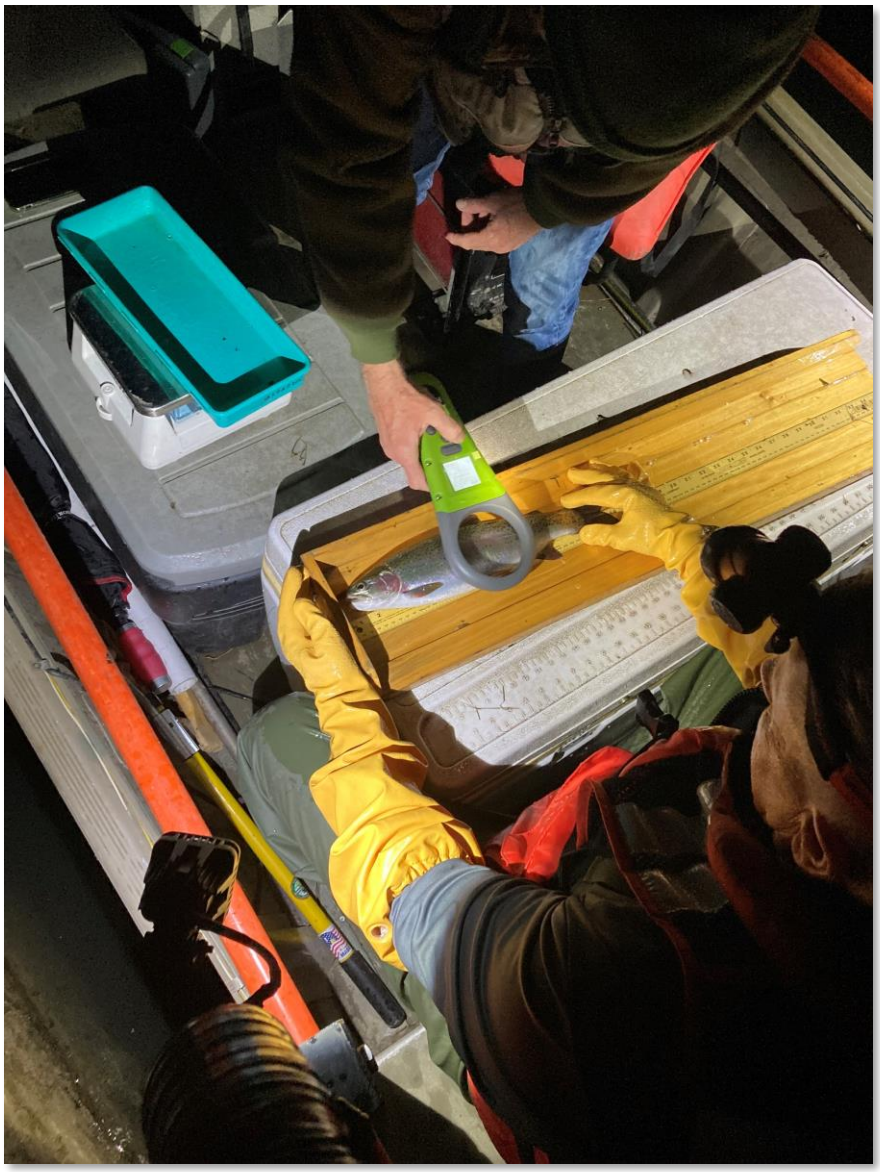
FISHERIES REPORT:

Region IV Coldwater Streams 2023

Tennessee Wildlife Resources Agency
Fisheries Report 23-05



Above photo: Scanning a Rainbow Trout for a PIT tag during the 2022 Norris tailwater monitoring sample. The TWRA/TN CFRU (TN Tech) cooperative research project during 2019-2023 determined that there is substantial natural reproduction by Rainbow Trout in the Norris tailwater and these wild Rainbows recruit into the fishery.

Cover photo: A large Brown Trout from the 2023 Norris tailwater monitoring sample.

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

FISHERIES REPORT:

REGION 4 COLDWATER STREAMS

2023

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TENNESSEE WILDLIFE RESOURCES AGENCY
FISHERIES REPORT 23-05

August 2023

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

Development of this report was financed in part by funds from Federal Aid in Fish and Wildlife Restoration (Public Law 91-503) as documented in Federal Aid Project FW-6 (4350)

Because tailwater monitoring data are available in March each year, 2023 data will be included in this report along with 2022 data. Region 4's annual Coldwater Fisheries reports (previously completed in May or June) will now summarize tailwater data from the current calendar year along with wild trout stream data for the previous year. Consequently, there will be no 2022 report.

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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. A 2021 mail/email survey of 5,952 anglers licensed to fish for trout in Tennessee produced 638 respondents who participated in trout fishing during the previous six years (Poudyal and Cavasos 2022). These anglers reported an average of 7.22 trout fishing trips in 2020, spending an average of $194 per trip (Poudyal and Cavasos 2022). Trout anglers across the state spent an estimated $46 million in 2021 (Poudyal and Cavasos 2022).

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. 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. About 1.4 million trout were produced or grown at five state (TWRA), one municipal (Gatlinburg), and two federal (U.S. Fish and Wildlife Service—USFWS) facilities to be stocked in Tennessee's hatchery-supported fisheries during 2022 (Roddy 2023). Most (75%) were Rainbow Trout and 86% of those were adult fish. Just over half (52%) of all trout stocked in 2022 went to Region IV waters, with 41% of those fish used to support tailwater fisheries, 40% for reservoir fisheries, and 19% for smaller streams, ponds, winter trout program fisheries, etc. (Roddy 2023).

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). 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 36 streams in Region IV by annually stocking hatchery-produced (adult) Rainbow Trout. Some stocked streams (e.g., Beaverdam Creek, Doe Creek, Laurel Fork, and Doe River) 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 230 km (144 mi) in 113 streams, or about 24% of the stream length supporting wild trout outside Great Smoky Mountain National Park (GSMNP). Brook Trout occur allopatrically (no other trout species are present) in 45 streams totaling 75 km (47 mi.), representing 33% of the Brook Trout resource. A new genetic survey using microsatellite DNA markers indicated that 83 populations can be considered native, 23 are of hatchery origin, and 7 are hatchery-influenced.

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. 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 from early spring throughout the summer and adult fish (229-305 mm) supplement the catch during peak angling season. Natural reproduction entirely supports the Brown Trout fisheries in the South Holston and Wilbur (Watauga River) tailwaters and recent work has shown that natural reproduction by Rainbow Trout may be significant in those tailwaters, as well as in Norris tailwater. The Holston River below Cherokee

Reservoir also supports a tailwater trout fishery, although high water temperatures (>21° C) during late summer and early fall limit survival and carryover. No fingerlings are stocked there, as few would survive the thermal bottleneck to recruit to the fishery. Investigations are underway to determine how stocked and wild fish are currently contributing to the trout fisheries in several Region 4 tailwaters.

One of TWRA's core functions identified in its Strategic Plan (TWRA 2021) is outdoor recreation, and a primary objective is to maintain or improve programs that promote high user satisfaction for hunters, anglers, and boaters. Over three-quarters (77%) of respondents to Poudyal and Cavasos's (2022) survey indicated being either somewhat or very satisfied with their recent fishing experience in Tennessee. Nonresidents reported a 91% level of satisfaction. 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 given the new genetics data available 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.

2. Wild Trout Monitoring

Selected Region IV wild trout streams are sampled annually at established monitoring stations to provide baseline trout abundance data and assess trends for management purposes. This annual monitoring began in the early 1990's and provides valuable information for angling regulation establishment, evaluation, and changes, as well as documentation of annual variability (e.g., associated with droughts and floods). Beaverdam Creek, Laurel Creek, Rocky Fork, and Left Prong Hampton Creek were quantitatively sampled during the 2022 field season (June-October). Most wild trout monitoring streams are now sampled on a rotational basis (every third year). Previously (1991-2010), several streams were sampled annually. Archived reports from earlier years, many of which contain more detailed survey data and stream history information, can be found on the TWRA website at: https://www.tn.gov/content/tn/twra/fishing/trout-information-stockings.html#FisheriesReport.

Sampling Methods

Wild trout stream sampling was conducted with battery-powered backpack electrofishing units employing inverters to produce AC outputs to complete TWRA's standard protocol for three-pass depletion. Output voltages were 125-600 VAC, depending upon water conductivity. Stocked Rainbow Trout, distinguishable by dull coloration, eroded fins, atypical body proportions, and large size (usually >229 mm), compared to wild Rainbow Trout were noted on data sheets but were not included in any analyses. Stream sample sites are part of TWRA Region 4 annual monitoring. Streams sampled in 2022 were Beaverdam Creek, Laurel Creek, Rocky Fork, Left Prong Hampton Creek, and Gentry Creek.

Removal-depletion data were analyzed with MicroFish 3.0 for Windows (http://microfish.org/). Trout ≤90 mm in length were analyzed separately from those >90 mm due to their lower catchabilities (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.

Beaverdam Creek

Beaverdam Creek is one of Tennessee's best-known wild trout streams and is still sampled annually. Flows during the 2022 sampling efforts were somewhat above normal and likely depressed density and biomass estimates due to lower capture efficiencies, especially at Site 1 (see Table 1).

Table 1. Fish population abundance estimates (with 95% confidence limits) for Beaverdam Creek sampled in 2022.

		Population Size			Mean	Biomass (kg/ha)			Density (fish/ha)		
Species	Total Catch	Est.	Lower C.L.	Upper C.L.	Fish Wt. (g)	Est.	Lower C.L.	Upper C.L.	Est.	Lower C.L.	Upper C.L.
Site 1											
RBT ≤90 mm	58	74	49	99	3.6	1.10	0.74	1.49	309	205	414
RBT >90 mm	30	31	26	35	61.7	7.99	6.70	9.02	129	109	146
BNT ≤90 mm	10	10	3	14	5.2	0.22	0.07	0.30	42	13	58
BNT >90 mm	15	15	13	17	202.7	12.70	11.01	14.39	63	54	71
Fantail Darter	76	191	0	439	1.2	0.96	0.00	2.20	798	0	1,834
Greenfin Darter	5	5	0	10	5.2	0.11	0.00	0.22	21	0	42
Longnose Dace	13	19	0	345	24.8	1.97	0.00	35.74	79	0	1,441
N. Hogsucker	11	12	4	20	101.1	5.07	1.69	8.45	50	17	84
Snubnose Darter	13	19	0	342	1.9	0.15	0.00	2.71	79	0	1,429
Mottled Sculpin	274	411	0	1731	3.7	6.39	0.00	26.75	1,717	0	7,231
Warpaint Shiner	36	101	0	332	4.6	1.93	0.00	6.38	422	0	1,387
Swannanoa Darter	18	30	0	73	7.0	0.88	0.00	2.13	125	0	305
Saffron Shiner	108	215	59	371	1.9	1.74	0.47	2.94	898	246	1,550
Blacknose Dace	5	13	0	107	2.6	0.14	0.00	1.16	54	0	447
Central Stoneroller	154	203	159	247	20.6	17.44	13.68	21.25	848	664	1,032
Creek Chub	1	1	1	1	25.0	0.10	0.10	0.10	4	4	4
River Chub	110	152	106	198	12.3	7.82	5.45	10.17	635	443	827
Site 2											
RBT ≤90 mm	53	61	47	75	4.1	0.96	0.75	1.19	236	182	290
RBT >90 mm	48	50	44	56	51.2	9.90	8.72	11.10	193	170	217
BNT ≤90 mm	17	17	13	21	5.3	0.35	0.27	0.43	66	50	81
BNT >90 mm	35	36	32	40	74.6	10.39	9.24	11.55	139	124	155
Fantail Darter	71	101	58	144	1.2	0.47	0.27	0.67	391	224	557
Greenfin Darter	3	3	0	15	3.3	0.04	0.00	0.19	12	0	58
Longnose Dace	6	6	0	12	8.3	0.19	0.00	0.39	23	0	46
N. Hogsucker	12	12	8	16	15.3	0.71	0.47	0.95	46	31	62
Snubonse Darter	4	4	0	9	1.3	0.02	0.00	0.05	15	0	35
Mottled Sculpin	479	762	603	921	5.2	15.37	12.13	18.53	2,949	2,334	3,564
Warpaint Shiner	21	25	12	38	3.5	0.34	0.16	0.51	97	46	147
Swannanoa Darter	13	13	9	17	3.2	0.16	0.11	0.21	50	35	66
Blacknose Dace	6	6	1	11	1.8	0.04	0.01	0.08	23	4	43
Central Stoneroller	92	101	89	113	12.0	4.67	4.13	5.25	391	344	437
Creek Chub	1	1	1	1	4.0	0.02	0.02	0.02	4	4	4
River Chub	123	131	121	141	11.8	5.98	5.53	6.44	507	468	546
White Sucker	1	1	1	1	12.0	0.05	0.05	0.05	4	4	4

Table 2. Site and sampling information for Beaverdam Creek Sites 1 and 2 in 2022.

Location	**Site 1**		**Site 2**	
Site code	0420221601		0420221602	
Sample date	23 August		20 September	
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	2394	177	2584
Electrofishing units	5	250 V AC	5	250 V AC
Habitat				
Mean width (m)	13.3		14.6	
Canopy cover (%)	70		60	
Est. % site pool/riffle	50	50	43	57
Habitat assessment score	166 (optimal)		162 (optimal)	
Water Quality				
Flow (cfs; visual)	54.83	HIGH	32.92	**high**
Temperature (C)	17.8		16.2	
pH	7.3		7.3	
Conductivity (µS/cm)	46		53	
Alkalinity (mg/L $CaCO_3$)	35		40	

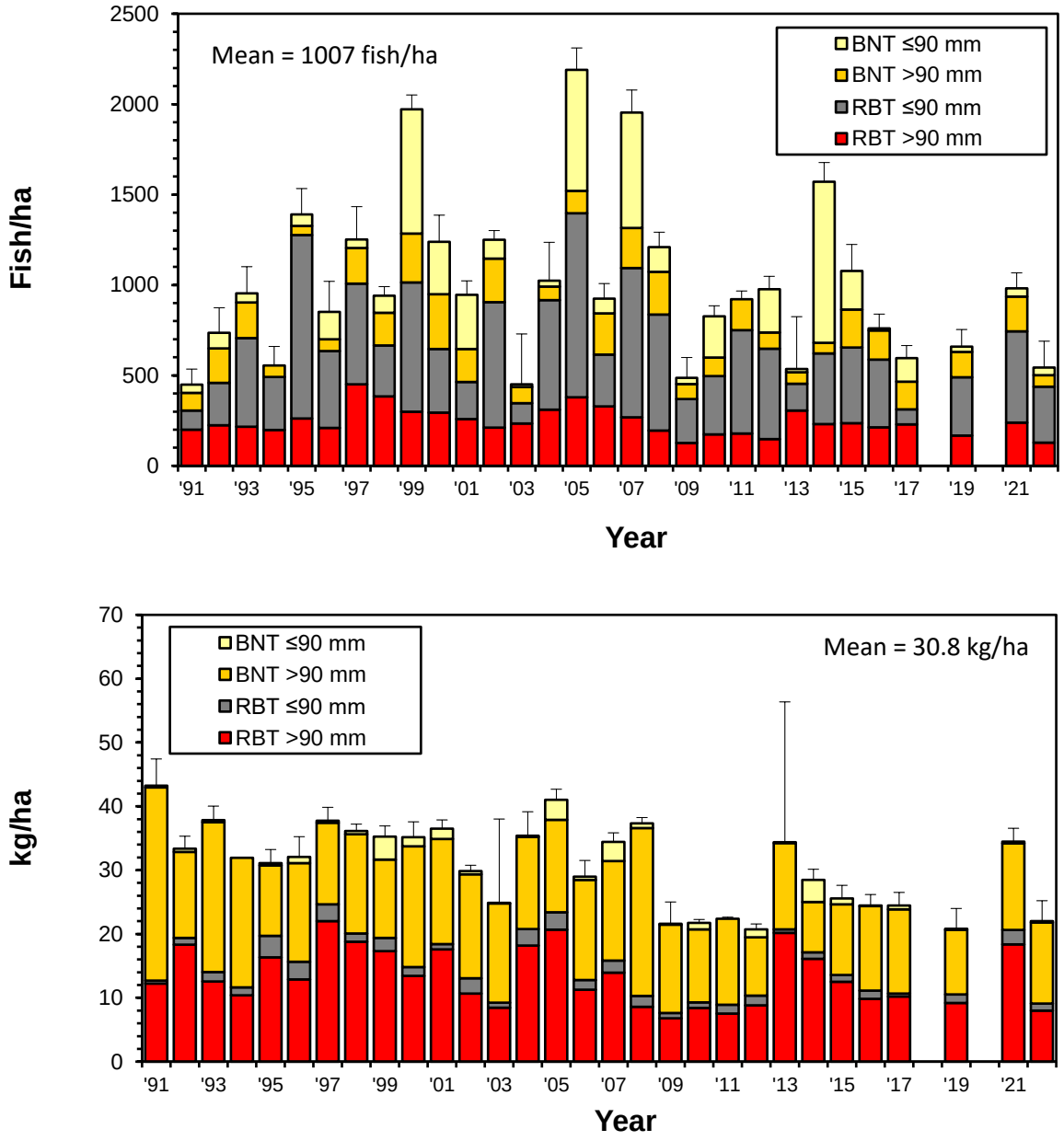


Figure 1. Beaverdam Creek Site 1 estimated trout density and biomass over time.

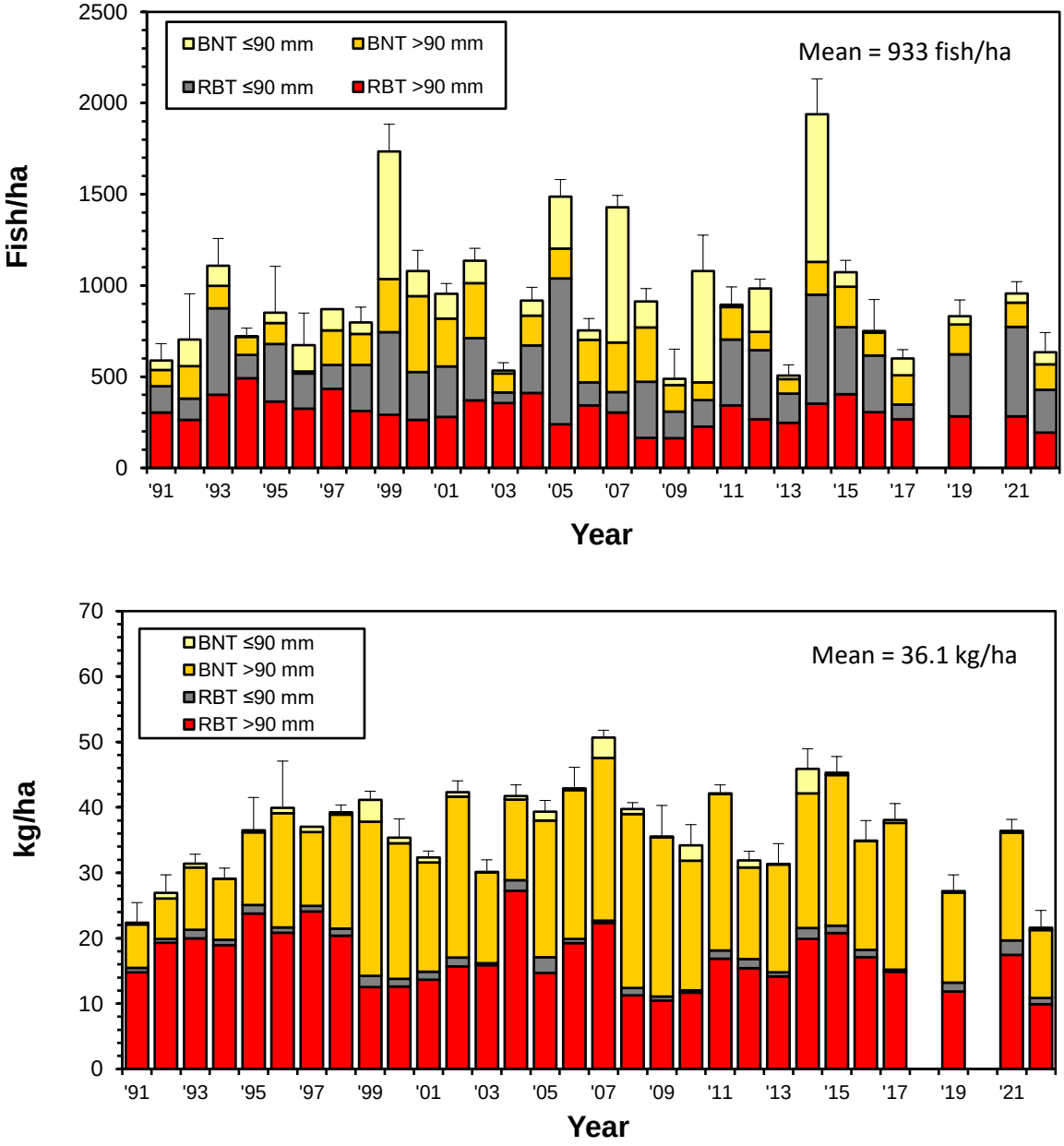


Figure 2. Beaverdam Creek Site 2 estimated trout density and biomass.

Laurel Creek

Trout abundances at Site 1 on Laurel Creek in 2022 were lower than for any previous survey year (Figure 3); however, below-average trout abundances were typical for most Rainbow Trout and Brown Trout populations this year.

Table 3. Fish population abundance estimates (with 95% confidence limits) for Laurel Creek Site 1 sampled in 2022.

		Population Size			Mean	Biomass (kg/ha)			Density (fish/ha)		
Species	Total Catch	Est.	Lower C.L.	Upper C.L.	Fish Wt. (g)	Est.	Lower C.L.	Upper C.L.	Est.	Lower C.L.	Upper C.L.
RBT ≤90 mm	41	46	35	57	4.5	0.82	0.62	1.02	182	139	226
RBT >90 mm	45	48	40	55	55.5	10.55	8.79	12.09	190	158	218
BNT ≤90 mm	7	7	1	13	18.9	0.52	0.07	0.97	28	4	51
BNT >90mm	34	36	29	43	78.3	11.16	8.99	13.34	143	115	170
Warpaint Shiner	70	96	60	133	4.5	1.71	1.07	2.37	380	238	527
Bluegill	3	3	0	15	20.3	0.24	0.00	1.21	12	0	59
Fantail Darter	92	153	70	236	1.8	1.09	0.50	1.68	606	277	935
Blacknose Dace	99	127	95	159	4.3	2.18	1.62	2.71	503	376	630
River Chub	137	160	138	182	12.7	8.06	6.94	9.16	634	547	721
Central Stoneroller	209	238	216	261	10.9	10.26	9.33	11.27	943	856	1,034
Creek Chub	14	14	13	15	8.9	0.49	0.46	0.53	55	51	59
Snubnose Darter	34	120	0	510	1.9	0.91	0.00	3.84	475	0	2,020
Northern Hogsucker	59	69	53	85	36.5	9.97	7.66	12.29	273	210	337
Banded Sculpin	880	1806	1330	2282	4.4	31.13	23.18	39.77	7,154	5,268	9,039
Saffron Shiner	211	277	227	327	2.5	2.72	2.25	3.24	1,097	899	1,295
White Sucker	5	5	0	10	36.8	0.73	0.00	1.46	20	0	40
Longnose Dace	7	7	1	13	7.4	0.21	0.03	0.38	28	4	51
Tennessee Shiner	5	6	0	21	5.0	0.12	0.00	0.42	24	0	83
Rosyside Dace	1	1	1	1	4.0	0.02	0.02	0.02	4	4	4
Swannanoa Darter	3	3	3	3	4.3	0.05	0.05	0.05	12	12	12
Largemouth Bass	2	2	0	39	7.0	0.06	0.00	1.08	8	0	154

Table 4. Site and sampling information for Laurel Creek Site 1 in 2022.

Location	**Site 1**	
Site code	420221701	
Sample date	21 September	
Watershed	S. Fork Holston River	
County	Johnson	
Lat-Long	36.60163 N, 81.75058 W	
Reach number	06010102-25,0	
Elevation (ft)	2,210	
Land ownership	USFS	
Fishing access	Good	
Description	Site begins ~10 m upstream of confluence with Elliot Branch (at wood duck box on LBD).	
Effort		
Station length (m)	165 m	2525 m^2
Electrofishing units	5	200 V AC
Habitat		
Mean width (m)	15.3	
Canopy cover (%)	42	
Estimated % of site in riffles	58	
Habitat assessment score	150 (suboptimal)	
Water Quality		
Flow (cfs; visual)	23.2;	normal
Temperature (C)	17.8	
pH	6.8	
Conductivity (µS/cm)	102	
Alkalinity (mg/L $CaCO_3$)	55	

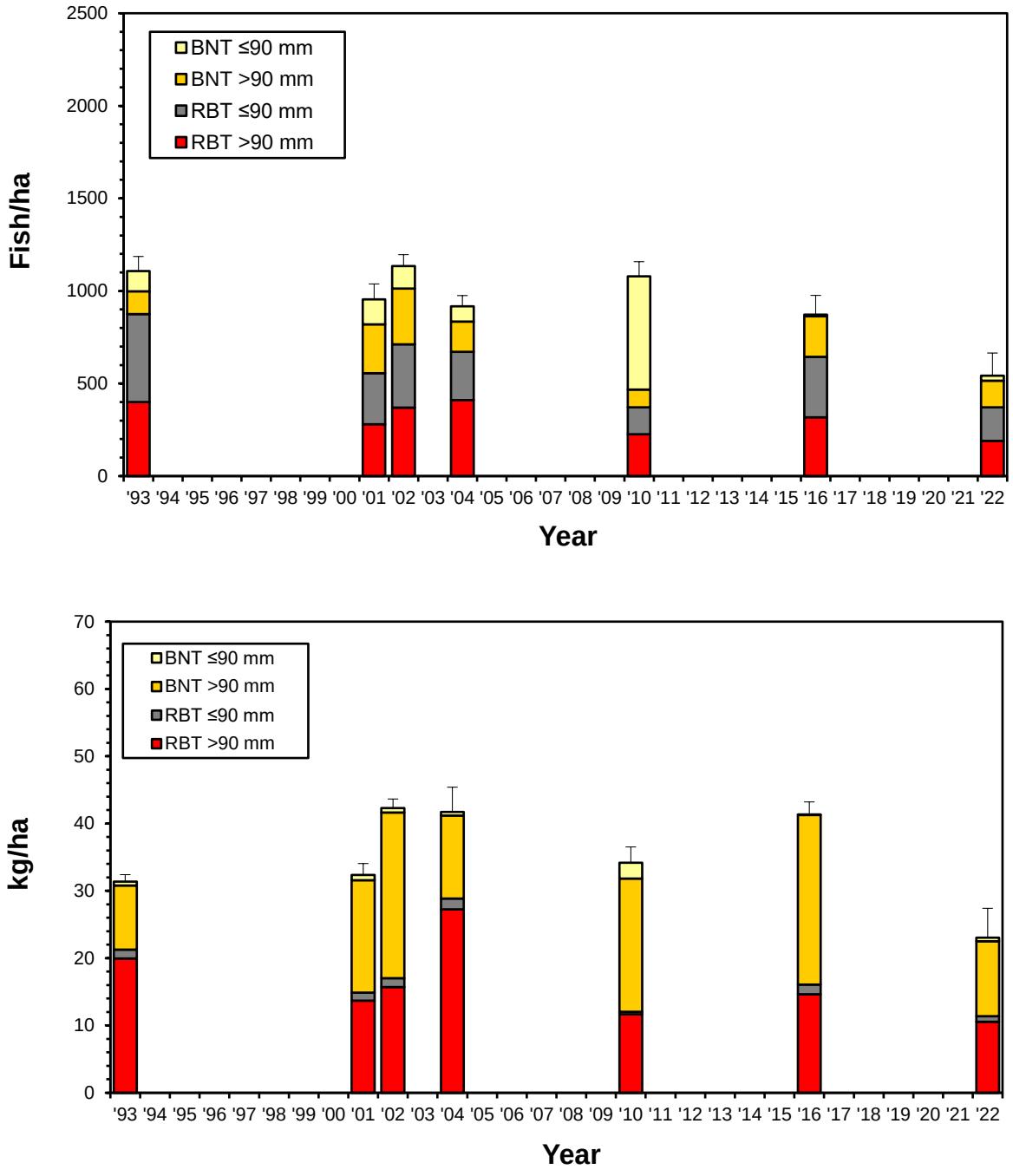


Figure 3. Laurel Creek Site 1 estimated trout density and biomass.

