

Management Plan for the Boone and Fort Patrick Henry Tailwater Trout Fisheries 2019-2024



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December 2018



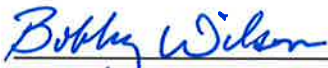
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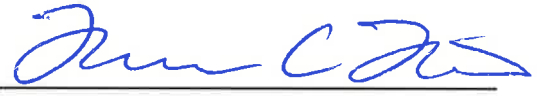
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December 2018

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TABLE OF CONTENTS

	Page
FOREWORD.....	1
1. MANAGEMENT GOAL AND STRATEGY	1
2. BACKGROUND	1
2.1. Boone.....	1
2.2 Ft. Patrick Henry.....	2
3. CURRENT TROUT FISHERY STATUS	3
3.1 Boone.....	3
3.1.1 Abundance	3
3.1.2 Size Structure.....	5
3.1.3 Condition	5
3.1.4 Stocking	6
3.1.5 Angler Use	7
3.2 Ft. Patrick Henry.....	17
3.2.1 Abundance	17
3.2.2 Size Structure.....	18
3.2.3 Condition	18
3.2.4 Stocking	20
3.2.5 Angler Use	20
4. MANAGEMENT OBJECTIVES AND RECOMMENDATIONS	29
4.1 Boone.....	29
4.2 Ft. Patrick Henry.....	31
5. REFERENCES	35
APPENDIX.....	37

FOREWORD

Meeting Tennessee's trout management challenges requires that the Tennessee Wildlife Resources Agency (TWRA) have a comprehensive management plan (TWRA 2017) capable of addressing current needs, while also anticipating areas where future needs may arise. This 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. The Boone and Fort Patrick Henry Tailwater Management Plan provides goals, strategies, and objectives for managing the trout fisheries in these tailwaters while also supporting several aspects of the STMP. Relevant goals, objectives, and strategies of the 2017-2027 STMP cited in this document are provided in the appendix and the entire STMP can be found at www.tnwildlife.org.

1. MANAGEMENT GOAL AND STRATEGY

The Tennessee Wildlife Resources Agency's (TWRA's) management goal for the Boone and Ft. Patrick Henry tailwaters on the South Fork Holston River is to fully develop and maintain their potential for producing large, well-conditioned trout, thus providing exceptional angling opportunities. The plan addresses STMP Hatchery Supported Fisheries Goal 1, Strategy 5).

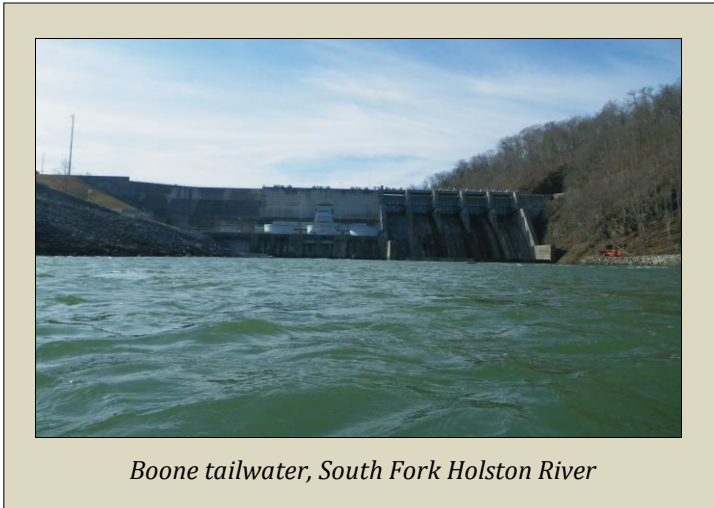
TWRA will use put-and-grow and put-and-take Rainbow Trout *Oncorhynchus mykiss*, Brown Trout *Salmo trutta*, and Brook Trout *Salvelinus fontinalis* (Boone tailwater) fisheries to attain the management goal for these tailwaters.

2. BACKGROUND

2.1 BOONE TAILWATER

Boone Dam (completed in 1952) impounds 4,400-acre Boone Reservoir on the South Fork Holston River (SFHR) and Watauga River in Sullivan and Washington counties near Johnson City and Kingsport, Tennessee. Both the South Holston and Wilbur tailwaters, which support two of Tennessee's best trout fisheries, flow into Boone Reservoir. A short (~0.6 mi.) tailwater exists downstream of Boone Dam at the upper end of Ft. Patrick Henry Reservoir. The dam (at SFH RM 18.6) has three autoventing turbines which help improve dissolved oxygen levels in the water released from Boone Reservoir. The Boone tailwater and Ft. Patrick Henry Reservoir provide coldwater habitat that TWRA stocked sporadically with fingerling Rainbow Trout and Brown Trout prior to 1978. After 1978, Ft. Patrick Henry Reservoir and the Boone tailwater were managed as a put-and-take fishery by stocking adult Rainbow Trout. TWRA's

electrofishing survey of this tailwater in 2008 indicated the presence of a good Rainbow Trout population including several large (≥ 18 in.), exceptionally-well-conditioned fish ($W_r \geq 120$). A few



Boone tailwater, South Fork Holston River

Brown Trout were also present—most likely migrants from the South Holston or Wilbur tailwaters upstream, as none had been stocked since 1956.

Evidence of some natural reproduction by Rainbow Trout (2-3 in. fish) was also detected during sampling at base flow in 2008. Based on these results, sub-adult (6-8 in.) Brown Trout and fingerling Rainbow Trout were added to the Boone tailwater stocking program in

2008 and annual monitoring began in 2009. The Boone tailwater trout fishery is currently subject to statewide trout angling regulations (7-fish creel limit and no size limit).

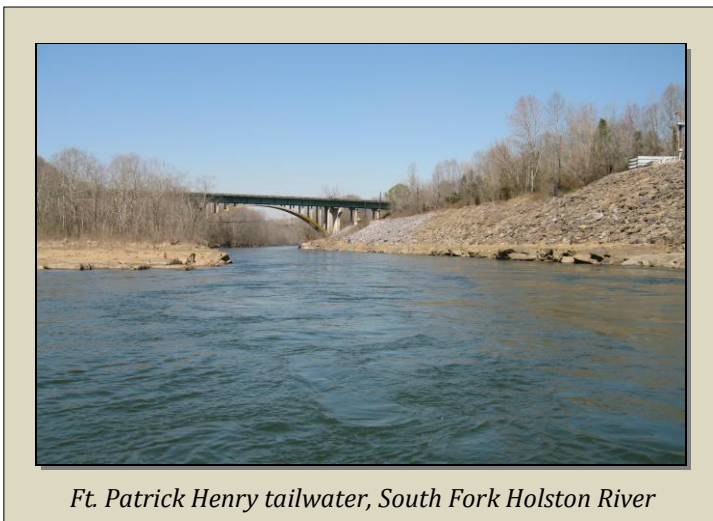
Water and sediment seepage from the riverbank below Boone Dam was discovered by the Tennessee Valley Authority (TVA) in October 2014. Subsequent evaluations by TVA determined that a composite seepage barrier at the dam was the best solution for addressing this issue. Work on this seepage barrier began in 2016 and TVA projects that it will require 5-7 years for completion and a return to normal operations. The reservoir is being held at ~10 feet below winter pool (~35 feet below summer pool) as a risk-reduction measure. TVA is extensively monitoring water quality in the reservoir and tailwater to identify any impacts associated with the reservoir drawdown and construction activities. No water temperature issues were observed during summer and fall of 2015-2017. Drought conditions during summer and fall of 2016 likely caused dissolved oxygen (DO) to frequently drop into 3-6 mg/L range but this DO levels were generally better in 2017 (Habera et al. 2017; 2018). Monitoring data do not indicate any particular water-quality-related impacts on the trout fishery.

2.2 FT. PATRICK HENRY TAILWATER

Ft. Patrick Henry Dam (completed in 1953) is located ~10 miles downstream of Boone Dam and impounds a small (895 acre) reservoir (Ft. Patrick Henry Reservoir) on the SFHR near Kingsport. The dam has two hydroelectric generating units and Ft. Patrick Henry Reservoir is operated by TVA as a “run-of-the-river” reservoir (i.e., there is no long-term water storage). Because of its small size and the short water retention time, TVA has no measures to improve

DO in the discharge from the dam (Scott et al. 1996). However, DO enhancement produced by Boone Dam's autoventing turbines also improves DO content in the Ft. Patrick Henry tailwater (Scott et al. 1996). The SFHR provides an important industrial water supply for Kingsport, in addition to hydropower generations, thus TVA maintains a minimum flow of 400 cubic feet/second (cfs) downstream of Ft. Patrick Henry Dam. This is provided by pulsing one or two turbines for one hour of every three hours.

Little biological data is available for the Ft. Patrick Henry tailwater prior to 2000, although TVA did note the presence of a "considerable" Rainbow Trout fishery in 1995 with many "unusually plump" fish (Scott et al. 1996). Evidence of some natural reproduction—probably from



Ft. Patrick Henry tailwater, South Fork Holston River

Kendrick Creek, a tailwater tributary—was also observed by Scott et al. (1996). TWRA has managed the Ft. Patrick Henry tailwater as a put-and-take and put-and-grow trout fishery with annual stockings of adult and fingerling Rainbow Trout since 1978. Before that (beginning in 1955), it was stocked with only fingerling Rainbow Trout and Brown Trout. Sub-adult (6-8 in.) Brown Trout were added to the annual stocking program in 1996. This tailwater was

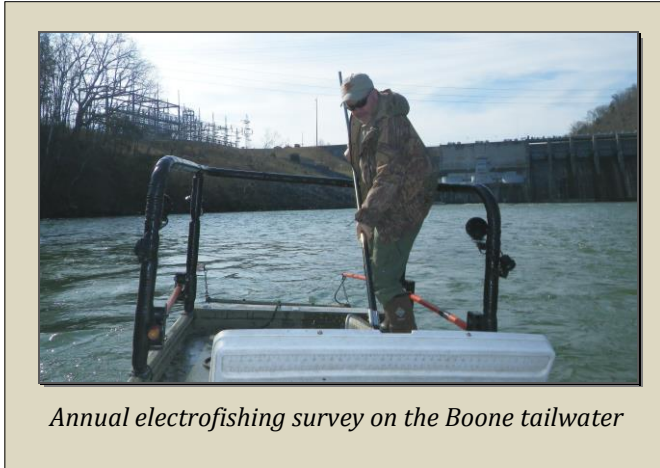
added to the Region 4 annual monitoring program in 2002 to acquire data for managing what has developed into a relatively unique fishery for large, well-conditioned Rainbow Trout. The Ft. Patrick Henry tailwater is currently subject to statewide trout angling regulations (7-fish creel limit and no size limit).

A temperature logger was deployed in the Ft. Patrick Henry tailwater (0.4 mi. downstream of the dam) during June-November 2015 to monitor potential impacts associated with TVA's extended drawdown of Boone Reservoir. Maximum daily water temperature peaked in the 62-64° F range during mid-June through mid-July, then generally declined through the rest of the summer and fall, indicating no temperature-related issues for the trout fishery.

3. CURRENT TROUT FISHERY STATUS

3.1 BOONE TAILWATER

3.1.1 Abundance



Annual electrofishing survey on the Boone tailwater

TWRA monitors the Boone tailwater trout fishery at four boat electrofishing stations (Figure 3-1) in March each year to provide an assessment of carry-over trout populations (including size structure) before stocking begins. These four stations are sampled (900 s each; 1 h of total effort) during the day at a flow of approximately 3,100 cfs (one unit operating at Boone Dam). Electrofishing catch per unit effort

(CPUE) estimates (fish/h) are calculated and based on trout at least 7 in. long, as this is the minimum size considered fully recruited to the sampling gear and technique.

