State of the Environment

2014

Orange County
Commission for the Environment

ACKNOWLEDGEMENTS

**This report is dedicated to Alice Gordon,
who has served Orange County for 24 years as County Commissioner.
She played a seminal role in the formation of the Commission for the Environment
and the Environment and Resource Conservation Department (*now DEAPR*).**

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Planning and Inspections Department	http://www.co.orange.nc.us/planning/index.asp
Cooperative Extension	http://orange.ces.ncsu.edu/

This report is available at Orange County public libraries and the DEAPR office in Hillsborough.

The report can also be viewed online at: http://www.co.orange.nc.us/deapr/

September 2014

The Orange County Commission for the Environment applauds the work of County staff, particularly Rich Shaw, Tom Davis, and Malcolm Munkittrick, a UNC graduate student intern, in preparing this detailed and thoughtful State of the Environment Report. We hope this report will help guide the County as it continues to implement its 2030 Comprehensive Plan. It is impossible to provide a truly comprehensive assessment of our county's environment, but this report packs a lot of important information in a readable format. We trust that it will help us better understand what is happening with the land, water, air, and other natural systems that sustain and surround us.

The recent spill of toxic coal ash into the Dan River—much like the chemical spill into the Elk River in West Virginia earlier in the year—is a potent reminder of the importance of vigilant regulations designed to protect our public health and our environment. As our state moves to weaken environmental regulations, we are thankful for local leadership from the County Commissioners and staff that recognizes the intrinsic link between healthy people and healthy ecosystems.

An assessment focused on Orange County in isolation, however, carries certain inherent blind spots. How we maintain our natural environment matters for people outside of our county, just as the acts of those outside Orange County have a tangible impact here. Maintaining healthy headwaters for the Eno and Little rivers benefits those downstream in Durham and Wake County who rely on these rivers for clean drinking water. Likewise, our air quality is affected whenever we are downwind of a coal powered power plant and by the flow of cars and trucks on Interstates 40 and 85. We are all in this together.

A report focused on Orange County alone also risks underemphasizing global climate change, the most pressing environmental threat we face. Our use of fossil fuels here, whenever we start a car engine or run our air conditioners, adds to the accumulation of carbon in the atmosphere that is rapidly destabilizing our climate. In 2012, leading climate activist and writer Bill McKibben summarized how close we are to reaching the limits of our carbon budget:

Scientists estimate that humans can pour roughly 565 more gigatons of carbon dioxide into the atmosphere by midcentury and still have some reasonable hope of staying below two degrees [Celsius]. ("Reasonable," in this case, means four chances in five, or somewhat worse odds than playing Russian roulette with a six-shooter)….

Reaching or surpassing that two degree rise in average global temperatures risks catastrophic consequences for our ability to grow food, maintain access to drinking water, and generally perpetuate human civilization as we now know it. All of the careful planning, conservation of native species, stewardship of beautiful natural places, promotion of biodiversity, and other crucial work at the county level threatens to be rendered meaningless if we cannot stave off the worst consequences of climate change.

In the absence of concerted action at the international, national, or state level, it is up to us in a place like Orange County to lead the way on developing a new economy – one that will better meet our human needs and reduce our use of fossil fuels. We can follow the example of places like Oberlin, Ohio, a community that has committed itself to reworking its economy to be more energy efficient, powered from renewable sources, based on local assets, tied into its local farm and food systems, and more fair to all.

Continued on next page

Our County Commissioners share this kind of commitment to sustainability, as articulated in the 2030 Comprehensive Plan:

What that means is that we must seek to develop a community that meets the needs of the present generation without compromising the ability of future generations to meet their needs. Current global trends have demonstrated the need for planning healthy and sustainable communities. One trend is the increasing impact of greenhouse gases on the world's climate and another is the decreasing supply of resources that support life. Sustainability is defined as aligning our built environment and socioeconomic activities with the natural systems that support life. In the long run, sustainability means adapting human activities to the constraints and opportunities of nature.

It is time to take this commitment a step further. Orange County has made great strides towards making is buildings more energy efficient. What can we do, in cooperation with our town governments, UNC, Durham Tech, businesses, the faith community, and other institutions to promote more energy efficient homes and businesses? How can we expand deployment of solar and other renewable energy? What options do we have for promoting businesses that have a commitment to true sustainability? How can we increase alternative transit options that will allow more county residents to leave a car at home, drive a shorter distance to reach a bus or train, or bike or walk to work? How can we continue to expand our recycling, waste reduction, and composting efforts? How can we expand access to locally and sustainably produced food?

These questions must be at the forefront of our minds if we want to continue to be environmental leaders over the next several years.

Sincerely,

David Neal, former Chair
Orange County Commission for the Environment

PURPOSE

The Orange County Commission for the Environment presents the 2014 State of the Environment to:

- *Describe the current status of Orange County's natural environment;*
- *Provide measures to monitor and evaluate progress toward a cleaner, healthier environment;*
- *Highlight the major environmental challenges facing the County; and*
- *Recommend actions to confront those challenges.*

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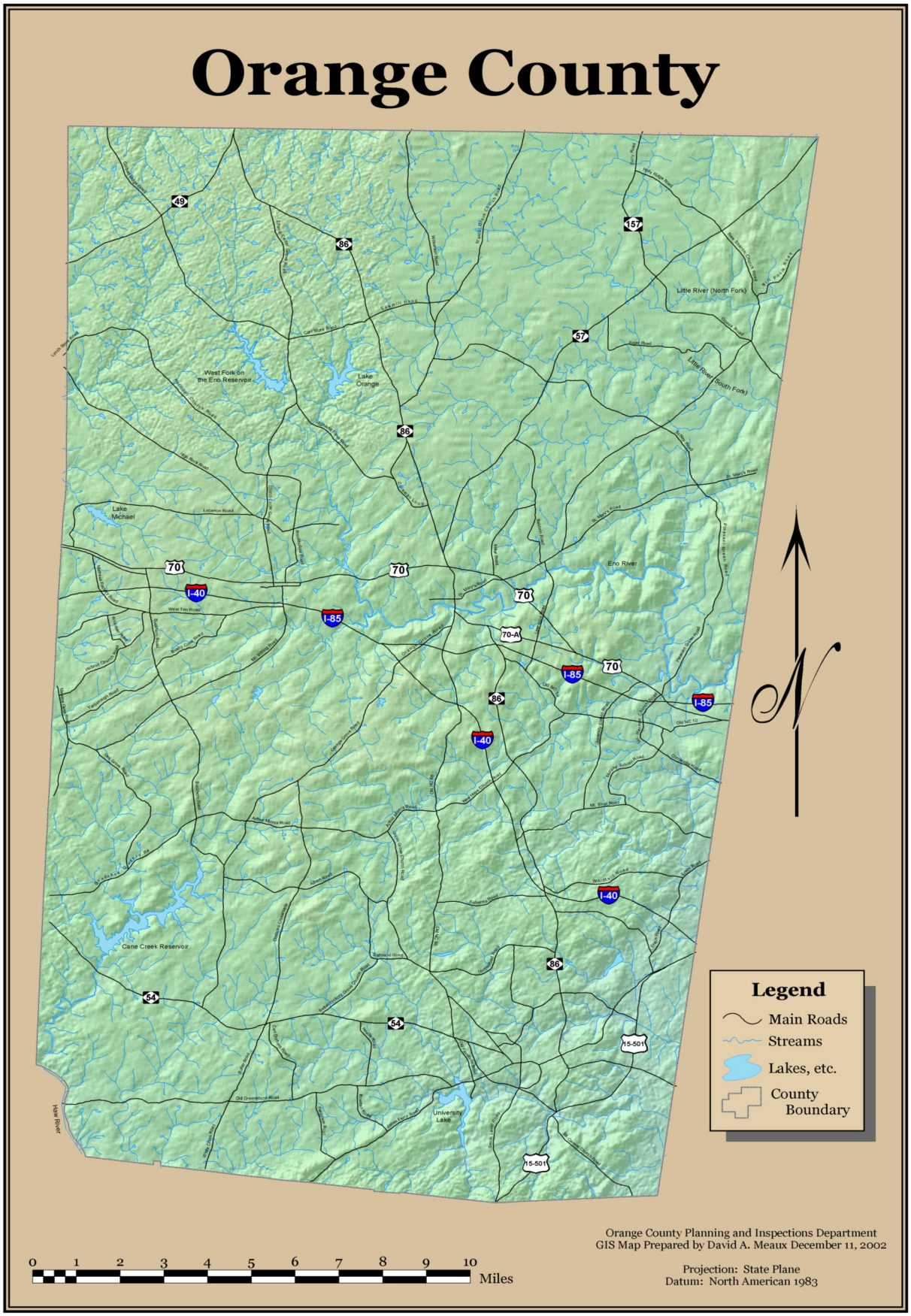
The current *status* and *trend* for each environmental indicator are summarized in the top right corner of its respective page.

Two examples are shown at right. In the first example the current *status* is "Poor" and the data indicates conditions appear to be declining. In the second, the status of the indicator is "Good" and conditions are improving.

The *status* of indicators ranges from "Poor" to "Fair" to "Good," while the *trend* ranges from "No Change" to "Declining" to "Improving." "Emerging" and "Uncertain" icons are also used to describe issues for which insufficient information was available to determine the current status or trend.

Figure 1: Physiographic Map of Orange County



ORANGE COUNTY
NORTH CAROLINA

Introduction

This State of the Environment report was prepared by the Orange County Commission for the Environment (CFE) and the Orange County Department of Environment, Agriculture, Parks and Recreation (DEAPR). The report provides an updated analysis of the county's natural environment and offers recommendations for helping Orange County refine, create, and implement more effective environmental policies.

Additionally, this report provides information to county residents who want to learn more or to play an active role in protecting and improving the natural environment in Orange County, NC.

While Orange County remains foremost among the region's counties in promoting planned growth instead of indiscriminate sprawl, our natural environment remains susceptible to degradation from the steady, long-term conversion of natural land to urban and suburban infrastructure. The public needs to understand the strategies available to protect our water, air, and land resources while also planning for future growth.

In preparing this fifth State of the Environment report, the CFE used a set of key **environmental indicators** adopted in the first report, published in 2000. These measurable indicators reveal trends in the County's environment, alert us to potential impacts on human health and natural resources, and suggest areas where additional information, research, and monitoring may be needed. The CFE has also included new indicators and some thoughts on **emerging issues** in this report.

The environmental indicators are grouped into three categories: Air and Energy Resources, Land Resources, and Water Resources. CFE members with expertise in each of these areas provided their assessment of the data and trends and contributed to the recommendations for each subject area. CFE members identified the **critical issues** listed on the next page and also highlighted several key recommendations that are drawn from the body of this report.

Critical Issues

- Invasive, non-native, plant and animal species threaten the biological diversity of Orange County's aquatic and terrestrial ecosystems. Non-native species replace natives, threatening critical ecosystem services such as plant pollination and posing risks to livestock, land, and public health.

    - Important data on the quality and quantity of Orange County's surface water and groundwater will remain unknown as reductions are made in State-led data collection efforts.

- If drilling for natural gas begins in the Deep River basin, nearby Orange County residents could experience negative impacts to air quality, water quality and supply, and infrastructure.

    - We need to do more to improve our air quality, chiefly by making changes that result in less reliance on cars. Locally, this can be achieved by: (1) increased availability and use of transit alternatives, including bus, rail, bicycle, and pedestrian pathways; and (2) town and county planning that fosters denser, walkable communities, reduces sprawl, and allows the clustering of development in urban buffers. The installation of ozone monitors could help track air quality more accurately.

- Orange County should continue to support the responsible deployment of clean and appropriately-sited renewable energy.

    - Reducing energy use is the first step in fighting climate change. Orange County has made great strides in improving the energy efficiency of the buildings under its management. We can build on this progress by investing more in energy efficiency programs for residential, commercial, and other government buildings.

Highlighted Recommendations

Air and Energy Resources

	Pages
1. Orange County should work with Carrboro, Chapel Hill, and Hillsborough to update the 2005 Greenhouse Gas Emissions Inventory and Forecast for the county, and assess our progress toward the emissions-reduction goals recommended in the 2005 Greenhouse Gas Emissions report.	**14**
2. Orange County should collaborate with its citizens and with civic organizations that are organizing for clean energy policy at the local, state, federal, or international level.	**12**
3. Orange County should incentivize green building techniques by offering reduced building permit fees for commercial and residential buildings that achieve demonstrable energy savings.	**12**
4. Orange County should continue to reduce the amount of solid waste sent to landfills by implementing a "pay-as-you-throw" system and stop trucking Orange County solid waste to the Durham transfer station.	**12**

Land Resources

	Pages
1. Orange County should work with its partners to protect at least 12% of county land area by 2020, with focus on Natural Heritage Areas, and develop a comprehensive conservation plan for a network of protected space throughout the county.	**26**
2. Orange County should continue educating and assisting the agricultural community with the Voluntary Agricultural District and Present Use Value Taxation programs.	**32,34**
3. Orange County should increase efforts to encourage homeowners and businesses to choose regionally native species for landscaping.	**35**

Water Resources

	Pages
1. Orange County should increase efforts to gather information related to water resources in Orange County; including data about surface water and groundwater quality, as well as concerning groundwater quantity. State-led efforts in these areas continue to decline due to budget and staff reductions.	**54, 57 68**
2. Orange County should undertake a campaign to inform the public about invasive aquatic species, including their current extent in our waterways, the likely ramifications of the occurrence of these species in Orange County, and what steps can be undertaken to slow their spread or eliminate them locally.	**70**
3. Orange County should continue to increase public awareness and understanding of water supply sources, related concerns, and what steps can be undertaken to improve or maintain the quality and quantity of our water supply resources.	**54, 57 61, 68**

Demographics

Residential growth is one of the fundamental factors affecting the pattern of development in Orange County. The county continues to experience dramatic population growth (Figures 2 and 3). From 1980 to 2012, Orange County's population grew from 77,055 to 138,330 residents —an 80 percent increase (3.6 percent average annual growth rate). Many people are attracted to Orange County for its central location in the Triangle region, as well as its high quality of life.

The greatest rate of population increase occurred in the Orange County portion of Mebane, with a 470 percent increase from 1980-2010 (and a 266 percent increase in 2000-10). Carrboro had the second highest rate at 267 percent over the same 30-year period (1980-2010). A complete breakdown of the population data is provided in Appendix 1.

Chapel Hill remains the county's dominant residential and commercial center with 41 percent of the total county population, but only 20 percent of the total land area.

The numbers of residents in the largely rural unincorporated areas (39 percent) have also increased significantly despite losing five square miles to the towns through annexation. This growing rural population poses challenges in the planning and provision of public services.

By 2020 the populations of Chapel Hill and Hillsborough are expected to have *doubled* since 1980, while the number of Carrboro residents will likely have *tripled* over that 30-year period.

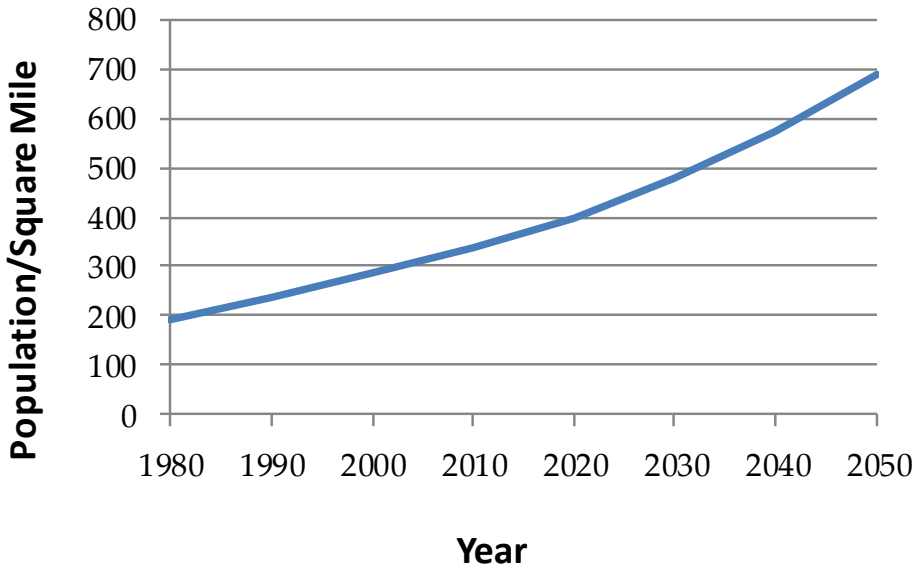


Figure 2: Population per Square Mile, Measured and Projected, 1980-2050

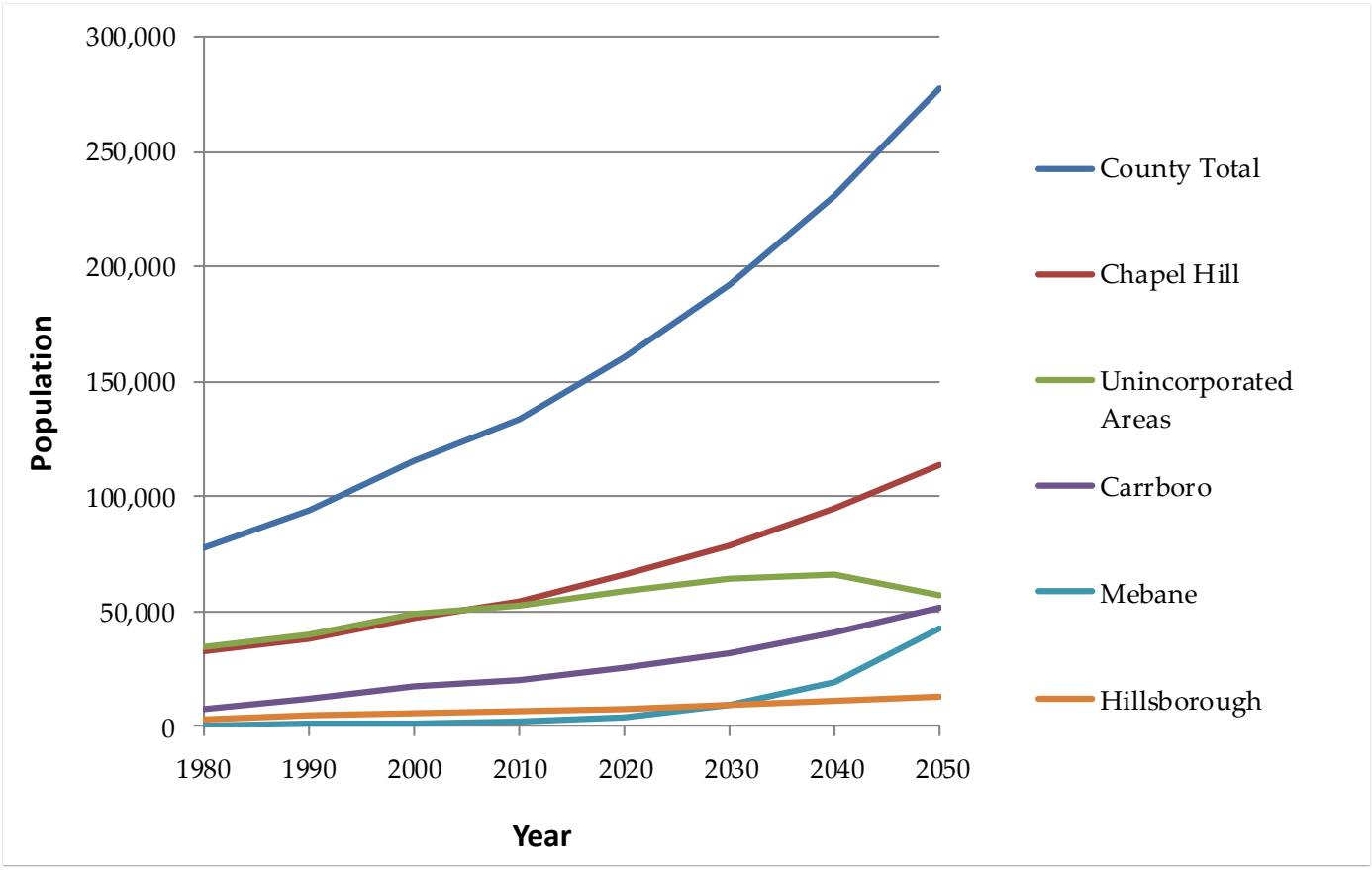


Figure 3: Population Growth, Measured and Projected, 1980-2050

Sources: US Census Bureau and Orange County Department of Planning and Inspections

Air and Energy Resources

Air quality and use of energy resources are intimately linked and are the reason we consider them together in this section. The combustion of fuel for either direct energy use (e.g. home heating, driving a car) or indirect (generation of electricity for use in homes and businesses) relies on the oxygen in the air for combustion and uses the properties of air to exhaust combustion gases, including pollutants, into the atmosphere.

"My Paintbrush" by Kirby Lau

Air quality continues to be a pressing issue as the Triangle region's population expands rapidly. Poor air quality can affect the health of Orange County residents and damage local ecosystems. County and regional emissions also contribute to global problems, particularly climate change.

When we discuss air quality, we are usually referring to the outdoor air, not the indoor air associated with buildings for living quarters and businesses. Air "quality" is both a qualitative and quantitative measure of pollutants in the air.

As we learned in school, air is primarily a mixture of nitrogen (approx. 79%) and oxygen (approx. 21%). There are small concentrations of naturally occurring inert gases and other gases that make up the balance. The typical adult human breathes in (and out) approximately 20 cubic meters of air each and every day. To put this into perspective, that is about the volume contained in 10,000 2-liter plastic (soft-drink) bottles each and every day. Children breathe in lower volumes of air compared to adults, but they breathe higher volumes compared to their size and bodyweight. This volume of air we breathe is important because, although we measure some pollutant concentrations in units like parts per million or parts per billion, the total exposure to some pollutants can be quite significant on a daily basis and over a lifetime.

How is Air Quality Quantified?

Under current Federal law there are national standards for certain pollutants that apply everywhere in the United States. State and local laws set up the framework for how these standards are achieved. The US Environmental Protection Agency (EPA) is responsible for overseeing the implementation of the law and provides guidance on how to meet these standards, however the state and local authorities are responsible for developing and enforcing laws and regulations to actually achieve the standards. States and localities may tailor their regulations to meet local conditions.

Air and Energy Resources Indicators

This section of the report provides an overview of seven indicators of our current environment:

- overall air **Emissions Estimates**;
- **Emissions from Point Sources** (large, stationary polluters; e.g., factories, electric power plants);

- **Ozone Exceedances**;
- **Daily Vehicle Miles Travelled** (for tracking emissions from mobile sources, e.g., cars/trucks);
- **Commuting Patterns and Modes** of transportation ; and
- **Innovations in Energy Conservation by Orange County Government.**

In addition , this section reports on the emerging issue of **Plug-in Electric Vehicle Infrastructure**.

Emissions data come from the NC Department of Environment and Natural Resources, Division of Air Quality (NC DAQ). The NC DAQ collects data on the release of many air pollutants, including volatile organic compounds, sulfur dioxide, nitrogen oxide, and particulate matter. These pollutants contribute to respiratory illnesses (e.g., asthma), aggravate heart and lung diseases, form acid rain, contribute to global warming, impair visibility, and pollute aquatic systems.

The County continues to implement initiatives for reducing pollutant emissions, such as a variety of recycling programs, leaf collection, use of biodiesel for County vehicles, provision of bicycle facilities, establishment of the Urban Services Boundary, provision of daylighting in new schools, utilizing geothermal heating and cooling systems in government buildings, purchase of hybrid vehicles, and support of Chapel Hill Transit's fare-free system.

To date, there has been no follow-up to the 2009 *Greenhouse Gas Emissions Inventory and Forecast*. The CFE recommends that the County commit to completing a greenhouse gas emissions inventory every five years to assess progress toward meeting targeted reduction levels.

What can you do to improve the quality of Orange County's air?

Ozone and particle pollution, the two biggest air quality concerns in NC, come from many of the same sources, primarily motor vehicles and industry (including power plants). Our individual activities create air pollution, and all of us have the power to improve air quality through our actions. Try some of the following:

- Use Public Transportation.

  Gotriangle: http://gotriangle.org/index.php

  Orange Public Transit: http://www.co.orange.nc.us/transportation/index.asp

  Triangle Transit: http://www.triangletransit.org/

  Chapel Hill Transit:: http://www.townofchapelhill.org/index.aspx?page=1175

- Bike, walk, telecommute, carpool, or vanpool. http:/www.co.orange.nc.us/transportation/BusAlternatives.asp http://www.sharetheridenc.org/

- Don't let your car idle unnecessarily. http://www.ncair.org/motor/idle/

- Drive in an environmentally responsible fashion. http://www.ncdot.gov/travel/drivegreen/

- Install a programmable thermostat or adjust your thermostat when leaving home for the day.

- Weatherize your home to make it energy efficient. http://pueblo.gsa.gov/cic_text/housing/weather/weather.htm

- Don't burn trash or woody debris. Dispose of them at the Solid Waste Convenience Centers. http://www.co.orange.nc.us/recycling/hhw.asp

- Use alternative energy such as solar and wind to help reduce air pollution.

- Take other steps to reduce energy consumption and your contributions to air pollution including greenhouse gases. http://www.epa.gov/greenhomes/ReduceEnergy.htm http://www.epa.gov/climatechange/wycd/home.html

- Get involved with civic organizations that are organizing for clean energy policy at the local, state, federal, or international level. http://350.org/ http://greenforall.org/ http://www.sierraclub.org/

- Change your light bulbs to LEDs or compact fluorescents. http://www.energystar.gov/index.cfm?c=cfls.pr_cfls

Emissions Estimates

Good

Trend: improving

Why is this indicator important?

Tracking air pollutant emissions is critical to assessing and developing strategies to improve air quality. Reducing the amount of ground-level ozone has been one of the greatest challenges facing Orange County and the entire Triangle region. Although a portion of this ozone is the result of the transport of gases from other areas, a significant portion comes from local (mobile source) transportation emissions.

Chapel Hill Transit

In 2004, the US Environmental Protection Agency (US EPA) designated Orange County and seven other neighboring counties as "nonattainment areas" for ozone. In 2007, US EPA reclassified the Triangle region as "in attainment of the ambient standards of a maintenance area." However, recent regulatory changes to more stringent standards may return the Triangle area, including Orange County, to nonattainment status. [See also pages 13-14]

How is this indicator measured?

Ground-level ozone is formed in the atmosphere through a photochemical reaction involving a number of air pollutants. The primary contributors to ground-level ozone are:

- Nitrogen oxides (NOx), which are formed when vehicles or industrial plants burn fossil fuels, and
- Volatile organic compounds (VOCs), which are hydrocarbons present in fuels and solvents.

The NC Division of Air Quality (NC DAQ) estimates historical NOx and VOCs emissions and projects future emissions for air quality through the use of a computer model. This model utilizes demographic data and area inventories to estimate emissions. Until recently, NC DAQ also estimated emissions of carbon monoxide (CO), a colorless, odorless gas that forms during the incomplete combustion of carbon and hydrocarbons (e.g., fuels). CO can also indicate the presence of organic compounds that contribute to ozone formation. Unfortunately, NC DAQ no longer provides estimates for CO emissions.

For mobile emission sources, air quality engineers calculate daily vehicle miles traveled (DVMT) and use an US EPA-approved model to predict road vehicle emissions. This model accounts for new vehicle emission controls and the types of cars in use, as well as future growth, travel patterns, and other variables.

For non-road emissions, NC DAQ uses another US EPA model. Gas stations, dry cleaners, and vehicle repair facilities are inventoried and utilized to create area emission estimates. A similar process is used for industrial facilities to calculate point source emission estimates. Finally, NC DAQ calculates biogenic source emissions by estimating pollutants released by trees, cattle, and other living organisms.

What is the trend in Orange County?

Figures 4 and 5 depict recent and predicted emissions for NOx and VOCs in Orange County. Models predict that Orange County will see continued reductions in NOx and VOC emissions through 2018. Orange County may differ from a typical North Carolina county in several ways, including the overall levels of growth, the number of vehicle miles traveled, and local transportation

How can Orange County improve?

To support a sustainable future, Orange County should:

- Update the local Greenhouse Gas Inventory and set ambitious reduction targets for the next decade;
- Continue supporting enhanced public transit services following the County's successful 2012 transit referendum; and
- Collaborate with other partners to install ozone monitors along the I-40 and I-85 roadway corridors.

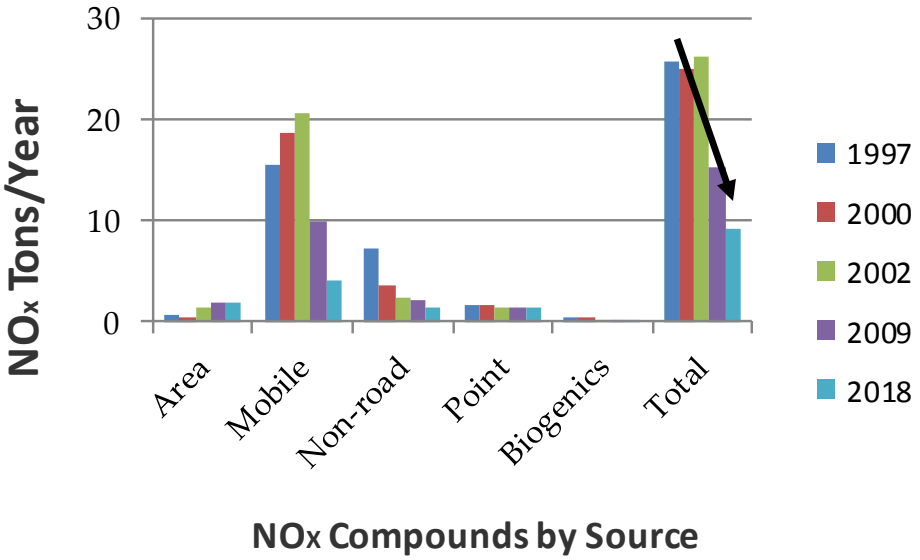


Figure 4. Inventoried and Projected Nitrous Oxides Emissions by Source (tons/year), 1997-2018

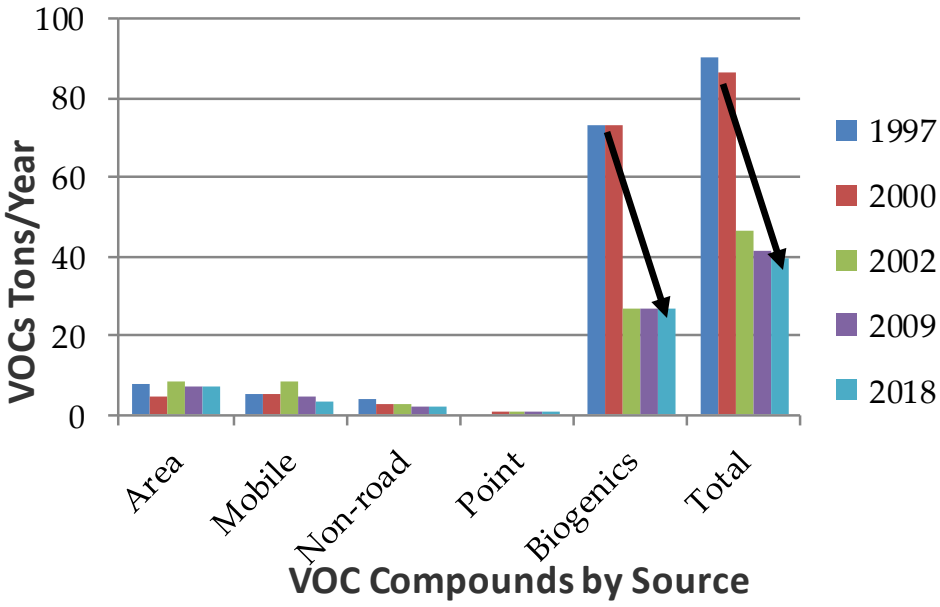


Figure 5. Inventoried and Projected Volatile Organic Compound Emissions by Source (tons/year), 1997-2018

Emissions from Point Sources

Fair

Trend: improving

Why is this indicator important?

