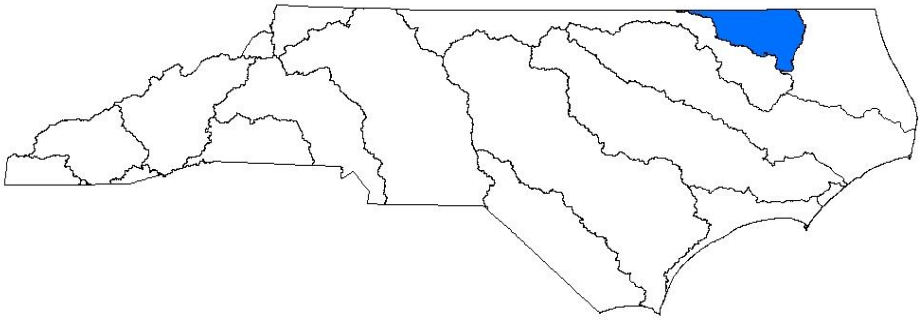
Chapter 1
Chowan Basin Overview



1.1. General Description

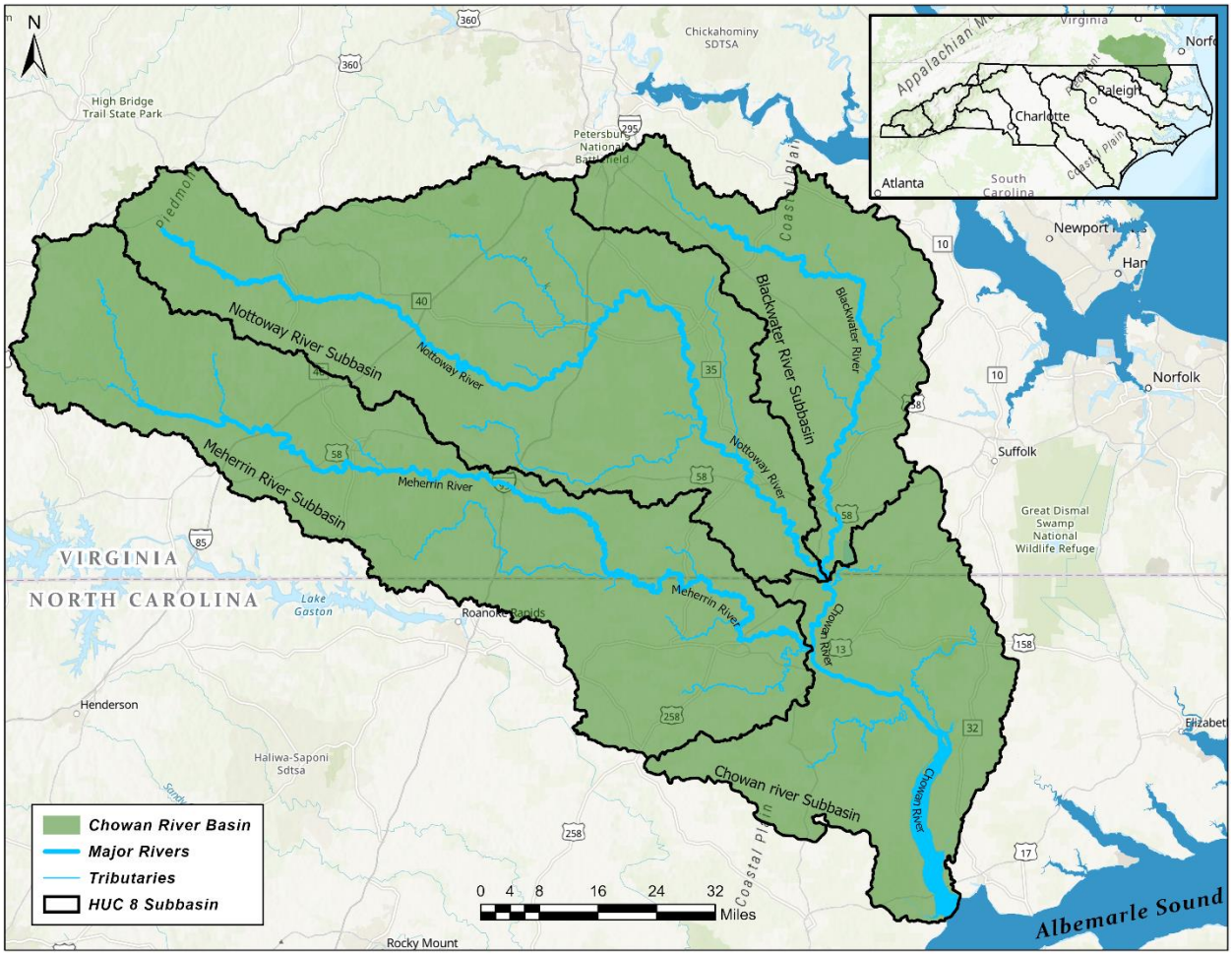
The North Carolina portion of the Chowan River basin is in the northeastern coastal plain, but its headwaters begin in Virginia (VA). Three major rivers – the Blackwater, Nottoway and Meherrin – begin in VA and flow south-southeast to form the Chowan River near the Virginia-North Carolina state line. Nearly 1,300 square miles of land is included in the North Carolina (NC) portion of the basin, but most of the drainage area (3,600 square miles) lies in VA (Figure 1-1). Major tributaries to the Chowan River in NC include Potecasi Creek, Wiccacon River, and Ahoskie Creek. All or portions of Northampton, Hertford, Gates, Bertie and Chowan counties are located in the basin along with several local municipalities including Ahoskie, Colerain, Conway, Gatesville, Powellsville and Rich Square (Figure 1-2). Most of the water used in the basin for public or private use comes from groundwater sources. Projected use estimates indicate that there will be a small increase in water use over the next several years.

Important natural resources in the basin include wetlands, anadromous fish spawning areas and Merchant's Millpond State Park. The North Carolina Natural Heritage Program (NHP) considers 100 miles of the Chowan River and its tributaries significant aquatic habitat because of diverse, rare, and vulnerable populations of freshwater mussels. Five mussel species are listed as threatened by the Wildlife Resources Commission (WRC). These include the triangle and alewife floaters, the eastern lampmussel, the eastern pondmussel and the tidewater mucket. No species in this basin have been listed as endangered.

The basin is part of the larger Albemarle-Chowan River basin (HUC 030102), which includes southeastern VA and NC's Pasquotank River basin. The Chowan River is the second-largest tributary to the Albemarle Sound, one the country's largest estuaries. The Albemarle Sound, in turn, is part of the Albemarle-Pamlico Estuarine System. It is the second largest estuarine system in the United States and includes portions of or all of the Chowan, Pasquotank, Roanoke, Tar-Pamlico, Neuse, and White Oak river basins. In recognition of the numerous benefits provided by the Albemarle and Pamlico Sounds, the United States Congress designated the Albemarle-Pamlico Estuarine System an "estuary of national significance" in 1987. That same year, the Albemarle-Pamlico Estuarine Study (APES) was among the first of 28 National Estuary Programs established by the EPA through amendments to the Clean Water Act (CWA). Upon adoption of its first Comprehensive Conservation Management Plan (CCMP) in 1994, the program became known as

the Albemarle-Pamlico National Estuary Program (APNEP) and it broadened its mission to include applied conservation, management and engagement initiatives to protect natural resources within the region. In 2012, the program was formally renamed and identified as a Partnership, reflecting the importance of coordinated and integrated efforts for protecting and restoring the estuarine ecosystem in the region.

Figure 1-1: General Map of the Entire Chowan River Basin



1.2. Watershed Boundaries in the Chowan River Basin

The Division of Water Resources' (DWR) previous basin plans used subbasin boundaries that were numbered based on the river basin and location within the river basin. DWR has changed how these subbasins are grouped to conform to the federal cataloging unit known as hydrologic unit codes (HUCs). Each hydrologic unit is identified by a unique number. The largest HUC is two digits (region). Two additional digits can be added to the HUC to sub-divide it into smaller areas, or watersheds. The HUCs are nested within each other from the largest geographic area (region) to the smallest geographic area (cataloging unit) (USGS, 2020). Each HUC represents the area of the landscape that drains to a portion of the stream network (USGS, 2020). This report is organized by chapters at the HUC 8. The conversion from DWR subbasins to HUC 8 is illustrated in Figure 1-3. Note that a portion of the Chowan River basin near Edenton is now in the Pasquotank River basin based on the USGS Watershed Boundary Dataset (WBD) (USGS, 2020).

