

TWRA Fisheries Report No. 17 - 10

# Trout Management Plan for Tennessee

## 2017 – 2027



Edited by  
James W. Habera

Tennessee Wildlife Resources Agency  
October 2017



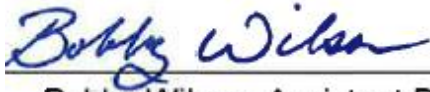
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Approved by:



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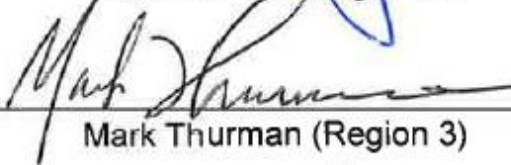
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## **Foreword**

Meeting Tennessee's trout management challenges requires that the Tennessee Wildlife Resources Agency (TWRA) have a comprehensive management plan capable of addressing current needs while also anticipating areas where future needs may arise. This document updates, where necessary, the goals, objectives, and strategies of TWRA's previous statewide trout management plan (Fiss and Habera 2006). It continues to provide guidance for the management of Tennessee's trout fisheries given the current status of wild trout resources and hatchery trout production, as well as changing trout angler preferences and attitudes and new resource management issues. It also serves as a foundation for annual management recommendations to the Tennessee Fish and Wildlife Commission (TFWC). This plan is not intended to address the management of specific streams, rivers, or other waters (e.g., by establishing or changing stocking rates or angling regulations), as this is beyond its scope.

As part of the revision process, we again asked Tennessee anglers and other stakeholders to review the updated draft plan and provide input. We received over 30 comments and recommendations from these sources, and this input (summarized at the end of the plan) was incorporated where feasible. Suggestions beyond the scope of this plan (e.g., those directed at the management of specific streams or tailwaters) were not included.

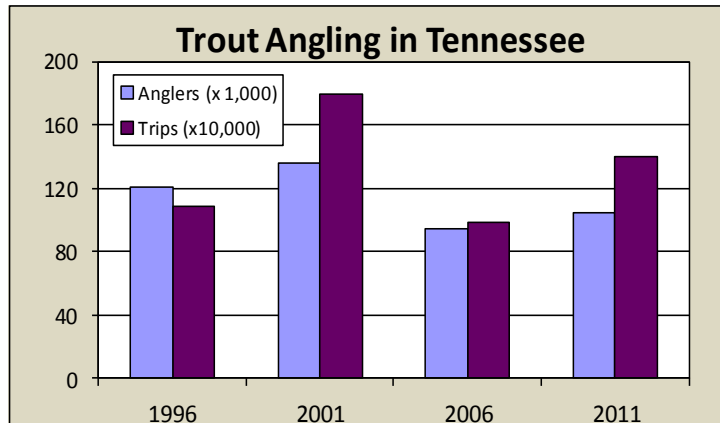
## **Acknowledgments**

The management goals, objectives, and strategies outlined in this plan were developed and refined by a committee of TWRA's coldwater fishery specialists from across the state: Jason Henegar (Assistant Chief of Fisheries), Brandon Simcox (Statewide Streams Program Coordinator), David Roddy (Statewide Hatcheries Coordinator), Jim Habera (Rivers and Streams Manager, Region 4), Will Collier (Trout Biologist, Region 3), Travis Scott (Rivers and Streams Manager, Region 3), Jim Pipas and Justin Spaulding (Fisheries Managers, Region 2), and Michael Clark (Fisheries Manager, Region 1). Additional comments were provided by other TWRA staff. We would like to thank everyone, especially Tennessee's trout anglers, for taking time to read and comment on the draft plan. Your input helped produce what we believe will be another successful plan for managing our trout fisheries.

## **Current Status**

Prior to revising existing trout management goals, objectives, and strategies, an updated review of Tennessee's trout anglers, the different trout resources available to them, and TWRA's trout management and hatchery/stocking programs was completed. Management of Tennessee's trout fisheries is a multi-faceted process that ultimately seeks to provide a variety of angling opportunities and experiences for a diversity of stakeholders.

## TROUT ANGLERS



The U.S. Fish and Wildlife Service (USFWS) conducts nationwide angler surveys every five years to track trends in recreation. Based on the most recent (2011) survey, an estimated 105,000 resident and non-resident anglers (age 16 or older) fished for trout in Tennessee (Maillett and Aiken 2015). They made an estimated 1.4 million trips and represented 15% of all Tennessee

anglers (Maillett and Aiken 2015). The estimated total expenditure associated with these trips was approximately \$53 million. Compared with the previous survey (2006), the estimated number of trout anglers increased 10%, while trips increased 40%.

TWRA also periodically collects information about resident anglers through statewide telephone surveys conducted by the University of Tennessee. The 2012 survey indicated that 104,000 of Tennessee's anglers (15%) fished for trout, making an average of 15 trips (averaging 4 hours) that year (Schexnayder et al. 2014). Most anglers (85%) reported catching Rainbow Trout *Oncorhynchus mykiss* and on the average trip, six Rainbow Trout were caught and two were harvested. Fewer anglers (44%) caught Brown Trout *Salmo trutta* and only 18% of those surveyed in 2012 reported catching a Brook Trout *Salvelinus fontinalis*. Interestingly, nearly half (47%) of trout anglers reported that they at least sometimes used flyfishing gear in 2012, while 38% did in an earlier (2003) survey. Satisfaction with TWRA's management of Tennessee's trout fisheries was 80% in 2003 and remained at 89% in 2012, while 6% were somewhat to very dissatisfied. Statistics describing average trout angler characteristics can, however, be misleading because of the specialization among these anglers. For example, Hutt and Bettoli (2003) identified five subgroups ranging from generalists to non-consumptive specialists among tailwater trout angler across Tennessee. TWRA's trout managers are aware of this diversity and strive to account for it in providing trout angling opportunities and developing management goals, objectives, and strategies.

## TROUT RESOURCES

### Wild Trout Streams

Tennessee is fortunate to have an abundant wild trout resource. A wild trout can generally be defined as having spent its entire life cycle (egg through adult) in the wild. Populations of these fish are self-sustaining and require no stocking to survive. Because wild trout have specific habitat requirements (for water temperature, flow, spawning substrate, etc.), their distribution in Tennessee is primarily limited to the eastern part of the state (TWRA's



## Wild Trout



*Rainbow (top), Brown, (center), and Brook Trout occur as wild (self-sustaining) populations in many of Tennessee's coldwater streams. Rainbow and Brown Trout are not native to Tennessee and became naturalized through stocking. Because of limited natural food supplies, wild trout tend to have relatively short life spans (~3 years) and seldom exceed 10-12 inches in size.*

Regions 3 and 4), where they inhabit over 600 miles of coldwater streams in the Blue Ridge Mountains. About 70% of this wild trout habitat is located within the 625,000-acre Cherokee National Forest (CNF). The remainder primarily occurs on privately-owned lands and includes some of Tennessee's best wild trout streams. Additionally, the Tennessee portion of Great Smoky Mountains National Park (GSMNP) in Blount, Sevier, and Cocke counties contains another 245 miles of wild trout streams managed by the National Park Service (NPS). Less than a hundred years ago, several of Tennessee's larger coldwater streams including Beaverdam Creek, Doe Creek, and Tellico River had poor water quality and habitat conditions and few produced wild trout (Shields 1950, 1951). Today, these streams, along with many others, provide excellent wild trout fisheries.

Rainbow, Brown, and Brook Trout comprise Tennessee's wild trout populations. Rainbow Trout are the most abundant and widely distributed wild trout in Tennessee. Although native to Pacific drainages of the western U.S., Rainbow Trout became naturalized in many suitable Tennessee streams through the intensive stocking efforts that defined trout management during much of the twentieth century. Brown Trout are native to Europe and Asia and, like Rainbow Trout, became naturalized in Tennessee streams through

stocking. While not as widely distributed as Rainbow or Brook Trout, Brown Trout can live longer (up to 12 years) and may attain larger sizes (up to 25 inches or more). They typically occur with Rainbow Trout, but are the predominant wild trout species in a few streams.

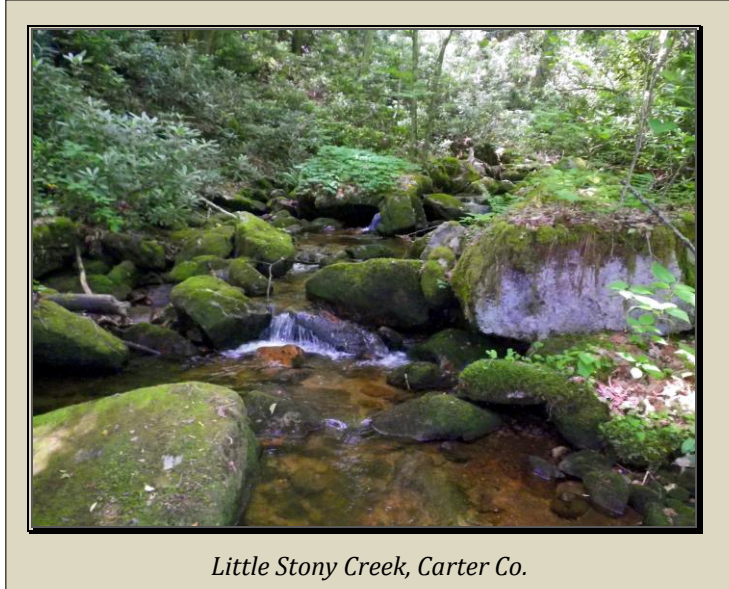
Brook Trout are Tennessee's only native trout and once occurred at elevations as low as 1,600' in some streams (King 1937). Habitat degradation (especially logging prior to the 1930s) and other land use changes, coupled with competition from introduced Rainbow and Brown Trout, caused substantial Brook Trout distribution losses during much of the previous century (King 1937; Bivens et al. 1985). Based on the most recent assessment by the Eastern Brook Trout Joint Venture (EBTJV 2016), Brook Trout are extirpated from 67 of the 118 HUC 12 subwatersheds (57%) they once occupied. Consequently, they now inhabit about 141 miles in 111 streams and one pond (at an elevation of 4,000') and represent about 25% of Tennessee's wild trout resource outside the Great Smoky Mountains National Park. Brook Trout occur allopatrically (no other trout species are present) in 40 streams totaling nearly 46 miles (32% of the resource). Another 18 streams have waterfalls or man-made barriers that maintain Brook Trout allopatry in most of the 38 miles of habitat they provide.

Recently-completed surveys (Habera et al. 2014) indicate that there has been a relatively small (~4%) overall net loss in distribution compared with previous assessment (Habera et al. 2001). Despite widespread stocking of Brook Trout over the years, genetic analyses have shown that over 60% of Tennessee's Brook Trout populations are of native, southern Appalachian heritage. The remaining populations are directly descended from hatchery-origin (stocked) Brook Trout or show introgression from hatchery fish. Through the cooperation of TWRA, the U.S. Forest Service (USFS), Trout Unlimited (TU) and others, many of Tennessee's Brook Trout populations on the CNF were renovated or enhanced during the 1980s and 1990s by constructing barriers and removing non-native Rainbow Trout. Although Brook Trout distribution losses related to Rainbow Trout encroachment appear to have stabilized for now (Strange and Habera 1998; Habera et al. 2001; Habera et al. 2014), Brook Trout populations remain subject to habitat degradation and other threats. Ongoing Brook Trout restoration and enhancement projects will help offset distribution from these and other causes.

Tennessee's wild trout streams are quite pleasing aesthetically, but most have a limited capacity for producing trout. Their extremely soft waters lack dissolved minerals (alkalinity is usually  $\leq 20$  ppm as  $\text{CaCO}_3$ ) because of the underlying geology, causing them to be naturally infertile and poorly buffered against pH changes. Food is the primary limiting factor to trout populations in these streams, particularly during the summer months when trout metabolic rates are highest (Cada et al. 1987; Ensign et al. 1990). Consequently, Tennessee's wild trout are relatively small and short-lived. Most do not exceed 10 inches or three years of age and average abundance is relatively low (20-30 lbs./acre; Habera et al. 2003). Wild trout populations throughout the southern Appalachian Mountains are similar (Habera and Strange 1993). Trout production is positively correlated with alkalinity (Kwak and Waters 1997) and increases in streams where alkalinity exceeds 40 ppm, such as those influenced by springs. The upper limit for wild trout abundance is about 100 lbs./acre in Tennessee, but can be much higher in other regions where streams are naturally more productive (Platts and McHenry 1988; Behnke 1992).



Wild trout (especially native Brook Trout) are important ecologically and because of the fisheries management opportunities they offer. Wild trout populations reflect the quality and stability of the aquatic systems they inhabit, which are linked to the quality and stability of associated terrestrial systems. Recreational fishing for trout and salmon is extremely popular throughout the United States (Epifanio 2000) and wild trout support much of this activity. Accordingly, state fisheries agencies typically consider protecting and enhancing wild trout, as



*Little Stony Creek, Carter Co.*

the most important issue addressed by their coldwater fisheries management plans (Born and Stairs 2003). Wild trout are an important component of TWRA's current strategic plan for managing Tennessee's streams and rivers and are particularly valuable as they expand the number and variety of trout fishing opportunities available to increasingly specialized anglers at very little cost. Most wild trout streams in Tennessee are currently managed with TWRA's statewide trout regulations: a daily creel limit of

seven fish, no size limit, and no gear restrictions. Special wild trout regulations with reduced creel limits and gear restrictions are in place on several streams. While these regulations were adjusted recently (in 2013) to be more biologically sound, they still function mainly to diversify angling experiences. Such regulations have little potential to affect wild trout populations given their biological limitations and typically low levels of pressure and harvest.

