Norris Tailwater
Trout Fishery Management Plan
2020-2025

Tennessee Wildlife Resources Agency

July 2020

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2020-2025

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FOREWORD

Meeting Tennessee's variety of 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. The Statewide Trout Management Plan (STMP) provides guidance for the management of Tennessee's trout fisheries given the current status of wild trout resources and hatchery trout production (TWRA 2017). The Norris Tailwater Management Plan provides goals, strategies, and objectives for managing the trout fishery in this tailwater in accordance with the Mission Statement of the STMP. Other relevant goals, objectives, and strategies of the 2017-2027 STMP supported by this management plan are provided in the appendix and the entire STMP can be viewed at https://www.tn.gov/content/dam/tn/twra/documents/Tennessee-Trout-Management-Plan-2017-2027.pdf.

MANAGEMENT GOAL: Maintain the enhanced opportunity for catching quality-sized trout available to the variety of Norris tailwater anglers.

Quality trout angling opportunities typically involve a better opportunity to catch larger fish (i.e., ≥14 inches) and a variety of species, thus management will continue to focus on these outcomes. This basic goal was developed with public input (including public meetings in 2001 and 2007) and was incorporated in all previous management plans (Habera et al. 2002, 2008, 2014). It continues to apply, given that 82% of Norris tailwater anglers questioned during the 2019 creel survey (n=210) rated TWRA's management of the Norris tailwater as 'good' or 'excellent'.

STRATEGIES:

- **Provide hatchery-supported fisheries for Rainbow Trout *Oncorhynchus mykiss*, Brown Trout *Salmo trutta,* and Brook Trout *Salvelinus fontinalis***
- **Maintain the effective 14-20-inch protected length range (PLR) or "slot limit" regulation for all trout**

TWRA will maintain a hatchery-supported trout fishery during 2020-2025 capable of sustaining at least the recent levels of angling pressure (13,000-17,000 trips/year; Black 2016, 2018). The existing 14-20-inch PLR regulation for all trout will continue to be the primary means for achieving the 'quality' aspect of the Norris tailwater management goal. This regulation has been in place since March 2008 (Habera et al. 2008) and has proven effective at maintaining higher abundances of 14-20-inch trout (as determined by annual monitoring) and improving the relative stock density of trout 14 inches and over (RSD-14). Angling regulations also include a daily creel limit of 7 fish, one of which may exceed 20 inches, and no bait restrictions.

1. BACKGROUND

Hypolimnetic discharges from Norris Dam on the Clinch River in Anderson County create coldwater habitat that permits the tailwater to be managed as a year-round trout fishery. Rainbow Trout were stocked in the tailwater following completion of the dam in 1936 (Tarzwell 1939) and, after 1950, by the Tennessee Game and Fish Commission (Swink 1983) and TWRA. The Tennessee Valley Authority (TVA) began a Reservoir Release Improvements Program (TVA 1980) to address chronic low dissolved oxygen (DO) levels and a lack of minimum flow that had suppressed development of the trout fishery (Boles 1980; Yeager et al. 1987). Turbine hub baffles (Yeager et al. 1987), autoventing systems (Scott et al. 1996), and more recently (2005), liquid oxygen diffusion in the forebay of the dam have improved DO levels. Currently, DO is now maintained at or above the target level of 6 mg/L, particularly during the summer and fall (see table). Additionally, a minimum flow of 200 ft^3/s (cfs) was established in 1984 and is maintained by a re-regulation weir located about 2 miles downstream of the dam (Yeager et al. 1987). Benthic invertebrate abundance and distribution in the tailwater—and

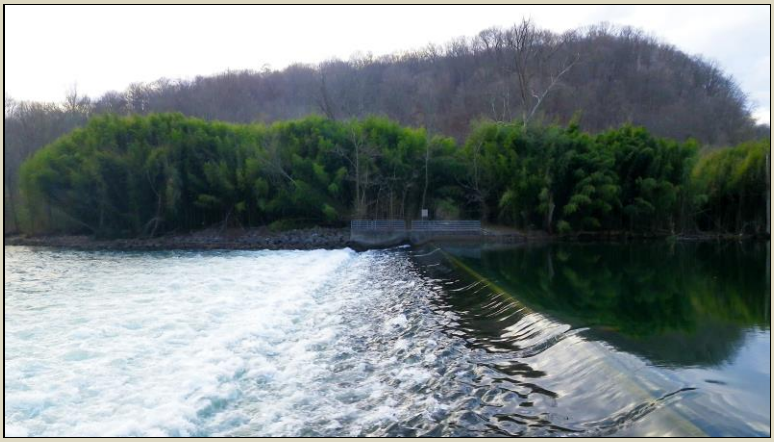
Norris Dam and tailwater, Clinch River

Norris Tailwater DO (mg/L)							
	May	Jun	Jul	Aug	Sep	Oct	Nov
2017							
Canoe portage	10.0	7.8	9.0	7.0	6.1		
Below Weir					5.7		
Boat Ramp Below Weir	10.7	8.0	9.2	7.3	5.8		7.8
Highway 61 Bridge	10.1	9.1	10.2	9.1	7.4		
2018							
Canoe portage		7.5	7.5	8.6	8.6	7.5	7.7
Below Weir			9.1				
Boat Ramp Below Weir	8.9	8.4	7.2	8.4	8.3	7.5	7.8
Highway 61 Bridge		8.6	9.9	8.0	8.9	8.7	9.3
2019							
Canoe portage		14.1	6.3	4.6	5.1	4.8	
Below Weir				4.7		4.7	
Boat Ramp Below Weir		12.3	7.9	5.7	5.2	5.7	
Highway 61 Bridge		12.0	7.2	7.5	5.4	7.0	

Monthly average DO data (grab samples) for 2017-2019 (D. Baxter, TVA)

ultimately trout carrying capacity and condition—improved as DO and minimum flow issues were resolved (Yeager et al. 1987; Scott et al. 1996).

The tailwater now supports a popular 12.5-mi fishery for Rainbow Trout, Brown Trout, and Brook Trout. It is hatchery-supported through annual put-and-take and put-and-grow stocking of both fingerling and adult trout. Bettoli and Bohm (1997) documented a small amount of Rainbow Trout reproduction with minimal recruitment to the tailwater fishery. Clear Creek, which is closed to fishing during November through March to protect spawning fish, was considered a likely source of this reproduction. However, more recent surveys (2018 and 2019) have documented abundant wild age-0 Rainbow Trout in much of the tailwater, suggesting that successful spawning could be occurring outside of Clear Creek and that the fish produced may be a more significant component of the fishery than previously understood. Accordingly, a multi-year research project through the Tennessee Cooperative Fisheries Research Unit (TN CFRU) at Tennessee Tech University is underway to investigate the roles and performance of wild and stocked Rainbow Trout fingerlings in the Norris tailwater. If natural reproduction by Rainbow Trout does substantially contribute to this fishery, then the fingerling Rainbow Trout stocking strategy would be adjusted accordingly.



Norris tailwater weir dam

Earlier (1995-2005), TN CFRU completed numerous studies focusing on the Norris tailwater trout fishery. These included fate, dispersal, and persistence of stocked Rainbow Trout (Bettoli and Bohm 1997), seasonal movements (Bettinger and Bettoli 2000), spawning habitat, growth, and fecundity of Brown Trout (Holbrook and Bettoli 2006), trout predation by Striped Bass (Bettoli 2000), a review of management options (Bettoli 2001), and several angler surveys (Bettoli 2002, 2006; Hutt and Bettoli 2003). Consequently, no other tailwater trout fishery in Tennessee has been the subject of more research.

2. CURRENT TROUT FISHERY STATUS

2.1 Abundance

TWRA monitors the Norris tailwater trout fishery at 12 boat electrofishing stations (Figure 2-1) in late February or March each year to provide an assessment of carry-over trout populations before stocking begins (see Habera et al. 2019 for additional sample site details). These 12 stations are sampled (600 s each; 2 h of total effort) at night during a flow of approximately 3,100 cfs (one unit operating at Norris Dam). Electrofishing catch per unit effort (CPUE) estimates (fish/h) for trout ≥7 inches (the minimum size considered fully recruited to the sampling gear and technique) and in the 14-20-inch size range (i.e., within the PLR) are calculated, along with relative weights (W_r) and relative stock densities for trout ≥14 inches (RSD-14).

