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**SURVIVAL, GROWTH AND YIELD OF STOCKED DOMESTICATED
BROWN AND RAINBOW TROUT FINGERLINGS IN BLACK EARTH CREEK**

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ABSTRACT

Fall-stocked fingerling brown trout had 51 to 90 percent survival to the following spring. Fall-hatched rainbow trout fingerlings stocked in the fall, had 42 to 60 percent survival to the following spring.

June-stocked fingerling brown trout had 13 percent survival to the following September. June-stocked fingerling fall-hatched rainbow trout had 26 to 30 percent survival to the following September, whereas 40 percent of the June-stocked winter-hatched rainbow trout fingerlings survived to the following September.

All stocks of rainbow trout had higher total weights in April than the total weights stocked the previous June or September. The highest gain in total weight from June to the following April was 894 percent. Out of 5 stocks of brown trout, 3 stocks weighed more the following April than when stocked the previous June or September.

All stocks of rainbow trout censused yielded more pounds of trout flesh to the creel the following fishing season than was originally stocked. None of the brown trout stocks yielded more pounds to the creel the following fishing season than was originally stocked.



Black Earth Creek between stations 10 and 11 is the lower part of the trout stocking area. Water cress and water buttercup are the common plants in the stream.

INTRODUCTION

Hatchery-reared trout are stocked in sections of Wisconsin's trout streams that lack natural reproduction of trout or where natural reproduction is inadequate to support a trout fishery under present fishing pressures. Most of the hatchery-reared brook, brown and rainbow trout in Wisconsin are released in April as yearlings just prior to the opening of the trout fishing season in May. These trout are rapidly harvested by anglers before they can convert trout food in the streams to trout flesh. An insignificant number of the April-stocked yearlings survive to grow in the streams and to exhibit the desired characteristics of wild trout.

Summer and fall stocking of fingerling brown and rainbow trout continues to gain momentum in southern Wisconsin because here sections of fertile streams with low resident trout stocks are excellent environments for growth of stocked trout which rapidly acquire the characteristics of wild trout anglers desire. Moreover, summer- and fall-stocked brown trout fingerlings are not as readily caught by anglers the following fishing season as are yearling brown trout released in the spring just prior to the trout fishing season. A higher percentage of the summer- and fall-stocked brown trout fingerlings, then, carry-over to succeeding fishing seasons and make available desirable stream-grown trout to the angler.

The results of stocking brown and rainbow trout as early summer and fall fingerlings since 1957 in Black Earth Creek, Dane County, will be discussed in this report. Published results of stocking brown trout fingerlings in Black Earth Creek during the fall prior to 1958 are available (Brynildson and Christenson, 1961).

Data on survival and growth of stocked trout in Black Earth Creek have been obtained on various stocks up to the time a particular stock had nearly disappeared from the stream. Previous investigations in Wisconsin had not studied any particular stock of hatchery-reared trout more than 2 years (Brynildson and Christenson, 1961).

DESCRIPTION OF STREAM

Black Earth Creek is a fertile stream draining a watershed which lies in limestone country. Additional fertility from domestic sewage enters the stream just below the Village of Cross Plains. Groundwater discharge enters Black Earth Creek at intervals along its course and the water temperatures are suitable for trout for 15 miles. The upper 2 miles of Black Earth Creek contains most of the wild brown trout and the spawning grounds. Here riffles and pools are interspersed with runs. The main trout stocking area begins a mile below the spawning grounds between stations 7 and 12 (Fig. 1) and contains low numbers of wild trout but high populations of white suckers. Here the 12 cu. ft./sec. of relatively deep water flows over rubble and muck and the instream cover of water cress and water buttercup offers abundant shelter for trout food and trout fingerlings during all but the coldest months. Because of the continuous ground water discharge in the stocking area, this section is ice-free during the winter.

METHODS

Trout Stocking

Fingerling trout selected for release into Black Earth Creek were from the regular production stock of domesticated brown and rainbow trout from Nevin and Westfield Hatcheries.

