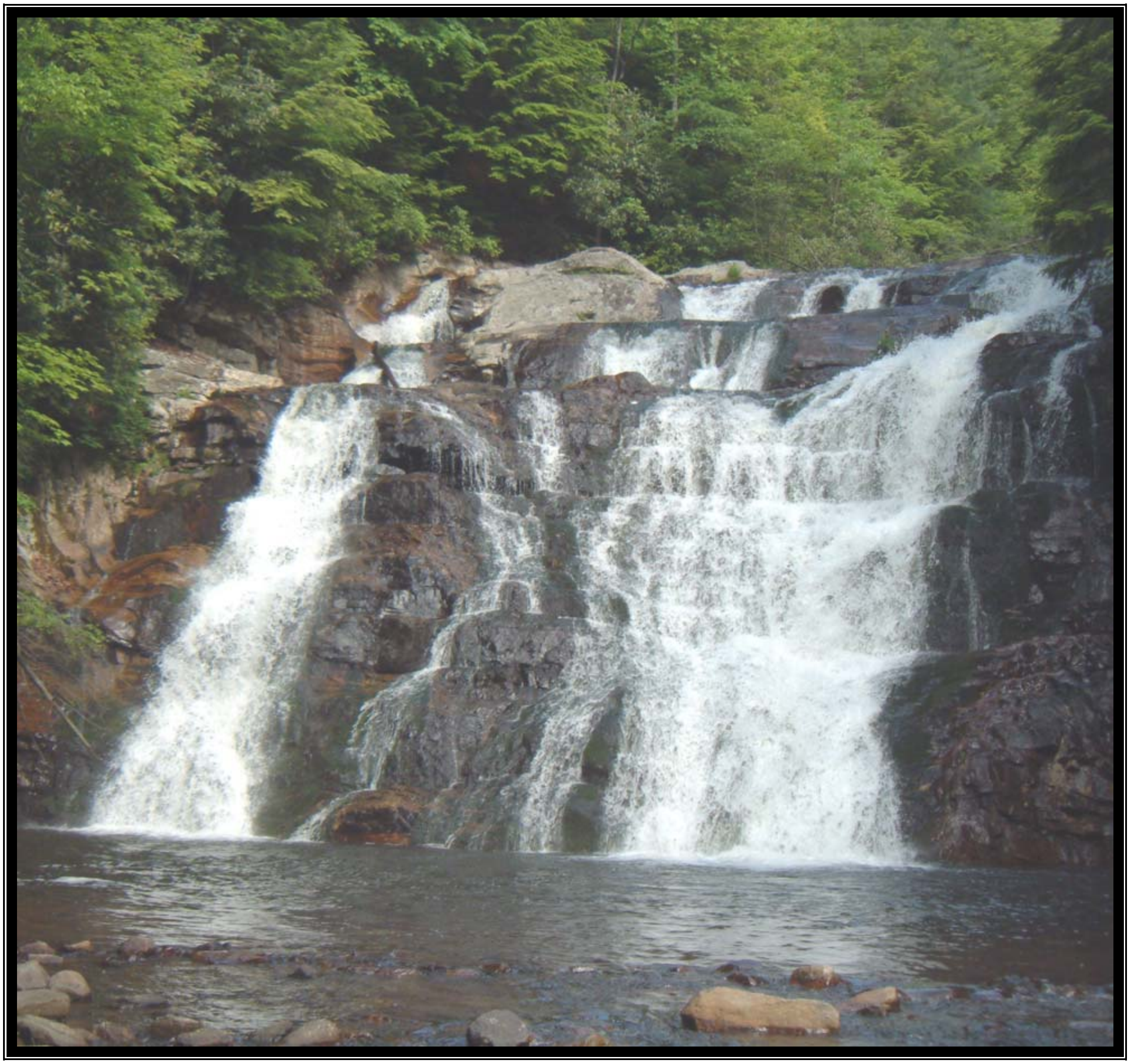
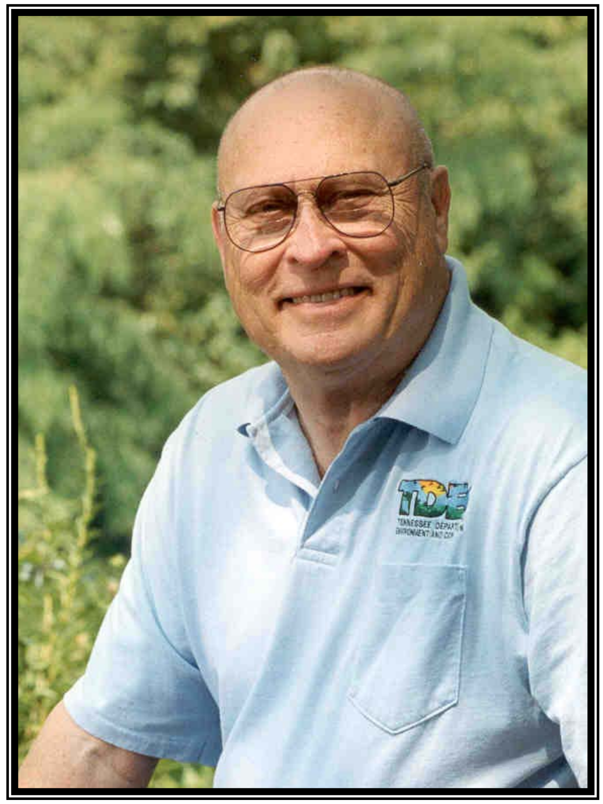
2002 305(b) Report
The Status of Water Quality in Tennessee



Division of Water Pollution Control
Tennessee Department of Environment and Conservation

Message from Commissioner
Milton H. Hamilton, Jr.



As I write this, I am nearing the end of my term as commissioner of the Department of Environment and Conservation. As I look forward to retirement, there is much I'll miss about the job I am leaving. First and foremost, I will miss the daily interaction with the dedicated employees I have had the pleasure of working with during the last five years.

We have many accomplishments to show for our efforts to protect Tennessee's water resources. With the passage of the Inter-basin Transfer Act and our work towards the development of regional approaches to water supplies, we are taking the steps needed to tackle critical water quantity issues. Tennesseans can no longer take for granted that water supplies will be unlimited and inexpensive. Neither can we assume that our friends in neighboring states are not considering how they can help quench their growing thirsts with Tennessee water.

We have restored some important streams. The Pigeon River, while still not as clean as it needs to be, is the cleanest it has been in nearly a century. The 12-year old dioxin advisory on the Pigeon was recently lifted and fish caught there are safe to eat. I was proud to stand with Nashville Mayor Purcell as signs warning against water contact on a large portion of the Cumberland River were recently taken down. The French Broad River and the Ocoee River, both with long-standing water quality issues, now have sections that have been removed from the state's list of impaired waters.

I'm just as proud of the work done by others to improve water quality. Arkansas Creek was once severely impacted by the Williamson County Landfill. Lewis Bumpus and his staff at the landfill decided to do something about it. They improved operations, installed world-class erosion control devices, and brought in biologists to study the creek. The results were dramatic. Aquatic life has returned to the stream and is flourishing. Arkansas Creek has gone from being a liability to an asset.

Being the commissioner of the Department of Environment and Conservation has been one of the highlights of my career. I know that the dedication and professionalism this department has shown during my tenure will continue into the future. Significant challenges remain, including the need to balance the desires of our rapidly growing population with the imperative to preserve Tennessee's abundant natural resources. I am confident the state and people of Tennessee will successfully meet these challenges.

2002 305(b) Report
The Status of Water Quality in Tennessee

prepared by

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December 2002

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The authors would like to express appreciation to the Water Pollution Control staff of TDEC's regional environmental assistance centers (EACs) and the Aquatic Biology staff of the Tennessee Department of Health (TDH) who collected the stream data documented in this report. The managers of the staff in these offices are:

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Paul Schmierbach	Knoxville EAC
Andrew Tolly	Johnson City EAC
Tim Wilder	Columbia EAC
Fran Baker	Cookeville EAC
David Stucki	Aquatic Biology, TDH

Cover photo: Laurel Falls on Laurel Fork in the Cherokee National Forest as seen from the Appalachian Trail. Photo provided by Lee Keck, Division of Water Supply.

II. Executive Summary

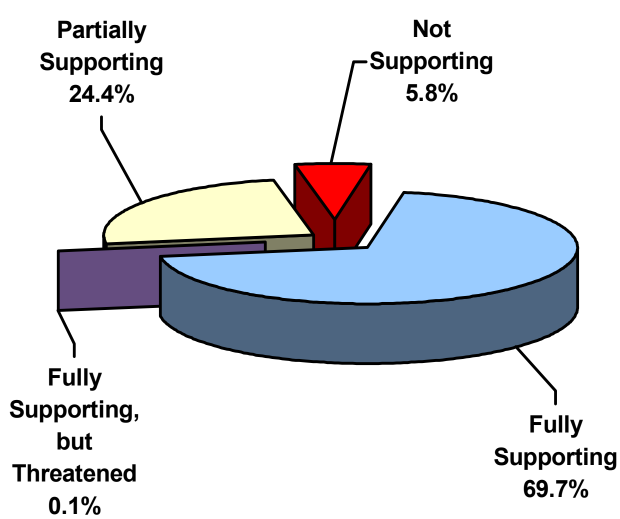
The federal Water Pollution Control Act, Section 305(a) requires a biannual accounting to congress of the water quality in each state. Section 305(b) requires that each state provide a biennial water quality report to EPA. Tennessee's Water Quality Control Act also requires a report of the water quality in each state. Tennessee Department of Environment and Conservation (TDEC), Division of Water Pollution Control has primary responsibility for assessment and reporting of the quality of surface waters.

Assessment Process

The Tennessee Water Quality Control Act requires the protection of water quality and maintenance of the designated uses as defined in our water quality standards. These standards have three components. Use classifications establish seven designated uses of waterways. Criteria identify the level of water quality needed to support each of the designated uses. The antidegradation section protects existing uses of all waters and establishes procedures for authorizing a lowering of water quality.

Water quality data collected across the state are compared to the criteria established for the designated uses assigned to each stream. Streams that meet these criteria are considered to be unpolluted and supporting designated uses.

Water Quality in Streams and Rivers

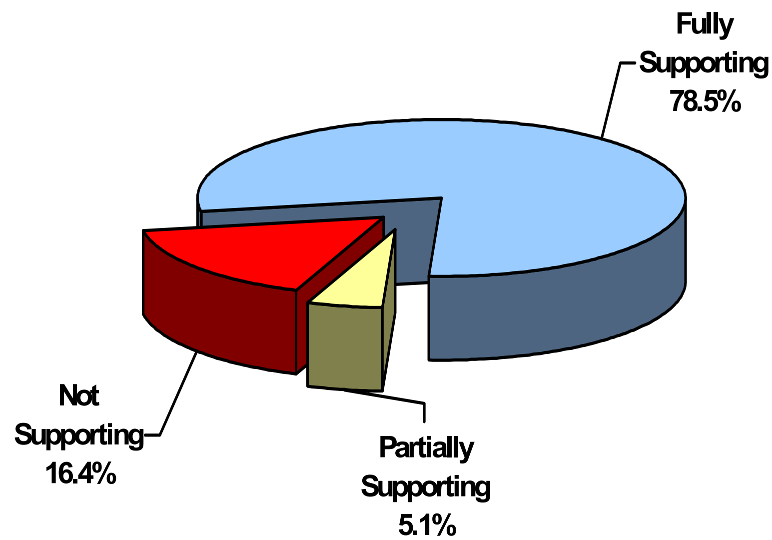


Tennessee has over 60,000 miles of streams and rivers. Almost half of these stream miles have been recently monitored and assessed. EPA defines recent information as data collected in the last five years. Streams without recent data are generally assigned to the category "not assessed." Of the streams that can be assessed, about 70 percent of the stream miles are characterized as fully supporting designated uses.

The remainder of the streams have been assessed as impaired to some degree and therefore, either partially or not supporting some of their uses. Over 24 percent of the stream miles are assessed as partially supporting due to moderate pollution levels. Six percent are considered not supporting due to severe pollution. Figure 1 on page 5 provides an illustration of water quality statewide.

Water Quality in Lakes and Reservoirs

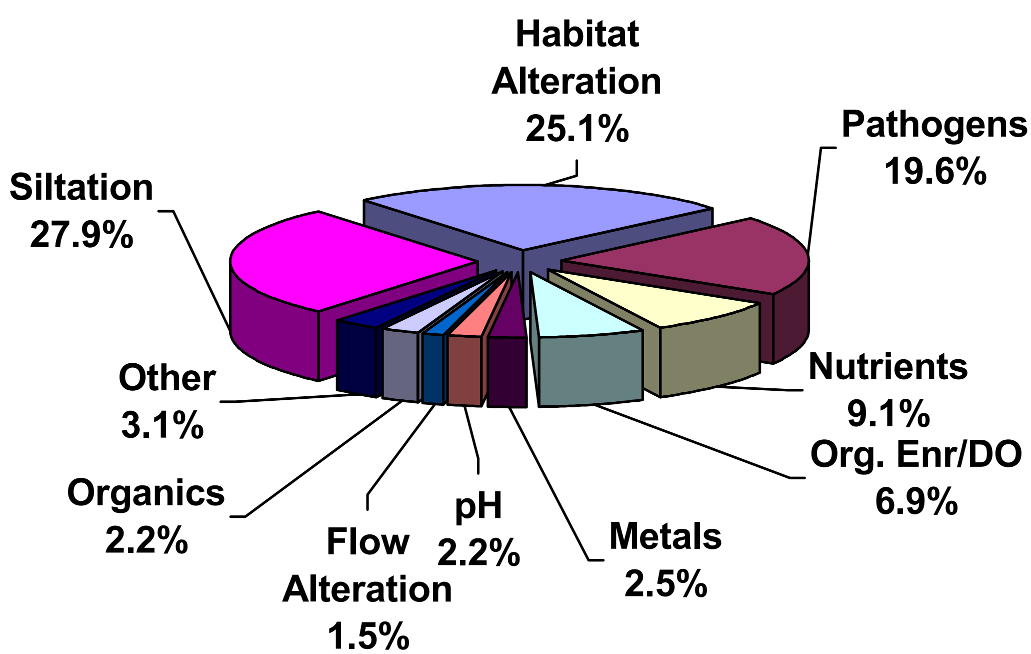
Tennessee has 91 publicly owned reservoirs and a large lake (Reelfoot) that together total 536,724 lake acres. Almost all the large reservoirs and lakes have been recently monitored. Over 78 percent of the lake acres were found to be fully supporting of all uses. Five percent of the lake acres were assessed as partially supporting. About 16 percent of the lake acres are assessed as not supporting designated uses.

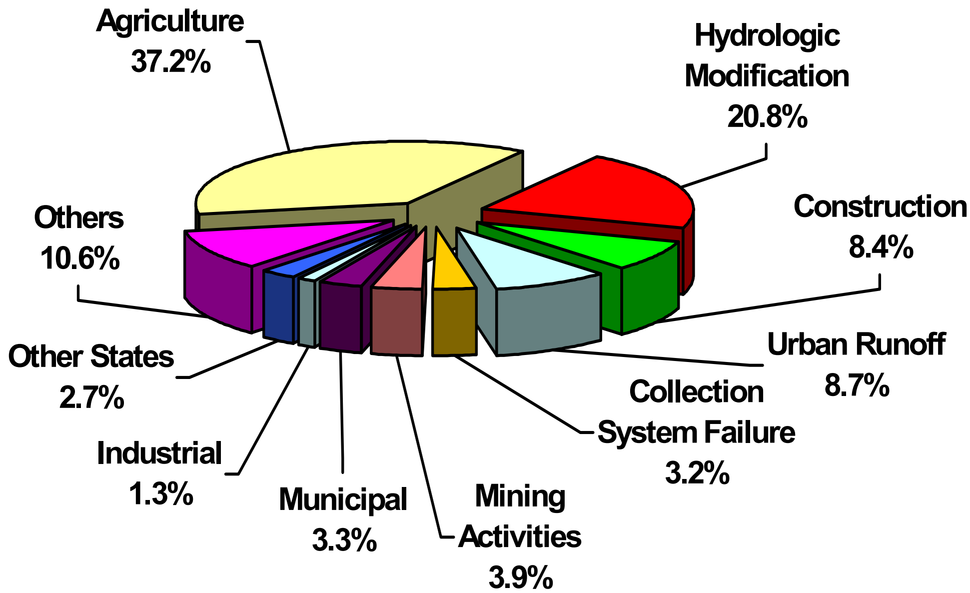


Causes and Sources of Pollution

Once it is determined that a stream, river or reservoir is not fully supporting its designated uses it is necessary to figure out what the pollution is (cause) and where it is coming from (source). The most common causes of pollution in rivers and streams are siltation, habitat modification, nutrients and pathogens. Similarly, the main sources of this pollution in rivers and streams are agricultural activities, hydrological modification, construction, and urban sources. The leading causes of pollution in reservoirs are organic substances like PCBs, chlordane and dioxins. The dominant pollution source in reservoirs is the contaminated sediment that contains these substances.

