MANAGEMENT PLAN
for the
NORRIS TAILWATER TROUT FISHERY
2014-2019

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October 2014

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Management Plan for the Norris Tailwater Trout Fishery (2014-2019)

I. Management Goal and Strategies

The Tennessee Wildlife Resources Agency (TWRA) seeks to maintain the enhanced quality of trout angling opportunities available to the variety of anglers who fish the Norris tailwater. Quality trout angling opportunities typically involve a greater potential to catch larger (i.e., ≥14 inches) fish, thus management will continue to focus on this outcome. This basic goal was developed with public input and remains unchanged from previous management plans (Habera et al. 2002; 2008).

To meet the management goal for the Norris tailwater, TWRA will continue to provide hatchery-supported fisheries for rainbow, brown, and brook trout capable of sustaining at least the recent level of angling pressure (~12,000 trips/year; Black 2014). The existing 14-20 inch protected length range (PLR) or "slot limit" regulation for all trout will continue to be the primary strategy for meeting the Norris tailwater management goal during 2014-2019. This regulation has been in place since March 2008 (Habera et al. 2008) and includes a daily creel limit of 7 fish, one of which may exceed 20 inches. It applies to ~12 miles of the tailwater (including tributaries) from Norris Dam downstream to the Highway 61 Bridge (Figure 1) and has no gear or bait restrictions.

II. Background

Norris Dam impounds the Clinch River in Anderson County, forming 34,213-acre Norris Reservoir. Hypolimnetic discharges created coldwater habitat and rainbow trout were stocked in the tailwater shortly after completion of the dam in 1936 (Tarzwell 1939). The Tennessee Game and Fish Commission stocked trout during 1950-1970 and managed the river as a year-round fishery (Swink 1983). Because chronic low dissolved oxygen levels and a lack of minimum flow limited development of the trout fishery (Boles 1980; Yeager et al.1987), TVA began a Reservoir Release Improvements Program (TVA 1980) to address these problems. Dissolved oxygen concentrations were improved initially by fitting the turbines with a hub baffle system (Yeager et al. 1987). Later (1995 and 1996), both turbines were replaced with a more efficient autoventing system (Scott et al. 1996), which maintains dissolved oxygen around 6 parts per million (6 mg/L). A minimum flow of 200 ft^3/s (cfs) was established in 1984 and has been maintained since then by a re-regulation weir located about 2 miles downstream of the dam (Yeager et al. 1987). The weir was upgraded in 1995 to increase its holding capacity and improve public access (Bettoli and Bohm 1997).

Improvements in dissolved oxygen and minimum flows increased the abundance and distribution of benthic invertebrates, as well as trout carrying capacity and trout condition (Yeager et al. 1987; Scott et al. 1996). The Norris tailwater currently supports a 14-mile hatchery-supported fishery for rainbow, brown, and brook trout before entering Melton Hill Reservoir. Bettoli and Bohm (1997) documented a small amount of natural reproduction by rainbow trout, but recruitment to the tailwater fishery was considered to be minimal. Some of this natural reproduction comes from Clear Creek, which large rainbow trout enter to spawn each winter. Clear Creek is closed to fishing from November 1 through March 31 each year to protect spawning fish.

Prior to revising the 2002-2006 Norris tailwater management plan, TWRA sought public input at a meeting in Clinton in March 2007 and through June 2007 via email. Although this input indicated that anglers held a variety of opinions concerning how this trout fishery should be managed, 50% requested establishment of some sort of special regulations (e.g., a slot limit, catch and release zones, delayed harvest, single-hook artificial lures only, etc.). The largest proportion (42%) of the requests for special regulations specified a slot limit. While anglers were not asked to specify a preference between the way the fishery was currently being managed and some new approach, few endorsed the existing set of regulations/strategies. Given the reduced quality of the Norris tailwater's trout fishery at that time (Habera et al. 2009a), angler dissatisfaction, support for a regulation change, and the potential that the right one could help meet the tailwater's management goal, it was apparent that the 2008-2013 Norris tailwater management plan should incorporate an alternative regulation strategy.

A quality zone with a minimum size limit, reduced creel limit, and gear restrictions had already been tried (unsuccessfully) during the 1990s to increase the abundance of larger fish. Later, Bettoli's (2001) review of management alternatives confirmed that these strategies, along with maximum size limits, flyfishing only zones, and delayed harvest regulations would be unsuitable for the Norris tailwater trout fishery. Bettoli (2001) did consider the Norris tailwater suitable for a protected length range (PLR) or "slot limit" because of the Clinch River's fertility, trout growth rates, habitat for large fish, and low natural mortality rates for fingerling-stocked fish.

Consequently, a 14-20 inch PLR for all trout, with one fish per day >20 inches permitted and no gear restrictions, was approved by the Tennessee Wildlife Resources Commission in 2007 and became effective for the entire tailwater (Norris Dam to Highway 61 Bridge) on 1 March 2008.