Rocky Fork

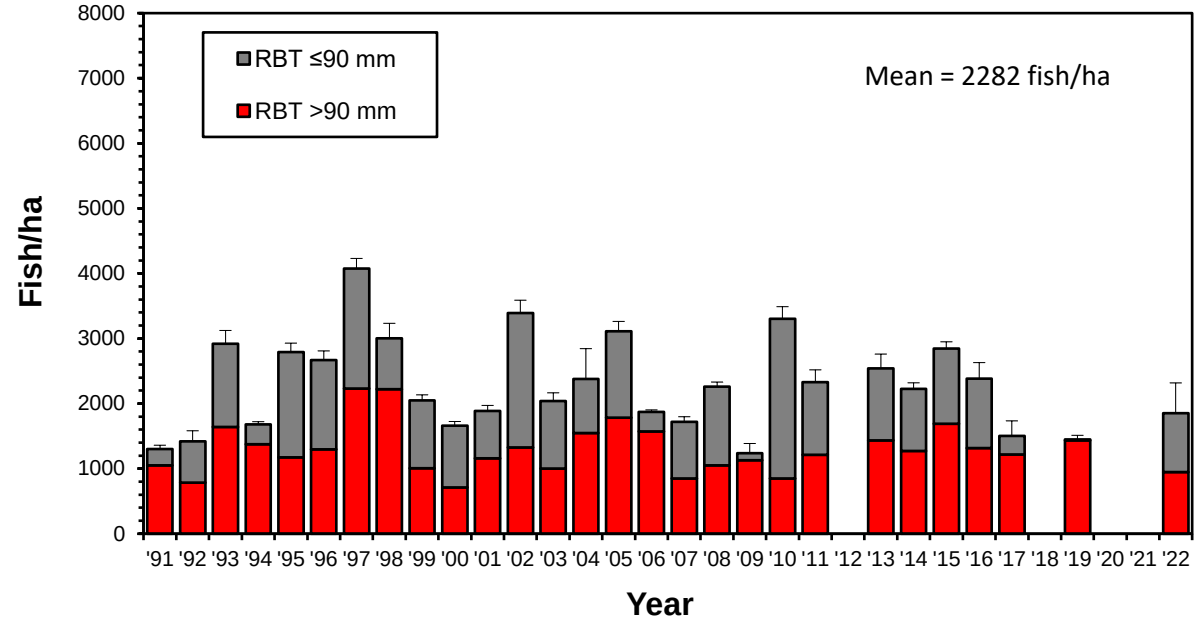
Rocky Fork provides a good fishery for wild Rainbow and Brook Trout. Because the stream is relatively long (> 13 km) and access is limited to foot travel, it provides an ideal setting for anglers seeking a more solitary experience. Rainbow Trout abundance at Site 1 was below average in 2022 (Figure 4). 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 Lamar Alexander Rocky Fork State Park and upstream areas in the CNF.

Table 5. Fish population abundance estimates (with 95% confidence limits) for Rocky Fork Sites 1 and 2 sampled in 2022.

		Population Size				Biomass (kg/ha)			Density (fish/ha)		
Species	Total Catch	Est.	Lower C.L.	Upper C.L.	Mean Fish Wt. (g)	Est.	Lower C.L.	Upper C.L.	Est.	Lower C.L.	Upper C.L.
Site 1											
RBT ≤90 mm	1	1	1	1	6.7	0.09	0.09	0.09	13	13	13
RBT >90 mm	110	112	107	117	31.3	45.01	42.94	46.95	1,436	1,372	1,500
Longnose dace	6	6	1	11	18.7	1.44	0.24	2.64	77	13	141
Blacknose dace	144	173	146	200	4.3	9.58	8.05	11.03	2,218	1,872	2,564
Mottled sculpin	141	314	71	557	7.6	30.69	6.92	54.27	4,026	910	7,141
Site 2											
RBT ≤90 mm	1	1	1	1	5.0	0.11	0.11	0.11	23	23	23
RBT >90 mm	23	23	20	26	45.6	23.82	20.73	26.95	523	455	591
BKT ≤90 mm	10	11	3	19	5.6	1.41	0.38	2.42	250	68	432
BKT >90 mm	17	17	15	19	20.6	7.95	7.02	8.90	386	341	432

Table 6. Site and sampling information for Rocky Fork Sites 1 and 2 in 2022.

Location	**Site 1**		**Site 2**	
Site code	420221601		420221602	
Sample date	20 September		20 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	TN State Park		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	949 m²	100 m	510 m²
Electrofishing units	2	500 V AC	1	550 V AC
Habitat				
Mean width (m)	7.3		5.1	
Canopy cover (%)	95		100	
Estimated % of site in pools	45	55	38	62
Habitat assessment score	NM	NM	NM	NM
Water Quality				
Flow (cfs; visual)	8.8	normal	NM	normal
Temperature (C)	16.3		15.1	
pH	6.9		7.0	
Conductivity (µS/cm)	15		10.5	
Alkalinity (mg/L $CaCO_3$)	10		NM	



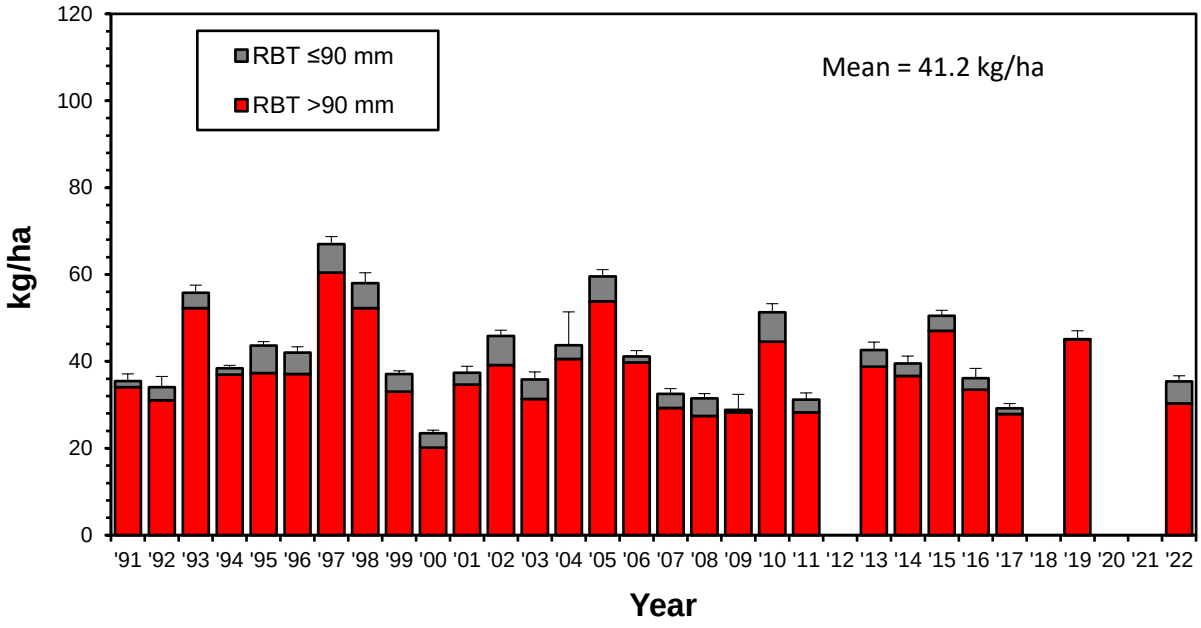


Figure 4. Rocky Fork Site 1 estimated trout density and biomass.

Left Prong Hampton Creek

Over the past 10 years, Rainbow Trout abundance has declined, at Site 1 (Figure 5), likely as a result of decreasing quantity and quality pools there. Brook Trout abundance at Site 2 increased for the first time since 2019 but remains below the previous Rainbow trout abundance (Figure 6)—likely as the result of diminished pool quantity and quality there as well. 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 at Station 3 (68.7 kg/ha, Figure 7) has historically exceeded the statewide average for other streams (about 21 kg/ha) although it has generally declined since 2008. Water temperature monitoring data for 2019-2022 indicate that maximum temperature did not exceed 17.7 C (well below the thermal maximum for Brook Trout), thus stream temperature does not appear to be a contributing factor to lower Brook Trout abundance. Trout Unlimited (TU) worked with Hampton Creek Cove land manager to improve fences on the property and add fences in areas of high erosion from cattle grazing. Although immediate increases in trout abundance are not expected, these actions will provide long-term improvement to the watershed by reducing erosion and sediment load. 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.

Table 7. Fish population abundance estimates (with 95% confidence limits) for Left Prong Hampton Creek in 2022.

		Population Size			Mean	Biomass (kg/ha)			Density (fish/ha)		
	Total		Lower	Upper	Fish Wt.		Lower	Upper		Lower	Upper
Species	Catch	Est.	C.L.	C.L.	(g)	Est.	C.L.	C.L.	Est.	C.L.	C.L.
Site 1											
RBT ≤90 mm	66	68	63	73	3	5.28	4.82	5.59	1,735	1,607	1,862
RBT >90 mm	16	16	16	17	26.4	10.77	10.78	11.45	408	408	434
BKT ≤90 mm	1	1	1	1	3.0	0.08	0.08	0.08	26	26	26
BKT >90 mm	1	1	1	1	7.0	0.18	0.18	0.18	26	26	26
Blacknose dace	64	65	61	69	5	8.21	7.78	8.80	1,658	1,556	1,760
Fantail darter	6	6	0	13	3.5	0.54	0.00	1.16	153	0	332
Site 2											
BKT ≤90 mm	50	83	77	89	3.0	5.46	5.24	6.05	1,882	1,746	2,018
BKT >90 mm	42	42	40	44	18.6	17.71	16.87	18.56	952	907	998
Site 3											
BKT ≤90 mm	87	89	85	94	2.9	7.40	7.04	7.79	2,543	2,429	2,686
BKT >90 mm	69	69	67	71	20.9	41.11	40.01	42.40	1,971	1,914	2,029

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Table 8. Site and sampling information for Left Prong Hampton in 2022.

Location	Site 1	Site 2	Site 3
Site code	420221401	420221402	420221403
Sample date	14 July	14 July	14 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	94	100
Personnel	3	33	3
Electrofishing units	1 300 V AC	1 450 V AC	1 450 V AC
Habitat			
Mean width (m)	3.7	4.7	3.5
Aquatic vegetation	scarce	scarce	scarce
Estimated % of site in pools	45	NM	NM
Estimated % of site in riffles	55	NM	NM
Habitat assessment score	158 (suboptimal)	157 (suboptimal)	159 (suboptimal)
Water Quality			
Flow (cfs; visual)	1.2 normal	NM **normal**	NM normal
Temperature (C)	18.1	N/M	NM
pH	7.1	N/M	NM
Conductivity (µS/cm)	32	N/M	NM
Alkalinity (mg/L $CaCO_3$)	25	N/M	NM

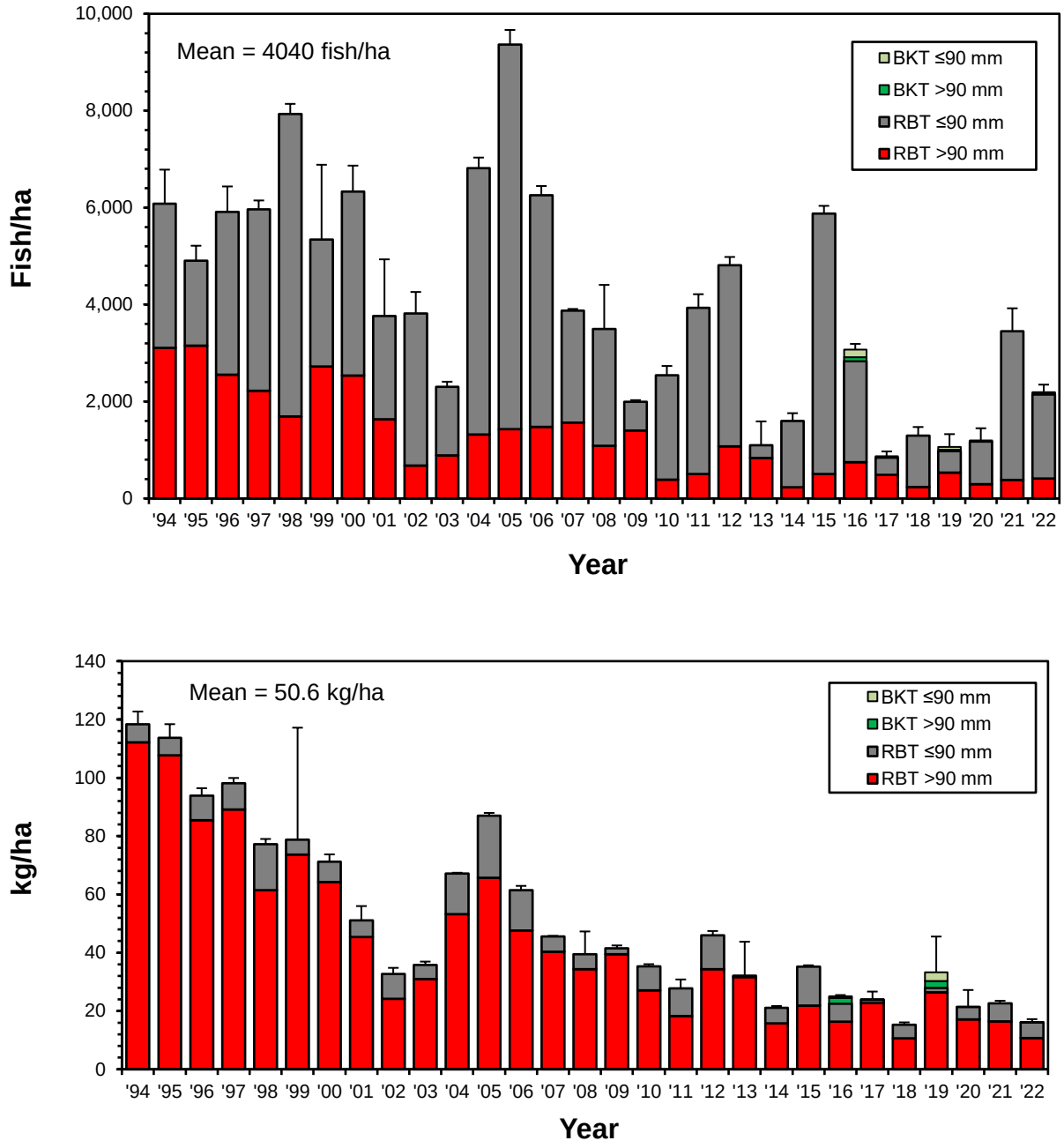
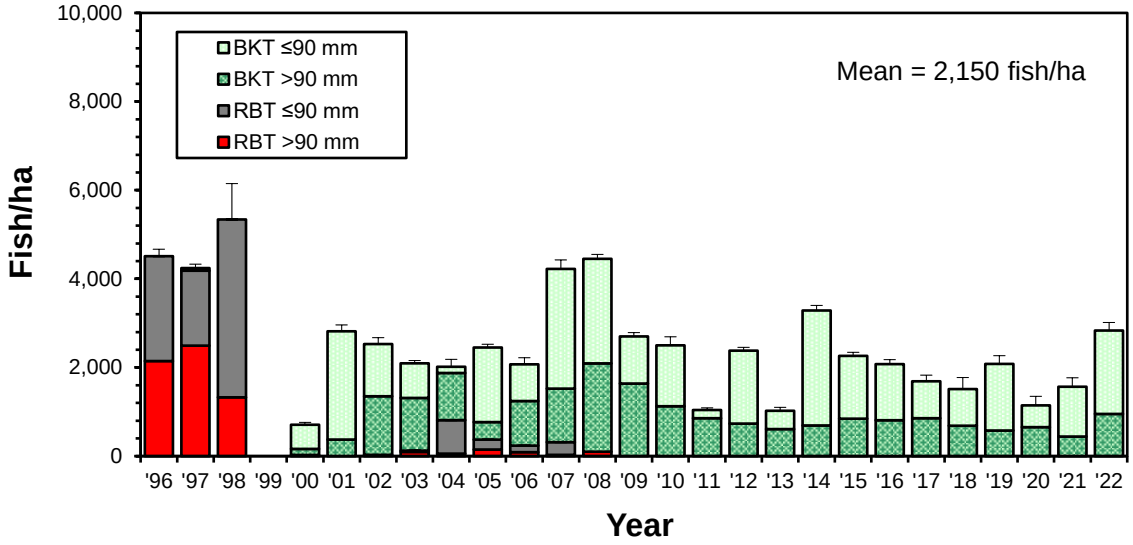


Figure 5. Left Prong Hampton Creek Site 1 estimated trout density and biomass.



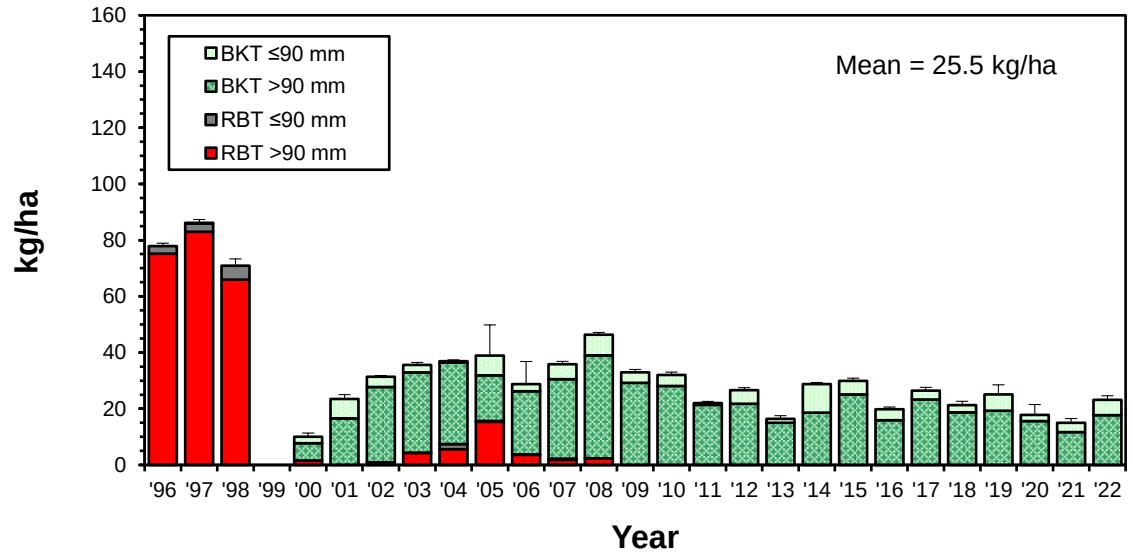


Figure 6. Left Prong Hampton Creek Site 2 estimated trout density and biomass.

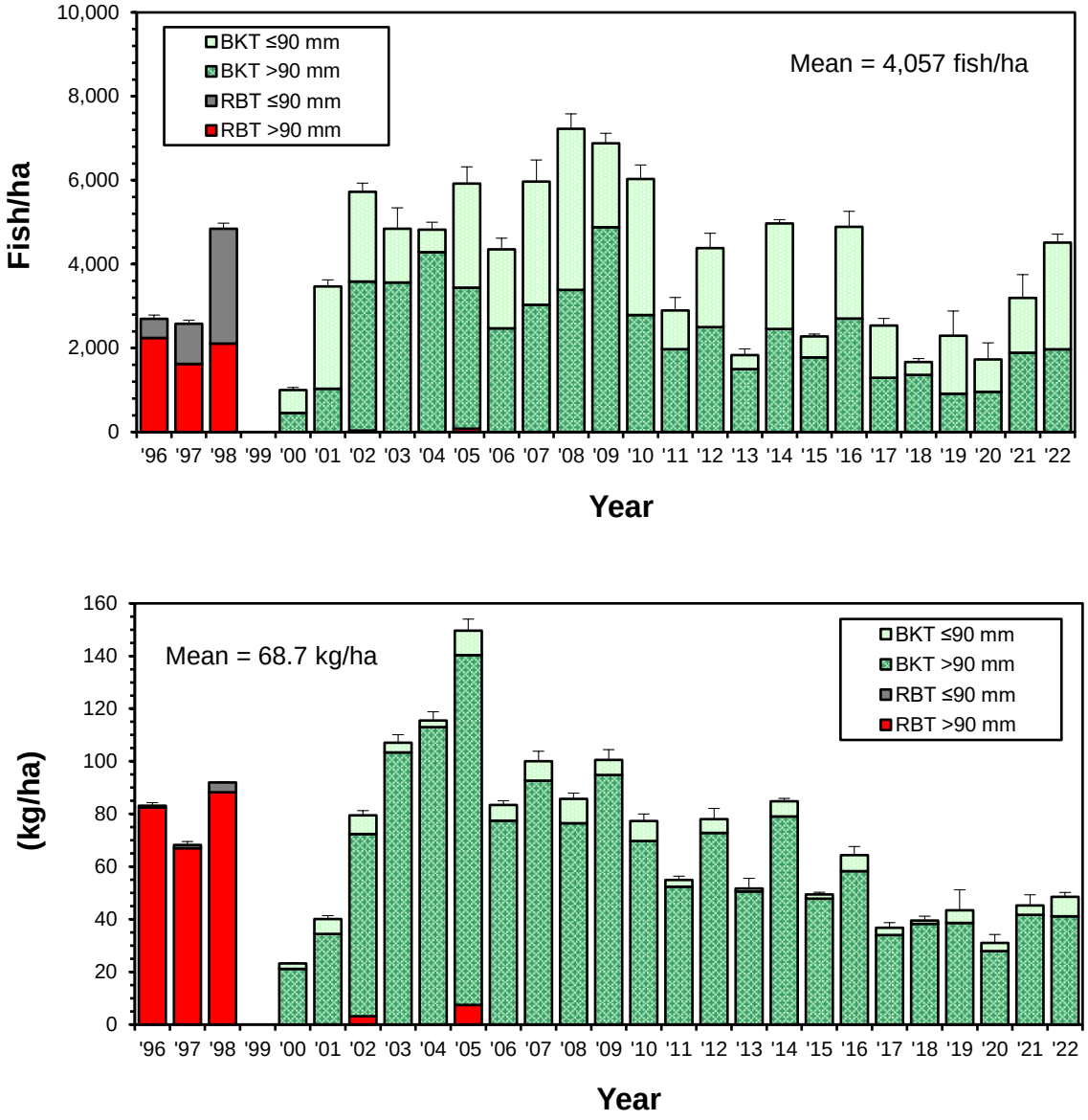


Figure 7. Left Prong Hampton Creek Site 3 estimated trout density and biomass.

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 during 1900-1977 caused managers to be concerned that Rainbow Trout might displace native Brook Trout (Kelly et al. 1980).

Moore et al. (1983) and Larson and Moore (1985) showed that Rainbow Trout suppress Brook Trout abundance and reproduction, and Whitworth and Strange (1983) showed that Rainbow Trout 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 primarily by 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 ebb and flow in Tennessee streams 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. The objective is to determine if, over time, Rainbow Trout can displace Brook Trout in these populations and how relative abundance responds to stochastic events.

Rocky Fork (Figure 8) and Gentry Creek (Figure 9) have been sampled over the past 25-30 years to examine Brook Trout and Rainbow Trout relative abundance trends under sympatric conditions. Percent Brook Trout density and biomass often increase during droughts and Rainbow Trout appear to be more negatively impacted. Extended drought, however, may eliminate Brook Trout populations in marginal habitats regardless of the presence of any sympatric salmonids (Habera et al. 2014).

Although Brook Trout relative abundance has fluctuated over the years at these 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; 2014) 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. 2014). Future monitoring of these streams will be on a triennial schedule to further document relative abundance trends.