All trout stocked were marked for future identification by removal of an adipose or ventral fin, and 150 to 200 from each group stocked were measured to the nearest 0.1 inch in total length and weighed to the nearest gram. Data on the stocked trout are presented in Tables 1 and 2.

The trout were released in mid-June during the trout fishing season or after the trout fishing season closed in the fall. All fall-stocked rainbow trout fingerlings and all June-stocked brown and rainbow trout fingerlings were scatter-planted in a section (Stations 7 to 15, Fig. 1) of Black Earth Creek below the 2-mile section containing the bulk of the resident wild brown trout. The fall-stocked brown trout fingerlings were released from stations 3 to 7 (1960) and stations 1 to 4 (1958-59 and 1961). Although stations 1 to 7 contain fair (35 lbs. per acre) stocks of wild brown trout throughout the year, the highest density (85 lbs. per acre) is between stations 1 and 1a.

Population Estimates

Trout population estimates were made during April, just prior to the opening of the trout fishing season in May, and in the fall after the season closed September 7. Electrofishing operations started 1.5 miles below the 1-mile area where the fish were released and covered the upper 5.6 miles of trout water in Black Earth Creek.

A 230-volt, 2500-watt, direct-current electric shocker was used and the size of the population computed on the Peterson-type mark and recapture method. For details on procedure and efficiency of the electrofishing gear, see McFadden (1961) and Hunt *et al.* (1962). Recapture values on trout 6 to 17 inches in total length were 60 to 90 percent of the original number captured, marked and released during the first run of the electrofishing unit.

Population estimates of the trout were made by 1-inch length groups and by age groups except whenever numbers of trout were small, as in the years following the year a particular group of trout was stocked, when the estimate was made by

