Environmental Assessment of the Lower Cape Fear River System, 2014

By

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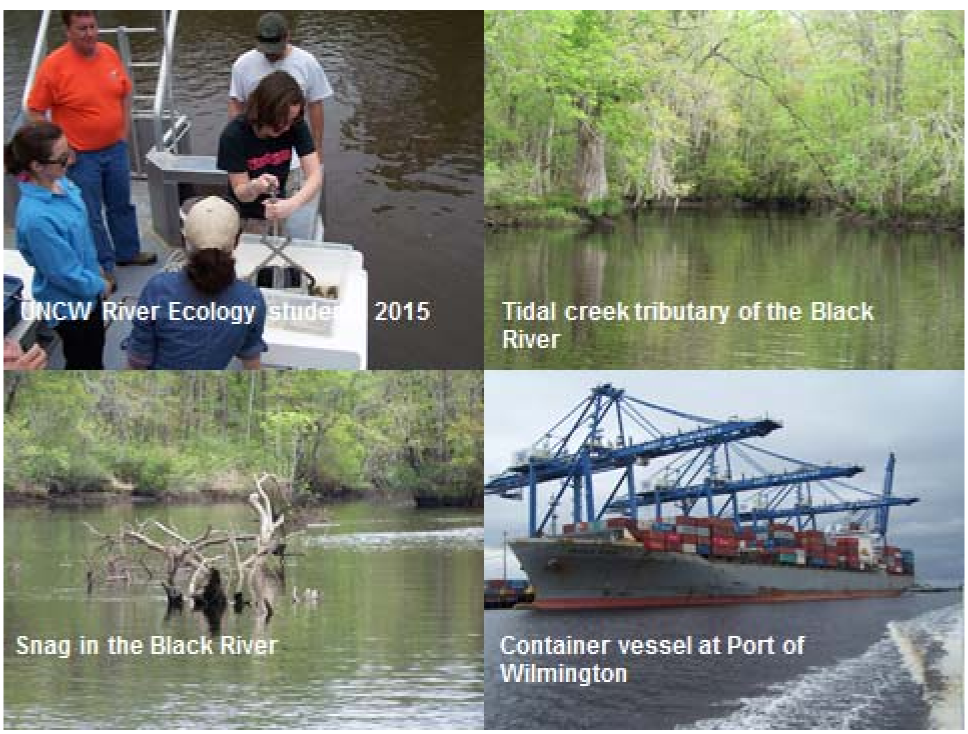

Executive Summary

Multiparameter water sampling for the Lower Cape Fear River Program (LCFRP) http://www.uncw.edu/cms/aelab/LCFRP/index.htm, has been ongoing since June 1995. Scientists from the University of North Carolina Wilmington's (UNCW) Aquatic Ecology Laboratory perform the sampling effort. The LCFRP currently encompasses 33 water sampling stations throughout the lower Cape Fear, Black, and Northeast Cape Fear River watersheds. The LCFRP sampling program includes physical, chemical, and biological water quality measurements and analyses of the benthic and epibenthic macroinvertebrate communities, and has in the past included assessment of the fish communities. Principal conclusions of the UNCW researchers conducting these analyses are presented below, with emphasis on water quality of the period January - December 2014. The opinions expressed are those of UNCW scientists and do not necessarily reflect viewpoints of individual contributors to the Lower Cape Fear River Program.

The mainstem lower Cape Fear River is a 6th order stream characterized by periodically turbid water containing moderate to high levels of inorganic nutrients. It is fed by two large 5th order blackwater rivers (the Black and Northeast Cape Fear Rivers) that have low levels of turbidity, but highly colored water with less inorganic nutrient content than the mainstem. While nutrients are reasonably high in the river channels, major algal blooms have until recently been rare because light is attenuated by water color or turbidity, and flushing is usually high (Ensign et al. 2004). During periods of low flow (as in 2008-2012) algal biomass as chlorophyll *a* increases in the river because lower flow causes settling of more solids and improves light conditions for algal growth. Periodically major algal blooms are seen in the tributary stream stations, some of which are impacted by point source discharges. Below some point sources, nutrient loading can be high and fecal coliform contamination occurs. Other stream stations drain blackwater swamps or agricultural areas, some of which periodically show elevated pollutant loads or effects (Mallin et al. 2001).

Average annual dissolved oxygen (DO) levels at the river channel stations for 2014 were generally higher than the average for 1995-2013. Dissolved oxygen levels were lowest during the summer and early fall, often falling below the state standard of 5.0 mg/L at several river and upper estuary stations. There is a dissolved oxygen sag in the main river channel that begins at Station DP below a paper mill discharge and near the Black River input, and persists into the mesohaline portion of the estuary. Mean oxygen levels were highest at the upper river stations NC11 and AC and in the middle to lower estuary at stations M35 to M18. Lowest mainstem average 2014 DO levels occurred at the lower river and upper estuary stations DP, IC, NAV, HB, BRR and M61 (7.0-7.3 mg/L). As the water reaches the lower estuary higher algal productivity, mixing and ocean dilution help alleviate oxygen problems.

The Northeast Cape Fear and Black Rivers generally have lower DO levels than the mainstem Cape Fear River. These rivers are classified as blackwater systems because of their tea colored water. The Northeast Cape Fear River generally has lower dissolved oxygen than the Black River; as such, in 2014 Stations NCF117 and B210, representing those rivers, had average DO concentrations of 6.3 and 7.1 mg/L, respectively. Several stream stations were severely stressed in terms of low dissolved oxygen during the year 2014, including NC403, GS, ANC and SR. River stations NAV, HB, and IC were all below 5.0 mg/L on 42% or more of occasions sampled, and BRR, DP and M61 were below on 25% of occasions sampled. Considering all sites sampled in 2014, we rated 15% as poor for dissolved oxygen, 24% as fair, and 61% as good, an improvement from 2013

Annual mean turbidity levels for 2014 were lower than the long-term average in all estuary stations. Highest mean turbidities were at NC11-DP, plus NAV (11-12 NTU) with turbidities generally low in the middle to lower estuary. The estuarine stations did not exceed the estuarine turbidity standard on our sampling trips except in January 2014. Turbidity was considerably lower in the blackwater tributaries (Northeast Cape Fear River and Black River) than in the mainstem river. Average turbidity levels were low in the freshwater streams, with the exception of one excursion to 81 NTU in August at SR.

Regarding nutrient concentrations, chronic or periodic high nitrate levels were found at a number of stream stations, including ROC (Rockfish Creek), 6RC (Six Runs Creek), PB (Panther Branch), NC403 and GCO (Great Coharie Creek). Average chlorophyll *a* concentrations across all sites were low in 2014. We note the highest levels in the river and estuary typically occur late spring to mid-summer. During the growing season May-September river flow as measured by USGS at Lock and Dam #1 was 35% higher for 2014 compared with the average for the blue-green algal bloom years 2009-2012 (2,593 CFS compared with 1,698 CFS). Higher flows restrict algal bloom formation by maintaining relatively high turbidity; thus troublesome cyanobacteria (i.e. blue-green algal blooms) did not occur in the Cape Fear River during 2014. Stream algal blooms exceeding 20 µg/L in 2014 occurred at ANC, SR, PB and GS. Several stream stations, particularly PB, SR, GS, LRC, ROC, BRN, HAM and ANC showed high fecal coliform bacteria counts on a number of occasions.

For the 2014 period UNCW rated 100% of the stations as good in terms of chlorophyll *a* and turbidity. Fecal coliform bacteria counts were high in the system in 2014 and the lower estuary had high enterococcus on some occasions. For bacterial water quality overall, 34% of the sites rated as poor, 44% as fair, and 22% as good in 2014. Using the 5.0 mg/L DO standard for the mainstem river stations, and the 4.0 mg/L “swamp water” DO standard for the stream stations and blackwater river stations, 39% of the sites were rated poor or fair for dissolved oxygen. In addition, by our UNCW standards excessive nitrate and phosphorus concentrations were problematic at a number of stations.

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1.0 Introduction

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The Lower Cape Fear River Program is a unique science and education program that has a mission to develop an understanding of processes that control and influence the ecology of the Cape Fear River, and to provide a mechanism for information exchange and public education. This program provides a forum for dialogue among the various Cape Fear River user groups and encourages interaction among them. Overall policy is set by an Advisory Board consisting of representatives from citizen's groups, local government, industries, academia, the business community, and regulatory agencies. This report represents the scientific conclusions of the UNCW researchers participating in this program and does not necessarily reflect opinions of all other program participants. This report focuses on the period January through December 2014.

The scientific basis of the LCFRP consists of the implementation of an ongoing comprehensive physical, chemical, and biological monitoring program. Another part of the mission is to develop and maintain a data base on the Cape Fear basin and make use of this data to develop management plans. Presently the program has amassed an 19-year (1995-2014) data base that is available to the public, and is used as a teaching tool for programs like UNCW's River Run. Using this monitoring data as a framework the program goals also include focused scientific projects and investigation of pollution episodes. The scientific aspects of the program are carried out by investigators from the University of North Carolina Wilmington Center for Marine Science. The monitoring program was developed by the Lower Cape Fear River Program Technical Committee, which consists of representatives from UNCW, the North Carolina Division of Water Quality, The NC Division of Marine Fisheries, the US Army Corps of Engineers, technical representatives from streamside industries, the Cape Fear Public Utility Authority, Cape Fear Community College, Cape Fear River Watch, the North Carolina Cooperative Extension Service, the US Geological Survey, forestry and agriculture organizations, and others. This integrated and cooperative program was the first of its kind in North Carolina.

Broad-scale monthly water quality sampling at 16 stations in the estuary and lower river system began in June 1995 (UNCW Aquatic Ecology Laboratory, directed by Dr. Michael Mallin). Sampling was increased to 34 stations in February of 1996, 35 stations in February 1998, and 36 stations in 2005, then lowered to 33 in 2011. The Lower Cape Fear River Program added another component concerned with studying the benthic macrofauna of the system in 1996. This component is directed by Dr. Martin Posey and Mr. Troy Alphin of the UNCW Biology Department and includes the benefit of additional data collected by the Benthic Ecology Laboratory under Sea Grant and NSF sponsored projects in the Cape Fear Estuary. These data are collected and analyzed depending upon the availability of funding. The third major biotic component (added in

January 1996) was an extensive fisheries program directed by Dr. Mary Moser of the UNCW Center for Marine Science Research, with subsequent (1999) overseeing by Mr. Michael Williams and Dr. Thomas Lankford of UNCW-CMS. This program involved cooperative sampling with the North Carolina Division of Marine Fisheries and the North Carolina Wildlife Resources Commission. The fisheries program ended in December 1999, but was renewed with additional funds from the Z. Smith Reynolds Foundation from spring – winter 2000. The regular sampling that was conducted by UNCW biologists was assumed by the North Carolina Division of Marine Fisheries.

1.1. Site Description

The mainstem of the Cape Fear River is formed by the merging of the Haw and the Deep Rivers in Chatham County in the North Carolina Piedmont. However, its drainage basin reaches as far upstream as the Greensboro area (Fig. 1.1). The mainstem of the river has been altered by the construction of several dams and water control structures. In the coastal plain, the river is joined by two major tributaries, the Black and the Northeast Cape Fear Rivers (Fig. 1.1). These 5th order blackwater streams drain extensive riverine swamp forests and add organic color to the mainstem. The watershed (about 9,164 square miles) is the most heavily industrialized in North Carolina with 203 permitted wastewater discharges with a permitted flow of approximately 429 million gallons per day, and (as of 2010) over 2.07 million people residing in the basin (NCDENR Basinwide Information Management System (BIMS) & 2010 Census). Approximately 23% of the land use in the watershed is devoted to agriculture and livestock production (2006 National Land Cover Dataset), with livestock production dominated by swine and poultry operations. Thus, the watershed receives considerable point and non-point source loading of pollutants. However, the estuary is a well-flushed system, with flushing time ranging from 1 to 22 days with a median flushing time of about seven days, much shorter than the other large N.C. estuaries to the north (Ensign et al. 2004).

Water quality is monitored by boat at eight stations in the Cape Fear Estuary (from Navassa to Southport) and one station in the Northeast Cape Fear Estuary (Table 1.1; Fig. 1.1). We note that after July 2011 sampling was discontinued at stations M42 and SPD, per agreement with the North Carolina Division of Water Quality; and in 2012 sampling was expanded at Smith Creek at the Castle Hayne Road bridge (Table 1.1) and initiated at a new site along the South River (SR-WC). Riverine stations sampled by boat include NC11, AC, DP, IC, and BBT (Table 1.1; Fig. 1.1). NC11 is located upstream of any major point source discharges in the lower river and estuary system, and is considered to be representative of water quality entering the lower system (we note that the City of Wilmington and portions of Brunswick County get their drinking water from the river just upstream of Lock and Dan #1). Station BBT is located on the Black River between Thoroughfare (a stream connecting the Cape Fear and Black Rivers) and the mainstem Cape Fear, and is influenced by both rivers. We consider B210 and NCF117 to represent water quality entering the lower Black and Northeast Cape Fear Rivers, respectively. Data has also been collected at stream and river

Table 1.1 Description of sampling locations for the Lower Cape Fear River Program, 2014.

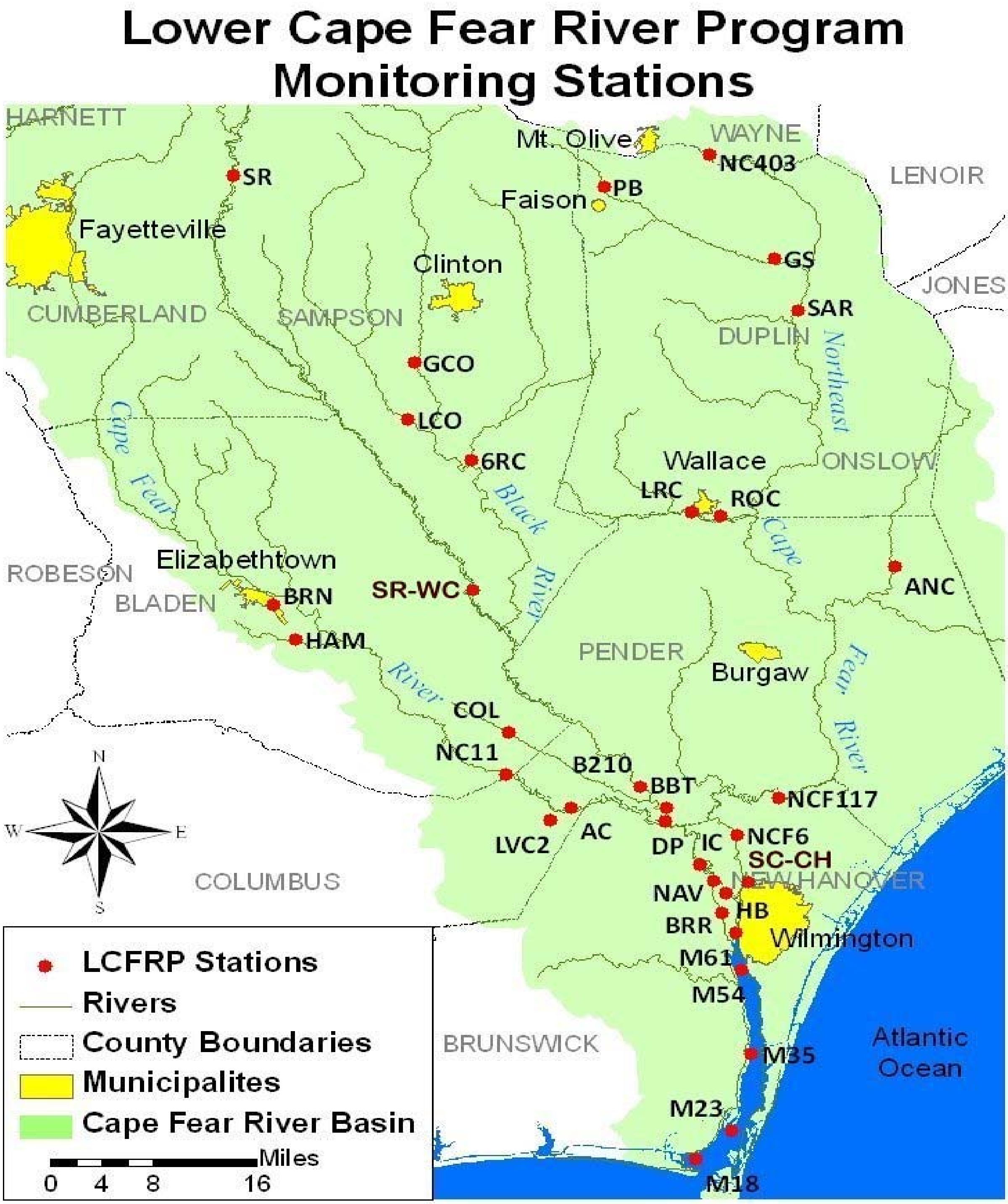
Collected by Boat

AEL Station	DWR Station #	Description	Comments	County	Lat	Lon	Stream Class.	HUC
NC11	B8360000	Cape Fear River at NC 11 nr East Arcadia	Below Lock and Dam 1, Represents water entering lower basin	Bladen	34.3969	-78.2675	WS-IV Sw	03030005
LVC2	B8441000	Livingston Creek at Momentive Walkway nr Acme	DWR ambient station, Downstream of Momentive	Columbus	34.3353	-78.2011	C Sw	03030005
AC	B8450000	Cape Fear River at Neils Eddy Landing nr Acme	1 mile below IP, DWR ambient station	Columbus	34.3555	-78.1794	C Sw	03030005
DP	B8465000	Cape Fear River at Intake nr Hooper Hill	AT DAK intake, just above confluence with Black R.	Brunswick	34.3358	-78.0534	C Sw	03030005
BBT		Black River below Lyons Thorofare	UNCW AEL station	Pender	34.3513	-78.0490	C Sw ORW+	0303005
IC	B9030000	Cape Fear River ups Indian Creek nr Phoenix	Downstream of several point source discharges	Brunswick	34.3021	-78.0137	C Sw	0303005
NAV	B9050025	Cape Fear River dns of RR bridge at Navassa	Downstream of several point source discharges	Brunswick	34.2594	-77.9877	SC	0303005
HB	B9050100	Cape Fear River at S. end of Horseshoe Bend nr Wilmington	Upstream of confluence with NE Cape Fear River	Brunswick	34.2437	-77.9698	SC	0303005
BRR	B9790000	Brunswick River dns NC 17 at park nr Belville	Near Belville discharge	Brunswick	34.2214	-77.9787	SC	03030005
M61	B9800000	Cape Fear River at Channel Marker 61 at Wilmington	Downstream of several point source discharges	New Hanover	34.1938	-77.9573	SC	03030005
M54	B9795000	Cape Fear River at Channel Marker 54	Downstream of several point source discharges	New Hanover	34.1393	-77.946	SC	03030005
M35	B9850100	Cape Fear River at Channel Marker 35	Upstream of Carolina Beach discharge	Brunswick	34.0335	-77.937	SC	03030005
M23	B9910000	Cape Fear River at Channel Marker 23	Downstream of Carolina Beach discharge	Brunswick	33.9456	-77.9696	SA HQW	03030005
M18	B9921000	Cape Fear River at Channel Marker 18	Near mouth of Cape Fear River	Brunswick	33.913	-78.017	SC	03030005
NCF6	B9670000	NE Cape Fear nr Wrightsboro	Downstream of several point source discharges	New Hanover	34.3171	-77.9538	C Sw	0303007

