Evaluation of Spring Sport Fish Survey Results for Watts Bar Reservoir, 2002-2011

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Acronyms and Abbreviations

CRM	Clinch River Mile
cfs	cubic feet per second
ERM	Emory River Mile
KIF	Kingston Fossil Plant
msl	Mean sea level
TRM	Tennessee River Mile
TVA	Tennessee Valley Authority
Wr	Relative Weight

Introduction

The Spring Sport Fish Survey is designed to provide fisheries information on three species of black bass (largemouth, smallmouth and spotted bass) and black and white crappie in Tennessee Valley reservoirs. Spring Sport Fish Surveys have been conducted annually on Watts Bar reservoir since 2002 as part of the Tennessee Valley Authority's (TVA) Valley-wide monitoring program, termed Vital Signs Monitoring. These surveys are a major component of the biological monitoring program for the Kingston Fossil Plant (KIF) Ash Recovery Project. Three far-field locations including Blue Springs, Caney Creek, and Watts Bar Forebay have been sampled annually since 2002. Clinch River 2.5 also was sampled from 2002 through 2005 before being discontinued. Annual sport fish surveys were resumed at Clinch River 2.5 in 2009 following the ash release at the Kingston Fossil Plant (KIF) in December 2008, and an additional location was added in 2009 at Emory River 2.5 to evaluate immediate near-field effects. This report provides a summary of survey results for Watts Bar Reservoir from 2002 through 2011.

Study Area

The KIF is located at the confluence of the Emory and Clinch Rivers on Watts Bar Reservoir, approximately 4.5 river miles upstream of the confluence of the Tennessee and Clinch Rivers. The Emory River borders the KIF ash cells to the east. The KIF cooling water intake is located at Emory River mile (ERM) 2.0. Heated water from KIF is discharged to the Clinch River, rather than to the Emory, at approximately Clinch River mile (CRM) 2.6. The Emory River originates on the Cumberland Plateau and its inflows to Watts Bar Reservoir are not regulated (not controlled by an upstream flood storage dam or navigation structure), but the Watts Bar Reservoir summer pool extends upstream to above Harriman, Tennessee (ERM 11.0). Flows in the nearby Clinch River arm of Watts Bar Reservoir are dependent on flows from Melton Hill Dam.

The river elevation near KIF is controlled by Watts Bar Dam (Tennessee River Mile [TRM] 529.9) approximately 40 miles downstream of KIF. The summer pool elevation (May 15—October 31) for the Emory River at KIF is approximately 740 to741 feet mean sea level (msl) and the winter pool elevation (December 1—March 31) is 735 to 737 feet msl. The Watts Bar annual spring reservoir fill period is April 1- May14.

Watts Bar is a large reservoir; the surface area varies between approximately 32,000 acres at minimum winter pool level to 39,000 acres at the normal maximum summer pool level. Watts Bar Reservoir extends 72 miles up the Tennessee River to Fort Loudoun Dam and 61 miles up the Tennessee and Clinch Rivers to Melton Hill Dam (CRM 23.1). Watts Bar is a main stem Tennessee River reservoir with an average annual discharge of about 27,000 cubic feet per second (cfs). Most of the water entering Watts Bar Reservoir (86 percent) comes from outside the immediate drainage area. The Tennessee and Little Tennessee Rivers (i.e., average annual discharge from Fort Loudoun Dam, 18,200 cfs) account for approximately 67 percent of the flow into the reservoir. The Clinch River (i.e., annual average discharge from Melton Hill Dam, 5,000 cfs) accounts for about 19 percent of the flow into the reservoir. The remaining 14 percent is contributed by local inflows.

Sampling Sites

Five sampling sites were selected on Watts Bar Reservoir. The Caney Creek and Blue Springs sites are embayments located at approximately TRM 562.0 and TRM 547.5, respectively (Figure 1). The Watts Bar Forebay site is located immediately upstream of Watts Bar Dam at TRM 531.0 (Figure 1). The Clinch River 2.5 site is centered at the KIF heated water discharge with nine electrofishing runs distributed from CRM 0.0 to CRM 5.6 and three runs from ERM 0.0 to ERM 1.0 (Figure 2). The Emory River 2.5 site is located adjacent to the KIF ash cells and in the immediate area of the ash spill. This area was sampled with twelve electrofishing runs distributed between approximately ERM 1.2 and 4.2 (Figure 3).

Methods

Field Procedures

Spring Sport Fish Surveys have been conducted on Watts Bar Reservoir during April or early May of each year. Five locations including three far-field locations (Blue Springs, Caney Creek, and Watts Bar Forebay) and two near-field locations (Clinch River 2.5 and Emory River 2.5) have been sampled as described above. Twelve electrofishing runs were conducted at each location during each survey. Electrofishing runs consisted of thirty minutes of continuous electrofishing at fixed stations in the littoral zones of the various habitat types present. All black bass and crappie collected were indentified to species, weighed, measured, enumerated and visually inspected for general health – noting disease, parasites, and anomalies – then released.

Data Analysis

Black bass populations were evaluated based on catch rate and general health, with additional reporting of largemouth bass results for length frequency and relative weight (Wr). Typically, insufficient numbers of smallmouth bass and spotted bass are collected to develop meaningful length frequency histograms. Comparisons were made to historical surveys conducted within the impacted reaches (Clinch River 2.5) before the ash spill and to surveys conducted at far-field sites. Relative weights of largemouth bass were evaluated based on three length categories: stock (8-11 inches), quality (12-14 inches), and preferred (15-19 inches). Relative weights are considered to be a reflection of fish condition and are derived from the ratio of the actual weight of a fish to a standard weight for a fish of similar length. However, within-species variance in length-weight relationships can be substantial, depending on factors such as season, sex, population, and/or primary productivity. Considering seasonal variations, fish are presumably gaining weight after winter months and during the early spring pre-spawn period, followed by a period of weight loss during the spawn and immediate post-spawn period. This can result in substantial changes in length-weight relationships during spring. For this report, standard weights were derived from historical data collected during autumn from Tennessee Valley reservoirs. Therefore, these relative weights may not represent an accurate measure of condition for a given site, but are used for spatial and temporal comparisons in this report. The relative weights of sub-stock (0-7 inches) largemouth bass were not evaluated because scales measuring in five-gram increments were used in the field and because a difference of even one or two grams in the actual weight of these smaller fish results in substantial variation (depending on length) in relative weights. Largemouth bass in the memorable category (20-24 inches) were not evaluated due to the low numbers [0-9] collected annually at any given location. Black crappie and white crappie also were collected during each survey, but, historically, insufficient numbers

have been collected in the vicinity of KIF for a comprehensive assessment of temporal trends (Table 3).

Results and Discussion

Catch Rates

The seven annual surveys (2002-2005 and 2009-2011) conducted at Clinch River 2.5 yielded 2,008 black bass for an average catch rate of 47.8 fish/hour (Table 1). The highest catch rates (62.7 and 59.5 fish/hour) were observed at this site in 2009 and 2010, respectively. The 2011 survey yielded the lowest catch rate (27.8 fish/hour) for the site as well as for Watts Bar Reservoir overall. Similar results were observed at Emory River 2.5. The three annual surveys (2009, 2010, and 2011) at this site yielded 817 black bass for an average catch rate of 45.4 fish/hour. Catch rates of 53.2 and 50.7 fish/hour were observed in 2009 and 2010, respectively, which were slightly lower than observed at Clinch River 2.5 in each of the corresponding years, but greater than Clinch River's pre-spill average of 46.2 fish/hour. In 2011, the catch rate at Emory River 2.5 declined to 32.3 fish/hour.

Of the ten annual surveys (2002-2011) conducted at far-field sites, Caney Creek exhibited the highest catch rates for black bass overall with a 10-year average of 67.6 fish/hour, followed by the Forebay (57.9 fish/hour), and then Blue Springs (52.8 fish/hour) (Table 1). Caney Creek also exhibited the most variability among these sites, with both the highest (96.5 fish/hour in 2010) and lowest (42.5 fish/hour in 2006) catch rates observed and year-to-year differences often exceeding 20 fish/hour (28% annual average variation). Blue Springs exhibited the most consistent catch rates, ranging from 44.7 to 67.2 fish/hour (2002 and 2008, respectively), with an average annual difference of less than 10 fish/hour (17%).

Similar to near-field sites, black bass catch rates declined at far-field sites in 2011. Catch rates were above the long-term average at the three far-field sites from 2008 through 2010. This time period also included the highest catch rate observed at each site. In 2011, catch rates at Caney Creek (56.3 fish/hour) and Blue Springs (44.0 fish/hour) were approximately 42% and 32% lower than their respective highs (96.5 and 67.2 fish/hour) and represented the third lowest catch rate at each site for the 10-year period. The 2011 catch rate at the Forebay was 54.3 fish per hour, which was considerably lower (~28%) than the high observed in 2010 (75.8 fish/hour), but similar to the long-term average.

Black bass populations tend be cyclical in Valley reservoirs with annual recruitment dependent on a variety of biotic and abiotic factors. One of the most germane is meteorology. Meteorological conditions (air temperatures, sunlight, and the amount, frequency, and seasonal distribution of rainfall) significantly affect the hydrology (flows and retention times) and ecological conditions (e.g., water temperature, primary productivity) in reservoirs. In mainstem Tennessee River reservoirs, for example, extended periods of high flow during summer tend to result in decreased recruitment of largemouth bass (Maceina and Bettoli 1998; Buynak et al 1991). Conversely, during years when low flow conditions persist, recruitment tends to increase. These differences appear to be at least partially related to summer retention time and the differential response in phytoplankton productivity. Because mainstem reservoirs have retention times ranging generally from 5 to 20 days, productivity tends to be more limited by light exposure rather than nutrients due to mixing within the water column. Dry periods tend to

increase algal productivity by reducing flow and extending retention times, allowing more time for algae to utilize available nutrients. This can result in higher overall production at lower trophic levels (i.e, zooplankton and planktivorous fish), which benefits young-of-year bass. In contrast, periods of normal to heavy rain tend to increase flow and turbidity which can limit algal productivity by reducing light availability and shortening retention times.

It is believed that the concurrent declines in catch rates at all sites in 2011 were associated with factors that extended reservoir-wide. In this case, sampling efficiencies were likely affected as surveys coincided with rather extreme fluctuations in reservoir conditions. The Spring Sport Fish Surveys were conducted the week of April 17, immediately following a period of significant rainfall. On April 17, Watts Bar's pool elevation peaked about four feet above the operating guide for mid-April (739 msl) (Figure A-1), and releases from Watts Bar Dam exceeded 78,000 cfs (Figure A-2). Surface elevation and flow declined throughout the week as TVA operated the river system to evacuate flood water and recover flood storage capacity. The changing reservoir conditions (i.e., reservoir pool level, flow, turbidity, and water temperature; Figures A-1 through A-5) would likely affect bass behavior and distribution, but the extent to which this affected survey results is unknown.

It is probable that the high flow event(s) in 2011 exerted greater influence on survey results at Emory River 2.5 and Clinch River 2.5. Because these sites are in more riverine reaches of the reservoir, and due to the fact that flows in the Emory River are not regulated, changes in velocity, water temperature, and/or turbidity are often more intense. When the survey was conducted at Clinch River 2.5 on April 18, 2011, Watts Bar's surface elevation was about three feet above the operating guide and the reservoir was extremely turbid. Flows in the Emory River had increased from approximately 2,500 cfs to 60,000 the weekend prior to the survey (Figure A-3). When Emory River 2.5 was sampled on April 22, the surface elevation was about two feet above the operating guide, and the Emory River was moderately turbid with flows near 2000 cfs. Acknowledging that these conditions likely affected sampling efficiencies, a second attempt was made to sample under more normal conditions two weeks later (April 29), but rain events continued to cause conditions to fluctuate in the reservoir and the resulting catch rate (31 fish/hour at Clinch River 2.5) was comparable to that observed during the initial survey.