Relative Causes of Impacts in Rivers and Streams





Relative Sources of the Pollutants Causing Impacts in Rivers and Streams

One of the Division's experienced biologists explains the nuances of benthic macroinvertebrate taxonomy to an elementary school student.

Innovative Programs

TDEC, in partnership with numerous agencies and groups, has developed several innovative programs and projects to assist in the management, protection, and restoration of the state's water resources.

The watershed program provides a systematic approach to the water quality monitoring, assessment, permitting, and stream restoration efforts of the department. The Division continues to meet all TMDL development goals.

The ecoregion project divided the state into similar areas called subecoregions. Reference streams were identified and intensively monitored in each area to provide information about the background quality of streams in that region.

Additionally, TDEC is testing new ways to monitor water quality. In the probabilistic monitoring project, the Division is experimenting with randomly selecting sampling stations rather than doing what is commonly referred to as "targeted" monitoring. If this experiment proves successful, a more widespread application of this approach will be considered.

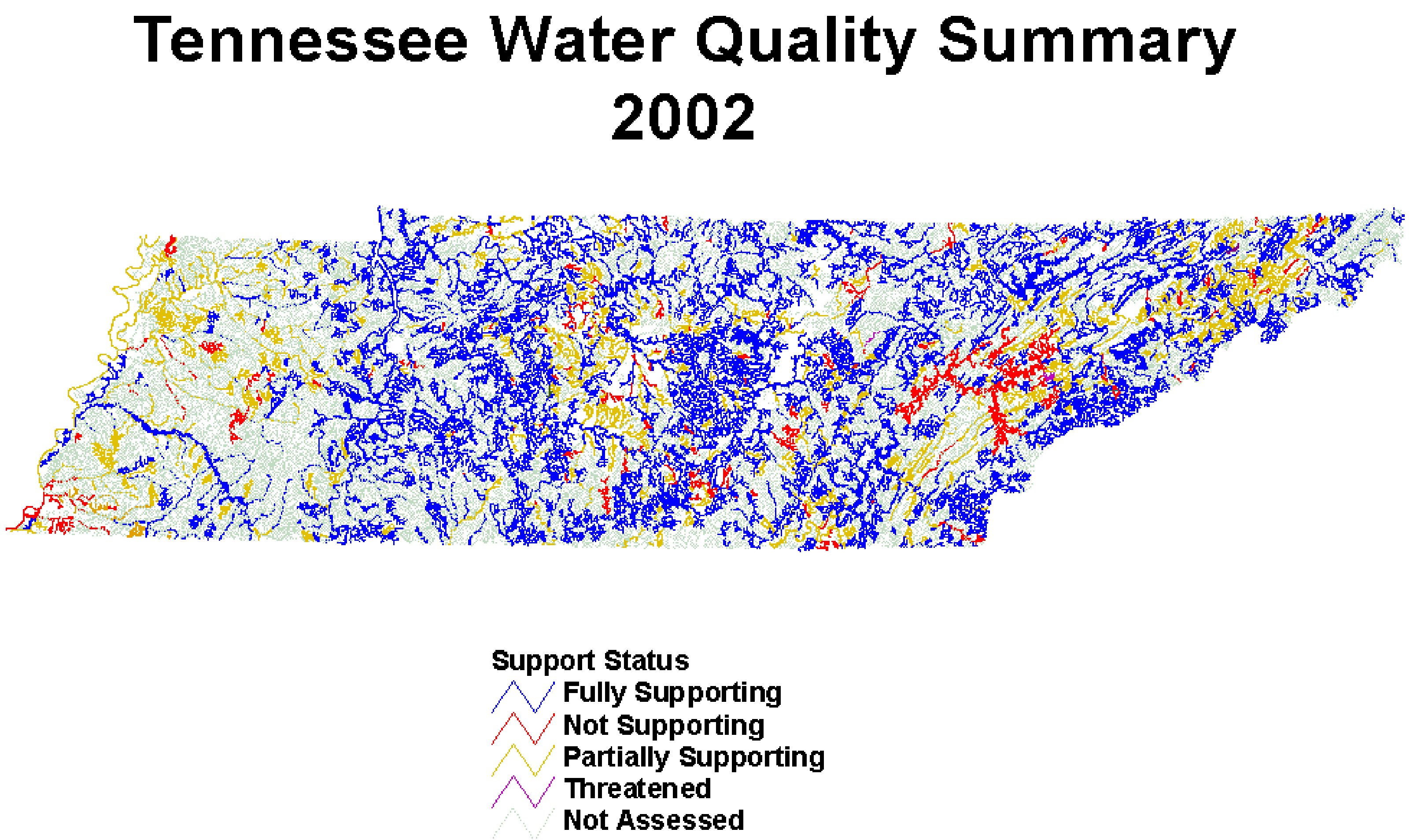


Figure 1: Tennessee Water Quality Summary 2002

III. Definitions and Acronyms

Definitions

Benthic Community: Animals living on the bottom of the stream.

Biocriteria: Numerical values or narrative expressions that describe the reference biological condition of aquatic communities inhabiting water of a given designated aquatic life use. Biocriteria are benchmarks for water resources evaluation and management decisions.

Biometeric: A calculated value representing some aspect of the biological population's structure, function or other measurable characteristic that changes in a predictable way with increased human influence.

Bioregion: An ecological subregion, or group of ecological subregions, with similar aquatic macroinvertebrate communities that have been grouped for assessment purposes. Tennessee has defined 15 bioregions.

Ecoregion: A relatively homogenous area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, and other ecologically relevant variables. There are eight (Level III) ecoregions in Tennessee.

Ecological Subregion (or subecoregion): A smaller area that has been delineated within an ecoregion that has even more homogenous characteristics than does the original ecoregion. There are currently 25 (Level IV) ecological subregions in Tennessee. (Delineation of subecoregions in neighboring states has indicated that three additional subregions may need to be added to this total.)

Ecoregion Reference: Least impacted, yet representative, waters within an ecoregion that have been monitored to establish a baseline to which alteration of other waters can be compared.

Habitat: The instream and riparian features that influence the structure and function of the aquatic community in a stream.

Macroinvertebrate: Animals without backbones that are large enough to be seen by the unaided eye and which can be retained by a U.S. Standard No. 30 sieve (28 meshes/inch, 0.595 mm).

Pathogens: Disease causing micro-organisms.

Regulated Sources: Pollution originating from sources governed by state or federal permitting requirements. These sources are typically from discrete conveyances, but also include stream alterations, urban runoff, and stormwater runoff from construction sites.

Definitions Continued

Non-Regulated Sources: Activities exempted from state or federal permitting requirements. In Tennessee, these sources are agricultural and forestry activities which utilize appropriate management practices. Additionally, sources such as atmospheric deposition might be considered unregulated sources, since they are not controllable through the water program.

Riparian Zone: An area that borders a waterbody.

Water Pollution: Alteration of the biological, physical, chemical, bacteriological or radiological properties of water resulting in loss of use support.

Watershed: A geographic area which drains to a common outlet, such as a point on a larger lake, underlying aquifer, estuary, wetland or ocean.

Acronyms

ADB: Assessment Database

EAC: Environmental Assistance Center

EPA: United States Environmental Protection Agency

EPT: Ephemeroptera (Mayflies) Plecoptera (Stoneflies) Trichoptera (Caddisflies)

GIS: Geographic Information System

GPS: Global Positioning System

HUC: Hydrological Unit Code (Watershed Code)

ONRW: Outstanding Natural Resource Water

OSM: Office of Surface Mining

PAS: Planning and Standards Section

RIT: Reach Indexing Tools

STORET: EPA's STOrage and RETrieval Database

TDEC: Tennessee Department of Environment and Conservation

TDA: Tennessee Department of Agriculture

TDH: Tennessee Department of Health

TMDL: Total Maximum Daily Load

TVA: Tennessee Valley Authority

TWRA: Tennessee Wildlife Resource Agency

USACE: U.S. Army Corps of Engineers

USGS: U.S. Geological Survey

USFWS: U.S. Fish and Wildlife Service

WPC: Water Pollution Control

IV. Introduction

According to the federal Water Pollution Control Act, commonly called the Clean Water Act, each state is required to assess water quality and report the results to Congress and the public biannually. Section 305(b) of the original law passed in 1977 required a biannual description and analysis of each state's waterways. In addition to the federal requirements, the state's Water Quality Control Act of 1977 requires the Division of Water Pollution Control to produce a technical report on the status of water quality in Tennessee. This report serves the requirements of both the federal and state laws.

Both federal and state water quality laws require that emphasis be placed on identifying and restoring impacted waters. The assessment of streams, lakes, and reservoirs requires recently collected, high quality information. To facilitate both of these goals the state has adopted two methods, which work in parallel. One is an organizational framework called the watershed management approach, which coordinates watershed monitoring, assessments, and public participation. The other is the ecoregion approach that helps establish reasonable water quality expectations in different geological ecoregions of the state. Monitoring the best obtainable yet representative streams in each area identifies these regional water quality goals.

TDEC goals for the 305(b) Report are:

- Assess the general water quality conditions of rivers, streams, lakes, and wetlands.
- Identify the causes and sources of water pollution.
- Specify waters that pose human-health risks due to elevated bacteria levels or contamination of fish.
- Highlight areas of improved water quality.

In order to establish a background for understanding water pollution, the 305(b) Report is organized from general information to very specific data. Chapter VI provides an overview of water quality statewide and takes a closer look at conditions in west, middle, and east Tennessee. Information specific to each watershed is detailed starting on page 114.

This report is only on surface waters in Tennessee. The Department's Division of Water Supply has prepared a report on ground water quality entitled "*Tennessee Ground Water 305(b) Water Quality Report*." For a copy of this report or information regarding the quality of ground water and water supply issues in Tennessee, please contact the Division of Water Supply at (615) 532-0191.

A. Cost of Water Pollution

It may not be possible to place a dollar value on the cost of water pollution. Everyone is affected by it and has a vested interest in improving water quality. There may be costs of water pollution that have yet to be realized.

Two of the most obvious costs from water pollution are the expense of health care and loss of productivity while people are ill. When untreated or inadequately treated human or animal wastes are in the water they can expose people to any number of pathogens (disease causing organisms). Another health risk is from eating contaminated fish that can increase cancer risk and other health problems especially in children and pregnant women. Both of these risks are further discussed in Chapter IX.

The community loses an important resource when the water is no longer safe for recreational activities. Commercial fisherman lose income when it is no longer safe to sell fish. Subsistence fishermen are faced with the loss of their primary protein source.

Commercial navigation as a means to move goods and services around the country is one of the most economical methods of transportation. As channels fill with sediment from upland erosion, commercial navigation becomes less practical. Siltation also reduces the useful lifespans of lakes and reservoirs.

B. Other Water Quality Assessment Reports by the Division

Another provision in the federal Water Pollution Control Act is a requirement for a biannual document listing Tennessee's streams, rivers, and reservoirs that do not meet established standards. Like the 305(b) Report, the 303(d) List is titled after the section of the federal Water Pollution Control Act that required the report.

Once a stream has been placed on the 303(d) List it is considered a priority for water quality improvement efforts. Enforcement activities, TMDL development, and permits are all targeted toward improving water quality.

For additional information concerning water quality issues:

please contact staff at: (615) 532-0699

or

e-mail Gregory.Denton@state.tn.us.

or

Visit the department's home page at
http://www.state.tn.us/environment

How Is This 305(b) Report Different From the Previous Ones?

A 305(b) Report is a summary of the water quality information that is accumulated in any reporting period. Both the quantity and quality of the information gathered varies dramatically by reporting cycle. This variation is due, in part, to changes in sampling intensity, methodology, and priority. For these reasons, the 305(b) Report is not considered to be a reliable indicator of water quality trends throughout the state. It is instead, a snap-shot in time of the conditions existing at the time it was drafted.

The 2002 305(b) Report is, however, considered an improvement over previous versions for several reasons.

Increased Coverage. In 1996, the division began the watershed approach, a significant departure from how assessments had been done in the past. Instead of attempting to maintain a statewide coverage of monitoring stations in order to generate assessment reports, we began concentrating efforts into specific watersheds each year based on a prearranged schedule.

In the previous 305(b) generated in 2000, we had intensively studied watershed Groups 1, 2 and 3. By 2001, we had completed intensive monitoring in the rest of the watershed groups and had statewide assessment coverage. Additionally, we were much more successful in obtaining water quality information from other agencies, making the 2002 303(b) Report the most comprehensive water quality inventory ever accomplished in Tennessee.

More Precision. In previous reports, the division lacked the ability to segment waterbodies into smaller sections. As a result, large watersheds containing significant numbers of stream miles were frequently lumped together. While this approach was necessary at the time, EPA's Assessment Database and Reach Indexing Tool software, plus new powerful computers and databases, have allowed existing waterbodies to be segmented into an almost infinite number of sections. Each section can have its own identifier and assessment information.

When these tools are combined with more comprehensive monitoring under the watershed approach, we can provide the type of precision necessary to more accurately document water quality status, facilitate development of control strategies, and measure progress towards clean water goals. In 1996, the Division identified approximately 850 individual stream segments. In 2002, these existing waterbodies have been divided into over 4,000 segments.

C. Ecoregions

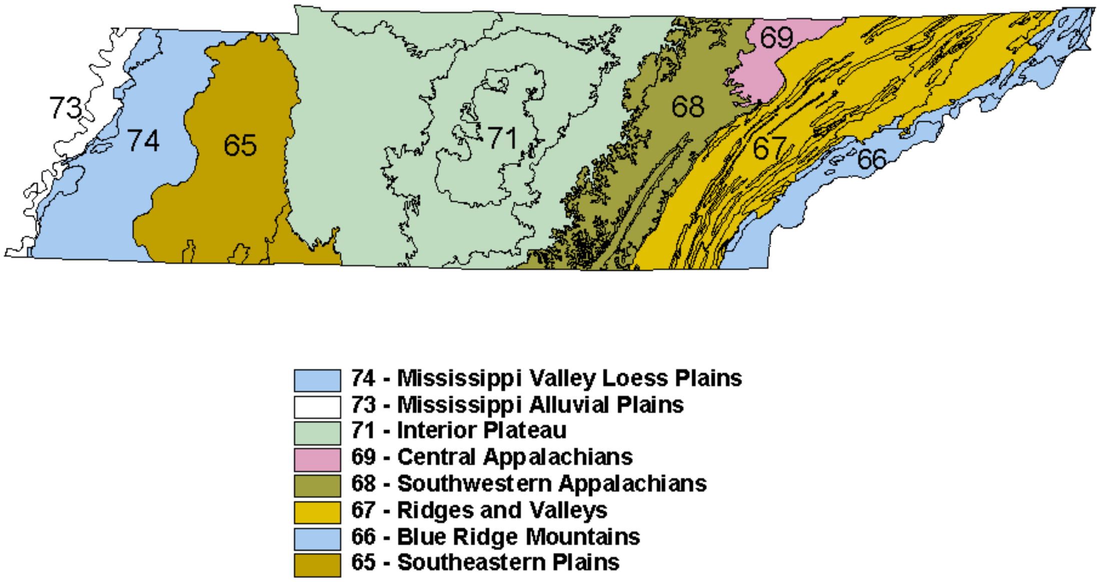


Figure 2: Level III Ecoregions of Tennessee.

In order to understand how geology, soil, land use, vegetation and other regional aspects affect stream biological health and water quality, a regional approach proposed by EPA has been adopted by the state. Initiated in 1994, a joint effort between federal and state agencies delineated eight distinctive geological regions called Level III ecoregions (Figure 2). These ecoregions were further subdivided into 25 Level IV subecoregions.

> An ecoregion is a relatively homogeneous area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, and other ecologically relevant variables.

Within each of these 25 Level IV subecoregions, the least impacted yet representative streams were chosen to serve as reference streams. These subecoregion reference streams have been monitored since 1996 to establish reasonable chemical and biological expectations for different regions of the state. The ecoregion approach is further discussed in Chapter XI.

