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FINAL ENVIRONMENTAL ASSESSMENT

TIMS FORD DAM FLOW MODIFICATION FOR HABITAT QUALITY IMPROVEMENTS

Franklin County, Tennessee

TENNESSEE VALLEY AUTHORITY

JUNE 2008

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ACRONYMS, ABBREVIATIONS, SYMBOLS, AND TECHNICAL TERMS

cfs	cubic feet per second
ERM	Elk River Mile (Distance in miles from Mouth of Elk River)
ft	Feet
ft/s	Feet per second
msl	mean sea level
sluice	Noun - An artificial channel for conducting water fitted with a gate. Verb - to allow water to drain through a sluice.
sluiceway	See Noun definition of sluice
spill	Verb - to allow water to flow over a spillway
spillway	a passage through which surplus water escapes from a reservoir
ACDNR	Alabama Department of Conservation and Natural Resources
TDEC	Tennessee Department of Environment and Conservation
TFD	Tims Ford Dam
TFH	Tims Ford Hydroelectric Plant
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WI	Wadeability Index - The mathematical product of the linear velocity of water flowing in a stream in feet per second and the channel depth in feet.

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CHAPTER 1

1.0 PURPOSE OF AND NEED FOR ACTION

1.1. The Decision

The Tennessee Valley Authority (TVA) proposes to modify releases of water from the Tims Ford Hydroelectric Plant and Dam (TFH) to improve habitat conditions for two federally listed as endangered species, the boulder darter and cracking pearlymussel. The Elk River Watershed is the only known habitat for the boulder darter. Cracking pearlymussel has been eliminated from the majority of its former range in the Tennessee and the Cumberland Rivers and is currently known only from the mainstem of the Tennessee River (Kentucky Reservoir), the Elk River, and the upper Clinch River. The proposed changes for improving habitat for the boulder darter and the cracking pearlymussel should also benefit, four other federally listed endangered mussels (shiny pigtoe, fine-rayed pigtoe, birdwing pearlymussel, and Cumberland monkeyface) in the Elk River. The changes would also benefit two other Elk River mussels (slabside pearlymussel and sheepnose) that are candidates for federal protection.

TVA proposes to modify releases from the dam by implementing a combination of sluicing, spilling, and generating through the hydropower turbine so the resulting spring through fall tailwater flows from TFH would more closely resemble natural free-flowing stream water temperatures and flows in downstream reaches of the river. This would result in improved native mussel and fish habitat. TVA would implement these changes in 2008.

The Tims Ford tailwater section of the Elk River starts at the discharge from Tims Ford Dam at Elk River Mile (ERM) 133.3 and extends to the Wheeler Reservoir pool at approximately ERM 21. (See Figure 1-1.) For the purposes of this project with respect to aquatic animals, the river can be divided into two reaches; an upstream reach from Tims Ford Dam (ERM 133) to Fayetteville, and a downstream reach from Fayetteville to the backwaters of Wheeler Reservoir (~ERM 21). Boulder darters are present in the vicinity of Fayetteville and downstream in the Elk River to ERM 30 or 31. Targeted water temperature and habitat improvements would be most evident in the upstream reach.

Native animal species that historically were found in the Elk River below Tims Ford Dam are less tolerant of the cold-water releases from Tims Ford Dam than trout. Native fish and mussel populations have been adversely affected by the extreme variations in flow and temperature related to present current operations of the turbine at Tims Ford Dam. Trout are also affected by the variations in flow throughout the trout reach, and by variations in temperature at the downstream end of the trout reach.

TVA is required to implement these modifications to operations as a result of a recent consultation with the U.S. Fish and Wildlife Service (USFWS) on TVA's routine dam operations, including Tims Ford Dam (USFWS, 2006). The range of these modifications to operations at TFH can be bounded by elimination of all generation by the existing large unit at TFH during warm weather months to a wide variety of spilling/sluicing/short duration generation pulse scenarios, all aimed at improving water quality and habitat conditions for the above listed species. This EA is intended to ensure that the potential environmental consequences associated with the proposed operational changes at TFH would be identified and mitigated to insignificance.

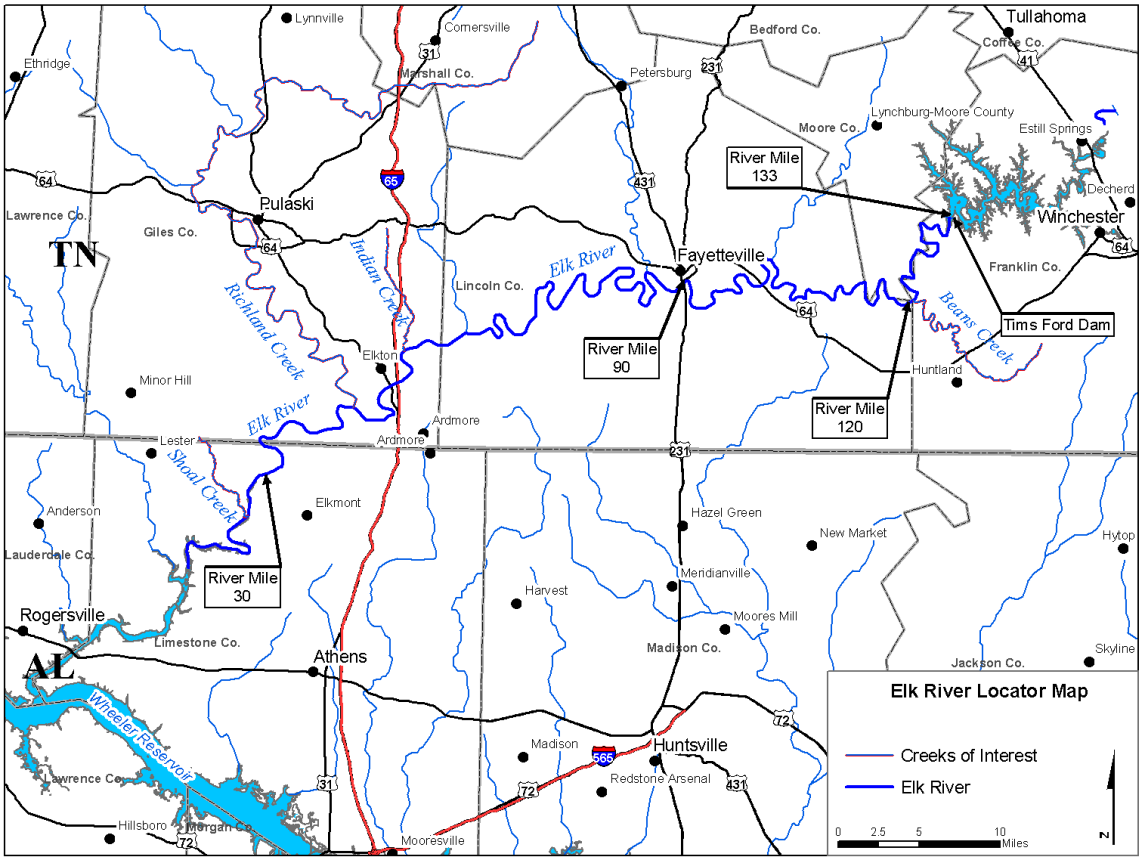

Figure 1-1. Map of the Elk River from Tims Ford Dam to Wheeler Reservoir

1.2. Other Pertinent Environmental Reviews or Documentation

In 2004, TVA began a programmatic consultation with the USFWS concerning routine operation and maintenance of TVA's dams. In October of 2006, the USFWS issued a Biological Opinion (USFWS, 2006) that maintains TVA's ability to control and operate the integrated Tennessee River system while ensuring TVA's compliance with the *Endangered Species Act* (ESA). As part of this agreement, TVA has committed to implement several protective measures at multiple sites to help conserve and recover listed species, minimize adverse effects to listed species, and to avoid potential jeopardy to listed species. Implementation of this proposal would fulfill TVA's flow modification obligations for Tims Ford Dam as outlined in the Biological Opinion. TVA and the USFWS would accomplish species recovery actions by implementing an adaptive approach that includes activities designed to provide permanent improvements that would contribute toward protection and recovery of the species of concern.

TVA included the NEPA review of the implementation of flow modifications for the benefit of endangered species at Bear Creek Dam in the EIS for the Bear Creek Dam Leakage Resolution Project (TVA, 2007). The modifications proposed under the Biological Opinion for Wilson Hydro were within the scope of activities reviewed for the *Wilson Hydro Plant Modernization of Hydroturbines* Environmental Assessment (TVA, 2005) so no additional NEPA review was deemed necessary.

1.3. The Scoping Process and Public Involvement

As a result of the programmatic consultation with the USFWS described above, TVA established a multi-agency working group consisting of representatives from the USFWS, the U.S. Geological Survey (USGS), Tennessee Wildlife Resource Agency (TWRA), and the Alabama Department of Conservation and Natural Resources (ADCNR), and TVA technical staff. Under the Biological Opinion, the multi-agency working group would evaluate the impacts of proposed operational changes at the Bear Creek dams, Tims Ford Dam, and Wilson Dam.

The multi-agency working group met for the first time on March 22, 2007, and for the second time on February 20, 2008. TVA technical staff and the multi-agency working group identified the following potential issues as needing evaluation for this environmental assessment (EA): water quality, aquatic ecology, cultural resources, and recreation. Water quality issues include water supply, erosion, and physical and chemical characteristics of the water of the Elk River downstream of Tims Ford Dam and also in Tims Ford Reservoir. Aquatic ecology includes the threatened and endangered aquatic species as well as other aquatic animals. Cultural resource issues include historic structures and archaeological resources. Recreation issues include fishing, rafting, and canoeing on the Elk River downstream of Tims Ford Dam.

Correspondence with the various state and federal agencies appears in Appendix A. On April 25, 2008, the draft version of this environmental assessment was issued for public and interagency review and comment. TWRA and two offices of the USFWS commented on the Draft EA during the review period. The Tennessee Department of Environment and Conservation (TDEC) commented on the Draft EA on June 9, 2008. All comments by the public were received after the review period, but all comments received on or before June 10, 2008, and TVA's responses have been included in Appendix B.

1.4. Necessary Federal Permits or Licenses

No known federal permits or licenses would be required to implement the proposed action.

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CHAPTER 2

2.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter describes the background, alternatives, and consequences of the proposed action.

2.1. Background

TFH is a multi-purpose tributary project located along the Elk River in south-central Tennessee in Franklin County. It is approximately 10 miles west of Winchester and 12 miles south of Tullahoma (Figure 1-1). Construction of TFH began in 1966 and was completed in 1970. The Elk River originates in Grundy County and flows west forming the border of Franklin and Coffee Counties until it is impounded by the Elk River Dam (Woods Reservoir) near the U.S. Air Force's Arnold Engineering Development Center. Waters just below the Elk River Dam begin the formation of Tims Ford Reservoir. Below TFH the Elk River meanders southwest as it borders Franklin, Moore, and Lincoln Counties and travels toward Fayetteville. The river flows into Giles County and meets the Tennessee River (Wheeler Reservoir) in Limestone County, Alabama.

Tims Ford Dam provides recreation, flood protection for downstream locations on the Elk River (primarily for Fayetteville), generates hydropower, and provides for economic development and water quality and supply. As will be discussed in Section 3.1, the largest part of the original justification for TFH was recreation, and to accommodate this objective, a minimum pool level is maintained for recreation on the reservoir May 1 through October 15 each year. The Elk River is popular with canoeists, kayakers, and anglers. The increased flow from the generator turbine discharge takes from 8 to 10 hours to reach the Shelton Creek confluence with Elk River near Elk River Mile (ERM) 109. Canoe outfitter companies offer river trips on weekdays by consulting TVA's generation schedules and then planning river excursions so that their customers are safely off the river before the surge from the hydro turbine discharge catches up with them. (Personal Communication Ben Towry, Elk River Canoe Rental, LLC 1-23-2008). Hydro operations during much of the year are adjusted to accommodate downstream recreation, to the extent practicable, by not generating from 6 p.m. on Fridays until the following Monday morning.

TFH is operated to maximize power production through turbine generation during high demand periods and to provide continuous minimum flows via sluicing. The hydroelectric plant has one operational generating unit. It is rated at 45,000 kilowatts (kW), 3890 cubic feet per second (cfs). A second, smaller minimum flow unit, rated at 39 kW, 74 cfs, was installed to provide minimum flows as part of TVA's Reservoir Release Improvements Plan. The smaller, minimum flow turbine was permanently damaged in a flood of the powerhouse in May 2004. The minimum flow of 80 cfs has been provided via the sluiceway since that time.

The Elk River contains a regionally important trout fishery and, over the years, TVA has taken several measures to improve the aquatic habitat in the Elk River. When generating electricity, two large air blowers are used to protect water quality conditions in the TFH tailwater. These blowers force air into the water as it passes through the main turbine. If

total dissolved gas (TDG) levels approach target limit concentrations or if additional aeration is needed, TVA uses an oxygen-injection system in the forebay of Tims Ford Reservoir to help maintain the 6 mg/L minimum water quality criterion for dissolved oxygen for waters having a “trout stream” use designation. Tims Ford was also TVA’s first hydroelectric facility retrofitted with a small generating unit for the purpose of maintaining downstream minimum flows. Because the minimum flow turbine is now inoperable, TVA releases water through the sluiceway at the dam to maintain minimum flows when the large hydroelectric generation turbine is not operating.

As their name implies, boulder darters are typically found in moderately flowing pools or flowing areas among large, flat rocks relatively clean of silt or where there is large rubble from old collapsed bridge materials. The amount of this highly specific habitat in the tailwater is limited. Boulder darter distribution in the Elk River is further affected by both thermal characteristics of reservoir releases and siltation impacts from nonpoint agricultural sources. Because these darters live only two or three years, successful annual reproduction is critical. It is thought that the darters prefer less variable flows than they have been exposed to in the tailwater, temperatures between 16-20 degrees Celsius (60º-70º F) for spawning and warmer temperatures for growth of juveniles. Breeding season is typically May to June. Spawning occurs only in particularly defined, clean-swept crevices beneath large rocks in riffles, runs, or flowing pools. Laboratory investigations and field observations indicate narrowly defined requirements for shape, size, and orientation of the cavity (space beneath the rock) where spawning boulder darters deposit their eggs. Unlike many other darter species, whose larvae remain on the stream bottom after hatching, boulder darter larvae raise into the water column and drift with the current for a week or more before settling to the stream bottom to continue the bottom-dwelling existence as juveniles and adults.

Peaking hydropower operations cause fluctuations in water levels that de-water areas of suitable habitat, which can result in erosion of the riverbanks and exacerbate sedimentation, and increase habitat instability. Depending upon length of hydroturbine generation, a drop in the water temperatures resulting from water released through the hydroturbine can be detected many miles downstream of the dam. This can result in thermal shock to the boulder darter during the spawning season, and can also affect growth of young boulder darters. The species is not resilient to habitat changes; when spawning crevices under slab rocks become clogged with silt, the fish are no longer able to use that area.

The entire known range of the boulder darter in the Elk River is being affected by current operations and maintenance activities of Tims Ford Dam. Individuals are scattered throughout the middle and lower reach of the Elk River in areas still containing suitable habitat and appropriate water temperatures (i.e., from ERM 30 to about ERM 90). Boulder darters are found in a small reach of Richland Creek, tributary to the Elk River. Although boulder darters have recently been reintroduced into Shoal Creek, a viable, reproducing population has not yet been established in that stream. Recovery of the species to the point that it is no longer an endangered species is not likely to be achieved without the proposed operational changes at TFH.

Freshwater mussel species of concern downstream from Tims Ford Dam live in gravel/cobble habitats with moderately flowing waters. Five species of freshwater mussels that are federally listed as endangered occur in the Elk River system; cracking pearlymussel, shiny pigtoe, fine-rayed pigtoe, birdwing pearlymussel, and Cumberland

monkeyface. Two federal candidates, slabside pearlymussel and sheepnose, are also present in the Elk River.

Mussels release their larvae into the water column and use fish as a "host." Larvae attach to the gills or fins of one or a few specific species of fishes for several weeks, after which they drop to the stream bottom and become juvenile mussels. Factors likely hindering successful reproduction include water temperature fluctuations, excessive sedimentation, and possibly low densities (or absence) of appropriate fish hosts. Cold temperatures prevent adult mussels from releasing their larvae or from receiving the appropriate environmental triggers for reproduction. Silt and fine sediments keep juvenile mussels from developing into adults by clogging their gills and smothering them or covering the fine gravel or sandy habitats appropriate for settling juvenile mussels. Since the appropriate fish "host" species is needed for successful reproduction, ensuring the fishes' needs are met is also important to maintaining healthy mussel populations. Unlike their fish counterparts, it is believed that some species of freshwater mussels may live up to 100 years or more. For this reason, adult mussels can survive some hard times; however, too many years in a row with little or no successful reproduction has led to the decline of many species.

2.2. Alternatives

TVA has determined that from the standpoint of the *National Environmental Policy Act* (NEPA) there are two alternatives available for consideration: the No Action Alternative and the Adaptive Management Alternative. The Adaptive Management Alternative actually consists of many potential combinations of spilling, sluicing, or short periods of generating through the hydroturbine.

2.2.1. Alternative A – The No Action Alternative

Under this alternative, TVA would continue to operate TFH under historic multi-use guidelines established when the project was completed in 1970. These operations would maximize power production through generation during high demand periods and TVA would meet continuous minimum flow requirements of at least 80 cfs. No generation would occur on summer weekends in order to provide additional recreational opportunities below TFH.

Maximizing power production would result in generation through the hydroturbine that would continue to release high flows of cold water from the lower portion of the reservoir for intervals of 1 to 6 hours or longer, depending on the amount of water needing to be released to maintain reservoir operating guidelines. The duration, timing, temperatures, and rate of these flows would continue to result in conditions that adversely affect the endangered warm-water fish and mussels found in the Elk River downstream of Tims Ford Dam, and would violate the USFWS Biological Opinion requirements. When generating, TVA would continue to meet the established dissolved oxygen criterion appropriate for trout of 6 mg/L through turbine air injection and oxygen injection. Operational activities would be maintained within the flood guide. In a flood situation, the large unit could be used around the clock to help evacuate water from the reservoir and restore the pool level to below flood-guide conditions. In a drought, there could be lengthy periods of no turbine releases; however, minimum flows would continue to be maintained for water quality, habitat, and water supply, and would likely be released by spilling or sluicing.

2.2.2. Alternative B – The Adaptive Management Alternative

Under this alternative, TVA would seek to balance improved habitat for federally listed aquatic species (i.e., the boulder darter, shiny pigtoe, fine-rayed pigtoe, birdwing pearlymussel, Cumberland monkeyface, and cracking pearlymussel) with other program interests such as flood protection, water supply, water quality, recreation, and power production.

As will be described in detail in Section 3.1.1.2, computer modeling of historic water years' flows and temperatures on the Elk River downstream of Tims Ford Dam was used to develop the Adaptive Management Alternative. It is TVA's determination that implementation of the changes described below would benefit populations of the boulder darter, shiny pigtoe, fine-rayed pigtoe, birdwing pearlymussel, Cumberland monkeyface, and cracking pearlymussel by minimizing impacts from dam releases and improving habitat conditions in the Elk River. The existing trout fishery would remain viable (and may improve) in the upper Tims Ford tailwater.

Key elements of the Adaptive Management Alternative are as follows:

- TVA will adjust releases from Tims Ford Dam through a combination of spilling, sluicing, or generating to provide water temperatures appropriate for the warm-water endangered species and the trout by monitoring temperature throughout the tailwaters of Tims Ford Dam. The appropriate water temperatures vary seasonally. A predictive hydrothermal model (similar to those employed to ensure thermal compliance at TVA power plants) would be developed to plan releases on a weekly basis. Target temperature ranges are those suitable for trout immediately below Tims Ford Dam, transitioning to those ranges suitable for boulder darters and the mussels further downstream.

- To meet temperature goals, TVA may need to use combinations of sluicing and spilling non-generation flows from May 1 - October 15. Use of the large turbine would be limited during this period to shorter duration pulses than observed under previous No Action Alternative operations. Sluicing the minimum flows would ensure that temperatures in the upper tailwater do not become too warm for trout. During the May 1 to October 15 period, if there is adequate water supply, TVA would increase allowable non-generation flow at the dam to 200 - 300 cfs (possibly more) in order to move water through the system. A minimum flow of 80 cfs would continue to be implemented during low inflow conditions. Non-generation flows might vary to higher ranges in response to large rainfall events. The Adaptive Management process would be used to determine appropriate non-generation flows, with water supply needs and flood-protection needs being balanced against the needs of recreational users (anglers and small non-motorized watercraft) to access the river.