Collected by Land

AEL Station	DWR Station #	Description	Comments	County	Lat	Lon	Stream Class.	HUC
6RC	B8740000	Six Runs Creek at SR 1003 nr Ingold	Upstream of Black River, CAFOs in watershed	Sampson	34.7933	-78.3113	C Sw ORW+	03030006
LCO	B8610001	Little Coharie Creek at SR 1207 nr Ingold	Upstream of Great Coharie, CAFOs in watershed	Sampson	34.8347	-78.3709	C Sw	03030006
GCO	B8604000	Great Coharie Creek at SR 1214 nr Butler Crossroads	Downstream of Clinton, CAFOs in watershed	Sampson	34.9186	-78.3887	C Sw	03030006
SR	B8470000	South River at US 13 nr Cooper	Downstream of Dunn	Sampson	35.156	-78.6401	C Sw	03030006
BRN	B8340050	Browns Creek at NC87 nr Elizabethtown	CAFOs in watershed	Bladen	34.6136	-78.5848	C	03030005
HAM	B8340200	Hammond Creek at SR 1704 nr Mt. Olive	CAFOs in watershed	Bladen	34.5685	-78.5515	C	03030005
COL	B8981000	Colly Creek at NC 53 at Colly	Pristine area	Bladen	34.4641	-78.2569	C Sw	03030006
B210	B9000000	Black River at NC 210 at Still Bluff	1st bridge upstream of Cape Fear River	Pender	34.4312	-78.1441	C Sw ORW+	03030006
NC403	B9090000	NE Cape Fear River at NC 403 nr Williams	Downstream of Mt. Olive Pickle, CAFOs in watershed	Duplin	35.1784	-77.9807	C Sw	0303007
PB	B9130000	Panther Branch (Creek) nr Faison	Downstream of Bay Valley Foods	Duplin	35.1345	-78.1363	C Sw	0303007
GS	B9191000	Goshen Swamp at NC 11 and NC 903 nr Kornegay	CAFOs in watershed	Duplin	35.0281	-77.8516	C Sw	0303007
SAR	B9191500	NE Cape Fear River SR 1700 nr Sarecta	Downstream of several point source discharges	Duplin	34.9801	-77.8622	C Sw	0303007
ROC	B9430000	Rockfish Creek at US 117 nr Wallace	Upstream of Wallace discharge	Duplin	34.7168	-77.9795	C Sw	0303007
LRC	B9460000	Little Rockfish Creek at NC 11 nr Wallace	DWR Benthic station	Duplin	34.7224	-77.9814	C Sw	0303007
ANC	B9490000	Angola Creek at NC 53 nr Maple Hill	DWR Benthic station	Pender	34.6562	-77.7351	C Sw	0303007
SR WC	B8920000	South River at SR 1007 (Wildcat/Ennis Bridge Road)	Upstream of Black River	Sampson	34.6402	-78.3116	C Sw ORW+	03030006
NCF117	B9580000	NE Cape Fear River at US 117 at Castle Hayne	DWR ambient station, Downstream of point source discharges	New Hanover	34.3637	-77.8965	B Sw	0303007
SC-CH	B9720000	Smith Creek at US 117 and NC 133 at Wilmington	Urban runoff, Downstream of Wilmington Northside WWTP	New Hanover	34.2586	-77.9391	C Sw	0303007

Figure 1.1. Map of the Lower Cape Fear River system and the LCFRP sampling stations.



2.0 Physical, Chemical, and Biological Characteristics of the Lower Cape Fear River and Estuary

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2.1 - Introduction

This section of the report includes a discussion of the physical, chemical, and biological water quality parameters, concentrating on the January-December 2014 Lower Cape Fear River Program monitoring period. These parameters are interdependent and define the overall condition of the river. Physical parameters measured during this study included water temperature, dissolved oxygen, field turbidity and laboratory turbidity, total suspended solids (TSS), salinity, conductivity, pH and light attenuation. The chemical makeup of the Cape Fear River was investigated by measuring the magnitude and composition of nitrogen and phosphorus in the water. Three biological parameters including fecal coliform bacteria or enterococcus bacteria, chlorophyll *a* and biochemical oxygen demand were examined.

2.2 - Materials and Methods

All samples and field parameters collected for the estuarine stations of the Cape Fear River (NAV down through M18) were gathered on an ebb tide. This was done so that the data better represented the river water flowing downstream through the system rather than the tidal influx of coastal ocean water. Sample collection and analyses were conducted according to the procedures in the Lower Cape Fear River Program Quality Assurance/Quality Control (QA/QC) manual. Technical Representatives from the LCFRP Technical Committee and representatives from the NC Division of Water Quality inspect UNCW laboratory procedures and periodically accompany field teams to verify proper procedures are followed. By agreement with N.C. Division of Water Quality, after June 2011 sampling was discontinued at stations M42 and SPD, but full sampling was added at SC-CH and SR-WC in 2012. We note the Town of Burgaw left the program as of 2013 and Stations BCRR and BC117 are no longer being sampled.

<u>Physical Parameters</u>

Water Temperature, pH, Dissolved Oxygen, Turbidity, Light, Salinity, Conductivity

Field parameters other than light attenuation were measured at each site using a YSI 6920 (or 6820) multi-parameter water quality sonde displayed on a YSI 650 MDS. Each parameter is measured with individual probes on the sonde. At stations sampled by boat (see Table 1.1) physical parameters were measured at 0.1 m and at the bottom (up to 12 m). Occasionally, high flow prohibited the sonde from reaching the actual bottom and measurements were taken as deep as possible. At the terrestrially sampled stations (i.e.

from bridges or docks) the physical parameters were measured at a depth of 0.1 m. The Aquatic Ecology Laboratory at the UNCW CMS is State-certified by the N.C. Division of Water Quality to perform field parameter measurements. The light attenuation coefficient *k* was determined from data collected on-site using vertical profiles obtained by a Li-Cor LI-1000 integrator interfaced with a Li-Cor LI-193S spherical quantum sensor.

Chemical Parameters

Nutrients

A local State-certified analytical laboratory was contracted to conduct all chemical analyses except for orthophosphate, which is performed at CMS. The following methods detail the techniques used by CMS personnel for orthophosphate analysis.

Orthophosphate (PO_4^{-3})

Water samples were collected ca. 0.1 m below the surface in triplicate in amber 125 mL Nalgene plastic bottles and placed on ice. In the laboratory 50 mL of each triplicate was filtered through separate1.0 micron pre-combusted glass fiber filters, which were frozen and later analyzed for chlorophyll *a*. The triplicate filtrates were pooled in a glass flask, mixed thoroughly, and approximately 100 mL was poured into a 125 mL plastic bottle to be analyzed for orthophosphate. Samples were frozen until analysis.

Orthophosphate analyses were performed in duplicate using an approved US EPA method for the Bran-Lubbe AutoAnalyzer (Method 365.5). In this technique the orthophosphate in each sample reacts with ammonium molybdate and anitmony potassium tartrate in an acidic medium (sulfuric acid) to form an anitmony-phospho-molybdate complex. The complex is then reacted with ascorbic acid and forms a deep blue color. The intensity of the color is measured at a wavelength of 880 nm by a colorimeter and displayed on a chart recorder. Standards and spiked samples were analyzed for quality assurance.

Biological Parameters

Fecal Coliform Bacteria / Enterococcus

Fecal coliform bacteria were analyzed by a State-certified laboratory contracted by the LCFRP. Samples were collected approximately 0.1 m below the surface in sterile plastic bottles provided by the contract laboratory and placed on ice for no more than six hours before analysis. After August 2011 the fecal coliform analysis was changed to *Enterococcus* in the estuarine stations downstream of NAV and HB (Stations BRR, M61, M35, M23 and M18).

Chlorophyll a

The analytical method used to measure chlorophyll *a* is described in Welschmeyer (1994) and US EPA (1997) and was performed by CMS personnel. Chlorophyll *a* concentrations were determined utilizing the 1.0 micron filters used for filtering samples for orthophosphate analysis. All filters were wrapped individually in foil, placed in airtight containers and stored in the freezer. During analysis each filter was immersed in 10 mL of 90% acetone for 24 hours, which extracts the chlorophyll *a* into solution. Chlorophyll *a* concentration of each solution was measured on a Turner 10-AU fluorometer. The fluorometer uses an optimal combination of excitation and emission bandwidth filters which reduces the errors inherent in the acidification technique. The Aquatic Ecology Laboratory at the CMS is State-certified by the N.C. Division of Water Quality for the analysis of chlorophyll *a* (chlorophyll at four LCFRP stations are required by NCDWR to be analyzed by state-certified methods).

Biochemical Oxygen Demand (BOD)

Five sites were originally chosen for BOD analysis. One site was located at NC11, upstream of International Paper, and a second site was at AC, about 3 miles downstream of International Paper (Fig.1.1). Two sites were located in blackwater rivers (NCF117 and B210) and one site (BBT) was situated in an area influenced by both the mainstem Cape Fear River and the Black River. For the sampling period May 2000-April 2004 additional BOD data were collected at stream stations 6RC, LCO, GCO, BRN, HAM and COL in the Cape Fear and Black River watersheds. In May 2004 those stations were dropped and sampling commenced at ANC, SAR, GS, N403, ROC and BC117 in the Northeast Cape Fear River watershed for several years. The procedure used for BOD analysis is Method 5210 in Standard Methods (APHA 1995). Samples were analyzed for both 5-day and 20-day BOD. During the analytical period, samples were kept in airtight bottles and placed in an incubator at 20^{o} C. All experiments were initiated within 6 hours of sample collection. Samples were analyzed in duplicate. Dissolved oxygen measurements were made using a YSI Model 5000 meter that was air-calibrated. No adjustments were made for pH since most samples exhibited pH values within or very close to the desired 6.5-7.5 range (pH is monitored during the analysis as well); a few sites have naturally low pH and there was no adjustment for these samples because it would alter the natural water chemistry and affect true BOD. Data are presented within for the five original sites.

Parameter	***Method***	***NC DWR Certified***
Water Temperature	SM 2550B-2000	Yes
Dissolved Oxygen	SM 4500O G-2001	Yes
pH	SM 4500 H B-2000	Yes
Specific Conductivity	SM 2510 B-1997	Yes
Lab Turbidity	SM 2130 B-2001	Yes
Field Turbidity	SM 2130 B-2001	No

Chlorophyll *a*	EPA 445.0 Rev. 1.2	Yes
Biochemical Oxygen Demand	SM 5210 B-2001	No
Parameter	***Method***	***NC DWR Certified***
Total Nitrogen	By addition	
Nitrate + Nitrite	EPA 353.2 Rev 2.0 1993	Yes
Total Kjeldahl Nitrogen	EPA 351.2 Rev 2.0 1993	Yes
Ammonia Nitrogen	EPA 350.1 Rev 2.0 1993	Yes
Total Phosphorus	SM 4500 P E-1999	Yes
Orthophosphate	EPA 365.5	No
Fecal Coliform	SM 9222 D-1997	Yes
Enterococcus	Enterolert IDEXX	Yes

2.3 - Results and Discussion

This section includes results from monitoring of the physical, biological, and chemical parameters at all stations for the time period January-December 2014. Discussion of the data focuses both on the river channel stations and stream stations, which sometimes reflect poorer water quality than mainstem stations. The contributions of the two large blackwater tributaries, the Northeast Cape Fear River and the Black River, are represented by conditions at NCF117 and B210, respectively. The Cape Fear Region did not experience any significant hurricane activity during this monitoring period (after major hurricanes in 1996, 1998, and 1999). Therefore this report reflects low to medium growing season flow conditions for the Cape Fear River and Estuary.

<u>Physical Parameters</u>

Water temperature

Water temperatures at all stations ranged from 1.1 to 30.2^{o}C, and individual station annual averages ranged from 14.0 to 19.2^{o}C (Table 2.1). Highest temperatures occurred during July and August and lowest temperatures during January. Stream stations were generally cooler than river stations, most likely because of shading and lower nighttime air temperatures affecting the shallower waters.

Salinity

Salinity at the estuarine stations (NAV through M18; also NCF6 in the Northeast Cape Fear River) ranged from 0.0 to 34.1 practical salinity units (psu) and station annual means ranged from 1.2 to 26.3 psu (Table 2.2). Lowest salinities occurred in mid-summer and highest salinities occurred in late fall and winter. The annual mean salinity for 2014 was similar to that of the eighteen-year average for 1995-2013 for all of the estuarine stations (Figure 2.1). Two stream stations, NC403 and PB, had occasional oligohaline conditions due to discharges from pickle production facilities. SC-CH is a tidal creek that enters the Northeast Cape Fear River upstream of Wilmington and salinity there ranged widely, from 0.1 to 18.5 psu.

Conductivity

Conductivity at the estuarine stations ranged from 0.10 to 51.92 mS/cm and from 0.06 to 4.79 mS/cm at the freshwater stations (Table 2.3). Temporal conductivity patterns followed those of salinity. Dissolved ionic compounds increase the conductance of water, therefore, conductance increases and decreases with salinity, often reflecting river flow conditions due to rainfall. Stations PB and NC403 are below industrial discharges, and often have elevated conductivity. Smith Creek (SC-CH) is an estuarine tidal creek and the conductivity values reflect this (Table 2.3).

pH

pH values ranged from 3.7 to 8.1 and station annual means ranged from 4.0 to 7.9 (Table 2.4). pH was typically lowest upstream due to acidic swamp water inputs and highest downstream as alkaline seawater mixes with the river water. Low pH values at COL predominate because of naturally acidic blackwater inputs at this near-pristine stream station. We also note that LRC had an unusually high pH level (8.0) in September 2014 (Table 2.4).

Dissolved Oxygen

Dissolved oxygen (DO) problems have been a major water quality concern in the lower Cape Fear River and its estuary, and several of the tributary streams (Mallin et al. 1999; 2000; 2001a; 2001b; 2002a; 2002b; 2003; 2004; 2005a; 2006a; 2006b; 2007; 2008; 2009; 2010; 2011; 2012; 2013; 2014). Surface concentrations for all sites in 2014 ranged from 0.7 to 13.7 mg/L and station annual means ranged from 6.2 to 10.1 mg/L (Table 2.5). Average annual DO levels at the river channel and estuarine stations for 2014 were slightly higher than the average for 1995-2013 (Figure 2.2). River dissolved oxygen levels were lowest during the summer and early fall (Table 2.5), often falling below the state standard of 5.0 mg/L at several river and upper estuary stations. Working synergistically to lower oxygen levels are two factors: lower oxygen carrying capacity in warmer water and increased bacterial respiration (or biochemical oxygen demand, BOD), due to higher temperatures in summer. Unlike other large North Carolina estuaries (the Neuse, Pamlico and New River) the Cape Fear estuary rarely suffers from dissolved oxygen stratification. This is because, despite salinity stratification the oxygen remains well mixed due to strong estuarine gravitational circulation and high freshwater inputs (Lin et al. 2006). Thus, hypoxia in the Cape Fear is present throughout the water column.

There is a dissolved oxygen sag in the main river channel that begins at DP below a paper mill discharge and persists into the mesohaline portion of the estuary (Fig. 2.2). Mean oxygen levels were highest at the upper river stations NC11 and AC and in the low-to-middle estuary at stations M35 to M18. Lowest mainstem mean 2014 DO levels occurred at the river and upper estuary stations IC, NAV, HB, BRR and M61 (7.0-7.3 mg/L). Stations NAV, HB and IC were all below 5.0 mg/L on 33% or more of occasions sampled, and BRR, M61 and DP were below on 25% of occasions sampled. Average estuary DO concentrations were an improvement from 2013. Based on number of occasions the river stations were below 5 mg/L UNCW rated NAV, HB and IC as poor for 2014; the mid to lower estuary stations were rated as fair to good. Discharge of high BOD waste from the paper/pulp mill just above the AC station (Mallin et al. 2003), as well as inflow of blackwater from the Northeast Cape Fear and Black Rivers, helps to diminish oxygen in the lower river and upper estuary. Additionally, algal blooms periodically form behind Lock and Dam #1 (including the blue-green algal blooms in recent years), and the chlorophyll *a* they produce is strongly correlated with BOD at Station NC11 (Mallin et al. 2006b); thus the blooms do contribute to lower DO in the river. As the water reaches the lower estuary higher algal productivity, mixing and ocean dilution help alleviate oxygen problems.

The Northeast Cape Fear and Black Rivers generally have lower DO levels than the mainstem Cape Fear River (NCF117 2014 mean = 6.3, NCF6 = 6.9, B210 2014 mean = 7.1) . These rivers are classified as blackwater systems because of their tea colored water. As the water passes through swamps en route to the river channel, tannins from decaying vegetation leach into the water, resulting in the observed color. Decaying vegetation on the swamp floor has an elevated biochemical oxygen demand and usurps oxygen from the water, leading to naturally low dissolved oxygen levels. Runoff from concentrated animal feeding operations (CAFOs) may also contribute to chronic low dissolved oxygen levels in these blackwater rivers (Mallin et al. 1998; 1999; 2006; Mallin 2000). We note that phosphorus and nitrogen (components of animal manure) levels have been positively correlated with BOD in the blackwater rivers and their major tributaries (Mallin et al. 2006b).

Several stream stations were severely stressed in terms of low dissolved oxygen during the year 2014. Station GS had DO levels below 4.0 mg/L 33% of the occasions sampled, as did NC403, and SR was below that level 25% (Table 2.5). Some of this can be attributed to low summer water conditions and some potentially to CAFO runoff; however point-source discharges also likely contribute to low dissolved oxygen levels at NC403 and possibly SR, especially via nutrient loading (Mallin et al. 2001a; 2002a; 2004). Hypoxia is thus a continuing and widespread problem, with 39% of the sites impacted in 2014 (an improvement from 2012 and 2013 however).

Field Turbidity

Field turbidity levels ranged from 0 to 81 Nephelometric turbidity units (NTU) and station annual means ranged from 0 to 13 NTU (Table 2.6). The State standard for estuarine turbidity is 25 NTU. Highest mean turbidities were at NC11-DP, plus NAV (12-13 NTU) with turbidities generally low in the middle to lower estuary (Figure 2.3). The estuarine stations did not exceed the estuarine turbidity standard on our 2014 sampling trips except during January. Annual mean turbidity levels for 2014 were well below the long-term average at all estuary sites (Fig. 2.3). Turbidity was considerably lower in the blackwater tributaries (Northeast Cape Fear River and Black River) than in the mainstem river. Average turbidity levels were low in the freshwater streams, with the exception of one excursion to 81 NTU in August at SR. The State standard for freshwater turbidity is 50 NTU.