The Boone tailwater supports a relatively-low-abundance total trout population, with an overall mean electrofishing catch rate (all trout ≥ 7 in.) of 80 fish/h (Figure 3-2). Total trout CPUE averaged nearly 100 fish/h during 2008-2010, then generally declined through 2015, but has recently reached 100 fish/h again (Figure 3-2). Rainbow Trout represented an average of 88% of the total electrofishing catch each year through 2016, but Brown Trout have become an important part of this fishery since their regular addition to the stocking program in 2008. Brown Trout relative abundance increased to 25% in 2017 (including all trout ≥ 18 in.) and exceeded 20% again in 2018. A few Brook Trout were captured during 2013-2015, but catch increased to 19 (18%) in 2017 and 48 (44%) in 2018. A 14-in. Lake Trout *Salvelinus namaycush* was collected in 2011—most likely a downstream migrant from either South Holston Reservoir or Watauga Reservoir.

TWRA's long-term monitoring has shown that the Boone tailwater typically produces relatively high catch rates for Rainbow Trout ≥ 14 in. (range, 6-39 fish/h; mean, 23 fish/h). However, catch rates for these larger trout have generally declined since 2010, with a mean CPUE of 9 fish/h in 2018 (Figure 3-3). The mean catch rate for trout ≥ 18 in. is 7.7 fish/h and these fish are typically Rainbow Trout in both the Boone and Ft. Patrick Henry tailwaters, making them the most likely locations for tailwater anglers in Region 4 to catch a 'trophy'. However, the

catch rate for Rainbow Trout ≥ 18 in. in the Boone tailwater has declined recently from 12 fish/h in 2015 to 3 fish/h in 2018 (Figure 3-3). The cause for this decline is uncertain, although the catch rate for Brown Trout ≥ 18 in. has generally increased during that same period (Figure 3-3).

3.1.2 Size Structure



28.8-in., 12.8-lb. Boone tailwater Brown Trout



26.3-in., 6.7 lb. Boone tailwater Rainbow Trout



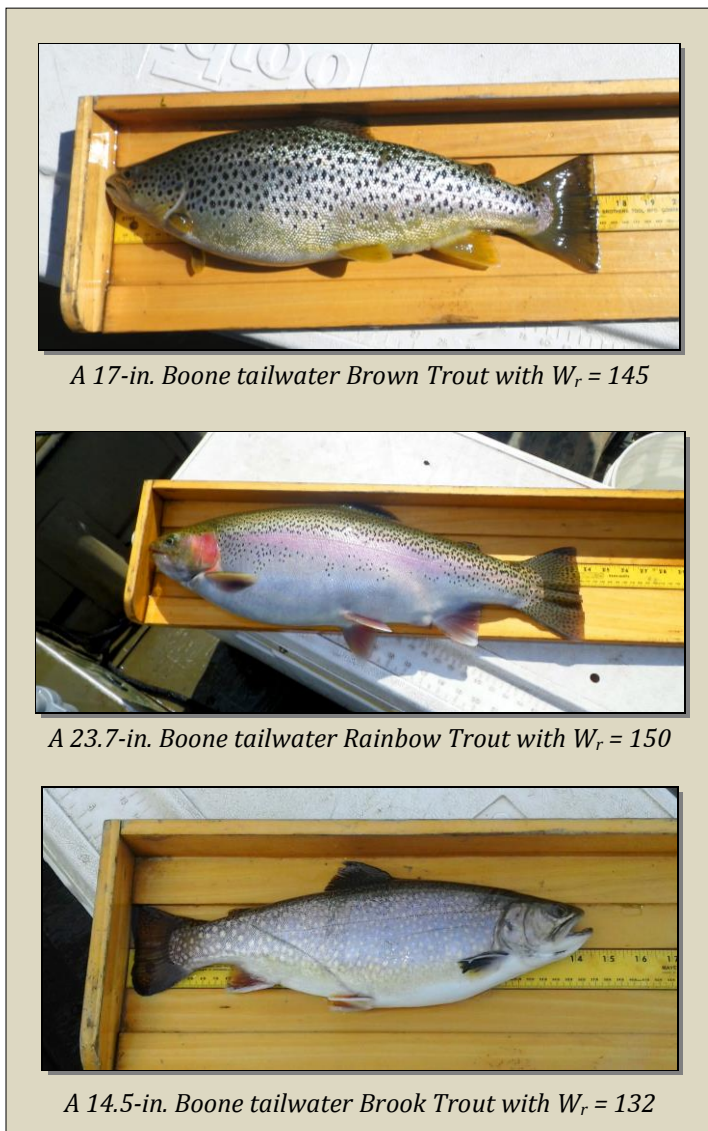
20.3-in., 4.3-lb Boone tailwater Brook Trout

Rainbow Trout have typically exhibited a bimodal size distribution, with the 9-11 in. and 14-16 in. size classes most abundant (Figure 3-4). Among Region 4 tailwaters, only Ft. Patrick Henry has produced more Rainbow Trout ≥ 22 in. since 2008 than has Boone. Brown Trout have become established since their addition to the stocking program in 2008 and have shown good growth potential, with several fish in the 23-28 in. range captured during monitoring efforts (Figure 3-4). Adult (9-10 in.) Brook Trout, stocked in 2009, 2012, 2014, 2017, and 2018 have also shown good growth potential, with three fish >14 in. captured during monitoring efforts since 2013. One of these (20.3 in. and 4.3 lbs.) would have been the new Tennessee angling record at the time (2014). No Brook Trout larger than the 12-in. size class have been captured in Region 4 tailwaters where they are currently stocked (Norris) or were formerly stocked (Wilbur).

Relative stock density for all trout ≥ 18 in. (RSD-18)—based on a stock size of 10 in. for both Rainbow Trout and Brown Trout (Willis et al. 1993)—has been variable (range,

4-38; mean, 17), but was highest (22-38) during 2013-2015 (Figure 3-5) when total CPUE ≥ 7 in. was 30-60 fish/h. An RSD-18 of 22, for example, indicates that 22% of all stock-size trout—those at least 10 in. in length—are ≥ 18 in. and is representative of a trout fishery with an exceptional proportion of larger fish. Brown Trout CPUE (≥ 7 in.) in the Boone tailwater was typically < 10 fish/h prior to 2016, thus a few fish ≥ 18 in. produce high RSD-18 values (≥ 40) if calculated separately. Ideally, management of the Boone tailwater will maintain RSD-18 near the higher levels previously observed for this fishery (~ 20), particularly for Rainbow Trout (mean 13; maximum 38).

3.1.3 Condition



The Boone tailwater consistently produces large, well-conditioned trout (Figure 3-6). Mean relative weight (W_r) for fish ≥ 7 in. and fish ≥ 14 in. exceeds 100 for Rainbow Trout (Table 3-1), Brown Trout (Table 3-2), and Brook Trout captured at least one year post-stocking (mean = 119; SE= 6.51). Maximum W_r has reached 175 for Rainbow Trout (Table 3-1), 163 for Brown Trout (Table 3-2), and 132 for Brook Trout. Additionally, larger trout (≥ 14 in.) with exceptionally high relative weights are common, as 19% of Rainbow Trout and 40% of Brown Trout in this size range had $W_r \geq 120$ during 2008-2018 (Tables 3-1 and 3-2). One of three Brook Trout collected at least one year post-stocking also had $W_r \geq 120$. There was no decline in mean W_r for larger (≥ 14 in.) Rainbow Trout compared to the mean for all fish ≥ 7 in. (Figure 3-6; Table 3-1) and mean W_r for Brown Trout

≥ 14 in. was higher (117) than the mean for fish ≥ 7 in. (107; Table 3-2).

Only the Ft. Patrick Henry tailwater (~10 mi. downstream) has trout with comparable W_r in Region 4. Other Region 4 tailwaters have mean $W_r \leq 95$ for both Rainbow Trout and Brown Trout ≥ 7 in. (Tables 3-1 and 3-2). Maximum W_r for these other tailwaters ranged from 120-130 for Rainbow Trout and 112-147 for Brown Trout. Additionally, mean W_r for larger Rainbow Trout (≥ 14 in.) in other Region 4 tailwaters was notably lower relative to corresponding values for fish ≥ 7 in., indicating declining condition in larger fish—particularly in the Norris and South Holston tailwaters (Table 3-1). The abundance of clupeids (shad) in Boone Reservoir is typically higher than in other reservoirs with cold tailwaters such as Norris, Cherokee, and South Holston (Negus and Peterson 2005). Thus, more consistent passage of these forage fish into the tailwater (and ultimately to the Ft. Patrick Henry tailwater) provides the supplemental food resources necessary to permit the exceptional trout growth and condition that occur there.

3.1.4 Stocking

Stocking of Ft. Patrick Henry Reservoir (including Boone tailwater) during 1990-2007 involved only adult Rainbow Trout and was quite variable, averaging 9,700/year during (Figure 3-7). Since then, adult Rainbow Trout stocking rates have remained variable, although at a lower average (8,600/year for 2008-2017; Figure 3-7). Fingerling Rainbow Trout were first stocked in 2008 (Figure 3-7) and have been included in the stocking program during most years since then (average of 10,000 per year when stocked), although their recruitment has not been assessed. Given the Boone tailwater's potential to produce large fish, Brown Trout were also added to the program in 2008 and since then, ~14,000 Brown Trout (typically 7-8 in.) have been stocked annually, (Figure 3-7). Brook Trout (9-10 in. adults) have been stocked occasionally since 2009 (~6,000 per year when stocked) and have shown relatively limited survival, but good growth potential. Overall, about 38,600 trout (including fingerling Rainbow Trout) were stocked annually in the Boone tailwater during 2014-2018 (Figure 3-7). An important objective of this management plan will be to determine optimum trout stocking rates for the Boone tailwater that can then be consistently applied each year.

3.1.5 Angler Use

Angler use data are limited for the Boone tailwater, although TWRA did complete an angler survey on Ft. Patrick Henry Reservoir (including the Boone tailwater) in 2013 (Black 2014). Some angling pressure for trout occurs in the reservoir downstream of the tailwater area, but these areas are combined in the following results. Total estimated fishing pressure for anglers targeting trout was 6,783 h (11% of angling pressure for all species). Trout anglers made 1,646 trips (4.1 h/trip) and caught an estimated 5,450 trout (68% Rainbow Trout; 32% Brown Trout),



which was 10% of the estimated catch for all species. The overall trout catch rate was 0.8 fish/h (3.3 fish/trip) and would generally be considered representative of good fishing (>0.7 fish/h; McMichael and Kaya 1991; Wiley et al. 1993). An estimated 1,704 trout were harvested (79% Rainbow Trout), which represented over half (56%) of all fish harvested in Ft. Patrick Henry Reservoir in 2013 and yielded an

overall trout harvest rate of 0.25 fish/h (1.0 fish/trip). A majority of Ft. Patrick Henry Reservoir anglers in 2013 (89%) were from Tennessee—primarily from local counties—with another 10% being non-resident anglers from Virginia. By comparison, anglers made an estimated 24,285 trips (5.4 h/trip) to the nearby 13.7-mi. South Holston tailwater in 2014, caught an estimated 284,933 trout, and harvested 25,294 (Black 2015). Even though the South Holston is primarily a wild Brown Trout fishery, 52% of the trout caught there and 81% of those harvested were Rainbow Trout. It will be important to conduct periodic angler surveys on the Boone tailwater (with data separate from the rest of Ft. Patrick Henry Reservoir) to help evaluate management strategies applied to this trout fishery.

