RECLAMATION OF PINE CREEK, TENNESSEE

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ABSTRACT

Fish in Pine Creek, in DeKalb County, Tennessee, were eradicated with rotenone and brown trout were stocked in the stream. This management tool, stream reclamation, was evaluated by studying the growth rate of the brown trout, their condition, the rate at which other species of fish re-entered the stream, and the effect of the toxicant, rotenone, on the bottom fauna.

Populations of bottom dwelling organisms were reduced from 34 to 100 per cent by the rotenone. All organisms except two, Plecoptera and Isopoda, recovered up to or beyond their original abundance within one year after eradication.

The brown trout had an average growth rate per month of 11 millimeters in length and 18.1 grams in weight during the 16-month study period. This growth rate was exceptional when compared to the growth rate of brown trout reported by other investigators and was equal to the growth rate of brown trout in a Tennessee hatchery. The coefficients of condition of the brown trout in Pine Creek were low in comparison to brown trout in other streams. These data indicate that reduction of competition results in increased growh rate of brown trout.

Species of fish other than trout re-entered the stream approximately three months after eradication. Sixteen months after eradication, 12 of the 17 species of fish originally present in the stream had reappeared.

The brown trout did not mature earlier than those in streams that have not been reclaimed. Recommendations and management possibilities are discussed.

RECLAMATION OF PINE CREEK, TENNESSEE

The restoration of productive sport fisheries in ponds and lakes through the control of undesirable species of fish has become an accepted and valuable practice in fishery management (Boussu 1959, Chance and Miller, 1952, Clemens and Martin 1952, Krumbolz 1948, Mayer 1963, Stroud 1958). During the past several years much emphasis has been placed upon controlling and manipulating these fish populations in lakes and ponds by using chemicals (Mayer 1963). Only recently has this technique of reclamation been applied to streams.

Mullan and Tompkins (1959) state, "competition from resident fishes, directly or indirectly, is believed to account for the significant loss of stocked trout" and "the possibilities of counterbalancing physical and chemical shortcomings of water environments for trout, by the elimination or control of competition, has become self-evident in recent years." Trout pond management has shown that reduction of other fish populations causes an explosive and dramatic increase in trout production and fishing success (Mullan 1959). Canadian biologists have shown that the same conditions exist in streams and that hatchery trout exhibit the greatest survival and growth rates in areas free of other fish (Mullan and Tompkins, 1959).

California biologists reported a thirteenfold increase in the steelhead rainbow trout population in some of the headwater areas of the Russian River after it was reclaimed in 1954 (Printer and Johnson 1958). Two streams were reclaimed in the Great Smoky Mountains National Park in 1955 with similar results (Lennon and Parker 1959). In Massachusetts, three small streams were treated in 1955, and samples

showed a two-to-fivefold increase in the trout-carrying capacity of two of these streams (Mullan 1959).

In Middle and East Tennessee there are several hundred miles of streams that are marginal to both warm- and cold-water game fish (Parsons 1954). The general physical characteristics and fish populations of these streams have been described by Ruhr (1957). It is generally believed that these streams are too cold for optimum production of warmwater game fish and are too warm for optimum production of cold-water game fish. These streams generally are considered worthless by the fishermen (Parsons 1954).

At the present time, the Tennessee Game and Fish Commission stocks some of these marginal streams with adult, catchable-size trout. Adult trout are stocked because it is believed that this less desirable type of habitat is not suited for reproduction of the trout and in most instances not even capable of over-summering the species (Sharpe 1960). This has resulted in a put-and-take trout fishery in which the adult trout are stocked in hopes that they will be caught by fishermen before high temperatures of the water during the summer kill the fish. Present investigations have shown that temperature is not a limiting factor for trout survival in most of these streams that are presently being stocked.

It is my belief that removal of competing species of fish would improve the trout-carrying capacity of these Tennessee streams. This could eliminate the need of stocking adult trout, except in streams where excessive fishing pressure would require supplemental stocking. Fingerling size trout could be stocked, and would provide more fish at less expense with a better quality of fishing.

It was the objective of this research to evaluate stream reclamation as a management tool and to determine if it is practical and of value in managing so-called marginal trout streams in Tennessee. This evaluation was attempted by studying the following: (1) the rate of growth of trout in a reclaimed stream, (2) the condition of these trout, (3) the rate at which other species of fish re-entered the stream, and (4) the effects of the toxant, rotenone, on the aquatic insects of the stream.

MATERIALS AND METHODS

The Study Area

Pine Creek is in the Cumberland River drainage. It is a springfed stream located in DeKalb County, 3.5 miles south of Smithville, Tennessee, and flows in an easterly direction. It begins at a large spring 900 feet north of Watkins School on the Short Mountain Road and continues for approximately 10.2 miles to its confluence with the Caney Fork River sector of the Center Hill Reservoir between Adcocks Bend and Youngs Bend. The watershed is approximately 18,000 acres. The surface rock strata in the area are limestone.

