

Year class	Age	N	L_c	S.E.	L_1	S.E.	L_2	S.E.	L_3	S.E.	L_4	S.E.	L_5	S.E.	L_6	S.E.	L_7	S.E.	L_8
Fryingpan River - Brook Trout - Fall 1980																			
1980	0+	1	11.0	--															
1979	1+	13	15.5	1.13	10.00	1.56													
1978	2+	35	21.7	2.52	9.10	1.58	16.9	2.69											
1977	3+	11	27.8	3.25	9.45	1.62	16.8	2.52	22.7	2.92									
1976	4+	2	36.5	4.94	9.29	1.22	16.8	1.40	24.7	0.81	32.6	3.03							
Fryingpan River - Cutthroat Trout - Fall 1980																			
1979	1+	1	19.0	--	10.70	--													
1978	2+	3	20.3	1.53	6.94	1.85	13.5	1.30											
1977	3+	2	30.5	4.95	9.90	--	14.9	0.67	24.4	2.70									
Fryingpan River - Brown Trout - Spring 1980																			
1979	2	10	17.8	2.10	8.24	1.89													
1978	3	24	24.5	4.19	7.99	1.99	17.2	2.78											
1977	4	19	29.0	3.00	6.32	1.34	15.0	3.06	22.7	2.93									
1976	5	8	32.0	3.34	7.56	2.61	13.6	2.65	18.4	3.36	27.2	3.96							
1975	6	2	42.0	7.07	6.76	0.61	20.2	5.84	26.9	4.98	33.7	6.32	39.4	6.10					
1974	7	1	55.0	--	13.00	--	--	--	30.6	--	45.9	--	50.5	--	52.7	--			
1973	8	1	58.0	--	12.50	--	21.9	--	30.8	--	40.2	--	44.4	--	48.6	--	53.3	--	
Fryingpan River - Rainbow Trout - Spring 1980																			
1978	3	6	30.4	5.45	9.92	1.75	23.1	4.62											
1977	4	8	32.6	2.97	7.28	2.21	14.7	5.14	25.1	3.76									
1976	5	7	35.4	2.99	8.08	1.09	15.2	2.49	24.7	2.98	30.5	2.23							
1975	6	3	35.7	3.51	5.64	0.65	11.2	1.88	20.1	2.82	26.9	5.40	31.5	4.40					
1974	7	1	34.0	--	5.06	--	8.7	--	13.7	--	19.2	--	24.6	--	29.3				

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1980-81 (continued).

Year class	Age	N	L_c	S.E.	L_1	S.E.	L_2	S.E.	L_3	S.E.	L_4	S.E.	L_5	S.E.	L_6	S.E.	L_7	S.E.	L_8
Fryingpan River - Rainbow Trout - Fall 1981																			
1981	0+	2	10.0	--															
1980	1+	15	12.7	1.75	7.98	1.19													
1979	2+	23	17.5	2.61	5.80	1.45	13.3	2.39											
1978	3+	27	23.6	3.59	6.30	1.69	13.4	2.63	19.7	3.55									
1977	4+	14	33.1	5.57	6.23	1.93	13.2	3.36	20.9	5.01	28.4	5.73							
1976	5+	3	36.0	2.65	5.80	1.81	9.3	2.00	15.6	3.82	25.3	6.82	31.8	3.87					
Fryingpan River - Brown Trout - Fall 1981																			
1981	0+	2	10.0	1.41															
1980	1+	25	13.0	1.40	6.89	0.68													
1979	2+	25	18.6	1.83	6.69	1.32	13.4	1.88											
1978	3+	21	23.4	2.84	6.56	1.28	13.2	1.68	18.5	2.26									
1977	4+	55	31.1	4.89	5.89	1.53	11.6	2.98	17.9	3.67	24.8	4.49							
Gunnison River (Smith Fork-North Fork) - Rainbow Trout - August 1981																			
1980	1+	59	20.5	6.41	11.50	3.25	Wild Rainbows												
		25	20.1	2.54	8.67	1.96	15.6	1.99	Suspected Fingerling Rainbow Plants										
1979	2+	24	34.5	4.09	9.46	2.85	24.7	4.93											
1978	3+	10	41.7	3.62	9.69	1.76	22.5	3.69	33.7	4.15									
1977	4+	9	46.2	2.44	8.18	1.92	18.0	2.72	28.6	3.20	38.3	4.56							
Gunnison River (Duncan-Ute Trail) - Rainbow Trout - August 1981																			
1980	1+	11	19.1	7.11	9.95	2.67													
1979	2+	14	40.8	4.08	8.32	1.88	27.5	4.04											
1978	3+	37	44.6	3.21	8.23	1.91	23.8	4.30	35.9	4.85									
1977	4+	5	47.4	2.07	8.08	1.89	21.6	4.70	32.1	5.75	41.8	4.93							

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1980-81 (continued).

Year class	Age	N	L_c	S.E.	L_1	S.E.	L_2	S.E.	L_3	S.E.	L_4	S.E.	L_5	S.E.	L_6	S.E.	L_7	S.E.	L_8
Gunnison River (Duncan-Ute Trail) - Brown Trout - August 1981																			
1981	0+	28	13.9	1.84															
1980	1+	50	25.0	3.32	12.80	2.85													
1979	2+	28	33.9	4.18	12.80	3.61	28.8	4.24											
1978	3+	7	39.1	3.84	10.90	3.06	21.9	5.49	33.0	4.58									
1977	4+	6	45.0	0.89	11.80	2.93	22.6	3.07	33.2	2.95	42.3	0.98							
Middle Fork of the South Platte - Brown Trout - 1981																			
1980	1+	36	15.8	0.24	7.90	0.18													
1979	2+	42	22.6	0.61	7.60	0.21	16.3	0.39											
1978	3+	26	30.9	0.64	7.80	0.23	18.2	0.30	25.7	0.62									
1977	4+	17	36.2	0.57	7.60	0.29	16.9	0.49	24.8	0.56	30.0	0.82							
Rio Grande (Coller Fly Water) - Brown Trout - August 1981																			
1980	1+	27	15.7	1.75	8.43	1.62													
1979	2+	23	22.0	1.31	8.32	1.65	15.3	1.42											
1978	3+	21	26.6	1.75	8.38	1.65	15.2	2.35	22.0	2.39									
1977	4+	35	28.2	8.85	7.93	1.99	13.4	3.16	20.1	3.52	26.2	3.18							
1976	5+	4	35.8	1.71	7.22	1.53	11.3	1.57	19.2	2.99	27.0	2.87	32.9	2.17					
Rio Grande (State Bridge) - Brown Trout - August 1981																			
1980	1+	37	18.3	2.01	8.59	1.34													
1979	2+	34	25.6	5.43	9.39	1.53	19.4	2.78											
1978	3+	48	34.1	4.22	8.33	1.51	18.9	3.43	29.0	4.06									
1977	4+	9	44.8	1.39	10.70	1.30	23.1	3.37	32.0	3.15	40.1	1.72							
1976	5+	18	44.8	2.70	10.60	1.51	20.3	3.17	30.7	3.40	37.5	3.06	41.9	3.36					
1975	6+	5	49.6	4.93	8.18	2.30	18.1	4.74	27.9	1.25	35.5	4.02	41.2	5.18	46.5	4.79			

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1980-81 (continued).

Year class	Age	N	L_c	S.E.	L_1	S.E.	L_2	S.E.	L_3	S.E.	L_4	S.E.	L_5	S.E.	L_6	S.E.	L_7	S.E.	L_8
South Fork of the Rio Grande (Park Creek & Chain Station) - Brown Trout - Fall 1981																			
1980	1+	19	15.9	1.76	7.93	1.92													
1979	2+	16	20.6	1.82	8.58	2.02	15.4	2.04											
1978	3+	15	24.3	2.35	7.49	1.66	14.9	2.01	20.2	2.22									
1977	4+	9	30.9	3.33	7.28	1.64	14.2	2.24	19.7	1.63	26.4	1.88							
South Fork of the Rio Grande (Beaver Creek Bridge) - Brown Trout - Fall 1981																			
1980	1+	15	16.7	1.23	7.48	0.95													
1979	2+	8	21.6	0.92	6.56	1.86	14.4	2.29											
1978	3+	17	25.9	2.15	7.93	1.70	15.5	2.43	21.7	2.33									
1977	4+	1	31.0	--	--	--	16.4	--	22.8	--	27.2	--							
1976	5+	1	35.0	--	7.36	--	12.4	--	17.0	--	29.0	--	32.3						
South Fork of the Rio Grande - Rainbow Trout - Fall 1981																			
1980	1+	13	18.4	3.38	9.66	2.26													
South Platte River (Canyon Stations) - Rainbow Trout - Fall 1981																			
1980	1+	5	18.2	1.28	9.10	0.29													
1979	2+	14	28.2	0.54	8.60	0.51	20.2	0.65											
1978	3+	22	33.7	0.58	8.20	0.27	19.8	0.51	27.8	0.76									
1977	4+	11	35.4	0.56	8.20	0.34	19.6	0.64	26.7	0.66	30.8	1.60							
1976	5+	3	34.7	1.20	6.80	0.49	15.9	1.30	21.8	1.55	26.7	1.20	30.1	1.54					
South Platte River (Deckers) - Rainbow Trout - Fall 1981																			
1980	1+	21	20.1	0.69	7.70	0.36													
1979	2+	10	26.4	0.37	7.40	0.56	18.0	0.57											
1978	3+	7	31.7	0.42	7.40	0.44	17.4	0.71	25.4	0.58									

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1980-81 (continued).

Year class	Age	N	L_c	S.E.	L_1	S.E.	L_2	S.E.	L_3	S.E.	L_4	S.E.	L_5	S.E.	L_6	S.E.	L_7	S.E.	L_8
South Platte River (Deckers) - Brown Trout - Fall 1981																			
1980	1+	41	20.8	0.38	9.50	0.22													
1979	2+	26	27.4	0.39	10.30	0.32	19.1	0.40											
1978	3+	18	31.7	0.68	8.20	0.57	16.3	0.49	24.4	0.78									
1977	4+	3	33.3	1.24	6.50	0.40	14.2	0.45	20.8	1.38	26.2	1.32							
St. Vrain River - Brown Trout - September 24, 1981																			
1981	0+																		
1980	1+	38	20.3	0.44	9.80	0.29													
1979	2+	22	25.1	0.49	9.10	0.39	18.9	0.37											
Taylor River (Almont) - Brown Trout - Fall 1981																			
1980	1+	29	17.0	1.88	6.73	1.23													
1979	2+	28	22.4	1.97	7.02	2.03	15.1	2.11											
1978	3+	19	27.3	1.33	7.48	1.29	16.0	1.91	22.5	1.85									
1977	4+	9	30.7	1.12	6.32	1.52	15.8	2.75	23.3	2.43	27.9	1.27							
1976	5+	9	32.6	1.01	5.85	1.13	12.6	2.32	20.4	1.97	26.4	2.01	30.4	1.08					
1975	6+	2	41.0	7.07	6.83	0.83	14.9	4.10	22.2	5.66	26.7	5.73	33.2	4.17	37.8	3.96			
Taylor River (Perkin Sams) - Brown Trout - Fall 1981																			
1980	1+	10	16.0	1.25	8.63	1.25													
1979	2+	23	18.7	1.60	4.65	1.16	12.0	1.38											
1978	3+	28	24.0	2.52	5.61	1.33	13.5	2.35	20.0	2.93									
1977	4+	28	30.0	3.87	5.18	1.04	13.6	2.67	21.0	3.22	27.0	3.92							
1976	5+	13	34.8	4.78	5.64	1.61	13.7	2.70	21.0	4.61	27.0	4.41	31.8	4.62					
1975	6+	6	36.5	7.00	6.56	2.25	13.5	2.21	20.7	3.77	26.1	4.15	30.7	4.07	33.7	3.87			
1974	7+	1	48.0	--	8.41	--	13.4	--	17.8	--	29.2	--	38.6	--	42.1	--	45.2		
1973	8+	1	49.0	--	6.00	--	16.5	--	22.5	--	26.0	--	30.0	--	36.5	--	41.5	--	44.0

Table III-2. Life Tables - Cache la Poudre River (rainbow trout/ha).

Sample period season	calendar year	Year class 1981	1980	1979	1978	1977	1976
Big Bend Campground							
Fall	1980			3	27	30	14
Fall	1981	(68)	65	29	23	13	
Upper Wild Trout Water							
Fall	1980			69	61	82	36
Fall	1981	(148)	181	136	113	49	
Lower Control							
Fall	1980			52	63	108	65
Fall	1981	(155)	157	196	125	53	
Indian Meadows							
Fall	1980			155	150	135	41
Fall	1981	(93)	226	203	81	40	
Kelly Flats Campground							
Fall	1980			177	107	120	22
Fall	1981	(169)	343	177	40	6	

Table III-2. Life Tables - Cache la Poudre River (brown trout/ha).

Sample period season	calendar year	1981	1980	1979	1978	1977	1976
				Year class			
Big Bend Campground							
Fall	1980		(8)[a]	43	100	56	17
Fall	1981	(158)	118	104	90	45	27
Upper Wild Trout Water							
Fall	1980		(22)	45	61	28	
Fall	1981	(61)	120	135	123	56	12
Lower Control							
Fall	1980		(8)	46	115	56	4
Fall	1981	(33)	104	92	99	42	12
Indian Meadows							
Fall	1980		(31)	27	45	38	
Fall	1981	(20)	56	46	45	16	3
Kelly Flats Campground							
Fall	1980		(38)	132	134	25	
Fall	1981	(113)	128	104	58	20	
Lower "Poudre" Wild Trout							
Fall	1980			910	356	33	
Fall	1981		393	372	14		
Lower "Poudre" Control							
Fall	1980			693	283	13	
Fall	1981		221	311	13		

[a] Number of YOY collected/station

Table III-2. Life Tables - Colorado River (brown trout/ha).

Sample season		Year class					
season	calendar year	1980	1979	1978	1977	1976	1975
		Thompson Ranch - Catch & Release					
Fall	1981	12	42	36	24	0	0
		Hot Sulphur Springs, Pioneer Park - 8 Trout/Day					
Fall	1981	25	25	6	0	0	0
		State Ranch, Lone Buck - 8 Trout/Day					
Fall	1981	2	10	6	4	0	2
		Parshall - Catch & Release Area					
Fall	1981	19	206	57	11	2	0
		Con Ritschard's Ranch - Catch & Release					
Fall	1981	0	30	9	3	0	0

Table III-2. Life Tables - Colorado River (rainbow trout/ha).

Sample period		Year class							
season	calendar year	1980	1979	1978	1977	1976	1975	1974	1973
Thompson Ranch - Catch & Release									
Fall	1980		3	17	62	53	5	3	
Fall	1981	31	11	94	84	3	0	0	
Hot Sulphur Springs, Pioneer Park - 8 Trout/Day									
Fall	1981	37	38	3	0	0	0		
State Ranch at Lone Buck - 8 Trout/Day									
Fall	1979				76	104	39	11	0
Fall	1980		1	25	42	22	0		
Fall	1981	23	17	45	13	0	0		
Parshall - Catch & Release Area									
Fall	1981	72	487	207	119	10	1		
Con Ritschard's Ranch - Catch & Release Area									
Fall	1979			12	33	85	78	12	
Spring	1980				3	51	78	25	
Fall	1980		4	28	80	77	8	11	
Fall	1981	26	127	77	46	7	1		
Skylark Ranch - Catch & Release									
Fall	1979				13	23	15	6	
Fall	1981	8	74	46	31	2	0		

Table III-2. Life Tables - Eagle River (brown trout and rainbow trout/ha).

Sample period season	calendar year	Year class 1981	1980	1979	1978	1977	1976	1975
Wolcott (brown trout)								
Spring	1980				73	239	41	15
Fall	1980			49	171	33	1	0
Fall	1981	8	13	55	50	8	0	0
Wolcott (rainbow trout)								
Spring	1980				21	45	3	0
Fall	1980		3	27	35	34	0	0
Fall	1981	0	6	1	2	0	0	0
Upper End (brown trout) - Catch & Release								
Fall	1981	4	27	48	34	1	4	0
Upper End (rainbow trout) - Catch & Release								
Fall	1981	7	16	3	13	0	0	0
Lower End (brown trout) - Catch & Release								
Fall	1981	5	55	33	35	1	0	0
Lower End (rainbow trout) - Catch & Release								
Fall	1981	5	76	35	0	0	0	0

Table III-2. Life Tables - Fryingpan River (brown trout/ha).

Sample period season	calendar year	Year class 1980	1979	1978	1977	1976	1975	1974	1973
Gaging Station Pool #1 - Catch & Release									
Fall	1979			31	109	106	46	17	0
Fall	1980		24	186	397	168	9	0	0
Fall	1981	61	50	95	517	0	0	0	0
Ruedi Damsite Station #2 - Catch & Release									
Fall	1978				51	204	108	34	3
Fall	1979			159	180	69	53	5	0
Spring	1980			70	91	51	26	13	0
Fall	1980		51	174	171	31	4	0	0
Fall	1981	101	113	85	162	0	0	0	0
Old Faithful Station #3 - Catch & Release									
Fall	1979			243	352	107	40	0	0
Spring	1980			194	208	67	14	0	0
Fall	1980		204	479	248	21	0	0	0
Fall	1981	121	251	258	243	0	0	0	0
Upper Standard Regulation Station #4 - 8 Fish/Day									
Fall	1979			252	271	58	27	4	0
Spring	1980			108	85	22	6	3	0
Fall	1980		104	226	77	6	0	0	0
Fall	1981	84	140	117	88	0	0	0	0
Taylor River Station #5 - 8 Fish/Day									
Fall	1978				86	198	131	44	0
Fall	1979			348	265	80	31	0	0
Spring	1980			237	170	43	13	6	0
Fall	1980		192	170	110	32	0	0	0
Fall	1981	151	157	102	180	0	0	0	0
Big Pullout Station #6 - 8 Fish/Day									
Fall	1980		30	39	54	16	0	0	0

Table III-2. Life Tables - Fryingpan River (rainbow trout/ha).

Sample period season	calendar year	Year class 1980	1979	1978	1977	1976	1975	1974	1973
Gaging Station Pool #1 - Catch & Release									
Fall	1979				51	124	98	20	
Fall	1980		31	23	121	112	78	38	
Fall	1981	6	29	29	56	44	0	0	
Ruedi Damsite Station #2 - Catch & Release									
Fall	1978				46	245	71	41	12
Fall	1979			30	81	58	40	11	0
Spring	1980			45	87	84	59	22	0
Fall	1980		45	71	66	35	16	8	0
Fall	1981	24	51	44	16	4	0	0	0
Old Faithful Station #3 - Catch & Release									
Fall	1979			29	134	96	46	19	0
Spring	1980			26	113	77	35	12	0
Fall	1980		78	98	84	43	29	12	0
Fall	1981	18	19	21	26	8	0	0	0
Upper Standard Regulation Station #4 - 8 Fish/Day									
Fall	1979			125	122	75	19	7	0
Spring	1980			17	53	20	2	0	0
Fall	1980		13	19	10	6	0	0	0
Fall	1981	20	8	28	6	0	0	0	0
Taylor Creek Station #5 - 8 Fish/Day									
Fall	1978				130	267	84	10	3
Fall	1979			345	206	53	22	6	0
Spring	1980			130	212	49	24	7	0
Fall	1980		140	97	22	11	10	0	0
Fall	1981	121	123	75	8	5	0	0	0
Big Pullout Station #6 - 8 Fish/Day									
Fall	1979			122	168	50	1	0	0
Fall	1980		146	212	159	50	15	0	0

Table III-2. Life Tables - Gunnison River (numbers/ha).

Sample period season	calendar year	1980	1979	1978	1977	1976
		Smith Fork, North Fork (rainbow trout)				
Fall	1981	314	26	9	6	0
		Duncan, Ute Trail (rainbow trout)				
Fall	1981	197	91	41	10	0
		Smith Fork, North Fork (brown trout)				
Fall	1981	88	13	3	2	0
		Duncan, Ute Trail (brown trout)				
Fall	1981	641	170	31	3	0

Table III-2. Life Tables - Middle Fork of the South Platte River (brown trout/ha).

Sample period season	calendar year[1]	Year class 1981	1980	1979	1978	1977	1976	1975	1974	1973
Station #1 - at Garo Bridge										
Fall	1979			(655)	491	770	144	109	12	0
Fall	1980		(353)	1058	630	68	10	0	0	0
Fall	1981	(328)	524	664	71	0	0	0	0	0
Station #2 - at Gaging Station Bridge										
Fall	1979			(1007)	403	374	118	47	8	0
Fall	1980		(115)	592	267	83	43	8	0	0
Fall	1981	(259)	517	550	59	26	0	0	0	0
Station #3 - 1 Mile below Gaging Station Bridge										
Fall	1979			(1624)	856	418	127	26	9	0
Fall	1980		(342)	1047	390	238	12	49	25	0
Fall	1981	(538)	766	796	144	17	12	0	0	0
Station #4 - 2 Miles below Gaging Station Bridge										
Fall	1980		(636)	604	321	265	67	8	0	0
Fall	1981	(704)	689	759	129	25	2	0	0	0
Station #5 - 3 Miles below Gaging Station Bridge										
Fall	1980		(524)	708	321	172	85	19	19	6
Fall	1981	(378)	744	645	187	109	48	7	6	0

Table III-2. Life Tables - Rio Grande River (brown trout/ha).

Sampe period season	calendar year	Year class 1980	1979	1978	1977	1976	1975
		Coller Fly Water					
August	1981	65	41	66	64	8	0
		State Bridge Section					
August	1981	26	19	36	11	3	2

Table III-2. Life Tables - South Fork of the Rio Grande (brown trout/ha).

Sample period: season	calendar year	Year class: 1980	1979	1978	1977	1976	1975	1974	1973	1972
					Beaver Creek Bridge					
Fall	1977					659	301	1470	180	59
Fall	1978				630	111	217	86	0	0
Fall	1979			736	726	148	30	32		
Fall	1980		27	1057	200	77	17			
Fall	1981	262	109	616	15	10				
					Park Creek Campground					
Fall	1977					235	576	1045	42	0
Fall	1978				857	158	252	267	47	
Fall	1979			639	699	274	37	10		
Fall	1980		62	674	329	30				
Fall	1981	147	351	356	44	0				
					Chain Station					
Fall	1977					348	479	1067	44	22
Fall	1978				620	128	203	12	0	0
Fall	1979			620	669	151	20	10	0	
Fall	1980		52	706	363	47	10	10		
Fall	1981	99	354	473	74	0				

Table III-2. Life Tables - South Platte River (brown trout/ha).

Sample period season	calendar year	Year class 1980	1979	1978	1977	1976	1975	1974	1973
		Upper Canyon Section - Catch & Release							
Fall	1979			78	245	402	36	0	0
Spring	1980		6	230	385	75	0	0	0
Fall	1980		182	311	472	43	0	0	0
Spring	1981	12	162	318	43	8	0	0	0
Fall	1981	77	284	64	13	0	0	0	0
		Lower Canyon Section - Catch & Release							
Fall	1979			116	367	520	42	0	0
Spring	1980		22	237	595	195	0	0	0
Fall	1980		219	319	492	34	0	0	0
Spring	1981	36	187	539	242	8	0	0	0
Fall	1981	106	383	190	27	0	0	0	0
		Deckers Bidge Section - 8 Fish/Day							
Fall	1979			657	327	435	30	0	0
Spring	1980		142	816	433	35	0	0	0
Fall	1980		993	678	66	31	11	0	0
Spring	1981	49	544	397	33	4	0	0	0
Fall	1981	460	623	171	12	0	0	0	0
		Scraggy View - 8 Fish/Day							
Fall	1979			102	343	512	16	0	0
Spring	1980		360	769	264	14	0	0	0
Fall	1980		562	195	10	3	0	0	0
Spring	1981	161	453	138	18	0	0	0	0
Fall	1981	412	301	35	0	0	0	0	0

Table III-2. Life Tables - South Platte River (rainbow trout/ha).

Sample period season	calendar year	Year class 1980	1979	1978	1977	1976	1975	1974	1973
				Upper Canyon Section - Catch & Release					
Fall	1979			106	682	583	56	0	0
Spring	1980			177	786	626	78	0	0
Fall	1980		35	344	655	288	139	0	0
Spring	1981	4	26	375	505	187	70	0	0
Fall	1981	23	86	465	224	45	0	0	0
				Lower Canyon Section - Catch & Release					
Fall	1979			105	758	685	88	0	0
Spring	1980			93	732	703	114	0	0
Fall	1980		20	249	557	274	127	0	0
Spring	1981	4	26	375	505	187	70	0	0
Fall	1981	10	115	434	138	49	7	0	0
				Deckers Bridge Section - 8 Fish/Day					
Fall	1979			237	181	62	8	0	0
Spring	1980			45	67	51	32	6	0
Fall	1980		243	141	30	1	0	0	0
Spring	1981	14	54	24	10	7	0	0	0
Fall	1981	119	100	54	7	8	0	0	0
				Scraggy View Section - 8 Fish/Day					
Fall	1979			107	152	24	2	0	0
Spring	1980			53	67	17	1	0	0
Fall	1980		162	68	6	0	0	0	0
Spring	1981		86	50	6	0	0	0	0
Fall	1981	44	62	20	2	0	0	0	0

Table III-2. Life Tables - St. Vrain River (brown trout/ha).

Sample period season	calendar year	1980	1979	1978	1977	1976	1975	1974	1973
				City Park					
Fall	1980		(66)	1944	356	0	0	0	0
Fall	1981	(176)	1186	352	0	0	0	0	0
				Gaging Station					
Fall	1980		(34)	922	187	0	0	0	0
Fall	1981	(169)	228	217	0	0	0	0	0

Table III-2. Life Tables - Taylor River (brown trout/ha).

Year class	Spring 1974	Fall 1974	Spring 1975	Fall 1975	Fall 1979	Fall 1980	Fall 1981
			Almont Station				
1969	9	9					
1970	171	41	6	0			
1971	372	421	47	43			
1972	310	322	249	360			
1973		106	119	296			
1974			89	57	6	0	
1975					27	37	3
1976					289	62	44
1977					713	429	38
1978					143	438	209
1979						79	385
1980							338
			Elsinore Cattle				
1969		15					
1970	91	75	--	18			
1971	231	493	53	93			
1972	278	263	190	405			
1973		159	217	262			
1974				88	28	0	
1975					39	49	14
1976					263	110	61
1977					684	385	36
1978					228	447	146
1979						141	318
1980							370
			One Mile Campground				
1969	20	5	0				
1970	31	37	15	22			
1971	573	527	0	44			
1972	392	433	407	386			
1973		283	353	334			
1974				199	66	0	2
1975					10	42	12
1976					324	83	36
1977					1066	525	163
1978					530	855	373
1979						328	397
1980							383

Table III-2. Life Tables - Taylor River (brown trout/ha) (continued).

Year class	Spring 1974	Fall 1974	Spring 1975	Fall 1975	Fall 1979	Fall 1980	Fall 1981
				Lower Sams			
1969		42					
1970	322	297	--	33			
1971	730	467	168	420			
1972	74	124	532	395			
1973		14	128	137			
1974				25	31		
1975					53	87	22
1976					463	170	72
1977					711	952	550
1978					36	603	878
1979						186	659
1980							285
				Upper Sams			
1969		47					
1970	170	395	--	30			
1971	695	439	190	358			
1972	108	65	474	554			
1973		54	103	166	0	0	2
1974					68	0	2
1975					100	96	33
1976					507	192	111
1977					566	601	444
1978					78	288	420
1979						46	170
1980							59

APPENDIX IV

Examples of forms used to tabulate length/frequency data in the field (IV-1); biomass calculation (IV-2); and life table determination (IV-3).

Figure IV-1. Example of length/frequency data tabulation on field form.

	1	2	3	4	5	6	7	8	9
1									
2		UN MARKED			MARKED	UNMARKED		MARKED	
3		RAIN BOWS			RAINBOWS	BROWNS		BROWNS	
4									
5									
6									
7									
8									
9									
10						II			
11				TOTAL	TOTAL	I			
12				772	131	II			
13						I			
14									
15						I			
16									
17				3			TOTAL		TOTAL
18				2			245		23
19				4					
20				3	1				
21				20	3		5		
22				38	4		15		
23				86	6		16		1
24				69	6		24		1
25				72	5		29		2
26				51	4		23		2
27				29	7		23		1
28				29	4		9		2
29				32	7		6		1
30				34	11		6		1
31				40	7		7		
32				23	7		16		6
33				22	7		18		2
34				23	1		15		
35				16	8		8		
36				21	3		6		1
37				18	5		4		
38				29	6		5		2
39				22	11		3		1
40				20	4		2		
41				8	6				
42				11	5		4		
43				8	1				
44				11					
45				9	2		1		
46				4					
47				7	2				
48				3	2				
49				2					
50									

51-1 52-0 53-11 3

Figure IV-2. Example of biomass calculation from length/frequency field data summary.

UNMARKED RAINBOWS

TOTAL RAINBOW ESTIMATE = 9916 = $\hat{N}$ estimate

SAMPLE AREA ≈ 11.6 HECTARES

TOTAL SAMPLE SIZE (1,2,3, PASSES) = 2270 = N sample

Weight = a L^b a = 0.0128 b = 2.93

L = Length in cm

	1 1ST PASS	2 2ND PASS	3 3RD PASS	4 TOTAL UNMARKED RAINBOWS	%N	g/cm/estimate
14	1			1	.0004	128
15	2	1		3	.0013	468
16	2	5		7	.0031	1320
17	13	9	3	25	.0110	5632
18	14	12	2	28	.0123	7458
19	16	22	4	42	.0185	13,107
20	34	37	3	74	.0326	26,839
21	62	60	20	142	.0626	59,417
22	64	60	38	162	.0714	77,864
23	92	9[illegible]	86	269	.1185	146,938
24	34	74	69	177	.078	109,525
25	28	51	72	151	.0665	105,308
26	25	38	51	114	.0605	89,186
27	19	33	29	81	.0357	25,219
28	25	34	29	88	.0388	85,541
29	21	23	32	76	.0335	81,877
30	25	23	34	82	.0361	97,566
31	28	22	40	90	.0396	117,883
32	17	18	23	58	.0256	83,375
33	12	12	22	46	.0203	72,364
34	13	26	23	62	.0273	106,450
35	21	19	16	56	.0247	104,671
36	14	12	21	47	.0207	95,408
37	18	14	18	50	.0220	109,982
38	17	18	29	64	.0282	152,218
39	14	14	22	50	.0220	128,325
40	10	15	20	45	.0198	124,385
41	17	10	8	35	.0154	104,002
42	14	7	11	32	.0141	102,044
43	9	6	8	23	.0101	78,579
44	7	7	11	25	.0110	91,364
45	7	10	9	26	.0115	101,486
46	2	6	4	12	.0053	49,955
47	3	1	7	11	.0048	48,771
48	2	2	3	7	.0031	33,011
49	1	0	2	3	.0013	15,029
50	1	1	0	2	.0009	10,630
OVER50		1	3	4		

7	8	9
51	.0004	5633
53	.0009	12,609

$\Sigma\Sigma$ = 2,681,765 g/estimate

= 2681 kg/est.

= 231.1 kg/Ha

= 205.9 lbs/Acre

Figure IV-3. Example of Life table analysis from age/growth data and length/frequency distribution from field data.

	1+ 1980	2+ 1979	3+ 1978	4+ 1977	5+ 1976	6+ 1975	7	8	9	%$\hat{N}$
1										
2										
3							$\hat{N}$ = 889 Rainbow/Ha			
4				1980	1979	1978	1977	1976	1975	
5				1+	2+	3+	4+	5+	6+	
6			N/Ha/YR →	71	487	207	119	10	1	
7				.0806	.5477	.2331	.1342	.0113	.0016	
8										
9										
10										
11										
12										
13										
14				.0004						.0004
15	3			.0013						.0013
16	5			.0031						.0031
17	4			.0110						.0110
18	4	1		.0098	.0025					.0123
19	3			.0185						.0185
20	4	1		.0261	.0065					.0326
21	1	5		.0104	.0522					.0626
22		6			.0714					.0714
23		6			.1185					.1185
24		5			.0780					.0780
25		4			.0665					.0665
26		3			.0605					.0605
27		4			.0357					.0357
28		2	2		.0194	.0194				.0388
29		2	2		.0167	.0168				.0335
30			5			.0361				.0361
31		2	2		.0198	.0198				.0396
32			5			.0256				.0256
33			2	3		.0081	.0122			.0203
34			6	3		.0182	.0091			.0273
35			3	2		.0148	.0099			.0247
36			4	1		.0166	.0041			.0207
37			4	3		.0126	.0094			.0220
38			3	5		.0106	.0176			.0282
39			2	3	1	.0073	.0110	.0037		.0220
40			6	2		.0148	.0050			.0198
41			4	7		.0056	.0098			.0154
42			1	6		.0020	.0121			.0141
43			1	8		.0011	.0090			.0101
44			3	5	1	.0037	.0061	.0012		.0110
45				7			.0115			.0115
46				4	1		.0042	.0011		.0053
47				1	5	1	.0007	.0034	.0007	.0048
48				4	1		.0025	.0006		.0031
49					1			.0013		.0013
50									.0009	.0009

APPENDIX V

Creel census data from F-51-R study streams, 1979 through 1981.

Table V-1. Arkansas River creel census results, May - October, 1981, lower study area (Water Code 32968)

Parameter	Count/Interview System mean	Count/Interview System S.E.	Postcard Mailback System mean	Postcard Mailback System S.E.
Total hours	12,826	814.4	10,920	679.6
Total catch	3,652	728.6	5,912	893.5
Total CPMH	0.285	0.060	0.541	0.066
Brown catch	3,524	727.1	5,415	865.6
Cutthroat catch	128	34.2	497	177.8
Brown CPMH	0.275	0.059	0.496	0.065
Creel catch	2,536	456.2	--	--
Brown creel catch	2,423	457.6	--	--
Hours/ha	155.6	--	132.5	--
Creel catch/ha	30.8	--	--	--
No. contacts	1,237	--	142	--

Table V-2. Arkansas River creel census results, May - October 1981, upper study area (Water Code 32982) and catch and release (Water Code 32970).

Parameter	Count/Interview System upper mean	S.E.	C&R mean	S.E.	combined[a] mean	Postcard Mailback System upper mean	S.E.	C&R mean	S.E.	combined[a] mean
Total hours	7,384	487.5	2,033	180.5	9,417	6,234	437.6	2,018	202.0	8,252
Total catch	5,214	737.1	918	81.5	6,132	5,266	1687.2	1,160	389.4	6,426
Total CPMH	0.706	0.11	0.451	0.122	0.651	0.845	0.244	0.575	0.201	0.779
Brown catch	4,908	716.6	909	230.6	5,816	4,541	1640.7	1,140	383.4	5,681
Cutthroat catch	223	141.9	9	9.0	--	725	310.1	20	20.0	--
Rainbow catch	84	63.9	0	0	--	0	0	0	0	--
Brown CPMH	0.665	0.106	0.447	--	0.618	0.728	0.24	0.565	0.198	0.688
Creel catch	3,211	345.1	156	60.5	--	5,255	1688.0	580	194.7	--
Brown creel catch	3,058	360.4	155	60.0	--	4,541	1640.7	570	191.7	--
Hours/ha	251.1	--	247.9	--	--	212.0	--	246.100	--	--
Creel catch/ha	109.2	--	19	--	--	178.7	--	70.1	--	--
No. contacts	557		240			53		22		

[a] Use combined to compare 1980 data

Table V-3. Eagle River creel census data - summer 1981.

Statistics	Horn Lease mean	Horn Lease S.E.	Catch & Release mean	Catch & Release S.E.	Milk Creek - Wolcott mean	Milk Creek - Wolcott S.E.
Total hours	7344	1067	2523	479	3733	764
Total catch	3390	814	1280	463	1966	707
Total CPMH	0.462	0.120	0.507	0.202	0.527	0.209
Creel catch	1933	495	823	399	1051	340
Rainbow catch	2852	713	1014	428	689	322
Brown catch	519	155	266	137	1277	431
Rainbow creeled	1605	429	603	357	676	242
Brown creeled	328	106	221	134	375	160

Table V-4. Fryingpan River creel census data - Section 1 (Water Code 27602), 1979-1981.

Statistics	Count/Interview System: May-Sept. 1979 mean	May-Sept. 1979 S.E.	May-Oct. 1980 mean	May-Oct. 1980 S.E.	Postcard Return Method: 1980 mean	June-Oct. 1981 mean
Total hours	3325	359	3991	604	3194	2175
Total catch	2405	604	2295	514	1816	887
Total CPMH	0.723	0.197	0.575	0.141	0.566	0.408
Rainbow catch	2263	588	1727	389	1210	841
Brown catch	142	58	484	273	590	45
Brook catch	--	--	17	16	--	--
Rainbow CPMH	0.681	0.191	0.433	--	0.377	0.387
Brown CPMH	0.043	0.018	0.121	--	0.184	0.021
Brook CPMH	--	--	--	--	--	--
Catch 15 in.	--	--	--	--	91	36
Catch 18 in.	--	--	--	--	0	0

Table V-5. Fryingpan River creel census data - Section 2 (Water Code 27614), 1979-1981.

Statistics	Count/Interview System May-Sept. 1979 mean	S.E.	May-Oct. 1980 mean	S.E.	Postcard Return Method 1980 mean	May-Oct. 1981 mean	S.E.
Total hours	6967	517	7530	1353	5331	6241	805
Total catch	4131	720	3110	527	3401	3414	581
Total CPMH	0.593	0.112	0.413	0.090	0.638	0.550	0.066
Rainbow catch	2285	392	1917	438	2127	1562	298
Brown catch	1821	447	1147	235	1193	1581	337
Brook catch	25	20	38	38	--	231	77
Rainbow CPMH	0.328	0.061	0.255	--	0.399	0.250	0.039
Brown CPMH	0.261	0.067	0.152	--	0.224	0.253	0.041
Brook CPMH	--	--	--	--	--	0.037	0.012
Catch 15 in.	--	--	--	--	169	87	--
Catch 18 in.	--	--	--	--	0	0	--

Table V-6. Fryingpan River creel census data - Section 3 (Water Code 27626) 1979-1981.

	Count/Interview System				Postcard Return Method		
	May-Sept. 1979		May-Oct. 1980		1980	May-Oct. 1981	
Statistics	mean	S.E.	mean	S.E.	mean	mean	S.E.
Total hours	5533	450	6486	1198	5334	7536	707
Total catch	3067	276	4131	681	3454	4026	862
Total CPMH	0.554	0.066	0.637	0.138	0.648	0.530	0.107
Rainbow catch	2737	289	2615	528	1892	1671	285
Brown catch	312	69	1483	329	1475	2271	616
Brook catch	18	13	19	19	--	83	69
Rainbow CPMH	0.495	0.065	0.403	--	0.355	0.222	0.035
Brown CPMH	0.056	0.013	0.229	--	0.277	0.301	0.078
Brook CPMH	--	--	--	--	--	0.011	0.009
Catch 15 in.	--	--	--	--	132	228	--
Catch 18 in.	--	--	--	--	25	0	--

Table V-7. Fryingpan River creel census data - Section 4 (Water Code 27638) 1979-1981.

	Count/Interview System				Postcard Return Method		
	May-Sept. 1979		May-Oct. 1980		1980	May-Oct. 1981	
Statistics	mean	S.E.	mean	S.E.	mean	mean	S.E.
Total hours	7,180	451	9,548	1,358	8,441	10,570	745
Total catch	8,302	657	10,786	1,845	8,106	18,955	2,283
Total CPMH	1.156	0.116	1.13	0.187	0.96	1.793	0.179
Rainbow catch	5,948	469	6,140	1,179	5,070	9,609	1,228
Brown catch	1,376	168	2,272	524	1,524	6,134	1,159
Brook carch	978	164	1,884	460	1,568	3,114	687
Rainbow CPMH	0.828	0.083	0.643	--	0.601	0.909	0.094
Brown CPMH	0.192	0.026	0.238	--	0.181	0.580	0.100
Brook CPMH	0.136	0.024	0.197	--	0.186	0.295	0.061
Catch 15 in.	--	--	--	--	1,279	4,064	--
Catch 18 in.	--	--	--	--	206	673	--

Table V-8. Middle Fork of South Platte River creel census data Tomahawk Wildlife Area, 1980 and 1981.

Parameter	1980[a] combined	1981[b] combined	Lease (control)	Tomahawk (slot limit)
Area in hectares	8.73	8.73	4.76	3.97
Fisherman contacts	272.0	231.0	81.0	150.0
Total hours	7,569.0	7,000.0	3,017.0	3,984.0
Total catch	18,817.0	14,293.0	5,474.0	8,822.0
Total CPMH	2.48	2.04	1.82	2.22
Creel catch	4,444.0	835.0	503.0	332.0
% throwbacks	76.4	94.2	90.8	96.2
Kill/ha	509.0	95.6	105.7	83.6

[a]June - October (5 mos.)

[b]May - August (4 mos.)

Table V-9. South Platte creel census data - standard regulations section (Water Code #11825), 1979-1981.

Statistics	Count/Interview System: May-Sept. 1979 mean	S.E.	May-Oct. 1980 mean	S.E.	Postcard Return Method: May-Sept. 1979 mean	May-Oct. 1980 mean	May-Sept. 1981 mean	S.E.
Total hours	39,601	1,739	38,621	4,511	37,594	32,628	27,120	4,797
Total catch	34,532	8,529	24,142	5,617	29,197	22,705	19,369	3,840
Total CPMH	0.872	--	0.625	0.161	0.777	0.696	0.714	0.177
Rbw catch	23,415	9,019	10,237	1,944	15,384	8,522	8,820	2,014
Brown catch	11,049	1,442	13,905	4,682	13,535	14,183	10,550	2,083
Rainbow CPMH	0.591	--	0.265	--	0.409	0.261	0.325	0.090
Brown CPMH	0.279	--	0.360	--	0.360	0.434	0.389	0.094
Catch 15 in.		--		--	227	108	332	--
Catch 18 in.		--		--	77	--	0	--

Table V-10. South Platte creel census data- catch/release section (Water Code #11837), 1979-1981.

Statistics	Count/Interview System May-Oct. 1980 mean	Count/Interview System May-Oct. 1980 S.E.	Postcard Return Method May-Sept. 1979 mean	Postcard Return Method May-Oct. 1980 mean	Postcard Return Method May-Sept. 1981 mean	Postcard Return Method S.E.
Total hours	28,397	2,540	25,550	29,954	23,643	3,702
Total catch	32,488	6,759	25,402	27,861	43,908	6,418
Total CPMH	1.144	0.237	0.994	0.930	1.857	0.346
Rainbow catch	22,796	5,115	18,798	18,533	33,392	5,209
Brown catch	9,692	1,761	6,514	9,872	10,516	1,707
Rainbow CPMH	0.803	--	0.736	0.619	1.412	0.27
Brown CPMH	0.341	--	0.255	0.330	0.445	0.091
Catch 15 in.			3,864	4,385	8,750	--
Catch 18 in.			384	--	1,250	--

Table V-11. Taylor River creel census data, June - September 1981.

Statistics	Mean	S.E.
Total hours	23,280	2,141
Total catch	15,633	1,745
Creel catch	11,936	1,346
Native catch	1,008	233
Brown catch	7,377	1,038
Rainbow catch	6,395	1,077
Brook catch	839	479
Native creeled	623	176
Brown creeled	5,503	692
Rainbow creeled	5,066	799
Brook creeled	729	397
TOTAL CPMH	0.672	--
NATIVE CPMH	0.043	
BROWN CPMH	0.317	
RAINBOW CPMH	0.275	
BROOK CPMH	0.036	

Table V-12. Voluntary fisherman attitude survey - acceptance of special management (catch & release) regulations on Colorado's trout streams, summer 1981.

		Approved		Opposed		No opinion	
Section	Regulation	no.	%	no.	%	no.	%
		Fryingpan River					
1	Standard	10	52.6	4	21.1	5	26.3
2	Standard	23	41.1	23	41.1	10	17.8
3	Standard	42	48.8	37	43.0	7	8.2
4	Catch/Release	132	76.7	36	20.9	4	2.4
	Totals	207	62.2	100	30.0	26	7.8
		South Platte River					
1	Standard	58	47.9	43	35.5	20	16.5
2	Catch/Release	125	93.3	7	5.2	2	1.5
	Totals	183	71.8	50	19.6	22	8.6
		Arkansas River					
1	Standard	31	58.5	16	30.2	6	11.3
2	Standard	90	61.6	42	28.8	14	9.6
3	Catch/Release	10	50.0	7	35.0	3	15.0
	Totals	131	59.8	65	29.7	23	10.5
		Arkansas River (personal contact)					
1	Standard	357	81.5	37	8.4	44	10.1
2	Standard	708	75.0	135	14.3	101	10.7
3	Catch/Release	183	85.5	10	4.7	21	9.8
	Totals	1248	78.2	182	11.4	166	10.4

STREAM FISHERIES INVESTIGATIONS

F-51-R

1983

by

R. B. Nehring and R. Anderson

STREAM FISHERIES INVESTIGATIONS

F-51-R

1983

by

R. B. Nehring and R. Anderson

STREAM FISHERIES INVESTIGATIONS

Federal Aid Study F-51-R

Job 1. Fish Flow Investigations by R. B. Nehring and R. Anderson

Job 3. Special Regulations Evaluations by R. B. Nehring and R. Anderson

Job 4. Wild Trout Introduction by R. A. Anderson

Job 5. Arkansas River Aquatic Invertebrate Investigations by R. Anderson and D. Winters

Job 6. Colorado River Aquatic Invertebrate Investigations by R. B. Nehring

COLORADO · DIVISION OF WILDLIFE ·

Jack R. Grieb, Director

Federal Aid in Fish and Wildlife Restoration

Job Progress Report

F-51-R

Colorado Division of Wildlife

Fish Research Section

Fort Collins, Colorado

July 1983

STATE OF COLORADO

Richard C. Lamm, Governor

COLORADO DEPARTMENT OF NATURAL RESOURCES

Hamlet J. Barry, Acting Director

COLORADO DIVISION OF WILDLIFE

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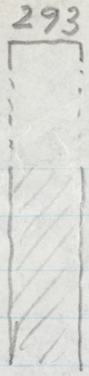


123 | 710

71
52

60% of 8in+ >12in.
9% 16in+

	1	3	2	
	52	58	13	RB
3 - 6 in	8+ to 12	12+ - 16	16 - 18	
age 0	1	2 - 4	5 - 6	

- BT, - Nat, repro - 5 (4-6 in)
2 (6-8 in)
45 8-12 in
62 12-16 in
14 16-18 in+

45 / .76 121 | 760. 63 / 726 / 340

63% of 8in >12in
12% >18 in

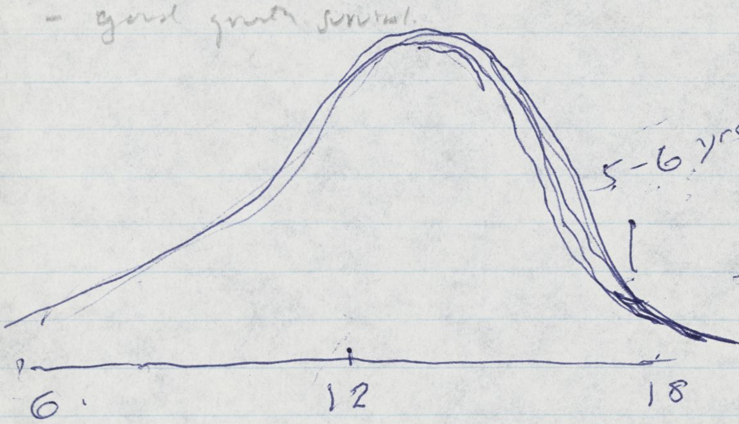
~ 80% biomass
183 lb/acre - S, Pr 60 - 3X biomass
125 lb >12in

at ~ 15 lb/A = ~ 8X

47
.76
1.3

6.123
246 | 1480
476
246

poor angling
no recruitment -
- good growth survival



5-6 yrs

Rel. Stk. Dens
Powder 2-20% (for >6in >12in)
$\bar{x}$ 10%
N. Fk. 60%

Gold Medal
of all 8in
20% 14in
-25% RB
37% BT -31%

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Date 8/18/83

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JOB PROGRESS REPORT

State: COLORADO

Project No. 45-02-508 Name: Statewide Fish Research

Study No. F-51-R Title: Stream Fisheries Investigations

Period Covered: May 1, 1982 to June 30, 1983

Study Objective: Quantitatively describe the interrelationships and determine the impacts of flow regimes, special regulations, macroinvertebrate densities and trout species introductions on established trout populations in selected major streams in Colorado.

Job No. 1

Job Title: Fish Flow Investigations

Job Objective: Quantify the interrelationships between flow regimes and trout population dynamics on selected sections of the following streams: Colorado, Arkansas, Taylor, Eagle, South Fork of the Rio Grande, Middle Fork of the South Platte, South Platte, Fryingpan, Rio Grande, Gunnison, Cache la Poudre, and St. Vrain rivers.

INTRODUCTION

Background

This project began in 1973 as the "Upper Gunnison River Investigations." In 1975, the title was changed to "Stream Fishery Investigations" (F-51-R). At that time the project included Job 1, "Taylor River Flow Investigations" and Job 2, "Influence of Artificial Stream Flow Alterations on Trout Populations." Job 1 involved studies done from 1973-1975 to determine the status of the fishery under the existing Taylor River flow regime and has been reported on by Burkhard (1977). In 1976, the flow regime was changed to conform to a pattern specified by Burkhard. Following 3 years of this pattern, the fishery was to be reexamined to determine if any significant changes had taken place.

In 1979, this study was reactivated with Job 1 continued, Job 2 discontinued and a new Job 3, "Special Regulations Evaluations," added. The study continued as two jobs through April 1982. Effective May 1, 1982, the title for Job 1 (Taylor River Flow Investigations) was changed to Fish Flow Investigations. The number of rivers to be examined as a part of Job 1 was increased from one (the Taylor River) to twelve (including the Taylor River) for the next 5 years (May 1982 - May 1987).

In addition to Jobs 1 and 3, three new jobs were also added to the project, effective May 1, 1982. These jobs are designated as:

Job 4. Wild Trout Introductions
Job 5. Arkansas River Aquatic Invertebrate Investigations
Job 6. Colorado River Aquatic Invertebrate Investigations

Each job will be dealt with sequentially, in its entirety, in this report. Each job will be under a separate title and section.

The overall objective of Job 1, "Fish Flow Investigations," is as follows: Quantify the interrelationships between flow regimes and trout population dynamics on selected sections of the following streams: Colorado, Arkansas, Taylor, Eagle, South Fork of the Rio Grande, Middle Fork of the South Platte, South Platte, Fryingpan, Rio Grande, Gunnison, Cache la Poudre, and St. Vrain rivers.

During the May 1, 1982 - June 30, 1983 segment, we had proposed to collect all of the field data for the cross sectional flow analyses (using the IFG3 and IFG4 flow models) on the Taylor, Arkansas, South Platte, and South Fork of the Rio Grande rivers. Due to a lack of proper equipment for measuring flows on larger rivers, we were unable to complete the collection of data on the Taylor and Arkansas rivers during the 1982 field season. However, we were able to complete this job on the Gunnison River a year ahead of time. Thus, we are still on schedule as we will report on the South Platte, the South Fork of the Rio Grande, and the Gunnison rivers in this report. We plan to have the heavy equipment required for use in large rivers in 1983 and should have no trouble acquiring the field data for the Taylor, Arkansas, Cache la Poudre, St. Vrain, and Colorado rivers during the 1983-84 segment.

METHODS AND MATERIALS

Fishery biologists for decades have suspected that relationships exist between the amount of water flowing in a stream and the numbers and sizes of fish that occur in a stream (Brett 1951; Bulkley and Benson 1962; Drummond 1966; Gagmark and Bakkala 1960; Johnson 1956; McKernan, et al. 1950; Wickett 1958). However, only in the last 7 to 10 years has it become increasingly possible to document the relationships between stream flows and fish habitat(s).

The base of knowledge in this area has been substantially increased primarily due to the efforts of personnel working for the U. S. Fish and Wildlife Service at the Cooperative Instream Flow Service Group in Fort Collins, Colorado (Stalnaker and Arnett 1976; Bovee, et al. 1977; Bovee and Cochnauer 1977, Bovee 1978; Bovee and Milhous 1978;

Milhous et al. 1981). Without the initiative and efforts of these people, we would probably still be in the "dark ages" as far as the melding and interfacing of fish population data and stream flows through computer modeling and simulations.

The theories and techniques developed by the authors cited above will be used in this job. We used the incremental method for collecting field data in conjunction with the PHABSIM (Physical Habitat Simulation System) and IFG-4 computer models to derive weighted usable areas (WUA) for the life stages of trout species in each stream under study. A minimum of three different flow measurements was made on the study areas for each of the twelve streams.

Flow measurements were collected and analyzed according to the time schedule set down for each stream in Table 1. Weighted usuable area (WUA) curves for the various life stages of trout for a given stream versus discharge can be determined as soon as the flow data has been reduced and run through the computer simulations. However, procedures specified for this job require analyses of the relationships between age class and year class strength with annual discharge patterns. Our experience on the South Fork of the Rio Grande indicates that probably a minimum of 4 years of population estimation data, and perhaps as much as 6-7 years, will be required to make some definitive statements about these relationships. Accordingly, it will probably take until the final project segment (July 1, 1986 - June 30, 1987) to complete all analyses on some of these streams.

Plans, procedures, survey methods, and analysis techniques used in this investigation have previously been described by Bovee and Milhous 1978; Nehring 1979; Hilgert 1982) and will not be discussed in further detail here.

Table 1. Fish Flow Investigations study streams.

Stream name	Region	County	Field year	Analysis year
Cache la Poudre	NE	Larimer	83	84
St. Vrain	NE	Boulder	83	84
South Platte	NE	Jefferson/ Douglas	82	83
Arkansas	SE	Chaffee/ Fremont	84	85
Middle Fork-South Platte	SE	Park	83	85
Colorado	NW	Grand	83	84
Eagle	NW	Eagle	84	85
Fryingpan	NW	Eagle	84	85
Gunnison	SW	Montrose/ Delta	82	83
Rio Grande	SW	Mineral/ Rio Grande	85	86
South Fork Rio Grande	SW	Mineral/ Rio Grande	82	83
Taylor	SW	Gunnison	83	84

RESULTS AND DISCUSSION

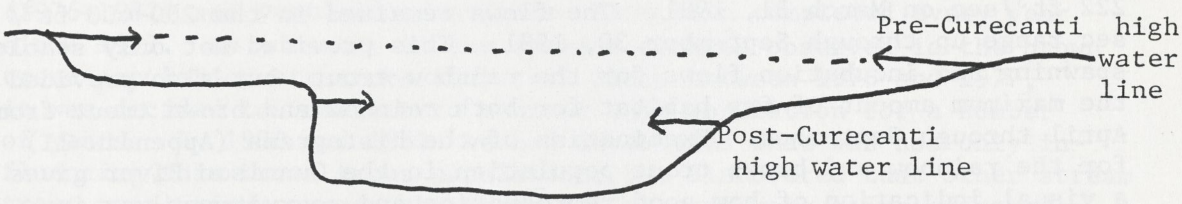
Gunnison River

The Gunnison River from the outfall of Crystal Dam to the confluence with the North Fork of the Gunnison, near Hotchkiss, Colorado, is classified as both a Wild Trout and Gold Medal water, indicating that this 43 km (26.5 miles) section of the Gunnison River is one of the premiere stream trout fisheries in the state. As such, maintaining the integrity of this stream is of utmost importance to the Division of Wildlife and the fishermen of this state.

The collection of field data was originally scheduled for completion in 1983 and analysis in 1984. However, the U. S. Bureau of Reclamation has proposed to install an additional generator in Crystal Dam, the most downstream impoundment on the Curecanti system within the Colorado River Water Storage Project (CRWSP). A part of the pre-installation studies for the environmental assessment report (EAR) was to be an evaluation of the instream flow needs for fish, particularly for rainbow and brown trout.

Since the Bureau of Reclamation was interested in acquiring this data as soon as possible, an agreement was reached to work with the Division of Wildlife to collect this data in 1982. Flows were manipulated by changing the discharge from Crystal Dam and the necessary field measurements were collected on November 3, 4, and 5, 1982. Personnel from the Division of Wildlife and Bureau of Reclamation participated in this cooperative project.