From the information gathered from the chemical and biological sampling, it has been possible to further refine water use criteria. New subecoregion criteria have been proposed for biological, nutrient, pH and dissolved oxygen criteria. These proposed criteria changes are further discussed in Chapter XII.

D. Watersheds

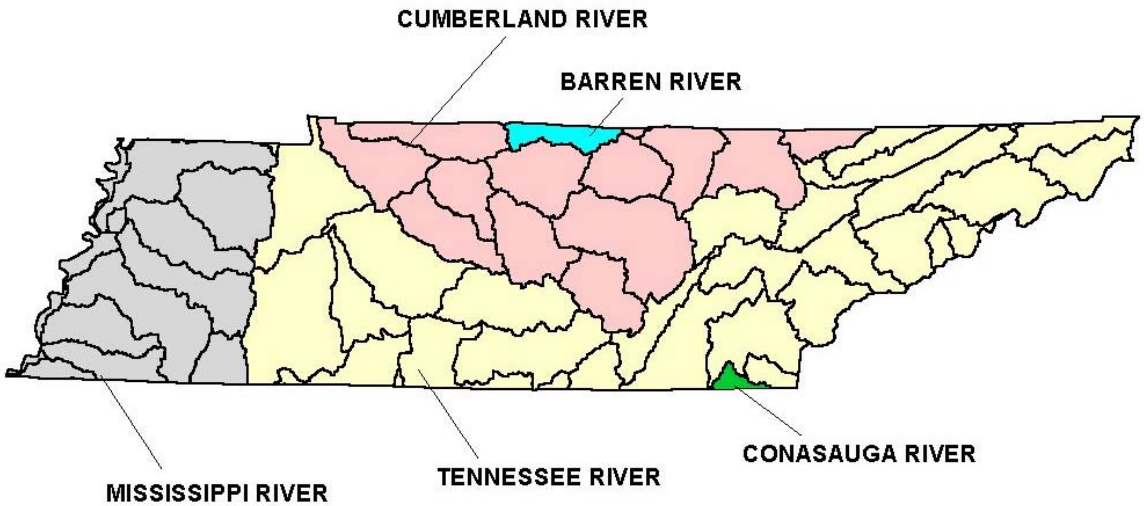


Figure 3: Tennessee's Major Basins and Smaller Watersheds.

Ecoregions serve as a geographical framework for establishing water quality expectations. The watershed approach is an organizational framework for systematic monitoring to define the state's water quality problems. The entire area that drains into a river or reservoir is called a watershed.

> A watershed is a geographic area that drains to a common outlet.

The Division has developed a unified process for identification of water quality problems called the watershed approach. Tennessee includes five main river systems. Three of these, the Cumberland, the Mississippi, and the Tennessee Rivers, drain most of the state's water. These main systems have been further subdivided by USGS into 54 watersheds (Figure 3). The 54 watersheds have been divided into five groups for assessment purposes. Each year, the five watershed groups are in a different phase of the watershed cycle. This approach to water quality management provides for coordinated action with the public and other agencies.

The cycle begins with planning and data collection for the appropriate watershed group in the first year. In the second year of the cycle, the streams are monitored and in the third year they are assessed. In the fourth year wasteload allocations are determined and in the fifth year permits are issued. In this way different agencies and the public are coordinated in their efforts to improve water quality. Every year each of the five watershed groups is in a different phase of the watershed cycle. In this way each watershed is thoroughly assessed every five years. The watershed approach is further discussed in Chapter XIII.

Tennessee State Atlas

State population (2000 Census)……………………………………………5,689,283
Largest Cities (2000 Census)
Memphis…………………………………………………650,100
Nashville…………………………………………………545,524
Knoxville…………………………………………………173,890
Chattanooga……………………………………………155,554
Clarksville……………………………………………...103,455
Murfreesboro……………………………………………68,816
Jackson…………………………………………………..59,643
Johnson City……………………………………………55,469

Number of Counties…………………………………………………………95
State Surface Area (square miles)…………………………………………42,244

Number of Major Basins……………………………………………………13
Number of Level III Ecoregions………………………………………………8
Number of Level IV Ecoregions……………………………………………25
Number of Watersheds………………………………………………………54
Number of Stream Miles Forming State Border……………………………213
(The Mississippi River forms most, but not all,
of these miles shared another state.)
Stream Miles Statewide (Reachfile 3)……………………………………..60,226

Largest Rivers at Low Flow (7Q10 in ft^3/sec.)
Mississippi River at Memphis……………………………………..109,000
Tennessee River at South Pittsburg………………………………12,500
Cumberland River at Dover…………………………………………2,280
Hiwassee River at Charleston………………………………………1,150
French Broad River near Newport……………………………………533
Obion River at Menglewood…………………………………………357
Hatchie River at Rialto………………………………………………..309
Duck River near Only…………………………………………………303

Publicly-owned Lake Acres Statewide…………………………………...536,794

Largest Lakes (size in acres)
Kentucky Reservoir (Tennessee portion)…………………………117,500
Watts Bar Reservoir ……………………………………………..39,000
Barkley Reservoir (Tennessee portion)……………………………37,000
Chickamauga Reservoir…………………………………………….35,400

Estimated Acres of Wetlands………………………………………………...787,000

V. Water Quality Assessment Process

The water quality assessment process in Tennessee consists of three parts:

1. Development of clean water goals.

2. Development and implementation of a statewide water quality monitoring program.

3. Comparison of data to water quality standards in order to place each waterbody into the proper assessment category.

A. Water Quality Standards

The Tennessee Water Quality Control Act requires the protection of water quality and the designated uses as defined in Tennessee's water quality standards (Tennessee Department of Environment and Conservation, 1999). Tennessee standards have three sections. The first section establishes seven designated uses for Tennessee waterways. All surface waters have at least four basic uses: fish and aquatic life, recreation, irrigation, and livestock watering and wildlife. The second section establishes water quality criteria to protect the designated uses. The final section is an antidegradation policy designed to protect established water uses and prevent future damage to water quality.

Because streams are generally classified for multiple uses and may have multiple criteria for each substance, the most stringent criteria must be met. The combination of classified uses, the most stringent criteria for those uses, and the antidegradation policy provisions create the water quality standards for each stream segment.

Classification + Criteria + Antidegradation = Standards

1. Stream-use Classification

Tennessee has approximately 60,000 stream miles and 536,000 publicly owned lake acres. All the streams and lakes are classified for at least four public uses: protection of fish and aquatic life, recreation, irrigation, and livestock watering and wildlife. This minimum standard is consistent with the national goal that all waters provide for the "protection and propagation of…fish and wildlife…and allow recreational activities in and on the water".

Current Stream-Use Classifications:

1. Fish and aquatic life
2. Recreation
3. Irrigation
4. Livestock watering and wildlife
5. Drinking water supply
6. Navigation
7. Industrial water supply

The Tennessee Water Quality Control Board is responsible for the designation of beneficial uses of all waterbodies. Most streams are classified for fish and aquatic life protection, recreation, irrigation, and livestock watering and wildlife. The drinking water supply designation is generally assigned to waterbodies currently or likely to be used as domestic water sources in the future. The navigation and industrial water supply classifications are generally limited to waters currently being used for those uses, but can be expanded to other waters as needed.

Designated uses are goals, not necessarily the current use of that waterbody. Even if a stream or reservoir is not currently used for a given activity, it should still be protected for that use in the future. As Tennessee's population continues to expand, more stress is placed on all natural resources. A safe sustainable water supply is essential for the state's social and economic development.

a. **Fish and Aquatic Life (FAL)** - FAL criteria protect aquatic life. These criteria consist of two types of toxicity. One is acute toxicity. It refers to the level of a contaminant that causes death in organisms in a relatively short time. The other type is chronic toxicity. In chronic toxicity, a lower level of a contaminant causes death over a longer period of time or has other effects such as reproductive failure. Some of these criteria are specific to trout waters due to the sensitivity of trout species. Trout waters are specifically noted in the regulation.

b. **Recreation** - These criteria protect the use of streams for swimming and fishing. They include criteria designed to prevent elevated bacteria levels in the water. Historically, fecal coliform has been used as the indicator of contamination in streams. In 1997, the Division began a shift towards using *E. coli* as the primary indicator of pathogens in streams. The current *E. coli* criterion is 126 colonies per 100 ml of water, as a geometric mean of ten or more samples.

Another provision of recreational criteria is the prevention of the accumulation of dangerous levels of metals or organic compounds from the water or sediment that may eventually accumulate in fish tissue. Additionally, the Water Quality Control Act suggests that streams be posted if swimming or fishing poses an unacceptable risk to human health. Additional information about fishing advisories is provided in Chapter IX.

Some of the most valuable uses of our waterways are related to recreational activities. Old Hickory Reservoir (Photo by Debbie Arnwine, Planning and Standards.)

c. **Irrigation** - Irrigation criteria protect the quality of water so it may be used for agricultural needs.

d. **Livestock Watering and Wildlife** - These criteria protect wildlife and farm animals.

e. **Drinking Water Supply** – Drinking water criteria insure that water supplies contain no substances that might cause a public health threat, after conventional water treatment. Since many contaminants are difficult and expensive to remove, it is more cost effective to keep pollutants from entering the water supply in the first place.

f. **Navigation** – Criteria designed to protect navigational rivers and reservoirs from any alterations that would adversely affect commercial uses.

g. **Industrial Water Supply** - These criteria protect the quality of water used for industrial purposes.

Specific designated uses for surface waters in Tennessee are listed in Rules of TDEC, Chapter 1200-4-4 (Tennessee Department of Environment and Conservation, 1999). All surface waters that are not specifically listed in the regulations are classified for fish and aquatic life, recreation, irrigation, livestock watering and wildlife.

A copy of this regulation can be viewed or downloaded at the Tennessee Secretary of State's Homepage. There is a link to this site from the department's home page:

http://www.state.tn.us/environment
or
(http://www.tdec.net)

2. Water Quality Criteria

The Water Quality Control Board has assigned specific water quality criteria to each of the designated uses. These criteria establish the level of water quality needed to support each of the designated uses. There are two types of criteria:

a. Narrative criteria are written descriptions of water quality. These descriptions generally state that the waters should be "free from" particular types or effects of pollution.

b. Numeric criteria establish a measurable safe level for pollutants.

All streams are classified for at least four uses. The regulations require that the most stringent criteria be applied as the clean water goal for that stream. Typically, the most stringent criteria are the protection of either aquatic life or recreational uses.

General water quality criteria for surface waters in Tennessee are listed as part of a specific regulation: Chapter 1200-4-3. A copy of this regulation can be viewed at the Tennessee Secretary of State's Homepage. There is a link to this site from the Department's homepage:

http://www.state.tn.us/environment

Since Tennessee does not perform primary research into the adverse effects of pollutants, reliance is placed on EPA for this information. EPA's standards are usually based on the following research:

- Toxicity tests performed on lab animals.
- The number of cancer incidences occurring in laboratory animals after exposure to a substance.
- The tendency of a substance to concentrate in the food chain.

The water quality criteria provide numeric or narrative descriptions of the level of water quality necessary to support classified uses.

3. Antidegradation

The final section of Tennessee water quality standards is an antidegradation statement. This portion of the law protects existing uses of all surface waters. The antidegradation standard protects both high quality streams and streams that have been impacted by pollution. This section of the law also provides for the highest level of protection for Tennessee Outstanding National Resource Waters (ONRW). Tennessee has designated eight ONRWs. Table 1 illustrates the level of protection afforded to different classifications of water.

Table 1: Antidegradation Categories.

Category	Protections
Tier I	Most waters of the state are Tier I. Existing uses will be maintained by application of the general water quality criteria. Additional loadings of pollutants cannot be allowed if the water quality standard of a stream is currently being violated. Degradation can be allowed in some Tier I streams, but only if non-degrading alternatives are generally unavailable. Degradation must be in the public's interests.
Tier II	High quality waters in which no degradation will be allowed unless and until it is demonstrated that a change is justifiable as a result of necessary economic or social development and will not interfere with or become injurious to any classified uses existing in such waters. Degradation in Tier II streams can only be authorized by the Tennessee Water Quality Control Board.
Tier III (Outstanding National Resource Waters)	These high quality waters constitute an outstanding national resource, such as waters of national and state parks, wildlife refuges and waters of exceptional recreational or ecological significance. No degradation will be allowed in these waters.

B. The Assessment Process

The water quality assessment data in this report summarize of how well the streams in Tennessee meet their assigned water quality standard. To facilitate this analysis, all major rivers, streams, reservoirs, and lakes have been divided into sections called waterbody segments. Assessed waterbodies were placed in one of five categories:

1. **Fully Supporting** waterbodies have water quality that will support its designated uses. Most streams in Tennessee fall into this category. Water quality criteria are generally always met in these streams. Additionally, they support a level of biological integrity generally comparable to that found in reference streams in the same region.

2. **Fully Supporting but Threatened** are those waterbodies that, if current trends continue, will loose the ability to support designated uses in the next two years. This assessment must be supported by data indicating a pattern of water quality degradation.

3. **Partially Supporting** waterbodies are moderately impacted by pollution and water quality criteria are violated on a regular basis. Water quality is considered somewhat impacted. Significant differences may be noted between biological communities at partially and fully supporting streams.

4. **Not Supporting** waterbodies are highly impacted by pollution. Water quality criteria are frequently violated. Water quality is considered severely impacted. Substantial differences in biological communities are noted when compared to fully supporting streams.

5. **Not Assessed** are waterbodies where recent water quality data are not available. Rather than make an assessment in which the Division would have low confidence, streams are placed in this category.

Types of Assessments

Evaluated rivers and lakes were assessed using data more than five years old, or were based on special data, such as land use, watershed information, or predictive models. Very few of Tennessee's assessments are based on evaluations.

Monitored rivers and lakes were assessed using current (less than five years old) data, including fixed-station ambient, intensive surveys, NPDES compliance sampling, or biological monitoring.

According to EPA guidance, assessments can either be based on recent data (monitored) or other types of information (evaluations). TDEC strongly prefers to base stream assessments on recently collected data as judgments based on modeling or land use are much harder to defend. Very few of Tennessee's water quality assessments are evaluations.

It is not possible to monitor all of Tennessee's streams during the two years covered by this report. Some streams are very difficult to access. Others are very small with intermittent flows. During periods of low flow, many of these streams may be dry.

A strategy based on the watershed cycle has been designed and implemented to systematically sample and monitor as many streams as possible. Rivers and lakes are assessed separately. For example, the Tennessee River is no longer a free-flowing river, but rather, is a series of reservoirs. For this reason, it is included under reservoir information.

For this report, 48.8% (29,406 miles) of the stream miles (Figure 4) and almost all of the lake acres (Figure 5) in the state were assessed for existing water quality. 30,820 miles of Tennessee's streams could not be assessed during this cycle. However, it should be noted that most of the larger rivers and streams have been assessed.

The Division continues to increase its reliance on rapid biological assessments. These assessments provide a quick and accurate assessment of the general water quality in a stream. However, biological assessments do not provide information to pinpoint specific toxic pollutants or bacterial levels in water.

The challenge in the next few years will be to combine biological assessments with chemical and bacteriological data so that both use support status and accurate cause and source information can be generated.

