Chapter 7

Natural Environment

NATURAL ENVIRONMENT: INTRODUCTION

Greensboro's limited surface waters are a system of small streams and lakes. Geographically, Greensboro is located at the headwaters (or "top of the hill", with most water flowing from the City toward nearby rivers) of the Cape Fear River Basin, the largest of the 17 major river basins in North Carolina. The lakes, ponds and streams in Greensboro are formed from rainfall that runs off of streets and rooftops, and from water that seeps up from local springs. This water ultimately ends up in the Atlantic Ocean, just south of Wilmington, NC. That same water passes through a number of towns and communities along its journey to the sea and picks up various pollutants from the continually changing landscape along the way. Water that starts here in an urban piedmont landscape passes by numerous farms, factories, highways, shopping centers, neighborhoods, and wastewater treatment plants (WWTPs) on its way to the coast. The characteristics of the water (both quality and quantity), which starts in Greensboro, are ultimately transformed along the way due to those changing conditions.

In addition to water quality characteristics, this chapter also includes watershed classifications and descriptions, air quality (depicted in data measuring ozone emissions), and endangered and threatened species, which are classified according to state and federal regulations.

NATURAL ENVIRONMENT: SUMMARY HIGHLIGHTS

Stream Quality

Samples taken from some of Greensboro's local streams between July 1999 and July 2000 indicated that the water quality is typical of urban areas. Measurements were completed at selected sites in the North Buffalo, South Buffalo, and water supply watersheds.

These measurements revealed exceedances in the state standards for fecal coliform in all areas, and for high turbidity at one site in the South Buffalo Watershed. Fecal coliform bacteria are caused by animal waste runoff, septic systems, sewer overflows, and point discharges of water from wastewater treatment plants. Turbidity is a measure of water clarity and may be caused by a variety of suspended materials in the stream system.

Biological Indicators

From 1997 through 2000, the diversity and health of the aquatic insect community was fair to good-fair in the urban streams and good-fair in the City's watershed steams. For the years 1994, 1998, and 1999, the diversity of fish in Greensboro's urban streams was poor and the watershed streams were rated fair to good-fair.

Favorable habitat conditions do not exist in several of Greensboro's streams to support fish and other aquatic communities. However, this does not indicate poor water quality on its own, but rather the result of intense urbanization that is typical of many North Carolina cities.

Lake Water Quality

The Water Quality Index score, which is a combination of nine parameters, was predominantly above average from May 1999 to November 2000 in the City's three water supply lakes.

Water Supply/ Watershed

The eight state designated water supply watersheds located within Guilford County are regulated by state mandates and are based upon the existing development pattern within the drainage area of the intake or reservoir. Minimum state standards contain different requirements for low and high-density developments that may require the construction of a water quality device, such as a pond or a bioretention area.

Air Quality

Ground level ozone, a colorless, odorless gas, is the pollutant that is most likely to lower air quality in North Carolina. In 1999 and 2000, North Carolina was one of the top ten states in the country (ranking third, only behind California and Texas) in emissions of ground level ozone.

Exceedances in the Triad region from 1997-1999, which indicate the number of occurrences above the state standard, reveal that the highest numbers (18) were recorded in Guilford County in 1998 and 1999, and in 1998 in Forsyth County.

Ozone measurements are taken between April and October every year. From 1998 through 2000, the month with the highest number of exceedances in the Triad region was August, generally the hottest month of the year. In 2000, the region listed more than 30 "code orange" ozone days.

Endangered and Threatened Species

Endangered, Threatened, and Species of Concern have been classified under state and federal guidelines. In 2000, Randolph County had the most state designated species and habitats (38), followed by Rockingham and Forsyth Counties with 33 and 29, respectively. Guilford County had 21, perhaps due to the urbanization of the area. Alamance, the smallest county in the Triad region, had the lowest number, at 17.

ENVIRONMENTAL QUALITY

Local Surface Waters

Locally, the condition of Greensboro's three primary drinking water lakes is largely a result of the quality and quantity of the streams that flow into those lakes. Likewise, the condition of the water in local streams is related to land use and the quality and quantity of the rainfall washing off the landscape. In an urban setting like Greensboro, the predominant factors in determining the water quality characteristics of streams and lakes are the pollutants washing off Greensboro's urban landscape. This type of pollution is called "non-point source pollution", because it comes from everywhere – homes, yards, cars, roads, office buildings, etc. – rather than from just one identifiable source. Every time it rains, local streams and lakes are subject to "non-point" source pollution. An example of "point" source pollution is a factory or a Wastewater Treatment Plant (WWTP) where treated wastewater is directly discharged into the creek or river. In a rural or non-urban setting, rainfall has a greater chance to soak into the ground, pass slowly overland, or absorb into wetlands, all of which improve water quality through physical and biological processes. On the other hand, in Greensboro and other urban areas, rainfall does not have as much opportunity to soak into the ground due to the urbanized landscape (buildings, parking lots, etc.), and quickly washes off into local lakes and streams – carrying with it pollution and/or trash. For these reasons, it is important to compare the water quality of the streams and lakes in Greensboro to those of other similar urban settings.

Characterizing water quality can be very complicated. No one measurement can truly characterize the relative "quality" of a water body. In fact, Greensboro conducts dozens of water quality tests at many sites throughout the City. Tests include measurements like the temperature of the water, the amount of oxygen in the water, or the level of bacteria in the water. Other, more complicated tests include Biochemical Oxygen Demand (BOD), a measurement of the oxygen-demanding materials in the water body. BOD is usually an indication of water pollution if found at high levels. Some tests, such as Chlorophyll *a*, are an indirect estimate of the amount of algae growing in a water body. High levels of Chlorophyll *a* can indicate elevated levels of nutrients like Nitrogen and Phosphorus.

Greensboro recently began regular monitoring of fish and benthic macroinvertebrate communities ("aquatic insects") as an indicator of water quality, consistent with the methods used by the State of North Carolina. This recognizes a trend in the water quality field where the overall biological community is used as a gauge of environmental health in addition to the multitude of specific chemical tests in determining overall stream health.

To show general trends in the water quality of local streams and lakes, Greensboro is now using a nationally accepted water quality index (WQI) to generate relative numeric scores and descriptions, which broadly characterize the water quality in local lakes and streams. Indices to characterize the fish and aquatic insect communities have been developed at the State level and are being utilized in Greensboro to show comparable trends in the biological health of local streams. These indices use scientific formulas to account for the most important measures of water quality and biological conditions, and to describe those conditions in a more understandable format. Although these indices are an acceptable means of compar-

ing conditions of overall surface water quality, they do not indicate acceptability as a source of water supply, nor do they indicate whether a stream meets surface water quality goals as established by state or federal regulators. These indices are utilized as a public education tool to convey water quality conditions to the general public, local elected officials and managers, and other community stakeholders.

One of the most difficult issues in establishing the relative "quality" of a stream or lake is the variability of the data being collected. Seasonal fluctuations, geographic location, and local sampling conditions can contribute to variations in collected data. For example, Chlorophyll *a*, an indicator of undesirable algae growth, is typically seen at low levels during the winter and is expected to rise during the summer months, even in a "pristine" Piedmont lake. Chlorophyll *a* is usually found at higher levels in shallow coves than in the larger, deeper body of a lake. This is due to the warmer temperatures typical of shallower water, thus causing the algae to grow more rapidly. Scientists and local staff can only gather this data during limited time periods and in limited locations, thus contributing to the variability of the data collected. In addition, stream quality can be highly variable based on the quantity of water within the stream. Following the "first flush" of urban runoff from a heavy rain, streams can show a higher concentration of pollutants than were present prior to or shortly after the rain (due to dilution). All of this indicates that water quality is a complex issue that requires consideration of many factors when assessing the overall "health" and "quality" of an aquatic environment. Given these complexities in dealing with water quality, the following information is offered about Greensboro's aquatic environment.

Stream Water Quality – Why Are Greensboro's Stream Banks Changing?