Night electrofishing survey on Norris tailwater

Processing trout during a Norris tailwater survey

The mean electrofishing catch rate for all trout ≥7 inches for the Norris tailwater has typically ranged from 150-200 fish/h (mean, 188 fish/h) since the establishment of the PLR regulation in 2008 (Figure 2-2). This is primarily a Rainbow Trout fishery, with an average post-PLR relative abundance of 76% Rainbow Trout (mean CPUE = 143 fish/h) and 22% Brown Trout (mean CPUE = 41fish/h). Brook Trout have never represented more than 5% of the fish captured in any monitoring sample since their introduction to the fishery in 2008 and have only occasionally reached a 5-fish/h CPUE (Figure 2-3). The 2014-2019 mean CPUE for Brook Trout (2.7 fish/h) did not attain the corresponding management plan objective (5 fish/h, Habera et al. 2014). However, annual Brook Trout stocking rates during 2014-2019 were often below the prescribed level (20,000; Section 2.4). Pre-PLR CPUEs (i.e., those prior to 2009) for all trout ≥7 inches were somewhat lower on average (137 fish/h), but there has been no particular increase in

overall trout abundance since 2008. The intent of the PLR regulation is to increase the abundance of larger trout (i.e., 14-20 inches) through a shift in population size structure (Section 2.2), not by means of an overall increase in abundance.

23-inch Norris tailwater Rainbow Trout

28-inch, 8.6 lb. Norris tailwater Brown Trout

11-inch Norris tailwater Brook Trout

The mean electrofishing CPUE for all 14-20-inch trout increased substantially following implementation of the PLR in 2008 and reached 90 fish/h in 2019 (Figure 2-4). Mean PLR CPUE has typically exceeded 50 fish/h since 2011 (Figure 2-4) and averaged 76 fish/h during 2014-2019, which exceeded the objective for that management plan (28 fish/h; Habera et al. 2014) by nearly a factor of 3. Furthermore, the 2019 catch rate for fish within the PLR represented more than a 25-fold increase from the 2008 level (3.5 fish/h). These results indicate that the PLR has been effective at both increasing and maintaining the abundance of larger trout in the tailwater—which achieves the management goal. The PLR primarily targets Rainbow Trout and while they have provided most of the increase in the PLR catch rate (Figure 2-4), the mean CPUE for 14-20-inch Brown Trout has also increased from 4 fish/h (pre-PLR) to 7 fish/h since 2008. No Brook Trout within (or above) the PLR have been captured to date during annual monitoring, although there have been anecdotal reports of a few being caught by anglers.

The PLR might also be expected to ultimately produce more trout >20 inches given the substantial increase in the abundance of 14-20-inch fish. However, there do not appear to be any well-defined or sustained CPUE increases for trout >20 inches during the 11 years since establishment of the PLR (Figure 2-5). A

regression line fitted to the post-2008 CPUE data for Brown Trout does have a positive slope (Figure 2-5), suggesting they may have some long-term potential for increasing the overall abundance of fish >20 inches. Rainbow Trout >20 inches have been relatively uncommon in pre- and post-PLR monitoring samples and there is currently little expectation that they could contribute to any overall increase in abundance of fish outside the upper boundary of the PLR (Figure 2-5; Section 2.3).

2.2 Relative Stock Density (RSD-14)

Relative stock densities for trout ≥14 inches (RSD-14) are based on a stock size of 10 inches for both Rainbow Trout and Brown Trout (Willis et al. 1993). RSD-14 was below 50 for both species and typically below 30 for Rainbow Trout prior to establishment of the PLR in 2008 (Figure 2-6). Subsequently, RSD-14 for both species has improved, with values often exceeding 50 and seldom failing to reach at least 30 since 2011(Figure 2-6). Consistently higher RSD-14 values since implementation of the PLR indicate that trout population size structures have shifted toward larger fish (≥14 inches) (Figure 2-6)—which is what PLR regulations are designed to accomplish. An RSD-14 value of 50 indicates that 50% of all stock-size trout—those at least 10 inches in length—are 14 inches or larger and is representative of a trout fishery with an exceptional proportion of larger fish. Ideally, management of the Norris tailwater will maintain these higher RSD-14 levels (e.g., 40-50), particularly for Rainbow Trout.

Norris Tailwater PLR Effect

	Mean CPUE (fish/h 14-20 inches)			Mean RSD-14	
	Rainbow	Brown	Total	Rainbow	Brown
Pre-PLR	15	4	19	24	29
Post-PLR	50	7	57	43	36

Effects of the PLR regulation on the Norris tailwater trout fishery

2.3 Relative Weight (W_r)

Relative weights (W_r) provide an index of body condition, with a W_r of 100 considered ideal and values approaching 70 considered low and suggestive of poor health or insufficient food resources (Blackwell 2000). Mean W_r for Norris tailwater Rainbow Trout declines to 80 for 16-inch fish and to nearly 70 for 20-inch fish (Figure 2-7). Some larger Rainbow Trout are in a 'post-spawn' condition when annual monitoring occurs (late winter), which would lower W_r, but the general scarcity of fish ≥20 inches suggests that low W_r may limit survival to these larger sizes. Elsewhere, only the Boone and Ft. Patrick Henry tailwaters routinely produce Rainbow Trout ≥20

inches with W_r ≥100 (Habera et al. 2018). Smaller Rainbow Trout (7-14-inch size classes) from Norris tailwater have an annual mean W_r near or above 90. Mean Brown Trout W_r, however, increases as size increases in the Norris tailwater (as in other Region 4 tailwaters), and surpasses100 for fish ≥18 inches (Figure 2-7). Piscivory is more prevalent among Brown Trout than Rainbow Trout (Yard et al. 2011; Arismendi et al. 2012) and can increase Brown Trout growth rates and longevity (Jonsson et al. 1999; Hughes et al. 2018); therefore, it likely affects condition (i.e., W_r) as well. An investigation of factors influencing condition of Tennessee's tailwater Rainbow Trout and Brown Trout (particularly larger fish) would benefit management—especially when considering size regulations.

2.4 Stocking

Over 50 years ago, Pfitzer (1962) recommended annual stocking rates for the Norris tailwater of 50,000 Rainbow Trout (including 40,000 fingerlings) and 4,000 Brown Trout—the highest for any east Tennessee tailwater at that time. Annual trout stocking rates for the Norris tailwater have increased since then (to about 237,000/year) and remain the highest among all Tennessee tailwaters. Prescribed annual stocking rates during 2014-2019 (Habera et. al 2014) were 197,000 Rainbow Trout (160,000 4-5-inch fingerlings and 37,000 9-12-inch adults), 40,000 Brown Trout (6-8-inch sub-adults) and 20,000 Brook Trout (8-9-inch adults). Interestingly, Pfitzer (1962) did not recommend stocking Brook Trout as both adults and fingerlings had performed poorly in the six tailwaters where they were stocked in the 1950s (including Norris).

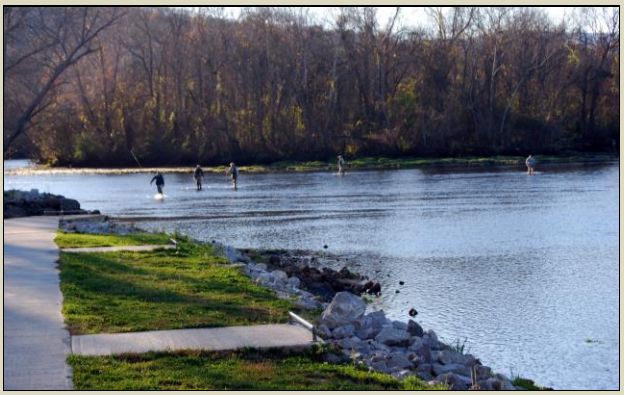
Annual stocking rates during the previous management plan cycle varied from prescribed rates because of seasonal water quality issues at Dale Hollow National Fish Hatchery (DHNFH) and inconsistent availability of Brook Trout. Poor water quality conditions at DHNFH in November 2016 made it necessary to stock the 2017 fingerling Rainbow Trout allotment that month, thus increasing the 2016 stocking rate (Figure 2-8). Subsequent fingerling stocking rates in 2017 and 2018 were reduced to compensate and maintain the prescribed annual rate (160,000, Habera et al. 2014). Additionally, the 2019 fingerling stocking rate was reduced to 111,000 to accommodate marking these fish (adipose fin clips) for the TN CFRU research project. The return of poor water quality conditions at DHNFH in November 2017 necessitated stocking all the 2018 Brook Trout allocation that month. No Brook Trout were stocked in 2015 or 2018 (Figure 2-8) because of extremely limited availability. Reduced availability of Brook Trout from DHNFH during 2014-2019 lowered the average annual stocking rate for the Norris tailwater to 12,000 instead of the 20,000 prescribed in the management plan (Habera et al. 2014). Consequently, the reduced stocking

rates likely affected annual monitoring catch rates and attainment of the associated management objective to 2014-2019 (Figure 2-3; Section 2.1)

