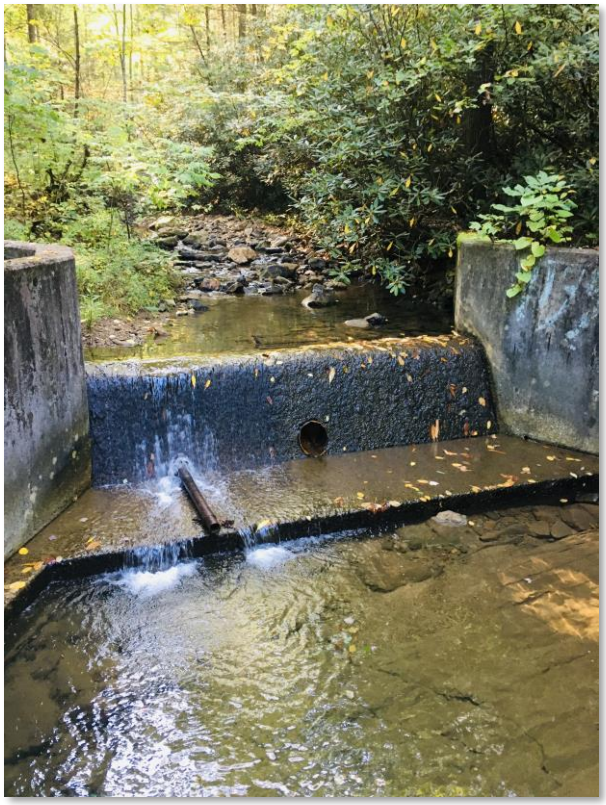
FISHERIES REPORT:

Region IV Coldwater Streams 2020

Tennessee Wildlife Resources Agency
Fisheries Report 21-05



Above photo: Rainbow Trout were removed by electrofishing down to this fish passage barrier on lower Little Jacob Creek in 2020, extending native Brook Trout distribution by 1.2 km. Photo by Jim Habera (TWRA).

Cover photo: The upper Wilbur tailwater, Carter Co., Tennessee. An abundant wild Brown Trout population has developed there much like the one in the nearby South Holston tailwater. Photo by Jim Habera (TWRA).

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FISHERIES REPORT:

REGION 4 COLDWATER STREAMS

2020

Prepared by:

James W. Habera
Sally J. Petre
Bart D. Carter
and
Carl E. Williams

TENNESSEE WILDLIFE RESOURCES AGENCY
FISHERIES REPORT 21-xx

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This report contains progress and accomplishments for the following TWRA Projects: "Stream Survey".

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Executive Summary

Wild Trout Monitoring: Two wild trout streams (Left Prong Hampton Creek and Doe Creek) were quantitatively sampled during 2020 at established monitoring stations. Trout biomass estimates declined in both streams relative to 2019 and were at the lowest levels observed since monitoring began at Left Prong Hampton Creek site 3 and Doe Creek. Wild trout abundances have typically remained below long-term averages since the region-wide drought in 2016.

Sympatric Brook/Rainbow Trout streams: Relative Brook Trout biomass in Birch Branch (80%) increased to the highest level since monitoring began in 1995. Brook Trout relative abundance (density and biomass) often increase during and after droughts (Rainbow Trout appear to be more negatively impacted) and the Birch Branch population has continued to exist in sympatry with Rainbow Trout for over 25 years.

Native Brook Trout Restoration and Enhancement: The restoration project in Little Stony Creek (Watauga Lake tributary) was evaluated in 2020 and considered successful and complete. Rainbow Trout removals were completed in Shell Creek, Green Mountain Branch, Trail Fork of Big Creek, and nearly completed for the Little Jacob Creek enhancement. Native Brook Trout produced by Tennessee Aquarium Conservation Institute were released in Shell Creek and native fish from three Beaverdam Creek tributaries were translocated to Green Mountain Branch. No reproduction by the native Brook Trout translocated to Phillips Hollow in 2019 was observed in 2020, but several adult fish were present. An assessment of the potential culvert barrier on Right Prong Rock Creek was also initiated by marking Rainbow Trout captured upstream of the culvert and releasing them in the pool just downstream.

Norris tailwater: Mean CPUE for trout within the PLR (356-508 mm) exceeded 100 fish/h for the first time in 2020 and RSD-14 for Rainbow Trout (80) and Brown Trout (100) in 2020 were the highest observed to date. Corresponding objectives for the new Norris tailwater management plan (2020-2025) are a mean PLR CPUE of ≥56 fish/h and RSD-14s of ≥45. Preliminary results for the ongoing research project through the Tennessee Cooperative Fisheries Research Unit (TN CFRU) at Tennessee Tech University suggest that natural reproduction by Rainbow Trout contributes substantially to this fishery.

Cherokee tailwater: The Cherokee tailwater was sampled in June and October 2020. The 2020 overall mean CPUE (12.5 fish/h) was the highest obtained since 2015 and mean CPUE for Rainbow Trout (10.5 fish/h) was higher than for any previous sample. Mean catch rates for larger trout in October 2020 (10.5 fish/h ≥356 mm and 2.5 fish/h ≥457) mm were also higher than for any previous sample year. Mean CPUE for Rainbow Trout ≥178 mm in June 2020 (18 fish/h) was comparable to the June 2019 sample (15 fish/h) and while June CPUEs have been somewhat higher than subsequent fall catch rates, they also exhibit higher variability among sites. There was no coldwater habitat (minimum daily water temperature exceeded 21° C) for 41 days near the dam and 45 days at Blue Spring. Water temperatures in the Cherokee tailwater typically exceed 21° C in September and return to trout-tolerant levels by mid- to late October.

Wilbur tailwater: Mean CPUE for Brown Trout ≥178 mm in the upper portion of the tailwater (Stations 1-6) remained above 300 fish/h in 2020. Mean Rainbow Trout CPUE (all sites) declined to 28 fish/h—the lowest level observed since the fish kill in 2000. The mean catch rate for larger trout (≥356 mm) exceeded 20 fish/h again in 2020 and has been in the 20-27 fish/h range since 2010 (most of the fish in this size range are Brown Trout). A new angler survey in 2020 indicated that 70% of the 383 anglers interviewed indicated that they did not fish in the QZ during the past year and only a slight majority (54%) of those who did believed they caught more trout ≥14 in. there. Regarding the trout fishery in the lower Wilbur tailwater (below Blevins Bend), 83% rated it as good or excellent and no one assigned a rating fair or poor.

Ft. Patrick Henry tailwater: Mean electrofishing catch rates for trout ≥178 mm and ≥356 mm declined slightly relatively to 2019, although catch rates for the largest trout (≥457 mm) increased in 2020, with the Brown Trout CPUE (5 fish/h) exceeding that for any previous sample. RSD-18 for Rainbow Trout increased to 74 in 2020—the highest level observed to date and well above the objective (20) established in the Boone and Ft. Patrick Henry Tailwater Trout Fisheries Management Plan. Preliminary results of TN CFRU's research indicate that adult-stocked (~254 mm or 10 in.) Rainbow Trout primarily support that fishery and that these fish can grow to exceed 21 in. within 16 months (an average growth rate of 19.4 mm or 0.76 in. per month).

Boone tailwater: Mean electrofishing catch rates for Rainbow Trout and Brown Trout ≥178 mm and ≥356 mm were comparable to corresponding 2019 CPUEs. The catch rate for Brown Trout ≥457 mm increased to the highest level observed to date (9 fish/h)—as was also observed for the Ft. Patrick Henry tailwater. RSD-18 for Boone tailwater Rainbow Trout decreased to 14 in 2020, although it was unchanged (27) for all trout. The 2020 values exceed the objectives (10 for Rainbow Trout and 20 for all trout) established in the Boone and Ft. Patrick Henry Tailwater Trout Fisheries Management Plan. The extended drawdown of Boone Reservoir (3.1 m below winter pool) continued in 2020 and TVA's water quality monitoring data from the tailwater indicated no particular issues with elevated water temperature (>21°C). Dissolved oxygen depressions into the 3.0 mg/l range were recorded on 13 days during the first three weeks of September.

South Holston tailwater: The mean electrofishing catch rate (CPUE) for all trout ≥178 mm increased to 420 fish/h in 2020 and mean CPUE for Brown Trout ≥178 mm (377 fish/h) was the highest observed to date. Rainbow Trout CPUE has been relatively stable during the past five years at 30-40 fish/h. The overall PLR catch rate decreased to 10.5 fish/h in 2020 and has typically ranged from 9-15 fish/h since 2010. Brown Trout RSD declined to 5 in 2020 and has remained in the 3-8 range since 2010, indicating that Brown Trout population size structures have not maintained the shift toward larger fish that occurred during 2005-2007. Mean W_r for Brown Trout in the PLR size classes (81.2) was the lowest observed to date. Results for the 2019 South Holston tailwater creel survey indicated that angling pressure (hours) was 35% higher than in 2017 (estimated 86,080 hours) and trips increased by only 16%. Harvest also increased substantially for both Rainbow Trout and Brown Trout, with the Brown Trout harvest rate increasing to 11% in 2019. However, Brown Trout harvest likely remains too low to affect abundance based on an average catch of 100,000 fish/year as estimated by the 2014-2019 creel surveys.

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1. Introduction

The Tennessee Wildlife Resources Agency (TWRA) manages trout fisheries in a variety of waters in Tennessee including streams, tailwater rivers, and reservoirs, providing a popular and important set of angling opportunities. The Agency's current statewide trout management plan (TWRA 2017) features management goals and strategies designed to manage stocked trout and conserve wild trout and their habitat while providing a variety of angling experiences. The most recent U.S. Fish and Wildlife Service (USFWS) survey providing demographic and economic data for trout angling for Tennessee (2011), estimated that 105,000 resident and non-resident anglers (age 16 or older) fished for trout in Tennessee (Maillett and Aiken 2015). They made an estimated 1.4 million trips spending an estimated total of $53 million and represented 15% of Tennessee anglers (Maillett and Aiken 2015). A statewide survey by the University of Tennessee in 2012 also indicated that 15% of Tennessee's anglers fished for trout, making an average of 15 trips (averaging 4 hours) that year (Schexnayder et al. 2014). Most of those anglers targeted trout in hatchery-supported fisheries.

Accordingly, while TWRA management emphasizes habitat preservation and maintenance of wild stocks where they occur, artificially propagated trout are essential for managing substantial portions of the coldwater resource. Nearly 2 million trout are produced or grown annually at five state (TWRA), one municipal (Gatlinburg), and two federal (USFWS) facilities to be stocked in Tennessee's hatchery-supported fisheries (Roddy 2020). Nearly half of those trout are stocked in Region IV waters, with 52% of those fish used to support tailwater fisheries, 27% used to provide reservoir fisheries, and 21% used for smaller streams, winter trout program fisheries, etc.

The Blue Ridge physiographic province of eastern Tennessee contains about 1,000 km (621 mi) of coldwater streams inhabited by wild (self-sustaining) populations of Rainbow Trout *Oncorhynchus mykiss*, Brook Trout *Salvelinus fontinalis*, and Brown Trout *Salmo trutta*. Wild trout occur in 9 of Region IV's 21 counties (primarily those that border North Carolina; Figure 1-1). Most of Region IV's wild trout resource is within the U.S. Forest Service's (USFS) 253,000-hectare (625,000-acre) Cherokee National Forest (CNF) with about 30% on privately owned lands and includes some of the State's best wild trout streams. Many streams with unregulated flows can support trout fisheries but are limited by marginal summer habitat or levels of natural production insufficient to meet existing fishing pressure. TWRA provides or supplements trout fisheries in 34 such streams in Region IV by annually stocking hatchery-produced (adult) Rainbow Trout. Some stocked steams (e.g., Beaverdam Creek, Doe Creek, Laurel Fork, and Doe River) do support excellent wild trout populations as well, but the moderate stocking rates employed are considered to pose no population-level problems for the resident fish (Meyer et al. 2012).

Brook Trout are Tennessee's only native salmonid and once occurred at elevations as low as 490 m (1,600 ft.) in some streams (King 1937). They currently occupy about 225 km (140 mi) in 110 streams, or about 24% of the stream length supporting wild trout outside Great Smoky Mountain National Park. Brook Trout occur allopatrically (no other trout species are present) in 42 streams totaling 71 km (44 mi.), representing 31% of the Brook Trout resource. Another 14 streams have waterfalls or man-made barriers that maintain Brook Trout allopatry in most of the 38 km (23 mi.) of habitat they provide.

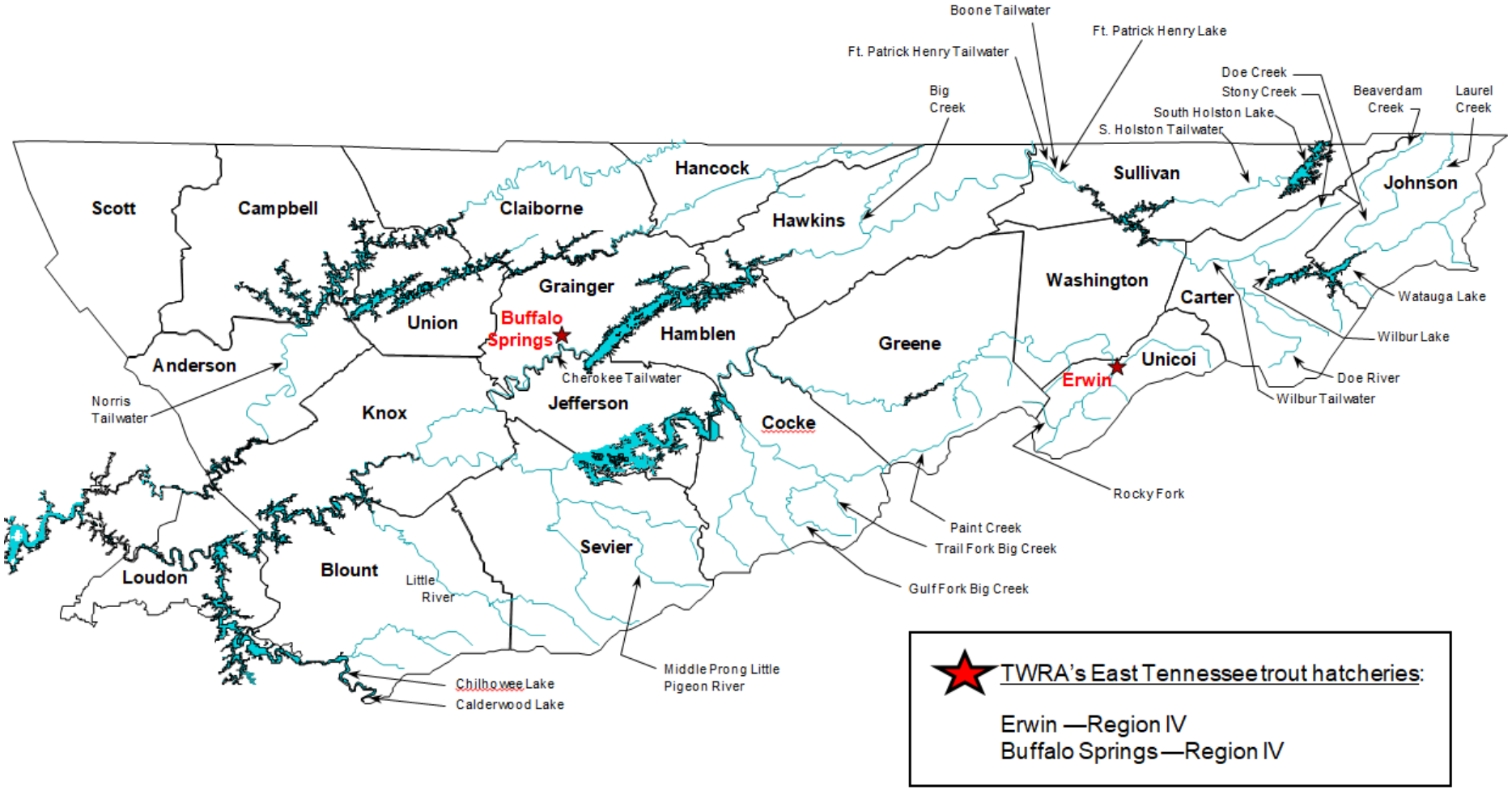
Cold, hypolimnetic releases from five Tennessee Valley Authority (TVA) dams in Region IV (Norris, Ft. Patrick Henry, South Holston, Wilbur, and Boone) also support year-round trout fisheries in the tailwaters downstream (Figure 1-1). The habitat and food resources that characterize these tailwaters provide for higher carrying capacities and allow trout to grow larger than they normally do in other streams. Tailwaters are typically stocked with fingerlings (100-150 mm) in the early spring and adult fish (229-305 mm) throughout the summer. Stocked adult trout supplement the catch during peak angling

season and by fall, fingerlings have begun to enter these fisheries, meaning they are a catchable size. Natural reproduction entirely supports the Brown Trout fisheries in the South Holston and Wilbur (Watauga River) tailwaters. Recent surveys have also shown natural reproduction by Rainbow Trout may be significant in those tailwaters, as well as in Norris tailwater. The Holston River below Cherokee Reservoir (Figure 1-1) also supports a tailwater trout fishery, although high water temperatures (>21° C) during late summer and early fall limits survival and carryover. No fingerlings are stocked there, as few would survive the thermal bottleneck to recruit to the fishery. More research is needed to determine what fish are currently contributing to the trout fisheries in our tailwaters.

One of TWRA's core functions identified in its Strategic Plan (TWRA 2014) is outdoor recreation, and a primary objective is to maintain or improve programs that promote high user satisfaction for hunters, anglers, and boaters. Tennessee's trout anglers recently expressed a high level of satisfaction (89%) with the Agency's management of the State's trout fisheries (Schexnayder et al. 2014). Maintaining this level of satisfaction will require effective management of existing resources and opportunities—as well as development of new ones. TWRA's statewide trout management plan for 2017-2027 (TWRA 2017) addresses how these goals can be accomplished. This plan includes management guidelines for Tennessee's native Brook Trout, particularly considering new genetics data being acquired for all Brook Trout populations. Acquisition of trout population status and dynamics data from streams and tailwaters through standardized stream survey techniques (e.g., abundance trends and size structures, etc.) will also continue to be an important strategy for managing these fisheries.

Region IV Trout Streams, Tailwaters, and Reservoirs

Figure 1-1. Locations of selected Region IV trout fisheries managed by TW



2. Wild Trout Monitoring

Region IV personnel sample wild trout streams annually to obtain abundance and population trend data. This annual monitoring began in 1991 and has provided valuable information for management of Tennessee's wild trout resources, (e.g., regulation changes). Two wild trout streams were quantitatively sampled during the 2020 field season (June-October). Stream sampling was reduced from previous years because of Coronavirus restrictions on crew size (from TWRA and partner agencies) and reallocation of priorities within the work unit. Previous reports contained large amounts of survey data and stream history. Stream survey data are still being collected as usual; however, details can be found either in previous reports or in the TWRA TADS database. Archived reports can be found on the 'Fishing' tab of the TWRA website at: https://www.tn.gov/content/tn/twra/fishing/trout-information-stockings.html#FisheriesReport.

Sampling Methods

Wild trout stream sampling was conducted with battery-powered backpack electrofishing units employing inverters to produce AC outputs to complete TWRA's standard protocol for three-pass depletion. Output voltages were 125-600 VAC, depending upon water conductivity. Stocked Rainbow Trout, distinguishable by dull coloration, eroded fins, atypical body proportions, and large size (usually >229 mm), compared to wild Rainbow Trout were noted on data sheets but were not included in any analyses. Stream sample sites are part of TWRA Region 4 annual monitoring.

Removal-depletion data were analyzed with MicroFish 4.0 for Windows (http://microfish.org/). Trout ≤90 mm in length were analyzed separately from those >90 mm due to their lower catchabilities (Lohr and West 1992; Thompson and Rahel 1996; Peterson et al. 2004; Habera et al. 2010), making separate analysis necessary to avoid bias. These two groups also roughly correspond to young-of-the-year (YOY or age-0) and adults.

Doe Creek

Site location and sampling details are provided in Tables 2-1 and 2-2. Doe Creek remains one of Tennessee's most productive wild trout streams. The seasonal hatchery-supported trout fishery in Doe Creek is popular (Habera et al. 2004), but management of this stream features the outstanding wild trout population. Citizens inquired during the 2020 sample if a fish kill related to the "white sludge" that came down the creek the previous weekend was being investigated (although they did not report seeing any dead fish). Trout abundance was lower in 2020 than in any previous sample (Figures 2-1 and 2-2), but other species did not appear to be notably affected (Figure 2-3), thus it seems unlikely there was a significant fish kill at the monitoring site.

Doe Creek

Table 2-1. Site and sampling information for Doe Creek in 2020.

Location	**Site 1**	
Site code	420202001	
Sample date	10 September	
Watershed	Watauga River	
County	Johnson	
Lat-Long	36.42709 N, -81.93725 W	
Elevation (ft)	2,210	
Land ownership	Private	
Fishing access	Good	
Description	Site ends at small dam just below Lowe spring.	
Effort		
Station length (m)	134 m	978 m2
Electrofishing units	3	125 V AC
Habitat		
Mean width (m)	7.3	
Canopy cover (%)	45	
Est. % site pool/riffle	37	63
Habitat assessment score	155 (suboptimal)	
Water Quality		
Flow (cfs; visual)	19.03	normal
Temperature (C)	17.1	
pH	7.9	
Dissolved oxygen (mg/L)	NM	
Alkalinity (mg/L $CaCO_3$)	75	

Table 2-2. Fish population abundance estimates (with 95% confidence limits) for the monitoring station on Doe Creek sampled in 2020.

	Total	Pop. Size		Biomass (kg/ha)		Density (fish/ha)	
Species	Catch	Est.	C.I.	Est.	C.I.	Est.	C.I.
RBT ≤90 mm	0	0	(0-0)	0.00	(0.00-0.00)	0	(0-0)
RBT >90 mm	50	51	(47-55)	30.38	(28.02-32.79)	521	(481-562)
Creek Chub	3	3	(3-3)	0.02	(0.02-0.02)	31	(31-31)
Blacknose Dace	163	172	(162-182)	5.92	(5.63-6.33)	1759	(1656-1861)
Fantail Darter	35	38	(30-46)	0.66	(0.52-0.80)	389	(307-470)
Mottled Sculpin	402	550	(468-632)	17.43	(14.83-20.03)	5624	(4785-6462)
C. Stoneroller	101	104	(98-110)	42.75	(40.28-45.21)	1063	(1002-1125)
N. Hogsucker	4	4	(0-9)	5.21	(0.00-11.73)	41	(0-92)

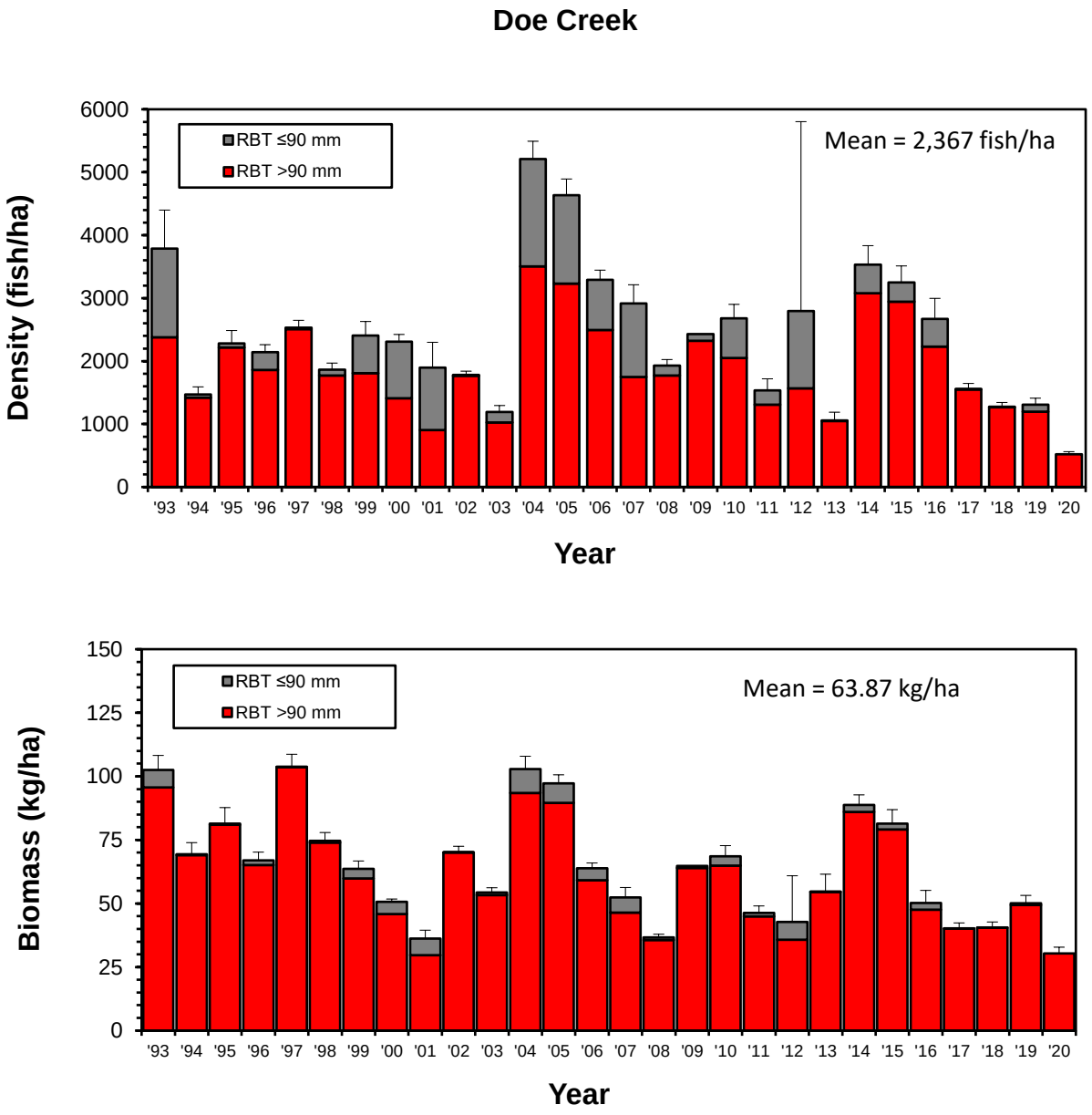


Figure 2-1. Annual abundance estimates at the Doe Creek monitoring station.

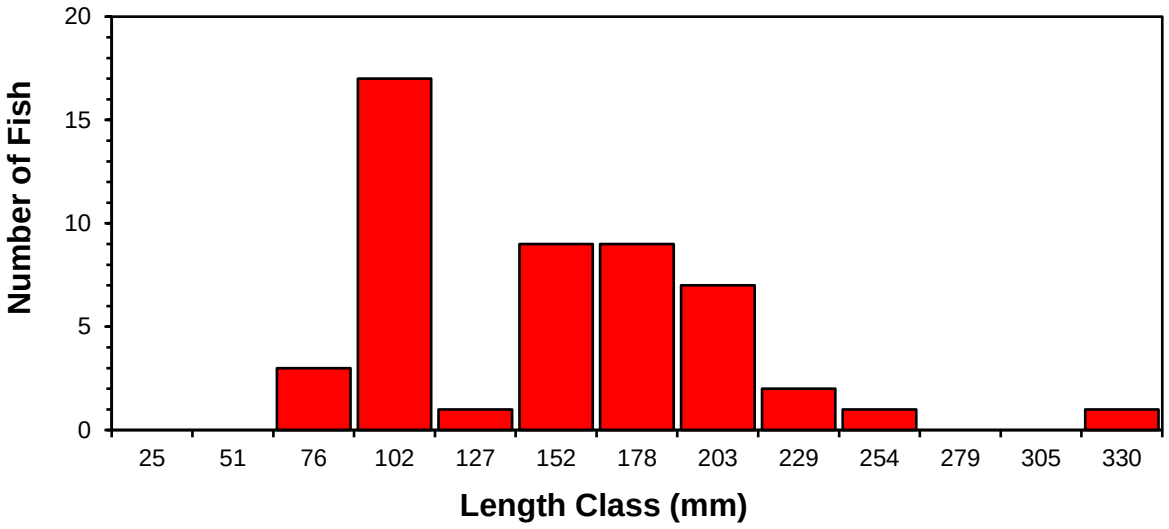


Figure 2-2. Length-frequency histogram for the 2020 Doe Creek sample.