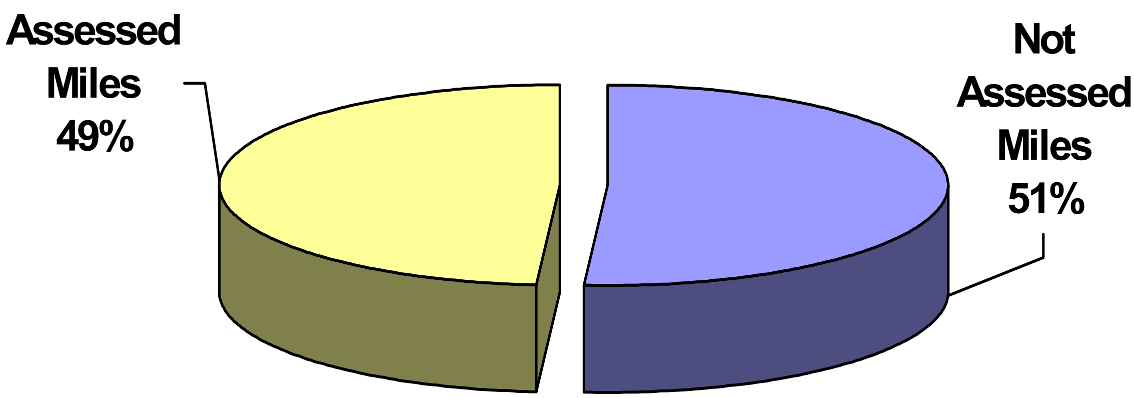


Figure 4: Percent of Rivers and Stream Miles Monitored

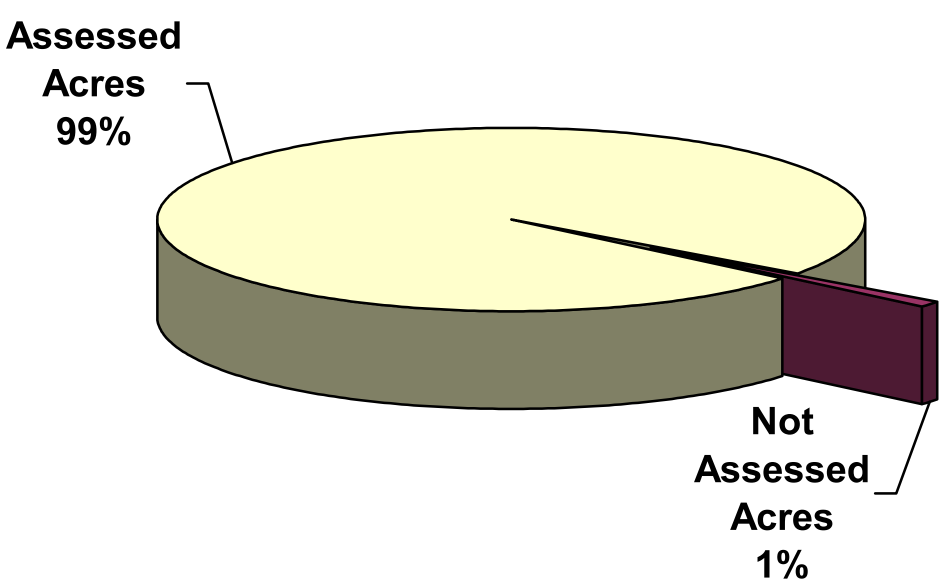


Figure 5: Percent of Reservoir and Lake Acres Monitored

1. Data Sources

The division uses all reliable data gathered in the state for the assessment of Tennessee's waterways. This includes data from TDEC as well as other state and federal agencies and private organizations (Table 2). In December of 2001, the division issued a public notice requesting water quality data for use in this water quality report. Information regarding Tennessee's water quality was received from EPA, TVA, USGS, OSM, TWRA, USCOE.

EPA has developed an updated version of the national STOrage and RETrieval database called STORET. This recently updated database allows for easy access to chemical information collected throughout the state. Currently, TVA, USCOE, OSM, and USGS are not using the STORET database. Therefore, these agencies were contacted directly for additional information.

2. Data Analysis Tools

The Division has several tools that have increased the efficiency and accuracy of assessments. Modern high-speed computers combined with new software have greatly expanded the ability to accurately assess water bodies. These improvements have helped not only with the organization of large quantities of information, but also analysis of specific water bodies.

The STORET database is used to access water quality information. The new version is easier and faster to use and should continue to improve the efficiency of water quality assessments.

Data Analysis Tools

- STORET
- ADB
- GIS
- RIT

The **Assessment Database (ADB)** used by the Division was developed by EPA to store and retrieve assessment information on individual stream and lake segments. The ADB allows for specific analysis of small stream segments, as well as, overall assessments of total watersheds. The ADB system is linked to the **Geographic Information System (GIS)**. The combination of these technologies allow for easy assess to information on specific streams by merely locating them on the GIS map.

EPA also developed the **Reach Indexing Tool (RIT)**. This software is linked to the ADB and GIS allowing quick georeferencing of assessment information. The RIT can produce maps of specific stream information. It is the Division's goal in the near future to have the ADB, the GIS, and the RIT available to the public on the website. Maps of assessment information at the watershed level are available at the department's home page: (http://.state.tn.us/environment).

Table 2: Types Of Data Used in the Water Quality Assessment Process

Chemical Data	Biological Data	Physical Data	Sediment And Tissue Data
Compliance monitoring performed at the nearly 2,000 permitted dischargers in Tennessee. Data collected as a result of complaint investigations, fish kills, spills, and in support of enforcement activities.	Rapid biological surveys completed in association with the watershed project. These were performed primarily in tributary streams as a means of monitoring biological integrity.	Temperature and flow data collected throughout Tennessee.	Sediment and fish tissue data collected at various sites across Tennessee.
Ambient data collected at over 355 fixed-station monitoring sites. Also, over 2,500 stations were established to support the Watershed approach.	Ecoregion biological monitoring. Benthic and fish IBI scores calculated at many sites.	Quantitative assessments of habitat made in conjunction with biological surveys.	EPA's report The Incidence and Severity of Sediment Contamination in Surface Waters of the United States.
Data collected at the Division's 100 ecoregion reference sites. (These stations provide a baseline to which other sites within that ecoregion can be compared.)	Bioassay studies of effluent toxicity at most major NPDES dischargers. Many minor facilities also do this type testing.	Time-of-travel studies of flow, dissolved oxygen sags and BOD decay rates.	Locations of existing fishing advisories in Tennessee.
Chemical data collected by other agencies*.	Biological data collected by other agencies*.	Physical data collected by other agencies*.	Sediment and tissue data collected by other agencies*.

* The Division of Water Pollution Control is grateful to the following agencies for providing their monitoring data and reports: U.S. Environmental Protection Agency (STORET, sediment report, Index of Watershed Integrity); Tennessee Valley Authority biological data, Reservoir Vital Signs Monitoring, NPDES discharge monitoring, recreational area fecal coliform sampling, tailwater monitoring; Tennessee Wildlife Resources Agency (biological surveys and fish tissue monitoring data); U.S. Geological Survey (gaging station data); U.S. Army Corps of Engineers (water, sediment, and tailwater monitoring), and U.S. Fish and Wildlife Service (species databases).

3. Data Use

The Division's goal is to make assessments more numerically quantifiable (objective) and therefore require less professional (subjective) judgment.

WPC is accomplishing this goal as follows:

a. The ecoregion project has dramatically reduced the uncertainty associated with the application of narrative criteria.

b. Data from a sampling point are extrapolated a much shorter distance than in the past. The decision on how far the information is applicable is made on a site-by-site bases using factors such as amount and type of data and the uniformity of the stream.

c. Minimum data requirements for the specific types of data have been set.

d. Certain collection seasons and types of data have proven more important for the protection of specific water uses. For instance, the critical period for parameters like toxic metals or organics is the low flow season of late summer and early fall. Other activities like swimming and wading are mostly likely to occur in the summer.

4. Data Application

Tennessee's water quality standards assign specific water quality criteria to each of the use classifications. Two types of criteria are established in Tennessee's regulation. Numeric criteria establish specific levels for conditions or constituents in water. Narrative criteria state that the water should not have particular types or effects that indicate loss of use support.

Water quality assessment is simply the application of water quality criteria to the ambient data previously collected. However, several factors complicate this process:

- Narrative criteria provide only descriptions of conditions that either comply with, or violate, the water quality standards. The Division is left to interpret what these acceptable levels are.

- In order to make defensible assessments, data quality objectives must be met. For some parameters, a minimum number of observations must be established in order to have confidence in the accuracy of the assessment.

- Provisions in the water quality criteria instruct staff to determine whether violations are caused by man-induced conditions or natural conditions. Natural conditions are not considered to be pollution.

- The magnitude, frequency, and duration of violations must be considered in the assessment process.

- Many streams in Tennessee experience periodic dryness. It can be a challenge to determine if changes in biological integrity are related to man induced conditions or simply that the stream was recently dry.

In order to address these issues and concerns, the division has developed an assessment strategy. This strategy is summarized in the following section.

Environmental Specialist Michael Robbins collects water samples for chemical analysis. When the Division assesses these data, the natural background conditions of streams in that region will be factored into the conclusions. (Photo by Dan Murray, Mining, Knoxville EAC)

a. Parameters with Numeric Criteria

Metals and Organics Guidance

- One or two chemical samples are not considered an accurate representation of stream conditions. Therefore, more than two observations were used in all assessments. Acute fish and aquatic life protection criteria were generally used unless a site had 12 or more chemical collections. If a site had 12 or more chemical collections, chronic criteria could be applied.

- All metals data are appropriately "translated" according to the water quality standards before comparison to criteria. For example toxicity of metals is altered by stream hardness and the amount of total suspended solids in the stream. Widely accepted methodologies are available to make these and other translations of the data.

Bacteriological Guidance

- Streams will not be assessed as impacted due to high bacteria levels with less than three water samples. The only streams assessed with one or two observations are streams previously listed due to elevated bacteria levels.

- E. coli data are generally considered more significant than fecal coliform data.

- If flow data are available, low flow, dry season data are considered more meaningful than high flow, wet season data. In the absence of flow data, samples collected in late summer and fall are considered low flow or dry season samples. It is important to note that wet season pathogen samples are not disregarded. They are simply given less weight than dry season pathogen samples.

b. Parameters with Narrative Criteria

Nutrients

- One or two chemical collections are considered a valid assessment only if they are supported by evidence of biological impairment. For example, if the biology of a stream is very poor and the amount of algae present indicates organic enrichment, then one or two chemical collections could be used to identify a suspected cause of pollution.

- Regional nutrient goals were developed and used during this assessment cycle. (Denton et al., 2001). The Division intends to recommend promulgation of these goals as specific water quality criteria during the next triennial review of water quality standards.

Suspended Solids/Siltation

- Historically, silt is one of the primary pollutants in Tennessee surface waters. The division has experimented with multiple ways of collecting sufficient data to determine stream impairment due to siltation. These methods include visual observations (dirt in the water), chemical analysis (total suspended solids), and macroinvertebrate/habitat surveys. Biological surveys that include a habitat assessment have proven to be the most satisfactory method.

- Through work at reference streams, staff found that the appearance of dirt in the water is often, but not always, associated with loss of biological integrity. Additionally, the various ecoregions are very dissimilar in the amounts of silt that can be tolerated before aquatic life is impacted. Thus, for water quality assessment purposes, it is good to establish whether or not aquatic life is being impacted. For those streams where loss of biological integrity can be documented, the habitat assessment can easily determine if the stream has excessive amounts of silt.

- The division has published a study of habitat quality at reference streams (Arnwine and Denton, 2001). This guidance is used as a guide for wadeable test streams within the same region.

Biological Data

- Biological surveys using macroinvertebrates as the indicator organisms are the preferred method for assessing support of the fish and aquatic life designated use. Two standardized biological methods, biorecons and semi-quantitative samples, are used to produce a biological score or biological index (TDEC, 2002).

- The most commonly utilized biological surveys are biorecons. Biological scores are compared to the metric values obtained in ecoregion reference streams. The principal metrics used are the number of mayflies, stoneflies, and caddisflies (EPT) families (or genera), the total families (or genera), and the number of pollution intolerant families (or genera) found in a stream.

- If a more definitive assessment is needed, a single habitat, semi-quantitative sample is collected. Organisms are identified to genus, and an index based on seven metrics is used for comparison to ecoregion reference streams.

- Streams where biological integrity does not fall within the expected range of conditions found at reference streams, are considered impacted. (Note: the stream being compared to the reference stream database and sampling techniques must be similar for this methodology to be valid.)

- If the data from the Division and another agency do not agree, more weight is given to the Division's data unless the other agency's data is considerably more recent.

- Regional numeric goals for biological integrity have been developed and were used during this assessment cycle. (Arnwine and Denton, 2001). The Division intends to recommend promulgation of these goals as specific water quality criteria during the triennial review of water quality standards.

Habitat Data

- Division staff use a standardized scoring system developed by EPA to rate the habitat in a stream.

- Habitat scores calculated by Division biologists are compared to the ecoregion reference stream database. Streams where habitat scores are not within 75 percent of the median reference score are considered impacted. However, streams are not assessed as habitat impacted if the documented biological integrity meets expectations.

- Guidance on the interpretation of the narrative habitat criterion has been developed and was used during this assessment cycle (Arnwine and Denton, 2001).

Amy Fritz of the Jackson EAC sorts through the invertebrates she just collected in Pompey Branch near Pickwick Lake. Pompey Branch is a reference stream for subecoregion 65j. (Photo by Pat Patrick, Jackson EAC.)

VI. Overview of Water Quality Information

Historically, Tennessee has been divided into three grand divisions: east, middle, and west (Figure 6). Some water quality problems like urban development and collection system problems occur throughout the state. However, other sources of pollution tend to be concentrated in certain areas of the state. More specific information on individual watersheds can be found in the section that begins on page 114.

The majority of the streams and reservoirs in Tennessee are fully supporting of their classified uses. Some of the streams and reservoirs in the state have been impacted by pollution and are only partially supporting of their designated uses. Even smaller percentages of the streams and reservoirs have received a not supporting designation due to severe impairment. This chapter generally discusses the overall results of the two-year assessment period.

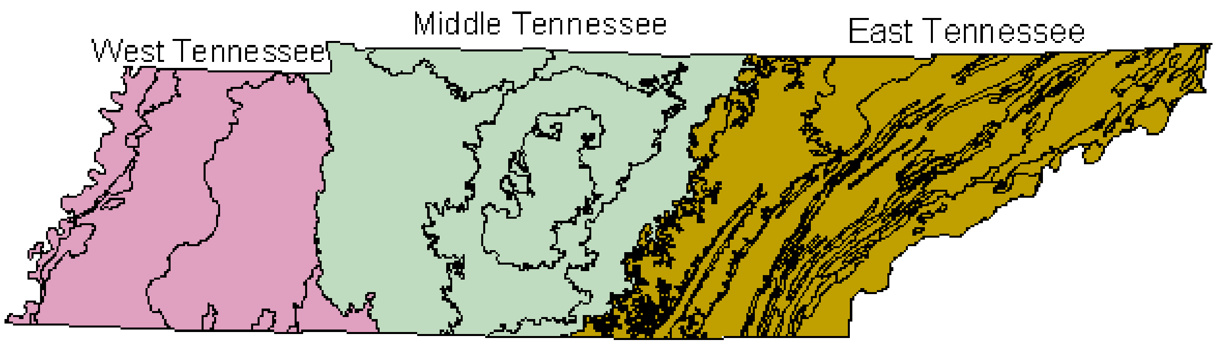


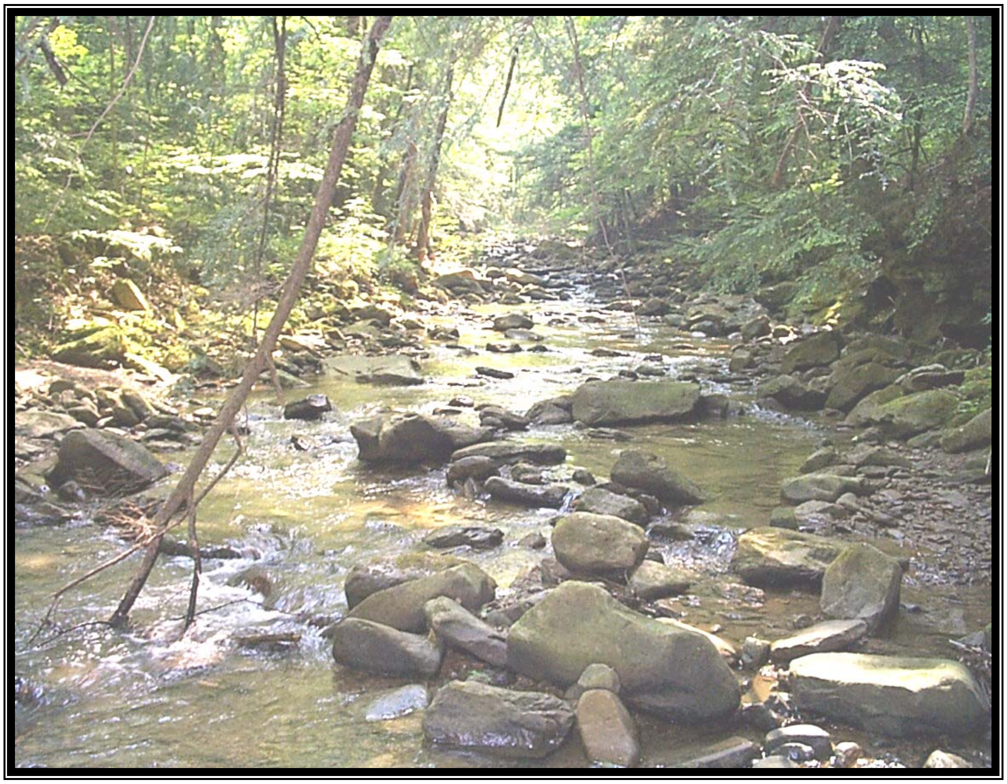
Figure 6: The Grand Divisions of Tennessee

Each of Tennessee's three grand divisions face different water quality challenges. East Tennessee is fortunate to have seven of the state's eight Outstanding Natural Resource Waters (ONRWs), the only Wild and Scenic River, and eight of the Scenic Rivers. Unfortunately, east Tennessee also has 10 of the state's 16 water bodies with fish consumption advisories.