Note: In addition to the laboratory-analyzed turbidity that are required by NCDWQ for seven locations, the LCFRP uses nephelometers designed for field use, which allows us to acquire in situ turbidity from a natural situation. North Carolina regulatory agencies are required to use turbidity values from water samples removed from the natural system, put on ice until arrival at a State-certified laboratory, and analyzed using laboratory nephelometers. Standard Methods notes that transport of samples and temperature change alters true turbidity readings. Our analysis of samples using both methods shows that lab turbidity is nearly always lower than field turbidity; thus we do not discuss lab turbidity in this report.

Total Suspended Solids

A new monitoring plan was developed for the LCFRP in September 2011. These changes were suggested by the NC Division of Water Resources (then DWQ). NCDWR suggested the LCFRP stop monitoring TSS at Stations ANC, GS, 6RC, LCO, SR, BRN, HAM, COL, SR-WC and monitor turbidity instead. DWQ believed turbidity would be more useful than TSS in evaluating water quality at these stations because there are water quality standards for turbidity. TSS is used by the DWQ NPDES Unit to evaluate discharges. No LCFRP subscribers discharge in these areas.

Total suspended solid (TSS) values system wide ranged from 1 to 54.3 mg/L with station annual means from 3 to 15 mg/L (Table 2.7). The overall highest river values were at NAV, HB, M54 and M18. In the stream stations TSS was generally considerably lower than the river and estuary, except for a few relatively minor incidents at Station PB. Although total suspended solids (TSS) and turbidity both quantify suspended material in the water column, they do not always go hand in hand. High TSS does not mean high turbidity and vice versa. This anomaly may be explained by the fact that fine clay particles are effective at dispersing light and causing high turbidity readings, while not resulting in high TSS. On the other hand, large organic or inorganic particles may be less effective at dispersing light, yet their greater mass results in high TSS levels. While there is no NC ambient standard for TSS, many years of data from the lower Cape Fear watershed indicates that 25 mg/L can be considered elevated. The fine silt and clay in the upper to middle estuary sediments are most likely derived from the Piedmont and carried downstream to the estuary, while the sediments in the lowest portion of the estuary are marine-derived sands (Benedetti et al. 2006).

Light Attenuation

The attenuation of solar irradiance through the water column is measured by a logarithmic function (k) per meter. The higher this light attenuation coefficient is the more strongly light is attenuated (through absorbance or reflection) in the water column. River and estuary light attenuation coefficients ranged from 0.08 to 6.40/m and station annual means ranged from 1.68 at M18 to 4.14 /m at HB (Table 2.8). Elevated mean and median light attenuation occurred from DP in the lower river downstream to M54 in the estuary (Table 2.8). In the Cape Fear system, light is attenuated by both turbidity and water color.

High light attenuation did not always coincide with high turbidity. Blackwater, though low in turbidity, will attenuate light through absorption of solar irradiance. At NCF6 and BBT, blackwater stations with moderate turbidity levels, light attenuation was high. Compared to other North Carolina estuaries the Cape Fear has high average light attenuation. The high average light attenuation is a major reason why phytoplankton production in the major rivers and the estuary of the LCFR is generally low. Whether caused by turbidity or water color this attenuation tends to limit light availability to the phytoplankton (Mallin et al. 1997; 1999; 2004; Dubbs and Whalen 2008).

Chemical Parameters – Nutrients

Total Nitrogen

Total nitrogen (TN) is calculated from TKN (see below) plus nitrate; it is not analyzed in the laboratory. TN ranged from 50 (detection limit) to 9,400 μg/L and station annual means ranged from 424 to 3,121 μg/L (Table 2.9). Mean total nitrogen in 2014 was somewhat lower than the eighteen-year mean at the river and estuary stations, except at the blackwater river sites (Figure 2.4). Previous research (Mallin et al. 1999) has shown a positive correlation between river flow and TN in the Cape Fear system. In the main river total nitrogen concentrations were highest between NC11 and DP, entering the system then declined into the lower estuary, most likely reflecting uptake of nitrogen into the food chain through algal productivity and subsequent grazing by planktivores as well as through dilution and marsh denitrification. The highest median TN value at the stream stations was at ROC, with 2,415 μg/L; other elevated TN values were seen at PB, NC403 and 6RC.

Nitrate+Nitrite

Nitrate+nitrite (henceforth referred to as nitrate) is the main species of inorganic nitrogen in the Lower Cape Fear River. Concentrations system wide ranged from 10 (detection limit) to 8,300 μg/L and station annual means ranged from 18 to 1,670 μg/L (Table 2.10). The highest average riverine nitrate levels were at NC11 and AC (819 and 714 μg/L, respectively – and much higher than in 2013) indicating that much of this nutrient is imported from upstream. Moving downstream, nitrate levels decrease most likely as a result of uptake by primary producers, microbial denitrification in riparian marshes and tidal dilution. Despite this, the rapid flushing of the estuary (Ensign et al. 2004) permits sufficient nitrate to enter the coastal ocean in the plume and contribute to offshore productivity (Mallin et al. 2005b). Nitrate can limit phytoplankton production in the lower estuary in summer (Mallin et al. 1999). The blackwater rivers carried lower concentrations of nitrate compared to the mainstem Cape Fear stations; i.e. the Northeast Cape Fear River (NCF117 mean = 458 μg/L) and the Black River (B210 = 395 μg/L). Lowest river nitrate occurred during early summer and early fall; in general, average concentrations in 2014 exceeded those of 2013.

Several stream stations showed high levels of nitrate on occasion including ROC, 6RC, GCO, NC403, and PB. 6RC, ROC and GCO primarily receive non-point agricultural or animal waste drainage, while point sources contribute to NC403 and PB. Over the past several years a considerable number of experiments have been carried out by UNCW researchers to assess the effects of nutrient additions to water collected from blackwater streams and rivers (i.e. the Black and Northeast Cape Fear Rivers, and Colly and Great Coharie Creeks). These experiments have collectively found that additions of nitrogen (as either nitrate, ammonium, or urea) significantly stimulate phytoplankton production and BOD increases. Critical levels of these nutrients were in the range of 200 to 500 μg/L as N (Mallin et al. 1998; Mallin et al. 2001a; Mallin et al. 2002a, Mallin et al. 2004). Thus, we conservatively consider nitrate concentrations exceeding 500 μg/L as N in Cape Fear watershed streams to be potentially problematic to the stream's environmental health.

Ammonium/ammonia

Ammonium concentrations ranged from 10 (detection limit) to 1,000 μg/L and station annual means ranged from 26 to 118 μg/L (Table 2.11). River areas with the highest mean ammonium levels this monitoring period included AC and DP, which are downstream of a pulp mill discharge, and M61 and M54 in the upper estuary, nearest the wastewater treatment plant discharge from Wilmington. At the stream stations, areas with highest levels of ammonium were PB, LVC2, NC403, ANC and SR (due to one unusual peak of 1,000 μg/L in August (Table 2.11). PB had the second highest peak of 460 μg/L in May.

Total Kjeldahl Nitrogen

Total Kjeldahl Nitrogen (TKN) is a measure of the total concentration of organic nitrogen plus ammonium. TKN ranged from 50 (detection limit) to 3,400 μg/L and station annual means ranged from 321 to 1,375 μg/L (Table 2.12). TKN concentration decreases ocean-ward through the estuary, likely due to ocean dilution and food chain uptake of nitrogen. Several individual peaks at or exceeding 2,000 μg/L range occurred in stations ANC, GS, LRC, ROC and COL; ANC also had the highest median concentrations.

Total Phosphorus

Total phosphorus (TP) concentrations ranged from 10 (detection limit) to 830 μg/L and station annual means ranged from 33 to 298 μg/L (Table 2.13). in contrast to 2013, mean TP for 2014 was lower than the eighteen-year mean in the estuary and river stations

(Figure 2.5). In the river TP was highest at the upper riverine channel stations NC11, AC and DP and declined downstream into the estuary. Some of this decline is attributable to the settling of phosphorus-bearing suspended sediments, yet incorporation of phosphorus into bacteria and algae is also responsible.

The experiments discussed above in the nitrate subsection also involved additions of phosphorus, either as inorganic orthophosphate or a combination of inorganic plus organic P. The experiments showed that additions of P exceeding 500 µg/L led to significant increases in bacterial counts, as well as significant increases in BOD over control. Thus, we consider concentrations of phosphorus above 500 µg/L to be potentially problematic to blackwater streams (Mallin et al. 1998; 2004). Streams periodically exceeding this critical concentration included ROC and PB. Station PB is downstream of industrial or wastewater discharges, while ROC is in a non-point agricultural areas.

Orthophosphate

Orthophosphate ranged from undetectable to 600 µg/L and station annual means ranged from undetectable to 175 µg/L (Table 2.14). Much of the main river orthophosphate load is imported into the Lower Cape Fear system from upstream areas, as NC11 or AC typically have high levels; there are also inputs of orthophosphate from the paper mill above AC (Table 2.14). The Northeast Cape Fear River had higher orthophosphate levels than the Black River. Orthophosphate can bind to suspended materials and is transported downstream via particle attachment; thus high levels of turbidity at the uppermost river stations may be an important factor in the high orthophosphate levels. Turbidity declines toward the lower estuary because of settling, and orthophosphate concentration also declines. In the estuary, primary productivity helps reduce orthophosphate concentrations by assimilation into biomass. Orthophosphate levels typically reach maximum concentrations during summertime, when anoxic sediment releases bound phosphorus. Also, in the Cape Fear Estuary, summer algal productivity is limited by nitrogen, thereby allowing the accumulation of orthophosphate (Mallin et al. 1997; 1999). In spring, productivity in the estuary is usually limited by phosphorus (Mallin et al. 1997; 1999).

ROC, ANC and GCO had the highest stream station concentrations. All of those sites are in non-point source areas.

<u>Chemical Parameters - EPA Priority Pollutant Metals</u>

The LCFRP had previously sampled for water column metals (EPA Priority Pollutant Metals) on a bimonthly basis. However, as of 2007 this requirement was suspended by the NC Division of Water Quality and these data are no longer collected by the LCFRP. Revised metals sampling is being re-initiated in late 2015, however.

Biological Parameters

Chlorophyll a

During this monitoring period in most locations chlorophyll *a* was low, except for elevated concentrations in June-July in the upper estuary and March in the upper river stations (Table 2.15). The state standard was not exceeded in our samples in 2014. We note that at the upper site NC11 it has been demonstrated that chlorophyll *a* biomass is significantly correlated with biochemical oxygen demand (BOD5 – Mallin et al. 2006b). System wide, chlorophyll *a* ranged from undetectable to 37 μg/L and station annual means ranged from 1-9 μg/L, lower than in 2013. Production of chlorophyll *a* biomass is usually low to moderate in the rivers and estuary primarily because of light limitation by turbidity in the mainstem (Dubbs and Whalen 2008) and high organic color and low inorganic nutrients in the blackwater rivers.

Spatially, besides Station NC11 along the mainstem high values are normally found in the mid-to-lower estuary stations because light becomes more available downstream of the estuarine turbidity maximum (Fig. 2.6). On average, flushing time of the Cape Fear estuary is rapid, ranging from 1-22 days with a median of 6.7 days (Ensign et al. 2004). This does not allow for much settling of suspended materials, leading to light limitation of phytoplankton production. However, under lower-than-average flows there is generally clearer water through less suspended material and less blackwater swamp inputs. For the growing season May-September, long-term (1995-2013) average monthly flow at Lock and Dam #1 was approximately 3,529 CFS; however, for cyanobacterial bloom years 2009-2012 the growing season average flow was 1,698 CFS (USGS data; (http://nc.water.usgs.gov/realtime/real_time_cape_fear.html). For 2014, discharge in May-September was 35% above the 2009-2012 average at 2,593 CFS. Thus, cyanobacterial bloom formation in the river and upper estuary were suppressed by increased flow; however most riverine and upper estuarine stations showed chlorophyll *a* increases relative to the long-term average (Figure 2.6).

As noted in earlier reports, blooms of cyanobacteria (blue-green algae) called *Microcystis aeruginosa* began occurring in 2009 and continued to occur in summer 2010, 2011 and 2012. This species contains many strains long known to produce toxins, both as a threat to aquatic life and to humans as well (Burkholder 2002). At least some of the blooms in the main stem of the Cape Fear have produced toxins (Isaacs 2013). River discharge appears to be a major factor controlling formation and persistence of these blooms. The blooms in 2009-2012 all occurred when average river discharge for May-September was below 1,900 CFS. The cyanobacterial blooms were suppressed by elevated river flow in 2013-2014.

Phytoplankton blooms occasionally occur at the stream stations, with a few occurring at various months in 2014 (Table 2.15). These streams are generally shallow, so vertical mixing does not carry phytoplankton cells down below the critical depth where respiration exceeds photosynthesis. In areas where the forest canopy opens up large blooms can occur. When blooms occur in blackwater streams they can become sources of BOD upon death and decay, reducing further the low summer dissolved oxygen conditions common to these waters (Mallin et al. 2001a; 2002a; 2004; 2006b). Stations ANC, GS, PB and SR had minor algal blooms in 2014, although not exceeding the state standard of 40 µg/L (Table 2.15).

Biochemical Oxygen Demand

For the mainstem river, median annual five-day biochemical oxygen demand (BOD5) concentrations were approximately equivalent between NC11 and AC, suggesting that in 2014 (as was the case with 2007 through 2013) there was little discernable effect of BOD loading from the nearby pulp/paper mill inputs (Table 2.16). BOD5 values between 1.0 and 2.0 mg/L are typical for the rivers in the Cape Fear system (Mallin et al. 2006b) and in 2014 BOD5 values ranged from 0.7 – 3.0 mg/L. There were no major differences among sites for BOD5 or BOD20 in 2013. BOD20 values showed similar patterns to BOD5 in 2014.

Fecal Coliform Bacteria/ Enterococcus bacteria

Fecal coliform (FC) bacterial counts ranged from 5 to 60,000 CFU/100 mL and station annual geometric means ranged from 12 to 710 CFU/100 mL (Table 2.17). The state human contact standard (200 CFU/100 mL) was exceeded in the mainstem twice at several locations in 2014. During 2014 the stream stations showed very high fecal coliform pollution levels. Ham exceeded 200 CFU/100 mL 75% of the time sampled; BRN 67%, ANC, PB, LRC 50%, GS 42%, and SAR, NC403, ROC, LCO and SR 33% of the time sampled. Notably excessive counts occurred of 43,000 CFU/100 mL at SAR and 31,000 CFU/100 mL at ROC in December, 32,000 CFU/100 mL at HAM and 18,000 CFU/100 mL in October. NC403 and PB are located below point source discharges and the other sites are primarily influenced by non-point source pollution.

Enterococcus counts were initiated in the estuary in mid-2011, as this test is now the standard used by North Carolina regulators for swimming in salt waters. Sites covered by this test include BRR, M61, M54, M35, M23 and M18. The State has a single-sample level for Tier II swimming areas in which the enterococci level in a Tier II swimming area shall not exceed a single sample of 276 enterococci per 100 milliliter of water (15A NCAC 18A .3402); the LCFRP is using this standard for the Cape Fear estuary samples in our rating system. As such, in 2014 station BRR, M61, M54, M23 and M18 all exceeded the standard on two occasions, and M35 exceeded the standard on one occasion each. Overall, elevated fecal coliform and enterococcus counts are problematic in this system, with 78% of the stations rated as Fair or Poor in 2014, higher than the previous year 2013.

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Table 2.1 Water temperature (°C) at the Lower Cape Fear River Program stations during 2014.

	NAV	HB	BRR	M61	M54	M35	M23	M18
JAN	8.8	8.9	8.9	9.1	9.3	9.8	10.9	11.2
FEB	5.4	5.7	6.6	6.1	6.9	7.5	10.8	10.5
MAR	9.3	9.5	9.2	10.3	9.9	10.2	10.0	10.7
APR	12.7	13.2	13.3	13.4	13.8	14.0	13.2	12.8
MAY	22.1	23.6	23.1	22.8	22.2	22.4	22.2	22.5
JUN	25.1	25.2	26.7	25.7	25.3	25.5	24.6	24.4
JUL	29.0	29.5	30.2	29.3	29.4	28.9	28.4	28.1
AUG	26.5	26.0	27.4	26.6	27.3	28.0	28.2	28.4
SEP	27.3	27.0	27.2	27.5	27.4	27.8	27.2	27.5
OCT	22.2	22.8	23.1	23.2	23.2	23.3	23.3	23.5
NOV	16.2	16.6	16.3	16.7	16.6	16.6	16.7	17.1
DEC	10.6	11.7	11.4	12.2	12.4	13.1	13.6	14.0
mean	**17.9**	**18.3**	**18.6**	**18.6**	**18.6**	**18.9**	**19.1**	**19.2**
std dev	8.4	8.3	8.5	8.2	8.1	7.9	7.3	7.2
median	19.2	19.7	19.7	19.8	19.4	19.5	19.5	19.8
max	29.0	29.5	30.2	29.3	29.4	28.9	28.4	28.4
min	5.4	5.7	6.6	6.1	6.9	7.5	10.0	10.5

	NC11	AC	DP	BBT	IC	NCF6
JAN	6.7	6.8	6.9	7.3	7.0	8.1
FEB	5.4	5.6	5.9	7.4	6.5	6.7
MAR	9.9	10.0	9.9	10.3	10.3	11.2
APR	16.6	16.6	16.8	16.7	17.0	15.6
MAY	21.5	21.6	22.0	22.0	22.0	22.6
JUN	25.9	26.0	25.7	24.0	24.8	25.6
JUL	29.6	29.5	28.5	27.7	28.3	28.3
AUG	25.8	25.9	25.3	24.5	25.0	24.8
SEP	28.4	28.9	28.5	27.3	27.8	27.4
OCT	21.8	22.1	21.3	21.5	21.5	22.1
NOV	16.3	16.6	15.5	15.6	15.9	16.9
DEC	8.8	9.2	9.1	7.5	8.4	9.5
mean	**18.1**	**18.2**	**18.0**	**17.7**	**17.9**	**18.2**
std dev	8.7	8.7	8.4	7.9	8.2	7.9
median	19.1	19.1	19.1	19.1	19.3	19.5
max	29.6	29.5	28.5	27.7	28.3	28.3
min	5.4	5.6	5.9	7.3	6.5	6.7