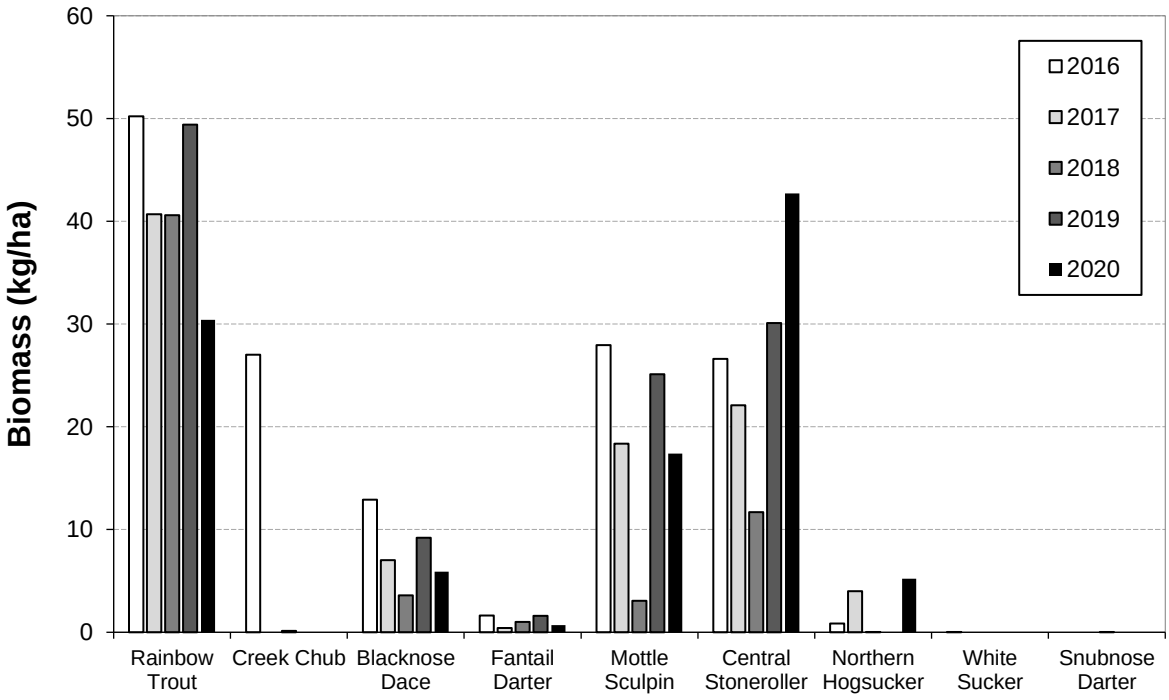


Figure 2-3. Biomass (kg/ha) of fishes in Doe Creek samples from 2016-2020.

Left Prong Hampton Creek

Site location and sampling details are provided in Tables 2-3 and 2-4. Upper Left Prong Hampton Creek's Brook Trout population has made it one of Tennessee's premier Brook Trout fisheries. Since fully established in 2003, mean Brook Trout biomass for the upper station (71 kg/ha) has historically exceeded the statewide average for other streams (about 21 kg/ha), and was comparable to the mean biomass for the previous Rainbow Trout population (81 kg/ha). However, mean abundance has declined over the last ten years, particularly in sites 1 (Rainbow Trout) and 3 (Figure 2-4) and few fish ≥203 mm size were present in 2020 (Figure 2-5). Brook Trout biomass at site 3 in 2020 was the lowest observed since this population was established in 2002 (Figure 2-4). Decreasing abundance trends may be related to decreasing quantity and quality pools, thus a more detailed habitat analysis may be useful. Deployment of instream water temperature loggers show a maximum water temperature in 2019 and 2020 to be no more than 17.7 C, well below the thermal maximum for Brook Trout, thus temperature is not a contributing factor to decreasing abundance of Brook Trout. Management of Left Prong Hampton Creek should continue to feature its native Brook Trout fishery and development of this important database should continue through annual monitoring at all three sites.

Table 2-3. Site and sampling information for Left Prong Hampton Creek in 2020.

Location	**Site 1**		**Site 2**		**Site 3**	
Site code	420201601		420201602		420201603	
Sample date	6-Aug		6-Aug		5-Aug	
Watershed	Watauga River		Watauga River		Watauga River	
County	Carter		Carter		Carter	
Lat-Long	36.15132 N, -82.05324 W		36.14673 N, -82.04917 W		36.13811 N, -82.04473 W	
Elevation (ft)	3,080		3,240		3,560	
Stream order	2		2		2	
Land ownership	State (Hampton Cove)		State (Hampton Cove)		State (Hampton Cove)	
Fishing access	Good		Good		Good	
Description	Begins ~10 m upstream of the first foot bridge.		Begins 50 m upstream of the fish barrier.		Begins 880 m upstream of the upper end of Site 2.	
Effort						
Station length (m)	106 m	477 m²	94	489 m²	100	480 m²
Electrofishing units	1	350 V AC	1	400 V AC	1	400 V AC
Habitat						
Mean width (m)	4.5		5.2		4.8	
Canopy cover (%)	70		90		95	
Aquatic vegetation	scarce		scarce		scarce	
Estimated % site riffle	NM	NM	NM	NM	NM	NM
Habitat assessment score	158 (suboptimal)		157 (suboptimal)		159 (suboptimal)	
Water Quality						
Flow (cfs; visual)	NM	normal	NM	normal	NM	normal
Temperature (C)	17.5		17		14.8	
pH	6.5		6.5		6.5	
Conductivity (µS/cm)	22		18.4		12.7	
Alkalinity (mg/L $CaCO_3$)	NM		NM		NM	

Table 2-4. Fish population abundance estimates (with 95% confidence limits) for the monitoring stations on Left Prong Hampton Creek sampled 5 and 6 August 2020.

Species	Total Catch	Pop. Size Est.	Pop. Size C.I.	Biomass (kg/ha) Est.	Biomass (kg/ha) C.I	Density (fish/ha) Est.	Density (fish/ha) C.I.
Site 1							
RBT ≤90 mm	39	42	(34-50)	4.34	(3.49-5.14)	881	(713-1048)
RBT >90 mm	14	14	(10-18)	17.15	(16.33-22.04)	294	(210-377)
BKT ≤90 mm	1	1	(1-1)	0.13	(0.13-0.13)	21	(21-21)
BKT >90 mm	0						
Blacknose dace	57	69	(50-88)	6.00	(4.30-7.56)	1,447	(1048-1845)
Fantail darter	7	8	(0-19)	0.57	(0.00-1.35)	168	(0-398)
Site 2							
BKT ≤90 mm	24	24	(21-27)	2.21	(1.93-2.48)	491	(429-552)
BKT >90 mm	30	32	(26-39)	15.62	(12.71-19.06)	654	(532-798)
Site 3							
BKT ≤90 mm	30	37	(21-53)	3.13	(1.79-4.53)	771	(438-1104)
BKT >90 mm	46	46	(43-49)	27.88	(26.07-29.71)	958	(896-1021)

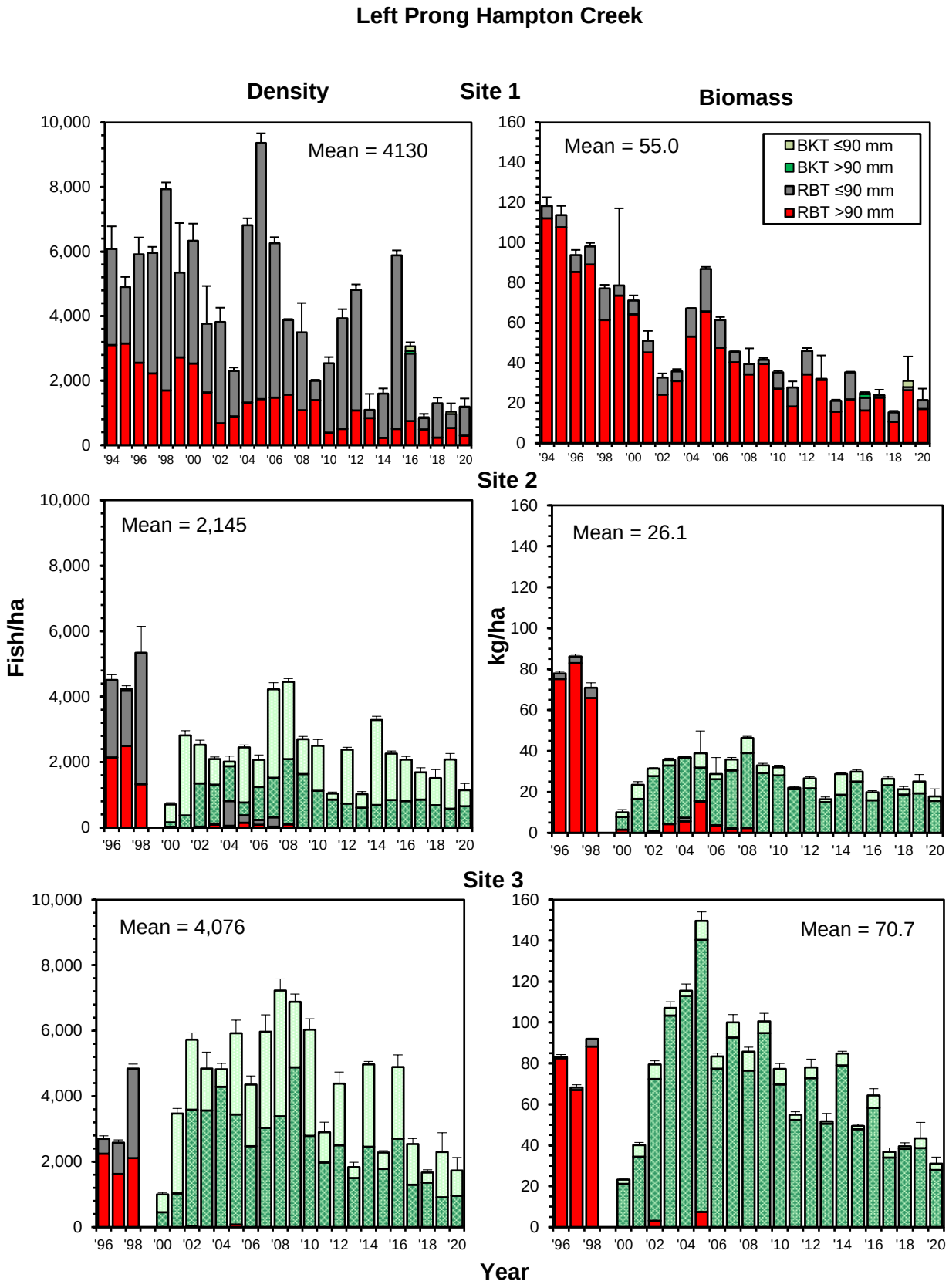


Figure 2-4. Abundance estimates for Left Prong Hampton Creek sites 1-3 in 2020.

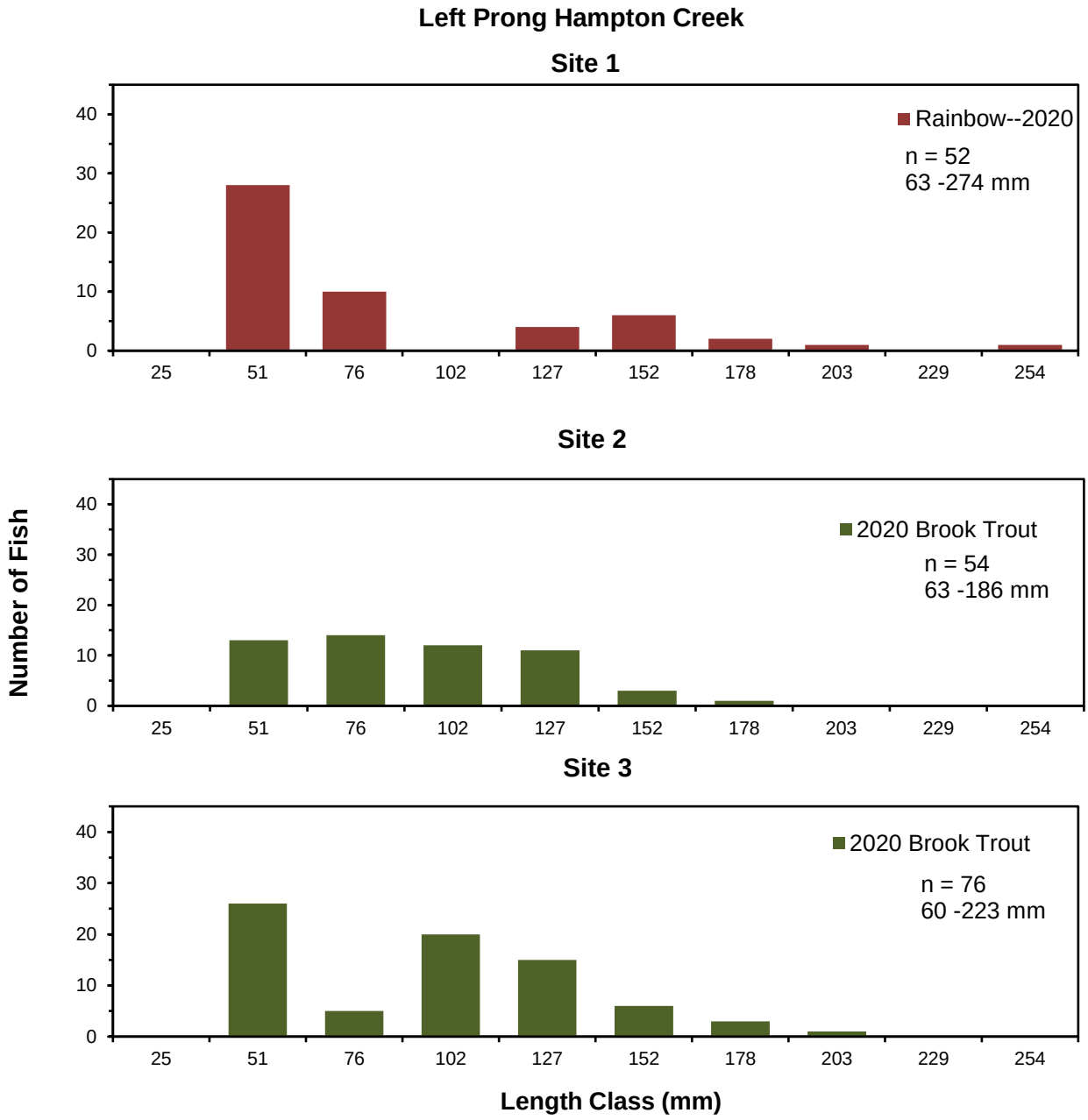


Figure 2-5. Length-frequency histogram for trout from the 2020 Left Prong Hampton Creek sample.

3. Sympatric Brook Trout / Rainbow Trout Monitoring

Brook Trout historically occurred in most coldwater streams in eastern Tennessee and were the dominant salmonids before the 1900s. Logging and the resulting habitat loss between 1903 and 1937 and the introduction of nonnative Rainbow Trout (beginning in 1910) and Brown Trout (after 1950) negatively affected wild Brook Trout populations (Kelly et al. 1980; Larson and Moore 1985; Larson et al. 1995). Monitoring between 1900 and 1977 caused managers to be concerned that Rainbow Trout might displace native Brook Trout (Kelly et al. 1980).

Moore et al. (1983) and Larson and Moore (1985) showed that Rainbow Trout suppress Brook Trout abundance and reproduction, and Whitworth and Strange (1983) showed that Rainbow Trout dominate where they coexist with Brook Trout. Allopatric Brook Trout range decreased by 60% between 1935 and 1977 in the Great Smoky Mountains National Park, apparently because of nonnative salmonid (primarily Rainbow Trout) encroachment (Larson and Moore 1985).

Managers have long been concerned about range expansion by Rainbow Trout and associated loss of Brook Trout distribution, although Larson et al. (1995) found that Brook Trout density and distribution ebbs and flows despite the presence of Rainbow Trout. Additionally, Strange and Habera (1998) found that Rainbow Trout were not generally affecting downstream limits of Brook Trout distribution in Tennessee streams. Our long-term monitoring supports these previous study results and suggests that Brook Trout distribution and relative abundance in Tennessee streams may respond more directly to environmental factors such as droughts and floods. Consequently, Rainbow Trout may have no particular competitive advantage and Brook Trout can coexist for many years at some general equilibrium.

Relative Brook Trout abundance (% density and % biomass) has been monitored in four streams (elevations range from 640-984 m) with sympatric Rainbow trout populations since 1995. The objective is to determine if, over time, Rainbow Trout can displace Brook Trout in these populations, or if variations in relative abundance are attributable to stochastic events. Previous coldwater reports, detailing site location and other data can be found at https://www.tn.gov/content/tn/twra/fishing/trout-information-stockings.html#FisheriesReport.

Results for Birch Branch (one of the four monitoring streams) indicate that while total biomass has decreased over the past five years, relative Brook Trout biomass exceeded 80% in 2020—the highest level observed since monitoring began in 1995 (Figure 3-1). Brook Trout density and biomass often increase during droughts, as Rainbow Trout appear to be more negatively impacted. Extended drought, however, may eliminate Brook Trout populations in marginal habitats regardless of the presence of any sympatric salmonids (Habera et al. 2014).

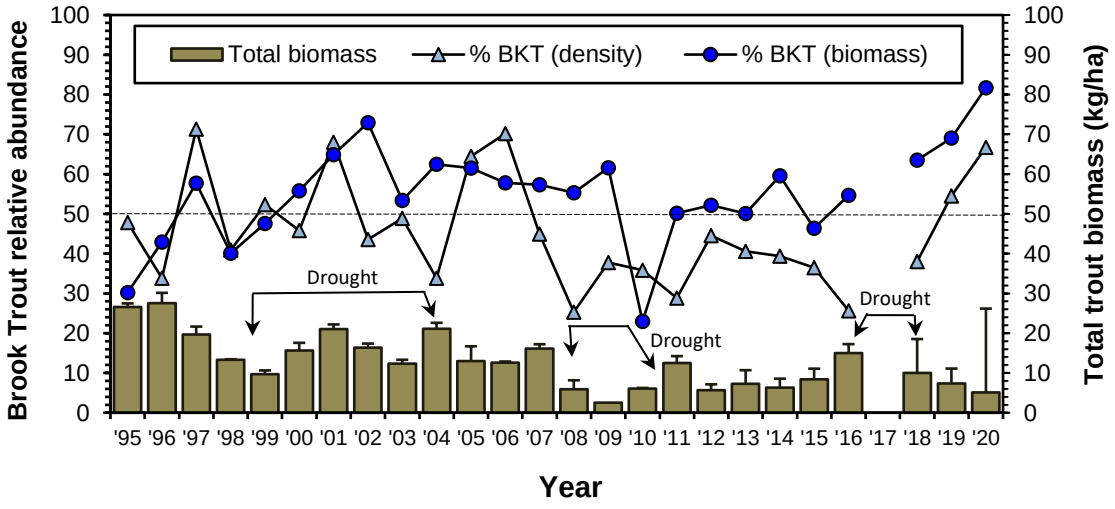


Figure 3-1. Brook Trout and Rainbow Trout relative abundance and abundance estimates over time in Birch Branch.

4. Native Brook Trout Restoration and Enhancement Projects

TWRA's Native Brook Trout Management Plan (TWRA 2017) includes a list of potential restoration, enhancement, and reintroduction projects for 2017-2027 developed cooperatively with the USFS. These projects involve re-establishing native Brook Trout in suitable streams by completely removing any existing nonnative trout (Tier 1—highest priority) or only initially thinning existing nonnative trout (Tier 2). Tier 2 projects are generally lower priority but provide opportunities to return native Brook Trout to streams or watershed where they have long been absent. These would be managed as sympatric populations unless enhancement become feasible. Tier 1 projects involve re-establishing an allopatric native Brook Trout population and maintaining it as such. Enhancement projects remove Rainbow Trout from an existing sympatric native Brook Trout population and extend Brook Trout distribution downstream to a natural barrier. Native Brook Trout restoration projects are listed in Tables 4-1 and 4-2 and work completed in 2020 is summarized in the following stream accounts. These projects involve the efforts of several partners including TWRA Region 3, the USFS, USFWS, Trout Unlimited, the Tennessee Division of Forestry, Tennessee Aquarium Conservation Institute (TNACI), and private landowners.

Table 4-1. Potential Tier 1 Brook Trout restoration and enhancement projects in Region 4. BKT = Brook Trout, RBT = Rainbow Trout and BNT = Brown Trout.

Stream	Watershed	Species present	Barrier	Start elevation (ft)	Length (miles)	Comments	Status
Green Mountain Branch	South Fork Holston	BKT	Yes	3,130	1.0	Barrier may be compromised at high flow	Translocation complete. Monitoring in 2021
Little Jacob Creek	South Fork Holston	RBT/BKT	Yes (2)	2,270	1.0	Extending down to USFS Job Corp. barrier	Translocation and monitoring complete in upper section. RBT removal ongoing in lower section
Phillips Hollow	Nolichucky	BKT	Yes (2)	2,230	0.6	Fish from N. Toe system in NC	Monitoring in 2021 to evaluate additional translocation needs
Little Paint Creek	French Broad	None	Yes	2,000	1.5	TBD, maybe from Smoky Mountain National Park within the watershed.	In progress—temperature data obtained in 2020
Devil Fork	Nolichucky	RBT	Yes (3)	1,900	0.5	Restore between lower 2 falls; no fish above upper falls	Not in progress
Trail Fork Big Creek	French Broad	None	Yes	2,640	2.2	Use fish from Gulf Fork tribs.; propagate at Tellico facility	In progress; RBT removal complete; BKT translocation 2021; AOP project in progress

Table 4-1. (cont.)

Stream	Watershed	Species present	Barrier	Start elevation (ft)	Length (miles)	Comments	Status
Jennings Creek	Nolichucky	RBT	TBD	TBD	TBD	Use fish from Phillips Hollow; account for Round Knob Branch	Not in progress
Horse Creek	Nolichucky	RBT	TBD	TBD	TBD	Remove RBT if barrier exists; otherwise move to Tier 2	Not in progress
Right Prong Rock Creek	Nolichucky	RBT	Yes?	2,220	1.7	Potential barrier located and moved to tier 1	Marked and moved RBT below culvert barrier in 2020 to evaluate its effectiveness

Table 4-2. Potential Tier 2 Brook Trout re-introduction projects in Region 4.

Stream	Watershed	Species present	Barrier	Start elevation (ft)	Length (miles)	Comments	Current status
Sinking Creek	Watauga	RBT/BNT	No	2,060	1.3	Initially thin RBT/BNT; include Basil Hollow trib.	No barrier present; check downstream for end of trout distribution in 2021
Upper Granny Lewis Creek	Nolichucky	RBT	No	2,800	1.0	Initially thin RBT	Not in progress

Green Mountain Branch

Five electrofishing passes through Green Mountain Branch since 2018 removed 780 Rainbow Trout (including 580 age-0 fish). The 2020 effort removed 8 Rainbow Trout—likely remnant age-0 fish from 2019—near the barrier. Another electrofishing pass will be completed in 2021 to check for any remaining Rainbow. Ninety-one Brook Trout were translocated from Beaverdam Creek tributaries into the upper third of Green Mountain Branch in August 2020 (22 from Chalk Branch, 26 from Maple Branch, and 43 from Birch Branch). A pelvic fin clip was taken from each fish and preserved to characterize the genetic composition of the founding population. The presence of age-0 Brook Trout during the 2021 electrofishing effort will verify that these fish successfully spawned during 2020. Additional Brook Trout will be translocated from the three donor streams if necessary.

Little Jacob Creek

Brook Trout have been established in Little Jacob Creek down to the culvert at the USFS road (FR 4002) crossing (Habera et al. 2019). Another barrier (2-m high concrete structure) ~1.2 km further downstream on USFS Job Corp property (36.56090 N, -81.97489 W; elevation 1,913 ft) was evaluated in

2019 to determine the feasibility of extending Brook Trout range downstream to that point. Temperature loggers deployed at the barrier (lowest point downstream) in August 2019 determined that the 7-day mean (MEANT) and maximum (MAXT) temperatures were 20.0°C and 20.8°C, respectively, for August and 19.9°C and 20.8°C for September. These were below the upper thermal tolerance limits for MEANT and MAXT (23.3°C and 25.4°C, respectively for Brook Trout) as described by Wehrly et al. (2007). Thus, the temperatures are marginal in this section. Fish community composition near the barrier includes Central Stoneroller *Campostoma anomalum*, Creek Chub *Semotilus atromaculatus*, and Blacknose Dace *Rhinichthys atratulus*, suggesting that water temperature may be marginal for Brook Trout.

Three electrofishing passes between the FR 4002 culvert and the Job Corps barrier in 2020 removed 224 Rainbow Trout (24 age 0, 131 sub-adults, 69 adults). Brook Trout had already begun to colonize this reach and several adult and age-0 fish were captured during each removal effort in 2020. Another electrofishing pass will be made in 2021 to ensure removal of Rainbow Trout in this reach. Future plans to improve habitat may include replacement of the FR 4002 culvert (original barrier) with a bottomless arch structure designed to allow for aquatic organismal passage (AOP) and habitat improvement in the lower portion of the creek to increase pool frequency and depth. These habitat improvements may help increase Book Trout abundance in that area.

A monitoring site (Table 4-3) was established about 100 m upstream of the FR 4002 road crossing in 2020 to evaluate development of the Brook Trout population in that area. Although few Brook Trout were present (Table 4-4), 3 of the 11 fish captured were age 0, indicating Brook Trout are reproducing.

Table 4-3. Site and sampling information for Little Jacob Creek in 2020.

Location	**Site 1**	
Site code	420202501	
Sample date	17 July	
Watershed	South Holston	
County	Sullivan	
Lat-Long	36.55127 N, -81.96718 W	
Elevation (ft)	2319	
Land ownership	Public	
Fishing access	Good	
Description	Begins at tail end of large pool ~ 30 m upstream of first trail crossing.	
Effort		
Station length (m)	124	422 m2
Electrofishing units	2	350 V AC
Habitat		
Mean width (m)	3.4	
Canopy cover (%)	85	
Est. % site pool/riffle	42	58
Habitat assessment score	159	
Water Quality		
Flow (cfs; visual)	1.12	normal
Temperature (C)	19.2	
pH	NM	
Dissolved oxygen (mg/L)	NM	
Alkalinity (mg/L $CaCO_3$)	NM	

Table 4-4. Abundance estimates for Little Jacob Creek in 2020.

	Total	Pop. Size		Biomass (kg/ha)		Density (fish/ha)	
Species	Catch	Est.	C.I..	Est.	C.I.	Est.	C.L.
RBT ≤90 mm	0	0	(0-0)	0	(0-0)	0	(0-0)
RBT >90 mm	1	1	(1-1)	1.63	(1.63-1.63)	24	(24-24)
BKT ≤90 mm	3	3	(3-3)	0.45	(0.45-0.45)	71	(71-71)
BKT >90 mm	8	8	(8-8)	11.09	(11.09-11.09)	190	(190-190)

Little Stony Creek

A native Brook Trout restoration project was initiated in a 1.4-km reach of Little Stony Creek (tributary to Watauga Lake) during fall 2014 (Habera et al. 2015a). Native Brook Trout propagated at TNACI using adults from Left Prong Hampton Creek were stocked in 2014, 2015, 2018 and 2019. A three-pass depletion sample at the monitoring site (Table 4-5) in the lower portion of the restoration zone (290 m upstream of the falls) was completed in 2020 to determine Brook Trout abundance and successful reproduction (presence of age-0). Age-0 Brook Trout were present and abundance estimates were 23.9 kg/ha and 983.4 fish/ha (Table 4-6). The pre-removal (2014) Rainbow Trout biomass estimate for this site was 23 kg/ha. Given the presence of age-0 Brook Trout and the comparability of current Brook Trout biomass with pre-removal Rainbow Trout biomass, this Brook Trout restoration project can be considered successful and complete.

Table 4-5. Site and sampling information for Little Stony Creek in 2020.

Location	**Site 1**	
Site code	420201201	
Sample date	22 June	
Watershed	Watauga River	
County	Johnson	
Lat-Long	36.29183 N, -82.06678 W	
Elevation (ft)	2410	
Land ownership	Public	
Fishing access	Good	
Description	Between waterfall and road crossing	
Effort		
Station length (m)	150	600 m2
Electrofishing units	2	500 V AC
Habitat		
Mean width (m)	4	
Canopy cover (%)	65	
Est. % site pool/riffle	44	56
Habitat assessment score	162	
Water Quality		
Flow (cfs; visual)	NM	normal
Temperature (C)	16.7	
pH	7.0	
Dissolved oxygen (mg/L)	NM	
Alkalinity (mg/L $CaCO_3$)	NM	

Table 4-6. Abundance estimates for Little Stony Creek in 2020.