The black bass population in Watts Bar Reservoir has been comprised of mostly largemouth bass (Table 2). By comparison, smallmouth bass and spotted bass have never been very abundant in the reservoir. Smallmouth bass have comprised from 4.0 to 8.5% of the total catch on average at each site, with the exception of Emory River 2.5. Of the three annual surveys conducted at Emory River 2.5, smallmouth bass were collected only in 2010 (5 fish, or 1.2 % of the total catch). It remains to be seen whether this is a typical representation of smallmouth bass at this site or a reflection of a short-term decline. There has been a decline in the number spotted bass collected reservoir wide since 2005 (Table 2). This decline was rather abrupt and more pronounced at Clinch River 2.5 and Watts Bar Forebay. Following the decline in spotted bass, largemouth bass usually comprised upwards of 88% of the total bass collected.

Low numbers of crappie were collected during pre- and post-spill surveys, but they were collected in greater numbers at Emory River 2.5 than at Clinch River 2.5, and the composition of black crappie was considerably higher in the Emory River (Table 3).

Length Distribution

Largemouth bass length frequency histograms for the Clinch and Emory Rivers (Figures 4-13) illustrated either the typical bell curve or bimodal distribution, with one mode representing age-one fish (~3-7 inches) and the other representing subsequent age classes. For example, the greater representation of age-one fish at Clinch River 2.5 in 2009 and 2002, respectively, likely indicates better recruitment of young-of-year fish from the preceding year. The histograms also show that the lower catch rates at all sites (near-field and far-field) in 2011 resulted largely from collecting fewer 10 to 13 or 10 to 14 inch fish (predominately fish age 2 to 4) than in most previous years (Figures 4-17).

Relative Weights

The annual average relative weights for largemouth bass in three incremental length categories (sub-stock, quality, and preferred) ranged from approximately 80-107% (Figures 18-20). Largemouth bass in each category typically had slightly lower (~2 to 6%) average relative weights at Clinch River 2.5 than at far-field sites. However, this was the case during both pre-spill and post-spill surveys. In contrast, average relative weights typically were higher at Clinch River 2.5 than at Emory River 2.5. Averages fell within the range of approximately 80-95% at Emory River 2.5 as compared to 85-105% at Clinch River 2.5 during the same period (2009-2011). Overall, the lowest relative weights for both stock and quality largemouth bass were observed in 2010 (range, ~83 to 93%) and 2003 (range, ~87 to 92%), respectively.

It is likely that the differences in relative weights among sites are at least partially due to the sampling sites being on three river systems with differing characteristics (watershed geology, hydrological regimes, water quality, etc.) and to the longitudinal gradients in physical, chemical, and biological properties (e.g., primary productivity) that exist within the reservoir because of a downstream transition from more riverine environments to more lacustrine environments. Although site differences existed in relative weights, one of the more interesting aspects is that similar temporal patterns were evident at all sites for each length category. This suggests that relative weights were influenced by factors common among sites such as, perhaps, annual differences in meteorology and hydrology which in turn affect overall conditions in the reservoir (e.g., water temperature, primary productivity, etc.) and thereby affect fish growth, spawning, and/or recruitment. For example, because sites typically were sampled during the same week in a given year, length-weight relationships likely are influenced by annual differences in timing of the spawn relative to sampling. That is, more fish may be in the pre-spawn, spawn, or post spawn stage when surveys are conducted in any given year.

Anomalies

The long-term (2002-2005 and 2009-2011) average percent of black bass with physical anomalies at Clinch River 2.5 was 3.5% (Table 1). There were no appreciable differences between instances of anomalies prior to the ash release (range, 2.3 to 5.5%) compared to those observed after the ash release (range 2.4 to 4.8%). At Emory River 2.5, the percentages of physical anomalies observed in black bass during the three consecutive years following the spill were 1.3%, 2.3%, and 5.7%, which were within the historic range for other locations on Watts Bar Reservoir (Table 1). At far-field sites from 2002 to 2010, the proportion of bass with physical anomalies ranged from 0.7 to 6.1%, with no specific trend of increasing or decreasing through time. Percentages were highest at all far-field sites in 2011, with 6.4% at the Forebay,

6.9% at Blue Springs, and 13.9% at Caney Creek. The higher percentages at each site were largely due to increases in the number of fish with lesions, fin rot and/or fungus.

Parasites

The percentages of black bass with external parasites at Clinch River 2.5 were higher during post-spill surveys than during pre-spill surveys (2002-2005). Pre- and post-spill percentages ranged from 0 to 3.6% and 6.7 to 13.0%, respectively. Similar percentages were observed at Emory River 2.5, with external parasites found on approximately 9 to 13% of black bass collected during the three post-spill surveys. The instances of external parasites also have shown an overall trend of increasing (Table 1, Figure 21) at far-field sites. Percentages increased considerably in 2007 and again in 2008, and then peaked (8.5 to 10.2%) at all sites in 2009 before decreasing in subsequent years to a range of 4.4 to 8.6%. Because sampling was discontinued from 2006 through 2008 at Clinch River 2.5 and no pre-spill surveys were conducted at Emory River 2.5, it is unknown if similar increases occurred at these sites prior to the spill. However, as observed for other measures (i.e., catch rates, length frequency distributions, and relative weights), site similarities in instances of parasites suggest that factors unrelated to the ash spill are contributing to these increases, such as the increased frequency of years that are hotter and drier than normal.

Summary of Results

- Of the seven annual surveys conducted at Clinch River 2.5, black bass catch rates were highest in 2009 and 2010, respectively.
- Catch rates at Emory River 2.5 in 2009 and 2010 were slightly lower than at Clinch River 2.5 in each corresponding year, but higher than Clinch River's pre-spill average.
- Of the 10 annual surveys conducted at far-field sites, catch rates were highest in 2008 (Blue Springs) and 2010 (Caney Creek and Watts Bar Forebay).
- Catch rates were lowest at both near-field sites in 2011. This coincided with a decline in catch rates at far-field sites and with rather extreme fluctuations in reservoir conditions that likely affect bass behavior and sampling efficiencies.
- Largemouth bass within the combined 10-13 or 10-14 inch group were under represented at all sites in 2011.
- While some site differences existed in the average relative weights of largemouth bass, these differences were evident among the sites sampled prior to the spill.
- There were no appreciable difference between instances of anomalies prior to the ash release and those observed after the ash release.
- The percentages of black bass with external parasites at near-field sites were higher during post-spill surveys compared to pre-spill surveys conducted at Clinch River 2.5. Similar results were observed at far-field sites, but percentages increased consecutively from 2007 through 2009 and then remained above pre-spill averages in 2010 and 2011.

Conclusion

It is believed that the Spring Sport Fish Survey results from the immediate area adjacent to KIF (Clinch River 2.5 and Emory River 2.5), as well as downstream in Watts Bar Reservoir, showed no clear evidence of adverse effects associated with the KIF ash spill. Although several measures used to evaluate bass populations might at first appear to indicate ash related effects, similar spatial and temporal patterns in catch rates, length frequency distributions, relative weights, and instances of external parasites among sites (near-field and far-field) both before and after the spill, provides strong evidence that the patterns observed were associated with factors that extended reservoir-wide (e.g. meteorology) and/or site differences in limnological properties (e.g., velocity, primary productivity). If there were impacts to the black bass population resulting from the KIF ash spill in December 2008, a gradient in impacts would have been anticipated with higher levels near the spill impact zone and progressively lessening levels at downstream sites.

The lower catch rates for black bass at near-field sites in 2011 would be the most concerning, except they were preceded by two post-spill surveys with above average catch rates and the fact that the 2011 surveys coincided with rather extreme fluctuations in reservoir conditions (i.e., pool level, flow, turbidity, and water temperature) that likely affected sampling efficiencies. Additionally, the likelihood that an adverse impact of the spill would be realized concurrently over an area of approximately 10 river miles, to the same degree, two and one-half years after the spill, is doubtful. Likewise, the general similarities with results at far-field locations, also indicates reservoir-wide influences during the 2011 survey. TVA will continue to monitor black bass population on Watts Bar to determine if any latent effects become apparent.

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Tables

Table 1. Summary of Spring Sport Fish Survey results for black bass collected at sites on the Emory, Clinch and Tennessee Rivers, Watts Bar Reservoir, 2002-2011

Location	Year	Total # of Bass	Catch Rate (no./hr.)	Parasites		Physical Anomalies											Hook Injury	
				Total	%	Lesions	Emaciated/ Skinny	Scoliosis	Fin Rot	Fungus	Blind-eye	Cancerous growth	Popeye	Deformed	Total Anomalies	% Anomalies	Total	%
Emory River 2.5	2009	319	53.2	30	9.4%	1			1	2					4	1.3%	3	0.9%
	2010	304	50.7	39	12.8%	2		1	3	1	1				8	2.6%	5	1.6%
	2011	194	32.3	18	9.3%	4		1	2	4					11	5.7%	8	4.1%
Emory River Minimum		194	32.3	18	9.3%	1	0	0	1	1	0	0	0	0	4	1.3%	3	0.9%
Emory River Maximum		319	53.2	39	12.8%	4	0	1	3	4	1	0	0	0	11	5.7%	8	4.1%
Emory River Average		272	45.4	12.4	10.5%	2.3	0.0	0.7	2.0	2.3	0.3	0.0	0.0	0.0	7.7	3.2%	5.3	2.2%
Clinch River 2.5	2002	311	51.8		0.0%	3				3	1				7	2.3%	6	1.9%
	2003	289	48.1	1	0.3%	2	1			6	1		1		11	3.8%	9	3.1%
	2004	256	42.7	1	0.4%	5	1			7	1				14	5.5%	13	5.1%
	2005	252	42.0	9	3.6%	2		1		3	1	1			8	3.2%	4	1.6%
	2009	376	62.7	49	13.0%	6		2			1				9	2.4%	12	3.2%
	2010	357	59.7	24	6.7%	2	4	1		2		1			10	2.8%	8	2.2%
	2011	167	27.8	16	9.6%	3		1	1	2				1	8	4.8%	7	4.2%
	2011-B	186	31.0	19	10.2%	6			4	2					12	6.5%	15	8.1%
Clinch River Minimum		167	27.8	0	0.0%	2	0	0	0	0	0	0	0	0	7	2.3%	4	1.6%
Clinch River Maximum		376	62.7	49	13.0%	6	4	2	1	7	1	1	1	1	14	5.5%	15	8.1%
Clinch River Average		274	47.8	14.3	4.8%	3.3	0.9	0.7	0.1	3.3	0.7	0.3	0.1	0.1	9.9	3.5%	9.3	3.7%
Caney Creek	2002	468	78.0	1	0.2%	1		1		3					5	1.1%	9	1.9%
	2003	367	61.2	2	0.5%				2	6					8	2.2%	10	2.7%
	2004	351	58.5	3	0.9%	3	1		2	9					15	4.3%	13	3.7%
	2005	314	52.3	4	1.3%	2			2		2		1	2	9	2.9%	4	1.3%
	2006	255	42.5	2	0.8%			1	1	2	1				5	2.0%	3	1.2%
	2007	393	65.5	7	1.8%	2			1	4	2				9	2.3%	10	2.5%
	2008	560	93.3	16	2.9%	4	1	1	3	15	1	1			26	4.6%	12	2.1%
	2009	429	71.5	38	8.9%	1		1	2	4	1				9	2.1%	11	2.6%
	2010	579	96.5	41	7.1%	1		5	1	2	2				11	1.9%	20	3.5%
	2011	338	56.3	16	4.7%	14		3	20	7		1	2		47	13.9%	14	4.1%
Caney Creek Minimum		255	42.5	1	0.2%	0	0	0	0	0	0	0	0	0	5	1.1%	3	1.2%
Caney Creek Maximum		579	96.5	41	8.9%	14	1	5	20	15	2	1	2	2	47	13.9%	20	4.1%
Caney Creek Average		405	67.6	13.0	2.9%	2.8	0.2	1.2	3.4	5.2	0.9	0.2	0.3	0.2	14.4	3.7%	10.6	2.6%
Blue Springs	2002	268	44.7		0.0%	2				2	2				6	2.2%	3	1.1%
	2003	313	52.2		0.0%	9			3	4	3				19	6.1%	1	0.3%
	2004	274	45.7	1	0.4%	1	1	1	2	4	1				10	3.6%	5	1.8%
	2005	309	51.5	2	0.6%	2	1	1	1	3	1				9	2.9%	5	1.6%
	2006	361	60.2		0.0%	3			1	5	1				10	2.8%	2	0.6%
	2007	301	50.2	10	3.3%	3		1		2	1		1		8	2.7%	5	1.7%
	2008	403	67.2	21	5.2%	5			3	10		1			19	4.7%	17	4.2%
	2009	323	53.8	33	10.2%	5	3	2	3	1	1				15	4.6%	8	2.5%
	2010	338	56.3	29	8.6%		1	1	3	3					8	2.4%	19	5.6%
	2011	276	46.0	15	5.4%	2			9	6		2			19	6.9%	13	4.7%
Blue Springs Minimum		268	44.7	1	0.0%	0	0	0	0	1	0	0	0	0	6	2.2%	1	0.3%
Blue Springs Maximum		403	67.2	33	10.2%	9	3	2	9	10	3	2	1	0	19	6.9%	19	5.6%
Blue Springs Average		317	52.8	11.1	3.4%	3.2	0.6	0.6	2.5	4	1	0.3	0.1	0	12.3	3.9%	7.8	2.4%

