Pamlico River Subbasin

Subbasin HUC 03020104

Includes the confluence of the Tar and Pamlico Estuary and Tributaries

Water Quality Overview: Water quality in this subbasin is primarily impacted by nutrient loading and resulting chlorophyll *a* impairment in the estuary. The current chlorophyll *a* impairment extends from just below Washington in the Pamlico River to Saint Claire Creek, similar to the 1994 conditions. DWQ also recently began assessing for metal toxicity, resulting in several new impairments because of copper levels.

General Description

In 2009, DWQ adopted the national Watershed Boundary Dataset which is based on USGS 1:24,000 ridgelines. The Pamlico River Subbasin, hydrologic unit code (HUC) 03020104, now includes all of old DWQ subbasin 03-03-07 and small portions of 03-03-08, 03-01-51, 03-01-53, and 03-02-09, covering ~1,307 square miles. Some exceptions to this dataset were made in the coastal areas for management purposes; the areas previously part of the Roanoke or Pasquotank Basins now included in the Pamlico River Subbasin maintain their classifications and are not subject to the NSW management strategy, unless reclassification occurs in the future (map provided in Appendix 4D).

This subbasin extends from the town of Washington to Roos Point (Figure 4-1). Freshwater streams in this subbasin are limited to headwaters of estuarine creeks and the East Dismal Swamp. Most streams in the East Dismal Swamp are ditched canals. Non-freshwater streams in this subbasin are primarily estuarine and tides tend to be wind dominated rather than following a lunar cycle.

Primary land use is row-crop agriculture and forest, with more developed areas found near Washington. In addition, PCS Phosphate operates a large phosphate mine near the town of Aurora.

In 2007, Goose Creek Tidal Freshwater Marsh and Mallard

Subbasin at a Glance

Counties: Beaufort, Hyde, Pamlico

Municipalities: Aurora, Bath, Belhaven, Chocowinity, Pantego, Washington

Permitted Facilities:

NPDES WWTP: 18
- Major:.....3
- Minor: 15

Non-discharge:.....16

Stormwater:
- General:.....16

Animal Operations:.....19

2000 Population: 47,563

Area: 1,307 sq mi.

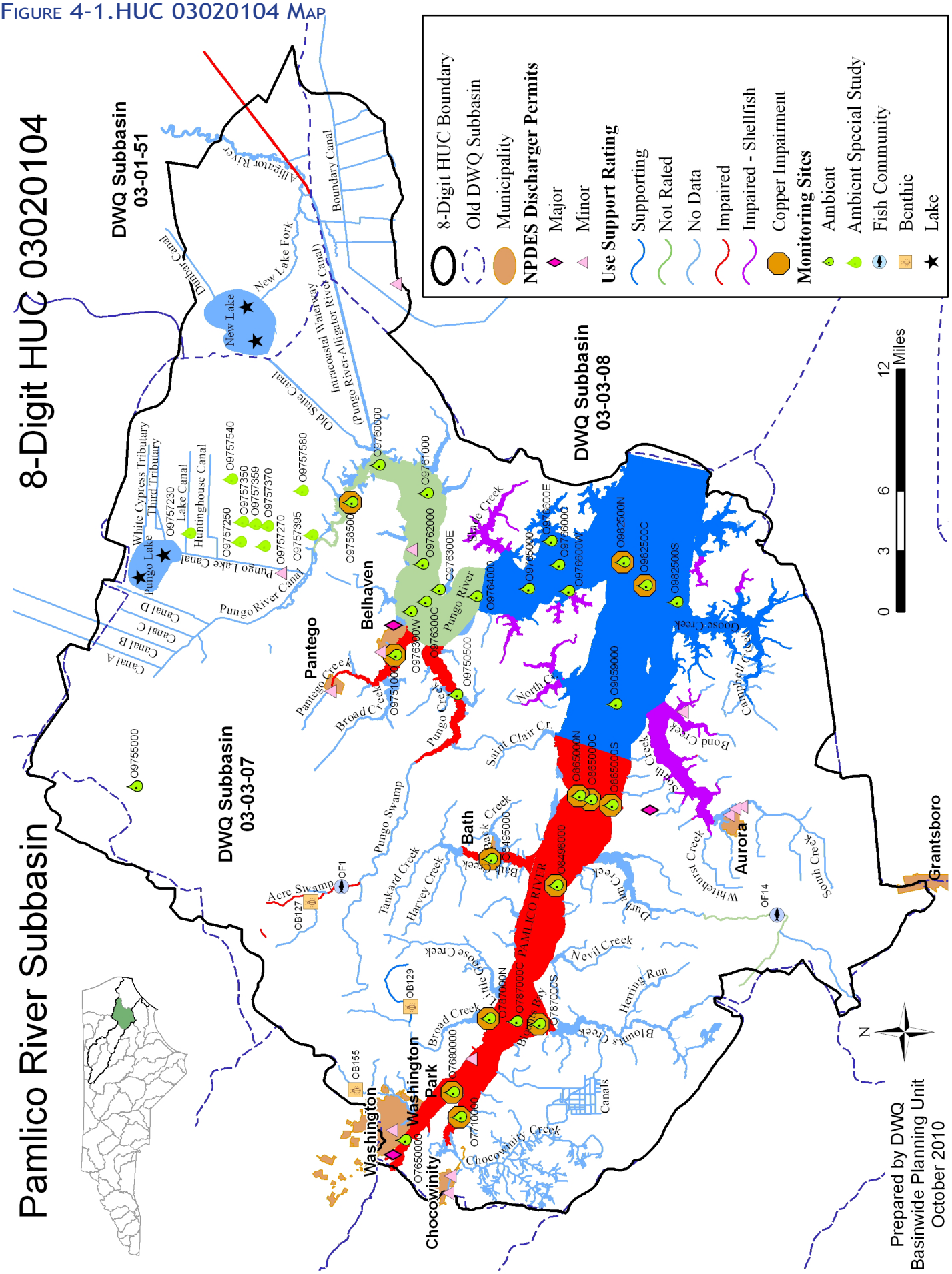
Impervious Surface Estimate: 6 sq mi.

Primary Classifications found in HUC 03020104:

Freshwater	Miles	Freshwater	Acres	Saltwater	Acres
Total...	309	Total...	3,156	Total...	113,249
Supplemental Classifications:					
C;Sw.....	14	C;NSW.....	370	SA;HQW.....	2
C;NSW.....	104	C;Sw,NSW.....	2,786	SA;HQW,NSW..	55,586
C;Sw,NSW.....	190			SB;NSW.....	49,297
C;HQW,NSW....	1			SC.....	176
				SC;HQW,NSW..	57
				SC;NSW.....	8,131

Classification descriptions are found at:
http://portal.ncdenr.org/web/wq/ps/csu/classifications

FIGURE 4-1. HUC 03020104 MAP

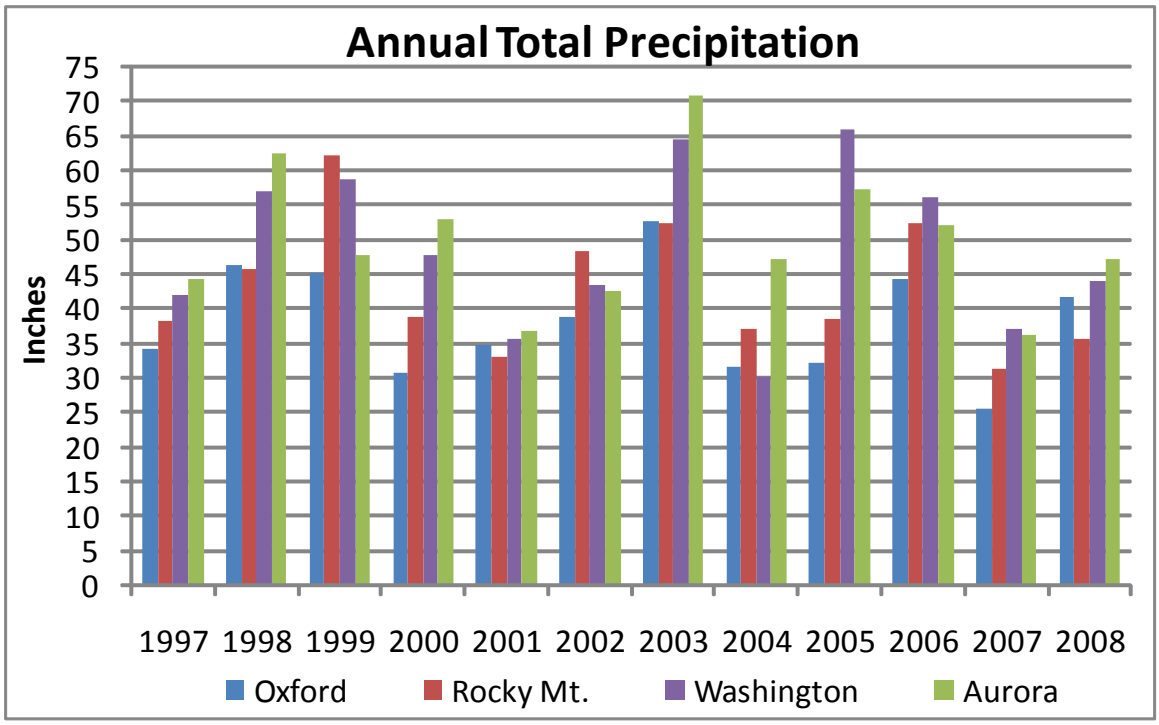


Creek Tidal Freshwater Marsh were reclassified as WL UWL (~272 acres). Unique wetlands (UWL) are of exceptional state or national ecological significance which require special protection to maintain existing uses.

Precipitation

Precipitation data from the State Climate Office of North Carolina are shown in Figure 4-2 for four selected sites to show differences in the upper, middle and lower portions of the basin. The driest years for rainfall in Washington are 2001 & 2004 and 2001 & 2007 for Aurora while 2003 stands out as the year with the most precipitation in the estuary (Hurricane Isabel made landfall on the NC Outer Banks in September 2003). (http://www.nc-climate.ncsu.edu/).

Figure 4-2. Annual Precipitation at selected sites within the Basin



Current Status and Significant Issues

Use Support Assessment Summary

All surface waters in the state are assigned a classification reflecting the best-intended use of that water. To determine how well waterbodies are meeting their best-intended uses, chemical, physical, and biological parameters are regularly assessed by DWQ. These data are used to develop use support ratings every two years as required by EPA; the collected list of all monitored waterbodies and their water quality rating is called the Integrated Report (IR) and Impaired waters are also reported on the 303(d) list. Water quality evaluation levels and how a waterbody earns a rating of Supporting or Impaired is explained in detail in the IR methodology. The 2010 IR is based on data collected between 2004 and 2008; the IR and methodology are available on the DWQ Modeling/TMDL Unit webpage at: http://portal.ncdenr.org/web/wq/ps/mtu/assessment. The most current use support ratings for this subbasin can be found in Appendix 4A.

In this subbasin, use support was assigned for aquatic life, recreation, fish consumption, shellfish harvesting, and water supply categories. Waters are Supporting, Not Rated, or No Data in the aquatic life and recreation categories on a monitored or evaluated basis. All waters are Impaired in the fish consumption category on an evaluated basis based on statewide fish consumption advice issued by the Department of Health and Human Services. All waters are Supporting in the

water supply category on an evaluated basis based on reports from Division of Environmental Health (DEH) regional water treatment plant consultants. Shellfish harvesting assessments are based on DEH Shellfish Sanitation Survey Reports.

Recreation

Recreation uses in tidal saltwaters are rated based on NC's Enterococcus standard which requires a geometric mean of < 35 enterococci per 100 ml based upon a minimum of five samples within any consecutive 30 days. Enterococci are a subgroup of the fecal streptococcus group which generally occur in the digestive systems of humans and other warm-blooded animals along with fecal coliform bacteria. According to the EPA Enterococci bacteria are better able to survive in saltwater and, thus, more closely mimic other pathogens in saltwater than do the fecal coliform bacteria.

Enterococcus samples are collected by the N.C. Recreational Water Quality Program (NCRWQP) within the Division of Environmental Health and not by DWQ. Their sampling results and current swimming advisories are available online at: http://www.deh.enr.state.nc.us/shellfish/Water_Monitoring/RWQweb/home.htm.

Within this subbasin there are 48,299 acres of water classified for primary recreation (SB), of which, 865 acres (2%) are Impaired. An additional 740 acres (9%) out of 8,364 acres of waters classified for secondary recreation are also impaired for recreational uses. Waterbodies with past high levels of enterococcus bacteria include:

Pamlico River upper segment: AU#s 29-(1) & 29-(5)a1
Bath Creek: AU# 29-19-(5.5)
Pungo River near Pantego Creek: AU# 29-34-(12)b

The Recreational Water Quality Program tests recreational beaches during the swimming season beginning on April 1st and ends October 31st. All ocean beaches and high-use sound-side beaches (Tier 1) are tested weekly during the swimming season. Lower-use beaches (Tier II and Tier III) are tested twice a month. All sites are tested twice a month in October and monthly from November through March. The NCRWQP currently uses a running geometric mean and single sample tests to determine compliance with their rules (15A NCAC 18A .3402): (a) The Enterococcus level in a Tier I swimming area shall not exceed either: (1) A geometric mean of 35 enterococci per 100 milliliter of water, that includes a minimum of at least five samples collected within 30 days; or (2) A single sample of 104 enterococci per 100 milliliter of water. (b) The enterococci level in a Tier II swimming area shall not exceed a single sample of 276 enterococci per 100 milliliter of water. (c) The enterococcus level in a Tier III swimming area shall not exceed two consecutive samples of 500 enterococci per 100 milliliter of water."

