Chapter 17
Water Quality Stressors and Sources

17.1 Stressor Identification

17.1.1 Introduction and Overview

Human activities can negatively impact surface water quality, even when the activity is far removed from surface waters. The many types of pollution generated by human activities may seem insignificant when viewed separately, but when taken as a whole can result in significant cumulative impacts on the aquatic ecosystem. Water quality stressors are identified when impacts have been noted to biological (fish and benthic) communities or water quality standards have been violated. Stressors apply to one or more use support categories and may be identified for Impaired waters, as well as Supporting waters with noted impacts.

Identifying stressors is challenging because direct measurements of the stressor may be difficult or prohibitively expensive. DWQ staff use field observations from sample sites, special studies and data from ambient monitoring stations, as well as information from other agencies and the public to identify stressors and their potential sources. The Division of Environmental Health Shellfish Sanitation Section collects data and information regarding potential sources of water quality stressors in shellfish growing areas. It is important to identify stressors and potential sources of stressors so that water quality programs can target limited resources to address the stressor.

Stressors to recreational use include pathogenic indicators, such as fecal coliform bacteria *escheria coli* (*E. coli*) and *enterrococci*. In the fish consumption category, mercury is typically the noted stressor. Other substances may also result in the issuance of a fish consumption advisory or advice by the NC Division of Health and Human Services (NCDHHS).

Most stressors to the biological community are a complex grouping of many different stressors that individually may not degrade water quality or aquatic habitat, but together can severely impact aquatic life. Sources of stressors are most often associated with land use in a watershed, as well as the quality and quantity of any treated wastewater that may be entering a stream. During naturally severe conditions such as droughts or floods, any individual stressor, or group of stressors, may have more severe impacts to aquatic life than during normal climatic conditions. The most common source of stressors is from altered hydrology.

17.1.2 Stressor Sources

Pollutants that enter waters fall into two general categories: *point sources* and *nonpoint sources*. Point sources are typically piped discharges and are controlled through regulatory programs administered by the state. All regulated point source discharges in North Carolina must apply for and obtain a National Pollutant Discharge Elimination System (NPDES) permit from the state.

Point Sources

Piped discharges from:

- Municipal wastewater treatment plants
- Industrial facilities
- Small package treatment plants
- Large urban and industrial stormwater systems

Nonpoint sources are from a broad range of land use activities. Nonpoint source pollutants are typically carried to waters by rainfall, runoff, and snowmelt. Sediment and nutrients are most often associated with nonpoint source pollution. Other pollutants associated with nonpoint source pollution include fecal coliform bacteria, nutrients, heavy metals, oil and grease, and any other substance that may be washed off the ground or deposited from the atmosphere into surface waters. Unlike point source pollution, nonpoint pollution sources are diffuse in nature and occur intermittently, depending on rainfall events and land disturbance. Given these characteristics, it is difficult and resource intensive to quantify nonpoint contributions to water quality degradation in a given watershed.

Nonpoint Sources

- Construction activities
- Roads, parking lots and rooftops
- Agriculture
- Failing septic systems and straight pipes
- Timber harvesting
- Hydrologic modifications

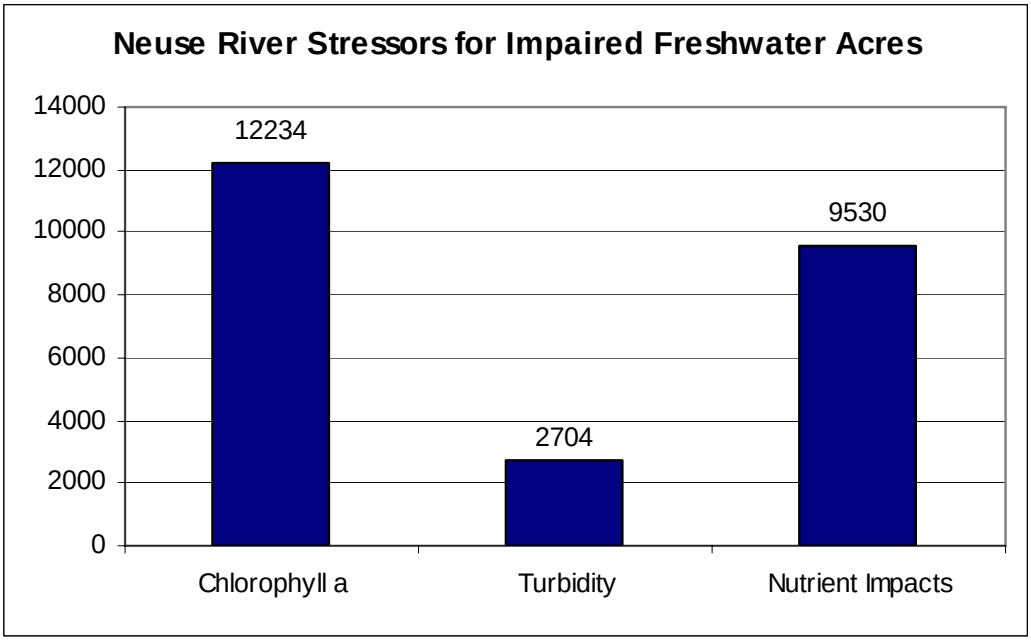
DWQ identifies the source of a stressor, point or nonpoint, as specifically as possible depending on the amount of information available in a watershed. Most often the source is based on the predominant land use in a watershed. Stressors sources identified in the Neuse River Basin during this assessment period include stormwater runoff, development, row crop agriculture, concentrated animal operations and land application of municipal, industrial and animal waste. Point source discharges are also considered a water quality stressor source. In addition to these sources, many impacts originate from unknown sources.

17.1.3 Overview of Stressors Identified in the Neuse River Basin

The stressors noted below are summarized for all waters and for all use support categories. Figures 40-43 identifies stressors noted for Impaired waters and those with noted impacts in both miles and acres. Estuarine stressors are represented separately from the freshwater segments of the Neuse River basin. The Neuse River Estuary is affected by the large assortment of stressors contributed to the system in the area of the estuary and from the entire upstream watershed. These stressors come from existing and new development contributions, industrial, municipal and agricultural waste contributions and from the array of agricultural and forestry practices in the entire Neuse River watershed. The accumulative affect of all these contributions can be seen in the estuary resulting in Impairment due to excessive nutrient contributes throughout the watershed.

The stressors noted in the figure may not be the sole reason for the impairment or noted impacts. For specific discussion of stressors to the impaired or noted waters, refer to the subbasin chapters. Stressor definitions and potential impacts are discussed in the remainder of this chapter. The figures show the primary stressors in the Neuse River Basin are habitat degradation, nutrient impact, chlorophyll *a*, turbidity and fecal coliform bacteria.