	ANC	SAR	GS	NC403	PB	LRC	ROC
JAN	4.4	1.3	2.6	3.3	2.6	6.7	3.6
FEB	8.9	8.2	10.5	9.6	11.4	9.3	8.9
MAR	5.1	3.7	4.3	5.3	5.2	6.2	5.3
APR	12.2	13.4	14.6	14.2	15.2	15.9	14.5
MAY	19.4	21.4	23.7	23.9	27.3	25.2	22.1
JUN	21.3	23.0	23.5	24.9	27.5	26.6	22.5
JUL	26.1	26.0	26.8	27.5	29.7	28.3	25.6
AUG	23.0	24.1	24.7	24.9	26.6	26.4	24.5
SEP	26.2	27.9	27.9	28.2	28.5	30.1	26.3
OCT	15.5	15.5	16.2	17.0	17.6	17.8	15.7
NOV	11.8	11.9	12.4	12.5	12.1	14.9	12.6
DEC	9.7	9.6	9.7	9.9	9.8	10.7	9.1
mean	**15.3**	**15.5**	**16.4**	**16.8**	**17.8**	**18.2**	**15.9**
std dev	7.8	8.9	8.8	8.9	9.8	8.8	8.1
median	13.9	14.5	15.4	15.6	16.4	16.9	15.1
max	26.2	27.9	27.9	28.2	29.7	30.1	26.3
min	4.4	1.3	2.6	3.3	2.6	6.2	3.6

	6RC	LCO	GCO	SR	BRN	HAM
JAN	2.4	1.9	1.1	1.6	3.7	3.6
FEB	6.7	6.4	6.5	7.1	8.3	7.2
MAR	6.1	5.8	4.9	5.4	6.0	5.8
APR	16.6	16.2	16.4	16.8	17.2	16.8
MAY	18.6	17.7	18.8	21.3	20.2	18.6
JUN	23.5	23.8	25.0	23.8	24.0	22.9
JUL		24.3	24.2	24.1	23.4	23.3
AUG		22.7	23.1	24.6	23.5	22.8
SEP		19.7	18.7	18.2	18.1	18.0
OCT		15.2	15.9	15.7	15.0	14.9
NOV	7.2	6.5	6.4	6.8	5.2	5.8
DEC	8.4	8.3	7.7	7.5	8.9	9.2
mean	**11.2**	**14.0**	**14.1**	**14.4**	**14.5**	**14.1**
std dev	7.4	7.9	8.3	8.3	7.7	7.4
median	7.8	15.7	16.2	16.3	16.1	15.9
max	23.5	24.3	25.0	24.6	24.0	23.3
min	2.4	1.9	1.1	1.6	3.7	3.6

	NCF117	B210	COL	SR-WC	LVC2	SC-CH
JAN	7.4	6.5	5.3	6.0	6.2	8.2
FEB	7.3	8.0	8.3	7.3	8.1	7.1
MAR	12.0	11.7	11.5	12.0	12.2	10.5
APR	16.5	16.6	16.4	15.3	16.0	15.5
MAY	24.0	23.0	21.5	22.0	22.3	24.3
JUN	28.1	27.8	23.5	25.4	25.6	27.0
JUL	27.4	28.2	24.3	26.3	25.3	27.9
AUG	24.9	24.8	23.5	23.9	24.2	25.8
SEP	25.5	24.4	22.4	23.5	23.2	26.3
OCT	21.6	19.7	17.4	18.0	18.9	21.9
NOV	15.5	14.4	14.2	13.6	13.4	16.0
DEC	8.6	6.2	5.1	5.2	6.3	9.1
mean	**18.2**	**17.6**	**16.1**	**16.5**	**16.8**	**18.3**
std dev	8.0	8.2	7.2	7.8	7.5	8.1
median	19.1	18.2	16.9	16.7	17.5	19.0
max	28.1	28.2	24.3	26.3	25.6	27.9
min	7.3	6.2	5.1	5.2	6.2	7.1

Table 2.2 Salinity (psu) at the Lower Cape Fear River Program estuarine stations during 2014.

	NAV	HB	BRR	M61	M54	M35	M23	M18	NCF6	SC-CH
JAN	0.0	0.1	0.1	0.6	2.0	5.1	11.3	17.1	0.2	0.1
FEB	2.3	4.2	1.8	4.2	8.8	21.5	10.5	12.5	0.1	0.1
MAR	0.1	0.5	0.1	1.0	3.6	9.6	14.8	31.5	0.2	0.1
APR	0.1	0.1	0.1	0.3	1.7	7.8	20.8	31.2	0.0	0.1
MAY	0.1	0.1	0.1	2.0	3.1	5.5	11.2	13.5	0.1	0.2
JUN	0.1	0.3	3.3	7.4	9.3	13.3	23.4	26.0	1.7	9.2
JUL	7.0	8.8	9.6	13.6	17.1	24.3	31.0	34.1	0.1	4.3
AUG	0.1	0.1	0.1	0.5	2.3	12.0	23.6	29.8	0.1	0.1
SEP	3.4	3.5	7.0	9.5	12.4	23.7	26.5	32.4	0.1	3.1
OCT	0.1	0.1	0.9	5.4	7.4	12.0	22.9	24.8	3.2	6.0
NOV	4.3	5.9	9.0	14.1	17.0	22.3	28.8	31.7	8.0	9.8
DEC	0.3	3.5	2.6	7.5	8.7	15.5	23.9	30.4	0.1	1.9
mean	**1.5**	**2.3**	**2.9**	**5.5**	**7.8**	**14.4**	**20.7**	**26.3**	**1.2**	**2.9**
std dev	2.3	2.9	3.6	5.0	5.5	7.0	7.1	7.7	2.4	3.6
median	0.1	0.4	1.4	4.8	8.1	12.7	23.2	30.1	0.1	1.1
max	7.0	8.8	9.6	14.1	17.1	24.3	31.0	34.1	8.0	9.8
min	0.0	0.1	0.1	0.3	1.7	5.1	10.5	12.5	0.0	0.1

Table 2.3 Conductivity (mS/cm) at the Lower Cape Fear River Program stations during 2014.

	NAV	HB	BRR	M61	M54	M35	M23	M18
JAN	0.10	0.11	0.12	1.23	3.73	9.04	18.95	27.84
FEB	4.25	7.71	3.45	7.70	15.25	34.54	17.52	20.69
MAR	0.11	0.11	0.16	1.86	6.58	16.36	24.40	48.43
APR	0.12	0.14	0.16	0.63	3.21	13.51	33.24	47.85
MAY	0.10	0.12	0.22	3.83	5.66	9.84	18.86	22.28
JUN	0.18	0.52	6.13	12.77	15.91	22.23	37.04	40.69
JUL	12.27	15.19	16.48	22.66	27.97	38.37	47.70	51.92
AUG	0.16	0.14	0.22	1.04	4.35	20.30	37.78	46.12
SEP	5.88	6.28	12.24	16.20	20.74	37.49	41.40	49.73
OCT	0.15	0.23	1.67	9.68	12.83	20.14	36.29	38.91
NOV	7.66	11.18	15.52	23.28	27.41	35.35	44.49	48.45
DEC	0.53	6.41	4.75	12.94	14.88	25.43	37.65	46.77
mean	**2.63**	**4.01**	**5.09**	**9.48**	**13.21**	**23.55**	**32.94**	**40.81**
std dev	4.04	5.25	6.22	8.22	8.84	10.67	10.45	11.09
median	0.17	0.38	2.56	8.69	13.85	21.26	36.67	46.44
max	12.27	15.19	16.48	23.28	27.97	38.37	47.70	51.92
min	0.10	0.11	0.12	0.63	3.21	9.04	17.52	20.69

	NC11	AC	DP	BBT	IC	NCF6
JAN	0.10	0.11	0.11	0.09	0.10	0.18
FEB	0.11	0.12	0.14	0.10	0.13	0.16
MAR	0.12	0.14	0.13	0.12	0.13	0.37
APR	0.11	0.11	0.14	0.13	0.13	0.10
MAY	0.10	0.20	0.15	0.10	0.11	0.11
JUN	0.14	0.23	0.21	0.10	0.14	3.19
JUL	0.13	0.29	0.20	0.14	0.19	0.20
AUG	0.12	0.15	0.16	0.08	0.11	0.10
SEP	0.16	0.28	0.26	0.13	0.18	0.11
OCT	0.13	0.16	0.16	0.16	0.17	5.81
NOV	0.16	0.29	0.22	0.21	0.26	13.66
DEC	0.14	0.29	0.24	0.13	0.19	0.18
mean	**0.13**	**0.20**	**0.18**	**0.12**	**0.15**	**2.01**
std dev	0.02	0.07	0.05	0.04	0.05	4.07
median	0.12	0.18	0.16	0.12	0.14	0.18
max	0.16	0.29	0.26	0.21	0.26	13.66
min	0.10	0.11	0.11	0.08	0.10	0.10

	ANC	SAR	GS	NC403	PB	LRC	ROC
JAN	0.11	0.15	0.15	0.31	0.58	0.13	0.15
FEB	0.15	0.16	0.16	0.24	0.55	0.13	0.15
MAR	0.10	0.16	0.16	0.28	0.84	0.13	0.15
APR	0.09	0.13	0.13	0.23	0.75	0.11	0.11
MAY	0.10	0.17	0.16	0.45	2.25	0.12	0.13
JUN	0.10	0.20	0.19	1.16	4.79	0.24	0.19
JUL	0.16	0.17	0.16	0.53	2.43	0.15	0.14
AUG	0.09	0.12	0.13	0.31	1.87	0.10	0.10
SEP	0.13	0.19	0.18	0.45	3.66	0.18	0.17
OCT	0.13	0.17	0.16	0.31	1.04	0.16	0.17
NOV	0.14	0.21	0.19	0.68	1.59	0.21	0.40
DEC	0.13	0.19	0.18	0.27	0.57	0.16	0.17
mean	**0.12**	**0.17**	**0.16**	**0.44**	**1.74**	**0.15**	**0.17**
std dev	0.02	0.03	0.02	0.27	1.35	0.04	0.08
median	0.12	0.17	0.16	0.31	1.31	0.14	0.15
max	0.16	0.21	0.19	1.16	4.79	0.24	0.40
min	0.09	0.12	0.13	0.23	0.55	0.10	0.10

	6RC	LCO	GCO	SR	BRN	HAM
JAN	0.15	0.10	0.13	0.08	0.14	0.15
FEB	0.16	0.10	0.14	0.08	0.14	0.16
MAR	0.15	0.10	0.13	0.08	0.13	0.16
APR	0.14	0.10	0.14	0.08	0.12	0.15
MAY	0.12	0.07	0.09	0.06	0.09	0.13
JUN	0.15	0.10	0.21	0.08	0.12	0.19
JUL		0.09	0.12	0.10	0.13	0.20
AUG		0.10	0.15	0.19	0.12	0.12
SEP		0.08	0.12	0.08	0.13	0.18
OCT		0.09	0.15	0.08	0.14	0.19
NOV	0.16	0.12	0.24	0.10	0.15	0.23
DEC	0.16	0.11	0.17	0.09	0.15	0.19
mean	**0.15**	**0.10**	**0.15**	**0.09**	**0.13**	**0.17**
std dev	0.02	0.01	0.04	0.03	0.02	0.03
median	0.15	0.10	0.14	0.08	0.13	0.17
max	0.16	0.12	0.24	0.19	0.15	0.23
min	0.12	0.07	0.09	0.06	0.09	0.12

	NCF117	B210	COL	SRWC	LVC2	SC-CH
JAN	0.13	0.08	0.07	0.06	0.11	0.43
FEB	0.12	0.10	0.07	0.07	0.09	0.20
MAR	0.11	0.09	0.07	0.07	0.08	0.16
APR	0.10	0.09	0.06	0.07	0.07	0.17
MAY	0.13	0.07	0.07	0.06	0.11	0.46
JUN	0.18	0.09	0.07	0.08	0.13	15.71
JUL	0.14	0.10	0.07	0.09	0.09	7.88
AUG	0.09	0.07	0.07	0.07	0.06	0.22
SEP	0.11	0.09	0.07	0.10	0.09	5.72
OCT	0.13	0.09	0.07	0.07	0.11	10.65
NOV	0.21	0.12	0.06	0.09	0.15	16.67
DEC	0.16	0.11	0.07	0.08	0.14	3.59
mean	**0.13**	**0.09**	**0.07**	**0.08**	**0.10**	**5.15**
std dev	0.03	0.01	0.00	0.01	0.03	6.23
median	0.13	0.09	0.07	0.07	0.10	2.03
max	0.21	0.12	0.07	0.10	0.15	16.67
min	0.09	0.07	0.06	0.06	0.06	0.16

Table 2.4 pH at the Lower Cape Fear River Program stations during 2014.

	NAV	HB	BRR	M61	M54	M35	M23	M18
JAN	6.5	6.7	7.0	7.1	7.3	7.7	7.8	7.7
FEB	7.6	7.6	8.0	7.8	8.0	7.9	7.6	7.7
MAR	6.9	7.0	7.2	7.1	7.4	7.8	8.0	8.0
APR	6.8	6.9	7.0	7.2	7.3	7.8	8.1	8.1
MAY	6.5	6.5	6.6	6.7	6.8	7.1	7.5	7.7
JUN	6.7	6.8	7.0	7.0	7.2	7.7	8.0	8.0
JUL	7.0	7.1	7.2	7.4	7.9	8.0	8.0	8.0
AUG	6.4	6.4	6.5	6.5	6.7	7.3	7.9	8.0
SEP	6.8	6.9	6.9	7.0	7.2	7.7	7.8	7.9
OCT	6.5	6.8	6.7	6.7	7.0	7.2	7.7	7.8
NOV	7.1	7.1	7.2	7.3	7.5	7.8	7.9	8.0
DEC	6.9	7.1	7.2	7.4	7.4	7.8	8.0	8.1
mean	**6.8**	**6.9**	**7.0**	**7.1**	**7.3**	**7.7**	**7.9**	**7.9**
std dev	0.3	0.3	0.4	0.4	0.4	0.3	0.2	0.2
median	6.8	6.9	7.0	7.1	7.3	7.8	7.9	8.0
max	7.6	7.6	8.0	7.8	8.0	8.0	8.1	8.1
min	6.4	6.4	6.5	6.5	6.7	7.1	7.5	7.7

	NC11	AC	DP	BBT	IC	NCF6
JAN	6.2	6.6	6.6	6.4	6.7	6.8
FEB	6.3	6.6	6.8	6.4	6.7	6.8
MAR	6.9	7.0	7.0	6.9	6.9	6.8
APR	7.0	7.0	7.0	6.9	6.9	6.7
MAY	6.6	6.9	6.7	6.3	6.5	6.2
JUN	6.8	7.0	6.9	6.3	6.6	6.7
JUL	6.9	7.2	6.8	6.5	6.7	6.7
AUG	6.5	6.6	6.6	5.9	6.3	6.3
SEP	6.8	7.1	6.9	6.5	6.7	6.4
OCT	6.7	6.8	6.6	6.6	6.6	6.5
NOV	6.4	6.9	6.5	6.5	6.6	6.9
DEC	6.5	6.9	6.9.	6.4	6.7	6.6
mean	**6.6**	**6.9**	**6.8**	**6.5**	**6.7**	**6.6**
std dev	0.3	0.2	0.2	0.3	0.2	0.2
median	6.7	6.9	6.8	6.5	6.7	6.7
max	7.0	7.2	7.0	6.9	6.9	6.9
min	6.2	6.6	6.5	5.9	6.3	6.2

	ANC	SAR	GS	NC403	PB	LRC	ROC
JAN	5.0	5.9	6.1	6.3	6.3	6.6	6.2
FEB	5.4	6.0	6.1	6.0	6.4	6.7	6.5
MAR	5.5	6.9	7.0	6.8	6.9	7.4	7.1
APR	4.8	6.6	7.0	6.6	7.1	7.0	6.7
MAY	5.8	6.8	6.8	6.7	6.8	7.3	6.9
JUN	6.0	7.0	6.7	6.7	6.9	7.9	7.1
JUL	6.7	6.7	6.5	6.5	6.7	7.6	7.0
AUG	5.2	6.4	6.5	6.2	6.8	6.9	6.4
SEP	6.3	6.9	6.8	6.9	6.9	8.0	7.3
OCT	5.7	6.3	6.5	6.6	6.7	7.4	6.8
NOV	5.8	6.4	6.4	6.5	6.5	7.3	7.0
DEC	5.5	6.1	6.2	6.3	6.5	7.0	6.6
mean	**5.6**	**6.5**	**6.6**	**6.5**	**6.7**	**7.3**	**6.8**
std dev	0.5	0.4	0.3	0.3	0.2	0.4	0.3
median	5.6	6.5	6.5	6.6	6.8	7.3	6.9
max	6.7	7.0	7.0	6.9	7.1	8.0	7.3
min	4.8	5.9	6.1	6.0	6.3	6.6	6.2

	6RC	LCO	GCO	SR	BRN	HAM
JAN	6.0	6.1	6.2	6.3	6.4	6.5
FEB	6.0	6.2	6.3	6.8	6.5	6.7
MAR	7.0	6.6	6.6	6.5	6.9	7.0
APR	6.9	6.7	6.7	6.5	6.8	7.0
MAY	6.8	6.1	6.6	6.4	6.5	6.8
JUN	7.1	6.9	7.0	6.2	7.0	7.2
JUL		6.6	6.5	6.3	7.1	7.4
AUG		6.6	6.6	6.5	6.4	6.4
SEP		6.4	6.4	6.1	6.9	7.1
OCT		6.0	6.5	5.7	6.5	6.9
NOV	6.4	6.5	6.6	5.9	6.6	7.0
DEC	6.4	6.5	6.4	6.1	6.7	6.8
mean	**6.6**	**6.4**	**6.5**	**6.3**	**6.7**	**6.9**
std dev	0.4	0.3	0.2	0.3	0.2	0.3
median	6.6	6.5	6.6	6.3	6.7	7.0
max	7.1	6.9	7.0	6.8	7.1	7.4
min	6.0	6.0	6.2	5.7	6.4	6.4

	NCF117	B210	COL	SRWC	LVC2	SC-CH
JAN	6.2	5.8	3.9	5.3	6.6	6.4
FEB	6.5	6.0	3.9	5.4	6.6	6.7
MAR	6.5	6.2	4.0	5.8	6.5	6.7
APR	6.3	6.2	4.0	6.0	6.4	6.7
MAY	6.5	6.2	4.1	6.1	6.5	6.7
JUN	6.6	6.4	4.1	6.4	6.8	7.0
JUL	6.6	6.4	4.1	6.5	6.7	6.9
AUG	6.2	5.7	3.9	5.2	6.0	5.6
SEP	6.3	6.1	4.0	6.4	6.6	6.6
OCT	6.3	6.1	3.9	6.0	6.9	6.5
NOV	6.6	6.1	3.7	5.9	6.8	7.1
DEC	6.3	6.0	3.9	6.4	6.8	6.4
mean	**6.4**	**6.1**	**4.0**	**6.0**	**6.6**	**6.6**
std dev	0.2	0.2	0.1	0.5	0.2	0.4
median	6.4	6.1	4.0	6.0	6.6	6.7
max	6.6	6.4	4.1	6.5	6.9	7.1
min	6.2	5.7	3.7	5.2	6.0	5.6

Table 2.5 Dissolved Oxygen (mg/l) at the Lower Cape Fear River Program stations during 2014.

