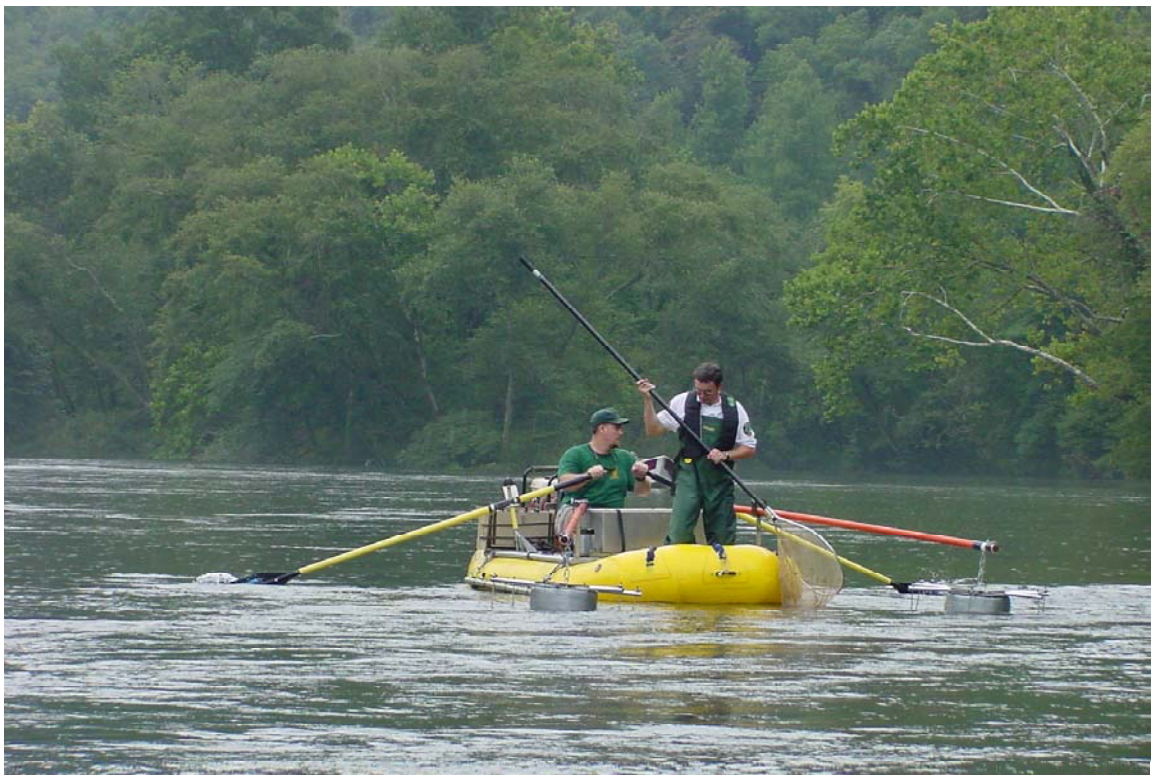
Management Plan for the Hiwassee River Trout Fishery, 2005-2010



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TENNESSEE WILDLIFE RESOURCES AGENCY
January 2005

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TENNESSEE WILDLIFE RESOURCES AGENCY

Management Plan for the Hiwassee River Trout Fishery, 2005 - 20010

The Hiwassee River is a popular trout fishery located in the Cherokee National Forest. Tennessee Wildlife Resources Agency (TWRA) annually commits substantial resources to stock trout and monitor this fishery. The purpose of this plan is to identify TWRA's goal, objectives, and management strategies for this fishery.

Goal

TWRA seeks to enhance the quality of the trout fishery on the Hiwassee River by increasing the abundance of larger trout in the river while maintaining existing angler catch rates.

Objectives

1. Continue to provide fisheries for rainbow trout and brown trout capable of sustaining at least 19,000 trips annually from March through September. Trips will be estimated by creel survey in 2008.

2. Maintain angler catch rates greater than 1 trout/hour measured by creel survey in 2008.

3. Increase the abundance of brown trout that are 10 inches and larger, by 2008. Data from electrofishing surveys in 2001-2004 will be compared to data collected in 2006-2008.

Current Status

Site overview

The Hiwassee River flows westerly approximately 140 miles through Georgia, North Carolina, and Tennessee where it joins the Tennessee River. The Hiwassee watershed drains over 4,000 miles of streams and encompasses about 2,700 square miles. Approximately 30% is above 1,600 feet elevation with almost 90% of the watershed consisting of mountainous, forested topography, of which one third belongs to the US Forest Service. The Hiwassee River from the Tennessee state line downstream to the Highway 411 Bridge is designated as a Tennessee State Scenic River. The 17-mile trout management section is located between the powerhouse and Patty Bridge (Figure 1).

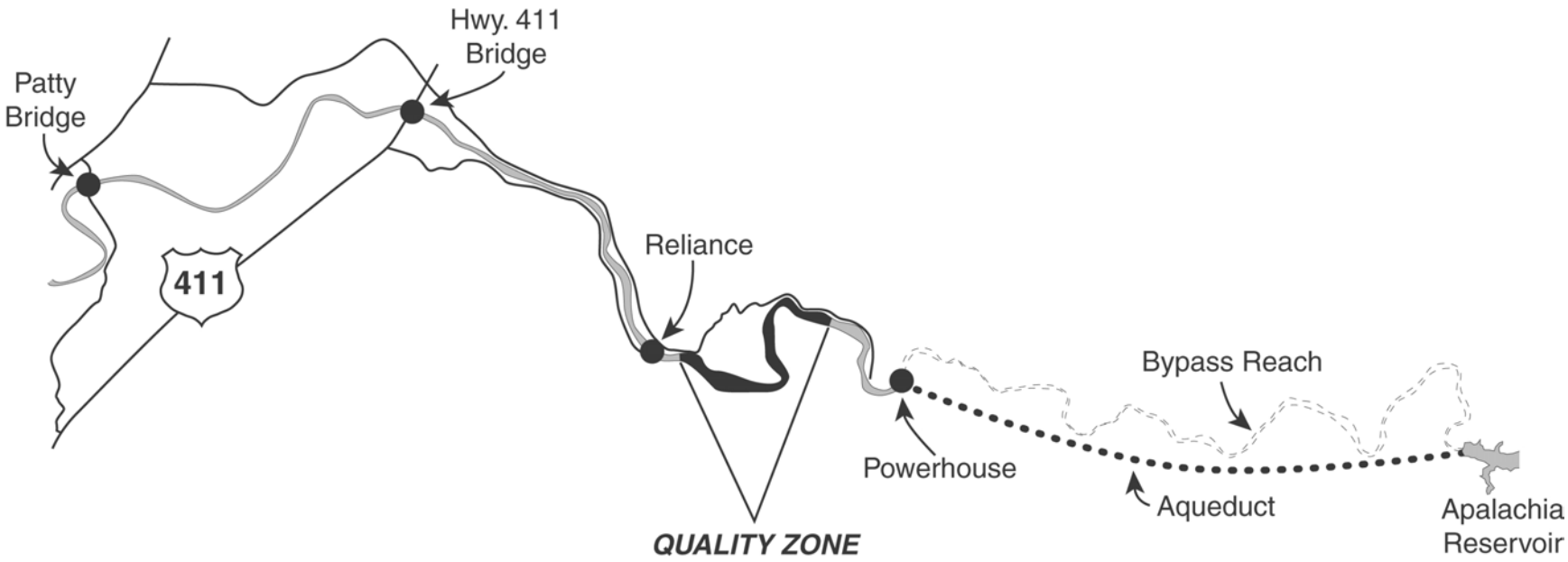

Figure 1. Map of Hiwassee River.