Middle Tennessee's water quality is generally good, with the main threats being agriculture and urban development. This portion of the state has four designated Scenic Rivers, while only one reservoir currently has a fishing advisory.

West Tennessee has one ONRW, Reelfoot Lake, and one Scenic River, the Hatchie River. The primary impacts to streams and rivers in this part of the state are extensive channelization and intensive row cropping. Five waterways in the Memphis area are currently posted with fishing advisories due to chlordane and other organic substances.

1. East Tennessee



Blue Ridge Mountain Stream. (Photo provided by Jonathan Burr, Knoxville EAC)

ONRWs in East Tennessee:

- Obed River
- Big South Fork Cumberland River
- Middle Prong Little Pigeon River
- West Prong Little Pigeon River
- Abrams Creek
- Little River
- East Prong Little Pigeon River

Four major ecoregions are located in east Tennessee. These are the Blue Ridge Mountains, the Ridge and Valley, Central Appalachians, and the Southwestern Appalachians. Generally, water quality is very good in the mountain regions of east Tennessee. Most of the state's trout streams are located in the Blue Ridge ecoregion, including those streams that provide habitat for the native brook trout.

Seven of the eight formally recognized ONRWs are located in East Tennessee. These seven ONRW are portions of the Obed River, Big South Fork Cumberland River, Middle Prong Little Pigeon River, West Prong Little Pigeon River, Abrams Creek, Little River, and East Prong Little Pigeon River. Most of these ONRWs are located in state or federally protected areas.

Tennessee's only National Wild and Scenic River is the Obed River in the Cumberland Plateau. About 45 miles of the Obed River from the western border of the Catoosa Wildlife Management Area to the confluence with the Emory River including portions of Clear Creek and Daddy's Creek are included in the designation.

Wild and Scenic River:

- Obed River

East Tennessee also has eight of the state's Scenic Rivers designated by the legislature under the Tennessee Scenic River Act. Portions of Blackburn Fork, Clinch River, Conasauga River, French Broad River, Hiwassee River, Roaring River, Spring Creek, and Tuckahoe Creek are designated as Scenic Rivers.

Scenic Rivers:

- Blackburn Fork
- Clinch River
- Conasauga River
- French Broad River
- Hiwassee River
- Roaring River
- Spring Creek
- Tuckahoe Creek

Generally speaking, ridge and valley streams are more heavily altered by agriculture and urban development. Many of these streams have bacteria problems due to urban runoff, municipal bypassing, or dairy and other animal operations. Streams impacted by urban stormwater can be found in Chattanooga, Knoxville, Bristol, Kingsport, Johnson City, and other densely populated areas.

Six reservoirs have fishing advisories due to the accumulation of organic pesticides (primarily PCBs) in fish tissue. Nickajack, Tellico, Watts Bar, Melton Hill, Boone and Fort Loudoun reservoirs currently have fishing advisories. Three streams, Chattanooga Creek, East Fork of Poplar Creek (PCBs and mercury), and North Fork of Holston River (mercury) also have fishing advisories. The fish consumption advisory on the Pigeon River was recently lifted. See Chapter IX for more specific information on fishing advisories.

Six east Tennessee rivers are impacted by flow alteration, low dissolved oxygen, or temperature alteration below dams. These rivers include: the Hiwassee River below Apalachia Dam, Ocoee River below Parksville Reservoir, Clinch River below Norris Reservoir, Holston River below Cherokee Reservoir, French Broad below Douglas Reservoir, and the South Fork Holston below Fort Patrick Henry Reservoir.

Both historical and current mining operations have impacted streams in east Tennessee. Several streams in the Cumberland Mountains and Cumberland Plateau continue to be impacted by runoff or discharges from either abandoned or active coal mining activities. Mining impacts downstream of the Copper Basin in Polk County are from historical copper smelting operations.

Pollutants from mining sites commonly include low pH, siltation, and elevated metals. These metals can impact aquatic life through direct toxicity, or they can deposit a thick precipitant that will limit habitat available to aquatic life.

2. Middle Tennessee

Creech Hollow Branch is a typical middle Tennessee stream in Subecoregion 71f. (Photo provided by Annie Goodhue, Nashville EAC.)

The middle Tennessee region extends from the Cumberland Plateau to the western Tennessee River. The middle portion of the state consists of a single Level III ecoregion, the Interior Plateau. Middle Tennessee has four rivers that have been designated as Scenic Rivers: the Buffalo, Collins, Duck, and Harpeth rivers.

Scenic Rivers:

- Buffalo River
- Collins River
- Duck River
- Harpeth River

Water quality is generally good, but has been impacted in some areas by rapid urban development. Eleven streams currently have bacteria advisories due to urban runoff, municipal bypassing, or collection system problems. Cities with significant problems related to bypasses or discharges of inadequately treated wastes include Nashville, Franklin, Murfreesboro, Manchester, Tullahoma, and Mt. Pleasant. Streams impacted by urban stormwater runoff have been documented in these cities as well as Clarksville, Columbia, and Lebanon.

Like the ridge and valley region of east Tennessee, many middle Tennessee streams are impacted by agriculture activities, predominantly livestock grazing. In certain areas, especially in southern middle Tennessee, intensive livestock feeding areas cause bacteriological problems. These agricultural activities as well as urban expansion have reduced the available habitat for stream life.

Only one middle Tennessee waterbody currently has a fish consumption advisory. The public has been advised to limit consumption of Woods Reservoir catfish due to elevated PCB levels.

Seven middle Tennessee streams located downstream of dams continue to be impacted by flow alteration, low dissolved oxygen, elevated metals, or temperature alteration. These streams include: the Duck River below Normandy Dam, the Elk River below Woods and Tims Ford Reservoirs, the Obey River below Dale Hollow Reservoir, the Caney Fork below Center Hill Dam, and Stones River below Percy Priest Dam.

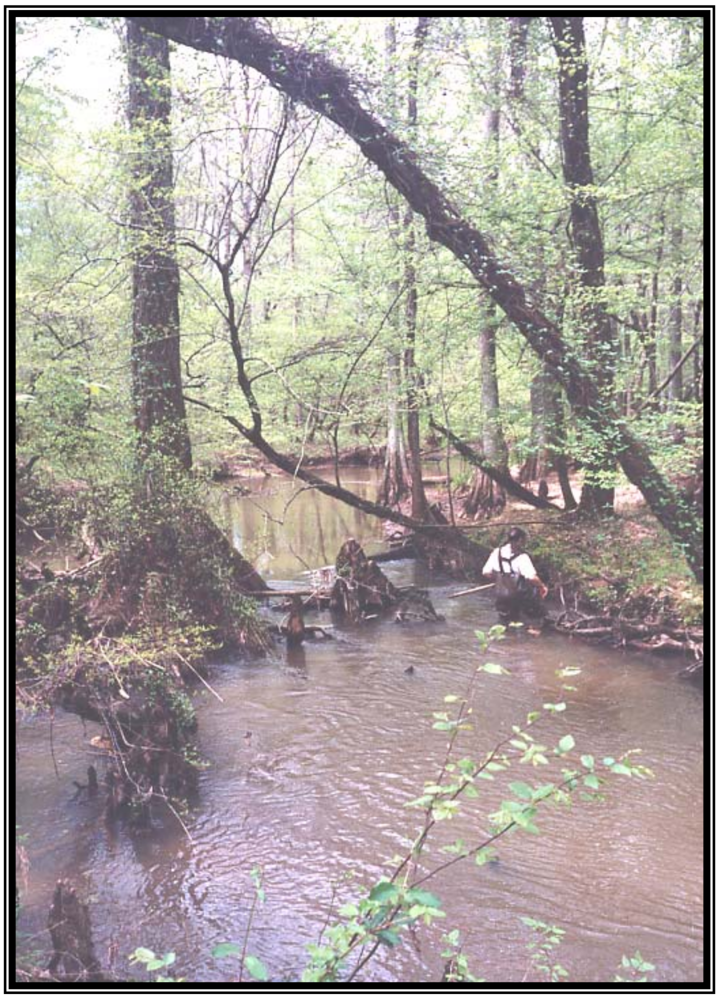
McCrory Creek in the Stones River watershed.
(Photo provided by Annie Goodhue, Nashville EAC.)

3. West Tennessee

The west Tennessee region extends from the Tennessee River to the Mississippi River. This region consists of four Level III ecoregions, Southeastern Plains, The Mississippi Valley Loess Plains, the Mississippi Alluvial Plains, as well as a small section of the Western Highland Rim of the Interior Plateau.

The predominant agricultural activity in west Tennessee is row cropping. Cotton, corn, soybeans, and wheat are common crops. However, intensive hog and chicken farming is increasing in this region.

One ONRW is located in the northwestern corner of the state, Reelfoot Lake. Reelfoot Lake is unique because it is the only large naturally-occurring lake in the state. Additionally, the Hatchie River has been designed as a Scenic River.



Division biologist Amy Fritz of the Jackson EAC collects a biological sample from an undercut streambank. (Photo by Sharon King, Mining, Jackson EAC.)

Many west Tennessee streams have been highly altered and water quality has been severely impacted. The widespread practice of channelization has the following detrimental effects:

- Destroys productive wetlands.
- Eliminates in-stream habitat for fish and other aquatic life.
- Increases downstream flood damage.
- Accelerates the transport of pollutants.
- Promotes the loss of fertile soil.
- Causes down cutting of the streambed until the creeks have water levels that can be considerably lower than the surrounding land.
- Creates "valley plugs," downstream accumulations of sand.

West Tennessee Outstanding Natural Resource Water:

- Reelfoot Lake and its associated wetlands.

Scenic River:

- Hatchie River

Some west Tennessee streams continue to be impacted by poor quality municipal discharges or collection system overflows. Memphis and the rapidly developing surrounding counties have historical problems with urban stormwater runoff. Urban runoff is also a problem in Jackson, Union City, Dyersburg, and Brownsville.

The Mississippi River at Memphis, portions of Nonconnah Creek, the Loosahatchie River and Wolf River, currently have fishing advisories. These advisories were originally issued due to chlordane, a pesticide historically manufactured in Memphis. However recent analyses have indicated other toxic substances as well including dioxin and PCBs.

Cypress Creek is a typical slow moving west Tennessee stream.
(Photo by Amy Fritz, Jackson EAC.)

A. Water Quality in Streams and Rivers

1. Overall Use Support

According to EPA's Reachfile 3 database, there are 60,226 miles of streams in Tennessee. Using recent specific data, the Division was able to assess almost half (29,406 miles) of the stream miles in the state (Table 3 and Figure 7). Most of the streams not assessed are very small or inaccessible tributaries to larger streams that have been assessed.

Table 3: Assessed Stream Miles

Stream Assessment	Miles
Total Assessed Miles	29,406.0
Fully Supporting	20,490.0
Fully Supporting, but Threatened	33.6
Partially Supporting	7,183.7
Not Supporting	1,698.7
Not Assessed	30,820.5
Total Miles	60,226.5

- A total of 20,490.0 of the assessed stream miles (69.7%) are fully supporting their designated uses.
- An additional 33.6 miles (0.1%) have been assessed as fully supporting, but threatened. Threatened streams are those that are currently meeting water quality standards, but the Division has reliable data indicating a downward trend in water quality that will likely lead to a decline in water quality status in two years.
- 7,183.7 stream miles (24.4%) are assessed as partially supporting due to a definite degree of impairment.
- 1,698.7 stream miles (5.8%) are considered not supporting due to severe impairment.

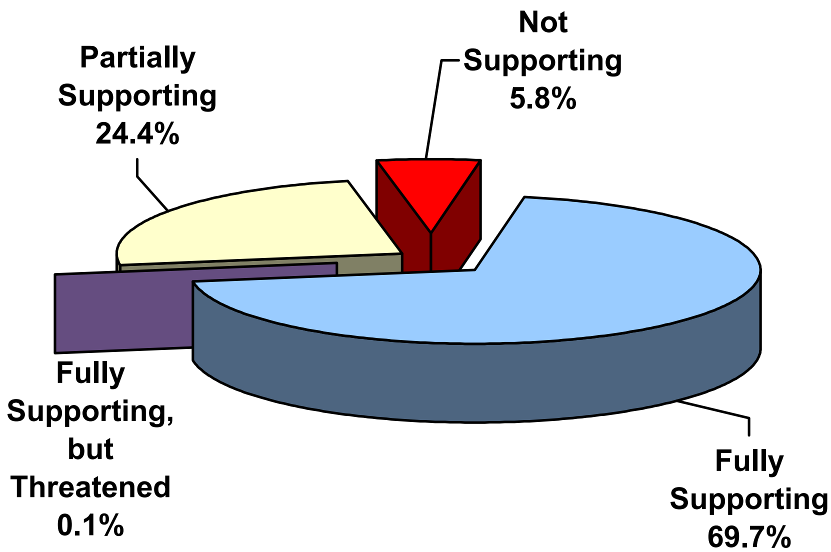
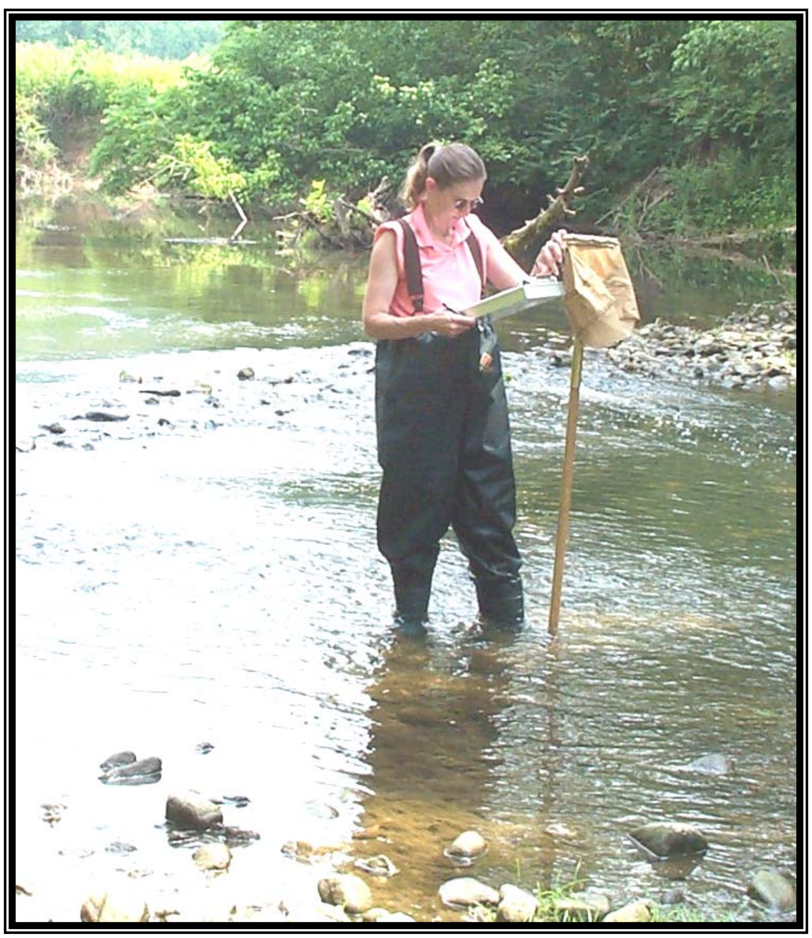


Figure 7: Percent Use Support in Assessed Rivers and Streams

2. Support of Individual Uses for Streams and Rivers

For each stream in Tennessee, overall use support has either been assessed or the stream has been called "not assessed" if no recent data are available. Additionally, the degree of support of individual uses has also been assessed, if possible. At times, a stream can be assessed for one use, but not another.