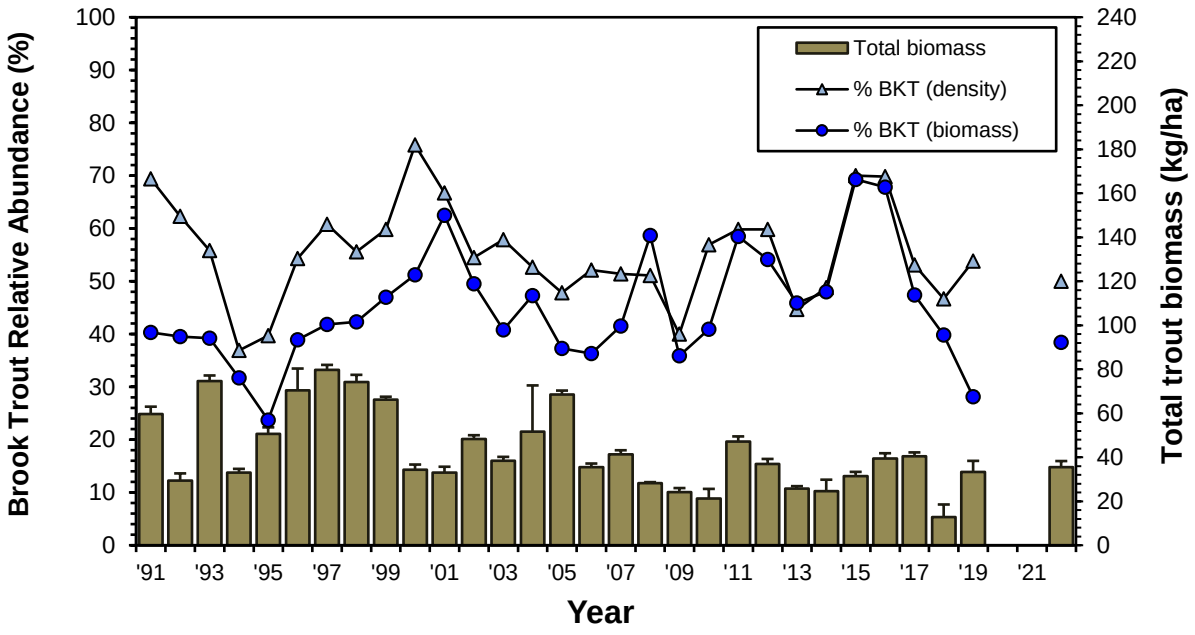


Figure 8. Brook Trout and Rainbow Trout relative abundance and abundance estimates for Rocky Fork.

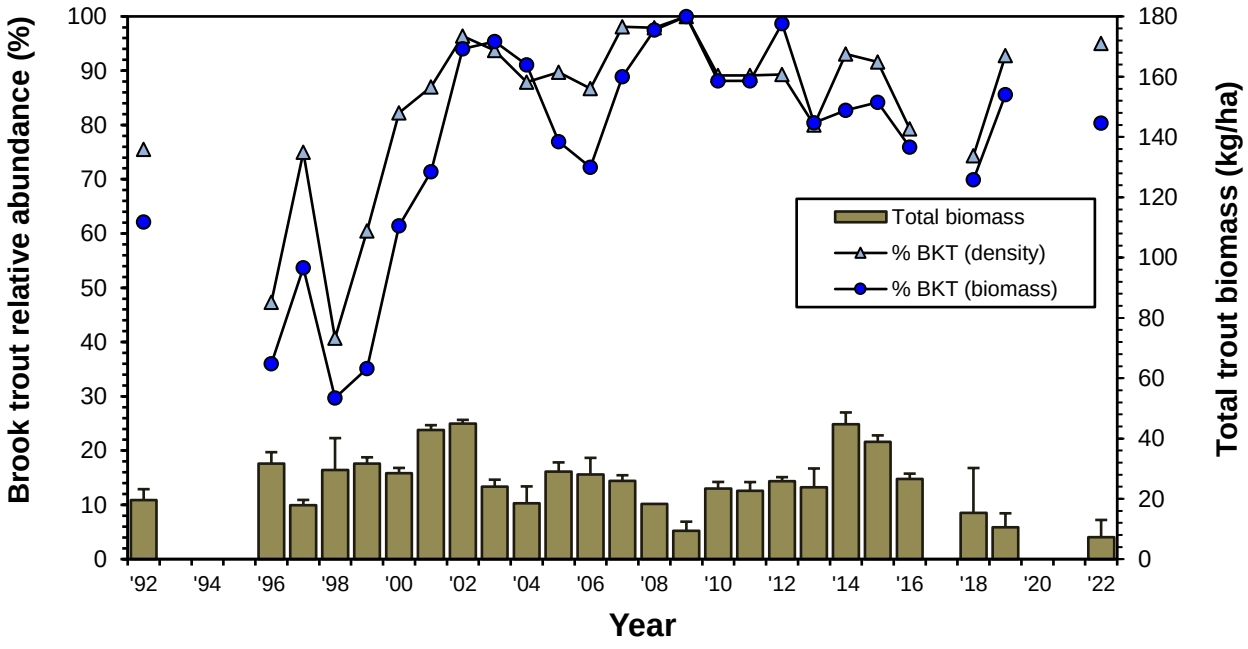


Figure 9. Brook Trout and Rainbow Trout relative abundance and abundance estimates for Gentry Creek.

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 (Tables 9 and 10). 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 becomes feasible. Restoration projects involve re-establishing an allopatric

Table 9. Potential Tier 1 Brook Trout restoration and enhancement projects in Region 4. "BKT" = Brook Trout, RBT = Rainbow Trout, and "BNT" = Brown Trout.

Stream	Watershed	Species present	Barrier	Start elevation (ft)	Length (miles)	Comments	Current status
Green Mountain Branch	South Fork Holston	BKT	Yes	3,130	1.0	Barrier may be compromised at high flow	Translocation complete. Monitoring in 2022
Little Jacob Creek	South Fork Holston	RBT/BKT	Yes (2)	2,270	1.0	Extended down to USFS Job Corp.	Translocation and monitoring complete in upper section. RBT removal ongoing in lower section
Phillips Hollow	Nolichucky	BKT	Yes (2)	2,230	0.6	Fish from N. Toe system in NC	Monitoring in 2022 to evaluate additional translocation needs
Little Paint Creek	French Broad	None	Yes	2,000	1.5	TBD, maybe from Smoky Mountain National Park within the watershed.	In progress—temperature data obtained in 2020-2022.
Devil Fork	Nolichucky	RBT	Yes (3)	1,900	0.5	Restore between lower 2 falls; no fish above upper falls	Not in progress
Trail Fork Big Creek	French Broad	None	Yes	2,640	2.2	Use fish from Gulf Fork tribs.	In progress; RBT removal, BKT translocation and AOP project completed 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	RBT removal in progress

Table 10. Potential Tier 2 Brook Trout re-introduction projects in Region 4.

Stream	Watershed	Species present	Barrier	Start elevation (ft)	Length (miles)	Comments	Current status
Sinking Creek	Watauga	RBT/BNT	No	2,060	1.3	Initially thin RBT/BNT; include Basil Hollow trib	No barrier present; check downstream for end of trout distribution in 2023
Upper Granny Lewis Creek	Nolichucky	RBT	No	2,800	1.0	Initially thin RBT	Not in progress

native Brook Trout population and maintaining it as such. Enhancement projects remove Rainbow Trout from an existing sympatric native Brook Trout population or extend Brook Trout distribution downstream to a natural barrier. Work completed on native Brook Trout restoration projects in 2022 is summarized in the following accounts. These projects involve the efforts of several partners including TWRA Region 3, the USFS, USFWS, TU, the Tennessee Division of Forestry, Tennessee Aquarium Conservation Institute (TNACI), and private landowners.

Green Mountain Branch

Five electrofishing passes through Green Mountain Branch since 2018 have removed 780 Rainbow Trout (including 580 age-0 fish). A total of 91 Brook Trout were translocated from Beaverdam Creek tributaries into the upper third of Green Mountain Branch in August 2020 (22 from Chalk Branch, 26 from Maple Branch, and 43 from Birch Branch). Fin clips were taken from these fish to characterize the genetic composition of the founding population. An electrofishing survey in July 2021 produced adult and age-0 Brook Trout throughout the restoration area, indicating that Brook Trout spawned in the fall of 2020. However, several age-0 Brown Trout, age-0 Rainbow Trout, and adult Rainbow Trout were removed from the lower 500 m, indicating the barrier is passable. Sixteen adult Rainbow Trout were removed during the 2022 survey, most of which were captured in the lower half of the restoration area. No age-0 Rainbow Trout or Brown Trout were captured and Brook Trout (adults and age-0 fish) were found throughout the restoration area. Future work in Green Mountain Branch entails removal of non-native salmonids above the barrier and building a more robust log crib barrier like those on Maple Branch and Chalk Branch.

Little Jacob Creek

Brook Trout have been established in Little Jacob Creek down to the culvert at the USFS road crossing (FR 4002; Habera et al. 2019). Another man-made concrete barrier (2 m high) ~1.2 km further downstream on USFS Job Corp property (1,913 ft elevation) was evaluated in 2019 to determine the feasibility of extending Brook Trout range down to this barrier. Although summer water temperatures and fish community composition near the barrier (Habera et al. 2022) indicated that habitat there is marginal for Brook Trout, it improves upstream as elevation increases.

Five electrofishing passes between the FR 4002 culvert and the Job Corps barrier during 2020-2022 removed 280 Rainbow Trout, with only six adults being captured in 2022, thus removal is considered complete. Future management plans may include replacement of the FR 4002 culvert with a bottomless arch structure designed to allow for aquatic organismal passage (AOP) under the road and habitat improvement in the lower portion of the creek to increase pool frequency and depth. Habitat improvement would include porous log jams built in partnership with TU and the USFS. These habitat improvements may help increase Book Trout abundance in that area.

Phillips Hollow

TWRA, through a partnership with North Carolina Wildlife Resources Commission (NCWRC), private landowners in North Carolina, USFS, USFWS, and TU translocated 76 Brook Trout (13 adults) from two North Toe River system streams to Phillips Hollow in September 2019. Subsequent surveys of the 800-m restoration zone indicated no Brook Trout reproduction had occurred by June 2020, but 30 age-0 fish were present in 2021. In 2022, 21 adults, 14 subadults, and 29 age-0 Brook Trout were captured, indicating that a

population has now been established. This population will be used as a source for native Brook Trout restorations in other Nolichucky-basin streams in Tennessee beginning with, if abundance is suitable, Right Prong Rock Creek in 2024.

Trail Fork of Big Creek

Just over 700 Rainbow Trout were removed from the 3.5-km restoration area in Trail Fork of Big Creek during 2018-2020 (five full passes and one partial pass). Attempts to spawn 41 native Brook Trout collected from three Gulf Fork of Big Creek tributaries in 2019 and 2020 were unsuccessful, thus none were available for release into Trail Fork in 2020. The surviving broodstock Brook Trout (9) were released into the upper portion of Trail Fork in 2021, along with 27 Brook Trout (12 adult; 15 age 0) translocated from nearby Wolf Creek. TU, TWRA, USFS, USFWS, the Nature Conservancy, the Tennessee Wildlife Resources Foundation, and other partners secured funding to remove the double culvert (FR 3249 crossing) within the restoration zone on this stream and replaced it with a bridge in 2021.

Electrofishing surveys during 2022 produced one adult, one subadult, and 79 age-0 Brook Trout, while 12 adult Rainbow Trout were captured and removed. Additional Brook Trout (18 adults and 52 age-0 fish) from Brown Gap Creek and Middle Prong Gulf Creek (Gulf Fork of Big Creek tributaries) were translocated in September to lower Trail Fork between the confluence with Lemon Prong/Rattlesnake Branch and the new bridge (~400 m). Another survey will be completed in 2023 to confirm complete removal of Rainbow Trout and assess Brook Trout abundance and distribution.

Right Prong Rock Creek

TWRA has worked with the USFS and TU since 2018 to assess the suitability of this stream for native Brook Trout restoration and prepare for their reintroduction. These efforts have included evaluation of the perched box culvert at the lower State Hwy. 395 crossing as a barrier to Rainbow Trout movement, modification of the plunge pool below the culvert, stream temperature monitoring, and riparian rhododendron trimming. The upper distribution limit of Rainbow Trout was determined in 2022 and 63 were removed (8 adult, 22 subadult, and 33 age-0 fish). Further work to remove Rainbow Trout will be completed in 2023 and ultimately native Brook Trout from Phillips Hollow will be translocated to Right Prong Rock Creek, which can then serve as second source of native fish for restorations elsewhere in the Nolichucky River basin.

Norton Creek

Native Brook Trout were restored in a 2-km reach of upper Norton Creek (Sevier Co. near Gatlinburg) in 2021 by removing the existing hatchery-origin (nonnative) Brook Trout population and translocating ~300 fish from sources in Great Smoky Mountains National Park (Habera et. al. 2022). This effort was a partnership among the landowners (the Worshams), TWRA, the National Park Service (NPS), TU, and others and restores native Brook Trout to a sub-watershed where they had been extirpated.

The restoration zone was checked during the summer of 2022 numerous age-0 Brook Trout were found throughout, confirming that the translocated adult Brook Trout successfully spawned. Previous native Brook Trout restoration work by TWRA and NPS has shown that three years are typically required for a restored population to become established and approach carrying capacity for their new habitat. Accordingly, two representative sites will be selected, and three-pass depletion samples conducted to estimate population density, and biomass in 2024. Average density and biomass for wild Brook Trout populations in Tennessee (TWRA data) are 1,285 fish/ha (SE, 82.9) and 20.1 kg/ha (SE, 1.4), respectively. Brook Trout in the supplementally fed area at the downstream end of the restoration zone can also be sampled at that time to compare size distributions and relative weights (W_r) with corresponding data from the initial translocation and from other sample areas to determine effectiveness of that program.

Shell Creek

Shell Creek (Doe River, Cater County) was sampled in 2019 as part of a USFS BioBlitz and Rainbow Trout were the only fish present in the upper portion of the stream. A potential fish passage barrier was identified just downstream of the USFS boundary and suitable trout habitat extends ~1 km upstream. Consequently, Shell Creek was added to the native Brook Trout restoration program as a Tier 1 stream (will be managed as a Tier 2 stream if the barrier is ineffective). Three electrofishing passes during 2019 and

2020 removed 77 Rainbow Trout (only 13 subadults during the May 2020 effort). About 400 51-mm (2-inch) native Brook Trout fingerlings produced by TNACI (progeny of Left Prong Hampton Creek adults) were stocked throughout the stream in June 2020. A follow-up assessment during summer 2022 found 170 age-0 and 16 adult Brook Trout throughout the 1-km restoration area, indicating survival of some of the TNACI fish and successful reproduction in 2021. No Rainbow Trout were captured, indicating that removal was complete and the barrier is effective.

Temperature Monitoring

Temperature loggers were deployed in various Tennessee trout streams across elevational and latitudinal gradients to obtain baseline data and to evaluate suitability for native Brook Trout restoration (see Table 11. below). Tennessee Brook Trout typically occur in streams above 2,100 ft elevation and where summer temperatures remain below 20°C. Little Paint Creek is being considered for native Brook Trout restoration in 2023 or 2024 and did have some higher temperatures in 2022 (Figure 10). More temperature monitoring should be conducted there before proceeding with a restoration project.

Table 11. Streams with temperature loggers in them in 2021 and 2022. An asterisk indicates no data collected in 2022. Elevation (ft) indicates elevation the temperature logger was placed.

Stream	Elevation (ft)	Trout Present
Little Stony Creek	1,846	Brook Trout
Round Knob Branch	1,937	Brook Trout
Squibb Creek	1,962	Brook Trout
Little Jacob Creek*	1,996	Brook Trout, Rainbow Trout
Sinking Creek	2,089	Rainbow Trout
Little Paint Creek	2,105	None
Briar Creek	2,238	Brook Trout, Rainbow Trout
Phillips Hollow*	2,300	Brook Trout
Right Prong Rock Creek*	2,459	Rainbow Trout
Trail Fork Big Creek	2,732	Brook Trout
Left Prong Hampton Creek*	3,262	Brook Trout
Right Prong Middle Branch*	3,845	Brook Trout

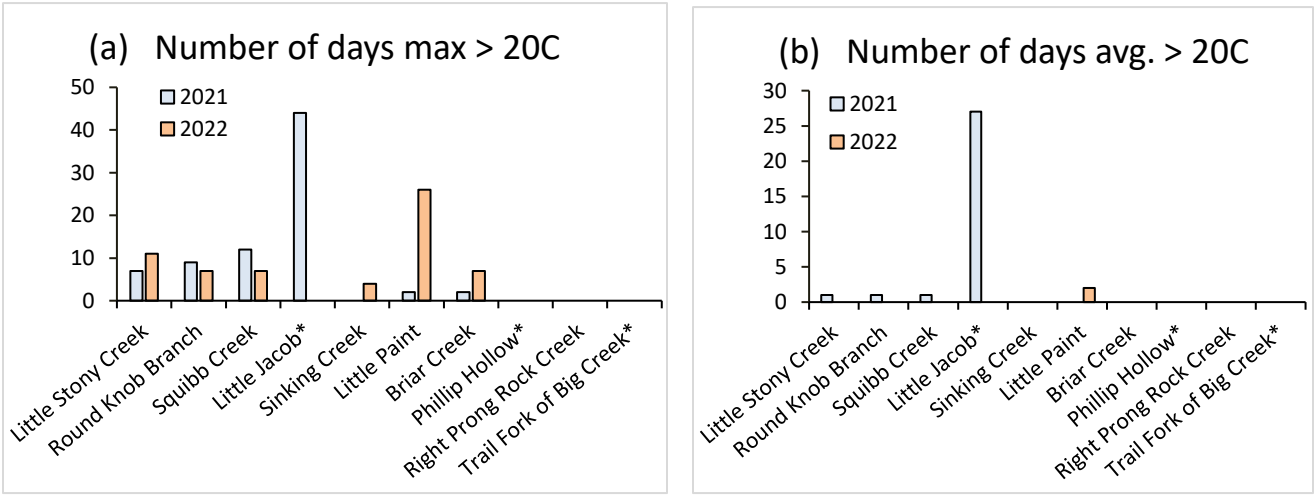


Figure 10. Number of days with maximum stream temperature >20C (a) and number of days with average temperature of 20C (b) for selected Tennessee Brook Trout streams.

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). Natural reproduction is variable and tailwater trout fisheries tend to be largely hatchery-supported, with abundances and size/age-class densities related to stocking rates. However, Brown Trout fisheries in the South Holston and Wilbur tailwaters are self-sustaining and substantial natural reproduction by Rainbow Trout has also been documented in these tailwaters, as well as in the Norris tailwater. TWRA prefers to manage for wild trout fisheries where possible (TWRA 2017), thus management strategies (e.g., fingerling Rainbow Trout stocking) will be adjusted in tailwaters to reflect the significance of contributions by wild fish.

Six Region IV tailwater trout fisheries (Norris, Cherokee, Wilbur, Ft. Patrick Henry, Boone, South Holston) are currently monitored annually. Sampling is conducted annually in late February or March (except Cherokee) if appropriate flows are available to assess the overwintering trout populations present before stocking begins. The Cherokee tailwater (Holston River) is sampled in both summer (June) and fall (late October/early November). Trout survival over the summer/early fall is the most important issue for the Cherokee tailwater fishery, thus sampling is timed to document trout abundance before and after the high water temperatures (daily minimum >21° C) that occur then. Catch per unit effort (CPUE) for each trout species at each site (fish/h), as well as overall means, are calculated to monitor abundance trends.

Trout fishery management plans are in place for the Norris (Habera et al. 2020), Wilbur (Habera et al. 2022b), South Holston (Habera et al. 2022c), and Boone/Ft. Patrick Henry (Habera et al. 2018). A management plan for the Cherokee tailwater will be developed during 2023-2024. Annual monitoring helps determine if management plan goals and objectives are being met.

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). Tailwater sampling information is summarized in Table 12 below:

Table 12. Tailwater sampling conditions and effort.

Tailwater	Year annual monitoring began	Sample time	Area sampled	Stations	Approximate flow	Total effort (h)
Norris	1999	Night	Dam to Llewellyn Is.	12	114 m^3/s (4,000 cfs)	2.00
Cherokee	2003	Day	Hwy. 92 to Indian Cave	12	114 m^3/s (4,000 cfs)	2.00
Ft. Patrick Henry	2002	Day	Dam to SFH RM 7.3	4	88 m^3/s (3,100 cfs)	1.00
Wilbur	1999	Day	Bee Cliff to Watauga Flats	13[1]	71 m^3/s (2,500 cfs)	2.16
Boone	2009	Day	Dam to Hwy. 75	4	88 m^3/s (3,100 cfs)	1.00
South Holston	1999	Day	Dam to J. F. Thomas access	12	71 m^3/s (2,500 cfs)	2.00

[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

Monitoring samples at the 12 Norris tailwater monitoring stations (Figure 11) produced 302 trout in 2022 and 317 in 2023 (Figure 12). No Brook Trout were captured in either sample, although none have been stocked since 2020. Rainbow Trout in the 229 mm size class and below were wild fish (unmarked). Overall, 41% of trout >178 mm captured in 2022 and 23% captured in 2023 were within the 356-508 mm (14-20 in.) protected length range (PLR) (Figure 5-2).

CPUE

The mean electrofishing CPUE for all trout ≥178 mm in 2022 and 2023 increased relative to 2021 and were near the post-PLR mean of 142 fish/h (Figure 13). However, Brown Trout CPUE declined to 3.0-3.5 fish/h, which are the lowest catch rates observed to date (Figure 13) and are likely related to reduced stocking rates during 2018-2020(16,000-20,000/year). Mean CPUE for trout within the PLR (356-508 mm) fell to 34 fish/h in 2023, which is the lowest catch rate for fish in this size range since 2013 (Figure 13). The PLR catch rate objective for the current Norris tailwater management plan is a mean of ≥56 fish/h for 2020-2025 (Habera et al. 2020).

RSD-14

Relative stock density for trout ≥356 mm or 14 in. (RSD-14) has improved for both Rainbow Trout and Brown Trout post-PLR, with values often exceeding 50 and seldom below 30 since 2011 (Figure 14). These consistently higher RSD-14 values indicate that trout population size structures have shifted toward larger fish (≥14 in.)—which is what PLR regulations are intended to accomplish. An RSD-14 value of 50 indicates that 50% of all stock-size trout—those at least 10 in. in length—are 14 in. or larger and is representative of a trout fishery with an exceptional proportion of larger fish. RSD-14 for Rainbow Trout and Brown Trout was at or above the objective for the current Norris tailwater management plan (mean RSD-14 ≥45; Habera et al. 2020) in 2022 and 2023 (Figure 14).

Stocking

The 2019-2022 fingerling Rainbow Trout stocking rates were reduced (Figure 15) to accommodate marking these fish (fin clips/coded wire tags) for the recent TWRA / Tennessee Cooperative Fisheries Research Unit (TN CFRU) research project (see below). The Rainbow Trout fingerling stocking rate was held at 100,000 in 2023 and stocking of these fish may eventually be suspended pending the results and recommendations provided in the final report for this project. Despite the return to the prescribed stocking rate for Brown Trout since 2021 (40,000/year; Figure 15), recent Brown Trout catch rates have not responded, thus it may become necessary to increase the stocking rate if fish are available from Dale Hollow National Fish Hatchery (DHNFH).

Angler Surveys

Trout anglers made an estimated 6,481 trips comprising 22,202 hours of effort in 2022 (Black 2023), which is slightly below effort estimates for the 2019-2021 survey (Figure 16). However, total estimated trout catch and harvest for 2022 declined substantially from 2021, primarily as a result of reduced catch and harvest of Brown Trout, which were unusually high in 2021 (Figure 16). Anglers in 2022 reported that 31% of Rainbow Trout and <1% of Brown Trout they caught were in the PLR, while 6% of Rainbow Trout and 2% of Brown caught were ≥20 in. Anglers released 90% of the trout they caught that were ≥20 in. When asked about TWRA's management of the Norris tailwater trout fishery, 65% of anglers (n=184) agreed or somewhat agreed that management goals were being met, 9% somewhat or completely disagreed, and the remainder

were neutral or offered no opinion. A new creel survey is being conducted during 2023 on the Norris tailwater and results will be available in 2024.

Research

Field work associated with the four-year TN CFRU cooperative research project to evaluate contributions of stocked and wild Rainbow Trout in the Norris tailwater was completed in 2022. Results from 2022 shoreline electrofishing samples during June, September, and October further indicated that wild Rainbow Trout are more abundant than stocked fingerling Rainbows and that the wild fish survive and recruit better than stocked fingerlings. Consequently, Norris tailwater's Rainbow Trout population appears to be substantially supported by natural reproduction. The final report associated with this project will provide information on survival, growth, and recruitment of stocked and wild Rainbow Trout in the Norris tailwater and will help guide future management.

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 of anglers who enjoy this fishery (Habera et al. 2020). The PLR regulation, established in March 2008, has successfully increased abundances of 14-20-inch trout (particularly Rainbow Trout), thereby improving trout population size structures (RSD-14). Accordingly, the PLR regulation continues to be the primary strategy for attaining the goal during 2020-2025. Future fingerling Rainbow Trout stocking may be reduced or eliminated given the results TN CFRU's research and TWRA's policy to manage for wild trout where feasible (TWRA 2017; Hatchery-Supported Fisheries Goal 1: Optimize use of hatchery trout, Strategy 1). The substantial level of Rainbow Trout reproduction throughout the tailwater may reflect the increased number of potential spawners resulting from the PLR regulation.

