TVA

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

March 24, 2011

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

Watts Bar Nuclear Plant, Unit 2
NRC Docket No. 50-391

10 CFR 50.4

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

References: 1. TVA Letter dated January 4, 2011, "Watts Bar Nuclear Plant (WBN) Unit 2 - Additional Information Related To U.S. Nuclear Regulatory Commission (NRC) Request For Additional Information (RAI) Regarding Environmental Review (TAC No. MD8203)"

The purpose of this submittal is to provide two additional TVA reports to support NRC Environmental Review. Enclosure 1 provides a report entitled, "Discussion of the Results of the 2010 Mollusk Survey of the Tennessee River Near Watts Bar Nuclear Plant (Rhea County, Tennessee)." TVA has previously provided the 2010 Mollusk Survey via Reference 1. Enclosure 2 provides a report entitled, "Comparison of 2010 Peak Spawning Seasonal Densities of Ichthyoplankton at Watts Bar Nuclear Plant at Tennessee River Mile 528 with Historical Densities during 1996 and 1997."

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 24th day of March, 2011.

Respectfully,

David Stinson
Watts Bar Unit 2 Vice President

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NRR

Enclosures:

1. Discussion of the Results of the 2010 Mollusk Survey of the Tennessee River Near Watts Bar Nuclear Plant (Rhea County, Tennessee)
2. Comparison of 2010 Peak Spawning Seasonal Densities of Ichthyoplankton at Watts Bar Nuclear Plant at Tennessee River Mile 528 with Historical Densities during 1996 and 1997

cc (Enclosures):

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Enclosure 1
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
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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

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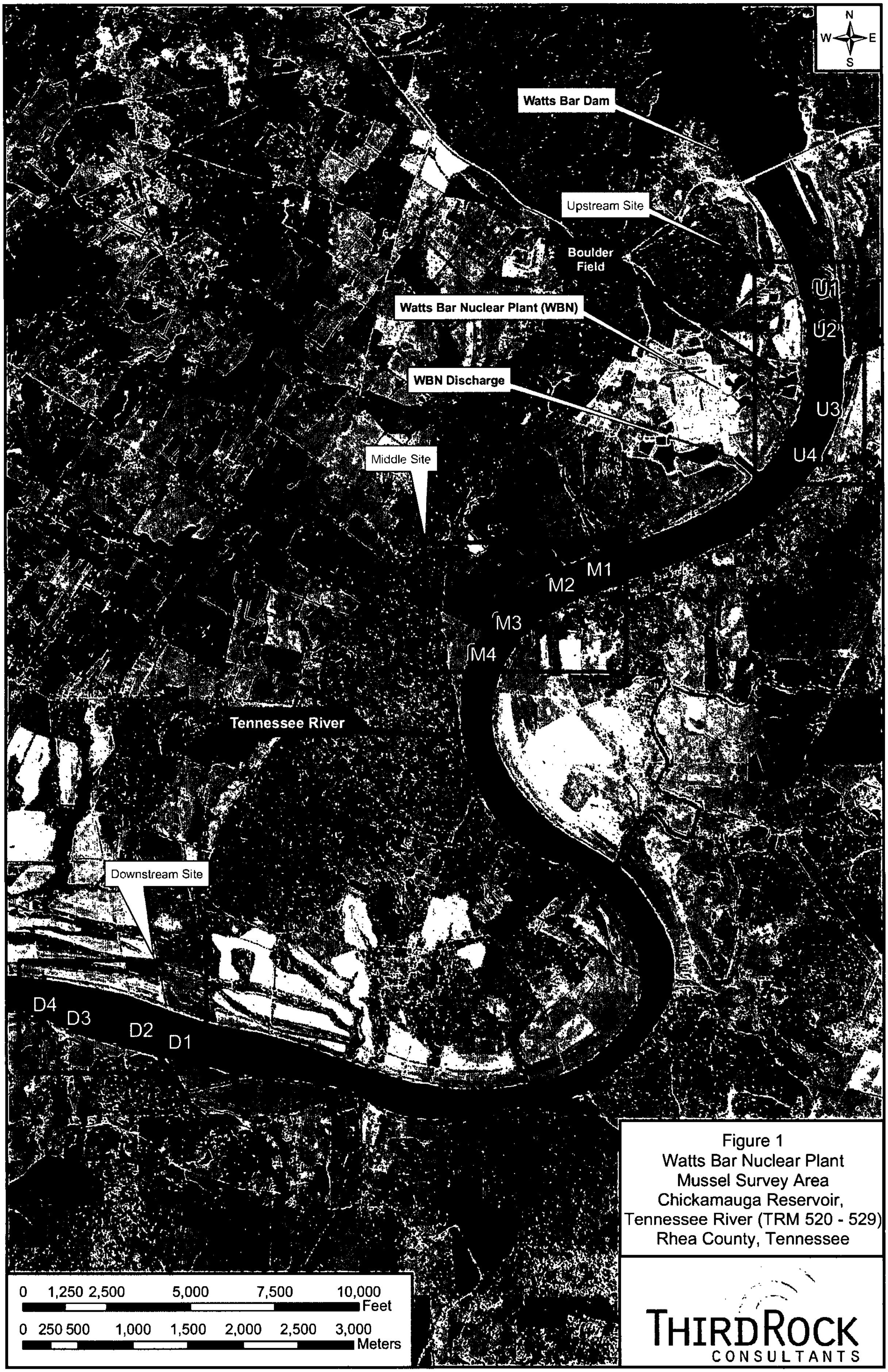

Figure 1
Watts Bar Nuclear Plant
Mussel Survey Area
Chickamauga Reservoir,
Tennessee River (TRM 520 - 529)
Rhea County, Tennessee