From the Tennessee state line to Reliance the Hiwassee River has a gradient of 20 feet per mile. The rock substrate of the watershed is composed of metamorphosed sedimentary siltstones, sandstones, and shale from the Blue Ridge physiographic province (McGregor 1986). The soft water condition of the trout section of the Hiwassee owes to such inert parent material. Low alkalinity on the Hiwassee (< 12 mg/L $CaCo_3$) contributes to poor growth and survival rates of trout in the Hiwassee (Luisi and Bettoli 2001).

For approximately 12 river miles downstream of the powerhouse, the substrate consists of areas of rubble mixed with deposits of sand/gravel that form small islands and shoal areas with abundant bedrock. Some reaches of the upper trout water section have long, shallow bedrock pools, extending over 300 yards in length and 100 yards wide, terminated by inverted bedrock strata where rubble accumulates. This bedrock/rubble colluvium, creates numerous stair-step pools, producing Class II whitewater in some areas. Pool-riffle-run-shoal, percentages by total surface area are 39, 4, 22, and 35 percent respectively, with pools and shoals dominating the upper section, above Reliance (Luisi & Bettoli 2001). Most of the lengthy pools are no more than 3 feet deep with a few deep pockets in excess of 10 feet.

Impounded in 1943 Apalachia Dam is the last of the four TVA dams on the Hiwassee River. Hiwassee, Chatuge, and Nottely reservoirs are located upstream of Apalachia Dam. Apalachia Dam was designed primarily for power generation, having virtually no flood storage capacity, with water level maintained between 1272 and 1280 feet.

Power generation does not take place at Apalachia Dam. The mode of generation utilizes an 18-foot diameter tunnel system, connected to the dam at a depth of about 58 feet. From the dam, the aqueduct runs in a relatively straight line for 8.3 miles and reconnects to the powerhouse downstream at HiRM 53.6. The powerhouse effluent rejoins the Hiwassee River in the vicinity of the Smith Creek confluence. This design creates 440 feet of head for two turbines at the powerhouse. Average monthly discharge from the powerhouse is 2140 cfs.

In 1991, TVA implemented a year round minimum flow of 200 cfs by pulsing one of two turbines for one hour every four hours. In addition to the minimum flow schedule, in 1995 TVA instituted a flow regime consisting of full generation between 11 am and 7 pm from Memorial Day until the end of August to benefit rafters and float recreation. This plan had to be modified in 2001 to only weekends due to a shortage of water and the practice is subject to review each year.

Water Temperature

Water temperature affects growth, survival, and reproduction of trout and is likely the most limiting factor on the Hiwassee River. Rainbow trout prefer temperatures between 12 and 19 C, while brown trout prefer temperatures between 12 and 17 C (Mettee et al. 1996). It has been shown that optimum growth for rainbow trout occurs around 16 C (Leitritz and Lewis 1980). Water temperatures for extended periods above 23 C can be lethal, and brown trout are more tolerant to high temperatures than rainbow trout (Rhode et al. 1994).

Discharge from Apalachia Reservoir released at the powerhouse has created a section of river where water temperature is too cold for many native fish populations and marginally cold enough for the survival of stocked trout. Warm water temperature has been identified as a limiting factor for trout survival on the Hiwassee River (Luisi and Bettoli 2001). The section of the Hiwassee River from the powerhouse downstream to Reliance is stocked with trout year-round. The lower section from Reliance to Paddy Bridge is too warm in the summer months and is only stocked in the spring.

In 2001, TWRA initiated temperature monitoring in the upper section of the Hiwassee River. Monitors were placed at the powerhouse (one mile below the effluent) and at Reliance (Figure 1). Water temperature at the powerhouse site did not exceed 19 C from May 9 to June 13, 2001 (Figure 2). During July and August water temperature did exceed 20 C in four separate periods (Figure 3), including a 19-hour period with water temperature averaging 23.6 C. These extreme temperatures were an exception and were associated with necessary maintenance of the hydropower operations. The status of trout during these temperature extremes is unknown and no associated fish kills were documented. High temperatures at the powerhouse are of great concern because temperatures can only increase downstream because there are no significant coldwater tributaries downstream.

Daily maximum water temperatures exceeded 19 C on approximately half of the days in May and June (Figure 4). These sub-lethal temperatures (19 to 24 C) stress trout, reducing growth, survival, and catchability. On a few days in mid May and Early June, the water temperature at Reliance was barely below the lethal threshold for trout (24 C).

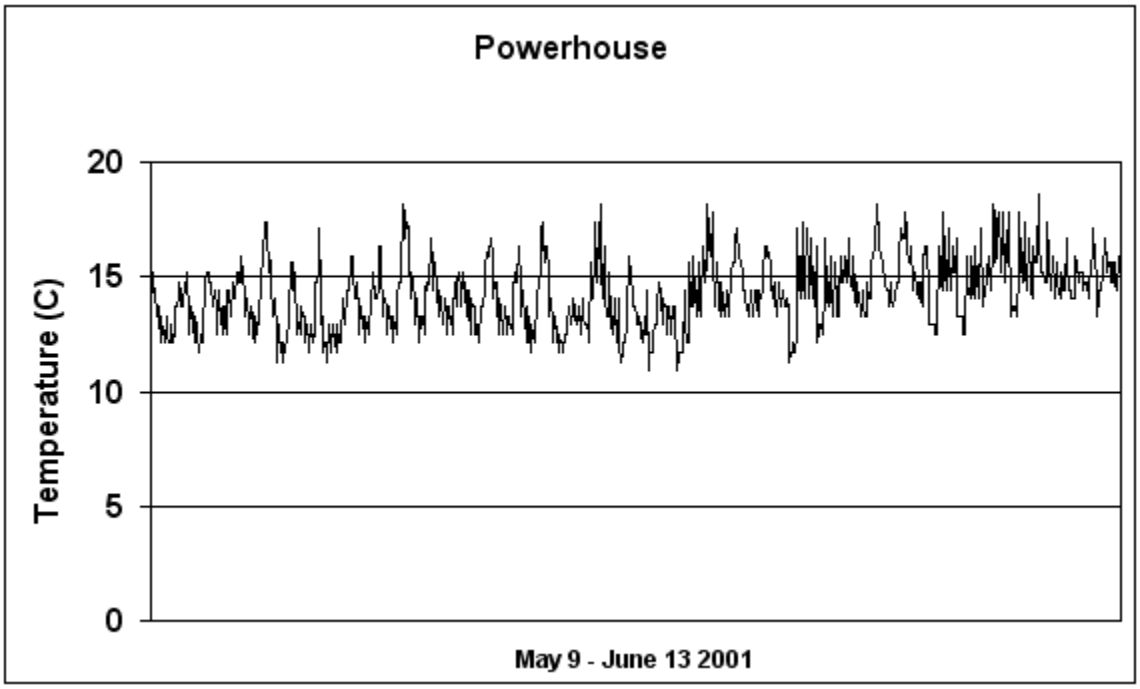

Figure 2. Water temperature of Hiwassee River at the powerhouse, May 9 through June 13, 2001.