Norris Tailwater

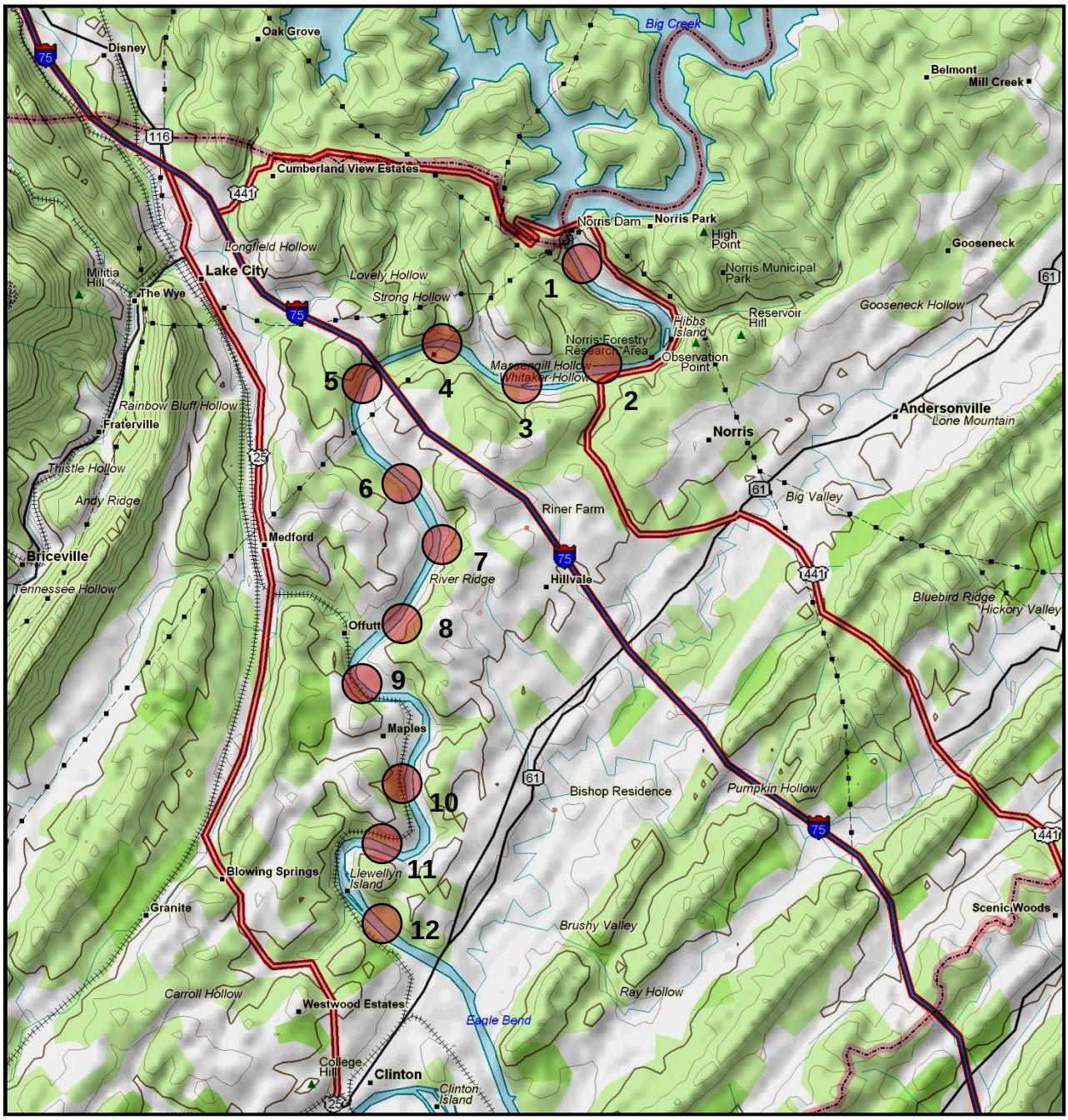


Figure 11. Locations of the Norris tailwater (Clinch River) monitoring stations.

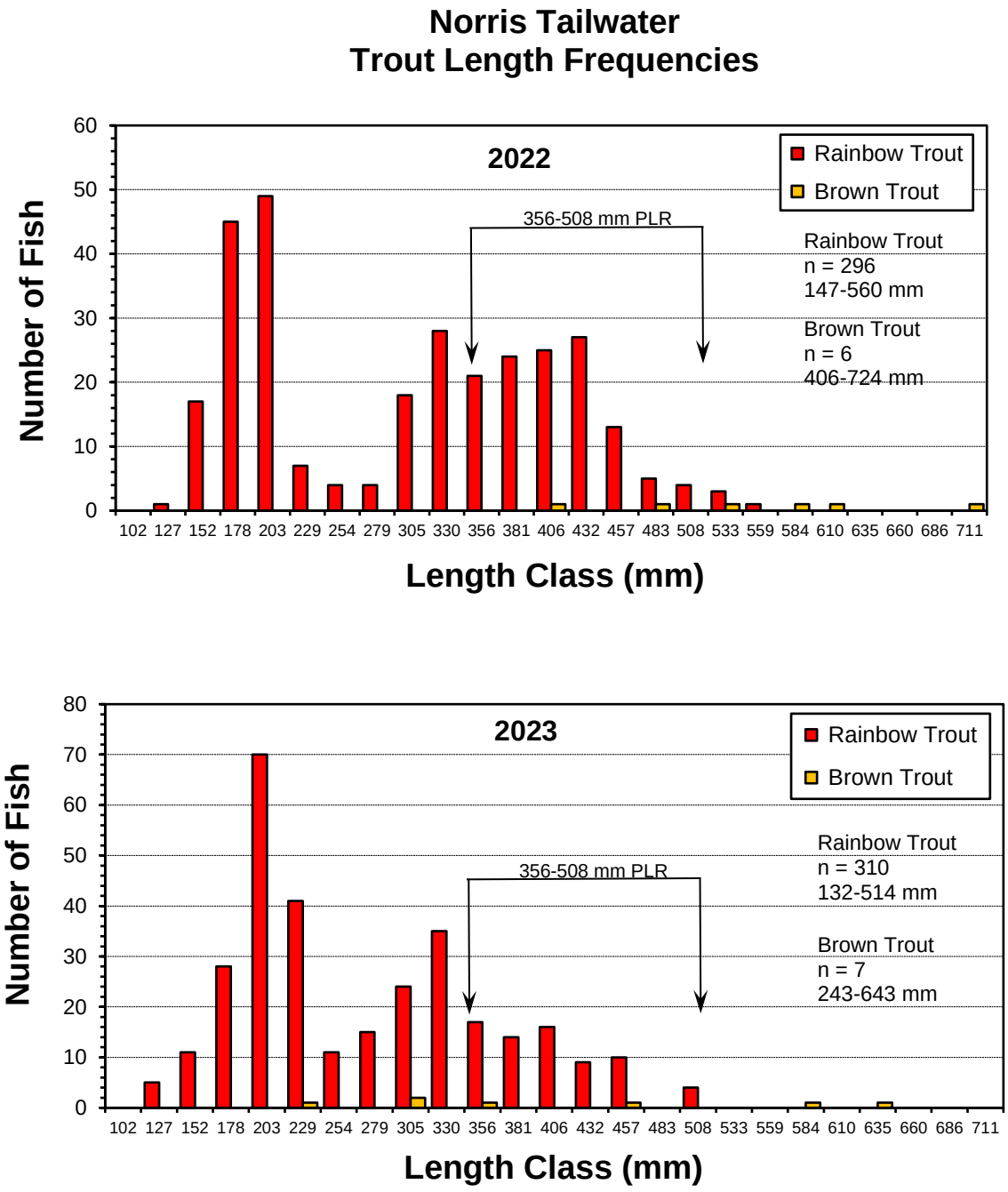


Figure 12. Trout length frequency distributions for Norris tailwater in 2022 and 2023. All Rainbow Trout in the 127-229 mm size classes were wild fish.

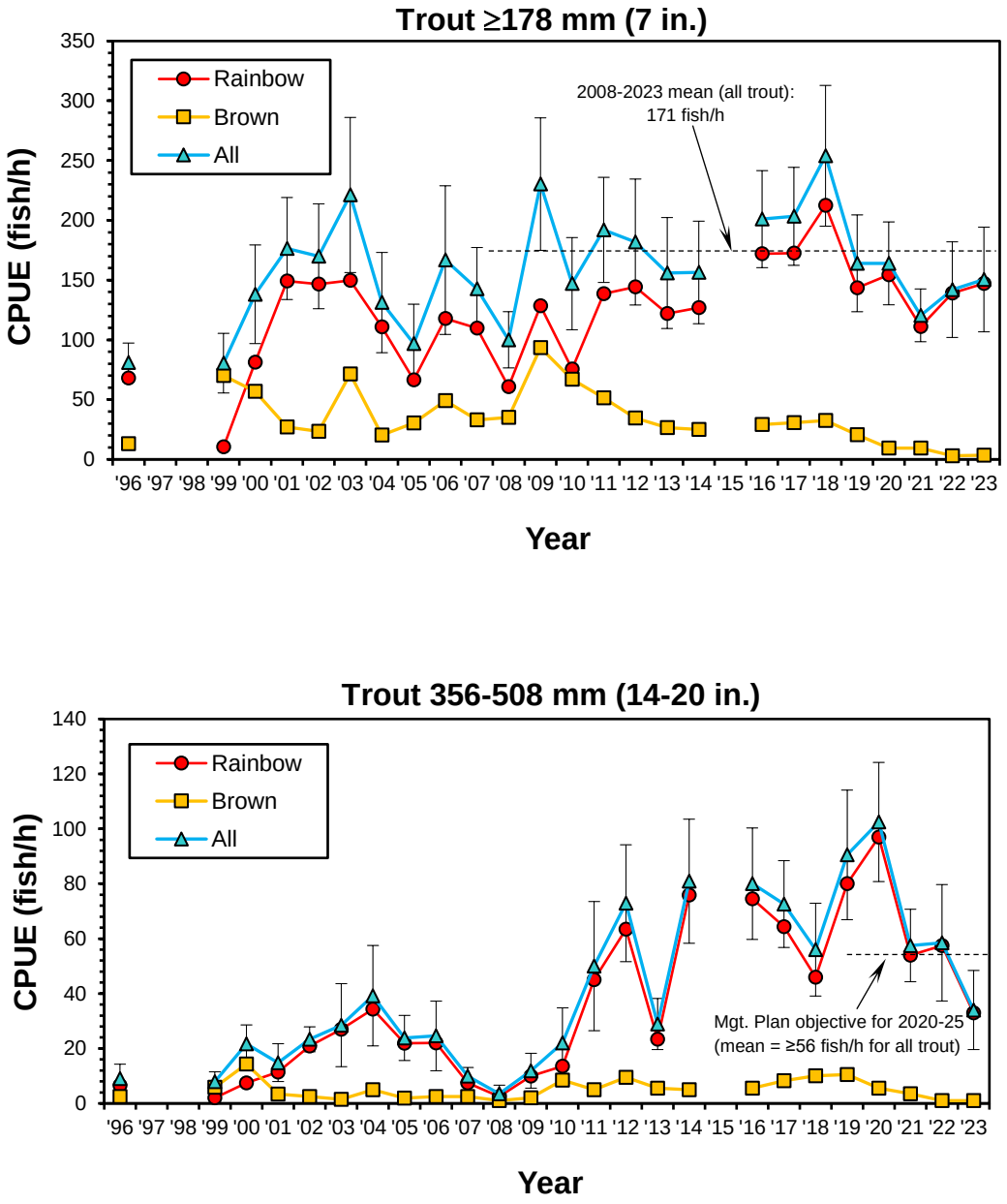


Figure 13. Mean trout CPUEs for the Norris tailwater samples. Bars indicate 90% confidence intervals. The 356-508 mm PLR regulation was established in 2008.

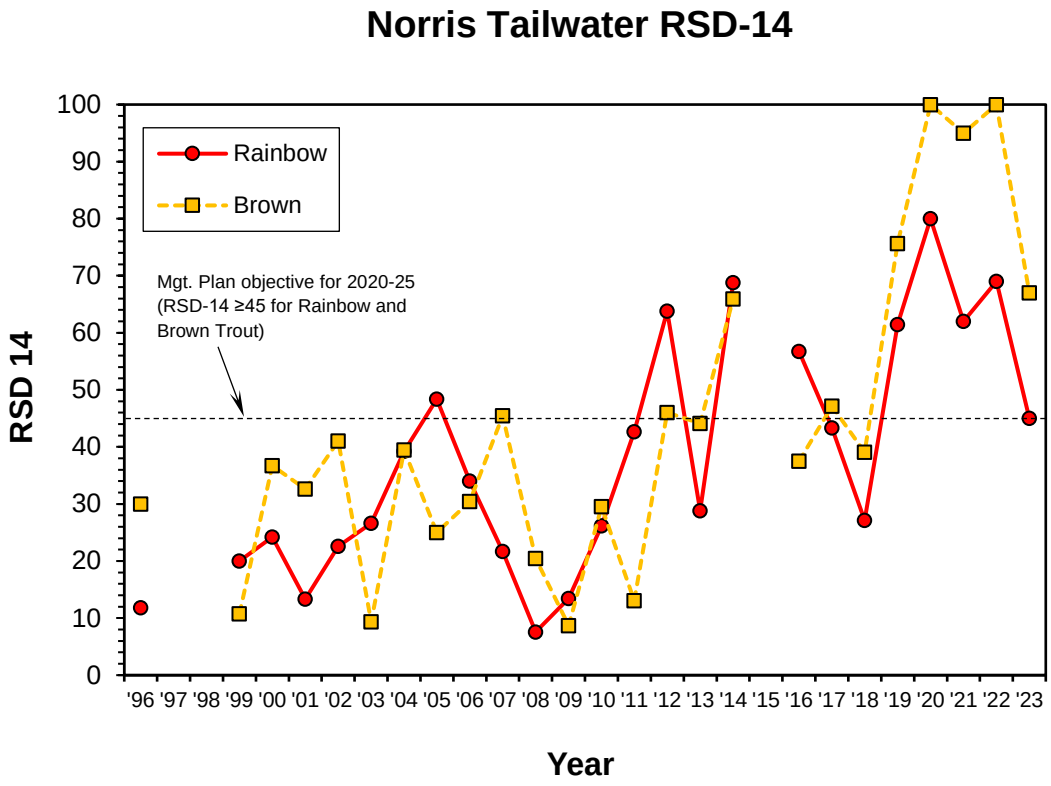


Figure 14. Relative stock densities for Norris tailwater Rainbow Trout and Brown Trout ≥14 in. (RSD-14).

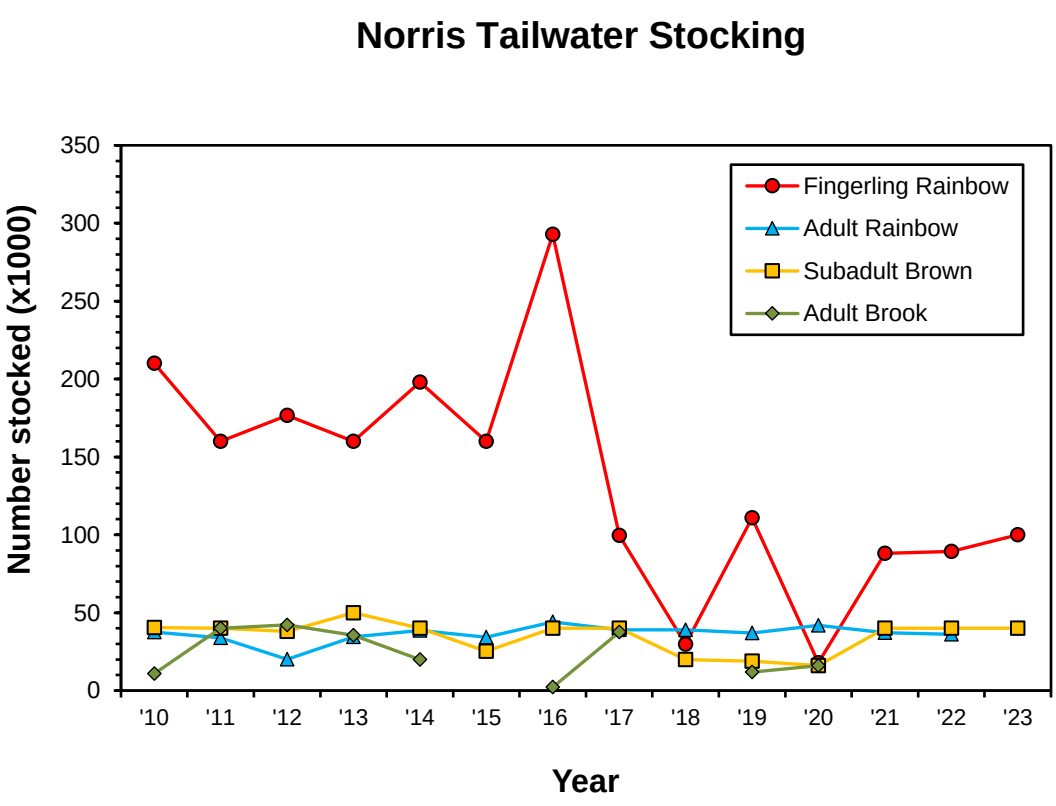


Figure 15. Recent trout stocking rates for the Norris tailwater. The 2019-2022 fingerling Rainbow Trout stocking rates were reduced to accommodate marking fish for the TN CFRU research project. Adult Rainbow Trout stocking for 2023 is incomplete but 37,000 fish are allocated.

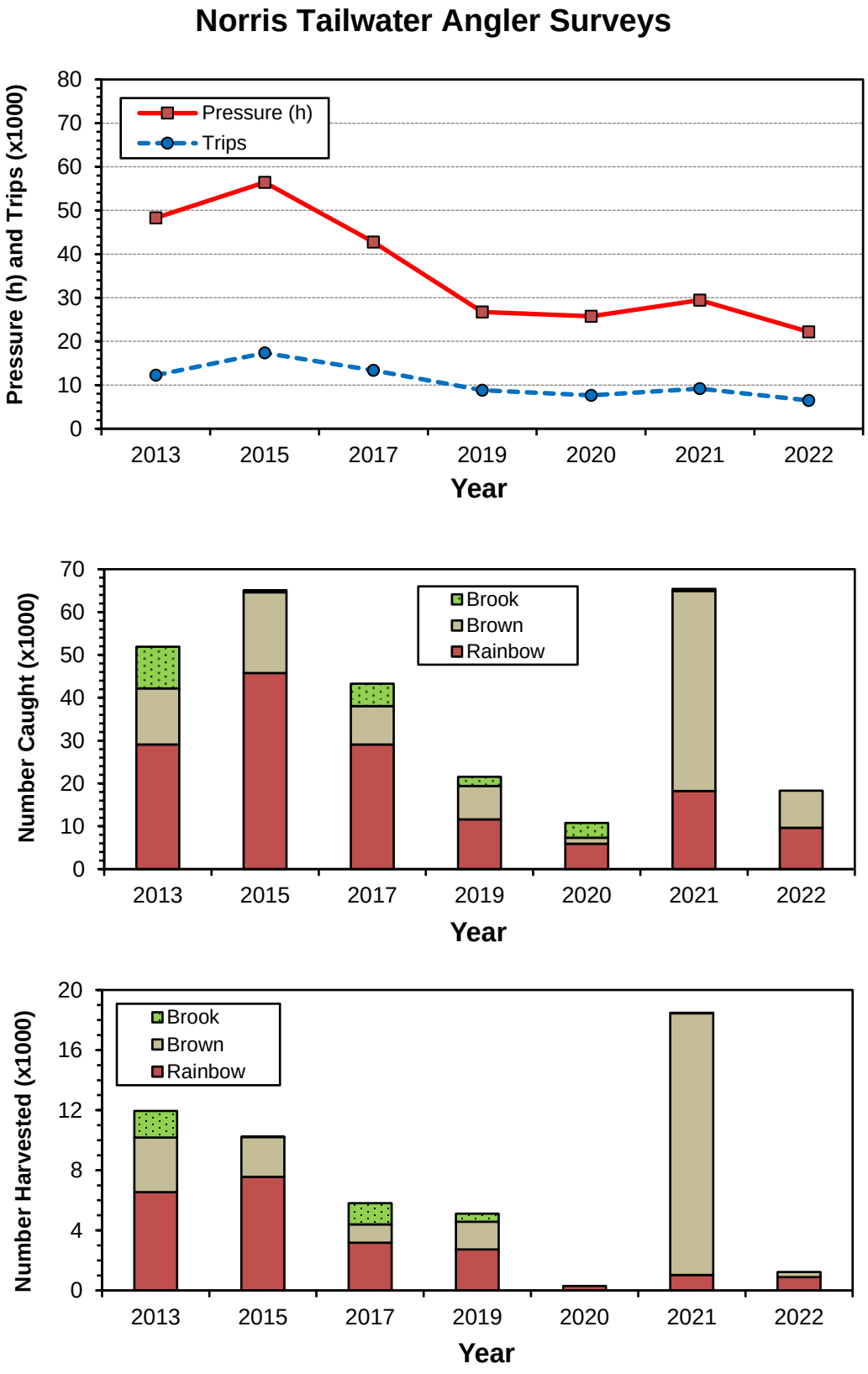


Figure 16. Angler use, catch and harvest estimated by Norris tailwater creel surveys (1998-2022). The 1998-2006 surveys covered only March-October.

Cherokee (Holston River)

Catch and Length Frequency

The 12 Cherokee tailwater monitoring stations (Figure 17) produced 16 trout (13 Rainbow Trout, 3 Brown Trout) during the November 2022 sample. There was no summer (June) sample in 2022 because TVA was unable to provide adequate flow. Half of the trout captured were in the 356 mm size class or larger (Figure 18).

CPUE

Mean CPUE for the November 2022 sample (8 fish/h) decreased somewhat relative to the 2021 catch rate (12.5 fish/h) but remained near the average for the past 10 years (9 fish/h; Figure 19). The mean catch rate for larger trout (5 fish/h ≥356 mm) also decreased relative to 2021 but remained near the past 10-year average (6.0; Figure 19).

Stocking

The Cherokee tailwater received 55,000 adult (229-254 mm) Rainbow Trout and 34,000 sub-adult (203-229 mm) Brown Trout in 2022 (Figure 20). Average annual stocking rates during the past five years have been 40,000 adult Rainbow Trout and 26,000 sub-adult Brown Trout.

Water Temperature Monitoring

Hourly water temperature data were collected (Onset TidbiT® *v2* loggers) at the monitoring site at Blue Spring (13 km downstream of Cherokee Dam) during June through mid-November 2022. Maximum daily water temperature was ≥21° C for 50 days in 2022 (27 August-15 October; Figure 21) and consistently reached 24° C during 16-29 September. Minimum daily water temperature reached 21° C on 2 September and remained ≥21° C during all but one day through 5 October (33 days total; Figure 21), thus there was no coldwater habitat during that period. Based on 2003-2022 data, there is typically no coldwater habitat (daily minimum water temperature is ≥21° C) at Blue Spring during 3 September-13 October (41 days; Figure 21).

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-September. 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 = 0.54) inverse relationship (2nd order polynomial) between the number of days where minimum water temperature was ≥23° C at the Blue Spring site and the electrofishing catch rate (log_{10}-transformed +1) for all trout ≥178 mm (Figure 22). There is also a relatively strong (R^2 = 0.57) positive relationship (2nd order polynomial) between water temperatures (expressed as the number of days where the minimum was ≥21° C at Blue Spring) and mean flow during March-September (Figure 23). Extended periods of low flows and high air temperatures in late summer (e.g., in 2016; Figure 23) 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. Some fish do find thermal refugia such as groundwater upwellings or cooler tributaries (Baird and Krueger 2003) and survive through at least one thermal bottleneck to produce the large (≥457 mm) fish that are captured in most monitoring samples.

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

Cherokee Tailwater

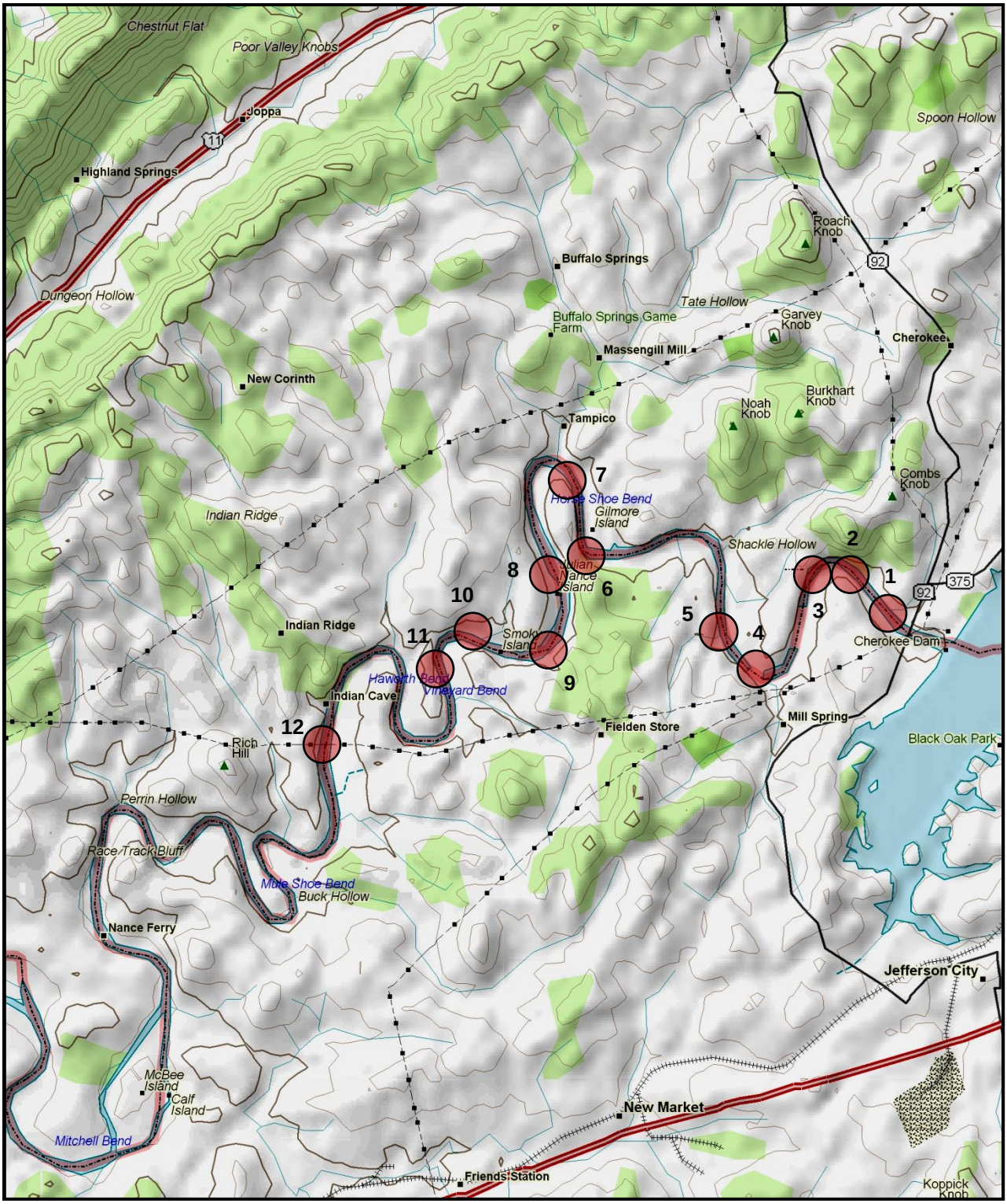


Figure 17. Locations of the Cherokee tailwater (Holston River) monitoring stations.

