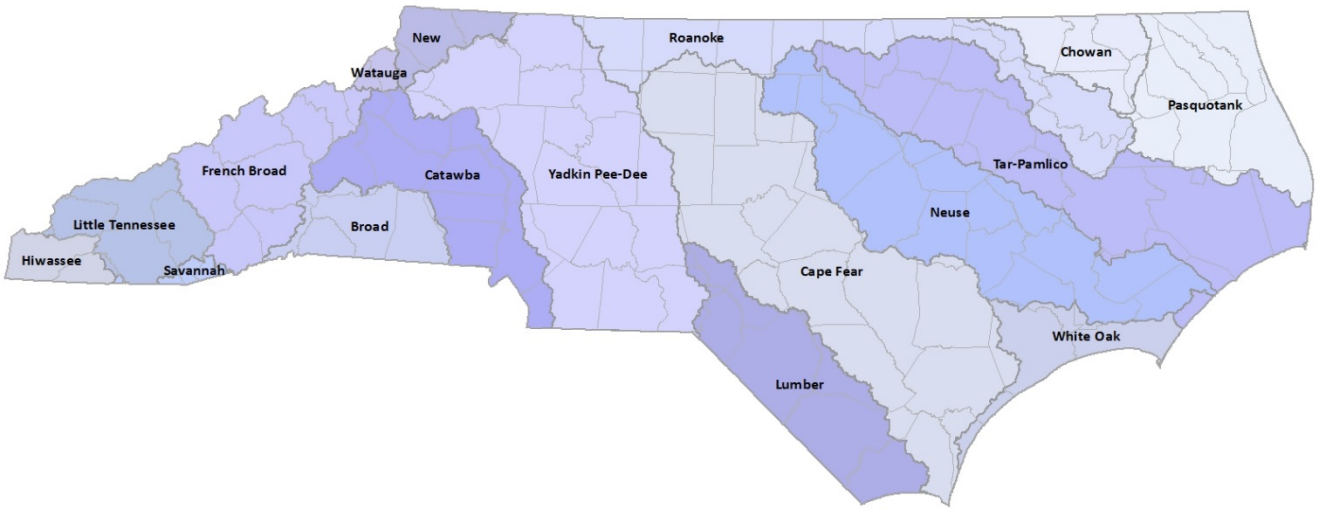
Annual Report to the General Assembly
Environmental Review Commission
Basinwide Water Resource Management Plans

July 2018 to June 2019



Environmental Management Commission
North Carolina Department of Environmental Quality
Division of Water Resources

This report is submitted to meet the requirements of General Statute (G.S.) 143-215.8B(d) and 143-355(p), which requires annual reporting on the development of basinwide water quality management plans and hydrologic models.

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Introduction

Basinwide water resources management plans (basin plans) are developed by the Basin Planning Branch (BPB) in the Division of Water Resources (DWR) in the North Carolina Department of Environmental Quality (Department or DEQ). Basin plans are prepared for each of the 17 major river basins and are used to communicate with policy makers, government officials, entities required to adhere to water quality standards (e.g., wastewater managers and operators, stormwater engineers, contractors and developers, etc.) and the public on water resource issues across the state. When applicable, the basin plans also include recommendations for protecting water quality and explanations regarding why there are long-term management strategies in place for rivers designated as nutrient sensitive waters (NSW) as well as existing measures to protect areas identified as having significant or outstanding water quality. Numerous federal, state and local agencies, watershed groups, universities, and the public are contacted throughout the basin planning process.

Implementation of recommendations, action plans or strategies presented in the basin plan is coordinated with various resource agencies and local communities. Regulatory actions or regional voluntary measures may be used to address water quality concerns identified in the basin plan. Information presented in each basin plan also aids local watershed groups in developing and prioritizing site-specific restoration and protection strategies. Basin plans are not a rule, are circulated to local agencies and the public for review and comment and are approved by the North Carolina Environmental Management Commission (EMC) at least every 10 years.

General Statute (G.S.) 143-215.8B(d) states that the Environmental Management Commission (Commission) and the Department shall each report on an annual basis to the Environmental Review Commission (ERC) on "the progress in developing and implementing basinwide water quality management plans and on increasing public involvement and public education in connection with basinwide water quality management planning. The report to the Environmental Review Commission by the Department shall include a written statement as to all concentrations of heavy metals and other pollutants in the surface waters of the State that are identified in the course of preparing or revising the basinwide water quality management plans." In October 2017, G.S. 143-355(p) directed the Department to also include progress on developing basinwide hydrologic models in the annual report submitted to the ERC for basinwide water quality management plans. These models are often referred to as "water supply" models, and information on the status of hydrologic models is included in this report.

Basin Plan Development

Developing basin plans is a multi-year process built on reviewing available water quality data, discharge permits, and communicating with stakeholders prior to presenting the results. North Carolina has used an integrated, watershed-based approach to evaluate point and nonpoint sources of pollution from municipal wastewater facilities, industrial facilities, on-site wastewater collection systems and stormwater since 1983. The Tar-Pamlico River basin plan was approved by the EMC in 2015 and was the first plan to incorporate water quality and quantity issues. The basin plan included in-depth water quality assessments and recommendations for improving water quality, as well as information made available through the

hydrologic model. For basins that do not have a hydrologic model, information about future water demands, projections and groundwater use will be based on best available data collected by DWR.

In October 2018, the EMC approved the Watauga River Basin Plan. In addition to the in-depth water quality and quantity analysis, the plan incorporated online tools such as ArcGIS Online (AGOL) interactive maps and a story map (Watauga Story Map). These online, interactive tools will allow the basin plans to remain linked to maps and reference information that are frequently updated, allowing users access to the most currently available data. Currently, the Cape Fear, Chowan, Neuse, Pasquotank, White Oak and Yadkin-Pee Dee River basin plans are under development.

Progress on Developing Hydrologic Models

Hydrologic models are based on historic stream flow data and capture the effects of current management protocols (i.e., regulated releases from dams), surface water withdrawals, and wastewater discharges. The models can be used to evaluate the potential effects on surface water availability produced by anticipated changes in water demands and management regimes. Although not as precise as a site-specific study for accessing impacts, the models can be used to evaluate potential impacts of permit decisions. Examples include the approval of water supply allocations from lakes and reservoirs or approval of surface water transfers. The models are available to anyone who requests access and can be used to evaluate potential flow impacts from proposed projects and identify flow conditions, the reoccurrence of which could produce water shortages, potentially limiting the ability to meet expected demand. The models also evaluate the possible magnitude of the water shortages. By statute, the models are subject to a 60-day comment period and must be resubmitted to the EMC if there are substantial comments and/or updates. Representatives from both the public and private sector participate in the development of the models and include DEQ, NC Wildlife Resources Commission (WRC), NC Department of Agriculture & Consumer Services (NCDA&CS), Soil & Water Conservation Districts (SWCD), municipalities, riverkeepers, and Duke Energy. DWR continues to review water use data that is incorporated into the model and ensure that all water users are accounted for in the basins.

DWR hosts hydrologic models for the Tar-Pamlico, Roanoke and Broad River basins, along with the combined Cape Fear-Neuse River basin model through OASIS (Operational and Simulations of Integrated Systems) (Table 1). A hydrologic model is also available for the Catawba-Wateree River basin. Hydrologic models for the French Broad, New and Watauga River basins are near completion. Once complete, hydrologic models for the Yadkin-Pee Dee and Lumber River basins will begin.

Water Quality Monitoring and Pollutant Concentrations

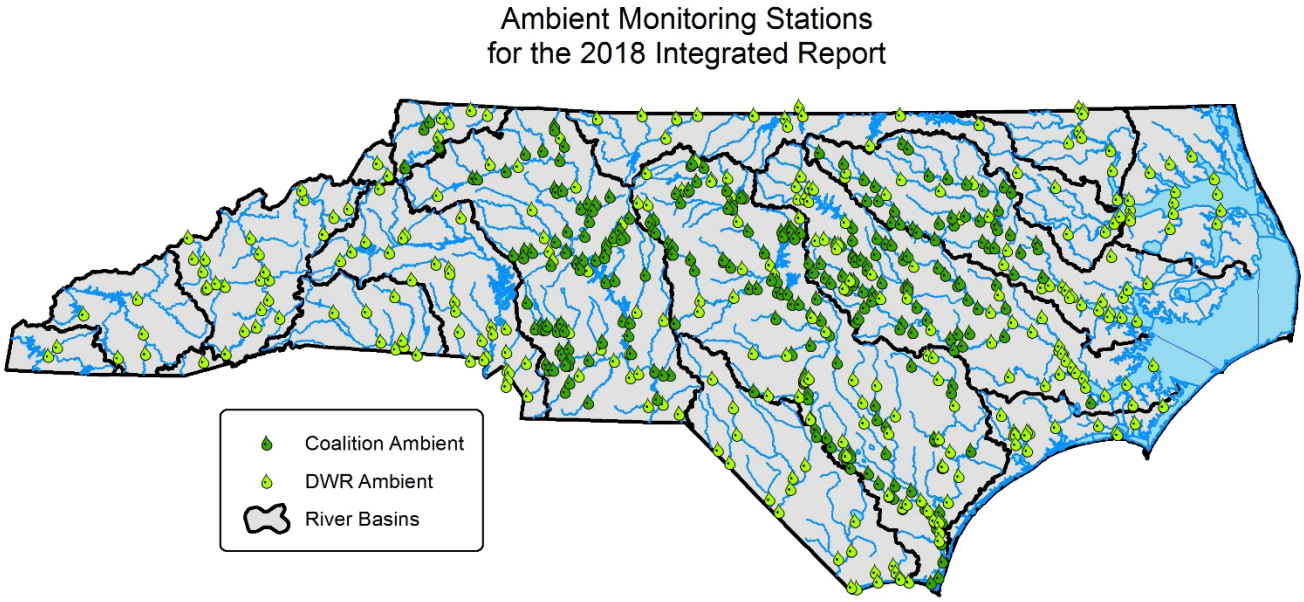
Chemical, physical and biological parameters are regularly assessed to determine how well waterbodies are meeting their best intended use. DWR's Ambient Monitoring System (AMS), along with seven monitoring coalitions, collect physical and chemical data from ambient monitoring stations across the state. A monitoring coalition is a group of stakeholders that combine resources and expertise to collectively fund and perform an instream monitoring program (e.g., NPDES coalition, citizen science). Coalitions can be found in the Cape Fear, Neuse, New, Tar-Pamlico and Yadkin-Pee Dee river basins. Data collected from 329 DWR AMS stations and 291 coalition monitoring stations were used to assess water quality for the 2018 Integrated Report (IR) (Figure 1).

Table 1: North Carolina River Basin Quantity Models and Nutrient Strategies

River Basin	Basin Planner	Quantity Model Platform	Nutrient Criteria Development	Management Strategy	Web Links to Executive Summary
Chowan	BPB	n/a		NSW	CHO
Pasquotank	BPB	n/a	Estuarine – Albemarle Sound		PAS
Broad	Raquet	OASIS			BRD
Neuse	Deamer/Davis	OASIS		NSW	NEU
Lower Cape Fear	Deamer/Davis	OASIS	Flowing River & Stream - Central CFR		CPF
Upper Cape Fear	Deamer/Davis	OASIS	Flowing River & Stream - Central CFR	Haw R.-NSW	CPF
Yadkin-Pee Dee	Baker	OASIS^	Lake - High Rocky Lake		YAD
White Oak	McMillan	n/a		New R.-NSW	WOK
Lumber	McMillan	OASIS^			LBR
French Broad	Raquet	OASIS *			FBR
Catawba	Raquet	CHEOPS			CAT
New River	Raquet	OASIS *			NEW
Hiwassee	Baker	TVA			HIW
Little Tennessee	Tarver	TVA			LTN
Savannah	Tarver	n/a			SAV
Roanoke	Davis	OASIS		216 Study	ROA
Tar-Pamlico	Deamer	OASIS		NSW	TAR
Watauga	Raquet	OASIS*			WAT

NSW = Nutrient Sensitive Waters,
NCDP = Nutrient Criteria Development Plan,
OASIS = Operational and Simulation of Integrated Systems (by HydroLogics). A hydrologic mass balance model used mainly in evaluating planning and management alternatives,
OASIS* - To be completed in 2020,
OASIS^ – Start development in 2020; Possible combined Yadkin-Pee Dee/Lumber model,
CHEOPS = Duke Energy's (Computerized Hydroelectric Operations and Planning Software) computer model,
TVA= Tennessee Valley Authority model,
n/a – currently hydrologic models are not being developed for coastal areas and the Savannah River Basin.

