FISHERIES REPORT:

Region IV Coldwater Streams

2019

Tennessee Wildlife Resources Agency

Fisheries Report 20-03

Above photo: TWRA and North Carolina Wildlife Resources Commission personnel prepare to collect native Brook Trout from Jones Creek in Avery Co., NC in September 2019. TWRA and NCWRC, along with several other partners, are working to restore a population of native Brook Trout in the Nolichucky River basin (Phillips Hollow in Greene Co., TN).

Cover photo: Tennessee Tech University students, along with TWRA fisheries staff and interns, tag fingerling Rainbow Trout at Buffalo Springs Hatchery. TWRA is funding a project with the Cooperative Fisheries Research Unit at Tennessee Tech University to study survival and growth of Rainbow Trout in Region IV tailwaters. Photo by Sally Petre (TWRA).

Visit TWRA's website at www.tnwidlife.org, where you can learn more about Tennessee's trout fisheries across the state.

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REGION 4 COLDWATER STREAMS

2019

Prepared by:

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

TENNESSEE WILDLIFE RESOURCES AGENCY
FISHERIES REPORT 20-03

May 2020

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

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Executive Summary

Wild Trout Monitoring: Seven wild trout streams were quantitatively sampled during 2019 at established monitoring stations. It was expected wild trout abundance would be negatively affected for two or three years following the region-wide drought in 2016. This has generally been the case, and while there were some improvements in 2019, abundances typically remained below long-term averages.

Sympatric Brook/Rainbow Trout streams: Relative Brook Trout biomass decreased in the two monitoring streams that were below 50% in 2018 and increased in the two streams that were above 50% last year. Brook Trout relative abundance (density and biomass) often increase during droughts, as Rainbow Trout appear to be more negatively impacted.

Native Brook Trout Restoration and Enhancement: Progress was made during 2019 on four ongoing native Brook Trout restoration projects. Lower Little Stony Creek was stocked with additional fingerling Brook Trout propagated by the Tennessee Aquarium Conservation Institute, which should complete that project except for monitoring. Additional Rainbow Trout removals were conducted in Green Mountain Branch and Trail Fork Big Creek—both of which experienced some reproduction following the 2018 removal efforts. Native Brook Trout (76) were translocated into Phillips Hollow from two streams in in the Nolichucky River basin in North Carolina. Additionally, water temperature was monitored near a fish-passage barrier further downstream on Little Jacob Creek that might provide an opportunity for extending that restoration zone. Finally, a new restoration project was initiated on Shell Creek (Carter Co.) after location of a potential barrier and two Rainbow Trout removal passes were completed. Plans for these projects in 2020 include electrofishing to verify or complete Rainbow Trout removal in Green Mountain Branch, Trail Fork, and Shell Creek. If the removal efforts are successful in Green Mountain Branch and Shell Creek, genetically appropriate native Brook Trout can be translocated into these streams in September. The potential barrier on Right Prong Rock Creek (Unicoi Co.) will be evaluated by a 'mark and move' assessment using Rainbow Trout captured upstream of the barrier.

Norris tailwater: The mean electrofishing catch rate for trout within the PLR (356-508 mm) approached 100 fish/h in 2019 and met management plan objectives (28 fish/h) during 2008-2019. The relative stock density of trout 356 mm (14 in.) and larger (RSD-14 exceeded 50 for both Rainbow Trout and Brown Trout in 2019, indicating that trout population size structures have been shifted toward larger fish. A new angler survey was conducted in 2019 and based on a supplemental opinion questionnaire, 62% of Norris tailwater anglers continue to support the PLR regulations, while only 12% oppose it. A new multi-year research project through the Tennessee Cooperative Fisheries Research Unit (TN CFRU) at Tennessee Tech University was begun in 2019 to investigate the roles of wild and stocked fingerling Rainbow Trout in the fishery.

Cherokee tailwater: The Cherokee tailwater was sampled again in both June and October 2019. The mean electrofishing catch rate for the June sample (15 fish/h ≥178 mm) was similar to the June 2018 sample (18 fish/h). Additionally, the mean CPUE for trout ≥356 mm (11 fish/h) in June 2019 exceeded that for any fall sample (including 2019). Mean CPUE for the subsequent October sample in 2019 declined to 1.5 fish/h (one of the lowest catch rates obtained to date). Water temperatures in the Cherokee tailwater in 2019 were the warmest observed since 2003. There was no coldwater habitat (minimum daily water temperature exceeded 21° C) for 72 days near the dam and 68 days at Blue Spring. Water temperatures in the Cherokee tailwater typically return to trout-tolerant levels (<21° C) by mid- to late October, but this occurred during the first week of November in 2019.

Wilbur tailwater: The Brown Trout population in the Wilbur tailwater continued to expand in 2019, with mean electrofishing catch rate (fish ≥178 mm) reaching its highest level to date (242 fish/h). Mean Brown Trout CPUE in the upper portion of the tailwater (Stations 1-6) reached 400 fish/h. The abundance of large trout (≥457 mm or 20 in.) also increased to its highest level to date (mean CPUE 8 fish/h; all Brown Trout).

The angler survey completed in 2018 indicated that estimated pressure, trips, catch, and harvest all decreased relative to the 2016 survey, with harvest rate declining to 9% (from 14% in 2013). A composite sample of 30 age-0 wild Rainbow Trout collected in July was screened for the whirling disease parasite (*Myxobolus cerebralis*) by the Southeastern Cooperative Fish Parasite and Disease Lab at Auburn University—results were negative.

Ft. Patrick Henry tailwater: The mean electrofishing catch rate for larger trout (≥356 mm and ≥457 mm) increased in 2019 after 2-3 years of decline. Rainbow Trout RSD-18 increased to 29 in 2019, exceeding the objective (20) established in the Boone and Ft. Patrick Henry Tailwater Trout Fisheries Management Plan. A research project through the TN CFRU began in August to investigate the contributions of stocked fingerling Rainbow Trout and any natural reproduction from the Kendrick Creek spawning run to the fishery.

Boone tailwater: The mean electrofishing catch rate for all trout ≥178 mm decreased in 2019 (to 65 fish/h) because of the lack of Brook Trout. However, mean electrofishing catch rate for larger trout (≥356 mm and ≥457 mm) increased relative to 2018. Mean CPUE for trout ≥457 mm (16 fish/h) was the highest obtained to date. RSD-18 for Rainbow Trout (23) and for all trout (27) exceeded the objectives (10 and 20, respectively) 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 2019 and TVA water quality monitoring data from the tailwater indicted no particular issues with elevated water temperature (>21°C) or low dissolved oxygen levels.

South Holston tailwater: The overall PLR catch rate (14.5 fish/h) increased relative to 2018, reaching its highest level since 2014, although it remains well below the 2004-2007 range (25-29 fish/h). Brown Trout RSD-16 also improved slightly to 8 in 2019, but also remains below the level it reached during 2005-2007 (20). Brown Trout relative weight (W_r) also remained depressed, particularly for fish in the size classes just below the PLR (305-406 mm). Results for the 2019 angler survey should reveal if the slight increase in the Brown Trout harvest rate observed in 2017 has been maintained.

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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 2018). 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

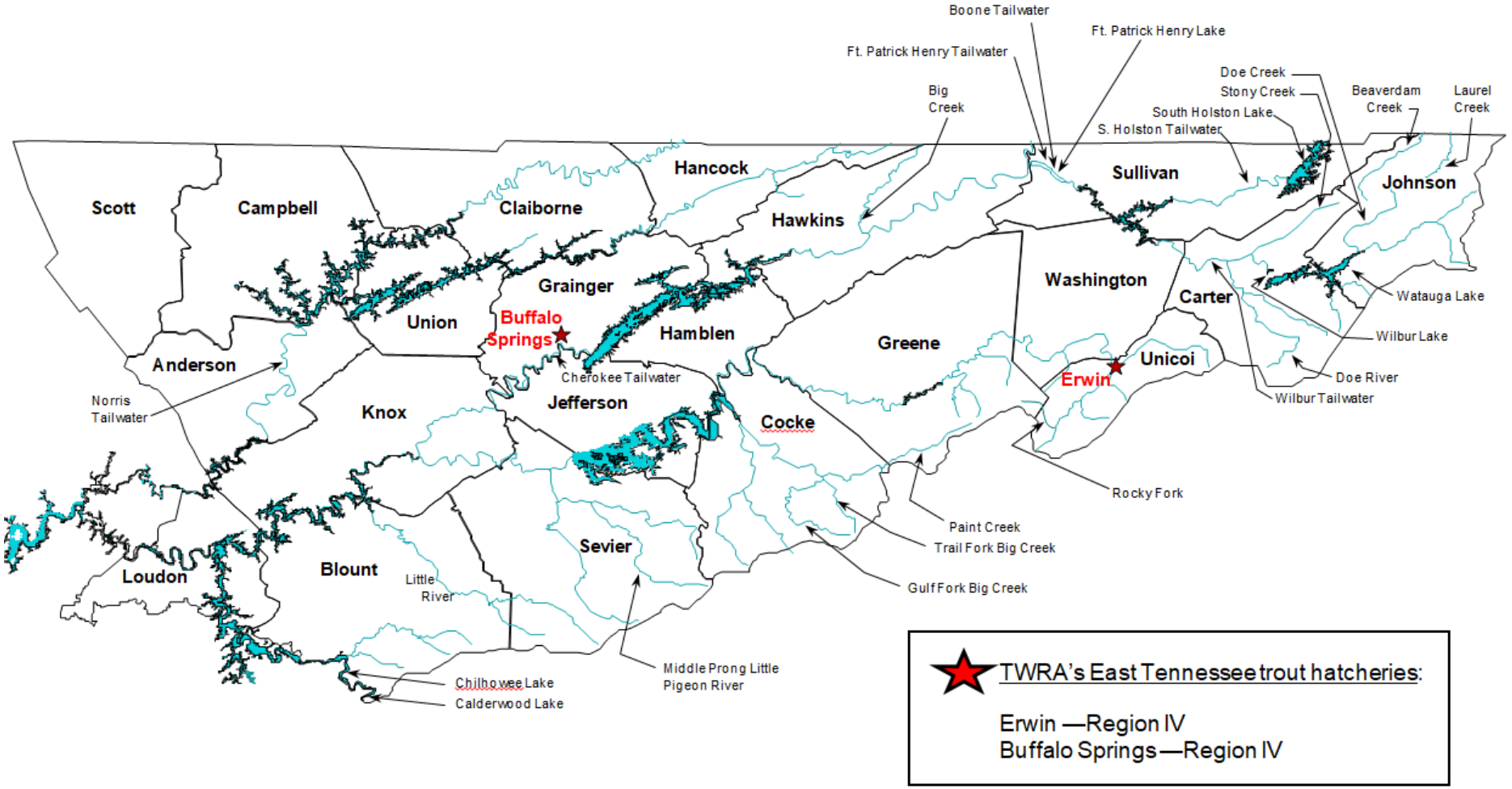


Figure 1-1. Locations of selected Region IV trout fisheries managed by TW

2. Wild Trout Monitoring

Region IV TWRA personnel sample streams annually to provide trout abundance trend data for managing these resources. This annual monitoring began in the early 1990's and helps inform decisions to maintain or change angling regulations, as well as to further document annual variability and understand factors that affect it. Seven trout streams were quantitatively sampled during the 2019 field season (June-October). Previous reports contained large amounts of survey data and stream history information. Data are still being collected as usual, but only a portion will be provided in this and future reports. Other details such as habitat, site, fish species data and stream histories can be found in stream accounts in previous reports (https://www.tn.gov/content/tn/twra/fishing/trout-information-stockings.html#FisheriesReport) or in the TWRA TADS database. Details from 2019 and previous years can also be found in the TADS database.

Sampling Methods

Wild trout stream sampling was conducted with battery-powered backpack electrofishing units employing inverters to produce AC outputs per 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 were part of TWRA Region 4's established annual monitoring program.

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.

Results and Management Implications

Catch data, abundance estimates and length frequency histograms are provided below for each wild trout stream sampled in 2019. Because of the region-wide drought in 2016, it was expected wild trout abundance would be negatively affected over the next two or three years and would start to improve in 2019. This has generally been the case, although trout abundances remained below long-term averages in 2019.

Beaverdam Creek

Beaverdam supports one of Tennessee's best wild trout fisheries, which management should continue to maintain and emphasize. The current stocking program is not incompatible with wild trout management and native fish assemblages (Weaver and Kwak 2013), but there should be no expansion of the area or number of catchable trout currently stocked.

Doe Creek

Doe Creek remains one of Tennessee's most productive wild trout streams and TWRA is committed to maintaining it. The seasonal hatchery-supported trout fishery in Doe Creek is popular (Habera et al. 2004), but management of this stream should feature the outstanding wild trout population. The current stocking program is not incompatible with the wild trout management and native fish assemblages (Weaver and Kwak 2013), but it should not be expanded in scope or scale. The annual monitoring state near Lowe Spring should continue and may help to identify any impacts related to Mountain City's water withdrawals (0.5 million gallons per day) from the spring, which began in 2002. Trout abundance does not seem to be affected, however.

Laurel Creek

Laurel Creek supports an excellent wild trout fishery that is comparable to the one present in nearby Beaverdam Creek. While future management of Laurel Creek should maintain and feature wild trout, the current level of stocking with catchable-size Rainbow Trout is not incompatible with wild trout management and native fish assemblages (Weaver and Kwak 2013), but should not be expanded in scope or scale.

Left Prong Hampton Creek

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 (76 kg/ha) has substantially exceeded the statewide average for other streams (about 21 kg/ha), and is comparable to the mean biomass for the previous Rainbow Trout population (81 kg/ha). Native Brook Trout may be better adapted to and more tolerant of drought conditions (common during the past decade) than are nonnative Rainbow Trout. Monitoring data from other streams such as Rocky Fork and Gentry Creek also indicate Brook Trout have greater drought tolerance compared to Rainbow Trout. Management of Left Prong Hampton Creek should feature its Brook Trout fishery and development of this important database should continue through annual monitoring at all three sites. Because of the decreasing biomass and density trends at all three stations, suboptimal habitat scores, and decreasing quantity and quality pools, a more detailed habitat analysis may be useful. Deployment of instream water temperature loggers would also help identify any potential effects on Brook Trout abundance related to temperature.

Right Prong Middle Branch

Right Prong Middle Branch had the largest increases in biomass and density in 2019 compared to other monitored streams. Right Prong Middle Branch has had significant movement of bedload over the past three years due to flooding, which may be improving habitat for Brook Trout. No special management of Right Prong Middle Branch is suggested at this time other than protection of the resource. Because of the small size of this stream and its relative obscurity, angling pressure is probably light. Sampling at the monitoring station should continue in order to increase our understanding of Brook Trout population dynamics, particularly in higher elevation streams.

Rocky Fork

Rocky Fork provides a good fishery for wild Rainbow and Brook trout. Because the stream is relatively long (> 13 km) and access is limited to foot travel, it provides an ideal setting for anglers seeking a more solitary experience. Monitoring of the Rocky Fork Stations should be conducted annually to maintain the continuity of this important wild trout database and document any effects related to development of the road/trail system in the State Park and upstream areas in the Cherokee National Forest.

Stony Creek

Stony Creek supports an excellent population of wild Rainbow Trout, along with good populations of Brown Trout and Brook Trout (in the upper reaches not sampled). Its above-average fertility (alkalinity of 95 mg/L as $CaCO_3$ in 2016) also enables it to produce some of Tennessee's larger wild trout. Accordingly, management of this fishery resource should emphasize wild trout. The current level of stocking with adult Rainbow Trout is not incompatible with wild trout management or native fishes (Weaver and Kwak 2013) but should not be expanded in scope or scale, particularly given the limited angler use observed in the 2015 creel survey. The Stony Creek monitoring station is on a three-year sampling rotation and is next scheduled to be sampled during 2022. A qualitative survey during December-March might help determine if Rainbow Trout spawners from the Wilbur tailwater are using this portion of Stony Creek and contributing to the high abundance of age-0 fish in monitoring samples there.

Beaverdam Creek

Table 2-1. Site and sampling information for Beaverdam Creek in 2019.

Location	Site 1		Site 2	
Site code	420191901		420191902	
Sample date	27 August		28 August	
Watershed	S. Fork Holston River		S. Fork Holston River	
County	Johnson		Johnson	
Lat-Long	36.59176 N, -81.81847 W		36.56576 N, -81.87315 W	
Elevation (ft)	2,160		2,440	
Land ownership	USFS		USFS	
Fishing access	Excellent		Excellent	
Description	Begins at Tank Hollow Rd. near Backbone Rock.		Begins at Hwy. 133 mile marker 5 near Arnold Br.	
Effort				
Site length (m)/ Area (m2)	200 m	2640 m^2	177 m	2443 m^2
Electrofishing units	4	250 V AC	4	250 V AC
Habitat				
Mean width (m)	13.2		13.8	
Canopy cover (%)	70		60	
Est. % site pool/riffle	50	50	51	49
Habitat assessment score	166 (optimal)		162 (optimal)	
Water Quality				
Flow (cfs; visual)	39.1	normal	37.4	normal
Temperature (C)	18.1		17.5	
pH	7.3		7.2	
Conductivity (µS/cm)	103		35	
Alkalinity (mg/L $CaCO_3$)	35		35	

Table 2-2. Electrofishing data for Beaverdam Creek in 2019.

	Site 1					Site 2				
	Total	Pop. Size	Biomass (kg/ha)		Density (fish/ha)	Total	Pop. Size	Biomass (kg/ha)		Density (fish/ha)	
Species	Catch	Est. C.I.	Est.	C.I.	Est. C.I.	Catch	Est. C.I.	Est.	C.I.	Est.	C.I.
RBT ≤90 mm	80	85 (76-94)	1.38	(1.24-1.53)	322 (288-356)	78	83 (74-92)	1.36	(1.21-151)	340	(303-377)
RBT >90 mm	43	44 (39-49)	9.17	(8.14-10.23)	167 (148-186)	67	69 (63-75)	11.86	(10.99-13.08)	282	(258-307)
BNT ≤90 mm	8	8 (4-12)	0.17	(0.08-0.25)	30 (15-45)	11	11 (7-15)	0.25	(0.16-0.34)	45	(29-61)
BNT >90 mm	35	37 (30-44)	10.09	(8.18-12.00)	140 (114-167)	40	40 (37-43)	13.74	(12.71-14.77)	164	(151-176)
Fantail Darter	67	123 (25-221)	0.77	(0.16-1.42)	466 (95-837)	45	54 (37-71)	0.41	(0.33-0.64)	221	(151-291)
Greenfin Darter	6	6 (3-9)	0.17	(0.08-0.25)	23 (11-34)	2	2 (0-53)	0.09	(0.00-2.49)	8	(0-217)
Longnose Dace	4	6 (0-252)	0.42	(0.00-17.66)	23 (0-955)	-	- -	-	-	-	-
N. Hogsucker	15	15 (11-19)	8.85	(6.49-11.21)	57 (42-72)	3	3 (0-15)	0.14	(0.00-0.68)	12	(0-61)
Snubnose Darter	13	19 (0-334)	1.03	(0.00-2.53)	72 (0-1265)	7	8 (0-19)	0.07	(0.00-0.16)	33	(0-78)
Mottled Sculpin	402	785 (505-1064)	12.16	(7.84-16.52)	2973 (1913-4030)	462	781 (581-973)	16.82	(21.17-35.45)	3197	(2378-3983)
Warpaint Shiner	31	37 (22-52)	0.95	(0.57-1.34)	140 (83-197)	15	15 (11-19)	0.44	(0.32-0.56)	61	(45-78)
Swannanoa Darter	9	9 (5-13)	0.16	(0.09-0.23)	34 (19-49)	5	13 (0-108)	0.32	(0.00-2.65)	53	(0-442)
Saffron Shiner	104	131 (101-161)	1.36	(1.03-1.65)	496 (383-610)	59	64 (55-73)	0.69	(0.59-0.78)	262	(225-299)
Blacknose Dace	-	- -	-	-	- -	3	3 (3-3)	0.05	(0.05-0.05)	12	(12-12)
Central Sonteroller	162	182 (163-201)	17.66	(15.81-19.49)	689 (617-761)	31	33 (26-40)	3.60	(3.02-4.65)	135	(106-164)
Longnose Dace	-	- -	-	-	- -	2	2 (0-39)	0.11	(0.00-2.16)	8	(0-160)
Creek Chub	1	1 (1-1)	0.02	(0.02-0.02)	4 (4-4)	-	- -	-	-	-	-
River Chub	184	227 (192-262)	11.41	(9.67-13.20)	860 (727-992)	150	155 (148-162)	10.31	(10.18-11.84)	634	(606-663)
White Sucker	1	1 (1-1)	0.00	(0.00-0.00)	4 (4-4)	1	1 (1-1)	0.06	(0.06-0.06)	4	(4-4)

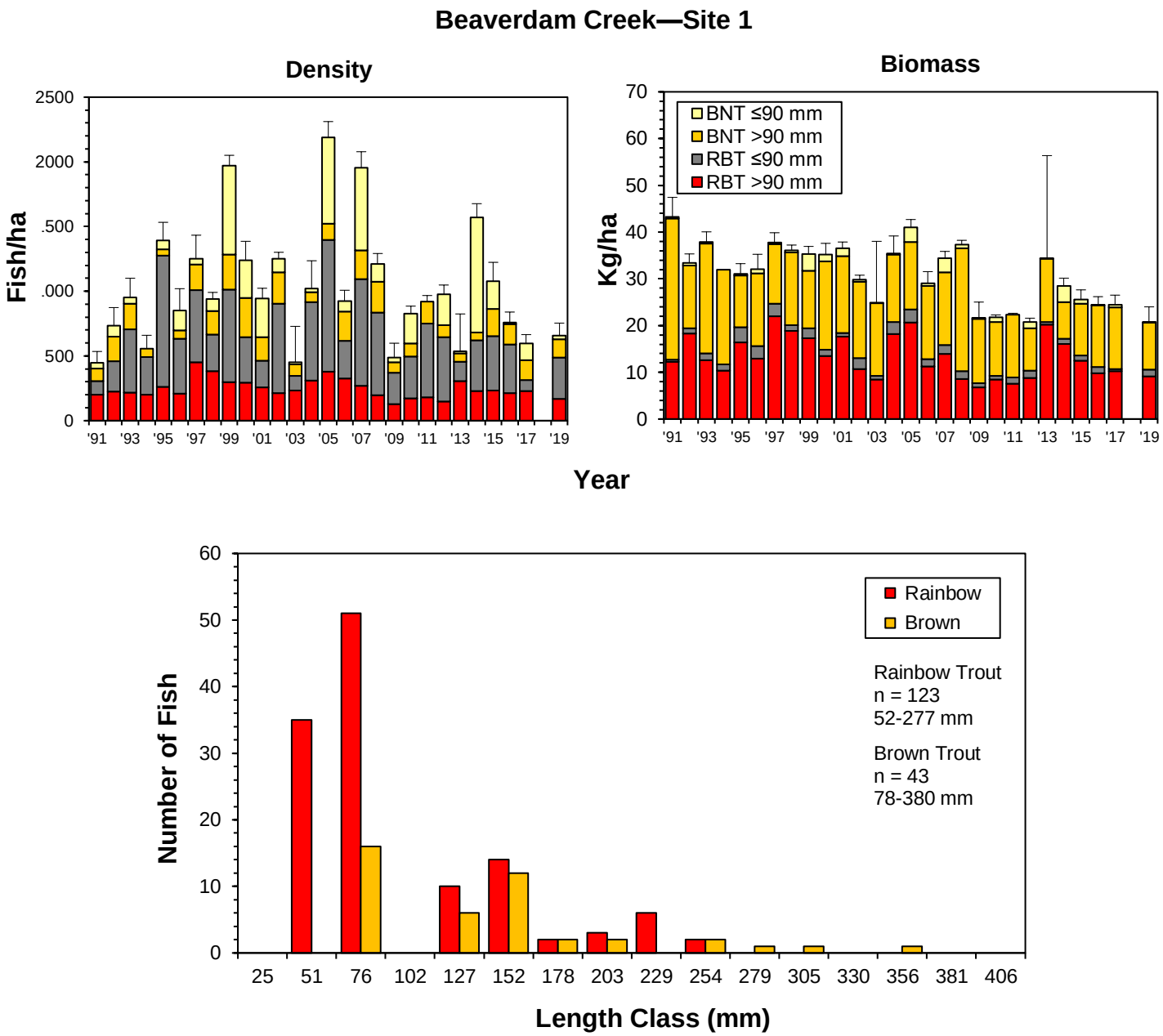


Figure 2-1. Wild trout abundance estimates (with upper 95% confidence limits) and 2019 length frequencies for Beaverdam Creek Site 1.

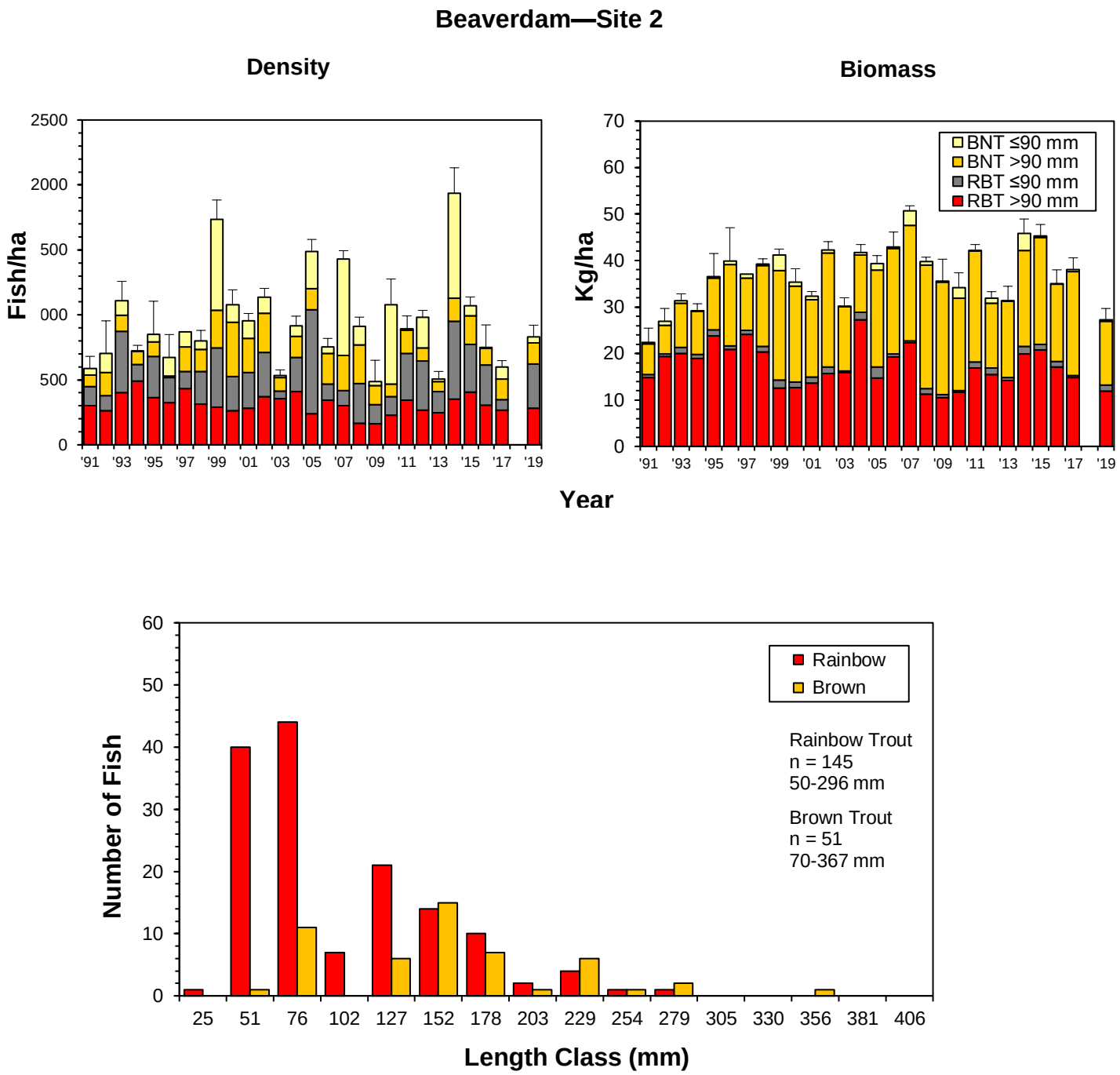


Figure 2-2. Wild trout abundance estimates (with upper 95% confidence limits) and 2019 length frequencies for Beaverdam Creek Site 2.

Doe Creek

Table 2-3. Site and sampling information for Doe Creek in 2019.

Location	Site 1	
Site code	420192201	
Sample date	11 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 m^2
Electrofishing units	3	125 V AC
Habitat		
Mean width (m)	7.3	
Canopy cover (%)	45	
Est. % site pool/riffle	40	60
Habitat assessment score	155 (suboptimal)	
Water Quality		
Flow (cfs; visual)	12.5	normal
Temperature (C)	15.9	
pH	7.7	
Dissolved oxygen (mg/L)	NM	
Alkalinity (mg/L $CaCO_3$)	80	

Table 2-4. Electrofishing data for Doe Creek in 2019.