Table 1, Con't. Summary of Spring Sport Fish Survey results for black bass collected at sites on the Emory, Clinch and Tennessee Rivers, Watts Bar Reservoir, 2002-2011

Location	Year	Total # of Bass	Catch Rate (no./hr.)	Parasites		Physical Anomalies											Hook Injury	
				Total	%	Lesions	Emaciated/ Skinny	Scoliosis	Fin Rot	Fungus	Blind-eye	Cancerous growth	Popeye	Deformed	Total Anomalies	% Anomalies	Total	%
Watts Bar Forebay	2002	321	53.5		0.0%	1				1	3				5	1.6%	2	0.6%
	2003	390	65.0	2	0.5%	2	1		2		1				6	1.5%	10	2.6%
	2004	365	60.8	2	0.5%	2		2	1	3		1			9	2.5%	11	3.0%
	2005	274	45.7	2	0.7%	2		1	1	1	1			1	7	2.6%	5	1.8%
	2006	311	51.8		0.0%	2		1		1	1		2		7	2.3%	1	0.3%
	2007	275	45.8	10	3.6%	2									2	0.7%	4	1.5%
	2008	368	61.3	27	7.3%	3	1	1	2	4	1	3			15	4.1%	2	0.5%
	2009	388	64.7	33	8.5%	2	1			4					7	1.8%	19	4.9%
	2010	455	75.8	20	4.4%	2	1	2		1	2	1	1		10	2.2%	17	3.7%
	2011	326	54.3	19	5.8%	3		1	8	8		1			21	6.4%	4	1.2%
Forebay Minimum		274	45.7	2	0.0%	1	0	0	0	0	0	0	0	0	2	0.7%	1	0.3%
Forebay Maximum		455	75.8	33	8.5%	3	1	2	8	8	3	3	2	1	21	6.4%	19	4.9%
Forebay Average		347	57.9	11.5	3.1%	2.1	0.4	0.8	1.4	2.3	0.9	0.6	0.3	0.1	8.9	2.6%	7.5	2.0%

Table 2. Number and composition of largemouth, smallmouth, and spotted bass collected during Spring Sport Fish Surveys on Watts Bar Reservoir, 2002-2011.

		Number of Black Bass Collected by Species				Composition by Species		
Location	Year	Largemouth bass	Smallmouth bass	Spotted bass	Total	Largemouth bass	Smallmouth bass	Spotted bass
Emory River 2.5	2009	304	0	15	319	95.3%	0.0%	4.7%
	2010	297	5	2	304	97.7%	1.6%	0.7%
	2011	192	0	2	194	99.0%	0.0%	1.0%
Clinch River 2.5	2002	247	19	45	311	79.4%	6.1%	14.5%
	2003	206	30	53	289	71.3%	10.4%	18.3%
	2004	192	22	42	256	75.0%	8.6%	16.4%
	2005	199	23	30	252	79.0%	9.1%	11.9%
	2009	344	28	4	376	91.5%	7.4%	1.1%
	2010	314	37	6	357	88.0%	10.4%	1.7%
	2011	155	12	0	167	92.8%	7.2%	0.0%
	2011-B*	158	26	2	186	84.9%	14.0%	1.1%
Caney Creek	2002	446	19	3	468	95.3%	4.1%	0.6%
	2003	320	34	13	367	87.2%	9.3%	3.5%
	2004	321	17	13	351	91.5%	4.8%	3.7%
	2005	285	19	10	314	90.8%	6.1%	3.2%
	2006	211	38	6	255	82.7%	14.9%	2.4%
	2007	346	43	4	393	88.0%	10.9%	1.0%
	2008	539	19	2	560	96.3%	3.4%	0.4%
	2009	403	22	4	429	93.9%	5.1%	0.9%
	2010	545	31	3	579	94.1%	5.4%	0.5%
	2011	307	28	3	338	90.8%	8.3%	0.9%
Blue Springs	2002	261	6	1	268	97.4%	2.2%	0.4%
	2003	270	21	22	313	86.3%	6.7%	7.0%
	2004	252	14	8	274	92.0%	5.1%	2.9%
	2005	271	25	13	309	87.7%	8.1%	4.2%
	2006	346	14	1	361	95.8%	3.9%	0.3%
	2007	290	11	0	301	96.3%	3.7%	0.0%
	2008	380	17	6	403	94.3%	4.2%	1.5%
	2009	315	8	0	323	97.5%	2.5%	0.0%
	2010	333	5	0	338	98.5%	1.5%	0.0%
	2011	268	7	1	276	97.1%	2.5%	0.4%
Watts Bar Forebay	2002	266	20	35	321	82.9%	6.2%	10.9%
	2003	312	13	65	390	80.0%	3.3%	16.7%
	2004	246	25	94	365	67.4%	6.8%	25.8%
	2005	172	47	55	274	62.8%	17.2%	20.1%
	2006	263	32	16	311	84.6%	10.3%	5.1%
	2007	255	18	2	275	92.7%	6.5%	0.7%
	2008	359	8	1	368	97.6%	2.2%	0.3%
	2009	370	18	0	388	95.4%	4.6%	0.0%
	2010	436	19	0	455	95.8%	4.2%	0.0%
	2011	305	21	0	326	93.6%	6.4%	0.0%

* *Due to elevated reservoir pool levels and turbid conditions during the April 18, 2011 survey, a second survey was conducted on April 29.*

Table 3. Number and composition of black and white crappie collected during Spring Sport Fish Surveys on Watts Bar Reservoir, 2002-2011.

		Number of Crappie Collected by Species			Composition by Species	
Location	Year	Black crappie	White crappie	Total	Black crappie	White crappie
Emory River 2.5	2009	28	12	40	70.0%	30.0%
	2010	23	16	39	59.0%	41.0%
	2011	42	50	92	45.7%	54.3%
Clinch River 2.5	2002	8	18	26	30.8%	69.2%
	2004	5	18	23	21.7%	78.3%
	2005	6	10	16	37.5%	62.5%
	2009	2	11	13	15.4%	84.6%
	2010	8	23	31	25.8%	74.2%
	2011	2	18	20	10.0%	90.0%
	2011-B*	2	17	19	10.5%	89.5%
Caney Creek	2002	27	117	144	18.8%	81.3%
	2003	43	62	105	41.0%	59.0%
	2004	12	93	105	11.4%	88.6%
	2005	15	65	80	18.8%	81.3%
	2006	56	153	209	26.8%	73.2%
	2007	15	165	180	8.3%	91.7%
	2008	25	193	218	11.5%	88.5%
	2009	15	91	106	14.2%	85.8%
	2010	24	111	135	17.8%	82.2%
	2011	4	75	79	5.1%	94.9%
Blue Springs	2002	33	5	38	86.8%	13.2%
	2003	65	17	82	79.3%	20.7%
	2004	52	32	84	61.9%	38.1%
	2005	47	66	113	41.6%	58.4%
	2006	140	138	278	50.4%	49.6%
	2007	37	74	111	33.3%	66.7%
	2008	30	62	92	32.6%	67.4%
	2009	37	80	117	31.6%	68.4%
	2010	22	50	72	30.6%	69.4%
	2011	24	24	48	50.0%	50.0%
Watts Bar Forebay	2002	13	5	18	72.2%	27.8%
	2003	19	0	19	100.0%	0.0%
	2004	34	5	39	87.2%	12.8%
	2005	23	3	26	88.5%	11.5%
	2006	84	38	122	68.9%	31.1%
	2007	10	25	35	28.6%	71.4%
	2008	14	15	29	48.3%	51.7%
	2009	33	27	60	55.0%	45.0%
	2010	36	1	37	97.3%	2.7%
	2011	26	13	39	66.7%	33.3%

* *Due to elevated pool levels and turbid conditions during the April 18, 2011 survey, a second survey was conducted on April 29.*