Figure 1: Ambient Monitoring Stations – 2018 Integrated Report



DWR's Biological Assessment Branch (BAB) evaluates the water quality of rivers and streams using the biological communities (benthic macroinvertebrates and fish) that live in them. Given the variety of life cycles these aquatic organisms exhibit, biological communities can often reflect both long- and short-term environmental conditions. Biocriteria have been developed for the major ecoregions using species diversity, abundance, and pollution sensitivity of the organisms. Data collected from 3,320 benthic macroinvertebrate stations and 960 fish community stations were used to assess water quality for the 2018 IR (Figure 2). Of those, 716 benthic and 423 fish stations where sampled during the five-year assessment window for the 2018 IR. Not all stations are resampled every assessment period due to staffing and resource limitations; therefore, data collected during previous assessment periods are carried forward and used for the remaining biological stations.

In North Carolina, all water quality parameters collected in a waterbody, or assessment unit (AU), are assessed independently and are based on the frequency of exceedances of the numeric or narrative water quality standard (Table 2). The IR includes: (1) a list of waterbodies that are sampled for chemical, physical and biological parameters; (2) the water quality assessment associated with that parameter (e.g., meeting criteria, exceeding criteria, data inconclusive; and (3) the EPA category the parameter is assigned (Table 3). The IR fulfills the reporting requirements of Section 303(d) and 305(b) of the Federal Clean Water Act (CWA).

Impaired waters, or waters that are exceeding criteria, are reported on the 303(d) list. The 303(d) list is submitted to the EPA for approval every two years. Five-year assessment periods, or datasets, are used for determining whether a waterbody is meeting or exceeding criteria. The datasets are quality assured and quality controlled (QA/QC) by DWR. Procedures used to evaluate water quality and assign categories are explained in detail in the IR methodology available on DWR's Modeling and Assessment Branch's (MAB)

website. EPA approved North Carolina's 2018 303(d) list on May 22, 2019. Waterbodies assessed for the 2018 IR are shown in Figure 3.

Figure 2: Biological Monitoring Stations – 2018 Integrated Report

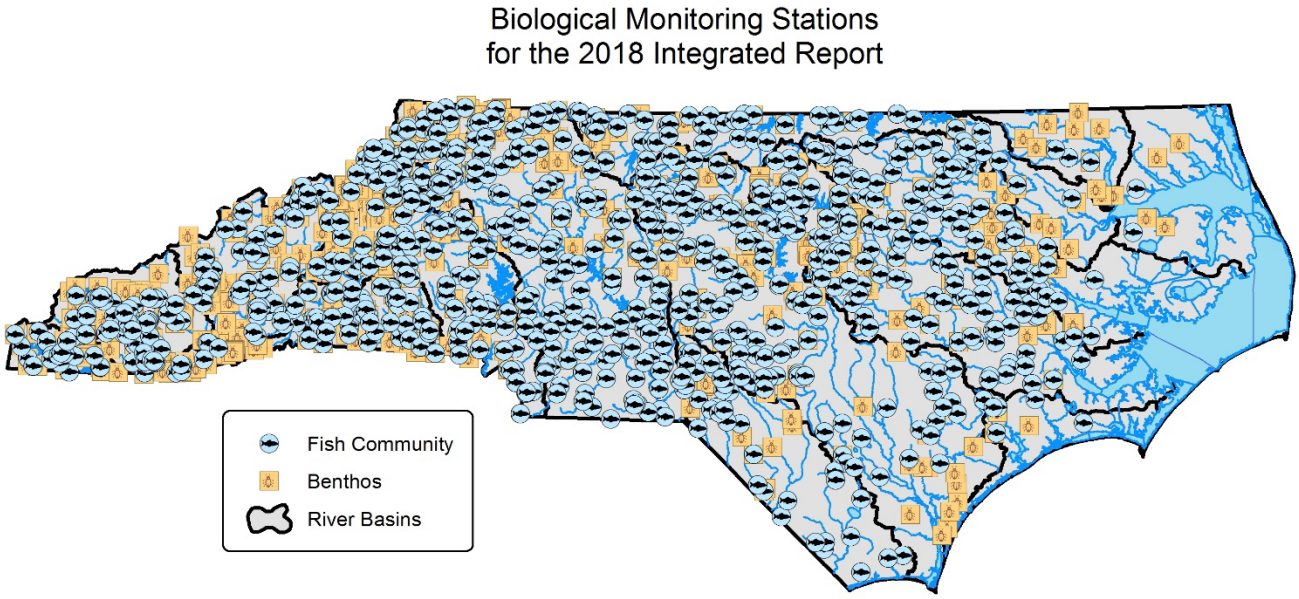


Table 2: North Carolina Ambient Monitoring Program Water Quality Parameters+

Physical Parameters	Chemical Parameters	Biological Parameters
Dissolved Oxygen	Nutrients – NH_3, NO_2+NO_3, TKN, TP	Fecal Coliform Bacteria – Fresh & Saltwater
pH	Hardness	*Enterococcus* Bacteria – Saltwater
Specific Conductance	Chlorophyll *a* *	Biological Integrity – Benthic Macroinvertebrate Community
Water Temperature	Metals ^ – Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Ni, Zn	Biological Integrity – Fish Community
Turbidity		

+ Not all parameters listed are collected at each station or collected at the same sampling frequency. Generally, all stations are monitored monthly.

* Chlorophyll *a* is collected in lakes and estuaries or in areas of slower moving water such as behind a dam on flowing streams.

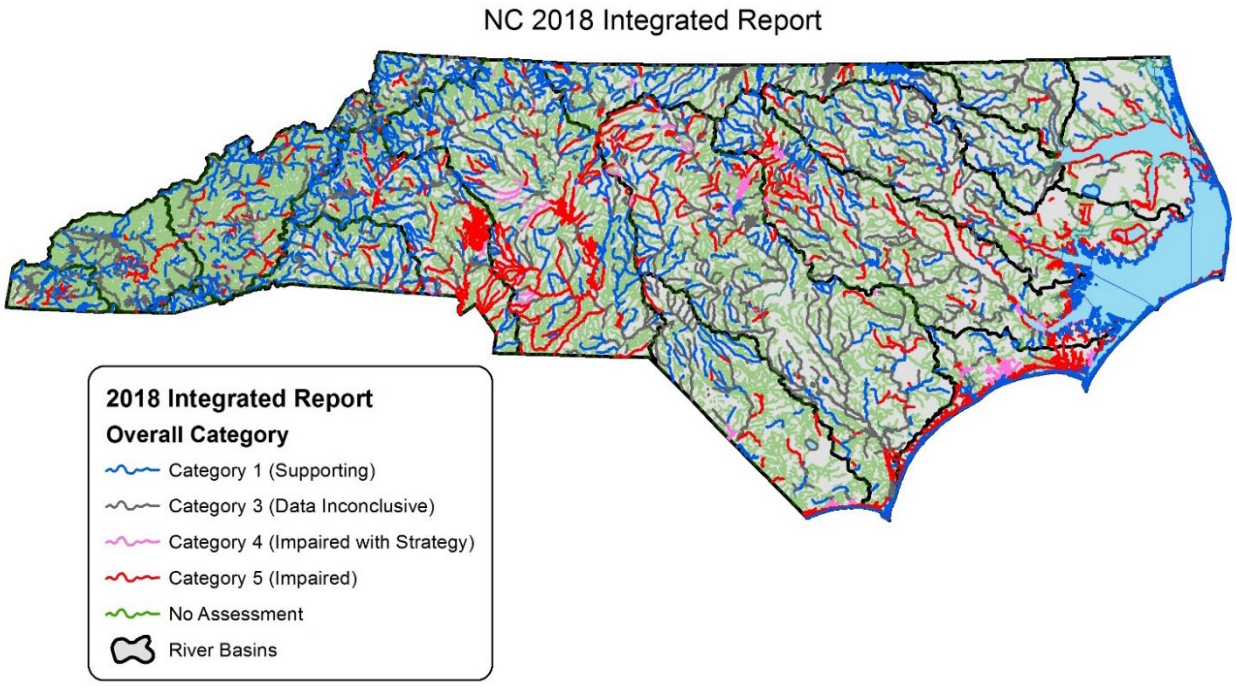
^ The standard for metals changed from total recoverable to dissolved metals as part of the 2015 Triennial review process. In 2007, DWR suspended sample collection for total recoverable metals due to the change in the proposed metals standard. In 2015, DWR started collecting dissolved metals for assessment purposes at select stations throughout the state.

Table 3: North Carolina Assessment Criteria Based on North Carolina Numerical and/or Narrative Statements and Associated IR Categories

Water Quality Assessments	Water Quality Assessment Definitions	Integrated Report Category (EPA)
Meeting Criteria (MC)	Meeting water quality standard criteria for parameter of interest	Category 1 Category 2
Data Inconclusive (DI)	Data inconclusive to make an assessment for parameter of interest	Category 3
Exceeding Criteria (EC)	Exceeding standard criteria for parameter of interest	Category 4* Category 5**

*Category 4 is assigned when a parameter is exceeding criteria, but (1) the development of a total daily maximum load (TMDL) is not required, (2) a TMDL or management strategy is already in place, and/or (3) a variance is in place. The development of a TMDL includes a study of the watershed to identify the sources of the pollutant(s), calculations and modeling to identify the pollutant(s) contributing to the impairment and reductions needed from point and nonpoint sources of pollution.
**Category 5 is assigned when a parameter is exceeding criteria, and a TMDL or management strategy is required. Category 5 assessments are the 303(d) list, which is also referred to as the Impaired Waters List. Definitions and more detailed information about each category can be found in the 2018 listing and delisting methodology. The methodology is also referred to as the 2018 Water Quality Assessment Process.

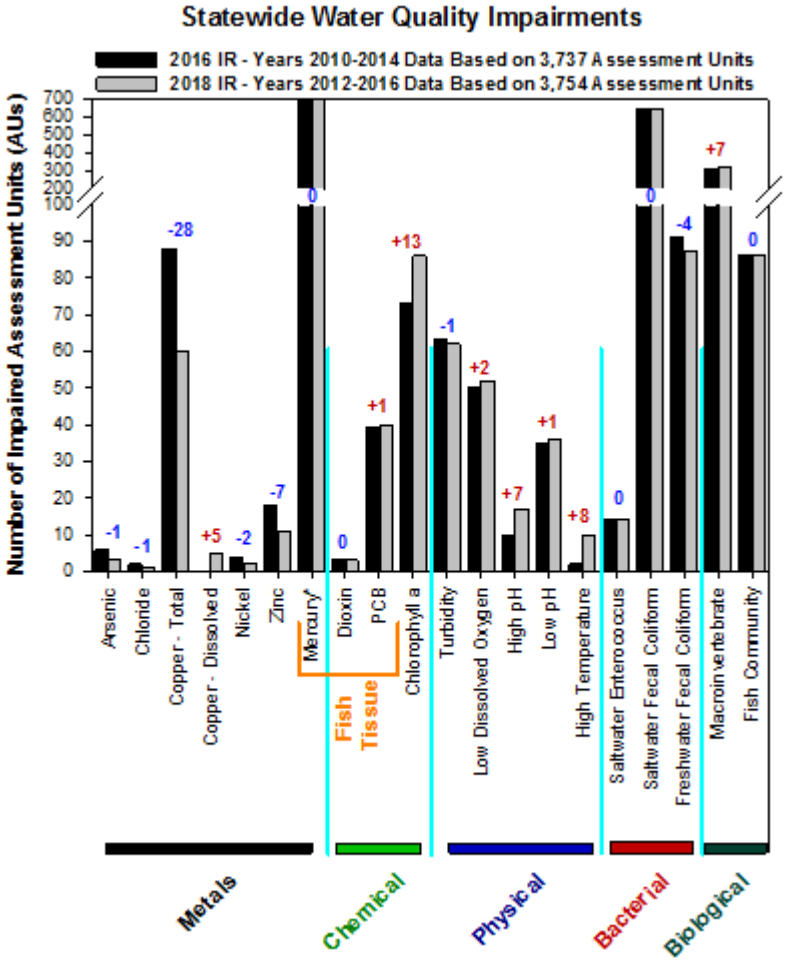
Figure 3: Overall Categories for Monitored Waters in North Carolina – 2018 Integrated Report



There are currently 13,676 AUs, or stream segments, assessed in the state. Each AU varies in size based on the specific characteristics of the waterbody being evaluated. Because the characteristics of AUs vary, some units are only monitored for a subset of parameters.