	NAV	HB	BRR	M61	M54	M35	M23	M18
JAN	10.1	10.2	10.2	10.3	10.6	10.6	10.1	9.7
FEB	12.9	12.4	12.7	12.5	12.2	11.3	9.7	9.7
MAR	9.7	9.6	9.7	9.6	10.0	9.9	9.9	8.8
APR	9.5	9.2	9.3	9.1	9.3	9.4	9.4	9.1
MAY	5.2	5.3	5.4	5.3	5.5	6.2	7.0	7.2
JUN	4.6	4.6	6.5	5.5	6.1	6.9	7.3	7.2
JUL	4.6	4.7	6.2	6.5	8.3	7.8	6.6	6.5
AUG	3.8	3.6	3.9	3.7	4.1	5.0	5.8	6.3
SEP	3.5	3.7	3.5	3.9	4.2	5.2	6.1	5.7
OCT	4.8	4.7	4.8	4.9	5.0	5.7	6.3	6.6
NOV	6.8	7.3	7.2	7.3	7.6	8.1	8.3	8.1
DEC	8.7	8.5	8.6	8.3	8.5	8.7	8.4	8.0
mean	**7.0**	**7.0**	**7.3**	**7.2**	**7.6**	**7.9**	**7.9**	**7.7**
std dev	3.1	2.9	2.8	2.8	2.7	2.1	1.6	1.4
median	6.0	6.3	6.9	6.9	8.0	8.0	7.8	7.6
max	12.9	12.4	12.7	12.5	12.2	11.3	10.1	9.7
min	3.5	3.6	3.5	3.7	4.1	5.0	5.8	5.7

	NC11	AC	DP	BBT	IC	NCF6
JAN	11.5	11.1	11.0	10.4	10.6	10.5
FEB	13.7	13.3	13.2	11.6	12.7	12.0
MAR	11.2	11.0	11.0	10.7	10.7	9.7
APR	9.1	8.8	8.7	8.5	8.1	7.2
MAY	7.4	7.0	6.6	4.7	5.7	4.2
JUN	6.1	6.0	5.2	4.6	4.6	5.1
JUL	6.6	6.1	4.4	4.1	4.2	4.8
AUG	5.2	5.3	5.0	4.0	4.5	4.1
SEP	5.4	5.2	3.6	3.3	3.3	3.4
OCT	6.6	6.3	4.8	4.9	4.6	4.9
NOV	8.3	7.9	6.9	7.2	6.8	7.5
DEC	10.5	9.9	9.5	9.6	9.3	8.8
mean	**8.5**	**8.2**	**7.5**	**7.0**	**7.1**	**6.9**
std dev	2.7	2.7	3.1	3.0	3.1	2.9
median	7.9	7.5	6.8	6.1	6.3	6.2
max	13.7	13.3	13.2	11.6	12.7	12.0
min	5.2	5.2	3.6	3.3	3.3	3.4

	ANC	SAR	GS	NC403	PB	LRC	ROC
JAN	10.2	13.1	13.3	11.3	11.6	12.6	12.5
FEB	11.4	10.7	11.2	10.3	10.7	12.8	11.6
MAR	11.7	12.0	13.0	12.1	12.8	12.8	11.8
APR	7.0	7.6	9.9	8.8	11.8	10.2	8.3
MAY	6.1	5.7	5.5	5.0	4.8	7.9	6.7
JUN	4.7	6.2	1.4	3.7	9.3	8.6	6.6
JUL	2.3	5.4	2.3	2.7	6.0	8.9	6.4
AUG	4.4	5.1	4.1	3.3	5.8	7.1	4.8
SEP	4.3	5.2	1.9	3.3	4.7	9.1	5.5
OCT	7.1	8.2	6.6	7.6	8.2	10.8	9.3
NOV	3.8	8.8	3.8	7.6	6.6	9.0	8.7
DEC	7.6	8.7	8.2	7.7	7.9	11.1	10.1
mean	**6.7**	**8.1**	**6.8**	**6.9**	**8.4**	**10.1**	**8.5**
std dev	3.1	2.7	4.3	3.3	2.9	2.0	2.6
median	6.6	7.9	6.1	7.6	8.1	9.7	8.5
max	11.7	13.1	13.3	12.1	12.8	12.8	12.5
min	2.3	5.1	1.4	2.7	4.7	7.1	4.8

	6RC	LCO	GCO	SR	BRN	HAM
JAN	12.8	12.8	13.0	13.3	13.6	12.7
FEB	12.2	12.3	11.2	12.0	11.7	12.8
MAR	11.5	11.7	11.1	12.1	12.2	12.3
APR	8.2	8.4	6.3	7.0	8.8	8.7
MAY	7.3	6.7	6.8	6.1	8.1	7.6
JUN	6.5	6.8	6.1	1.5	7.4	6.3
JUL		6.8	5.3	0.7	8.1	7.0
AUG		7.1	5.7	1.3	7.0	7.0
SEP		7.4	6.1	7.1	8.4	7.3
OCT		9.0	7.3	5.6	9.5	8.0
NOV	10.4	11.4	10.1	4.1	11.2	9.3
DEC	10.8	10.8	9.9	8.2	10.9	10.0
mean	**10.0**	**9.3**	**8.2**	**6.6**	**9.7**	**9.1**
std dev	2.3	2.4	2.6	4.3	2.1	2.4
median	10.6	8.7	7.1	6.6	9.2	8.4
max	12.8	12.8	13.0	13.3	13.6	12.8
min	6.5	6.7	5.3	0.7	7.0	6.3

	NCF117	B210	COL	SRWC	LVC2	SC-CH
JAN	11.0	11.1	9.9	11.1	9.4	10.7
FEB	10.2	10.9	8.7	10.6	10.6	11.7
MAR	9.2	8.9	6.7	8.9	7.9	9.7
APR	7.1	7.9	6.2	8.9	7.6	7.8
MAY	4.5	5.0	5.2	6.3	2.3	5.3
JUN	4.6	4.3	4.8	5.6	2.1	4.7
JUL	4.1	4.9	5.1	5.7	4.3	4.4
AUG	4.1	5.1	4.6	6.4	5.6	4.5
SEP	3.0	3.8	4.7	6.3	4.9	3.8
OCT	3.9	5.8	6.5	7.8	5.1	4.8
NOV	5.9	7.0	6.5	8.5	5.6	7.1
DEC	7.8	10.3	9.8	11.4	9.2	9.0
mean	**6.3**	**7.1**	**6.6**	**8.1**	**6.2**	**7.0**
std dev	2.7	2.7	1.9	2.1	2.7	2.8
median	5.3	6.4	6.4	8.2	5.6	6.2
max	11.0	11.1	9.9	11.4	10.6	11.7
min	3.0	3.8	4.6	5.6	2.1	3.8

Table 2.6 Field Turbidity (NTU) at the Lower Cape Fear River Program stations during 2014.

	NAV	HB	BRR	M61	M54	M35	M23	M18
JAN	58	47	46	27	17	5	1	4
FEB	15	15	10	7	6	14	8	8
MAR	14	13	16	12	14	8	5	11
APR	6	6	13	23	18	6	6	4
MAY	6	7	7	5	7	5	1	1
JUN	6	5	4	3	3	2	2	2
JUL	9	4	7	3	5	2	0	0
AUG	6	10	10	9	6	2	2	4
SEP	11	13	8	3	7	3	2	4
OCT	7	0	0	0	0	0	0	0
NOV	5	3	3	2	2	0	0	1
DEC	9	5	6	4	2	1	1	5
mean	**13**	**11**	**11**	**8**	**7**	**4**	**2**	**4**
std dev	15	12	12	9	6	4	3	3
median	8	7	8	5	6	3	2	4
max	58	47	46	27	18	14	8	11
min	5	0	0	0	0	0	0	0

	NC11	AC	DP	BBT	IC	NCF6
JAN	32	35	35	8	21	8
FEB	7	9	9	1	5	3
MAR	12	12	10	7	6	8
APR	17	17	10	9	6	4
MAY	12	12	16	7	12	2
JUN	10	13	13	7	7	5
JUL	3	5	7	4	7	14
AUG	16	8	11	4	8	3
SEP	5	6	11	5	7	2
OCT	7	4	1	1	4	0
NOV	5	6	4	2	6	3
DEC	16	12	16	3	8	4
mean	**12**	**12**	**12**	**5**	**8**	**5**
std dev	8	8	8	3	5	4
median	11	11	11	5	7	4
max	32	35	35	9	21	14
min	3	4	1	1	4	0

	ANC	SAR	GS	NC403	PB	LRC	ROC
JAN	2	1	0	0	0	0	0
FEB	2	0	0	0	3	0	2
MAR	6	0	0	0	3	1	1
APR	5	0	0	0	0	4	3
MAY	12	5	0	2	8	1	4
JUN	9	2	0	1	6	20	2
JUL	2	2	0	0	3	0	1
AUG	2	0	0	0	2	3	3
SEP	7	4	4	1	14	2	5
OCT	0	0	0	0	0	0	0
NOV	4	1	0	0	7	2	0
DEC	2	0	0	0	1	1	1
mean	**4**	**1**	**0**	**0**	**4**	**3**	**2**
std dev	4	2	1	1	4	6	2
median	3	1	0	0	3	1	2
max	12	5	4	2	14	20	5
min	0	0	0	0	0	0	0

	6RC	LCO	GCO	SR	BRN	HAM
JAN	1	0	0	0	2	5
FEB	2	2	0	0	2	2
MAR	1	0	0	0	4	1
APR	4	0	0	0	2	0
MAY	3	0	0	0	6	3
JUN	1	0	0	0	1	2
JUL		10	2	10	1	5
AUG		9	4	81	10	10
SEP		2	2	2	11	3
OCT		1	0	1	1	1
NOV	0	0	0	0	0	0
DEC	0	0	0	0	0	1
mean	**2**	**2**	**1**	**8**	**3**	**3**
std dev	1	4	1	23	4	3
median	1	0	0	0	2	2
max	4	10	4	81	11	10
min	0	0	0	0	0	0

	NCF117	B210	COL	SRWC	LVC2	SC-CH
JAN	2	2	0	2	0	14
FEB	2	0	0	0.0	1	5
MAR	4	0	0	0	3	5
APR	2	0	0	0	1	8
MAY	3	4	2	2	6	13
JUN	0	1	0	0	4	4
JUL	1	0	0	0	3	10
AUG	2	0	0	0	0	7
SEP	0	1	0	1	4	14
OCT	0	0	0	0	1	4
NOV	1	1	0	0	4	7
DEC	1	0	0	0	2	1
mean	**2**	**1**	**0**	**0**	**2**	**8**
std dev	1	1	1	1	2	4
median	2	0	0	0	3	7
max	4	4	2	2	6	14
min	0	0	0	0	0	1

Table 2.7 Total Suspended Solids (mg/L) at the Lower Cape Fear River Program stations during 2014.

	NAV	HB	BRR	M61	M54	M35	M23	M18
JAN	54.3	45.3	30.0	22.7	17.2	17.0	9.1	15.5
FEB	17.3	19.4	11.4	9.9	14.0	34.3	11.9	12.1
MAR	9.9	6.9	9.4	9.3	14.6	11.8	13.7	20.7
APR	7.1	8.6	12.2	30.0	24.0	13.8	24.0	23.6
MAY	6.5	7.8	8.8	8.1	9.2	9.7	8.8	8.9
JUN	5.5	3.8	9.0	8.4	9.3	10.1	11.5	17.8
JUL	12.3	13.6	15.8	13.2	18.0	16.2	16.6	1.3
AUG	7.9	13.8	13.4	19.3	11.2	10.2	10.9	20.2
SEP	17.7	24.4	17.4	10.0	20.4	16.4	15.9	18.1
OCT	5.4	4.1	3.9	5.3	6.5	6.4	11.4	12.7
NOV	12.6	10.1	13.1	15.1	9.9	12.6	14.4	12.4
DEC	14.3	5.6	11.5	9.6	7.6	7.2	7.0	16.3
mean	**14.2**	**13.6**	**13.0**	**13.4**	**13.5**	**13.8**	**12.9**	**15.0**
std dev	13.3	11.8	6.4	7.2	5.5	7.3	4.5	6.0
median	11.1	9.4	11.9	10.0	12.6	12.2	11.7	15.9
max	54.3	45.3	30.0	30.0	24.0	34.3	24.0	23.6
min	5.4	3.8	3.9	5.3	6.5	6.4	7.0	1.3

	NC11	AC	DP	IC	NCF6
JAN	23.8	25.6	25.8	13.2	9.4
FEB	5.7	8.0	10.0	4.9	7.0
MAR	15.6	14.8	12.0	7.3	12.2
APR	19.9	23.3	14.2	8.0	6.4
MAY	15.6	14.7	16.9	13.0	8.6
JUN	9.0	13.4	19.7	8.6	9.9
JUL	5.9	7.3	12.4	16.2	26.9
AUG	12.4	8.0	13.2	9.4	5.2
SEP	5.0	6.7	10.9	14.1	3.9
OCT	5.8	3.8	3.6	4.7	4.6
NOV	4.9	5.9	4.8	9.8	9.0
DEC	1.4	12.6	15.9	9.6	4.3
mean	**10.4**	**12.0**	**13.3**	**9.9**	**7.9**
std dev	7.0	6.9	6.1	3.6	3.0
median	7.5	10.3	12.8	9.5	7.0
max	23.8	25.6	25.8	16.2	12.2
min	1.4	3.8	3.6	4.7	4.3

	ANC	SAR	GS	NC403	PB	LRC	ROC
JAN		1.4		1.4	1.6	1.5	3.1
FEB		1.4		1.4	3.7	3.3	6.8
MAR		1.5		1.4	4.0	1.4	3.1
APR		3.6		3.0	5.3	5.4	8.1
MAY		7.5		4.2	7.8	1.5	7.1
JUN		3.9		4.3	11.2	7.2	3.6
JUL		9.1		4.6	12.0	1.4	4.5
AUG		2.9		2.9	3.9	8.1	6.3
SEP		5.6		3.3	8.0	1.5	1.4
OCT		1.4		1.4	3.1	1.5	1.4
NOV		1.5		1.4	20.0	1.5	1.4
DEC		1.3		1.3	6.6	1.3	4.6
mean		**3.4**		**2.6**	**7.3**	**3.0**	**4.3**
std dev		2.7		1.3	5.1	2.5	2.4
median		2.2		2.2	6.0	1.5	4.1
max		9.1		4.6	20.0	8.1	8.1
min		1.3		1.3	1.6	1.3	1.4

	6RC	LCO	GCO	SR	BRN	HAM
JAN			1.4			
FEB			1.8			
MAR			1.4			
APR			4.3			
MAY			1.4			
JUN			1.4			
JUL			7.0			
AUG			10.2			
SEP			4.8			
OCT			3.2			
NOV			1.4			
DEC			1.4			
mean			**3.3**			
std dev			2.8			
median			1.6			
max			10.2			
min			1.4			

	NCF117	B210	COL	SR-WC	LVC2	SC-CH
JAN	3.9	1.4			1.4	19.5
FEB	3.5	1.4			1.4	8.9
MAR	4.0	1.4			3.2	9.2
APR	1.4	14.7			5.7	11.8
MAY	2.8	3.8			4.6	16.3
JUN	1.4	1.4			3.5	12.2
JUL	4.0	1.3			4.2	20.3
AUG	3.9	3.4			6.6	13.8
SEP	4.0	1.4			5.1	23.7
OCT	1.4	1.4			4.4	11.2
NOV	3.0	1.4			1.4	15.2
DEC	1.4	1.4			1.4	3.8
mean	**2.9**	**2.9**			**3.6**	**13.8**
std dev	1.2	3.8			1.8	5.6
median	3.3	1.4			3.9	13.0
max	4.0	14.7			6.6	23.7
min	1.4	1.3			1.4	3.8

Table 2.8 Light Attenuation (k) at the Lower Cape Fear River Program stations during 2014.

	NAV	HB	BRR	M61	M54	M35	M23	M18
JAN	5.55	6.24	5.68	4.10	3.77	2.74	2.04	2.51
FEB							2.16	2.08
MAR	3.22	2.82	3.21	3.38	3.01	2.12	2.26	1.76
APR			3.90		3.79	2.64	1.77	1.29
MAY	4.46	5.13	5.13	4.29	4.08	3.51	2.43	2.20
JUN	3.39	3.30	3.89	2.92	3.12	1.95	1.37	1.36
JUL	2.58	2.97	2.17	2.00	2.07	1.30	0.08	0.67
AUG	4.20	5.60	6.37	4.48	4.31	2.64	1.67	1.58
SEP	5.64	4.94	4.45	4.33	4.25	2.27	2.17	1.86
OCT	3.59	3.51	3.45	3.28	3.34	2.45	1.76	1.58
NOV	3.24	3.15	2.84	3.05	2.45	2.15	1.38	1.50
DEC	3.51	3.69	3.72	3.03	3.00	2.28	1.55	1.80
mean	**3.94**	**4.14**	**4.07**	**3.49**	**3.38**	**2.37**	**1.72**	**1.68**
std dev	1.02	1.23	1.25	0.80	0.73	0.55	0.62	0.48
max	5.64	6.24	6.37	4.48	4.31	3.51	2.43	2.51
min	2.58	2.82	2.17	2.00	2.07	1.30	0.08	0.67

	NC11	AC	DP	BBT	IC	NCF6
JAN	3.87	4.15	4.03	2.92	3.46	3.65
FEB	2.02	2.28	2.18	2.11	2.05	2.84
MAR	2.89	2.49	2.46	1.94	1.25	2.36
APR	2.57	2.61	2.24	2.28	2.43	3.30
MAY	4.30	4.60	4.48	5.69	4.33	5.48
JUN	2.96	3.55	3.80	4.89		4.52
JUL	2.00	2.39	3.17	3.17	3.71	5.55
AUG	3.10	2.65	3.27	4.40	3.97	3.59
SEP	2.07	2.37	3.41	4.47	3.86	6.42
OCT	2.48	2.56	3.40	3.29	3.26	3.32
NOV	2.11	2.51	3.06	2.90	3.16	3.44
DEC						
mean	**2.76**	**2.92**	**3.23**	**3.46**	**3.15**	**4.04**
std dev	0.77	0.80	0.73	1.23	0.96	1.28
max	4.30	4.60	4.48	5.69	4.33	6.42
min	2.00	2.28	2.18	1.94	1.25	2.36

Table 2.9 Total Nitrogen (μg/l) at the Lower Cape Fear River Program stations during 2014.