The portion of Pine Creek that was studied intensively begins at the head of the stream and ends 7.8 miles downstream at the Pine Creek water falls. These falls are approximately 30 feet high and present a natural barrier to fish moving or migrating upstream.

The elevation of the stream at the headwaters is 1,040 feet and at the top of the water falls is 800 feet, with a drop of 240 feet and an average gradient of 32 feet per mile. The average width of the stream is 20 feet with a range between seven and 43 feet. The average pool depth is two feet, and the average riffle depth is seven inches. The majority of the pools are deeper and wider than the average width and depth of the stream. The volume of flow during most months of the year is 6.4 cubic feet per second at the head of the stream and 17.8 cubic feet per second at the falls. The velocity of the stream varies from 0.5 feet per second at the head to two feet per second in other parts of the stream. During the study period water temperatures ranged from 48° to 67° F. The average monthly temperature of the water during this time was 58° F. The stream bottom is course gravel, rubble, and bed rock in various combinations. Shelter for fish in most pools consists of undercut banks, log jams, and small ledges. The pools

in the lower part of the stream have less cover than do those in other parts of the stream. Most of the tributaries entering the stream are short and spring fed. The few tributaries that do not originate at springs become dry during the summer months.

The major portion of the shore line is wooded, with young hardwood species being dominant. The land adjacent to these wooded areas is primarily old fields, pastures, and fields in row-crops. Most of the stream is shaded. There is little, if any, flooding. The stream does not become extremely muddy unless there is a prolonged heavy rain. There is no pollution except from soil erosion. Silting is slight in the stream bed except near highway crossings.

Eradication of the Stream

The fish of Pine Creek and its tributaries were eradicated on October 20 and 21, 1962, with rotenone (Noxfish) as the toxant. Five-gallon cans with holes punched in them were calibrated and used as drip buckets to apply the rotenone. Cans with holes of different sizes were used to apply the rotenone at the desired rate.

To estimate the stretch-out, dilution, and velocity of the toxant moving downstream and to be sure it did not dilute below 1 ppm., the following technique was used prior to eradication. Fluorescein dye solutions of 0.5, 1, 2, 3, 4, and 5 ppm. were set up in clear pint bottles. The dye was released into the headwaters of the stream in the same manner and concentration as the rotenone would be released during the actual eradication. As the dye progressed downstream the concentration was checked by comparing the color of water samples taken from the stream to the bottles of dye containing known parts per million. As the dye began to dilute to near 1 ppm., other drip stations were set up, and this procedure was repeated throughout the stream.

The rotenone was introduced at the headwaters of the main stream and its tributaries at the rate of 5 ppm. for the first hour and at the rate of 1 ppm. for five hours thereafter as recommended by Lennon and Parker (1959). During the eradication, fluorescein dye was added to the rotenone in the drip buckets at the same concentration as the rotenone. The dilution was again checked and other drip buckets were set up as needed to keep the concentration of rotenone at least 1 ppm. All seeps, marshy areas, and pot holes were sprayed with rotenone by using back-pack pumps and walking the entire length of the stream. The rotenone was neutralized at the top of the waterfalls with KMNO4. The KMNO4 was applied by stretching a perforated hose across the stream and pumping the KMNO4 solution through it. One pound of KMNO4 was used per pint of rotenone. No fish were killed below the water falls.

An attempt was made to pick up all fish that were killed in the main stream. This was done by placing small mesh nets across the stream at several locations and by having men walk the stream with dip nets and buckets. Fish were picked up for three successive days after the rotenone application. The fish were counted, identified, weighed, and measured. Members of each species were weighed together.

Stocking and Sampling

Approximately one month after eradication, November 16, 1962, 3,000 brown trout, *Salmo trutta* Linnaous, were distributed evenly throughout the study area. These fish averaged 136 mm. in total length and 26 g in weight. All fish were tagged at the base of the dorsal fin with No. 1 strap tags.

During the following 16 months, with the exception of December, 1962, samples of fish were collected each month as near the 15th of the month as working conditions permitted. Collections were made by using electro-fishing gear (February, 1963), and creosol. One-quarter mile sections were sampled each time. Samples were collected from the upper, middle, and lower portions of the study area. Within these three general areas the sampling sites were selected at random. At least two of the sections were sampled each month and some months all three of the sections were sampled. All trout collected were weighed to the nearest gram and measured to the nearest millimeter. These data were

used to determine the growth rate and condition of the trout, and were compared with the growth rates and condition of trout reported by other workers from streams that have not been reclaimed, and from a Tennessee hatchery. When fish other than trout were collected, except for the last month of the study period, they were not weighed or measured but were identified and their numbers recorded. At the end of the study period, March, 1964, fish were collected with creosol from four one-quarter mile sections spaced evenly along the stream. All fish were identified, counted, and weighed. These data were compared with those collected during eradication to help evaluate the re-entry of other fish.

