DESIGNATED USE SUPPORT ON LAKE STANDARDS RESERVOIRS AND COMPLIANCE WITH GROWING SEASON MEAN CHLOROPHYLL *a* STANDARD

Review Summary

Six reservoirs in Georgia have site-specific in-lake numeric nutrient and chlorophyll *a* standards established. Each of the six lakes is listed below along with the dates that the criteria were adopted and the number of sampling sites established for assessing compliance. All six lakes have the designated use of Recreation, and although all but W.F. George and Jackson additionally have drinking water source intakes, only Allatoona currently carries the additional designated use of Drinking Water Source.

- West Point Lake (1996) at one station. One non-standard dam forebay site monitored as a supplemental station since 2003.
- Jackson Lake (1997) at one station. One non-standard dam forebay site monitored as a supplemental station since 2003.
- Lake W.F. George (1997) at two stations.
- Lake Allatoona (2000) at five stations.
- Lake Lanier (2000) at five stations. Five non-standard embayment sites monitored as supplemental stations since 2001.
- Carters Lake (2002) at two stations.

The chlorophyll *a* standard is a measure used for estimation of algal biomass and lake productivity, and a response parameter indicating bioavailable nutrient load. The chlorophyll *a* standard is an arithmetic average of the annual 7-month growing season of April-October.

For the Georgia EPD 305(b)/303(d) List of Impaired Waters, the last 5 years of chlorophyll *a* data are evaluated for compliance. If no exceedance of a standard has occurred in the last 5 years, that representative site is evaluated as supporting the designated use(s). If one exceedence of the standard has occurred in the last five years, then the site is evaluated as "assessment pending". If two or more exceedances have occurred, then that representative site is listed as impaired. Table 1 provides a period-of-record listing of growing season average chlorophyll *a* concentrations at the six lakes and the 2008 305(b)/303(d) List evaluation for use support. Colored cells in Table 1 indicate those years where a site-specific standard was exceeded.

This document is a review of the use support status of these six lakes as they are related to nutrient loading and algal productivity. Three primary areas of use are covered: Recreation (human health and aesthetic); Drinking Water Source (human health, taste and odor, treatment costs); and Fishing/Aquatic Life support (dissolved oxygen and available habitat; cool water oxygenated habitat for cold water fisheries). Human health issues related to excess algal productivity are production of trihalomethane and haloacetic acid in drinking water, and

Table 1

2008 305(b)/303(d) List Use Support Assessment for Most Current 5-Year Period 2003-2007

GADNR-EPD PERIOD OF RECORD GROWING SEASON AVERAGE * CHLOROPHYLL *a* STANDARDS DATA, 1996-2007 MONITORING YEARS

Lake	Standard Station	Chlorophyll *a* Std.* ug/L	1996 Average	1997 Average	1998 Average	1999 Average	2000 Average	2001 Average	2002 Average	2003 Average	2004 Average	2005 Average	2006 Average	2007 Average ***	2008 303(d) Status
West Point	LaGrange Intake	27	12.4	9	11	16.7	25.9	13.4	15.6	15.2	11.1	11.0	6.7	14.0	Supporting
Jackson	2 mi. DS South/Yellow, Midlake	20	NM	15	14	22.6	19.8	10.8	19.6	12.3	10.2	8.2	12.9	13.5	Supporting
W.F. George **	Midlake Hwy 82	18	NM	12	14	17.1	18.7	13.7	18.7	20.0	12.7	10.4	8.6	17.6	Assessment Pending
W.F. George **	Dam Forebay	15	NM	12	12	18.0	17.1	11.0	13.4	18.9	9.9	8.8	8.4	13.5	Assessment Pending
Lanier	Dam Forebay	5	NM	NM	NM	NM	3.3	3.8	3.8	5.8	3.8	5.2	3.6	3.7	Assessment Pending
Lanier	US Flowery Br.	5	NM	NM	NM	NM	4.0	4.7	3.7	5.8	4.0	6.1	4.3	3.8	Not Supporting
Lanier	Browns Bridge	5	NM	NM	NM	NM	6.0	4.6	5.4	7.2	4.4	8.0	4.8	4.2	Not Supporting
Lanier	Bolling Bridge	10	NM	NM	NM	NM	5.9	5.4	6.8	9.0	5.0	7.7	3.9	4.9	Supporting
Lanier	Lanier Bridge	10	NM	NM	NM	NM	9.8	9.2	9.4	10.5	7.6	11.1	5.6	7.3	Not Supporting
Allatoona	US Dam Forebay	10	NM	NM	NM	NM	10.2	3.9	7.5	8.8	5.8	5.5	3.9	6.8	Supporting
Allatoona	Allatoona Creek Arm	10	NM	NM	NM	NM	9.4	7.1	18.5	14.9	9.7	9.5	7.5	23.8	Not Supporting
Allatoona	Midlake DS Kellogg	10	NM	NM	NM	NM	11.7	8.3	10.5	10.7	7.3	8.2	5.2	10.1	Assessment Pending
Allatoona	Little River US Hwy 205	15	NM	NM	NM	NM	26.6	16.2	17.7	15.2	12.4	18.9	8.7	17.8	Not Supporting
Allatoona	Etowah, US Sweetwater	12	NM	NM	NM	NM	14.7	9.5	15.4	13.6	11.6	12.5	10.2	18.5	Not Supporting
Carters	US Woodring Br., Midlake	5	NM	NM	NM	NM	NM	NM	21.3	12.5	16.1	10.3	10.5	15.2	Not Supporting
Carters	Coosawattee Embay. Mouth	10	NM	NM	NM	NM	NM	NM	21.4	13.4	10.4	11.3	7.2	20.5	Not Supporting

Growing Season defined as April through October seven month period

* The above site-specific standards are growing season average standards, not single-sample maximum standards

Chlorophyll a is corrected for Pheophytin a Using Spectrophotometric Method for Years 1996-2006. For 2007 and later, Fluorescence, Modified non-acidified Welchmeyer

NM: Not monitored as specific lake standards had not yet been adopted for this lake

** For the W.F. George 1999 and 2004 Growing Season Averages, and average of the Alabama DEM and Ga EPD 1999 and 2004 growing season averages were used

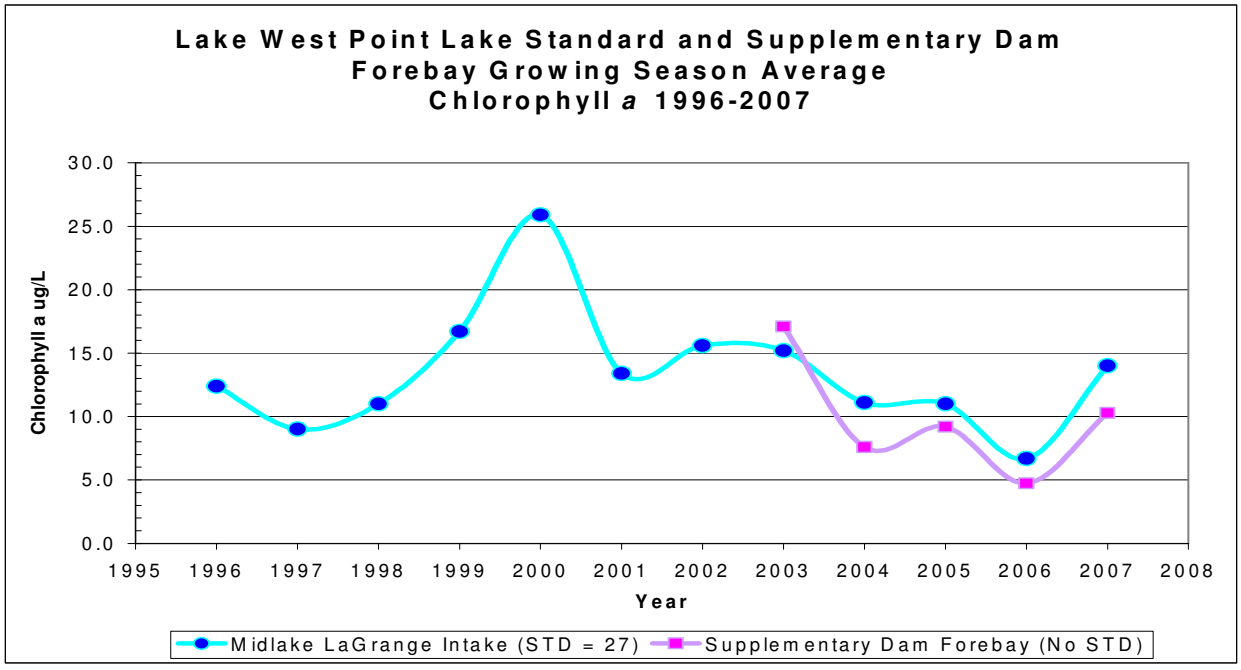
*** In 2007, Lanier TMDL study included two data set for months of May-Oct. Additional samples analyzed by EPA SESD Athens. Averages of average monthly chlorophyll a represent growing season average entered here.

cyanotoxin exposure during contact recreational use or in drinking water from cyanobacterial blooms. Toxin producing cyanobacteria and cyanotoxin toxicology is an emerging research issue in environmental health for human, aquatic life, wildlife and domestic animal exposure.