Figure 1-2: General Map of the Chowan River Basin in North Carolina

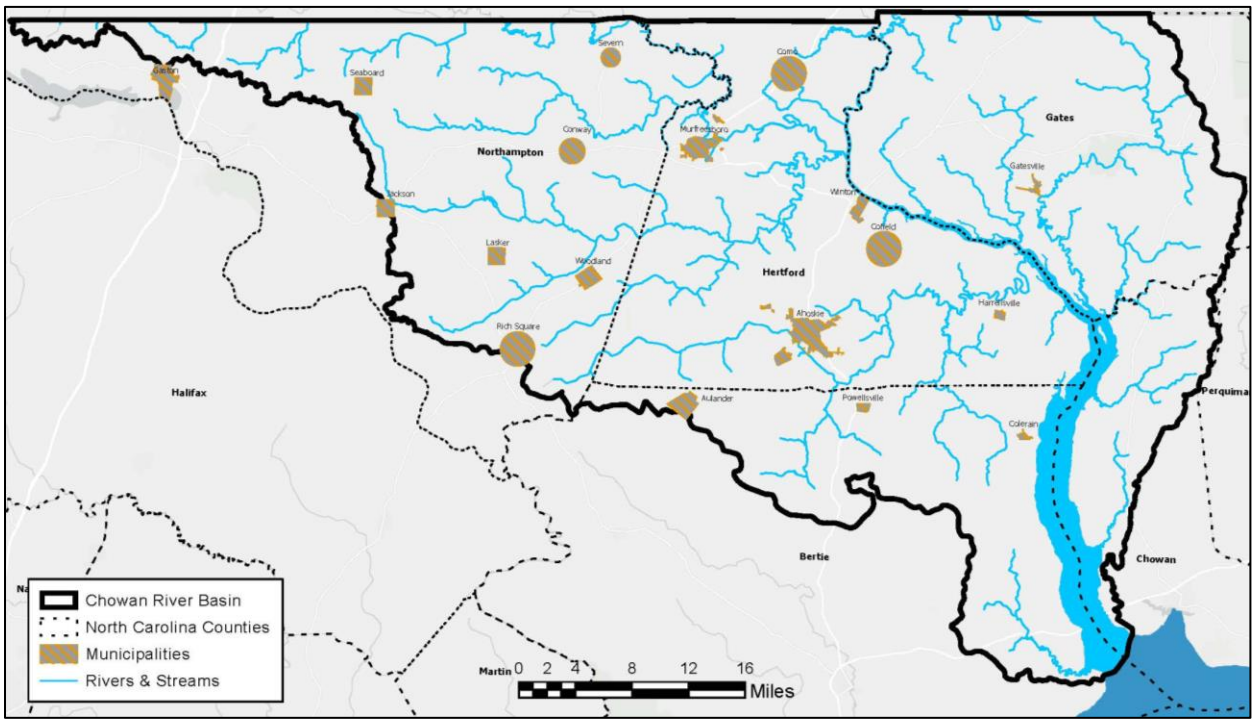
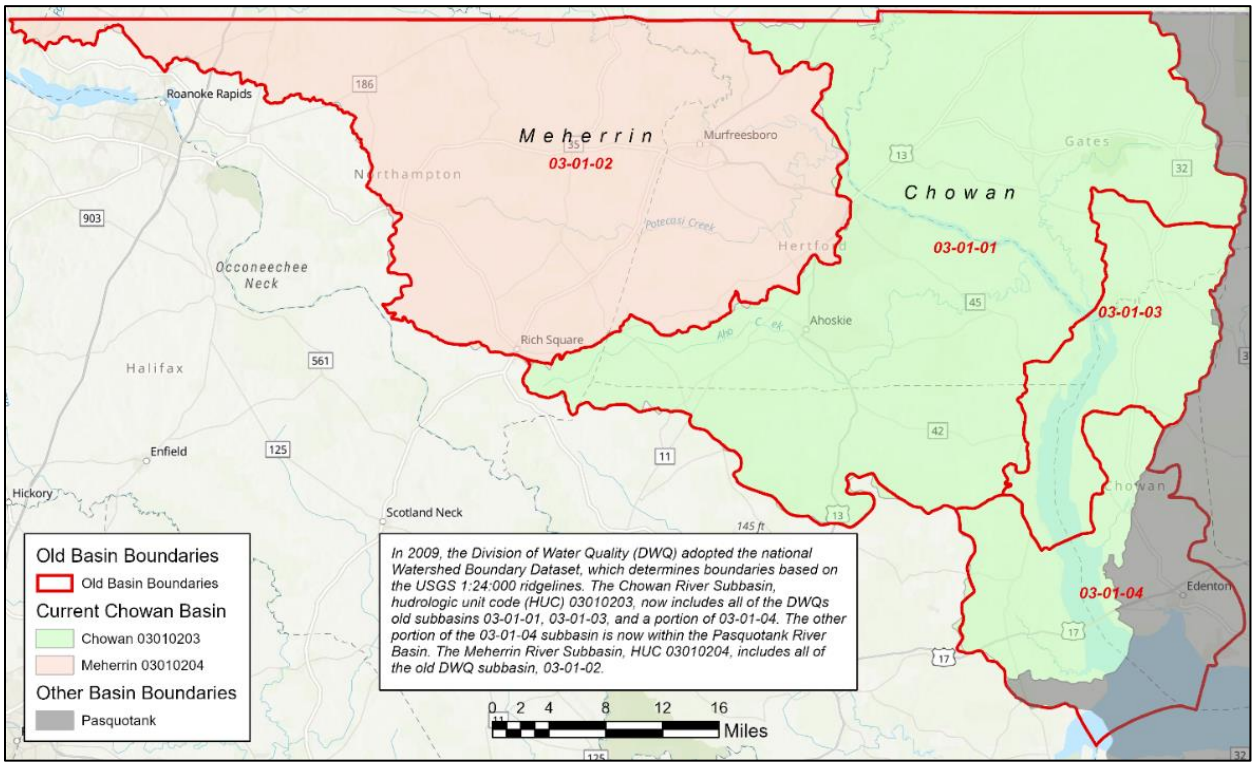


Figure 1-3: Comparison between DWR Subbasins and 8-Digit Hydrologic Units



1.3. Aquatic Habitats

The areas where rivers and sounds meet are described as “drowned river estuaries” (Riggs and Ames 2003). Due to the retreat of the last glacial maximum, the old river channels were submerged over the past 17,000 years due to sea-level rise. The transition zone from river to estuary occurs in a broad zone where riverine processes become estuarine. The Chowan River, like the Roanoke River, is a mainstem or trunk river, discharging large volumes of fresh water into the Albemarle Sound estuary. The erosion of upland clay soils is the source of significant loads of sediment deposited in the sound following storms.

1.3.1. Types of Aquatic Habitats

The Fisheries Reform Act was passed in 1997 by the NC General Assembly in recognition that protecting habitat is as important as preventing overfishing. The act established the requirement to develop a Coastal Habitat Protection Plan (CHPP) to protect and enhance important coastal fisheries habitats. (NCDMF and NCWRC, 2017). The CHPP lists six distinguishable habitat types along the state’s coast: water column, submerged aquatic vegetation, shell, soft and hard bottom habitats, and wetlands (NCDMF, 2016).

Water Column

The water column is a unique, dynamic habitat with changing physical and chemical properties that links all the various habitats and provides the means of transport of organisms from one habitat type to another. Water depth and direction of flow can vary depending on meteorological events, such as precipitation and wind direction, tidal events, and proximity to inflow from inland rivers and outflow through the coastal inlets. These factors also influence mixing of the water column’s dissolved gases and ions, suspended particles, and temperature.

Submerged Aquatic Vegetation (SAV)

The submerged aquatic vegetation (SAV) habitat is populated with various species of plants that are not able to support themselves out of the water. The plant composition is dependent upon factors such as depth, salinity, wave action and water clarity. The SAV provide surface area for organism residency and egg deposition, refuge from predation, and food matter for grazers and detritivores.

Shell Bottom Habitat

Shell bottom habitat is comprised of, as the name suggests, both living oysters, clams and other shellfish and the shell remnants of these organisms. Some of these habitats are called beds, rocks, or reefs while others may be layers of heavily weathered and broken shell fragments upon finer, underlying sediments. Established mollusks beds can function as "living shorelines," defusing wave action and reducing the rate of shoreline erosion.

Soft Bottom Habitat

The unconsolidated, unvegetated soft bottom habitat is not unique to the marine, or brackish-water environments, but extends up to the headwaters of freshwater channel networks. Soft bottom habitat is nourished and maintained by shoreline erosion and stormwater runoff throughout the basin and by transport from the headwaters to the estuaries and sounds. The composition of the bottom can vary from organic detrital material to fine silt, clay and sand to coarse sands.

Hard Bottom Habitat

The hard bottom habitat is typically located offshore, beyond the breakers. Hard bottom is colonized by sessile organisms and provides vertical relief, which attracts and sustains economically important species

and their prey. The establishment of artificial reefs, both in the sounds and the ocean, as well as shipwrecks helps to supplement hard bottom habitat. Near shore and in the estuaries, this habitat can be negatively impacted by degraded water quality.

Hard and shell bottom habitats are less abundant in the Chowan River basin due to the low salinity levels. Low salinity limits the distribution of oysters, clams and other marine mollusks, and sediment load deposited on the estuary bottom. The sole artificial reef built in the Albemarle Sound is at the mouth of the Chowan River, named Black Walnut Point Reef (AR-191). The reef was established in the mid-1980's to create additional hard bottom habitat, attract sport fish and provide a recreational opportunity accessible for small vessels.

Wetlands

Wetlands provide a transition zone between terrestrial and aquatic habitats. The extent to which wetlands are inundated depends on the elevation of the bottom materials and the height, or stage, of the water column. The species diversity and distribution of wetlands is influenced by the factors mentioned above and determines whether the wetlands are periodically inundated (intertidal) or always submerged (subtidal) (CHPP, 2016). Wetland habitat types are identified by the depth and duration of the hydrology, the landscape position, the soil type, and the dominant vegetation (Carolina Wetland Association, 2016).