The City of Greensboro's Stormwater Management Division implements various programs to address water pollution and improve the quality of the City's streams. In addition, the need to comply with increasingly more stringent water quality regulations suggests that all of Greensboro's limited water resources must be protected. Comprehensive watershed management not only includes the treatment of pollutants, but the prevention of those pollutants as well. The implementation of vegetated stream buffers along the City's streams is one important step toward stopping those pollutants from entering streams.

One of the first steps necessary to protect limited water resources is to enhance or restore a stream's capacity to function as a natural, ecological system. One established method of improving a stream's natural function is to create a vegetated buffer system along the stream channel. Stream buffers filter pollutants, shade and cool the water, provide channel stability, and provide storage for floodwaters. Stream buffers allow for the development of natural stream meanders, increase the diversity of aquatic life, provide areas for recreational opportunities, filter air and noise pollution, enhance wildlife habitat, etc. For Greensboro to follow the stream buffer restoration method requires a major change in previous practices. Prior to 1999, Parks and Recreation staff were mowing many of Greensboro's stream corridors on public property on a periodic basis to give the appearance of a manicured, park-like setting. Although the manicured look may be aesthetically pleasing to certain residents, this practice is detrimental to water quality and the ecosystem of the streams.

The need for urban stream restoration efforts has been expressed across the nation, in vari-

ous communities, for various reasons. As Greensboro continues to grow, the quality of its water has become increasingly important and more difficult to maintain. Growth necessitates increased watershed protection to provide clean drinking water, and improved water quality for the supply of industrial, commercial, and residential needs. Also present is the need to ensure that the environment in which residents live is sustainable for future generations. A strategic approach to comprehensive watershed management should include a master planning effort, strategic best management practices (BMPs) designed to reduce pollutants, the creation of vegetated buffers along streams, public education, and source reduction of pollution through identification and elimination. These systems are now in place in various stages in the City of Greensboro.

The Stormwater Management Division is developing the programs to predict and measure the benefits and successes of both a master planning effort and the creation of stream buffers. The watershed computer model will track changes in the watershed and predict how proposed management practices affect both the water quality and water quantity of surrounding areas. Comprehensive monitoring of streams will track improvements and/or deterioration in water quality and aquatic life. Public education efforts have been and will continue to be a crucial part of changing the way people regard the precious water resources in Greensboro. Creating vegetated stream buffers is just one vital step toward providing a sustainable environment, which then sustains the economy, which in turn provides a higher quality of life.

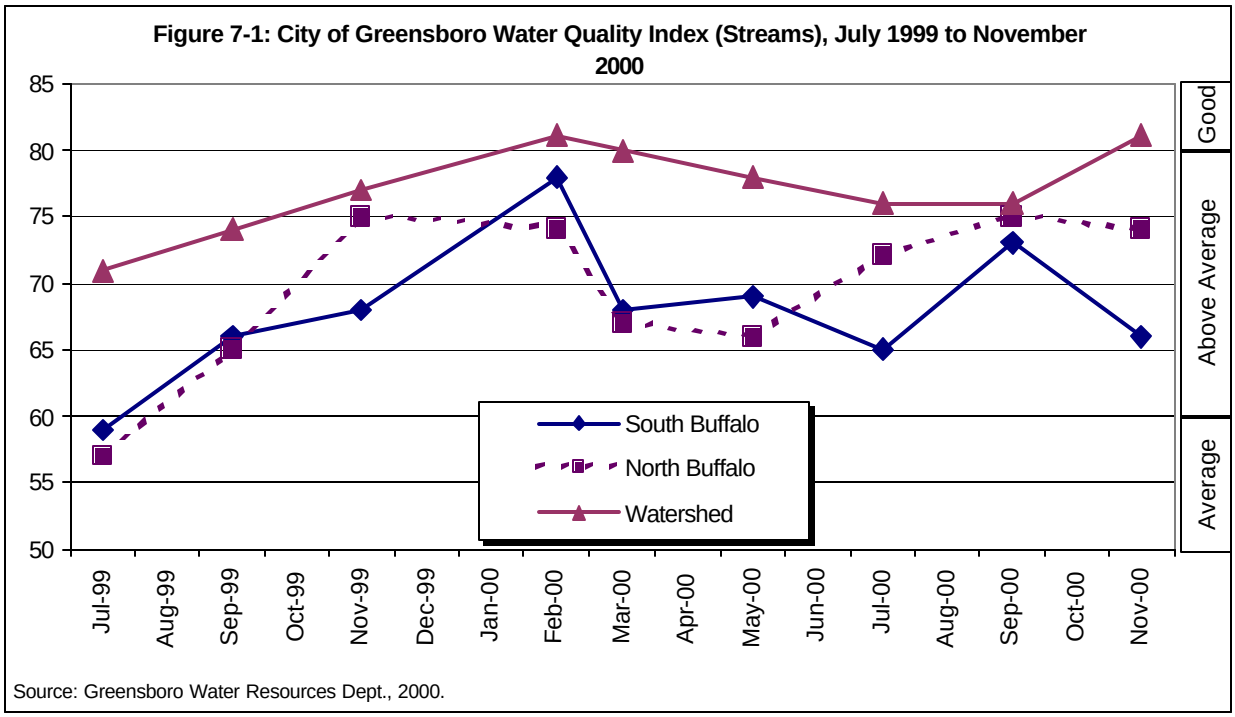
Water quality data from local streams during 1999 and 2000 indicated water quality in Greensboro's streams was typical of urban areas. Greensboro's most prolific pollutant was Fecal Coliform bacteria, which indicates bacterial contamination from warm-blooded animals, uncontrolled sewage, farm operations, and urban runoff. Fecal Coliform was consistently elevated and exceeded State and City standards throughout the time period, although this is typical of urbanized areas. BOD, an indicator of organic pollution typically associated with sewage, industrial, and animal-farming wastes, was well within normal ranges except for downstream of the North Buffalo Water Reclamation Facility (a WWTP), where levels were only slightly elevated. Nutrients such as Nitrogen and Phosphorus were at acceptable levels with the exception of downstream of the North Buffalo Facility. The nutrient contribution from the WWTP is currently within permit limits set by the State, but this level may be reduced as a result of current regulatory actions. Results from 1999-2000 water quality tests during dry weather (ambient) conditions are in Tables 7-1, 7-2, and 7-3, followed by a summary graph (Figure 7-1) of current Water Quality Index (WQI) results.

Table 7-1: North Buffalo Watershed, Average Ambient Instream Results: July 1999-July 2000								
	Sites					Standards		
Water Quality Measurements	Aycock	Church	Rankin Mill	16th St.	White St.	NC DWQ Standard	City Action Level	Units
Alkalinity	53.5	61.8	59.3	55.1	73.6	none	>100	mg/l
BOD	2.4667	2.767	4.6	2.367	2.21667	none	>10	mg/l
COD	20.4	20.8	34	23.8	20	none	>30	mg/l
Fecal Coliform	3914	3436	2526	1350	1272	200	>3000	CFU/100
Hardness	65.1	72.5	63.4	60.5	97	none	>120	mg/l
Nitrate Nitrogen	0.3117	0.282	7.365	0.31	0.51833	none	>5.0	mg/l
Nitrite Nitrogen	0.1	0.1	0.13	0.1	0.11	none	>1.0	mg/l
TDS	109	135.3	295.2	117.3	180.3	none	>400	mg/l
TSS	5.5	4.2	11.2	10.7	2	none	>65	mg/l
TKN	0.7667	0.65	2.4333	0.683	0.65	none	>2.5	mg/l
T. Phosphorus	0.0733	0.07	0.8967	0.045	0.06833	none	>0.6	mg/l
Cadmium	0.0002	0.00008	0.0003	0.00002	0.0002	2	>2	mg/l
Copper	0.0033	0.004	0.0055	0.005	0.00467	7	>7	mg/l
Lead	0.0008	0.001	0.0013	0.003	0.00133	25	>6	mg/l
Zinc	0.0073	0.008	0.0598	0.02	0.016	50	>35	mg/l
PH	6.84	6.95	6.56	6.73	7.01	<6->9	<6 or >9	su
Temperature	16.63	16.71	17.25	15.55	15.44	none	>30	o C
DO	7.93	7.15	5.97	6.64	9.05	<5.0	<5	mg/l
Turbidity	16.97	12.61	20.94	31.61	18.38	50	>50	NTU
Conductivity	210.86	235	473.29	184.7	316	500	>500	umho/cm
Source: Greensboro Water Resources Dept., 2000.								
Red = exceedance of State standard								
Blue = exceedance of City standard								