Figure 40 Stressors Identified in Impaired Water, in Acres and Miles



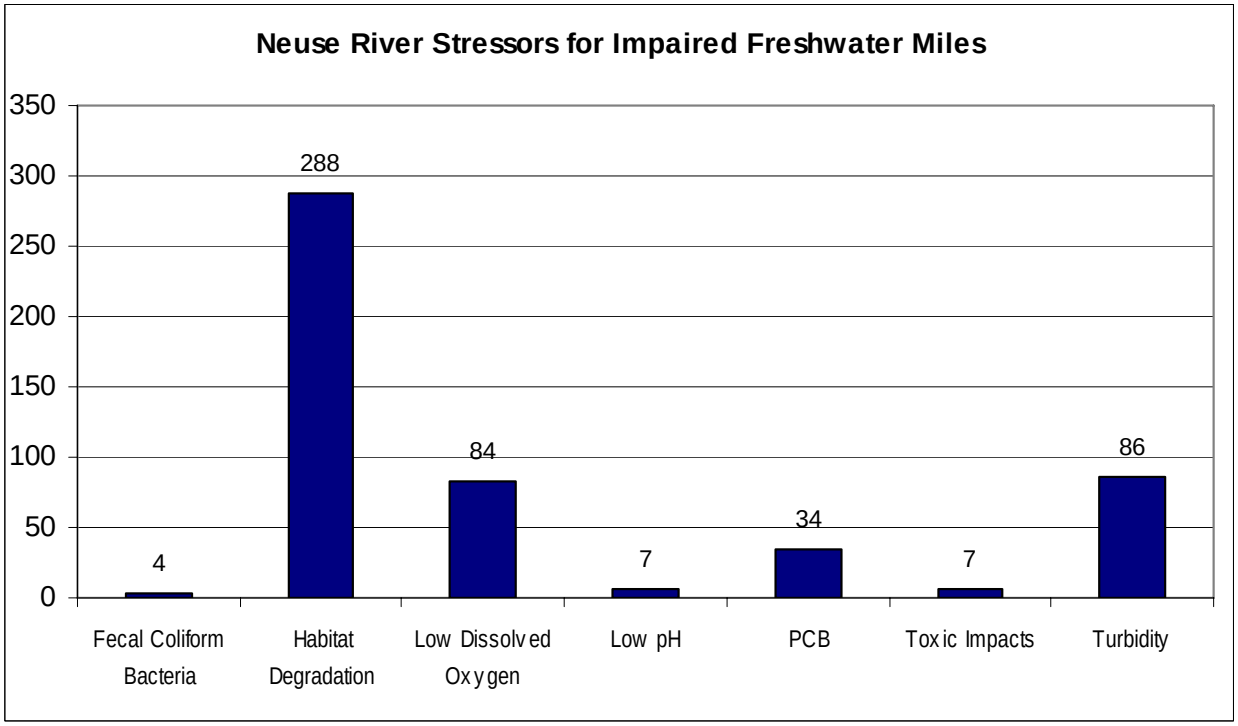


Figure 41 Stressors Identified in Impaired Estuarine Waters, in Acres

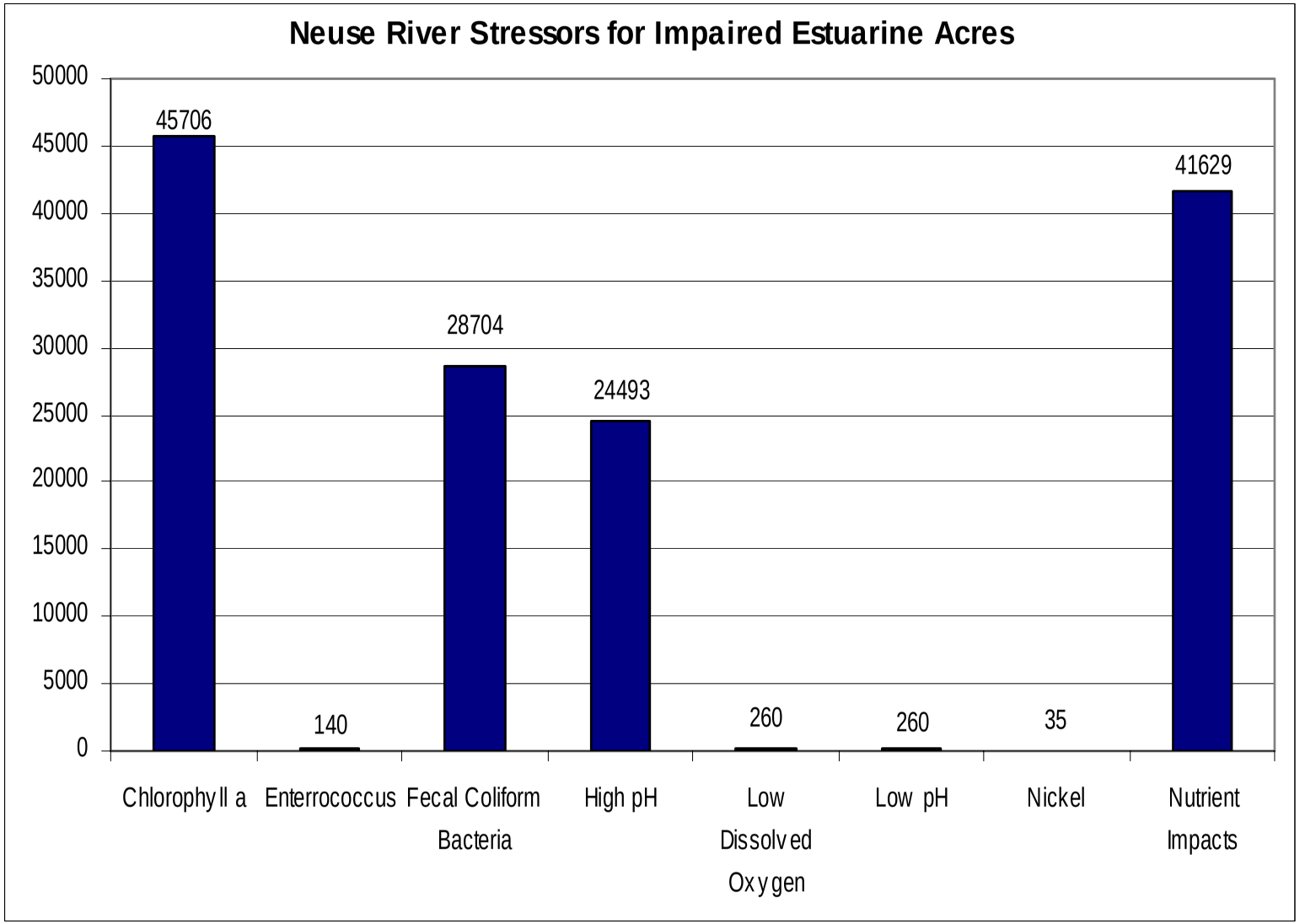
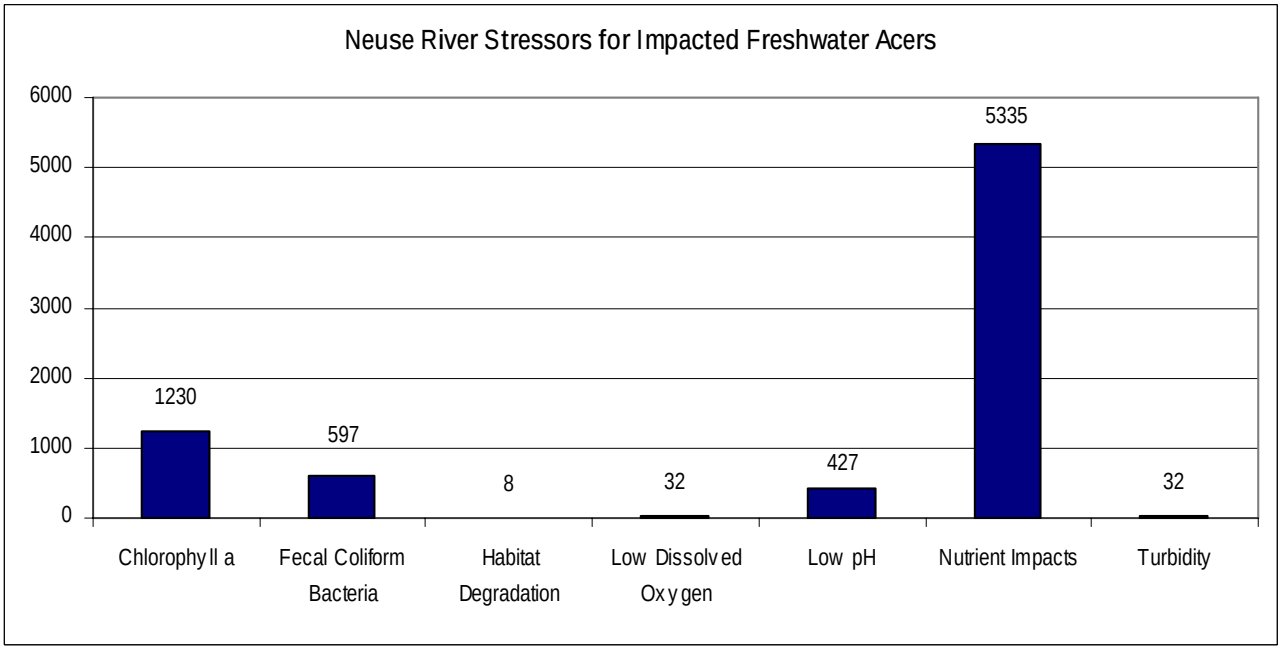


Figure 42 Stressors Identified in Impacted Waters, in Acres and Miles



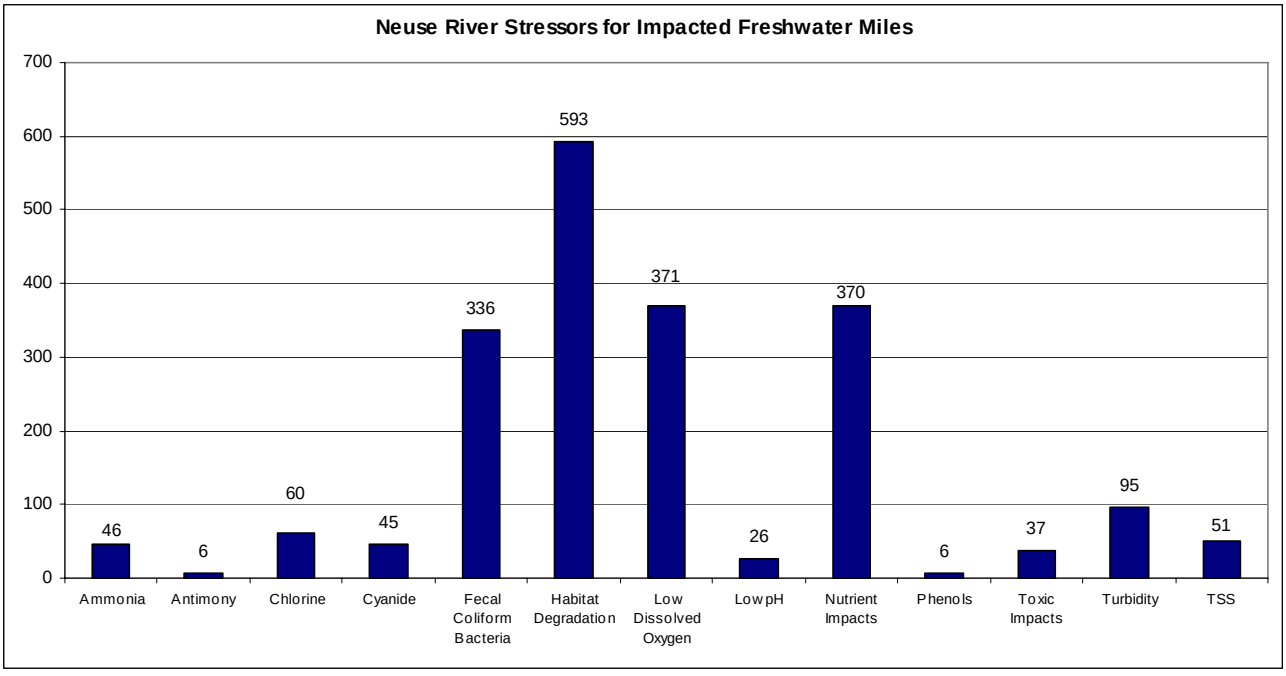
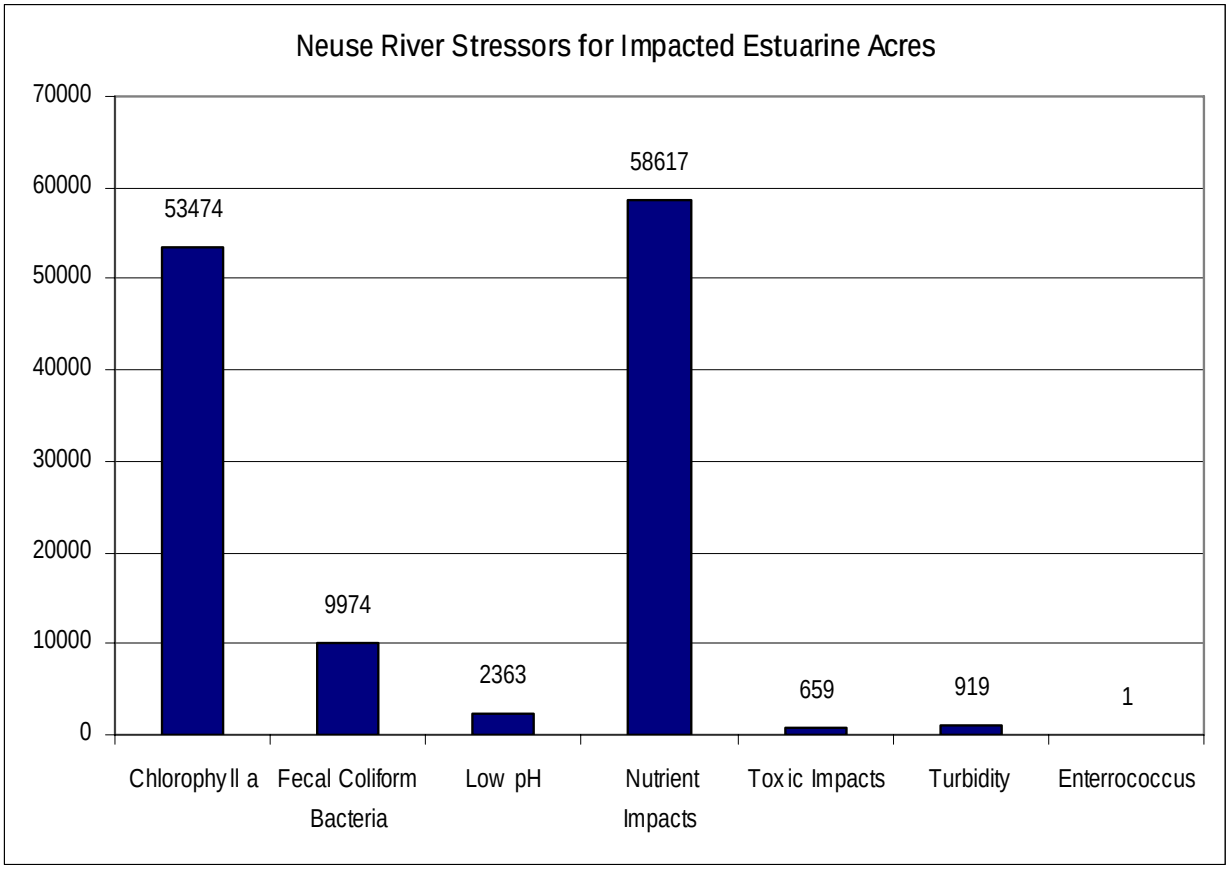