	Total	Pop. Size		Biomass (kg/ha)		Density (fish/ha)	
Species	Catch	Est.	C.I.	Est.	C.I.	Est.	C.I.
BKT ≤90 mm	8	13	(0-46)	0.68	(0.00-2.38)	217	(0-767)
BKT >90 mm	45	46	(42-50)	23.22	(21.21-25.25)	767	(700-833)
Blacknose Dace	53	111	(0-240)	10.93	(0.00-24.80)	1,850	(0-4000)

Shell Creek

Shell Creek is a tributary to the Doe River in Cater County and is separated from Left Prong Hampton Creek by Big Ridge. Shell Creek was sampled in 2019 as part of a USFS BioBlitz and Rainbow Trout were the only fish present in the upper portion of the stream. A potential fish passage barrier was identified at 36.147231 N, -82.030345 W, just downstream of the USFS boundary, and suitable trout habitat extends ~1 km upstream. Consequently, Shell Creek was added to the native Brook Trout restoration program as a Tier 1 stream (will be managed as a Tier 2 stream if the barrier is ineffective).

A two-pass Rainbow Trout removal effort in August 2019 removed 64 fish (including 47 age-0), while a third pass in May 2020 removed 13 more Rainbow Trout which were all <127 mm and likely remnant age-0 fish from 2019 effort. Just over 400 51 mm (2 inch) Brook Trout fingerlings produced by TNACI (progeny of Left Prong Hampton Creek adults) were stocked throughout the stream in June 2020. Brook Trout reproduction, distribution and abundance will be assessed in 2022.

Phillips Hollow

TWRA, through a partnership with North Carolina Wildlife Resources Commission (NCWRC), private landowners in North Carolina, USFS, USFWS, and TU, translocated 76 Brook Trout from the North Toe River system to Phillips Hollow in September 2019. An electrofishing pass through the 800-m restoration zone in June 2020 produced only adult Brook Trout. The lack of Brook Trout reproduction was not unexpected given that only 13 adults were part of the 2019 translocation. Another assessment will be made in 2021 to check Brook Trout reproduction, distribution, and abundance, and determine if an additional translocation is necessary. Ultimately, the Phillips Hollow population will be used to provide fish for native Brook Trout restorations in other Nolichucky-basin streams in Tennessee.

Trail Fork of Big Creek

Just over 700 Rainbow Trout were removed from the 3.5-km restoration area in Trail Fork of Big Creek during 2018-2019 (four full passes and one partial pass). An additional electrofishing pass in 2020 captured only two adults, indicating that Rainbow Trout removal is complete. Attempts to spawn the 41 native Brook Trout collected from three Gulf Fork of Big Creek tributaries in 2019 were unsuccessful, thus none were available for Trail Fork in 2020. If spawning and rearing success improve in 2020, then fingerlings could be available for release in Trail Fork during summer 2021. Additional Brook Trout from the Gulf Fork of Big Creek tributaries or from Wolf Creek may also be translocated if necessary. Newly acquired genetics information indicates that Wolf Creek fish would be suitable for this restoration.

Trout Unlimited, TWRA, USFS, USFWS, TNC, Tennessee Wildlife Resources Foundation and other partners have requested funding (including through the Eastern Brook Trout Joint Venture) to remove the double culvert on this stream and replace it with a bottomless arch culvert that is conducive to aquatic organism passage.

Right Prong of Rock Creek

Twenty-eight Rainbow Trout (including nine captured upstream of the Hwy. 395 culvert) were adipose clipped and released in the pool below this potential barrier. If any of these fish are captured

upstream of the culvert in a 2021 follow-up survey, it would indicate that it is ineffective barrier and potentially would limit the success of a Brook Trout restoration project in this stream.

Stream Temperature Monitoring

Temperature loggers were deployed in several streams across elevational and geographical gradients to collect baseline data during June-September and determine suitability for Brook Trout restoration (Little Paint Creek). Average monthly temperature remained below 20°C in each case, although maximum temperature can exceed 20°C in Little Paint Creek during August and September (Figure 4-1). Additional stream temperature data will be collected during 2021.

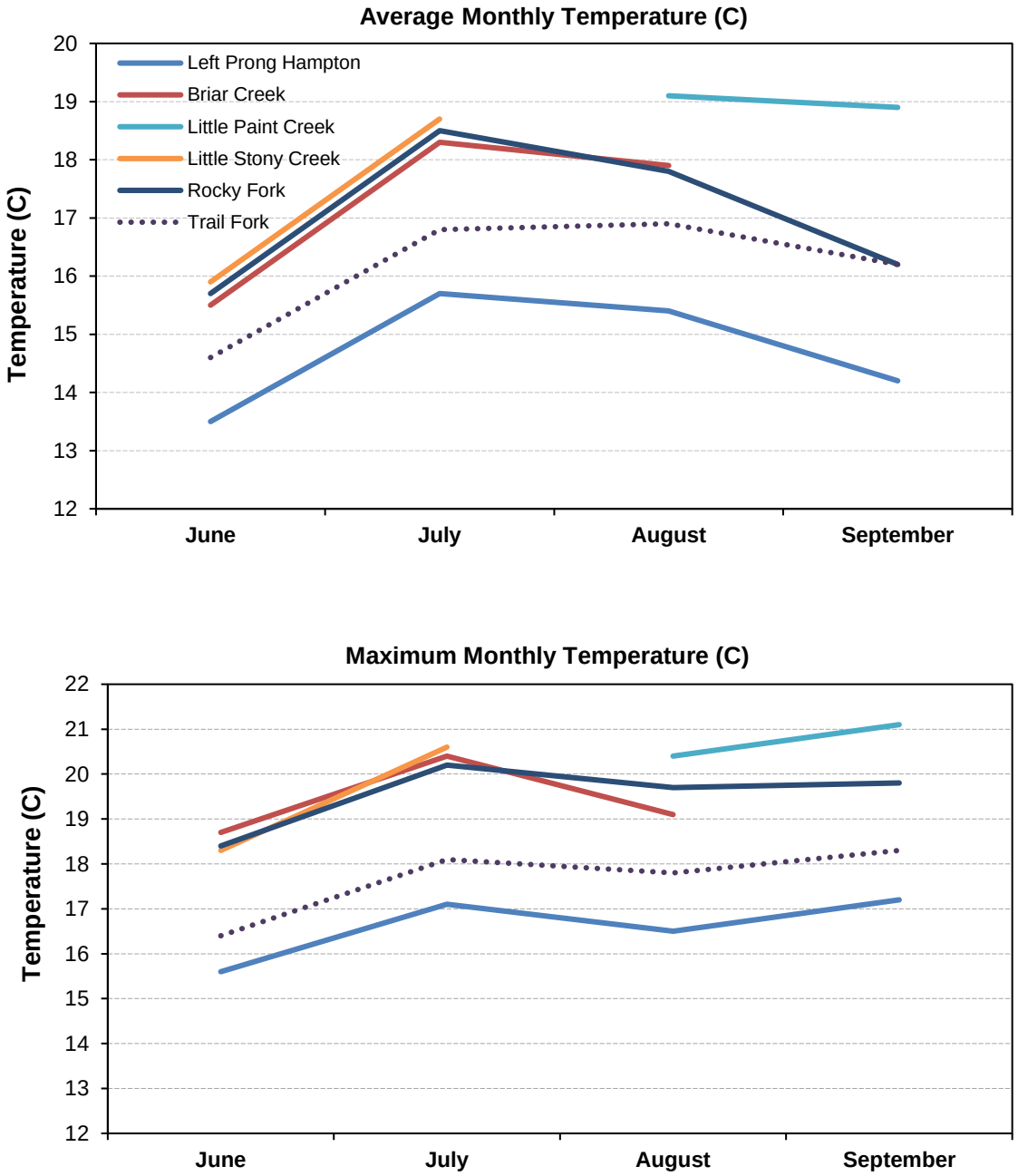


Figure 4-1. Average monthly and maximum monthly temperatures (°C) for trout streams monitored in 2020.

5. Tailwater Monitoring

Region IV's tailwater trout fisheries present unique fishery management problems and opportunities for which no standard solutions or practices apply (Hill 1978). The problems inherent in sampling tailwaters, such as their large size, fluctuating flows, and the lack of any practical means for maintaining closed populations, make it difficult at best to collect quantitative data from these systems. Natural reproduction is variable and most tailwater trout fisheries are substantially hatchery-supported, with abundances and size/age-class densities related to stocking rates. However, Brown Trout fisheries in the South Holston and Wilbur tailwaters are self-sustaining and substantial natural reproduction by Rainbow Trout has been recently been documented in the Norris, Wilbur, and South Holston tailwaters. TWRA prefers to manage for wild trout fisheries where possible (TWRA 2017), thus management strategies in these tailwaters (e.g., fingerling Rainbow Trout stocking) will be adjusted accordingly.

Six Region IV tailwater trout fisheries (Norris, Cherokee, Wilbur, Ft. Patrick Henry, Boone, South Holston; Figure 1-1) are currently monitored annually. Sampling is conducted each year in late February or March (except Cherokee) to provide an assessment of the overwintering trout populations present before stocking begins. The Cherokee tailwater (Holston River) monitoring stations are currently sampled in the summer (June) and fall (October/November). Trout survival over the summer is the most important issue for the Cherokee tailwater fishery, so sampling is timed to document trout abundance before and after the high water temperatures (daily minimum >21° C) that occur in late summer/early fall. Catch per unit effort (CPUE) for each species at each site (fish/h), as well as means for each tailwater, are calculated annually to monitor trout abundance trends. Annual monitoring samples have occasionally been cancelled (e.g., 2015 at Norris, 2008-09 at Wilbur, and 2008 at South Holston) because appropriate flows were unavailable.

Trout fishery management plans are in place for the Norris (Habera et al. 2020), Wilbur (Habera et al. 2015b), Boone/Ft. Patrick Henry (Habera et al. 2018), and South Holston (Habera et al. 2015c) tailwaters. The Wilbur and South Holston management plans are scheduled to be updated in 2021.

Sampling Methods and Conditions

Sampling effort for the Norris, Cherokee, South Holston, and Wilbur tailwaters annually consists of 600-s (pedal time) runs at each of 12 monitoring stations with boat-mounted electrofishing systems (120 pulses/s DC, 4-5 amps). The smaller Ft. Patrick Henry and Boone tailwaters are sampled using 900-s runs at 4 stations. Electrofishing on these tailwaters (except Norris) is conducted during the day with generation by one unit (turbine). Only trout are collected during these efforts. Tailwater sampling conditions and effort are summarized below:

Table 5-1. Tailwater sampling conditions and effort.

Tailwater	Year annual monitoring began	Sample time	Stations	Approximate flow	Total effort (h)
Norris	1999	Night	12	114 m^3/s (4,000 cfs)	2.0
Cherokee	2003	Day	12	114 m^3/s (4,000 cfs)	2.0
Ft. Patrick Henry	2002	Day	4	88 m^3/s (3,100 cfs)	1.0
Wilbur	1999	Day	13[1]	71 m^3/s (2,500 cfs)	2.0
Boone	2009	Day	4	88 m^3/s (3,100 cfs)	1.0
South Holston	1999	Day	12	71 m^3/s (2,500 cfs)	2.0

[1]An extra site was added in 2010 to help evaluate the Quality Zone; effort there (600 s) is not included in total effort.

Norris (Clinch River)

Catch and Length Frequency

The 12 Norris tailwater monitoring stations (Figure 5-1) produced 331 trout weighing nearly 183 kg in 2020 (Table 5-2; Figure 5-2). The catch included 312 Rainbow Trout and 41 Brown Trout. No Brook Trout were captured, although 12,000 were stocked in 2019. Trout in the 356-508 mm (14-20 in.) protected length range (PLR) were present at all 12 monitoring stations (Table 5-1). The 199 14-20 in. Rainbow Trout was the highest catch in the PLR obtained to date. Overall, 63% of Rainbow Trout and 58% of Brown Trout >178 mm were within the PLR (Figure 5-2). The remainder of the Brown Trout catch was >508 mm. Several sub-adult (152-208mm) Rainbow Trout without adipose fin clips were captured, indicating that these fish represent natural reproduction.

A PLR Rainbow Trout from the 2020 Norris tailwater sample.

CPUE

The mean electrofishing CPUE for all trout ≥178 mm in 2020 (164 fish/h) was within the typical post-PLR range (150-200 fish/h; Figure 5-3). Brown Trout CPUE (9 fish/h) was the lowest observed to date and is likely related to reduced stocking rates (20,000/year) in 2018 and 2019. Mean CPUE for trout within the PLR (356-508 mm) has increased substantially since 2008 and exceeded 100 fish/h for the first time in 2020 (Figure 5-3). The PLR catch rate objective for the new Norris tailwater management plan is a mean of ≥56 fish/h for 2020-2025 (Habera et al. 2020).

RSD-14

Relative stock density for trout ≥356 mm or 14 in. (RSD-14) has improved for both Rainbow Trout and Brown Trout post-PLR, with values often exceeding 50 and seldom below 30 since 2011(Figure 5-4). These consistently higher RSD-14 values indicate that trout population size structures have shifted toward larger fish (≥14 in.)—which is what PLR regulations are intended to accomplish. An RSD-14 value of 50 indicates that 50% of all stock-size trout—those at least 10 in. in length—are 14 in. or larger and is representative of a trout fishery with an exceptional proportion of larger fish. RSD-14 for Rainbow Trout (80) and Brown Trout (100) in 2020 were the highest observed to date (Figure 5-4). The RSD-14 objective for the new Norris tailwater management plan is ≥45 for 2020-2025 (Habera et al. 2020).

Stocking

Norris typically has the highest trout stocking rate of any Tennessee tailwater (about 237,000/year). Annual allocations have been 197,000 Rainbow Trout (160,000 4-5 in. fingerlings and 37,000 9-12 in. adults), 20,000 Brown Trout (6-8 in. sub-adults) and 20,000 Brook Trout (8-9 in. adults). Stocking rates have varied recently (Figure 5-5) because of Dale Hollow National Fish Hatchery's (DHNFH) need to stock fish early in 2016 and 2017 (poor fall water quality) and inconsistent availability of Brook Trout. Additionally, the 2019 (111,000) and 2020 (18,000) fingerling stocking rates were reduced to accommodate marking these

fish (fin clips/coded wire tags) for the TN CFRU research project. Only 18,000 fingerlings could be marked in March 2020 before Covid-19 restrictions at DHNFH curtailed that effort.

Angler Surveys

Results for the 2019 Norris tailwater creel survey (Black 2020) indicated that trout anglers made an estimated 8,813 trips comprising 26,729 hours of effort. Both estimates are substantially below the 2017 survey estimates (13,346 trips; 42,770 hours) and less than half the effort estimated in 2015 (56,427 hours; 17,348 trips). Consequently, estimated catch for 2019 declined to 21,546 fish (54% Rainbow, 36% Brown, 10% Brook)—about half of the 2017 level. Interestingly, harvest (5,118 fish; 53% Rainbow, 36% Brown, 11% Brook) was relatively unchanged from 2017 and overall harvest rate (24%) was higher than it has been since 2013 (22%). Anglers reported in 2019 that 35% of Rainbow Trout and 14% of Brown Trout they caught were in the PLR, while about 2% of Rainbow Trout and 1% of Brown Trout were above the PLR (>20 in.). Another angler survey was conducted on the Norris tailwater in 2020 and results will be available for the 2021 report.

Research

Preliminary results of the 2019-2020 TN CFRU study indicate that the Norris tailwater Rainbow Trout population is primarily supported by natural reproduction. This is based on the high proportion of unmarked juvenile fish (see photo below) captured relative to marked hatchery-origin fish (all 129,000 fingerlings stocked during 2019-2020 were marked). Because further analysis is needed to accurately determine survival, recruitment, and growth, this project will be extended for another two years to track PIT tagged fish, increase capture rates of marked fish, and explore fish movement throughout the tailwaters. As part of the ongoing TN CFRU project, 100,000 fingerling Rainbow Trout are scheduled to be marked for stocking in March 2021.

A wild Rainbow Trout yearling from the 2020 Norris tailwater sample (adipose fin present).

Management Recommendations

TWRA's current management goal for the Norris tailwater is to maintain the enhanced quality of trout angling opportunities available to the variety anglers who enjoy this fishery (Habera et al. 2014). The PLR regulation, established in March 2008, has successfully increased abundances of 14-20-inch trout, improving trout population size structures (RSD-14), and maintained these improvements. Anglers have recognized this by overwhelmingly expressing their support for the PLR during the 2013 and 2019 creel surveys. Accordingly, the PLR regulation continues to be the primary strategy for attaining the goal in the 2020-2025 Norris tailwater management plan. Future stocking of fingerling Rainbow Trout may be substantially reduced or eliminated given the results TN CFRU's research and TWRA's policy to manage for wild trout where feasible (TWRA 2017; Hatchery-Supported Fisheries Goal 1: Optimize use of hatchery trout, Strategy 1). The notable increase in Rainbow Trout reproduction may reflect the increased number of potential spawners resulting from the PLR regulation.

Norris Tailwater

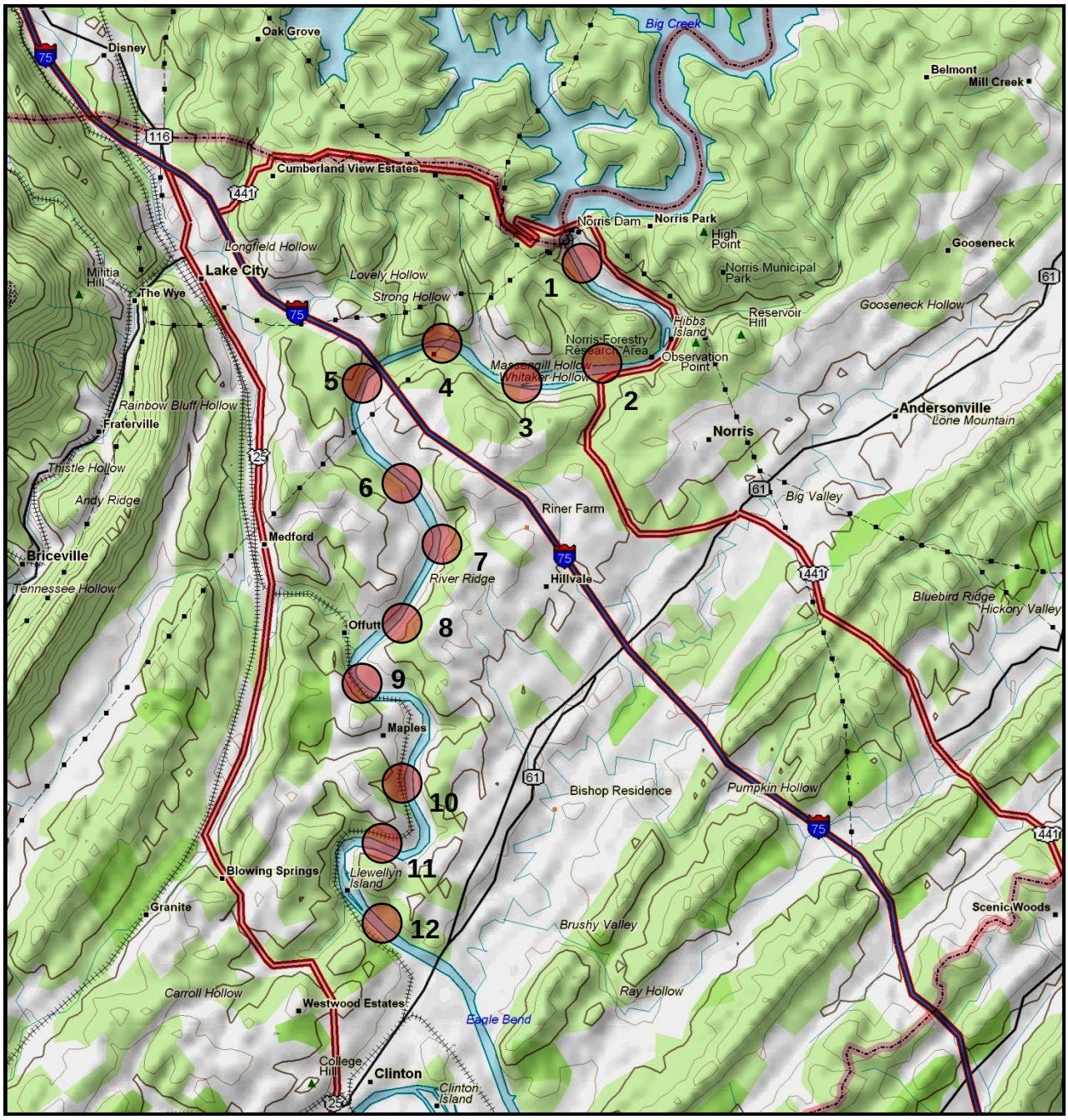


Figure 5-1. Locations of the Norris tailwater (Clinch River) monitoring stations.

Table 5-2. Catch data for the12 electrofishing stations on the Norris tailwater sampled 18 March 2020.

Station	Species	Total catch	Size range (mm)	Total weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow	11	369-506	9,780	65	59
	Brown	6	475-498	6,736	35	41
Totals		**17**		**16,516**	**100**	**100**
2	Rainbow	50	185-561	29,859	100	100
Totals		**50**		**29,859**	**100**	**100**
3	Rainbow	34	155-486	18,146	97	96
	Brown	1	431	768	3	4
Totals		**35**		**18,914**	**100**	**100**
4	Rainbow	12	231-433	5,804	100	100
Totals		**12**		**5,804**	**100**	**100**
5	Rainbow	18	292-438	9,571	100	100
Totals		**18**		**9,571**	**100**	**100**
6	Rainbow	13	203-436	5,360	81	53
	Brown	3	463-601	4,720	19	47
Totals		**16**		**10,080**	**100**	**100**
7	Rainbow	24	185-501	12,184	86	68
	Brown	4	449-552	5,648	14	32
Totals		**28**		**17,832**	**100**	**100**
8	Rainbow	31	185-498	13,136	100	100
Totals		**31**		**13,136**	**100**	**100**
9	Rainbow	27	183-497	12,926	100	100
Totals		**27**		**12,926**	**100**	**100**
10	Rainbow	23	197-473	8,935	85	53
	Brown	4	497-760	8,083	15	47
Totals		**27**		**17,018**	**100**	**100**
11	Rainbow	27	177-495	10,634	100	100
Totals		**27**		**10,634**	**100**	**100**
12	Rainbow	42	165-532	19,186	98	94
	Brown	1	505	1,300	2	6
Totals		**43**		**20,486**	**100**	**100**
Total Rainbow Trout		312	155-561	155,521	94	85
Total Brown Trout		19	431-760	27,255	6	15
Overall		**331**		**182,776**	**100**	**100**

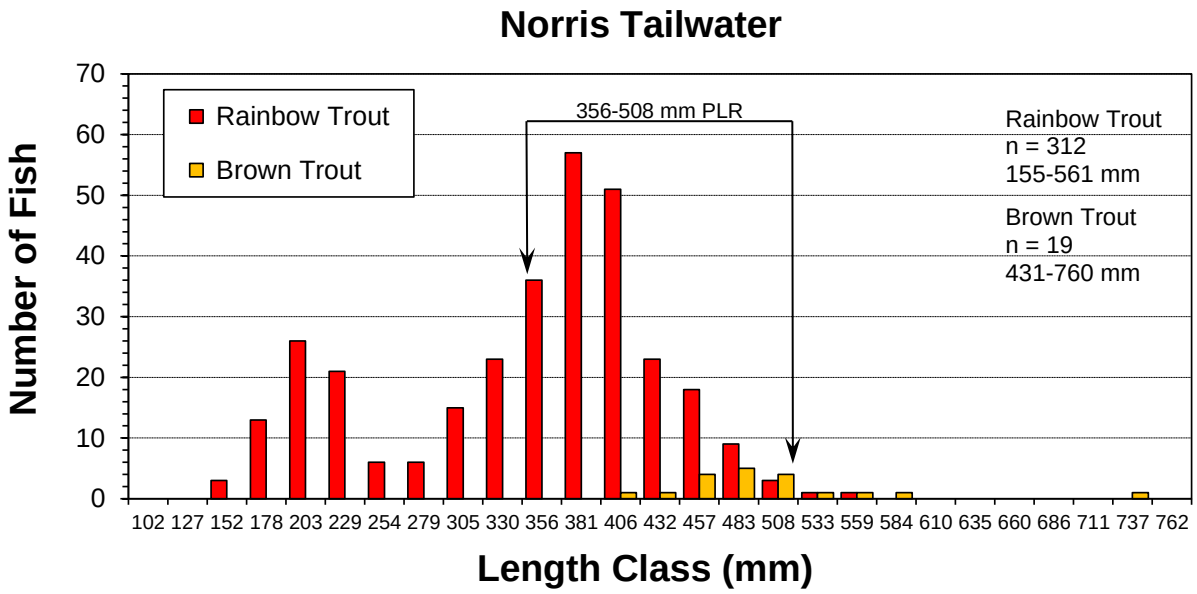


Figure 5-2. Length frequency distributions for trout from the Norris tailwater monitoring stations in 2020.

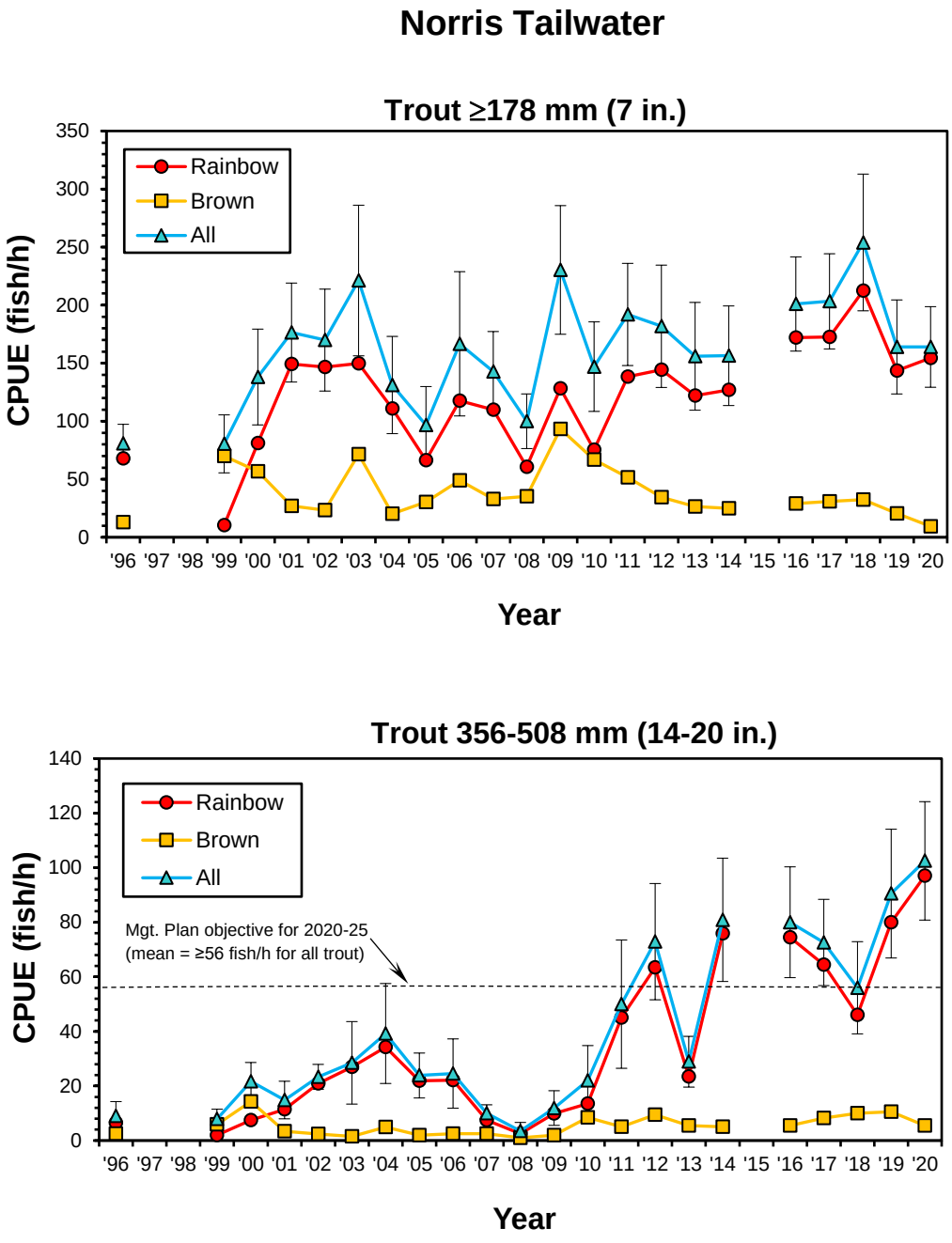


Figure 5-3. Mean trout CPUEs for the Norris tailwater samples. Bars indicate 90% confidence intervals. The 356-508 mm PLR regulation was established in 2008.