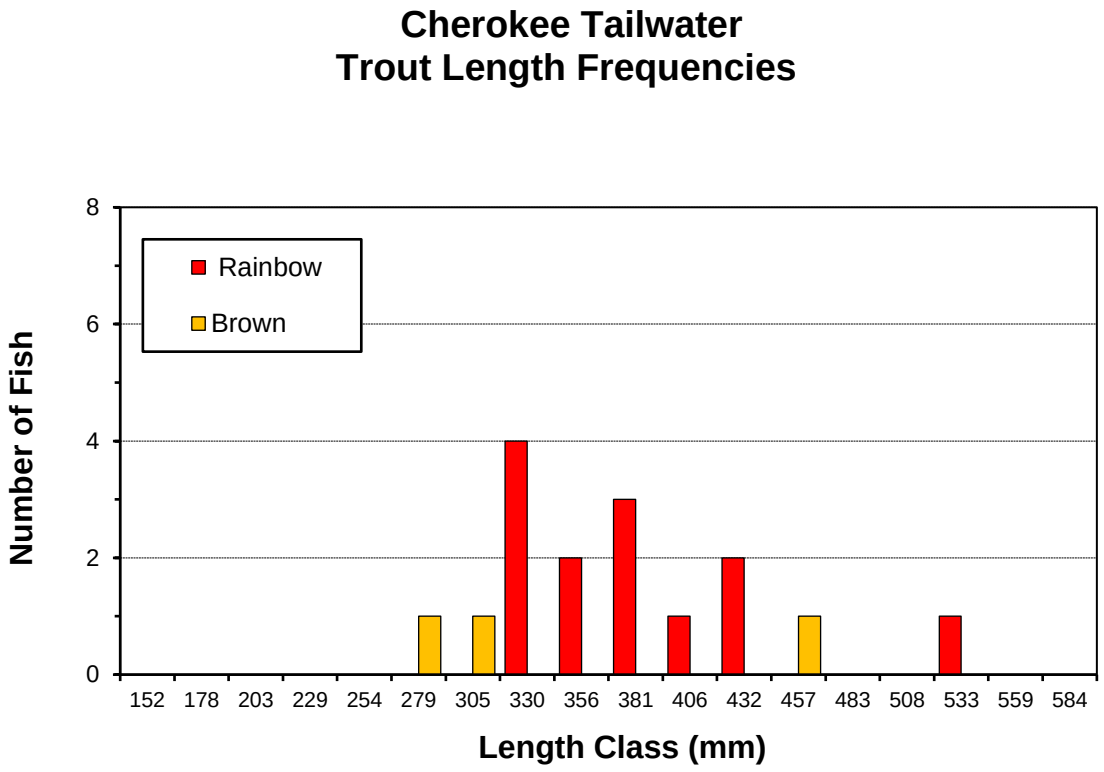


Figure 18. Trout length frequency distributions for the Cherokee tailwater (November 2022).

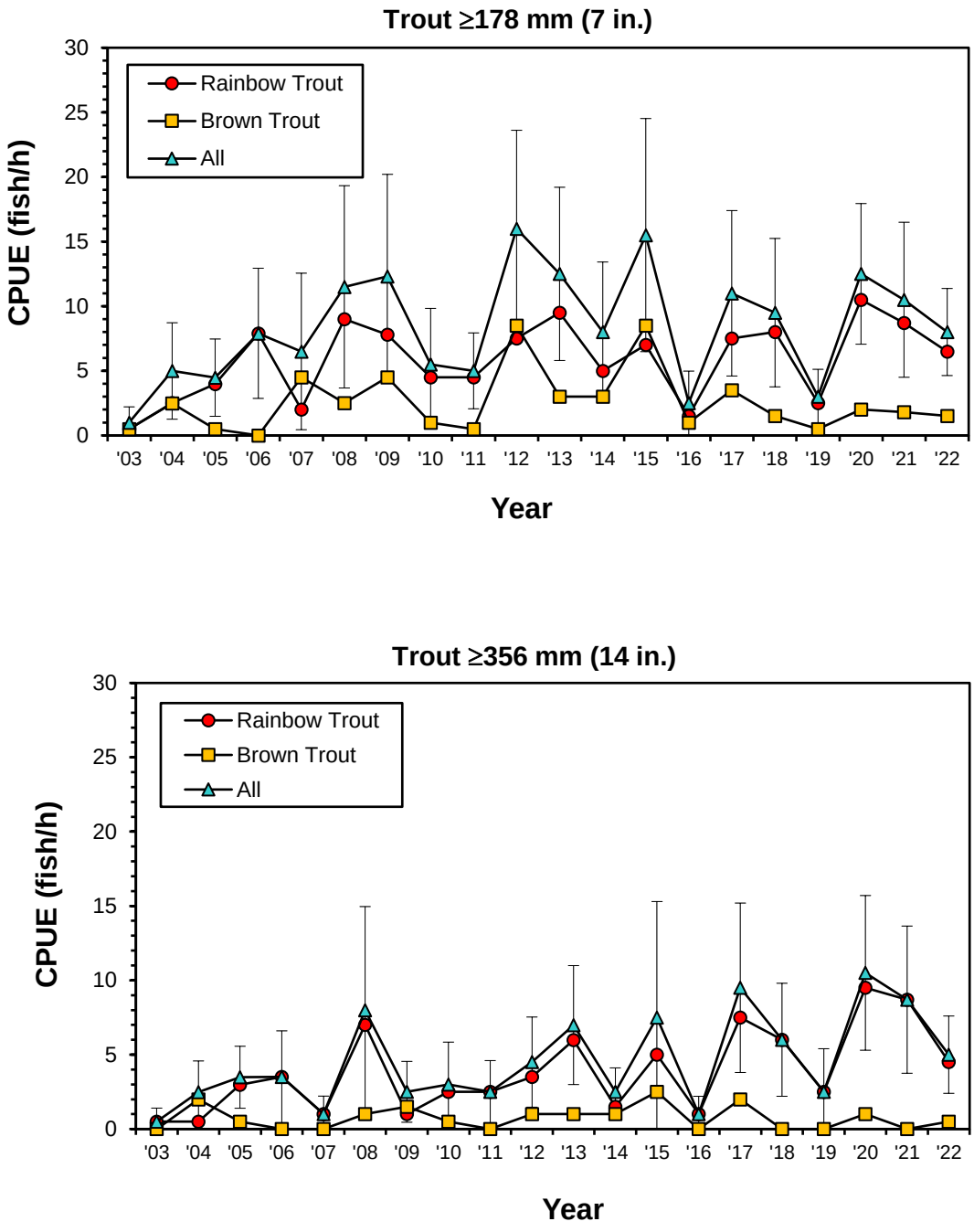


Figure 19. Mean trout CPUEs for the annual October/November Cherokee tailwater monitoring samples. Bars indicate 90% confidence

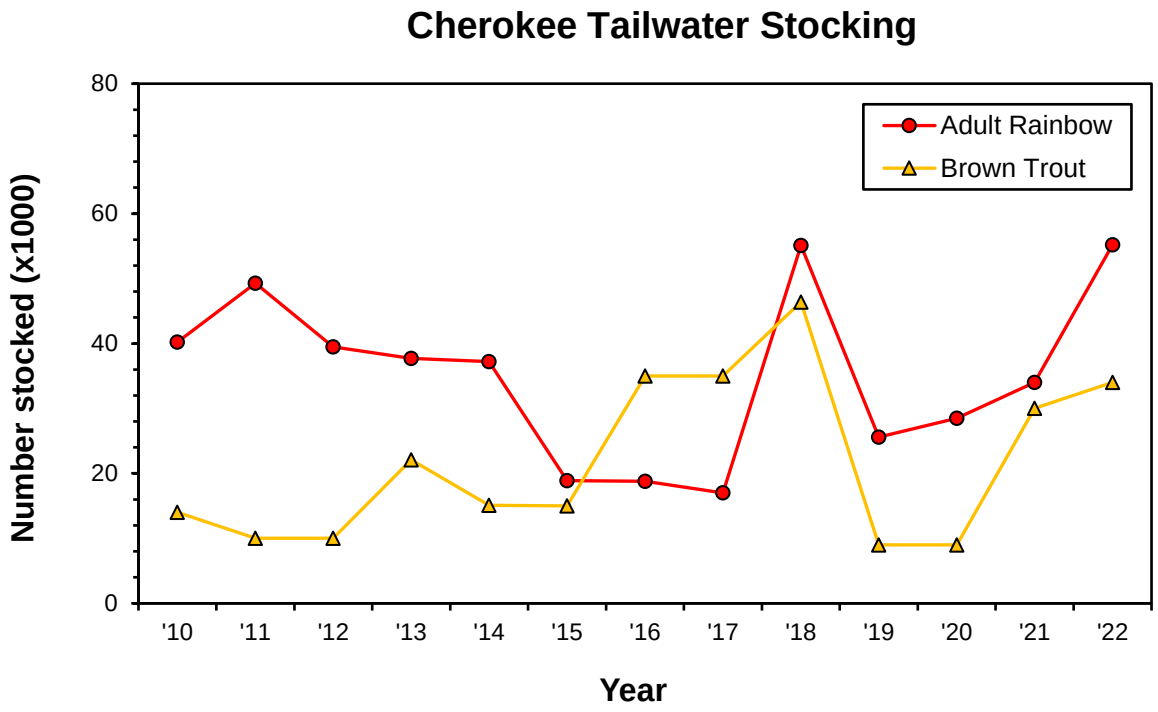


Figure 20. Recent trout stocking rates for the Cherokee tailwater. About 39,000 adult Rainbow Trout and 26,000 adult/sub-adult Brown Trout have been stocked annually since 2018.

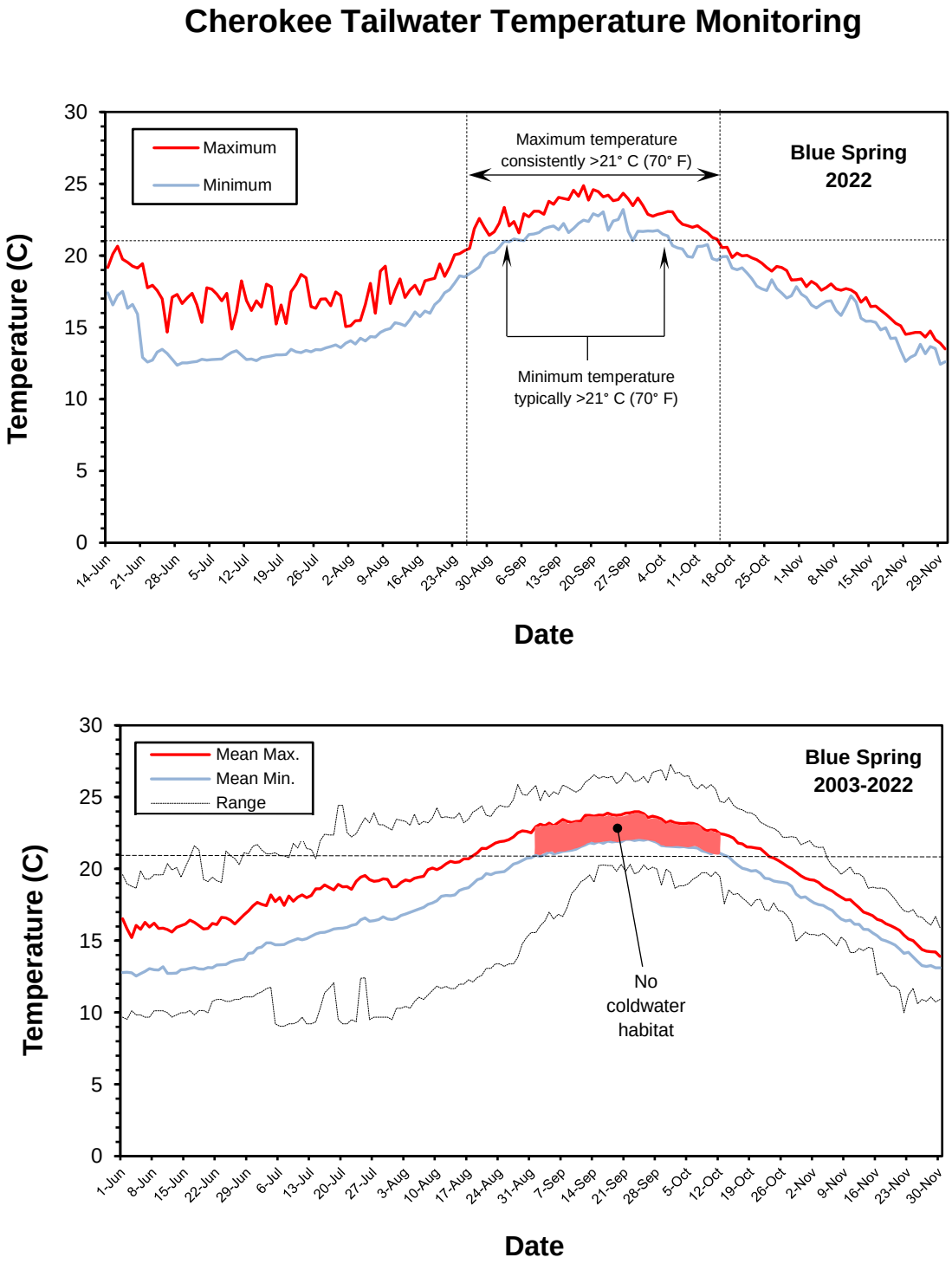


Figure 21. Daily temperature maxima and minima for June through mid-November at Blue Spring (~13 km below the dam) in 2022 (upper graph) and 2003-2022 means (lower graph, with range).

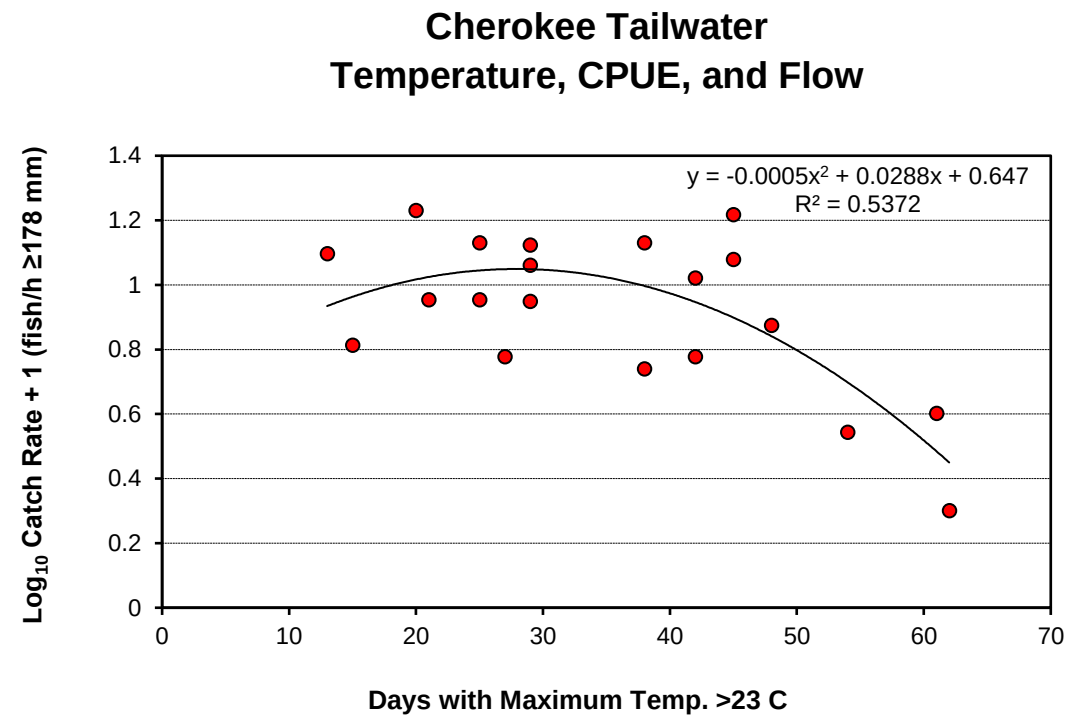


Figure 22. Relationship between temperature (days during June-Oct. with minimum >22 C at Blue Spring) and October/November electrofishing catch rate for the Cherokee tailwater.

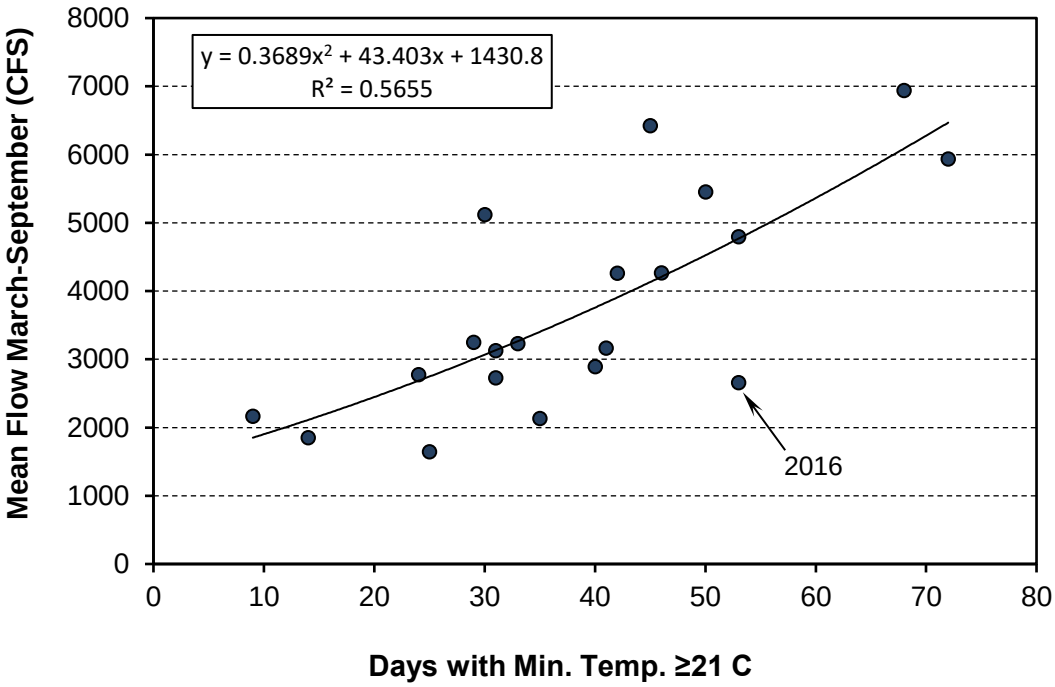


Figure 23. Relationship between mean flow (March-August) and temperature (days during June-October with minimum ≥21 C at Blue Spring) for the Cherokee tailwater.

Wilbur (Watauga River)

Catch and Length Frequency

The 12 Wilbur tailwater monitoring stations (Figure 24) produced 505 trout in 2022 (73% Brown Trout) and 425 trout in 2023 (74% Brown Trout; Figure 25). Most Brown Trout (58-69%) and Rainbow Trout (67-75%) were in the 203-305 mm size range (Figure 25).

CPUE

Mean CPUE for all trout ≥178 mm (all sites) has generally declined since 2019, primarily because reduced Brown Trout catch rates (Figure 26). Reduced Brown Trout CPUEs primarily occurred in the upper portion of the tailwater (above Blevins Bend, Stations 1-8), where they decreased from the higher catch rates during 2017-2020 (Figure 27). Mean Rainbow Trout CPUE (all sites) for 2022 and 2023 (57 fish/h; Figure 26) exceeded the management plan objective of 42 fish/h (Habera et al. 2022b), indicating suspension of fingerling Rainbow Trout stocking in 2021 has so far had no negative effect on the fishery. Mean Rainbow Trout CPUE in the lower tailwater (below Blevins Bend, Stations 9-12) has begun to improve following the decline during 2015-2020 (Figure 27). The mean catch rate for larger trout (≥356 mm and ≥457 mm) has generally increased since 2021 (Figure 26) and most of the larger fish in the Wilbur tailwater are Brown Trout (Figure 26).

Stocking

Retired Rainbow Trout broodstock from Erwin National Fish Hatchery are now allocated annually for the Wilbur tailwater and 1,630 of these fish (averaging 457 mm or 18 in.) were stocked in 2022 (Figure 28), particularly in the reach below Blevins Bend. No fingerling Rainbow Trout were stocked in 2022 or 2023 (Figure 28) and stocking of these fish will be suspended (potentially through 2027) while the contribution of natural reproduction by Rainbow Trout is evaluated during the current Wilbur tailwater trout fishery management plan (Habera et al. 2022b)

Management Recommendations

The Wilbur tailwater management plan (Habera et al. 2022b) recommends increasing the overall adult Rainbow Trout stocking rate from 40,000/year to 47,000/year, which would align it with the corresponding stocking rate for the South Holston tailwater. This increase would be appropriate given that recent (2019-2020) angling pressure, trips, and Rainbow Trout harvest estimates are comparable for these two tailwaters. Most (or all) of the additional 7,000 fish would likely need to come from DHNFH and this increase was agreed to at the 2022 trout allocation meeting hosted by TWRA. The annual adult Rainbow Trout stocking rate for Wilbur tailwater will increase to 47,000 in 2023, with the additional fish to be stocked during June-September. Fingerling Rainbow Trout stocking (previously 50,000/year) can be eliminated if annual monitoring data continue to indicate that natural reproduction is capable of maintaining abundance.

Wilbur Tailwater

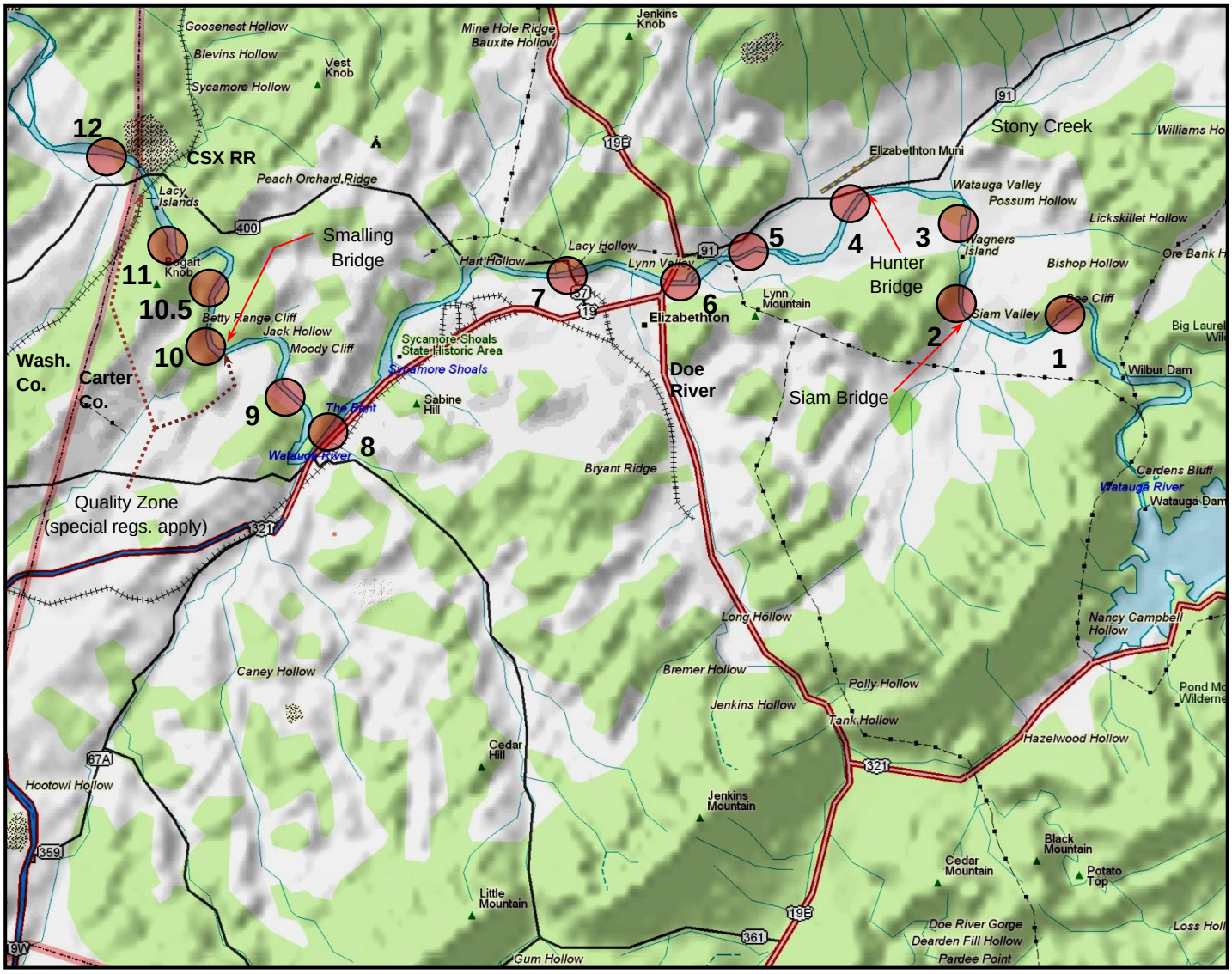


Figure 24. Locations of the Wilbur tailwater (Watauga River) monitoring stations. Station 10.5 was added in 2010 to help evaluate the Quality Zone (which also includes stations 10 and 11).

