TVA

Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

March 28, 2011

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Watts Bar Nuclear Plant, Unit 2 — 10 CFR 50.4
NRC Docket No. 50-391

Subject: WATTS BAR NUCLEAR PLANT (WBN) UNIT 2 - ADDITIONAL INFORMATION RELATED TO U.S. NUCLEAR REGULATORY COMMISSION (NRC) ENVIRONMENTAL REVIEW (TAC NO. MD8203)

Reference: 1. TVA Letter dated March 24, 2011, "Watts Bar Nuclear Plant (WBN) Unit 2 - Additional Information Related To U.S. Nuclear Regulatory Commission (NRC) Environmental Review (TAC No. MD8203)"

The purpose of this submittal is to provide one additional TVA report to support NRC Environmental Review and to provide a correction to a graph contained in a report previously submitted in Reference 1. Enclosure 1 provides a report entitled, "Fish Impingement at Watts Bar Nuclear Plant Intake Pumping Station Cooling Water Intake Structure during March 2010 through March 2011."

Enclosure 2 provides a correction to Figure 2 of previously provided report (Reference 1) entitled, "Discussion of the Results of the 2010 Mollusk Survey of the Tennessee River Near Watts Bar Nuclear Plant (Rhea County, Tennessee)." In Reference 1, Figure 2 of the report had incorrectly identified WBN Unit 1 operation as "1992" rather than "1996." For reviewer convenience, the entire report has been provided with the correction inserted.

There are no new commitments made in this letter. If you have any questions, please contact William Crouch at (423) 365-2004.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 28th day of March, 2011.

Respectfully,

Ed Freeman
Unit 2 Engineering Manager

D030
NRR

Enclosures:

1. Fish Impingement at Watts Bar Nuclear Plant Intake Pumping Station Cooling Water Intake Structure during March 2010 through March 2011
2. Discussion of the Results of the 2010 Mollusk Survey of the Tennessee River Near Watts Bar Nuclear Plant (Rhea County, Tennessee)

cc (Enclosures):

U. S. Nuclear Regulatory Commission
Region II
Marquis One Tower
245 Peachtree Center Ave., NE Suite 1200
Atlanta, Georgia 30303-1257

NRC Resident Inspector Unit 2
Watts Bar Nuclear Plant
1260 Nuclear Plant Road
Spring City, Tennessee 37381

Enclosure 1
Watts Bar Nuclear Plant

Report Entitled "Fish Impingement at Watts Bar Nuclear Plant Intake Pumping Station Cooling Water Intake Structure during March 2010 through March 2011"

Fish Impingement at Watts Bar Nuclear Plant Intake Pumping Station Cooling Water Intake Structure during March 2010 through March 2011

TENNESSEE VALLEY AUTHORITY

ENVIRONMENTAL STEWARDSHIP AND POLICY

March 2011

Table of Contents

List of Figures

List of Tables

List of Acronyms and Abbreviations

CCW	**Condenser Cooling Water**
CWA	**Clean Water Act**
EPA	**Environmental Protection Agency**
EPRI	**Electric Power Research Institute**
FPS	**Feet Per Second**
GPM	**Gallons Per Minute**
IPS	**Intake Pumping Station**
MSL	**Mean Sea Level**
MW	**Megawatts**
NPDES	**National Pollutant Discharge Elimination System**
RFAI	**Reservoir Fisheries Assemblage Index**
TRM	**Tennessee River Mile**
TVA	**Tennessee Valley Authority**
VS	**Vital Signs**
WBH	**Watts Bar Hydroelectric Plant**
WBN	**Watts Bar Nuclear Plant**

Introduction

Tennessee Valley Authority (TVA) is conducting additional monitoring during 2010–2011 in Chickamauga Reservoir to estimate annual impingement mortality of fish in the vicinity of Watts Bar Nuclear Plant (WBN) due to the proposed operation of WBN Reactor Unit 2 at the Plant site. The National Pollutant Discharge Elimination System (NPDES) Permit No. TN0020168 for WBN is subject to compliance with the Federal Clean Water Act (CWA). Section 316(b) of the CWA requires the location, design, construction, and capacity of cooling water intake structures to reflect the best technology available for minimizing adverse environmental impacts. A potential impact associated with cooling water intake structures is impingement of aquatic organisms. Impingement occurs when fish and shellfish are trapped against intake screens by the force of cooling water withdrawal. Impingement data were collected during March 2010 through March 2011 to update baseline data collected during the same period 1996 through 1997 (both sampling periods during operation of Unit 1) and to assess potential impingement impacts from the proposed operation of WBN Unit 2. This report presents annual impingement data collected from the Condenser Cooling Water (CCW) intake screens during March 2010 through March 2011.

Plant Description

WBN is located on the right descending (west) bank of upper Chickamauga Reservoir at Tennessee River Mile (TRM) 528 approximately 1.9 miles downstream of Watts Bar Hydroelectric Dam (WBH; TRM 529.9) and one mile downstream of the idled Watts Bar Fossil Plant (Figure 1). Commercial operation of WBN Unit 1 began on May 27, 1996 and is designed for a net electrical output of 1,160 megawatts (MW; gross electrical output of 1,218 MW).

Cooling water flows from Chickamauga Reservoir through the plant intake channel to the intake pumping station (IPS) located approximately 1.9 miles downstream of Watts Bar Dam at TRM 528 (Figure 1). WBN Unit 1 and proposed Unit 2 use closed-cycle cooling such that the cooling water withdrawn at the intake pumping station is to make-up for evaporation of cooling tower blowdown. The intake channel leading to the pumping station has a cross-sectional area of approximately 1,650 ft^2 at a Chickamauga Reservoir winter pool elevation of 675 ft mean sea level (msl), and 3,150 ft^2 at a summer pool elevation of 682.5 ft msl. This produces average water velocities between approximately 0.03 feet per second (fps) (high pool) and 0.05 fps (low pool) in the intake channel. The IPS includes four gated openings containing a combined gross flow area of approximately 360 ft^2, producing an average intake velocity (in front of screen) of about 0.2 fps. At the traveling water screens, the combined unobstructed through-screen area of the flow corresponding to the gated openings is reduced to approximately 140 ft^2, producing an average through-screen velocity of approximately 0.6 fps. The average flowrate at the IPS for WBN Unit 1is approximately 80 cubic feet per second (cfs), or 0.3% of the long-term average river flow (27,000 cfs) past the plant (Table 1).

With the operation of both Unit 1 and proposed Unit 2, intake (in front of screen) and through-screen velocities are projected to be 0.3 fps and 0.8 fps, respectively. The average flowrate at the IPS during operation of both units is expected to be approximately 116 cfs, or 0.4% of the long-term average river flow past the plant of approximately 27,000 cfs (Table 1).

Methods and Analysis

Impingement

Impingement data presented in this report represent weekly samples collected from March 26, 2010 through March 17, 2011. Quality Assurance/Quality Control procedures for impingement sampling (TVA 2004) were followed to ensure sampling was consistent with historical impingement monitoring methods used during 1996 through 1997.

Impinged fish were collected after each routinely scheduled weekly 24-hour screen washes. TVA's Biological and Water Resources (B&WR) crew removed impinged fish that were washed into a fish collection basket (Figure 1). Fish were sorted from debris, identified, separated into 25-mm (1-in) length classes, enumerated, and weighed. Any fish collected alive were returned to the reservoir after processing. Incidental numbers of fish which appeared to have been dead for more than 24 hours (i.e., exhibiting pale gills, cloudy eyes, fungus, or partial decomposition) were not included in the sample. Data recorded by one member of the B&WR crew was checked and verified (signed) by the other for quality control.

