12/8/71

Bob

The fisherman harvest of the R x N fish is enclosed. First year returns were not as high as for a plant of catchable rainbow made prior to the season in 1967. However, native trout could not be kept until August of 1971 and fishermen may have released some of the crosses thinking they were natives.

Two reports are enclosed that may be of general interest to you.

WD Klein

RB / Browns
Angling / Parvin 2.

Statutory Reference

(e) Unit 74 - that portion north and east of Cascade Creek, south of the divide between the Animas and San Miguel Rivers, and west of U.S. Highway No. 550 from Red Mountain Pass to Silverton.

Unit 75 - that portion of the Animas River drainage north of Needle Creek and that portion of the Unit within the San Juan Primitive Area.

Units 77 and 78 - those portions within the San Juan Primitive Area.

Unit 78 - all national forest land within the Rio Blanco River and Fish Creek drainages above their confluence.

ONE DEER ANTLERED ONLY-ANTLERS MUST HAVE FOUR POINTS OR BETTER ON ONE SIDE

3. AUGUST 22 through SEPTEMBER 7, 1970:

(a) Unit 43 - that portion in the Maroon-Snowmass Wilderness Area, except the Snowmass Creek drainage east of Bear Creek and Snowmass Creek.

4. AUGUST 22 through SEPTEMBER 7, 1970--PERMITS LIMITED BY AREA:

(a) 50 permits: Units 5, 14 and 16 - those portions within the Mount Zirkel Wilderness.

(b) 50 permits: Units 6 and 7 - those portions within the Rawah Wilderness; all lands above timberline from the Rawah Wilderness to State Highway No. 14 (Cameron Pass) and that portion of the Medicine Bow Range above timberline.

(c) 50 permits: Units 28 and 29 - those portions along the Continental Divide north of Rollins Pass (Corona Pass) and above timberline.

119 stocked 12/22/70 1971 Harvest by Fishermen
Mean length 12.47"
Range 7.7 - 16.1

Rainbow x Native

Anal clip (R♂ x N♀)

May

	8.0-8.9	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0		Total
Flies		1		||||| ||||| ||||| ||||| 1			23
Hardware			1	||| ||| ||||| ||| ||			17
Combination				1	||||| ||||1	|||				19
June											
F			1	1	1	1	||			6
H											0
C				1	1	||||			6
July											
F				||		1	||			6
H											0
C				1	1						2
Aug											
F				|||	||		||			7
H											0
C											0
Sept											
F						1					1
H											0
C											0
Total		1	2	17	18	24	22	3			87
Anal-Rd clip		2	1	12	9	6					
Total		3	3	29	27	30	22	3			117

NATIONAL
42 383

1971 Harvest by Fishermen

85 stocked 12/22/70
Mean length 11.02"
Range 7.3 - 13.7

Rainbow x Native

An Ad clip (R ♀ x N ♂)

May

	9.0-8.9	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0		Total
Flies		1		IIII	II	1					10
Hardware				II	III						5
Combination					II						2
					June						
Flies		1		III		II					6
Hardware					1						1
Combination											
					July						
Flies			1		1	1					3
Hardware						II					2
Combination											
					August						
Flies											
Hardware											
Combination											
					Sept.						
Flies				1							1
Hard											
Comb											
Total		2	1	12	9	6					30

RESPONSES OF RAINBOW (*Salmo gairdneri*) and BROWN TROUT (*Salmo trutta*) TO ANGLING IN PARVIN LAKE

W. D. Klein 11/29/71

Introduction

Brown and rainbow trout are the most important resident species in Colorado trout waters below 9,000 feet elevation where they coexist in most major streams and on channel reservoirs. Attainment of their respective maximum potentials in the state-wide fishery depends on a thorough understanding of the habits of each in a variety of situations. Observations made on brown and rainbow trout since 1965 in a sympatric relationship under the circumstances found at Parvin Lake contributes to this understanding in several areas and provides information of direct management value. This report concentrates on return to the creel aspects of the investigations.

Location and Description of the Study Area

Parvin Lake is located 45 miles northwest of Fort Collins, Colorado in Larimer County. It has a maximum depth of 32 feet and an area of 62 acres. Buscemi (1961) stated that the mean depth is 14.4 feet and that the shoreline distance is 10,669 feet which includes 892 feet around islands. He considered that 58.6% of the total area was littoral or sublittoral.

The lake is formed by two earthen dykes, faced with rock rip-rap, which block the South Fork of Lone Pine Creek. This small inlet maintains the lake at spillway level.

Parvin Lake is eutrophic and exhibits the usual characteristics of lakes of this type. High winds in the spring keep the water in cir-

culation for a sustained period which permits uniform warming to approximately 50 F prior to summer stratification and oxygen depletion below the thermocline. Maximum surface temperatures of about 70 F are encountered. Ice cover exists from about December through March. Oxygen depletion is severe in deep water in late winter, but winter-kill of fish has not occurred.

Elodea canadensis grows profusely in areas protected from wind, and extends into the lake to a depth of about 8 feet. Filamentous algae also is abundant from time to time. Heavy blooms of blue-green algae are a common phenomenon late in the summer. Woody vegetation, principally willow (Salix spp.) is dense along about one-half of the shoreline. Some areas cannot be fished in an efficient manner without wading because of terrestrial and aquatic vegetation. In addition to the usual array of invertebrate fauna, Asellus intermedius and crayfish (Orconectes virilis) are plentiful and important as trout food.

Rainbow and brown trout were the co-dominant game fish present from 1965 through 1969. A plant of 4,680 five-inch native trout (Salmo clarki) in 1970 placed this species in a position of numerical superiority over brown trout. Relatively small numbers of hybrid trout (Salvelinus fontinalis x Salvelinus namaycush), grayling (Thymallus signifer), and silver salmon (Oncorhynchus kisutch) were present. The latter species had virtually disappeared by 1967. In addition to the game fish, fathead minnows (Pimephales promelas) were common along with a small population of longnose suckers (Catastomus catostomus).

Methods

Information on all fishermen and their catch was obtained at a check station normally operated throughout the fishing season. In 1965, the census was partial but an accurate estimate of harvest and use was made. The total length of each trout in inches was obtained. Fish that had not been dressed, approximately 85% of those caught, were weighed in ounces.

The fishing season extended from the third Saturday in May through September. Bait fishing was not allowed and special size limit regulations were in effect. Rainbow trout were protected by a 12-inch minimum size limit through 1965 and brown trout through 1966. Fishing from boats or floating devices has always been prohibited. The size limit and terminal tackle regulations reduced use by fishermen below a level previously encountered under normal statewide regulations.