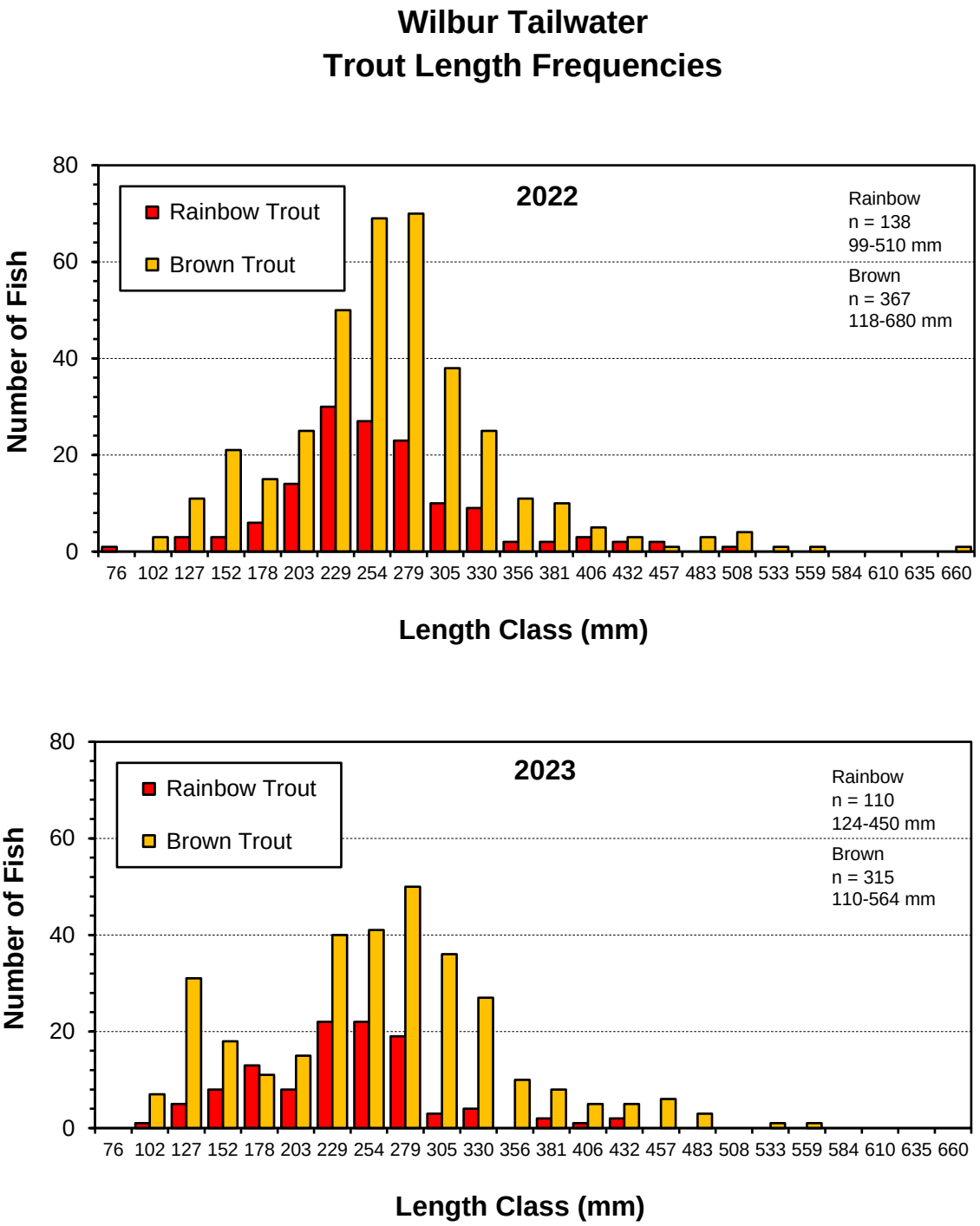


Figure 25. Length frequency distributions for trout from the 2022 and 2023 Wilbur tailwater monitoring samples (excluding Station 10.5).

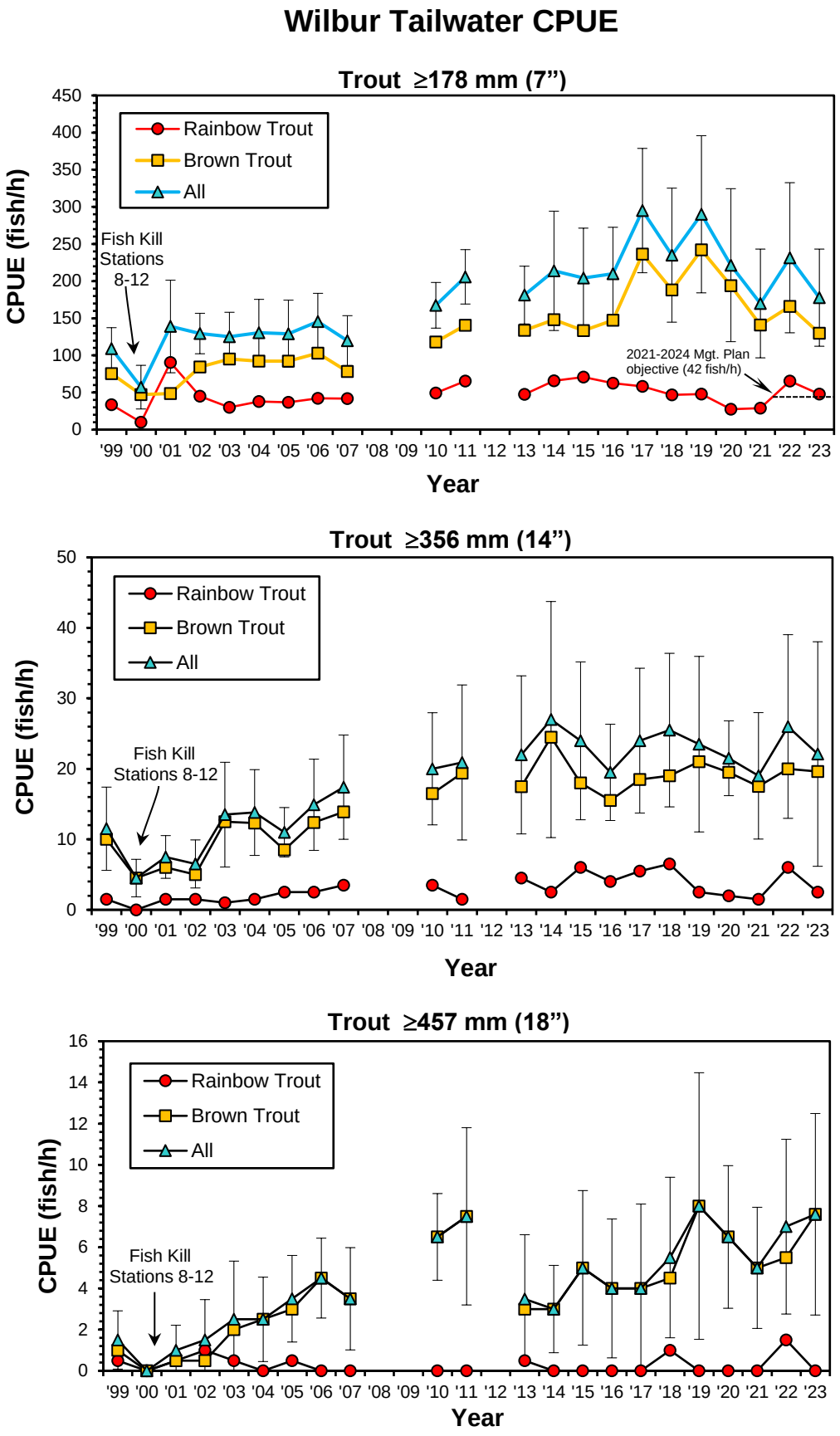


Figure 26. Mean trout CPUEs for the Wilbur tailwater samples. Bars indicate 90% confidence intervals.

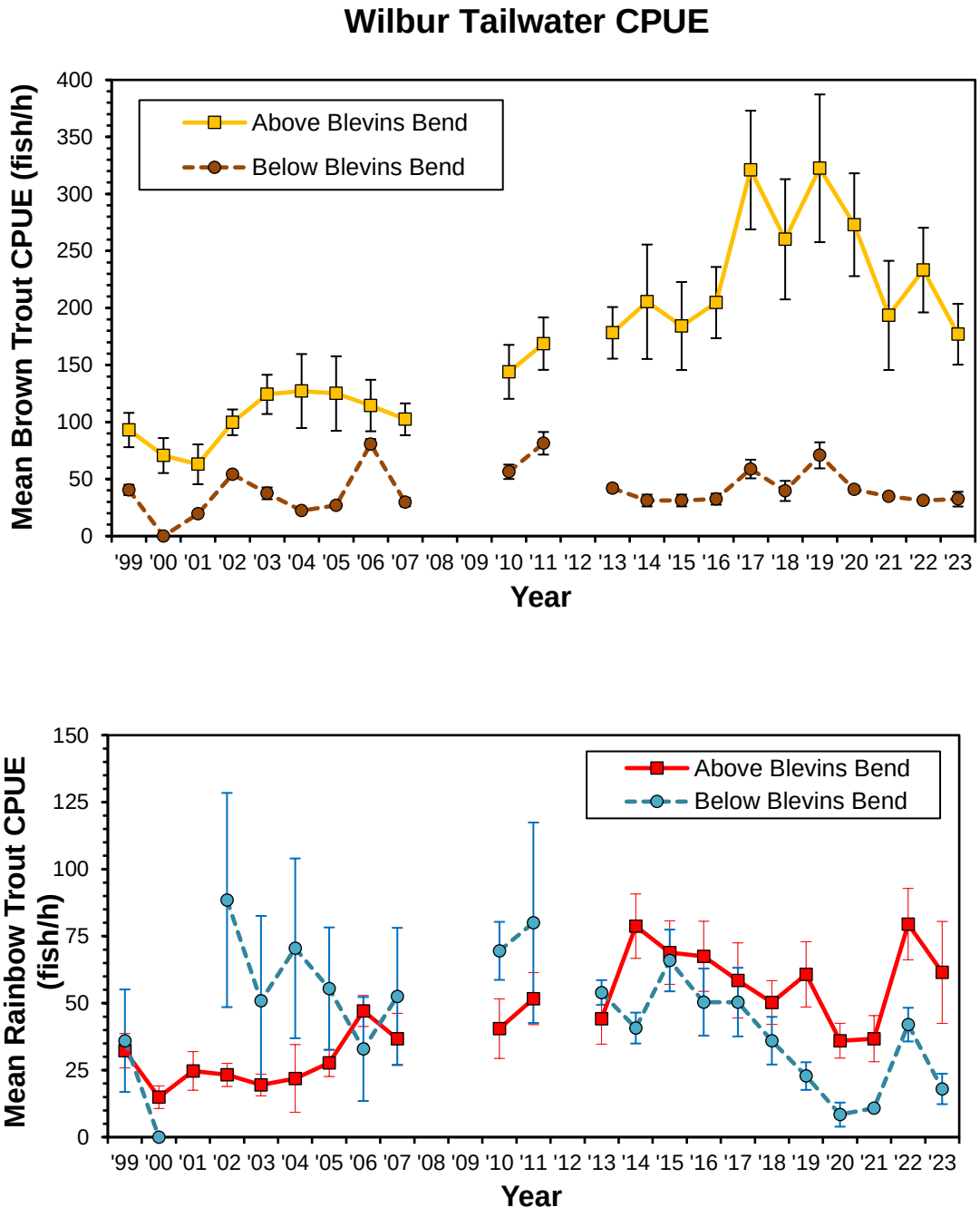


Figure 27. Mean trout CPUEs (fish ≥178 mm) for the Wilbur tailwater above (Stations 1-8) and below (Stations 9-12) Blevins Bend. Bars indicate standard errors (SE).

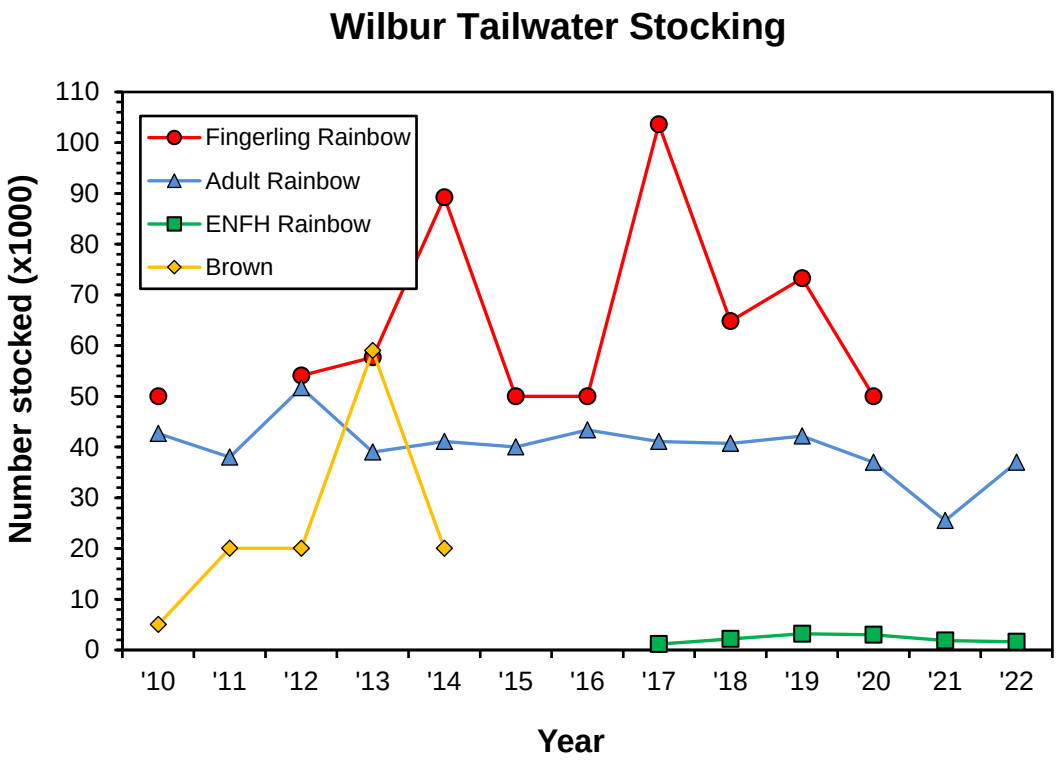


Figure 28. Recent trout stocking rates for the Wilbur tailwater. Fingerling Rainbow Trout stocking (50,000/year) was suspended in 2021 to evaluate the contribution of natural reproduction as part of the updated (2022-2027) management plan. Erwin National Fish Hatchery stocked 1,600 retired brood Rainbow Trout (18 in.) in 2022.

Fort Patrick Henry (South Fork Holston River)

Catch, Length Frequency, and W_r

The four Ft. Patrick Henry tailwater monitoring stations (Figure 29) produced 19 trout in 2022 and 14 in 2023 (Figure 30). Rainbow Trout >508 mm (20 in.) were captured in both samples and Brown Trout >508 mm were present in 2022 (Figure 30). Mean relative weight (W_r) was 118 for Rainbow and Brown Trout in 2022, while it was 125 for Rainbow Trout and 123 for Brown Trout in 2023.

CPUE

Mean electrofishing CPUE for trout ≥178 mm was the lowest observed to date in 2021 and improved only slightly in 2022 and 2023 (Figure 31). Catch rates for larger trout (≥356 mm and ≥457 mm) have generally declined since 2015 and remained relatively low in 2022 and 2023 (below the long-term averages of 27 fish/h and 10 fish/h for these size classes).

RSD-18

The relative stock density for Rainbow Trout 18 in. (457 mm) and larger (RSD-18) has regularly exceeded 20 in the Ft. Patrick Henry tailwater (Figure 32). 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 has been >20 since 2015 (Figure 32). Maintaining a mean RSD-18 of ≥20 during 2019-2024 is an objective of the current Boone and Ft. Patrick Henry Tailwater Trout Fisheries Management Plan (Habera et al. 2018).

Stocking

The Ft. Patrick Henry tailwater was stocked with 9,500 adult Rainbow Trout, 8,000 fingerling Rainbow Trout, and 5,000 subadult Brown Trout in 2021 (Figure 33). All Rainbow Trout were marked with fin clips as part of the ongoing TN CFRU research project (see below). The 2022 stocking rates were consistent with rates established in the Boone and Ft. Patrick Henry Tailwater Trout Fisheries Management Plan for 2019-2024 (Habera et al. 2018).

Research

The cooperative research project with TN CFRU was completed in 2022 and results indicate that the Fort Patrick Henry tailwater Rainbow Trout population is primarily supported by stocked adults, as stocked fingerlings were infrequently captured and did not appear to recruit to larger size classes. Some naturally reproduced fingerlings were observed in Kendrick Creek, thus there likely is a wild component to the Rainbow Trout fishery as well. Data from recaptured (PIT-tagged) fish indicate that adult-stocked Rainbow Trout fish grow 26.0 to 27.7 mm/month (over 1 in.). Identification of optimal stocking rates is an objective of the current Ft. Patrick Henry tailwater trout fisheries management plan (Habera et al. 2018) and results from this work will help inform future stocking strategy, with respect to Rainbow Trout fingerlings. It will also provide a better understanding of survival, recruitment, and growth of Rainbow Trout in this tailwater.

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 stock adult Rainbow Trout and Brown Trout to attain the management goal for this fishery. Annual fingerling Rainbow Trout stocking may be eliminated in 2024 pending the results of the final report from the TN CFRU research project. The cause of the decline in trout abundance (particularly Rainbow Trout) remains unknown at this time but may be addressed through increased stocking rates if enough fish can be allocated.

Ft. Patrick Henry Tailwater

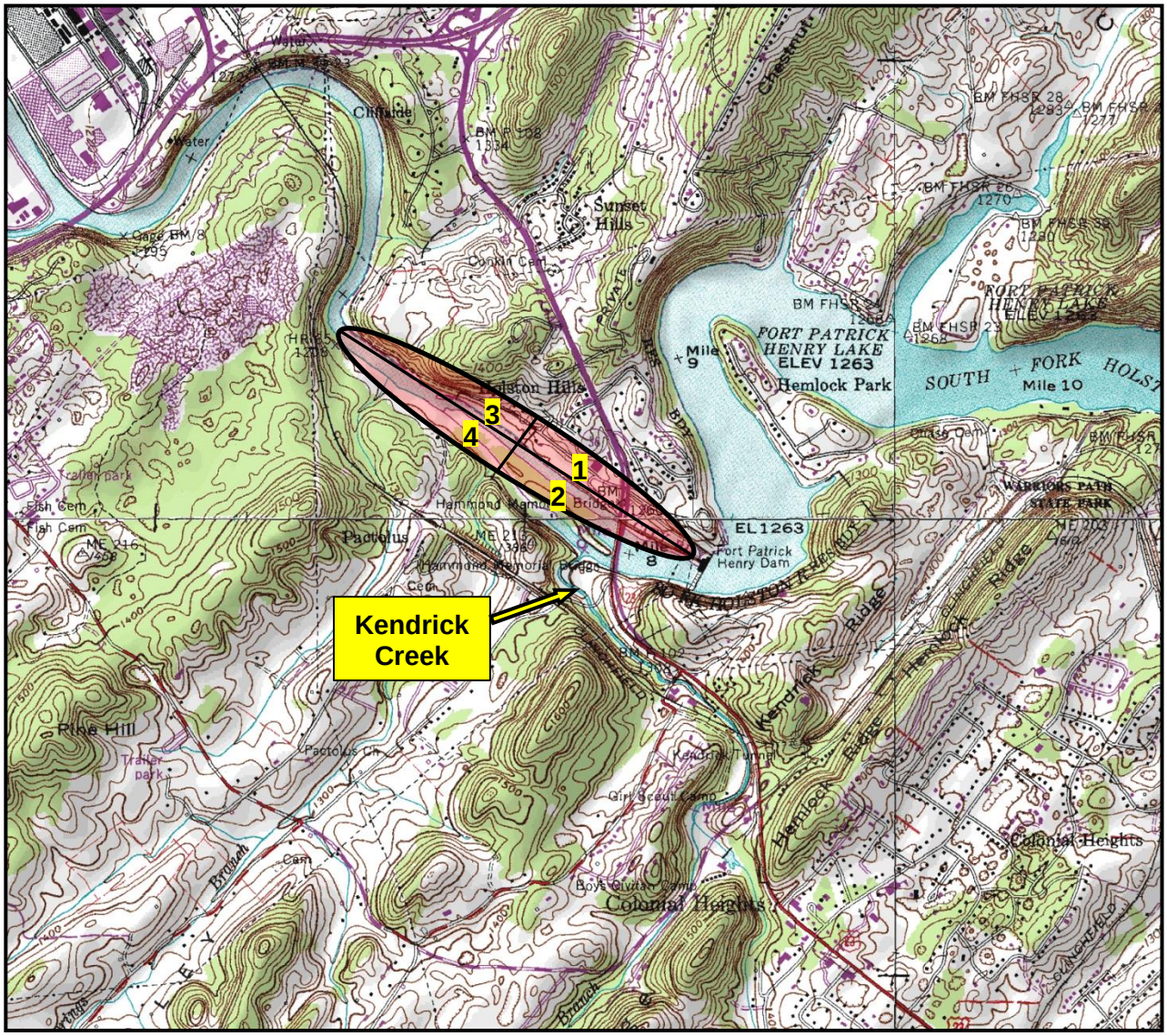


Figure 29. Location of the Ft. Patrick Henry tailwater (South Fork Holston River) monitoring stations.

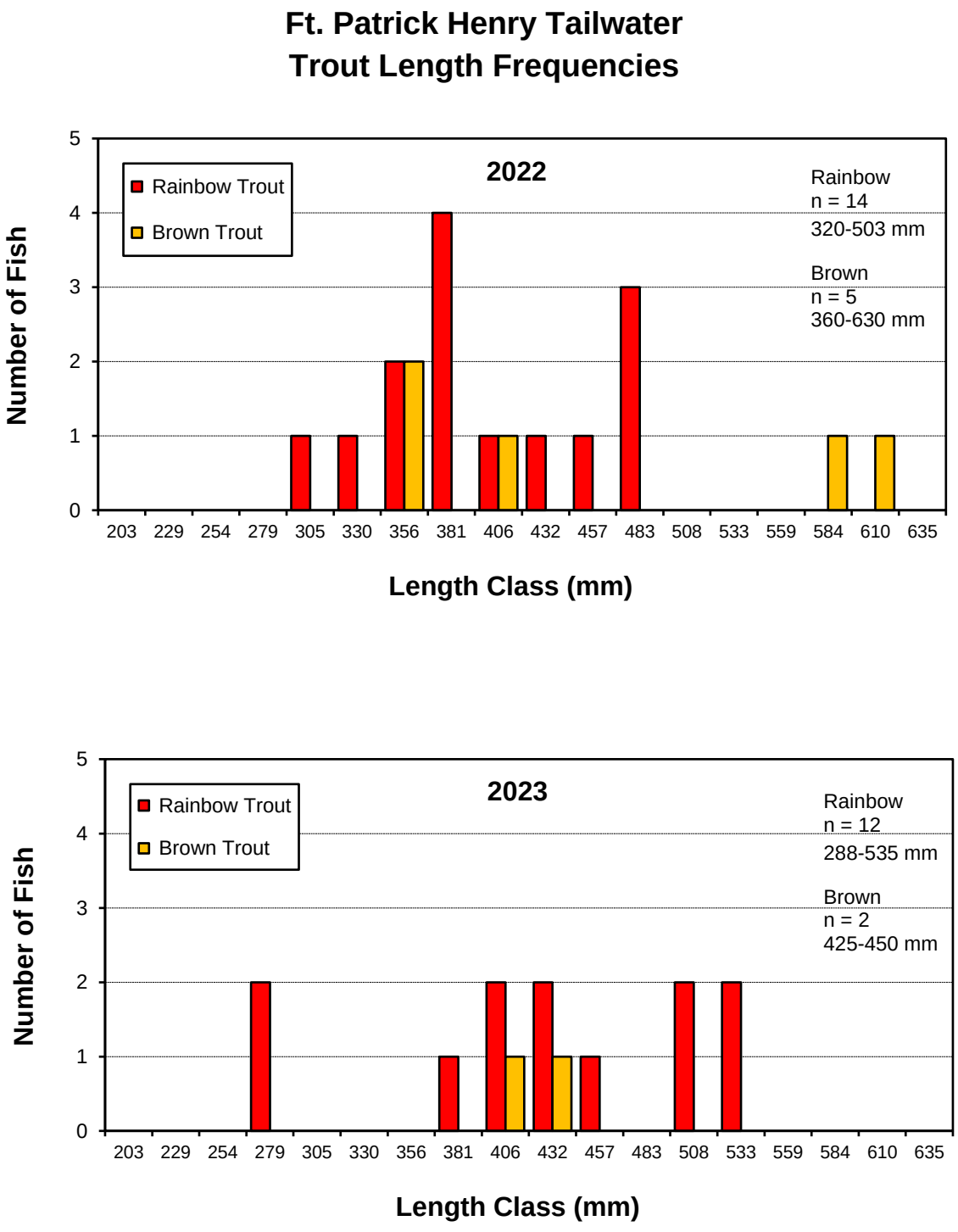


Figure 30. Trout length frequency distributions for the Ft. Patrick Henry tailwater samples in 2022 and 2023.