The two sets of criteria most commonly violated are for fish and aquatic life protection and recreation. About 30 percent of the stream miles that can be assessed for recreational use violated those standards. A little over 26 percent of the assessed stream miles violated fish and aquatic life standards. Less than one percent of the streams were assessed as violating the domestic water supply use criteria. All waters classified for irrigation, navigation, and industrial water supply uses were found to be fully supporting (Table 4 and Figure 8).



Chattanooga EAC biologist Tammy Hutchinson collects a biological sample from the riffle area of a stream. (Photo by Terry Whalen, Chattanooga EAC.)

Table 4: Individual Classified Use Support for Rivers and Streams

Designated Uses	Miles Of Stream Classified	Classified Miles Assessed	Miles Meeting Use	Percentage Of Assessed Miles Meeting Use*
Fish and Aquatic Life Protection	60,226.5	28,944.7	21,327.1	73.7%
Recreation	60,222.6	11,749.5	8,232.3	70.1%
Irrigation	60,222.6	29,346.8	29,346.8	100.0%
Livestock Watering and Wildlife	60,222.6	29,074.1	29,059.7	99.9%
Domestic Water Supply	3,586.1	3,586.1	3,565.0	99.4%
Navigation	844.0	844.0	844.0	100.0%
Industrial Water Supply	3469.6	3469.6	3469.6	100.0%

Note- All streams are classified for more than one use, but may or may not have all uses impacted. Thus, this table cannot be used to derive percentages for overall use support in Tennessee. Also, assessment rates for individual uses may not match overall use assessment rates.

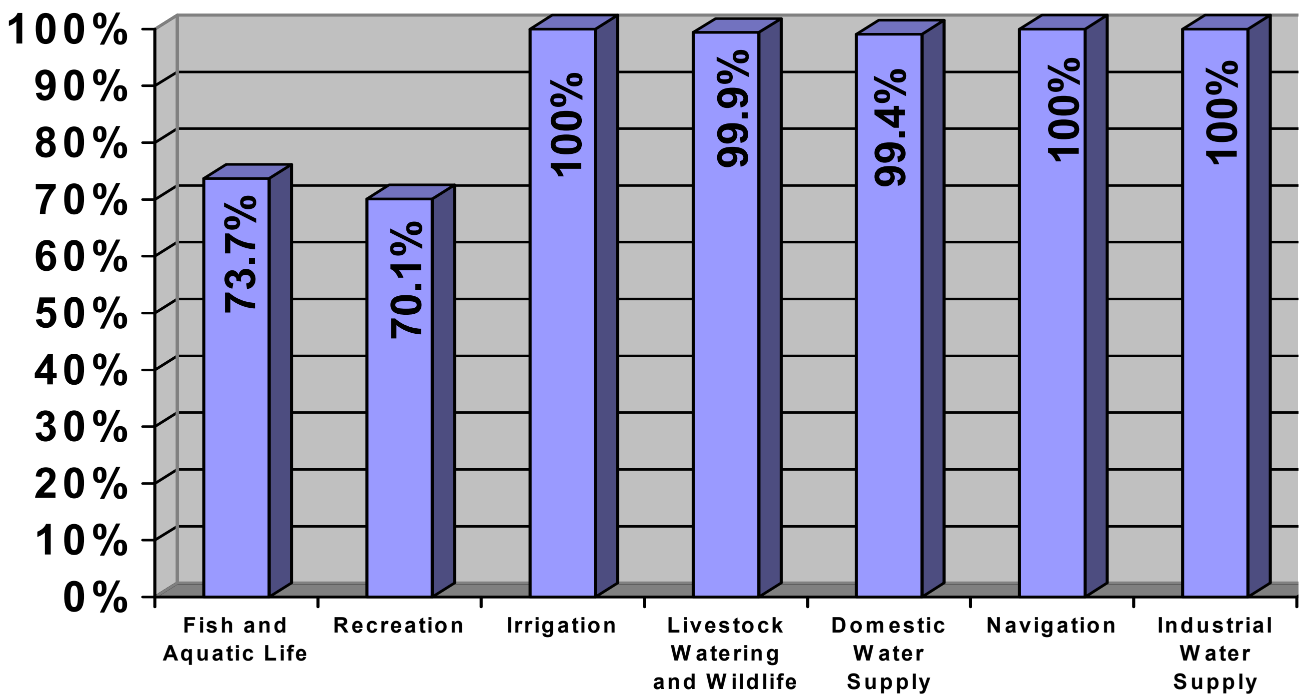


Figure: 8: Percent Use Support for Individual Classified Uses in Assessed Rivers and Streams

B. Water Quality in Reservoirs and Reelfoot Lake

1. Overall Lake Use Support

Table 5: Assessed Lake Acres

Lakes Assessment	Acres
Total Assessed Acres	530,629
Fully Supporting	416,743
Fully Supporting, but Threatened	0
Partially Supporting	26,872
Not Supporting	87,014
Not Assessed	6,165
Total Acres	536,794

Tennessee has 92 publicly owned reservoirs or lakes that total 536,794 lake acres. For the purpose of this report, a public reservoir or lake is a publicly accessible reservoir or lake larger than five acres.

Most lakes in Tennessee were created by the impoundment of a stream or river. One exception is Reelfoot Lake, thought to have been formed by a series of earthquakes in 1811 and 1812. Since natural processes formed Reelfoot Lake, it is categorized as a freshwater lake for assessment purposes. (Reelfoot Lake is not the only naturally formed lake in Tennessee, but it is the largest and the only one that has been assessed for this report.) For the purposes of this report, the generic term "lake acre" refers to both reservoirs and lakes.

By using available data, the Division of Water Pollution Control was able to assess 530,629 lake acres (Figure 9). This means that 98.8 percent of the lake acres in Tennessee have been assessed (Table 5). Only assessed lake acres are included in the rating shown below.

- A total of 416,743 lake acres (78.5%) are fully supporting.
- The Division had no data that would justify the assessment of any Tennessee lake as "threatened."
- 26,872 lake acres (5.1%) are assessed as partially supporting due to a certain degree of impairment.
- 87,014 lake acres (16.4%) are considered not supporting due to severe impairment from pollution.

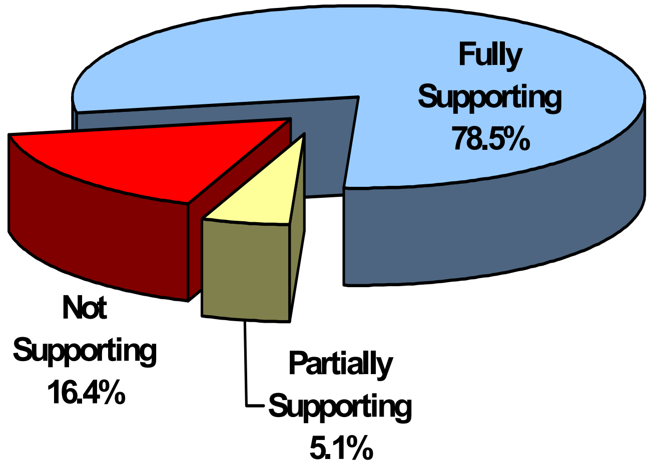
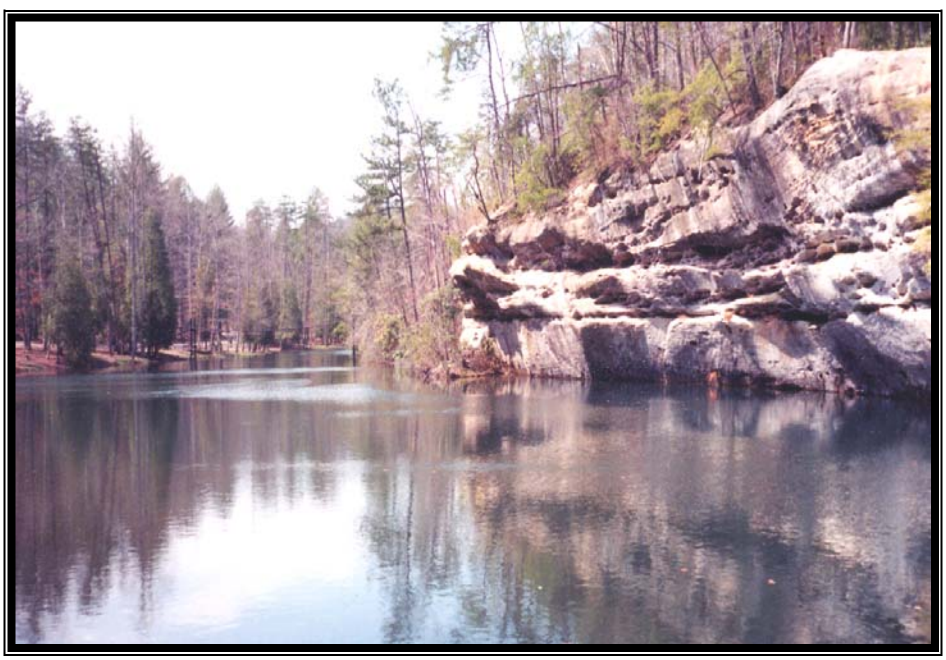


Figure 9: Percent Use Support in Assessed Reservoirs (including Reelfoot Lake).

2. Support of Individual Uses in Lakes and Reservoirs

As in streams and rivers, the two most commonly violated use designations are fish and aquatic life and recreation (Table 6). However, these were the only two classified uses violated in reservoirs and lakes. Recreational use was the most frequently violated classified use. Twenty percent of the reservoir/lake acres exceed recreational use standards. Less than four percent of the reservoir/lake acres exceeded fish and aquatic standards. All other designated uses were fully supporting all assessed acres (Figure 10).



Pickett State Park Reservoir (Photo by Kim Sparks, Planning and Standards.)

Table 6: Individual Classified Use Support for Reservoirs and Reelfoot Lake

Designated Uses	Acres Classified	Classified Acres Assessed	Acres Meeting Use	Percentage of Assessed Acres Meeting Use*
Fish and Aquatic Life Protection	536,794	524,929	505,521	96.3%
Recreation	536,794	494,489	394,422	79.8%
Irrigation	536,794	495,219	495,219	100%
Livestock Watering and Wildlife	536,794	366,015	366,015	100%
Domestic Water Supply	505,457	505,162	505,162	100%
Navigation	260,664	260,664	260,664	100%
Industrial Water Supply	430,957	395,542	395,542	100%

Note: Reservoirs are classified for more than one use, but may or may not have all uses impacted. Thus, this table cannot be used to derive percentages for overall use support in Tennessee. Also, assessment rates for individual uses may not match overall use assessment rates.

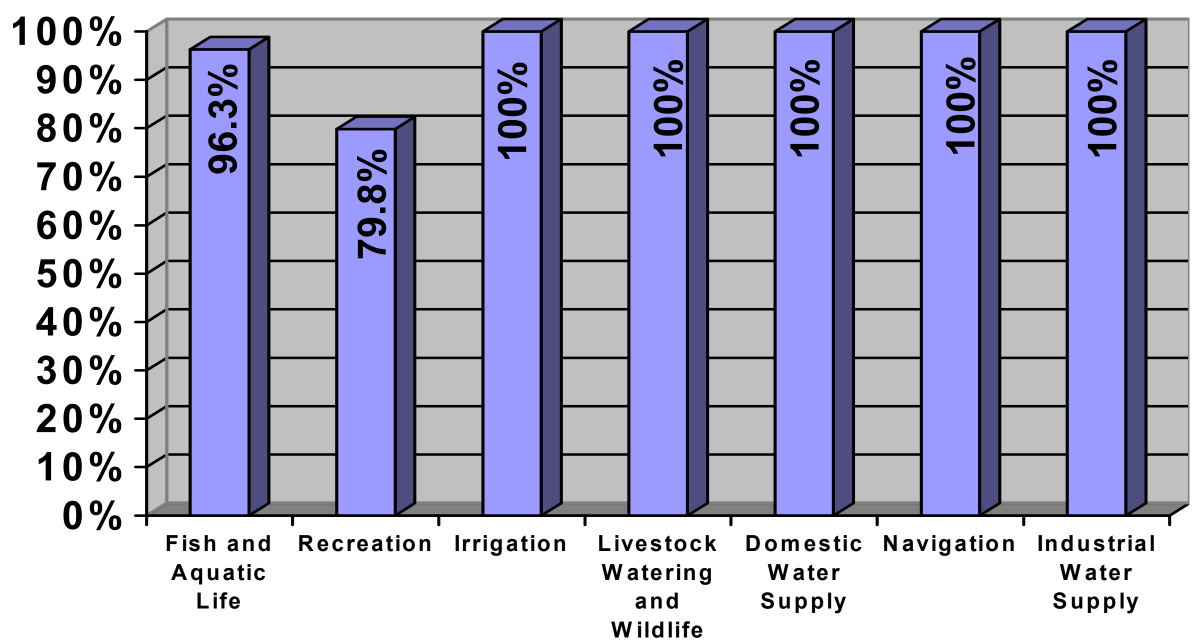


Figure 10: Percent Use Support for Individual Uses in Assessed Reservoirs and Reelfoot Lake

C. Water Quality in Wetlands

Wetlands are some of Tennessee's most valuable natural resources. Wetlands serve as buffer zones along rivers, help filter pollutants from surface runoff, store floodwaters during times of high flows, provide spawning areas for fish, and serve as repositories for specialized plants and wildlife species. Over the last century, Tennessee has lost hundreds of thousands of wetland acres. This loss represents over 60 percent of Tennessee's wetlands. Today, approximately 787,000 acres of wetlands remain in Tennessee.

The largest single cause of impact to existing wetlands in Tennessee is loss of hydrologic function due to channelization and leveeing. These changes to wetlands were done initially to prevent flooding. Unfortunately, instead of preventing flooding, it merely diverts water downstream.

Another significant impact in wetlands is siltation. Siltation is the movement of soil from the surrounding land into a waterway. Sources of silt include runoff from farms or construction projects like roads, shopping centers, and golf courses. Proper soil conservation practices at these sites are critical to prevent further siltation. While land development contributes most of the pollution, a few wetlands have been contaminated by historical industrial activities. Several of these wetlands are now Superfund sites.

Tennessee's Wetlands Conservation Strategy was first published in 1989, in cooperation with state and federal agencies, to plan for the protection and restoration of wetlands. Tennessee was one of the first states in the nation to have a protection strategy and has been recognized by EPA as establishing a national model for wetlands planning. To view the strategy, visit the web site at http://www.state.tn.us/environment.

Tennessee Wetland Atlas

Estimated Number of Historical Wetland Acres……………………..1,937,000

Estimated Number of Existing Wetland Acres……787,000

Percentage of Historical Acres Lost …………………….60%

Number of Existing Wetland Acres Considered Impacted by Pollution and/or Loss of Hydrologic Function……..54,811

Tennessee has sought to stop the decline in wetlands through the implementation of a "no net loss" policy. This policy includes purchasing wetlands, establishing mitigation banks, and the issuance of permits.

The Division has identified 54,811 impacted wetlands acres. Wetlands that have been altered without prior approval and have not yet been adequately restored are considered impacted. Also sites that were not altered according to the approved plan are considered impacted. In instances where the wetland was altered, but the state received compensatory mitigation for the loss of water resources, the resource was not considered impacted.

VII. Causes Of Water Pollution

Pollution is an alteration of the physical, chemical, biological, bacteriological, or radiological properties of water that result in an impairment of designated uses. In assessing the causes of pollution in streams and lakes, the Division follows the guidance provided by EPA. In order to help standardize the naming of pollutants, EPA's Assessment Database (ADB) has a menu of potential pollutants that can be selected for impaired streams. Additionally, states can create subcategories. For example, "nutrients" is an EPA category in the ADB. Tennessee has added "nitrate+nitrite" and "total phosphorus" as sub-categories.

A. Causes of Pollution in Streams and Rivers

Pollutants such as siltation, suspended solids, nutrients, organic enrichment, and low dissolved oxygen are the leading causes of impairment in Tennessee streams. Silt and suspended solids impact streams by eliminating habitat, blocking light penetration, and smothering aquatic life. Organic enrichment caused by excessive nutrients or BOD stimulates algae growth which causes wide fluctuations in dissolved oxygen levels (Figure 11). These factors alter biological communities to favor species tolerant for these conditions. The public's uses of these streams are impacted when biological integrity goals are not met. Other common pollutants in streams include toxic substances, bacteria, flow alteration and habitat destruction.