2.5 Angler Use

Roving creel surveys conducted by TWRA in 2015 (Black 2016), and 2017 (Black 2018) indicated that pressure and trips (Figure 2-9), along with catch and harvest (Figures 2-10 and 2-11) decreased over that two-year period. Pressure, catch, and harvest were also below the levels observed during the 2013 survey (Black 2014; Figures 2-9, 2-10, and 2-11). However, average trout catch rates (fish/h) were similar for the three surveys (1.08, 1.15, and 1.01 for 2013-2017), with catch rates over 0.7 fish/h generally considered representative of good fishing (McMichael and Kaya 1991; Wiley et al. 1993). Average catch decreased by about 1 fish/trip from 2013 to 2017—mainly because trip length decreased (from 3.94 to 3.20 h). The overall trout harvest rate declined from the 23% in 2013 to 13% in 2017 (Figure 2-12) and is similar to the most recent trout harvest rates for the South Holston (13%; Black 2018) and Wilbur (10%; Black 2017) tailwaters. The average number of trout harvested by Norris tailwater anglers has also decreased from 1 fish/trip in 2013 to about 1 fish/2 trips in 2017. Rainbow Trout represented the majority of catch (56-70%) and harvest (55-73%) during the 2013-2017 creel surveys, followed by Brown Trout and Brook Trout (Figure 2-10). Brook Trout harvest exceeded that for Brown Trout in 2017, likely as a result of the relatively high stocking rate that year (Section 2.4).

Norris tailwater drift boat anglers



Norris tailwater anglers at Miller Island

An angler survey was completed on the Norris tailwater in 2019 and results will be available for inclusion in TWRA's 2020 Trout Fisheries report. Anglers were asked supplemental

opinion questions in 2019 including how they view the PLR regulation and TWRA's overall management of the fishery. Preliminary results indicate that 59% (n=210) mostly or completely support the 14-20-inch PLR, while only 11% mostly or completely oppose it. Additionally, 82% of those same anglers rated TWRA's management of the Norris tailwater trout fishery as good or excellent, while only 1% considered it fair or poor. Lengths of harvested trout were recorded during the 2019 survey and anglers were asked to categorize the size of trout they released (as below, in, and above the PLR). Preliminary results (288 angler surveys) indicate that 35% of Rainbow Trout and 14% of Brown Trout caught were in the PLR, while about 2% of Rainbow Trout and 1% of Brown Trout were above the PLR (>20 inches). Seven trout >20 inches were caught by these anglers (5 Rainbow Trout and 2 Brown Trout), but only one Rainbow Trout was harvested (14%).

2.6 *Myxobolus cerebralis* Screening

Cranial deformity of a Rainbow Trout from S. Holston tailwater (top)—a common clinical sign of infection by the whirling disease parasite (M. cerebralis)—compared to the typical appearance of an uninfected Rainbow Trout (bottom).

Detection of *Myxobolus cerebralis*, the parasite that causes whirling disease, in the South Fork Holston and Wilbur tailwaters in 2017 prompted TWRA to begin screening many of the trout fisheries it manages, including the Norris tailwater. Fingerling Rainbow Trout from the weir dam area (45) and Llewelyn Island (23) were collected in August 2018 and examined for *M. cerebralis* by the Southeastern Cooperative Fish Parasite and Disease Lab (SCFPDL) at Auburn University. Results were negative, but it will be important to periodically screen fish from this and other tailwaters for *M. cerebralis*, as well as to keep anglers informed of the importance of taking biosecurity measures to prevent introducing this parasite where it doesn't occur. These measures include cleaning waders and fishing gear and not moving potentially infected fish (especially those used as bait). Accordingly, the Tennessee Fish and Wildlife Commission restricted the use (as bait) of wild-caught trout from *M. cerebralis*-positive waters to the waters where they were harvested (effective March 1, 2020).

Norris Tailwater

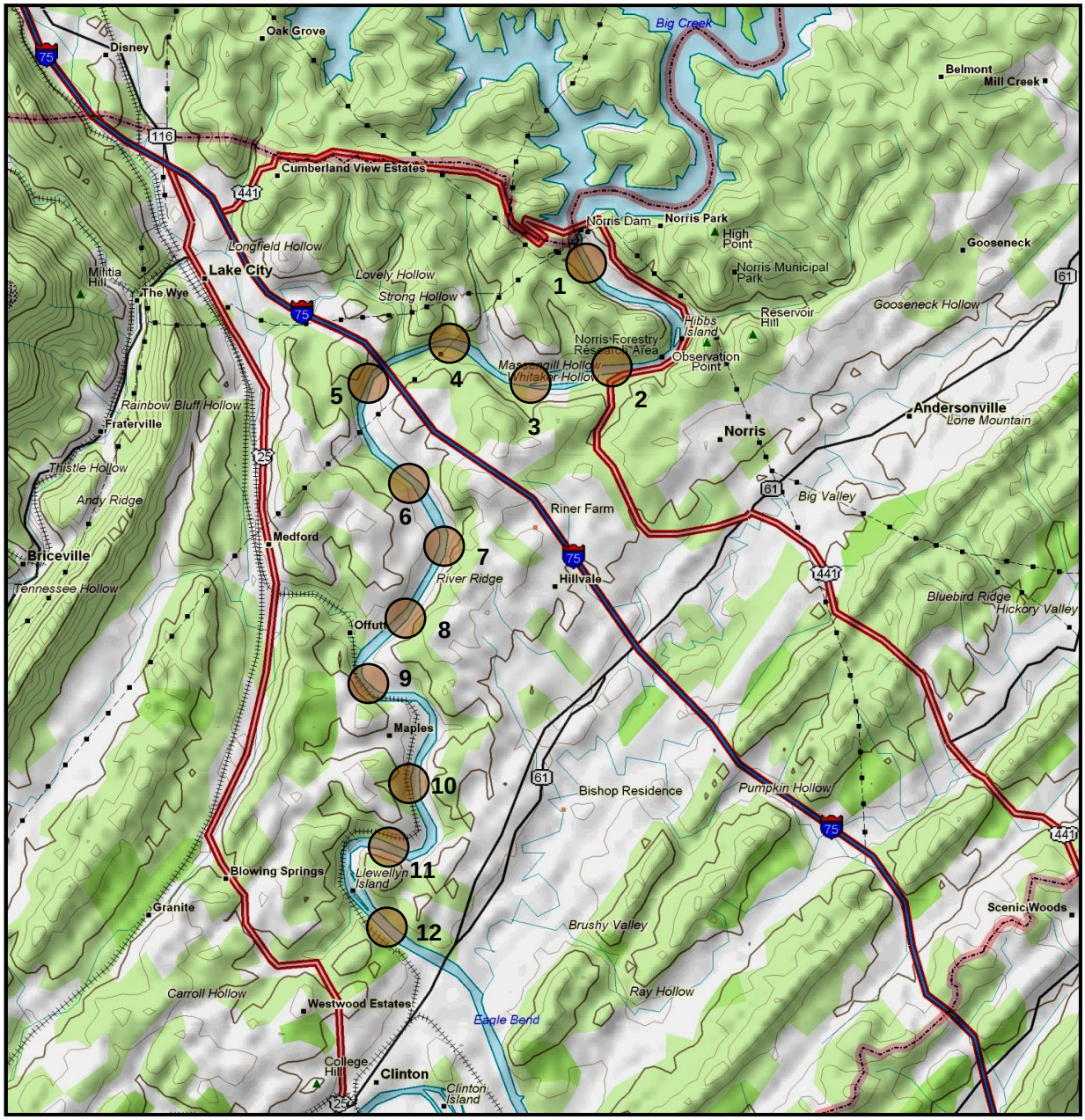


Figure 2-1. Locations of the 12 annual monitoring stations on the Norris tailwater (Clinch River).

