

LITTLE TENNESSEE RIVER INVESTIGATION

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ABSTRACT

A cooperative fishery survey of the terminal 33 miles of the Little Tennessee River, a tailwater environment, was made using an unequal probability sampling creel census and limited population sampling.

From June 1964 to June 1965, 29,349 anglers caught 64,714 fish at a rate of 0.75 fish per-angler-hour, or 2.2 fish per-angler-day. Of all anglers, 56% were successful, 91% lived within 40 miles of the stream, and the average expense per-trip was \$2.41.

The catch was 70.5% trout, 16.3% sauger, and 13.2% other species. All trout and 83% of all fish were caught in the upper half (14 miles) of the river. The catch in the lower half was 80% sauger.

Various sizes and species of marked trout were stocked at different times to determine best management methods. Returns from catchable-sized brown trout were slow but extended. Catchable rainbow returns ranged from 78 to 96%. Early spring stocking gave best distribution of fish to more anglers. Summer stocking gave the highest, most rapid returns. Later stocking resulted in inefficient harvesting. Returns from all groups of catchable rainbows were too rapid to realize significant growth. Brown trout growth was apparently no better than rainbow.

Fingerling trout stocked in very early spring gave better survival and growth than fingerlings stocked later, which apparently suffered severe predation by other fish species.

Population sampling by electrofishing, netting, and rotenone treatments revealed the species composition, distribution, and certain implications of predation or interaction of other species on trout.

INTRODUCTION

In a cooperative agreement between the Tennessee Game and Fish Commission, the Tennessee Valley Authority, and the Bureau of Sport Fisheries and Wildlife, a fishery survey of the terminal 33 miles of the Little Tennessee River was initiated in 1964, to evaluate the existing fishery, the stream's potential for a trout fishery, and to test management methods. We agreed to use a sampling type creel census, for one full year and an additional quarter, and limited population sampling. This report includes the results from June 22, 1964 to September 19, 1965.

DESCRIPTION OF THE AREA

The section of the river studied was the tailwater below Chilhowee Dam which was built in 1957. Three major hydro-electric dams are above Chilhowee, the largest being Fontana, a 440-foot structure which regulates 60% of the runoff of the watershed with a reservoir of 10,670 acres. It thus accounts for the major stream flow regulation and the cold discharge from the successive dams downstream.

Thick density currents pass through these deep and narrow reservoirs with little change in temperature and oxygen in route (Dendy and Stroud 1949). In general the water temperature of the discharge from Chilhowee Dam is lowest in the early spring and increases gradually until autumn. Thus, mid-winter temperatures are higher than those in the spring. This results from the drawdown of Fontana with the warmer strata approaching the penstocks toward autumn.

As indicated by water samples taken at Chilhowee Dam, there was no time during the survey when temperature or oxygen were adverse to trout survival (Table 1). There was no correlation found between weekly mean temperatures and the weekly catch rates or between weekly mean discharges and catch rates.

Before Chilhowee was built, the Calderwood tailwater, above this point, was investigated by Pfitzer (in 1951-53), and found to be exceptional trout habitat.

TABLE 1
 Mean Water Temperatures* and Dissolved Oxygen** of Little Tennessee River Discharge from Chilhowee Dam

Temp. °F.	1964												1965			
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.
Max.	59	61	66	65	62	60	53	48	46	47	57	58	59	58	61	63
Min.	55	57	61	61	50	58	51	45	43	43	51	52	54	54	57	59
Dissolved Oxygen	9.0	8.8	8.1	7.3	6.8	6.7	8.3	9.6	10.1	10.5	10.2	9.7	9.1	9.3	8.7	7.4

*Temp. taken daily by U.S.G.S., Water Resources Division. 0.8 miles below Chilhowee Dam
 Extremes - 1964-65: Max. 67°F. Sept. 28; Min. 38°F. Feb. 27

**Dissolved oxygen samples collected weekly from penstocks at Chilhowee Dam by personnel of Aluminum Co. of America.
 Samples analyzed by Environmental Hygiene Branch Laboratory, Winkler procedure.

However, some of the better shoals and food producing areas were inundated when Chilhowee was completed.

The river drops 50 feet between Chilhowee and the mouth where it empties into the main stream of the Tennessee River near Lenoir City. The average flow from the 1964-65 water year was 5,383 cfs. with a daily maximum of 16,000 and minimum of 1,340 cfs. In the upper 10 miles, it cuts through Chilhowee Mountain, adjacent to the Smoky Mountains National Park, and is intermittently shallow with a bottom of transverse strata of shale, boulders, and smaller stones. Wading is practical only across shoal areas at low flows (2,000 cfs. or less). At normal flows in this area, fishing must be done either from the bank or by boat, as is the case in the remainder of the river which is rather deep at any flow.

CREEL CENSUS METHOD

Dr. Don W. Hayne gave assistance in the creel census design. The total hours of angler use were estimated from sampling the fishing pressure by non-uniform probability. The entire fishing day (daylight hours) was divided into equal periods which varied in number and duration according to the season or hours of daylight (Table 2), and a random period was drawn by a non-uniform probability of the expected angling frequency for that portion of the day. The probability of expected hourly distribution of fishing pressure was previously determined by a series of hourly counts. Estimates of the total pressure were thus obtained by:

$$F = \frac{N}{p} \left(\frac{h}{c} \right)$$

Where F = estimated total fishing pressure for the day

p = probability of selecting the counting period used

h = length of fishing day in hours

c = number of counting periods in day

N = number of fishermen counted

A ground census of 12 accessible miles of the river was made by car and on foot. Further expansion of the data to include the inaccessible areas was facilitated by weekly airplane flights to obtain the ratio of fishing pressure not counted in the daily car census. The flight days and hours were also selected by previously determined non-uniform probabilities at random.