- There would be no change in the management of floods or other rain-induced high-flow events.

- TFH would be operated as in previous years from November through April.

- TVA, TWRA, and USFWS would monitor the effects of operations to evaluate whether or not implementation of the Adaptive Management Alternative improves habitat and water quality conditions upstream of Fayetteville to the point that boulder darter and listed mussel species could be re-introduced into this section of the river. If the planned changes do not provide sufficient benefit to these species, additional changes in dam operations or other mitigative measures may be necessary.

Under this adaptive management strategy, TVA would implement changes at TFH and monitor the effects of these changes. Monitoring information would be shared with the multi-agency working group formed as a result of the consultation (USFWS, 2006) Input from technical experts will help guide recommendations of the multi-agency working committee. The multi-agency working committee exists to assess operational changes and their effects, and to make recommendations to TVA based on adaptive management techniques for refinement of changes at TFH if the original changes fail to produce the desired habitat, water quality improvements, and biological responses. TVA would also continue to work with public and private landowners to improve habitat conditions on public and private lands on the Elk River and its tributaries. To the extent resources permit, TVA would also continue to provide technical assistance to the efforts of grass roots watershed conservation organizations and landowners in the Tennessee and Alabama portions of the Elk River.

The desired future conditions for the Elk River below Tims Ford Dam are water temperatures and flow conditions which more closely simulate a free-flowing stream of this size in this part of the watershed in areas downstream of the existing trout fishery. This presumably would result in improved benthic habitat, population size, and distribution of the listed species. Included in this improved distribution of the listed species is an objective to allow for boulder darter and mussel populations to be re-established in areas upstream of their present geographic ranges. Since the listed species (particularly mussels) are unlikely to physically travel to the reaches not presently occupied within the 10-year period established by the USFWS Biological Opinion, populations would be reintroduced when habitat monitoring indicates sufficient improvements. Success of flow modifications would be evaluated by comparing monitoring results of tailwater temperatures with monitoring results of adjacent free-flowing streams (for representative temperatures) and by habitat and biological monitoring of the listed mussels and fish in the Elk River. Monitoring results would help guide future actions (i.e., the changes that result in adaptive management).

By providing more stable, seasonally appropriate water temperatures and flows, habitat and water quality conditions for sensitive aquatic species would be expected to improve downstream of Tims Ford Dam. TVA would continue to meet the established dissolved oxygen criterion of 6 mg/L in the tailwater and would manage water temperatures to benefit the trout fishery.

Operational activities would be maintained within the existing flood guide. During drought conditions, no large turbine generation would occur. Minimum flows would be met by sluicing or spilling, depending upon temperature requirements.

Through sluicing, spilling and short-duration generation pulses from May 1 through October 15, the objective of maintaining water temperatures appropriate for boulder darter and mussel reproduction and survival would be met with daily average minimum flows usually ranging from 80 to 300 cfs depending on weather conditions and water availability.

Releases would be evenly distributed throughout the week and would match the estimated weekly average flow to maintain Tims Ford Reservoir levels and provide municipal water supply for the town of Fayetteville, Tennessee.

The weekly average reservoir release volume and daily flow velocities at Fayetteville, Tennessee would remain unchanged compared to the No Action Alternative since Tims Ford Reservoir would be maintained at the same operating guidelines currently used for flood protection and water supply needs. Only the distribution of the Tims Ford Dam releases would change. The hourly flow rates in the Elk River downstream of Tims Ford Dam would tend to vary less over the course of the day. Lessened fluctuations in flow rates would also tend to favor the establishment of riparian vegetation, which would be expected to reduce bank erosion.

Five Aquatic Species Habitat and Water Quality Improvement Objectives are listed below. These will be discussed in further detail in Section 3.2.

Management Objective 1 - Improve water quality and habitat conditions for survival and successful reproduction of boulder darter and listed mussel species upstream of Fayetteville as much as feasible.

- Measure of success - Water temperatures, flow regime, and habitat conditions in this reach meet the requirements of boulder darter and mussels in this reach.

- Measure of success – Fish Index of Biotic Integrity (IBI) and Benthic Index of Biological Integrity (BIBI) scores improve in this reach over the current condition downstream of the trout zone.

Management Objective 2 - Improve habitat and water quality conditions so that reproduction, survival, and growth of boulder darter and listed mussel species are enhanced within their present geographic ranges.

- Measure of success - Water temperatures, flow regime, and habitat conditions meet the requirements of boulder darter and mussels in these reaches.

- Measure of success – Reproduction of boulder darter and listed mussel species is documented in these reaches.

- Measure of success – IBI and BIBI scores improve over current conditions in these reaches.

Management Objective 3 - Improve warm-water fish and benthic communities within the present geographic range of the boulder darter and listed mussel species.

- Measure of success – IBI and BIBI scores improve over current conditions in these reaches.

Management Objective 4 – Successfully reintroduce the boulder darter and listed mussel species in areas upstream of their present geographic range in the Elk River.

- Measure of success – Survival of boulder darter and listed mussel species is observed in this reach.

- Measure of success – Reproduction of boulder darter and listed mussel species is documented in this reach.

Management Objective 5 – Maintain dissolved oxygen levels and water temperatures suitable for the rainbow and brown trout fishery in the upper Tims Ford tailwater.

- Measure of success – Dissolved oxygen levels in dam releases would be maintained at 6 mg/L or above.

- Measure of success - Temperatures at monitoring stations in the trout zone show acceptable temperatures for trout.

The above management criteria would not be applied to the transition zone in which temperature conditions have not yet stabilized.

2.3. Comparison of Alternatives

Table 2-1 compares the No Action Alternative with the Adaptive Management Alternative. The 100 percent spill alternative is included only as one boundary to a large range of possible water release options, not as a likely alternative from TFH.

2.4. The Preferred Alternative

TVA's preferred alternative is the Adaptive Management Alternative.

2.5. Summary of TVA Commitments and Proposed Mitigation Measures

Adoption of the Adaptive Management Alternative would include the following commitments and mitigation measures:

1. TVA would monitor temperature throughout the tailwater to evaluate the impacts of operations. These data would be used to evaluate the effectiveness of implementing the Adaptive Management Alternative and to provide input for adjustments needed in operations.

2. TVA would monitor physical and biological conditions throughout the tailwater to evaluate the impacts of operations. These data would be used to evaluate the effectiveness of implementing the Adaptive Management Alternative and to provide input for adjustments needed in operations.

3. TVA (in cooperation with USFWS, USGS, TWRA, and ADCNR) would conduct surveys of the Elk River between Tims Ford Dam and Fayetteville to identify areas that contain suitable habitat for the boulder darter and the listed mussel species that occur in the Elk River.

4. TVA (in cooperation with USFWS, USGS, TWRA, and ADCNR) would monitor existing boulder darter populations in the Elk River to assess and document viability of these populations and document any increased reproductive success.

Table 2-1. Comparison of Alternatives Based on Computer Modeling of Historic Flows and Temperature Information (Modeled With 100 Percent Spill)

	Water Temperatures Downstream of Beans Creek (ERM 119.3)						Flow Variability	Erosion	Effect on Trout Fishery
	May	June	July	August	September	October			
No Action Alternative	Temperatures do not meet criteria. T < 20°C. Temperature drops >10°C when turbine is operated. Minimum temperatures ~10°C.	Temperatures do not meet criteria. T < 20°C. Temperature drops >10°C when turbine is operated. Minimum temperatures ~10°C.	Temperatures do not meet criteria. T < 20°C. Temperature drops >10°C when turbine is operated. Minimum temperatures ~10°C.	Temperatures do not meet criteria. T < 20°C. Temperature drops >10°C when turbine is operated. Minimum temperatures ~10°C.	Temperatures do not meet criteria. T < 20°C. Temperature drops >10°C when turbine is operated. Minimum temperatures ~10°C.	Temperatures do not meet criteria. T < 20°C. Temperature drops >10°C when turbine is operated. Minimum temperatures ~10°C.	Highly variable year-round. Turbine usually operated for morning and evening electrical peaks of 3 - 6 hours Monday - Friday. No generation on summer weekends	Peaking operation contributes to erosion by saturating shoreline soils and inundating vegetation resulting in loss of soils and vegetation	No change where river temperatures already exceed 20°C during summer at and downstream of ERM 119
Meets Habitat Improvement Objectives?	NO	NO	NO	NO	NO	NO	NO	NO	NO
Adaptive Management - Alternative	Temperatures meet criteria	Temperatures vary between 17°C and 22°C. This temperature range is 1°C to 4°C below criteria for entire month	Begin July: 17°C< T < 22°C. End of July: 20°C< T < 22°C Temperatures approach criteria by the mid-month and meet for the latter 1/2 of the month	Begin August: 20°C< T < 22°C. End of August: 22°C< T < 25°C. Temperatures within boulder darter criteria for most of the month	Release temperatures meet criteria for entire month	Release temperatures meet criteria for entire month - releases begin to cool as surface temperatures cool	Much more stable flows May - October - adjusted 1 or 2 times/week - Returns to peaking operation November - April	Stable flows during growing season allow growth of shoreline vegetation - decrease in erosion when compared to all other alternatives	Potentially beneficial to trout survival and growth due to decrease in temperature fluctuations
Meets Habitat Improvement Objectives?	YES	Approaching suitable conditions	YES in latter half of the month	YES	YES	YES	YES, for May to October. Flow still variable in winter due to peaking	YES, erosion decreased	YES

5. TVA would analyze effectiveness of the implementation of the Adaptive Management Alternative and revise the activities as necessary to support the five Aquatic Species Habitat Improvement Objectives listed in Section 2.2.2.

6. Implementing the Preferred Alternative would be an adaptive management process; and effectiveness in reducing impacts of TVA's operations at Tims Ford Dam to threatened and endangered species and meeting the stated aquatic species water quality and habitat goals would provide input needed to determine if future actions are needed. If it is determined that the operational changes described in this EA are not effective in improving habitat conditions and lessening impacts on threatened and endangered species, TVA would analyze alternative actions that could meet these objectives.

7. TVA would organize annual meetings of the Multi-Agency Working Group to review improvements to listed aquatic species habitat on the Elk River. With concurrence of the Multi-Agency Working Group, TVA could proceed with additional measures such as those described in Appendix D. Results of monitoring would be reported to USFWS, USGS, TWRA, and ADCNR yearly.

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CHAPTER 3

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1. Water Quality

3.1.1. Affected Environment

Background on the Elk River, Tims Ford Dam, Prior Efforts to Improve Water Quality, and Designated Uses
The Elk River is located in south-central Tennessee and flows from the western edge of the Cumberland Plateau in Grundy County west-southwest, where it joins the Tennessee River in Wheeler Reservoir. There are two dams on the upper reaches of the Elk River, the Elk River Dam which impounds Woods Reservoir at ERM 170, and Tims Ford Dam which impounds Tims Ford Reservoir approximately 36.7 miles downstream. The U.S. Army Corps of Engineers (USACE) operates the Elk River Dam. Since Elk River Dam is upstream of Tims Ford Reservoir, and since the proposed action would not affect the levels of Tims Ford Reservoir, no further mention of the Elk River Dam and Woods Reservoir are included.

Tims Ford Dam is a multipurpose dam located on the Elk River in Franklin County, Tennessee, in south-central part of the state. The dam is located at ERM 133.3. Tims Ford Dam is 175 feet high and stretches 1580 feet across the Elk River. Tims Ford Dam was completed on December 1, 1970, and the single hydroturbine started producing power in March 1972. The original capital benefits that formed the basis for construction of Tims Ford Dam are listed in Table 3-1.

Table 3-1. Tims Ford Project Original Capital Benefits (in millions)

	Capital Benefits (in millions of dollars)	Percentages
Recreation	27.0	47.3
Flood Control	7.8	13.7
Shoreline Development	7.8	13.7
Power	6.6	11.6
Fish and Waterfowl	5.05	8.8
Water Supply and Water Quality Control	2.05	3.6
Commercial Fishing	0.8	1.4
	57.1	100.0

The Tims Ford Project on the Elk River, Tennessee Valley Authority, Planning Report No. 54-100, Knoxville TN, March 1965.

As can be seen in Table 3-1, the greatest potential benefit for construction of Tims Ford Dam was recreation. To accommodate the objective of recreational use of Tims Ford Reservoir, a minimum reservoir pool between elevation 888 and 883 feet above mean sea

level (msl) is maintained, when possible, from May 1 through October 15. In drought years, however, the pool level may be lower, as it was in 2007. This can be seen in Figure 3-1.

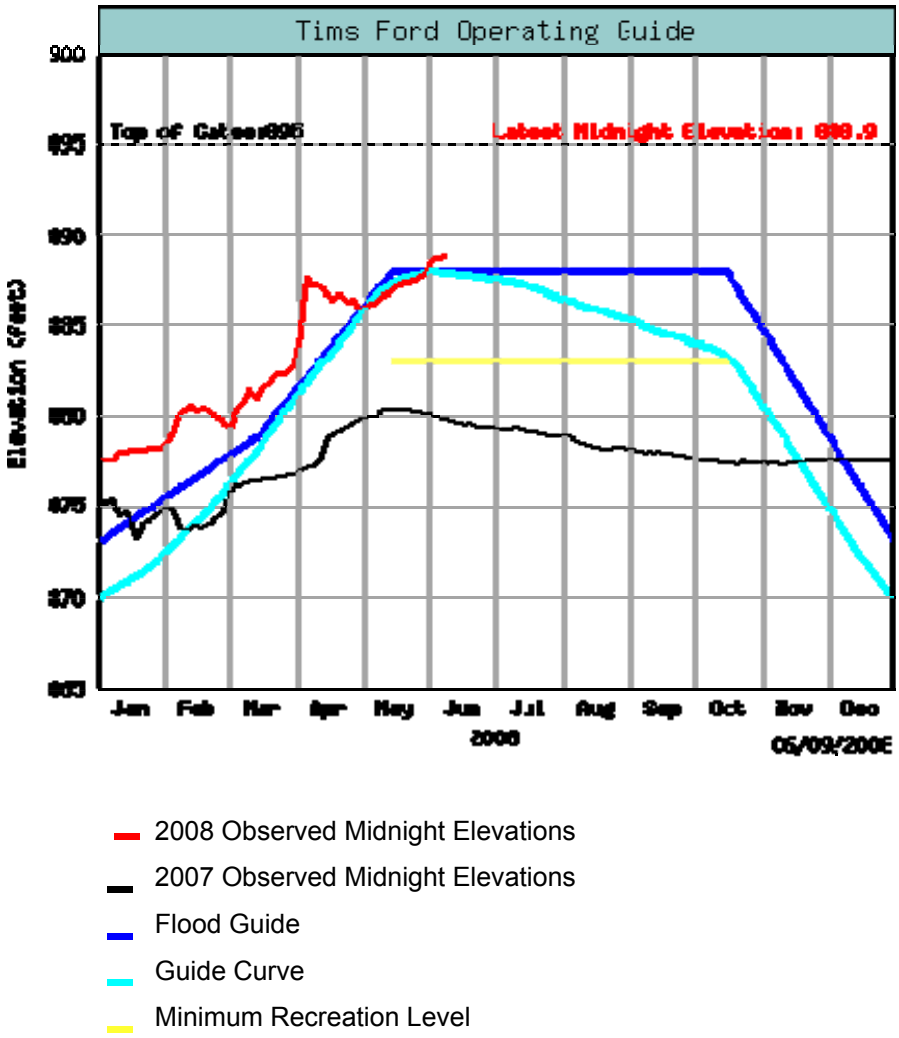


Figure 3-1. Tims Ford Operating Guide

Recreation in the tailwater below the dam is also important to the region, as people are drawn to the area for trout fishing and floating down the river in kayaks or rafts. Several commercial outfitters run float trips in the tailwater. The trout fishery below the dam is stocked by TWRA and can be maintained because Tims Ford Dam releases cold water. Tims Ford Reservoir varies from about 125 to 140 feet deep in the forebay (the area immediately upstream of the dam). During winter, water flowing into Tims Ford Reservoir is cold, roughly 40 to 50 degrees Fahrenheit. Cold water is dense water. When warm weather returns in spring and summer, water flowing into Tims Ford is warmer, roughly 60 to 70 degrees Fahrenheit. Warm water is less dense than cold water. While some mixing of the cold and warm water masses occurs, generally speaking, the masses retain their original warm or cold temperature. This phenomenon is termed thermal stratification. The warm, less dense water entering the reservoir in spring flows on top of the cool, denser

water and, more or less, stays there. Another component of thermal stratification is that as the water layers become warmer, they are less likely to mix with each other. The result of these characteristics of water is that Tims Ford has a large mass of cold or cool water near the bottom of the reservoir, at the level of the intake of the turbine and the sluice. The only way to change the temperature of water leaving Tims Ford Reservoir is to remove water from a layer at an elevation different from the intake. That is one reason why water is sometimes released from the spillway. The hydroturbine draws approximately 3800 cfs of flow from the cold layer near the bottom of the water column.

Native animal species historically found in the Elk River below Tims Ford Dam are less tolerant of cold water than trout. Extreme variations in flow and temperature resulting from operation of the turbine at Tims Ford Dam adversely affect native fish and mussel populations. Some species have experienced severe declines or have been entirely eliminated from the Elk River.

Until recently, releases from Tims Ford Dam could come from four different sources: the large hydroturbine, the small hydroturbine, the sluice, and the spillway. In 1987, Tims Ford was TVA's first hydroelectric facility retrofitted with a small generating unit to maintain instantaneous downstream minimum flows. Installation of the small turbine was a result of TVA's Reservoir Release Improvements (RRI) program recommendations for improving habitat for aquatic creatures.

Water released from Tims Ford Dam during normal hydropower operations passes through the large hydroelectric turbine, having a maximum generating flow capacity of approximately 3800 to 4000 cfs. When the large hydroturbine is not in use, water is released through the sluice or spillway to maintain minimum flows.

Before the RRI Program, the first five to 10 miles of the Tims Ford tailwater were generally inhospitable to fish (including trout) and other aquatic life due to dry channel conditions when the turbine was not in use. When the large turbine was in use, the dissolved oxygen (DO) content of the releases was near zero for much of the summer and fall. As part of the RRI program, both the small hydroturbine and a DO augmentation system were installed.

The RRI program actually made four modifications to improve the quality of the aquatic environment below the dam. The addition of (1) the small hydro unit, (2) a penstock oxygen injection system, (3) air injection into the large hydro unit via a blower, and (4) air injection into the small hydro unit via an air compressor. The smaller, minimum flow turbine was permanently damaged as a result of flooding of the powerhouse in May 2004. The minimum flow has been provided via the sluice since that time.

In 2005, a forebay aeration system was installed to replace the penstock aeration system. The new aeration system, which includes a 21,000 gallon oxygen (O_2) tank and 12,000 feet of new diffuser line, operated an average of 157 days per year, 2005 through 2007. Based upon data collected in grab samples during 2005-2007, DO levels in the tailwater remained at or above the 6.0 milligrams per liter (mg/L), DO criterion for trout streams. Tailwater temperature averaged 9.6 °C (49.3 °F), with a maximum of 16.6 °C (61.7 °F), in grab samples collected April through December of 2005 through 2007.

The designated uses for the Elk River above Tims Ford Dam, which includes Tims Ford Reservoir, are domestic water supply, industrial water supply, fish and aquatic life, recreation, livestock watering and wildlife, and irrigation. From Tims Ford Dam to ERM 90.5 (Fayetteville, Tennessee) the Elk River has all of the above designated uses plus the designated use as a trout stream. From Fayetteville, Tennessee, down to the confluence with Wheeler Reservoir of the Tennessee River, similar designated uses apply as with the upper reaches. Table 3-2 summarizes the designated uses of the Elk River.