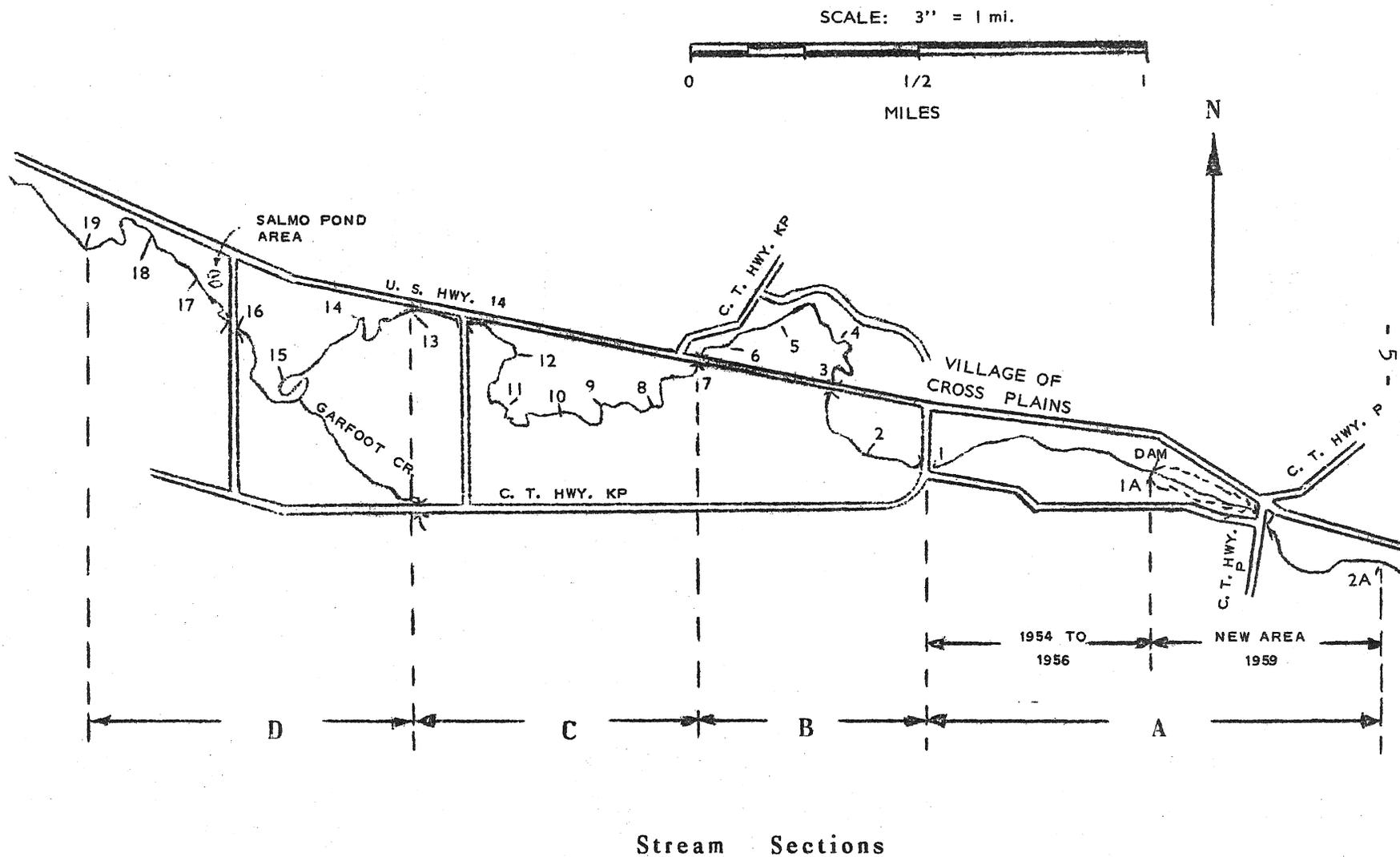


Figure 1. Map of the 4.9 stream mile study area of Black Earth Creek, Dane County, Wisconsin. Numbers refer to the locations of station markers.

age group only. Confidence limits of 95 percent were calculated on estimates made by age group. In testing significance of difference between the population size of any two groups, the lower confidence limit of the larger group and the upper limit of the smaller group were compared by Chi square.

All trout captured with the electric shocker were measured to the nearest 0.1 inch in total length and a representative sample weighed to the nearest gram on a 500- or 1,000-gram Hanson dietetic scale at each 300-yard station within the 5.6-mile stretch of stream.

Creel Census

A creel census was conducted on Black Earth Creek during the 1960 and 1963 trout fishing seasons. An estimated 70 to 80 percent of the anglers were contacted by patrolling the stream during the daylight hours in 1960 and from daylight to 10 a.m. and from 4 p.m. to darkness in 1963.

RESULTS

Survival of Trout

Brown Trout. The fall-stocked fingerling brown trout had 51 to 90 percent survival to the following spring during the years 1958-61. The trout stocked November 9, 1960 were the largest fingerlings stocked and were stocked latest in the fall of any of the various stocks (Table 1). Their 90 percent overwinter survival was significantly higher ($P < 0.01$, by chi square) than the survival of the other fall-stocked brown trout (51 to 56 percent). The fingerling trout released September 8, 1959 were reduced to 63 percent of the original stock within 3 weeks, and 51 percent of the original stock by April, 1960.

The 5,000 fingerlings stocked June 14, 1962 had 13 percent survival to September, 1962. Of these survivors, 58 percent were estimated to be present in the 5.6-mile study area in April, 1963 (7 percent of the number originally stocked). Further survival estimates of this group beyond April, 1963, cannot be compared to survival of other groups of trout in other years because most of the June, 1962 stock was killed by organic pollution in July, 1963.

Survival of the fall-stocked fingerling brown trout from the following April to September in Black Earth Creek ranged from 11 to 20 percent. This compares with 2 to 4 percent summer survival of spring-stocked yearling brown trout in Black Earth Creek (Brynildson and Christenson, 1961). Survival of the "carry-over" fall-stocked brown trout through their second and successive winters ranged from 74 to 100 percent, indicating that the surviving trout from the original fingerling stock, now grown to adults, survived the winters better than newly stocked fingerlings.

