

**ENVIRONMENTAL ASSESSMENT FOR USING A  
PISCICIDE FOR BROOK TROUT RESTORATION  
GREAT SMOKY MOUNTAINS NATIONAL PARK**

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**I. PURPOSE AND NEED FOR ACTION**

**A. Purpose**

The United States Department of the Interior, National Park Service (NPS), Great Smoky Mountains National Park (GRSM) proposes to chemically treat about 4.0 kilometers of Sams Creek with a piscicide (Antimycin) in order to eliminate non-native fish and to allow the restoration of native brook trout *Salvelinus fontinalis*. Sams Creek is a third order, headwater stream located in the Middle Prong Little River watershed of Tennessee (Appendix A). The treatment is proposed for October 2000 during traditional low water flow periods. If successful, this technique will eventually be used to restore sections of Bear Creek, Lynn Camp Prong, Meigs Post Prong, Desolation Creek, Little Cataloochee Creek and Indian Creek. If additional streams meet the criteria for restoration in the future, they will be added to this list.

The need for this management action is based on the protection of the native Southern Appalachian brook trout, which has been, and in some cases continues to be, out competed by one or more introduced non-native trout species. The purpose for which Great Smoky Mountains National Park was established includes the preservation and perpetuation of the natural resources of the Park in an undisturbed natural condition. As a unit of the National Park System, legislation mandates that Park resources are to be managed in such manner and by such means as will leave them unimpaired for the enjoyment of future generations (NPS Organic Act 1916). NPS Management Policies state that management of exotic (non-native) species, up to and including eradication will be undertaken whenever such species threaten Park resources or public health and when control is prudent and feasible (NPS Management Policies 1988).

The NPS determined that the eradication of non-native fish species and the reestablishment of native brook trout populations are feasible within upper stream reaches of

the above listed streams and that such action is required under its legislative mandates and management policies.

This document reviews the potential environmental impacts of the proposed action and alternatives to this action as required by the National Environmental Policy Act (NEPA) and provides evidence and analysis necessary in determining the need to develop an environmental impact statement in reference to the proposed action.

## **B. Background**

The purpose of this action is to protect the native brook trout of Great Smoky Mountains National Park.

This fish species is the only trout native to the Southern Appalachians. Since the turn of the century, this native trout has lost approximately 75 percent of its range in the Park (Kelly et al. 1980). Initial range loss (about 50 percent) has been attributed to logging and resultant water quality degradation (King 1937). This activity virtually eliminated brook trout in streams below about 914 meters (m) (3,000 ft) in elevation. In turn, residents and loggers became concerned because they had no fish to catch. To meet the demand for recreational angling at the time (around 1910), logging companies began stocking both non-native rainbow trout (*Oncorhynchus mykiss*) and northern brook trout. Stocking of northern brook trout continued into the 1950s and stocking of rainbow trout until 1974.

Until 1974, Park staff saw no harm in stocking rainbows and believed that as reforestation occurred in logged-over areas, brook trout would reclaim lost range. However, distribution surveys in the 1970s showed this not to be true and that 45 percent of the range exclusively occupied by brook trout had been lost since the mid-1930s (Kelly et al. 1980). The decline in stream miles exclusively occupied by brook trout was the direct result of rainbow trout encroachment into previously unstocked brook trout streams (Larson and Moore 1985). Native brook trout had become restricted to marginal headwater streams above 1,067 m (3,500 ft), characterized by steep gradients with pH's that were and are slightly more acidic than lower elevations. Based on the report by Kelly et al. (1980), it was determined that the only places brook trout could not

be displaced was in streams above waterfalls where rainbows could not ascend.

However, we have now determined that some of the high-elevation headwater streams that were previously thought to be secure brook trout habitat have lost or are losing their populations due to poor water quality. To date, range loss of this type has been documented in six streams. Water quality data from one of these streams show it to be too acidic to support trout life.

Park-wide water quality monitoring data show that stream acidity increases with increasing elevation. Acid deposition monitoring indicates that areas above 1,463 m (4,800 ft) receive some of the highest acidic deposition in North America, and stream acidity appears to be increasing (Flum et al. 1997). If acid deposition continues at current levels, brook trout and other aquatic species may be eliminated from additional headwater streams as well.

Historically, local residents were very vocal about introduced northern strains of brook trout being different from the native brook trout or "speckled trout." Studies in the 1950s showed that physical differences do exist between Southern Appalachian brook trout and hatchery fish (Lennon 1967). In 1996, a study conducted by the University of Tennessee provided conclusive evidence that Southern Appalachian brook trout are genetically distinct at the subspecies level from northern populations (McCracken et al. 1993). The report also recommends that everything possible be done to protect Southern Appalachian brook trout, the only trout species native to the Southeast.

### **C. ALTERNATIVES**

The National Park Service has considered four alternatives to alleviate the problem of brook trout decline. These are: 1) to eliminate the presence of non-native fish through the use of the piscicide Antimycin, 2) to eliminate the presence of non-native fish through the use of another chemical fish toxicant, Rotenone, 3) to eliminate the presence of non-native fish through the use of electroshocking equipment, and 4) to take no action with regards to the presence of non-native fish and the documented loss of native brook trout.

Alternatives considered but rejected include: hook-and-line fishing, as studies have shown that this approach is only about 20% effective in removing non-native salmonids from a mountain stream habitat; netting or seining, as these devices cannot be used effectively in a boulder strewn flowing river or creek; and the use of explosives, because of concerns for non-target aquatic organisms, low probability of total removal of all non-natives, and potential non-desirable habitat impacts.