Estimated weekly and annual impingement rates were calculated by extrapolating impingement rates from 24-hr samples [i.e., 24-hr sample x 7 days (weekly) x 52 weeks (annual)].

Fish Community Assessment - RFAI

The health of the fish community in the vicinity of WBN, with Unit 1 operating, was assessed using a standardized index. Prior to 2000, WBN was operating under a 316(a) Alternative Thermal Limit (ATL) that had been continued with each permit renewal based on studies conducted in the mid-1970s. In 1999, EPA Region IV began requesting additional data in conjunction with NPDES permit renewal applications to verify that a "Balanced Indigenous Population" (BIP) of fish and shellfish was being maintained at TVA's thermal plants with ATLs. TVA proposed that its existing Vital Signs (VS) monitoring program, supplemented with additional fish and benthic macroinvertebrate community monitoring upstream and downstream of thermal plants with ATLs, was appropriate for that purpose. The VS monitoring program began in 1990 in the Tennessee River System. This program was implemented to evaluate ecological health conditions in major reservoirs as part of TVA's stewardship role. One of five indicators used in the VS program to evaluate reservoir health is the Reservoir Fish Assemblage Index (RFAI) methodology. RFAI has been thoroughly tested on TVA and other reservoirs and published in peer-reviewed literature (Jennings, et al., 1995; Hickman and McDonough, 1996; McDonough and Hickman, 1999).

TVA initiated a study to evaluate fish communities in areas immediately upstream and downstream of WBN during 1999–2010 using RFAI multi-metric evaluation techniques. This report presents the results of autumn RFAI data collected in the vicinity and downstream of WBN during autumn 1999–2010 to illustrate the health and stability of the fish community in Chickamauga Reservoir (TVA, 2011).

Results and Discussion

Impingement

Weekly impingement sampling at WBN from March 26, 2010 through March 17, 2011, resulted in collection of 1,939 fish, comprising three species (Table 2). Gizzard shad were predominant in the samples (60.4%) followed by threadfin shad (39.5%) and inland silverside (0.1%). Historical impingement monitoring at WBN conducted during March 1996 through March 1997 resulted in the collection of 16 fish representing eight species. Gizzard shad, threadfin shad, bluegill, white crappie and freshwater drum comprised 81.3% of fish impinged during March 1996 through March 1997 monitoring (Table 2). The rate of impingement was highest during January through March 2011 (99.6%). The two largest samples were collected during the second and fourth weeks in February 2011 and contained 618 and 613 fish (extrapolated weekly estimates of 4,326 and 4,291), respectively, comprising 63.5% of the total fish collected for the year (Table 3, Figure 2). Gizzard shad comprised 61.8% and threadfin shad 38.2% of these two samples.

Annual extrapolated estimates of numbers impinged by species for 1996–1997 and 2010–2011 are presented in Table 4. Estimated annual impingement for 2010–2011 (13,573) was significantly higher than that estimated for 1996–1997 (161). The difference in numbers between years was due to larger numbers of gizzard and threadfin shad collected during cold-weather months of January through March 2011. Most (99.9%) of the fish impinged during this period were gizzard and threadfin shad. The timing of this peak impingement period and species composition of fish impinged suggests stress and cold-shock. This is a common and natural phenomenon observed during colder winter months at fossil and nuclear facilities in TVA and other southeastern reservoirs (Loar, 1978; McLean et al., 1980; McLean et al., 1985). Shad are noticeably affected by temperature becoming lethargic and moribund when temperatures fall below 50°F, making them more susceptible to impingement. Shad cannot tolerate drastic temperature changes and typically experience winter die-offs when water temperatures are between 40–55°F, particularly when the change in temperature is quick and drastic (Griffith, 1978 and Fost, 2006). Threadfin and/or gizzard shad typically comprise over 90% of fish impinged on cooling water intake screens of thermal power stations in the Southeastern United States (Loar, 1978). Referenced literature (McLean et al., 1980) has shown that climate-controlled events such as winter shad kills will occasionally occur but populations of the two affected species are able to recover in a relatively short time.

Water temperatures collected at WBN during November 2010 through March 2011 were compared to those during the same period 1996 through1997. Daily water temperatures for December 2010 and January, February, and March 2011 averaged 1.4, 2.3, 1.5 and 3.2°F lower, respectively, than corresponding months in 1996 and 1997. From November 2010 to January 2011, averages of daily water temperatures decreased 17.5°F compared to 11.9°F during the same period in 1996 through 1997 (Table 5; Figure 3). This large and rapid decrease in water temperatures during November 2010 to January 2011 could have stressed shad causing them to become lethargic and moribund. It is likely that cold-stressed shad would possibly require 2-3 weeks of regular exposure to low water temperatures before being collected in samples, as illustrated in Figure 2. Any lethargic or moribund shad in the forebay of Watts Bar Dam would have been vulnerable to passage through the dam during generation. The continued decline of water temperatures into January, consistently low water temperatures in January and February (Figures 2 and 3), and/or passage through the dam could have caused further decline in condition and die-offs increasing their susceptibility to impingement at the WBN IPS. Some fish could actually be impinged after dying but cold temperatures could have delayed decomposition causing them to not be recognized as dead prior to impingement.

Fish Community Assessment - RFAI
In 2010, fish community RFAI scores of 44 ("Good"), 39 ("Fair") and 40 ("Fair") were observed at three sites in Chickamauga Reservoir: in the vicinity of WBN at TRM 529 (near-field), the Transition zone of the reservoir at TRM 490.5 and Forebay of Chickamauga Dam at TRM 482 (far-field), respectively (Table 6). Scores at these three sites were within 6 points of each other and met criteria to be considered similar (TVA, 2011). The RFAI was not used in 1996–1997 so there is not a direct comparison with 2010–2011, but average scores also rated "Good" for 1999–2010 and ranged from 44 to 45 (Table 6).

Summary and Conclusions

Proposed operation of Unit 2, given that both units would only withdraw water through the IPS to provide make-up for evaporation of cooling tower blowdown, would increase velocities upstream of the screen and through-screen, average flow rates and percent hydraulic entrainment to values shown in Table 1. It could be assumed that numbers of impinged fish could increase proportionally to average flowrates which would expand numbers impinged by the ratio of 80 to 116 cfs (Table 1). Lethargic, moribund, or dead shad would be drifting without much, if any, maneuverability and could be passively drawn to the IPS. However, considering the unpredictability of the environmental factors which influence cold-shock in shad, it is nearly impossible to estimate numbers of fish that will be impinged at WBN after the addition of Unit 2. Therefore, it is suggested that impingement at the WBN IPS with two-unit operation would be driven more by the severity of cold-shock or winter-kills of shad rather than the projected increase in flow values, given the increased impingement observed during winter 2011 from that of winter 1997 with one-unit operation.