Table 3-2. Designated Uses of the Elk River

Description of Reach of the Elk River	Domestic Water Supply	Industrial Water Supply	Fish and Wildlife	Recreation	Livestock Watering and Wildlife	Irrigation	Navigation	Trout Stream
ERM 133.3 (Tims Ford Dam) to Origin	X	X	X	X	X	X		
ERM 90.5 to ERM 133.3 (Tims Ford Dam)	X	X	X	X	X	X		X
ERM 36.3 to ERM 90.5	X	X	X	X	X	X		
Tenn-Ala State Line (ERM 33.6) to ERM 36.3	X	X	X	X	X	X	X	
Alabama Highway 99 to Tenn-Ala State Line (ERM 33.6)	X		X					
Tennessee River (Wheeler Reservoir to Alabama Highway 99			X	X				

TVA maintains an 80 cfs minimum flow at Tims Ford Dam both to improve water quality in the tailwater reach and to ensure that the Fayetteville Water System has the approximately 120 cfs flow needed for their intake. The remaining approximately 40 cfs comes from inflowing streams between Tims Ford Dam and Fayetteville. Limestone County Water Authority (LCWA) has an existing municipal intake, and has indicated that they intend to apply for a new intake farther downstream. Athens Utilities has an existing intake on the Elk River. Giles County Southern Water Authority is considering adding a possible intake on the Elk River.

The Trout Stream use designation means that the Elk River in that reach is a TWRA managed (stocked) trout fishery. Tennessee's water quality standards for this designation require DO to be greater than or equal to 6.0 mg/L and maximum water temperatures to remain below 20°C. However, as will be discussed in Section 3.1.1.2, in the summer, the Elk River from near river mile 119 downstream to river mile 90.5 does not meet temperature criteria. During low flow releases, the temperature warms above 20°C.

In 2005 (the year of TVA's most recent biological survey), the location nearest Tims Ford Dam (2.5 miles downstream) scored "poor" based on both the fish IBI (a measure of the warmwater fish community) and Ephemeroptera/Plecoptera/Trichoptera (EPT) scores and

"fair" for the macroinvertebrate BIBI. Comments on the assessment indicated severe impairments due to cold releases from the dam. Biological metric scores farther downstream indicated moderate impairment.

The Elk River below Tims Ford Dam is listed on Tennessee's May 2008 Proposed Final 303(d) list as impaired due to thermal modification and habitat loss due to stream flow alteration caused by the upstream impoundment of Tims Ford Dam. Other reaches of the Elk River which are listed as impaired on the Tennessee and Alabama 303(d) lists appear in Table 3-3.

Despite the impairments listed in Table 3-3, several reaches of the Elk River are included on the State of Tennessee list of Exceptional Tennessee Waters and Outstanding National Resource Waters (Table 3-4). The Exceptional Tennessee Waters designation means that under most circumstances, activities which would lead to degradation of the waterbody would not be permitted. (TDEC, 2007)

3.1.2. Water Quality Environmental Consequences

3.1.2.1. No Action Alternative

Under the No Action Alternative, TVA would continue to operate TFH under historical multi-use guidelines established when the project was completed in 1970 and as modified over the years to include minimum flows. These operations would maximize power production through generation during high demand periods. Continuous minimum flows of at least 80 cfs in the tailwater would be met.

No generation would occur on summer weekends in order to provide recreational opportunities below TFH. TFH would be operated in accordance with flood guides, water supply needs, and to maintain the recreation pool elevation target levels in Tims Ford Reservoir.

Maximizing power production would mean generation would continue to release high flows of cold water from the lower portion of the reservoir for intervals of 1 to 6 hours or longer depending on the amount of water needed to conform to reservoir operating guidelines. The duration, timing, temperatures, and rate of these flows would continue to provide less than optimal conditions for sensitive aquatic species in the Elk River and could depress population sizes of all native aquatic species.

Minimum flows provided by sluicing between generation periods would not be enough to meet the requirements imposed by the 2006 Biological Opinion. When generating, TVA would continue to meet the established dissolved oxygen criterion of 6.0 mg/L through turbine air injection and oxygen injection. Operational activities would be maintained within the flood guide. In a flood situation, the large unit would be used around the clock to help evacuate water from the reservoir and restore the pool level to below flood-guide conditions. In a drought, there would be lengthy periods of no turbine releases; however, minimum flows via sluicing or spilling would continue to maintain water quality, habitat, and water supply in the Tims Ford tailwater.

Table 3-3. Elk River Waterbodies Listed as Impaired from Tennessee and Alabama 303(d) Lists

Waterbody ID	Impacted Waterbody	County	Miles /Acres Impaired	Cause (Pollutant)	Pollutant Source
TN060003 036_1000	Woods Reservoir (Elk River impounded by Elk River Dam)	Franklin Coffee (Tennessee)	3908 ac	PCBs	Contaminated Sediments
TN060003 035_1000	Elk River Below Elk River Dam	Franklin Coffee (Tennessee)	6.2	Habitat loss due to stream flow alteration	Upstream Impoundment
TN060003 015_1000	Elk River from Tims Ford Dam to the confluence with Beans Creek near the Moore, Lincoln, and Franklin County Lines	Franklin Moore (Tennessee)	15.4	Thermal Modification Habitat loss due to stream flow alternation	Upstream Impoundment
TN060003 010_1000	Elk River (Begin at confluence with Mulberry Creek to the North of US Hwy 64. End at the Norris Creek - Elk River confluence south of US Hwy 231 and just east of the US Hwy 231- US Hwy 431 intersection in Fayetteville, TN	Lincoln (Tennessee)	13.91	Escherichia coli	Pasture grazing
TN060004 013_1000	Elk River	Giles (Tennessee)	7.4	Escherichia coli	Undetermined source
AL060300 04-0105-101	Elk River from Anderson Creek to Tennessee River (Wheeler Reservoir)	Limestone Lauderdale (Alabama)	1569.21 ac	pH, Nutrients	Pasture grazing, Non-irrigated crop production

Table 3-4. Reaches of the Elk River Listed by the State of Tennessee as Exceptional Tennessee Waters and Outstanding National Resource Waters

HUC	Watershed Name	Waterbody	County	Description	Basis for Inclusion	From Lat	To Lat	From Long	To Long
06030003	Elk-Upper	Elk River	Franklin	From Rock Creek to Elk River dam.	Federal endangered Pale Lilliput and Little-wing Pearlymussel	35.2536	35.2975	-86.1412	-86.0967
06030003	Elk-Upper	Tims Ford Reservoir	Franklin	Portion surrounded by Tims Ford State Park.	Tims Ford State Park	-	-	-	-
06030003	Elk-Upper	Woods Reservoir	Franklin	Portion surrounded by Woods Reservoir Wildlife Refuge.	Woods Reservoir Wildlife Refuge	-	-	-	-
06030003	Elk-Upper	Elk River	Giles, Lincoln	From Sinking Creek to confluence of Beans Creek.	Federal endangered Birdwing Pearlymussel, Fine-rayed Pigtoe, Shiny Pigtoe, Cumberland Monkeyface, Cracking Pearlymussel, Boulder Darter, and state threatened Ashy Darter.	-	-	-	-
06030003	Elk-Upper	Elk River	Grundy, Franklin, Coffee	From Woods Reservoir to headwaters.	Federal endangered mussels identified in TDOT ARAP permit for two bridges on I-24. Woods Reservoir Wildlife Refuge, state endangered Sharp's Lejeuna.	35.3142	35.3602	-85.9887	-85.8538
06030004	Elk-Lower	Elk River	Giles	From Tennessee state line to boundary of 06030003.	Federal endangered Boulder Darter and threatened Snail Darter.	-	-	-	-

Implementation of this alternative would lead to continued impairment of the tailwaters of Tims Ford Dam due to the temperature and flow fluctuations of the tailwater. The dark blue line in Figure 3-2 illustrates the variations in flow which routinely occur under the No Action Alternative. As can be seen in Figure 3-2, the flow varies from the minimum flow of 80 cfs to about 3800 cfs when the hydroturbine is in use.

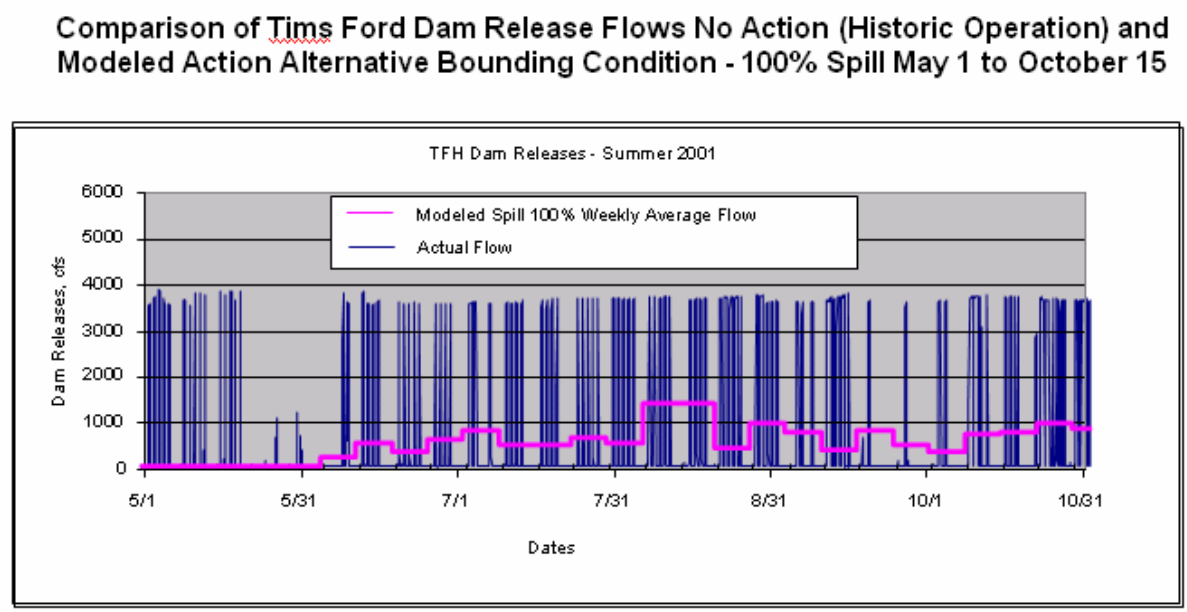


Figure 3-2. Summer 2001 Actual Tims Ford Dam Release Flows and Modeled Action Alternative Bounding Condition (100 Percent Spilling of Average Weekly Flow)

TWRA currently stocks the tailwaters of Tims Ford Dam with rainbow trout and brown trout. The upper limit temperature for the survival of rainbow trout is 25°C (USFWS 1984). Actual monitoring data from the Elk River below Tims Ford Dam for May through November 2007 for 7 monitoring stations are shown in Figure 3-3. Three of these monitoring stations, ERM 124, ERM 119, and ERM 105 are within the reach of the Elk River below Tims Ford Dam designated as trout stream by Tennessee Department of Environment and Conservation (TDEC). As can be seen in Figure 3-3, in 2007, the water temperature at ERM 124 met the 20°C trout stream temperature criterion all summer. ERM 105, about 14.5 miles upstream of the lower boundary of the reach of the Elk River below Tims Ford Dam designated as trout stream, consistently exceeded the 20°C trout stream temperature criterion from late May until early October, and even exceeded the 25°C upper temperature limit for survival of rainbow trout during the warmest part of August. The water temperatures at ERM 119 only exceeded 20°C during the extremely hot period in August. While 2007 was a record drought year which also included some extremely hot air temperatures, temperature data derived by computer modeling of release data from other years also indicates that the Elk River from ERM 119 and other points farther downstream does not meet the 20°C trout stream temperature criterion. Figure 3-6 includes computer models of the May to October water temperatures at Old Dam Ford (ERM 119.3) for actual releases in 2001 and 2004. Temperatures routinely fluctuated by 10°C or more, and frequently exceeded the 20°C trout stream temperature criterion. The Elk River at ERM 119.3 exceeded 25°C three times in 2001 and four times in 2004. Both rainbow and brown trout need stable temperatures to

thrive (USFWS 1984 and 1986). Rapid temperature fluctuations stress the trout populations.

Thermal stress is even more extreme at ERM 97.3, which is only 6.8 miles upstream of the lower boundary of the reach designated as trout stream (Figure 3-3). For both 2001 and 2004, the water temperature at ERM 97.3 frequently exceeded 20°C. In 2001 and 2004, there were 11 and 7 episodes of water temperatures exceeding 25°C, respectively. Table 3-5 illustrates percentages of the time in the summer when the water temperature in Elk River reaches between ERM 119.3 and ERM 97.3 currently do not meet trout stream temperature criteria. Clearly, the Elk River downstream of ERM 119.3 does not fully support its designated use as a trout stream. As the temperatures and flows resulting from current operations also do not support the endangered native fish and mussel species, the Elk River below Tims Ford Dam does not fully support its fish and wildlife use. Implementation of the No Action Alternative would continue these problems.

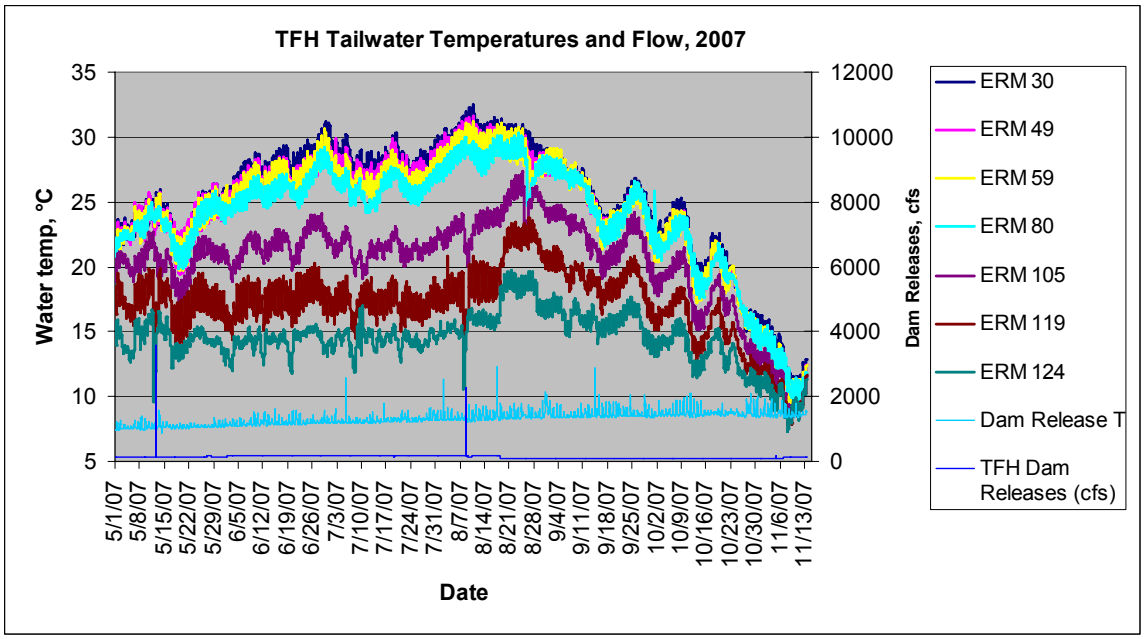


Figure 3-3. Elk River Below Tims Ford Dam Water Temperatures and Dam Releases 2007 (Sluicing Except for Two Short Generation Periods)

Table 3-5. Percent of Time Temperatures Exceed 20°C and 25°C for Elk River Between Old Dam Ford (ERM 119.3) and Fayetteville (ERM 97.3) for No Action Alternative

Percent of Time May 1 to Nov 1 Water Temperature	ERM 119.3	ERM 105	ERM 97.3
2007[1]			
Exceeded 25°C	0.0%	4.1%	Not Available
Exceeded 20°C	11.0%	71.5%	Not Available
2004[2]			
Exceeded 25°C	0.8%	Not Available	5.6%
Exceeded 20°C	29.7%	Not Available	49.2%
2001[2]			
Exceeded 25°C	0.8%	Not Available	5.5%
Exceeded 20°C	34.3%	Not Available	40.0%

Notes:
1 = Actual Monitoring Data
2 = Computer Model Results

3.1.2.2. Water Quality Action Alternative

Adaptive Management Alternative
Under the Adaptive Management Action Alternative, TVA would change operations as discussed in Chapter 2, to meet temperature and flow objectives. Tims Ford Dam would continue to operate in accordance with flood guides, water supply needs, and to maintain the recreation pool elevation target levels in Tims Ford Reservoir. Between May and November, use of the large hydro turbine would be limited as necessary to support temperature and flow stabilization goals. Limits on the use of the large hydroturbine would probably take the form of shortening generation periods so that non-generation flows could be varied from 80 to 300 cfs to determine an optimum flow rate for the endangered species, trout, and recreational users.

From May through November, TVA would determine allowable releases from Tims Ford Dam by monitoring temperature throughout the tailwaters of Tims Ford Dam. A predictive hydrothermal model (similar to those employed to ensure thermal compliance at TVA power plants) would be developed to plan releases on a weekly basis. Temperature ranges suitable for trout immediately below TFH would transition to temperature ranges (Table 3-6) suitable for the boulder darter downstream.

Table 3-6. Target Temperatures for Boulder Darters in the Elk River

Month	Temperature (^{o}C)	Temperature (^{o}F)
March	11	52
April	14	57
May	19	66
June	21	70
July	23	73
August	24	75
September	21	70
October	19	66

The location of the transition zone between the trout reaches and the endangered native species reaches would vary in size and location depending on the season of the year. For example, in May, the lowest suitable target temperature for boulder darters is 19°C, so the trout reach, the transition zone, and the endangered species reach would overlap in the area where the water temperature varied from 19°C to 20°C. In August, the trout reach would extend from Tims Ford Dam, downstream to where the water temperatures reach 20°C, then the transition zone would extend from the point where the water temperatures were 20°C to the point where the water temperatures reach 24°C. The location of these temperature ranges would move over the course of a day if sufficient water were available for brief periods of generation. If the available water supply is insufficient to support generation, the minimum flow would be sluiced as it was in 2007. As can be seen in Figure 3-3, in late August 2007, the trout reach extended from Tims Ford Dam (ERM 133) to approximately ERM 124. The transition zone extended from approximately ERM 124 to some unknown point between ERM 119 and ERM 105. Under this same scenario, the endangered species reach would begin at the unidentified point between ERM 119 and ERM 105 and extend downstream.

Data collected in the summer of 2007 that included two brief periods of generation showed that those brief periods of generation did not decrease water temperatures for extended periods of time, so studies involving short generation pulses are continuing. Long-term study and development of thermal control strategies for the Elk River below Tims Ford Dam may, in the future, lead to operational scenarios ranging from complete elimination of generation from the large hydro unit generator at TFH during warm weather months to a blend of short generation pulses, sluicing, and spilling. For the present, the Adaptive Alternative including limited use of the turbine, sluicing, and spilling and increased non-generation flow-rate from May through November is estimated to offer the greatest probability of maintaining the trout fishery and successfully restoring warm season tailwater temperatures and more stable flows to the Elk River below Tims Ford Dam

Potential Water Quality Impacts to Tims Ford Reservoir

Since the same reservoir levels would be maintained as with the No Action Alternative, no effect on reservoir levels would be expected from implementing the Adaptive Management Alternative. However, changing *where* the water is withdrawn from the reservoir could have some impacts on water temperatures in the reservoir. Comparisons of reservoir water temperatures and DO for actual conditions in June, July, August, and September 2001 versus the modeled hypothetical 100 percent spill option for the same year are shown in Figures 3-4 and Figure 3-5. This option represents the largest potential change from

present operations and was used only to illustrate the greatest potential impacts under the Adaptive Management Alternative. The year 2001 represents a fairly normal or average year in terms of precipitation and air temperature. Numerous reservoir water quality samples were taken in Tims Ford reservoir that year as part of TVA's valley-wide monitoring program.

In the spill-only simulation, more cool water remained in the bottom of the reservoir during the summer because the turbine was not used. Since more of the warm, upper level water was released in the simulation, less warm water remained near the top of the reservoir. The modeling results shown in Figures 3-4 and 3-5 indicate more dissolved oxygen in the forebay of Tims Ford Reservoir for longer periods of time for the most extreme possible release scenario option (spill only) than for the No Action Alternative. Thus, according to the model, no adverse impacts to the water quality of Tims Ford Reservoir would be expected from the implementation of the Adaptive Management Alternative.

Potential Water Quality Impacts to Tims Ford Dam Tailwaters

This discussion focuses on the potential effects of spilling or sluicing 100 percent of the weekly average flow to be spilled or sluiced May 1 through October 15. The scenario of no large unit generation brackets the universe of potential impacts of implementing the Adaptive Management Alternative. Figure 3-2 shows the actual summer 2001 Tims Ford Dam Releases and the modeled flows. Under this scenario, the maximum peak flow would have been about 1500 cfs, much less than the 3800 cfs flow associated with use of the large hydroturbine.