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.
RBT ≤90 mm	11	11	(8-14)	0.71	(0.51-0.89)	112	(82-143)
RBT >90 mm	113	117	(110-124)	49.45	(46.45-52.36)	1196	(1125-1268)
Creek Chub	4	4	(0-13)	0.02	(0.00-0.07)	41	(0-133)
Blacknose Dace	236	261	(242-280)	9.25	(8.66-0.02)	2669	(2474-2863)
Fantail Darter	62	94	(43-145)	1.60	(0.75-2.52)	961	(440-1483)
Mottled Sculpin	550	825	(0-2686)	25.11	(0.00-82.39)	8436	(0-27464)
C. Stoneroller	123	129	(120-138)	30.12	(27.98-32.17)	1319	(1227-1411)
N. Hogsucker	2	2	(0-69)	0.02	(0.00-0.71)	20	(0-706)

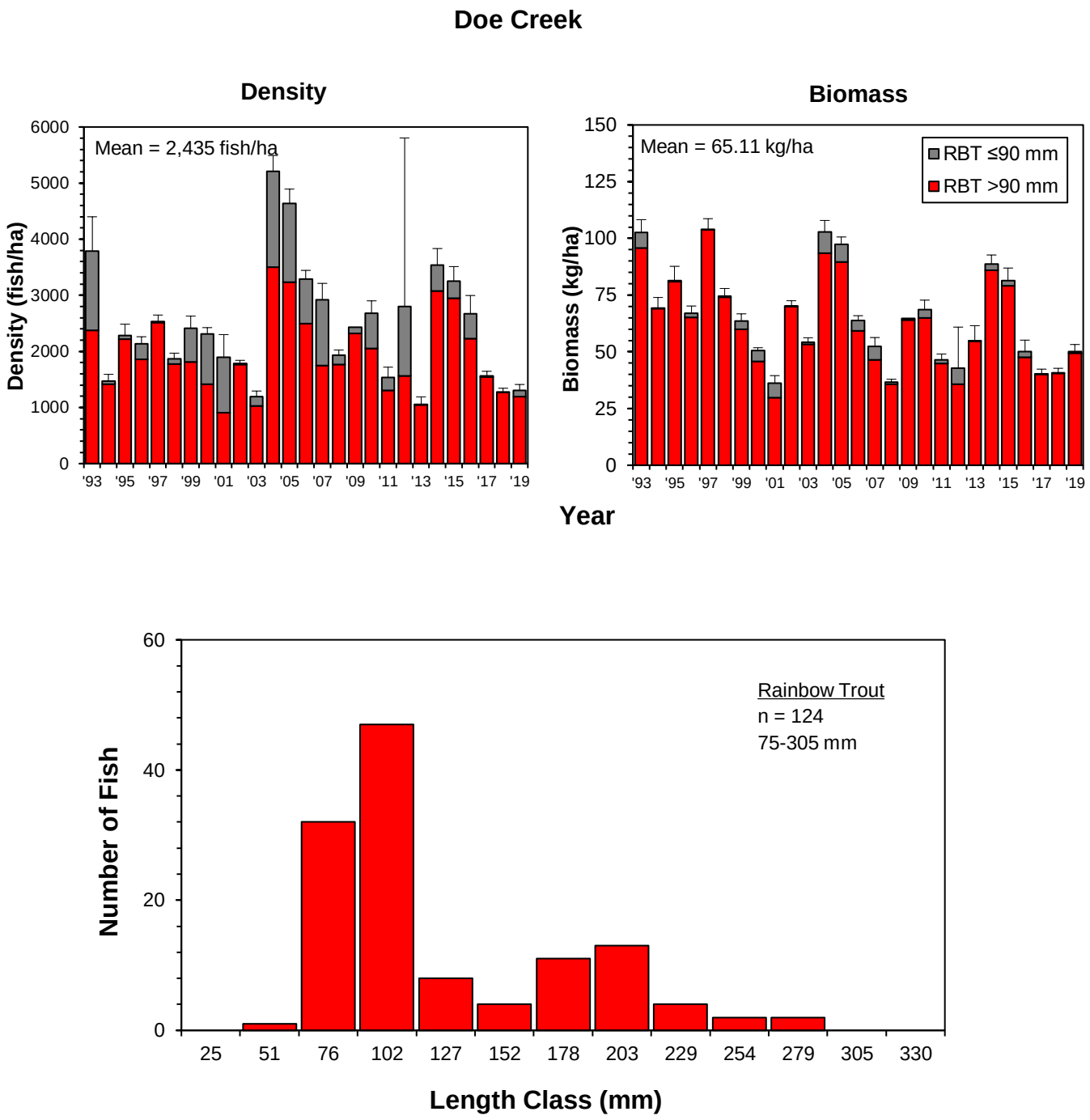


Figure 2-3. Rainbow Trout abundance estimates (with upper 95% confidence limits) and 2019 length frequencies for Doe Creek.

Laurel Creek—Site 2

Table 2-5. Site and sampling information for Laurel Creek in 2019.

Location	**Site 2**	
Site code	420192002	
Sample date	04 September	
Watershed	S. Fork Holston River	
County	Johnson	
Lat-Long	36.58580 N, -81.75177 W	
Reach number	06010102-25,0	
Elevation (ft)	2,280	
Land ownership	USFS	
Fishing access	Good	
Description	Site begins ~300 m upstream of confluence with Lyons Branch along Hwy 91.	
Effort		
Station length (m)	200 m	2200 m^2
Electrofishing units	4	125 V AC
Habitat		
Mean width (m)	11.0	
Canopy cover (%)	15	
Estimated % of site in riffles	51	
Habitat assessment score	151 (suboptimal)	
Water Quality		
Flow (cfs; visual)	26.3; normal	
Temperature (C)	18.5	
pH	8.4	
Conductivity (µS/cm)	140	
Alkalinity (mg/L $CaCO_3$)	75	

Table 2-6. Electrofishing data for Laurel Creek in (Site 2) in 2019.

		Pop. Size		Biomass (kg/ha)		Density (fish/ha)	
Species	Total Catch	Est.	C.I.	Est.	C.I	Est.	C.I.
RBT ≤90 mm	17	20	(8-31)	0.45	(0.18-0.69)	91	(36-141)
RBT >90 mm	47	47	(44-50)	12.47	(11.68-13.27)	214	(200-227)
BNT >90mm	54	57	(50-64)	19.22	(16.86-21.59)	259	(227-291)
Warpaint Shiner	4	4	(0-13)	0.15	(0.00-0.47)	18	(0-59)
Bluegill	2	2	(0-39)	0.04	(0.00-0.80)	9	(0-177)
Fantail Darter	102	129	(98-159)	0.99	(0.94-1.52)	586	(445-723)
Blacknose Dace	80	83	(77-89)	1.33	(1.23-1.42)	377	(350-405)
River Chub	118	130	(116-143)	11.36	(10.12-12.48)	591	(527-650)
Central Stoneroller	267	284	(270-298)	31.75	(30.19-33.32)	1,291	(1227-1355)
Creek Chub	1	1	(1-1)	0.06	(0.06-0.06)	5	(5-5)
Snubnose Darter	21	50	(0-171)	0.52	(0.00-1.79)	227	(0-777)
Northern Hogsucker	44	75	(71-78)	28.73	(27.21-29.89)	341	(323-355)
Banded Sculpin	465	778	(592-964)	11.29	(8.61-14.02)	3,536	(2691-4382)
Saffron Shiner	223	237	(224-250)	3.19	(3.05-3.41)	1,077	(1018-1136)
Green Sunfish	2	2	(0-53)	0.07	(0.00-1.81)	9	(0-241)
Spotted Bass	1	1	(1-1)	0.01	(0.01-0.01)	5	(5-5)

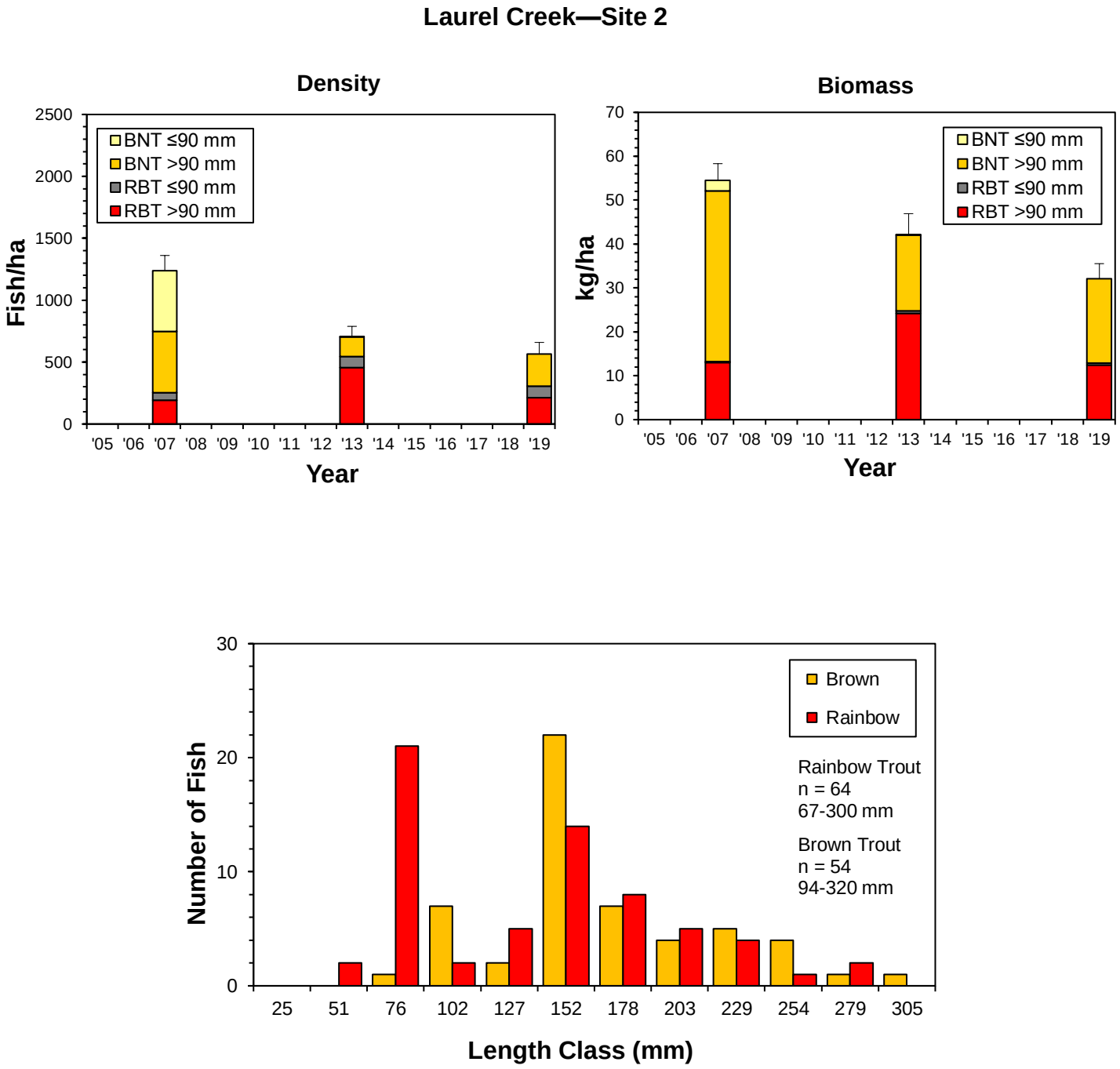


Figure 2-4. Wild trout abundance estimates (with upper 95% confidence limits) and 2019 length frequencies for Laurel Creek (Site 2).

Left Prong Hampton Creek—Sites 1, 2, 3

Table 2-7. Site and sampling information for Left Prong Hampton Creek in 2019.

Location	Site 1		Site 2		Site 3	
Site code	420191401		420191402		420191403	
Sample date	2 July		2 July		2 July	
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	339 m²	94	432 m²	100	340 m²
Electrofishing units	1	350 V AC	1	500 V AC	1	500 V AC
Habitat						
Mean width (m)	3.2		4.6		3.4	
Canopy cover (%)	70		90		95	
Estimated % of site in riffles	36	64	NM	NM	NM	NM
Habitat assessment score	158 (suboptimal)		157 (suboptimal)		159 (suboptimal)	
Water Quality						
Flow (cfs; visual)	2.75	normal	NM	normal	NM	normal
Temperature (C)	17.9		16.0		NM	
pH	6.9		6.8		NM	
Conductivity (µS/cm)	54		26.2		NM	
Alkalinity (mg/L $CaCO_3$)	20		N/M		NM	

Table 2-8. Electrofishing data for Left Prong Hampton Creek in 2019.

	Site 1					
	Total	Pop. Size		Biomass (kg/ha)		Density (fish/ha)	
Species	Catch	Est.	C.I.	Est.	C.I	Est.	C.I.
RBT ≤90 mm	15	15	(11-18)	1.55	(1.14-1.86)	442	(324-531)
RBT >90 mm	18	18	(17-19)	26.39	(16.33-27.86)	531	(501-560)
BKT ≤90 mm	2	2	(2-2)	0.21	(0.21-0.21)	59	(59-59)
BKT >90 mm	1	1	(1-1)	2.29	(2.29-2.29)	29	(29-29)
Blackn. dace	68	74	(64-84)	12.66	(10.95-14.37)	2,183	(1888-2478)
Fantail darter	6	6	(0-12)	0.92	(0.00-1.84)	177	0-354)
		Site 2					
	Total	Pop. Size		Biomass (kg/ha)		Density (fish/ha)	
Species	Catch	Est.	C.I.	Est.	C.I	Est.	C.I.
BKT ≤90 mm	65	65	(63-67)	5.87	(5.69-6.05)	1,505	(1458-1551)
BKT >90 mm	25	25	(23-27)	19.27	(17.73-20.81)	579	(532-625)
	Site 3						
	Total	Pop. Size		Biomass (kg/ha)		Density (fish/ha)	
Species	Catch	Est.	C.I.	Est.	C.I	Est.	C.I.
BKT ≤90 mm	44	47	(39-54)	4.84	(4.01-5.56)	1,382	(1147-1588)
BKT >90 mm	31	31	(28-33)	38.66	(34.92-41.15)	912	(824-971)

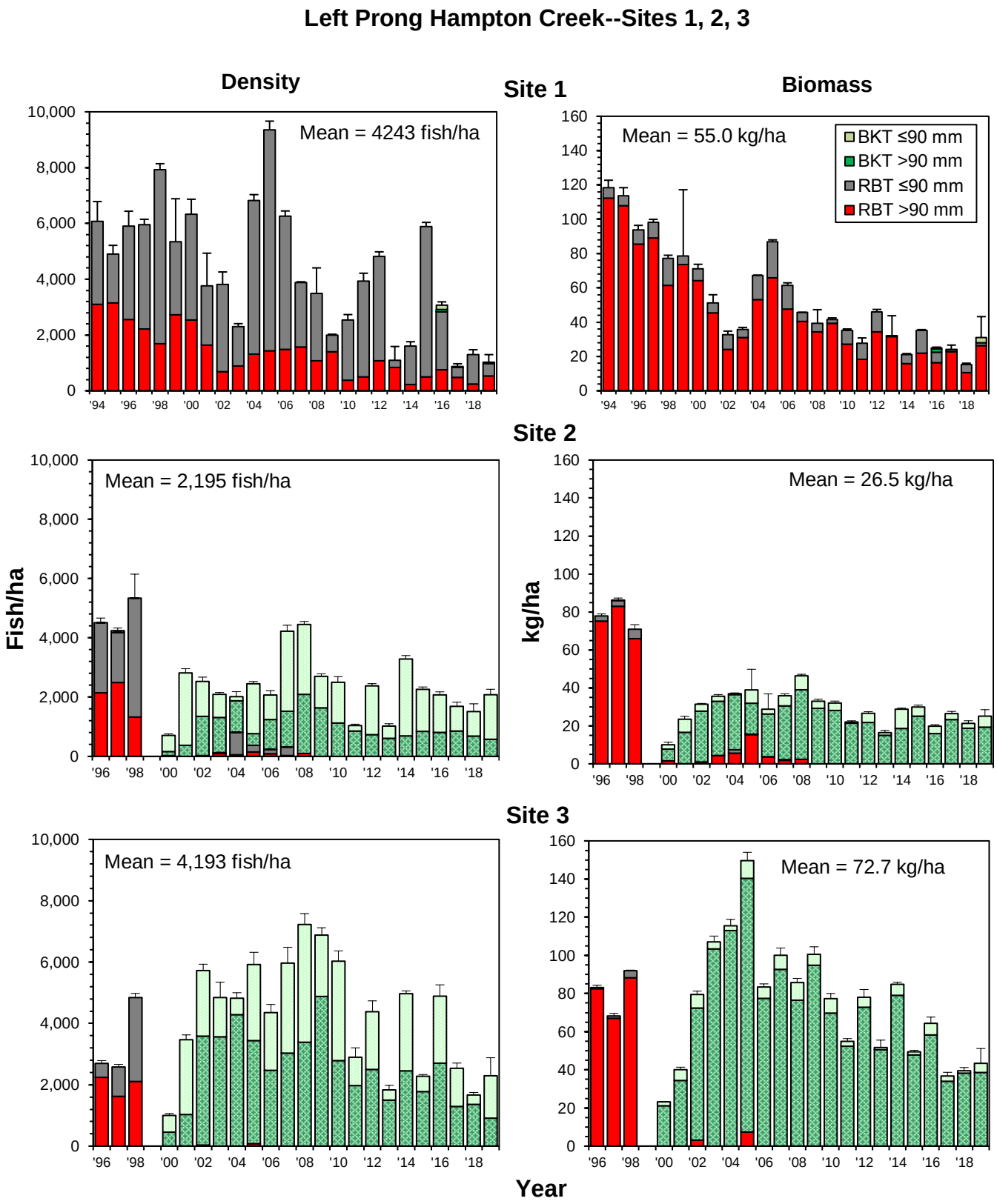


Figure 2-5. Wild trout abundance estimates (with upper 95% confidence limits) for Left Prong Hampton Creek.

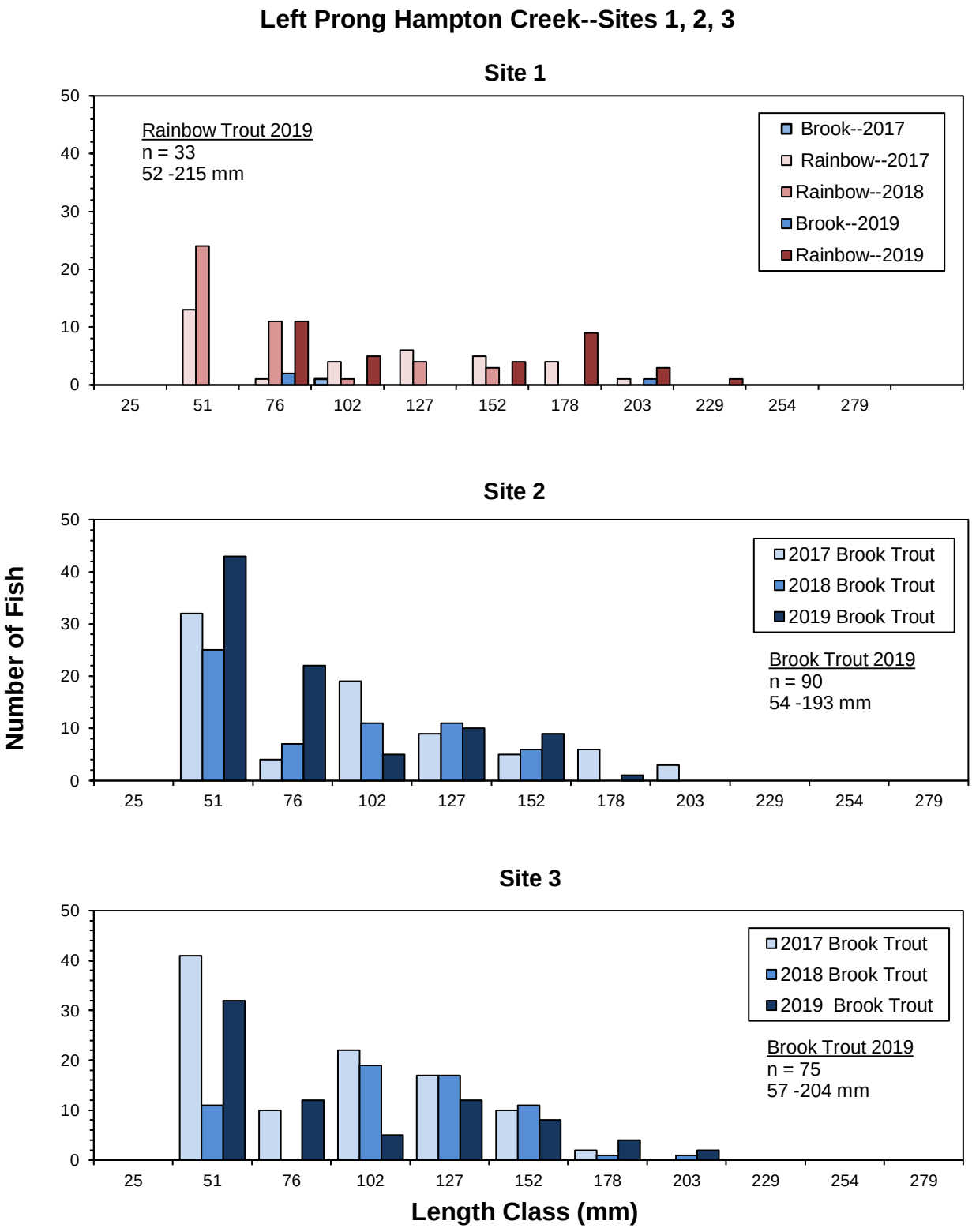


Figure 2-6. Wild trout length frequencies for Left Prong Hampton Creek for 2017-2019.

Right Prong Middle Branch

Table 2-9. Site and sampling information for Right Prong Middle Branch in 2019.

Location	Station 1	
Site code	420191801	
Sample date	16 August	
Watershed	Watauga River	
County	Carter	
Lat-Long	36.12007 N, -82.09574 W	
Elevation (ft)	4,070	
Land ownership	USFS	
Fishing access	Limited	
Description	Begins at head of small island ~270 m upstream of Rt. 143.	
Effort		
Station length (m)	90 m	243 m²
Electrofishing units	1	250 V AC
Habitat		
Mean width (m)	2.7	
Canopy cover (%)	95	
Est. % of site in riffles	41	59
Habitat assessment score	NM	
Water Quality		
Flow (cfs; visual)	0.56	normal
Temperature (C)	14.5	
pH	7.0	
Conductivity (µS/cm)	NM	
Alkalinity (mg/L $CaCO_3$)	15	

Table 2-10. Electrofishing data for Right Prong Middle Branch in 2019.

	Total	Pop. Size		Biomass (kg/ha)		Density (fish/ha)	
Species	Catch	Est.	C.I.	Est.	C.I.	Est.	C.I.
BKT ≤90 mm	47	48	(44-51)	7.86	(7.24-8.56)	1,975	(1811-2140)
BKT >90 mm	29	29	(26-32)	50.70	(28.78-55.97)	1,193	(1070-1317)

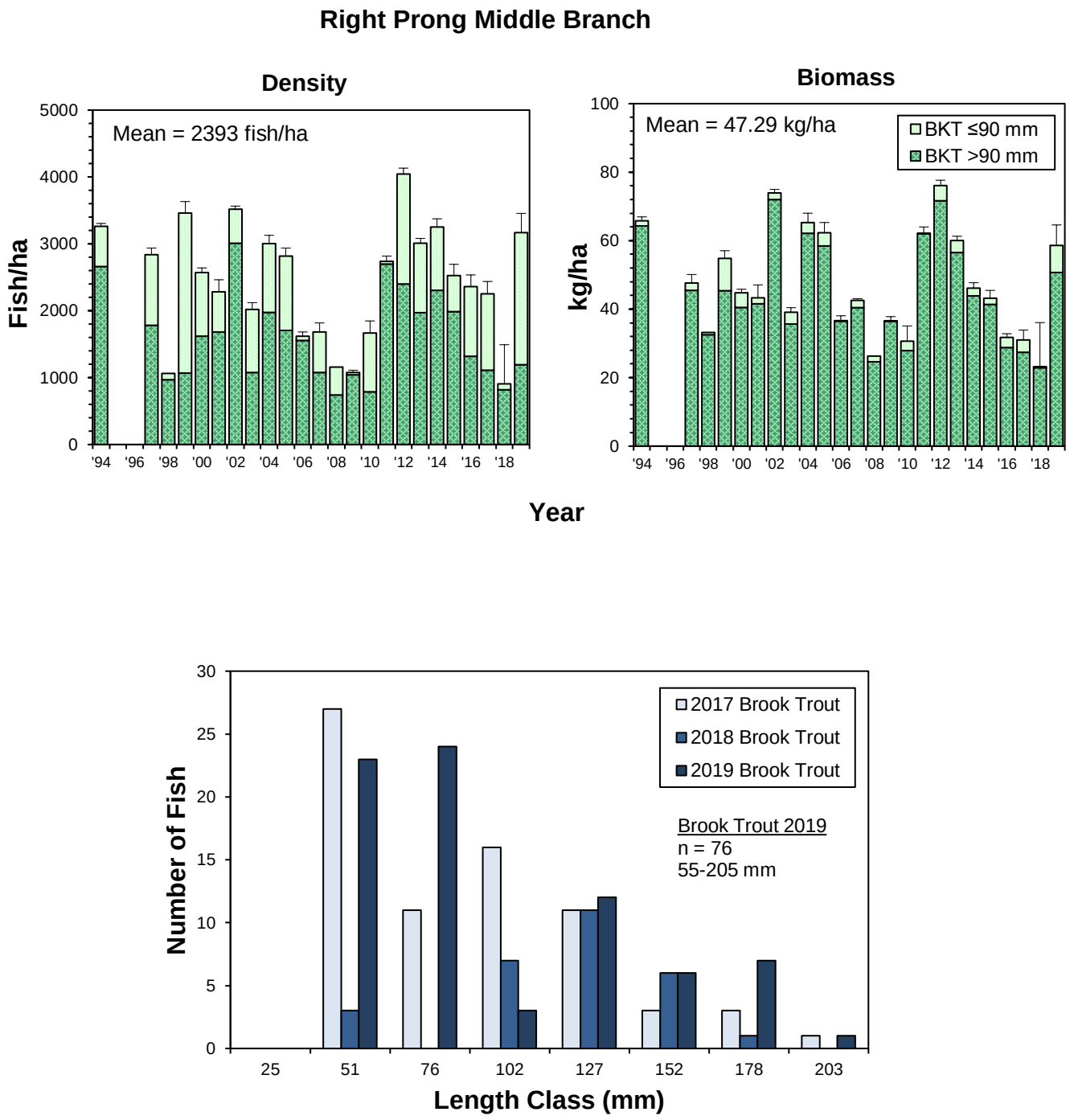


Figure 2-7. Wild trout abundance estimates (with upper 95% confidence limits) and length frequencies for Right Prong Middle Branch (2017-2019).

Rocky Fork

Table 2-11. Site and sampling information for Rocky Fork in 2019.

Location	Station 1		Station 2	
Site code	420192301		420192302	
Sample date	17 September		17 September	
Watershed	Nolichucky River		Nolichucky River	
County	Unicoi		Greene	
Lat-Long	36.04801 N, -82.55889 W		36.06758 N, -82.59608 W	
Elevation (ft)	2,360		3,230	
Stream order	4		3	
Land ownership	State of TN (TDEC)		USFS	
Fishing access	Good		Limited	
Description	Begins ~100 m upstream of the blue gate.		Ends ~10 m upstream of confl. with Ft. Davie Ck.	
Effort				
Station length (m)	130 m	780 m²	100 m	440 m²
Electrofishing units	2	450 V AC	1	600 V AC
Habitat				
Mean width (m)	6.0		4.4	
Canopy cover (%)	NM		NM	
Estimated % of site in pools	NM	NM	NM	NM
Habitat assessment score	NM	NM	NM	NM
Water Quality				
Flow (cfs; visual)	2.5	low	NM	low
Temperature (C)	17.7		17.3	
pH	6.9		7.0	
Conductivity (µS/cm)	40		9.3	
Alkalinity (mg/L $CaCO_3$)	15		NM	

Table 2-12. Electrofishing data for Rocky Fork in 2019.

	Total	Pop. Size		Biomass (kg/ha)		Density (fish/ha)		Total	Pop. Size		Biomass (kg/ha)		Density (fish/ha)	
Species	Catch	Est.	C.I	Est.	C.I	Est.	C. I.	Catch	Est.	C.I	Est.	C.I	Est.	C. I.
RBT ≤90 mm	1	1	(1-1)	0.09	(0.09-0.09)	13	(13-13)	1	1	(1-1)	0.11	(0.11-0.11)	23	(23-23)
RBT >90 mm	110	112	(104-117)	45.01	(42.94-46.95)	1,436	(1372-1500)	23	23	(20-26)	23.82	(20.73-26.95)	523	(455-591)
BKT ≤90 mm	-	-	-	-	-	-	-	10	11	(3-19)	1.41	(0.38-2.42)	250	(68-432)
BKT >90 mm	2	2	(2-15)	0.30	(0.30-2.27)	26	(26-192)	17	17	(15-19)	7.95	(7.02-8.90)	386	(341-432)
Longn. dace	6	6	(1-11)	1.44	(0.24-2.64)	77	(13-141)	-	-	-	-	-	-	-
Blackn. dace	144	173	(146-200)	9.58	(8.05-11.03)	2,218	(1872-2564)	-	-	-	-	-	-	-
Mtld. sculpin	141	314	(71-557)	30.69	(6.92-54.27)	4,026	(910-7141)	-	-	-	-	-	-	-

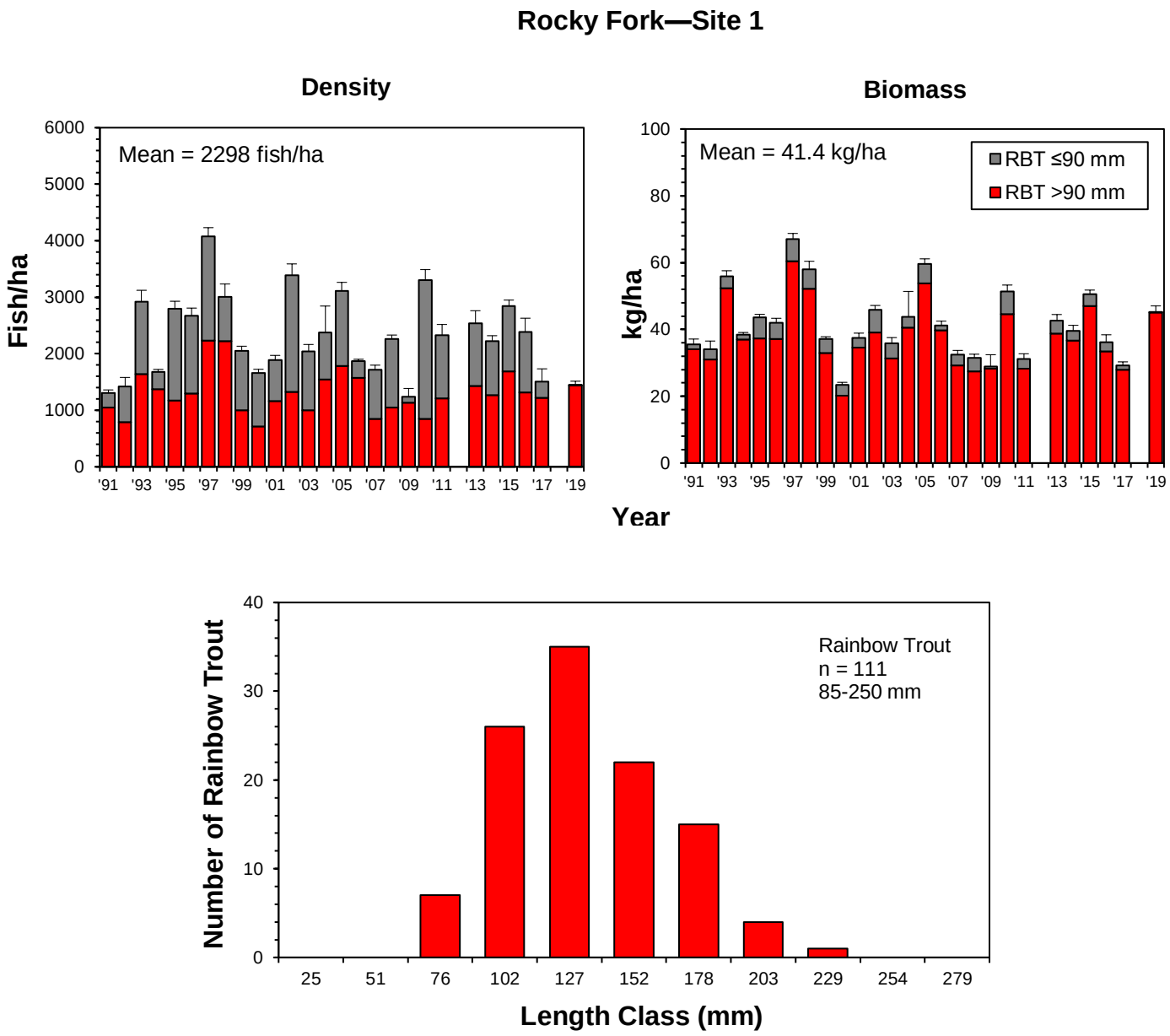


Figure 2-8. Rainbow Trout abundance estimates (with upper 95% confidence limits) and 2019 length frequencies for Rocky Fork Site 1.