Historical impingement estimated from WBN during the winter of 1997 was extremely low compared to that observed during the winter of 2011. Colder climatic conditions and probable cold-shock events during winter 2010–2011 appear to be the major factors in the increased impingement. Aside from occasional and uncontrollable cold-shock events, estimated numbers and species composition of impinged fish, low projected average flow rate (116 cfs or 0.4 % of average river flow) and through-screen velocity (0.8 fps), and "Good" ratings for the adult fish community in Chickamauga Reservoir suggest that proposed operation of two units at WBN will not affect the health and structure of the downstream reservoir fish community.

References

Baxter, D.S., J.P. Buchanan, G.D. Hickman, J.J. Jenkinson, J.D. Milligan, and C.J. O'Bara (1998). Aquatic environmental conditions in the vicinity of Watts Bar Nuclear Plant during two years of operation, 1996–1997. Norris, TN: Tennessee Valley Authority.

EPA. 2004. NPDES – Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities; Final Rule. Volume 69 Federal Register No. 131, July 9, 2004.

Fost, B. A. 2006. Physiological & Behavioral Indicators of Shad Susceptibility to Impingement at Water Intakes. M.S. Thesis, University of Tennessee, Knoxville. 45pp.

Griffith. J. S. 1978. Effects of low temperature on the survival and behavior of threadfin shad, *Dorosoma petenense.* Transactions of the American Fisheries Society. 107(1): 63-70.

Hickman, G.D. and T.A. McDonough. 1996. Assessing the Reservoir Fish Assemblage Index- A potential measure of reservoir quality. *In*: D. DeVries (Ed.) Reservoir symposium- Multidimensional approaches to reservoir fisheries management. Reservoir Committee, Southern Division, American Fisheries Society, Bethesda, MD. pp 85-97.

Jennings, M. J., L. S. Fore, and J. R. Karr. 1995. Biological monitoring of fish assemblages in the Tennessee Valley reservoirs. Regulated Rivers 11:263-274.

Loar J.M., J.S. Griffith, and K.M. Kumar. 1978. An analysis of factors influencing the impingement of threadfin shad at power plants in the southeastern United States. Chicago, Illinois.

McDonough, T.A. and G.D. Hickman. 1999. Reservoir Fish Assemblage Index development: A tool for assessing ecological health in Tennessee Valley Authority impoundments. *In*: Assessing the sustainability and biological integrity of water resources using fish communities. Simon, T. (Ed.) CRC Press, Boca Raton, pp 523-540.

McLean, R.B., P.T. Singley, J.S. Griffith, and M.V. McGee. 1980. Threadfin shad impingement: Effect of cold stress. ORNL/NUREG/TM-340 and NUREG CR-1044. Oak Ridge National Laboratory, Oak Ridge, TN. 106 pp.

McLean, R.B., J.S. Griffith, and M.V. McGee. 1985. Threadfin shad, *Dorosoma petenense* Gunther, mortality: causes and ecological implications in a South-eastern United States reservoir. Journal of Fisheries Biology. Vol 27. pp 1-12.

Tennessee Valley Authority. 2004. Impingement Counts. Quality Assurance Procedure No. RSO&E-BR-23.11, Rev 1. TVA River Systems Operation and Environment, Aquatic Monitoring and Management Knoxville TN. 11 pp.

Tennessee Valley Authority. 2011. Biological Monitoring of the Tennessee River near Watts Bar Nuclear Plant Discharge, Autumn 2010. Tennessee Valley Authority, Aquatic Monitoring and Management, Knoxville, Tennessee. 78 pp.

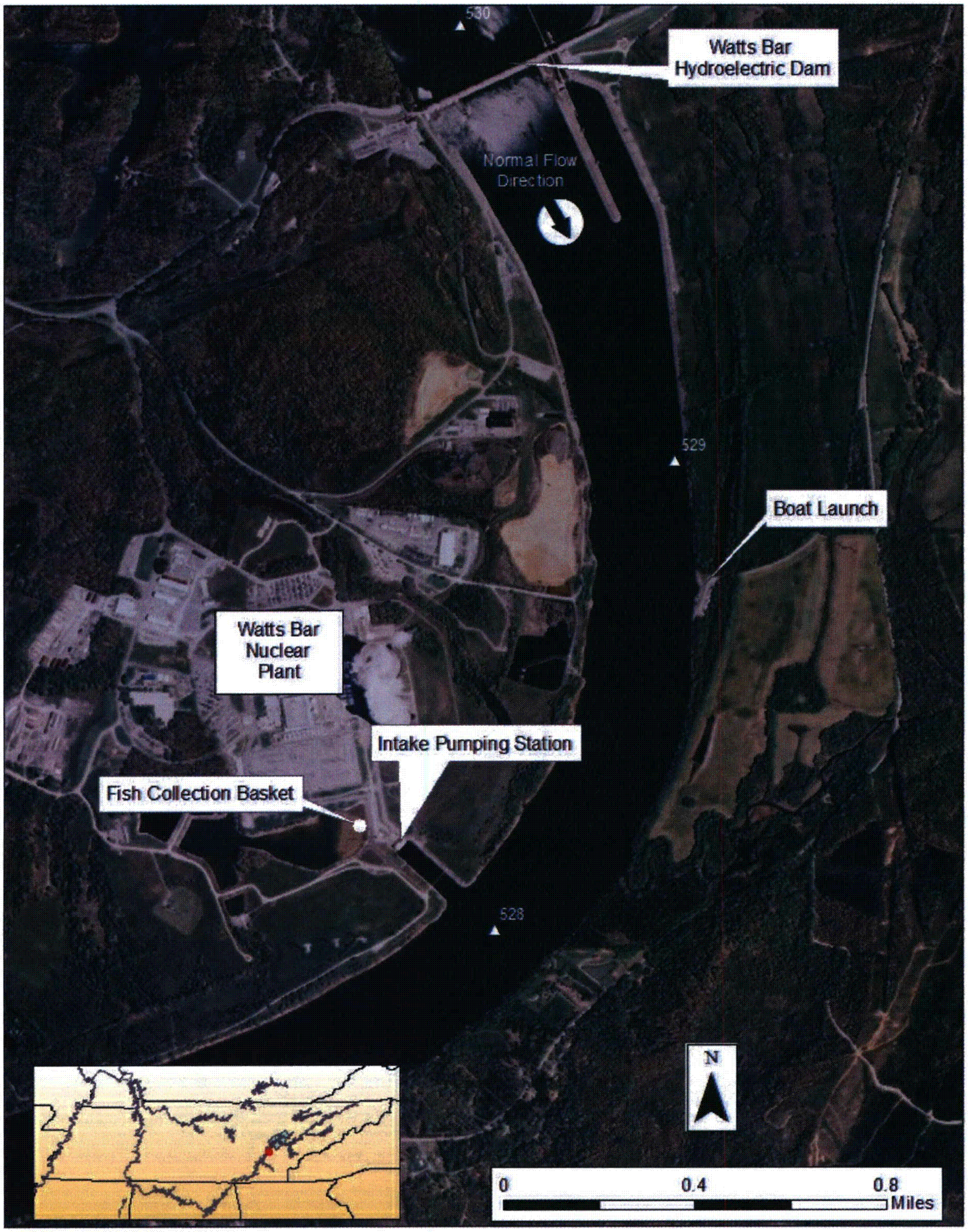

Figure 1. Location of Watts Bar Nuclear Plant, Watts Bar Hydroelectric Dam, Fish Collection Basket, and Intake Pumping Station.