III. Current Status

Numerous research projects focusing on or including the Norris tailwater trout fishery were completed by Dr. Phillip Bettoli and several graduate students at the Tennessee at Tennessee Technological University's Cooperative Fishery Research Unit during 1995-2006. These included studies of abundance, growth and survival, movement, spawning potential, predation by striped bass, angler specialization and preferences, and three creel surveys. No other tailwater trout fishery in Tennessee has been studied as thoroughly. In summary, the Norris tailwater is primarily a rainbow trout fishery (Bettoli and Bohm 1997; Meerbeek and Bettoli 2005) that is sustained by fingerling stocking (Bettoli and Bohm 1997). It has no potential for management as a self-sustaining (wild) trout fishery because of poor spawning substrate, unsuitable flows and unsuitable temperatures during brown trout spawning season (Banks and Bettoli 2000; Holbrook and Bettoli 2006). Impacts from striped bass predation were considered inconsequential (Bettoli 2000).

Trout Abundance

Processing a Norris tailwater rainbow trout

TWRA monitors the Norris tailwater trout at 12 boat electrofishing stations (Figure 1) in late February or early March each year to assess the overwintering trout populations before stocking begins. Sampling is conducted at night with one unit at Norris Dam operating (~4,000 cfs). Mean electrofishing catch rates for trout ≥7 inches (the minimum size considered fully recruited to the sampling gear) and in the 14-20 inch size range (i.e., within the PLR) are calculated, along with relative weights (W_r).

The mean catch rate for all trout ≥7 inches has averaged 151 fish/h (70% rainbow trout) since 1996, and catch rates for these fish have been at or somewhat above the long-term mean during the past five years (Figure 2). The mean catch rate for all 14-20 inch trout increased substantially following implementation of the PLR in 2008, reaching 73 fish/h in 2012 (Habera et al. 2013; Figure 3). The 2012 catch rate for fish within the PLR (14-20 inches) represented more

than a 20-fold increase from the 2008 level (3.5 fish/h), suggesting that the PLR had effectively increased the abundance of large trout. Although the catch rate for 14-20 inch trout decreased to 29 fish/h in 2013 (Figure 3), the 2011-2013 mean was 51 fish/h—well above the primary objective (28 fish/h) for the previous management plan (Habera et al. 2008). Additionally, the PLR catch rate increased again in 2014 to 81 fish/h—its highest level since monitoring began in 1996 (Figure 3). The PLR is targeted toward rainbow trout and they have provided most of the increase in the PLR catch rate, but the mean catch rate for 14-20 inch brown trout has increased moderately from 4 fish/h (pre-PLR) to 6 fish/h since 2008.

The 16-22 inch PLR (no gear restrictions) established on the South Holston tailwater in 2000 also produced positive, although less impressive results. That regulation targets the South Holston's wild brown trout fishery and increased the PLR catch rate by nearly a factor of four in the first six years (8 to 29 fish/h; Habera et al. 2013). However, the PLR catch rate has declined since 2006 and was at 8.5 fish/h in 2013, which is similar to the mean catch rate for 16-22 inch fish prior to establishment of the PLR (Habera et al. 2013). It is also below the current (2009-2014) South Holston management plan's objective of 25 fish/h (Habera et al. 2009b). The decline was likely related to production of some exceptionally strong brown trout year classes and excessive population growth (particularly for 8-12 inch fish), which eventually affected growth, condition, and ultimately recruitment into the PLR (Habera 2013). If brown trout year-class strength and density-dependent control factors moderate, recruitment into the PLR should begin to improve.

The increasing abundance of 14-20 inch trout in the Norris tailwater is not the result of an increase in overall trout abundance. In fact, catch rates for all trout ≥7 inches have actually declined somewhat since 2009, while rainbow trout catch rates have been relatively stable except for a temporary decline from 2009-2010 (Figure 2). This indicates a population size structure shift (particularly for rainbows) in favor of larger fish (Figure 4). By 2014, 52% of all trout ≥7 inches captured during the monitoring effort were within the PLR (14-20 inches)—a 10-fold increase during the past five years (Figure 4).

Since their introduction to the fishery in 2008, brook trout have been captured as far downstream as Station 10 (Figure 1), although most (60%) occur near the dam. The catch rate for brook trout during 2008-2013 averaged 4.9 fish/h, which essentially meets the previous management objective of 5 fish/h (Habera et al 2008), indicating the establishment of a minor fishery for this species. To date, all brook trout captured during monitoring efforts have been in the 8-13 inch size range (mean, 10.6 inches).

Trout Growth and Condition

Both rainbow and brown trout fingerlings exhibit good growth and survival rates (Table 1). Survival of rainbow trout stocked as adults (9-12 inches) is poor (<6%; Table 1) because of their excessive movement (Bettinger and Bettoli 2000) and their return rate to the creel is relatively low (19%; Table 1).