Except for the use count period, the clerk's time was spent making angler interviews, recording effort, success, and fish measurements. Estimates of the total catch were then obtained by the product of the catch rate (from the actual interviews) and the estimated pressure.

With the exception of the final quarter, the river was divided into two study areas, the "upper" and "lower" river sections. The division between sections was the U. S. Highway 411 bridge, 19 miles above the mouth. A clerk was assigned to each section until August 30, 1964. Thereafter, one clerk covered both sections. Seven-day-per-week coverage was obtained.

TABLE 2
Creel Census Schedules

Weeks	Dates	Fishing Day		Use Count Periods	
		No. of Hrs.	A.M.--P.M.	Number	(Duration (Hours))
1-10	6/22-8/30/64	14	6:30-8:30	7	2.00
11-17	8/31-10/18/64	13	7:00-8:00	4	3.25
18-26	10/19-12/20/64	10	8:00-6:00	3	3.33
27-37	12/21/64-3/7/65	10	8:00-6:00	5	2.00
38-44	3/8-4/25/65	12	7:00-7:00	6	2.00
45-52	4/26-6/20/65	14	6:00-8:00	7	2.00
53-61	6/21-8/29/65	14	6:30-8:30	7	2.00
62-65	8/30-9/19/65	13	7:00-8:00	4	1.75

RESULTS AND DISCUSSION

Angling Effort and Success

The precision of the estimated totals of the catch statistics was 14.3% at the 95% confidence level, or 11.8% at the 90% level. This was based on an estimated variance of the total catch calculated by the difference between successive weekly measurements for the first full year.

During the first full year, 29,349 anglers fished 86,123 hours and caught 64,714 fish in the entire river. They fished 2.93 hours on the average and caught 2.2 fish per angler. At least one fish was caught by 56% of the anglers, and they averaged 3.18 fish per angler (Table 3).

The best fishing of the entire year was realized in the fourth quarter. Almost 57% of the year's catch was taken then at a rate of one fish per-angler-hour. About 70% of all anglers in this quarter were successful in catching at least one fish. Most of this increase in catch was due to the trout plants made in the upper river in February, May, and June.

The least fishing activity was in the second quarter, or fall months. Less than 7% of the catch was taken by less than 9% of the total anglers. Oddly, the catch rate increased by 48% over the previous quarter, even though pressure and total catch decreased by 76 and 64% respectively. This resulted from the advent of colder weather and the sauger run. The casual anglers were replaced by the serious or skilled anglers.

Fishing success in the third quarter (December 21, 1964 to March 21, 1965) was comparatively better than either the summer or autumn periods (quarters 1 and 2). Although the pressure (4,714 angler days) was less than 60% of that during the preceding summer period (quarter 1), the total catch was almost the same. The consequent catch rate was thereby twice that of the first quarter. Two events contributed to this overall increase in the total catch and catch rate during the third quarter. The sauger run was very active in January, which contributed heavily to the catch when trout fishing was at a minimum in the upper river. By February, new trout plants were followed by an immediate pressure response and high catch rate. Relatively good fishing was also sustained on the lower river thereafter.

Comparison in Fishing After One Year

After a full year's census, one additional quarter was extended to the upper river. This was to compare a duplicate period after experimental management.

The most significant change was a two-fold increase in the total catch (comparing the first and fifth quarters). This did not reflect a similar increase in fishing pressure. There was a 48% increase in angler days, but only 28.4% increase in angler hours. The average angler spent 15.3% less time and though the catch rate increased 56.7%, this still does not measure up to the relative increase in the total catch.

There is implication that experienced or skilled anglers accounted for the relatively greater catch increase. Successful fishermen increased 15.4% and their respective catch 16.9%. Since the overall catch per-angler-hour increased 56.7% and the catch per-angler-day increased only 36.1%, the contribution of the most successful and experienced anglers to the total catch must have greatly influenced the fishing quality. Still, the improvement shown by the total catch did not reflect a comparable amount of angling pressure.

Origin and Expense of Anglers

Apparently this fishery is utilized mainly by fishermen living nearby. In the first year, 90.9% of all anglers interviewed were local residents (within a 40-mile radius of the river.). Others classified as non-local residents and non-residents comprised 3.5% and 5.6%, respectively. This is reflected in the low mean expense per-angler-trip (\$2.41). The mean expense values for the local residents, non-local residents, and non-residents determined individually were: \$1.98, \$6.54 and \$6.96, respectively. The total expenditure by all anglers (29,349) for the first year was \$70,646.30 (Table 4).

By comparison, the average spent per-angler-trip by 33,341 anglers at the Dale Hollow Lake's tailwater (Clay County, Tennessee) was \$6.41 for the same period.

TABLE 3
 Angler Use and Catch Summary From Little Tennessee River Below Chilhowee Dam for Period June 22, 1964 to September 19, 1965.

