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EVALUATION OF RAINBOW TROUT (SALMO GAIRDNERI)
REMOVAL PROJECT; SAM'S CREEK,
GREAT SMOKY MOUNTAINS NATIONAL PARK

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INTRODUCTION

Brook trout (Salvelinus fontinalis) management within the Great Smoky Mountains National Park (GSMNP) has centered around renovating selected headwater streams. These streams are considered good potential brook trout habitat but have invading populations of rainbow trout (Salmo gairdneri). Stream sections above suitable barriers were chosen for removal of rainbow trout via a massive electrofishing effort. These fish were then displaced to an area outside the renovated section. It was felt that up to 90% of the rainbow trout could be removed by this method. This would then reduce competition enough to allow the brook trout population to expand their range within the stream.

Sam's Creek and Road Prong were first renovated in the summer of 1978. They were subsequently reshocked in the spring of 1979. This study, initiated in the summer of 1979, has sought to evaluate the success of the Sam's Creek Renovation effort. Not only does this evaluation provide information for possible modification or redirection of the brook trout program, but it also provides information on the use of electrofishing as a management tool.

OBJECTIVES

There were two principle objectives of this evaluation: 1) estimate the number of rainbow trout per 100 meters of stream for each habitat type and 2) determine the condition of these remaining rainbow trout.

METHODS AND MATERIALS

Sam's Creek was chosen for evaluation because of three main factors: 1) a trail running adjacent to the stream made it readily accessible

by foot, 2) the stream habitat, which varied from large boulders and deep pools to intermediate boulders with medium to shallow pools, provided an evaluation of the variable effectiveness of electroshocking with habitat type, and 3) Sam's Creek contains more potential brook trout habitat than Road Prong.

In order to facilitate the original renovation effort, Sam's Creek was divided into 35 "stream sections". Starting at 3,350' elevation, and going downstream, the sections were numbered -1, -2, -3, 1, 2, 3, etc., to section 32 at 2,120' elevation. The portion of stream I chose to sample was the area from the main barrier at 1,260' (stream section 31) to the lower end of an ongoing study section (Moore, 1979) at 2,970' (stream section 10). This portion of stream was 2.5 km long and included two principle habitat types, large boulders with deep pools, and intermediate boulders with medium pools. Three 100 meter "evaluation sections" were established approximately equidistant throughout the area. Evaluation section one was located at 2,200' elevation, or about 150 meters above the main barrier, and consisted entirely of very large boulders and large, deep pools which ranged from 1 to 4 feet deep. Evaluation section two was located at 2,625' elevation (stream section 21) which was about midway between evaluation sections I and III. Evaluation section III was about 2.4 km above the main barrier at 2,920' elevation (stream section 11). Evaluation sections II and III were similar in composition consisting mainly of intermediate-sized boulders and medium pools about 2' deep or less.

To insure a closed population, block nets were erected at the top and bottom of each evaluation section while that section was being

sampled. Using standard electrofishing techniques, each section was sampled three times. The fish captured during each sample run were held in separate net cages, and the tally for each sample run was noted. In addition, lengths (nearest mm) and weights (nearest g) were taken of all fish. All rainbow trout taken were preserved in formalin; scales were collected from all brook trout.

The data ^{are} ~~is~~ presented in three tables. Table I presents the raw data. Here, the numbers of brook trout and rainbow trout taken from each sample section during each sample run are given. Estimates of the 1978 and 1979 populations ($\hat{N}$) are given in Table II. Three estimates are given for each year. These estimates correspond to the lower, middle, and upper evaluation sections and are considered typical of that portion of the stream in which they occur. Furthermore, these estimates are given per 100 meters of stream. The 1979 estimates were calculated using the Leslie method as given by Ricker (1958). The 1978 estimates were calculated by combining my estimates of the 1979 population with the 1978 removal data provided by the Park Service. Because this removal data was given by stream section, I was able to divide the data into three groups: lower third (stream sections 25-31), middle third (stream sections 18-24), and top third (stream sections 10-17). After calculating the mean number of rainbows removed per 100 meters for each third, I added this to my estimate of the 1979 adult rainbow population per 100 meters. The 1979 adult estimates were obtained by multiplying my overall estimate by the percentage of adults in the sample. After estimating the 1978 and 1979 populations, I estimated the percent reduction in the population from 1978 to 1979.

This was calculated by dividing the 1979 estimates by the 1978 estimates and subtracting from 100.

Table III gives condition factors (K) for the adult and young-of-the-year (Y-O-Y) rainbows. It also compares these to condition factors of Sam's Creek rainbows before renovation, and to condition factors of rainbows from several similar streams throughout East Tennessee. Condition factors were calculated using the methods of Thompson and Bennett (1939).