Alternative 1. (Preferred Alternative) Removal of non-natives with the use of Antimycin (Fintrol)

Under this alternative, approximately 4.0 kilometers (km) of Sams Creek upstream of the waterfall at an elevation of 646 m would be treated with the piscicide Antimycin, a chemical compound fatally toxic to fish and aquatic insects but less toxic to aquatic animals other than scaled fish. The toxicity of Antimycin below the treatment site would be neutralized (detoxified) with the use of potassium permanganate (KMnO<sub>4</sub>). The Sams Creek treatment site would be used as a test for the effectiveness and environmental compatibility of this method of treatment and, if successful, this method would be used to treat other similar streams within Great Smoky Mountains National Park to reestablish displaced native brook trout populations.

Antimycin is an antibiotic, produced in cultures of *Streptomyces*, is toxic to fish, and sold under the trade name of Fintrol. It is EPA approved for fishery use and it kills fish by inhibiting cellular respiration. The toxicity of Antimycin is diminished by high alkalinity, temperature, sunlight, and the metabolic activity of aquatic organisms. Antimycin has a half-life of only a few hours in fast moving non-acidic waters. Antimycin, when used in proper concentration, is less harmful than the recommended killing concentration of Rotenone (Alternative 2) to aquatic animals other than fish. Lennon et al. (1971) stated that Antimycin is the ideal fish toxicant because of its selective effects, its effectiveness at low concentrations in a short exposure time in a wide range of water qualities, it is not repulsive to fish, it is effective on all size classes, and it leaves no residue. Bruce Rosenlund, a U.S. Fish and Wildlife Service biologist with many years experience

using Antimycin in the removal of non-native trout in Rocky Mountain National Park, has stated that other advantages include lack of effect on eggs in the gravel and that colder water temperatures do not reduce the toxicity to fish (personal communication). With every 61-76 m (200-250 ft) drop in elevation, aeration and tumbling in the stream break up the large Antimycin molecules, which neutralizes the toxicity of this piscicide. This alternative is anticipated to have the least overall environmental impact with the highest potential for success.

Prior to treatment, flow (discharge) will be determined at six to eight locations along the length of stream to be treated. The discharge at each station will be used to determine the exact amount of Antimycin needed to maintain a concentration of 8 parts per billion (ppb) for 8 hours in the section being treated. Treatment will begin at the upstream end of the project area and proceed downstream. At the end of the first day, the treatment stations will be moved down about 30 m (100 ft) in elevation. Treatment for Day 2 will begin at this point. This stepwise treatment procedure will be followed for the entire project area and will insure two complete applications of Antimycin are administered. During treatment, potassium permanganate ( $\text{KMnO}_4$ ), a detoxifying agent, will be applied to the stream at the downstream end of the project area. This chemical will be applied for a minimum of eight hours each day of treatment to insure that all of the toxicant has been neutralized. It is anticipated that five workdays will be required to complete the treatment.

Additionally, dye retention studies will be used to determine travel time for every 61-76 m (200-250 ft) drop in elevation. These data will estimate the length of time required for the chemical to travel from one treatment station to the next and to coordinate the release of chemical at each station.

One to two days prior to treatment, the stream sections of Sams and Starkey Creeks occupied by brook and rainbow trout will be electrofished to collect as many brook trout as possible. These native trout will be transported to refuge areas that are upstream of the treatment area and released. If possible, these fish will be adipose fin clipped to determine if they return to the areas from which they were collected.

The day prior to treatment, rainbow trout will be collected and placed in holding cages in selected stream reaches along the area to be treated and monitored during treatment to assess effectiveness. Concurrently, selected stream sections (representative of stream size and habitat) will be closed off with block nets and electrofished (three pass removal). The block nets will be left in place and during treatment, individuals will be assigned to collect, measure and weigh all trout from the section. These data will be used to validate population depletion models currently being used to estimate the population size of stream fishes. All dead rainbow trout within the treatment area will be collected and enumerated. A subset of these fish will be individually weighed and measured to assess population size structure. Once these data are recorded, all fish will be buried to prevent incidental ingestion by wildlife.

Within a week of the completion of treatment, stream reaches selected for population model validation will be electrofished to determine if any fish survived the treatment. In June of the next year, the entire length of treated stream will be electrofished (one pass) to check for the presence of rainbow trout. These data will also be used to evaluate the re-colonization of upstream reaches, the downstream movement of marked fish and reproductive success. Population monitoring will also be conducted in control sites and Inventory and Monitoring (I&M) sites in the treatment area, if fish are present.

If brook trout have only started to re-colonize upstream reaches of the treatment area, then approximately 100 brook trout will be collected and transported downstream and released. Release sites, as well as adjacent sites, will be re-surveyed in September or October to determine survival and movement. This same process will be followed in Year 2 if necessary, the only difference being that releases will target the downstream-most segment of the treatment area. Beginning in Year 3, annual monitoring will be initiated. The project will be considered a success when no rainbow trout are collected for two years and a viable reproducing population of brook trout exists in the treatment area. When this occurs, treatment of other streams identified for chemical renovation in this document will be recommended.