Figures

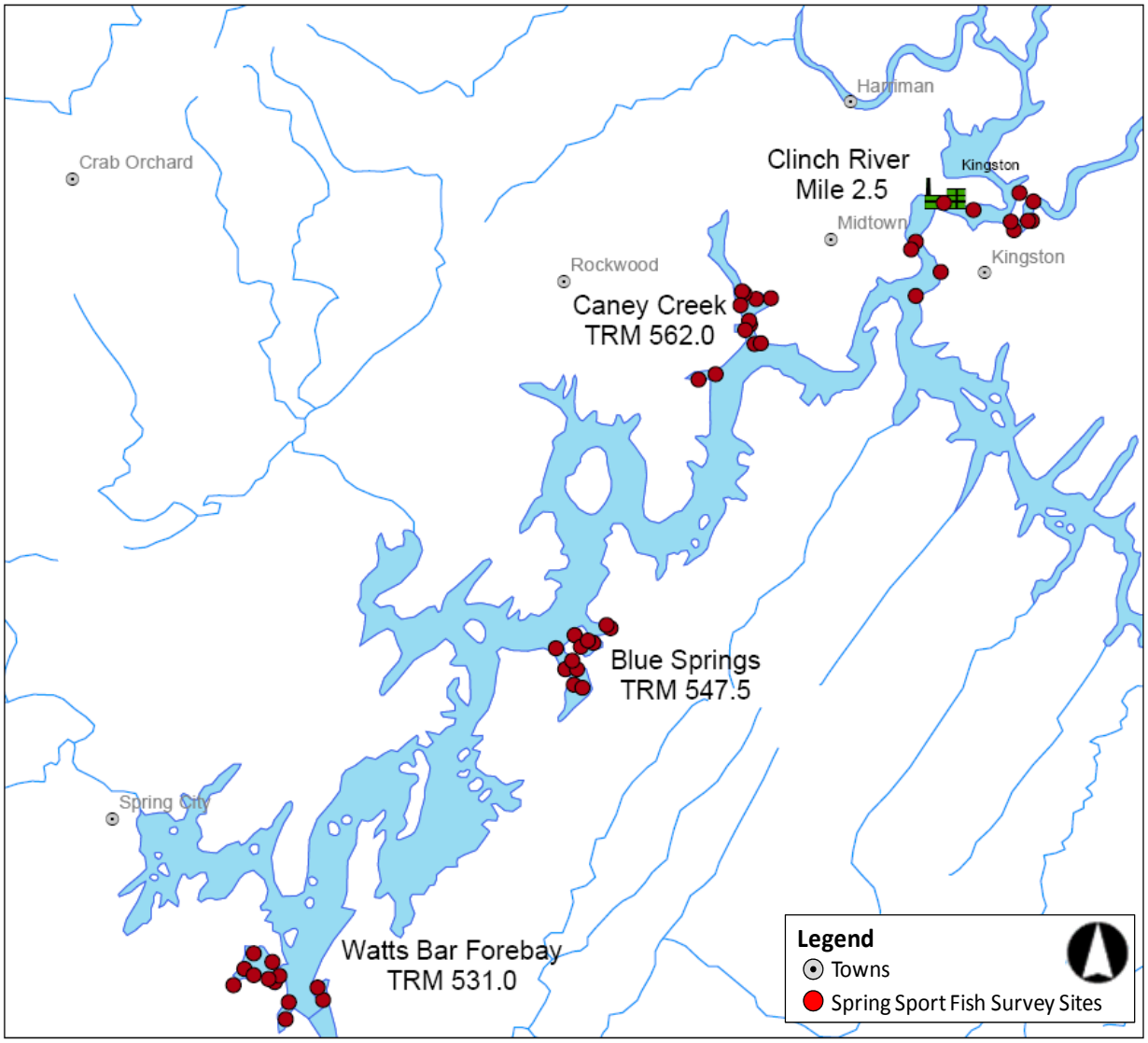
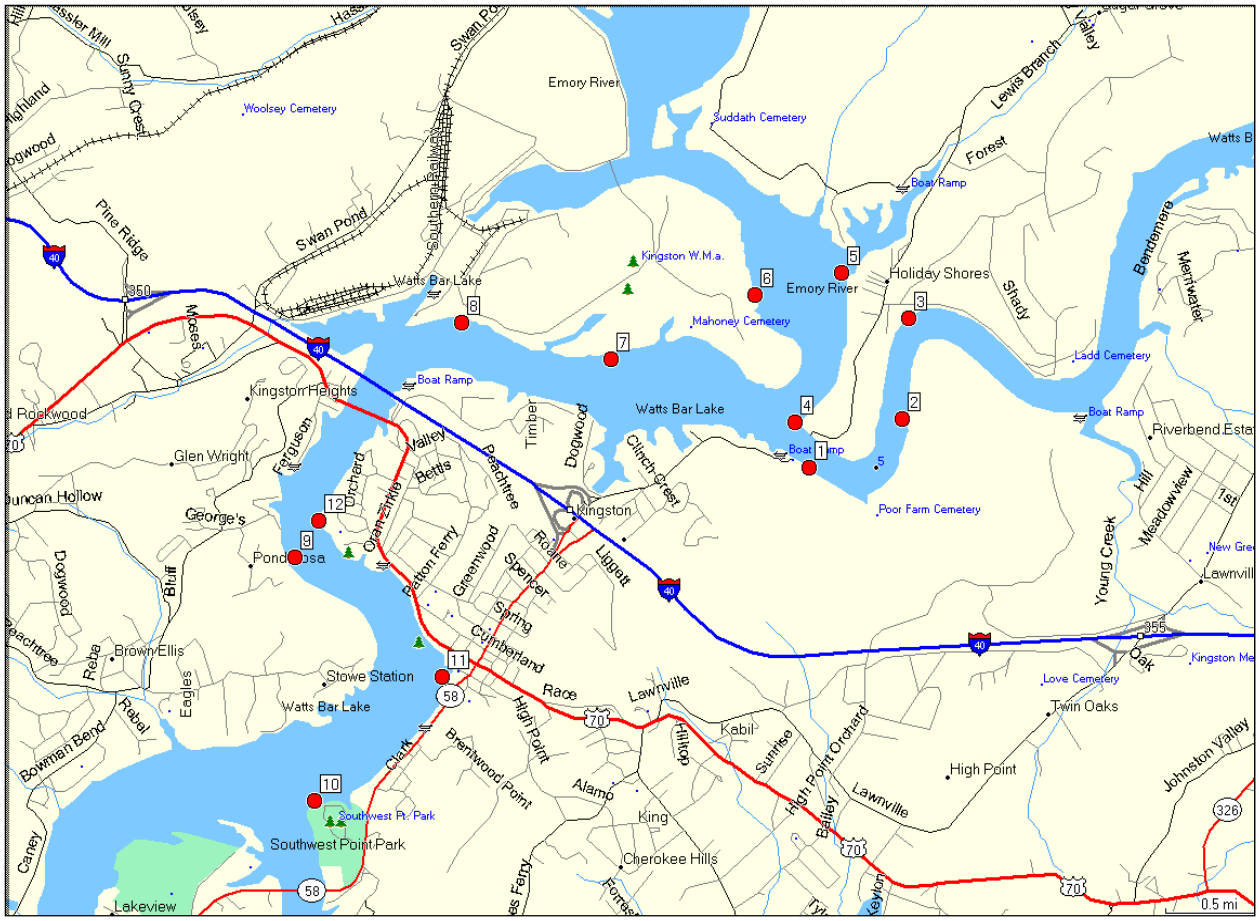
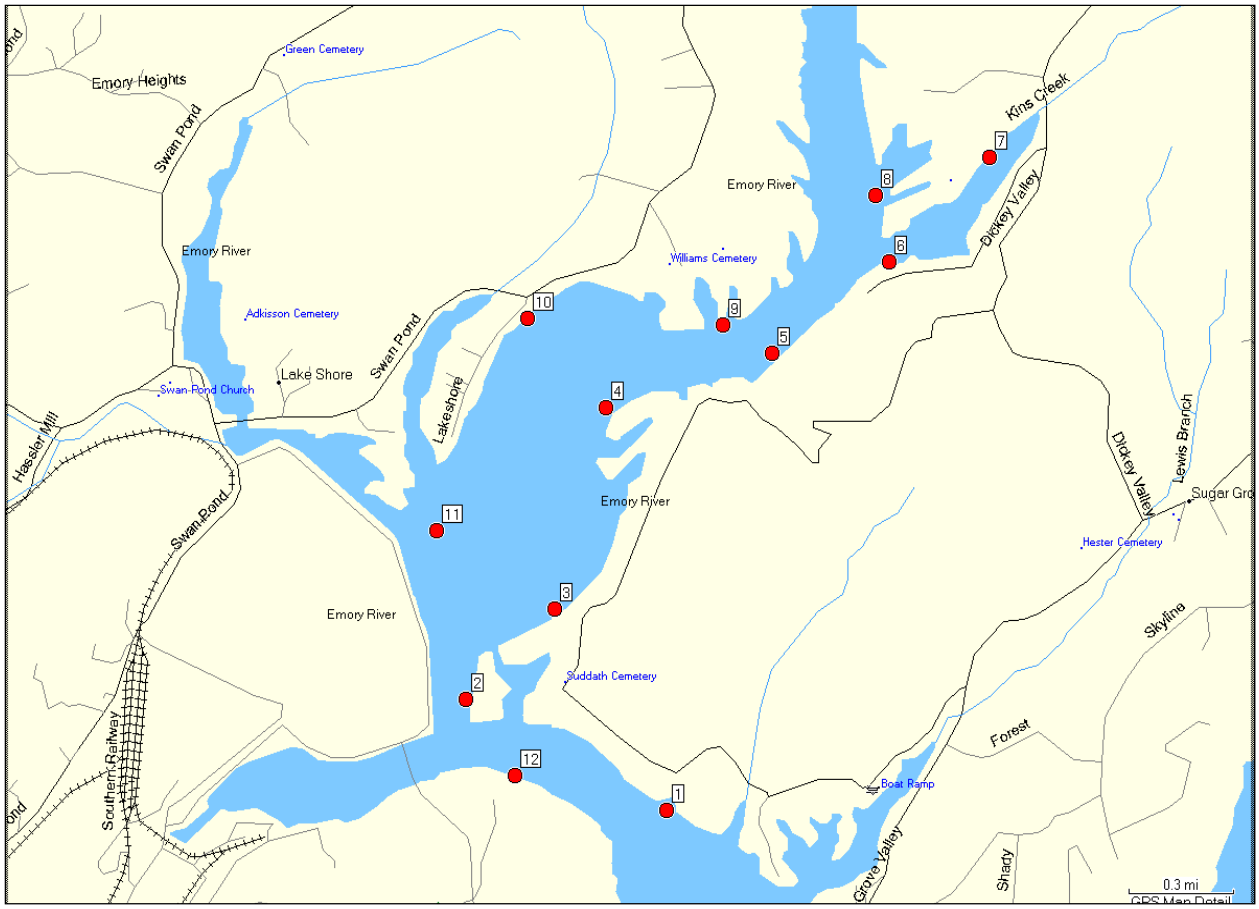


Figure 1. Historic (prior to 2009) Spring Sport Fish Survey sampling sites on Watts Bar Reservoir — Clinch River mile 2.5 and far-field locations (Caney Creek, Blue Springs, and Watts Bar Forebay).



Electrofishing Sites	GPS Coordinates	
1	N35 53.056	W84 29.343
2	N35 53.246	W84 28.884
3	N35 53.643	W84 28.850
4	N35 53.732	W84 29.612
5	N35 53.235	W84 29.414
6	N35 53.821	W84 29.185
7	N35 53.482	W84 30.326
8	N35 53.626	W84 31.065
9	N35 52.706	W84 31.890
10	N35 51.753	W84 31.794
11	N35 52.237	W84 31.161
12	N35 52.850	W84 31.771

Figure 2. Spring Sport Fish Survey electrofishing sites at Clinch River 2.5, Watts Bar Reservoir.



Electrofishing Run	GPS Coordinates	
1	N35 54.099	W84 29.517
2	N35 54.363	W84 30.135
3	N35 54.578	W84 29.861
4	N35 55.111	W84 29.503
5	N35 55.191	W84 29.192
6	N35 55.409	W84 28.835
7	N35 55.659	W84 28.526
8	N35 55.569	W84 28.873
9	N35 56.181	W84 28.969
10	N35 55.586	W84 29.019
11	N35 55.274	W84 29.943
12	N35 54.182	W84 29.984

Figure 3. Spring Sport Fish Survey electrofishing sites at Emory River 2.5, Watts Bar Reservoir.

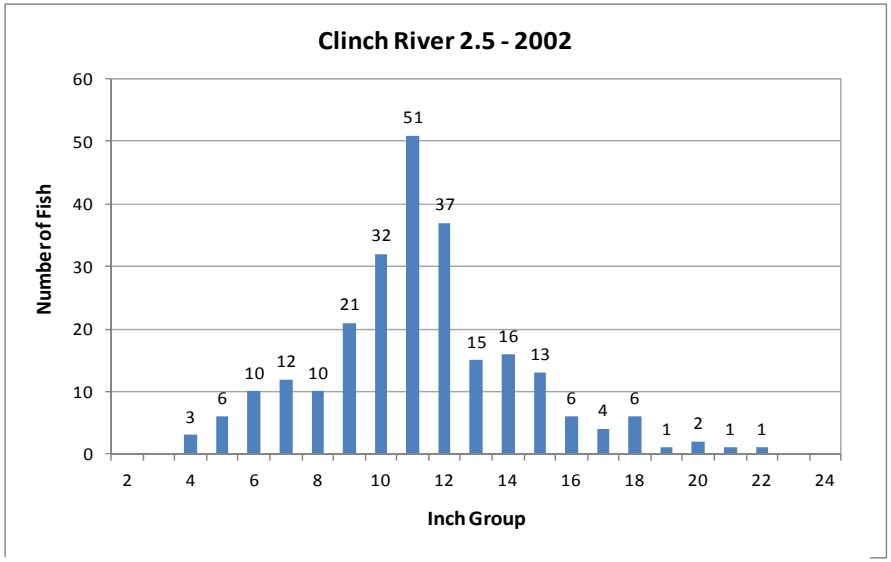


Figure 4. Length frequency of largemouth bass collected at Clinch River 2.5 in Spring 2002.