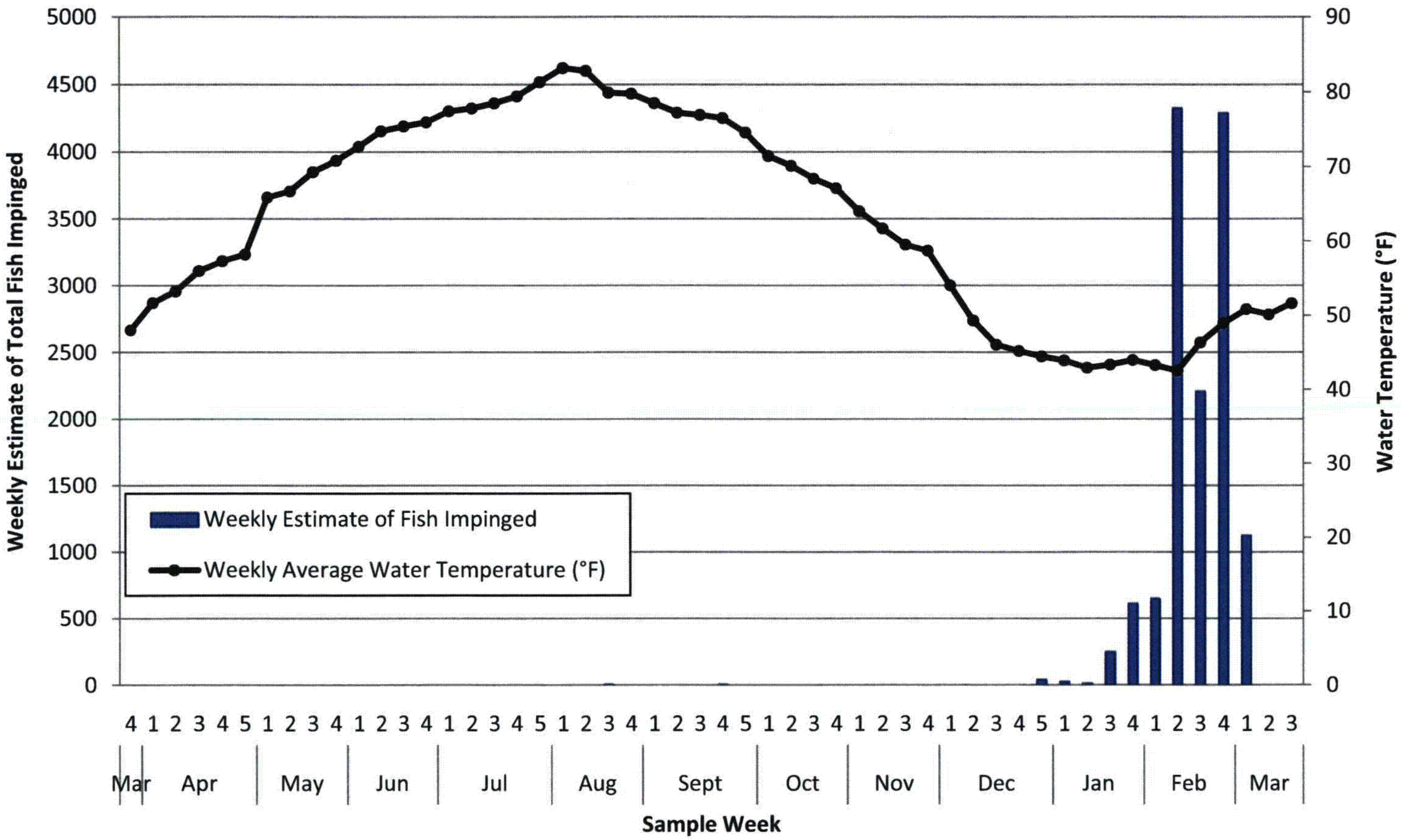

Figure 2. Estimated Weekly Fish Impingement and Weekly Average Water Temperatures (°F) at the WBN Intake Pumping Station, March 26, 2010 Through March 17, 2011.

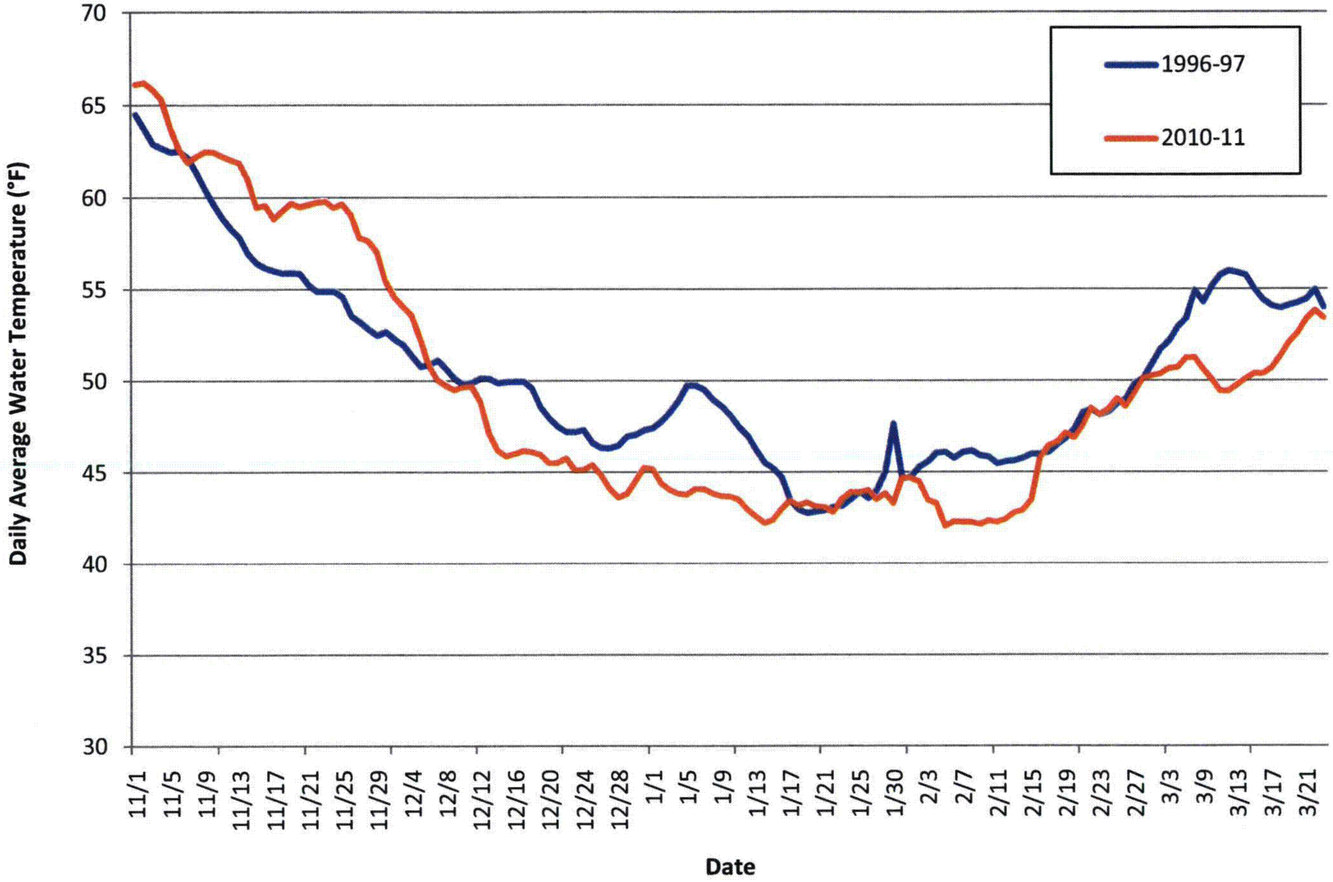

Figure 3. Daily Average Water Temperatures (°F) Collected from Chickamauga Reservoir in the Vicinity of WBN during November 1996 through March 1997 and November 2010 through March 2011.