Wetlands also provide critical habitat for waterfowl, certain mammals and amphibians, reptiles, aquatic insects, fish and birds (ASWM, 2019b). Many migratory bird species, like tundra swans, egrets, herons, and various duck and songbird species, use wetlands to rest, forage for food, and seek shelter from predators and inclement weather. These safe-haven patches in the landscape are essential for the survival of migratory birds (Wisconsin Wetland Association, 2016). Geographically isolated wetlands are particularly important for amphibians, as many frogs and salamander species require a network of fish-free small wetlands to survive and prosper (Leibowitz, 2003). There are also many rare and at-risk species that require wetlands to survive. Approximately 70 percent of the NC endangered species depend on wetlands (DWR, 2018). Estuarine wetlands serve as nursery habitat for clams, oysters and crayfish. They are also an important source of fish and shellfish food production for striped bass, pike, sunfish, crappie, crab, clams, oysters, crayfish, and shrimps. Besides providing ecosystem services, wetlands are great places for recreation, such as fishing, boating, hunting, birdwatching, hiking, and enjoying nature (DWR, 2018). Examples of publicly accessible wetlands found in the Chowan River basin in Gates County include the Chowan Swamp Game Land and Merchant Mill Pond State Park. More information about these and other publicly accessible wetlands can be found on DWR's ncwetlands.org website.

1.3.2. Fisheries in the Chowan River Basin

The Chowan River basin has historically been a significant fisheries resource. Some of the species that have been sought include striped bass (*Morone saxatilis*), Atlantic sturgeon (*Acipenser oxyrinchus*), American shad (*Alosa sapidissima*), hickory shad (*Alosa mediocris*), and alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*), collectively known as "river herring". All of these species are anadromous meaning they migrate from the ocean as adults through inlets into the coastal bays and sounds and ascend the freshwater rivers and creeks to spawn. They typically return to the waters in which they were spawned. Some will return for several years to spawn again while some will die after spawning only once. The region where the Chowan and Roanoke rivers discharge into the western Albemarle Sound is an important nursery area for the anadromous larval fish transported downstream where they mature

before moving to the ocean. Cues that trigger spawning runs are warming temperatures and high-water flows.

Anadromous fish spawning runs have supported important commercial harvest industries and recreational fishing, have provided families sustenance and been the focus of cultural events throughout the region. Commercial fishery still exists but not at the harvest levels of the past. The cumulative impacts of unregulated fishing offshore and inland, habitat and water quality degradation, and limited access to historical spawning habitat by dam and culvert construction have contributed to the decline of anadromous fish populations in the basin. With the implementation of fishing moratoria, seasons, and limits for commercial and other harvests, some species populations have recovered. Striped bass has recovered, but river herring stocks have not despite harvest restrictions (NCDMF, 2016).

Three fish species found in the Chowan River basin are designated as endangered: the Atlantic sturgeon, the shortnose sturgeon (*Acipenser brevirostrum*), and the Roanoke logperch (*Percina rex*). The shortnose sturgeon is uncommon in the basin and easily confused with its more common relative, the Atlantic sturgeon. The primary threats to sturgeons are habitat degradation, water pollution, dredging, water withdrawals, fishing net entanglement, and habitat access impediments (NOAA, 2020a; b). The logperch in the basin is only found in Virginia in the upper reaches of the Nottoway River and its tributaries. A survey of the North Carolina portion of the Meherrin River has been recommended to determine if populations of logperch live in that watershed (NCDWR, 2014). Some of the threats to Roanoke logperch populations are siltation and hydrologic alteration from changes in land use, channelization, water withdrawal, toxic spills, and disrupted gene flow and habitat loss from damming (NCDWR, 2014).

The upper reach of the Chowan River is globally significant due to its overall freshwater mussel diversity according to Alderman and Alderman (2009). This area provides habitat for six state-listed mussel species. Additionally, the yellow lance (Elliptio lanceolata), a federally designated threatened species, and the Atlantic pigtoe (Fusconaia masoni), a candidate for threatened designation, are found in the upper reaches of the Nottoway River. Mussels are particularly sensitive to siltation as well as hydrologic alteration from changes in land use, channelization and disrupted gene flow and habitat loss from dam and culvert construction. Mussels are also dependent on sustainable populations of the host fish species for the successful maturation of their young, or glochidia.

1.4. Population and Land Cover

1.4.1. Population

Population and density data help identify the watersheds likely to have the most impacts from urban growth. Increases in population often result in more impervious surface cover which often increases the amount of nonpoint source pollution and stormwater runoff. Increases in stormwater runoff can impact aquatic habitats, stream flow and downstream flooding. Population data can also be used to project future water demand and assist with local water supply planning efforts. Population information presented here is intended to estimate expected population growth in the counties and municipalities located wholly or partially in the Chowan River basin. Information presented here is available on North Carolina's Office of State Budget and Management (OSBM) website.

Based on the 2010 census, the estimated population for the basin is just over 95,000. Most of the population growth is occurring in Gates and Hertford counties. County population projections for 2020

and 2030 indicate that populations in all counties are expected to decrease. Bertie and Northampton counties are expected to see the largest decreases (Table 1-2).

Table 1-2: Population Growth and Projections by County

County	% of County in Basin	Population 2000	Population 2010	Percent Growth 2000-2010	Population Projection 2020	Percent Growth 2010-2020	Population Projection 2030	Percent Growth 2010-2030
Bertie	30%	19,773	21,282	7.6	19,058	-10.5	16,454	-22.7
Chowan	67%	14,526	14,793	1.8	14,668	-0.8	14,670	-0.8
Gates	80%	10,516	12,197	16.0	11,915	-2.3	11,914	-2.3
Hertford	100%	22,601	24,669	9.2	24,121	-2.2	23,360	-5.3
Northampton	65%	22,086	22,099	0.1	20,416	-7.6	19,057	-13.8
Totals		89,520	95,040	6.2	90,178	-5.1	85,455	-10.1

Note: The numbers reported here reflect county population. The county is not entirely within the basin. The intent is to demonstrate growth for counties located wholly or partially in the basin.

Municipal populations in the Chowan River basin are relatively small, ranging from 91 in Como to 4,855 in Ahoskie (2017) (Table 1-3). Growth in municipal areas was modest between 2000 and 2010. There were slight declines in most of the municipalities between 2010 and 2015. Murfreesboro was the only municipality with an increase in population between 2010 and 2015. The largest municipalities, Ahoskie and Murfreesboro, grew by 7.3 percent and 33.2 percent, respectively, between 2000 and 2015.

Table 1-3: Population Growth by Municipality

Municipality	Population 2000	Population 2010	Population 2015	Percent Growth 2000-2010	Percent Growth 2010-2015	Percent Growth 2000-2015
Ahoskie	4,523	5,039	4,855	11.4	-3.7	7.3
Aulander	922	895	850	-2.9	-5.0	-7.8
Cofield	347	413	407	19.0	-1.5	17.3
Como	78	91	91	16.7	0.0	16.7
Conway	734	836	835	13.9	-0.1	13.8
Gatesville	281	321	313	14.2	-2.5	11.4
Jackson	695	513	487	-26.2	-5.1	-29.9
Lasker	103	122	121	18.4	-0.8	17.5
Murfreesboro	2,421	2,835	3,225	17.1	13.8	33.2
Rich Square	931	958	943	2.9	-1.6	1.3
Seaboard	695	632	604	-9.1	-4.4	-13.1
Severn	263	276	270	4.9	-2.2	2.7
Winton	956	769	734	-19.6	-4.6	-23.2
Woodland	833	809	767	-2.9	-5.2	-7.9

Note: The numbers reported reflect municipality population. The intent is to demonstrate growth for municipalities located wholly or partially within the basin.

1.4.2. Land Cover – National Land Cover Data (NLCD)

Land cover assists with developing land use management policies, modeling nutrient and pesticide runoff, understanding spatial patterns in biodiversity, ecosystem status and health, and evaluating the effects of land use changes on water quality over time (Homer et al., 2012). North Carolina uses land cover datasets available from the National Land Cover Database (NLCD). In the Chowan River basin, changes in land use mirrors population with a greater percentage of impervious surface near population centers. Land cover types and percent coverage are included in Table 1-4. Spatial distribution is shown in Figure 1-5.