Boone Tailwater

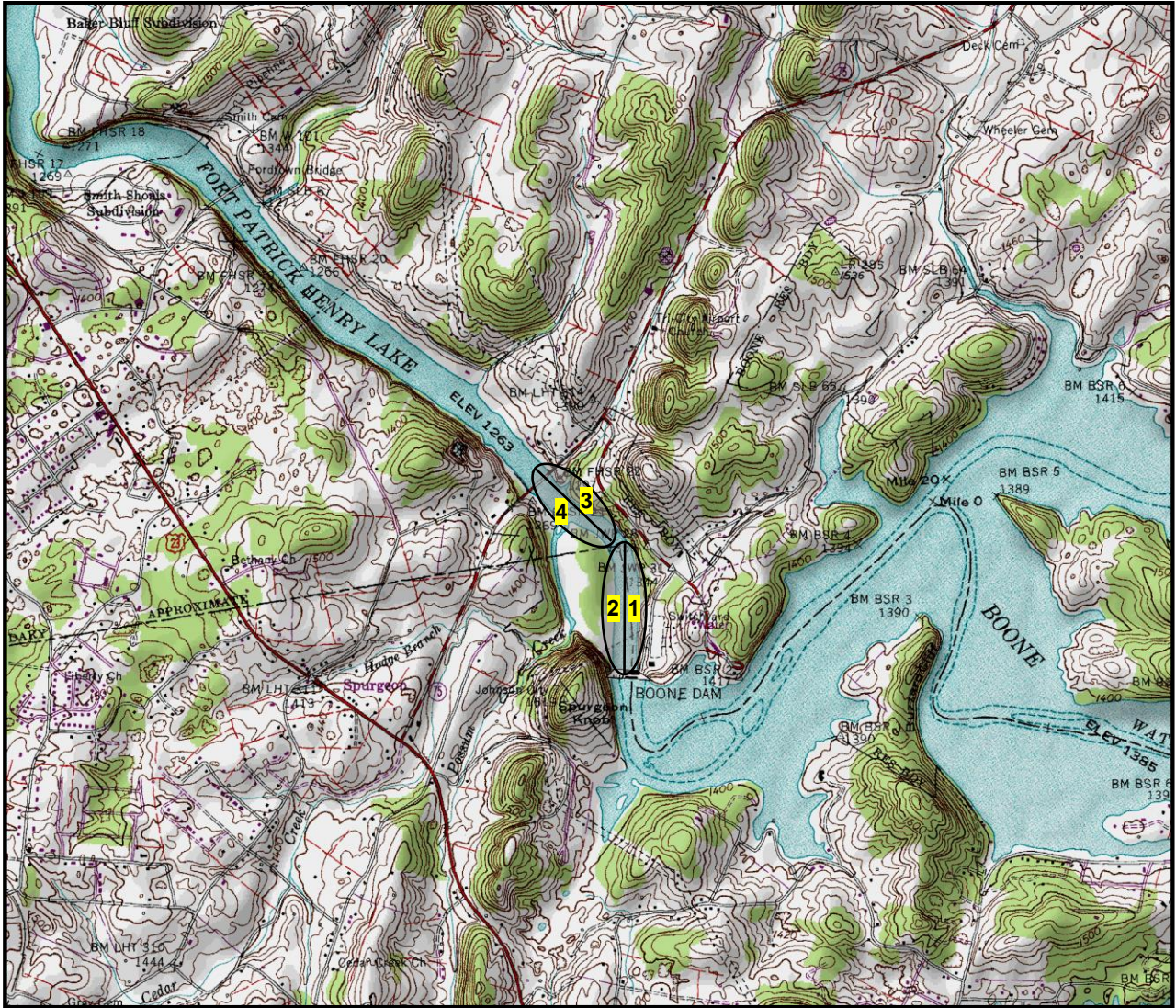


Figure 3-1. Locations of the four annual monitoring stations on the Boone tailwater (South Fork Holston River),

Boone Tailwater Electrofishing Catch Rates

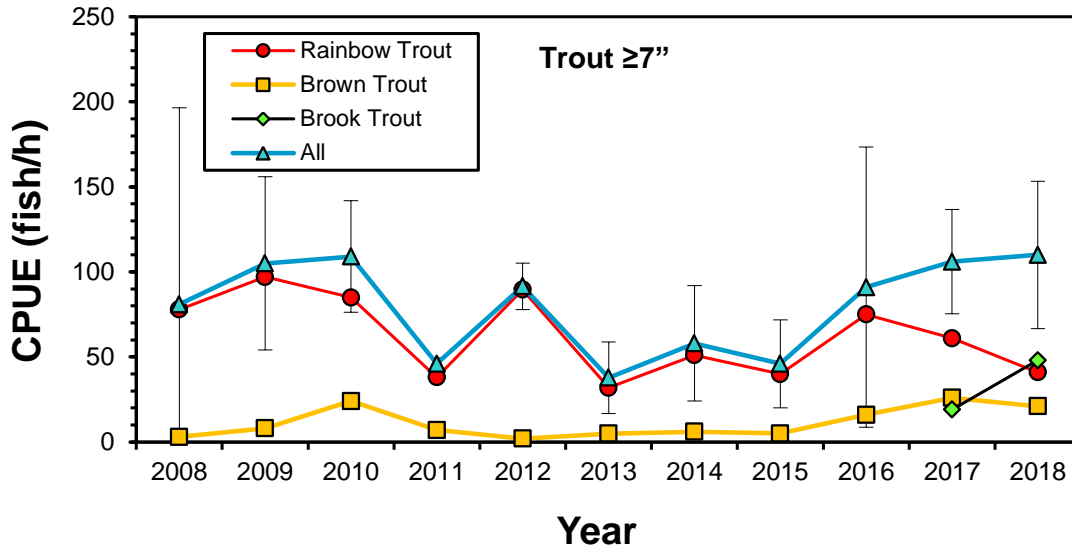


Figure 3-2. Mean electrofishing catch per unit effort (CPUE) for trout ≥ 7 in. for the Boone tailwater. Bars indicate 90% confidence intervals.

Boone Tailwater Electrofishing Catch Rates (Larger Trout)

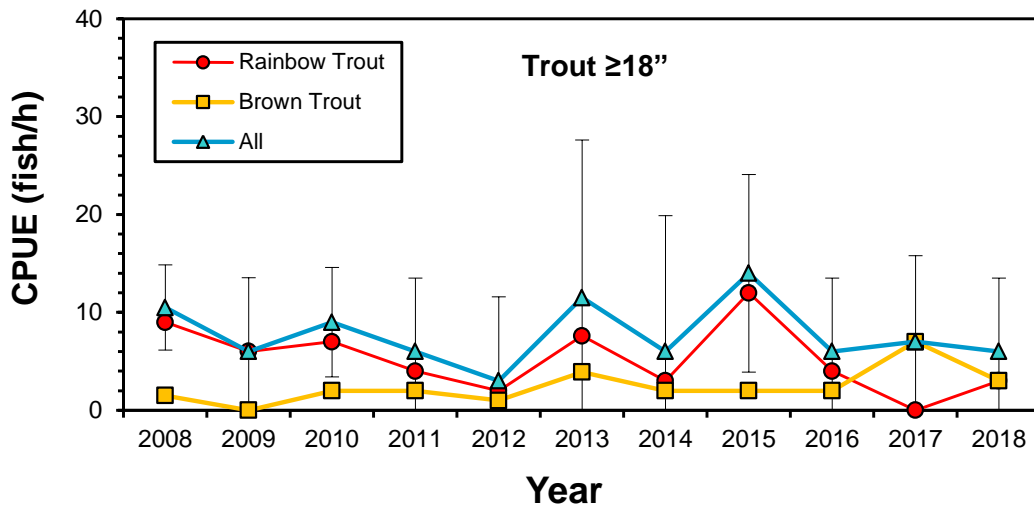
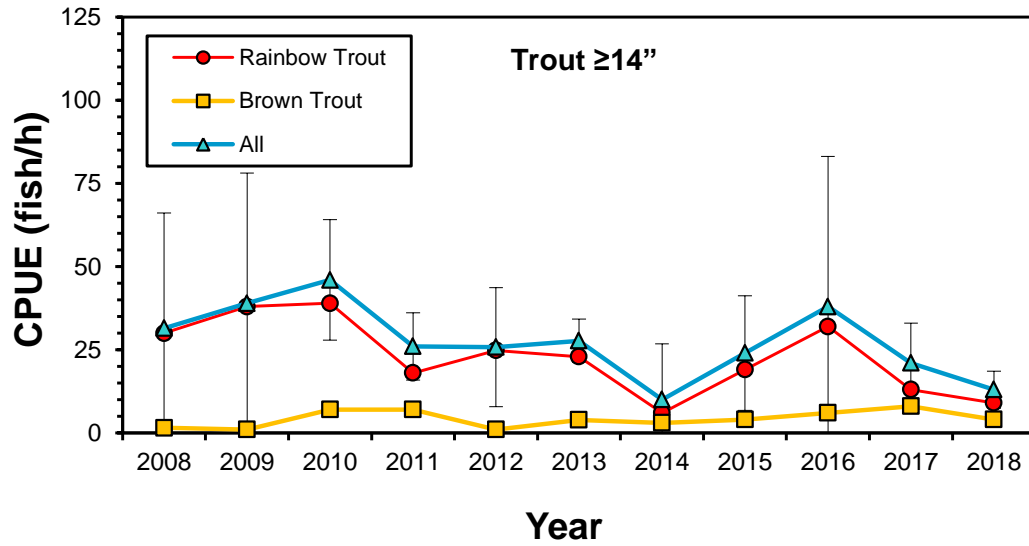


Figure 3-3. Mean electrofishing catch per unit effort (CPUE) for larger trout for the Boone tailwater. Bars indicate 90% confidence intervals.

Boone Tailwater Trout Length Frequency Distributions

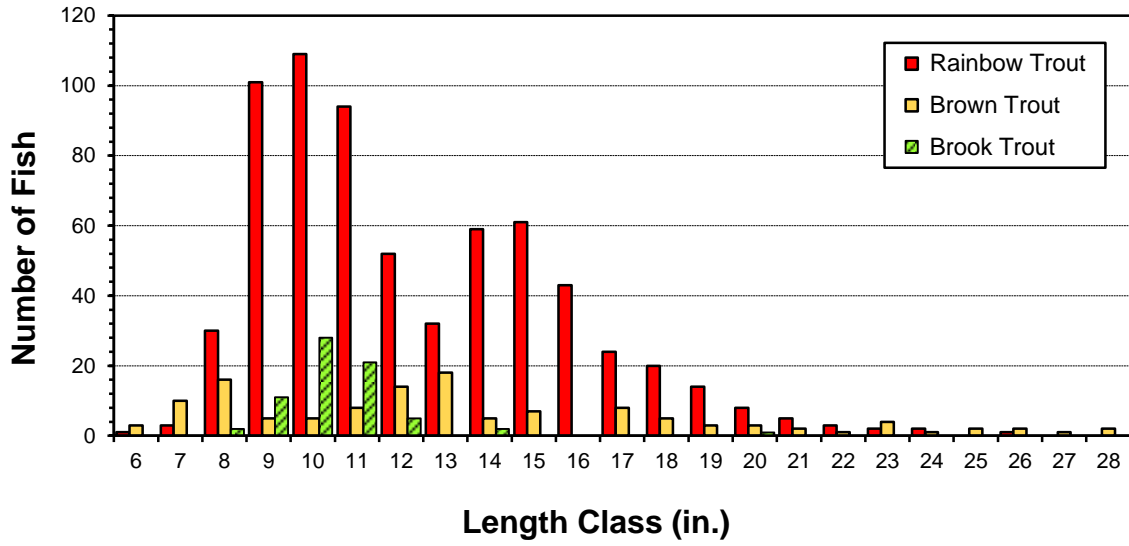


Figure 3-4. Length frequency distributions for Rainbow, Brown, and Brook trout from the Boone tailwater annual monitoring samples (2008-2018).