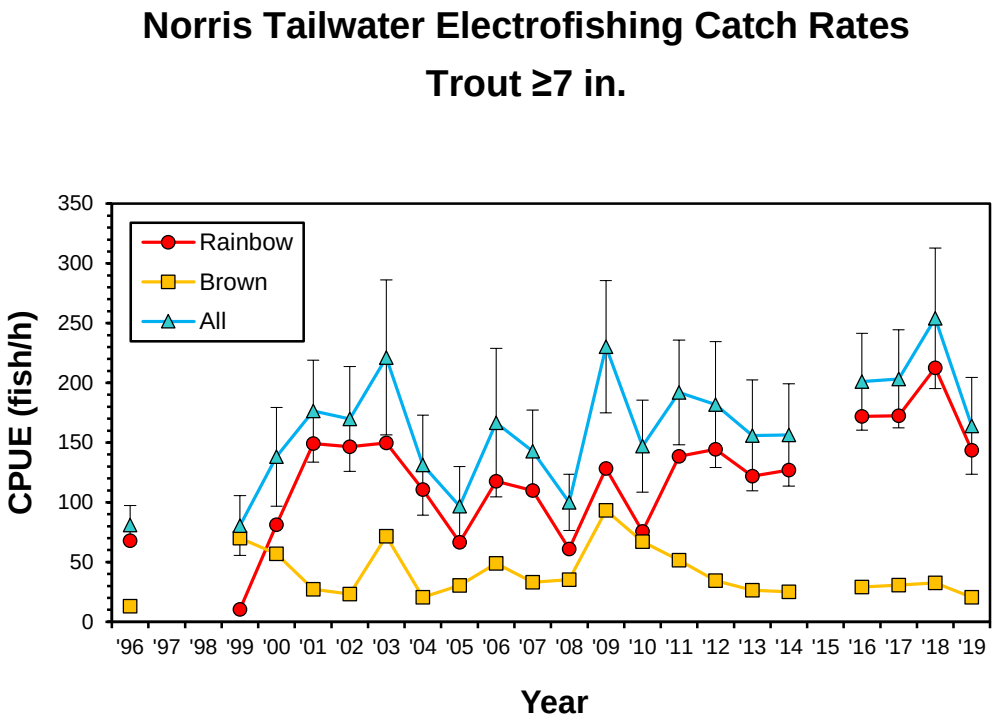


Figure 2-2. Mean electrofishing catch per unit effort (CPUE) for trout ≥7 in. for the Norris tailwater. Bars indicate 90% confidence intervals. CPUE data for 'All' includes Brook Trout.

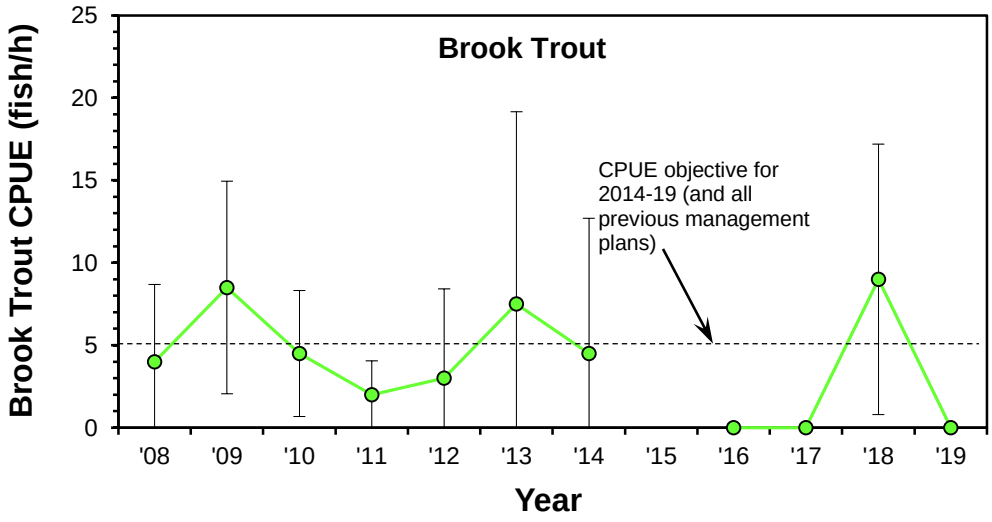


Figure 2-3. Mean electrofishing catch per unit effort (CPUE) for Brook Trout ≥7 in. for the Norris tailwater. Bars indicate 90% confidence intervals. Mean CPUE for 2014-2019 was 2.7 fish/h.

Norris Tailwater Electrofishing Catch Rates
Trout 14-20 in. (PLR) and ≥20 in.

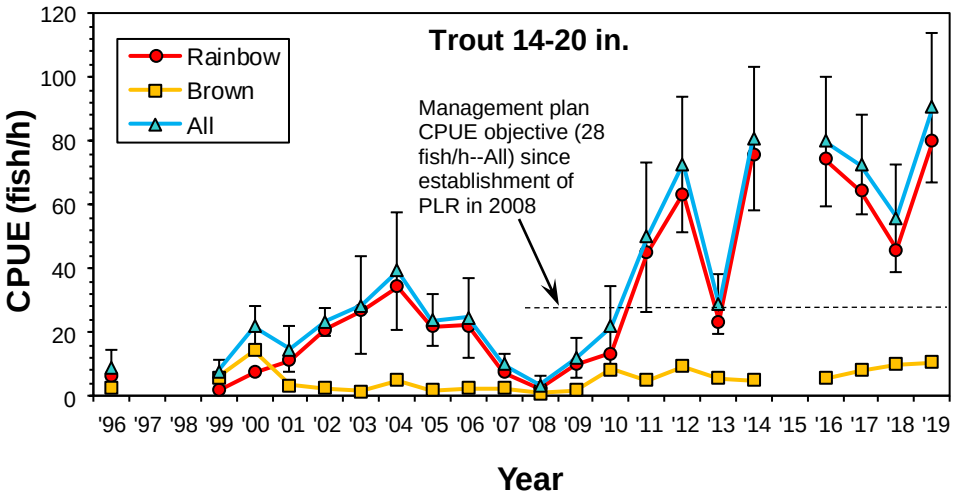


Figure 2-4. Mean electrofishing catch per unit effort (CPUE) for Norris tailwater trout in the 14-20 in. PLR. Bars indicate 90% confidence intervals. No 14-20-in. Brook Trout have been captured.

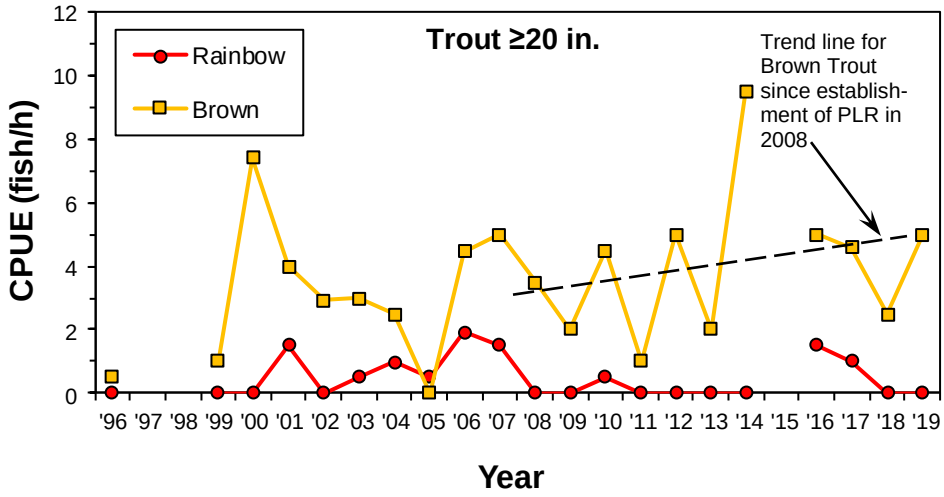


Figure 2-5. Mean electrofishing catch per unit effort (CPUE) for Norris tailwater trout ≥20 in. Dashed line is Brown Trout CPUE trend (linear regression) since 2008. No Brook Trout ≥20 in. have been captured.