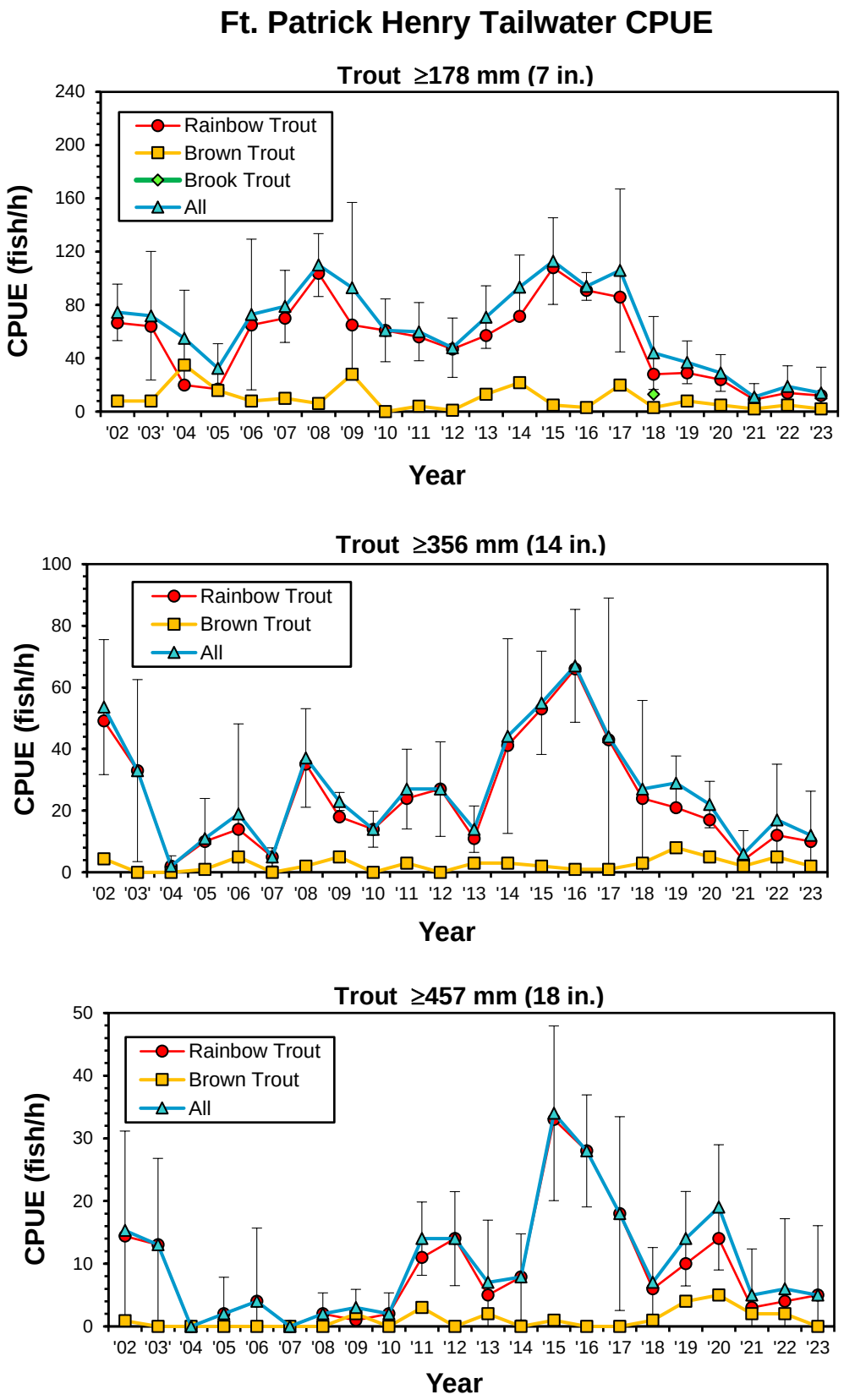


Figure 31. Mean trout CPUEs for the Ft. Patrick Henry tailwater. Bars indicate 90% confidence intervals.

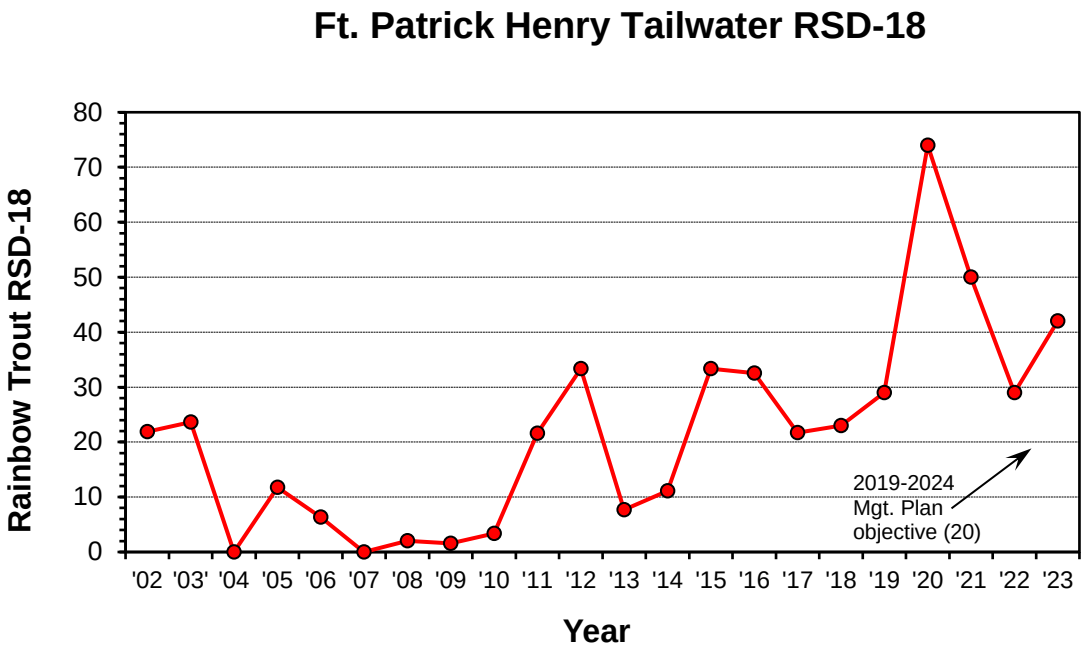


Figure 32. RSD-18 for Ft. Patrick Henry tailwater Rainbow Trout from annual monitoring samples.

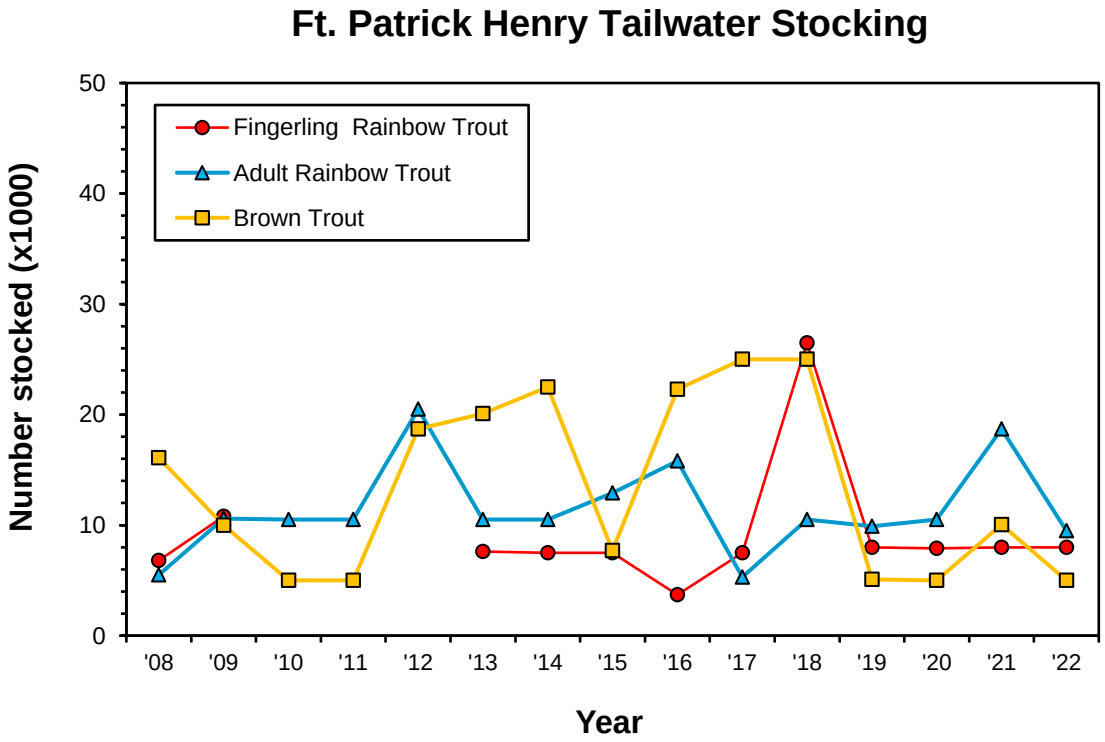


Figure 33. Recent trout stocking rates for the Ft. Patrick Henry tailwater.

Boone (South Fork Holston River)

Catch, Length Frequency, and W_r

The four Boone tailwater monitoring stations (Figure 34) produced 62 trout in 2022 and 48 in 2023 (Figure 35). Cutthroat Trout *Oncorhynchus clarkii* from the 2021 stocking were captured during both samples and grew from the 229-279 mm size range to 432-483 mm (Figure 35). Rainbow Trout >500 mm and Brown Trout >600 mm were also captured during each sample (Figure 35). Mean relative weight (W_r) for Rainbow Trout was 109 both years, while mean Brown Trout (W_r) was 118 in 2022 and 116 in 2023.

CPUE

The mean electrofishing catch rate for all trout ≥178 mm fell below the long-term average (76 fish/h) in 2022 and 2023, primarily because of decreasing CPUE for Rainbow Trout (Figure 36). However, mean CPUE for the ≥356 mm and ≥457mm size classes has increased since 2021, with CPUE for the largest trout (≥457mm) in 2023 exceeding all previous samples (23 fish/h, Figure 36).

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 37). An RSD-18 value of 20 indicates that 20% of all stock-size Rainbow and Brown Trout—i.e., those at least 254 mm (10 in.) in length—are 457 mm (18 in.) or larger. RSD-18 exceeded 40 for Rainbow Trout and all trout by 2023 (Figure 37), exceeding the objectives established in the management plan for the Boone tailwater trout fishery (10 for Rainbow Trout and 20 for all trout; Habera et al. 2018).

Stocking

The Boone tailwater was stocked with 10,000 adult Rainbow Trout, 7,500 fingerling Rainbow Trout, and 5,000 subadult Brown Trout and in 2022 (Figure 38). No Cutthroat Trout were available for stocking in 2022, but they are currently scheduled to be stocked during fall 2023. The 2022 stocking rates for Rainbow and Brown Trout were consistent with the annual stocking rates established in the 2019-2024 Boone tailwater trout fishery management plan (Habera et al. 2018). The effectiveness of fingerling Rainbow Trout stocking has not yet been evaluated, but results from the research project on the Ft. Patrick Henry tailwater (summarized above) should provide some insight and may help guide future stocking strategy.

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 (along with Brook Trout and Cutthroat Trout when available) to attain this management goal.

Boone Tailwater

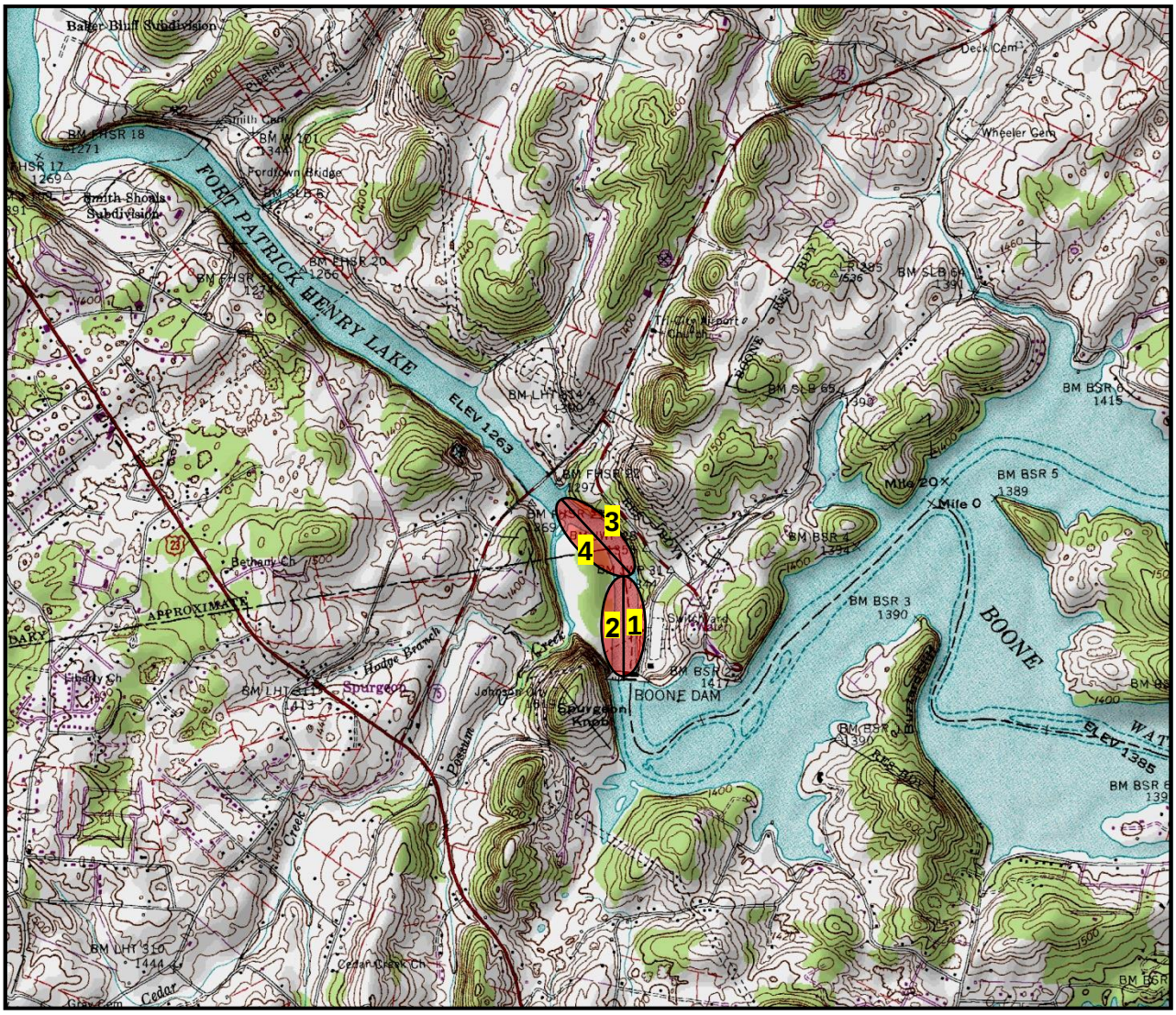


Figure 34. Location of the Boone tailwater (South Fork Holston River) monitoring stations.

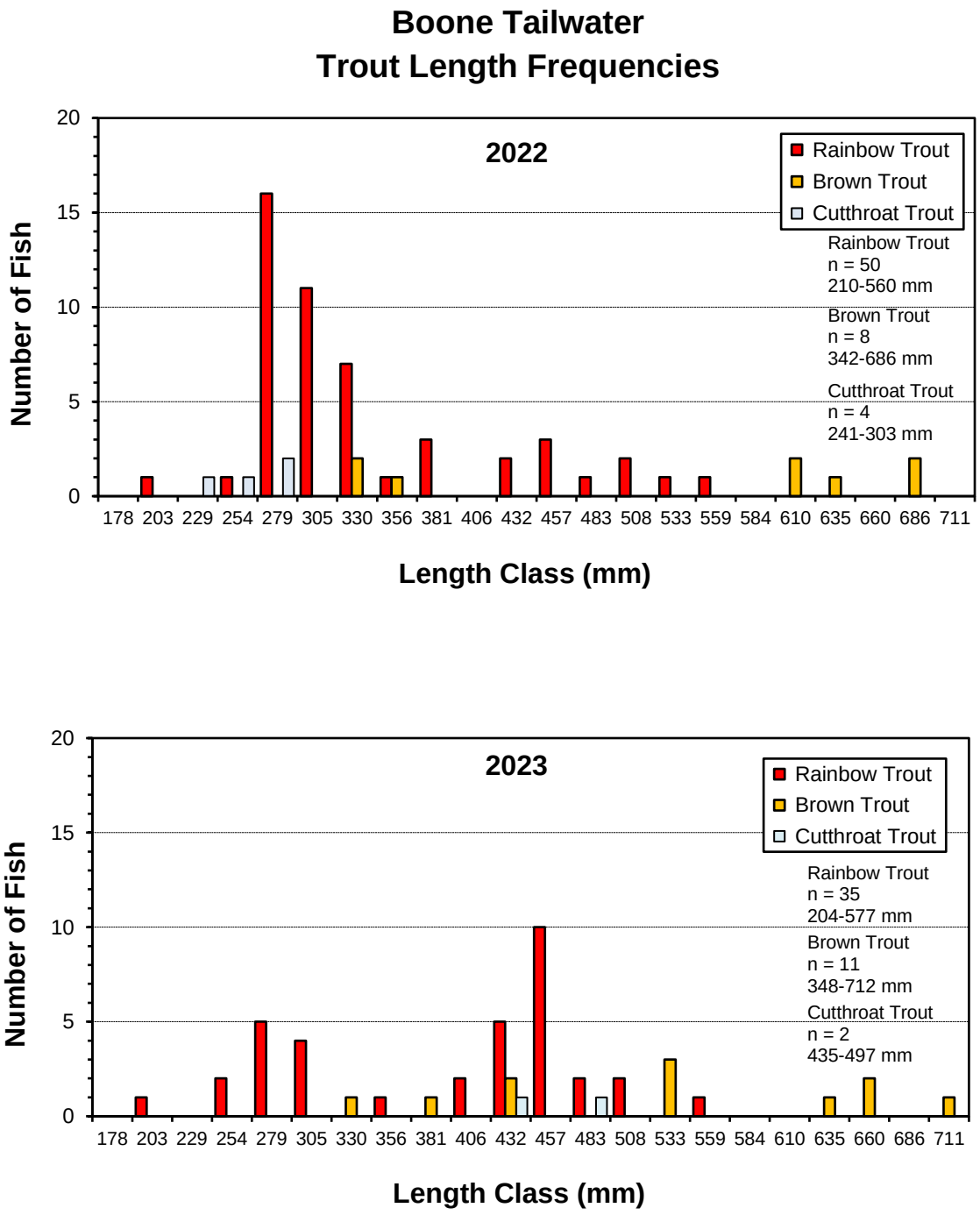


Figure 35. Trout length frequency distributions for the Boone tailwater samples in 2022 and 2023.

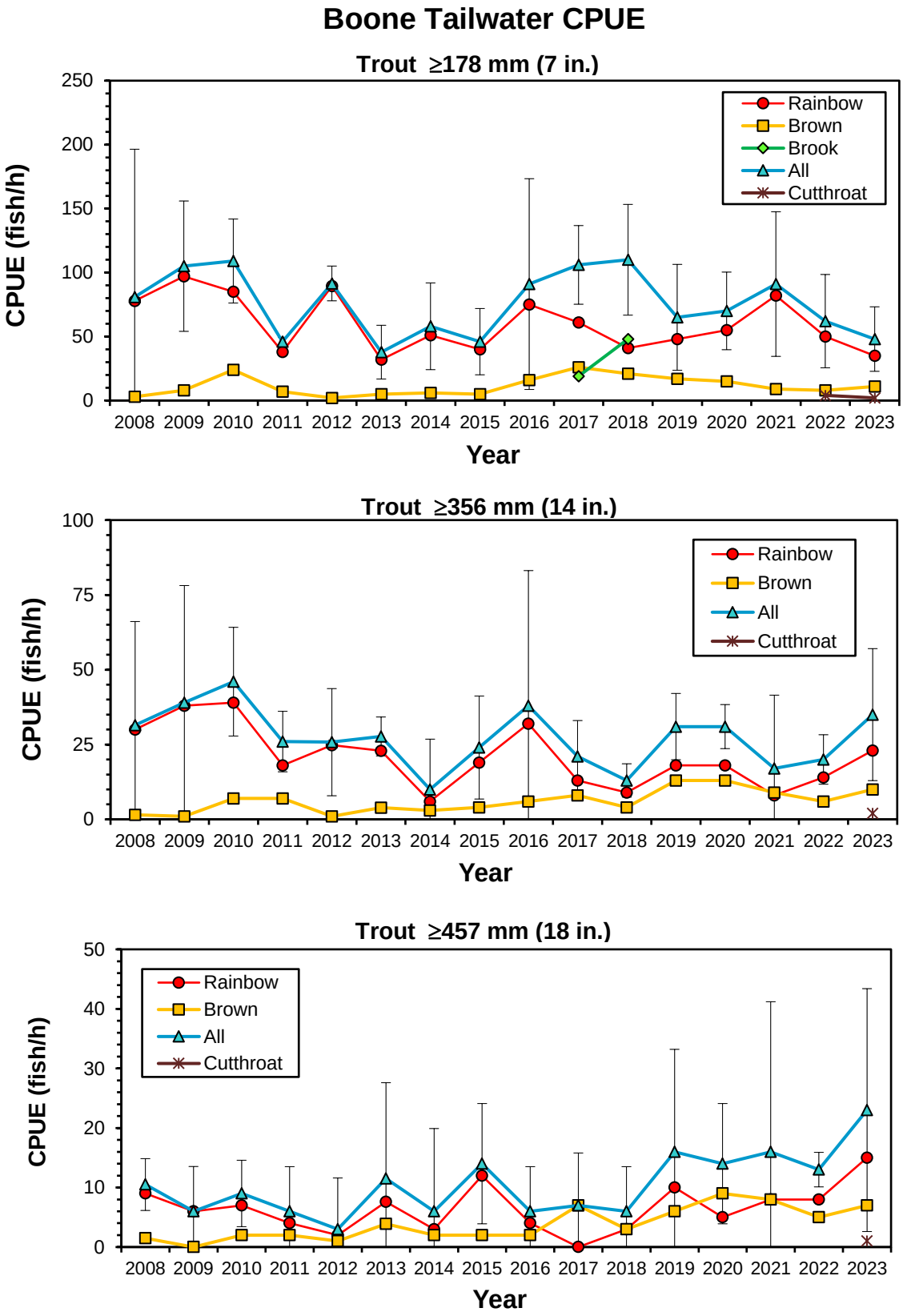


Figure 36. Mean trout CPUEs for the Boone tailwater monitoring samples. Bars indicate 90% confidence intervals.

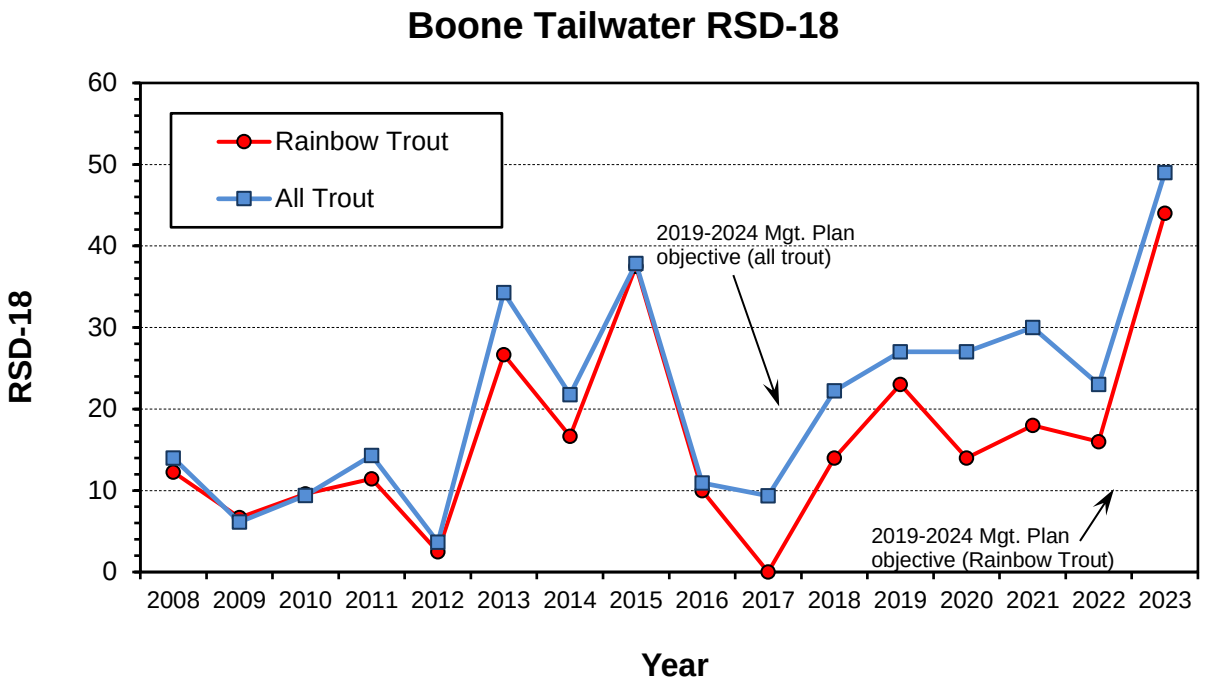


Figure 37. RSD-18 for Boone tailwater trout from annual monitoring samples.

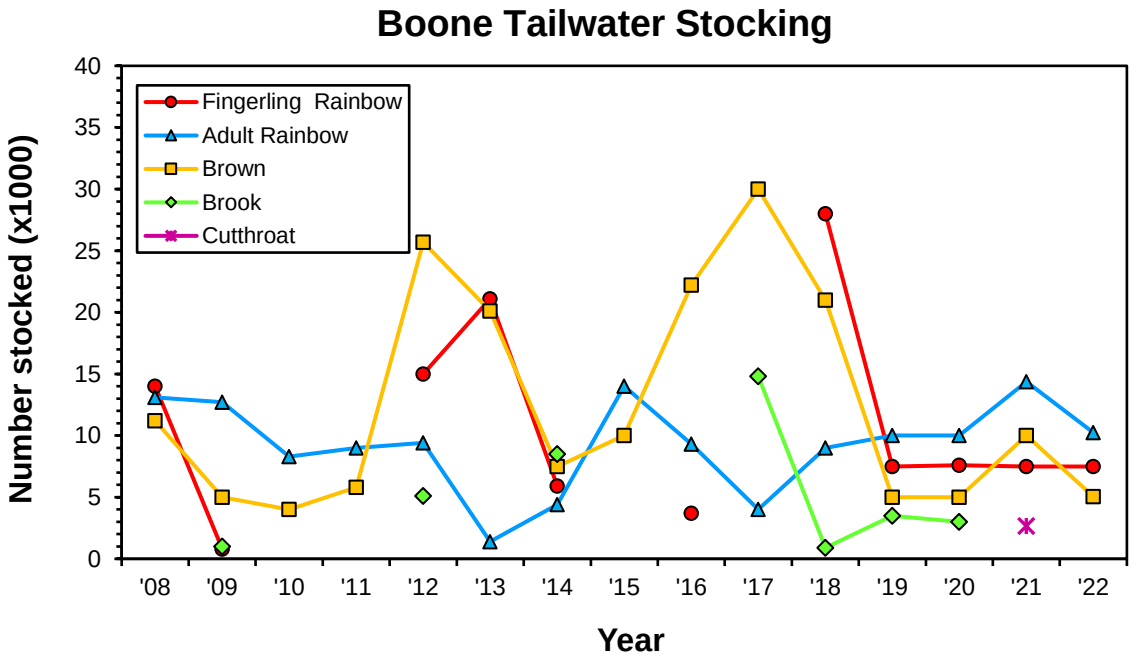


Figure 38. Recent trout stocking rates for the Boone tailwater.

