

NRPP Project 241

**BROOK TROUT RESTORATION, SAMS CREEK
GREAT SMOKY MOUNTAINS NATIONAL PARK**

Annual Report FY 2001

Submitted By:

Stephen E. Moore, Matt A. Kulp: Fishery Biologist
John Hammonds, Fishery Technician
Great Smoky Mountains National Park

National Park Service

Project Background

Brook trout range in Great Smoky Mountains National Park (GRSM) has declined approximately 75% since the turn of the century. In 1976 the Park initiated a program to evaluate the effectiveness of electrofishing for the eradication of non-native rainbow trout upstream of waterfalls or cascades. This method proved successful and to date segments of six streams have been successfully restored. However, the majority of streams in which this method can be used have been completed and alternative methods must be evaluated if larger stream segments are to be restored for brook trout.

In 2000, GRSM received funding to evaluate the use of the piscicide antimycin in Sams Creek for brook trout restoration in a larger stream.

Objectives:

The objectives of this study are:

1. To eliminate non-native rainbow trout from 4.8 km (3.0 miles) of Sams Creek (upstream of a waterfall at 646 m [2120 ft.]);
2. Determine the short-term impacts of antimycin application to non-target aquatic fauna (aquatic macro-invertebrates, salamanders and crayfish);
3. To document the recovery process of the aquatic community following antimycin treatment (including brook trout, aquatic macro-invertebrates, salamanders and crayfish);
4. Validate or improve the three-pass depletion population models currently being used; and
5. To conduct mark-and-move barrier validation studies in five streams and use the data to prioritize these and other streams for restoration.

Results:

Brook Trout Re-Colonization

Field surveys were conducted in March and September 2001 to evaluate brook trout re-colonization from upstream refuge areas and to remove rainbow trout from this area. In both surveys, 800 m of Sams Creek and 600 m of Starkey Creek were electrofished to evaluate the number and size of fish that re-colonized the upstream reaches of the treatment area. In March, ten brook trout were collected in the 800m of Sams Creek surveyed. Nine of these fish were age I+ and had a mean length of less than 90mm. The other fish was an adult with a length of 148mm. In Starkey Creek, 20 brook trout were collected in the 600m of stream surveyed. Five of these fish were adults with a mean length of 155mm and 15 were age I+ fish with a mean

length of less than 90mm. In September, only 600m of Sams Creek were electrofished because brook trout were virtually non-existent downstream of the Sams/Starkey Creek confluence. In Sams Creek, 63 young of the year (YOY) and 12 adult brook trout were collected. In Starkey Creek, 31 YOY and 6 adult brook trout were collected. These data indicate that there is limited downstream movement during the winter months and that there is more re-colonization by YOY brook trout during the spring and summer months. This information also shows that re-colonization from upstream areas alone cannot re-populate the stream in two to three years. Therefore it is imperative that native "Southern Appalachian" brook trout be collected from nearby streams for reintroduction into downstream segments of Sams Creek.

Rainbow Trout Removal with Electrofishing

Non-native rainbow trout that were collected during the March and September surveys were removed from the stream. Prior to disposal, each fish was inspected to determine if it had a fin clip from 2000. During the March survey, six adult rainbow trout were collected in Sams Creek and nine were collected in Starkey Creek. Each rainbow trout collected in Sams creek was fin clipped and three of the nine collected in Starkey Creek had been clipped. With the exception of one fish, each marked fish was collected in the site where it was released in 2000. During the September effort, only one YOY rainbow trout was collected in Sams Creek.

Antimycin Application

Rainbow Trout Removal

Experience with antimycin in western park streams that have water quality similar to that of Sams Creek indicated that an application of 8 ppb for 8 hours (64 exposures) would be sufficient to eradicate non-native rainbow trout from the stream. This work also indicated the chemical would be effective throughout a 61-76 m (200-250 ft.) drop in elevation before being neutralized by tumbling and hydrolysis (B. Rosenlund, personal communication). Our experience in the fall of 2000 demonstrated that treatment must be initiated and completed prior to peak leaf fall.