The five-year assessment period for the 2016 and 2018 IR and 303(d) list are based on data collected from 2010-2014 and 2012-2016, respectively. Figure 4 illustrates the number of AUs impaired for each assessment period based on the water quality parameters shown on the bottom of the graph and denotes an increase (red) or decrease (blue) in the number of AUs between the two periods.

Figure 4: Statewide Water Quality Impairments for Integrated Reporting (IR) Years 2016 and 2018



Water quality monitoring for total recoverable metals assessment was suspended in April 2007 to allow for evaluations, revisions, and re-adoption of water quality standards. Using the most current science, the EMC was presented, and consequently approved, new water quality standards for dissolved metals in November 2014. The water quality standards for dissolved metals were submitted to EPA for review and approval. EPA approved the new standards in April 2016. With the approval of the new standards, DWR began monitoring for dissolved metals at "targeted stations" in waterbodies listed on the 303(d) list. The stations were prioritized for metals monitoring because more information was needed before EPA would approve removing the waterbodies from the 303(d) list.

Based on the 2016 targeted study, DWR removed 35 stream segments (AU's) from the 303(d) list for a total of 41 metal delistings as part of the 2018 IR assessment period. Some stations had more than a single metal impairment which brought the total number of delistings for metals to 41. The targeted study also confirmed that five AU's should remain on the 303(d) list for dissolved copper. This included one stream segment in the Cape Fear, Catawba and Roanoke River basins and two in the Yadkin-Pee Dee River basin.

DWR, with the assistance from the point source monitoring coalitions, are targeting a new set of stations for the next round of metals confirmation. These stations will be sampled between 2019 and 2020 and will be assessed as part of the 2022 IR assessment. These stations are targeting waterbodies that are currently only impaired for total recoverable metals. The metals impairments shown in Figure 4 includes the AU's listed based on the dissolved metals water quality standards and the remaining AU's listed for total recoverable metals that have not been resampled.

DWR, including the BPB, uses the information from the statewide water quality assessment (IR) process to help guide our understanding of water quality concerns and where to focus efforts to restore, protect and preserve water quality. This information is also used to help understand possible sources of pollutants, where regulatory efforts may be needed to improve protections, guide the need for additional special studies as well as where there is a need for management actions such as a TMDL (total maximum daily load). Information is being incorporated into online, interactive mapping tools and basin plans for easier access for resource agencies, stakeholders and the public.

Other Pollutants in Surface Waters

Basinwide water quality evaluations often go beyond the assessment of parameters with specific water quality standards such as those reported as part of the biennial IR assessment process. Basin plans must also address other pollutants which can result in nutrient over enrichment and algal blooms. Emerging issues and compounds, changes to water quality and stream flow over time, and climate resiliency are topics that will be incorporated into future basin plans.

Nutrients (nitrogen and phosphorus) have been identified as a major water quality concern across most of North Carolina's river basins. They are introduced to an aquatic ecosystem from municipal and industrial treatment processes, runoff from urban or agricultural land, inputs from groundwater and from atmospheric deposition. The growth of algae and other plants can result in eutrophic conditions and increased biological productivity, or algal blooms.

A statistical analysis of nutrients in the Neuse and Tar-Pamlico NSW watersheds found that while some nutrients have declined or remained steady, organic nitrogen has been increasing in these two basins since the early 2000s. This led to a statewide evaluation which indicated that organic nitrogen instream concentrations are increasing across all basins. Mechanisms driving this increase are not well understood. Changes in urban, agricultural and waste disposal activity, effects from groundwater and legacy sediments, and changes in atmospheric deposition and rain pH levels, along with changes to stream flow, may be contributing to the increase in organic nitrogen. Changes in stream flow could also impact the amount of waste that can be discharged to a waterbody without changing existing conditions. Additional research and analytical tools are needed to help DWR understand the sources of increasing organic nitrogen and how to manage them.

Algae are responsive to the physical and chemical conditions in the aquatic environment. Algal blooms occur when certain conditions exist, such as optimal temperatures, sufficient nutrients, and static or stable waterbodies. DWR's Algal Assessment Program uses phytoplankton unit densities of greater than 10,000 cells/mL to define an algal bloom. In North Carolina, there is a growing concern about the number of cyanobacterial blooms (commonly called bluegreen algae) occurring across the state. Some species of cyanobacteria have the ability to produce toxins, which presents a potential health risk to humans and animals that come into contact with an affected waterbody. As such, blooms that are dominated by cyanobacteria are designated as harmful algal blooms (HABs). Algae are of most concern in drinking water supplies, reservoirs, impoundments and slow-moving/flushing estuaries. While some algae have the ability to produce toxins, many non-toxic blooms can also cause taste and odor problems, water discoloration, form large mats which can interfere with boating, swimming and fishing, and can be associated with fish kills and decreased biodiversity.

DWR now documents reported algal blooms on an online interactive map. In 2018, DWR investigated 37 algal blooms in eight different river basins. Of those, 19 blooms (51%) were categorized as HABs (cyanobacteria dominant). The 2018 HABs occurred in the Neuse, Cape Fear, Chowan, Pasquotank, Tar-Pamlico and Little Tennessee River basins. As of June 2019, DWR collected 17 episodic bloom samples in six different river basins, these include the Neuse, Cape Fear, Chowan, Pasquotank, Tar-Pamlico and Yadkin Pee-Dee River basins. Of those, 12 blooms (70%) were categorized as HABs.

In addition to episodic bloom evaluations, algal monitoring is done as part of the routine basinwide monitoring of North Carolina's lakes and reservoirs. Sites chosen are generally in areas likely to have favorable conditions for algal growth, so the numbers are not necessarily representative of what is happening in all waterbodies across the state. Overall, there were 204 routine samples collected from lakes and reservoirs in the Cape Fear River Basin in 2018. Of those, 140 (69%) met the algal bloom density criterion (greater than 10,000 cells/mL as described above) with 108 (77%) of those being categorized as HABs. Routine basinwide monitoring for 2019 is underway in the Hiwassee, Little Tennessee, Roanoke and White Oak River basins. A total of 33 monitoring stations will be sampled monthly between May and September from 25 different waterbodies. The results will be available in late 2019.

Emerging compounds is a potential issue for all waters (surface and ground) of the state and come from a wide range of sources including pharmaceuticals, pesticides, disinfection by-products, wood preservatives, personal care products and industrial chemicals as well as their by-products. Potential sources include conventional wastewater treatments plants, individual on-site wastewater collection systems, and industrial and chemical manufacturing facilities. GenX and 1,4-dioxane are examples of emerging compounds recently identified in North Carolina surface waters. They often go undetected and untreated because facilities do not have the analytical tools, methods or treatment systems in place that can detect, eliminate or treat them.

While a compound may be unique to a specific source or river basin, many are widespread. The effects of emerging compounds on aquatic ecosystems and on human health are mostly unknown, and the lack of appropriate analytical methods and monitoring techniques makes identification and management a challenge. The uncertainty of whether these emerging compounds are present, their effects on human

health and their impacts to aquatic ecosystems is a growing public concern. Because emerging compounds are not fully understood, States and EPA are working on test methods to identify the compounds in a variety of media (water, wastewater, biosolids, soils, sediment, agricultural products) and identify treatment options for public water supply systems to provide safe drinking water to the public and ensure that aquatic ecosystems are protected.

Specific emerging compounds and emerging issues identified within a basin will be discussed in detail as part of the basin plan document. There were several special studies conducted in 2018 which are summarized below in the specific basin in which the study was undertaken. Basin plans will incorporate as much information as possible on these subjects, however many of these issues are being assessed by several divisions within DEQ. A more comprehensive assessment will likely be available on the Department's website as reports are completed and scientific advisory boards complete their tasks (e.g. GenX Investigation website).

Additional data collected and reported in basin plans include special studies completed at the request of the legislature or Environmental Management Commission or as the result of natural or man-made impacts like hurricanes, droughts or coal ash spills. The results are generally summarized and posted on DWR's website. When appropriate, the results of these analysis are incorporated into our biennial statewide assessment (IR) process and into the basin plan updates. An example of this is the survey of surface water quality impacts and recovery associated with Hurricane Florence which occurred in September 2018. Hurricane Florence impacted nine major river basins including the Cape-Fear, Catawba, Chowan, Lumber, Neuse, Tar-Pamlico, White Oak and the Yadkin-Pee Dee River basins. Samples were collected across 31 counties for a period of up to 10 weeks to evaluate conditions at 55 sites. More than 13,800 individual data points were collected during the two phases (short and long term) monitoring study.

Dilution caused by record-setting rainfall amounts served to minimize initial pollutant impacts on surface waters, although early nutrient and fecal coliform bacteria levels demonstrated elevated concentrations when compared to historic median values. Dissolved oxygen (DO) concentrations were depleted as low DO waters from swamps and low-lying wetlands were flushed out of backwaters and into main river channels.

As flood waters subsided and river levels returned to near baseline conditions, most physical and chemical parameters returned to levels consistent with historic median values, with the exception of instream solids, turbidity and fecal coliform bacteria, all of which increased in concentrations as baseflow conditions returned and accounted for a greater percentage of stream flow. As of April 2019, routine ambient monitoring indicated a return to historic levels for these lingering elevated constituents as well. The completed study results are available here and will be reported in future basin plans.

The Division of Water Resources continues to work in conjunction with the Department of Environmental Quality to implement the Clean Energy Plan, as part of Governor Cooper's Executive Order 80, which supports resiliency measures and planning for climate change impacts across the state. The division reviews water and wastewater treatment facility upgrades with the understanding that the operation must prepare for greater impacts from future storms because of climate change. Interconnection opportunities are also evaluated where marginal facility operations have been evident and common goals could be met in a more efficient, economic, and resilient manner with coordinated use of infrastructure. Discussion with local

facility operators and local officials on potential opportunities are conducted to mitigate fiscal and environmental impacts from climate change.

Summary of Each River Basin

Broad River Basin

Aquatic habitat degradation (as indicated by impaired biological integrity) continues to be identified as a major water quality concern throughout the Broad River basin. Fecal coliform bacteria, turbidity and water temperature have also been identified as parameters of concern. Much of the aquatic habitat degradation and water temperature concerns are due to the cumulative effect of several stressors acting in concert. These stressors often originate in the upstream portions of the basin and may include runoff from impervious surface, sedimentation and stormwater from construction activities, general agricultural practices, and/or other land disturbing activities. Soils in much of the basin are naturally erodible, making sedimentation and erosion a constant concern throughout the basin.

Stormwater, increased flow and velocity, erosion and sediment control, steep slope development, pesticide/herbicides and nutrient management from urban and agricultural land (crop, animal and aquaculture facilities), animal access to streams, and damaged or aging wastewater collection systems have been identified as key contributors to water quality issues and habitat degradation in the basin in the past. It has been recognized that there are also several abandoned furniture manufacturing plants that are contributing large amounts of stormwater runoff due to unmaintained stormwater catch basins and/or impervious surface cover. It has been suggested that these abandoned structures could be marketed for economic redevelopment. Redevelopment could incorporate appropriate stormwater control measures that could reduce the flow and velocity of stormwater runoff, potentially improving downstream water quality.