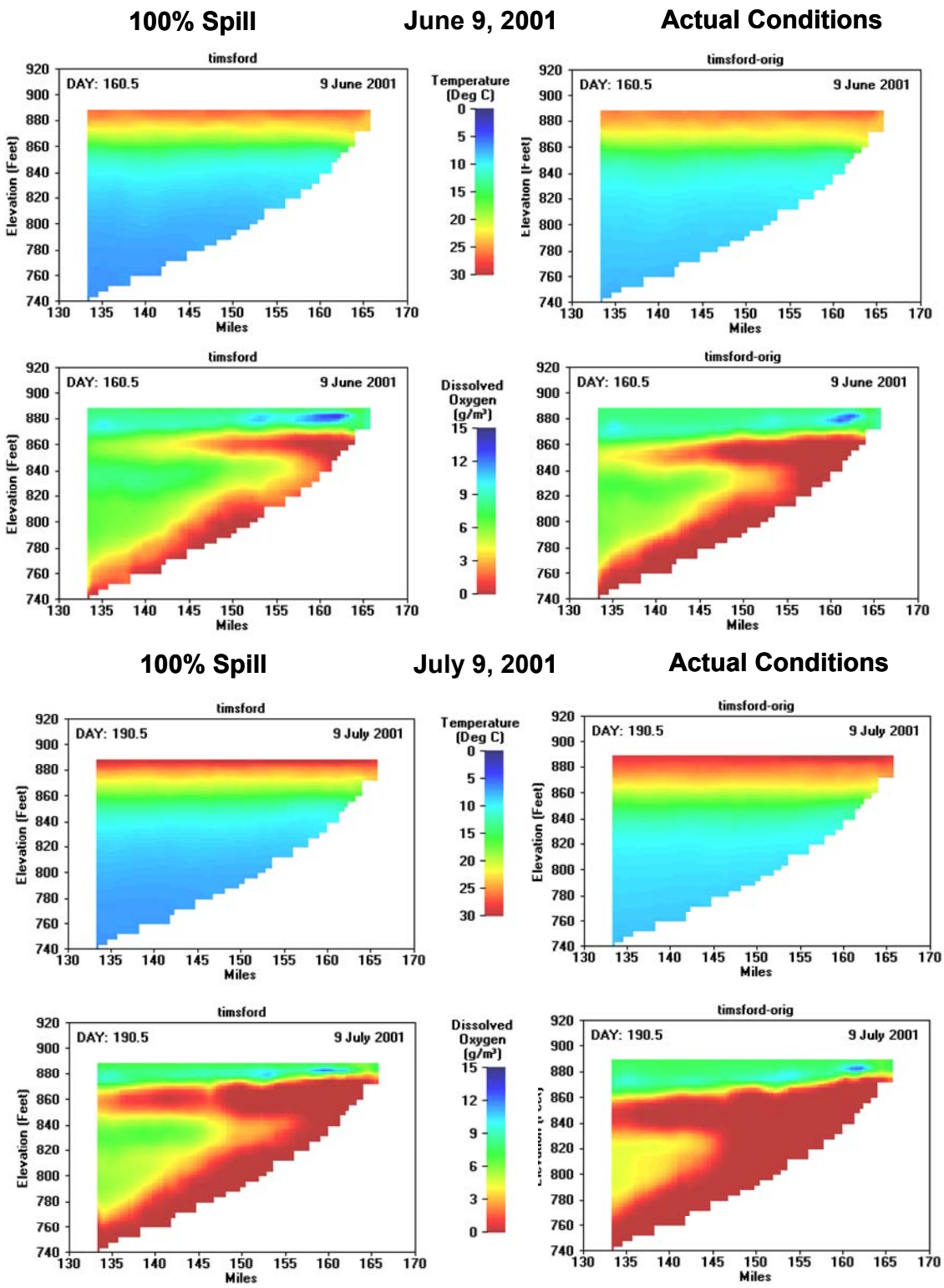


Figure 3-4. Reservoir Temperature and DO Conditions in June and July 2001 Modeled for 100 Percent Spill and Actual Conditions

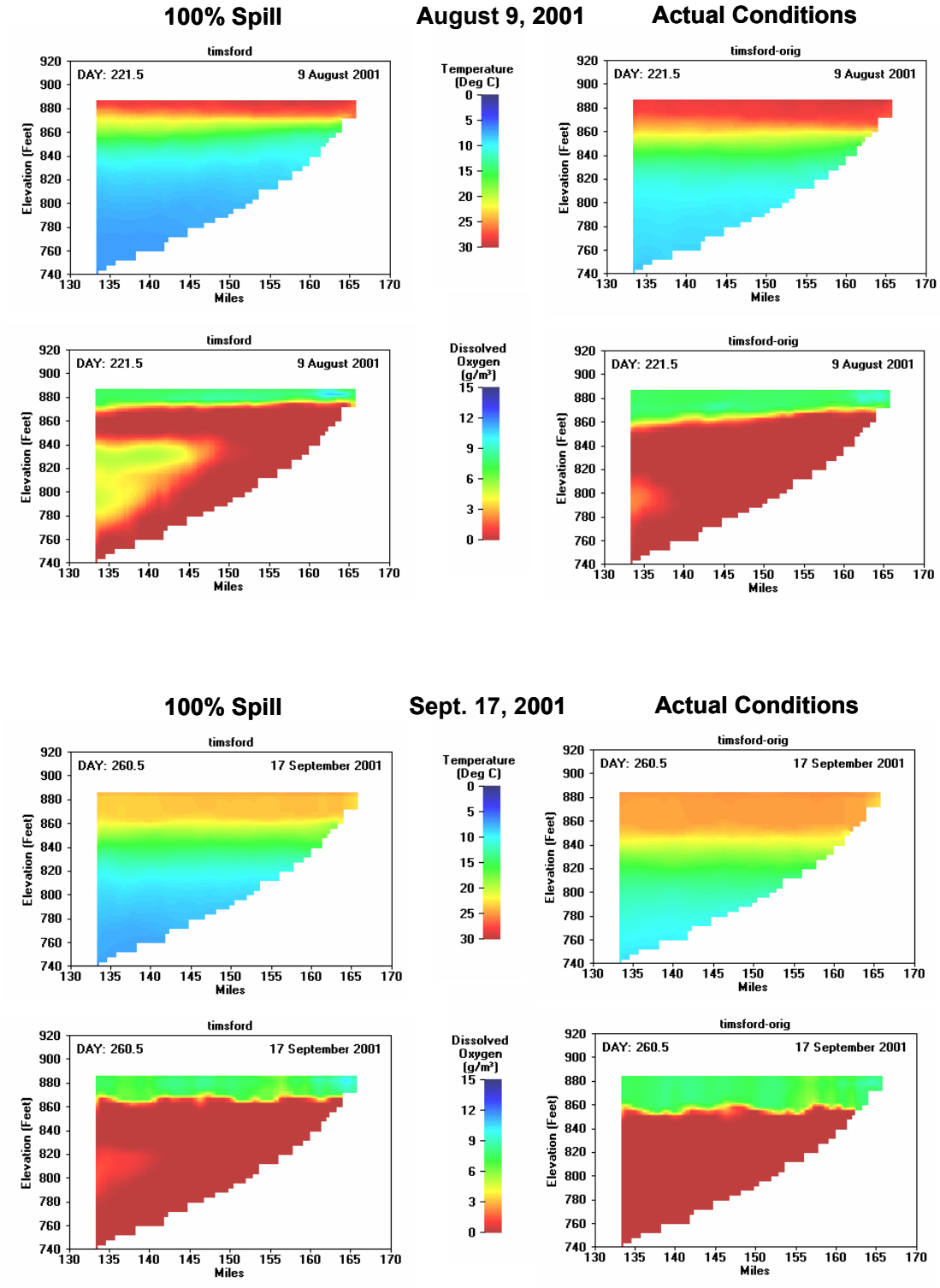


Figure 3-5. Reservoir Temperature and DO Conditions in August and September 2001 for 100 Percent Spill and Actual Conditions

Figure 3-6 compares the tailwater temperatures at ERM 119.3 from the No Action Alternative (actual releases) and spilling 100 percent spill of weekly average flows using 2001 and 2004 reservoir and climate conditions. Even with a hypothetical 100 percent spill, the June to mid-July tailwater temperatures are still slightly lower than optimum for the boulder darters at this locality. This is because the spillway pulls water from 35-40 feet below the water surface. While this water is warmer than turbine discharges, it is not as warm as the water nearer the surface of the reservoir. The spillway crest elevation is about 100 feet higher than the turbine or sluice elevation, and the spill water is warmer than the turbine or sluice water. Utilizing the spillway and sluice greatly reduces the temperature fluctuations in the river, reducing the thermal shock potential for the fish from a rapid decrease in water temperature.

At increasing distances from Tims Ford Dam, solar heat gain and warm surface water inflows tend to increase the temperature of the water. Figure 3-7 shows the temperatures for 2001 and 2004 at ERM 97.3, in Fayetteville, Tennessee. By the time the water released via spill reaches ERM 97.3 in Fayetteville, Tennessee, the water temperatures are nearly all within the range preferred by the boulder darter (Figure 3-7).

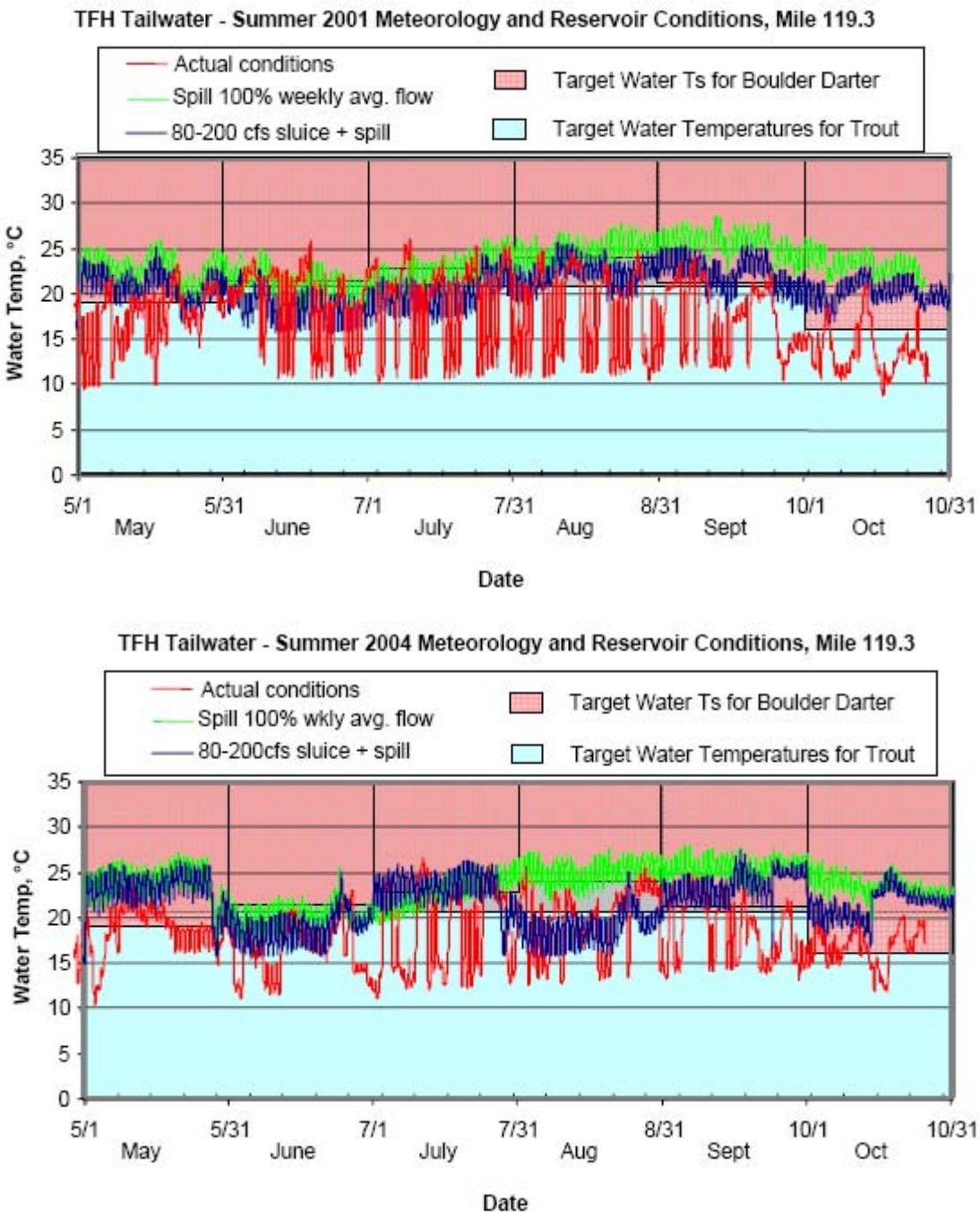
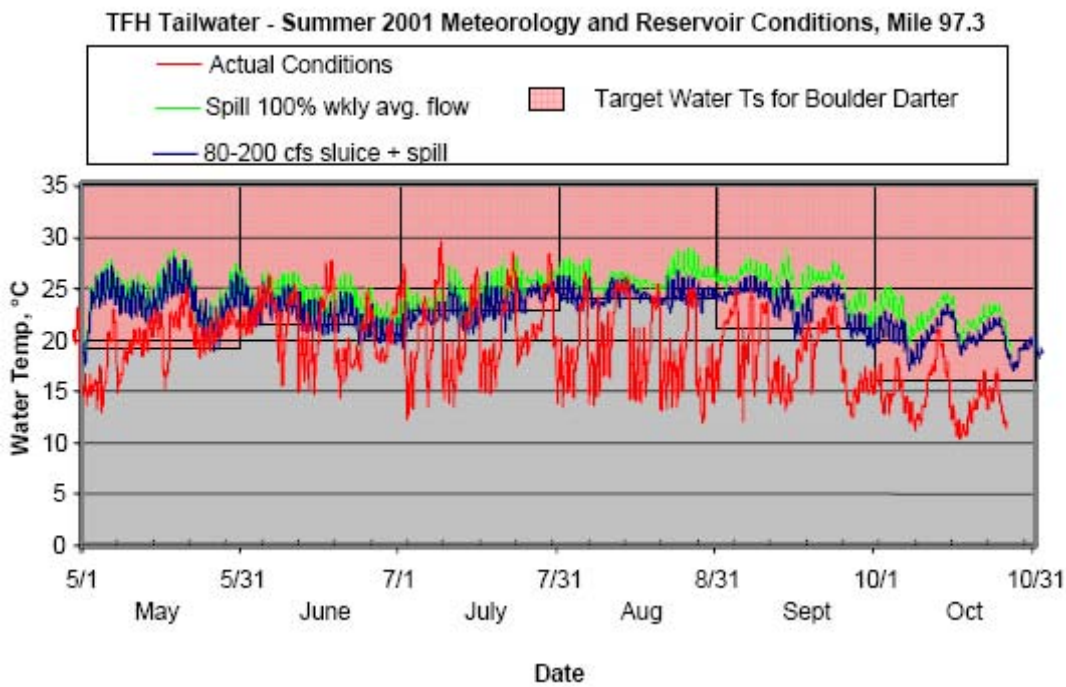


Figure 3-6. Tims Ford Hydro Tailwater Temperatures at ERM 119.3 for Actual Releases, Modeled 100 Percent Spill, and Modeled 80 to 200 cfs Sluice Plus Spill for Summers 2001 and 2004



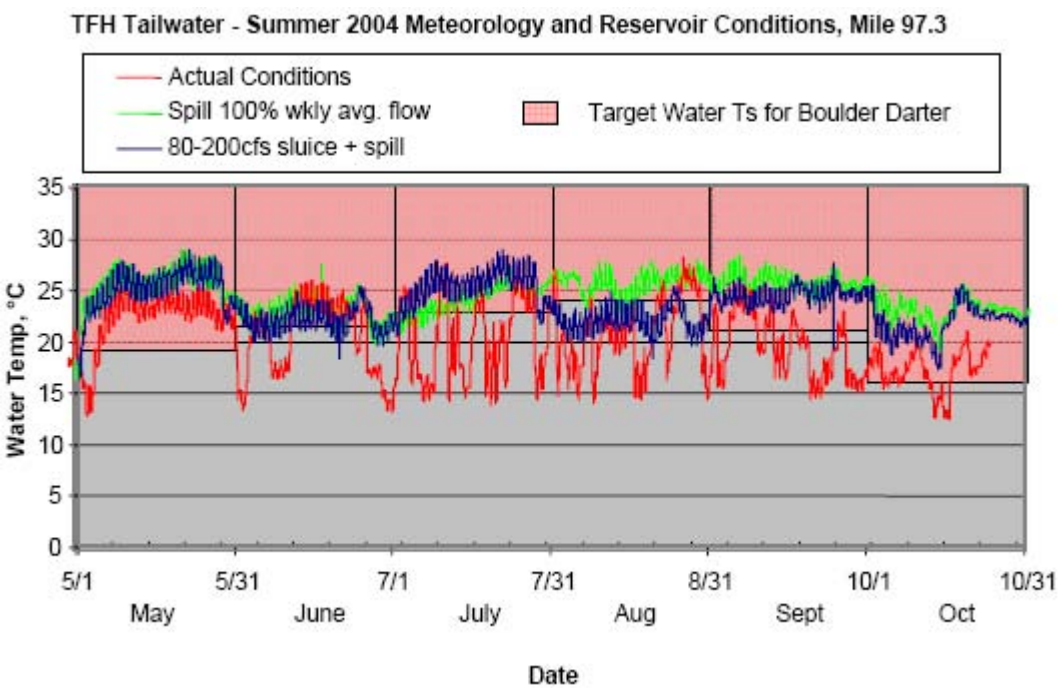


Figure 3-7. Tims Ford Hydro Tailwater Temperatures at ERM 97.3 for Actual Releases, Modeled 100 Percent Spill, and Modeled 80 to 200 cfs Sluice Plus Spill for Summers 2001 and 2004

According to these modeling results, water temperatures at ERM 128 would be within the range suitable for trout but not boulder darters until mid-July (Figure 3-8) even if 100 percent of releases were spilled. Since the reservoir temperatures at spillway elevation would be expected to exceed the 20°C required for a trout stream by mid-July, spilling 100

percent of the releases from Tims Ford Dam would not support the trout fishery. The blue line in Figure 3-8 shows the temperatures that would be expected if the sluice were used in combination with spilling to keep water temperatures closer to ranges appropriate for trout. Figure 3-3 illustrates how nearly 100 percent sluicing kept the water temperature at ERM 124 from exceeding 20°C under the extreme conditions of 2007. ERM 124 is four miles farther downstream than ERM 128, so water at ERM 124 would have an additional four miles of travel time to be heated by environmental conditions. Based on modeling results and 2007 data, use of the sluice alone or in combination with spilling and some limited use of the large turbine would be expected to maintain tailwater temperatures between Tims Ford Dam and ERM 119.3 to continue supporting the trout fishery.

The Adaptive Management Alternative would greatly reduce the extreme thermal and flow variability on the Elk River downstream of Tims Ford Dam. Simulated results from all blended spill and turbine alternatives show an improvement over existing conditions, which would be expected to benefit both the endangered species and the trout fishery in the upper portions of the tailwater. At present, little to no actual data exists to demonstrate the impacts to the reservoir from spillway releases. The spillway withdrawal zone may extend higher up in the reservoir than the modeled scenarios considered, producing warmer water temperatures than those shown in the modeled results. Preliminary findings indicate that pulsing the turbine in the summer may be essential to supporting the trout fishery. Further work is needed to determine the extent to which generation pulses may decrease the reach of the Elk River available for re-establishing the endangered species.

Under the Adaptive Management Alternative, a real-time temperature monitor would be installed at the upstream boundary of the reach being reclaimed for the endangered species. Temperature data transmitted from the real-time temperature monitor would be used to verify the temperature of the water entering the target reach against the flow/temperature model being used to predict water temperature responses to various adjustments in the combination of sluicing, spilling, and generating. Flow rates would be determined at least once per week (or more if precipitation events warrant) and adjusted as necessary to respond to changing conditions. Other TVA monitoring activities are described in Appendix C. The monitoring activities in Appendix C are subject to changes as necessary to meet temperature and habitat objectives.