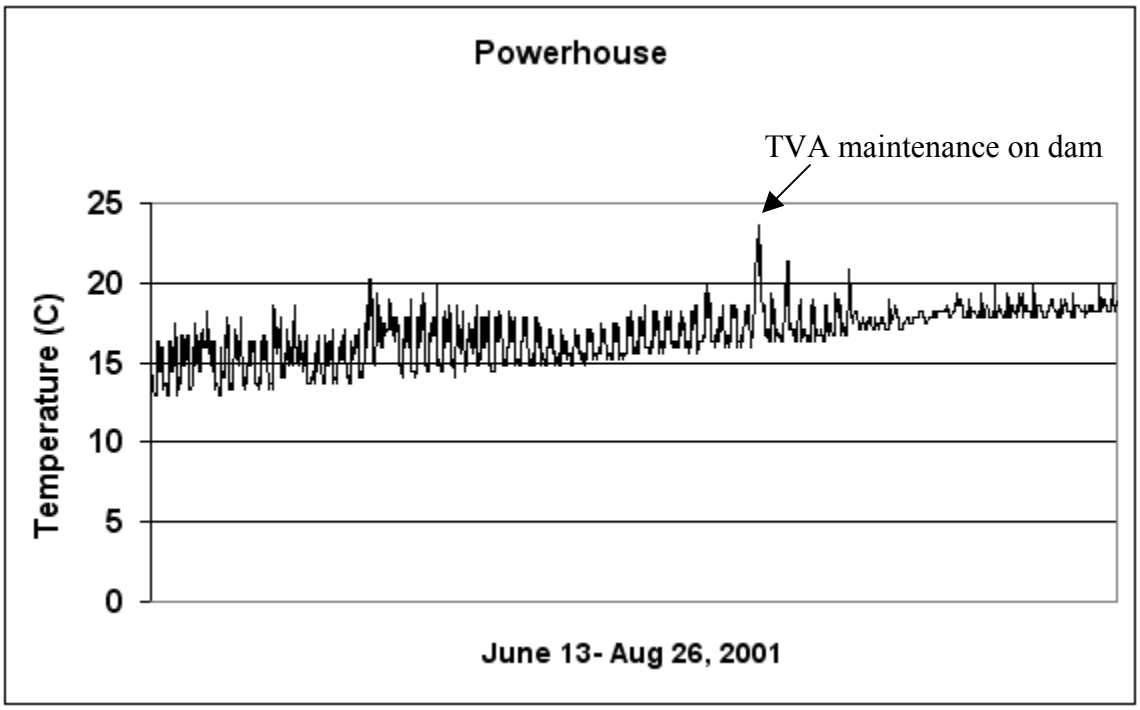

Figure 3. Water temperature of Hiwassee River at the powerhouse, June 13 through August 26, 2001.

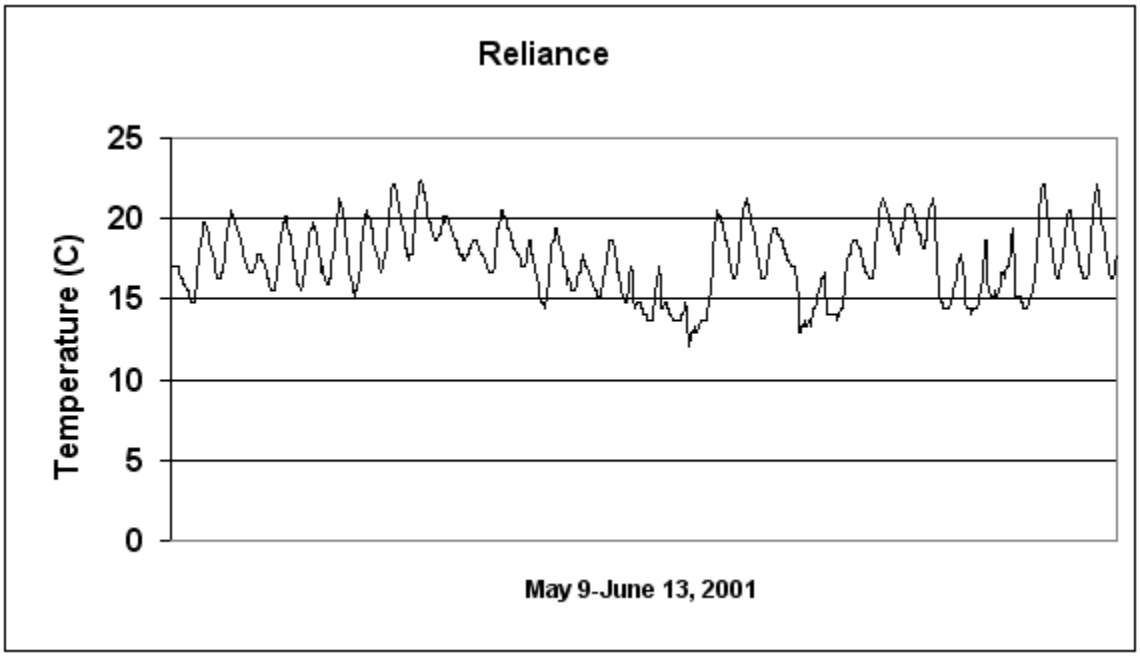

Figure 4. Water temperature of Hiwassee River at Reliance, May 9 through June 13, 2001.

In 2002 temperature data were collected at the powerhouse, Reliance, and HWY 411 Bridge and Patty Bridge from May 10 through September 13 (Figure 1). At the powerhouse water temperature was consistently above 20 degrees C in the month of September with peaks up to 21 (Figure 5). Data collected in 2002 at Reliance showed water temperature consistently above 20 degrees C during the month of September (Figure 6). Brown or rainbow trout survival in the Reliance area of the Hiwassee River is questionable in late summer at these elevated water temperatures. Water temperatures at HWY 411 Bridge and Patty Bridge were too warm for trout most of the time, especially after June 1 (Figures 7-8). Due to these warm temperatures TWRA stocking policy is to terminate stocking at the Patty ramp by mid-May and stock at the discretion of the manager at HWY 411 Bridge through May. By June all stocking occurs between the powerhouse and Reliance to avoid the lethal and sub-lethal water temperatures.

The temperature data collected by TWRA, with the exception of the 19-hour spike in July of 2001, appear to be consistent with historic data collected by U.S. Forest Service (US Forest Service, unpublished data). In 1999, Luisi and Bettoli (2001) also observed warm temperatures at the powerhouse (> 20 C) in September and October, and they also documented a severely warm period in late August similar to the spike in July 2001. Given multiple years of data showing sub-lethal temperatures, it is clear that warm temperatures are not abnormal occurrences, but rather a chronic problem on the Hiwassee River.