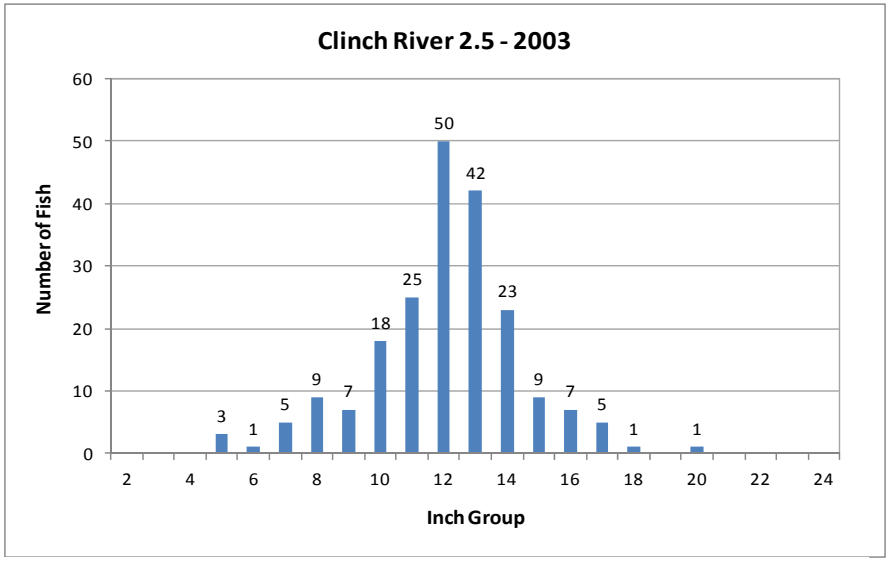


Figure 5. Length frequency of largemouth bass collected at Clinch River 2.5 in Spring 2003.

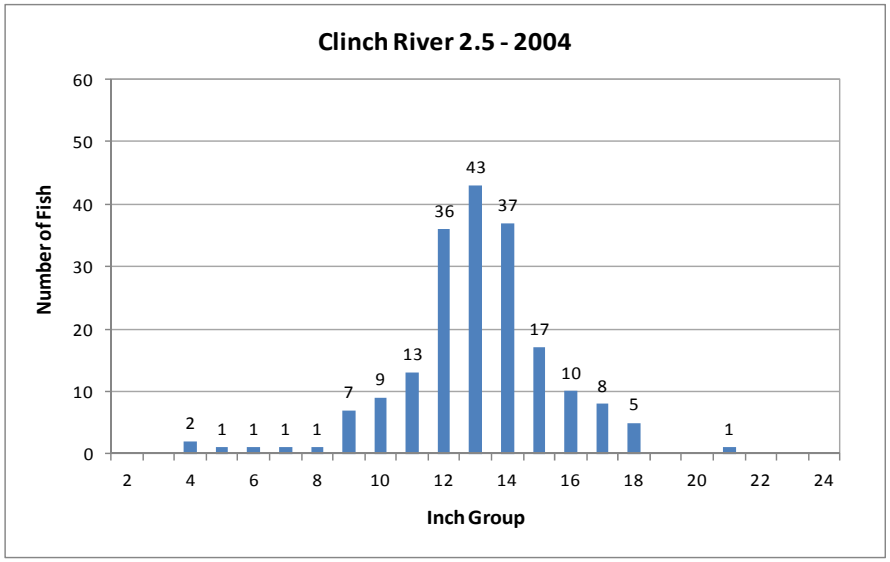


Figure 6. Length frequency of largemouth bass collected at Clinch River 2.5 in Spring 2004.

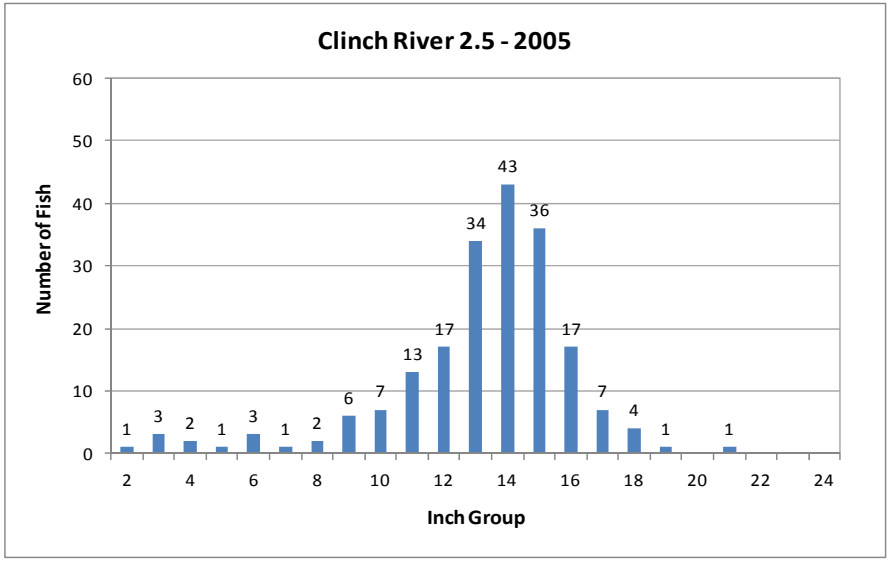


Figure 7. Length frequency of largemouth bass collected at Clinch River 2.5 in Spring 2005.

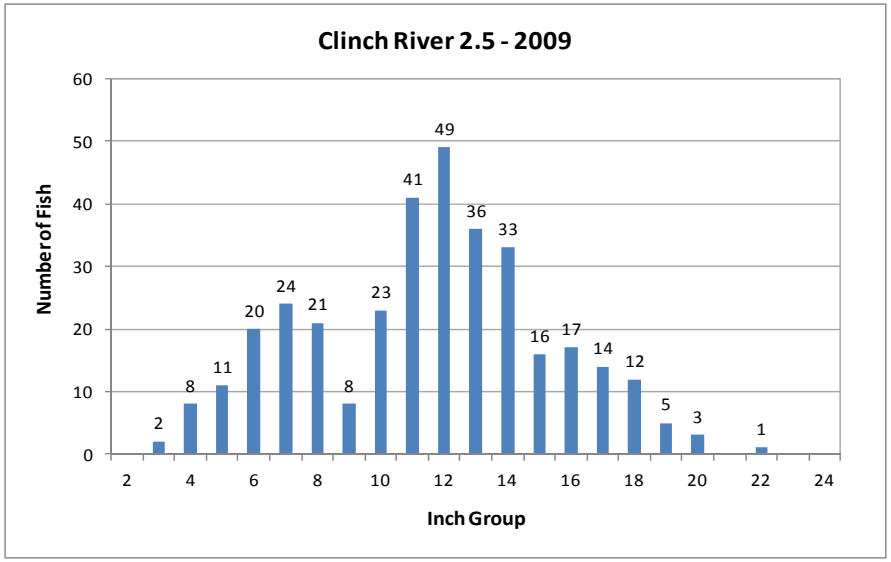


Figure 8. Length frequency of largemouth bass collected at Clinch River 2.5 in Spring 2009.

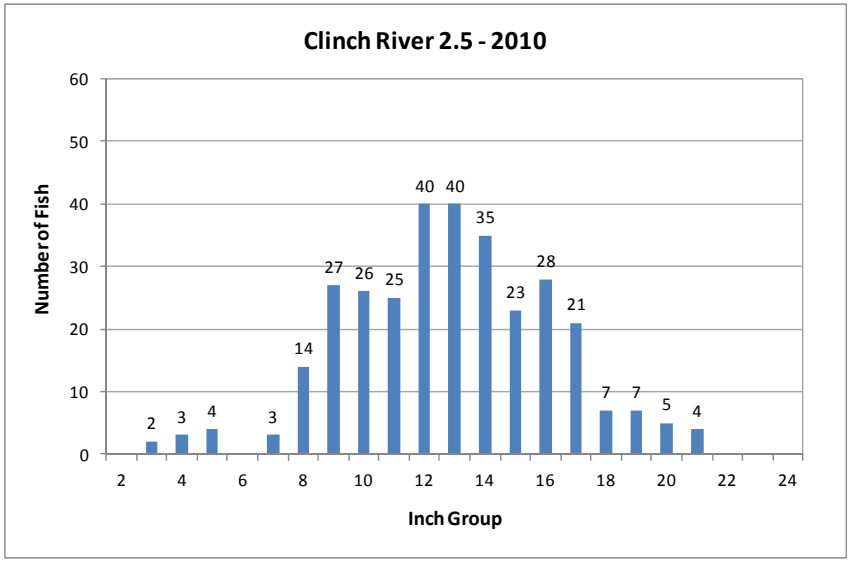


Figure 9. Length frequency of largemouth bass collected at Clinch River 2.5 in Spring 2010.

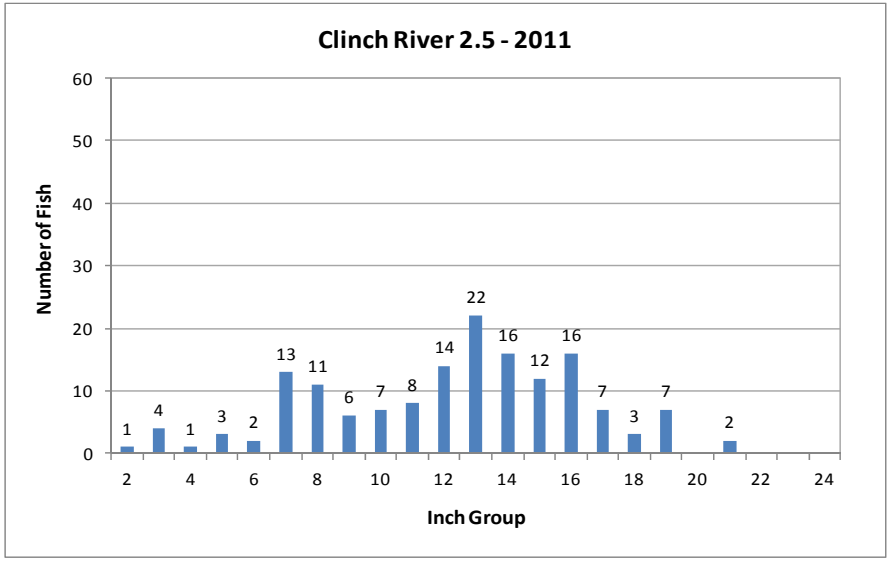


Figure 10. Length frequency of largemouth bass collected at Clinch River 2.5 in Spring 2011.

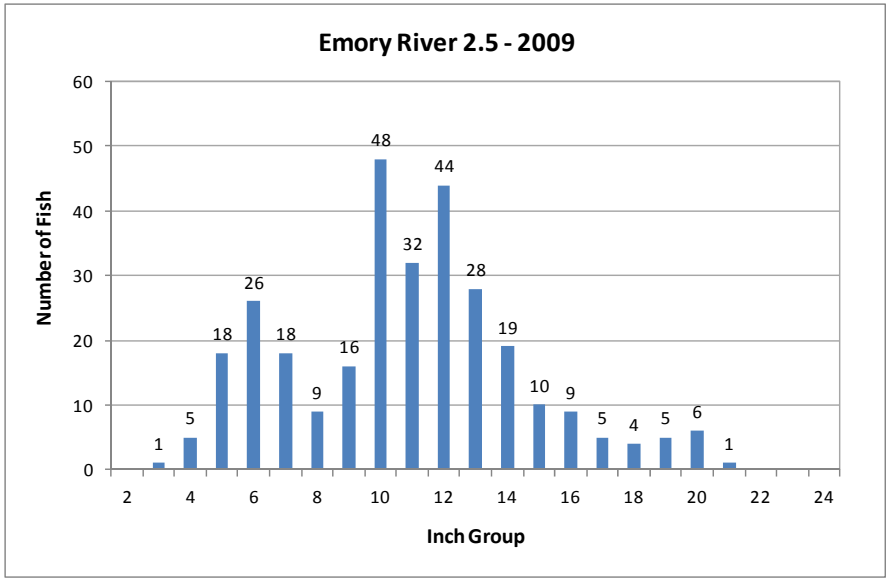


Figure 11. Length frequency of largemouth bass collected at Emory River 2.5 in Spring 2009.