Treatment was initiated September 30, 2001 at the upstream end of rainbow trout distribution in Sams and Starkey Creeks. The intent was to treat each stream segment at 8 ppb for 8 hours and to eliminate all fish in the section being treated in 24 hours. Observations the morning of October 1, 2001 revealed that the trout in the live car at Sams S-40 (42.7 m [140 ft.]) downstream of the treatment station were impacted but none were dead. In Starkey Creek, one of five fish in the live car at ST-5 (24 m [80 ft]) was dead and the other four were impacted. Based on this information and data from October 2000, we assumed that the antimycin was not surviving for more than a 30.5 m (100 ft) drop in elevation. To test this assumption, the upper treatment station for Sams was moved downstream approximately 30.5 m (100 ft.) in elevation and the upper Starkey Creek station was moved downstream about 18.3m (60 ft.) and live cars were placed at 100-m intervals downstream of the treatment stations. Antimycin was then applied at 8ppb for eight hours. Field observations the morning of October 2, 2001 revealed that in Sams Creek all fish in the live car at S-41, a 15.2 m (50-ft) drop in elevation were dead. In S-40, a 36.5-m (120-ft) drop in elevation, one fish was dead and the remainder heavily impacted. Fish downstream of this point did not appear to be impacted. Observations in Starkey Creek revealed

that in S-5, a 15.2m (50-ft.) drop in elevation, that four of five fish were dead and the other fish was moribund. In S-4, a 30.5-m (100-ft.) drop in elevation, 2 were dead and the others impacted and in S-3, a 42.7 m (140 ft.) drop in elevation, 2 fish had died and the remained were impacted by the antimycin. These data provided the first quantifiable evidence that the effective LD 100 for the treatment was about 15.2 m (50 ft) of elevation loss, with impacts up to 30.5 m (100 ft.) of elevation loss. Based on this information, two treatment stations were set about every 15.2-m of elevation loss on Sams Creek and Starkey Creek the morning of October 2, 2001. The goal of this treatment was to eliminate fish down to the confluence of Sams and Starkey Creeks. Observations the morning of October 3 revealed that this strategy was successful in Sams Creek but that some fish in S-2 and S-1, though heavily impacted had not died. This area was retreated the next day and three stations were placed in Sams Creek downstream of the confluence. The strategy of placing treatment stations every 15.2-m drop in elevation to insure complete removal of non-native rainbow trout was adhered to for the remainder of the project.

During treatment each day, fish in live cars were observed to evaluate the effectiveness of the antimycin. Approximately four hours after treatment was initiated, the coloration of rainbow trout in the live cars within a 15.2 – 22.9m (50 – 75 ft) drop in elevation would start to become lighter on top of the head and along the back. Two to four hours later, these fish had lost color over the entire body and as well as most of their fright response. During this latter time frame, very pale trout (ghost fish) could be observed in areas with little to no current. The next morning, all of these fish had died. Attempts were made to recover as many “wild” fish as possible. This effort recovered 66 trout of which 64 were rainbow trout and 2 were brook trout. The length range for recovered rainbow trout was 96 – 266 mm and 80 – 93 mm for brook trout. Numerous “ghost fish” were observed holding in eddies at the end of each day, but they were too lively to be collected at that time. These fish could not be located the next day. The most reasonable explanation for this failure is that as the fish died, they had either washed under rocks and could not be seen or crayfish devoured them.

Impacts to Aquatic Insects

Prior to treatment, benthic macroinvertebrate samples were collected at nine locations in Sams and Starkey Creeks on 22 September 2001. Data for five of the nine sites were available for this reports (Figure 1). The remaining four sites are located in tributaries that were not treated and therefore serve as controls for the project. Post treatment samples were collected 5, 7 and 11 October 2001 at the same sites to evaluate the effect of treatment on this segment of the aquatic community. Five of the sites are located in areas that were not treated with antimycin (2 upstream and 3 in tributaries). Three stations were located in the area treated with antimycin and one site was located downstream of the potassium permanganate station.

The upper Sams Creek control site (I-1) was sampled 22 September and 5 October 2001. Changes in the number of specimens and taxa collected per hour were not expected at this site (Figure 2). The reason for the decline in the number of specimens and taxa per hour are not clear, but may be related to cold water and air temperatures or sampling variability.