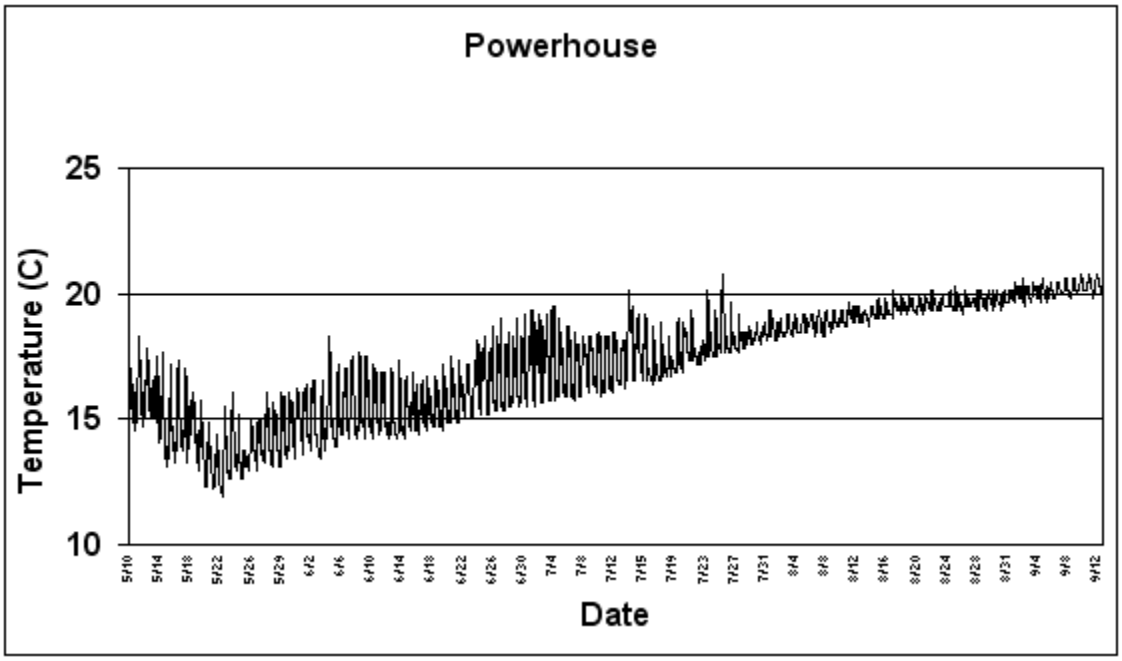

Figure 5. Water temperature of Hiwassee River at the powerhouse, May 10 through September 12, 2002.

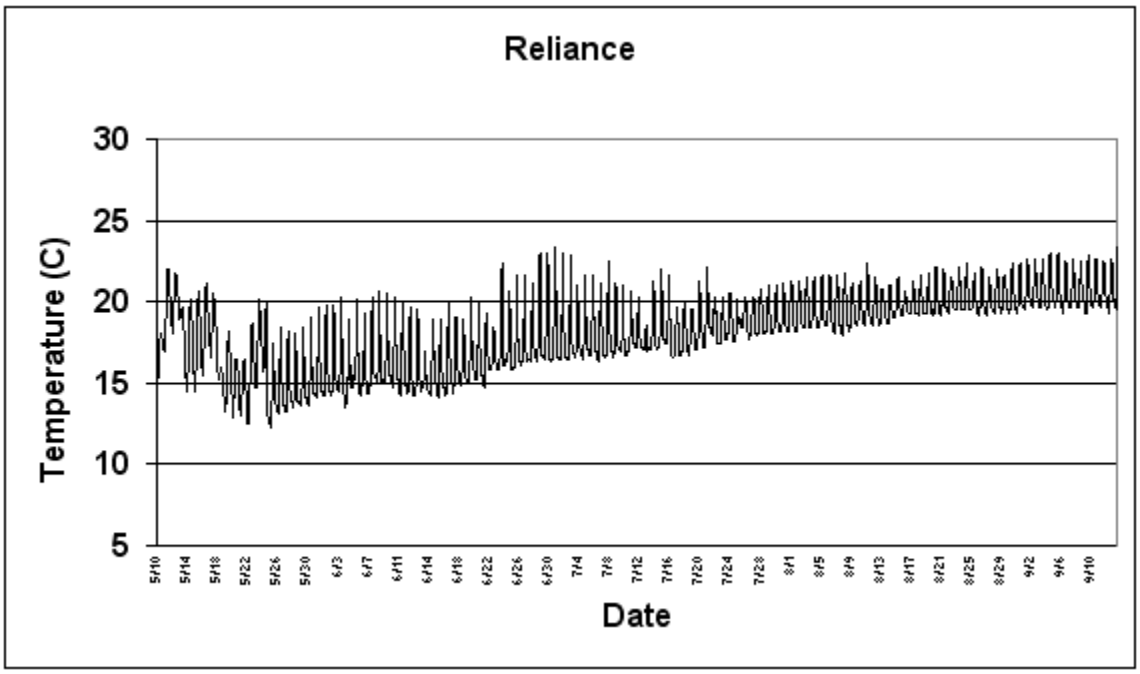

Figure 6. Water temperature of Hiwassee River at Reliance, May 10 through September 12, 2002.

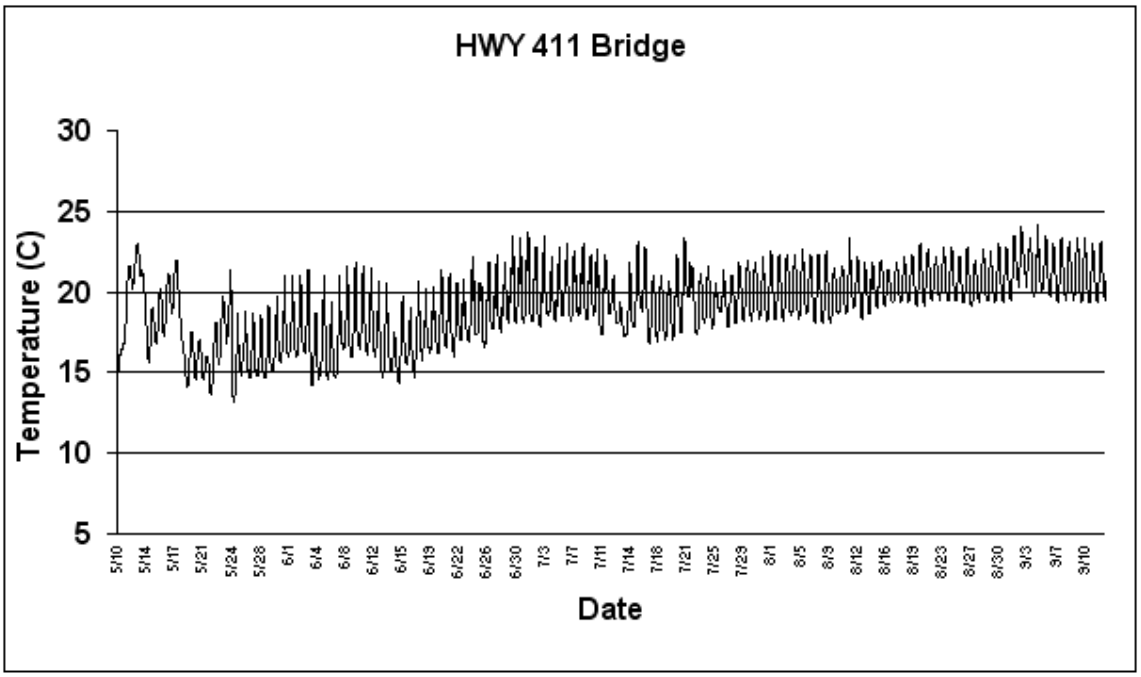

Figure 7. Water temperature of Hiwassee River at HWY 411 Bridge, May 10 through September 12, 2002.