### Hatchery-Supported Waters

#### *Streams and Small Lakes*

Wild trout are generally limited to East Tennessee's mountain streams, but there is a wider demand for trout fishing opportunities. Managers address this demand by stocking trout in select streams across the state. These hatchery-supported streams and lakes are primarily warmwater habitats that cannot support trout year round. Some streams that support wild trout populations are also stocked, but these waters typically have low wild trout productivity or extremely high fishing pressure, like Tellico River (Monroe County). Because survival of stocked trout is usually limited by summer water temperatures, harvest of trout in these waters is generally encouraged. Regulations typically permit the harvest of seven trout per day with no size restrictions.

## *Trout and Kids' Fishing Day Events*



*TWRA sponsors or hosts dozens of Kids' Fishing Day events across Tennessee. Several are held at coldwater hatcheries (including Dale Hollow) or other locations where trout can be provided. They often provide kids with the opportunity to catch their first trout.*

Approximately 330,000, 9- to 11-inch Rainbow Trout are stocked into 84 hatchery-supported streams and small lakes in Tennessee annually. Brown Trout are also stocked in a few streams, such as Tumbling Creek and Turtletown Creek in Polk County. Stocking rates vary from 300 to 62,000 trout annually and are largely based on historical rates that reflect the amount of access, anticipated fishing pressure, and availability of trout. Most trout are harvested within a few weeks after stocking, so streams are typically stocked multiple times (on a weekly or monthly basis) throughout the season to maintain better catch rates. Most streams are stocked from March through June, while others can be stocked later into summer, depending on the individual temperature regimes.

Previous research (O'Bara and Eggleton 1995) has shown that that catch rates for three stocked Tennessee streams ranged from 1.0 to 1.9 fish/hour during the week following stocking, only 23% of the stocked trout were harvested, and that most of the unharvested fish go unused by anglers. In a larger system (Tellico River), Bates (1997) estimated that 95% of the trout stocked are harvested by anglers. Additional research to determine the minimum stocking rates that optimize angler satisfaction would be beneficial.

Many trout anglers observe that fishing is best soon after TWRA stocks and want to know the stocking schedule. Approximate stocking schedules are listed in the annual fishing guide and on the TWRA website, which also provides stocking location maps. These schedules list the week that a particular location will be stocked, with the hatchery having the option of stocking any day during that week. Although anglers would prefer to know actual stocking dates, such forecasting would not give hatchery managers sufficient operational flexibility. Announcement of stocking dates could also cause access problems along streams for hatchery personnel. Some streams (e.g., Tellico River) have set closure days that ensure adequate stream access for hatchery personnel and provide more time for fish to disperse.

Many hatchery-supported streams are located on private property, thus anglers are expected to obtain permission to fish. Landowners are generally expected to grant permission,

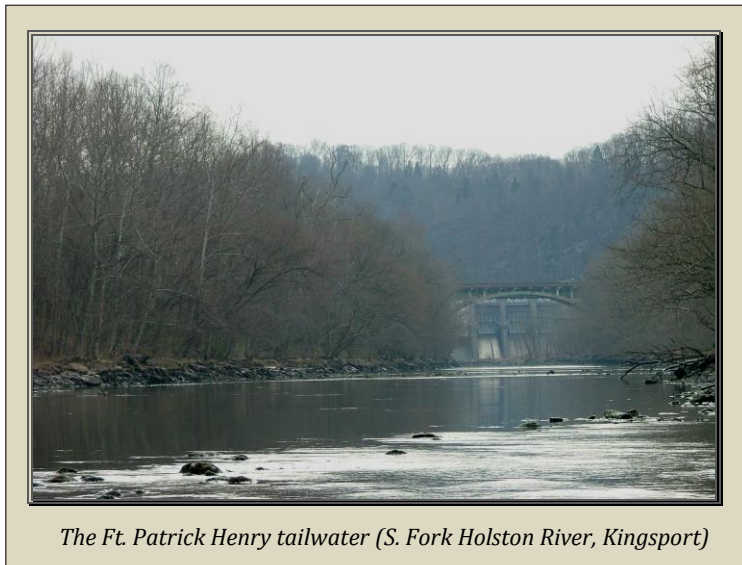
but if this is routinely denied, then that location is removed from the stocking list. Lack of access is the typical reason for removing a stream from the stocking list.

TWRA frequently receives—but rarely grants—requests to stock new waters. TWRA biologists must carefully evaluate each proposed new location to determine that the risk of damaging native fauna by stocking trout is low compared with the public benefits of establishing a new fishery. Selected locations should be large enough to support a fishery and have adequate public access and parking.

Delayed harvest (DH) areas are popular in several states and were first introduced in Tennessee in Gatlinburg (four streams) during 1997. Subsequently, TWRA also established DH areas on Paint Creek, Tellico River, Hiwassee River, and Piney River. The goal of TWRA's DH program is to provide additional fall and winter fishing opportunities with relatively few hatchery trout. This is achieved by lightly stocking streams in the fall and allowing catch-and-release angling until March, when harvest is again permitted. Bait fishing is prohibited during the catch-and-release season to improve survival of released fish. Resumption of harvest coincides with the beginning of traditional stocking season. Delayed harvest fisheries are an excellent choice for stocking larger trout, such as the retired brood fish provided by the Erwin National Fish Hatchery. These fish are quite popular with anglers but are in limited supply, thus DH fisheries permit them to be caught more than once before being harvested.

### *Tailwaters*

Cold water released from hydropower dams operated by the Tennessee Valley Authority (TVA) and the U.S. Army Corps of Engineers (USACE) have largely eliminated fish populations



*The Ft. Patrick Henry tailwater (S. Fork Holston River, Kingsport)*

that formerly occurred in the river reaches downstream. TWRA and USFWS stock trout below these dams to mitigate for the lost fisheries and TWRA is committed to creating quality trout fishing opportunities in these altered habitats. TWRA manages 12 tailwaters (totaling 127 miles) located in middle and east Tennessee. All differ in water quality, instream habitat, and potential for trout production.

Consequently, TWRA manages each tailwater differently with respect to stocking and fishing regulations. TWRA has implemented specific management plans for the Wilbur, South Holston, Norris, Center Hill, and Apalachia tailwaters (available at TWRA's website) and will develop plans for the remaining



tailwaters in the next few years. TWRA biologists survey most tailwaters annually to document trout abundance and size distributions. Additionally, TWRA conducts angler surveys on selected tailwaters each year. All this information helps TWRA optimize stocking rates,

evaluate proposed regulations, develop new management techniques, and ultimately improve tailwater trout fisheries.

## Tailwater Monitoring

*Wilbur tailwater*



*Hiwassee tailwater*



*Tennessee tailwaters offer some of the finest trout fishing experiences available anywhere. While tailwaters can present sampling challenges, TWRA monitors these important fisheries annually to ensure that management goals and objectives are being met. Periodic angler surveys are also conducted to supplement trout population data and help guide management strategies including stocking rates and angling regulations.*

TWRA, in cooperation with Dale Hollow National Fish Hatchery stocks about 1 million trout into tailwaters each year. Stocking rates, species, and sizes vary among tailwaters, but all are stocked with 9-inch Rainbow Trout (~490,000 annually). The Normandy and Ocoee tailwaters do not have cold water year-round and receive only 9-inch Rainbow Trout seasonally. The Cherokee and Appalachia tailwaters also have summer thermal bottlenecks (with water temperatures >70° F) and receive adult Rainbow and Brown Trout during the fall and spring. Fingerling Rainbow Trout are stocked (~275,000 annually) where they are capable of growing to desirable sizes and are most successful in the Norris, Wilbur, and South Holston tailwaters. Brown Trout, averaging about 7 inches, are stocked into most tailwaters, although at much lower rates than Rainbow Trout (about 250,000 annually). Significant natural reproduction by Brown Trout, occurs in the South Holston and Wilbur tailwaters, enabling TWRA to manage this species as a wild trout fishery in both tailwaters (no Brown Trout are stocked).

The Norris, Appalachia, Center Hill, Dale Hollow, and Tims Ford tailwaters are stocked with adult Brook Trout (up to 80,000 annually depending upon availability) to provide fisheries for this species that is usually found in smaller streams at higher elevations.

Creel surveys conducted since 1995 (e.g. Bettoli 1996a; Bettoli 2004; Black 2014; Black 2015) conservatively estimate that anglers make over 130,000 fishing trips to Tennessee

tailwaters each year. Angler use varies annually at each tailwater and is primarily controlled by generation schedules. Lightly- to moderately-fished tailwaters (3,000 to 10,000 trips/year) include Dale Hollow, Normandy, Tims Ford, and Cherokee. Heavily-fished tailwaters, such as Wilbur, Norris, South Holston, Apalachia, and Center Hill, typically support 20,000 to 25,000 trips per year.

Average catch rates over 0.7 fish/hour are generally considered representative of good fishing (McMichael and Kaya 1991; Wiley et al. 1993) and most of Tennessee's tailwaters exceed this standard. Creel surveys conducted since 2000 have reported catch rates varying



*Cherokee tailwater Rainbow Trout*

from 0.6 to 2.6 trout/hour. Depending on the tailwater, total catch during an average trip ranged from 2 to 12 trout, with harvest ranging from 0.2 to 3.0 trout per trip. Brown Trout represented a small percentage (10-20%) of the trout caught.

Hutt and Bettoli (2003) studied the recreational preferences of tailwater anglers in Tennessee and found that they fished 32 days per year, had nearly 16 years of trout fishing experience, and were twice as likely to use bait (68%) as artificial lures and flies (32%). They

also identified five distinct groups of anglers that fish Tennessee tailwaters. These groups are defined by anglers whose experience varies from novice to expert and who may, or may not, harvest fish. Such diversity challenges TWRA to provide something for all types of tailwater trout anglers.

TWRA uses a variety of fishing regulations to maintain or improve fishing quality and diversify angling opportunities in tailwaters. Most tailwaters are under statewide regulations that include a seven-trout creel limit with no size restrictions. Special regulation zones on the Wilbur and Apalachia tailwaters were established to maintain higher catch rates and improve fish size (Wilbur). They prohibit the use of bait and limit harvest (seasonally on Apalachia). The Wilbur quality zone also has a 14-inch minimum size limit. Protected length ranges (PLRs or "slots") are used on the Norris (14- to 20-inch), Center Hill (14- to 20-inch, Rainbow and Brook Trout) and South Holston (16- to 22-inch) tailwaters to improve trout population size structures and produce more fish in the protected ranges. Seasonal closures of spawning areas on the South Holston tailwater are also used to protect large spawning trout. More restrictive regulations for Brown Trout in the Center Hill (24-inch minimum, limit of one) and Tims Ford (20-inch minimum,



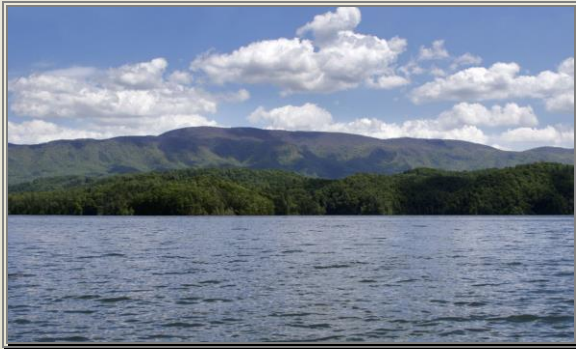
limit of one) tailwaters were recently established in an effort to increase the abundance of quality-sized fish.

Historically, many of Tennessee's tailwaters were limited by poor water quality and inadequate flows. Poor water quality reduces trout growth and survival, making higher stocking

rates necessary to maintain angler catch rates and limiting the potential for producing quality-sized fish. Installation of weirs and oxygen injection systems, establishment of minimum flows, and other efforts by TVA have greatly improved water quality below many of its dams (Scott et al. 1996), particularly South Holston, Cherokee, and Norris. Operational improvements at Center Hill Dam by the USACE have also greatly improved water quality in the Caney Fork, although further improvements there and at Dale Hollow (Obed River) would help improve these fisheries.