In 1965 and 1966, flies only were used on 55.4% of the trips, other types of lures only (primarily hardware) on about 16%, and the remaining fishermen used a combination of flies and other types of lures. From June through September 1966, spinning gear only was used on 86% of the trips, conventional fly rod and reel on 9% while both methods were used on 5%. On those trips where the only lure used was flies, percentages changed to 81, 15, and 4, respectively. Fishing methods probably remained about the same in all years.

Electrofishing was carried out each spring within two weeks of the opening of the fishing season. The work was conducted at night using pulsating direct current from a boat. One complete trip was made around the lake following the shore lines. Most of the fish were recovered in less than four feet of water.

Gill netting was accomplished on two occasions in 1971 to gather information on the number of large trout remaining in the lake and to obtain brown trout eggs. Six 100' x 6' nets of 2-inch mesh (bar measure) were fished continuously for 40 hours, October 5-October 7, and for 7 hours on October 26. Nets were checked at about three hour intervals during both settings and those failing to catch fish were moved to new locations. The trout were held in live boxes until netting was completed and then spawned, measured in inches, marked by an opercle punch and by injecting fluorescent pigment under the skin on the lower jaw, and released. Some of the browns captured during the first netting were held for a week to see if the green females would ripen.

The fish population was maintained primarily with fingerling stocking, but limited natural reproduction did occur. Stocking and fish population density increased from 1964 through 1971, however, at no time did either approach high levels that had historically existed. Fingerling stocking ranged from about 65 trout per acre in 1964 to 338 in 1970. Fingerlings were marked prior to release in the lake by removing one or two fins.

Fishing pressure varied moderately from 1965 to ~~1970~~ 1971. The range in pressure in terms of fishing trips was from a low of 5,490 in 1960 to a high of 7,335 in 1971. On an hour basis, the range was from 19,460 in 1969 to 25,409 in 1965.

Seasonal Harvest Pattern

Weekly harvest data shows the dominant response to depletion by angling of identified groups of trout along with variation in their harvest pattern necessarily related to extraneous factors such as water

temperature, weather, plankton blooms, availability of natural foods, and ability of the fishermen (Tables 1 and 2). Those periods of better fishing provided by each group when percent of harvest exceeded percent of time expended are underlined.

Good fishing and heavy depletion during the first six weeks of the season resulted in fewer fish and poorer fishing later. Extremes of this situation were exemplified by returns from fingerling plants of brown trout which were not particularly vulnerable to early season harvest and sustained fishing well throughout the season, and by catchable rainbow trout stocked just prior to opening day which were rapidly caught. Plants of fingerling rainbow trout occupied a middle ground that still tended toward heavy early season harvest. Brown trout would be particularly valuable from the standpoint of harvest pattern where a fishery is maintained by fingerling stocking and artificial replenishment is not used to buoy up fishing at intervals throughout the season.

Differences in age and size of the brown trout did not have a noticeable influence on seasonal pattern of harvest. Likewise, similarity in seasonal patterns of removal of fish from fingerling plants of rainbow trout were apparent despite age and size differences (Tables 1 and 2).

Returns from the 1967 plant of rainbow trout fingerlings gave the lowest cumulative harvest at the end of six weeks of any of the rainbow groups (Table 2). Fishermen probably rejected many of these fish at the start of the season because of small size which would result in some curtailment of early harvest.

Table 1. Percent of 1967 harvest, by weeks, of 5 trout groups and percent of use (hours fished) each week.

Week of season	Hours fished and harvest, percent 3/					
	Hours	Brown 1965 plant	Rainbow 1964 plant	Rainbow 1965 plant	Rainbow 1966 plant	Rainbow 1967 plant 2/
1	13.8	14.6	23.2	24.1	22.9	38.0
2	9.3	7.3	9.8	13.8	13.2	23.8
3	7.1	5.9	9.2	10.3	8.2	8.6
4	5.8	7.3	4.5	9.1	9.7	5.6
5	6.0	6.5	9.2	10.3	10.0	8.3
6	7.0 (49.0)	7.7 (49.3)	7.8 (63.7)	6.6 (74.2)	9.7 (73.7)	5.1 (89.4)
7	8.9	7.8	7.5	8.4	6.9	2.7
8	4.3	4.9	3.6	3.7	3.7	2.0
9	4.1	3.7	4.5	0.6	2.1	0.5
10	4.3	3.5	2.5	1.9	2.4	0.7
11	4.0	3.0	1.1	0.0	1.4	0.5
12	3.9	3.2	1.9	1.2	1.1	0.2
13	3.2	3.5	1.7	1.6	1.1	0.5
14	3.7	3.8	3.4	1.2	0.3	1.5
15	2.9	3.3	2.2	3.1	1.3	0.7
16	3.8	2.1	1.1	0.6	1.7	0.2
17	1.5	2.6	0.3	0.0	0.3	0.5
18	1.8	1.8	1.9	0.3	1.1	0.0
19 1/	4.2	7.9	4.5	2.5	2.4	0.5
Total hours and fish caught	21,787	1,498	358	320	697	408
Mean length of fish		13.3	13.7	11.7	12.1	12.7

1/ Eight days.

2/ Tagged creel size stocked 2 days prior to opening day. The other groups were fingerling plants.

3/ Entries underlined when percent harvest exceeds percent of hours expended. Cumulative percentage through 6 weeks in parentheses.

Table 2. Percent of 1968 harvest, by weeks, of 3 trout groups and percent of use (hours fished) each week.[1/]

Week of season	Hours fished and harvest, percent[2/]			
	Hours	Brown 1965 plant	Brown 1966 plant	Rainbow 1967 plant
1	14.2	17.3	17.8	20.5
2	10.2	6.7	7.1	7.5
3	8.3	6.5	6.2	6.2
4	5.6	6.4	4.5	5.8
5	6.8	7.3	6.2	7.8
6	7.5 (52.6)	7.7 (51.9)	8.7 (50.5)	8.8 (56.6)
7	6.1	4.9	4.5	5.5
8	4.5	4.2	3.9	4.0
9	4.7	5.7	4.9	4.2
10	4.8	4.7	4.4	4.2
11	4.2	2.8	3.9	5.2
12	4.3	4.7	7.2	5.5
13	3.3	2.4	2.2	2.1
14	3.0	3.3	2.7	1.6
15	2.2	1.6	2.4	1.1
16	3.4	2.4	4.2	3.1
17	2.7	2.9	2.5	2.3
18	2.1	1.3	2.7	1.7
19	1.3	1.6	3.2	1.9
20[3/]	1.0	2.0	0.8	1.0
Total hours and fish caught	22,812	614	595	1,607
Mean length of fish		14.2	12.2	10.6

1/ All groups stocked as fingerlings.
2/ Entries underlined when percent harvest exceeds percent of hours expended. Cumulative percentage through 6 weeks in parentheses.
3/ Three days