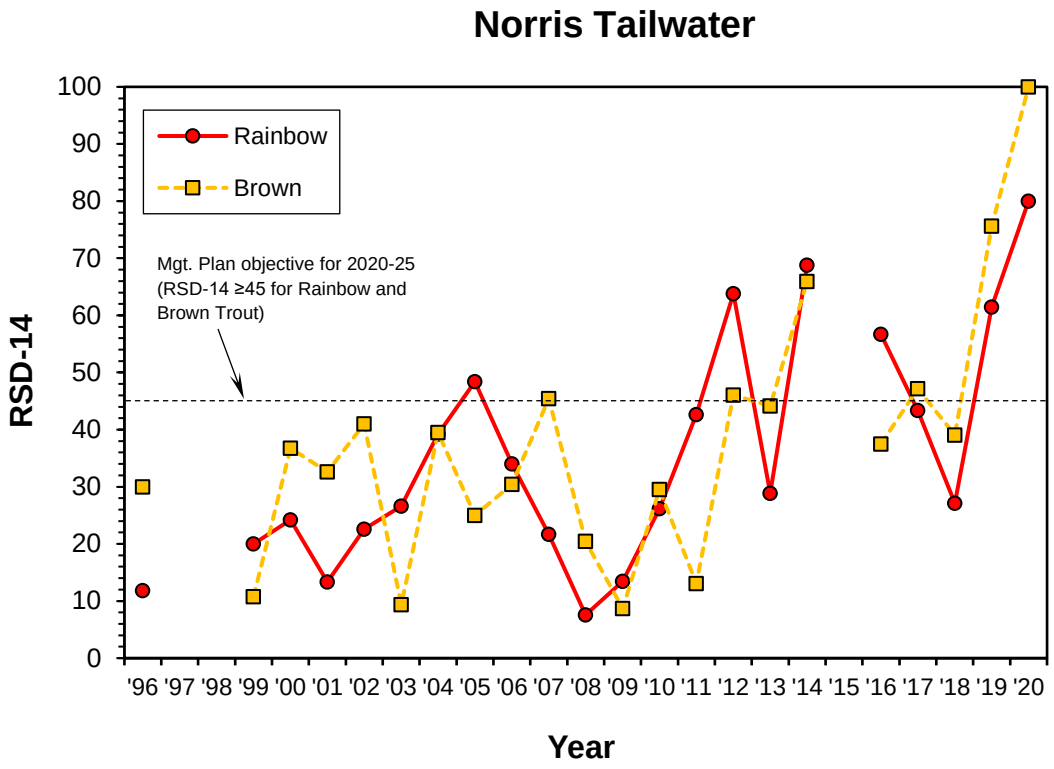


Figure 5-4. Relative stock densities for Norris tailwater Rainbow Trout and Brown Trout ≥14 in. (RSD-14) for 1996-2020.

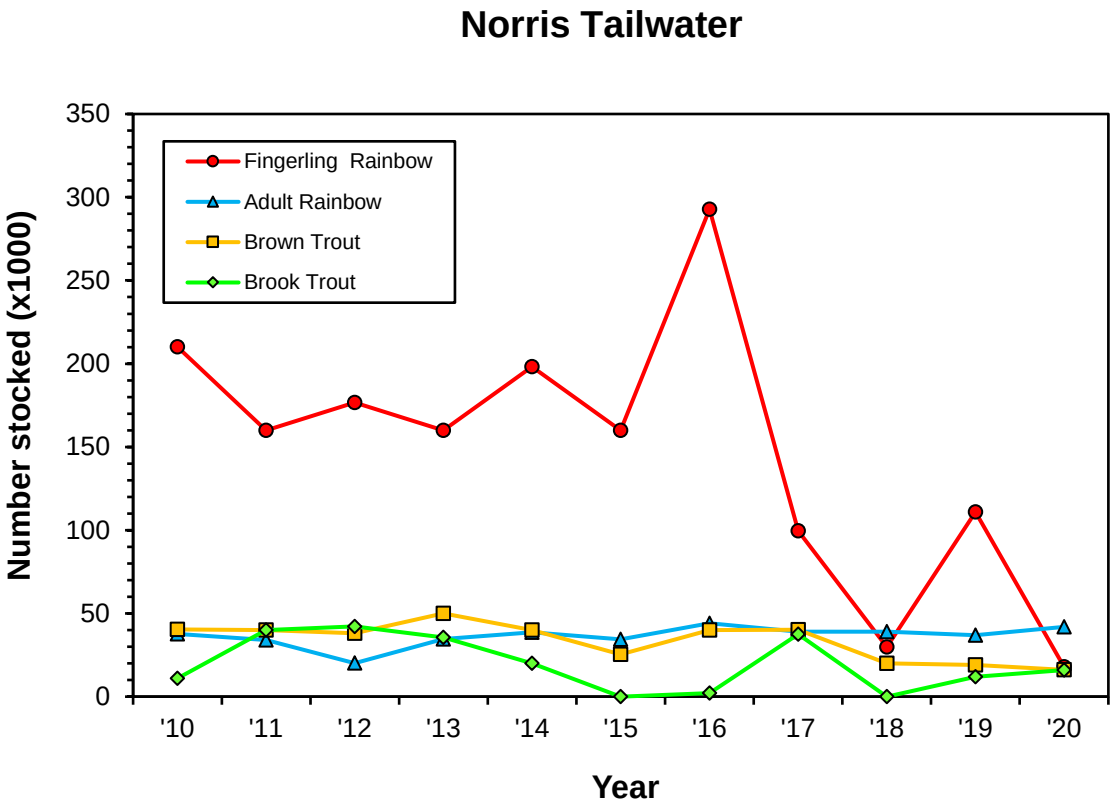


Figure 5-5. Trout stocking rates for the Norris tailwater (2010-2020). The 2019 and 2020 fingerling Rainbow Trout stocking rates (111,000 and 18,000) were reduced to accommodate marking (fin clips coded wire tags) for the TN CFRU research project.

Cherokee (Holston River)

Catch and Length Frequency

The 12 Cherokee tailwater monitoring stations (Figure 5-6) produced 36 trout (35 Rainbow Trout, 1 Brown Trout) weighing over 35 kg on 18 June 2020 (Table 5-3). Water temperature on that date averaged 15.8° C. Rainbow Trout were predominantly in the 356 to 432-mm size classes, although five fish >500-mm were also captured (Figure 5-7). The 4 November 2020 sample produced 25 trout (21 Rainbow Trout, 4 Brown Trout) weighing just over 22 kg (Table 5-3); water temperature averaged 19.2° C during that effort. Most Rainbow Trout captured in November were in the 381-457 mm size classes and none were >500 mm, although two Brown Trout >500 mm were captured (Figure 5-7).

The Cherokee tailwater near Blue Spring.

CPUE

While the October 2019 Cherokee tailwater sample produced one of the lowest mean catch rates (trout ≥178 mm) to date (1.5 fish/h), the 2020 mean CPUE (12.5 fish/h) increased to its highest level since 2015 and mean CPUE for Rainbow Trout (10.5 fish/h) was higher than for any previous sample (Figure 5-8). Mean catch rates for larger trout in November 2020 (10.5 fish/h ≥356 mm and 2.5 fish/h ≥457) mm were also higher than for any sample year (Figure 5-8).

The mean catch rate for Rainbow Trout ≥178 mm (18 fish/h) for June 2020 was similar to the June 2019 sample (15 fish/h, Figure 5-9). Mean summer (June) CPUEs have been somewhat higher than subsequent fall catch rates, but also exhibit higher variability among sites (wider 90% confidence intervals; Figure 5-9). Given the annual thermal bottleneck in this tailwater, it is unsurprising that trout catch rates decline from June through the late October/early November.

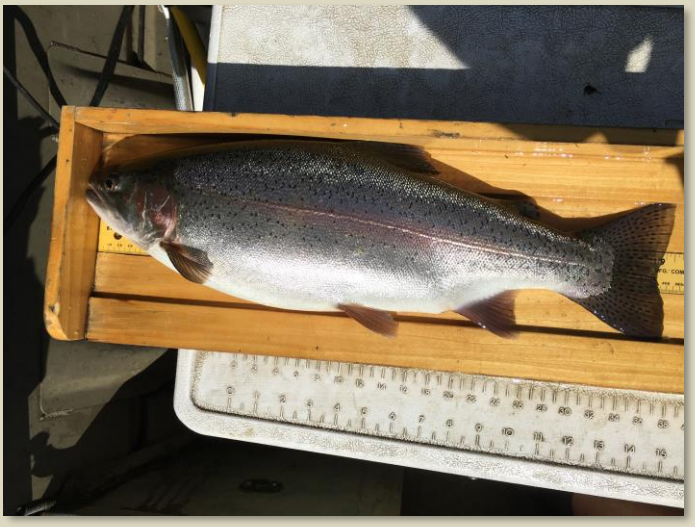
Stocking

The Cherokee tailwater received 28,500 adult (mean length, 248 mm) Rainbow Trout and 9,000 sub-adult (mean length, 173 mm) Brown Trout in 2020 (Figure 5-10). Stocking rates during the past five years have averaged 29,000 adult Rainbow Trout and 27,000 sub-adult Brown Trout annually.

Water Temperature Monitoring

Hourly water temperature data were collected (Onset TidbiT® *v2* loggers) at the monitoring sites near Cherokee Dam and at Blue Spring during June-November 2020. Maximum daily water temperature near Cherokee Dam was ≥21° C for 54 days (25 August-18 October; Figure 5-11) but did not reach 25° C. Minimum daily water temperature reached 21° C on 4 September and remained ≥21° C from 8 September--16 October (total of 41 days; Figure 5-11), thus there was no coldwater habitat during that period. Based on 2005-2020 data, there is typically no coldwater habitat (daily minimum water temperature is ≥21° C) near the dam during 13 September-12 October (30 days; Figure 5-11).

Maximum daily water temperature at the Blue Spring site (13 km below Cherokee Dam) was ≥21° C for 71 days in 2020 (consistently from 22 August-27 October; Figure 5-12) but reached 25° C only once (21 September). Minimum daily water temperature reached 21° C on 30 August and remained ≥21° C through 14 October (45 days; Figure 5-12), thus there was no coldwater habitat during that period. Based on 2003-2020 data, there is typically no coldwater habitat (daily minimum water temperature is ≥21° C) at Blue Spring during 31 August-12 October (43 days; Figure 5-12).



A large (500 mm) well-conditioned Rainbow Trout from the June 2020 Cherokee tailwater sample.

Fall electrofishing catch rates appear to be generally correlated with summer/early fall water temperatures, which in turn are related to variability in flow from Cherokee Dam during March-August. Above average precipitation in some years (e.g., 2003, 2013, 2017-2019) results in higher average flows from Cherokee Dam, earlier depletion of cold water stored in the reservoir, and unsuitably warm tailwater temperatures for long periods of time. The reverse is true during dry years such as 2007 and 2008. Consequently, there is a relatively strong (R^2 = 0.50) inverse relationship (2nd order polynomial) between the number of days where minimum water temperature was ≥22° C at the Blue Spring site and the overall electrofishing catch rate (log_{10}-transformed +1) for all trout ≥178 mm (Figure 5-13). There is also a relatively strong (R^2 = 0.56) positive relationship (2nd order polynomial) between water temperatures (expressed as the number of days where the minimum was ≥21° C at Blue Spring) and mean flow during March-August (Figure 5-14). Extended periods of low flows and high air temperatures in late summer (e.g., in 2016) can also raise water temperatures to levels that impact trout survival.

Management Recommendations

Trout in the Cherokee tailwater are subject to a lack of coldwater habitat (i.e., minimum daily temperatures exceed >21° C during September and part of October each year. Consequently, most trout survive less than a year, even with a relatively low harvest rate (Habera et al. 2015a). Some fish do find thermal refugia such as groundwater upwellings or cooler tributaries (Baird and Krueger 2003) and survive through at least one thermal bottleneck to produce the large (≥457 mm) fish that are captured in most monitoring samples.

Current management policy excludes stocking fingerling Rainbow Trout because of their low recruitment potential and avoids stocking fish during July-October because of high water temperatures (>21° C) during those months. General, statewide angling regulations for trout are appropriate for maintaining this fishery. Special regulations (minimum size or slot limits) would offer little benefit, as few fish protected by such measures would survive the next summer thermal bottleneck. Summer and fall electrofishing at the 12 existing monitoring stations, annual water temperature monitoring, and periodic angler surveys (a new survey will be conducted during 2021) should continue. This information will be used to develop a trout fishery management plan for this tailwater. Objectives of the plan will likely focus on determining optimal annual stocking rates and evaluating survival and growth of various stocked cohorts.

Cherokee Tailwater

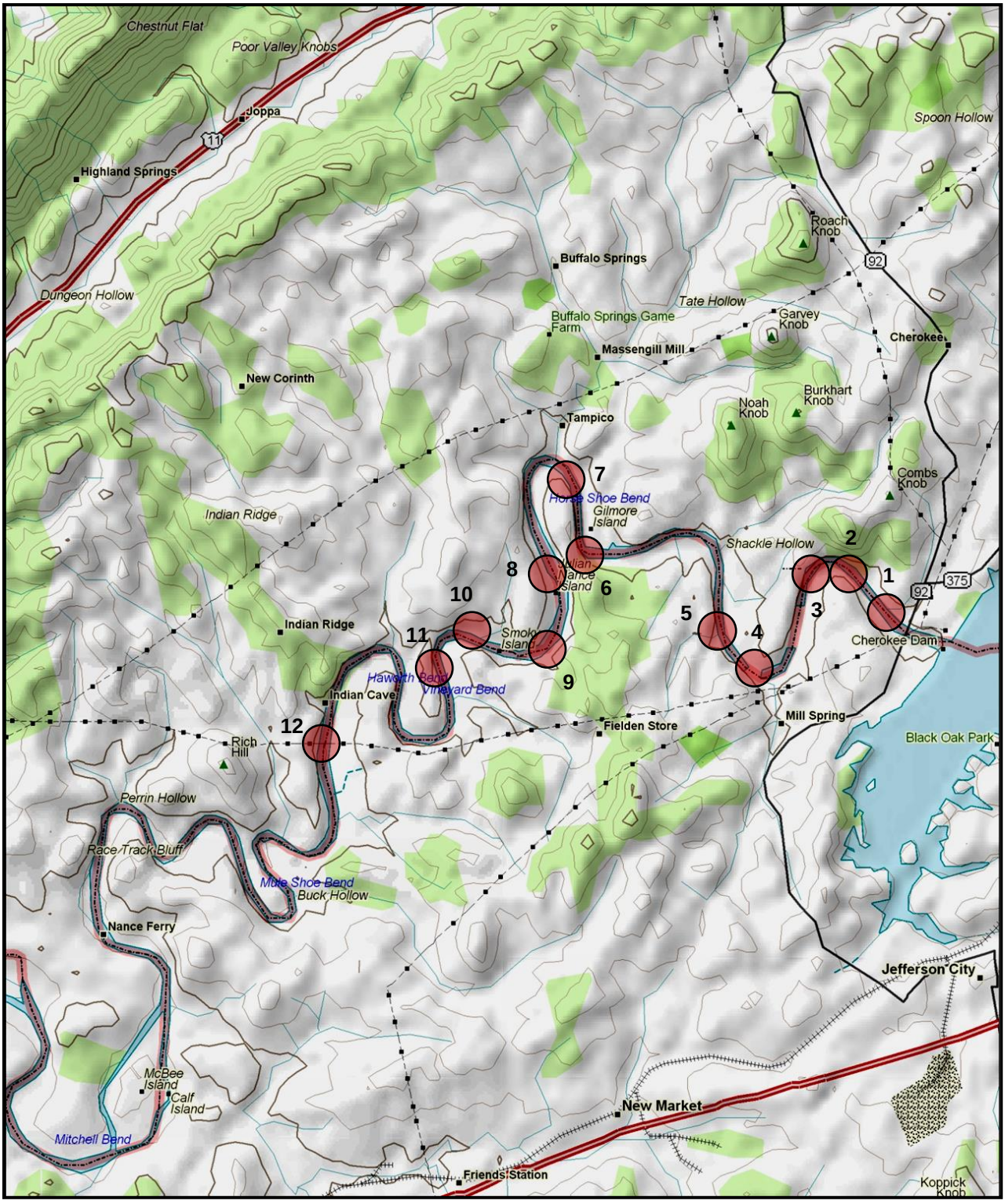


Figure 5-6. Locations of the Cherokee tailwater (Holston River) monitoring stations.

Table 5-3. Catch data for the 12 electrofishing stations on the Cherokee tailwater (June and November 2020).

		June 2020 Sample			November 2020 Sample		
Station	Species	Total Catch	Size Range (mm)	Total Weight (g)	Total Catch	Size Range (mm)	Total Weight (g)
1	Rainbow	0	--	0	0	--	0
	Brown	0	--	0	0	--	0
Totals		**0**		**0**	**0**		**0**
2	Rainbow	9	191-528	5,984	4	316-433	2,258
	Brown	0	--	0	0	--	0
Totals		**9**		**5,984**	**4**		**2,258**
3	Rainbow	0	--	0	0	--	0
	Brown	1	220	113	0	--	0
Totals		**1**		**113**	**0**		**0**
4	Rainbow	0	--	0	1	417	758
	Brown	0	--	0	0	--	0
Totals		**0**		**0**	**1**		**758**
5	Rainbow	2	369-412	1,657	2	426-462	2,151
	Brown	0	--	0	1	528	1,729
Totals		**2**		**1,657**	**3**		**3,880**
6	Rainbow	1	395	826	1	466	1,148
	Brown	0	--	0	0	--	0
Totals		**1**		**826**	**1**		**1,148**
7	Rainbow	1	191	69	1	404	744
	Brown	0	--	0	1	355	482
Totals		**1**		**69**	**2**		**1,226**
8	Rainbow	0	--	0	0	--	0
	Brown	0	--	0	0	--	0
Totals		**0**		**0**	**0**		**0**
9	Rainbow	6	420-456	7,113	3	426-478	3,091
	Brown	0	--	0	0	--	0
Totals		**6**		**7,113**	**3**		**3,091**
10	Rainbow	8	373-528	10,742	3	415-423	2,520
	Brown	0	--	0	1	519	1,728
Totals		**8**		**10,742**	**4**		**4,248**
11	Rainbow	1	434	831	1	385	629
	Brown	0	--	0	1	323	363
Totals		**1**		**831**	**2**		**992**
12	Rainbow	7	360-510	8,184	5	401-455	4,556
	Brown	0	--	0	0	--	0
Totals		**7**		**8,184**	**5**		**4,556**
Rainbows		35	226-526	35,406	21	316-478	17,855
Browns		1	230-595	113	4	323-528	4,302
Overall		**36**		**35,519**	**25**		**22,157**

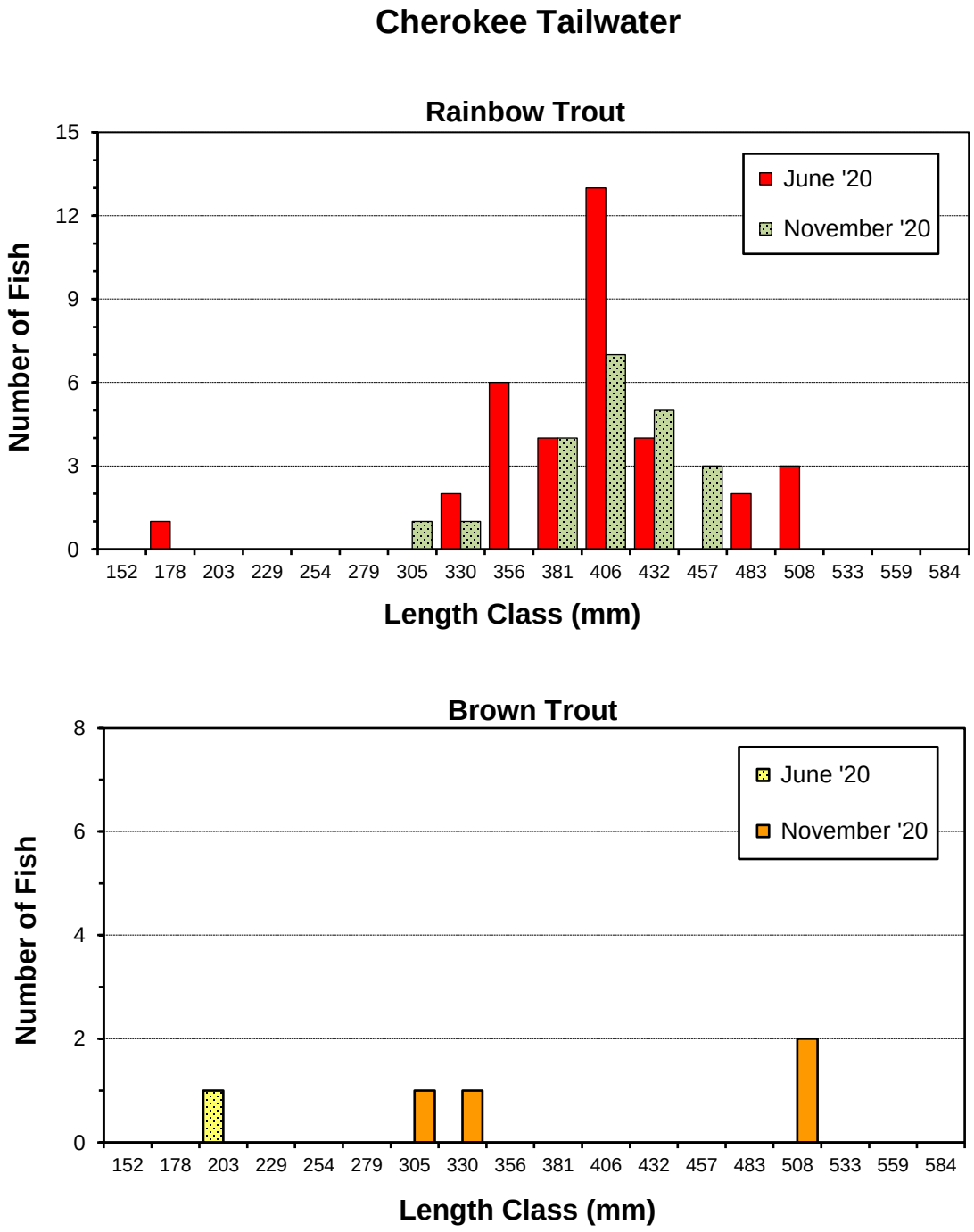


Figure 5-7. Length frequency distributions for trout from the Cherokee tailwater monitoring stations during the June and November 2020 samples.

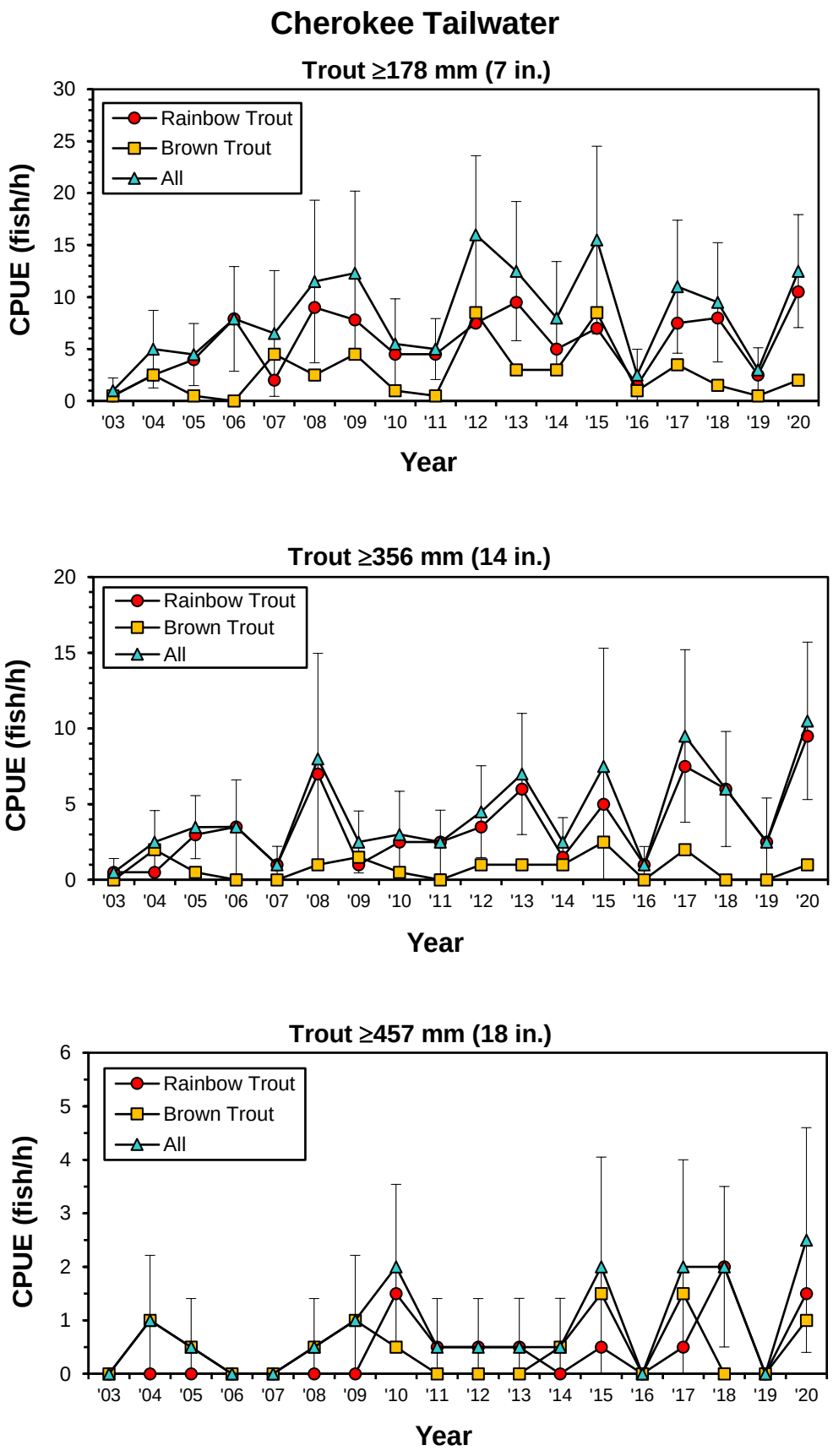


Figure 5-8. Mean trout CPUEs for the annual October/November Cherokee tailwater samples. Bars indicate 90% confidence intervals.

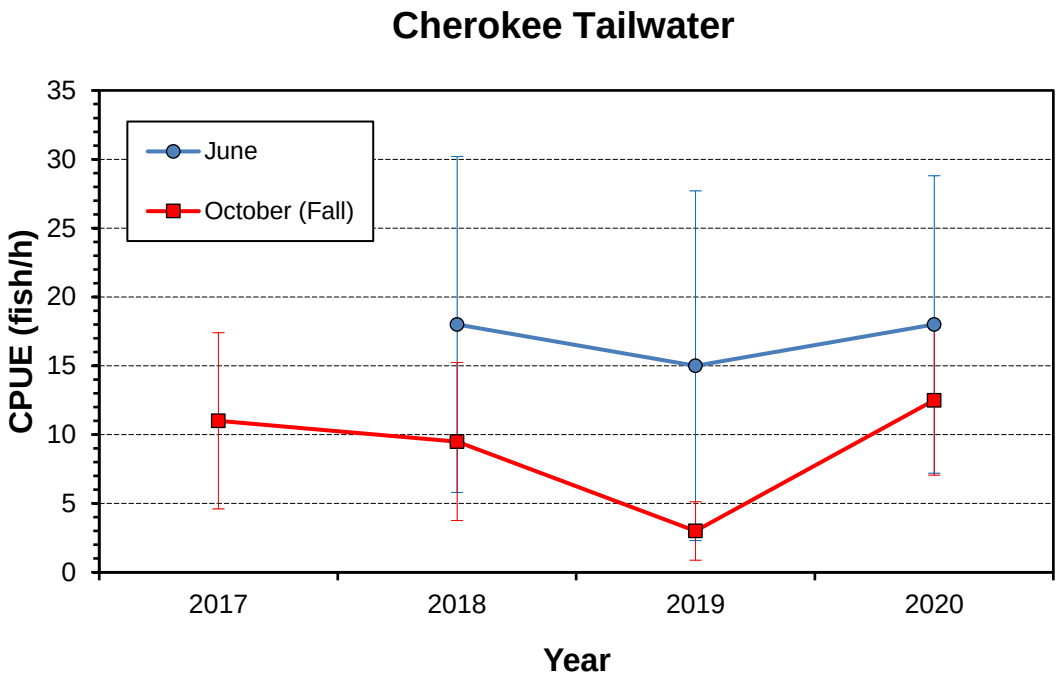


Figure 5-9. Comparison of mean CPUEs (trout ≥178 mm) for June and October/November samples from the Cherokee tailwater. Bars indicate 90% confidence intervals.