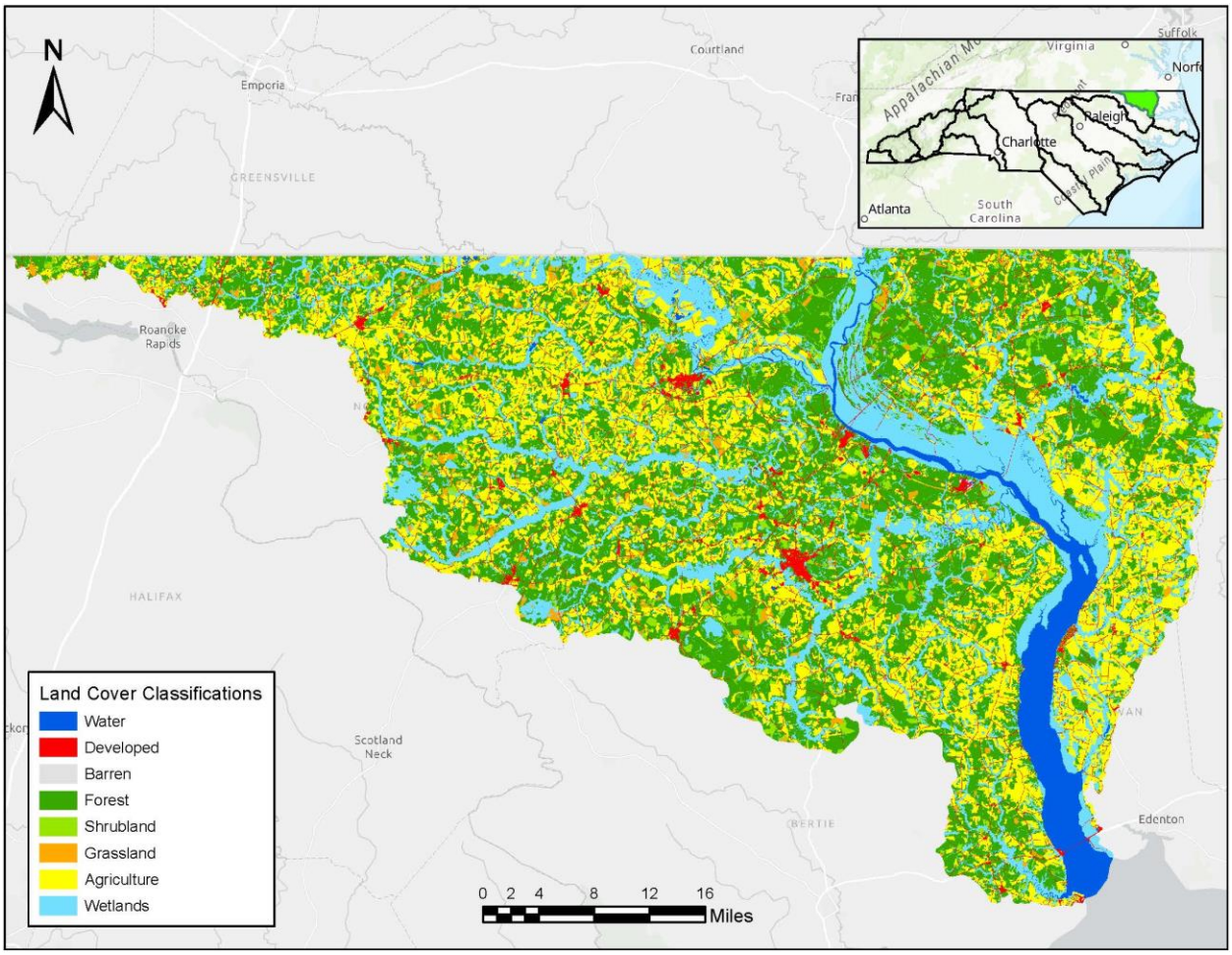
Table 1-4: Land Cover – North Carolina Portion of the Chowan River Basin HUC 030102 from NLCD 2016

Land Cover Type	2001		2011		2016	
	Square Miles	Percent of Total	Square Miles	Percent of Total	Square Miles	Percent of Total
Agriculture	387.5	29.9%	381.1	29.4%	381.3	29.4%
Barren	0.4	0.0%	0.4	0.0%	0.4	0.0%
Developed	53.7	4.1%	54.5	4.2%	55.4	4.3%
Forest	445.4	34.3%	436.3	33.6%	466.3	35.9%
Grassland/Shrubland	94.1	7.3%	108.5	8.4%	77.5	6.0%
Open Water	52.6	4.1%	53.2	4.1%	53.1	4.1%
Wetland	264.4	20.4%	264.2	20.4%	264.3	20.4%
Total	1,298		1,298		1,298	

1.5. Point Source Pollution

Point source pollution refers to pollution that enters surface waters through “any discernable, confined and discrete conveyance, such as a pipe, ditch, channel, tunnel, conduit, discrete fissure, or container” (US EPA, 2019). Point source pollutants are primarily associated with wastewater and stormwater discharges from municipal (city and county) and industrial wastewater treatment facilities. They can also originate from small, domestic wastewater systems that serve schools, commercial properties, residential subdivisions, and individual homes. To ensure that point source pollution does not negatively impact water quality or human health, wastewater and stormwater point source pollutants are regulated through the National Pollutant Discharge Elimination System (NPDES) Program. The NPDES permitting program sets monitoring and treatment requirements for facilities discharging wastes directly to surface waters (US EPA, 2019). The program also keeps records of the spatial location of point sources of pollution. This information from the NPDES program can be assessed alongside ambient water quality data to ensure that both permit requirements are being met and are sufficient to protect the water quality of receiving streams and rivers. More information about permitted programs can be found in Permitted and Registered Activities chapter (Chapter 7).

Figure 1-5: Chowan River Basin Land Cover[1] (Source: NLCD 2016, https://www.mrlc.gov/data)



[1]Developed, Forest, Grassland/Shrubland, Agriculture, and Wetland classes were created by aggregating two or more 2016 NLCD classifications. Developed is a combination of Developed, Open Space, Developed, Low Intensity, Developed, Medium Intensity, and Developed High Intensity. Forest represents deciduous, evergreen, and mixed forest classes. Grassland/Shrubland is Grassland/Herbaceous and Shrub/Scrub. Agriculture is Pasture/Hay and Cultivated Crops. Wetland is Woody Wetlands and Emergent Herbaceous Wetlands. Definitions of the 2016 NLCD classifications can be found here: https://www.mrlc.gov/data/legends/national-land-cover-database-2016-nlcd2016-legend.

1.6. Nonpoint Source Pollution

Nonpoint source pollution can result from any number of activities and land uses. Construction and land clearing activities, agricultural operations, golf courses, mining operations, solid waste disposal sites, tree harvesting, urban landscapes, and on-site wastewater treatment systems (septic systems) all contribute to nonpoint source pollution and can add sediment, nutrients, bacteria, heavy metals, oil, and grease to a waterbody. Nonpoint source pollution is difficult to monitor and account for. DWR works with several local agencies to identify potential nonpoint sources of pollution and the types of activities that may be impacting water quality in the area, but data gaps still exist. These unknowns include the amount of fertilizers, pesticides, herbicides, and dry-litter animal waste applied to land on a watershed scale, as well

as the level at which these same pollutants may be impacting groundwater and air quantity and eventually reaching surface waters through baseflow or atmospheric deposition.

There are several programs in place through various organizations that protect water resources from nonpoint source pollution. Many include funding for best management practices (BMPs) that can reduce the amount of sediment, nutrients, and bacteria entering a waterbody as well as protect streambanks, reduce erosion, and manage waste. More information about these programs can be found in the Statewide, Regional and Local Initiatives chapter (Chapter 6).

> *A **best management practice (BMP)** can be any practice that reduces the movement of waste products (including odors) away from the receiving site, and into groundwater, surface water or adjacent properties. BMPs are structural or operational practices that help individuals and companies operate a waste management system with the least chance of negative impacts on the environment. Crops, as well as crop residues, cultural practices and structures are used alone or in combination to hold the soil in place and allow water to move into it rather than to runoff the surface (NCDENR, 2015).*

1.6.1. Agriculture

Section 404(f)(1) of the Clean Water Act provides exemptions for ongoing farming, ranching, and silviculture (the growing and cultivation of trees) activities. Activities include plowing, seeding, cultivating, minor drainage, harvesting to produce food, fiber, and forest products, or upland soil and water conservation practices (EPA, 2019). Therefore, under federal law, some farming, ranching, and silviculture practices are considered nonpoint source pollution.

In NC, approximately 29 percent of the land use in the Chowan River basin is identified as agriculture (Table 1-4). Excess nutrients, pesticides, herbicides, bacteria and sediment are often associated with agricultural activities. In the Chowan River basin, significant efforts have been made to reduce nitrogen and phosphorus loads originating from agricultural land through the installation of BMPs. Between July 2010 and June 2020, more than $1.2 million has been spent by the Soil and Water Conservation Districts (SWCDs) through various cost share programs managed by the North Carolina Department of Agriculture & Consumer Services (NCDA&CS) Division of Soil and Water Conservation (DSWC) to install BMPs throughout the basin. Several practices have also been installed using funds available through programs managed by the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS). A list of practices that have been installed in the basin can be found in the Local Initiatives chapter (Chapter 6).

To understand how agriculture has changed over the past 10 to 15 years, the USDA, National Agricultural Statistic Service's (NASS) Census of Agriculture was reviewed. The USDA publishes the Census of Agriculture every five years. The data collected by and reported in the census provide an overview of agricultural operations on a national, state, county or county equivalent scale to show the importance and value of agriculture to a particular region, evaluate historic agricultural trends to formulate policies and develop programs, identify and allocate local and national funds for agricultural programs (USDA, 2017). The data can be queried at the state, county or watershed scale. Because the watershed scale includes portions of VA, agriculture data was queried to the county scale for counties located in the Chowan River basin. This included Bertie, Chowan, Gates, Hertford, and Northampton counties.

Per the 2017 census of agriculture, 959 farm operations are operating on 510,698 acres (798 square miles) in Bertie, Chowan, Gates, Hertford, and Northampton counties. The number of farm operations and the total acreage have decreased since 2007 with the number of acres identified as cropland increasing slightly since 2007 and pastureland and woodland slightly declining.