Shellfish Harvesting Water

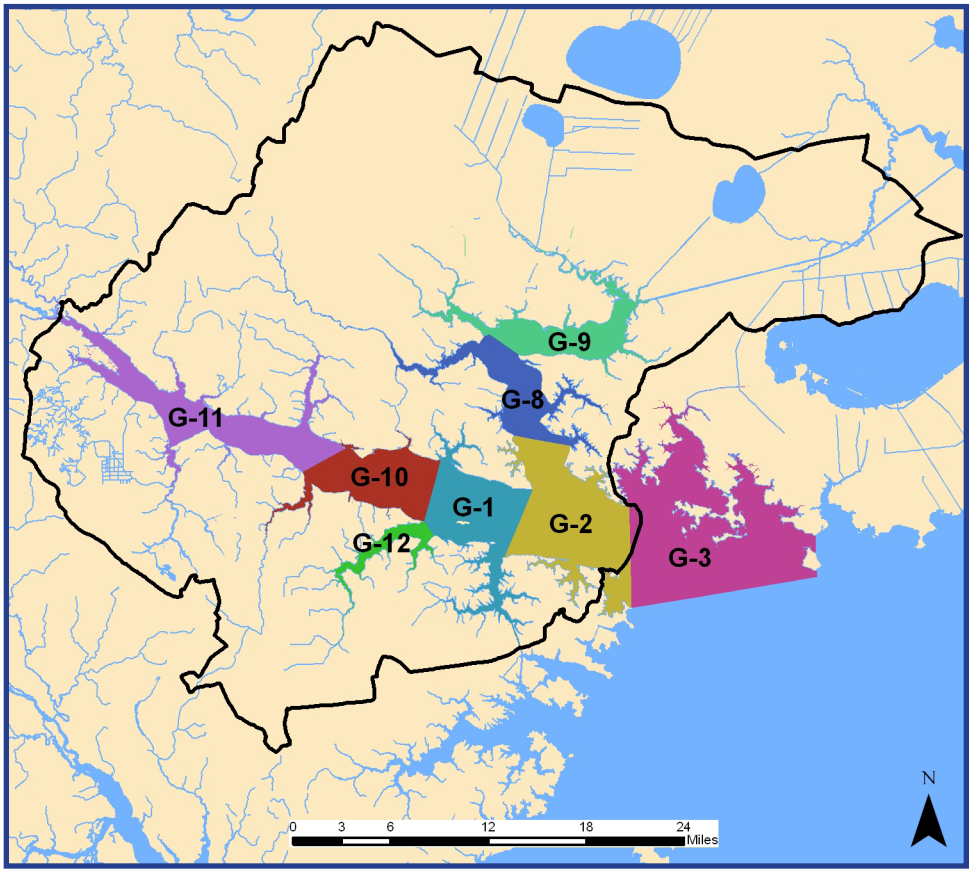
There are 55,569 acres classified as shellfish harvesting waters (SA;HQW), of which 5,397 acres are Impaired because of potential fecal coliform bacteria contamination. Specific Impaired waterbodies are listed in Appendix 4A. The Shellfish Sanitation and Recreational Water Quality Section of the Division of Environmental Health (DEH) is responsible for monitoring and classifying coastal waters as to their suitability for shellfish harvesting for human consumption, and inspection and certification of shellfish and crustacea processing plants.

The Shellfish Sanitation Program is conducted in accordance with the guidelines set by the Interstate Shellfish Sanitation Conference contained in the National Shellfish Sanitation Program (NSSP) Guide for the Control of Molluscan Shellfish Model Ordinance. Classifications of coastal waters for shellfish harvesting are done by means of a Sanitary Survey, which includes: a shoreline survey of sources of pollution, a hydrographic and meteorological survey, and a bacteriological survey of growing waters. Sanitary Surveys are conducted for all potential shellfish areas in coastal North Carolina and recommendations are made to the Division of Marine Fisheries of which areas should be closed for shellfish harvesting. Detailed maps are available

from the DEH website showing current shellfish growing areas: http://www.deh.enr.state.nc.us/shellfish/maps.htm.

DWQ uses DEH classifications to assign use support ratings for the shellfish harvesting category. By definition, Conditionally Approved-Open areas are areas that DEH has determined do not, or likely do not, meet water quality standards and these areas are rated Impaired, along with Conditionally Approved-Closed and Prohibited or Restricted areas. Only DEH Approved growing areas are rated as Supporting.

FIGURE 4-3. SHELLFISH GROWING AREAS IN HUC 03020104



This subbasin contains seven DEH shellfish growing areas including: G1, G2, G8, G9, G10, G11 & G12 as shown in Figure 4-3. The following summaries are from the most current and available DEH Shellfish Sanitation Sanitary Surveys. Note, not all growing areas are surveyed by DEH.

Areas G-1 and G-2 include portions of the Pamlico River, Goose Creek, Pungo River and numerous small creeks, covering ~46,000 acres (DEH Shellfish Sanitation Sanitary Survey, May 2005). Area G-1 has little significance as a shellfishing area, producing only a few oysters and *Rangia* clams, while area G-2 has fair oyster production. Pamlico Beach, Lowland, and Hobucken are the most populous (~1,000) towns and industry in this area includes agriculture, silviculture, commercial fishing, and aquaculture. Pollution sources include drainage from aquaculture ponds, waterfowl impoundments, and closed seafood businesses now being used as junk yards. The dispersion of pollution in these areas is wind driven. Rainfall and stormwater were not identified as influencing bacteria levels these areas. Sampling results indicated bacteriological water quality declined near Ross and Bailey Creeks where recent development has occurred, while conditions improved near Satterwaite Creek.

Areas G-8 and G-9 includes the upper portion of the Pungo River. The city of Belhaven is the largest population (~1,900) center in a predominately rural agricultural area. Potential pollution from both crop and animal agriculture, permitted WWTP dischargers, and surface runoff from small businesses are dispersed through the water by prevailing winds. Oyster production in these waters is considered low and produces mostly *Rangia* clams. Bacteriological water quality sampling indicated a decline in conditions in Lower Dowry Creek and waters surrounding Belhaven. The increase in bacteria levels appear to be spreading into the main channel of the Pungo River.

General Biological Health

Due to limited habitat in this subbasin there has been little invertebrate and fish community sampling. Most streams north of the Pamlico River are channelized and drain agricultural catchments. The one on-going macroinvertebrate site on Beaverdam Swamp had a Moderate Stress bioclassification in both 2002 and 2007. Sampling in Acre Swamp (AU# 29-34-35-1-1), in 2002, resulted in a benthic Severe rating and a Not Rated fish community sample. A special study, completed in 2008, conducted on an unnamed tributary to Herring Run (AU# 29-3-3) resulted in a Not Rated benthic rating; this site is co-located with a Random Ambient Monitoring Systems (RAMS) station O7660000. South of the Pamlico Estuary, Durham Creek (AU# 29-3-3) had a fish community sample collected in 2002 resulting in a Not Rated status. There were no fish community or fish tissue collections in this subbasin between 2002 and 2007.

There were 21 reported fishkills in this subbasin between 2002 and 2007. Four kills were reported on the Pamlico River, and one each from Bond Creek, Durham Creek, Jacks Creek, Duck Creek, Pungo River Canal, Blounts Creek, and one kill reported in a Pond. The causes of these fishkills include low DO, algal blooms and unknown sources; more details can be found at: **http://portal.ncdenr.org/web/wq/ess/fishkills**.

Ambient Data

Subbasinwide, monthly chemical and physical samples are taken by DWQ. There are 30 stations, of which 11 were discontinued in the Pungo River and 9 new stations were started in 2005 for a special study of the canals draining to the Pungo River. A majority of the ambient stations are associated with waterbody locations where potential pollution could occur from known land use activities. There are also portions of the subbasin where no water quality data are collected; therefore, we cannot evaluate the condition of the water quality in those areas. Parameters collected depend on the waterbody classification, but typically include conductivity, chlorophyll *a*, dissolved oxygen, pH, temperature, turbidity, nutrient measurements, metals, and fecal coliform. Each classification has an associated set of standards the parameters must meet in order to be considered supporting the waterbody's designated uses. Stressors are either chemical parameters or physical conditions that at certain levels prevent waterbodies from meeting the standards for their designated use. Ten sample results are required within the five year data collection window in order to evaluate the water quality parameter and compare it to the water quality evaluation levels. Ambient stations are listed in Table 4-1, and their locations are found in Figure 4-1 and on watershed maps provided in Appendix 4D.

Table 4-1. Ambient Stations in HUC 03020104

Station ID	Data Collected Since	Waterbody	AU#	Station Location	Stressors
O7650000	7/6/68	Pamlico R.	29-(1)	US 17 at Washington	Low pH, Chlorophyll a
O7680000	3/7/92	Pamlico R.	29-(5)a	Cm 16 near Whichard Beach	Low pH, Copper, Chlorophyll a
O7710000	3/7/92	Chocowinity Bay	29-6-(5)	Above Silas Cr near Whichard Beach	Chlorophyll a, Copper
O787000C	6/13/74	Pamlico R.	29-(5)b1	Mouth of Broad Cr near Bunyon Mid Channel	Chlorophyll a, Copper
O787000N	6/14/89	Pamlico R.	29-(5)b1	Mouth of Broad Cr near Bunyon N Shore	Low pH, Copper, Chlorophyll a

Station ID	Data Collected Since	Waterbody	AU#	Station Location	Stressors
O787000S	5/18/99	Blounts Bay	29-9	Mouth of Broad Cr near Bunyon S Shore	Chlorophyll a, Copper
O8495000	2/14/74	Bath Cr	29-19-(5.5)	NC 92 near Bath	Chlorophyll a, High pH, Copper
O8498000	5/31/89	Pamlico R.	29-(5)b2	Cm 5 near Core Point	Chlorophyll a, Copper
O865000C	5/18/99	Pamlico R.	29-(5)b3	Cm 4 near Gum Point Mid Channel	Chlorophyll a, Copper
O865000N	5/18/99	Pamlico R.	29-(5)b3	Cm 4 near Gum Point N Shore	Copper
O865000S	5/18/99	Pamlico R.	29-(5)b3	Cm 4 near Gum Point S Shore	Chlorophyll a, Copper
O9059000	8/10/77	Pamlico R.	29-(5)b4	Hickory Pt near South Cr	-
O9750500	10/15/81	Pungo Cr	29-34-35	NC 92 at Sidney Crossroads	Chlorophyll a, Copper, Arsenic
O9751000	10/15/81	Pantego Cr	29-34-34-(2)	NC 92 at Belhaven	Low pH, Chlorophyll a, Copper
O9755000	8/1/84	Van Swamp	23-55	NC 32 near Hoke	Low pH, Copper
O9758500	10/15/81	Pungo R	29-34-(5)	US 264 near Ponzer	Low Do, Low pH, Copper
O9760000	5/18/99-10/1/05	Pungo R	29-34-(12)a	Cm 24 near Icw	Low Do, Low pH
O9761000	5/18/99-10/1/05	Pungo R.	29-34-(12)a	Cm 19 near Scranton Cr	-
O9762000	5/18/99-10/1/05	Pungo R.	29-34-(12)a	Cm 14 near Haystack Point	-
O976300C	5/18/99-10/1/05	Pungo R.	29-34-(12)a	Cm 1Bc Between Durants Point and Pantego Cr	-
O976300E	5/18/99-10/1/05	Pungo R.	29-34-(12)a	off Durants Point	-
O976300W	5/18/99-10/1/05	Pungo R.	29-34-(12)a	Cm 6 at Mouth of Pantego Cr	-
O9764000	5/18/99-10/1/05	Pungo R.	29-34-(12)a	Cm 7 near Woodstock Point	-
O9765000	5/18/99-10/1/05	Pungo R.	29-34-(38)	Cm 4 near Sandy Point	-
O976600C	5/18/99-10/1/05	Pungo R.	29-34-(38)	Between Fortescue Cr and Wright Cr Mid Channel	-
O976600E	5/18/99-10/1/05	Pungo R.	29-34-(38)	Mouth of Fortescue Cr	-
O976600W	5/18/99-10/1/05	Pungo R.	29-34-(38)	Marker 2Wc at Mouth of Wright Cr	-
O982500C	5/18/99	Pamlico R.	29-(27)	Between Mouths of Pungo River and Goose Cr Mid Channel	Copper
O982500N	5/18/99	Pamlico R.	29-(27)	Between Mouths of Pungo River and Goose Cr N Shore	Copper
O982500S	5/18/99	Pamlico R.	29-(27)	Between Mouths of Pungo River and Goose Cr S Shore	-
O7660000	RAMS 2007-2008	UT Herring Run	29-3-3	off SR 1518 near Washington	Low DO
O9757230 O9757540 O9757250 O9757350 O9757359 O9757270 O9757370 O9757580 O9757395	1/2005	Pungo Lake Canals	29-34-3	Pungo Lake Canals, south of Pocosin Lakes National Wildlife Refuge and north of Pungo River.	NH_3-N, inorganic nitrogen, TP, and fecal coliform
"-" indicates no stressors identified					

The following discussion of ambient monitoring parameters includes graphs showing the median and mean concentration values for all ambient stations (n=30) in this subbasin for a specific parameter over each year. These graphs are not intended to provide statistically significant trend information or loading numbers, but rather provide an idea of how changes in land use conditions or climate change effect parameter readings over the long term. The difference between median and mean results indicate the presence of outliers in the dataset. Box and whisker plots of individual ambient stations were completed by parameter for data between 2002-2007 and can be found in the Ambient Monitoring report found at: http://portal.ncdenr.org/c/document_library/get_file?uuid=994c08a8-a98d-4ff5-9425-656cadf8cfa4&groupId=38364. Summary sheets for ambient stations are found in Appendix 4C.

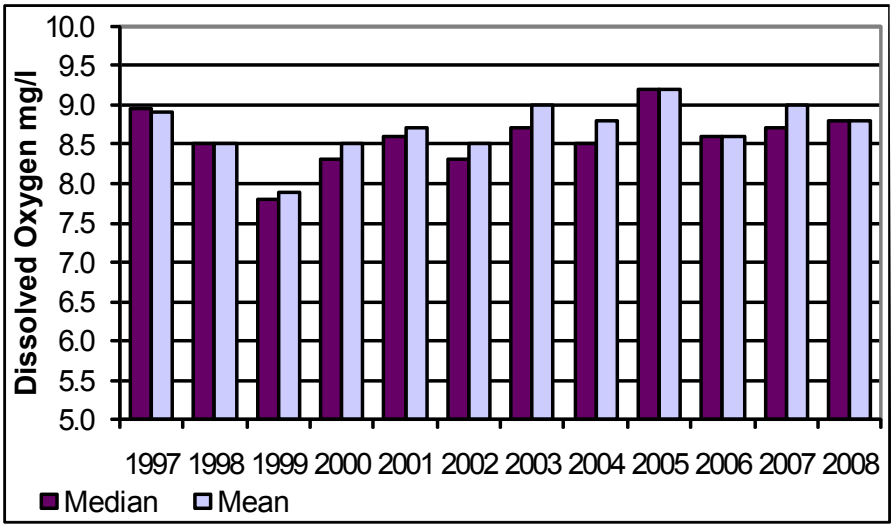
Dissolved Oxygen

The dissolved oxygen (DO) water quality standard for saltwater is not less than 5 mg/L and for freshwater it is not less than a daily average of 5 mg/L or a minimum instantaneous value of not less than 4 mg/L. Swamp waters may have lower values if the low DO level is caused by natural conditions. Dissolved oxygen can be produced by wind or wave action that mix air into the water or through aquatic plant photosynthesis. During the day, DO levels are higher when photosynthesis occurs and they drop at night when respiration occurs by aquatic organisms. High levels are found mostly in cool, swift moving waters and low levels are found in warm, slow moving waters. In slow moving waters, such as reservoirs or estuaries, depth is also a factor. Wind action and plants can cause these waters to have a higher dissolved oxygen concentration near the surface, while biochemical reactions lower in the water column may result in concentration as low as zero at the bottom.