Table 1. Growth and survival rates for trout from the Norris tailwater

	Growth (inches/month)[a]		Survival (%)[a]		Return to creel	Years to reach 14 inches[b]	Years to reach 15 inches[b]
	Fingerlings	Adults	Fingerlings	Adults			
Rainbow trout	0.79	0.47	26	<6	19%	1.6	1.9
Brown trout	0.47	--	43-52	--	--	1.5	1.7

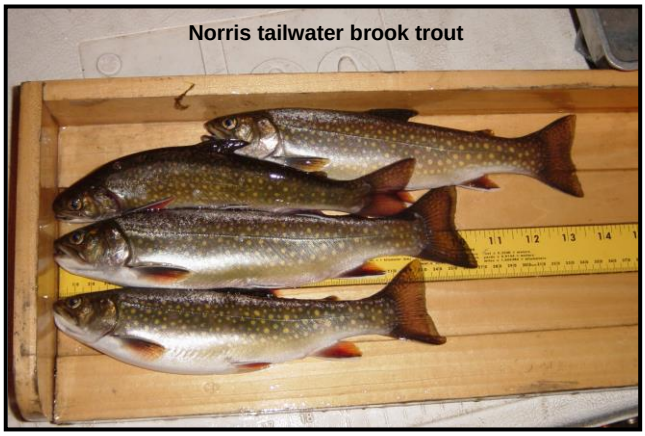
[a]Applies to first year at large in the tailwater.
[b]For rainbows stocked at 5 inches and browns stocked at 6 inches.

There was a notable decline in condition of 14-20 inch rainbow trout throughout the tailwater during 2010-2013 (to a mean W_r of 76.9; Figure 5). Many rainbows in this size range are in a "post-spawn" condition at this time of year (late winter) and mean W_r has typically been below 90, although rarely below 80 (Figure 5). Mean W_rs around 100 would be considered ideal and those approaching 70 would be considered low (Blackwell 2000) and suggestive of poor health or insufficient food resources. Norris tailwater rainbows in the 7-14 inch size class have generally had mean W_rs above 90, as have both size groups of brown trout (Figures 5 and 6). Interestingly, mean W_rs for 14-20 inch rainbow trout from the Norris tailwater and corresponding data for the Wilbur and South Holston tailwaters have been quite similar, especially since 2009 (Figure 7). In all three cases, mean W_rs for 14-20 inch rainbow trout were at or very near the lowest levels observed in 2013 and generally increased in 2014 (Figure 7).

Although mean W_r for 14-20 inch rainbow trout from the Norris tailwater was actually lower in 2007 (75.2) after a three-year decline (Figure 5), anglers did not voice any particular concerns. They did notice the relatively poor condition of these fish in 2012 and began inquiring about it. No management action was considered at that time, as W_rs might fluctuate with trout abundance (and density-dependent control factors) and food supply (e.g., cold-stressed or killed shad passing through the dam). Indeed, following the reduced abundance of PLR rainbows in 2013 and the exceptionally cold winter of 2013-2014, mean W_r increased to 88 for the 2014 sample (Figure 5).

Stocking

Norris tailwater trout stocking rates for 1990-2013 are provided in Figure 8. About a quarter of a million (251,000) rainbow and brown trout were released annually during 1990-2001. The 176,000 fingerling rainbows released annually during those years made up 80-85% of all rainbow trout stocked, with adults comprising the remainder (~37,000). An average of 41,000 4-inch to 9-inch brown trout (average, 7 inches) was also stocked annually during that time.



During in 2002-2008, the stocking rate increased to >400,000 trout per year as rainbow and brown trout fingerlings produced at Eagle Bend Hatchery were added according to the 2002-2006 management plan (Habera et al. 2002). On average, just over a half million trout were stocked each year during that time at a stocking rate of ~806/acre. Adult rainbow trout stocking has consistently remained at about 37,000/year since 1990. About 100,000 surplus brook trout 4-inch fingerlings from West Virginia (Bowden strain) were stocked in the Norris tailwater in May 2007 in accordance with the 2002-2006 management plan (Habera et al. 2002). Since then, 32,800 brook trout averaging 8 inches have been stocked annually (Figure 8). Rainbow and brown trout stocking rates returned to pre-2002 levels with the implementation of the 2008-2013 management plan (Habera et al. 2008) and will remain there during 2014-2019 (see Section IV). All of the rainbow trout fingerlings and over half (57%) of the adult rainbow trout stocked in the Norris tailwater in 2012 were supplied by the Dale Hollow National Fish Hatchery. Loss of some or all of these 'mitigation' fish because of federal budget shortfalls could affect the stocking rates recommended in this management plan.

Angler Use

Previous creel/angler use surveys for the Norris tailwater were completed during 1996-2005 (Bettoli and Bohm 1997; Bettoli 2002; Bettoli 2006; Tables 2 and 3). A new survey, conducted by TWRA personnel, was completed in 2013 (Black 2014) and indicated decreases in pressure, trips, catch, and harvest relative to 2005 (Table 2). Although the 2001 and 2005 surveys did not cover the late fall and winter months, ~20% of pressure, trips, catch, and harvest occurred during January-March and November-December 2013. While the Norris tailwater was one of Tennessee's most heavily-fished trout tailwaters in 2005 (Bettoli 2006), some of this

pressure has likely been diverted to the nearby Cherokee tailwater (Holston River), where an angler use survey is currently (2014) underway. Norris tailwater anglers overwhelmingly (76%) supported the PLR regulation and 85% rated TWRA's management of this fishery as good or excellent during the 2013 survey.