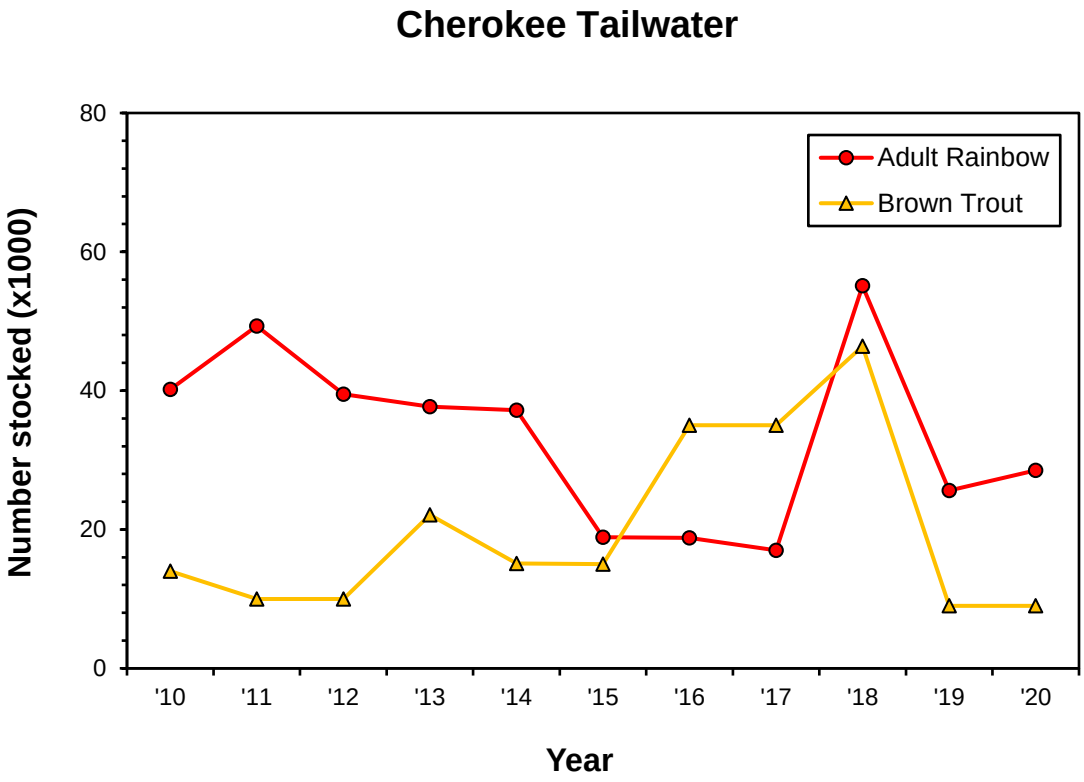


Figure 5-10. Recent trout stocking rates for the Cherokee tailwater. About 27,000 adult Rainbow Trout and 25,000 Brown Trout have been stocked annually since 2015.

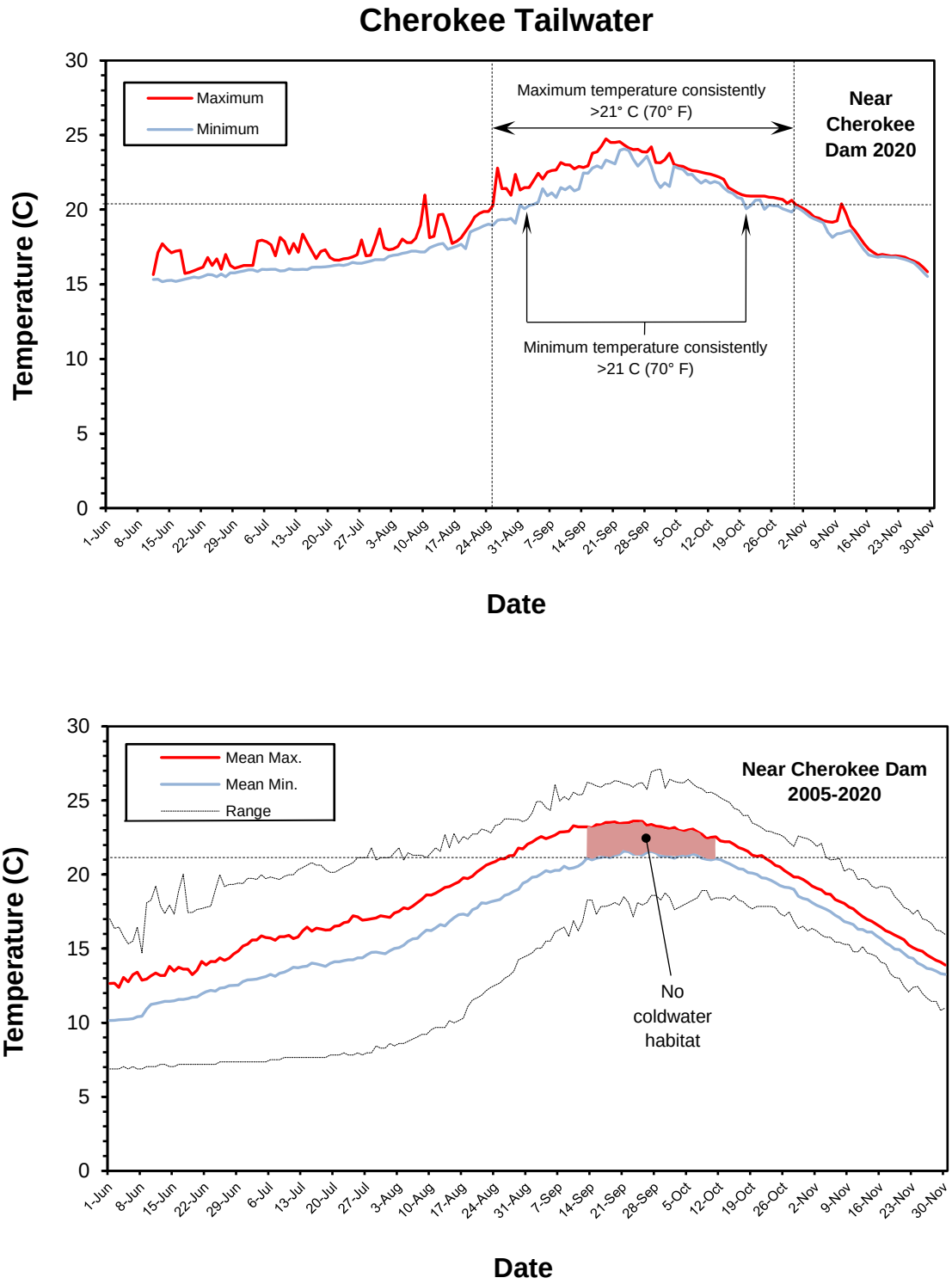


Figure 5-11. Daily temperature maxima and minima for June-November near Cherokee Dam (~1.6 km below the dam) in 2020 (upper graph) and 2005-2020 means (lower graph, with range).

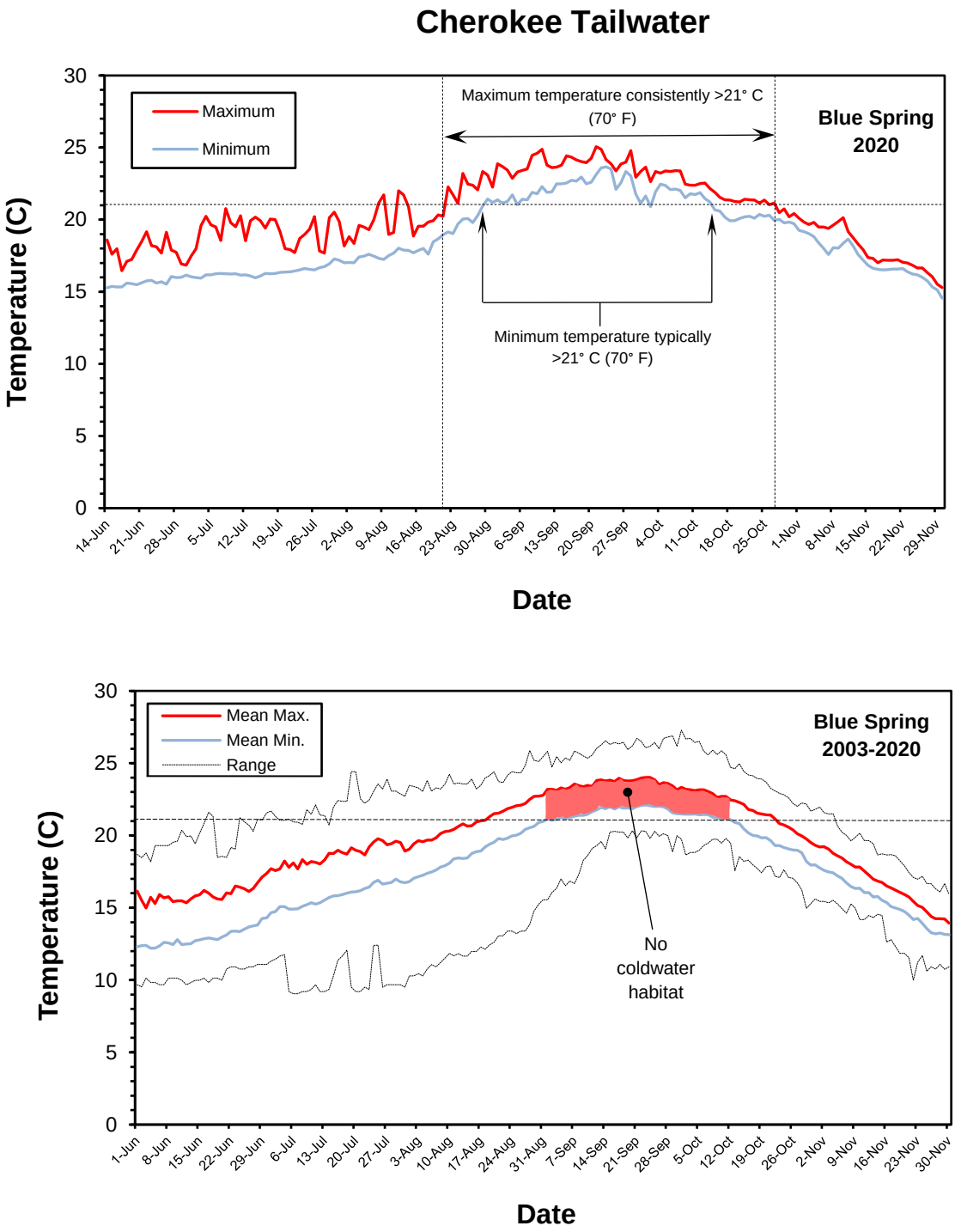


Figure 5-12. Daily temperature maxima and minima for June-November at Blue Spring (~13 km below the dam) in 2020 (upper graph) and 2003-2020 means (lower graph, with range).

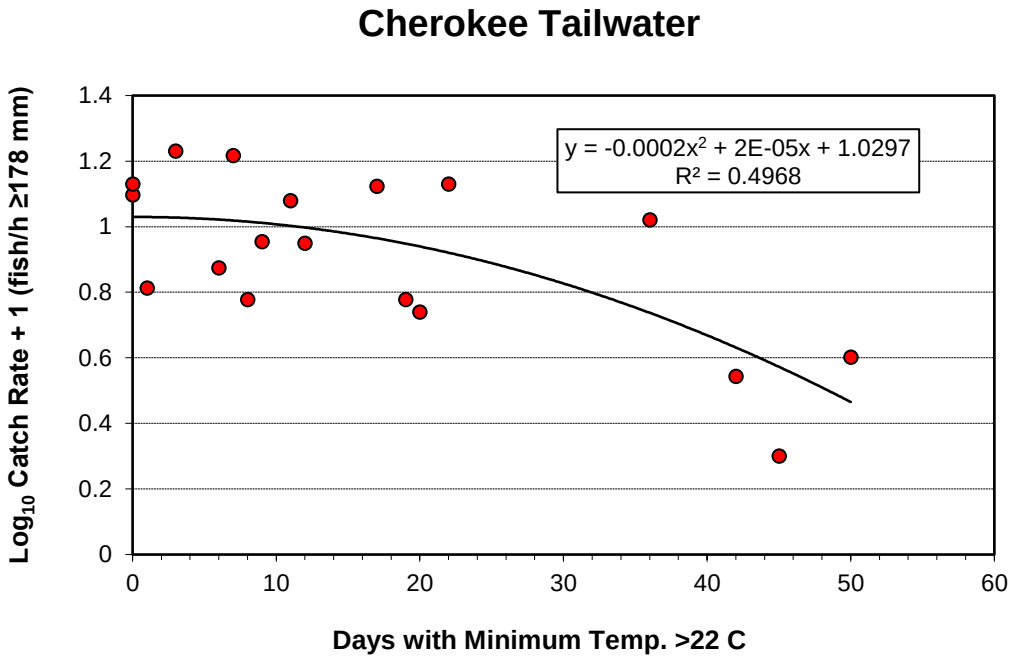


Figure 5-13. Inverse relationship between temperature (days during June-Oct. with minimum >22 C at Blue Spring) and October/November electrofishing catch rate for the Cherokee tailwater.

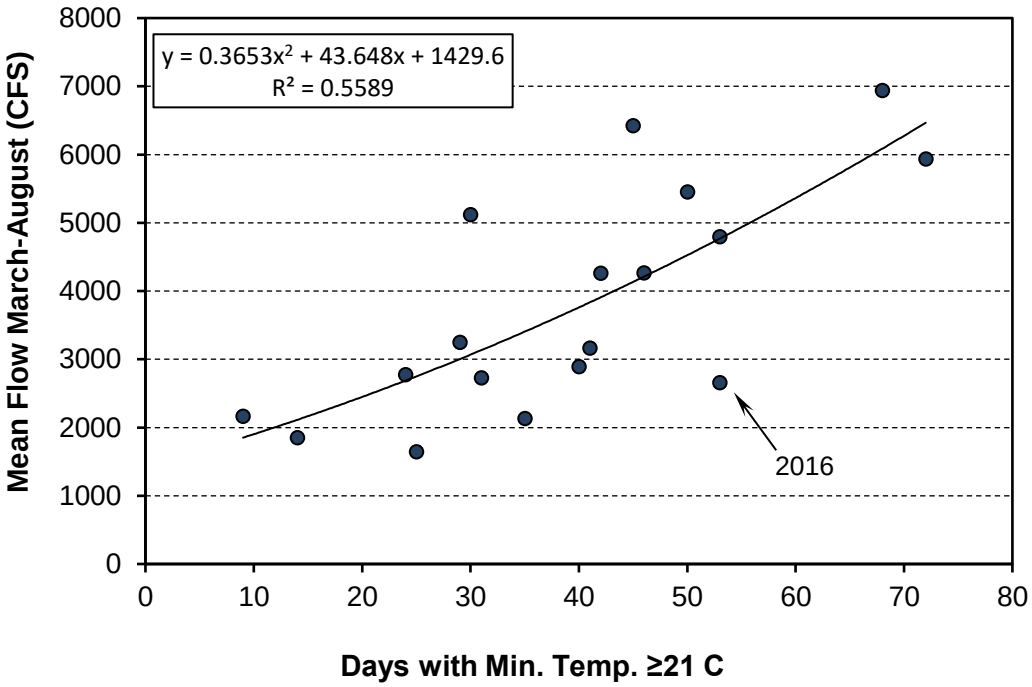


Figure 5-14. Relationship between mean flow (March-August) and temperature (days during June-October with minimum ≥21 C at Blue Spring) for the Cherokee tailwater.

Wilbur (Watauga River)

Catch and Length Frequency

The 12 Wilbur tailwater monitoring stations (Figure 5-15) produced 473 trout weighing over 105 kg in 2020 (Table 5-4). Brown Trout represented 88% of the total catch in 2020—the largest proportion to date, although the total number in the sample was down from 2019 (494 ≥178 mm). Most Brown Trout (74%) and Rainbow Trout (83%) in 2020 were in the 203-279 mm size range (Figure 5-16). Eight Brown Trout ≥508 mm (20 in.) were captured in 2020 (Figure 5-16)—more than in any previous sample except 2019 (9).

CPUE

Mean CPUE for Brown Trout ≥178 mm (all sites) fell below 200 fish/h in 2020 (from 242 fish/h in 2019; Figure 5-17), although CPUE for the upper portion of the tailwater (Stations 1-6) remained above 300 fish/h (Figure 5-18). Mean Rainbow Trout CPUE also declined to 28 fish/h—the lowest level observed since the fish kill in 2000. Consequently, total trout CPUE (≥178 mm) decreased to 222 fish/h (Figure 5-17), although that is the average for the past 10 years.

Wilbur tailwater near Siam Bridge.

The mean catch rate for larger trout (≥356 mm) exceeded 20 fish/h again in 2020 and has been in the 20-27 fish/h range since 2010 (Figure 5-17). Most of the fish in this size range are Brown Trout. Ten large (457 mm) Rainbow Trout identifiable as retired brood-stock from Erwin National Fish Hatchery (ENFH) were not included in the analyses.

Some anglers again reported poor results for Rainbow Trout in the Wilbur tailwater reach downstream of Blevins Bend (includes Stations 9-12, Figure 5-15) during 2020, often citing predation by Striped Bass *Morone saxatilis* from Boone Reservoir as the cause. Rainbow Trout CPUE data (fish ≥178 mm) from the tailwater reach below Blevins Bend (including Station 10.5) does indicate a decline since 2017 (Figure 5-19). Actions to address this issue are provided in the Stocking and Management Recommendations sections below.

Stocking

The Wilbur tailwater was stocked with 37,000 adult 50,000 fingerling Rainbow Trout during 2020 (Figure 5-20). Additionally, 1,929 retired Rainbow Trout broodstock from ENFH were stocked in 2020, including in the reach below Blevins Bend where they would typically not be susceptible to Striped Bass predation.

Angler Surveys

A new angler survey was conducted on the Wilbur tailwater in 2020. Estimated pressure, trips, catch, and harvest will be available in the 2021 Region IV Coldwater Streams report. Anglers interviewed in 2020 were also asked supplemental questions to document their opinions regarding the fishery in the Quality Zone (QZ) and the lower portion of the tailwater (below Blevins Bend). Most (70%) of the 383 anglers providing responses indicated that they did not fish in the QZ during the past year. A slight majority (54%) of those who did fish in the QZ did not believe they caught more trout ≥14 in. there. When asked to rate the trout fishery in the lower Wilbur tailwater (below Blevins Bend) on a 1 (poor) to 5 (excellent) scale, 83% said it was good (4) or excellent. No one assigned a rating of 1 or 2 (fair). Thirteen percent had no opinion.

A 581 mm (22.9 in.), 2.29 kg (5.0 lb.) Brown Trout from the 2020 Wilbur tailwater sample (Station 5).

<u>Myxobolus</u> Screening

The parasite that causes whirling disease (*Myxobolus cerebralis*) was detected in both Rainbow Trout and Brown Trout (adult fish) from the Wilbur tailwater following screening efforts in 2017. Additional testing of Rainbow Trout in 2019 by the Southeastern Cooperative Fish Parasite and Disease Lab (SCFPDL) at Auburn University produced negative results. However, further histological analyses of one adult Rainbow Trout exhibiting typical cranial and spinal deformities associated with *M. cerebralis* identified myxospores in cranial cartilage and erosion consistent with whirling disease lesions, making this one of the first confirmed cases of whirling disease in southern Appalachian rivers and streams (Ksepka et al. 2020).

While whirling disease is present in the Wilbur tailwater, it appears to be at a level insufficient to be detrimental to the current trout populations.

Management Recommendations

The wild Brown Trout fishery in the upper half of the tailwater has expanded substantially during the past few years. There also appears to be a notable wild component to the Rainbow Trout fishery now as well—indicated by the abundant age-0 fish observed during collection of *M. cerebralis* screening samples in 2019. Accordingly, new objectives will be developed when the Wilbur tailwater management plan is updated in 2021.

Although none of the 383 anglers interviewed during the 2020 creel survey rated the trout fishery in the lower Wilbur tailwater (below Blevins Bend) any lower than ‘okay’ (3 on a 1-5 scale), TWRA continued to respond to concerns by others that Striped Bass predation is having a negative effect. Retired Rainbow Trout broodstock from ENFH were stocked in this area in the summer and fall (when Striped Bass are present). Additionally, some Wilbur tailwater’s adult Rainbow Trout stocking allocation during the summer months was redirected to the lower reach in November and December for the 2020-2021 cycle. It will be of interest to determine if increased Striped Bass usage of this area continues after TVA begins to return Boone Reservoir to a normal operating guide in 2021.

Wilbur Tailwater

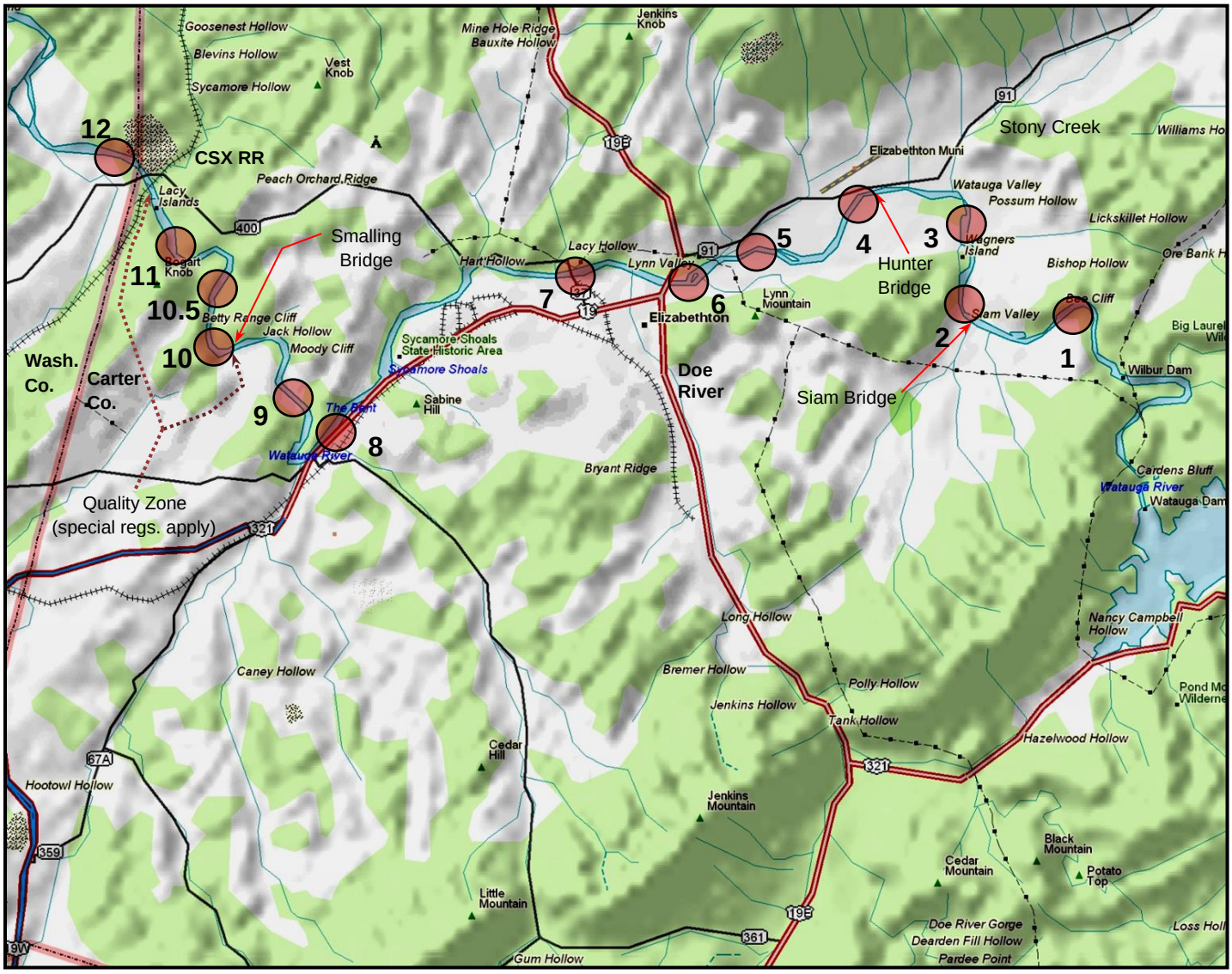


Figure 5-15. Locations of the Wilbur tailwater (Watauga River) monitoring stations. Station 10.5 was added in 2010 to help evaluate the Quality Zone (which also includes stations 10 and 11).

Table 5-4. Catch data for the 13 electrofishing stations on the Wilbur tailwater sampled 30 March 2020.

Station	Species	Total Catch	Size Range (mm)	Total Weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow	7	250-325	1,333	11	12
	Brown	59	208-410	10,247	89	88
Totals		**66**		**11,580**	**100**	**100**
2	Rainbow	5	227-290	716	6	5
	Brown	79	133-475	14,082	94	95
Totals		**84**		**14,798**	**100**	**100**
3	Rainbow	6	161-251	454	15	6
	Brown	34	129-641	7,510	85	94
Totals		**40**		**7,964**	**100**	**100**
4	Rainbow	6	200-332	1,225	8	9
	Brown	70	127-472	12,864	92	91
Totals		**76**		**14,089**	**100**	**100**
5	Rainbow	4	210-317	912	6	7
	Brown	65	127-581	12,856	94	93
Totals		**69**		**13,768**	**100**	**100**
6	Rainbow	1	311	248	2	3
	Brown	46	163-516	9,665	98	97
Totals		**47**		**9,913**	**100**	**100**
7	Rainbow	9	249-359	2,198	24	26
	Brown	29	186-375	6,314	76	74
Totals		**38**		**8,512**	**100**	**100**
8	Rainbow	12	156-350	2,969	57	35
	Brown	9	270-526	5,414	43	65
Totals		**21**		**8,383**	**100**	**100**
9	Rainbow	4	275-378	1,400	31	24
	Brown	9	157-538	4,362	69	76
Totals		**13**		**5,762**	**100**	**100**
10	Rainbow	2	250-356	724	50	21
	Brown	2	455-610	2,679	50	79
Totals		**4**		**3,403**	**100**	**100**
10.5	Rainbow	0	--	0	0	0
	Brown	10	300-560	6,393	100	100
Totals		**10**		**6,393**	**100**	**100**
11	Rainbow	1	322	304	10	6
	Brown	9	210-519	4,830	90	94
Totals		**10**		**5,134**	**100**	**100**
12	Rainbow	0	--	0	0	0
	Brown	5	187-430	2,020	100	100
Totals		**5**		**2,020**	**100**	**100**
Total Rainbows[1]		57	156-378	12,483	12	12
Total Browns[1]		416	127-641	92,843	88	88
Overall totals[1]		**473**		**105,326**	**100**	**100**

[1]Overall totals do not include Station 10.5, which was added in 2010 to help evaluate the Quality Zone (stations 10, 10.5, and 11 are in the QZ). Retired brood fish (430-450 mm Rainbow Trout) from Erwin National Fish Hatchery are not included.

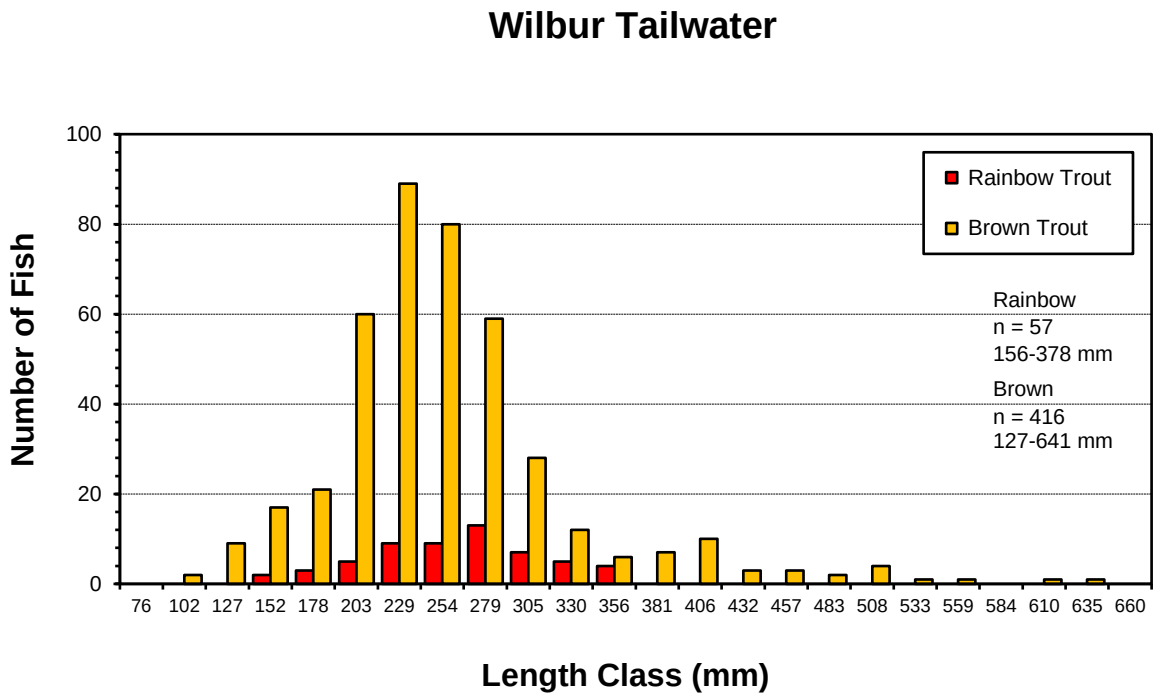


Figure 5-16. Length frequency distributions for trout from the Wilbur tailwater monitoring stations in 2020 (excluding Station 10.5).