Table 1. Comparison of Intake (in front of screen) and Through-Screen Velocities, Average Flow Rates, Percent Hydraulic Entrainment (Percent of River Flow) at and River Flow (Long-Term Average) Past WBN's Intake Pumping Station during Operation of Unit 1 Only and Expected Values during Operation of Units 1 and 2 Combined.

	Unit 1 Only	**Units 1 and 2 (combined)**
Intake velocity (in front of screen)	0.2 fps	0.3 fps
Through-screen velocity	0.6 fps	0.8 fps
Average flow rates	80 cfs	116 cfs
Percent hydraulic entrainment	0.3%	0.4%
River flow (long-term average)	27,000 cfs	27,000 cfs

Table 2. List of Fish Species by Family, Scientific, and Common Name Including Actual Numbers and Percent Composition Collected in Impingement Samples During March 1996 through March 1997 and March 26, 2010 Through March 17, 2011 at TVA's Watts Bar Nuclear Plant.

Family	Scientific Name	Common Name	3/1996 - 3/1997		3/26/2010 - 3/17/2011	
			Total Number Impinged	Percent Composition	Total Number Impinged	Percent Composition
Clupeidae	*Dorosoma cepedianum*	Gizzard shad	4	25.0%	1,172	60.4%
	Dorosoma petenense	Threadfin shad	2	12.5%	766	39.5%
Ictaluridae	*Ictalurus punctatus*	Channel catfish	1	6.3%	---	0.0%
	Pylodictus olivaris	Flathead catfish	1	6.3%	---	0.0%
Centrarchidae	*Lepomis macrochirus*	Bluegill	2	12.5%	---	0.0%
	Lepomis microlophus	Redear sunfish	1	6.3%	---	0.0%
	Pomoxis annularis	White crappie	2	12.5%	---	0.0%
Sciaenidae	*Aplodinotus grunniens*	Freshwater drum	3	18.8%	---	0.0%
Atherinopsidae	*Menidia beryllina*	Inland silverside	---	-	1	0.1%
		Total Number of Fish	**16**		**1,939**	
		Total Number of Species	**8**		**3**	
		Total Number of Sample Days	**52**		**52**	

Table 3. Actual Numbers and Weekly Estimates and Percent of Annual Total of Fish Impinged at Watts Bar Nuclear Plant by Month During March 26, 2010 Through March 17, 2011.

Year	Month	Week	Actual Numbers Impinged	Estimated Weekly Numbers Impinged	Percent of Annual Total
2010	March	4	0	0	0.0%
	April	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
		5	0	0	0.0%
	May	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
	June	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
	July	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
		5	0	0	0.0%
	August	1	0	0	0.0%
		2	0	0	0.0%
		3	1	7	0.1%
		4	0	0	0.0%
	September	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	1	7	0.1%
		5	0	0	0.0%
	October	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
	November	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
	December	1	0	0	0.0%
		2	0	0	0.0%

Table 3. (Continued)

Year	Month	Week	Actual Numbers Impinged	Estimated Weekly Numbers Impinged	Percent of Annual Total
		3	0	0	0.0%
		4	0	0	0.0%
		5	6	42	0.3%
2011	January	1	4	28	0.2%
		2	2	14	0.1%
		3	36	252	1.9%
		4	88	616	4.5%
	February	1	93	651	4.8%
		2	618	4,326	31.9%
		3	316	2,212	16.3%
		4	613	4,291	31.6%
	March	1	161	1,120	8.3%
		2	0	0	0.0%
		3	0	0	0.0%
	Total (Annual)	**52**	**1,939**	**13,573**	**100%**

Table 4. Estimated Annual Numbers and Percent Composition of Fish Impinged by Species at Watts Bar Nuclear Plant During March 1996 Through March 1997 and March 26, 2010 Through March 17, 2011.

Species	3/1996 - 3/1997		3/26/2010 - 3/17/2011	
	Estimated Number	Percent Composition by Number	Estimated Number	Percent Composition by Number
Gizzard shad	41	25.0%	8,204	60.4%
Threadfin shad	20	12.5%	5,362	39.5%
Channel catfish	30	18.8%		0.0%
Flathead catfish	10	6.3%		0.0%
Bluegill	10	6.3%		0.0%
Redear sunfish	20	12.5%		0.0%
White crappie	10	6.3%		0.0%
Freshwater drum	20	12.5%		0.0%
Inland silverside	---	---	7	0.1%
Total	**161**	**100%**	**13,573**	**100%**

Table 5. Comparison of Daily Average Water Temperatures (°F) Collected from Watts Bar Reservoir in the Vicinity of WBN During November 1996 Through March 1997 and November 2010 Through March 2011.

	Daily Average Water Temperatures (°F)		
Period	**1996–1997**	**2010–2011**	**Difference**
November	57.9	61.2	3.3
December	49.2	47.8	-1.4
January	45.9	43.6	-2.3
February	46.8	45.3	-1.5
March	54.3	51.1	-3.2
November – March	50.6	49.7	-0.9
December – January	47.6	45.8	-1.8
December – February	47.4	45.6	-1.8
January – February	46.4	44.4	-2.0

Table 6. Summary of RFAI Scores from Fish Community Sample Sites Located Downstream of Watts Bar Nuclear Plant 1999-2010 as Part of the Vital Signs Monitoring Program in Chickamauga Reservoir.

Station	Location	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average
Downstream Inflow (Near-Field)	TRM 529.0	42	44	46	48	48	42	42	42	42	44	44	44	**45 (Good)**
Transition (Far-Field)	TRM 490.5	45	46	45	51	42	49	46	47	44	34	41	39	**44 (Good)**
Forebay (Far-Field)	TRM 472.3	45	45	48	46	43	43	46	43	41	41	42	40	**44 (Good)**

RFAI Scores: 12-21 ("Very Poor"), 22-31 ("Poor"), 32-40 ("Fair"), 41-50 ("Good"), or 51-60 ("Excellent").

Enclosure 2
Watts Bar Nuclear Plant

Report Entitled "Discussion of the Results of the 2010 Mollusk Survey of the Tennessee River Near Watts Bar Nuclear Plant (Rhea County, Tennessee)"

Discussion of the results of the 2010 Mollusk Survey of the Tennessee River Near Watts Bar Nuclear Plant (Rhea County, Tennessee)

John T. Baxter

March 2011

Tennessee Valley Authority
Biological Compliance
Knoxville, Tennessee

The purpose of this document is to evaluate and compare data reported from the 2010 mussel survey conducted for Tennessee Valley Authority (TVA) by Third Rock Consultants, LLC (TRC 2010) to data collected at the three mussel beds (Figure 1) previously monitored by TVA. Specifically, the 2010 data are compared to mussel data collected by TVA for preoperational (1983 - 1994) and operational (1996 - 1997) monitoring for Unit 1 of the Watts Bar Nuclear Plant (WBN), located on the Tennessee River in Rhea County, Tennessee (TVA 1998). As described further below, these data indicate that the current mussel community adjacent to WBN is substantially similar to conditions near the end (1996-1997) of the WBN Unit 1 operational and pre-operational monitoring period. Both species composition and the number of mussels collected are similar.