The drought conditions in 2005 and 2007 impacted DO levels throughout the basin. However, low DO levels detected over several years in approximately 16,000 acres of the Pungo River (AU#s 29-34-(5) & 29-34-(12)a) and the upper segment of the Pamlico River (AU# 29-(1)) raise the question of whether drought, low flow or natural conditions are contributing to low DO.

The graph in Figure 4-7 represents results from 4,276 samples collected in estuarine waters over a 12 year period, of which 94 (2%) of these samples had a DO reading below 5 mg/L.

Figure 4-7. Dissolved Oxygen Levels for all data collected at Estuarine Ambient Stations in HUC 03020104 at 1m depth



pH

The water quality standard for pH in surface freshwater is 6.0 to 9.0 standard units and between 6.8-8.5 standard units in saltwater. Swamp water (supplement Class Sw) may have a pH as low as 4.3 if it is the result of natural conditions. Several waterbodies have *low pH* conditions including:

Pamlico River: (Class SC) from US 17 in Washington to the mouth of Broad Creek, AU#s 29-(1), 29-(5)a, & 29-(5)b1

Pungo River: (Class SC) upriver from Woodstock Point & Quilley Point, AU#s 29-34-(5) & 29-34-(12)a

Pantego Creek: (Class SC) AU# 29-34-34-(2)

Van Swamp: (Class C, SW) AU# 23-55

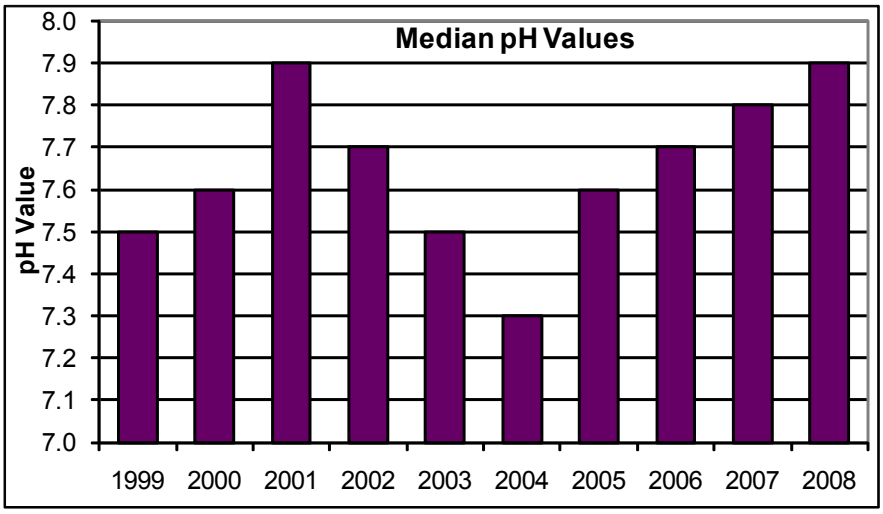
High pH conditions were detected at:

Bath Creek: (Class SC) AU# 29-19-(5.5)

pH is a measure of hydrogen ion concentration that is used to express whether a solution is acidic or alkaline (basic). Low values (< 7.0) can be found in waters rich in dissolved organic matter, such as swamp lands, whereas high values (> 7.0) may be found during algal blooms. Lower values can have chronic effects on the community structure of macroinvertebrates, fish and phytoplankton.

Figure 4-6, graph represents results from 3,759 samples collected over a 10 year period, of which 187 (5%) have low pH levels and and 68 (2%) have high pH levels.

FIGURE 4-6. SUMMARIZED PH VALUES FOR ALL DATA COLLECTED AT ESTUARINE AMBIENT STATIONS IN HUC 03020104 AT 1M DEPTH



Turbidity

The turbidity standard for freshwater streams is 50 NTUs and 25 NTUs for salt waterbodies. There are currently no streams impaired or impacted because of turbidity violations. The majority of monitored waterbodies in this subbasin are estuarine and are held to the 25 NTUs standard. Turbidity is a measure of cloudiness in water and is often accompanied with excessive sediment deposits in the streambed. Excessive sediments deposited on stream and lake bottoms can choke spawning beds (reducing fish survival and growth rates), harm fish food sources, fill in pools (reducing cover from prey and high temperature refuges), and reduce habitat complexity in stream channels. Excessive suspended sediments can make it more difficult for fish to find prey and at high levels can cause direct physical harm, such as clogged gills. Sediments can cause taste and odor problems, block water supply intakes, foul treatment systems, and fill reservoirs.

Figure 4-4. Summarized Turbidity values for all data collected at Ambient Stations in HUC 03020104

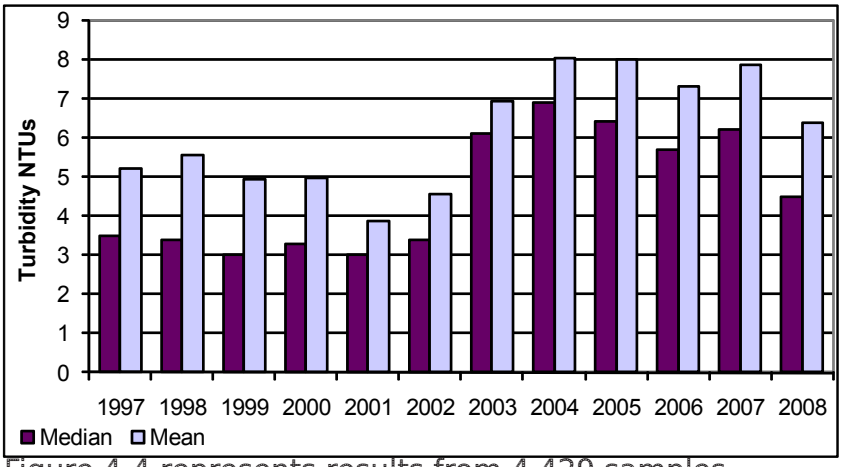


Figure 4-4 represents results from 4,429 samples collected over the 12 year period, of which 52 (1%) of those samples exceed their turbidity standard.

Fecal Coliform Bacteria

The fecal coliform bacteria standard for freshwater streams is not to exceed the geomean of 200 colonies/100ml or 400 colonies/100ml in 20% of the samples where five samples have been taken in a span of 30 days (5-in-30). Only results from a 5-in-30 study are to be used to indicate whether the stream is Impaired or Supporting. Waters with a classification of B (primary recreation water) will receive priority for 5-in-30 studies. Other waterbodies will be studied as resources permit. Data through 2007 indicate several streams where bacteria colony numbers exceeded 400 colonies/100ml.

Canal B near Rose Acres Farm (Special Study) is the only waterbody where 10% of the samples were over 400 colonies/100ml; this water is considered impacted.

The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of humans or other warm-blooded animals. At the time this occurred, the source water might have been contaminated by pathogens or disease producing bacteria or viruses that can also exist in fecal material. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Fecal coliform bacteria may occur in ambient water as a result of the overflow of domestic sewage or nonpoint sources of human and animal waste.

Figure 4-5. Summarized Fecal Coliform Bacteria numbers for all data collected at Ambient Stations in HUC 03020104

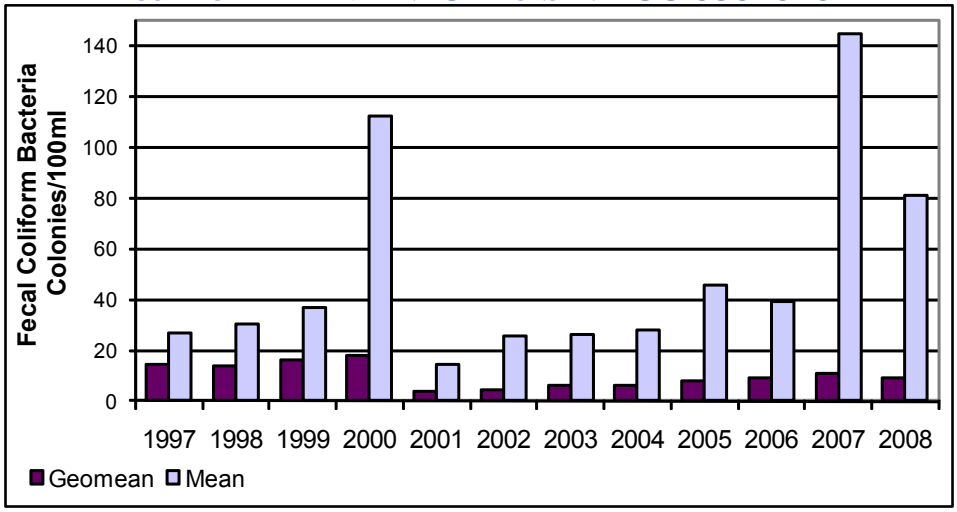


Figure 4-5, graph represents results from 5,006 samples collected over a 12 year period, of which 119 (2%) of these samples had more than 400 fecal coliform bacteria colonies /100 ml. Review of individual station data over the 12 year period indicate 29 samples occurred in waters classified for primary recreation.

Nutrient Enrichment

Compounds of nitrogen and phosphorus are major components of living organisms and thus are essential to maintain life. These compounds are collectively referred to as "nutrients". Nitrogen compounds include ammonia as nitrogen (NH_3), Total Kjeldahl Nitrogen (TKN) and nitrite+nitrate nitrogen (NO_2+NO_3). Total nitrogen (TN) is the sum of TKN and NO_2+NO_3. Phosphorus is measured as total phosphorus (TP) by DWQ. When nutrients are introduced to an aquatic ecosystem from municipal and industrial treatment processes or runoff from urban or agricultural land, the growth of algae and other plants may be accelerated. In addition to the possibility of causing algal blooms, ammonia-nitrogen may combine with high pH water to form ammonium hydroxide (NH_4OH), a form toxic to fish and other aquatic organisms.

Phosphorus loading to the estuary decreased significantly as a result of two events. Effective January 1, 1988, the NC General Assembly adopted a statewide phosphate detergent ban, which resulted in significant drops in stream phosphorus concentrations statewide, however this ban does not include dishwasher detergent. Also, in the fall of 1992, PCS Phosphate, located on the Pamlico River estuary in Aurora, began a wastewater recycling program that reduced its phosphorus discharge by about 97 percent.

Due to excessive levels of nutrients resulting in massive algal blooms and fish kills the entire Tar-Pamlico River Basin was designated as Nutrient Sensitive Water (NSW) in 1989. This designation resulted in the development and implementation of a nutrient management strategy to achieve a decrease in TN by 30% and no increase in TP loads compared to 1991 conditions. Even though implementation of the strategy has occurred by wastewater treatment plant (WWTP) dischargers, municipal stormwater programs, and agriculture, nutrient enrichment continues to be cumulatively impacting the Pamlico Estuary. A review of the NSW strategy, including implementation activities, progress towards meeting the loading goals and additional actions are discussed in Chapter 6.

Basin trend analyses were completed for nutrient concentration and daily loads to evaluate progress towards meeting TMDL reduction goals, as discussed in detail in the NSW Chapter 6. These analyses detected a statistically significant increase in TKN concentration and a decrease in NH_3 and NO_2+NO_3. There were no basinwide detected trends for TN or TP concentrations. TKN is defined as total organic nitrogen and NH_3. An increase in organic nitrogen is the likely source for the increase in TKN concentrations since NH_3 concentrations have decreased basinwide.

Chlorophyll *a*

The chlorophyll *a* standard is 40 µg/L (micrograms per liter) for lakes, reservoirs and slow moving waters in North Carolina. Almost 29 thousand acres are impaired in the Pamlico estuary because chlorophyll *a* levels exceeded the 40 µg/L standard in more than 10% of the samples. The following waterbodies have high chlorophyll *a* levels:

Kennedy Creek: AU# 28-104

Pamlico River from downstream of Runyon Creek and Rodman Creek to to a line from Huddy Creek (south shore) to Saint Claire Creek (north shore), including Blounts Bay: AU#s 29-(5)a, 29-(5)b1, 29-9, 29-(5)b2, & 29-(5)b3

Chocowinity Bay: AU#s 29-6-(1) & 29-6-(5)

Bath Creek: AU# 29-19-(5.5)

Pungo Creek: AU# 29-34-35

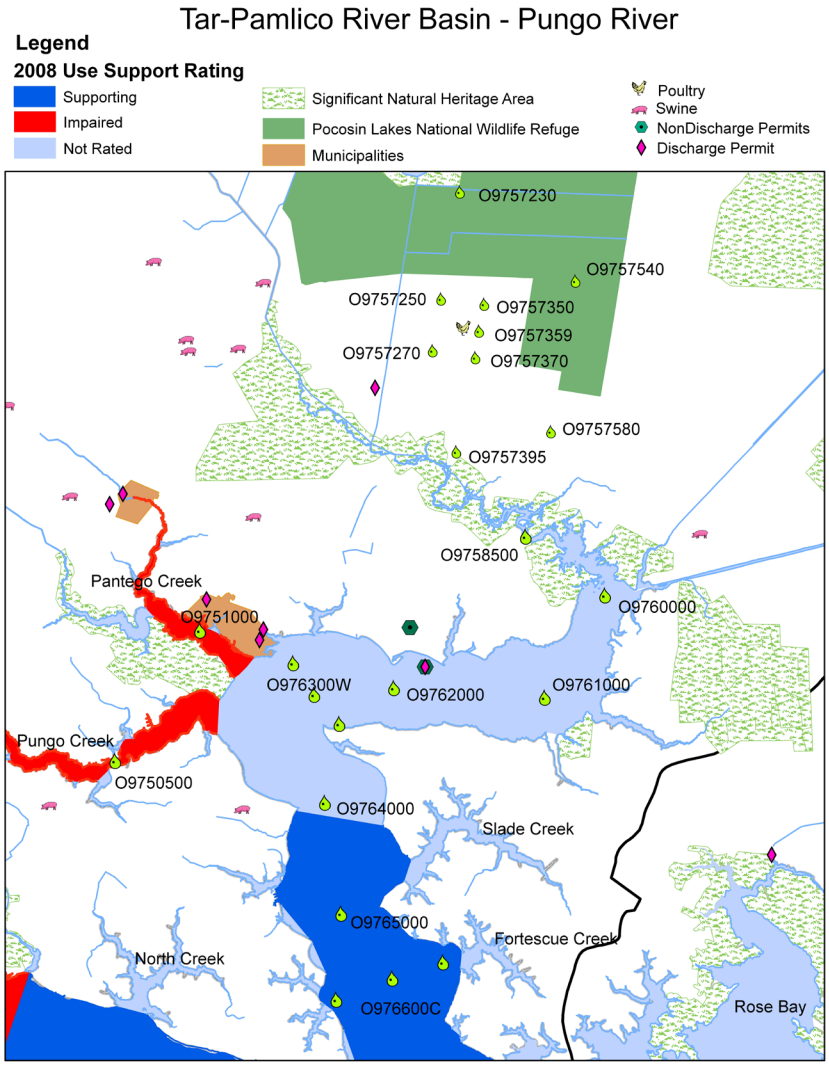
Pantego Creek: AU# 29-34-34-(2)

Water Quality in the Pungo River

The Pungo River watershed drains ~401,926 acres. The area has an extensive ditch network that drains large agricultural areas. Increased waterfront development is also occurring. Although the Pungo River flows into the Pamlico Estuary below the Impaired segments of the estuary, the Pungo River and tributaries are also classified as NSW. Any land use activities (regulated and non-regulated) that contribute nutrients to the system should be using best available technology, BMPs, and mitigation measures to reduce their impacts.