## *Reservoir Trout*

*South Holston Reservoir*



*Watauga Reservoir Lake Trout*



*Tennessee's reservoir trout fisheries are not as well-known or utilized as those that often occur in the downstream tailwaters. However, they provide alternative trout angling opportunities, especially for large fish. Additionally, South Holston and Watauga reservoirs now have excellent lake trout fisheries. Consistent evaluations of population status and angler use would permit refinement of stocking programs (e.g., species, rates, sizes, and timing) and other management strategies.*

### *Reservoirs*

Stocking trout in reservoirs diversifies angling opportunities in these waters. Only reservoirs that maintain a year-round supply of cold, well-oxygenated water can support trout fisheries. Tennessee has nine reservoirs that currently support trout fisheries: Dale Hollow, Parksville, South Holston, Wilbur, Watauga, Fort Patrick Henry, Calderwood, Chilhowee, and Tellico (~62,400 acres total). Some reservoir trout attempt to spawn in tributaries, but these attempts are largely unsuccessful and stocking is required to maintain reservoir fisheries. Trout are stocked during the winter to assure that surface

water temperatures are cold enough for their survival. Stocking later in winter (March vs. January) can help decrease mortality due to predation, especially by Walleye *Sander vitreus*

(Ivasauskas and Bettoli 2010). Approximately 215,000 9-inch Rainbow Trout are stocked into Tennessee reservoirs annually. Lake Trout (*S. namaycush*) are stocked in Watauga, South Holston, and Chilhowee reservoirs (about 150,000 6-inch fish annually) and provide a unique opportunity not only for Tennessee anglers, but for those throughout the Southeast as well. Russell and Bettoli (2011) found that annual Lake Trout growth rates in Watauga and South



*VDGIF stocking trout in South Holston Reservoir*

Holston were high enough to suggest that neither system was being overstocked. Brown Trout are currently stocked in Watauga and South Holston reservoirs (25,000 trout/ reservoir) to create new fisheries, but there is little information regarding angler success for this species. The timing of Brown Trout production yields a 6-inch Brown Trout for winter stocking, and these smaller trout may be more vulnerable to predation compared to the 9-inch Rainbow Trout that seem to have

better survival. South Holston and Calderwood lakes border Virginia and North Carolina, respectively, thus the Virginia Department of Game and Inland Fisheries (VDGIF) and North Carolina Wildlife Resources Commission partner with TWRA to cooperatively manage these waters by stocking a portion of the trout each receives annually.

Most successful anglers catch trout in reservoirs by targeting them during summer when they are limited to deep-water habitat. Anglers commonly troll lures with downriggers or fish bait suspended in deep water (often at night). Length restrictions are impractical for managing reservoir trout fisheries during the summer because warm surface temperatures can increase the mortality of released fish. Catch rates are typically low on reservoirs (<0.25 trout/hour, Bettoli 1996b; Malvestuto and Black 2003), although Calderwood produced catch rates of up to 0.6 trout/hour in 1999 (Yow et al. 2002) and Hyman et al. (2016) reported 0.74 trout/hour for Virginia lakes. Where creel surveys have been conducted, the number of trout harvested in reservoirs is also typically very low (<10%) relative to the number stocked.

Despite low return rates and relatively low use by anglers, TWRA managers continue to support a reservoir trout program because of its potential to provide unique fisheries that could be enhanced with better information. For example, Bergthold and Bettoli (2009) found that Rainbow Trout switched to piscivory at about 10 inches in length and fed almost exclusively on alewives *Alosa pseudoharengus* in Dale Hollow, South Holston, and Watauga reservoirs. Therefore, stocking Rainbow Trout at larger sizes each winter (>10 inches) would enable them to begin feeding on alewives immediately, thus promoting faster growth earlier in the year, reduced predation, and improved return rates to the creel.

## Winter Trout Program

This program provides trout angling opportunity during the winter months, particularly where there are few or no other trout fisheries. Whereas the DH program is intended for more

experienced anglers, the winter trout program is designed to recruit new anglers, especially from urban areas. Winter trout events are typically located near town centers on public property with ample parking. Stocking dates are published well in advance of each event and higher stocking rates are used to assure high catch rates. Additional trout that permitted development of this program were made available through innovative production techniques at Flintville Hatchery and Dale Hollow National Fish Hatchery.

### Winter Trout

*Winter trout stocking, Cumberland Mountain State Park*



*Winter trout anglers, J. Percy Priest tailwater, Nashville*



*The popular winter trout program has grown to include 40 locations across the state since 1999. Its goal is to provide trout angling opportunities (with higher catch rates) where these are limited, especially in urban areas in Regions 1, 2, and 3.*

The winter trout program began in December 1999 at J. Percy Priest tailwater in Nashville. Its immediate popularity was documented by a creel survey that estimated 779 trips during a 17-day period and by a substantial increase in local trout license sales. The program now includes 40 locations from Memphis to Chattanooga, with 14 of these added since 2006. Over 93,000 trout were stocked during the 2015-16 season. TWRA receives requests annually to further expand the winter trout program, but growth is limited by hatchery production, which is now at capacity. Stocking rates

have not been evaluated, so expansion may be possible by optimizing stocking rates at existing locations. An evaluation of the winter program (including stocking rates) is currently being developed given the additional fish it could potentially require in future years.



### Private Trout Fisheries

Private trout fisheries are ponds or streams where all access is privately controlled and landowners may charge the public a fee to fish. These operations typically use feeding stations

to keep fish from leaving the area and to produce larger trout. While some utilize existing wild trout populations, most rely entirely or largely on stocked trout to maintain fisheries. Currently, only a few private trout fisheries are known in Tennessee, but many more are managed for personal use and are not publicized. TWRA's angler recognition program (TARP) has documented that some of these streams routinely produce trophy trout.

Privately-managed trout waters have the potential to provide unique fishing opportunities for anglers that are willing to pay for the experience, but there are risks. The primary concern is that a potentially harmful species of fish would be introduced, or that a disease, parasite or some other exotic organism could be released with trout from uncertified sources, as has recently happened with whirling disease *Myxobolus cerebralis* and possibly gill lice *Salmincola edwardsii* in North Carolina. The spread of exotic species has been recognized as a major threat to aquatic ecosystems (Simon and Townsend 2003; Dunham et al. 2004). TWRA uses disease-free

eggs and monitors its hatchery for pathogens regularly to reduce this risk. Currently, it is illegal to stock streams without TWRA's approval. Landowners wanting to establish private fisheries in

### Biosecurity Risks

*A wild Brook Trout infected with gill lice (photo courtesy of J. Rash, NC Wildlife Resources Commission)*



*Cranial deformity in a Rainbow Trout with whirling disease (photo courtesy of Dr. S. A. Bullard, Auburn Univ.)*



*Unregulated trout stocking carries the risk of introducing harmful parasites and diseases such as gill lice (above) and whirling disease (below).*

streams must obtain permission from TWRA to release fish. This is necessary because the risk of harmful introductions is high relative to the potential public benefit. While this approval process provides TWRA with a means for controlling the establishment of private trout fisheries in streams, it is only effective if the public is aware of it and complies.

Further development of private trout fisheries will establish a market for fishing opportunity (much as it has for deer hunting opportunity). Once a price is set, other landowners may be less willing to allow “free” fishing. This could impact many anglers because most trout fishing outside of federal lands occurs on privately-owned land. However, landowners may also value their aquatic resources more, making them stronger advocates for healthy streams.

## TWRA TROUT PROGRAM and FACILITIES

### Management Budget and Personnel

License fees and Tennessee’s share of federal funding pay for trout production and stocking, management, research, and enforcement of fishing and water quality regulations. Most of TWRA’s trout program budget funds hatchery production and stocking (~\$1.1 million

### *Trout Stream Monitoring*



*Regional trout management teams monitor trout populations in selected streams, often in cooperation with partner agencies (e.g., the USFS, NPS, USFS, and TVA) and stakeholder groups (e.g., TU). These efforts provide abundance trend and other information that is necessary for interpreting responses to both environmental conditions (droughts and floods) and management actions (e.g., new angling regulations, Brook Trout restorations, etc.).*

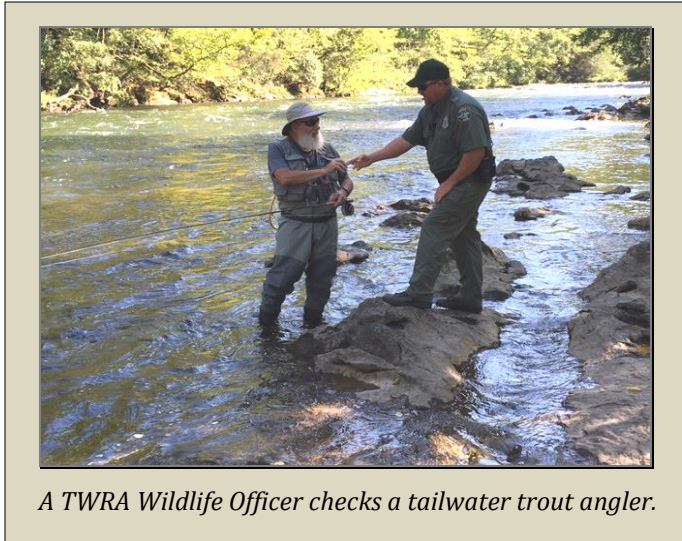
annually). There are 3 to 4 stream management positions in each of TWRA’s four regions and a streams program coordinator in the Fisheries Management Division (Nashville). These personnel may assist with multiple TWRA programs, but primarily work with the trout and warmwater stream programs. The resources dedicated to trout management vary from region to region in proportion to the number of trout fisheries being managed. Because producing and stocking fish are integral parts of TWRA’s trout management efforts, trout fisheries currently consume, mile for mile, more agency resources than typical stream bass (*Micropterus* spp.) fisheries.

The regional trout management teams are responsible for monitoring trout populations and habitat,



recommending regulations and stocking rates, and reviewing requests for new stocking locations (including private fisheries). They also communicate with anglers in various forums to share information and stay informed of local issues. The regional trout management teams provide expertise at the local level, while the streams program coordinator provides guidance and support for the regional teams, directs research, prepares strategic plans and reports, and maintains statewide fisheries databases.

County Wildlife Officers schedule a portion of their time to enforce trout fishing regulations and water safety. For example, Region 4 Wildlife Officers worked 613 hours during



*A TWRA Wildlife Officer checks a tailwater trout angler.*

March-June 2016 to check 2,048 trout anglers in nine counties and reported a 95% compliance rate (both overall and for tailwaters separately). Maintaining a high level of compliance with trout angling regulations helps optimize the effectiveness of all management strategies. When warranted, several officers may cooperate to perform special details designed to monitor compliance. These operations are often covert and not visible to the public. Trout anglers highly value enforcement activity, and TWRA frequently receives

requests for additional enforcement on trout streams (especially hatchery-supported streams and tailwaters). Wildlife Officers also play an important role in communication between anglers and TWRA, and may help stock trout and monitor trout populations.

TWRA trout hatcheries currently have 16 full-time employees that are responsible for the production and delivery of trout according to the schedule developed by the management teams. With over 50,000 people visiting TWRA hatcheries each year (Roddy 2016), hatchery staff also have a major role in educating the public about the trout program (and other agency programs). They often assist the regional trout management teams with population assessments and other stream management efforts. They also host, staff, and provide trout for several Kids' Fishing Day events.


Angler survey technicians (two to four per region) also provide important information to the regional trout management teams. They collect angler use and preference data from selected stream and tailwater trout fisheries each year and may assist with various sampling, monitoring, and restoration efforts. These technicians are also an important point of contact with the public and therefore represent another avenue for outreach and education regarding Agency programs (especially trout).

## Hatcheries


TWRA operates four trout hatcheries—Buffalo Springs, Erwin, Tellico, and Flintville—which together provided approximately 264,000 pounds of trout (~606,000 fish) at a cost of

### *TWRA Hatcheries*

*Erwin*



*Flintville*



*TWRA's four coldwater hatcheries provide about 800,000 Rainbow Trout annually to the trout program. Most of these are 10-12 in. fish used in various stocking programs. Improvements at these facilities during the past 10 years (e.g., raceway renovations, liquid oxygen aerations systems, and effluent collection ponds) have helped maintain and slightly improve production, but they are currently operating at capacity.*

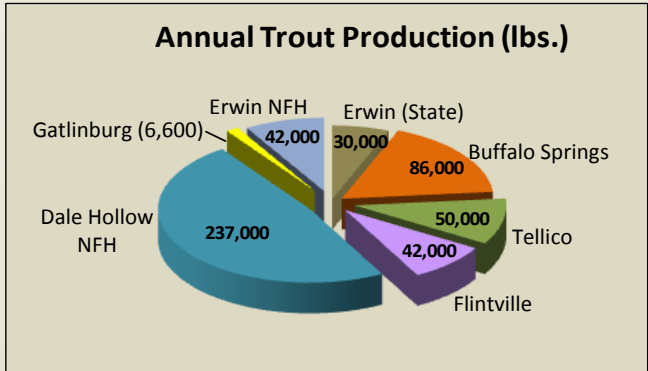
~\$1.2 million for the trout program in 2016. An additional 1.55 million trout (293,000 pounds) were provided in 2016 by Dale Hollow National Fish Hatchery (DHNFH), which is operated by the USFWS. The Erwin National Fish Hatchery (ENFH)—a USFWS egg production facility—also provides retired brood fish (12-18 inch Rainbow Trout) for several fisheries (37,000 pounds in 2016). Relatively minor roles are played in the trout program by TWRA's Humboldt Hatchery (a warmwater facility) and the City of Gatlinburg's small hatchery. Humboldt helps provide about 5,000 fish annually for the winter trout program in Region 1, while Gatlinburg produces about 10,000 pounds of Rainbow Trout annually for a few streams within the city that provide fisheries for local anglers as well as the area's many tourists. Gatlinburg acquires its start-up fingerlings from Buffalo Springs, which are then grown to stocking size.