New impairments were identified for benthic, fish, turbidity and water temperature during the 2018 water quality assessment period. The basin plan will include additional information about water quality monitoring data, water resource concerns, and information about water quality violations in the basin.

Catawba River Basin

Aquatic habitat degradation has been identified as a major water quality concern and has resulted in many biological impairments throughout the Catawba River basin. Changes in land use, particularly an increase in developed and impervious surface areas in and around urban areas, has resulted in more stormwater runoff and an increase in flow and velocity even during small rain events. The sudden increase in volume and velocity can cause significant scouring and erosion along streambanks, eliminating aquatic habitat and increasing sedimentation. Additional studies are needed to determine where stormwater management practices could have the greatest impact on protecting aquatic habitats.

High levels of fecal coliform bacteria have been an ongoing issue in the upper portions of the basin. Sources of bacteria include failing septic systems, straight pipes and animal operations. The Wastewater Discharge Elimination (WaDE) Program was established in 1996 by the NC General Assembly with the goal of eliminating straight-piping and untreated wastewater into western NC rivers and stream. For many years,

the WaDE Program provided financial assistance to repair failing systems in lower income areas. Progress was being made and fecal coliform bacteria levels were starting to decline but progress has slowed with the loss of the WaDE Program. Local efforts by the counties and the Western Piedmont Council of Government (COG) continues the efforts established by WaDE to provide financial assistance on a limited basis. These efforts have resulted in the continuing decline in fecal coliform bacteria levels. Reinstatement of the WaDE Program would greatly decrease the rate at which fecal coliform bacteria is released in streams often used for recreational purposes.

Lake Rhodhiss, Lookout Shoals Lake and Lake Wylie, three of the eight reservoirs sampled by the Intensive Survey Branch (ISB) in 2017, were identified as eutrophic (high biological productivity and low water transparency). Lake Rhodhiss and Lookout Shoals Lake have historically been considered mesotrophic (moderate biological productivity and water transparency) indicating that the reservoirs could be receiving excess nutrients. More information and continued monitoring are needed to identify potential changes to the trophic status of reservoirs in the basin.

Under Session Law (S.L.) 2017-209, Section 12, DEQ was tasked with conducting a nutrient study in the Catawba River basin. The study included using water quality data collected from 41 existing ambient monitoring stations. Ten new stations were added to address data gaps and to identify potential nutrient issues. The study focused on the Catawba River mainstem and major tributaries upstream of Lake Norman as well as the South Fork Catawba River and major tributaries in Burke and Caldwell Counties. Nutrient concentrations were monitored from January 2018 to July 2018.

DWR's Water Sciences Section (WSS) presented a report to the ERC in October 2018. It included information about the study design, existing water quality data, land use, results and conclusions. Data from the report was also included in a Catawba Nutrient Study Story Map. Results showed that the highest mean concentrations of most nutrients were observed in urbanized areas in lower portions of the basin. Some streams north and south of Lake Hickory, however, also experienced high mean ammonia concentrations. In most cases, monitoring stations located immediately downstream of where major tributaries entered the mainstem of the Catawba River experienced an increase in nutrient concentrations while lakes/reservoirs acted as nutrient "sinks", or features that absorb nutrients. Because of the short duration of the study, statistical analyses could not be conducted. Statistical analyses can help identify potential areas of significantly elevated nutrient concentrations. DWR will continue monitoring nutrients at the existing ambient monitoring stations and four of the 10 temporary stations that were sampled during the study period. The study also concluded that more information is needed to understand land use changes over time and how the number of animals and the types of agricultural operations can potentially impact the amount of nutrients in the basin. The report also concluded that an in-depth analysis is needed to identify specific sources of nutrients and that continued maintenance and protection of existing riparian buffers is critical to reducing nutrient loads to the Catawba River.

Efforts are underway throughout the entire basin to protect water supply/source water watersheds. Stakeholders are continually identifying and learning how best to protect those areas. Protecting source water areas can help guide local decisions on water supply needs, economic development, agriculture, and land conservation.

Cape Fear River Basin

Emerging compounds have been identified as a major water quality concern throughout the Cape Fear River basin. DWR has worked with EPA to assess surface waters for 23 different per- and polyfluoroalkyl (PFAS) substances (i.e., C8, GenX, Nafion byproducts) as well as 1,4-dioxane and bromide. Jordan Lake and the watershed draining to it were sampled once a month between January and June 2018. Between May and September 2018, 17 additional water supply reservoirs were sampled once for these same emerging compounds.

In the Jordan Lake watershed study, 1,4-dioxane was detected at five of the 13 stations assessed, mainly in the Haw River arm and the lower portions of Jordan Lake. These same five stations, plus two additional stations north of the lake (New Hope Creek arm and Morgan Creek arm), had one or more of the seven PFAS compounds detected at or above the minimum reporting limit (MRL) on at least one occasion. Bromide was not detected in Jordan Lake or the watershed draining to it. For more specific details on this study see the April 2019 report titled Identification of Select Emerging Compounds in B. Everett Jordan Reservoir, Haw River Arm Watershed, and New Hope Creek Arm Watershed.

Of the 17 additional reservoirs sampled between May and September 2018, 1,4-dioxane was detected in Randleman and Buckhorn reservoirs. PFAS was detected in Cane Creek Reservoir and Lake Brandt. Specific details from this report can be found in the April 2019 report titled Identification of Select Emerging Compound in Public Water Supply Reservoirs in the Cape Fear, New and Watauga River Basins. The basin plan will include detailed information from these emerging compound special studies as well as results from the lower portion of the river basin below Chemours. For specific information on the GenX investigation and the Chemours Consent Order, see the DEQ GenX Investigation website.

Nineteen lakes and water supply reservoirs were also monitored as part of a pilot project for cyanotoxins at a station closest to a water intake. The reservoirs were sampled once a month between May and September 2018 as part of the Cape Fear River basin's routine monitoring by the Intensive Survey Branch's Ambient Lakes Monitoring Program. Samples were analyzed by the Ecosystems Branch's Algal Assessment Program. All microcystin samples were below the instrument detection limit of 0.4 µg/L with one exception. Low levels of microcystin (0.4 µg/L) were detected in Oak Hollow Lake during the August sampling event. This is below the World Health Organization's (WHO) drinking water guidelines for microcystin concentration of 1.0 µg/L. The corresponding phytoplankton sample analysis found a total cyanobacterial cell density of 142,000 cells/mL. Two algal species capable of producing microcystin toxin were documented.

Nutrient enrichment was identified as a major water quality concern in the basin which led to the development of a TMDL and nutrient management strategies in portions of the basin. The basin is also experiencing many of the common water quality concerns seen throughout the state, including increased aquatic life impairments and aquatic habitat degradation due to excessive stormwater runoff. In addition to aquatic habitat degradation, excessive stormwater runoff also leads to increased sedimentation and often elevated fecal coliform concentrations. The lack of riparian buffer protections and requirements throughout the basin may be contributing to many of the water quality issues identified in the basin. The continual loss of riparian buffers will continue to exacerbate impacts to water quality.

A Jordan Lake TMDL was approved by EPA in 2007, and in May 2008, the EMC adopted a nutrient management strategy for the Jordan Lake watershed encompassing both the Haw and New Hope drainage areas. Implementation of certain rules within the strategy has been delayed as a result of multiple legislative mandates beginning in 2012, including the prohibition of local implementation of stormwater rules regarding new development and Stage 2 existing development.

S.L. 2016-94 Section 14.13(e) and S.L. 2017-57 Section 13.24 mandated the study of in-situ treatments in Jordan Lake itself. In the Fall of 2017, a proposed study was denied approval by the US Army Corps of Engineers primarily due to lack of data about effects on biological communities and the potential loss of water storage in the lake.

S.L. 2016-94 Section 14.13(c) and S.L. 2018-5 Section 13.8 directed the NC Policy Collaboratory to undertake a nutrient management study for Jordan Lake, update a quantitative model of Jordan Lake and the Haw River subbasin, evaluate the costs and benefits of nutrient strategies in other states, and provide a final report the legislature by December 31, 2019. The final report is to include recommendations for further actions regarding a regulatory nutrient strategy for Jordan Lake. Interim Collaboratory reports (December 2016, 2017 and 2018) can be found online. The Environmental Management Commission is required to begin Jordan rulemaking upon receipt of the final results, modeling and recommendations of the Collaboratory, or by December 31, 2020, whichever comes first. Ongoing strategy implementation delays will most likely yield additional nutrient reduction needs to sufficiently reduce algal growth to meet water quality standards in Jordan Lake.

As a result of elevated nutrient loading, water quality issues can also be found in the Haw, Deep and Cape Fear rivers below Jordan Lake. In recent years, portions of the Cape Fear River have begun to experience algal blooms, some of which are potentially toxic and have resulted in human contact advisories. Research is occurring at the university level to determine the causes and potential solutions. In addition, DWR is in the beginning stages of developing nutrient and dissolved oxygen models for portions of the Cape Fear River basin. The model(s) will provide tools to evaluate assimilative capacity and provide a mechanism to evaluate the relative impact of various sources on nutrient and dissolved oxygen conditions in the modeled areas. With support from DWR and the associated discharger monitoring coalitions, a two-year intensive monitoring study began in January 2019. The water quality model(s) will be developed following the completion of the study.

White Lake is a unique, Carolina Bay Lake used extensively for water-based recreation activities. This NC State Park lake historically had clear, acidic water with low biological productivity. DWR has monitored White Lake since 1981 as part of the routine basinwide Ambient Lakes Monitoring Program. This routine monitoring indicates that there has been a shift in the biological productivity during the last several years. In 2015, DWR initiated a study as a result of concerns about reduced water clarity and increased algal productivity. To understand why the water quality has changed so drastically in the last several years, a groundwater/surface water survey was done in 2017. That study indicated that deep groundwater aquifers may no longer be providing the inflows that were experienced in the past. It appears the hydrology of the system is now predominantly driven by precipitation and nutrient-rich (nitrogen and phosphorus) shallow groundwater.

In early 2018, the Town of White Lake requested a permit from DWR to apply alum (aluminum sulfate) to the lake to help improve the water clarity and reduce the phosphorus concentrations, thereby limiting algal growth. This treatment (May 2018) coincided with an ongoing intense algal bloom, which acted as a co-stressor with the alum treatment, resulting in a large fish kill. This conclusion was supported by a fish necropsy report conducted by North Carolina State University (NCSU), which referenced a combination of stresses caused by environmental factors from an algal bloom (DO and pH fluctuations) and "acute exposure to Alum" as "a cause of this multi-species fish kill". Dissolved metals analyses from samples collected during the fish kill later confirmed that the concentrations of copper and aluminum were at levels that could cause toxic effects to aquatic organisms.

The results of the 2018 DWR water quality study in White Lake (May - September 2018) found that the application of alum was temporarily successful in shifting the trophic status of the lake from a hyper- to a mesotrophic system. However, it also resulted in the loss of 40 to 50% of the total fish population (Kyle T. Rachels, WRC, personal communication May 2019), resulting in a significant impact on the water quality and ecosystem of the lake. Chlorophyll *a* concentrations began to increase within a few months of the alum application. This, coupled with the fact that sources of nutrients have not been mitigated, indicates that water quality will likely continue to decline.

The Town of White Lake funded researchers from UNCW and the Bald Head Island Conservancy to help better document the sources of groundwater, surface water and nutrients to the lake. The study concluded that rainwater currently drives the hydrologic function in White Lake as opposed to groundwater springs. DWR supports many of the studies recommendations. These include a comprehensive assessment of the town's wastewater collection system for repair/rehabilitation needs, development of a plan to control stormwater runoff and reduce lawn fertilization, reduction of the number of bulkheads, installation of vegetated buffers around the lake and maintaining outflow to reduce lake residence time to improve the lake's water quality.