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

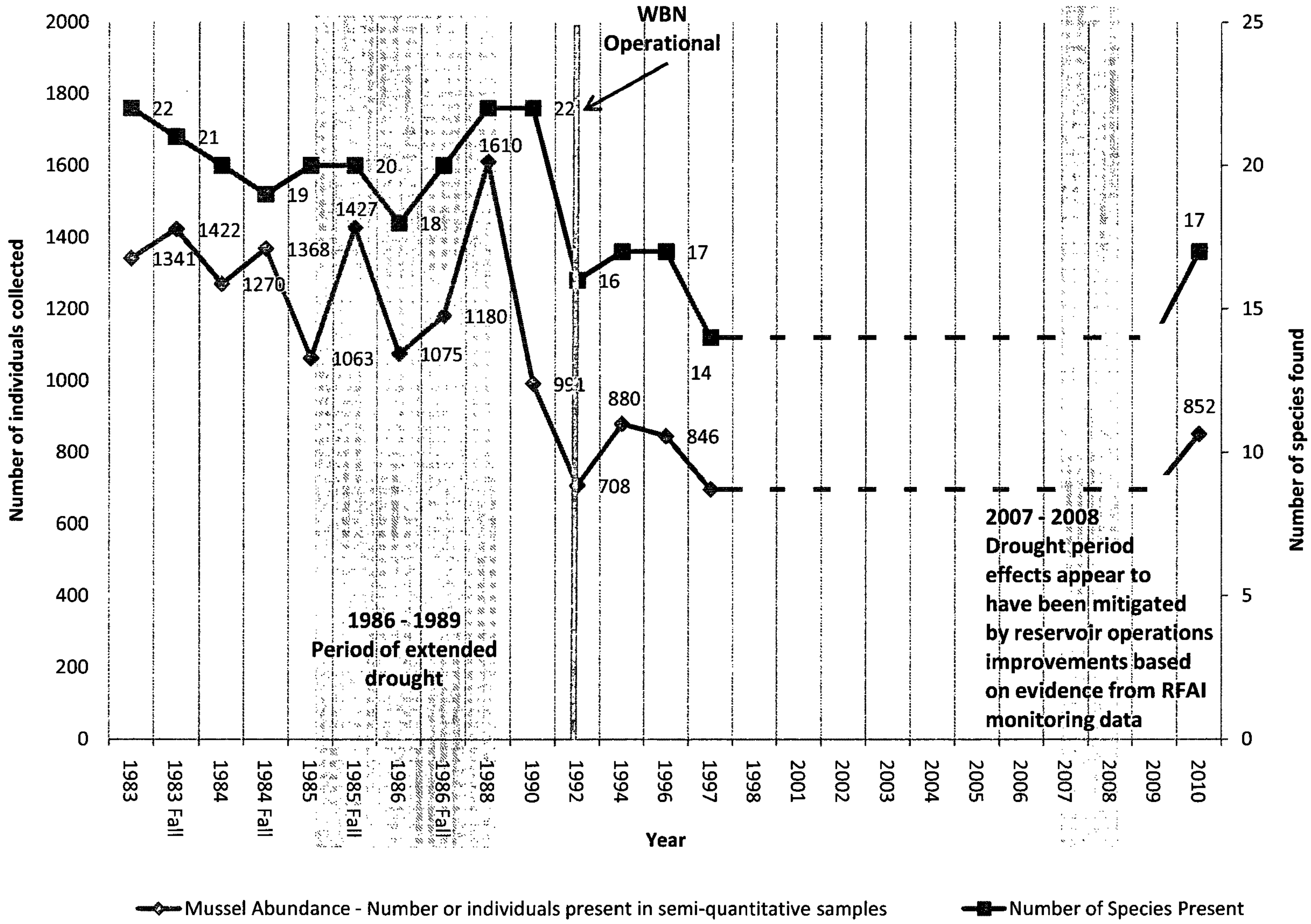

Table 1 . Total numbers of each native mussel species collected during preoperational (1983-1994) and operational (1996-1997) surveys near Watts Bar Nuclear Plant.
Source: Table 3-7 from TVA SEIS (TVA, 2007) revised to include 2010 collection data (TRC, 2010).

		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**

Enclosure 2
Watts Bar Nuclear Plant

Report Entitled "Comparison of 2010 Peak Spawning Seasonal Densities of Ichthyoplankton at Watts Bar Nuclear Plant at Tennessee River Mile 528 with Historical Densities during 1996 and 1997"

Comparison of 2010 Peak Spawning Seasonal Densities of Ichthyoplankton at Watts Bar Nuclear Plant at Tennessee River Mile 528 with Historical Densities during 1996 and 1997

TENNESSEE VALLEY AUTHORITY

ENVIRONMENTAL STEWARDSHIP AND POLICY

APRIL 2011

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Abbreviations and Acronyms

cfs	cubic feet per second
CTB	cooling tower blowdown
fps	feet per second
msl	mean sea level
SCCW	Supplemental Condenser Cooling Water
TRM	Tennessee River Mile
TVA	Tennessee Valley Authority
WBH	Watts Bar Hydroelectric Dam
WBN	Watts Bar Nuclear Plant

Introduction

Tennessee Valley Authority (TVA) is conducting additional monitoring during 2010–2011 in Chickamauga Reservoir to estimate entrainment mortality of fish in the vicinity of Watts Bar Nuclear Plant (WBN) due to the proposed operation of an additional nuclear reactor (Unit 2) at the Plant site. This monitoring began March 2010 and will serve to update and verify historical monitoring conducted in 1996 and 1997. This report will present taxonomic composition, densities and estimated entrainment during April through June 2010 and compare these data from the same period during 1996 and 1997.

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 decommissioned Watts Bar Fossil Plant (Figure 1). Unit 1 went into commercial operation on May 27, 1996 and is designed for a net electrical output of 1,160 megawatts (gross electrical output of 1,218 megawatts).

Materials and Methods

Data Collection

Ichthyoplankton samples during 1996 and 1997 monitoring of Unit 1 were collected biweekly, on a diel schedule (day and night), during April through June. Reservoir samples were collected at five stations along a transect located at TRM 528.4, which was perpendicular to river flow just upstream of the cooling tower make-up water intake channel (Figure 1). Four intake samples were collected within the Intake Pumping Station (IPS) canal located at TRM 528 (Figure 1). Samples were taken with a beam net (0.5 m square, 1.8 m long, with 505 micron "nitex" mesh netting) towed upstream at a speed of 1.0 m/s for ten minutes. The volume of water filtered through the net was measured with a large-vaned General Oceanics Inc.® flowmeter. Approximately 150 m^3 of water were filtered per ten-minute sample. Water temperature was recorded using a mercury thermometer calibrated to the tenth degree. Ichthyoplankton samples during 2010 monitoring were collected using the same methods, diel schedule (day and night), sampling period (April through June), and at the same sampling locations as those used in 1996 and 1997 monitoring, with one exception. During 2010 monitoring, samples were collected weekly instead of biweekly. Detailed ichthyoplankton sampling procedures used during 1996, 1997, and 2010 monitoring are outlined in S&F OPS-FO-BR-23.5 (TVA, 2010a).

Laboratory Analysis

Laboratory analyses also followed the same procedures in 2010 as in 1996 and 1997. Larval fish were removed from the samples, identified to the lowest possible taxon, counted and measured to the nearest millimeter total length following procedures outlined in S&F OPS-FO-BR-24.1 (TVA, 2010b). Taxonomic decisions were based on TVA's "Preliminary Guide to the Identification of Larval Fishes in the Tennessee River," (Hogue et al., 1976) and other pertinent literature (Wallus et al., 1990; Kay et al., 1994; Simon and Wallus, 2003; Simon and Wallus, 2006; Wallus and Simon, 2006; and Wallus and Simon, 2008).

The term "unidentifiable larvae" applies to specimens too damaged or mutilated to identify, while "unspecifiable" before a taxon implies a level of taxonomic resolution (i.e., "unspecifiable catastomids" designates larvae within the family *Catostomidae* that currently cannot be identified to a lower taxon). The category "unidentifiable eggs" applies to specimens that cannot be identified due to damage or lack of taxonomic knowledge. Taxonomic refinement is a function of specimen size and developmental stage. Throughout this report, the designation "unspecifiable clupeids" refers to clupeids less than 20 mm in total length and could include *Dorosoma cepedianum* (gizzard shad), *D. petenense* (threadfin shad), and/or *Alosa chrysochloris* (skipjack herring) (Table 2). Any clupeid specimen identified to species level represents a postlarva or juvenile 20 mm or longer in total length.

Developmental stage of moronids also determines level of taxonomic resolution. *Morone saxatilis* (striped bass) hatch at a larger size than either *M. chrysops* (white bass) or *M. mississippiensis* (yellow bass). Although it is currently impossible to distinguish between larvae of the latter two species, *M. saxatilis* can be eliminated as a possibility based on developmental characteristics of specimens 5 mm or less in total length (hence, the taxonomic designation "*Morone* not *saxatilis*"). Specimens identified as "*Morone* sp." are those greater than 5 mm total length that could be any of the three species.