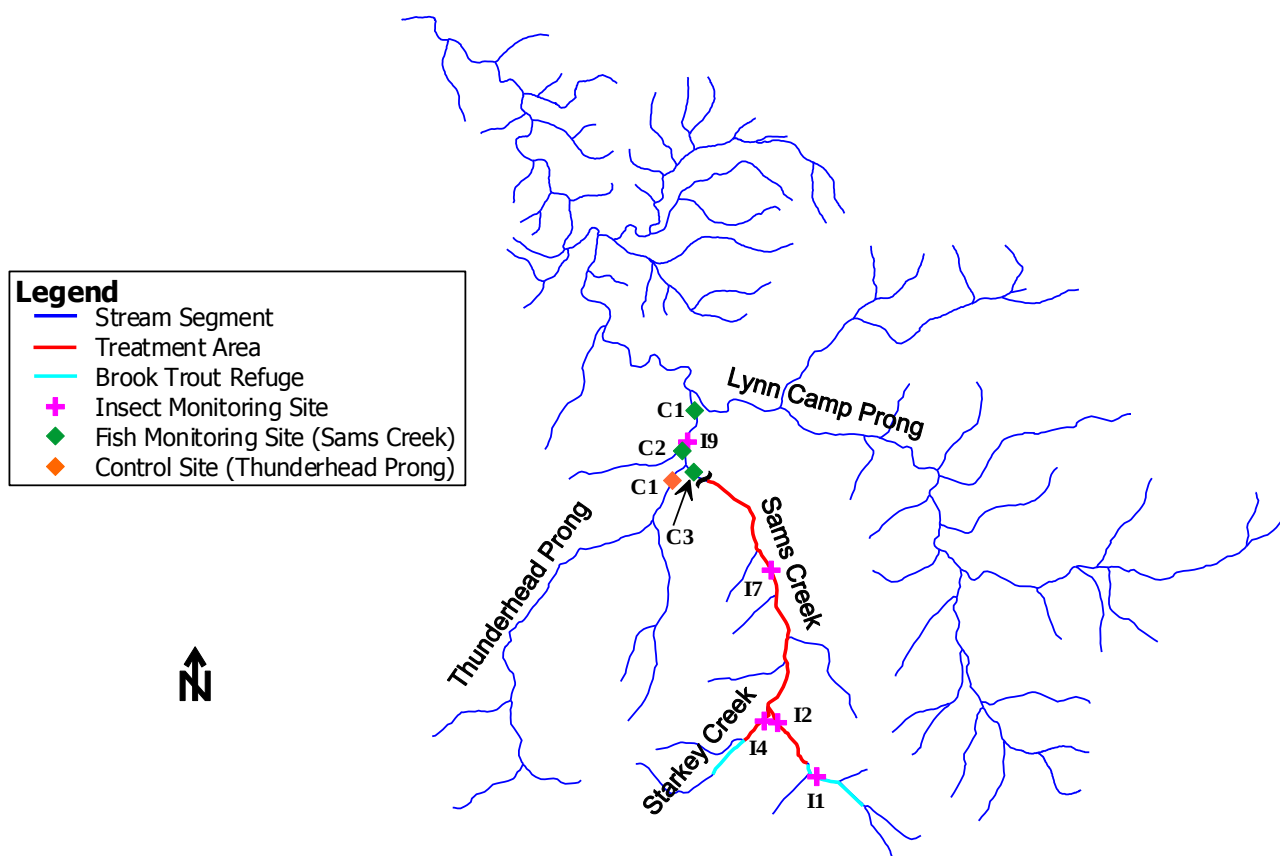


Figure 1. Location of aquatic insect monitoring and fish control sites.

Results for the three sites in the treatment area are not consistent between sites (Figure 2). The lower Sams Creek site (I-2) was not impacted by the treatment. Post treatment collections in the lower Starkey Creek site (I-4) declined 64.3% in the number of specimens per hour and a 25.6% decline in the number of taxa hour. These results are not surprising as this area of Starkey Creek was treated a third time because the second treatment failed to kill all the fish in the live cars. Results for Sams Creek site I-7 indicate that the number of specimens and taxa collected per hour following treatment declined 57.1% and 15.8% respectively.