	Quarter Periods of Weekly Totals					
	1	2	3	4	5	1-4
Total Catch	11,993.2	4,310.1	11,743.7	36,667.2	21,591.2	64,714.2
% Trout	83.4	30.7	54.7	81.4	89.3	70.5
% Sauger	1.4	49.7	41.2	2.9	1.9	16.3
% other fish	15.2	19.6	4.1	15.7	8.8	13.2
Total Angler Days	8,039.1	2,618.5	4,713.6	13,978.2	9,708.1	29,349.4
Total Angler Hours	27,975.8	6,781.9	13,763.8	37,601.5	29,900.9	86,123.0
Catch/Ang. Hr.	0.429	0.636	0.853	0.975	0.722	0.751
Catch/Ang. Day	1.49	1.65	2.28	2.44	2.22	2.20
Mean Hrs./Ang.	3.48	2.59	2.92	2.70	3.08	2.93
% Successful Ang.	49.1	55.8	66.0	69.9	58.4	56.02
Catch/Success. Ang.	2.97	3.02	3.46	3.49	3.59	3.18
Expense/Ang. Day	4.08	1.52	1.36	1.97	2.00	2.41
Total Expense of Ang.	\$32,812.50	\$ 3,972.09	\$ 6,393.04	\$27,468.67	\$19,416.20	\$70,646.30
<i>Origin of Anglers (%)</i>						
Local*	85.9	93.6	99.3	91.1	84.7	90.9
Non-Local Residents	4.8	3.8	.4	3.9	6.8	3.5
Non-Residents	9.3	2.6	.3	5.0	8.5	5.6
Quarter Periods	6/22 to 9/20/64	9/21 to 12/20/64	12/21/64 to 3/21/65	3/22 to 6/20/65	6/21 to 9/19/65	6/22/64 to 6/20/65

* Within 40-mile radius

TABLE 4.
 Angler Use and Economics of Fishery From Little Tennessee River Below Chilhowee Dam — From 6/22/64 to 9/19/65

Quarter Period	Total Use			Origin of Anglers				Angler's Expense				Total	
	Angler Hours	Angler Days	Local %	Local		Non-Local		Local Res.	Non-Local Res.	Local Res.	Non-Local Res.		Mean
				Res. %	Res. %	Res. %	Res. %						
1 6/22-9/20/64	27,975.8	8,039.1	85.9	4.8	9.3	\$3.56	\$9.06	\$6.33	\$4.08	\$32,812.50			
2 9/21-12/20/64	6,781.9	2,618.5	93.6	3.8	2.6	1.11	6.20	9.32	1.52	3,972.09			
3 12/21/64-3/21/65	13,763.8	4,713.6	99.3	0.4	0.3	1.33	3.33	7.44	1.36	6,393.04			
4 3/22-6/20/65	37,601.5	13,978.2	91.1	3.8	5.0	1.54	4.94	7.39	1.97	27,468.67			
Total	86,123.0	29,349.4	90.9	3.5	5.6	1.98	6.54	6.96	2.41	70,646.30			
5* 6/21-9/19/65	29,900.0	9,708.1	84.7	6.8	8.5	1.21	5.54	7.09	2.00	19,416.20			

* Quarter No. 5 not included in total (One complete year)

However, 53% of the fishermen, for the entire year, were out-of-state, or had driven 100 miles or more to fish this stream. One of their major items of expense was automobile gasoline (Little, 1966).

Reasons for the low proportion of non-residents using the Little Tennessee River appear to be limited recreational development and public access. Float trips are an attraction here but have not been fully commercialized.

Distribution of Fishing Effort and Catch

The Highway 411 bridge was selected as the division point between the two study areas mainly because the major trout range was above this point and for convenience of the census schedule.

In the entire year, 81% of the fishing effort and 83% of the catch occurred in the upper river (Table 5). There was a considerable increase in fishing in the lower river in the winter (third quarter) because of the sauger run. Still, this section never produced more than one-third of the total catch and effort.

Considering the whole river, boat anglers were somewhat more successful than bank anglers. They contributed 56% of the total effort and caught 60% of the fish. Their catch rate was 17.5% better.

Considered separately, the lower river was predominantly a boat fishery, with 72% of the effort contributed by boat anglers. They accounted for 84% of the total catch, and their catch rate was more than twice that of the bank anglers. Boat fishing was particularly important during the fish runs in the winter months. The difference in bank and boat fishing in the upper river was not so great.

Catch Composition

Of all fish recorded, 70.5% were trout and 16.3% were sauger (Table 6). Of course the predominance of trout was augmented by stocking. Although several warm water game species occur in the entire river, their contribution was small. More than half (55.3%) of the non-trout catch was sauger, while other species followed with: sunfish 13.1%, drum 7.3%, crappie 5.8%, white bass 4.5% and black bass 2.7%.

All of the trout, one-fifth of the sauger, and most of the other species came from the upper river, while virtually all of the white bass were caught in the lower river.

Although sauger were taken in every month of the year, 88.6% of them were caught from December through March. Most (92.9%) of the white bass were taken from February through June.

TROUT STOCKING, RETURNS, AND GROWTH

Catchable-size Trout

Before the survey began, much of the State's stocking consisted of unscheduled trout with little opportunity for marking groups in advance, therefore, it was difficult to distinguish residual stocked trout from possible wild trout (Table 7). One group of 4,000 8-inch rainbows marked LV were stocked March 10, 1964. Part of this group (6.7%) returned after the census began, but they were depleted by September 1964 (Table 8).