Table 7-2: South Buffalo Watershed, Average Ambient Instream Results: July 1999-July 2000								
	Sites					Standards		
Water Quality Measurements	Merritt	Randleman	McConnell	W. JJ Dr.	Fieldcrest	NC DWQ Standard	City Action Level	Units
Alkalinity	62.1	64.5	64.7	69.8	82.6	none	>100	mg/l
BOD	2.4	2.9333	2	2	2.2833	none	>10	mg/l
COD	21.2	23.4	20.8	22.8	20.7	none	>30	mg/l
Fecal Coliform	2404	1215	1704	1250	6715	200	>3000	CFU/100
Hardness	69.6	73.3	88.3	70.7	140	none	>120	mg/l
Nitrate Nitrogen	0.34	0.3667	0.36	0.25	0.315	none	>5.0	mg/l
Nitrite Nitrogen	0.1	0.1	0.1	0.19	0.1	none	>1.0	mg/l
TDS	136.7	143.5	156.7	122.2	248.7	none	>400	mg/l
TSS	25.3	5.5	3.7	4	11	none	>65	mg/l
TKN	0.667	0.6333	0.6	0.68	0.583333	none	>2.5	mg/l
T. Phosphorus	0.072	0.0483	0.03833	0.05	0.1	none	>0.6	mg/l
Cadmium	0.00009	0.00008	0.00007	0	0.0001	2	>2	mg/l
Copper	0.005	0.0032	0.00333	0	0.00333	7	>7	mg/l
Lead	0.003	0.001	0.0007	0	0.001133	25	>6	mg/l
Zinc	0.016	0.0082	0.0083	0.01	0.0121	50	>35	mg/l
PH	6.87	7.01	7.28	7.68	7.25	<6->9	<6 or >9	su
Temperature	16.22	16.92	18.14	20.5	17.9	none	>30	o C
DO	7.61	8.21	8.98	12.3	9.37	<5.0	<5	mg/l
Turbidity	81.19	24.05	15.08	15.3	18.03	50	>50	NTU
Conductivity	206	224.43	291.86	198	347.64	500	>500	umho/cm
Source: Greensboro Water Resources Dept., 2000.								
Red = exceedance of State standard								
Blue = exceedance of City standard								

Table 7-3: Water Supply Watershed, Average Ambient Instream Results: July 1999-July 2000											
	Sites								Standards		
Water Quality Measurements	Pleasant Ridge	Friendship Church	Oak Ridge	Battleground	Bluff Run	Flemming Ridge	Kivett	Mackay	NC DWQ Standard	City Action Level	Units
Alkalinity	36.7	51.7	65.3	52.2	48.7	41.7	64.5	65	none	>100	mg/l
BOD	2.367	2	3	2	2.8167	3.15	2.22	2.767	none	>10	mg/l
COD	20	20	23.5	20	20	20	20.4	20	none	>30	mg/l
Fecal Coliform	178	805	431	1183	1553	1090	200	142	200	>3000	CFU/100
Hardness	31.3	39.9	70.7	52.1	44.4	36.4	90.1	54.6	none	>120	mg/l
Nitrate Nitrogen	0.24	0.2	0.3983	0.37	0.2033	0.32	0.26	0.247	none	>5.0	mg/l
Nitrite Nitrogen	0.1	0.1	0.1	0.1	0.1	0.1	0.1	3.42	none	>1.0	mg/l
TDS	60.7	76.7	97.8	100.3	71.3	67	113	94.8	none	>400	mg/l
TSS	9.4	3.3	3.4	7.8	5	5.7	3.8	13.1	none	>65	mg/l
TKN	0.583	0.57	0.55	0.6667	0.6167	0.55	0.57	0.633	none	>2.5	mg/l
T. Phosphorus	0.032	0.02	0.0917	0.0883	0.0367	0.05	0.05	0.043	none	>0.6	mg/l
Cadmium	0.00011	0	0.0003	0.000055	0.000055	0	0	0.00004	2	>2	mg/l
Copper	0.002	0	0.0038	0.0023	0.0022	0	0	0.002	7	>7	mg/l
Lead	0.00004	0	0.0005	0.0004	0.0004	0	0	0.00005	25	>6	mg/l
Zinc	0.006	0.01	0.0077	0.005	0.0083	0.01	0.01	0.005	50	>35	mg/l
PH	7.17	6.75	7.05	6.98	6.81	6.9	6.94	6.97	<6->9	<6 or >9	su
Temperature	13.18	14.6	14.04	14.96	14.49	15.8	15.5	16.08	none	>30	o C
DO	8.2	7.57	7.85	7.89	7.85	9.01	7.94	8.53	<5.0	<5	mg/l
Turbidity	19.88	9.64	8.16	16.57	8.48	22.4	8.85	9.53	50	>50	NTU
Conductivity	93.29	98	182.43	147.43	114.29	105	207	160.6	500	>500	umho/cm
Source: Greensboro Water Resources Dept., 2000.											
Red = exceedance of State standard											
Blue = exceedance of City standard											

Summary graph of current Water Quality Index (WQI) scores:



The Water Quality Index (WQI) is the combination of nine (9) parameters combined into a common index value.

In general, the measured water quality in streams within the water supply watershed is better than that of the non-water supply watersheds, including North and South Buffalo creeks. This is largely a result of extensive water quality protection measures established for the water supply watershed and the dense urbanization of areas such as the North and South Buffalo Creek basins. The poor water quality in areas outside the water supply watershed is an indication of what can happen to water quality when uncontrolled development occurs. Greensboro should be vigilant in its development around the water supply lakes while looking for optimal ways to protect and restore water quality in other areas of the City.

BIOLOGICAL QUALITY

Aquatic Insects (Macroinvertebrates)

Biological sampling was conducted in 1997, 1999, and 2000, to determine the diversity and health of aquatic insect populations in Greensboro's streams. Table 7-4 summarizes the aquatic insect community sampling results. Although City data indicate that the diversity and health of aquatic insect populations in Greensboro's streams are fair to good-fair in the urban streams and good-fair in many of the City's watershed streams, these results are typical of developing urban communities.

Table 7-4: Greensboro Average Aquatic Insect Community NCBI* Scores, 1997-2000

Area	1997		1999		2000	
South Buffalo Creek	6.2	Good-Fair	6.93	Fair	7.13	Fair
North Buffalo Creek	6.41	Good-Fair	6.98	Fair	n/a	n/a
Watershed Creeks	5.77	Good	5.77	Good	n/a	n/a

Source: Greensboro Water Resources Dept., 2000. * NCBI = North Carolina Biotic Index

Note: Bioclassification criteria for North Carolina Biotic Index for the North Carolina Piedmont (NCDEHNR 1995).

Table 7-5: NC Biotic Index, 1995

Bioclassification	Biotic Index Value
Excellent	< 5.19
Good	5.19 - 5.78
Good – Fair	5.79 - 6.48
Fair	6.49 - 7.49
Poor	> 7.48

Source: NCDEHNR. 1995. Basinwide assessment report support document Cape Fear River Basin, DEM.

Fish

Sampling of the diversity and health of fish populations in Greensboro's streams was conducted during 1999. Very little historical fish community data is available, although the State Division of Water Quality has some limited sampling data from 1994 and 1998. The data indicate that the diversity of fish and aquatic insects in Greensboro's urban streams is poor and streams in the watershed area are considered fair to good-fair. Again, these results are typical of developing urban communities.