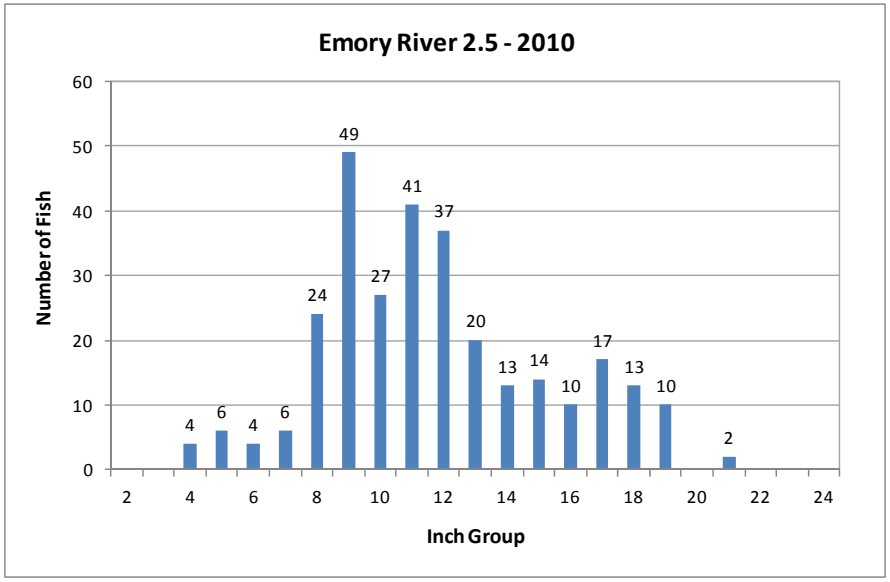


Figure 12. Length frequency of largemouth bass collected at Emory River 2.5 in Spring 2010.

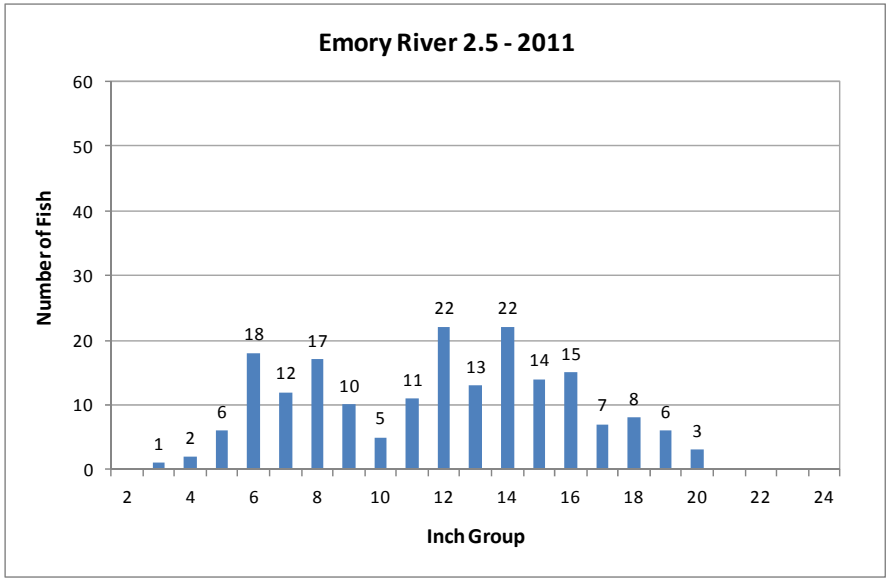


Figure 13. Length frequency of largemouth bass collected at Emory River 2.5 in Spring 2011.

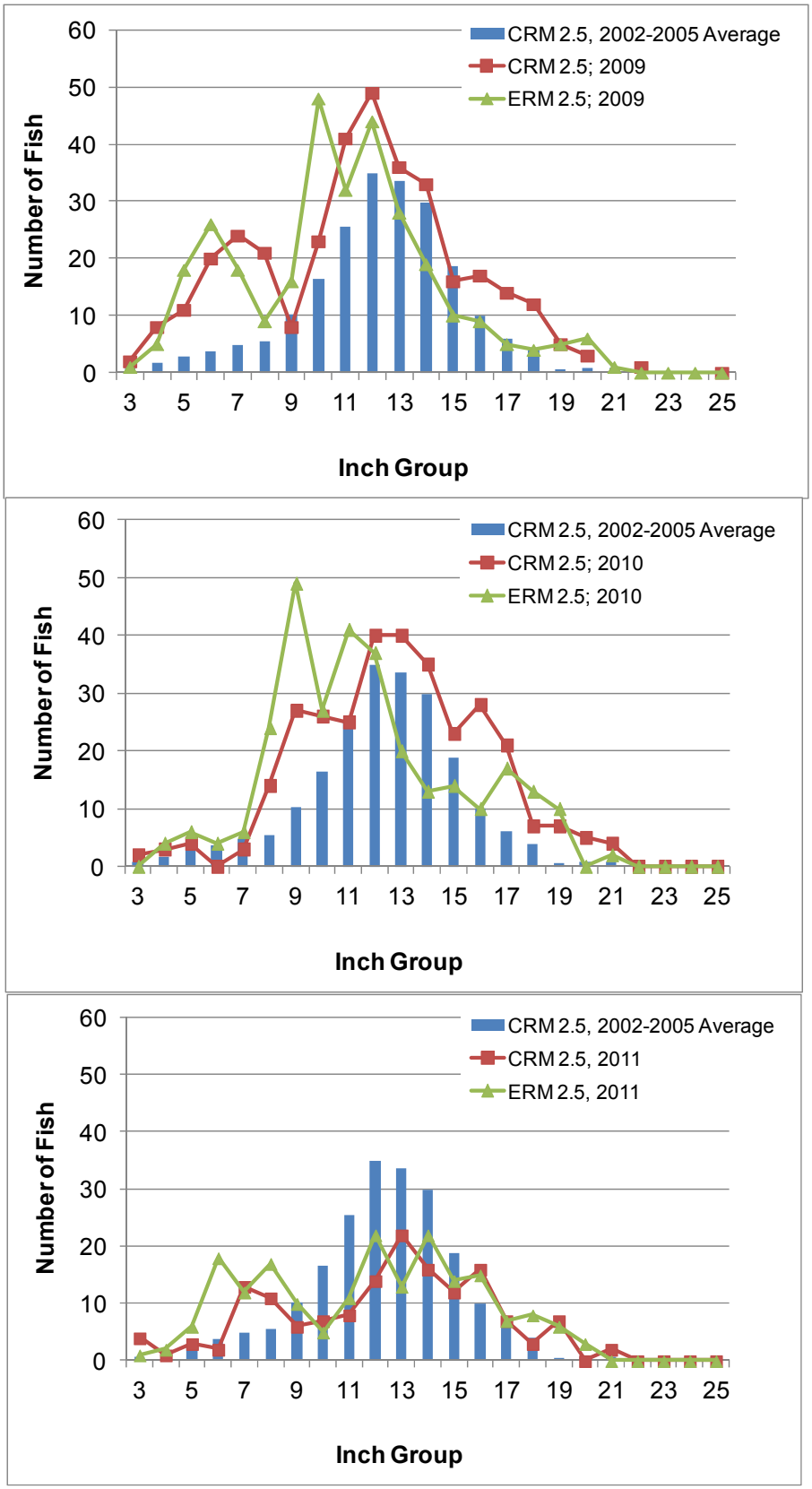


Figure 14. Length frequency of largemouth bass collected at Clinch River 2.5 and Emory River 2.5 in 2009 (top), 2010 (middle), and 2011 (bottom) compared to the pre-spill averages for Clinch River 2.5.

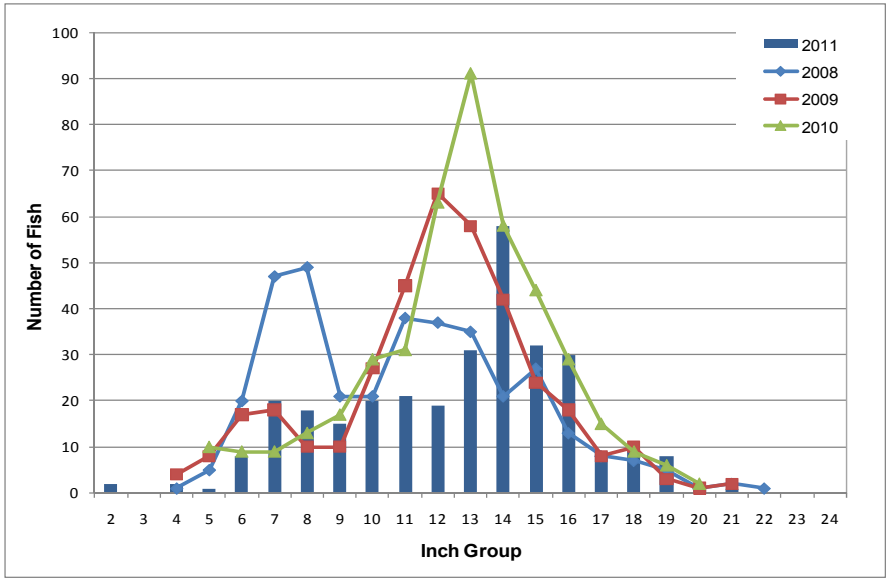


Figure 15. Caney Creek largemouth bass length frequency in 2011 compared to 2008, 2009, and 2010.

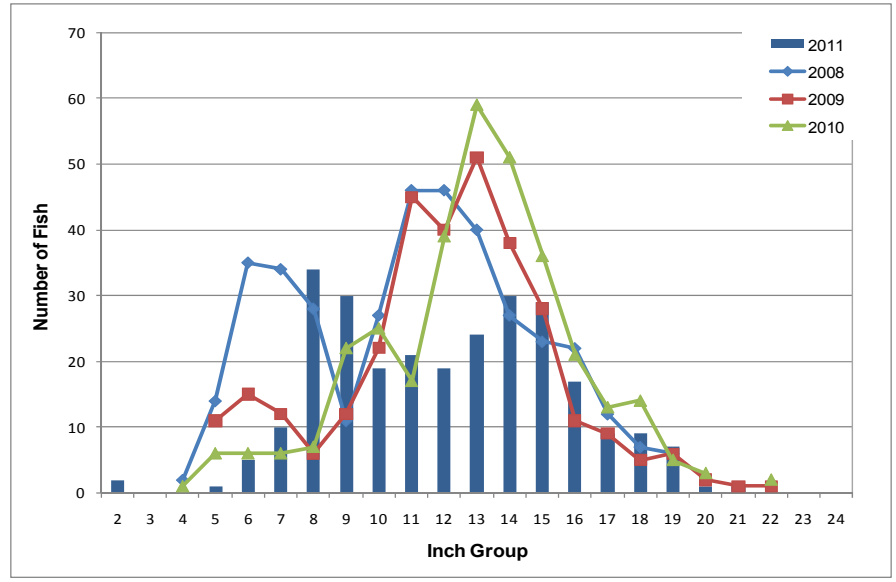


Figure 16. Blue Springs largemouth bass length frequency in 2011 compared to 2008, 2009, and 2010.