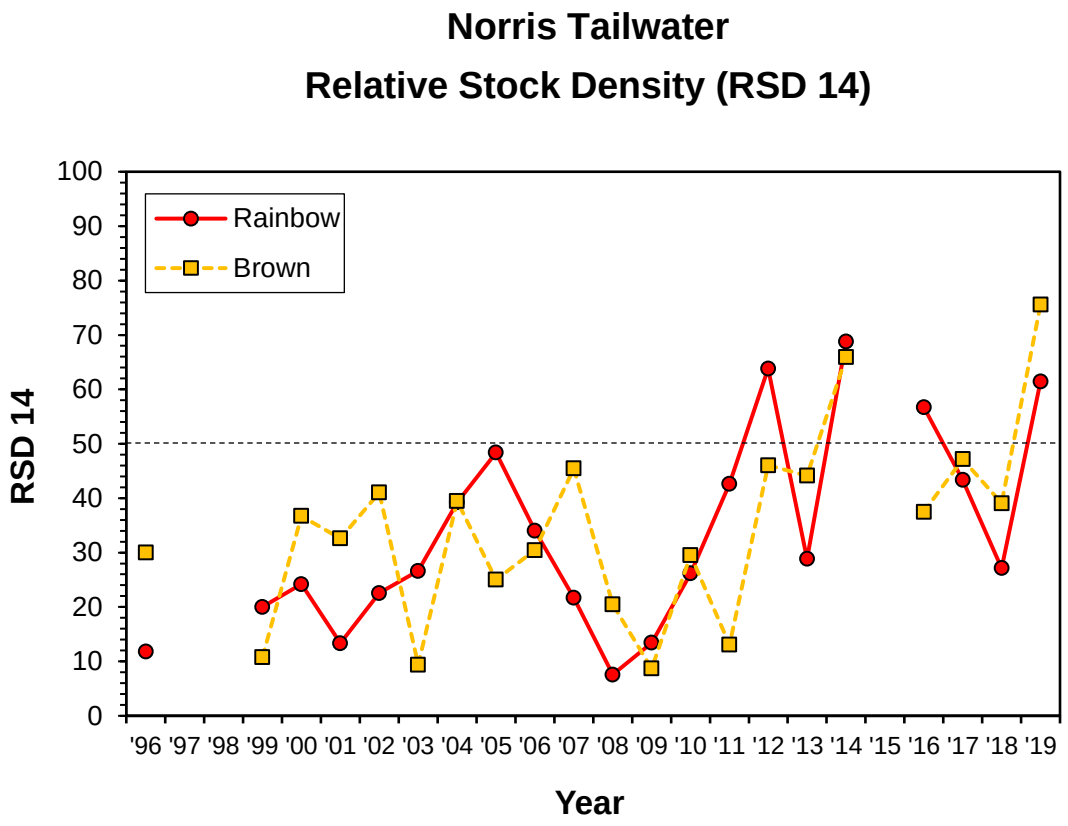


Figure 2-6. Relative stock densities for Norris tailwater Rainbow Trout and Brown Trout ≥14 in. (RSD 14) for 1996-2019.

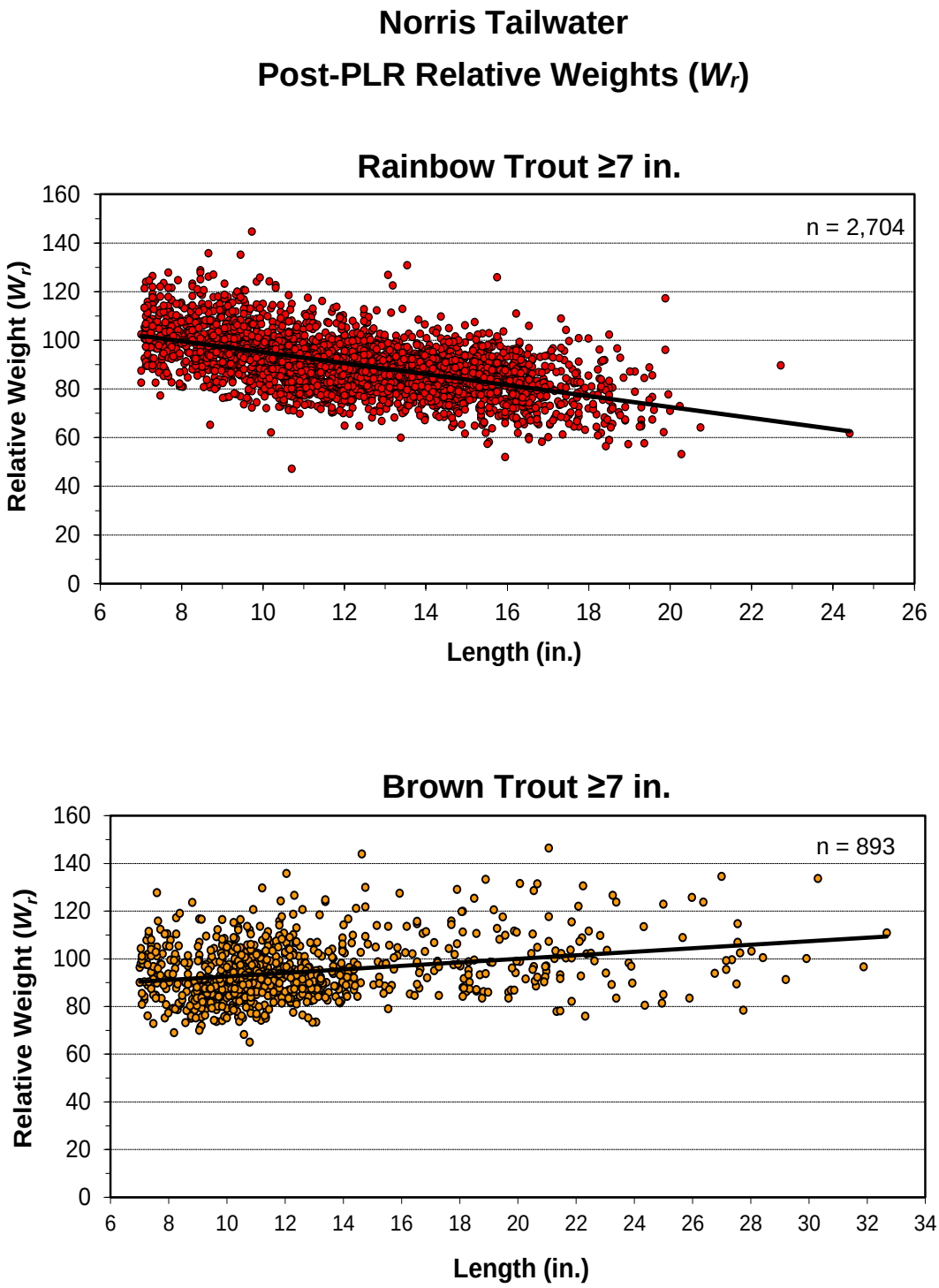


Figure 2-7. Relative weight (W_r) scatter plots with trend lines for Rainbow Trout and Brown Trout (≥7 in.) from the Norris tailwater during 2008-2019 (post-PLR).

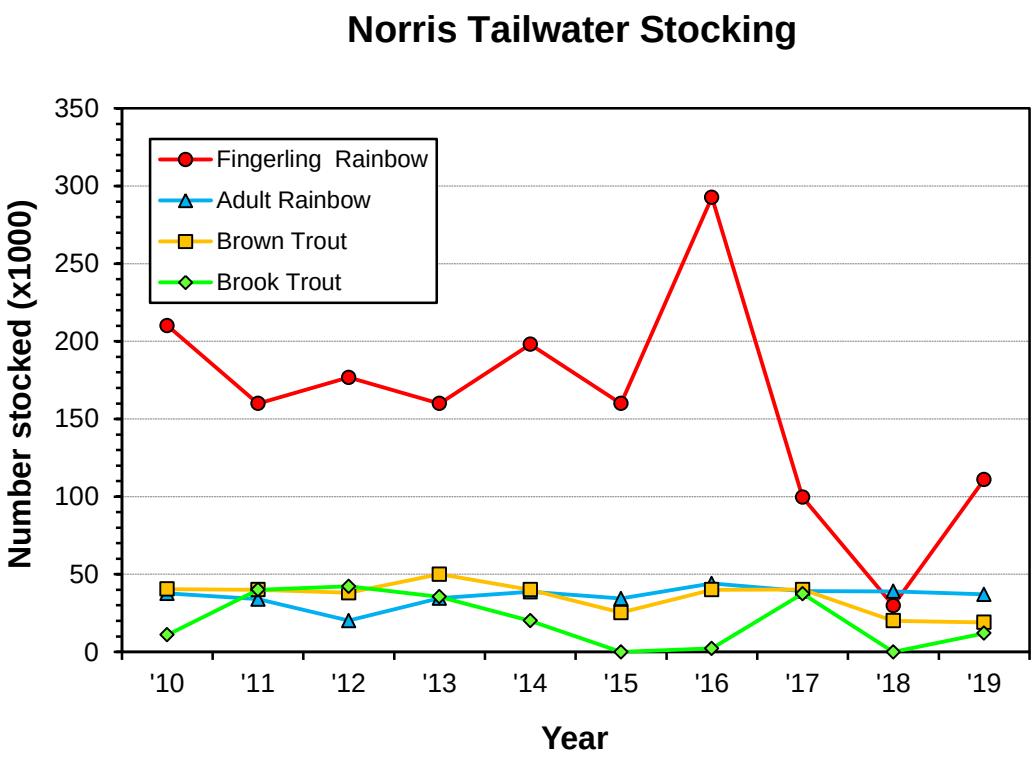


Figure 2-8. Trout stocking rates for the Norris tailwater (2010-2019). Poor water quality at Dale Hollow National Fish Hatchery during November 2016 made it necessary to stock the 2017 fingerling Rainbow Trout allocation that month and reduce subsequent stocking rates in 2017 and 2018 to compensate. The 2019 fingerling stocking rate was reduced to 111,000 to accommodate marking (fin clips) for the TN CFRU research project.