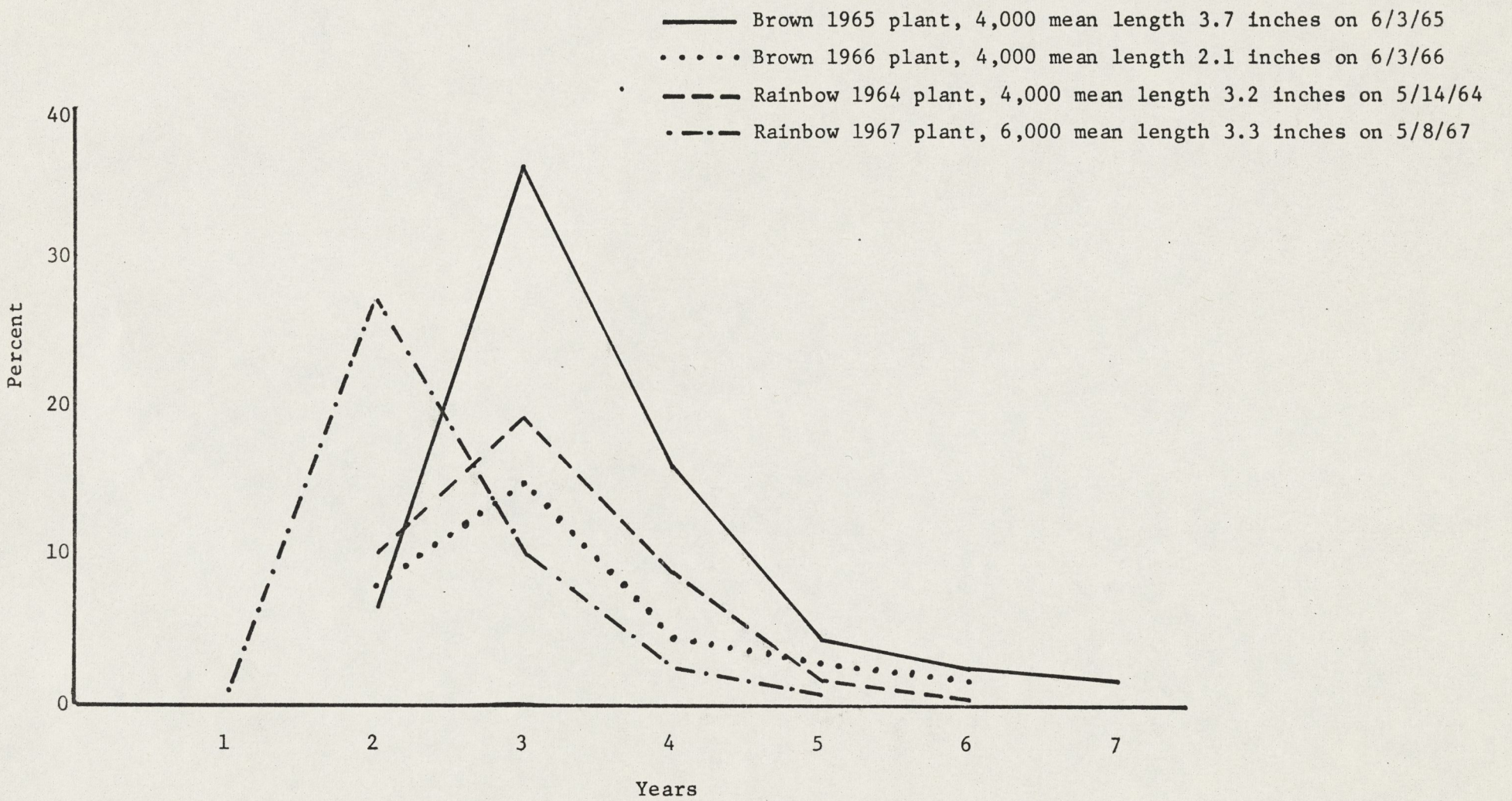
Annual and Total Harvest

Annual harvest from various plants of rainbow and brown trout was much the same when the influences of rejection by fishermen of small fish and size limits were appropriately considered (Fig. 1). The 1964 plant of rainbow trout was protected by a 12-inch limit for the same length of time as was the 1965 plant of brown trout. The latter, however, failed to put as many fish over the limit the year following the plant which curtailed second year harvest and allowed third year harvest to be relatively heavy. Harvest of both groups was sharply reduced in the fourth year and again in the fifth. Only a few rainbow trout from the 1964 plant were caught in the sixth year and none in the seventh while the brown trout held up in the catch comparatively well in the sixth year and were still contributing in the seventh.

Mean length of 32 brown trout from the group stocked in 1966 was only 6.5 inches when recovered by electrofishing on May 11, 1967. Consequently, rejection of small fish caught from this plant was heavy in 1967 and contribution to the creel light. Maximum returns to the creel were obtained in the third year followed by a severe drop in the fourth. Additional depletion of the remaining fish continued annually. An obvious similarity in second, third, and fourth year harvest of the 1966 plant of brown trout and 1964 plant of rainbow trout can be noted (Fig. 1).

The 1967 plant of rainbow trout gave rather typical returns for a fingerling plant in Parvin Lake. A few fish reached acceptable size and were kept in the first year, harvest peaked the second, dropped drastically in the third, again in the fourth, and only 0.8% of the original plant was harvested in the fifth year.

Figure 1. Annual harvest of plants of rainbow and brown trout expressed as a percent of the total number stocked.



Total returns were good for all plants, exceeding 30% of the number stocked in each case. An exceptionally high return of 66.9% from the 1965 plant of brown trout was probably related to their relatively large size when stocked. The 1967 plant of rainbow trout fingerlings gave the usual satisfactory returns when released into a substantial population of larger brown trout.

Two additional but atypical plants of rainbow trout were made during the period under consideration. Two thousand fingerlings (mean length 2.3 inches) were stocked September 14, 1965. The fin clip applied to fish from this plant was duplicated in 1967 which prevented accurate identification of fourth year and later recoveries of this group. However, returns of 3.2% in the second year (1966) and 16.1% in the third suggested the usual annual pattern of harvest, but a low total return, probably related to fall planting and relatively small size of the trout when stocked.

The other group of 2,000 fish, atypical because they averaged 5.3 inches when stocked on May 4, 1966, gave a total return of 58.7%, a figure compatible with the large initial size of the trout. Returns for the first through fourth year were 19.1%, 34.9%, 4.5%, and 0.2%, respectively. Heavy harvest in the first and second year depleted the population and left few fish for later.