Prior to treatment, aquatic insect surveys will be conducted at the nine sample sites established in 1996-97 and the results compared to those data. The findings will also be compared to I&M data from 1992 - present. If possible, during treatment drift nets will be placed in the stream in an effort to validate the accuracy of current survey techniques for assessing diversity and relative abundance. Within a week of treatment, all sites will be resurveyed to determine the impact of Antimycin on aquatic insect populations. A quarterly sampling schedule will then be implemented for a period of three years to evaluate re-colonization and recovery, if initial sampling indicates that Antimycin has had a negative impact on non-target organisms.

#### Detoxification of Antimycin

Potassium permanganate ( $\text{KMnO}_4$ ) is a strong oxidizing agent that has been used for various purposes in agriculture, industry, medicine, and water treatment (Rose and Rose 1966). Walker (1967) pointed out that  $\text{KMnO}_4$  could be used to detoxify the fish toxicant Antimycin, however Marking and Bills (1975) show that  $\text{KMnO}_4$  is toxic to trout at low concentrations ( $< 4\text{mg/l}$ ). On site toxicity tests at Sams Creek indicate that concentrations of 3 mg/l or less of  $\text{KMnO}_4$  resulted in no mortality and that 4 mg/l resulted in only 20 percent mortality. These tests also showed that 2 mg/l of  $\text{KMnO}_4$  are sufficient to detoxify Antimycin in Sams Creek (Moore et al. 1998, unpublished data).

#### Alternative 2. Removal of non-native fish through the use of a different chemical fish toxicant (Rotenone).

The only other EPA approved and commonly used alternative to Antimycin is Rotenone. Rotenone kills fish by blocking oxygen transport across the gill membrane. Rotenone can also be detoxified by the application of potassium permanganate, but is more difficult to neutralize and will hold its toxicity for several days depending on the field conditions encountered. Other disadvantages of using Rotenone include: 1) that it must be used in higher concentrations than Antimycin, 2) it works slowly in colder water temperatures if at all, and 3) fish can detect its presence and move to upwellings of ground water, springs, and tributaries to escape, thus lowering the potential for successful elimination of non-native fish. While Rotenone is generally non-toxic to most

mammals and birds at concentrations used to sample fish, these concentrations are generally lethal to zooplankton and many aquatic invertebrates. Magnum and Madrigal (1999) found that aquatic insect populations had not returned to pre-treatment levels five years after a Rotenone treatment in the Strawberry River, Utah. It is anticipated that the use of Rotenone would result in a higher potential for impact to the non-target aquatic organisms within the system. It would also be more difficult to control unwanted impacts to non-target organisms than if Antimycin was used.

If Rotenone was used it would be applied in the same locations and generally under the same methods and control procedures as have been described for Antimycin (Alternative 1).

Alternative 3. Removal of non-native fish through the use of electroshocking equipment.

Electroshocking is a commonly used method of temporarily stunning fish to allow their capture and removal from aquatic habitats. It involves establishing an electrical current (usually AC in GRSM) between two electrodes placed in the water. Fish encountering the electrical current are temporarily stunned, roll over and are easily captured. Electrofishing, when properly conducted, does not result in permanent damage to the majority of fish (Habera et al. 1996). Once captured, fish can be removed or released back into the aquatic environment essentially unharmed.

This approach would have the least amount of impact on non-target aquatic organisms, but is not likely to be successful in the full removal of non-native fish species. Electroshocking has been proven to be about 75% successful in removal of fish from small streams receiving multiple removals in one year or treated annually for five to seven years (Kulp and Moore in press, Moore and Larson 1989, West et al. 1990) in GRSM streams smaller than Sams Creek. Past electroshocking efforts in larger streams with numerous deep pools (> 1.0 m) have never been successfully reclaimed, even when multiple removals were conducted. Results of Habera et al. (1992) indicate that the successful eradication of non-native salmonids is highly improbable in streams with a mean width greater than six meters and four or more pools greater than one meter in

depth per kilometer of stream length. In fact, the restoration of Sams Creek using backpack electrofishing techniques was attempted in 1978 and 1979. This effort resulted in the rainbow trout population being significantly reduced in all stream sections. The smallest reductions in density (~75%) occurred in the downstream section, which has numerous deep (>1.0 m) pools and complex habitat (Whitworth 1979). This was also the only reach in which reproduction occurred the year following treatment.

#### Alternative 4. No Action

If the Park were not to implement the proposed action, it is anticipated that the native brook trout population would continue to decline within Great Smoky Mountains National Park and may eventually become extirpated from all of its native range within the Park.

Under a no-action alternative, the National Park Service would not be meeting its mandate to preserve and protect the natural resources of the Park un-impacted for present and future generations. No action would mean a willful disregard for scientifically viable remedial actions and failure to successfully manage Park resources. The temporary limited environmental impacts to habitat and native aquatic species that will occur under the preferred alternative are not sufficient to justify no action.

### **D. DESCRIPTION OF THE AFFECTED ENVIRONMENT**

#### **A. Non-Living Components**

3. Air - Air pollutants are impacting certain Park resources. Air quality and its effects (acid deposition, regional haze, and ozone pollution) are determined by a number of factors, some natural but most are anthropogenic. The addition of liquid Antimycin to Sams and Starkey Creeks or any other stream listed (i.e. Bear Creek, Lynn Camp Prong, Meigs Post Prong, Desolation Creek, Little Cataloochee Creek, and Indian Creek) will not affect the quality of air resources.
2. Water - Surrounding vegetative communities, soil chemistry and underlying geology primarily

determine water quality in the Park. Mid-elevation streams are characterized as slightly acidic pH (i.e. 6.2-6.9) with low buffering capacity. Toxicity tests at U. S. Fish and Wildlife Service laboratories indicate that water quality is not affected by the addition of Antimycin (Schnick 1974). The use of this chemical in Park streams is not anticipated to have any adverse effects on water quality. The treatment of Sams Creek or any stream listed will not affect ground water because all the ground water (in the area) is in the form of upwelling that adds flow to the stream.