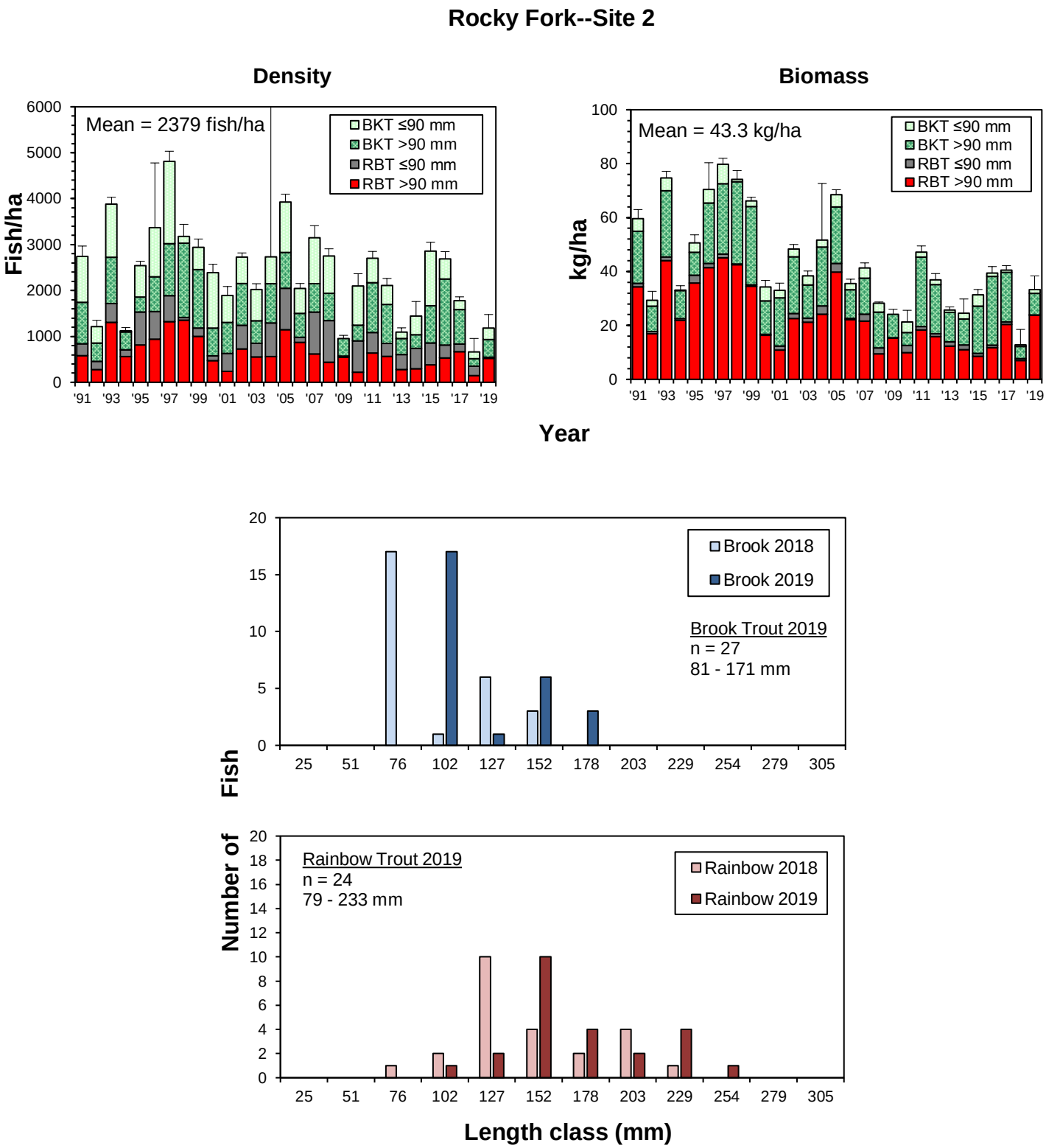


Figure 2-9. Wild trout abundance estimates (with upper 95% confidence limits) and length frequencies for Rocky Fork Site 2.

Stony Creek

Table 2-13. Site and sampling information for Stony Creek in 2019.

Location	Station 1	
Site Code	420192101	
Sample Date	5 September	
Watershed	Watauga River	
Lat-Long	36.41442 N, 82.07841 W	
Elevation (ft)	1,860	
Stream Order	4	
Land Ownership	Private	
Fishing Access	Good	
Description	Begins ~50 m upstream of bridge at Stony Ck. VFD	
Effort		
Station Length (m)	211 m	1656 m²
Electrofishing Units	3	125 V AC
Habitat		
Mean width (m)	7.85	
Canopy cover (%)	40	
Est. % site pools/riffles	48	52
Visual Hab. Assess. Score	139 (suboptimal)	
Water Quality		
Flow (cfs; visual)	6.33	normal
Temperature (C)	20.1	
pH	7.7	
Conductivity (µS/cm)	188	
Alkalinity (mg/L $CaCO_3$)	75	

Table 2-14. Electrofishing data for Stony Creek in 2019.

	Total	Pop. Size		Biomass (kg/ha)		Density (Fish/ha)	
Species	Catch	Est.	C.I.	Est.	C.I.	Est.	C.I.
RBT ≤90 mm	207	252	(217-286)	6.82	(5.90-7.77)	1,522	(1310-1727)
RBT >90 mm	213	218	(211-225)	27.18	(26.25-27.99)	1,316	(1274-1359)
BNT >90 mm	6	8	(0-27)	13.80	(0.00-46.58)	48	(0-163)
Blacknose dace	497	551	(523-579)	11.65	(11.05-12.24)	3,327	(3158-3496)
Fantail darter	285	382	(318-446)	5.20	(4.42-6.19)	2,307	(1920-2693)
Snubnose darter	23	35	(0-444)	0.55	(0.00-6.97)	211	(0-2681)
Mottled sculpin	554	1,403	(732-2074)	60.66	(33.59-95.18)	8,472	(4420-12524)
Stoneroller	192	198	(190-206)	30.79	(29.60-32.09)	1,196	(1147-1244)
N. hogsucker	12	12	(8-16)	6.26	(4.17-10.26)	72	(48-97)

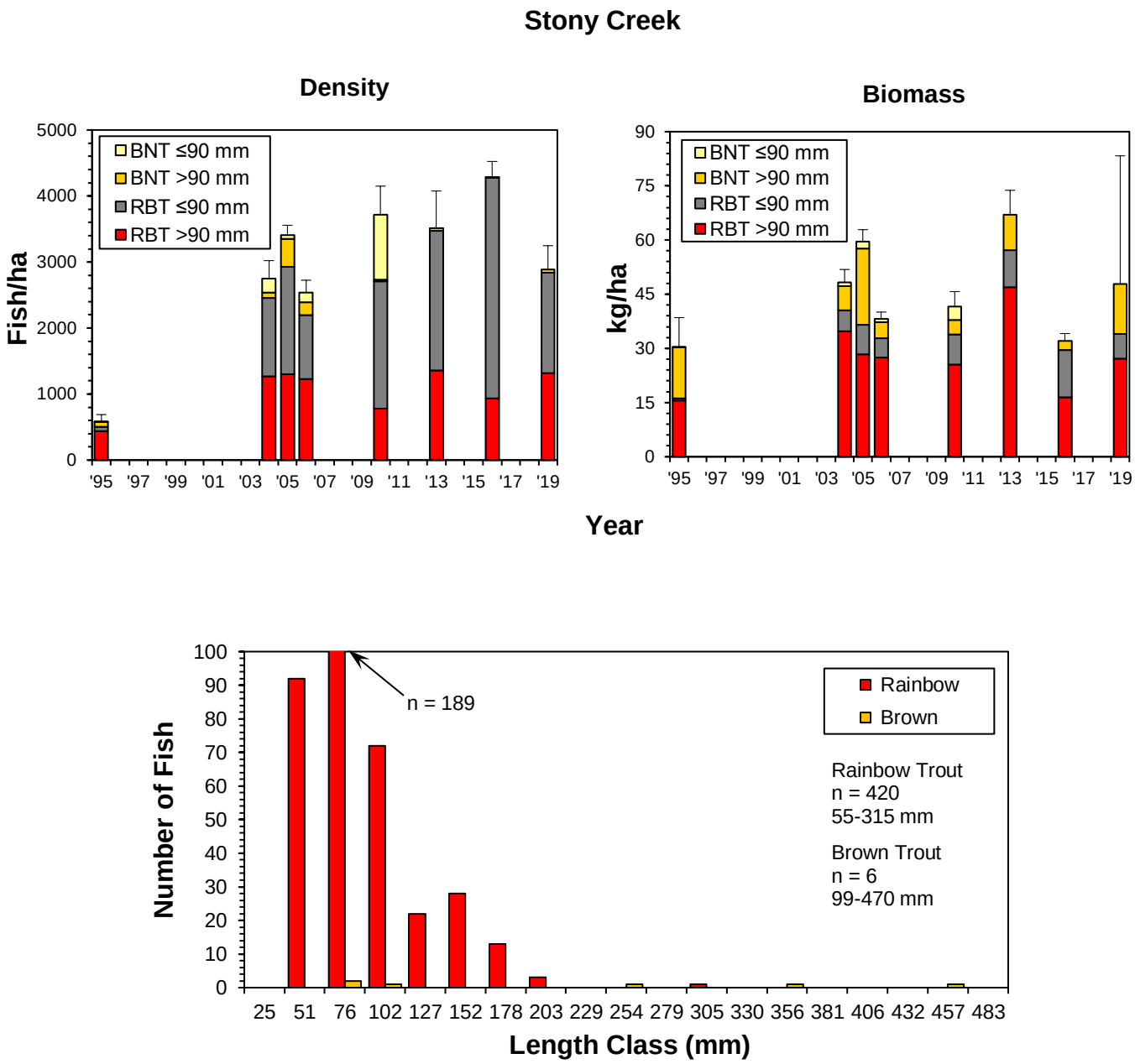


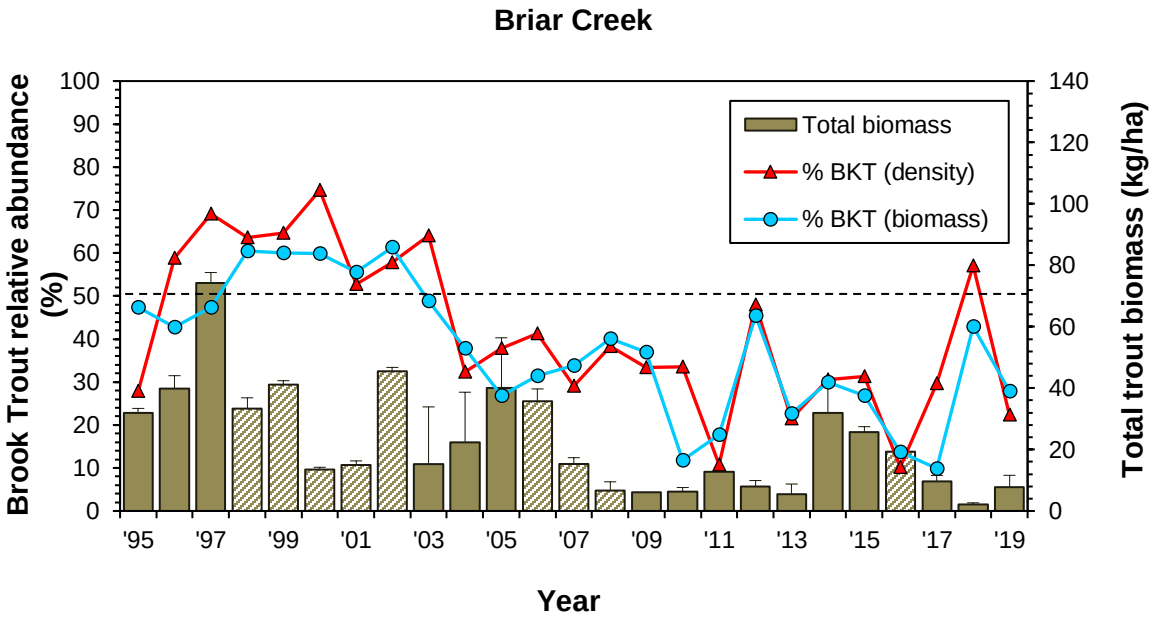
Figure 2-10. Wild trout abundance estimates (with upper 95% confidence limits) and 2019 length frequencies for Stony Creek.

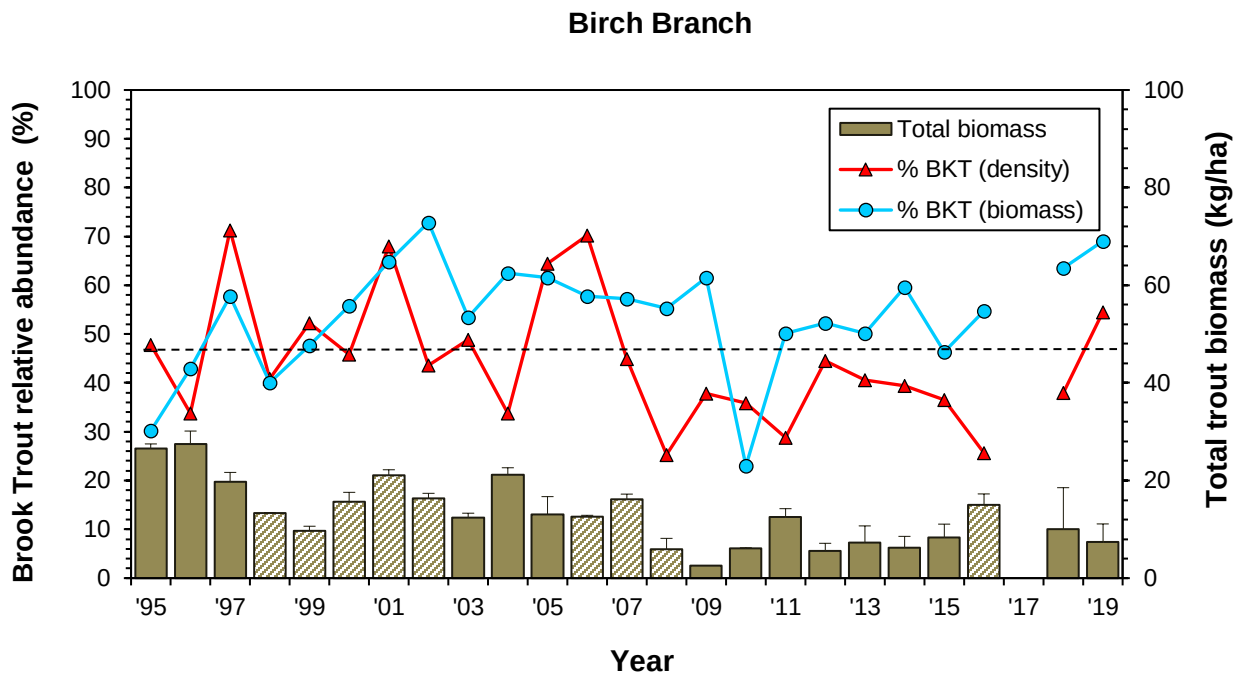
3. Sympatric Brook Trout / Rainbow Trout Monitoring

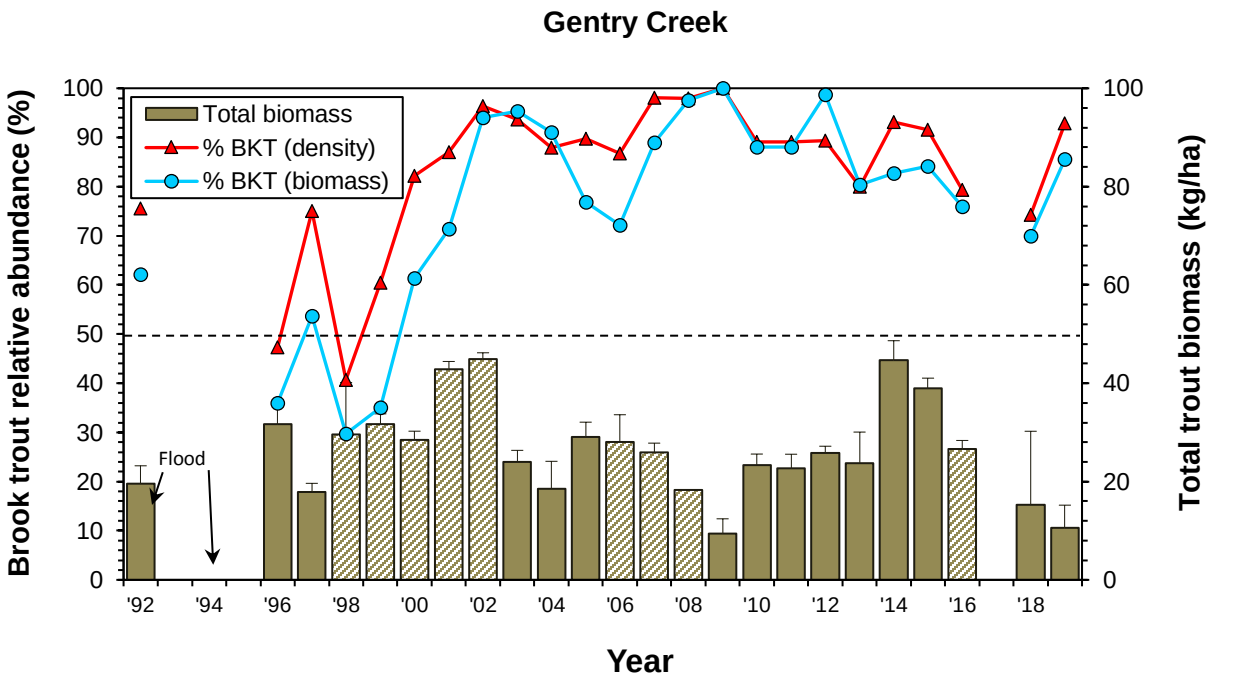
Brook Trout would have historically occurred in most coldwater streams in eastern Tennessee and were the dominant salmonids before the 1900s. Logging and the resulting habitat loss between 1903 and 1937 and the introduction of nonnative Rainbow Trout (beginning in 1910) and Brown Trout (after 1950) negatively 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 may displace native Brook Trout (Kelly et al. 1980).

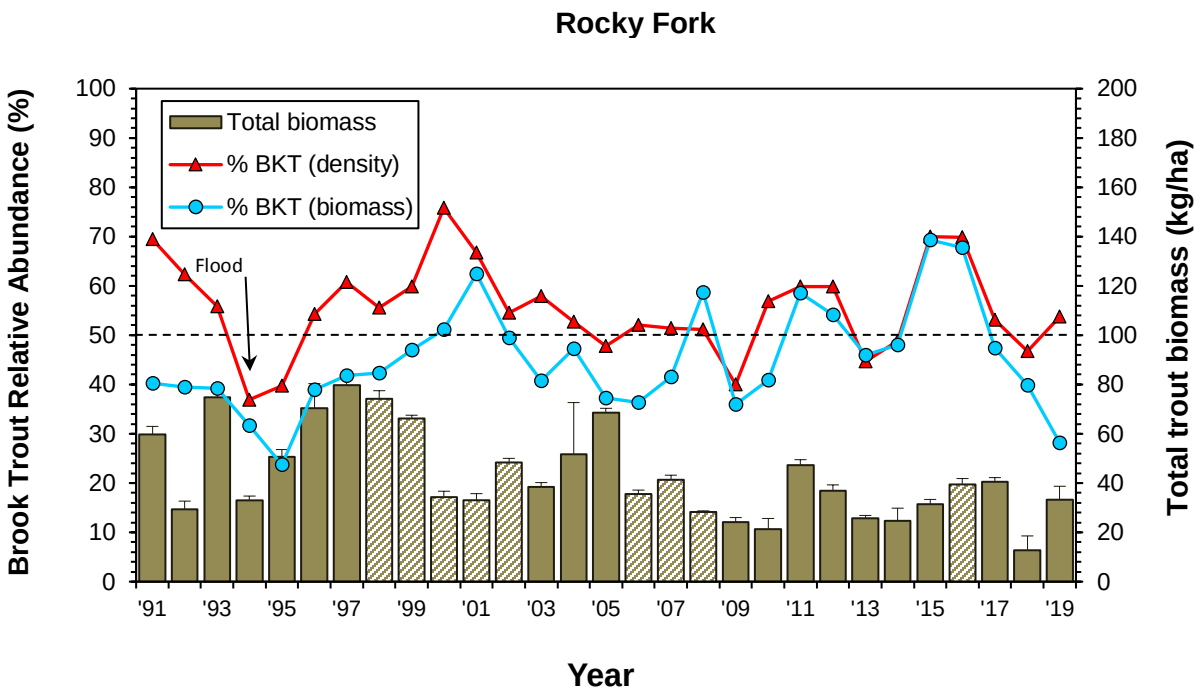
Moore et al. (1983) and Larson and Moore (1985) showed that Rainbow Trout suppress Brook Trout abundance and reproduction, and Whitworth and Strange (1983) showed that Rainbow Trout are the dominant trout where Brook Trout and Rainbow Trout coexist. Allopatric Brook Trout range decreased by 60% between 1935 and 1977 in the Great Smoky Mountains National Park, apparently because of nonnative salmonid encroachment of (particularly Rainbow Trout; Larson and Moore 1985). Consequently, managers have been concerned about the potential range expansion by Rainbow Trout and associated loss of Brook Trout distribution. However, Larson et al. (1995) found Brook Trout density and distribution ebbs and flows even in the presence of Rainbow Trout and Strange and Habera (1998) found that Rainbow Trout were not affecting downstream limits of Brook Trout distribution in Tennessee streams. These results, as well as our long-term monitoring, indicate that Brook Trout and Rainbow Trout distribution and relative abundance in the southern Appalachian streams will ebb and flow in response to environmental factors such as droughts and floods.

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 (see graphs below). Our 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 specific annual data can be found at https://www.tn.gov/content/tn/twra/fishing/trout-information-stockings.html#FisheriesReport.




Birch Branch
Brook Trout relative abundance (%)
Total trout biomass (kg/ha)
Total biomass
% BKT (density)
% BKT (biomass)
Year
'95
'97
'99
'01
'03
'05
'07
'09
'11
'13
'15
'17
'19


Gentry Creek
Brook trout relative abundance (%)
Total trout biomass (kg/ha)
Total biomass
% BKT (density)
% BKT (biomass)
Flood
Year
'92
'94
'96
'98
'00
'02
'04
'06
'08
'10
'12
'14
'16
'18



The above graphs depict total trout biomass (bars with 95% upper confidence limits; secondary y-axis) along with percent Brook Trout density (red triangles; primary y-axis) and percent Brook Trout biomass (blue circles; primary y-axis) for the four study streams during the past 25-29 years. Patterned biomass bars indicate drought years. Percent 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. 2014a).

Although Brook Trout relative abundance has fluctuated over the years at the monitoring stations, it appears that Rainbow Trout have no particular competitive advantage, thus these species can coexist for many years at some general equilibrium. Strange and Habera (1998) and Habera et al. (2001; 2014a) found no broad-scale loss of distribution or inexorable replacement by Rainbow Trout in sympatric populations. Furthermore, Brook Trout have gained distribution (2 km or more in some cases) in the presence of Rainbow Trout in several streams since the 1990s (Habera et al. 2014a).

Future monitoring of these streams will be on a triennial schedule to further document relative abundance trends. Water temperature monitoring data could help explain Brook Trout and Rainbow Trout abundance trends in Tennessee streams, thus temperature loggers will be deployed in selected streams in 2020 to obtain this information.

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 2019 is summarized in the following stream accounts.

Table 4-1. Potential Tier 1 Brook Trout restoration and enhancement projects in Region 4.

Stream	Watershed	Species present	Barrier	Start elevation	Length (miles)	Comments	Current status
Green Mountain Branch	South Fork Holston	RBT	Yes	3,130	1.0	Barrier located and moved to tier 1	In progress; RBT removal and BKT translocation 2020
Little Jacob Creek	South Fork Holston	RBT/BKT	Yes	2,270	1.0	Monitor for Brook Trout survival	Complete except for monitoring 2020
Phillips Hollow	Nolichucky	None	Yes (2)	2,230	0.6	Fish to be acquired from NC	Fish translocated in 2019; monitor/ assess in 2020.
Little Paint Creek	French Broad	None	Yes	2,000	1.5	Use fish from Gulf Fork tribs.	In progress
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	RBT	Yes	2,640	2.2	Use fish from Gulf Fork tribs.	In progress; RBT removal and BKT translocation 2021
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	Mark and move RBT to evaluate barrier in 2020

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

Stream	Watershed	Species present	Barrier	Start elevation	Length (miles)	Comments	Current status
Sinking Creek	Watauga	RBT/BNT	No	2,060	1.3	Initially thin RBT/BNT; include Basil Hollow tributary	No barrier present; check downstream for end of creek 2020
Upper Granny Lewis Creek	Nolichucky	RBT	No	2,800	1.0	Initially thin Rainbows	Not in progress

Green Mountain Branch

Additional electrofishing passes were made through the restoration zone (2.74 km main channel and 0.17 km tributary) in June (1) and September (2) 2019 to complete removal of the Rainbow Trout population. The June effort removed 48 adults, 23 subadults, and 52 young-of-the-year (age-0). The September efforts (during low water) removed 7 adults and 20 age-0 fish, then 1 adult and 1 age-0, respectively. While the 2019 efforts indicated that some Rainbow Trout reproduction occurred after the initial removal passes in 2018, it was essentially eliminated after the second pass in September. Overall, 780 Rainbow Trout (including 580 age-0 fish) have been removed from Green Mountain Branch since 2018.

Plans for 2020 are to remove any remaining Rainbow Trout and, if no age-0 fish are found, (indicating no reproduction occurred), introduce pre-spawn Brook Trout in September. These will likely be obtained from Beaverdam Creek tributaries such as Fagall Branch, Heaberlin Branch, and East Fork Beaverdam Creek, pending genetic data analysis.

Little Jacob Creek

Brook Trout have been established in Little Jacob Creek down to the culvert at USFS road (FR 4002) crossing (Habera et al. 2019). Another barrier ~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 down to this barrier. This barrier is a 2 m (6.5 ft) high concrete waterfall that would stop Rainbow Trout movement upstream. Temperature loggers deployed 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 25.4C, respectively) as described by Wehrly et al. (2007). However, fish community composition near the barrier (which includes Central Stoneroller *Campostoma anomalum*, Creek Chub *Semotilus atromaculatus*, and Blacknose Dace *Rhinichthys atratulus*) suggests water temperature may be marginal for Brook Trout.

Additional water temperature monitoring data will be collected in 2020 to further document summer conditions in this portion of Little Jacob Creek and help determine if establishment of Brook Trout in the area could be successful.

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 the Tennessee Aquarium Conservation Institute (TNACI) from adults collected from Left Prong Hampton Creek were stocked in 2014, 2015, and 2018. Given that Brook Trout abundance in the lower portion of the Little

Stony Creek restoration area remained low in 2018 (primarily because of low initial stocking densities), a supplemental stocking was necessary there to complete the project. Accordingly, 388 Brook Trout fingerlings produced by TNACI were stocked in this area in May 2019 (some stream-reared age-0 Brook Trout were also present).

A check for any remaining Rainbow Trout in the lower 800 m of the restoration zone will be made in 2020, followed by quantitative sampling at the monitoring site in this reach. The stream segment immediately above the barrier at the upper end of the introduction zone will also be checked to determine if Brook Trout have completely

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 supports a wild Rainbow Trout population and was being sampled as part of an area BioBlitz by the USFS. A potential fish passage barrier was found on the creek at 36.147231 N, -82.030345 W, just downstream of USFS boundary. Consequently, Shell Creek was added to the native Brook Trout restoration program as a potential Tier 1 stream. If the barrier proves to be ineffective, Shell Creek will be managed as a Tier 2 stream (with a sympatric Brook/Rainbow population). A two-pass Rainbow Trout removal effort was conducted in August 2019 under low flow conditions. The first electrofishing pass captured 4 adult, 12 sub-adult, and 45 age-0 Rainbow Trout, while the second pass removed 3 age-0 fish. Suitable trout habitat extends upstream for about 1 km to 36.13966 N, -82.025303 W (4,220 ft).

Another Rainbow Trout removal pass will be completed in 2020 in early summer 2020, after which fingerling Brook Trout spawned at TNACI during fall 2019 (progeny of Left Prong Hampton Creek adults) will be stocked.