Data Analysis

Temporal occurrence and relative abundance of eggs and larvae by taxon are presented and discussed for 1996, 1997, and 2010 monitoring periods. Densities of fish eggs and larvae were expressed as numbers per 1,000 m^3 and were calculated using the equation:

$$D = \frac{1{,}000(\textit{Number fish eggs or larvae collected})}{\textit{Sample volume}}$$

Estimated entrainment of fish eggs and larvae was calculated by the following equation:

$$Ent = \frac{\sum DQ}{1000}$$

where *Ent* is estimated entrainment of fish eggs and larvae, *D* is the mean density (number/1,000 m^3) of fish eggs or larvae and *Q* is the flow (m^3/d). To calculate estimated entrainment of fish eggs and larvae that were transported past WBN (from reservoir samples), densities of fish eggs and larvae from all stations along reservoir transect at TRM 528 were averaged and multiplied by the corresponding 24-hour river flow past the plant. Entrainment estimates for intake samples were calculated using the same method, except densities of fish eggs and larvae from the intake samples and plant intake (IPS) water demand were used.

Percentage of transported ichthyofauna entrained by the plant was estimated using the formula:

$$E = \frac{100 D_i Q_i}{D_r Q_r},$$

where D_i is the mean density (number/1,000 m^3) of fish eggs or larvae in intake samples; D_r is the mean density (number/1,000 m^3) of fish eggs or larvae in the river transect at TRM 528; Q_i is the plant intake water demand (m^3/d); and Q_r is the river flow past WBN (m^3/d).

Results and Comparison with Historical Data (1996 through 1997)

During thirteen sample periods in 2010, the average volume of water filtered each period was 676 m^3 for intake samples and 720 m^3 for reservoir samples (Table 1). A list of families of fish eggs and larvae collected April through June during 1996, 1997, and 2010, including the lowest level of taxonomic resolution, is presented in Table 2.

Fish Eggs

A total of 1,002 fish eggs was collected in weekly sampling during April through June 2010. Composition was 55 percent centrarchids, 38 percent freshwater drum, 4.3 percent moronids and 2.7 percent clupeids. During this same period in 1996 and 1997 (biweekly sampling), 2,929 and 1,605 fish eggs were collected, respectively (Table 3). Nearly 100 percent of eggs collected in 1996 and 1997 were mutilated and unidentifiable; this was most likely due to turbine passage through Watts Bar Dam. During 2010 monitoring, densities of eggs peaked on 05/17 at 112/1,000 m^3 in intake and on 06/01 at 684/1,000 m^3 in reservoir samples (Table 4). Average seasonal density for eggs was 55/1,000 m^3 in the intake and reservoir samples combined and peaked the week of 6/1 (Table 5; Figure 2).

Fish Larvae

A total of 6,249 larval fish was collected in weekly samples during April through June 2010, compared to 4,926 and 9,849 during the same period 1996–1997 (biweekly samples) respectively. Relative abundance for all taxa of larval fish collected during the thirteen weekly sample periods of 2010 was dominated (64 %) by clupeids (gizzard and threadfin shad and skipjack), centrarchids (17%), *Morone* (12.4 %) and freshwater drum (5.1%). Table 3 provides a comparison of relative abundance of eggs and larvae by taxon during April through June 1996, 1997, and 2010. Clupeids were the dominant family of larvae all three years. Occurrence by sample period for all taxa of eggs and larvae is presented for April through June 1996, 1997, and 2010 in Table 6. Larval *Morone* and percids (darters and sauger) were the first taxa to be collected all three years.

Average densities (525, 924, 347), peak seasonal densities (1,387; 1,699; 1,288) and dates of peak densities (06/03, 05/15, 05/17) for larvae during April through June 1996, 1997, and 2010, respectively, are presented in Table 5. All of these values for samples collected during 2010 were within the range of the two previous years (1996 and 1997) of monitoring. During 2010, average seasonal density for larvae was 347/1,000 m^3 in the intake and reservoir samples combined and the peak density occurred on the week of 5/17 (Table 5; Figure 3). It should be noted that this peak density of fish larvae on 05/17 was coincidentally the date that there was no turbine flow through WBH to accommodate a hydrothermal survey of the WBN SCCW thermal plume under no-flow condition (TVA, 2011).

Estimated Entrainment

Entrainment estimates for fish eggs and larvae by sample period for during April through June 1996, 1997, and 2010 and total percent entrainment for the period sampled are presented in Table 7. Highest seasonal entrainment recorded for eggs was 0.29% and for larvae 0.57% both in 1996. During April through June 2010, seasonal entrainment for fish eggs and larvae was estimated to be 0.14% and 0.38%, respectively. During one sample period (May 17) in 2010, density of fish eggs in intake samples (112/1,000 m^3) was significantly higher than in reservoir samples (14/1,000 m^3) and resulted in a higher entrainment estimate (3.5%) for that period. Similarly for fish larvae in 2010, during sample periods 8 through 12 (05/24 through 06/21) densities were higher in intake samples and entrainment estimates ranged from 0.60% to 8.65% (Table 7).

Conclusion

Seasonal entrainment percentages for both fish eggs and larvae during April through June 2010 were similar to those estimated for previous operational monitoring during the same period 1996 and 1997. It was concluded in the report on those data (TVA, 1998) that those entrainment levels would not be detrimental to the ichthyoplankton population of upper Chickamauga Reservoir. Therefore, the April through June 2010 ichthyoplankton population in upper Chickamauga Reservoir was not adversely affected due to entrainment by WBN.

Historically, adult fish communities measured by TVA's Reservoir Fish Assemblage Index in the vicinity of WBN have averaged a "Good" rating annually since monitoring began in 1999 (TVA, 2010c). This is further evidence that operations of WBN have not adversely affected the fish community in Chickamauga Reservoir.