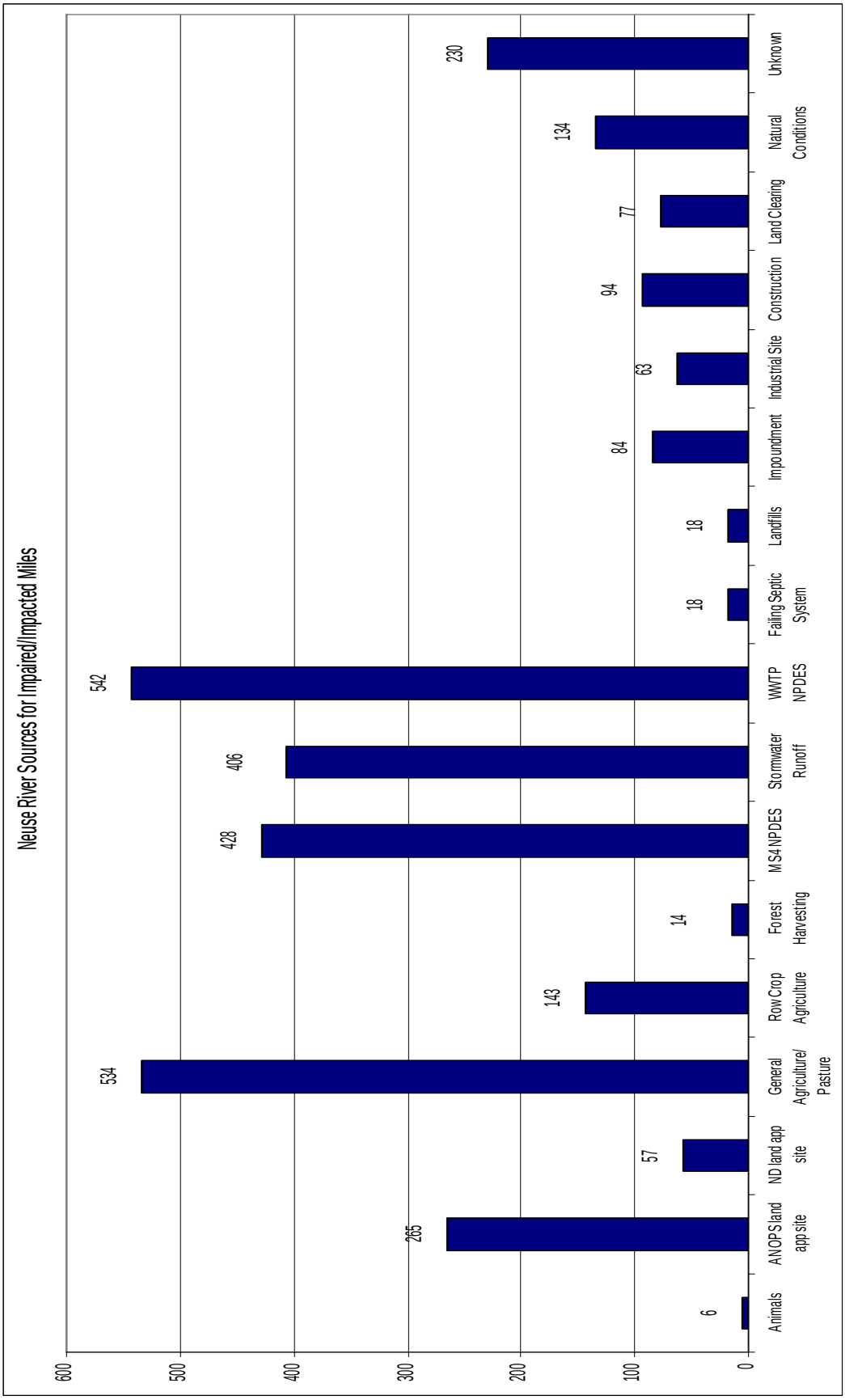
Figure 43 Stressors Identified in Impacted Estuary Waters, in Acres



17.1.4 Overview of Stressor Sources Identified in the Neuse River Basin

The sources noted below are summarized for all waters and for all use support categories. Figures 44, 46; 47 identify sources of stressors noted for waters in the Neuse River Basin during the most recent assessment period. Refer to the subbasin chapters (Chapters 1 – 14) for a complete listing and discussion of sources by stream. The Neuse River Estuary is affected by the accumulation of all the stressors contributed to the system in the area of the estuary and from the entire upstream watershed. The sources of these stressors come from existing and new development, on-site, municipal, industrial and agricultural waste and from the assortment of agricultural and forestry practices in the entire Neuse River watershed. The accumulative affect of all these contributions can be seen in the estuary resulting in Impairment due to excessive nutrient contributes throughout the watershed. Figure 44 shows sources identified for both freshwater and saltwater.

Figure 44 Sources Suspected in Impaired/Impacted Waters, in Miles



Wastewater treatment plants

Wastewater treatment plants (WWTPs) were noted as a potential source to many of the freshwater and saltwater stream miles and acres in the Neuse River basin. WWTPs are just one of many sources that can contribute excess nutrients that may increase the potential for algal blooms and cause exceedances of the chlorophyll *a* standard. This includes all discharges upstream of the Impairment or impacted area. Point source dischargers have substantially reduced their nitrogen contribution over the last several years. The Neuse River NSW Management Strategy which required a 30 percent reduction in nitrogen contribution was fully implemented in 2003. The majority of the point source dischargers have exceeded the required 30 percent reduction. During this assessment period, Falls Lake in the upper portion of the Neuse River basin is newly impaired due to elevated chlorophyll *a* levels. A TMDL is currently being developed for the Falls Lake watershed. The results from this process may require dischargers contributing to this impairment to reduce their nitrogen and phosphorus contribution further. Rules will be developed after the completion of the TMDL to address the required reductions needed in order for Falls Lake to support its designated uses. More information can be found in Chapter 1 (subbasin 03-04-01) and 24.

Land application of sludge from industrial and municipal WWTPs as well as from concentrated animal operations is also becoming a concern. Contribution of groundwater with high levels of nitrogen is a potential source of nutrients not originally recognized in the management strategy. Research is finding that groundwater below these fields have exceedingly high levels of nitrogen concentrations (personal communication – DWQ Aquifer Protection Section; Harden and Spruill, 2004; Harden and Spruill, 2008). Research has also found that if this groundwater flows through a well establish buffer zone, nutrient removal can often occur, reduce the load and impact to the receiving stream (Harden and Spruill, 2008). When the buffer zone is breached due to ditches or tile drains then the nutrient load can be considerable and needs to be addressed with an appropriate BMP to reduce this contribution.

Stormwater/Nonpoint Source Runoff

Stormwater runoff from a variety of land use practices is identified as the primary source of impairment to the surface waters in the Neuse River Basin (Table 53), based on data for the 2008 Integrated Report). Runoff is recognized as contributing to water quality decline in at least 1,600 freshwater stream miles in the Neuse River Basin (Table 53). This accounts for 50 percent of the Freshwater stream miles in the Neuse River Basin. These numbers likely underestimate the true stream miles affected by the many different types of nonpoint source runoff.

Runoff from rain events carry sediment and nutrients that affect the aquatic habitat and fecal coliform bacteria that result in impairment of the recreation and shellfish harvesting use support categories. Excessive nutrient loading is ultimately the primary stressor in the Neuse River basin resulting in the impairment of Falls Lake and the Neuse River Estuary due to the elevated chlorophyll *a* concentrations. While great strides have been made in the reduction of nitrogen contribution from both point and nonpoint sources to the Neuse River Basin, more needs to be done to reduce the nutrient load.