Table 7-6: Greensboro Average Fish Community NCIBI* Scores, 1994-1999

Area	1994		1998		1999	
South Buffalo Creek	27	Poor	20	Poor	24	Poor
North Buffalo Creek	22	Poor	30	Poor	31	Poor
Watershed Creeks	42	Fair	44	Good-Fair	37	Fair

Source: 1994 & 1998 data = NC Div. of Water Quality; 1999 data = Greensboro Water Resources Dept. * NCIBI = North Carolina Index of Biotic Integrity

Notes: NCIBI scores and class characteristics.

Table 7-7: NC Index of Biotic Integrity, 1999

NCIBI Scores	Integrity Classes	Class Characteristics
56-60	Excellent	Good species diversity for the stream size. Species unable to live in a polluted environment are present. The food chain in the stream is well balanced for all inhabitants & species of different age groups were found.
50-54	Good	Species diversity a little below what is expected for the stream. Most species unable to live in pollution are not present & the food chain structure is showing signs of stress.
44-48	Good-Fair	Continued signs of deterioration in the stream's fish community. There is a decline in species diversity & an unbalanced food chain structure.
38-42	Fair	Diseased fish are sometimes present. The fish community is dominated by species able to live in polluted areas.
≤36	Poor	Very few fish were found & species diversity is very low. The majority of the population is introduced (exotic/ non-native) species & those species able to live in pollution.

Source: Stream Fish Community Structure Assessment. Biological Assessment Group, Div. of Water Quality, NC Dept. of Environment & Natural Resources (NCDENR), 1999.

Habitat

In many of Greensboro's streams, habitat conditions favorable for supporting healthy aquatic communities are not common due to the long-term impacts of urbanization. Poor habitat conditions consist of impacts from past stream channelization (straightening) and the loss of riffles, pools, and stream bank shade trees usually necessary for healthy fish populations. The loss of potential food sources and shelter due to the frequent flushing of local streams during heavy rain events adds to poor habitat conditions. By standard criteria, the biological scores indicate poor diversity within the fish and insect populations. The only numbers indicating fair conditions were in the upper reach of North Buffalo Creek and the water supply watershed creeks (with the exception of the Horsepen Creek sample). Again, this data does not necessarily indicate poor water quality on its own, but the combination of impacts that an urbanized community can have on its local waterways.

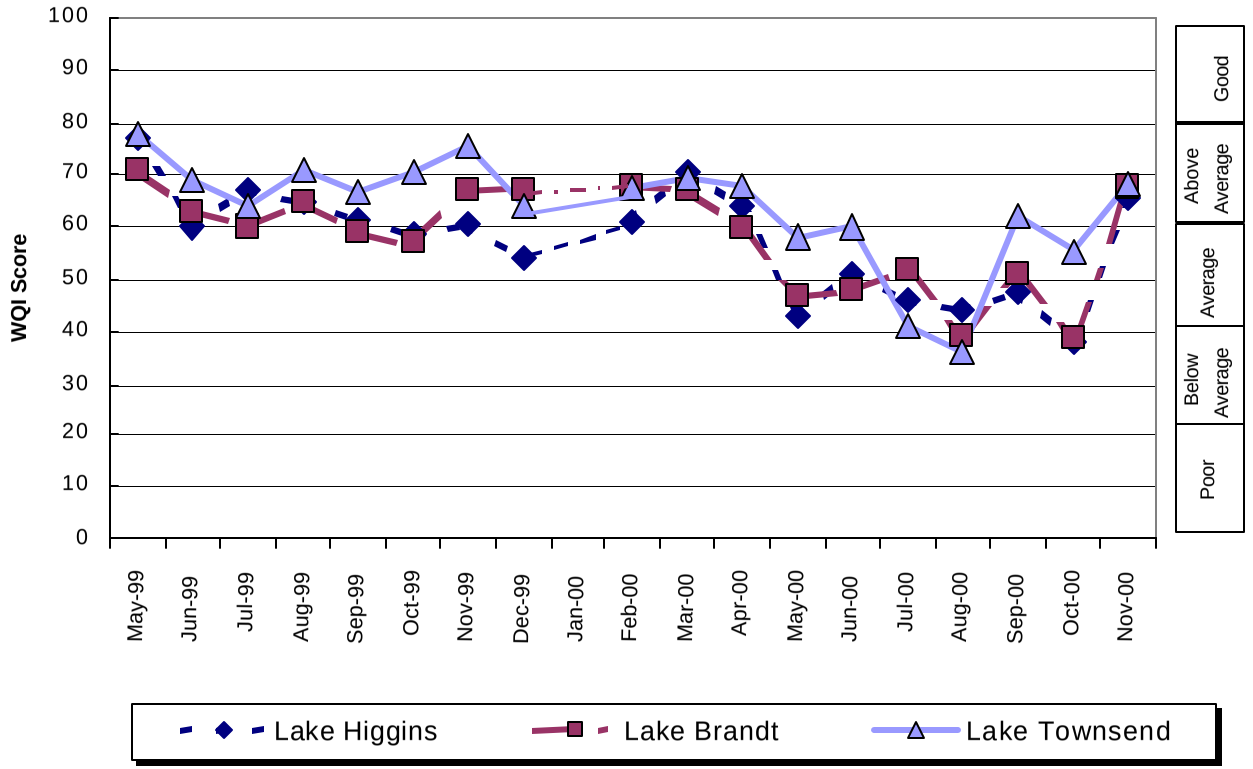
LAKE WATER QUALITY

The limited data generated for Greensboro's three water supply lakes indicate that water quality is typical for lakes located in the Piedmont area of North Carolina. The one parameter of concern is that of Chlorophyll *a*, again, indicative of elevated levels of nutrients like Nitrate and Phosphorus. Data collection for Chlorophyll *a* was only routinely begun in 1999 and the laboratory analysis during that year has been found to be of questionable value. In calendar year 2000, the data indicates an expected seasonal increase of Chlorophyll *a* during the summer months, most notably in the shallower areas of the lakes. When the data was averaged, it showed amounts of Chlorophyll *a* for all three lakes as below average to average (40 micrograms per liter, (mg/l)), but Lake Higgins showed an average amount in October 2000 (46 mg/l) and Lake Townsend showed an average amount in July (43 mg/l) and in August (53 mg/l) 2000.

It is essential to note that for all the parameters measured for the water supply lakes, only Chlorophyll *a* (algae) has been shown to seasonally exceed surface water standards. There is great debate about the use of the 40 mg/l Chlorophyll *a* standard for surface waters in regions like the Piedmont where natural nutrient levels and summertime light and temperatures combine to produce natural algae levels of this quantity.

Figure 7-2 shows a summary of the Water Quality Index (WQI) for Greensboro's three primary drinking water lakes. It is important to note that the seasonal variation seen during the summer of 2000 was a result of some higher than average Chlorophyll *a* values which resulted in a lower than normal WQI score for that time period. At no time was the quality of the drinking water unsuitable for human consumption. Regardless, it is essential that Greensboro recognize the sensitivity of its limited drinking water source and seek to continue to protect the watershed from unacceptable development, as mandated by North Carolina rule.

Figure 7-2: City of Greensboro Water Quality Index (Lakes), 1999-2000



Source: Greensboro Water Resources Dept., 2000.

The Water Quality Index (WQI) is the combination of nine (9) parameters combined into a common index value.

STATE DESIGNATED WATER SUPPLY: WATERSHEDS AND CRITICAL AREAS

As a result of a series of state mandates, cities and counties within North Carolina have adopted ordinances with regulations that place additional restrictions on development that occurs within the drainage area for all state designated water supply watersheds. All watershed areas are not state designated water supply watersheds. A state designated water supply watershed is the entire area contributing drainage (stormwater flow) to the designated water supply reservoir or intake. These watersheds are the source of our drinking water and by limiting the amount of development, we are reducing the amount of pollutants that enter into them. The minimum state standards to be enforced for each reservoir are based on a state's designation for that water supply watershed. The designation is based on the existing development pattern within the drainage area of the intake or reservoir. The minimum state standards also contain two sets of regulations, one for high-density type developments and one for low-density type developments. The main difference between high- and low-density type developments is that on high-density development sites, a water quality device (e.g. pond, bioretention area) must be constructed to treat the stormwater runoff from the proposed built upon area (BUA), if the proposed project exceeds a certain percentage of BUA. BUA is material placed on the site that does not allow stormwater to infiltrate in to the soil. Examples of BUA are asphalt, concrete and gravel.