Effects of Rotenone on Aquatic Insect Populations

Since trout are dependent upon aquatic organisms, primarily aquatic insects (Tebo and Hassler 1963), as a source of food, it was considered important to know the effect of rotenone upon natural populations of these organisms. Miller (1963) has discussed and summarized the use of rotenone for controlling fish populations and has pointed out that very little is known about the effects of rotenone-containing products on aquatic organisms other than fish.

The bottom fauna of Pine Creek was sampled at three different times by using a Suber square-foot bottom sampler. The first series of samples were taken four days before the rotenone was applied, the second series of samples were taken one week after, and the third series one year later. Thirty-six square-foot bottom samples were taken each time. These samples were taken from riffles approximately one-quarter mile apart. Each series of samples was taken from the same riffles each time. Cans of spray paint were used to mark each riffle. The organisms were preserved in 70 percent isopropyl alcohol and later identified and counted. These samples were compared to evaluate the effects of the rotenone on the bottom fauna and to evaluate their recovery.

RESULTS

Bottom Fauna

The bottom-dwelling organisms collected during the three series of samples are shown in Table I. Table II shows the per cent increase or decrease in the number of organisms between the first and second series of samples, first and third series, and the second and third series.

Fish in Pine Creek

The species of fish in Pine Creek that collected during eradication are shown in Table III. Names are in accordance with those given by the American Fisheries Society (1960). Table IV shows the species present, total number, total weight, per cent of total number and weight of each species, length range, average number per mile, and average weight per mile of the fish collected.

Growth and Condition of the Brown Trout

The average monthly length, weight, and growth increment of the brown trout stocked in November, 1962, are shown in Table V for the 16-month study period. Figure 1 shows the growth in length by month and Figure 2 shows the growth in weight by month. The length-weight relationship of the brown trout in Pine Creek for the 16-month period is shown in Figure 3.

The average monthly coefficients of condition of the brown trout during the same period are shown in Table VI. Reciprocals given by Carlander were used to calculate K.

Re-entry of Other Species

Following eradication, periodic sampling with creosol throughout the stream during November and December, 1962, did not reveal any live fish, except the brown trout that were stocked. Fish other than stocked trout were first seen during the middle part of February 1963. At this time seven rosyside dace, four black bullheads, two green sunfish, and one bluegill were seen. These fish were removed

from the stream. During March, three sculpins, 11 stonerollers, and six creek chubs were found and removed. During April, May, and June, the adult fish in the stream spawned, and fry were observed as follows: stoneroller, southern redbelly dace, creek chub, and sculpin. Table VII shows a comparison of the species found, average number and weight per mile of stream of the fish collected during eradication, and those collected at the end of the study, March, 1964. During March, April, and May, 1963, the Tennessee Game and Fish Commission stocked approximately 600 adult rainbow trout in the stream on a put-and-take basis. These fish were caught out rapidly and were not considered of any measurable significance in this study.

Sexual Maturity and Spawning Success

Checks were made during the fall of 1963 which showed that the male brown trout were sexually mature and the female brown trout were not. This is in agreement with other population of brown trout as reported by Beyerle and Cooper (1960). Fry of brown trout were not observed at any time during the study.

Movements of the Brown Trout

Practically all of the trout lost their tags a short time after stocking, and the study of the movements of these fish was abandoned.

DISCUSSION AND CONCLUSIONS

Bottom Fauna

Data collected on the populations of bottom-dwelling organisms show

Table I. A Comparison of the Kind and Number of Bottom Organisms Found Four Days Before, Eight Days After, and One Year After Eradication of Pine Creek.

	Before		After		One Year Later	
Order	No.	Per Cent of Total	No.	Per Cent of Total	No.	Per Cent of Total
Insecta						
Plecoptera	27	1.33	8	1.15	18	.50
Coleoptera	377	17.62	443	63.39	711	19.62
Ephemeroptera	1006	49.79	70	10.01	1650	45.60
Trichoptera	248	11.27	68	9.74	389	10.72
Diptera	140	5.92	93	13.30	737	20.35
Hemiptera	11	.53	1	.13	11	.33
Odonata	1	.05	2	.28	6	.17
Neuroptera	14	.69	9	1.29	23	.64
Crustacea						
Isopoda	278	12.75	5	.71	66	1.82
Amphipoda	1	.05	0	0.00	9	.25
Total	2103	100.00	699	100.00	3620	100.00

Table II. Comparison of the Three Series of Bottom Samples Showing Per Cent Increase or Decrease from First Series of Samples to Second, First to Third, and From Second to Third.