Table 2. Angling pressure and associated data from previous Norris tailwater creel surveys.

Year[a]	Pressure (h)	Mean Trip length	Trips	Catch[b]	Harvest[a]
1996	80,589	2.98	26,165	94,000 (98)	28,200 (98)
2001	79,405	3.57	22,242	43,000 (81)	19,300 (94)
2005	82,331	3.42	24,073	170,000 (76)	29,200 (85)
2013	48,317	3.94	12,249	52,114 (56)	11,946 (55)

[a]The 2001 survey covered March-October; the 2005 survey covered April-October.
[b]Values in parentheses are percentages represented by rainbow trout.

The average trout catch rate was 1.08 fish/h during the 2013 creel survey, with an average catch per trip of over 4 fish (Table 3). Catch rates over 0.7 fish/h are generally considered representative of good fishing (McMichael and Kaya 1991; Wiley et al. 1993). Average harvest was again low in 2013 (0.99 fish/h) and has been below 2 fish/ trip during all previous surveys, with most of those trips harvesting no fish (Table 3). Anglers occasionally suggest lowering creel limits as a means to improve trout fisheries in tailwaters. Norris's harvest characteristics, combined with the recent decline in the number of trips, indicate that reducing the creel limit would have little effect unless the reduction was substantial (e.g., 2 fish/day; Bettoli 2001). However, any regulation that would reduce exploitation of recently-stocked 9-12 inch rainbow trout would be ill-advised because of their poor survival (Bettoli 2001). Additionally, a separate (lower) creel limit for brown trout would generally be ineffective because few anglers (<1%) harvest more than one brown trout per trip (Bettoli 2001).

Table 3. Catch and harvest rates and angler characteristics from previous Norris tailwater creel surveys.

Year	Catch rate (fish/h)	Avg. catch (fish/trip)	Avg. harvest (fish/trip)	No-harvest trips	Local anglers	Bait anglers	Fly anglers
1996	1.42	4.02	1.31	63%	80%	73%	16%
2001	0.71	2.38	0.61	79%	87%	71%	17%
2005	2.21	7.22	1.21	63%	76%	66%	17%
2013	1.08	4.26	0.99	--	--	--	--

IV. Management Objectives and Recommendations

The two primary objectives of the previous Norris tailwater management plan (Habera et al. 2008) were successfully achieved during 2008-2013, thereby attaining the tailwater's management goal. The electrofishing catch rate for 14-20 inch (PLR) trout increased to an average of 51 fish/h for 2011-2013, exceeding the objective of 28 fish/h. Additionally, a brook trout fishery was established producing an average electrofishing catch rate of 5 fish/h (4.9 fish/h during 2008-2013). Maintaining both the abundance of trout in the PLR and the brook trout fishery given existing regulations and strategies will be the primary focus of the current management plan (2014-2019). Accordingly, the management objectives for fulfilling the management goal during 2014-2019 will be:

Objective 1: Maintain the abundance of trout in the 14"-20" PLR

The Norris tailwater's primary management objective during the previous plan's 2008-2013 term was to increase, through the PLR, abundance of larger trout in the fishery. Given that this was successful, the primary objective will now be to maintain a mean PLR catch rate of ≥28 fish/h during 2014-2019. Consumption-oriented anglers will continue to have ample harvest opportunities with the existing PLR regulation, as rainbows stocked as adults are typically <14 inches and one trophy fish can be taken per day. The PLR's boundaries (14 and 20 inches) target rainbow trout because the Norris tailwater is primarily a rainbow trout fishery and rainbows represent 55% of harvest (Black 2014); however, brown trout have benefitted as well. This regulation is no longer considered experimental and will be re-evaluated at the conclusion of the new management plan's term (2019).

Objective 2: Maintain the brook trout fishery

With the establishment of a brook trout fishery in the Norris tailwater during 2008-2013, the objective for the current management plan will be to maintain this brook trout fishery with an average electrofishing catch rate of 5 fish/h during 2014-2019 and potentially produce some fish ≥14 inches.

Objective 3: Maintain current trout stocking rates

Provided that sufficient numbers of trout continue to be available from the Dale Hollow National Fish Hatchery, annual stocking rates for the Norris tailwater will remain:

- 37,000 adult (9-12 inch) and 160,000 fingerling (4-inch) rainbow trout.

- 20,000 6-7 inch brown trout each spring; additional brown trout fingerlings (up to 20,000) may be stocked in the fall as available.
- 20,000 5-6 inch brook trout each spring

The following actions are also recommended during 2014-2019 to achieve the Norris tailwater management objectives and ultimately fulfill the management goal for this important trout fishery:

1. Continue annual evaluation of the trout fishery by electrofishing the 12 established monitoring stations in late February or early March. This will provide catch rates, population size structures, and determine fulfillment of the primary management objective–maintaining the increased abundance of 14-20 inch fish (at ≥28 fish/h) that has been achieved through the PLR.