Buffalo Springs Hatchery receives eggs from disease-free sources, such as ENFH, incubates and hatches the eggs, and rears trout to various sizes up to 11 inches. Buffalo Springs supplies Erwin State Fish Hatchery with fingerling (5-inch) Rainbow Trout as their starter fish.

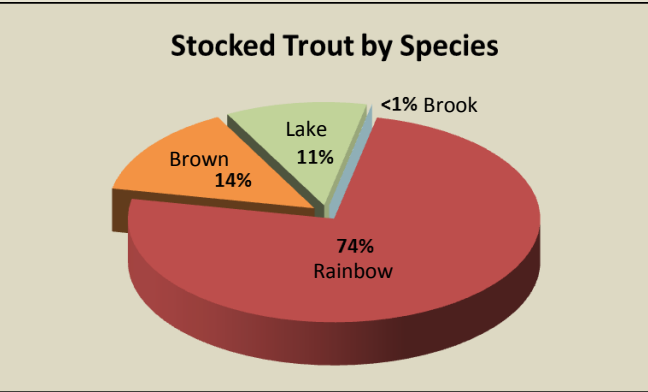
Similarly, Buffalo Springs provides 6-inch Rainbow Trout to the City of Gatlinburg's hatchery to be grown out and stocked in Gatlinburg streams. The bulk of Buffalo Springs' production supplies trout for hatchery-supported streams, reservoirs, and tailwaters in east Tennessee.

## The Stocking Program

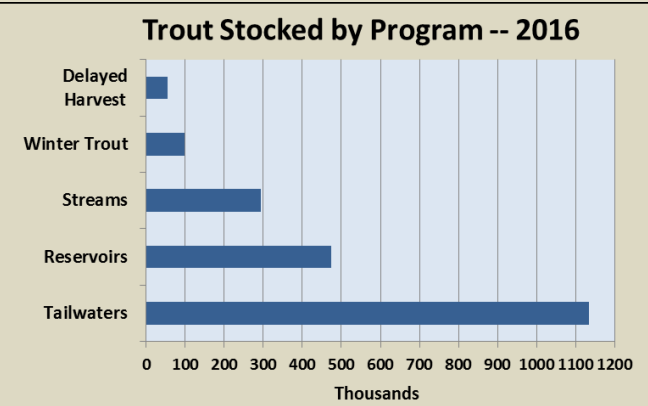
**Annual Trout Production (lbs.)**



**Stocked Trout by Species**



**Trout Stocked by Program -- 2016**



*Annual production, species composition, and distribution of trout used in Tennessee's hatchery-supported fisheries. Over half a million pounds of trout from all sources (about 2 million fish) were stocked in Tennessee waters in 2016. Most of these support tailwater fisheries.*

One driver on Buffalo Springs' staff is dedicated to transporting trout from DNHFH to Tellico Hatchery and east Tennessee reservoirs and tailwaters.

Erwin State Hatchery rarely handles eggs, relying instead on 4-5 inch starter fish from Buffalo Springs Hatchery. Most fish reared at Erwin are 10-inch Rainbow Trout to be stocked primarily in about 20 hatchery-supported streams in upper east Tennessee during March through June.

Tellico Hatchery receives 8-9 inch Rainbow Trout from DNHFH, which are then grown to 10-12 inches and stocked frequently into the Tellico River, Citico Creek, and Green Cove Pond. This intense management requires additional fees to support the program and a special Tellico-Citico permit is required to fish these waters. Several Polk County streams are also stocked with trout from Tellico Hatchery. Additionally, native, southern Appalachian Brook Trout are spawned and reared in a special facility at Tellico for nearby Sycamore Creek and various other restoration projects.

Flintville Hatchery was established in 1933 and is Tennessee's oldest trout hatchery.

This hatchery grows Kamloops-strain Rainbow Trout from eggs to a variety of sizes for waters in middle Tennessee. Flintville's trout are primarily stocked in hatchery-supported streams and winter trout program locations, as well as a few tailwaters.



## *DHNFH's Contribution*

*Dale Hollow National Fish Hatchery, Celina*



*The Hiwassee tailwater receiving DHNFH trout*



*DHNFH produces over half of the trout stocked in Tennessee annually, including all \*Brown, Brook, and Lake Trout. Most of these are stocked in TVA and USACE tailwaters. TWRA funded expansion of this hatchery in 1992 and under a contract in place since 1994, receives 100,000 lbs. of trout annually for \$100,000. (\*Except for South Holston Reservoir)*

Tennessee continues to rely heavily on trout from DHNFH to support fisheries in tailwaters and reservoirs, and to supply trout to Tellico Hatchery. DHNFH provided 293,000 pounds of trout (1.55 million fish) in 2016 to mitigate for fisheries that were permanently lost due to the construction and operation of Tennessee Valley Authority (TVA) and U.S. Army Corps of Engineers (USACE) dams. All Brown Trout, Brook Trout, and Lake Trout stocked in Tennessee are from DHNFH (except for Brown Trout stocked in South Holston Reservoir by VDGIF). Its production is currently at capacity. Recently, the USFWS was directed by Congress to seek reimbursement for trout production costs at hatcheries across the nation—raising uncertainty about future trout production at DHNFH and ENFH. However, a long-term multi-agency funding agreement (including USFWS, TVA, and USACE) was reached in 2015 ensuring that these facilities will continue to provide trout for Tennessee anglers.

Erwin National Fish Hatchery is one of several USFWS facilities that provide a source of disease-free Rainbow Trout eggs for federal and state fish hatcheries. Trout are raised to maturity ( $\geq 2$  years) at ENFH and used to produce fertilized eggs for

shipment around the country. Broodstock that are no longer useful for egg production are stocked in several streams and other locations, particularly in east Tennessee. These large fish (12-18 inches) are popular with anglers and are particularly good choices for supplementing fisheries where capture rates are high or where they can be caught more than once before harvest (e.g., DH streams).

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*The Results...  
Successful Anglers!*



*Whether it's through a new state record Brook Trout (above) or just another nice Rainbow Trout (below), TWRA's strives to produce successful, satisfied anglers through its trout program while ensuring the integrity of other aquatic resources.*

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Trout production at TWRA's hatcheries increased about 10% during the past decade (from 250,000 lbs. in 2005; Fiss and Habera 2006), largely as a result of improvements at Flintville, Buffalo Springs, and Erwin. These included major raceway renovations at Flintville and installation of liquid oxygen aeration systems and effluent collection ponds at Erwin and Buffalo Springs. The new effluent management system at Buffalo Springs permitted eight raceways to be placed back into production.

Further hatchery improvements, such as low-head oxygenators (Tellico), or the consistent use of higher-quality feeds (e.g., from Bio-Oregon) may marginally improve total trout production, but it will likely remain 40,000 lbs. or more below what would be needed for optimizing TWRA's stocking programs and meeting future needs. These may include fish for additional winter program and DH sites, as well as more large trout similar to the retired broodstock from ENFH. TWRA would like to build a new hatchery, but this would cost about \$18 million and—assuming funding becomes available—require several years to complete. Consequently, this management plan identifies uses for additional trout, but does not rely on a new source to solve existing supply limitations.

Tennessee's abundant trout resources (wild and hatchery-supported), together with TWRA's management

program goals and objectives, continue to provide a diversity of opportunities for resident and visiting anglers to catch trout across the State. Through this management plan, the Agency seeks to maintain and, where possible, expand or enhance these opportunities while protecting the integrity of Tennessee's other aquatic resources.



## Mission Statement

The mission of TWRA's trout program is to:

***“Provide a variety of quality trout angling opportunities that are compatible with Tennessee's other aquatic resources.”***

## Management Goals

### BIOSECURITY

#### ***GOAL 1. Proactively address threats from introduced species and pathogens.***

**Objective:** Avoid or minimize impacts to Tennessee's trout fisheries caused by introduced exotic species and pathogens.

**Problems:** The introduction and spread of invasive exotic species and pathogens such as whirling disease *Myxobolus cerebralis*, gill lice *Salmincola edwardsii*, New Zealand mud snails *Potamopyrgus antipodarum*, and *Didymosphenia geminata* (“*Didymo*”) could potentially damage some trout fisheries. *Didymo*, a diatom (single-celled algae) that can form extensive mats on river bottoms, is well-established in the South Holston, Wilbur, Norris, and Cherokee tailwaters and has been observed in the Dale Hollow tailwater (Murdock et al. 2016). High *Didymo* mat coverage (>50%) can alter what macroinvertebrates and trout consume in these tailwaters (Murdock and Knorp 2016). Whirling disease (WD) is present in Virginia, while both WD and gill lice (ectoparasitic copepods) are present in the Watauga River watershed in NC—posing a risk to Tennessee trout fisheries such as Watauga Reservoir, Wilbur and South Holston tailwaters, and wild trout stream tributaries to these. Mitro (2016) found that gill lice epizootics under stressful environmental (drought) conditions can severely reduce age-0 Brook Trout recruitment and potentially lead to population loss. Many anglers may still be unaware of these threats or how they can help prevent their spread.

#### **Strategies:**

1. Educate anglers and the public at large about exotic species and pathogens that threaten Tennessee trout fisheries and how their spread can be controlled. Use news releases, the Agency website and social media pages, *Tennessee Wildlife* magazine, stakeholder meetings (e.g., Trout Unlimited), Trout in the Classroom projects, and other outreach formats to accomplish this task. Provide periodic updates regarding the status of any existing invasions and means for controlling them.
2. Maintain communication/cooperation with other agencies (particularly the North Carolina Wildlife Resources Commission) and anglers to quickly identify any new threats or invasions. Encourage anglers to report trout with abnormalities (e.g., cranial deformities) that may indicate WD or other fish health issues.

3. Periodically conduct screening for the presence and distribution of WD (Wilbur and South Holston tailwaters; wild trout streams in the Watauga River watershed) and gill lice (wild Brook Trout populations, particularly in the Watauga River watershed).
4. Develop a basic framework or guidelines for responding to the detection of a new aquatic disease, parasite, or invasive species.
5. Continue to provide periodic Hazard Analysis and Critical Control Points (HACCP) training for coldwater hatchery personnel and implement existing biosecurity plans.
6. Construct and deploy (with assistance from interested stakeholder groups) wader decontamination stations at selected trout waters, fly shops, and guide services, to help control the spread of *Didymo* and other aquatic nuisance species and educate anglers about their potential harmful effects.

**GOAL 2. *Integrate trout management and native aquatic ecosystem protection.***

**Objective:** Minimize potential impacts of trout stocking on native aquatic ecosystems.

**Problems:** There is a continual demand to stock more streams with trout. TWRA routinely receives requests to stock trout at new locations and landowners often seek permission to stock their own streams with trout purchased from private producers. These requests must be weighed against potential risks to native aquatic ecosystem biodiversity and existing trout fisheries. Generally, hatchery-produced trout are poor competitors in natural stream settings and have minimal impacts on native fish assemblages (Weaver and Kwak 2013). However, they may have serious ecological effects in some locations (e.g., where sensitive aquatic fauna are present or where native Brook Trout may be displaced). Hatchery trout—especially from private facilities—also carry the risk of introducing diseases and pathogens at every stocking event. Additionally, some streams are stocked without TWRA’s authorization, which bypasses the Agency’s ability to assure that fish are disease free and appropriate for a particular location. Landowners and anglers may, in many cases, be unaware that such stocking is illegal.

**Strategies:**

1. Thoroughly evaluate all candidate stocking locations to identify potential impacts on native fauna in consultation with:
  - The USFWS in cases where federally listed species may be present.
  - The Tennessee Department of Environment and Conservation (TDEC), Division of Natural Heritage where locations in State Natural Areas are involved or in cases where state listed species may be present.
  - State Park managers where locations in State Parks are involved.

2. Stock hatchery trout only at locations where the expected benefit to anglers is substantially high and potential impacts from introducing exotic species and non-endemic pathogens is extremely low. Do not stock trout in new locations from which they are likely to enter areas where reproduction could occur and undesired permanent populations could be established.
3. Work with Tennessee's private fish culture facilities to help ensure that they are providing only fish that are free of potentially problematic diseases. Also seek assistance from these facilities to increase their customers' awareness that TWRA's authorization is required before trout can be stocked in any privately-owned stream.
4. Publicize the restriction against stocking streams by the general public (and why this is important) through various outlets such as the Agency website and magazine.
5. Require that stocking records (including fish sources) be submitted to TWRA annually in cases where permission has been granted for stocking trout in private streams.

## **HABITAT PROTECTION**

### ***GOAL 1. Protect wild trout waters from habitat degradation.***

**Objective:** Work with appropriate agencies and partners to prevent the loss of wild trout populations to habitat degradation, limit impacts on wild trout where some habitat degradation is unavoidable, and identify/restore critical habitats that have been degraded.