Animals are reported as the number of animals in a production contract or by inventory. Inventory is what was measured as of December 31 of the census year. Per the 2017 census of agriculture, the poultry inventory increased between 2007 and 2012, but then dropped slightly between 2012 and 2017 (Table 1-6). Bertie County has the highest inventory followed by Hertford (Table 1-7). The number of cattle operations increased slightly between 2012 and 2017, but the number of animals decreased. The number of hog operations also increased between 2012 and 2017 as did the number of animals. As of May 2020, there are 40 permitted animal operations in the Chowan River basin (Figure 1-6). All are permitted swine operations. A table of permitted animal feeding operations as well as a general overview of animal feeding operations can be found in the Permitted and Registered Activities (Chapter 7). More information can also be found on the Animal Feeding Operations (AFO) Program's website. A more detailed review of how the number of animals has changed over time can be found in Appendix I.

Poultry operations are deemed permitted in North Carolina. Operations that are deemed permitted have fewer animals than the state requires to obtain a permit or have a waste management system that does not require a state or federal permit. Most poultry operations have dry-litter poultry waste systems and do not require a state or federal permit. Owners or operators of dry-litter poultry waste facilities are, however, required to adhere to rules set forth under 15A NCAC 02T .1303 and General Statute 143-215.10C, which include minimum stream setbacks, land application rates, soil analysis, and recordkeeping. Because information about the location, number of animals, amount of dry-litter poultry waste produced and fields on which the dry-litter poultry waste is applied is unknown, determining the extent of potential impacts from dry-litter poultry waste to water quality is difficult to assess. Often, information about these facilities is restricted due to federal rules and regulations under the USDA. Additional information is needed about the location of poultry operations and land application sites statewide in order for DWR to establish new monitoring stations to assess potential nutrient impacts to aquatic ecosystems and water quality. To obtain additional information about the location of poultry operations and land application sites, NCDEQ should evaluate existing regulatory requirements for poultry operations. This includes a possible registration program specific to poultry operations.

Table 1-6: USDA Census of Agriculture Data – Bertie, Chowan, Gates, Hertford and Northampton counties (2007, 2012, 2017)

	2007	2012	2017	2007	2012	2017
	Number of Operations			Number of Acres/Animals		
Number of Farms & Land Area	1,153	1,129	959	532,071	513,991	510,698
Land Use						
Total Cropland	849	870	722	354,632	351,288	372,265
Total Pastureland	324	243	193	13,625	12,738	10,331
Total Woodland	694	652	506	153,280	140,508	123,356
Harvested Cropland	704	710	589	341,186	338,520	341,036
Land in irrigated farms	145	115	79	166,909	142,720	119,587
Irrigated land	145	115	79	26,361	21,688	15,947
Livestock Inventory						
Cattle (including calves)	115	96	114	4,100	4,142	3,798
Hogs	46	45	57	292,637**	130,480**	133,084**
Chickens*	114	131	132	9,496,888	11,396,089	10,993,282
Crops						
Corn, Grain	366	263	240	64,711	35,961	40,192
Soybeans	495	525	466	100,189	119,854	131,062
Cotton	317	289	225	117,573	116,848	98,143
Tobacco	59	44	32	4,442	5,997**	6,910**
Peanuts	242	171	159	31,557	29,101	29,188
Wheat	178	287	162	22,505	47,864	30,860
Forage (hay, haylage, silage, greenchop)	61	48	45	4,855	2,520	2,636**
Fertilizers and Chemicals						
Cropland fertilized, except cropland pastured	616	585	495	305,945	289,554	244,064
Pastureland and rangeland fertilized	71	38	46	1,669	830	1,165
Manure	161	158	145	21,475	16,524	21,424
Organic fertilizer***	(NA)	(NA)	18	(NA)	(NA)	480
Acres treated with chemicals to control:						
Insects	476	490	393	249,455	241,083	300,818
Weeds, grass or brush	504	654	514	279,184	320,746	341,188
Nematodes	141	190	138	49,996	81,275	56,737
Diseases in crops and orchards	129	214	177	36,523	78,639	87,243
Growth, thin fruit, ripen or defoliate	256	213	221	96,981	94,841	102,629

*Broilers and other meat-type chickens.

**(D) Information withheld from one or more counties to avoid disclosing data for individual farms (USDA, 2017).

(NA) Information not available (USDA, 2017).

***This is a new item for 2017. These are the number of cropland or pastureland on which approved organic fertilizers were applied (USDA, 2017).

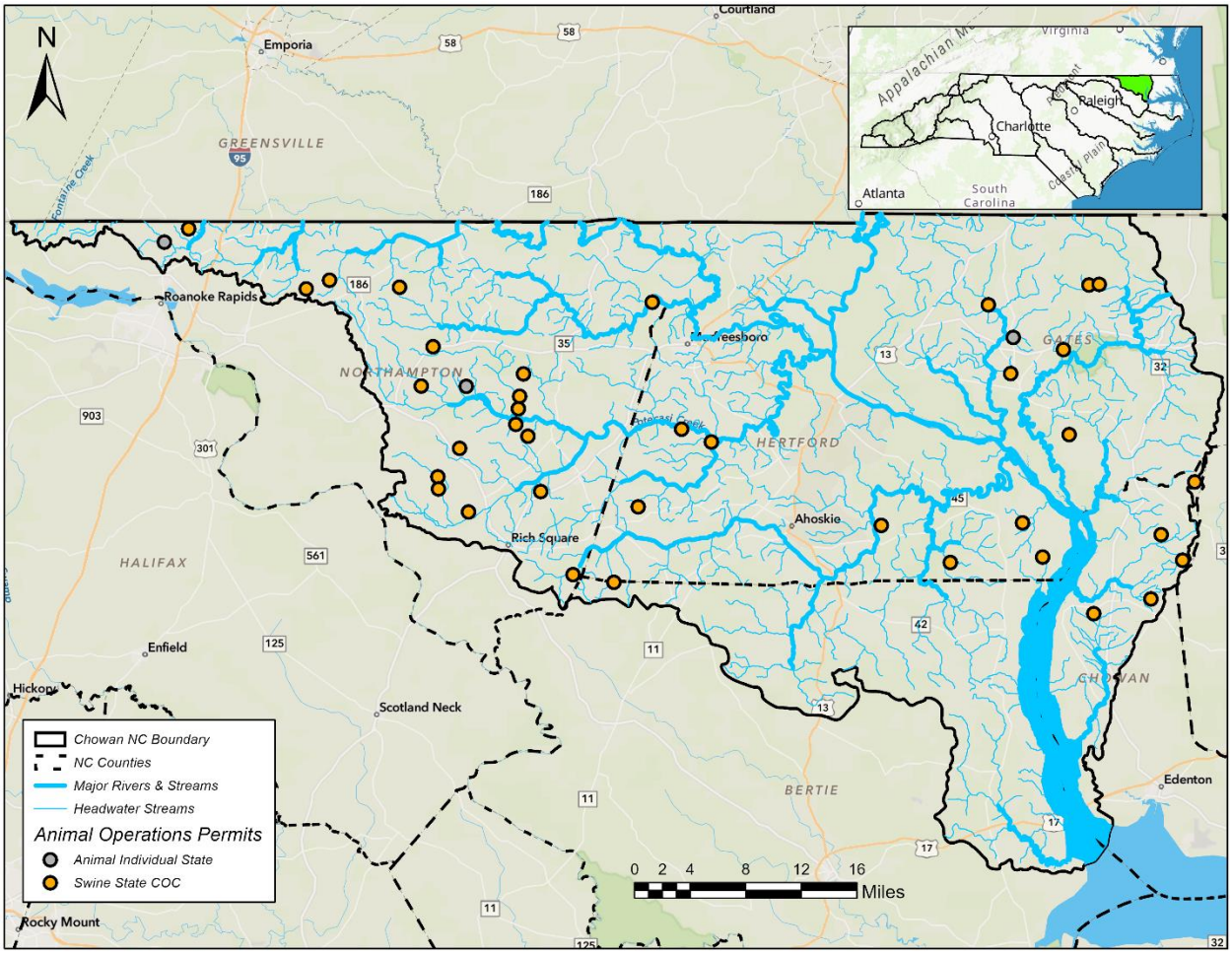
Table 1-7: USDA Census of Agriculture Data – Poultry Inventory 2007, 2012, 2017

County	2007	2012	2017	2007	2012	2017
	Number of Farms			Number of Animals (Poultry)*		
Bertie	51	63	67	5,251,485	6,083,898	5,863,743
Chowan	8	6	2	259,495	250,475	**(D)
Gates	12	17	20	826,791	1,125,530	1,474,245
Hertford	21	31	25	1,623,690	2,116,632	2,140,814
Northampton	22	14	18	1,535,427	1,819,554	1,514,480
Totals	114	131	132	9,496,888	11,396,089	10,993,282

*Broilers and other meat-type chickens.

**(D) Information withheld from one or more counties to avoid disclosing data for individual farms (USDA,2017)

Figure 1-6: Animal Operation Permits Map



Soil and water technicians along with the Albemarle Resource Conservation and Development Council, Inc. (ARCD) are continually working with agricultural operations to identify areas to implement nutrient

and sediment loading BMPs as well as identifying how best to redesign drainage from agricultural fields to reduce the amount and speed at which stormwater runoff enters a waterbody.