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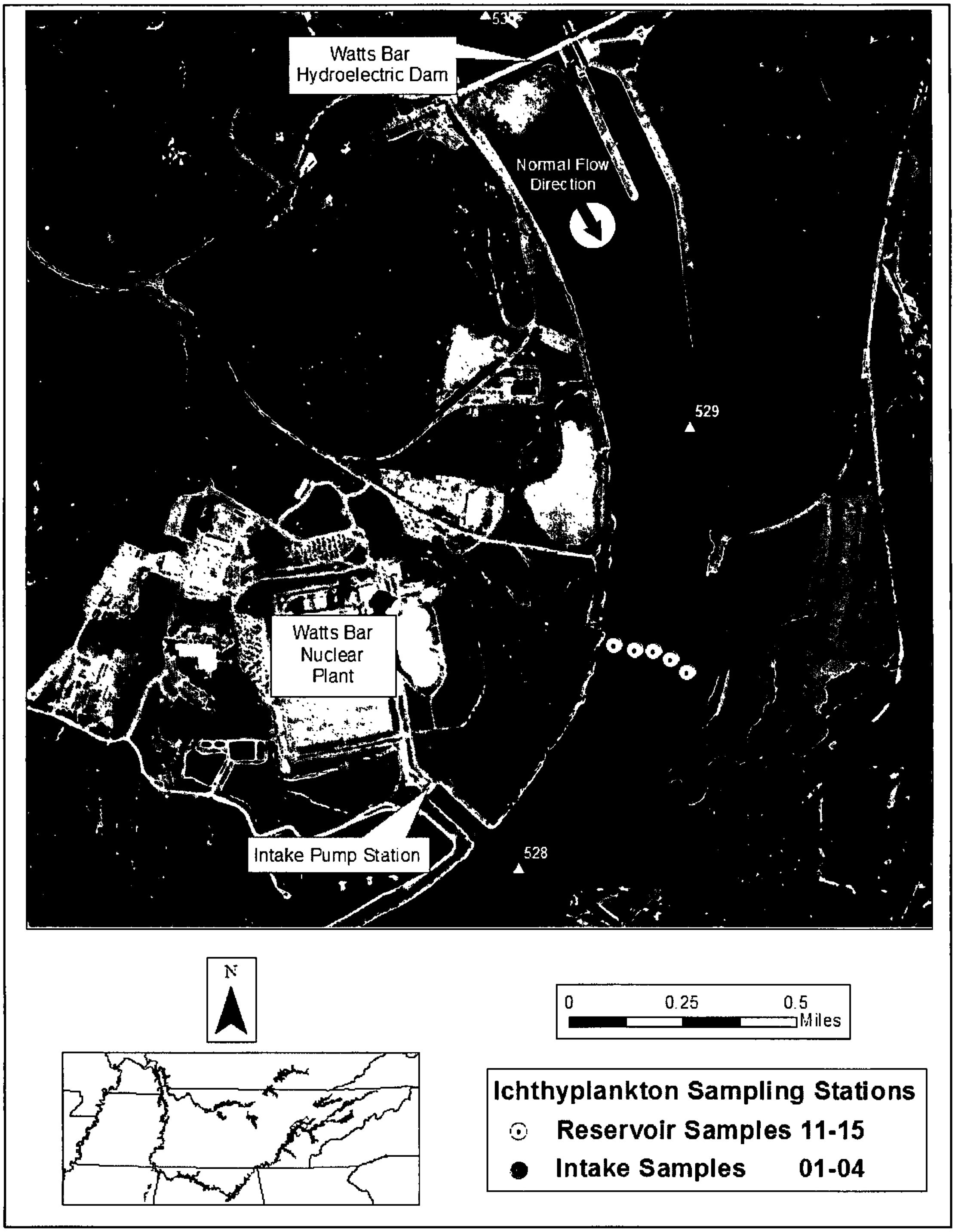

Figure 1. Locations of intake (Intake Pumping Station) and reservoir transects and sampling stations used to collect ichthyoplankton (fish eggs and larvae) during April through June 1996, 1997, and 2010 in the vicinity of Watts Bar Nuclear Plant, Chickamauga Reservoir, Rhea County, TN.

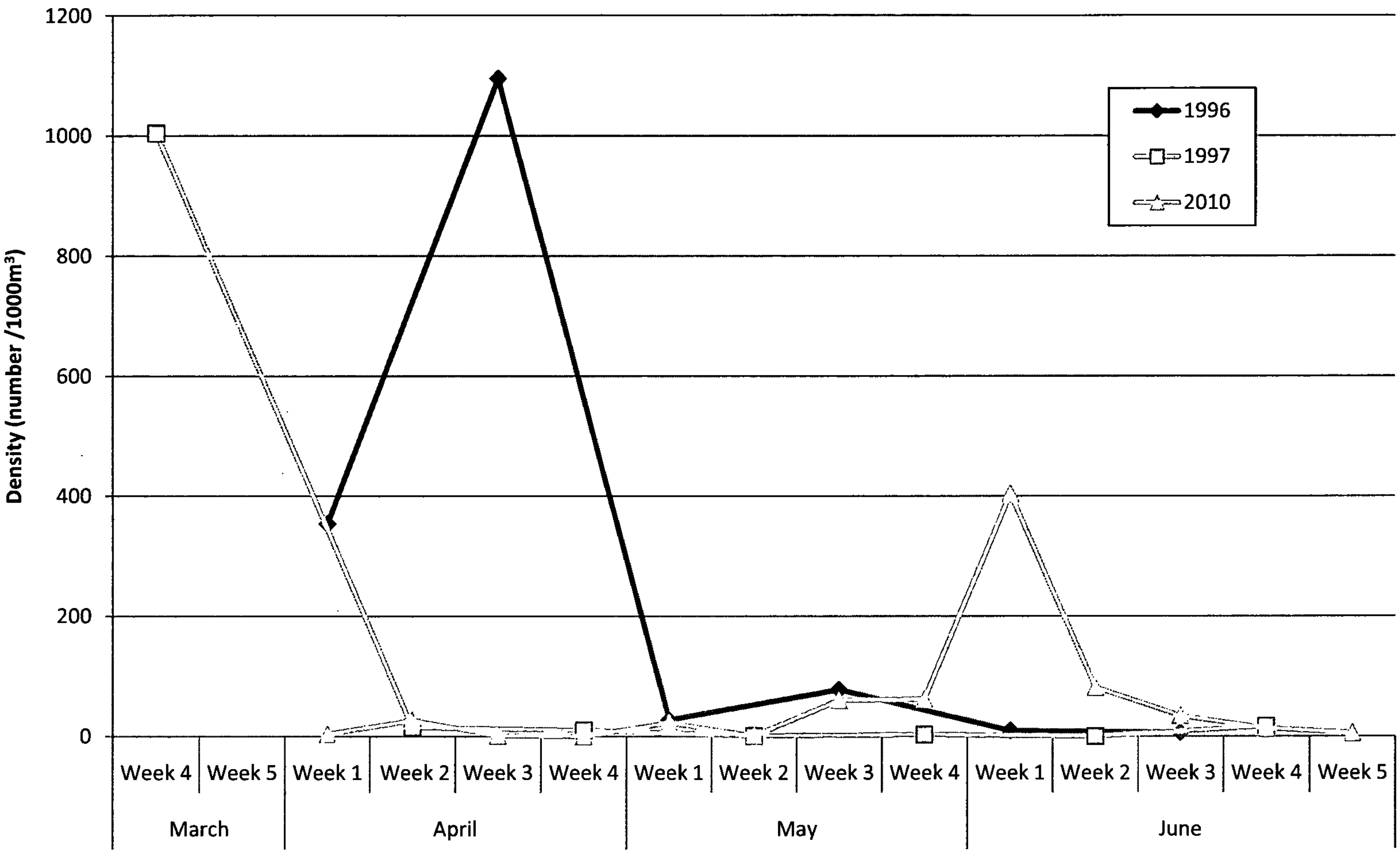

Figure 2. Weekly densities of fish eggs collected from sampling stations located in the Intake Pumping Station canal and in the Reservoir transect (combined) in the vicinity of Watts Bar Nuclear Plant, Rhea County, TN, during April through June 1996, 1997, and 2010.