West Point Lake

Nutrient and chlorophyll a standards were adopted for West Point Lake in 1996 and included one in-lake site-specific station located at the LaGrange water supply intake. The numeric chlorophyll *a* standard for the station is a growing season average of 27 µg/L. Over the twelve-year period of record of standards monitoring, there have been no exceedances of this standard. The highest growing season average chlorophyll *a* concentration documented for this station occurred in 2000 during a long-term major drought and was 25.9 µg/L. Figure 1 provides a period-of-record plot of growing season average chlorophyll *a* at the West Point lake standard station and supplementary dam forebay station.

Figure 1



Recreational Use Support

West Point beaches, operated by the U.S. Army Corps of Engineers (COE), are located in the lower half of the lake. There have been no recreational closures due to algal blooms at any of the COE-operated beaches (personal communication, Bob Chitwood, COE).

Fisheries Use Support

There have not been any fish kills in West Point Lake associated with oxygen deficits since standards were adopted. Following the phosphate detergent ban and phosphorus limits in NPDES permits in the early 1990's, algal productivity declined in the lake and resulted in increased water clarity. WRD Fisheries Biologists subsequently documented during standardized monitoring a shift in the dominant black bass species from largemouth bass to spotted bass. Spotted bass seem to have a competitive advantage over largemouth bass in clear, more infertile waters. The decline in the largemouth bass fishery is reflected in decreased growth and recruitment of the fish, and a reduction in angler satisfaction. A local lake advocacy group, the West Point Lake Coalition, has sponsored spotted bass fishing tournaments to offset the impact from the species shift, providing an alternative to largemouth bass tournaments. WRD has also removed the minimum length limit to encourage anglers to harvest more spotted bass.

The WRD began stocking of Gulf-race striped bass to West Point Lake as part of their native species restoration efforts. Striped bass, especially adults over 11 pounds, are a temperate cool water species that require at a minimum habitat having temperatures of less than 25 deg C and with greater than 3 mg/L of dissolved oxygen. Water temperatures of 22 deg C or less with dissolved oxygen concentrations of 5 mg/L or more are optimal for this species. Whereas the decreased algal productivity has had a negative effect on the largemouth bass sport fishery, a positive impact is expected for restoration of the Gulf-race striped bass fishery.

Drinking Water Source Use Support

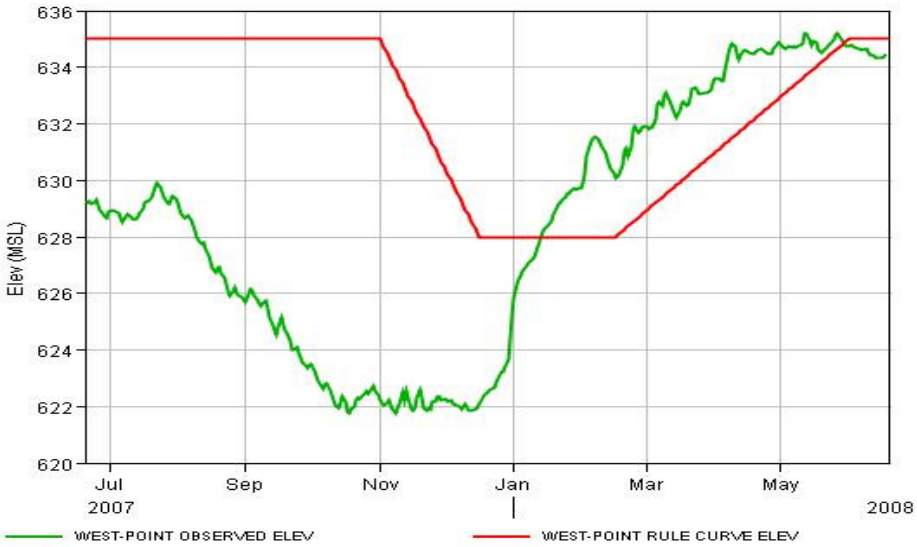
The original City of LaGrange water intake was in the Chattahoochee River channel at an elevation of 618 feet above mean sea level (msl), and was replaced in subsequent years following lake impoundment with intakes constructed at elevations of 628, 625 and 623 feet msl. The design summer operating pool of West Point is 635 feet msl. The City has found that the depth of the epilimnion layer containing the majority of algal biomass is confined within the top 10 feet at their intake facility, and withdrawals are made using the intake below this layer when possible. With declining water levels during the Summer of 2007, the City was forced to withdraw water in the epilimnion. Water treatment costs increased and taste and odor complaints to the City became more numerous. The City has had similar problems in past dry years when summer lake levels were well below the design summer pool elevation. Figure 2 is a Corps of Engineers surface elevation plot for West Point Lake for the July 2007 to June 2008 period.

In September 2007, the lake level elevation projections for late November to December 2007 were 619 feet msl, and the City began repair and refurbishment of the original riverbed intake at 618 feet msl. The EPD assisted the City by collecting lake sediment samples nearfield to the intake and upstream in November, and analyzed for metal and organic contaminants. The results were below laboratory reporting limits.

The City of LaGrange has requested the EPD to re-evaluate the lake standards for West Point Lake, and consider amending the chlorophyll *a* standard at the LaGrange intake, to a value lower than 27 µg/L. The City position is that a lower chlorophyll *a* standard would initiate regulatory

actions for reduced nutrient loading and problems with increased water treatment costs and taste and odor could be reduced or prevented.

Figure 2: West Point Lake Surface Elevation Summer 2007-2008 (COE)



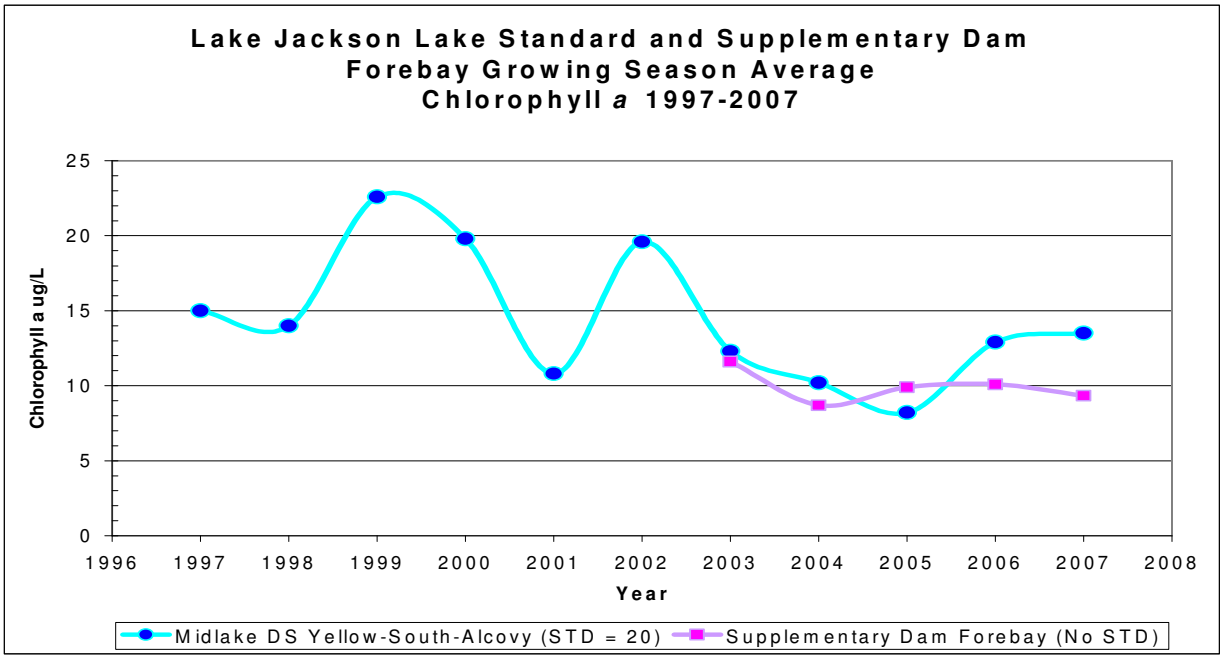
Jackson Lake

Nutrient and chlorophyll *a* standards were adopted for Jackson Lake in 1997 and included one in-lake site-specific station located below the confluence of the South/Yellow and Alcovy River arms. The numeric chlorophyll *a* standard for the station is a growing season average of 20 µg/L. Over the eleven-year period of record of standards monitoring, there has been a single exceedance of this standard in 1999. For two additional years of this period of long-term drought, the growing season average chlorophyll *a* concentration equaled the standard (2000 and 2002). Figure 3 provides a period-of-record plot of growing season average chlorophyll *a* at the Jackson lake standard station, and the supplementary dam forebay station.