Sediment transported into the steams via runoff accounted for a large increase in the number of stream miles and acres impaired as result of instream turbidity standard violations. There were also many stream miles that have elevated turbidity levels (greater than 7 percent exceedance of the state standard) and were classified as impacting water quality due these elevated levels. Many

more stream miles are likely to become impaired during the next assessment period if this trend continues. The biologist often identified sedimentation as a possible cause of stress to the biotic communities being assessed (see section17.2.2 and 17.3.3). Stormwater contributions from all the land use practices in this watershed need to be reduced further in order for the Neuse River to support a healthy aquatic resource. Better stormwater controls are needed throughout the watershed on both existing and new development as well as from forestry harvesting and the many different agricultural practices.

Table 53 Number of Freshwater Stream Miles Impaired or Impacted by Nonpoint Source Runoff.

Nonpoint Sources of Runoff/Stormwater	**Impaired or Impacted Freshwater Miles**	**Total Miles**
Urban Nonpoint Source Stormwater/Runoff		
MS4 NPDES	428 miles	
Non-MS4 Stormwater	406	
Construction	94	
Land Clearing	77	
		1005 miles
Other Nonpoint Source Runoff		
General Agriculture	534 miles	
Row Crop Agriculture	143 miles	
Forest Harvesting	14 miles	
		691 miles

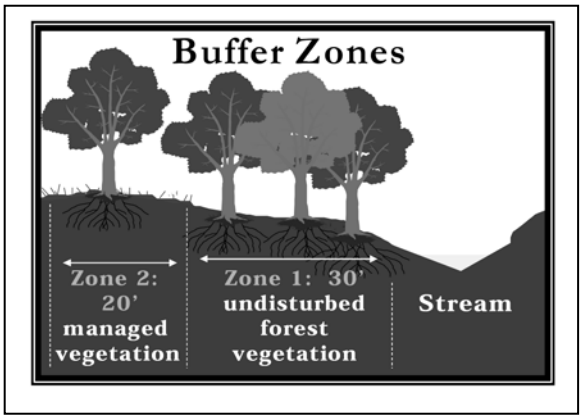
Note: Total miles affected by urban and other nonpoint source runoff is 1,696 miles.
Total number of freshwater stream miles in the Neuse River Basin is 3,389 miles.
Data is from the NC 2008 Integrated Report.

Recommendations on how to protect and reduce water quality impacts from agricultural practices in the watershed can be found in Chapter 6 and from existing and future urbanization of the watershed can be found in Chapter 12 of the *Supplemental Guide to North Carolina's Basinwide Planning* document (http://h2o.enr.state.nc.us/basinwide/SupplementalGuide.htm).

As part of the Neuse River Basin NSW Nutrient Management Strategy, stormwater rules were passed which required several local governments to adapt rules that were specifically designed to reduce nitrogen contribution from new development. Details can be found in Chapter 24 and at http://h2o.enr.state.nc.us/nps/Neuse_NSW_Rules.htm. It is apparent that these rules need to be strengthened and extended beyond the original local governments covered in the stormwater rule.

A riparian buffer protection rule was also passed as part of the nutrient management strategy which requires that up to 50 feet of the riparian area be protected and maintained on the banks of waterways throughout the basin. This rule does not require establishment of new buffers unless the existing use of the buffer changes. A fact sheet on the Neuse riparian buffer rules can be found at http://h2o.enr.state.nc.us/nps/BufRulFakSheet-NeuseTP2-00.pdf or at the link above.

Figure 45 Diagram of a Buffer Zone



Riparian buffers reduce the quantity and velocity of stormwater as well as aids in nutrient removal as it flows through the buffer zones. Buffers also reduce the nutrient contribution from groundwater which flow through these buffer zones. It is important to protect the existing buffers and to establish new and possibly wider buffers where at all possible (Wenger, 1999). Preserving riparian buffers on ephemeral streams would also help to reduce nutrient loading to the watershed.

Agriculture

Agriculture was noted as a potential source of water quality stressors when field observations and watershed studies noted agriculture as the predominant land cover. In the Neuse River basin, the majority of agricultural land is cultivated crop. Impacts to streams from agricultural activities can include excessive nutrient loading, pesticide and herbicide contamination, bacterial contamination, and sedimentation. Pasture and row crop agriculture was noted as a source of stressors in 677 freshwater stream miles. Agriculture impacts and programs are discussed in more detail in Chapter 19.

Concentrated animal feed operations (CAFOs) also have an impact on the water quality in the Neuse River basin. The number of CAFOs grew tremendously throughout the 1990's. The land application of waste (wet and dry) is contributing to runoff of nutrients to the nutrient sensitive waters of the Neuse as well as from contaminated groundwater. Many of the facilities and land application fields are in an area of the coastal plain where the groundwater table is high which requires ditching or tile drain in order to allow for crop harvesting and waste application. These are direct conveyances for the highly nutrient laden water to reach surface waters. These operations are having a significant negative impact on the Neuse River water quality. There is a great need for these facilities to incorporate appropriate BMPs to reduce this contribution.

CAFOs (hog and poultry) throughout the coastal plain of NC are contributing to a substantial increase in atmospheric nitrogen concentration and deposition in the Neuse River watershed. Research to date indicates that atmospheric contribution accounts for 15 to 55 percent of the total nitrogen to the Neuse River Estuary and that these contributions have risen over the last two decades with the increase in concentrated animal operation in the coastal region of our state (Whitall et al., 2003). A full report on the atmospheric contribution to the Neuse River can be found in Appendix VI.

Development

Land clearing activities for residential and commercial development, for road/highway construction as well as for timber harvest was noted as potential sources of water quality stressors. Streams where land clearing is a noted source are likely to be more heavily impacted in the future by increased development and impervious surfaces. Studies have demonstrated that water quality begins to decline when only 5 to 12 percent of a watershed is covered by impervious surfaces such as roads, rooftops and parking lots (Center for Watershed Protection, 2003).

Due to the chronic introduction of pollutants found in urban stormwater, along with an increase in both the velocity and flow of stormwater into streams, attention to stormwater control in urban areas is critical. Without proper BMPs, urban development can alter the hydrology of a watershed often resulting in downstream flooding, streambank erosion and severely degraded habitats.

The Division of Water Quality recommends the use of riparian buffers as well as better site design and development planning techniques to minimize the negative impacts of new development on water quality. Many local government ordinances would have to be modified in order to allow for this type of development. For more information on "better site design" techniques and model ordinances, go to the Center for Watershed Protections website http://www.cwp.org/Resource_Library/Better_Site_Design/index.htm#pwp.

Refer to Chapter 16 for more information related to population growth and land cover changes and its potential impacts on water quality.

Boats and Marinas

Currently, there are more than 360,000 boaters using North Carolina waterways each year (DCM website http://dcm2.enr.state.nc.us/Marinas/marinas.htm). The number of marinas in the Neuse River Estuary is projected to increase over the next several decades. There are development plans for several instream and upland marina in the area. Marinas can pose a great risk to water quality. In the Neuse River basin, the Division of Environmental Health reports that 45 acres of shellfish harvesting waters (in growing areas F-1 to F-7) are closed because of marina.

A large source of pollution from commercial and recreational boaters is sewage, along with litter and gasoline spills. Each can cause any number of problems, with wastewater carrying many different bacteria or viruses that impact human health. Bacteria also impact shellfish harvesting areas and recreational beaches.

Many boat owners add chlorine and formaldehyde to their wastewater holding tanks to control odor or to disinfect, which if released, can be toxic to aquatic life. Most of these chemical additives are now biodegradable; however, if the wrong amount or the wrong type is added, it can be toxic to aquatic life.

Sewage is also high in nutrients (i.e., nitrogen and phosphorus), which is the main reason the estuary is impaired. Sewage can also result in a decrease in dissolved oxygen levels which is required for the survival of aquatic organisms. These problems can become magnified in enclosed marinas and harbors where water circulation is poor.

The Clean Marina Program was initiated in 2000 by the Division of Coastal Management. This is a voluntary program designed to show that marina operators can help safeguard the environment

by using management and operations techniques that go above and beyond regulatory requirements (for more information on the Clean Marina Program see section 22.2.8 or go to http://dcm2.enr.state.nc.us/Marinas/marinas.htm). DWQ encourages all marinas within the Neuse River basin to participate in the Clean Marina Program.