The two major tributaries (Pantego Creek AU# 29-34-34-(2), 952 ac. & Pungo Creek AU# 29-34-35, 1,702 ac.) to the Pungo River are Impaired because of high chlorophyll *a* levels (Figure 4-8). Both Pantego Creek and the Pungo River (AU# 29-34-(5)) headwaters are Impaired because of copper violations. There is one area, near Belhaven, consisting of 2.8 acres within the Pungo River (AU# 29-34-(12)b) that was Impaired for recreation. In the rest of the river, the data are inconclusive or no data are available; the lower segment is Supporting.

Figure 4-8 Pungo River Drainage



Eleven ambient monitoring stations in the mainstem of the Pungo river have been discontinued. To ensure the Pungo River is meeting water quality standards it is recommended that ambient sampling be reestablished at site O9764000 or O9765000. This will help capture the cumulative load of potential pollutants coming from, existing developments/industry, new developments and agriculture before the water enters the Pamlico Sound.

Special Study- Rose Acres

In 2003, DWQ began investigating environmental conditions for a proposed chicken egg laying facility. DWQ collected data before and after the farm was populated with birds. Surface water quality data were collected at nine stations, starting in 2005, located around the farm as shown in Figure 4-8 (near Pocosin Lakes National Wildlife Refuge). The data indicate a significant increase in ammonia nitrogen, total inorganic nitrogen, total phosphorus, and fecal coliform concentrations. When evaluating on a station by station basis, only a few stations had significant differences between the pre and post operation data sets. Station O9757350 in the northeast corner had significantly elevated levels of ammonia, total inorganic nitrogen, total phosphorus and fecal coliform. (DWQ-ESS. 5/6/09. "Summary of the Rose Acres Farm Sampling Program"). These water quality stations will be discontinued by DWQ, but will continue to be sampled by the farm.

Due to concerns about atmospheric emissions and the near and far field deposition of ammonia on water quality, the US Fish & Wildlife Service initiated an investigation to study the effects of atmospheric deposition in the area. Preliminary review of data indicates that the farm is a contributing local source for ammonia and nitrogen deposition. This study report is found in Appendix 4E and more detailed discussion about the farms permit requirements and recommendations are discussed under the Agriculture section of this document.

Presently, ambient data are taken in the headwaters of the Pungo River which is likely only capturing runoff from agriculture and wildlife. Figures 4- 9,10 & 11 show chlorophyll *a*, TN, and TP concentration levels from this station over the last several years. Both TN and TP levels decreased during the 2007-08 drought, while chlorophyll *a* levels increased but not enough to exceed standards.

Figure 4-9. Chlorophyll *a* at Ambient station O9758500

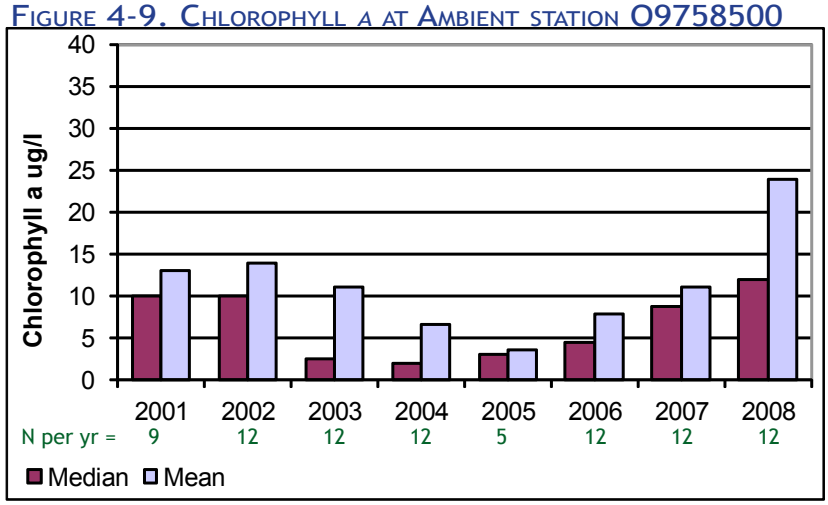


Figure 4-10. Total Nitrogen at Ambient station O9758500

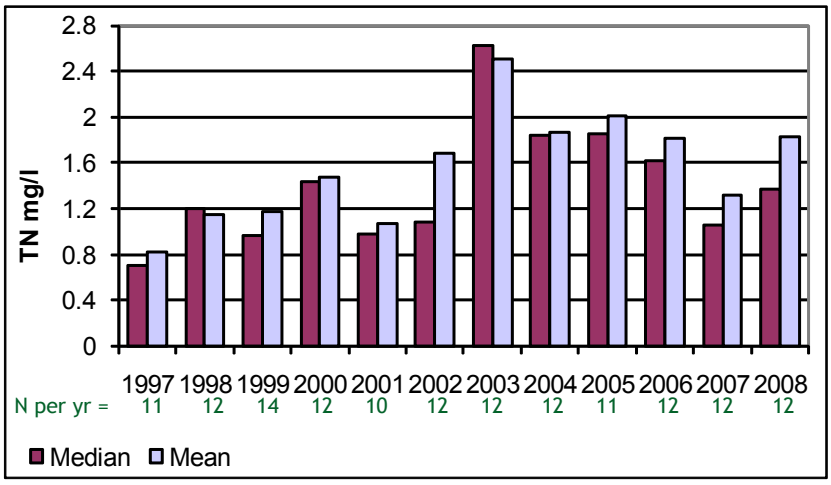
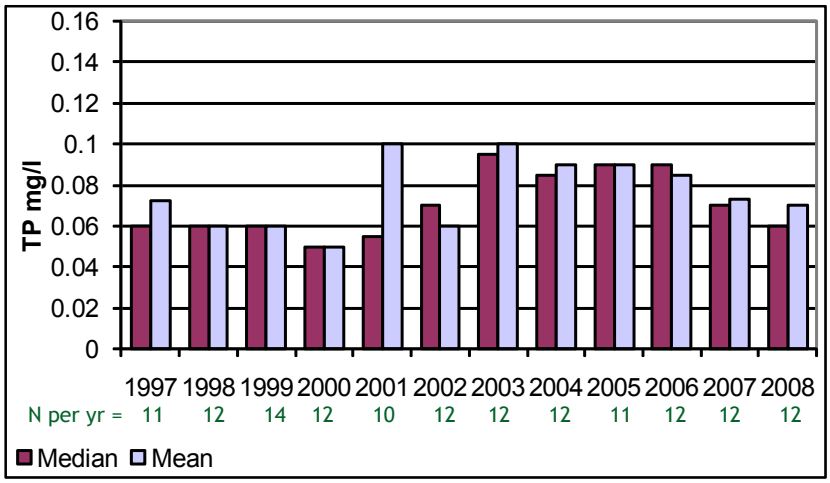


Figure 4-11. Total Phosphorus at Ambient station O9758500



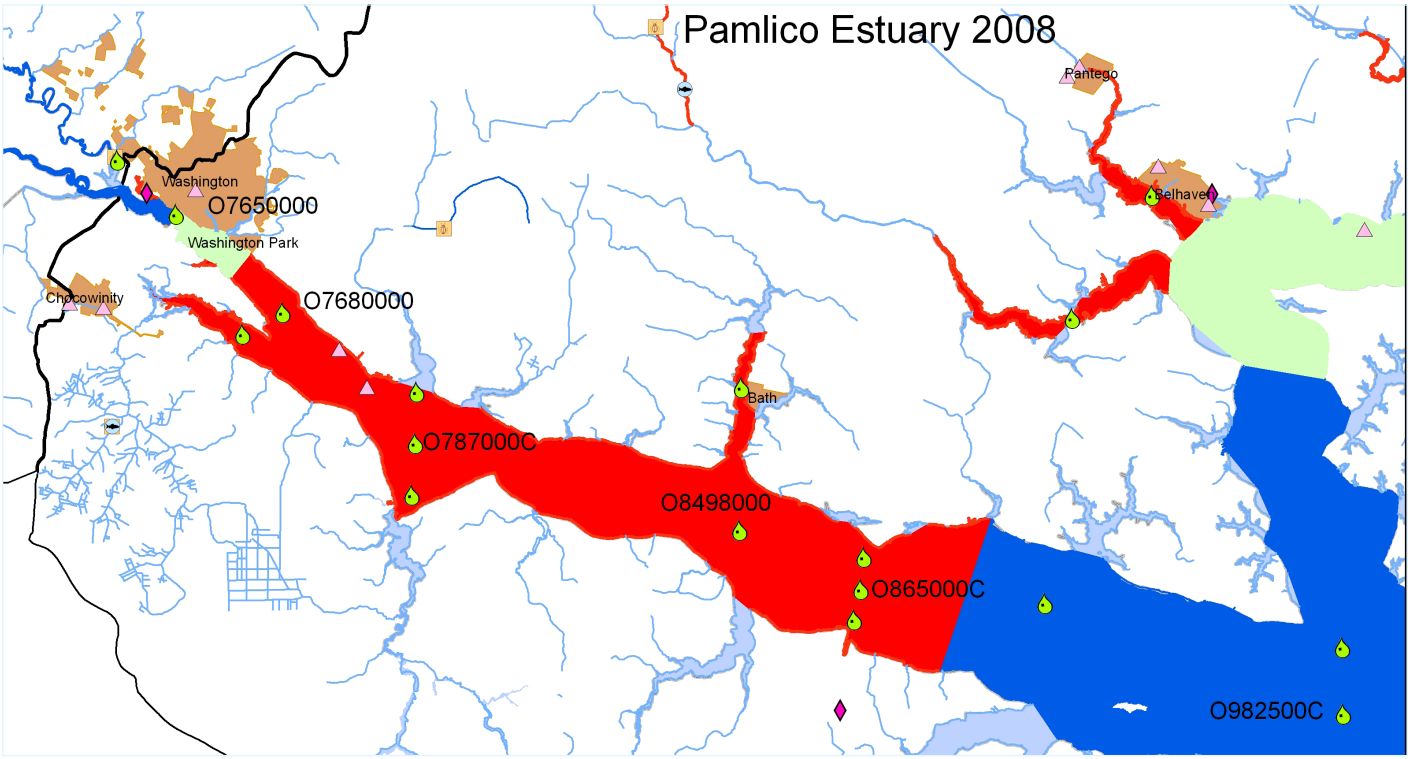
Water Quality in the Pamlico Estuary

Recurring nutrient-related problems have been documented in the Pamlico River estuary through the latter half of the 20th century. The state documented increasing numbers of fish kills in the estuary from the mid-70s through the early 1990s. Researchers in the estuary have investigated the presence of fish and crab diseases, algal blooms, hypoxic conditions, loss of aquatic vegetation, and degradation of the region's water quality. Researchers estimated that there was a several-fold increase in nitrogen inputs to the basin during the last century. Most of the increases were attributed to increased crop fertilization and production, particularly since the 1950s. Increases in farm animals and municipal and industrial discharges also contributed to the rise in nitrogen inputs. However, recent studies have shown that nitrogen levels instream have decreased somewhat in the last thirty years. Although, they are still considered to be sufficiently high to foster harmful algal blooms.

Nitrogen and phosphorus TMDLs were approved by EPA in August 1995 based on results of estuarine response modeling. The TMDL and management strategies were outlined in the 1994 Tar-Pamlico Basinwide Water Quality Management Plan (http://portal.ncdenr.org/web/wq/ps/bpu/basin) and called for reducing instream nitrogen loading at Washington, NC by 30 percent from current levels to 1991 levels and holding phosphorus loading to 1991 levels. These values were based on minimizing exceedances of the 40 µg/L chlorophyll *a* standard.

Water quality in the Pamlico Estuary has been reported in basinwide plans since 1994. In the 1994 basin plan the area known to be exceeding chlorophyll *a* data extended from Washington to a line from Huddy Creek (south shore) to Saint Claire Creek (north shore). In 1999 and 2004, the data indicated the chlorophyll *a* violations only extended to a line 0.65 miles downstream of Chocowinity Bay including Chocowinity Bay. The 2008 and 2010 assessment indicated this impairment extending again to Huddy and Saint Claire Creeks (~28,923 ac). Ambient data are reassessed every two years and it is possible that fluctuations in Supporting (meeting water quality standards) or Impairment (not meeting water quality standards) status will change with each assessment data period. Six estuary ambient sites, shown in Figure 4-12, were selected for nutrient analyses. Chlorophyll a, TP and TN concentration levels over the last several years are graphed in Figures 4- 13-30.

FIGURE 4-12. CORRESPONDING AMBIENT SITES TO NUTRIENT GRAPHS



Figures 4- 13-18 show the differences in chlorophyll *a* concentrations throughout the Pamlico Estuary, moving from a station near Washington to station near the mouth of the Pungo River, between 2001-2008. Station O7650000 is near Washington at the upper most portion of the estuary, this area is currently not Impaired and the last station O982500C is also in an unimpaired segment of the estuary because chlorophyll *a* levels do not exceed standards. Figures 4- 14-17 represent stations where water is considered Impaired because chlorophyll *a* levels exceed the standard. The drought during 2007-2008 appears to have influenced the upper estuary chlorophyll *a* levels more so than waters closer to the sound, whereas during the rainier years chlorophyll *a* levels tend to be higher in the central portion of the estuary. For comparison, 1991 nutrient concentration data at Station O7650000 includes a median chlorophyll *a* level of 12.5 ug/l and a mean of 39.8 ug/l.