1983 - 1997 Collection Methods

Between 1983 and 1985, collection was conducted by two pairs of SCUBA divers collecting mussels for 11 minutes each (for an aggregate total of approximately 45 minutes of diver search time) in four sampling sites within each of three mussel beds. Collections conducted from 1985-1997 were conducted by two divers, each collecting mussels for 22 minutes from each of the three mussel beds. This sampling was semi-quantitative in nature and was designed to maximize the number of individuals collected by each diver (TVA, 1998).

1983 - 1997 Collection Data

Examining the entire dataset from these monitoring sites (Figure 2) indicates that there was a decline in both species numbers and abundance between the 1988 and 1992 sampling efforts near WBN. A drop in the number of individual mussels collected was observed between 1988 and 1990. A similar drop in species numbers is seen between the 1990 and 1992 sampling efforts. An extreme drought period occurred across the Tennessee Valley from 1986 to 1992, with particularly extreme conditions seen from 1987 to 1988 (Riebsame et al. 1991). Sustained periods of low flow and extremely low dissolved oxygen levels (DO) were seen in Watts Bar Reservoir and the Watts Bar Dam tailwater during this time. These effects are believed to be primarily responsible for the decline in species numbers and abundance observed after the drought peaked in 1988 in the Southeast.

Changes to Watts Bar Dam releases during and following the collection of pre-operational data

In 1991, under the Lake Improvement Plan (LIP) (TVA 1990), TVA adopted efforts to increase DO concentrations in the releases from 16 dams (including Watts Bar Dam) and to provide project specific minimum flows. In 1996, TVA installed an aeration system in the forebay of Watts Bar Reservoir to reduce reservoir stratification and associated dissolved oxygen problems in the vicinity of Watts Bar Dam. This has resulted in higher dissolved oxygen levels in the dam releases and appears to have mitigated some of the effects of the more recent 2007 - 2008 drought period on aquatic communities (based on TVA Reservoir Fisheries Assemblage Index data).

TVA also established a "system minimum flow" operating scheme as a result of the Reservoir Operations Study (TVA 2004). These changes established a weekly average minimum flow at Chickamauga Dam (downstream of Watts Bar Dam) of 13,000 cfs/week from June 1 to July 31, and 25,000 cfs/week from August 1 to Labor Day. This effectively institutes a minimum flow at Watts Bar Dam, which replaces an operating scheme that previously resulted in extended periods of low flow (or essentially no flow) during summer months.

Because the observed mussel declines from 1988 to 1992 pre-date WBN Unit 1 operation in 1996 and the LIP release improvements at Watts Bar Dam, the decline cannot be attributed to operation of WBN Unit 1. It is therefore appropriate to examine the potential effects of WBN Unit 2 operation with 1992 and 1994 numbers as the environmental baseline for mussel communities near WBN.

2010 Collection Methods

Semi-quantitative and quantitative mollusk sampling was conducted September 28-30, 2010, at the three sampling areas that were part of the pre-operational (1983-1994) and operational (1996-1997) monitoring for WBN Unit 1. Details of the methodology are discussed in the full 2010 survey report (TRC 2010). A total of 120 semi-quantitative and forty quantitative samples were taken during the 2010 survey. This methodology is designed to be more repeatable than the semi-quantitative (timed search) samples taken previously. No quantitative sampling was conducted in previous years. In addition to sampling in the three mussel beds surveyed in previous sampling, a survey of the experimental boulder field placed by TVA (Fraley et al. 2002) was conducted. Very few mussels were found in the boulder field, and that sampling effort is not discussed further in this document.

2010 Collection Data

A total of 17 species (902 individuals) was collected in the semi-quantitative (17 species, 852 individuals) and quantitative (6 species, 50 individuals) sampling (TRC 2010). The data are well within the range of variation for samples collected from 1992 and 1994 (pre-operational monitoring), and 1996 and 1997 (operational monitoring) (Figure 2). One individual of the federally listed endangered pink mucket and one individual of the federal candidate sheepnose mussel were collected at transects downstream of the WBN discharge. The highest densities of mussels occurred in the two sampling sites downstream of the WBN discharge (TRC 2010).

Only the semi-quantitative data from 2010 were used in Table 1 in order to provide a reasonable comparison to previous sampling methods. As noted above, the quantitative sampling added no new species to the survey, and relatively few (50) individual mussels. There is a lack of sampling data between 1997 and 2010, and therefore it is difficult to speculate how mussel numbers may have fluctuated over this period. The expectation is that LIP and ROS improvements to Watts Bar Dam releases would have at least provided a relatively stable environment for the mussel community when compared to conditions prior to 1996.

Of note in the data is evidence that recent recruitment (individuals aged at < 5 years) has occurred in at least five mussel species (*Cyclonaias tuberculata, Leptodea fragilis, Megalonaias* *nervosa, Potamilus alatus, and Utterbackia imbecillis*). Fifteen of the seventeen species collected contained individuals that were less than 40 years old (TRC 2010), indicating that reproduction in these species has occurred since closure of Watts Bar Dam. Previous data (TVA 1998) indicated "that individual mussels in the Tennessee River near WBN are continuing to grow slowly, but some species are disappearing from the communities and the some more abundant populations are demonstrating statistically significant declines. The freshwater mussels in the vicinity of WBN are quite old and most of the 30 species found may not have reproduced in the past 50 years." Data on young mussels collected in 2010 indicates that this statement may no longer be true, or that previously indicated downward trends have shown improvement.

Conclusions

The species that declined between 1992 and 1994 were present in the mussel community at extremely low densities prior to 1994 and are usually represented by the collection of only one or two individuals during any sampling effort (Table 1). These species may still be present at extremely low densities within the community and were simply not collected in subsequent sampling. A good illustration of this is the collection of a single sheepnose mussel in 2010. Prior to this collection, this species was found only in 1983 (2 individuals), 1992 (1 individual) and 1994 (1 individual). This indicates an extremely low frequency of occurrence in the population, and a corresponding low probability of detection, but does not necessarily indicate that the species is no longer present.

Since 1992, mussel species numbers and abundance appear to be relatively stable (Figure 2). The relative stability in the number of mussel species present in the samples sites, along with reasonable population sizes, indicates that operation of WBN Unit 1 has not led to any decline in the mussel community in the Tennessee River near WBN when compared to the 1992-1994 data. Evidence of reproduction in many of the mussels sampled, and evidence of very recent recruitment of five mussel species is further evidence that operation of WBN Unit 1 is not having a significant adverse effect on this resource.

Hydrothermal and water quality analyses conducted by TVA indicate that water quality conditions (particularly thermal conditions) in the Tennessee River in the vicinity of the WBN discharge would not change significantly with the addition of WBN Unit 2. No adverse impacts to mussel resources in the Tennessee River adjacent to WBN are anticipated to occur as a result of operating both WBN Unit 1 and WBN Unit 2.