	NAV	HB	BRR	M61	M54	M35	M23	M18
JAN	1,690	1,470	1,360	1,040	1,730	1,740	2,210	1,360
FEB	1,090	910	1,000	830	770	430	650	790
MAR	970	940	980	1,120	810	820	630	290
APR	890	860	810	790	880	600	350	50
MAY	1,110	1,120	1,190	870	950	950	280	840
JUN	1,440	1,100	1,050	1,310	1,020	560	50	300
JUL	1,000	880	780	800	490	400	400	100
AUG	1,360	1,230	1,250	1,330	1,180	670	640	430
SEP	920	770	730	620	510	280	50	200
OCT	520	500	600	500	500	300	50	50
NOV	1,300	1,050	1,040	1,020	630	520	160	300
DEC	1,090	1,040	1,000	1,040	1,060	830	260	380
mean	**1,115**	**989**	**983**	**939**	**878**	**675**	**478**	**424**
std dev	303	243	223	253	354	397	591	389
median	1,090	990	1,000	945	845	580	315	300
max	1,690	1,470	1,360	1,330	1,730	1,740	2,210	1,360
min	520	500	600	500	490	280	50	50

	NC11	AC	DP	IC	NCF6
JAN	1,430	920	1,540	1,360	1,560
FEB	1,370	1,390	1,530	1,310	330
MAR	490	510	510	410	400
APR	1,360	1,170	1,190	1,310	900
MAY	1,040	1,140	1,130	990	980
JUN	1,400	1,400	1,300	1,170	1,110
JUL	1,480	1,740	1,600	1,450	1,160
AUG	1,350	1,330	1,300	1,270	1,080
SEP	1,310	1,380	1,570	1,200	810
OCT	1,260	1,150	750	660	610
NOV	2,220	2,020	1,320	1,340	860
DEC	2,020	1,920	1,760	1,250	890
mean	**1,394**	**1,339**	**1,292**	**1,143**	**891**
std dev	432	420	363	311	338
median	1,365	1,355	1,310	1,260	895
max	2,220	2,020	1,760	1,450	1,560
min	490	510	510	410	330

	ANC	SAR	GS	NC403	PB	LRC	ROC
JAN	3,530	1,910	1,170	3,890	4,940	4,670	3,600
FEB	2,100	2,180	1,250	3,180	2,450	1,300	1,870
MAR	1,350	1,760	1,180	3,730	2,540	910	1,920
APR	2,420	1,440	920	3,010	1,850	2,590	1,630
MAY	1,550	1,080	940	1,820	1,130	980	2,280
JUN	1,620	1,370	1,030	1,260	1,340	550	4,810
JUL	1,400	1,050	1,020	1,220	750	120	2,550
AUG	2,000	1,020	650	1,660	880	980	1,320
SEP	1,380	1,070	800	1,050	2,000	990	2,670
OCT	980	270	50	860	530	140	3,650
NOV	1,040	980	600	1,920	2,220	540	9,400
DEC	2,580	820	2,800	3,640	4,830	780	1,750
mean	**1,829**	**1,246**	**1,034**	**2,270**	**2,122**	**1,213**	**3,121**
std dev	738	521	646	1,140	1,453	1,262	2,223
median	1,585	1,075	980	1,870	1,925	945	2,415
max	3,530	2,180	2,800	3,890	4,940	4,670	9,400
min	980	270	50	860	530	120	1,320

	6RC	LCO	GCO	SR	BRN	HAM
JAN	1,900	1,720	1,590	720	1,950	2,420
FEB	2,710	2,210	1,800	540	1,480	1,120
MAR	2,500	1,970	1,570	660	1,370	1,140
APR	2,630	1,860	1,470	1,180	1,500	1,560
MAY	1,280	900	1,000	900	1,390	1,160
JUN	1,420	1,040	1,320	660	930	2,820
JUL		1,220	990	1,120	1,090	560
AUG		1,310	930	2,010	940	1,190
SEP		850	730	1,050	790	560
OCT		310	350	240	330	240
NOV	1,520	390	1,150	370	610	50
DEC	1,770	860	850	540	1,180	780
mean	**1,966**	**1,220**	**1,146**	**833**	**1,130**	**1,133**
std dev	572	613	418	472	443	822
median	1,835	1,130	1,075	690	1,135	1,130
max	2,710	2,210	1,800	2,010	1,950	2,820
min	1,280	310	350	240	330	50

	NCF117	B210	COL	SR-WC	LVC2	SC-CH
JAN	2,530	2,160	2,500	1,760	1,560	1,510
FEB	1,690	1,330	620	640	550	1,240
MAR	1,490	1,160	600	650	400	980
APR	1,550	1,320	1,000	810	290	1,050
MAY	1,470	1,100	1,430	950	170	1,010
JUN	1,290	1,290	1,400	600	740	780
JUL	1,240	1,240	1,330	1,160	1,200	1,160
AUG	1,310	1,090	1,130	900	740	770
SEP	560	590	930	960	540	740
OCT	300	500	700	670	240	1,350
NOV	840	880	820	760	750	670
DEC	1,920	770	900	650	560	2,110
mean	**1,349**	**1,119**	**1,113**	**876**	**645**	**1,114**
std dev	596	432	523	326	402	407
median	1,390	1,130	965	785	555	1,030
max	2,530	2,160	2,500	1,760	1,560	2,110
min	300	500	600	600	170	670

Table 2.10 Nitrate/Nitrite (μg/l) at the Lower Cape Fear River Program stations during 2014.

	NAV	HB	BRR	M61	M54	M35	M23	M18
JAN	590	570	560	240	630	540	410	260
FEB	690	610	700	530	470	230	350	490
MAR	570	540	580	620	510	420	330	90
APR	490	460	410	390	380	300	150	20
MAY	410	420	390	370	350	350	280	240
JUN	540	400	350	310	320	160	30	10
JUL	400	380	380	300	90	10	10	10
AUG	460	330	350	330	380	270	140	30
SEP	320	270	230	220	210	80	50	10
OCT	20	10	10	10	10	10	70	30
NOV	600	450	440	320	330	220	60	10
DEC	590	540	600	540	560	430	260	80
mean	**473**	**415**	**417**	**348**	**353**	**252**	**178**	**107**
std dev	177	162	184	163	183	168	141	150
median	515	435	400	325	365	250	145	30
max	690	610	700	620	630	540	410	490
min	20	10	10	10	10	10	10	10

	NC11	AC	DP	IC	NCF6
JAN	330	320	640	560	260
FEB	1,070	990	1,130	1,010	30
MAR	490	510	510	410	400
APR	660	470	490	410	10
MAY	440	440	430	290	180
JUN	800	700	600	470	510
JUL	880	840	700	550	260
AUG	550	530	400	370	180
SEP	710	680	770	500	110
OCT	1,160	750	350	260	110
NOV	1,420	1,320	720	640	260
DEC	1,320	1,020	960	550	190
mean	**819**	**714**	**642**	**502**	**208**
std dev	356	289	233	196	144
median	755	690	620	485	185
max	1,420	1,320	1,130	1,010	510
min	330	320	350	260	10

	ANC	SAR	GS	NC403	PB	LRC	ROC
JAN	1,030	1,210	770	3,390	4,440	1,270	1,600
FEB	1,400	1,780	1,050	2,880	1,950	1,000	1,370
MAR	450	1,160	580	3,130	1,940	610	1,520
APR	920	840	320	2,510	1,250	1,090	930
MAY	150	280	40	820	130	180	1,380
JUN	220	470	30	460	40	50	3,410
JUL	100	250	20	320	50	120	1,450
AUG	200	220	50	860	180	180	420
SEP	80	270	10	450	100	190	1,770
OCT	180	70	10	760	330	140	2,950
NOV	40	480	10	1,620	1,620	40	8,300
DEC	680	120	10	2,840	3,830	180	1,050
mean	**454**	**596**	**242**	**1,670**	**1,322**	**421**	**2,179**
std dev	449	536	362	1,191	1,518	449	2,095
median	210	375	35	1,240	790	180	1,485
max	1,400	1,780	1,050	3,390	4,440	1,270	8,300
min	40	70	10	320	40	40	420

	6RC	LCO	GCO	SR	BRN	HAM
JAN	1,400	1,220	1,090	120	1,250	1,320
FEB	1,910	1,710	1,400	240	1,080	820
MAR	1,700	1,470	1,170	160	870	740
APR	1,230	660	370	80	500	460
MAY	580	300	200	100	390	460
JUN	920	440	720	60	430	120
JUL		220	90	20	790	160
AUG		310	30	110	140	290
SEP		150	130	50	290	160
OCT		110	150	40	230	40
NOV	1,220	190	850	70	610	10
DEC	1,070	360	250	40	580	180
mean	**1,254**	**595**	**538**	**91**	**597**	**397**
std dev	423	555	484	62	342	391
median	1,225	335	310	75	540	235
max	1,910	1,710	1,400	240	1,250	1,320
min	580	110	30	20	140	10

	NCF117	B210	COL	SR-WC	LVC2	SC-CH
JAN	730	560	10	260	160	410
FEB	1,190	1,030	20	340	250	640
MAR	890	760	10	250	200	380
APR	550	420	10	110	90	250
MAY	470	200	30	150	170	410
JUN	390	490	10	10	340	380
JUL	340	240	30	460	100	260
AUG	410	390	30	300	140	170
SEP	60	90	30	560	40	140
OCT	10	10	10	70	40	50
NOV	140	280	20	260	250	270
DEC	320	270	10	150	160	210
mean	**458**	**395**	**18**	**243**	**162**	**298**
std dev	344	287	9	160	89	157
median	400	335	15	255	160	265
max	1,190	1,030	30	560	340	640
min	10	10	10	10	40	50

Table 2.11 Ammonia (μg/l) at the Lower Cape Fear River Program stations during 2014.

	NAV	HB	BRR	M61	M54	M35	M23	M18
JAN	30	30	40	40	130	40	40	10
FEB	120	120	100	180	140	60	60	70
MAR	40	30	30	50	90	20	10	10
APR	30	30	20	50	80	50	10	10
MAY	130	140	160	190	150	170	80	50
JUN	70	70	20	40	40	10	10	10
JUL	100	110	40	30	10	10	10	10
AUG	80	60	60	70	100	30	10	10
SEP	40	60	210	330	40	30	30	120
OCT	40	40	40	40	130	50	40	20
NOV	60	80	70	70	70	40	10	10
DEC	50	50	40	70	80	50	20	10
mean	**66**	**68**	**69**	**97**	**88**	**47**	**28**	**28**
std dev	35	37	59	91	44	42	23	35
median	55	60	40	60	85	40	15	10
max	130	140	210	330	150	170	80	120
min	30	30	20	30	10	10	10	10

	NC11	AC	DP	IC	NCF6
JAN	80	90	80	50	40
FEB	50	50	50	50	30
MAR	20	30	30	20	40
APR	50	70	70	70	60
MAY	110	280	160	120	60
JUN	90	220	210	160	60
JUL	30	160	110	120	20
AUG	260	120	140	90	40
SEP	20	20	110	70	10
OCT	40	80	70	40	20
NOV	30	110	70	50	40
DEC	60	150	130	80	30
mean	**70**	**115**	**103**	**77**	**38**
std dev	66	77	51	40	17
median	50	100	95	70	40
max	260	280	210	160	60
min	20	20	30	20	10

	ANC	SAR	GS	NC403	PB	LRC	ROC
JAN	130	10	10	60	210	30	50
FEB	180	10	10	10	30	10	70
MAR	90	20	10	20	40	30	30
APR	170	30	20	130	40	100	90
MAY	90	10	10	80	460	50	20
JUN	200	30	90	110	50	60	30
JUL	180	60	70	130	50	40	50
AUG	120	60	70	90	160	180	180
SEP	50	60	110	80	70	40	60
OCT	110	50	30	70	120	50	60
NOV	90	20	10	70	10	10	10
DEC	10	10	10	130	50	10	10
mean	**118**	**31**	**38**	**82**	**108**	**51**	**55**
std dev	57	21	37	40	126	48	46
median	115	25	15	80	50	40	50
max	200	60	110	130	460	180	180
min	10	10	10	10	10	10	10

	6RC	LCO	GCO	SR	BRN	HAM
JAN	70	10	10	10	90	20
FEB	420	10	10	10	20	10
MAR	90	20	10	10	90	30
APR	100	30	80	10	50	110
MAY	40	20	20	10	40	30
JUN	40	50	60	60	40	70
JUL		40	50	160	30	50
AUG		70	390	1,000	130	150
SEP		20	20	30	40	40
OCT		20	30	10	20	20
NOV	10	10	10	10	10	10
DEC	10	10	10	10	10	10
mean	**98**	**26**	**58**	**111**	**48**	**46**
std dev	135	19	107	283	37	44
median	55	20	20	10	40	30
max	420	70	390	1,000	130	150
min	10	10	10	10	10	10

	NCF117	B210	COL	SR-WC	LVC2	SC-CH
JAN	10	10	10	20	60	50
FEB	10	10	10	10	10	10
MAR	100	10	10	10	40	30
APR	50	10	10	10	10	40
MAY	40	20	60	20	20	60
JUN	40	100	390	90	140	170
JUL	60	50	90	40	90	80
AUG	80	40	60	60	50	90
SEP	30	20	70	10	10	10
OCT	60	40	70	50	130	80
NOV	40	10	10	10	290	90
DEC	40	10	20	10	140	60
mean	**47**	**28**	**68**	**28**	**83**	**64**
std dev	26	27	106	26	83	44
median	40	15	40	15	55	60
max	100	100	390	90	290	170
min	10	10	10	10	10	10

Table 2.12 Total Kjeldahl Nitrogen (µg/l) at the Lower Cape Fear River Program stations during 2014.

	NAV	HB	BRR	M61	M54	M35	M23	M18
JAN	1100	900	800	800	1100	1200	1800	1100
FEB	400	300	300	300	300	200	300	300
MAR	400	400	400	500	300	400	300	200
APR	400	400	400	400	500	300	200	50
MAY	700	700	800	500	600	600	50	600
JUN	900	700	700	1000	700	400	50	300
JUL	600	500	400	500	400	400	400	100
AUG	900	900	900	1000	800	400	500	400
SEP	600	500	500	400	300	200	50	200
OCT	500	500	600	500	500	300	50	50
NOV	700	600	600	700	300	300	100	300
DEC	500	500	400	500	500	400	50	300
mean	**642**	**575**	**567**	**592**	**525**	**425**	**321**	**325**
std dev	227	191	197	231	245	267	491	289
median	600	500	550	500	500	400	150	300
max	1,100	900	900	1,000	1,100	1,200	1,800	1,100
min	400	300	300	300	300	200	50	50

	NC11	AC	DP	IC	NCF6
JAN	1100	600	900	800	1,300
FEB	300	400	400	300	300
MAR	50	50	50	50	50
APR	700	700	700	900	900
MAY	600	700	700	700	800
JUN	600	700	700	700	600
JUL	600	900	900	900	900
AUG	800	800	900	900	900
SEP	600	700	800	700	700
OCT	100	400	400	400	500
NOV	800	700	600	700	600
DEC	700	900	800	700	700
mean	**579**	**629**	**654**	**646**	**688**
std dev	300	242	257	264	321
median	600	700	700	700	700
max	1,100	900	900	900	1,300
min	50	50	50	50	50

	ANC	SAR	GS	NC403	PB	LRC	ROC
JAN	2500	700	400	500	500	3400	2000
FEB	700	400	200	300	500	300	500
MAR	900	600	600	600	600	300	400
APR	1,500	600	600	500	600	1,500	700
MAY	1400	800	900	1000	1000	800	900
JUN	1400	900	1000	800	1300	500	1400
JUL	1300	800	1000	900	700	50	1100
AUG	1800	800	600	800	700	800	900
SEP	1300	800	800	600	1900	800	900
OCT	800	200	50	100	200	50	700
NOV	1000	500	600	300	600	500	1100
DEC	1900	700	2800	800	1000	600	700
mean	**1,375**	**650**	**796**	**600**	**800**	**800**	**942**
std dev	514	202	696	273	449	909	432
median	1,350	700	600	600	650	550	900
max	2,500	900	2,800	1,000	1,900	3,400	2,000
min	700	200	50	100	200	50	400

	6RC	LCO	GCO	SR	BRN	HAM
JAN	500	500	500	600	700	1100
FEB	800	500	400	300	400	300
MAR	800	500	400	500	500	400
APR	1,400	1,200	1,100	1,100	1,000	1,100
MAY	700	600	800	800	1000	700
JUN	500	600	600	600	500	2700
JUL		1000	900	1100	300	400
AUG		1000	900	1900	800	900
SEP		700	600	1000	500	400
OCT		200	200	200	100	200
NOV	300	200	300	300	50	50
DEC	700	500	600	500	600	600
mean	**713**	**625**	**608**	**742**	**538**	**738**
std dev	327	308	271	478	307	704
median	700	550	600	600	500	500
max	1,400	1,200	1,100	1,900	1,000	2,700
min	300	200	200	200	50	50

	NCF117	B210	COL	SR-WC	LVC2	SC-CH
JAN	1800	1600	2500	1500	1400	1100
FEB	500	300	600	300	300	600
MAR	600	400	600	400	200	600
APR	1,000	900	1,000	700	200	800
MAY	1000	900	1400	800	50	600
JUN	900	800	1400	600	400	400
JUL	900	1000	1300	700	1100	900
AUG	900	700	1100	600	600	600
SEP	500	500	900	400	500	600
OCT	300	500	700	600	200	1300
NOV	700	600	800	500	500	400
DEC	1600	500	900	500	400	1900
mean	**892**	**725**	**1,100**	**633**	**488**	**817**
std dev	440	352	524	308	394	434
median	900	650	950	600	400	600
max	1,800	1,600	2,500	1,500	1,400	1,900
min	300	300	600	300	50	400

Table 2.13 Total Phosphorus (µg/l) at the Lower Cape Fear River Program stations during 2014.