The Bureau's first catchable plant was 14,765 8.2-inch (4.4/lb.) brown trout stocked on August 4 and 11, 1964. These were stocked seven miles below the dam, and many of them promptly moved down stream into an inaccessible area. They did not enter the catch until August 27, and a population sample taken ten miles below the dam on August 29 indicated that many were still in the area not heavily fished. Although they gradually became available in the more accessible areas upstream, their return was slow, and after 14 months, amounted to less than 13% of the number stocked (Table 8).

To determine the best period for releasing catchable-sized trout, the Bureau allotted three similar groups of rainbow trout for spaced stocking in 1965. Each group was marked differently and uniformly dispersed at points 1, 2, 4, and 6 miles below the dam.

The first group (RV) was stocked on February 8 and 11 (Table 8). They were immediately vulnerable to anglers, particularly those using whole kernel corn for bait. By the end of the third quarter, 42 days after stocking, 39.1% were caught, but a

TABLE 5
Comparison of Boat and Bank Fishing and Different River Sections

Quarters	Upper River		Lower River		Entire River (% of total)		
	Boat	Bank	Boat 1 (6/22-9/20/64)	Bank 1 (6/22-9/20/64)	Boat	Bank	Lower
1 (6/22-9/20/64)							
% of total hours	56.9	43.1	47.9	52.1	55.1	44.9	19.4
% of total catch	56.6	43.4	55.2	44.8	56.4	43.6	12.0
Catch per hour	0.466	0.472	0.304	0.227	0.438	0.417	0.264
2 (9/21-12/20/64)							
% of total hours	38.5	61.5	69.1	30.9	45.2	54.8	21.9
% of total catch	32.5	67.5	87.3	12.7	47.0	53.0	26.5
Catch per hour	0.505	0.657	0.970	0.315	0.661	0.615	0.769
3 (12/21/64-3/21/65)							
% of total hours	46.3	53.7	97.1	2.9	64.7	35.3	32.2
% of total catch	39.9	60.1	98.2	1.8	59.9	40.1	34.5
Catch per hour	1.755	0.981	1.823	0.508	1.791	0.967	0.813
4 (3/22-6/20/65)							
% of total hours	53.7	46.3	73.6	26.4	56.1	43.9	11.8
% of total catch	60.8	39.2	79.8	20.2	63.1	36.9	12.1
Catch per hour	1.101	0.824	1.077	0.760	1.097	0.819	0.993
5 (6/21-9/19/65)							
% of total hours	63.4	36.6					
% of total catch	71.9	28.1					
Catch per hour	0.819	0.554					
Total (Quarters 1-4)							
% of total hours	52.7	47.3	71.8	28.2	56.3	43.7	19.0
% of total catch	55.3	44.7	84.1	15.9	60.2	39.8	17.1
Catch per hour	0.808	0.727	0.790	0.380	0.804	0.684	0.674

TABLE 6
Catch Composition and Anglers Interviewed On
Little Tennessee River From June 1964 to September 1965

	1	2	3	4	5	Total 1-4	Total U.R.*	1-4 L.R.**
<i>Trout</i>								
Rainbow	2,225	121	760	1,032	1,258	4,138	4,138	
Brown	191	93	55	27	131	366	366	
E. Brook				1		1	1	
Total Trout	2,416	214	815	1,060	1,389	4,505	4,506	
<i>Other Species</i>								
Sauger	41	347	615	38	30	1,041	214	827
Sunfish	156	40	4	47	47	247	184	63
Drum	104	14	1	19	7	138	91	47
Crappie	58	26	10	16	67	110	103	7
White Bass	1	1	21	62	1	85	1	84
Shad	11	30	14	24	1	79	56	23
Carp	32	4	6	12	5	54	48	6
SM Bass	17	1	3	12	6	33	17	16
Catfish	14	13		1		28	26	2
Suckers	12	3		4		19	16	3
LM Bass	9	2	1	6	1	18	9	9
Hornyhead	9					9	6	3
Chub	8					8	3	5
Rock Bass	6	1				7	7	0
Walleye		2				2	1	1
Redeye Bass							0	1
Log Perch	1					1	1	0
Longnose Gar	1				1	1	1	0
Spotted Bass			1	2		3	1	2
Total	481	484	676	243	166	1,884	785	1,099
Total All Fish	2,897	698	1,491	1,303	1,555	6,389	5,290	1,099
% Trout	83.4	30.7	54.7	81.4	89.3	70.5	85.2	0
% Sauger	1.4	49.7	41.2	2.9	1.9	16.3	4.0	75.3
% Other Fish	15.2	19.6	4.1	15.7	8.8	13.2	10.8	24.7
No. Anglers	1,987	414	653	534	741	3,588	2,999	589
% Suc. Anglers	49.1	55.8	66.0	69.9	58.4	56.0	56.1	55.9
Periods	6-9/64	10-12/64	1-3/65	4-6/65	7-9/65	6/64-6/65	6/64-6/65	6/64-6/65

* Upper River

** Lower River

TABLE 7
Stocking Record of Trout In Little Tennessee River for Years 1964 and 1965.