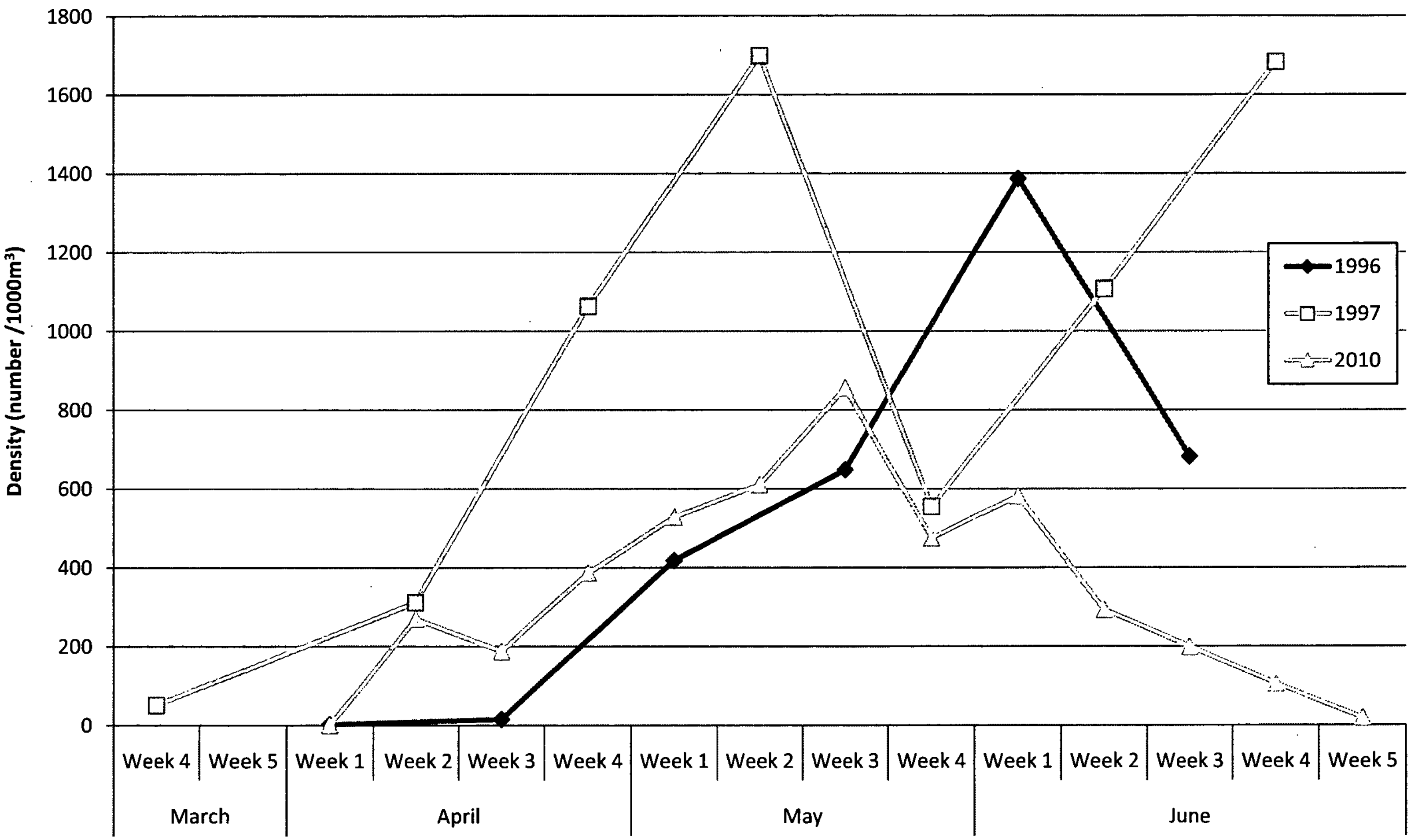

Figure 3. Weekly densities of larval fish collected from sampling stations located in the Intake Pumping Station (IPS) canal and in the Reservoir transect (combined) in the vicinity of Watts Bar Nuclear Plant, Rhea County, TN, during April through June 1996, 1997, and 2010.

Table 1. Total volume of water filtered weekly April through June 2010–2011 at stations at the Intake Pumping Station canal and the reservoir transect near Watts Bar Nuclear Plant to estimate densities and entrainment of fish eggs and larvae.

		2010		
Month	**Week**	**Intake**	**Reservoir**	**Total**
April	1	744	595	1,338
	2	751	612	1,363
	3	760	623	1,382
	4	809	609	1,419
May	1	800	618	1,419
	2	588	774	1,362
	3	616	699	1,315
	4	621	797	1,418
June	1	594	816	1,409
	2	587	814	1,401
	3	628	799	1,427
	4	647	813	1,460
	5	647	787	1,434
	Total	**8,792**	**9,356**	**18,147**
	Average	**676**	**720**	**1,396**

Table 2. List of fish eggs and larvae by family collected near Watts Bar Nuclear Plant during April through June 1996, 1997, and 2010, and lowest level of taxonomic resolution for each family.

1996		1997		2010	
Scientific Name	**Common Name**	**Scientific Name**	**Common Name**	**Scientific Name**	**Common Name**
Fish Eggs				**Eggs**	
Unidentifiable fish eggs		Unidentifiable fish eggs		Clupeidae spp. eggs	Unidentifiable clupeid eggs
				Dorosoma cepedianum eggs	Gizzard shad eggs
				Moronidae spp. eggs	
				Lepomis spp. eggs	Lepomid eggs
Aplodinotus grunniens eggs	Freshwater drum eggs	*Aplodinotus grunniens* eggs	Freshwater drum eggs	*Aplodinotus grunniens* eggs	Freshwater drum eggs
Fish Larvae					
Clupeidae		**Clupeidae**		**Clupeidae**	
Unspecifiable clupeids	Unspecified shad and/or herring	Unspecifiable clupeids	Unspecified shad and/or herring	Unspecifiable clupeids	Unspecified shad and/or herring
		Alosa chrysochloris	Skipjack herring	*Alosa chrysochloris*	Skipjack herring
Dorosoma cepedianum	Gizzard shad	*Dorosoma cepedianum*	Gizzard shad	*Dorosoma cepedianum*	Gizzard shad
Dorosoma petenense	Threadfin shad	*Dorosoma petenense*	Threadfin shad	*Dorosoma petenense*	Threadfin shad
Cyprinidae		**Cyprinidae**		**Cyprinidae**	
Unspecifiable cyprinids	Unspecified minnow or carp	Unspecifiable cyprinids	Unspecified minnow or carp		
Cyprinus carpio	Common carp	*Cyprinus carpio*	Common carp		
		Notropis volucellus	Mimic shiner		
				Cyprinella spp.	Various shiners
				Pimephales spp.	Fathead, bullhead or bluntnose minnow
Catostomidae				**Catostomidae**	
				Ictiobinae	Unspecified Ictiobines (buffalofish)
Minytrema melanops	Spotted sucker				
Ictaluridae				**Ictaluridae**	
Ictalurus punctatus	Channel catfish			*Ictalurus punctatus*	Channel catfish
Moronidae		**Moronidae**		**Moronidae**	
Morone sp.	Unspecified temperate bass	*Morone* sp.	Unspecified temperate bass	*Morone* sp.	Unspecified temperate bass
Morone chrysops	White bass	*Morone chrysops*	White bass	*Morone chrysops*	White bass
Morone mississippiensis	Yellow bass	*Morone mississippiensis*	Yellow bass		
Morone (not *saxatilis*)	Unspecified temperate bass(not striped bass)	*Morone* (not *saxatilis*)	Unspecified temperate bass(not striped bass)	*Morone* (not *saxatilis*)	Unspecified temperate bass (not striped bass)
Centrarchidae		**Centrarchidae**		**Centrarchidae**	
Lepomis sp.	Unspecified sunfish	*Lepomis* sp.	Unspecified sunfish	*Lepomis* sp.	Unspecified lepomid
		Micropterus sp.	Unspecified black bass		
				Micropterus (not *dolomieu*)	Unspecified black bass (not smallmouth bass)