1.6.2. Forestry

Special attention is needed to ensure that water quality is protected while timber is being harvested. Inappropriate management practices can impact water quality by altering in-stream habitat, increasing sediment load, and increasing stream temperature. These impacts can also alter the interface of the aquatic and terrestrial ecosystem and change watershed functions. Without appropriate practices in place during and after harvests, sediment entering a waterbody can have a negative impact on water quality. Sediment can stem from exposed cuts for skid trails, slopes with bare soil, and improperly constructed stream crossings, forest roads, and log decks. As a result, the majority of regulations and erosion control recommendations pertaining to forestry focus on preventing debris and sediment from entering waterbodies. Properly planned and executed forest management plans facilitate the sustainable harvest of forest products while protecting water quality.

Forest Practices Guidelines (FPG) Related to Water Quality

The North Carolina Forestry Service (NCFS) is delegated the authority to monitor and evaluate forestry operations in North Carolina. NCFS staff regularly inspect timber harvests for compliance with the Forest Practice Guidelines (FPG) for Water Quality. The FPGs are a set of results-based guidelines meant to protect water quality and are mandatory, statewide requirements defined by North Carolina Administrative Code (02 NCAC 60C .0100-.0209). All forestry-related, site-disturbing activities must comply with the FPGs if that activity is to remain exempt from permitting and other requirements specified in the North Carolina Sedimentation Pollution Control Act (SPCA) of 1973 (NCFS, 2017). Inspections often involve NCFS staff visiting the same site multiple times to provide forest operators and landowners technical assistance for BMPs to minimize impacts of forestry on water quality.

Locations of Harvests

Over the last ten years, timber harvests were scattered throughout the entire basin. Compared to other counties, however, there have been relatively fewer harvests in portions of Bertie and Chowan counties, particularly in the Cypress Swamp, Edenhouse Point-Chowan River, and Mount Gould Landing-Chowan River watersheds (Figures 1-7 and 1-8).

Between July 2007 and June 2012, the NCFS inspected 569 timber harvests in the Chowan River basin, totaling 37,395 acres (Figure 1-7). NCFS found 12 harvests to be out of compliance, resulting in a compliance rate of 97.9%. The most common violations were related to streamside management zones (SMZ), debris entering streams, stream crossings, or rehabilitation of the project site.

Between July 2012 to June 2017, the NCFS inspected 734 timber harvests, totaling 44,669 acres (Figure 1-8). Six harvests were out of compliance, resulting in a compliance rate of 99.2%. The most common violations were related to debris entering streams (Table 1-8).

Because landowners are not required to notify NCFS of timber harvesting or related forestry activities, the numbers reported here are not be a full representation of the timber harvests in the basin (Coats, 2017).

Table 1-8: Number of Inspections Conducted by NCFS in the Chowan River Basin

Time Period	# Inspected Timber Harvests	Total Acres	# Out of Compliance
07/2007-06/2012	569	37,395	12
07/2012-06/2017	734	44,669	6

Figure 1-7: Water Quality Inspections in the Chowan River Basin July 2007 - June 2012 (NCFS, 2020)

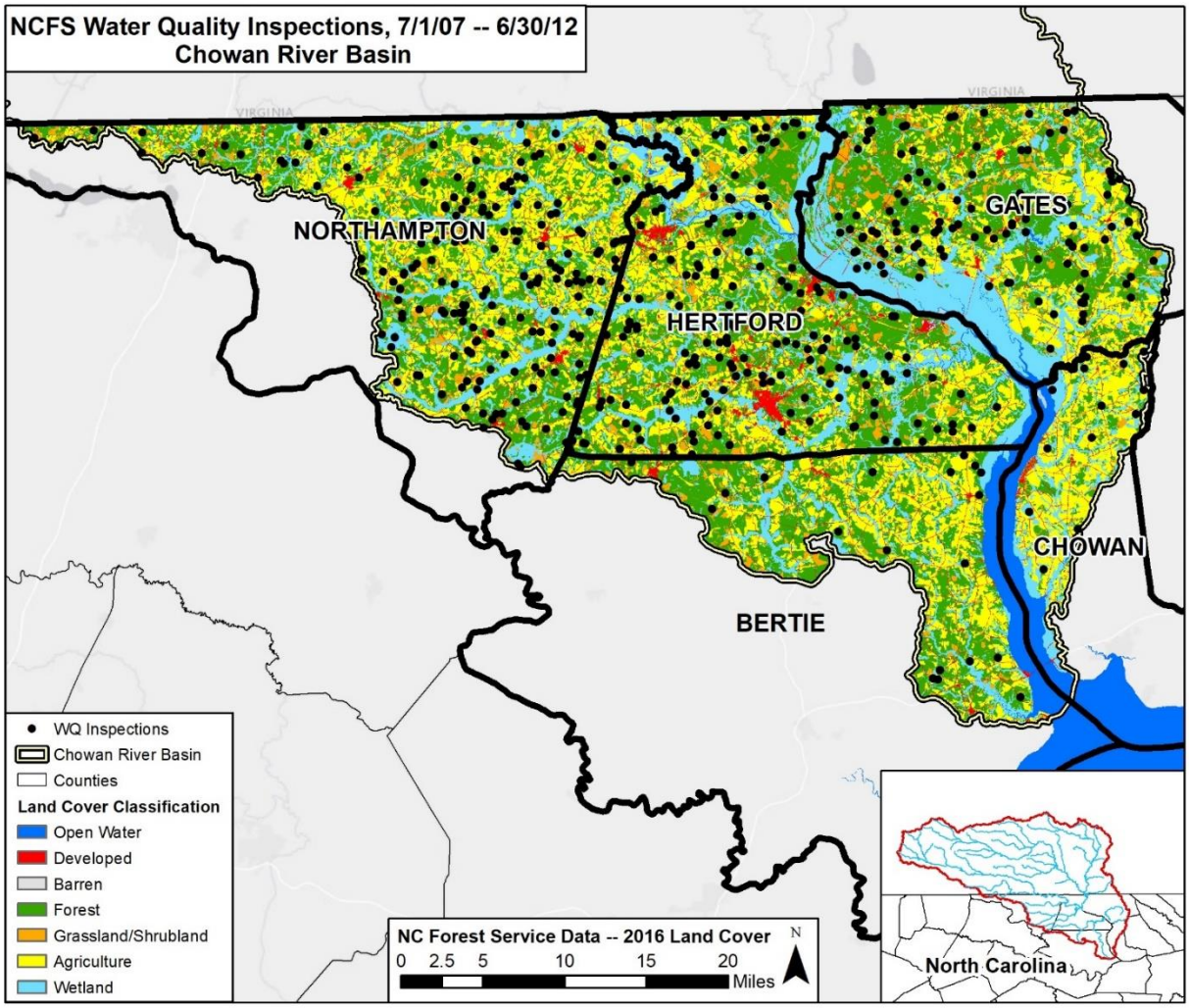
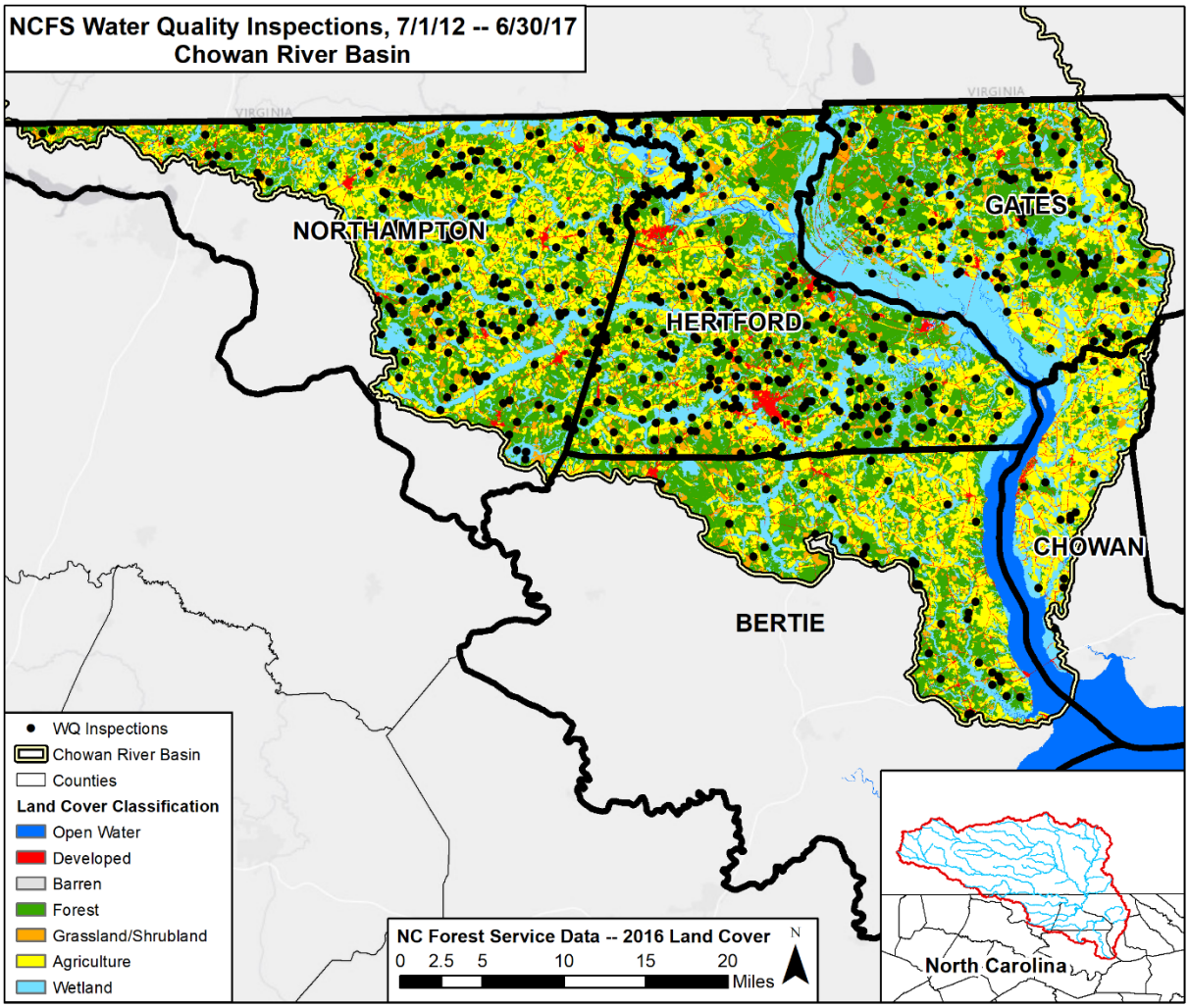