Phillips Hollow

NCWRC and TWRA personnel collecting Brook Trout in Pyatt Creek, September 2019.

TWRA has been working with the North Carolina Wildlife Resources Commission (NCWRC) since 2016 to identify Brook Trout donor streams in North Carolina suitable for restoring a native population in a Tennessee stream in the Nolichucky River basin (Phillips Hollow, Greene Co.). Based on favorable genetics, fish abundance, and negative disease screening results, Jones Creek and Pyatt Creek (North Toe River system in NC) were chosen to provide fish for translocation into Phillips Hollow. TWRA and NCWRC personnel collected 6 adults and 40 age-0/subadults from Jones Creek and 7 adults and 19 age-0/subadults from Pyatt Creek on September 10, 2019. These 76 Brook Trout were transported and stocked the same day into an 800-m reach of Phillips Hollow beginning upstream of the barrier at 2,230 ft. This effort was a partnership with NCWRC, USFS, USFWS, TU, TWRA, and private landowners in North Carolina.

Preparing Brook Trout for transport to Phillips Hollow (top photo); USFWS personnel releasing Brook Trout in Phillips Hollow, September 2019.

A survey of the 800-m introduction zone will be conducted during the summer of 2020 to evaluate survival and reproduction and determine if additional stocking is necessary. Ultimately, the Phillips Hollow population will be used to provide fish for additional native Brook Trout restorations in other Nolichucky-basin streams in Tennessee.

Trail Fork of Big Creek

Two full electrofishing passes in Trail Fork of Big Creek and its tributaries (Lemon Prong and Rattlesnake Branch) in 2018 removed 519 Rainbow Trout from the 3.5-km restoration area. Another 183 Rainbow Trout (including 11 age 0) were removed in 2019 with two more electrofishing passes and partial third pass in the area where most fish were captured during the second pass.

The unique genetic characteristics of native Brook Trout in three Gulf Fork of Big Creek tributaries made them the most appropriate sources of fish for the Trail Fork restoration. TWRA (including Region III and Tellico Hatchery staff), Tennessee Division of Forestry, and USFS personnel collected a total of 41 Brook Trout from Deep Gap Creek (n = 5), Brown Gap Creek (n = 20), and Middle Prong of Gulf Creek (n = 21) in September 2019. These fish were taken to the Brook Trout spawning facility at Tellico Hatchery, but attempts to spawn them later that fall were unsuccessful, and no progeny have survived. Spawning and rearing success should improve in 2020 as the fish grow and mature while being held at Tellico Hatchery.

An electrofishing pass will be made through Trail Fork of Big Creek in 2020 to remove any remaining Rainbow Trout. If efforts to spawn the fish being held at Tellico Hatchery during fall of 2020, fingerling (age 0) Brook Trout would be available for release in Trail Fork of Big Creek in the spring of 2021. Additional spawners from the Gulf Fork of Big Creek tributaries may be collected if necessary (September 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. Natural reproduction by Brown Trout in the South Holston and Wilbur tailwaters is sufficient to sustain those fisheries, thus requiring a different set of management strategies.

Annual tailwater monitoring in Region IV began in 1991 (Bivens et al. 1992), but efforts prior to 1999 provided limited information. Consequently, TWRA sponsored more intensive studies through the Tennessee Cooperative Fisheries Research Unit (TN CFRU) at Tennessee Tech University. These studies focused on assessment of trout abundance, the fate of stocked fish, natural reproduction, movements, and angler use in the Norris, South Holston, and Wilbur tailwaters (e.g., Bettoli and Bohm 1997; Bettoli 1999; Bettoli et al. 1999; Banks and Bettoli 2000; Bettinger and Bettoli 2000; Bettoli 2002; Bettoli 2003a; Bettoli 2003b; Hutt and Bettoli 2003; Meerbeek and Bettoli 2005; Bettoli 2006; Holbrook and Bettoli 2006; Bettoli 2007; Damer and Bettoli 2008). Beginning in 1999, TWRA began a more intensive annual monitoring program employing the techniques and sample sites developed through the TN CFRU research.

Six Region IV tailwater trout fisheries (Norris, Cherokee, Wilbur, Ft. Patrick Henry, Boone, South Holston; Figure 1-1) are currently monitored annually. Trout fishery management plans are in place for the Norris (Habera et al. 2014b), Wilbur (Habera et al. 2015b), Boone/Ft. Patrick Henry (Habera et al. 2018a), and South Holston (Habera et al. 2015c) tailwaters. 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 sampled in the fall (October), as trout survival over the summer is a more important issue for that fishery. They have also been sampled in June 2018 and 2019 to document trout abundance prior to the onset of the late summer/early fall water temperature bottleneck. 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 TVA was unable to provide the appropriate flows.

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 330 trout weighing nearly 174 kg 2019 (Table 5-1; Figure 5-2). The catch included 289 Rainbow Trout (141-479 mm) and 41 Brown Trout (257-760 mm). No Brook Trout were captured, but none were stocked in 2018. Trout in the 356-508 mm (14-20 in.) protected length range (PLR) were present at all 12 monitoring stations (Table 5-1). Overall, 56% of Rainbow Trout and 51% of Brown Trout >178 mm were within the PLR (Figure 5-2). Another 24% of the Brown Trout catch was >508 mm.

A 29.9 in., 8.9 lb. Brown Trout from the 2019 Norris tailwater sample.

CPUE

The mean electrofishing CPUE for all trout ≥178 mm for the Norris tailwater has typically ranged from 150-200 fish/h (mean, 188 fish/h) since the establishment of the PLR in 2008 (Figure 5-3). Mean CPUE for trout within the PLR (356-508 mm) has increased substantially since 2008 and approached 100 fish/h in 2019 (Figure 5-3). Mean PLR catch rate met corresponding Norris tailwater management plan objectives (28 fish/h) for 2008-2019 (Habera et al. 2008, 2014).

RSD-14

Relative stock density for trout ≥356 mm or 14 in. (RSD-14) was below 50 for both species and typically below 30 for Rainbow Trout prior to establishment of the PLR in 2008 (Figure 5-4). Subsequently, RSD-14 for both species has improved, with values often exceeding 50 and seldom failing to reach at least 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.

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 need to stock fish early in 2016 and 2017 (poor fall water quality) and inconsistent availability of Brook Trout. Additionally, the 2019 fingerling stocking rate was reduced to 111,000 to accommodate marking these fish (fin clips) for the TN CFRU research project and this rate for the 4-year duration of that study.

Angler Surveys

Results for the 2017 Norris tailwater creel survey were summarized in Habera et al. (2019), but basically, pressure, trips, catch, and harvest decreased relative to the 2015 survey (Black 2015, 2017, while pressure, catch, and harvest were also below the levels observed during the 2013 survey (Black 2014). A new angler survey was completed on the Norris tailwater in 2019 and effort, catch, and harvest estimates will be available for inclusion in TWRA's 2020 Trout Fisheries report. Anglers were asked some supplemental opinion questions during this survey, including how they view the current PLR regulations, as well as TWRA's overall management of the fishery. Based on preliminary results, 62% of Norris tailwater anglers (n=164) mostly or completely support the PLR regulation, while only 12% mostly or completely oppose it. Additionally, 86% of those same anglers rated TWRA's management of the Norris tailwater trout fishery as good or excellent, while only 2% considered it fair or poor. Through November 2019, 288 anglers reported 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.). Only one of the seven trout >20 in. caught by anglers (five were Rainbow Trout) was harvested (a Rainbow).

New Research

A multi-year research project through the TN CFRU began in August 2019 to investigate the roles of wild Rainbow Trout and stocked fingerlings in the Norris tailwater trout fishery. If natural reproduction by Rainbow Trout does contribute substantially contribute to the tailwater trout fishery, then the fingerling stocking strategy would be adjusted accordingly. The annual fingerling Rainbow Trout stocking rate has been reduced somewhat to 110,000 to facilitate marking these fish during the TN CFRU research project.

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 revision now being drafted.

Norris Tailwater

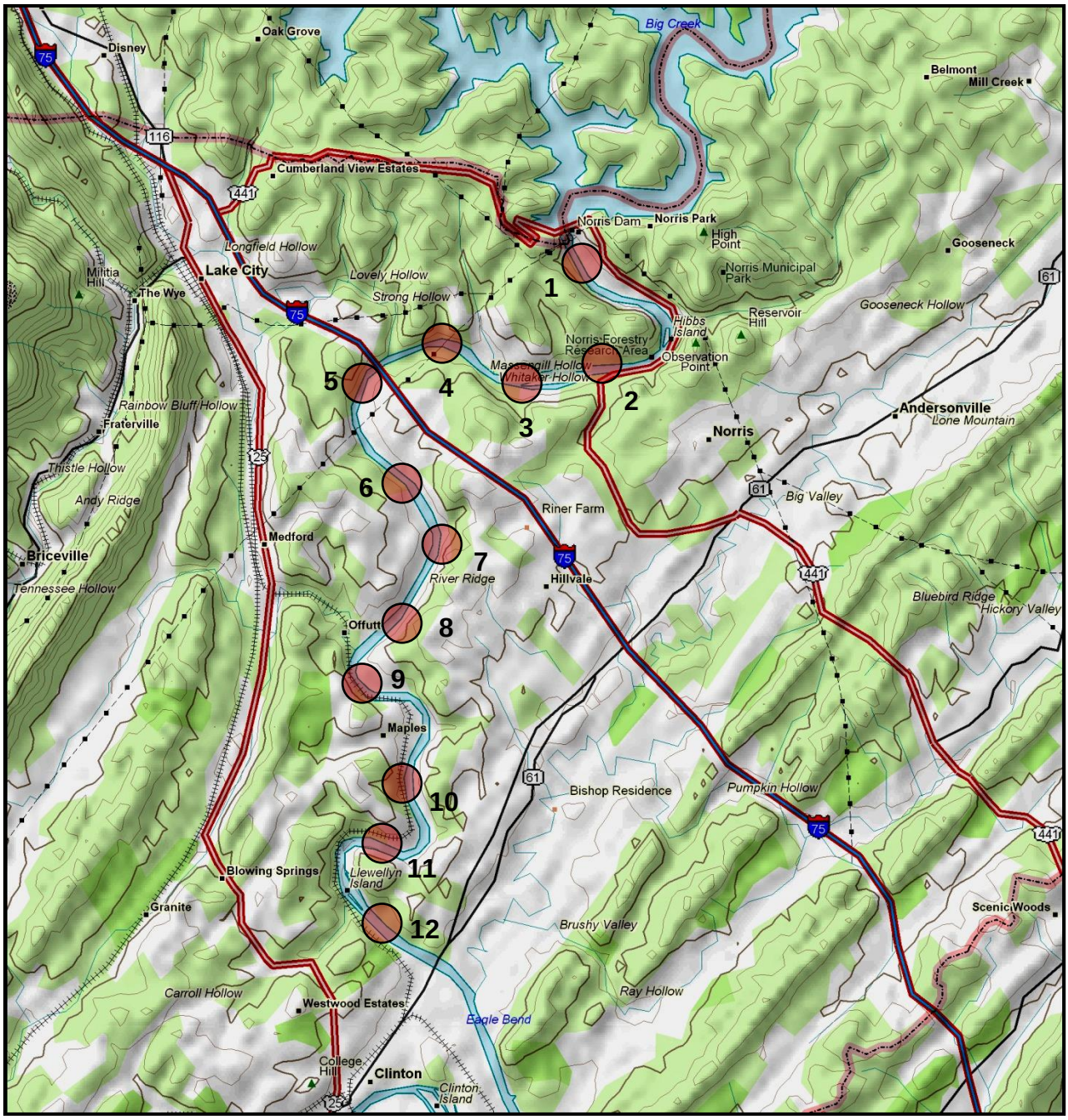


Figure 5-1. Locations of the Norris tailwater (Clinch River) monitoring stations.

Table 5-1. Catch data for the12 electrofishing stations on the Norris tailwater sampled 2 April 2019.

Station	Species	Total catch	Size range (mm)	Total weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow	10	378-458	6,220	67	61
	Brown	5	384-461	3,966	33	39
Totals		**15**		**10,186**	**100**	**100**
2	Rainbow	31	141-441	14,629	82	81
	Brown	7	290-553	3,387	18	19
Totals		**38**		**18,016**	**100**	**100**
3	Rainbow	43	210-450	20,534	90	91
	Brown	5	257-409	2,142	10	9
Totals		**48**		**22,676**	**100**	**100**
4	Rainbow	5	186-466	3,051	100	100
Totals		**5**		**3,051**	**100**	**100**
5	Rainbow	39	238-436	18,478	100	100
Totals		**39**		**18,478**	**100**	**100**
6	Rainbow	14	257-435	6,874	88	81
	Brown	2	405-415	1,646	13	19
Totals		**16**		**8,520**	**100**	**100**
7	Rainbow	28	240-446	11,426	72	45
	Brown	11	320-640	13,894	28	55
Totals		**39**		**25,320**	**100**	**100**
8	Rainbow	21	218-430	9,436	91	69
	Brown	2	475-658	4,272	9	31
Totals		**23**		**13,708**	**100**	**100**
9	Rainbow	28	162-445	13,128	85	77
	Brown	5	331-542	3,930	15	23
Totals		**33**		**17,058**	**100**	**100**
10	Rainbow	19	221-479	9,265	90	63
	Brown	2	592-760	5,546	10	37
Totals		**21**		**14,811**	**100**	**100**
11	Rainbow	17	234-464	7,920	100	100
Totals		**17**		**7,920**	**100**	**100**
12	Rainbow	34	185-447	11,713	94	83
	Brown	2	375-579	2,468	6	17
Totals		**36**		**14,181**	**100**	**100**
Total Rainbow Trout		289	141-479	132,674	88	76
Total Brown Trout		41	257-760	41,251	12	24
Overall		**330**		**173,925**	**100**	**100**

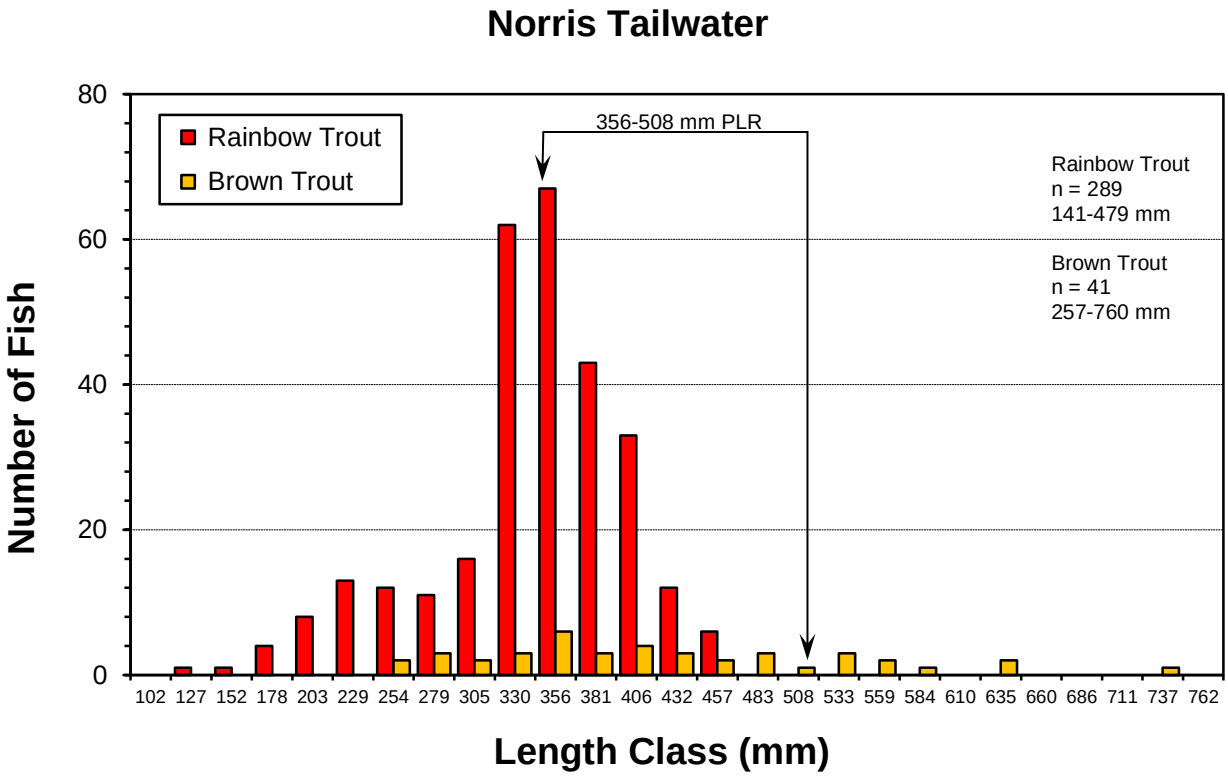


Figure 5-2. Length frequency distributions for trout from the Norris tailwater monitoring stations in 2019.

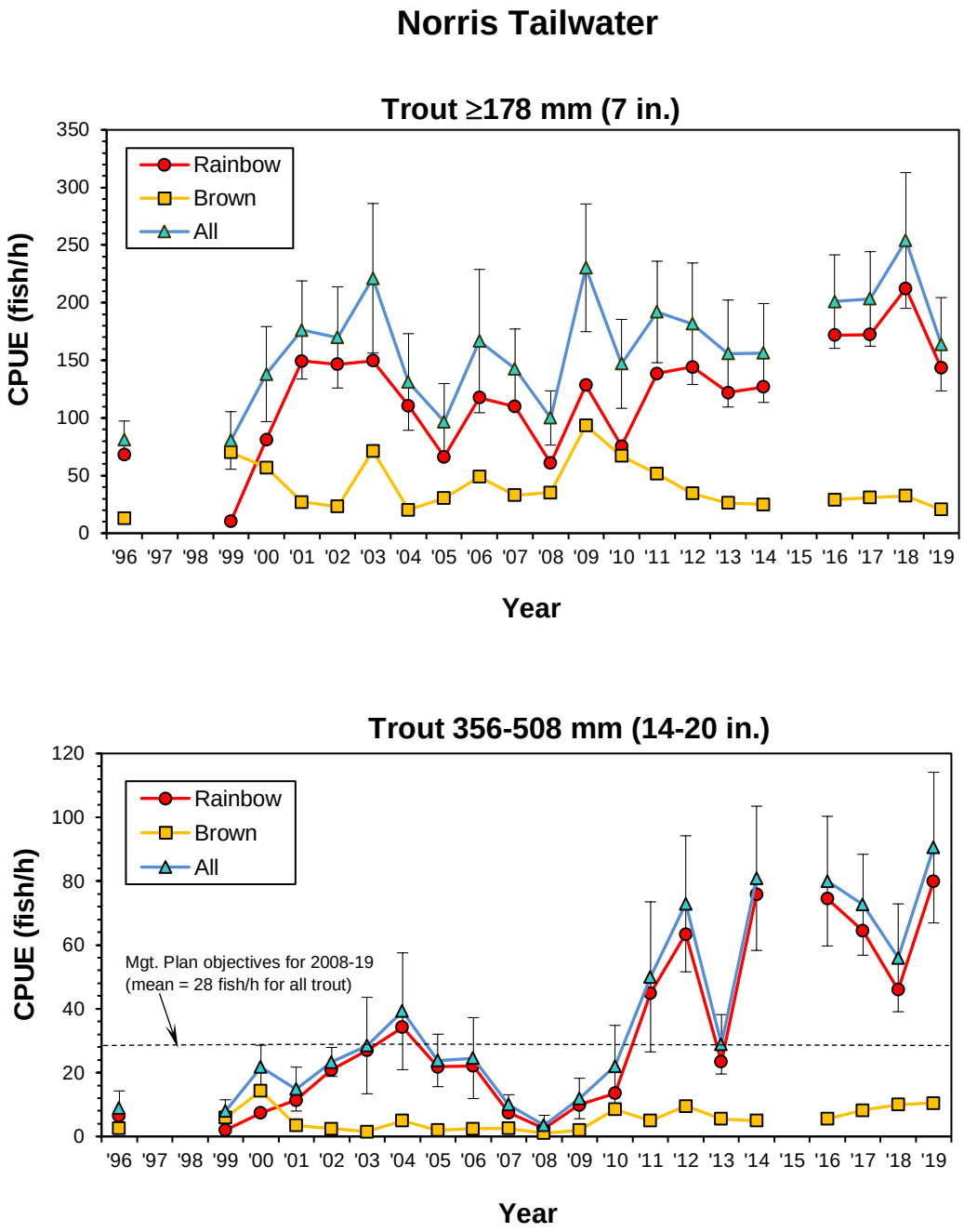


Figure 5-3. Mean trout CPUEs for the Norris tailwater samples. Bars indicate 90% confidence intervals. The 356-508 mm PLR regulation was established in 2008.

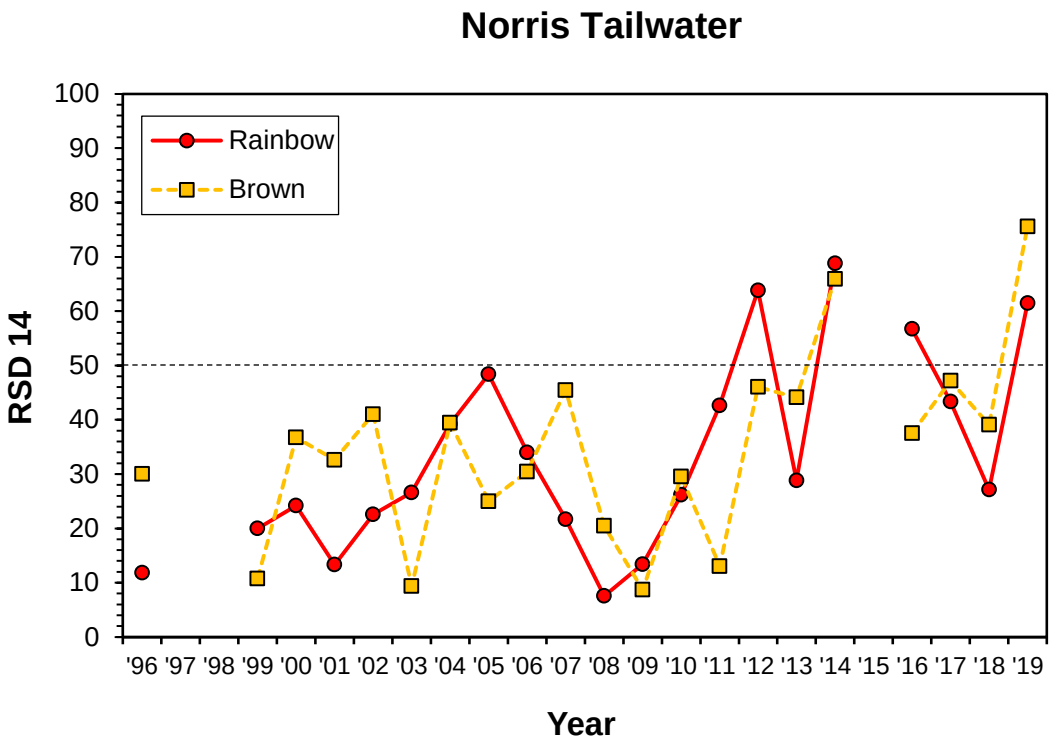


Figure 5-4. Relative stock densities for Norris tailwater Rainbow Trout and Brown Trout ≥14 in. (RSD 14) for 1996-2019.

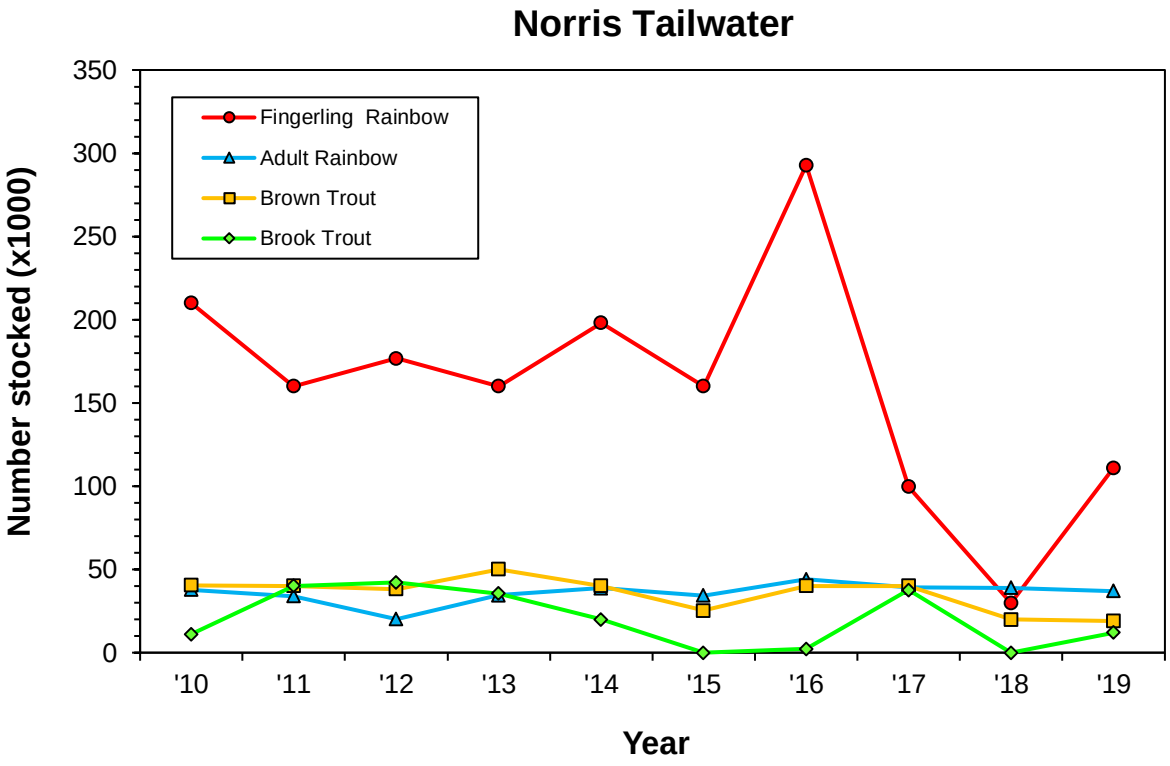


Figure 5-5. Trout stocking rates for the Norris tailwater (2010-2019). Poor water quality at Dale Hollow National Fish Hatchery during fall 2016 made it necessary to stock the 2017 fingerling Rainbow Trout allocation early. Fingerling stocking rates in 2017 and 2018 were reduced to compensate and the 2019 stocking rate was reduced to 111,000 to accommodate marking (fin clips) for the TN CFRU research project.

Cherokee (Holston River)

Catch and Length Frequency

The 12 Cherokee tailwater monitoring stations (Figure 5-6) produced 31 trout (29 Rainbow Trout, 2 Brown Trout) weighing over 24 kg on 17 June 2019 (Table 5-2). Water temperature on that date averaged 15.4° C. Rainbow Trout were predominantly in the 330 to 406-mm size classes, although one 560-mm (22-in.) fish was captured (Figure 5-7). The 29 October 2019 sample produced only six trout weighing 3 kg (Table 5-3) and water temperature averaged 21.4° C during that effort. All trout captured in October were in the 254 to 305-mm size classes (Figure 5-7).

Processing the catch during the October 2019 Cherokee tailwater survey.

CPUE

The mean catch rate for all trout ≥178 mm (15.0 fish/h, Figure 5-8) was similar to the June 2018 sample (18.0 fish/h, Figure 5-9) and within the range for previous fall samples (maximum, 16.0 fish/h in 2012; Figure 5-8). The mean catch rate for trout ≥356 mm in the June 2019 sample (11.0 fish/h; Figure 5-10) exceeded the range for fall samples (maximum, 9.5 fish/h; Figure 5-8), but the catch rate for trout ≥457 mm (0.5 fish/h; Figure 5-8) did not. Given the annual thermal bottleneck in this tailwater, it is unsurprising that mean catch rates for all trout size classes decline from June to the end of October (Figure 5-9).

The subsequent 29 October 2019 Cherokee tailwater sample produced one of the lowest mean catch rates (trout ≥178 mm) to date (1.5 fish/h; Figure 5-8). Mean catch rates for larger trout in October 2019 (1.5 fish/h ≥356 mm and 0 fish/h ≥457) mm also decreased relative to the June sample (Figure 5-9).

Stocking

The Cherokee tailwater received 26,000 adult (mean length, 241 mm) Rainbow Trout and 9,000 sub-adult (mean length, 209 mm) Brown Trout in 2019 (Figure 5-10). Stocking rates during the past five years have averaged 27,000 adult Rainbow Trout and 28,000 sub-adult Brown Trout annually. There is little correlation between adult/sub-adult Rainbow Trout and Brown Trout stocking rates during October-May (35,000-109,000) and subsequent fall electrofishing catch rates (Figure 5-11).

Water Temperature Monitoring

Temperature data were collected again (measured hourly by Onset TidbiT® *v2* loggers) near Cherokee Dam and at Blue Spring during June-November 2019. Water temperatures near Cherokee Dam were warmer than in any year since monitoring began there in 2005. Maximum daily water temperature was ≥21° C for 76 days (17 September-31 October; Figure 5-12) and exceeded 26° C 16 days during 14 September-6 October. Minimum daily water temperature reached 21° C on 18 August and remained ≥21° C through 27 October (71 days; Figure 5-12), thus there was no coldwater habitat during that period. Based on 2005-2019 data, there is no coldwater habitat (daily minimum water temperature is ≥21° C) near the dam during 15 September through 9 October (Figure 5-12).

Water temperatures at the Blue Spring site (13 km below Cherokee Dam) in 2019 were warmer than in any year since 2003. Maximum daily water temperature was ≥21° C for 95 days (during 19 July-31 October; Figure 5-13) and exceeded 26° C 21 days during 12 September-5 October. Minimum daily water temperature reached 21° C on 17 August and remained ≥21° C through 22 October (67 days; Figure 5-13), thus there was no coldwater habitat during that period. Based on 2005-2019 data, there is no coldwater habitat (daily minimum water temperature is ≥21° C) at Blue Spring during 1 September through 9 October (Figure 5-13).

Cherokee tailwater, October 2019.