Table 2. (Continued)

1996		1997		2010	
Scientific Name	**Common Name**	**Scientific Name**	**Common Name**	**Scientific Name**	**Common Name**
Pomoxis sp.	Unspecified crappie	*Pomoxis* sp.	Unspecified crappie	*Pomoxis* sp.	Unspecified crappie
				Pomoxis annularis	White crappie
Percidae		**Percidae**		**Percidae**	
Unspecifiable darter	Unspecified darter	Unspecifiable darter	Unspecified darter		
				Unidentifiable darter (not *Percina caprodes*)	Unidentifiable darter
				Unidentifiable darter (*Percina caprodes* type)	Unidentifiable darter, Logperch type
Perca flavescens	Yellow perch			*Perca flavescens*	Yellow perch
		Sander sp.	Walleye or sauger		
				Sander canadensis	Sauger
Sciaenidae		**Sciaenidae**		**Sciaenidae**	
Aplodinotus grunniens	Freshwater drum	*Aplodinotus grunniens*	Freshwater drum	*Aplodinotus grunniens*	Freshwater drum
				Atherinopsidae	
				Atherinopsidae spp.	Unspecified silverside (brook or inland)
				Menidia beryllina	Inland silverside

Table 3. Actual numbers and percent composition of fish eggs and larvae collected in impingement samples during April through June 1996, 1997, and 2010 in the vicinity of Watts Bar Nuclear Plant.

	1996		1997		2010	
Taxon	**Total Numbers Collected**	**% Comp**	**Total Numbers Collected**	**% Comp**	**Total Numbers Collected**	**% Comp**
EGGS						
Unidentifiable fish eggs	2,908	99.28%	1,591	99.13%		
Clupeidae eggs					3	0.30%
Clupeidae (not skipjack) eggs					20	2.00%
Dorosoma cepedianum eggs					4	0.40%
Centrarchidae (*Lepomis*) eggs					553	55.19%
Moronidae (not *saxatilis*) eggs					43	4.29%
Aplodinotus grunniens eggs	21	0.72%	14	0.87%	379	37.82%
Total	**2,929**	**100%**	**1,605**	**100%**	**1,002**	**100%**
LARVAE						
Clupeidae						
Unspecifiable clupeids	4,132	83.88%	8,083	82.07%	3,805	60.89%
Alosa chrysochloris			8	0.08%	1	0.02%
Dorosoma cepedianum	74	1.50%	1	0.01%	216	3.46%
Dorosoma petenense	50	1.02%	2	0.02%	3	0.05%
Cyprinidae						
Unspecifiable cyprinids	2	0.04%	6	0.06%		
Cyprinidae (*Cyprinella* group)					1	0.02%
Cyprinidae (*Pimephales* group)					26	0.42%
Cyprinus carpio	2	0.04%	2	0.02%		
Notropis volucellus			2	0.02%		
Catostomidae						
Ictiobinae					2	0.03%
Minytrema melanops	3	0.06%				
Ictaluridae						
Ictalurus punctatus	2	0.04%			1	0.02%
Moronidae						
Morone sp.	41	0.83%	820	8.33%	127	2.03%
Morone chrysops	5	0.10%	2	0.02%	89	1.42%
Morone mississippiensis	16	0.32%	6	0.06%		
Morone (not *saxatilis*)	161	3.27%	382	3.88%	560	8.96%
Centrarchidae						
Lepomis sp.	95	1.93%	130	1.32%	522	8.35%
Micropterus sp.			3	0.03%		
Micropterus (not *dolomieu*)					19	0.30%
Pomoxis sp.	8	0.16%	125	1.27%	487	7.79%
Pomoxis annularis					15	0.24%
Percidae						
Unidentifiable darter	5	0.10%	8	0.08%		
Unidentifiable darter (not *Percina caprodes*)					1	0.02%
Unidentifiable darter (*Percina caprodes* type)					4	0.06%
Perca flavescens	6	0.12%			7	0.11%
Sander sp.			2	0.02%		
Sander canadensis					1	0.02%
Sciaenidae						
Aplodinotus grunniens	324	6.58%	267	2.71%	318	5.09%
Atherinopsidae						
Atherinopsidae sp.					43	0.69%
Menidia beryllina					1	0.02%
Total	**4,926**	**100%**	**9,849**	**100%**	**6,249**	**100%**

Table 4. Densities (number/1,000 m^3) by sample period of fish eggs and larvae collected at reservoir, intake, and reservoir and intake combined during April through June 1996 and 1997 (biweekly) and 2010 (weekly) at Watts Bar Nuclear Plant.

Fish Eggs		1996			1997			2010		
Month	Week	Intake	Reservoir	Combined*	Intake	Reservoir	Combined*	Intake	Reservoir	Combined*
March	4	---	---	---	177	1,070	1,004	---	---	---
	5	---	---	---	---	---	---	---	---	---
April	1	17	382	354	---	---	---	0	7	4
	2	---	---	---	0	16	15	0	48	26
	3	109	1,528	1,095	---	---	---	0	3	1
	4	---	---	---	0	11	10	0	0	0
May	1	59	26	28	---	---	---	3	38	23
	2	---	---	---	0	1	1	0	1	1
	3	0	84	78	---	---	---	112	14	60
	4	---	---	---	0	3	3	6	105	62
June	1	9	10	10	---	---	---	19	684	404
	2	---	---	---	0	0	0	49	105	81
	3	0	7	7	---	---	---	43	28	34
	4	---	---	---	9	18	17	2	22	13
	5	---	---	---	---	---	---	0	10	6

Table 4. (Continued)

Fish Larvae		1996			1997			2010		
Month	Week	Intake	Reservoir	Combined*	Intake	Reservoir	Combined*	Intake	Reservoir	Combined*
March	4	---	---	---	35	52	51	---	---	---
	5	---	---	---	---	---	---	---	---	---
April	1	0	1	1	---	---	---	0	0	0
	2	---	---	---	232	319	312	278	264	270
	3	0	22	15	---	---	---	151	217	187
	4	---	---	---	427	1,115	1,063	406	372	386
May	1	294	426	419	---	---	---	377	646	529
	2	---	---	---	1,822	1,689	1,699	663	570	610
	3	1,348	594	648	---	---	---	696	998	856
	4	---	---	---	625	550	555	488	465	475
June	1	5,575	1,065	1,387	---	---	---	627	549	582
	2	---	---	---	2,260	1,032	1,107	380	230	293
	3	2,354	551	682	---	---	---	358	74	199
	4	---	---	---	2,646	1,600	1,683	221	14	106
	5	---	---	---	---	---	---	9	25	18

--- denotes no sample collected during sample period.
***Values in the "Combined" column are not sums of corresponding values in "Reservoir" and "Intake" columns. Densities in "Combined" column were calculated using total (reservoir and intake combined) numbers of fish eggs and/or larvae collected and total volumes sampled (see "Data Analysis" section).**

Table 5. Average and peak density (number per 1,000 m^3) of fish eggs and larvae (reservoir and intake combined) with mean water temperatures collected in the vicinity of Watts Bar Nuclear Plant during April through June 1996, 1997, and 2010.