Flow measurements were made at discharge levels of 179, 661 and 1,453 ft^3/sec (5.4, 19.8, and 43.6 m^3/sec). Using these three discharge levels as calibration flows, we determined the WUA for fry, juvenile, adult, and spawning life stage requirements for rainbow and brown trout on a range of flows from 50 to 3,000 ft^3/sec (1.5 - 90 m^3/sec). Plots of WUA versus discharge for fry, juvenile, and adult rainbow and brown trout indicate a unimodal curve exists for all life stages for both species as long as the discharge does not go overbank. The Gunnison River below Crystal Dam has presently restablized in its "low flow" channel since pre-Curecanti discharge levels no longer occur. Theoretically, if the discharge were to increase to the 6,000 - 10,000 ft^3/sec range (170 - 283 m^3/sec) a bimodal curve of WUA vs discharge would probably occur, but the



second mode would probably not be as high as the first mode which occurs in the 300-900 ft^3/sec range depending upon the species and life stage in question. WUA curves versus discharge for fry, juvenile, and adult rainbow and brown trout are depicted in Figures IV-1 and IV-2 of Appendix IV.

Thus far we only have 2 years of electroshocking data available for correlating age and year class strength with discharge levels. Therefore, it will be at least 1985 before we will have the minimum amount of population data available for a good correlation of year class strength with discharge levels. However, we have already witnessed the disastrous impact of drastic changes in flow during the spawning and incubation period for brown and rainbow trout in the Gunnison River.

Water discharge patterns during the 1981 water year (October 1980 - September 1981) were just about ideal for maximizing natural reproduction for both brown and rainbow trout. Fall spawning browns deposit their eggs in October, or possibly early November in the Gunnison River. Approximately 100-120 days are required for incubation of the eggs. After hatching in late February, the sac-fry may spend several more weeks in the gravel prior to "swim-up" when they absorb the yolk sac and begin actively foraging for food. Spring-spawning rainbow trout begin spawning activity around April 1. This can commence 2 or 3 weeks earlier or later depending upon temperature conditions in the river (Dodge and MacCrimmon 1971). Rainbow trout spawning activity in the Gunnison is probably over by May 1 in most years. Egg incubation can take 30-60 days, averaging about 45 days in most years. One to 3 weeks could be required between the time of hatching and swim-up. Therefore, to optimize natural reproduction and recruitment for brown trout, it is best to have stable flow conditions from about mid-October through late February and possibly late March (to insure successful emergence of the brown fry). Similarly, stable flows from April 1 through July 1 are also requirements to maximize spawning success for rainbow trout. Finally, the WUA versus flow curves (Figs. IV-1 and IV-2, Appendix IV) indicate flows in the 200-600 ft^3/sec range provide the maximum fry habitat for both rainbow and brown trout.

Returning to our earlier statement (the ideal conditions for both species during the 1981 water year) we find that flows were high (in excess of 1,000 ft^3/sec) but stable from October 1980 through early March 1981, equating to successful incubation and hatching of brown trout eggs. The flow, 1,260 ft^3/sec on March 1, 1981, was gradually decreased to 222 ft^3/sec on March 31, 1981. The flows remained in the 200-400 ft^3/sec range up through September 30, 1981. This provided not only stable spawning and incubation flows for the rainbow trout, but also provided the maximum amount of fry habitat for both rainbow and brown trout from April through September. Examination of the histograms (Appendix II) for the rainbow and brown trout population in the Gunnison River gives a visual indication of how good reproduction and recruitment was in 1981 as well as how poor it was in 1982. Table 15 in the discussion section of Job 3 on the Gunnison River gives a numerical illustration of the number of the young-of-the-year (YOY) rainbow and brown trout sampled in 1981 and 1982. If we accept the sampling efforts were equal in 1981 and 1982, then we can tentatively conclude we had about an 88% and 95% reduction in recruitment for brown and rainbow trout between 1981 and 1982, respectively.

One is amazed upon examination of the record of daily discharge levels in the Gunnison River below the Gunnison Tunnel for the period March 1 through June 21, 1982. The gyrations and fluctuations in flow were phenomenal and the effects on brown and rainbow trout recruitment were disastrous. Probably the "final blow" came during the period of April 15-20, 1982, when flows were dropped from 34 m^3/sec (1,200 ft^3/sec) to 3 m^3/sec (105-300 ft^3/sec). One of the authors (B. Nehring) was present in the Duncan-Ute Trail section of the Gunnison Canyon in late April 1982 when the flow was between 3-8.5 m^3/sec (105-300 ft^3/sec). Dozens of rainbow trout redds were found on dry gravel bars 1-10 m from the waterline. Nehring concluded at that time the implications were ominous for the rainbow and brown trout recruitment in 1982. Further fluctuations in the flow from 6.6-24.2 m^3/sec (233-1,030 ft^3/sec) between June 11 and June 21, 1982, may have further exacerbated the situation by creation of tremendously unstable and fluctuating environmental conditions for the few brown and rainbow trout fry that were lucky enough to have survived the first sequence of flow gyrations in April 1982.

As a result of the above flows, a meeting was called to discuss the "fishery problems" in the Gunnison Canyon in August 1982. Representatives of the U. S. Bureau of Reclamation, the U. S. Fish and Wildlife Service, the Colorado Division of Wildlife, the Uncompahgre Valley Water Users Association, and the Upper Gunnison Water Conservancy District were in attendance. The result of the meeting was a much better understanding of all the problems involved on the part of all agencies and persons in attendance. The conclusion was that with better prior planning, it would be possible under almost all operational schemes to do a better job of providing for the needs of the trout population and at the same time meeting the needs of the water users as well as the demand for electric power.

South Fork of the Rio Grande

Three sections of this stream have been electroshocked for 7 years (1976-1982) and population estimates have been completed every year since 1977. As a result of the dynamic changes observed in the brown trout population structure that took place between 1976 and 1977, it was decided to continue to monitor this population for a number of years. By 1980 and 1981 we had determined what was not only influencing this brown trout population, but discovered that other stream trout populations across the State of Colorado were being effected in a similar fashion. Results of this study on the South Fork of the Rio Grande are the primary reason why this job (formerly Taylor River Flow Investigations) was expanded from one stream to twelve as of May 1, 1982.

Examination of the length-frequency histograms of the brown trout population in the South Fork of the Rio Grande (Appendix II) reveals that recruitment of young brown trout to the population is extremely variable between years. The years 1977, 1978 and 1981 were years of excellent recruitment while 1976, 1979, and 1980 were poor recruitment years. In 1982 recruitment of brown trout was moderate. Why the variation?

Initially we thought it had to be parent spawner density; however, by 1981 that theory was put to rest, at least as the dominant controlling factor. To test the hypothesis that recruitment is positively correlated with parent spawner densities, we had to make several assumptions. We assumed:

1. A 1:1 sex ratio for the adult spawning population

2. That fecundity is positively correlated with length

3. That all brown trout greater than 20 cm body length were sexually mature

4. A 100% hatch on all eggs "available for deposition" the previous fall

Concerning assumption 1, while we acknowledge that the literature abounds with examples of trout populations where the male to female sex ratio is not 1:1 and can be 2:1 or even 4:1 (Van Velson 1974), much of the same literature indicates that whatever the "real" sex ratio, it is oftentimes quite stable from one year to the next and thus would not bias the relationship between the number of spawners available from one year to the next and the number of eggs available for deposition between years.

Examples of the positive relationship between salmonid body length and fecundity are legion in the literature (Taube 1976), thus making our second assumption valid. Our third assumption (all browns 20 cm in length and larger are sexually mature) was verified on the field electroshocking expeditions. Brown trout body length-fecundity relationships for the purpose of this study were taken from Taube (1976) in his paper on sexual maturity and fecundity of brown trout in the Platte River, Michigan. Our fourth assumption (100% of all eggs are deposited and hatched successfully) is also a tenuous assumption; however, we maintain that if it is not 100% then whatever the percentage is, it is probably relatively constant between years (in the South Fork of the Rio Grande) and therefore should not bias the relationship in number of eggs deposited and hatched between years. The magnitude or number of eggs deposited would vary yearly but in the same relationship between years, thus maintaining the validity of this assumption. Thus, the number of eggs available for deposition (generated from the length frequency distribution and population estimates each year) is regressed against the number of YOY sampled each fall over the past 7 years. After 4 years of sampling (1977-1980), the correlation coefficient (r) was +0.7139 and r^2 value of +0.5097. However, after 6 years of sampling, the correlation coefficient (r) had decreased to +0.3793 and an r^2 value of +0.1438, indicating a very poor correlation existed between parent spawner density and YOY recruited to the population. We concluded some other factor(s) must be involved.

The years of excellent recruitment levels (1977, 1978 and 1981) were extremely dry years both for snow pack the previous winters as well as for stream-swelling summer rains. Conversely, the years 1976, 1979 and 1980 (years of very poor recruitment) were years of near record snow pack levels. In 1982 the snow pack was well above normal and summer rains were unusually strong and frequent. 1982 was a year of intermediate recruitment and the water year and snow pack was average. The question arose, are levels of brown trout recruitment inversely proportional to the intensity of the spring runoff? Spring runoff commences about the time of fry emergence (or just after) on the South Fork of the Rio Grande and peaks in May, June, and early July, during the first 3 months of life for brown trout fry. The literature abounds with studies that indicate relationships do exist between flow and levels of recruitment (McKernan et al. 1950; Bulkley and Benson 1962; Brett 1951; Johnson 1956; Vernon 1958; Wickett 1958; Gagmark and Bakkala 1960). A study done in Colorado indicated a strong negative relationship between spring runoff levels and recruitment of cutthroat trout (Drummond 1966). This is the suspected relationship on the South Fork of the Rio Grande.

To eliminate some of the variability in the number of young-of-the-year sampled, we divided this sample by the number of eggs theoretically "available for deposition" the previous fall. This number (times 100%) gives a number we call "relative percent survival." Relative percent survival is then regressed against mean discharge (by month for April, May, June, and July 1976 - 1981). The results of this regression analysis are given in Table 2.

Table 2. Regression[a] analysis of relative percent survival (YOY) versus mean discharge by month April - July, 1976-1981.

Month	r	r^2
April	-0.8868	0.7864
May	-0.9150	0.8372
June	-0.8423	0.7096
July	-0.9782	0.9569

[a] A power curve regression analysis.

Examination of Figure IV-3 in Appendix IV depicts the relationship between habitat units (ft^2 WUA) versus stream discharge. It is self-evident that once the discharge level exceeds about 2.8 m^3/sec (100 ft^3/sec) the regression relationship is negative in a reverse exponential fashion. Thus as discharge increases, WUA decreases. Therefore, if recruitment (as measured by relative percent survival) is negatively correlated with discharge, then we should expect a positive correlation between relative percent survival and WUA habitat units. Indeed, this is the case as shown in Table 3.

Table 3. Regression[a] analysis of relative percent survival (YOY) versus brown trout fry WUA by month for April - July, 1976-1981.

Month	r	r^2
April	+0.8961	0.8030
May	+0.8017	0.6427
June	+0.8694	0.7558
July	+0.9835	0.9674

[a] A power curve regression analysis

Figures IV-4 and IV-5 in Appendix IV depict the changes in WUA for fry and juvenile brown trout (expressed as percent of total habitat area for a "dry" year [1977] and a "wet" year [1979]). The percent WUA remains near maximum levels throughout all of 1977 except for a short period in May. Brown trout recruitment was the second best that year (1977) for the period 1976 - 1982. Conversely, percent WUA for 1979, (a heavy snow-pack year) dropped from 35.8% (prior to the onset of spring runoff) to the 1-10% range for a period of about 120 days (April through July). Recruitment of YOY brown trout in 1979 was the worst for the 6-year period 1976-1982.

Brown trout population estimates for study areas on the South Fork of the Rio Grande are presented in Tables I-14 and I-15 in Appendix I. Fluctuations in both numerical density and biomass occur regularly. Most of these fluctuations are manifestations of changes in recruitment between years previously described. Age and growth information on this population is given in Appendix III.

Angler harvest is having negligible (if any) impact on the standing crop of brown trout observed in the South Fork of the Rio Grande. In 1981 anglers caught an estimated 2,765 brown trout in this river. Our fall 1981 brown trout population estimates 28,800 brown trout 20 cm and larger for the approximately 22.6 km of river between South Fork, Colorado and the point where U. S. Highway 160 leaves the river. That works out to an exploitation rate (see Job 3 for definition of exploitation rate) of 8.75% for 1981. Even if we used the upper 95% confidence limit (4,731) on the harvest for 1981, the exploitation rate is still only 14.1%, a very low harvest figure. The vast majority of anglers on the South Fork of the Rio Grande are non-resident novice anglers and they are apparently very ineffective (as a group) at angling for brown trout.

South Platte River

The objective of this study is to identify how the trout population dynamics in Cheesman Canyon have been affected by changes in habitat quality due to fluctuations in discharge. The population parameters under evaluation were recruitment rates (fry production and survival combined) and adult survival rate. If strong correlations exist, then it is possible to predict trout density and biomass based on stream hydrology. This would be very useful since it would give us an accurate definition of minimal and optimal instream flow needs.

Cheesman Reservoir is a bottom release reservoir that provides the flow in the South Platte through Cheesman Canyon. The Denver Water Board operates this reservoir for municipal water use. The outflow can fluctuate drastically on short notice and there is no way to predict when fluctuations will occur. Discharge curves for the last 9 years are presented in Figures 6 - 10 in Appendix IV. The 57 year average discharge is 157 cfs up to the 1981 water year. The minimum winter discharge is set at 15 cfs or can match the inflow if it is lower. Between 1974 and 1982, the winter base flow in Cheesman Canyon was less than 15 cfs in 1974 (13), 1975 (10), 1978 (14), 1979 (8.4), and 1981 (13). It was at 15 cfs in 1976 and 1982 and was 16 cfs in 1980. The 9 year average low discharge is 14.2 cfs. The peak discharge has ranged from 298 to 1,300 cfs over the past 9 years and the average peak flow is 715 cfs.

The Cheesman Canyon area on the South Platte River is a good area to study trout/flow relationships because of the catch and release regulation which removed angling mortality from the population in 1976. Table 21 (see Job 3) gives electrofishing results from fall 1979 to fall 1982. The South Platte in Cheesman Canyon was probably at carrying capacity in 1979; the density estimate was 2,251/ha and the biomass was 650 kg/ha. Density and biomass were also high in the fall of 1980. There was a large decline in density (41%) and biomass (30%) in the fall of 1981 from the previous year, but the population had stabilized by 1982. From 1979 to 1982 the rainbow density had dropped from 1,412/ha to 806/ha (43%) and biomass was down by 29%. Brown trout did not decline as much but were still down by 19% in numbers and 31% in biomass.

Inadequate fry production appears to have been an important factor in the population decline from 1979 to 1982. The number of age 0 and age 1 trout were low for rainbows and only modest for browns during this time period. It appears that recruitment was not sufficient to keep up with mortality of adults. However, to date this has not been a concern from a fisheries standpoint since the adults are still abundant and have low mortality rates. Indeed any stream that has an abundant adult population is better served by reduced recruitment since this eases intraspecific competition. However, if recruitment is poor for a period of 4 or 5 years then the possibility of a population crash becomes more likely.

The daily discharge patterns of the South Platte (Figs. 6-10, Appendix IV) were examined to see how flow had influenced fry production over the past 5 years. Since the few YOY had been collected at the two canyon stations, the number of age 1+ trout from the fall samples were used as an indicator of year class strength for the previous year. This assumes that mortality from age 0 to age 1 was primarily due to physical factors and was density independent.

The two wettest years (1979 and 1980) had the poorest rainbow year classes (Table 4). The best rainbow production for the period was in 1977, a low runoff year with stable flows throughout the year. Nineteen seventy-eight would probably have been a better recruitment year for rainbows if the April (spawning) flows had been higher. Fry production was probably negatively influenced in 1981 since flows were high in April but dropped off in May which dewatered redds along the bank.

The correlation analysis indicated that the greatest effect on rainbow YOY production comes in the spring and varies due to the magnitude of the runoff. When rainbow year class strength and peak flow for the year were exponentially regressed, the result was an r value of -0.96 (Fig. 1). The linear model was not as good with an r value of -0.75, which was nonsignificant at the 0.05 level (Fig. 2). Correlations were also run on year class strength versus mean monthly discharge in April (spawning period), May (incubation and swim-up period), and June and July (run-off months). July had the best r value for the monthly flows but was still not as good as peak flow.

Examination of life tables (Appendix III) showed that in all study years rainbow year classes increased in density at age 2 (Table 5). The most likely explanation is that rainbow adults found better areas suited for spawning outside of our electrofishing stations and that the fry and fingerlings stayed in those areas until the start of their second winter. At that time they migrated into the lower electrofishing station to overwinter. In 1980, 1981 and 1982, the 1978, 1979 and 1980 rainbow year classes were 281, 354, and 345% more numerous at age 2+ than in the preceding year as one-year-olds (Table 6). The average for these 3 years (327%) was used to estimate the number of age 1+ rainbows for the 1977 year class.

The Table 5 age data indicates that our electrofishing stations, which contain primarily adult habitat, may not be respresentative of the number of age 0 and age 1 trout at large in the canyon. This complicates the analysis of year class strength/discharge relationships. The assumption must be made that the number of age 1 trout found at our stations is directly proportional to the rest of the population. This assumption appears to be valid for both the rainbows and browns for the study period. The 1978 brown year class increased at age 2+ in the fall of 1980 by 260%, and the 1980 year class had a 274% higher density as 2-year-olds than as ones, but no immigration was found for brown at age 2 for the 1979 year class. Nineteen seventy-nine had a high spring runoff (895 cfs), low flows during the spawning season (26 cfs) and a very low winter flow of 8 cfs. The low spawning flows would have eliminated many normally good spawning areas and concentrated the redds at the deepest riffles, such as our sampling station. Also only the deepest redds would be submerged

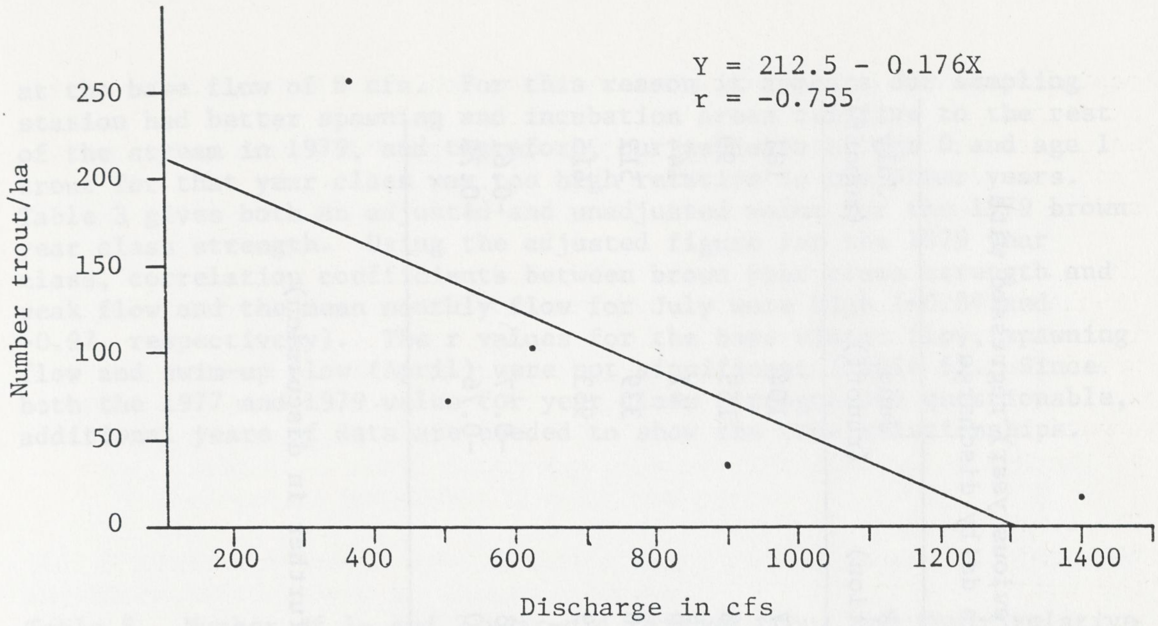


Figure 1. Rainbow trout year class strength (as age 1+) versus peak annual discharge in Cheesman Canyon, South Platte River 1977 to 1981.

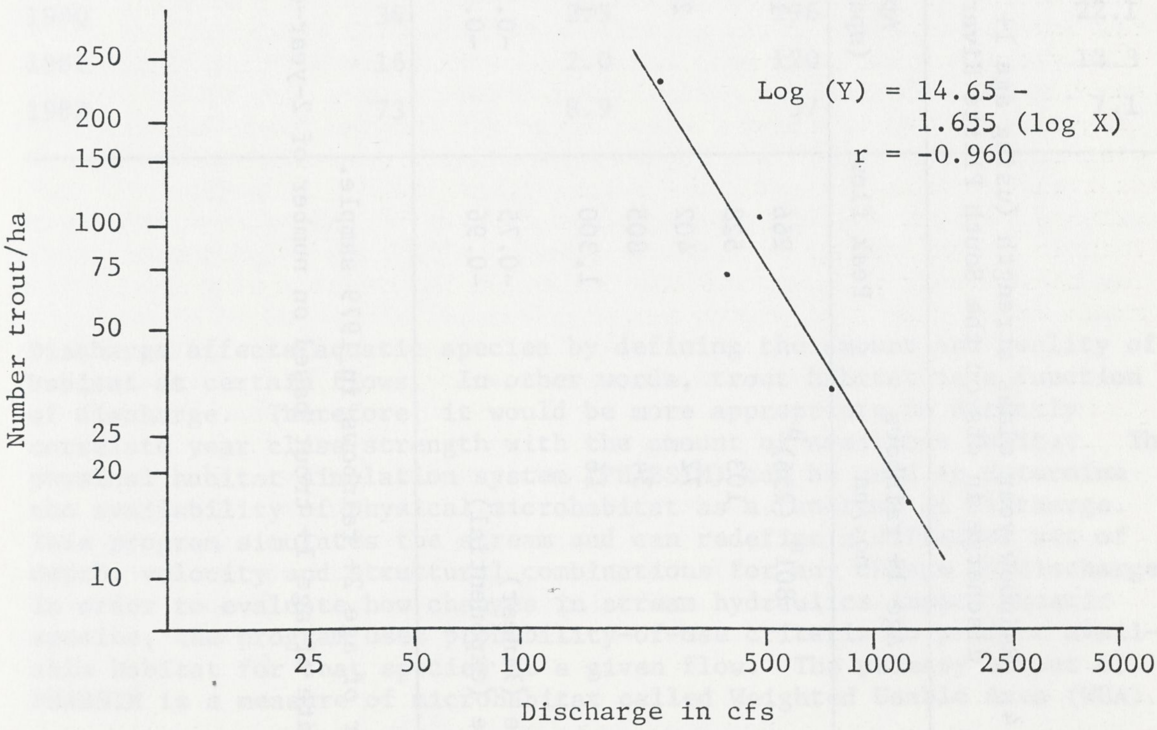


Figure 2. Full log relationship for rainbow trout year class strength versus peak annual discharge in Cheesman Canyon 1977 to 1981.

Table 4. Rainbow year class strength (using age 1+ trout for the previous year) regressed with discharge in cfs on the South Platte River. Months in mean daily discharge.

Year class	Age 1+ rainbows no./ha	Peak flow	April (spawning)	May (incubation)	June (runoff)	July (runoff)
1977	801[a] (256)[b]	266	116	117	104	181
1978	103	528	26	48	155	99
1981	72	402	232	63	47	144
1979	34	805	63	26	339	512
1980	16	1,300	157	809	953	615
r value (linear)		-0.75	-0.11	-0.38	-0.57	-0.61
r value (exponential)		-0.96	-0.18	-0.40	-0.76	-0.79

[a]Number of age 2+ rainbows in 1979 sample.

[b]Estimate of age 1+ trout based on number of 2-year-olds (explained further in discussion).

at the base flow of 8 cfs. For this reason it appears our sampling station had better spawning and incubation areas relative to the rest of the stream in 1979, and therefore, our estimate of age 0 and age 1 trout for that year class was too high relative to the other years. Table 3 gives both an adjusted and unadjusted value for the 1979 brown year class strength. Using the adjusted figure for the 1979 year class, correlation coefficients between brown year class strength and peak flow and the mean monthly flow for July were high (-0.84 and -0.97, respectively). The r values for the base winter flow, spawning flow and swim-up flow (April) were not significant (Table 6). Since both the 1977 and 1979 value for year class strength are questionable, additional years of data are needed to show the true relationships.

Table 5. Number of 1- and 2-year-old rainbow trout and their relative abundance in Cheesman Canyon in 1979 to 1982.

	Age 1+		Age 2+	
Sample year	No./ha	% of total	No./ha	% of total
1979	105	7.3	720	56.7
1980	34	2.5	296	22.1
1981	16	2.0	120	12.3
1982	73	8.9	57	7.1

Discharge affects aquatic species by defining the amount and quality of habitat at certain flows. In other words, trout habitat is a function of discharge. Therefore, it would be more appropriate to directly correlate year class strength with the amount of available habitat. The physical habitat simulation system (PHABSIM) can be used to determine the availability of physical microhabitat as a function of discharge. This program simulates the stream and can redefine a different set of depth, velocity and structural combinations for any change in discharge. In order to evaluate how changes in stream hydraulics impact aquatic species, the program uses probability-of-use criteria to predict available habitat for that species at a given flow. The primary output of PHABSIM is a measure of microhabitat called Weighted Usable Area (WUA).

Table 6. Brown year class strength (using age 1+ trout from the previous year) regressed with discharge in cfs on the South Platte River. Months in mean daily discharge.

Year class	Age 1+ browns no./ha	Peak flow	October (spawning)	Winter base flow	April (swim-up)	July (runoff)
1978	218	528	75	16	26	99
1977	324[a] (180)[b]	266	105	35	116	181
1981	165	403	71	13	232	144
1979	268 (100)[c]	805	25	8	63	512
1980	72	1,300	251	16	157	651
r value (linear)		-0.48	-0.94	-0.22	-0.61	-0.34
r value (exponential)		-0.49	-0.90	-0.28	-0.56	-0.44
r value[c] (linear)		-0.84	-0.48	-0.39	-0.25	-0.97
r value[c] (exponential)		-0.84	-0.23	-0.40	-0.37	-0.97

[a]Number of age 2+ trout in 1979.

[b]Estimate of age 1+ trout based on number of 2-year-olds.

[c]1979 year class strength adjusted to other years.

Bovee (1982) listed some general statements about most habitat curves:

a. More water does not necessarily mean more habitat.

b. Maximum habitat for different life stages are at different discharges.

c. Optimal flows are different for different species.

d. Optimal flows in one section of a river may not be the same for other areas.

e. Flows of a given amount may not provide the same amount of habitat at different time of the year.

All of these statements were found to apply to the trout population of the South Platte River in Cheesman Canyon.

The lower electrofishing station of Cheesman Canyon was set up to take the discharge measurements pertinent to PHABSIM analysis. Depth, velocity, and substrate variables were measured at four different flows (21, 51, 152 and 319 cfs) and entered into the model. The preference curves for these variables for the different life stages of rainbow and brown trout were obtained from Bovee (1977).

Brown trout fry had nearly twice the WUA as rainbow fry at nearly all flows for the Lower Cheesman Canyon station (Figs. IV-11 and IV-12 in Appendix IV). This was mainly due to the fact that the preference curves, which used similar depth and velocity requirements for both species, indicated rainbow fry avoid sandy substrates but brown fry do not. Electrofishing results were supportive of the fry curves in that the number of YOY and age 1+ brown trout in fall samples was more than double that of rainbow trout in spite of the fact that rainbows had a larger brood population (Tables 4 and 6). In the fall of 1982, there were more rainbow YOY collected than browns, but spawning flows appeared to be much more favorable in the spring 1982 than in the fall of 1981 (Fig. IV-14, Appendix IV). It is likely that the areas with more gravel in the substrate would have similar available habitat for rainbow and brown fry.

The discharges in Tables 4 and 6 were converted to the appropriate WUA and regressed against year class strength. The rainbow year class strength was significantly correlated with peak flow ($r = +0.96$) and the June mean monthly discharge ($r = 0.83$) (Table 7). Using the 1979 adjusted year class estimate (100/ha), the brown correlations were significant for July ($r = 0.96$) and for the spawning period ($r = 0.90$) (Table 8).

The percent change in wetted perimeter from spawning flow to the base winter flow (brown trout) was also calculated. This is the time when brown eggs are in the gravel and a large reduction in flow would dewater redds. Table 9 illustrates this point. When flows are dropped

Table 7. Rainbow year class strength (using age 1+ trout for the previous year) regressed against weighted usuable area on the Lower Cheesman Canyon station.

		Fry habitat			Spawning & incubation	
Year class	Age 1+ rainbows no./ha	Peak flow WUA	June	July	April	% change in wetted perimeter
1977	801[a] (256)[b]	6,755	19,063	11,787	12,899	-0.1
1978	103	2,730	14,103	19,354	5,595	+12.3
1981	72	3,400	15,240	15,153	9,007	-19.5
1979	34	2,100	4,366	2,566	10,462	-16.4
1980	16	(500)	(2,100)	(1,500)	11,971	+13.1
r value (linear)		0.96	0.832	0.46	0.25	
r value (exponential)		-0.93	0.94	0.84	-0.15	

[a]Number of age 2+ rainbow in 1979 sample.

[b]Estimate of age 1+ trout based on number of 2-year-olds in 1979.

Table 8. Brown year class strength (using age 1+ trout from the previous year) regressed against weighted usable area (ft^2) on the Lower Cheesman Canyon station.

		Fry habitat			Incubation & spawning	
Year class	Age 1+ browns no./ha	Peak flow WUA	April (swim-up)	July (runoff)	October	% change in wetted perimeter
1978	218	15,482	32,467	45,898	10,444	-35.9
1977	324[a] (180)[b]	29,042	43,974	35,206	10,940	-17.0
1981	165	19,261	32,355	41,939	9,992	-39.7
1979	268 (100)[c]	12,000	44,387	15,708	4,695	-46.0
1980	72	(8,000)	40,669	(10,000)	5,794	-53.7
r value (linear)		0.19	0.08	0.29	0.01	
r value (exponential)		0.50	-0.04	0.54	0.14	
r value[c] (linear)		0.64	-0.56	0.96	0.90	
r value[c] (exponential)		0.80	-0.54	0.98	0.88	

[a] Number of age 2+ brown in 1979 sample.

[b] Estimate of age 1+ browns based on number of 2-year-olds in 1979.

[c] 1979 year class adjusted to conform with other years.

from 150 to 20 cfs the stream width is decreased by 39%. All areas that were less than one foot deep at 150 cfs became dry at 20 cfs. Figure 3 illustrated that as flows drop below 200 cfs, the wetted perimeter drops quickly. The wetted perimeter dropped by at least 35% from the time brown trout spawned to the base flow in all years except 1977.

Table 9. Discharge-habitat relationships for the Lower Cheesman Canyon station.

Discharge (cfs)	Mean stream width (ft)	Water column depth (ft)	Water column velocity (ft/sec)
300	94	1.6	3.3
150	86	1.0	1.9
50	70	0.4	0.5
20	52	0.0	0.0

The most common use of the WUA curves (Figs. IV-11 and IV-12 in Appendix IV) would be to select a flow that would maximize the habitat for the fish population or identify critical flows where habitat drops off rapidly. If we could pick any flow we wanted for instream use, we would logically pick the flow that gives the best mix of beneficial flows or which would minimize negative impacts. Table 10 uses the optimization technique from Bovee (1982) to arrive at the "best" flow during the spawning period for brown trout (October).

The WUA for each life state is listed at various discharges. The smallest WUA in each column is placed at the bottom row. The highest WUA in the bottom row is the optimal flow. The optimal flow for browns spawning is between 75 and 125 cfs according to this method. Using the same principle with all life stages of rainbow trout included with the browns, an optimal discharge can be derived for each month or time period for an annual cycle. This would be a flow of 100 cfs for browns spawning (October) and 75 cfs for the brown incubation period (November - March). Flow should be 150 cfs for rainbow spawning and incubation (April and May) and not much over 200 cfs for the runoff period (June - August). This optimal flow scenario developed for the trout population in Cheesman Canyon may be unrealistic from a water management viewpoint. Also this optimal flow cycle may not be highly desirable from a fisheries standpoint since it may produce the highest trout densities but perhaps not the best quality population by the Gold Medal definition.

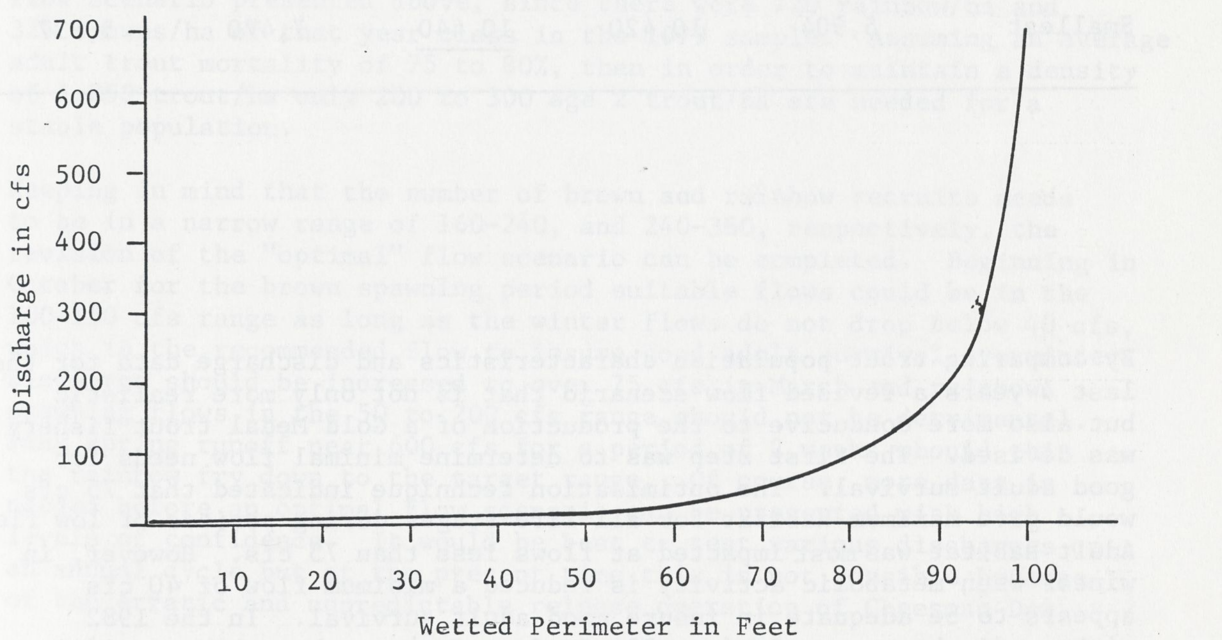


Figure 3. Discharge and wetted perimeter relationship for Cheesman Canyon.

Table 10. Optimization matrix for determining optimal flow for a mix of life stages for brown trout in the South Platte River. Weighted usable area (WUA) is square feet of habitat per 1,000 feet of stream.

Life stage	WUA at 35 cfs	WUA at 75 cfs	WUA at 125 cfs	WUA at 175 cfs	WUA at 250 cfs
Fry	36,670	46,434	43,730	35,910	30,480
Juvenile	31,549	39,755	37,800	32,320	28,850
Adult	14,902	19,671	24,040	25,010	23,760
Spawning	5,904	10,420	10,440	7,470	5,837
Smallest	5,904	10,420	10,440	7,470	5,837

By comparing trout population characteristics and discharge data for the last 4 years a revised flow scenario that is not only more realistic but also more conducive to the production of a Gold Medal trout fishery was devised. The first step was to determine minimal flow needs for good adult survival. The optimization technique indicated that 75 cfs would give maximum habitat for all life stages during periods of low flow. Adult habitat was most impacted at flows less than 75 cfs. However, in winter when metabolic activity is reduced a minimum flow of 40 cfs appears to be adequate in insure good adult survival. In the 1982 winter, discharge remained at 32 cfs from January through May. Adult rainbow trout survival was fairly good from the fall of 1981 to the fall of 1982 at 0.84. This reflects an annual mortality rate of about 16% of which most probably occurs during the low flow period. However, some of this mortality may be due to hooking mortality or poaching in spring and summer, so the adult survival rate overwinter was probably near 90%. In 1982, the annual survival rate on brown trout was 63%. The annual survival rate of rainbow and brown trout from 1980 to 1981 was 0.52 and 0.29, respectively. The 1981 base winter flow was also less with the discharge near 15 cfs for a 2-month period. This suggests that a 40 cfs flow from December to March is much better for adult survival than the 15 cfs minimal winter discharge presently used.

Over the 4 years of population samples, 1979-1982, total trout biomass ranged from 700 to 450 kg/ha (Appendix I). The density of the two canyon stations in 1980 was 2,400 trout/ha and the mean size of the adult trout was 29 cm. In 1980 another station was also sampled just below the dam in an area that is closed to all fishing. At this area density was 1,250 trout/ha but the mean adult size was 37 cm (Nehring and Anderson 1981). Total biomass was nearly the same. This suggests that growth and body size were density dependent and that a build-up of trout over 16 inches was precluded by the high population numbers. It appears that a trout density of 1,200 to 1,400 trout/ha, of which about 60% are rainbow, is most likely to produce the best size structure for this population.

It would be a big advantage for management of Gold Medal streams if recruitment rates could be adjusted to adult mortality rates so that a stable population at a desirable density could be maintained. It appears very feasible that the manipulation of discharge could be used to control year class strength in regulated streams. Fry production was overabundant in 1977, a year that closely resembled the "optimal" flow scenario presented above, since there were 720 rainbow/ha and 324 browns/ha of that year class in the 1979 sample. Assuming an average adult trout mortality of 75 to 80%, then in order to maintain a density of 1,250 trout/ha only 200 to 300 age 2 trout/ha are needed for a stable population.

Keeping in mind that the number of brown and rainbow recruits needs to be in a narrow range of 160-240, and 240-360, respectively, the revision of the "optimal" flow scenario can be completed. Beginning in October for the brown spawning period suitable flows could be in the 100-150 cfs range as long as the winter flows do not drop below 40 cfs, which is the recommended flow to insure good adult survival overwinter. Discharge should be increased to over 75 cfs in March and rainbow spawning flows in the 50 to 200 cfs range should not be detrimental. Peak spring runoff near 600 cfs for a period of 2 weeks should thin the rainbow fry down to the target range. Of course, more data is needed before an optimal flow scenario can be presented with high levels of confidence. It would be best to test various discharges on an annual cycle but at the present time this is not possible because of the erratic and unpredictable release operation of Cheesman Dam.

Taylor River

Methodologies used and experimental design employed in early years (1973-1975) were described by Burkhard (1977). Methods, techniques, and experimental design used in the later years (1979-1982) of the study were described by Nehring (1980) and Nehring and Anderson (1981, 1982). The reader is referred to those job segment reports for the details rather than reiterate them here.

Fall brown trout population estimates for the 6 years of electroshocking are presented in Table 11 below.

Table 11. Taylor River brown trout population estimations from October 1974, 1975, 1979, 1981, and 1982. (Estimates in no./km.)

Sample station	1974	1975	1979	1980	1981	1982
Almont	1,775	1,482	2,975	2,823	2,728	4,656
Elsinore Cattle Company	2,156	1,866	2,460	2,531	2,013	2,228
One Mile Campground	2,384	1,829	3,641	3,741	2,784	2,904
Perkins Sam	1,817	1,974	2,825	3,575	4,032	3,211

A paired t-test analysis of all possible pairings of the data (between years) shown in Table 11 is presented in Table 12.

Table 12. Statistical evaluation of brown trout populations in the Taylor River from October 1974, 1975, 1979, 1980, 1981, and 1982.

Years tested	df	Calculated t value	t percentile	t value
1974 vs 1975	3	-1.662 nsd[a]	0.90	1.638
1974 vs 1979	3	-4.296 ***	0.95	2.353
1974 vs 1980	3	-3.886 ***	0.975	3.182
1974 vs 1981	3	-1.694 *	0.990	4.541
1975 vs 1979	3	-4.242 ***	0.995	5.841
1975 vs 1980	3	-5.224 ****		
1975 vs 1981	3	-2.782 **		
1974/75 av vs 1981	3	-2.184 *		
1979 vs 1980	3	-0.990 nsd		
1979 vs 1981	3	+0.191 nsd		
1980 vs 1981	3	+0.923 nds		
1974/75 av vs 1982	3	-2.208 *		
1974 vs 1982	3	-1.966 *		
1975 vs 1982	3	-2.431 **		
1979 vs 1982	3	-0.526 nsd		
1980 vs 1982	3	-0.138 nsd		
1981 vs 1982	3	-0.631 nsd		

[a] nsd = No significant difference
* Level of significance between 0.90 and 0.95
** Level of significance between 0.95 and 0.975
*** Level of significance between 0.975 and 0.99
**** Level of significance between 0.99 and 0.995

Table 13 indicates the percent change in the Taylor River brown trout population in the fall of 1979, 1980, 1981, and 1982 as compared to the average population size for the fall of 1974-75.

Table 13. Percent increase in Taylor River brown trout populations (no./km) for October 1979, 1980, 1981, and 1982 over the October 1974-75 average.

Sample station	1974-75 average	1979	% inc.	1980	% inc.	1981	% inc.	1982	% inc.
Almont	1629	2975	83	2823	73	2728	67	4656	186
Elsinore Cattle Co.	2011	2460	22	2531	26	2013	0	2228	11
One Mile Campground	2112	3641	72	3741	77	2784	32	2904	38
Perkins Sam	1896	2825	49	3575	89	4032	113	3211	69
Average increase	--	--	57	--	66	--	53	--	76

The data presented in Tables 11-13 indicate a significant increase in the Taylor River brown trout population had occurred by 1979 and that level of increase has been maintained since that time. It is our conclusion that this increase is due to the stabilization of water release patterns out of Taylor Park Reservoir during the fall-winter (November-March) months.

Earlier (Nehring 1980; Nehring and Anderson 1981) we indicated the increases in the population levels observed in 1979 and 1980 could easily have been the result of unusually high recruitment levels that occurred during the near-record-low water years in 1977 and 1978. We have demonstrated that recruitment of brown trout in some Colorado streams is inversely proportional to maximum levels of spring runoff (Nehring and Anderson 1980). Therefore, we recommended the continuation of this study through the fall of 1982. In so doing, we would be able to determine if the near-record high runoff years in 1979-80 in the Taylor River Basin would once again hamper recruitment and reduce the brown trout population levels to those observed in 1974-75, at a time prior to the stabilization of the fall-winter flow regime.

The Taylor River brown trout population density has ranged from 53% to 76% higher in the period 1979-1982 as compared to the 1974-75 average. This improvement has been maintained over the 4-year period despite near record extreme drought (1977-78) followed by near record runoff years (1979-80). Thus climatic variables have in essence been eliminated as operative variables in the observed increases in the Taylor River brown trout population density. Fishing pressure and harvest have not changed appreciably between the 1973-1975 period and the 1979-1982 period (Burkhard 1977; Nehring and Anderson 1982). Thus, angling pressure and harvest are also eliminated as variables. The stocking of catchable size rainbow trout has been an annual on-going phenomenon in the Taylor River throughout the past 15 years, thereby eliminating stocking changes as an operative variable.

Table 14 reveals the magnitude of variation in flows in the Taylor River during the brown trout spawning and incubation period over the past 10 years.

Table 14. Maximum and minimum 7-day discharge levels (ft^3/sec) in the Taylor River below Taylor Park Reservoir during brown trout spawning and incubation period (November - March 1971-1981).

Time period	Maximum (ft^3/sec)[a]	Minimum (ft^3/sec)[b]	Difference (ft^3/sec)
Nov. 71 - Mar. 72	509	52	457
Nov. 72 - Mar. 73	336	47	289
Nov. 73 - Mar. 74	480	62	418
Nov. 74 - Mar. 75	253	61	192
Nov. 75 - Mar. 76	282	85	197
Nov. 76 - Mar. 77	82	58	24
Nov. 77 - Mar. 78	109	89	20
Nov. 78 - Mar. 79	63	53	10
Nov. 79 - Mar. 80	150	57	97
Nov. 80 - Mar. 81	194	71	123

[a] Average 7-day maximum flow during October 15 - November 30 (spawning period)

[b] Average 7-day minimum flow during November - March (incubation period)

A rigorous regression analysis of the potential impacts of flow variations on the Taylor River brown trout population was conducted last year and was presented in the 1982 progress report (Nehring and Anderson 1982). Those analyses indicated that flow variations and manipulations in the Taylor River impact the brown trout population in several different ways.

1. A positive correlation exists between brown trout year class strength (age 1+) and mean monthly flows throughout the calendar year.

2. This positive correlation is strongest (high r values) during the November - April spawning and incubation period.

3. Flow reductions during the brown trout incubation period (November - March) show a high negative correlation with year class strength (r values from -0.7598 to -0.9395).

4. Significant year class augmentation occurs between the second (1+) and third (2+) year of life at all electroshocking stations in all years. This augmentation apparently results from off-channel spawning and recruitment in four major side tributaries to the Taylor River. These fish apparently move into the Taylor River between their second (1+) and third (2+) year of life. We hypothesize that the numbers moving into the Taylor River each year are probably in proportion to the year class strength. Since these tributaries are not affected by impoundments, we further hypothesize that a negative relationship exists between year class strength (2+) and peak levels of spring runoff as has been shown to be the case on several trout streams in Colorado (Drummond 1966; Nehring and Anderson 1981). A regression analysis revealed negative correlation coefficients (r) in 54 of 60 possible regressions (5 electroshocking stations times 12 months) with the strongest negative correlations coming in the period May - October, during the first 6 months of life for young-of-the-year brown trout. It is during the first 6 months of life that trout are the weakest swimmers, the least mobile, and most susceptible to density independent mortality resulting from extreme environmental conditions, i.e., excessively heavy spring runoff. Thus, these regression analyses support our hypotheses alluded to above.

It was our intention to have completed an IFG4 instream flow analysis of the Taylor River during the 1982 field season. However, due to an unusually heavy electroshocking field schedule and a very wet summer with significant delays in electroshocking, we were unable to complete the instream flow evaluation. However, it is our intention to complete collection of the data for the instream flow analysis in the 1983 field season and hopefully include the analysis in the 1984 progress report.

RECOMMENDATIONS AND CONCLUSIONS

Gunnison River

Habitat units (WUA) for fry, juvenile, and adult rainbow and brown trout are heavily controlled by water release patterns out of Crystal Dam during all months of the year. Similarly, when diversions through the Gunnison Tunnel are in operation (April - October in most years) WUA for all life stages of rainbow and brown trout are affected as well.

We will continue to monitor the trout population in this river over the next several years to insure that we are able to recognize and document the impacts of discharge fluctuations on the rainbow and brown trout populations of the Gunnison River.

South Fork of the Rio Grande River

We have documented a strong negative correlation between spring discharge levels and brown trout recruitment on this river over the past 7 years (1976-1982). Incremental flow analysis using the IFG3 and IFG4 models indicates WUA habitat parameters for fry, juvenile, and adult brown trout on the South Fork of the Rio Grande are inversely correlated with discharge levels once the flow exceeds about 100 ft^3/sec (3 m^3/sec). Similarly, we found a strong positive correlation between WUA for fry and juvenile brown trout and the level of brown trout recruitment over the 7-year period (1976-1982).

We recommend that this study area be dropped after the 1983-84 project segment.

South Platte River

Significant correlations between year class strength and discharge patterns were found in Cheesman Canyon. However, additional years of data are needed to add strength to the analysis. Also, because of habitat differences between Cheesman Canyon and the South Platte below Deckers, a second IFG4 station appears necessary to describe the habitat there. We will collaborate with John Goettl in this field work and also with IFG4 work on the Middle Fork of the South Platte.

Taylor River

This study has clearly demonstrated the benefits of a stabilized fall-winter flow regime that are manifested in the brown trout population of the Taylor River. Overwinter losses are minimized and brown trout recruitment in the main channel has been augmented. We will complete an incremental flow analysis (IFG3 and IFG4) of the Taylor River during the 1983-84 project segment. We recommend that the Taylor River be dropped from the study after the 1983-84 project segment.

Job No. 3

Job Title: Special Regulations Evaluations

Job Objective: Determine the impacts of special regulations management (including Wild Trout and Gold Medal Trout Waters) on trout population dynamics and the fishing public.

Period Covered: May 1, 1982 to June 30, 1983

INTRODUCTION

Background

This job began in 1979 with a study of eight streams. Streams have been added and deleted from the study since that time. A total of 16 streams have been evaluated during the period 1979-1983 and 11 streams are currently under investigation in Job 3. They include the Arkansas, Cache la Poudre, Colorado, Eagle, Fryingpan, Gunnison, Middle Fork of the South Platte, North Platte, Rio Grande, South Platte, and St. Vrain rivers.

In the past 2 years, Colorado has implemented Wild Trout and Gold Medal trout management programs. These programs rely on special restrictive angling regulations to aid in achieving the objective of producing larger numbers of quality-size (14 inches and larger) trout. More than 200 miles of river in Colorado are presently under special regulations management as compared to less than 25 miles in 1981. Evaluation of these areas is a high priority and this project will be responsible for the evaluation of most of the Gold Medal waters.

METHODS AND MATERIALS

Study streams were selected so a wide variety of special regulations could be evaluated. Gold Medal streams were given a high priority. Representative sampling stations were established within the special regulation (study) and standard regulation (control) areas. Many of the study sites had been selected at the onset of this project in 1979 (see Nehring 1980). Others were selected because earlier researchers had used them in their studies.

All trout populations were sampled by electrofishing. The electroshocking unit was a Coffelt Model VVP-2C (1,000 to 2,000 watt output) powered by a gasoline generator. On streams shallow enough to wade, the shocking unit and the stationary negative terminal was positioned at mid-station. Three to five positive electrodes were used to shock fish. The field crew usually consisted of seven to ten people. The crew started at the downstream end of the station and slowly worked upstream collecting the stunned fish in dip nets. The electrofishing stations were from 183 to 366 m in length.

Two methods were used to estimate density on these streams. The Seber and LeCren (two pass) method was used on narrow streams where a large proportion (@70%) of the population could be taken on the first pass. First pass trout were held in a large crib until completion of the second pass. The formula for this estimate, described be Seber and LeCren (1967) is:

$$\hat{N} = \frac{C_1^2}{C_1 - C_2}$$

Where, $\hat{N}$ = the population estimate, C_1 = the first past catch and C_2 = the second pass catch. The formula to determine the standard error for this estimate is:

$$S.E. = \frac{C_1 C_2 \sqrt{C_1 + C_2}}{(C_1 - C_2)^2}$$

The Peterson method (mark and recapture) was used on streams with lower sampling efficiency. On the first pass, all trout over 12 cm were marked by punching a small hole in their caudal fin. The marked trout were returned to the stream, usually within 15-30 m of the point of capture after the crew advanced far enough upstream. The second pass was completed between 1 and 4 days later. The formula for this method as described by Robson and Regier (1971) is:

$$N = \frac{mc}{r}$$

where N = density estimate, m = total number of marked fish in the population, c = the number of fish in the sample, and r = the number of marked fish recaptured in the sample. When r was less than 10, one was added to each of the equation terms. The standard error of N is:

$$S.E. = \sqrt{\frac{M^2 C(C-R)}{R^3}}$$

On large and deep rivers (Arkansas, Colorado, Gunnison and Rio Grande) the electrofishing unit was mounted on a Jon boat. Trout were collected while the boat was in a controlled downstream drift. Stations varied in length from 2.2 to 6.8 miles. One to three marking runs along with one recapture run were made on each station. The Schnabel (multiple mark-recapture) method was used to estimate density. This method is described by Robson and Regier (1971). Because of the size-selectivity of electrofishing gear, separate estimates were computed for 5 cm size-groups and compared to the overall estimate.

All trout captured by electrofishing were measured to the nearest centimeter. Scale samples were also taken from 5 trout in each centimeter length group for age-growth analysis.

Length-weight relationships ($W = aL^b$) were developed for rainbow and brown trout for each study stream in the first year it was sampled. In subsequent years weights were computed from these equations. Biomass estimates were made by multiplying the number of trout in each centimeter group by the estimated weight for that length and then by summing all the centimeter groups to give a total weight estimate per station.

Age determination was made from scales with the aid of a microprojector. Life tables were constructed by summing the number of trout/hectare in each age-group.

Relative stock density (RSD) is a ratio of large trout to stock-sized trout. The standard set for Gold Medal streams is 20% of the trout over 8 inches must be over 14 inches and this value was used to note quality.

Two methods of obtaining creel information has been used in this study. The count/interview system, as described by Powell (1975) was used in an area where fishermen could easily be seen from the road. This method required that fishermen be counted four times a day at 3-hour intervals. The number of count days per month can vary but were randomly selected by weekdays and weekend days. Between count periods fishermen were interviewed to obtain pertinent creel data. The count/interview system was not utilized in 1982.

A voluntary mail-back postcard questionnaire system was found to give estimates very comparable with the count/interview system even though it was much less time consuming (Nehring and Anderson 1981). This system used on the Gunnison River in 1982 includes having a clerk distribute numbered and dated postcards on the windshields of all vehicles parked at the trail heads used by fishermen. Data on the returned card represented completed trip information.

Arkansas River

The trout population of the Arkansas River was sampled between March 7-25, 1983. The Loma Linda and Salida stations have now had 2 years to respond to the catch and release regulation that went into effect at these areas in January 1981. The regulation at these two stations is all trout under 16 inches must be returned alive and tackle is restricted to flies and lures only. Descriptions of the four study areas were given in 1981 progress report. Density and biomass estimates for 1983 are given in Table 1 of Appendix I.

Of a total of 7,678 trout netted at the four stations, 99.3% were brown trout. Rainbows were the next highest group with 0.6% and were most prevalent at the Salida Station (1.0%). Three Snake River cutthroats and one lake trout were also caught. Job 4 gives additional information on the rainbow population.

Recruitment of age 1 brown trout was very good in 1982 (Nehring and Anderson 1982), but was found to be very poor this year (Table 1).

Table 1. Number and mean size of age 1 trout collected from the Arkansas River.

Sample period	Year class	No. collected	Mean size (cm)	(S.E.)
1981	1980	835	14.4	0.062
1982	1981	2,562	15.7	0.035
1983	1982	231	12.3	0.091

Not only was recruitment depressed but the growth rate was much less. Job 1 was set up to evaluate the relationship between flow and trout population dynamics and initial results of this study will be presented in the 1984 report.

Compared to last year, 1983 estimates of density of total trout were up by 32 to 54% at the four stations. Biomass was found to be slightly down at all stations except Tezaks (Table 2).

Table 2. Total density and biomass estimates for trout over 20 cm (age 2 and up) for the four Arkansas River stations.

Year	Tezak no./ha	Tezak kg/ha	Coaldale no./ha	Coaldale kg/ha	Loma Linda no./ha	Loma Linda kg/ha	Salida no./ha	Salida kg/ha
1981	292	66.3	274	54.8	239	53.5	378	84.7
1982	358	96.8	244	69.7	361	93.0	351	98.1
1983[a]	531	98.4	331	61.4	477	84.7	539	94.7

[a]= trout over 17 cm

When the population is divided into two size groups (20-30 cm, and over 30 cm), we can clearly see what caused the increase in numbers this year. The number of 2-year-old brown trout (1981 year class) was high resulting in nearly twice the number of browns between 20 and 30 cm compared to last year. In contrast the density of browns over 30 cm was down from last year to near 1981 levels (Table 3).

Table 3. Density estimates for brown trout 20 to 30 cm and for trout over 30 cm.

Year	Tezak	Δ%	Coaldale	Δ%	Loma Linda	Δ%	Salida	Δ%
				20 to 30 cm				
1981	236		238		201		311	
1982	266	+12.7	154	-35.3	275	-36.8	217	- 32.1
1983[a]	469	+76.3	289	+87.7	434	+57.8	467	+115.2
				30 cm and larger				
1981	56		36		38		67	
1982	93	+66.1	67	+86.1	87	+128.9	134	+100.0
1983	63	-32.2	41	-38.8	42	51.7	71	- 97.0

[a]= size from 17 to 30 cm

Weather conditions (the mild 1981 winter) apparently led to the larger population of trout over 30 cm in 1982 through improved growth rates (Nehring and Anderson 1982).