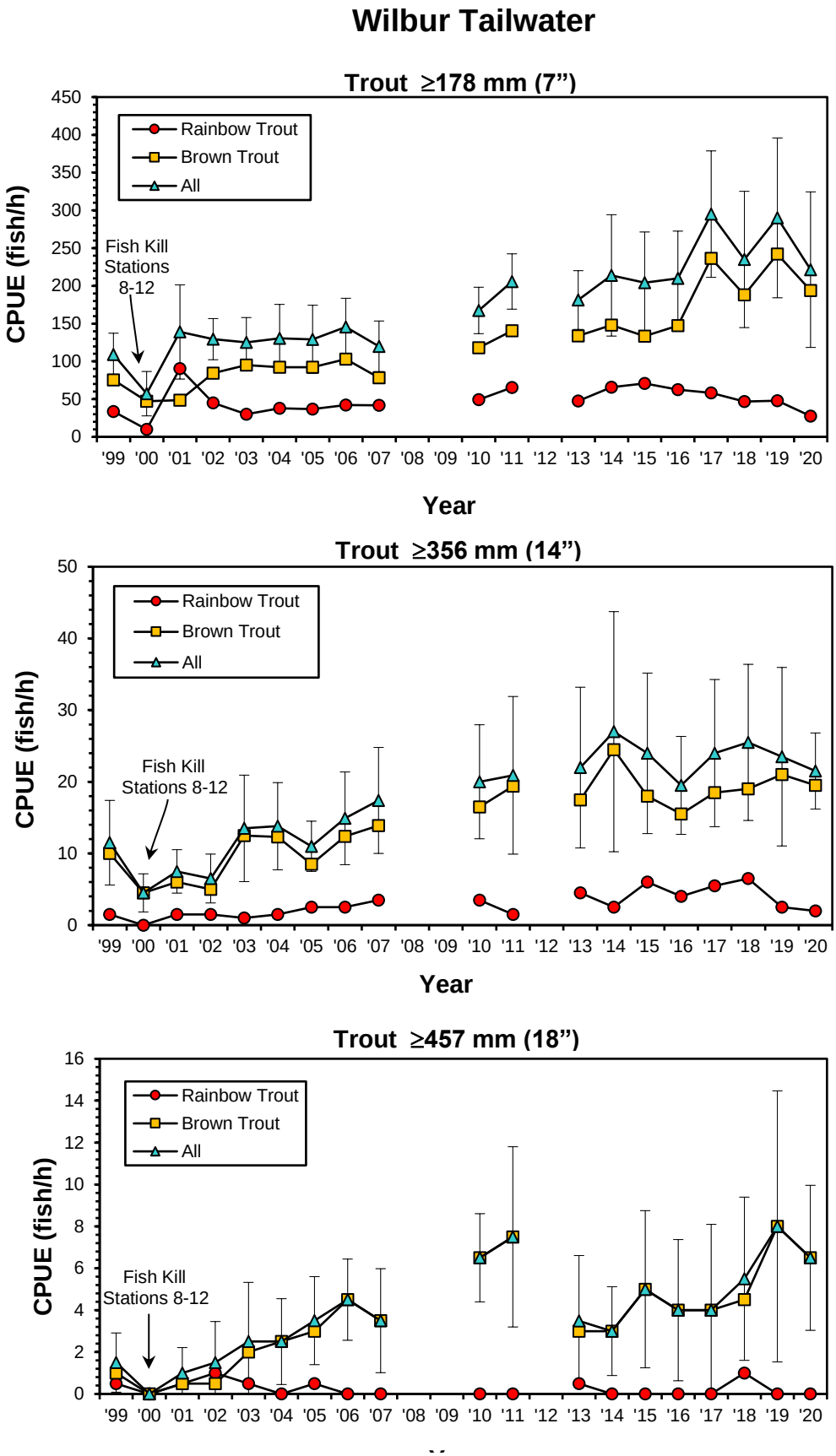


Figure 5-17. Mean trout CPUEs for the Wilbur tailwater samples. Bars indicate 90% confidence intervals.

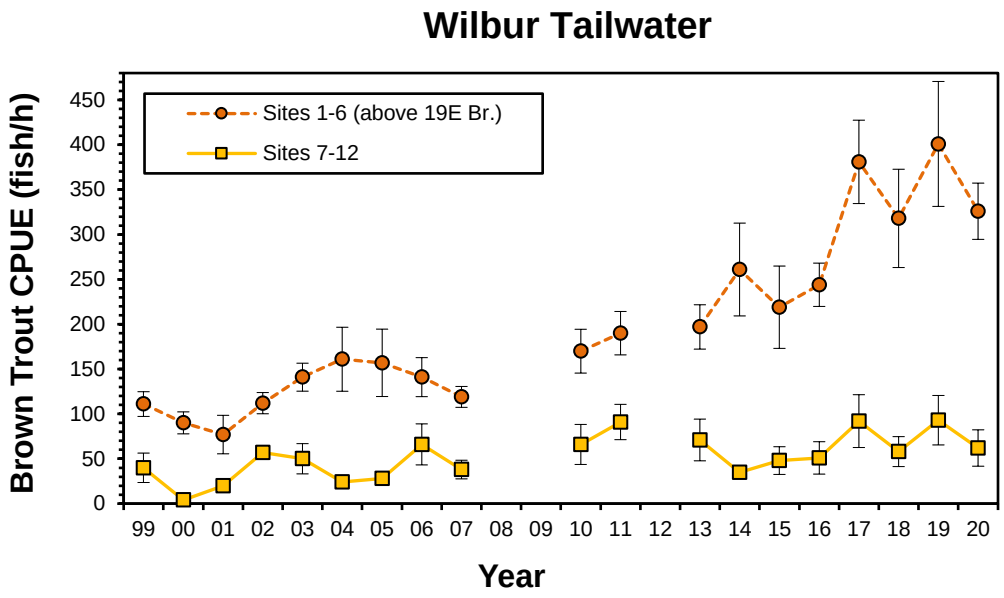


Figure 5-18. Mean Brown Trout CPUEs for the upper (Stations 1-6) and lower (Stations 7-12) portions of the Wilbur tailwater. Bars indicate 90% upper confidence limits.

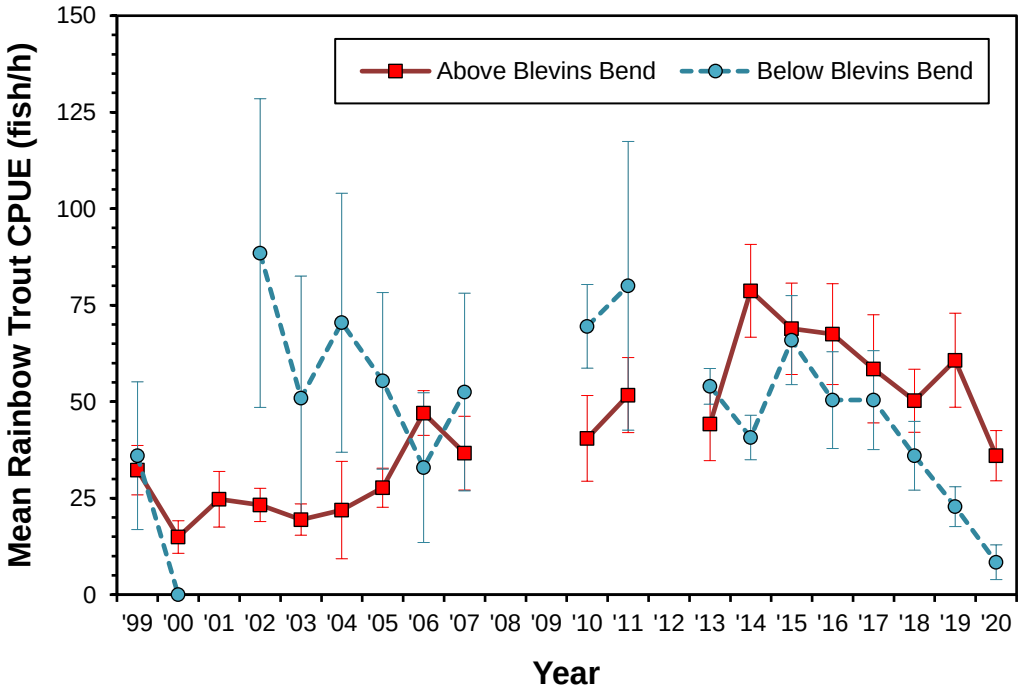


Figure 5-19. Mean Rainbow Trout CPUEs (fish ≥178 mm) for the Wilbur tailwater above (Stations 1-8) and below (Stations 9-12) Blevins Bend. Bars indicate standard errors (SE).

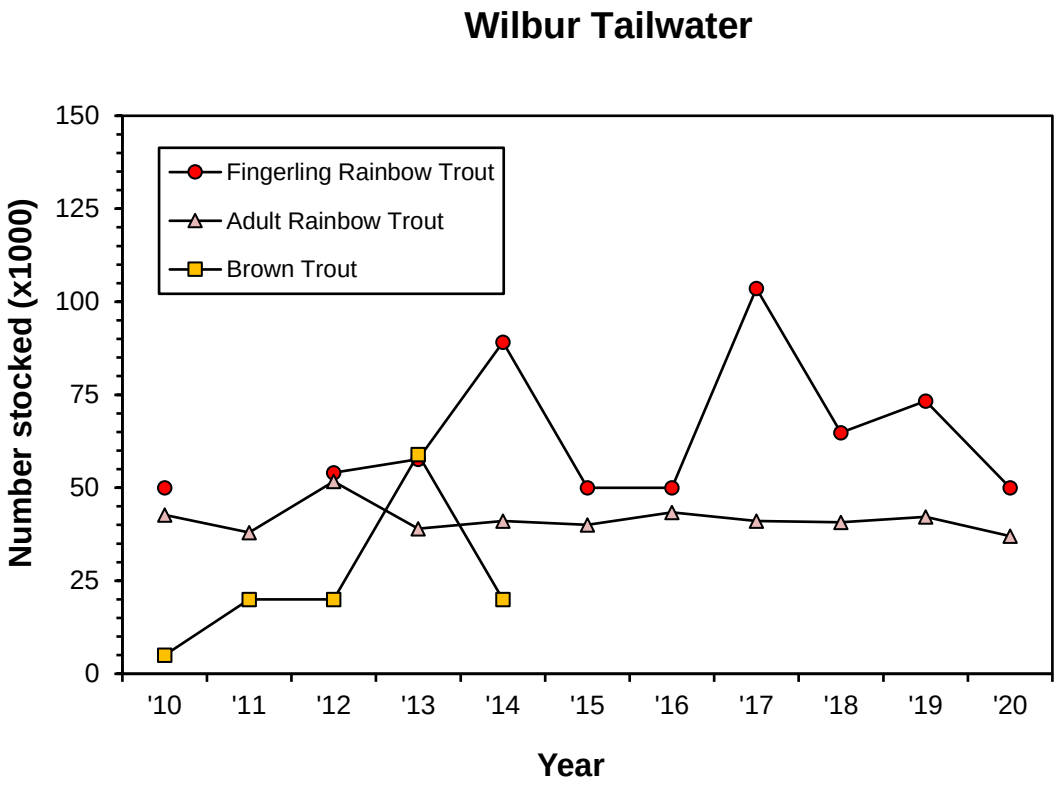


Figure 5-20. Recent trout stocking rates for the Wilbur tailwater. Stocking rates under the current management plan (2015-2020) are 40,000 adult and 50,000 fingerling Rainbow Trout annually. Erwin National Fish Hatchery stocked 1,929 retired brood Rainbow Trout (18 in.) in 2020.

Fort Patrick Henry (South Fork Holston River)

Catch, Length Frequency, and W_r

The four Ft. Patrick Henry tailwater electrofishing stations (Figure 5-21) produced 29 trout weighing over 44 kg in 2020 (Table 5-5). Rainbow Trout ranged from 237-592 mm and fish in the 229 and 508 mm (9 and 20 in.) size classes were most abundant (Figure 5-22). Brown Trout ranged from 540-629 mm (Figure 5-23). Mean relative weight (W_r) was 119 (SE=5.23) for Rainbow Trout and 109 (SE=6.40) for Brown Trout.

A 515 mm, 2.4 kg (5.3 lb.) adipose-clipped Rainbow Trout from the 2020 Ft. Patrick Henry tailwater sample.

Closer view of the adipose clipped Rainbow Trout shown above.

CPUE

Mean electrofishing catch rates for trout ≥178 mm declined slightly relatively to 2019, as did CPUEs for trout ≥356 mm (Figure 5-23). However, catch rates for the largest trout (≥457 mm) increased in 2020 (Figure 5-23), with the Brown Trout CPUE (5 fish/h) exceeding that for any previous sample. The abundance of trout ≥457 mm had been substantially depressed during 2004-2010 (0 to 4 fish/h), but has improved since then, averaging 16 fish/h (Figure 5-23).

RSD-18

The relative stock density for Rainbow Trout 18 in. (457 mm) and larger (RSD-18) regularly reaches or exceeds 20 (Figure 5-24) in the Ft. Patrick Henry tailwater. An RSD-18 value of 20 indicates that 20% of all stock-size trout—i.e., those at least 254 mm (10 in.) in length—are 457 mm (18 in.) or larger. RSD-18 for Ft. Patrick Henry tailwater Rainbow Trout increased to 74 in 2020 (Figure 5-24), the highest level observed to date and well above the objective (20) established in the Boone and Ft. Patrick Henry Tailwater Trout Fisheries Management Plan (Habera et al. 2018).

Stocking

The Ft. Patrick Henry tailwater was stocked with 10,500 adult Rainbow Trout, 7,900 fingerling Rainbow Trout, and 5,000 subadult Brown Trout in 2020 (Figure 5-25). Annual stocking rates established in the Boone and Ft. Patrick Henry Tailwater Trout Fisheries Management Plan (2019-2024) are 10,000 adult Rainbow Trout, 7,500 fingerling Rainbow Trout, and 10,000 Brown Trout (Habera et al. 2018).

Research

Initial results from the TN CFRU research project indicate that the Fort Patrick Henry tailwater Rainbow Trout population is primarily supported by stocked adults, as no stocked fingerlings have been captured. Some naturally reproduced fingerlings have been captured in Kendrick Creek, thus there likely is a wild component to the Rainbow Trout fishery as well. PIT-tag data indicated that fish stocked in 2019 at 9.5 in. could exceed 21 in. within 16 months—an average growth rate of 0.76 in. (19.4 mm) per month. Research will continue for another two years, as more analysis is needed to better understand survival, recruitment, and growth. This will permit further tracking of PIT tagged fish, as well as the opportunity to increase capture rates of marked fish and explore fish movement throughout the tailwater. Identification of optimal stocking rates is an objective of the current trout fisheries management plan for Boone and Ft. Patrick Henry tailwaters (Habera et al. 2018), results from this work will help inform future stocking strategy.

Management Recommendations

The Ft. Patrick Henry tailwater provides a relatively unique fishery that consistently produces large, extremely well-conditioned trout. This attribute is recognized in the management goal for this tailwater, which focuses on fully developing and maintaining this potential and the exceptional angling opportunities it provides. TWRA will continue to use stocked Rainbow Trout and Brown Trout fisheries to attain the management goal and no changes are recommended at this time.

Ft. Patrick Henry Tailwater

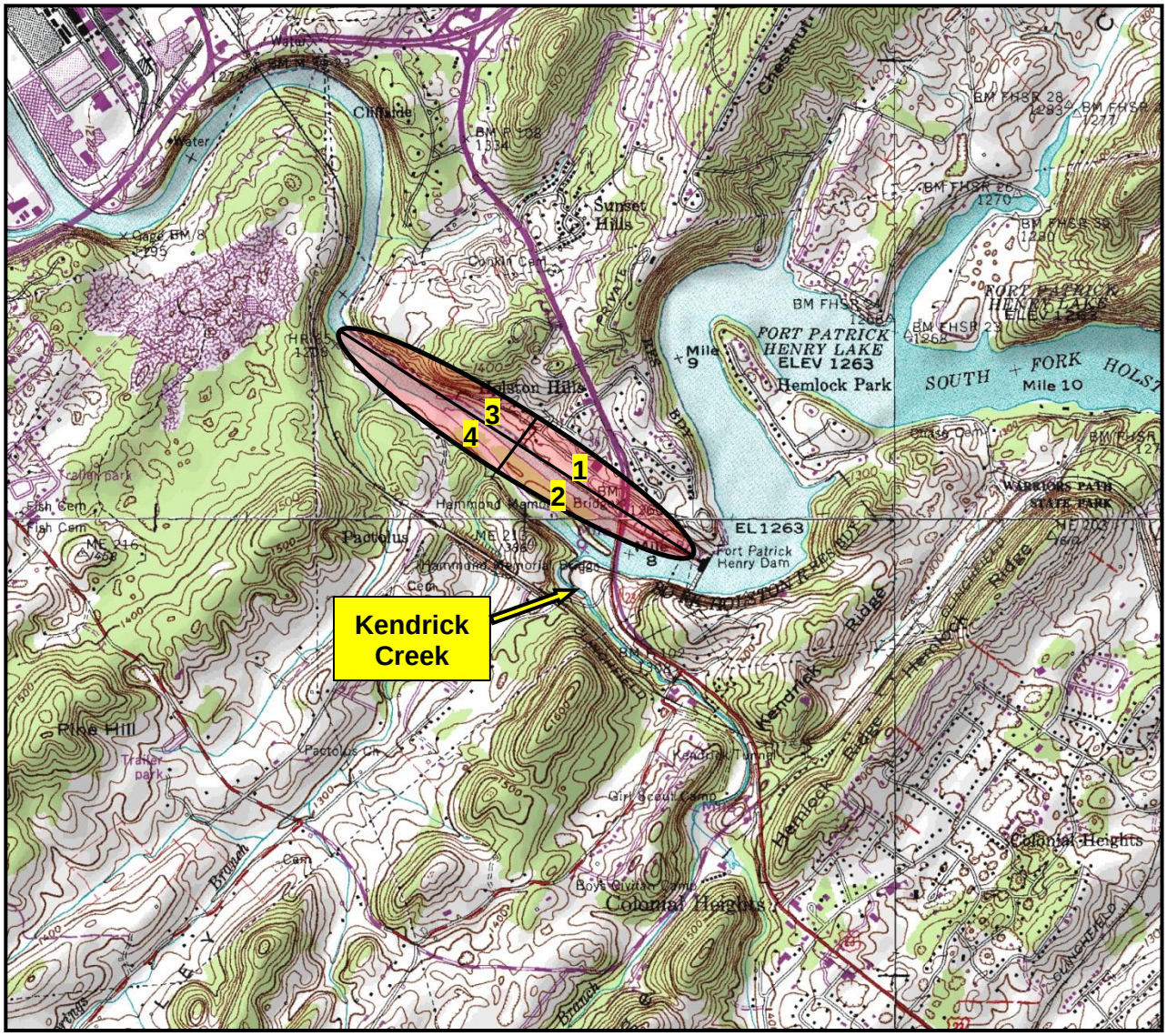


Figure 5-21. Location of the Ft. Patrick Henry tailwater (South Fork Holston River) monitoring stations.

Table 5-5. Catch data for the four electrofishing stations on the Ft. Patrick Henry tailwater sampled 12 March 2020.

Station	Species	Total Catch	Size Range (mm)	Total Weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow Trout	7	238-517	8,494	100	100
	Brown Trout	--	--	--	0	0
Totals		**7**		**8,494**	**100**	**100**
2	Rainbow Trout	8	237-592	10,674	89	85
	Brown Trout	1	564	1,899	11	15
Totals		**9**		**12,573**	**100**	**100**
3	Rainbow Trout	3	367-515	5,062	75	77
	Brown Trout	1	540	1,532	25	23
Totals		**4**		**6,594**	**100**	**100**
4	Rainbow Trout	6	242-540	8,607	67	52
	Brown Trout	3	581-629	8,085	33	48
Totals		**9**		**16,692**	**100**	**100**
Total Rainbow Trout		**24**	237-592	**32,837**	83	74
Total Brown Trout		**5**	540-629	**11,516**	17	26
Overall totals		**29**		**44,353**	**100**	**100**

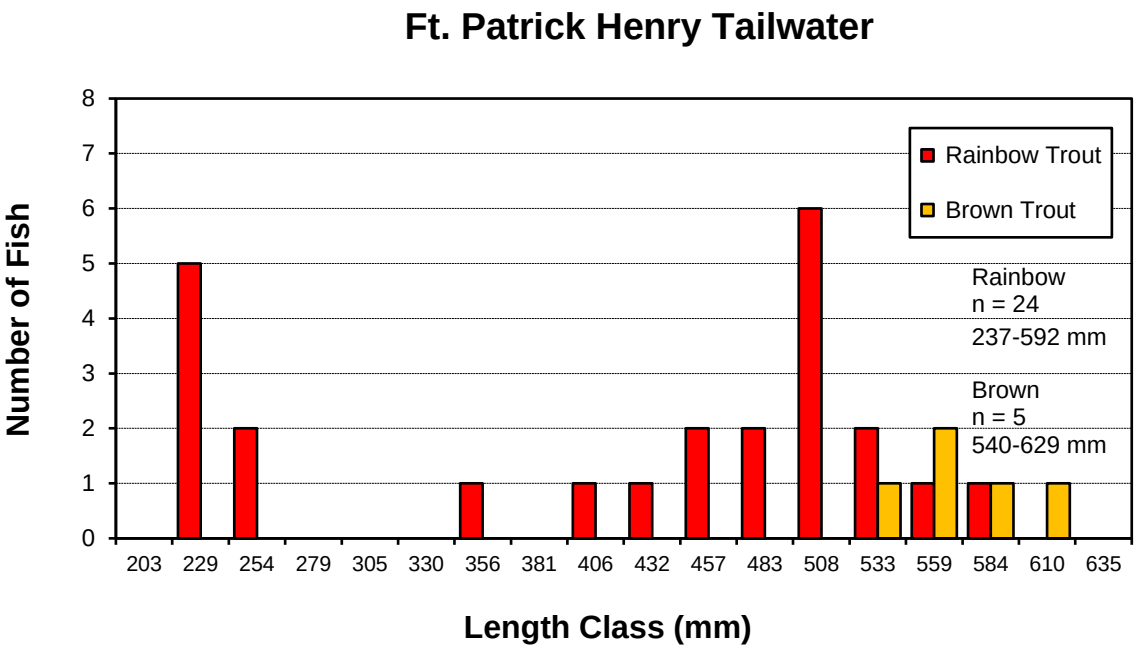


Figure 5-22. Length frequency distributions for trout from the Ft. Patrick Henry tailwater monitoring stations in 2020.

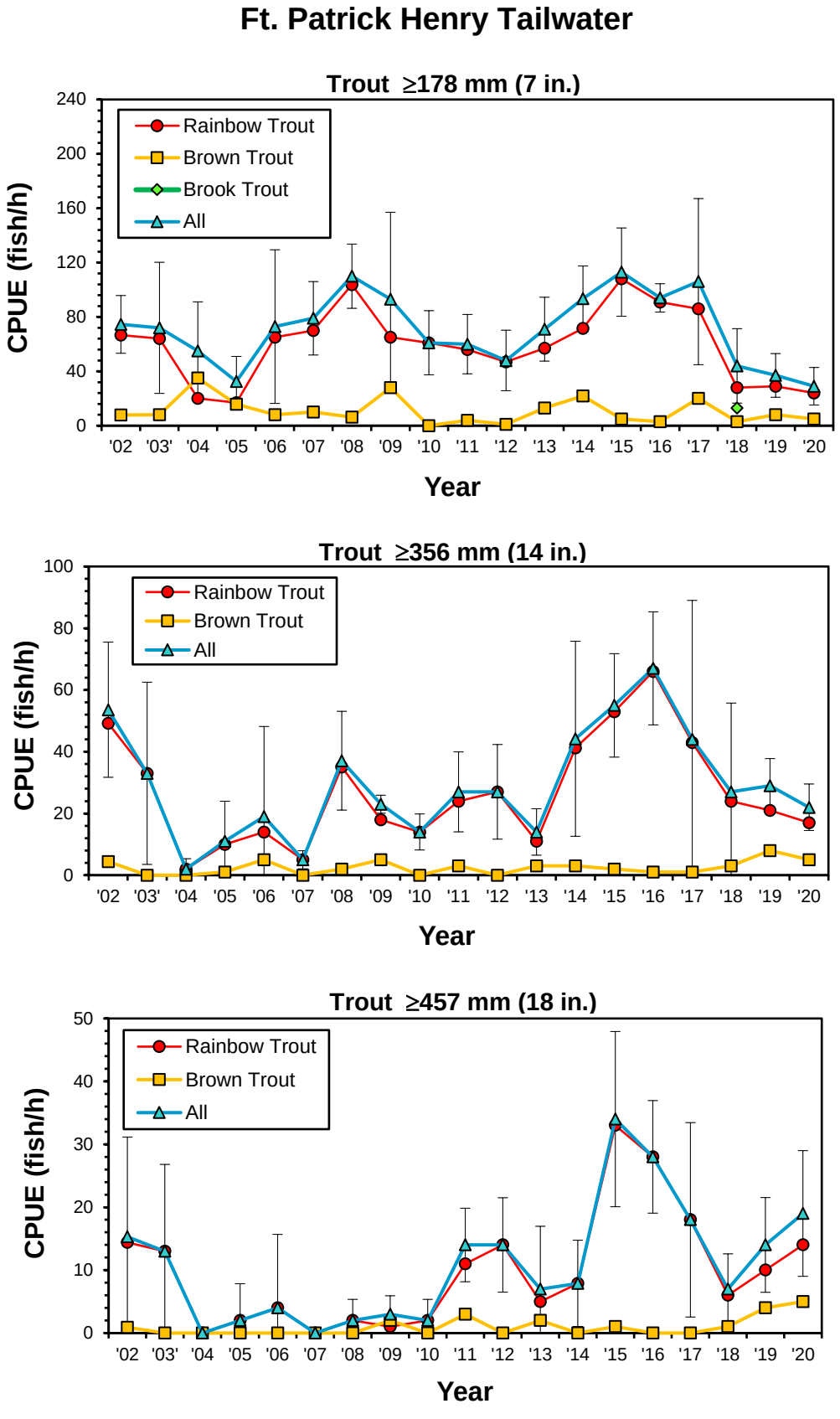


Figure 5-23. Mean trout CPUEs for the Ft. Patrick Henry tailwater sample. Bars indicate 90% confidence intervals.