The regulations concentrate on the effects of stormwater runoff on the quality of water at the intake or within the reservoir. The condition of the stormwater runoff that flows from a site to the intake or reservoir depends on the quantity of runoff and how quickly the stormwater runoff flows from the site to the intake or reservoir. These factors are directly related to the amount of BUA constructed on the site and the distance the stormwater must travel to get to the intake or reservoir.

There are eight state designated water supply watershed basins located within Guilford County. Those basins are Greensboro (Lake Brandt and Lake Townsend), Polecat Creek, Uwharrie (Lake Reece), Lake Mackintosh, Reidsville, Dan River, Upper Randleman (Oak Hollow Lake, High Point City Lake, and Oakdale Reservoir), and Lower Randleman (the future Randleman Lake). Each one of these watershed basins crosses two or more municipal boundaries. The regulations vary from city to county and watershed to watershed but must contain the minimum state standards. The watersheds located in Guilford County are classified as either WS-III or WS-IV. The regulations associated with WS-III, which are watersheds that contain an existing development pattern that is not as urban as WS-IV, are more restrictive than the WS-IV classification. The Greensboro, Polecat Creek, and Uwharrie basins are classified as WS-III. Lake Mackintosh, Reidsville, and Dan River basins are classified as WS-IV. Although the Randleman Watershed is classified as a WS-IV, the minimum state standards are different and it is divided into two separate districts. The two districts are considered Upper Randleman and Lower Randleman. The upper portion of the Randleman Watershed contains the General Watershed Area and Watershed Critical Area for Oak Hollow Lake and High Point Lake. The lower portion contains the General Watershed Area and Watershed Critical Area for Oakdale reservoir and the future Randleman Lake.

In general, the regulations become more restrictive the closer the development occurs to the

intake or the edge of the water contained in the reservoir. Two overlay districts cover designated water supply watersheds. These districts are the Watershed Critical Area (WCA) and the General Watershed Area (GWA). The WCA covers the area adjacent to a water supply intake or reservoir, where risk associated with pollution is greater than from the remaining portions of the watershed. No portion of the WCA outer boundary is closer than one-half (1/2) mile to the normal pool elevation or intake and draining to an existing or proposed designated reservoir. The WCA is further divided into four tiers, located around the intake or the edge of the water contained in the reservoir. The tiers are numbered from one to four, with Tier One being located closest to the reservoir and the most restrictive for development, and Tier Four being farthest away and least restrictive. The GWA covers the rest of the watershed draining to the reservoir or intake. These overlay districts serve to restrict development, so as to limit the amount of pollution that enters into our reservoirs.

It is interesting to note that the majority of the City is located in the Buffalo Creek watershed (a non-state designated water supply watershed), which drains to the Haw River and is not a part of Greensboro's water supply. Greensboro's water supply comes from three City-owned lakes on the north side of the City. The water drains into the City's lakes from the west. A large portion of the Greensboro water supply watershed is within the town limits of Summerfield.

AIR QUALITY

Ground level ozone, a colorless, odorless gas, is the pollutant that is most likely to lower air quality in North Carolina. Ozone is a problem in many areas across the United States. In 1999 and 2000, North Carolina ranked third in the country (only behind California and Texas), in emissions of ground level ozone. It is a pollutant that is unhealthy and even harmful to breathe (especially for sensitive persons, such as children, the elderly, and those who have asthma), and it can cause damage to plant life.

Air quality is measured on the amount and exposure time to ground level ozone. The EPA has determined that long-term exposure to lower levels of ozone is more harmful to human health than short-term exposure at higher concentrations. The standard of 0.08 parts per million (ppm) averaged over an 8-hour period is the current government limit, or standard, for acceptable exposure without risking human health. Parts per million is a ratio that in this case means the maximum healthy concentration of ground-level ozone is less than $1/10^{th}$ of one part of ozone for every one million parts of air.

Since 1997, the Triad region has exceeded state ozone standards multiple times. Ozone measurements are taken between April and October every year. In 2000, the Triad listed more than 30 "code orange" ozone days. From 1998 through 2000, the month with the highest number of exceedances in the Triad region was August, generally the hottest month of the year.

Ozone data in this chapter are from measurements conducted at six sites in Forsyth, Guilford, and Rockingham Counties: Hattie Avenue, Pollirosa, Shiloh Church, and Union Cross in Forsyth, McLeansville in Guilford, and Bethany in Rockingham. The measurements were conducted from 1997 to 1999. Exceedances which indicate the number of occurrences

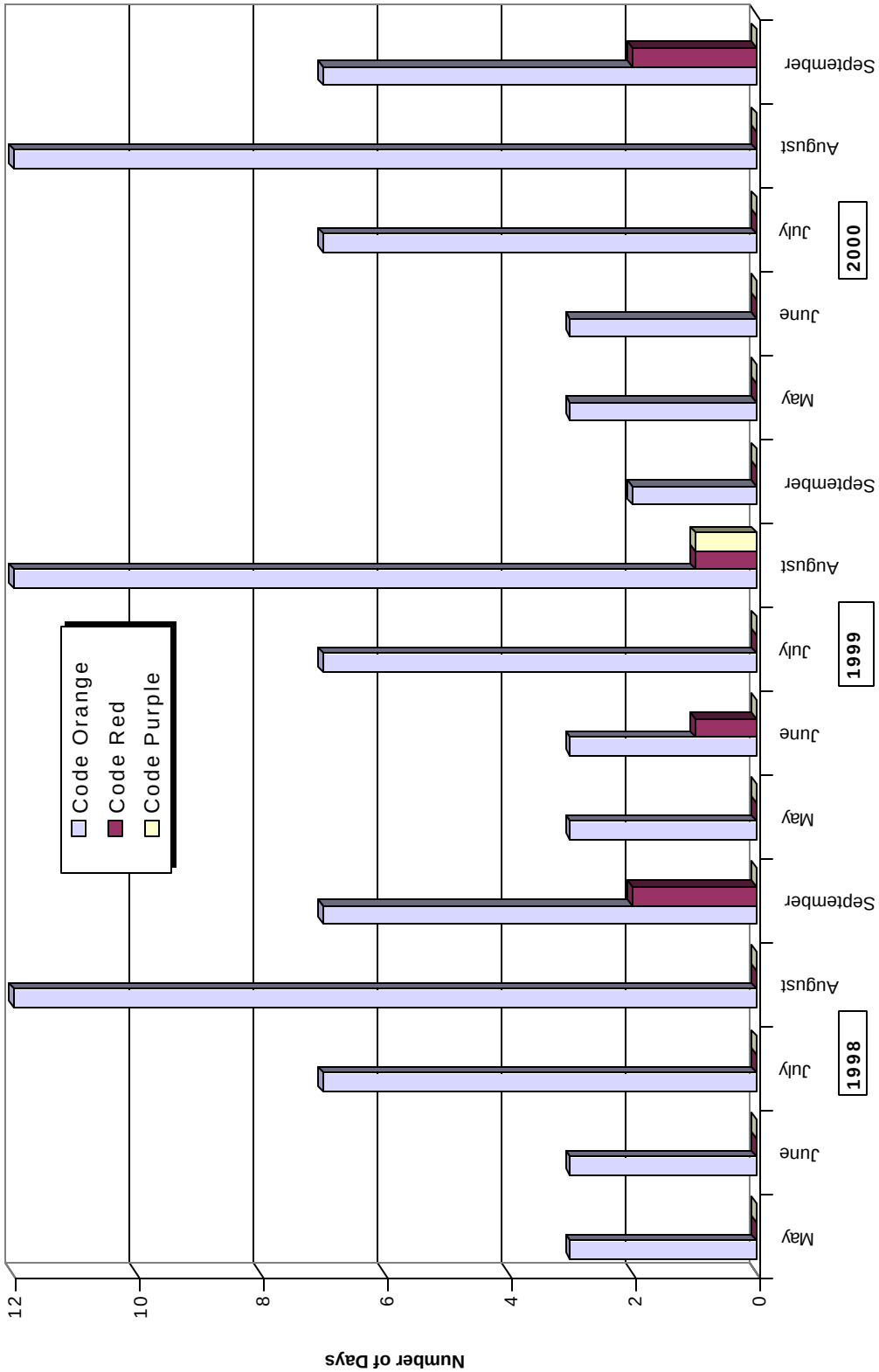
above the state standard reveal that the highest exceedances (18) were recorded in Guilford County in 1998 and 1999 at the McLeansville site and in 1998 at the Union Cross site in Forsyth County. The Hattie site in Forsyth County registered exceedances of 15 and 16 for 1998 and 1999, respectively.