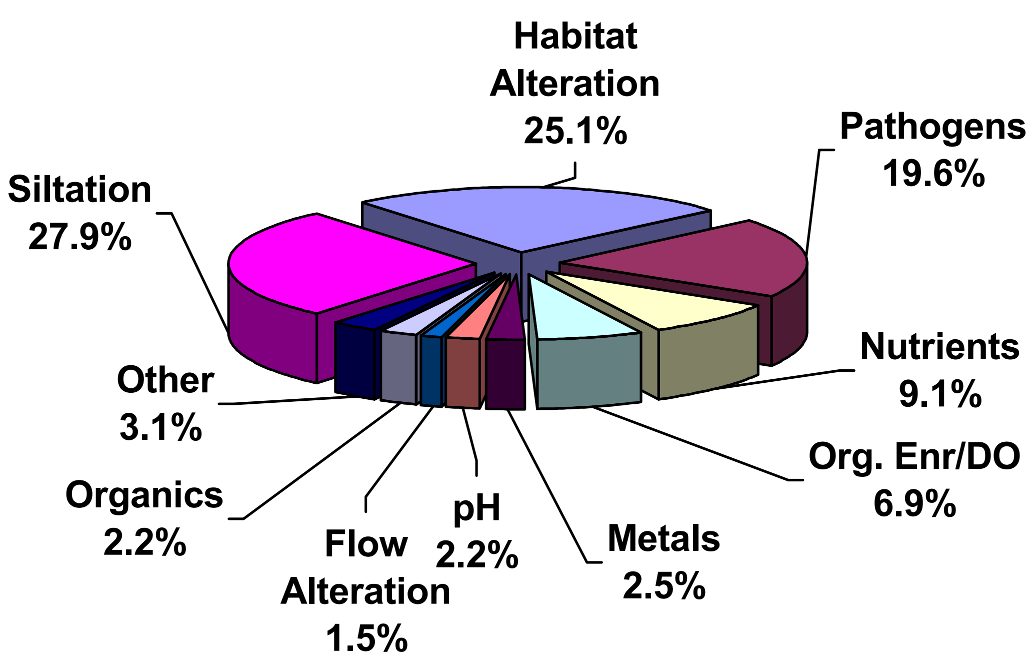


Figure 11: Relative Impacts of Pollution in Assessed Rivers and Streams

1. Siltation

The most frequently cited pollutant in Tennessee is siltation, impacting over 4,860 miles of streams. Siltation is generally associated with land disturbing activities such as agriculture and construction. Some of the significant economic impacts caused by siltation are increased water treatment costs, filling in of reservoirs, loss of navigation channels, and increased likelihood of flooding.

Silt alters the biological properties of waters by:

- Smothering eggs and nests of fish.
- Transporting other pollutants, in possibly toxic amounts, or providing a reservoir of substances that may become concentrated in the food chain.
- Clogging the gills of fish and other forms of aquatic life.
- Interfering with fish ability to see food.
- Covering substrate that provides habitat for aquatic insects, a main prey of fish.
- Reducing biological diversity by altering habitats to favor burrowing species.
- Accelerating growth of submerged aquatic plants and algae.

Silt alters the chemical properties of waters by:

- Interfering with photosynthesis.
- Decreasing available oxygen due to decomposition of organic matter. Decomposing organic matter in the absence of light causes a deficiency in dissolved oxygen.
- Increasing nutrient levels that accelerate eutrophication in reservoirs.
- Transporting organic chemicals and metals into the water column (especially if the original disturbed site was contaminated).

Silt alters the physical properties of waters by:

- Reducing or preventing light penetration.
- Changing temperature patterns.
- Decreasing the depth of pools or lakes.
- Changing flow patterns.

Whether calculated by volume or number of impacted stream miles, soil in the water is the largest single pollutant in Tennessee. Some erosion is natural, however, tons of excess soil are lost every year as a result of human activities.

Preventive planning in land development projects can protect steams from siltation and protect valuable topsoil. Best Management Practices (BMPs) such as the installation of silt fences and maintenance of trees and undergrowth as buffer zones along creek banks can prevent soil entering the creek. Farming practices that minimize land disturbance such as fencing livestock out of creeks and no-till practices contribute greatly to protecting our waters.

2. Habitat Alteration

Many streams in Tennessee appear to have impaired biological communities, in the absence of obvious chemical pollutants. Often the cause is physical alteration of the streams which results in a loss of habitat. Habitat is often removed by agricultural activities, urban development, bridge or other construction, and /or dredging.

The Division uses an EPA method to score the stream habitat by evaluating ten components of habitat stability. This is a standardized way to identify and quantify impacts to stream habitat. Tennessee has developed regional guidance based on reference data to evaluate habitat (Arnwine and Denton, 2001). This is discussed in more detail in Chapter XII.

A permit is required to modify a stream in Tennessee. The permit will not be issued unless the water resources can be protected.

3. Pathogens

Pathogens are disease-causing organisms such as bacteria or viruses that can pose an immediate and serious health threat if ingested. Many bacteria and viruses that can be transferred through water are capable of causing serious or even fatal diseases in humans. The main sources for pathogens are untreated or inadequately treated human or animal fecal matter.

Water quality criteria use indicators to test for the presence of pathogens. Tennessee traditionally used total fecal coliform counts as the indicator of risk, but is in the process of finalizing a shift to an *E. coli* -based criteria. The *E. coli* group is considered by EPA to be a better indicator of true human risk.

Water contact like swimming, wading, splashing or fishing in water contaminated with these pathogens could have dangerous consequences. Currently, Tennessee has 32 streams and rivers posted for no water contact due to high pathogen levels. See Chapter IX for more specific information on these streams and rivers.

4. Nutrients

Another problem in Tennessee waterways is elevated nutrient concentrations. The main sources for nutrient enrichment are agricultural activities, wastewater plants, urban runoff, and improper application of fertilizers. Nutrients stimulate algae growth that produces oxygen during daylight hours, but uses oxygen at night, leading to significant diurnal fluctuations. Elevated nutrient levels cause the aquatic life in a stream to shift towards groups tolerant to organic loadings and leads to a reduction in biological diversity.

Types of Nutrients Impacting Tennessee Streams (Where Specified)

Nutrient	Stream Miles Impacted
Nitrate-Nitrite…….	694.9
Phosphorus……….	235.0

Note: Streams can be impacted by more than one nutrient, so these totals are not additive.

Streams with elevated nutrients often have floating algal mats and clinging filamentous algae. Nutrient pollution is difficult to control. Restrictions on point source dischargers alone may not solve this problem. The other major contributors to nutrient problems are agricultural activities like over application of fertilizers and intensive livestock grazing.

Some states have banned the use of laundry detergents containing phosphates. Therefore, most commercially available detergents do not contain phosphates. Many fertilizers for crops or lawn application contain both nitrogen and phosphorus. If fertilizers are applied in heavy concentrations, rain will carry the fertilizer into nearby waterways.

The ecoregion study has increased understanding of the natural distribution of nutrients throughout the state. Using this information Tennessee is in the process of developing regional water quality criterion for nutrients (Denton et al., 2001). More information on the proposed nutrient criteria can be found in Chapter XII.

5. Low Dissolved Oxygen

Low levels of dissolved oxygen in water will restrict or eliminate aquatic life. The water quality standard for dissolved oxygen in non-trout streams is currently five parts per million. While some species of fish and aquatic insects can tolerate lower levels of oxygen for short periods of time, prolonged exposure may affect biological diversity and in extreme cases, cause massive fish kills.

Low dissolved oxygen levels are usually caused by the decay of a large amount of organic material. This condition can be improved by reducing the amount of organic matter entering a stream. Streams that receive substantial amounts of ground water inflow can have naturally low dissolved oxygen levels.

Tennessee is in the process of studying dissolved oxygen patterns at reference streams. The results of these investigations may lead to adjustments of the current dissolved oxygen criterion. It is thought that a regional criterion that reflects natural fluctuations would be more appropriate than the current one-size-fits-all approach. Chapter XII discusses this project in more details.

6. Metals

Types of Metals Impacting Tennessee Streams (Where Specified)

Metal	Stream Miles Impacted
Iron	131.8
Manganese	94.9
Lead	88.2
Copper	56.3
Mercury	27.1
Zinc	11.9
Aluminum	7.2

Note: Streams can be impacted by more than one metal, thus these totals are not additive.

Metals can pose a serious health threat. The most common metals that impact Tennessee waters include copper, lead, iron, and manganese. Occasionally, zinc, mercury, and aluminum levels can also violate water quality standards. The major concern regarding metal contamination is toxicity to fish and aquatic life, plus the danger it poses to people who come in contact with the water or eat fish from the contaminated waterbody.

In particular, mercury can be a serious threat to human health due to bioconcentration in the food chain. East Fork Poplar Creek and North Fork Holston River are currently posted against fish consumption due to mercury. This is discussed in more detail in Chapter IX.

Occasionally, metals are elevated in streams due to natural conditions. For example, elevated manganese levels in west Tennessee streams may be naturally occurring in the groundwater. However, it is relatively rare for streams to violate standards simply on the basis of natural conditions.

7. Organic Contaminants

Organic contaminants are man-made chemicals containing the element carbon. These include chemicals like PCBs, pesticides and dioxins. These substances include, but are not limited to, compounds listed by EPA as priority pollutants. EPA classifies organic pollutants such as PCBs, chlordane, DDT and dioxin as probable human carcinogens (cancer causing agents).

In some streams these substances have accumulated in sediment and pose a health threat to those that consume fish or shellfish. Currently, seven rivers and streams are posted for dangerous levels of organic pollution. Five of the listed streams and rivers, McKellar Lake (Mississippi River), Loosahatchie River, Mississippi River, Nonconnah Creek, and Wolf River are located in west Tennessee. The other two streams are located in east Tennessee: Chattanooga Creek and East Fork Poplar Creek.

Some organic pollutants in very low concentrations can pose a threat to human health. Unfortunately, organic substances remain in the environment for a very long time. Many of these compounds have been banned from use for several decades. However, organic pollution that occurred decades ago still poses a serious threat. This is discussed in more detail in Chapter IX.

One problem in identifying organic pollution is that the water quality criteria are often below current detection levels. Tennessee currently has no numeric organic sediment criteria. Detection of these substances is generally made either by fish tissue levels and/or by use of sediment screening values provided by EPA.

8. pH

Low pH or elevated alkalinity, or even a significant change in the pH or acidity of the water over a relatively short period of time, will greatly impact aquatic life. A common reason for a change in pH is runoff from active or abandoned mine sites that lowers the pH of a creek and make it more acidic. Excessive amounts of algae can cause streams to violate standards on the alkaline side, but this phenomenon more commonly occurs in lakes.

pH also plays an important role in the toxicity of metals, with levels below 5.5 generally increasing toxic effects. The current criterion for the support of fish and aquatic life is a pH of 6.5 to 9.0. The Division is developing a proposal to revise the pH criterion to reflect natural conditions in the various ecoregions. Currently, 376 stream miles are listed as impaired by low pH. Most of these impacted streams are in areas with significant amounts of historical mining activities.

9. Flow Alteration

Two hundred and fifty-five stream miles are currently assessed as impaired by flow alteration. One source of flow alteration is channelization, the straightening and widening of channels. Channelization destroys habitat and increases sediment transport to downstream waters. Increased stream velocities following channelization causes extreme down-cutting of stream channels.

One of the most common sources of flow alterations is dams. In extreme cases, the receiving stream downstream of the dam does not have enough water flow to support aquatic life. Additionally, water released from the bottom of reservoirs can have very poor quality. Streams impacted by flow alterations due to dams and the management of reservoirs include: the Obey River (Dale Hollow), Caney Fork River (Center Hill), Stones River (Percy Priest), South Fork Holston River (Fort Patrick Henry and South Holston), Holston River (Cherokee), French Broad (Douglas), Tennessee (Fort Loudoun), Obed River (Lake Holiday), Hiwassee River (Apalachia), Ocoee River (Ocoee 1, 2, & 3), Elk River (Woods and Tims Ford), and the Duck River (Normandy).

Walter Hill Dam on the East Fork Stones River. Old mill dams such as this are common in Middle Tennessee. They usually do not cause a flow alteration problem due to the amounts of water seepage under and around the structure.
(Photo by Annie Goodhue, Nashville EAC.)

B. Causes Of Pollution In Reservoirs and Lakes

Some of the same types of pollutants that occur in rivers and streams impact reservoirs, although to different magnitudes. The main pollutants in reservoirs are organic substances such as PCBs, chlordane, and dioxins, as well as siltation, nutrients, and low DO (Figure 12 and Table 7). The effects of most of these pollutants are the same as in flowing water. However, substances are more likely to accumulate and remain in reservoirs for a very long time.

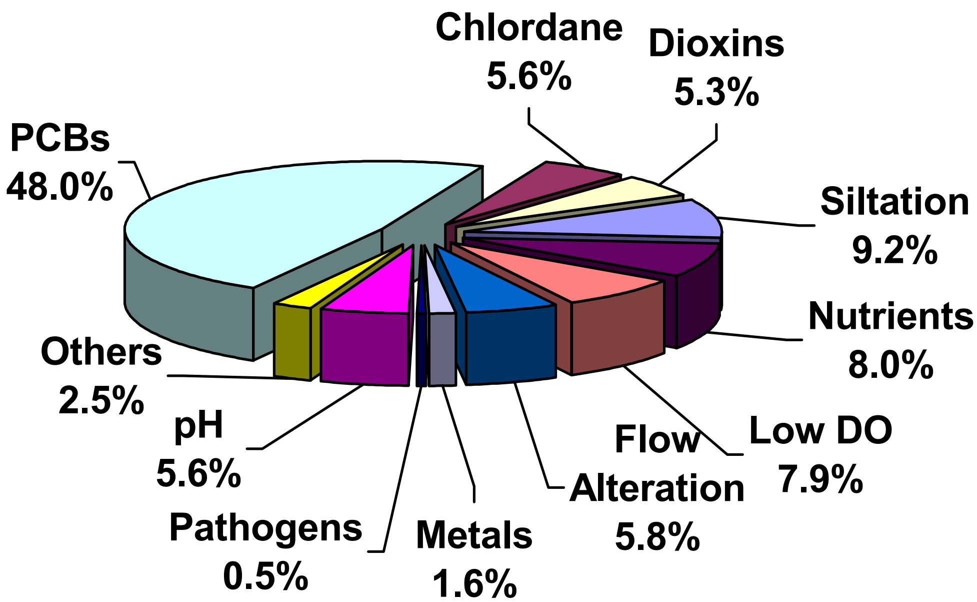


Figure 12: Relative Impacts of Pollution in Assessed Reservoirs. (Includes Reelfoot Lake)

1. Organic Substances

Priority organic substances such as PCBs, dioxins, and chlordane are the cause of pollution in almost sixty percent of the impaired lake acres. Since reservoirs serve as sediment traps, once a pollutant gets into the sediment it is very difficult to remove. Once in the sediment, these materials move through the food chain and can become concentrated in fish tissue. People eating fish from the waterbody will also bioconcentrate these substances.

PCBs were extensively used in the US for industrial and commercial uses until they were banned in 1978. Unfortunately, over 1.5 billion pounds of PCBs were produced before the ban. It is not known how many tons ended up in waterways. Unsafe levels of PCBs have been found in fish tissue collected from seven reservoirs. These include Fort Loudoun, Boone, Tellico, Watts Bar, Nickajack, and Melton Hill reservoirs in east Tennessee and Woods Reservoir in middle Tennessee.

Dioxin is a man-made by-product of herbicide manufacturing, certain historical papermill manufacturing processes, plus the incineration of chlorine-based chemicals. Dioxins are considered among of the most toxic substances released into the environment as EPA has found no "safe exposure level". EPA has determined that dioxins are not only "probable carcinogens", but also cause reproductive and developmental problems. Dioxin has been detected in several reservoirs.

Chapter IX has specific information on posted reservoirs and the health hazards of eating contaminated fish. Currently, 115,928 lake acres are posted for organic contamination.

2. Siltation

As in rivers and streams, siltation causes significant problems in reservoirs. Three reservoirs, Ocoee # 3, Ocoee #2, and Davy Crockett, have almost filled in with sediment due to siltation caused by upstream disturbances. Since reservoirs and lakes serve as sediment traps, once sediment enters a lake it tends to settle out, initially in embayment and headwater areas, but ultimately throughout the lake. It is difficult and expensive to remove sediment from reservoirs.