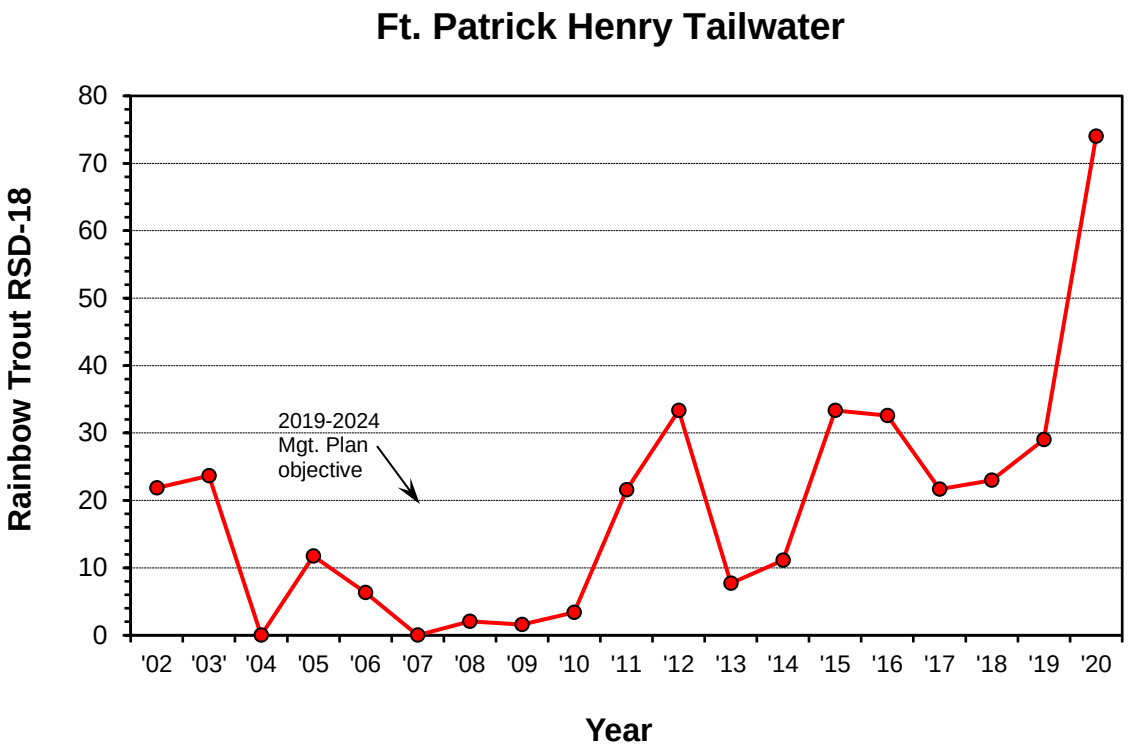


Figure 5-24. RSD-18 for Ft. Patrick Henry tailwater Rainbow Trout.

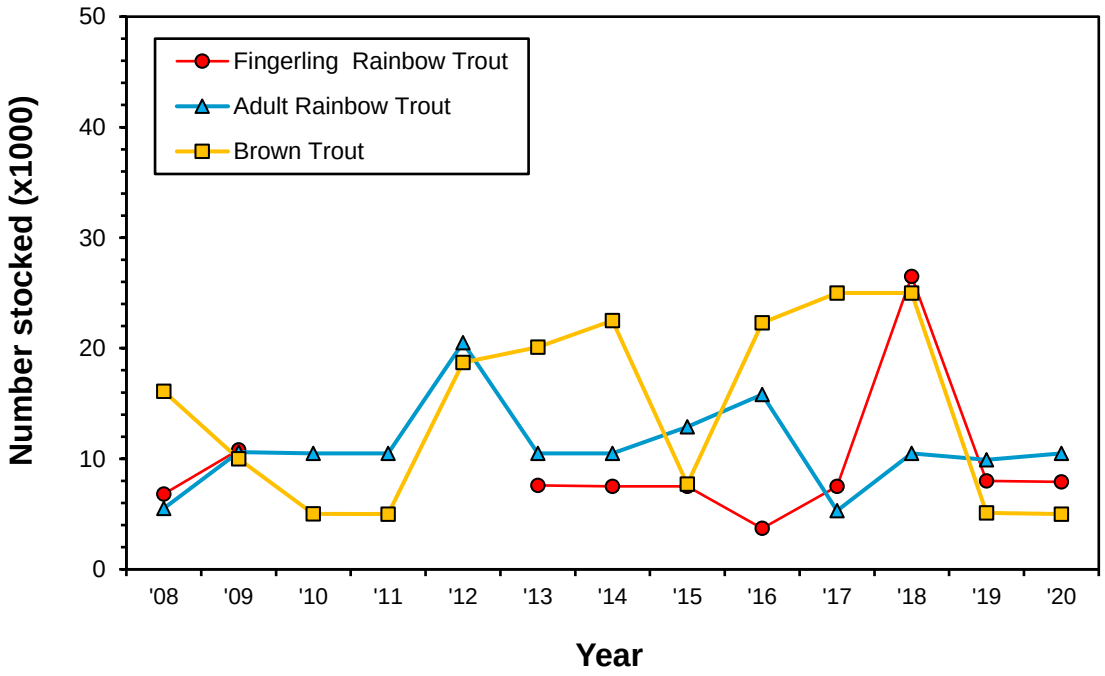


Figure 5-25. Recent trout stocking rates for the Ft. Patrick Henry tailwater.

Boone (South Fork Holston River)

Catch, Length Frequency, and W_r

The four Boone tailwater monitoring stations (Figure 5-26) produced 70 trout (55 Rainbow Trout and 15 Brown Trout) weighing nearly 48 kg in 2020 (Table 5-6). Rainbow Trout in the 229-254 mm (9-10 in.) size classes were most abundant, although fish ranging up to 575 mm (22 in. size class) were also captured (Figure 5-27). Brown Trout ranging up to 592 mm (23 in. size class) were captured and all 15 were ≥330 mm or 13 in. (Figure 5-27). Mean relative weight (W_r) was 99 (SE=2.58) for Rainbow Trout and 115 (SE=4.15) for Brown Trout. The sub-100 W_r for Rainbow Trout was related to the predominance of 229-254 mm fish from the February 2020 stockings.

2020 Boone tailwater electrofishing survey.

CPUE

Mean electrofishing catch rates for Rainbow Trout and Brown Trout ≥178 mm and ≥356 mm were comparable to corresponding 2019 CPUEs (Figure 5-28). The catch rate for Brown Trout ≥457 mm increased to the highest level observed to date (9 fish/h; Figure 5-28), while the catch rate for Rainbow Trout ≥457 mm decreased to 5 fish/h. Brown Trout CPUE exceeded Rainbow Trout CPUE for this size class in only one other year (2017; Figure 5-28).

A 23 in., 6.45 lb. Brown Trout (W_r = 1.39) from the 2020 Boone tailwater survey.

RSD-18

The relative stock density for Rainbow Trout ≥457 mm or 18 in. (RSD-18) regularly reaches or exceeds 10, while RSD-18 often exceeds 20 for all trout in the Boone tailwater (Figure 5-29). An RSD-18 value of 20 indicates that 20% of all stock-size trout—i.e., those at least 254 mm (10 in.) in length—are 457 mm (18 in.) or larger. RSD-18 for Boone tailwater Rainbow Trout decreased to 14 in 2020, although it was unchanged (27) for all trout (Figure 5-29). The 2020 values exceed the objectives (10 for Rainbow Trout and 20 for all trout) established in the Boone and Ft. Patrick Henry Tailwater Trout Fisheries Management Plan (Habera et al. 2018).

Stocking

The Boone tailwater was stocked with 10,000 adult Rainbow Trout, 7,600 fingerling Rainbow Trout (marked with left pelvic fin clips), 5,000 subadult Brown Trout, and 3,000 Brook Trout in 2020 (Figure 5-30). These are consistent with the annual stocking rates established in the 2019-2024 Boone and Ft. Patrick Henry Tailwater Trout Fisheries Management Plan (Habera et al. 2018). The effectiveness of fingerling Rainbow Trout stocking has not yet been evaluated but results from the ongoing research project on the Ft. Patrick Henry tailwater (summarized above) should provide some insight and may help guide future stocking strategy.

Boone Reservoir Drawdown Effects

The extended drawdown of Boone Lake to an elevation of 412 m (1,352')—3.1 m (10') below winter pool continued during 2020. Data from TVA's water quality monitoring station in the tailwater near the dam indicated that water temperatures reached 21 °C on only one day during 2020 (9 July) and there have been no particular issues with elevated temperatures (>21 °C) during 2015-2019 (Habera et al. 2020). The Boone tailwater reach of the South Fork Holston River is listed under TDEC's water usage classifications (Chapter 0400-40-04; TDEC 2013) and water quality standards (Chapter 0400-40-03; TDEC 2015) as trout water with a minimum dissolved oxygen (DO) criterion of 6 mg/l. Summer and early fall DO levels frequently fell below 6.0 mg/l in 2020 (76 days), particularly during August and September. Additionally, DO levels in the 3.0 mg/l range were recorded on 13 days during the first three weeks of September. It is currently unknown if these DO depressions had any effect on the tailwater trout fishery, but the March 2021 electrofishing samples should provide some insight. TVA projects that repairs to the dam will be completed in 2022.

Management Recommendations

The Boone tailwater provides a relatively unique fishery that consistently produces large, extremely well-conditioned trout. This attribute is recognized in the management goal for this tailwater, which focuses on fully developing and maintaining this potential and the exceptional angling opportunities it provides. TWRA will continue to use put-and-grow and put-and-take Rainbow Trout and Brown Trout fisheries to attain the management goal and no changes are recommended at this time.

Boone Tailwater

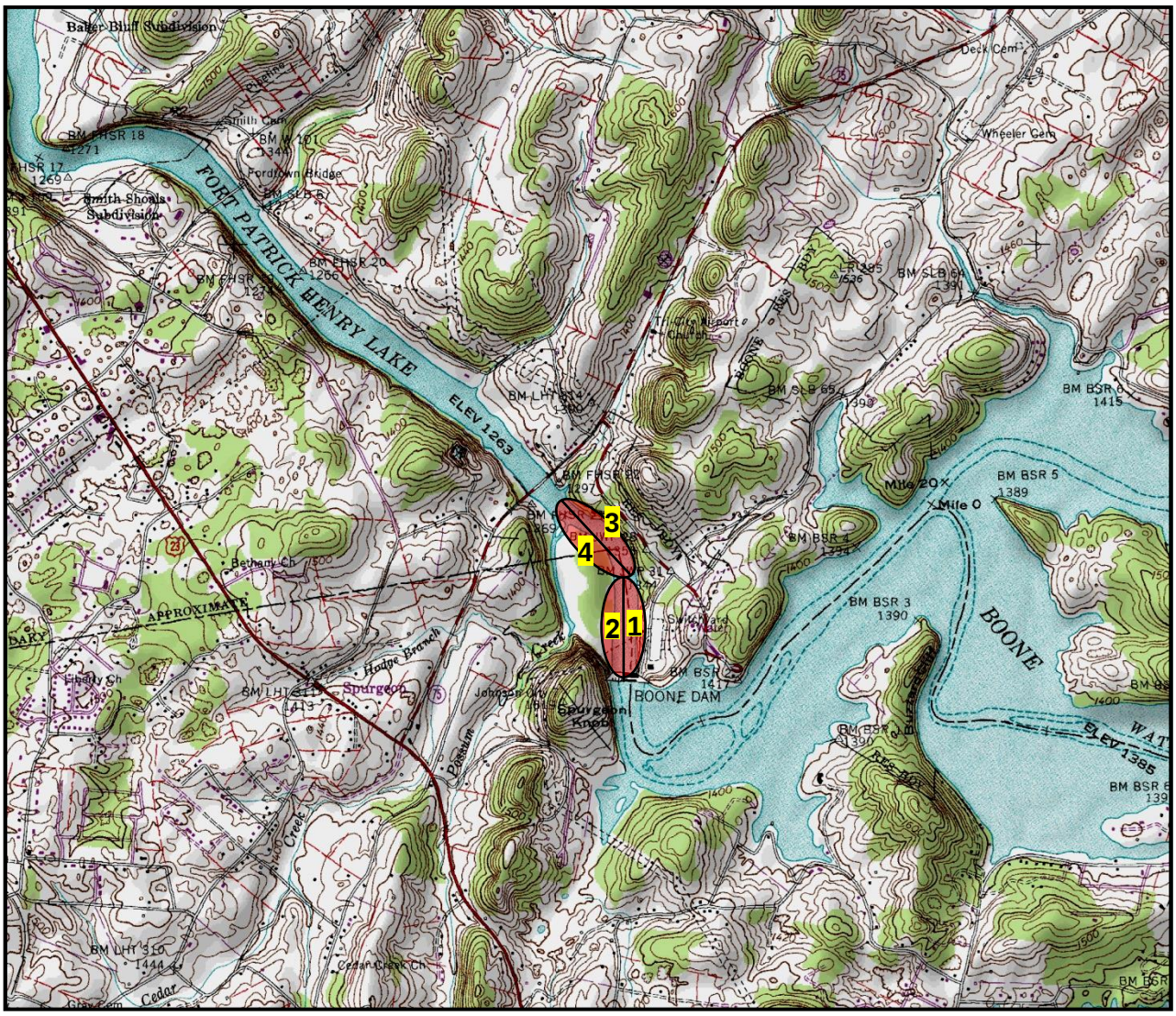


Figure 5-26. Location of the Boone tailwater (South Fork Holston River) monitoring stations.

Table 5-6. Catch data for the four electrofishing stations on the Boone tailwater sampled 12 March 2020.

Station	Species	Total Catch	Size Range (mm)	Total Weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow Trout	7	249-477	2,996	58	37
	Brown Trout	5	353-592	5,110	42	63
Totals		**12**		**8,106**	**100**	**100**
2	Rainbow Trout	23	215-465	9,926	96	82
	Brown Trout	1	532	2,174	4	18
Totals		**24**		**12,100**	**100**	**100**
3	Rainbow Trout	11	227-381	2,014	58	13
	Brown Trout	8	341-585	13,338	42	87
Totals		**19**		**15,352**	**100**	**100**
4	Rainbow Trout	14	181-575	10,782	93	88
	Brown Trout	1	475	1,404	7	12
Totals		**15**		**12,186**	**100**	**100**
Total Rainbow Trout		**55**	181-575	**25,718**	79	54
Total Brown Trout		**15**	341-592	**22,026**	21	46
Overall totals		**70**		**47,744**	**100**	**100**

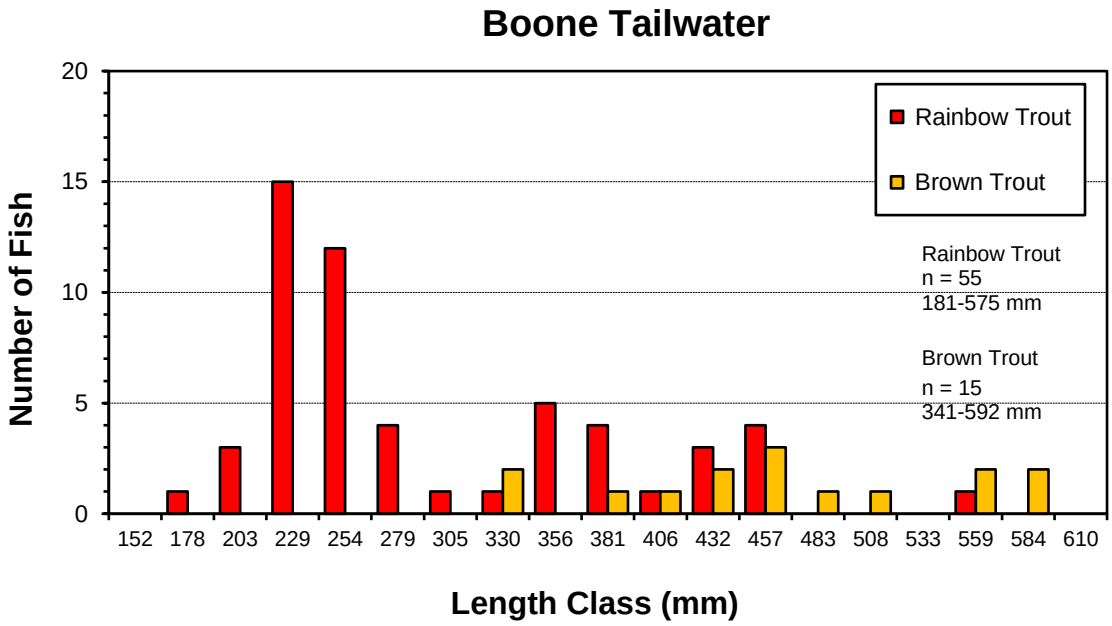


Figure 5-27. Length frequency distributions for trout from the Boone tailwater monitoring stations in 2020.

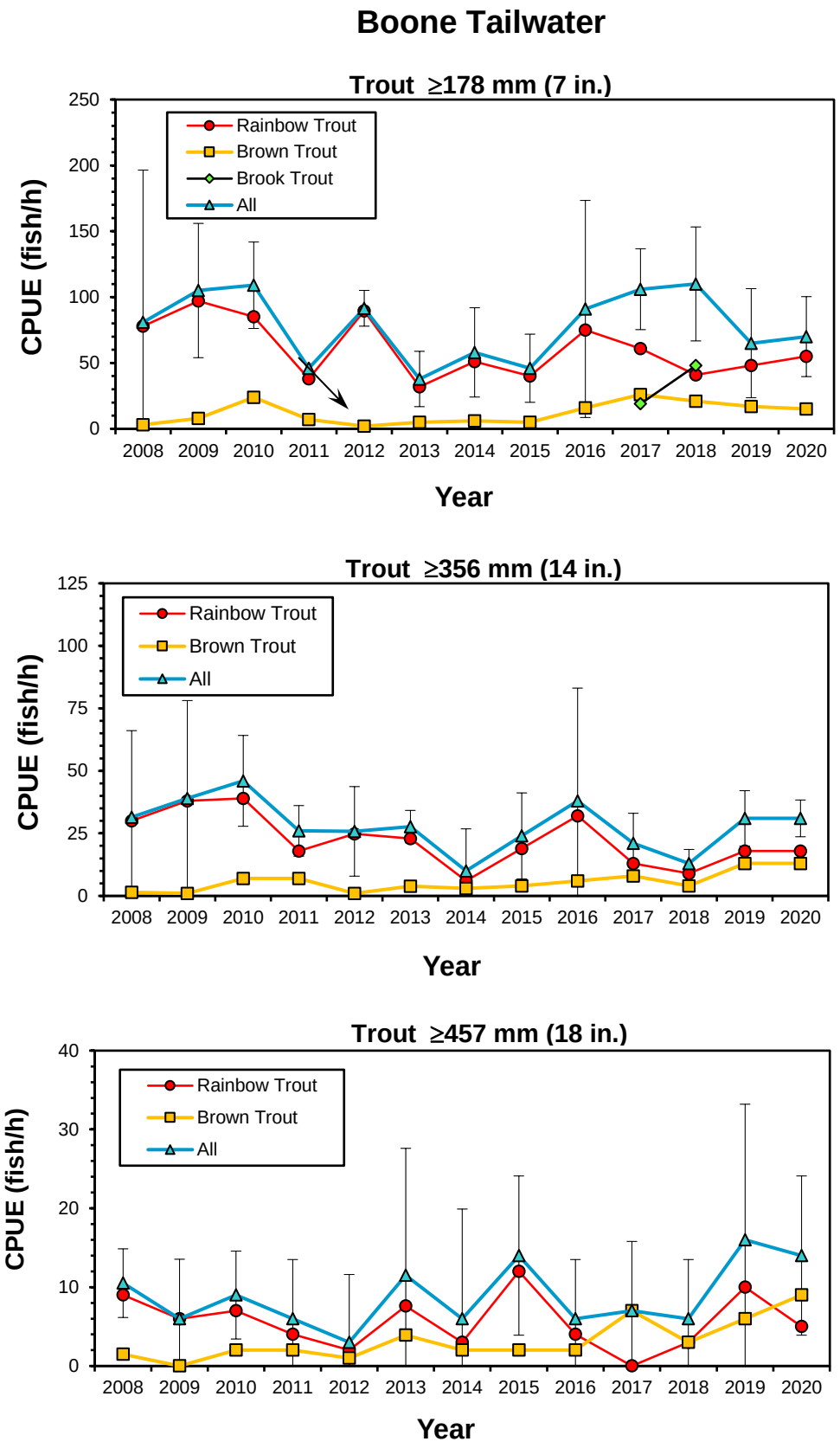


Figure 5-28. Mean trout CPUEs for the Boone tailwater samples. Bars indicate 90% confidence intervals.

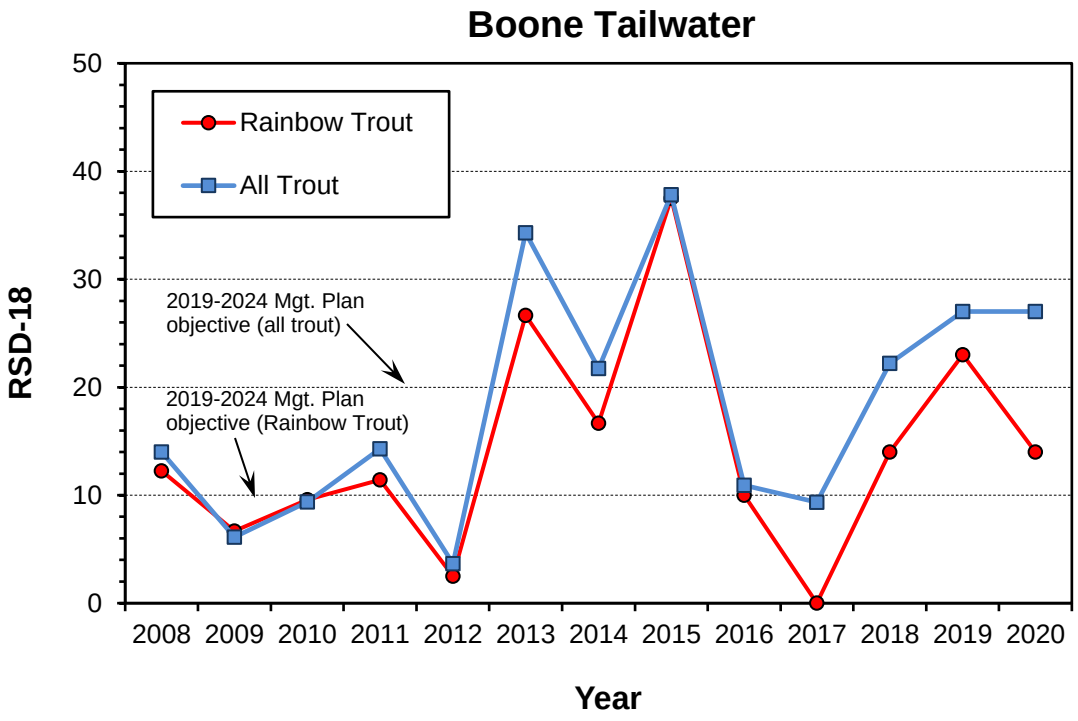


Figure 5-29. RSD-18 for Boone tailwater trout (2008-2020).

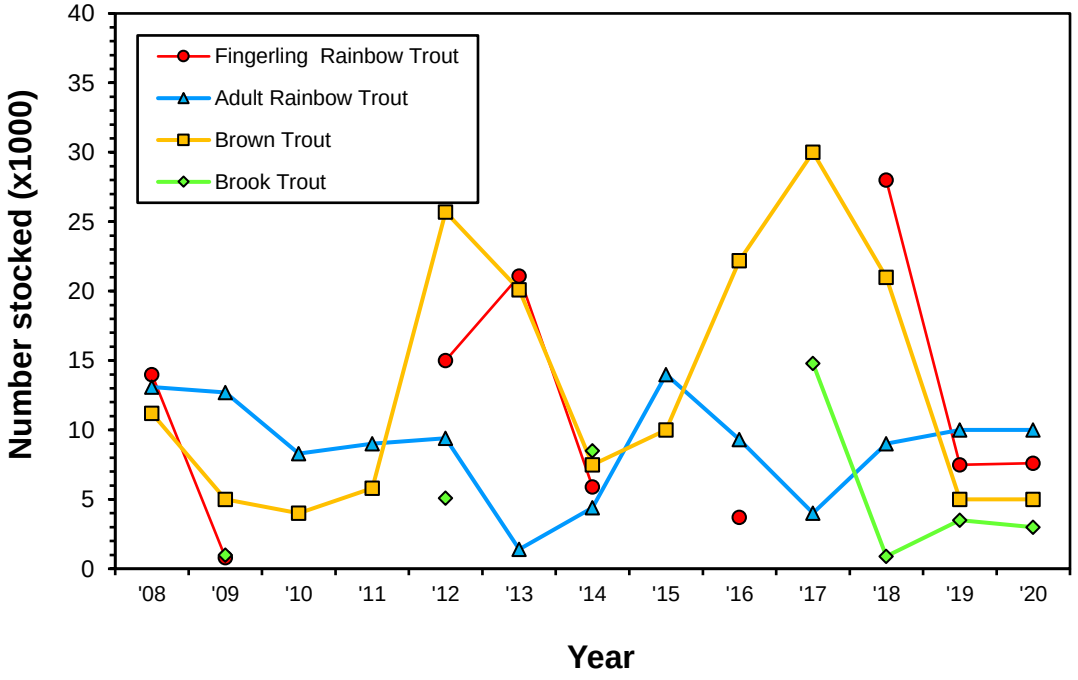


Figure 5-30. Recent trout stocking rates for the Boone tailwater.

South Holston (South Fork Holston River)

Catch and Length Frequency

The 12 South Holston tailwater monitoring stations (Figure 5-31) produced 877 trout weighing over 165 kg in 2020 (Table 5-7). Brown Trout represented 90% of the catch by number and 86% by biomass. Brown Trout in the 203-279-mm size classes were most abundant (Figure 5-32), which likely represent age-2 fish (Habera et al. 2020). Fewer Brown Trout in the PLR (19) were captured in 2020 than 2019 (28). Most Rainbow Trout (83%) were in the 229-330 mm size classes and only two fish were within the PLR (Figure 5-32).

The South Holston tailwater.

CPUE

The mean electrofishing catch rate (CPUE) for all trout ≥178 mm increased to 420 fish/h in 2020, with Brown Trout responsible for most of the change (Figure 5-33). In fact, mean CPUE for Brown Trout ≥178 mm (377 fish/h) was the highest observed to date (Figure 5-33). Rainbow Trout CPUE has been relatively stable during the past five years at 30-40 fish/h. The overall PLR catch rate decreased to 10.5 fish/h in 2020 and has typically ranged from 9-15 fish/h since 2010 (Figure 5-33)—well below the range observed during 2005-2007 (25-29 fish/h).

RSD-16

Relative stock density for Brown Trout ≥406 mm (RSD-16)—based on a stock size of 254 mm (Willis et al. 1993)—also declined in 2020 to 5 (Figure 5-34). Brown Trout RSD-16 exceeded 20 during 2005-2007 (following establishment of the PLR), but declined as total CPUE (≥178 mm) increased into the 300-400 fish/h range and has remained in the 3-8 range since 2010 (Figure 5-34). This indicates that Brown Trout population size structures have not maintained the shift toward larger fish, which is the basic intent of a PRL. Brown Trout RSD-16 could improve if mean CPUE for trout ≥178 mm returns to the 150-200 fish/h range (Habera et al. 2015c), but that currently seems unlikely. Rainbow Trout ≥406 mm are uncommon in the South Holston tailwater and corresponding RSD-16 has averaged 3 both pre- and post-PLR.

South Holston tailwater Brown Trout (below the 16-22" PLR).

Relative Weight (W_r)

Mean W_r for Brown Trout in the PLR and the size classes just below the PLR (305-406 mm) has generally declined since 2005 (Figure 5-35). The 2020 mean for fish in the PLR size classes (81.2) was the lowest observed to date. Several studies have shown that density-dependent factors can limit growth,

condition, and recruitment into the larger size classes for trout and other gamefish (McKinney et al. 2001; Fox and Neal 2011; Dibble et al. 2015; Yard et al. 2015). Dreves et al. (2016) observed a three-fold increase in Brown Trout CPUE over 10 years in the Lake Cumberland tailwater (KY) following establishment of a 508-mm (20-in.) minimum size limit and 1 fish/day creel limit. Brown Trout size structure also improved, but overall abundance (CPUE of 89 fish/h) most likely remained below the tailwater's carrying capacity and density-dependent responses were not triggered (Dreves et al. 2016). Ultimately, if food availability and fish growth are limited in tailwater trout fisheries (e.g., in high abundance populations), then restrictive angling regulations may be unsuccessful (Flinders and Magoulick 2017).

Angler Survey

Results for the 2019 South Holston tailwater creel survey (Black 2020) indicated that trout anglers made an estimated 19,441 trips comprising 116,203 hours of effort. Angling pressure (hours) was 35% higher than the 2017 estimate (86,080 hours), although trips increased by only 16%. Harvest also increased substantially for both Rainbow Trout and Brown Trout in 2019 (Figure 5-36). While the Brown Trout harvest rate increased from under 4% in 2014 to 11% in 2019 (Figure 5-36), it likely remains too low to affect abundance based on an average catch of 100,000 fish/year as estimated by the 2014-2019 creel surveys.

Management Recommendations

The South Holston tailwater's exceptional wild Brown Trout fishery is the primary means for attaining the tailwater's management goal of providing a high-quality trout fishery and the associated variety of angling opportunities it offers (Habera et al. 2015c). Even with the expansion of Brown Trout abundance, Rainbow Trout remain an important part of the fishery—particularly in terms of angler harvest. Rainbow Trout are maintained through annual stocking of adults and fingerlings. However, the recent observation of substantial numbers of wild age-0 Rainbow Trout indicates an assessment of fingerling stocking would be beneficial. Therefore, the South Holston tailwater trout fishery management plan update (2021) will recommend suspension of fingerling Rainbow Trout stocking until it can be determined if natural reproduction (and subsequent recruitment) is sufficient to replace these fish.