4. Soils - The soils in the area around the streams identified for restoration are colluvial in nature, formed primarily from sandstone formations and the Anakeesta formation. These soils are deep, well drained and generally have a thick dark surface. The sideslopes further away from the creeks contain residual soils from the same geologic formations and range in depth from 0.5 to 1.0 m (20 to 40 in). The implementation of this project will not affect the surrounding soils of any stream listed in this document in any way.
5. Geology - The underlying geology of the Park is primarily of sedimentary origin (King et al. 1968). The majority of the bedrock found along streams is sandstone, gneisses and schists. Pyritic formations (i.e. acid-bearing rock) underlay some streams. If exposed, leachates from this formation will eliminate all aquatic life for several kilometers downstream. The addition of Antimycin to target streams listed in this document will not affect the underlying geology of these areas.

## **B. Living Components**

Within the Park there are two major ecosystems, one aquatic, one terrestrial. The aquatic ecosystem is made up of approximately 3,404 km of streams in 28 watersheds (Parker and Pipes 1990). Stream elevations range from 266 m to 2,025 m above mean sea level. These streams are deeply incised into the mountains and are characterized by steep gradients, stairstep pools, cascades, riffle habitats, and a substrate composed primarily of boulder, rubble and cobble. Because of this configuration these

streams do not have well defined flood plains. Based on established criteria for the determination of wetlands accepted by the NPS, no wetland resources occur within the project area for Sams Creek or any other stream to be eventually proposed for restoration, assuming the Sams Creek restoration is successful.

1. Vegetation - Overstory vegetation along the slopes of Sams Creek and other streams proposed for restoration is dominated by second growth yellow birch (*Betula alleghaniensis*), sweet birch (*Betula lenta*), maples (*Acer sp.*), hemlock (*Tsuga canadensis*), yellow buckeye (*Aesculus flava*), and tulip poplar (*Liriodendron tulipifera*). The dominant understory immediately overhanging the streams includes *Rhododendron* species, *Hydrangea arborescens*, and doghobble (*Leucothoe fontaensiana*).
2. Aquatic Insects - Aquatic insect surveys conducted by Dr. David Etnier of the University of Tennessee indicated that 118 species live within or near the proposed treatment area of Sams and Starkey Creeks in 1997. Most species (>75%) occur in one of the following groups: mayflies (Ephemeroptera), caddisflies (Trichoptera), stoneflies (Plecoptera), and true flies (Diptera). Etnier's study located one invertebrate, a caddisfly, which is an undescribed species. This caddisfly (*Rhyacophila* n.) was found within and outside of the treatment area and is common in Thunderhead Prong and Alum Cave Creek.

In 1987, Dr. Chuck Parker of the US Geological Survey, Biological Resources Division (USGS, BRD) collected an undescribed caddisfly of the genus *Neophylax* at the confluence of Sams and Starkey Creeks (the upper end of the area to be treated). He has since described and named his find as *Neophylax kolodskii* (Parker, in press). Since this collection, Dr. Parker has returned to the original collection site five times, four of which were at the same time of the year. He has also sent biological technicians out twice to attempt to locate additional specimens of this species. One trip was to Sams Creek and the other was a more extensive survey in the Middle Prong of the Little River watershed. None of these efforts were successful at locating additional specimens of this caddisfly.

Dr. David Etnier intensively looked for *Neophylax kolodskii* while conducting aquatic insect surveys for this environmental assessment in 1996 and 1997. Since then, he has looked for this caddisfly, once in September, 1997 and again in September 1998. In September, 1999, Dr. Etnier, his wife, four of his students and a NPS fishery biologist spent 10 hours each searching the upper reaches of Sams Creek for this species. These efforts failed to collect additional caddisfly specimens.

Aquatic insect samples have also been collected annually in Sams Creek since 1992 as part of the Inventory and Monitoring program. These efforts have also failed to produce additional specimens of this species.

Additional efforts to locate *Neophylax kolodskii* will occur in 2000. Between late April and mid-May *Neophylax* pupae will be collected from Sams Creek and returned to a Living Stream at Twin Creeks for captive rearing. *Neophylax* larvae attach their cases to rocks early in the year and aestivate through the summer, before pupating and emerging as adults in the fall. Because the summers have been unusually hot and dry for the past several years, aestivating *Neophylax* larvae may have been experiencing higher than natural mortality during the summer, which could make locating this species more difficult. Captive rearing should increase the survival and likelihood of collecting this species if it does live in Sams Creek. These pupae should hatch in mid- to late September and will be identified at that time.

In addition to this, the Middle Prong of Little River watershed, as well as other watersheds in the Park, will be intensively sampled with light traps and sweep nets. These collection methods are known to be very effective for collecting adult caddisflies. Collections will be at the same elevation the original collection was made as well as higher and lower elevations in each stream sampled. These collections will also bracket the time of original collection.