Rainbow Trout. Of the two groups of fall-hatched rainbow trout stocked September 10, 1959, the one that contained the largest fingerlings survived best (Table 2). The larger fingerlings averaged 1.8 inches longer and had double the average weight of their counterparts stocked with them in the same section of Black Earth Creek. The group with the larger trout had 72 percent survival from early September to early October and 60 percent survival to the following April. The group with the smaller trout had 60 and 42 percent survival, respectively, during the same period. The higher survival of the larger trout during their first month in the stream was significant ($P < 0.05$), but the higher survival from October to April was not significant. However, the higher survival of the larger trout from date of stocking in September to the following April was highly significant ($P < 0.01$).

The two groups of fall-hatched rainbow trout fingerlings stocked June 14, 1960, varied in average length by only 0.3 inches when released and 0.4 inches in late September, 1960 (Table 2). Difference (1 percent) in summer survival of these two groups was not significant, but the 18 percent survival of the larger trout as compared to only 14 percent of the smaller trout from date of stocking in June to the following April was significant ($P < 0.05$).

The group of fall-hatched rainbow trout fingerlings stocked June 14, 1962, averaged over an inch smaller than the fingerlings stocked June 14, 1960 (Table 2), and yet their summer survival of 30 percent was higher although not significantly different from the 27 percent summer survival of the highest surviving group stocked June 1960. The June, 1962 stock averaged over an inch less in length in September as compared to the June, 1960 group containing the largest trout. The overwinter survival of the 1962 stock was 67 percent and was as good as the 69 percent survival of the 1960 group containing the larger trout. The survival from date of stocking in June to the following April was from 14 to 20 percent for the 3 groups of trout. After the fall-hatched rainbow trout were exposed to their first trout fishing season, as legal-sized trout, few were found in the streams in September (Table 2).

One group of winter-hatched rainbow trout was stocked June 12, 1961. Although these trout averaged over an inch smaller than trout from the 1962 stock and over 2 inches smaller than the trout from the 1960 stocks, their summer survival was 40 percent compared to the 30 and 27 percent summer survival of the 1962 stock and the best surviving group of the 1960 stocks, respectively. The higher summer survival of the June, 1961, stock as compared to the June, 1962, stock was highly significant ($P < 0.01$), but there was no significant difference in overwinter survival between the 1961 and 1962 stocks. More of the legal-sized winter-hatched rainbow trout survived their exposure to a fishing season than did the fall-hatched rainbow trout (Table 2). The June, 1961, stock of winter-hatched rainbow trout that did survive the summer of 1962 spawned during late winter of 1963, and a small population of wild rainbow trout were found in the study area in September, 1963.

Growth of Trout

Brown Trout. Growth in length and weight and the average coefficient of condition R are presented in Table 1. Growth in length and weight was rapid. Although growth in length was more rapid from April to September, there was an increase in average length of 1 to 2 inches from September to April. The generally higher coefficient of condition in April as compared to September indicates that the stocked brown trout in Black Earth Creek maintain a high condition factor all year.

Overwinter gain in total weight above the total weight stocked in the fall occurred in the 1958 and 1960 stocks. The group released June 14, 1962 lost in total weight from June to September but regained the stocked weight by the following April (Table 1).

Rainbow Trout. Growth in length of both the fall-hatched and winter-hatched rainbow trout from September to April averaged 2 to 3 inches (Table 2), an inch longer on an average than the growth in length of the stocked brown trout during the same period. The average coefficient of condition, although high in September, was higher in April, indicating as with the brown trout that a high condition factor was maintained all year by the stocked rainbow trout.