Size of Fish Harvested

Comparison of the 1964 plant of rainbow trout and 1965 plant of brown trout shows that browns placed a higher percentage of fish 15 inches and larger in the creel and reached a larger size (Table 3). Of the brown trout harvested, 11.5% entered the creel at a length of 15.0 inches or

Table 3. Length-frequency distribution by one inch size groups of trout caught by fishermen from the 1964 rainbow and 1965 brown trout plants.[1/]

Year of harvest	Length-frequency distribution												Total	Mean length
	9	10	11	12	13	14	15	16	17	18	19	20>		
Second [2/]	2 (3)	4 (15)	68 (50)	229 (140)	64 (42)	19 (9)	4 (3)	2					392 (262)	12.6 (12.4)
Third	10 (7)	59 (67)	185 (505)	291 (564)	175 (219)	39 (58)	6 (12)	(7)	(1)				765 (1440)	12.4 (13.3)
Fourth		6 (1)	23 (4)	58 (86)	118 (232)	115 (186)	30 (75)	7 (35)	1 (15)	(5)	(1)		358 (640)	13.7 (14.2)
Fifth			3	16 (7)	35 (33)	38 (49)	14 (38)	1 (22)	(11)	(5)			107 (165)	13.9 (15.0)
Sixth			1 (1)	1 (2)	4 (15)	8 (33)	(14)	2 (15)	1 (7)	(6)	(2)	(2)	17 (97)	14.4 (15.4)
Seventh					(7)	(14)	(20)	(9)	(8)	(2)	(1)	(2)	(59)	(15.8)
Total	12 (10)	69 (83)	280 (560)	595 (799)	396 (548)	219 (349)	54 (152)	12 (88)	2 (41)	(16)	(4)	(3)	1639 (2644)	
Percent of total harvest	0.7 (0.4)	4.2 (3.1)	17.1 (21.1)	36.3 (30.2)	24.2 (20.5)	13.4 (13.2)	3.3 (5.7)	0.7 (3.3)	0.1 (1.5)	(0.6)	(0.2)	(0.1)		

1/ Brown trout in parentheses.

2/ Rainbow harvest estimated from a partial census.

larger as compared with 4.1% for rainbow. A few brown trout exceeded 20.0 inches in length while rainbow trout did not go beyond the 17.0-inch size group. Mean length of rainbow trout exceeded that of brown trout only in the second year, subsequently brown trout were about an inch longer. The dominant size group was never larger than 14.0 inches for either species in any year, except for brown trout in the seventh (15.0-inch group dominant), and both exhibited a wide range in size of the fish entering the creel, particularly in later years. Growth rates of individual trout evidently varied greatly.

This size spread introduced the probability of minor error in determination of numbers of brown trout caught by fishermen from 12.0 to 14.9 inches in length in the seventh year in the case of the 1965 plant and in the sixth year for the 1966 plant because a few brown trout with the same marks, stocked in August 1969, exceeded 14.0 inches in 1971. Rational treatment of the length-frequency information and age determination from scale samples collected from a portion of the fish caught were used to separate the conflicting groups. Harvest data for the 1965 and 1966 plants of brown trout considered elsewhere, were, of course, subject to the same difficulty.

About the same situation noted in Table 3 as to size of fish caught, eventually developed from the 1966 plant of brown trout. Mean length of these fish in the harvest in the fourth, fifth, and sixth years, were, respectively, 14.3, 15.1 and 16.0 inches. Fourth-year rainbow trout from the 1967 plant were harvested at a mean length of 14.0 inches, comparable with 13.7 inches for fourth-year returns from the 1964 plant of rainbow trout.

An inherent ability of a relatively few brown trout from a plant to survive and grow large was important to the fishery because these fish had a psychological value in excess of their numerical importance. Fishermen realized that a reasonable chance existed to catch a trophy fish and some fished the lake primarily because of this potential.

From a biological standpoint, large trout were an asset because of an abundance of large crayfish which contributed extensively to their diet. Stomach contents of 40 brown trout 16.0 - 17.9 inches in length collected throughout a fishing season consisted of 83.7% crayfish by volume. Larger crayfish are consistently vulnerable to predation only by trout 16.0 inches and larger because of particle size. Without big fish, biomass contained in large crayfish is not utilized. Probably, crayfish also serve as a good buffer against predation on small trout by large trout.

Poundage Harvested

High survival to the creel, of course, guarantees a substantial poundage return to fishermen. The 1965 plant of brown trout with 66.9% recovery of the 4,000 fish stocked gave a return of 2,519 pounds on a 180-pound investment (weight of the fingerlings stocked) over a 7-year period while the 4,000 rainbow trout fingerlings stocked in 1964 (40.9% recovered) returned 1,291 pounds to the creel.

By assuming the same total survival for brown trout as for rainbow trout (1,639 fish), it is possible to examine the above plants for weight contribution to the creel on a comparable basis (Table 4). The results show a balance of 246 pounds in favor of brown trout. Mean weight of rainbow trout taken in the second year slightly exceeded that of brown trout, but thereafter brown trout held an advantage. The weight advantage

Table 4. Estimated poundage contribution to the creel from 1964 plant of rainbow trout and 1965 plant of brown trout.[1/]

Year	Number of fish		Weight in pounds		Mean weight	
	Rainbow	Brown	Rainbow	Brown	Rainbow	Brown
Second	392	164	268.5	108.5	.68	.66
Third	765	885	595.2	766.8	.78	.87
Fourth	358	392	323.1	388.6	.90	.99
Fifth	107	103	89.1	139.8	.83	1.36
Sixth	17	59	18.3	80.9	1.08	1.37
Seventh		36		55.3		1.54
Total	1,639	1,639	1,294.2	1,539.9		

1/ Brown trout total numerical contribution to the creel assumed same as for rainbow trout. Yearly harvest of brown trout determined from known annual harvest.

could well go to rainbow trout if a size limit were not involved and harvest of both species was relatively heavy among smaller fish; small rainbow were heavier than small brown trout. Mean weights of seven brown and seven rainbow trout of identical size (range 7.5 - 9.4 inches) recovered by electrofishing on the same day were respectively 3.8 and 4.1 ounces.

Brown Trout Remaining

Gill nets were set on two occasions in October 1971 to explore the population of larger brown trout that remained after long exposure to fishing. The nets thoroughly sampled the population of spawning brown trout as indicated by their near failure to catch additional fish toward the end of the netting periods (captured fish were contained), and by the high percent of recaptures observed during the second period of netting. A record of the reduced efficiency of the nets over time was not kept, but toward the conclusion of netting only an occasional trout was caught and moving the nets failed to locate more fish. The second netting recovered 11 male brown trout (9 recaptures) and 8 females (2 recaptures). The entire operation accounted for 88 brown trout spawners, 76 of which were 15.0 inches or larger, probably the majority of fish in the lake in these categories. An assumption of the presence of about 100 brown trout 15.0 inches or larger appears reasonable.

When the nets were first set early in October at the beginning of spawning, most females captured were green and trout of both sexes rapidly entered the nets. At the second netting, toward the end of spawning, only ripe females and males were caught which indicated that spent fish were no longer vulnerable to capture and that any attempt

to arrive at a precise population estimate from the recapture data would be subject to considerable bias, particularly in the case of the females.