Figure 1-8: Water Quality Inspections in the Chowan River Basin July 2012 - June 2017 (NCFS, 2020)



Forestry Best Management Practices (BMPs)

Knowing the soils and hydrology of a site can help with addressing harvest schedules, equipment types, flooding potential, and reforestation options. Silvicultural, or forestry, activities in wetlands, regardless of size, should be conducted in a manner that minimizes adverse impacts on the unique hydrologic and ecological functions of those ecosystems. Implementing forestry BMPs is strongly encouraged to protect the water resources of North Carolina efficiently and effectively.

The NC Forestry BMP Manual details specific tools and methods which can be used during forestry operations to reach compliance with the FPGs. From 2013 to 2016, the NCFS carried out surveys across the state to assess the implementation of BMPs on timber harvests. These surveys gave a snapshot of practices used in different areas of the state and helped to understand where additional recommendations may be needed. In the Chowan River basin, the NCFS conducted surveys on seven sites, assessing 542 total BMPs. Seventy-nine percent of the BMPs assessed were implemented successfully. NCFS found that when BMPs were properly implemented, there was no risk to water quality (Coats, 2017).

To protect the waters of NC and promote the use of bridgemats, the NCFS allows loggers and timber buyers to borrow the NCFS's bridgemats for use during forestry-related operations. A bridgemat consists

of a panel that establishes a temporary crossing over streams, ditches, or small water channels. Temporary bridges can be a very effective solution for stream crossings since the equipment and logs stay out of the water channel. When installed and removed correctly, bridgemats cause very little soil disturbance. Bridgemats are free to borrow from the NCFS for forestry use in the Chowan River basin and have been for several years. More information about bridgemats is available on the NCFS website.

Forestry and Algal Blooms

In recent years, there has been growing concern over forest management and its influence on algal blooms in the Chowan River basin. In August 2016, NCFS personnel conducted an aerial assessment via aircraft along the Chowan River to see if algal blooms were emanating from timber harvests. At that time, the NCFS found no visible algal growth originating from past timber harvests of varying ages. NCFS met with stakeholders in the basin, including the SWCD and the ARCD, to discuss riparian buffer incentives for landowners wanting to harvest timber adjacent to known nutrient-sensitive waters. NCFS continues to explore how forest management may influence water quality by collaborating with landowners, state and federal agencies, and researchers (Coats, 2017).

Forestry: Next Steps

Several state and local entities are working together to understand forestry's impacts on water quality in the Chowan River basin. SMZs are "an area along both sides of intermittent streams and perennial streams and along the margins of perennial waterbodies where extra precaution is used in carrying out forestry-related, land-disturbing activities to protect water quality" (02 NCAC 60C .0102). Per administrative code, the SMZ shall be of sufficient width to "confine visible sediment resulting from accelerated erosion" (02 NCAC 60C .0201). Chapter 4 of the North Carolina Forestry BMP Manual includes information about SMZs and riparian buffers, and it states the general recommendation for SMZ width is "50 feet along each side of intermittent streams, perennial streams and perennial waterbodies" (NCFS, 2006). The width of the SMZ may vary depending on the purpose of the SMZ and the site's conditions. Wider SMZs are needed for sites that exhibit highly erodible soils, soil areas with little or minimal groundcover near the waterbody, and special waters such as trout, water supply watersheds, nutrient-sensitive waters and shellfish waters (NCFS, 2006). Because waters in the Chowan River basin have been designated as nutrient-sensitive waters (NSW), a wider SMZ is recommended for forestry-related, land-disturbing activities in the basin to best protect water quality. A wider SMZ could also minimize the number of trees damaged and the amount of woody debris entering a waterbody after heavy rainfall or extreme storm events.

Forestry-related, land-disturbing activities can alter hydrologic processes and influence water quality. It can take months to years for water quality to return to pre-harvest conditions (Ensign and Mallin, 2001), but forestry research studies also demonstrate that properly implemented BMPs effectively protect aquatic and riparian ecosystems (Cristian et al., 2016). More research specific to the Chowan River basin and silviculture in forested swamps is needed to understand the relationship between forestry-related operations, groundwater, nutrients, and algal blooms within the basin. Stakeholders throughout the watershed have acknowledged that there is no one clear source, or cause, of the algal blooms, however, this also does not rule out forestry practices as a significant contributing source. Continued monitoring could help pinpoint some of the point and nonpoint sources of nutrients entering the basin. In addition, NCFS has recommended a "comprehensive water quality study" of forestry-related activities in coastal bottomland swamp forests to help understand the relationship of silviculture and algal blooms. The study would require substantial new funding for five or more years, landowner commitment, and experienced foresters and researchers to conduct the study. “Although not in a position to fund such a project, NCFS

has offered to assist with project scoping, selecting foresters and researchers willing to participate in such a project, provide technical expertise on forestry practices, provide applicable references for literature review and general review and oversight" (Brogan, 2018).

Local stakeholders have been working with local foresters to identify ways to protect forested areas in the Chowan River basin. One recommendation is to establish a conservation program for swamp forest buffers similar to existing federal and state cost-share programs for agricultural lands. The program could provide an economic incentive to landowners to conserve and manage swamp forest buffers. Conserving and managing the swamp forest buffers, in turn, could protect critical drainage areas, protect water quality and provide aquatic and terrestrial habitat throughout the basin.

1.6.3. Golf Courses

Golf courses utilize intensive turf management practices that often rely heavily on the use of fertilizers and chemical pesticides. Stormwater runoff then carries these pollutants to nearby streams, impacting aquatic life and habitat. The construction of golf courses can also introduce sediment into streams and destabilize streams that are straightened or altered to meet the design of the golf course (NC DWR, 2008). Because there is little information on stormwater management and the amount of commercial fertilizers or pesticides used for turf management on golf courses, it is difficult to assess the impact they may be having on water quality in the Chowan River basin.

1.6.4. Stormwater

Stormwater runoff is rainfall or snowmelt that flows across the ground and impervious surfaces (e.g., buildings, roads, parking lots, etc.). In urbanized areas, stormwater systems often concentrate stormwater runoff into smooth, straight conduits. The runoff gathers speed and volume as it travels through the system before it is released. The outfall is often directed to a surface waterbody where the high velocity can scour streambeds, damage streambanks and vegetation, and destroy aquatic habitat. The volume can cause flooding, damage infrastructure, and cause unnaturally high fluctuations in stream flow.

Many daily activities have the potential to cause stormwater pollution, and in an area where activities (e.g., construction, land clearing, etc.) have the potential to contribute more pollutants through stormwater runoff, measures should be taken to minimize impacts from runoff. One major component in reducing impacts from stormwater runoff involves planning up front during the design process. New construction designs should include plans to prevent or minimize the amount of runoff leaving the site. Wide streets, large cul-de-sacs, long driveways, and sidewalks lining both sides of the street are all features of urbanizing areas that create excess impervious cover and consume natural areas. Green infrastructure (GI) can be used to minimize the impact from runoff. GI has several definitions but generally involves the use of natural landscape features (e.g., soil, vegetation, forests, wetlands, etc.) to help maintain ecological processes, sustain natural resources, and contribute to community and individual health and quality of life (Firehock, 2013).

The presence of intact riparian buffers, floodplains and/or wetlands in urban areas can also reduce the impacts of development. These porous, natural landscapes hold rainwater and snowmelt and allow the water to infiltrate slowly. This slow infiltration also helps recharge groundwater supplies. Where feasible, establishing and protecting existing buffers, floodplains and wetlands should be considered, and the amount of impervious cover should be limited as much as possible. Preserving the natural streamside vegetation or riparian buffer is one of the most economical and efficient BMPs for reducing the amount

of stormwater reaching surface waters. In addition, riparian buffers provide a variety of benefits including: moderating water temperature by providing shade, holding water and decreasing the high temperatures often measured in stormwater runoff; preventing erosion and lose of land; providing flood control; moderating stream flow; and providing food and habitat to aquatic and terrestrial life (Burgess, 2004). For more information on stormwater and how to manage it, refer to the Division of Energy, Mineral and Land Resources (DEMLR) Stormwater website: https://deq.nc.gov/about/divisions/energy-mineral-land-resources/stormwater.