2. Enforce angling regulations as prioritized in the quarterly law enforcement planning process.

3. Continue to obtain input from anglers to determine their level of satisfaction with the quality and variety of trout angling opportunities being provided in the Norris tailwater through additional TWRA angler surveys conducted in 2015, 2017, and 2019.

4. Continue to seek access for anglers.

5. Continue to cooperate with TVA to determine any potential effects related to the presence of *Didymosphenia geminata* (didymo). Didymo is a stalked diatom (single-celled algae) that can form extensive mats on the stream bed, potentially impacting benthic macroinvertebrates and trout abundance (Spaulding and Elwell 2007). Didymo has been present in the Norris, South Holston, and Wilbur tailwaters since at least the early 2000s, although it does not appear to have impacted these fisheries.

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Norris Tailwater

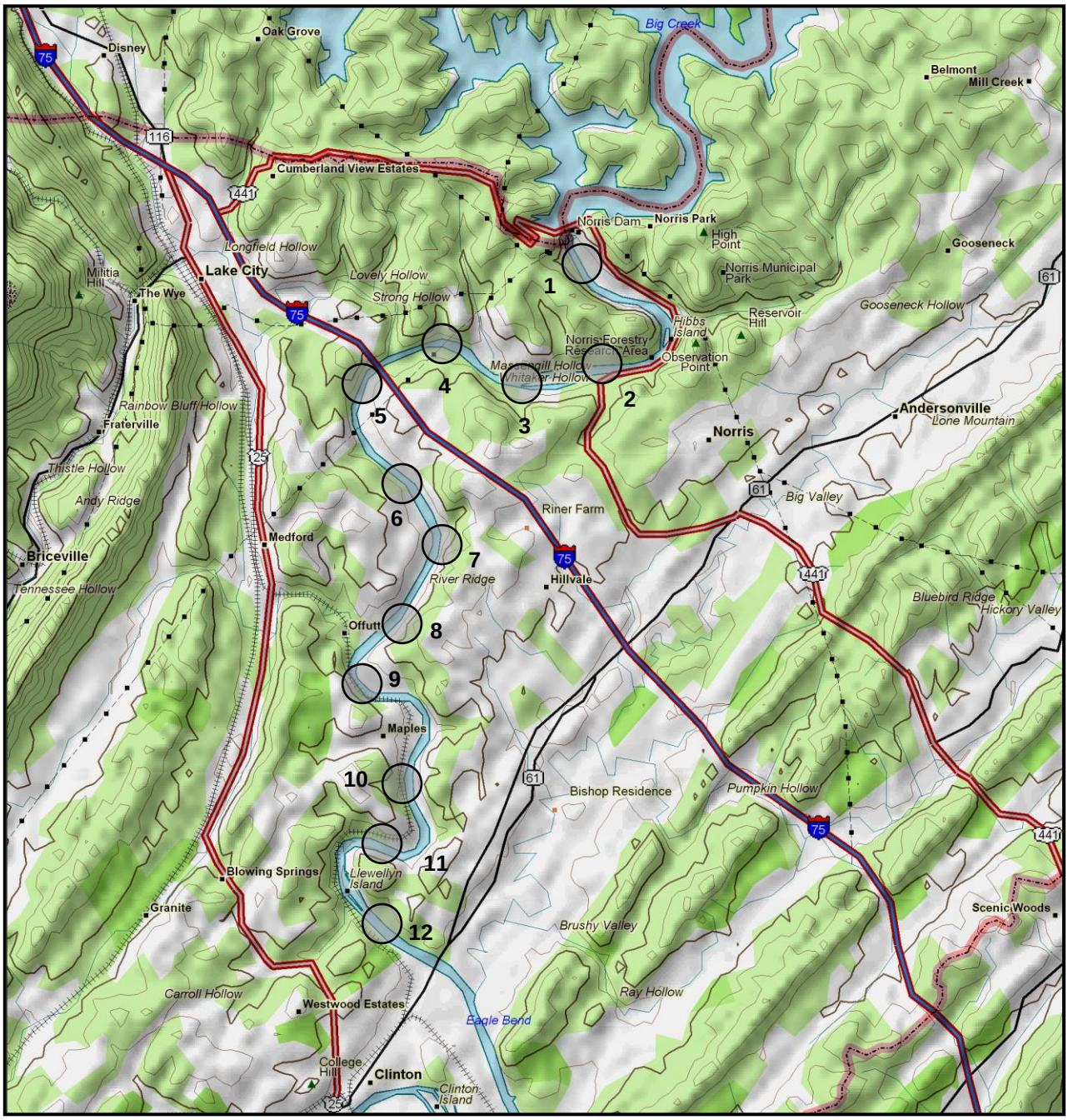

Figure 1. Locations of the 12 Norris tailwater (Clinch River) monitoring stations.