**Problems:** Land use changes, water withdrawals, road construction, and other development-related activities threaten or have already impacted wild trout habitat. Such threats will become increasingly significant in the presence of any effects on stream temperatures and flows induced by climate change. TDEC regards all waters supporting wild trout as "Exceptional Tennessee Waters" (TDEC 2015), yet several (including some tailwater reaches) still do not have the appropriate usage classification.

#### **Strategies:**

1. Work with landowners, TWRA's Environmental Services Division, and TDEC to provide guidance and minimize impacts where land-use activities potentially affect wild trout habitat. Verify compliance with Clean Water Act (Section 404) dredge and fill permits and Aquatic Resource Alteration Permits where these are required.
2. Promote the use of Best Management Practices (BMPs) in watersheds where soil-disturbing activities may impact wild trout habitat. Publicize the benefits of improved water/habitat quality by publishing success stories in various media outlets showing how whole communities benefit, not just fish and anglers.

3. Ensure that all waters supporting wild trout (especially Brook Trout) are subject to TDEC water quality standards (Chapter 0400-40-03; TDEC 2015) and usage classifications (Chapter 0400-40-04; TDEC 2013) designed to protect wild trout. TWRA and TDEC reviewed and updated trout stream designations in 2010, resulting in 82 streams in Region 4 being upgraded to the naturally-reproducing trout stream classification; however, some wild trout waters still lack this designation.
4. Continue to maintain current information on TWRA's website regarding all state and federal grants and programs available to landowners for protecting and improving stream riparian zones, water quality, and trout habitat.
5. Begin a summer/fall temperature monitoring program in a range of wild trout streams to document potential impacts related to climate change and prioritize management efforts (e.g., riparian habitat protection, improvement and restoration; Brook Trout restoration; etc.).

## ***GOAL 2. Optimize habitat quality in trout tailwaters.***

**Objective:** Tailwaters managed for trout should meet appropriate state water quality standards (e.g., dissolved oxygen and temperature) and provide flows that benefit the existing trout fisheries.

**Problems:** Because of basic water quality and habitat alterations associated with the operation of hydroelectric facilities, cold tailwaters typically appear on TDEC's 303(d) list of impaired streams (TDEC 2016). However, seasonally low dissolved oxygen levels, extended periods of low flow (and elevated temperatures) during droughts, and other conditions can periodically impact trout fisheries in some tailwaters.

### **Strategies:**

1. Request that TDEC strictly enforce water quality standards in trout tailwaters and their tributaries.
2. Continue to support TVA's Reservoir Operation Study (ROS) initiatives to improve water and habitat quality below hydroelectric projects.
3. Continue to work with TVA and USACE to maintain water quality improvements that have been made in trout tailwaters, resolve periodic water quality and flow issues that may arise, and monitor situations that may affect water quality in tailwaters (e.g., the extended Boone Lake drawdown). Cooperation between TWRA and TVA was instrumental during June and July of 2011 and 2014 in addressing increased temperatures in the lower portion of the South Holston tailwater resulting from extended periods of minimum flow (90 cfs) releases.

4. Utilize the Agency I&E division to educate the public regarding any ongoing or new water quality deficiencies in trout tailwaters.

## HATCHERY-SUPPORTED FISHERIES

### *GOAL 1. Optimize use of hatchery trout.*

**Objective:** Ensure that all hatchery-produced trout are used efficiently and effectively within designated programs. This has recently been accomplished in tailwater fisheries by optimizing fingerling Rainbow Trout stocking rates—reducing them where possible and eliminating them where recruitment is negligible, by eliminating Brown Trout stocking where natural reproduction is adequate, and by discontinuing Brook Trout stocking where it has proven ineffective.

**Problems:** There is a limited supply of hatchery trout and many waters are being stocked at traditional rates that have not been rigorously evaluated. Some fisheries inherently require more trout than others, but there may also be opportunities to reduce the number of trout stocked (or eliminate stocking) without impacting angler benefits. Hyman et al. (2016) correlated angler catch rates with stocking density, time after stocking, and angler satisfaction and suggested that agencies often could reduce stocking densities and frequencies with little effect on angler satisfaction. Additionally, length of fish caught can have a more important effect on angler satisfaction than catch rate (McCormick and Porter 2014; see Goal 3 below). A few other privately-owned or controlled waters have also traditionally been supported with some hatchery trout.

### Strategies

1. Emphasize wild trout management where feasible. Hatchery trout are most effectively used to provide fisheries where wild trout are unsustainable. Shifts to wild trout management have recently been accomplished with Brown Trout in the South Holston and Wilbur tailwaters. Hatchery fish continue to be stocked in some wild trout streams based largely on historic demand. These streams should be re-evaluated and, where possible, stocking should be curtailed or eliminated in favor of wild trout management. Where wild trout cannot support angling pressure, strategies for enhancing abundance (e.g., improving habitat or reducing harvest) should be considered.
2. Avoid excessive stocking rates by determining the minimum number of trout that can be stocked while still providing good fishing. This has been addressed on some tailwaters (e.g., South Holston and Wilbur), but more work (e.g., research, angler use surveys, or trial and error) is needed on other hatchery-supported waters (e.g., reservoirs and winter trout program fisheries) to determine optimum stocking rates.



3. When considering new fisheries (or changes to management of existing fisheries), emphasize the use of fewer hatchery trout. For example, DH areas are popular with anglers and can be sustained with relatively few hatchery trout.
4. Select ponds or small lakes rather than streams for new winter trout program events to reduce the number of fish needed and maximize benefits from those that are stocked. High stream flows (common during the winter season) preclude fishing and can displace stocked trout, thereby limiting their utilization in these locations.
5. Develop tailwater trout fisheries management plans where these are currently lacking (e.g., Cherokee, Ft. Patrick Henry, and Boone) in accordance with TWRA's Strategic Plan (TWRA 2014); include objectives for optimizing stocking rates based on monitoring data and angler use/harvest information.
6. Work with ENFH personnel to incorporate retired brood fish produced by that facility into the annual allocation process; prioritize DH areas, kids' fishing events, and locations where higher return rates would be expected. Avoid tailwaters and reservoirs where return rates would be much lower, large fish are typically already present, and special regulations may apply.
7. Discontinue providing trout for private fisheries unless public access is permitted.
8. Evaluate existing hatchery-supported streams to determine if current use warrants continued stocking; discontinue stocking if it does not.
9. Encourage ENFH and DHNFH to consider Rainbow Trout strains that may perform better in warmer environments (e.g., the Cherokee and Apalachia tailwaters) if they become available. Recent research (Verhille et al. 2016; Hartman and Porto 2014) indicates that there are notable thermal performance differences among Rainbow Trout strains and that selective breeding may yield stock with improved tolerance and growth at warmer temperatures.

***GOAL 2. Produce more trout at TWRA facilities for hatchery-supported fisheries.***

**Objective:** Produce an additional 40,000 pounds of trout annually.

**Problem:** There has been only a modest (10%) increase in trout production at TWRA hatcheries since 2005 and these facilities are now operating at capacity. Additional trout (especially larger fish) could enhance some existing fisheries, expand the winter trout program, and permit development of more fishing events for kids and physically-limited anglers.

**Strategies:**

1. Maintain existing production at TWRA's trout hatcheries and increase where possible through additional infrastructure upgrades (e.g., low-head oxygenators at Tellico) and

other means, including consistent use of high-quality feeds and wider employment of circular production tanks (now in use at Flintville).

2. Purchase trout as needed from private sources (certified to be disease free in accordance with BIOSECURITY Goal 2) to supplement TWRA production.
3. Build a new trout hatchery to substantially increase annual production (~40,000 pounds).

### ***GOAL 3. Improve the quality of stocked trout.***

**Objective:** Improve the appearance of all adult Rainbow Trout stocked from TWRA hatcheries and use at least 10-inch fish in all programs. TWRA hatcheries met this minimum size objective for 96% of all adult Rainbow Trout stocking events (4,259) during 2011-2016—the last six years of the previous management plan term. This represents an improvement over the 10 years prior to 2011 (94%), although the number of events involving trout under the 10-inch minimum can be further reduced.

**Problems:** Adult Rainbow Trout have poor survival rates in most hatchery-supported waters, thus they do not have the opportunity to grow larger after stocking. Anglers obviously prefer to catch larger trout, thus TWRA should strive to stock fish that are at least 10 inches long provided appearance is not degraded. Stocking smaller fish or combining them with 10-inch trout can detract from an angler's fishing experience. The appearance of stocked fish can also be a problem (e.g., eroded and missing fins) if overcrowding occurs in hatchery raceways. Limiting the number of low quality "finless" trout would be appreciated by anglers.

#### **Strategies:**

1. Do not stock fish that are short of the desired length. If some portion of the lot to be stocked is below the 10-inch target length, do not stock the short fish. It would be better to stock fewer fish than scheduled but provide a better product.
2. Dedicate a portion of hatchery production to large trout ( $\geq 14$  inches) to be included in selected hatchery-supported fisheries (see also ANGLING OPPORTUNITIES Goal 1, Strategy 5.). The 2012 statewide angler survey (Schexnayder et al. 2014) indicated that a majority (55-57%) of trout anglers would be willing to pay 5-20\$ more for the opportunity to catch larger (14-inch and 16-inch) stocked trout. Flintville Hatchery is currently including two to four 15-18" Rainbow Trout with each winter stocking event.
3. Identify stocking events in DH areas, kids' events, and selected hatchery-supported streams that would benefit from the inclusion of some larger ( $\geq 14$  inch) trout (e.g., ENFH surplus brood fish) in the allocation.
4. Avoid overcrowding trout in hatchery raceways to minimize fin erosion/loss and enhance the appearance of stocked trout.

**GOAL 4. Enhance reservoir trout fisheries.**

**Objective:** Acquire information necessary to better-manage reservoir trout fisheries and promote these fisheries to anglers.

**Problems:** Tennessee's reservoir trout fisheries are second only to tailwaters in terms of trout stocked, yet they likely have not achieved their full potential within the trout program, particularly with respect to angler utilization. More complete information regarding reservoir trout fisheries would enable TWRA to manage them more effectively and promote them to anglers, especially their ability to produce large fish. Recent research has shown that growth and survival of Rainbow Trout stocked in reservoirs can be improved by stocking larger fish (>10 inches) later in winter (February or March), but these guidelines have not yet been fully implemented. During 2011-2016, 75% of the 464 reservoir stocking events involving Rainbow Trout (two-thirds of which were conducted by DHNFH) consisted of fish <10 inches and in reservoirs where Walleye are present, 38% occurred outside the February/March timeframe.

**Strategies:**

1. Schedule Rainbow Trout stocking events later in winter (after January) where Walleye are present.
2. Stock reservoirs with Rainbow Trout >10 inches to improve survival, growth, and creel return rates (also supports Goal 3 above); do not stock fingerlings. Strategies 1. and 2. will require coordination with ENFH and DHNFH; most Rainbow Trout stocked in reservoirs are provided by DHNFH.
3. Evaluate current reservoir stocking rates for Rainbow, Brown, and Lake Trout and adjust where necessary to promote the efficient use of hatchery trout (in support of Goal 1 above).
4. Conduct a trout population assessment in one reservoir in Region 3 or 4 on an annual, rotating basis through coordination between the trout management and reservoir management teams.
5. Routinely evaluate reservoir trout angler effort and success. Include nighttime angler surveys where appropriate (e.g., Dale Hollow).
6. Promote reservoir trout fisheries in articles in TWRA publications, on the Agency website, and in other public forums.

## ANGLING OPPORTUNITIES

### *GOAL 1. Maintain a variety of trout fisheries.*

**Objective:** Continue to offer trout fishing opportunities in streams, tailwaters, reservoirs, and other permanent or temporary habitats that satisfy a diverse public's many different skill levels and definitions of quality.

**Problem:** Tennessee's diversity of potential trout habitats has enabled TWRA to develop a variety of angling options. Consequently, diversity among trout anglers has increased, but management that optimizes opportunities or satisfaction for one group may exclude or diminish satisfaction for other groups.

#### **Strategies:**

1. Accommodate physically-limited anglers where possible, such as at the new ADA-compliant Dillard Ponds seasonal trout fishery (a Region 4 cooperative effort with the USFS and TU) and at Green Cove Pond (Region 3). Other ADA-accessible trout fisheries include Paint Creek (USFS), the Norris tailwater (Clear Creek and Miller's Island; TVA) and the South Holston tailwater (Osceola Island; TVA).
2. Further expand the number of DH areas and winter trout program waters where sufficient trout can be allocated (e.g., through attainment of HATCHERY-SUPPORTED FISHERIES Goals 1 and 2). Two DH areas (Piney River and the Hiwassee tailwater) and 14 winter program locations have been added since 2006.
3. Maintain or modify (where appropriate) existing regulations designed to diversify angling experiences, such as Cherokee National Forest wild trout regulations and tailwater quality zones. Special CNF wild trout regulations were modified in 2013 to be more biologically sound while still providing alternative angling experiences. Delayed harvest regulations (Strategy 2.) also accomplish this purpose.
4. Establish or explore the utility of new regulations, such as a catch-and-release areas, to diversify angling experiences.
5. Stock large trout ( $\geq 14$  inch fish) in selected hatchery-supported streams. The weight of each particular lot of stocked fish would remain the same, but would necessarily include fewer fish. Catch rates may be reduced, but many anglers would prefer the opportunity to catch larger fish. Consider using reduced creel limits for these streams if necessary.
6. Continue conducting opinions surveys periodically to make sure TWRA's management and trout angler preferences align as much as possible.