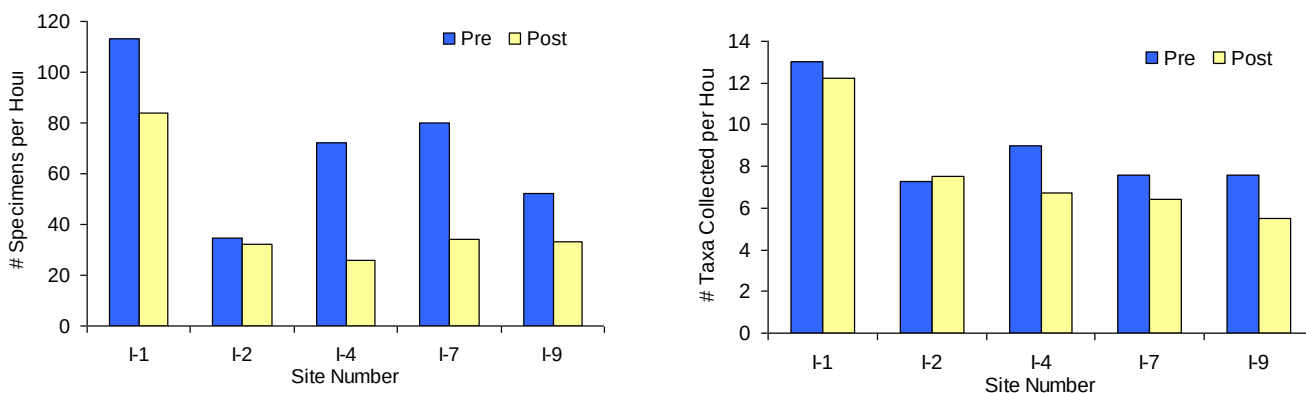


Figure 2. Changes in the number of aquatic insects and taxa collected pre hour before and after treatment.

Comparisons of pre and post treatment data for percent Ephemeroptera, Plecoptera and Trichoptera (EPT's) and total taxa indicate that the application of the ichthyocide did not significantly alter the aquatic insect community (Figure 3). When these data are compared to data for September and October 2000, the results are very similar. A follow up sample in February 2001 indicated that the %EPT's and total taxa were almost identical to pre-treatment values. This limited data set indicates that the aquatic insects had apparently recovered from the treatment. Recovery of the aquatic insect community is also expected this year. However, this cannot be determined until additional samples are collected in 2002 and a more in-depth analysis of the data is completed. Recovery in Thunderhead Prong (I-9) is also expected as all mayfly species are found upstream and downstream of the site and re-colonization is expected to occur.

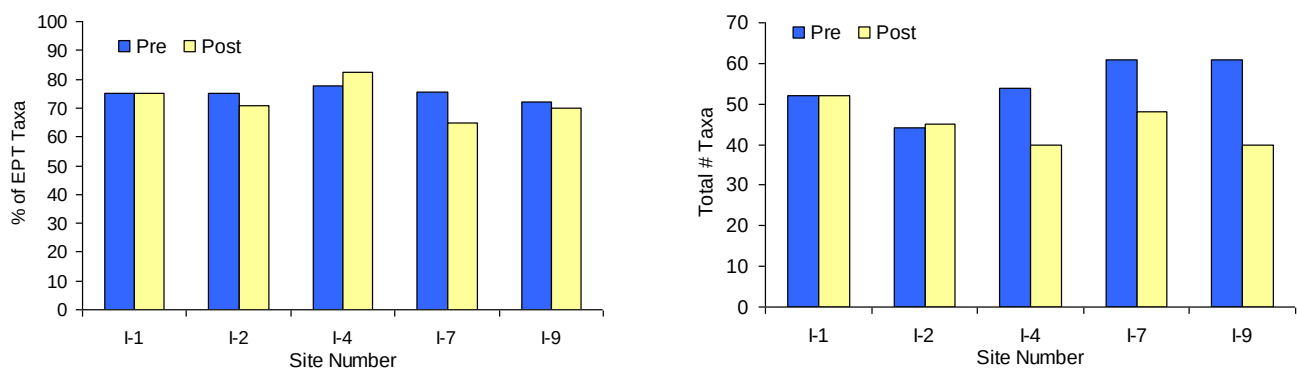


Figure 3. Changes in %EPT and Total Taxa before and after treatment

Live *Desmognathus* and *Eurycea* salamanders were present in all sites during and after treatment. Crayfish were also observed throughout the project area after the project was completed. Field observations before and after treatment indicate that the antimycin did not affect these organisms.