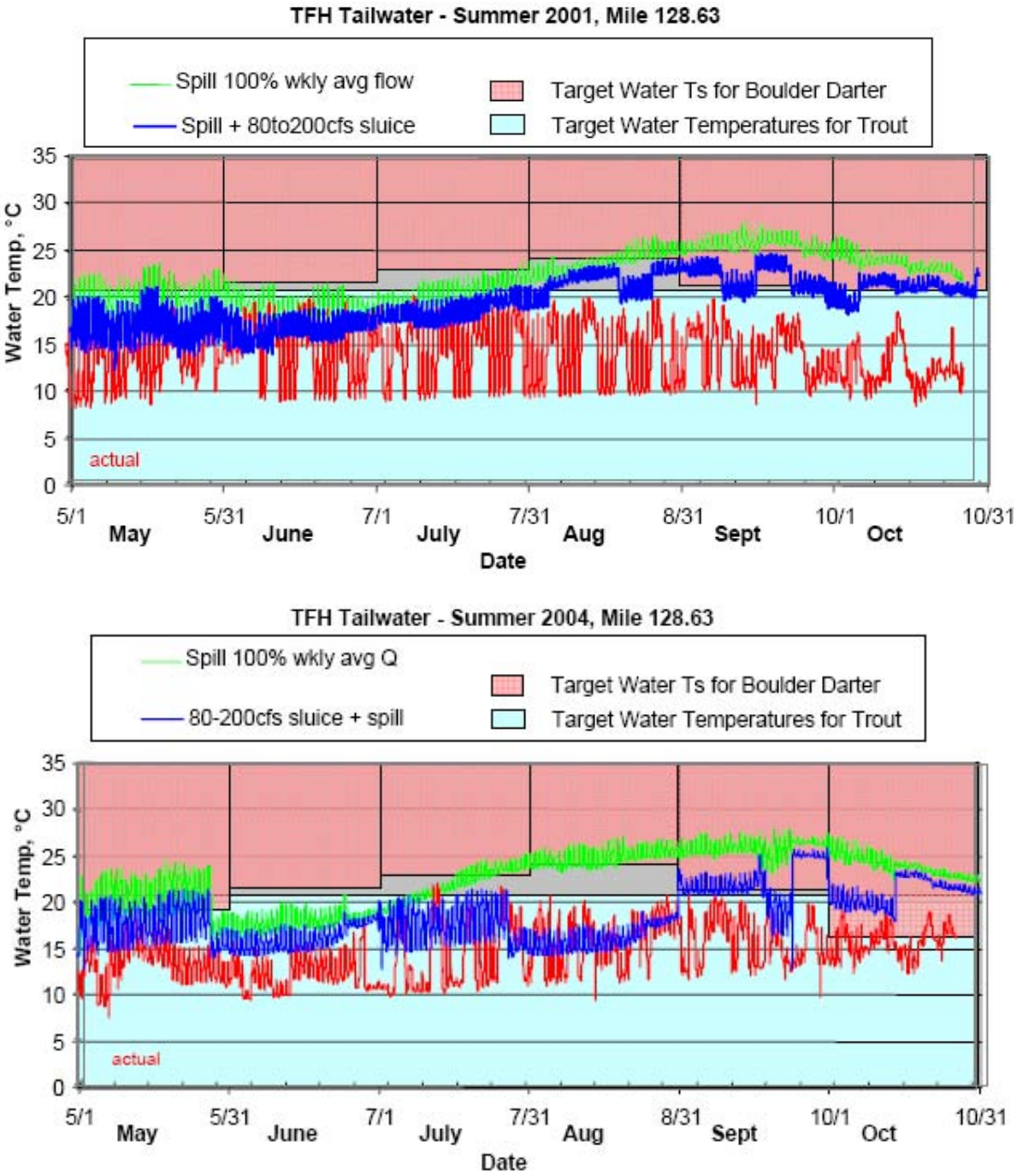


Figure 3-8. TFH Tailwater Temperatures at ERM 128.6 for Actual Releases, Modeled 100 Percent Spill, and Modeled 80 to 200 cfs Sluice Plus Spill for Summers 2001 and 2004

3.1.3. Water Quality Erosion and Sedimentation

3.1.3.1. Affected Environment

The form of natural stream channels evolves over time to balance water flow characteristics, sediment supply, and erosion rates to create a stable or dynamically stable system. Depth, width, and slope adjust to provide transport capacity that matches the flow regime and sediment supply. Vegetation growing on the banks protects underlying soil from flowing water and roots provide reinforcement to the soil mass. Changes in any of these factors make a stream channel less stable as net erosion or net sediment deposition force it to seek a new equilibrium.

The construction of a dam tends to reduce the sediment supply downstream of the dam by trapping sediment within the reservoir. If hydrology remained constant, this would likely lead to net channel erosion and bed degradation (downcutting) because there is nothing available to replace material after it is moved downstream by flowing water. Under these circumstances, the channel can enlarge laterally, and channel degradation can result in the banks being too steep to be stable, which in turn leads to failures of the stream bank. Erosion is most rapid on the outside of bends, where the momentum of the water creates greater stresses that cause erosion.

A dam operated for peaking power generation can accelerate these erosional processes. The area between the water surface elevation at no generation and the water surface during generation is alternately saturated and dried out once or twice each day and is inhospitable to vegetation growth. The death of vegetation in this zone exposes soil to erosion and which can lead to bank undercutting and collapse. In addition, operation for power generation means that the duration of flows that are high enough to accelerate erosion are increased.

A dam operated for flood control tends to reduce the impact of the factors that increase erosion in tailwaters. Reduction of the frequency and magnitude of peak flows reduces sediment transport capacity.

The Tims Ford tailwater section of the Elk River starts at the discharge from Tims Ford Dam at ERM 133.3 and extends to the Wheeler Reservoir pool at approximately ERM 21. The watershed area is about 529 square miles at the dam, and 1940 square miles at ERM 21.

The channel of the Elk River has a low gradient. The river loses 195 feet of elevation over 109 miles. The slope decreases from 0.063 percent near the dam to 0.017 percent at the downstream end, averaging 0.03 percent.

The Elk River has cut a meandering course through the rolling hills of the Outer Nashville Basin ecoregion. The ratio of the length of the channel to the length of the valley (sinuosity) is about 2.1. Limestone bluffs or boulders are common on the outside of the meander bends. The insides of bends are formed from material deposited by the river, and consist of alluvial soil or recently deposited material of mixed sizes (sand, gravel, and cobble).

The river valley is narrow but the alluvial soils of the bottom lands are suitable for agriculture, and these areas are used for both pasture and row crops. Steeper areas along the river corridor are generally forested.

Most of the river bank has at least some forested riparian buffer. Only three percent of the tailwater was considered to have an “inadequate” buffer, according to a study based on aerial photography (TVA unpublished data, 1996), although 51 percent was considered “marginal”.

A few scattered segments of stream bank that exhibit significant erosion can be observed. Most of these are on the inside of bends where there is little or no buffer between agricultural fields and the river. In most cases, bedrock or boulders limit erosion on the outside of bends. The effects of dam operation for peaking are evident through the upper part of the tailwater. The vegetation on the lower part of the bank is stunted or absent, and there is a tendency toward erosion and undercutting of the bank.

3.1.3.2. Environmental Consequences

Alternative A: No Action
If there were no change in operation, there would be no change in erosion trends in the Tims Ford tailwater. Minor to moderate erosion would continue, mostly in areas with inadequate riparian vegetation.

Alternative B: Adaptive Management
This alternative is likely to reduce present erosion rates in the tailwater.

There would be reduced duration operation for power generation from May to the middle of October. Any reduction in frequency or duration of daily generation pulses is likely to encourage vegetation to become reestablished on the lower part of the river bank, though the greatest density of vegetation, and therefore greatest reduction in bank erosion rate, would likely be realized with no peaking operations. Generating for peaking power would still take place October through April, but plants are less susceptible to damage from inundation when they are dormant. In addition, less total time would be spent at higher flows that lead to erosion (Figure 3-9).

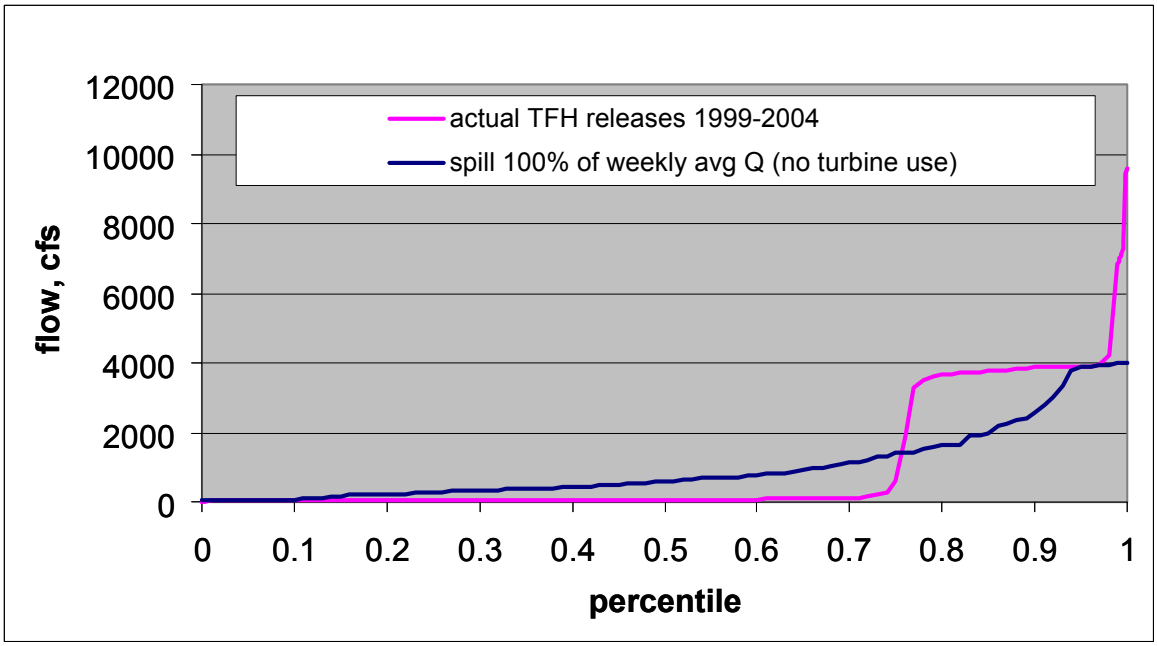


Figure 3-9. Flow-Duration Curves for Historical Operation (May - October) and Hypothetical 100 Percent Spill Option for Adaptive Management Alternative

3.2. Aquatic Ecology and Listed Species

3.2.1. Affected Environment Aquatic Ecology and Listed Species

The Elk River is located in south-central Tennessee and flows from the western edge of the Cumberland Plateau in Grundy County westward, where it joins the Tennessee River in Wheeler Reservoir. The river is approximately 200-miles long of which 125 miles is un-impounded, but is affected by releases from Tims Ford Dam.

Tims Ford Dam (ERM 133) was constructed by TVA in 1970 for flood control, water supply, recreation, and power generation. The lower 25-31 miles of the river are impounded from the backwaters of Wheeler Reservoir, a mainstream impoundment on the Tennessee River operated by TVA for navigation and flood control.

Tim's Ford Dam is one of several tributary dams that release water from the hypolimnion of the reservoir. Water is typically low in dissolved oxygen with altered temperature regimes and fluctuating water levels depending upon periods of power generation. However, TVA has implemented a new aeration system to improve DO and this EA addresses recommended operations to benefit biological communities downstream from the dam. For example, the RRI improvements made at Normandy Dam on the Duck River were extremely successful for freshwater mussel reproduction and recruitment in the river downstream of Shelbyville, which were not apparent prior to RRI (Ahlstedt, et al. 2004). Pre- and post-monitoring of biological communities in the Elk River are critical for determining the success of future improvements made at Tims Ford Dam.

For the purposes of this project with respect to aquatic animals, the river is divided into two reaches; an upstream reach from Tims Ford Dam (ERM 133) to Fayetteville, and a downstream reach from Fayetteville to the backwaters of Wheeler Reservoir (~ERM 21).

Freshwater Mussels

Historical Surveys

The Elk River is a major tributary to the Tennessee River and is biologically important for its assemblage of Cumberlandian endemic mussels that exist only in the Tennessee and Cumberland River systems. The Cumberlandian mussels, being intolerant of stream perturbations, are considered to be good indicators of water and habitat quality. The Cumberlandian fauna group, including mussel species that are now considered extinct, is unfortunately well represented on the Federal list of endangered species.

Historically, approximately 60 mussel species are reported from the Elk River, 21 of which are Cumberlandian species. Mussel records for the Elk are based upon surveys conducted in 1924 (Remington and Clench 1925), 1925 (Ortmann 1925), 1965-1967 (Isom et al. 1973), and 1980 (Ahlstedt 1983). The mussel assemblage reported from the Elk historically was comparable to that found in the Duck, Paint Rock, and Clinch Rivers.

Isom, et al.'s (1973) mussel survey of the Elk River was done just prior to completion of Tim's Ford Dam and serves as the most recent pre-impoundment assessment of mussels in the river. He stated that "the mussel fauna downstream from the dam will survive only if conditions for a warm water fishery are met." TVA's 1980 mussel survey (Ahlstedt 1983) is now considered historical information since more than 25 years have passed, but results from this survey showed marked post-impoundment reductions in species diversity and densities. Similar reductions in fish diversity are seen, particularly in the reach of the river between the dam and Fayetteville (~ERM 90).

Recent Surveys

Hubbs et al. (1991) qualitatively sampled mussels in the Elk River between river miles 75 and 70.5 in 1989. Their study was discontinued because of water clarity problems, due to sludge (alum) released from the city of Fayetteville's water treatment plant. Before the study was discontinued, relict (shell was eroded and weathered, and nacre on inside of shell was no longer lustrous) valves were found from 12 mussel species. In 1990, the river was float-surveyed between river miles 112.7 and 105.5 in an area previously known to support the greatest concentration of mussels (23 species) based upon TVA's 1980 survey (Ahlstedt, 1983). A quantitative sample at river mile 109.7 (unnamed island below Shelton Creek) consisted of 80 quarter-meter square quadrats and resulted in eight individuals of only four species: *Actinonaias pectorosa* (5), *Elliptio dilitata* (1), *Fusconaia barnesiana* (1), and *F. cor* (1, endangered). The qualitative survey within this reach included a total of 24 species, but 17 were represented only by relict shells. All mussels found were noted as old individuals and no juveniles were present, suggesting there had been little recent successful reproduction. The survey was discontinued below Fayetteville because of the extensive beds of dead mussels and insufficient numbers of living mussels to warrant additional quantitative sampling. The absence of successful reproduction and the paucity of living mussels in this section of the Elk River was attributed to the long-term exposure of mussels to cool water discharges released from Tims Ford Dam as well as agricultural and quarry washing activities in the watershed (Hubbs et al., 1991).

In 1999, biologists from the USFWS (Cookeville, Tennessee) float- surveyed the Elk River for mussels from river mile 77 (downstream of Harms Mill) downstream to Whitfield Island

river mile 37 (USFWS 1999). A total of 24 mussel species were reported from live or fresh-dead specimens (tissue left in shell, shiny nacre) at 16 sampling sites. The number of individuals found during their survey was not reported. They noted that the majority of live individuals collected were old, eroded individuals and few young adult or juvenile mussels were found. However, three individuals of one federally listed species (*Hemistena lata*) were found upstream from Morrell Mill. Also, one fresh dead *Epioblasma triquetra*, one live *Hemistena lata*, and two live *Quadrula c. cylindrica* were collected downstream from Harms Mill.

Sampling at four sites between ERM 105 and ERM 31.7 resulted in five to fifteen species (depending upon the site) found alive or fresh dead. An additional two to five species (again depending upon site) documented were relict specimens. Total numbers of individuals observed at these sites range from 25 to 162, which a catch-per-unit effort (CPUE) of 0.01 to 0.38. Evidence of reproduction was noted for eight species, including one federally listed species.

At one of the Richland Creek sites, nine mussels species were found alive or fresh dead, and thirteen additional species were found as relict shells. A total of 56 individual was found, for a CPUE of 0.18. At the other Richland Creek site, individuals of six species were found alive, and two additional species documented were relict shells. Nineteen total specimens were observed for a CPUE of 0.13.

In 2007, biologists from the Alabama Department of Conservation and Natural Resources (Paul Johnson, ADCNR, pers. comm.) performed qualitative and quantitative samples at three sites in the lower Elk River, Giles County, Tennessee, and Limestone County, Alabama. The total (live and dead) species richness at these three sites was 16, 22, and 19 species, respectively for both sampling methods combined. Mussel density at each of the sites was 1.4, 1.9, and 2.1 individuals per square meter, respectively. The federally listed cracking mussel was found alive and as a freshly-dead specimen, and relict shells of the federally listed rough pigtoe were found as well. In the reach containing the three sites sampled in 2007, 28 total species were found, 21 (=75 percent) of which were found as live or freshly-dead specimens. Of the total mussel fauna collected for this reach, 12 species are tracked as rare species in Alabama and four of the species are considered rare in Tennessee.

Recent work by TVA documented a total of 27 live mussel species during quantitative and qualitative sampling in the Elk River (Table 3-7) (TVA unpublished data).

Table 3-7. Localities of Five Fixed Station Elk River Mussel Monitoring Sites, September 2005

Site	Elk River Mile	Live Mussel Species
Dickey Bridge	105.0	1
Chennault Ford	97.0	7
Harms Mill	75.7	20
I-65 Bridge	49.3	14
Veto Bridge	34.5	17

The federally listed *Hemistena lata* and a candidate for federal listing (*L. dolabelloides*) were documented in quantitative samples. Two other mussels found in these surveys are

currently being reviewed for federal candidate status: *Epioblasma triquetra* and *Quadrula c. cylindrica*. Of the 27 species recorded, 21 are members of the Ohioan and Mississippian faunal groups. These species have invaded river systems pre- and post-impoundment and are considered relatively tolerant of stream perturbations.

The freshwater mussel fauna continues to be depressed in the Elk River, especially in the reach upstream of Fayetteville (Table 3-8).

Table 3-8. Listed Mussel and Snail Species Present in the Elk River at or Upstream of Fayetteville, Tennessee

Common Name	Scientific Name	State Status	Federal Status
Mussels			
Shiny Pigtoe Pearlymussel	*Fusconaia cor*	END	END
Fine-rayed Pigtoe	*Fusconaia cuneolus*	END	END
Cracking Pearlymussel	*Hemistena lata*	END	END
Cumberland Monkeyface	*Quadrula intermedia*	END	END
Slabside Pearlymussel	*Lexingtonia dolabelloides*	TRKD	CAND
Round Hickorynut	*Obovaria subrotunda*	TRKD	-
Tennessee Clubshell	*Pleurobema oviforme*	TRKD	-
Snails			
Ornate Rocksnail	*Lithasia geniculata*	TRKD	-
Warty Rocksnail	*Lithasia lima*	TRKD	-

Status abbreviations: END = endangered, CAND = candidate for federal listing, TRKD = tracked

The declines seen in the Elk River mussel community are believed to be a result of habitat alteration due to extremely cold water temperatures from dam releases, and large daily variations in flow related to the operation of the large hydroturbine unit at Tims Ford Dam. Releases from the dam can range from a minimum flow of 80 cfs to a sustained flow of 3,900 cfs and can lower water temperatures 10 - 15° C in the reach upstream of Fayetteville. Depending upon the amount of time the large unit is operated, these cold-water releases can result in temperature depression in the entire tailwater reach down to Wheeler Reservoir.

Increased sedimentation due to land-use (particularly agricultural) is also believed to be a major stressor of the mussel community in the Elk River. Virtually no federally listed or candidate species have been observed upstream of the US 64 bridge (ERM 99.4). Listed mussel species present in the Elk River are shown in Tables 3-8 and 3-9.