**GOAL 2. Increase access to trout fisheries.**

**Objective:** Increase or improve access to trout fisheries in tailwaters and hatchery-supported streams by adding or upgrading 20 locations during the next 10 years. Since 2006, 21 access areas have been added or upgraded on tailwaters, hatchery-supported streams, and one reservoir (Appendix A).

**Problems:** According to a recent nationwide assessment (ASARM 2010), three-fourths of anglers must travel to fish, thus access through public or private lands is necessary. Few anglers (18%) perceived that fishing access from public lands had improved over the five years prior to the assessment and even fewer (8%) thought that private access was better. Closure by landowners was considered the most important reason why access from private lands had decreased (ASARM 2010). Although all streams are public waters, the stream banks and bed can be privately-owned in Tennessee, thus many trout fisheries have limited access for bank and wade anglers. More public and private access would be beneficial to Tennessee's trout anglers.

**Strategies:**

1. Work with landowners on existing hatchery-supported streams to keep these areas open to the public. Inform them of laws exempting them from liability.
2. Make access a primary consideration for new fisheries. Streams with municipal greenways are likely candidates (e.g., West Fork Stones River in Murfreesboro). Exclude streams that already provide substantial fisheries for other species. Hatchery-supported streams receive high levels of use over short periods of time. Such fishing pressure could strain existing relations between landowners and anglers, causing anglers to lose access to waters they were formerly allowed to fish year-round.
3. Purchase or develop donated properties on trout tailwaters that will provide strategic access points for float and wade or bank fishing.
4. Purchase land along streams, then sell unwanted portions of these tracts to generate funds for purchasing access areas on other streams or developing an access-leasing program (similar to that for dove fields).
5. Provide a benefit (e.g., a trout stamp exemption) to landowners willing to permit public access to a trout fishery.
6. Request that the Tennessee Department of Transportation (TDOT) provide access where bridges are constructed or repaired.
7. Continue partnering with other federal and state agencies (e.g., TDEC, TDOT, and TVA) and local governments that manage public lands to develop new trout fishery access locations or upgrade existing sites.

8. Re-allocate fish to alternative locations (new or existing) if public access to a hatchery-supported stream is eliminated or substantially reduced by adjacent landowners (also helps attain HATCHERY-SUPPORTED FISHERIES Goal 1). A recent example is Cassi Creek (Region 4), which received Camp Creek's allocation in 2016 after anglers complained that landowners there were no longer permitting public access.
9. Promote under-utilized fisheries by announcing stocking dates in press releases and asking landowners to post "fishing permitted signs".

### ***GOAL 3. Expand trout fishing opportunities for children.***

**Objective:** Continue to provide trout for kids' fishing events and develop new events that target young anglers (particularly in urban areas).

**Opportunity/Problem:** A kid's fishing derby is a great opportunity to introduce children to fishing. Due to high participation rates at these events, trout are typically used efficiently. However, as with other programs, expansion of kids' fishing events is limited by trout availability.

#### **Strategies:**

1. All trout provided for kids fishing events should be at least 10 inches in length to maintain a quality fishing experience.
2. Require that event organizers notify TWRA a year in advance to plan trout allocation.
3. Create new youth fishing events using existing fisheries in selected hatchery-supported streams, at winter trout program events, or in DH areas by setting aside the first day after stocking for kids only (similar to TWRA's youth hunting programs/ seasons).

## **NATIVE BROOK TROUT**

### ***GOAL 1. Conserve Tennessee's native Brook Trout.***

**Objective:** Maintain Tennessee's existing native (i.e., uninfluenced by stocking of hatchery fish) Brook Trout populations and expand this resource where appropriate (in accordance with TWRA's Strategic Plan; TWRA 2014). These fish currently inhabit ~82 miles distributed among 67 streams and have been successfully maintained since 2006, when ~80 miles in 57 streams were recognized. The current resource includes over four miles of distribution created by the recent Sycamore Creek (Monroe County) and Little Stony Creek (Carter County) restorations.

**Problems:** Brook Trout continue to represent only about one fourth of Tennessee's wild trout resources, while native populations (unaffected by stocked hatchery fish) make up just over half

of the total Brook Trout resource. These ecologically, culturally, and recreationally important fish continue to face a number of threats (Hudy et al. 2008), including habitat degradation, non-native species encroachment, and loss of genetic integrity through improper stocking practices.

**Strategies:**

1. Manage Tennessee's native Brook Trout based on the goals and strategies outlined in TWRA's "Managing Tennessee's Native Brook Trout" (Appendix B) and the position statement on managing these fish published by the American Fisheries Society's Southern Division Trout Committee (Habera and Moore 2005). Work with the AFS SDTC to update its guidelines to include the latest available Brook Trout population genetics information and its implications for restoration and enhancement projects.
2. Periodically monitor the status and distribution of other Brook Trout populations (hatchery origin or hatchery influenced), particularly those that provide significant fisheries; take management actions as necessary to protect these resources.

**OUTREACH**

***GOAL 1. Effectively and interactively communicate with all trout anglers.***

**Objective:** Ensure that anglers are informed about trout fisheries, management policies, and current issues through numerous avenues of communication. Also ensure that managers remain aware of and responsive to angler concerns and preferences.

**Problems:** TWRA has a number of outlets through which to share information and obtain feedback from anglers, but they may not always be effectively utilized. Furthermore, it can be difficult to gauge opinions or determine consensus among trout anglers because they represent several distinct groups. Some anglers are unwilling to participate in public meetings designed to gather public input, yet become active after management decisions are made that negatively affect them. Often the only groups that provide input or share opinions prior to making management recommendations represent extreme viewpoints.

**Strategies:**

1. Attend various stakeholder group meetings (e.g., TU chapters and local sportsmen's organizations) to communicate the current status of trout fisheries, discuss current issues and policies, and gauge interest in or support for various management options.
2. Continue collecting trout angler preference and satisfaction data via telephone and creel surveys (including reservoirs, DH areas, and winter trout events); incorporate this information where appropriate into management strategies and policy.

3. Continue to welcome calls, letters, and emails submitted to TWRA and provide timely responses.
4. Make TWRA's annual trout fishery reports and other related information available through links on the Agency and regional websites and social media pages.
5. Conduct local public meetings to discuss important or potentially controversial trout management issues and strategies (e.g., regulation changes).
6. Encourage anglers to review the statewide trout management plan and existing tailwater trout management plans; host local public meetings to discuss updates to plans.
7. Encourage anglers and other interested volunteers to get involved in trout population assessments (e.g., annual wild trout monitoring efforts) and other management activities (e.g., Brook Trout restoration projects).

**GOAL 2. Increase awareness of trout fishing opportunities in Tennessee.**

**Objective:** Provide anglers with the detailed information they need to have safe, legal, and satisfactory trout fishing trips.

**Problems:** Anglers want as much information as possible about a location before committing the resources to go fishing. New residents and non-resident anglers often do not know where to go trout fishing, and other anglers may want to try new locations. However, specific information may not be readily available and anglers often do not know where to obtain the information they need. For example, the nationwide assessment by ASARM (2010) found that 70% of anglers did not utilize state or federal agency websites to seek information on places to fish or access to them.

**Strategies:**

1. Maintain (and update as needed) TWRA's new website maps providing detailed information on stocking locations for hatchery-supported streams, tailwaters, reservoirs, and winter trout program events, as well as stream and tailwater access areas.
2. Make the wild trout fishing map available on the website.
3. Establish and maintain a "Wild Trout Fishing Hotspots" map on the website spotlighting some of Tennessee's best wild trout fishing locations.
4. Publicize the Agency website (through the fishing guide, *Tennessee Wildlife* magazine, news releases, fishing and outdoor shows, etc.) as a source for information on where to go trout fishing and make it easy to find there (also supports Goal 1. above).
5. Develop and post signs identifying stocked streams and providing stocking schedules. For example, a sign might read "Stocked Trout Stream, Fishing Permitted—Laws Will Be Enforced, Stocked Monthly March-May".



6. Evaluate license requirements that may discourage potential trout anglers and consider re-instating the one-day non-resident trout fishing license, as well as creation of a “no harvest” trout license.

**GOAL 3. *Maintain and publicize compliance with trout angling regulations.***

**Objective:** Minimize both the impacts of anglers who fail to comply with regulations (e.g., size limits, creel limits, and gear restrictions) and dissatisfaction among some stakeholders that these impacts are common or are not being adequately addressed.

**Problem:** Although compliance rates are typically high, some trout fisheries could be hindered by illegal harvest. Additionally, anglers sometimes perceive that violations are damaging or limiting the potential of some fisheries—particularly just after stocking events and in tailwaters with PLR (slot limit) regulations. This perception is reinforced because these anglers infrequently observe law enforcement activity or are unaware of its results.

**Strategies:**

1. Ensure that County Wildlife Officers are advised in a timely manner of all stocking events so that appropriate enforcement activities can be conducted as needed.
2. Request special or undercover law enforcement details in locations where multiple reports of violations are occurring.
3. Coordinate with the TWRA Law Enforcement to summarize results of trout-related enforcement efforts, particularly on tailwaters, and publicize this information in press releases, *Tennessee Wildlife* magazine, the TWRA website, appropriate Agency reports, and other outlets.

## Public Input

TWRA received comments and suggestions on the draft statewide trout management plan from over 30 anglers, as well as a unified response from Tennessee's eight Trout Unlimited Chapters. This input focused on stocking practices, angling regulations, licenses, user conflicts, access, tailwater minimum flows, and biosecurity issues. Most of the recommendations (70%) were directed at specific waters, particularly the Caney Fork and other tailwaters, and sought changes in stocking numbers, locations, and species, alternative angling regulations, and resolution of user conflicts (Caney Fork). However, management specifics for particular trout fisheries are outside the scope of this plan. Tailwater trout fisheries are (or will be) managed by individual plans (HATCHERY SUPPORTED FISHERIES Goal 1, Strategy 5) that will solicit public input when they are initially developed or updated.

Notwithstanding any focus on particular fisheries, the most common suggestion (32% of respondents) sought establishment of catch-and-release (CR) angling regulations—usually prohibiting the use of bait. Establishing a CR area on a wild trout stream was suggested in the draft plan, but there is considerable interest in applying this regulation to tailwaters as well. Accordingly, ANGLING OPPORTUNITIES Goal 1, Strategy 4 was modified to include establishing or exploring the utility of new angling regulations on trout waters in general.

Most other comments aligned with or supported goals and strategies outlined in the draft plan. Those mentioning stocking larger trout to manage selected fisheries (HATCHERY SUPPORTED FISHERIES Goal 1) were in favor of that approach, provided that the appearance of the larger fish is not degraded. Expansion of the DH program (HATCHERY SUPPORTED FISHERIES Goal 1, Strategy 3; ANGLING OPPORTUNITIES Goal 1, Strategy 2) was endorsed by four respondents and this is now underway, with two new areas in Region 4 to be considered by the TFWC in 2017. Managing for wild trout fisheries where possible (HATCHERY SUPPORTED FISHERIES Goal 1, Strategy 1), improving angler access (ANGLING OPPORTUNITIES Goal 2), and optimizing tailwater minimum flows (HABITAT PROTECTION Goal 2, Strategies 2 and 3) were other suggestions that are addressed in the management plan sections indicated. TWRA was also encouraged to proactively confront potential whirling disease and gill lice introduction, as well as to establish fishing gear decontamination stations to help control aquatic nuisance species; BIOSECURITY Goal 1 was adjusted accordingly.

Two comments questioned the cost effectiveness of the winter Trout Program, given a perception that some of these events were being underutilized. While there has been a general demand for expansion of the winter trout program during recent years, it is also beneficial to continually evaluate hatchery-supported fisheries to ensure that these resources are used effectively. Accordingly, HATCHERY SUPPORTED FISHERIES Goal 1, Strategy 2 now specifically mentions the winter trout program. Finally, there were requests for reinstatement of the one-day non-resident trout fishing license, as well as the creation of a "no harvest" trout license. These were addressed with a new strategy (6.) under OUTREACH Goal 2.

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**APPENDIX A**

New and Upgraded Trout Fishery Access Areas



Table A-1. New and upgraded (since 2006) trout fishery access areas.