YEAR	1964											
	Rainbow			FINGERLINGS			Brown					
	CATCHABLES	FINGERLINGS		CATCHABLES	FINGERLINGS		FINGERLINGS		FINGERLINGS			
Date Stocked	Number Stocked	Mark	Length Inches	Number Stocked	Mark	Length Inches	Number Stocked	Mark	Length Inches	Number Stocked	Mark	Length Inches
1/8	3,480		9									
1/10	2,892		10									
1/16-17	5,844		9									
1/17				9,800	RV	3						
1/21	2,784		10	64,960		3						
3/10	4,000		8		LV							
4/20				15,000	RF	3.4						
4/21	2,500		14									
5/19	2,500		13									
5/21	2,500		9-10									
5/26				39,000		3						
5/28	500		14				53		21			
6/23-7/15*				207,327	LP(5%)	4.1						
7/8	5,750		9-10									
7/21	6,000		8-10									
7/22												
8/4-11*							14,675	Ad(17.7%)	8.2	53,300		3
8/11	3,825		6									
9/10	7,546		7				14,728					
TOTAL	50,121			336,087						53,300		
YEAR							1965					
2/8-11*	14,800	RV	8.7									
4/14-26*	15,000	LV	8.6									
4/2-5/6*				200,000	Ad(10%)							
5/13	2,000		12									
5/28										35,000		2
6/4-9*	5,000	D	8.2									
7/20-8/4							1,200	LVAAd	9-10			
7/22-8/4	2,250	LVAAd	8-14									
TOTAL	37,050			200,000			1,200			35,000		

* Stocked by Bureau of Sport Fisheries & Wildlife

greater return (46.0%) came in the fourth quarter. They were virtually depleted in the fifth quarter, giving a cumulative return of 86.2% by the end of the study period (in 224 days).

The second group (LV) was stocked from April 14 to 26 (Table 8). By this time, angling pressure had increased considerably, and a rapid return of 73.3% resulted during the remaining 38 days of the fourth quarter. However, only 4.4% returned in the fifth quarter, to give an accumulative return of 77.7% in 159 days. Subsequent plants in the fifth quarter may have depressed the return from this plant.

The third group (D) was stocked on June 4 and 8 (Table 8). In the remaining 17 days of the fourth quarter, 66.4% was caught, and in the fifth quarter, 29.3% mounted the cumulative return to a total of 95.7% (in 108 days).

In evaluating the stocking at the three periods, the success of each group must be considered in terms of both the percentage return and also their dispersion benefit to the available angling pressure. It appears that the group stocked earliest (in February) served the greatest benefit. A high return (86.2%) over a longer period distributed the catch to more individuals. The merit of the April stocking was shown by this lot's availability at the peak of fishing pressure. Even though a good portion of the February plant still contributed in the fourth quarter, this was largely before May (when the pressure was highest). Therefore, the second stocking, in April, was desirable and necessary to bolster the fishery in order to maintain a high catch rate during the period of high demand. Although summer stocking will produce the maximum return, since fishing pressure is generally high, the disadvantage is that the recovery is so short-termed that it does not benefit enough individual anglers. Two-thirds of the group stocked in June was recovered in the first 17 days after stocking. As mentioned before, in comparing the first and fifth quarters, a two-fold increase in the catch did not reflect a comparable increase in fishing pressure. If summer stocking is to provide an equitable distribution of fish among individual anglers, it must be done by dividing the allotment into a number of spaced stockings. Otherwise, there would be various periods of the season when the catch rate would be unstable and unsatisfactory.

TABLE 8
 Cumulative Percentage Returns from Marked Groups of Catchable-Sized Trout Stocked in Little Tennessee River, Tennessee.

Date	Species	Mark	Number Stocked	No. Per Pound	F.L. in Inches	1	2	3	4	5	Cumulative Total	Number of Days
3/10/64*	RT	LV	4,000		8	2.6					6.7	560
8/4-11/64	Bn	Ad	14,675	6.2	7.3	2.6	2.8	1.9	4.1	1.5	12.9	413
2/3/65	RT	RV	14,800	3.0	8.7			39.1	46.0	1.1	86.2	229
4/14-26/65	RT	LV	15,000	3.4	8.6				73.3	4.4	77.7	159
6/4-8/65	RT	D	5,000	4.4	8.2				66.4	29.3	95.7	108
7/20-8/4/65*	Bn	LVAd	2,750		9-10					46.8	46.8	62
7/22-8/4/65*	RT	LVAd	2,550		8-14					75.9	75.8	60

*Stocked by State of Tennessee

Late summer or fall stocking of catchables may be desirable if the amount of fishing pressure warrants it, but usually the pressure on a stream fishery dwindles toward fall, and there is a risk of inefficient harvesting. In spite of two groups of large-sized brown and rainbow trout stocked by the State from July 20 to August 4, 1965 (Table 8) fishing pressure declined steadily after mid-August. By the end of the study period (in 60 days), 46.8% of the browns and 75.9% of the rainbows had been returned. Although their ultimate return is unknown, it appears that their exploitation was not as efficient as that of other marked groups of smaller trout stocked earlier in 1965.

The growth of domestic rainbows stocked at catchable size is often not realized because of their rapid return. Also, if the angler's catch is the only index of growth, there is usually a bias due to size selection by the large fish being caught first. Such appears to be the case in the three spaced groups stocked in 1965 if the monthly mean lengths are compared (Table 9). However, if the accumulated lengths are averaged, the first group (RV) stocked in February shows the greatest length increment during its recovery period. There may have been more food available to the fish stocked earliest, but their extended recovery would seem largely responsible for the comparatively better growth indicated.