Four scenarios are possible as a result of this search:

- A) *Neophylax kolodskii* is only found in the target area. In this case treatment would commence downstream of the area in which it is found. This assumes it is only found in the area of original collection. If found only in Sams Creek, chemical treatment would be abandoned.
- B) The caddisfly is found inside and outside the target area of Sams Creek and other streams. In this case the project will proceed as planned.
- C) The caddisfly is outside the target area, either in Sams Creek or another stream. In this case the project will be conducted as planned.
- D) If these efforts fail to collect additional specimens of this caddisfly inside or outside the target area, then it will be assumed that everything possible has been done to locate it and treatment of the stream will not adversely impact its existence.

No state or federally threatened or endangered invertebrate species were found in the treatment area.

The aquatic insect populations of GRSM have not been as thoroughly studied as other segments of the aquatic ecosystem, and are therefore not as well known. Prior to the implementation of restoration activities on other streams listed in this document, detailed aquatic insect surveys must be conducted to determine species composition and to look for new or rare species. If none are located then the project should follow the same procedure as outlined for Sams and Starkey Creeks.

- 3. Reptiles and Amphibians - Reptiles are rarely observed in the project area, but northern copperhead (*Agkistrodon contortrix mokeson*), timber rattlesnake (*Crotalus horridus*), black rat snake (*Elaphe obsoleta obsoleta*), and eastern garter snake (*Thamnophis sirtalis sirtalis*) have been observed occasionally. The application of Antimycin to Sams Creek or any other stream listed will not threaten the survival of any of these species.

Amphibian surveys in the Sams Creek project area by Dr. David Etnier indicated that black belly salamander (*Desmognathus quadramaculatus*) and shovelnose salamander (*Desmognathus marmoratus*) are common in the stream area to be treated. These species also were common in tributaries to Sams Creek that will not be treated and are found throughout the Park. The red spotted newt (*Notophthalmus viridescens viridescens*) is also common in the seeps and small tributaries of Sams Creek and other streams proposed for restoration. Areas of this nature will not be chemically treated and therefore pose no threat to the survival of these species in the Park.

4. Fish - Brook trout and rainbow trout are the only fish species found in Sams Creek, Ekaneetlee Creek, Desolation Creek, Bear Creek, Meigs Post Prong, Little Cataloochee Creek, Beech Creek, and Gunter Fork. However, native non-game fish species [longnose dace (*Rhinichthys cataractae*) and blacknose dace (*Rhinichthys atratulus*)] do live in Lynn Camp Prong and Roaring Fork. In these streams, biologists will collect as many of these fish as possible prior to treatment and transport them to refuge areas downstream where they are commonly found. Once a system has recovered from treatment and stabilized, similar numbers will be collected and returned to the restored stream. If a small number of these fish are lost due to chemical treatment, it will not negatively affect the survival and well being of these populations in the watershed or the Park.

In 1997, the rainbow trout population estimate for the 2.72 km (1.7 mi) of Sams Creek exclusively occupied by rainbow trout was about 755 fish per kilometer or a total of 2,054 rainbow trout. A mixed population of rainbow and brook trout (sympatric) occupies the next 1.28 km (0.8 mi) and the first 0.8 km (0.5 mi) of Starkey Creek. Approximately 385 rainbow trout and 757 brook trout occupy the sympatric section of Sams Creek. The mixed zone of Starkey Creek had about 75 rainbow trout and 140 brook trout based on the 1997 estimate. The intent is to permanently remove rainbow trout from all these sections.

5. Terrestrial Animals - Mammals that would be expected to occur in the project site include black bear (*Ursus americanus*), white-tailed deer (*Odocoileus virginianus*), the exotic European wild boar (*Sus scrofa*), coyotes (*Canis latrans*), squirrels (*Sciurus sp.*), and other small rodents. Several species of passerine birds are expected to occur in the project area. Hawks, owls, and crows may possibly enter the area, but have not historically been seen along the stream corridor. None of the above species is expected to be affected by the application of Antimycin to Sams and Starkey Creeks or any other stream listed in this document.

6. Wilderness - Much of the area within GRSM has been proposed for wilderness designation. Because of this, the majority of the Park, including the treatment area, is managed as defacto wilderness.

NPS Management Policies state: "The Park Service will take no action that would diminish the wilderness suitability of an area recommended for wilderness study or for wilderness designation until the legislative process has been completed."

The proposed project area is located within the area proposed for wilderness designation and, as such, this action could be viewed by some as a negative impact to wilderness values. However, the Park believes that the successful completion of this project will enhance wilderness values by restoring a native trout to a portion of its historic range and simultaneously eliminating an exotic species.

7. Threatened and Endangered Species - There are no federal or state listed threatened or endangered species that are known to inhabit the area to be treated in Sams or Starkey Creeks or any stream listed in this document. Therefore, none would be affected by the proposed action.

8. Human Impacts - The preferred alternative will impose no water quality or ingestion threats to humans in and/or below the treatment area of Sams and Starkey Creeks or any stream listed in this document (Schnick 1974). Antimycin and potassium permanganate ( $\text{KMnO}_4$ ) used for detoxification will be broken down into naturally occurring organic compounds at non-

detectable levels before they leave the Park boundary in Townsend.

#### **E. EDUCATIONAL AND SCIENTIFIC INTEREST**

As an experiment, the proposed renovation of Sams Creek provides Park staff with the rare opportunity to study and evaluate the effects of Antimycin on a southeastern stream. Park fishery biologists have demonstrated that methods currently used to estimate population size in a small stream actually underestimate the population by as much as 30 percent! This restoration effort will provide an opportunity to validate the three-pass population estimation technique in different stream orders. In addition, biologists will evaluate the effects of the chemical on aquatic insect and salamander populations. Based on pre-treatment data, biologists can monitor (as needed) the recovery of aquatic insect, salamander, and native brook trout populations.