Boone Tailwater Relative Stock Density (RSD-18)

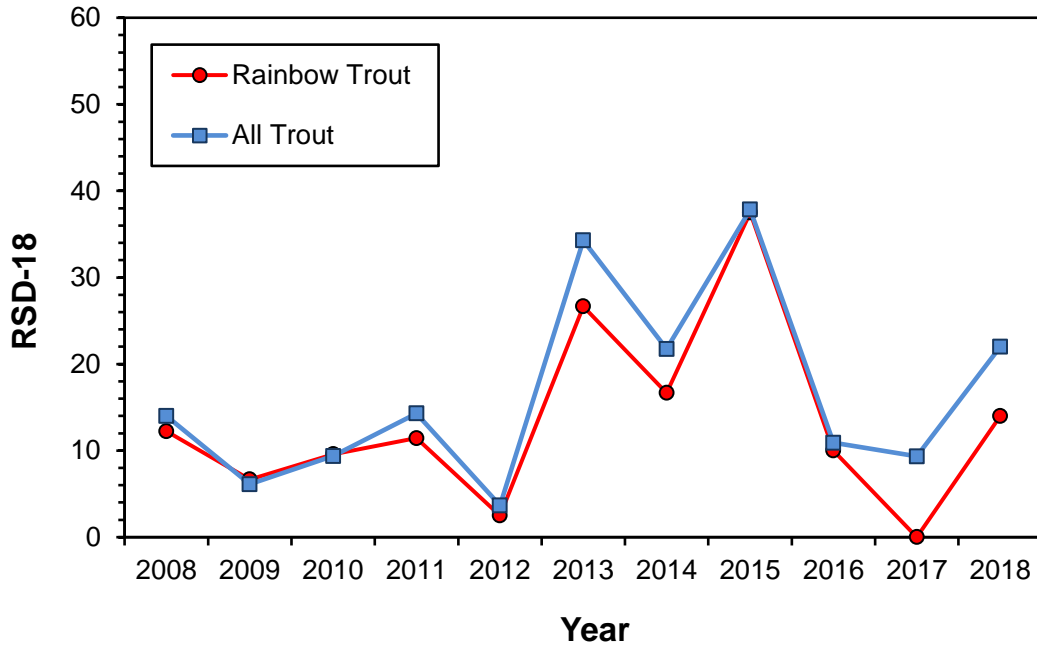


Figure 3-5. Relative stock density for Rainbow Trout and all trout ≥ 18 in. (RSD-18) from the Boone tailwater annual monitoring samples (2008-2018).

Boone Tailwater Relative Weights (W_r)

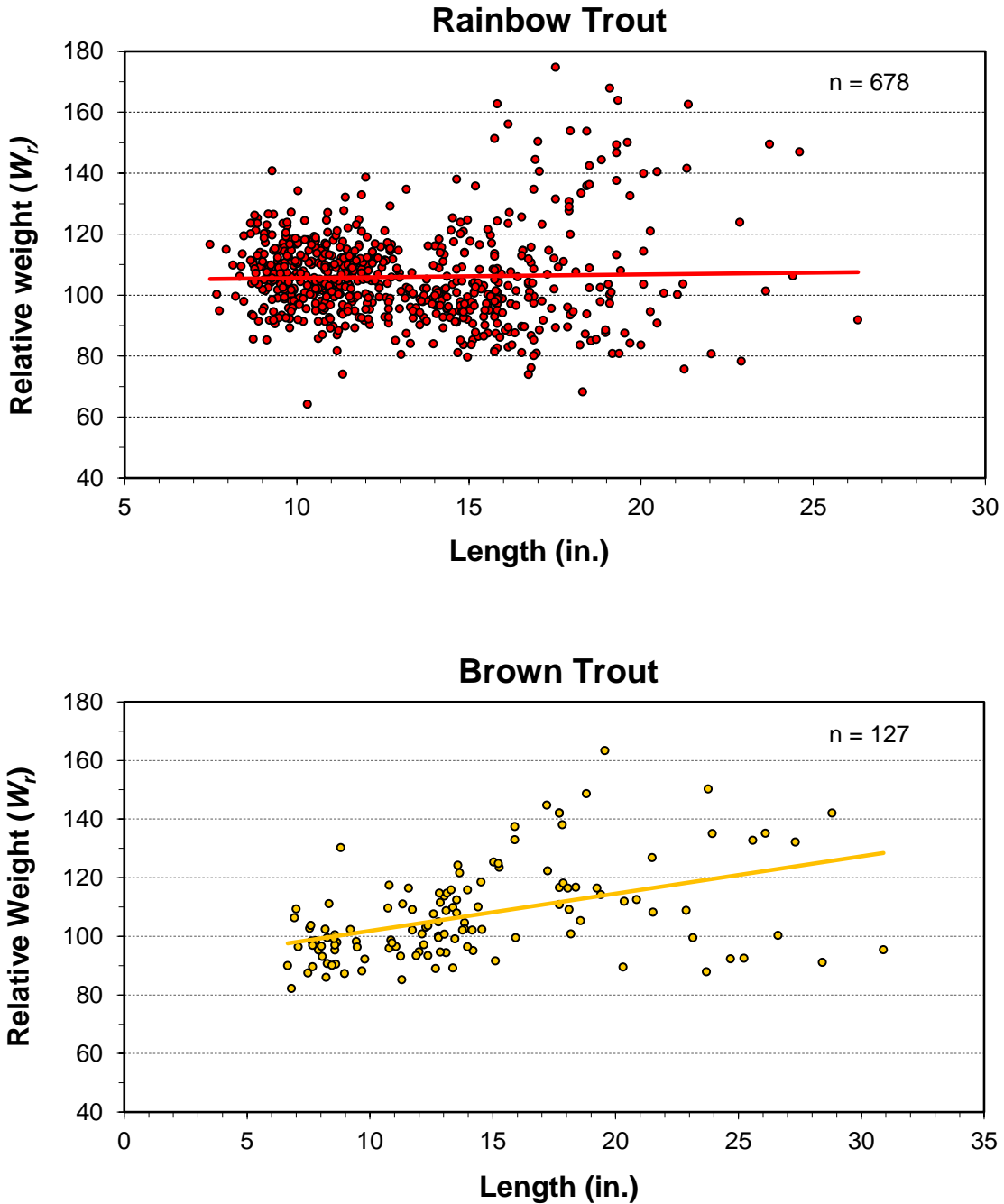


Figure 3-6. Relative weight (W_r) scatter plots with trend lines for Rainbow and Brown Trout from the Boone tailwater (2008-2018).

Boone Tailwater Stocking

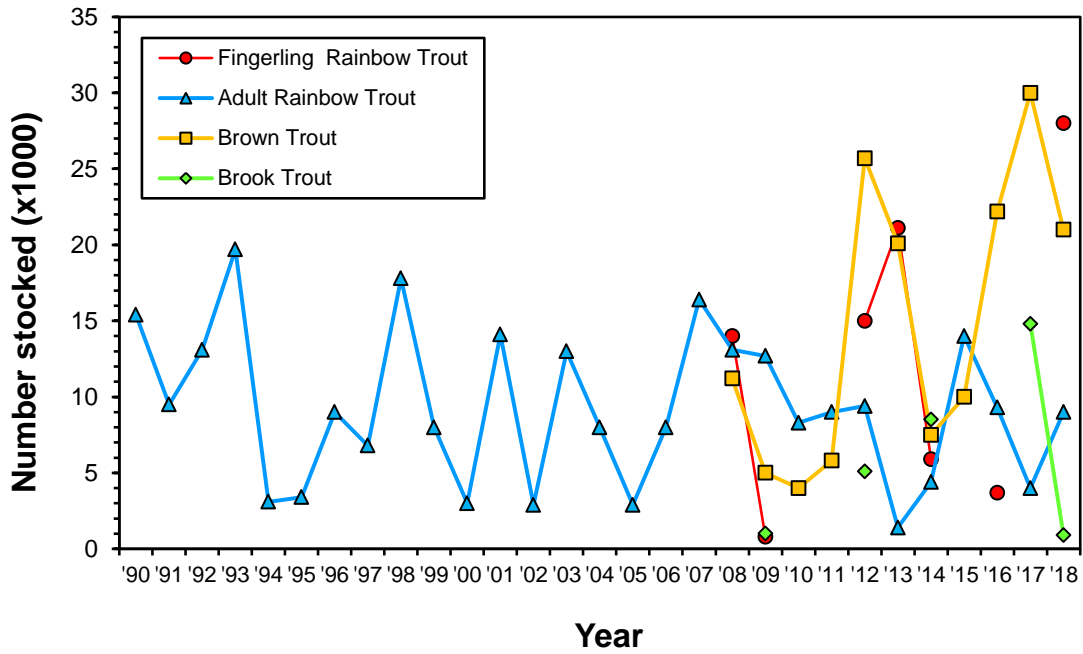


Figure 3-7. Trout stocking rates for the Boone tailwater (1990-2018). Only adult Rainbow Trout were stocked prior to 2008. Brown Trout are stocked as sub-adults (6-8 in.) and Brook Trout as adults (9-10 in.).

Region 4 Tailwater Relative Weights (W_r)

Table 3-1. Rainbow Trout relative weight (W_r) statistics for Region 4 tailwaters.

Tailwater	≥7 in.			≥14 in.				
	Sample size (n)	Mean W_r	Standard error (SE)	Sample size (n)	Mean W_r	Standard error (SE)	Max. W_r	$W_r \geq 120$ (%)
Boone	678	106	0.55	247	106	1.26	175	19
Ft. Patrick Henry	1,086	107	0.46	468	106	0.88	168	23
Cherokee	147	92	0.86	78	91	1.03	120	<1
Norris ¹	2,582	90	0.24	835	83	0.34	126	<1
Wilbur	1,702	93	0.32	104	92	1.24	130	2
South Holston ²	1,676	94	0.28	217	88	0.77	124	1

¹Post-PLR regulation (2009-2018).²Post-PLR regulation (2001-2018).Table 3-2. Brown Trout relative weight (W_r) statistics for Region 4 tailwaters.

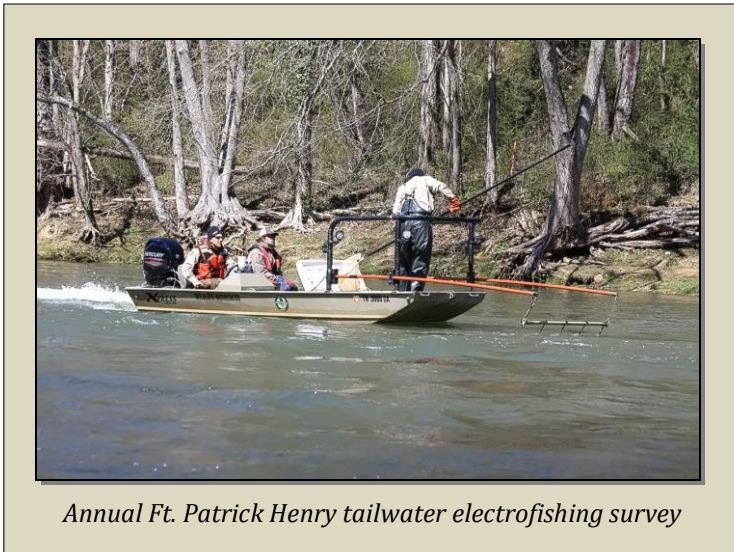
Tailwater	≥7 in.			≥14 in.				
	Sample size (n)	Mean W_r	Standard error (SE)	Sample size (n)	Mean W_r	Standard error (SE)	Max. W_r	$W_r \geq 120$ (%)
Boone	124	107	1.41	48	117	2.71	163	40
Ft. Patrick Henry	217	107	0.95	33	121	2.76	163	39
Cherokee	81	93	0.95	22	97	1.54	112	0
Norris ¹	781	95	0.44	190	101	1.01	146	12
Wilbur	4,414	91	0.14	485	90	0.44	144	1
South Holston ²	7,686	92	0.10	1,144	91	0.28	147	1

¹Post-PLR regulation (2009-2018).²Post-PLR regulation (2001-2018).

3.2 FT. PATRICK HENRY TAILWATER

3.2.1 Abundance

TWRA's monitoring of the Ft. Patrick Henry tailwater trout fishery is similar to that for the Boone tailwater— four boat electrofishing stations (Figure 3-8) in March each year. The purpose is to assess the carry-over trout populations (including size structure) before stocking begins. These four stations are sampled (900 s each) during the day at a flow of approximately 3,100 cfs (one unit operating at Ft. Patrick Henry Dam). Electrofishing catch per unit effort (CPUE)



estimates (fish/h) are based on trout at least 7 in. long, as this is the minimum size considered fully recruited to the sampling gear and technique.