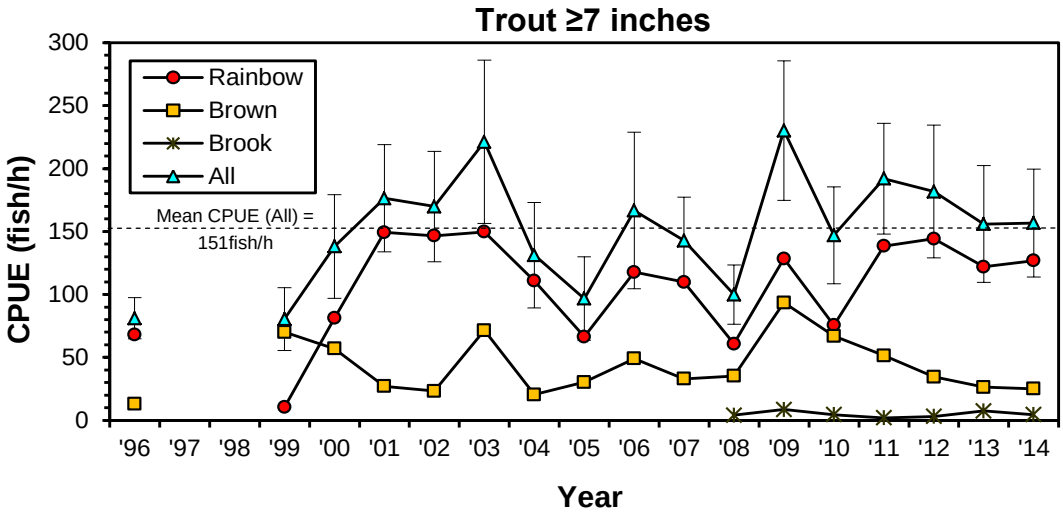

Figure 2. Mean electrofishing catch rates for trout ≥7 inches from the Norris tailwater monitoring samples. Bars indicate 90% confidence intervals.

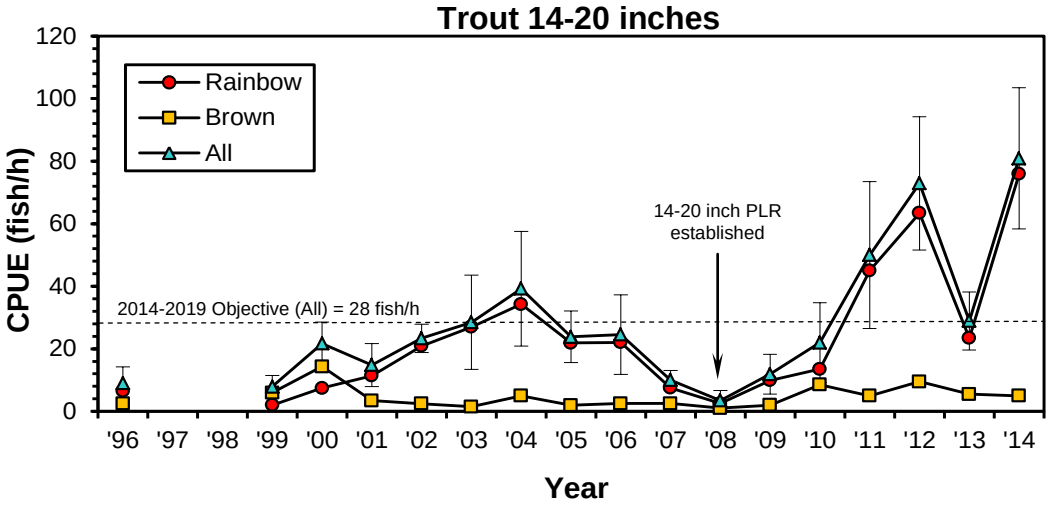

Figure 3. Mean electrofishing catch rates for 14-20 inch trout from the Norris tailwater monitoring samples. Bars indicate 90% confidence intervals.