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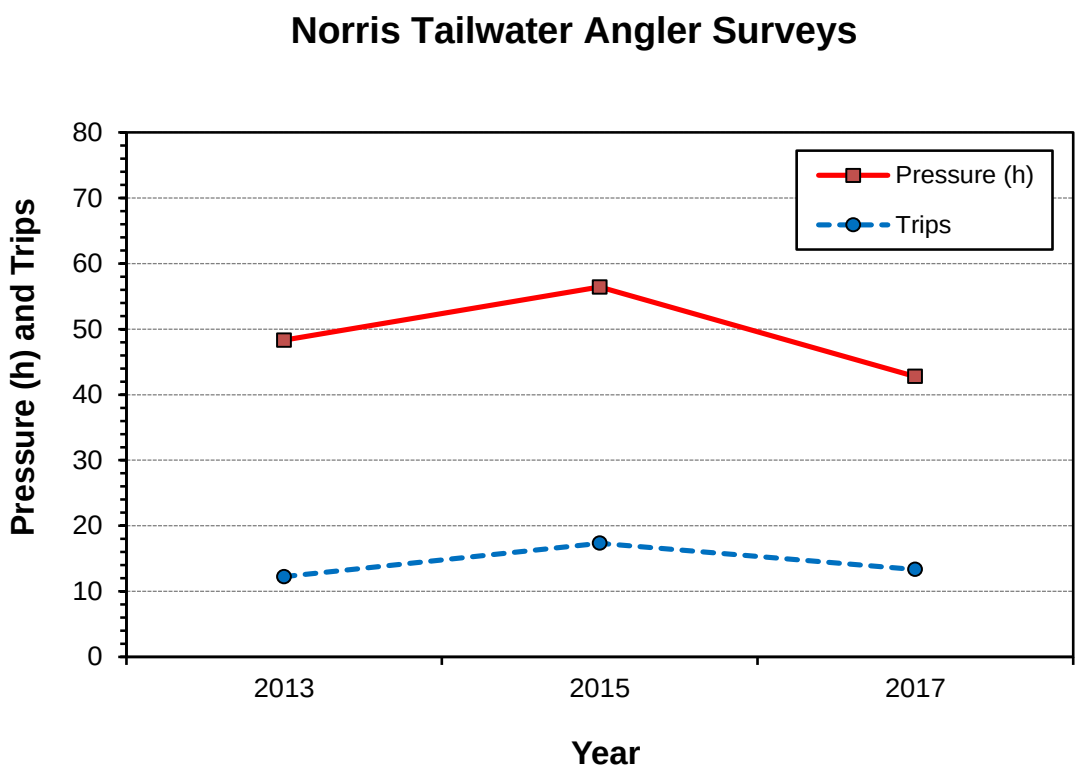

Figure 2-9. Estimated angling pressure and trips for the Norris tailwater from the most recent creel surveys (2013, 2015, and 2017).

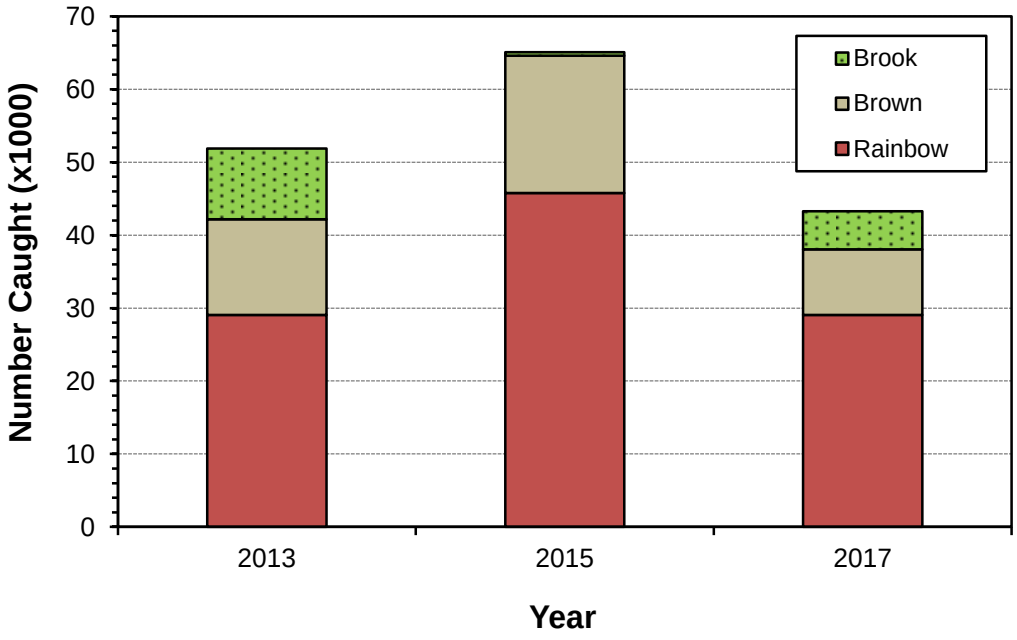

Figure 2-10. Catch estimates for the Norris tailwater from the most recent creel surveys (2013, 2015, and 2017).

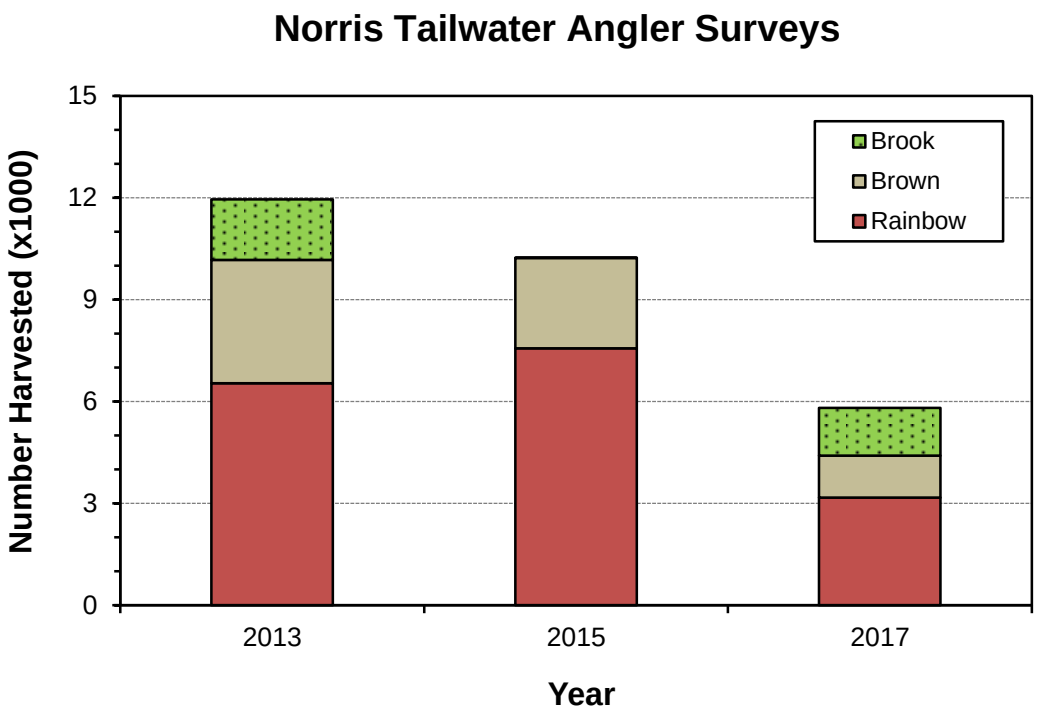

Figure 2-11. Harvest estimates for the Norris tailwater from the most recent creel surveys (2013, 2015, and 2017).