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 = 0.52) inverse relationship (2^{nd} order polynomial) between the number of days where minimum water temperature was ≥22° C at the Blue Spring site and the electrofishing catch rate (log_{10}-transformed +1; Figure 5-14). There is also a relatively strong (R^2 = 0.62) positive relationship (2^{nd} 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 5-15). 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 be offer little benefit, as few fish protected by such measures would survive the next summer thermal bottleneck. Summer and fall sampling at the 12 existing monitoring stations, along with annual water temperature monitoring, should continue in order to provide information necessary for developing a trout fishery management plan for this tailwater (to begin during 2020). Objectives will likely focus on determining optimal annual stocking rates and evaluating survival and growth of various stocked cohorts.

Cherokee Tailwater

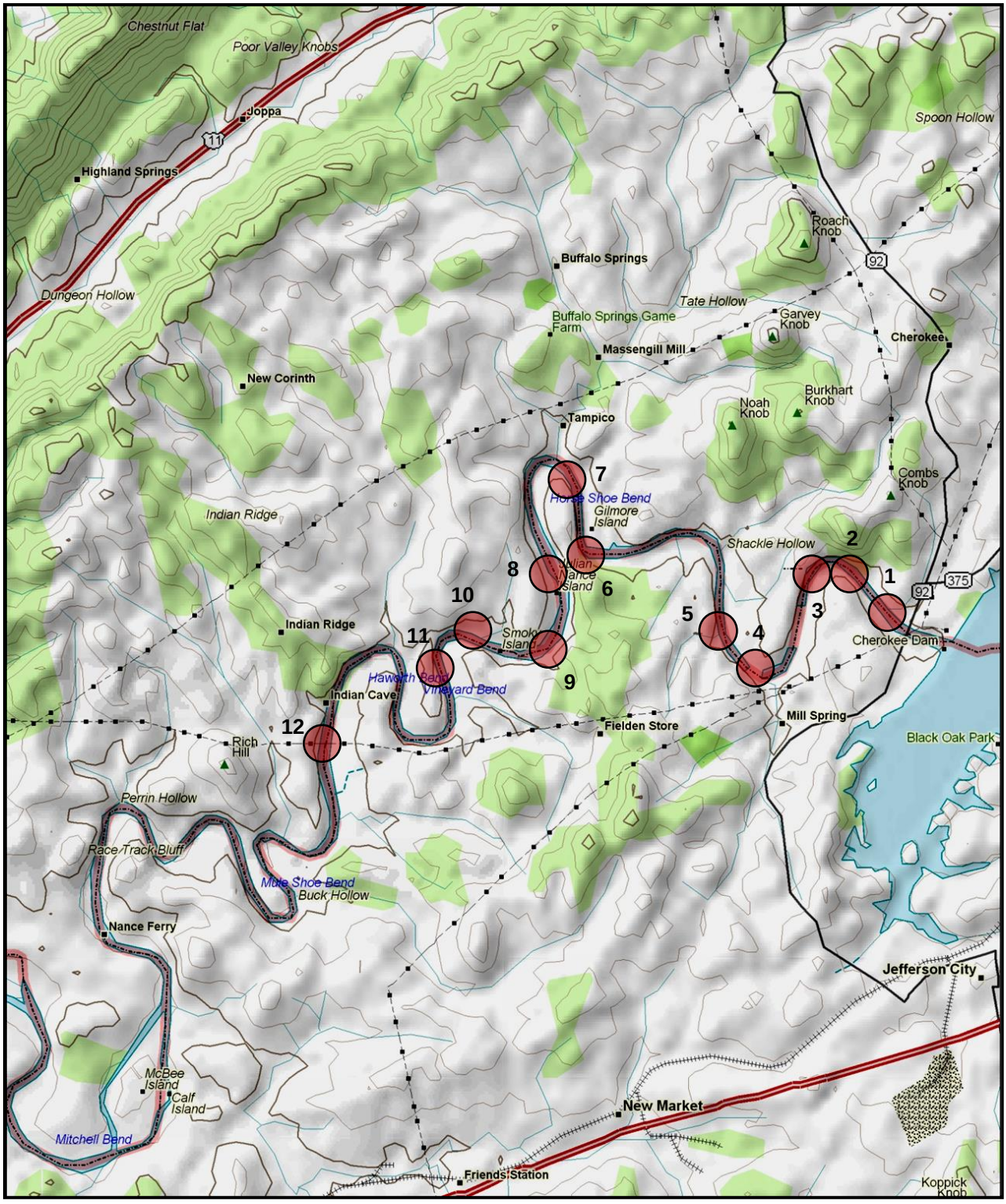


Figure 5-6. Locations of the Cherokee tailwater (Holston River) monitoring stations.

Table 5-2. Catch data for the 12 electrofishing stations on the Cherokee tailwater sampled 17 June 2019.

Station	Species	Total Catch	Size Range (mm)	Total weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow	1	324	467	100	100
	Brown	0	--	0	0	0
Totals		**1**		**467**	**100**	**100**
2	Rainbow	2	365-399	1,276	100	100
	Brown	0	--	0	0	0
Totals		**2**		**1,276**	**100**	**100**
3	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
4	Rainbow	1	394	718	100	100
	Brown	0	--	0	0	0
Totals		**1**		**718**	**100**	**100**
5	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
6	Rainbow	1	438	948	100	100
	Brown	0	--	0	0	0
Totals		**1**		**948**	**100**	**100**
7	Rainbow	1	153	36	100	100
	Brown	0	--	0	0	0
Totals		**1**		**36**	**100**	**100**
8	Rainbow	0	--	0	0	0
	Brown	1	278	246	33	71
Totals		**1**		**246**	**100**	**100**
9	Rainbow	14	313-560	11,728	100	100
	Brown	0	--	0	0	0
Totals		**14**		**11,728**	**100**	**100**
10	Rainbow	4	308-472	2,800	100	100
	Brown	0	--	0	0	0
Totals		**4**		**2,800**	**100**	**100**
11	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
12	Rainbow	5	321-411	2,692	83	90
	Brown	1	295	284	17	10
Totals		**6**		**2,976**	**100**	**100**
Total Rainbows		29	153-560	20,665	94	84
Total Browns		2	278-295	530	6	16
Overall		**31**		**24,628**	**100**	**100**

Table 5-3. Catch data for the 12 electrofishing stations on the Cherokee tailwater sampled 29 October 2019.

Station	Species	Total Catch	Size Range (mm)	Total weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
2	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
3	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
4	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
5	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
6	Rainbow	1	365	395	100	100
	Brown	0	--	0	0	0
Totals		**1**		**395**	**100**	**100**
7	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
8	Rainbow	1	396	598	100	100
	Brown	0	--	0	0	0
Totals		**1**		**598**	**100**	**100**
9	Rainbow	0	--	0	0	0
	Brown	0	--	0	0	0
Totals		**0**		**0**	**0**	**0**
10	Rainbow	1	384	512	100	100
	Brown	0	--	0	0	0
Totals		**1**		**512**	**100**	**100**
11	Rainbow	0	--	0	0	0
	Brown	1	325	325	100	100
Totals		**1**		**1,187**	**100**	**100**
12	Rainbow	2	376-397	1,126	100	100
	Brown	0	--	0	0	0
Totals		**2**		**1,651**	**100**	**100**
Total Rainbows		5	365-397	2,631	83	89
Total Browns		1	325	325	17	11
Overall		**6**		**2,956**	**100**	**100**

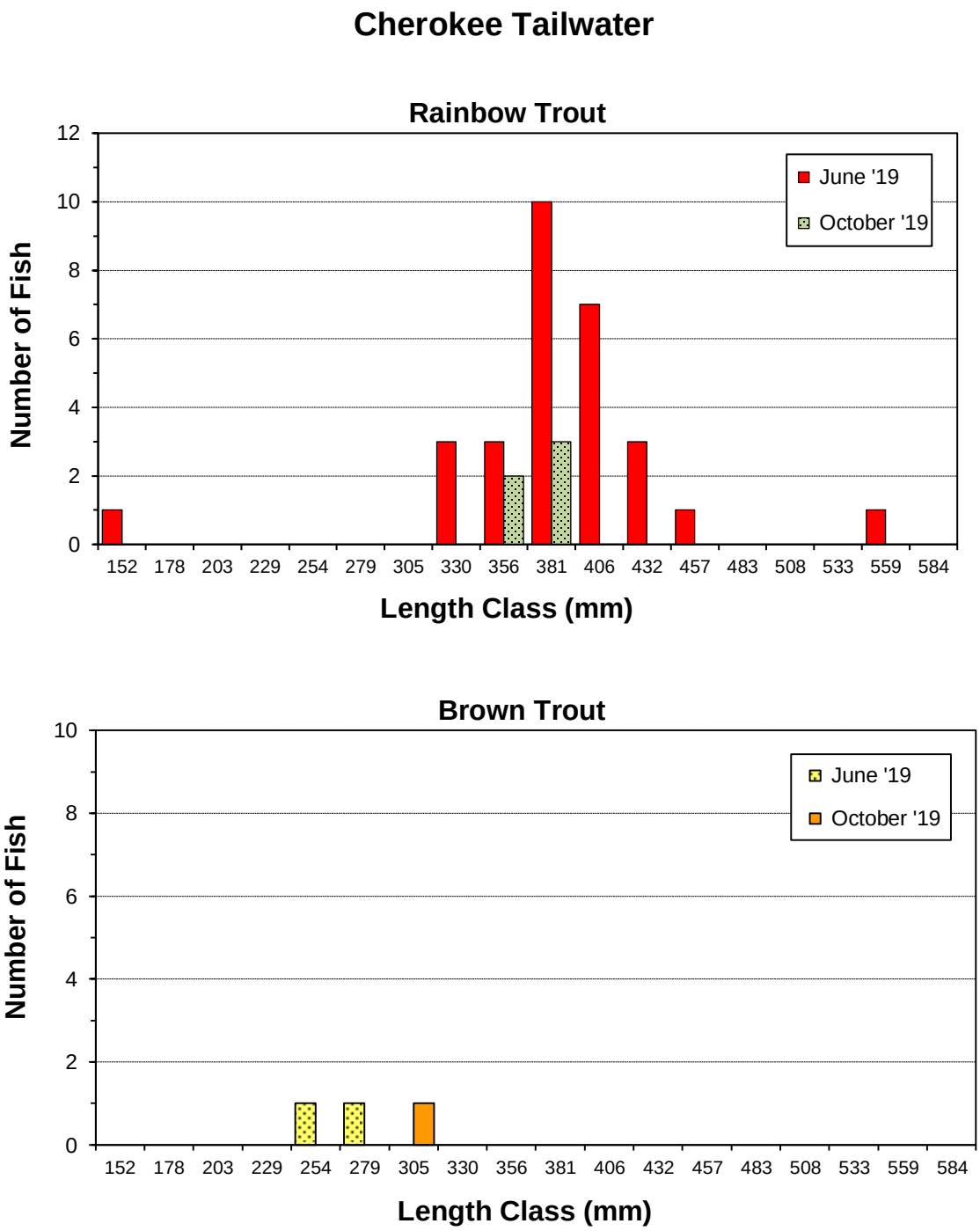


Figure 5-7. Length frequency distributions for trout from the Cherokee tailwater monitoring stations during the June and October 2019 samples.

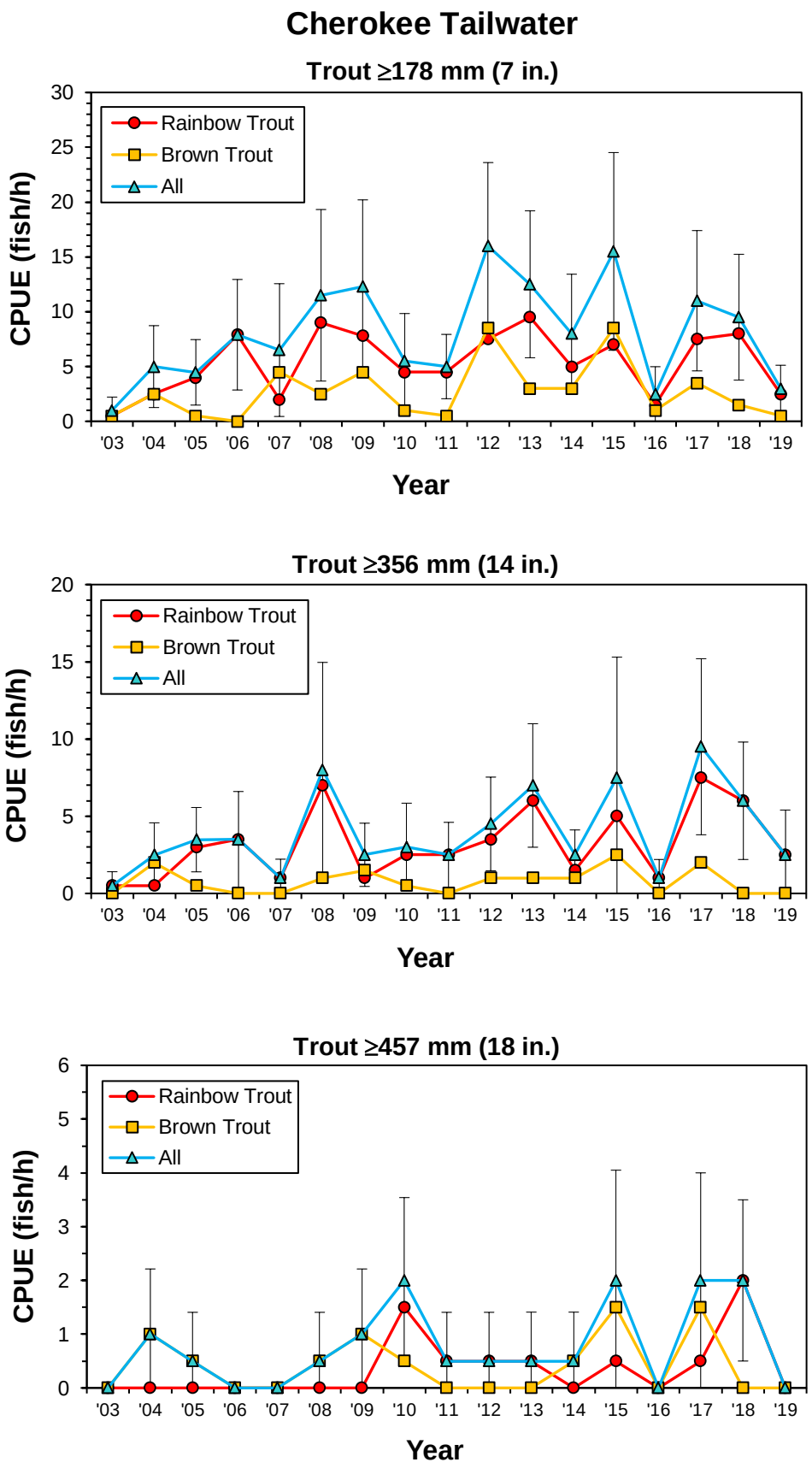


Figure 5-8. Mean trout CPUEs for the annual October Cherokee tailwater samples. Bars indicate 90% confidence intervals.

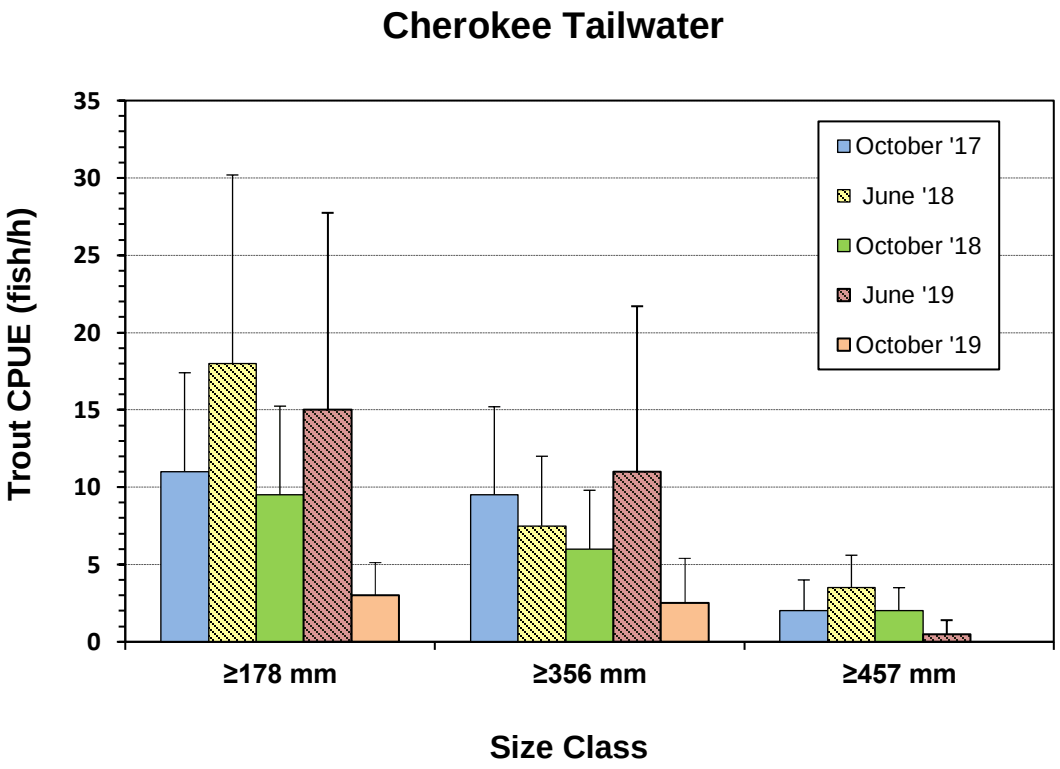


Figure 5-9. Mean CPUEs (by trout size class) for the previous five Cherokee tailwater samples (October 2017-October 2019). Bars indicate 90% confidence intervals.

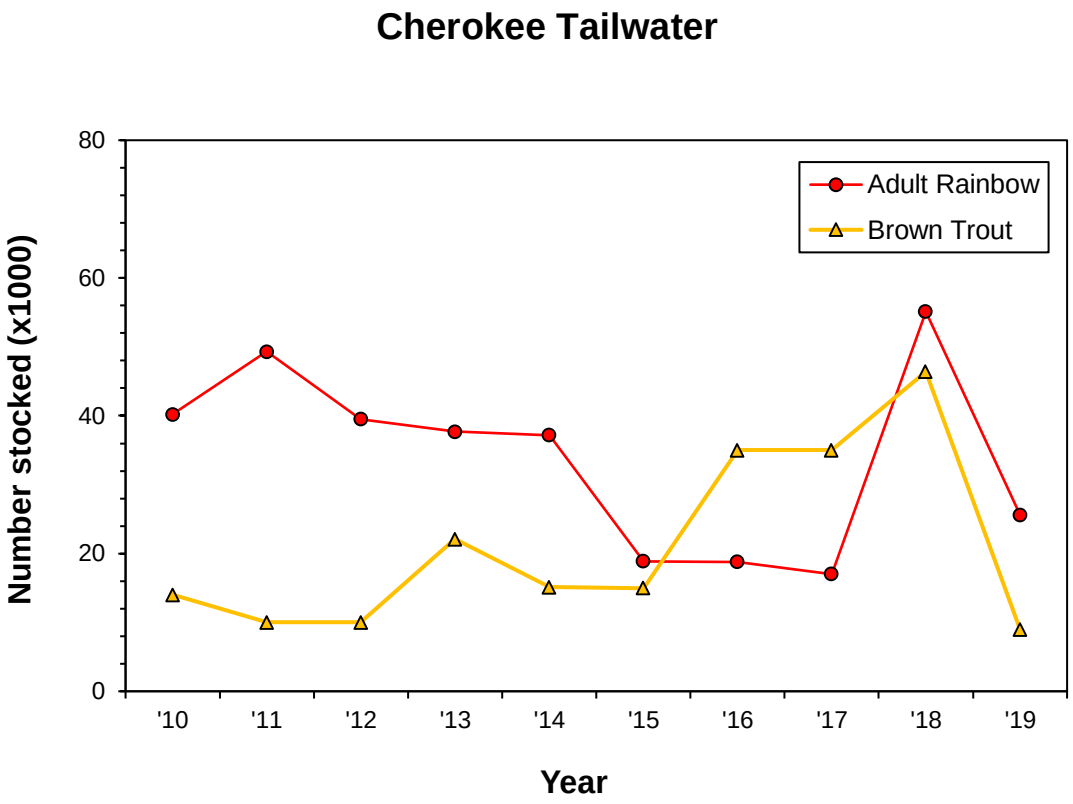


Figure 5-10. Recent trout stocking rates for the Cherokee tailwater. About 27,000 adult Rainbow Trout and 28,000 Brown Trout have been stocked annually since 2015.

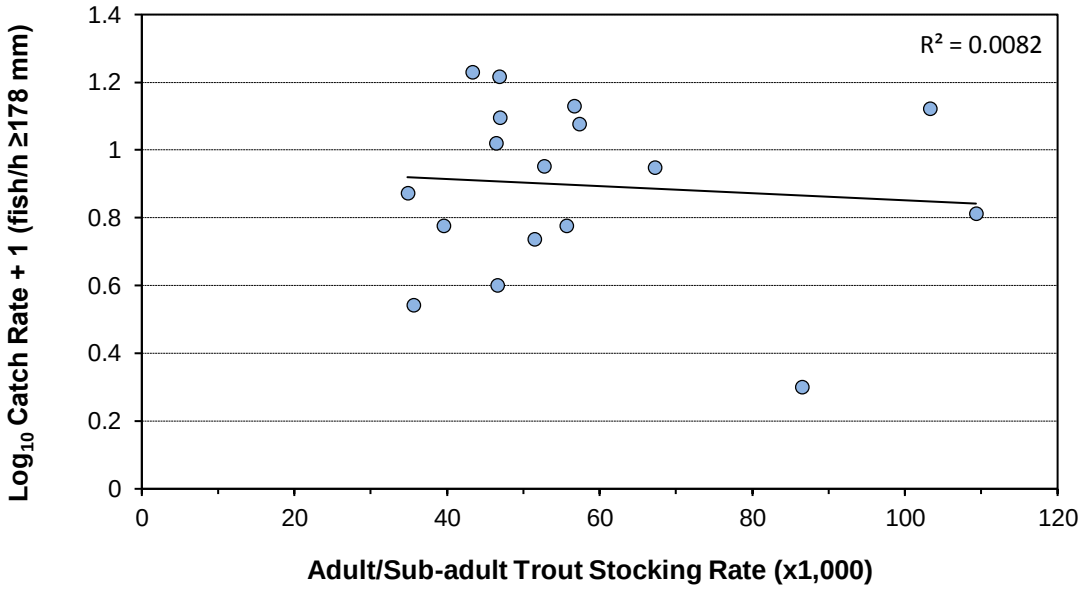


Figure 5-11. Relationship between trout stocking rates (Rainbow Trout and Brown Trout) during October-May and subsequent fall electrofishing catch rates for the Cherokee tailwater.

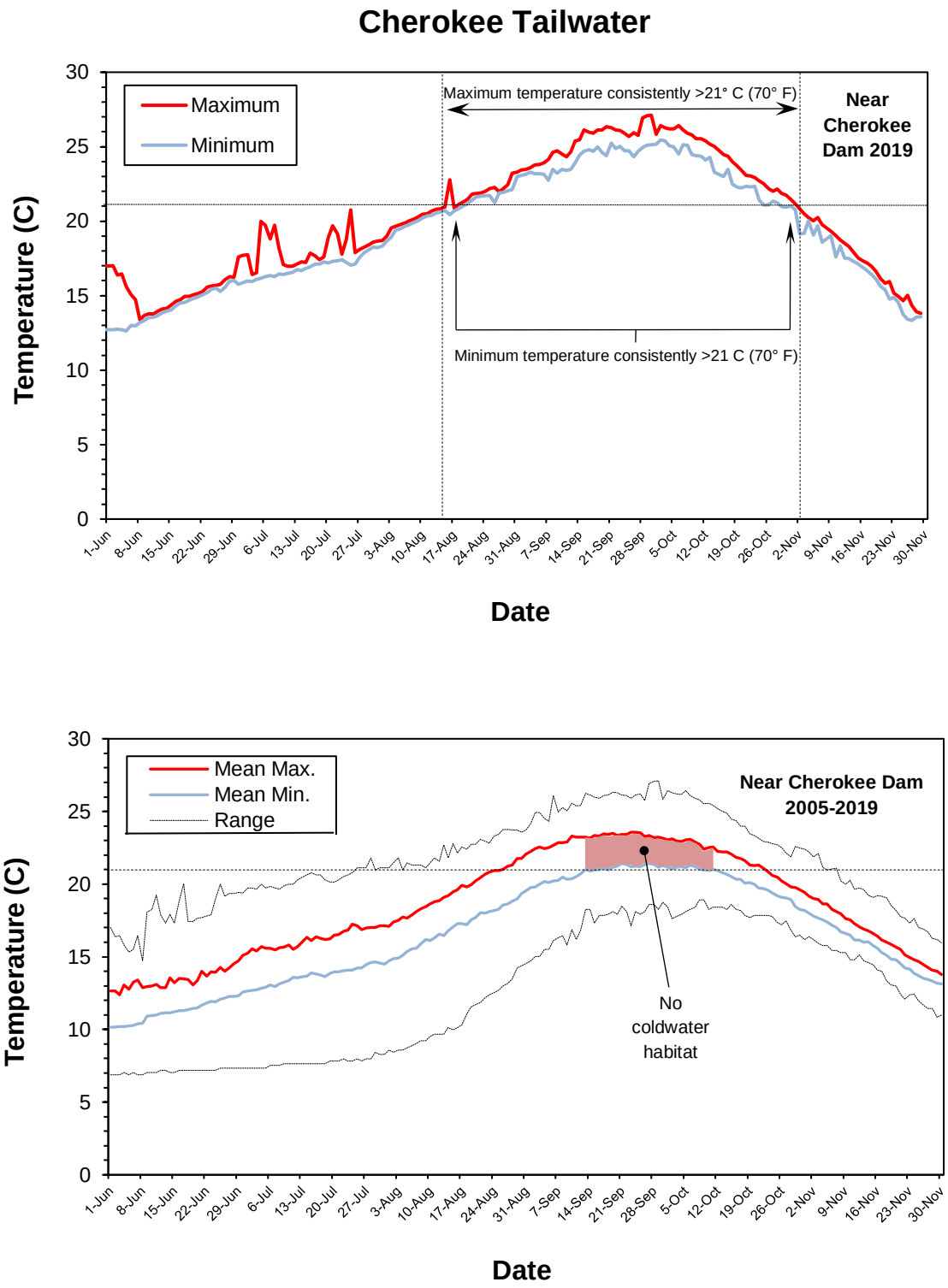


Figure 5-12. Daily temperature maxima and minima for June-November near Cherokee Dam (~1.6 km below the dam) in 2018 (upper graph) and 2005-2019 means (lower graph, with range).

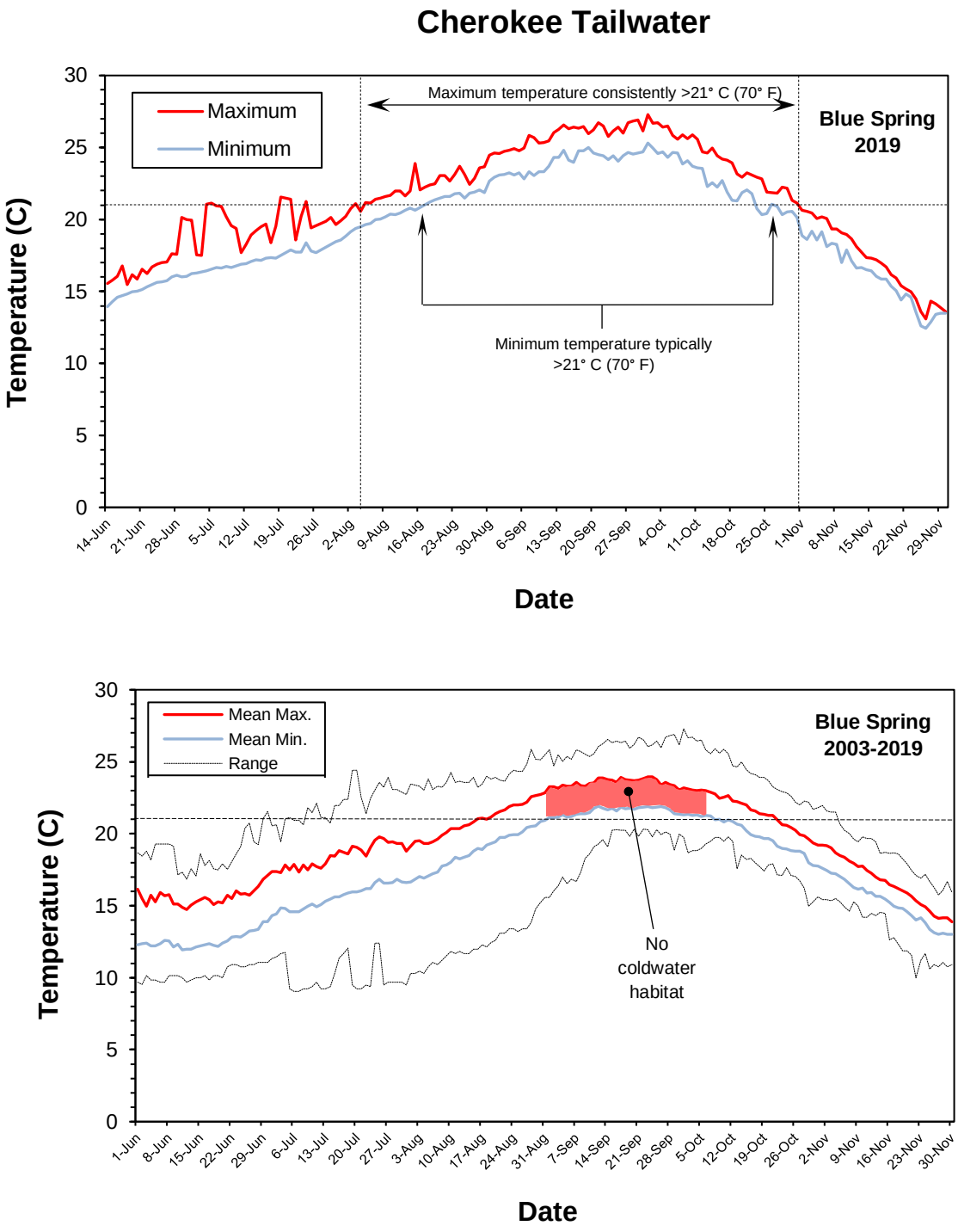


Figure 5-13. Daily temperature maxima and minima for June-November at Blue Spring (~13 km below the dam) in 2019 (upper graph) and 2003-2019 means (lower graph, with range).