Like the Boone tailwater, the Ft. Patrick Henry tailwater supports a relatively-low-abundance total trout population, with an overall mean electrofishing catch rate (all trout ≥ 7 in.) of 75 fish/h (Figure 3-9). Mean CPUE (≥ 7 in.) has occasionally exceeded 100 fish/h and did so most

recently in 2017 (Figure 3-9). Rainbow Trout are the predominant species in this fishery, representing an average of 82% of the total electrofishing catch for 2002-2018. Brook Trout are not stocked in this tailwater, but one 12.6-in. fish was captured in 2013 and 13 (10-12 in.) were captured in 2018 and were likely transients from the Boone tailwater upstream.

Catch rates for trout ≥ 14 in. have been variable in the Ft. Patrick Henry tailwater (mean, 30 fish/h; range, 2-67 fish/h), but have typically been >40 fish/h since 2013 (Figure 3-10). Catch rates for trout ≥ 18 in. have averaged 10 fish/h since 2002 and these fish are primarily Rainbow Trout, making Ft. Patrick Henry (along with Boone) an ideal location for tailwater anglers in Region 4 to catch a “trophy”. The catch rate for Ft. Patrick Henry tailwater Rainbow Trout ≥ 18 in. has declined from its peak of 33 fish/h in 2015 (Figure 3-10) and was below the long-term average (10 fish/h) in 2018. Despite substantial Brown Trout stocking (14,500/year since 2002), monitoring station catch rates for Brown Trout ≥ 18 in. average <1 fish/h annually.

3.2.2 Size Structure

Rainbow Trout have typically exhibited a bimodal size distribution, with the 11-12 in. and 16-17 in. size classes most abundant (Figure 3-11). More Rainbow Trout ≥ 22 in. have been



29-in., 10 lb. Ft. Patrick Henry tailwater Brown Trout



22.4-in., 4.6 lb. Ft. Patrick Henry tailwater Rainbow Trout

captured in the Ft. Patrick Henry tailwater since 2008 (13) than in any other Region 4 tailwater and together, the Ft. Patrick Henry and Boone tailwaters have produced 21 of 24 Rainbow Trout of this size captured in Region 4 tailwaters during the past 11 years (with 12% of the total sampling effort). Brown Trout are typically present but do not appear to have the recruitment potential as those in the Boone tailwater, as most fish (77%) have been in the 7-15 in. range with few (~3%) ≥ 20 in. (Figure 3-11).

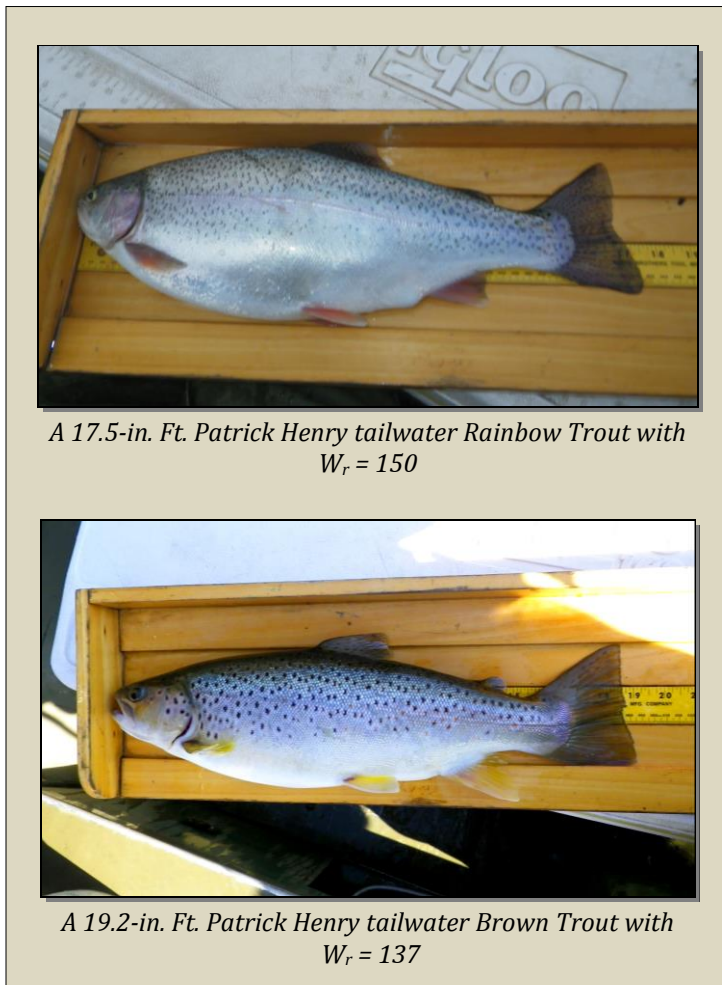
Relative stock density for Rainbow Trout ≥ 18 in. (RSD-18)—based on a stock size of 10 in. (Willis et al. 1993)—has been variable (0-33; mean, 15) but has commonly exceeded 20, particularly in most years since 2011 (Figure 3-12). An RSD-18 of 20, for example, indicates that 20% of all trout at least 10 in. in length are 18 in.

or larger and indicates a trout fishery with an exceptional proportion quality-sized fish. Ideally, management of the Ft. Patrick Henry tailwater will maintain Rainbow Trout RSD-18 at the higher levels currently observed for this fishery (≥ 20).

3.2.3 Condition

Like the Boone tailwater, the Ft. Patrick Henry tailwater also consistently produces exceptionally well-conditioned trout (Figure 3-13). Mean relative weight (W_r) substantially exceeds 100 for Rainbow Trout (Table 3-1, Section 3.1) and Brown Trout (Table 3-2, Section 3.1)

for all fish ≥ 7 in., as well as for larger fish (≥ 14 in.). Maximum W_r for fish ≥ 14 in. has reached 168 for Rainbow Trout (Table 3-1) and 163 for Brown Trout (Table 3-2), and trout in this size range with exceptionally high W_r (≥ 120) are common (23% of Rainbow Trout and 39% of Brown Trout; Tables 3-1 and 3-2). Although there was a slight decline in mean W_r for larger Rainbow Trout (Figure 3-13; Table 3-1), mean W_r for the larger size classes does not fall below 100 as in other Region IV tailwaters (except Boone). Mean W_r increases with length for Brown Trout (Figure 3-13), with the mean for fish ≥ 7 in. (107) increasing to 121 for fish ≥ 14 in. (Table 3-2).



Only the Boone tailwater (~10 mi. downstream) has Rainbow Trout and Brown Trout with comparable W_r in Region 4 (Section 3.1.3). Other Region 4 tailwaters have mean $W_r \leq 95$ for both Rainbow Trout and Brown Trout ≥ 7 in., with maximum W_r for these tailwaters also lower than for Ft. Patrick Henry and Boone (Tables 3-1 and 3-2). Additionally, mean W_r for Rainbow Trout decreases substantially with size in other Region 4 tailwaters, indicating declining condition in larger fish—particularly in the Norris and South Holston tailwaters (Table 3-1). Clupeid spp. (shad) abundances in Boone Reservoir are typically higher than in other reservoirs with cold tailwaters such as Norris, Cherokee, and South Holston (Negus and Peterson 2005). Thus, more consistent

passage of these forage fish into the tailwater (and ultimately to the Ft. Patrick Henry tailwater) provides the supplemental food resources necessary to permit the exceptional trout growth and condition that occur there.

3.2.4 Stocking

The Ft. Patrick Henry tailwater was primarily stocked with fingerling Rainbow Trout and Brown Trout during the 1950s through the 1970s. Emphasis shifted to adult Rainbow Trout by the 1980s, with an average stocking rate of 4,300/year during that decade. Fingerling Rainbow



Ft. Patrick Henry tailwater angler displaying a large Rainbow Trout

Trout were being stocked again on a relatively consistent basis by 1990 and sub-adult Brown Trout re-entered the stocking program in 1996. Since 1990, adult Rainbow Trout stocking rates have varied from 3,000 to 20,000 per year (Figure 3-14), with an average of 11,000/year. Fingerling Rainbow Trout stocking (Figure 3-14) rates have ranged from 3,000 to 49,000/year, with an average rate of about 18,000/year when stocked, but recruitment has not been assessed. Sub-adult (i.e., 6-8 in.) Brown Trout have been stocked annually since 1996, with stocking rates increasing since 2012 to an average of 20,000/year (Figure 3-14). Overall, 42,000 trout (including fingerling Rainbow Trout) were stocked annually in the Ft. Patrick Henry tailwater during the past five

years (Figure 3-14). An important objective of this management plan will be to determine optimum trout stocking rates for the Ft. Patrick Henry tailwater that can then be consistently applied each year.

3.2.5 Angler Use

Angler use data are also limited for the Ft. Patrick Henry tailwater, although TWRA recently completed an angler survey there in 2017 (Black 2018). Total estimated fishing pressure was 13,472 h (98% was directed specifically at trout) and anglers made 4,296 trips (3.1 h/trip) in 2017. An estimated 16,641 fish were caught, and 99% of these were trout (*Walleye Sander vitreus* and Striped bass *Morone saxatilis* comprised the other 1%). Rainbow Trout dominated the catch (92%), while Brown Trout represented 7%. The overall catch rate was 1.2 fish/h (3.9 fish/trip) and would generally be considered representative of good fishing (>0.7 fish/h;

McMichael and Kaya 1991; Wiley et al. 1993). An estimated 4,004 fish were harvested, nearly all of which were trout (98% overall, 94% Rainbow Trout). The overall harvest rate was 0.3 fish/h (0.9 fish/trip), with 76% of Rainbow Trout and 84% of Brown Trout being released. The trout catch for the Boone tailwater was lower (0.8 fish/h), but harvest rates there were similar (0.25 fish/h and 1.0 fish/trip; Section 3.1.5). A majority of Ft. Patrick Henry tailwater anglers in 2017 (97%) were from Tennessee and most of those (94%) were from local counties. Most of the anglers interviewed (88%) travelled 25 miles or less (one way) to fish. It will be important to conduct periodic angler surveys on the Ft. Patrick Henry tailwater to help evaluate management strategies applied to this trout fishery.