All stocks of rainbow trout had higher total weights in April than the total weights stocked the previous June or September. The fall-hatched rainbow trout stocked September, 1959 gained on an average of 63 percent in total weight from time of stocking to the following April. The fall-hatched rainbow trout stocked in June gained from 34 to 197 percent above the stocked weight by the following April. The one group of winter-hatched rainbow trout stocked had higher total weight gain from time of release in June to the following April than any of the fall-hatched rainbow trout groups. The gain in total weight from June, 1961 to April, 1962, was 894 percent. These trout were only 2 - 3 inches in total length when stocked (Table 2), and percentage gain in total weight was expected to be higher than for the larger fall-hatched rainbow trout.

Yield

Brown Trout. The harvest in 1960 of the brown trout stocked in October, 1958 and the brown trout stocked in September, 1959 was recorded during a creel census in the 1960 trout fishing season and the harvest in 1963 of the brown trout stocked in October, 1961 and June, 1962 was recorded during a creel census in 1963 (Table 1). The 61 trout of the 1958 stock remaining in Black Earth Creek in April, 1960 yielded 46 percent of their April number and 58 percent of their weight during the 1960 trout fishing season. The September, 1959 stock had 32 percent of their April, 1960 number and 46 percent of their weight harvested during their first exposure to a fishing season. The October, 1961 and June, 1962 stocks contributed only 11 and 29 percent of their April, 1963 numbers and 20 and 35 percent of their weight to the catch during May-June, 1962 respectively, before organic pollution killed most of the remaining trout of these groups in July, 1963. None of the brown trout stocks produced more pounds of trout to the creel the following fishing season than was originally stocked.

Rainbow Trout. Of the two groups of rainbow trout stocked in September, 1959, an average of 61 percent of their April, 1960 number and 74 percent of their weight was harvested in May - June, 1960. These two groups of trout contributed 21 percent more pounds of trout flesh to the creel the following fishing season than was originally stocked. The rainbow trout stocked in June, 1962 contributed 29 percent of their April, 1963 number and 35 percent of their weight to the catch during May - June, 1963 before most of the remaining trout of this group were killed by the July, 1963 organic pollution. These trout contributed 7 percent more pounds of trout flesh to the creel than was originally stocked.

DISCUSSION

The 90-percent overwinter survival of the brown trout fingerlings stocked November 9, 1960 indicates that these larger trout survived the winter in Black Earth Creek better than the other groups of brown trout stocked. Stocked a month later in the fall than any other group, these trout also escaped exposure to bird and water snake predators which are still active through relatively warm Octobers in southern Wisconsin. In Convict Creek, California, Reimers (1963) found that rainbow trout stocked late in the fall survived best to the following June. He suggested late-fall-stocked trout may have more reserve energy to allow for increased activity and exploitation of the spring food source and hence less late winter and early spring mortality would occur. The brown and rainbow trout stocked in early September, 1959 (Tables 1 and 2) had higher mortality during their first month of life in Black Earth Creek than from October to the following April. Bird and snake predators are active during September on Black Earth Creek, especially migrating great blue herons. The group of rainbow trout stocked September 10, 1959 which contained the largest fingerlings survived their first month in Black Earth Creek better than the groups of rainbow and brown trout with relatively smaller

fingerlings. Under possibly increased predator pressure or under intra-species competition the relatively larger fingerling trout may survive the best. Wide length range of fingerling trout in a given stock may favor the larger fingerlings when competing for cover in a stream.

Although the stock density was greater and the size of the rainbow trout released June 12, 1961 was smaller than any trout stocked, these trout had the best summer survival. However, the length range of these fingerling trout was narrower than any of the groups of trout stocked. A narrow length range of the individuals of a group of trout may have survival value to that group in that no large group of larger and stronger individuals are present to dominate the smaller trout and thus prevent them from establishing secure homes. Higher density of stocked fingerling trout may be another factor influencing higher total survival of the stock. Ricker (1952) describes one type of predation where predators of any given density take a fixed number of the prey species during the time they are in contact, enough to satiate them. The surplus prey escapes. During the summer on Black Earth Creek, the predator population is relatively fixed. By increasing the density (within carrying capacity) of the June stocks of fingerling trout, a higher percentage of the total stock might survive because the individuals captured by predators could act as buffers to predation on the total stock. During April and September, migratory bird predators would probably take advantage of high density stocks of trout and high density could mean lower percentage survival of a stock.