Emissions from point sources in Orange County are relatively small compared to emissions from other sources. Nevertheless, it is important to track point source trends due to the possibility of concentrated impacts in one area or cumulative impacts on a surrounding region. Tracking the pollutants included in this indicator is important because of their potential impact on human health and local ecosystems.

How is this indicator measured?

The NCDAQ tracks the point sources that discharge pollutants in Orange County. These pollutants include:

- Carbon monoxide (CO);
- Nitrogen oxides (NOx);
- Volatile organic compounds (VOCs);
- Particulate matter (PM) of varying sizes (e.g., PM10 are up to 10 micrometers in size; TSP = total suspended particulate matter)
- Sulfur dioxide (SO_2); and
- Approximately 180 other potentially dangerous compounds.

Carbon monoxide, NOx, and VOCs are discussed in the Emissions Estimates for Ozone Formation section. Sulfur dioxide is a gas that is released when fuels such as coal and oil are burned. Particulate matter are particles such as dust, dirt, soot, smoke, and liquid droplets. Significant health risks are associated with PM2.5 ("P-M-two-point-five," which is particulate matter that behaves like an ideal particle that is 2.5 microns in diameter) because these fine particles can penetrate deeply into lung tissue and cause or contribute to heart and lung disease and strokes, among other illnesses.

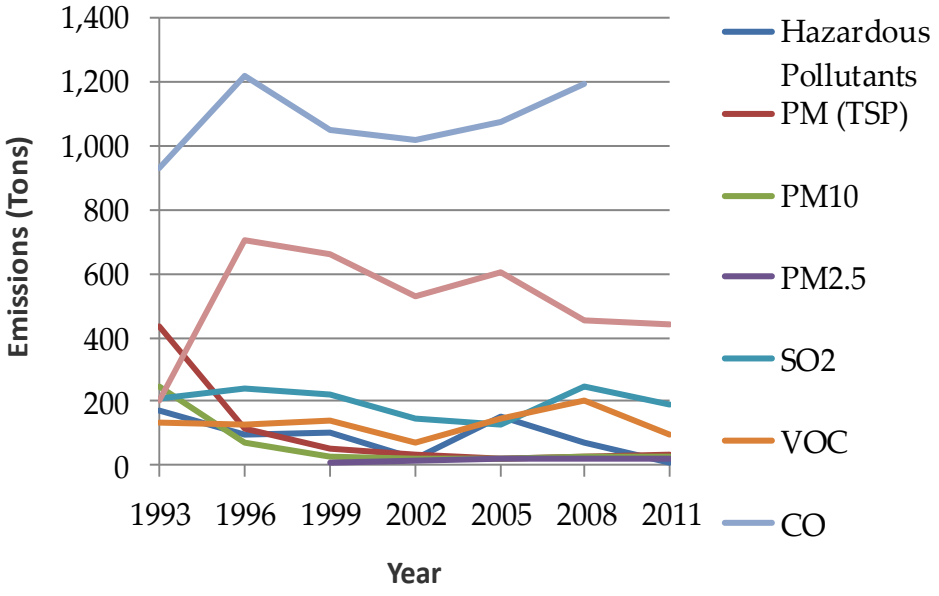


Figure 6: Point Source Air Pollution (tons/year), 1993-2011

What is the trend in Orange County?

The number of facilities reporting emissions decreased from 18 in 1999 to 4 in 2011, the most recent data available. In general, this reduction in facilities is related to decreases in most pollutant emissions. Figure 6, however, shows the trend is mixed in point source pollution reduction.

Emissions of CO, SO_2,VOC, and hazardous pollutants have decreased since 2008. Emissions of TSP, PM10, and PM2.5 have increased slightly over the past decade, and although NOx has decreased since 2005 the reductions have been small.

Sources:

NCDENR Department of Air Quality
https://xapps.ncdenr.org/aq/ToxicsReport/toxrpt.jsp?ibeam=true

NCDENR Division of Air Quality, North Carolina Point Source Emissions Report
http://xapps.ncdenr.org/aq/ToxicsReport/toxrpt.jsp?

"June Morning" by Valerija Gilfillen

How can Orange County improve?

To support a sustainable future, Orange County should:

- Collaborate with its citizens and with civic organizations that are organizing for clean energy policy at the local, state, federal, or international level;
- Partner with Duke Energy and Piedmont Electric Membership Corporation to create an affordable, county-wide, on-bill financing option for energy efficiency upgrades for residential and commercial customers;
- Incentivize green building techniques by offering reduced building permit fees for commercial and residential buildings that achieve demonstrable energy savings;
- Foster increased deployment of clean, renewable energy, by supporting efforts like *Solarize Orange*, and finding new ways to make County-owned property available for clean energy production;
- Continue to reduce the amount of solid waste sent to landfills by implementing a "pay-as-you- throw" system and stop trucking Orange County solid waste to the Durham transfer station; and
- Encourage more coordinated distribution of locally-grown foods to commercial and residential customers.

Ozone Exceedances

Fair

Trend: improving

Why is this indicator important?

Ground-level ozone pollution is a major concern in Orange County. This harmful pollutant is created by a chemical reaction between sunlight, nitrogen oxides, and volatile organic compounds. Ground-level ozone can trigger health problems, including asthma and permanent lung damage, and can damage plants and ecosystems. Ground-level ozone should not be confused with "good" stratospheric ozone, which is located in the upper atmosphere and protects us from the sun's harmful radiation.

"Clouds over St. Mary's" by Valerija Gilfillen

How is this indicator measured?

Because urban non-attainment status is assessed at the Metropolitan Statistical Area (MSA) level, Orange County's official ozone status is generated by assessments of the eight ozone monitors located throughout the Triangle region (Figure 7). Based on US Environmental Protection Agency (US EPA) monitoring protocols for urban areas, the NCDAQ currently does not operate an ozone monitor in Orange County. Therefore, statistics from individual monitoring stations surrounding Orange County provide a general profile of ozone levels in our area. When an ozone monitor records levels exceeding federal standards, a threshold exceedance is registered for the entire area.

In March 2008, the EPA adjusted federal standards for ozone from 0.08 parts per million (ppm) over an 8-hour average to the more protective 0.075 ppm. The US EPA based this decision upon research indicating that exposure to ozone at levels below the previous standard can have serious negative health effects. The US EPA is under court order to further review this latest standard for possible revision by the fall of 2015.

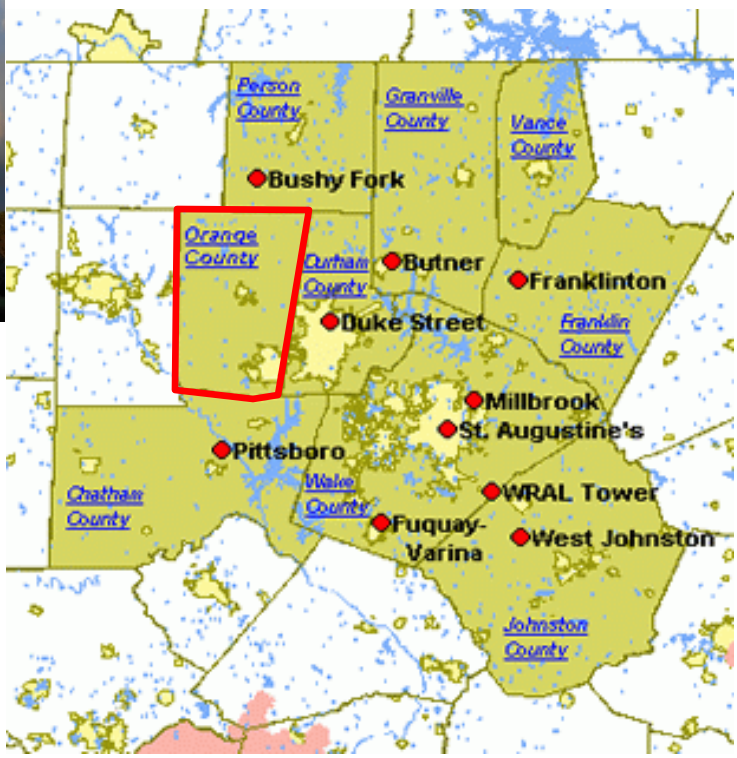


Figure 7: Ozone Monitor Locations in the Triangle Region, 2014

Additionally, EPA designates MSAs as either in *attainment* or *nonattainment* of the federal ozone standards. Once an MSA is designated as nonattainment it may be re-designated as a maintenance area if it is reclassified as being in attainment of the 8-hour ozone standard.

What is the trend in Orange County?

In April 2004, the US EPA designated Orange County and seven other counties comprising the Triangle MSA as a nonattainment area for ozone. In 2007, the Triangle was upgraded to a maintenance area. This action occurred under the previous air quality standards. With more protective standards in place and the standards under review for possible revision, Triangle region governments must continue to develop policies and programs to mitigate ozone and remain in attainment.

Figure 8 shows the variation in the number of ozone nonattainment days that occurred from 1997 to 2012. The majority of ozone exceedance days occur during summer months, when high temperatures yield conditions favorable for ozone-generating reactions. The ozone concentration value used in determining the attainment status for Orange County (and elsewhere in North Carolina) has shown a variable decrease since the late 1990s.

Part of that decrease is due to changes in power plant design, new control equipment installation, and industrial operations moving outside of Orange County. Other significant contributions are changes in vehicle fleet characteristics, lower emissions from newer vehicles, and benefits from using ultra-low-sulfur gasoline (which helps catalytic converter operation).

Sources:
NC DENR Division of Air Quality
http://www.ncair.org/monitor/data/o3design/

State of North Carolina Implementation Plan
http://www.epa.gov/region4/air/sips/

Orange County Greenhouse Gas Emissions and Inventory Report:
http://www.co.orange.nc.us/ercd/greenhousegas.asp

How can Orange County improve?

To support a sustainable future, the County should:

- Stringently follow the NC State Implementation Plan (SIP) to maintain ozone standards through 2017 in order to remain in attainment;
- Work towards the installation of an ozone monitor in Orange County that will yield more accurate, local air quality data; and
- Work with Carrboro, Chapel Hill, and Hillsborough to update the 2005 Greenhouse Gas Emissions Inventory and Forecast for Orange County, and assess our progress toward the emissions-reduction goals recommended in the 2005 Greenhouse Gas Emissions report.

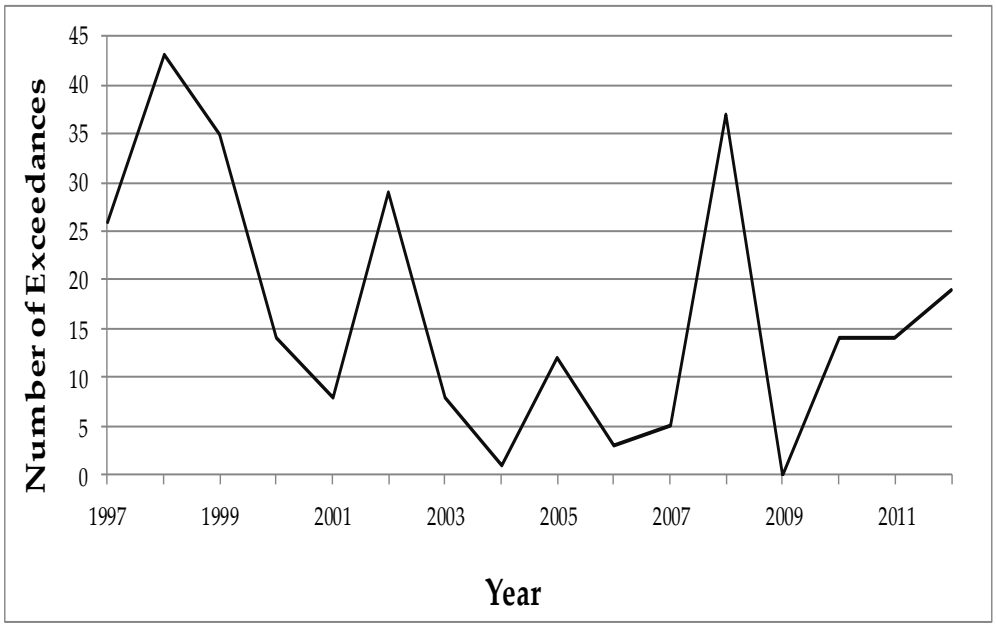


Figure 8: Ozone Exceedance Days (per year), 1997-2012

Daily Vehicle Miles Traveled

Fair

Trend: declining

Why is this indicator important?

Daily vehicle miles traveled (DVMT) represents vehicle use on all public roads. Analysis of these data is critical for estimating the impact of vehicle emissions on air quality within the county.

The number of road lane miles represents the overall capacity of the transportation system. Additional lane miles can result in higher DVMT and increased vehicle emissions. However, new lane miles that allow freer flow of traffic can also potentially reduce congestion and associated emissions.

Triangle traffic on I-40

How is this indicator measured?

DVMT data from 1990 to 2003 was gathered from the North Carolina Department of Transportation (NC DOT). The 2006 DVMT estimate was taken from the North Carolina Office of State Budget and Management. The 2012 estimate was included in the Triangle J Council of Government's Conformity Analysis and Determination Report (2013).

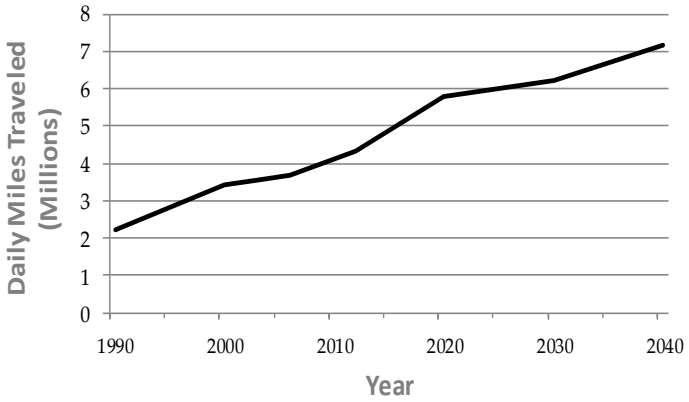


Figure 9: Actual and Projected Total Annual Vehicle Miles Traveled, 1990-2040

What is the trend in Orange County?

Figures 9 and 10 indicate that total DVMT continues to rise in the county, and that DVMT projections reflect that trend. Based on past trends—expected population and job growth and development patterns—there will likely be ongoing increases in DVMT unless comprehensive measures are enacted to reduce single-occupant vehicle trips.

ORANGE BUS

Orange County Public Transportation

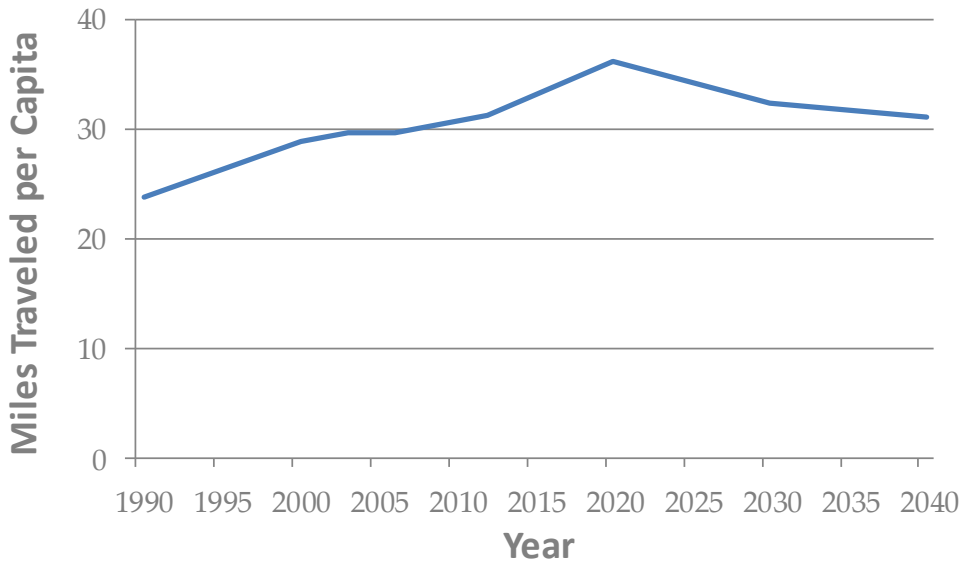


Figure 10: Actual and Projected Daily Vehicle Miles Traveled per capita, 1990-2040

How can Orange County improve?

To support a sustainable future, Orange County should:

- Work to reduce vehicle trips by increasing telecommuting, co-locating jobs and residences, and by developing walkable, bicycle-friendly, and mass transit-oriented communities;
- Study commuting patterns in Orange County and develop new transit options based those patterns
- Encourage and offer incentives for regional employers to promote telecommuting and carpooling to take cars off the road;
- Improve transportation efficiency by promoting more public transportation, ride sharing, and alternative transportation (e.g., bikes, walking);
- Improve public education and advertising of existing transit services; and
- Work with nearby jurisdictions to integrate County plans with regional goals and objectives for an intermodal system to meet projected travel demand that reduces congestion and reliance on single-occupancy vehicles.

Sources:

- 2006 estimate of total DVMT from NC Office of State Budget and Management, NC Department of Transportation
- 2012 DVMT estimate from Federal Highway Administration
- 2012 population estimate from American Community Survey
- Projections from Triangle J COG Conformity Analysis and Determination Report http://www.triangleair.org/topics.htm#transconf

Commuting Patterns and Modes

Fair

Trend: declining

Why is this indicator important?

Time spent driving to work directly correlates to air pollution emissions. Because the dominant mode of transportation is the single-occupancy motor vehicle, statistics on average travel time for single occupancy commuters is an important measure of air pollution. On the other hand, using public transportation reduces fossil fuel consumption and traffic congestion. Therefore, tracking the use of alternative transportation modes for commuting can be used to gauge the success of policies that aim to encourage behaviors that reduce transportation-related air pollution. These policies can be further evaluated by examining overall bus ridership figures.

How is this indicator measured?

The US Census Bureau and American Community Survey provide data for average commuting times and the means by which Orange County residents travel to work. Bus ridership data is acquired from three agencies that operate bus routes serving Orange County residents: Triangle Transit, Chapel Hill Transit, and Orange Public Transit. (The Robertson Scholar's Express Bus, once operated by Duke Transit, is now operated by Triangle Transit.) Bus ridership is measured by the number of trips traveled by bus, defined as each time a passenger boards a bus. However, not all data is available; for instance, most ridership data for Robertson Scholars bus use in 2009 is unavailable.

What is the trend in Orange County?

Commuting time for Orange County workers continues to increase (Figure 11). Although single-occupancy vehicles remain the dominant mode of transportation for Orange County commuters, the percentage of workers driving alone is lower in Orange County than the state average (Figures 12 and 13). In contrast, the percentage of commuters using public transit, walking/biking, and working at home in Orange County is significantly higher than elsewhere in the state.

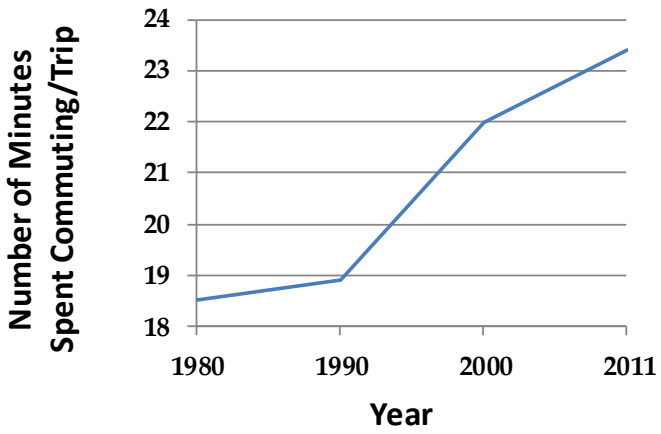


Figure 11: Average Travel Time to Work in Orange County

Overall bus ridership in the county has increased fairly steadily since 2004. Chapel Hill Transit (CHT) saw a 40 percent increase in ridership in 2002 with its move to a fare-free system (not shown in Figure 14 on Page 18). Since 2008, CHT ridership has hovered around 7 million. Triangle Transit has experienced steady growth as a result of increased service hours for the 500/550 route from Raleigh to Chapel Hill. Increased demand is likely due in part to the recent spike in gas prices. Demand was significant enough from 2004-2006 for Triangle Transit to add two additional routes in Orange County, the 420 from Hillsborough to Chapel Hill and the 500/550 from Raleigh to Chapel Hill. A new Orange-Durham Express bus is expected to begin sometime in 2014. Orange Public Transit (OPT) and Triangle Transit ridership remains low but steady.

Some route changes and service changes to certain Triangle Transit Routes have been required since peak traffic flow has caused problems with on-time service. The most observable indication of this type of change is BOSS (Bus on Shoulder System).

The four transit agencies are collaborating on efforts to improve the linkages between Triangle Transit, OPT, and CHT and provide service to all of Orange County's communities.

Sources:

- NC DOT Bus on the Shoulder System http://www.ncdot.gov/nctransit/boss/%20
- American Community Survey http://www.census.gov/acs/www/

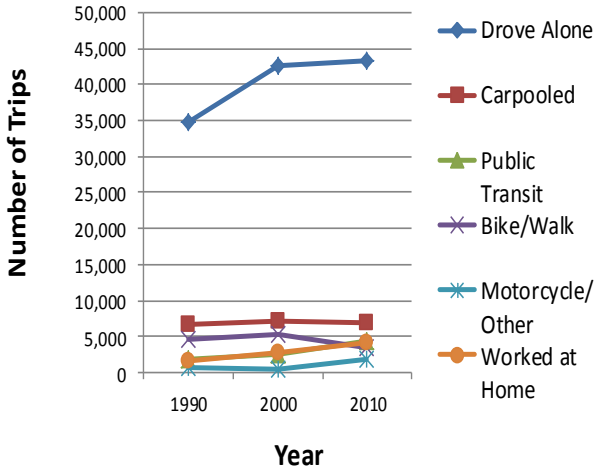


Figure 12: Means of Transportation to Work in Orange County, 1990-2010

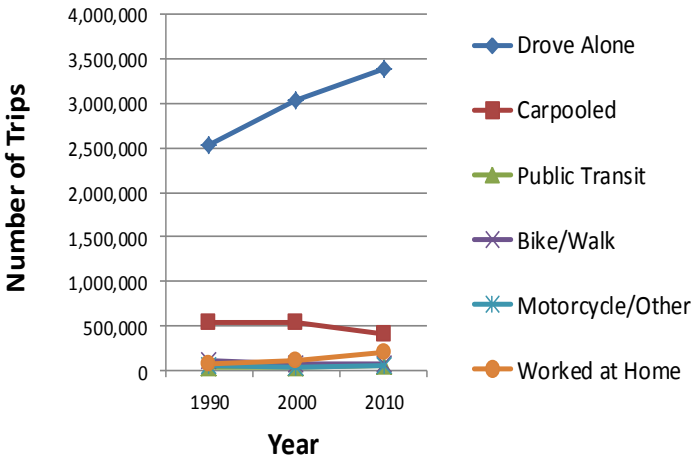


Figure 13: Means of Transportation to Work in North Carolina, 1990-2010

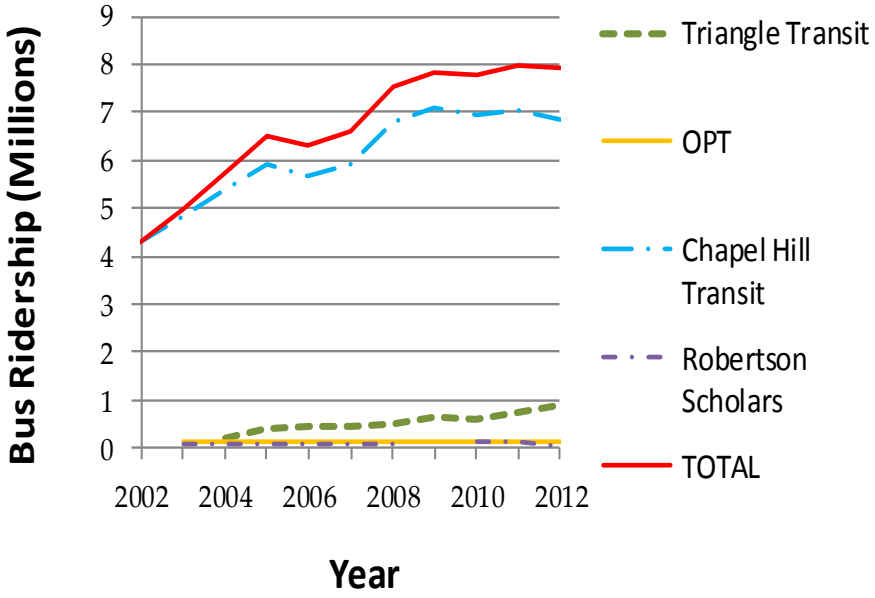


Figure 14: Bus Ridership by Provider, 2002-2012

Innovations in Energy Conservation by Orange County Government

Over the years Orange County has participated in multiple efforts to promote and practice responsible environmental stewardship. In 1994 the County adopted a sustainability policy (*Toward a Sustainable Community*), and worked with a citizen committee that developed a *Shaping Orange County's Future* report with 44 indicators of sustainable practices. Subsequent reports refined those indicators and identified trends and challenges.

In 2006 Orange County examined its own operations and adopted an Environmental Responsibility Goal for County government. The goal included 10 objectives designed to help County government become a more responsible steward of the environment and to lead by example. Toward that end, the County adopted energy, water and vehicle fuel conservation policies for government buildings, facilities, and vehicles. To help monitor and implement those policies, the County formed a team of representatives from each County department—the Environmental Stewardship Action Committee.

In 2011 the County began detailed monitoring of its energy, water, and fuel consumption, and providing annual reports to the board of county commissioners. The annual reports include a "scorecard" on progress toward meeting certain goals and objectives. In 2013 the County implemented new guidelines for lighting, heating, and cooling its buildings, including windows and landscaping.

Utility and Fuel Management

The Orange County Assets Management Services Department (AMS) is responsible for managing utilities (electricity, natural gas, water/sewer, propane, fuel oil) and fuel used by County facilities, vehicles, and equipment. Within AMS, an Energy Management Team was formed to:

- Provide recommendations on how to implement the County's energy, water and fuel conservation policies;
- Document, analyze, and report energy, water, and fuel use to County stakeholders annually;
- Educate County stakeholders about energy, water, and fuel use and conservation practices;
- Oversee energy and water systems, maintenance procedures, and equipment to achieve optimal and consistent reductions in use ;
- Oversee the use of fuel-efficient vehicles, maintenance procedures, and equipment to achieve optimal and consistent reductions in fuel used by County vehicles and equipment;
- Manage utility and fuel use to achieve the following goals established in June 2011:
  - ⇒ Reduce cumulative energy use by 20 percent by FY 15 (from FY 10 baseline); and by an additional 10 percent by FY 17.

    [*As of June 2013 the County had reduced cumulative energy use by 14.3%]*
  - ⇒ Reduce cumulative fuel use by *10 percent* by FY 15 (from FY10 baseline), and by an additional 5 percent by FY 17.

    [As of June 2013 the County had increased fuel use by 8.1% due to more vehicles on the road and more miles driven by the Sheriff's Dept., Emergency Services, and Orange Public Transportation. Other departments, however, had reduced fuel use by 13%.]

Lighting at County Buildings and Facilities

The County installs energy efficient lighting in new facilities, and when feasible works to retrofit light fixtures at older buildings and facilities. In 2013-14 the County replaced the deck lighting with LED fixtures at its Eno River Parking Deck. The cost will be paid back from annual savings in about 5 ½ years. LED lighting was also installed at the Whitted Building for the new board of county commissioners meeting room.

Geothermal Heating / Cooling of Buildings

The County recently installed geothermal heating and cooling systems to replace conventional HVAC systems at many older buildings in Hillsborough, including the jail and the courthouse. The geothermal system uses the Earth as a heat source in winter and a heat sink in summer, and distributes heated and cooled air as needed. In general, ground temperatures remain constant at approximately 55°F, thus allowing the system to use less energy to heat and cool spaces to a comfortable level.

Geothermal wells being installed ay the Farmers Market Pavilion

Geothermal systems save 30-35 percent in energy use annually over a conventional system, reduce greenhouse gases released to the atmosphere, lower overall maintenance requirements, are less costly to operate, and eliminate noisy outdoor equipment. A geothermal system is slightly more expensive to install over a conventional system, but that cost is often recovered by energy savings within 5-10 years.

Beginning in 2014 the County could reduce energy use by 2,025 MMBTUs and save $8,000 annually. Additional savings will be realized from improved insulation as part of roof replacements at two buildings and the installation of digital controls at four locations. County employees will also begin receiving "Know Your Building" education and outreach.

Landfill Gas Project

Since 2000 Orange County has worked with the University of North Carolina at Chapel Hill (UNC) on a project to extract and collect methane gas from the Orange County landfill and convert it into electricity for UNC's Carolina North campus. In phase one (2012) the collection system, extraction wells, and flare station were installed to burn methane generated by the decomposing waste rather than allowing the gas to vent directly into the atmosphere. Methane is a "greenhouse gas" that is 25 times more potent than carbon dioxide in trapping heat.