#### **F. ENVIRONMENTAL CONSEQUENCES**

##### **A. Anticipated Site-Specific Impacts of Alternatives Considered**

The anticipated environmental consequences of each of the alternatives considered are presented by alternative in the following sections.

##### **1. Alternative 1. (Proposed Action) Removal of non-native fish with the use of Antimycin**

###### **a. Anticipated Impacts**

###### **1. Short Term Impacts**

The short-term impacts of treating this reach of Sams Creek with Antimycin will be profound. All rainbow trout and some brook trout will not survive in Sams or Starkey Creek or any stream listed in this document.

Many of the aquatic insects in the 4-kilometer treatment reach also may not survive the treatment. Aquatic insect surveys indicate that a minimum of 118 species of aquatic insects can be found in Sams Creek (Etnier 1997, unpublished report). Based on observations by Rosenlund during treatment of

western streams, it is believed that the majority of the aquatic insects within the treatment area of Sams and Starkey Creeks will not survive. This same effect will be observed in all other streams proposed for restoration in this document. Precise estimates of the numbers cannot be made because techniques to quantitatively estimate the number of organisms per square meter do not work in streams dominated by boulder, rubble and cobble substrates. These are renewable resources and their loss is not irrevocable. The brook trout refuge and all fishless tributaries have similar aquatic insect communities. Re-colonization from upstream reaches, tributaries, and untreated downstream reaches will begin almost immediately.

While this scenario appears extreme, experience in mid-west and western streams treated with Antimycin (Jacobi and Deagan 1977; Minckley and Mihalick 1981), shows that the aquatic environment is strongly resilient and the treated reach will return to a stable habitat in a period of months. These studies indicate that within three years of treatment no significant difference in the diversity and density of aquatic insect populations could be detected. We expect similar results in Sams Creek.

Results from the Sun Creek restoration effort in Crater Lake National Park indicate that initially mayfly and stonefly populations were significantly reduced in density but caddisflies were not significantly impacted (Mark Buktenica, personal communication). Based on limited monitoring data the aquatic insect community recovered to pre-treatment levels quickly (Mark Buktenica personal communication). This effort was conducted in the early fall when water temperatures were 0-3°C (33-38°F). In order to reduce potential impacts to the aquatic insect community in Sams Creek, this project will be conducted in late October after water temperatures have declined below 10°C (50°F). Dr. Etnier's report (1997) stated that it is reasonable to assume the proposed piscicide application would not result in the extinction of any species of aquatic insects. All entomologists consulted agree that the proposed action is not

likely to result in the extinction of any species from the treatment area, however, it may temporarily eliminate one or more species from Sams Creek.

Additionally, Schnick (1974) indicates that 10-80 ppb of Antimycin had no effect on the survival of mole salamanders or tiger salamanders. This report also indicates that tadpoles and frogs are not affected by 5-10 ppb of Antimycin in laboratory and field studies. These values are at or below application rates proposed for this project. During field toxicity tests in 1998 at Sams Creek, adult and larval (with gills) salamanders were placed in the 8 ppb test bucket with rainbow trout. All trout died within two hours but the salamanders were unaffected after eight hours of exposure. Therefore, it is highly unlikely that these faunal groups will be affected in any way.

Based on studies by Moore et al. (1985) and unpublished results from other studies involving the marking of brook trout and monitoring of their movements, brook trout from the refuge areas will begin to move downstream and re-populate the upstream reaches of the treatment area within a month. Small numbers of brook trout (5-10/100 m) should inhabit the uppermost 0.5 - 1.0 km of the restored stream within a year of treatment.

Not all fish will be lost to the chemical. Three to four weeks prior to treatment the first 3.2 km (2.0 mi) will be opened to fishing (angling will not be allowed in the sympatric zone). Each angler fishing the stream will be required to keep every rainbow trout he/she catches. Based on a previous study of this type conducted in the Park (Larson et al. 1986) we believe that anglers will remove about 50% of the fish from the 3.2 km reach.

The sympatric zone will be electrofished and all brook trout collected will be transported upstream to refuge areas and released. All rainbow trout collected will be euthanatized; however they will become part of continuing studies for age and growth validation and other related scientific investigations.

Those species that may rely on Sams Creek for a portion of their subsistence may be temporarily displaced from the project area. These species may include reptiles and amphibians (snakes, frogs, and salamanders), mid-sized mammals (raccoons and opossum), and possibly bears and the exotic European wild hog. However, none of these species rely solely on the resources in the treatment area of Sams Creek for their survival. No threatened or endangered animal species are known to inhabit the area of Sams Creek.