As was found last year, the Coaldale Station, the standard regulation area, had the lowest total density for trout over 20 cm (Table 2). The difference was due to the number of trout between 20 and 30 cm, primarily 2-year-olds. In March 1983, the age 2+ (1981 year class) browns were 34% more numerous at Loma Linda (catch and release station) than at Coaldale (Life Table, Appendix III). However, in March 1982 the number of age 1+ (1981 year class) was 39% higher at Loma Linda than Coaldale. This implies that the regulation was not a factor in producing a larger population of 20-30 cm trout at Loma Linda. Also, if the regulation had been effective, there should have been more trout at Loma Linda between 12 and 16 inches than at Coaldale. This was not found either. The Tezak Station, private access with light pressure, also serves as a control area. The density of trout over 30 cm was 12.5% higher in March 1983 than was found in March 1981. The Coaldale population was +13.9% and the two catch and release stations were only +10.5% (Loma Linda) and +6.0% (Salida) compared to the pre-regulation year (Table 3).

The length-frequency histograms for March 1983 (Appendix II) had the same general configuration as was found in 1981 and 1982, except for the fewer number of age 1 browns. In March 1983, the age 2 browns peaked at 22 to 23 cm. Since the age 1 browns of March 1982 peaked at 15 to 16 cm, this indicates that the average trout grew only 7 cm over the 1982 growing season. In contrast, growth over the 1981 season was about 12.5 cm (the 1980 year class grew from 14.5 cm as age 1+ to 27 cm by age 2+). The number of 30 cm long trout per hectare decreased in a stair-step manner until there are less than 2/ha at 37 cm. And as was the case in 1981 and 1982, there were very few individuals collected that were over 40 cm.

It was hoped that the catch and release regulation would allow a build up of larger trout at Loma Linda and Salida stations over the 1981 levels relative to the standard regulation station. Relative stock density (RSD) values clearly show that the population has not responded to special regulations in the first 2 years (Table 4).

Nineteen eighty-two had the highest RSD at all stations while 1981 was next and 1983 the lowest. There is a greater variation between years than between stations. This indicates that the size structure is being manipulated more by environmental factors within the annual cycle than by differences in the regulations at various stations.

A high natural mortality rate appears to be responsible for the lack of response to the catch and release angling. Life table information for 1981 and 1982 is given in Table III-2 of Appendix III. Total annual mortality for browns over 2 years between March 1981 and March 1982 was 62, 64, 56 and 47% at the Tezak, Coaldale, Loma Linda and Salida stations, respectively. The 1979 year class (2-year-olds) averaged

53% mortality between 1981 and 1982, while the 1978 year class (3-year-olds in 1981) suffered a 95% mortality at the three lower stations. The trout scales were not read by the time this report was due so life table information for the 1983 data is not included. But by using length frequency data and the growth history for this river, a rough estimate of the overall mortality from March 1982 to March 1983 for trout over 2 years was determined to be 70% at Tezak, 66% at Coaldale, 71% at Loma Linda and 54% at Salida.

Table 4. RSD values for the Arkansas River brown trout, n is the number of stock sized trout (20 cm).

	1981		1982		1983	
	RSD	n	RSD	n	RSD	n
RSD for Trout over 30 cm (12 inches)						
Tezak	31.3	1,347	37.8	1,832	15.9	1,961
Coaldale	26.7	1,161	42.9	1,006	16.8	1,266
Loma Linda	31.4	1,127	34.7	1,358	17.2	1,684
Salida	25.4	1,647	45.6	1,516	19.7	2,198
RSD for Trout over 35 cm (14 inches)						
Tezak	6.3	1,347	11.2	1,832	2.9	1,961
Coaldale	4.2	1,161	7.5	1,006	2.7	1,266
Loma Linda	5.9	1,127	7.4	1,358	2.9	1,684
Salida	2.3	1,647	6.8	1,516	2.9	2,198

Creel census data collected in the summer and fall 1981, showed an angler exploitation rate of 43% for the Coaldale areas. Angler exploitation in the range of 35 to 50% usually results in overharvest and size structure is somewhat depressed. The size structure of this population has been depressed, but now indications are that angling may not be the primary cause of this, unless there is an unusual amount of poaching within the catch and release areas. Other factors such as water quality will be investigated. The forage potential of the river is being evaluated under Job 5.

Cache la Poudre River

The seven electrofishing stations established in 1980 were sampled for the third time in October 1982. Of the five "upper" stations (Big Bend, Wild Trout Water, Lower Control, Indian Meadows, and Kelly Flats: upstream to downstream) only one has a special regulation. This is the Upper Wild Trout Water (UWTW) where bait fishing is prohibited.[1]

Species composition for the five upper stations has been fairly consistent between years (Table 5). The largest variation was at the Indian Meadows Station where browns have fluctuated between 24 to 36% of the population over 15 cm. The variation among stations in a given year has been high, ranging from 33 to 74% brown trout at the Lower Control and Big Bend stations, respectively.

Table 5. Species composition for trout in the Upper Poudre River, 1982.

Station	Brown				Rainbow			
		Average		Range	1982	Average		Range
	%	%	yrs	%	%	%	yrs	%
Big Bend	74	76	5	74-80	26	24	5	20-26
Upper Wild Trout	54	48	8	44-54	46	52	8	46-56
Lower Control	33	38	6	33-44	67	62	6	56-67
Indian Meadows	36	29	3	24-36	64	71	3	64-76
Kelly Flats	44	44	5	39-48	56	56	5	52-61

In streams where adult rainbow and brown trout mortality rates are similar, the species composition is regulated to a great extent by recruitment rates for each species (fry production and survival in correlation to flows will be examined in an upcoming study). However, the assumption of similiar mortality rates of adults by species is not at all valid when the population is exposed to heavy angling pressure such as exists on the Poudre River. With new regulations in 1983, changes in harvest, if they occur, should alter the species composition for the two stations.

[1]Since new restrictive regulations were established effective 1983 on the Poudre, the data collected from 1980-1982, along with that from earlier research, has been summarized for this report.

Density and biomass estimates for 1982 are given in Table I-2 of Appendix I. Only one station had a significantly (0.05) different density estimate from the previous year, the Upper Wild Trout Water (UWTW) (Table 6). Estimates were slightly up at the Kelly Flats and Big Bend campgrounds and somewhat down at the Lower Control and Indian Meadow stations from those of 1981.

The coefficient of variation (standard deviation ÷ sample mean X 100) for the Upper Wild Trout Water Station was 31.0% indicating a fairly high degree of variability at this station for the 9 years of data. Therefore, future changes in density must be dramatic for them to be statistically significant. However, the success of protective regulations should not be judged only by improvements in density, but by improvements in size structure, and gains in the number of trout over a certain size. In the Poudre River since there are very few trout over 12 inches in the population, this is the size that will be used to judge improvements.

Length frequency histograms are presented in Appendix II. Mean trout lengths declined at all stations for brown trout and all except Kelly Flats for rainbows in 1982 when compared with the previous year (Table 7).

Another measure of size structure is the RSD. In the upper stations, RSD_{12} ranged from 2% at Kelly Flats to 20% at the Big Bend Campground (Table 8). RSDs were very similar to those of 1981 and appear to be quite similar to those of Klein (1974) and Marshall (1973) from examination of length frequency histograms.

Since harvest up to a certain level selects for larger trout, the catch and release regulation at Indian Meadow should respond with larger average trout and higher RSD values.

Growth rates were generally less in 1982 than last year (Table III-3 in Appendix III). Average size of young-of-year trout was significantly (0.05) less for both rainbows and browns in 1982 than in 1981 (Table 9). Average length of brown trout in the 1981 year class was 9.7 cm in October 1981. By October 1982, this year class had a mean length of 16 cm which means that the average brown trout grew 6.4 cm in the 1982 growing season. The 1981 rainbow year class grew on an average of 6.5 cm in 1982, from an average length of 7.9 cm in October 1981 to an average of 14.4 cm in 1982.

The same conditions that characterized the trout of the "lower" canyon in 1980 and 1981 were again found in 1982. Browns comprised 93 and 91% of the population in the Lower Wild Trout Water (LWTW) and Greeley Control Station, respectively. Table 10 gives the 3-year average for density and biomass estimates for these stations.

The average size brown trout was 19.8 cm in the LWTW and 18.9 cm in the Greeley Control Station. Only one 30 cm trout was caught in the Lower Control and none over 30 cm in the LWTW. The 0 and 1% RSD ($\geq$ 30 cm) of the lower stations clearly show the poor quality of this fishery. I believe this portion of the river has the potential to produce trout

Table 6. Density and biomass for the five upper stations for years where data is available based on trout over 15 cm.

Year	Big Bend no./ha	Big Bend kg/ha	UWTW no./ha	UWTW kg/ha	Lower Control no./ha	Lower Control kg/ha	Indian Meadows no./ha	Indian Meadows kg/ha	Kelly Flats no./ha	Kelly Flats kg/ha
1962[a]	498	47.2	399	54.3	459	56.3	--	--	--	--
1963[a]	617	65.3	671	83.6	444	54.2	--	--	--	--
1964[a]	--	--	676	65.0	--	--	--	--	--	--
1970[a]	--	--	382	58.1	341	44.2	--	--	--	--
1971[b]	--	--	522	85.9	--	--	--	--	574	77.8
1972[b]	--	--	506	79.5	--	--	--	--	565	72.8
1980	301	51.5	364	48.8	509	76.4	61.5	75.2	672	70.9
1981	444	73.2	892	133.5	870	124.8	702	83.5	787	76.9
1982	493	58.7	635	72.0	818	99.9	650	82.9	881	87.0
Mean	[471	59.2]	[561	75.6]	[574	76.0]	[656	80.5]	[695	77.0]

[a] from Klein 1974

[b] from Marshall 1973

Table 7. Mean lengths of brown and rainbow trout collected in October samples from the Cache la Poudre River. Those reported by Klein are for trout ≥ 15.6 cm, otherwise ≥ 14 cm.

Station	Year	Brown trout no.	Brown trout mean length	Rainbow trout no.	Rainbow trout mean length
Big Bend Campground	1962[a]	76	20.3	54	20.3
	1963[a]	91	21.0	73	20.3
	1980	51	25.9	19	23.4
	1981	92	24.5	25	23.7
	1982	64	22.5	23	21.2
Lower Study Area (UWTW)	1962[a]	61	23.4	61	23.4
	1963[a]	75	22.3	46	22.6
	1964[a]	74	20.8	70	20.1
	1967[a]	74	22.8	65	24.4
	1969[a]	55	24.6	74	25.4
	1970[a]	55	24.6	57	23.9
	1971[b]	235	24.7	341	23.1
	1972[b]	252	23.7	345	23.8
	1980	36	22.9	68	22.4
	1981	146	24.5	190	22.3
	1982	97	20.4	91	20.9
Lower Control Area	1962[a]	48	23.9	83	22.1
	1963[a]	44	22.3	96	21.8
	1967[a]	74	21.3	114	21.1
	1969[a]	100	23.1	150	24.1
	1970[a]	79	23.6	165	22.1
	1980	56	24.3	71	23.2
	1981	117	24.3	149	22.6
	1982	91	22.1	198	21.1
Kelly Flats Campground	1971[b]	481	23.7	587	21.7
	1972[b]	488	22.4	582	22.3
	1980	84	21.0	117	20.3
	1981	99	22.1	153	19.3
	1982	86	21.0	116	19.4
Indian Meadows	1980	41	24.3	122	21.0
	1981	55	24.1	157	21.5
	1982	57	21.9	107	21.9

[a] Data from Klein (1974) converted to metric.
[b] Data from Marshall (1973).

Table 8. PSD_{12} (percent of trout over 8 inches that are over 12 inches) values for trout from the 1981 and 1982 population samples.

Station	Rainbow 1981	Rainbow 1982	Browns 1981	Browns 1982	Combined 1981	Combined 1982
Big Bend	22	15	24	21	23	20
UWTW	13	17	19	9	16	13
Lower Control	9	7	18	13	13	9
Indian Meadows	9	8	17	29	12	14
Kelly Flats	0	0	8	4	4	2

Table 9. Mean length of age 0 and age 1+ trout in the Upper Poudre River stations.

	Age 0+				Age 1+			
	Browns		Rainbows		Browns		Rainbows	
Station	Length mean cm	n	Length mean cm	n	Length mean cm	n	Length mean cm	n
Big Bend	6.6	9	--	0	14.2	58	12.8	14
Wild Trout Water	8.1	8	6.0	18	16.5	57	14.4	52
Lower Control	7.6	10	6.1	15	16.9	36	14.4	84
Indian Meadows	8.2	8	6.2	5	17.1	27	14.9	31
Kelly Flats	8.4	22	6.2	13	17.0	44	15.6	57
1982 mean	7.9	57	6.1	51	16.1	222	14.4	181
1981 mean	9.7	125	7.9	208				
1980 mean	9.5	30	7.3	51				

larger than 30 cm in greater numbers but that the size structure is severely depressed by overharvest. The disadvantages of a 2 trout/day bag limit were presented in the 1982 report. We still feel that this regulation will not reduce harvest and decrease overexploitation and therefore do not expect improvements in the LWTW population. For streams with high angling pressure (> 1,000 hr/ha) the 2 trout/day regulation may have some merit but only if it discourages fishermen from the area to the extent that it becomes essentially a catch and release fishery.

Table 10. Brown trout density and biomass estimates for the LWTW and Greeley Control stations.

Year	Lower Wild Trout Water no./ha	Lower Wild Trout Water kg/ha	Greeley Control no./ha	Greeley Control kg/ha
1980	1,361	105.5	1,019	82.0
1981	909	88.3	621	68.0
1982	1,079	85.4	1,015	87.2
Mean	1,116	93.1	885	79.1

Density and biomass estimates are in Table I-2 of Appendix I. Length frequency histograms are in Appendix II. Age and growth data is in Appendix III-1. Life Table information is found in Table III-2 of Appendix III.

Colorado River

Six electroshocking stations were surveyed in October 1982. Three stations were on heavily fished public access areas with no special regulations or terminal tackle restrictions. These three public access areas were located between three sampling stations either on private land with restricted access (and hence low angler use) or public lands with restrictive angling regulations (catch and release on all trout between 12 and 20 inches, a 2 trout bag limit with a flies and lures only terminal tackle restriction).

Data collected on the trout population of the Colorado River in the fall of 1982 indicates that conditions remain unchanged since 1979. On private ranches where river access is either posted or restricted to a few members of a fishing club, rainbow trout densities and standing crop remain high. Public access areas continue to harbor low densities and low standing crops of rainbow and brown trout. The reader is referred to Table I-3 in Appendix I for details.

The data in Table 11 below gives a stark indication of the impacts of unrestricted angling on wild trout populations when compared with areas of restricted access and reduced harvest through angling restrictions. The average (on a unit area basis) number of trout/ha was 4.2 times higher, trout biomass was 3.7 times higher and numbers of trout $\geq$ 35 cm were 6.8 times greater in the restricted access or restrictive regulations areas.

Table 11. Comparison of total trout, standing crop, and numbers of trout $\geq$ 35 cm (14 in.) per hectare for six different sections of the Colorado River in October 1982.

Study area	Location[a]	No./ha	Kg/ha	no./ha $\geq$ 35 cm
Restricted Access and/or Restricted Regulations				
Thompson Ranch	1	319	141	124
Parshall Section	5	584	172	226
Ritschard Ranch	6	704	261	203
Average		536	138	184
Public Access and Standard Angling Regulations				
Pioneer Park	2	202	41	14
Paul Gilbert Wildlife Area	3	55	21	17
Lone Buck Wildlife Area	4	127	49	50
Average		128	37	27

[a]= position of study areas in a upstream to downstream location

This year (1983) angling regulations restrict the daily bag limit to one rainbow and one brown trout in all study areas except for the Pioneer Park and Thompson Ranch areas. It will be interesting to document the changes, if they occur, in the trout populations at the Paul Gilbert and Lone Buck Wildlife Areas. In addition, terminal tackle is limited to flies and lures only, except for stonefly nymphs, which may be used as bait.

Eagle River

Five stations were electroshocked on the Eagle River in September 1982. Water levels were too high and slightly turbid for optimum electro-shocking conditions. However, trout densities are continuing to decline at all stations. Density estimates below the confluence with Milk Creek are precariously low and biomass estimates (single pass electro-shocking) ranged from 2.4 to 5.4 kg/ha. In contrast, on a private ranch near Edwards (with one electroshocking pass) biomass estimates were 9-10 times higher and numerical density was also 10 times higher. Numerical density of trout 35 cm and larger is virtually zero at every station. For details see Table I-4 in Appendix I.

Division of Wildlife fishery biologists have known for a long time that reproduction and recruitment of young rainbow and brown trout in the Eagle River is very poor. Heavy siltation is a severe chronic problem in the Eagle River below the Milk Creek confluence. As early as March 1980, we recommended that special regulations were a necessity if the Eagle River trout population was not to be decimated by excessive angler harvest. However, the regulations as recommended at that time were not implemented and the trout population has indeed declined. Up through 1978 most of the Eagle River remained closed to angling because of private ownership. In 1979, the Division acquired a fishing easement on the Horn Ranch between Eagle and Wolcott on about 11 km of the Eagle River. Fishing pressure in 1979 (Table 12) remained low as high run-off levels and a lack of signing along the stream limited angler awareness of the public access. However, with proper signing in 1980 and lower water levels angler use began to increase. By 1981, angler awareness of the Horn Lease had increased and fishing pressure reached 500-650 hrs/ha between May 1 and September 7, 1981. This is approximately the level of use observed on Standard Regulations sections of the Fryingpan River during a similar time period. The numbers of rainbow and brown in the 35 cm and larger size category has dropped catastrophically over the past 2 years.

Table 12. Numbers of rainbow and brown trout/ha $\geq$ 35 cm in the Eagle River (1978-1982).

Station	September 1978	March 1980	November 1980	September 1981	September 1982
			Rainbow Trout		
Wolcott	--	3	20	2	0
BLM[a]	13	--	--	0	0
			Brown Trout		
Wolcott	--	14	13	34	0
BLM[a]	32	--	--	19	0

[a]2.4 km section of BLM land juxtaposed between sections of the Horn Lease.

Commencing in 1983, this study area on the Eagle River will be under a flies and lures only terminal tackle restriction with a daily bag and possession limit of one rainbow and one brown trout. We hope that this regulation together with reduced angler use (due to the lack of good numbers of quality-size trout) will eventually result in a recovery of the trout population in the Eagle River. Judging from past experience, it could take at least 3 to 5 years for full recovery. It is the judgment of the authors and the Fish Management biologists in the NW Region that the 2-bag limit (one rainbow and one brown) may not be adequate. Our recommendation was total catch and release for several years.

Fryingpan River

In our 1982 progress report (Nehring and Anderson 1982), we identified two problems with the trout fishery in the Fryingpan River. First, overharvest of both rainbow and brown trout stocks (larger than 30 cm) had become a very serious problem by 1981 in the 8 trout/day creel limit sections. This problem was further exacerbated during 1982, especially for the rainbow trout. Brown trout numbers have been maintained quite well but the numbers of brown trout 30-35 cm and larger has decreased somewhat over the years. This data on numbers and biomass per hectare for the Ruedi Dam and Taylor Creek stations illustrates our point (Table 13).

Rainbow density and biomass has fallen precipitously since 1978 when supplemental stocking of catchable-size rainbow trout was eliminated on the Fryingpan River at the Taylor Creek Study Area where the 8 trout/day bag limit remained in effect in 1982.

Table 13. Fryingpan River trout biomass estimates, 1972-1982.

Month	Year	Brown trout no./ha	Brown trout kg/ha	Rainbow trout no./ha	Rainbow trout kg/ha
Ruedi Dam Station (Catch and Release)					
September	1972	161	48	368	45
October	1973	180	44	358	82
September	1977	340	60	680	220
October	1978	401	91	416	112
September	1979	466	101	220	88
September	1980	431	87	241	73
September	1981	461	70	138	15
April	1982	511	83	466	126
September	1982	495	86	464	113
Taylor Creek Station (8 trout/day)					
September	1972	704	172	891	181
October	1973	432	110	889	186
September	1977	320	--	320	--
October	1978	462	93	486	69
September	1979	724	75	635	61
September	1980	504	78	280	30
September	1981	591	91	349	31
April	1982	703	131	379	34
September	1982	724	158	181	29

Rainbow numbers in the catch and release area fell to very low levels by September 1981 (Ruedi Dam Station). However, the problem in the catch and release area was a different one. Hypolimnal releases from Ruedi Dam result in water temperatures in the 37-38 F range during the rainbow spawning and incubation period. At water temperatures below

42 F, egg mortality becomes excessive (McAfee 1966). At 38 F egg losses approach 100%. Thus, our second problem (lack of rainbow trout reproductive success in the first 3-4 km below Ruedi Dam) can only be solved by supplemental stocking if the rainbow component of the population is to be maintained.

Thirty thousand 11-12 cm rainbow trout were stocked in the Fryingpan River in October 1981. Electroshocking surveys in the spring and fall of 1982 revealed excellent growth and survival of these rainbows. For details see Table I-5 and Table I-6 in Appendix I and the histograms for the Fryingpan in Appendix II. Rainbow trout numbers at the Ruedi Dam Station are near an all-time high and the highest they have been since September 1977.

Another 30,000 fingerling rainbow (76 mm average size) were stocked in July 1982. These fish were spray-marked with florescent orange pigment. An additional 2,400 advanced fingerling rainbow were stocked (adipose clip) in October 1982, in the upper 4.8 km (3 miles) of the Fryingpan River. Over the next 2 to 3 years we will be evaluating the growth and survival rates for these stocked fingerling rainbows.

We already know the October 1981 plant excelled in growth and survival. They averaged 11.5 cm when stocked in October 1981. By late April 1982, the mean size was 16 cm. The mean size was about 22 cm by September 1982. The stocked fingerlings comprised an estimated 50% of the rainbow population at the Ruedi Dam Station in April 1982 and an estimated 86% of the population at the uppermost station (above the Ruedi Dam Gage). Those percentages were similar in the fall of 1982.

The 30,000 florescent orange-marked rainbow fingerlings stocked in July 1982 were stocked totally in the lower portion of the Fryingpan River. All rainbows (less than 20 cm) collected at the Taylor Creek and Big Pullout stations were checked with an ultra-violet lamp for a pigment mark. At the Big Pullout Station, 24 rainbows were checked. Fifteen of 16 fish (93.8%) between 10 and 20 cm were marked. Eight that were 7-8 cm in length were not marked. These rainbows were apparently from natural reproduction. The situation at the Taylor Creek Station was similar. None of the rainbows under 10 cm were marked and were probably from natural reproduction. Five out of five at 12-13 cm were spray-marked and none larger than 15 cm were marked.

We (Nehring and Anderson 1982) recommended a bag limit of one rainbow and one brown trout as the regulation for the Fryingpan River in 1983-84, commencing at the lower boundary of the catch and release area downstream to the confluence with the Roaring Fork River. This recommendation was implemented with a fly and lure only terminal tackle restriction commencing in 1983, except children under 15 years of age may fish with bait.

We believe the new regulations will result in a significant reduction in harvest of rainbow and brown trout. As a result quality-size stocks should increase significantly in the next 2 to 3 years. We will be monitoring this to document any changes in the trout population density and size structure.

Gunnison River

Electroshocking studies on the Gunnison River began in the summer of 1981. Population estimates were completed on three sections of the river during 1982. The uppermost was a 3.2 km (2 miles) section located between the Duncan and Ute trails access points on the west rim of the Black Canyon. The mid-section that was surveyed is 6.4 km (4 miles) long and takes in that portion of the river 0.4 km upstream from the Smith Fork confluence downstream to the North Fork of the Gunnison confluence. The lowermost section runs from the North Fork confluence 13.4 km (8.3 miles) downstream near the village of Austin.

The Gunnison River in the upper two sections (Duncan-Ute and Smith Fork-North Fork) falls in a regular stairstep fashion (pool-riffle-pool-riffle) down the canyon. The lower section (North Fork-Austin) has a much lower gradient with some pools running from 0.4 to 0.8 km in length. These pool sections are broken up by riffles and deep runs that are up to 0.4 km in length. Heavy irrigation returns degrade the river with high silt loads and increased water temperatures from the North Fork of the Gunnison valley. This undoubtedly has a profound impact on the aquatic ecology of the Gunnison River.

Until October 1981, the standard statewide angling regulations (8 trout/day and no terminal tackle restrictions) were in effect on the Gunnison River. However, the Wildlife Commission was receiving numerous reports of many overlimit catches and other problems from concerned anglers. As a result of these reports and the results of our 1981 electroshocking studies, the Wildlife Commission implemented a complex regulation on 42 km of the Gunnison River in the Black Canyon in October 1981. The bag limit was reduced from 8 trout/day to 4, with all trout between 12 to 16 inches being returned to the water. Only one of four trout could be over 16 inches and terminal tackle was restricted to artificial flies and lures only. This regulation will remain in effect at least through 1984 while we evaluate angler impacts on the trout population.

We were most concerned about the impacts of overharvest on the trout population in the Smith Fork to North Fork sections of the Gunnison River. This was the area that was receiving the heaviest fishing pressure. A creel census conducted in 1977 by W. Wiltzius (1978) revealed more than 5,000 hours of angling effort on this 6.4 km section of river. Our survey of the same area in 1982 revealed more than 17,000 hours of angling effort, 3.25 times as much pressure as was observed in 1977. Details of the creel census for 1982 and the comparison with the 1977 creel census can be found in Appendix V, Tables V-1 through V-9.

Total angling effort on the 42 km section of river was estimated at more than 51,000 hours from May through September 1982. Total catch was estimated at 57,400 trout. We estimated a catch of 31,800 (55.4%) rainbow and 24,900 (43.3%) brown trout, with a harvest (trout kept) of 10,100 (58%) rainbow and 7,300 (42%) brown trout.

These statistics indicate that the regulations imposed in October 1981 are having the intended impact, i.e., recycling the trout. The creel survey in 1982 indicated 68% of all rainbow and 71% of all brown trout caught were released. We estimated the rainbow exploitation rate at 22.2% and the brown exploitation rate at 14.5%. Exploitation rate is defined as:

$$\text{Exploitation rate (\%)} = \frac{\text{Angler harvest}}{\text{Angler harvest + population estimate}} \times 100\%$$

The creel census used was the postcard method previously described by Nehring and Anderson (1981). Vehicle counts were made twice daily on two randomly selected weekdays and one weekend day each week. Thus, 40% of all weekdays, 50% of all weekend days, and 100% of all holidays were censused. Access to the river is by a paved road at the upper end (Crystal Dam Access Road), an improved gravel road at the lower end (North Fork Access Area) and four steep trails (Chukar, Bobcat, Duncan, and Ute) from the west side of the canyon across BLM land. Due to the difficulty of access and the time required to hike down and along trails in the canyon, we determined that two vehicle counts per day resulted in a near 100% count for each count day. A total of 1,060 postcard census forms were put out, 402 were returned, for a 37.9% return. This return rate was similar to return rates for the same method on the Arkansas, Fryingpan, and South Platte rivers in 1980 and 1981 (Nehring and Anderson 1981, 1982).

Angler catch-per-man-hour (CPMH) averaged 1.12 over the 1982 season with the rainbow CPMH averaging 0.62 and the brown CPMH averaged 0.49. Total catch in 1977 was estimated at 14,345 trout. Total catch in 1982 was estimated at 57,363 trout, four times the estimated catch in 1977.

The results of our population surveys in 1981 and 1982 indicate the regulations imposed appear to be having a positive impact on the trout population, especially on the Smith Fork-North Fork Section. While the total number of rainbows ($\geq$ 15 cm) decreased from 7,092 in 1981 to 4,360 in 1982, rainbows $\geq$ 30 cm increased from 489 in 1981 to 1,189 in 1982. Numbers of rainbows $\geq$ 40 cm remained approximately the same. The large increase in the number of rainbow between 30 cm (12 inches) and 40 cm (16 inches) was undoubtedly due to the impact of the regulation on angler harvest in that size class.

Brown trout numbers increased from 2,297 to 3,857 between 1981 and 1982 in the Smith Fork-North Fork Section of the river. Browns $\geq$ 30 cm also increased from 323 to 563 between 1981 and 1982. Numbers of brown trout $\geq$ 40 cm remained about the same between years. We hope to see some improvement in the numbers of brown trout and rainbow trout $\geq$ 40 cm in 1983 and 1984. However, it is quite possible these fish will be continually cropped off by angler harvest.

On the Duncan-Ute Trail Section, we did not see any dramatic changes in either the brown or rainbow trout population between 1981 and 1982 except that brown trout $\geq$ 30 cm decreased from 1,903 to 736. Total rainbow numbers increased 11.8% and total brown numbers decreased by 32%.

The growth rate of both rainbow and brown trout in the Gunnison River is very fast. Rainbows average 35-39 cm and browns 41-44 cm in length at age 4. Proper management should maintain excellent numbers of both species in the 40 cm to 50 cm and larger size classes.

Over the long run the numbers of quality size trout that can be maintained in the Gunnison River will probably be controlled more by the stability of water flows out of Crystal Dam than any other single factor. These flows have been remarkably stable since 1977 when Crystal Dam went into operation. However, in the spring of 1982, severe short-term fluctuations occurred between April 15 and April 25. This was right during the rainbow spawning and incubation period. Flows were stable at about 1,200 ft^3/sec up until April 15. This flow completely fills the channel and high water velocities occur all across the channel forcing the rainbows to spawn close to the bank. Flows decreased rapidly commencing on April 16 and dropped to 105 ft^3/sec on April 20 (see Table 14 for details). On April 24, dozens of dry rainbow redds were observed in the section of the river between the Duncan and Ute trails. We hypothesized that the entire 1982 year class of rainbow trout was probably lost as well as many of the brown trout for the 1982 year class. Examination of the histograms for the Gunnison River in Appendix III reveal that these expectations were realized. Both rainbow and brown trout recruitment were negligible for 1982 compared to 1981. Table 15 presents actual numbers of young-of-the-year (YOY) rainbow and brown trout sampled in 1981 and 1982 during the electroshocking surveys. These numbers indicate a loss of about 88% of the 1982 brown year class and 95% of the 1982 rainbow year class, when using the 1981 year as a base level for recruitment.

An incremental analysis of the Gunnison River flows was completed on the Duncan-Ute Trail Section of the river in early November 1982. Based on these results, we will be making recommendations for a range of flows throughout the year to the Bureau of Reclamation and the Uncompahgre Valley Water Users Association. This subject is dealt with the detail under Job 1, within this report.

Table 14. Discharge patterns in the Gunnison River below the Gunnison Tunnel in April 1982.

Date	Maximum	Minimum
4/1 - 4/15	1,200	1,210
4/16	620	608
4/17	608	338
4/18	--	338
4/19	--	339
4/20	338	105
4/21	213	190
4/22	207	190
4/23	310	206
4/24	300	214
4/25	--	214

Table 15. Young-of-the-year (YOY) rainbow and brown trout sampled in the Gunnison River in 1981 and 1982.

	1981		1982	
	Brown	Rainbow	Brown	Rainbow
Duncan-Ute	179	125	29	11
North Fork-Smith Fork	239	138	24	2

Middle Fork of South Platte River

We sampled five stations on the Middle Fork of the South Platte (MFSP) on September 27 and 28, 1982. The three catch and release stations were the 1, 2, and 3 mile areas while the other two (Garo and Gaging station) have the standard 8 trout/day bag limit. As was found in 1979-1981, brown trout comprised over 97% of the population.

Compared to earlier years, the 1982 densities were low (Table 16). Four of the five stations were significantly lower than 1981 at the 0.05 level of probability. The station that was not significant (1 mile) had a ± 50% confidence interval bracketing the mean (Table I-10, Appendix I).

Table 16. Brown trout density estimates for 1979-1982 in the Middle Fork of the South Platte for trout over 12 cm.

Year	Garo Bridge no./ha	Gaging Station no./ha	1 mile no./ha	2 mile no./ha	3 mile no./ha
1979	1,526	950	1,436	--	--
1980	1,776	993	1,763	1,265	1,330
1981	1,310	1,151	1,735	1,614	1,745
1982	681	705	1,359	364	676

Examination of the Life Table (Table III-2, Appendix III) and Table 17 gives some indication of what happened to the population in 1982. Both YOY and age 1 trout numbers were down in 1982 (Table 17). The number of yearlings was lower in spite of the fact that there was good fry production in 1981. High spring runoff has been shown on other streams to cause low survival of fry and smaller trout. This may have happened in 1982. Flow records (not available until the fall of 1983) will be examined under Job 1.

Table 17. Estimates of trout density by age-group and their survival rates from the previous year for brown trout in the Middle Fork of South Platte River 1979-1982.

Year	Age 0 no./ha	Age 1 no./ha	% survival	Age 2 no./ha	% survival	Age 3 no./ha	% survival	Age 4 & up no./ha
1979	1,095	827		311		140		32
			(0.467)		(0.530)		(0.307)	
1980	390	802		386		154		43
			(0.852)		(0.310)		(0.188)	
1981	441	648		683		118		31
			(0.367)		(0.315)		(0.110)	
1982	97	284		238		215		13

In fall 1981, 2-year-old trout (1979 year class) were abundant due to high survival (0.852 - Table 17) probably because of favorable physical conditions over winter that year. In 1982, the number of 2-year-olds was lower than earlier years with a lower survival rate of 0.367. Survival of the 1979 year class (age group 3) 1981-82 was similar to earlier years. Even though protective fishing regulations were in effect in 1981 and 1982, the survival for age 3 to age 4 (and older) was only 0.188 and 0.110 in 1981 and 1982, respectively. This indicates that natural mortality is high and that habitat problems are more critical to this population than angling mortality. Special regulation management is only effective on streams that have relatively low natural mortality rates of adult trout. If natural mortality precludes the buildup of larger and older trout in the population, then elimination of angling mortality (catch and release) is superfluous and serves only to influence the public.

Of course, the survival rates calculated with the life table data depends on various assumptions. One of which is that there is limited migration into and out of the area. This, however, does not appear to be the case. The construction of Spinney Mountain Reservoir (10 miles downstream of the study area) cut off fish movements into and out of the Middle Fork of the South Platte River from Eleven Mile Reservoir 20 miles downstream. Prior to the filling of Spinney Mountain, the South Fork and Middle Fork below Hartsel were treated with rotenone (October 1981) in an attempt to eliminate suckers so that they could not get a quick start in the new reservoir. The operation was considered successful with a high kill (Kaska, SE biologist, personal communication). Along with the suckers, the stream brown trout population was also decimated. In spite of this, a good number of age 2+ brown trout were taken in gillnets in the summer of 1982 from Spinney Mountain. In a 125 ft experimental gillnet, 0 suckers, 13 brown trout and 20 Snake River cutthroats were caught in one overnight net set (Kaska, SE biologist, personal communication). At the time of capture, the brown trout averaged 31.2 cm and the Snake River cutthroat averaged 19.3 cm. The fact that 438,000 Snake River cutthroat were planted in May 1982 and that brown trout made up 39% of the net haul on August 3, 1982, indicates that Spinney Mountain already has a large brown trout population. These brown trout must have moved into the reservoir early in 1982 probably coming down from the Middle Fork above Hartsel.

Another suggestion of movement from the Middle Fork of the South Platte River to downstream reservoirs originated from age and growth analysis. Two distinctive growth patterns were identified from age 2 trout in the fall of 1982. The slower growing group ranged in size from 18 to 23 cm (20.3 cm mean) at time of capture and grew an average of 5.2 cm from the time of the second annulus formation. The other had a range of 26 to 35 cm (29.7 cm mean) and grew an average of 9.3 cm in 1982. Forty-seven percent of the age 2 brown trout in the Middle Fork of the South Platte River were in the faster growing group. The back-calculated length and growth rates of the faster group closely matched those of the age 2+ brown trout taken from Spinney Mountain in the summer of 1982. Forty-four percent of the age 3+ brown trout had the faster growth pattern in the Middle Fork of the South Platte River in September 1982. These brown trout ranged in size from 31 to 37 cm at time of capture, while the slow growth group ranged from 22 to 29 cm in length. A re-examination of the 1981 scale readings indicated that 17% of the 2-year-olds and 57% of the 3-year-olds were of the faster growing group that year.

Nine trout over 20 inches were captured in 1980. In 1981, after the new dam was constructed,only 2 brown trout over 20 inches were captured and in 1982, none were found. Confirmation of the importance of the reservoir to the trout population in the Middle Fork of the South Platte River will be provided in the future if the number of large brown trout (over 20 inches) returns to the previously observed levels and if the Snake River cutthroat replaces the rainbow trout currently found in the Middle Fork of the South Platte River.

Length-frequency histograms for the Middle Fork of the South Platte River are given in Appendix II. Age and growth data is given in Table III-1 of Appendix III.

As was the case in 1981, creel census cards were available for anglers to pick up and return on a voluntary basis. This survey method does not provide an estimate of hours of fishing effort. However, the cards that were returned showed that the length of the average fishing trip was shorter in 1982 (3.2 hr/trip, n = 71) compared to 1981 (4.0 hr/trip, n = 128). Also the catch rate derived from these cards was less in 1982 (2.6 trout/hr) compared to 1981 (3.2 trout/hr). These two statistics suggest that fishing success was lower in 1982, which was confirmed by the 1982 electrofishing data.

North Platte River

Beginning January 1, 1983, the North Platte River from the Routt Forest boundary downstream to the Wyoming state line (6.4 km) was designated as a Wild Trout Water. The regulation was changed from an 8 to 2 trout per day bag limit. The fly and lure only restriction, which started in 1973, is still in effect. The North Platte study was reactivated to evaluate the 2 trout/day bag limit. Since this regulation has been adopted on other wild trout streams, it should be evaluated.

The Wild Trout area of the North Platte River was electrofished on October 5, 6 and 11, 1982, using the boat shocking method. This technique proved to be more effective than the walk shocking method done in this area in August 1980. The North Platte River within the U. S. Forest has limited access points for vehicles, therefore most of the angling in this area is done from boats. In 1980, species composition was 66.3% brown trout and 33.7% rainbow trout (n = 92). In 1982, the species composition was 65.3% and 34.7% browns and rainbows, respectively (n = 762). Trout biomass and density estimates for 1982 are given in Table I-11 of Appendix I. Compared to most other trout streams in this study, the North Platte trout density (116/ha) and biomass (37.8 kg/ha) estimates for fish over 17 cm were low.

The first peak in the length frequency histogram for brown trout is at 22 cm (Appendix II). Scale analysis identified these trout as second summer trout. The first annulus was formed when the trout averaged 7.2 cm in length (Table III-1, Appendix III). Therefore, 1-year-old brown trout on the average grew nearly 14 cm in 1982. This is a very rapid growth rate, especially when considering the small size of the fry. Rapid growth was also found in the older age-groups. Three-year-old brown trout had an average length of 35 cm in the fall. Length-frequency histograms also show that there were a fair number of trout sampled in the 14 to 18 inch range. RSD_{14} (36 cm) ratios for trout were 23.5% for brown trout and 21.9% for rainbow trout. Combined RSD_{14} for both species was 22.9%. These values are high enough to qualify the North Platte as a Gold Medal stream.

Very few YOY (7-14 cm) were collected. This could be partially due to reduced sampling efficiency on the smaller fish. It could also mean that there are problems with spawning or incubation habitat and/or poor fry survival in the main stem of the North Platte.

Special regulations management is not effective on every stream, even ones with high fishing pressure. However, special regulations should be very effective on streams with trout populations that have good growth rates, but moderate to low density because of poor fry production or high harvest rates. The North Platte fits this description. If substantial improvements in the trout population are not noted in the next couple of years, then the 2 trout/day bag should be replaced with a more protective regulation.

Rio Grande River

Electroshocking studies on the Rio Grande River began in 1981 and were continued in 1982. The Rio Grande River from the upper boundary of the Coller Wildlife Area to the Farmers Union Canal outtake (approximately 36.3 km or 22.5 miles) was designated as a Gold Medal Trout Water in 1982. That portion of the Rio Grande on the Coller Wildlife Area (approximately 3.4 km) is receiving intense angling pressure (about 500 hrs/ha or 200 hrs/acre) and appears to be overharvested as no brown trout 40 cm or larger have been collected in this area during our electroshocking studies in 1981 or 1982. Therefore, the bag limit was reduced to two trout and all brown trout less than 16 inches (40.6 cm) must be returned to the water immediately. Artificial flies and lures remains as a terminal tackle restriction. We will be evaluating the impact of these new regulations throughout 1983, 1984, and beyond.

Two sections were studied in 1981, the State Bridge Section and the Coller Wildlife Area. The State Bridge Section (10.8 km or 6.7 miles) runs from State Bridge (between Del Norte and South Fork) to the Farmers Union Canal outtake. The Coller Wildlife Area lies about 8 km (5 miles) west of South Fork, Colorado and about 17.4 km (10.8 miles) upstream from State Bridge. These two sections were resurveyed in 1982. In addition, a third survey area was added in 1982 on the Wason Ranch near Creede, Colorado, approximately 32 km (20 miles) west of South Fork and 24 km (15 miles) upstream from the Coller Wildlife Area. We added the Wason Ranch to see if brown trout $\geq$ 40 cm in length existed in the Rio Grande above the Coller Wildlife Area as well as downstream in the State Bridge Area. We found a number of brown trout in both areas (State Bridge and Wason Ranch) in the 40-46 cm size class while none were taken on the Coller in either 1981 or 1982. We consider this strong evidence that the only explanation is overharvest of stocks on the Coller since sampling both upstream and downstream eliminates virtually all other environmental variables as controlling factors.

Population estimates for brown trout on the Coller in 1981 and 1982 were 3,802 and 4,109, respectively. The size structure for the 2 years did not change noticeably. Brown trout biomass estimates for 1981 and 1982 were 42.9 and 38.9 kg/ha, respectively. No estimates were completed on the rainbow trout since virtually all are the result of stocking catchable rainbow trout.

The brown trout population density did show some increase on the State Bridge Section, 5,168 in 1981 versus 6,753 in 1982. The majority of the increase was in a larger 1+ (1981) year class in 1982 as compared to the 1+ (1980) year class that entered the population in 1981. Most other year classes either stayed the same or fluctuated slightly up or down. For details, refer to Table III-2 in Appendix III.

Brown trout biomass on the State Bridge Section was 39.3 kg/ha in 1981 and 42.4 kg/ha in 1982, the slight increase coming with larger numbers of 1+ brown trout. A small number of rainbow trout exist in the State Bridge Area but comprise less than 10% of the trout population. Age and growth analysis indicates most are survivors of catchable plants from upstream areas or farm ponds along the river. However, they do grow into the 40-50 cm size categories and no doubt provide an occasional pleasant surprise to anglers. The estimate for brown trout $\geq$ 40 cm remained essentially unchanged, 426 in 1981 and 397 in 1982, for the State Bridge Section.

Two sections on the Wason Ranch were electroshocked in 1982. The upper section was 3.06 km (1.9 miles) long and is designated a catchable rainbow stocking area and has an 8 trout/day regulation with no terminal tackle restrictions. The lower section (2.9 km or 1.8 miles) is designated as flies only with a 14-inch minimum size limit. Both sections had virtually identical brown trout population densities, 2,648 versus 2,734 for the upper and lower sections, respectively. However, brown trout biomass was 59.2 kg/ha in the upper standard regulations section and 80.4 kg/ha in the lower fly-only 14-inch minimum size limit area. Virtually all of this difference was due to the greater number of brown trout between 30 and 40 cm in the fly only, 14-inch minimum size limit area. That section had a brown trout biomass of 54.4 kg/ha for browns between 30 cm (12 inches) and 40 cm (16 inches). In contrast, brown trout from 30 to 40 cm in the standard regulations area had a biomass of only 33.3 kg/ha, a difference of 21.1 kg/ha. The difference in total brown trout biomass between the two areas was 21.2 kg/ha. This strongly supports the hypothesis that wild brown trout populations can be overexploited and will respond to restrictive angling regulations. Numbers of brown trout $\geq$ 30 cm in the standard regulations and 14-inch minimum size limit areas were 531 and 1,034, respectively; once again, supportive evidence of the positive benefits of restrictive regulations in producing more quality size trout.

It has been suggested that environmental variables, such as differences in habitat and/or water temperature (as these factors impact growth) could be the reasons for the differences in numbers of brown trout $\geq$ 40 cm in the Coller Wildlife Area (none) as compared to the State Bridge and Wason Ranch, where brown trout in the 40-50 cm size range exist. We maintain that angling pressure and harvest, not environmental variables such as habitat and/or temperature, are the major controlling factors. Brown trout in the 40 cm and larger size classes occur at State Bridge (24 km or 15 miles) below the Coller and on the Wason Ranch (24 km or 15 miles) upstream of the Coller. That virtually eliminates water temperatures as an operative factor since water temperatures at the Wason Ranch are undoubtedly colder than the Coller while they are virtually identical on the Coller and State Bridge sections. The latter is known from thermograph data collected on the Coller and at State Bridge in June, July, and August 1982. We plan to install thermographs in all three areas in 1983.

Persistent skeptics will still maintain habitat differences may be the major control as it is well known that adult brown trout are the most cover-oriented of all the trout. Overhead cover is in short supply on the Coller (even with all of the stream improvement installations). However, overhead cover (the presence or absence of it) should have no impact on the average size of individual trout for given year classes. It will only affect the carrying capacity of a section of stream for larger trout. In Table 18, brown trout age and growth data from the State Bridge, Coller, and Wason Ranch areas are presented.

Table 18. Age and growth data for brown trout in the Rio Grande River.

Study area	n	Age (yrs)	Av size (cm)
Wason Ranch	51	3+	30.9[a]
Coller	21	3+	26.6
State Bridge	48	3+	34.1[a]
Wason Ranch	7	4+	36.3[a]
Coller	35	4+	28.2
State Bridge	18	4+	38.2[a]

[a]Significantly (P = 0.005 or less) larger than Coller brown trout of same age.

A statistical analysis of all possible pairings of age and growth data was completed for brown trout from the State Bridge Area versus the Coller, the Coller versus the Wason Ranch, and the State Bridge Area versus the Wason Ranch. The following is a summary of the analysis:

1. There were no significant differences in average size for brown trout on the Coller and State Bridge sections at age 1 for four year classes (1977-1980).

2. Average size of brown trout from the State Bridge Area for age 2, 3 and 4 were significantly larger (P = 0.005) than Coller Wildlife Area brown trout for the 1977, 1978, and 1979 year classes.

3. There were no significant differences in growth for brown trout on the Coller and Wason Ranch areas at age 1 and 2 for four year classes (1977-1980).

4. Average size of brown trout from the Wason Ranch Area for age 3 and 4 were significantly larger (P = 0.005) than Coller Wildlife Area brown trout for the 1977 and 1978 year classes.

5. There were no significant differences in average size of brown trout on the Wason Ranch and State Bridge sections for age 1, 2, 3, and 4 for four year classes (1978-1981).

In summary, no differences in average size of brown trout were observed between any of the three areas for age 1 (collected as 1+ or second summer) brown trout. Second summer brown trout in all three areas average less than 20 cm (8 inches) total length and thus are not subjected to the same harvest pressure as older age groups since most anglers return trout less than 20 cm to the water. Age 2 and older brown trout on the Coller are significantly smaller than the same age brown trout from the State Bridge (17.4 km downstream) and the Wason Ranch (24 km upstream). At age 2 and older, brown trout in all three areas are larger than 20 cm and are vulnerable to angler harvest. In rivers such as the Rio Grande where standing crops of wild brown trout are low to moderate (40-80 kg/ha) even moderate levels of angler harvest (200 hrs/acre) are going to have significant impacts on the standing stock of quality size (35 cm) stocks of trout. The data presented in the preceding paragraphs give very strong indications that this is what is happening on the Rio Grande River in the Coller Wildlife Area.

The owners of the Wason Ranch have verbally agreed to allow the Division of Wildlife to continue to electroshock the Rio Grande River on the Wason Ranch as part of this study. They have also tentatively agreed to change the flies only, 14-inch minimum size limit that was in effect in 1982 on the lower half (2.9 km) on their portion of the river. The new regulation for 1983 will be flies only, a 14-inch maximum size limit, with a 2 trout daily bag limit. We anticipate this new regulation will result in larger numbers of brown trout in the 35 to 45 cm (14 to 18 inch) size classes.

South Platte River

Six South Platte River stations were sampled on December 6-8, 1982. The Upper and Lower Cheesman Canyon stations have been catch and release fishing since 1976. The above Deckers, below Deckers, Scraggy View and Twin Cedars stations (1.5, 2.0, 8.4, and 11.2 miles downstream of the Wigwam Club, respectively) are harvest areas that allow for an 8 trout/day bag and possession limit. The above Deckers, Scraggy View and Twin Cedars stations corresponds to Stations 1, 5, and 6 in a U. S. Fish and Wildlife Service survey done in 1975 and 1976 (Boaze 1977).

In 1982, rainbow trout again dominated the species composition in the catch and release area, while brown trout were dominant in the harvest stations (Table 19). The South Platte, because of the Gold Medal designation, will be managed with catch and release regulations from the Wigwam Club downstream to Scraggy View starting in 1983. The change in regulations at the two Deckers stations should have an effect on species composition. We have repeatedly attributed the higher proportion of rainbows in the canyon to the protective regulations because rainbows are more vulnerable to angler exploitation. Therefore, a shift toward a higher percentage of rainbows should be noticeable within 2 or 3 years.

Table 19. Species composition of age 1 and up (over 14 cm) for the South Platte River 1982.

	Cheesman Canyon (2 stations)		Deckers (2 stations)		Scraggy View & Twin Cedars	
Sample period	Rainbows %	Browns %	Rainbows %	Browns %	Rainbows %	Browns %
March	57.7	42.3	15.3	84.7	15.2	84.8
December	54.1	45.9	13.2	86.8	15.7	84.3

Species composition of the young-of-year (YOY) was also examined in 1982. It was found to be similar to that found for the older age groups. The 20.2% YOY rainbow trout (Table 20) may seem rather large in relation to the number of brood-sized rainbow trout normally found at the lower four stations. However, if YOY rainbows were moving downstream out of Cheesman Canyon into these areas, it is logical that the further downstream stations would have fewer YOY rainbows. This is not indicated by data in Table 20. Also YOY rainbows comprised about 20% of the YOY population in 1975 and 1976 (Boaze 1977), which was prior to the build-up of the large rainbow population in the canyon.

Table 20. Percent composition of rainbows from the YOY population in the lower four South Platte stations.

Sample period	Year class	Above Deckers	Below Deckers	Scraggy View	Twin Cedars	Combined
Fall 1975[a]	1975	--	--	--	--	19.4 (n=184)
Fall 1976[a]	1976	--	--	--	--	20.9 (n=281)
Spring 1982	1981	7.6	4.5	17.2	11.0	8.8 (n=108)
Fall 1982	1982	23.3	19.0	15.9	18.0	20.2 (n=188)

[a] Data from Boaze (1977)

Density and biomass estimates for the trout population in the Cheesman Canyon Area for the fall of 1982 (Table I-16, Appendix I) were very similiar to those found in the fall of 1981 (Table 21). Trout biomass in the catch and release area was twice that in the standard regulation sections. The higher brown trout density at Deckers and Scraggy View in 1982 was due to the extraordinarily large number of 1-year-olds present in the population.

Table 21. South Platte River trout density and biomass estimates 1979-1982.

Sampling period	Year	Cheesman Canyon no./ha	Cheesman Canyon kg/ha	Deckers & Scraggy View no./ha	Deckers & Scraggy View kg/ha
		Rainbow Trout			
Fall	1979	1,412	451	335	55
Spring	1980	1,512	489	140	26
Fall	1980	1,344	462	325	42
Spring	1981	1,633	586	137	20
Fall	1981	818	327	204	39
Spring	1982	958	385	75	15
Fall	1982	806	319	269	35
		Brown Trout			
Fall	1979	839	199	1,050	144
Spring	1980	814	179	984	140
Fall	1980	1,036	205	1,256	149
Spring	1981	777	161	818	109
Fall	1981	575	139	1,006	180
Spring	1982	757	160	636	96
Fall	1982	678	137	1,700	194

The length frequency histograms (Appendix II) clearly illustrate the difference in size structure between the canyon and downstream populations. In December 1982, the mean size of adult rainbows (age 2 and over) in Cheesman Canyon was 34.4 cm (Table 22). The mean length of adult rainbows in the lower stations was 28.3 cm with very few rainbows there over 30 cm. Mean length of adult rainbows has increased each year since 1979, while during the same period total trout biomass has declined each year (Table 22). Fewer smaller rainbows in the population, however, may be responsible for this.

Table 22. Mean length of adult (age 2 and up) trout in Cheesman Canyon, 1979-1982.

Year	Total biomass (kg/ha)	Rainbow mean length (cm)	Brown mean length (cm)
1979	702	31.5	30.0
1980	667	32.2	28.5
1981	466	33.8	30.0
1982	456	34.4	28.8

Another measure of the size structure of a population is relative stock density (RSD). Since Gold Medal waters need to have a RSD of 20% for trout over 14 inches, this ratio is now important when evaluating these areas. The RSD for the canyon population was 11.0 and 12.4% in 1979 and 1980, respectively and surpassed 20% in 1981 (Table 23). Low RSD values at the Deckers Area reflects the high angler exploitation of the trout population.

Back-calculated lengths at time of annulus formation, determined by scale analysis, for South Platte trout are given in Table III-1 of Appendix III. Growth in 1982 was typical of earlier years. YOY browns ranged from 8 to 15 cm in the fall (time of capture). Age 1+ browns were from 15 to 25 cm and age 2+ browns ranged from 24 to 32 cm, very similiar to growth rates reported for last year (Nehring and Anderson 1982).

Table 23. Relative stock density for the South Platte River for trout over 14 inches.

Year	Cheesman Canyon (C & R) Rainbow	Cheesman Canyon (C & R) Brown	Cheesman Canyon (C & R) Combined	Deckers & Scraggy View (C & R) Rainbow	Deckers & Scraggy View (C & R) Brown	Deckers & Scraggy View (C & R) Combined
1979	13.8	6.2	11.0	0.0	0.5	0.4
1980	18.3	2.8	12.4	1.5	0.3	0.6
1981	29.8	6.0	20.7	3.3	1.2	1.5
1982	35.7	2.1	20.9	1.9	0.3	0.5

Life Tables, given in Table III-2 in Appendix III, give number of trout per hectare by age group. Logically the number per hectare should decline in each successive year because of mortality. However, many Cheesman Canyon trout over age 3 have been difficult to age because of false annuli formed due to rapid changes in water temperature when water spills over Cheesman Dam and the very slow growth rate for trout over 30 cm. Because of this, 2-year-old and older trout were grouped together to estimate total annual mortality of adult trout. In Cheesman Canyon, total annual mortality rate primarily reflects natural mortality since all indications are that poaching and hooking mortality is insignificant. Table 24 shows that total annual mortality has been much less in the catch and release area than in the downstream stations where fishing mortality plays a major role in controlling the population.

Table 24. Estimated total annual mortality for adult trout (age 2 and over) for the South Platte River 1979-1982.

Year	Rainbow Catch & release	Rainbow Catch & keep	Brown Catch & release	Brown Catch & keep
1979-80	28.3%	73.0%	70.8%	89.7%
1980-81	48.1%	68.7%	66.7%	78.0%
1981-82	15.7%	70.0%	36.9%	92.0%

Total annual mortality rate for Cheesman Canyon is discussed in relation to habitat availability in Job 1. Also, importance of high natural survival rate in determining whether a population can meet Gold Medal standards is discussed in the St. Vrain section.

Creel census surveys, conducted from 1979-1981, contrasted fishing opportunities in the catch and release area versus the standard regulation area and were summarized in the 1982 report. Neither electrofishing data nor DWM observations indicated that use patterns differed in 1982 from earlier years. A number of reports from concerned anglers reported high levels of "poaching" in Cheesman Canyon in 1982 and they felt that a drastic decrease in the canyon trout population would be evident through our fall 1982 electroshocking surveys. This definitely was not the case. Changes between the spring and fall 1982 were very small.