From February through May (four months) the first group's (RV) increment was 1.08 inches. From April through July (four months) the second group's (LV) increment was 0.48 inch, and from June through August (three months) the third group's (D) was 0.63 inch. For comparison, a tagged rainbow caught June 3, 1965 had actually grown 2.0 inches in ten months.

TABLE 9
Size Range and Mean Lengths* of Rainbow Trout Caught in 1965 From Three Spaced Stockings of Catchables.

Mark	RV			LV			D		
	No.	Length Range	Mean F.L.	No.	Length Range	Mean F.L.	No.	Length Range	Mean F.L.
Number Stocked	14,800			15,000			5,000		
Date Stocked	2/8-11/65			4/14-26/65			6/4-8/65		
Hatchery Sample	228	6.5-11.4	8.68	175	7.0-10.9	8.61	251	7.0-10.4	8.16
Feb.	325	7.0-11.9	9.20						
March	132	7.0-11.4	9.06						
April	128	7.0-10.9	8.83	140	6.5-10.9	8.59			
May	25	8.0-11.4	9.76	117	6.0-10.9	8.65			
June	4	9.0-10.4	9.75	13	8.0-10.9	9.17	17	7.0-9.9	8.04
July	2	8.5-10.4	9.15	16	7.0-12.4	9.19	41	7.0-10.4	8.52
Aug.				2	8.5-9.4	8.95	11	7.0-10.4	8.79
Sept.				4	9.0-11.4	10.05	1	8.0-8.4	8.00
TOTAL	616	7.0-11.9	9.11	292	6.0-12.4	8.69	70	7.0-10.4	8.44

*Fork Length In Inches

The growth of the 8.2 inch brown trout catchables stocked August 4-11, 1964 was not clearly shown by monthly mean lengths of the marked fish recorded. Only 17.7% of the group was marked, and the gradual return did not provide adequate samples (Table 10). However, the length frequency of all unmarked browns measured during the survey reflected the majority of lengths recorded from this plant, and there was no indication that the growth of stocked browns was superior to that of the marked rainbow catchables. The accumulated average lengths of all unmarked browns was 9.52 inches, and only 4.5% of these were greater than 12.4 inches. Moreover, the mean length for some months was biased by occasional catches of trophy-size browns which may have resulted from a plant made by the State on May 28, 1964 consisting of 53 browns averaging 21 inches.

TABLE 10
Size Range and Mean Lengths* of (Ad) Marked and Unmarked Brown Trout Caught In 1964 and 1965.

Date Stocked	Marked (Ad)			Unmarked		
	8/4 & 11/64					
	No.	Length Range	Mean F.L.	No.	Length Range	Mean F.L.
Hatchery Sample 7/28/64	96	6.5-10.4	8.23			
1964 - June				4	9.5-21.9	14.10
July				7	10.5-19.4	13.01
Aug.				52	6.5-29.9	9.98
Sept.	11	6.0-9.9	8.45	84	7.0-15.9	8.64
Oct.	6	7.5-10.9	9.15	44	7.0-10.9	8.85
Nov.	3	7.5-10.9	8.57	18	7.5-10.4	8.90
Dec.	2	8.5-8.9	8.75	5	7.5-11.9	9.44
1965 - Jan.	1		10.10	21	8.0-12.4	9.69
Feb.	1		11.10	9	7.0-16.4	12.51
March	1		9.50	11	8.0-10.9	10.40
April				7	8.0-10.0	9.12
May				9	9.0-12.4	10.39
June				1	12.0-12.4	12.10
July				5	8.0-11.4	9.54
Aug.				5	8.5-10.4	9.86
Sept.				7	8.0-9.4	9.23
TOTAL	25	6.0-11.4	8.87	289	6.5-29.9	9.52

* Fork Length In. Inches

Fingerling Trout

Although the State had stocked some small groups of marked fingerlings prior to the survey, the fish were small and the results were negligible.

The major fingerling plants were those made by the Bureau using larger size rainbow trout. The first group (207,327) averaged 4.09 inches (Table 11). They were stocked from June 23 to July 15, 1964 in the upper seven miles of the river. By August 28, their average length, determined from a population samples, was 4.76 inches. They entered the catch in September at less than five inches, contributed to the catch on through November at approximately six inches and abruptly disappeared with a cumulative return of less than 0.18%. Their disappearance was coincidental with the sauger run (which moved into the upper river in November) to be discussed under population sampling.

TABLE 11

Size Range and Mean Lengths* of Rainbow Trout Caught From Spring and Summer Fingerling Plants.

Mark -----		LP		
Date Stocked -----		June 23 to July 15, 1964		
		Number	Length Range	Mean F.L.
Hatchery Sample 7/7/64 ----		254	2.0-5.4	4.09
Population Sample 8/29/64		133	3.5-6.4	4.76
Catch ---	September	15	4.0-6.9	4.98
	October	5	5.5-6.9	6.02
	November	29	4.5-7.9	5.90
Mark -----		Ad		
Date Stocked -----		April 2 to May 6, 1965		
Hatchery Sample 4/1/65 ---		259	3.0-6.4	4.85
Catch ---	May	25	3.5-6.9	6.17
	June	10	6.0-6.9	6.35
	July	39	5.5-7.9	6.75
	August	4	7.0-8.9	7.82
	September	3	7.0-8.4	7.63

* Fork Length In Inches

A second group (200,000) averaging 4.85 inches was stocked in the same area from April 2 to May 6, 1965. By May 22, some of the group began to enter the catch at slightly less than six inches. By the end of the fourth quarter (in 30 days) 13.7% of the group was caught. In the fifth quarter, 6.6% more increased the cumulative return to 20.3%. Although these fish became vulnerable at a small size, they grew approximately three inches and made a major contribution by increasing the angler's catch rate.