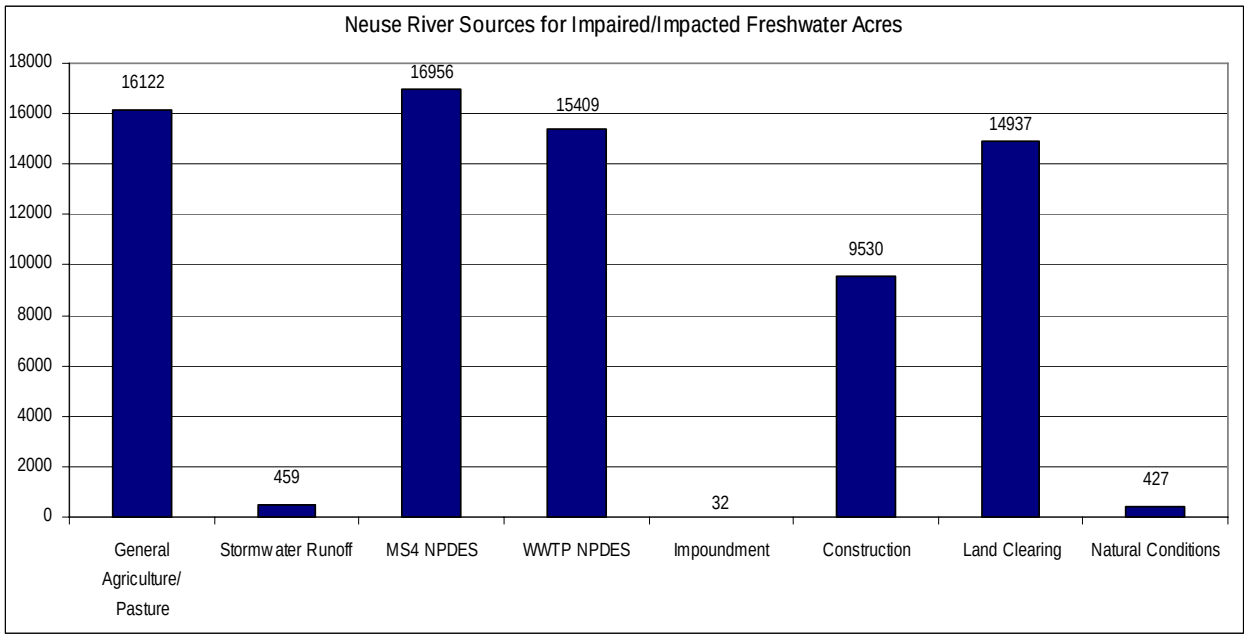


Figure 46 Sources Identified in Impaired/Impacted Freshwaters, in Acres

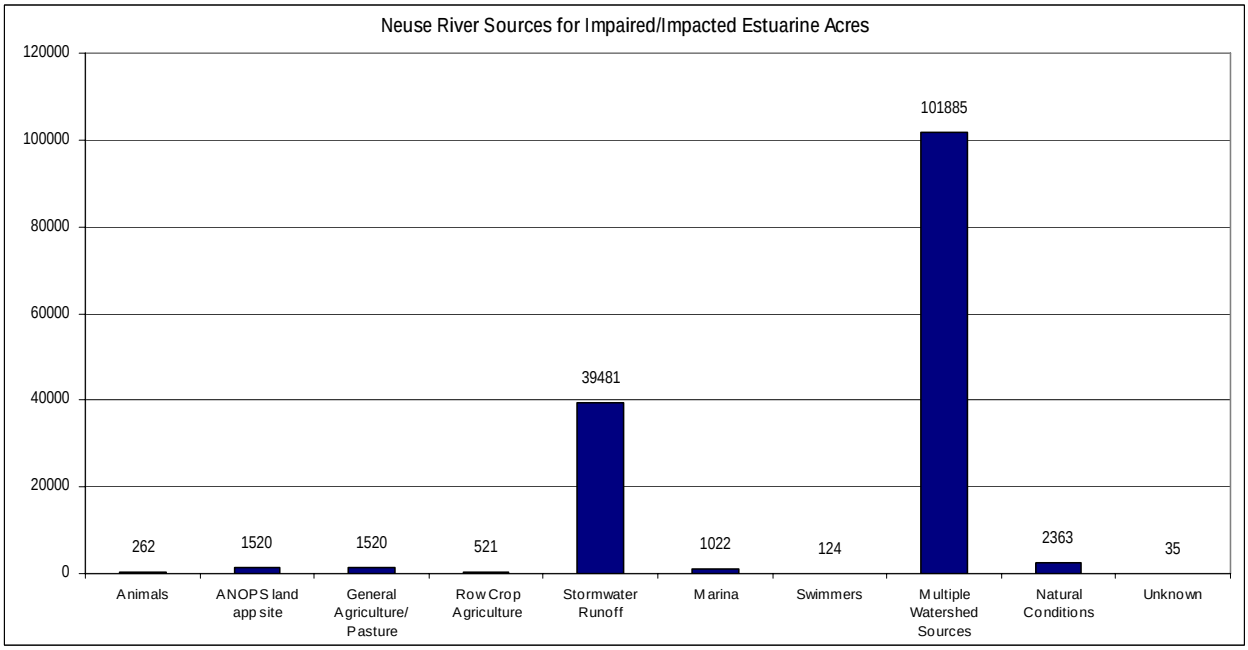


Figure 47 Sources Identified in Impaired/Impacted Estuarine Waters, in Acres

17.2 Aquatic Life Stressors - Habitat Degradation

17.2.1 Introduction and Overview

Instream habitat degradation is identified as a notable reduction in habitat diversity or a negative change in habitat. This term may include sedimentation, lack of organic (woody and leaf) habitats and channelization. These stressors to aquatic insect and fish communities can be caused by many different land use activities and less often by discharges of treated wastewater. In the Neuse River basin, 288 stream miles are Impaired where at least one form of habitat degradation has been identified as the stressor. There is an additional 593 stream miles where habitat degradation is a noted impact to water quality. Many of the stressors discussed below are either directly caused by or are a symptom of altered watershed hydrology. The altered hydrology increases both sources of stressors and delivery of stressors to receiving waters. Refer to the subbasin chapters (Chapters 1-14) for more information on the types of habitat degradation noted at sample locations and in watershed studies.

Some Best Management Practices

Agriculture

- No till or conservation tillage practices
- Strip cropping and contour farming
- Leaving natural buffer areas around small streams and rivers

Construction

- Using phased grading/seeding plans
- Limiting time of exposure
- Planting temporary ground cover
- Using sediment basins and traps

Forestry

- Controlling runoff from logging roads
- Replanting vegetation on disturbed areas
- Leaving natural buffer areas around small streams and rivers
- Avoid stream crossings during forest operations

Good instream habitat is necessary for aquatic life to survive and reproduce. Streams that typically show signs of habitat degradation are in watersheds that have a large amount of land-disturbing activities (construction, mining, timber harvest and agricultural activities) or a large percentage of impervious surface area (Center for Watershed Protection, 2003).
A watershed in which most of the riparian vegetation has been removed from streams or channelization has occurred also exhibits instream habitat degradation. Streams that receive a discharge quantity that is much greater than the natural flow in the stream often have degraded habitat as well. All of these activities result in altered watershed hydrology.

Quantifying amounts of habitat degradation is difficult in most cases. To assess instream habitat degradation in most streams would require extensive technical and monetary resources and even more resources to restore the stream. Although DWQ and other agencies are starting to address this issue, local efforts are needed to prevent further instream habitat degradation and to restore streams that have been Impaired by activities that cause habitat degradation. As point sources become less of a source of water quality impairment, nonpoint sources that pollute water and cause habitat degradation need to be addressed to further improve water quality in North Carolina's streams and rivers.

17.2.2 Sedimentation as a Stressor Related to Turbidity and Total Suspended Solids

Sedimentation is a natural process important to the maintenance of diverse aquatic habitats. Overloading of sediment in the form of sand, silt and clay particles fills pools and covers or embeds riffles that are vital aquatic insect and fish habitats. A diversity of these habitats is important for maintenance of biological integrity. Suspended sediment can decrease primary

productivity (i.e. photosynthesis) by shading sunlight from aquatic plants, affecting the overall productivity of a stream system. Suspended sediment also has several effects on various fish species including avoidance and redistribution, reduced feeding efficiency, and therefore, reduced growth by some species, respiratory problems, reduced tolerance to diseases and toxicants, and increased physiological stress (Roell, 1999). Sediment filling rivers, streams and reservoirs also decreases their storage volume and increases the frequency of floods (NCDENR-DLR, 1998). Across the state, sediment overloading too many streams has reduced biological diversity to the point of the stream being Impaired for aquatic life.

Sediment comes from land-disturbing activities in a watershed. The cause of this form of sedimentation is erosion of land in the watershed. Land-disturbing activities such as the construction of roads and buildings, crop production, livestock grazing and timber harvesting can accelerate erosion rates by causing more soil than usual to be detached and moved by water.

Streambank erosion, caused by very high stormwater flows after rain events, is another source of sediment overloading. Watersheds with large amounts of impervious surfaces transport water to streams very rapidly and at higher volumes than occurs in watersheds with less impervious surfaces. In many urban areas, stormwater is delivered directly by storm sewers. This high volume and velocity of water after rain events undercuts streambanks causing bank failure and large amounts of sediment to be deposited directly into the stream. Many urban streams are adversely impacted by sediment overloading from the watershed as well as from the streambanks.

Sedimentation can be controlled during most land-disturbing activities by using appropriate BMPs. Substantial amounts of erosion can be prevented by planning to minimize the amount and time that land is exposed during land-disturbing activities and by minimizing impervious surface area and direct stormwater outlets to streams. Erosion can be controlled during most land-disturbing activities by using appropriate BMPs. In fact, erosion can substantially be prevented by minimizing the amount and time the land is exposed. DWQs role in sediment control is to work cooperatively with those agencies that administer sediment control programs to maximize the effectiveness of these programs and to protect water quality. Where programs are not effective, as evidenced by a violation of instream water quality standards, and where DWQ can identify a source, appropriate enforcement action can be taken. Generally, this entails requiring the landowner or responsible party to install acceptable BMPs.

As a result of new stormwater rules enacted by EPA in 1999, construction or land development activities that disturb one acre or more are required to obtain a NPDES stormwater permit. An erosion and sediment control plan must also be developed and approved for these sites under the state's Sedimentation Pollution Control Act (SPCA) administered by the NC Division of Land Resources. Site disturbances of less than one acre are required to use BMPs, but an approved plan is not required. Many local governments located in the Neuse basin are covered by a specific Neuse River Basin NSW Management Strategy stormwater rules. Details can be found in Chapter 24 and at http://h2o.enr.state.nc.us/nps/Neuse_NSW_Rules.htm. These rules were specifically designed to reduce nitrogen contribution from new development in these designated areas. It is apparent that these rules need to be extended beyond the original local governments covered in the initial stormwater rule.

Establishing, conserving and managing streamside vegetation (riparian buffer) is one of the most economical and efficient BMPs. Forested buffers provide a variety of benefits including filtering

runoff and taking up nutrients, moderating water temperature, preventing erosion and loss of land, providing flood control and helping to moderate streamflow, and providing food and habitat for both aquatic and terrestrial wildlife (NCDENR-DWQ, 2004). To obtain a free copy of DWQs *Buffers for Clean Water* brochure, call (919) 733-5083, ext. 558.