RESULTS AND DISCUSSION

Tables I and II reveal that the largest number of rainbows, and the largest absolute number of fish, were found in the lower one-third of the stream. Twenty adult and Y-O-Y rainbow trout were removed from sample section I (TABLE I). Table II shows that the actual 1979 N was 20.88 fish per 100 meters. This compares to the 1978 $\hat{N}$ of 98.25 fish per 100 meters, or a 78.75% reduction from 1978 to 1979. When this is compared to section II and III, we see a definite increase in the original removal success. Section II showed a reduction of 92.75%, from 82.78 to 6.06 rainbows per 100 meters. In addition, section III showed an even higher reduction of 98.32%, from 58.37 rainbow in 1978 down to 1.00 rainbow per 100 meters in 1979. It should be noted that these figures do not necessarily reflect the true removal success of the 1978 renovation effort. No Y-O-Y rainbows were found in sections II and III; therefore, I do consider these figures to reflect the actual removal success. In section I, however, I found 10 Y-O-Y rainbows which were obviously 1979 recruitment. These fish were included in the calculations of Table II. When these 10 Y-O-Y rainbows

SAMPLE RUN	SAMPLE SECTION I		SAMPLE SECTION II		SAMPLE SECTION III	
	Rainbow Trout	Brook Trout	Rainbow Trout	Brook Trout	Rainbow Trout	Brook Trout
1	14	0	2	0	1	7
2	5	0	3	1	0	5
3	1	0	0	0	0	2
Y-0-Y	10	0	0	0	0	3
Adults	10	0	5	1	1	11
TOTAL	20	0	5	1	1	14

TABLE 1. Raw data, numbers of fish captured in each section for each run.

SAMPLE SECTION		N. 1978	N. 1979	PERCENT REDUCTION
1	Rainbow	98.32	21	78.75%
	Brook	0.00	0	0.00
2	Rainbow	82.58	6	92.75%
	Brook	2.00	1	50.00%
3	Rainbow	58.37	1	98.32%
	Brook	19.25	18	7.74%

TABLE II. Estimates of 1978 and 1979 brook and rainbow trout populations per 100 meters for each sample section. Percent reduction from 1978 to 1979 are also given.

	ADULT K (≥ 101 mm)	Y-0-Y K (≤ 100 mm)
Sam's Creek Postrenovation 1979	1.21 (SD = 0.11 N = 16)	1.18 (SD = 0.16 N = 10)
Sam's Creek Prerenovation 1978	1.22 (SD = 0.20 N = 22)	-----
Sam's Creek Prerenovation 1977	1.03 (SD = 0.13 N = 13)	-----
Sam's Creek Prerenovation 1967	1.12 (SD = 0.14 N = 96)	-----
Rocky Fork Creek (Unicoi Co.)	0.96 (SD = 0.17 N = 24)	1.21 (SD = 0.34 N = 12)
Flint Creek (Unicoi Co.)	0.94 (SD = 0.08 N = 21)	1.35 (SD = 0.28 N = 17)
Heaton Creek (Carter Co.)	1.06 (SD = 0.05 N = 8)	1.49 (SD = 0.11 N = 6)
Middle Branch (Carter Co.)	1.07 (----- N = 1)	1.37 (SD = 0.12 N = 14)

TABLE III. Comparison of mean K values of rainbow trout from various streams. Prerenovation Sam's Creek data is taken from Moore (1979). Data other than Sam's Creek is taken from Whitworth (Unpublished data). SD = Standard deviation, N = Sample size.

are not considered, we see a much higher removal rate of 89.82%.

The differences in population reduction from section I through section III apparently reflect differences in habitat type. As stated previously, the lower one-third of the stream consists of very large boulders with very deep pools. This not only makes electrofishing very difficult, but allows the fish plenty of room for escape, during the electrofishing effort. On the other hand, sections II and III consist principally of intermediate-sized boulders, and much shallower pools than section I. Although absolute numbers of fish removed by me from these sections (Table I) was lower, the percent reduction (and also percent removal) from 1978 to 1979 was much higher.

In view of the original aim of removing about 90% of the rainbow trout population, this evaluation shows that the renovation effort has met or exceeded this goal in every habitat type. Mere removal of fish is not, however, the only consideration.

As this data clearly shows, 100% removal of a fish population from a stream habitat such as Sam's Creek is probably an impossibility, short of using a chemical ichthyocide. With the drastic reduction in competition which occurs after such a removal process, there remains a very high potential for fast growth and strong breeding success on the part of the remaining rainbow trout population. In light of this, therefore, it seems logical to assume that, if left unchecked, the remaining rainbow trout population would continue to increase at an increased rate thus reducing the chance for potential brook trout recovery. This would be especially pronounced in the lower end of the stream which has the largest established population of rainbow

trout. This portion of stream is also farthest from the established brook trout population, on which it is depending for new recruits.

To alleviate this problem, therefore, I recommend that, during future renovation efforts, brook trout should be introduced into the portion of stream from which rainbows have been removed. These fish could be transplanted from the head of the same stream, or taken from an adjoining stream. Regardless, this would have a two-fold affect. First, the introduced brook trout would have a head-start on establishing their presence in the lower end of the stream. Second, through competition, this population of brook trout would help to reduce the expansion of the remaining rainbow trout population.

Chemical ichthyocides, because of their low selectivity and lethal nature, have not been considered for use in rainbow trout removal for the brook trout restoration program in the GSMNP. Electrofishing, on the other hand, is a nonlethal and highly selective method, thus making it a seemingly natural alternative. Because it is labor-intensive, however, and not 100% effective, electrofishing has been questioned as an appropriate method of fish removal in rugged mountain streams such as are found in the GSMNP. Although several years of post renovation data are needed, this study suggests that electrofishing can be an affective method for removing undesirable fish from mountain streams. It is apparent from the data presented that, depending on habitat type, from 90% to 99% of the rainbow trout in Sam's Creek were removed during the original renovation effort and a follow-up effort during the following spring. It seems likely, therefore, that if this effort is combined with stocking of brook trout immediately following rainbow trout removal, it will prove to be an affective method for increasing the present brook trout habitat within the GSMNP.

Literature Cited

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