Figure 4-13. Station O7650000 Chlorophyll a Yearly Concentrations

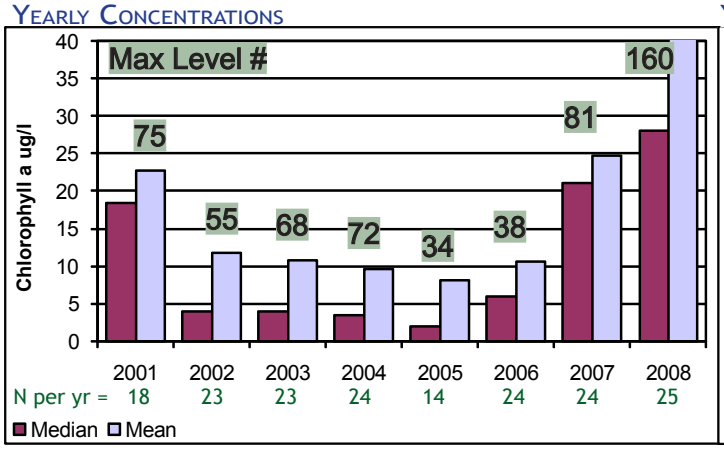


Figure 4-14. Station O7680000 Chlorophyll a Yearly Concentrations

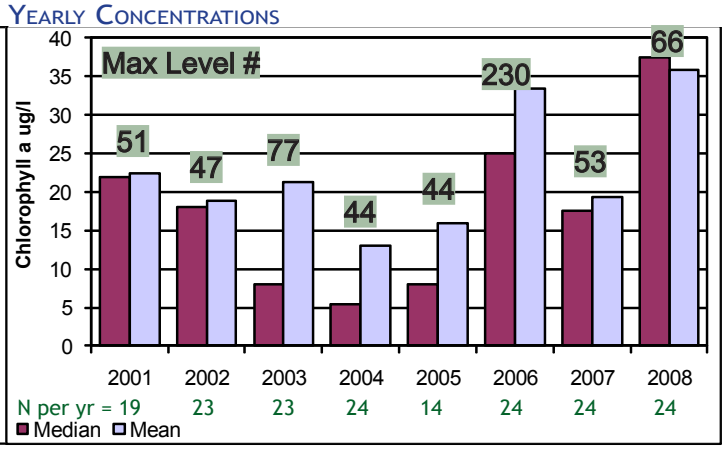


Figure 4-15. Station O787000C Chlorophyll a Yearly Concentrations

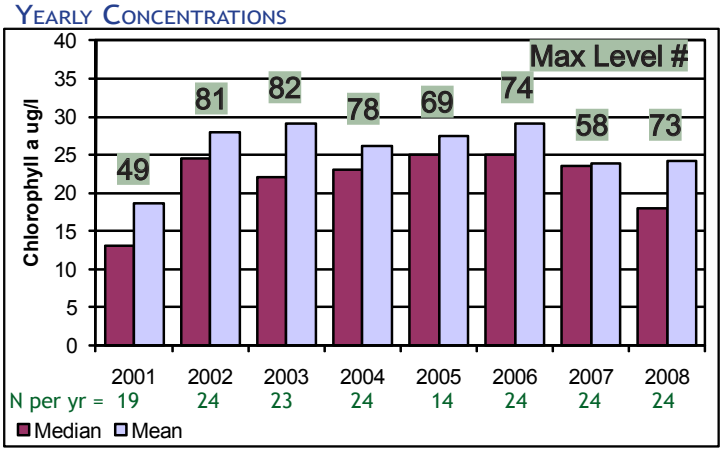


Figure 4-16. Station O8498000 Chlorophyll a Yearly Concentrations

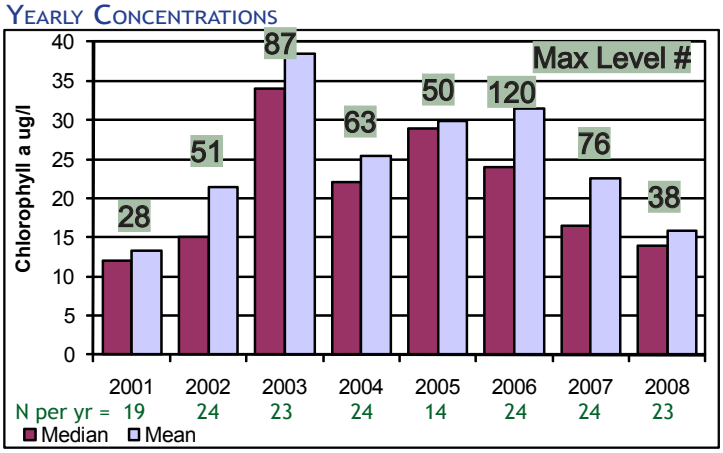


Figure 4-17. Station O865000C Chlorophyll a Yearly Concentrations

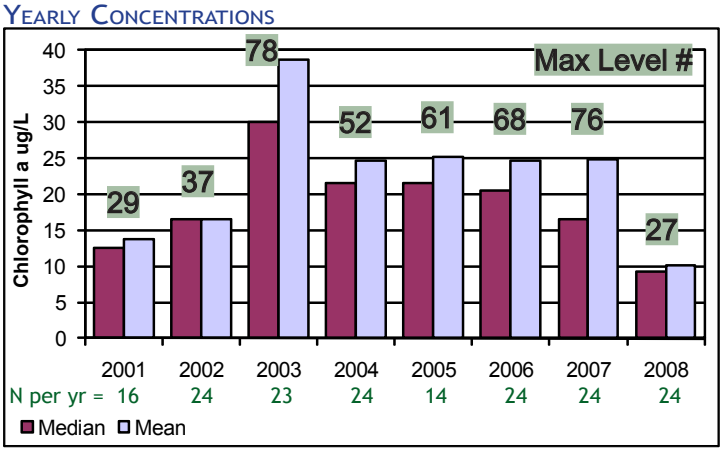
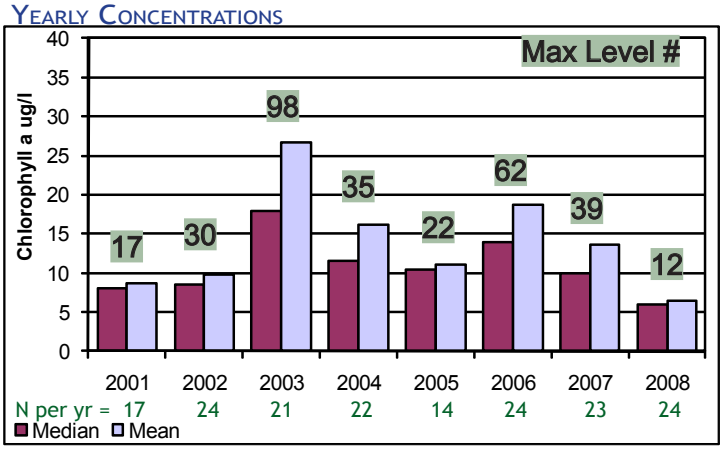


Figure 4-18. Station O982500C Chlorophyll a Yearly Concentrations



Figures 4- 19-24 represent yearly total nitrogen concentrations at selected ambient stations within the Pamlico Estuary. Each graph shows a general increase in total nitrogen over the past decade with total nitrogen concentrations becoming less at stations closer to the sound, which is likely a result of uptake and dilution. The TMDL compliance point is at station O7650000 near Washington where data from 1991 were used for calibration conditions for modeling estuary nutrient conditions. For comparison, 1991 nutrient concentration data at Station O7650000 includes a median total nitrogen level of 1.04 mg/L and a mean of 1.06 mg/L.

Figure 4-19. Station O7650000 Total Nitrogen Yearly Concentrations

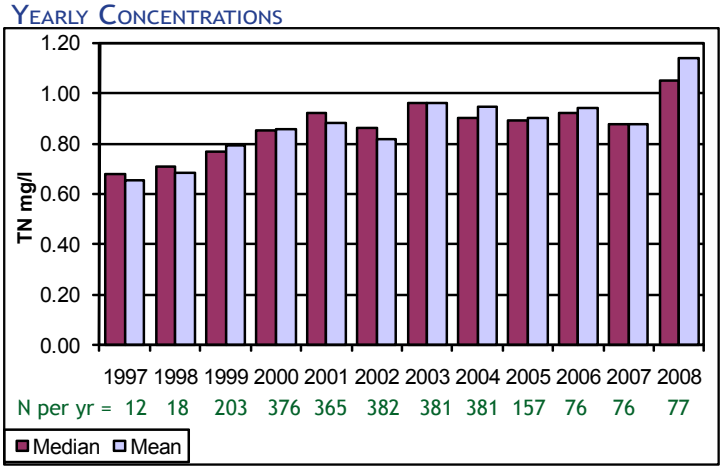


Figure 4-20. Station O7680000 Total Nitrogen Yearly Concentrations

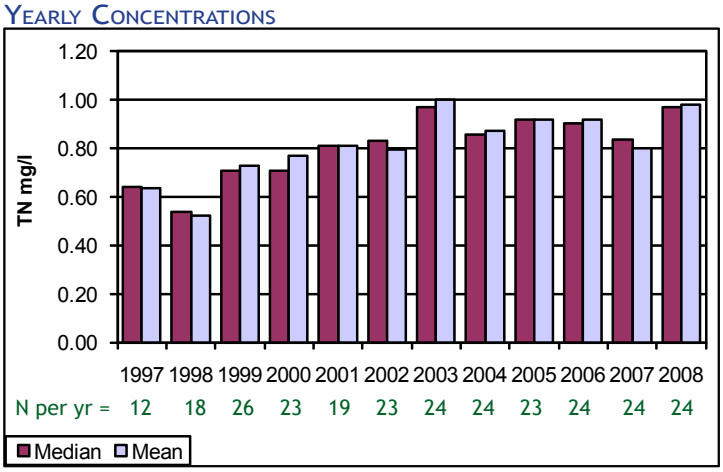


Figure 4-21. Station O787000C Total Nitrogen Yearly Concentrations

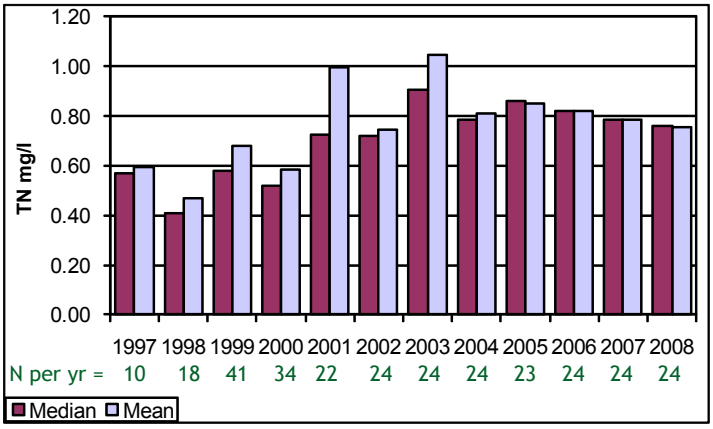


Figure 4-22. Station O8498000 Total Nitrogen Yearly Concentrations

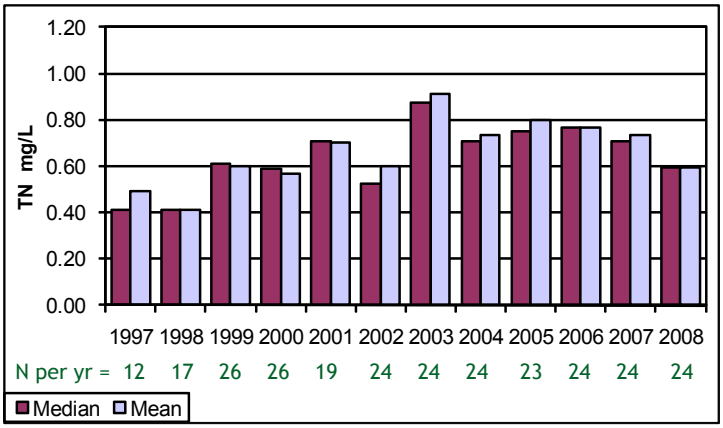


Figure 4-23. Station O865000C Total Nitrogen Yearly Concentrations

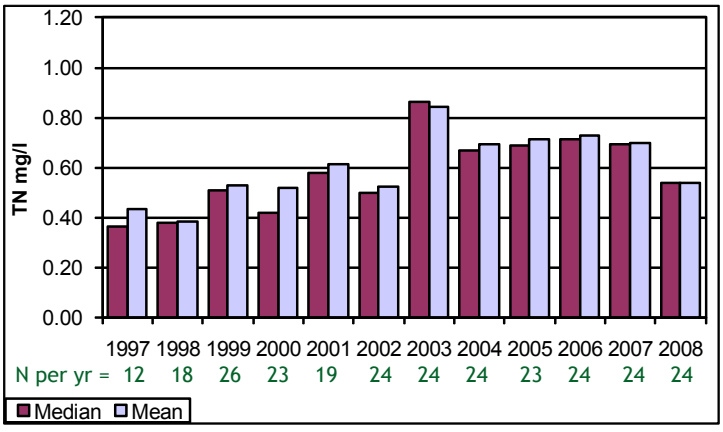
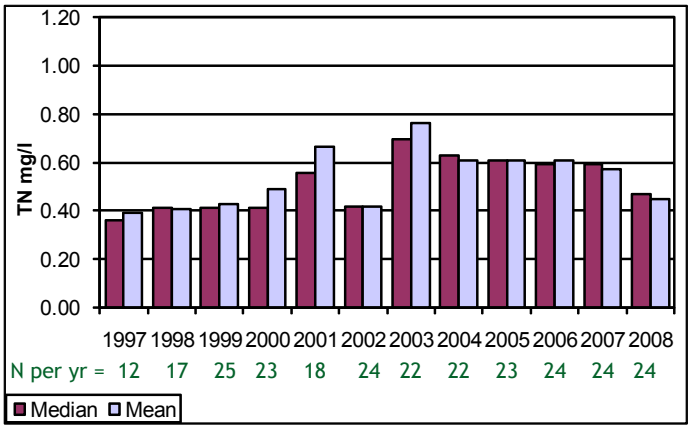


Figure 4-24. Station O982500C Total Nitrogen Yearly Concentrations



Figures 4- 25-30 represent total phosphorus concentrations at ambient stations throughout the Pamlico estuary. With the exception of a few events that likely caused the mean TP to rise, the median TP concentrations have decreased with each station moving progressively further out into the estuary. The TMDL compliance point is at station O7650000 near Washington where data from 1991 were used for calibration conditions for modeling estuary nutrient conditions. For comparison, 1991 nutrient concentration data at Station O7650000 includes a median total phosphorus level of 0.17 mg/L and a mean of 0.16 mg/L.