Greensboro and many other cities are required to monitor air quality to meet state standards. Unmanned monitors take multiple air quality measurements per hour. An exceedance occurs when the standard is surpassed.

Table 7-8: Ozone Air Quality Index (AQI) Color Code Table, 2000				
Ozone Level	AQI Range	8-hour Ozone Concentration	Related Weather Conditions	Health Effects
Purple (Very Unhealthy)	201-300	0.125-0.374	Cool summer temperatures; windy; significant cloud cover; heavy or steady precipitation	No negative health effects.
Red (Unhealthy)	151-200	0.105-0.124	Temperatures in the upper 70s-lower 80s; light to moderate winds; partly cloudy or mostly sunny skies; chance of rain or afternoon thunderstorms	People unusually sensitive to ozone should limit extended outdoor exertion.
Orange (Unhealthy for Sensitive Groups)	101-150	0.085-0.104	Temperatures in the 80s & 90s; light winds; mostly sunny skies; slight chance of afternoon thunderstorms	Everyone (especially sensitive people, such as those with asthma) should limit extended outdoor exertion.
Yellow (Moderate)	51-100	0.065-0.084	Hot, hazy, & humid; stagnant air; sunny skies; little chance of precipitation	Sensitive people (respiratory diseases such as asthma) should avoid extended outdoor exertion; everyone else (especially children) should restrict extended outdoor exertion.
Green (Good)	0-50	0.000-0.064	Hot & very hazy; extremely stagnant air; sunny skies; no precipitation	All sensitive people should avoid all outdoor activities; everyone else (especially children) should restrict outdoor exertion & avoid heavy outdoor exertion entirely.
Source: Forsyth County Environmental Affairs Department, 2001, and NC Division of Air Quality, NC Ozone Forecast Center, 2001.				

Table 7-9: Monthly Ozone Exceedances in the Triad Region by Code, 1998-2000				
		Number of Days at:		
Year	Month	Code Orange	Code Red	Code Purple
1998	May	3	0	0
	June	3	0	0
	July	7	0	0
	August	12	0	0
	September	7	2	0
1999	May	3	0	0
	June	3	1	0
	July	7	0	0
	August	12	1	1
	September	2	0	0
2000	May	3	0	0
	June	3	0	0
	July	7	0	0
	August	12	0	0
	September	7	2	0
Source: Forsyth County Environmental Affairs Dept., 2001.				

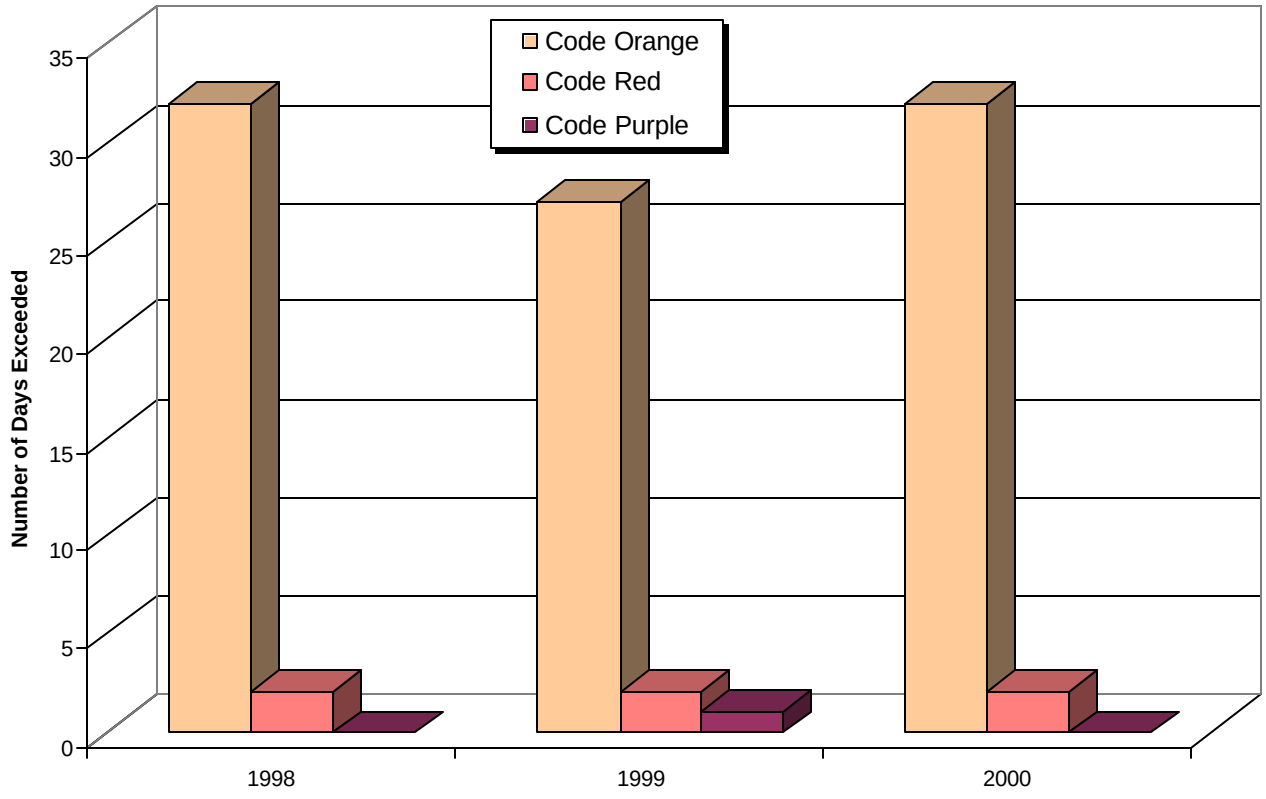
Figure 7-3: Monthly Ozone Exceedances in the Triad Region by Code, 1998-2000



Source: Forsyth County Environmental Affairs Dept., 2001.

Table 7-10: Annual Ozone Exceedances in the Triad Region by Code, 1998-2000			
	Number of Days at:		
Year	Code Orange	Code Red	Code Purple
1998	32	2	0
1999	27	2	1
2000	32	2	0
Source: Forsyth County Environmental Affairs Dept., 2001.			