In phase two , UNC installed a three-mile long pipe line from the landfill to Carolina North. Gas that has been cleaned up at the landfill flare station is piped from the landfill to a power generation system located on the Carolina North campus. The generator began operation in February 2013.

The total emissions reduction as a result of the project is equivalent to annual greenhouse gas emissions from 8,000 passenger vehicles or carbon sequestered annually by 9,000 acres of pine forest.

Laying gas pipeline through trash at the closed landfill

Emerging Issue: Plug-in Electric Vehicle Infrastructure

Emerging

Overview

Most analysts agree that converting from internal combustion automobiles to plug-in electric vehicles (PEV) will go a long way toward improving air quality. PEV adoption forestalls degradation of air quality, since the production of electricity produces less air pollution than burning fossil fuels in most internal combustion engines. PEVs are gaining traction in the US automotive market.

In 2013, the NC Plug-In Electric Vehicle (PEV) Taskforce, a joint initiative of the NC Department of Commerce and Advanced Energy (a NC-based non-profit organization founded to research energy conservation initiatives), published the NC PEV Readiness Initiative report entitled, *Plugging-in from Mountains to Sea* (Figure 15).

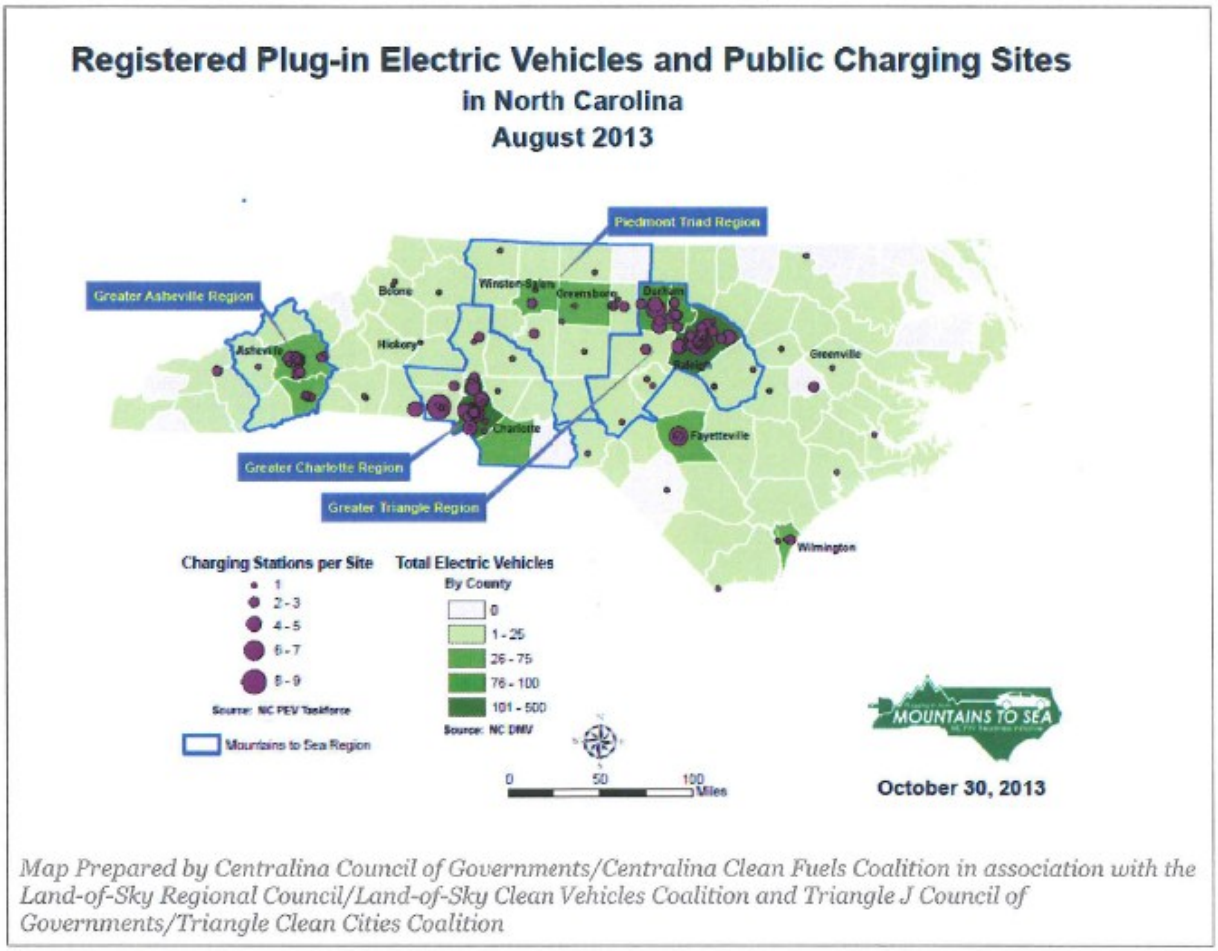


Figure 15: Registered Plug-in Electric Vehicles and Public Charging Sites in NC, 2012
Source: *Plugging-In from Mountains to Sea* report, 2013

PEV Usage in Triangle Region and Statewide
As of August 2012, the NC Division of Motor Vehicles' (NC DMV) records documented 291 registered electric vehicles in the seven-county region that includes Moore, Lee, Chatham, Orange, Durham, Wake, and Johnston counties. That accounted for 40 percent of the total 719 electric vehicles registered in all of North Carolina at that time.

Using NC DMV's data on the number of registered PEVs in North Carolina as a baseline, the Electric Power Research Institute (EPRI) extrapolated PEV adoption for the next 20 years. They estimated by 2020 there could be 22,000 registered electric vehicles in the Triangle, and as many as 158,000 by 2030. Although EPRI's model could have a high degree of error (estimated to be as high as a factor of ten) due to the uncertainty of future petroleum prices, analysts agree that the PEV market in North Carolina will grow slowly over the next several years before increasing dramatically in the years leading up to 2030.

A number of factors contribute to the rapid PEV adoption in the Triangle area. For one, the Triangle population is highly educated and environmentally and socially conscious, traits that contribute to the early adoption of new technology. Additionally, there are high levels of hybrid vehicle ownership in the region, engaged electrical utilities and cooperatives, and proactive municipal and regional governments. These factors are predicted to be crucial to PEV adoption. Finally, according to EPRI's 2012 NC PEV and EVSE Penetration Estimate, the greatest gains in adoption will occur in the metropolitan regions along the I-40 and I-95 corridors, which run through and border the Triangle, respectively.

Charging Station Infrastructure Needs

As of this report's publication, there were 288 public and private non-residential charging stations in the Triangle region, counting each connection cord as a single station. 152 of these stations are accessible to the public and 112 are maintained by private organizations for use by their employees. These 288 charging stations represent roughly 54 percent of the state's total of 531 stations. **As a result, the EV Casebook recently ranked the Triangle as one of the top cities in the world for EV readiness**.

For most PEV drivers, the majority of charging takes place at home, typically overnight. On the other hand, many employees report taking advantage of charging stations at work. Employers who install stations in their parking lots view this service as a fringe benefit for their employees. Vehicle charging has not yet emerged as a standalone business.

Public charging stations are to date less utilized than private stations, perhaps due to the length of time required to charge a vehicle. Until fast-charging stations are more widespread, municipal governments must weigh the costs and benefits of providing charging stations to the public. Is encouraging early adoption of PEVs worth the capital and maintenance costs?

Building the Triangle's charging station infrastructure will require a vast network of stations, since, unlike the other metropolitan regions in the state that are anchored by one major city, the Triangle is polycentric in nature, with huge numbers of commuters and dispersed population agglomerations. However, it will be crucial to build a charging station infrastructure, accompanied by a thoroughly-considered public information campaign, in order to reduce "range anxiety" and encourage PEV adoption in the region and entire state.

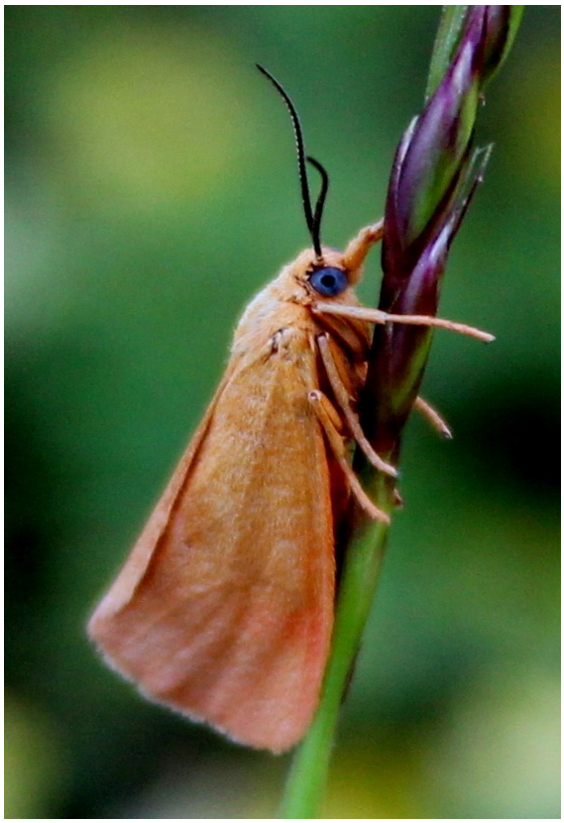
Sources:

- Plugging-in from Mountains to Sea, NC PEV Readiness Plan http://www.advancedenergy.org/portal/ncpev/
- Advanced Energy http://www.advancedenergy.org/index.php

PEV charging station at the County's Eno River Parking Deck

Land Resources

Orange County is home to a wealth of biological resources within a variety of natural communities, from the forested hills known as "monadnocks" (such as Occoneechee Mountain) to the bottomland swamp forests of the Triassic Basin (like the Mason Farm Biological Reserve). Poorly-planned development can devour valuable natural areas and fragment the landscape, thereby disrupting the habitats of native plants and animals. It is, therefore, critical for Orange County to work with landowners and other partners to identify, monitor, and protect its most significant natural areas and native species.



"Butterfly Blues" by Kirby Lau

"Snack!" by Angie Thompson

Land Resources Indicators

This section of the report aims to evaluate land conservation and stewardship efforts by the many entities working in Orange County. The **Acres of Protected Land** indicator shows the cumulative efforts of local governments, land trusts, and other private conservation-minded organizations. The **Acres of Protected Natural Heritage Areas** is a subset of the protected land figures, tracking the protection of highly important natural areas recognized by the NC Natural Heritage Program. The **Acres in the Present Use Value Program** tracks the amount of land receiving special tax treatment as agricultural, forest, or horticultural land. Finally, the **Status of Rare Plants and Animals** presents current information for Orange County from the NC Natural Heritage Program.

New to this edition of the report are data trends for solid waste disposal and recycling as part of **Solid Waste Management**, and farmland acres enrolled

in the County's **Voluntary Agricultural District** program. This section also provides an update on **Invasive Terrestrial Plants and Animals** and the **Land Application of Biosolids** on farmland.

"Butterfly on Flowering Quince" by Velerija Gilfillen

What can you do to improve the quality of Orange County's land?

Garden without conventional fertilizers and pesticides:

- Advice from the UNC Botanical Garden http://ncbg.unc.edu/environmentally-responsible-gardening-practices/
- Importance of building soil fertility http://www.thepermaculturepodcast.com/2012/the-soil-food-web-with-jeff-lowenfels/
- Purchase mulch and compost from Orange County http://www.co.orange.nc.us/recycling/earthproducts.asp

Plant species native to North Carolina:

- Information from the NC Native Plant Society http://www.ncwildflower.org/natives/natives.htm
- Importance of native species http://www.thepermaculturepodcast.com/2012/interview-dr-doug-tallamy-author-of-bringing-nature-home/
- Certify a garden with National Wildlife Federation http://www.nwf.org/How-to-Help/Garden-for-Wildlife/Create-a-Habitat.aspx

Compost your food waste:

- Composting demonstrations and general info. http://www.growingagreenerworld.com/episode225/ http://orangecountync.gov/recycling/compost.asp https://www.bae.ncsu.edu/topic/composting/
- Compost indoors (vermicomposting) http://www.bae.ncsu.edu/topic/vermicomposting/
- Take your food waste to the Walnut Grove Church Road Convenience Center to be composted http://www.orangecountync.gov/recycling/centers.asp

Enroll your land in the County's preservation programs:

- Present Use Value Program — Orange County Tax Assessor's Office: 919-245-2100
- Voluntary Agricultural District Program http://www.co.orange.nc.us/ercd/apb_voluntary_agriculture_districts.asp

Consider a conservation easement for your property:

- Orange County Lands Legacy Program http://www.co.orange.nc.us/ercd/lands_legacy.asp
- Triangle Land Conservancy http://triangleland.org/
- Eno River Association http://www.enoriver.org/

Dispose of your garbage properly and recycle as much as possible:

- Recycle and dispose of hazardous waste, electronics, metal, wood, and appliances at one of the County's five Solid Waste Convenience Centers http://www.co.orange.nc.us/recycling/hhw.asp
- Don't put any waste into storm drains

Support local farms through the farmer's markets:

- Carrboro Farmers Market http://www.carrborofarmersmarket.com/
- Chapel Hill Farmers Market http://www.thechapelhillfarmersmarket.com/
- Eno River Farmers Market http://www.enoriverfarmersmarket.com/
- Hillsborough Farmers Market http://www.hillsboroughfarmersmarket.org/Pages/default.aspx

Visit local parks and nature preserves:

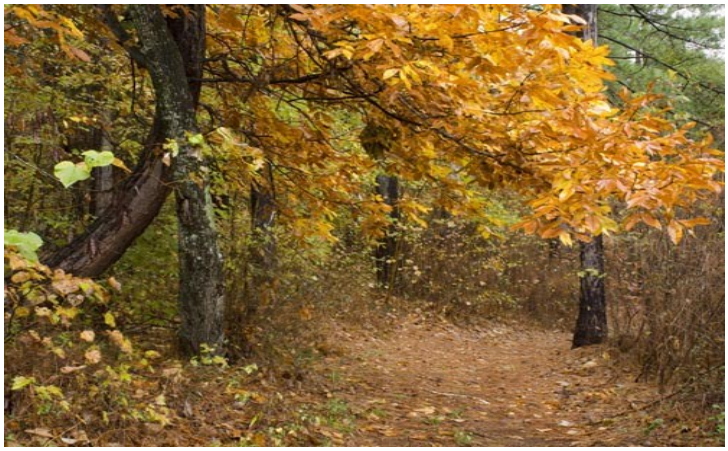
- Locate a park within and outside Orange County http://server2.co.orange.nc.us/parklocator/ http://ncparks.gov/Visit/parks/by_activity/main.php
- Stroll around the NC Botanical Garden http://ncbg.unc.edu/visit/
- Hike or fish in Duke Forest http://www.dukeforest.duke.edu/
- See how biking trails connect in Orange County http://www.ncdot.gov/travel/mappubs/bikemaps/default.html

Acres of Protected Land

Why is this indicator important?

Lands that are protected from future development provide innumerable benefits for the people of Orange County. These lands are community assets with intrinsic value, but they also provide valuable services. Large, undisturbed, natural areas protect our air and water quality, provide habitat for native plants and animals, and serve as recreational and scenic areas for county residents. Protected areas also provide a carbon sink and help trap greenhouse gases that cause climate change.

These values are recognized in Orange County's 2030 Comprehensive Plan, (Objective NA-1), which calls upon the County to "conserve high-priority natural areas and wildlife habitats, including wetlands, rivers and streams, floodplains, steep slopes, prime forests, wildlife corridors, and other critical habitats."



"Rainy Day on the Trail" by James Burton

The most effective ways to protect land for conservation purposes is to acquire the land and manage it properly or to work with the current landowners on restricting future development with a conservation easement. Conservation easements

"White Flowers" by Michelle Cook

are voluntary, legal agreements between the landowners and a qualified conservation organization (e.g., land trust) or local government. The landowners give up certain rights to develop the land in the future, and are usually compensated with tax benefits or partial payment for this long-term commitment.

How is this indicator measured?

Orange County DEAPR maintains a database of protected lands in Orange County. Appendix 2 lists the different entities working to protect land over the past few decades and Figure 16 shows the amount of land considered to be permanently protected or partially protected.

"Permanently protected" lands are those areas most likely to remain intact and safe from future development. They include lands owned by conservation organizations and lands protected by conservation agreements (e.g., easements).

"Partially protected" lands are intended to remain undeveloped, but they lack binding agreements for permanent protection (e.g., Duke Forest, UNC's Mason Farm Biological Reserve, and most local government parks and open space properties).

What is the trend in Orange County?

An active collaboration of private landowners, local governments, and non-profit organizations helps protect important natural resource lands in Orange County. The County became a full partner in this effort when it established the Lands Legacy Program in 2000.

Since the 2009 State of the Environment report, another 1,741 acres were protected in Orange County. Those additional protected areas include 606 acres by Triangle Land Conservancy for the Brumley Forest Preserve, 350 acres by the Eno River Association, and a 258-acre portion of Carolina North by the University of North Carolina. An additional 487 acres of prime farmland and natural open space lands were protected by Orange County with permanent conservation easements [See Appendix 2].

There are 24,648 acres of protected land in Orange County— 9.6 percent of the county's total land area. Of that total area, 14,473 acres (5.8% of the county) are considered "permanently protected." Although that falls short of the CFE's "10 percent by 2010" goal, there has been considerable progress during a period where funding for land conservation was scarce. But there is still considerable more work to be done— many important natural and cultural resource lands remain entirely unprotected.

"Dragonfly" by Darren Strickland

Source: Orange County DEAPR
http://www.co.orange.nc.us/deapr/

How can Orange County improve?

To support a sustainable future, Orange County should:

- Work with its conservation partners to achieve the protection of at least 12 percent of the county land area by 2020— 8 percent of which should be permanently protected;
- Continue to collaborate with private land-owners and other conservation partners (e.g., land trusts, Duke University, UNC-Chapel Hill, State of NC, OWASA) to conserve high-priority natural areas and wildlife habitats including rivers and streams, floodplains, steep slopes, prime forests, and wildlife corridors;
- Develop a comprehensive conservation plan for achieving a continuous network of protected open space throughout the county, which addresses a) threats to important natural areas and wildlife habitat, b) connectivity between protected areas, c) coordination with neighboring counties, and d) sustainable management of critical natural resources; and
- Encourage the reforestation of land, especially along streams and important wildlife corridors.

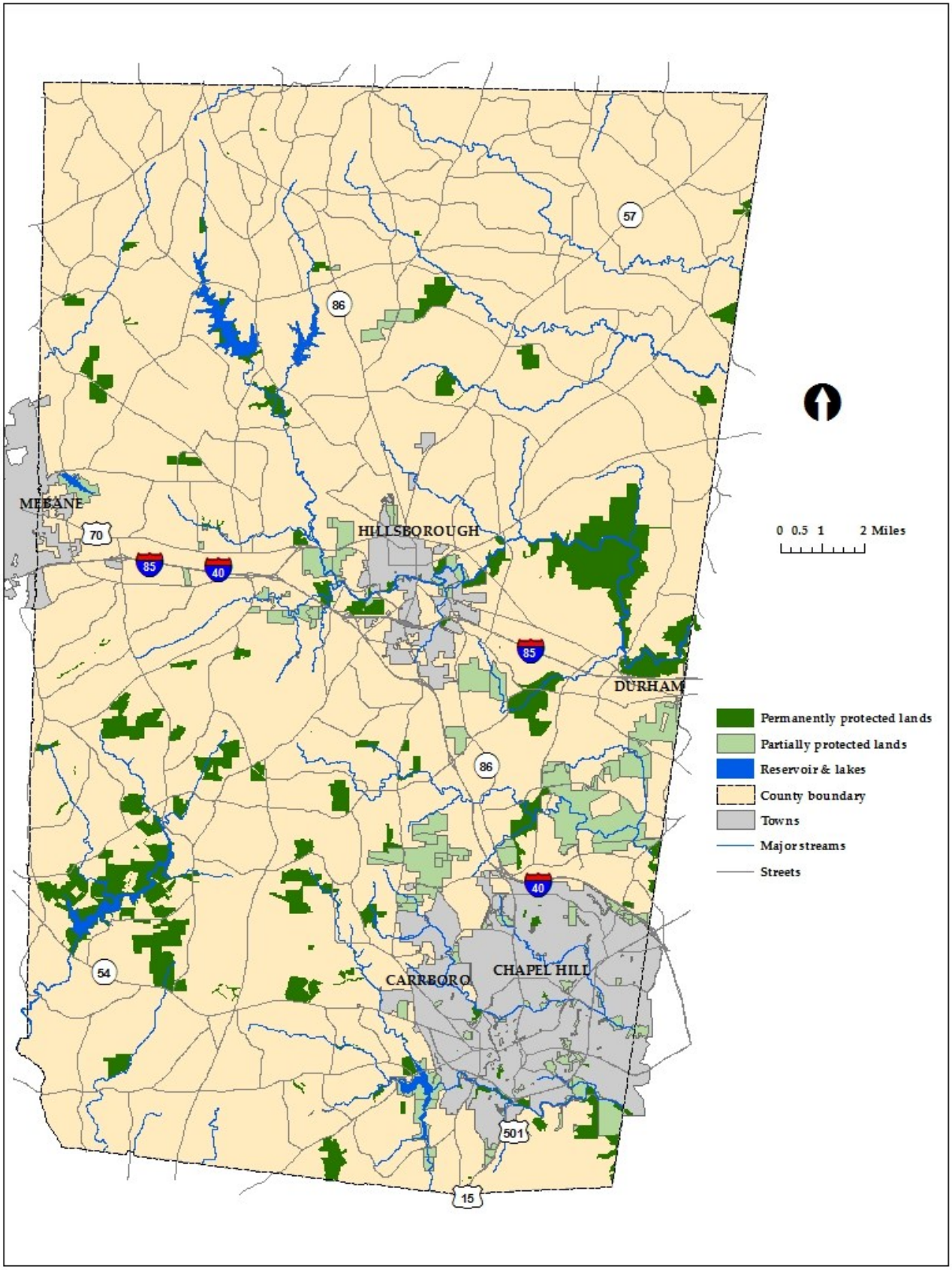


Figure 16: Protected Lands in Orange County, 2013

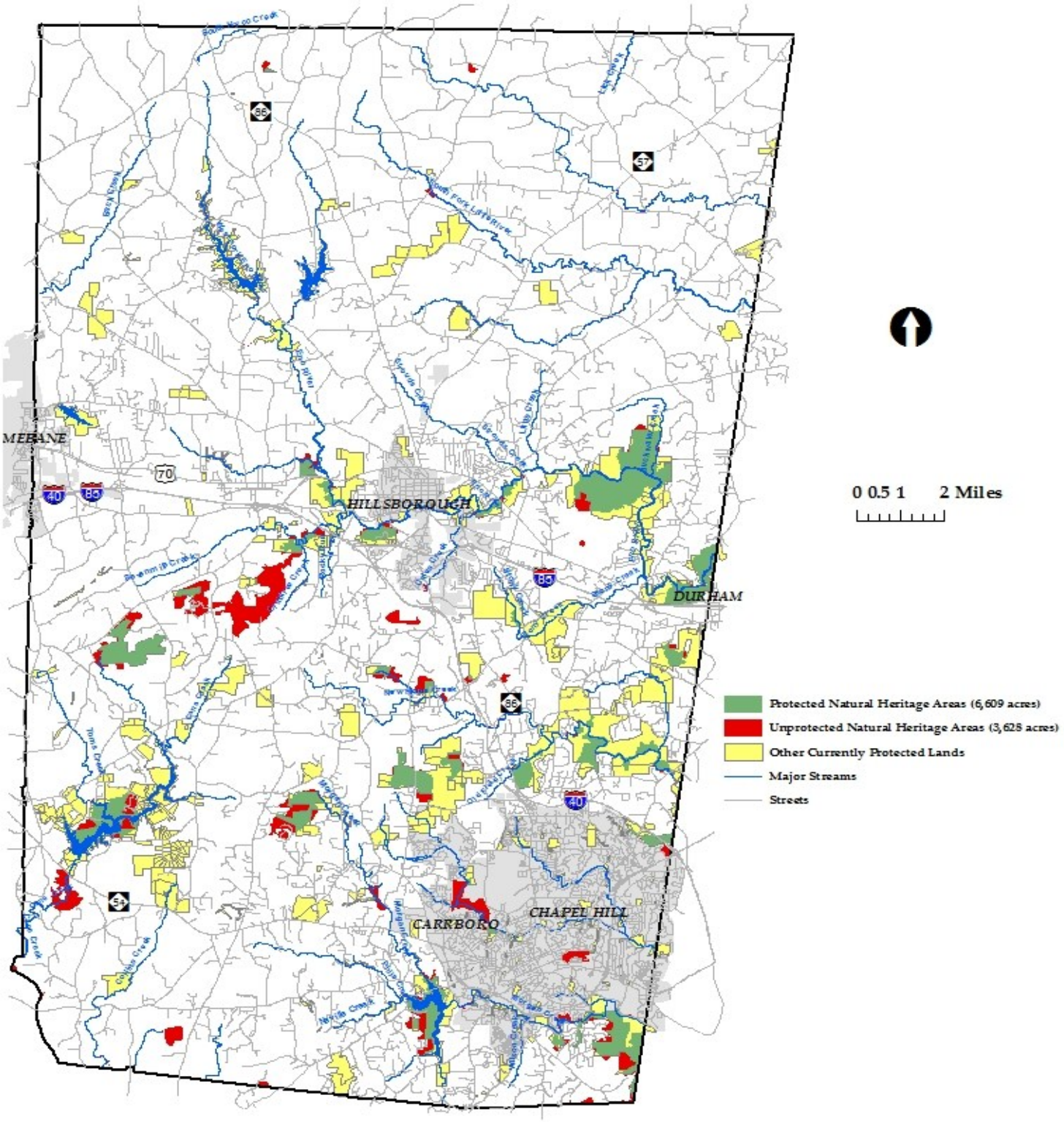


Figure 17: Protection Status of Natural Heritage Areas in Orange County, 2013

Acres of Protected Natural Heritage Areas

"Flight" by Kirby Lau

Why is this indicator important?

Orange County's 2030 Comprehensive Plan (Objective NA-15) calls upon the County to "protect land in and around biologically significant areas, and connections between these areas, to allow for the maintenance of native wildlife and plant populations and their functional relationships."

Natural areas provide habitat for native plant and animal species, protect our local waterways, and can also serve as recreational and scenic places for Orange County residents. The NC Natural Heritage Program recognizes highly significant natural areas as "Natural Heritage Areas." Many of these sites include unique and exemplary habitats that are critical to support rare animals, plants, and ecosystems.

How is this indicator measured?

The first *Inventory of the Natural Areas and Wildlife Habitats of Orange County, North Carolina* was published in 1988. That report identified significant natural areas recognized by the North Carolina Natural Heritage Program.

An update to the Orange County inventory was completed in 2004, resulting in adjustments to many site boundaries. Some Natural Heritage Areas were combined, others were reduced in size due to recent development activities, and some sites were enlarged to encompass newly-discovered areas of significance.

Further updates to the inventory have been made since 2004, but the County now maintains the data electronically rather than having to publish the reports in paper form.

"Golden Maple" by Anggie Thompson

Orange County, through its Lands Legacy Program, works with its conservation partners to monitor and protect Natural Heritage Areas. The County keeps track of the protection status of those areas with data gathered from organizations active in land conservation. Figure 17 shows those portions of Natural Heritage Areas that are protected to some extent and those areas that remain unprotected.

"Nature's Lace" by Kirby Lau

What is the trend in Orange County?

Since the last State of the Environment report (2009), another 403 acres of land within Natural Heritage Areas was permanently protected, including natural areas located *along New Hope Creek, Morgan Creek, and the Eno River*.

Figure 17 shows that well over half (65% or 6,209 acres) of the county's 10,234 acres of Natural Heritage Areas are either permanently or partially protected. Approximately 3,625 acres (35%) remain unprotected and at risk to future development.

Sources:
Orange County DEAPR
(http://www.co.orange.nc.us/deapr/)

NCDENR Natural Heritage Program
(http://www.ncnhp.org/)

How can Orange County improve?

To support a sustainable future, Orange County should:

- Ensure that any Natural Heritage Areas located on County-owned lands are protected with adequate ecosystem management and stewardship;
- Work with landowners and other partners to protect all Natural Heritage Areas of national or state significance;
- Discourage or prohibit development that would cause adverse impacts to Natural Heritage Areas;
- Collaborate with the NC Natural Heritage Program to support more frequent updates to the county's inventory of natural areas and wildlife habitat; and
- Inventory previously unexplored areas of the county to identify any potential new Natural Heritage Areas.

Acres in Voluntary Agricultural Districts

Why is this indicator important?

Orange County is losing active farmland. Although the number of individual farms in the county is actually *increasing*, the amount of acreage under cultivation is decreasing rapidly. This trend is alarming because farms are crucial to the rural character of the county, agriculture is vital to the local economy, and farms promote tourism-based economic development. From an environmental perspective, farming forestalls development, maintains scenic views, strengthens local food ways, and protects wildlife habitat. An active farm community also benefits the county because farms lessen the demand for residential infrastructure from local governments, thereby conserving land without the spending of public funds.

The importance of preserving agricultural land is espoused in the 2030 Comprehensive Plan (Objective NA-9), in which the County commits to encouraging "long-term productivity of farms and timberlands through best land-use management practices and conservation agreements."

How is this indicator measured?

The State of North Carolina authorizes counties to implement programs to encourage farmland preservation. Many NC counties have passed ordinances establishing Voluntary Agricultural Districts (VAD) and Enhanced Voluntary Agricultural Districts (EVAD). These ordinances call for the formation of Agricultural Advisory Boards, which review applications to establish and join districts. Districts may contain a single farm or two or more contiguous farms.