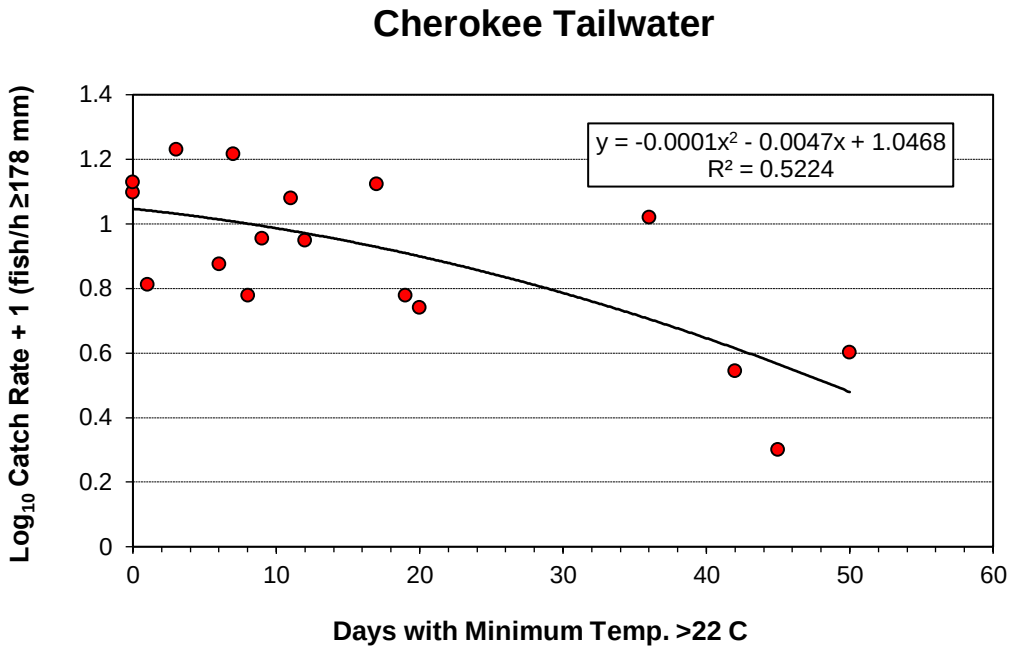


Figure 5-14. Inverse relationship between temperature (days during June-Oct. with minimum >22 C at Blue Spring) and October electrofishing catch rate for the Cherokee tailwater.

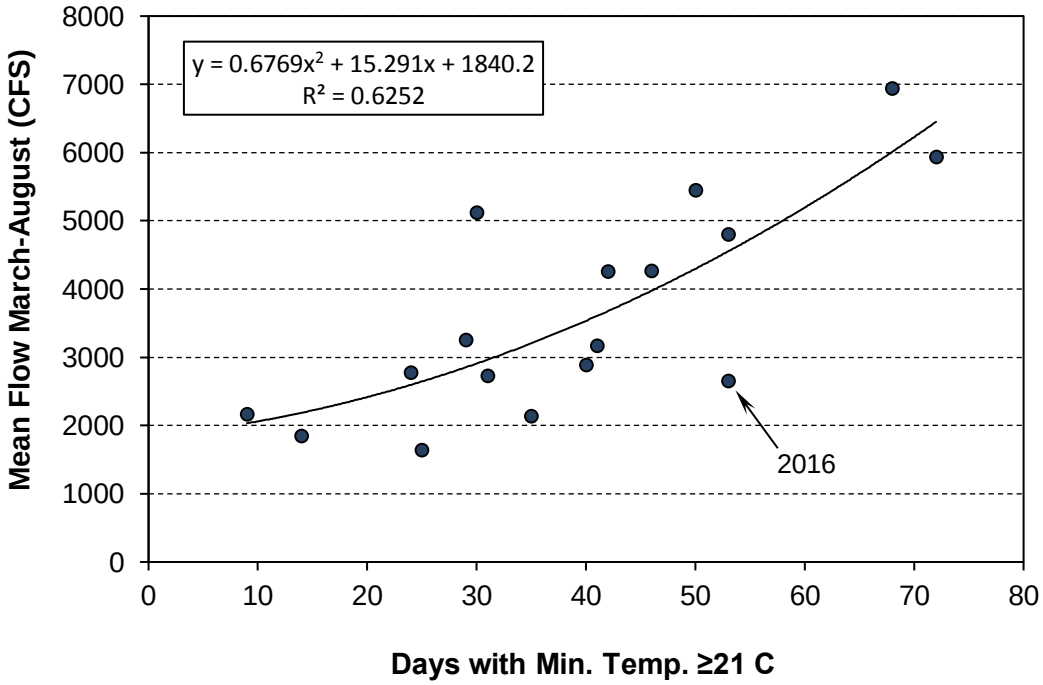


Figure 5-15. Relationship between mean flow (March-August) and temperature (days during June-October with minimum ≥21 C at Blue Spring) for the Cherokee tailwater.

Wilbur (Watauga River)

Catch and Length Frequency

The 12 Wilbur tailwater monitoring stations (Figure 5-19) produced 637 trout weighing nearly 140 kg in 2019 (Table 5-4). Data from Station 10.5 are used only for comparing electrofishing catch rates inside and outside the QZ. Brown Trout reached 85% of the total catch in 2019 and more were captured during the 2019 monitoring efforts than in any previous survey total catch or fish (≥178 mm). Most Brown Trout (75%) and Rainbow Trout (83%) in 2019 were in the 203-305 mm size range (Figure 5-17). Along with the increase in overall catch, more Brown Trout ≥508 mm (20 in.) were captured in 2019 (9; Figure 5-17) than in any previous sample.

Electrofishing at a Wilbur tailwater monitoring station.

CPUE

The mean catch rate for all trout ≥178 mm increased to 290 fish/h in 2019 and Brown Trout CPUE reached its highest level to date (242 fish/h, Figure 5-18). Mean Brown Trout CPUE for the upper portion of the tailwater (Stations 1-6) reached 400 fish/h in 2019, while mean CPUE has remained below 100 fish/h in the lower portion of the tailwater (Figure 5-19). An objective of the current Wilbur tailwater management plan (Habera et al. 2015b) is to maintain a mean Brown Trout catch rate of ≥40 fish/h (≥178 mm) in the lower portion of the tailwater and this has been accomplished.

The mean catch rate for larger trout (≥356 mm) exceeded 20 fish/h again in 2019 and has been in the 20-27 fish/h range since 2010 (Figure 5-17). The mean catch rate for the largest trout (≥457 mm) increased to 8 fish/h in 2019 (Figure 5-17)—the highest level observed to date. All of the trout in this size range were Brown Trout. Large Rainbow Trout identifiable as retired brood-stock from Erwin National Fish Hatchery (ENFH) are not included in the analysis.

A 665 mm (26.2 in.), 2.6 kg (5.8 lb.) Brown Trout from the 2019 Wilbur tailwater sample Station 11).

Anglers have recently reported poor results for Rainbow Trout in the Wilbur tailwater reach downstream of Blevins Bend (includes Stations 9-12, Figure 5-16), causing some to shift their effort to the upper tailwater. Increased predation by Striped Bass *Morone saxatilis* from Boone Reservoir—possibly as a result of the extended drawdown for repairs to the dam—has been suggested as the cause for the poor results. TWRA conducted an effort to assess Striped Bass abundance in this area in 2018 (Habera et al. 2019). An examination of Rainbow Trout CPUE data (fish ≥178 mm) from the tailwater below Blevins Bend (including Station 10.5) does indicate a decline since 2017 (Figure 5-20). Actions to address this issue are provided in the Stocking and Management Recommendations sections below.

Stocking

The Wilbur tailwater was stocked with 42,000 adult Rainbow Trout during 2019 (Figure 5-21) as directed in the current management plan (Habera et al. 2015b). The 50,000 fingerling Rainbow Trout prescribed by the management plan annual were also stocked, along with 5,000 surplus fingerlings from ENFH and 18,000 from Buffalo Springs Hatchery (Figure 5-21). ENFH and TWRA have now developed annual allocations for retired Rainbow Trout broodstock and Wilbur Tailwater is to receive about 2,000 of these annually. Many were stocked in the lower portion of the tailwater in late 2019 to supplement the fishery there.

Angler Surveys

Roving creel surveys on the Wilbur tailwater have been conducted by TWRA in 2013 (Black 2014), 2016 (Black 2017), and 2018 (Black 2019). Wilbur tailwater angling effort in 2018 was almost entirely directed at trout (98%). The 2018 survey indicated that estimated pressure, trips, catch, and harvest decreased relative to 2016 (see table below). However, except forf harvest, the 2018 results were similar to those for the 2013 survey.

Year	Pressure (h)	Mean Trip length (h)	Trips	Catch[a]	Harvest[a]	Harvest Rate (%)
2013	61,764	3.88	15,909	103,233 (68)	14,234 (86)	14
2016	112,627	4.90	22,965	213,673 (71)	21,477 (88)	10
2018	61,026	5.03	12,135	102,160 (70)	9,484 (87)	9

[a]Values in parentheses are percentages represented by Rainbow Trout.

While average catch per trip decreased by about one fish between 2016 and 2018 (from 9.3 to 8.4), what has changed most notably over the three surveys is angler harvest rate. Anglers harvested 14% of the trout they caught in 2013, 10% in 2016, and 9% in 2018. Despite the increasing relative abundance of Brown Trout since 2016 (Figure 5-19), the proportions of both species represented in catch and harvest estimates has remained relatively unchanged. A new angler survey will be conducted on the Wilbur tailwater in 2020.

Myxobolus Screening

The parasite that causes whirling disease (*Myxobolus cerebralis*) was detected in both Rainbow Trout and Brown Trout (adult fish) from the Wilbur tailwater as a result of screening efforts in 2017 conducted by the U.S. Fish and Wildlife Service's Warm Springs lab (Habera et al. 2018). A composite sample of 30 age-0 Rainbow Trout from the Siam Bridge and Hunter Bridge areas was collected in July 2019 and analyzed by the Southeastern Cooperative Fish Parasite and Disease Lab (SCFPDL) at Auburn University. Results for these fish were negative. An adult Rainbow Trout collected during the 2019 monitoring efforts exhibited the typical cranial deformity associated with the presence of *M. cerebralis* and is undergoing further histological analyses at SCFPDL (results are pending).

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.

TWRA responded to angler concerns in 2019 about the trout fishery in the lower reach of the Wilbur tailwater by allocating a portion of ENFH's retired Rainbow Trout broodstock for this area in the summer and fall (when Striped Bass are present). Additionally, some of TWRA's annual adult Rainbow Trout allocation was redirected there in November and December for the upcoming 2020-2021 cycle. These changes will be incorporated into the upcoming management plan revision as well.

Wilbur Tailwater

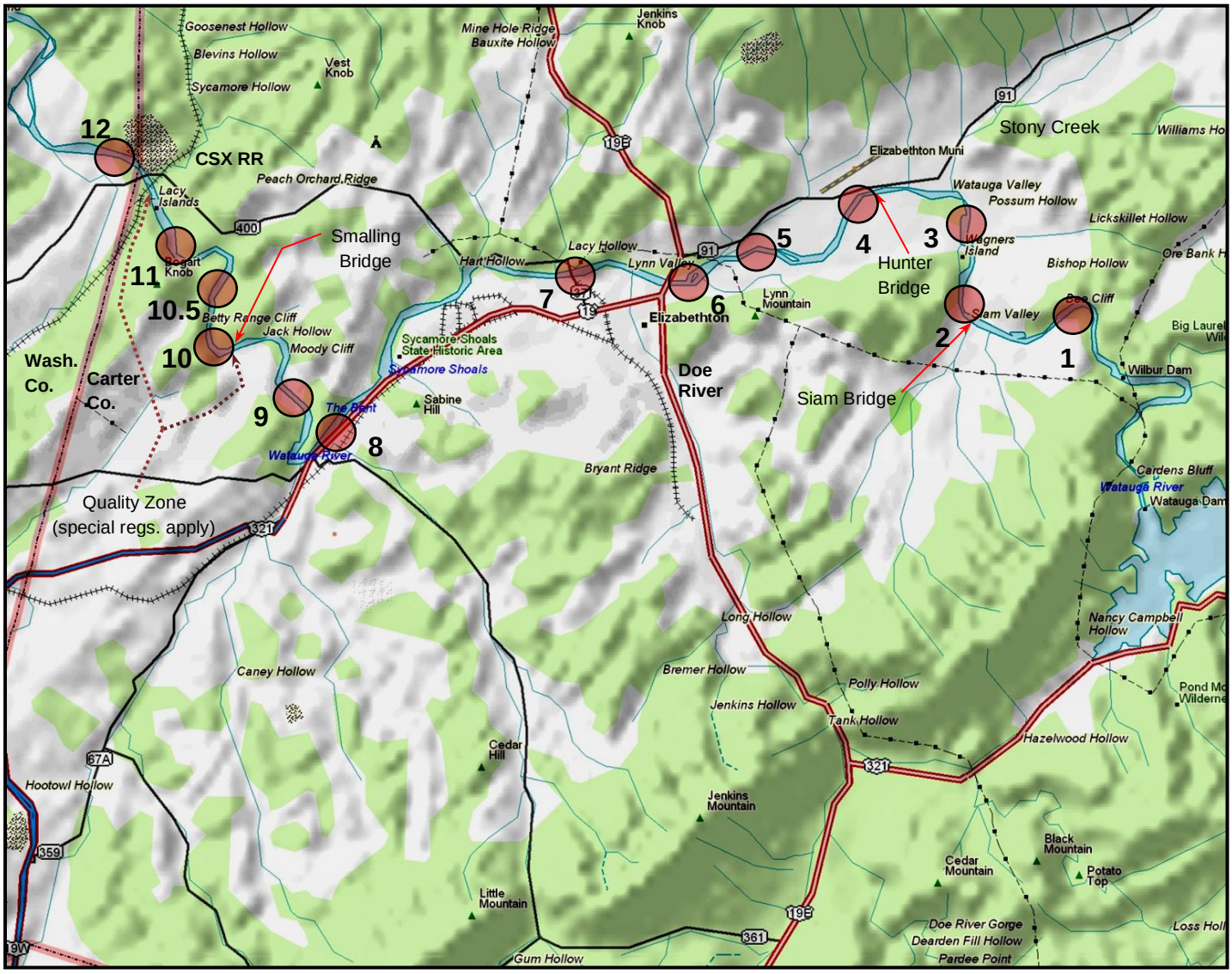


Figure 5-16. Locations of the Wilbur tailwater (Watauga River) monitoring stations. Station 10.5 was added in 2010 to help evaluate the Quality Zone (which also includes stations 10 and 11).

Table 5-4. Catch data for the 13 electrofishing stations on the Wilbur tailwater sampled 7 March 2019.

Station	Species	Total Catch	Size Range (mm)	Total Weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow	8	219-299	1,321	12	10
	Brown	60	157-370	11,917	88	90
Totals		**68**		**13,238**	**100**	**100**
2	Rainbow	15	212-341	2,633	14	13
	Brown	95	121-394	17,456	86	87
Totals		**110**		**20,089**	**100**	**100**
3	Rainbow	4	165-264	488	10	9
	Brown	36	127-350	5,020	90	91
Totals		**40**		**5,508**	**100**	**100**
4	Rainbow	8	219-345	1,622	10	11
	Brown	73	139-542	12,724	90	89
Totals		**81**		**14,346**	**100**	**100**
5	Rainbow	6	225-272	941	5	5
	Brown	115	138-620	19,342	95	95
Totals		**121**		**20,283**	**100**	**100**
6	Rainbow	15	221-295	2,718	18	22
	Brown	67	104-350	9,799	82	78
Totals		**82**		**12,517**	**100**	**100**
7	Rainbow	6	198-377	1,150	15	14
	Brown	33	143-448	7,299	85	86
Totals		**39**		**8,449**	**100**	**100**
8	Rainbow	19	192-336	4,426	70	61
	Brown	8	207-503	2,800	30	39
Totals		**27**		**7,226**	**100**	**100**
9	Rainbow	1	313	272	9	5
	Brown	10	188-451	4,859	91	95
Totals		**11**		**5,131**	**100**	**100**
10	Rainbow	2	198-295	372	15	4
	Brown	11	285-614	10,042	85	96
Totals		**13**		**10,414**	**100**	**100**
10.5	Rainbow	4	209-292	573	44	16
	Brown	5	296-502	2,911	56	84
Totals		**9**		**3,484**	**100**	**100**
11	Rainbow	5	249-399	1,830	16	11
	Brown	26	260-665	14,982	84	89
Totals		**31**		**16,812**	**100**	**100**
12	Rainbow	7	161-450	2,564	50	45
	Brown	7	244-538	3,174	50	55
Totals		**14**		**5,738**	**100**	**100**
Total Rainbows[1]		96	161-450	20,337	15	15
Total Browns[1]		541	111-574	119,414	85	85
Overall totals[1]		**637**		**139,751**	**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).

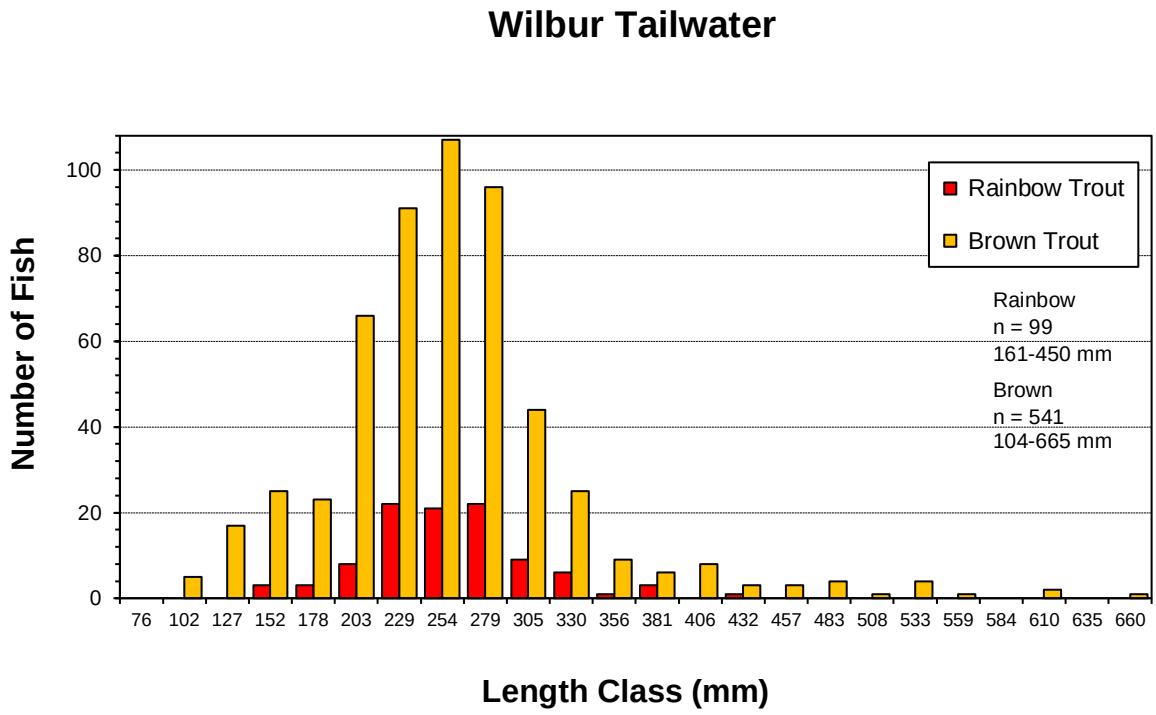


Figure 5-17. Length frequency distributions for trout from the Wilbur tailwater monitoring stations in 2019 (excluding Station 10.5).

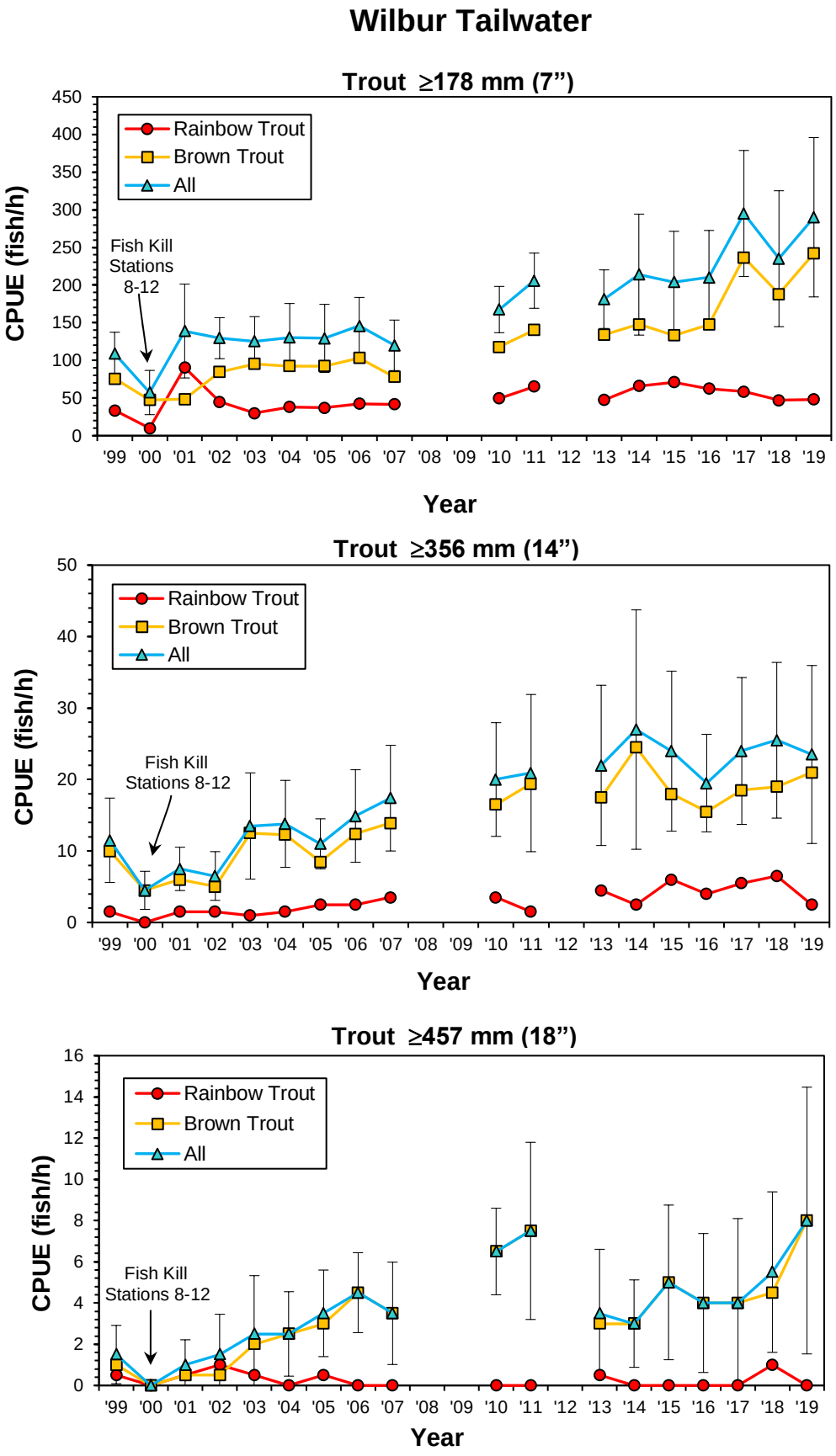


Figure 5-18. Mean trout CPUEs for the Wilbur tailwater samples. Bars indicate 90% confidence intervals.

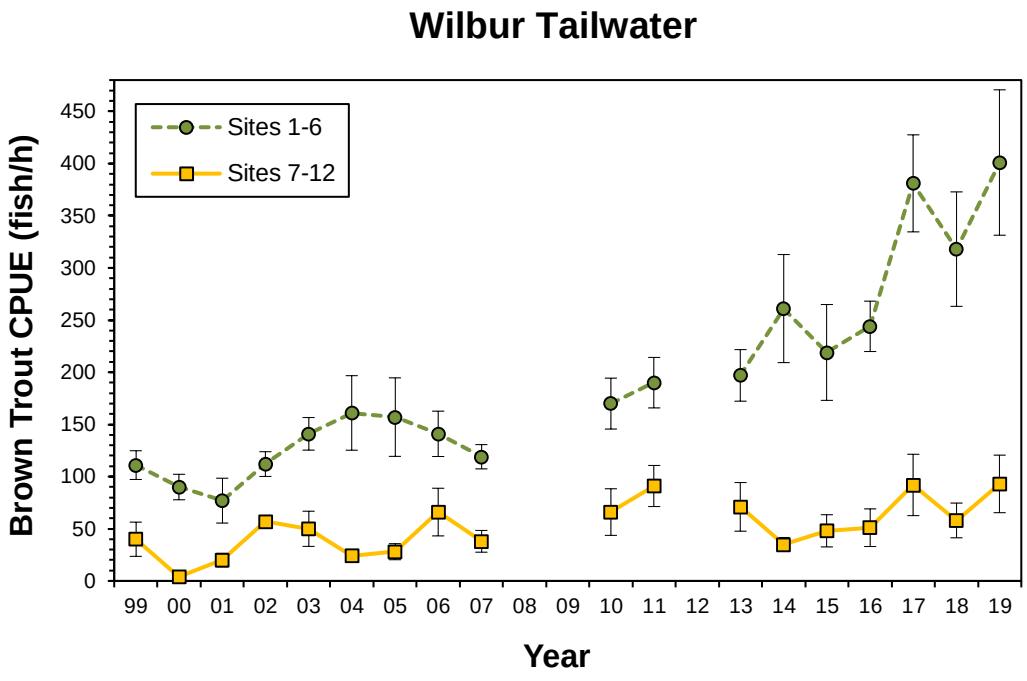


Figure 5-19. Mean Brown Trout CPUEs for the upper (Stations 1-6) and lower (Stations 7-12) portions of the Wilbur tailwater. Bars indicate 90% upper confidence limits.

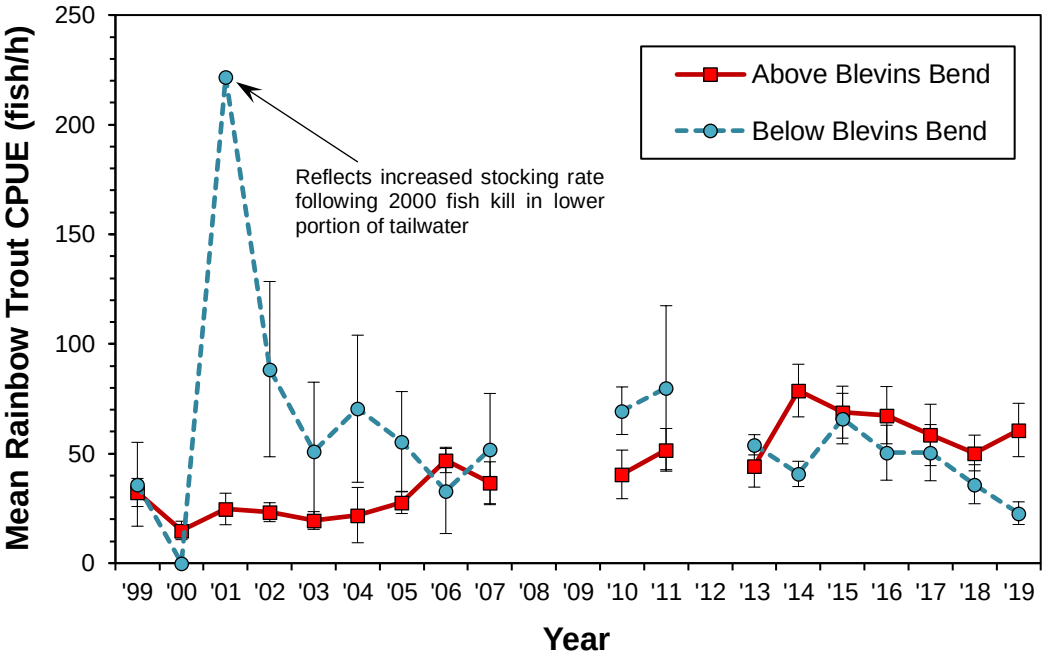


Figure 5-20. Mean Rainbow Trout CPUEs (fish ≥178 mm) for the Wilbur tailwater above (Stations 1-8) and below (Stations 9-12) Blevins Bend. Bars indicate standard errors (SE).

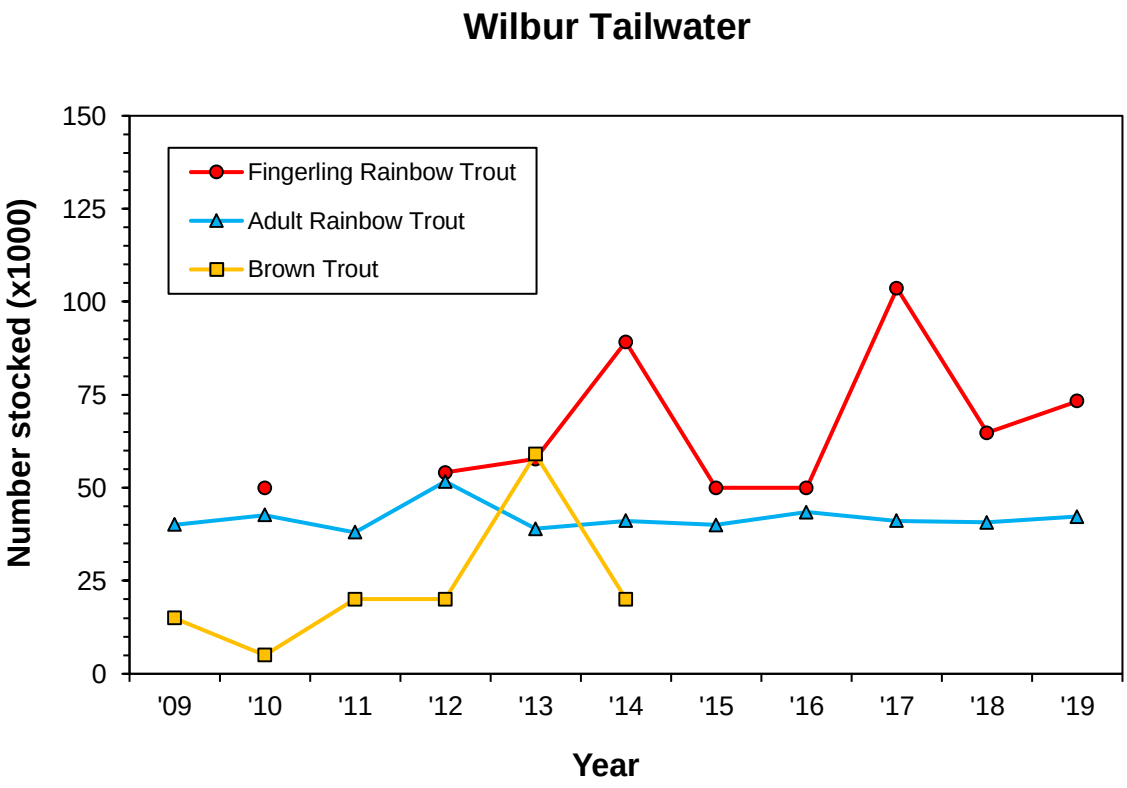


Figure 5-21. Recent trout stocking rates for the Wilbur tailwater. Stocking rates under the current management plan (2015-2020) are 40,000 adult and 50,000 fingerling Rainbow Trout annually.