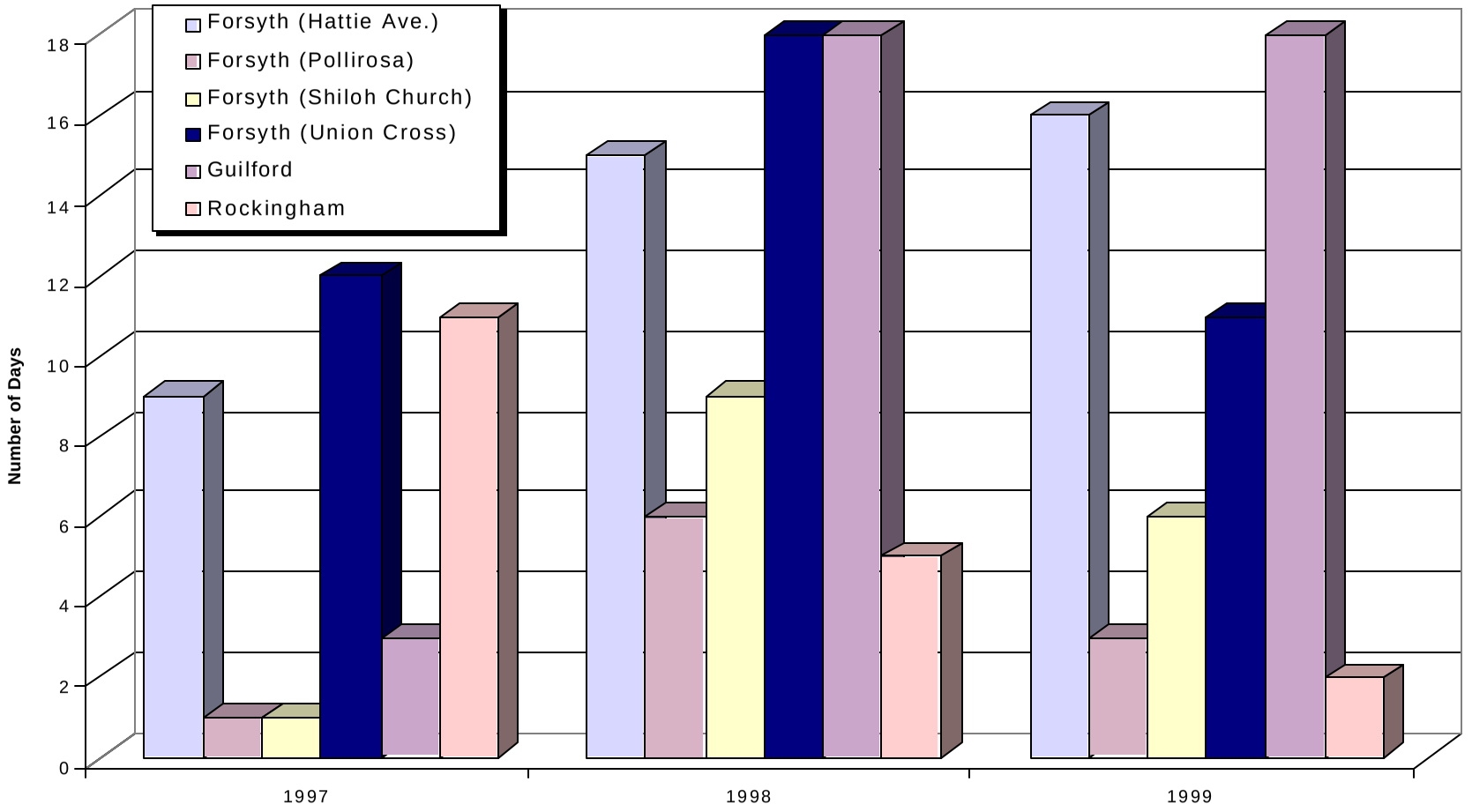
Figure 7-4: Annual Ozone Exceedances in the Triad Region by Code, 1998-2000



Source: Forsyth County Environmental Affairs Dept., 2001.

Table 7-11: Triad Regional Ozone Exceedances, 1997-1999			
Site	County	Year	Annual Exceedances
Hattie Ave.	Forsyth	1997	9
		1998	15
		1999	16
Pollirosa	Forsyth	1997	1
		1998	6
		1999	3
Shiloh Church	Forsyth	1997	1
		1998	9
		1999	6
Union Cross	Forsyth	1997	12
		1998	18
		1999	11
McLeansville	Guilford	1997	3
		1998	18
		1999	18
Bethany	Rockingham	1997	11
		1998	5
		1999	2
Source: NC Dept. of Environment & Natural Resources, Div. of Air Quality, 2000.			

Figure 7-5: Triad Regional Ozone Exceedances, 1997-1999



Source: NC Dept. of Environment & Natural Resources, Div. of Air Quality,

ENDANGERED SPECIES

In 2000, the federal and state lists showed only one Endangered species in Guilford County, the Bald Eagle. However, on the state list, there were 14 species listed as Significantly Rare or Of Special Concern, meaning that state or federal action could be possible in the future, and six habitats listed as Special Natural Communities. Guilford County listed a lower number of Endangered, Threatened, or "Special Concern" species than any of the other counties in the study area, except for Alamance, a county smaller in size. This was perhaps due to the urbanization of the county.

Table 7-12: Federally Protected Species in Triad Regional Counties, 2000					
Status	Alamance	Forsyth	Guilford	Randolph	Rockingham
Endangered Species		Red-cockaded woodpecker (V) Small-anthered bittercress (VP)		Cape Fear shiner (V)	Smooth coneflower (VP)
Threatened Species		Bog turtle (V)	Bald eagle (T)		
Species of Concern*	Carolina darter (V) Carolina redhorse (V) Yellow lampmussel (I) Sweet pinesap (VP)			Carolina darter (V) Carolina redhorse (V) Atlantic pigtoe (I) Brook floater (I) Carolina creekshell (I) Pee Dee crayfish ostracod (I)	Heller's trefoil (VP)
Total	4	3	1	7	2

Source: US Fish & Wildlife Service, NC Ecological Services, "List of Endangered & Threatened Species, as Well as Species of Concern by County for NC", Feb. 2001. *Potential Threatened Species, protected by state law. Key: V=Vertebrates, I=Invertebrates, VP=Vascular Plants.

Table 7-13: State Protected Species & Habitats in Triad Regional Counties, 2000					
Status	Alamance	Forsyth	Guilford	Randolph	Rockingham
Endangered Species		Red-Cockaded Woodpecker (B)	Bald Eagle (B)	Cape Fear Shiner (F)	Smooth Coneflower (VP)
		Bog Rose (VP)		Schweinitz's Sunflower (VP)	Goldenseal (VP)
		Small-Anthered Bittercress (VP)			
Threatened Species	Squawfoot (Mk)	Yellow Fringeless Orchid (VP)		Brook Floater (Mk)	
	Yellow Lampmussel (Mk)	Small's Portulaca (VP)		Roanoke Slabshell (Mk)	
		Bog Turtle (R)		Atlantic Pigtoe (Mk)	
				Squawfoot (Mk)	
				Georgia Aster (VP)	
Significantly Rare, of Special Concern, or Candidate Species	Loggerhead Shrike (B)	Loggerhead Shrike (B)	Eastern Fox Squirrel (M)	Star-Nosed Mole-Coastal Plain Population (M)	Mole Salamander (A)
		Bigeye Jumprock (F)	Loggerhead Shrike (B)	Black Vulture (B)	Four-Toed Salamander (A)
		Blunt-Lobed Grape Fern (VP)	Mole Salamander (A)	Four-Toed Salamander (A)	Riverweed Darter (F)
		Brown Bog Sedge (VP)	Carolina Darter-Eastern Piedmont Population (F)	Notched Rainbow (Mk)	Roanoke Hog Sucker (F)
		Hop-Like Sedge (VP)	Greensboro Burrowing Crayfish (C)	Eastern Creekshell (Mk)	Bigeye Jumprock (F)
			American Barberry (VP)	Carolina Creekshell (Mk)	Notched Rainbow (Mk)
					Eastern Creekshell (Mk)
					Caddisfly-Ceraclea mentiea (I)
					Mayfly-Ephemerella berneri (I)
					Caddisfly-Micrasema sprulesi (I)
					Flattened Entodon (Mo)
					Thin-Pod White Wild Indigo (VP)
					American Barberry (VP)