## 2. Long Term Impacts

No negative long-term impacts are anticipated. Antimycin is an antibiotic that was originally produced for veterinary use. The tumbling action of the stream physically breaks this chain molecule apart and it loses its toxicity with every 61-76 m (200- 250 ft) drop in elevation. The fragmentation of the molecule produces inert breakdown by-products. To insure complete neutralization of the Antimycin, the chemical potassium permanganate ( $\text{KMnO}_4$ ) will be added at the downstream barrier, the end of the project area. The potassium permanganate oxidizes quickly in natural waters and breaks down into inert compounds. The by-products of these chemicals will be diluted to the range of nanograms per liter and then into the range of non-detection long before the stream exits the Park. No residual effect of this material has been reported in the literature or is expected here. Water chemistry should return to pre-treatment conditions within 48 hours in Sams Creek or any stream listed for restoration. The production (density and biomass) of aquatic insects is expected to be close to pre-treatment levels within one year. The diversity of aquatic insects should return within three years. Based on restoration experiences in other streams the density of brook trout should return to at least the densities observed for rainbow and brook trout within three to four years as well.

b. Mitigating Measures

1. Short-Term Impacts

Amending the water at the downstream limit of the treatment area with potassium permanganate in Sams Creek will mitigate the impact of toxic effect beyond the area of treatment or any stream proposed for restoration in this document. The application of both toxin and neutralizer will be done by highly qualified individuals who are experienced in the field of aquatic management, and have credentials at the post graduate level in biology and chemistry.

By setting the project start date in late October, the impact of the chemical treatment on aquatic insect populations will be lessened. Experience from Crater Lake National Park demonstrated that in colder water the Antimycin will still kill some aquatic insects but the impact will be small.

Fish and organisms removed by this proposed action will be retrieved from Sams/Starkey Creek or any stream listed in this document and used for scientific research projects, or buried to avoid ingestion by opportunistic scavengers.

Closing the treatment reach to visitor use will stop incidental consumption of the water of Sams Creek or any stream proposed for restoration by the visiting public. However, past research has shown that Antimycin is not hazardous to human health even if someone were to accidentally ingest some of the treated water (Schnick 1974). Downstream reaches of the stream will be posted to advise the visiting public of the project and what precautions that they should take. Treatment will be planned for late October when visitation is low. Human presence and activity will, for the most part, warn off local mammals. A review of toxicity studies relating to Antimycin (Schnick 1974) indicates that animals must be fed large concentrated oral dosages (1-5 mg/kg) before any effect is seen. Given the small concentration of the two chemicals that would be in the stream, and then for only a short time,

an animal could not possibly drink enough water to harm itself.

## 2. Long-Term Impacts

No negative long-term impacts are expected, however, a program to evaluate the success of this proposed action is planned. For three to five years following treatment, annual brook trout population surveys and quarterly aquatic insect and water quality surveys above, in, and below the treatment area will be conducted. The results of these efforts will be compared to data from pre-treatment surveys to evaluate recovery. Appropriate mitigating actions will be considered, if necessary, although the need for further management action, other than monitoring, is remote.

## **2. Alternative 2. Removal through the use of Rotenone**

Under this alternative, the same or greater short-term impacts to aquatic insect populations would be anticipated. However, a study in Utah (Magnum and Madrigal 1999) indicates that aquatic insect populations do not recover as quickly from Rotenone treatment. Detoxification is also more difficult although monitoring procedures would be the same as for Alternative 1.

Because fish can detect the presence of Rotenone and will move to refuge areas, and this chemical is not as effective in cold water, the probability of success is much lower. Additionally, it is more difficult to neutralize Rotenone in water with colder temperatures, therefore, increasing the likelihood of downstream impacts.

## **3. Alternative 3. Removal of non-natives by electroshocking**

Restoration using backpack electrofishing techniques would be the least impacting to non-target organisms. However, efforts to restore Sams Creek to brook trout using electrofishing in 1978 and 1979 failed to remove all non-native rainbow trout. The reasons for failure were primarily due to the numerous deep pools, complex habitat, especially in the downstream half of the area to be

treated and loss of funding. Restoration efforts using electrofishing techniques have also failed in five other streams because of stream size, complex habitat, numerous deep pools and loss of funding.

#### **4. Alternative 4. No Action Alternative**

If this alternative were to be selected, Sams Creek and any of the other streams identified for future chemical treatment, would not be restored using Antimycin and the species residing in and around them would continue to co-evolve. No temporary or long-term negative impacts would occur to the stream aquatic insect or amphibian communities due to the fish removal actions, but long-term impacts may continue to occur due to the presence of non-native fish. No action could also result in local extinction of native brook trout populations in Sams Creek and other headwater streams throughout the Park. This alternative would result in the National Park Service neglecting its legislatively mandated policy (NPS Organic Act 1916) to protect and restore native species where feasible (NPS Management Policies 1988).

#### **B. Biological Community Relationship Impacts**

Aquatic ecosystems of the Park are made up of different populations that interact and form communities that are naturally regulated. Similar communities are found in main streams and tributaries across the Park where the underlying geology, soils, and vegetative communities are the same. The implementation and completion of this project will not disrupt community balance outside the project area.

#### **C. Cumulative Impacts**

No negative long-term environmental impacts are anticipated through implementation of the proposed action. Negative environmental impacts of the proposed action are anticipated to be temporary and will result in an overall improvement to the environment, since exotic fish will have been removed from a portion of the Park.

The Park will continue attempts to restore native brook trout by mechanical and other means as well. However, these

are known to be ineffective in larger streams. The cumulative impact of the proposed action will be a further reduction of non-native trout species in the Park.

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#### **VII. PUBLIC INTEREST**

In as much as this is a proposal to affect living creatures in a National Park, there is expected to be some public interest. The proposed action is not an unusual or special project in the field of aquatic resource management as evidenced by its use in other National Parks and other areas of the United States. The fact that it is being done in a National Park is enough to seek a forum for public comment. The circulation of this document and the comments received concerning this project may indicate

the level of public interest in the proposed action and will be used to modify project implementation as necessary.