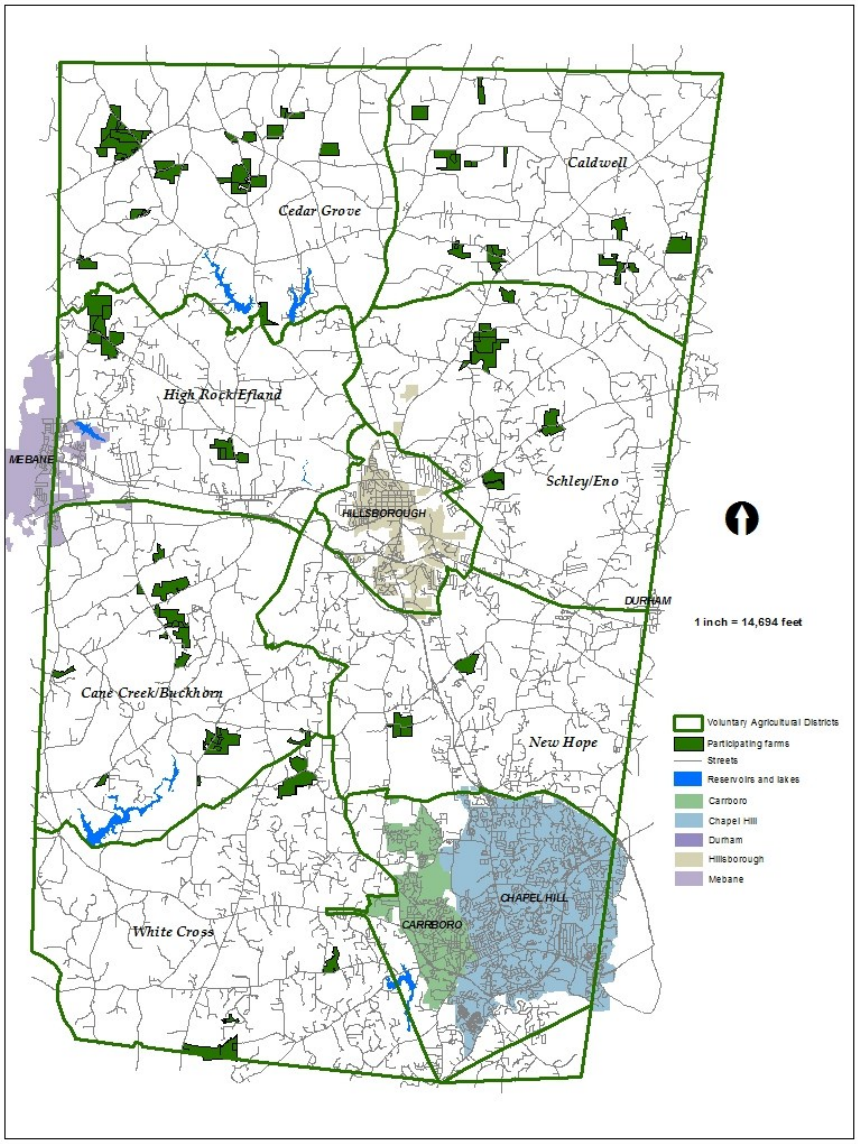


Figure 18: Voluntary Agricultural Districts, 2013

In addition to recognition of their farm, farmers enrolled in the VAD program enjoy increased protection from nuisance suits related to noise, odor, or slow-moving farm vehicles; waived fees for connections to County water and sewer systems; the right to a public hearing for public projects that may condemn their land; and greater access to local, state, and federal farmland preservation funds.

Farms enrolled in the EVAD program are also entitled to receive as much as a quarter of gross sales from non-farm products and still qualify as a "farm exempt" from zoning regulations. EVAD farms may also be eligible to receive a much higher percentage of cost-share funds under the Agriculture Cost Share Program (as high as 90 percent).

To be eligible for a VAD, a farm must 1) be participating in or eligible for the Present Use Value taxation program; 2) be managed in accordance with erosion control practices for highly erodible land, as defined by the Soil Conservation Service; and 3) be subject to a conservation agreement that prohibits development for at least ten years, except for an allowance of no more than three sub-divided lots. The landowner may revoke the conservation agreement at any time, at which point the farm would no longer qualify for VAD status.

To qualify for EVAD status, a farm must meet all the terms for VAD status, but the conservation agreement is irrevocable for ten years and renewed automatically for another three years.

What is the trend in Orange County?

There are seven Agricultural Districts in Orange County. Each district has at least one farm enrolled as a VAD or EVAD and each district is represented by a member on the Agricultural Preservation Board. The number of acres enrolled in the program nearly doubled in the past year, thanks to new management of the program and improved communication with the farming community.

Some farmers enrolled in the EVAD program have also granted permanent conservation easements through the County's Lands Legacy program, thereby guaranteeing their farms are protected from non-agricultural development in perpetuity.

Sources: Orange County Soil and Water Conservation (http://www.co.orange.nc.us/soilwater/)

NC Department of Agriculture & Consumer Services (http://www.ncadfp.org/documents/VADBrochure.pdf)

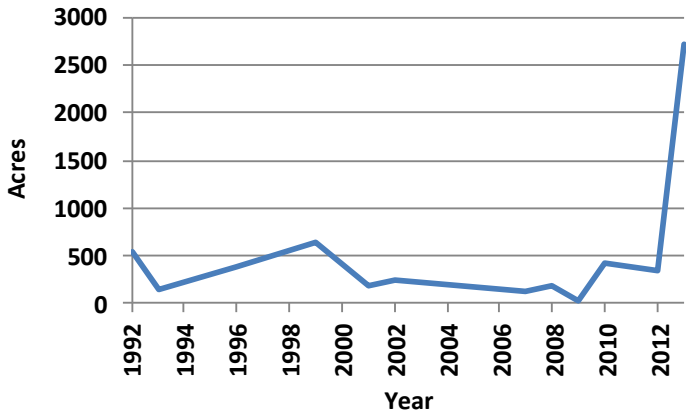


Figure 19: Total Acres Enrolled in a VAD or EVAD, 1992-2013

How can Orange County improve?

To support a sustainable agricultural future, Orange County should:

- Continue assisting the farming community with federal, state, and local funding programs that help protect the environment and natural resources while improving farm productivity;
- Continue to support agricultural landowners with information and educational programs that provide updates on economic growth opportunities and markets for product sales;
- Continue to pursue growth in businesses or industries that use local agricultural products; and
- Attempt to enroll larger, "commercial" farms in the VAD program.

Acres in the Present Use Value Program

Why is this indicator important?

The State of North Carolina allows counties to reduce local property taxes for certain qualifying farmland, forestland, and horticultural land (NCGS 105-277.2 *et seq*.). In doing so, these "working lands" are taxed based on their **current** use (such as farming) rather than their **potential** use (such as a residential subdivision). This lessening of the tax burden reduces pressures on landowners that might otherwise sell their land for development.

Orange County's Present Use Value (PUV) program enables landowners to provide essential agricultural products to the community while also encouraging the protection of open space and lessening the opportunities for urban sprawl.

"Early Morn Swing" by Lisa Tate

The PUV program provides farm and forest landowners significant financial incentives to maintain the productivity and the rural nature of important resource lands.

In 2002, Orange County supported state legislation that would allow farms and forest land protected by conservation easements to be exempt from having to pay deferred taxes if the land were withdrawn from the PUV program. The NC General Assembly enacted that change in 2008.

How is this indicator measured?

The Orange County Tax Assessor's Office administers the PUV program and maintains a database of participating properties. The numbers of properties enrolled in the PUV program since 1993 are provided in Appendix 3. The table in Appendix 3 also specifies the amount of land classified as being used for agriculture, forestry, and horticulture.

The NC General Assembly approved the addition of a fourth category— Wildlife Conservation Land — in 2008 (effective 2010), but the eligibility criteria is limited to special animal wildlife habitats that are managed under an agreement with the NC Wildlife Commission. To date, there are no such properties enrolled in Orange County.

What is the trend in Orange County?

Over 43.5 percent of the total land area in Orange County is enrolled in the PUV program (See Appendix 3). Between 1993 and 2013, the number of properties (or "land parcels") active in the program increased from 37,906 parcels in 1993-1996 to 54,092 parcels in 2013.

Figure 20 shows that despite there being substantially more properties in the program, the actual land acreage enrolled in the Agriculture and Forestry categories between 1996 and 2013 decreased by 3,300 acres and 2,200 acres respectively. Since 2008, however, the land in Agriculture and Forestry combined has *increased* by over 4,000 acres.

The amount of land within the Horticulture land use category has increased steadily, from only 13 acres in 1993 to 243 acres in 2013. In spite of that growth, Horticulture makes up only a small portion of the land in the program (0.2 percent).

This cropland is enrolled in the Present Use Value Program

How can Orange County improve?

To support a sustainable future, Orange County should:

- Continue to inform and educate landowners about their eligibility for the PUV program;
- Monitor enrolled lands to ensure their compliance with the PUV program; and
- Determine whether it would be feasible to incorporate the Wildlife Conservation Land category in the County's PUV program and, if so, promote this potential opportunity to landowners.

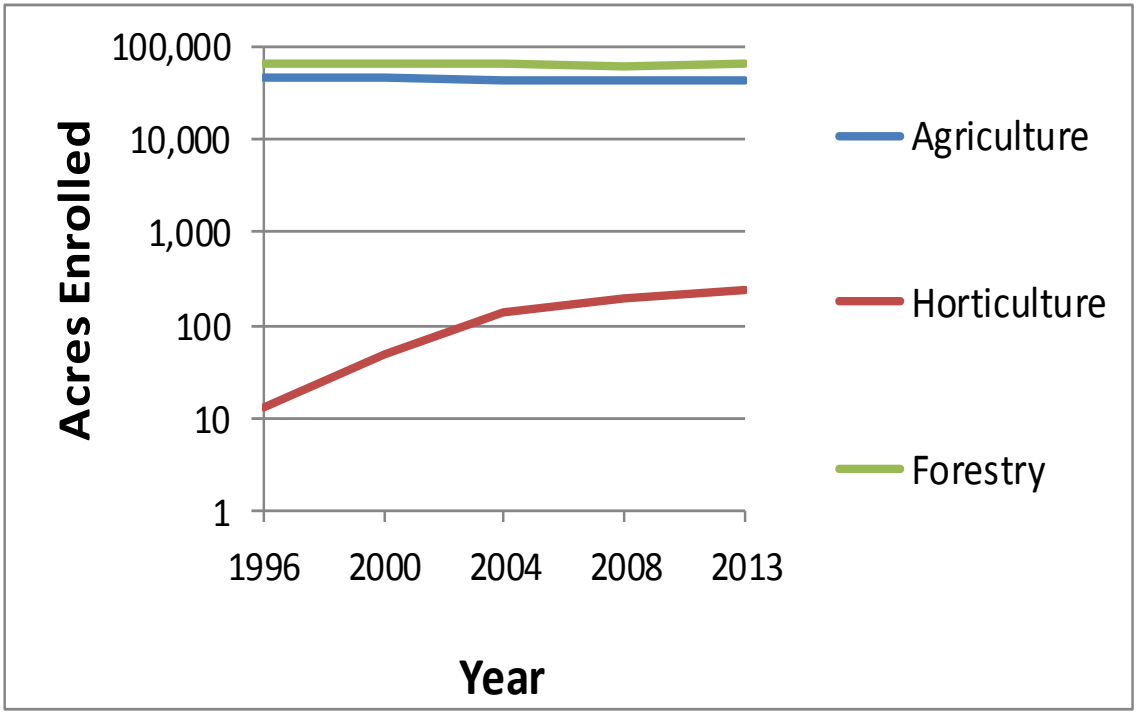


Figure 20: Number of Acres Enrolled in the Present Use Value Program, 1996-2013

Status of Rare Plants and Animals

Why is this indicator important?

The interactions among organisms within an ecosystem are complex. The loss of one plant or animal species can harm the health and survival of other species. Plants and animals perform critical functions (known as ecosystem services) including pollination, seed dispersal, water filtration, and soil building that could be lost if the web of life were disrupted through the extinction of species. Additionally, ecosystems with great biodiversity are typically more resilient to extreme events such as fire or long-term drought. The 2030 Comprehensive Plan recommends the County "develop a way of monitoring common indicator species as a way to measure the 'state of biodiversity' in Orange County."

How is this indicator measured?

The North Carolina Natural Heritage Program (NHP) monitors the status of rare plants and animals throughout North Carolina. The NHP maintains a current list of important species for each county. The status of Orange County's rare plant and animal species is provided in Table 2.

The US Fish and Wildlife Service determines the federal status (i.e., species of concern, threatened, or endangered) of rare species as required under the Endangered Species Act. In North Carolina, the State Plant Conservation Program and the Endangered Wildlife Program of the NC Wildlife Resources Commission hold these responsibilities.

What is the trend in Orange County?

The development of land and its impacts to natural areas (i.e., habitat fragmentation, increased water runoff, and contamination) has reduced habitat for many native plant and animal species.

"Sweet Cherry" by Ed Coleman

How can Orange County improve?

To support a sustainable future, Orange County should:

- Inform the public that loss of habitat and the spread of invasive species are the major causes of native species extirpation and local extinction;
- Protect enough land in and around biologically significant areas, and linkages between areas, to allow the maintenance of native wildlife and plant populations and their functional relationships;
- Use only regionally native species for landscaping on County-owned property, and encourage home-owners and businesses in the community to do the same; and
- Support additional fieldwork to document and recommend management strategies to protect rare plant and animal species in the County.

Monitoring common indicator species

Birds and amphibians are important vertebrates that can be monitored fairly easily. Since 2011, four areas of the county have been surveyed regularly along designated routes through the Calling Amphibian Survey Program. Tree frogs, toads, and frogs are surveyed by trained volunteers listening for their breeding calls (Appendix 5). Although there isn't enough data to determine population trends in this county, it is widely accepted that amphibian populations are declining worldwide. The NC Museum of Natural Sciences maintains an inventory of amphibians in Orange County (Appendix 5).

Although most bird species do not show a statistically significant change over time in their population within Orange County, the Minibird Breeding Census does show a marked decline for 11 species (Wood Thrush, Indigo Bunting, Eastern Towhee, Pileated Woodpecker, European Starling, Ovenbird, Carolina Chickadee, Eastern Wood-Pewee, and Eastern Kingbird), and an increase in population for two species (Rock Pigeon and Yellow-breasted Chat). This decline in population is also shown for the Wood Thrush in counts from the Spring Bird Count (1999-2013) by the Chapel Hill Bird Club (Appendix 6). The decline of song bird populations can be an indicator of habitat degradation.

Table 2 : Status of Orange County's Rare Plants and Animals, 2013

ANIMALS	Scientific Name	Common Name
Endangered	*Alasmidonta varicosa*	Brook Floater (bivalve)
	Fusconaia masoni	Atlantic Pigtoe (bivalve)
	Lampsilis cariosa	Yellow Lampmussel (bivalve)
	Lasmigona subviridis	Green Floater (bivalve)
	Toxolasma pullus	Savannah Lilliput (bivalve)
	Villosa vaughaniana	Carolina Creekshell (bivalve)
Threatened	*Haliaeetus leucocephalus*	Bald Eagle
	Alasmidonta undulata	Triangle Floater (bivalve)
	Lampsilis radiata	Eastern Lampmussel (bivalve)
	Strophitus undulatus	Creeper (bivalve)
Special Concern	*Hemidactylium scutatum*	Four-toed Salamander
	Necturus lewisi	Neuse River Waterdog (salamander)
	Villosa constricta	Notched Rainbow (bivalve)
	Etheostoma collis	Carolina Darter (fish)
PLANTS	**Scientific Name**	**Common Name**
Endangered	*Anemone berlandieri*	Southern Anemone
	Skutllaria leonardii	Shale-barren Skullcap
Threatened	*Platanthera peramoena*	Purple Fringeless Orchid
Special Concern	*Monotropsis adorata*	Sweet Pinesap
	Ruellia purshiana	Pursh's Wild-petunia
	Thermopsis mollis	Appalachian Golden-banner

"The Hunt" by Kirby Lau

Sources:

NC Natural Heritage Program: http://www.ncnhp.org.

Calling Amphibian Survey Program: http://www.ncparc.org/casp/casp.htm

Chapel Hill Bird Club: http://chbc.carolinanature.com/

New Hope Audubon's ebird: http://ebird.org/content/ebird/

Minibird Breeding Census: http://www.unc.edu/~rhwiley/mbbs/trends/Orange2009/

Solid Waste Management: Waste Reduction and Recycling

Why is this indicator important?

Municipal solid waste (MSW) is composed of food waste, paper, containers, packaging, and other miscellaneous wastes from residential, commercial, and institutional sources. Presently, about 62,000 tons of MSW are generated annually in Orange County (Figure 21). About 41,000 tons were disposed of here in FY 12-13; the remainder was shipped out of county. Since the MSW landfill closed in June 2013 all waste travels more than 100 miles for disposal outside the county.

Even with the County's aggressive long-term commitment to waste reduction and recycling, more than two-thirds of the waste generated within the county was landfilled rather than recycled or composted. That includes construction and demolition wastes, although MSW does not typically include construction or industrial waste, which is regulated differently than MSW. The County continues to operate a separate construction and demolition waste landfill, which has a projected 20 years of life remaining at current rates of use. The County continues its ban on landfilling cardboard, metal, and clean wood wastes while also accepting, processing, and marketing those materials separately.

In 2012 the County decided it would not develop a transfer station (for now); instead deciding it would ship waste out of county for three to five years. The large privately-owned landfills that receive Orange County's waste generally have less rigorous oversight than did the County facility, which was smaller and staffed at a level that far exceeded regulatory standards. The current approach of shipping MSW out of county is a necessary interim measure that will continue until the County and its municipal partners devise a more comprehensive and environmentally-sound long-term plan for managing solid wastes.

For the past 26 years, Orange County and its municipal partners, as well as UNC, have used, supported, encouraged, and publicized the following "landfill diversion" approaches to reduce the amount of MSW destined for landfills:

- Source reduction programs (e.g., eliminating junk mail);
- Re-use programs (e.g., donations of clothes and household goods);
- Backyard composting or central composting of organic waste to reduce biodegradable waste going to the landfill; and
- Recycling collection programs for materials with active recycling markets.

Truck delivering solid waste to the County landfill (Closed June 30, 2013)

Waste reduction is important from several environmental perspectives. Overall, any goods landfilled represent embodied energy and material resources that are wasted. Furthermore, anaerobic, bacterial decomposition of organic waste (such as food wastes) produces a more acidic landfill leachate fluid ("garbage tea"), which can increase leaching

of toxins and dissolved metallic ions from landfilled materials. This type of decomposition will also generate methane gas and small amounts of Volatile Organic Compounds (VOCs) in landfills. Thus, it is crucial to reduce the quantity of waste that is produced. The 2030 Comprehensive Plan (Objective SW-1) calls for the County to continue to affirm, support, and work towards achieving its goal of 61 percent waste reduction that was adopted in 1997. The same goal was also adopted and reaffirmed over the past 13 years by all three towns. At present, Orange County and the towns are close to achieving that goal, with 58 percent waste reduction as of FY 2012-13.

Recycling is a subset of the overall waste reduction effort and the County has focused much of its effort on implementing recycling programs that serve its population effectively with a combination of curbside collection and drop-off opportunities, along with ongoing and comprehensive public education efforts. Recycling is beneficial because it diverts valuable material from landfills and towards markets for their remanufacture into new products. Recycling also conserves resources; can reduce air, water, and land pollution; and stimulates North Carolina's economy.

How is this indicator measured?

Waste Reduction

Waste reduction is measured in North Carolina by calculating the current tons of waste per capita landfilled as a percentage of the tons per capita landfilled in the statutorily selected base year, 1991. The NCDENR Division of Waste Management (DWM) receives statistical accounts of tons of waste produced within each county each fiscal year regardless of disposal destination. These numbers include waste collected by both municipal and county governments, as well as private collectors and any construction waste reported as originating from within that county. Thus the calculated percentages include not only waste landfilled within the county, but also that which is transferred to a landfill in another county.

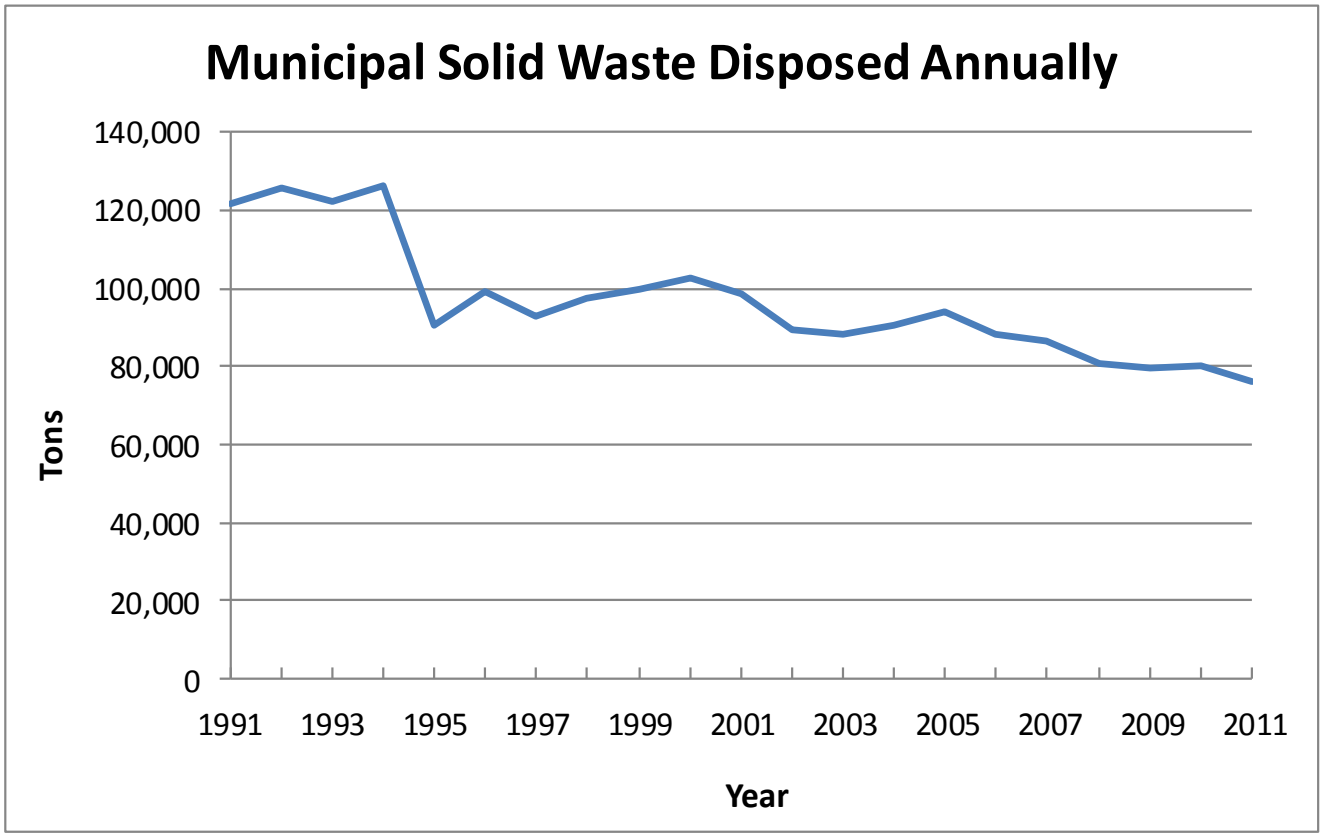


Figure 21: Municipal Solid Waste Collected from all Sources within Orange County, 1991-2011

Solid Waste Management: Waste Reduction and Recycling (continued)

The known tonnage is divided for each county by a census-based population figure for each county at the beginning of each fiscal year. These statistics are applied to each county in North Carolina, and while the tonnage may reflect some underreporting of Orange County waste disposed beyond county lines, there is no other reliable available data.

Recycling Rate

Several years ago, the North Carolina Division of Environmental Assistance and Outreach began tracking rates of recycling as well as overall waste reduction rates by county. They use the annual state-required report forms to create a metric of total tons recycled and tons per capita recycled.

The NCDENR Division of Waste Management collects the individual county reports of tonnage of recyclable materials and tons of recycling per capita. However, tracking recycling is not a statutory requirement in North Carolina, and the parameters for measuring recyclables vary. There is no standard; just what is reported on local government reporting forms is included. For instance, these data do not include private recycling such as grocery store cardboard or industrial plastics recovery.

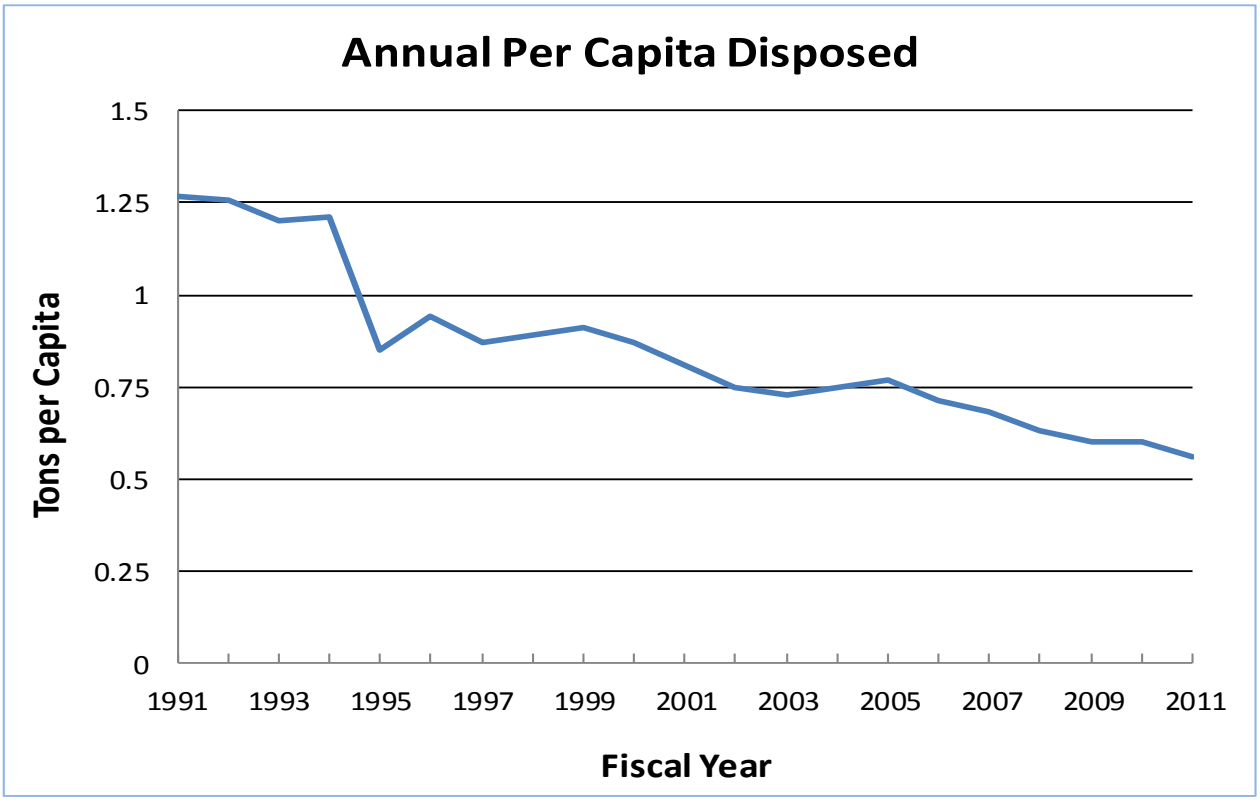


Figure 22: Waste Disposal Rate (tons per capita), 1991-2011

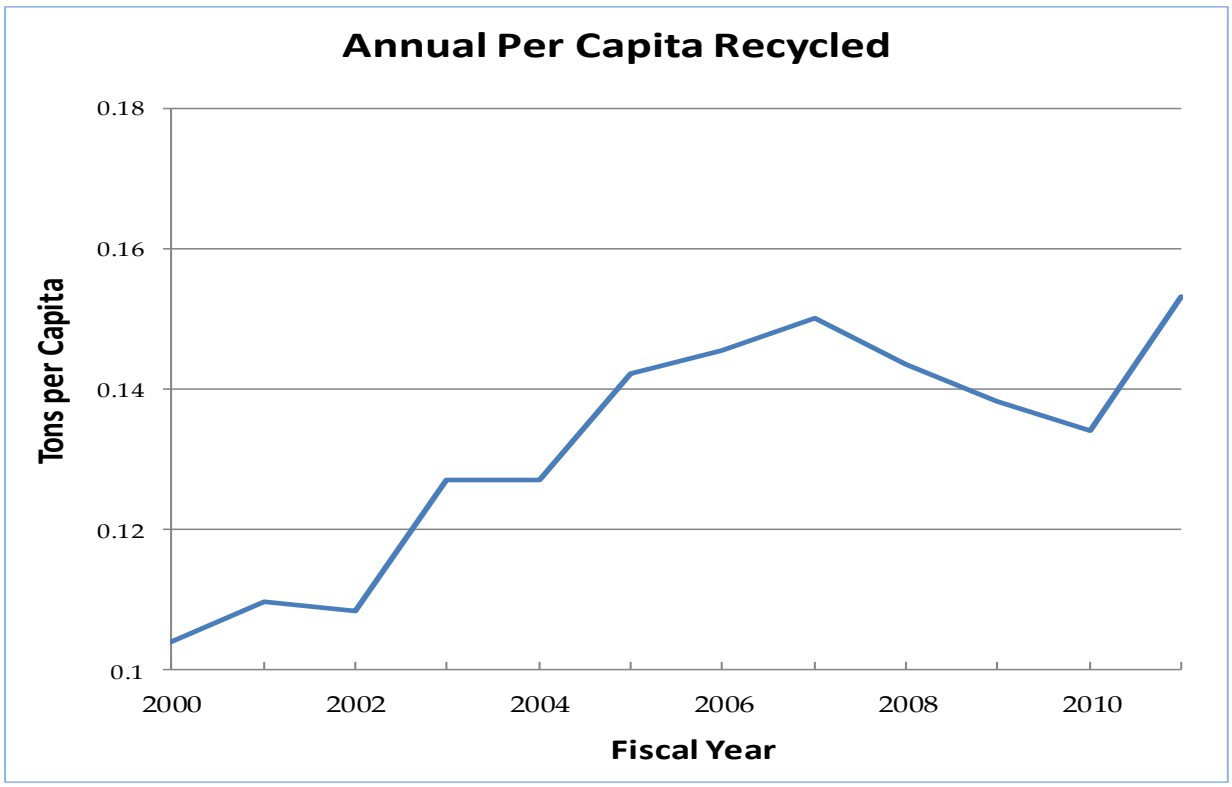


Figure 23: Recycling Rate (tons per capita), 2000-2013

What is the trend in Orange County?