Greenfield Lake Algal Bloom on May 14, 2019 (Photo courtesy DWR)

A lake-wide cyanobacteria (blue-green algae) bloom was reported on May 14, 2019 in Greenfield Lake. The bloom presented as a bright green surface scum covering nearly 100% of the water's surface. Similar bloom events have been documented annually in Greenfield Lake since 2014. Cyanotoxin analysis did not find detectable levels of microcystin present at the time of sampling. Greenfield Lake has been listed as impaired since 2014 due to exceedances of the chlorophyll *a* standard. A watershed restoration plan was approved in 2016 and revised in April 2019. Several watershed restorations efforts are underway by local stakeholders to address nutrient sources to the lake. This is a highly urbanized watershed and will take a large concerted effort to reduce nutrient loading to the lake.

The long-term water supply needs of the public water systems that depend on surface water from the Deep, Haw and Cape Fear river subbasins were evaluated using the Cape Fear-Neuse River Basins Hydrologic Model. The multi-year process resulted in round four of the Jordan Lake surface water allocation. The allocation was approved in March 2017 by the EMC and included new and increased water supply allocations from the Jordan Lake water supply pool. The EMC approved water supply allocations to the following 10 water supply systems: a joint allocation to the towns of Cary and Apex and Wake County, Chatham County, the city of Durham, the town of Hillsborough, the town of Holly Springs, the town of Morrisville, Orange County, Orange Water and Sewer Authority, the town of Pittsboro, and the city of Raleigh.

The water supply pool of Jordan Lake is 95.9% allocated following the round four allocation process. During the 2019 reporting period, staff and attorneys with DEQ as well as attorneys with the Attorney General's Office prepared and distributed draft contracts to the water supply systems, received comments back from the systems, and are finalizing contracts for the round four water supply allocations. Details of the Jordan Lake water supply allocations and the Cape Fear River surface water supply evaluation can be found on the DWR website.

The EMC also approved an interbasin transfer (IBT) certificate for Pender County at the commission's July 12, 2018 meeting. The IBT certificate allows Pender County to transfer up to 14.5 million gallons per day (mgd) from the Cape Fear River IBT basin to the South River IBT basin, Northeast Cape Fear River IBT basin, and the New River IBT basin. The transfer amount is based on population growth and water use projections through the year 2050, as well as planned water system expansions into the county's other four water and sewer districts that are not currently served by county municipal water. Additionally, there are plans for service to be provided to local municipalities within Pender County that currently operate their own water systems and are reliant upon groundwater. This includes the towns of Burgaw, Topsail Beach, Surf City and Wallace as well as a water utility, Utilities, Inc. During the 2019 reporting period, Pender County was transferring between 1 and 2 mgd day from the Cape Fear River IBT basin.

Water quality and quantity issues will be discussed in detail in the Cape Fear River basin plan. Due to the size of the Cape Fear River basin, the basin plan will be presented to the EMC as major watersheds or sections are completed.

Chowan River Basin

The Chowan River basin plan is scheduled to be presented to the EMC for approval in 2020. Nutrient loading continues to be a water quality issue throughout the basin. First documented in the 1990s, the basin was the first to have nutrient reduction goals with a 20% reduction of nitrogen and 35% reduction of phosphorus. The goals were established through the Nutrient Sensitive Waters (NSW) Water Quality Management Plan for the Chowan River Basin. Even with the NSW management plan in place, the Chowan River and its tributaries have seen a steady increase in organic nitrogen concentrations since 2000, with

significant algal blooms reported since 2015. Algal blooms were confirmed as early as June 2018 near the Chowan Beach and as early as May 2019 on the Chowan River near Harrellsville. DWR defines an algal bloom as having dissolved oxygen (DO) concentrations at or above 9 milligrams per liter (mg/L) (110% saturation) and a pH higher than 8 mg/L. An algal bloom is also defined as algal concentrations at or above 10,000 units/mL (unit density). The bloom confirmed on May 13, 2019 on the Chowan River near Harrellsville had algal cell counts of 697,300 cells/mL. The physical parameters (DO and pH) did not indicate the presence of an algal bloom. The chlorophyll *a* concentration, however, was 610 µg/L. The state's current chlorophyll *a* standard is 40 micrograms per liter (µg/L).

Algal Bloom on the Chowan River May 13, 2019 (Photo courtesy of DWR)

Since 2002, a portion of the Chowan River was on the 303(d) list for exceeding the cadmium water quality standard for aquatic life. In 2016, the river was included in the targeted study for sampling based on the new dissolved metals water quality standards. Based on sampling data collected during the 2018 IR assessment period, this portion of the Chowan River was delisted.

Because 75% of the river basin is in Virginia, the Albemarle-Pamlico National Estuary Partnership (APNEP) is working with natural resource agencies and stakeholders in Virginia and North Carolina to understand nutrient loading and its impact to water quality in North Carolina. The Albemarle Commission has obtained grants from the Clean Water Management Trust Fund (CWMTF) and the US Fish and Wildlife Service (USFS) to study what is contributing to the algal blooms. These efforts include state agencies, universities and local, citizen-led environmental groups. A meeting was held in Edenton in January 2019 to share information on the possible causes and solutions to the algal blooms occurring in the Albemarle region.

French Broad River Basin

Sediment, nutrients and bacteria are the most significant threats to water quality and aquatic habitats in the French Broad River basin. Several stream segments and waterbodies within the basin are classified for recreational use, and fecal coliform bacteria has been identified as a water quality concern in some of these recreational areas. Sources of bacteria include (but are not limited to) failing septic systems, straight pipes, sanitary sewer overflows and animal access to streams. Heavy storm events often result in increased levels of fecal coliform bacteria being delivered to waterbodies via nonpoint source runoff. Increased flows also resuspend or mix bottom sediment which can increase bacterial levels in the water during and after rain events.

Between August and September 2018, DWR worked with Duke Energy and Warren Wilson College to study chronic cyanobacterial blooms in Waterville Lake. Waterville Lake is an impoundment on the Pigeon River in Haywood County in the French Broad River basin. A bloom was first observed in early August 2018. The bloom persisted until early September 2018 but dissipated after Hurricane Florence swept through the

region. The dominant, bloom-forming taxon, *Microcystis aeruginosa,* is a known producer of the cyanotoxin microcystin. Analysis of cyanotoxin samples collected during bloom monitoring found detectable levels of microcystin on eight occasions. Three samples (two in August and one in September) exceeded the recreational guideline of 10 µg/L recommended by the World Health Organization (WHO). Cyanotoxin results from August 24, 2018 and August 28, 2018 (580 µg/L and 260 µg/L, respectively) are among the highest concentrations of microcystin detected by DWR to date.

Working with Duke Energy, Warren Wilson College and Haywood Waterways Association (HWA), efforts are underway by DWR's Asheville Regional Office (ARO) to identify potential causes of the cyanobacterial blooms in Waterville Lake. In December 2018, 14 additional sampling locations were added to the six existing ambient monitoring stations in the watershed. These 14 stations will evaluate water quality conditions in streams that could be contributing fecal coliform bacteria and nutrients to the Pigeon River watershed as a whole.

Hiwassee

Sediment, warmer temperatures in areas with inadequate riparian buffers, and unstable streambanks is a significant threat to aquatic habitat in the Hiwassee River basin. Bacterial contamination caused by a combination of cattle access to streams, failing septic systems, year-round Canada geese populations, and aging wastewater infrastructure have been associated with bacterial impairments in the basin. Significant hydrologic modification in the basin from the Chatuge, Hiwassee, and Appalachia dams along the Hiwassee River have altered the natural flow regime and stream habitat. Generally, the water released from the dams is good quality, but the colder waters released from the dams have changed the fish community from historic records and there is limited information on what alterations to the benthic communities may have occurred. The magnitude and duration of the dam releases have also caused some problems downstream. Streambank erosion from fast moving water and flooding of homes and agricultural fields were reported because of dam releases after heavy rain events in 2018.

Construction in the basin has increased impervious surface areas and altered natural hydrology by inhibiting stormwater infiltration. Building near steep and unstable streambanks has been particularly problematic for stream sediment inputs. Implementation of stormwater best management practices (BMPs), riparian buffers, and cattle exclusion fencing is highly needed in some areas of the basin. Ambient water quality monitoring by DWR in the basin is also limited. Currently, there are only two permanent ambient monitoring stations in the entire 644 square mile watershed.

DWR staff met with Commissioner Marion Deerhake and Callie Moore, the director of the Hiwassee River Watershed Coalition (HRWC), to tour the basin in July 2018 and June 2019. Areas known to have water quality issues or flooding were reviewed along with successfully implemented BMPs such as restored streams and riparian buffers.

A section of the Valley River (from Vengeance Creek near Marble to Marble Creek above Murphy) was delisted for fecal coliform bacteria in 2018. An upstream point source discharger is in the process of improving its collection system and modernizing its treatment technology. This likely resulted in the

reduction of instream fecal coliform bacteria concentrations and the water quality improvement recorded in the river.

Little Tennessee River Basin

Impairments on the 2018 303(d) report in the Little Tennessee Basin are fecal coliform bacteria (FCB) and exceedances of both benthic macroinvertebrate and fish community ratings. Identified as key contributors to water quality concerns in the 2012 basin plan were steep-slope development, agricultural runoff, streambank erosion, reduced riparian areas, failing culverts and damaged or aging individual septic and municipal wastewater collection systems.

Iotla Creek was removed/delisted from the 2018 303(d) impaired list for fish community but still remains for FCB. Whiteoak Creek was delisted for benthos as well. The Tuckasegee-Little Tennessee river confluence at Fontana Reservoir was added to the list for FCB.

Fontana Reservoir, a Tennessee Valley Authority (TVA) impoundment, is formed by a dam downstream of the confluence of the Little Tennessee, Tuckasegee and Nantahala rivers. Although the Tuckasegee arm of Fontana Lake had potentially harmful algal blooms (pHABs) during the summers of 2015 through 2017, no blooms were reported for 2018 or 2019. Although previous water quality data collected at the ambient monitoring station just upstream of the impoundment indicate that nonpoint source runoff during rain events may be adding excess nutrients to the river and contributing to the algal blooms, the exact source of the nutrients or the triggering conditions to create a noticeable algal bloom are unknown. Additional research and analytical tools would help DEQ understand the cause of the algal blooms.

Fontana Reservoir is scheduled for water-quality sampling by DWR in the summer of 2019, including microcystin toxin analysis (cyanobacteria toxin). Also scheduled for sampling in the basin are five impoundments owned by Duke Energy (Nantahala, Bear Creek, Cedar Cliff, Wolf Creek, Thorpe), three owned by Brookfield Renewable (Santeetlah, Cheoah, Calderwood) and one owned by the town of Highlands (Sequoyah).

The Asheville Regional Office (ARO) has a focused sampling efforts on the lower Cullasaja River with assistance from Mainspring Conservation Trust. In July 2018, the Cullasaja River exhibited a decline in benthic macroinvertebrate bioclassification ratings from the headwaters moving downstream to the confluence with the Little Tennessee River. The Cullasaja River changed from an Excellent rating at the most upstream reference site to a Good and then Good-Fair rating furthest downstream near the confluence with the Little Tennessee River. This trend suggests possible water quality declines in the downstream reaches due to nonpoint source pollution. In addition to overall declines in benthic richness and abundance when comparing the reference to the downstream reaches, the increased biotic indices suggests fewer pollution intolerant and more tolerant benthic fauna.

A watershed action plan (WAP) was developed for the Scotts Creek watershed using a Clean Water Management Trust Fund grant and local contributions. The creek is classified as C; Tr; passes through the towns of Sylva and Dillsboro; and is a tributary of the Tuckasegee River, with the confluence at a popular boating access site at Highway 23/441, just downstream of the site of the Dillsboro dam removal. Scotts Creek, as well as the Tuckasegee River, is 303(d)-listed for FCB. Some of the recommendations in the WAP

include a county-wide assistance program to repair failing septic systems, high-impact stormwater and riparian restoration projects at 17 locations identified within Sylva and an improvement plan for the town's Bridge Park.