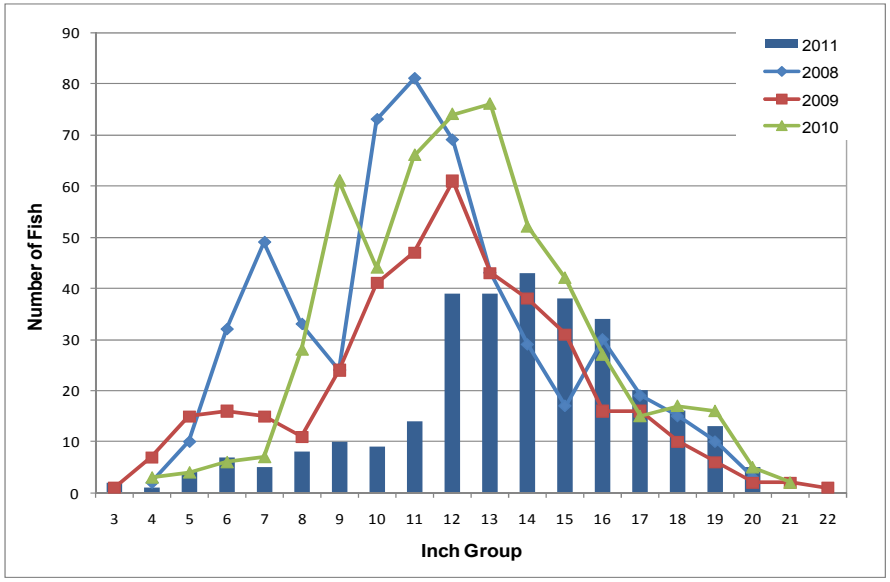


Figure 17. Watt Bar Forebay largemouth bass length frequency in 2011 compared to 2008, 2009, and 2010.

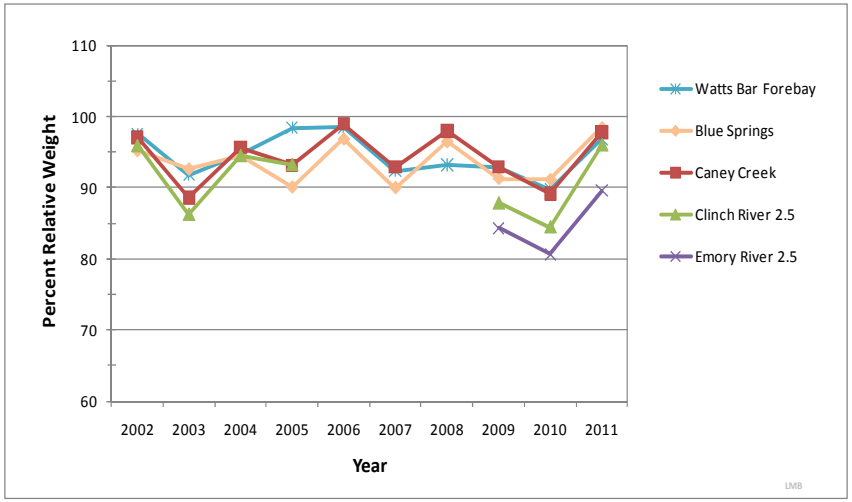


Figure 18. Average relative weights (Wr) for stock (8-11 inch) largemouth bass.

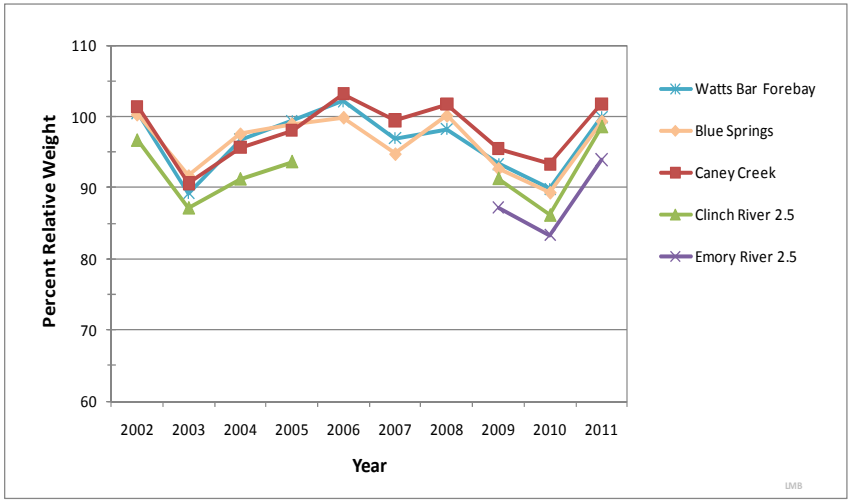


Figure 19. Average relative weights (Wr) for quality (12-14 inch) largemouth bass.

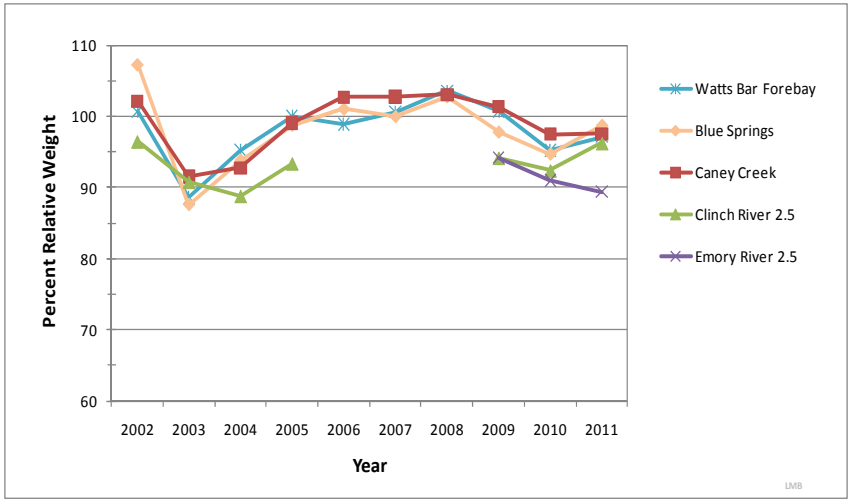


Figure 20. Average relative weights (Wr) for preferred (15-19 inch) largemouth bass.

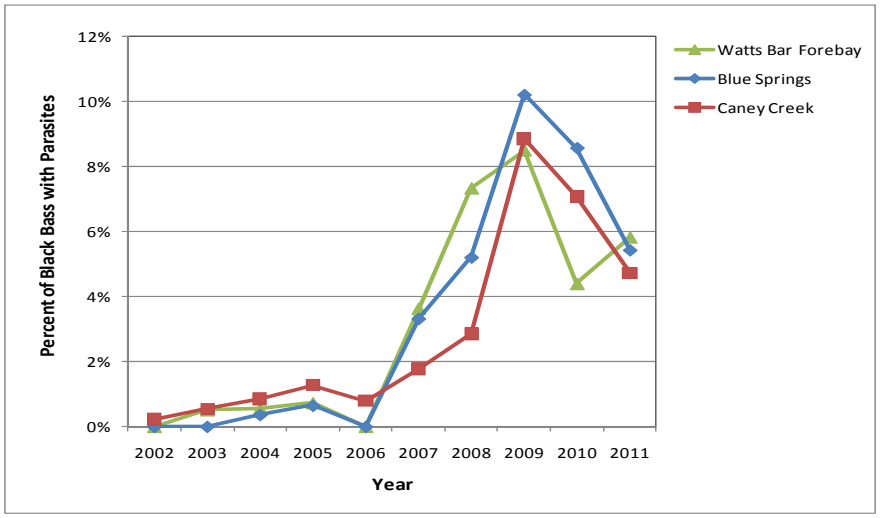


Figure 21. Percent of black bass with parasites at far-field locations on Watts Bar Reservoir, 2002-2011.

Appendix

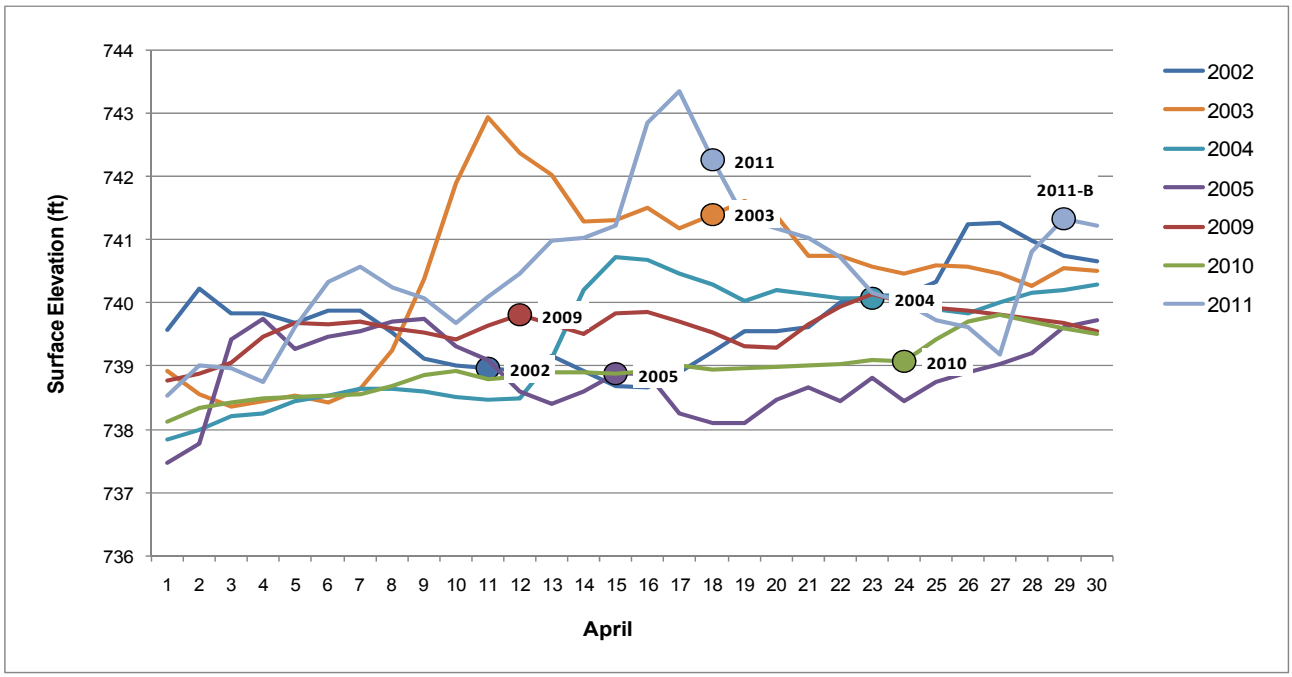


Figure A-1. Daily average surface elevations on Watts Bar Reservoir during April 2002-2005 and 2009-2011, with emphasis on dates that Spring Sport Fish Surveys were conducted at Clinch River 2.5.