Table 5 presents size composition, sex, and number of recaptured fish netted from the 1965 and 1966 plants of fingerling brown trout. Thirty-three trout from the 1965 plant and 29 from the 1966 plant were accounted for, close to the entire population remaining from the two groups. Brown trout spawners of unknown origin and ripe males from a fingerling plant made in 1968 were also netted.

On the basis of a known harvest of 129 fish and 62 taken in gill nets, about two-thirds of the brown trout available from the 1965 and 1966 plants at the start of the 1971 fishing season were taken by fishing in 1971. However, the likely presence of a few more fish than were netted suggests a rough estimate of capture by anglers of half the available trout from these groups.

Fishermen had exploited throughout the population of older brown trout in 1971 to the extent of 59 from the 1965 (Table 3) and 70 from the 1966 plant. The largest brown trout caught by angling was in the 21.0-inch size group. The only suggestion in 1971 of large unharvestable brown trout existed in the presence of two males in the 23.0-inch size group from the 1966 plant netted in October.

Of the brown trout recovered in the nets from the 1965 and 1966 plants, 27 were males and 35 females. Alm (1959) considers that a preponderance of females among older age groups is due to greater loss among males by predation and fishing gear. His experiments at Kalarne did not suggest that differential mortality between sexes was due to purely physiological reasons.

Table 5. Brown trout from the 1965 and 1966 plants recovered by gill nets in October, 1971.

Size groups	First netting				Second netting [1]			
	1965 plant		1966 plant		1965 plant		1966 plant	
	Male	Female	Male	Female	Male	Female	Male	Female
12.0-12.9		1						
13.0-13.9	2	1						
14.0-14.9		1						
15.0-15.9	4	5	2	5	(1)		(1)	1(1)
16.0-16.9	4		1	4	1		(1)	1(1)
17.0-17.9	2	3	2	4		2		1
18.0-18.9	2	1	1	1	(1)			
19.0-19.9	1	1	2			1	(1)	
20.0-20.9			1	1				
21.0-21.9		1						
22.0-22.9								
23.0-23.9			2				(2)	
Total	15	14	11	15	1(2)	3	(5)	3(2)
Mortality	2	2		2				
Released	13	12	11	13				

[1] Recaptures in parentheses.

Several potential sources of error in the results presented on the netting operations are worthy of mention. First, functional traps in the inlet and outlet, located a short distance from the lake, failed to capture brown trout of spawning size leaving the lake in October or for several months earlier; therefore, the population of larger brown trout was contained in the lake at the time the nets were fishing. Secondly, some mature brown trout may have skipped spawning and not have been very vulnerable to the nets. Information is not available on numbers (if any) of mature brown trout that fail to spawn in consecutive years in Parvin Lake, but probably they would have appeared in the nets to some extent had they been present in appreciable numbers. All brown trout from the 1965 and 1966 fingerling plants caught in the nets were judged from emission of sex products or external characteristics to be spawners; the males were ripe. Thirdly, since nets of only one mesh size (2-inch bar measure) were used, they undoubtedly were not equally efficient in catching all sizes of spawning trout. However, the nets did capture spawners from 12.0 to 23.0 inches with seeming effectiveness. Probably they were adequately sampling fish from the population of spawning brown trout 12.0 inches and larger.

Selective Harvesting

Electrofishing a short time prior to opening of the fishing season permitted comparison of trout recovered with the shocker and by hook and line fishing. Trout caught by anglers no later than eight days after the season opened were used in the comparison, thus growth in the interval between recovery by the two methods was negligible.

Length-frequency distribution of the fish sampled shows a repeated tendency of fishermen to harvest more heavily among the larger size groups than electrofishing (Figs. 2 and 3). It is not known, however, that samples obtained by electrofishing accurately represented the size distribution of the entire population of the respective groups of fish. But, references on selectivity of hook and line trout fishing indicate that the difference in length-frequency distribution of trout recovered by the two methods at Parvin Lake probably represents a measure of selectivity by fishing of larger, faster-growing fish. Cooper (1953), comparing samples (back calculating growth from scales) secured by electrofishing and angling, found that in the Pigeon River angling selected the faster-growing brook trout from each age group but not brown trout, and Larkin and Smith (1954), working with kamloop trout (Salmo gairdneri) in Paul Lake, established that hook and line fishing removed the faster-growing fish at an earlier age. Cooper considered that the difference he observed for brook trout was not repeated in the case of brown trout because brown trout were not as readily caught by fishermen.

At Parvin Lake, brown trout did not demonstrate immunity to selective harvest of the larger fish by angling as shown by returns from the two sampling methods for the 1965 plant in 1967 and 1968 (Figs. 2 and 3). The situation was less clear for 1969 returns from this same plant, possibly because of small sample size.

Figure 2. Length-frequency distribution by 1-inch size groups of rainbow trout recovered by electrofishing and by fishermen in May.