Recreational Use Support

Prior to 2007, there had not been any beach closures due to algal blooms on Jackson Lake. During the week prior to the 2007 Labor Day weekend, cyanobacterial blooms, primarily in the upper half of the lake and into the South/Yellow River and Alcovy River arms rapidly developed. Georgia Power and EPD developed and issued a precautionary lake-wide health advisory for recreational water contact activities at the weekend start. The advisory materials were issued by e-mail to lake homeowners by Georgia Power, an advisory poster was provided to marinas and was posted by Law Enforcement at boat ramps, and an additional fact sheet was provided through Georgia Power through an information call-in number. Georgia Power closed their public beach located near the dam during Labor Day weekend as a precaution, and reopened upon receiving laboratory results that microcystin concentrations were well below recreational exposure guidelines (WHO). Butts County officials were kept informed of these

Figure 3



activities and information on the bloom because of the operation of their water supply intake on the Ocmulgee River below the Lloyd Shoals Dam. The bloom did not fully dissipate until 3-4 weeks later, with the intensity and area coverage fluctuating over that period. Samples collected by both Georgia Power and EPD indicated that potentially two different microcystin-producing species had been represented in the bloom (*Microcystis sp.* or other). Figure 4a is a photomicrograph of the involved cyanobacteria species, and Figure 4b shows one area of the bloom on upper Jackson Lake on August 31.

Figure 4a

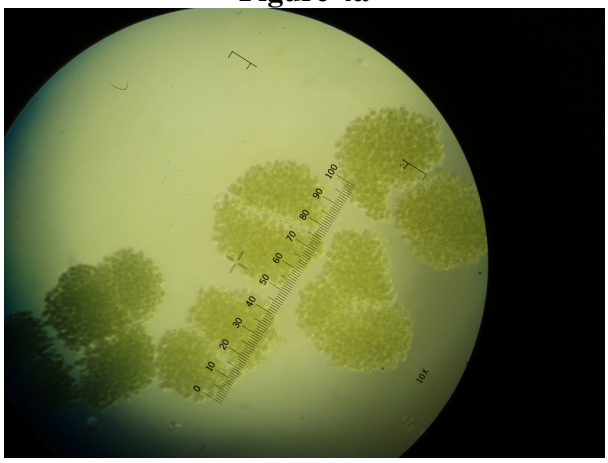


Figure 4b

Fisheries Use Support

A fish kill was investigated on Lake Jackson in the summer of 2005 that was caused by a de-watering event following a significant rain. This de-watering event was caused by faulty trip boards on Lloyd Shoals Dam. As a result, a heavy concentration of fish were trapped in small body of water and oxygen levels become deficient. This kill was not related to lake productivity and this type of kill will continue until Georgia Power replaces the trip boards that are currently in use on Lloyd Shoals Dam.

Lowered productivity in Lake Jackson has not been beneficial for the largemouth bass fishery. The reduction of phosphorus has lowered productivity and increased visibility, which has benefited spotted bass (illegally introduced in the late 1980's). Spotted bass prefer clear, cool water and they have thrived in Lake Jackson. Based on recent standardized sampling data, the spotted bass population has stabilized. However, this direct competition will have an effect on largemouth bass populations.

WRD has initiated an Atlantic Coast striped bass restoration program for the entire Altamaha River Basin system (inclusive of the Ocmulgee and Oconee sub-basins). Striped bass are a temperate cool water species that require at a minimum critical habitat having temperatures of less than 25 deg C and with greater than 3 mg/L of dissolved oxygen. Water temperatures of 22 deg C or less with dissolved oxygen concentrations of 5 mg/L or more are optimal for this species. Whereas the decreased algal productivity has had a negative impact on the warm water black bass sport fishery, a positive impact is expected for restoration of the stocked Atlantic Coast striped bass due to increased habitat in Jackson Lake.

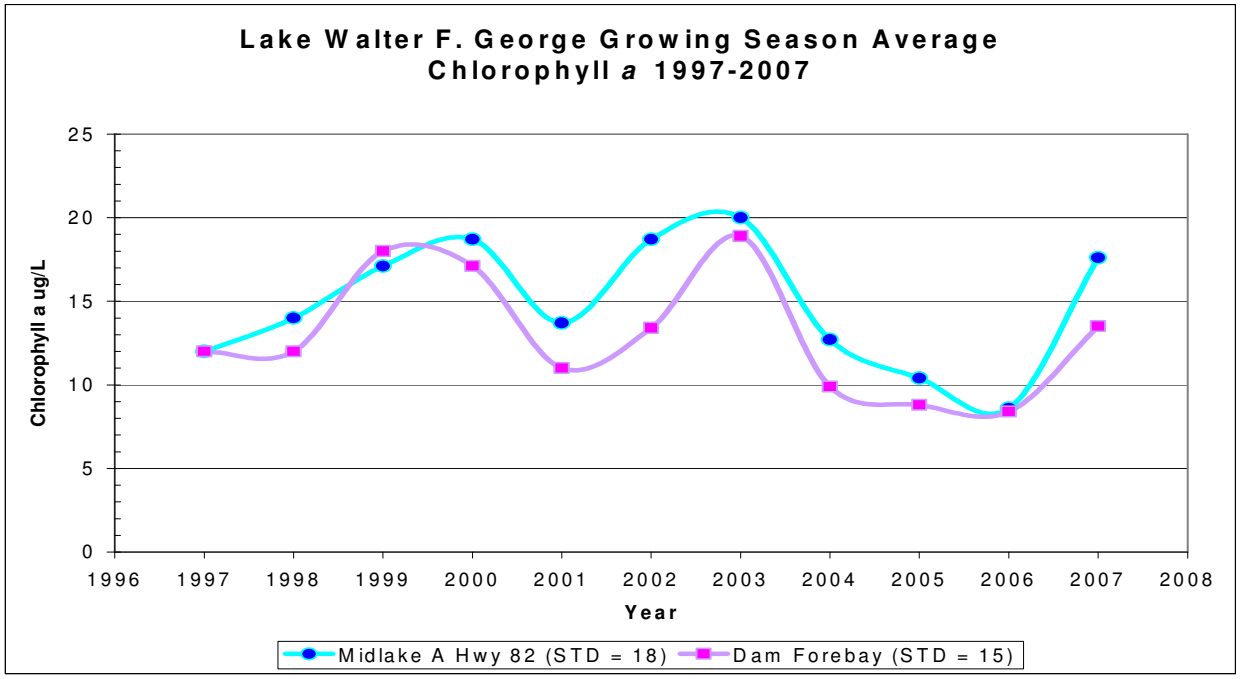
Drinking Water Source Use Support

There are no drinking water intakes on Lake Jackson.

Lake Walter F. George (Eufaula)

Nutrient and chlorophyll a standards were adopted for Lake W.F. George in 1997 and included two in-lake site-specific stations located midlake at Highway 82 and at the dam forebay. The numeric chlorophyll *a* standards are a growing season average of 18 µg/L at Highway 82 and 15 µg/L at the dam forebay. Over the eleven-year period-of-record of standards monitoring, there have been three exceedances of this standard at the Highway 82 station (2000, 2002 and 2003), and three exceedances at the dam forebay station (1999, 2000 and 2003). A four-year major drought occurred in Georgia from the summer of 1998 through the fall of 2002, where reservoir levels were at lowered levels and volume, and retention time increased. Figure 5 provides a period-of-record plot of growing season average chlorophyll *a* at the W.F. George lake standard stations. Based on the two exceedances at the Highway 82 station over the 2001-2005 period, the upper half of W.F. George was listed as impaired for nutrients on the 2006 305(b)/303(d) List. A single exceedance (2003), at both stations occurred during the five-year evaluation period of 2003-2007 used for the 2008 305(b)/303(d) List and the entire lake was assessed as “assessment pending” until more data are collected.

Figure 5



Recreational Use Support (personal communications, Sara Jernigan and Dan Milburn, COE)

Since 2001 the COE has documented several apparent cyanobacterial blooms in a number of small embayments, each year in September, lasting approximately three weeks. They are characterized by floating, bright green slimy surface films, which have encroached upon COE beaches in those embayments. The COE has not identified the causative species of these blooms. They have not closed any of their beaches during these blooms, but may consider such action for any future occurrences. Blooms occurred in 2007 in the Hardridge (Creek) Access, Cotton Hill Park (Sandy Creek), Sandy Branch and Rood Creek COE recreational areas. In past years, blooms have also occurred in the Highland Park, White Oak Creek and Cheneyhatchee Creek Parks. These blooms have not been observed in the main body of the lake. The public beach operated by the Georgia DNR Parks at the George T. Bagby State Lodge Park is on the lake main body below the mouth of Sandy Creek. Figure 6 provides a Google aerial map showing these locations on W.F. George.