Figure 4-25. Station O7650000 Total Phosphorus Yearly Concentrations

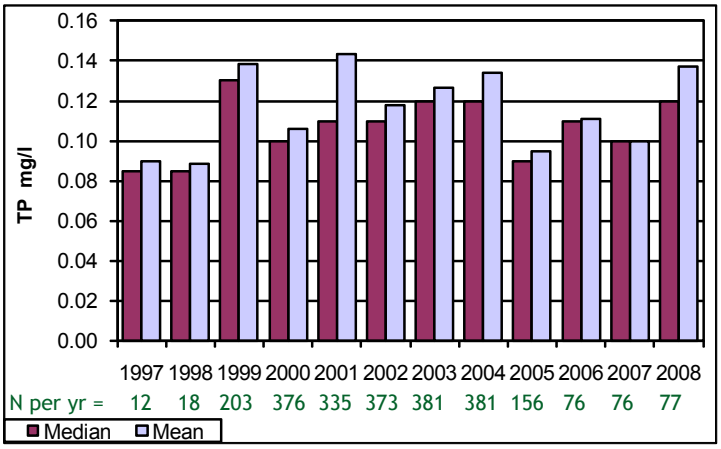


Figure 4-26. Station O7680000 Total Phosphorus Yearly Concentrations

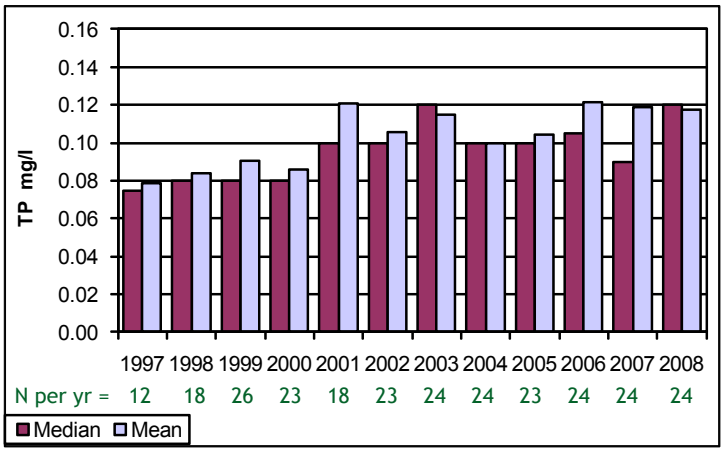


Figure 4-27. Station O787000C Total Phosphorus Yearly Concentrations

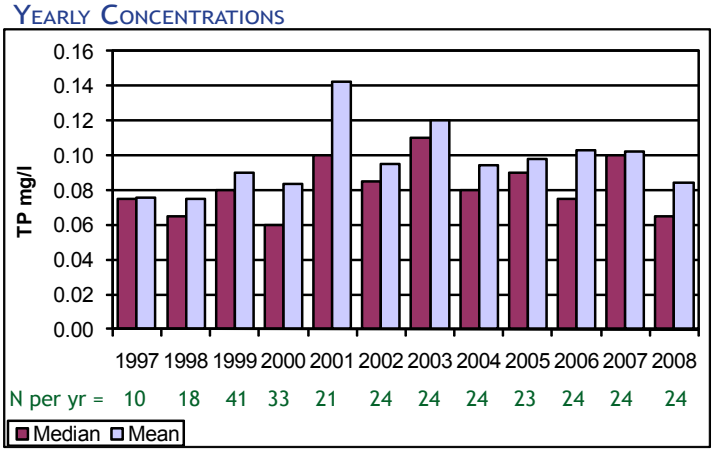


Figure 4-28. Station O8498000 Total Phosphorus Yearly Concentrations

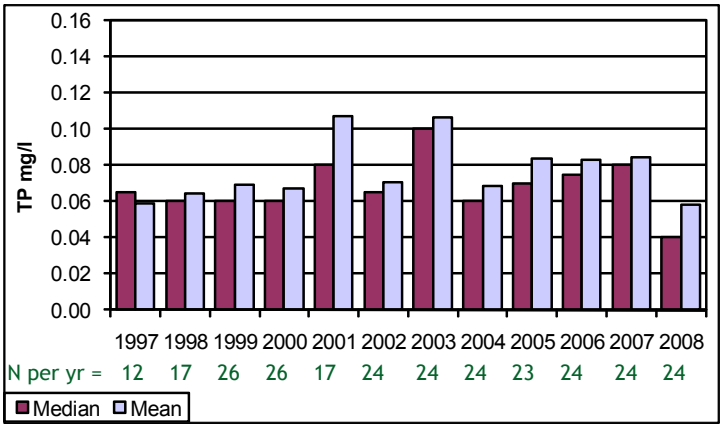


Figure 4-29. Station O865000C Total Phosphorus Yearly Concentrations

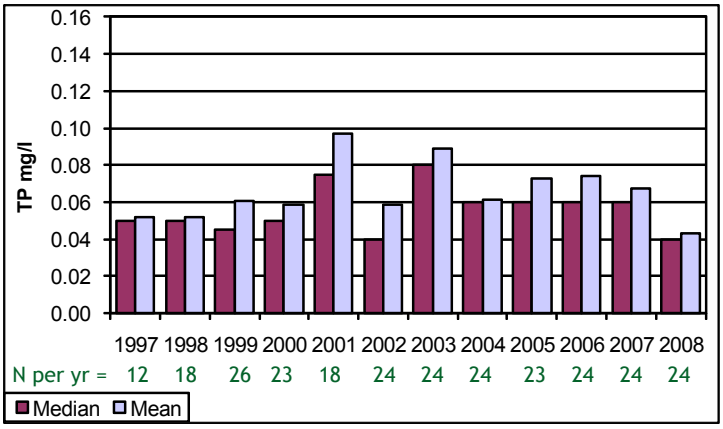
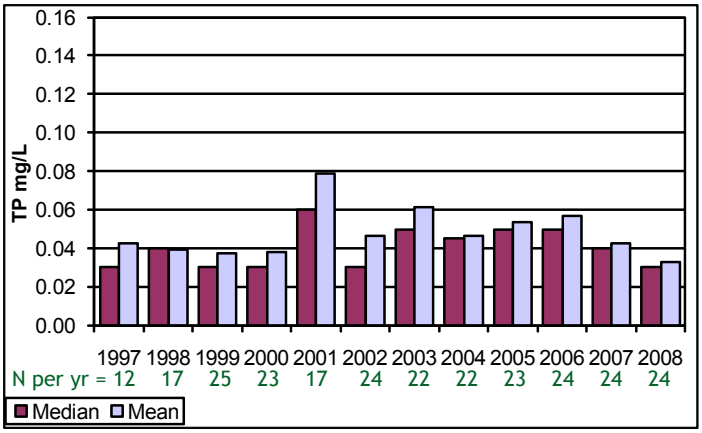


Figure 4-30. Station O982500C Total Phosphorus Yearly Concentrations



Wastewater Dischargers

The National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States, as authorized by the Clean Water Act. Non-compliance with permit limits on wastewater flow and constituents can lead to discharge of pollutants that degrade surface waters making them unsafe for drinking, fishing, swimming, and other activities. The NPDES Permitting and Compliance Programs of DWQ is responsible for administering the program for the state. These permits are reviewed and are potentially renewed every 5 years. A list of NPDES permits are listed in Table 4-2 and locations on Figure 4-1.

The Federal and State Pretreatment Program gives regulatory authority for EPA, States, and Municipal Governments to control the discharge of industrial wastewater into municipal Wastewater Treatment Plants (WWTPs) or Publicly Owned Treatment Works (POTWs). The objectives of the Pretreatment Program are to prevent pass-through, interference, or other adverse impacts to the POTW, its workers, or the environment; to promote the beneficial reuse of biosolids; and to assure all categorical pretreatment standards are met. There are currently around 700 Significant Industrial Users (SIUs) who discharge industrial wastewater to over 120 POTWs throughout the state of North Carolina. The City of Washington is the only WWTP covered by POTW Pretreatment Program in this subbasin.

Table 4-2 NPDES Discharge Permits in HUC 03020104

Permit #	Facility Name	Owner Type	Permit Type	Class	Receiving Stream	Permit Flow MGD
NC0003255	Aurora Mine	Non-Government	Industrial Process & Commercial Wastewater	Major	Pamlico River	0
NC0004057	Carolina Seafood	Non-Government	Industrial Process & Commercial Wastewater	Minor	Muddy Creek	
NC0004081	Aurora Packing Company	Non-Government	Industrial Process & Commercial Wastewater	Minor	South Creek	0.0012
NC0020648*	Washington WWTP	Government - Municipal	Municipal Wastewater Discharge, Large	Major	Tar River	3.65
NC0021521	Aurora WWTP	Government - Municipal	Municipal Wastewater Discharge, < 1MGD	Minor	South Creek	0.12
NC0026492*	Belhaven WWTP	Government - Municipal	Municipal Wastewater Discharge, Large	Major	Battalina Creek	1.0
NC0036919	Pantego Municipal Center WWTP	Government - Municipal	Discharging 100% Domestic < 1MGD	Minor	Pantego Creek	0.006
NC0040584	Pantego Rest Home	Non-Government	Discharging 100% Domestic < 1MGD	Minor	Pantego Creek	0.004
NC0068233	Fairfield WTP	Government - County	Water Plants and Water Conditioning	Minor	Lake Mattamuskeet	0.1
NC0069426	Dowry Creek WWTP	Non-Government	Discharging 100% Domestic < 1MGD	Minor	Pungo River	0.05
NC0077992	Ponzer WTP	Government - County	Water Plants and Water Conditioning	Minor	Pungo Lake Canal	0.108
NC0081191*	Washington WTP	Government - Municipal	Water Plants and Water Conditioning	Minor	Pamlico River	0.42
NC0083216	Hughes Street WTP	Government - Municipal	Water Plants and Water Conditioning	Minor	Maple Branch	0
NC0083224	Edgewood Drive WTP	Government - Municipal	Water Plants and Water Conditioning	Minor	Maple Branch	0
NC0084808	Richland WTP	Government - County	Water Plants and Water Conditioning	Minor	South Creek	0
NC0086584*	Belhaven WTP	Government - Municipal	Water Plants and Water Conditioning	Minor	Pantego Creek	0.22

Permit #	Facility Name	Owner Type	Permit Type	Class	Receiving Stream	Permit Flow MGD
NC0087491	Chocowinity/Richland Township WTP	Government - County	Water Plants and Water Conditioning	Minor	Pamlico River	
NC0088072	Sea Safari Ltd	Non-Government	Industrial Process & Commercial Wastewater	Minor	Battalina Creek	
* Indicates Tar-Pamlico Basin Association Permittee Member						

On-Site Wastewater Treatment Systems (Septic Systems)

Wastewater from many households is treated on-site through the use of permitted septic systems instead of being sent to a wastewater treatment facility. Poorly planned and/or maintained systems can fail and contribute to nonpoint source pollution. Wastewater from failing septic systems can contaminate groundwater and surface water. Failing septic systems are health hazards and are considered illegal discharges of wastewater if surface waters are impacted. Information about the proper installation and maintenance of septic tanks can be obtained by contacting the Department of Environmental Health and local county health departments. Local health departments are responsible for ensuring that new systems are sited and constructed properly and an adequate repair area is available. County, town and city planners need to understand the economic and human health ramifications caused by failing septic systems and plan for long-term septic system sustainability.

In 2007, North Carolina Agricultural Research Service completed a report concerning nitrogen contributions from on-site wastewater systems for each river basin. The results for this subbasin based on 1990 census data indicate a population of 26,245 people using 12,429 septic systems resulting in a potential nitrogen loading of 262,449 lbs/yr and nitrogen loading rate of 262 lbs/mi^2/yr. These numbers reflect the total N discharged to the soil from the septic system and does not account for N used because of soil processes and plant uptake. (Pradhan et al. 2007).

Wastewater Residuals (Biosolids)

Residuals, biosolids or treated sludge, are by-products of the wastewater treatment process. After pathogen reduction, vector attraction reductions, and metal limits are met, these residuals are disposed in a manner to protect public health and the environment. Disposal sites include land fills, dedicated residual disposal sites, agricultural land for crops not for human consumption, and distribution to the public for home use. When applied to the land, steps must be taken to assure that residuals are applied at or below agronomic rates based on the soil and crop types present at the disposal site. If these criteria cannot be met, permitted disposal must take place at a dedicated residual disposal site or landfill.

In this subbasin, PCS Phosphate applies residuals on two fields covering 10 acres. A rough estimate of 700 lbs/yr of nitrogen and 900 lbs/yr of phosphorus are applied to these fields. This estimate does not include Class A residuals which are not monitored by DWQ, but are another source of nutrients. For more information about residuals please see DWQ's Aquifer Protection Section: http://portal.ncdenr.org/web/wq/aps/lau.

Non-Discharge

Non-discharge systems have been the preferred alternative to discharge to surface waters for some NSW waterbodies and DWQ requires all new and expanding NPDES permit applicants to provide documentation that considers alternatives to surface waters. Non-discharge wastewater options include spray irrigation, rapid infiltration basins, and drip irrigation systems. Although these systems are operated without a discharge to surface waters, they still require a DWQ permit. The permit insures that treated wastewater is applied to the land at a rate that is protective of groundwater resources, and does not produce ponding or runoff into a waterbody. More information about land application and non-discharge requirements can be found on the

DWQ Aquifer Protection Section Land Application Unit website: http://portal.ncdenr.org/web/wq/aps/lau. Non-discharge permits in this subbasin are listed in Table 4-3.

Run-off and spills are not common at non-discharge facilities. In general, maintaining compliance with permit conditions largely falls back to having a properly managed facility. Aging sewer systems may lead to increased flows from inflow and infiltration or a facility may not be properly prepared to expand as flows increase and the upper limits of a plant's capacity are reached. Non-discharge facilities, just like any other, must properly plan for any elevated flows and take action to ensure that the facility is capable of managing the wastewater.

Groundwater moving into surface water is a mechanism to introduce nutrients into the surface water system in the absence of direct discharges and in NSW systems it is important to be able to better quantify these potential nutrient loads. Some facilities have a groundwater monitoring program to measure compliance with groundwater quality standards. However, it should be noted that a facility can be compliant with groundwater quality requirements while still contributing to the overall nutrient loading of a surface water system. A better understanding of the groundwater/surface water interaction process at non-discharge facilities may help to identify and quantify nutrient loading from these locations.