	First to Second	First to Third	Second to Third
Order	Per Cent Increase or Decrease	Per Cent Increase or Decrease	Per Cent Increase or Decrease
Insecta			
Plecoptera	— 71	— 33	125
Coleoptera	18	89	61
Ephemeroptera	— 94	64	2260
Trichoptera	— 73	57	472
Diptera	— 34	427	685
Hemiptera	— 91	0	1000
Odonata	100	500	200
Neuroptera	— 36	64	156
Crustacea			
Isopoda	— 98	76	1220
Amphipoda	—100	800	

Table III. Species of Fish in Pine Creek at Time of Eradication

Common Name	Scientific Name
SALMONIDAE	
Rainbow trout	*Salmo gairdneri* (Richardson)
CYPRINIDAE	
Stoneroller	*Campostoma anomalum* (Rafinesque)
Goldfish	*Carassius auratus* (Linnaeus)
Southern redbelly dace	*Chrosomus erythrogaster* (Rafinesque)
Rosyside dace	*Cilinostomus funduloides* (Girard)
Blacknose dace	*Rhinichthys atratulus* (Hermann)
Creek chub	*Semotilus atromaculatus* (Mitchell)
CATOSTOMIDA	
Northern hog sucker	*Hypenthelium nigricans* (Le Sueur)
ICTALURIDAE	
Black bullhead	*Ictalurus melas* (Le Sueur)
AMBLYOPSIDAE	
Spring cavefish	*Chologaster agassizi* (Putnam)
CENTRACHIDAE	
Green sunfish	*Lepomis cyaneilus* (Rafinesque)
Bluegill	
Largemouth bass	*Micropterus salmoides* (Lacepede)
Rock bass	*Ambloplites rupestris* (Rafinesque)
COTTIDAE	
Banded sculpin	*Cottus carolinae* (Gill)
PERCIDAE	
Tennessee snubnose darter	*Etheostoma simoterum* (Cope)
Greenside darter	*Etheostoma blenniorides* (Rafinesque)

that many of the populations are drastically reduced by using rotenone to reclaim streams (Tables I and II). The first series of samples taken four days before rotenone application contained 2,103 organisms. The second series of samples taken eight days after rotenone application contained only 699 organisms. This is a decrease of 68 per cent in the total number of organisms. The only organisms not affected were Odonata and Coleoptera. There were so few individuals of Odonata collected that the results are not considered significant. The other organisms were decreased from 34 per cent up to 100 per cent. The average decrease of all the organisms was 75 per cent. During the collection of the second series of samples, I observed large numbers of dead aquatic insects, especially Ephemeroptera and Trichoptera. These organisms were in various states of decay and most were covered with fungi.

The recovery of the bottom fauna was evaluated by collecting the third series of samples, one year after rotenone application (Tables I and II). All of the organisms had recovered to or beyond their original abundance except two, Plecoptera and Isopoda. Since the total number of individuals collected of the Order Plecoptera is small and could be due to variation in sampling these results are not considered significant. However, it is clear that members of the Order Isopoda did not recover to anywhere near their original abundance one year after treatment. None of the organisms composing these Orders were extirpated.

Growth in Length

Data in Table V show that the brown trout in Pine Creek grew in length much faster than brown trout studied by other investigators, and that they grew at a rate equal to that of brown trout grown in a Tennessee trout hatchery.

The brown trout stocked in November, 1962, averaged 11 millimeters total length increase per month for a 16-month period. The greatest growth in one month was 23 mm. This occurred in April. At the end of the 16-month study period, the brown trout had just passed their second year of life, and averaged 312 mm. in length. The trout grew only