Waste Reduction

As Figure 22 shows, the waste disposal rate continues to decrease in Orange County. By the waste reduction metric described above, the County achieved a 58 percent waste reduction rate in FY 2012-13 (0.56 tons/capita landfilled, or roughly 3 lbs./person/day, compared to 1.36 tons/capita and 8.4 lbs./person/day in FY 1991). Orange County has consistently reduced its solid waste disposal rate since measurement began in 2000. Fifty-eight percent is the highest percentage of waste reduction in the State and within three percentage points of the County's goal. That rate fell one point from 2011-12 when it was 59 percent.

Many factors have been instrumental in achieving Orange County's high diversion rates, including:

- Long-term public and government commitment to the county-wide waste reduction goal;
- High levels of recycling and backyard composting;
- Well financed and operated programs;
- A set of rigorously-enforced landfill bans; and
- An effective on-going public education program.

Some of this reduction may also be attributed to a reduction in consumption during the recent recession. The shrinking size of newspapers and some packaging containers has also reduced the volume of solid waste. Nevertheless, Orange County's waste disposal reduction rate is better than its neighboring counties (Alamance 26%, Chatham 44%, Durham 6%, Wake 25%) and lower than the statewide solid waste disposal rate of 12 percent.

Recycling Rate

Figure 23 shows that after a peak in the per capita recycling rate in FY 2007-08 there was a three-year decline, but since then the recycling rate has increased to the county's highest rate ever of 0.15 recycled tons per capita in FY 2012-13. The three-year decrease in recycling tonnage was probably due, again, to the decreasing mass of packaging and newspapers and less consumption during the recession, rather than a decrease in participation. The recent increase in recycling rate is likely a result of conversion from dual- to single-stream recycling discussed below. Landfill tonnage from Orange County also declined during this period, which is reflected in the waste reduction rate.

Solid Waste Management: Waste Reduction and Recycling (continued)

The recycling rate is likely to continue this increase in the future, since the County has converted to a "single stream" collection system. Single stream collection makes recycling less labor-intensive and tends to increase recycling rates. Urban curbside recycling increased by 5 percent in FY 2012-13. Rates will likely improve with the conversion from the 18-gallon bins to 95-gallon roll carts, which began in FY 2014-15 for curbside recycling in urban areas, and may become available in some of the suburban areas.

Recycling programs are not financially self-sufficient, and the existing sources of local funding will be revised: the 2013 suspension of 3-R Curbside/multi-family fees to finance urban and rural curbside and apartment recycling collections (leaving just the Basic 3-R Fee of $47 on the 2013 the County and towns. The fee that financed unincorporated area curbside recycling may be replaced by either a solid waste services district with accompanying tax or a voluntary subscription based service. That decision will be made in 2014.

For FY 2014-15, the fees for urban curbside collection and multifamily are scheduled to be reinstituted pending a revised interlocal agreement between the County and the towns. The fee that financed unincorporated area curbside recycling may be replaced by either a solid waste services district with accompanying tax or a voluntary subscription-based service. That decision will be made by the board of county commissioners in 2014 following public hearings and in consultation with the towns' elected boards.

What does the future hold?

Orange County is at a crossroads for its waste management efforts. The County closed its 26-acre MSW landfill in June 2013. Household and business waste is now hauled in low-mileage, diesel-fueled, trucks to transfer stations located mostly in Durham County. From there it is loaded onto tractor trailers and driven to landfills in Sampson and Montgomery counties. Some privately-hauled waste may be taken to the Upper Piedmont Landfill located in Person County.

To protect the environment at the closed landfill, the County is installing a 12-inch layer of low-permeability clay over the final layer of waste, covered by an impermeable polyethylene cap that will be covered by another two feet of soil and grasses. The County will maintain the cap and conduct environmental monitoring (including groundwater and methane) for at least 30 years.

With no local disposal facility (landfill or transfer station), the County will be unable to enforce local disposal bans and disincentives for wasting. County residents are, however, strongly encouraged to continue reducing their waste, as currently the county's waste (and associated environmental risks) is exported to other North Carolina counties and nearby states.

Because MSW disposal will continue to be a pressing environmental issue for some time to come, a longer-term view will also entail coordinating and collaborating with neighboring counties and cities seeking broader, creative, more regional solutions.

Orange County will also need to continue maximizing integration of operations between the County and the three municipalities.

Most residents within the town limits of Hillsborough, Carrboro, and Chapel Hill now qualify for weekly curbside collection of recycling in 95-gallon roll carts.

Rural biweekly recycling collection

How can Orange County improve?

Waste characterization studies show that Orange County MSW, as recently as 2010, still contained over 30 percent recyclable material (including textiles, electronics, scrap metals, and hazardous wastes) and another 30 percent or more that was potentially compostable (including food, wet paper, and some vegetative waste not now captured).

An aggressive, yet practical, recycling and composting program without extreme measures and extraordinary expenses might include:

- Use of roll carts for residential recycling (scheduled for FY 2014-15);
- Increased efforts to divert residential organics (compostables);
- Expanded commercial recycling services;
- Expanded commercial food waste collection from most larger generators;
- Creation of a solid waste services utility; and
- New regulatory measures such as recycling mandates and additional materials' collection bans.

Implementing this mix of programs and services could practically yield a projected potential 70 percent waste reduction rate. Going higher than that would be challenging. Continuing to pursue the County's aggressive yet practical approach to waste minimization will require long-term stable and predictable funding, continued cooperation among the political bodies, and the ongoing high level of participation of the populace.

Due to the changing interpretation of state rules on the financing of services, the County should create a different means of taxation or fees to support the recycling program. Also, increasing composting at both commercial and residential levels could significantly reduce the total amount of solid waste generated annually.

Emerging Concern: Invasive Terrestrial Plants

Overview

Orange County's native plants (species that have evolved within the Piedmont ecosystem) clean our water and air, provide wildlife habitat, and help protect us from floods. However, a small percentage of non-native (or exotic) plants found here and in other parts of this region threaten the continued existence of our native plants, the quality of habitat for wildlife, and the overall biological diversity of our natural areas.

These non-native plant species have traits that allow them to outcompete indigenous plants, and they have thus been labeled invasive plants. They may grow faster, reproduce at a more rapid rate, have a larger reproductive dispersal zone, or be able to tolerate a wider range of environmental conditions. Non-native plants outcompete native plants for nutrients, light, space, or water, and can significantly disrupt or modify environments. The insects, diseases, or foraging animals that limit the growth of these plants in their native regions may not exist here in the Piedmont. Our insects often cannot utilize exotic plants; thus, as non-native species replace natives, insects begin to suffer, impacting the food chain as a whole and threatening critical ecosystem services such as plant pollination. Invasive plants create monocultures, which do not provide food for native animal species and thus can reduce populations of local animals.

Many invasive plants in the southeastern US originated in Asia, due to the similarity of southeastern Asia's geographical and environmental conditions to those in the southeastern US. Some invasives were introduced accidentally, while others were brought to North America intentionally as ornamental or decorative varieties.

Invasive Exotic Plants of North Carolina, a 2012 guide published by NC Department of Transportation, identifies 17 plant species known to be invasive and to degrade habitat in the Piedmont region. Several are noxious weeds—plants detrimental to crops or other desirable plants, livestock, land, or public health. Noxious weeds may not be brought into NC, and some existing species are quarantined to particular counties. The sale of all noxious weeds is prohibited, with the exception of Oriental bittersweet (*Celastrus orbiculatus*), which can be sold in only 18 quarantined counties in western NC.

Exotic animals also pose a risk to ecosystem health. One of the newest invaders of North Carolina is the Emerald Ash Borer, a small beetle from Asia that kills ash trees. The insect drills a U-shaped hole in the tree trunk, destroys the internal bark, and quickly kills the tree. Since this beetle was first discovered in North Carolina in 2013, it has been found in Person, Vance, and Granville counties. Many insect pests, including the Emerald Ash Borer, are spread by people transporting firewood from one part of the state to another.

How can Orange County improve?

To support a sustainable future, Orange County should work with its partners to educate homeowners and land managers on the following:

- Identify and eradicate invasive species; replace with native species;
- Revisit locations where invasive species were removed to ensure regrowth has not occurred;
- Minimize changes to natural habitats because invasive species tend to thrive in areas where existing flora is disturbed, either naturally or through human activity;

- When landscaping, choose ecologically-sensitive landscapes that minimize site disturbance and mimic the diverse, heterogeneous plant varieties found in nature;
- Use certified "weed-free" forage, firewood, hay, mulch, and soil ;
- Be mindful not to introduce invasive plants into gardens or yards, choosing native species (or non-invasive, non-native species) instead;
- Clean hiking boots, waders, boats, trailers, off-road vehicles, and other potential pathways to stop the spread of the seeds of invasive plants to new locations;
- Volunteer to remove invasive species from natural areas in the community; and
- Report new invasive species and range expansions to one of the organizations listed below.

Sources:

- Smith, Cherri. *Invasive Exotic Plants of North Carolina.* NC Department of Transportation. 2012.
- NC Botanical Garden. *Controlling Invasive Plants.* 2007. http://ncbg.unc.edu/invasive-plants-resources/
- Tallamy, Doug. *Bringing Nature Home*. Timber Press, 2007.

For more information on exotic and native plants, please visit:

- NC Botanical Garden http://ncbg.unc.edu/plants-and-gardening/
- NC Native Plant Society http://www.ncwildflower.org/natives/natives.htm
- NC Department of Agriculture and Consumer Services www.ncagr.com/plantindustry/plant/weed/weedprog.htm

For more information on the Emerald Ash Borer, Red Imported Fire Ant, and Brown Marmorated Stink Bug, see:

- Center for Invasive Species & Ecosystem Health www.bugwood.org
- US Dept. of Agriculture http://www.aphis.usda.gov/plantHhealth/plantHpestHinfo/emeraldHashHb/
- US Forest Service http://na.fs.fed.us/spfo/pubs/pest_al/eab/eab.pdf
- National Sustainable Agriculture Information Service https://attra.ncat.org/attra-pub/viewhtml.php?id=131
- Stop BSMB http://www.ces.ncsu.edu/depts/ent/notes/O&T/trees/note148/note148.html

Bamboo

Periwinkle

Silvergrass

Bradford Pear

Chinese Privet

English Ivy

Chinese Wisteria

Bush Honeysuckle

Emerald Ash Borer

Brown Marmorated Stink Bug

Tree of Heaven

Japanese Stiltgrass

Figure 24: Some of the invasive species common to Orange County

Update: Land Application of Biosolids

Biosolids in Orange County

Biosolids are produced from sewage sludge using anaerobic digestion and heat to reduce pathogen levels. Land application of biosolids, rather than incineration or landfilling, is the most cost-effective means of disposal. The US Environmental Protection Agency's Standards for the Disposal of Sewage Sludge define two types of biosolids for land application: ***Class A*** biosolids are heavily treated to reduce pathogens to a very low level such that access to application sites need not be limited, whereas ***Class B*** biosolids are treated to reduce pathogens only to a level safe for land application, such that access to application sites is initially restricted.

The NC Division of Water Resources administers a permitting process and enforces regulations intended to reduce environmental health risks associated with land application. Although Orange County maintains local oversight of biosolids application activities, State regulations supersede any County requirements.

The area of farmland in Orange County with active permits to receive biosolids reduced slightly from 3,009 acres in 2009 to 2,963 acres in 2013. Figure 25 shows the areas permitted to receive biosolids from the OWASA, Hillsborough, Mebane, Durham, and Burlington wastewater treatment facilities. The majority of biosolids spread in Orange County are Class B, so strict application practices are critical for reducing the risk of adverse environmental impacts during and after application.

Ongoing Concerns and Recommendations

Inspections of biosolids application sites and practices by Orange County Environmental Health Services reveal periodic non-compliance with permitted application procedures. Additionally, some utilities that generate biosolids are reluctant to report their disposal activities; thus their level of compliance with State and local regulations is unknown. Furthermore, although the County's zoning rules prohibit biosolids disposal in "critical areas" of protected watersheds, State and County demarcations of these areas differ. As a result, Burlington is permitted to apply biosolids within he Cane Creek critical area, as defined by the County.

Although many organic and inorganic pollutants are routinely found in biosolids, current US EPA regulations require states to monitor for only nine inorganic metal pollutants. Additionally, there are no requirements to monitor exposure of humans or grazing animals near application sites or monitor for the presence of pharmaceutical or other contaminants in surface and ground water.

In 2005 the NC Department of Health and Human Services recommended the State enact additional protective measures governing the land application of biosolids. The recommendations included 1) establishing a monitoring requirement for wells located near land application sites; 2) increasing the current application setback distance requirements from adjacent properties; 3) developing a surveillance program to determine adverse health effects among humans and animals living near application sites; and 4) developing specific environmental siting criteria, based on current scientific information, to control the location of application sites.

How can Orange County improve?

The CFE recommends forming a county or regional task force to examine the environmental and public health issues related to the application of biosolids on farmland.

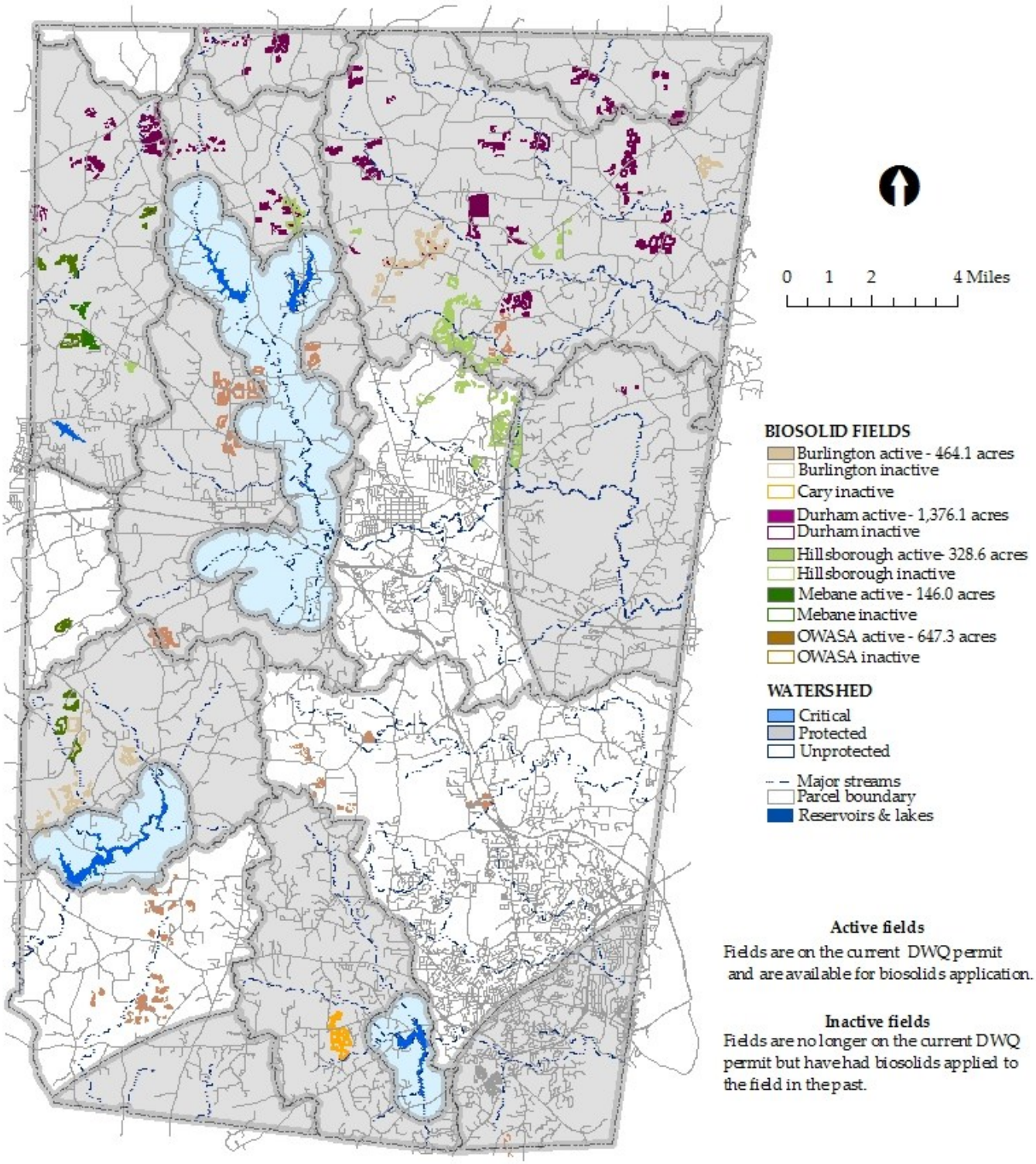


Figure 25: Farmland permitted to receive biosolids in 2013

Water Resources

Sustainable, secure supplies of potable water are crucial to the citizens of Orange County, either from private wells or through a water utility. This is one of Orange County's goals as stated in the 2030 Orange County Comprehensive Plan.

More than 50 percent of the county's residents obtain their water from a water utility, as described below (see also Figure 28):

- **Orange Water and Sewer Authority (OWASA)** supplies Chapel Hill, Carrboro, and a small area of the County with water from University Lake and Cane Creek Reservoir;
- **Orange-Alamance Water System (OAWS)** supplies Mebane and rural areas with water from the Eno River, water supply wells, and with water bought from the Town of Haw River;
- **The Town of Hillsborough** supplies Hillsborough with water from West Fork of the Eno Reservoir and Lake Orange (via Lake Ben Johnson);
- **The City of Mebane** supplies most of Mebane with water from the Graham-Mebane Reservoir; and
- **The City of Durham** supplies a limited area of the eastern portion of the county along the I-85 corridor with water from Lake Michie and the Little River Reservoir.

About 40 percent of Orange County's population relies on groundwater for their water supply.

The County has adopted a range of strategies and policies to protect groundwater and surface water resources. Continued active management and wise utilization of our water resources are important to ensure that adequate supplies of clean water are available in the future.

Since 2008, Orange County has:

- Upgraded well construction standards;
- Revised Critical Watershed Protection Area boundaries to ensure protection of surface water reservoirs;
- Participated in the Falls Lake Nutrient Management Strategy, the Jordan and Falls Lakes Watershed Oversight Committee meetings, and the Jordan Lake Partnership stakeholder meetings;
- Continued to participate in the Upper Neuse River Basin Association (UNRBA);
- Implemented the **Orange Well Net (OWN)**, a network of groundwater observation wells designed to monitor and publicize groundwater levels throughout the County; and
- Initiated benthic macroinvertebrate monitoring of County streams classified as "impaired."

Water Resources Indicators

The environmental indicators included in the Water Resources section of this State of the Environment report have been revised from previous reports to provide clearer, more focused information on **Water Resources in Orange County** and to track the status of **Water Usage**, **Groundwater Quantity**, **Groundwater Quality**, and **Surface Water Quality** in terms of Use and Assessment.

In addition, **Specific Conductivity** has been added as a readily available measure of surface water quality. New Emerging Concern pages were also added to provide information about **Hydraulic Fracturing** and **Aquatic Invasive Species**, which are both subjects of recent concern.

What can you do to protect Orange County's water resources?

* Use less toxic alternatives, preferably labeled as "biodegradable," to conventional household products.
* Properly dispose of household chemicals, used motor oil, and unused pharmaceuticals at the household hazardous waste facilities operated by the County.
* Start or support a project to improve water quality in your neighborhood: https://creeklife.com/watershed
* Perform a soil test before using an appropriate amount of low phosphorus lawn fertilizer.
* Use water-efficient appliances, and run the dishwasher and washing machine only when full.
* Replace older, less efficient toilets with newer versions that use less water.
* Use a car wash that captures and recycles the wash water.
* Do not dispose of grease, oil, or unused medications down the drain or toilet.
* Minimize impervious surfaces, including paved areas, on your property. Replace some grassed yard area with mulch and native plants.
* Limit pesticide use on your property.
* Build a rain garden to encourage storm water infiltration.
* Use efficient irrigation systems, including rain barrels, and periodically check the operation of the system. Irrigate plants during the cooler morning or evening hours, instead of watering during the hotter afternoon hours when water will evaporate more quickly.
* Maintain and periodically pump out your septic system and test your well water.
* Properly abandon your out-of-use well.

Eno River

Water Resources In Orange County

When precipitation in Orange County does not evaporate, is not absorbed by plants through the process of transpiration, and does not infiltrate the subsurface and become groundwater, it leaves the County as stormwater runoff and enters one of three rivers: the Cape Fear River, the Neuse River, or the Roanoke River. Nearly all Orange County residents live in either the Cape Fear or the Neuse River basins, with only a small portion of the County draining to the Roanoke River Basin (Figures 26 and 27). Each of these basins is a watershed, an area of land where all of the water drains to the same body of water.

Precipitation that falls in the Cape Fear Basin watershed portion of Orange County flows to Jordan Lake, and then on to the Atlantic Ocean. Jordan Lake is currently the water supply for Apex, Cary, and Morrisville, but several jurisdictions, including Durham, Chapel Hill, and Orange County, plan to use Jordan Lake water in the near future.

Runoff that leaves the Neuse River watershed portion of Orange County flows to Falls Lake and then ultimately to the Atlantic Ocean. Falls Lake is the principal water supply for the City of Raleigh.

Runoff from the small portion of the county in the Roanoke River Basin flows to Kerr Lake, Lake Gaston, and then on to the Atlantic Ocean.

Stormwater runoff from developed areas, wastewater treatment plants, agricultural operations, and roadways can transport nutrients (nitrogen and phosphorus) to Jordan and Falls lakes. This has resulted in the growth of problematic amounts of algae in these lakes. Consequently, both the Jordan Lake and Falls Lake watersheds are now subject to nutrient management rules intended to improve the water quality in these water supply reservoirs. Both nutrient management rules require significant reductions in nutrient contributions to the reservoirs from the sources listed. Modeling indicates that water quality in the reservoirs should improve once nutrient runoff to the lakes is reduced.

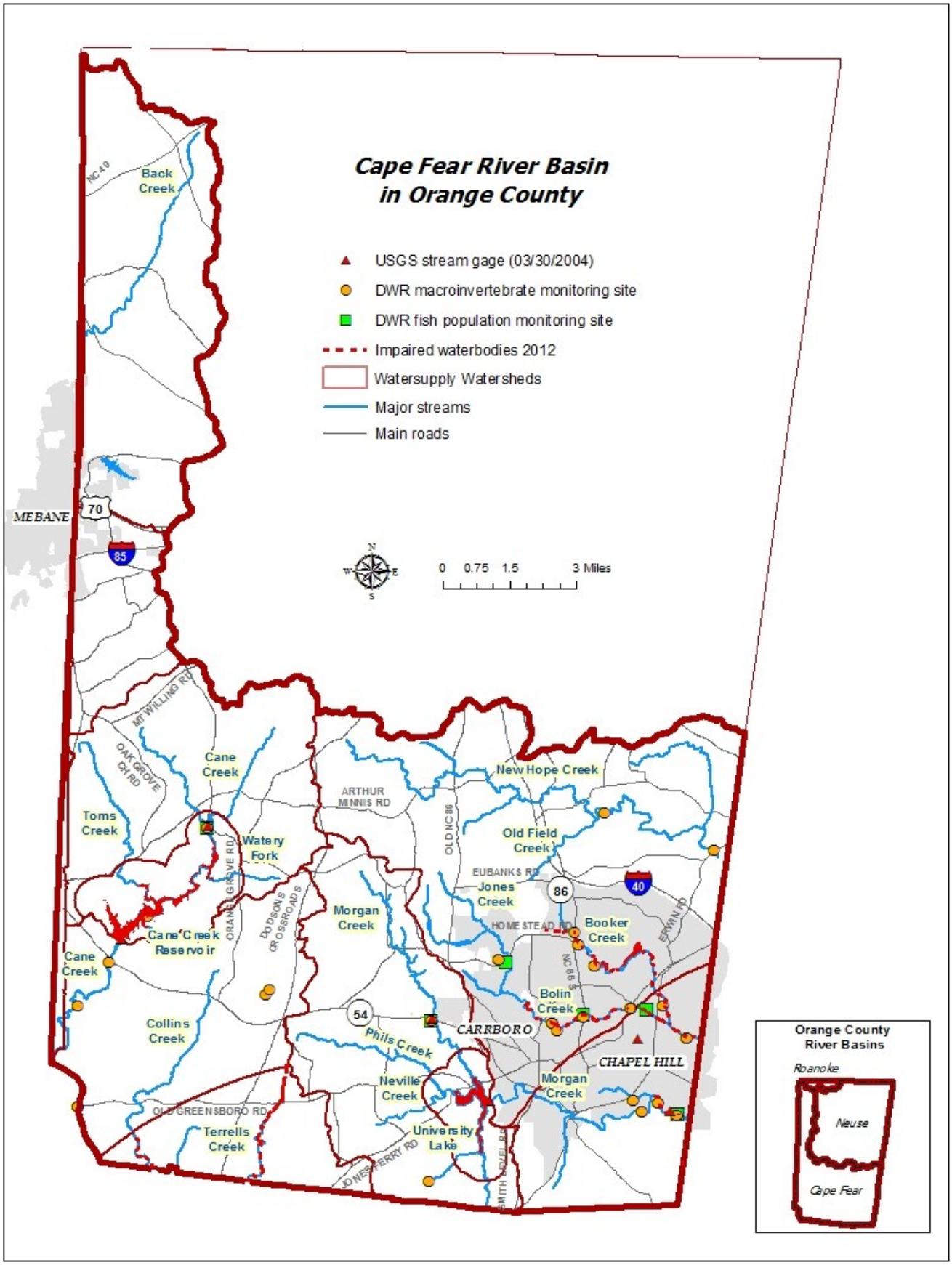


Figure 26: Cape Fear River Basin Watershed Area in Orange County

Water Resources In Orange County (continued)

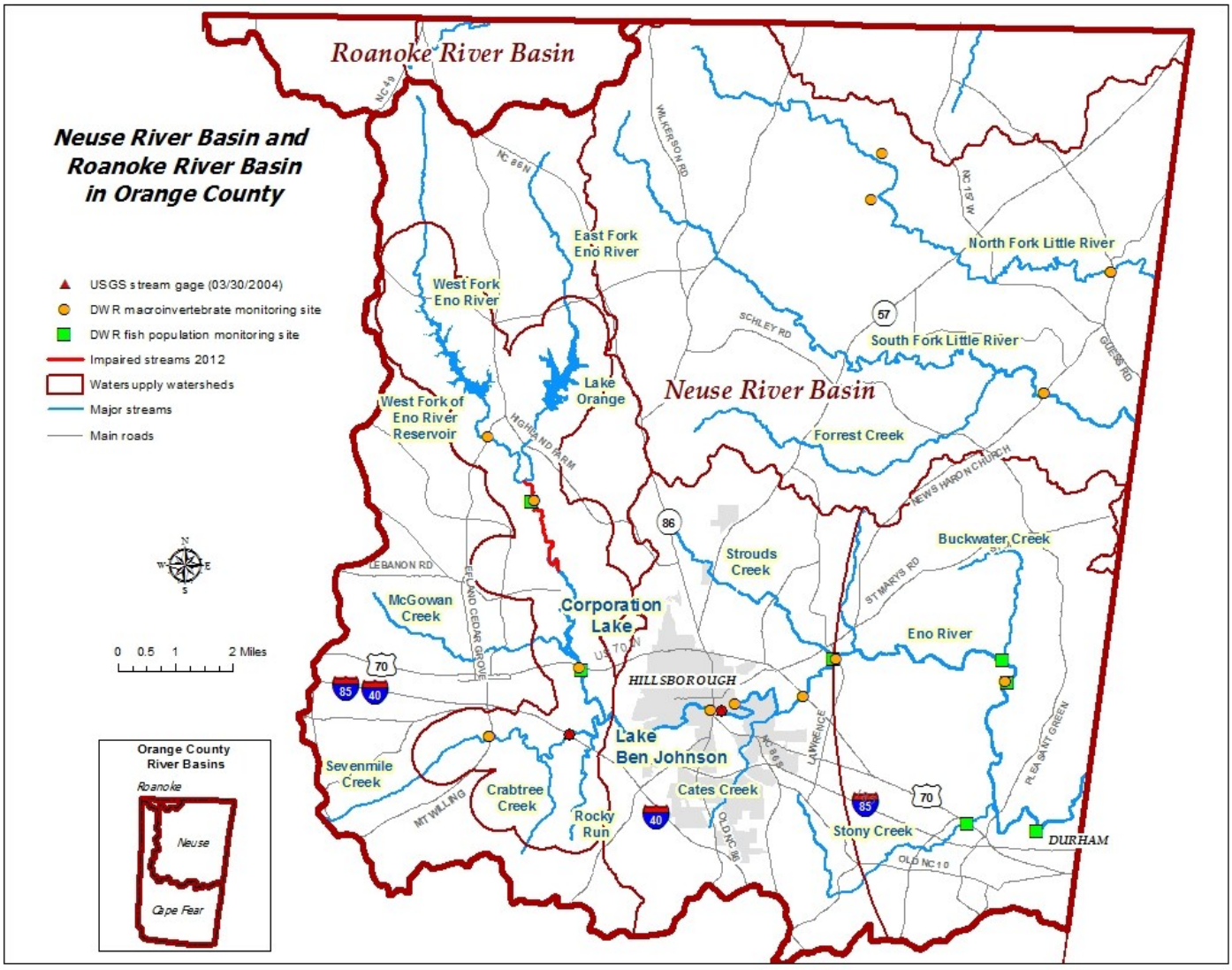


Figure 27: Neuse River and Roanoke River Basin Watershed Areas in Orange County

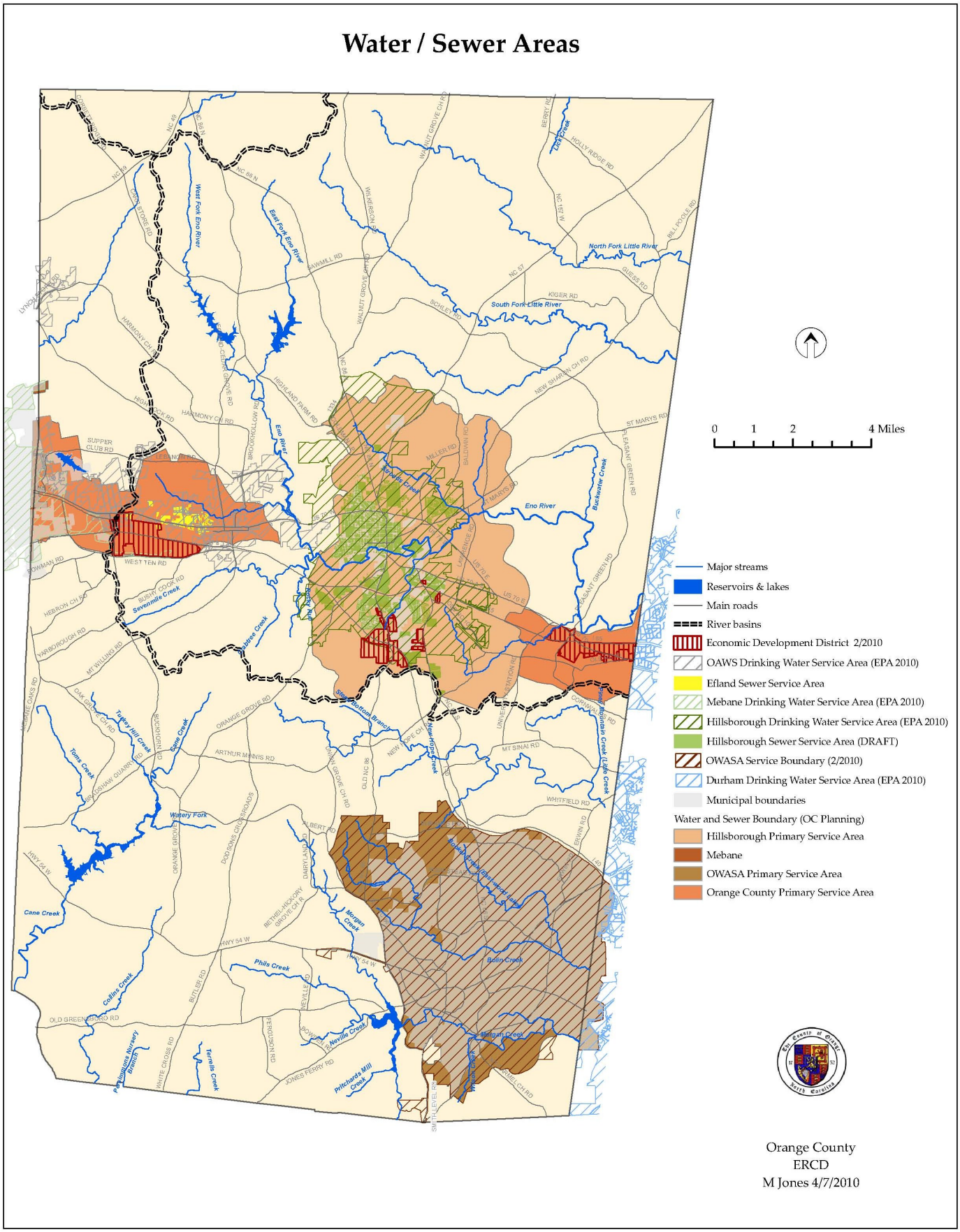


Figure 28: Water and Sewer Service Areas in Orange County

Water Usage

Why is this indicator important?