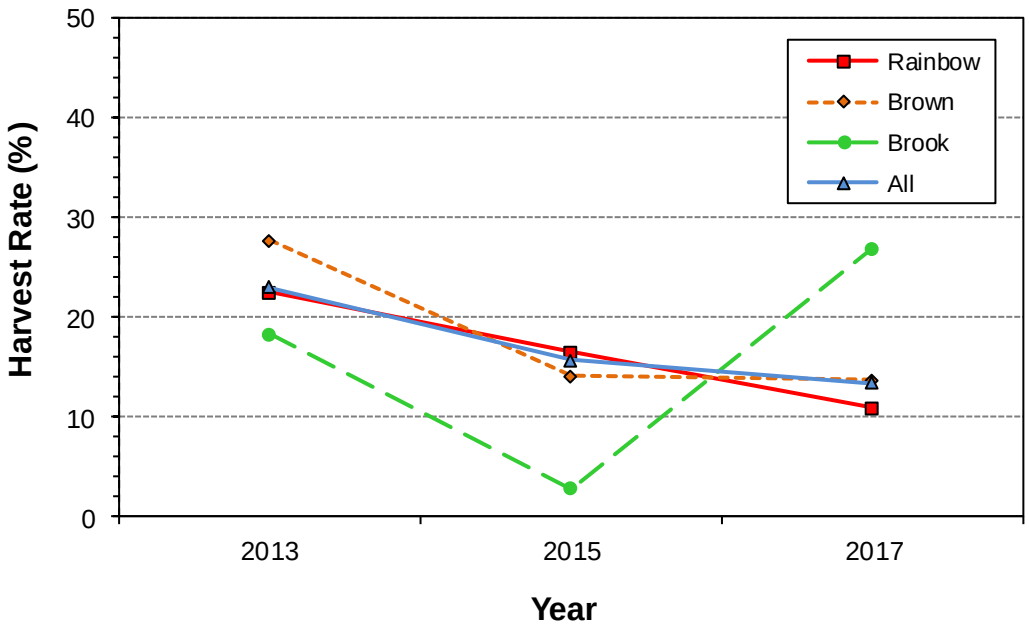

Figure 2-12. Harvest rates (% of fish caught) for the Norris tailwater from the most recent creel surveys (2013, 2015, and 2017).

3. MANAGEMENT OBJECTIVES AND RECOMMENDATIONS

The management goal for the Norris tailwater is to ***"Maintain the enhanced opportunity for catching quality-sized trout available to the variety of Norris tailwater anglers".*** Based on this goal and the current status of the Norris tailwater trout fishery, corresponding objectives during 2020-2025 will be:

OBJECTIVES:
1. ***Mean electrofishing CPUE for trout in the PLR (14-20") of ≥56 fish/h***
2. ***Mean RSD-14 of ≥45 for both Rainbow Trout and Brown Trout***
3. ***Identify the optimal fingerling Rainbow Trout stocking rate***
4. ***Address existing and potential biosecurity threats to the trout fishery***

<u>Objective 1:</u> A *mean electrofishing CPUE for trout in the PLR (14-20") of ≥56 fish/h*

Primary objectives for previous Norris tailwater management plans have been to improve and then maintain the abundance of larger trout (≥14 inches) in the fishery through the PLR regulation. Mean electrofishing CPUE for trout in the PLR during annual monitoring has been used to assessing these objectives. Given that the response to the PLR regulation—as indicated by mean electrofishing CPUE for 14-20-inch fish—has been substantial and well-sustained, the previous objective (28 fish/h; Habera et al. 2014) is increased to 56 fish/h for 2020-2025. This new objective is the mid-point between the lowest (22 fish/h) and highest (90 fish/h) PLR CPUE for the past 10 years (2011-2019) and should better reflect the fishery's potential. Consumption-oriented anglers will continue to have ample harvest opportunities with the PLR regulation, as stocked Rainbow Trout adults are 9-12 inches and one fish >20 inches can be taken per day. The PLR focuses on Rainbow Trout because they are the primary component of the Norris tailwater trout fishery and have represented 62% of harvest over the past three angler surveys (2013, 2015, and 2017). Monitoring data indicate that the PLR has benefitted Brown Trout as well. This objective supports STMP Angling Opportunities Goal 1 (maintain a variety of trout fisheries) Strategy 3 (maintain or modify) existing regulations designed to diversify angling experiences.

<u>Objective 2:</u> A *mean RSD-14 of ≥45 for both Rainbow Trout and Brown Trout*

The intent of PLR regulations is to shift population size structures toward larger fish. Data indicate that mean RSD-14 has increased from 24 to 43 for Rainbow Trout and from 29 to 36 for Brown Trout since establishment of the PLR regulations in 2008. Even more notable is that mean RSD-14 was slightly above 50 for both species during the previous management plan term (2014-

2019). Therefore, the PLR has been successful at improving trout population size structures and anglers are catching these larger fish (Section 2.5)—thus achieving the Norris tailwater's overall management goal. By comparison, mean RSD-14 values for both Rainbow Trout and Brown Trout from the South Holston and Wilbur tailwaters during 2014-2019 have been in the 11-18 range. Mean RSD-14 for the Norris tailwater after 2010—when the PLR had fully taken effect—is 47 for Rainbow Trout and 44 for Brown Trout, thus the objective of 45 for both species will be used during this management plan term (2020-2025). This objective supports STMP Angling Opportunities Goal 1, Strategy 3.

Objective 3: Identify the optimal fingerling Rainbow Trout stocking rate

An important objective of this management plan will be to determine an optimum annual fingerling Rainbow Trout stocking rate, given the unknown level of natural reproduction and its recruitment to the fishery. The multi-year TN CFRU project currently underway will address this objective and should provide the necessary information for the next Norris tailwater management plan update. Management of the Norris tailwater's Rainbow Trout fishery has been based on the understanding that it is primarily supported by fingerling stocking, although the long-standing annual stocking rate (160,000) has not been evaluated. If substantial numbers of wild Rainbow Trout are now recruiting to the fishery, fingerling stocking can be reduced accordingly, and those fish used where they can provide a greater benefit. This objective addresses the STMP Hatchery-Supported Fisheries Goal 1, Strategies 1 and 2.

Recommended annual Norris tailwater trout stocking rates for 2020-2025 are provided below. The fingerling Rainbow Trout stocking rate is set at 110,000 to facilitate marking these fish during the TN CFRU research project. It will be important to adhere to these stocking rates so management plan objectives can be properly evaluated.

- 37,000 adult (9-12 inches) Rainbow Trout (March-August)
- 110,000 fingerling (4-5 inches) Rainbow Trout (March)
- 40,000 sub-adult (6-8 inches) Brown Trout (March-April)
- 20,000 adult (8-9 inches) Brook Trout (June, depending upon availability)

Brook Trout are retained in the 2020-2025 stocking allocations even though they attain low abundances in the fishery (CPUE ≤5 fish/h during annual monitoring) and have shown essentially no potential for reaching the PLR size range. They provide a relatively unique facet to the fishery and anglers do catch and harvest them—including anglers who otherwise might not have

opportunities to catch Brook Trout. This generally supports the STMP Angling Opportunities Goal 1 (maintain a variety of trout fisheries).

Objective 4: Address existing and potential biosecurity threats to the trout fishery

Results of recent screening for the parasite that causes whirling disease (*Myxobolus cerebralis*) were negative for the Norris tailwater (Clinch River), but *M. cerebralis* does occur in the South Holston and Wilbur tailwaters. *Didymosphenia geminata* (*Didymo*)—the stalked, mat-forming diatom that can cover stream bottoms—is present in the Norris tailwater. It was first identified in Tennessee in 2004 and has also been documented in the Cherokee, South Holston, and Wilbur tailwaters in Region 4 (Murdock et al. 2016). Murdock and Knorp (2016) found that *Didymo* mats changed what macroinvertebrates and trout consumed in Tennessee streams when mat coverage was >50% but did not greatly impact food webs when coverage was low (<20%)—such as in the Norris tailwater. The quality of the Norris tailwater trout fishery has markedly improved in the presence of *Didymo* (Sections 2.1 and 2.1), thus *Didymo* does not appear to have had a negative impact. However, its effects have been inconsistent (Murdock and Knorp 2016) and it would certainly be an unwelcome addition to any unaffected system.

Aquatic nuisance species (ANS) signs will be posted at access points on the Norris tailwater to inform anglers of potential threats to the resource, how they can be avoided, and what to do if a potential ANS is observed (supports STMP Biosecurity Goal 1, Strategies 1 and 2). Screening for *M. cerebralis* through TWRA's partnership with the SCFPDL should be conducted periodically (at least every three years) so that appropriate action can be taken (Section 2.6) if *M. cerebralis* is detected (supports STMP Biosecurity Goal 1, Strategy 3).