Table IV. Fish in Pine Creek at Time of Eradication

Species	No.	Per cent of Total	Weight in Pounds	Per Cent of Total	Length Range In Inches	Average Number Per Mile	Average Weight (lb.) Per Mile
R. B. Trout	61	.48	22.2	5.73	5 - 15	7.82	2.85
Stoneroller	5187	40.70	122.1	31.50	1 - 8	665.00	15.67
Goldfish	1	.08	1.8	.46	1	.13	.23
S. Redbelly Dace	768	6.03	4.5	1.16	1 - 5	98.40	.58
Rosy Side Dace	1416	11.11	15.6	4.02	1 - 5	181.60	2.00
Blacknose Dace	1737	13.62	38.4	9.90	1 - 5	222.50	4.92
Creek Chub	2172	17.05	92.4	23.75	1 - 9	278.00	11.83
N. Hog Sucker	150	1.18	38.7	10.01	2 - 15	19.25	4.96
Black Bullhead	28	.22	5.1	1.30	3 - 9	3.59	.65
Spring Cavefish	33	.26	.8	.21	1 - 2	4.23	.10
Green Sunfish	169	1.33	4.0	1.03	2 - 7	21.65	.51
Bluegill	109	.86	18.3	4.72	1 - 8	13.98	2.35
Largemouth Bass	1	.08	.1	.03	1 - 2	.13	.01
Rock Bass	63	.49	11.7	3.02	1 - 10	8.80	1.50
Banded Sculpin	611	4.80	11.2	2.88	1 - 6	78.40	1.44
Tenn. S. Darter	131	1.03	.7	.18	1 - 5	16.80	.09
Greenside Darter	96	.75	.4	.10	1 - 5	12.30	.05
Total	12733	100.00	388.0	100.00		1031.86	49.74

Table V. Average Monthly Length, Weight, and Growth Increment of the Brown Trout Stocked in Pine Creek, Beginning November, 1962.

Month After Stocking	Total Length MM.	Length Increment MM.	Weight Grams	Weight Increment Grams	No. of Fish
0 November	136		26		3000
1 December					
2 January	145	9	31	5	104
3 February	158	13	37	6	61
4 March	176	18	63	26	72
5 April	199	23	85	22	49
6 May	221	22	107	22	30
7 June	240	19	130	23	47
8 July	257	17	154	24	40
9 August	266	9	187	33	40
10 September	274	8	215	28	31
11 October	280	6	239	24	37
12 November	286	6	255	16	33
13 December	291	6	271	16	16
14 January	298	7	286	15	11
15 February	305	7	302	16	19
16 March	312	7	316	14	9

Table VI. Average Monthly Coefficients of Condition (K) of the Brown Trout in Pine Creek.

Month	K	Number of Fish in Sample
November	1.03	3000
December	—	—
January	1.02	104
February	.94	61
March	1.15	72
April	1.08	49
May	.99	30
June	.94	47
July	.91	40
August	.99	40
September	1.04	31
October	1.09	37
November	1.09	33
December	1.09	16
January	1.08	11
February	1.06	19
March	1.04	9
Average	1.03	

nine mm. the first two months after stocking. This could be due to the reduced number of aquatic food organisms or could represent the time required for the trout to become accustomed to stream conditions. From January, 1962, to April, 1963, there was a gradual and rapid increase in the rate of growth of the trout. From May until August, 1963, the growth rate per month decreased. From August until the end of the study period, the monthly growth rate was relatively uniform averaging 6.9 mm. each month. This decrease in growth rate, beginning in April, coincides with the increase in numbers of other species of fish. As fish other than trout spawned and the fry hatched and grew larger, the growth rate of the trout decreased. This decrease in growth rate could, of course, be due to some factor other than the increase in numbers of other species of fish.

Brown trout in the Flintville Hatchery, located near Flintville, Tennessee, and operated by the Tennessee Game and Fish Commission, have an average monthly growth rate of 11 or 12 mm. per month (Miller,