	NAV	HB	BRR	M61	M54	M35	M23	M18
JAN	120	190	100	110	80	60	100	40
FEB	110	100	150	80	70	70	60	40
MAR	90	90	90	80	70	60	50	50
APR	40	40	50	60	50	30	30	30
MAY	110	100	130	100	110	90	70	60
JUN	130	110	110	70	130	50	30	30
JUL	120	130	120	80	90	40	30	30
AUG	120	150	120	120	110	60	40	40
SEP	130	150	90	90	90	60	50	40
OCT	130	150	90	90	90	60	50	50
NOV	100	80	80	80	70	50	30	30
DEC	130	80	110	110	90	80	40	40
mean	**111**	**114**	**103**	**89**	**88**	**59**	**48**	**40**
std dev	25	39	25	17	21	16	20	9
median	120	105	105	85	90	60	45	40
max	130	190	150	120	130	90	100	60
min	40	40	50	60	50	30	30	30

	NC11	AC	DP	IC	NCF6
JAN	120	130	110	60	70
FEB	150	140	140	100	70
MAR	10	40	40	40	40
APR	60	50	60	50	70
MAY	140	160	160	150	130
JUN	100	100	100	90	90
JUL	160	190	160	140	180
AUG	130	130	110	110	120
SEP	190	210	230	190	120
OCT	170	150	110	100	80
NOV	190	230	120	110	80
DEC	160	150	170	120	70
mean	**132**	**140**	**126**	**105**	**105**
std dev	51	55	49	41	36
median	145	145	115	105	80
max	190	230	230	190	190
min	10	40	40	40	40

	ANC	SAR	GS	NC403	PB	LRC	ROC
JAN	160	40	50	90	220	50	100
FEB	220	50	50	90	280	40	110
MAR	80	40	30	110	140	40	150
APR	200	40	30	60	60	40	80
MAY	90	80	60	120	280	100	320
JUN	280	180	150	170	210	70	460
JUL	240	160	160	260	320	60	370
AUG	530	180	140	160	270	100	210
SEP	270	200	230	200	830	150	500
OCT	230	120	80	110	260	60	380
NOV	200	110	90	60	200	50	680
DEC	260	70	60	120	140	60	210
mean	**230**	**106**	**94**	**129**	**268**	**68**	**298**
std dev	110	59	60	56	184	32	179
median	225	95	70	115	240	60	265
max	530	200	230	260	830	150	680
min	80	40	30	60	60	40	80

	6RC	LCO	GCO	SR	BRN	HAM
JAN	10	30	140	20	60	60
FEB	60	30	120	10	50	60
MAR	50	30	130	30	60	70
APR	60	30	180	30	50	60
MAY	90	70	200	60	120	160
JUN	90	50	220	50	70	130
JUL		100	350	90	80	190
AUG		110	320	180	120	90
SEP		100	330	80	80	190
OCT		40	210	50	90	160
NOV	60	30	300	50	60	90
DEC	60	40	160	40	60	120
mean	**60**	**55**	**222**	**58**	**75**	**115**
std dev	23	30	79	43	23	48
median	60	40	205	50	65	105
max	90	110	350	180	120	190
min	10	30	120	10	50	60

	NCF117	B210	COL	SR-WC	LVC2	SC-CH
JAN	10	40	20	20	10	110
FEB	70	40	10	20	10	70
MAR	80	40	10	20	30	70
APR	60	60	50	70	60	50
MAY	130	110	60	60	60	140
JUN	80	90	50	60	40	110
JUL	120	130	50	50	30	120
AUG	200	100	40	50	30	120
SEP	100	100	80	70	30	120
OCT	90	70	30	50	40	100
NOV	100	70	40	40	40	80
DEC	70	50	30	30	10	70
mean	**93**	**75**	**39**	**45**	**33**	**97**
std dev	44	29	20	18	16	27
median	85	70	40	50	30	105
max	200	130	80	70	60	140
min	10	40	10	20	10	50

Table 2.14 Orthophosphate (μg/l) at the Lower Cape Fear River Program stations during 2014.

	NAV	HB	BRR	M61	M54	M35	M23	M18
JAN	20	20	20	20	20	10	20	10
FEB	30	30	30	20	20	10	20	20
MAR	20	20	30	20	20	20	10	10
APR	20	20	20	20	20	20	10	10
MAY	40	40	40	40	40	30	20	20
JUN	40	50	40	30	30	20	10	0
JUL	30	40	30	30	10	10	10	0
AUG	30	50	40	50	40	20	20	10
SEP	40	60	50	40	60	40	30	10
OCT	40	40	50	40	40	40	30	30
NOV	40	40	40	40	40	30	20	10
DEC	50	50	50	50	50	40	30	20
mean	**33**	**38**	**37**	**33**	**33**	**24**	**19**	**13**
std dev	10	13	11	12	15	12	8	9
median	35	40	40	35	35	20	20	10
max	50	60	50	50	60	40	30	30
min	20	20	20	20	10	10	10	0

	NC11	AC	DP	BBT	IC	NCF6
JAN	30	30	20	10	20	20
FEB	70	60	50	10	40	10
MAR	20	20	10	10	10	10
APR	30	30	40	30	30	50
MAY	50	60	30	40	40	50
JUN	60	60	40	30	40	60
JUL	100	100	70	50	60	60
AUG	40	50	30	20	20	50
SEP	110	110	120	50	70	60
OCT	70	70	50	40	40	40
NOV	110	110	60	50	50	30
DEC	70	70	60	20	40	30
mean	**63**	**64**	**48**	**30**	**38**	**39**
std dev	31	30	29	16	17	19
median	65	60	45	30	40	45
max	110	110	120	50	70	60
min	20	20	10	10	10	10

	ANC	SAR	GS	NC403	PB	LRC	ROC
JAN	90	10	10	10	30	60	40
FEB	120	0	0	30	60	0	40
MAR	50	10	10	40	30	0	70
APR	310	20	20	50	30	10	40
MAY	110	50	50	100	50	20	100
JUN	140	50	50	120	20	10	150
JUL	130	50	60	120	80	20	250
AUG	570	60	50	80	70	10	100
SEP	140	60	50	80	50	20	250
OCT	150	30	30	30	80	10	220
NOV	110	20	20	20	20	10	600
DEC	180	20	30	50	60	20	120
mean	**175**	**32**	**32**	**61**	**48**	**16**	**165**
std dev	139	21	20	38	22	16	158
median	135	25	30	50	50	10	110
max	570	60	60	120	80	60	600
min	50	0	0	10	20	0	40

	6RC	LCO	GCO	SR	BRN	HAM
JAN	10	0	60	0	10	20
FEB	10	10	80	0	10	10
MAR	10	10	90	0	10	20
APR	30	10	220	10	20	30
MAY	30	20	120	10	30	50
JUN	40	30	260	10	30	60
JUL		30	210	10	40	70
AUG		20	180	0	30	40
SEP		20	140	20	40	80
OCT		20	130	10	30	60
NOV	30	10	240	10	20	60
DEC	30	10	90	10	20	50
mean	**24**	**16**	**152**	**8**	**24**	**46**
std dev	12	9	68	6	11	22
median	30	15	135	10	25	50
max	40	30	260	20	40	80
min	10	0	60	0	10	10

	NCF117	B210	COL	SR-WC	LVC2	SC-CH
JAN	20	10	10	0	0	20
FEB	20	10	0	0	0	10
MAR	30	10	0	0	0	10
APR	50	20	10	0	0	20
MAY	60	40	10	10	10	50
JUN	50	50	20	20	10	50
JUL	40	60	20	20	0	40
AUG	80	40	10	20	0	40
SEP	50	40	50	20	0	50
OCT	40	20	10	20	0	40
NOV	30	20	10	10	0	30
DEC	30	20	10	10	0	30
mean	**42**	**28**	**13**	**11**	**2**	**33**
std dev	17	17	13	9	4	15
median	40	20	10	10	0	35
max	80	60	50	20	10	50
min	20	10	0	0	0	10

Table 2.15 Chlorophyll *a* (µg/l) at the Lower Cape Fear River Program stations during 2014.

	NAV	HB	BRR	M61	M54	M35	M23	M18
JAN	4	4	4	4	4	4	4	6
FEB	7	5	6	4	5	9	4	5
MAR	5	5	5	4	3	3	3	6
APR	12	9	10	9	8	7	7	7
MAY	1	1	3	1	1	3	6	4
JUN	3	3	37	11	12	8	6	6
JUL	13	13	17	30	27	16	5	3
AUG	2	2	4	2	9	6	6	9
SEP	2	3	3	6	4	6	7	5
OCT	1	1	1	1	2	2	3	3
NOV	1	2	3	2	3	5	5	6
DEC	1	1	1	2	2	3	4	5
mean	**4**	**4**	**8**	**6**	**7**	**6**	**5**	**5**
std dev	4	4	10	8	7	4	1	2
median	3	3	4	4	4	6	5	6
max	13	13	37	30	27	16	7	9
min	1	1	1	1	1	2	3	3

	NC11	AC	DP	BBT	IC	NCF6
JAN	7	6	6	2	4	2
FEB	5	5	6	2	5	3
MAR	22	21	20	16	14	6
APR	8	7	7	7	6	1
MAY	1	1	1	1	1	1
JUN	3	2	4	1	3	2
JUL	13	8	7	2	3	3
AUG	4	3	3	1	2	1
SEP	5	5	3	1	2	1
OCT	2	4	1	1	1	5
NOV	3	2	1	1	1	3
DEC	6	5	5	1	3	0
mean	**7**	**6**	**5**	**3**	**4**	**2**
std dev	6	5	5	4	4	2
median	5	5	5	1	3	2
max	22	21	20	16	14	6
min	1	1	1	1	1	0

	ANC	SAR	GS	NC403	PB	LRC	ROC
JAN	2	4	12	2	3	3	1
FEB	4	14	28	10	19	16	8
MAR	2	2	4	4	7	7	2
APR	4	3	3	4	6	3	2
MAY	3	1	2	3	4	1	1
JUN	9	2	10	14	11	1	0
JUL	26	2	8	7	9	3	1
AUG	1	1	2	4	3	11	1
SEP	15	1	7	11	12	0	1
OCT	3	1	4	3	4	1	0
NOV	2	1	6	4	26	0	1
DEC	1	3	3	2	4	2	2
mean	**6**	**3**	**7**	**6**	**9**	**4**	**2**
std dev	7	4	7	4	7	5	2
median	3	2	5	4	7	3	1
max	26	14	28	14	26	16	8
min	1	1	2	2	3	0	0

	6RC	LCO	GCO	SR	BRN	HAM
JAN	2	1	1	1	2	2
FEB	3	2	4	2	1	4
MAR	2	2	2	1	2	3
APR	2	1	2	9	3	2
MAY	1	1	2	4	1	1
JUN	1	0	1	4	0	1
JUL		1	1	2	6	5
AUG		2	3	32	4	2
SEP		3	5	6	7	3
OCT		0	1	3	1	0
NOV	1	2	1	1	0	0
DEC	1	1	1	2	1	0
mean	**2**	**1**	**2**	**6**	**2**	**2**
std dev	1	1	1	9	2	2
median	2	1	2	3	2	2
max	3	3	5	32	7	5
min	1	0	1	1	0	0

	NCF117	B210	COL	SR-WC	LVC2	SC-CH
JAN	8	3	1	2	2	4
FEB	2	4	0	2	2	3
MAR	1	4	3	2	2	2
APR	1	2	1	4	1	3
MAY	1	1	1	0	2	1
JUN	4	2	3	0	2	9
JUL	1	1	6	0	1	6
AUG	1	1	1	2	1	2
SEP	0	2	3	2	2	2
OCT	0	0	0	0	1	3
NOV	0	0	1	0	1	2
DEC	0	0	0	0	0	1
mean	**2**	**2**	**2**	**1**	**1**	**3**
std dev	2	1	2	1	1	2
median	1	2	1	1	2	3
max	8	4	6	4	2	9
min	0	0	0	0	0	1

Table 2.16 Biochemical Oxygen Demand (mg/l) at the Lower Cape Fear River Program stations during 2014.

5-Day Biochemical Oxygen Demand

	NC11	AC	BBT	NCF117	B210	LVC2
JAN	3.0	2.7	1.4	1.4	1.4	1.9
FEB	1.6	1.4	1.1	1.8	1.2	0.9
MAR	1.9	2.0	1.6	1.5	1.2	0.9
APR	1.6	1.4	1.4	1.3	1.1	0.9
MAY	1.1	1.5	1.5	0.8	0.9	1.6
JUN	1.3	1.5	1.0	1.7	1.2	1.4
JUL	1.6	1.6	0.8	1.5	1.0	1.5
AUG	1.7	2.0		1.4	1.3	1.0
SEP	0.7	1.5	0.9	1.0	1.5	1.5
OCT	0.9	1.3	1.3	0.8	1.2	0.8
NOV	0.9	2.1	1.1	1.6	1.4	2.4
DEC	1.5		1.2	1.5	1.2	0.9
mean	1.5	1.7	1.2	1.4	1.2	1.3
stdev	0.6	0.4	0.3	0.3	0.2	0.5
median	1.5	1.5	1.2	1.5	1.2	1.2
max	3.0	2.7	1.6	1.8	1.5	2.4
min	0.7	1.3	0.8	0.8	0.9	0.8

20-Day Biochemical Oxygen Demand

	NC11	AC	BBT	NCF117	B210	LVC2
JAN	5.4	5.5	3.1	3.2	2.9	3.7
FEB	3.9	3.8	2.7	4.1	2.6	2.5
MAR	4.8	5.0	4.1	4.0		2.5
APR	4.0	3.4	3.6	4.1	2.5	2.3
MAY	3.0	5.0	4.5	2.7	2.5	4.1
JUN	3.6	4.0	3.2	2.7	2.6	2.9
JUL	3.8	5.1	2.8	3.4	2.7	3.7
AUG	4.5	4.9		4.2	3.9	3.0
SEP	2.7	5.1	3.5	3.4	3.5	4.1
OCT	2.5	3.3	3.1	2.4	2.8	2.6
NOV	2.5	5.7	3.3	3.8	3.1	7.1
DEC	3.9		3.4	3.9	2.7	2.6
mean	3.7	4.6	3.4	3.5	2.9	3.4
stdev	0.9	0.9	0.5	0.6	0.4	1.3
median	3.9	5.0	3.3	3.6	2.7	3.0
max	5.4	5.7	4.5	4.2	3.9	7.1
min	2.5	3.3	2.7	2.4	2.5	2.3

Table 2.17 Fecal Coliform (cfu/100 mL) and Enterococcus (MPN) at the Lower Cape Fear River Program stations during 2014.

	NC11	AC	DP	IC	NCF6	NAV	HB
JAN	73	55	127	55	19	16,000	60,000
FEB	145	172	172	220	46	5	37
MAR	10	136	37	91	320	10	37
APR	240	37	19	46	290	64	73
MAY	46	19	19	91	73	37	82
JUN	37	28	37	37	55	28	28
JUL	10	5	10	55	28	37	91
AUG	240	37	1,180	46	91	46	91
SEP	28	37	91	46	46	280	420
OCT	91	109	270	260	5,900	154	118
NOV	9	28	37	73	109	73	46
DEC	28	28	100	37	10	82	19
mean	**80**	**58**	**175**	**88**	**582**	**1,401**	**5,087**
std dev	81	50	312	71	1,606	4,402	16,557
max	240	172	1,180	260	5,900	16,000	60,000
min	9	5	10	37	10	5	19
Geomean	45	40	69	70	89	73	114

ENTEROCOCCUS

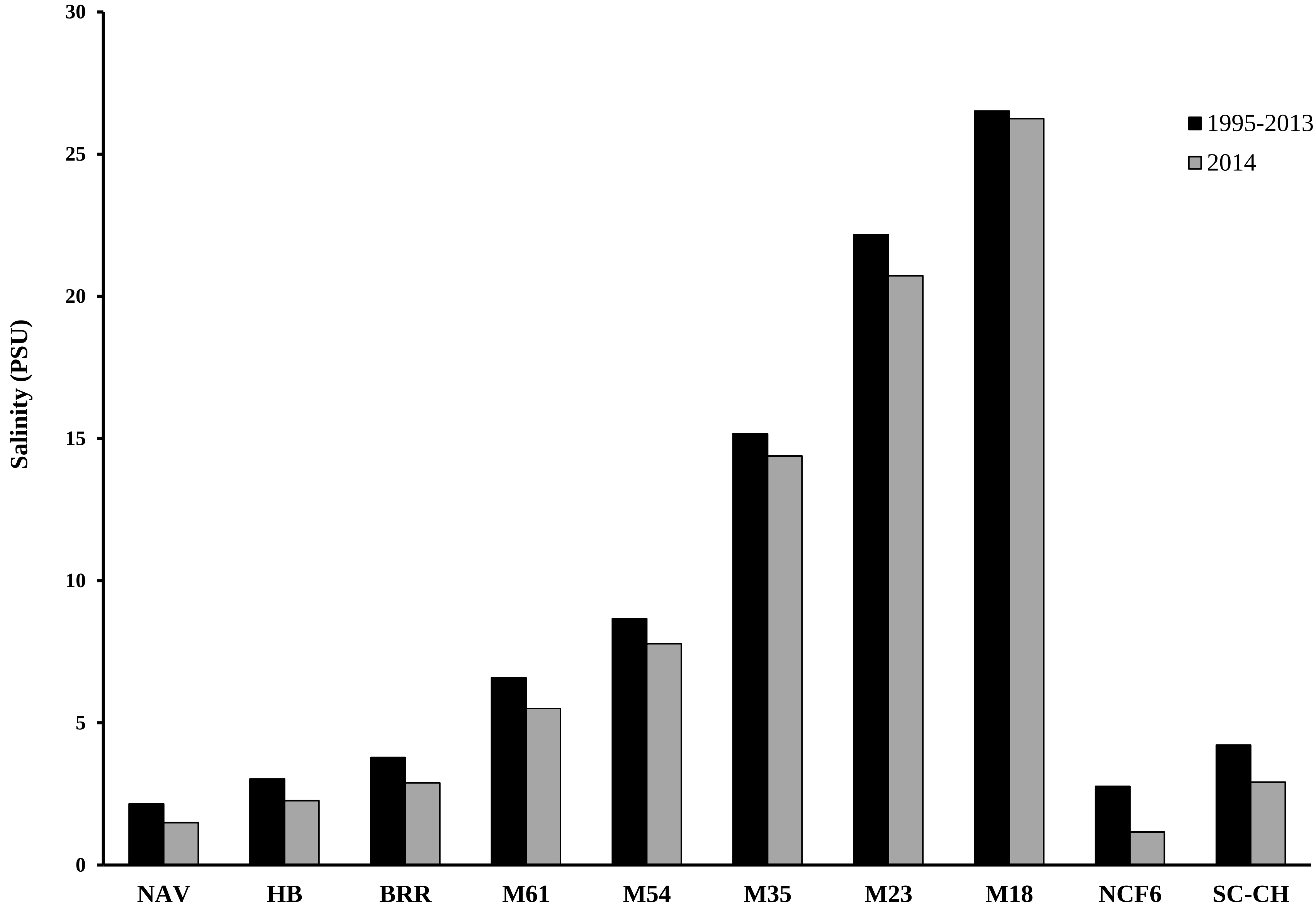
	BRR	M61	M54	M35	M23	M18
JAN	1,515	1,376	985	31	293	337
FEB	10	5	5	10	31	5
MAR	5	20	10	10	10	10
APR	31	20	31	5	5	5
MAY	20	10	10	63	10	5
JUN	20	20	5	5	5	5
JUL	10	10	5	5	5	5
AUG	10	10	5	5	5	5
SEP	156	134	74	31	5	5
OCT	336	677	1,198	529	1,682	1,552
NOV	5	5	10	5	5	5
DEC	5	5	10	5	5	5
mean	**177**	**191**	**196**	**59**	**172**	**162**
std dev	414	401	403	143	462	429
max	1,515	1,376	1,198	529	1,682	1,552
min	5	5	5	5	5	5
Geomean	27	27	23	14	15	12

	ANC	SAR	GS	NC403	PB	LRC	ROC
JAN	145	127	64	64	37	400	91
FEB	280	154	37	46	64	28	200
MAR	100	109	28	19	172	240	127
APR	145	163	28	55	55	455	100
MAY	64	460	73	1,180	91	163	172
JUN	190	118	136	1,730	390	73	154
JUL	455	546	455	145	728	136	455
AUG	470	200	273	182	3,600	210	1,090
SEP	280	145	728	145	181	82	181
OCT	307	420	250	728	340	500	220
NOV	172	100	55	46	210	64	73
DEC	1,640	43,000	1,820	1,270	6,000	4,700	31,000
mean	**354**	**3,795**	**329**	**468**	**989**	**588**	**2,822**
std dev	407	11,822	493	577	1,783	1,249	8,500
max	280	43,000	1,820	1,730	6,000	4,700	31,000
min	64	100	28	19	37	28	73
Geomean	240	300	136	178	272	204	284

	6RC	LCO	GCO	SR	BRN	HAM
JAN	172	136	100	37	181	208
FEB	118	172	37	10	91	73
MAR	91	28	5	55	300	55
APR	127	55	163	46	230	217
MAY	400	430	1,460	1,270	364	17,000
JUN	73	19	46	91	470	1,360
JUL		230	490	55	181	200
AUG		100	200	728	3,000	2,500
SEP		270	181	136	4,100	1,820
OCT		2,000	1,910	1,730	18,000	32,000
NOV	64	109	100	2,000	490	637
DEC	118	46	55	64	172	210
mean	**145**	**300**	**396**	**519**	**2,298**	**4,690**
std dev	101	525	596	704	4,893	9,403
max	400	2,000	1,910	2,000	18,000	32,000
min	64	19	5	10	91	55
Geomean	123	127	135	150	543	710

	NCF117	B210	COL	SRWC	LVC2	SC-CH
JAN	73	127	64	73	37	127
FEB	100	73	100	118	55	64
MAR	728	73	73	199	181	440
APR	64	82	64	154	64	100
MAY	19	37	360	82	73	109
JUN	91	28	118	91	46	55
JUL	19	46	100	91	91	136
AUG	19	82	55	172	91	118
SEP	145	100	200	119	455	819
OCT	37	28	64	64	136	37
NOV	37	55	136	118	28	46
DEC	10	55	64	127	37	55
mean	**112**	**66**	**117**	**117**	**108**	**176**
std dev	190	29	84	39	113	220
max	728	127	360	199	455	819
min	10	28	55	64	28	37
Geomean	52	59	98	111	77	108

Figure 2.1 Salinity at the Lower Cape Fear River Program estuarine stations, 1995-2013 versus 2014.