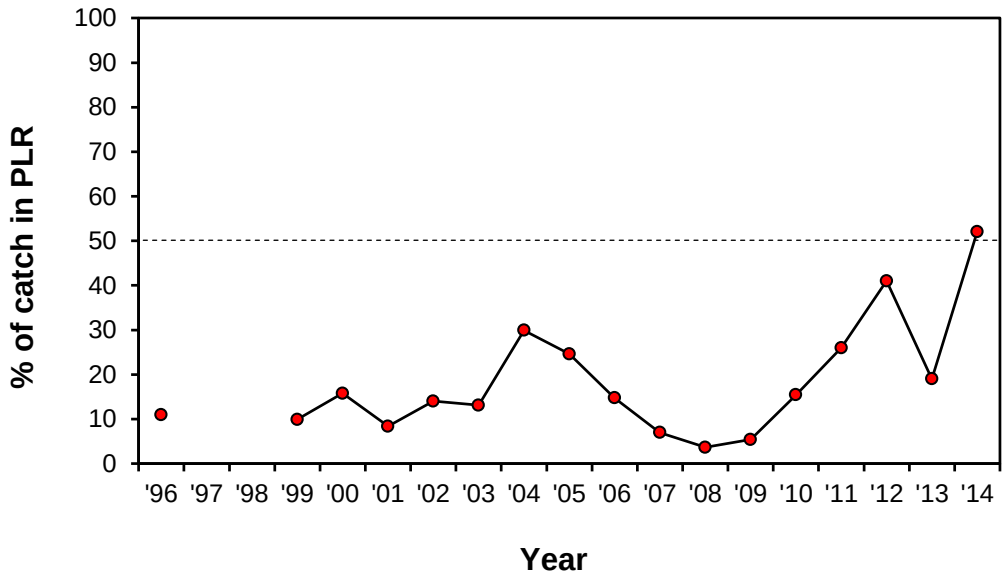

Figure 4. Percentages of total catch (trout ≥7 inches) from the Norris tailwater monitoring samples comprised by 14-20 inch fish.

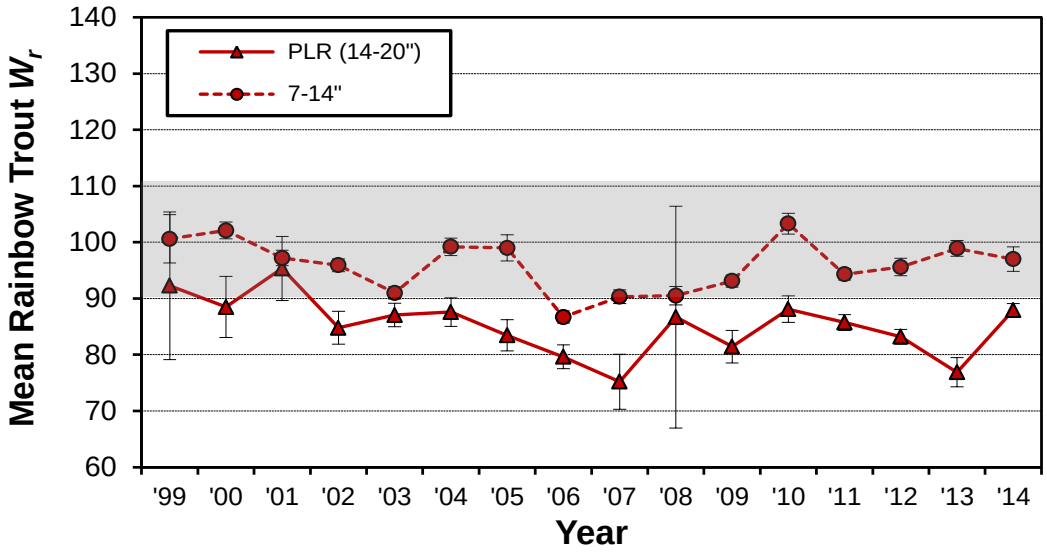

Figure 5. Mean relative weights (W_r) for 7-14 inch and 14-20 inch rainbow trout from the Norris tailwater monitoring samples. Bars indicate 90% confidence intervals.

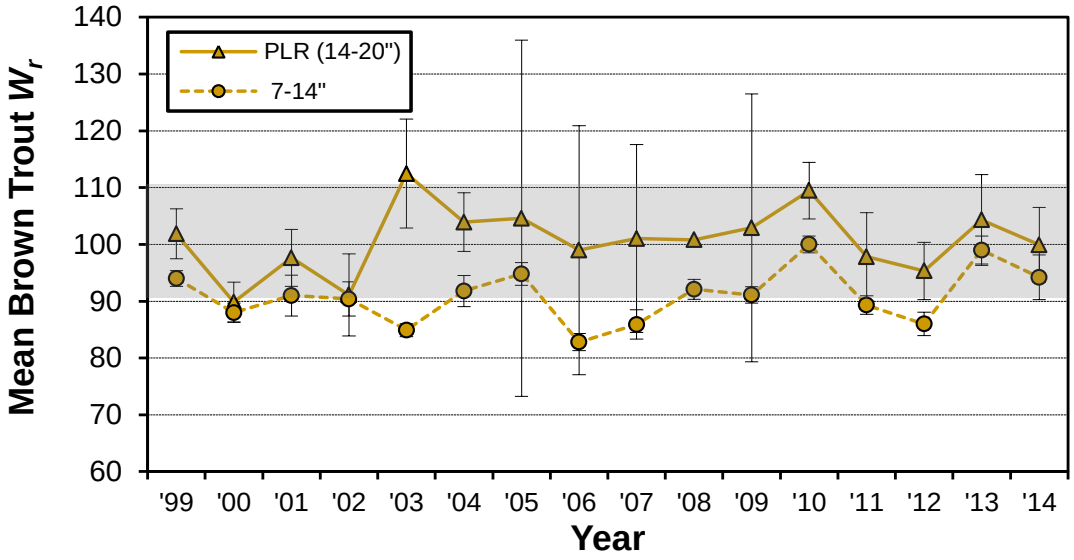

Figure 6. Mean relative weights (W_r) for 7-14 inch and 14-20 inch brown trout from the Norris tailwater monitoring samples. Bars indicate 90% confidence intervals.