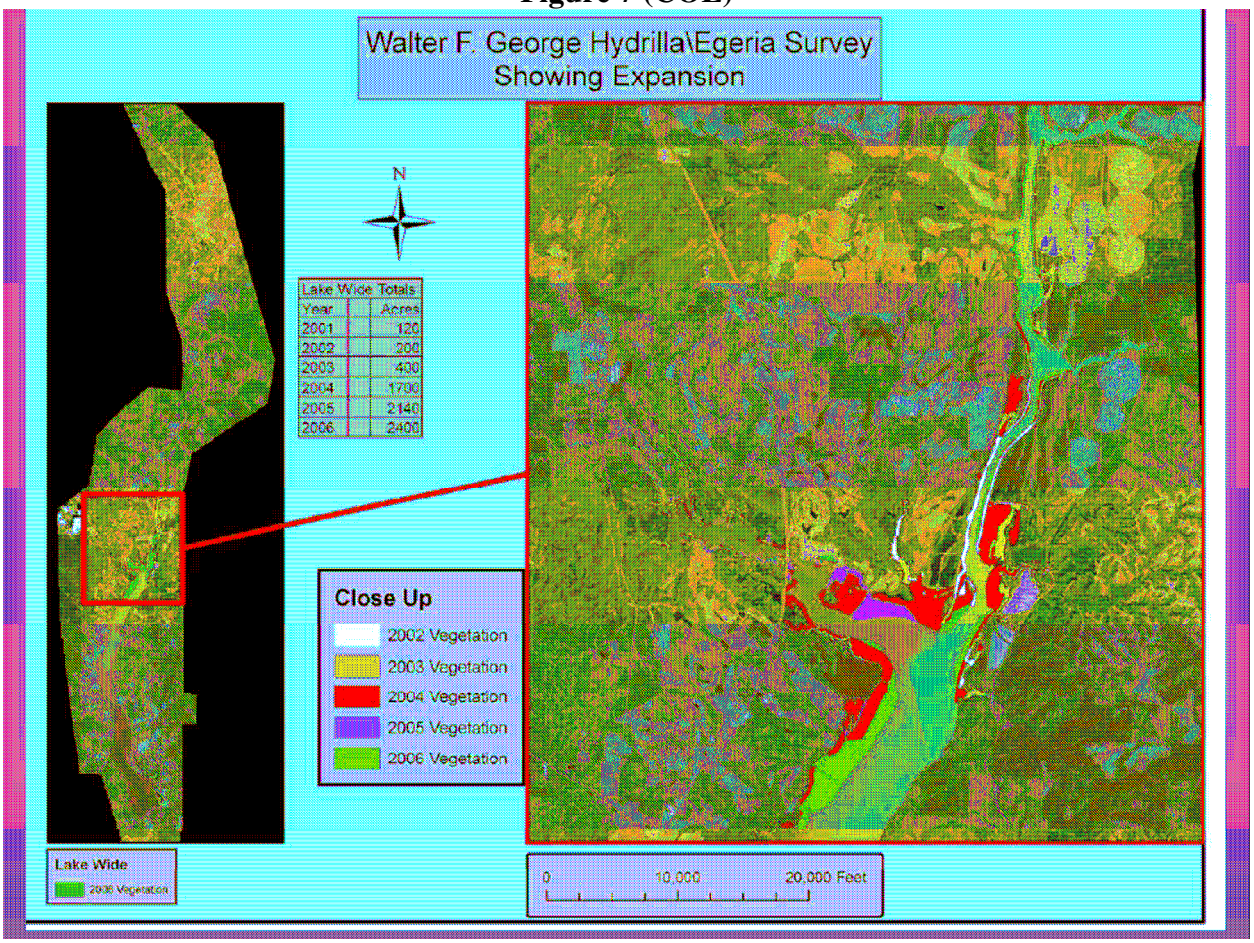
Walter F. George Lake has not historically had problems with invasive aquatic plants. *Hydrilla* was first discovered on the lake in 1991. From 1992-2000, small infestations of *Hydrilla* were found and treated with herbicides. By 2002 the *Hydrilla* problem escalated. In the following years, the infestation approximately doubled each year (2001=120; 2002=200; 2003=400; 2004=1,700; 2005=2,140; 2006=2,400; and 2007=4000 acres). This infestation of *Hydrilla* is still in a relatively early stage, and the density of the vegetation covered about 30% of the infested area in 2006. The extreme drought and subsequent lower lake levels provided additional

Figure 6: W.F. George Embayment COE Recreation Areas with Cyanobacterial Blooms

shallow water habitat for the further expansion in 2007. The expanded infestation started mainly in the upper Chattahoochee arm above the mouth of the Cowikee Creek arm in 2002. In subsequent years, it expanded throughout this area, into the Cowikee Creek embayment and below the Cowikee Creek mouth in the main lake body along the western shoreline. The COE

will continue the historical herbicide application program for *Hydrilla*, and is considering stocking triploid grass carp for additional control. Figure 7 is a COE map showing the 2002-2006 Hydrilla infestation areas in the upper lake by the Cowikee Creek arm (2007 mapping not available yet).

Figure 7 (COE)



In 1994 a new fatal disease called Avian Vacuolar Myelinopathy (AVM), was described that affected bald eagles, coots and other avian species. AVM is characterized by spongy degeneration throughout the white matter of the central nervous system, particularly in the optic lobes. The South Carolina Algal Ecology Lab has been responsible for much of the research done on the causative agent(s) for AVM (http://www.dnr.sc.gov/ael/research/avm/intro.html). Subsequent research showed the disease to be associated with *Hydrilla* that was colonized by an unknown species of epiphytic filamentous cyanobacteria in the Order Stigonematales. Locations where AVM has been documented all have *Hydrilla* with epiphytic colonies of the unknown Stigonematales species. Other lakes with *Hydrilla* that are negative or have rare occurrences of the unknown Stigonematales species have had no occurrence of AVM. Figure 8 provides a diagram showing the theorized disease pathway (South Carolina Algal Ecology Lab). Although AVM has not been documented in birds from W.F. George, *Hydrilla* has been tested for the presence of the unknown Stigonematales species and found to be present.

Figure 8: South Carolina Algal Ecology Lab Diagram For AVM

Fisheries Use Support

There have not been any fish kills in Walter F. George that were documented as caused by oxygen depletion. Periodically, fish kills occur in the spring that are believed mostly related to spawning stress. During these times, there is no evidence that dissolved oxygen levels are a cause of fish mortality. There was also a larger-scale fish kill during 1997 that was believed to be from Largemouth Bass Virus. From a fisheries standpoint, current levels of chlorophyll *a* are beneficial to the fishery in Walter F. George reservoir.

Drinking Water Source Use Support

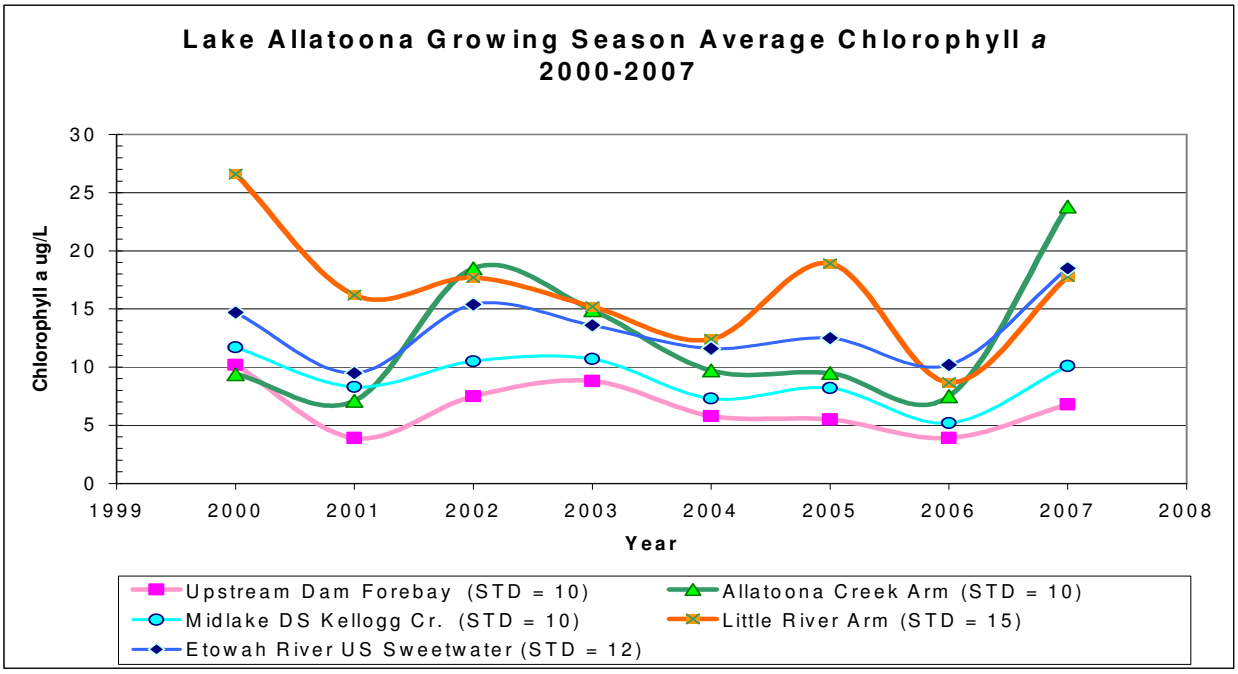
There are no drinking water intakes on Lake W. F. George.