Table 3-9. Listed Mussel and Snail Species Present in the Elk River From Fayetteville, Tennessee (ERM 90) Downstream to Wheeler Reservoir

Common Name	Scientific Name	State Status - State Rank	Federal Status
Mussels			
Butterfly	*Ellipsaria lineolata*	TRKD - S3	-
Shiny Pigtoe Pearlymussel	*Fusconaia cor*	END - S1	END
Fine-rayed Pigtoe	*Fusconaia cuneolus*	END - S1	END
Cracking Pearlymussel	*Hemistena lata*	PROT - AL - SX END - TN - S1	END
Wavy-rayed Lampmussel	*Lampsilis fasciola*	TRKD - S1S2	-
White Heelsplitter	*Lasmigona complanata*	TRKD - S2S3	-
Birdwing Pearlymussel	*Lemiox rimosus*	END - S1	END
Slabside Pearlymussel	*Lexingtonia dolabelloides*	TRKD - S2	CAND
Rabbitsfoot	*Quadrula cylindrica cylindrica*	TRKD - S3	-
Cumberland Monkeyface	*Quadrula intermedia*	END - S1	END
Monkeyface	*Quadrula metanevra*	TRKD - S3	-
Snails			
Warty Rocksnail	*Lithasia lima*	TRKD - S2	-
Varicose Rocksnail	*Lithasia verrucosa*	TRKD - S3	-
Round Hickorynut	*Obovaria subrotunda*	TRKD - S3	-
Skirted Hornsnail	*Pleurocera pyrenella*	TRKD - S2	-

Status abbreviations: END = endangered, PROT = protected, TRKD = tracked, State ranks: S1 = critically imperiled, S2 = imperiled, S3 = rare or uncommon, SX = extirpated in state

Fish Communities - Tims Ford tailwater

Fish communities in the Tims Ford tailwater show a present distributional pattern similar to the freshwater mussel pattern described above. The species found near the dam are more tolerant of habitat alterations and colder water temperatures and are not representative of the warmwater fish community that was present in the Elk River prior to its impoundment by Tims Ford Dam. Cold releases from the dam allow a 'put-and-take' fishery for two non-native trout species (rainbow trout and brown trout) to be maintained in the Tims Ford tailwater. TDEC has listed "trout stream" as a designation of the Elk River from Tims Ford Dam downstream to Fayetteville. This area supports trout during the cooler fall and winter months; however, during summer months water temperatures in the area between Fayetteville and Beans Creek increase above the temperatures that trout prefer (Bettoli, 2001). Water temperature conditions suitable for trout survival and growth in the Elk River are typically restricted to areas upstream of Old Dam Ford, beginning in July. TWRA identifies only the area from Old Dam Ford upstream to Tims Ford Dam as a trout tailwater in its Stocked Trout Program.

The species that make up the native warm-water fish community in the Elk River increase in number with distance from Tims Ford Dam. As a result of TVA's Elk River IBI surveys (TVA unpublished data) in 2005, 23 native fish species were observed at ERM 130.8 (just downstream of the dam), 38 were observed at ERM 105.5 (just above Fayetteville), and 49

were observed at ERM 75 (20 miles downstream of Fayetteville). This includes three species of fish on federal- or state-protected species lists (Tables 3-10 and 3-11).

Shephard et al. (2006) reported the results of 2004-2006 fish surveys at 25 sites in the lower Elk River mainstem in Limestone County, Alabama. They reported a diverse fish community, including 12 of 13 species that were designated as species of conservation concern in Alabama.

Until recently, boulder darters have only been known from the Elk River drainage, including lower Richland Creek. This species has not been known from the reach upstream of Fayetteville until improvements in minimum flows and dissolved oxygen levels in releases from Tims Ford Dam allowed for stocking of boulder darters in areas immediately upstream of Fayetteville (Pat Rakes, Conservation Fisheries, Inc., personal communication). Non-essential experimental population status was designated for Shoal Creek (also a direct tributary to the Tennessee River, Wheeler Reservoir, downstream of the Elk River). Captive-propagated individuals have been recently introduced into the Shoal Creek system (Pat Rakes, CFI personal communication).

Threats to the boulder darter in the Elk River include high turbidity levels of streams in the watershed, siltation from land use practices (including agriculture), improper pesticide use, toxic chemical spills, the cold-water releases from Tims Ford Reservoir, and/or mining of phosphate in the watershed (USFWS 1989). Recent surveys indicate that the ashy darter and highfin carpsucker are still present within the system (TVA unpublished data).

One of the primary goals of the proposed operational changes at TFH is to reduce the extreme variability in flows and water temperatures during the spring, summer, and fall. The expected results are water temperatures and flows that are more similar to natural, free-flowing streams in the region. This should result in habitat and water quality improvements in the upstream reach of the Elk River so that boulder darters and mussels can be reintroduced into this portion of the Elk River drainage. Any improvements in the upstream reach of the Elk River would also benefit boulder darters and other sensitive fish and mussels in the rest of the Elk River downstream of Fayetteville.

Table 3-10. Listed Fish Species Present in the Elk River at or Upstream of Fayetteville, Tennessee

Common Name	Scientific Name	State Status - State Rank	Federal Status
Boulder Darter*	*Etheostoma wapiti*	END - S1	END
Ashy Darter	*Etheostoma cinereum*	THR - S2S3	-

* Boulder darter populations upstream of Fayetteville have been augmented by stocking with captively propagated individuals.
Status abbreviations: END = endangered, THR = threatened; State ranks: S1 = critically imperiled, S2 = imperiled, S3 = rare or uncommon

Table 3-11. Listed Fish Species Present in the Elk River from Fayetteville, Tennessee, Downstream to Wheeler Reservoir

Common Name	Scientific Name	State Status - State Rank	Federal Status
Boulder Darter	*Etheostoma wapiti*	END - S1	END
Ashy Darter	*Etheostoma cinereum*	THR - S2S3	-
Highfin Carpsucker	*Carpiodes velifer*	NMGT - S2S3	-

Status abbreviations: END = endangered, THR = threatened, NMGT = in need of management; State ranks: S1 = critically imperiled, S2 = imperiled, S3 = rare or uncommon

Tims Ford Reservoir - Reservoir Ecological Condition

TVA surveyed several biological and water quality parameters at Tims Ford Reservoir annually between 1992 and 1996 to establish baseline data on the reservoir's ecological health under a range of weather and flow conditions. Tims Ford is now evaluated every other year. Although Tims Ford Reservoir is well known locally for its striped bass, smallmouth bass, and largemouth bass fishery, the ecological health rating indicates poor conditions (Figure 3-10). Because of consistently low DO levels in the portions of the water column and a low diversity of benthic species Tims Ford Reservoir rated poor in 2006, as it had in previous years. Lower ratings for chlorophyll at the mid-reservoir location have been an issue in recent years.

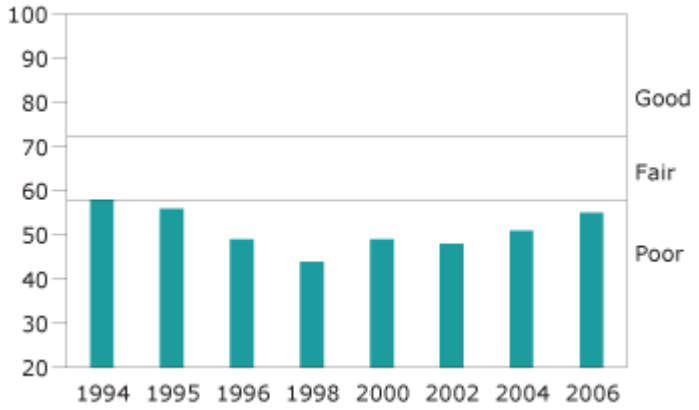


Figure 3-10. Tims Ford Reservoir Ecological Health Ratings, 1994-2006

Tims Ford Ecological Health Scores 1994-2006. These scores are an index based on TVA data for dissolved oxygen concentration, chlorophyll concentration, fish assemblage, bottom life, and sediment quality.

No state- or federally listed aquatic animals are known to occur in Tims Ford Reservoir.

3.2.2. Environmental Consequences Aquatic Ecology and Listed Species

No Action Alternative

Warmwater communities (including Endangered and Threatened species)

Existing fish and benthic communities (including listed mussel and fish species) in the Elk River downstream of Tims Ford Dam are not anticipated to change significantly under the No Action alternative. The extreme variability and potentially high daily volume of releases from the large turbine would continue to provide unnatural flow conditions and depress

water temperatures. This could occur during critical spawning periods for listed mussel and fish species in the Tims Ford tailwater (Elk River). Unnatural flow conditions could continue throughout the spring, summer, and fall months. Warm-water fish and mussel communities have shown some improvement following establishment of minimum flows and aeration of tailwater releases. However, these improvements have not resulted in conditions that would allow survival and reproduction of many species in the reach of the river upstream of Fayetteville, and cold releases due to turbine generation continues to depress native fish and mussel populations even in the lower portion of the Elk River.

Reservoir Fisheries
Reservoir fish communities would remain unchanged under the No Action alternative.

Trout Fishery
The tailwater trout fishery would be maintained immediately downstream of Tims Ford Dam in its current condition.

Action Alternative – Adaptive Management of Tims Ford Dam releases

Warm-water communities (including Endangered and Threatened species)
Although bolder darters and mussels have been affected by land-use practices that result in sediment deposition on the stream bottom, the present rarity of the boulder darter in the Elk River has been attributed in large part to the extreme fluctuations in flow and water temperatures that result from turbine releases at Tims Ford Dam. The intent of the proposed changes to Tims Ford releases is to provide more stable habitat conditions in the Elk River and water temperatures that are more similar to a warm-water stream. Modification of the Tims Ford Dam releases to meet the flow and temperature conditions necessary to support survival and reproduction of the boulder darter and listed mussels present in the Elk River would require that TVA reduce peaking operations at Tims Ford Dam from May 1 – October 15 for most water years. Minimum flows would likely be increased in order to maintain Tims Ford Reservoir at the level required by the current operating guide curve. Target water temperatures are derived from data provided from successful laboratory propagation of the boulder darter (see Table 3-6) (Pat Rakes, CFI, personal communication).

Minimum flows from May 1 – October 15 would be provided primarily by spilling water through the floodgates. Modeling results indicate that any use of the large turbine during this period could result in a 10° to 15° C drop in water temperatures in the Elk River downstream of Tims Ford Dam. Because temperature and flow variation have been identified as negative impacts on boulder darters and listed mussels, releases that result in such large drops in water temperature and highly variable flow conditions would not be used under this alternative.

Modeling results indicate that conditions for warm-water communities (including the boulder darter and listed mussels) can be improved in the Elk River. These improvements would be most noticeable in the reach from Fayetteville (ERM 97) upstream. Stabilization of flow regimes and improvements in water temperatures would also occur in areas currently occupied by boulder darter and listed mussel species downstream of Fayetteville. Reductions in flow variation during periods critical for reproductive success of these species, and warmer water temperatures during these periods are anticipated to improve reproductive success of boulder darters and listed mussel species.

The spillway gate at Tims Ford Dam draws water from approximately 35 feet below the summer pool level; therefore, water withdrawals are from cooler subsurface layers. During spring and early summer, these cooler subsurface water withdrawals are still too cool to meet warm-water requirements. Warm-water outflows from Beans Creek result in an increase in water temperatures in the Elk River to levels that are appropriate for boulder darter survival and growth from its confluence at ERM 119 and areas downstream.

Adoption of the Action Alternative would result in stabilization of water temperatures and flow regimes during periods that are critical for spawning success and growth of the federally listed boulder darter, and the federally listed mussel species present in the Elk River downstream of Tims Ford Dam. Habitat monitoring and biological monitoring would be conducted within this reach to document whether or not changes in releases at Tims Ford Dam result in expected improvements to habitat conditions. The Action Alternative would be expected to improve water quality and habitat conditions upstream of Fayetteville to the extent that these species could be re-introduced into at least some areas within this reach. Improvements to habitat conditions downstream of Fayetteville are also expected to occur. The stability in temperature and flow resulting from implementation of the Adaptive Management Alternative would result in improvements to water quality and habitat that would allow the existing populations of the boulder darter and the listed mussels in the Elk River downstream of Fayetteville to expand their populations through successful reproduction and expansion. Habitat and water quality improvements would also benefit the overall aquatic community in this portion of the river, including fishes that might be hosts for the listed mussels. Habitat monitoring and biological monitoring would also be conducted in this reach, as shown in Figure 3-11.

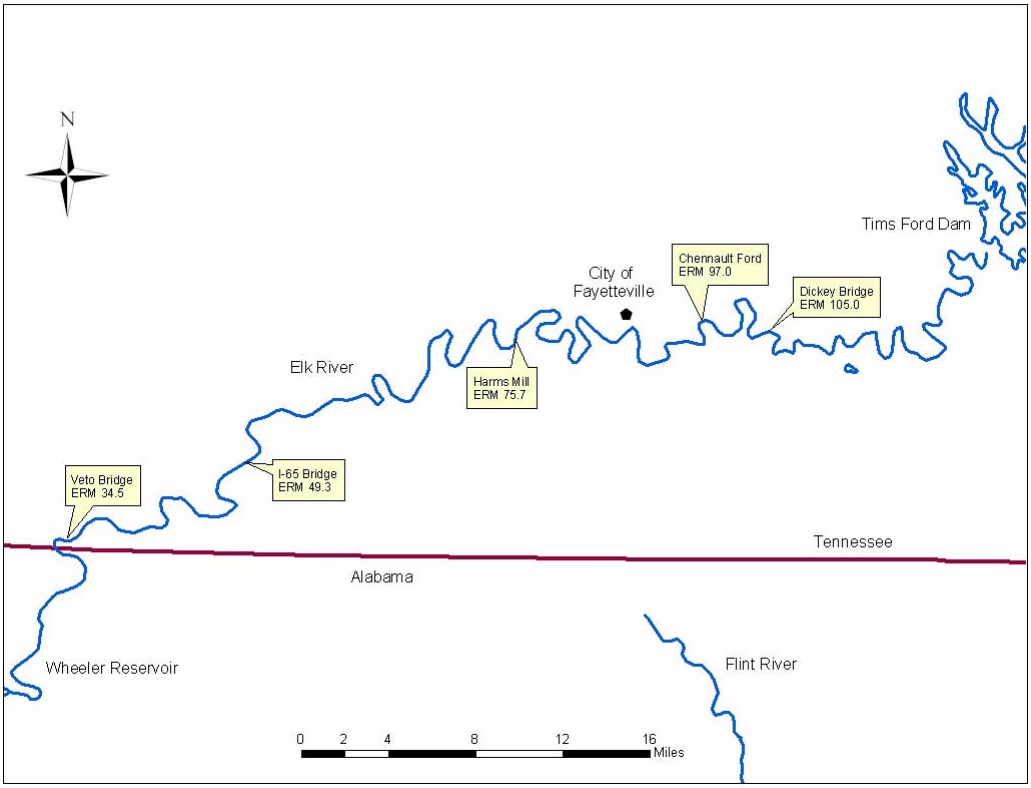


Figure 3-11. Five Fixed-Station Biological Monitoring Sites on the Elk River, Tennessee

These management criteria would not be applied to the transition zone in which temperature conditions have not yet stabilized.

It is TVA's determination that these proposed release changes would benefit populations of the boulder darter, shiny pigtoe pearlymussel, fine-rayed pigtoe, birdwing pearlymussel, Cumberland monkeyface, and cracking pearlymussel by minimizing impacts from dam releases and improving habitat conditions in the Elk River.

Management Objective 1 - Improve water quality and habitat conditions so that survival, and successful reproduction of boulder darter and listed mussel species is likely upstream of Fayetteville as much as feasible.

- Measure of success - Water temperatures, flow regime, and habitat conditions meet the requirements of boulder darter and mussels in this reach.

- Measure of success – Fish Index of Biotic Integrity (IBI) and benthic Index of Biological Integrity (BIBI) scores improve over current conditions.

Management Objective 2 - Improve habitat conditions so that reproduction, survival and growth of boulder darter and listed mussel species are enhanced with their present geographic ranges.

- Measure of success - Water temperatures, flow regime and habitat conditions meet the requirements of boulder darter and mussels in these reaches.

- Measure of success – Reproduction of boulder darter and listed mussel species is documented in these reaches.

- Measure of success – IBI and BIBI scores improve over current conditions

Management Objective 3 - Improve warm-water fish and benthic communities within the present geographic range of the boulder darter and listed mussel species.

- Measure of success – IBI and BIBI scores improve over current conditions

Management Objective 4 – Successfully reintroduce the boulder darter and mussel species in areas upstream of their present geographic range in the Elk River

- Measure of success – Survival and reproduction of boulder darter and listed mussel species is observed in this reach.

Management Objective 5 – Maintain dissolved oxygen levels and water temperatures suitable for the rainbow and brown trout fishery in the upper Tims Ford tailwater during summer months.

- Measure of success – DO levels in dam releases would be maintained at 6 mg/L or above.

- Measure of success – Temperatures at monitoring stations in the summer trout zone (upstream of Beans Creek) show acceptable temperatures for trout.

The above Management Objectives would not apply to the transition zone between the trout reach and the endangered species reach.

Reservoir Fisheries

No significant impact to reservoir fisheries is anticipated to occur as a result of these proposed operational changes. The amount of warmer surface waters may be somewhat reduced during spring and early summer because releases would be from the spillway gate rather than through the large turbine. The thermocline would be higher in the reservoir than under current conditions. However, these changes are small in relation to the amount of water stored in the reservoir. These release changes would not alter the current reservoir operating guide curve and reservoir elevations would not be affected. Modeling indicates that DO conditions in the reservoir would not be adversely affected, and some improvement in the oxygen concentrations in the forebay could be seen because oxygenated water would not be released through the large turbine, and would remain in the reservoir. Available habitat for reservoir communities, including important game fish, would not be reduced by these changes.

Trout Fishery

The Elk River downstream of Tims Ford Dam is a regionally important trout fishery managed by TWRA. TDEC has listed “trout stream” as a designation of the Elk River from Tims Ford Dam downstream to Fayetteville. This area supports trout during the cooler fall and winter months. However, during summer months, water temperatures in areas between Fayetteville and Beans Creek increase above the temperatures that trout prefer (Bettoli, 2001). Water temperature conditions suitable for trout survival and growth in the Elk River are typically restricted to areas upstream of Old Dam Ford beginning in July. TWRA identifies only the area from Old Dam Ford upstream to Tims Ford Dam as a trout tailwater in its Stocked Trout Program.

TVA has developed the proposed operational changes in cooperation with TWRA to ensure that these changes minimally affect the trout fishery. Because the opening of the spillway gates at Tims Ford Dam is 35 feet below the surface elevation, water spilled from the dam is cooler than would be provided from surface spill. Cold water can also be released from the sluiceway, located at the bottom of the dam.

Under the Action Alternative, TVA would release the majority of flows through the spillway and/or sluicing, resulting in warmer temperatures than are currently present in the tailwater. However, water temperatures would still likely be within the range appropriate for trout survival and growth (<20 ^{o}C). Additional flow could be provided by releasing colder water through the sluiceway to minimize any effects on trout fisheries in this reach. This would allow water temperatures in the reach downstream of the dam to be maintained in a range that would support growth and survival of trout. The influence of warm outflows from Beans Creek would then raise in-stream temperatures to levels that would support warm-water fisheries. There would be no significant reduction in the amount of river suitable for trout under this alternative. Stabilization of flows from May to October would benefit trout by reducing erosion and in-stream bedload movement.

Management Objective 5 – Maintain dissolved oxygen levels and water temperatures suitable for the rainbow and brown trout fishery in the upper Tims Ford tailwater.

- Measure of success – DO levels in dam releases would be maintained at 6 mg/L or above.

- Measure of success - Temperatures at monitoring stations in the trout zone show acceptable temperatures for trout.

TVA Monitoring Commitments
In order to determine the effectiveness of these operational changes in meeting the five management objectives of the proposed action, TVA would commit to the following monitoring activities. If it is determined that these operational changes are not effective in improving habitat conditions and lessening impacts on threatened and endangered species, TVA would analyze alternative actions that could meet these objectives. This action is intended to be an adaptive management process and effectiveness in meeting these stated goals would inform future actions.

Temperature Monitoring

Old Dam Ford, just upstream of the mouth of Beans Creek, represents the current downstream limit to the trout fishery in the Elk River (Bettoli, 2001). Warm water inflows from Beans Creek currently limit the downstream extent of the trout fishery. Old Dam Ford was identified as the most upstream point where warm-water conditions can be provided without negative effects on the trout fishery. TVA would place a real-time temperature monitor near the downstream limit of the current trout waters. Daily data from this monitor would be used in a thermal compliance model to determine releases from Tims Ford Dam.