Detoxification of Antimycin

The potassium permanganate (KMnO_4) station was set up approximately 10 m downstream of the barrier at 646-m (2,120 ft.) so that the antimycin could be effectively neutralized. Based on flow times, the station was activated September 30 and operated daily for the remainder of the project. In total, just over 110 kg (242.6 lb.) of KMnO_4 was applied to Sams Creek over 64 hours (Table 1). This equates to approximately 208 exposures (ppm x hours) to the fish and benthos downstream of the potassium permanganate station.

Effects of Potassium Permanganate

Fish: Fish population surveys were conducted at three sites downstream of the potassium permanganate station to evaluate the impact of this chemical on the fish community (Figure 4). A site in Thunderhead Prong upstream of its confluence with Sams Creek served as a control for these sites (Figure 1). Based on information in Figure 4, the only area impacted by potassium

Table1. Summary of KMnO_4 application in Sams Creek September and October 2001. * indicate that potassium permanganate was not applied these days.

Date	Stream Flow (cfs)	Hours Treated	Dosage (ppm)	KMnO_4 Applied (g/hr)	Total KMnO_4 Applied (kg)
9/30/01	4.5	6	2	918	5.51
10/1/01	6.1	6	2	1,224	7.34
10/2/01	5.7	8	2	1,122	8.98
10/3/01	5.2	8	3	1,530	8.98
10/4/01	4.5	9	4	1,735	15.62
10/5/01	3.5	9	4	1,428	12.85
10/6/01	4.8	9	4	1,937	17.43
10/7/01	4.8	9	4	1,937	17.43
10/8/01	*				
10/9/01	*				
10/10/01	3.5	9	4	1,428	12.85
1					
Total		64			110.25

permanganate was the 180m of Sams Creek from the potassium permanganate station to the confluence with Thunderhead Prong (Sams C3). This area received nine days of treatment to neutralize antimycin and impacts in this area were not totally unexpected. In-stream toxicity tests indicated that 4ppm of potassium permanganate was lethal to 40% of the trout in the test but were not affected by lower concentrations. Data from the other two sites indicate that population density after treatment was higher than prior to treatment (Figure 4). The primary reason for this apparent increase is that water levels during the post treatment sample were lower than during the initial sampling period. The lower water levels during post treatment sampling increased the efficiency of the electrofishing effort.

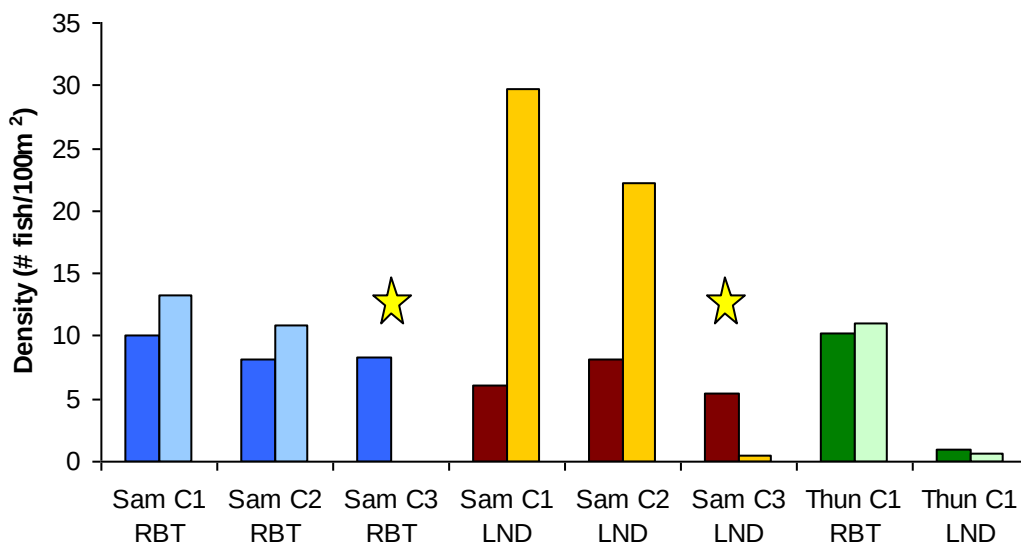


Figure 4. Density of rainbow trout (RBT) and longnose (LND) dace in Sams Creek fish control sites before and after treatment