Table 4-3. Non-Discharge Permits

Facility Name	Permit Type	Permit #	Size
PCS Phosphate Co-Onsite Fac	High-Rate Infiltration	WQ0000889	Major
PCS Phosphate Co-Texasgulf/Co	Wastewater Recycling	WQ0001105	Major
Town of Bath Wastewater Spray Irrigation	Surface Irrigation	WQ0002520	Major
Single Family Residence	Surface Irrigation	WQ0004181	Minor
PCS Phosphate Co-Gypsum 3&4	Wastewater Recycling	WQ0005682	Minor
Acre Station Meat Farm-Huettmann	Surface Irrigation	WQ0010034	Major
E Carolina Council/Boy Scout	Surface Irrigation	WQ0011655	Major
Pamlico River Ferry Terminal	Surface Irrigation	WQ0012696	Minor
Single Family Residence	Surface Irrigation	WQ0015652	Minor
Washington City	Reuse	WQ0019179	Minor
Washington City - Sludge	Land Application of Residual Solids (503)	WQ0001026	Major
Aurora Mine	Land Application of Residual Solids (503)	WQ0004095	Minor
PCS Phosphate-Gypsum Pile 6	Wastewater Recycling	WQ0008570	Major
Single Family Residence	Surface Irrigation	WQ0013969	Minor
Fountain Powerboats Incorporated	Gravity Sewer Extension, Pump Stations, & Pressure Sewer	WQ0020068	Minor
Tree Shade Subdivision	Gravity Sewer Extension, Pump Stations, & Pressure Sewer	WQ0024009	Minor

Riparian Buffers

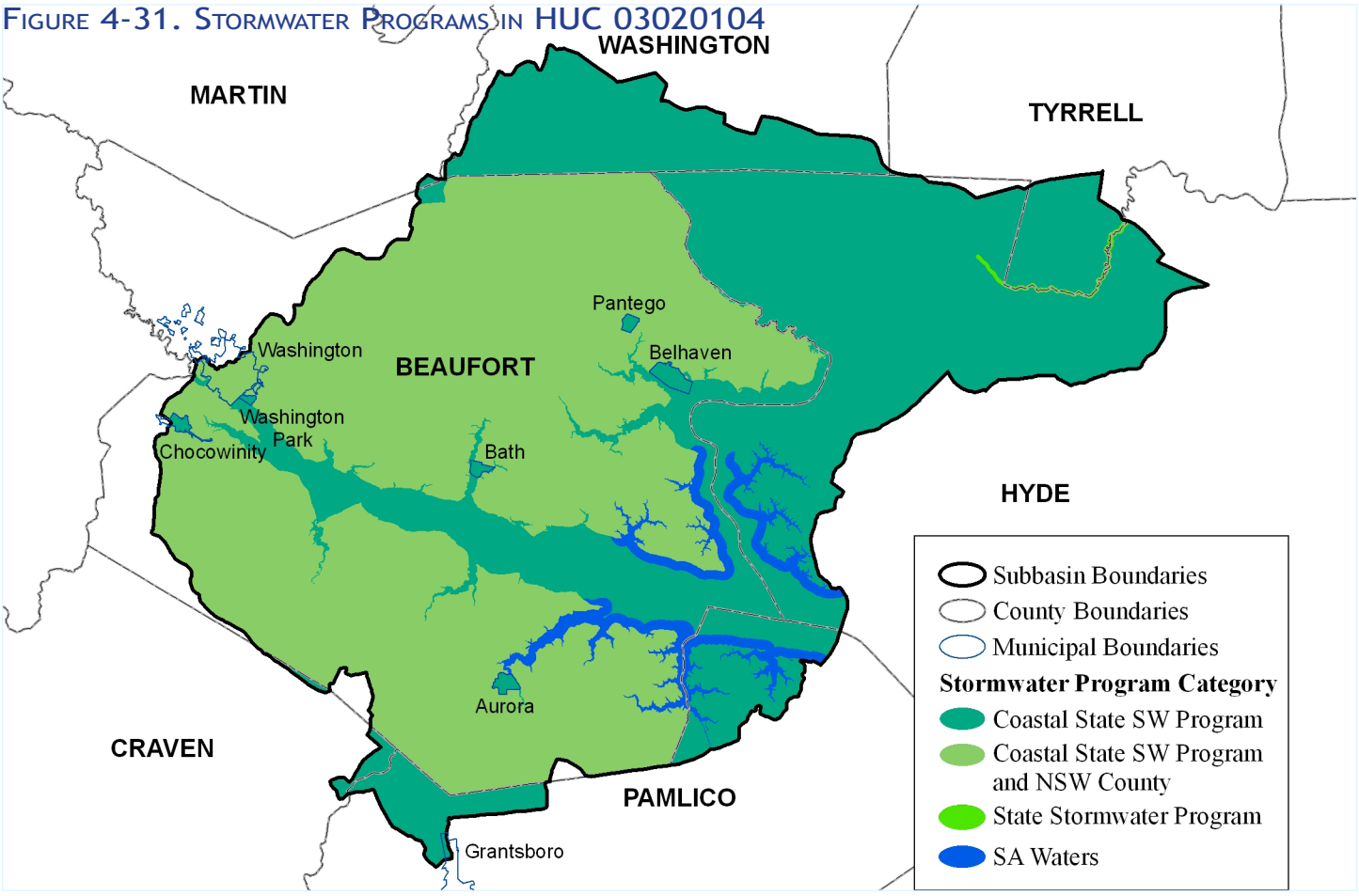
Riparian buffers in the basin are to be protected and maintained on both sides of intermittent and perennial streams, lakes, ponds, and estuarine waters. Tar-Pamlico River Basin Buffer Rules (15A NCAC 2B.0259) do not establish new buffers unless the existing use in the buffer area changes. The footprints of existing uses such as agriculture, buildings, commercial, and other facilities, maintained lawns, utility lines, and on-site wastewater systems are exempt. A total of 50 feet of riparian area is required on each side of waterbodies; within this 50 feet, the first 30 feet is to remain undisturbed and the outer 20 feet must be vegetated. Activities that disturb this buffer require a buffer authorization from DWQ or may require a major variance approval from the Environmental Management Commission. More information about the buffer rules are available at: http://portal.ncdenr.org/web/wq/swp/ws/401/riparianbuffers.

Stormwater

There are several different stormwater programs administered by DWQ. One or more of these programs affects many communities in the Tar-Pamlico River Basin. The goal of the DWQ stormwater discharge permitting regulations and programs is to prevent pollution from entering the waters of the state through the use of stormwater runoff controls. These stormwater control programs include Phase II NPDES and State post-construction, coastal stormwater, HQW/ORW stormwater, Tar-Pamlico River Basin NSW stormwater, and associated with the Water Supply Watershed Program requirements. Figure 4-31 shows the different stormwater programs in this subbasin.

All counties in this subbasin are required to implement the Coastal Stormwater Rules, while Washington and Beaufort County are required to implement Tar-Pamlico NSW stormwater rules. These local programs are to include new development controls to reduce nitrogen runoff by 30 percent compared to pre-development levels and to keep phosphorus inputs from increasing over those pre-development levels. The local programs must also identify and remove illicit discharges; educate developers, businesses, and homeowners; and make efforts toward treating runoff from existing developed areas. As of July 2009, there are 16 general stormwater permits issued in this subbasin.

FIGURE 4-31. STORMWATER PROGRAMS IN HUC 03020104



Central Coastal Plain Capacity Use Area

In 2001, the EMC enacted the Central Coastal Plain Capacity Use Area (CCPCUA) rules. These regulations were developed to control groundwater use in the Cretaceous Aquifers in response to decreasing groundwater levels and increasing saltwater intrusion. The CCPCUA rules require groundwater users in impacted areas to reduce their consumption in three phases between 2008 and 2018. In this subbasin Beaufort, Craven, Hyde, Pamlico and Washington counties are within the CCPCUA. More information about the CCPUA is available from Division of Water Resources website: http://www.ncwater.org/Permits_and_Registration/Capacity_Use/Central_Coastal_Plain/.

Wetland Or Surface Water Disturbance (401 Certification)

The "401" refers to Section 401 of the Clean Water Act. The North Carolina DWQ is the state agency responsible for issuing 401 water quality certifications (WQC). When the state issues a 401 certification this certifies that a given project will not degrade waters of the state or violate State water quality standards. A 401 WQC is required for any federally permitted or licensed activity that may result in a discharge to waters of the U.S. Typically, if the United States Army Corps of Engineers determines that a 404 Permit or Section 10 Permit is required because a proposed project involves impacts to wetlands or surface waters, then a 401 WQC is also required. Locations of 401 WQCs are included on each watershed map. Examples of activities that may require permits include:

- Any disturbance to the stream bed or banks,
- Any disturbance to a wetland,
- The damming of a stream channel to create a pond or lake,
- Placement of any material within a stream, wetland, or open water, including material that is necessary for construction, culvert installation, causeways, road fills, dams, dikes, or artificial islands, property protection, reclamation devices and fill for pipes or utility lines, and
- Temporary impacts including dewatering of dredged material prior to final disposal and temporary fill for access roads, cofferdams, storage, and work areas.

Agriculture

Agriculture is NC's leading industry and is especially strong in the Tar-Pamlico River Basin. Nonpoint source pollution from agriculture is an identified significant source of stream degradation in the Tar-Pamlico River Basin. The approach taken in North Carolina for addressing agriculture's contribution to the nonpoint source water pollution problem is to primarily encourage voluntary participation by the agricultural community. This approach is supported by financial incentives, technical and educational assistance, research, and regulatory programs.

The conversion of agricultural lands to developed lands with impervious surfaces is another potential nonpoint source of pollution. A report by the American Farmland Trust organization identifies this subbasin as having high quality farmland with large areas threatened by development. A map of these areas is available from their website: **http://www.farmland.org/**. Some farmers are protecting their land from development through the Conservation Reserve Enhancement Program (CREP). CREP is a voluntary program utilizing federal and state resources to achieve long-term protection of environmentally sensitive cropland and marginal pastureland. These voluntary protection measures are accomplished through 10-, 15-, 30-year and permanent conservation easements. In this subbasin there are approximately 2,891 acres in easements, of which 76% are in 30 year or permanent easements.

North Carolina Agriculture Cost Share Program

Financial incentives are provided through North Carolina's Agriculture Cost Share Program, administered by DENR's Division of Soil and Water Conservation to protect water quality by installing BMPs on agricultural lands. In the Pamlico River Subbasin $883,682 was spent, between 2003-2008, on BMPs to reduce nonpoint source pollution from agriculture. Approximately, 19,996 acres were affected by BMPs that prevented an estimated 17,940 tons of soil, 240,259 lbs of nitrogen and 130,081 lbs of phosphorous from running off into surface waters. Animal waste BMPs also accounted for better management of an estimated 69,150 lbs of nitrogen and 49,681 lbs of phosphorous.

DWQ's Animal Feeding Operations Unit The Animal Feeding Operations Unit is responsible for the permitting and compliance activities of animal feeding operations across the state. Poultry farms with dry litter waste are not regulated or monitored by DWQ. Table 4-4 summarizes the number of registered livestock operations, total number of animals, number of facilities, and total steady state live weight (SSLW) in this subbasin. These numbers reflect only operations required by law to be registered, and therefore, do not represent the total number of animals in the subbasin.

Animal waste is often stored in lagoons before it is applied to fields. It is a concern that several animal operations in the basin will be abandoned without proper closeout of the lagoons. Numerous environmental hazards exist from these lagoons including: ammonia emissions, overflows into surface waters, and groundwater contamination.

Table 4-4. Animal Operations in HUC 03020104

Type	# of Facilities	# of Animals	SSLW
Animal Individual	2	4,750,000	17,500,000
Swine	15	54,946	15,109,646

*Steady State Live Weight (SSLW) is in pounds, after a conversion factor has been applied to the number of swine, cattle or poultry on a farm. Conversion factors come from the US Department of Agriculture, Natural Resource Conservation Service (NRCS) guidelines. Since the amount of waste produced varies by hog size, this is the best way to compare the sizes of the farms.

A better understanding of groundwater quality in relation to animal feeding operation locations is needed. Most animal operations are located immediately adjacent to surface water bodies. Groundwater that is moving from beneath a facility into the surface water system may transport significant levels of nutrients. However, lack of groundwater quality data at animal operations hampers quantifying their contributions.

Special Study- Aquaculture

There are many aquaculture farms located in the Eastern portion of North Carolina. They range from small catfish farms to large hybrid striped bass production facilities. Citizen complaints about water quality in creeks (Bond, Muddy, Spring and Campbell Creeks) on the south side of the Pamlico River near Aurora initiated an inquiry by DWQ to find potential pollution sources. As a result, the DWQ Pamlico Response Team was requested to assist the DWQ's Washington Regional Office Surfacewater Protection Section with data collection and quantification of discharge from several hybrid striped bass aquaculture facilities. (Hybrid striped bass farms tend to be larger than other fish farms and can discharge over 30 times a year.) Water quality sample results found that discharges from three hybrid striped bass farms resulted in violation of water quality standards for DO and Chlorophyll *a* in the tributaries receiving fish pond drainage water. (DWQ PRT, 2007). As follow-up to the study, DWQ's Washington Regional Office is working with five hybrid striped bass farms under Special Orders by Consent to eliminate their discharges or require that they obtain permits under the NPDES program. Currently, these farms are covered under a general permit and, up until this study, individual hybrid striped bass farm discharges were not monitored. This situation, however, revealed the need to examine aquaculture discharges to assure the quality of their effluent does not compromise water quality standards in receiving waters. The amount of nutrients entering surface waters from aquaculture facilities is unknown and currently the Agriculture Nutrient Control Strategy does not account for added nutrients from fish farms.

Special Study- Rose Acres

In 2003, DWQ began investigating environmental conditions and permit requirements for a proposed chicken egg laying facility. In 2004, the Rose Acres Chicken Farm was granted a permit (NCA148024) with an animal capacity of no greater than 4,000,000 layers and 750,000 pullets. The waste management system includes waste from 14 high-rise laying houses, 3 pullet houses with manure storage building, 17,849 ft^3 aeration basin, 23,749 ft^3 denitrification basin, a 557,086 ft^3 storage basin, and 17.2 acre wetted land application site. Waste is to be managed according to their Certified Animal Waste Management Plan. DWQ permits the land application of liquid egg wash wastewater on 17.2 acres. The permit requires monthly instream/canal water quality monitoring for NH_3, NO_2-NO_3, TKN, TP, DO, and fecal coliform, pH, temperature and flow. The farm operation includes a composting facility that is permitted by Division of Waste Management (DWM). The composting facility permit includes requirements of an annual report to DWM indicating amount, type, and where the compost is distributed. Nutrient content of the compost is calculated for every 6,000 tons and Rose Acres Farms requires a nutrient management plan from any individual that receives more than 10 tons per visit. The 2009-

2010 annual report indicated over 22 thousand tons of composted Class A chicken litter was distributed in Hyde County. This compost fertilizer is in high demand by other farmers throughout the area and is likely being used instead of inorganic commercial fertilizer, although it is possible that the compost may be being applied at nitrogen application rates which would lead to the over application of phosphorous and vice versa.