Ft. Patrick Henry Tailwater

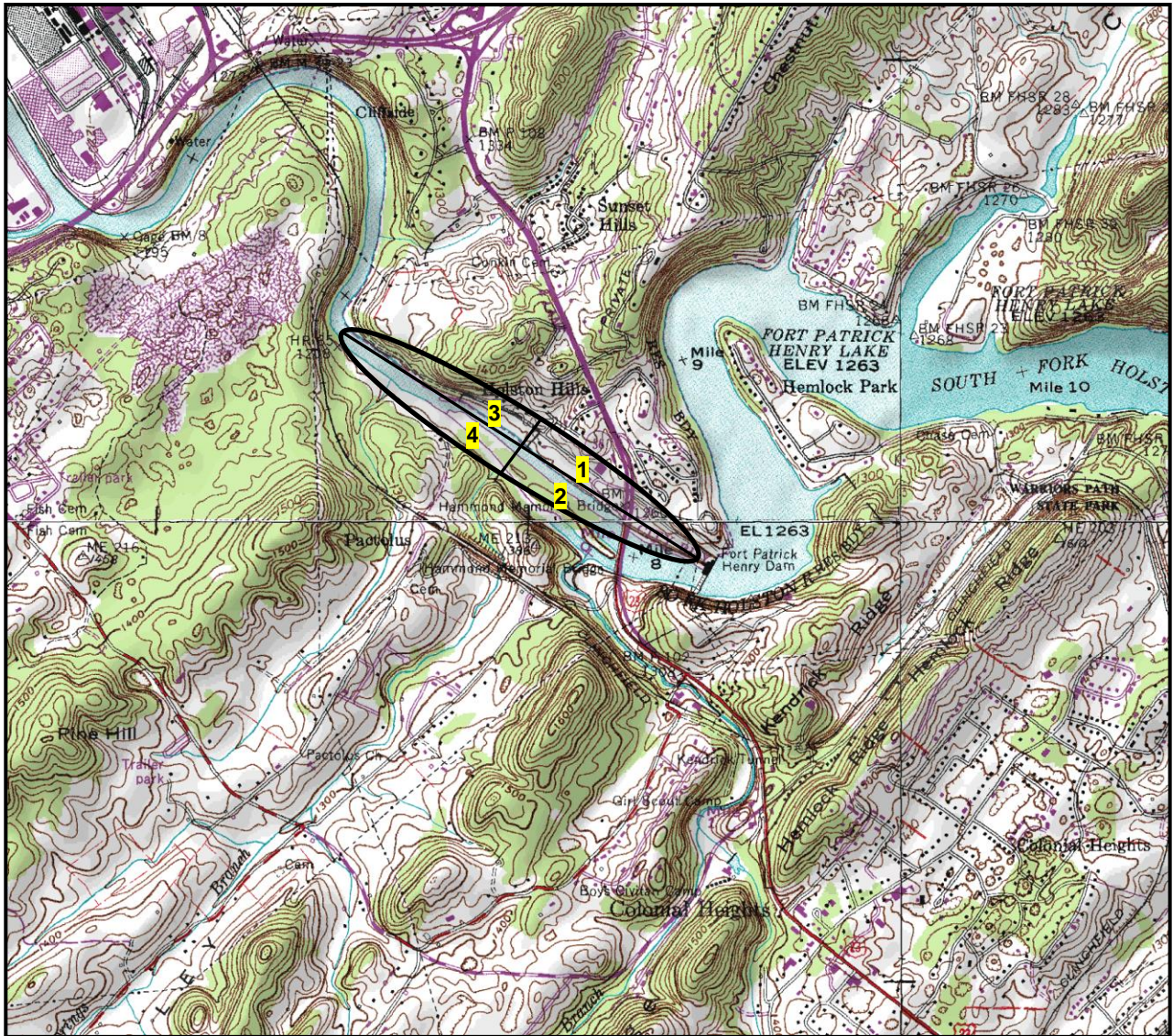


Figure 3-8. Locations of the four annual monitoring stations on the Ft. Patrick Henry tailwater (South Fork Holston River).

Ft. Patrick Henry Tailwater Electrofishing Catch Rates

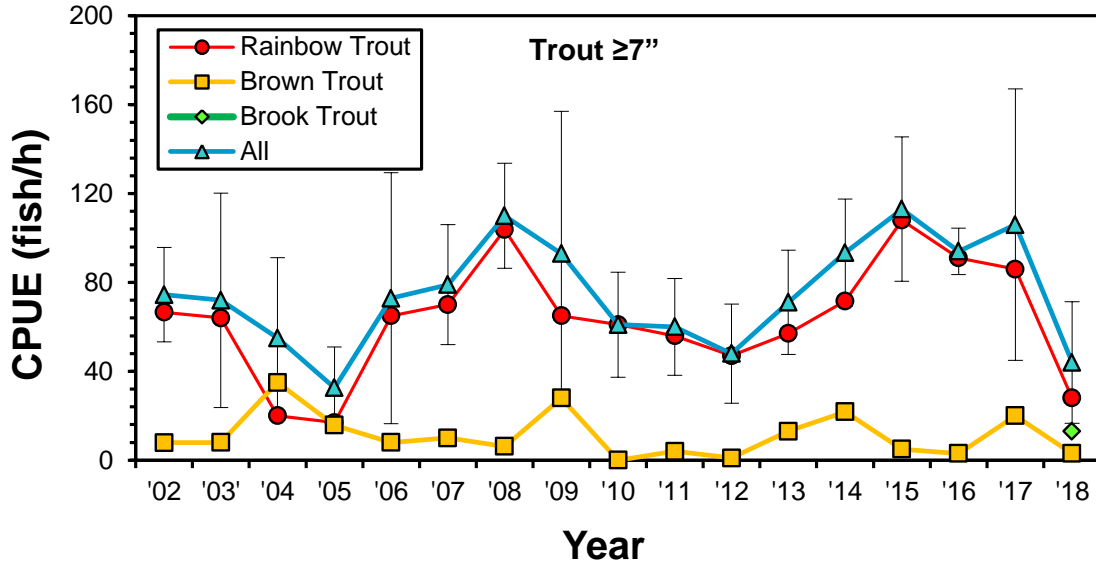


Figure 3-9. Mean electrofishing catch per unit effort (CPUE) for trout ≥ 7 in. for the Ft. Patrick Henry tailwater. Bars indicate 90% confidence intervals.

Ft. Patrick Henry Tailwater Electrofishing Catch Rates (Larger Trout)

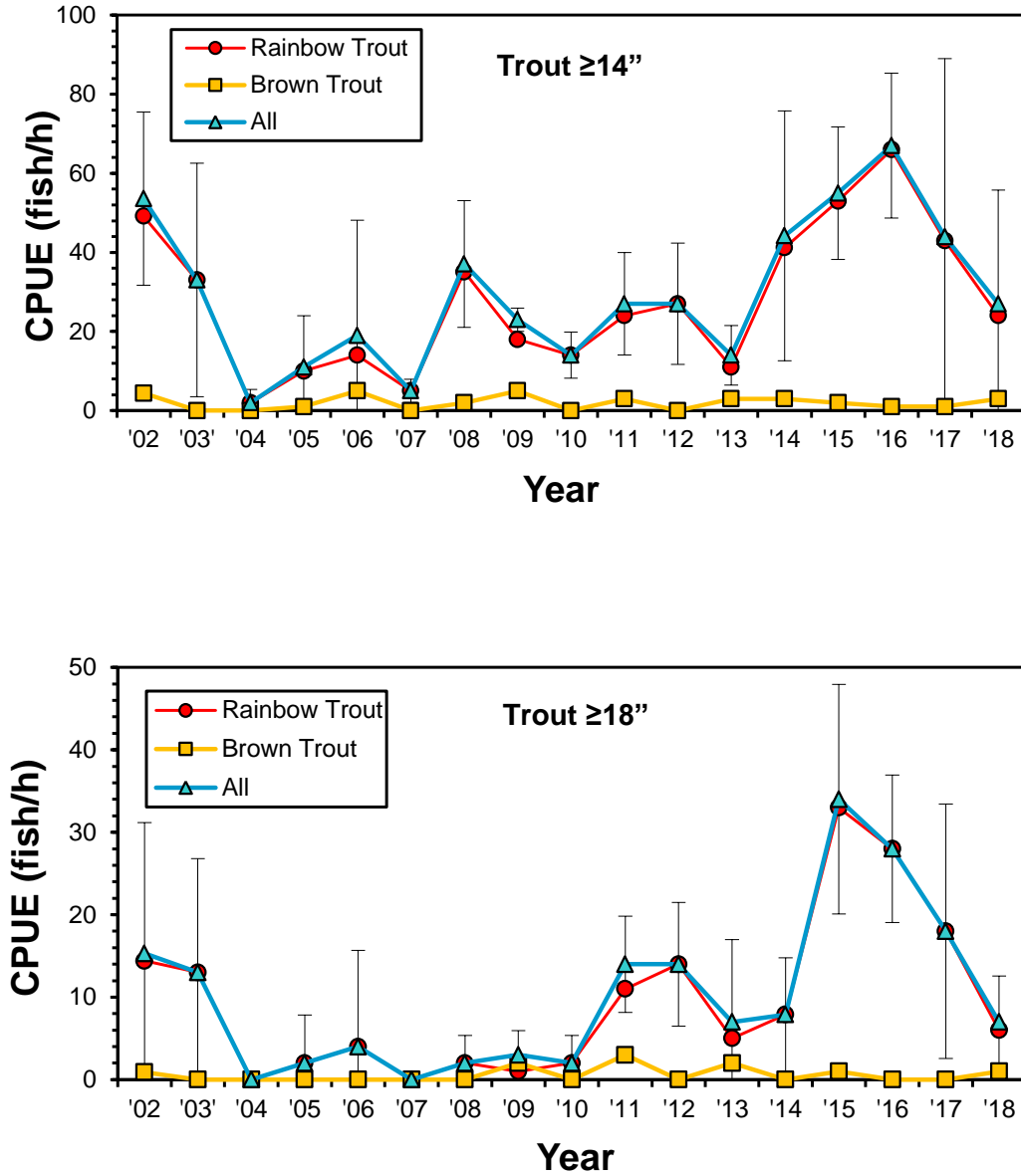


Figure 3-10. Mean electrofishing catch per unit effort (CPUE) for larger trout from the Ft. Patrick Henry tailwater. Bars indicate 90% confidence intervals.

Ft. Patrick Henry Tailwater Trout Length Frequency Distributions

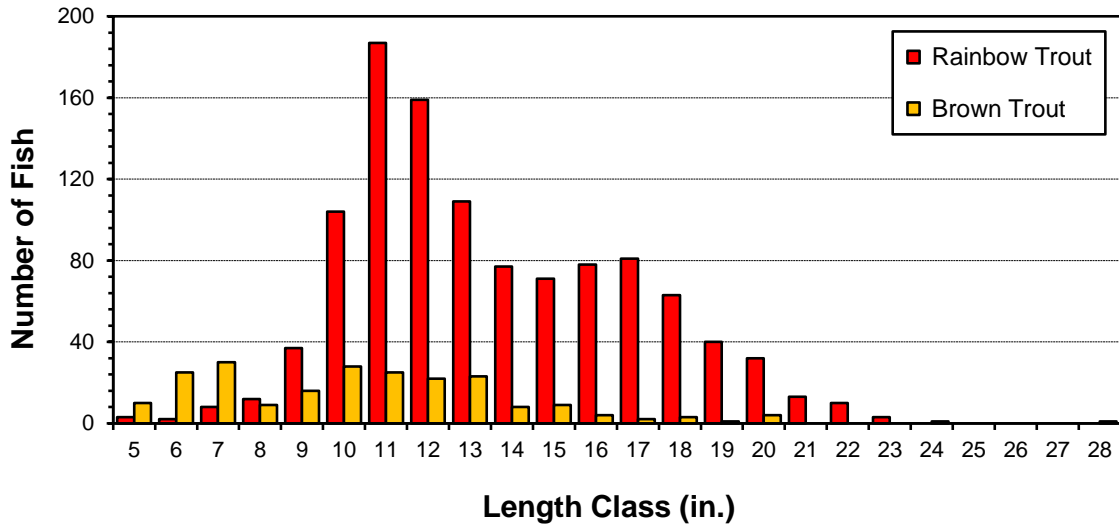


Figure 3-11. Length frequency distributions for Rainbow Trout and Brown Trout from the Ft. Patrick Henry tailwater annual monitoring samples (2002-2018).