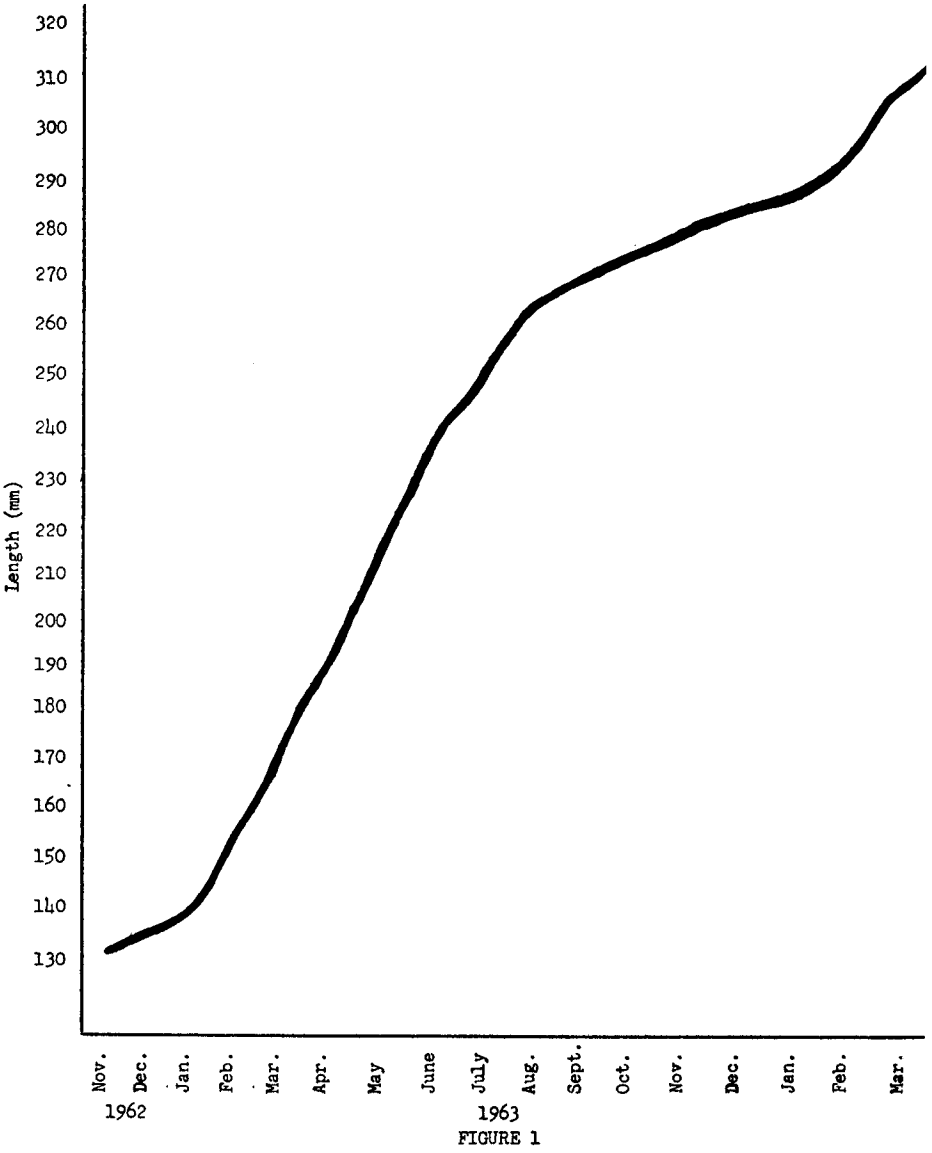

FIGURE 1

ABSOLUTE GROWTH (BY MONTH) OF BROWN TROUT IN PINE CREEK

personal communication). The brown trout in Pine Creek grew at an equal rate. The brown trout in Pine Creek grew five mm. per month faster than did trout in Calfkiller River, Putnam County, Tennessee (Little, unpublished data). These two streams were stocked at approximately the same time and are similar in many ways. Sigler (1951) reports that brown trout in Logan River, Utah, grow at approximately three inches (76 millimeters) per year, after the first year of life. This growth in length per year is about the same as many other populations (Eddy and Carlander 1944); (Bean 1902); (Beyerle and Cooper 1960). In one year, January, 1963, to January, 1964, the brown trout in Pine Creek had an average growth of 153

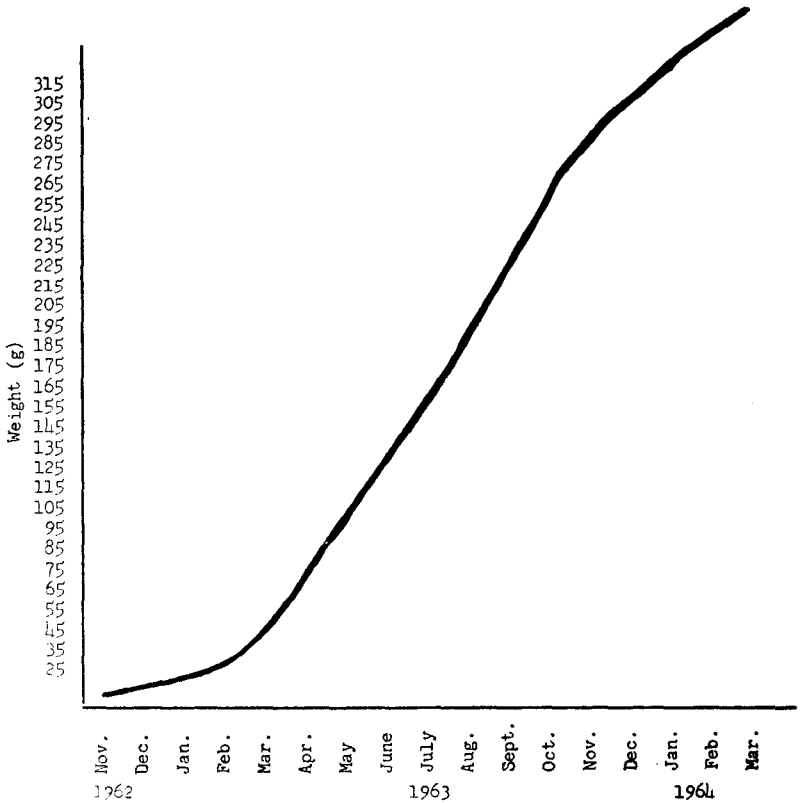

FIGURE 2

ABSOLUTE GROWTH (BY MONTH) OF BROWN TROUT IN PINE CREEK

mm. This is an average growth of 87 mm. per year greater than the brown trout in Logan River, Utah.