<u>Lake Allatoona</u>

Nutrient and chlorophyll *a* standards were adopted for Lake Allatoona in 2000 and included five in-lake site-specific stations, with two located on major embayments and the remaining three along the main Etowah River channel spanning the upper, midlake and forebay regions. Figure 9 provides the eight-year period-of-record plot of growing season average chlorophyll *a* at the Allatoona lake standard stations.

The Little River chlorophyll *a* standard was exceeded following standards adoption and was evaluated as impaired for nutrients on the 2002 305(b)/303(d) List. Three additional stations were placed on the 2006 305(b)/303(d) List for nutrient impairment based on two or more

Figure 9



chlorophyll *a* exceedances in the 2001-2005 period (Allatoona Creek Arm, Midlake below Kellogg Creek, and the Etowah River above Sweetwater Creek). Over the period of 2003-2007, one exceedance of the standard occurred at the Midlake station and was re-evaluated as "assessment pending" on the 2008 305(b)/303(d) List. The Dam Forebay standard station has consistently met the chlorophyll *a* standard since adoption (2000-2007).

Recreational Use Support

There have been no recreational closures due to algal blooms at any of the U.S. Army Corps of Engineers beaches on Lake Allatoona (personal communication, Jim Shinall, COE).

Fisheries Use Support

There have been no fish kills in Lake Allatoona due to dissolved oxygen deficiency since nutrient standards were adopted. Allatoona has both a warm water and cool water fishery. The black bass fishery is good, with spotted bass representing 80-90% of the population. Largemouth bass prefer higher productivity and lower clarity water and are more prevalent in the upper Etowah and Little Rivers arms. Spotted bass prefer clear, cool water and utilize deeper water than largemouth bass.

The Allatoona cool water fishery is supported through WRD stocking of striped bass and hybrid bass (striped and white bass cross). Hybrid bass will tolerate water temperatures a few degrees higher than striped bass, and the Allatoona fishery is considered one of the better hybrid fishing reservoirs in Georgia. Striped bass require at a minimum critical habitat having temperatures of less than 25 deg C and with greater than 3 mg/L of dissolved oxygen. Water temperatures of 22 deg C or less with dissolved oxygen concentrations of 5 mg/L or more are optimal for this

species. Following the spring spawn the larger striped bass spend the remainder of the summer in cold water refuges, primarily in the Etowah River upstream of Lake Allatoona, as far as Dawson County. WRD monitoring of these populations indicates that summer water quality (e.g. insufficient habit with cool temperatures and higher dissolved oxygen), negatively influences striped bass growth and survival. Tables 2a, 2b and 2c below are WRD tabulations of their mid-August striped bass habitat ratings and depth thickness (where water temperature was less than 25 deg C and dissolved oxygen was greater than 3 mg/L), and the number of stations exceeding the chlorophyll *a* standard for those years.

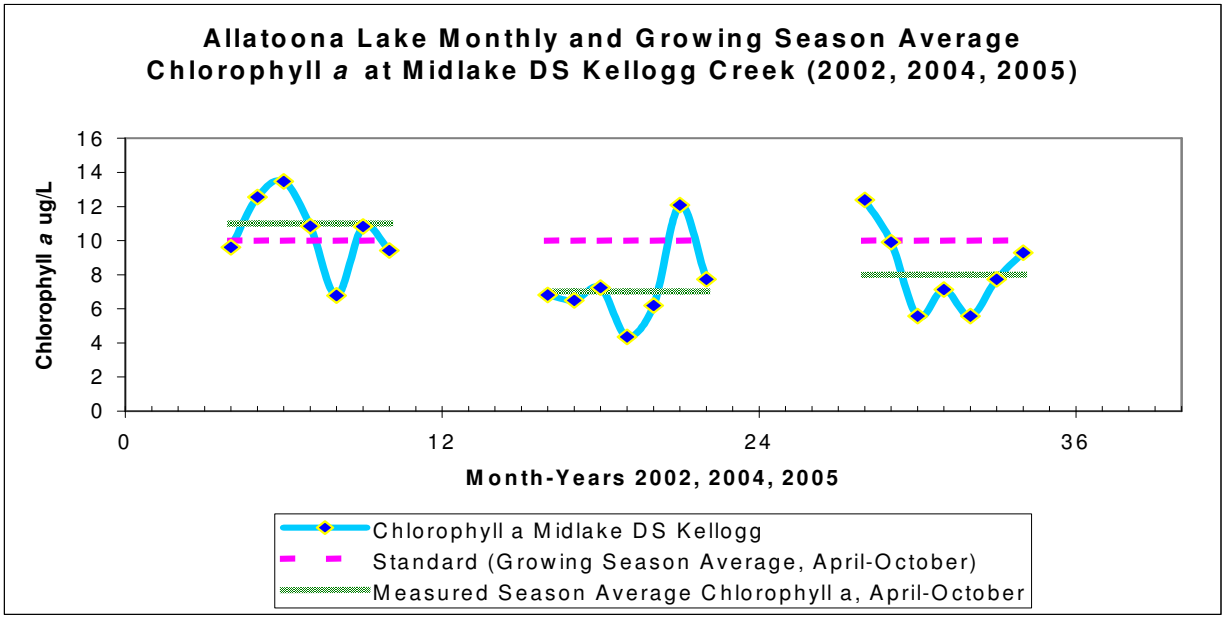
Tables 2a-c: WRD Calhoun Fisheries August Striped Bass Habitat Rating For Allatoona

Table 2a: Dam Area (Proximal to Standard Station)				
Mid-August; Year	Habitat Rating	Critical Habitat Depth [T<25 & DO > 3]	Optimal Habitat Depth [T<22 & DO > 5]	Number of Stations With Chlorophyll *a* Exceedances
2001	Poor	0 meters	0 meters	One (Little River)
2002	Poor	0 meters	0 meters	Four (Little River, Allatoona Cr., Midlake, Upper Etowah)
2003	No Data	No Data	No Data	Three (Allatoona Cr., Midlake, Upper Etowah)
2004	Poor	0 meters	0 meters	None
2005	Poor	0 meters	0 meters	Two (Little River, Upper Etowah)
2006	Poor	0 meters	0 meters	None
2007	Poor	0 meters	0 meters	Three (Little River, Allatoona Cr., Upper Etowah)
Table 2b: Allatoona Arm at Bethany Bridge/Red Top Mtn. Rd. (Not Proximal to Standard Station)				
Mid-August; Year	Habitat Rating *	Critical Habitat Depth [T<25 & DO > 3]	Optimal Habitat Depth [T<22 & DO > 5]	Number of Stations With Chlorophyll *a* Exceedances
2001	No Data	No Data	No Data	As in 2a
2002	Poor	0 meters	0 meters	
2003	No Data	No Data	No Data	
2004	Poor	0 meters	0 meters	
2005	Poor	0 meters	0 meters	
2006	Poor	0 meters	0 meters	
2007	Poor	0 meters	0 meters	
Table 2c: Etowah Arm at Allatoona Yacht Club (~Mid-distance between Dam Forebay and Midlake Station Stations)				
Mid-August; Year	Habitat Rating *	Critical Habitat Depth [T<25 & DO > 3]	Optimal Habitat Depth [T<22 & DO > 5]	Number of Stations With Chlorophyll *a* Exceedances
2001	No Data	No Data	No Data	As in 2a
2002	Poor	0 meters	0 meters	
2003	No Data	No Data	No Data	
2004	Poor	0 meters	0 meters	
2005	Poor	0 meters	0 meters	
2006	Poor	0 meters	0 meters	
2007	Poor	0 meters	0 meters	

* Habit rating is a subjective evaluation and not based on any scientific method or matrix. It is based on general observations made of the condition of the fishery for that period.
Allatoona does not provide summer in-lake striped bass habitat, and without the Etowah River above the lake providing summertime cool water refugia to this species, there likely would not be any striped bass fishery possible in the lake during late fall to spring as exists now.