In comparing the two groups, the importance of timing was evident. The 1964 group was stocked too late in the season for adequate growth and survival, and consequently, was of little benefit except possibly as forage for other fish. The group stocked in the spring of 1965, although a little larger in average size, was early enough to make a major contribution to the catch. They apparently had a better food supply, grew faster, and were available to the angler before the possible advent of sauger predation.

Based on the number (40,640) returned from the latter group, it would be more economical to stock fish at this size than to stock enough catchable-sized trout to provide the same catch. The chief disadvantage is that the average size would be less, in this stream, than catchables stocked for immediate return. In other tailwaters where predation is no problem and growth is better, fingerling stocking is a better practice. Similar size fingerlings stocked in the Dale Hollow Lake's tailwater survive well and grow seven inches per year (Little, 1966).

Fish Population Sampling

All three agencies cooperated in fish sampling in the spring and fall of 1964. On May 23-24, the stream flow was reduced to 1,500 cfs., and fish were collected by electro-fishing and by variable mesh gill nets. Because of the stream bed irregularity and current in the upper river, these methods were impractical in the major trout

habitats (shallow shoal areas); however, the estimated angler's catch of 1,050 trout during the two days of sampling was obvious evidence of their abundance in the area. The sample stations selected were 1/4, 1, 6, and 14 miles below the dam. Although they do not reflect the relative abundance of each species in the entire river section, the composite of the samples does represent the presence and distribution of various adult species in different habitats. For instance, there was obviously a large concentration of longnose gar in the Old Niles Ferry area (river mile 20), a deep river section near the mouths of Nine-mile Creek and the Tellico River (Table 12).

To learn more about the general structure of the fish population, the range of trout below the dam, and to check the survival and growth of rainbow fingerlings stocked from June 23 to July 15, a more extensive sampling was done by these agencies from August 28 to 30, 1964. A complete shutdown of the flow was arranged, however, leakage from the dam and natural accretions amounted to 26 cfs. Sample stations were selected at 1, 4, 11, and 16 miles below the dam.

Samples at the first station were taken by collecting stranded fish in pools over a broad shoal area above Harrison Island. The fish were mainly trout fingerlings, about an equal number of sculpins, and a few hog suckers. On August 28, 526 rainbow fingerlings, 4 brown fingerlings, and 4 rainbow catchables were rescued and released in the free running section of the stream. On August 29 and 30, 703 more rainbow fingerlings, 4 brown fingerlings, and 4 rainbow trout catchables were recovered dead. Five percent of all rainbow fingerlings were marked LP, which was the same percentage marked of the initial group stocked in June and July. Because of the identical marked ratio, and size regularity of the unmarked fingerlings, it was assumed that virtually all of the rainbow fingerlings were from the recent plant. Judging by the abundance of fingerlings observed in the free running section of the stream, it was apparent that most of the fingerlings escaped the stranding during the drawdown. Their loss in the most critical area was only 0.34%.

Rotenone was used to collect fish at the other three stations, but by-passes were selected to prevent unnecessary loss of fish in the main course of the river. Although the samples do not fully represent the population structure of the entire river, the increased representation of different sizes and species revealed more evidence on the ranges and habitats of different species. The gar, for instance, were found both at mile 17 and 29, below, and well above the Niles Ferry (mile 20) area where they were previously found so concentrated during the May sampling (Table 13). Only three trout were found at mile 17 (Rose Island) which may imply that predation by gar, or for whatever reason, significantly limits the trout's distribution beyond the Niles Ferry area.

In addition to the 1,245 trout recovered at the first sample station (mile 33), 1,546 trout were caught by anglers in the river above mile 28. In view of this and the diminishing relative abundance of trout to other species in the samples taken at the successive stations downstream, it is evident that trout prefer the uppermost part of the river. Judging by the samples, rough fish begin to dominate the population approximately five miles below the dam, and other game fish (excluding trout) apparently are a minor part of the population throughout the river, however, this was not a likely period to find many sauger or white bass.

Predation was suspected as the cause for the sudden disappearance of the trout from the 1964 fingerling plant (LP) after they were known to have survived their early life stage (as evidenced by the population sample and their contribution to the catch). Many fish from this group still occupied a one-acre side pool below the dam in November 1964 just before they dwindled from the catch and the sauger catches increased. To find if the sauger were responsible for their disappearance, an experimental gill net was fished in the pool on December 11. The resulting catch was 20 sauger, ranging from 8.5 to 17.5 inches, 15 gizzard shad, 4 sunfish, 1 blue herring, 1 mooneye, 1 bullhead catfish, and 1 drum. No trout were recovered, either in the net or in the sauger stomachs. If they were not consumed earlier, they must have been driven out of the pool. The pool was sampled again on September 21, 1965. The catch was: 2 sauger (11.6 and 14.5 inches), 7 sunfish, 3 rock bass, 1 rainbow trout (7.7 inches), 1 crappie, and 1 white sucker. Fish bones found in the larger sauger's stomach appeared to be from trout.