References

Fraley et al. 2002. S.J. Fraley, J.J. Jenkinson, and Brennan T. Smith. Watts Bar Native Mussel Enhancement Project. Preliminary Evaluation of an Artificial Boulder Field for Enhancing Native Mussel Habitat in the Watts Bar Tailwater, Tennessee River Mile 528.5. Tennessee Valley Authority, River Systems Operation and Environment, Resource Stewardship. Norris, Tennessee.

Riebsame, W. E., S. A. Changnon, and T. R. Karl. 1991. Drought and natural resources management in the United States: impacts and implications of the 1987-89 drought. Westview Press 11-92.

TVA (Tennessee Valley Authority). 1990. Lake Improvement Plan, Tennessee River and Reservoir System Operating and Planning Overview. Final Environmental Impact Statement. (TVA/RDG/EQS-91/1.)

TVA (Tennessee Valley Authority). 1998. Aquatic Environmental Conditions in the Vicinity of Watts Bar Nuclear Plant during two years of operation, 1996-1997.

TVA (Tennessee Valley Authority). 2004. Reservoir Operations Study. Final Environmental Impact Statement.

TVA (Tennessee Valley Authority). 2007. Completion and Operation of Watts Bar Nuclear Plant Unit 2, Rhea County, Tennessee. Final Supplemental Environmental Impact Statement.

TRC (Third Rock Consultants). 2010. Mollusk Survey of the Tennessee River Near Watts Bar Nuclear Plant (Rhea County, Tennessee). Prepared for Tennessee Valley Authority by Third Rock Consultants, LLC, Lexington, KY. October 28, 2010. Revised November 24, 2010.

P:\Project_Files\Tennessee\TN10-026_TVA_WattsBar_Mussels\Mapping\GIS\Exhibit1_Upper_Mussels WCO 10/21/10

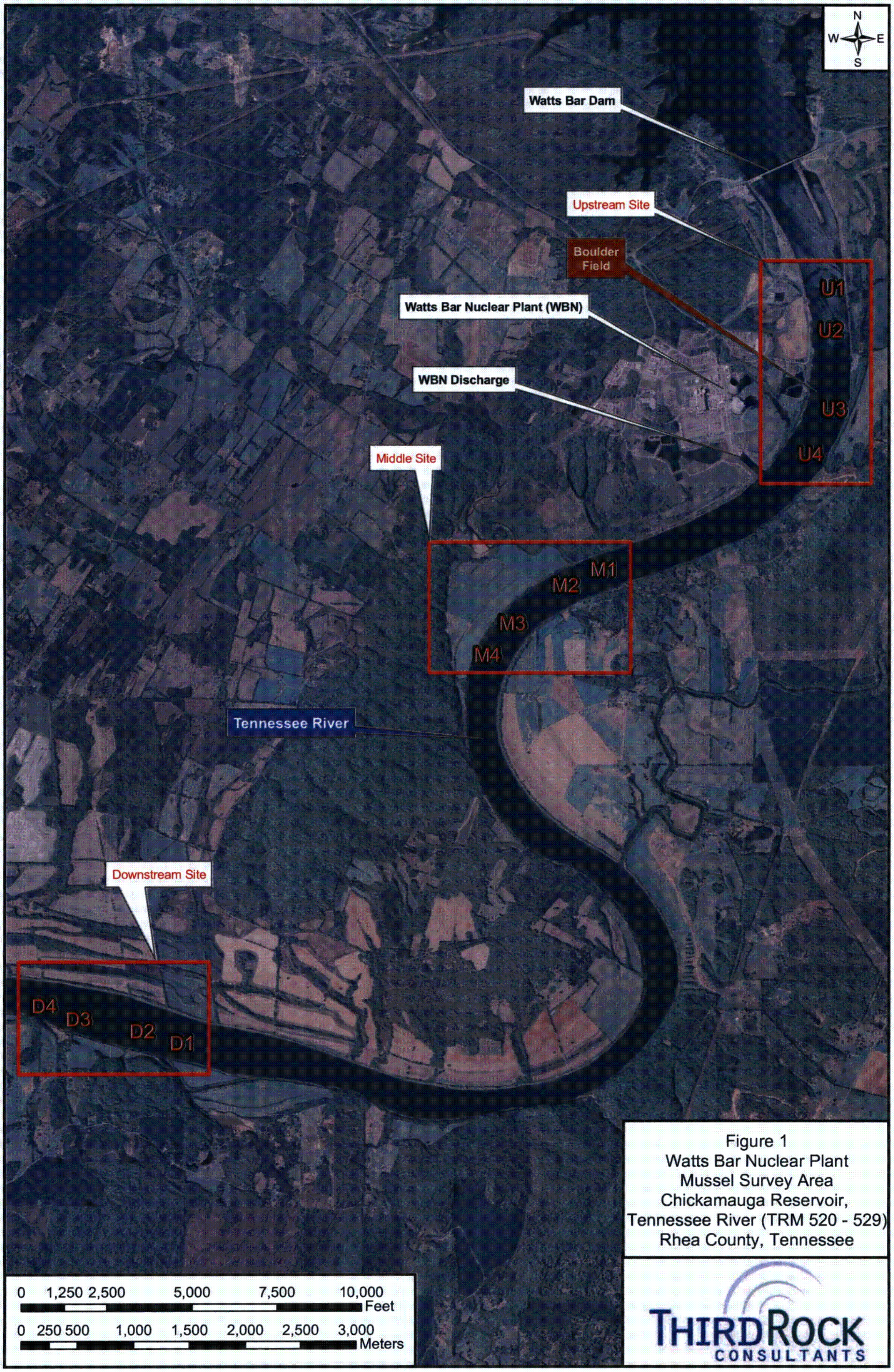

Figure 1
Watts Bar Nuclear Plant
Mussel Survey Area
Chickamauga Reservoir,
Tennessee River (TRM 520 - 529)
Rhea County, Tennessee

Figure 2. Comparison of historical and current mussel species and abundances in the Tennessee River in the vicinity of Watts Bar Nuclear Plant