A riparian buffer protection rule was also passed as part of the nutrient management strategy which requires that up to 50 feet of the riparian area be protected and maintained on the banks of waterways throughout the basin. This rule does not require establishment of new buffers unless the existing use of the buffer changes. A fact sheet on the Neuse riparian buffer rules can be found at http://h2o.enr.state.nc.us/nps/BufRulFakSheet-NeuseTP2-00.pdf or at the link above.

Channelization refers to the physical alteration of naturally occurring stream and riverbeds. Although increased flooding, bank erosion and channel instability often occur in downstream areas after channelization has occurred, flood control, reduced erosion, increased usable land area, greater navigability and more efficient drainage are frequently cited as the objectives of channelization projects (McGarvey, 1996). Direct or immediate biological effects of channelization include injury and mortality of benthic macroinvertebrates, fish, shellfish/mussels and other wildlife populations, as well as habitat loss. Indirect biological effects include changes in benthic macroinvertebrate, fish and wildlife community structures, favoring species that are more tolerant of or better adapted to the altered habitat (McGarvey, 1996). Channelization has occurred historically in parts of the Neuse River Basin and continues to occur in some watersheds, especially in small headwater streams.

17.2.3 Loss of Riparian Vegetation and Organic Aquatic Microhabitats

During the 2005 basinwide sampling, DWQ biologists reported degradation of aquatic communities at numerous sites throughout the Neuse River basin in association with narrow or nonexistent zones of native riparian vegetation. Riparian vegetation loss was common in rural and residential areas as well as in urban areas. The loss of riparian vegetation and subsequent reduction of organic aquatic habitats is caused by removal of riparian areas most commonly by land clearing for development, field agriculture, and pastureland as well as forestry and by grazing animals. Instream organic habitat removal has also been caused by de-snagging activities.

Removing trees, shrubs and other vegetation to plant grass or place rock (also known as riprap) along the bank of a river or stream degrades water quality. Removing riparian vegetation eliminates habitat for aquatic macroinvertebrates that are food for trout and other fish. Rocks or concrete lining a bank absorb the sun's heat and warm the water. Some fish require cooler water temperatures as well as the higher levels of dissolved oxygen cooler water provides. Trees, shrubs and other native vegetation cool the water by shading it. Straightening a stream, clearing streambank vegetation, and lining the banks with grass or rock severely impact the habitat that aquatic insects and fish need to survive.

Establishing, conserving and managing streamside vegetation (riparian buffer) is one of the most economical and efficient BMPs. Forested buffers in particular provide a variety of benefits including filtering runoff and taking up nutrients, moderating water temperature, preventing erosion and loss of land, providing flood control and helping to moderate streamflow, and

providing food and habitat for both aquatic and terrestrial wildlife. To obtain a free copy of DWQs *Buffers for Clean Water* brochure, call (919) 733-5083, ext. 558.

Organic microhabitat (leafpacks, sticks and large wood) and edge habitat (root banks and undercut banks) play very important roles in a stream ecosystem. Organic matter in the form of leaves, sticks and other materials serve as the base of the food web for small streams. Additionally, these microhabitats serve as special niches for different species of benthic macroinvertebrates, providing food and/or habitat. For example, many stoneflies are found almost exclusively in leafpacks and on small sticks. Some beetle species prefer edge habitat, such as undercut banks. If these microhabitat types are not present, there is no place for these specialized macroinvertebrates to live and feed. The absence of these microhabitats in some streams in the Neuse River basin is directly related to the absence of riparian vegetation and increased flashiness of the streams. Organic microhabitats are critical to headwater streams, the health of which is linked to the health of the entire downstream watershed.

17.2.4 Channelization

Channelization refers to the physical alteration of naturally occurring stream and riverbeds. Channelization is caused by mechanical straightening of channels or by hydraulic overloading during rain events. Often streams in urban areas become channelized as part of the development process in essence using the stream channels as stormwater conveyances. Although increased flooding, bank erosion and channel instability often occur in downstream areas after channelization has occurred, flood control, reduced erosion, increased usable land area, greater navigability and more efficient drainage are frequently cited as the objectives of channelization projects (McGarvey, 1996).

Typical Channel Modifications

- Removal of any obstructions, natural or artificial, that inhibit a stream's capacity to convey water (clearing and snagging).
- Widening, deepening or straightening of the channel to maximize conveyance of water.
- Lining the bed or banks with rock or other resistant materials.

Channelization reduces the sinuosity of streams greatly increasing the velocity of water flowing down these streams. Direct or immediate biological effects of channelization include injury and mortality of benthic macroinvertebrates, fish, shellfish/mussels and other wildlife populations, as well as habitat loss. Indirect biological effects include changes in benthic macroinvertebrate, fish and wildlife community structures, favoring species that are more tolerant of or better adapted to the altered habitat (McGarvey, 1996).

Restoration or recovery of channelized streams may occur through processes, both naturally and artificially induced. In general, streams that have not been excessively stressed by the channelization process can be expected to return to their original forms. However, streams that have been extensively altered may establish a new, artificial equilibrium (especially when the channelized streambed has been hardened). In such cases, the stream may enter a vicious cycle of erosion and continuous entrenchment. Once the benefits of a channelization project become outweighed by the costs, both in money and environmental integrity, channel restoration efforts are likely to be taken (McGarvey, 1996).

Channelization of streams within the continental United States is extensive and promises to become even more so as urban development continues. Overall estimates of lost or altered

riparian habitats within US streams are as high as 70 percent (U.S. Fish and Wildlife). Unfortunately, the dynamic nature of stream ecosystems makes it difficult (if not impossible) to quantitatively predict the effects of channelization (McGarvey, 1996). Channelization has occurred historically in parts of the Neuse River basin and continues to occur in some watersheds, especially in small headwater and coastal streams.

17.2.5 Recommendations for Reducing Habitat Degradation

In March 2002, the Environmental Management Commission (EMC) sent a letter to the Sedimentation Control Commission (SCC) outlining seven recommendations for improving erosion and sedimentation control, based on a comprehensive performance review of the turbidity standard conducted in 2001 by DWQ staff. Specifically, the recommendations are that the EMC and SCC:

1. Evaluate, in consultation with the Attorney General's Office, whether statutory authority is adequate to mandate temporary ground cover over a percentage of the uncovered area at a construction site within a specific time after the initial disturbance of the area. If it is found that statutory authority does not exist, then the EMC and SCC should prepare resolutions for the General Assembly supporting new legislation to this effect;

2. Prepare resolutions supporting new legislation to increase the maximum penalty allowed in the Sedimentation Pollution Control Act from $5,000 to $25,000 for the initial response to a noncompliant site;

3. Jointly support a review of the existing Erosion and Sediment Control Planning and Design Manual by DLR. This review should include, but not be limited to, a redesign of the minimum specifications for sedimentation basins;

4. Evaluate, in consultation with the Attorney General's Office, whether the statutory authority is adequate for effective use of the "Stop Work Order" tool and, if found not to be adequate, to prepare resolutions for the General Assembly supporting new legislation that will enable staff to more effectively use the "Stop Work Order" tool;

5. Support increased research into and experimentation with the use of polyacrylamides (PAMs) and other innovative soil stabilization and turbidity reduction techniques;

6. Jointly support and encourage the awarding of significant monetary penalties for all activities found to be in violation of their Stormwater Construction General Permit, their Erosion and Sediment Control Plan, or the turbidity standard; and

7. Hold those individuals who cause serious degradation of the environment through excessive turbidity and sedimentation ultimately responsible for restoration of the area.

DWQ will continue to work cooperatively with DLR and local programs that administer sediment control in order to maximize the effectiveness of the programs and to take appropriate enforcement action when necessary to protect or restore water quality. However, more voluntary

implementation of BMPs is needed for activities that are not subject to these rules in order to substantially reduce the amount of widespread sedimentation present in the Neuse River basin. Additionally, more public education is needed basinwide to educate landowners about the value of riparian vegetation along small tributaries and the impacts of sedimentation to aquatic life.

Funding is available through numerous federal and state programs for landowners to restore and/or protect riparian buffer zones along fields or pastures, develop alternative watering sources for livestock, and fence animals out of streams (refer to Chapters 19 and Chapter 6 of the *Supplemental Guide to North Carolina's Basinwide Planning* document (http://h2o.enr.state.nc.us/basinwide/SupplementalGuide.htm). EPA's *Catalog of Federal Funding Sources for Watershed Protection* (Document 841-B-99-003) outlines some of these and other programs aimed at protecting water quality. A copy may be obtained by calling the National Center for Environmental Publications and Information at (800) 490-9198 or by visiting the website at http://www.epa.gov/OWOW/watershed/wacademy/fund.html. Local contacts for various state and local agencies are listed in Appendix IV.

17.3 Aquatic Life Stressors – Water Quality Standard Violations

17.3.1 Introduction and Overview

In addition to the habitat stressors discussed in the previous section, the stressors discussed below are identified by water quality standards. These are usually direct measures of water quality parameters from ambient water quality monitoring stations. The water quality standards are designed to protect aquatic life. As with habitat degradation, altered watershed hydrology greatly increases the sources of these stressors as well as delivery of the stressors to the receiving waters. The following are water quality standards that were identified for waters with noted impacts. Refer to the subbasin chapters (Chapter 1 – 14) for more information on the affected waters.

17.3.2 Low Dissolved Oxygen

Maintaining an adequate amount of dissolved oxygen (DO) is critical to the survival of aquatic life and to the general health of surface waters. A number of factors influence DO concentrations including water temperature, depth, biological activity and turbulence. Oxygen-consuming wastes such as decomposing organic matter and some chemicals can reduce DO levels in surface water through biological activity and chemical reactions. NPDES permits for wastewater discharges set limits on certain parameters in order to control the effects that oxygen depletion can have in receiving waters.

Waters are Impaired for aquatic life when greater than 10 percent of samples collected exceed the state DO standard and at least 10 samples were collected. The DO water quality standard for Class C waters is not less than a daily average of 5 mg/l with a minimum instantaneous value of not less than 4 mg/l. Swamp waters (supplemental Class Sw) may have lower values if caused by natural conditions. In the Neuse River basin during this assessment period, there were 83 stream miles and 260 estuarine acres that are Impaired where low DO is a stressor. There were also over 370 freshwater stream miles where low DO is a stressor for waters with noted impacts, although many of these streams are in swampy areas where low DO levels are likely from natural sources.