TVA would also monitor temperatures at nine habitat monitoring sites further downstream in the Elk River. Data from these monitors would be collected for the period (May – October) when the release changes would occur. Data would be downloaded following this period in order to analyze the effectiveness of the release changes in moderating temperature fluctuations. Results of temperature monitoring would be reported to USFWS and TWRA yearly and discussed by the multi-agency working group described earlier.

Habitat Monitoring

Boulder Darter and Mussel Habitat
TVA (in cooperation with USFWS, USGS. TWRA, ADCNR) would conduct surveys of the Elk River between Tims Ford Dam and Fayetteville to identify areas that contain suitable habitat for the boulder darter and the listed mussel species that occur in the Elk River.

TVA (in cooperation with USFWS and TWRA) would monitor existing boulder darter populations in the Elk River to assess continued viability of these populations and document any increased reproductive success. Results of this monitoring would be reported to USFWS and TWRA yearly.

Fixed Monitoring Stations
TVA has established seven monitoring sites in the Elk River downstream of Tims Ford Dam (see Figure 3-11). Habitat evaluations, fish IBI sampling, BIBI sampling (in addition to temperature monitoring) would be conducted at each of these sites to identify any changes in habitat conditions and biological communities that result from operational changes at Tims Ford Dam. The results of this sampling would be reported to USFWS and TWRA yearly.

3.3. Terrestrial Ecology

3.3.1. Terrestrial Animals and Threatened and Endangered Animal Species

3.3.1.1. Affected Environment

Terrestrial Ecology (Animals)
Impacts from the proposed changes in the water releases from Tims Ford Dam are largely restricted to the Elk River riparian zone, downstream of the dam. The river is relatively narrow with a variety of pools, “riffles” and runs used by a variety of birds including belted kingfisher, great blue heron, green heron, black-crowned night-heron, double-crested cormorant, wood duck, mallard, osprey, and ring-billed gull. Other common species in the river include muskrat, American beaver, midland water snake, eastern cottonmouth, queen snake, Southern painted turtle, false map turtle, red-eared slider bullfrog, and green frog.

Terrestrial habitats within the riparian zone provide a mixture of open and forested habitats. Common species found in these riparian zones include Northern rough-winged swallow, common grackle, scarlet tanager, blue gray gnatcatcher, prothonotary warbler, common yellowthroat, white-throated sparrow and swamp sparrow. Other species found along the shoreline include, raccoon, white-tailed deer, gray squirrel, Virginia opossum, eastern cotton rat, white-footed mouse, slimy salamander, and gray treefrog.

No uncommon terrestrial habitats are known from the immediate area. Approximately 19 caves occur within three miles of the project area. All caves occur greater than 800 feet away from Elk River except one which is approximately 225 feet from Elk River.

Terrestrial Threatened and Endangered Species (Animals)
A review of the TVA Natural Heritage database during March 2008 indicates records of two Tennessee state-listed species and one Alabama state-listed species within three miles of Elk River. In addition, one species tracked by the Tennessee Natural Heritage Program has been recorded within three miles of Elk River. Two federally listed species and one federally protected species have also been reported within three miles of Elk River (Table 3-12).

Table 3-12. Federally and State-Listed Terrestrial Animals Reported From Limestone County, Alabama and Giles, Lincoln, Moore, and Franklin Counties, Tennessee

Common Name	Scientific Name	Federal Status	Alabama Status (Rank)	Tennessee Status (Rank)
Amphibian				
Hellbender	*Cryptobranchus alleganiensis*	--	--	NMGT (S3)
Tennessee Cave Salamander	*Gyrinophilus palleucus*	--	NOST (S2)	--
Bird				
Bald Eagle	*Haliaeetus leucocephalus*	--	PROT (S3)	NMGT (S3)
Mammals				
Southeastern Shrew	*Sorex longirostris*	--	--	NMGT (S4)
Gray Bat	*Myotis grisescens*	END	PROT (S2)	END (S2)
Indiana Bat	*Myotis sodalis*	END	--	END (S1)
Invertebrates				
Cave Obligate Beetle	*Ptomaphagus fecundus*	--	--	TRKD (S1)

Status abbreviations: END = endangered, NMGT = in need of management, PROT = protected, TRKD = tracked, NOST = no status; State ranks: S1 = critically imperiled, S2 = imperiled, S3 = rare or uncommon, S4 = apparently secure in the state but with cause for long-term concern

Hellbenders are found in running rivers and large streams with large rocks and snags to use as shelter. One record exists 1.2 miles away from the Elk River along Richland Creek. There are numerous tributaries of the Elk River in the area and therefore, ample suitable habitat exists for this species within the project area.

Tennessee cave salamanders inhabit cave systems with clear, sediment-free streams. The species has been reported from Robinson Sinks Cave approximately 2.5 miles from the Elk River. Neither this species, nor suitable habitat for this species exists in the affected project area.

Bald eagles have been recently removed from the endangered species list but are still protected by the *Bald and Golden Eagle Protection Act*. They typically nest in forested habitats near large reservoirs and rivers. Nesting and post-breeding bald eagles are regularly observed throughout Wheeler reservoir system. A new bald eagle nest is located near the mouth of the Elk River. The project area and vicinity provides ample suitable habitat for this species.

Southeastern shrews are found in a variety of habitats including swamps, marshes, and river bottoms as well as in dense ground cover in wooded areas. One record exists 2.3 miles away from Elk River. This species likely occurs within the riparian corridor surrounding the Elk River.

Gray bats roost in caves year-round, particularly along large tributaries of the Tennessee River over which they forage. Gray bat summer colonies have been reported from Indian Cave and Caney Hollow Cave, approximately 1.3 and 2.9 miles from the Elk River,

respectively. An additional colony occurs in a cave 225 feet from Elk River near Fayetteville, Tennessee. The species is known to forage throughout the Elk River riparian corridor (Best and Hudson, 1996). Abundant foraging habitat occurs throughout Elk River, as well as Tims Ford and Wheeler Reservoirs.

The federally listed **Indiana bat** hibernates in caves during the winter and typically forms summer roosts under the bark of dead or dying trees (Menzel et al., 2001). Their summer roosts are found in mature forests with an open subcanopy, usually near water (Romme et al., 1995), and they primarily forage in forested areas along streams or other corridors. Records for this species exist from Caney Hollow Cave and from a cave 225 feet from Elk River near Fayetteville, Tennessee. However, Indiana bats have not been found in these caves during recent surveys. Suitable summer habitat occurs in the area and abundant foraging habitat occurs throughout Elk River, as well as Tims Ford and Wheeler Reservoirs.

A **Cave Obligate Beetle** is restricted to cave habitats and has been recorded from Caney Hollow Cave, approximately 2.9 miles from Elk River below Tims Ford Dam. Neither this species, nor suitable habitat for this species exists in the affected project area.

3.3.1.2. Environmental Consequences

Terrestrial Ecology (Animals)

No Action Alternative

Under the No Action Alternative, TVA would continue to operate the Tims Ford Hydroelectric Plant and Dam to maximize power production under the current operating guidelines. The duration, timing, temperatures, and rates of the flows would continue to provide conditions for some aquatic species in the Elk River that do not meet the requirements of TVA's 2006 Biological Opinion. Current operation regimes are not known to result in adverse impacts to terrestrial animals and their habitats. The No Action Alternative would not impact caves in the project area.

Action Alternative

Under the Action Alternative, TVA would modify turbine operations at Tims Ford Dam to ensure that the flows are spread uniformly and that the majority of the time, base minimum flows would be released through the spillway, the sluice, or a combination of both. These modifications would result in flow conditions more closely resembling free-flowing streams, warmer water temperatures, reduced erosion of riverbanks and decreased amounts sedimentation. These changes are not expected to cause losses of any terrestrial habitats, or to affect terrestrial wildlife along the Elk River or its adjacent areas. The new regime would likely result in improved water quality and more stable water temperatures in the river that would improve this habitat often used by terrestrial animals.

Nine caves occur within three miles of the proposed affected area. All caves are at least 800 feet away from Elk River except one; this unnamed cave is 225 feet away from the river in an adjacent bluff, 120 feet above the river. The Action Alternative would not impact these caves because they are outside the influence of the river. The Action Alternative would not result in significant direct, indirect, or cumulative adverse impacts to terrestrial animals or their habitats.

Terrestrial Threatened and Endangered Species (Animals)

No Action Alternative

Under the No Action Alternative, TVA would continue to operate the Tims Ford Hydroelectric Plant and Dam to maximize power production under the current operating guidelines. The duration, timing, temperatures and rates of the flows would continue to provide conditions for some aquatic species in the Elk River that do not meet the requirements of the 2006 Biological Opinion. However, since the existing flow regime does not currently affect protected terrestrial animals or their habitats, an adoption of the no action alternative would also not impact protected terrestrial animals or their habitats.

Action Alternative

There is no suitable habitat at the proposed affected area for Tennessee cave salamander and cave obligate beetle. The southeastern shrew would not be impacted by the project. None of these protected species would be affected under the Action Alternative.

Bald eagles nest near the mouth of the Elk River. This species also nests on Wilson and Wheeler Reservoirs. The Action Alternative would result in increased water temperatures and decreased erosion along the shorelines of the Elk River, which is expected to increase diversity of fish populations in the river. This increase in prey base might benefit resident bald eagles in this watershed. No impacts to roosting trees or other bald eagle habitat would be expected.

Gray bats occur in Indian Cave, Caney Hollow Cave, and another unnamed cave near Fayetteville, Tennessee. Similarly, records exist for Indiana bats from Caney Hollow Cave and the cave near Fayetteville, Tennessee, though these records are questionable as there are no recent observations of this species in these caves. All of these caves are beyond the influence of the river. Gray bats are known to forage throughout the Elk River riparian corridor and nearby reservoirs. Foraging and roosting habitat for Indiana bats occurs in the corridor as well. The Action Alternative would not impact roosting habitat, nor result in direct impacts to gray or Indiana bats. Improved water quality and temperatures would benefit insect prey items, improving the quality of foraging areas throughout the Elk River Corridor.

Improved water quality and habitat expected under the Action Alternative would benefit eastern hellbenders. The Action Alternative would improve foraging areas for protected terrestrial animals along the Elk River. These improvements would not result in significant direct, indirect or cumulative impacts to protected terrestrial animals along the Elk River.

3.3.2. Terrestrial Ecology (Plants), Invasive Species, and T&E Plants

3.3.2.1. Affected Environment

Terrestrial Ecology (Plants)

The upper Elk River between Fayetteville, Tennessee and Tims Ford Dam is located in the Outer Nashville Basin, a subdivision of the Interior Low Plateau Ecoregion (Griffith et al. 1998). The Outer Nashville Basin is characterized by rolling and hilly topography with higher elevations than the Inner Basin. Forests along with pasture and cropland are the dominate land covers. According to TDEC (2003), the land use distribution in the Upper Elk River Watershed is predominately forested (54.2 percent) with 36.6 percent as deciduous forest, 12.8 percent mix forest, and 4.8 percent as evergreen forest. Agricultural uses in the form of pastures and row crops comprise almost 40 percent of the available land within the

watershed. Emergent herbaceous and forested wetlands make up an additional 1.4 percent of the total. Commercial, residential, along with open water are found on the remaining lands of the upper Elk River Watershed.

Herbaceous Vegetation: The grass/forbs habitat occurs primarily as agricultural row crops and pastures. In addition, this vegetation type can be found along highway rights-of-way and within commercial and residential areas. Row crops include: corn, cotton, soybeans, and wheat. Weedy species commonly found are Bermuda grass, foxtail grass, Johnson grass, tall fescue, and various other grasses and weedy broadleaved species.

Deciduous Forest: Most of the forested area is in the form of oak-hickory forest with bur oak, chinquapin oak, white oak, pignut hickory, and shagbark hickory as the dominate species. American elm, black gum, black walnut, hackberry, sugar maple and sweetgum can also be present.

Evergreen-Deciduous Forest: A portion of the forested area occurs as a mixed forest with the presence of evergreen species, Eastern red cedar, and shortleaf pine along with blue ash, hackberry, hickories, red and white oaks, and winged elm.

Evergreen Forest: Eastern red cedar and shortleaf pine are the dominate species found in the evergreen forest.

There are no uncommon terrestrial plant communities, designated critical plant habitat or otherwise noteworthy botanical areas occurring on or adjacent to the Elk River between Fayetteville and Tims Ford Dam.

Invasive Terrestrial Species (Plants)
Common invasive exotic plant species known to occur within and near the project area include: Chinese privet, Japanese honeysuckle, Japanese stilt grass, mimosa, multiflora rose, and sericea lespedeza. All of these species have the potential to adversely impact the native plant communities because of their potential to spread rapidly and displace native vegetation. Much of the lands adjacent to the river have been extensively altered as a result of previous land-use history. All of these invasive species are Rank 1 (severe threat) and are of high priority to TVA (James, 2002).

Endangered and Threatened Species (Plants)
The TVA Regional Natural Heritage database documents four Tennessee state-listed species from within five miles of the upper Elk River between Fayetteville, Tennessee, and Tims Ford Dam and two federally listed plant species are reported from Franklin County, Tennessee (Table 3-13). There are no records of federally listed plants from Lincoln and Moore Counties. Seven populations of Alabama snow-wreath occur along a 21.5-mile stretch of the Upper Elk River between ERM 95 and ERM 116.5. Six of the seven populations are reported on limestone bluffs above the river in Moore and Lincoln Counties.

Current rankings of federal- and state-listed species were verified through NatureServe website (NatureServe, 2007).

Table 3-13. Plant Species of Conservation Concern Reported From Within 5 Miles of the Upper Elk River Between Fayetteville and Tims Ford Dam and Federally Listed Species Known From Franklin County, Tennessee

Common Name	Scientific Name	Federal Status	StateRank/ Status
*Alabama snow-wreath	*Neviusia alabamensis*	--	S2/THR
American ginseng	*Panax quinquefolius*	--	S3S4/S-CE
Butternut	*Juglans cinerea*	--	S3/THR
*Monkey face orchid	*Platanthera integrilabia*	C	S2S3/END
*Morefield's leather flower	*Clematis morefieldii*	END	S1/END
Narrowleaf bushclover	*Lespedeza angustifolia*	--	S2/THR

***** Species descriptions found in the text
Federal abbreviations: C=Candidate; END= Endangered;
State Rank abbreviations: S1=critically imperiled with less than five occurrences; S2 =imperiled with six to twenty occurrences; S#S#=occurrence numbers are uncertain
State Status abbreviations: END=Endangered; THR=Threatened; S-CE=Species of special concern, commercially exploited.

Alabama snow-wreath *(Neviusia alabamensis)* is listed as a Tennessee state threatened species. Most typical habitat is considered to be forested areas on thin soil over limestone that is moist for part of the year. These areas are found on seasonal streambeds, margins of sinkholes, and river-bluffs. In Tennessee, this species is known from four counties, three of which are within the upper Elk River Watershed (Franklin, Lincoln, and Moore).

Monkey-face orchid (*Platanthera integrilabia*) is listed as a federal candidate species that favors damp, flat areas including stream-heads, and forested bogs. In Tennessee it is state-listed as Endangered and currently known from 10 counties. Habitat for this species is not present within the action area.

Morefield's leather flower (*Clematis morefieldii*) is a federally listed as endangered species with a restricted distribution on the Cumberland Plateau of Alabama and Tennessee. It occurs in patches on limestone bluffs within open red cedar-hardwood forests, and near springs, seeps, and ephemeral streams in rocky limestone woods. It has been found only in Franklin County, Tennessee. Habitat for this species is not present within the action area.

3.3.2.2. Environmental Consequences

Terrestrial Ecology (Plants)

No Action Alternative

Under the No Action Alternative, the releases from Tims Ford dam would remain unchanged. Since the terrestrial communities surrounding the action area are common and representative of the region, adoption of the No Action Alternative would have no impacts to these resources.

Action Alternative

The plant communities present within the area are common and representative of the region; therefore, based on the scope and duration of the project, no impacts to these resources are expected.

Invasive Terrestrial Species (Plants)

No Action Alternative

Under the No Action Alternative, the flows from TFH would remain unchanged. Current management practices would continue to prevent the introduction and spread of exotic/invasive species.

Action Alternative

Due to the scope and duration of the proposed action, no significant impacts are expected to the introduction and spread of invasive species as a result of the proposed Action Alternative.

Endangered and Threatened Species (Plants)

No Action Alternative

Under the No Action Alternative, the flows from Tims Ford Dam would remain the same resulting in no impacts to rare plant populations growing near the banks of the Elk River.

Action Alternative:

Adoption of the Action Alternative would have no significant impacts to rare plant populations. Alabama snow-wreath, a state-listed-as-threatened plant, is known to occur on bluffs above the river channel along a 21.5-mile stretch of the Elk River within the action area. However, due to the scope and duration of the project, no impacts are anticipated to these rare plants as result of the proposed action.

3.4. Cultural Resources

3.4.1. Affected Environment

East Tennessee has been an area of human occupation for the last 12,000 years. Human occupation of the area is generally described in five broad cultural periods: Paleo-Indian (11,000-8,000 BC), Archaic (8000-1600 BC), Woodland (1600 BC-AD 1000), Mississippian (AD 1000-1700), and Historic (AD 1700 to present). Prehistoric land use and settlement patterns vary during each period, but short- and long-term habitation sites are generally located on flood plains and alluvial terraces along rivers and tributaries. Specialized campsites tend to be located on older alluvial terraces and in the uplands. European interactions with Native Americans in this area began in the 17th and 18th centuries associated with the fur trading industry. Euro-American settlement increased in the early 19th century as the Cherokee were forced to give up their land. Franklin County was created by the Tennessee General Assembly in 1807 after the extinction of Cherokee claims to the land between the Duck and Tennessee Rivers (Smith, 1998). Numerous archaeological surveys have been conducted in the Tims Ford Reservoir area. While no systematic archaeological surveys have been conducted below the dam in the project area, eleven archaeological sites have been recorded along the Elk River.

TVA proposes the area of potential effects (APE) to include the affected shorelines below the dam extending to the town of Fayetteville, Tennessee. The Tennessee SHPO concurred with this APE determination by letter dated April 8, 2008. Eleven archaeological sites are recorded within the APE. These sites are considered potentially eligible for listing in the National Register of Historic Places (NRHP). No additional archaeological investigations were conducted.

3.4.2. Environmental Consequences

From May through November, the effects of implementing the Adaptive Management Alternative range from those associated with limited power generation to the effects of a blend of sluicing, spilling, and short duration generation pulses. The reduced duration of daily pulses would be expected to encourage the reestablishment of vegetation along the lower parts of the banks where erosion is most evident. Vegetation is anticipated to help stabilize those banks that are currently subject to erosion.

Eleven archaeological sites are recorded within the APE. These sites are considered potentially eligible for listing in the NRHP. While no additional archaeological investigations were conducted for this project, TVA finds that the project as currently proposed would have a beneficial impact to these, as well as other unknown resources located downstream of Tims Ford Dam. This finding is based on the anticipated reduced erosion impacts as a result of the reduction in operational pulsing from dam generation and the potential for increased vegetation growth that would naturally stabilize the existing shoreline.

TVA has determined that the proposed action does not have the potential to effect historic property. TVA has submitted a letter dated March 28, 2008, to the Tennessee SHPO seeking their concurrence with these findings. TVA received concurrence from the Tennessee SHPO by letter dated April 8, 2008. These letters appear in Appendix A

3.5. Recreation

3.5.1. Affected Environment

The Elk River below Tims Ford Dam provides a wealth of recreational opportunities. From Tims Ford Dam at Elk River Mile ERM 133 down to ERM 90.5 the Elk River is designated a “trout stream,” although temperatures below the confluence of the Elk River with Beans Creek near ERM 119 are too warm in summer months to fully support that use. TWRA stocks the portion of the Elk River above ERM 119 with trout. Anglers come from surrounding areas to enjoy trout fishing. Canoeing, kayaking, and rafting float trips on the Elk River are also popular ways of enjoying the scenic beauty of the river. The 3800 cfs flows associated with the use of the hydroelectric turbine at Tims Ford Dam result in water velocities which make the Elk River below the dam dangerous for wade-fishing and small non-powered personal watercraft. TVA has limited weekend use of the hydroelectric turbine at Tims Ford Dam between late May and early October to increase the availability of the Elk River below Tims Ford Dam to anglers, canoeists, kayakers, and rafters. Outfitters, anglers, and local canoe and kayak enthusiasts have accomplished weekday use of the Elk River during the warm season by consulting TVA's release schedule to understand which release conditions provide for safe use of the river.