Summer striped bass habitat within Allatoona Lake is not present due to water temperatures exceeding their tolerance level in the upper epilimnion where dissolved oxygen levels support aquatic life. Figure 10 provides a comparative plot of monthly chlorophyll *a* concentrations at the midlake below Kellogg Creek standard station for the years 2002 and 2004 and 2005 reflecting conditions at the end of extended drought (2002), average water year (2004), and a high precipitation year in 2005 do to extensive tropical weather activity July-September.

Figure 10: Monthly and Season Average Midlake below Kellogg Creek Chlorophyll *a* during 2002, 2004 and 2005



Drinking Water Source Use Support

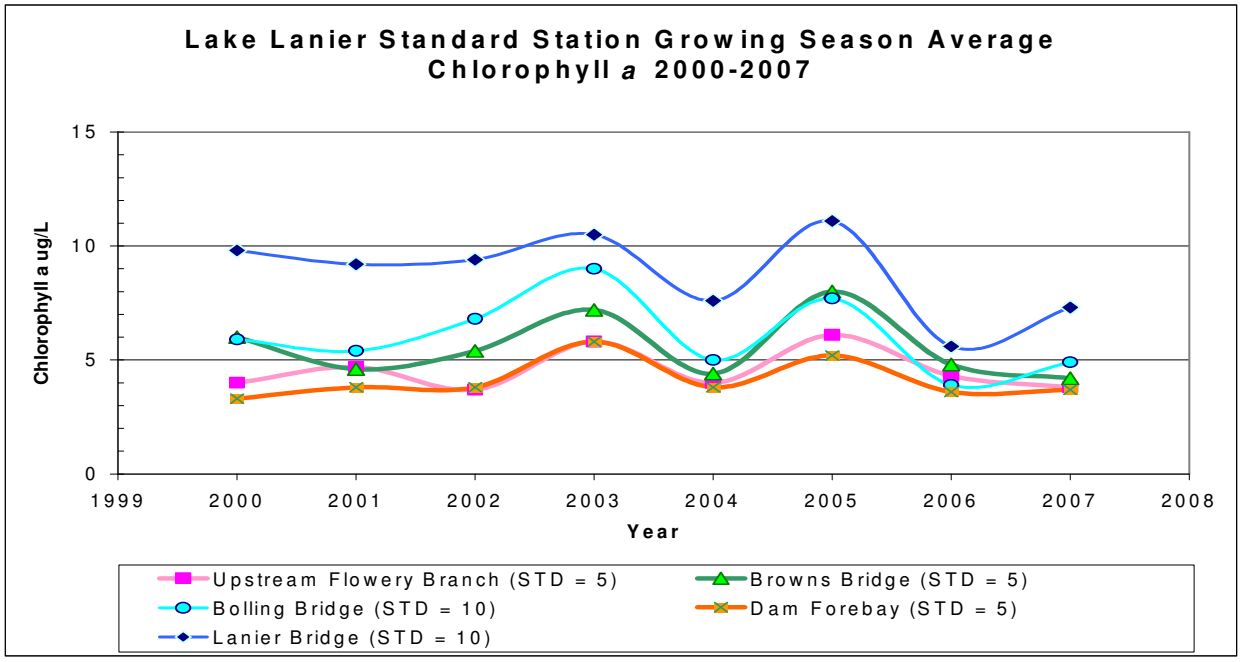
The Cobb County Marietta Water Authority (CCMWA) has a water supply intake in the Allatoona Creek arm uplake from the standard station. They have experienced problems with high algal biomass over the years with increased treatment costs (chemicals and other), and taste and odor complaints. Various algal groups have been implicated in some blooms including nanoplankton and diatoms that have caused problems by plugging filters. The CCMWA experienced such problems through the summer of 2007 where algal productivity was high in the Allatoona Creek arm over the 2007 growing season.

The City of Cartersville has a drinking water intake facility located in Lake Allatoona at the dam that is furnished with intakes pipes set at several elevations. They have rarely experienced taste and odors problems due to their ability to utilize intake pipes at levels below the algal biomass.

Lake Lanier

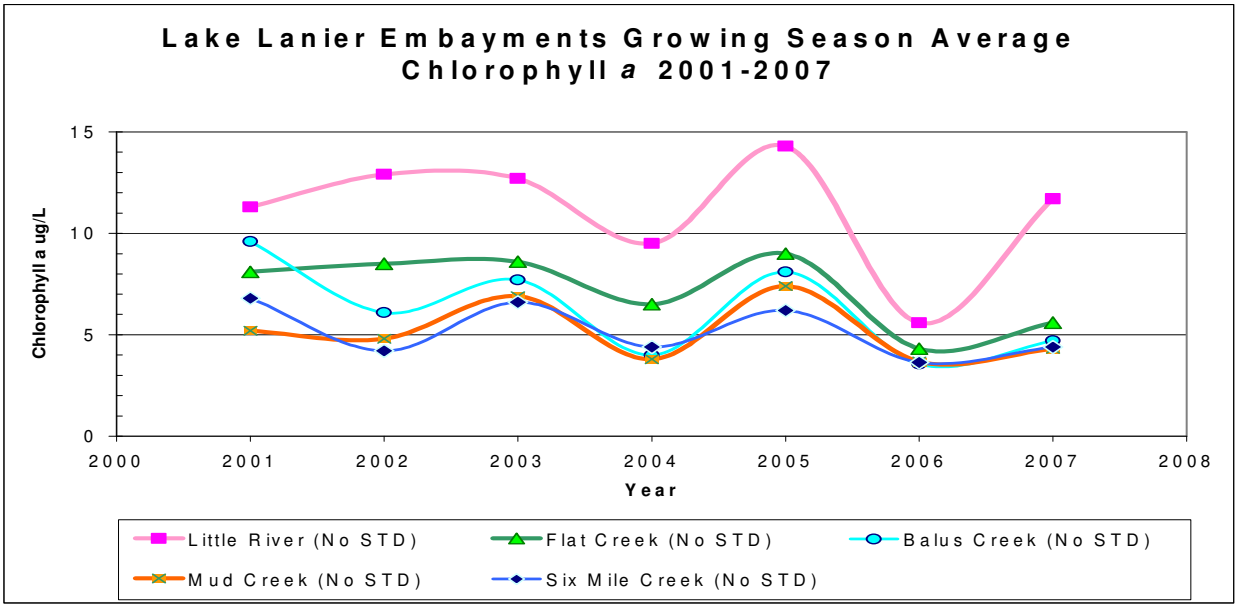
Nutrient and chlorophyll a standards were adopted for Lake Lanier in 2000 and included five in-lake site-specific stations, with four along the main Chattahoochee River channel spanning the upper, midlake and forebay regions, and one on the second main lake arm. Figure 11 provides the eight-year period of record plot of growing season average chlorophyll *a* at the Lanier lake standard stations. In 2001, annual growing season monitoring was added at five supplementary embayment stations to generate a database to support potential additional lake standards development. Figure 12 provides the seven-year period-of-record plot of chlorophyll a at these supplementary embayment stations.

Figure 11



The chlorophyll *a* standard has been consistently met in the Chestatee arm of Lanier over the eight years of standards monitoring, and the portion of the lake represented by this station has been assessed as supporting its use. The dam forebay had one exceedance in 2003 and this portion of the lake was assessed as "assessment pending" on the 2008 list. The Chattahoochee River at Browns Bridge station had chlorophyll *a* exceedances in 2000, 2003 and 2005. The standard was exceeded at the midlake Flowery Branch and Lanier Bridge stations in 2003 and 2005. The lake areas represented by the Lanier Bridge, Browns Bridge and midlake stations were evaluated as impaired for nutrients in the 2006 305(b)/303(d) List (2 exceedances each in last five years), and remain in that status on the 2008 305(b)/303(d) List.

Figure 12



Recreational Use Support

There have been no recreational closures due to algal blooms at any of the U.S. Army Corps of Engineers beaches on Lake Lanier (personal communication, Jim Shinall, COE).

Fisheries Use Support

There have been no fish kills in Lake Lanier due to dissolved oxygen deficiency since nutrient standards were adopted. This lake has both a warm water and cool water fishery. The black bass fishery is good, with spotted bass dominating the population. Spotted bass prefer clear, cool water and utilize deeper water than largemouth bass. Lanier also has a good crappie fishery.

The Lanier cool water fishery is supported through WRD stocking, and in 2007, 424,000 striped bass and 189,000 walleye fingerlings were stocked to boost these fisheries. Striped bass require a minimum critical habitat having temperatures of less than 25 deg C and with greater than 3 mg/L of dissolved oxygen. Water temperatures of 22 deg C or less with dissolved oxygen concentrations of 5 mg/L or more are optimal for this species. Following the spring spawn the larger striped bass spend the remainder of the summer in cold water refuges typically found in depths greater than 25 feet.