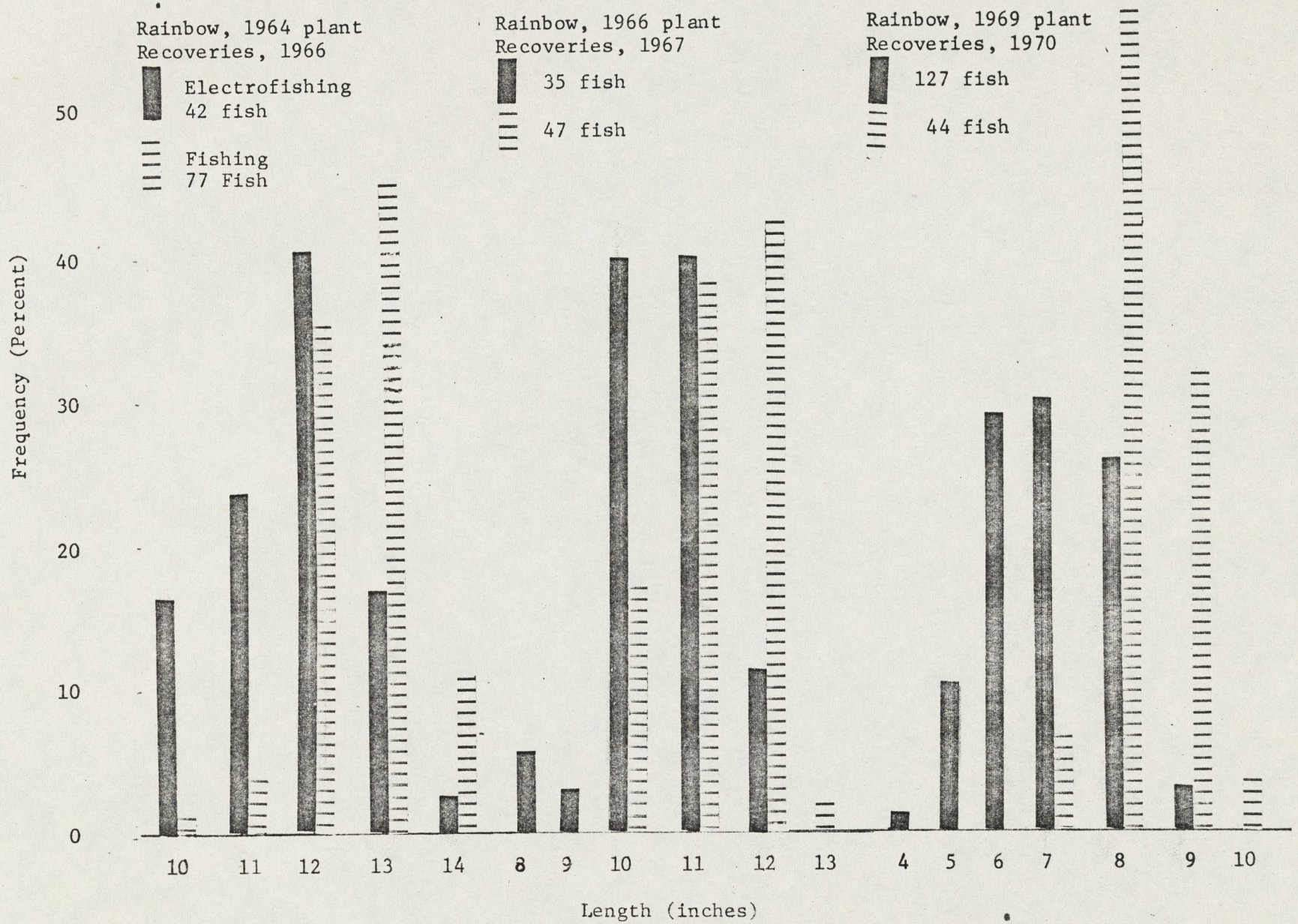
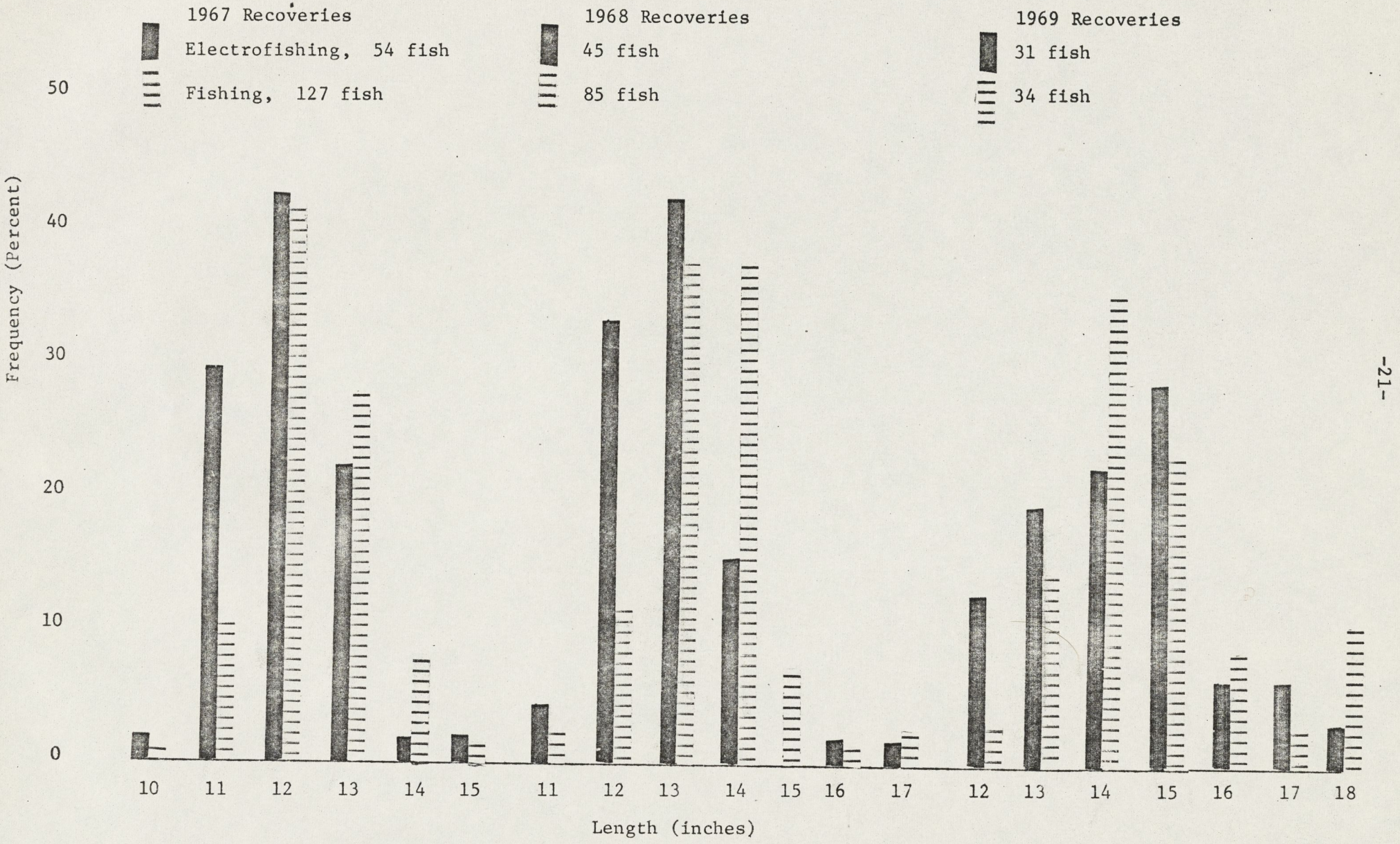


Figure 3. Length-frequency distribution by 1-inch size groups of brown trout from the 1965 plant recovered by electrofishing and by fishermen in May



One cause of selectivity of hook and line fishing for larger trout relates to response of the fish to fishing and another to response of the fishermen. In situations where all trout in a group are of a normally desirable creel size, size selectivity is essentially due to response of the trout to angling with the larger and presumably more aggressive fish tending to be the first caught. However, even when the smallest trout of a group exceeds 10 or 11 inches, the possibility of release of the smaller fish caught remains a factor; individual fishermen vary greatly as to size of trout they will keep.

A strong influence of size selectivity by fishermen is apparent in returns from the 1969 plant of rainbow trout (Fig. 2). Electrofishing revealed an abundance of trout in the 6-inch size group which was completely rejected by fishermen. A few 7.0- to 7.9-inch fish were kept, but the trout were not well accepted until they were 8.0 inches or over.