Fort Patrick Henry (South Fork Holston River)

Catch, Length Frequency, and W_r

The four Ft. Patrick Henry tailwater electrofishing stations (Figure 5-22) produced 37 trout weighing over 367 kg in 2019 (Table 5-5). Rainbow Trout ranged from 253-550 mm and fish in the 356-432 mm (14-17 in.) size classes were most abundant (Figure 5-23). Brown Trout ranged from 379-551 mm (Figure 5-23). Mean relative weight (W_r) was 114 (SE=3.19) for Rainbow Trout and 117 (SE=5.59) for Brown Trout from the 2019 sample.

Brown Trout from the 2019 Ft. Patrick Henry tailwater sample.

CPUE

The mean catch rate for all trout ≥178 decreased slightly to 37 fish/h in 2019 (Figure 5-24). However, mean catch rates for larger trout (≥356 mm and ≥457 mm) increased in 2019 (Figure 5-24) and are now at or above the correspond long-term averages (30 fish/h and 10 fish/h, respectively). 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 5-24).

RSD-18

The relative stock density for Rainbow Trout ≥457 mm or 18 in. (RSD-18) regularly reaches or exceeds 20 (Figure 5-25) 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 29 in 2019 (Figure 5-25), exceeding the objective (20) established in the Boone and Ft. Patrick Henry Tailwater Trout Fisheries Management Plan (Habera et al. 2018a). Rainbow Trout RSD-18 has averaged 28 since 2015 (Figure 5-25).


A large, well-conditioned Ft. Patrick Henry tailwater Rainbow Trout (2019).

Stocking

The Ft. Patrick Henry tailwater was stocked with 9,900 adult Rainbow Trout, 8,000 fingerling Rainbow Trout, and 5,100 subadult Brown Trout in 2019 (Figure 5-26). 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. 2018a).

Research

A multi-year research project through the TN CFRU began in August 2019 to investigate the contributions of stocked fingerling Rainbow Trout any natural reproduction from the Kendrick Creek (Figure 5-22) spawning run to the fishery. Survival and growth of stocked fingerling Rainbow Trout have not been previously assessed in this tailwater and determining optimal stocking rates is an objective of the current trout fisheries management plan for Boone and Ft. Patrick Henry tailwaters (Habera et al. 2018a). All 8,000 fingerlings stocked in 2019 were marked with an adipose clip. Additionally, all 7,500 fingerling Rainbow Trout stocked in the Boone Tailwater in 2019 were marked with left pelvic clips so any that move downstream can be distinguished from the Ft. Patrick Henry tailwater fish and wild fish.

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 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.

Ft. Patrick Henry Tailwater

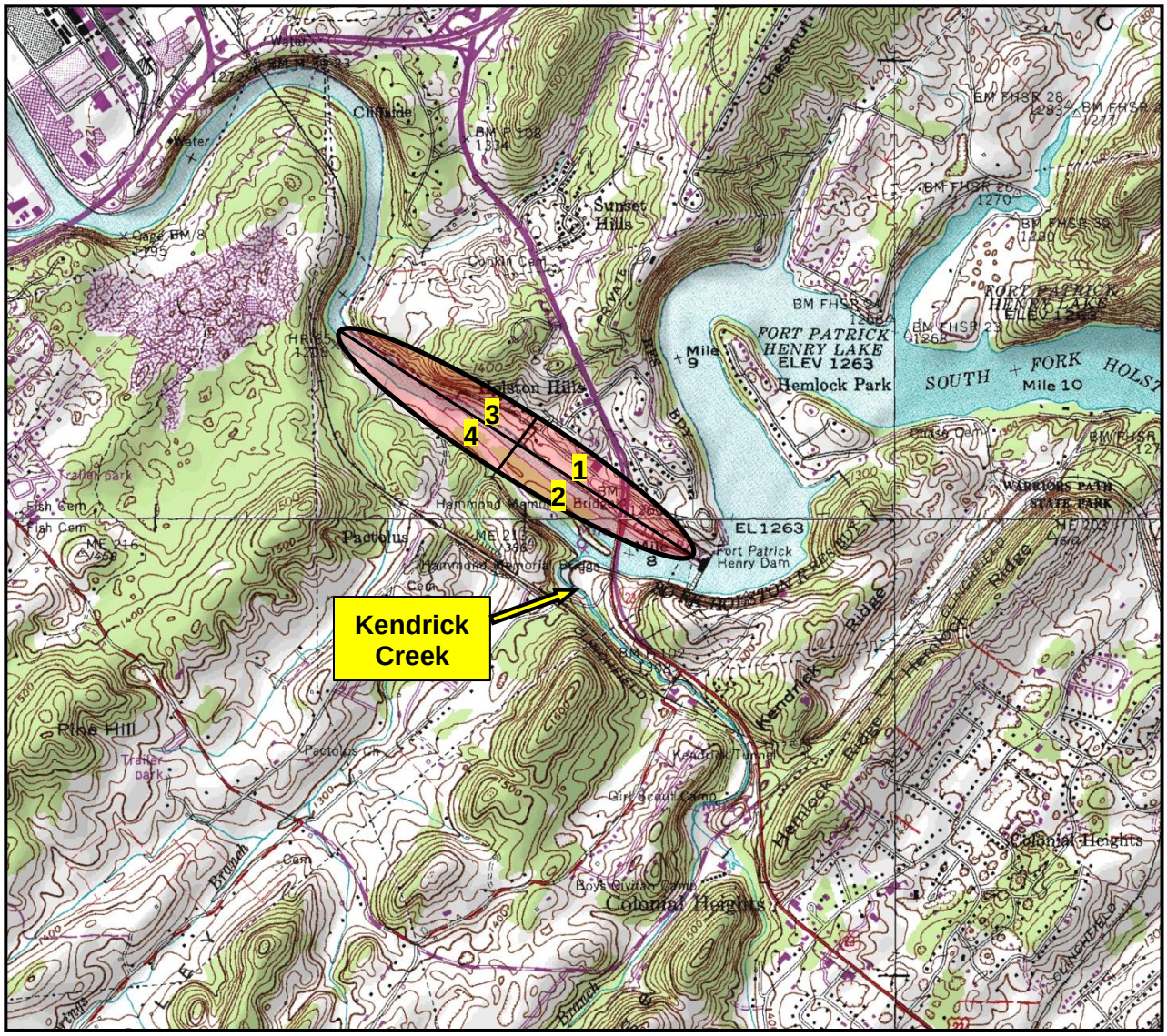


Figure 5-22. Location of the Ft. Patrick Henry tailwater (South Fork Holston River) monitoring stations.

Table 5-5. Catch data for the four electrofishing stations on the Ft. Patrick Henry tailwater sampled 25 March 2019.

Station	Species	Total Catch	Size Range (mm)	Total Weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow Trout	6	368-548	8,743	75	75
	Brown Trout	2	425-539	2,972	25	25
Totals		**8**		**11,715**	**100**	**100**
2	Rainbow Trout	11	300-490	8,135	92	94
	Brown Trout	1	379	534	8	6
Totals		**12**		**8,669**	**100**	**100**
3	Rainbow Trout	3	253-550	3,936	50	56
	Brown Trout	3	406-502	3,152	50	44
Totals		**6**		**7,088**	**100**	**100**
4	Rainbow Trout	9	281-450	5,949	82	59
	Brown Trout	2	505-551	4,199	18	41
Totals		**11**		**10,148**	**100**	**100**
Total Rainbow Trout		**29**	253-550	**26,763**	78	71
Total Brown Trout		**8**	379-551	**10,857**	22	29
Overall totals		**37**		**37,620**	**100**	**100**

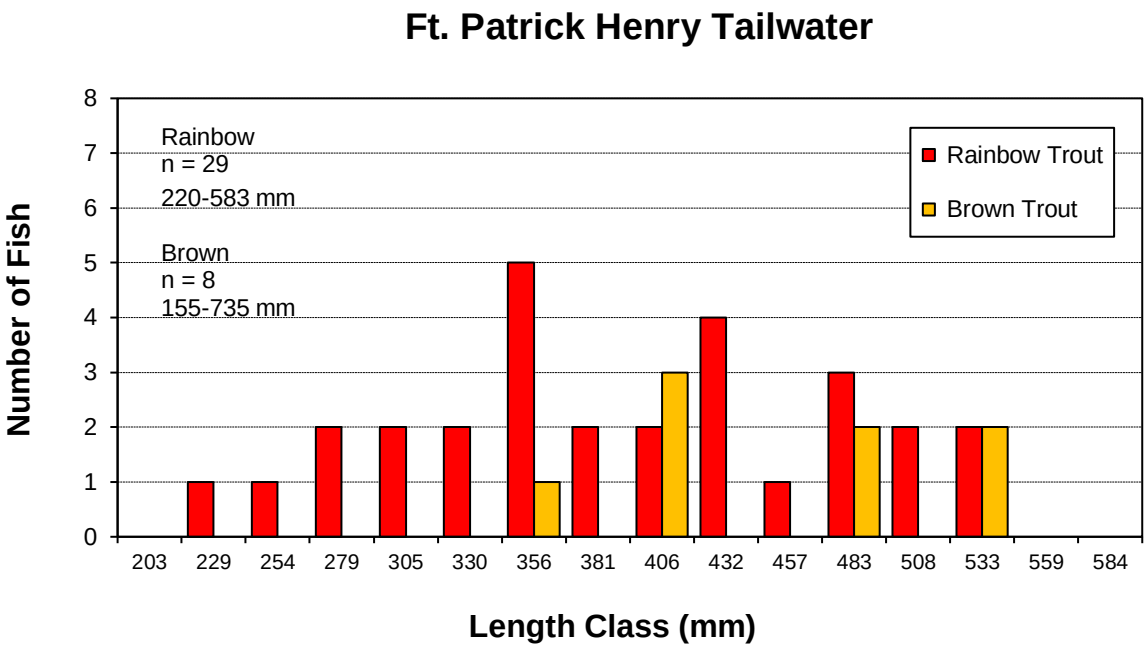


Figure 5-23. Length frequency distributions for trout from the Ft. Patrick Henry tailwater monitoring stations in 2019.

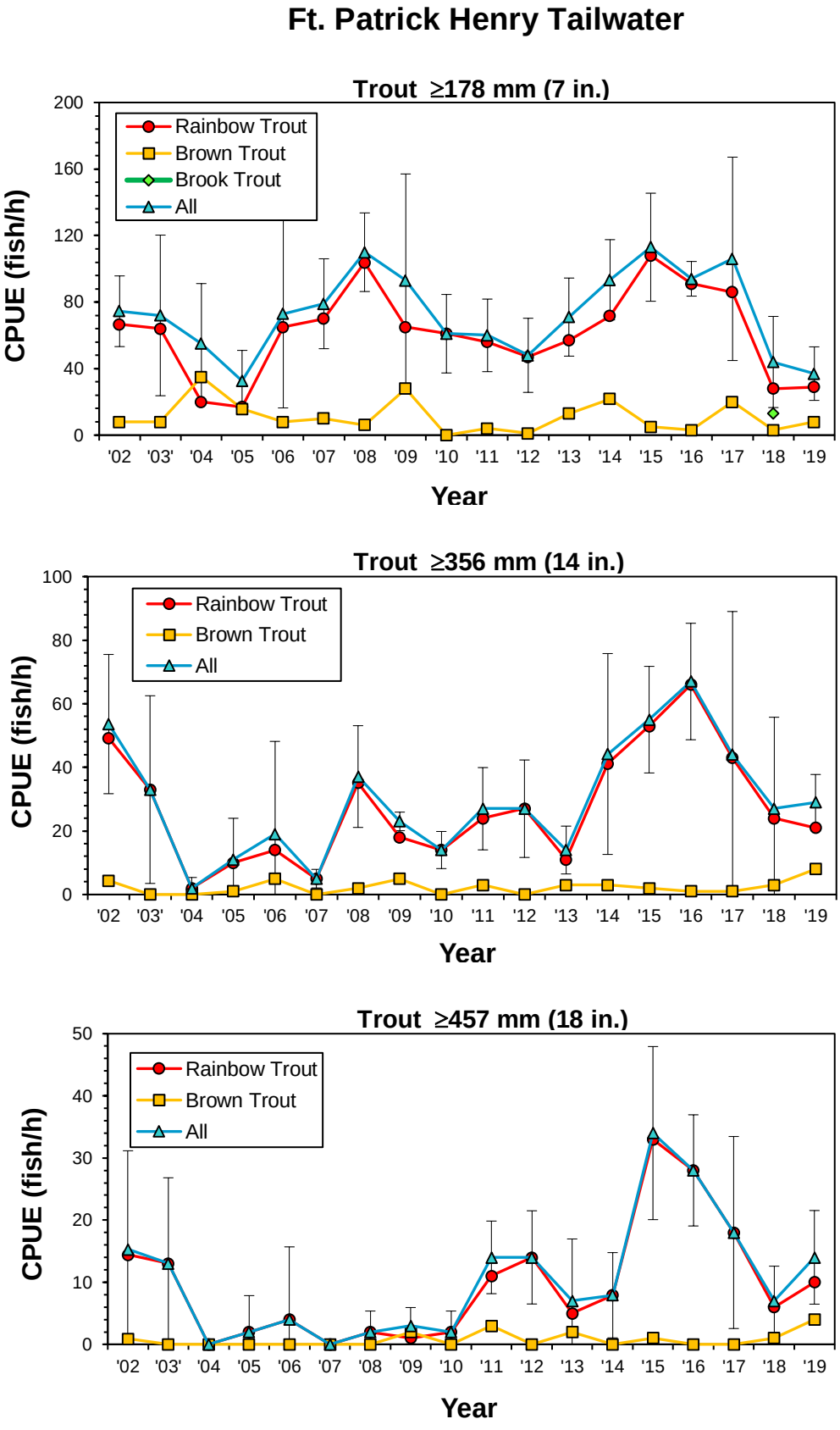


Figure 5-24. Mean trout CPUEs for the Ft. Patrick Henry tailwater sample. Bars indicate 90% confidence intervals.

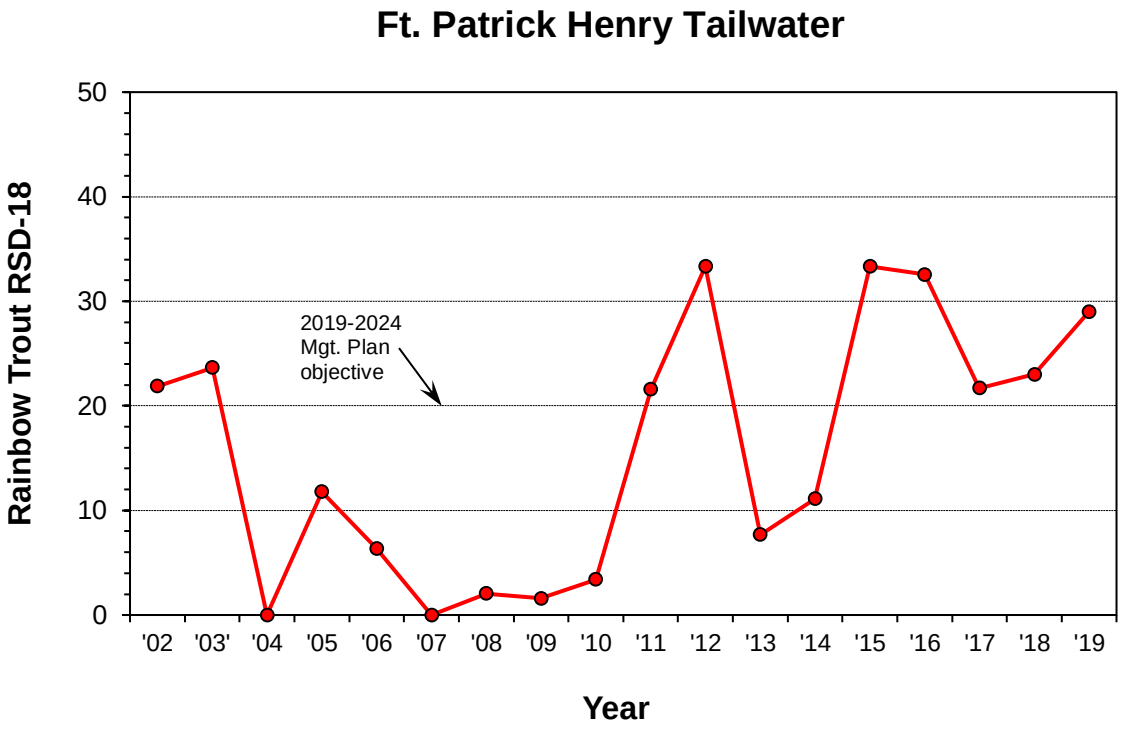


Figure 5-25. RSD-18 for Ft. Patrick Henry tailwater Rainbow Trout.

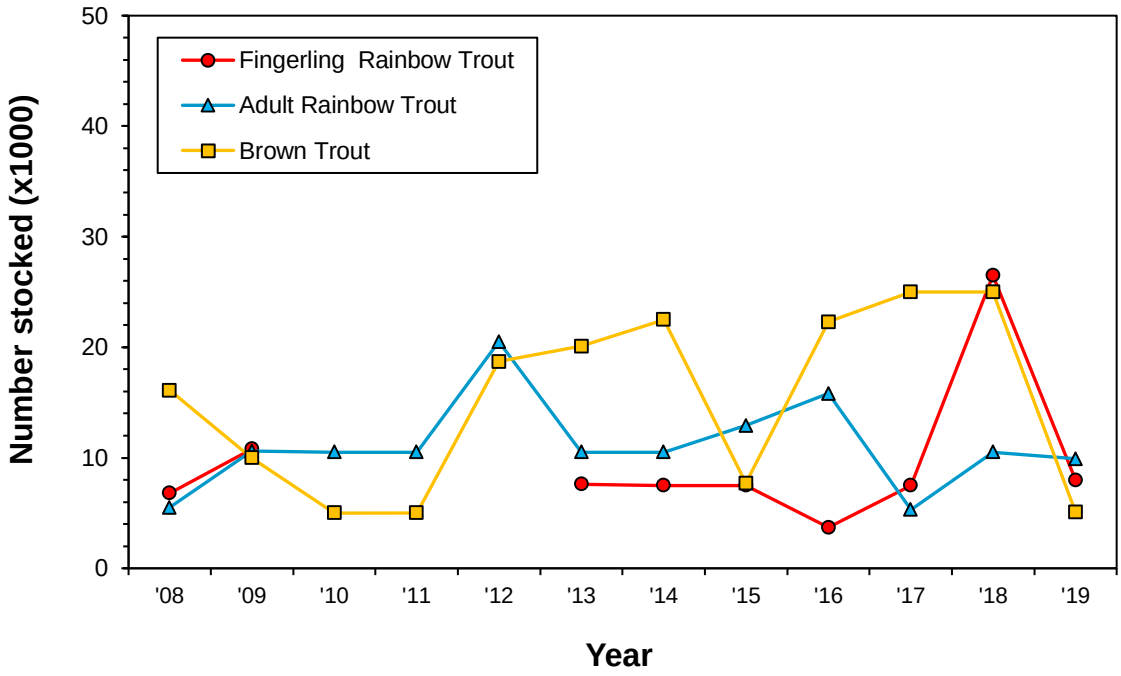


Figure 5-26. Recent trout stocking rates for the Ft. Patrick Henry tailwater.

Boone (South Fork Holston River)

Catch, Length Frequency, and W_r

The four Boone tailwater monitoring stations (Figure 5-27) produced 67 trout (48 Rainbow Trout and 19 Brown Trout) weighing nearly over 50 kg in 2019 (Table 5-6). Rainbow Trout in the 254-279 mm (10-11 in.) size classes were most abundant, although fish ranging up to the 610 mm (24 in.) size class were also captured (Figure 5-28). Brown Trout ranging up to the 635 mm (25 in.) size class were captured and most were ≥330 mm or 13 in. (Figure 5-28). Mean relative weight (W_r) was 102 (SE=2.21) for Rainbow Trout and 109 (SE=3.63) for Brown Trout.

A 24 in., 6.75 lb. Boone tailwater Rainbow Trout (W_r = 122) from the 2019 survey.

CPUE

Although 2019 mean electro-fishing catch rates for Rainbow Trout and Brown Trout ≥178 mm were similar to 2018 CPUEs, the total CPUE decreased (to 65 fish/h) because of the absence of Brook Trout (Figure 5-29). However, catch rates for larger trout (≥356 mm and ≥457 mm) increased relative to 2018 (Figure 5-29). The catch rate for Brown Trout ≥356 mm was the highest observed to date, as was the total catch rate for trout ≥457 mm (Figure 5-29).

A large Brown Trout (25 in., 6.77 lb.) from the 2019 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 5-30). 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. Mean RSD-18 for Boone tailwater Rainbow Trout increased to 23 in 2019 and increased to 27 for all trout (Figure 5-30). This exceeds 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. 2018a).

Stocking

The Boone tailwater was stocked with 10,000 adult Rainbow Trout, 7,500 fingerling Rainbow Trout (marked with left pelvic fin clips), 5,000 subadult Brown Trout, and 3,500 Brook Trout in 2019 (Figure 5-26). 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,

and 2,000 Brook Trout (Habera et al. 2018a). The effectiveness of fingerling Rainbow Trout stocking here (as in the Ft. Patrick Henry tailwater) has not yet been evaluated. All 7,500 fingerlings stocked in 2019 were marked so their growth and recruitment can be generally assessed and they can be distinguished from any wild fish or from fingerlings stocked in the Ft. Patrick Henry tailwater should any move downstream past Ft. Patrick Henry Dam.

Boone Reservoir Drawdown Effects

Repairs to the earthen portion of Boone Dam continued in 2019 and require the extended drawdown of Boone Lake to an elevation of 412 m (1,352')—3.1 m (10') below winter pool. Data from TVA's water quality monitoring station in the tailwater near the dam indicated that water temperatures did not reach 20 °C during 2019. Additionally, there were no particular issues with elevated water temperatures (>21 °C) during 2015-2018 (Habera et al. 2016, 2017, 2018b, 2019). 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 in the 5.0-6.0 mg/l range occurred frequently in 2019, but this was observed during 2016-2018 as well with no apparent effect on the tailwater trout fishery. 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

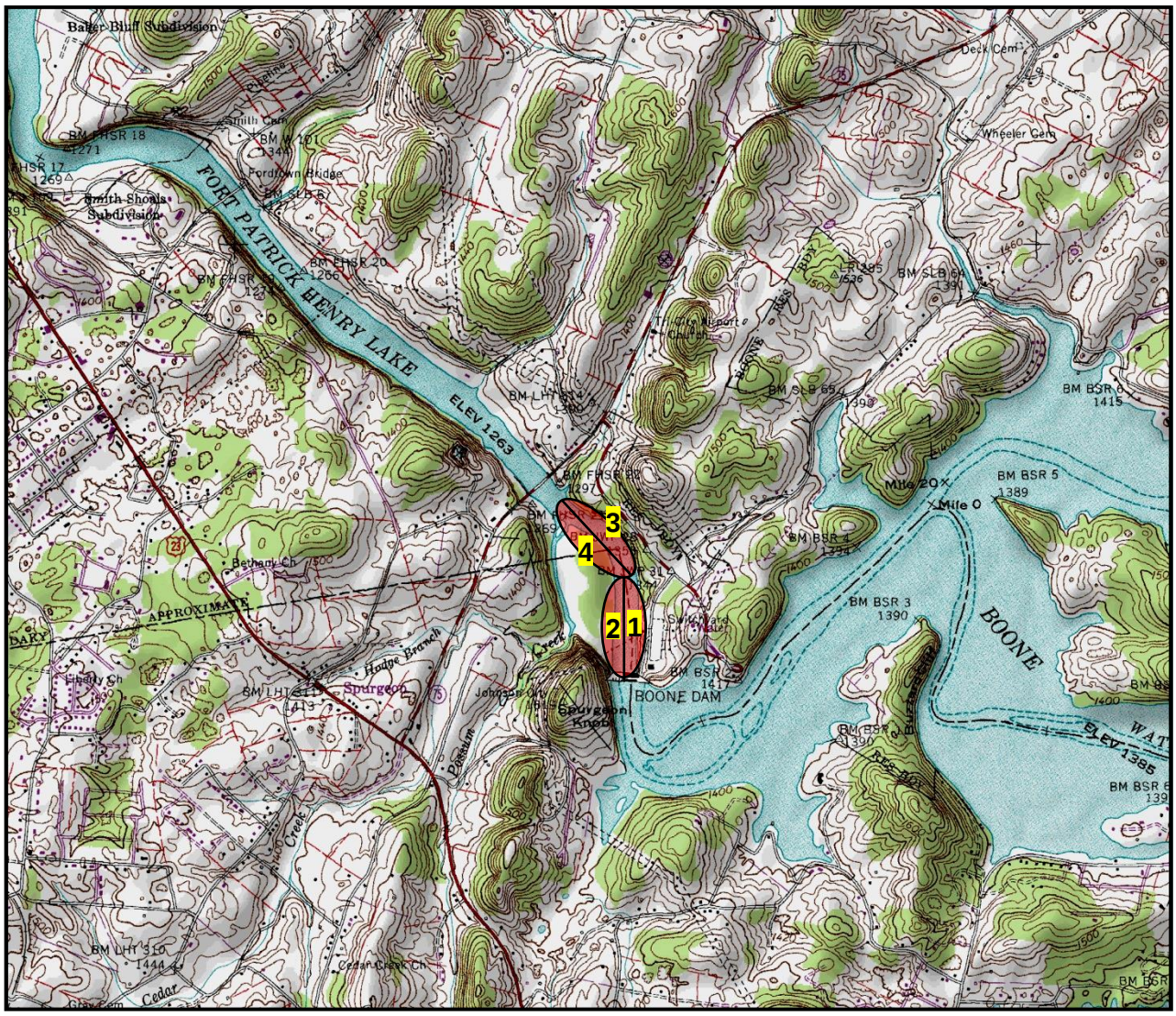


Figure 5-27. Location of the Boone tailwater (South Fork Holston River) monitoring stations.

Table 5-6. Catch data for the four electrofishing stations on the Boone tailwater sampled 25 March 2019.

Station	Species	Total Catch	Size Range (mm)	Total Weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow Trout	13	185-610	9,656	68	50
	Brown Trout	6	332-641	9,845	32	50
Totals		**19**		**19,501**	**100**	**100**
2	Rainbow Trout	21	185-513	8,247	81	65
	Brown Trout	5	168-602	4,390	19	35
Totals		**26**		**12,637**	**100**	**100**
3	Rainbow Trout	6	296-586	7,304	60	62
	Brown Trout	4	385-509	4,482	40	38
Totals		**10**		**11,786**	**100**	**100**
4	Rainbow Trout	8	230-473	4,653	67	71
	Brown Trout	4	134-410	1,941	33	29
Totals		**12**		**6,594**	**100**	**100**
Total Rainbow Trout		**48**	185-610	**29,860**	72	59
Total Brown Trout		**19**	134-641	**20,658**	28	41
Overall totals		**67**		**50,518**	**100**	**100**

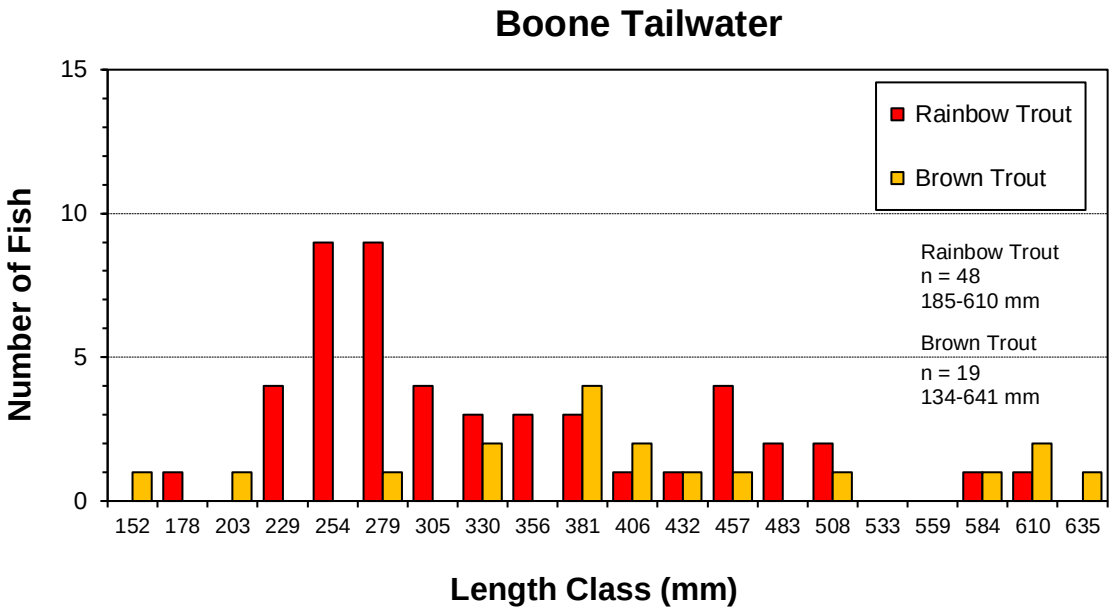


Figure 5-28. Length frequency distributions for trout from the Boone tailwater monitoring stations in 2019.