In April 2019, the U.S. Forest Service published, a draft environmental assessment (dEA) for the Buck Project, a 20,638-acre management unit in southeastern Clay County that includes the Buck Creek watershed, which is a tributary to the Nantahala River upstream of Nantahala Reservoir. The dEA is a multidimensional plan that encompasses timber harvest, temporary road construction, invasive plant control, stand improvements, controlled burns, wildlife forage plantings and stream restorations. In the Buck Creek watershed, proposed restoration efforts include reintroducing brook trout to Little Buck Creek; removing dispersed campgrounds in the Glade Branch floodplain, stabilizing streambanks, removing trash dumps and eliminating off-road vehicle access and an old road in the Barnards (Branch) Creek riparian zone, removing a log crib fish barrier and stabilizing stream banks.

In preparation for the 2021 Little Tennessee River basin plan, DWR basin planners and ARO staff traveled with Environmental Management Commission (EMC) member Marion Deerhake to tour areas of the basin in July 2018 and June 2019. Some locations known to have water quality or flooding problems were inspected along with successfully implemented best management practices (BMPs) such as restored streams and riparian buffers. In addition, the group met with representatives from environmental groups active in the basin and members of the business community that utilize the natural resources.

Lumber River Basin

Stormwater, rapid growth and development, damaged or aging wastewater infrastructure, and large agricultural operations were identified as water quality issues in the 2010 Lumber River basin. Elevated bacteria concentrations from stormwater runoff, leaking septic systems and/or municipal wastewater collection systems are impacting shellfish harvest areas with all shellfish waters impaired due to either permanently or frequently closed shellfish areas. In 2019, nearly 3,000 acres of shellfishing waters were closed indefinitely, leaving both commercial fisherman and seafood dealers concerned about their livelihoods.

Much of the stormwater runoff can be attributed to population growth in Brunswick County which is in the lower part of the basin. Brunswick County alone has grown over 500% in the last 50 years. Efforts are underway to reduce stormwater runoff in the Lockwoods Folly River watershed along the Brunswick County coast. A Water Quality Management Plan became effective in 2014 and includes Lockwoods Folly River north from the Intracoastal Waterway to a line extending from Genoes Point to Mullet Creek to protect and improve water quality throughout the watershed. Proper planning including stormwater management programs, wastewater treatment plant upgrades, and land conservation are required to protect water quality as the area continues to grow. For activities, such as stormwater controls, proactive implementation prior to development can save considerable costs compared to retrofitting. Low dissolved oxygen, turbidity and low pH have also been identified as parameters of interest in the basin.

As with Hurricane Matthew in 2016, Hurricane Florence had a devastating impact on the Lumber River Basin. Three months before Hurricane Florence, Governor Cooper's office published extensive studies of

flooding concerns and possible solutions for flooding in the Neuse, Cape Fear and Lumber rivers during Hurricane Michael. These studies looked at a range of flood prevention projects, including new dams, reservoirs and levees. The studies concluded that the most cost-effective approach is elevating flood-prone buildings or buying out the properties and demolishing buildings.

In the fall of 2018, Duke Energy awarded a $100,000 grant to the Lumber River Conservancy to benefit both Scotland and Roberson Counties. This effort supports a partnership with UNC-Pembroke researchers to characterize and better understand the impact of excess nutrients on the Lumber River's microbial biodiversity. It is anticipated that gaining this knowledge will serve to provide necessary information to make informed decisions on how to best improve, protect and monitor the water quality of the Lumber River.

This past March, staff met with Commissioner Shannon Arata for a meeting that included a preliminary discussion on the Lumber River basin.

Upon completion of hydrologic models for the New, Watauga, and French Broad River basins, DWR will begin developing a hydrologic model for the Lumber and Yadkin-Pee Dee River basins.

Neuse River Basin

The Neuse River Basin Water Resources Plan is currently being updated. The basin plan will be completed in two steps. The first piece will include an assessment of the Neuse River Basin NSW Strategy and trend analysis. The main focus during this reporting period has been on trend analysis and interpretation which is ongoing at this time. The full plan will follow and will include a Falls Lake Management implementation progress report, the Cape Fear–Neuse River basin hydrologic model and analysis along with the general water quality and quantity issues at the subbasin and basin level.

Nutrient strategy implementation efforts are ongoing for the Neuse River Estuary and have been reported to the Water Quality Committee (WQC) and EMC over time, as requested and through the annual agricultural report to the EMC. DWR resources and implementation activities in the Neuse River Basin have also focused heavily on the implementation of the Falls Lake Nutrient Strategy.

Water quality analysis of basinwide nitrogen loading in the Neuse River Estuary indicates that the overall nutrient strategy goal to reduce total nitrogen by 30% has not been achieved. Initial nutrient reduction efforts were successful in reducing loads from both municipal and agricultural sources, as well as mitigated nutrient loading from increased population growth within the basin. The required riparian buffers have helped to limit additional nutrient-laden stormwater runoff from new and existing development throughout the basin. However, despite these efforts and reductions that have been made, DWR has identified an increase in the organic nitrogen load. This increase is currently offsetting the reductions made as result of the nutrient strategy rules.

The goal of limiting total nitrogen loading is to reduce exceedances of chlorophyll *a*, an indicator of algal growth. Because of this, changes in chlorophyll *a* in the estuary are also being assessed alongside trends in nutrient loading. The extent of the chlorophyll *a* impairment increased in the Neuse River Estuary between the 2016 and 2018 Integrated Reports. For the 2016 Integrated report, the lowest point in the estuary that

exceeded criteria for chlorophyll *a* was Minnesott Beach. In the 2018 report, assessment units that exceed criteria stretch from the confluence of the Trent River at New Bern to the South River. DWR ambient data indicates that this is related to high mean annual flows in recent years (Figure 5). Greater flows through the Neuse River carry nutrients further into the estuary before conditions become favorable for algal growth. In wet years like 2015 and 2016, chlorophyll *a* exceeds the standard more frequently in the lower middle (station J8910000) and lower (J9810000) segments of the estuary, whereas dry years like 2017 exhibit higher algal growth in the upper middle (station J8902500) estuary (Figure 5). Because of the yeartoyear changes in spatial extent of chlorophyll *a*, primarily driven by meteorological conditions, it is challenging to discern whether management actions have resulted in a reduction in algal growth. Further analysis will be included in the NSW chapter.

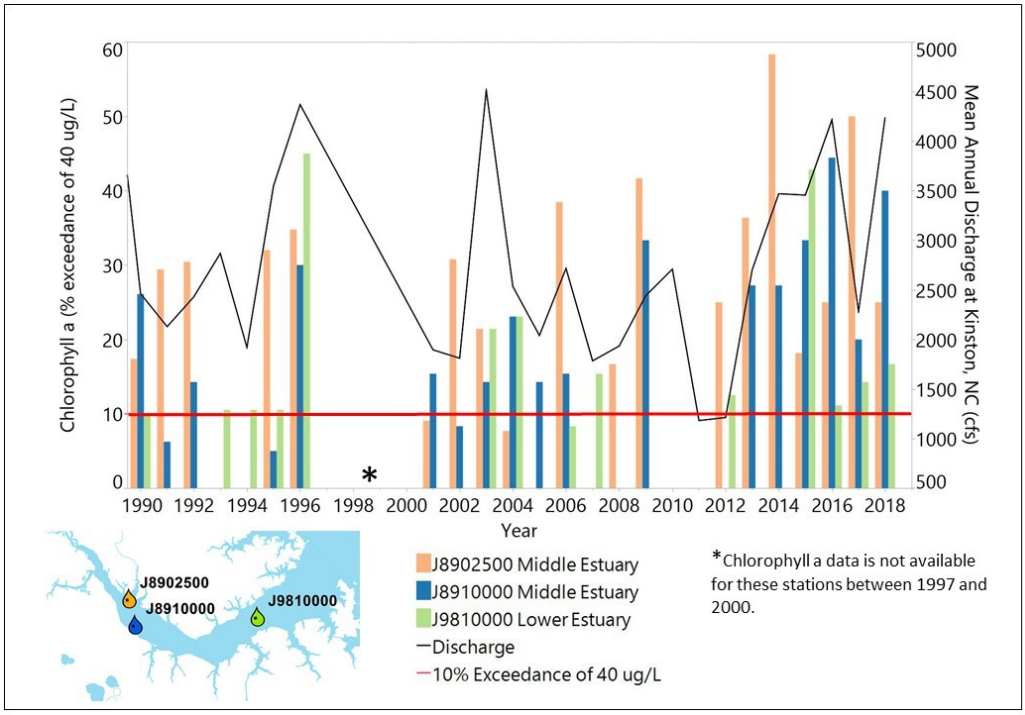


Figure 5: Percent Chlorophyll *a* Standard Exceedances in the Neuse River Estuary and Mean Annual Discharge at Kinston, NC

As part of the required basin planning process in a designated NSW watershed, the success and limitations of the NSW rules are evaluated. In the Neuse River basin, the last basin plan identified gaps in the existing nutrient management strategy and included recommendations or modifications to improve the strategy's efficacy. Some of these recommendations have been proposed for inclusion in the readoption of the Neuse strategy rules that is currently underway pursuant to G.S. 150B-21.3A. Draft amended Neuse and Tar nutrient rules are currently scheduled for EMC adoption at its September 2019 meeting.

The DWR continues to develop and assess new information that can inform future Neuse nutrient strategy improvements. Recent internal efforts have focused on identifying potential sources of increasing organic

nutrient loads to the Neuse River Estuary. Areas of inquiry include the potential influence of poultry operations, changes in acid rain deposition and soil pH resulting in increased export of organic nutrients, an evaluation of organic nitrogen trends in North Carolina and neighboring states, and an evaluation of laboratory methods over time. To date, no single source has been identified as the cause for increasing organic nitrogen trends. Further systematic evaluation is needed to identify or exclude many potential sources of increasing organic nitrogen in the Neuse River basin.

Buffer and new development rules and Stage I of agriculture and wastewater rules are fully implemented in the Falls Lake watershed. Recent efforts have focused on implementing Stage I of the rule related to existing development. These efforts have included the development of credits for new nutrient reduction practices and establishment of local jurisdictional load reduction requirements. The Upper Neuse River Basin Association (UNRBA) continues its longstanding advancement of these rules by providing a forum for engagement and policy discussion among Falls Lake local governments and by providing water quality data and modeling support for a reevaluation of the Stage II requirements.

By recent session laws, Falls Stage II initiation is postponed and will presumably be supplanted by the results of Falls Lake rules readoption. The timeline for the Falls Lake nutrient strategy rules readoption was delayed by S.L. 2016-94 and S.L. 2018-5. According to the current timeline, the N.C. Policy Collaboratory will provide the final results and recommendations of its Falls Lake study by December 31, 2023. SL 2018-5 further requires the Environmental Management Commission begin Falls Lake rulemaking upon receipt of the Collaboratory's findings or by December 31, 2024, whichever comes first.

Emerging compounds have been identified as a concern in several river basins. The division conducted a special study evaluating surface waters at five stations in Falls of Neuse Reservoir and five stations in the watershed draining to it (once a month, July – December2018; except for September) for 23 different per and polyfluoroalkyl substances (such as C8, GenX and Nafion byproducts) as well as 1,4-dioxane and bromide.

Knap of Reeds Creek (J1210000; at WWTP outfall near Butner) was the only site to exhibit detectable concentrations of one of two target PFAS analytes at or above the minimum reporting limit (MRL) on July 26, 2018 and November 29, 2018. Only a single detection of 1,4-dioxane was found at the Falls Lake/Ledge Creek station (NEU18E; mouth of Ledge Creek near Creedmoor) on August 16, 2018. Bromide was not detected throughout Falls Lake or the watershed draining to it. For more specific details on this study see the April 2019 Identification of Select Emerging Compounds in Falls of Neuse Reservoir and Surrounding Watershed.