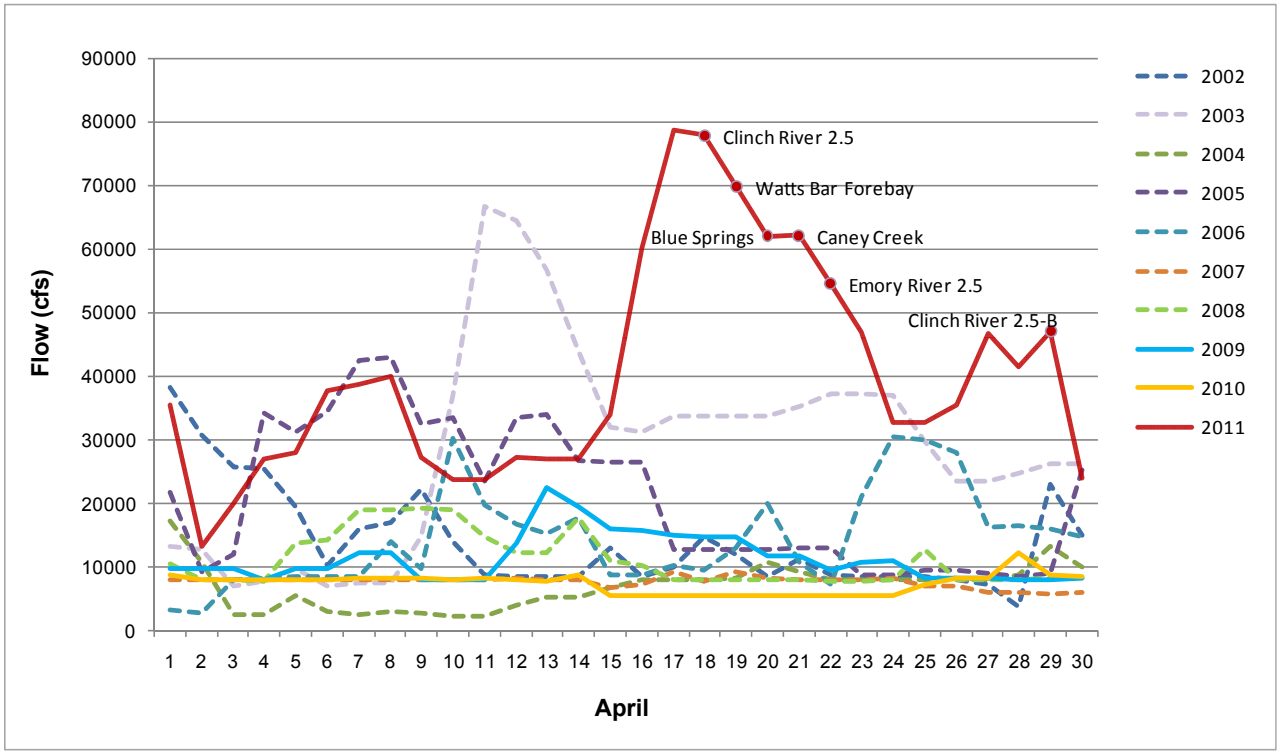


Figure A-2. Average daily releases from Watts Bar Dam during April 2002-2011, with emphasis on 2011 and Spring Sport Fish sampling dates at near-field and far-field sites.

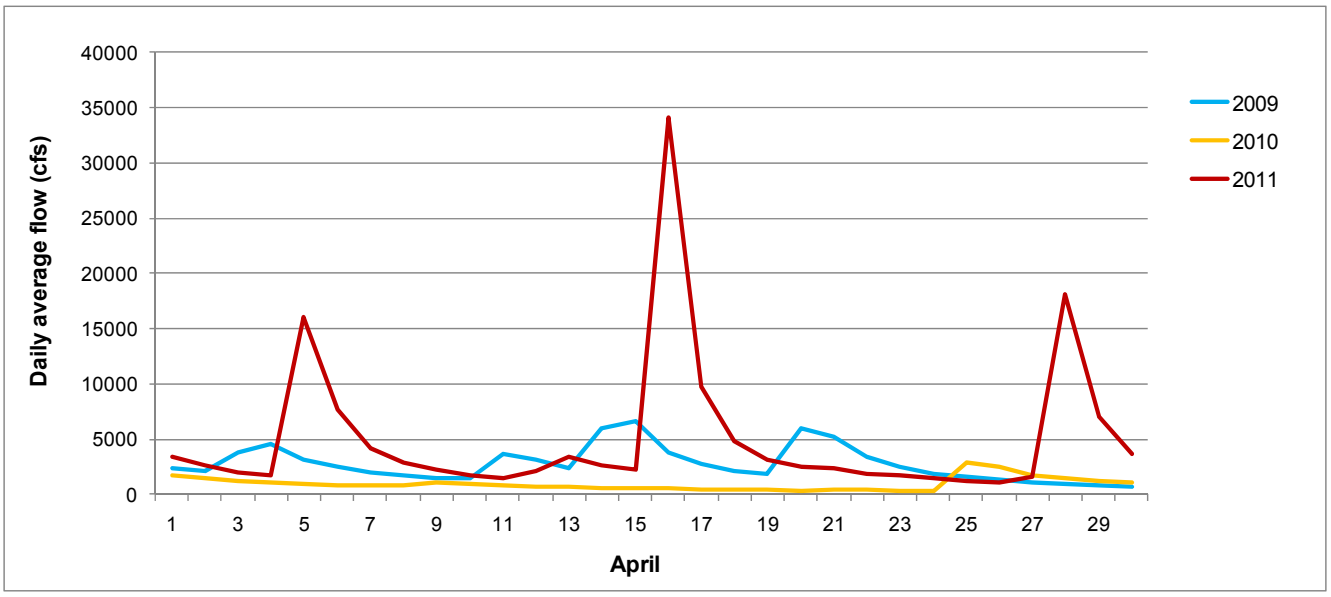


Figure A-3. Daily average flow in the Emory River (Oakdale, TN; USGS 03540500), April 2009-2011.

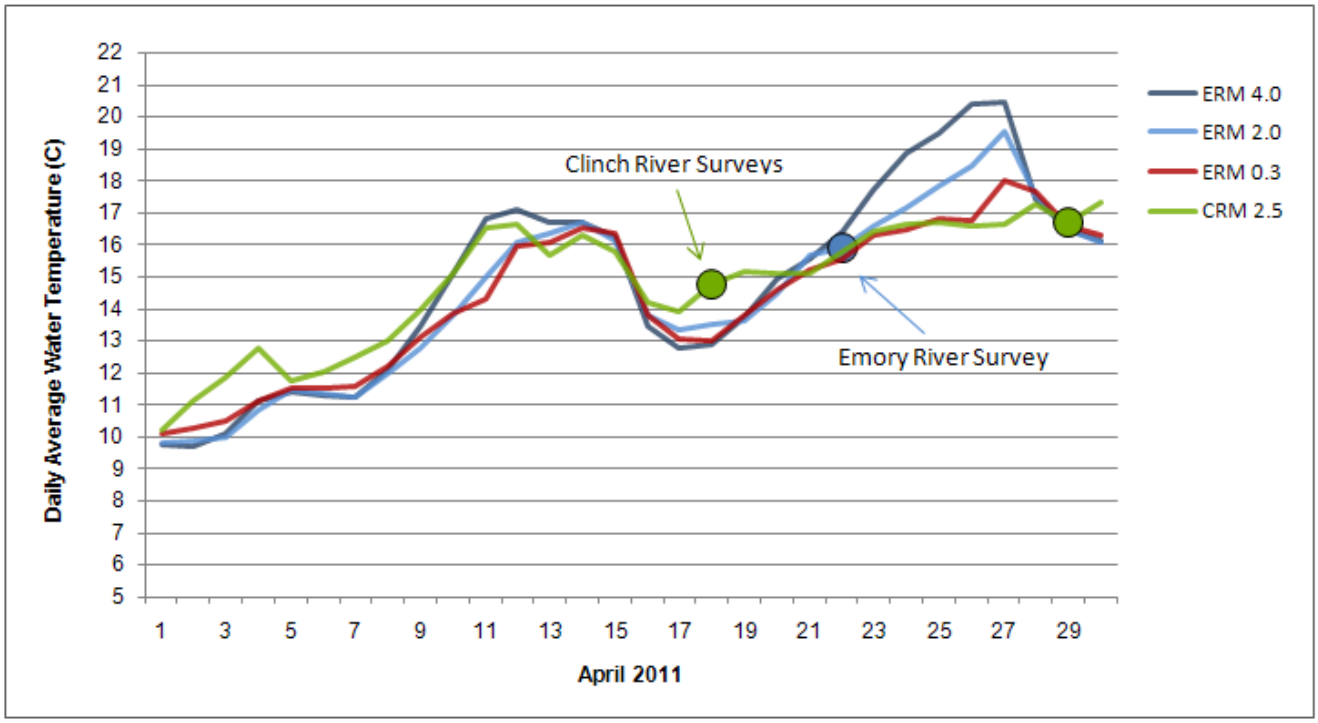


Figure A-4. Daily average water temperatures in the Emory and Clinch Rivers during April 2011, with emphasis on dates that Spring Sport Fish Surveys were conducted (water temperature was recorded at 15 minute intervals at the approximate depth of two meters at each location).

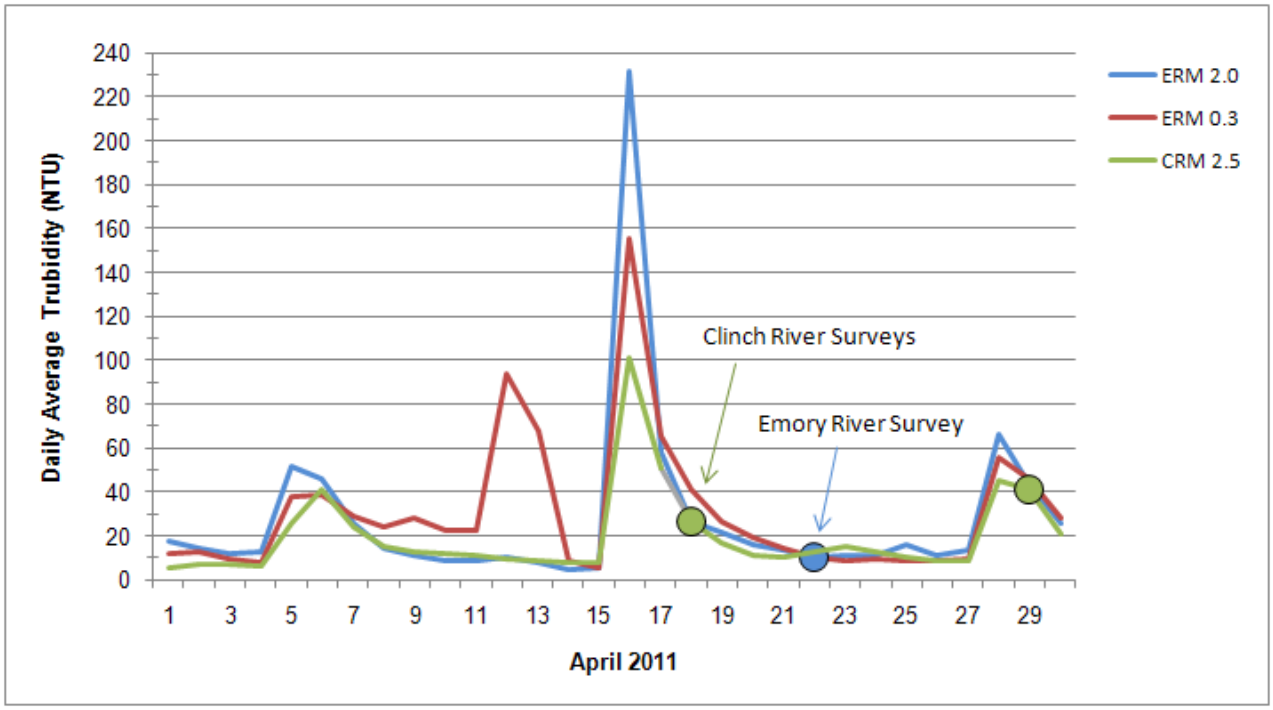


Figure A-5. Daily average turbidity (NTU) in the Emory and Clinch Rivers during April 2011, with emphasis on dates that Spring Sport Fish Surveys were conducted (turbidity was measured at 15 minute intervals at the approximate depth of two meters at each location).