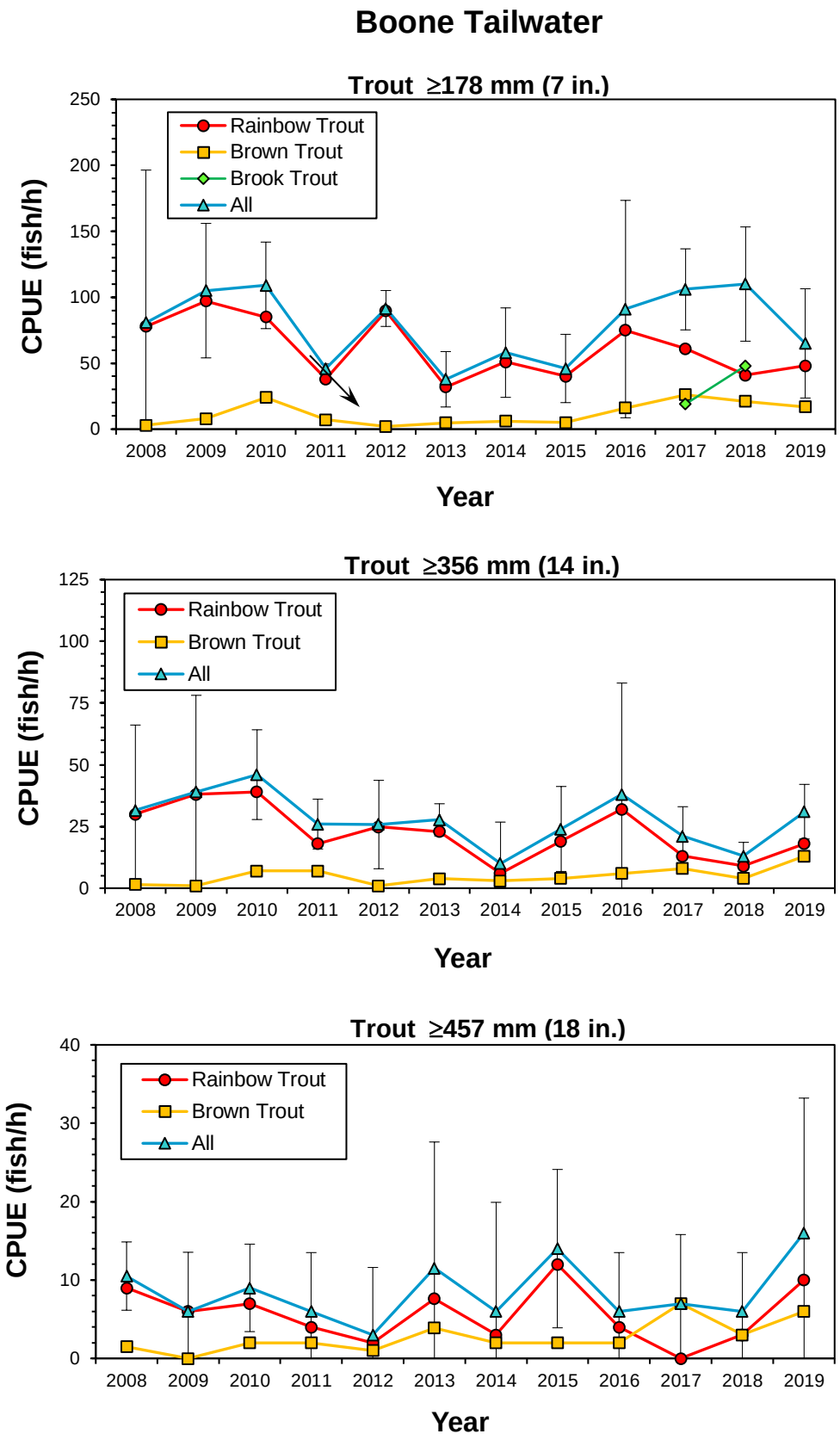


Figure 5-29. Mean trout CPUEs for the Boone tailwater samples. Bars indicate 90% confidence intervals.

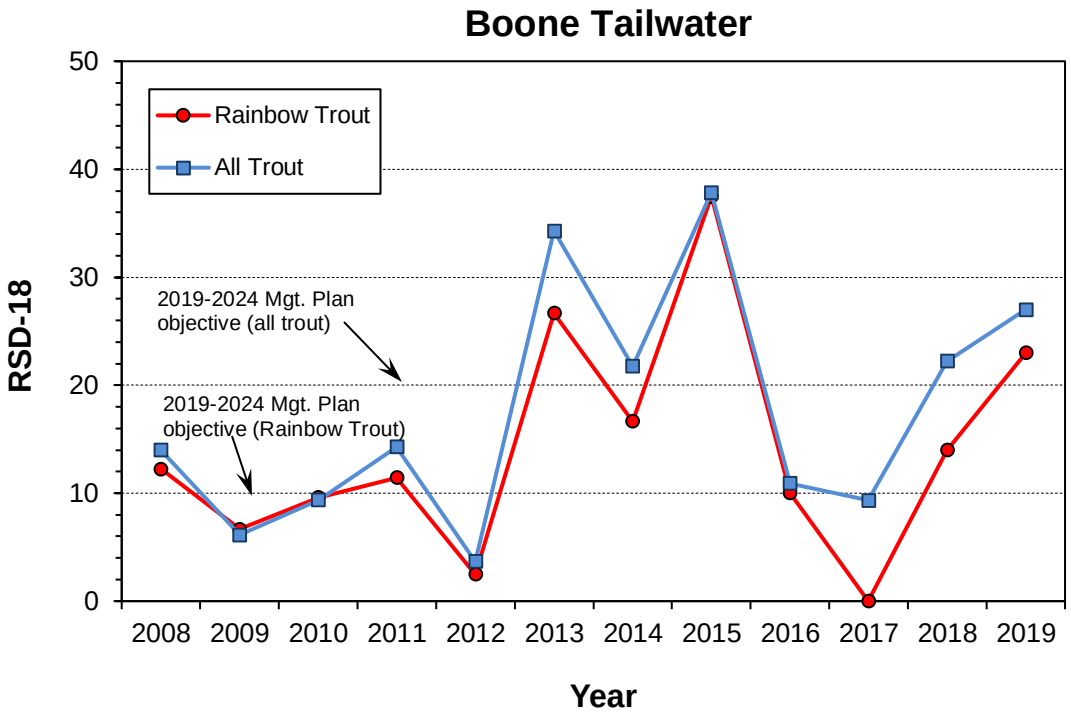


Figure 5-30. RSD-18 for Boone tailwater trout (2008-2019).

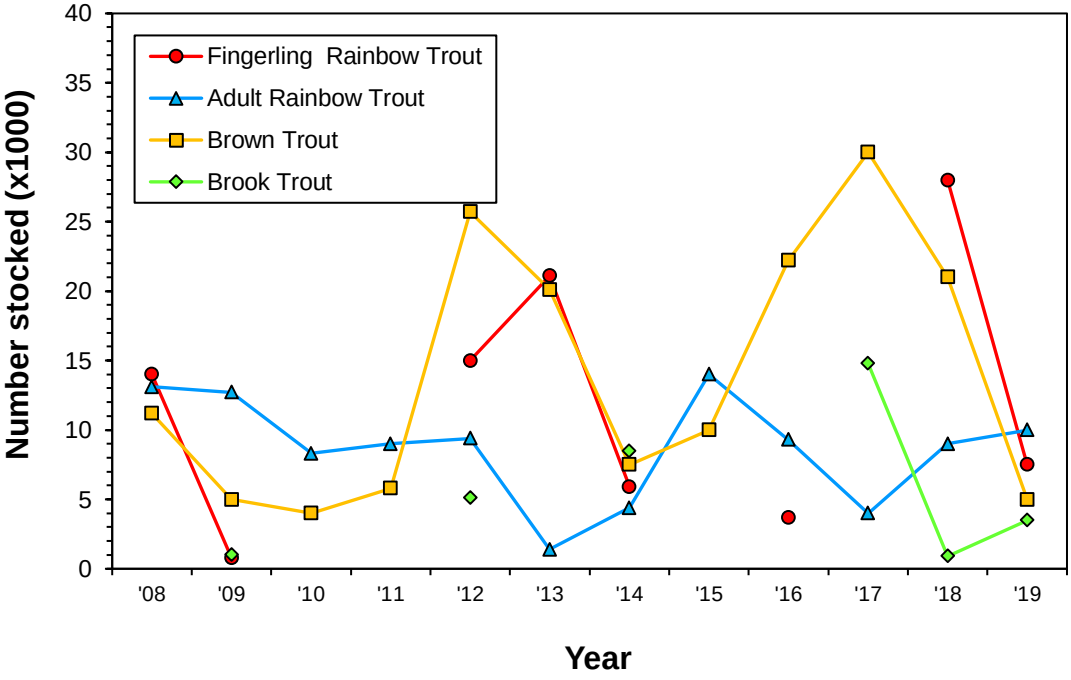


Figure 5-31. Recent trout stocking rates for the Boone tailwater.

South Holston (South Fork Holston River)

Catch and Length Frequency

The 12 South Holston tailwater monitoring stations (Figure 5-32) produced 794 trout weighing over 147 kg in 2019 (Table 5-7). Brown Trout represented 90% of the catch by number and 88% by biomass. Brown Trout exhibited the typical bimodal length frequency distribution, with modes at the 127-mm and 279-mm classes (Figure 5-33), which likely represent age-1 and age-2 fish. More Brown Trout in the PLR (28) were captured in 2019 than in any sample since 2009. Most Rainbow Trout (70%) were in the 229-305 mm size classes and only one fish was within the PLR (Figure 5-33).

The South Holston tailwater.

CPUE

The mean electrofishing catch rate (CPUE) increased slightly for Rainbow Trout, Brown Trout, and overall (to 270 fish/h ≥178 mm; Figure 5-34). Mean CPUE for Brown Trout ≥356 mm and within the PLR also increased relative to 2018 (Figure 5-34). Consequently, the overall PLR catch rate in 2019 (14.5 fish/h) was the highest since 2014, although it still remains 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)—improved slightly to 8 in 2019 (Figure 5-35). Brown Trout RSD-16 exceeded 20 during 2005-2007 (following establishment of the PLR), but has declined as total CPUE (≥178 mm) increased into the 300-400 fish/h range (Figure 5-35). Consequently, 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 total mean CPUE for trout ≥178 mm returns to the 150-200 fish/h range considered in the management plan (Habera et al. 2015c) to be more conducive for recruitment into the PLR. Rainbow Trout ≥406 mm are uncommon in the South Holston tailwater and corresponding RSD-16 has averaged 3 both pre- and post-PLR.

A South Holston tailwater Brown Trout (within 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 5-36). The

2019 mean for fish in the 305-406 mm size classes (83.8, Figure 5-36) 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). Brown Trout CPUE in the Lake Cumberland tailwater (KY) increased 3-fold over 10 years following establishment of a 508-mm (20-in.) minimum size limit and 1 fish/day creel limit (Dreves et al. 2016). However, overall abundance (CPUE of 89 fish/h) most likely remained below the tailwater's carrying capacity, thus density-dependent responses were not triggered and Brown Trout size structure improved (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

Substantial majorities of 466 anglers interviewed during the 2019 creel survey indicated that they mostly or completely support the PLR regulation (90%) and the spawning area closures (88%). Additionally, 90% of those same anglers regarded TWRA's management of the South Holston tailwater trout fishery as excellent. Anglers (n=555) reported that 4% of Rainbow Trout and 12% of Brown Trout they caught in 2019 were in the PLR, while <1% of Rainbow Trout and 3% of Brown Trout were above the PLR (>22 in.). Only six of 127 trout >22 in. (5%) caught by anglers were harvested (four Brown Trout, two Rainbow Trout). A plurality of anglers (44%) responded during the 2017 survey that they would increase their harvest of smaller (9-12 inch) Brown Trout given that it would help improve population size structure. Survey results (Black 2018) indicated there was a slight increase in the Brown Trout harvest rate relative to 2014 (from 3.5% to 4.9%). The 2019 angler survey should reveal if anglers have continued to harvested more Brown Trout (results will be available in 2020).

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 sustained through consistent annual stocking of adults and fingerlings. However, the presence of substantial numbers of wild age-0 Rainbow Trout in 2018 suggests that it would be useful to re-examine the effectiveness of stocked fingerlings (e.g., by marking a cohort or suspending stocking for a one or two years). Currently, no management changes are recommended for this tailwater.

South Holston Tailwater

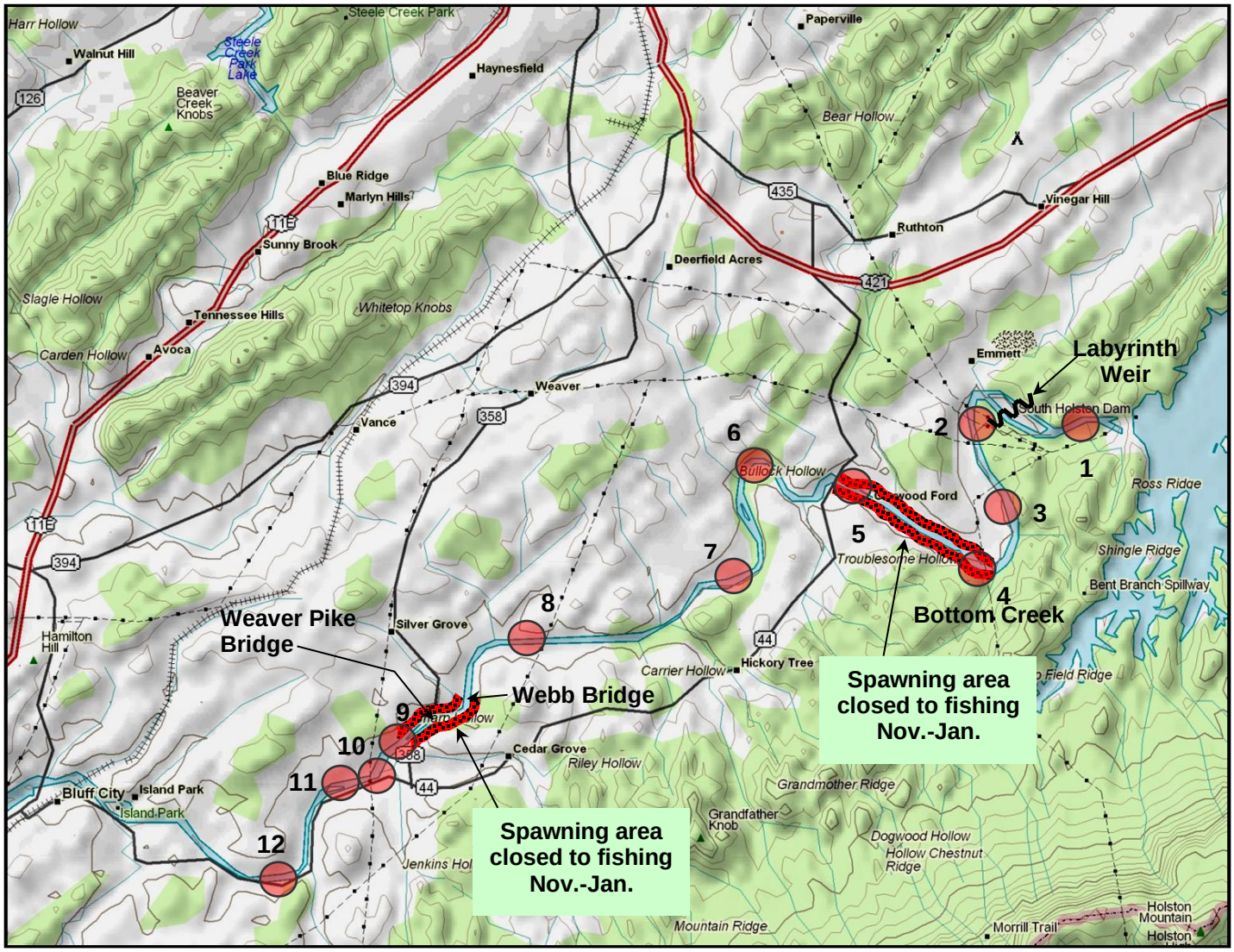


Figure 5-32. Locations of the South Holston tailwater (South Fork Holston River) monitoring stations.

Table 5-7. Catch data for the12 electrofishing stations on the South Holston tailwater sampled 1 April 2019.

Station	Species	Total Catch	Size Range (mm)	Total Weight (g)	% Abundance (number)	% Abundance (weight)
1	Rainbow	17	159-451	5,129	81	74
	Brown	4	296-414	1,811	14	17
Totals		**21**		**6,940**	**95**	**91**
2	Rainbow	15	135-296	2,123	13	14
	Brown	105	87-552	13,571	88	86
Totals		**120**		**15,694**	**100**	**100**
3	Rainbow	7	140-329	1,105	7	11
	Brown	95	86-374	9,022	93	89
Totals		**102**		**10,127**	**100**	**100**
4	Rainbow	6	149-275	869	7	6
	Brown	85	110-407	14,425	93	94
Totals		**91**		**15,294**	**100**	**100**
5	Rainbow	3	194-307	667	4	10
	Brown	67	84-381	6,345	96	90
Totals		**70**		**7,012**	**100**	**100**
6	Rainbow	2	320-321	692	3	6
	Brown	66	106-549	10,478	97	94
Totals		**68**		**11,170**	**100**	**100**
7	Rainbow	7	234-285	1,172	9	8
	Brown	71	155-460	13,868	91	92
Totals		**78**		**15,040**	**100**	**100**
8	Rainbow	5	224-316	1,060	9	7
	Brown	49	150-459	14,782	91	93
Totals		**54**		**15,842**	**100**	**100**
9	Rainbow	1	355	414	1	2
	Brown	74	118-570	16,490	99	98
Totals		**75**		**16,904**	**100**	**100**
10	Rainbow	2	254-289	382	7	4
	Brown	26	115-540	10,438	93	96
Totals		**28**		**10,820**	**100**	**100**
11	Rainbow	11	216-319	2,214	22	19
	Brown	39	140-460	9,614	78	81
Totals		**50**		**11,828**	**100**	**100**
12	Rainbow	5	267-347	1,480	14	14
	Brown	32	154-434	8,888	86	86
Totals		**37**		**10,368**	**100**	**100**
Total Rainbows		81	135-451	17,307	10	12
Total Browns		713	84-570	129,732	90	88
Overall totals		**794**		**147,039**	**100**	**100**

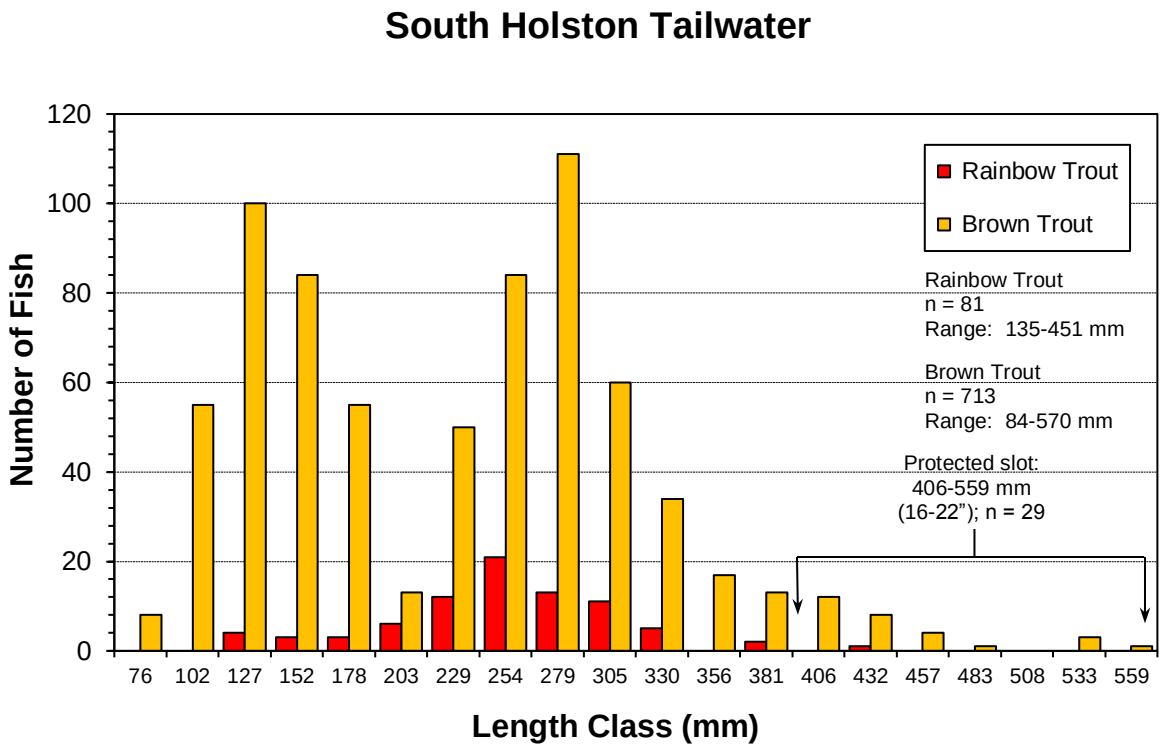


Figure 5-33. Length frequency distributions for trout from the South Holston tailwater monitoring stations in 2019.

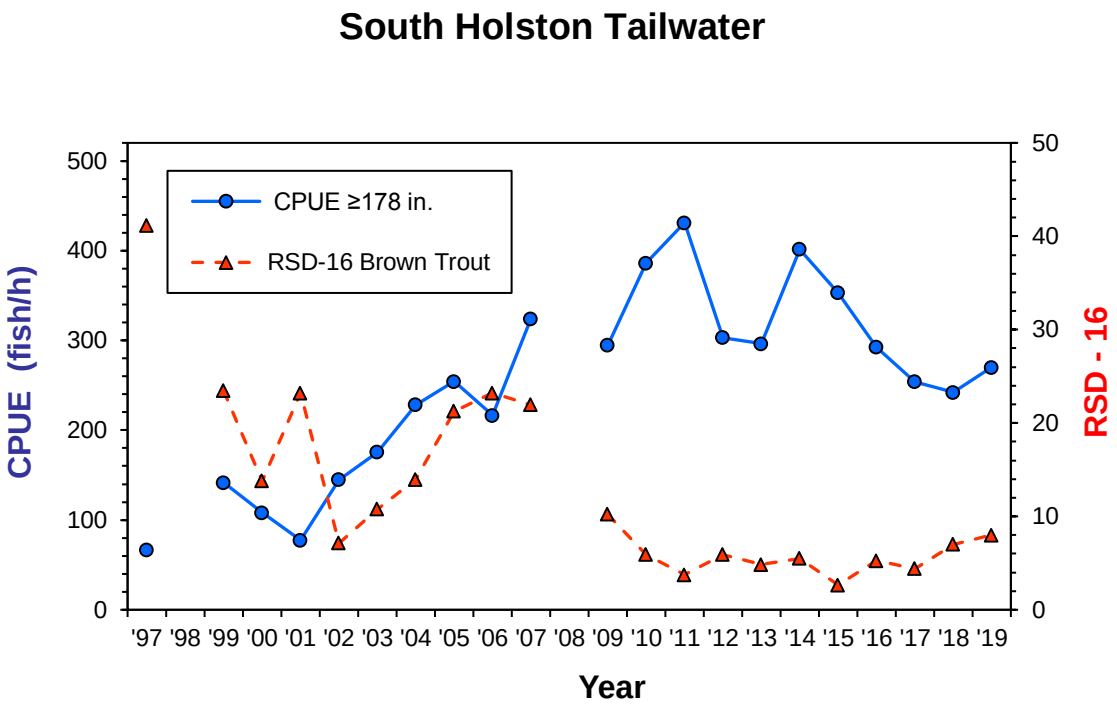


Figure 5-34. Comparison of mean CPUE (fish/h) for all trout ≥178 mm and RSD-16 (all trout) for the South Holston tailwater.

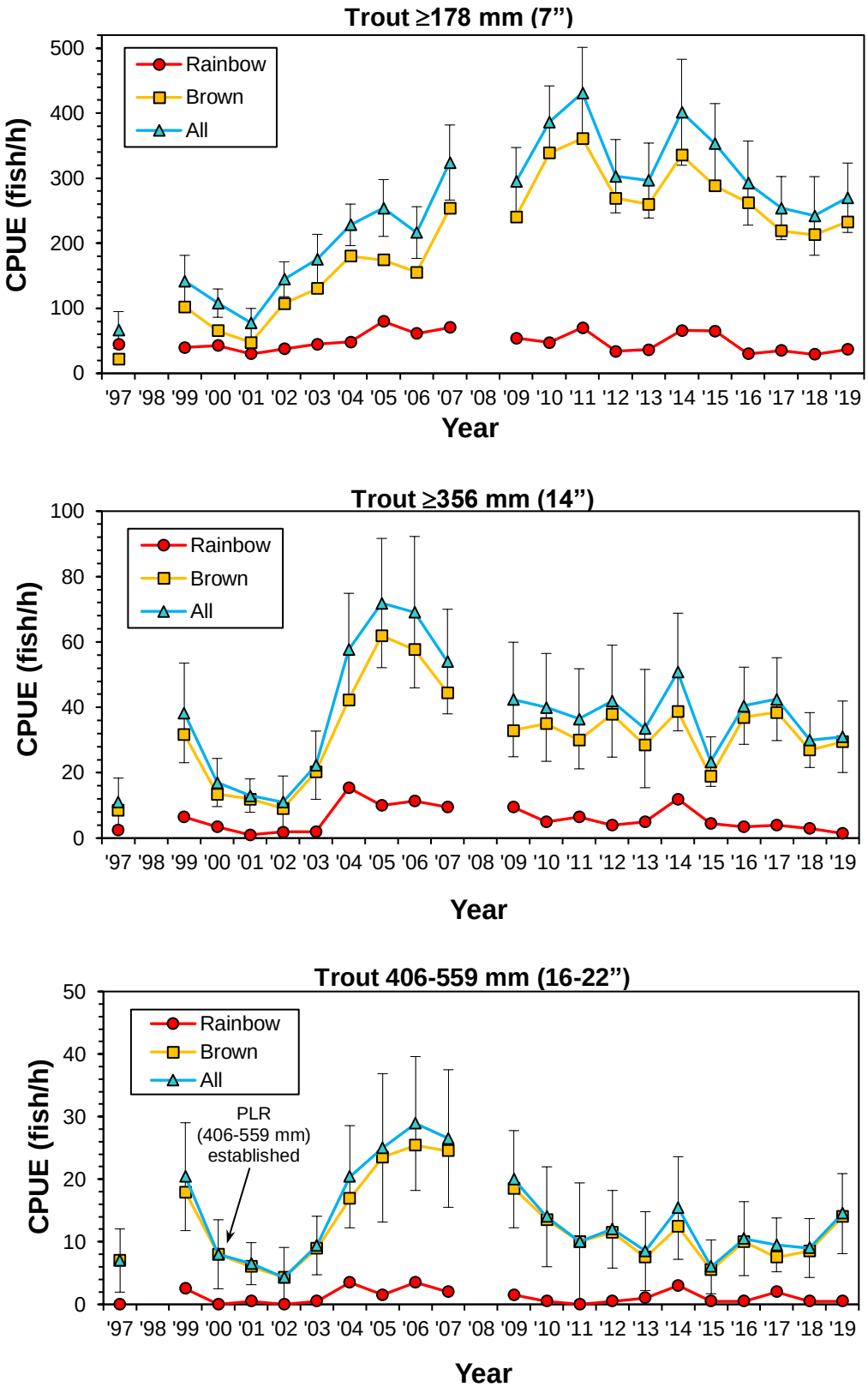


Figure 5-35. Mean trout CPUEs for the South Holston tailwater samples. Bars indicate 90% confidence intervals.

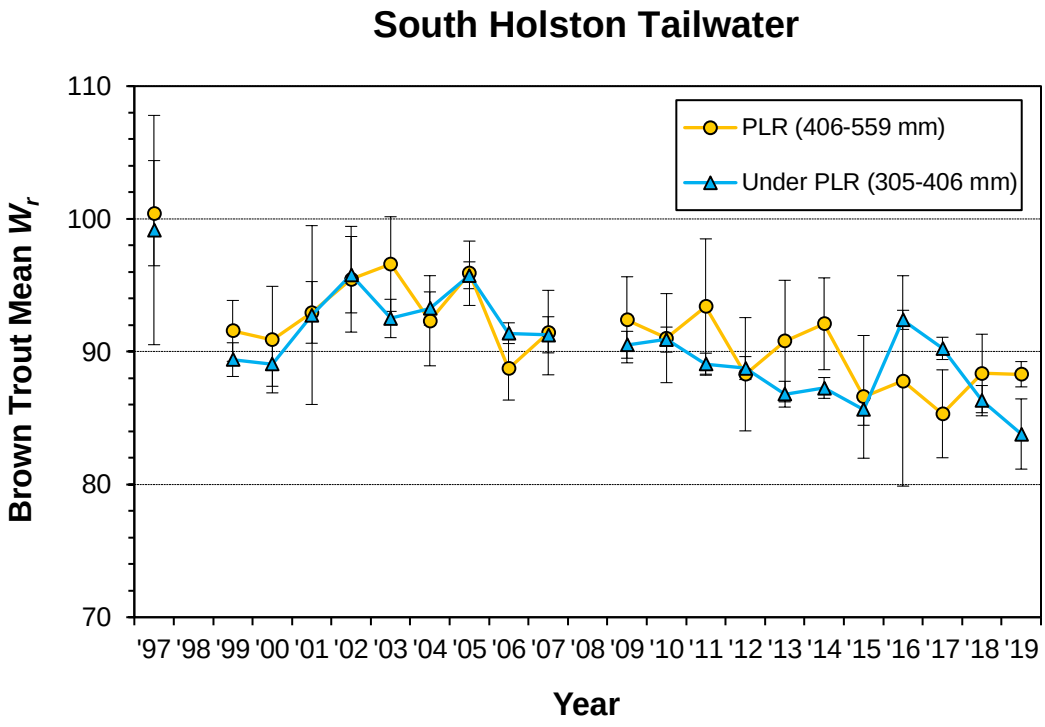


Figure 5-36. Mean relative weights (W_r) for Brown Trout from the South Holston tailwater. Bars indicate 90% confidence intervals.

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