The 30-percent survival of the fall-hatched rainbow trout fingerlings and 13-percent survival of the brown trout fingerlings from June 14 to mid-September, 1962 may indicate that the brown trout fingerlings could not successfully compete with rainbow trout fingerlings even though they were similar in size. Brynildson (1964) found that in the year rainbow and brown trout fingerlings were released in similar but different sections of Mt. Vernon Creek, Dane County, summer survival of the brown trout fingerlings was nearly as high as the survival of their rainbow trout counterparts.

SUMMARY AND MANAGEMENT IMPLICATIONS

Release Time: Fall

1. Brown and rainbow trout fingerlings released in Black Earth Creek in early September showed that mortality was greater during September than from October to April.
2. Brown trout fingerlings stocked in November had 90 percent survival to the following April. Those stocked in September and October had from 51 to 56 percent survival. The November stock had the advantage of larger size and perhaps less exposure to terrestrial predation than trout released in September and October.
3. Survival of the fall-stocked fingerling brown trout from the following April to September in Black Earth Creek ranged from 11 to 20 percent. Survival of spring-stocked yearling brown trout from April to September was only 2 to 4 percent. If carry-over stream-grown trout are desired by anglers, fall-stocking of fingerling brown trout in suitable streams should provide more of these trout than by releasing yearling brown trout during spring.
4. Of two groups of fall-hatched rainbow trout fingerlings stocked in September, the one that contained the largest fingerlings survived best to the following April.

Release Time: Summer

5. The winter-hatched rainbow trout fingerlings, stocked in mid-June at twice the density of the largest stock of fall-hatched rainbow trout fingerlings, had significantly higher summer survival than did the fall-hatched rainbow trout fingerlings. Although the winter-hatched fingerlings were smaller than other rainbow trout fingerlings, their high stock density may have acted as a buffer against a relatively fixed predator population during the summer on Black Earth Creek and as a consequence a higher percentage of the total stock survived.

Brown trout fingerlings released in the same stream section as rainbow trout fingerlings during summer had lower survival than brown trout fingerlings released in sections of stream without rainbow trout. Apparently the rainbow trout fingerlings out-compete the brown trout fingerlings.

Pounds of Fish Flesh

6. Both summer- and fall-stocked rainbow trout fingerlings contributed more pounds of trout to the creel the following fishing season than was originally stocked. None of the brown trout fingerling stocks contributed more pounds to the creel the following fishing season than was originally stocked. However, in two of five releases the total poundage present in April exceeded that stocked the previous fall. It is unknown whether these stocked fingerling brown trout would have contributed their stocked weight back to the creel during successive years of life in Black Earth Creek.

Angling Opportunities

7. To obtain desirable trout with wild characteristics for early season angling, rainbow trout should be released as summer or fall fingerlings. These fish will not only produce more pounds of trout flesh overwinter than brown trout fingerlings but this production is more easily harvested by novice anglers.
8. To obtain desirable trout with wild characteristics available to anglers for one or more seasons, brown trout should be released as summer or fall fingerlings. These fish survive and grow to be caught as larger and more desirable-size carry-over trout than their rainbow trout counterparts which are creeled early in the fishing season before they can grow large.