Ft. Patrick Henry Tailwater Rainbow Trout Relative Stock Density (RSD)-18

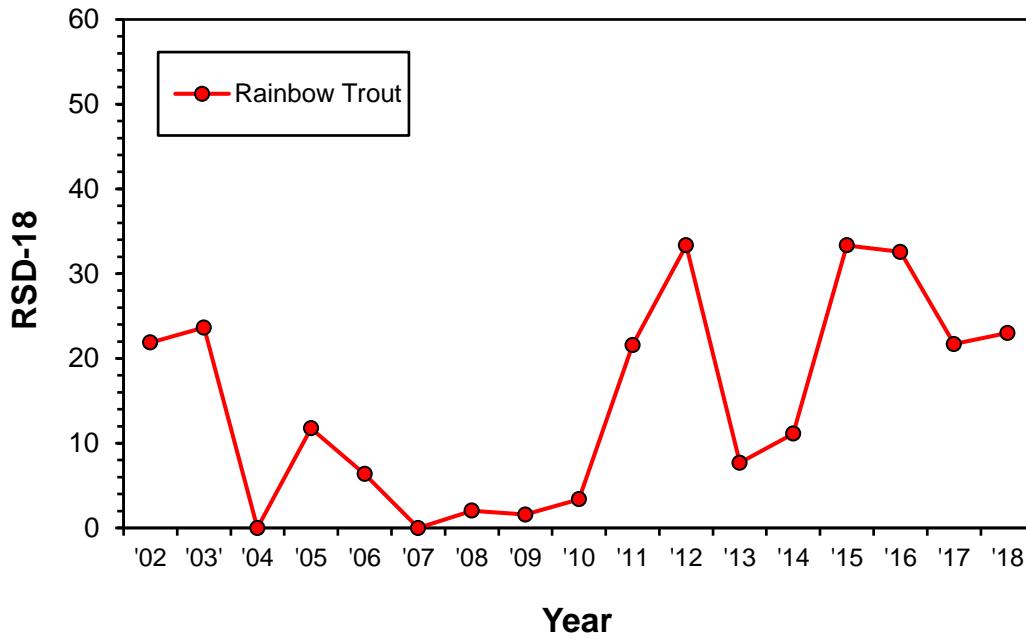


Figure 3-12. Relative stock density for Rainbow Trout ≥ 18 in. (RSD-18) from the Ft. Patrick Henry tailwater annual monitoring samples (2002-2018).

Ft. Patrick Henry Tailwater Relative Weights (W_r)

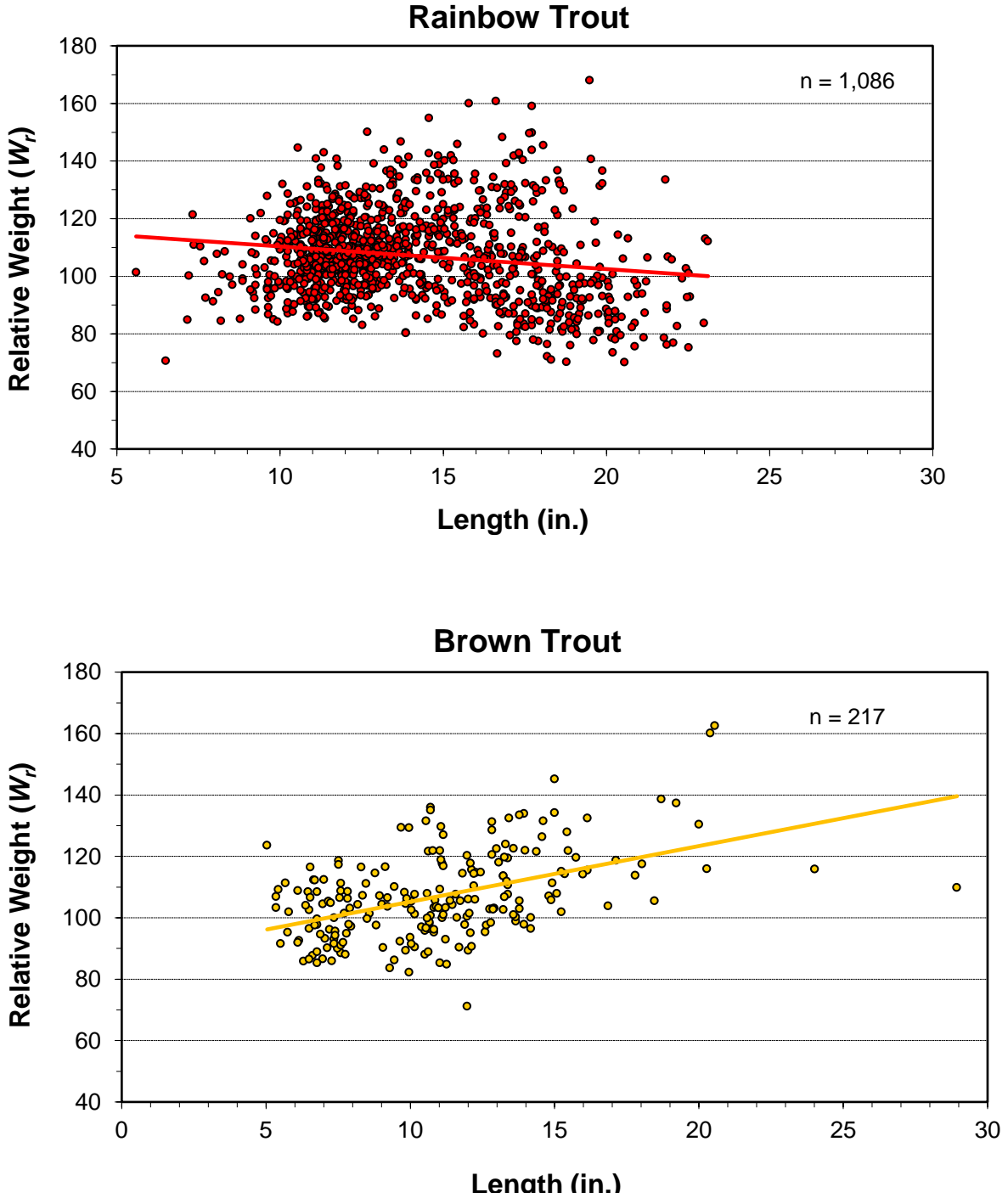


Figure 3-13. Relative weight (W_r) scatter plots with trend lines for Rainbow Trout and Brown Trout from the Ft. Patrick Henry tailwater (2002-2018).

Ft. Patrick Henry Tailwater Stocking

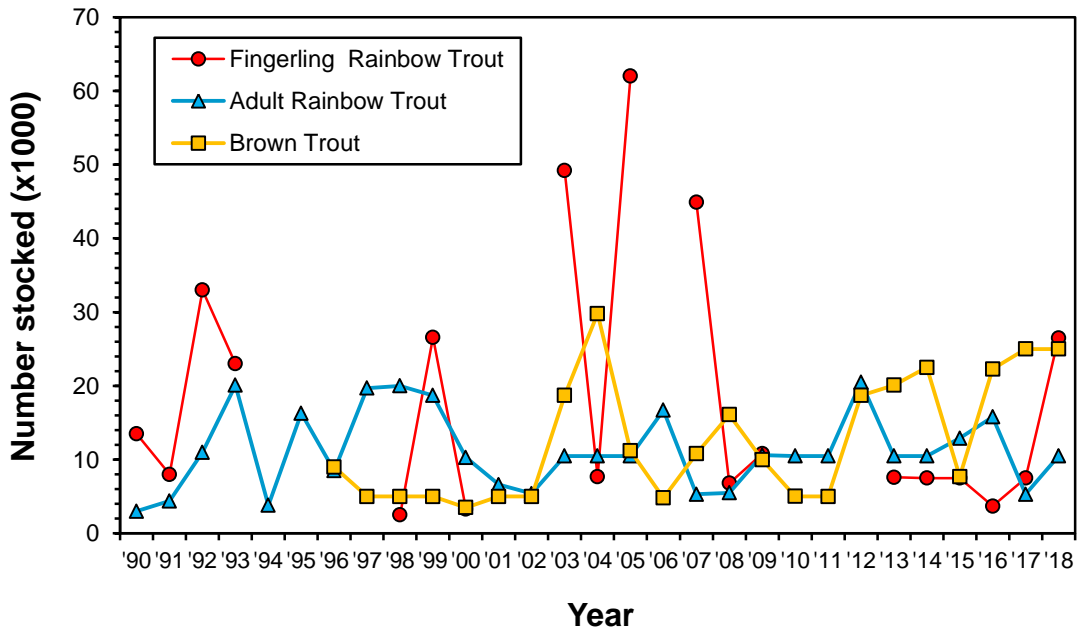
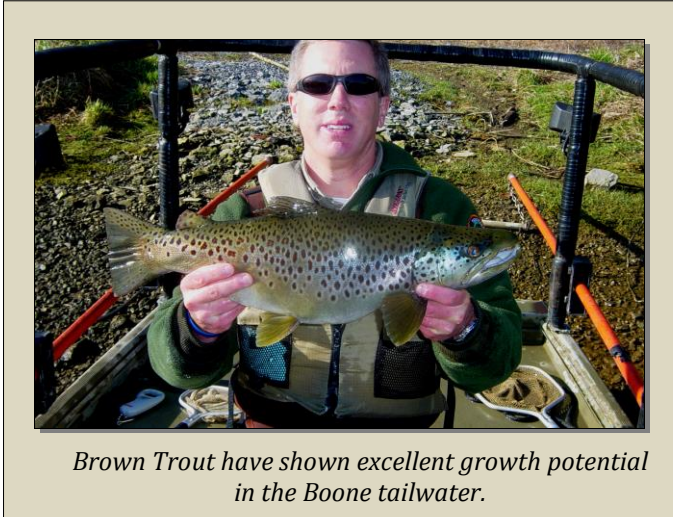


Figure 3-14. Trout stocking rates for the Ft. Patrick Henry tailwater (1990-2018). Brown Trout are stocked as sub-adults (6-8 in.).

4. MANAGEMENT OBJECTIVES AND RECOMMENDATIONS

4.1 BOONE TAILWATER



The management goal for the Boone tailwater (Section 1) is to fully develop and maintain its unique potential for producing exceptionally large, well-conditioned trout as part of the put-and-grow and put-and-take fisheries for Rainbow Trout, Brown Trout, and Brook Trout. Accordingly, the corresponding objectives for fulfilling the management goal during 2019-2024 will be:

Objective 1: Identify and consistently apply optimal trout stocking rates

The Boone tailwater trout fishery is primarily supported by stocking adult Rainbow Trout and sub-adult Brown Trout. Recent annual stocking allocations have been 9,000 adult Rainbow Trout (4,000 in March and 5,000 in December) and 10-20,000 Brown Trout (April), although actual stocking rates have varied considerably. It will be important to standardize and adhere to allocations so that stocking rates can be evaluated and optimized. It remains unclear if fingerling Rainbow Trout are recruiting to the fishery as they do in other Region 4 tailwaters (i.e., Norris, South Holston, and Wilbur). Consequently, fingerling stocking will be evaluated by marking a cohort of these fish during the current management plan term (planned for 2019) and evaluating their subsequent survival and recruitment. This objective addresses the STMP Hatchery-Supported Fisheries Goal 1, Strategy 2.

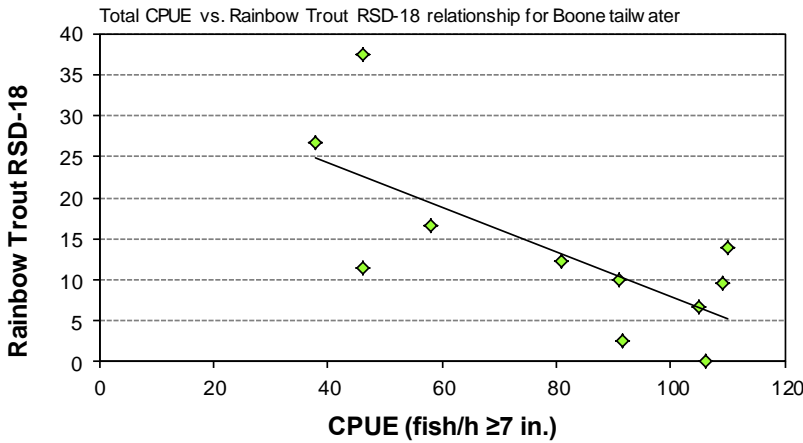
Recommended annual Boone tailwater trout stocking rates for 2019-2024 are:

- 10,000 adult Rainbow Trout
- 7,500 fingerling Rainbow Trout
- 10,000 sub-adult Brown Trout
- 2,000 adult Brook Trout (depending upon availability)

Stocking dates will remain as listed above, with fingerling Rainbow Trout stocked during August.