Growth in Weight

The growth in weight of the brown trout in Pine Creek was exceptional when compared to the growth rate of other brown trout populations as reported by Carlander (1950). The average monthly weight increase of the brown trout in Pine Creek was 18.1 grams for the 16-month study period. The greatest increase for any one month was 33 grams, occurring in August, 1963. The average weight increase for the first three months after stocking was 11 grams. This is an increase of only approximately four grams per month. The slow gain in weight for the first three months could be due to the reduced number of aquatic food organisms or could represent the time required for the trout to become adjusted to stream conditions. The growth in weight increased sharply in March and remained fairly constant until November when it dropped to 16 grams. This average increase per month remained about the same for the remainder of the study period. The average weight increase per month for brown trout in the Flintville Hatchery is approximately 24 grams. The monthly average for the brown trout in Pine Creek was six grams below the monthly average of trout in the Flintville Hatchery and was approximately six grams per month greater than the average monthly weight increase of the brown trout in Calfkiller River. The brown trout in Calfkiller River

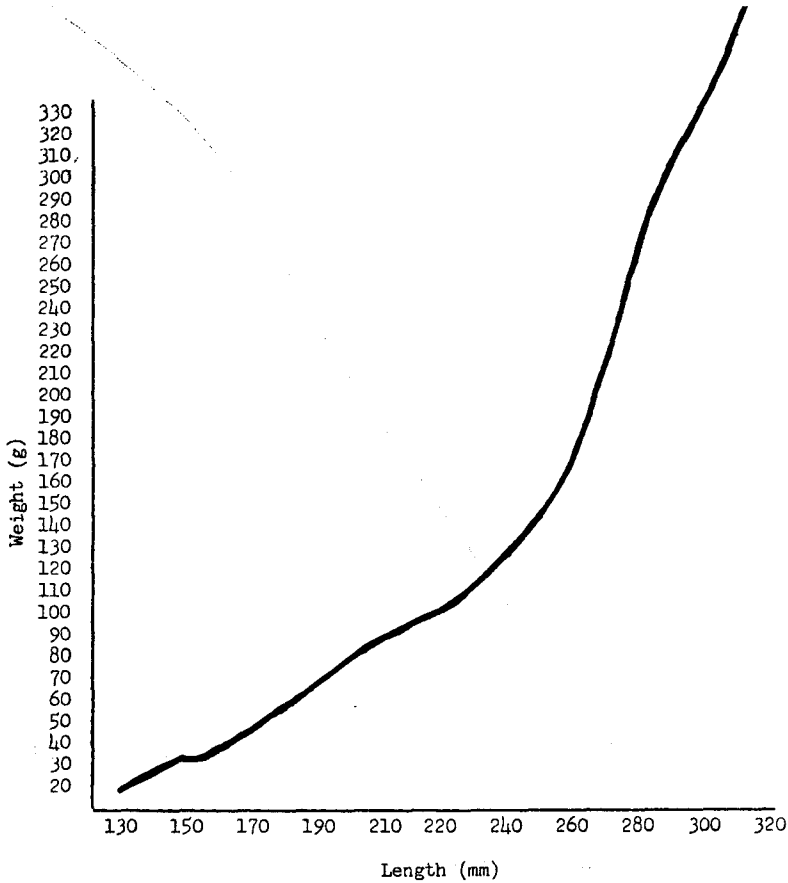

FIGURE 3

Length-Weight Relationship of the Brown Trout in Pine Creek

have an average growth rate of 12 grams per month (Little, unpublished data).

Condition

The coefficient of condition, K, of fish has been widely used by fishery investigators to express the condition, relative robustness, or "degree of well-being" of fishes. On this basis K has also been used for indicating the suitability or lack of suitability of an environment for a species, by comparison of the value for a specific locality with that for a region. It has also been used to measure the effects of environmental improvement (Lagler 1952).

The average coefficient of condition K of the brown trout in Pine Creek over the 16-month period was 1.03 (Table VI). In comparison with other brown trout populations this average is low (Carlander 1950). Parsons (1957) reported that fast-growing trout have coefficents of condition lower than average. This is contrary to observations made by Cooper (1960) on trout in the Pidgeon River, Michigan, but is true of the brown trout in Pine Creek.

The above analysis of data collected on growth of brown trout

Table VII. Average Number and Weight of Fish Per Mile in Pine Creek at Time of Eradication and Sixteen Months After Eradication.