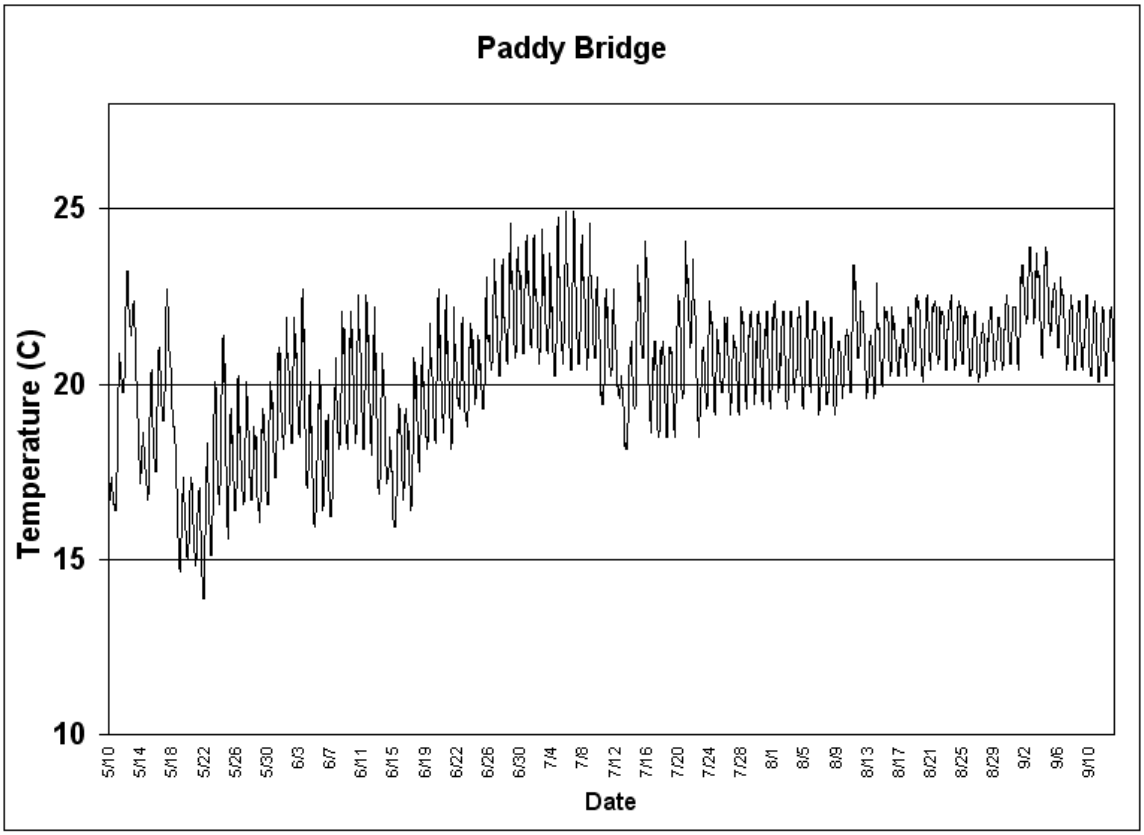

Figure 8. Water temperature of Hiwassee River at Paddy Bridge, May 10 through September 12, 2002.

Several factors affect temperature regimes in the trout section of the Hiwassee River:

1. Temperature of water at the mid-hypolimnion in Apalachia Reservoir.
2. Thermal stratification in Apalachia Reservoir.
3. Temperature of water released from Hiwassee Reservoir upstream.
4. Amount of flow in the natural river (cut off section).
5. Amount of heating of the water in the natural river.
6. Amount of generation at the powerhouse.
7. Various atmospheric conditions, mainly solar and ambient air heating.

Most factors are environmental, however management of water by TVA can affect river temperature. In 1991, TVA implemented a year-round minimum flow of 200 cfs by pulsing one turbine for one hour every four hours. This practice helps maintain cooler water temperatures throughout the summer months.

The current structure of Apalachia Dam and aqueduct provides little opportunity to decrease the discharge temperature. Data collected by TVA on Apalachia Reservoir in 1995 showed strong thermal stratification in July and then mixing of strata by September. The same data indicated pockets of colder water within the forebay at depths of 75 to 101 feet. These strata of colder water were at depths well below the aqueduct opening and are not directly available to the river downstream. However, if this colder water was made available to the powerhouse effluent, the supply is questionable and the concentration of dissolved oxygen would be low, requiring the addition of oxygen to the discharge.

The 12.4-mile natural riverbed, or bypass section, between the dam and powerhouse constitutes a warmwater fishery. Its flow is 25 to 200 cfs during the summer months, the result of dam leakage and small tributaries (Bender & Hauser TVA 1987). TVA recently approved an operation change that would set the minimum flow for this reach at 25 cfs. Water temperatures within this reach can exceed 32 C during the summer (Bender and Hauser 1987). Due to the relatively low flow at the confluence with the powerhouse the bypass reach is not considered a significant factor contributing to the warm temperatures in the trout section of the river.

Dissolved oxygen (DO)

TVA performed modifications to the generators by installing hub baffles at the powerhouse in 1993, which increased DO at the powerhouse during critical months. The hub baffles reduced the deficit days (number of days that target DO of 6 mg/l is not met, multiplied by the number of mg/l below target level) from 54 days to 1 day during 1996 (Scott et al. 1996). Additional aeration occurs from turbulence at the powerhouse release site, thus DO is not a limiting factor in the Hiwassee River downstream of the powerhouse with average yearly DO concentrations above 10.0 mg/l (Lindbom 1992).

Benthic productivity

The upper Hiwassee River is very low in minerals and contains soft water with low alkalinity since the watershed lacks substrates with carbonates or phosphates (McGregor 1986). The soft water condition in the Hiwassee relates to low productivity. Macroinvertebrate biomass and fish standing crops, in the Hiwassee River, are about one tenth and one third, respectively, that of the Norris tailwater, however the Hiwassee River supports significantly more diverse benthic organisms and fish species (Hill 1980). It supports 41 macroinvertebrate taxa (Hill 1980) and good Ephemeroptera, Plecoptera, & Tricoptera indices (Williams 1996). By number, the main groups consist of caddis fly, stonefly, and mayfly larvae (Lindbom 1992). The establishment of a 200-cfs minimum flow prevents dewatering of the substrate during extended non-generation periods, as a result macroinvertebrate biomass has more than tripled (Lindbom 1992).

Fishery

Bank and wade fishing access to the Hiwassee River is abundant. Much of the access upstream of Reliance is along the right descending bank, extending up to the powerhouse. Assess is most limited in the section of river between the Childers Creek confluence up to Big Bend parking lot. The U.S. Forest Service owns the majority of the adjoining lands along the upper section of the Hiwassee. Fishermen parking along the river must purchase a $2.00 daily, Forest Service parking fee.