South Holston (South Fork Holston River)

Catch and Length Frequency

The 12 South Holston tailwater monitoring stations (Figure 39) produced 733 trout in 2022 and 556 in 2023, with 16 fish in the 406-559 mm protected length range (PLR) each year (Figure 40). Brown Trout represented 82% of the catch in 2022 and 81% in 2023 and, as in recent years, fish in the 203-330 mm size range were most abundant (Figure 40). Most Rainbow Trout were in the 229-330 mm size classes and only one fish each year was within the PLR (Figure 40).

CPUE

The mean electrofishing catch rate (CPUE) for all trout ≥178 mm in 2023 (220 fish/h) decreased to the lowest level observed since 2006, with reduced Brown Trout CPUE responsible for most of the change (Figure 41). The overall PLR catch rate was 8 fish/h in 2022 and 2023 and has typically ranged from 8-15 fish/h (mean, 10.5 fish/h) since 2010 (Figure 41)—well below the range observed during 2005-2007 (25-29 fish/h). Mean Rainbow Trout CPUE (all sites) for 2022 and 2023 (57 fish/h; Figure 41) exceeded the management plan objective of 36 fish/h (Habera et al. 2022c), indicating suspension of fingerling Rainbow Trout stocking in 2021 has so far had no negative effect on the fishery.

RSD-16

Relative stock density for Brown Trout ≥406 mm (RSD-16)—based on a stock size of 254 mm (Willis et al. 1993)—declined in 2021 to 4 (Figure 42). Brown Trout RSD-16 exceeded 20 during 2005-2007 (following establishment of the PLR) but has declined as total trout CPUE (≥178 mm) increased into the 300-400 fish/h range. Brown Trout RSD-16 has remained in the 3-8 range since 2010 (Figure 42), indicating that Brown Trout population size structures have not maintained the shift toward larger fish (the basic intent of a PRL) achieved prior to 2010. Brown Trout RSD-16 could improve if mean CPUE for trout ≥178 mm returns to the 150-200 fish/h range. This did occur from 2022 to 2023, when CPUE decreased to 220 fish/h and the was a corresponding increase in RSD-16 from 3 to 6 (Figure 42).

Relative Weight (W_r)

Mean W_r for Brown Trout in the PLR and the size classes just below the PLR (305-406 mm) generally declined during 2005-2020 but have begun to increase since 2020 (Figure 43) as overall trout abundance has decreased (Figure 41). Several studies have shown that density-dependent factors can limit growth, condition, and recruitment into the larger size classes for trout and other gamefish (McKinney et al. 2001; Fox and Neal 2011; Dibble et al. 2015; Yard et al. 2015). Dreves et al. (2016) observed a three-fold increase in Brown Trout CPUE over 10 years in the Lake Cumberland tailwater (KY) following establishment of a 508-mm (20-in.) minimum size limit and 1 fish/day creel limit. Brown Trout size structure also improved, but overall abundance (CPUE of 89 fish/h) most likely remained below the tailwater's carrying capacity and density-dependent responses were not triggered (Dreves et al. 2016). Ultimately, if food availability and fish growth are limited in tailwater trout fisheries (e.g., in high abundance populations), then restrictive angling regulations (e.g., PLRs) may be unsuccessful (Flinders and Magoulick 2017).

Stocking

The South Holston tailwater was stocked with 48,000 adult Rainbow Trout in 2022. Fingerling Rainbow Trout stocking (50,000/year) was suspended in 2021 to assess the need for these fish given current levels of natural reproduction.

Angler Surveys

Trout anglers made an estimated 15,567 trips comprising 94,291 hours of effort in 2022 (Black 2023), which is somewhat below effort estimates for the previous (2019) survey (Figure 44). Total estimated trout catch and harvest for 2022 declined substantially for both Rainbow and Brown Trout relative to 2019 estimates (Figure 44). Anglers have been encouraged to harvest more Brown Trout in the South Holston tailwater (particularly 203-305 mm fish) and they did so in 2019, when estimated harvest increased to 11,000 fish from 3,000-5,000 fish during the two previous surveys. However, estimated Brown Trout harvest fell back to 5,000 fish in 2022. Based on supplemental survey questions in 2022, anglers (n=457) in 2022 reported that 3% of Rainbow Trout and 8% of Brown Trout they caught were in the PLR, while just under 1% of all trout caught were ≥559 mm (22 in.)—nearly all of which were Brown Trout. Anglers released 88% of the Brown Trout they caught that were ≥22 in. but did harvest two of the three Rainbow Trout in that size class. Twenty-eight percent of anglers caught fish in the PLR, 6% caught fish above the PLR, and 28% were on guided trips.

Management Recommendations

The goal for the South Holston tailwater trout fishery management plan (Habera et al. 2022c) is to continue providing a high-quality, largely self-sustaining trout fishery that offers a variety of angling opportunities. The South Holston tailwater's exceptional wild Brown Trout fishery is the primary means for attaining the management goal, but Rainbow Trout remain an important part of the fishery as well—particularly in terms of angler harvest. Management has sought to maintain the Rainbow Trout fishery through annual stocking of adults and fingerlings, but fingerling Rainbow Trout stocking (previously 50,000/year) can be eliminated if annual monitoring data continue to indicate that natural reproduction is capable of maintaining abundance.

South Holston Tailwater

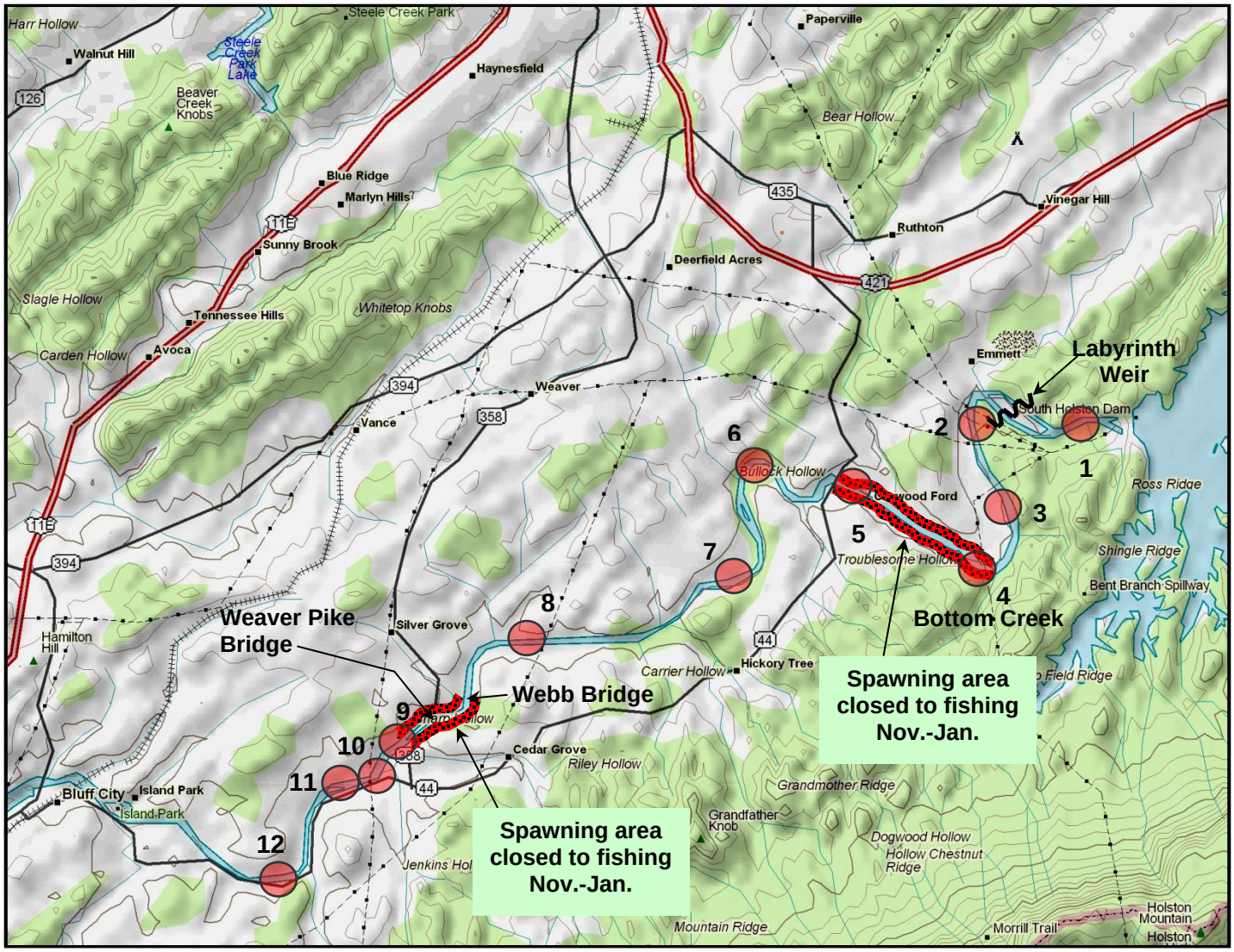


Figure 39. Locations of the South Holston tailwater (South Fork Holston River) monitoring stations.

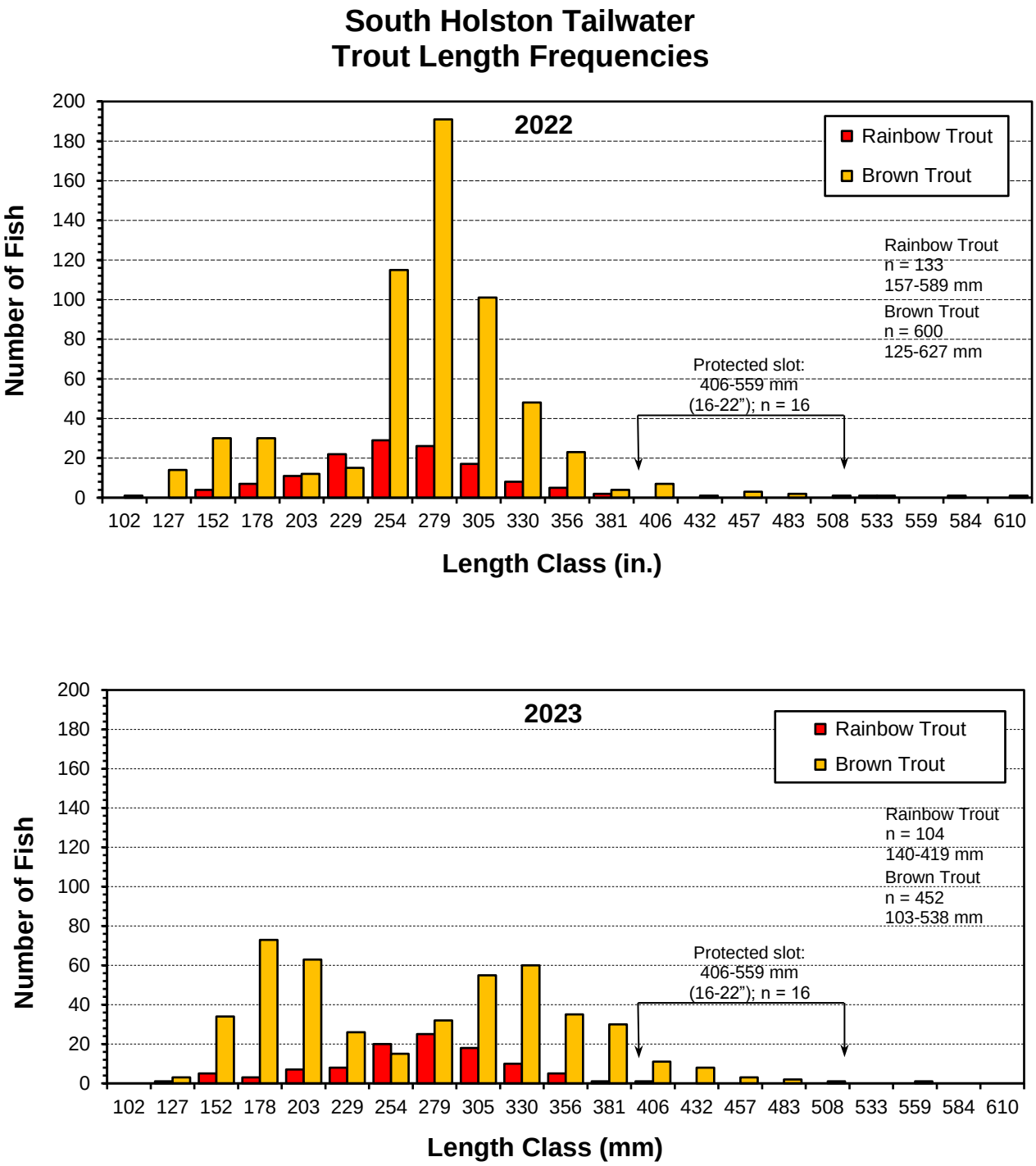


Figure 40. Trout length frequency distributions for the South Holston tailwater samples in 2022 and 2023.

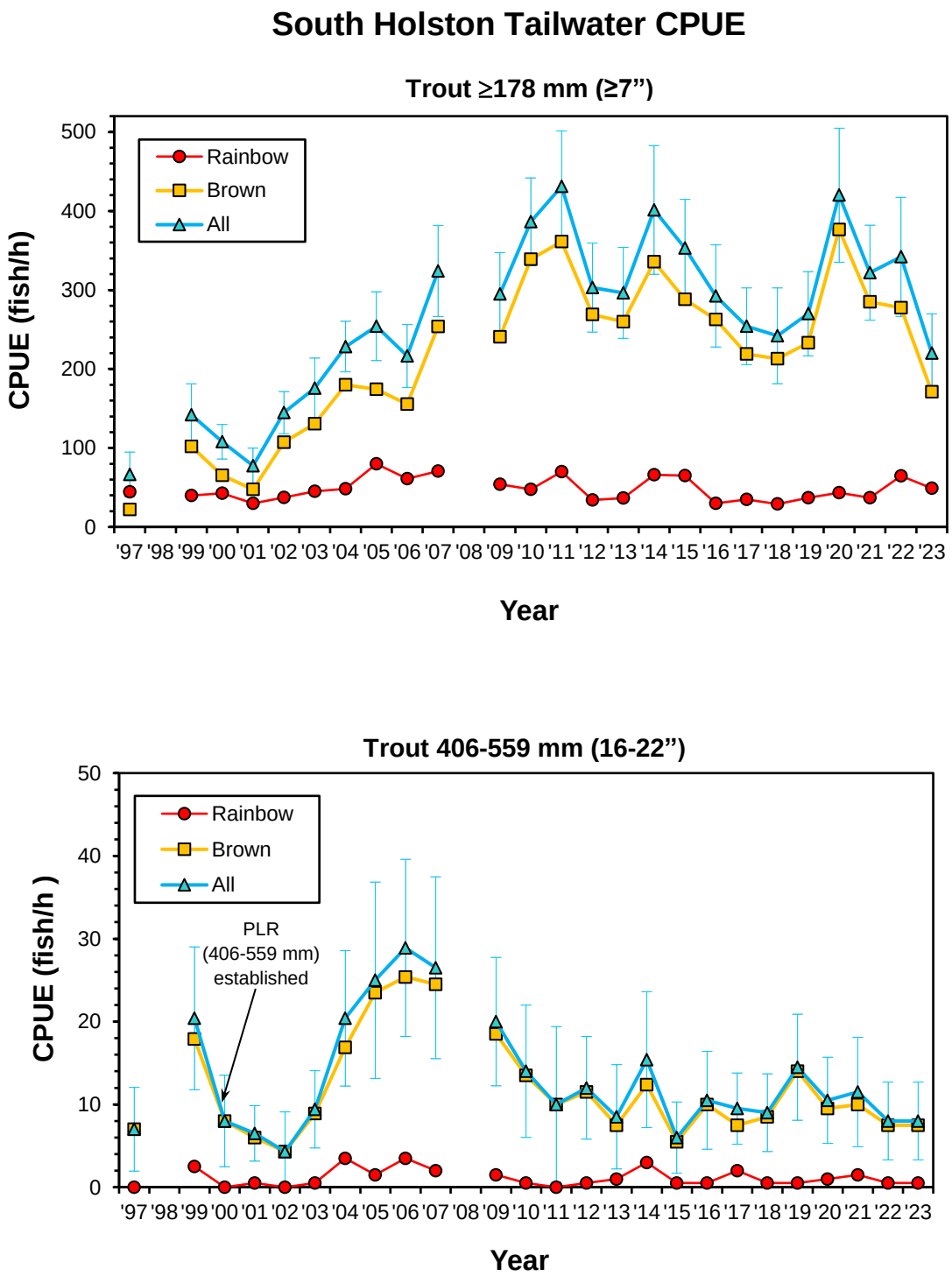


Figure 41. Mean trout CPUEs for the South Holston tailwater samples. Bars indicate 90% confidence intervals.

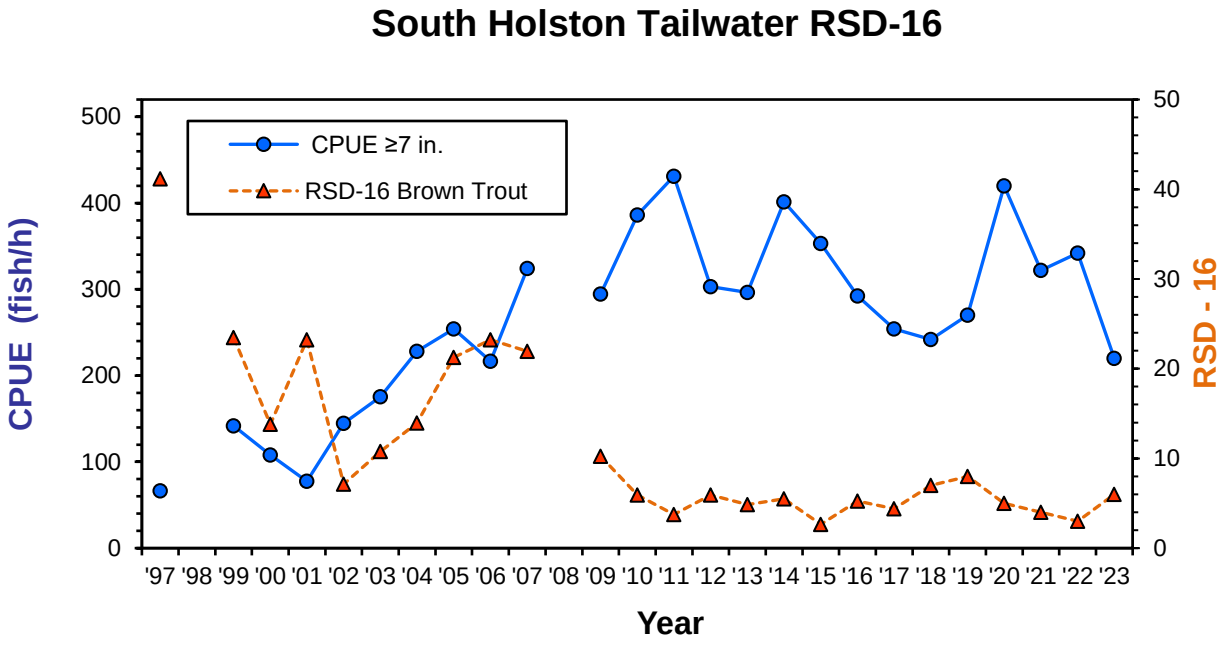


Figure 42. Comparison of mean CPUE (fish/h) for all trout ≥178 mm and RSD-16 (all trout) for the South Holston tailwater.

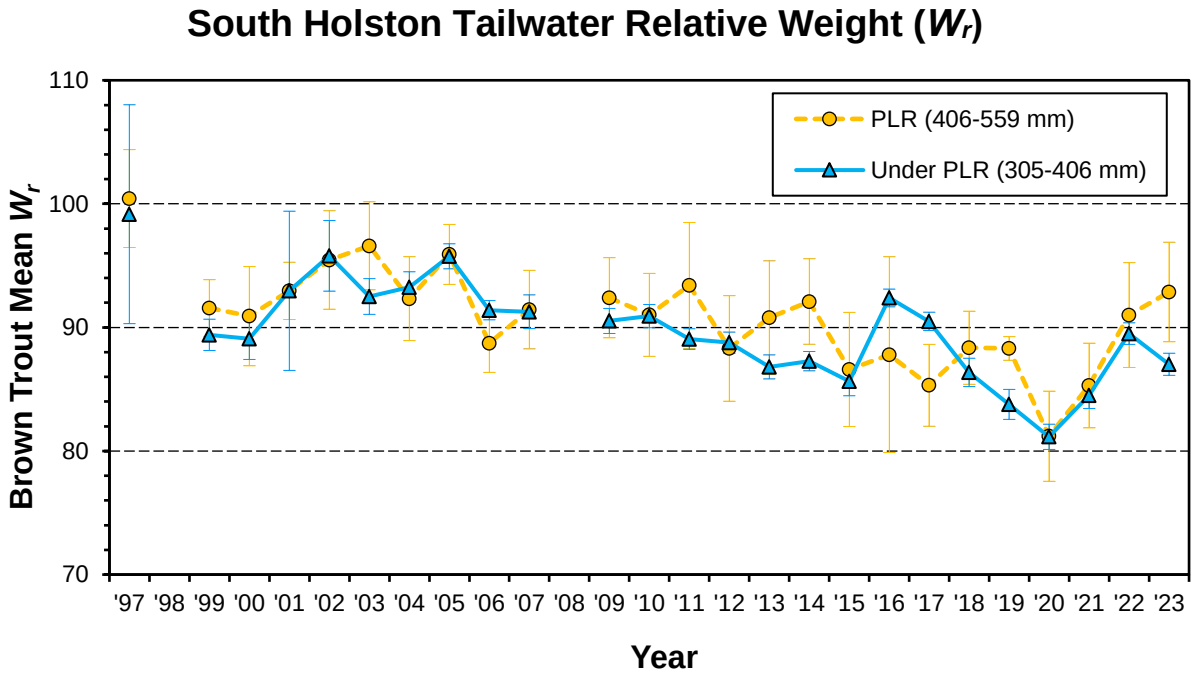


Figure 43. Mean relative weights (W_r) for Brown Trout from the South Holston tailwater. Bars indicate 90% confidence intervals.

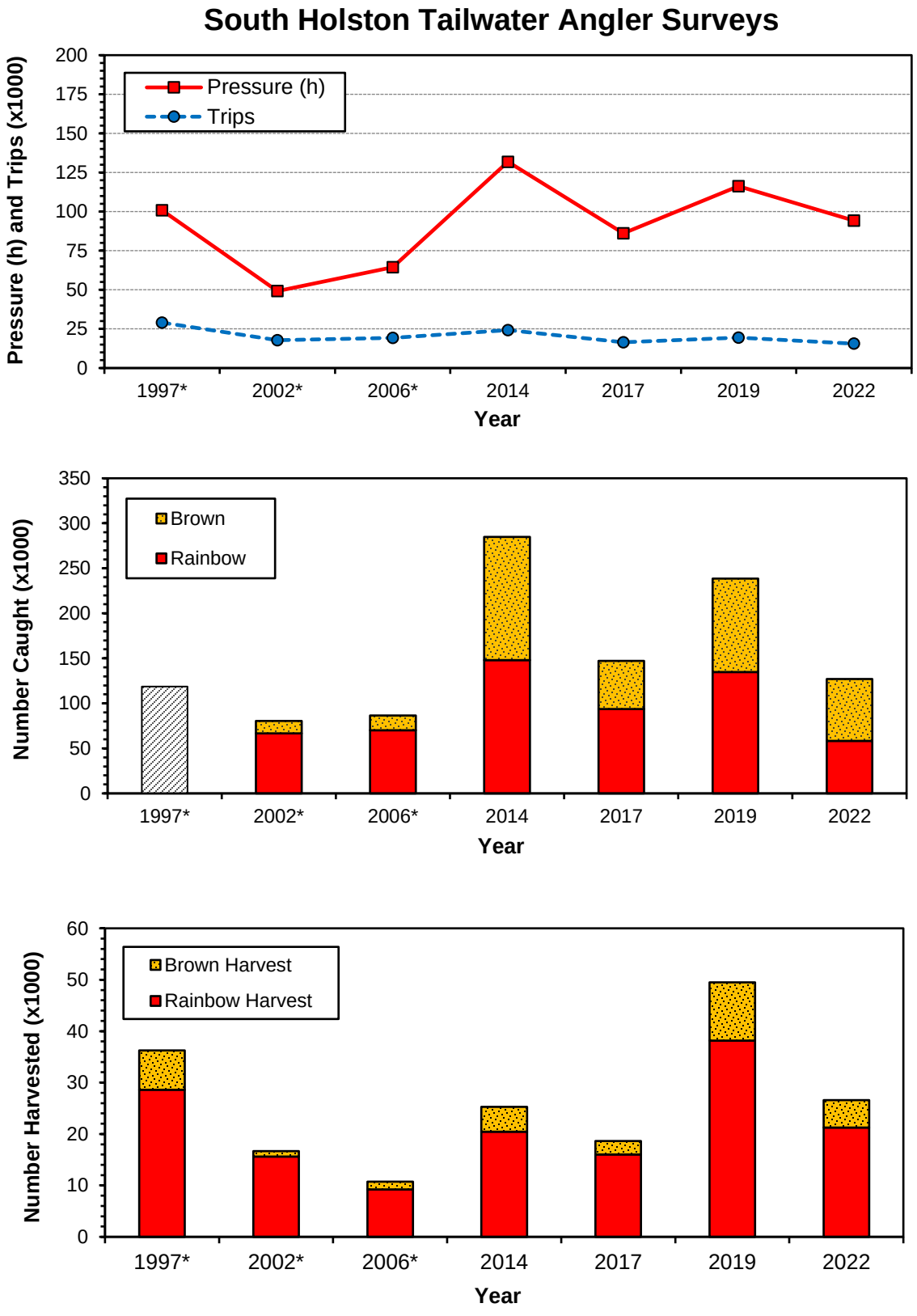


Figure 44. Angler use, catch and harvest estimated by South Holston tailwater creel surveys (1997-2022). The 1997-2006 surveys covered only March-October and trout were not separated by species in 1997.

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