Aquatic Insects: The results from Thunderhead Prong (I-9) downstream of the potassium permanganate station were surprising (Figure 1). Prior to treatment, 52.2 specimens and 7.6 taxa per hour were collected, with 33.3 specimens and 5.5 taxa per hour being collected in October (Figure 3). In the pre treatment sample, 72.1% of the aquatic insects collected were EPT's and 70% were EPT's in the follow up sample.. Total taxa before and after treatment were 61 and 40 respectively, with most of the decline attributed to the absence of Ephemeroptera taxa. The reason for this loss are not clear but it seems likely that the cumulative effect of nine days of treatment with this strong oxidizer eliminated the mayfly taxa and all but one individual in the common stonefly family Peltoperlidae.

Three Pass Population Model Validation/Improvement

Three years of drought, the fishing experiment and other population manipulations in 2000 had reduced the population size to such an extent that less than 20 trout could be collected in any 100m section. Therefore this objective could not be completed and has been dropped from the project.

Prioritization of Streams for Restoration

Five streams were slated for mark and move barrier validation studies in 2000 (Jonas Creek, Slab Camp Branch, White Mans Glory Creek, Desolation Creek and upper Little River). Field surveys revealed that the cascades on Slab Camp Branch and White Mans Glory Creek were of such large size that mark and move studies were not needed to validate their status as a barrier. Mark and move studies were initiated in Jonas Creek and Desolation Creek. Population surveys were conducted in 100m stream sections downstream of each cascade. Rainbow trout were collected from three 100m sections upstream of the cascade, adipose clipped and released in the downstream section. Unfortunately, time constraints prevented the initiation of a mark and move study for upper Little River in 2000.

Jonas Creek and Desolation Creek were sampled in 2001 to determine if marked rainbow trout were able to move upstream over the cascades thought to be a barrier. One marked fish was found upstream of the cascade on Jonas Creek, thus eliminating it as a candidate for restoration. No marked rainbow trout were found upstream of the cascade on Desolation Creek. A mark and move study was not completed in upper Little River in 2001 due to time constraints related to the initiation of the Sams Creek restoration project.

Summary

- The planned restoration of Sams Creek with antimycin was completed as scheduled. Initial treatments in 2001 gave indications that the antimycin was not traveling as far as projected. Field investigations soon revealed that the antimycin effectively removed trout through a 15.2 – 22.9m (50 – 75ft.) drop in elevation. This guideline was used to set multiple stations daily throughout the remainder of the project.

- Impacts to aquatic insect populations varied between sites. The chemical did not affect one Sams Creek site. However, at one downstream site and in Starkey Creek the number of specimens collected per hour was reduced 57.1 to 64.3% respectively. The number of taxa collected per hour in these sites declined 15.8 to 25.6% respectively. The post treatment analysis indicated that the total number of taxa collected in Sams Creek had declined 24.3% and in Starkey Creek the decline was 26.0%. These values are very similar to changes observed in October 2000 and the populations had recovered completely by February 2001. Complete recovery of aquatic insect populations is anticipated this year also.
- Aquatic insect populations downstream of the potassium permanganate were more severely impacted by this action than by the antimycin. Post treatment analysis indicated that the number of specimens and taxa collected per hour had declined 36.3% and 27.6% respectively. The total number of taxa collected had declined 34.4%. This decline was attributed to the elimination of mayfly taxa from this reach. This area is expected to recover completely but it may take up to two years for this to occur.
- YOY fish dominated brook trout re-colonization of upstream areas.

Plans for 2002

Based on the information gathered in FY 2001, plans for 2002 include:

- 1) Sams Creek will be surveyed with backpack electrofishing equipment to determine if any rainbow trout escaped the treatment.
- 2) Aquatic insect surveys will be conducted in February, May and August to evaluate the recovery of this community. If the community has not completely recovered by August 2002 sampling will continue in 2003 to evaluate recovery.
- 3) Based on the rate of brook trout re-colonization observed in 2001 and the small size of the upstream refuge, it is not practical to assume that the entire restored reach can be re-populated by fish from this area. Therefore it is recommended that native brook trout from nearby sources be collected and released into downstream segments of Sams Creek.
- 4) Mark and move barrier validation studies will be initiated in upper Little River.

.