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Table 7-13: State Protected Species & Habitats in Triad Regional Counties, 2000					
Status	Alamance	Forsyth	Guilford	Randolph	Rockingham
Significantly Rare, of Special Concern, or Candidate Species	Four-Toed Salamander (A)	Appalachian Golden-Banner (VP)	Dissected Toothwort (VP)	Greensboro Burrowing Crayfish (C)	Alabama Grape Fern (VP)
	Piedmont Horsebalm (VP)	Long-Bracted Frog Orchid (VP)	Piedmont Horsebalm (VP)	Piedmont Indigo Bush (VP)	Carolina Birdfoot-Trefoil (VP)
	Notched Rainbow (Mk)	Granite Flatsedge (VP)	Heller's Rabbit Tobacco (VP)	American Barberry (VP)	Glade Wild Quinine (VP)
	Eastern Creekshell (Mk)	Heller's Rabbit Tobacco (VP)	Glade Wild Quinine (VP)	Dissected Toothwort (VP)	Cliff Stonecrop (VP)
	Narrow-Leaved Aster (VP)	Northern Green Orchid (VP)	Purple Fringeless Orchid (VP)	Crested Coralroot (VP)	Virginia Cup-Plant (VP)
	American Barberry (VP)	Purple Fringeless Orchid (VP)	Dwarf Chinquapin Oak (VP)	Pursh's Wild-Petunia (VP)	Southeastern Bold Golden-rod (VP)
	Buttercup Phacelia (VP)	Pursh's Wild-Petunia (VP)	Carrion-Flower (VP)	Canby's Bulrush (VP)	Virginia Spiderwort (VP)
	Sweet Pinesap (VP)	Northern Cup-Plant (VP)	Appalachian Golden-Banner (VP)	Biltmore Carrion-Flower (VP)	Glade Bluecurls (VP)
Special Natural Community/ Habitat	Basic Mesic Forest (Piedmont subtype)	Basic Mesic Forest (Piedmont subtype)	Basic Mesic Forest (Piedmont subtype)	Basic Mesic Forest (Piedmont subtype)	Basic Mesic Forest (Piedmont subtype)
				Basic Oak-Hickory Forest	
				Dry Oak-Hickory Forest	
				Dry-Mesic Oak-Hickory Forest	
				Floodplain Pool	
				Low Elevation Seep	
		Dry Oak-Hickory Forest		Mesic Mixed Hardwood Forest (Piedmont subtype)	
		Dry-Mesic Oak-Hickory Forest		Piedmont Monadnock Forest	Basic Oak-Hickory Forest
		Granitic Flatrock		Piedmont/ Coastal Plain Acidic Cliff	Dry-Mesic Oak-Hickory Forest
		Low Elevation Seep		Piedmont/ Coastal Plain Heath Bluff	Mesic Mixed Hardwood Forest (Piedmont subtype)
		Mesic Mixed Hardwood Forest (Piedmont subtype)	Basic Oak-Hickory Forest	Piedmont/ Low Mountain Alluvial Forest	Piedmont Calcareous Cliff
		Piedmont Monadnock Forest	Low Elevation Seep	Rocky Bar & Shore	Piedmont/ Coastal Plain Heath Bluff

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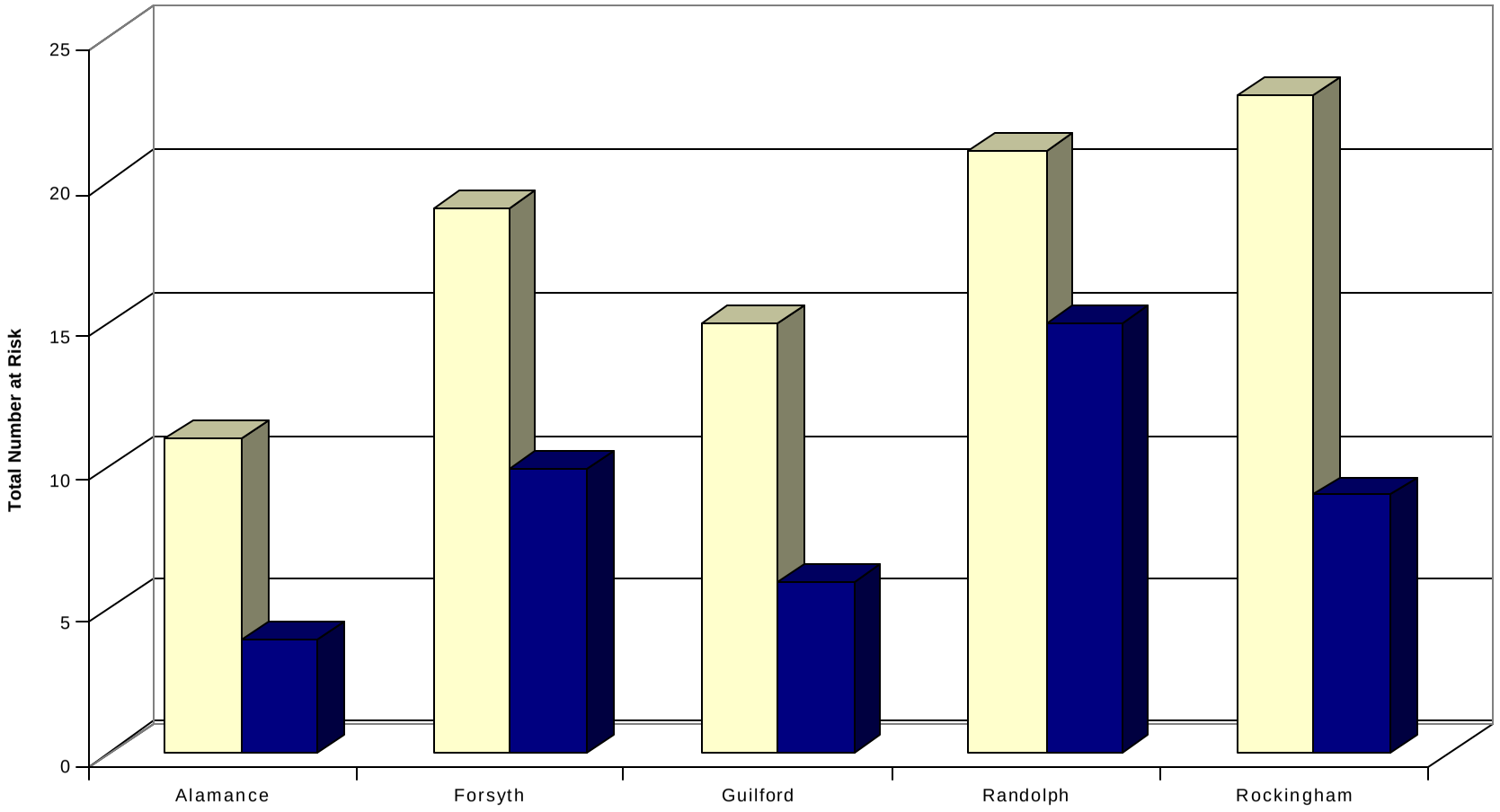
Table 7-13: State Protected Species & Habitats in Triad Regional Counties, 2000					
Status	Alamance	Forsyth	Guilford	Randolph	Rockingham
Special Natural Community/ Habitat	Basic Oak-Hickory Forest	Piedmont/ Coastal Plain Acidic Cliff	Piedmont/ Low Mountain Alluvial Forest	Upland Depression Swamp Forest	Piedmont/ Low Mountain Alluvial Forest
	Upland Depression Swamp Forest	Piedmont/ Low Mountain Alluvial Forest	Piedmont/ Mountain Swamp Forest	Upland Pool	Upland Depression Swamp Forest
	Xeric Hardpan Forest	Piedmont/ Mountain Semi-permanent Impoundment	Upland Depression Swamp Forest	Xeric Hardpan Forest	Xeric Hardpan Forest
Total Species	11	19	15	21	23
Total Habitats	4	10	6	15	9
Grand Total	15	29	21	36	32
Source: NC Natural Heritage Program, "Natural Heritage Program Database", Sept. 2000. Key: (A)-Amphibian, (B)-Bird, (C)-Crustacean, (F)-Fish, (I)-Insect, (M)-Mammal (Mk)-Mollusk, (Mo)-Moss, (R)-Reptile, (VP)-Vascular Plant.					

Figure 7-6: State Protected Species & Habitats in Triad Regional Counties, 2000



Source: NC Natural Heritage Program, "Natural Heritage Program Database", Sept.