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## **APPENDIX**

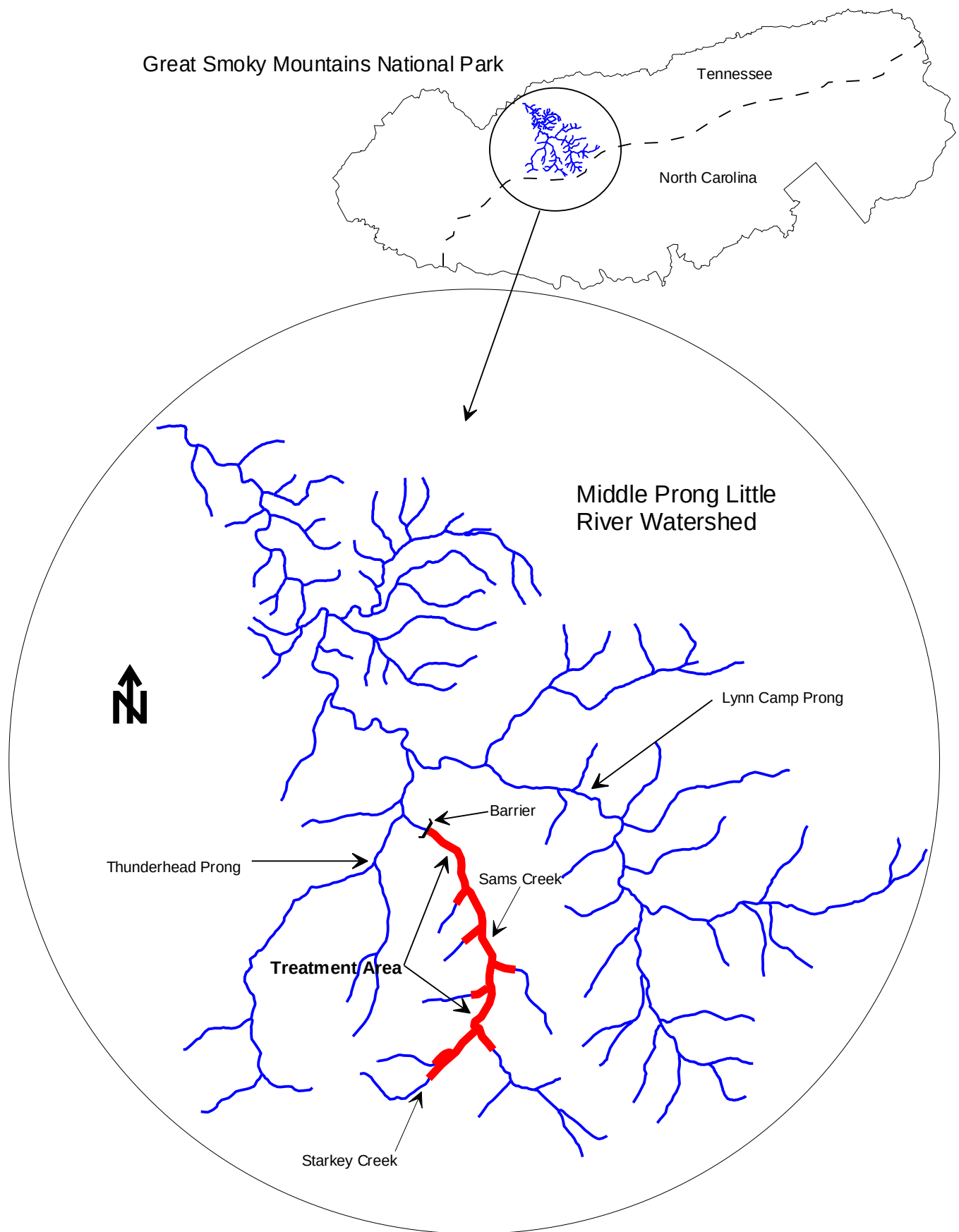


Figure 1.- Watershed map of Middle Prong Little River, Great Smoky Mountains National Park, including proposed treatment area on Sams Creek. Shaded area indicates proposed treatment area of Sams Creek.

**Table 1**

**Completed Task FY98 and 99**

- Rainbow/Brook Trout Distribution Surveys
- Annual Fish Population Surveys
- Annual Aquatic Insect Surveys (I&M) 2 sites
- Flow/Dye Retention Studies
- Aquatic insect surveys: 9 sites under our Cooperative Agreement with the University of Tennessee, including control sites upstream of the area to be chemically treated, a site in Thunderhead Prong, control sites in tributaries and sites in the reach of Sams Creek to be treated with the ichthyocide.

**Project Task FY99 - 02**

| TASK                                        | 1999 | 2000 | 2001 | 2002 |
|---------------------------------------------|------|------|------|------|
| Treatment                                   |      | X    | X*   |      |
| Dye Retention/Flow Studies                  | X    | X    |      |      |
| Fish Population surveys                     | X    | X    | X    | X    |
| Aquatic Insect/Salamander Monitoring        | X    | X    | X    | X    |
| Rainbow/Brook Trout Distribution Evaluation |      | X    | X    | X    |
| Water Quality Monitoring                    | X    | X    | X    | X    |
| Open to Angling (2 weeks)                   |      | X    |      |      |
| Move Brook Trout to Refugia                 |      | X    |      |      |
| Validation of Fish population Estimators    |      | X    |      |      |
| Progress Report                             |      | X    | X    | X    |
| Final Report                                |      |      |      | X    |

\*If necessary, for any rainbow trout found in follow-up surveys.