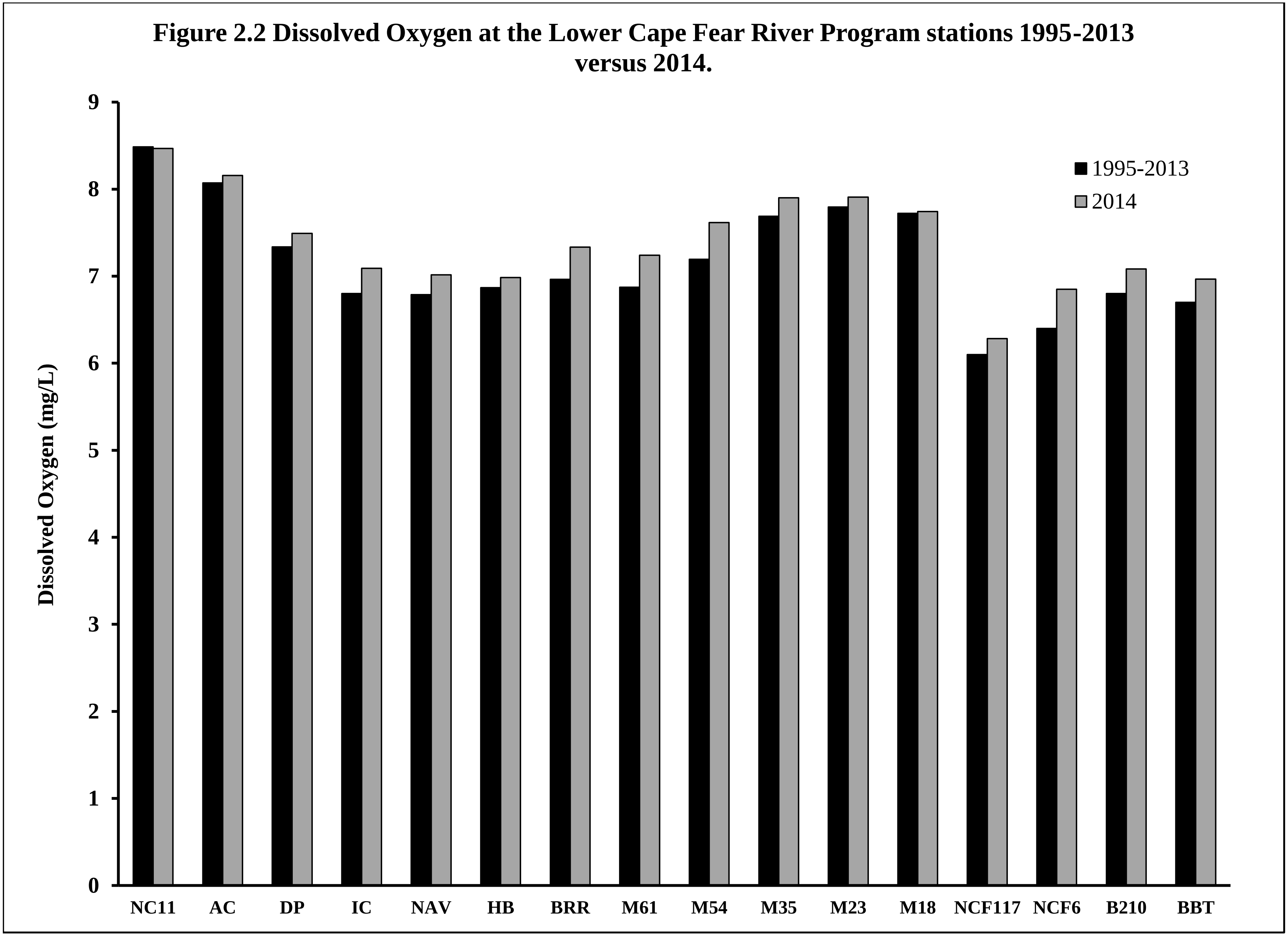


Figure 2.2 Dissolved Oxygen at the Lower Cape Fear River Program stations 1995-2013 versus 2014.
Dissolved Oxygen (mg/L)
0
1
2
3
4
5
6
7
8
9
1995-2013
2014
NC11
AC
DP
IC
NAV
HB
BRR
M61
M54
M35
M23
M18
NCF117
NCF6
B210
BBT

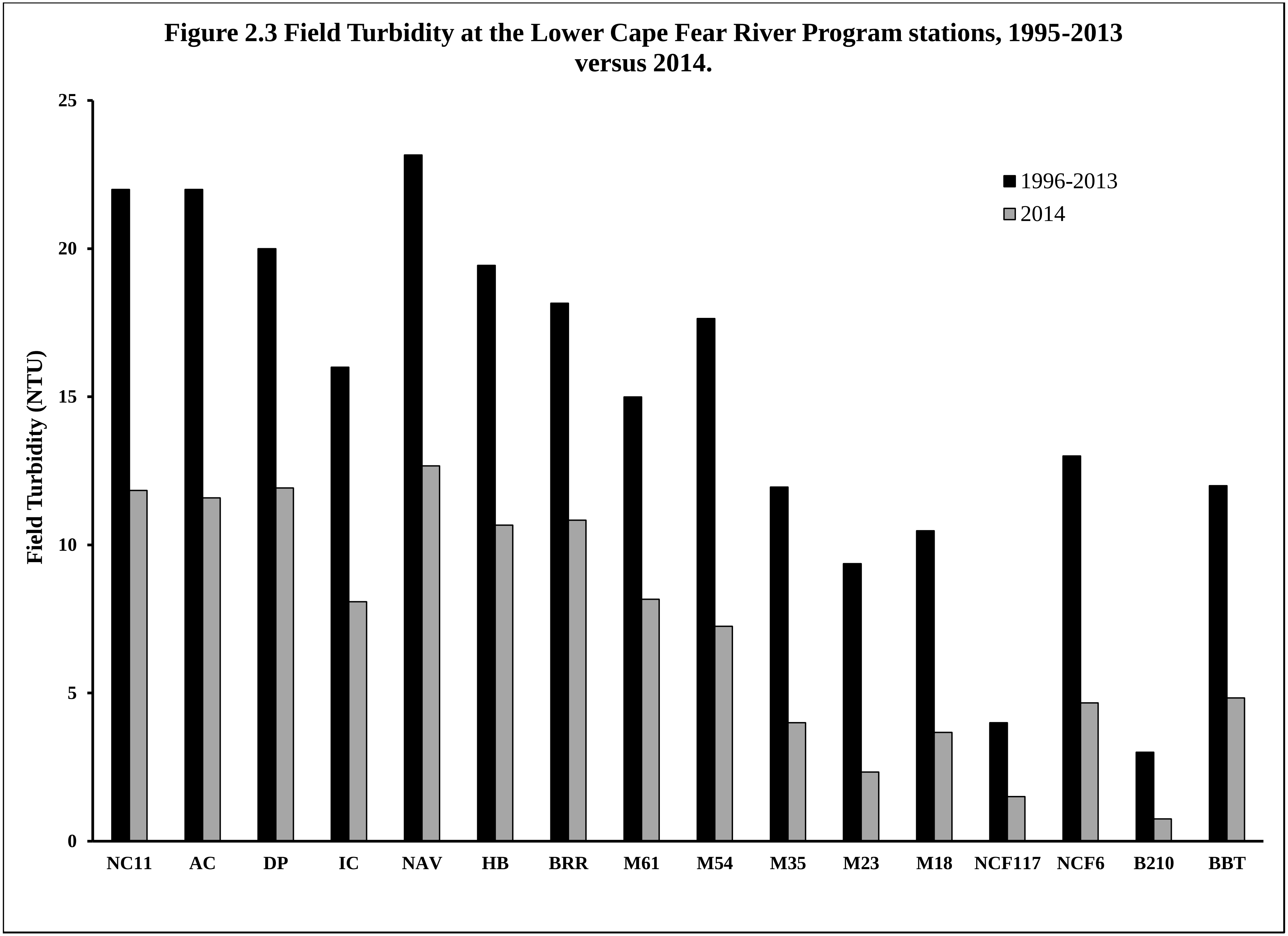


Figure 2.3 Field Turbidity at the Lower Cape Fear River Program stations, 1995-2013 versus 2014.
Field Turbidity (NTU)
25
20
15
10
5
0
1996-2013
2014
NC11
AC
DP
IC
NAV
HB
BRR
M61
M54
M35
M23
M18
NCF117
NCF6
B210
BBT

Figure 2.4 Total Nitrogen at the Lower Cape Fear River Program manstem stations, 1995-2013 versus 2014.

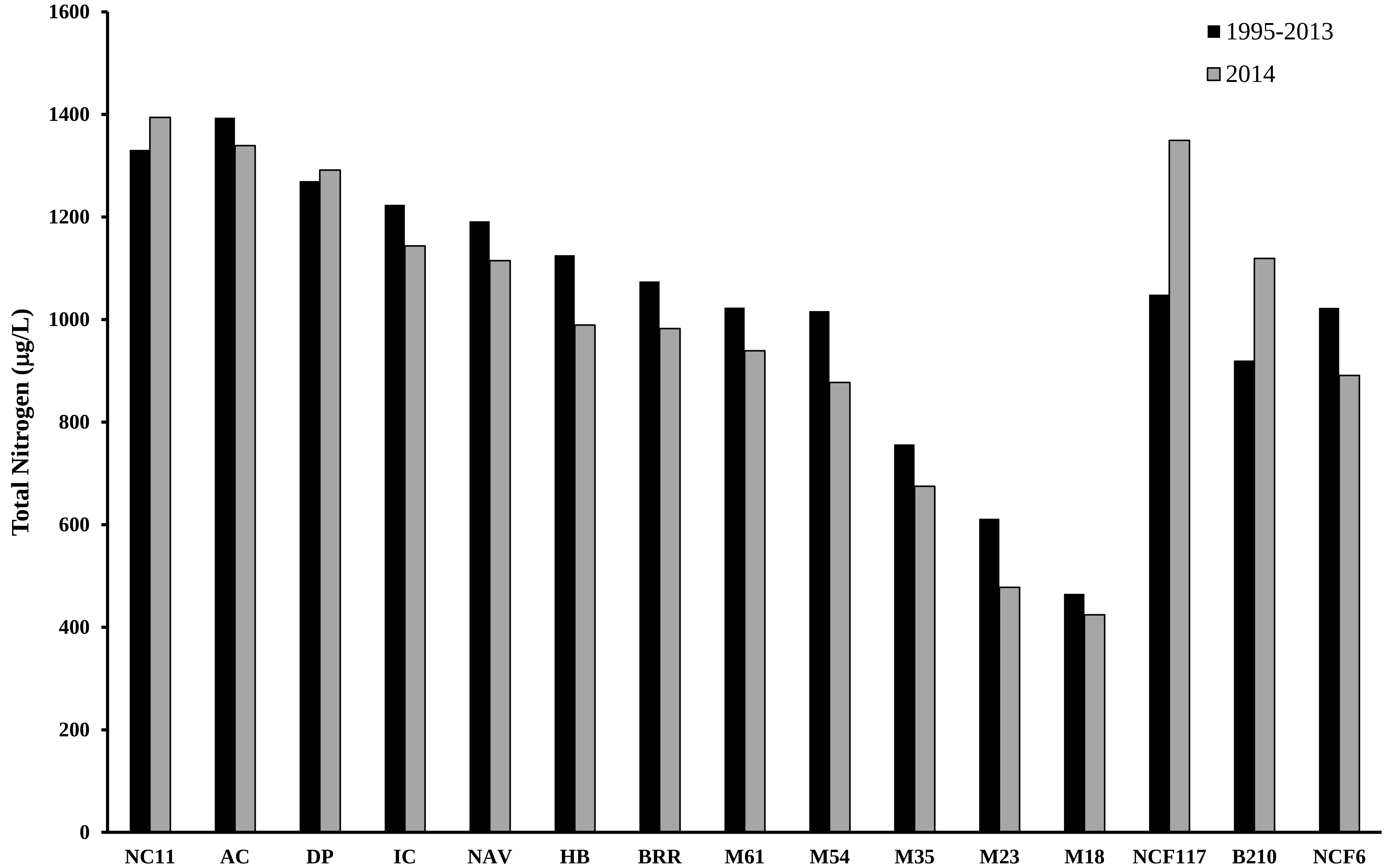


Figure 2.5 Total Phosphorus at the Lower Cape Fear River Program mainstem stations, 1995-2013 versus 2014.

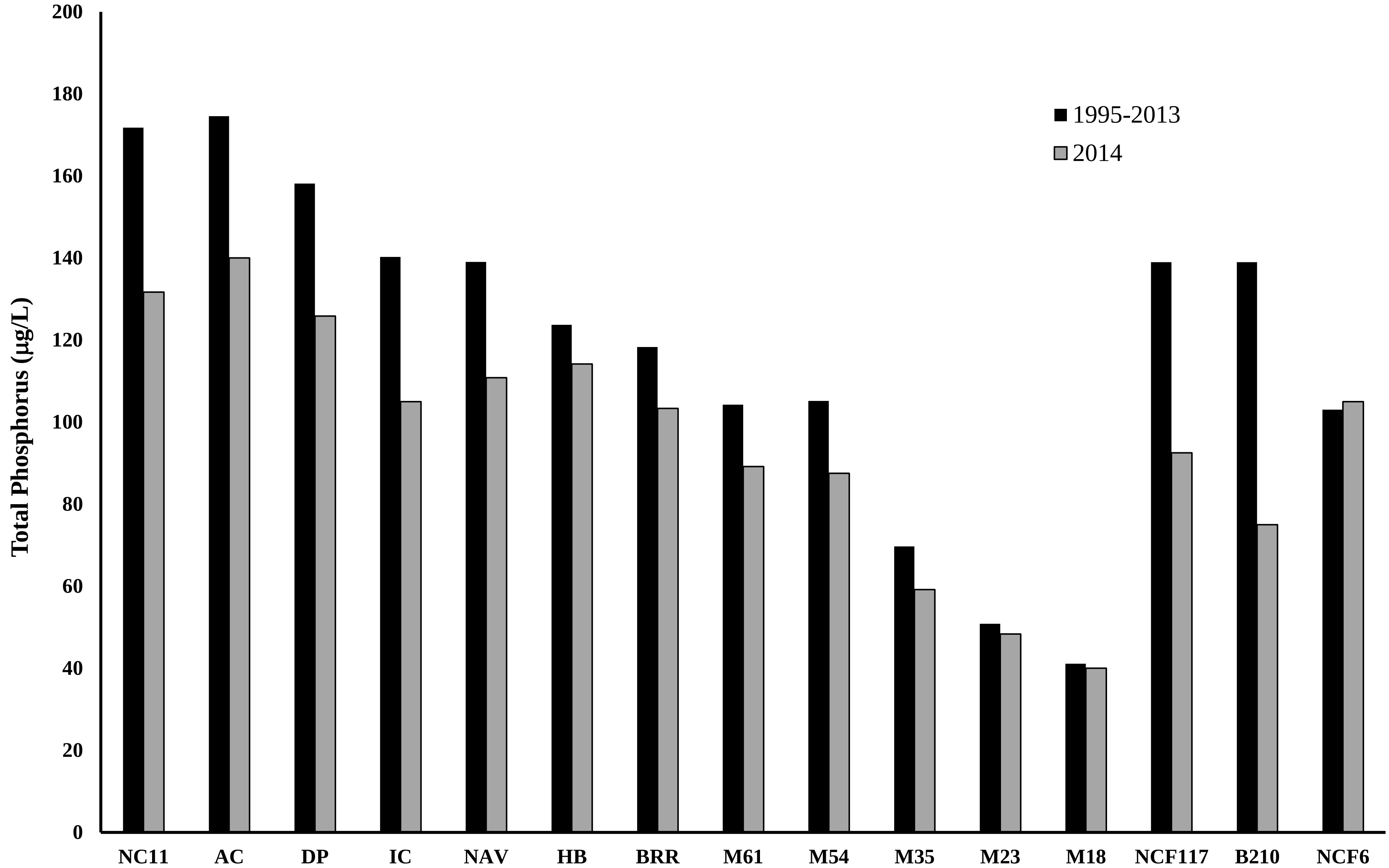


Figure 2.6 Chlorophyll *a* at the Lower Cape Fear River Program mainstem stations, 1995-2013 versus 2014.