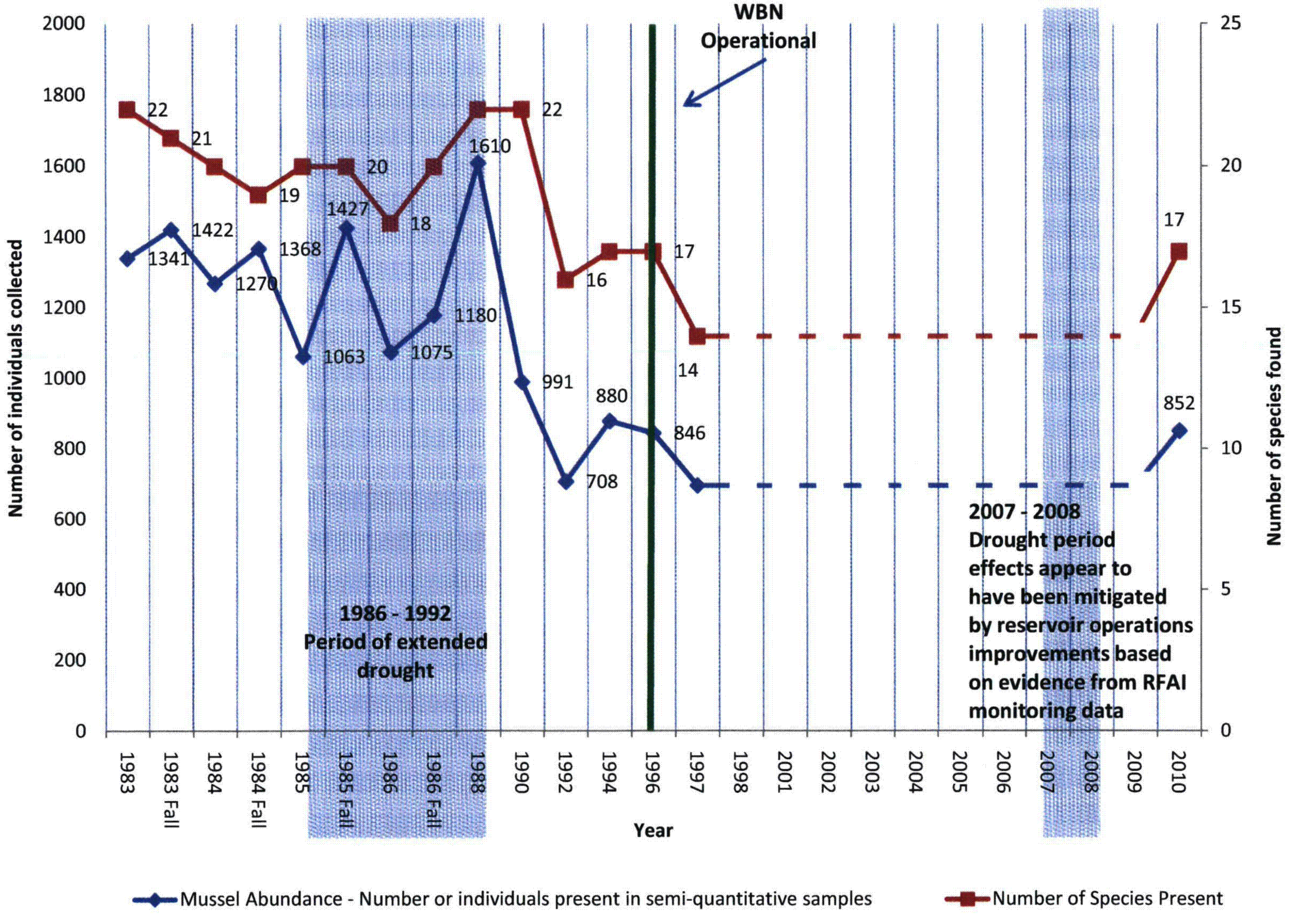

Table 1 . Total numbers of each native mussel species collected during preoperational (1983-1994) and operational (1996-1997) surveys near Watts Bar Nuclear Plant.
Source: Table 3-7 from TVA SEIS (TVA, 2007) revised to include 2010 collection data (TRC, 2010).

		Preoperational												Operational						
Scientific Name	**Common Name**	**1983**	**1983 Fall**	**1984**	**1984 Fall**	**1985**	**1985 Fall**	**1986**	**1986 Fall**	**1988**	**1990**	**1992**	**1994**	**1996**	**1997**	**Totals**	**Times Found**	**2010 Semi-Quantitative Data**	**2010 Quantitative Data**	**2010 Total - Excluding Boulder Field**
Elliptio crassidens	elephant ear	754	836	779	984	738	929	734	765	970	524	424	583	594	489	10103	14	521	13	534
Pleurobema cordatum	Ohio pigtoe	264	275	220	156	113	177	110	169	224	139	82	95	94	101	2219	14	125	0	125
Cyclonaias tuberculata	purple wartyback	88	70	73	62	60	66	55	76	93	90	68	64	38	47	950	14	81	2	83
Quadrula pustulosa	pimpleback	99	75	85	53	53	85	31	41	80	79	48	65	30	24	848	14	53	21	74
Potamilus alatus	pink heelsplitter	14	29	18	29	34	43	41	27	55	45	16	10	35	12	408	14	24	7	31
Ellipsaria lineolata	butterfly	24	29	24	25	8	27	19	18	23	28	14	11	15	8	273	14	27	0	27
Amblema plicata	threeridge	18	33	19	11	17	25	23	24	49	10	13	13	11	5	271	14	2	0	2
Pyganodon grandis	giant floater	18	10	5	4	3	7	9	7	29	20	5	7	7	1	132	14	1	0	1
Quadrula metanevra	monkeyface	14	24	11	13	6	10	7	7	8	8	8	4	2	2	124	14	3	0	3
Tritogonia verrucosa	pistogrip	6	12	5	5	4	15	8	13	18	9	9	7	4	1	116	14	0	0	0
Obliquaria reflexa	threehorn wartyback	14	6	8	3	7	5	9	3	7	11	6	11	6	3	99	14	5	5	10
Ligumia recta	black sandshell	6	3	4	10	3	8	8	10	7	2	3	1	2	1	68	14	0	0	0
Lampsilis abrupta	pink mucket	3	7	6	2	1	7	6	2	12	4	6	2	4	0	62	13	1	0	1
Leptodea fragilis	fragile papershell	1	3	4	2	3	2	6	3	12	8	0	3	1	2	50	13	3	2	5
Actinonaias ligamentina	mucket	3	2	2	0	4	7	0	8	3	5	1	0	0	0	35	9	0	0	0
Megalonaias nervosa	washboard	2	1	0	1	1	4	5	1	9	3	4	2	1	0	34	12	1	0	1
Lampsilis ovata	pocketbook	3	1	1	4	5	4	1	2	3	1	0	0	0	1	26	11	0	0	0
Elliptio dilatata	spike	4	2	1	1	0	2	2	1	3	1	0	0	1	0	18	10	2	0	2
Pleurobema oviforme	Tennessee clubshell	0	0	2	0	0	1	0	2	2	1	0	1	0	0	9	6	0	0	0
Utterbackia imbecillis	paper pondshell	0	0	0	2	0	0	0	1	1	1	0	0	0	0	5	4	1	0	1
Cyprogenia stegaria	fanshell	2	1	0	1	1	0	0	0	0	0	0	0	0	0	5	4	0	0	0
Pleurobema plenum	rough pigtoe	1	1	2	0	1	0	0	0	0	0	0	0	0	0	5	4	0	0	0
Plethobasus cyphyus	sheepnose	0	2	0	0	0	0	0	0	0	0	1	1	0	0	4	3	1	0	1
Pleurobema rubrum	pyramid pigtoe	0	0	0	0	0	3	0	0	1	0	0	0	0	0	4	2	0	0	0
Fusconaia subrotunda	longsolid	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	1
Anodonta suborbiculata	flat floater	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2	2	0	0	0
Lasmigona costata	flutedshell	0	0	0	0	0	0	1	0	0	0	0	0	1	0	2	2	0	0	0
Ptychobranchus fasciolaris	kidneyshell	0	0	1	0	0	0	0	0	0	1	0	0	0	0	2	2	0	0	0
Dromus dromas	dromedary pearlymussel	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Lasmigona complanata	white heelsplitter	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0
	Total Mussels	**1341**	**1422**	**1270**	**1368**	**1063**	**1427**	**1075**	**1180**	**1610**	**991**	**708**	**880**	**846**	**697**	**15878**		**852**	**50**	**902**
	Number of Species Collected	**22**	**21**	**20**	**19**	**20**	**20**	**18**	**20**	**22**	**22**	**16**	**17**	**17**	**14**	**30**		**17**	**6**	**17**