In 1999 a 42-week creel survey (February-November) documented 73,842 hours of fishing pressure, representing 20,761 trips (Luisi and Bettoli 2001). An economic valuation survey in 2001 (Williams and Bettoli 2003) estimated the value of the 26-week fishing season (peak season) on the Hiwassee River to be $1.7 million, representing $1.5 million in direct expenditures and $0.2 million in net value. This represented the highest direct expenditure estimate for Tennessee tailwaters and the second lowest net value estimate, implying that anglers are paying a lot to fish and they are not willing to pay much more.

Catch rates at or above 1.0 trout/hour are considered to be good for southeastern tailwaters. On the Hiwassee River in 1974 and 1975, from May through August, anglers caught 0.30 and 0.20 trout per hour respectively (Myhr

1977). In 1987 the catch rate was 0.84 trout/hour (Bettoli 1988). An evaluation of the QZ in 1989-1991, reported an average catch rate of 1.8 trout/hour in the QZ compared to 1.0 outside the QZ. (Lindbom1992). In 1999, the average catch rate was 0.9 trout per hour, and in the average trip 4.3 trout were caught and 1.2 trout were harvested (Lousi and Bettoli 2001). In that study, rainbow trout represented 94% of the harvest.

An angler survey designed to assess the preferences and attitudes of trout anglers was conducted in 2001 (Hutt and Bettoli 2003). The survey reported that anglers on the Hiwassee River were somewhat dissatisfied with fishing conditions. Anglers wanted the opportunity to catch bigger fish and that most would be willing to yield to special regulations that may increase size structure. Yet anglers are opposed to bait, hook, and seasonal limitations. Hiwassee anglers were comprised of a diverse group of fishing attitudes, very evenly divided. As result it would be difficult for managers to get overwhelming public support for some management alternatives.

Trout populations

The first stocking of rainbow and brown trout in the Hiwassee River is not well documented but early TWRA reports indicate stocking as early as 1951. Natural reproduction does not contribute substantially to the trout fishery in the Hiwassee due to the lack of proper habitat and substrate in the river, although wild trout have be collected which likely spawned in tributaries (Myhr 1977; Luisi and Bettoli 2001; Banks and Bettoli 2000).

Prior to 1995 stocking rates were variable due to a variable supply of hatchery fish. In 1995 the expansion of the Dale Hollow National Fish Hatchery (DHNFH) was completed providing a consistent supply of trout. Since 1995, DHNFH has been producing 80,000 to 100,000 9-inch rainbow trout for the Hiwassee River (Figure 9). Fingerling rainbow trout were occasionally stocked with little success, therefore fingerling stocking is not a priority. Occasionally large (~12 inch), surplus rainbow trout from Flintville Hatchery are stocked at the Hiwassee.

From 1991 through 2001, approximately 15,000 3- to 8-inch brown trout were stocked annually (Figure 10). Brown trout are stocked at a smaller size than rainbows due to hatchery limitations. Since 2001, the number of brown trout stocked has increased by over 10,000 while the number of rainbow trout has decreased by 10,000. This shift is an attempt to establish more brown trout in the fishery. Productivity is too low in the Hiwassee River to warrant additional stocking of brown trout without a reduction in rainbow trout, especially given the goal of growing bigger fish.

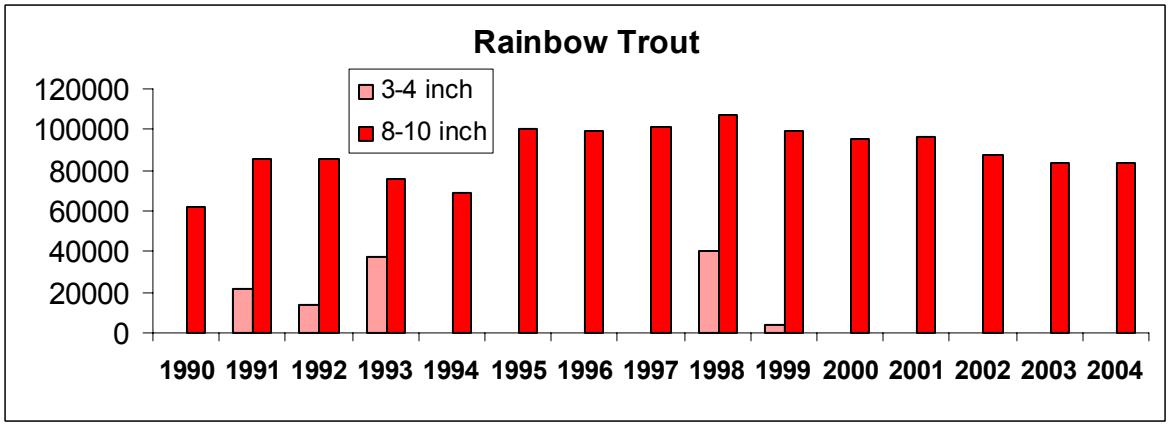

Figure 9. Number of rainbow trout stocked annually from 1990 through 2004.

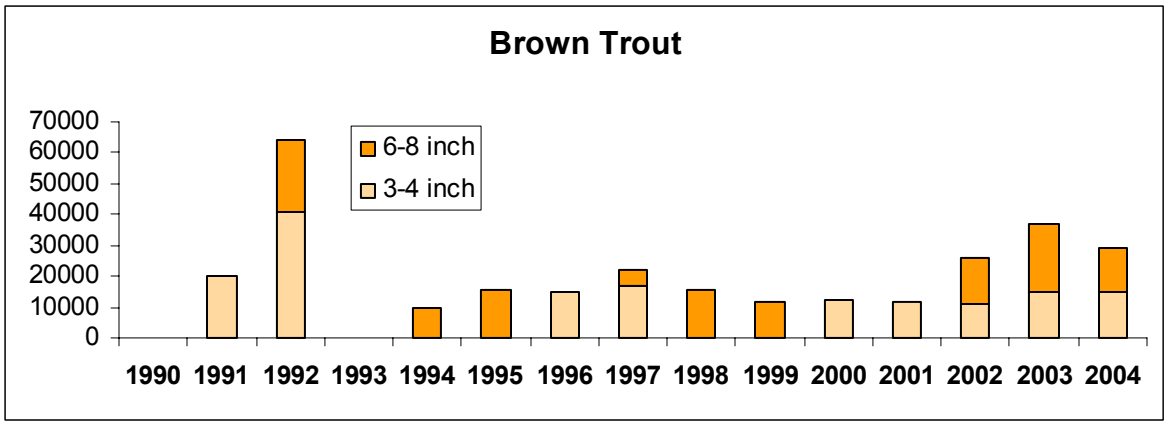

Figure 10. Number of brown trout stocked annually from 1990 through 2004.

Most trout are stocked upstream of Reliance. In March, April, and May some rainbow trout are stocked at HWY 411 Bridge and Paddy Bridge. Excessive warming of the river downstream of Reliance prohibits stocking at lower sites after May. In 2000 a new practice was initiated whereby the river is stocked up to twice a month year-round, rather than large stockings once a month in the spring. For a variety of reasons most freshly stocked rainbow trout are short-lived in the Hiwassee River (Luisi and Bettoli 2001). Therefore spreading out the stocking throughout the year allows for better use of trout by anglers.

Biologists and anglers occasionally observe striped bass and walleye, especially between Paddy Bridge and Reliance. These fish do eat trout, but these predators are not abundant enough to be considered to be a relevant factor limiting trout populations.