South Holston Tailwater

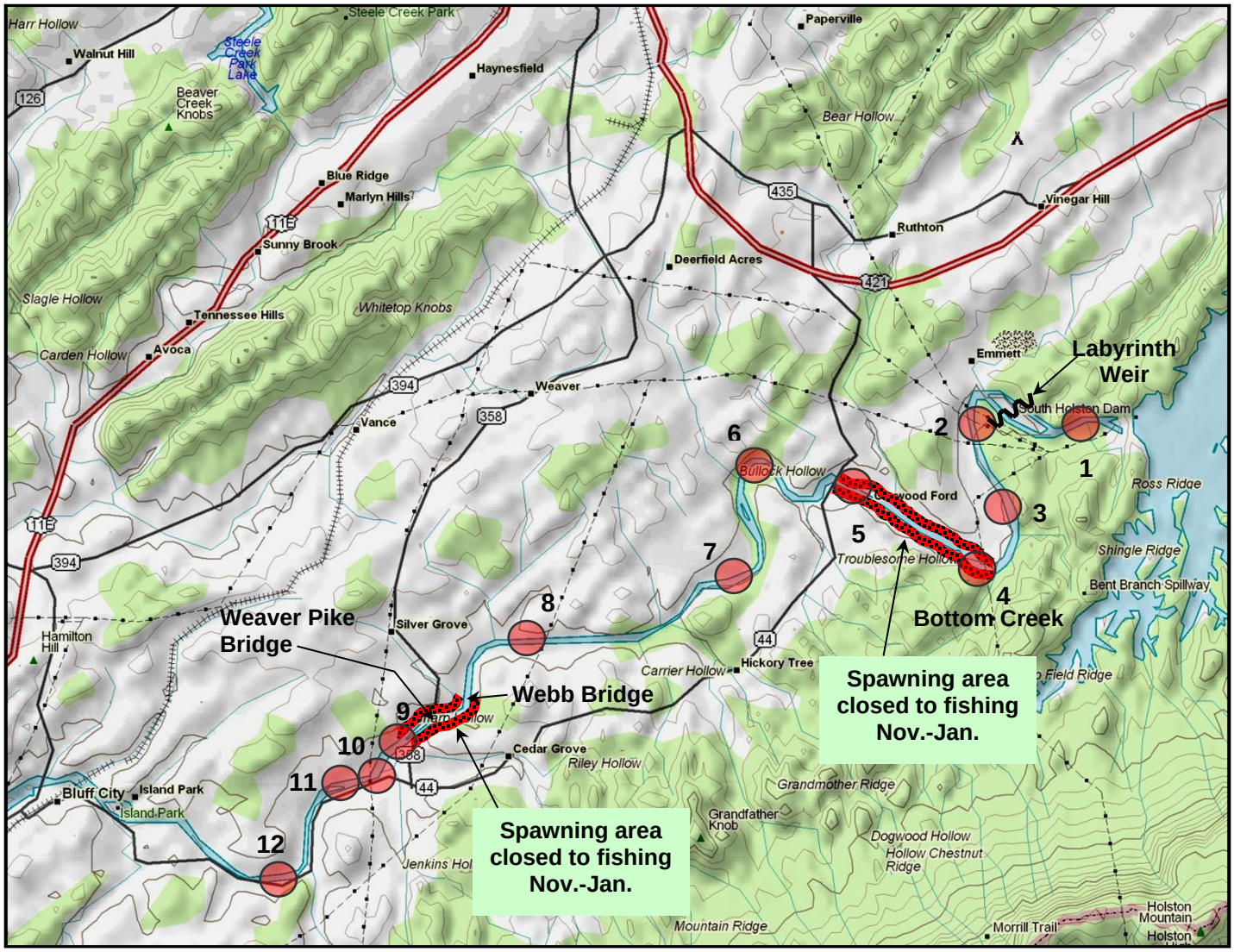


Figure 5-31. Locations of the South Holston tailwater (South Fork Holston River) monitoring stations.

Table 5-7. Catch data for the12 electrofishing stations on the South Holston tailwater sampled 10 March 2020.

Station	Species	Total Catch	Size Range (mm)	Total Weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow	29	210-397	7,615	100	100
	Brown	0	--	--	0	0
Totals		**29**		**7,615**	**100**	**100**
2	Rainbow	13	219-360	3,364	12	21
	Brown	98	168-400	12,291	88	79
Totals		**111**		**15,655**	**100**	**100**
3	Rainbow	8	217-320	1,871	6	11
	Brown	118	120-405	14,919	94	89
Totals		**126**		**16,790**	**100**	**100**
4	Rainbow	5	130-327	1,062	5	6
	Brown	98	125-399	16,576	95	94
Totals		**103**		**17,638**	**100**	**100**
5	Rainbow	1	281	211	2	2
	Brown	57	145-365	10,402	98	98
Totals		**58**		**10,613**	**100**	**100**
6	Rainbow	2	305-366	764	2	4
	Brown	81	161-454	16,887	98	96
Totals		**83**		**17,651**	**100**	**100**
7	Rainbow	6	255-432	1,714	8	12
	Brown	70	176-419	12,864	92	88
Totals		**76**		**14,578**	**100**	**100**
8	Rainbow	7	273-354	1,950	13	12
	Brown	45	244-538	14,036	87	88
Totals		**52**		**15,986**	**100**	**100**
9	Rainbow	1	250	140	1	1
	Brown	85	133-440	14,934	99	99
Totals		**86**		**15,074**	**100**	**100**
10	Rainbow	2	274-278	382	4	3
	Brown	43	187-462	11,490	96	97
Totals		**45**		**11,872**	**100**	**100**
11	Rainbow	8	168-332	1,202	13	10
	Brown	55	148-414	10,490	87	90
Totals		**63**		**11,692**	**100**	**100**
12	Rainbow	7	257-415	2,334	16	22
	Brown	38	155-437	8,052	84	78
Totals		**45**		**10,386**	**100**	**100**
Total Rainbows		89	130-432	22,609	10	14
Total Browns		788	120-538	142,941	90	86
Overall totals		**877**		**165,550**	**100**	**100**

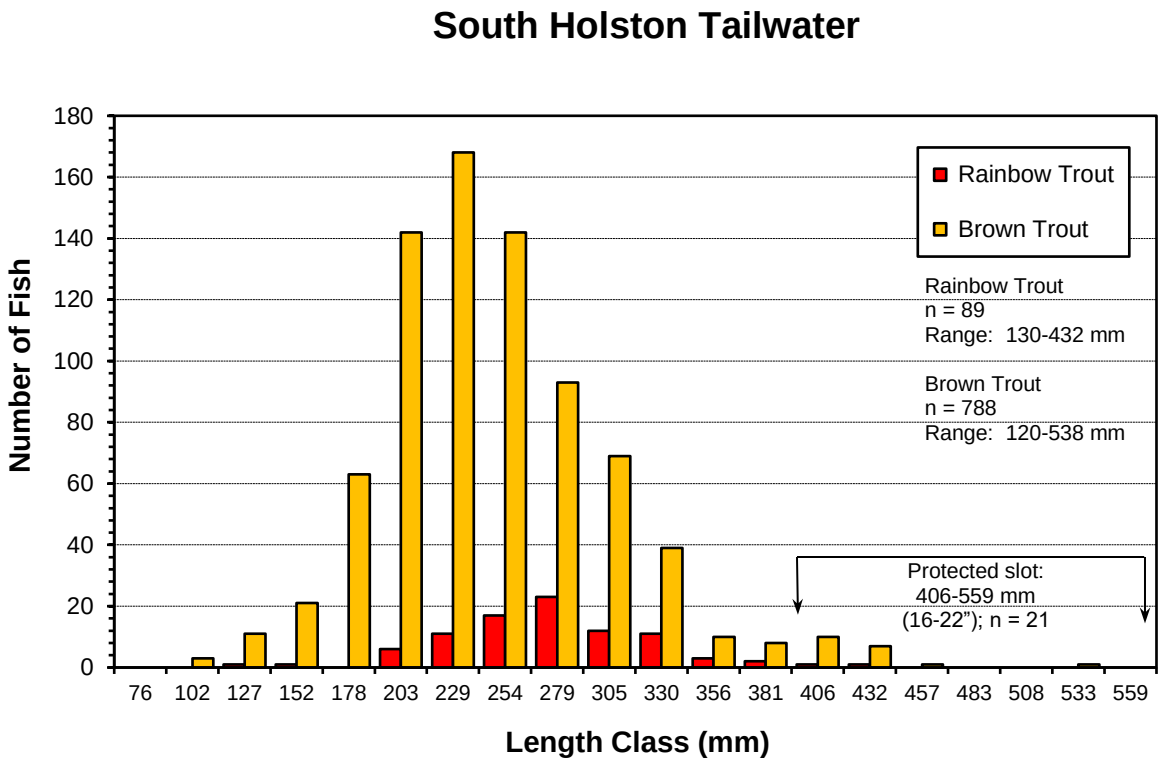


Figure 5-32. Length frequency distributions for trout from the South Holston tailwater monitoring stations in 2020.

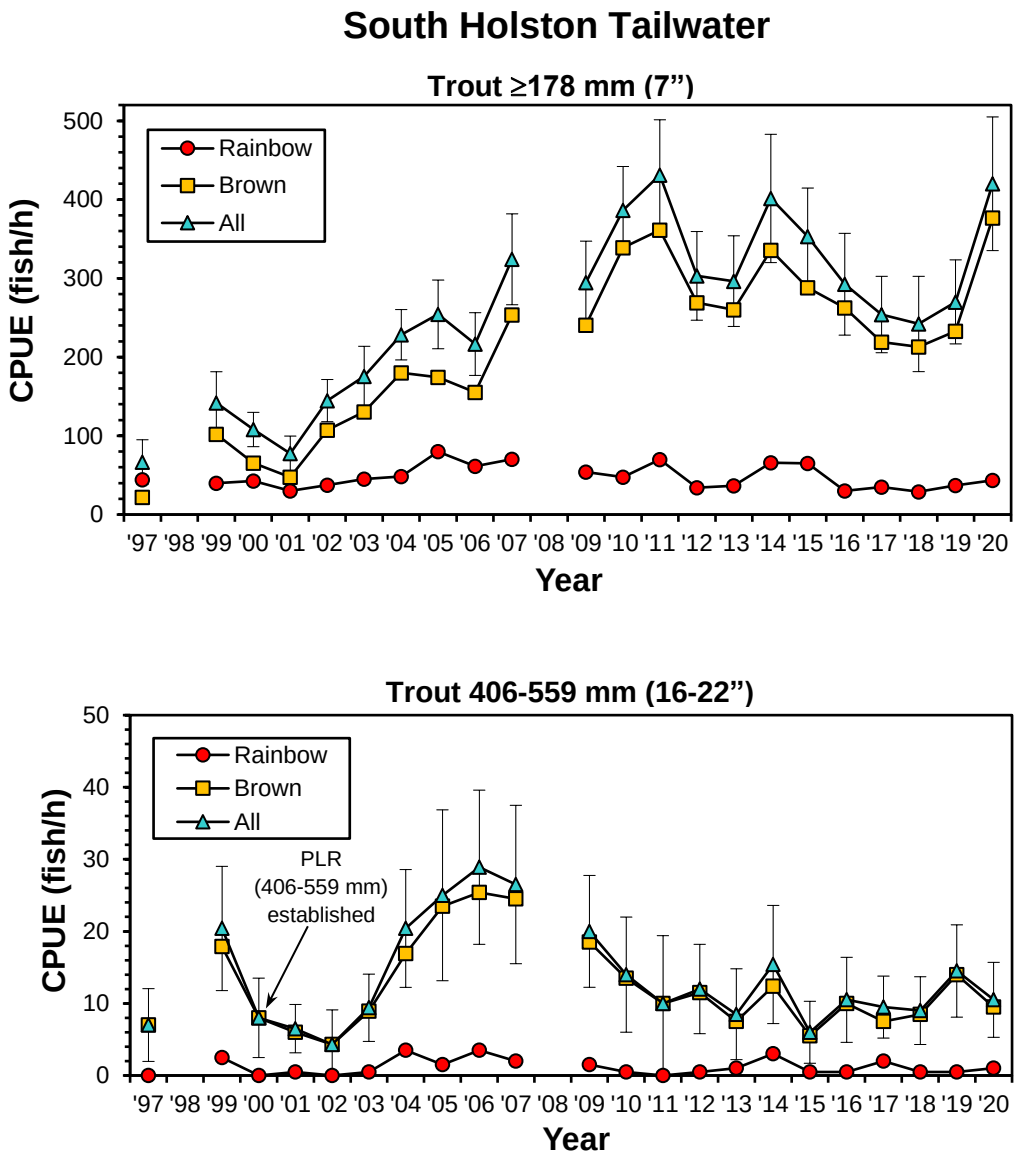


Figure 5-33. Mean trout CPUEs for the South Holston tailwater samples. Bars indicate 90% confidence intervals.

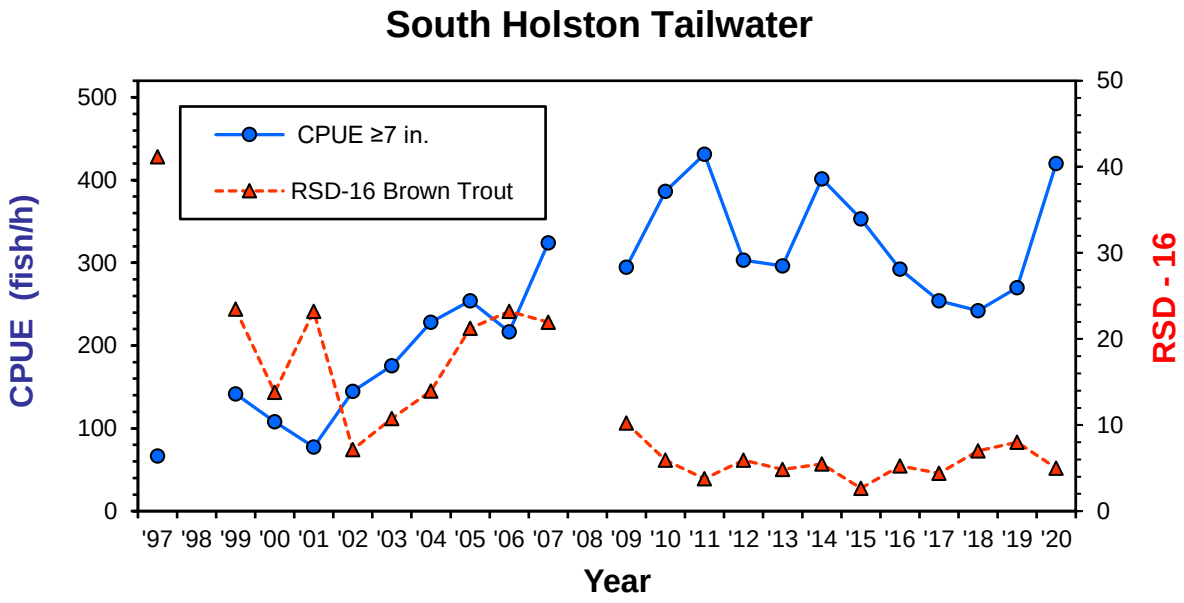


Figure 5-34. Comparison of mean CPUE (fish/h) for all trout ≥178 mm and RSD-16 (all trout) for the South Holston tailwater.

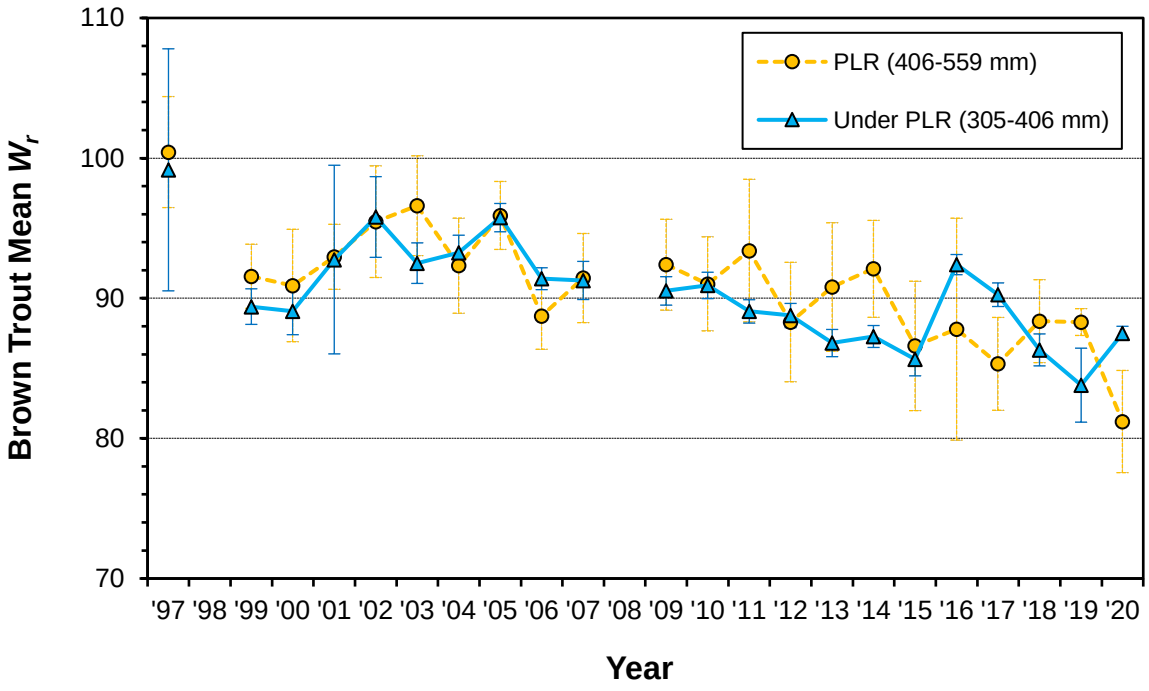


Figure 5-35. Mean relative weights (W_r) for Brown Trout from the South Holston tailwater. Bars indicate 90% confidence intervals.

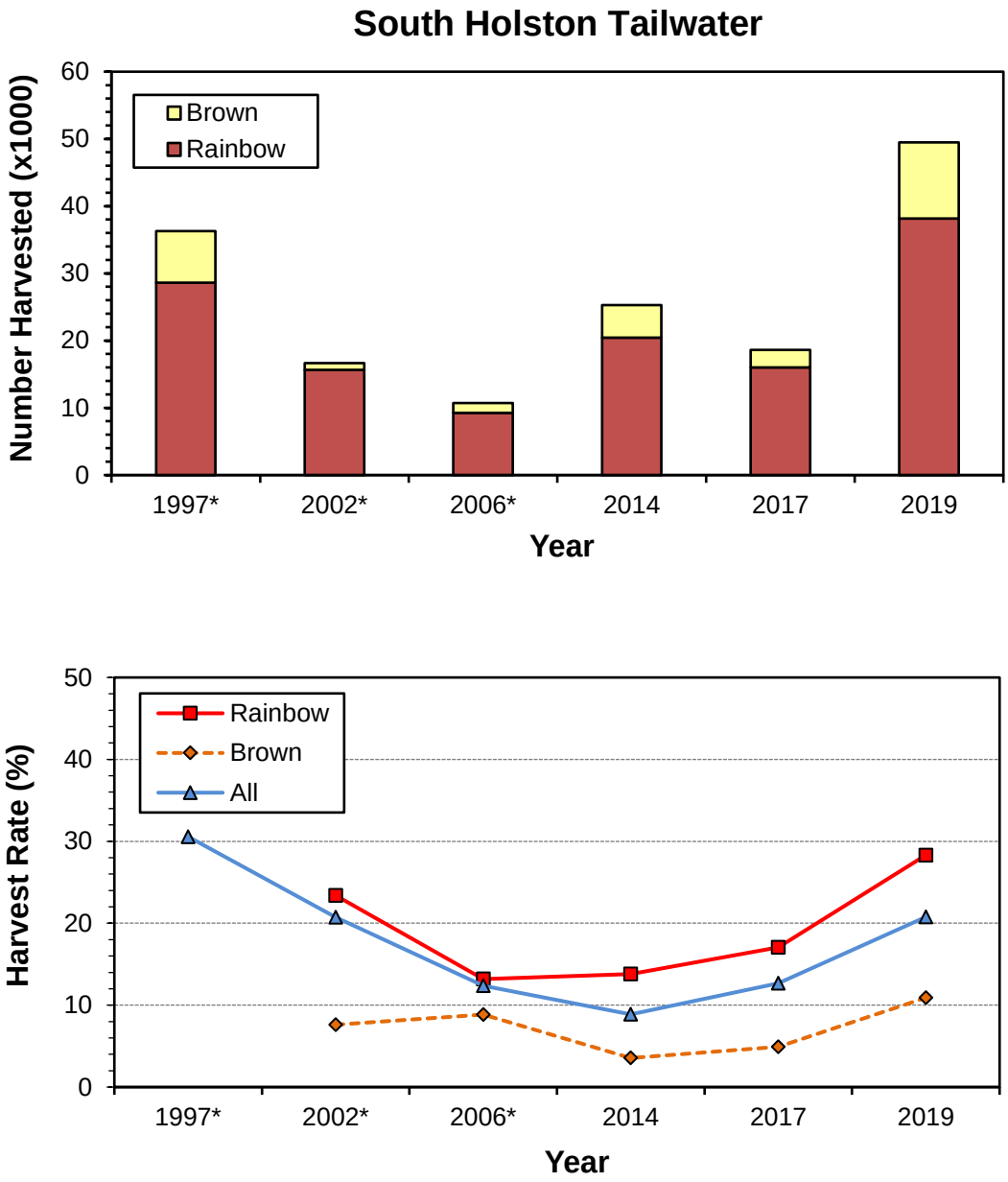


Figure 5-35. Total estimated harvest (upper plot) and harvest rates (lower plot) for South Holston tailwater creel surveys since 1997.

REFERENCES

Baird, O. E., and C. C. Krueger. 2003. Behavioral thermoregulation of brook and Rainbow Trout: comparison of summer habitat use in an Adirondack river, New York. Transactions of the American Fisheries Society 132:1194-1206.

Black, W. P. 2020. Tennessee Statewide Creel Survey: 2019 Results. Fisheries Report 20-07. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Dibble, K. L., C. B. Yackulic, T. A. Kennedy, and P. Budy. 2015. Flow management and fish density regulate salmonid recruitment and adult size in tailwaters across western North America. Ecological Applications 25:2168-2179.

Dreves, D. P., J. R. Ross, and J. T. Kosa. 2016. Effect of trophy regulations and reservoir discharge on a population of stocked Brown Trout in a large, southeastern United States tailwater. Journal of the Southeastern Association of Fish and Wildlife Agencies 3:167-177.

Flinders, J. M., and D. D. Magoulick. 2017. Spatial and temporal consumption dynamics of trout in catch-and-release areas in Arkansas tailwaters. Transactions of the American Fisheries Society 146:432-499.

Fox, C. N., and J. W. Neal. 2011. Development of a crowded largemouth bass population in a tropical reservoir. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies. 65:98-104.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2004. Region IV trout fisheries report: 2003. Fisheries Report No. 04-04. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., M. A. Kulp, S. E. Moore, and T. B. Henry. 2010. Three-pass depletion sampling accuracy of two electric fields for estimating trout abundance in a low-conductivity stream with limited habitat complexity. North American Journal of Fisheries Management 30:757-766.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2014. Region IV trout fisheries report: 2013. Fisheries Report No. 14-01. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, B. D. Carter, and C. E. Williams. 2015a. Region IV trout fisheries report: 2014. Fisheries Report No. 15-01. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, and B. D. Carter. 2015b. Management plan for the Wilbur Tailwater trout fishery 2015-2020. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Habera, J. W., R. D. Bivens, and B. D. Carter. 2015c. Management plan for the South Holston Tailwater trout fishery 2015-2020. 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.

Habera, J. W., S. J. Petre, B. D. Carter, and C. E. Williams. 2020. Management plan for the Norris tailwater trout fishery 2020-2025. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Hill, D. M. 1978. Tailwater trout management. Pages 66-75 in Southeastern trout resource: ecology and management symposium proceedings. USDA Forest Service, Southeastern Forest Experiment Station, Asheville, North Carolina.

Kelly, G. A., J. S. Griffith, and R. D. Jones. 1980. Changes in distribution of trout in Great Smoky Mountains National Park, 1900–1977. U.S. Fish and Wildlife Service Technical Papers 102.

King, W. 1937. Notes on the distribution of native speckled and rainbow trout in the streams of Great Smoky Mountains National Park. Journal of the Tennessee Academy of Science 12:351-361.

Ksepka Steven P., Jacob M. Rash, Brandon L. Simcox, Doug A. Besler, Haley R. Dutton, Micah B. Warren, and Stephen A. Bullard. 2020. An updated geographic distribution of *Myxobolus cerebralis* (Hofer, 1903) (Bivalvulida: Myxobolidae) and the first diagnosed case of whirling disease in wild-caught trout in the south-eastern United States. Journal of Fish Diseases 43:813-820.

Larson. G. L., and S. E. Moore. 1985. Encroachment of exotic rainbow trout into stream populations of native brook trout in the southern Appalachian Mountains. Transact.

Larson, G. L., S. E. Moore, and B. Carter. 1995. Ebb and flow of encroachment by nonnative Rainbow Trout in a small stream in the southern Appalachian Mountains. Transactions of the American Fisheries Society 124:613-622.

Lohr, S. C., and J. L. West. 1992. Microhabitat selection by Brook and Rainbow Trout in a southern Appalachian stream. Transactions of the American Fisheries Society 121:729-736.

Maillett, E. and R. Aiken. 2015. Trout fishing in 2011: a demographic description and economic analysis, addendum to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Report 2011-4. U.S. Fish and Wildlife Service.

McKinney, T., D. W. Speas, R. S. Rogers, and W. R. Persons. 2001. Rainbow Trout in a regulated river below Glen Canyon Dam, Arizona, following increased minimum flows and reduced discharge variability. North American Journal of Fisheries Management 21:216-222.

Meyer, K. A., B. High, and F. S. Elle. 2012. Effects of stocking catchable-sized hatchery Rainbow Trout on wild Rainbow Trout abundance, survival, growth, and recruitment. Transactions of the American Fisheries Society 141:224-237.

Moore, S. E., B. Ridley, and G. L. Larson. 1983. Standing crops of brook trout concurrent with removal of rainbow trout from selected streams in Great Smoky Mountains National Park. North American Journal of Fisheries Management 3:72-80.

Peterson, J. T., R. F. Thurow, and J. W. Guzevich. 2004. An evaluation of multipass electrofishing for estimating the abundance of stream-dwelling salmonids. Transactions of the American Fisheries Society 113:462-475.

Roddy, D., editor. 2020. Coldwater fish production—statewide hatchery report 2019. Fisheries Report No. 20-05. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Schexnayder, S. M., A. Griffin, and J. M. Fly. 2014. Fishing participation and attitudes of anglers in Tennessee, 2012. Human Dimensions Research Lab, Department of Forestry, Wildlife and Fisheries. University of Tennessee, Knoxville, Tennessee.

Strange, R. J., and J. W. Habera. 1998. No net loss of brook trout distribution in areas of sympatry with Rainbow Trout in Tennessee streams. Transactions of the American Fisheries Society 127:434-440.

TDEC (Tennessee Department of Environment and Conservation). 2013. State of Tennessee water quality standards: use classifications for surface waters, chapter 0400-40-04. Water Quality Control Board, Nashville.

TDEC (Tennessee Department of Environment and Conservation). 2015. State of Tennessee water quality standards: general water quality criteria, chapter 0400-40-03. Water Quality Control Board, Nashville.

Thompson, P. D., and F. J. Rahel. 1996. Evaluation of depletion-removal electrofishing of brook trout in small Rocky Mountain streams. North American Journal of Fisheries Management 16:332-339.

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.

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

Wehrly, K. E., L. Z Wang, and M. Mitro, M. 2007. Field-based estimates of thermal tolerance limits for trout: Incorporating exposure time and temperature fluctuation. Trans. Am. Fish. Soc. 136, 365-374.

Whitworth, W. E., and R. J. Strange. 1983. Growth and production of sympatric brook and Rainbow Trout in an Appalachian stream. Transaction of the American Fisheries Society 112:469-475.

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., J. Korman, C. J. Walters, and T. A. Kennedy. 2015. Seasonal and spatial patterns of growth of Rainbow Trout in the Colorado River in Grand Canyon, Arizona. Canadian Journal of Fisheries and Aquatic Sciences 73:125-139.