St. Vrain River

The 1982 density and biomass estimates from collections on October 14 and 15, 1982, are given in Table I-17 of Appendix I. To date, the St. Vrain has been a good example of where special regulations will not improve a fishery. Neither density nor size structure differs from that found in 1980, the preregulation sample period. In 1980, density of trout over 14 cm (age 1+ and up) in the catch and release section was 1,139/ha (Table 25). The drop in 1981 to 444 trout/ha was due to poor recruitment of 1-year-olds. By 1982, the number of 1+ trout was high again and they comprised 73% of the population at the Gaging Station. The control station (Meadow Park) had a similiar population trend, though the dip in 1981 was less dramatic (Table 25).

Table 25. Trout density estimates and the percent of 1-year-olds in the brown population for the Gaging Station (C & R) and the Park Station (8/day) for trout over 14 cm.

Year	Gaging Station		Meadow Park	
	no./ha	% age 1+	no./ha	% age 1+
1980	1,139	83.1	1,796	84.5
1981	444	51.2	1,130	77.1
1982	1,243	73.0	1,823	77.4

The other two stations sampled in 1982 were down from the 1980 density estimates (Table 26). But as was pointed out in the 1982 report, these stations had fish-kill problems that nearly eliminated the trout from these areas in the summer of 1981.

Table 26. Density estimates for the Ideal Concrete (C & R) and Martin Marietta (8 trout/day) sections for trout over 14 cm.

Year	Ideal Concrete		Martin Marietta	
	no./ha	kg/ha	no./ha	kg/ha
1980	1,406	115.5	238	22.2
1981	fish kill		fish kill	
1982	534	52.4	166	19.0

Length frequency histograms for 1982, given in Appendix II, were similiar to 1980 except that seven brown trout over 30 cm (12 inches) were caught in 1982 compared to zero in 1980. The presence of these seven trout (over 30 cm) is of minimal significance. The stream improvement work was completed on this section of the stream in the summer of 1982. Therefore, either these trout were able to overwinter in the unimproved habitat or were introduced to this area after completion of the improvement work (stocking or migration).

A detailed discussion of the stream hydrology and description of the physical habitat (pre and post improvement) of the St. Vrain at Lyons will be prepared for Job 1 in an upcoming progress report. The relevance of the stream improvement work to the catch and release regulation is that beginning in 1983, the St. Vrain is basically a new stream with a new trout carrying capacity. Prior to the improvement work, it was obvious that the catch and release regulation was superfluous in reducing total annual mortality of adult brown trout since natural mortality was nearly 100% (Table 27). With more and better quality pools, the survival rate of adults should be improved. The survival rate of an adult trout population is a good parameter to judge the success of an improvement project and to justify the continued use of the catch and release regulation.

Table 27. Density of trout by age groups and survival rates at the Gaging Station 1980 to 1982.

Year	Age 0 no./ha	Age 1 no./ha	% survival	Age 2 no./ha	% survival	Age 3 no./ha
1980	353	946		192		0
			22.9		0.0	
1981	856	228		217		0
			100.0		24.4	
1982	698	892		298		53

Perhaps the best information to have about a stream population when deciding to use a catch and release regulation is the fishermen exploitation rate (percent of the population harvested by anglers) which can be derived from creel catch and spring density estimates. The next best information is the annual natural mortality rate of adult trout (total annual mortality in an unfished or C & R stream). In order for a stream population to have the potential to be a quality fishery (Gold Medal) adult survival rates must be consistently over 50%. A 50% survival rate is necessary for the population to attain a RSD value of 20% for 14-inch fish. Table 28 illustrates this point. For this discussion, adult trout are defined as 2 to 6 year-old fish. One-year-old trout are excluded from the calculations since most of these would be under 8 inches by the end of their second summer. It is also assumed that most trout in age group 2 and 3 are between 8 and 14 inches and most trout in age groups 4, 5 and 6 are over 14 inches. At the 50% level of mortality for adults (2 to 6 year-olds), the RDS_{14} is 22.5%. At the 40% survival rate, RSD_{14} is down to 15% and at the 20% survival rate it is only 4%.

Table 28. Hypothetical RDS_{14}(number of trout over 14 inches ÷ number over 8 inches X 100) values at natural mortality rates of 50, 60 and 80% on adult trout.

Age	50% Mortality no./ha	60% Mortality no./ha	80% Mortality no./ha
2	500	500	500
3	250	200	100
4	125	80	20
5	62	32	4
6	31	13	1
Total 4-6	218	125	25
Total 2-6	968	825	625
RSD_{14}	22.5%	15.1%	4.0%

In the catch and release area of the South Platte River where annual mortality rates for adult rainbow trout were 28, 48, and 16% in 1980, 1981 and 1982, respectively (consistently under 50%), the RSD_{14} was 35.5%. In contrast, the Arkansas River trout mortality rate for age 2 to age 3 was found to be 53% in 1982 and for age 3 to age 4 was very high at 95% in 1982. The RSD_{14} of the Arkansas River in March 1983 was only 3%. It is hoped that the stream improvement work done on the St. Vrain will allow adult survival rates to average at least 20% for trout up to their fourth or fifth year. This is the minimum level which justifies the use of a zero bag regulation from a biological standpoint.

RECOMMENDATIONS AND CONCLUSIONS

Fish Populations

Arkansas River

Beginning in January 1983, the Arkansas River from Salida to Fernleaf Gulch was designated "Gold Medal." However, because most of the river within this area is privately owned, only three short sections are managed by catch and release. These areas are the Loma Linda section (1.6 miles), Cottonwood Creek section (1.5 miles) and the Salida area (1.8 miles). The rest of the river in the Gold Medal Area has the standard 8 trout per day regulation. Also, the C & R areas are short and intermittently spaced making the regulation confusing to the fishing public. The confusion may lead to high rates of poaching in the protected areas, thereby negating a possible positive response to the regulation. The best way to reduce the confusion is to confine the C & R fishing to one long piece of river (5-10 miles).

This would not only benefit the special regulations evaluation study but the rainbow introductions (Job 4) as well. Suggestions on the location of longer stations are given under Job 4. To date the data does not support the "Gold Medal" title for the Arkansas River. If no improvements in RSDs are seen by next year, it may be necessary to delete the Gold Medal designation. Nevertheless, there has been a positive response to the catch and release area by the public and this concept should remain in effect. A single large catch and release area would better serve the public and be more apt to improve the fishery.

Cache la Poudre River

The regulation changes on the Poudre effective January 1983 include a 2 trout/day bag limit in the wild trout waters. In addition, the Indian Meadows section will have a 16-inch minimum size limit with flies and lures only. Data from the 1960's, 1970's, and 1980's show that the size structure of the trout population in the Poudre has remained static over the last 20 years. Cold water temperatures, which reduce growth rates, along with high fishing pressure (which removes larger trout from the population) are the probable causes. The only way to improve the size structure is through protective regulations. Our studies have shown that anglers throw back most trout under 8-9 inches, but creel those over 10 inches. This happens if the bag limit is 8 or 2 trout per day. High-grading may also negatively influence growth rates since the slower growing trout are less apt to be killed by fishermen.

Colorado River

Public access fishing areas on the Colorado River have been severely overharvested since at least 1979 and 1980. Quality size (35 cm and larger) rainbow and brown trout stocks have been depleted. Rainbow and brown trout populations remain high on private land (restricted access) and on the Special Regulation Section (Parshall to Sunet Ranch) of the Colorado River. Densities of quality size trout are 6.8 times higher on the private access and/or restricted regulation sections. We will continue to evaluate the Gold Medal Section of the Colorado River over the next several years to document changes in population density as a result of the one rainbow - one brown trout bag limit implemented for the 1983-84 fishing seasons.

Eagle River

The trout population in the Eagle River below Milk Creek (near Wolcott) confluence is probably among the most severely depleted stream trout populations in the state. The combined impacts of low recruitment (due to chronic siltation problems from Milk Creek) and overexploitation by anglers have decimated this trout population. With the imposition of a fly and lure only regulation and a one rainbow - one brown trout bag limit, there is some hope for recovery of the fishery. However, with standing crop estimates in the 2 to 4 kg/ha range and continued angling pressure, it could take longer than 3 to 5 years for trout biomass to return to the 40 to 60 kg/ha levels observed in 1978 before heavy angler harvest became a problem. We will continue to monitor this river over the next several years to document the response (if any) to the restrictive regulations imposed in 1983.

Fryingpan River

Rainbow, and to a lesser extent, brown trout in the 8 trout/day sections of the Fryingpan River have been suffering from overhearvest of stocks 30 cm and larger. Larger, older rainbow trout in the catch and release area are dying of old age and are not being replaced due to a lack of rainbow recruitment in the first 3 to 5 km below Ruedi Dam. This latter problem is a result of very cold (hypolimnetic) releases from Ruedi Dam which are below the threshold temperatures at which rainbow trout eggs will incubate and hatch successfully.

A fingerling rainbow stocking program has been implemented in an attempt to augment rainbow populations in both the catch and release and limited kill (one rainbow and one brown) areas of the Fryingpan River. Both plants (30,000 in July and 2,400 in October) in 1982 were marked to aid in following these stocked fish through the population over time.

We will continue to evaluate the trout population in the Fryingpan River over the next several years to evaluate the impact of the one rainbow - one brown trout regulation implemented on the Fryingpan for the 1983-84 angling years.

Gunnison River

The special regulation implemented on the Black Canyon of the Gunnison is having a positive impact on the trout population. Sixty-eight percent of all rainbows and 71% of all browns caught were returned to the water in 1982, according to our creel census estimates. We observed a large increase in numbers of rainbow and brown trout in the 30 cm to 40 cm size class in the North Fork to Smith Fork study section. This section (6.5 km) receives the heaviest fishing pressure from the Crystal Dam access area to the Austin Bridge, a distance of 58 km (36 miles) on the river. We will continue to monitor changes in this trout population over the next several years.

Middle Fork of the South Platte River

After 2 years of catch and release on the Tomahawk property, there has been no positive change in the population density or size structure. This is attributed to the fact that large proportions of adult brown trout migrate early in the winter downstream to Spinney Mountain Reservoir. This migration apparently has caused the skewed shape of the length frequency distribution. Also certain physical characteristics of this stream, mainly the low winter flows, mean that adult habitat can be limiting. We intend to concentrate our efforts on Job 1 and drop this study stream after the 1984 field season.

North Platte River

The 1983 findings indicate that the North Platte has Gold Medal potential. This river possesses many of the characteristics that indicate it would effectively respond to special regulation management. For example, both the rainbow and brown trout have very good growth rates but recruitment may be limited. We will continue to monitor this population to evaluate the newly designated 2 trout/day bag limit.

Rio Grande River

The brown trout population on the Coller Wildlife Area is suffering from overexploitation by anglers. This problem should be alleviated with the new regulation imposed on the Coller Wildlife Area for 1983-84. The bag limit was reduced from 8 trout (1981-82) to 2 (1983-84) and all brown trout less than 16 inches must be returned to the water immediately. We will continue to monitor the trout population in the Rio Grande River over the next several years to document changes in the population size and age structure as a result of the regulation change.

South Platte River

Evaluations will continue on the South Platte River. We now have the opportunity to follow the trout population of the Deckers Area in its response to catch and release fishing. This is an ideal study area since we have 4 years of preregulation data. With strong rainbow and brown year classes for 1981 and 1982 entering the population, the catch and release regulation should allow the population to quickly reach the carrying capacity of the stream. It will also allow for a build-up of older trout. Currently, the vast majority of the population between Deckers and Scraggy View are 3-year-olds or younger. The new regulation will also give us the opportunity to directly compare the Deckers population with the Cheesman Canyon population after 2 or 3 years of catch and release angling. This will help us define the importance of habitat in controlling trout community structure.

St. Vrain River

The catch and release regulation on the St. Vrain has been ineffective because natural mortality of trout over 2 years of age has been very high. However, since the stream improvement project was completed in 1982, we will continue our population sampling for at least 2 more years. These samples will also be applied to Job 1 evaluations.

Job No. 4

Job Title: Wild Trout Introductions

Job Objective: To establish, then quantitatively describe, a wild rainbow trout population in the Arkansas River between Salida and Texas Creek.

Period Covered: May 1, 1982 to June 30, 1983

INTRODUCTION

Electrofishing surveys were started on the Arkansas River in the spring of 1981 at the start of Job 3. The trout population of the river is 99+% brown trout with moderate density (300-500/ha) compared to other large rivers such as the Gunnison and Colorado rivers. The Arkansas is characterized by wide sandy-bottomed runs, deep open pools and intermittently spaced shallow and deep riffles with high velocities. Scattered boulders provide most of the trout cover and the scarcity of cover appears to be a limiting factor for the brown population. Our electrofishing efforts found that brown trout concentrated around areas of cover and that most deep pools were devoid of trout thus leaving large amounts of unoccupied habitat. The introduction of a species that could exploit these underutilized habitats would greatly add to the trout standing crop and enhance angling opportunities. Rainbow trout are commonly electroshocked from deep open pools on the Colorado, Gunnison and South Platte and appear to be suited for Arkansas River.

Efforts have been made in the past to introduce rainbow trout to the Arkansas River (Carhart 1950) and catchables were stocked for a number of years, but a self-sustaining population was never established. Domestic strains, though well adapted to hatchery life, have a poor history for long-term survival in the wild (Borgeson 1966). Also, it has been demonstrated that hatchery strains do not successfully compete with resident trout (Miller 1957). Since we feel that a two species trout system would increase density and biomass over present levels and add a trophy fish to the population, we are making another attempt to introducing rainbow trout. But this time a wild strain of rainbows, that has proved itself to be genetically suited to compete with brown trout and successfully reproduces under high spring flows, will be planted.

METHODS AND MATERIALS

Wild rainbow trout in the Colorado River spawned in the middle of April in 1981 and 1982. Electrofishing equipment mounted on a Jon boat was used to collect ripe adults. Eggs were stripped and fertilized in the field, then transported to Mt. Shavano Fish Hatchery for incubation and care of fry. Hatchery personnel kept close records on egg and fry mortality.

In April 1981, 24,300 eggs were sent to the hatchery. On October 1, 1981, 14,000 fry about 400 to the pound (4.6 cm average length) were stocked in the Arkansas River. In April 1982, 85,500 eggs were collected. Fry were planted on August 18, 1982 (55,800; 725/lb, 3.8 cm average length). A portable fish tank was used to transport the fry from the hatchery to the river. The young were released at the Salida Electrofishing Station, the Coaldale Station, and the Loma Linda Station (stations were described in Job 3).

The relative success of the plants has been and will be (in the future) determined by the annual electrofishing surveys covered under Job 3.

RESULTS AND DISCUSSION

Only 5 rainbows from the 1981 plant were caught during the March 1982 electrofishing efforts. They ranged in size from 5 to 7 cm. One was from Salida, 3 from Coaldale and 1 from the Loma Linda Station. These trout had grown about 2 cm from October 1, 1981 to March 1982, but were still too small to be effectively collected.

Five larger rainbows between 24 and 31 cm were also found on the Salida Station in March 1982. This area is located only 6 km below Mt. Shavano Hatchery and these rainbows apparently originated from there.

It took a full growing season before the 1981 plant became susceptible to our sampling methods. In March 1983, we caught 26 rainbow trout at Salida, 7 at Loma Linda, 10 at Coaldale and 2 at Tezaks from the 1981 plant for a total of 45. They ranged in size from 16 to 24 cm and the mean was 19.5 cm. Two-year-old brown trout (1981 year class) had a mean size of 22 cm in March 1983. The age 2 brown trout were very numerous (see Job 3) which means that interspecific competition with the rainbow trout was keener in 1982 than would have been the case in other years.

Only one age 1 rainbow (1982 plant) was caught in March 1983. This was an 8 cm trout and was on the Tezak Station about 4 km downstream of the Loma Linda plant area. Problems were encountered with the 1982 plant, which if can be averted in the future, may result in higher survival rates of these wild rainbows. First, they were too small when planted (3.8 cm average) and may have been in a weakened condition. This could not be helped at the time because poor water quality at the hatchery made it advisable to get them out before mortality increased. Runoff was also above normal when the rainbow were planted in August

(650 cfs) which reduces the quality of the available habitat. Also the fall of 1982 had frequent thunderstorms which resulted in muddy water in the river throughout much of September and some of October. The fact that the 1982 brown trout year class was quite weak (see Job 3) indicated the severity of the environmental conditions that year. However, not until after we sample in March 1984 will be know the status of this plant.

Another source of mortality which may affect the success of this job is angling pressure. DWM Willie Travnicek informed us that 7 of 9 trout caught by a fisherman near Badger Creek, 8 km below the Salida stocking area, were rainbows in the 20 cm size range. Another angler (Dave Winters, Job 5) caught 1 rainbow from a total of 12 trout at Loma Linda, a rate still higher than we found in our electrofishing surveys.

Since the brown population appears to be relatively static, regardless of the protective fishing regulations, the addition of rainbows to the population should prove to be positive. We will continue to plant rainbow trout in 1983 and 1984 and follow their success.

RECOMMENDATIONS AND CONCLUSIONS

Clearly we must strive to achieve a higher survival rate on the wild rainbow plants. Planting at an average size of 7 to 10 cm should improve survival. In order to do this, we will rear the fish at Rifle Falls Hatchery. Also, mid to late September is a better time to stock the river. The Salida Station had the most age 2 rainbow trout in March 1983. Therefore, this area will be our primary planting zone. However, it would be beneficial if a catch and release regulation could be extended over a larger portion of river, since these small trout are susceptible to angling. Our first choice would be to enlarge the Salida catch and release section downstream to the upper edge of Howard. This is a distance of about 16 km. The major landowner in the stretch is Mr. Freek. Perhaps a lease agreement could be arranged with him. Our second choice is a long stretch from near Coaldale to Fernleaf Gulch. This is about 12 km. This area includes the town of Cotopaxi and the KOA Campground. Our last choice is a section of river from the KOA property downstream to Five Point Campground, about 16 km. Mr. Tezak is the major landowner here. The reason this is the third choice instead of second is that half of this area lies below Texas Creek which discharges silty water after heavy rainstorms. However, this would not be a serious concern in an average water year. If the Salida catch and release area can be enlarged to Howard then the two lower catch and release areas could be eliminated. If, however, the second or third choice could be negotiated, the Salida section should remain as is. Hopefully, these options will be investigated before the next regulation changes are due in July 1984.

Job No. 5

Job Title: Arkansas River Aquatic Invertebrate Investigations

Job Objective: Determine if there is an obvious correlation between the macroinvertebrate community structure and possible future variations in the trout population.

Period Covered: May 1, 1982 to June 30, 1983

INTRODUCTION

This job was designed with the belief that Jobs 3 and 4 would be successful on the Arkansas River and that by 1987 there would be a significant (approximately 50%) increase in trout biomass over present levels. The objective of this job is to determine if the changes in the trout population structure would noticeably impact the macroinvertebrate community of the river. In the planning stages of this job, it was assumed that the stonefly *Hesperoperla pacifica* would be a good indicator species. It is a large stonefly, and was found to be abundant in the initial Surber collections made in June 1981. Also, since trout growth rates were rapid and the trout density modest (250/ha), it appeared that the prey community was not overly stressed by predation. It is generally believed that predators can be largely responsible for regulating prey population community structure (Ricklefs 1973). However, Allen (1982) points out that the question of whether trout graze heavily on their prey or merely subsist on the surplus has not been resolved. Due to recent changes in management of the river fishery, this study has the potential to address some of the predator-prey interaction questions by quantifying the role of the prey base in determining the "quality" of a trout population.

Because of the complexities and time constraints of this study, a graduate student was given most of the responsibility of gathering invertebrate data for the first year. His efforts will include 12 months of samples from September 1982 to August 1983. The following is a summary of his findings up through December 1982.

METHODS AND MATERIALS

The study site is located 3.2 km upstream of the confluence of Texas Creek and the Arkansas River. A riffle area was chosen for invertebrate sampling, while areas with suitable trout holding habitat exist above and below the riffle.

Benthic invertebrate sampling was conducted with a Surber 0.1 m^2 sampler with a mesh diameter of 250 µm. Each month, beginning in July, five samples were collected in a transect across the stream to determine species composition and diversity. Invertebrate drift was sampled for 2-hour periods every 4 hours for a 24-hour period. Invertebrate drift samples were collected on the same dates as the benthic samples. Drift nets have an opening of 0.14 m and a mesh size of 250 µm. Three drift nets were positioned across the stream in the same transect as the benthic samples. One more net was placed on top of each submerged net to sample surface drift. Flow was measured directly in front of each net to determine the amount of water passing through each net.

On September 8, 1982, 38 trout were collected with a boat electroshocking unit and their foregut contents removed by flushing the contents out with a modified Seaburg stomach sampler. On December 15 and 16, trout were collected by the same method prior to nightfall. The following morning 18 more trout were collected to determine diel difference in their feeding. All the samples were preserved in 75% ethel alcohol and returned to the lab for analysis.

RESULTS AND DISCUSSION

A total of 27 taxa of aquatic invertebrates were identified (Appendix VI). Relatively rare species, such as the small caddisfly *Culoptila sp.* and some Diptera have not been verified by taxonomic specialists yet. Representatives of all major orders of aquatic invertebrates found in the foothill streams of the Rocky Mountains were collected and are listed in Table VI-1 of Appendix VI.

Simuliidae (blackflies) and Chironomidae (midges), members of the order Diptera, comprised the majority of the benthic invertebrates. *Baetis tricaudatus*, a member of the order Ephemeroptera (mayflies) was the third most common organism. *Brachycentris occidentalis*, a member of the order Trichoptera (caddisflies) although not as abundant as the aforementioned groups, were very concentrated on exposed roots and vegetation near the shore. One 0.1 m benthic sample collected near the shore produced 2,144 of these caddisflies. The numbers of organisms increased in the later months probably due to the hatching of eggs layed in the spring and summer.

The composition of the invertebrate drift was a reflection of the benthos with Simuliidae, Chironomidae and *Baetis tricaudatus* comprising the majority of the drift. *Brachycentris occidentalis* made up a minor portion of the drift, probably due to the heavy case of sand it builds around itself. Chironomid adults were the only insect group to show a major emergence during the sampling period. Hatches were documented during the November through January samplings, from the early afternoon through midnight.

Brachycentris occidentalis comprised 55% of the individuals found in the trout stomachs sampled in September. The next most important food item was terrestrial organisms at 19%. All other organisms found in the stomach samples comprised less than 10% of the total numbers of organisms. On December 15, *Brachycentris occidentalis* made up 45% and Chironomidae adults made up 37% of the food in the trout stomachs sampled before dusk. Of the trout samples collected the following morning, *Brachycentris occidentalis* made up 75% of the organisms, adult Chironomidae 6.7% and Chironomid larvae 8.4%.

Although *Brachycentris occidentalis* probably takes longer to digest than other organisms because of its case, they are still the preferred prey item for the brown trout in this section of the Arkansas River. These caddisflies drift very little and must be picked off the bottom, primarily near the shore where their density is greatest. When large numbers of organisms emerge, as in December when the Chironomidae emerged, the trout may be stimulated into changing their bottom feeding strategies to feed on the then abundant adult organisms.

RECOMMENDATIONS AND CONCLUSIONS

Hesperoperla pacifica was not commonly found in Surber samples or in trout stomaches from the September to December collections. It appears that the trout are heavily relying on small prey organisms *B. occidentalis* and chironomids, both less than 5 mm long, at least in the fall and winter. These organisms are not typically considered as preferred prey items for adult trout. This indicates to us that the caddisflies are either very abundant in the river and easy prey or that larger organisms are relatively unavailable as food. In either case, physical or chemical factors appear to be regulating the macroinvertebrate community with little impact from predation. This should be verified after the spring and summer samples are completed. Attempts will be made to improve the collecting efficiency of *H. pacifica* and other large invertebrates by using a 1 m^2 benthic sampler (described in Job 6). A series of samples will be taken in the spring for the next 2 years to see if this job should be continued through 1987.

Job No. 6

Job Title: Colorado River Aquatic Invertebrate Investigations

Job Objective: Determine if correlations exist between willow fly (*Pteronarcys californica*) populations and the temperature and flow regime of the Colorado River, and quantify the importance of the willow fly naiad in the rainbow trout diet.

Period Covered: May 1, 1982 to June 30, 1983

INTRODUCTION

Aquatic invertebrates in our larger trout streams make up the vast majority of the food resources for stream-dwelling trout. Stoneflies (*Plecoptera*) are among the most important aquatic insects in the diet of stream-dwelling trout. Dimick and Mote (1934) rated plecopterans as the second most important order of insects in the diet of rainbow trout in Oregon streams. Maitland (1965) also indicates stoneflies are an important food item for trout and salmon.

The willow fly naiad (*Pteronarcys californica*) is a stenothermic aquatic insect with very narrow tolerances for water velocities and required levels of dissolved oxygen (Knight and Gaufin 1963, 1964, 1966). *Pteronarcys californica* (as will be demonstrated further on in this report) is the primary food resource for rainbow and brown trout in the section of the Colorado River designated as Gold Medal trout water. Without the high densities of this aquatic invertebrate presently existing in the Colorado River, we would probably be unable to maintain the high density of large rainbow and brown trout presently extant in the Gold Medal trout water. A significant change in the thermal regime of the Colorado River near Hot Sulphur Springs could conceivably result in the demise of *Pteronarcys californica* (known as the willow fly or salmon fly) in that portion of river above the confluence with the Blue River.

All of these seemingly disconnected items of information are connected by one thing, the construction and operation plan for Windy Gap Dam just below the confluence of the Fraser and Colorado rivers near Granby, Colorado. The operational plan for this water project calls for the diversion of up to 50,000 acre-feet of water from the Colorado River system into the Big Thompson transmountain diversion project to meet increasing demands for agricultural, municipal, and industrial water supplies on the East Slope.

While the Division of Wildlife feels quite comfortable with the minimum flow agreement that will maintain the trout habitat, it is quite possible that the demise of this Gold Medal trout fishery will come about in a very indirect manner. The plan to annually divert 50,000 acre-feet of water from the Colorado River during the spring and early summer months may actually increase usable habitat for the trout during that period but result in a decreased trout population through elimination of its main food item, *Pteronarcys californica*.

As already indicated, *Pteronarcys californica* is a very stenothermic aquatic insect with a need for fairly high water velocities to maintain an adequate respiration rate. This is especially true during the spring and summer months when the water temperatures rise rapidly. At temperatures up to 15-20 C, much higher water velocities are necessary to maintain the respiration rate. It is precisely at this most critical time that the 50,000 acre-feet of water will be diverted from the Colorado River. The possible result will be a significant decrease in water velocities and an increase in temperatures which thereby decreases the level of oxygen saturation in the water. This makes the willow fly naiad subject to "double jeopardy" as its respiratory oxygen consumption rate increases with increasing temperatures. Therein lies the dilemma and the need for this investigation. We are in a unique position to document the potential loss of a unique stream fishery before it happens, rather than trying to figure out what happened "after the fact." Admittedly, the concept of a domino-theory (cause-effect) relationship may seem farfetched at first; nonetheless, we think the potential for a biological disaster definitely exists and deserves an investigation.

Our objective is to (1) determine if correlations exist between the willow fly (*Pteronarcys californica*) populations and the temperature and flow regime of the Colorado River, and (2) quantify the importance of the willow fly naiad in the rainbow trout diet.

METHODS AND MATERIALS

We designed and constructed a 1 m^2 area benthic invertebrate sampler for collecting quantitative samples in large cobble type stream habitats which are the preferred habitat of *Pteronarcys californica*. We used the sampler in May 1982 in a preliminary sampling survey to determine the number of square meter samples required for statistically reliable density estimates.

Originally we proposed to collect 10 rainbow trout stomach samples per month from April through October to quantify the importance of *Pteronarcys californica* in the diet of rainbow trout in the upper Colorado River. However, this proved to be too time consuming purely from a field travel time standpoint and could not be accomplished under the budgetary constraints of the project. Therefore, we used stomach samples collected by anglers (primarily Mr. Dean Swanson of Arvada, Colorado) who frequently fished the Colorado River during 1982. We shall continue this approach in the 1983-84 segment and periodically supplement it with stomach samples collected by electroshocking.

Cross-sectional data was not collected in 1982 due to a shortage of heavy sampling equipment for larger rivers. However, we hope to get the raw field data collected during 1983. A considerable amount of literature has been collected on environmental preferences (water velocity, temperature, dissolved oxygen, and substrate) of *Pteronarcys californica* over the past year. We will attempt via data from the literature, together with observations in the field, to construct probability of use curves for *Pteronarcys californica* for water velocity, temperature, dissolved oxygen, and substrate preferences. These probability of use curves will then be used in conjunction with field cross-sectional measurements to do an incremental flow analysis using the IFG3 and IFG4 computer models.

RESULTS AND DISCUSSION

Two different areas were sampled on the Colorado River in an attempt to quantify the density of *Pteronarcys californica* naiads, the variability in density between samples as well as between two different areas. Our sampling results indicated that five 1-m^2 samples would have given approximately the same results as 10 samples did. The results are given in Table 1.

Table 1. Mean estimates (no./m^2) and standard deviations for various combinations of 1 m^2 benthic samples of *Pteronarcys californica* from the Colorado River, May 1982.

Sample numbers	State Ranch Mean	State Ranch S.D.	Parshall Mean	Parshall S.D.
1-10	202.8	±111.2	134.9	± 92.4
1-5	221.8	±139.3	150.8	±128.5
6-10	183.8	± 86.8	119.0	± 45.3
1,3,5,7,9	198.8	±134.4	125.4	± 88.5
2,4,6,8,10	206.8	± 98.8	144.4	±105.6

Five samples of 5 each, drawn from the universe of 10 for each of the 2 sampling areas gave a mean estimate that was within ±20 naiads/m^2 of the mean estimate for a sample size of 10. Due to the very high random variation between samples (but within a sample area), a very large number of samples would be required to generate a really precise (narrow confidence interval) estimate of the mean. Fifty-one samples (m^2) would be required to estimate the true mean (μ) within ±25 naiads/m^2 for a 95% confidence limit, however, only about 5 samples (m^2) would be required to estimate within ±75 naiads/m^2. Sampling, preserving, sorting, and counting large numbers of aquatic invertebrate samples requires a monumental amount of time and manpower. Therefore, we will most likely take no more than five 1 m^2 benthic samples when quantifying willow fly naiad density in the future.

The densities of willow fly naiads found in our sampling (both mean and ranges) closely approximates the estimates obtained in 1980 and 1981 by another investigator (Dr. Robert Erickson, unpublished data). However, Erickson also found considerable variation within and between sampling sites over time. He sampled four different times between September 1980 and September 1981.

Riffle areas have long been known as the most important zones for aquatic invertebrate production. One of the objectives of this study is to document the importance of the willow fly naiad (both numerically and volumetrically) in relation to the rest of the aquatic invertebrate fauna of the Colorado River in this study area. Detailed data on comparisons between species, orders, etc., on a volumetric and numerical basis are given in Table VI-2 and VI-3 in Appendix VI. At the Byers Canyon Bridge Station, *Pteronarcys californica* naiads comprised 63.7% of the numerical density and 85.1% (by volume) of the total invertebrate biomass over the ten 1 m^2 samples. The average *Pteronarcys californica* density was 203/m^2 with a range of 44 to 403/m^2 over the 10 samples.

At the station near Parshall (a slower water velocity and shallower riffle area as compared to the Byers Canyon Station) Ephemroptera were the most numerous aquatic invertebrate, comprising 70% of the numbers in the 10 samples. *P. californica* only comprised an average of 8.4% of the numerical sample but comprised 48.5% of the total volume for these 10 samples. Since *Pteronarcys californica* has a 3-4 year life cycle, they probably comprise the majority of the invertebrate population, numerically and volumetrically from mid-summer to early winter, after the univoltine species such as the mayflies and caddisflies have emerged. These samples demonstrate beyond any shadow of a doubt the importance of *Pteronarcys californica* in the aquatic invertebrate biomass in the Colorado River.

Stomach samples taken from rainbow and brown trout over the past 3 years further illustrate the importance of *Pteronarcys californica* in the trout diet in the Colorado River (Table 2).

The willow fly naiad comprised a minimum of 42% of the food bolus (by volume) to a maximum of 94%. There can be no doubt about the importance of this organism in the diet of trout in the Colorado River from near Granby downstream to Kremmling, Colorado.

Table 2. Importance of *Pteronarcys californica* (P.c.) in the diet of trout in the Colorado River (1980-1982).

Date	No. stomach samples	No. P.c. in stomachs	Vol P.c. (ml) in stomachs	% P.c. in total volume
6/01/80	6	50	36	88
7/12/80	6	16	22	56
7/20/80	2	parts	6	55
9/13/80	3	18	17	94
5/16/81	4	77	34	61
6/29/81	3	7+ parts	8	53
7/12/81	5	6+ parts	5	42
7/25/81	4	6+ parts	6	60
7/11/82	5	16+ parts	6	52
7/25/82	3	20	10	80

RECOMMENDATIONS AND CONCLUSIONS

The willow fly naiad is the dominant benthic invertebrate in the riffle areas of the Colorado River from near Granby, Colorado, downstream to the confluence with Troublesome Creek, a distance of approximately 30 km. *Pteronarcys californica* made up 63.7% of the numerical density and 85.1% of the samples (by volume) near the Byers Canyon Bridge. Farther downstream (near Parshall) the average numerical density was only 8.4% *Pteronarcys californica* but they still comprised 48.5% of the total volume. Willow fly naiads comprised 42% to 94% of the food bolus in trout stomach samples (by volume) over 10 sampling dates in the past 3 years.

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APPENDIX I

Standing Crop and Biomass Estimates for the

1982 - 1983 Segment

Table I-1. Arkansas River standing crop and biomass estimates, March 1983.

Study section location	Study section size length (km)	width (m)	area (ha)	Species	Population statistics $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Tezak	4.34	36.6	15.9	Brown				
				<16 cm[a]	240		15	
				≥16 cm	8,450	±1,308	531	98.4
				Rainbows[a]	13		1	
				Snake River[a]	7		0.5	
Loma Linda	4.34	36.6	15.9	Brown				
				<16 cm[a]	513		32	
				≥16 cm	7,580	±1,275	477	84.7
				Rainbows[a]	53		3	
				Snake River[a]	13		1	
Coaldale	4.18	36.6	15.3	Brown				
				<16 cm[a]	827		54	
				≥16 cm	5,059	± 902	331	61.4
				Rainbows[a]	87		6	
Salida	4.02	36.6	14.7	Brown				
				<20 cm[a]	233		16	
				≥20 cm	7,922	± 922	539	94.7
				Rainbows[a]	173		12	

[a] Estimate made by using 15% efficiency on captured fish. Too few were collected for Peterson.

Table I-2. Cache la Poudre River standing crop and biomass estimates for trout $\geq$ 15 cm, October 1982.

Study section location	Study section size length (m)	width (m)	area (ha)	Species	Population statistics $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Big Bend Campground	243.8	18.3	0.446	Brown	171	±102	383	54.9
				Rainbow	41	± 29	93	11.3
				Total Trout	220	±107	493	66.2
Wild Trout Water 5 mi above Rustic	259	18.3	0.474	Brown	151	± 55	318	32.0
				Rainbow	150	± 63	316	40.0
				Total Trout	301	± 83	635	72.0
Lower Control 3 mi above Rustic	243.8	18.3	0.446	Brown	130	± 36	291	36.8
				Rainbow	237	± 40	531	63.1
				Total Trout	365	± 53	818	99.9
Indian Meadow 1 mi below Rustic	243.8	18.3	0.446	Brown	117	± 62	262	32.7
				Rainbow	176	± 58	395	50.2
				Total Trout	290	± 82	650	82.9
Kelly Flat Campground	243.8	18.3	0.446	Brown	148	± 59	332	35.5
				Rainbow	248	±105	556	51.0
				Total Trout	393	±111	881	86.5
Lower Wild Trout control above Greeley Diversion	243.8	19.8	0.483	Brown	473	±113	979	74.9
				Rainbow	48	± 34	99	10.5
				Total Trout	521	±118	1079	85.4
Lower Wild Trout water below Greeley	243.8	19.8	0.483	Brown	437	±134	904	77.9
				Rainbow	40	± 52	83	9.3
				Total Trout	490	±150	1015	87.2

Table I-3. Colorado River standing crop and biomass estimates, October 18-21, 1982.

Study section description	Study section size: length (m)	width (m)	area (ha)	Species	Population statistics: $\hat{N}$	95% C.I.	fish/ha	kg/ha	trout/ha $\geq$ 35 cm ($\geq$ 14 in.)
Thompson Ranch (private lease primarily Catch/Release)	183	19.5	0.357	Rainbow	55	± 10	154	61.0	75
				Brown	59	± 8	165	80.3	48
				Total Trout	114	± 12	319	141.3	124
Pioneer Park Public Access - no Special Regulations	183	19.5	0.357	Rainbow	30	± 4	84	14.4	0
				Brown	32	± 3	90	26.7	14
				Total Trout	72	± 4	202	41.1	14
State Ranch (Paul Gilbert) Wildlife Area - no Special Regulations	183	28.0	0.512	Rainbow	8	± 1	16	4.1	2
				Brown	20	± 2	39	16.6	15
				Total Trout	28	± 3	55	20.7	17
State Ranch Lone Buck Wildlife Area - no Special Regulations	183	28.0	0.512	Rainbow	45	± 4	88	32.2	33
				Brown	14	± 0	27	16.7	17
				Total Trout	65	± 4	127	49.0	50
Parshall to Sunset Ranch bridge - Catch/Release between 12 in. and 20 in.	3220	36.0	11.6	Rainbow	4756	±739	410	124.2	173
				Brown	2031	±588	175	47.6	53
				Brook	3	--	--	--	--
				Total Trout	6780	±929	584	171.8	226
Con Ritschards Ranch - private lease primarily Catch/Release	183	26.0	0.476	Rainbow	271	±353	569	202.8	173
				Browns	81	±582	170	58.3	30
				Total Trout	335	±443	704	261.1	203

Table I-4. Eagle River standing crop and biomass estimate, September 1982.

Study section description	Study section size: length (m)	width (m)	area (ha)	Species	Population statistics: $\hat{N}$	95% C.I.	N/ha	kg/ha	trout/ha ≥ 35 cm (14 in.)
Wolcott (Standard Regulations - above Mile Cr. confluence	213	31.4	0.669	Brown	88	±65	132	27.1	0
				Rainbow[a]	22	--	33	11.1	0
				Total Trout	112	±84	167	38.2	0
Below Highway 6 bridge (Standard Regulation - below Milk Cr. confluence)	183	19.8	0.362	Brown	not sampled - water too high, deep and fast				
				Rainbow					
				Total Trout					
Pullout Station (upper end of Catch/Release area)	244	19.8	0.483	Brown[b]	6	--	12	4.1	2
				Rainbow[b]	4	--	8	1.3	0
				Total Trout[b]	10	--	21	5.4	2
Irrigation Diversion (lower end of Catch/Release)	305	19.8	0.604	Brown[b]	8	--	13	4.0	0
				Rainbow[b]	2	--	3	0.4	0
				Total Trout[b]	10	--	17	4.4	0
Dumpsite (Standard Regulations - below Catch/Release area)	244	19.8	0.483	Brown[b]	2	--	4	0.5	0
				Rainbow[b]	4	--	8	1.9	0
				Total Trout[b]	6	--	12	2.4	0
Edwards (13 km upstream from Wolcott)	213	24.4	0.520	Brown[b]	89	--	171	42.9	4
				Rainbow[b]	1	--	2	1.0	0
				Brook[b]	1	--	2	1.0	0
				Total Trout[b]	91	--	175	44.9	4

[a]By subtraction from total trout estimate

[b]Collected on one electroshocking pass - not a population estimate

Table I-5. Fryingpan River population and standing crop estimates, April 1982.

Study section description	Study section size length (m)	width (m)	area (ha)	Species	Population statistics $\hat{N}$	95% C.I.	fish/ ha	kg/ ha	trout/ha ≥ 35 cm (14 in.)
Station 1 at Ruedi Dam Gage (Catch/ Release)	152	15.2	0.231	Brown	165	± 68	714	165.5	47
				Brook	87	± 72	377	44.7	0
				Rainbow[a]	29	± 21	125	--	--
				Rainbow[b]	248	± 99	1074	--	--
				Rainbow[c]	290	±106	1255	168.6	144
				Cutthroat	3	--	13	2.0	0
				Total Trout	556	±147	2407	380.8	161
Station 2 below Gaging Station (Catch/ Release)	305	15.2	0.464	Brown	237	± 73	511	83.0	22
				Brook	224	± 88	483	85.5	22
				Rainbow[a]	105	± 38	226	--	--
				Rainbow[b]	108	± 41	233	--	--
				Rainbow[c]	216	± 57	466	126.0	125
				Cutthroat	6	± 5	13	2.0	0
				Total Trout	674	±120	1453	343.9	169
Station 3 Old Faithful (Catch/ Release)	320	18.9	0.605	Brown	428	±110	712	114.0	19
				Rainbow	83	± 33	137	45.1	20
				Brook	14	± 11	23	2.4	2
				Cutthroat	4	± 5	7	1.0	0
				Total Trout	534	±113	883	162.5	41
Station 4 Upper Control, upper terminus (Standard Regulations)	366	18.6	0.681	Brown	431	±201	633	78.1	4
				Rainbow	137	±122	201	21.0	0
				Brook	15	± 24	22	2.1	0
				Total Trout	632	±271	928	101.2	4
Station 5 Taylor Creek (Standard Regulations)	305	15.2	0.464	Brown	325	±110	703	131.2	18
				Rainbow	176	± 90	379	33.5	10
				Total Trout	501	±142	1080	164.7	28

[a]Wild Rainbows

[b]Stocked Rainbows

[c]Total Rainbows

Table I-6. Fryingpan River population and standing crop estimates, September 1982.

Study section description	Study section size: length (m)	width (m)	area (ha)	Species	$\hat{N}$	95% C.I.	fish/ ha	kg/ha	trout/ha $\geq$ 35 cm (14 in.)
Station 1	213	15.2	0.324	Brown	236	±145	728	215.5	59
above Ruedi Dam				Rainbow	272	± 95	840	197.2	108
Gage (Catch/				Brook	196	±166	605	115.5	0
Release)				Cutthroat	1	--	3	1.0	0
				Total Trout	687	±203	2120	529.2	167
Station 2	335	15.2	0.509	Brown	252	± 54	495	86.1	23
below Ruedi Dam				Rainbow	236	± 58	464	112.7	53
Gage (Catch/				Brook	271	± 58	532	71.5	6
Release)				Cutthroat	4	--	8	2.0	0
				Total Trout	770	± 99	1513	272.3	82
Station 3	335	18.9	0.634	Brown	665	±124	1049	169.1	141
Old Faithful				Rainbow	92	± 35	145	44.3	54
(lower end of				Brook	34	± 18	54	12.1	9
Catch/Release)				Total Trout	789	±128	1244	225.5	204
Station 4	366	18.6	0.681	Brown	325	± 99	477	85.0	6
Upper Control				Rainbow	45	± 32	66	9.2	0
Station (Standard Regulations -				Brook	7	± 5	10	0.9	0
8 trout/day)				Total Trout	381	±106	559	95.1	6
Station 5	305	15.2	0.464	Brown	336	± 88	724	157.7	44
Taylor Creek				Rainbow	84	± 32	181	28.9	23
(Standard Regulation - 8 trout/day)				Total Trout	418	± 91	901	186.6	67
Station 6	213	15.2	0.324	Brown	52	± 32	160	49.9	6
Big Pullout				Rainbow	60	± 28	185	43.2[a]	5
(Standard Regulations - 8 trout/day)				Total Trout	116	± 48	358	93.1	11

[a] 18.1 kg/ha was stocked brood rainbows from Crystal River Hatchery

Table I-7. Gunnison River standing crop and biomass estimates, summer and fall 1982.

Study section description	Study section size: length (m)	width (m)	area (ha)	Species	Population statistics: $\hat{N}$	95% C.I.	fish/ha	kg/ha	trout/ha $\geq$ 35 cm (14 in.)
Duncan Trail (access by Canyon Trails - 370 m vertical drop)	3,220	31.0	10	Brown	6,031	±1,730	603	143.8	42
				Rainbow	3,916	±1,121	392	110.3	94
				Total Trout	9,847	±1,997	985	254.1	135
Smith Fork to North Fork (access by vehicle and foot trail along river)	6,440	31.0	20	Brown	3,734	±1,197	186	48.0	16
				Rainbow	4,554	±1,572	228	51.3	16
				Total Trout	8,233	±1,935	194	99.3	32
North Fork to Austin Bridge (vehicle and foot trail access)	12,900	45.7	59	Brown	3,565	±1,467	60	25.6	14
				Rainbow	2,195	±1,525	37	12.0	7
				Total Trout	5,875	±2,131	97	37.6	21

Table I-8. Comparison of Peterson mark/recapture and Schnabel multiple capture population estimates for the Gunnison River, August and September 1982.

	Browns									Rainbows								
	15 cm (16 in.) & up			30 cm (12 in.) & up			40 cm (16 in.) & up			15 cm (6 in.) & up			30 cm (12 in.) & up			40 cm (16 in.) & up		
Estimate	Est.	80%[a]	95%[b]	Est.	80%	95%	Est.	80%	95%	Est.	80%	95%	Est.	80%	95%	Est.	80%	95%
Gunnison River - Smith Fork to North Fork Confluence (4 miles - 49.5 acres)																		
First	4195	±1509	±2307	740	±408	± 624	59	±50	± 75	3960	±1315	±2010	969	± 486	± 743	130	±160	± 245
Second	3734	± 783	±1197	443	±147	± 225	59	±44	± 68	4554	±1028	±1572	1110	± 442	± 676	120	± 99	± 151
Schnabel	3857	2985[c]	5449[d]	563	374[c]	1141[d]	60	30[c]	3000[d]	4360	3357[c]	6220[d]	1189	770[c]	2604[d]	113	--	--
Average	3929			582			59			4291			1089			121		
Gunnison River - Duncan Trail to Ute Trail (2 miles - 24.7 acres)																		
First	5346	±1954	±2987	475	±221	± 338	29	±36	± 55	3458	±1083	±1655	1137	± 470	± 717	185	±131	± 200
Second	6031	±1132	±1730	817	±250	± 382	41	±22	± 49	3916	± 733	±1121	1632	± 449	± 687	520	±368	± 563
Schnabel	5879	4641[c]	8017[d]	736	516[c]	1286[d]	42	18[c]	109[d]	3788	3007[c]	5116[d]	1520	1103[c]	2440[d]	499	252[c]	24,900[d]
Average	5752			676			37			3721			1430			401		

[a] 80% confidence level

[b] 95% confidence level

[c] Lower 95% confidence limit

[d] Upper 95% confidence limit

Table I-9. Comparison of Gunnison River trout population estimates from 1981 and 1982.

	Smith Fork to North Fork			Duncan to Ute Trail		
	1981	1972	% change	1981	1982	% change
			Browns			
15 cm & up	2,170	3,929	+ 81%	8,691	5,752	-34%
30 cm & up	241	582	+141%	1,667	676	-59%
40 cm & up	52	59	+ 13%	37	37	0
			Rainbows			
15 cm & up	7,670	4,291	- 44%	3,147	3,721	+18%
30 cm & up	401	1,089	+172%	1,190	1,430	+20%
40 cm & up	162	121	- 25%	471	401	-15%

Table I-10. Middle Fork of the South Platte River population and standing crop estimates, September 1982.

Study section description	Study section size: length (m)	width (m)	area (ha)	Species	Population statistics: $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Highway 9 Bridge (8 trout/day bag area)	183	6.10	0.116	Brown				
				$\leq$12 cm[a]	11			
				>12 cm	79	±14	681	75.0
				Brook[a]	1			0.8
				Total Trout	80	±14	690	75.8
Gaging Station Bridge (8 trout/ day bag area)	183	7.62	0.139	Brown				
				$\leq$12 cm[a]	5			
				>12 cm	98	±12	705	87.0
				Brook[a]	1			1.0
				Total Trout	99	±12	712	88.0
1 mile below Gage (Catch/ Release between 8 and 16 in.)	183	6.40	0.117	Brown				
				$\leq$12 cm[a]	8			
				>12 cm	159	±80	1359	145.0
				Rainbow	5	± 3	43	3.6
				Total Trout	164	±79	1402	149.0
2 miles below Gage (Catch/ Release between 8 and 16 in.)	193	7.20	0.132	Brown				
				$\leq$12 cm[a]	9			
				>12 cm	48	±11	364	61.2
3 miles below Gage (Catch/ Release between 8 and 16 in.)	244	7.60	0.185	Brown				
				$\leq$12 cm[a]	13			
				>12 cm	121	±14	654	102.9
				Rainbow	4.5	± 3	24	2.5
				Total Trout	125	±14	675	104.4

[a]=number caught (no estimate)

Table I-11. North Platte River standing crop and biomass estimates, October 1982.

Study section description	Study section size: length (m)	width (m)	area (ha)	Species	Population statistics: $\hat{N}$	95% C.I.	fish/ha	kg/ha	trout/ha $\geq$ 35 cm (14 in.)
Forest Service Access below State Line Ranch Bridge to Ginger Quill Ranch	4830	36.6	17.7	Brown	1692	±467	96	32.1	22
				Rainbow	534	±110	30	8.8	6
				Total Trout	2059	±340	116	40.9	28

Table I-12. Rio Grande River standing crop and biomass estimates, summer 1982.

Study section description	Study section size length (m)	width (m)	area (ha)	Species	Population statistics $\hat{N}$	95% C.I.	fish/ha	kg/ha	trout/ha $\geq$ 35 cm (14 in.)
Wason Ranch	3,060	30.5	9.3	Brown	2,648	± 850	285	59.2	21
(Standard Regula-				Rainbow	325	± 432	35	5.7	1
tions 8 trout/day)				Total					
				Trout	3,082	± 948	331	64.9	22
Wason Ranch	2,900	30.5	8.8	Brown	2,734	±1,157	311	80.4	29
(Fly Water				Rainbow	39	± 52	4	1.5	0
14 in. minimum				Total					
size limit				Trout	3,021	±1,245	343	81.9	29
8 trout/day)									
Wason Ranch	5,960	30.5	18.1	Brown	5,286	±1,353	292	69.5	24
(combined				Rainbow	620	± 513	34	3.0	1
sections)				Total					
				Trout	6,128	±1,517	339	72.5	25
Coller Fly and	3,541	46.0	16.3	Brown	4,160	±1,045	255	38.9	7
Lure Water				Rainbow	All stocked - no estimate made				
(8 trout/day				Brook					
high fishing				Cutthroat	1	--	--	--	--
pressure)				Total					
				Trout	4,160	±1,045	255	38.9	7
State Bridge	10,950	46.0	50.4	Brown	7,295	±1,671	145	38.9	35
(8 trout/day				Rainbow	624	--	12	3.5	4
public and				Brook	1	--	--	trace	1
private low				Cutthroat	1	--	--	--	--
fishing pressure)				Total					
				Trout	7,719	±1,770	153	42.4	40

Table I-13. Comparison of Peterson mark/recapture and Schnabel multiple capture population estimates for the Rio Grande River, August 1982.

	Browns 6 in. & up			Browns 12 in. & up			Browns 16 in. & up			Rainbows		
Estimate	$\hat{N}$	80%[c]	95%[d]	$\hat{N}$	80%	95%	$\hat{N}$	80%	95%	$\hat{N}$	80%	95%
Coller Fly and Lure Water (2.1 miles - 40.3 acres)												
First	3,925	±1,256	±1,921	364	± 162	± 303	0	--	--	--[e]	--	--
Second	4,160	± 684	±1,045	464	± 129	± 197	0	--	--	--	--	--
Schnabel	4,109	3,325[a]	5,378[b]	450	319[a]	761[b]	0	--	--	--	--	--
State Bridge Section (6.8 miles - 124.5 acres)												
First	5,863	±1,156	±1,768	1,496	± 365	± 559	428	±261	±398	142	±120	± 184
Second	7,295	±1,093	±1,671	2,038	± 427	± 652	315	±117	±178	--	--	--
Schnabel	6,753	5,660[a]	8,369[b]	1,802	1,425[a]	2,449[b]	397	249[a]	970[b]	624	--	--
Wason Ranch - Standard Regulations Section (1.9 miles - 23 acres)												
First	3,705	±1,463	±2,236	1,609	±1,166	±1,782	--	--	--	325	±283	± 432
Second	2,648	± 556	± 850	531	± 152	± 232	10	± 11	± 18	--	--	--
Schnabel	2,900	2,227[a]	4,157[b]	744	505[a]	1,419[b]	--	--	--	498	252[a]	24,900[b]
Wason Ranch - Fly Water 14.0 in. Minimum-Size Unit (1.8 miles - 21.8 acres)												
First	5,019	±2,834	±4,333	2,335	±2,088	±3,193	--	--	--	59	± 51	± 77
Second	2,734	± 757	±1,157	1,034	± 413	± 630	6	± 5	± 8	--	--	--
Schnabel	3,336	2,368[a]	5,641[b]	1,516	917[a]	4,374[b]	--	--	--	199	83	--
Wason Ranch - Total Trout (3.7 miles - 44.8 acres)												
First	8,747	±2,938	±4,491	4,685	±2,962	±4,527	--	--	--	426	±304	± 464
Second	5,286	± 885	±1,353	1,485	± 359	± 549	24	± 28	± 43	620	±336	± 513
Schnabel	6,032	4,852[a]	7,969[b]	2,217	1,601[a]	3,602[b]	--	--	--	700	389[a]	3,504

[a] Lower 95% confidence limit

[b] Upper 95% confidence limit

[c] 80% confidence level

[d] 95% confidence level

[e] No estimate made - all rainbows were from hatchery stockings

Table I-14. South Fork of the Rio Grande River standing crop and biomass estimates, September 1982.

Study section description	Study section size: length (m)	width (m)	area (ha)	Species	Population statistics: $\hat{N}$	95% C.I.	N/ha	kg/ha	trout/ha ≥ 35 cm (14 in.)
Chain Station (base of Wolf Creek Pass on U.S. Hwy 160)	198	15.2	0.301	Brown	296	±144	983	109.7	9
				Rainbow	3	± 2	10	3.0	0
				Brook	7	± 6	23	3.0	0
				Total Trout	286	±121	1016	115.7	9
Park Creek Campground	198	14.6	0.289	Brown	301	±167	1042	77.5	0
				Brook	1		3	1.0	0
				Total Trout	306	±170	1127	78.5	0
Beaver Creek Station	198	18.6	0.368	Brown	375	±157	1019	115.5	14
				Rainbow	31	± 22	57	2.3	0
				Total Trout	408	±165	1075	117.8	14

Table I-15. South Fork of the Rio Grande brown trout standing crop and biomass estimates, September 1976-1982.

Study section description	Study section size: length (m)	width (m)	area (ha)	Year	Population statistics: $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Above Beaver	152	18.6	0.2827	1976	337[a]	--	1192	129.1
Creek Bridge	168	18.6	0.3124	1977	327	± 92	1047	153.3
	168	18.6	0.3124	1978	326	±106	1044	84.7
	198	18.6	0.3685	1979	405	±198	1585	115.7
	198	18.6	0.3685	1980	508	±136	1378	153.1
	198	18.6	0.3685	1981	373	± 95	1012	136.1
	198	18.6	0.3685	1982	375	±157	1018	115.5
At Park Creek	152	14.6	0.2219	1976	155[a]	--	699	78.8
Campground	168	14.6	0.2452	1977	200	± 44	816	99.0
	168	14.6	0.2452	1978	388	±195	1583	104.9
	183	14.6	0.2672	1979	430	±181	1609	92.7
	183	14.6	0.2672	1980	298	± 47	1115	84.3
	183	14.6	0.2672	1981	241	± 44	902	105.5
	183	14.6	0.2672	1982	301	±167	1126	83.6
Above Hwy 160	152	15.2	0.2310	1976	313[a]	--	1355	145.1
Chain Station	168	15.2	0.2554	1977	130	± 36	509	65.8
	168	15.2	0.2554	1978	246	± 85	963	65.0
	183	15.2	0.2782	1979	451	± 75	1621	118.1
	183	15.2	0.2782	1980	331	± 52	1190	90.1
	183	15.2	0.2782	1981	279	± 61	1003	128.3
	183	15.2	0.2782	1982	296	±144	1064	109.7

[a]Population estimate determined by expansion of 1976 single pass electroshocking data using average mark and recapture data from 1977 through 1982 for a mark and recapture ratio for 1976.