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TABLE 1

Survival, Growth, and Yield of Domesticated Brown Trout Released
as Summer and Fall Fingerlings in Black Earth Creek.
(Stocking Dates, Number and Pounds of Trout Stocked are in Parentheses)

Date	Fin Removed*	Trout Stock		Total Length Range (Inches)	Average Total Length (Inches)	Average Weight (Grams)	Average R**	Trout Creeled	
		Numbers	Pounds					Numbers	Pounds
(Oct. 24, 1958)	RV	(1,000)	(66)	5 - 7	5.7	30	1.62		
Apr. 14-20, 1959		562	85	6 - 7	7.2	69	1.72		
Sep. 28--Oct. 8, 1959		72	39	9 - 14	11.1	243	1.81		
Apr. 11-15, 1960		61	52	9 - 15	12.5	390	1.95		
May - Jun., 1960		Creel census		11 - 15	12.9	420	--	28	30
Sep. 23-27, 1960		21	28	13 - 18	14.9	605	1.78		
Apr. 3-8, 1961		20	31	13 - 19	15.3	714	1.96		
Sep. 18-27, 1961		6	11	13 - 18	16.7	835	1.80		
Apr. 3-9, 1962		7	14	15 - 19	16.9	909	1.99		
Sep. 8-14, 1962		2	3	15 - 17	15.9	625	1.56		
(Sep. 8, 1959)	2V	(1,125)	(67)	4 - 6	5.3	27	1.82		
Sep. 28--Oct. 8, 1959		709	48	4 - 7	5.7	31	1.69		
Apr. 11-15, 1960		610	112	6 - 9	7.7	83	1.77		
May-Jun., 1960		Creel census		7 - 11	8.8	120	--	193	51
Sep. 23-27, 1960		125	80	10 - 13	11.8	292	1.76		
Apr. 3-8, 1961		102	108	10 - 16	13.8	481	1.96		
Sep. 18-27, 1961		23	38	14 - 18	15.9	746	1.84		
Apr. 3-9, 1962		17	27	12 - 17	15.7	725	1.82		
Sep. 8-14, 1962		3	6	17 - 18	17.4	855	1.63		
(Nov. 9, 1960)	LV	(1,125)	(149)	6 - 8	6.8	60	1.91		
Apr. 3-8, 1961		1,008	224	6 - 11	8.1	101	1.76		
Sep. 18-27, 1961		113	91	10 - 15	12.3	367	1.78		
Apr. 3-9, 1962		99	97	10 - 18	13.5	445	1.81		
Sep. 8-14, 1962		26	36	13 - 17	15.4	620	1.72		
Apr. 1-8, 1963		21	39	14 - 18	16.3	817	1.85		
Sep. 9-19, 1963		3	6	16 - 18	17.2	935	1.85		

Table 1 (Cont.)

Date	Fin Removed*	Trout Stock		Total Length Range (Inches)	Average Total Length (Inches)	Average Weight (Grams)	Average R**	Trout Creeled	
		Numbers	Pounds					Numbers	Pounds
(Oct. 11, 1961)	RV	(1,112)	(100)	5 - 7	5.9	41	1.96		
Apr. 3-9, 1962		571	93	6 - 9	7.3	74	1.88		
Sep. 8-14, 1962		84	32	8 - 13	10.0	174	1.69		
Apr. 1-8, 1963		80	59	9 - 17	11.8	333	1.93		
May - Jun., 1963		Creel census		11 - 18	14.3	611	--	9	12
Sep. 9-19, 1963		8	8	12 - 15	13.5	469	1.89		
(Jun. 14, 1962)	LV	(5,000)	(110)	3 - 5	3.8	10	--		
Sep. 8-14, 1962		625	67	5 - 8	6.4	49	1.75		
Apr. 1-8, 1963		365	113	6 - 12	9.1	140	1.83		
May - Jun., 1963		Creel census ***		8 - 14	10.6	167	--	119	44
Sep. 9-19, 1963		15	10	11 - 14	12.0	297	1.70		

* Abbreviations for fins removed: A - adipose; L - left; R - right; V - ventral; 2 - both

** $R = \frac{W \times 10}{L^3}$ where W equals weight in grams and L equals total length in inches.

*** Five brown trout of these stocks were recorded creeled during the Jul.-Sep., 1963, creel census.