Access area	Location	Status	Type	Agency	Cooperators
<b>Region 4</b>					
Big Springs	S. Holston tailwater	New	Boat ramp; Bank/Wade	TWRA	TVA
Rockhold/Cameron tract	S. Holston tailwater	New	Bank/Wade	TWRA	TVA
Emmett Bridge	S. Holston tailwater	Upgrade	Boat ramp	TVA	TWRA
Bouton tract	S. Holston tailwater	Upgrade	Bank/Wade angling	TVA	TWRA
TVA Road South	S. Holston tailwater	Upgrade	Bank/Wade angling	TVA	TWRA
Piney Hill Road	S. Holston tailwater	New	Bank/Wade angling	TVA	TWRA
Watauga Bluffs	Wilbur tailwater	New	Bank/Wade angling	TWRA	TDEC, TU, TVA
Siam Bridge	Wilbur tailwater	New	Bank/Wade angling	TDOT	TWRA
Hwy. 400 Bridge	Wilbur tailwater	New	Bank/Wade angling	TDOT	TWRA
Near Wilbur Dam	Wilbur tailwater	Upgrade	Boat ramp	TVA	TWRA
Little Wilbur	Little Wilbur reservoir	New	Bank angling	TVA	TWRA
Ft. Patrick Henry Dam	Ft. Patrick Henry TW	New	Boat ramp; Bank/Wade	TVA	TWRA
Miller's Island	Norris tailwater	Upgrade	Boat ramp; Bank/Wade	TVA	TWRA
Llewellyn Island	Norris tailwater	New	Bank/Wade angling	TWRA	2 <sup>nd</sup> Baptist Church, Clinton
<b>Region 3</b>					
Gordonsville	Center Hill tailwater	New	Boat ramp/parking area	TWRA	
Betty's Island	Center Hill tailwater	Upgrade	Boat ramp	TWRA	
Hwy. 411	Apalachia tailwater	Upgrade	Boat ramp	TWRA	
Pepper Branch Park	Barren Fork	New	Bank/Wade angling	TWRA	
Wanamaker	Collins River	New	Boat ramp; Bank/Wade	TWRA	
<b>Region 2</b>					
Old Dam Ford	Tims Ford tailwater	Upgrade	Boat ramp	TWRA	
Farris Creek Bridge	Tims Ford tailwater	Upgrade	Boat ramp	TWRA	

## **APPENDIX B**

### Managing Tennessee's Native Brook Trout

## Managing Tennessee's Native Brook Trout

### Background

Tennessee's wild (self-sustaining) Brook Trout *Salvelinus fontinalis* resource currently consists of populations inhabiting about 141 miles in 111 streams and one pond (at an elevation of 4,000') in the mountains along the eastern margin of the state. Wild Brook Trout habitat is



*A native (Lower Interior Basin) Brook Trout from Sycamore Creek in Monroe Co., Tennessee*

characterized by first and second order (headwater) streams at elevations above about 2,400 ft. About 70% of this habitat occurs within the Cherokee National Forest. Another 70 miles of wild Brook Trout water is located in the Tennessee portion of Great Smoky Mountains National Park (GSMNP). While Brook Trout are Tennessee's only native salmonid, they currently represent only about 25% of the state's wild trout resources. Rainbow Trout and,

less frequently, Brown Trout occupy most of the coldwater habitat (~600 miles) that once supported Brook Trout. These introduced species occur along with Brook Trout in over half of the existing Brook Trout streams.

Genetic assessments of Tennessee's Brook Trout populations in the 1990s (allozyme electrophoresis), along with more recent (and ongoing) microsatellite DNA analyses, have revealed that about 60% are of native, southern Appalachian origin. These populations have not been influenced by stocking of hatchery-produced Brook Trout. Current population genetics work assigns these native fish to the "Lower Interior Basin" clade, one of six such groups of related Brook Trout populations with common ancestries. Native Brook Trout populations now inhabit ~82 miles in 67 streams in Regions 3 and 4. Although Brook Trout in 39 streams outside GSMNP have been restored or enhanced since the early 1980s by removing or initially reducing introduced salmonid populations, only 23 of these (59%) have native Brook Trout. Conservation of native or 'heritage' fish is now the primary focus of Brook Trout management efforts in Tennessee. They, along with Tennessee's other wild Brook Trout, continue to be threatened by competition from introduced species, changing land use practices, acidic deposition, and habitat loss associated with climate change.

The following goals and strategies are intended to guide management of Tennessee's native Brook Trout populations with respect to assessment, habitat protection, restoration/

enhancement, and public education/outreach. These goals and strategies align with the Tennessee Wildlife Resources Agency's (TWRA's) current Strategic Plan (TWRA 2014), as well as the guidelines (particularly for restoration and enhancement) recommended by the American Fisheries Society's Southern Division Trout Committee (Habera and Moore 2005). They also support the broader goals of the Eastern Brook Trout Joint Venture's conservation strategy (EBTJV 2011). TWRA and the U. S. Forest Service (USFS) are responsible for managing Brook Trout and their habitat in Tennessee (outside GSMNP). The Tennessee Valley Authority also provides assistance with restoration projects and helps protect Brook Trout habitat through its watershed restoration and reservoir release improvement programs. These agencies, along with assistance from the National Park Service, the conservation organization Trout Unlimited (TU), and other partners, work together to conserve Tennessee's Brook Trout.

### **Native Brook Trout Management Goals and Strategies**

#### **ASSESSMENT**

##### **Goal 1. Complete Tennessee's Brook Trout genetics assessment.**

**Strategy 1:** Collect DNA samples (fin clips) to verify, using more advanced genetic analysis techniques (e.g., microsatellite DNA), the identity (genotype) of all 112 extant Brook Trout populations (Habera et al 2017). Also determine various population genetics characteristics such as effective sizes ( $N_e$ ) and relatedness to other populations. Use this information to select appropriate native Brook Trout populations for restoration and enhancement projects.

##### **Goal 2. Continue to develop Tennessee's Brook Trout database.**

**Strategy 1:** Expand the existing quantitative database through monitoring programs and inventory sampling to document abundance and evaluate annual variability in a variety of native Brook Trout populations under allopatric and sympatric conditions.

**Strategy 2:** Maintain up-to-date distribution information Brook Trout (particularly native populations). Locate and obtain GPS coordinates for at least the lower distributional limits of each Brook Trout population on a consistent basis (e.g., 5-10 years). Periodically map new distributions and assess changes/trends since completion of the previous survey. Use this information to help identify populations in need of restoration or enhancement efforts.

##### **Goal 3. Develop a comprehensive native Brook Trout data GIS layer.**

**Strategy 1:** Develop and maintain a GIS database for Brook Trout distributions, abundances, genotypes, effective population sizes ( $N_e$ ), barriers, and other important characteristics. Archive and map historic and current Brook Trout distribution and genetic information.

## HABITAT PROTECTION

### **Goal 1. Minimize or eliminate habitat and water quality related impacts to native Brook Trout.**

**Strategy 1:** Develop cooperative long-term water quality monitoring programs that focus on key parameters (particularly summer temperature) along elevational gradients. Relate the results of this monitoring to native Brook Trout population monitoring results and identify areas where protection or management is needed.

**Strategy 2:** Ensure that all waters supporting native Brook Trout are subject to Tennessee Department of Environment and Conservation (TDEC) water quality standards (Chapter 0400-40-03; TDEC 2015) and usage classifications (Chapter 0400-40-04; TDEC 2013) designed to protect wild trout.

**Strategy 3:** Coordinate with regional habitat protection biologists to verify compliance with all Clean Water Act (Section 404) and Aquatic Resource Alteration Permits issued for projects affecting waters supporting native Brook Trout. Work with the US Army Corps of Engineers and TDEC to ensure that permit requirements adequately protect this habitat.

**Strategy 4:** Continue to work with the multi-agency TEARS-AM (Tennessee Ecologically at-Risk Streams: Appalachian Mountains) project initiated in 2015 and led by Dr. Ryan Otter (Middle Tennessee State University) to evaluate risks associated with climate change, contaminant levels (e.g., from atmospheric deposition of mercury) in native Brook Trout, and other factors that influence stream health at higher elevations.

**Strategy 5:** Improve connectivity by removing fish passage barriers (e.g., hanging culverts) on selected native Brook Trout streams, such as the current USFS Briar Creek project in Region 4. Improved connectivity can potentially restore gene flow among populations and make thermal refugia available (Carlson et al. 2015).

### **Goal 2. Improve native Brook Trout habitat in selected streams.**

**Strategy 1:** Develop selection criteria for native Brook Trout habitat improvement projects based on need, existing habitat (e.g., through a Restoration Suitability Index model), population genetics and distribution information, land ownership, likelihood for success, and angling access.

**Strategy 2:** Generate, based on Strategy 1, a prioritized list of native Brook Trout habitat improvement projects (~5) employing various stream restoration techniques as necessary (e.g.,



livestock exclusion, site re-vegetation, and in-stream channel modification). Seek project funding through established sources such as stream mitigation programs and State and Federal agricultural incentive programs.

## **RESTORATION AND ENHANCEMENT**

### **Goal 1. Further enhance Tennessee’s native Brook Trout resource.**

**Strategy 1:** Implement the management actions and guidelines recommended by the American Fisheries Society’s Southern Division Trout Committee in its position statement on managing southern Appalachian Brook Trout (Habera and Moore 2005). This document provides guidance regarding issues such as protecting biodiversity, genetic integrity and conducting restoration and enhancement projects.

**Strategy 2:** Conduct—in accordance with TWRA’s Strategic Plan (TWRA 2014)—native Brook Trout restoration, enhancement, and re-introduction projects based on a plan developed through cooperation with the USFS (see Appendix B) that can increase distribution by 13 to 15 miles or more during the next 10 years (2017-2027). These projects include one subwatershed where Brook Trout have been extirpated (EBTJV assessment) and potentially one third-order stream segment. Since 2006, TWRA has restored or re-established native Brook Trout in Little Stony Creek (Carter County) and Sycamore Creek (Monroe County) and completed the Left Prong Hampton Creek (Carter County) restoration project by removing Rainbow Trout upstream of the barrier constructed in 2007.

**Strategy 3:** Continue to refine propagation techniques at the Native Brook Trout Hatchery (at Tellico Hatchery in Region 3) and use this facility to produce fish for appropriate restoration projects (e.g., where sufficient numbers of fish are not available for translocation).

**Strategy 4:** Monitor restored or enhanced Brook Trout populations to evaluate project success.

### **Goal 2. Build partnerships with other conservation groups**

**Strategy 1:** Establish or continue cooperation with other agencies and organizations, such as NPS, TU, TDEC, and the Tennessee Aquarium Conservation Institute (TNACI), working to promote native Brook Trout conservation. Since 2006, TWRA has assisted the NPS (GSMNP) with native Brook Trout restoration projects on Lynn Camp Prong (2008-2011) and Anthony Creek (2016) and worked with TNACI and Tennessee Technological University to evaluate native Brook Trout propagation techniques and post-stocking performance during 2014-2015 (Cook and Johnson 2016). TWRA is also working with TDEC and other agencies to plan a

road/trail system in recently-established Rocky Fork State Park that is protective of the Brook Trout resources located there.

**Strategy 2:** Maintain involvement with the Eastern Brook Trout Joint Venture (EBTJV). This multi-agency effort has assessed the current status of wild Brook Trout populations across their range in the eastern United States (Maine to Georgia), developed a comprehensive conservation strategy (EBTJV 2011), and works to select and fund projects that restore or enhance Brook Trout and their habitat.

## **OUTREACH**

### **Goal 1. Create or enhance public interest in native Brook Trout.**

**Strategy 1:** Promote the ecological, cultural, and recreational importance of native, Tennessee Brook Trout by featuring them and associated management activities in various educational materials (e.g., updated maps, brochures, posters, articles, videos, and live fish displays) and presentations. Venues include the Agency website, magazine, and social media pages, as well as school programs, Trout Unlimited and other stakeholder meetings, fishing and outdoor shows, fairs, and outdoor radio programs.

**Strategy 2:** Enhance accessibility of a few native Brook Trout fisheries (close to roads) with trail improvements, fishing decks, or other improvements so that most anglers, especially those with physical limitations, have the opportunity to catch and develop an appreciation for these fish.

### **Goal 2: Increase landowner participation in habitat improvement programs.**

**Strategy 1:** Publicize information regarding all current Federal and State grants and programs available to private landowners for protecting and improving water quality and habitat in native Brook Trout streams. Provide technical assistance as needed.

**Strategy 2:** Publicize the application of best management practices (BMPs), as well as the benefits of protecting and improving water/habitat quality, by presenting success stories (in local newspapers, on websites, magazines, newsletters etc.) that show how entire communities benefit, not just fish and anglers.

### **Goal 3: Develop relationships that foster native Brook Trout conservation.**

**Strategy 1:** Facilitate achievement of Brook Trout conservation goals by establishing relationships with non-governmental organizations (NGOs), city and county governments, land trusts, and other organizations.

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**APPENDIX A**

Brook Trout Restoration, Enhancement, and Reintroduction Projects:  
2017-2027

## Brook Trout Restoration, Enhancement, and Reintroduction Projects: 2017-2027

The Tennessee Wildlife Resources Agency (TWRA) and U. S. Forest Service (USFS) cooperatively developed a list of native Brook Trout restoration, enhancement, and reintroduction projects (described below) proposed for 2017-2027. Restorations involve re-establishing an allopatric native Brook Trout population and maintaining it as such. These projects require a fish-passage barrier at the downstream end of the restoration area and



*Brook Trout enhancement projects involve removal of competing non-native salmonid populations (typically Rainbow Trout).*

removal of any nonnative trout (Rainbow, Brown, or hatchery-origin Brook Trout) upstream of the barrier (including tributaries). Enhancement projects (i.e., Little Jacobs Creek) remove Rainbow Trout from an existing sympatric native Brook Trout population and extend Brook Trout distribution downstream to a natural barrier. Proposed restorations and enhancements are classified as Tier 1 (higher-priority) projects and proposed streams are listed in

Table 1. Reintroduction projects involve re-establishing native Brook Trout populations in streams with suitable habitat without completely removing an existing nonnative trout population. Such efforts have previously been successful in Briar Creek (Washington County), Little Jacob Creek (Sullivan County), and Sycamore Creek (Monroe County). These projects (Tier 2) are generally lower-priority, but would provide the opportunity to get native Brook Trout back into streams or watersheds where they have long been absent (Table 2). Tier 2 streams would be managed as sympatric populations unless enhancement becomes feasible (e.g., through location or construction of a barrier).