Table I-16. South Platte River standing crop and biomass estimates, December 7-9, 1982.

Study section location	Study section size length (m)	width (m)	area (ha)	Species	Population statistics size (cm)	$\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Upper Canyon 1.5 mi above Wigwam Club (Catch/ Release)	183	14.0	0.256	Brown	>14	158	± 22	617	113.7
				Rainbow	≤14	22	± 20	86	0.6
				Rainbow	>14	223	± 16	871	319.8
				Total Trout	>14	380	± 25	1484	433.5
Lower Canyon 0.2 mi above Wigwam Club (Catch/ Release)	183	17.1	0.313	Brown	>14	231	± 24	738	160.0
				Rainbow	≤14	61	± 21	195	2.0
				Rainbow	>14	232	± 32	741	308.6
				Total Trout	>14	462	± 39	1476	468.6
Above Deckers stocked rainbow (Standard Regulations)	183	17.1	0.313	Brown	≤14	264	± 76	843	17.9
				Brown	>14	696	± 87	2224	250.4
				Rainbow	≤14	102	± 50	326	4.3
				Rainbow	>14	117	± 15	376	42.3
				Total Trout	>14	804	± 80	2569	292.7
Below Deckers (8 trout/day)	183	17.1	0.313	Brown	≤14	281	±104	600	19.8
				Brown	>14	810	±130	2588	295.4
				Rainbow	≤14	130	±263	415	6.6
				Rainbow	>14	189	±134	604	72.4
				Total Trout	>14	995	±169	3179	357.9
Scraggy View (8 trout/day)	183	17.1	0.313	Brown	≤14	156	± 18	498	11.2
				Brown	>14	374	± 19	1195	137.9
				Rainbow	≤14	36	± 24	115	1.5
				Rainbow	>14	51	± 3	163	27.2
				Total Trout	>14	423	± 19	1351	165.1
Twin Cedars (8 trout/day)	183	17.1	0.313	Brown	≤14	480	±330	1533	32.8
				Brown	>14	390	± 27	1246	137.2
				Rainbow	≤14	112		358	5.3
				Rainbow	>14	85	± 7	272	25.9
				Total Trout	>14	473	± 26	1511	163.1

Table I-17. St. Vrain standing crop and biomass estimates, September 1982.

Study section location	Study section size length (m)	width (m)	area (ha)	Species	Population statistics $\hat{N}$	95% C.I.	fish/ ha	kg/ ha
Meadow Park, Lyons	183	10.5	0.192	Brown				
				< 12	68	±26	354	
				> 13	350	±52	1823	121.4
				Rainbow[a]	4			
Lyons Gaging Station	243.8	14.5	0.354	Brown				
				< 12	247	±84	698	
				$\geq$ 14	440	±77	1243	102.2
				Rainbow	32	±16	90	12.9
Ideal Concrete, Lyons	137.2	17.4	0.239	Brown				
				< 12	89	±41	373	
				> 13	128	±42	535	52.4
Martin Marietta, Lyons	183	14.5	0.267	Brown				
				< 12	52	±24	195	
				> 13	44	±20	166	19.0

[a] =number caught on two passes (no estimates)

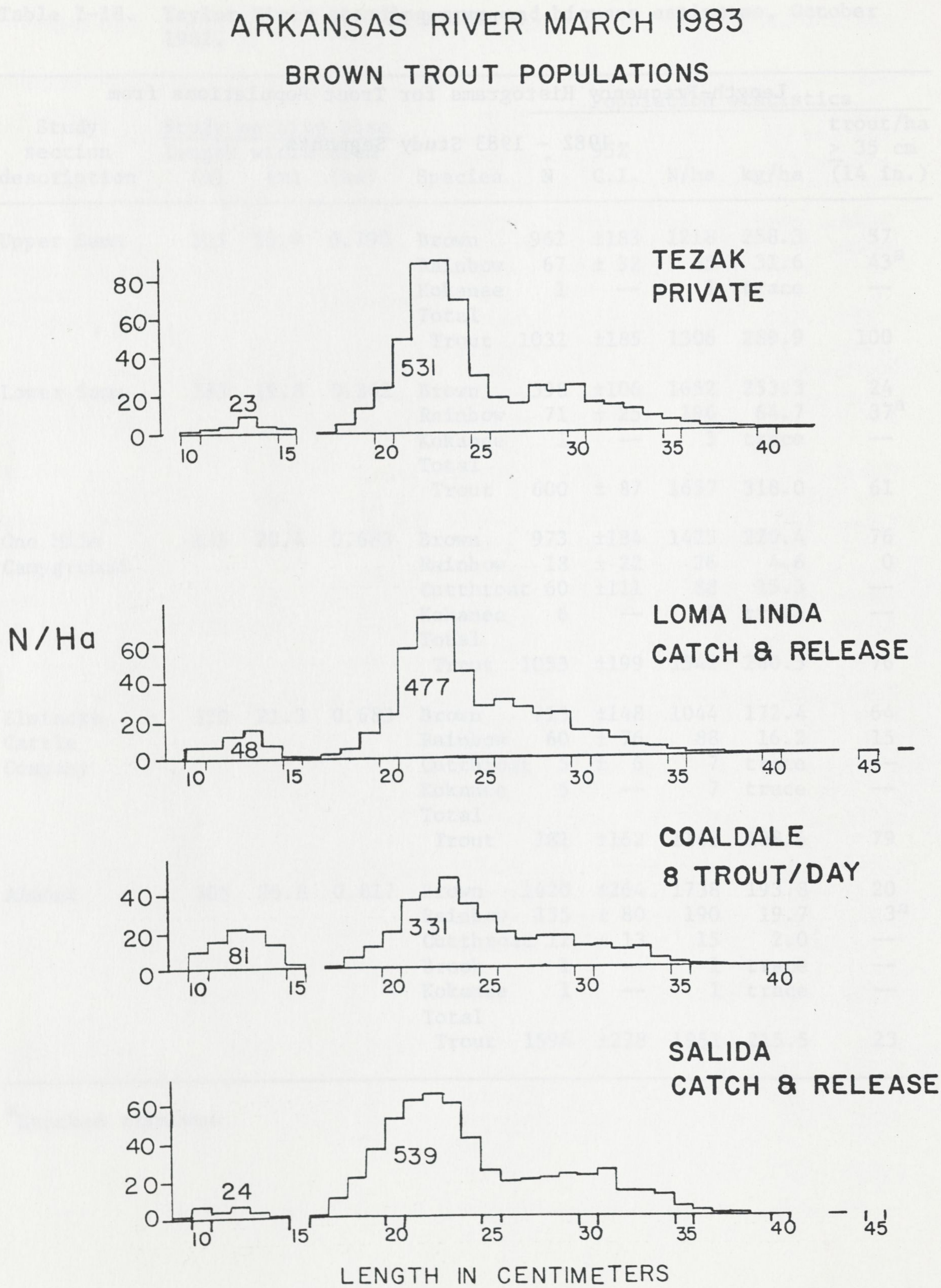
Table I-18. Taylor River standing crop and biomass estimates, October 1982.

Study section description	Study section size length (m)	width (m)	area (ha)	Species	Population statistics $\hat{N}$	95% C.I.	N/ha	kg/ha	trout/ha $\geq$ 35 cm (14 in.)
Upper Sams	305	25.9	0.790	Brown	962	±183	1218	258.3	57
				Rainbow	67	± 32	85	31.6	43[a]
				Kokanee	1	--	1	trace	--
				Total Trout	1032	±185	1306	289.9	100
Lower Sams	183	19.8	0.362	Brown	598	±106	1652	253.3	24
				Rainbow	71	± 25	196	64.7	37[a]
				Kokanee	1	--	3	trace	--
				Total Trout	600	± 87	1657	318.0	61
One Mile Campground	335	20.4	0.683	Brown	973	±184	1425	220.4	76
				Rainbow	18	± 22	26	4.6	0
				Cutthroat	60	±111	88	15.3	--
				Kokanee	6	--	9	trace	--
				Total Trout	1053	±199	1542	240.3	76
Elsinore Cattle Company	320	21.3	0.683	Brown	713	±148	1044	172.4	64
				Rainbow	60	± 76	88	16.2	15
				Cutthroat	5	± 6	7	trace	--
				Kokanee	5	--	7	trace	--
				Total Trout	781	±162	1143	188.6	79
Almont	305	26.8	0.817	Brown	1420	±264	1738	193.8	20
				Rainbow	155	± 80	190	19.7	3[a]
				Cutthroat	12	± 13	15	2.0	--
				Brook	1	--	1	trace	--
				Kokanee	1	--	1	trace	--
				Total Trout	1594	±278	1951	215.5	23

[a]Stocked rainbows

APPENDIX II

Length-Frequency Histograms for Trout Populations from 1982 - 1983 Study Segments



ARKANSAS RIVER MARCH 1983
BROWN TROUT POPULATIONS
TEZAK
PRIVATE
80
60
40
20
0
23
531
10
15
20
25
30
35
40
N/Ha
LOMA LINDA
CATCH & RELEASE
60
40
20
0
48
477
10
15
20
25
30
35
40
45
COALDALE
8 TROUT/DAY
40
20
0
81
331
10
15
20
25
30
35
40
SALIDA
CATCH & RELEASE
60
40
20
0
24
539
10
15
20
25
30
35
40
45
LENGTH IN CENTIMETERS

Figure II-1.

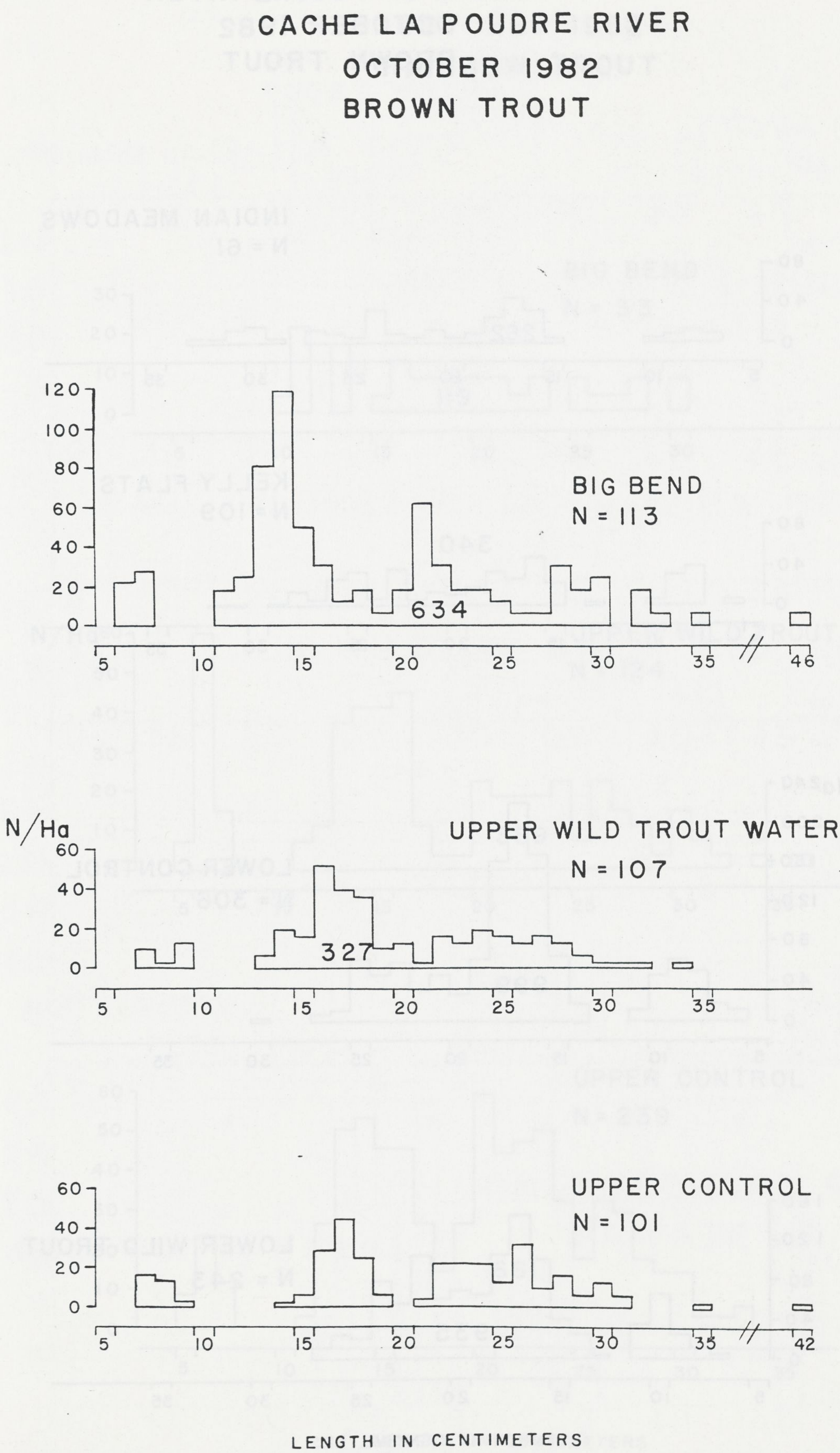

CACHE LA POUDRE RIVER
OCTOBER 1982
BROWN TROUT
BIG BEND
N = 113
634
UPPER WILD TROUT WATER
N = 107
327
UPPER CONTROL
N = 101
N/Ha
LENGTH IN CENTIMETERS

Figure II-2.

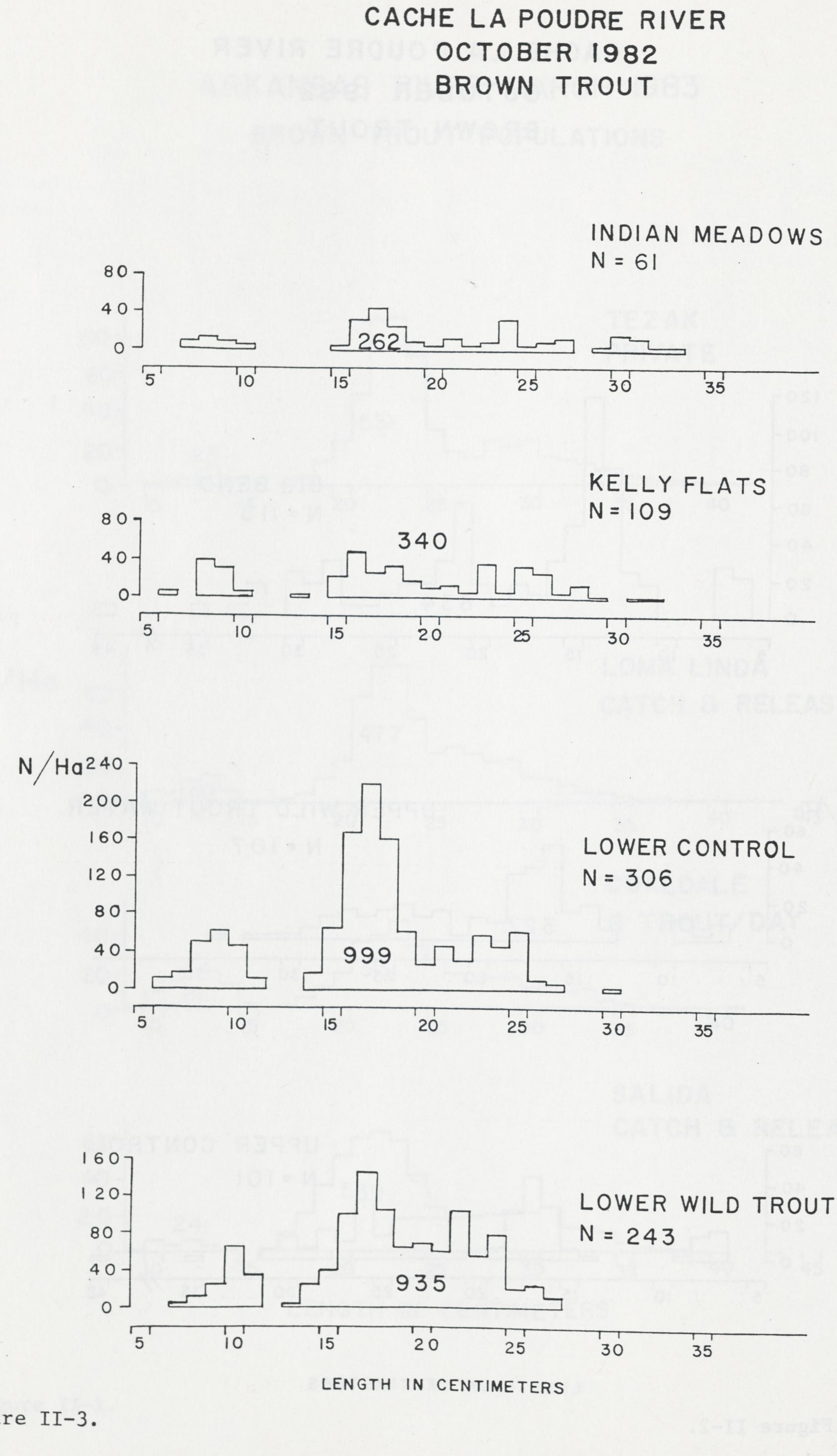

CACHE LA POUDRE RIVER
OCTOBER 1982
BROWN TROUT
INDIAN MEADOWS
N = 61
262
KELLY FLATS
N = 109
340
N/Ha
LOWER CONTROL
N = 306
999
LOWER WILD TROUT
N = 243
935
LENGTH IN CENTIMETERS

Figure II-3.

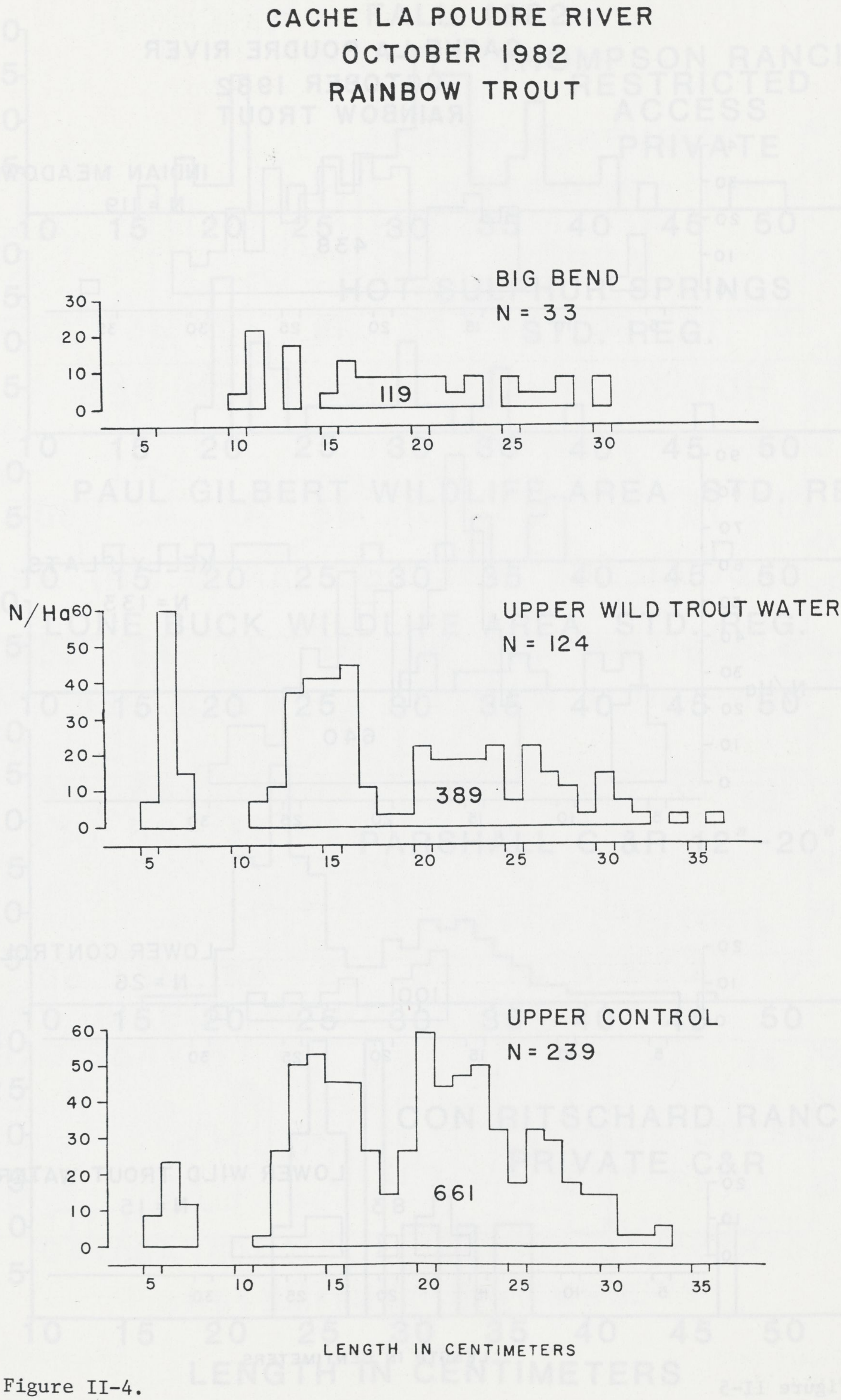

CACHE LA POUDRE RIVER
OCTOBER 1982
RAINBOW TROUT
BIG BEND
N = 33
119
UPPER WILD TROUT WATER
N = 124
N/Ha
389
UPPER CONTROL
N = 239
661
LENGTH IN CENTIMETERS

Figure II-4.

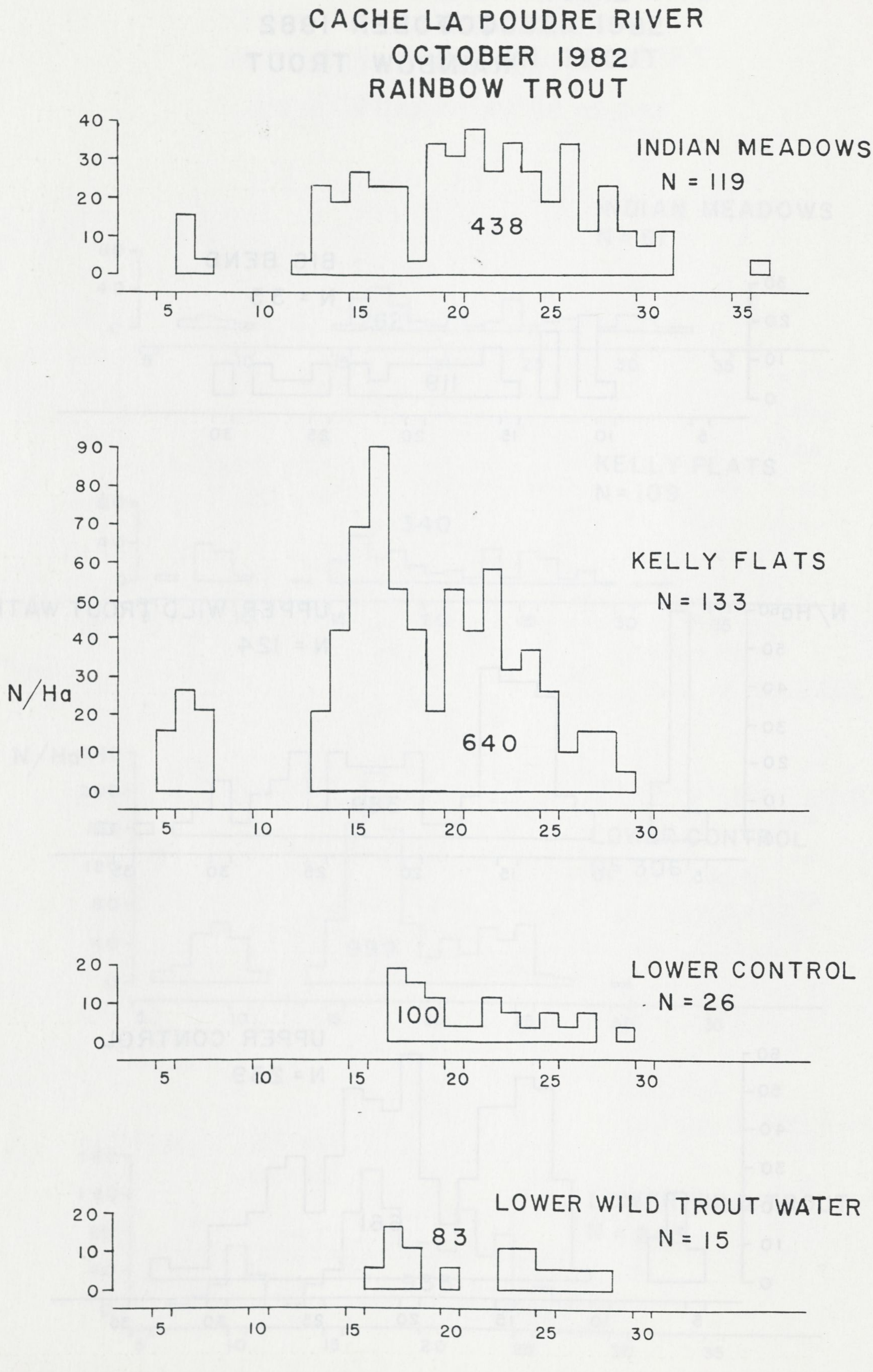

CACHE LA POUDRE RIVER
OCTOBER 1982
RAINBOW TROUT
INDIAN MEADOWS
N = 119
438
KELLY FLATS
N = 133
640
N/Ha
LOWER CONTROL
N = 26
100
LOWER WILD TROUT WATER
N = 15
83
LENGTH IN CENTIMETERS

Figure II-5

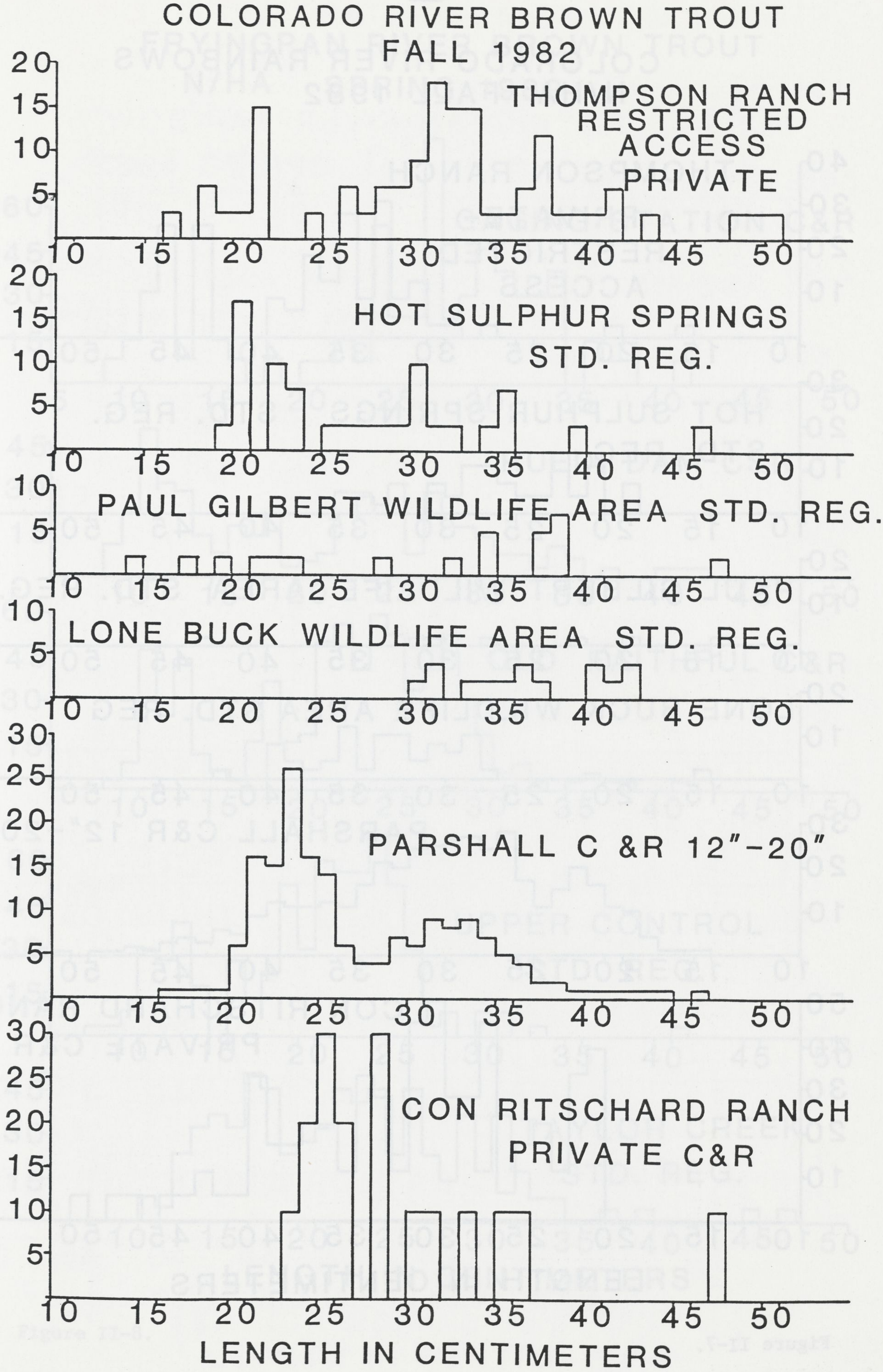

COLORADO RIVER BROWN TROUT
FALL 1982
THOMPSON RANCH
RESTRICTED
ACCESS
PRIVATE
HOT SULPHUR SPRINGS
STD. REG.
PAUL GILBERT WILDLIFE AREA STD. REG.
LONE BUCK WILDLIFE AREA STD. REG.
PARSHALL C &R 12"-20"
CON RITSCHARD RANCH
PRIVATE C&R
LENGTH IN CENTIMETERS

Figure II-6.

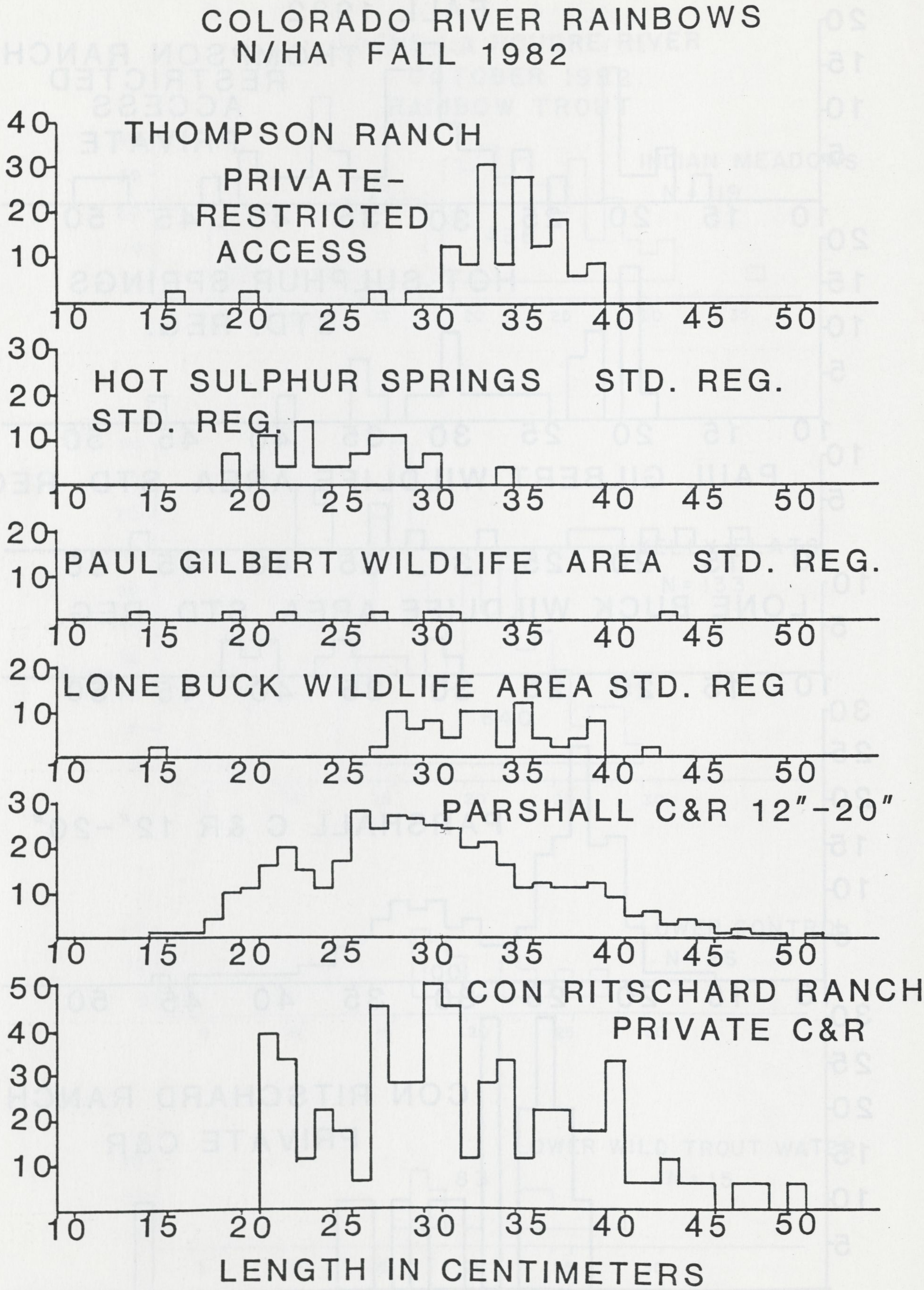

COLORADO RIVER RAINBOWS
N/HA FALL 1982
THOMPSON RANCH
PRIVATE-
RESTRICTED
ACCESS
HOT SULPHUR SPRINGS
STD. REG.
STD. REG.
PAUL GILBERT WILDLIFE AREA STD. REG.
LONE BUCK WILDLIFE AREA STD. REG
PARSHALL C&R 12"-20"
CON RITSCHARD RANCH
PRIVATE C&R
10 15 20 25 30 35 40 45 50
LENGTH IN CENTIMETERS

Figure II-7.

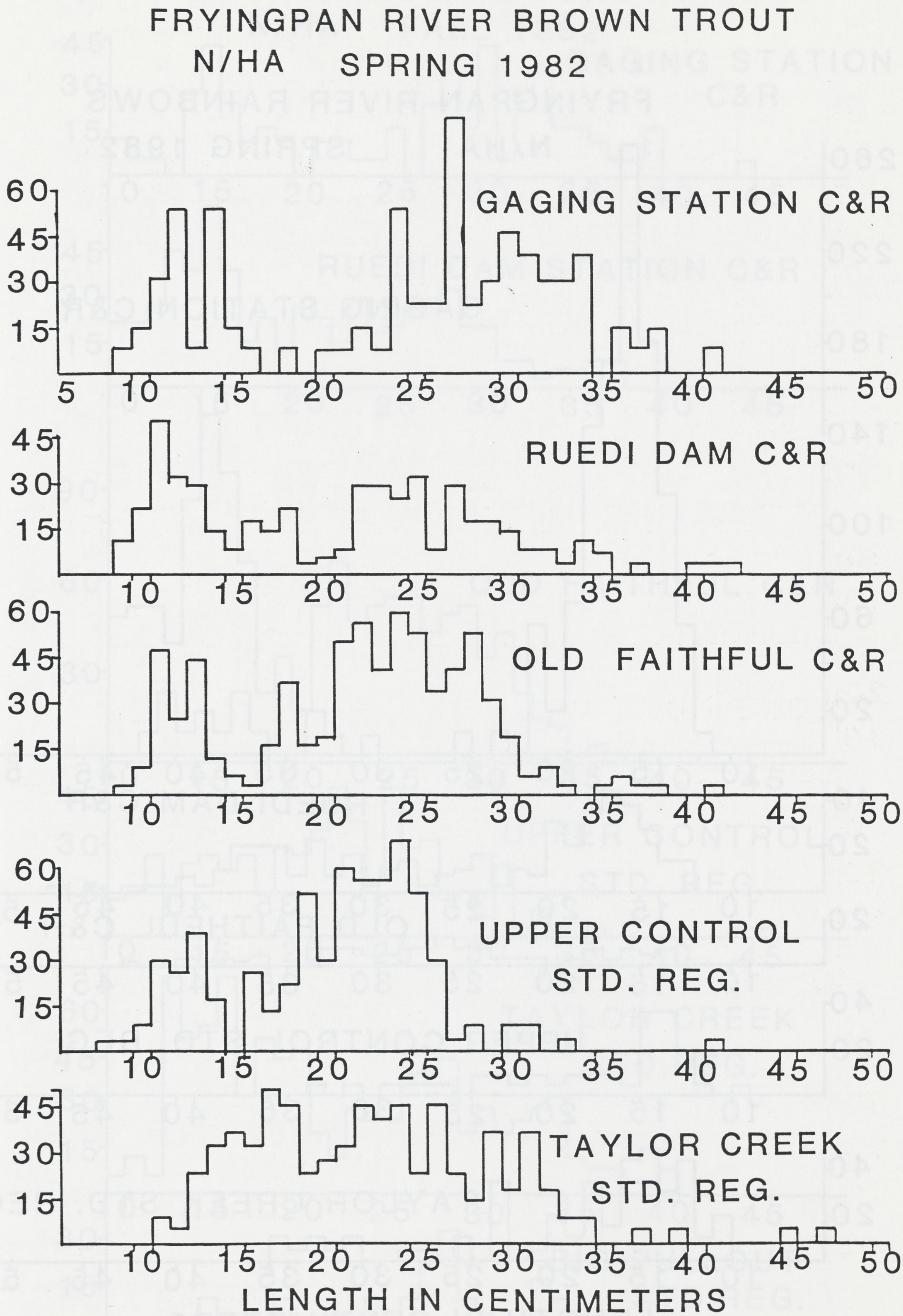

FRYINGPAN RIVER BROWN TROUT
N/HA SPRING 1982
GAGING STATION C&R
RUEDI DAM C&R
OLD FAITHFUL C&R
UPPER CONTROL
STD. REG.
TAYLOR CREEK
STD. REG.
LENGTH IN CENTIMETERS

Figure II-8.

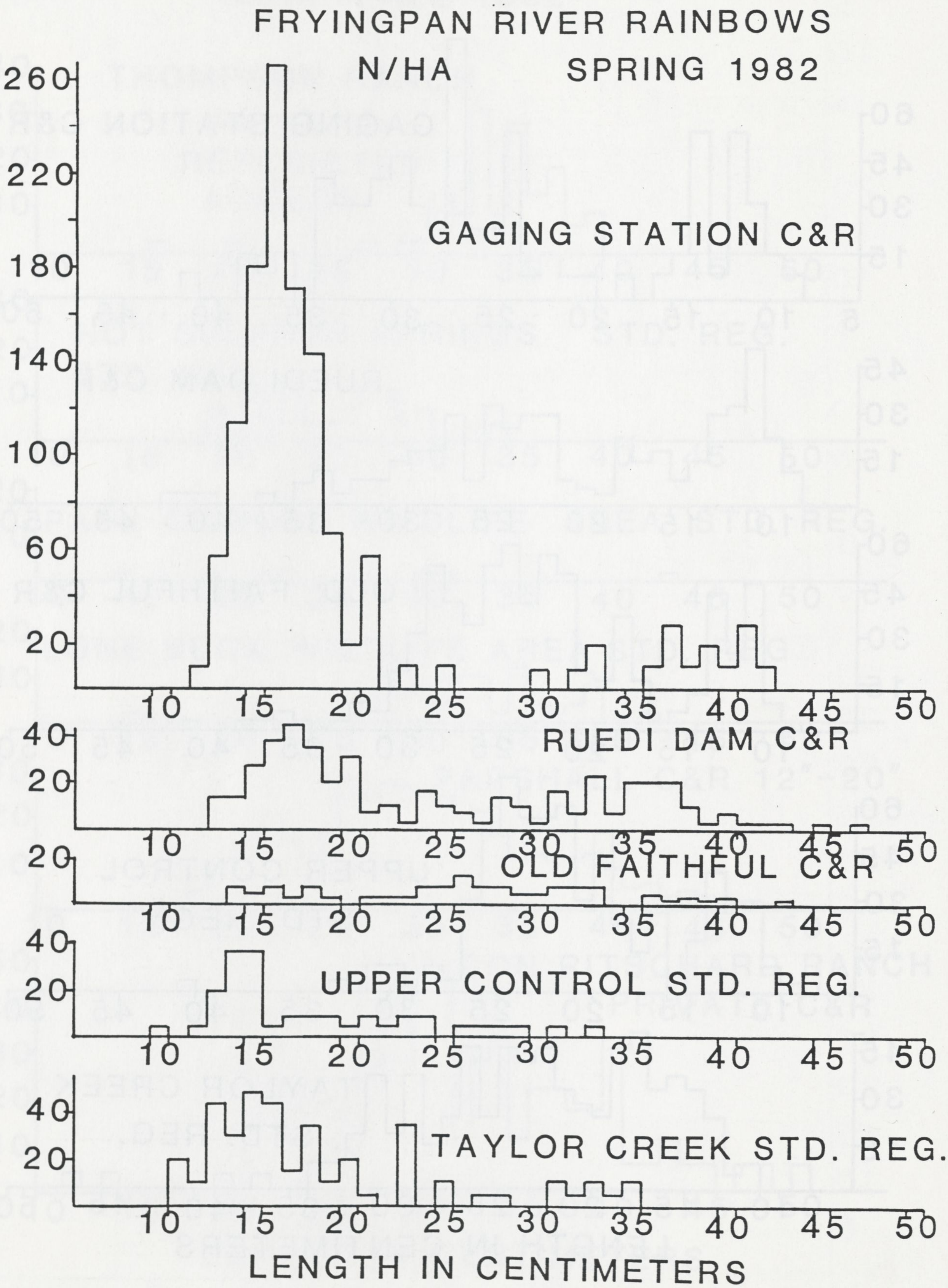

FRYINGPAN RIVER RAINBOWS
N/HA SPRING 1982
GAGING STATION C&R
RUEDI DAM C&R
OLD FAITHFUL C&R
UPPER CONTROL STD. REG.
TAYLOR CREEK STD. REG.
LENGTH IN CENTIMETERS

Figure II-9.

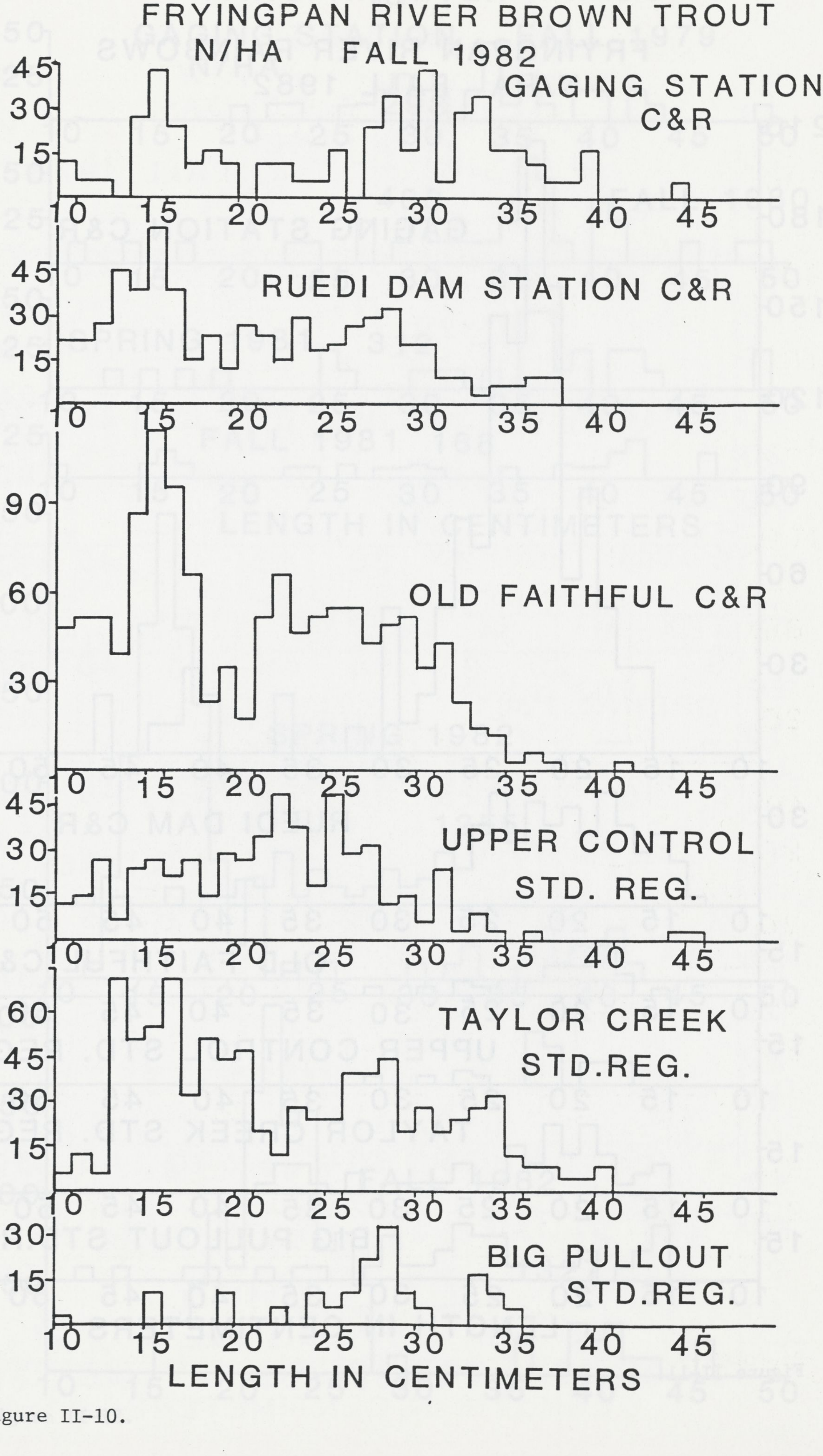

FRYINGPAN RIVER BROWN TROUT
N/HA FALL 1982
GAGING STATION C&R
45
30
15
10 15 20 25 30 35 40 45
RUEDI DAM STATION C&R
45
30
15
10 15 20 25 30 35 40 45
OLD FAITHFUL C&R
90
60
30
10 15 20 25 30 35 40 45
UPPER CONTROL STD. REG.
45
30
15
10 15 20 25 30 35 40 45
TAYLOR CREEK STD.REG.
60
45
30
15
10 15 20 25 30 35 40 45
BIG PULLOUT STD.REG.
30
15
10 15 20 25 30 35 40 45
LENGTH IN CENTIMETERS

Figure II-10.

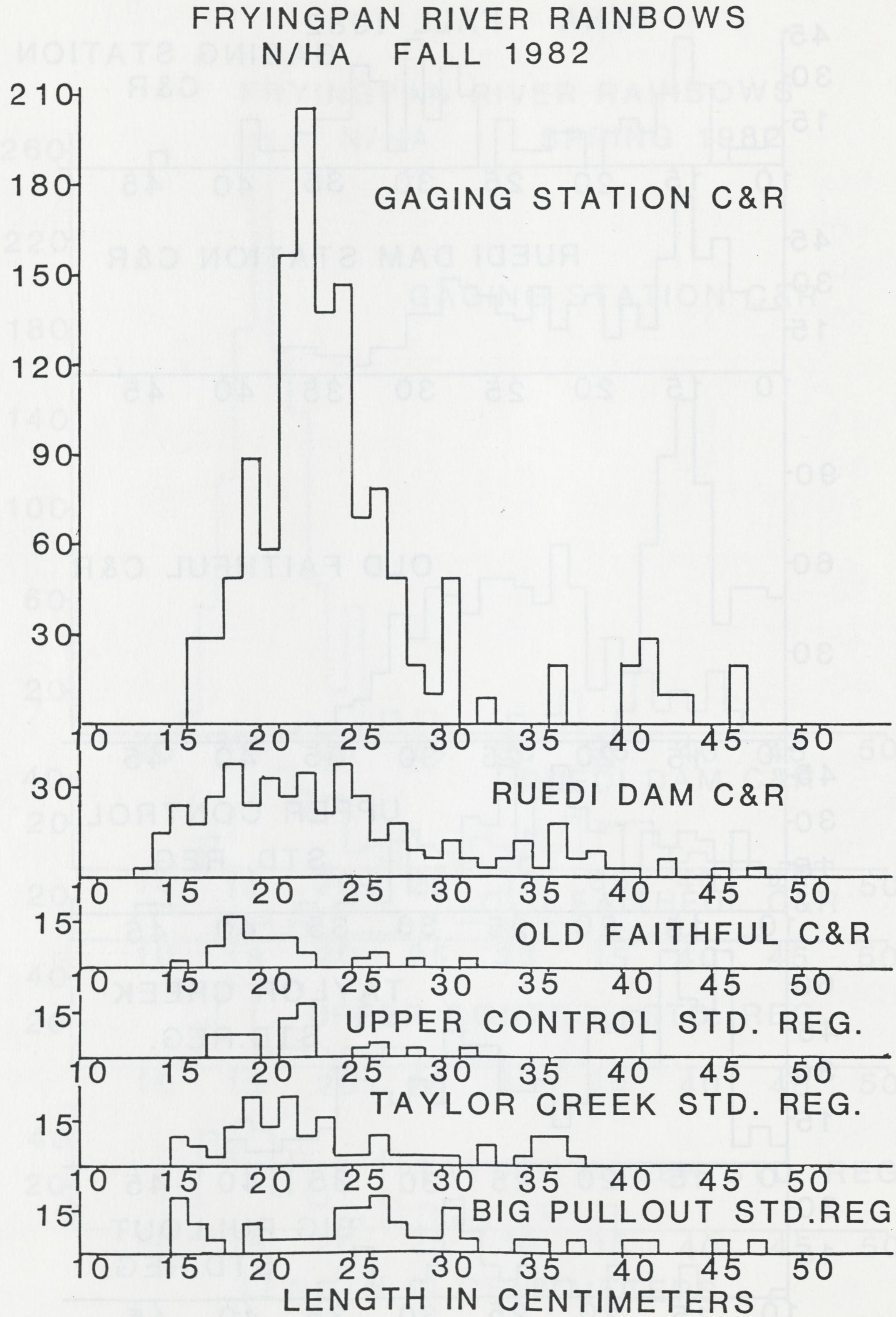

FRYINGPAN RIVER RAINBOWS
N/HA FALL 1982
GAGING STATION C&R
RUEDI DAM C&R
OLD FAITHFUL C&R
UPPER CONTROL STD. REG.
TAYLOR CREEK STD. REG.
BIG PULLOUT STD.REG.
LENGTH IN CENTIMETERS
210
180
150
120
90
60
30
15
10 15 20 25 30 35 40 45 50

Figure II-11.

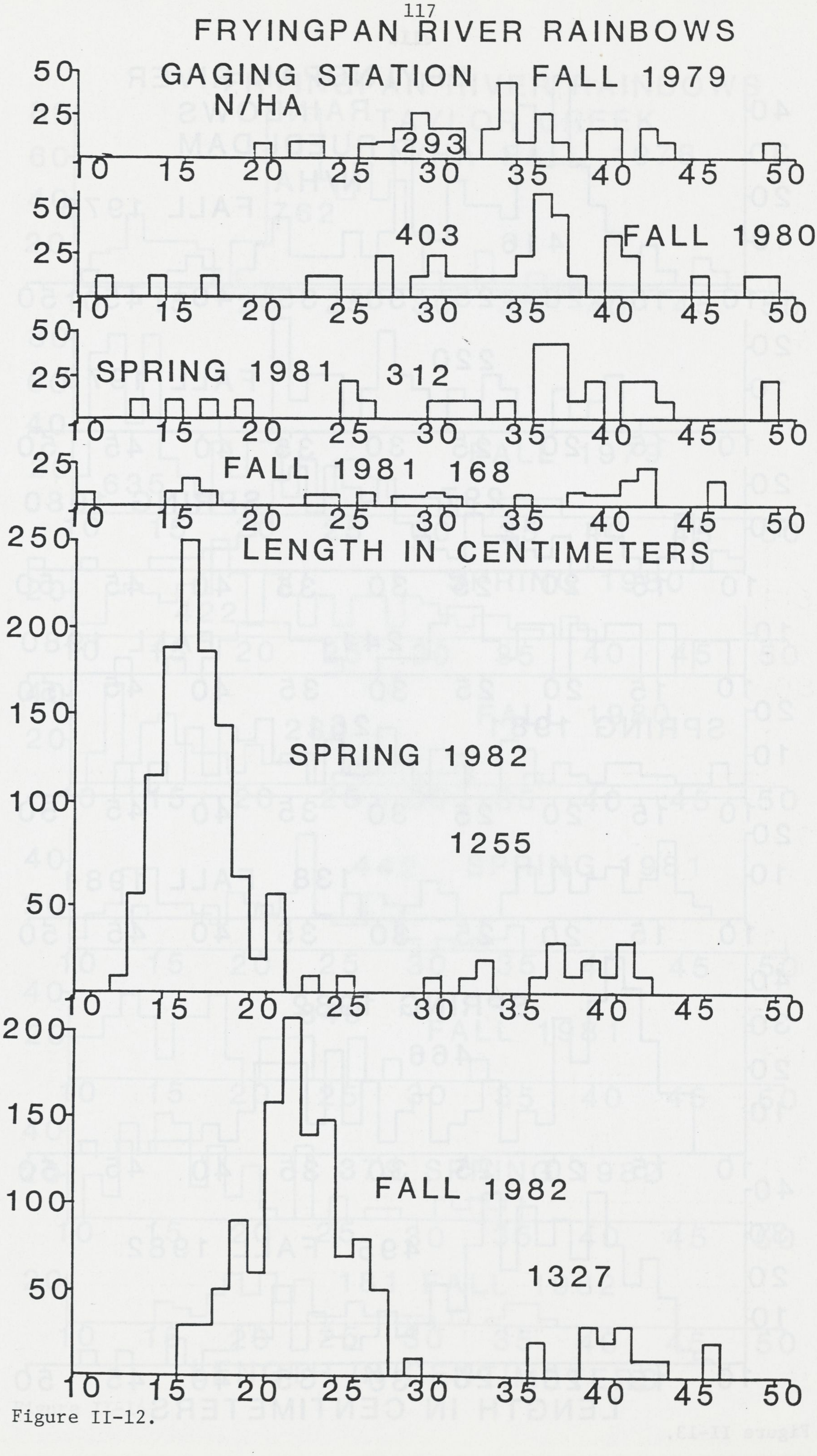

FRYINGPAN RIVER RAINBOWS
GAGING STATION
N/HA
FALL 1979
293
403
FALL 1980
SPRING 1981
312
FALL 1981
168
LENGTH IN CENTIMETERS
SPRING 1982
1255
FALL 1982
1327
50
25
250
200
150
100
10
15
20
25
30
35
40
45
50

Figure II-12.