Two potentially toxic algal blooms where investigated in the Neuse River basin. One in Lake Lynn (Raleigh) in October 2018. The dominant algal bloom species are known to potentially produce the toxin microcystin. Toxin analytical results were not available at the time. A similar cyanobacterial bloom occurred in 2017, with microcystin toxin detected at a concentration of 6 µg/L. A cyanobacterial bloom was detected in Bond Lake (Cary) on May 26, 2019. Bond Park lake staff were alerted to the presence of the potentially harmful algal bloom and posted warning signs at public access areas around the lake, they were removed once DWR confirmed the bloom had dissipated.

New River Basin

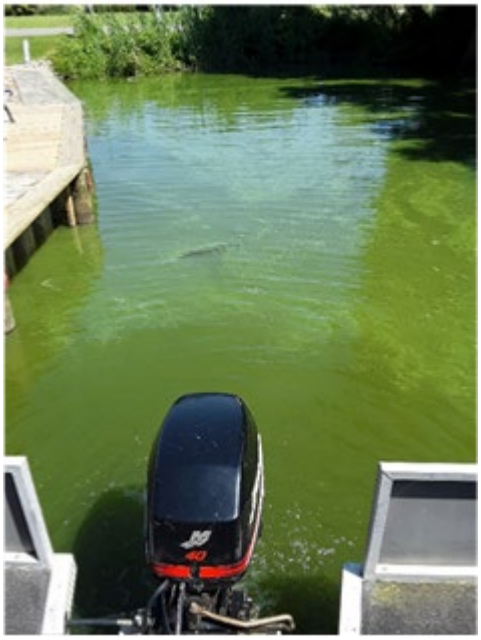
Aquatic habitat degradation (as indicated by impaired biological integrity and high turbidity) has been identified as a major water quality concern in the New River basin. In most cases, degradation is the result of the cumulative effect of several stressors acting in concert. The stressors often originate in the upstream portions of the basin and include runoff from impervious surface, sedimentation from construction runoff, general agricultural practices, and/or other land disturbing activities. The distribution of turbidity permit violations and standard exceedances at AMS stations make it difficult to isolate potential sources in the New River Basin. However, it appears that violations are highest in urban and agricultural areas. Violations are lowest in most headwater portions of the basin where land use is predominantly forested. This demonstrates the importance of protecting and conserving stream buffers and natural areas.

DWR staff members met with Commissioner Bill Puette, George Stantucci, President of the New River Conservancy (NRC), and Chelsea Blount, NRC River Restoration Director, in August 2018 to review the history of the New River and its Wild & Scenic River designation and to understand current events and existing water resource concerns throughout the entire basin. Mr. Stantucci and Ms. Blount reviewed existing and future projects within the basin and led the group on a tour of a restoration project on Naked Creek. The project daylighted several unnamed tributaries in such a way that the tributaries now follow existing topography. To date, 3,000 linear feet of stream have been restored. The ultimate goal is to remove the lower portion of Naked Creek (from Little Naked Creek to the South Fork New River) from the 303(d) list of impaired waters.

Pasquotank River Basin

Nutrients continue to be a water quality issue throughout the entire Pasquotank River basin. Since the early 1990s, monitoring data has shown a steady increase in phosphorus in the Little River, and a steady increase in organic nitrogen has also been identified across all ambient monitoring stations since the mid-1990s. The steady increase in nutrients are likely contributing to the algal blooms that were reported in the Albemarle Sound, Little River and Perquimans River since 2015.

Little River Algal Bloom July 2, 2019 (Photo by R. Johnson)



From late May 2019 to early July 2019, cyanobacterial blooms have been observed intermittently in the Little, Pasquotank, and Perquimans rivers. Local environmental groups reported a 1,600 acre algal bloom in the Little River on June 1, 2019. Water samples collected from the Little River and its tributaries indicate high levels of phosphorus are entering the system. Land use in the Little River watershed at ambient monitoring station M3500000 is 70% agricultural and 20% wetland.

The Albemarle Commission obtained grants from Clean Water Management Trust Fund (CWMTF) and US Fish and Wildlife Services to study the drivers of algal blooms in the Albemarle Sound. The Commission is collaborating with state agencies, universities and local citizen-led environmental groups. A

meeting was held in Edenton on January 30, 2019 to share information on the possible causes and solutions to the algal blooms occurring the Albemarle region. Research is currently focusing on the Little River Watershed in the Pasquotank River Basin.

The Albemarle Resource Conservation and Development Council (RC&D) and the Albemarle Soil and Water Conservation Districts (a multi-county soil and water conservation district), along with eight counties surrounding the Sound have adopted and sent to legislators a resolution to strengthen critical drainage and water quality infrastructure. Drainage canals can carry sediments and nutrients to the river, and residential and commercial developments contribute to increased pollution from stormwater runoff.

Roanoke River Basin

During previous sampling events, field biologists noted an increase in sedimentation at three fish community sampling sites and recommended additional sampling be done to confirm the biological ratings. Based on the additional sampling, the three stream segments were delisted from the 2018 303(d) list based on changes to the biological ratings, or improved bioclassifications. Declining dissolved oxygen levels as well as elevated water temperature, fecal coliform bacteria and turbidity concentrations, continue to be identified as water quality concerns throughout the entire basin. Field biologists noted higher levels of precipitation during benthic sampling, suggesting waterbodies are being impacted by increased nonpoint source pollutant runoff from upstream sources.

Since the approval of the 2012 basin plan, a major water quality issue that has been identified in the basin is the coal ash spill that occurred in the Dan River from Duke's Dan River Steam Station near Eden. The spill occurred in February 2014. Current water quality monitoring data of the Dan River indicate that levels of coal ash related constituents are similar to conditions measured upstream, indicating that the constituents are naturally occurring, or background levels. Coal ash excavation from the onsite basins started in November 2015. The dewatering and removal of coal ash from the Dan River Station surface impoundments was completed on May 20, 2019.

Savannah River Basin

Several streams in the Savannah River basin have the supplemental classification of Trout (Tr) and Outstanding Resource Waters (ORW) with portions of two rivers (Horsepasture and Chattooga) being designated as a National Wild and Scenic River. Horsepasture River below N.C. 281 to Lake Jocassee is also designated as a NC Natural and Scenic River. Currently, there are no waterbodies within the basin listed on the 2018 303(d) list. Biological sampling of stations in the basin occurs in 2019 and will be used to assess water quality during the 2020 IR assessment period. Ten benthic stations will be sampled in the basin by DWR in 2019. No lakes or fish stations are scheduled for assessment in 2019.

The federal government is the single largest land owner in the basin, and the U.S. Forest Service (USFS) has the responsibility for managing these resources. The management of the land and waters, as well as access and use, can have ramifications to the quality of the streams that drain these watersheds. The revised, draft Nantahala and Pisgah National Forests land management plan is scheduled for release in 2019 following a stakeholder process that began in 2014. The existing management plan was first published in 1987.

The USFS issued the Final Decision Notice and Finding of No Significant Impact in February 2019 for the Southside Project. The project will occur in southern Macon and Jackson counties and in various plots from the Norton Branch watershed to the Whitewater River watershed. The project is a multidimensional plan that encompasses timber harvest, temporary road construction, invasive plant control, stand improvements, controlled burns, wildlife forage plantings and some stream restoration. To address the sedimentation of Scotsman Creek, the USFS proposes instream structures and streambank stabilization to reduce erosion and improve instream pools.

In preparation for the 2021 Savannah River basin plan, DWR basin planners met with Commissioner Marion Deerhake and staff from the Asheville Regional Office (ARO) to tour the basin in July 2018 and June 2019. The group toured stream restoration sites and met with representatives of environmental organizations to discuss local water quality concerns and initiatives to address water quality concerns including low pH, elevated temperatures, sediment and fecal coliform bacteria in portions of the basin.

Tar-Pamlico River Basin

The 2015 Tar-Pamlico River basin plan was the first attempt to integrate water quality and water quantity planning. Stormwater, increased flow and velocity, erosion and sediment control, pesticide and nutrient management from urban and agricultural land (crop, animal and aquaculture facilities), and damaged or aging wastewater collection systems have been identified as key contributors to water quality issues in the basin. Several communities in the basin do not have or do not fall under a stormwater management program and additional research is needed to assess how uncontrolled stormwater runoff is impacting surface waters and nutrient loading to the estuary. Protecting existing riparian buffers can also play a critical role in stabilizing and protecting streambanks and reduce nutrients from overland flow.

Because nutrients have been a water quality concern for the basin, waters in the basin were designated as nutrient sensitive waters (NSW) in 1989. Despite the apparent successful implementation in reducing nutrient loads from municipal wastewater facilities and several agricultural practices, the goal of reducing total nitrogen by 30% has not been met. Data collected over the last several years indicate that organic nitrogen is increasing. As described in the Neuse River Basin section, recent internal efforts have focused on identifying potential sources of increasing organic loads to North Carolina's estuarine waters.

The plan also notes that there are likely nutrient sources beyond those regulated under the nutrient management strategy that may be contributing to the nutrient loads and that some nonpoint sources may not have been accounted for or are exceeding the original source (i.e., land use changes or changes to agricultural operations). While the implementation efforts taken to date have not fully achieved compliance with the NSW strategy, the nutrient reductions achieved by point sources and agriculture have helped reduce the severity of fish kills in the Pamlico River and Estuary. DEQ is continuing to work with municipal wastewater facilities and the agricultural community to maintain their compliance with the strategy.

As part of the required basin planning process in a designated NSW watershed, the success and limitations of the NSW rules are evaluated. In the Tar-Pamlico River basin, the evaluation identified gaps in the existing nutrient management strategy and included recommendations or modifications to possibly improve the strategy in order to meet water quality standards in the estuary. As a result of the required rules review

legislation (§150B-21.3A), the Tar-Pamlico River Basin NSW Management Strategy rules found in 15 NCAC 02B .0255 - .0261 must be re-adopted.

Since 2014, DEQ has worked with stakeholders to address concerns with the existing nutrient management strategy and the nutrient offset rule that applies across nutrient strategies. Because the water quality standard is still not met in the Pamlico River Estuary, DEQ has proposed minor modifications. The modifications address the recommendations identified during the basin planning process as well as the rules review and stakeholder input process. Reviewing and modifying the existing rules provides an opportunity for the State to grant additional protection and/or management measures in the basin to achieve the required goal of improving water quality and meeting water quality standards in the Pamlico River Estuary. As technology and scientific knowledge improves, as well as land use and development changes continue, it is important to utilize the adaptive management approach to improve the outcome and protections necessary to improve water quality in the estuary.

Located in the Tar-Pamlico River basin, Lake Mattamuskeet is the largest natural lake in NC and is part of the Mattamuskeet National Wildlife Refuge. The lake provides habitat for over 250,000 wintering waterfowl and other migratory birds. The entire lake was added to the 2016 impaired waters 303(d) list due to elevated chlorophyll *a* concentrations and pH levels. USGS monitored the lake on four occasions between May and September 2017. DWR monitored the lake in May 2017 and found that the lake's trophic status has increased from eutrophic to hypereutrophic. The chlorophyll *a* concentrations in June 2019 measured close to 200 µg/L (state standard is 40 µg/L). DWR is working with the US Fish and Wildlife Service (FWS) to better understand the water quality of this unique system and to understand the nutrient sources and algal bloom issues. Algal blooms have become a more frequent occurrence and contain harmful cyanotoxin concentrations leading the FWS to post warning signs around the lake in 2019 about health risks associated with harmful algal bloom exposure.

A local watershed restoration planning effort began in 2016 and has involved many different stakeholders in order to identify the sources of the problems within the watershed as well as identify solutions. The North Carolina Coastal Federation is partnering with the US Fish and Wildlife Service, the NC Wildlife Resources Commission and Hyde County to develop the *Lake Matthamuskeet Watershed Restoration Plan*. Development of the plan has included many stakeholder and public meetings. The three main goals of the plan are:

1. Protect the way of life in Hyde County while supporting the lake's natural resources.
2. Reduce flooding by improving the ability to control lake levels.
3. Restore water quality by reducing nutrients and sedimentation, which will promote the growth of submerged aquatic grasses for waterfowl habitat and removing the lake from the state's impaired waters list.