	1996	1997	2010
Fish Eggs			
Average Density	262	150	55
Peak Density	1,095	1,004	499
Date of Peak Density	4/22	3/21	6/2
Fish Larvae			
Average Density	525	924	347
Peak Density	1,387	1,699	1,288
Date of Peak Density	6/3	5/15	5/17
Mean Water Temperature (°C)	18.4	22.4	22.3

Table 6. Species list, total number collected, percent composition and occurrence spans of fish eggs and larvae collected during operational monitoring at Watts Bar Nuclear Plant, April through June 1996, 1997, and 2010.

1996								
TAXON	TOTAL COLLECTED	PERCENT COMPOSITION	OCCURRENCE BY SAMPLE PERIOD					
FISH EGGS			1	2	3	4	5	6
Unidentifiable fish eggs	2,908	99.28%	X	X	X	X	X	
Aplodinotus grunniens eggs	21	0.72%				X	X	X
Total	**2,929**	**100%**						
FISH LARVAE								
Clupeidae	4,132	83.88%			X	X	X	X
Dorosoma cepedianum	74	1.50%					X	X
Dorosoma petenense	50	1.02%					X	X
Cyprinidae	2	0.04%						X
Cyprinus carpio	2	0.04%				X	X	
Minytrema melanops	3	0.06%			X			
Ictalurus punctatus	2	0.04%						X
Morone sp.	41	0.83%				X	X	X
Morone chrysops	5	0.10%					X	
Morone mississippiensis	16	0.32%					X	
Morone (not *saxatilis)*	161	3.27%	X	X	X			
Lepomis sp.	95	1.93%					X	X
Pomoxis sp.	8	0.16%			X	X	X	
Percidae (not *Sander)*	5	0.10%	X	X	X			
Perca flavescens	6	0.12%		X	X			
Aplodinotus grunniens	324	6.58%				X	X	X
TOTAL	**4,926**	**100%**						

1997									
TAXON	TOTAL COLLECTED	PERCENT COMPOSITION	OCCURRENCE BY SAMPLE PERIOD						
FISH EGGS			1	2	3	4	5	6	7
Unidentifiable fish eggs	1,591	99.13%	X	X	X	X			X
Aplodinotus grunniens eggs	14	0.87%					X		X
Total	**1,605**	**100%**							
FISH LARVAE									
Clupeidae	8,083	82.07%	X	X	X	X	X	X	X
Alosa chrysochloris	8	0.08%					X	X	
Dorosoma cepedianum	1	0.01%							X
Dorosoma petenense	2	0.02%						X	X
Cyprinidae	6	0.06%						X	X
Cyprinus carpio	2	0.02%						X	
Notropis volucellus	2	0.02%		X	X				
Morone sp.	820	8.33%		X	X	X	X	X	X
Morone chrysops	2	0.02%				X	X		
Morone mississippiensis	6	0.06%					X	X	X
Morone (not *saxatilis*)	382	3.88%	X	X	X	X		X	
Lepomis sp.	130	1.32%					X	X	X
Micropterus sp.	3	0.03%					X		X
Pomoxis sp.	125	1.27%			X	X	X	X	X
Percidae (not *Sander*)	8	0.08%	X	X	X				
Sander sp.	2	0.02%	X						
Aplodinotus grunniens	267	2.71%				X	X	X	X
TOTAL	**9,849**	**100%**							

Table 6. (Continued)

2010															
TAXON	TOTAL COLLECTED	PERCENT COMPOSITION	OCCURRENCE BY SAMPLE PERIOD												
FISH EGGS	3	0.30%	1	2	3	4	5	6	7	8	9	10	11	12	13
Clupeidae eggs	20	2.00%									X				
Clupeidae (not skipjack) eggs	4	0.40%						X	X	X					
Dorosoma cepedianum eggs	553	55.19%									X				X
Centrarchidae (*Lepomis*) eggs	43	4.29%									X				X
Moronidae (not *saxatilis*) eggs	379	37.82%	X								X				
Aplodinotus grunniens eggs	3	0.30%							X	X	X	X	X	X	
TOTAL	**1,002**	**100%**													
FISH LARVAE															
Unspecifiable clupeids	3,805	60.89%			X	X	X	X	X	X	X	X	X	X	
Alosa chrysochloris	1	0.02%							X			X			
Dorosoma cepedianum	216	3.46%							X	X	X	X	X	X	X
Dorosoma petenense	3	0.05%										X	X	X	
Cyprinidae (*Cyprinella* group)	1	0.02%					X								
Cyprinidae (*Pimephales* group)	26	0.42%					X	X	X	X	X	X	X	X	X
Catostomidae (Ictiobinae)	2	0.03%				X									
Ictalurus punctatus	1	0.02%										X	X	X	
Morone sp.	127	2.03%				X	X	X	X	X	X	X	X		
Morone chrysops	89	1.42%						X	X	X	X	X	X	X	
Morone (not *saxatilis*)	560	8.96%		X	X	X	X	X							
Lepomis sp.	522	8.35%							X	X	X	X	X	X	X
Micropterus (not *dolomieu*)	19	0.30%								X	X	X			
Pomoxis sp.	487	7.79%				X	X	X	X	X	X	X	X	X	X
Pomoxis annularis	15	0.24%							X		X	X	X	X	
Unidentifiable darter (not *Percina caprodes*)	1	0.02%						X							
Unidentifiable darter (*Percina caprodes* type)	4	0.06%		X	X		X								
Perca flavescens	7	0.11%					X	X	X			X			
Sander canadensis	1	0.02%		X											
Aplodinotus grunniens	318	5.09%					X	X	X	X	X	X	X	X	X
Atherinopsidae sp.	43	0.69%						X	X	X	X	X		X	X
Menidia beryllina	1	0.02%									X		X	X	
TOTAL	**6,249**	**100%**													

Table 7. Estimated entrainment results of fish eggs and larvae during April through June 1996, 1997, and 2010 at Watts Bar Nuclear Plant including intake and reservoir flow, sample periods, average densities, and total numbers and percent entrained and transported past WBN.

1996-Eggs								
		Intake			Reservoir			
			Water	Estimated		River	Estimated	
	Sample	Density/	Demand	Number	Density/	Flow	Number	Percent
Date	Period	1,000 m³	m³/d	Entrained	1,000 m³	m³/d	Transported	Entrained
		D_i	Q_i		D_r	Q_r		
April 8	1	17.1	1.27E+05	2.18E+03	382.2	2.04E+07	7.80E+06	0.03%
April 22	2	108.9	7.10E+04	7.73E+03	1527.5	6.29E+07	9.61E+07	0.01%
May 6	3	58.8	1.62E+05	9.54E+03	25.7	2.41E+07	6.17E+05	1.55%
May 20	4	0.0	1.54E+05	0.00E+00	83.6	4.36E+07	3.64E+06	T
June 3	5	8.8	1.17E+05	1.03E+03	9.5	8.20E+07	7.80E+05	0.13%
June 17	6	0.0	2.26E+05	0.00E+00	7.0	6.94E+07	4.84E+05	T
			Total:	2.05E+04		Total:	1.09E+08	0.29%*