TABLE 12
 Fish Samples Taken by Electro-Fishing and Gill Nets on May 23 & 24, 1964 at four locations in the Little Tennessee River.

River Mile		34	33	28	20
Location		$\frac{1}{4}$ Mile Below Dam	Tallassee	Bacon Ferry	Miles Ferry
Method of Capture		Gillnet (3)	Elec. Fish. Gillnet (4)	Elec. Fish. Gillnet (4)	Gillnet (6)
Species C.N.	Total	Size Range	Number	Number	Number
Longnose Gar	105	25.4-54.6			105
Blue Sucker	12	25.1-31.2		9	3
Blue Herring	10	14.1-16.3	6	2	2
Buffalo	10	13.8-17.2	1	1	2
Hog Sucker	6	13.7-19.9		1	
Sunfish	4		4		
Redhorse	4	14.2-20.3			4
Drum	3	8.7-9.2	3		
Rainbow Trout	3	8.0-13.2		1	
Sauger	2	16.4-18.1		2	
Crappie	2		2		
Gizzard Shad	2	10.7-12.2		1	1
Catfish	1	17.3			1
Carpaucker	1	15.6		1	
TOTAL	165		9	13	7
				3	15
					118

TABLE 13

Fish Samples Taken By Chemical Treatment of By-Passes of Little Tennessee River on August 29 & 30, 1964.

River Mile	29	22	17	
Miles Below Dam	4	11	16	
Location	Near 4-Mile Creek	Calloway Island	Rose Island	Total
Rough Fish				
Hog Sucker	11	204	--	215
Redhorse	28	137	11	176
Gizzard Shad	1	126	--	127
Carp	77	36	10	123
Log Perch	6	85	--	91
Creek Chub	2	78	--	80
Sculpin	--	85	--	85
Buffalo	15	3	39	57
Mooneye	9	41	--	50
Blue Sucker	--	6	--	6
Longnose Gar	3	--	2	5
Lamprey	--	4	--	4
White Sucker	1	2	--	3
Quill Back	--	--	2	2
Assorted Sm. Minnows	90	92	150	332
Total Rough Fish	250	899	214	1,363
% of Total	(55.0)	(85.2)	(80.5)	(76.7)
Trout				
Rainbow	30	51	3	84
Brown	83	40	--	123
Total Trout	113	91	3	207
% of Total	(24.8)	(8.6)	(1.1)	(11.7)
Other Game Fish				
Bluegill Sunfish	16	1	34	51
Drum	18	26	--	44
Redbreast Sunfish	30	1	1	32
Rock Bass	16	4	2	22
Sauger	3	13	--	16
Spotted Bass	1	6	9	16
Channel Catfish	--	11	--	11
Smallmouth Bass	1	1	2	4
Bullhead Catfish	3	--	--	3
Green Sunfish	1	1	--	2
B. Crappie	1	--	--	1
W. Crappie	1	--	--	1
F.H. Catfish	--	1	--	1
L.E. Sunfish	--	--	1	1
Total Other G.F.	91	65	49	205
% of Total	(20.2)	(6.2)	(18.4)	(11.6)
TOTAL All Fish	454	1,055	266	1,775

On the following day a net was fished 1/4 mile downstream from the pool, and the catch was: 3 longnose gar (29, 46 and 48 inches) and 1 rainbow trout (8.1 inches). Each gar contained from one to four catchable sized trout. Some were identified, by marks, to be from the 1965 rainbow fingerling and catchable plants.

Although the extent of predation by saugers and gars on trout is not known, it seems reasonable to assume that saugers, during the peak of their run in 1964, accounted for the disappearance of the 5-6 inch trout which resulted from the fingerling plant that summer. At least the gars are capable of taking larger size trout.

Conclusions and Recommendations

The fishing pressure on this tailwater is largely from local fishermen. Improvements made in trout stocking in 1965 resulted in a two-fold increase in the catch over the similar period in 1964. Yet the relative increase in pressure was significantly less. A desirable catch rate should be maintained at a uniform level according to the existing fishing pressure if efficient harvesting is accomplished with satisfied anglers.

To this end, the most practical management of trout in this tailwater appears to be the stocking of catchable-sized rainbow. Fingerlings did not show enough potential in growth or survival to be of any advantage over larger stocked fish. Timing would be critical in stocking fingerlings in order that they grow to sufficient size to be caught during the same season and obviate natural losses by predation. However, they would still be less desirable to most anglers because of their smaller size.

Returns were high from all groups of catchable rainbows stocked. However, a more uniform catch rate, more equitable distribution among individual anglers, and more efficient harvesting can be accomplished through utilizing the facts that are now available about the angling pressure and other features of the fishery and by the results of the various test plants.

Stocking appears unnecessary in the late fall and winter months, when the trout fishing pressure subsides. Moreover, this period is bolstered sufficiently by the sauger fishery to keep the anglers' catch rate at a desirable level. Based on the trend of angling pressure and other features, stocking should therefore extend from very early spring to mid-summer. The following stocking rate of catchable size rainbows is recommended:

<i>Month</i>	<i>Number</i>
February	3,000
March	5,000
April	7,000
May	5,000
June	5,000
July	<u>5,000</u>
Total	30,000

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