Clean water is a necessary resource that is renewable but can be limited in availability at certain times. A reliable supply of clean water is vital for public health, agricultural production, economic growth, and ecosystem health. To continue to support a healthy environment and sustainable growth, the water resources of Orange County must be carefully managed such that our finite resources are not overwhelmed. Figure 28 illustrates the areas of Orange County that are served by different water utilities as well as surface water resources that are present in the county.

How is this indicator measured?

The self-reported water consumption data used in this section, shown in Table 3, were provided by NCDENR - Division of Water Resources (DWR). This information illustrates the average amount of water used per person from 1997 to 2012, with usage reported in gallons per day per person (g/d/p) by a water utility. The g/d/p is calculated by dividing the total average amount of water used per day by the current population served by the utility. This includes all residential, commercial, industrial, institutional, and system process uses, as well as unaccounted-for water losses due to leakage or unregistered water meters. These data are provisional and not verified for some of the years reported.

What is the trend in Orange County?

The number of people relying on municipal water supplies will increase as urban areas expand within the county. Surface water is used, almost exclusively, to meet urban water demand. While surface supplies can be vulnerable to impacts brought on by periods of drought, Table 3 shows that the average per capita demand for water in the areas of Orange County served by utilities has generally decreased markedly since the droughts of 2002 and 2007.

These droughts have alerted residents and large-scale water users of the need for immediate and on-going water conservation. This increased awareness may have led to a decline in the per capita consumption of water in the last 10 years.

Groundwater usage over time is difficult to track due to the lack of comprehensive data. It is expected that the ongoing growth in the total number of water supply wells in the county mirrors growth in groundwater consumption. The trend in decreasing per capita water consumption may reduce the net impact on groundwater; however large scale users of groundwater could offset the decrease in residential consumption .

Annual well installations in the county has slowed considerably since 2002 (Figure 29). This is likely the result of decreased residential development in this area since 2008, as well as the fact that numerous replacement wells were installed in 2002 to replace older wells that were not capable of providing an adequate supply of water during the severe drought that took place that year.

OWASA			
Year	Pop.	MGD	G/D/capita
1997	65,000	8.979	138
2002	73,700	9.571	130
2007	80,000	8.641	107
2008	80,000	7.87	98
2009	80,000	7.891	99
2010	79,400	7.697	97
2011	80,050	6.978	87
2012	80,288	6.759	84

Town of Hillsborough			
Year	Pop.	MGD	G/D/capita
1997	10,500	1.822	174
2002	12,000	1.045	87
2006	12,073	1.278	106
2007	12,305	1.279	104
2008	12,493	1.136	91
2009	13,980	1.14	82
2010	12,216	1.157	95
2011	12,216	1.133	93
2012	13,565	1.127	83

OAWS			
Year	Pop.	MGD	G/D/capita
1997	11,500	1.093	95
2002	9,074	1.136	125
2006	8,086	0.673	83
2007	8,194	0.64	78
2008	8,281	0.631	76
2009	8,294	0.629	76
2010	8,282	0.648	78
2011	8,199	0.644	79
2012	8,330	0.608	73

Mebane			
Year	Pop.	MGD	G/D/capita
1997	5,100	0.949	186
2002	8,076	1.168	145
2007	9,000	1.286	143
2009	9,200	1.628	177
2010	11,393	1.25	110
2011	11,796	1.305	111
2012	12,000	1.308	109

Table 3: Drinking Water Consumption Data for Orange County Utilities

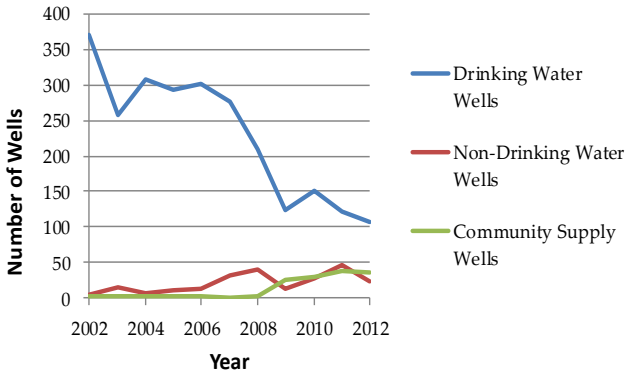


Figure 29
Number of Well Installations in Orange County since 2002.

How can Orange County improve?

To support a more sustainable future, Orange County should:

- Continue to educate citizens about the importance of conserving groundwater and surface water.
- Continue participating in the Jordan Lake Partnership, a regional effort to plan sustainable water supplies for the next 50 years.
- Maintain and expand the Orange Well Net (OWN), a network of groundwater observation wells being used to:
  - ⇒ Monitor local groundwater conditions;
  - ⇒ Publicize how the supply of groundwater is affected locally by drought and other climactic events; and to
  - ⇒ Further characterize the hydrogeologic system in Orange County.

Why is this indicator important?

Groundwater is a very important source of domestic, agricultural, and industrial water within the rural areas of Orange County. New supply wells are installed in the county each year but usage of groundwater is largely unrecorded and thus total demand is unknown. Two recent long-term droughts raised concerns about the sustainability of the groundwater supply. The Orange County Comprehensive Plan included the following recommendation: "Establish a county network of ground and surface monitoring wells to assist in water resources planning and drought monitoring." [Objective WR-10] Timely, accurate, local information concerning the availability of groundwater is needed to safely utilize and maintain this resource.

Bedrock observation wells monitor the impact of variations in climatic conditions and bedrock lithology (physical characteristics of a rock) on groundwater levels. Regolith observation wells monitor the quantity of groundwater contained in the unconsolidated material (regolith) present above bedrock. Groundwater present in the regolith represents the water stored for eventual use via supply wells that access water present in fractured bedrock (Figure 30).

How is this indicator measured?

Currently, groundwater level information is collected from six bedrock wells and three regolith wells located across Orange County. This network of wells is known as **Orange Well Net (OWN)**. The locations of the regolith and bedrock wells currently operating in OWN are shown in Figure 31.

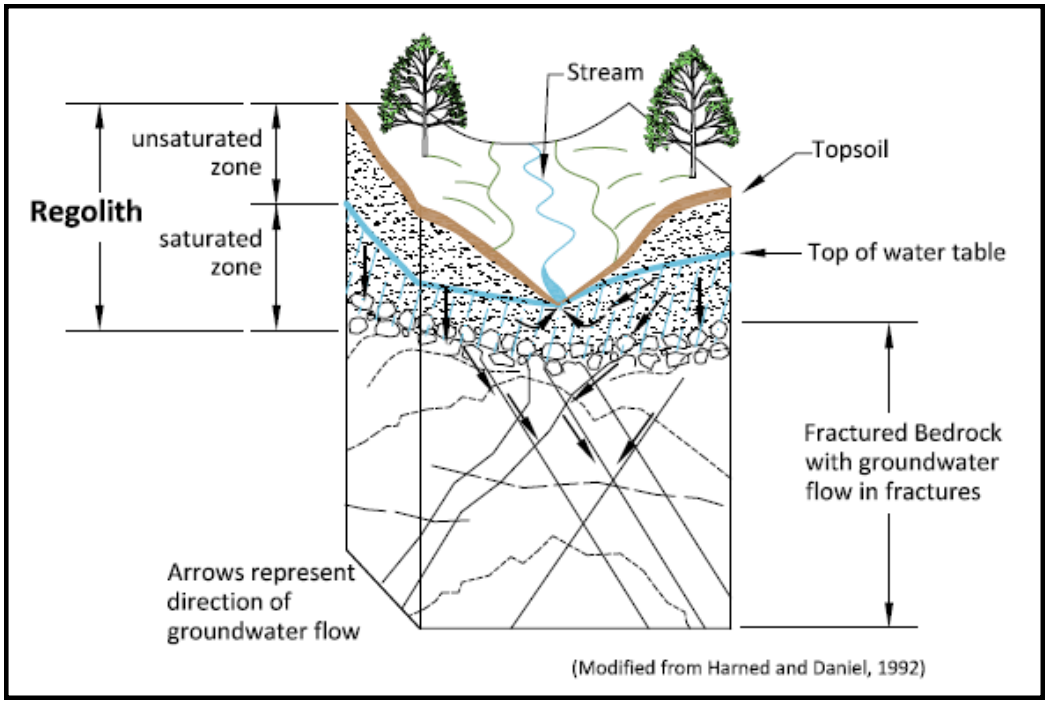


Figure 30. Diagram of Typical Groundwater Flows in the Piedmont Region of North Carolina.

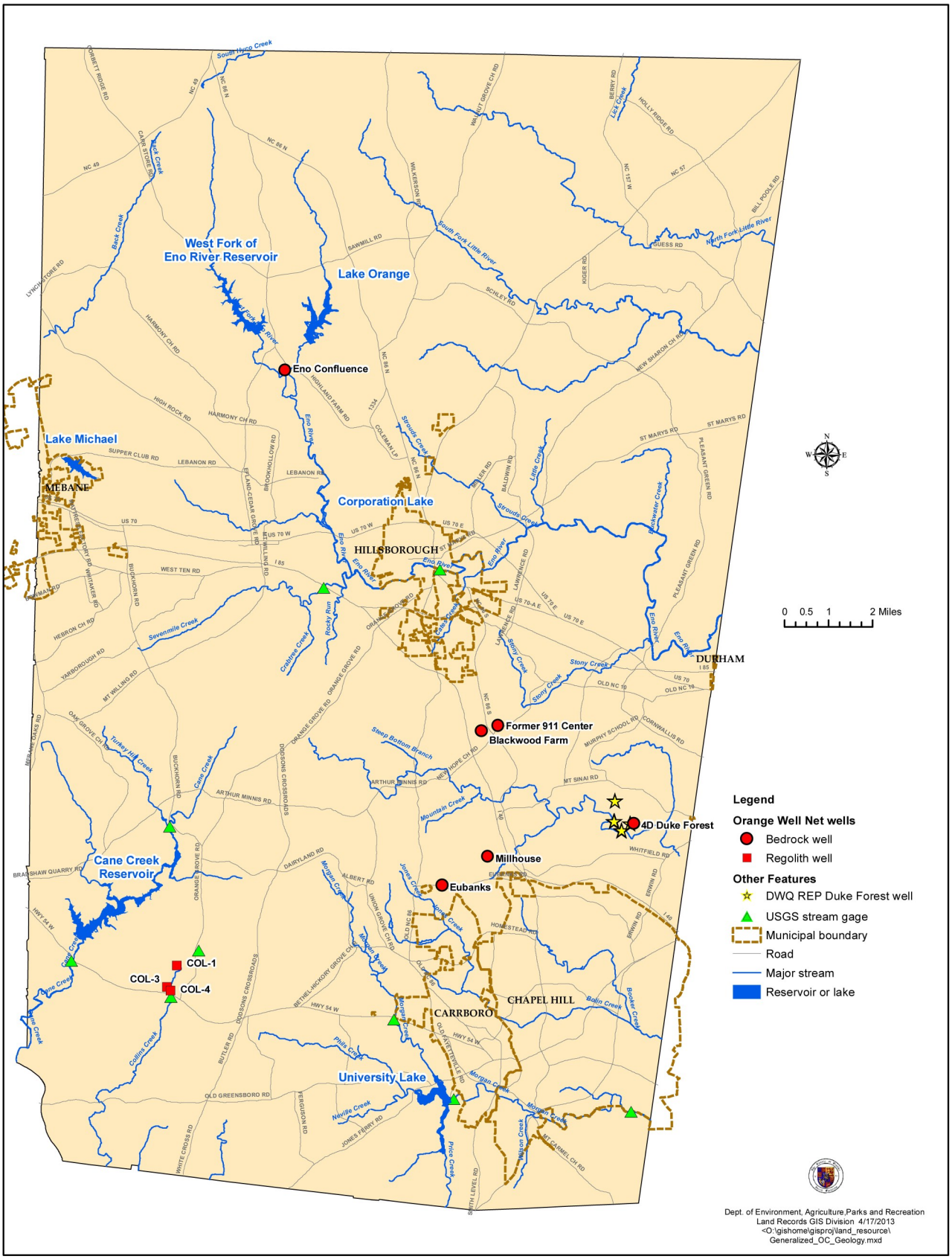


Figure 31. Orange Well Net Locations

Groundwater Quantity (continued)

Future plans for OWN include regolith and bedrock observation wells located in each of the nine main bedrock lithologies found in Orange County. All of the OWN bedrock wells were originally installed as water supply wells and are now being used only as observation wells. Additionally, the wells in use are located on parcels where further development of the site is unlikely, increasing the long-term usefulness of these wells.

Groundwater level data is automatically collected in each of the OWN wells. This information is downloaded periodically from the wells, and graphs of the data (known as hydrographs) are available to the public on the NCDENR Division of Water Resources web page:

http://www.ncwater.org/Data_and_Modeling/Ground_Water_Databases/leveltable.php?tl=1&net=orange&inactive

What is the trend in Orange County?

Example hydrographs, illustrating changes in groundwater levels over time in both a bedrock well and a regolith well, are provided in Figures 32 and 33. These figures illustrate how the groundwater level has fluctuated in the Blackwood Farm bedrock well and the Collins Creek regolith well (COL-4) since data collection began in these wells in 2010 and 2011, respectively. A statistical plot for the Blackwood Farm well hydrograph is also included. This graph demonstrates that the groundwater levels measured in January and February 2014 are considerably higher than similar measurements collected during those months since data collection began. This reflects the amount of rainfall that Orange County experienced throughout 2013 and into early 2014.

Additional information about OWN is available at:

http://orangecountync.gov/ercd/h2orange/wellobservation.asp

How can Orange County improve?

To support a sustainable future, Orange County should:

- Support the use of groundwater as a secure, sustainable source of potable water;
- Continue to operate and support the Orange Well Net groundwater observation well network; and
- Utilize the information obtained from OWN to increase awareness of local groundwater conditions.

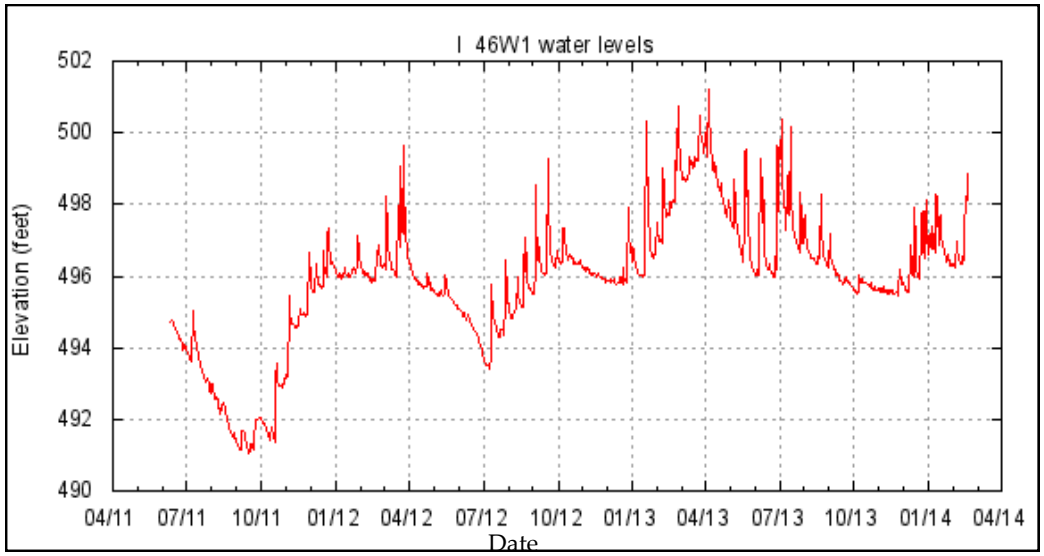
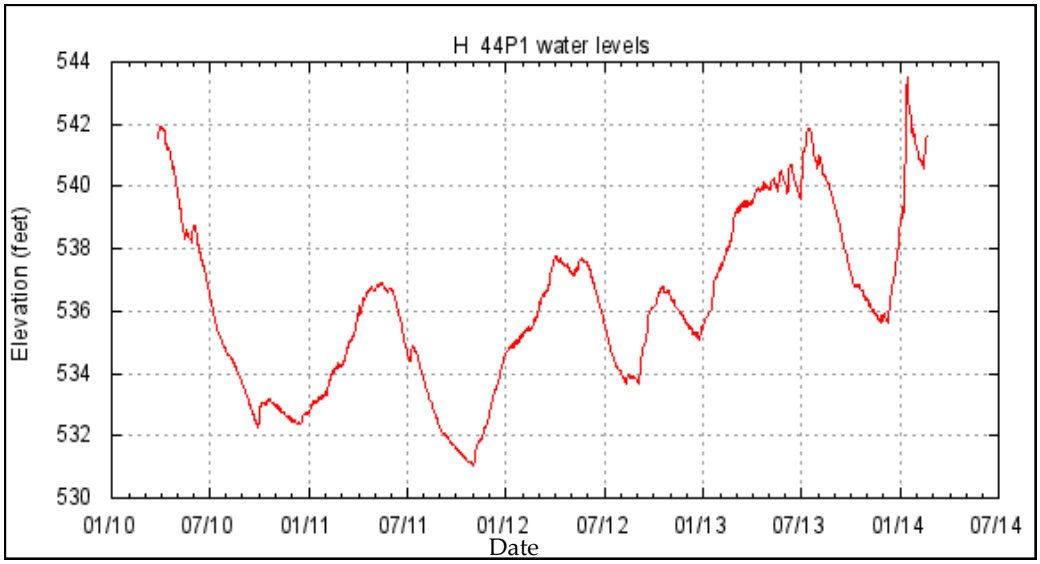


Figure 32. COL-4 Regolith Well Hydrograph



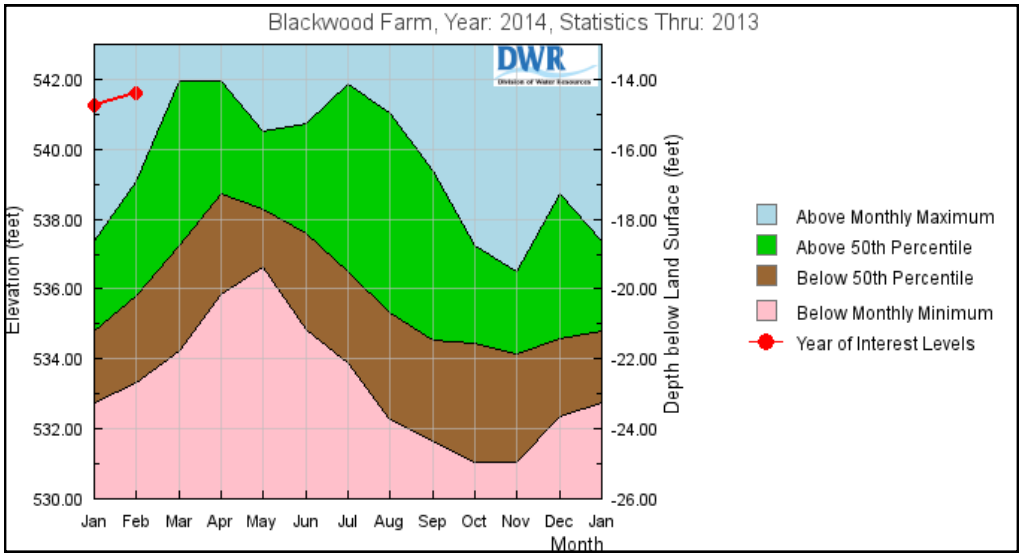


Figure 33. Blackwood Farm Bedrock Well Hydrograph and Statistical Plot

Why is this indicator important?

Information about groundwater quality in Orange County is somewhat limited. Cunningham and Daniel (2001) documented the quality of groundwater by sampling 51 wells across the county. While "few drinking water concerns" were identified through their research, their report did document a number of occurrences of compounds exceeding applicable drinking water standards. All of the reported instances involved compounds that naturally occur in groundwater, namely iron, manganese, zinc, radon and arsenic. As reported, no "organic contaminants analyzed (petroleum compounds and atrazine) or excessive nutrient concentrations were detected" in any of the groundwater samples collected during their investigation.

USGS Groundwater Observation Well in Duke Forest

How is this indicator measured?

Typically, groundwater quality is determined by collecting water samples and utilizing an analytical laboratory to measure the concentrations of certain compounds in the water. In Orange County, whenever a new drinking water well is installed, the water is sampled for bacteria, nitrates, nitrites, alkalinity, arsenic, calcium, chloride, copper, fluoride, hardness, iron, lead, magnesium, manganese, pH, sodium, and zinc. Testing for radon, pesticides, and organic constituents, such as those present in petroleum compounds, is also available upon request. While it is not possible to determine a "trend," an indication of local groundwater conditions can be determined based on available groundwater quality data.

What is the trend in Orange County?

Few non-naturally occurring compounds are detected in groundwater in Orange County. Though limited areas of groundwater contaminated with such materials do exist, they are nearly always present as a result of a spill or leak or similar incident.

Naturally-occurring compounds are also found in the groundwater in Orange County, some at concentrations above their respective Maximum Contaminant Levels (MCLs). The MCL is the maximum concentration of a compound that is allowed to be present in drinking water, as established by the US EPA. Iron, manganese, lead, zinc, radon, and arsenic are all naturally occurring compounds that have been found above their MCLs in the groundwater in Orange County, as shown in Figures 34 and 35.

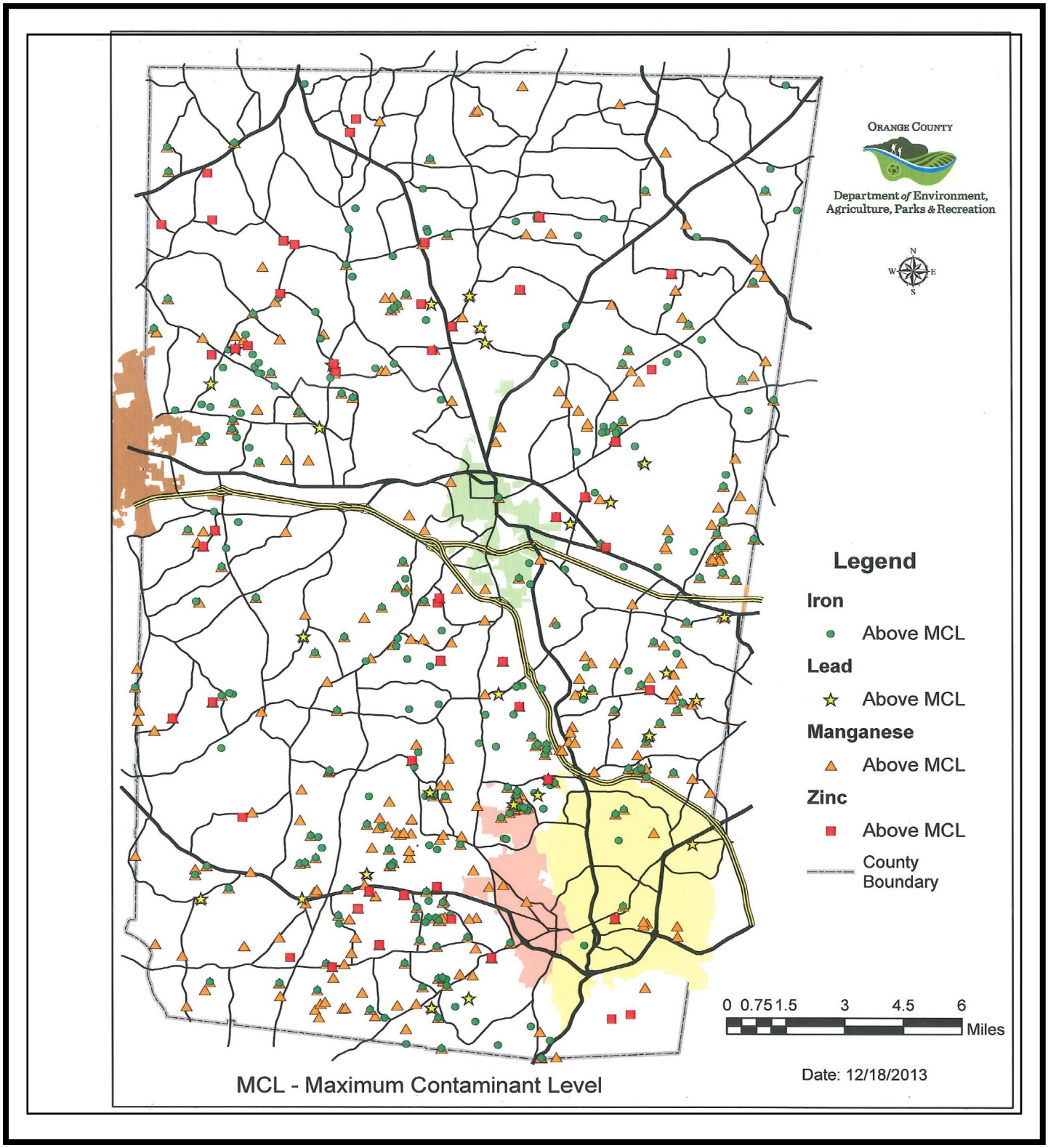


Figure 34: Iron, Lead, Manganese and Zinc in Groundwater
at Concentrations in Excess of their Respective Secondary MCLs

Groundwater Quality (continued)

Well House at Blackwood Farm

Iron, Manganese, and Zinc can affect the taste of water and cause staining. These compounds are termed "nuisance compounds" because they are most often not associated with human health impacts. Lead, which is often present in drinking water as a result of household plumbing materials, can cause health problems and is of larger concern.

More troublesome is the occurrence of arsenic and radon at concentrations in excess of their respective MCLs in groundwater in Orange County. Even though these compounds are naturally occurring, they can have serious health impacts. Radon, a gas formed from the decay of radium (typically found in granitic rocks), is the second leading cause of lung cancer in the United States.

While uncertainties exist concerning safe arsenic exposure levels, arsenic consumption has been linked to the occurrence of cancer as well as skin problems.

How can Orange County improve?

To support a sustainable future, Orange County should:

- Educate citizens about groundwater conditions in Orange County, including the occurrence of compounds with potential health risks;
- Encourage citizens to test their groundwater according to the schedule and rationale recommended by the Health Department;
- Make information available regarding groundwater contamination incidents in the county;
- Encourage residents to properly abandon out-of-service wells as required;
- Continue to educate residents of the importance of protecting groundwater from contamination; and
- Continue to inform citizens of the availability of the County Solid Waste Convenience Centers for the appropriate disposal of potentially hazardous materials.