The final draft of the plan was presented during a public symposium in Hyde County on December 3, 2018. The plan was submitted to DWR for approval in December 2018 and an addendum in July 2019 addressing a few missing elements needed to fulfill the EPA 9 element plan requirements, making the Lake Mattamuskeet watershed area eligible to receive EPA restoration funds. The plan was approved by DWR

on August 7, 2019. Research and restoration efforts identified in the plan are currently underway by several of the project partners.

Watauga River Basin

The Watauga River Basinwide Water Resource Management Plan was approved by the EMC in October 2018. Stormwater, steep slope development, limited riparian areas, streambank erosion, individual onsite wastewater collection systems as well as damaged or aging public water supply (PWS) systems and municipal wastewater collection systems are impacting water quality and quantity throughout the basin. Water quality data collected at the ambient monitoring stations and by the Wildlife Resources Commission indicate that water temperatures are increasing in the mainstem of the Watauga River. Many of the streams in the basin support a rich and diverse trout population, but the numbers have been declining over recent years due to development, limited shade from riparian areas and increased stormwater runoff.

Beaverdam Creek is the only impaired water in the North Carolina portion of the basin. Several agricultural BMPs have been installed and continue to be installed throughout the watershed in an effort to improve aquatic habitat with the goal of removing the stream from the impaired waters list.

Information about water supply and demand was included in the 2018 basin plan. Information about water supply and demand was obtained from various sources including programs managed by DWR's Water Supply Planning Branch. One PWS system, the town of Beech Mountain, was identified in the basin plan as a system that cannot meet its current water supply needs during low flow or drought conditions. DWR's Water Supply Development Program continues to work with the PWS to identify how best to meet current and future water supply needs.

White Oak River Basin

The White Oak River basin plan is currently being developed and is scheduled to be presented to the EMC for approval in 2020. Stormwater runoff, new development/construction, impervious surface areas, animal waste management, and damaged or aging wastewater collection systems are impacting water quality in the White Oak River basin. Coastal communities in the basin are constantly changing, and for decades, the traditional uses of waterfront property have been shifting to accommodate an increase in permanent residents, seasonal rental properties and new development. Residential development has moved inland along tidal creeks and rivers introducing more impervious surface area and increased stormwater runoff. As a result, many of the water dependent resources that people seek out from the coastal areas are diminishing. Public waterfront access is limited, high fecal coliform levels prevent shellfish harvesting and beach recreation, fish houses have closed, and overall fish harvests have continued to decline in the White Oak River basin. The Support Shellfish Aquaculture bill (S.L 2019-37), was passed in June 2019 during the General Assembly's long session. The bill establishes a shellfish enterprise area that will streamline the permitting and re-leasing processes, ensuring the sites growers are leasing won't interfere with other users of public trust waters.

Calico Creek, a tributary to the Newport River, is a shallow tidal estuarine creek located in Morehead City. The creek was added to the 2008 impaired waters 303(d) list due to standard violations for chlorophyll *a*, turbidity, dissolved oxygen and total copper. The creek also has high fecal coliform bacteria concentrations

which result in shellfish harvesting closures in the Newport River. DWR has completed a two year special monitoring study of the Calico Creek watershed to support the development of a nutrient model.

Several agencies, including DWR, Division of Coastal Management (DCM), Division of Energy, Mineral & Land Resources (DEMLR), Division of Marine Fisheries (DMF), the Soil and Water Conservation Districts (SWCDs), Parks and Recreation, and Environmental Health, are responsible for many coastal activities, policies and education and outreach throughout the basin. These responsibilities include stormwater management, development, erosion control programs, agriculture and land preservation, shellfish protection and recreational monitoring. Additional state programs and many interagency and group partnerships work together to protect the resources found in coastal waters and communities. The Coastal Habitat Protection Plan (CHPP) is a plan to manage and restore aquatic habitats critical to North Carolina's commercial and recreational fisheries resources. The New River NSW strategy will be evaluated as part of the basin plan update.

As with Hurricane Matthew in 2016, Hurricane Florence had a devastating impact on the White Oak River Basin. Wrightsville Beach was especially hit hard by Florence and was still conducting significant rebuilding in the first quarter of 2019.

Yadkin-Pee Dee River Basin

Several streams in the Yadkin-Pee Dee River basin are impaired for aquatic life due to aquatic habitat degradation and the associated water quality impacts. The impacts are found throughout the basin but are largely located in urban/suburban areas where increasing impervious surfaces result in greater stormwater runoff, higher peak flows (flashy streams) and lower baseflows. Streambank and instream habitat erosion along with elevated turbidity and pollutant loading concentrations are making it difficult to protect sustainable aquatic populations.

In addition to aquatic habitat degradation, elevated fecal coliform bacteria and nutrients are also a concern in the basin. Elevated levels are often the result of stormwater runoff in urban/suburban areas and/or failing or damaged wastewater infrastructure (i.e., wastewater from municipal or privately owned systems, septic systems). Agricultural operations may also contribute to elevated bacteria and nutrient loads. Local resource agencies and stakeholders throughout the basin have noted changes in the number of poultry production throughout the basin over the last several years. Specific geographic locations, numbers of birds, and amount of dry litter waste produced, transported and applied is not available, making it difficult to accurately evaluate water quality impacts from poultry operations. Protecting the existing riparian buffers and installing site-specific BMPs can aid in the protecting and stabilizing streams and reducing bacteria and nutrient loads to waterbodies.

High Rock Lake is impaired for turbidity, chlorophyll *a*, and high pH. The lake is very turbid in the upper reaches, and for a large portion of the year, experiences algal blooms in parts of the lake where the sediment settles out. Nutrient-related water quality criteria are being evaluated for High Rock Lake through the Science Advisory Council (SAC) in accordance with the Nutrient Criteria Development Plan (NCDP) facilitated by DWR. This process, to date, has been supported by extensive data analysis, ambient

monitoring studies, and a watershed and lake model. The data indicate that the lake's trophic status is eutrophic to hypereutrophic depending on the time of year.

The SAC is currently finalizing a site-specific chlorophyll *a* standard. Once complete, the proposed standard will be presented to the EMC for their consideration. If approved, the proposed site-specific standard would likely be included in the triennial standards review process, followed by an EPA approval process. The SAC has recommended the use of a chlorophyll *a* standard be used as a proxy for nitrogen and phosphorous instream criteria. A regulatory approach to reducing nitrogen, phosphorous, and sediment may ultimately be warranted for High Rock Lake. DWR is working with stakeholders in the basin, specifically the Yadkin-Pee Dee River Basin Association (YPDRBA), whose members hold NPDES permits, to understand their concerns.

DWR will begin development of a hydrologic model for the Yadkin-Pee Dee in 2020. The Yadkin-Pee Dee Water Management Group (YPDWMG), a stakeholder group composed of 19 public utilities and reservoir operators, plans to use the hydrologic model for a regional level "Master Water Supply Plan" and "Drought Response Plan". The YPDWMG held four basin stakeholder meetings in 2019 to gather information on water resource concerns and priorities in the basin. DWR staff provided a presentation on the water supply programs managed by the division and participated in the stakeholder discussions. DWR plans to collaborate with YPDWMG and other stakeholders in the basin on model development to ensure the model not only meets the state's planning needs, but also has the appropriate functionality needed by their members and for their Master Water Supply Plan and Drought Response Plan.

DWR staff provided a presentation on the Yadkin-Pee Dee River basin plan to the EMC basin liaison's, Commissioner Stan Meiburg and Commissioner Gerard Carroll in November 2018. DWR staff also met with Wilkesboro and Surry County SWCD in November 2018. Staff toured agricultural BMPs implemented in each county and also discussed water resource concerns in the upper portion of the basin.

As part of the 2018 IR assessment, the Yadkin-Pee Dee had 26 new 303(d) listings and 12 delistings based on data collected between 2012 and 2016. The new listings including water quality standards violations for dissolved copper, chlorophyll *a*, pH, dissolved oxygen, water temperature, and turbidity. One new listing was also due to impaired biological integrity (benthic community). Specific listings in the Yadkin-Pee Dee can be found on the 2018 303(d)/IR list and on the 2018 IR map. Details about specific water quality issues will be discussed in detail in the upcoming river basin plan.

Public Involvement and Education

Public involvement and education on a variety of water quality and quantity issues is an important component of the basin planning process. Examples include specific feedback on new rules and environmental protection measures, requests for data for watershed planning and assessment, and basin plan review and comments. Basin planners work with the public and resource agencies daily and act as a clearinghouse for basin related information. DWR continues to improve on data sharing capabilities to increase public access and enhance the public's ability to explore data on which basin plans are based.

While developing a basin plan, staff work directly with specific watershed stakeholders and resource agencies with the knowledge needed to understand and explain a concern or issue that has been identified in the basin. Stakeholders often provide information on local water quality issues, watershed activities, and issues affecting water availability. Site specific watershed restoration projects are included in each of the basin plans.

The number and amount of interaction with stakeholders and resource agencies varies depending on where the plan is in the development process. During this annual reporting period, staff worked directly with several soil and water conservation districts, local governments and resource agencies as well as several watershed groups. Planners have presented water quality and quantity information at several venues, including the Water Education for Teachers (Project WET)/teacher education workshops, science advisory committees, basin specific watershed groups and to DWR staff for cross -training purposes. Staff have also participated in several watershed meetings across the state and presented at the annual Water Resources Research Institute (WRRI) meeting held at North Carolina State University (NCSU).

In May 2018, the members of the Environmental Management Commission (EMC) agreed to work with the DWR's BPB to develop an "adopt-a-basin" partnership. The EMC members will serve as an informal liaison between the two partners, which will enhance discussion and bring a greater depth of understanding of basin specific issues to the full EMC basin approval process. Seven new members were appointed to the commission in July 2019. Staff from the BPB will work with new and existing members over the next year on basin specific issues, actions and goals.

DEQ's Stream Watch program is undergoing renewed initiatives to incorporate hands-on and interactive technology as well as broaden the audience of potential stream watch participants to include more schools and educational groups. Public involvement and citizen science programs, like NC Stream Watch, help connect local communities with state agencies like DWR. This network of active "stream watchers" benefits our environment while promoting relevant educational opportunities. Watershed groups and other stakeholders are able to utilize user-friendly surveys for stream monitoring on their mobile device or paper/pencil forms. During their time in the stream, they can collect data on a range of topics, depending on their interest. From simple trash tracking to educational water quality monitoring, the NC Stream Watch program allows stream monitoring to be relevant to communities as well as supportive for education.

The NC Stream Watch program has been updated with surveys that allow community members with minimal technical training to still be involved with the program. In an effort to meet NC Department of Public Instruction's (DPI) curriculum standards, these surveys can align with various grade level earth and environmental science standards. Teachers, students, and watershed networks will find the program useful because it creates a network of involved citizens while also creating awareness for water resource management issues. Councils of government, such as the Piedmont Triad Regional Council, plan on incorporating this program in to their educational outreach initiatives. The city of Raleigh has also been working with NC Stream Watch to determine how to overlay collected Adopt -A- Stream data to the statewide NC Stream Watch map as well. As this program grows, North Carolina citizens can access a GIS map that is populated with data collected by various educational groups across the state. Eventually, NC

Stream Watch hopes to be a robust educational program that is commonly utilized to promote the importance of water resource management and water quality issues.

Along with NC Stream Watch, DWR also encourages local governments, the general public and watershed specific groups to organize stream cleanup projects in their waterways. Statewide, these initiatives have removed tons of trash and pollutants from our waterways.

In an effort to make the basin plans more easily accessible and user-friendly, BPB has spent the last few years working to develop online resources for the basin plans. Examples of new formats and mapping capabilities are available through the Department's Open Data website and on the 2018 Final Watauga River Basin Water Resources Plan and the interactive Watauga story map.