3.5.2. Environmental Consequences

3.5.2.1. No Action Alternative

Under the No Action Alternative, TVA would continue operating Tims Ford Dam for peaking power on weekdays during the warm-weather months. On weekends, no generation would occur to promote recreational use of the river.

3.5.2.2. Adaptive Management Alternative

Under the Adaptive Management Action Alternative, recreation opportunities would continue at the same or increased levels. A more diverse selection of native fish including warm-water game species would be expected to result from the proposed changes. The trout populations would be less stressed by frequent rapid temperature changes and may have better growth rates. The populations of native warm-water game fish would be expected to increase fairly rapidly as they are present yet limited by the same temperature and flow issues that affect the listed fish and mussels. Anglers would adapt to the necessary lures, methods, bag limits, and seasons to catch these fish. Local fishing outfitters could probably increase their services to provide guide services for the increased numbers of available warm-water game fish. Use of the hydroelectric turbine at Tims Ford Dam would be more limited from May 1 to October 15. The minimum flow would probably vary between 80 cfs and 300 cfs depending on water availability. There would be no variation between weekday and weekend flows. Limiting the duration of generation pulses would lead to an increased number of hours per day during the summer months when the Elk River below Tims Ford Dam would be available for recreational use. Outfitters and private recreational users of the Elk River would still need to consult TVA's release schedule to understand which release conditions provide for safe use of the river. This alternative provides for continued summer water flows that are similar to current conditions and downstream flows, which would continue to provide for fishing and paddle sport- and float-related recreation.

Impacts of Increased Spill or Sluiced Releases on Tailwater Recreation

Another concern is how changing dam releases might alter tailwater recreation activities. There are presently two major forms of recreation in the Tims Ford tailwater. These are trout fishing and float trips via kayak, canoe, or raft. Spilling or sluicing most of the weekly average flow, rather than using the turbine, would provide more moderate, steady flow rather than a fluctuation between nearly nothing to a very full channel with swift velocities.

Impacts on Float Trips

The float trip outfitters operate by timing their excursions when flows from the large hydro unit have diminished and fall within the range of 80 to 1000 cfs. The outfitters can handle a somewhat higher flow than 80 cfs as long as it is steady. Figure 3-12 shows water velocities from steady flows ranging from 200 to 1000 cfs at three locations near the dam. The figure indicates that average channel velocities would range from about 0.8 to 1.3 feet per second (ft/s) at river access areas at 200 cfs, and the velocities would generally range from 1.0 to 2.5 ft/s at 1000 cfs. The 2.5 ft/s at 1000 cfs may be approaching the bounds of an enjoyable float trip for some people, but in general, the velocities appear manageable in this range of flow.

Impacts on Wade-Fishing

Because trout are stocked in the Tims Ford tailwater, wade-fishing occurs. A steady flow would be desirable for wade-fishing, if the velocity and depth are not too high to prevent safe wading. Depths range from 1.7 to 2.7 feet at a flow of 200 cfs, and from 3.5 to 4.2 feet at 1000 cfs. For wading, the mathematical product of depth in feet and linear velocity in feet per second is used to calculate a wadeability index (WI). TVA generally considers a WI of 4 or less to be safely wadeable, and depths of more than 4 feet, not wadeable. For the Elk River below Tims Ford Dam, this analysis would generally rule out wade-fishing for flows greater than 400 to 600 cfs in most locations depending on the shape of the river channel (TVA 1997).

At 200 cfs, the WI ranges from 1.4 to 3.2, which falls in a safe range of less than 4. At 400 cfs, the product ranges from 1.9 to 5.1. The highest WI product of the three evaluated locations occurs around river mile 131. Both depth and velocity are higher at this location, indicating either that the channel slope may possibly be steeper or the channel is narrower in that location than the other two locations.

One major factor that influences the safety of wading is a changing flow. If the flows remain steady, this makes the channel easier to negotiate for a wading fisherman than a situation in which the water is rising. If weekly flows were changed at the same time each week, and this time was posted, this would help make the tailwater safer for wade fishing, float fishing, and paddle sports.

Analyzing Maximum Potential Impacts

Figure 3-9 shows a comparison of flow-duration curves for the actual conditions versus the hypothetical 100 percent spill and sluice condition. As discussed in Section 3.1.2.2, analysis of the impacts of 100 percent of flows being spilled or sluiced represents the largest potential change from present operations and thus forms a boundary condition for accessing the impacts of the Adaptive Management Alternative. Actual impacts are expected to be somewhere in the range between existing conditions (No Action Alternative)

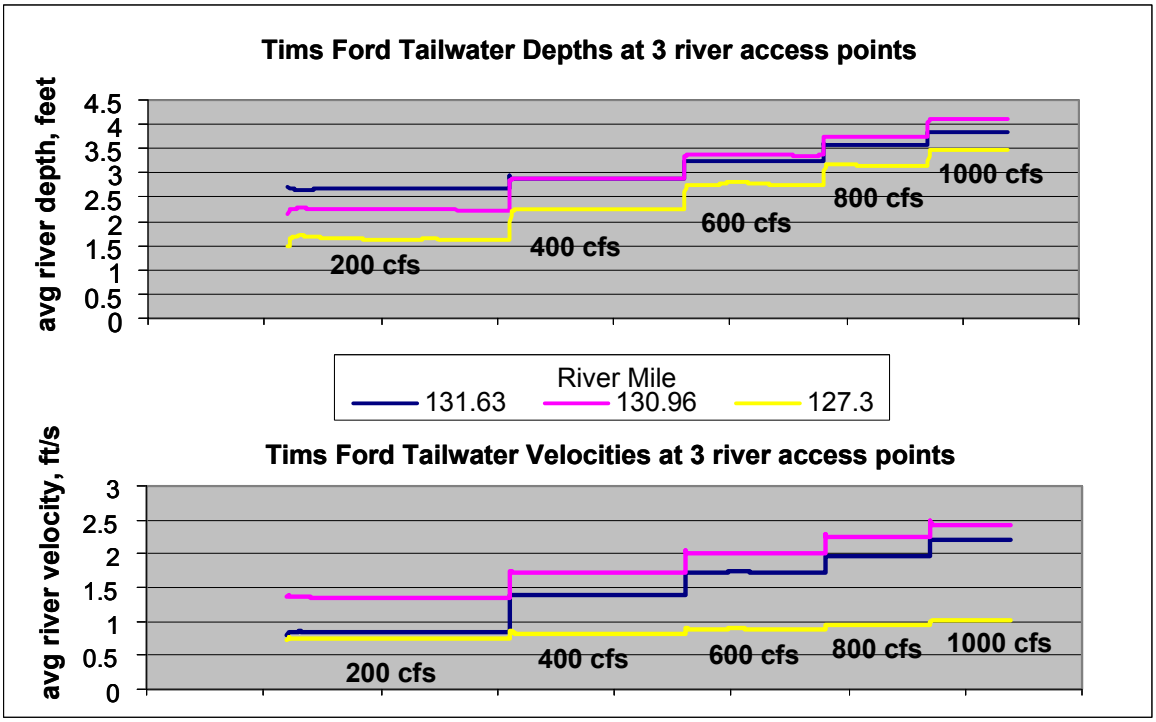


Figure 3-12. Average Depths and Velocities in Tims Ford Tailwater at Three Access Points

and the 100 percent spill and sluice scenario. For the 100 percent spill and sluice scenario, the weekly average flow would be 1000 cfs or less about 65 percent of the time, and about 500 cfs or less about 50 percent of the time. Under actual conditions, releases were about 80 cfs for 75 percent of the time. Interpreting Figure 3-9 to estimate increased availability of tailwater recreational resources can be somewhat deceptive, because a limited number of

hours of high flows can affect the elevations in the Elk River below Tims Ford Dam for several hours after generation ceases. Figure 3-2 provides a better illustration of the potential increased availability of Elk River below Tims Ford Dam tailwater recreation resources. For 2001, from May 1 to October 31, if 100 percent spill had been used, the tailwater would have been available for all but three brief periods of time when the flows equaled or exceeded 1000 cfs. Table 3-14 lists the potential changes in available tailwater recreation days. Under the Adaptive Management Action Alternative, the available recreation days would be bounded within the range of recreations days for the No Action Alternative and the 100 percent sluice and spill scenario. The Adaptive Management Action Alternative proposed in the EA constitutes a combination of spilling, sluicing, and pulsed generation. For such an action alternative, the number of days available for float-fishing and wade-fishing are not expected to change in going from the No Action Alternative to the Action Alternative. If the Action Alternative were comprised solely of spilling and sluicing and no generation, the number of days available for float fishing would increase, but the number of days available for wade-fishing may decrease.

Table 3-14. Tims Ford Dam Tailwater Recreation Days Available Between Generation or Spilling

Recreation Days	Year	
	2001	2004
Recreation Days Available for Wade Fishing or Floating (paddle sports) between Generation or Spilling May-October (No Action Alternative)	82	121
Recreation Days Potentially Available for floating (paddle sports) and float fishing when releases <1000 cfs May-October (Adaptive Management Alternative)	82 to 163	121 to 132
Recreation Days Potentially Available for wade fishing in addition to paddle sports when releases <400 cfs May-October (Adaptive Management Alternative)	54 to 82	41 to 121

3.6. Natural Areas

3.6.1. Affected Environment

A review of the Natural Heritage database indicated the waters of the Elk River are adjacent to four managed areas and/or ecologically significant sites. Additionally, the proposed action is within three miles of two other natural areas (Flintville State Fish Hatchery and Tims Ford State Rustic Park). The proposed action is located on one Nationwide Rivers Inventory stream.

- **Elk River,** a 97-mile segment in Giles, Lincoln, Moore, and Franklin Counties, Tennessee, from ERM 33 to ERM 130 is listed on the Nationwide Rivers Inventory. The National Park Service recognizes this segment of the river for the following Outstanding Resource Values: Scenery, Recreation, Fish, Wildlife, History, and Culture.

- **Sullenger Bend State Natural Area and Protection Planning Site** is a steep, east facing slope of Sullenger Bend adjacent to the project area. It lies along the west bank of the Elk River 40-90 feet above the river. It is located in a deep, cherty silt loam over

St. Louis limestone and is the site of the Alabama snow-wreath (*Neviusia alabamensis*), a state-threatened plant. The Natural Area is managed by the TDEC.

- **Mulberry Bridge Bluff Protection Planning Site** is a steep, river bluff forest community located adjacent to the project area on the east bank of the Elk River at river mile 102.5, and is noteworthy for the presence of the snow-wreath, a state-threatened species.

- **Lincoln County Bat Cave Protection Planning Site** is located adjacent to the project area on a bluff 20 feet above the river on the south bank of the Elk River at ERM 95.5. This area provides habitat for thousands of gray bats and historically held a maternity colony of Indiana bats.

- **Flintville State Fish Hatchery** is located 1.7 miles south of ERM 115. This coldwater hatchery was established in 1933, making it the oldest Tennessee hatchery. The hatchery, run by TWRA, previously raised both brown trout and rainbow trout, but now only raises rainbow trout from eggs to a variety of sizes that are stocked in Middle Tennessee streams. The hatchery receives its water from a spring found on the property.

- **Tims Ford State Rustic Park** is located 1.9 miles north of the proposed action. This 1900 acre park on Tims Ford Reservoir has many amenities including five miles of paved biking trails, a marina, 20 cabins, 52 campsites, a golf course, and a conference hall.

3.6.2. Environmental Consequences

3.6.2.1. No Action Alternative

Under the No Action Alternative, river flow would be maintained as it has been traditionally done in the past, sluice for minimum flow and turbine generation for peak power production. Therefore, no impacts would occur to Managed Areas, or Ecologically Significant Sites, as a result of the No Action Alternative. Although the Elk River's designation as a Nationwide Rivers Inventory (NRI) stream would not be adversely impacted as a result of the No Action Alternative, the resulting variations in water temperature and flow to the native fish and mussels would be less than optimal.

3.6.2.2. Adaptive Management Action Alternative

Under the proposed action, no impacts would be anticipated to Sullenger Bend State Natural Area, Lincoln County Bat Cave Protection Planning Site, and Mulberry Bridge Bluff Protection Planning Site. These Natural Areas occur mostly on bluffs above the river. Therefore, changes to the river flow rates would not impact them. Tims Ford Rustic State Park occurs well above the dam. Therefore, no impacts to this Managed Area would be anticipated. Flintville State Fish Hatchery uses a spring found on the property as its source of water. Therefore, changing the flow of water on the Elk River would not affect this Managed Area.

Impacts to the NRI-listed stream, Elk River, would be expected to be beneficial. The Adaptive Management Alternative includes specific goals for improving mussel and fish

habitat, so implementation of the action alternative would contribute to maintaining or improving the outstanding fishing value for which the Elk River is already known.

3.7. Visual Resources

3.7.1. Affected Environment

Visual resources are evaluated based on existing landscape character, distances of available views, sensitivity of viewing points, human perceptions of landscape beauty/sense of place (scenic attractiveness), and the degree of visual unity and wholeness of the natural landscape through the course of human alteration (scenic integrity).

The proposed project area lies along the Elk River in Franklin, Moore, and Lincoln Counties in Tennessee, downstream of TFH (ERM 133), extending to the town of Fayetteville (ERM 90). The Elk River is a winding tributary of the Tennessee River. The land flanking the Elk River is predominated by rural and agrarian development. Vegetation along the shorelines is moderate to heavy, and often screens backlying land uses and farming operations. The topography along this section of the Elk River varies, but is generally moderately sloping.

The Elk River is visible from the tailwater use area at TFH, from numerous roadway crossings and informal access areas, and from public and private land that adjoins the river. The number of views available within this section of the Elk River varies greatly, as does the duration of view. Recreational river users have immediate foreground (0' up to 300' from the observer) views of the Elk, as the Class I river offers many opportunities for canoeing and floating. The Elk River is listed by the National Park Service as exhibiting characteristics of the following Outstanding Remarkable Values: Scenery, Recreation, Fishing, Wildlife, History, and Cultural. Views from positions outside the foreground (0' up to 1/2 mile from the observer) are generally precluded, due to vegetation, and topography.

The existing scenic attractiveness is common, with some areas exhibiting characteristics of distinctive scenic attractiveness, and the existing scenic integrity is moderate to high.

3.7.2. Environmental Consequences

3.7.2.1. No Action Alternative

Under the No Action Alternative, TVA would not modify the releases from TFH and the existing landscape character would not be affected.

3.7.2.2. Action Alternative

Under the Action Alternative, TVA would modify releases from TFH in an effort to improve habitat for mussels and darters in the Elk River. The modified releases would result in more uniform flows downstream of TFH and could include increased spilling on the weekends. This proposed release modification would result in conditions downstream which more closely resemble free flowing watercourses. Recreational river users would potentially notice increased flows and slightly higher than expected water levels. The decrease in use of the hydroelectric turbines would be expected to favor establishment of riparian vegetation and decrease bank erosion and turbidity.

The modification of water releases from TFH, as proposed, would not result in significant impacts to existing scenic resources.

3.8. Wetlands

3.8.1. Affected Environment

The study area for this project consists of the Elk River from ERM 90 to ERM 133 at Tims Ford Dam. National Wetland Inventory maps indicate four types of wetlands occur in this area:

- Aquatic beds - submersed areas supporting aquatic vegetation.
- Seasonally exposed flats - areas of non-persistently vegetated and non-vegetated mudflats, as well as flats of other mixtures of sand, silt, cobble, and gravel.
- Emergent wetlands - areas of low-growing marshes and wet meadows.
- Scrub/shrub wetlands - areas with shrubs and or saplings.
- Forested wetlands - swamp and bottomland areas with hardwood and other wetland tree species.

Wetlands in this area are primarily riparian habitats present in the floodplain, where the topography is generally low-lying and flat. Forested wetlands are the most common type of wetlands in the Tims Ford tailwater, and these areas are typically small (less than 5-acres) and associated with tributary streams and islands. Emergent and scrub-shrub wetlands are uncommon in the tailwater; aquatic bed wetlands are exclusively found in limited areas in the reservoir itself and not below the dam.

3.8.2. Environmental Consequences

3.8.2.1. No Action Alternative

Under this alternative, TVA would continue to operate TFH under historic multi-use guidelines established when the project was completed in 1970. There would be no impacts to wetlands in the tailwater as the result of this alternative.

3.8.2.2. Action Alternative – Adaptive Management

Under this alternative, TVA would seek to balance power production, recreational opportunities, and efforts to improve habitat for federally protected aquatic species. The desired future conditions for the Elk River below Tims Ford Dam are higher water temperatures and more steady flow conditions which more closely simulate a free-flowing stream of this size in this part of the watershed.

The adaptive management alternative provides variations in water temperature and flow variability from the historic operating guidelines. The increase in temperature is not sufficient to affect wetland vegetation. Wetlands present in the tailwater are sustained as the result of temporary and seasonal flooding. The changes in flow regime associated with this alternative do not fall significantly outside of the variability in seasonal and occasional flood events that currently affect wetland habitats. No wetland impacts are expected as the result of the adaptive management alternative.

3.9 Economic Effects

The trout fishing in the Tims Ford tailwater is valued as a resource by TVA and by users. A 2003 study found that about 84 percent of the trout anglers at this site were from 22 Tennessee counties, with 48 percent from the three counties surrounding the site (Franklin, Lincoln, and Moore). This indicates the importance to nearby residents of the trout fishing opportunities. This study estimated that visitors spent an average of $54.45 per trip, with nonresident visitors spending an average of $158.43. The total economic value of the trout fishing opportunities in these tailwaters over the 26-week fishing season was estimated to be $182,852. While this value is well below that estimated for other Tennessee locations, this opportunity clearly is especially important to residents of nearby counties. In recognition of the importance of this resource, Habitat Improvement Objective number 5 in this EA is to maintain the trout fishery (see Sections 2.2.2 and 3.2.2 of the EA). Some of the proposed operational changes in Section 3.2.2 are designed specifically, in cooperation with the TWRA, to assure that the changes in operation would have at most minimal effects on the trout fishery. In addition, stabilization of flows from May to October would benefit trout by reducing erosion and in-stream bedload movement.

3.10 Cumulative Effects

Since the Adaptive Management Action Alternative would have no effects or negligible effects on terrestrial animals, terrestrial plants, cultural resources, natural areas, visual resources, and wetlands, no adverse cumulative effects are anticipated to these resources.

Implementation of the Adaptive Management Action Alternative would be expected to have only minor impact on the availability of the Elk River below Tims Ford Dam for recreational users May through mid-October. Currently recreational users of the tailwaters have to schedule their use of the tailwaters for times when water levels and currents are not affected by the relatively high 3800 cfs flow from the large hydro turbine. Since the action alternative would limit use of the large hydro turbine between May and mid-October, the Elk River below Tims Ford Dam could be more available to recreational users during that time. It is possible that minor economic benefits would result from more frequent visits to the Elk River below Tims Ford Dam by recreational users.

The Elk River and the sensitive aquatic species therein are affected by multiple environmental factors. One of the primary land-uses in the Elk River region is agriculture. Current agricultural practices result in increased erosion in areas adjacent to the Elk River and its tributaries. Deposition of these eroded sediments in area streams is an on-going impact to aquatic habitats. For water quality, one of the most visible short-term and cumulative effects anticipated from implementation of the Adaptive Management Action Alternative would be decreased erosion along the Elk River due to less frequent use of the existing large hydro turbine. Implementation of the Adaptive Management Action Alternative would also reduce the amount of thermal impairment due to cold-water discharges from Tims Ford Dam. Currently, 15.4 miles of the Elk River from Tims Ford Dam to the Confluence with Beans Creek near the Moore, Lincoln, and Franklin County Lines are listed on Tennessee's draft 303(d) list for thermal impairment, and the effects of this impairment can extend the entire reach of the Elk River from Tims Ford Dam to the Wheeler Reservoir backwaters.

For the listed aquatic species, the stabilization of flow and temperature regimes should enable the listed species to recover and for their populations to increase. The extent of

success of the action alternative over the next 10 years could range from relatively minor increases in the populations of the endangered species to establishment of stable, high-quality populations of these species.

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CHAPTER 4

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CHAPTER 6

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