Proposed streams under both tiers were chosen with the criteria that project areas are located on public lands relatively accessible to anglers and that, where necessary, existing nonnative trout can be removed or thinned by electrofishing. All projects will utilize native Brook Trout that are genetically appropriate (i.e., from the same watershed or river basin) for the project as determined by microsatellite DNA analyses.

### Tier 1 Restoration and Enhancement Streams

Potential Tier 1 native Brook Trout restoration and enhancement projects are listed in Table 1 and rationale for each project is provided below:



Table 1. Potential Tier 1 Brook Trout restoration and enhancement projects.

Stream	Watershed	Species present	Barrier	Start elevation	Length (miles)	Comments
Little Jacob Creek	South Fork Holston	RBT/BKT	Yes	2,270	1.0	Remove RBT above cascade
Phillips Hollow	Nolichucky	None	Yes (2)	2,230	0.6	Fish to be acquired from NC
Little Paint Creek	French Broad	None	Yes	2,000	1.5	Use fish from Gulf Fork tribs.
Devil Fork	Nolichucky	RBT	Yes (3)	1,900	0.5	Restore between lower 2 falls; no fish above 2 <sup>nd</sup>
Trail Fork Big Creek	French Broad	RBT	TBD	TBD	TBD	Use fish from Gulf Fork tribs.
Jennings Creek	Nolichucky	RBT	TBD	TBD	TBD	Use fish from Phillips Hollow; account for Round Knob Branch
Horse Creek	Nolichucky	RBT	TBD	TBD	TBD	Remove RBT if barrier exists; otherwise move to Tier 2
North Fork Citico Creek	Little TN	None	Yes	3,200	0.8	Use fish from Sycamore Creek
Sugar Cove Branch	Little TN	Hatchery-origin BKT	Yes	2,760	1.5	Use fish from Sycamore Creek

RBT = Rainbow Trout; BKT = Brook Trout. TBD = to be determined.

### Little Jacob Creek

Brook Trout management in Little Jacob Creek began as a re-introduction in 2000, when 180 native Brook Trout were translocated to this stream without completely removing the existing Rainbow Trout population. Brook Trout were still present during a survey in 2011 and had colonized the stream about 0.1 miles downstream of the introduction zone. The Brook Trout population in Little Jacob Creek could be made allopatric and its distribution extended by ~0.3 miles by removing Rainbow Trout upstream of the cascade at 2,270'. This work has begun with the removal of ~400 Rainbow Trout during extremely low flow conditions in October 2016 (Habera et al. 2017) and will continue in 2017. Abundance and biomass of allopatric brook trout should reach pre-enhancement levels (primarily composed of rainbow trout) in three years as has been observed in Left Prong Hampton Creek (Carter County) and several streams in GSMNP (Kanno et al. 2016). An additional 0.2 miles could be added to the enhancement by extending the Rainbow Trout removal downstream to a culvert at the U. S. Forest Service (USFS) road crossing.

### Phillips Hollow

This stream once supported Rainbow Trout, but no fish currently exist upstream of the barrier at 2,230', possibly as the result of removal efforts conducted during extremely low flow conditions by USFS contractors in 1991. Arrangements are being made with the North Carolina Wildlife Resources Commission to translocate fish from Elk Hollow Branch in the North Toe River system (Nolichucky basin in North Carolina) pending whirling disease screening. Projected availability of these fish is 2017 or 2018 (prior to spawning season). Habitat exists upstream of the cascade at 2,700' and Brook Trout could be stocked there also. Access is good via a USFS trail.

### Little Paint Creek

This stream supported a hatchery-influenced Brook Trout population upstream of the artificial barrier at 2,000' during the 1990s, but a TWRA survey in 2013 produced no trout upstream of the barrier. This restoration would require only translocating native Brook Trout from the French Broad watershed, possibly from Gulf Fork of Big Creek tributaries (Middle Prong Gulf Creek or Brown Gap Creek) or from Great Smoky Mountains National (GSMNP) streams (e.g., Cosby Creek or Toms Creek) in cooperation with the National Park Service (NPS). Access is good via a USFS trail.

### Devil Fork

Seventy-three native Brook Trout from the Watauga watershed were reintroduced into Devil Fork (Clark Creek tributary) in 1986 by Dr. Jerry Nagel (formerly with East Tennessee State University) with no thinning of the existing Rainbow Trout population. Subsequent TWRA surveys in 1997 and 1999 found no Brook Trout in the former introduction zone. Rainbow Trout could be removed between the lower two barrier falls on this stream (at 1,870' and 2,120') and Brook Trout restored to that area and possibly above the upper barrier, where no fish currently exist. North Fork and South Fork of Sill Branch, located nearby, could also be included as part of this project. Although relatively small, these streams have barrier falls near their mouths and no trout upstream. The Devil Fork restoration would depend upon a source of native Brook Trout from the Nolichucky watershed and could be obtained from a successful Phillips Hollow project. Access is good via USFS trails.

### Trail Fork of Big Creek

Upper Trail Fork currently has a wild Rainbow Trout population, as do some of its headwater tributaries (upstream of 2,720') which could be included. Potential barriers exist on Trail Fork which could provide the starting point for a restoration project that could include some third-order habitat. Native Brook Trout from the French Broad watershed—Gulf Fork of Big Creek tributaries or GSMNP streams with cooperation from the NPS—would be needed to complete the restoration. Access may be limited depending upon barrier location.

### Jennings Creek

Restoring Jennings Creek would depend on establishing a source of Brook Trout in Phillips Hollow and/or other streams in the Nolichucky watershed. If a potential barrier downstream of Round Knob Branch (near the USFS campground) is used, then that tributary and its hatchery-influenced Brook Trout population will have to be considered. Access is good via a USFS trail.

### Horse Creek

Two streams in this watershed (Squibb Creek and Sarvis Cove) contain nearly 4 miles of Brook Trout distribution, but they have been stocked with Owhi (hatchery origin) fingerlings and native Brook Trout from the Watauga watershed, thus both populations are now putatively hybridized. If an effective barrier on Horse Creek can be located upstream of the confluence with Sarvis Cove, then native Brook Trout could be restored in that area. If no suitable barrier exists, Horse Creek could still be included as a Tier 2 (reintroduction) project. In either case, a source of Brook Trout native to the Nolichucky watershed would be required (e.g., from successful Phillips Hollow or Devil Fork restorations). Access is good via a USFS road and trail.

### North Fork Citico Creek

Until recently, two streams in the Citico Creek watershed (Region 3) supported Brook Trout: upper North Fork Citico Creek and Falls Branch (a South Fork Citico Creek tributary). Genetic analyses during the 1990s (using allozyme electrophoresis) determined that both populations were of hatchery origin. However, a distribution survey in 2013 indicated that only the Falls Branch population remains. No fish were found in North Fork Citico Creek upstream of Goat Falls (at ~3,200'). About 0.8 miles of Brook Trout habitat above the falls could be restored in this stream and would only require stocking of Brook Trout native to the Little Tennessee watershed. Brook Trout from Sycamore Creek propagated at the Native Brook Trout Hatchery (Tellico) could be used for this purpose when available. A quantitative survey would be conducted 2-3 years post-stocking to examine success. Access to North Fork Citico Creek is good via USFS Trail 98.

### Sugar Cove Branch

Sugar Cove Branch is a North River tributary that supports a low-abundance hatchery-origin Brook Trout population (established in 1990) upstream of the cascades near the North River Road crossing. Rainbow Trout occupy Sugar Cove downstream of this area. The existing Brook Trout population upstream of the cascades could be removed by electrofishing and native fish from Sycamore Creek (propagated at the Tellico Hatchery) could be restored. Additionally, even if no suitable barrier exists downstream of the road crossing, the new Brook Trout population might still be extended there by thinning the Rainbow Trout and introducing Brook Trout from upper Sugar Cove Branch (or Sycamore Creek if necessary).

## Tier 2 Re-introduction Streams

Potential Tier 2 native Brook Trout re-introduction projects are listed in Table 2 and rationale for each project is provided below:

Table 2. Potential Tier 2 Brook Trout re-introduction projects.

Stream	Watershed	Species present	Barrier	Start elevation	Length (miles)	Comments
Green Mountain Branch	South Fork Holston	RBT	TBD	3,130	1.0	Thin RBT, move to Tier 1 if a barrier is located.
Sinking Creek	Watauga	RBT/BNT	No	2,060	1.3	Initially thin RBT/BNT; include Basil Hollow tributary
Upper Granny Lewis Creek	Nolichucky	RBT	No	2,800	1.0	Initially thin Rainbows
Right Prong Rock Creek	Nolichucky	RBT	No	2,220	1.7	Initially thin Rainbows
Sycamore Creek	Little Tennessee	RBT	Yes	2,120	2.3	Continue to remove Rainbows and supplementally stock propagated native Brook Trout

RBT = Rainbow Trout; BNT = Brown Trout. TBD = to be determined.

### Green Mountain Branch

A 2006 qualitative survey of this Beaverdam Creek tributary indicated the presence of a relatively abundant wild Rainbow Trout population at 3,080' along Hwy. 421. Although this is a smaller stream (1-2 m wide), it has above average fertility and relatively good habitat. Native Brook Trout from the South Fork Holston watershed (e.g., other Beaverdam Creek tributaries) could be introduced beginning at the USFS boundary (3,130') after Rainbow Trout are thinned. If a suitable barrier is located, Rainbow Trout could be completely removed and this stream elevated to a Tier 1 restoration project. Access is relatively good from adjacent Hwy. 421.

### Sinking Creek

A few Brook Trout were located in Sinking Creek (Washington County) during qualitative surveys in 2006. This stream has a wild Rainbow and Brown Trout population, but seven Brook Trout (six sub-adults, one adult) were captured in a 0.75-mile reach between 2,020' and 2,140'. However, a follow-up survey in 2007 was unable to relocate any Brook Trout in Sinking Creek or

Basil Hollow (a headwater tributary). There are no records of Brook Trout occurring in or being stocked into Sinking Creek and it is uncertain why none were found in 2007. This is a larger stream with good access (along Dry Creek Rd.) and suitable wild trout habitat that would provide an excellent opportunity to reintroduce Brook Trout to a Watauga River subwatershed where they have been extirpated (Eastern Brook Trout Joint Venture assessment). There are no potential barriers on this stream, so Rainbow and Brown Trout in upper Sinking Creek could be thinned from about 2,000' up to the Horse Cove area (including the Basil Hollow tributary). Native Brook Trout from the Watauga watershed (e.g., Left Prong Hampton Creek) could then be transplanted to this reach.

#### Upper Granny Lewis Creek

Although this stream once supported Brook Trout, it now has only a wild Rainbow Trout population and no potential barriers. However, Rainbow Trout could be thinned from about 2,800' upstream to about 3,200' (~1 mile), then native fish from a previously-established Tennessee population (e.g., Phillips Hollow or Devil Fork) could be released in this reach. Access is good from an adjacent USFS road.

#### Right Prong Rock Creek

Like Granny Lewis Creek, Right Prong Rock Creek once had Brook Trout but now supports only wild Rainbow Trout. It has no fish barrier, thus Rainbow Trout could be thinned from the mouth upstream to about 2,800', then native Brook Trout from previously-established Nolichucky watershed populations (e.g., Phillips Hollow, Devil Fork, Granny Lewis Creek, etc.) could be introduced.

#### Sycamore Creek

Work by TWRA and the USFS to re-introduce Brook Trout to Sycamore Creek (Tellico River tributary, Region 3) began in the 1990s and currently continues. Ongoing efforts involve removal of existing Rainbow Trout in the lower reaches of Sycamore Creek above the intake dam and supplemental stocking of propagated native Brook Trout from Tellico Hatchery. Results from annual monitoring at three stations (lower, middle, and upper) are used to ensure the continued success of these efforts. While complete removal of Rainbow Trout may not be possible, establishing a sympatric population of Brook Trout in lower Sycamore Creek with densities similar to those further upstream is an attainable ultimate goal.

Successful completion of all 14 Tier 1 and Tier 2 projects listed above would increase Tennessee's native Brook Trout distribution by an estimated 13-15 miles (16-18%) or more during the next decade. It would establish native Brook Trout populations in the Nolichucky watershed (where none exist) and bolster native Brook Trout distribution in the French Broad (currently 12 miles in eight streams) and Little Tennessee (currently 20 miles in nine streams) watersheds.



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