The one plant of creel size trout made two days before the opening of the fishing season in 1967 also responded selectively to angling in a manner similar to that noted for trout stocked as fingerlings. Mean length of these tagged trout when stocked was 12.3 inches (497 fish) while mean length of 243 harvested in May was 12.7 inches, a significant difference at the 5% level ($\chi^2 = 16.03$, df. 7, $p = 0.026$).

Selection of larger trout from a group by angling appears as an advantage in trout lakes functioning under a fingerling stocking program. The smaller trout of a plant are not caught or are rejected by fishermen at the first of the season in the year following stocking. These fish are then gradually harvested as the season progresses and they move up in the hierarchy of the selective process. In this manner, the fishery is sustained at a higher level throughout the season then would be possible if the plant were uniformly subject to capture at the start of the season.

Cooper (1953) points out that anglers selectively harvesting larger, faster-growing trout leave no way of obtaining an unbiased estimate of growth rate of an age group once the fish become vulnerable to angling, and that faster-growing trout with the greatest potential for reaching trophy size are removed first by fishermen. Conversely, runts of an age group are the trout most likely to remain and reproduce.

Discussion and Conclusions

Trout were extensively harvested during their first year of full exposure to harvest followed by a drastic drop in numbers removed the following year. All the normal fingerling plants considered gave total returns in excess of 30% of the number stocked. Larger trout of a group were probably most vulnerable to angling, and fishermen rejected rainbow trout under 8.0 inches in length.

Chief differences noted between rainbow and brown trout were more resistance to harvest in the spring, a more even yield to the creel throughout the fishing season, longer survival, and an eventual return to the creel of larger trout by the latter. Theoretical treatment of the data revealed that a plant of brown trout fingerlings returned a slightly greater poundage to the creel than a similar plant of rainbow trout.

A capacity of brown trout to contribute to the creel rather evenly over an entire season is especially valuable where a fishery is maintained by fingerling stocking and artificial replenishment is not used to buoy up fishing later in the year. The boom and bust pattern of harvest shown by rainbow trout takes good care of early season fishing but poorer fishing later is inevitable.

Survival and longevity of the brown trout resulted in the presence of about 100 fish 15.0 inches or larger seven years after the first introduction. Where an accumulation of larger fish results in utilization of a suitable food supply and the trout remain reasonably vulnerable to angling, as at Parvin Lake, this situation is desirable. The effectiveness of gill nets in capturing spawners indicated that an undesirable population of large brown trout could be readily controlled in Parvin Lake.

Trout recovered by anglers from the various plants were consistently larger than those recovered by electrofishing. Probably, hook and line fishing removed the larger, faster-growing trout from each plant first, leaving the smaller fish to grow and contribute to the harvest later. This circumstance was generally favorable because it permitted harvest from fingerling plants to be sustained at a higher level over a longer period than would have been possible if all the fish were equally vulnerable at the start of a fishing season.

Those basic responses to angling exhibited by trout in Parvin Lake will probably be repeated in other similar lakes operating under normal state-wide regulations of no closed season, bait fishing allowed, and no size limit restriction.

Brown trout are recommended for use in small, productive, heavily-fished lakes, particularly if a food supply suitable for large fish is available. They can advantageously be used with rainbow trout because the combination offers variety and advantages of each species which should please a larger segment of the fishing public than use of either alone.

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ANALYSIS OF A CREEL SIZE TROUT PLANT IN PARVIN LAKE

W. D. Klein

The general response of hatchery-reared trout of creel size to angling under state-wide regulations has previously been studied at Parvin Lake (Williams, 1952). However, a plant of creel-size rainbow trout (Salmo gairdneri) made in 1967, the subject of this report, offered an opportunity for a more detailed analysis than could be obtained from earlier plants because each fish was individually measured and identified with a tag prior to stocking. Further, the 1967 group provided information collected during a period when fishing was restricted to artificial lures only.

Location and Description of the Study Area

Parvin Lake is a 62-acre productive on-channel reservoir that receives heavy fishing pressure. It is located in Larimer County about 45 miles northwest of Fort Collins, Colorado. Buscemi (1961) has described Parvin Lake in detail.

Methods

All fishermen entered and left the Parvin Lake area via a check station where data on time spent fishing and their catch was recorded. Total length in inches of each trout was obtained along with species and tag or mark information.

Under special regulations which allowed only artificial lure fishing and prohibited use of boats or floating devices, 21,787 hours were expended on 5,771 trips in 1967. Fishing pressure was comparable in 1968 and 1969. The fishing season extended from May 20 to September 30, 1967, and it differed in later years by only a few days.

The study fish (497) were anesthetized, measured in inches (total length), tagged and stocked on May 18, 1967. Numbered monel metal tags 9/32 inch in diameter were applied to most of the fish while larger similar tags were used on the bigger trout. Mean length of these fish was 12.3 inches, and they ranged from 8.2 to 18.5 inches.

The tagged fish originated from eggs obtained from a commercial vendor. Details on the hatchery and rearing pond history of the group were not recorded. Fish supplied to the rearing unit where the study trout were raised usually arrived from a nearby hatchery in May or June at a length of 2 to 4 inches. The fingerlings are placed directly in a pond or temporarily held in raceways prior to release in a pond. The rearing ponds utilized river water, and they were ice-covered in winter. Larger fish in the group tagged were necessarily 2 years old; the smaller fish may have been younger.

Annual Harvest

In the first year 408 (82.1%) of the tagged trout were caught, 25 (5.0%) in the second year, and 3 (0.6%) in the third. The total recorded harvest was 436 trout, 87.7% of the number stocked. Probably, over 90% of the plant actually entered the catch; a few tags could have been lost from the fish prior to or after capture.

1967 Harvest Pattern

Rapid removal of the tagged trout occurred. Of those caught in 1967, 38% were removed in the first week of the season and about 89% in the first 6 weeks (Table 1). The 89% were removed with an expenditure of about 50% of the season fishing effort. In contrast, hatchery-reared trout stocked as fingerlings (fin clipped) were much more

Table 1. Returns to the creel by week of four groups of rainbow trout and the hours fished each week, May 20 - September 30, 1967.[a]