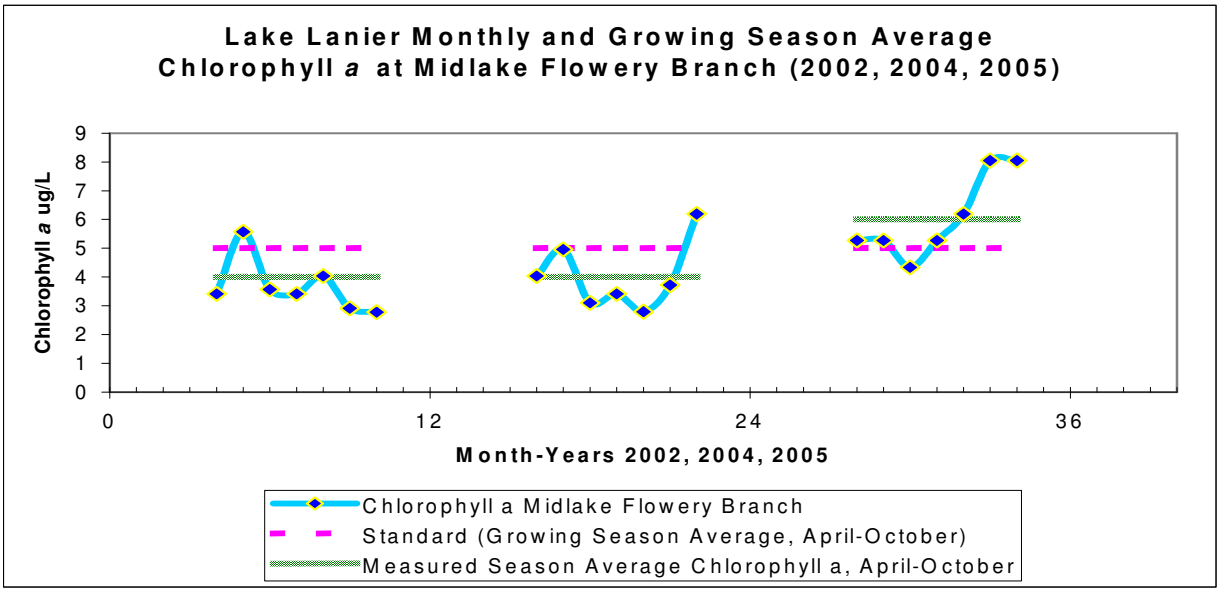
WRD biologists have noted that conditions that have provided good cool water habitat through the summer months for striped bass result in better growth, health and survival, and tend to occur when late winter/spring inflows to the lake are low. In years with high winter/spring inflows such as 2005, the cool water habitat conditions were poor. Table 3 is a WRD tabulation of their early September striped bass critical habitat ratings and depth thickness (where water temperature was less than 25 deg C and dissolved oxygen was greater than 3 mg/L), and the number of stations exceeding the chlorophyll *a* standard for those years. Figure 13 provides a comparative plot of monthly chlorophyll *a* concentrations at the midlake Flowery Branch

standard station when striped bass summer minimum supporting habitat was rated as good (2002 and 2004), and poor (2005).

Table 3: WRD Gainesville Fisheries Striped Bass Habitat Rating

September 1; Year	Habitat Rating *	Critical Habitat Depth [T<25 and DO > 3]	Number of Stations With Chlorophyll *a* Exceedances
2000	Good	9 meters	One (Browns Bridge)
2001	Good	18 meters	None
2002	Good	10 meters	None
2003	Poor	1 meter	Four (Dam Forebay, Midlake, Browns and Lanier Bridges)
2004	Good	12 meters	None
2005	Poor	0 meter	Three (Midlake, Browns and Lanier Bridges)
2006	Fair	3 meters	None
2007	Good	16 meters	None
* Habit rating is a subjective evaluation and not based on any scientific method or matrix. It is based on general observations made of the condition of the fishery for that period.			

Figure 13: Monthly and Season Average Midlake Chlorophyll a in Good (2002, 2004) and Poor (2005) Striped Bass Habitat Years



Drinking Water Source Use Support

The City of Gainesville has experienced periodic algal-related problems with water withdrawn from the Lanier intake. In May and December 2006, the utility had taste and odor problems.

Carters Lake

Nutrient and chlorophyll *a* standards were adopted for Carters Lake in 2002 and included two in-lake site-specific stations, at the upper Coosawattee arm and midlake along the Coosawattee River channel. Carters Lake is operated with pump-back storage in conjunction with a re-

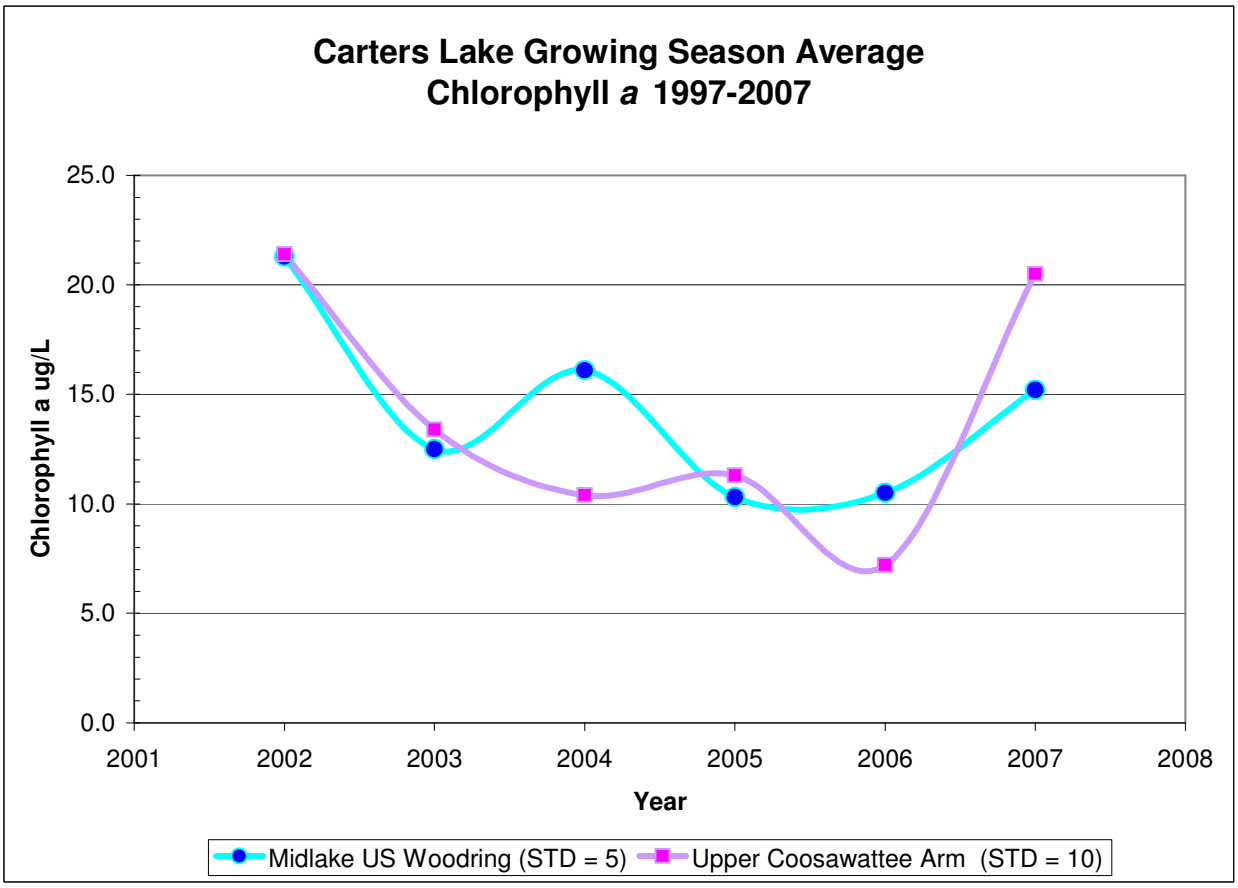
regulation reservoir below the Carters Dam that is supplied by the Talking Rock Creek watershed. Figure 14 provides the six-year period-of-record plot of growing season average chlorophyll *a* at the Carters lake standard stations.

The chlorophyll *a* standard has been exceeded all six years since standards were adopted at the downstream midlake station, and four of the six years at the upper Coosawattee River station (2002, 2003, 2005 and 2007). As a result, Carters Lake has been listed as impaired for nutrients on the 2004, 2006 and 2008 305(b)/303(d) List.

Recreational Use Support

There have been no recreational closures due to algal blooms at any of the U.S. Army Corps of Engineers beaches on Carters Lake (personal communication, Jim Shinall, COE).

Figure 14



Fisheries Use Support

There have been no fish kills in Carters Lake due to dissolved oxygen deficiency since nutrient standards were adopted. This lake has both a warm water and cool water fishery. The black bass

fishery is good, with spotted bass representing 90% of the population. Spotted bass prefer clear, cool water and utilize deeper water than largemouth bass.