1.7 Projects Requiring Water Quality Certifications (WQCs)

Although federal and state regulations have slowed the loss of wetlands since the mid-1980s, approximately one-third of the wetland alterations in the coastal plain have occurred since the 1950s, primarily due to agricultural and managed forests conversion (USGS, 1996). Currently, under Section 404 of the Clean Water Act (CWA), administered by the US Army Corps of Engineers (ACOE), it is unlawful to discharge dredged or fill material into waters of the United States without federal approval, unless the discharge is covered under an exemption. Most routine farming, ranching, or silviculture activities that are part of an "on-going" farming or forestry operation and do not convert a wetland area to an upland are considered exempt and do not require a Section 404 permit or DWR water quality certification. Routine activities include cultivation, plowing, harvesting, minor drainage, seeding, and bedding (EPA, 1990; USGS, 1996). The "Swampbuster" provision of the 1985 Food Security Act and amendments to the 1990 Food, Agriculture, Conservation, and Trade Act discourages (through financial disincentives) the draining, filling, or other alteration of wetlands for agricultural use. In some situations, farmers use the USDA Wetlands Reserve Program (WRP) to restore previously converted or altered wetlands and avoid penalties for new wetland conversions.

In addition to the federal authorization of the CWA's Section 404, Section 401 authorizes states to issue Water Quality Certifications (WQCs) for any federally permitted or licensed activity that results in dredged or fill material discharging to waters of the United States in the state where that discharge occurs (EPA, 2017a; EPA, 2017b). Wetland fill is the most common type of permanent impact approved under NC's 401 wetland certification program administered by DWR. Wetlands filled during construction activities (e.g. road construction, commercial and domestic development) generally lose all wetland functions. Other types of permanent impacts include excavation, grading, flooding, and vegetation clearing (in certain circumstances). Permitted projects must take steps to avoid and minimize impacts to wetlands, streams, and other aquatic resources and provide Compensatory Mitigation for unavoidable permanent losses as required by the federal permit (Individual or Nationwide) or state water WQC (EPA, 2017b).

Between 2007 to 2017, DWR approved certifications for over 36.5 acres of permanent wetland and 4,500 linear feet of permanent stream impacts in the Chowan River basin. The North Carolina Department of Transportation's (DOT) transportation improvement projects (TIPs) resulted in the largest permitted impacts of wetland acreage in the basin during this time period.

- The 2011 TIP for US 158 (NC DWR Project Number 20111075 / DOT TIP R-2583), in Hertford County, had 10.5 acres of permanent wetland impacts and 3,786 linear feet of permanent stream impacts.
- The 2012 TIP for road widening over seven miles of US 13/US 158 (NC DWR Project Number 20120296 / NC DOT TIP R-2507), from NC 45/US 158 near Winton in Hertford County to US158 in Tarheel in Gates County, resulted in over 21.7 acres of permanent wetland impacts. Both projects

met all compensatory mitigation requirements through purchasing credits from NC's in-lieu Fee program through the Division of Mitigation Services.

1.8. Climate Risk and Resiliency

Resilience is defined in the US Climate Resilience Toolkit as "the capacity of a community, business, or natural environment to prevent, withstand, respond to, and recover from disruption" (US Climate Resilience Toolkit, 2017). The concept of building resilience has become more prevalent in the natural resource management field to implement strategies that mitigate the potential impacts of climate change. Basinwide planning contributes to the climate resilience of the DWR's programs by identifying natural resources that may be affected by climate change and providing recommendations for adaptive management.

The 2017 US Climate Science Special Report (Special Report) presents extensive scientific evidence that our climate is changing and concludes that the past 100 years have seen an annual average global surface air temperature increase of 1.8°F. The report further asserts that the observed warming can be largely attributed to emissions of greenhouse gases (Wuebbles et al, 2017).

The Fourth National Climate Assessment (Assessment), completed in 2018, connects the climate science described in the Special Report to potential and current impacts occurring on a regional level. The Assessment details that the Southeastern United States, including North Carolina, is already experiencing impacts from a changing climate (particularly sea level rise and extreme rain events), which are expected to worsen in the future (USGCRP, 2018). Other predicted impacts cited in the Assessment include:

- Health impacts from increased heat.
- Increased risk of vector-borne disease as favorable climate conditions for disease-carrying mosquitoes expands.
- Increased extreme weather risks to infrastructure, including buildings, roads, bridges, railways, and drinking water and wastewater treatment facilities.
- Potential decline in air quality due to changing wind and temperature patterns.
- Increased coastal flooding due to sea level rise.
- Increased inland and coastal flooding due to extreme rainfall events.
- Transformation of natural ecosystems, especially from warming winter temperatures and saltwater encroachment.
- Increasing wildfire occurrence and reduction of prescribed fire effectiveness related to higher temperatures and more frequent drought conditions.
- Impacts to farmers' ability to raise livestock and grow regionally important crops from changing temperature and rainfall patterns.

Many of these impacts will be compounded by non-climate stressors such as population growth, urbanization, and economic inequality. Furthermore, climate-related impacts will have greater effects on vulnerable populations, exacerbating disparities that already exist.

In October of 2018, Governor Roy Cooper signed Executive Order 80 (EO80), "*North Carolina's commitment to address climate change and transition to a clean energy economy*". Section 9 of EO80 was a directive to the cabinet agencies to integrate climate change mitigation and adaptation practices into their programs (EO80, 2018).

In June 2020, the *North Carolina Climate Risk Assessment and Resiliency Plan* was published by DEQ. It includes the recommendations of the agencies involved with executing EO80, as well as stakeholders throughout the state, on how to integrate climate adaptation and resiliency planning into their policies, programs, and operations. It provides the state's best understanding of projected change in climate, considers climate justice issues, evaluates state infrastructure, assets, programs and services that are vulnerable and at risk to climate and non-climate stressors, and includes preliminary actions currently underway or which can be taken to reduce risk for at least three example vulnerable areas. It also includes nature-based solutions and recommendations to enhance ecosystem resiliency and sequester carbon through natural and working lands (NWL). The plan concludes by describing next steps for implementing and updating the North Carolina Resilience Plan as well as strategic resilience initiatives (DEQ, 2020).

DEQ's DWR has been involved in these efforts as many of DWR's programs will be affected by changes in precipitation and temperature patterns. Programs that may be impacted by changes in climate include:

- NPDES Discharges: Discharges permitted through NPDES are currently based on low-flow statistics calculated with historical stream flow data. Variable precipitation in the future could affect typical low flows, changing the capacity of receiving streams to assimilate pollutant loads.
- Water Supply Planning: Water supply planning will be affected by decreased water availability from more frequent drought conditions.
- Harmful Algal Blooms, Biotic Integrity, Fisheries: Increases to temperature and the length of the warm season can result in increased algal production, lower dissolved oxygen concentrations, degraded aquatic communities, and impacts to commercial and recreational fisheries.
- Water and Wastewater Facilities: More frequent and intense rain events increase the flood risk to many facilities that DWR regulates such as wastewater treatment plants and animal operations.
- Non-Point Source Pollution: More frequent and severe precipitation events can also increase the delivery of nonpoint source pollution loads to surface waters, such as sediment, nutrients, etc.

Basin plans, such as this one for the Chowan River basin, present a synthesis of water quality assessments and trends analyses, biological assessments, water supply planning, and when available, groundwater level and groundwater quality monitoring. These analyses provide the basis for determining if environmental conditions have changed and how those changes have impacted water resource conditions on a basin scale.

Basin plans frequently recommend protecting wetlands and floodplains, installing stormwater BMPs, identifying and retrofitting high-risk infrastructure, projecting and planning for changes in water use and availability, identifying areas that are disproportionately burdened with environmental hazards, and implementing green infrastructure (GI), low-impact development and living shorelines. These strategies are included above and can protect water quality and promote water resource sustainability. They have also been identified as means to mitigate impacts from increased precipitation and flood events caused by climate change (Atkins, 2015; US EPA, 2016; NC DEQ 2020). Additionally, basin plans encourage the collection of more data for many different DWR programs to garner a deeper understanding of current conditions and changes over time. The basin plans will continue to be a source of this information and will increasingly analyze NC's major river basins with a lens towards climate resiliency.

For more information on the Fourth National Climate Assessment: https://nca2018.globalchange.gov/

For more information on NC's efforts to address climate change: https://deq.nc.gov/energy-climate/climate-change.

1.9. Contaminants of Emerging Concern

Contaminants of emerging concern (CECs) are increasingly being detected in surface and groundwater across the state. They come from a wide range of sources including pesticides, lawn and agricultural products, disinfection by-products, wood preservatives, pharmaceutical and personal care products (PPCPs), and industrial chemicals as well as their by-products (EPA, 2019). 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 CECs recently identified in North Carolina surface waters. These compounds 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 CECs 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 CECs are not fully understood, state agencies and EPA are working on analytical 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.

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