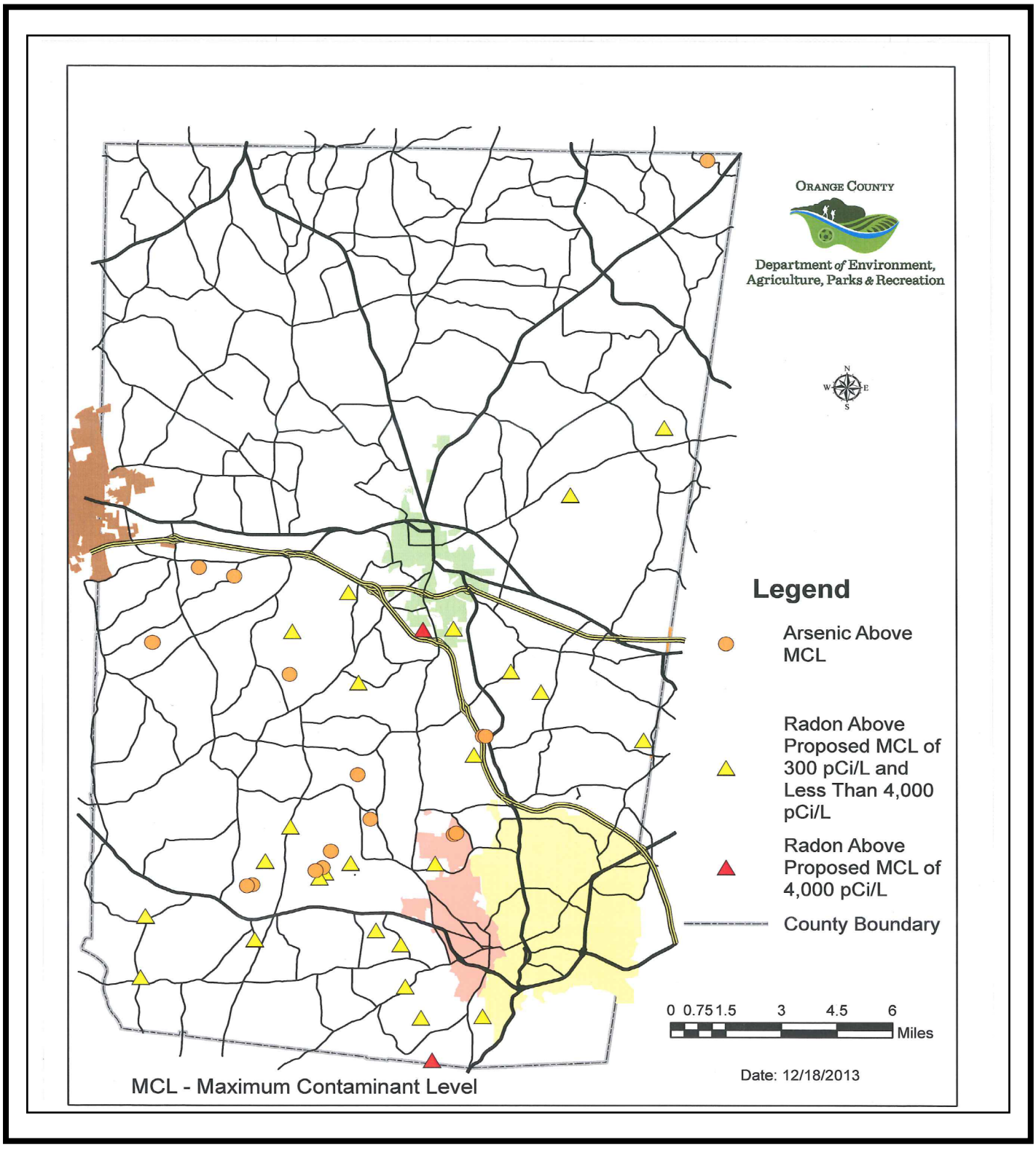


Figure 35: Arsenic and Radon in Groundwater
at Concentrations in Excess of Their Respective MCLs

Surface Water Quality: Specific Conductance

Why is this indicator important?

Specific conductance is a useful indicator of surface water quality because it is directly correlated with the amounts and types of dissolved inorganic solids, or ions, present in the water. Specific conductance is the measure of water's ability to conduct an electrical current. Typical ions in water include chloride, nitrate, sulfate, sodium, calcium, and phosphate, as well as metals such as iron and aluminum. Distilled water, which contains few, if any, dissolved solids, has a very low specific conductance, while sea water, which contains a significant concentration of ions, has a very high specific conductance.

Specific conductance, or conductivity, is affected by the geology of the area a stream runs through and the activities of people. Conductivity is also affected by surface area disturbances that create erosion and sedimentation, storm water runoff, and the release of waste materials into water bodies.

Tracking conductivity is a simple, low-cost means of monitoring surface water quality over time. According to the US EPA, "Conductivity is useful as a general measure of stream water quality. Each stream tends to have a relatively constant range of conductivity that, once established, can be used as a baseline for comparison with regular conductivity measurements. Significant changes in conductivity could then be an indicator that a discharge or some other source of pollution has entered a stream."

Objective NA-4 of the 2030 Comprehensive Plan encourages the County to support "adequate stormwater runoff controls in existing developed areas and require these controls for new subdivisions to protect sensitive downstream aquatic habitat."

How is this indicator measured?

Conductivity, which is measured in microsiemens per centimeter (uS/cm), is easily checked in the field using a hand-held water quality meter. Specific conductance is typically lowest when the volume of flow in a stream is highest (because of dilution), and conversely highest when flow is low.

According to the US EPA: "Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 μhos/cm. Conductivity outside this range could indicate that the water is not suitable for certain species of fish or macroinvertebrates."

What is the trend in Orange County?

Using data that is readily available online, the graphs on the accompanying page indicate that, in general, the specific conductance of the streams in Orange County that are included appears to be fairly low. Periodic elevated specific conductivity readings, such as the January 1996 elevated reading found in the Eno River at Hillsborough, are indicative of anomalies that would require further investigation to determine whether the variation is natural or due to human activity.

Canoeing in the Cane Creek Reservoir

Fairly consistent low conductivity measurements are illustrated in this graph of Eno River conductivity values at the US Geological Survey gage in Hillsborough (Figure 36). It also illustrates one isolated event in January 1996 of an elevated conductivity reading. It is not possible to pinpoint the cause of this elevated reading, although two winter storms in the area during the first two weeks of January may have influenced the conductivity reading obtained at that time, possibly as a result of some unusual activity (such as road salting) producing atypical runoff .

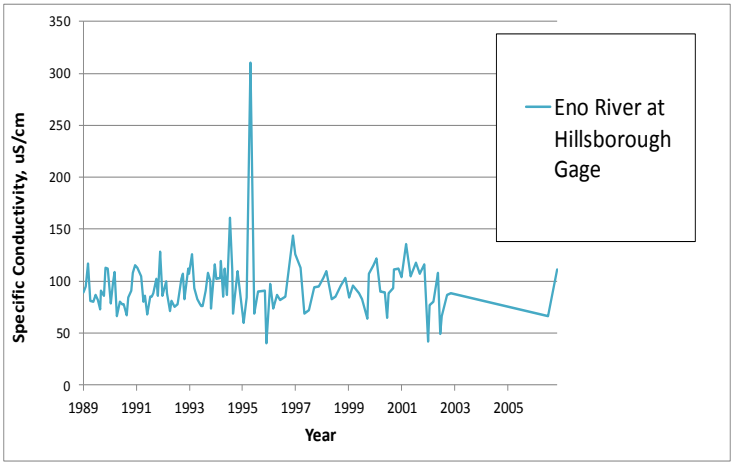


Figure 36. Specific conductivity values measured at USGS Eno River stream gage in Hillsborough, NC.

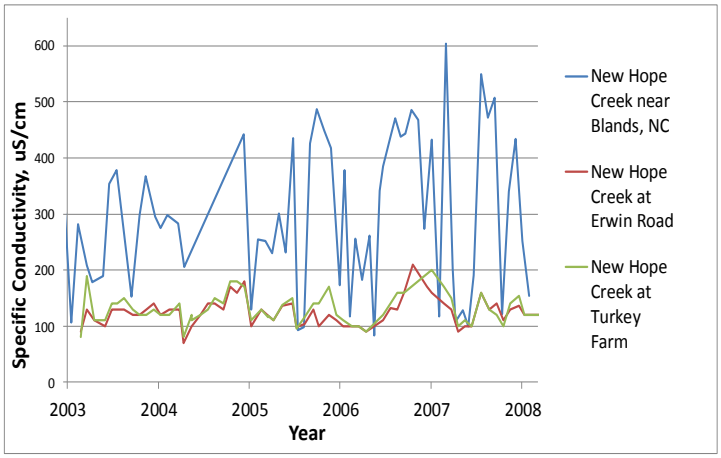


Figure 37. Specific conductivity values measured in New Hope Creek, Orange and Durham counties, NC.

Figure 37 demonstrates very little change in conductivity values as New Hope Creek flows through Duke Forest in Orange County from Turkey Farm Road to Erwin Road. The graph also illustrates an appreciable increase in conductivity values once the stream exits Orange County and flows past the wastewater treatment plant near Blands (just upstream of Jordan Lake). Much greater variation in conductivity values is observed at the Blands location than at the other two upstream sites.

Figure 38 demonstrates consistently low measurements of specific conductivity in the Little River, which drains the northern third of Orange County. Conductivity values for Cane Creek, in the southwestern area of the County, are also fairly uniform and low. The values for the Haw River however are much more variable and consistently higher. The Haw River drains a large watershed outside of and to the west of Orange County, including several urban centers (for example, Burlington) and a considerable amount of agricultural lands, both of which are likely to add significant amounts of ions to the water in the Haw.

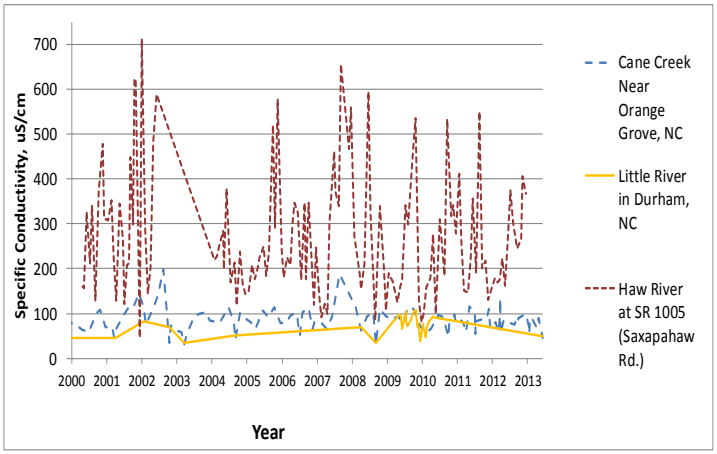


Figure 38. Specific conductivity values measured in Cane Creek, the Haw River and the Little River.

Data Sources: City of Durham Stormwater Services, USGS National Water Information System (http://waterdata.usgs.gov/nwis), and US EPA Storet (http://www.epa.gov/storet/)

Surface Water Quality: Surface Water Use Assessment

Why is this indicator important?

The NC Division of Water Resources (DWR) classifies all perennial waters in North Carolina according to their Highest and Best Intended Uses (including swimming, fishing, shellfish harvesting, and other uses). Periodically, DWR evaluates how closely water bodies are meeting (or "supporting") these designated uses. However, due to DWR staff and budget limitations, only the reservoirs and a few of the largest streams in Orange County are regularly monitored, with streams typically sampled only once every five years.

Biological and chemical data are collected from water bodies and used by DWR to determine if water bodies are supporting their designated uses. Through this process, waters that are found to be either Partially Supporting or Not Supporting their designated uses are considered Impaired and are placed on the North Carolina List of Impaired Water Bodies, commonly termed the "303(d) list." Waters that are found to be meeting their intended uses are termed Fully Supporting. All streams, lakes, and reservoirs that are sampled by DWR and are either impaired or supporting their assigned use are listed in the Integrated Report prepared by DWR every two years.

Stoneflies, an aquatic benthic macroinvertebrate, are indicative of good water quality (US EPA)

The importance of "use support ratings" was detailed in the 2030 Orange County Comprehensive Plan, which includes a County goal to "reduce the number of 303(d) impaired streams by minimizing impacts of non-point and point source pollution" (Objective WR-17).

Types of surface water impairment

The *National Rivers and Streams Assessment: 2008-2009: A Collaborative Survey*, published by the US EPA in 2013 concluded that "55% of the nation's rivers and streams do not support healthy populations of aquatic life, with phosphorus and nitrogen pollution and poor habitat the most widespread problems."

Surface waters in the Piedmont area of North Carolina are affected by several types of impairment. As reported by the US EPA, over-enrichment of nutrients (nitrogen and phosphorus) is common in lakes and reservoirs in this area. DWR does not directly measure nitrogen and phosphorus concentrations but instead uses concentrations of chlorophyll-a, a surrogate used as a measure of the concentration of algae, as an indicator of nutrient content. Other specific water quality parameters that periodically violate state-established standards in surface waters include dissolved oxygen, temperature, and nitrates. Excessive quantities of sediment in surface water are another common cause of poor water quality. All of these materials can negatively impact stream habitat, which in turn impacts benthic macroinvertebrate (bottom dwelling insect larvae) and fish populations. These populations can also be negatively affected by droughts and extended low flow conditions. Due to the sensitivity of these organisms, DWR monitors their populations as one of the primary means of assessing the quality of surface waters in the state over time.

Sediment in Old Field Creek
as it flows into New Hope Creek

How is this indicator measured?

DWR aquatic biologists sample surface water bodies across the state to measure fish and benthic macroinvertebrate populations. Biologists also test fish tissues for the presence of harmful metals and chemicals, measure algae blooms, and sample waters in order to measure the concentrations of various chemical compounds. This information allows scientists to determine the overall quality of a body of water and allow for analysis of changes in water quality over time.

In June 2013, in order to obtain more information about water quality in Orange County, the County completed a benthic macroinvertebrate study of two water bodies that were previously listed as impaired by DWR: Collins Creek and the uppermost reach of the Eno River, shown in Figure 40.

Collins Creek, a small stream located in the rural southwestern portion of the county, has had a range of ratings assigned by DWR since sampling was initiated in this stream in 1986. The upper reach of the Eno River, which has been sampled by DWR since 1991, was first listed as impaired by DWR in 2012.

What is the trend in Orange County?

It is difficult to determine an overall trend in surface water quality throughout Orange County. Of the 1,044 miles of streams in Orange County, 664 miles are intermittent streams. Intermittent streams are not assigned a Highest and Best Intended Use by DWR and as a result are never sampled for use assessment determination (See Table 4 below and Figure 40 on page 68).

Furthermore, 80 miles of perennial streams in the County have not been assigned a use by DWR and as a result were not assessed for inclusion in the 2012 Integrated Report. An additional 183 miles of perennial stream in Orange County with a designated use were also not assessed by DWR as part of the development of the 2012 Integrated Report. The net result is that only a small fraction of the streams found in Orange County (117 miles) were monitored for inclusion in the 2012 Integrated Report. This lack of widespread comprehensive information makes large-scale trend determination impossible; detailed information, along with general conclusions, are available for only a small number of streams and lakes in Orange County, and are included on the following pages.

Table 4.
Stream Assessment in Orange County

Stream Type	DWR Assessment Status	Miles
Intermittent Streams	Without Designated Use; thus Not Assessed by DWR	664
Perennial Streams	Without Designated Use; thus Not Assessed by DWR	80
Perennial Streams	With Designated Use, but Not Assessed by DWR in 2012 process	183
Perennial Streams	With Designated Use, and Assessed by DWR in 2012 process	117

Surface Water Quality: Surface Water Use Assessment (continued)

Specific Results for Orange County

As was noted earlier only 117 of the 1,044 total miles of streams in Orange County were assessed by DWR during the latest use support assessment process. The majority of streams that were assessed were determined to be meeting use assessment guidelines (i.e., not "impaired"). Only 19.8 miles of streams in the county were classified as "impaired" by DWR in its draft 2012 Integrated Report (Figure 39).

The following three streams are included as examples of the limited locations in the county for which specific water quality information is available:

Collins Creek

The June 2013 macroinvertebrate sampling conducted by Orange County rated Collins Creek (Figure 40) as "Fair." This was actually a slight improvement over a 2012 sampling event conducted by DWR. A rating of "Fair" or "Poor" causes a water body to be classified as impaired by DWR and added to the NC List of Impaired Water Bodies, also known as the "303(d) list." The 2013 sampling at this location indicated possible water quality problems in Collins Creek may be caused by organic loading, low dissolved oxygen content, and/or low water flow. Low flows are common during the summer months in streams in the Carolina Terrane region of North Carolina, which includes nearly all of Orange County.

East and West Forks of the Eno River

The benthic macroinvertebrate communities in the East and West Forks of the Eno River (Figure 40) were sampled in June 2013. The East Fork was rated "Fair" with infrequent riffles, a high silt load, and low summer flows listed as potential bio-logical stressors. The West Fork also received a "Fair" rating despite indications of better water quality than in the East Fork. The benthic biologist that completed this project postulated that repeat-ed recent summer droughts might be responsible for decreases in stream ratings since dry conditions negatively impact aquatic communities (including benthic macro-invertebrates).

Morgan Creek

Benthic sampling in Morgan Creek (Figure 40) since 1985 indicates a declining trend in water quality. The biologist conducting these investigations postulates that the decline may be due to increased upstream development in the Morgan Creek watershed, in addition to repeated droughts and low-flow conditions in the watershed.

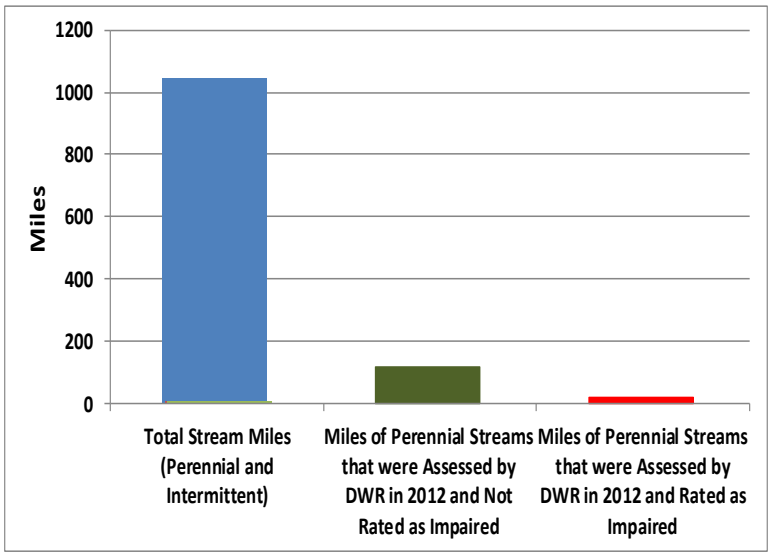


Figure 39
Summary of 2012 Stream Assessment in Orange County

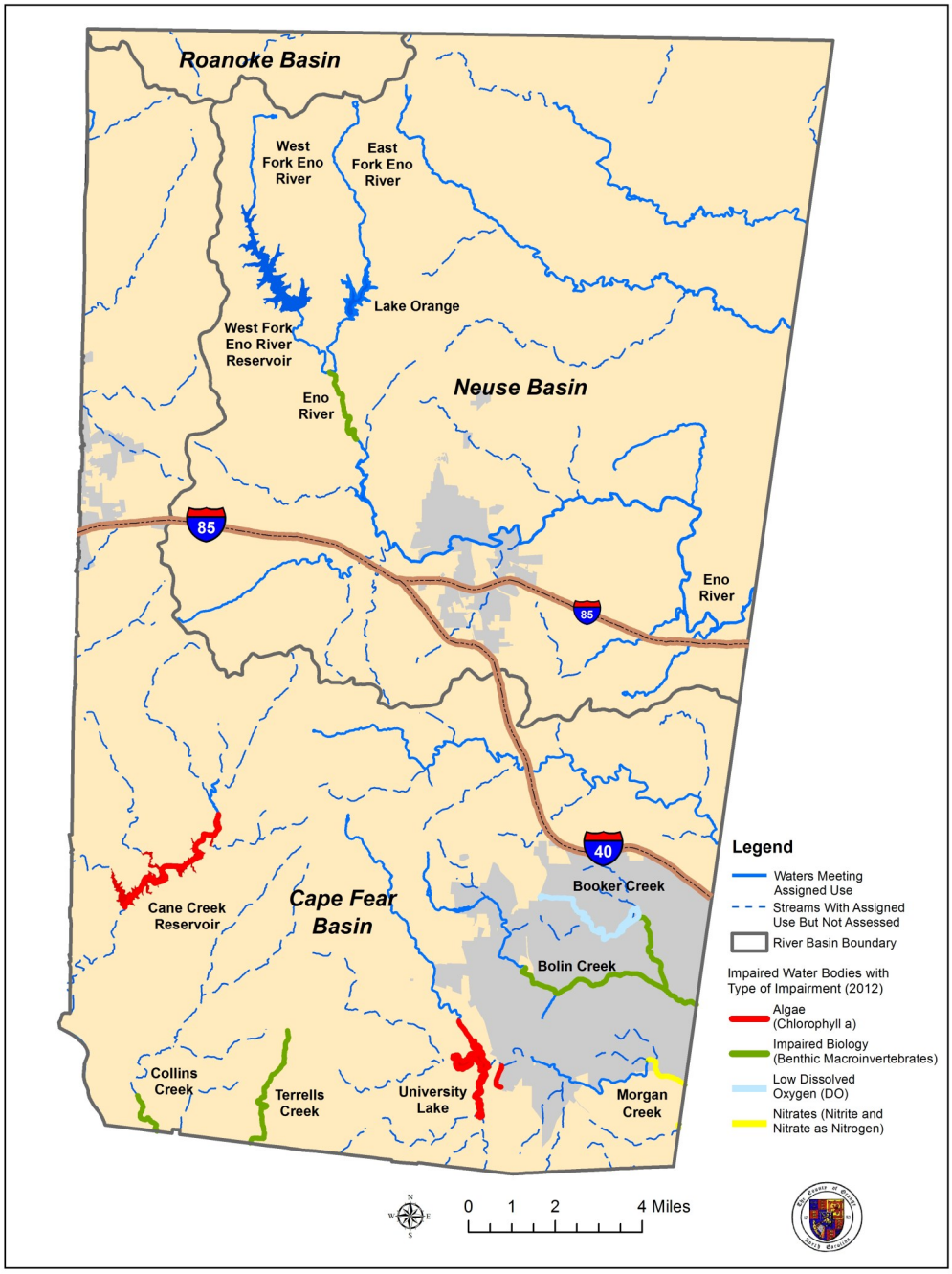


Figure 40: Impaired Water Bodies in Orange County, 2012

How can Orange County improve?

To support a sustainable future, Orange County should:

- Continue acquiring property and conservation easements to protect surface water bodies;
- Maintain and enforce streamside buffer requirements to protect water quality;
- Enforce and support regulations to control stormwater runoff, especially from construction sites;
- Seek and support efforts to gather additional water quality information where possible;
- Support efforts to improve water quality, especially downstream of urban areas of the County;
- Continue to collect and publicize information concerning surface water quality; and
- Publicize information about, and educate citizens concerning, surface water quality in the County.

Overview

Non-native, invasive aquatic plant species appear to be flourishing in many surface water bodies in Orange County. These plants compete with native vegetation and, without control, can result in water quality and aquatic habitat degradation. Many invasive aquatic plants were brought to the United States for use in aquariums or ornamental ponds; they were then most likely introduced to aquatic ecosystems when aquariums were cleaned, or when aquatic nurseries, ornamental ponds, or water gardens were flooded. In some cases, aquatic invasives have been intentionally introduced to the environment in a mistaken attempt to improve fish habitat. These plants can also be transported to new water bodies by boats, wind, aquatic birds, and through the natural movement of water.

Invasive plants deteriorate water quality in a number of ways. First, these plants often grow as dense mats of vegetation on top of or near the water surface, thereby reducing light penetration and potentially lowering the amount of dissolved oxygen in a water body. Dissolved oxygen is significantly decreased when this large amount of vegetation dies all at once, potentially leading to a massive fish kill.

These plants can also harm native ecosystems by crowding out native plant populations which can in turn lead to negative impacts on macroinvertebrates and other species dependent upon native aquatic plants for food or shelter. Large infestations can dramatically limit the availability of spawning areas for native fish.

Dense mats of vegetation can limit the use of ponds and lakes for swimming, fishing, boating, and other recreational activities. Severe infestations depreciate the aesthetic value of waterways. Water supply intake structures can be blocked by invasive aquatic plants.

Local Status

Invasive aquatic plants that are present in Orange County include hydrilla, parrot feather, creeping water primrose, brittle naiad, and alligator weed.

Hydrilla was first noted in the Eno River State Park in 2005. Since then, this invasive plant has spread dramatically such that park superintendent identifies hydrilla as the main resource management problem in the Park. Currently, a multi-agency group is investigating options for managing this invasive plant in the Eno River, including citizen education and awareness.

Hydrilla has been detected in the West Fork Reservoir since at least 2008 and was noted even earlier in Lake Orange. Repeated management efforts have been undertaken in these reservoirs to control this plant.

The Orange Alamance Water System has found both hydrilla and parrot feather in Corporation Lake, and has instituted management efforts to reduce the presence of hydrilla in their reservoir.

The Orange Water and Sewer Authority has detected alligator weed and brittle naiad in Cane Creek Reservoir and creeping water primrose in University Lake.

Infestation Management and Prevention

Aquatic weeds are managed using a number of different methods. Typically, removal of the weeds with tools or mechanical equipment is tried first. Sterile grass carp are often added to lakes and reservoirs to consume invasive aquatic plants. Several US EPA-approved herbicides are also available for managing invasive aquatic plants, even in water supply reservoirs.

Hydrilla in the Eno River at the Pleasant Green Access Area, 2011

(North Carolina Division of Parks and Recreation)

How can Orange County improve?

To support a sustainable future, Orange County should:

- Undertake a campaign to inform the public about invasive aquatic species, including their current extent in our waterways, the likely ramifications of the occurrence of these species in Orange County, and what steps can be undertaken to slow their spread or eliminate them locally.

What you can do:

- Report the presence of suspected invasive aquatic plants to the Orange County Cooperative Extension Center (919-245-2050), or the NC Division of Water Resources Aquatic Weed Control Program (919-707-9012);
- Don't dump live bait or aquarium water into waterways; and
- Check to be sure boating equipment and fishing boots are clear of plant life before using in a new location.

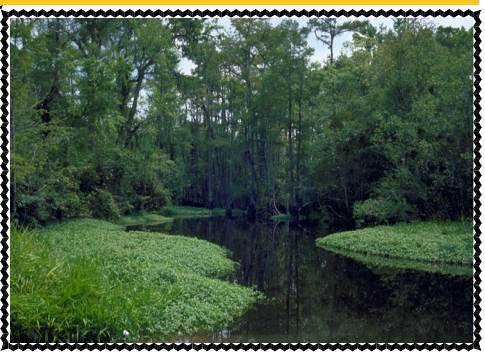
Sources: OWASA, Town of Hillsborough, Eno River Association, and NCDENR Division of Water Resources.

Parrot feather

Graves Lovell, Alabama Department of Conservation and Natural Resources

Creeping Water Primrose

Karan Rawlins, University of Georgia



Alligator weed

Gary Buckingham, USDA Agricultural Research Service

Introduction

The United States contains vast reserves of shale gas deposits, also known as "plays" (Figure 41). Extraction of the shale gas from these deposits is on-going using a technique known as hydraulic fracturing, or "fracking." In North Carolina, organic-rich shale deposits are known to exist only in sedimentary basins of Triassic age; those basins containing Triassic rocks that are exposed at the surface are shown in Figure 42

Only a small portion of Orange County is underlain by the Triassic age Deep River Basin which is composed of three sub-basins; from north to south they are the Durham sub-basin, the Sanford sub-basin, and the Wadesboro sub-basin (Figure 41). The central portion of the Sanford sub-basin contains an 800-foot-thick deposit of organic-rich shale known as the Cumnock Formation. Limited preliminary activity has identified potentially commercially viable natural gas resources in a 59,000-acre portion of the Sanford sub-basin located west of Sanford and mainly in Lee County.

In 2011, the NC General Assembly directed the departments of Environment and Natural Resources (DENR), Commerce, and Justice, to investigate the implications of directional drilling and fracking for oil and natural gas production in North Carolina. The resulting "North Carolina Oil and Gas Study" was published in April 2012.

In 2012 the General Assembly overrode then Governor Perdue's veto of the Clean Energy and Economic Security Act, thereby legalizing horizontal drilling for natural gas extraction. The Act prohibits the issuance of permits for drilling until the General Assembly approves regulations governing these activities. The Act also created a new state board, the North Carolina Mining and Energy Commission, and tasked this board with developing regulations governing horizontal drilling and fracking by no later than October 2014. Additionally, the North Carolina Environmental Management Commission will draft select regulations and NCDENR will coordinate all rulemaking activities.

Drilling Rig in Shale Gas Basin
Photo by Susan Brantley/Science

Concerns

Similar to other heavy industrial activities (including oil drilling, road construction, and large-scale residential, commercial, or industrial development), the fracking process includes several activities that could result in adverse environmental impact, including the following:

- Possible contamination of surface water and groundwater;
- Negative impacts to water supplies;
- Wastewater disposal issues;
- Negative air quality impacts;
- Negative infrastructure impacts; and
- Detrimental social impacts

Conclusions

The low price and large supply of domestic natural gas, as well as the significant amount of gas already known to exist in other large shale deposits in the United States, make extraction activities in North Carolina unlikely in the near term. Furthermore, wide-scale fracking within Orange County is even more unlikely given the limited extent of Triassic-age rocks within the county.

Nevertheless, were drilling to occur in nearby Lee and Chatham counties, indirect impacts could be felt in Orange County, thereby making it prudent for citizens to be concerned with the development of this industry.

Of particular interest in the coming months will be the draft regulations developed by the Energy and Mining Commission, including those that address setback requirements from water bodies, well-pad siting, forced pooling, and disclosure requirements for fracking fluids, as well as water withdrawal requirements and wastewater disposal regulations. For instance, in January 2014, the Energy and Mining Commission determined that fracking companies will not have to disclose information concerning the chemical make-up of fluids used in the fracking process except in limited emergency situations.