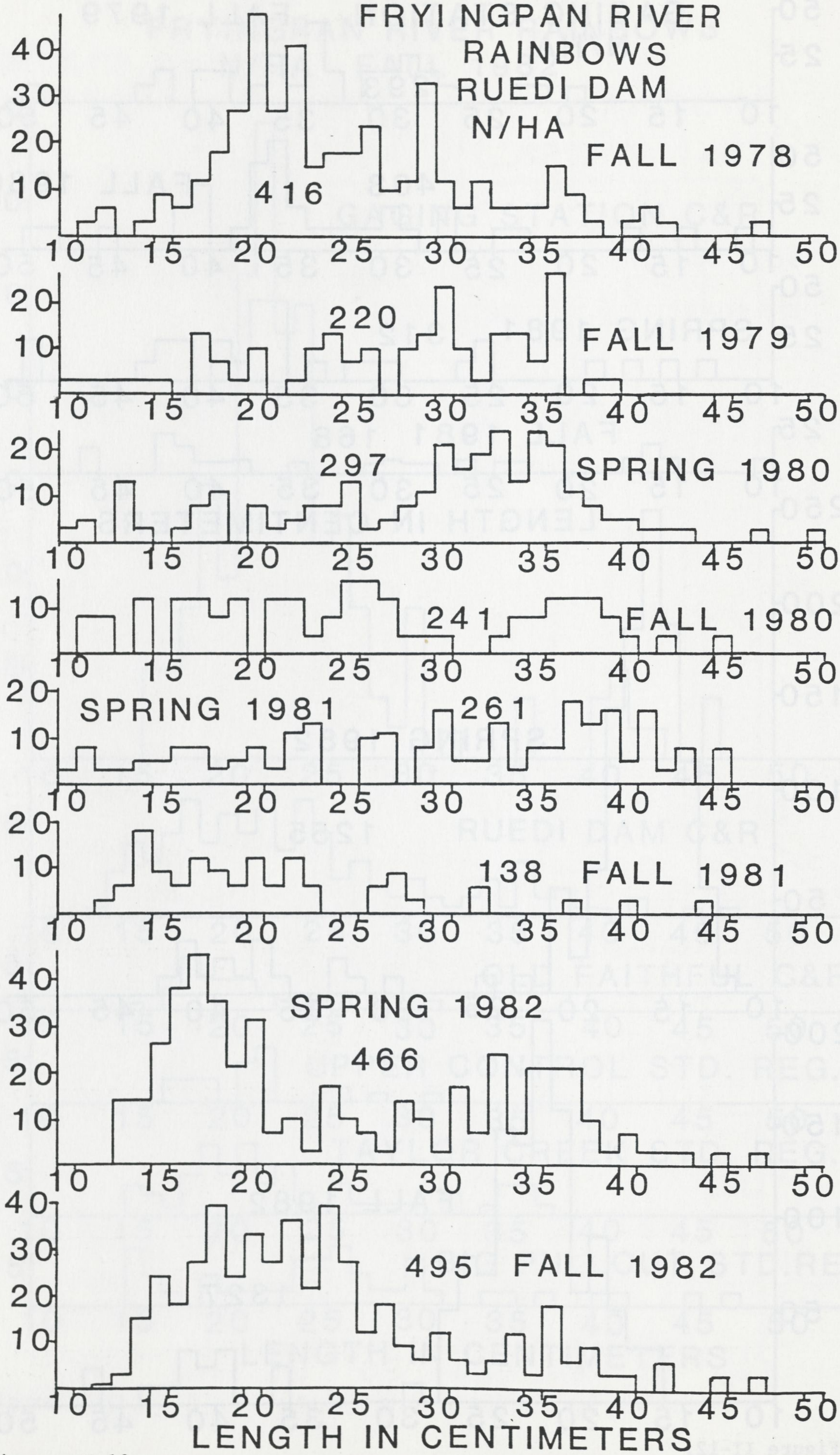

FRYINGPAN RIVER
RAINBOWS
RUEDI DAM
N/HA
FALL 1978
416
FALL 1979
220
SPRING 1980
297
FALL 1980
241
SPRING 1981
261
FALL 1981
138
SPRING 1982
466
FALL 1982
495
10 15 20 25 30 35 40 45 50
10
20
30
40
LENGTH IN CENTIMETERS

Figure II-13.

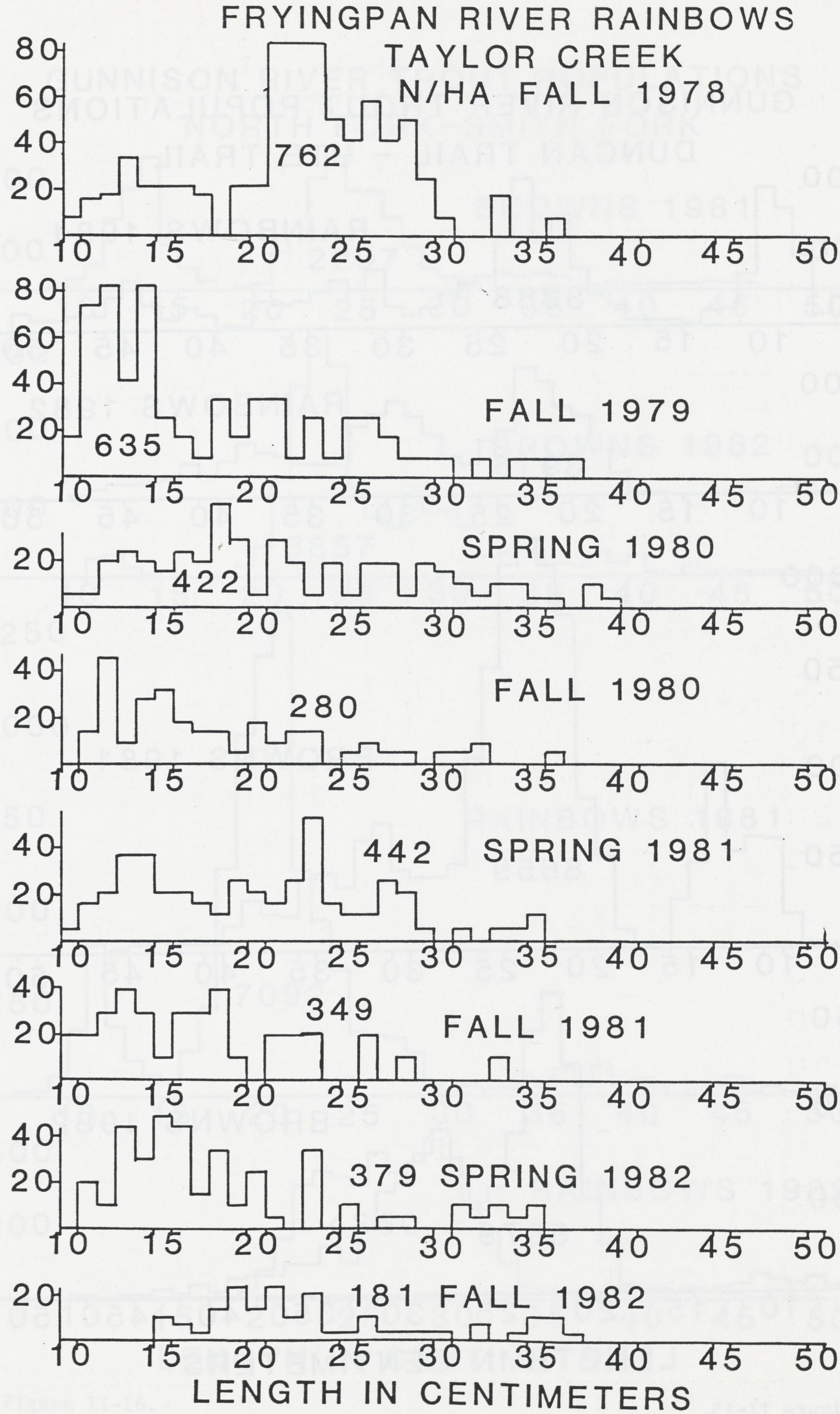

FRYINGPAN RIVER RAINBOWS
TAYLOR CREEK
N/HA FALL 1978
762
635
FALL 1979
422
SPRING 1980
280
FALL 1980
442
SPRING 1981
349
FALL 1981
379 SPRING 1982
181 FALL 1982
10 15 20 25 30 35 40 45 50
LENGTH IN CENTIMETERS

Figure II-14.

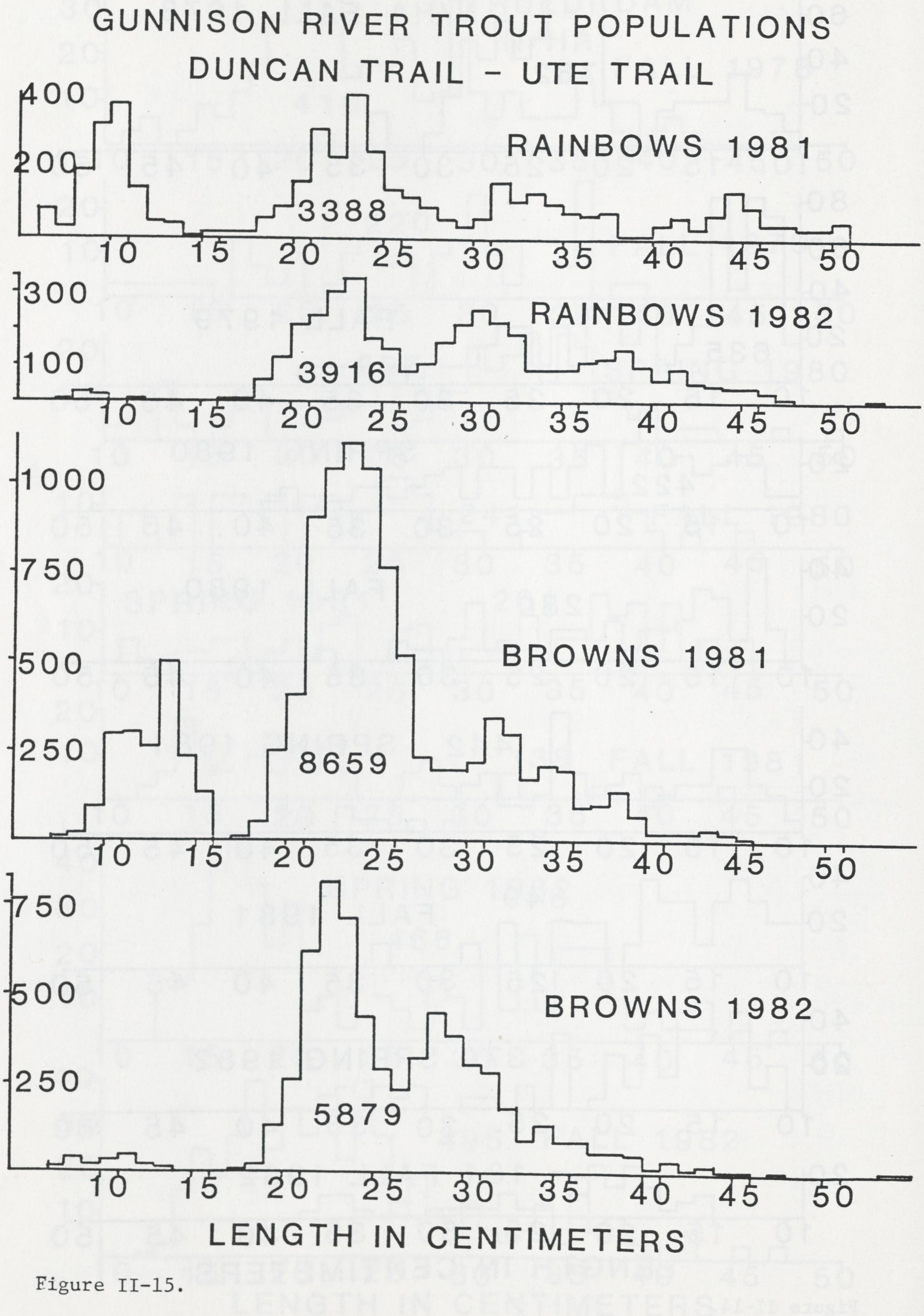

GUNNISON RIVER TROUT POPULATIONS
DUNCAN TRAIL - UTE TRAIL
RAINBOWS 1981
400
200
3388
10 15 20 25 30 35 40 45 50
RAINBOWS 1982
300
100
3916
10 15 20 25 30 35 40 45 50
BROWNS 1981
1000
750
500
250
8659
10 15 20 25 30 35 40 45 50
BROWNS 1982
750
500
250
5879
10 15 20 25 30 35 40 45 50
LENGTH IN CENTIMETERS

Figure II-15.

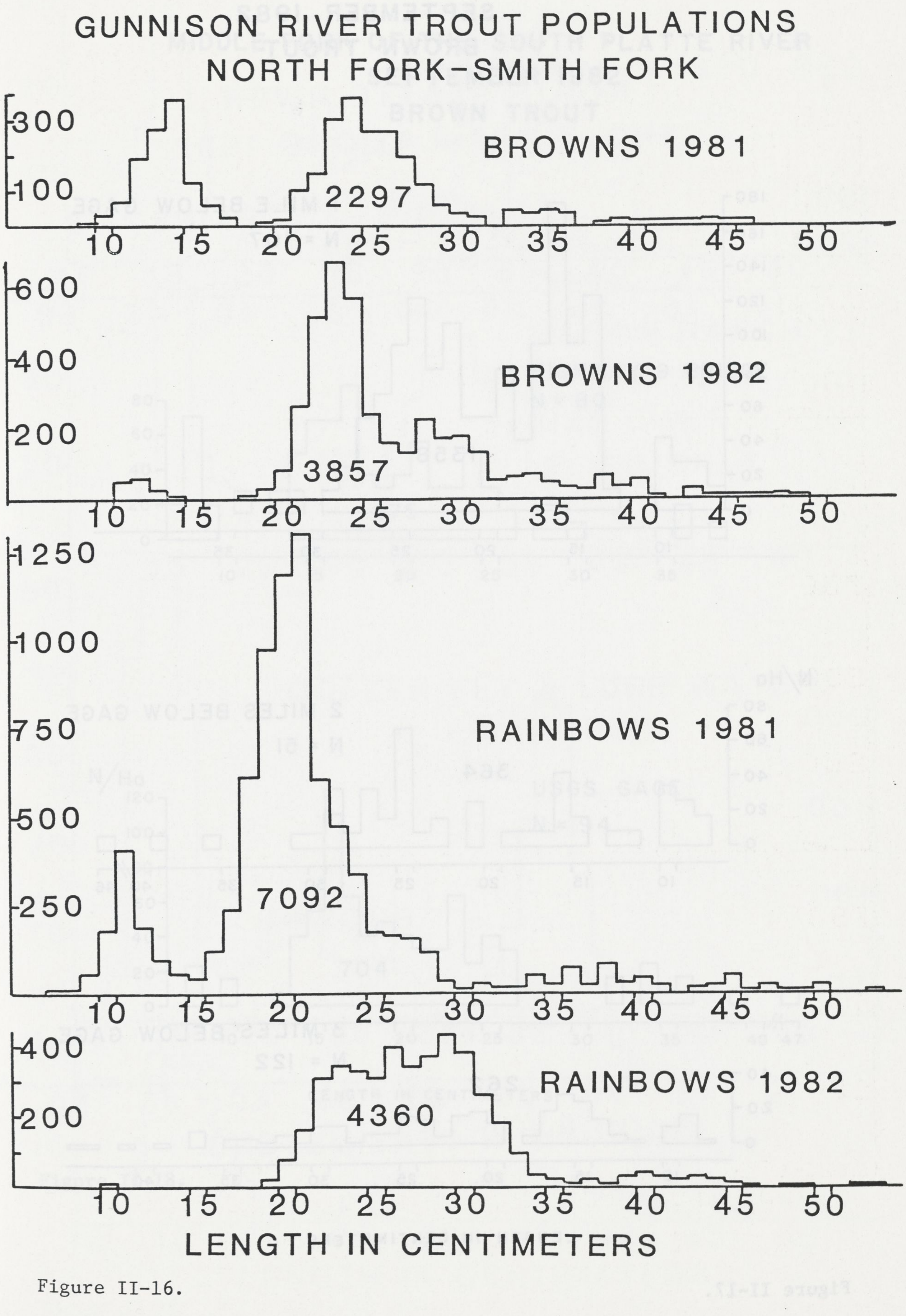

GUNNISON RIVER TROUT POPULATIONS
NORTH FORK-SMITH FORK
BROWNS 1981
2297
BROWNS 1982
3857
RAINBOWS 1981
7092
RAINBOWS 1982
4360
LENGTH IN CENTIMETERS

Figure II-16.

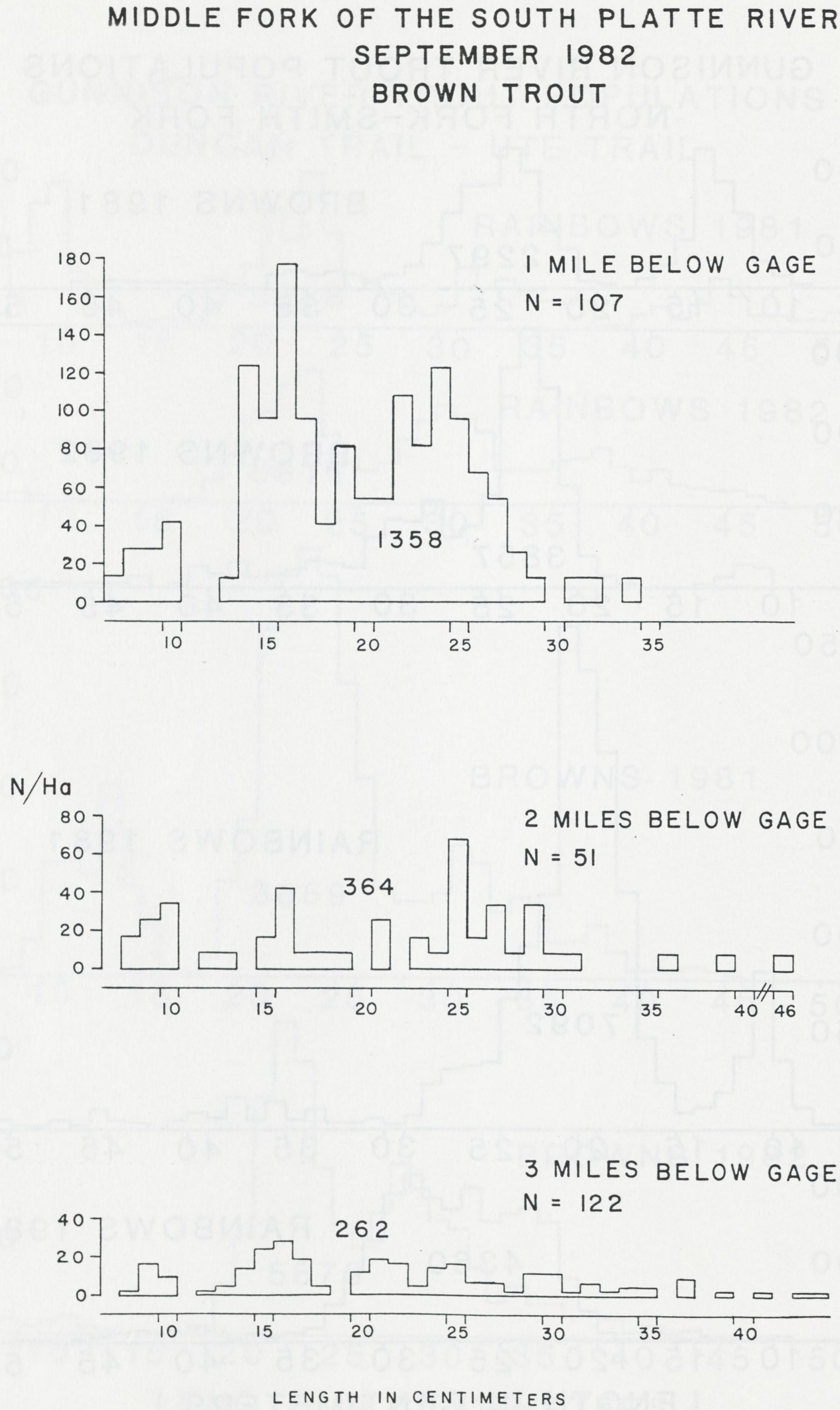

MIDDLE FORK OF THE SOUTH PLATTE RIVER
SEPTEMBER 1982
BROWN TROUT
1 MILE BELOW GAGE
N = 107
1358
180
160
140
120
100
80
60
40
20
0
10
15
20
25
30
35
N/Ha
2 MILES BELOW GAGE
N = 51
364
80
60
40
20
0
10
15
20
25
30
35
40
46
3 MILES BELOW GAGE
N = 122
262
40
20
0
10
15
20
25
30
35
40
LENGTH IN CENTIMETERS

Figure II-17.

MIDDLE FORK OF THE SOUTH PLATTE RIVER
SEPTEMBER 1982
BROWN TROUT

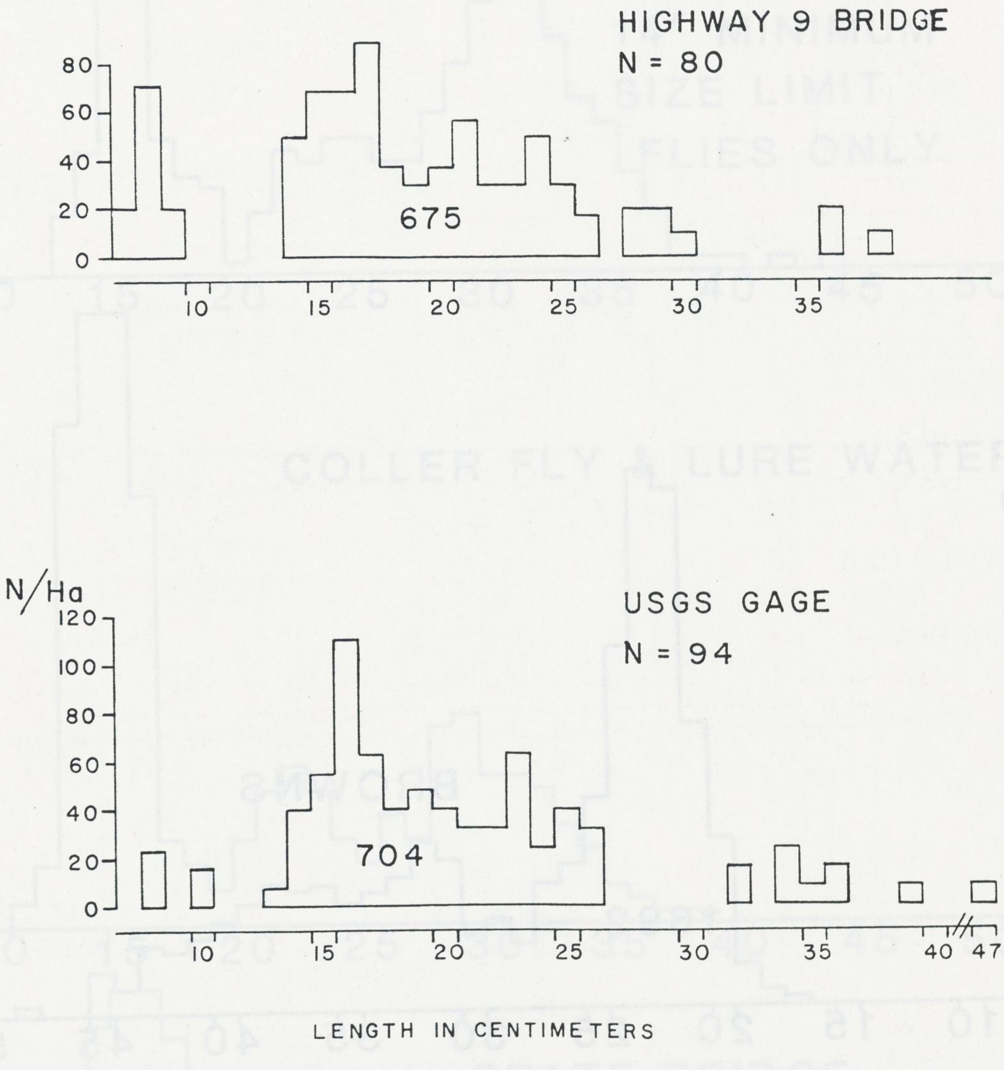


Figure II-18.

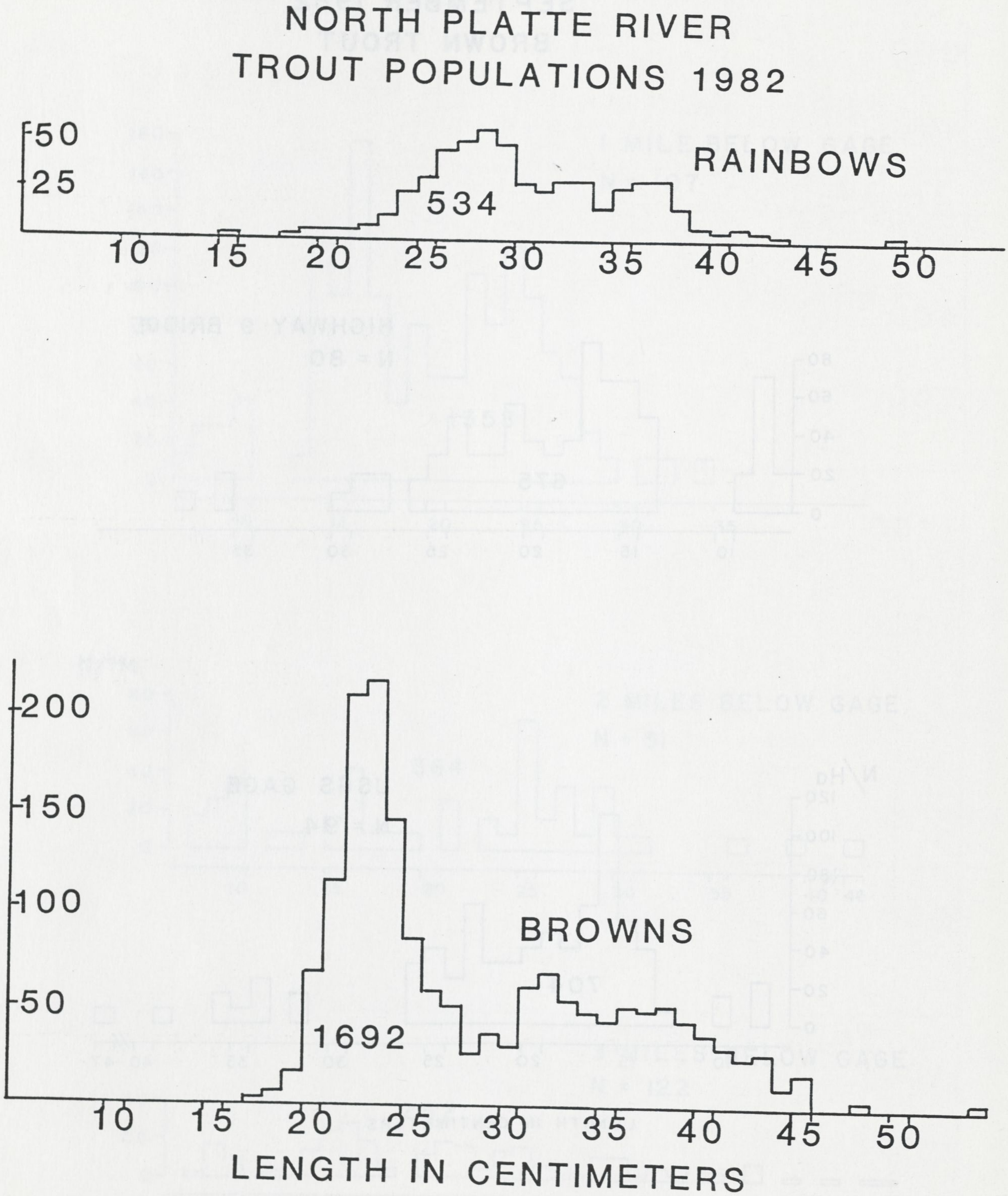

NORTH PLATTE RIVER
TROUT POPULATIONS 1982
50
25
RAINBOWS
534
10
15
20
25
30
35
40
45
50
200
150
100
50
BROWNS
1692
10
15
20
25
30
35
40
45
50
LENGTH IN CENTIMETERS

Figure II-19.

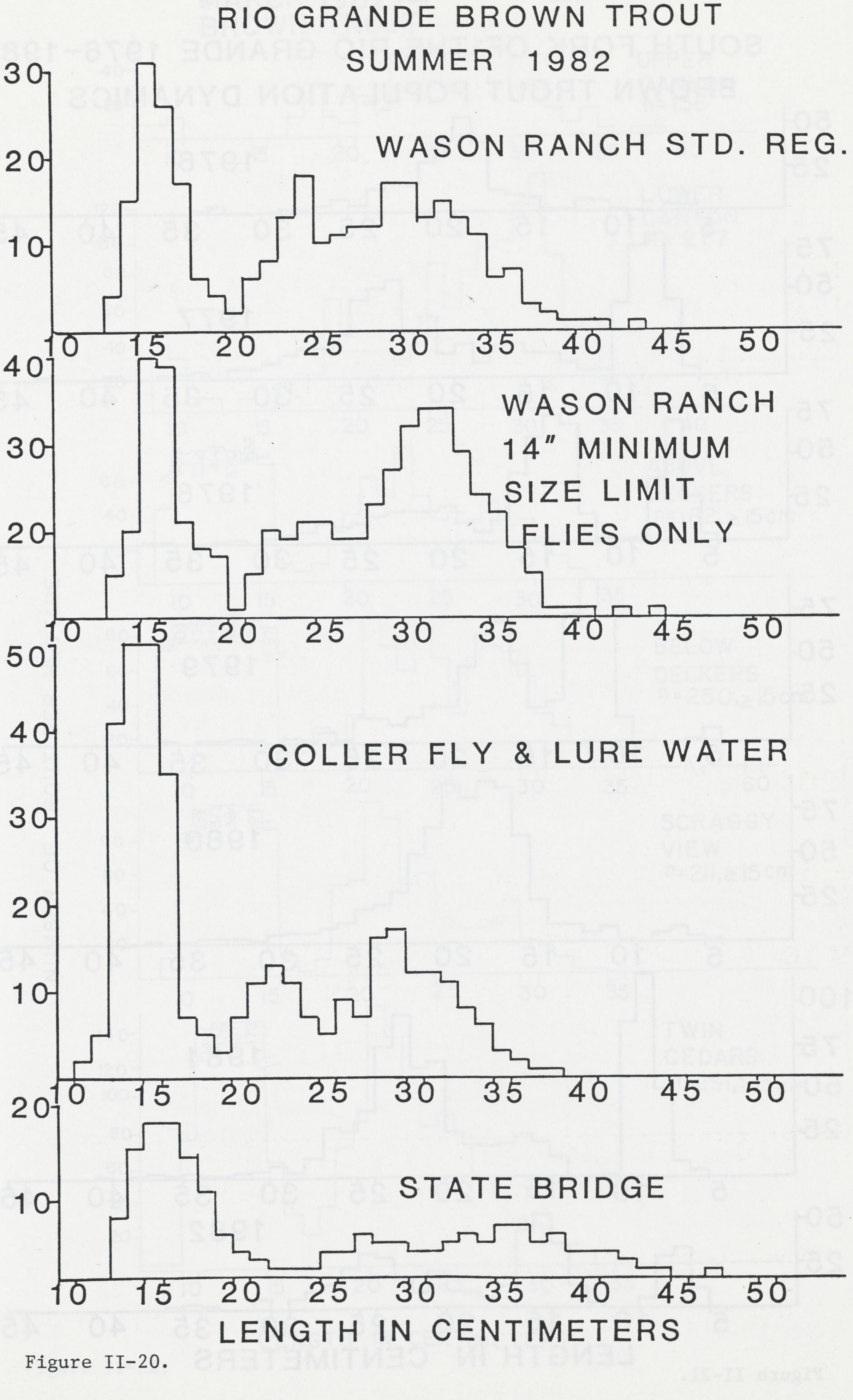

RIO GRANDE BROWN TROUT
SUMMER 1982
WASON RANCH STD. REG.
WASON RANCH
14" MINIMUM
SIZE LIMIT
FLIES ONLY
COLLER FLY & LURE WATER
STATE BRIDGE
10 15 20 25 30 35 40 45 50
LENGTH IN CENTIMETERS

Figure II-20.

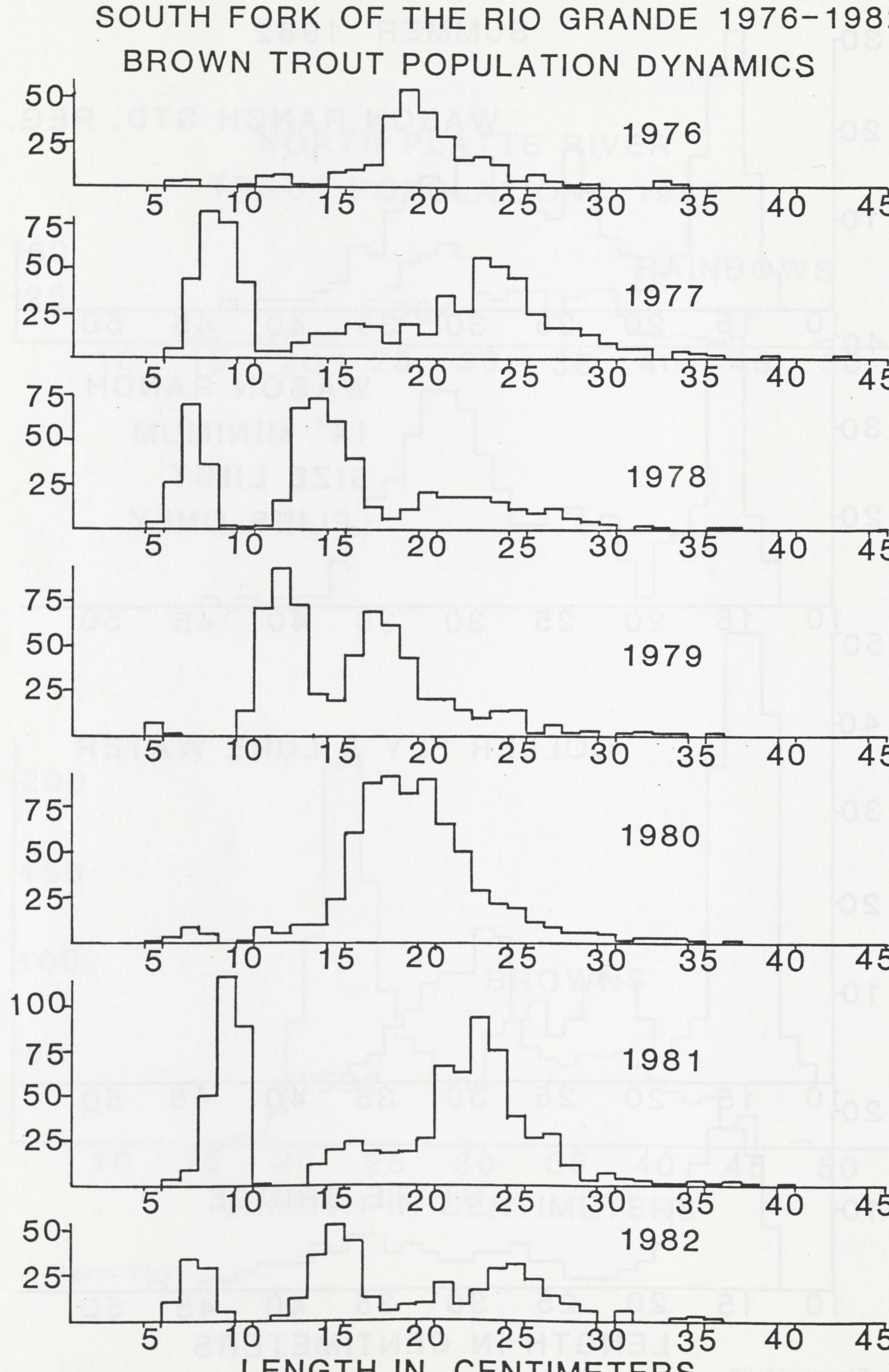

SOUTH FORK OF THE RIO GRANDE 1976-1982
BROWN TROUT POPULATION DYNAMICS
1976
1977
1978
1979
1980
1981
1982
LENGTH IN CENTIMETERS

Figure II-21.

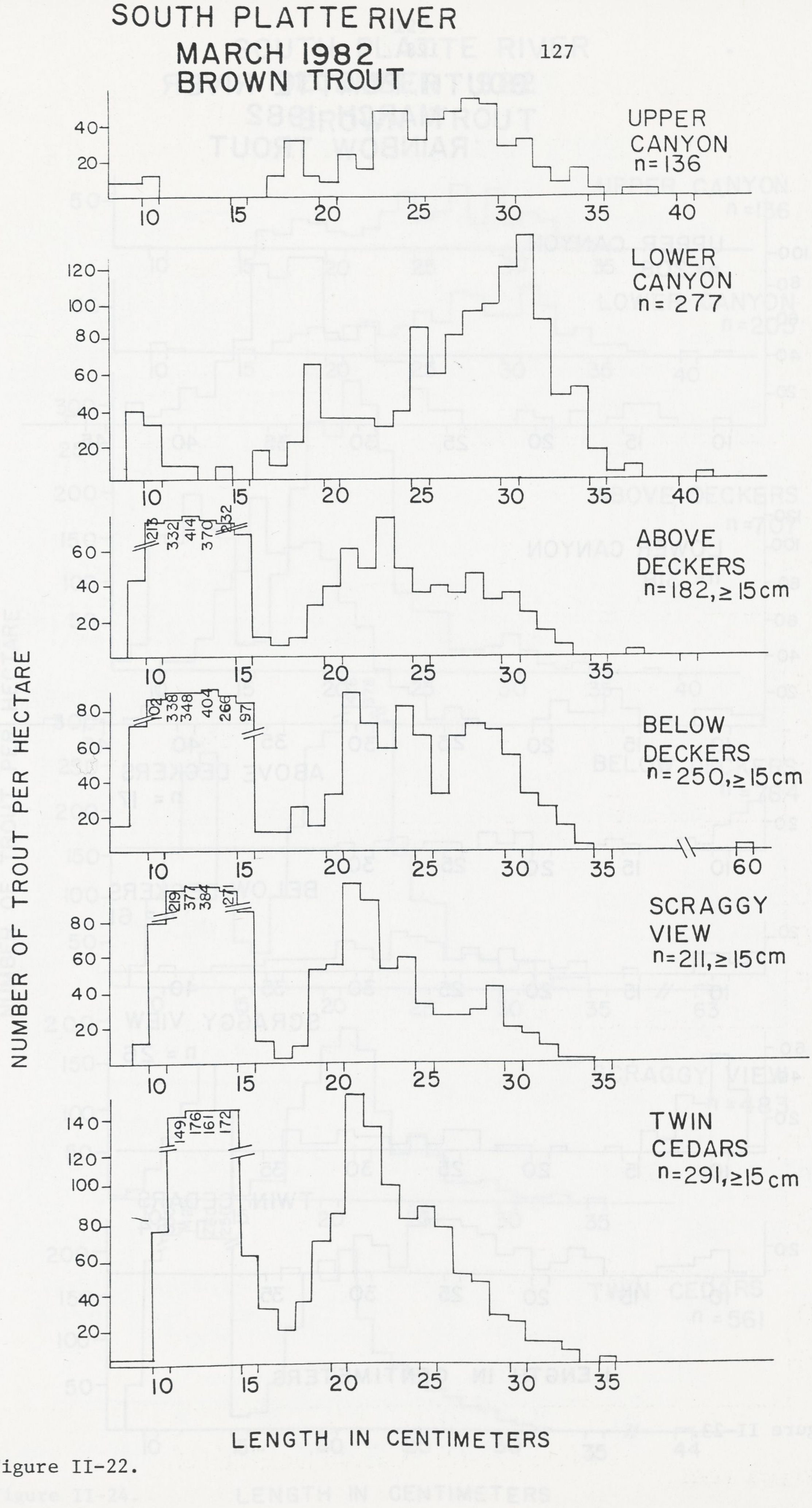

SOUTH PLATTE RIVER
MARCH 1982
BROWN TROUT
UPPER CANYON n=136
LOWER CANYON n=277
ABOVE DECKERS n=182, ≥15 cm
BELOW DECKERS n=250, ≥15 cm
SCRAGGY VIEW n=211, ≥15 cm
TWIN CEDARS n=291, ≥15 cm
NUMBER OF TROUT PER HECTARE
LENGTH IN CENTIMETERS

Figure II-22.

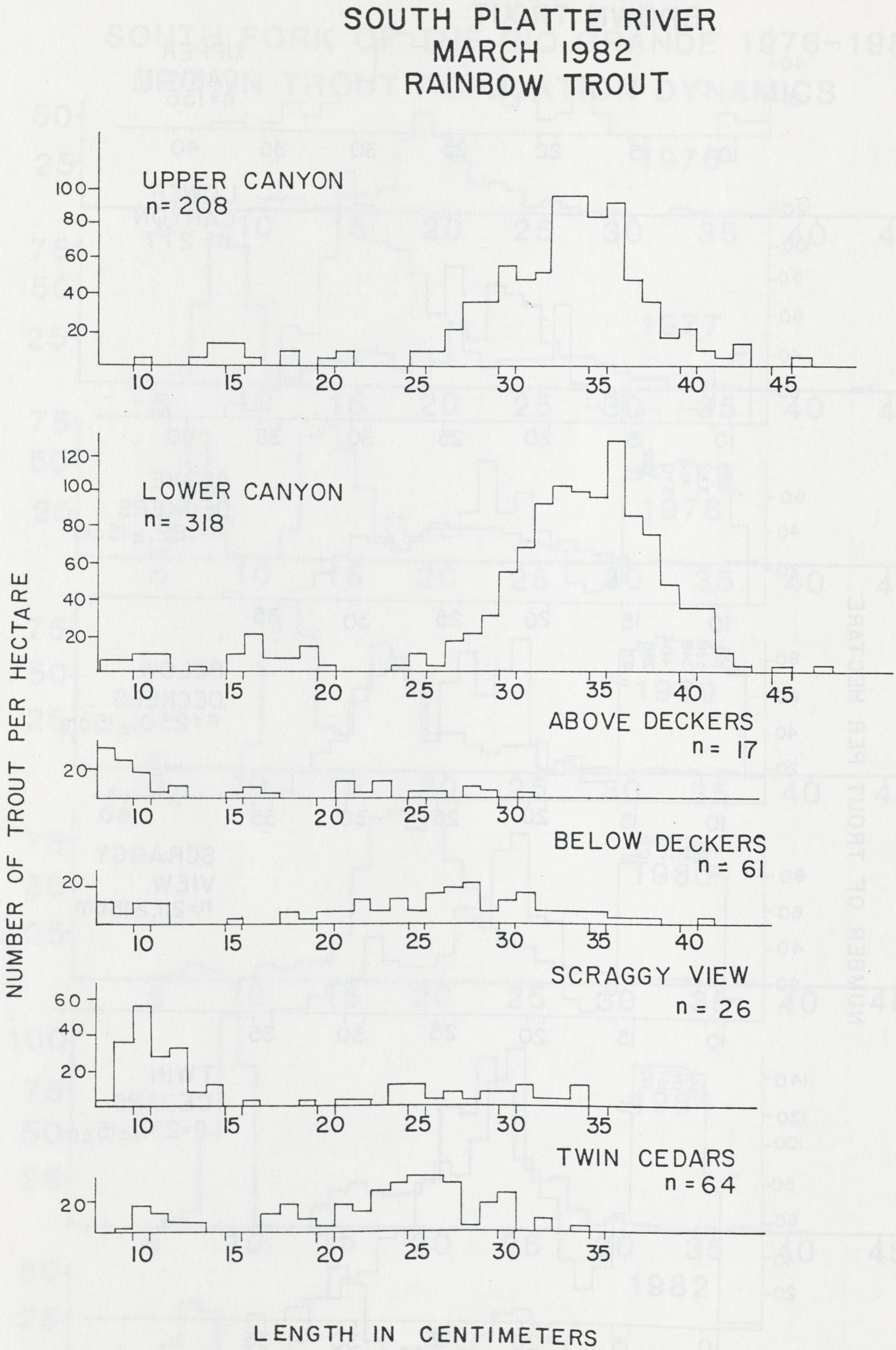

SOUTH PLATTE RIVER
MARCH 1982
RAINBOW TROUT
UPPER CANYON
n= 208
LOWER CANYON
n= 318
ABOVE DECKERS
n= 17
BELOW DECKERS
n= 61
SCRAGGY VIEW
n = 26
TWIN CEDARS
n = 64
NUMBER OF TROUT PER HECTARE
LENGTH IN CENTIMETERS

Figure II-23.

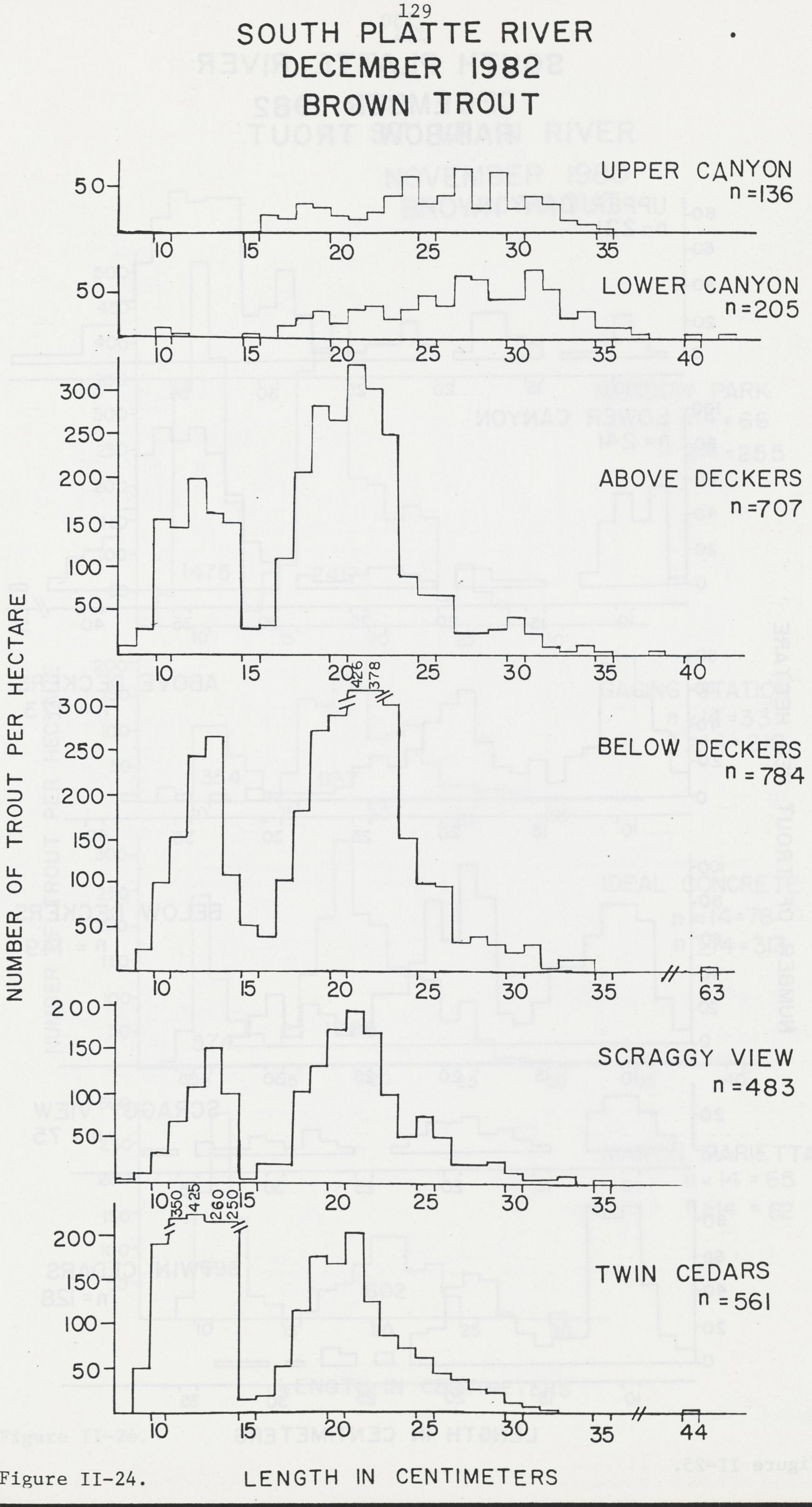
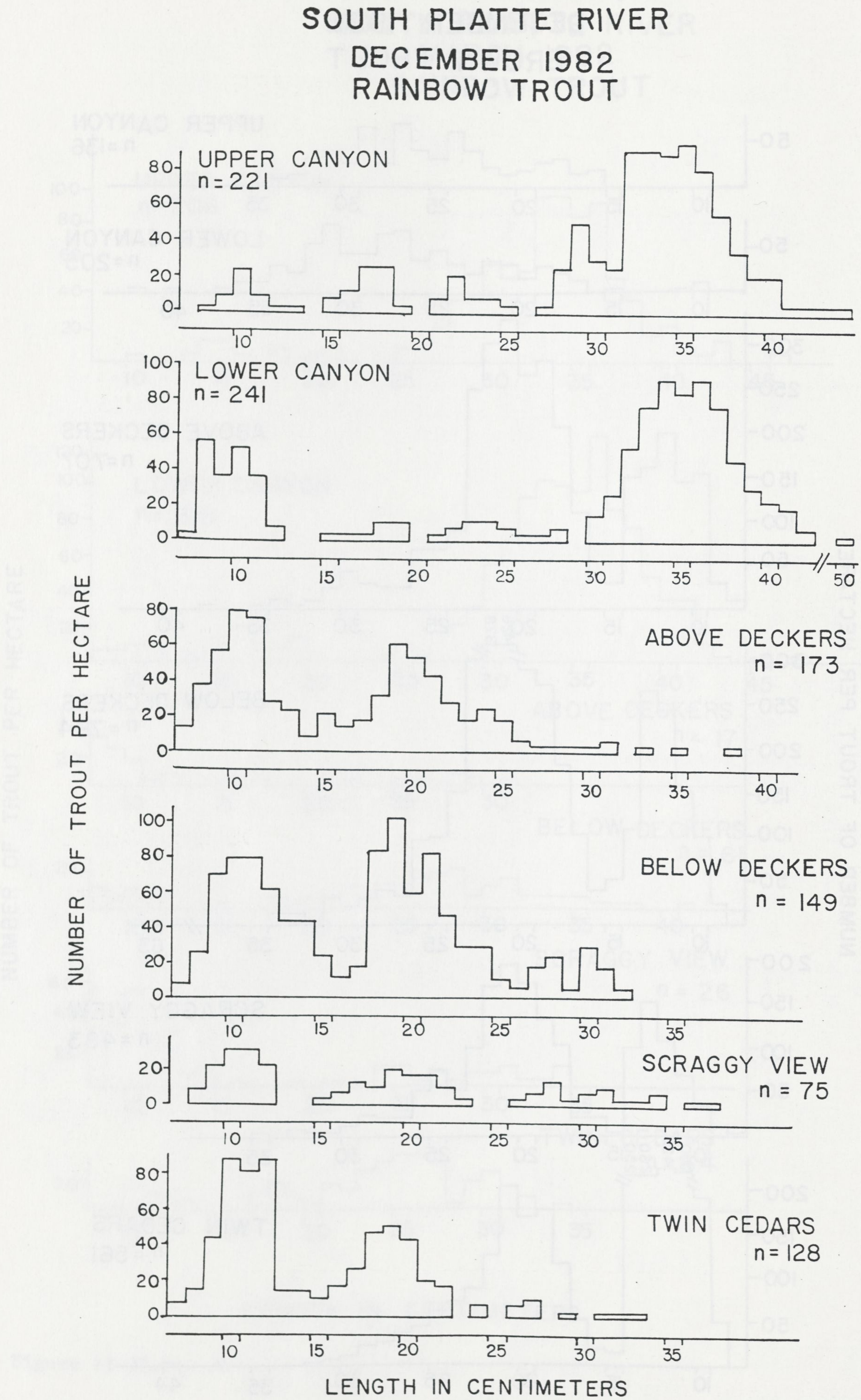


Figure II-24. LENGTH IN CENTIMETERS



SOUTH PLATTE RIVER
DECEMBER 1982
RAINBOW TROUT
UPPER CANYON
n=221
LOWER CANYON
n= 241
ABOVE DECKERS
n= 173
BELOW DECKERS
n = 149
SCRAGGY VIEW
n = 75
TWIN CEDARS
n= 128
NUMBER OF TROUT PER HECTARE
LENGTH IN CENTIMETERS

Figure II-25.

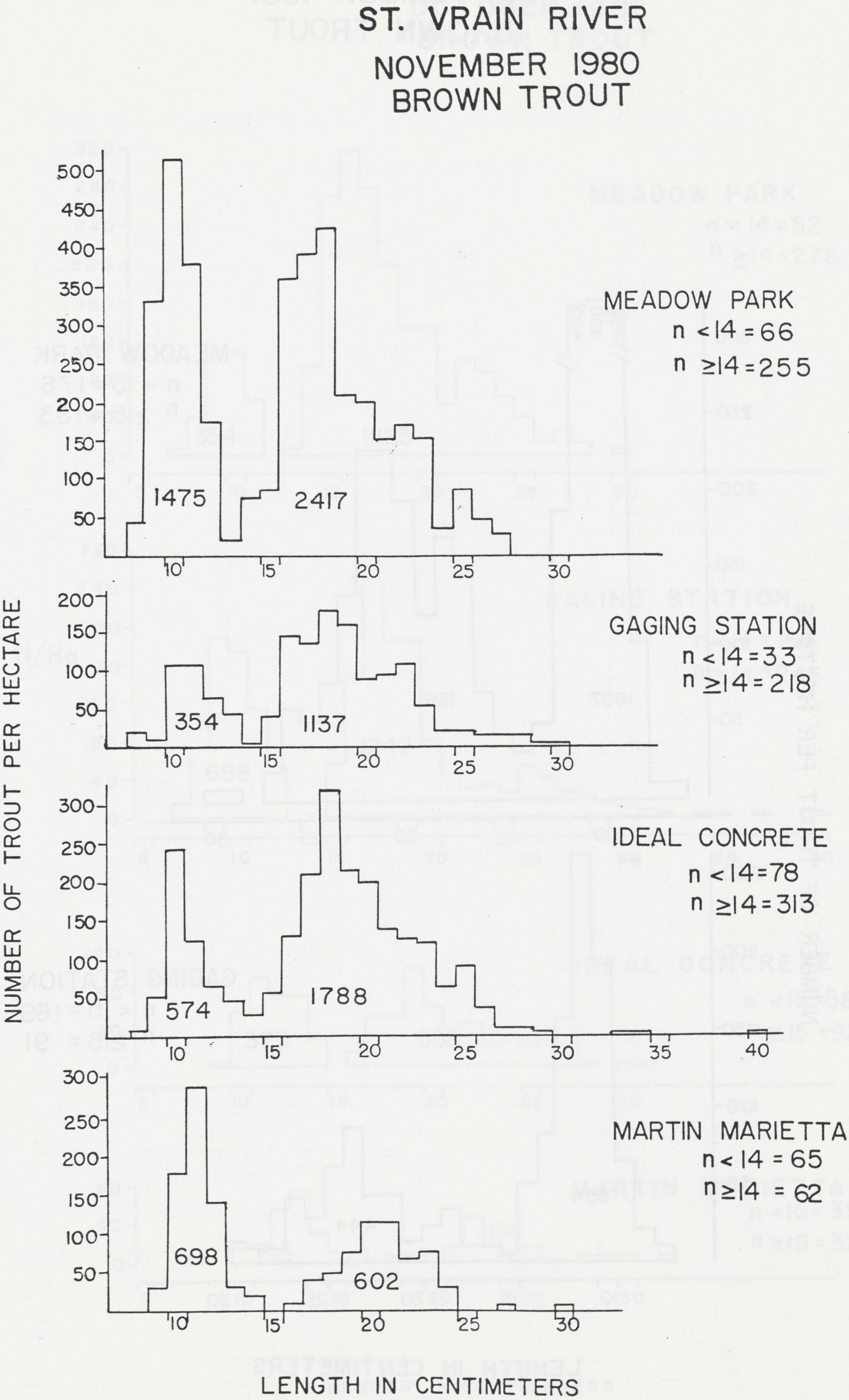

ST. VRAIN RIVER
NOVEMBER 1980
BROWN TROUT
MEADOW PARK
n <14 = 66
n ≥14 = 255
1475
2417
GAGING STATION
n <14 = 33
n ≥14 = 218
354
1137
IDEAL CONCRETE
n <14 = 78
n ≥14 = 313
574
1788
MARTIN MARIETTA
n < 14 = 65
n ≥ 14 = 62
698
602
NUMBER OF TROUT PER HECTARE
LENGTH IN CENTIMETERS

Figure II-26.