Trout populations in Tennessee tailwaters are monitored using electrofishing techniques to estimate the relative abundance and size structure of populations. Electrofishing on the Hiwassee River is challenging due to swift water with many hazards and extremely low conductivity. In 1999 surveys were conducted by Luisi and Bettoli (2001), and by TWRA annually from 2001-2004. Population estimates by Luisi and Bettoli (2001) estimated the abundance of trout at 61 and 22 trout per hectare in 1999 and 2000, respectively. These estimates were considerably low compared to other major tailwater trout fisheries.

TWRA surveys are conducted from the powerhouse to Reliance. Relative abundance of trout as indexed by TWRA surveys has been variable ranging from 10 to 48 trout per sample. Rainbow trout collected during the 2001-2004 electrofishing surveys were typically between 8 and 13 inches (Figure 11), a size range that is identical to the size of stocked rainbow trout. The lack of larger rainbow trout (> 13 inches) is attributed to poor survival and growth of rainbow trout in the Hiwassee River. Brown trout fair slightly better, ranging in size from 7 to 18 inches, but with relatively few fish over 10 inches in length (Figure 12). Again, the low number of larger brown trout is attributed to poor growth and survival. However the presence of fish over 12 inches demonstrates that brown trout can survive multiple years in the Hiwassee River.

Reported growth rates of trout in the Hiwassee River are average to poor relative to other Tennessee tailwaters. Myhr (1977) observed average growth of 0.55 and 0.45 inches/month for rainbow and brown trout, respectively. In a more recent study (Luisi and Bettoli 2001) during a drought year, brown trout stocked in March grew 0.31 inches/month initially, but growth ceased from June through October. During that study rainbow trout growth rates were extremely low and irrelevant because mortality was so high that these fish would not live long enough to grow an inch longer. Both studies observed slower growth rates in late summer months compared to spring.

In Tennessee tailwaters survival of stocked brown trout is typically better than survival of stocked rainbow trout. In 1999, 200-day post stocking survival of brown was estimated at 13% compared to 3-4 % for rainbow trout (Luisi and Bettoli 2001). Survival of both species was considered poor during 1999, and the creel data indicated that low survival was not due to harvest, but rather to natural mortality. Poor survival and growth observed during the 1999 drought was likely a worst-case scenario for trout in the Hiwassee River.

Fishing regulations

Statewide regulations permit the harvest of 7 trout per day with no size restrictions. In 1986 a Quality Trout Fishing Area, more popularly known as the Quality Zone (QZ), was established between the L&N railroad bridge at Reliance and the Big Bend Parking Area (Figure 1). Within the QZ the minimum length limit is 14 inches and only 2 trout may be harvested. The use of bait is prohibited in the QZ. The objective of the QZ was to reduce harvest, which in turn would increase angler catch rates and possibly increase the size of trout. In 1986-1987 a creel survey reported that fishing was better in the QZ and that anglers consistently caught more in the QZ compared to section upstream of the QZ (Lindbom 1992). Since its inception the QZ has been more effective at maintaining higher catch rates, than producing larger trout.

The QZ's inability to produce larger trout and results of the 1999 study, suggest that the Hiwassee River can only be managed for high catch rates rather than for larger trout. Rather than accept this as fact, with angler support TWRA managers chose to further test this hypothesis. In 2003 TWRA managers focused on brown trout as the best candidate for producing larger trout in the river. In 2004 regulations changed to protect brown trout using a 14-minimum length limit and 2 fish creel limit from the powerhouse downstream to Paddy Bridge. The objective was to reduce harvest of brown trout and hopefully increase the survival and ultimately the size of brown trout. Protection of brown trout in the reach from the powerhouse down to the QZ was important because this is where many of the brown trout are stocked, and this area has the best habitat on the river to support trout (coldest water). The area from Reliance to Paddy Bridge was included in the regulation to simplify the regulations. While managers were not sure this regulation would work, they were sure that it would not harm the existing fishery.

In 2005 the section from Reliance downstream to Paddy Bridge returned to statewide regulations. Local residents proposed this change because they felt that the brown trout regulation was too restrictive. This change will likely not affect the impact of the brown trout regulation because this lower reach of the river is too warm to support trout. As a result of this latest change the Hiwassee River has three different regulations for trout.

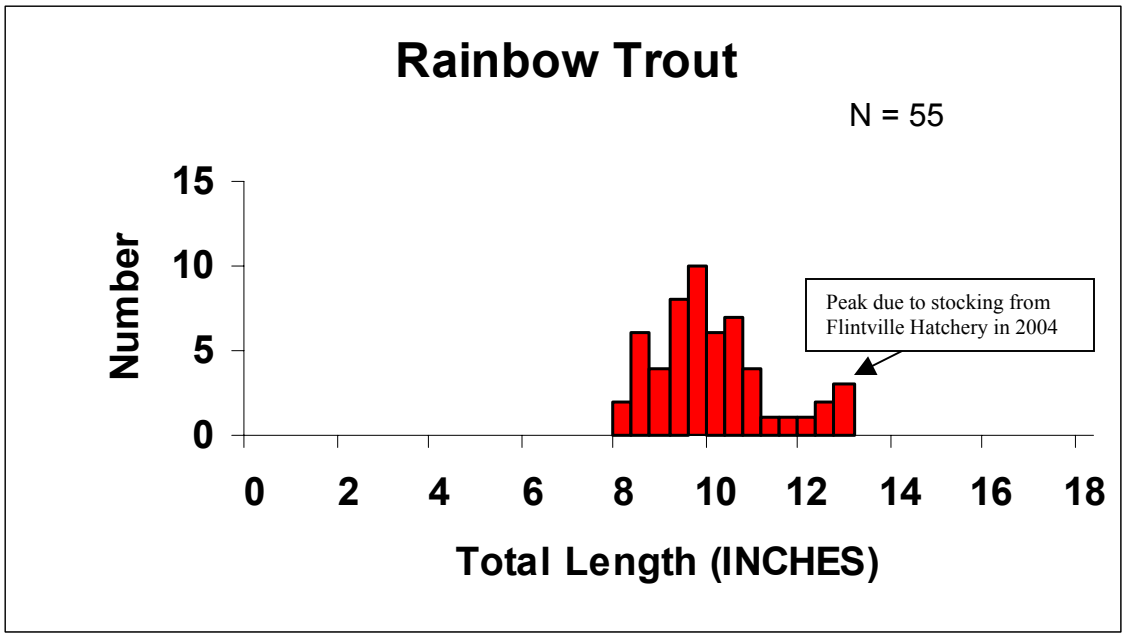

Figure 11. Length frequency distribution of rainbow trout captured during electrofishing surveys in 2001 through 2004. Data from all years are pooled.