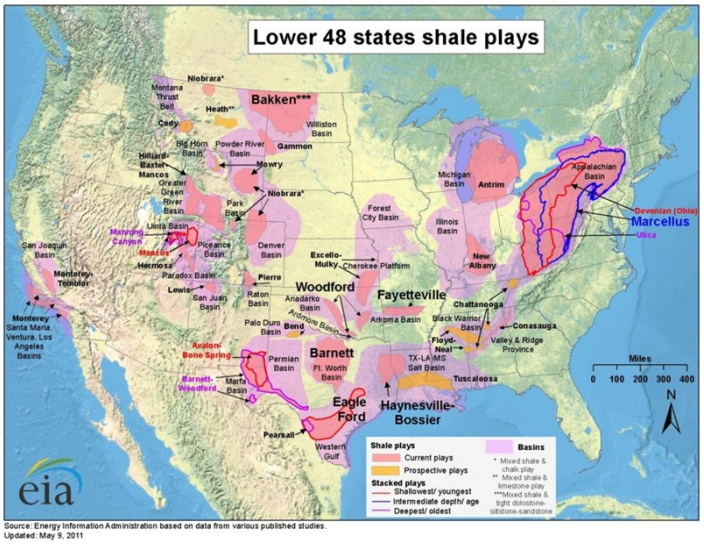


Figure 41. Shale Gas Deposits in the Continental US
(US Energy Information Administration)

What you can do:

Learn more about the fracking process and North Carolina geology:

- http://portal.ncdenr.org/web/guest/shale-gas
- http://www2.epa.gov/hydraulicfracturing
- http://www.ie.unc.edu/issues/fracking.cfm

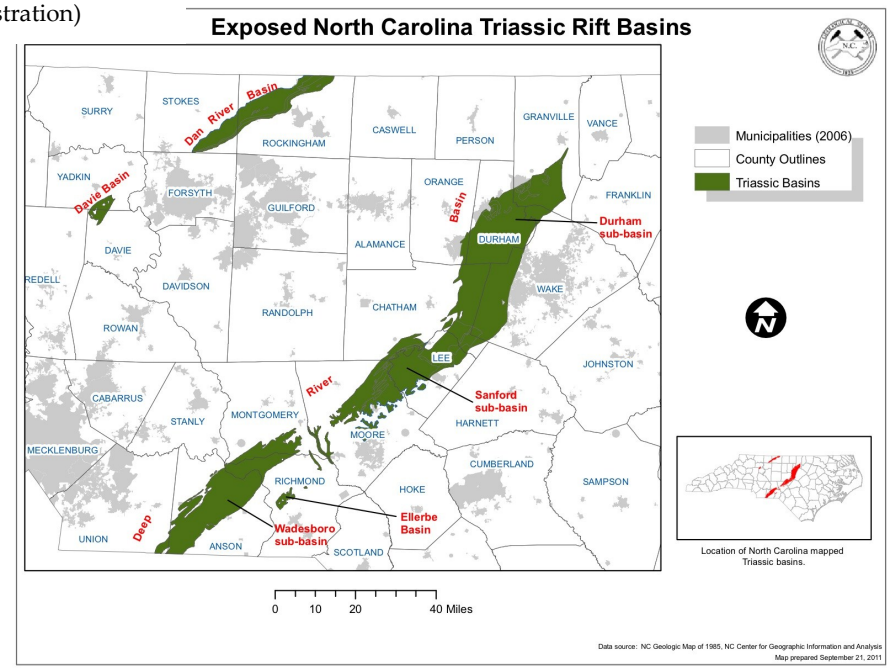


Figure 42
Exposed Triassic-Age Rift Basins in NC
(North Carolina Geological Survey)

Appendix 1

Municipal and Unincorporated Populations, 1980-2050

Municipal and Unincorporated Populations, 1980-2050
Orange County, NC

	1980 Census	1990 Census	2000 Census	2010 Census	2020 Projected	2030 Projected	2040 Projected	2050 Projected
Carrboro								
Population	7,336	12,134	16,782	19,582	24,967	31,833	40,587	51,749
Land area (sq. mi.)	2.47	3.53	4.47	6.30	6.50	6.50	6.50	6.50
Persons per sq. mi.	2,970	3,437	3,754	3,108	3,841	4,897	6,244	7,961
Chapel Hill (within Orange Co.)								
Population	32,038	37,596	46,798	54,397	65,440	78,724	94,705	113,930
Land area (sq. mi.)	12.37	15.98	18.37	19.53	20	20	20	20
Persons per sq. mi.	2,590	2,353	2,548	2,785	3,272	3,936	4,735	5,696
Hillsborough								
Population	3,019	4,263	5,446	6,087	7,292	8,736	10,466	12,538
Land area (sq. mi.)	2.16	3.55	4.58	5.30	5.40	5.40	5.40	5.40
Persons per sq. mi.	1,398	1,201	1,189	1,148	1,350	1,617	1,938	2,321
Mebane (within Orange County)								
Population	379	485	675	1,793	3,952	8,710	19,196	42,308
Land area (sq. mi.)	0.2	0.25	0.57	1.74	1.9	1.9	1.9	1.9
Persons per sq. mi.	1,895	1,940	1,184	1,030	2,080	4,584	10,103	22,267
Unincorporated Areas								
Population	34,283	39,373	48,526	51,942	58,655	64,240	65,816	56,782
Land area (sq. mi.)	382.8	376.7	372.0	367.1	366.7	366.7	366.7	366.7
Persons per sq. mi.	90	105	130	141	159	175	179	154
Total County								
Population	**77,055**	**93,851**	**115,531**	**133,801**	**160,306**	**192,243**	**230,770**	**277,307**
Land area (sq. mi.)	400	400	400	400	400.9	400.9	400.9	400.9
Persons per sq. mi.	**193**	**235**	**289**	**335**	**399**	**479**	**575**	**691**

	1980	**1990**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Carrboro	7,336	12,134	16,782	19,582	24,967	31,833	40,587	51,749
Chapel Hill	32,038	37,596	46,798	54,397	65,440	78,724	94,705	113,930
Hillsborough	3,019	4,263	5,446	6,087	7,292	8,736	10,466	12,538
Mebane	379	485	675	1,793	3,952	8,710	19,196	42,308
Unincorporated Areas	34,283	39,373	48,526	51,942	58,655	64,240	65,816	56,782
County Total	**77,055**	**93,851**	**115,531**	**133,801**	**160,306**	**192,243**	**230,770**	**277,307**

2012 population estimate of 138,330 from NC Office of State Budget and Management.

Appendix 2

Total Acres of Protected Land in Orange County, 2013

Total Acres of Protected Land In Orange County

Permanently Protected Lands

Organization	Type	Pre-1981	1981-90	1991-2000	2001-04	2005-08	2009-13	TOTALS
Black Family Land Trust	Easement						40	40
Botanical Garden Fdn	Fee-simple		17	77	3			97
Botanical Garden Fdn	Easement			23		*92**	6	29
Town of Carrboro	Fee-simple				27			27
Town of Chapel Hill	Easement						8	8
Cons. Trust for NC	Easement			143				143
Earthmark/EBX Neuse**	Easement					30	29	59
Eno River Association	Fee-simple			17	28	117	1	163
Eno River Association	Easement						102	102
Historic Preservation Fdn of NC	Fee-simple				1			1
NC Wildlife Habitat Foundation	Easement						60	60
Orange County (Lands Legacy)	Fee-simple			63	135	59	11	269
Orange County (Lands Legacy)	Easement			8	560	791	487	1,800
OWASA	Fee-simple	73	1,983	1,300	275	74		3,705
OWASA**	Easement			93	387			480
Eno River State Park	Fee-simple	800	800	374	1148	189	24	3,335
Town of Hillsborough	Fee-simple			726	2		23	751
Town of Mebane (Reservoir)	Fee-simple	258						258
Occoneechee. Mtn State Natural Area	Fee-simple			96		66		162
State of NC (NCSU)	Fee-simple				133	136		269
State of NC (CWMTF)*	Easement			*328*	*256*	*228*	25	25
State of NC (EEP)*	Easement					180	32	212
State of NC (ERSP)*	Easement				2	4	17	23
State of NC (CREP)	Easement							*0*
State of NC (DENR)	Easement						96	96
Triangle Land Conservancy	Fee-simple		5	428	35	262	718	1,448
Triangle Land Conservancy**	Easement		9	348	284	10	72	723
US Army Corps of Engineers	Fee-simple	98						98
US Fish & Wildlife Service**	Easement		45					45
SUB TOTALS		**1,229**	**2,859**	**3,696**	**3,020**	**1,918**	**1,751**	**14,473**

Partially Protected Lands

Organization	Type	Pre-1981	1981-90	1991-2000	2001-04	2005-08	2009-13	TOTALS
Town of Carrboro	Fee-simple		28	67	1	96		192
Town of Chapel Hill	Fee-simple	131	152	133	255	4	4	679
City of Durham	Fee-simple			11				11
Town of Hillsborough	Fee-simple		52	44		96		192
Moorefields Foundation	Fee-simple		85				-13	72
Orange County (Lands Legacy)	Fee-simple	331	33	38	404	147	13	966
Duke University	Fee-simple	2,419	397	2,175	71	40	-10	5,092
State of NC (CREP)	Term Easement					5		5
Private Homeowners Assoc.	Fee-simple	70	239	562	265	147	75	1,358
Classical Am Homes Preservation Trust	Fee-simple			263			-80	183
Univ. of NC at Chapel Hill	Fee-simple	200	1,093	90		41		1,424
SUB TOTALS		**3,151**	**2,079**	**3,383**	**996**	**576**	**-11**	**10,170**

TOTAL	**24,647**

DEAPR Dec 2013

* Only conservation easements held on previously unprotected land counted in totals (so not "double counted")

** If conservation easement held by more than one entity, only primary holder is counted in totals

Appendix 3

Total Acreage in the Present Use Value Program, 1993-2013

Total Acreage in the Present Use Value Program, 1993-2013
Orange County, NC

	1993-1996			1997-2000			2001-2004		
Land Use Category	Number of Parcels	Acres	Percent of Total County Land Area	Number of Parcels	Acres	Percent of Total County Land Area	Number of Parcels	Acres	Percent of Total County Land Area
Agriculture	1,676	46,774	18.2	1,721	46,252	18.0	1,742	44,981	17.5
Forestry	1,931	66,447	25.9	1,975	66,452	25.9	2,096	64,973	25.3
Horticulture	2	13	0.0	6	49	0.0	17	138	0.0
Land Use totals*	2,295	114,762	44.7%	2,324	114,412	44.6%	2,469	111,921	43.6%
County Totals **	37,906	256,800	100%	41,670	256,800	100%	45,043	256,800	100%

	2005-2008			2009-20013		
Land Use Category	Number of Parcels	Acres	Percent of Total County Land Area	Number of Parcels	Acres	Percent of Total County Land Area
Agriculture	1,816	42,8004	16.6	1,958	43,453	16.9
Forestry	2,227	60,818	23.7	2,483	64,229	25.0
Horticulture	26	193	0.0	31	243	0.0
Land Use totals*	2,619	105,679	41.2%	2,927	111,611	43.5%
County Totals **	350,969	256,800	100%	54,092	256,595	100%

* Some parcels are included in more than one category (e.g., both agriculture and forestry)

** Orange County's land area decreased from 256,800 acres to 256,595 acres following the revised boundary agreements with Alamance County in 2012-13

Appendix 4

Sample Results from the Calling Amphibian Survey Program

Calling Amphibian Survey Program

(Sample results from 4 routes in Orange County, 2010-2013)

Source: NC Partners in Amphibian and Reptile Conservation http://www.ncparc.org/casp/casp.htm

Note: 0 means not recorded as present; 1, 2, 3 mean species was detected calling on the survey route.

Cedar Grove (631004)

Species	Survey date	Stop number									
		1	2	3	4	5	6	7	8	9	10
American Toad	Apr-7-2011	1	2	1	0	0	0	0	0	0	0
	Feb-23-2012	0	0	1	1	0	2	0	0	0	0
	Apr-28-2012	0	0	0	1	0	0	0	0	0	0
	Apr-13-2013	0	0	0	1	0	0	0	0	0	0
Fowler's Toad	Jun-15-2013	0	0	2	1	0	2	0	0	0	0
Northern Cricket Frog	Apr-7-2011	0	3	0	0	0	3	0	0	0	0
	Jun-27-2011	3	0	0	0	0	0	0	0	0	0
	Apr-28-2012	0	2	0	0	0	0	0	2	1	0
	Jun-10-2012	0	3	3	0	3	3	3	3	3	3
	Apr-13-2013	0	2	0	0	0	0	0	2	1	0
	Jun-15-2013	0	3	0	0	3	3	3	3	3	0
Green Treefrog	Jun-27-2011	3	0	0	0	0	0	0	0	0	0
	Jun-10-2012	0	2	3	0	0	2	0	0	0	0
	Jun-15-2013	3	3	0	0	0	3	0	0	0	0
Squirrel Treefrog	Jun-15-2013	0	0	0	0	0	2	0	1	0	0
Cope's Gray Treefrog	Jun-27-2011	0	2	0	0	0	0	0	0	0	0
	Jun-10-2012	2	3	3	3	3	2	2	3	2	3
	Jun-15-2013	3	3	3	3	3	2	2	3	3	0
Spring Peeper	Feb-18-2011	3	2	2	2	0	0	2	1	0	1
	Feb-25-2011	3	3	3	3	0	0	0	1	0	1
	Apr-7-2011	3	3	3	2	2	3	2	2	3	2
	Feb-23-2012	3	3	3	2	2	3	3	3	2	2
	Apr-28-2012	0	0	2	1	0	0	0	0	0	1
	Jun-10-2012	1	0	0	0	0	0	0	0	0	0
	Mar-10-2013	3	3	3	3	3	2	2	3	2	2
	Apr-13-2013	0	0	2	1	0	0	0	0	0	1
Upland Chorus Frog	Feb-18-2011	2	0	3	2	0	0	2	3	3	0
	Feb-25-2011	0	0	1	0	0	0	0	1	3	0
	Apr-7-2011	0	0	0	0	0	0	0	0	0	3
	Feb-23-2012	2	1	2	1	1	3	2	2	2	1

	Apr-28-2012	0	0	0	0	0	0	1	0	0	0
	Mar-10-2013	0	2	1	1	0	0	0	2	2	0
	Apr-13-2013	0	0	0	0	0	0	1	0	0	0
Eastern Narrow-mouthed Toad	Jun-10-2012	0	0	3	0	3	3	3	0	3	2
	Jun-15-2013	2	0	2	0	0	3	2	3	2	3
American Bullfrog	Apr-28-2012	0	0	1	0	1	2	0	0	1	0
	Jun-10-2012	0	0	0	0	1	1	0	0	0	0
	Apr-13-2013	0	0	1	0	1	2	0	0	1	0
	Jun-15-2013	0	2	1	0	1	2	0	0	2	0
Green Frog	Apr-28-2012	0	2	0	0	0	0	0	2	0	0
	Jun-10-2012	0	2	2	1	1	2	1	0	1	0
	Apr-13-2013	0	2	0	0	0	0	0	2	0	0
	Jun-15-2013	0	2	0	0	0	1	0	1	1	0
Southern Leopard Frog	Apr-7-2011	1	1	0	0	0	0	0	0	0	0
	Feb-23-2012	0	1	1	0	0	1	0	0	0	0
	Apr-28-2012	1	0	0	0	0	0	0	0	0	0

Efland (630804)

Species	Survey date	Stop Number									
		1	2	3	4	5	6	7	8	9	10
American Toad	Mar-3-2012	0	2	2	0	0	3	2	0	0	0
Fowler's Toad	Jun-9-2010	0	1	0	1	3	3	3	2	0	2
	May-19-2011	0	0	1	1	0	3	3	0	0	0
	Apr-30-2012	2	2	2	3	2	3	3	3	3	0
	Jun-10-2012	1	1	1	1	2	2	1	1	0	2
	Jun-23-2012	0	0	2	2	1	3	1	0	1	3
Northern Cricket Frog	Apr-13-2010	0	0	0	0	0	2	0	3	0	0
	Jun-9-2010	3	0	3	0	0	3	0	0	0	0
	Apr-29-2011	0	0	2	0	0	0	0	3	0	0
	May-19-2011	0	0	3	0	0	2	0	3	0	0
	Apr-30-2012	0	0	3	0	0	3	0	3	0	0
	Jun-10-2012	0	0	3	0	0	3	0	3	0	0
	Jun-23-2012	2	0	3	0	0	3	0	3	0	0
	Apr-14-2013	0	0	0	0	0	0	0	3	0	0
Green Treefrog	Jun-9-2010	0	0	0	0	0	0	0	3	0	0
	Jun-10-2012	0	0	0	0	0	3	0	3	0	0
	Jun-23-2012	0	0	0	0	1	3	0	3	3	3
Cope's Gray Treefrog	Jun-9-2010	1	0	1	1	2	0	3	3	3	1

	May-19-2011	0	1	0	2	3	0	0	0	3	1
	Apr-30-2012	0	1	1	1	1	0	1	1	0	0
	Jun-10-2012	0	0	2	0	0	0	3	3	3	2
	Jun-23-2012	0	1	1	0	1	0	0	1	2	0
Spring Peeper	Mar-9-2010	0	1	1	0	0	1	1	3	0	1
	Apr-13-2010	3	2	3	1	0	2	2	2	0	1
	Mar-9-2011	2	1	2	0	0	0	0	3	2	2
	Mar-3-2012	2	3	3	3	1	3	1	3	1	2
	Apr-30-2012	1	0	0	1	0	0	0	0	1	0
	Apr-14-2013	2	2	3	2	1	2	2	2	2	2
Upland Chorus Frog	Mar-9-2011	2	2	3	1	2	1	2	0	3	1
	Mar-3-2012	0	0	2	2	2	1	3	0	3	2
American Bullfrog	Apr-13-2010	0	0	0	0	0	0	0	1	0	0
	Jun-9-2010	0	0	0	0	0	2	0	2	0	0
	Apr-29-2011	0	0	1	0	0	0	0	1	0	0
	May-19-2011	0	0	0	0	0	0	2	1	0	0
	Apr-30-2012	0	0	2	1	0	1	0	2	0	0
	Jun-10-2012	0	1	0	0	0	1	0	0	0	0
	Jun-23-2012	0	1	0	0	0	1	0	1	1	1
Green Frog	Jun-9-2010	1	0	1	1	0	1	0	2	1	0
	May-19-2011	0	2	1	0	0	1	0	1	0	0
	Apr-30-2012	1	0	0	0	0	0	0	1	0	0
	Jun-10-2012	1	0	0	1	0	1	0	1	1	0
	Jun-23-2012	1	0	1	1	1	1	0	1	2	0
Pickerel Frog	Apr-13-2010	0	0	0	0	0	1	0	0	0	0
	Mar-9-2011	0	0	0	0	0	0	0	2	0	0
	Mar-3-2012	0	0	0	0	0	2	0	3	0	0
	Apr-30-2012	0	0	0	0	0	1	0	1	0	0
	Apr-14-2013	0	1	0	0	0	1	0	1	0	2

Fairview (630104)

Species	Survey date	Stop Number									
		1	2	3	4	5	6	7	8	9	10
American Toad	Apr-27-2007	0	0	0	0	0	0	1	1	0	0
	Apr-10-2008	0	2	0	0	0	1	0	0	0	0
	Feb-27-2009	1	0	0	0	0	0	0	0	0	1
	Mar-10-2010	0	0	0	0	1	1	0	0	1	0
	Mar-18-2010	0	0	0	0	1	0	0	0	0	0
Fowler's Toad	Apr-27-2007	1	0	0	0	1	1	1	0	1	0

	Jun-7-2007	2	0	2	0	2	0	0	0	0	0
	Apr-10-2008	2	0	0	0	1	0	2	0	2	2
	May-29-2008	2	0	0	0	0	0	2	0	0	0
	Jun-9-2009	2	0	0	0	1	0	0	0	0	0
	Apr-22-2010	0	0	0	0	0	0	1	0	0	0
	Jun-15-2010	0	0	0	0	1	2	0	0	0	1
Northern Cricket Frog	Apr-27-2007	3	0	0	0	3	3	1	3	2	0
	Jun-7-2007	3	0	2	0	3	3	3	3	2	0
	Apr-10-2008	0	0	0	0	0	2	0	0	0	0
	May-29-2008	3	0	0	0	3	3	3	3	2	0
	Jun-9-2009	3	0	0	0	3	3	2	0	0	0
	Apr-22-2010	3	0	0	0	3	3	0	3	0	0
	Jun-15-2010	3	0	0	0	3	3	0	3	3	2
Green Treefrog	Jun-15-2010	0	0	0	0	2	0	0	3	0	0
Cope's Gray Treefrog	Apr-27-2007	2	0	2	0	1	0	0	0	0	0
	Jun-7-2007	1	2	2	0	3	1	3	3	3	2
	Apr-10-2008	0	0	1	0	2	0	1	0	0	0
	May-29-2008	3	2	3	0	1	2	2	1	0	0
	Jun-9-2009	1	3	2	0	0	2	1	0	0	0
	Jun-15-2010	2	0	2	0	0	3	0	1	0	2
Spring Peeper	Feb-21-2007	1	0	1	0	1	2	1	3	1	0
	Apr-27-2007	1	2	1	0	0	2	0	0	1	0
	Feb-5-2008	1	1	0	0	0	1	2	1	0	2
	Apr-10-2008	3	3	3	0	2	3	1	2	2	2
	Feb-27-2009	1	1	0	0	3	3	3	3	1	3
	Mar-10-2010	2	3	1	0	3	3	2	3	0	3
	Mar-18-2010	3	2	1	0	3	3	0	3	3	3
	Apr-22-2010	1	2	1	0	1	2	1	2	0	0
Upland Chorus Frog	Feb-21-2007	3	3	1	0	3	2	2	1	3	0
	Feb-5-2008	2	1	0	0	0	0	0	0	2	0
	Apr-10-2008	0	1	0	0	0	1	0	0	1	0
	Feb-27-2009	3	3	3	0	0	0	0	0	3	0
	Mar-10-2010	3	3	3	0	1	0	0	0	3	1
	Mar-18-2010	2	2	3	0	0	0	0	0	2	1
Eastern Narrow-mouthed Toad	Jun-9-2009	2	0	0	0	0	0	0	0	0	0
American Bullfrog	Apr-27-2007	0	0	0	0	0	0	1	2	1	1
	Jun-7-2007	0	0	1	0	0	1	1	2	1	0
	Apr-10-2008	0	0	0	0	0	0	0	1	0	0
	May-29-2008	0	0	0	0	1	0	0	2	1	0

	Apr-22-2010	1	0	0	0	1	1	1	2	0	0
	Jun-15-2010	1	0	0	0	0	1	0	1	1	1
Green Frog	Apr-27-2007	0	0	1	0	1	1	1	2	1	0
	Jun-7-2007	0	0	1	0	1	1	1	2	1	0
	Apr-10-2008	0	0	0	0	0	1	0	0	0	0
	May-29-2008	0	0	1	0	0	2	0	1	2	1
	Jun-9-2009	0	0	1	0	0	0	0	0	0	0
	Apr-22-2010	1	0	0	0	0	1	1	1	1	1
	Jun-15-2010	0	0	2	0	0	1	2	2	1	1
Southern Leopard Frog	Apr-27-2007	0	0	0	0	0	0	1	0	0	0
	Apr-10-2008	0	0	0	0	0	0	0	0	1	0
	Mar-10-2010	0	0	0	0	0	0	0	0	1	1
	Mar-18-2010	0	0	0	0	0	1	0	1	1	1
	Apr-22-2010	0	0	0	0	0	0	0	1	0	0
	Jun-15-2010	0	0	0	0	0	0	1	0	0	0
Pickerel Frog	Apr-10-2008	0	0	1	0	2	1	0	1	2	1
	May-29-2008	0	0	0	0	0	1	0	0	0	0
	Mar-18-2010	2	0	0	0	2	0	0	1	1	0
	Apr-22-2010	1	0	0	0	0	0	1	1	0	0

Rougemont (630704) [partial]

Species	Survey date	Stop Number									
		1	2	3	4	5	6	7	8	9	10
American Toad	Jun-29-2007	0	0	0	1	0	0	0	0	0	0
	Apr-27-2008	0	0	0	1	1	0	0	0	2	2
	Jun-30-2008	0	1	0	0	3	0	0	0	0	0
Fowler's Toad	Jun-29-2007	0	1	1	0	0	0	0	0	2	0
	Apr-27-2008	0	0	1	0	0	0	0	2	0	0
	Jun-30-2008	0	0	0	0	0	0	0	1	1	0
	Jun-8-2009	0	0	0	0	0	1	0	1	0	0
Northern Cricket Frog	Jun-29-2007	0	0	3	0	3	1	0	0	3	0
	Apr-27-2008	0	0	2	0	3	0	0	0	0	0
	Jun-30-2008	0	0	3	0	3	0	0	0	0	0
	Apr-28-2009	0	0	3	0	3	0	0	0	0	1
	Jun-8-2009	0	0	3	0	3	2	0	3	3	0
	Apr-19-2012	0	0	1	0	3	0	0	0	0	0
Green Treefrog	Jun-29-2007	0	0	0	0	3	0	0	0	0	0
	Apr-27-2008	0	2	0	0	0	0	0	0	0	0
	Jun-30-2008	0	0	0	0	3	0	0	0	0	0
	Jun-8-2009	0	0	2	0	3	0	0	0	2	0
	Jun-27-2011	0	0	0	0	3	0	0	0	0	0
Squirrel Treefrog	Apr-19-2012	1	0	0	0	0	0	0	0	0	0
Cope's Gray Treefrog	Jun-30-2008	0	0	1	0	0	0	0	2	1	1
	Jun-27-2011	0	2	0	0	2	0	0	0	0	0
Spring Peeper	Jun-29-2007	2	2	0	0	0	0	0	2	0	0
	Feb-26-2008	1	0	0	0	3	0	0	0	0	0
	Apr-27-2008	1	0	2	2	3	3	2	3	0	0
	Mar-5-2012	1	1	1	1	3	0	1	1	0	0

Appendix 5

Amphibians documented from Orange County, NC

Amphibians Documented from Orange County, NC

Necturus lewisi	Neuse River Waterdog	(33 specimens at NCMNS)
Necturus punctatus	Dwarf Waterdog	(70 specimens at NCMNS)
Ambystoma maculatum	Spotted Salamander	(76 specimens at NCMNS)
Ambystoma opacum	Marbled Salamander	(67+ specimens at NCMNS)
		(5 additional larvae catalogued as *Ambystoma* sp.)
Ambystoma talpoideum	Mole Salamander	(1 specimen at NCMNS)
Notophthalmus v. viridescens	Red-spotted Newt	(244 specimens at NCMNS)
Desmognathus fuscus	Northern Dusky Salamander	(272 specimens at NCMNS)
Eurycea cirrigera	Southern Two-lined Salamander	(357 specimens at NCMNS)
Eurycea guttolineata	Three-lined Salamander	(39 specimens at NCMNS)
Hemidactylium scutatum	Four-toed Salamander	(178+ specimens at NCMNS)
Plethodon cinereus	Red-backed Salamander	(2 specimens at NCMNS; others in Carnegie Museum)
Plethodon cylindraceus	White-spotted Slimy Salamander	(64 specimens at NCMNS)
Pseudotriton montanus	Mud Salamander	(75 specimens at NCMNS)
Pseudotriton ruber	Red Salamander	(150 specimens at NCMNS)
		(3 additional larvae catalogued as *Pseudotriton* sp.)
Scaphiopus holbrookii	Eastern Spadefoot	
	(2 specimens from 1960 were listed in Duke University collection, and are probably valid, but not found when NCMNS received that collection in 1993; specimens apparently lost)	
Bufo [=*Anaxyrus*] *americanus*	American Toad	(99 specimens at NCMNS)
Bufo [=*Anaxyrus*] *fowleri*	Fowler's Toad	(160 specimens at NCMNS)
Acris crepitans	Northern Cricket Frog	(317 specimens at NCMNS)
Hyla chrysoscelis	Cope's Gray Treefrog	(196+ specimens at NCMNS)
Hyla cinerea	Green Treefrog	
	(1 photographic voucher and several other observational records in NCMNS files, but no voucher specimens)	
Pseudacris crucifer	Spring Peeper	(228+ specimens at NCMNS)
Pseudacris feriarum	Upland Chorus Frog	(211 specimens at NCMNS)
Gastrophryne carolinensis	Eastern Narrow-mouthed Toad	(74 specimens at NCMNS)
Rana catesbeiana [=*Lithobates catesbeianus*]	American Bullfrog	(87 specimens at NCMNS)
Rana [=*Lithobates*] *clamitans*	Green Frog	(120 specimens at NCMNS)
Rana [=*Lithobates*] *palustris*	Pickerel Frog	(60 specimens at NCMNS)
Rana sphenocephala [=*Lithobates sphenocephalus*]	Southern Leopard Frog	(20 specimens at NCMNS)

Note: Numbers include larval and adult specimens, and, in some cases, egg clutches. A number followed by "+" usually means there is an indeterminate of eggs in addition to the number of specimens listed.

Source: North Carolina Museum of Natural Science (NCMNS)

American Toad

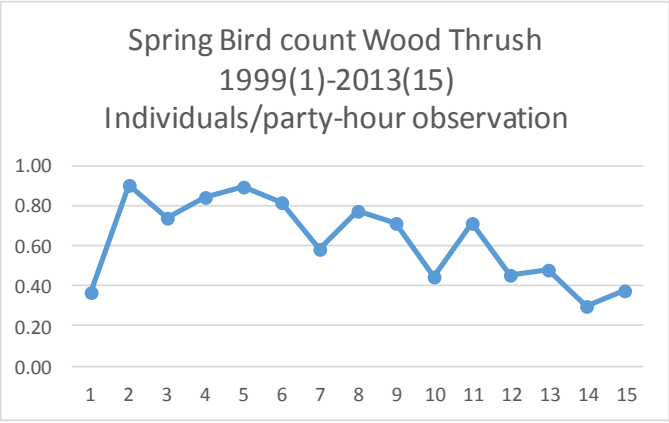
Green Frog

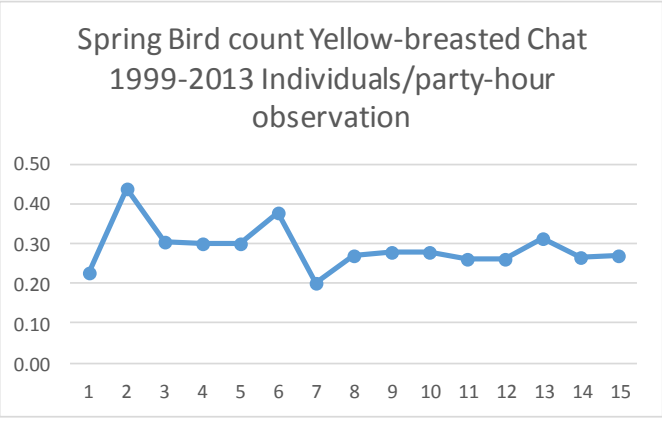
Appendix 6

Sample Results from the Chapel Hill Spring Bird Count, 1999-2013

Results from Chapel Hill Spring Bird Count, 1999-2013
Wood Thrush and Yellow-breasted Chat

Year	Number of Wood Thrush Observed	Hours	Observances per hour		Number of Yellow-Breasted Chat Observed	Hours	Year
1999	60	154	154		35	0.23	1999
2000	149	165.1	165.1		72	0.44	2000
2001	136	184.8	184.8		56	0.30	2001
2002	160	190.4	190.4		57	0.30	2002
2003	163	183.5	183.5		55	0.30	2003
2004	101	123.95	123.95		47	0.38	2004
2005	95	163.7	163.7		33	0.20	2005
2006	117	151.3	151.3		41	0.27	2006
2007	103	144	144		40	0.28	2007
2008	65	147.3	147.3		41	0.28	2008
2009	90	127	127		33	0.26	2009
2010	52	114.75	114.75		30	0.26	2010
2011	62	128.8	128.8		40	0.31	2011
2012	37	124	124		33	0.27	2012
2013	36	96	96		26	0.27	2013





Note: Wood Thrush population is declining.