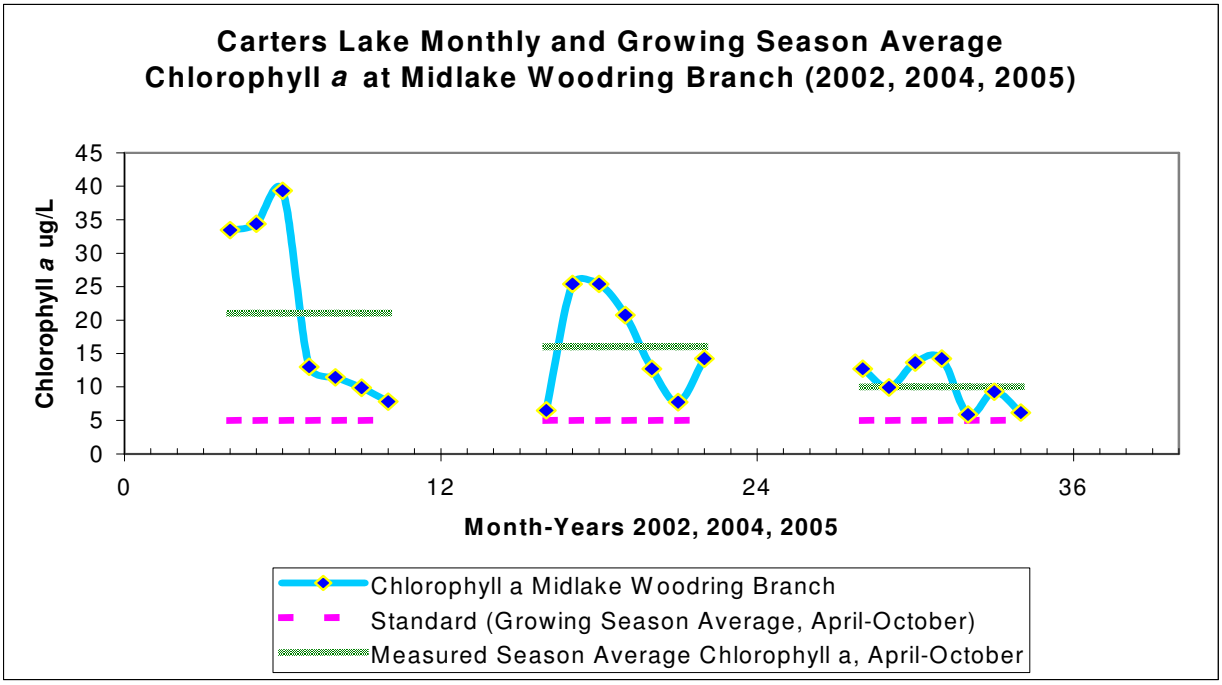
The Carters cool water fishery is supported through WRD stocking of striped bass, walleye and since 2003, hybrid bass (striped and white bass cross). Hybrid bass will tolerate water temperatures a few degrees higher than striped bass, and the Carters fishery for them is still developing. Striped bass require at a minimum critical habitat having temperatures of less than 25 deg C and with greater than 3 mg/L of dissolved oxygen. Water temperatures of 22 deg C or less with dissolved oxygen concentrations of 5 mg/L or more are optimal for this species. Following the spring spawn the larger striped bass spend the remainder of the summer in cool water refuges within Carters Lake. WRD research of the Carters striped bass fishery indicates that it has likely suffered from high summer water temperatures and low dissolved oxygen (e.g. insufficient habit with cool temperatures and higher dissolved oxygen). Tables 4a and 4b below are WRD tabulations of their mid-August striped bass habitat ratings and depth thickness (where water temperature was less than 25 deg C and dissolved oxygen was greater than 3 mg/L), and the number of stations exceeding the chlorophyll *a* standard for those years. Figure 15 provides a comparative plot of monthly chlorophyll *a* concentrations at the midlake Woodring Branch standard station when striped bass summer minimum supporting habitat was rated as good (2005), fair (2004), and poor (2002).

Tables 4a-b: WRD Calhoun Fisheries August Striped Bass Habitat Rating For Carters

Table 4a: Dam Area (Not Proximal to Standard Station)				
Mid-August; Year	Habitat Rating *	Critical Habitat Depth [T<25 and DO > 3]	Optimal Habitat Depth [T<22 and DO > 5]	Number of Stations With Chlorophyll *a* Exceedances
2001	Good*	> 10 meters	0 meters	Standards Not Adopted
2002	Good*	> 10 meters	0 meters	Two (Midlake and Upper Coosawattee Arm)
2003	No data	No data	No Data	Two (Midlake and Upper Coosawattee Arm)
2004	Good*	> 12 meters	0 meters	One ((Midlake)
2005	Good*	> 12 meters	0 meters	Two (Midlake and Upper Coosawattee Arm)
2006	Good*	> 11 meters	0 meters	One ((Midlake)
2007	Good*	22 meters	0 meters	Two (Midlake and Upper Coosawattee Arm)
Table 4b: Midlake at Woodring Recreational Area (Proximal to Standard Station)				
Mid-August; Year	Habitat Rating *	Critical Habitat Depth [T<25 and DO > 3]	Optimal Habitat Depth [T<22 and DO > 5]	Number of Stations With Chlorophyll *a* Exceedances
2001	Good*	7 meters	0 meters	As in 4a
2002	Poor	1 meter	0 meters	
2003	No Data	No Data	No Data	
2004	Fair	3 meters	0 meters	
2005	Good*	> 11 meters	0 meters	
2006	Good*	> 10 meters	0 meters	
2007	Good*	7 meters	0 meters	

* Though a relatively large "Depth of Minimal Supporting Habitat" for striped bass is available in most years at Carters using the criteria listed (Temp. <25°C and D.O >3.0 mg/L), a habitat rating of "good" is still inadequate to describe the true quality of the habitat available. That is to say, though there is a large column of water over 3.0 mg/L of D.O., the average DO in that column of water (<25°C) at Carters is typically less than 5.0 mg/L in a given year. This is below the "optimal" definition for this species. Therefore, using the above rating criteria for Carters actually "over-rates" the quality of cool-oxygenated thermal refugia for striped bass at Carters in August in a given year. Based on WRD data, the quality of summer thermal refuge in Carters would be more accurately described as "fair" to poor".

Figure 15: Monthly and Season Average Midlake Chlorophyll a in Good (2005), Fair (2004) and Poor (2002) Striped Bass Habitat Years



Drinking Water Source Use Support

The City of Chatsworth has a water supply intake at the very upper end of the Wurley Creek arm of Carters Lake. The City has had difficulty on many occasions treating this source water due to high algal concentrations. Treatment costs for chemicals were extremely high during most of the growing season in 2002 and 2006-2007, and taste and odor complaints escalated.

The City of Calhoun withdraws water from their intake located approximately 25 miles downstream from the Carters Re-regulation Reservoir dam, on the Coosawattee River. Calhoun has experienced problems with treating this source water due to elevated algal concentrations, and 2002 and 2006 were particularly bad. Increased treatment costs for chemicals and taste and odor complaints have resulted. Although some of the nutrient loading to the Coosawatttee below Carters is contributed by other sources such as from the high agricultural landuse along this segment, outflow from Carters is a significant contributor.

Acknowledgements

Several agencies provided information for this review and are acknowledged below.

Recreational Use Support

- U. S. Army Corps of Engineers: Jim Shinall (Allatoona, Carters and Lanier); Bob Chitwood (West Point); and Sara Jernigan and Daniel Milburn, on both algal bloom and *Hydrilla* issues on W.F. George.
- South Carolina Algal Ecology Lab for information on *Hydrilla* and Avian Vacuolar Myelinopathy (AVM) disease.
- Georgia DNR Parks, Recreation and Historic Sites Division.
- Georgia Power Company on Lake Jackson

Fishing Use Support

- GADNR WRD Calhoun Region Fisheries Biologists (Jim Hakala; Wayne Probst), fisheries status on Lakes Allatoona and Carters
- GADNR WRD Gainesville Region Fisheries Biologists (Reggie Weaver, Nick Jamison, Anthony Rabern, Lee Keefer and Jeff Durniak), fisheries status on Lake Lanier
- GADNR WRD Fort Valley Region Fisheries Biologists (Keith Weaver, Brent Hess and Ted Will), fisheries status on Lakes Jackson and West Point
- GADNR WRD Fort Valley Region Fisheries Biologists (John Kilpatrick and Rob Weller), fisheries status on Lake W. F. George

Drinking Water Source Use Support

EPD Watershed Protection Branch, Drinking Water Compliance and Permitting & Engineering (Onder Serefli; Brad Addison; Pete Zorbanos; Bill Defino; and John Ott).

Lake Standards Designated Use Review and Assessment

This review was done by the DNR EPD Watershed Protection Branch, Watershed Planning and Monitoring Program. Contributors were Elizabeth Booth, Ph.D., Susan Salter, Jeremy Smith and Linda Harn.