1996-Larvae								
		Intake			Reservoir			
			Water	Estimated		River	Estimated	
	Sample	Density/	Demand	Number	Density/	Flow	Number	Percent
Date	Period	1,000 m³	m³/d	Entrained	1,000 m³	m³/d	Transported	Entrained
		D_i	Q_i		D_r	Q_r		
April 8	1	0.0	1.27E+05	0.00E+00	1.4	2.04E+07	2.93E+04	T
April 22	2	0.0	7.10E+04	0.00E+00	22.1	6.29E+07	1.39E+06	T
May 6	3	294.1	1.62E+05	4.77E+04	426.2	2.41E+07	1.03E+07	0.47%
May 20	4	1348.2	1.54E+05	2.08E+05	594.2	4.36E+07	2.59E+07	0.80%
June 3	5	5575.2	1.17E+05	6.51E+05	1065.3	8.20E+07	8.73E+07	0.75%
June 17	6	2354.0	2.26E+05	5.32E+05	550.6	6.94E+07	3.82E+07	1.39%
			Total:	1.44E+06		Total:	1.63E+08	0.57%*

1997-Eggs								
		Intake			Reservoir			
			Water	Estimated		River	Estimated	
	Sample	Density/	Demand	Number	Density/	Flow	Number	Percent
Date	Period	1,000 m³	m³/d	Entrained	1,000 m³	m³/d	Transported	Entrained
		D_i	Q_i		D_r	Q_r		
March 21	1	177.0	1.03E+05	1.82E+04	1069.8	1.09E+08	1.17E+08	0.02%
April 14	2	0.0	1.24E+05	0.00E+00	16.0	2.38E+07	3.80E+05	T
April 28	3	0.0	1.01E+05	0.00E+00	10.5	5.43E+07	5.72E+05	T
May 15	4	0.0	1.04E+05	0.00E+00	0.7	4.96E+07	3.35E+04	T
May 27	5	0.0	1.10E+05	0.00E+00	2.7	4.63E+07	1.25E+05	T
June 9	6	0.0	1.19E+05	0.00E+00	0.0	7.49E+07	0.00E+00	T
June 23	7	9.1	1.23E+05	1.12E+03	18.1	9.99E+07	1.81E+06	0.06%
			Total:	1.94E+04		Total:	1.20E+08	0.02%*

1997-Larvae								
		Intake			Reservoir			
			Water	Estimated		River	Estimated	
	Sample	Density/	Demand	Number	Density/	Flow	Number	Percent
Date	Period	1,000 m³	m³/d	Entrained	1,000 m³	m³/d	Transported	Entrained
		D_i	Q_i		D_r	Q_r		
March 21	1	35.4	1.03E+05	3.65E+03	52.1	1.09E+08	5.70E+06	0.06%
April 14	2	232.1	1.24E+05	2.89E+04	318.5	2.38E+07	7.59E+06	0.38%
April 28	3	427.4	1.01E+05	4.30E+04	1115.3	5.43E+07	6.05E+07	0.07%
May 15	4	1822.0	1.04E+05	1.89E+05	1688.9	4.96E+07	8.37E+07	0.23%
May 27	5	625.0	1.10E+05	6.88E+04	550.0	4.63E+07	2.55E+07	0.27%
June 9	6	2260.4	1.19E+05	2.70E+05	1032.2	7.49E+07	7.74E+07	0.35%
June 23	7	2645.5	1.23E+05	3.25E+05	1600.0	9.99E+07	1.60E+08	0.20%
			Total:	9.28E+05		Total:	4.20E+08	0.22%*

Table 7. (Continued)

2010-Eggs								
Fish Eggs		Intake			Reservoir			
			Water Demand m^3/d	Estimated Number Entrained		River Flow m^3/d	Estimated Number Transported	
Date	Sample Period	Density/ 1,000 m^3			Density/ 1,000 m^3			Percent Entrained
		D_I	Q_I		D_r	Q_r		
April 5	1	0.0	9.82E+04	0.00E+00	6.7	2.14E+07	1.44E+05	T
April 12	2	0.0	9.68E+04	0.00E+00	47.9	1.74E+07	8.34E+05	T
April 19	3	0.0	8.98E+04	0.00E+00	2.6	1.48E+07	3.89E+04	T
April 26	4	0.0	1.01E+05	0.00E+00	0.0	2.55E+07	0.00E+00	T
May 3	5	3.2	1.56E+05	5.05E+02	37.5	1.19E+08	4.47E+06	0.01%
May 10	6	0.0	1.59E+05	0.00E+00	1.3	3.08E+07	3.98E+04	T
May 17	7	112.2	1.64E+05	1.84E+04	14.3	3.65E+07	5.21E+05	3.54%
May 24	8	6.4	1.64E+05	1.06E+03	105.3	2.88E+07	3.03E+06	0.03%
June 1	9	18.5	1.62E+05	3.01E+03	684.2	1.85E+07	1.27E+07	0.02%
June 7	10	49.4	1.65E+05	8.13E+03	104.5	3.46E+07	3.62E+06	0.22%
June 14	11	43.0	1.66E+05	7.12E+03	27.5	3.04E+07	8.36E+05	0.85%
June 21	12	1.5	1.66E+05	2.57E+02	22.1	3.14E+07	6.96E+05	0.04%
June 28	13	0.0	1.65E+05	0.00E+00	10.2	3.11E+07	3.17E+05	T
			Total:	3.85E+04		Total:	2.72E+07	0.14%*

2010-Larvae								
Fish Larvae		Intake			Reservoir			
			Water Demand m^3/d	Estimated Number Entrained		River Flow m^3/d	Estimated Number Transported	
Date	Sample Period	Density/ 1,000 m^3			Density/ 1,000 m^3			Percent Entrained
		D_I	Q_I		D_r	Q_r		
April 5	1	0.0	9.82E+04	0.00E+00	0.0	2.14E+07	0.00E+00	T
April 12	2	277.7	9.68E+04	2.69E+04	263.7	1.74E+07	4.58E+06	0.59%
April 19	3	150.9	8.98E+04	1.35E+04	217.2	1.48E+07	3.21E+06	0.42%
April 26	4	405.5	1.01E+05	4.09E+04	371.9	2.55E+07	9.48E+06	0.43%
May 3	5	376.9	1.56E+05	5.89E+04	645.7	1.19E+08	7.70E+07	0.08%
May 10	6	663.2	1.59E+05	1.05E+05	569.8	3.08E+07	1.76E+07	0.60%
May 17	7	695.8	1.64E+05	1.14E+05	997.6	3.65E+07	3.64E+07	0.31%
May 24	8	487.9	1.64E+05	8.00E+04	465.1	2.88E+07	1.34E+07	0.60%
June 1	9	626.7	1.62E+05	1.02E+05	549.3	1.85E+07	1.02E+07	1.00%
June 7	10	379.8	1.65E+05	6.25E+04	229.8	3.46E+07	7.96E+06	0.78%
June 14	11	358.4	1.66E+05	5.93E+04	73.8	3.04E+07	2.24E+06	2.65%
June 21	12	220.9	1.66E+05	3.68E+04	13.5	3.14E+07	4.25E+05	8.65%
June 28	13	9.3	1.65E+05	1.53E+03	25.4	3.11E+07	7.91E+05	0.19%
			Total:	7.02E+05		Total:	1.83E+08	0.38%*

T=less than 0.01 percent composition
***Total percent entrainment is calculated by dividing total Estimated Number Entrained by total Estimated Number Transported.**