Species	Time of Eradication		Sixteen Months After Eradication	
	Number	Weight (Lb.)	Number	Weight (Lb.)
R. B. Trout	7.82	2.85	3	2.6
Stoneroller	665.00	15.67	211	4.2
Goldfish	.13	.23	0	.0
S. Redbelly Dace	98.40	.58	43	.4
Rosy Side Dace	181.60	2.00	11	.1
Blacknose Dace	222.50	4.92	31	.6
Creek Chub	278.00	11.83	59	2.3
N. Hog Sucker	19.25	4.96	2	.8
Black Bullhead	3.59	.65	2	.9
Spring Cavefish	4.23	.10	0	.0
Green Sunfish	21.65	.51	17	.7
Bluegill	13.98	2.35	4	.5
Largemouth Bass	.13	.01	0	.0
Rock Bass	8.80	1.50	0	.0
Banded Sculpin	78.40	1.44	80	.9
Tenn. S. Darter	16.80	.09	7	.1
Greenside Darter	12.30	.05	0	.0
Total	1631.86	49.74	470	14.1

in Pine Creek indicates that by reducing the competition in a stream by the elimination of undesirable species of fish spectacular growth rates of brown trout have resulted. It further shows that it is practical to stock fingerling-size brown trout because they will grow to catchable size in a fairly short time. Since rainbow trout grow even faster than brown trout, even more spectacular results in growth could be anticipated with this species.

Re-entry of Other Species of Fish

Extensive observations after eradication did not reveal any live fish. It seemed that a complete kill had been obtained, although this may or may not have been the case. It was not until after several heavy and prolonged rains that any fish other than the brown trout were observed. The first fish were observed in February, three months after eradication. I believe that these fish came from a farm pond that overflowed into the stream during the heavy rains. At the time of eradication, the owner of this pond would not grant permission to kill out his pond. The pond was situated so that during high water periods it would have been possible for fish to move back and forth into the pond and the pond could have contained stream species of fish that do not normally live in ponds. It is possible, of course, for the fish to have been washed in from some unknown source or that a complete kill was not attained during eradication. Although very few fish were observed during the first six months after eradication, greater numbers were observed during the remainder of the time as a result of the spawning of the adult fish in the stream. Table VII shows that 16 months after eradication, of the 17 species of fish present at time of eradication, 12 had reappeared. At the time of eradication the average number of fish per mile was 1,632 having an average total weight of 49 pounds. As far as is known these numbers were reduced to zero when the stream was reclaimed. Sixteen months later the average number of fish per mile of stream was 470 having an average total weight of 14 pounds. It seems that it will be only a matter of time until the undesirable species of fish will have increased to their original abundance in Pine Creek, and the spectacular results attained from reducing competition will be short lived.

It is possible to keep undesirable fish out of streams after they have been reclaimed, but it will be extremely difficult. Fish in streams flowing through low, marshy terrain will be more difficult to eradicate than those in higher altitudes. Extreme care should be made to eradi-

cate all possible sources of fish in the stream area. A water fall or fish barrier of some type is essential in keeping out undesirable fish. When a natural barrier is not present a fish barrier should be constructed. After eradication, the stream should be stocked not only with fingerling trout but also with several hundred, depending upon stream size, adult pairs of trout to insure early spawning of trout in the stream.

A stream should not be reclaimed if there is a chance of eliminating a rare or restricted species of fish or other organism. A list of rare, restricted, and endangered species of fishes, amphibians, and reptiles has been compiled by the American Society of Ichthyologists and Herpetologists and is available to interested persons (Miller 1963). Since it seems that some species of fish are more detrimental to trout populations than are others (Parker 1960), the development of specific toxicants to eliminate these individual species should be considered and investigated.

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SUMMARY OF FISHERY MANAGEMENT ACTIVITIES ON LAKES EUCHA AND SPAVINAW, OKLAHOMA

1951-1964

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ABSTRACT

The City of Tulsa, Oklahoma has long been a proponent of the multiple-use concept of its water resources; including approximately 5,000 surface acres of impounded water. These waters are: Lake Eucha (2,880 surface acres), also known as Upper Spavinaw, Delaware County, Oklahoma, Spavinaw Lake (1,637 surface acres), Mayes County, Oklahoma, and Lake Yahola (425 surface acres) Tulsa County, Oklahoma (Jackson, 1957).

The fishery management program on the Spavinaw Lakes was initiated by A. D. "Bob" Aldrich in 1949 and has been expanded and continuous for a period of sixteen years. Although progress may have appeared slow at times during this period, the trend has been toward improved fishing and an improved fishable fish population.

The rough fish removal program was initiated in 1949. 436,513