The environmental impact of this Concentrated Animal Feeding Operation (CAFO) is currently being evaluated by DWQ and US Fish and Wildlife Service (FWS). DWQ has completed a pre- & post-water quality impact study. DWQ collected nutrient and fecal coliform bacteria samples from January 2005 through August 2006, post chicken occupation sampling started in mid-August 2006 through January 2010, with noted impacts from Evans Road Wildfire during the summer of 2008. The conclusion from 2005-2010 data comparison shows the operating data to be significantly higher then the pre-operating data for ammonia nitrogen, total inorganic nitrogen, total phosphorus, and fecal coliform. Stations near the farm showed a significant difference between pre and post data for ammonia nitrogen and organic nitrogen, while these differences were not detected at the further stations for these parameters. Both near and far stations resulted in significant differences for TP, inorganic nitrogen, nitrites/nitrates and fecal coliform bacteria between pre and post data. A detailed report with results of this study is available by contacting DWQ's Environmental Sciences Section: (919)-743-8400. (DWQ-ESS 5/6/09. "Summary of the Rose Acres Farm Sampling Program" and DWQ-ESS. 6/3/10. "Updated Summary of the Rose Acre Farm Sampling Program").

Due to concerns about atmospheric emissions and the near and far field deposition of ammonia on water quality and to the adjacent Pocosin Lakes National Wildlife Refuge (PLNWR), the FWS initiated an investigation to study the effects of facility emissions and atmospheric deposition in the area. The southern boundary of the PLNWR is located less than 2,000m from the farm operation. The FWS collaborated with several university researchers to develop a weight-of-evidence approach. Their study began in 2005, prior to bird stocking. Wet and dry deposition using several sampling techniques, nutrient bioassays, development of a dry deposition model and additional water quality monitoring are being assessed at this time. A 2009 interim review of the data indicate that the facility is affecting air quality conditions at the PLNWR, particularly near the southern boundary (US Fish and Wildlife Service Memorandum, August 7, 2009).

The preliminary wet depositional data indicate an increasing trend in total nitrogen and ammonium concentrations in rainwater at the closest monitoring station, about 840 meters northeast of the farm. This site captures the seasonal prevailing wind direction in this area, suggesting that as the bird stock increased at the farm so did the concentration of total nitrogen and ammonium in the rainwater overtime at this location. FWS found that the increased concentrations of ammonium in the rainwater was indicative of concentrations at other sampling sites around that state that are influenced by CAFO dominated sources (>2 kg/ha/yr).

The dry depositional data also show an increasing trend overtime with concentrations that are indicative of the presence of local sources of emissions similar to those seen for wet deposition. The early model results indicate a zone of influence with elevated ammonia deposition extending 1.5-2.5 miles into the PLNWR. When the model is complete, it will provide a site-specific air-surface exchange rate and provide estimates of concentrations and dry deposition rates as a function of distance from the facility into the refuge. Based on 1999-2005 wind summary data, the refuge will receive deposition from the farm 53% of the time.

Nutrient enrichment bioassays were performed to assess the effects of an estimated atmospheric depositional rate of nitrogen and/or phosphorus on the phytoplankton productivity of Lake Phelps and the Alligator River. The additional nitrogen and phosphorus contributions resulted in a significant increase in productivity of these two local water sources indicating that local waters in this region are susceptible to farm-based atmospheric nutrient inputs (personal communication

with Dr. Paerl, May 2010 (paper in prep)).

Based on the current preliminary results from the DWQ and FWS study, it appears that this CAFO and others like it in the watershed and airshed are likely contributing to the decline in water quality. As recommended by the hearing officer for the original NPDES permit for the Rose Acres farm, upon completion of these studies it should be determined "if Rose Acres should assist in the development and /or implementation of BMPs to address contributions shown to originate at the proposed facility" (Hearing Officer's Report, 2004. NPDES Permit Application No. NCA148024).

The agricultural Basin Oversight Committee (BOC) was established to oversee the required agricultural nutrient reductions in the Tar-Pamlico basin in response to the NSW strategy. The BOC develops and approves an annual report based on information provided by the Local Advisory Committees (LACs), summarizing local nitrogen and phosphorus loadings and estimated nutrient reductions based on implemented BMPs in the watershed. In 2008, the BOC annual report estimated a 49 % nitrogen loss from the baseline (1991) for Hyde County. Depending on the results of the atmospheric deposition study and the BOC's review of the data it may be recommended that the annual accounting estimates incorporate adjusted N rates from ammonia deposition contributions.

Restoration, Protection & Conservation Planning

Population

The 2000 census estimated population for this subbasin is 39,747. This is expected to increase with the results of the 2010 census. As population increases so does our demand for clean water from aquifer and surface water sources and for the land and water to assimilate wastes. Population estimates for each watershed within this subbasin are listed in Table 4-6.

Table 4-6. Watershed Population Estimates* for HUC 03020104

10-Digit HUC	2000 Population	2000 Population Density (per sq mi)	2010 Estimated Population	2020 Estimated Population	2030 Estimated Population
0302010401	23,906	114	24,751	25,281	25,504
0302010402	5,873	27	6,078	6,206	6,259
0302010403	4,250	25	4,362	4,422	4,430
0302010404	1,098	8	1,061	1,022	975
0302010405	1,200	6	1,161	1,116	1,064
0302010406	2,899	26	2,973	3,013	3,019
0302010407	521	9	527	528	523
03020104	39,747	36	40,913	41,590	41,774

*NC Office of State Budget and Management: http://www.osbm.state.nc.us/

Land Use

Waterfront development and agriculture continue to place increasing demands for achieving water quality and quantity. Table 4-7 lists the percentage of different predominant land cover types within this subbasin based on the 2001 national land cover database.

Local Initiatives & Conservation Planning

Resources & Guides

NCDENR's One North Carolina Naturally initiative promotes and coordinates the long-term conservation of North Carolina's threatened land and water resources. Each DENR division specializes in management of a specific natural resource, while the collaborative coordination and planning process results in cost effective implementation and management of multiple resources. Natural resource planning and conservation provides the science and incentives to inform and support conservation actions of North Carolina's conservation agencies and organizations. The Conservation Planning Tool was developed to assist in building partnerships through the exchange of conservation information and opportunities, support stewardship of working farms and forests, inform conservation actions of agencies and organizations, and guide compatible land use planning. A link to the interactive map view is found here: http://www.conservision-nc.net/.

Table 4-7. Land Cover Percentages in HUC 03020104

Land Cover Type	Percent
Developed Open Space	3.61
Developed Low Intensity	0.60
Developed Medium Intensity	0.12
Developed High Intensity	0.02
Total Developed	4.34
Bare Earth Transition	0.88
Deciduous Forest	3.45
Evergreen Forest	18.43
Mixed Forest	2.23
Total non-Wetland Forest	24.10
Scrub Shrub	4.69
Grassland Herbaceous	7.81
Pasture Hay	0.62
Cultivated Crops	26.20
Total Agriculture	26.82
Woody Wetlands	27.05
Emergent Herbaceous Wetland	4.30
Total Wetlands	31.35

Conservation planning is important on a local level to protect natural resources that provide recreational, aesthetic, and economic assets important to community sustainability and growth. The NC Wildlife Resources Commission developed a Green Growth Toolbox to assist towns and cities to grow in nature-friendly ways: http://www.ncwildlife.org/greengrowth/. The tools provide assistance with using conservation data, green planning, green ordinances and green development and site design. Also, a guide to help local governments protect aquatic ecosystems while streamlining environmental review is available here: http://www.ncwildlife.org/planningforgrowth/swimming_with_the_current.pdf.

Land conservation, accompanied with stream restoration projects, can be very successful at protecting water quality. Prevention and protection activities are known to be more cost effective than retrofits and restoration. DWQ strongly encourages conservation in this watershed. Local land trusts can help landowners explore conservation options and identify potential funding sources. For more information about land trusts in North Carolina see the Conservation Trust for North Carolina at: http://www.ctnc.org/. With the assistance of land conservancies, local governments, and several state and federal agencies ~82,816 acres are protected within this subbasin.

Erosion and Sedimentation Control

The Sedimentation Control Commission was created to administer the Sedimentation Control Program pursuant to the N.C. Sedimentation Pollution Control Act of 1973. It is charged with adopting rules, setting standards, and providing guidance for implementation of the Act. The Division of Land Resources (DLR) is the primary agency responsible for managing land disturbing activities that have the potential to violate the Sedimentation Pollution Control Act. For those land disturbing activities, an Erosion and Sedimentation Control Plan must be approved by DLR prior to land disturbing activities. Due to the large number of land disturbing activities and the limited number of DLR staff available to do inspections, cities and counties have been encouraged to adopt a local erosion and sediment control ordinance in compliance with State requirements. The Sedimentation Control Commission can then delegate the local government authority to administer the erosion and sedimentation control program within its jurisdiction. The

local programs' staff then performs plan reviews and enforces compliance with plans within their jurisdictions.

Construction Grants and Loans

The Construction Grants and Loans (CG&L) Section of DWQ provides grants and loans to local government agencies for the construction, upgrades, and expansion of wastewater collection and treatment systems. As a financial resource, the Section administers five major programs that assist local governments. Of these, two are federally funded programs administered by the state, the Clean Water State Revolving Fund (SRF) Program and the State and Tribal Assistance Grants (STAG). The STAG is a direct congressional appropriation for a specific "special needs" projects within NC. The High Unit Cost Grant Program, the State Emergency Loan (SEL) Program and the State Revolving Loan (SRL) Program are state funded programs, with the later two being below market revolving loan money. The Section also received an additional Capitalization Grant authorized by the American Recovery and Reinvestment Act of 2009 in the amount of $70,729,100. These funds are administered according to existing SRF procedures. All projects (Table 4-8) must be eligible under Title VI of the Clean Water Act. For more information please see the CG&L webpage at: **http://portal.ncdenr.org/web/wq/cgls**.

Table 4-8. CG&L Projects

Location	Project Description	Date	~Amount
Washington	WWTP flow increase from 3.2 to 3.65 & Reuse	12/10/2001	$3,000,000
Washington	WWTP expansion phase II	11/17/2003	$2,986,000

Section 319-Grant Program

The Section 319 Grant Program was established to provide funding for efforts to reduce nonpoint source (NPS) pollution, including that which occurs though stormwater runoff. The EPA provides funds to state and tribal agencies, which are then allocated via a competitive grant process to organizations to address current or potential NPS concerns. Each fiscal year NC is awarded nearly 3 million dollars to address NPS pollution through its 319 Grant Program. Thirty percent of the funding supports ongoing state nonpoint source programs. The remaining 70 percent is made available through a competitive grants process. More information can be found about these contracts and the 319 Grant Program at their website: **http://portal.ncdenr.org/web/wq/ps/nps/319program**.

Clean Water Management Trust Fund

Created in 1996, the Clean Water Management Trust Fund (CWMTF) makes grants to local governments, state agencies, and conservation non-profits to help finance projects that specifically address water pollution problems. The fund has made several investments in the Pamlico River Subbasin. Table 4-9 includes a list of recent projects and their cost.

Table 4-9. CWMTF Projects

Application ID	Proposed Project Description	Amount Funded	County
2002B-601 Beaufort Co. Water District V - Septic Systems/Pantego Cr.	Design, permit and construct a new wastewater collection system to connect 200 existing properties with failing septic tanks or straight pipes that drain to Pantego Creek. Route waste to the Belhaven WWTP for treatment.	$350,000	Beaufort
2003A-026 NC Coastal Land Trust - Acq./ Weyerhaeuser Tract, Nevill's Creek	Acquire through fee simple purchase 126 acres along Nevils Creek.	$489,000	Beaufort

Application ID	Proposed Project Description	Amount Funded	County
2004D-004 Pamlico-Tar River Foundation - Donated Minigrant/ Allan Tract, Blounts Bay	Minigrant to pay for transactional costs for a donated permanent conservation easement on 5.2 acres along the Pamlico River.	$16,000	Beaufort
2006B-040 Washington, City of - Acq/ Barger Tract, Pamlico River	Protect through fee simple purchase & donation of a conservation easement 220 wetland acres, along unnamed tributaries to the Tar River. Will aid in protection of an exceptional wetland and tract will become the Tar River Nature Park.	$60,000	Beaufort
2006B-601 Beaufort County - Septic/ Terra Ceia School, Broad Creek	Design, permit & construct a collection system to transport wastewater from a school's failing septic system, 10 residences and 1 commercial facility to Belhaven's WWTP for treatment. Reduces pollutant delivery to Pantego (303d) & Broad Creeks.	$107,000	Beaufort
2007-601 Beaufort County - Septic/ Autumnfield Assisted Living Center, Broad Creek	Design and permit infrastructure to transport wastewater from a business with failing septic system, to Belhaven WWTP to improve water quality in Broad Cr and Pantego Cr.	$28,000	Beaufort
2008-502 Bath, Town of - WW/ Spray Field Upgrades, Bath Creek	Design and permit package treatment plant to treat to reclaimed standards, and other improvements at WWTP to improve effluent quality, reduce ponding on disposal field and reduce pollutant loading in Carter Cr and Back Cr.	$117,000	Beaufort

Recommendations

- Identify sources of organic nitrogen that could be contributing to the increase in basinwide TKN concentrations. Basinwide, the ammonia component of TKN shows a decrease in concentration since 1991.

- Determine the amount of nutrients being recycled within the estuary that are contributing to algal productivity within the estuary.

- More research is needed to understand the amount of nutrients entering the Tar River and its tributaries through baseflow and how this contribution can be managed. The NSW strategy targets point and some nonpoint source nutrient contributions to surface waters. However, some nonpoint sources are not specifically addressed in the strategy. Nutrients from non-discharge spray field systems, wastewater residual applications, septic systems and tiled agriculture may all be contributing to nutrient loads in surface waters via groundwater.

- As recommended by the hearing officer for the original NPDES permit for the Rose Acres farm, upon completion of the water quality and atmospheric deposition study it should be determined “if Rose Acres should assist in the development and /or implementation of BMPs to address contributions shown to originate at the proposed facility”. Given the requirements of the agricultural rule, it is recommended that the Local Advisory Committee account for added nutrients contributed by Rose Acres Farm as a whole, including contributions from atmospheric deposition once the FWS ammonia deposition model is complete.

- Recommend DWQ Washington Regional Office continue follow-up actions on Hybrid Striped Bass Farms to improve their effluent quality and better quantify its impact to the Estuary. If warranted, include fish farms nutrient contributions in the Basin’s accounting of progress towards meeting nutrient reduction goals.

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