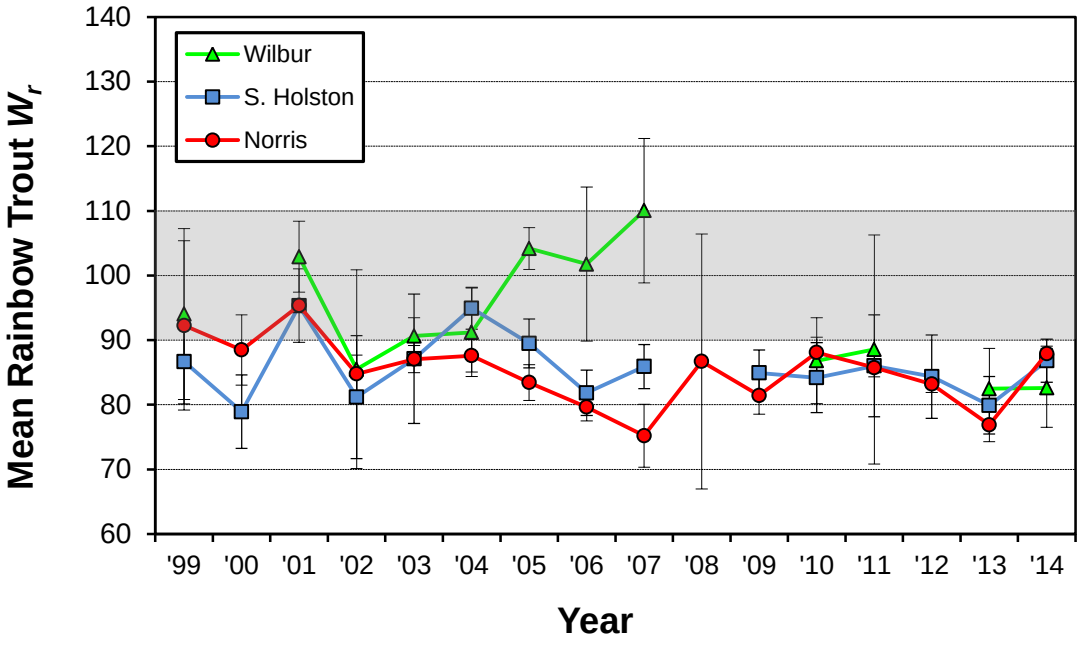

Figure 7. Comparison of mean relative weights (W_r) for 14-20 inch rainbow trout from the Wilbur, S. Holston, and Norris tailwater monitoring samples. Bars indicate 90% confidence intervals.

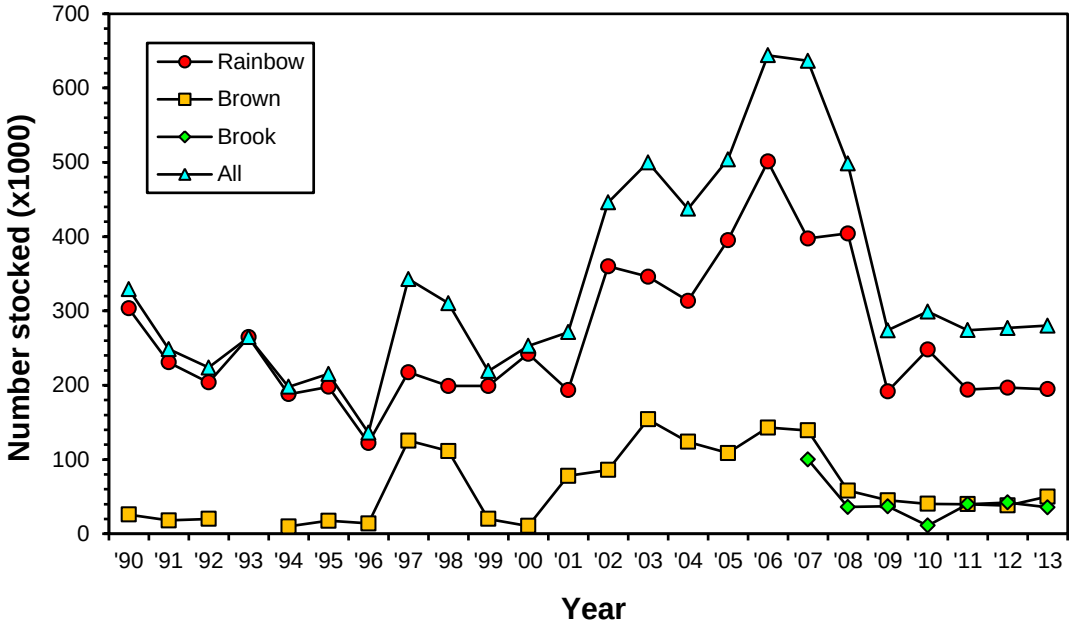

Figure 8. Stocking rates for the Norris tailwater, 1990-2013. About 37,000 adult (9-12 inch) and 160,000 fingerling rainbow trout are stocked each year.