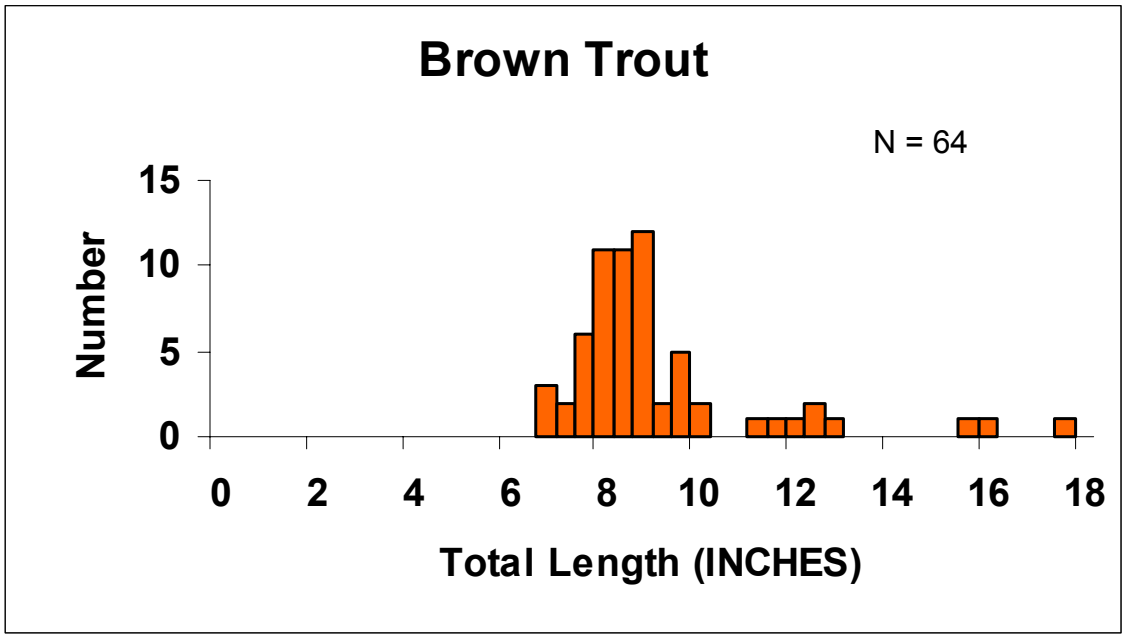

Figure 12. Length frequency distribution of brown trout captured during electrofishing surveys in 2001 through 2004. Data from all years are pooled.

Fisheries Management Strategies

The TWRA will follow these strategies to meet the stated objectives for the Hiwassee River:

1) Support any changes in operation of Apalachia Dam and powerhouse that would provide cooler water during the critical period from June through October. Request that TVA not conduct maintenance on powerhouse during periods that would result in extremely warm temperatures.

2) Continue stocking 86,000 rainbow trout annually
   a) Stock Powerhouse to Reliance year-round
   b) Stock HWY 411 Bridge as temperature allows in March through May
   c) Stock Paddy Bridge only in March and April

3) Continue stocking up to 36,500 brown trout annually (as available)
   a) Stock 21,500 7-inch brown trout from the powerhouse to Reliance
   b) Stock 15,000 3-inch brown trout from powerhouse to Reliance.

4) Monitor the fishery to measure objectives
   a) Conduct a creel survey in 2008 to measure angler use, catch rates, and satisfaction with fishery. This creel survey should also evaluate the QZ relative to other areas on the river.
   b) Annually estimate the relative abundance of trout.
      i) Increase sampling intensity to provide a more precise evaluation of trout population parameters.
      ii) Compare pre-and post-regulation size structure of brown trout to evaluate success of regulation (Figure 13).

5) TWRA managers consider the current minimum length limit on brown trout to be an experiment. If the length limit on brown trout does not have the desired effect (Figure 13; Objective 3 -more brown trout surviving to grow larger than 10 inches) by 2008, then the following actions should be considered.
   a) If the regulation increases the abundance of brown trout and does not increase the abundance of brown trout 10 inches and larger, that would indicate that there is too much competition among trout to allow the growth bigger fish. Managers would also observe a decrease in the relative weight (condition) of brown trout. In this case, managers should consider keeping the regulation and stocking substantially fewer trout in the river. A possible scenario would be to reduce the stocking rate of brown trout to 7,500 per year.
   b) If the brown trout population shows no response to the length restriction it would suggest that fishing mortality was not substantial, and the regulation should be removed.

6) If the Hiwassee fishery cannot be successfully managed for larger brown trout, then TWRA will consider stocked larger rainbow trout. The weight of 86,000 9-inch rainbow trout is approximately 27,300 pounds. If this poundage was stocked as larger trout, then the Hiwassee River could receive 50,000 11-inch trout or 35,000 12-inch trout. By 2010 TWRA is hopeful to have hatchery improvements completed that would make the stocking of larger rainbow trout more feasible.

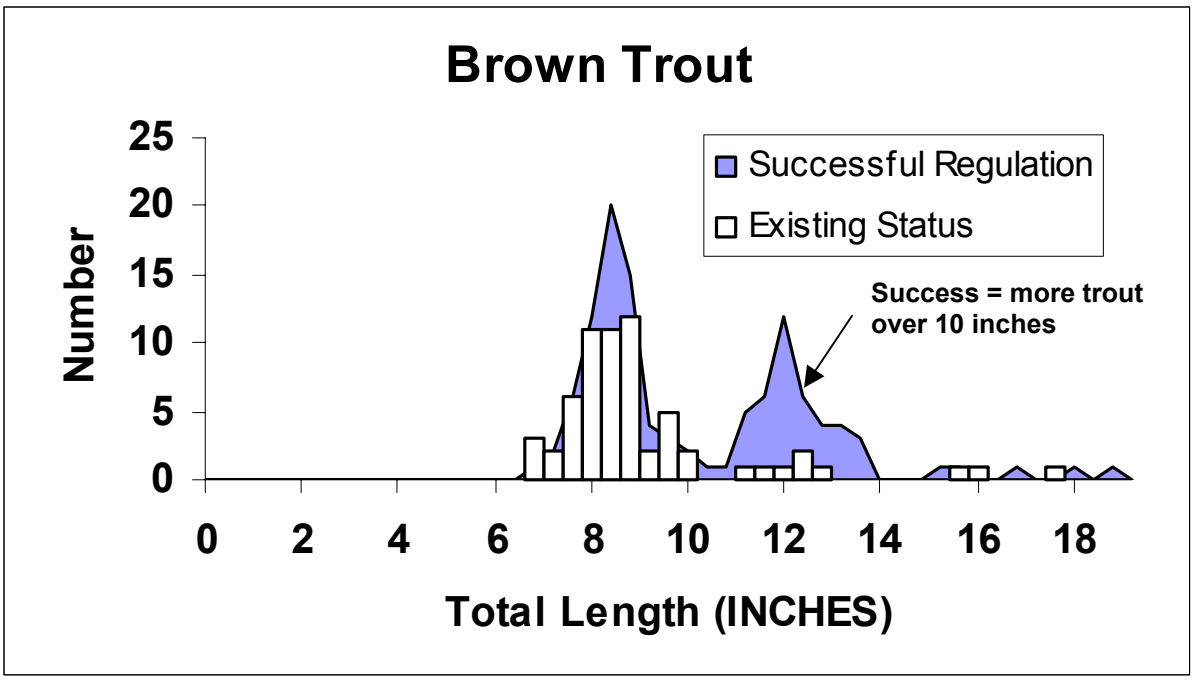

Figure 13. Hypothetical desired response of brown trout population to 14-inch minimum length. If the regulation is successful, then managers expect to see proportionally more trout in over 10 inches, relative to the number of trout less than 10 inches.

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