17.3.3 Turbidity

The major sources of elevated turbidity are from agriculture and land clearing activities as well as from urban stormwater. These sources also add other pollutants beside suspended particulates. Waters are Impaired for aquatic life when greater than 10 percent of samples collected exceed the state turbidity standard and at least 10 samples were collected. The turbidity water quality standard for Class C waters is not to exceed 50 Nephelometric Turbidity Units (NTU). However, salt waters (SC, SB and SA) as well as lakes and reservoirs are not to exceed 25 NTUs. In the Neuse River basin during this assessment period, there were 86 stream miles and 2,700 freshwater acres of Falls Lake Impaired where turbidity is a stressor. There were also 95 freshwater stream miles, 32 freshwater acres and 918 estuarine/saltwater acres that are impacted where turbidity is a stressor. This is likely a more wide spread problem than the data indicates. Most storm events are not sampled which is when most of the sediment runoff occurs and when the streams in the Neuse River Basin are most likely violating water quality standards.

17.3.4 Chlorophyll *a* Algal Blooms

Algae are aquatic, microscopic plants, which respond to nutrients, temperature and light, and are an important food source for fish and other aquatic animals. Algae also contain pigments, including chlorophyll, which enable them to photosynthesize and produce oxygen. During summer, algae respond to warm temperatures, high light and nutrients washed into waterways after rain events and from treated wastewater. When temperatures and nutrient concentrations are elevated, algae reproduce to high concentrations ("bloom"). When this occurs at a particular site, chlorophyll *a*, dissolved oxygen (DO) and pH increase. When a site experiences dissolved oxygen concentrations >9 mg/l, DO percent saturation >110 percent, pH >8, or chlorophyll *a* concentrations exceed the state standard of 40 µg/l, the site is likely experiencing an algal bloom. When these algae die off or respire at night, dissolved oxygen can become very low; often resulting in fish kills. Algal blooms have been a problem in lakes, reservoirs and estuaries that are overloaded with nutrients (Wetzel, 2001).

Waters are Impaired for aquatic life when greater than 10 percent of samples collected exceed the state chlorophyll *a* standard of 40 µg/l and at least 10 samples were collected. In the Neuse River basin during this assessment period, there were 12,200 freshwater acres and 45,700 estuarine acres that are Impaired where chlorophyll *a* is a stressor. There were also 1,230 freshwater acres and 53,470 estuarine acres that are impacted where chlorophyll *a* is a stressor.

17.3.5 pH

Waters are Impaired for aquatic life when greater than 10 percent of samples collected either do not meet the state minimum pH standard or exceed the state maximum standard where at least 10 samples were collected. The pH water quality standard for Class C waters is between 6.0 and 9.0. For Class SC waters the standard is between 6.8 and 8.5. Swamp waters (supplemental Class Sw) may have lower values if caused by natural conditions. In the Neuse River basin during this assessment period, there were 7 stream miles and 260 estuarine acres that are Impaired where low pH is a stressor. There were 24,493 estuarine acres that are Impaired where high pH is a stressor. There were also 427 freshwater acres, 2,363 estuarine acres and 26 stream miles that are impacted where low pH is a stressor, although many of these streams are in swampy areas where low pH levels are likely from natural sources. An additional 426 estuarine acres were impacted where high pH is a stressor.

17.3.6 Nutrients

In Nutrient Sensitive Waters (NSW) like those of the Neuse River basin, nitrogen and phosphorus are the nutrients of most concern. Nutrients in surface waters come from both point and nonpoint sources including agriculture and urban runoff, wastewater treatment plants, forestry activities and atmospheric deposition. While nutrients are beneficial to aquatic life in small amounts, excessive levels can stimulate algal blooms and plant growth, depleting dissolved oxygen in the water column, resulting in fish kills.

In the Neuse River Basin, over 12,000 freshwater acres and 45,000 saltwater acres are impaired due to excessive nutrients resulting in chlorophyll *a* standard violations. The accumulative affect of these nutrients from upstream sources are seen in Falls Lake and the Neuse River Estuary.

17.4 Water Quality Stressors Impairing Surface Waters Recreational Uses

Bacteria live in the digestive tract of warm-blooded animals (humans as well as other mammals) and are excreted in their waste. Fecal coliform bacteria do not actually pose a danger to people or animals. However, where fecal coliform are present, disease-causing bacteria may also be present and water that is polluted by human or animal waste can harbor other pathogens that may threaten human health.

Sources of Fecal Coliform in Surface Waters

- Urban stormwater
- Wild animals and domestic pets
- Improperly designed or managed animal waste facilities
- Livestock with direct access to streams
- Improperly treated discharges of domestic wastewater, including leaking or failing septic systems, straight pipes and WWTP overflows.

The presence of disease-causing bacteria tends to affect humans more than aquatic creatures. High levels of bacteria can indicate high levels of sewage or animal wastes that could make water unsafe for human contact (swimming). Fecal coliform bacteria and other potential pathogens associated with waste from warm-blooded animals are not harmful to fish and aquatic insects. However, high levels of bacteria may indicate contamination that increases the risk of contact with harmful pathogens in surface waters. Pathogens associated with fecal coliform bacteria can cause diarrhea, dysentery, cholera and typhoid fever in humans. Some pathogens can also cause infection in open wounds.

A number of factors beyond the control of any state regulatory agency contribute to elevated levels of disease-causing bacteria. Therefore, the state does not encourage swimming in surface waters. To assure that waters are safe for swimming indicates a need to test waters for pathogenic bacteria. Although bacteria standards have been used to indicate the microbiological quality of surface waters for swimming for more than 50 years, the value of this indicator is often questioned. Evidence collected during the past several decades suggests that the coliform group may not adequately indicate the presence of pathogenic viruses or parasites in water. The detection and identification of specific pathogenic bacteria, viruses and parasites such as *Giardia*, *Cryptosporidium* and *Shigella* are expensive, and results are generally difficult to reproduce quantitatively. Also, to ensure the water is safe for swimming would require a whole suite of tests for many organisms, as the presence/absence of one organism would not document the presence/absence of another. This type of testing program is not possible due to resource constraints.

17.4.1 DWQ Assesses the Recreation Use Support Category Based on Ambient Monitoring Data and DEH Program Recommendations

The recreation category is a human health related category intended to evaluate waters for the support of primary recreation activities such as swimming, water-skiing, skin diving, and similar uses involving human body contact with water where such activities take place in an organized manner or on a frequent basis. Waters of the state designated for these uses are classified as Class B, SB and SA.

The use support ratings applied to this category are currently based on the state's fecal coliform bacteria water quality standard where ambient monitoring data are available, on the Division of Environmental Health (DEH) enterococci standard or on the duration of local or state health agencies posted swimming advisories. The advisories are based on the state's enterococcus bacteria standards.

DWQ and the LNBA conducts monthly ambient water quality monitoring that includes fecal coliform bacteria testing. The DEH tests coastal recreation waters (beaches) for bacteria levels to assess the relative safety of these waters for swimming. The Recreational Beach Monitoring Program determines the quality of coastal waters and beaches for suitability for bodily contact activities. Shoreline surveys of potential sources of pollution that could affect the area are also conducted. Swimming advisories are posted when bacteriological standards are exceeded or point source discharges are found. If an area has elevated bacteria levels, health officials will advise that people not swim in the area by posting a swimming advisory and by notifying the local media and county health department. Water samples are collected and analyzed for fecal coliform bacteria from numerous sampling stations located throughout the coastal area for both the shellfish and recreational programs.

Water quality standards for fecal coliform bacteria are intended to ensure safe use of waters for recreation (refer to Administrative Code Section 15A NCAC 2B .0200). The North Carolina fecal coliform standard for freshwater is (1) 200 colonies/100ml based on the geometric mean of at least five consecutive samples taken during a 30-day period or (2) not to exceed 400 colonies/100ml in more than 20 percent of the samples during the same period (5-in-30). In the Neuse River Basin, there are 597 Freshwater acres and 339 stream miles of where this standard was exceeded, causing these waters to be Impacted or Impaired. These waters are discussed in the subbasin chapters.

The AU being assessed for the five-year data window is Supporting in the recreation category if neither number (1) nor (2) of the standard are exceeded. The AU being assessed is Impaired in the recreation category if either number (1) or (2) is exceeded. Waters without sufficient fecal coliform bacteria data (five samples within 30 days) are Not Rated, and waters with no data are noted as having No Data.

DWQ uses DEH Recreational Water Quality Monitoring Program data to assign use support ratings. Waters are Impaired when swimming advisories are posted for more than 61 days during the five-year assessment period or the geometric mean is greater than 35 enterococci per 100 ml in at least 5 samples taken over a 30 day period. Waters with beach monitoring sites with advisories posted less than 61 days are Supporting. Other information can be used to Not Rate unmonitored waters.

Assessing the water quality standard requires significant sampling efforts beyond the monthly ambient monitoring sampling and must include at least five samples over a 30-day period. Decades of monitoring have demonstrated that bacteria concentrations may fluctuate widely in surface waters over a period of time. Thus, multiple samples over a 30-day period are needed to evaluate waters against the North Carolina water quality standard for recreational use support. Waters classified as Class SA, SB and B are targeted for this intensive sampling effort due to the greater potential for human body contact.

DWQ attempts to determine if there are any swimming areas monitored by state, county, or local health departments or by DEH. Each January, DEH, county, or local health departments are asked to list those waters which were posted with swimming advisories in the previous year.

17.5 Shellfish Harvesting Issues

17.5.1 DEH Classifications and Protocols

DEH is required to classify all shellfish growing areas as to their suitability for shellfish harvesting. Estuarine waters are delineated according to DEH shellfish management areas (e.g., Outer Banks, Area H-5), which include Class SA, SB and SC waters. DEH samples growing areas regularly and reevaluates the areas by conducting shellfish sanitation shoreline surveys every three years to determine if their classification is still applicable. DEH classifications may change after the most recent sanitary survey. Classifications are based on DEH bacteria sampling, locations of pollution sources, and the availability of the shellfish resource. Growing waters are classified as shown in Table 54.