Other Recommendations:

Sampling of the 12 Norris tailwater monitoring stations should continue annually to track PLR CPUE and RSD-14. Angler surveys should be conducted on a biannual basis during the 2020-2025 management plan term to complement monitoring data and further develop and refine management strategies (supports STMP Angling Opportunities Goal 1, Strategy 6 and Outreach Goal 1, Strategy 2). A new survey is underway in 2020, thus additional surveys should be conducted in 2022 and 2024. Length data for harvested trout will be collected during angler surveys, along with the number of trout ≥14 inches caught and released. This will help determine if higher electrofishing CPUEs for trout in the PLR are reflected by higher angler catch rates for these quality-sized fish (the ultimate management goal). An assessment of management objective accomplishments will be made following completion of the 2025 monitoring efforts and

strategies will be adjusted, if necessary, to continue meeting the Norris tailwater management goal.

TWRA will routinely communicate with TVA regarding tailwater and forebay DO levels and work with TVA to help attain the 6 ppm DO target. This will help protect the quality trout fishery that has been cooperatively developed, particularly in the fall when lake destratification can impact DO in the upper portion of the tailwater (supports STMP Habitat Protection Goal 2, Strategy 3).

Any opportunities for developing new angler access areas on the Norris tailwater (or enhancing existing areas) should be pursued with TVA and other landowners. Improving angler access, particularly on tailwaters, is an important goal of the STMP (Angling Opportunities Goal 2, Strategies 2 and 3).

4. REFERENCES

Arismendi, I., J. González, D. Soto, and B. Penaluna. 2012. Piscivory and diet overlap between two non-native fishes in southern Chile. Austral Ecology 37(3):346-354.

Bettinger, J. M., and P. W. Bettoli. 2000. Movements and activity of Rainbow Trout and Brown Trout in the Clinch River, Tennessee, as determined by radio-telemetry. Fisheries Report No. 00-14. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W. 2000. Potential impacts of the striped bass on the trout fishery in the Norris Dam tailwater. Fisheries Report No. 00-31. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W. 2001. Management alternatives for the trout fishery in the Clinch River below Norris Dam. Fisheries Report No. 01-04. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W. 2002. Clinch River creel survey results: March-October 2001. Fisheries Report No. 02-01. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W. 2006. Clinch River creel survey results: April-October 2005. Fisheries Report No. 06-08. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Bettoli, P. W., and L. A. Bohm. 1997. Clinch River trout investigations and creel survey. Fisheries Report No. 97-39. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Black, W. P. 2014. Tennessee Statewide Creel Survey: 2013 Results. Final report, Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Black, W. P. 2016. Tennessee Statewide Creel Survey: 2015 Results. Fisheries Report No. 16-09. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Black, W. P. 2017. Tennessee Statewide Creel Survey: 2016 Results. Fisheries Report No. 17-07. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Black, W. P. 2018. Tennessee Statewide Creel Survey: 2017 Results. Fisheries Report No. 18-06. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Blackwell, B. G., M. L. Brown, and D. W. Willis. 2000. Relative weight (W_r) status and current use in fisheries assessment and management. Reviews in Fisheries Science 8(1): 1–44.

Boles, H. D. 1980. Clinch River (Norris tailwater) trout fishery investigations 1971-1977. Fisheries Resources Internal Report (Interim Summary Report). U. S. Department of Interior, Fish and Wildlife Service.

Habera, J. W., R. D. Bivens, and B. D. Carter. 2014. Management plan for the Norris Tailwater trout fishery 2014-2019. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., S. J. Petre, B. D. Carter, and C. E. Williams. 2018. Management plan for the Boone and Fort Patrick Henry tailwater trout fisheries 2019-2024. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., S. J. Petre, B. D. Carter, and C. E. Williams. 2019. Region IV trout fisheries report: 2018. Fisheries Report No. 19-08. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Holbrook, C., and P. W. Bettoli. 2006. Spawning habitat, length at maturity, and fecundity of Brown Trout in Tennessee tailwaters. Fisheries Report No. 06-11. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Hughes, M. R., O. E. Hooker, T. E. van Leeuwen, A. Thorne, P. Prodöhl, and C. E. Adams. 2018. Alternative routes to piscivory: Contrasting growth trajectories in Brown Trout (*Salmo trutta*) ecotypes exhibiting contrasting life history strategies. Ecology of Freshwater Fish 2018:1-7.

Hutt, C. P., and Bettoli, P. W. 2003. Recreational specialization, preferences, and management attitudes of trout anglers utilizing Tennessee tailwaters. Fisheries Report No. 03-01. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Jonsson, N., T. F. Næsje, B. Jonsson, R. Saksgård, and O. T. Sundlund. The influence of piscivory on life history traits of Brown Trout. 1999. Journal of Fish Biology 55:1129-1141.

McMichael, G. A., and C. M. Kaya. 1991. Relations among stream temperature, angling success for Rainbow and Brown Trout, and fishermen satisfaction. North American Journal of Fisheries Management 11:190-199.

Murdock, J. N and N. E. Knorp. 2016. Effects of *Didymosphenia geminata* on riverine food webs in the upper Tennessee River basin. Final Report to the Gulf Coast Marine Fisheries Commission. 55 pp.

Murdock, J. N., L. A. Hix, and A. N. Engle. 2016. Determining stream susceptibility to colonization and proliferation of the alga *Didymosphenia geminata* in the Chilhowee Reservoir watershed. Natural Resource Report NPS/GSMP/NRR—2016/. National Park Service, Fort Collins, Colorado.

Pfitzer, D. W. 1962. Investigations of waters below large storage reservoirs in Tennessee. D-J-R Project F-1-R. Tennessee Game and Fish Commission, Nashville, Tennessee.

Scott, E. M., K. D. Gardner, D. S. Baxter, and B. L. Yeager. 1996. Biological and water quality responses in tributary tailwaters to dissolved oxygen and minimum flow improvements. Tennessee Valley Authority, Water Management Services, Norris, Tennessee.

Swink, W. D. 1983. Survey of stocking of tailwater trout fisheries in the southern United States. Progressive Fish-Culturist 45(2):67-71.

Tarzwell, C. M. 1939. Changing the Clinch River into a trout stream. Transactions of the American Fisheries Society 68:228-233.

TVA (Tennessee Valley Authority). 1980. Improving reservoir releases. TVA Office of Natural Resources and Environmental Development, Knoxville, Tennessee.

TWRA (Tennessee Wildlife Resources Agency). 2017. Trout management plan for Tennessee 2017-2027 (J. Habera, editor). Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Wiley, R. W., R. A. Whaley, J. B. Satake, and M. Fowden. 1993. Assessment of stocking hatchery trout: a Wyoming perspective. North American Journal of Fisheries Management 13:160-170.

Willis, D. W., B. R. Murphy, and C. S. Guy. 1993. Stock densities: development, use, and limitations. Reviews in Fisheries Science 1(3):203-222.

Yard, M. D., L. G. Coggins Jr., C. V. Baxter, G. E. Bennett, and J. Korman. 2011. Trout piscivory in the Colorado River, Grand Canyon: Effects of turbidity, temperature, and fish prey availability. Transactions of the American Fisheries Society 140:471-486.

Yeager, B. L., D. M. Hill, W. M. Seawell, C. M. Alexander, and R. Wallus. 1987. Effects of aeration and minimum flow enhancement on the biota of Norris tailwater. TVA Office of Natural Resources and Environmental Development, Knoxville, Tennessee.

APPENDIX

2017-2027 Statewide Trout Management Plan Support

Statewide Trout Management Plan (TWRA 2017)
Mission Statement, Goals, and Strategies
Supported by the 2020-25 Norris Tailwater Management Plan

Page 1:

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."

Page 17 (Objectives 1 and 2):

ANGLING OPPORTUNITIES

GOAL 1. Maintain a variety of trout fisheries.

Strategy:

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.

Page 18 (Objective 3):

HATCHERY-SUPPORTED FISHERIES

GOAL 1. Optimize use of hatchery trout.

Strategy:

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.

ANGLING OPPORTUNITIES

GOAL 1. Maintain a variety of trout fisheries.

Page 19 (Objective 4):

BIOSECURITY

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

Strategy:

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 whirling disease (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).

Page 19 (Other Recommendations):

ANGLING OPPORTUNITIES

GOAL 1. Maintain a variety of trout fisheries.

Strategy:

6. Continue conducting opinions surveys periodically to make sure TWRA's management and trout angler preferences align as much as possible.

OUTREACH

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

Strategy:

2. Continue collecting trout angler preference and satisfaction data via telephone and creel surveys (including reservoirs, delayed harvest areas, and winter trout events); incorporate this information where appropriate into management strategies and policy.

HABITAT PROTECTION

GOAL 2. Optimize habitat quality in trout tailwaters.

Strategy:

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).

ANGLING OPPORTUNITIES

GOAL 2. Increase access to trout fisheries.

Strategy:

3. Purchase or develop donated properties on trout tailwaters that will provide strategic access points for float and wade or bank fishing.

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.