Week of season	Hours fished	Rainbow Caught: Fin clipped May 14, 1964	Fin clipped Sept. 14, 1965	Fin clipped May 4, 1966	Jaw tagged May 18, 1967
1	3,006 (13.8)	83 (23.2)	77 (24.1)	160 (22.9)	155 (38.0)
2	2,030 (9.3)	35 (9.8)	44 (13.8)	92 (13.2)	97 (23.8)
3	1,557 (7.1)	33 (9.2)	35 (10.3)	57 (8.2)	35 (8.6)
4	1,274 (5.8)	16 (4.5)	29 (9.1)	68 (9.7)	23 (5.6)
5	1,302 (6.0)	33 (9.2)	33 (10.3)	70 (10.0)	34 (8.3)
6	1,535 (7.0)	28 (7.8)	21 (6.6)	68 (9.7)	21 (5.1)
7	1,939 (8.9)	27 (7.5)	27 (8.4)	48 (6.9)	11 (2.7)
8	931 (4.3)	13 (3.6)	12 (3.7)	26 (3.7)	8 (2.0)
9	902 (4.1)	16 (4.5)	2 (0.6)	15 (2.1)	2 (0.5)
10	934 (4.3)	9 (2.5)	6 (1.9)	17 (2.4)	3 (0.7)
11	874 (4.0)	4 (1.1)	0 (0.0)	10 (1.4)	2 (0.5)
12	862 (3.9)	7 (1.9)	4 (1.2)	8 (1.1)	1 (0.2)
13	303 (3.2)	6 (1.7)	5 (1.6)	8 (1.1)	2 (0.5)
14	804 (3.7)	12 (3.4)	4 (1.2)	2 (0.3)	6 (1.5)
15	653 (2.9)	8 (2.2)	10 (3.1)	9 (1.3)	3 (0.7)
16	825 (3.8)	4 (1.1)	2 (0.6)	12 (1.7)	1 (0.2)
17	330 (1.5)	1 (0.3)	0 (0.0)	2 (0.3)	2 (0.5)
18	403 (1.8)	7 (1.9)	1 (0.3)	8 (1.1)	0 (0.0)
19	923 (4.2)	16 (4.5)	8 (2.5)	17 (2.4)	2 (0.5)
Total	21,787	358	320	697	408
Mean length in inches		13.7	11.7	12.1	12.7

[a] Figures in parentheses are percents of season totals.

resistant to angling, although they also were quite vulnerable to early season fishing. An ability of these fish to sustain a fishery over a longer period of time than the plant of tagged trout is obvious.

Size Selectivity of Angling

Angling was selective for large fish. Mean length of the tagged trout at time of planting on May 18 was 12.3 inches (497 fish), while mean length of 243 of these trout harvested in May was 12.7 inches, a significant difference (Table 2). Further evidence of early selection of large fish by angling was shown by the small size when stocked ($\bar{x}$ = 11.6 inches) of 25 tagged trout kept by fishermen in 1968, and small mean lengths at time stocked of those caught in June, July, August and September, 1967 (Table 3).

Delay in harvesting the smaller fish probably contributed to mortality and a reduced total harvest among them. A total of 28% of the trout under 11.0 inches when stocked were not harvested, while only 10% of those 11.0 inches and over when stocked failed to reach the creel.

Migration From Lake

Tagged fish did not leave Parvin Lake in appreciable numbers. Traps were functional in the inlet and outlet in 1967 and 1968, and partially so in 1969; three fish entered the trap in 1967 and one in 1968. A return was obtained from the outlet stream about one mile below the lake in 1969.

Growth

Tagged trout were so depleted by early season fishing that few remained to provide information on growth, and those that were left were the smaller of the fish stocked. However, these trout grew at a

Table 2. Chi-square analysis to test for a difference in length between tagged trout stocked May 18 and caught in May 1967.

Length in inches	Stocked		Caught		Total
	Number observed	Number expected	Number observed	Number expected	
< 9.9	26	21	5	10	31
10.0-10.9	73	60	17	30	90
11.0-11.9	111	115	60	56	171
12.0-12.9	142	143	71	70	213
13.0-13.9	92	99	55	48	147
14.0-14.9	22	25	15	12	37
15.0-15.9	12	14	9	7	21
16.0 >	19	20	11	10	30
Totals	497		243		740

$x^2 = 16.03$, df 7, $p = 0.025$

Table 3. Growth of tagged rainbow trout, stocked May 18, 1967.

Sampling periods	Number of fish	Mean number of days in lake	Mean length when stocked	Mean length when caught	Mean growth in inches		
					All fish	Fish under 12.0 inches when stocked	Fish 12.0 inches and over when stocked
June, 1967	120		12.0	12.6	0.6		
	57	29				0.76	
	63	24					0.37
July, 1967	23		11.8	12.9	1.1		
	13	52				1.21	
	10	55					0.86
August, 1967	13		12.1	13.5	1.4		
	6	98				1.85	
	7	88					0.93
September, 1967	4		11.7	13.7	2.0		
	1	130				3.50	
	3	118					1.50
May 18-31, 1968	14		11.9	13.9	2.0		
	7					2.79	
	7						1.03
June, 1968	7		10.4	12.9	2.5		
	7					2.51	

modest rate (about 2.0 inches in a year) and eventually entered the creel at a larger size than the mean length of the entire group (12.3 inches) at the time of stocking. Mean growth at various sampling periods is presented in Table 3. Growth from the time planted, among the individual trout recovered by fishermen in May 1968, ranged from a maximum of 4.0 inches to a minimum of 0.2 inches.

The data were arranged to show growth of trout under 12.0 inches in length at time of capture and of those 12.0 inches and over at time of capture (Table 3). At each sampling period, the smaller fish demonstrated the better growth. One might expect that the larger fish of a group would be the faster growing. A specific explanation for the opposite situation in this case is not available, but areas of potential influence would include age, sex, sexual development, available food, and the phenomenon of growth compensation.

Cooper (1953) noted that many workers dealing with many species of fish have found that initially slow-growing members of an age group grow faster in later years than do the initially fast-growing members of that same group. He found that this phenomenon of growth compensation occurred in brook trout (Salvelinus fontinalis) and brown trout (Salmo trutta) in the Pigeon River, Michigan, but that the compensation was not sufficient to overcome the original difference in growth exhibited during the first year; fish that were large yearlings maintained their superiority in size throughout the first 3 years.

The growth pattern noted at Parvin Lake was favorable from the standpoint of total value of the plant. In most cases, the smaller trout that escaped early capture grew to a respectable size before being caught.

Discussion

Rapid removal of creel size hatchery-reared trout is a well-documented phenomenon. However, precise data on removal of the tagged trout at Parvin Lake is additional information since it occurred under artificial lure fishing only. Also, the comparative information on returns to the creel of fingerling trout of hatchery origin provided some measure of the difference in response to angling of trout artificially sustained until stocked with fish that had extended exposure to a natural environment. The latter demonstrated an obvious ability to sustain a fishery for a longer period of time.

The practical value of findings relating to creel size, hatchery-reared trout that survive the first 2 weeks is minimized by rapid removal of these fish in many situations, particularly in small bodies of water. Fate of the few trout that remain after an initial onslaught of fishing is hardly a matter of consequence in the overall picture in these cases. But, in large lakes or reservoirs where trout may not be as rapidly removed, responses to the environment and to fishing of those that remain in the lake over relatively long periods are then important. The relevant findings at Parvin Lake are indicative of responses that might be expected among creel size trout of hatchery origin that survive for a substantial period of time in other lakes.

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