Table 54 DEH Classification and Criteria

DEH Classification	DEH Criteria
Approved (APP)	**Fecal Coliform Standard for Systematic Random Sampling:** The median fecal coliform Most Probable Number (MPN) or the geometric mean MPN of the water shall not exceed 14 per 100 milliliters (ml), and the estimated 90th percentile shall not exceed an MPN of 43 MPN per 100 ml for a 5-tube decimal dilution test. **Fecal Coliform Standard for Adverse Pollution Conditions Sampling:** The median fecal coliform or geometric mean MPN of the water shall not exceed 14 per 100 ml, and not more than 10 percent of the samples shall exceed 43 MPN per 100 ml for a 5-tube decimal dilution test.
Conditionally Approved-Open (CAO)	Sanitary Survey indicates an area can meet approved area criteria for a reasonable period of time, and the pollutant event is known and predictable and can be managed by a plan. These areas tend to be open more frequently than closed.
Conditionally Approved-Closed (CAC)	Sanitary Survey indicates an area can meet approved area criteria for a reasonable period of time, and the pollutant event is known and predictable and can be managed by a plan. These areas tend to be closed more frequently than open.
Restricted (RES)	Sanitary Survey indicates limited degree of pollution, and the area is not contaminated to the extent that consumption of shellfish could be hazardous after controlled depuration or relaying.
Prohibited (PRO)	No Sanitary Survey; point source discharges; marinas; data do not meet criteria for Approved, Conditionally Approved or Restricted Classification.

17.5.2 Shellfish Sanitary Surveys and Program Protocols

The Shellfish Sanitation (SS) and Recreational Water Quality Section of the Division of Environmental Health 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 (ISSC) contained in the *National Shellfish Sanitation Program (NSSP) Guide for the Control of Molluscan Shellfish Model Ordinance*. The NSSP is administered by the US Food and Drug Administration (FDA). 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 growing areas in coastal North Carolina and recommendations are made to the Division of Marine Fisheries of which areas should be closed for shellfish harvesting.

17.5.3 How DWQ Assesses the Shellfish Harvesting Category Based on DEH Program Recommendations

Use support assessment is conducted such that the DEH classification is used to assign a use support rating 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 Approved areas are rated Supporting. DWQ also used DEH fecal coliform bacteria data, if the geometric mean is greater than 14 FCU/100 ml or more than 10 percent of the samples collected are greater than 43 CFU per 100 ml than the area is also considered impaired, even if DEH has classified the waters as approved. In the Neuse River Estuary, there is over 28,000 acres Impaired bases on one of these assessment methods.

17.6 Fish Consumption

17.6.1 Advice Related to Mercury

All waters in NC are Impaired based on a fish consumption advisory for mercury in large mouth bass by the NC Department of Health and Human Services (DHHS). See list below for other fish included in the NC fish consumption advisory.

The presence and accumulation of mercury in North Carolina's aquatic environment are similar to contamination observed throughout the country. Mercury has a complex life in the environment, moving from the atmosphere to soil, to surface water, and eventually, to biological organisms. Mercury circulates in the environment as a result of natural and human (anthropogenic) activities. A dominant pathway for mercury in the environment is through the atmosphere. Mercury emitted from industrial and municipal stacks into the ambient air can circulate around the globe. At any point, mercury may then be deposited onto land and water. Once in the water, mercury can accumulate in fish tissue and humans. Mercury is also commonly found in wastewater; however, mercury in wastewater is typically not at levels that could be solely responsible for elevated fish levels.

Fish is part of a healthy diet and an excellent source of protein and other essential nutrients. However, nearly all fish and shellfish contain trace levels of mercury. The risks from mercury in fish depend on the amount of fish eaten and the levels of mercury in the fish. In March 2003, the Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA) issued a joint consumer advisory for mercury in fish and shellfish. The advice is for women who might become pregnant, women who are pregnant, nursing mothers, and young children. Aside from being issued jointly by two federal agencies, this advisory is important because it emphasizes positive benefits of eating fish and gives examples of commonly eaten fish that are low in mercury. In the past, the FDA issued an advisory on consumption of commercially caught fish, while the EPA issued advice on recreationally caught fish.

By following these three recommendations for selecting and eating fish, women and young children will receive the benefits of eating fish and shellfish and be confident that they have reduced their exposure to the harmful effects of mercury. These recommendations are:

- **Do not eat shark, swordfish, king mackerel, or tilefish**. They contain high levels of mercury.
- Eat up to 12 ounces (two average meals) a week of a variety of fish and shellfish that are lower in mercury. Five of the most commonly eaten fish that are low in mercury are shrimp, canned light tuna, salmon, pollock, and catfish. Another commonly eaten fish, albacore ("white") tuna, has more mercury than canned light tuna. So, when choosing your two meals of fish, you may eat up to 6 ounces (one average meal) of albacore per week.
- Check local advisories about the safety of fish caught by family and friends in your local lakes, rivers, and coastal areas. If no advice is available, eat up to 6 ounces (one average meal) per week of fish you catch from local waters. Don't consume any other fish during that week.

For more detailed information, visit EPA's website at http://www.epa.gov/waterscience/fish/ or the FDA's website at http://www.cfsan.fda.gov/seafood1.html The FDA's food information toll-free phone number is 1-888-SAFEFOOD.

The NC Department of Health and Human Services (DHHS) also issues fish consumption advisories and advice for those fish species and areas at risk for contaminants. DHHS notifies people to either limit consumption or avoid eating certain kinds of fish. While most freshwater fish in North Carolina contain very low levels of mercury and are safe to eat, several species have been found to have higher levels. More information regarding use support assessment methodology related to fish consumption advisories and advice can be found at http://h2o.enr.state.nc.us/tmdl/General_303d.htm. Due to high levels of mercury in seventeen saltwater and five freshwater fish species, the DHHS offers the following health advice (updated March 31, 2006).

Women of childbearing age (15 to 44 years), pregnant women, nursing women, and children under 15:

- **Do not eat** the following ocean fish: almaco jack, banded rudderfish, canned white tuna (albacore tuna), cobia, crevalle jack, greater amberjack, south Atlantic grouper (gag, scamp, red, and snowy), king mackerel, ladyfish, little tunny, marlin,

orange roughy, shark, Spanish mackerel, swordfish, tilefish, or tuna (fresh or frozen).
- **Do not eat** the following freshwater fish: bowfin (blackfish), catfish (caught wild), chain pickerel (jack fish), or warmouth caught in North Carolina waters south and east of Interstate 85.
- **Do not eat** largemouth bass caught in North Carolina waters (statewide).
- Eat up to two meals per week of other fish. A meal is 6 ounces of cooked fish for adults or 2 ounces of cooked fish for children under 15.

All other people:

- Eat no more than one meal (6 ounces) per week of ocean and/or freshwater fish listed above. These fish are often high in mercury.
- Eat up to four meals per week of other fish. A meal is 6 ounces of cooked fish for adults or 2 ounces of cooked fish for children under 15.

17.6.2 Neuse River Basin Site Specific Advisories

Neuse River, Wake County, just below Crabtree Creek to Auburn-Knightdale Road
Pollutant - Polychlorinated biphenyls (PCBs) **Date Issued** - 4/2/08
Limit consumption of carp and catfish to no more than one meal per month. High levels of chemicals called PCBs may be found in carp and catfish from these waters.

Walnut Creek and Rocky Branch, Wake County, just upstream of the Neuse River
Pollutant - Polychlorinated biphenyls (PCBs) **Date Issued** - 4/2/08
Limit consumption of carp and catfish to no more than one meal per month and limit consumption of all other fish to no more than one meal per week from these waters. High levels of chemicals called PCBs may be found in these fish.

Crabtree Creek, Wake County, above Lake Crabtree and below Lake Crabtree to where it enters the Neuse River
Pollutant - Polychlorinated biphenyls (PCBs) **Date Issued** - 3/31/06
Limit consumption of carp, catfish, and largemouth bass from Crabtree Creek to no more than one meal per month. High levels of chemicals called PCBs have been found in carp, catfish, and largemouth bass from these waters.

Brier Creek, Wake County (downstream of Brier Creek Reservoir), Lake Crabtree, Wake County
Pollutant - Polychlorinated biphenyls (PCBs) **Date Issued** - 5/7/04
Brier Creek - Do not eat any fish from Brier Creek. High levels of chemicals called PCBs have been found in the fish. Swimming, boating, and other recreational activities present no known significant health risks from PCBs and are not affected by this advisory. PCB-related risks, if any, from these activities have been shown to be negligible. If future testing reveals new information, then new advice will be given and new signs will be issued.
Lake Crabtree - Do not eat carp or catfish from Lake Crabtree. High levels of chemicals called PCBs have been found in these fish. Limit consumption of all other fish from Lake Crabtree to no more than one meal per month. When in doubt about the fish species, do not eat any of the fish. Swimming, boating, and other recreational activities present no known significant health risks from PCBs and are not affected by this advisory. PCB-related risks, if any, from these

activities have been shown to be negligible. If future testing reveals new information, then new advice will be given and new signs will be issued.
Note: These advisories are an extension of the fish advisories that were issued upstream along Little Brier Creek and Brier Creek Reservoir in December 2003 (see below).

Little Brier Creek, Wake County (downstream of Brier Creek Parkway), tributaries to Little Brier Creek, and Brier Creek Reservoir
Pollutant - Polychlorinated Biphenyls **Date Issued** - 12/8/03
Do not eat fish from Little Brier Creek (downstream of Brier Creek Parkway), its tributaries, and Brier Creek Reservoir. Fish from these waters are not safe to eat. High levels of chemicals (PCBs) have been found in the fish.

For more information and detailed listing of site-specific advisories, visit the NCDHHS website at http://www.epi.state.nc.us/epi/fish/index.html or call (919) 733-3816.