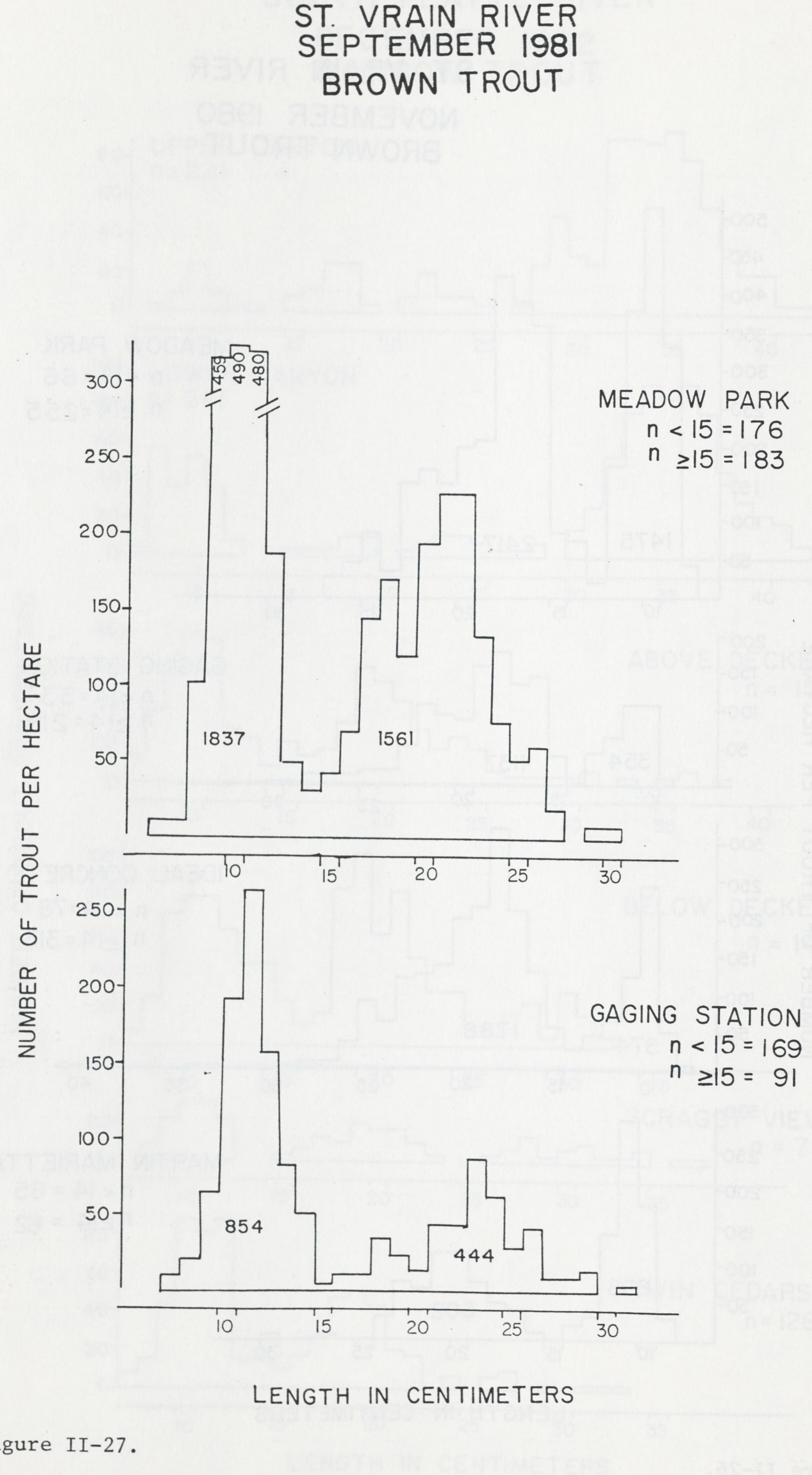

ST. VRAIN RIVER
SEPTEMBER 1981
BROWN TROUT
MEADOW PARK
n < 15 = 176
n ≥15 = 183
459
490
480
1837
1561
GAGING STATION
n < 15 = 169
n ≥15 = 91
854
444
NUMBER OF TROUT PER HECTARE
LENGTH IN CENTIMETERS

Figure II-27.

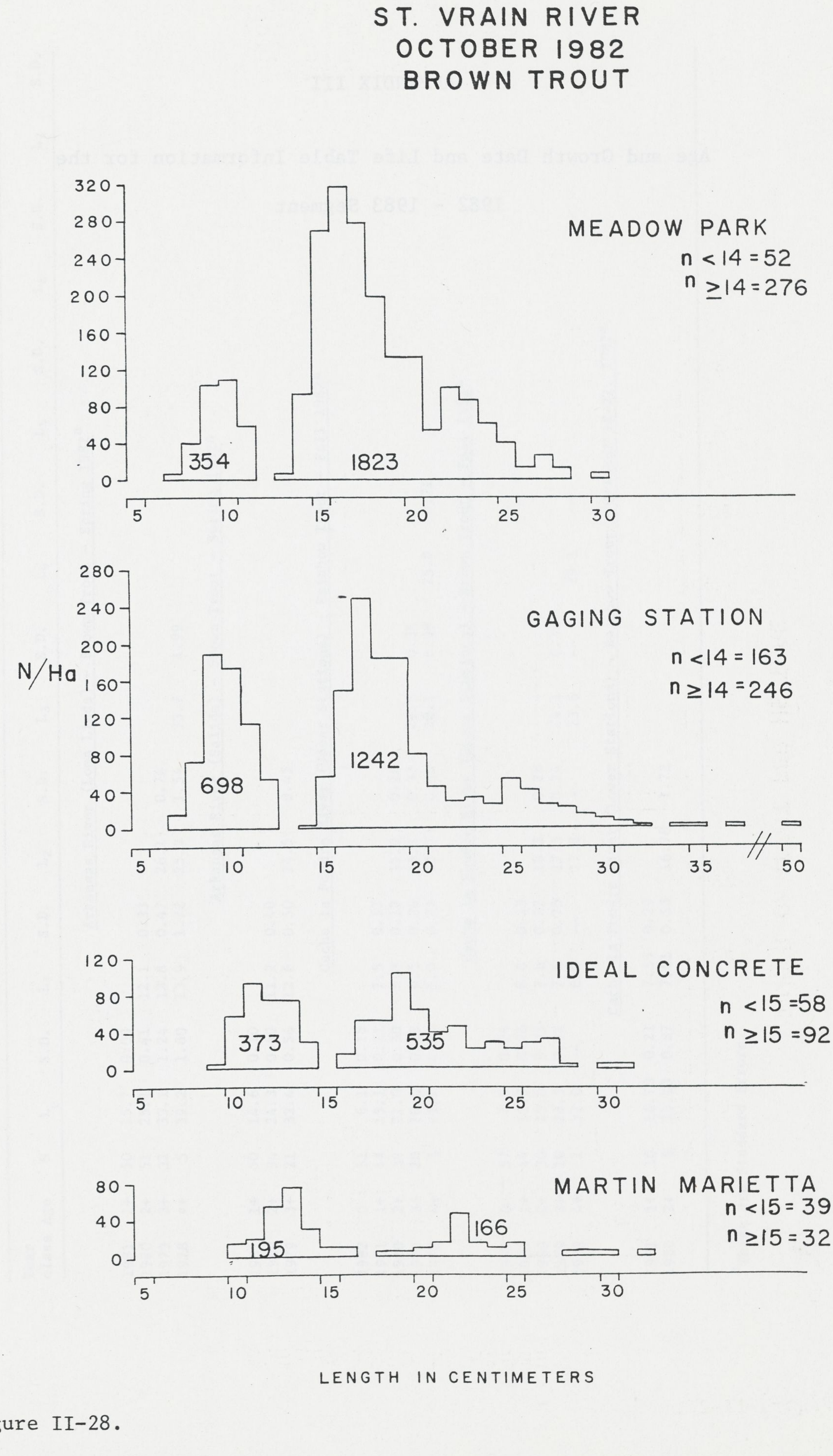

ST. VRAIN RIVER
OCTOBER 1982
BROWN TROUT
MEADOW PARK
n < 14 = 52
n ≥ 14 = 276
354
1823
GAGING STATION
n < 14 = 163
n ≥ 14 = 246
N/Ha
698
1242
IDEAL CONCRETE
n < 15 = 58
n ≥ 15 = 92
373
535
MARTIN MARIETTA
n < 15 = 39
n ≥ 15 = 32
195
166
LENGTH IN CENTIMETERS

Figure II-28.

APPENDIX III

Age and Growth Date and Life Table Information for the

1982 - 1983 Segment

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1982.

Year class	Age	N	L_c	S.D.	L_1	S.D.	L_2	S.D.	L_3	S.D.	L_4	S.D.	L_5	S.D.	L_6	S.D.	L_7	S.D.
Arkansas River (Loma Linda) - Brown Trout - Spring 1982[a]																		
1981	1+	50	15.7	0.03														
1980	2+	51	25.1	0.41	12.1	0.33												
1979	3+	32	33.1	1.24	13.8	0.47	26.1	0.74										
1978	4+	5	39.2	1.80	13.9	1.72	25.3	1.54	33.7	1.99								
Arkansas River (Salida) - Brown Trout - Spring 1982[a]																		
1981	1+	50	14.6	0.10														
1980	2+	34	24.3	0.40	11.2	0.40												
1979	3+	21	32.4	0.56	12.6	0.50	24.5	0.45										
Cache la Poudre River (Upper Stations) - Rainbow Trout - Fall 1982[a]																		
1982	0	51	6.1	0.15														
1981	1+	44	15.1	0.21	7.5	0.17												
1980	2+	39	21.0	0.30	6.8	0.19	15.9	0.28										
1979	3+	20	26.0	0.38	6.5	0.26	15.1	0.33	21.5	0.38								
1978	4+	5	29.2	0.80	5.0	0.27	13.7	0.49	20.1	0.38	25.9	0.71						
Cache la Poudre River (Upper Stations) - Brown Trout - Fall 1982[a]																		
1982	0	57	7.9	0.14														
1981	1+	44	16.9	0.26	8.6	0.23												
1980	2+	30	23.8	0.35	7.8	0.22	18.2	0.28										
1979	3+	10	28.5	0.52	7.6	0.70	17.3	0.24	24.1	0.33								
1978	4+	1	32.0	--	6.0	--	17.8	--	23.6	--	29.1	--						
Cache la Poudre River (Lower Stations) - Rainbow Trout - October 18-21, 1982[a]																		
1981	1+	10	16.70	0.21	7.55	0.29												
1980	2+	8	23.13	0.87	7.61	0.53	16.78	1.72										

[a]These are Standard Errors.

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1982 (continued).

Year class	Age	N	L_c	S.D.	L_1	S.D.	L_2	S.D.	L_3	S.D.	L_4	S.D.	L_5	S.D.	L_6	S.D.	L_7	S.D.
Cache la Poudre River (Lower Stations) - Brown Trout - October 18-21, 1982[a]																		
1982	0	85	9.14	0.14														
1981	1+	43	17.3	0.28	10.6	0.31												
1980	2+	44	23.2	0.32	9.1	0.23	18.0	0.25										
1979	3+	1	30.00	--	11.9	--	22.7	--	26.7	--								
Cochetopa River - Brown Trout - Fall 1982																		
1981	1+	25	17.8	1.59	9.46	1.70												
1980	2+	30	24.9	2.34	8.82	1.34	19.2	2.61										
1979	3+	23	29.2	3.92	8.41	1.47	18.1	3.19	24.6	3.89								
Cochetopa River - Rainbow Trout - Fall 1982																		
1981	1+	3	20.7	3.06	15.8	2.39												
1980	2+	4	22.8	2.99	7.52	1.26	17.3	2.01										
1979	3+	4	30.0	1.83	7.23	1.29	18.0	2.71	26.1	3.17								
Colorado River - Brown Trout - Fall 1982																		
1981	1+	30	22.4	2.19	10.4	1.90												
1980	2+	30	28.0	2.53	10.3	2.54	20.4	3.23										
1979	3+	38	34.7	3.14	9.55	1.90	21.0	3.44	29.3	3.80								
1978	4+	20	39.8	3.96	9.96	1.53	20.4	4.36	28.6	4.18	35.3	3.94						
1977	5+	2	53.5	2.12	14.0	1.20	21.2	0.42	31.2	0.99	42.8	0.50	49.0	2.19				
Colorado River - Rainbow Trout - Fall 1982																		
1981	1+	29	19.7	2.29	9.23	1.82												
1980	2+	40	26.2	2.50	7.57	1.27	17.6	2.36										
1979	3+	20	32.0	2.05	7.89	1.64	17.1	1.82	26.1	2.88								
1978	4+	36	37.2	5.64	7.81	1.65	18.6	2.97	27.6	3.54	33.5	4.65						
1977	5+	22	42.8	3.47	8.36	2.73	18.1	3.87	25.0	3.45	32.2	3.84	38.6	3.57				
1976	6+	7	46.7	2.63	7.13	1.79	15.2	3.20	21.7	4.80	30.4	3.31	36.4	3.54	43.0	2.90		

[a] These are Standard Errors.

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1982 (continued).

Year class	Age	N	L_c	S.D.	L_1	S.D.	L_2	S.D.	L_3	S.D.	L_4	S.D.	L_5	S.D.	L_6	S.D.	L_7	S.D.
Eagle River (Horn Lease) - Rainbow Trout - Fall 1982																		
1980	1+	8[b]	24.6	2.85	18.0	9.0												
1980	1+	10	20.5	3.38	7.81	1.95												
1979	2+	12	32.2	6.09	8.67	1.51	23.6	3.25										
1978	3+	13	36.5	4.05	7.75	0.97	22.4	2.29	32.0	2.90								
Eagle River (Wolcott) - Rainbow Trout - Fall 1982																		
1980	1+	7	22.3	1.70	8.84	1.95												
1979	2+	9	28.8	1.92	8.34	1.93	21.5	2.09										
1978	3+	4	36.3	4.72	6.70	1.66	19.4	0.98	30.9	1.61								
Eagle River (Catch and Release) - Rainbow Trout - Fall 1982																		
1980	1+	2	21.0	1.41	8.95	0.21												
1979	2+	2	34.5	6.36	8.00	0.14	25.5	1.91										
1978	3+	3	34.3	1.53	8.90	3.10	21.6	1.16	30.4	2.09								
1976	5+	1	44.0	--	7.50	--	19.1	--	31.3	--	38.8	--	42.3					
Eagle River (Horn Lease) - Brown Trout - Fall 1982																		
1979	2+	7	27.0	2.24	8.30	2.04	19.9	4.02										
1978	3+	13	31.8	3.24	8.60	3.30	17.1	5.83	27.5	3.16								
1977	4+	4	34.0	3.56	9.09	1.59	18.0	1.94	24.4	2.10	30.0	3.72						
1976	5+	1	46.0	--	7.6	--	11.4	--	24.4	33.6	33.6	--	40.0	--				
Eagle River (Wolcott) - Brown Trout - Fall 1982																		
1980	1+	2	20.0	0.00	9.10	0.28												
1979	2+	7	28.0	2.71	8.17	2.30	21.5	2.44										
1978	3+	7	29.1	1.46	9.16	2.63	19.1	3.21	26.7	1.44								
1977	4+	7	34.7	6.37	7.76	2.21	13.9	3.30	23.2	4.18	29.8	4.95						

[a] These are Standard Errors.

[b] Catchable rainbows

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1982 (continued).

Year class	Age	N	L_c	S.D.	L_1	S.D.	L_2	S.D.	L_3	S.D.	L_4	S.D.	L_5	S.D.	L_6	S.D.	L_7	S.D.
Eagle River (Catch and Release) - Brown Trout - Fall 1982																		
1979	2+	5	27.6	1.67	9.16	2.37	22.3	1.65										
1978	3+	4	31.0	1.15	9.03	1.29	17.4	5.01	26.5	1.24								
1977	4+	2	40.0	4.24	11.1	0.78	22.0	6.43	27.7	2.26	35.5	0.99						
Eagle River - Brown Trout - Fall 1982																		
1981	1+	24	19.6	1.67	10.5	1.54												
1980	2+	6	28.0	2.45	10.1	2.36	21.5	2.03										
1979	3+	18	30.8	3.42	9.13	2.61	19.3	4.36	26.1	3.95								
1978	4+	1	27.0	--	5.47	--	9.49	--	19.3	--	23.7	--						
Eagle River - Rainbow Trout - Fall 1982																		
1981	1+	2	21.0	1.41	9.06	3.08												
1980	2+	10	28.7	2.87	8.55	1.15	22.1	2.24										
Eagle River (Edwards) - Brown Trout- Fall 1982																		
1981	1+	28	17.9	2.08	10.5	4.84												
1980	2+	27	25.2	2.86	9.33	1.92	19.7	2.43										
1979	3+	16	31.2	2.32	9.21	2.17	19.2	2.86	27.1	2.41								
Eagle River (Edwards) - Rainbow Trout - Fall 1982																		
1979	3+	1	30.0	--	7.78	--	16.1	--	21.7	--								
Fryingpan River - Brown Trout - Fall 1982																		
1981	1+	19	14.5	1.22	8.22	1.36												
1980	2+	22	19.0	1.94	7.37	1.86	13.8	2.40										
1979	3+	27	24.2	3.76	6.80	1.46	14.5	2.29	20.0	3.04								
1978	4+	62	32.7	4.75	8.01	1.54	16.4	3.35	23.3	4.33	28.8	4.74						
1977	5+	2	31.0	5.66	6.26	1.43	11.6	1.70	16.4	3.32	22.8	6.51	26.9	5.73				

[a] These are Standard Errors.

[b] Catchable rainbows

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1982 (continued).

Year class	Age	N	L_c	S.D.	L_1	S.D.	L_2	S.D.	L_3	S.D.	L_4	S.D.	L_5	S.D.	L_6	S.D.	L_7	S.D.
							Fryingpan River - Rainbow Trout - Fall 1982											
1981	1+	10	14.0	1.70	8.94	1.58												
1980	2+	25	17.9	2.40	7.72	1.62	12.8	1.96										
1979	3+	40	25.3	4.34	7.86	1.79	14.3	2.67	20.1	3.93								
1978	4+	32	36.0	5.17	7.47	2.55	14.3	3.42	24.6	5.93	31.7	5.45						
1977	5+	19	36.7	4.33	6.71	1.82	13.6	2.57	20.8	2.85	28.6	3.75	33.7	4.31				
1976	6+	2	39.5	0.71	5.09	2.61	10.4	0.07	15.9	1.48	23.3	2.97	31.9	0.85	36.9	0.64		
1975	7+	1	36	--	4.74	--	8.05	--	11.8	--	17.5	--	22.7	--	28.4	--	33.6	--
							Gore Creek - Brown Trout - September 1982											
1981	1+	8	17.4	1.51	9.09	2.11												
1980	2+	17	24.9	2.44	9.64	2.41	19.1	2.53										
1979	3+	27	31.1	4.69	8.15	2.74	16.4	3.47	24.2	3.84								
1978	4+	5	40.2	5.93	8.65	2.41	17.0	4.00	25.2	3.13	32.2	2.64						
							Gore Creek - Rainbow Trout - September 1982											
1980	2+	4	26.0	1.41	8.83	1.01	20.6	1.31										
1979	3+	3	37.0	6.08	11.3	2.46	24.3	2.39	31.4	5.30								
1978	4+	3	35.0	1.00	6.98	0.76	16.4	1.02	25.0	1.85	30.6	1.72						
							Gunnison River - Brown Trout - August 1982											
1981	1+	40	23.6	3.26	13.7	2.55												
1980	2+	60	32.8	3.95	14.1	2.51	28.5	3.54										
1979	3+	24	41.8	3.34	12.6	3.57	26.8	6.46	37.9	3.57								
1978	4+	2	47.5	2.12	13.6	3.85	25.5	1.13	37.9	2.69	45.8	2.12						
1977	5+	2	52.0	5.66	11.7	8.06	18.4	8.34	33.6	11.5	44.4	3.32	49.7	3.68				

[a]These are Standard Errors.

[b]Catchable rainbows

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1982 (continued).

Year class	Age	N	L_c	S.D.	L_1	S.D.	L_2	S.D.	L_3	S.D.	L_4	S.D.	L_5	S.D.	L_6	S.D.	L_7	S.D.
						Gunnison River - Rainbow trout - August 1982												
1981	1+	35	20.9	2.40	9.32	2.39												
1981	1+	27	27.3	1.73	7.09[c]	2.17[c]	19.5[d]	3.66[d]										
1980	2+	24	32.1	2.84	9.19	2.08	26.2	3.60										
1980	2+	3	35.0	1.00	5.90[c]	1.68[c]	18.3[d]	2.62[e]	31.4[e]	1.32[e]								
1979	3+	42	38.6	3.05	7.38	1.62	23.7	3.74	34.2	3.70								
1978	4+	30	44.4	2.59	8.03	1.86	17.8	3.76	29.4	4.30	39.4	3.74						
1977	5+	5	48.4	4.39	7.78	1.79	13.3	2.98	23.0	4.02	35.3	6.95	44.2	4.84				
						North Platte River - Brown Trout - Fall 1982												
1981	1+	12	20.9	2.50	7.23	1.49												
1980	2+	41	24.6	3.15	8.38	2.28	18.2	3.14										
1979	3+	24	35.3	4.63	9.31	2.60	19.4	4.25	28.1	4.80								
1978	4+	42	37.5	4.75	7.96	2.03	16.1	4.03	24.0	4.72	32.6	1.69						
1977	5+	4	43.0	1.41	9.79	1.10	15.6	1.41	23.8	1.76	30.8	1.90	38.0	1.01				
						North Platte River - Rainbow Trout - Fall 1982[a]												
1981	1+	16	22.2	3.10	11.1	3.73												
1980	2+	25	27.4	3.37	9.74	3.69	20.8	3.71										
1979	3+	28	33.0	3.06	9.01	3.80	19.1	3.93	27.8	3.01								
1978	4+	5	38.4	2.30	8.21	3.15	17.4	3.72	27.3	2.42	34.4	1.77						
						Rio Grande River (State Bridge) - Brown Trout - August 1982												
1981	1+	42	17.0	2.59	9.93	2.44												
1980	2+	33	26.8	2.84	9.26	2.25	21.2	3.12										
1979	3+	48	35.3	3.79	9.36	1.92	21.3	3.85	30.7	4.20								
1978	4+	30	40.6	3.36	9.62	2.27	21.8	5.01	31.8	4.90	37.2	3.66						
1977	5+	6	42.5	3.33	8.99	1.40	16.7	3.49	27.0	5.74	35.2	4.41	39.8	3.47				

[a]These are Standard Errors.

[b]Catchable rainbows

[c]Planting check

[d]L_1

[e]L_2

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1982 (continued).

Year class	Age	N	L_c	S.D.	L_1	S.D.	L_2	S.D.	L_3	S.D.	L_4	S.D.	L_5	S.D.	L_6	S.D.	L_7	S.D.
Rio Grande River (State Bridge) - Rainbow Trout - August 1982																		
1982	0+	1	14.0	--														
1981	1+	6	17.8	2.71	7.88	1.26												
1980	2+	2	30.0	1.41	9.58	1.31	24.4	2.76										
1979	3+	5	36.0	3.81	8.24	2.89	20.2	7.16	30.5	4.43								
1978	4+	4	37.0	2.58	8.68	3.14	17.0	2.30	27.3	4.03	34.5	2.48						
1977	5+	1	39.0	--	7.62	--	15.2	--	20.6	--	31.4	--	37.2	--				
Rio Grande River (Wason Ranch) - Brown Trout - August 1982																		
1981	1+	22	15.1	1.82	10.1	1.47												
1980	2+	37	22.0	3.48	8.07	2.48	16.5	3.79										
1979	3+	51	30.9	3.61	8.84	2.51	17.2	3.29	25.5	3.41								
1978	4+	7	36.6	1.60	9.63	1.64	16.8	2.75	23.5	4.32	31.8	3.18						
Rio Grande River (Wason Ranch) - Rainbow Trout - August 1982																		
1980	2+	1	28	--	7.44	--	22.8	--										
1979	3+	1	35	--	9.75	--	16.6	--	28.1	--								
South Platte River (Lower Canyon and Deckers) - Brown Trout - Fall 1982[a]																		
1982	0+	18	12.9	0.27														
1981	1+	49	19.4	0.39	10.2	0.32												
1980	2+	29	28.2	0.55	10.3	0.34	21.4	0.46										
1979	3+	12	32.8	0.71	8.4	0.63	17.9	1.25	26.3	0.85								
South Platte River (Lower Canyon and Deckers) - Rainbow Trout - Fall 1982[a]																		
1981	1+	42	18.1	0.42	9.3	0.30												
1980	2+	23	26.2	0.55	9.6	0.41	18.7	0.43										
1979	3+	22	29.9	0.42	8.2	0.42	17.3	0.54	23.7	0.42								
1978	4+	17	33.9	0.49	7.8	0.44	16.6	0.63	24.7	0.60	29.9	0.49						
1977	5+	13	37.3	0.77	8.4	0.34	16.7	0.96	23.9	1.00	29.4	0.95	33.2	0.76				
1976	6+	5	39.8	0.25	7.8	0.87	16.9	1.57	23.9	0.73	29.0	1.03	33.4	0.84	36.5	0.43		

[a] These are Standard Errors.

[b] Catchable rainbows

[c] Planting check

[d] L_1

[e] L_2

Table III-1. Back-calculated lengths (cm) of trout from F-51-R Study Streams in 1982 (continued).

Year class	Age	N	L_c	S.D.	L_1	S.D.	L_2	S.D.	L_3	S.D.	L_4	S.D.	L_5	S.D.	L_6	S.D.	L_7	S.D.
St. Vrain River - Brown Trout - October 21-22, 1982[a]																		
1981	1+	44	16.9	0.40	8.4	0.33												
1980	2+	50	23.8	0.34	8.6	0.32	17.4	0.46										
1979	3+	7	30	0.87	9.5	0.83	18.1	1.57	24.6	0.99								
1978	4+	1	50	--	12.7	--	27.8	--	34.6	--	43.4	--						
St. Vrain River - Rainbow Trout - October 21-22, 1982[a]																		
1980	2+	2	24.5	1.50	7.0	0.75	15.6	0.85										
South Fork of the Rio Grande River - Brown Trout - August 1982																		
1981	1+	20	15.3	1.59	8.16	1.54												
1980	2+	22	18.9	2.12	8.15	2.28	14.57	2.10										
1979	3+	28	25.8	3.00	7.89	1.94	14.7	1.84	20.8	2.25								
1978	4+	6	30.3	4.41	8.03	1.88	13.4	3.83	20.3	5.24	25.4	3.94						
Taylor River - Brown Trout - October 1982																		
1981	1+	47	15.7	2.90	7.79	2.35												
1980	2+	22	23.2	1.76	8.05	3.06	17.9	1.98										
1979	3+	32	29.5	4.50	7.40	1.63	16.0	2.25	24.9	4.00								
1978	4+	23	36.7	5.28	7.07	2.34	15.4	3.27	24.0	5.24	31.9	4.35						
1977	5+	3	35.3	1.53	5.32	0.50	13.5	1.00	20.1	0.45	26.1	0.75	32.3	0.83				

[a] These are Standard Errors.
[b] Catchable rainbows
[c] Planting check
[d] L_1
[e] L_2

Table III-2. Life Tables - Arkansas River (brown trout/ha)

Sample period		Year class				
Season	Year	1981	1980	1979	1978	1977
			Tezak			
March	1981		247	231	61	1
March	1982	282	245	107	5	
			Loma Linda			
March	1981		127	195	45	1
March	1982	415	255	103	2	
			Coaldale			
March	1981		124	237	40	2
March	1982	251	142	99	2	
			Salida			
March	1981		13	199	181	1
March	1982	217	139	209	3	

Table III-2. Life Tables - Cache la Poudre River (brown trout/ha)

Sample period		Year class						
Season	Year	1982	1981	1980	1979	1978	1977	1976
				Big Bend Campground				
Fall	1980			(2)[a]	43	100	56	17
Fall	1981		(41)	118	104	90	45	27
Fall	1982	(9)	349	171	89	37	3	3
				Upper Wild Trout Water				
Fall	1980			(6)	45	61	28	
Fall	1981		(21)	120	135	123	56	12
Fall	1982	(8)	183	110	34	9		
				Lower Control				
Fall	1980			(2)	46	115	56	4
Fall	1981		(11)	104	92	99	42	12
Fall	1982	(10)	116	119	46	10	3	
				Indian Meadows				
Fall	1980			(9)	27	45	38	0
Fall	1981		(7)	56	46	45	16	3
Fall	1982	(8)	120	83	43	16	0	0
				Kelly Flats Campgrounds				
Fall	1980			(11)	132	134	25	
Fall	1981		(43)	128	104	58	20	
Fall	1982	(22)	158	142	35	4	0	
				Lower Cache la Poudre River - Wild Trout				
Fall	1980			(16)	910	356	33	
Fall	1981		(127)	393	372	14	0	
Fall	1982	(33)	495	442	0	0	0	
				Lower Cache la Poudre River - Control				
Fall	1980			(30)	693	283	13	
Fall	1981		(184)	221	311	13	0	
Fall	1982	(52)	700	295	4	0	0	

[a]Number of YOY collected

Table III-2. Life Tables - Cache la Poudre River (rainbow trout/ha).

Sample period		Year class						
Season	Year	1982	1981	1980	1979	1978	1977	1976
				Big Bend Campground				
Fall	1980			(1)	3	27	30	14
Fall	1981		(20)	65	29	23	13	
Fall	1982	(0)	50	43	15	11		
				Upper Wild Trout Water				
Fall	1980			(9)	69	61	82	36
Fall	1981		(60)	181	136	113	49	
Fall	1982	(18)	196	95	69	31	5	
				Lower Control				
Fall	1980			(2)	52	63	108	65
Fall	1981		(45)	157	196	125	53	
Fall	1982	(15)	258	241	131	31	3	
				Indian Meadows				
Fall	1980			(15)	155	150	135	41
Fall	1981		(29)	226	203	81	40	
Fall	1982	(5)	122	172	103	40	4	
				Kelly Flats Campground				
Fall	1980			(24)	177	107	120	22
Fall	1981		(54)	343	177	40	6	
Fall	1982	(13)	300	91	15			

Table III-2. Life Tables - Cochetopa Creek (brown and rainbow trout/ha)

Sample period		Year class				
Season	Year	1981	1980	1979	1978	1977
		Standard Regulation (Brown Trout)				
Fall	1982	19	16	32		
		Catch and Release (Brown Trout)				
Fall	1982	168	205	131		
		Catch and Release (Rainbow Trout)				
Fall	1982	19	19	46		

Table III-2. Life Tables - Colorado River (brown trout/ha)

Sample period Season	Year	Year class 1981	1980	1979	1978	1977	1976	1975
			Thompson Ranch - Catch and Release					
Fall	1981		12	42	36	24	0	0
Fall	1982	34	38	65	19	9	0	0
			Hot Sulphur Springs (Pioneer Park) - 8 Trout/Day					
Fall	1981		25	26	6	0	0	0
Fall	1982	42	21	21	6	0	0	0
			State Ranch (Lone Buck) - 8 Trout/Day					
Fall	1981		2	10	6	4	0	2
Fall	1982	0	2	12	13	0	0	0
			Parshall - Catch and Release Area					
Fall	1981		19	206	57	11	2	0
Fall	1982	85	42	40	8	0	0	0
			Con Ritschard's Ranch - Catch and Release					
Fall	1981		0	30	9	3	0	0
Fall	1982	44	73	35	8	10	0	0
			Paul Gilbert Wildlife Area - 8 Trout/Day					
Fall	1982	15	4	17	3	0	0	0

Table III-2. Life Tables - Colorado River (rainbow trout/ha)

Sample period		Year class							
Season	Year	1981	1980	1979	1978	1977	1976	1975	1974
Thompson Ranch - Catch and Release									
Fall	1980			3	17	62	53	5	3
Fall	1981		31	11	94	84	3	0	0
Fall	1982	6	10	41	88	9	0	0	0
Hot Sulphus Springs (Pioneer Park) - 8 Trout/Day									
Fall	1981		37	38	3	0	0	0	
Fall	1982	26	48	8	2	0	0	0	
State Ranch at Lone Buck - 8 Trout/Day									
Fall	1979					76	104	39	11
Fall	1980			1	25	42	22	0	0
Fall	1981		23	17	45	13	0	0	0
Fall	1982	2	20	25	31	10	0	0	0
Parshall - Catch and Release Area									
Fall	1981		72	487	207	119	10	1	
Fall	1982	61	165	70	82	29	3	0	
Con Ritschard's Ranch - Catch and Release Area									
Fall	1979				12	33	85	78	12
Spring	1980					3	51	78	25
Fall	1980			4	28	80	77	8	11
Fall	1981		26	127	77	46	7	1	0
Fall	1982	57	192	109	145	53	13	0	0
Skylark Ranch - Catch and Release									
Fall	1979					13	23	15	6
Fall	1981		8	74	46	31	2	0	
Paul Gilbert Wildlife Area - 8 Trout/Day									
Fall	1982	5	5	4	0	1	1	0	0

Table III-2. Life Tables - Eagle River (brown trout and rainbow trout/ha)

Sample period		Year class						
Season	Year	1981	1980	1979	1978	1977	1976	1975
				Wolcott (Brown Trout)				
Spring	1980				73	239	41	15
Fall	1980			49	171	33	1	0
Fall	1981	8	13	55	50	8	0	0
Fall	1982	67	15	48	2	0	0	0
				Wolcott (Rainbow Trout)				
Spring	1980				21	45	3	0
Fall	1980		3	27	35	34	0	0
Fall	1981	0	6	1	2	0	0	0
				Upper End (Brown Trout) - Catch and Release				
Fall	1981	4	27	48	34	1	4	0
				Upper End (Rainbow Trout) - Catch and Release				
Fall	1981	7	16	3	13	0	0	0
				Lower End (Brown Trout) - Catch and Release				
Fall	1981	5	55	33	35	1	0	0
				Lower End (Rainbow Trout) - Catch and Release				
Fall	1981	5	76	35	0	0	0	0
				Edwards (Brown Trout)				
Fall	1982	122	55	7	1	1	0	0

Table III-2. Life Tables - Fryingpan River (brown trout/ha)

Sample period		Year class							
Season	Year	1981	1980	1979	1978	1977	1976	1975	1974
Gaging Station Pool No. 1 - Catch and Release									
Fall	1979				31	109	106	46	17
Fall	1980			24	186	397	168	9	0
Fall	1981		61	50	95	517	0	0	0
Fall	1982	60	50	71	237	8	--	--	--
Ruedi Damsite Station No. 2 - Catch and Release									
Fall	1978					51	204	108	34
Fall	1979				159	180	69	53	5
Spring	1980				70	91	51	26	13
Fall	1980			51	174	171	31	4	0
Fall	1981		101	113	85	162	0	0	0
Fall	1982	122	97	114	156	6	--	--	--
Old Faithful Station No. 3 - Catch and Release									
Fall	1979				243	352	107	40	0
Spring	1980				194	208	67	14	0
Fall	1980			204	479	248	21	0	0
Fall	1981		121	251	258	243	0	0	0
Fall	1982	270	210	250	311	8	--	--	--
Upper Standard Regulation Station No. 4 - 8 Fish/Day									
Fall	1979				252	271	58	27	4
Spring	1980				108	85	22	6	3
Fall	1980			104	226	77	6	0	0
Fall	1981		84	140	117	88	0	0	0
Fall	1982	35	80	107	97	6	--	--	--
Taylor River Station No. 5 - 8 Fish/Day									
Fall	1978					86	198	131	44
Fall	1979				348	265	80	31	0
Spring	1980				237	170	43	13	6
Fall	1980			192	170	110	32	0	0
Fall	1981		151	157	102	180	0	0	0
Fall	1982	103	174	164	273	10	--	--	--
Big Pullout Station No. 6 - 8 Fish/Day									
Fall	1980			30	39	54	16	0	0
Fall	1982	11	8	46	90	5	--	--	--

Table III-2. Life Tables - Fryingpan River (rainbow trout/ha)

Sample period		Year class							
Season	Year	1981	1980	1979	1978	1977	1976	1975	1974
Gagling Station Pool No. 1 - Catch and Release									
Fall	1979					51	124	98	20
Fall	1980			31	23	121	112	78	38
Fall	1981		6	29	29	56	44	0	0
Fall	1982	10	323	833	91	70	--	--	--
Ruedi Damsite Station No. 2 - Catch and Release									
Fall	1978					46	245	71	41
Fall	1979				30	81	58	40	11
Spring	1980				45	87	84	59	22
Fall	1980			45	71	66	35	16	8
Fall	1981		24	51	44	16	4	0	0
Fall	1982	30	141	203	57	33	--	--	--
Old Faithful Station No. 3 - Catch and Release									
Fall	1979				29	134	96	46	19
Spring	1980				26	113	77	35	12
Fall	1980			78	98	84	43	29	12
Fall	1981		18	19	21	26	8	0	0
Fall	1982	4	37	55	30	19			
Upper Standard Regulation Station No. 4 - 8 Fish/Day									
Fall	1979				125	122	75	19	7
Spring	1980				17	53	20	2	0
Fall	1980			13	19	10	6	0	0
Fall	1981		20	8	28	6	0	0	0
Fall	1982	1	20	22	1	1	--	--	--
Taylor River Station No. 5 - 8 Fish/Day									
Fall	1978					130	267	84	10
Fall	1979				345	206	53	22	6
Spring	1980				130	212	49	24	7
Fall	1980			140	97	22	11	10	0
Fall	1981		121	123	75	8	5	0	0
Fall	1982	4	59	81	25	12	--	--	--
Big Pullout Station No. 6 - 8 Fish									
Fall	1979				122	168	50	1	0
Fall	1980			146	212	159	50	15	0
Fall	1982	4	43	86	34	13	--	--	--

Table III-2. Life Tables - Gunnison River (numbers/ha)

Sample period Season	Year	Year class 1981	1980	1979	1978	1977
		Smith Fork - North Fork (Rainbow Trout)				
Fall	1981		314	26	9	6
Fall	1982	167	42	11	7	1
		Duncan - Ute Trail (Rainbow Trout)				
Fall	1981		197	91	41	10
Fall	1982	212	85	71	20	3
		Smith Fork - North Fork (Brown Trout)				
Fall	1981		88	13	3	2
Fall	1982	122	55	7	1	1
		Duncan - Ute Trail (Brown Trout)				
Fall	1981		641	170	31	3
Fall	1982	363	216	14	--	--

Table III-2. Life Tables - Middle Fork of the South Platte River (brown trout/ha).

Sample period Season	Year	Year class 1982	1981	1980	1979	1978	1977	1976	1975	1974
				Station No. 1 - at Garo Bridge						
Fall	1979				(655)[a]	891	421	171	28	9
Fall	1980			(353)	1058	630	68	10	0	0
Fall	1981		(328)	524	664	71	0	0	0	0
Fall	1982	(142)	286	237	148	10	0	0	0	0
				Station No. 2 - at Gaging Station Bridge						
Fall	1979				(1007)	606	278	63	46	8
Fall	1980			(115)	592	267	83	43	8	0
Fall	1981		(259)	571	550	59	26	0	0	0
Fall	1982	(54)	289	206	191	19	0	0	0	0
				Station No. 3 - 1 Mile below Gaging Station Bridge						
Fall	1979				(1624)	983	235	187	23	7
Fall	1980			(324)	1047	390	238	12	49	25
Fall	1981		(538)	766	796	144	17	12	0	0
Fall	1982	(88)	518	432	406	0	0	0	0	0
				Station No. 4 - 2 Miles below Gaging Station Bridge						
Fall	1980			(636)	604	321	265	67	8	0
Fall	1981		(704)	689	759	129	25	2	0	0
Fall	1982	(102)	93	107	145	19	0	0	0	0
				Station No. 5 - 3 Miles below Gaging Station Bridge						
Fall	1980			(524)	708	321	172	85	19	19
Fall	1981		(378)	744	645	187	109	48	7	6
Fall	1982	(97)	234	209	181	15	15	0	0	0

[a] Number in parenthesis is young-of-year/ha

Table III-2. Life Tables - North Platte River (brown and rainbow/ha)

Sample season		Year class					
Season	Year	1981	1980	1979	1978	1977	1976
			(Brown Trout)				
Fall	1982	12	47	13	22	1	1
			(Rainbow Trout)				
Fall	1982	4	11	12	2	1	

Table III-2. Life Tables - Rio Grande River (brown trout/ha)

Sample period		Year class						
Season	Year	1981	1980	1979	1978	1977	1976	1975
				Coller Fly Water				
August	1981		65	41	66	64	8	0
August	1982	76	80	93	3	0	0	0
				State Bridge Section				
August	1981	26	19	36	11	3	2	
August	1982	65	21	33	12	2	0	0
				Wason Ranch - Standard Regulations				
August	1982	63	99	136	13	0	0	0
				Wason Ranch - Fly Water				
August	1982	71	98	190	19	0	0	0
				State Bridge Section (Rainbow Trout)				
August	1982	212	75	94	137	31	0	0

Table III-2. Life Tables - South Fork of the Rio Grande (brown trout/ha)

Sample period		Year class								
Season	Year	1981	1980	1979	1978	1977	1976	1975	1974	1973
					Beaver Creek Bridge					
Fall	1977						659	301	1470	180
Fall	1978					630	111	217	86	0
Fall	1979				736	726	148	30	32	
Fall	1980			27	1057	200	77	17		
Fall	1981		262	109	616	15	10			
Fall	1982	348	202	398	70					
					Park Creek Campground					
Fall	1977						235	576	1045	42
Fall	1978					857	158	252	267	47
Fall	1979				639	699	274	37	10	
Fall	1980			62	674	329	30			
Fall	1981		147	351	356	44	0			
Fall	1982	508	326	275	15					
					Chain Station					
Fall	1977						348	479	1067	44
Fall	1978					620	128	203	12	0
Fall	1979				620	669	151	20	10	0
Fall	1980			52	706	363	47	10	10	
Fall	1981		99	354	473	74	0			
Fall	1982	257	148	500	57					

Table III-2. Life Tables - South Platte River (brown trout/ha)

Sample period		Year class						
Season	Year	1981	1980	1979	1978	1977	1976	1975
Upper Canyon Section - Catch and Release								
Fall	1979				233	284	218	35
Spring	1980			6	230	385	75	0
Fall	1980			252	568	176	12	0
Spring	1981		12	162	318	43	8	0
Fall	1981		46	203	170	19	0	0
Fall	1982	165	205	203	43	0	0	0
Lower Canyon Section - Catch and Release								
Fall	1979				202	364	421	57
Spring	1980			22	237	595	195	0
Fall	1980			283	563	165	50	0
Spring	1981		36	187	539	242	8	0
Fall	1981		98	286	293	29	0	0
Fall	1982	164	189	235	128	22	0	0
Deckers Bridge Section - 8 Fish/Day								
Fall	1979				657	327	435	30
Spring	1980			142	816	433	35	0
Fall	1980			993	678	66	31	11
Spring	1981		49	544	397	33	4	0
Fall	1981		460	623	171	12	0	0
Fall	1982	1813	344	55	4	0	0	0
Scraggy View Section - 8 Fish/Day								
Fall	1979				102	343	512	16
Spring	1980			360	769	264	14	0
Fall	1980			526	195	10	3	0
Spring	1981		161	453	138	18	0	0
Fall	1981		412	301	35	0	0	0
Fall	1982	925	244	23	3	0	0	0

Table III-2. Life Tables - South Platte River (rainbow trout/ha)

Sample period		Year class						
Season	Year	1981	1980	1979	1978	1977	1976	1975
				Upper Canyon Section - Catch and Release				
Fall	1979				106	682	583	56
Spring	1980				177	786	626	78
Fall	1980			35	344	655	288	139
Spring	1981		4	26	375	505	187	70
Fall	1981		10	155	434	137	49	7
Fall	1982	101	70	132	328	209	32	0
				Lower Canyon Section - Catch and Release				
Fall	1979				105	758	685	88
Spring	1980				93	732	703	114
Fall	1980			20	249	557	274	127
Spring	1981		4	26	375	505	187	70
Fall	1981		23	86	465	224	45	0
Fall	1982	44	44	68	300	239	44	4
				Deckers Bridge Section - 8 Fish/Day				
Fall	1979				237	181	62	8
Spring	1980				45	67	51	32
Fall	1980			243	141	30	1	0
Spring	1981		14	54	24	10	7	0
Fall	1981		119	100	54	7	8	0
Fall	1982	275	88	17	10	0	0	0
				Scraggy View Section - 8 Fish/Day				
Fall	1979				107	152	24	2
Spring	1980				53	67	17	1
Fall	1980			162	68	6	0	0
Spring	1981			86	50	6	0	0
Fall	1981		44	62	20	2	0	0
Fall	1982	91	28	31	13	0	0	0

Table III-2. Life Tables - St. Vrain River (brown trout/ha)

Sample period		Year class						
Season	Year	1982	1981	1980	1979	1978	1977	1976
				City Park				
Fall	1980			(938)	1944	356	0	0
Fall	1981		(1406)	1186	352	0	0	0
Fall	1982	(354)	1392	418	15			
				Gaging Station				
Fall	1980			(353)	946	192	0	0
Fall	1981		(856)	228	217	0	0	0
Fall	1982	(698)	892	298	53	1	0	0
				Ideal Concrete				
Fall	1980			(473)	1032	358	15	1
Fall	1981		(100)	34	34	11		
Fall	1982	(427)	335	188	11			
				Martin Marieta				
Fall	1980			(303)	400	192	10	
Fall	1981		(93)	4	19	7		
Fall	1982	(195)	47	104	15			

Table III-2. Life Tables - Taylor River (brown trout/ha)

Sample period Season	Year	Year class 1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970	1969
							Almont Station							
Spring	1974										310	372	171	9
Fall	1974									106	322	421	41	9
Spring	1975								89	119	249	47	6	0
Fall	1975								57	296	360	43	0	0
Fall	1979				143	713	289	27	6	0	0	0		
Fall	1980			79	438	429	62	37	0	0	0	0		
Fall	1981		338	385	209	38	44	3	0					
Fall	1982	1043	368	285	38	4	0	0						
							Elsinore Cattle Company							
Spring	1974										278	231	91	
Fall	1974									159	263	493	75	15
Spring	1975									217	190	53	--	0
Fall	1975								88	262	405	93	18	0
Fall	1979				228	684	263	39	28	0	0	0	0	
Fall	1980			141	447	385	110	49	0					
Fall	1981		370	318	146	36	61	14						
Fall	1982	450	275	229	82	8	0							
							One Mile Campground							
Spring	1974										392	573	31	20
Fall	1974									283	433	527	37	5
Spring	1975									353	407	0	15	0
Fall	1975								199	334	386	44	22	
Fall	1979				530	1066	324	10	66	0	0	0	0	
Fall	1980			328	855	525	83	42	0					
Fall	1981		383	397	373	163	36	12	2					
Fall	1982	625	385	297	107	11	0	0	0					
							Lower Sams							
Spring	1974										74	730	322	42
Fall	1974									14	124	467	297	0
Spring	1975									128	532	168	--	0
Fall	1975								25	137	395	420	33	
Fall	1979				36	711	463	53	31					
Fall	1980			186	603	952	170	87						
Fall	1981		285	659	878	550	72	22						
Fall	1982	281	614	677	71	9	0	0						
							Upper Sams							
Spring	1974										108	695	170	
Fall	1974									54	65	439	395	47
Spring	1975									103	474	190	--	0
Fall	1975									166	554	358	30	0
Fall	1979				78	566	507	100	68	0				
Fall	1980			46	288	601	192	96	0	0				
Fall	1981		59	170	420	444	111	33	2	2				
Fall	1982	105	278	635	184	16	0	0	0	0				

APPENDIX IV

Fry, Juvenile, and Adult Brown and Rainbow Trout Habitat Curves

(expressed as square feet of weighted usable area - WUA)

versus Discharge Patterns

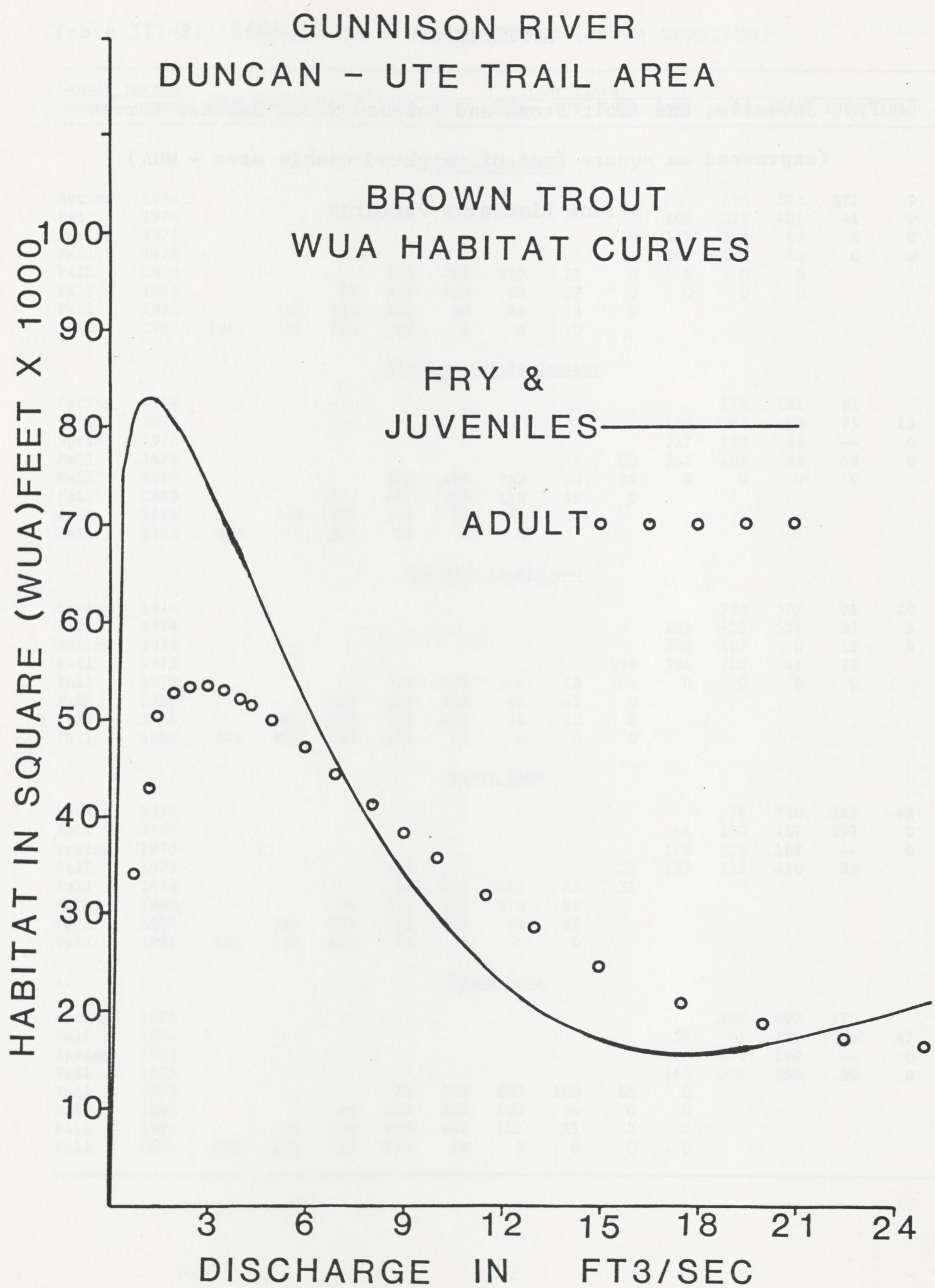

GUNNISON RIVER
DUNCAN – UTE TRAIL AREA
BROWN TROUT
WUA HABITAT CURVES
FRY &
JUVENILES
ADULT
HABITAT IN SQUARE (WUA)FEET X 1000
10
20
30
40
50
60
70
80
90
100
3
6
9
12
15
18
21
24
DISCHARGE IN FT3/SEC

Figure IV-1.

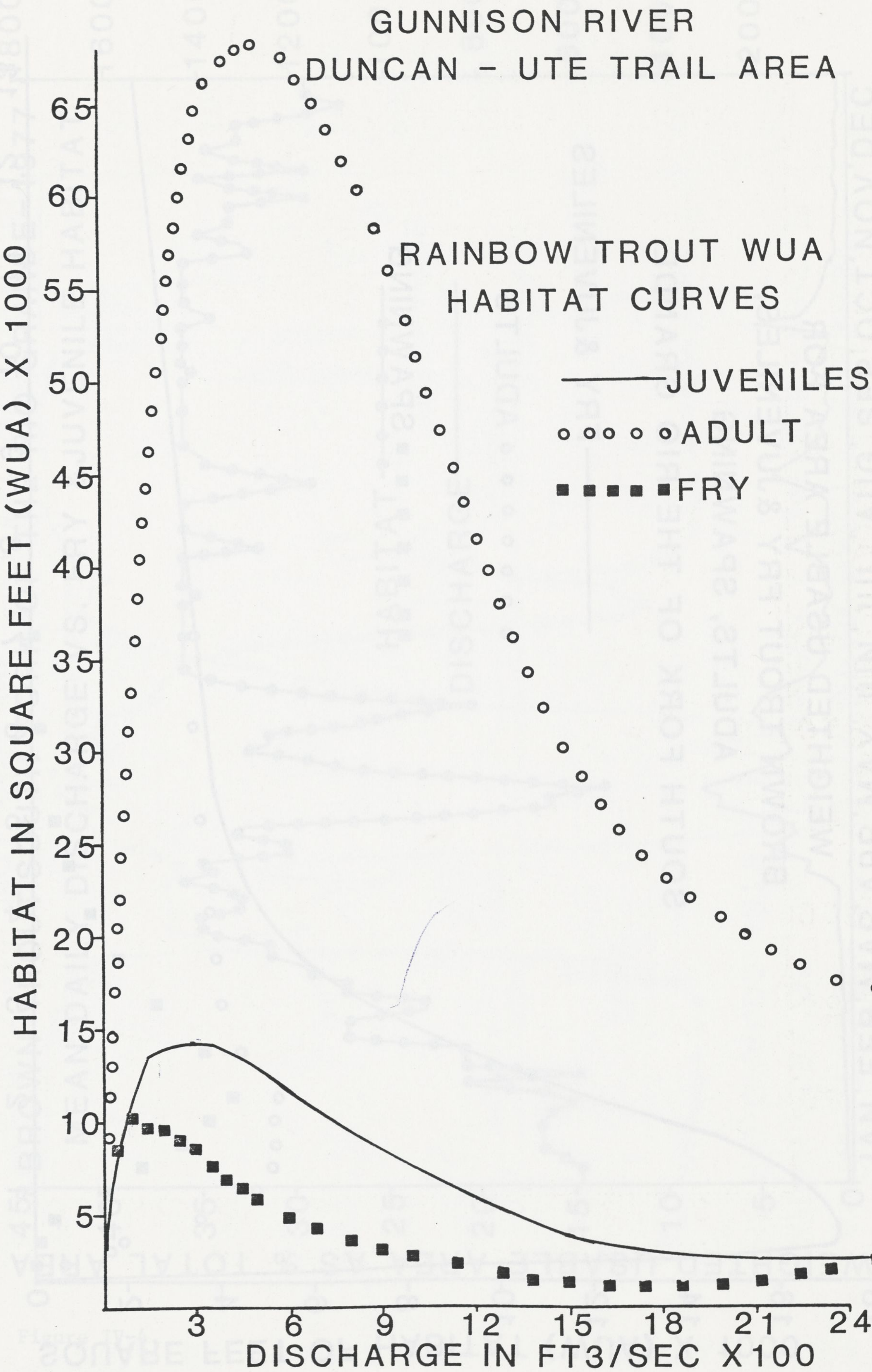
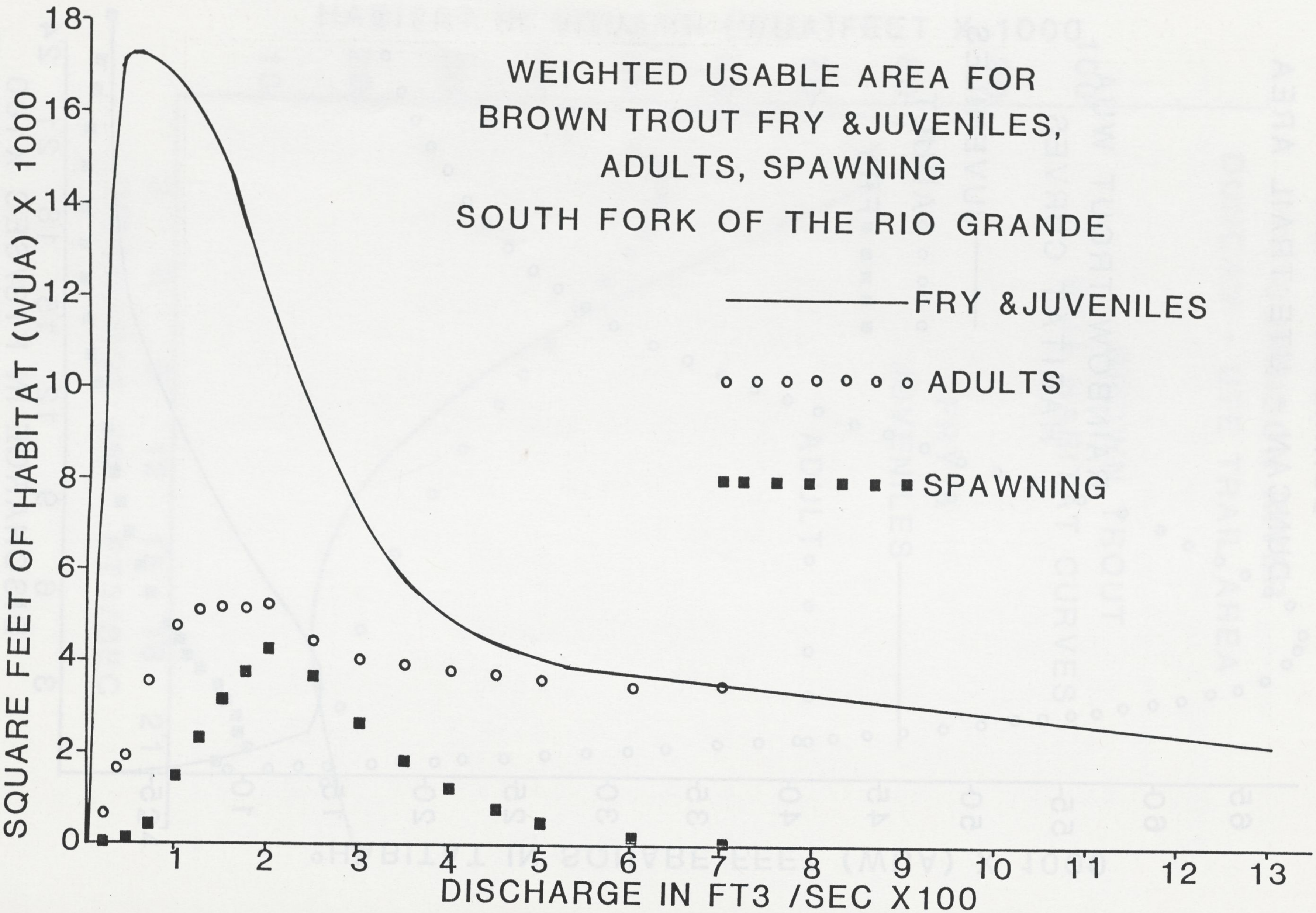

GUNNISON RIVER
DUNCAN - UTE TRAIL AREA
RAINBOW TROUT WUA
HABITAT CURVES
JUVENILES
ADULT
FRY
HABITAT IN SQUARE FEET (WUA) X 1000
5
10
15
20
25
30
35
40
45
50
55
60
65
3
6
9
12
15
18
21
24
DISCHARGE IN FT3/SEC X100

Figure IV-2.