Objective 2: *Maintain a mean RSD-18 of ≥ 20 for all trout and ≥ 10 for Rainbow Trout*

Mean RSD-18 (all trout) was 17 during 2008-2018 and 26 for the five highest years during that period. Therefore, achieving a mean RSD-18 of 20 for all trout during the management plan term should meet the goal for this tailwater, particularly given that mean RSD-18 (all trout) for other Region 4 tailwaters is < 10 . Large Rainbow Trout are the most significant component of this



fishery and mean Rainbow Trout RSD-18 for 2008-2018 was 13. Although large Brown Trout are becoming more numerous and have added a new facet to this fishery, it would be undesirable if this occurs at the expense of large Rainbow Trout. Therefore, the objective for Rainbow Trout during the management plan

term will be a mean RSD-18 of ≥ 10 and could require adjustment of the Brown Trout stocking rate. Monitoring data indicate that total CPUEs ≤ 80 fish/h (≥ 7 in.) are associated with Rainbow Trout RSD-18 values > 10 (see graph at above). Therefore, management—including stocking rates—should not cause trout abundance to consistently exceed that level. If necessary, angling regulations (e.g., size limits) can also be adjusted to help maintain Boone tailwater’s quality trout fishery. This objective (and Objective 3 below) supports STMP Angling Opportunities Goal 1 (maintain a variety of trout fisheries) and potentially Strategy 4.

Objective 3: *Maintain a mean $W_r > 100$ for all trout*

Only the Boone and Ft. Patrick Henry tailwaters in Region 4 produce trout with mean relative weights (W_r) > 100 and that commonly exceed 120. Additionally, mean W_r does not decline (as in other tailwaters) for Rainbow Trout as they reach larger size classes (e.g., ≥ 14 in.; Figure 3-6). Stocking rates can be adjusted if necessary to help maintain high W_r .

Objective 4: *Ensure that the trout fishery is not impacted by the Boone Reservoir drawdown*

Continue to work cooperatively with TVA to monitor and evaluate tailwater temperature, DO, and other parameters, particularly during summer and fall, to identify any water quality issues

that could impact the tailwater trout fishery. Work with TVA to develop solutions if any such impacts occur. This objective supports STMP Habitat Protection Goal 2, Strategy 3.

Objective 5: Educate anglers on potential biosecurity threats to the trout fishery

The parasite that causes whirling disease (*Myxobolus cerebralis*) has been detected in trout from the South Holston and Wilbur upstream. Aquatic nuisance species (ANS) signs will be posted at access points to make anglers aware of potential biosecurity threats to the resource and how they can be avoided (supports STMP Biosecurity Goal 1, Strategy 1).

Evaluation

Sampling of the four Boone tailwater monitoring stations (1 h total effort) will continue annually. Following completion of the 2024 sampling efforts, an assessment of management objective accomplishments will be made and strategies will be adjusted, if necessary, to meet the management goal. Another angler survey should be conducted at least once during the management plan term (2019-2024) to complement monitoring data, help evaluate and optimize stocking rates, and further develop management strategies (supports STMP Angling Opportunities Goal 1, Strategy 6 and Outreach Goal 1, Strategy 2).

4.2 FT. PATRICK HENRY TAILWATER



A colorful Ft. Patrick Henry tailwater Rainbow Trout

The management goal for the Ft. Patrick Henry tailwater parallels the goal for the Boone tailwater in that it seeks to fully develop and maintain its unique potential for producing exceptionally large, well-conditioned trout as part of the put-and-grow and put-and-take fisheries for Rainbow Trout and Brown Trout provided by TWRA. The corresponding objectives for fulfilling the management goal during 2019-2024 will be:

Objective 1: Identify and consistently apply optimal trout stocking rates

The Ft. Patrick tailwater trout fishery is primarily supported by stocking adult Rainbow Trout and sub-adult Brown Trout. Recent annual stocking allocations have been 10,500 adult

Rainbow Trout (5,500 in March and 5,000 in April), 7,500 fingerling Rainbow Trout (March), and 20-25,000 Brown Trout (January and April), although actual stocking rates have varied considerably. It will be important to standardize and adhere to allocations so that stocking rates can be evaluated and optimized. It remains unclear if fingerling Rainbow Trout are recruiting to the fishery as they do in other Region 4 tailwaters (i.e., Norris, South Holston, and Wilbur). For example, a large fingerling stocking in 2003 (49,000) was followed by declining Rainbow Trout catch rates the next two years, while Rainbow Trout CPUEs increased following a stocking of 44,000 fingerlings in 2007 (Figure 3-9). Consequently, fingerling stocking will be evaluated by marking a cohort of these fish during the current management plan term (planned for 2019) and evaluating their subsequent survival and recruitment. The recent increase in the sub-adult Brown Trout stocking rate for the Ft. Patrick Henry tailwater—from 10,000/year during 2002- 2011 to 20,000/year since 2012—has not produced a perceptible increase in Brown Trout catch rates during annual monitoring (Figure 3-9), thus it can be reduced to the previous level (10,000/year). This objective addresses the STMP Hatchery-Supported Fisheries Goal 1, Strategy 2.

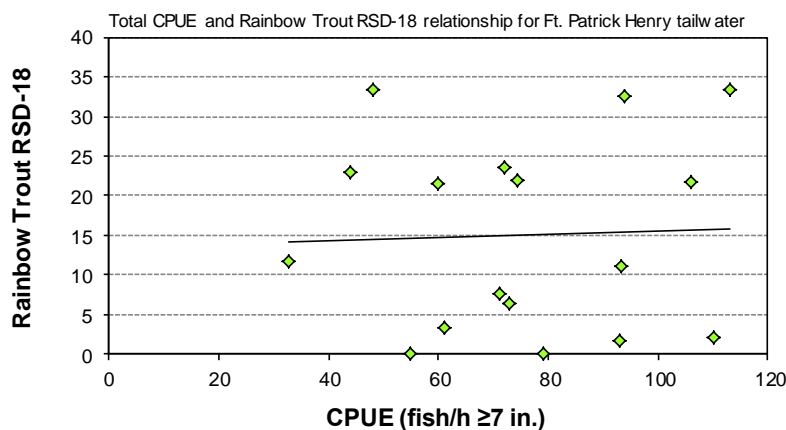
Recommended annual Ft. Patrick Henry tailwater trout stocking rates for 2019-2024 are:

- 10,000 adult Rainbow Trout
- 7,500 fingerling Rainbow Trout
- 10,000 sub-adult Brown Trout

Stocking dates will remain as listed above, with fingerling Rainbow Trout stocked during August.

Objective 2: *Maintain a mean RSD-18 of ≥ 20 for Rainbow Trout*

Large, well-conditioned Rainbow Trout are the most important component of the Ft. Patrick Henry tailwater fishery. Few Brown Trout ≥ 18 in. are captured, (Figures 3-10 and 3-11),



thus this size structure objective is based on Rainbow Trout. Mean Rainbow Trout RSD-18 since 2011 is 23 and has occasionally exceeded 30 during that period (Figure 3-12). Prior to 2011, mean Rainbow Trout RSD-18 was 8, but did occasionally reach 20. Therefore, maintaining

a mean RSD-18 of ≥ 20 for the management plan term (2019-2024) should meet the goal for this tailwater, particularly given that mean Rainbow Trout RSD-18 for other Region 4 tailwaters (excluding Boone) are ≤ 5 . Total trout catch rates have ranged from 33-113 fish/h (≥ 7 in.), but there is no particular relationship between catch rate and Rainbow Trout RSD-18 (see graph above). However, total trout abundance (as indicated by CPUE for fish 7 in.) should probably not increase substantially above a mean of 100 fish/h. Stocking rates and, if necessary, angling regulations (e.g., size limits) can be adjusted to maintain the unique aspect of the Ft. Patrick Henry tailwater Rainbow Trout fishery. This objective (and Objective 3 below) supports STMP Angling Opportunities Goal 1 (maintain a variety of trout fisheries) and potentially Strategy 4.

Objective 3: Maintain a mean $W_r > 100$ for trout

Only the Boone and Ft. Patrick Henry tailwaters in Region 4 produce trout with mean relative weights (W_r) > 100 and that commonly exceed 120. Additionally, although mean W_r for Rainbow Trout declines for larger fish in the Ft. Patrick Henry tailwater, it does not fall below 100 (Figure 3-13) as in other tailwaters (excluding Boone). Stocking rates can be adjusted if necessary to help maintain high W_r .

Objective 4: Improve public angling access to the Ft. Patrick Henry tailwater

Public angling access is essentially confined to the right descending bank along the Wesley Road corridor. Access could be improved by working with Kingsport Parks and Recreation to develop the property behind the Wal-Mart on Ft. Henry Drive (supports STMP Angling Opportunities Goal 2, Strategy 1).

Objective 5: Educate anglers on potential biosecurity threats to the trout fishery

The parasite that causes whirling disease (*Myxobolus cerebralis*) has been detected in trout from the South Holston and Wilbur upstream. Aquatic nuisance species (ANS) signs will be posted at access points to make anglers aware of potential biosecurity threats to the resource and how they can be avoided (supports STMP Biosecurity Goal 1, Strategy 1).

Evaluation

Annual sampling at the four Ft. Patrick Henry tailwater monitoring stations (1 h total effort) will continue during 2019-2024. Information provided by an angler in 2017 suggested that large (i.e., ≥ 18 in.) Brown Trout may use habitat in late winter that is farther downstream from the existing monitoring stations. If so, this could explain their comparatively low catch rates (relative

to Rainbow Trout) in previous monitoring samples. These downstream areas will be sampled during 2019-2024 to determine if they produce higher abundances of large Brown Trout than the tailwater segment containing the monitoring stations.

Following completion of the 2024 sampling efforts, an assessment of management objective accomplishments will be made and strategies will be adjusted, if necessary, to meet the management goal. At least one angler survey should be conducted during the management plan term (2019-2024) to complement monitoring data, help evaluate and optimize stocking rates, and further develop management strategies (supports STMP Angling Opportunities Goal 1, Strategy 6 and Outreach Goal 1, Strategy 2).

5. REFERENCES

- Black, W. P. 2014. Tennessee Statewide Creel Survey: 2013 Results. Final report, Tennessee Wildlife Resources Agency, Nashville, Tennessee.
- Black, W. P. 2015. Tennessee Statewide Creel Survey: 2014 Results. Final report, 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.
- Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2017. Region IV trout fisheries report: 2016. Fisheries Report No. 17-02. Tennessee Wildlife Resources Agency, Nashville, Tennessee.
- Habera, J. W., S. J. Petre, B. D. Carter, and C. E. Williams. 2018. Region IV trout fisheries report: 2017. Fisheries Report No. 18-01. Tennessee Wildlife Resources Agency, Nashville, Tennessee.
- 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.
- Negus, J and D. C. Peterson. 2005. Norris Reservoir Annual Report 2005. Tennessee Wildlife Resources Agency, 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.
- TWRA (Tennessee Wildlife Resources Agency). 2014. Protecting, preserving, and perpetuating Tennessee's wildlife and ecosystems: Strategic plan 2014-2020. Tennessee Wildlife Resources Agency, Nashville, Tennessee. Cited in appendix.

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.

APPENDIX

**Statewide Trout Management Plan (TWRA 2017) Goals and Strategies
Supported in the Boone and Ft. Patrick Henry Tailwater Management Plan**

Page 1:

HATCHERY-SUPPORTED FISHERIES

GOAL 1. Optimize use of hatchery trout.

Strategy:

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.

Pages 29 and 32:

HATCHERY-SUPPORTED FISHERIES

GOAL 1. Optimize use of hatchery trout.

Strategy:

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.

Pages 30 and 33:

ANGLING OPPORTUNITIES

GOAL 1. Maintain a variety of trout fisheries.

Strategy (potential):

4. Establish or explore the utility of new regulations, such as a catch-and-release areas, to diversify angling experiences.

Page 31:

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). 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.

Pages 31 and 33:

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.

Pages 31 and 34:

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.

Page 33:

ANGLING OPPORTUNITIES

GOAL 2. *Increase access to trout fisheries.*

Strategy:

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.