WEIGHTED USABLE AREA FOR
BROWN TROUT FRY &JUVENILES,
ADULTS, SPAWNING
SOUTH FORK OF THE RIO GRANDE
FRY &JUVENILES
ADULTS
SPAWNING
SQUARE FEET OF HABITAT (WUA) X 1000
0
2
4
6
8
10
12
14
16
18
1
2
3
4
5
6
7
8
9
10
11
12
13
DISCHARGE IN FT3 /SEC X100

Figure IV-3.

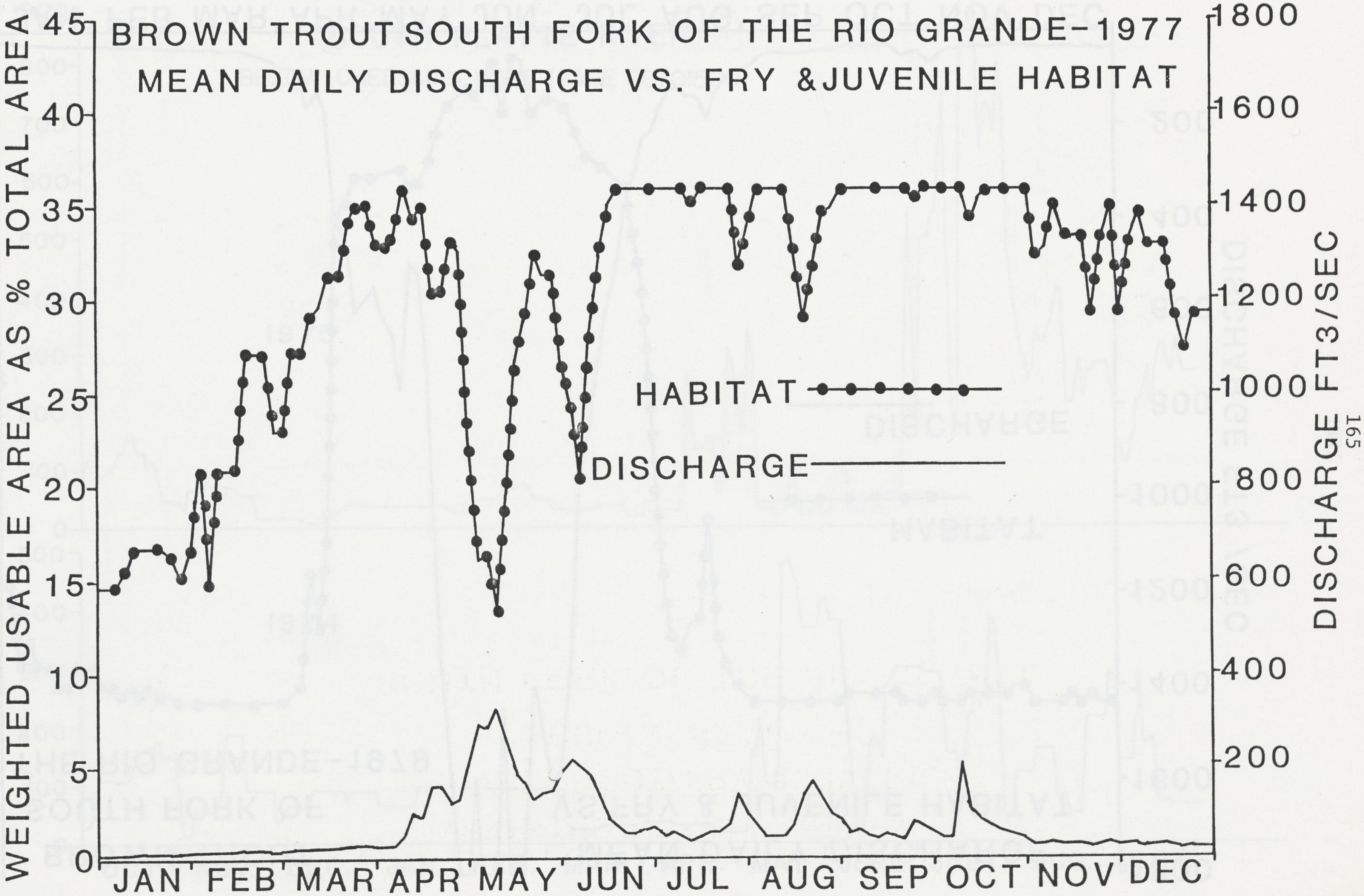

BROWN TROUT SOUTH FORK OF THE RIO GRANDE-1977
MEAN DAILY DISCHARGE VS. FRY & JUVENILE HABITAT
HABITAT
DISCHARGE
WEIGHTED USABLE AREA AS % TOTAL AREA
DISCHARGE FT3/SEC
0
5
10
15
20
25
30
35
40
45
200
400
600
800
1000
1200
1400
1600
1800
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Figure IV-4.

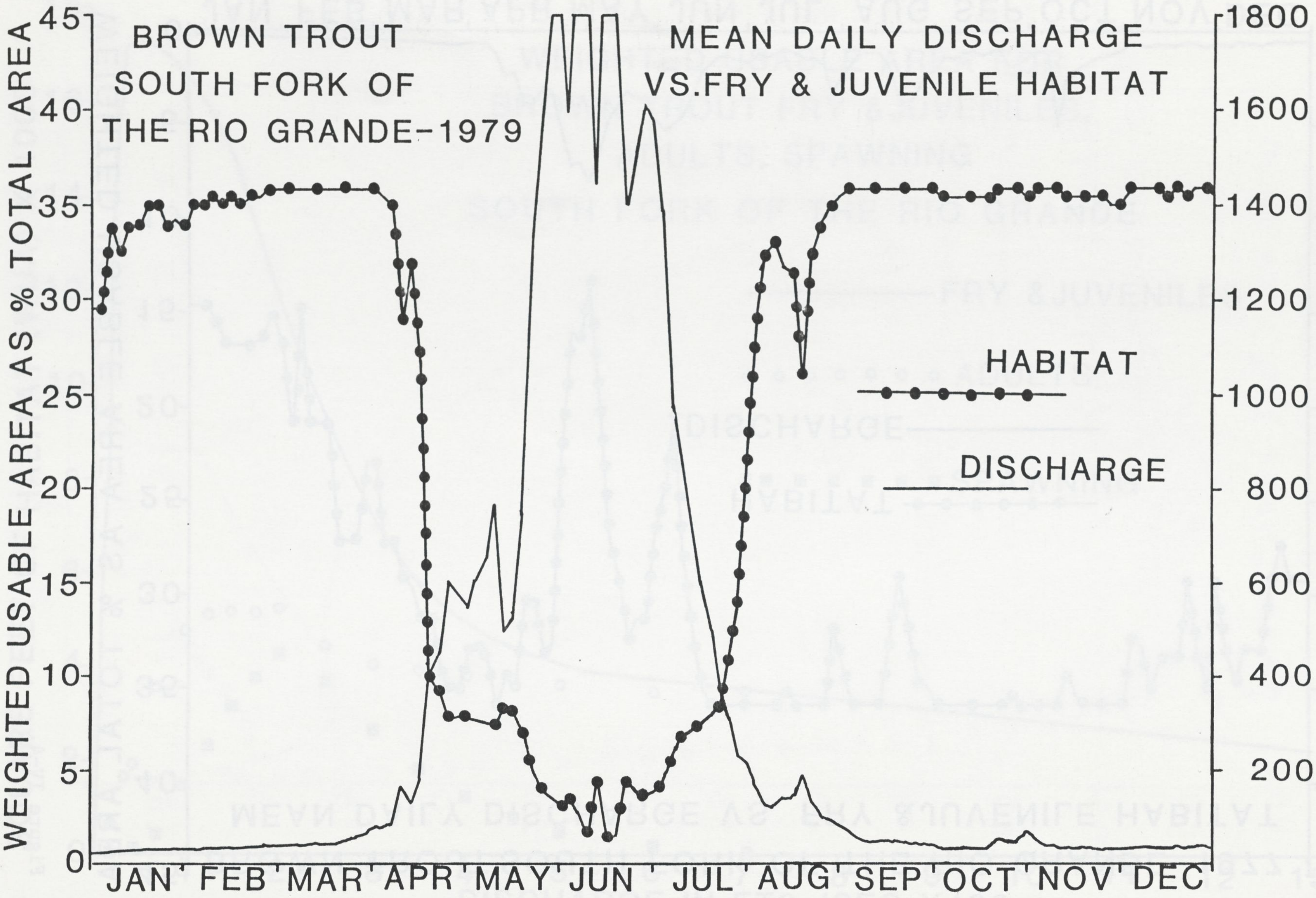
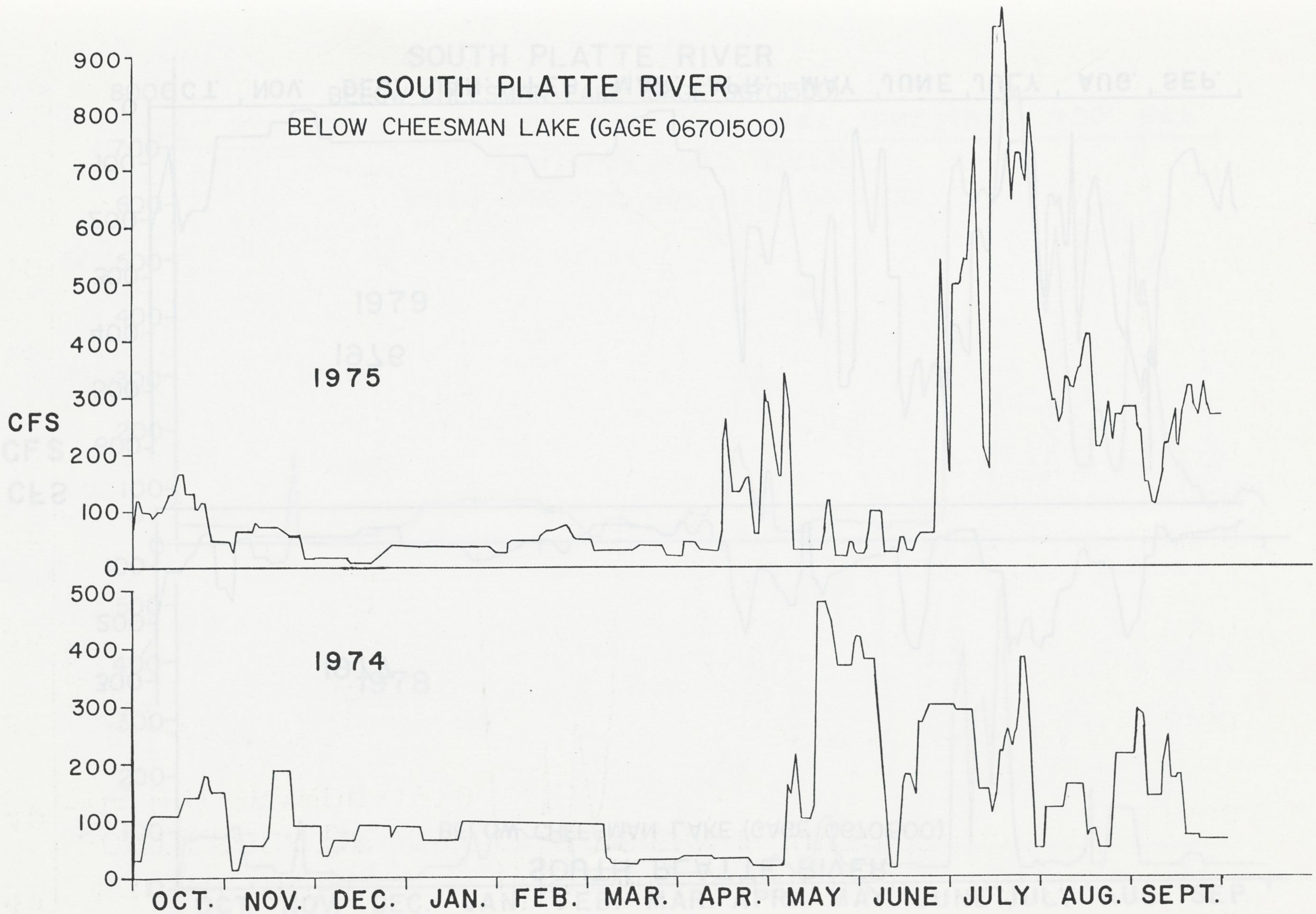

BROWN TROUT
SOUTH FORK OF
THE RIO GRANDE-1979
MEAN DAILY DISCHARGE
VS.FRY & JUVENILE HABITAT
HABITAT
DISCHARGE
WEIGHTED USABLE AREA AS % TOTAL AREA
DISCHARGE FT3 /SEC
0
5
10
15
20
25
30
35
40
45
200
400
600
800
1000
1200
1400
1600
1800
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Figure IV-5.

Figure IV-6.



SOUTH PLATTE RIVER
BELOW CHEESMAN LAKE (GAGE 06701500)
1975
1974
CFS
900
800
700
600
500
400
300
200
100
0
500
400
300
200
100
0
OCT.
NOV.
DEC.
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEPT.

SOUTH PLATTE RIVER

BELOW CHEESMAN LAKE (GAGE 06701500)

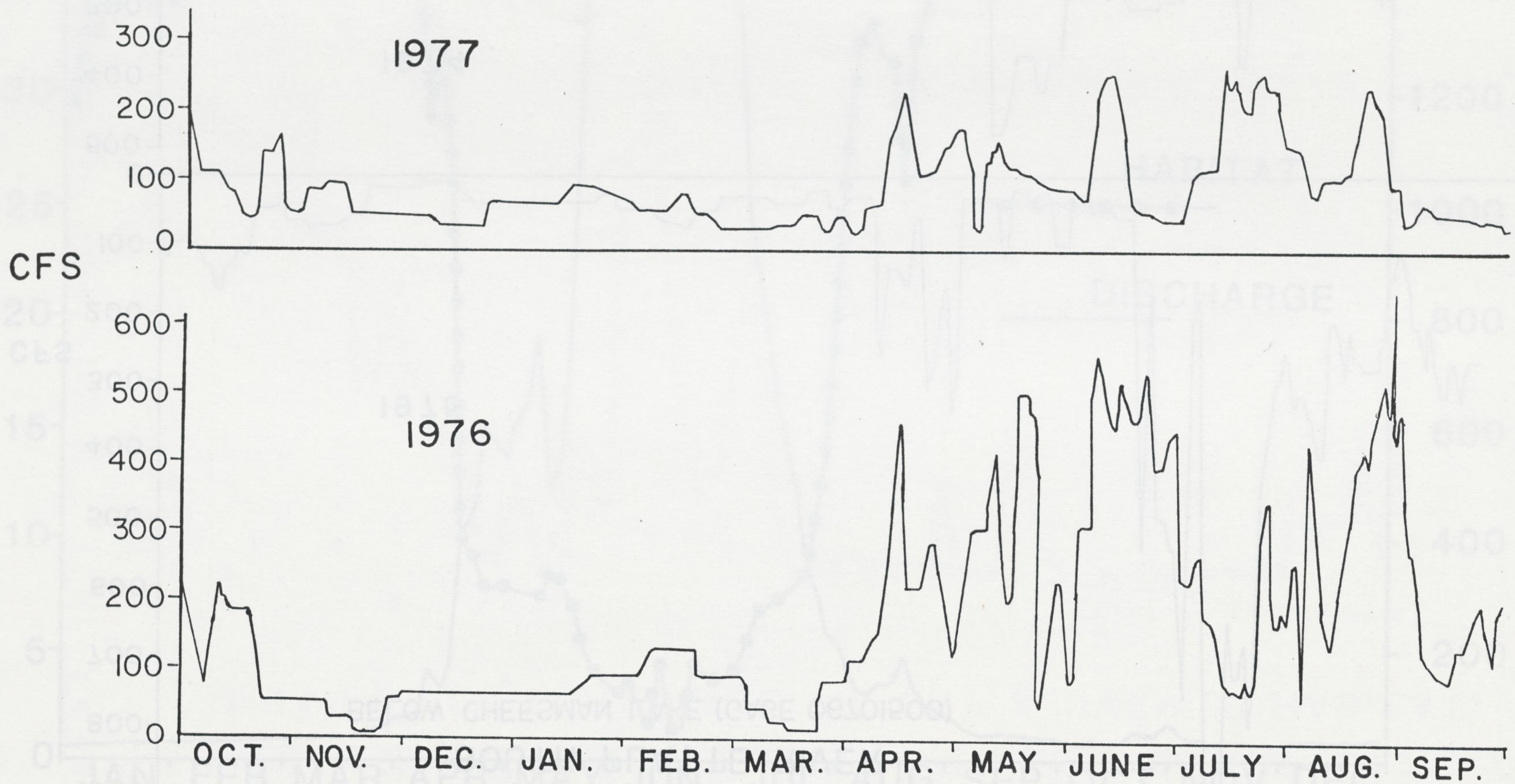


Figure IV-7.

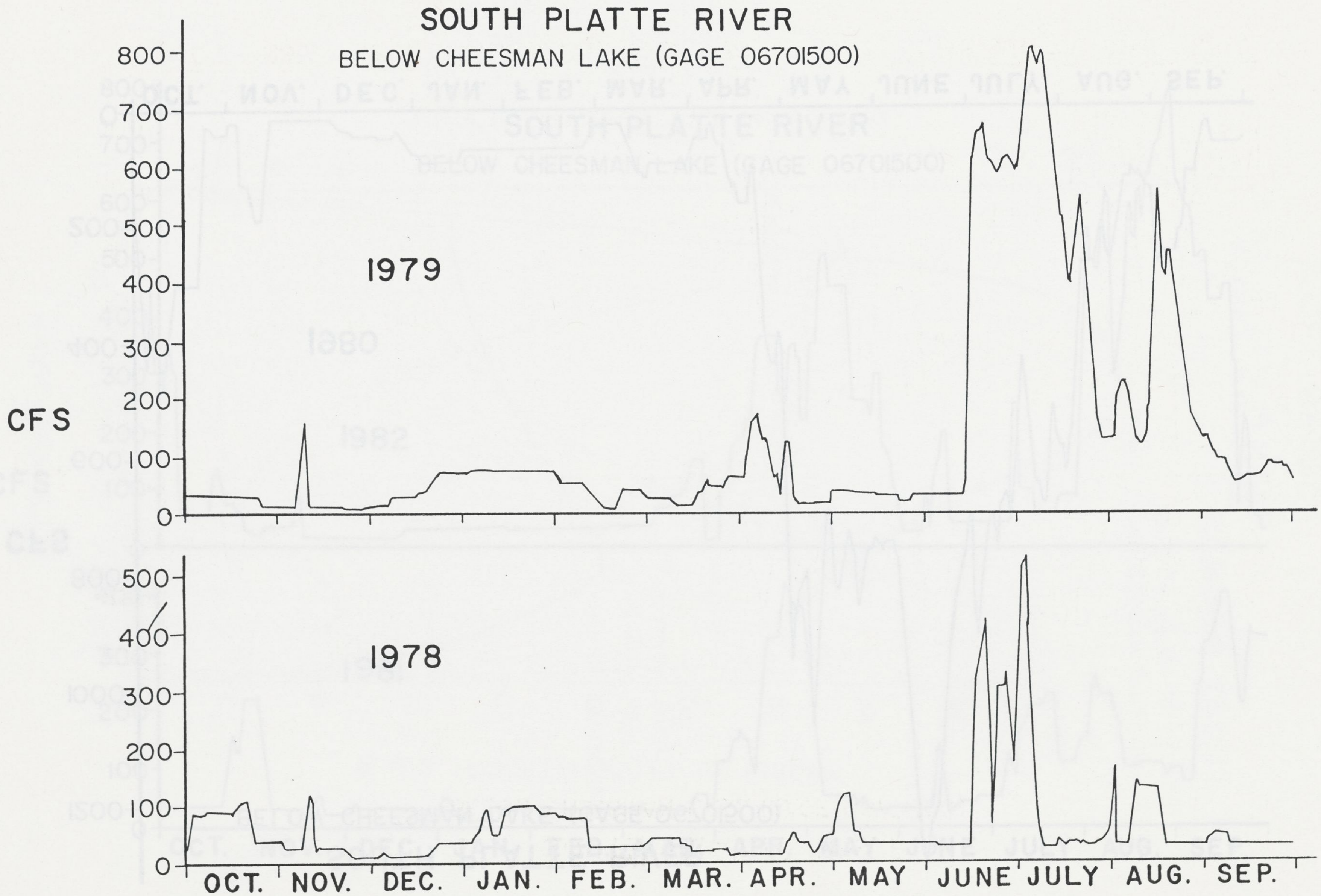

SOUTH PLATTE RIVER
BELOW CHEESMAN LAKE (GAGE 06701500)
CFS
1979
1978
0
100
200
300
400
500
600
700
800
OCT.
NOV.
DEC.
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEP.

Figure IV-8.

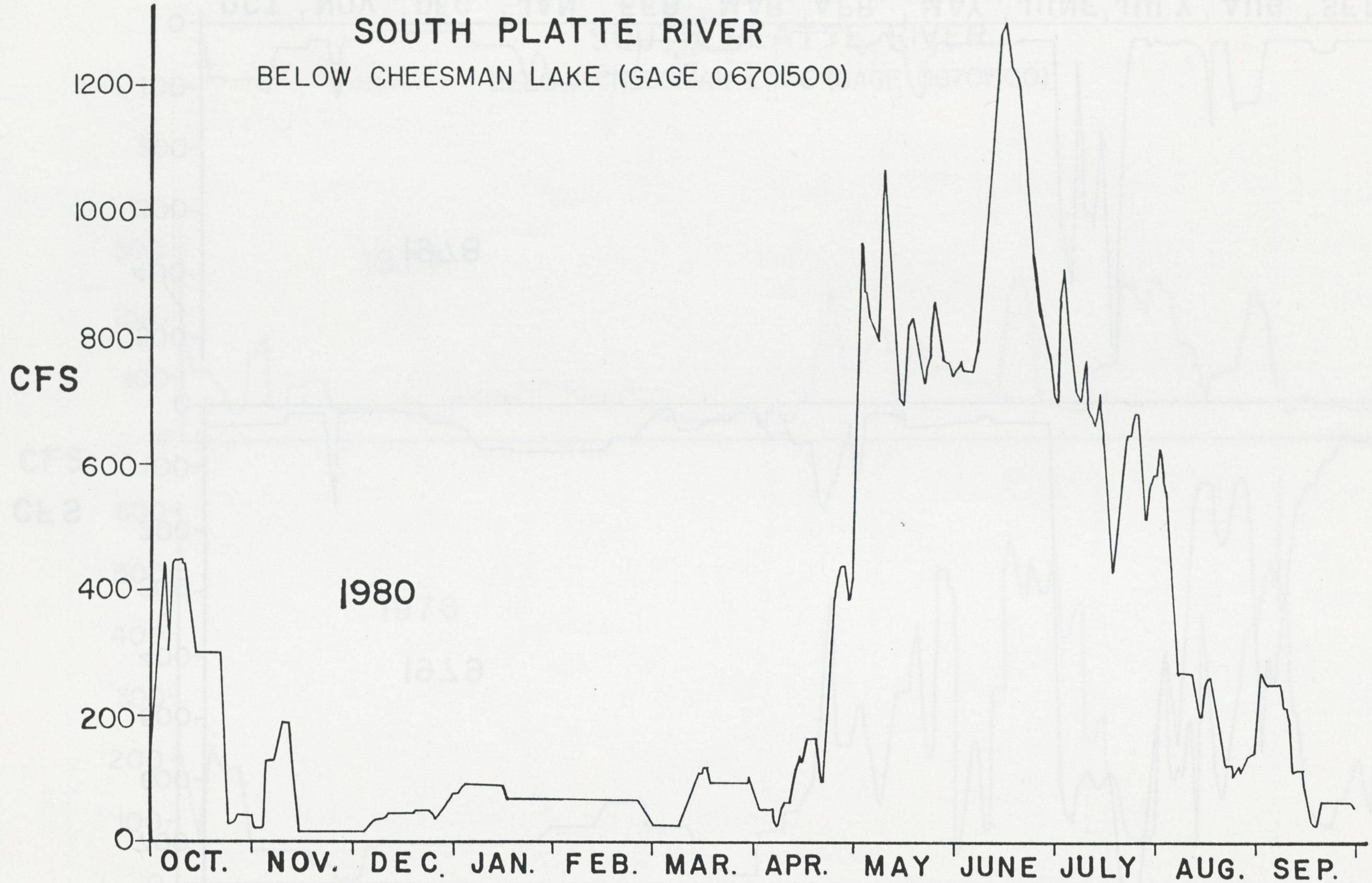

SOUTH PLATTE RIVER
BELOW CHEESMAN LAKE (GAGE 06701500)
CFS
1200
1000
800
600
400
200
0
1980
OCT.
NOV.
DEC.
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEP.

Figure IV-9.

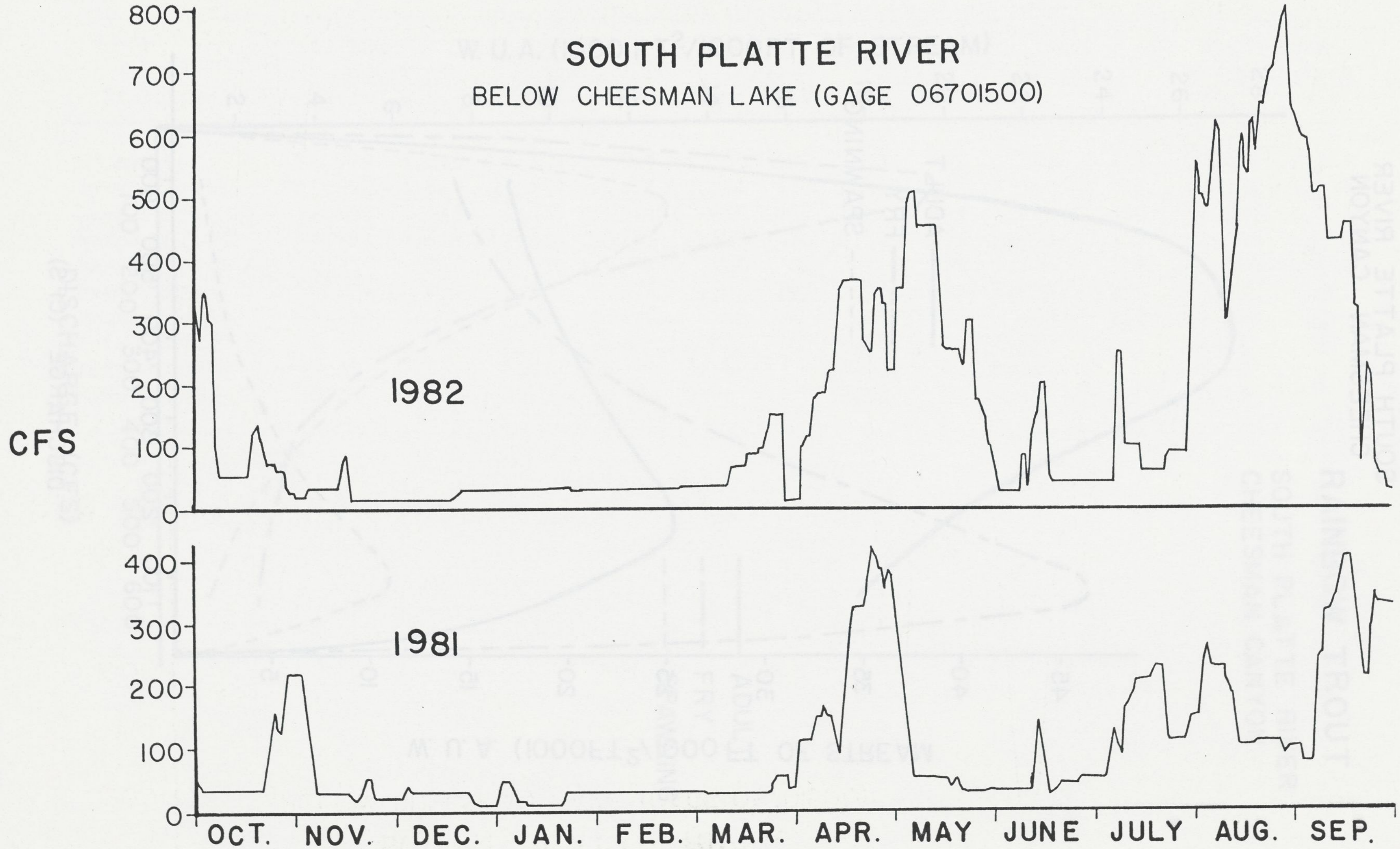

SOUTH PLATTE RIVER
BELOW CHEESMAN LAKE (GAGE 06701500)
CFS
1982
1981
0
100
200
300
400
500
600
700
800
OCT.
NOV.
DEC.
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEP.

Figure IV-10.

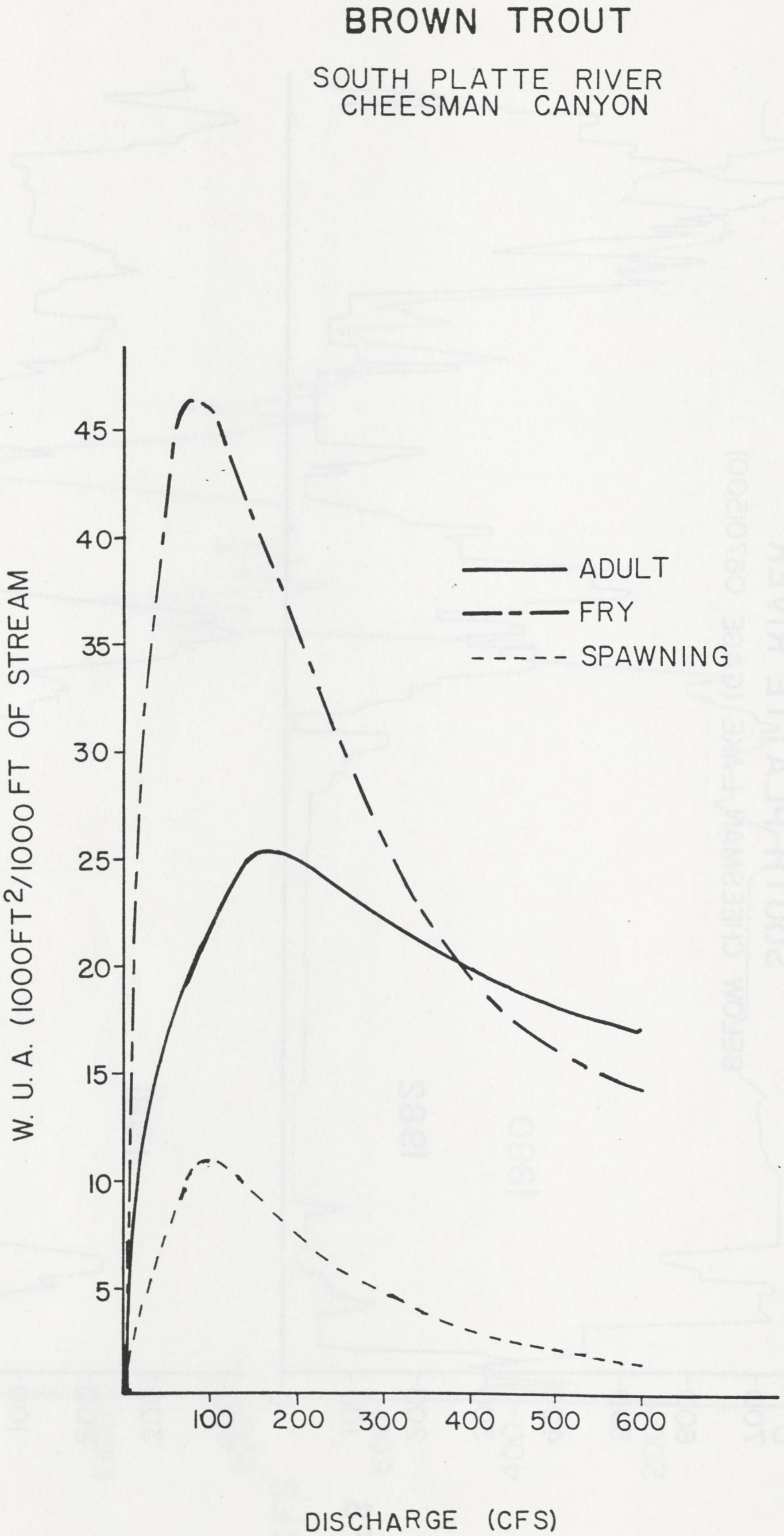

BROWN TROUT
SOUTH PLATTE RIVER
CHEESMAN CANYON
ADULT
FRY
SPAWNING
W. U. A. (1000FT²/1000FT OF STREAM
45
40
35
30
25
20
15
10
5
100
200
300
400
500
600
DISCHARGE (CFS)

Figure IV-11.

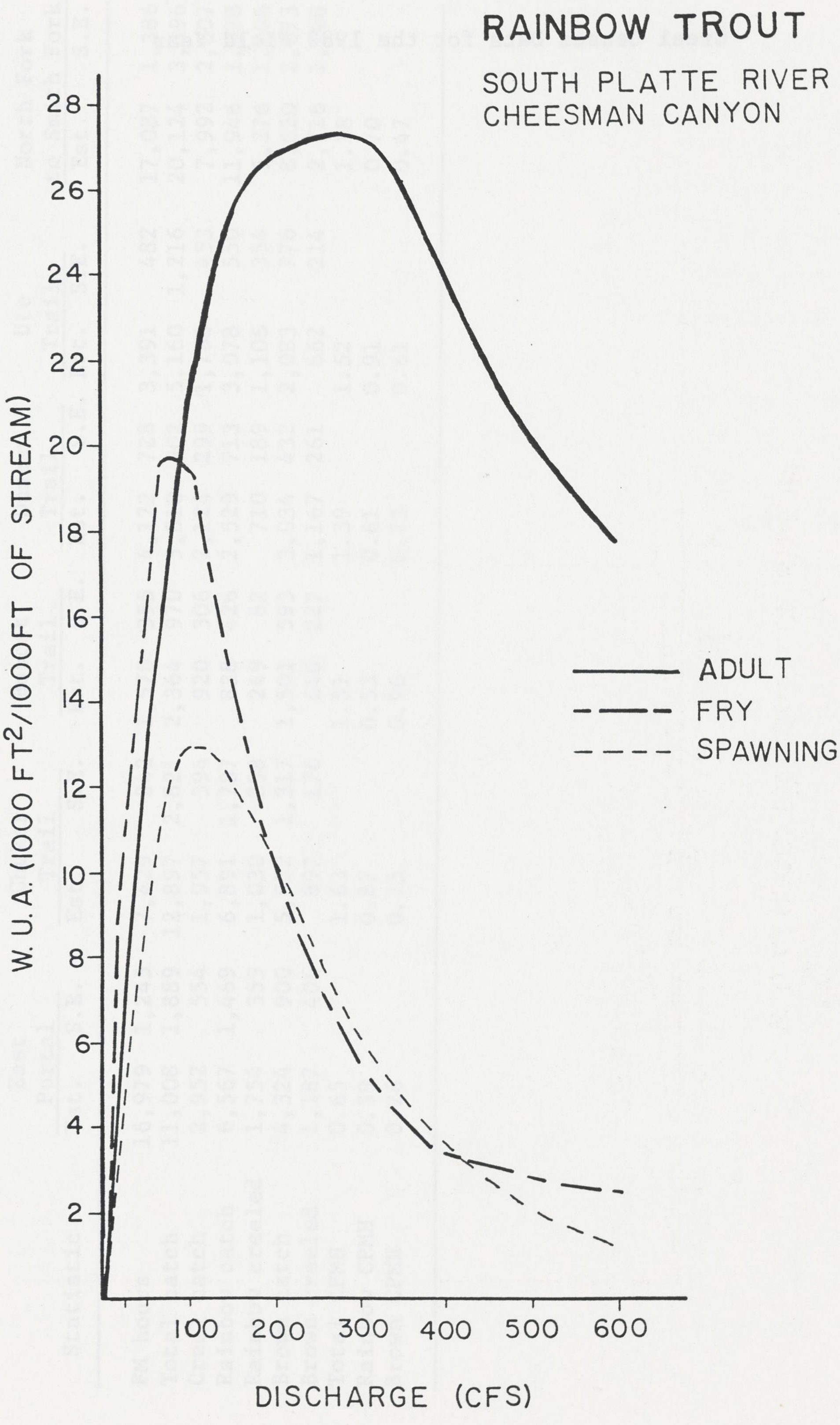

RAINBOW TROUT
SOUTH PLATTE RIVER
CHEESMAN CANYON
ADULT
FRY
SPAWNING
W. U. A. (1000 FT^2/1000FT OF STREAM)
DISCHARGE (CFS)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
100
200
300
400
500
600

Figure IV-12.

APPENDIX V

Creel Census Data for the 1982 Field Year

Table V-1. Creel census results from the Gunnison Canyon, May - September 1982.

Statistic	East Portal Est.	East Portal S.E.	Chukar Trail Est.	Chukar Trail S.E.	Bobcat Trail Est.	Bobcat Trail S.E.	Duncan Trail Est.	Duncan Trail S.E.	Ute Trail Est.	Ute Trail S.E.	North Fork to Smith Fork Est.	North Fork to Smith Fork S.E.
FM hours	16,979	1,245	7,429	842	1,570	355	4,172	728	3,391	482	17,087	1,386
Total catch	11,008	1,889	12,897	2,821	2,364	970	5,810	902	5,160	1,216	20,124	3,396
Creel catch	2,952	554	1,957	394	920	306	2,124	299	1,768	453	7,992	2,007
Rainbow catch	6,567	1,469	6,891	1,787	838	426	2,529	713	3,078	550	11,946	1,978
Rainbow creeled	1,754	359	1,030	298	249	82	710	189	1,106	354	5,276	1,706
Brown catch	4,324	900	5,972	1,317	1,501	593	3,034	432	2,083	776	8,020	2,073
Brown creeled	1,187	406	897	176	646	227	1,167	261	662	214	2,716	1,168
Total CPMH	0.65		1.63		1.51		1.39		1.52		1.18	
Rainbow CPMH	0.39		0.87		0.53		0.61		0.91		0.70	
Brown CPMH	0.26		0.75		0.96		0.73		0.61		0.47	

Table V-2. Comparison of creel census statistics from April 16 - October 11, 1977 vs May - September 1982 for the Black Canyon of the Gunnison.

	1977 est.	1982 est.
FM hours	22,079	51,128
Total catch	14,345	57,363
Creel catch		17,713
Rainbow catch	11,634	31,849
Rainbow creeled		10,125
Brown catch	2,529	24,934
Brown creeled		7,275
Total CPMH	0.65	1.12
Rainbow CPMH	0.53	0.62
Brown CPMH	0.12	0.49

Table V-3. Harvest distribution by species, numbers, size, and location on the Gunnison River, May - September 1982.

Species kept/ released	0-6 in.	6-9 in.	9-12 in.	12-15 in.	15-18 in.	18-21 in.	21-24 in.	Total in.
East Portal Access Area								
Rainbow kept	20	139	658	159	219	359	199	1753
Rainbow released	103	535	2017	948	843	185	182	4813
Brown kept		204	575	204	167	18	19	1187
Brown released	301	403	1349	359	704	14	7	3137
Chukar Trail Area								
Rainbow kept	82	107	348	13	240	240		1030
Rainbow released	506	695	948	1627	1469	616		5861
Brown kept	87	99	560	26	99	26		897
Brown released	186	571	1780	1754	731	53		5075
Bobcat Trail Area								
Rainbow kept	32	76	108	--	11	22		249
Rainbow released		111	103	144	151	80		589
Brown kept	89	177	342	38				646
Brown released		315	282	116	108	34		855
Duncan Trail Area								
Rainbow kept	8	62	386	69	123	54	8	710
Rainbow released		561	368	735	116	39	0	1819
Brown kept	50	367	648	60	43			1168
Brown released	15	504	904	337	107			1867
Ute Trail Area								
Rainbow kept	9	179	383	153	332	34	17	1107
Rainbow released	29	114	743	714	286	86		1972
Brown kept	12	121	386	96	48			663
Brown released		711	437	109	164			1421
North Fork Access Area								
Rainbow kept		879	2970	879	273	273		5274
Rainbow released	260	2153	3007	840	336	76		6672
Brown kept	75	175	1745	424	199	75	25	2718
Brown released	257	1189	2427	1125	225	81		5304

Table V-4. Creel census of the Black Canyon of the Gunnison River, May - September 1982, Crystal and East Portal access area.

Statistic	May Mean	May S.E.	June Mean	June S.E.	July Mean	July S.E.	August Mean	August S.E.	September Mean	September S.E.	Totals Mean
FM - hours	5282	898	2516	332	4059	552	3465	413	1656	398	16978
Total catch	2490	1053	739	388	3211	786	2086	712	2493	1089	11009
Creel catch	802	281	241	170	1138	386	306	135	464	178	2951
Rainbow catch	2299	990	500	341	1000	181	1395	458	1374	905	6568
Rainbow creeled	622	220	241	170	362	110	253	115	277	163	1755
Brown catch	180	72	240	159	2115	701	680	294	1109	449	4325
Brown creeled	170	71	0	0	777	384	53	34	187	106	1187
Total CPMH	0.47		0.29		0.79		0.60		1.50		0.65
Rainbow CPMH	0.44		0.20		0.25		0.40		0.83		0.39
Brown CPMH	0.03		0.09		0.52		0.20		0.67		0.26

Table V-5. Creel census of the Black Canyon of the Gunnison River, May - September 1982, Chukar Trail access.

Statistic	May Mean	May S.E.	June Mean	June S.E.	July Mean	July S.E.	August Mean	August S.E.	September Mean	September S.E.	Totals Mean
FM hours	2067	424	1338	538	1356	268	2385	349	783	214	7929
Total catch	1558	547	409	199	4828	1182	4224	2022	1878	1460	12897
Creel catch	567	179	136	77	271	98	638	146	345	294	1957
Rainbow catch	969	480	176	105	2272	830	2577	1352	897	660	6891
Rainbow creeled	249	87	57	45	102	22	368	175	254	219	1030
Brown catch	555	151	233	121	2556	757	1647	680	981	814	5972
Brown creeled	288	118	79	39	169	77	270	66	91	74	897
Total CPMH	0.75		0.31		3.56		1.77		2.40		1.63
Rainbow CPMH	0.47		0.13		1.68		1.08		1.15		0.87
Brown CPMH	0.27		0.17		1.88		0.69		1.25		0.75

Table V-6. Creel census of the Black Canyon of the Gunnison River, May - September 1982, Bobcat Trail access.

Statistic	May Mean	May S.E.	June Mean	June S.E.	July Mean	July S.E.	August Mean	August S.E.	September Mean	September S.E.	Totals Mean
FM hours	600	212	415	182	337	166	88	62	130	130	1570
Total catch	311	201	389	135	446	446	455	319	763	763	2364
Creel catch	189	149	325	93	86	86	90	51	230	230	920
Rainbow catch	131	99	76	17	257	257	51	2	324	324	839
Rainbow creeled	65	50	76	17	34	34	22	4	52	52	249
Brown catch	181	109	288	105	189	189	405	317	439	439	1502
Brown creeled	124	99	225	68	51	51	68	55	178	178	646
Total CPMH	0.52		0.94		1.32		5.17		5.87		1.51
Rainbow CPMH	0.22		0.18		0.76		0.58		2.49		0.53
Brown CPMH	0.30		0.69		0.56		4.60		3.38		0.96

Table V-7. Creel census of the Black Canyon of the Gunnison River, May - September 1982, Duncan Trail access area.

Statistic	May Mean	May S.E.	June Mean	June S.E.	July Mean	July S.E.	August Mean	August S.E.	September Mean	September S.E.	Totals Mean
FM hours	1316	589	942	283	604	140	789	239	520	163	4171
Total catch	1005	226	601	80	1167	601	1079	135	1959	614	5811
Creel catch	435	203	497	48	228	34	348	55	616	204	2124
Rainbow catch	565	156	108	108	722	616	501	84	633	293	2529
Rainbow creeled	319	159	40	40	52	37	171	40	128	76	710
Brown catch	440	154	246	189	445	65	578	95	1326	338	3035
Brown creeled	116	50	211	178	176	19	177	30	488	181	1168
Total CPMH	0.76		0.64		1.93		1.37		3.77		1.39
Rainbow CPMH	0.43		0.11		1.20		0.63		1.22		0.61
Brown CPMH	0.33		0.26		0.73		0.73		2.55		0.73

Table V-8. Creel census of the Black Canyon of the Gunnison River, May - September 1982, Ute Trail access area.

	May		June		July		August		September		Totals
Statistics	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean
FM hours	1264	229	804	273	516	214	487	200	320	139	3391
Total catch	1151	670	977	489	2003	638	173	123	857	608	5160
Creel catch	451	291	342	246	695	215	115	97	166	62	1769
Rainbow catch	732	483	790	426	1010	51	42	26	503	381	3077
Rainbow creeled	232	117	300	209	499	259	15	15	61	32	1107
Brown catch	419	226	187	107	992	688	131	98	354	235	2083
Brown creeled	219	183	42	38	196	44	101	82	105	48	663
Total CPMH	0.91		1.22		3.88		0.36		2.68		1.52
Rainbow CPMH	0.58		0.98		1.96		0.09		1.57		0.91
Brown CPMH	0.33		0.23		1.92		0.27		1.11		0.61

Table V-9. Creel census of the Black Canyon of the Gunnison River, May - September 1982, North Fork area.

Statistic	May Mean	May S.E.	June Mean	June S.E.	July Mean	July S.E.	August Mean	August S.E.	September Mean	September S.E.	Totals Mean
FM hours	2044	488	2030	500	5219	689	5706	872	2088	445	17087
Total catch	2015	1106	0	0	9748	2247	6806	2263	1555	374	20124
Creel catch	1898	1087	0	0	3880	1485	1256	658	958	457	7992
Rainbow catch	288	170	0	0	6996	1562	3556	1130	1106	406	11946
Rainbow creeled	288	170	0	0	3325	1519	1059	629	603	423	5275
Brown catch	1728	1155	0	0	2751	1326	3092	1070	450	250	8021
Brown creeled	1611	1119	0	0	555	197	196	82	355	261	2717
Total CPMH	0.99		0		1.87		1.19		0.74		1.18
Rainbow CPMH	0.14		0		1.34		0.62		0.53		0.70
Brown CPMH	0.85		0		0.63		0.54		0.22		0.47

Table V-10. Comparison of creel census statistics from the Taylor River for 1981 and 1982.

	June-September 1981		June-October 1982
	Estimate	S.E.	Estimate
FM hours	23,418	2,149	22,137
Total catch	15,633	1,745	15,614
Creel catch	11,936	1,346	11,966
Rainbow catch	6,395	1,077	4,468
Rainbow creeled	5,066	799	4,045
Brown catch	7,377	1,038	9,761
Brown creeled	5,503	692	6,618
Brook catch	839	479	428
Cutthroat catch	1,008	233	958
Brook creeled	729	397	397
Cutthroat creeled	623	176	910
Total CPMH	0.668		0.705
Rainbow CPMH	0.273		0.202
Brown CPMH	0.315		0.441
Brook CPMH	0.036		0.019
Cutthroat CPMH	0.043		0.043

APPENDIX VI

Aquatic Invertebrate Sampling Data for

Jobs 5 and 6 - 1982 Field Year

Table VI-1. Invertebrate species list - Upper Arkansas River.

Sampling site locations: between Texas Creek and Cotopaxi, Chaffee County

Diptera

Atherix pachypus
Hexatoma sp.
Prosimulium sp.
Simulium sp.
Tipula sp.
Chironomidae*

Coleoptera

Elmidae*

Ephemeroptera

Baetis tricaudatus
Ephemerella inermis
Rithrogena hageni

Plecoptera

Claasenia sabulosa
Hesperoperla pacifica
Isogeoides zionensis
Isoperla fulva
Isoperla quinquepunctata
Isoperla petersoni
Triznaka signata

Trichoptera

Brachycentris occidentalis
Culoptila sp.
Hydropsyche cockerelli
Hydropsyche occidentalis
Hydropsyche oslari
Leucotrichia sp.
Micrasema sp.
Rhyacophila coloradensis

Amphipoda

Gammarus lacustris

Oligochaeta*

*Identified further when I have access to appropriate keys.

Additional species sampled in Texas Creek, approximately 2.5 miles upstream from its confluence with the Arkansas River;

Helicopsyche borealis
Cinygmula sp.

Table VI-2. Aquatic invertebrate samples from Colorado River below Byers Canyon Bridge, May 20, 1982.

Invertebrate type	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Total
P. californica	136[a] (18)[b]	228 (87)	44 (8)	298 (64)	403 (164)	164 (32)	170 (22)	286 (52)	241 (25)	58 (8)	2028 (480)
Claassenia	1 (1)	8 (1.5)	13 (3)	14 (3)	13 (3)	2 (0.5)	10 (1.5)		16 (2.5)	6 (2)	83 (18)
Isogenus	4 (1)	5 (2)	15 (4)	6 (2)	5 (1)	7 (1.0)	9 (2)	13 (2)	4 (1.5)	6 (1.5)	74 (18)
Ephemeroptera	19 (0.5)	15 (0.5)	126 (2.5)	12 (*)	12 (*)	6 (*)	28 (0.5)	111 (2.5)	66 (2.0)	12 (*)	407 (8.5)
Trichoptera	24 (0.5)	24 (1)	32 (2)	34 (1)	27 (1)	4 (*)	1 (*)	56 (0.5)	3 (*)	3 (*)	208 (6)
Diptera	14 (0.5)		4 (*)				5 (*)				23 (0.5)
Rhagionidae	135 (11.5)	12 (1)	7 (1)	25 (2)	19 (1.5)	39 (3.5)	45 (3)	20 (2)	23 (1.5)	9 (0.5)	334 (27.5)
Tabanidae								1 (*)	2 (*)	3 (*)	6 (*)
Tipulidae			2 (2)						1 (0.5)		3 (2.5)
Hirudinea			3 (1.5)								3 (1.5)
Gastropoda	2 (*)										2 (*)
Annelida		3 (1)					1 (*)				4 (1)
Oligochaetes			4 (0.5)								4 (0.5)
Odonata					1 (*)				1 (*)		2 (*)
Mollusca					4 (*)						4 (*)
P. californica % total nos.	40.6	77.3	17.6	76.6	83.3	73.9	63.2	58.7	67.5	59.8	63.7
P. californica % total volume	54.5	92.6	32.7	88.9	96.2	86.5	75.9	88.1	75.8	66.7	85.1
Total nos.	335	295	250	389	484	222	269	487	357	97	3185
Total volume	33	94	24.5	72	170.5	37	29	59	33	12	564

NOTE: (*) volume less than 0.5 ml

[a]Numbers/m^2

[b]Volume ml/m^2

Table VI-3. Aquatic invertebrate samples from Colorado River near Parshall, May 20, 1982.

Invertebrate type	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Total
P. Californica	270[a] (91)[b]	8 (3)	66 (14)	301 (78)	109 (17)	147 (24)	137 (49)	158 (70)	45 (11)	108 (38)	1349 (395)
Claassenia	44 (4)	17 (2)	59 (8)	41 (3.5)	28 (1.5)	12 (1.5)	13 (2)	29 (5)	47 (4.0)	15 (1.5)	305 (33)
Isogenus	28 (2.5)	48 (3)	45 (6)	35 (1.5)	17 (0.5)	24 (2)	37 (2)	71 (5)	5 (0.5)	39 (2.5)	349 (25.5)
Ephemeroptera	1300 (26)	1150 (23)	1100 (22)	700 (14)	800 (16)	1200 (24)	1053 (21)	2000 (40)	843 (21.5)	1100 (22)	11246 (229.5)
Trichoptera	324 (11.5)	25 (1)	207 (5)	197 (8)	279 (8.5)	278 (10)	157 (6.5)	98 (3.5)	121 (4)	162 (7)	1866 (65)
Diptera											
Rhagionidae	3 (*)		5 (0.5)	9 (1)	84 (6.5)		72 (6.5)		5 (*)	33 (3)	211 (17.5)
Tabanidae		1 (*)	1 (*)			5 (*)	1 (*)	10 (0.5)		1 (*)	19 (0.5)
Tipulidae						3 (1)		2 (3)		11 (0.5)	6 (4.5)
Hirudinea	1 (*)	3 (1)			1 (0.5)	1 (*)	3 (*)				9 (1.5)
Gastropoda											
Annelida	207 (10)				85 (2.5)		65 (3.5)	15 (1.5)	23 (3)	31 (2)	426 (22.5)
Oligochaetes		8 (1)	70 (5)	148 (8)		29 (3.5)					255 (17.5)
Odonata		2 (2)				2 (0.5)		1 (0.5)			5 (3)
Mollusca											
P. californica % total nos.	12.3	0.63	4.2	21.0	7.8	8.6	8.9	6.6	4.1	7.2	8.4
P. californica % total volume	62.8	8.3	23.1	68.4	32.1	36.1	54.1	54.3	25.0	49.7	48.5
Total nos.	2195	1262	1553	1431	1403	1701	1538	2384	1089	1490	16046
Total volume (ml)	145	36	60.5	114	53	66.5	90.5	129	44	76.5	815

NOTE: (*) volume less than 0.5 ml

[a]Numbers/m^2

[b]Volume ml/m^2