3. Nutrients

Another major impact in reservoirs and lakes is nutrients. Reelfoot Lake comprises 98 percent of the reservoir and lake acres currently listed as impacted by nutrients in Tennessee. When reservoirs and lakes have elevated levels of nutrients, the amount of algae and other aquatic plants dramatically increase. Green plants produce oxygen during daylight hours and use oxygen at night. As aquatic vegetation dies and decays, oxygen is depleted and may drop below the levels needed for fish and other aquatic life.

As reservoirs and lakes age, they go through a process called eutrophication. When this occurs naturally, it is caused by a gradual accumulation of the effects of nutrients over hundreds of years. Ultimately, eutrophication results in the filling in of the lake from soil, silt, and organic matter from the watershed. Pollution from human activities can greatly accelerate this process.

Tennessee's water quality criterion for nutrients in lakes is currently narrative. Our assessment basis is to consider lakes impaired if the level of eutrophication present interferes with the intended uses of the lake. This process is complicated by the complex nature of the public's uses for lakes and reservoirs. For example, algae production can help some species of fish thrive, which can be seen to benefit sport fishermen. However, swimmers and boaters prefer clear water.

Stages of Eutrophication:

1. **Oligotrophic** lakes are young lakes with relatively low levels of nutrients and high levels of dissolved oxygen. Since these lakes have low nutrient levels, they also have little algae and aquatic vegetation.

2. **Mesotrophic** lakes have moderate amounts of nutrients, but maintain a high level of dissolved oxygen. This results in more algae and aquatic vegetation that serve as a good food source for other aquatic life yielding a high biological diversity.

3. **Eutrophic** lakes have high levels of nutrients and therefore, high amounts of algae. Often, in the summer, an algae bloom will occur causing the dissolved oxygen levels to drop in the lake's lower layer.

4. **Hypereutrophic** lakes have extremely high nutrient levels. The algae at this stage are so thick it sometimes makes the lake look like pea soup. The dissolved oxygen in the lower layer of the lake may drop to the point where fish and other aquatic life cannot survive. Lakes that are hypereutrophic do not typically support the uses for which they are designated.

4. Dissolved Oxygen

The dissolved oxygen (DO) minimum water quality standard for reservoirs and lakes is five mg/L measured at a depth of five feet unless the lake is less than ten feet deep. If the lake is less than ten feet deep the DO is measured at mid-depth. In eutrophic reservoirs the DO can be much lower than five mg/L. Even in reservoirs that have a DO of five mg/L at the prescribed depth, the dissolved oxygen levels can be near zero deeper in the reservoir.

The most common reason lakes and reservoirs have fish kills due to low DO is eutrophication. Overproduction of algae raises oxygen levels while the sun is out, but on cloudy days and at night, the resulting algae die-off can cause DO levels to plummet. Additionally, high levels of biomass will restrict light penetration to a few feet or even inches. Below the depth where light can penetrate, DO levels will be very low.

DO levels in lakes and reservoirs can also be affected by discharges from upstream dams. Usually water from near the bottom of the reservoir is discharged from dams resulting in very low DO levels in the receiving stream. Currently, 15,637 lake and reservoir acres are listed as impacted by organic enrichment and/or low DO.

Table 7: Causes Of Impairment In Assessed Rivers And Reservoirs*

Cause Category	Impaired Rivers and Stream Miles	Impaired Reservoir/Lake Acres
Conventional Pollutants		
Siltation	4860.5	18,186
Suspended Solids	13.9	
Nutrients	1591.2	15,738 **
Organic Enrichment\ Low DO	1199.9	15,637 **
Pathogens	3423.7	1004
Toxic Pollutants		
Metals	431.5	3,254
Pesticides	1.1	
Chlordane	78.3	11,090
PCBs	128.9	94,468
Dioxins	86.7	10,370
Other Priority Organics	23.8	
Nonpriority Organics	72.3	
Undetermined Toxicity	136.0	
Inorganic Pollutants		
Unionized Ammonia	52.0	
Chlorine	12.2	
Sulfates	69.0	
Salinity\TDS\Chlorides	22.4	
pH	376.0	10,955 **
Other Inorganics	6.7	
Hydrologic Modifications		
Flow Alterations	256.2	11,444 **
Thermal Modifications	102.8	
Other Habitat Alterations	4370.3	
Noxious Aquatic Plants		4,555 **
Other Causes		
Oil and Grease	51.9	
Taste and Odor	6.7	45
Algal Growth	2.4	
Unknown Cause	58.0	

*Note - Rivers and reservoirs can be impaired by more than one cause. Rivers include both river and stream miles. Data in this table should only be used to indicate relative contributions. Totals are not additive.

** The majority of impaired lake acres in these categories are in Reelfoot Lake

VIII. Sources Of Water Pollution

The predominant sources of impairment in streams and rivers are agricultural activities and hydromodification (channelization, dams, and dredging). Additional streams are impacted by municipal discharges, runoff, urban development, and mining impacts as well as many other impacts. The major source of impacts to reservoirs is contaminated sediment. Table 8 provides a detailed break down of the various sources of pollution in Tennessee's streams, rivers, and reservoirs.

A. Relative Sources Of Impacts to Rivers and Streams

Some impacts, like point source discharges and urban runoff, are evenly distributed across the state. Other pollutants are concentrated in certain areas of the state. For instance, channelization and crop related agriculture is most widespread in west Tennessee. Dairy farming and other intensive livestock operations are concentrated in the Ridge and Valley region of east Tennessee and in southern Middle Tennessee.

An emerging threat in middle Tennessee is very rapid commercial and residential development in Nashville and other urban areas. Mining continues to negatively impact steams in the Cumberland Plateau and Central Appalachian regions. Figure 13 illustrates the percent contribution of pollution sources in assessed rivers and streams.

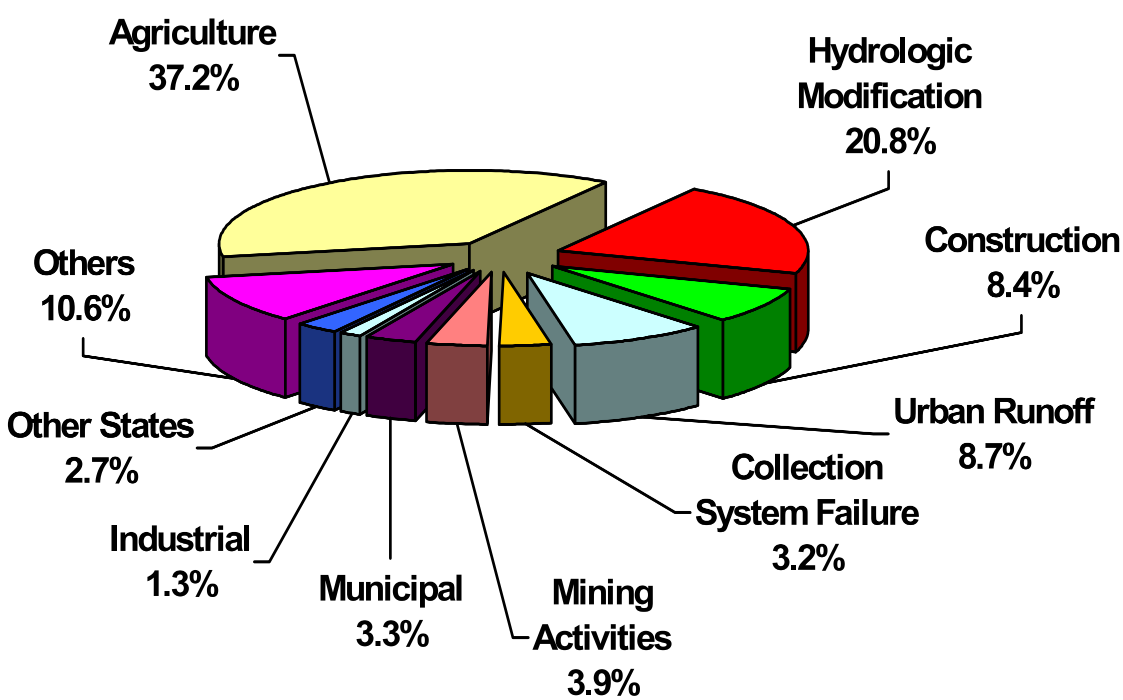


Figure 13: Percent Contribution of Pollution Sources in Assessed Rivers and Streams.

Table 8: Sources of Pollutants in Rivers and Reservoirs*

Sources Category	Total Impacted River Miles	Total Impacted Reservoir Acres
Industry		
Unspecified Industry	65.0	1000
Major Industry	96.7	
Minor Industry	14.9	
Municipal		
Major Municipal Point Source	224.3	994
Minor Municipal Point Source	265.1	
Package Plants	2.9	
Combined Sewer Overflows	9.8	994
Collection System Failure	452.1	10
Agriculture		
Agriculture (unspecified)	1118.9	595
Crop related sources	1237.8	15,500
Grazing related sources	2696.0	11
Intensive Animal Feeding Operations	117.2	34
Silviculture	14.9	
Resource Extraction		
Unspecified Resource Extraction	101.4	494
Surface Mining	28.2	
Abandoned Mining	366.4	480
Inactive Mining	18.7	
Petroleum activities	17.9	
Mill Tailings	5.0	
Mine Tailings	8.5	
Urban Sources		
Unspecified Urban Runoff/Storm Sewers	1154.7	1,054
Non-industrial Permitted Stormwater	8.4	
Industrial Permitted Stormwater	38.7	
Illicit Connections	6.5	
Hwy. /Road/Bridge Runoff	32.8	

(Table Continued on Next Page)

Table 8: Sources of Pollutants in Rivers and Reservoirs (Continued)

Sources Category	Total Impacted River Miles	Total Impacted Reservoir Acres
Hydromodification		
Unspecified	306.7	5
Channelization	2051.9	
Dredging	258.3	
Upstream Impoundment	275.1	494
Flow Regulation/Modification		2900**
Construction		
Unspecified Road or Bridge Construction	55.3	10,965**
Land Development	1099.3	10,965**
Habitat Modification		
Unspecified Habitat Modification	47.9	
Bank or Shoreline Modification	96.5	
Riparian Vegetation Removal	295.8	
Drainage/Filling Wetland		10,950**
Land Disposal		
Sludge	3.1	
Landfills	57.9	
Hazardous Waste	118.2	
Septic Tanks	150.4	
Other Sources		
Internal Nutrient Cycling		15,500**
Sources in Other States	313.7	383
Spills	10.3	
Golf Courses	0.5	
Groundwater Loading	1.1	
Waste Storage Tanks Leaks	4.3	
Leaking Underground Storage Tanks	8.9	
Hwy. Maintenance and Runoff	31.0	
Sources Unknown	479.5	

*Rivers and reservoirs can be impacted by more than one source of pollutants. Data in this table should only be used to indicate relative contributions. Totals are not additive.

** Majority of impairment sources in these categories are in Reelfoot Lake.

1. Agriculture

Almost half of the land in Tennessee is used for agriculture, so it is not surprising that these activities are responsible for approximately 37 percent of the impaired stream miles in the state. In west Tennessee tons of soil are lost annually due to erosion. In middle Tennessee, livestock grazing is the major agricultural activity. Intensive hog farming is widespread in the southern middle portion of the state and in West Tennessee. In East Tennessee runoff from feedlots and dairy farms greatly impact some streams. Throughout the state, in-stream watering of livestock is a significant source of fecal coliform bacteria, especially in the summertime. Figure 14 illustrates the relative percentage of the primary agricultural impairment sources.

In areas like the Sequatchie Valley, intensive grazing and direct access of cattle to streams causes habitat impacts and elevated pathogen levels, both major causes of pollution. (Photo by Terry Whalen, Chattanooga EAC)

The Tennessee Water Quality Control Act does not give the Division authority to regulate nonpoint pollution originating from normal agricultural activities such as plowing fields, tending animals and crops, and cutting trees. However, the agricultural activities that may result in a significant point source pollution, such as failing animal waste system discharges, are regulated.

Tennessee agriculture has made great strides in recent years to prevent agricultural and forestry impacts. Educational and cost-sharing projects promoted by NRCS and UT Agricultural Extension Service has helped farmers install best management practices all over the state. Farmers have also helped to decrease erosion rates and thereby protect streams by increasing riparian habitat zones and setting aside substantial amounts of acreage as conservation reserves.

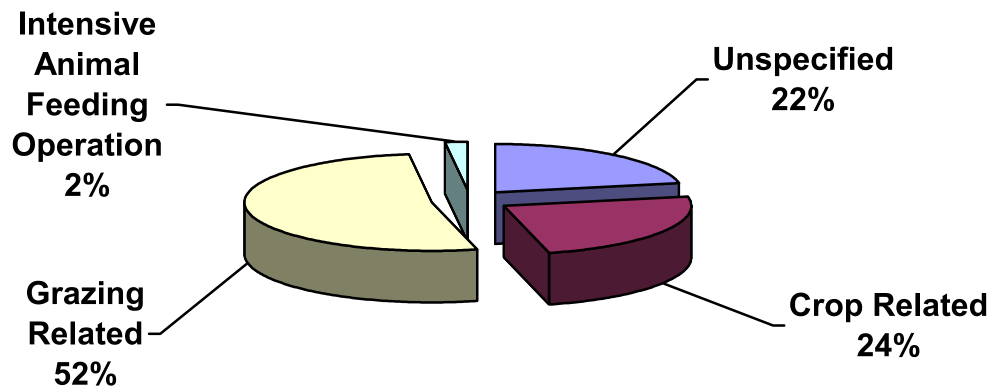


Figure 14: Sources of Agricultural Pollution in Assessed Rivers and Streams

The Division has a Memorandum of Understanding with the Tennessee Department of Agriculture (TDA). Under this agreement, the Division and TDA will continue to resolve complaints about water pollution from agricultural activities. When a problem is found or a complaint has been filed, TDA has the responsibility to contact the farmer or logger. Technical assistance is offered to correct the problem. If these efforts are unsuccessful, the TDA will be supportive of the Division's more formal enforcement process. TDEC and TDA coordinate on water quality monitoring, assessment, 303(d) list development, TMDL generation, and control strategy implementation.

2. Hydrologic Modifications

Hydrologic modification (altering the physical properties of streams) is a source of impairment in over 20 percent of the assessed streams in Tennessee. Hydrologic modifications include channelization (straightening streams), culverting (burying streams), stream lining, or impoundments (damming streams for the construction of a pond or reservoir).

Physical alteration of streams can only be done as authorized by the state. Permits to alter streams are called Aquatic Resource Alteration Permits (ARAPs). Failure to obtain a permit before modifying a stream can lead to enforcement actions that require restoration of the stream.

a. Culverting

Many streams, especially those located in cities, have been totally enclosed by culverts. In the most extreme cases, buildings or shopping centers have been built on top of streams. These waters are no longer available for public recreation and aquatic life cannot survive. Many of these culverts were installed before the Division had regulatory authority over physical alteration of streams. Now an Aquatic Resources Alteration Permit must be obtained to install a culvert. Generally speaking, a bridge or even relocation of a stream is preferred over installing a culvert. Compensatory mitigation may be required for larger projects where culverting is unavoidable.

In some of the urbanized areas of Tennessee, streams were historically lined with concrete. While this practice helped develop areas prone to flooding, it had a devastating affect on water quality. Streams such as the one pictured above in Memphis, have very little chance to meet water quality goals. (Photo by Terry Templeton, Memphis EAC)

b. Stream impoundment

Problems associated with the impoundment of streams are increasing as more free flowing streams are dammed on both a large and small scale. It has been the experience of the Division that very few of these impoundments can be managed in such a way as to avoid water quality problems.

Problems often associated with stream impoundment include:

- Erosion during dam construction.
- Loss of stream for recreational use.
- Change in the water flow downstream of the dam.
- Elevated metals downstream of the dam.
- Low dissolved oxygen levels in tailwaters decrease biological diversity downstream and threatens species with special status.
- Habitat change results in loss of stream organisms.
- Barriers to fish migration.

c. Channelization

Many rivers and streams in Tennessee have been straightened or channelized. Originally, channelization was implemented to control flooding and protect croplands along the river. Additionally, especially in West Tennessee, channelization was used extensively to drain wetlands so more land may be used for crops.

Channelization continues to be a major source of impacts, especially in West Tennessee. The stream pictured above has already begun the process of "downcutting" as the channel seeks to regain its stability. (Photo by Amy Fritz, Jackson EAC)

Some of the costs associated with channelization or decreasing stream meanders include:

1. Increases erosion rates and soil loss.

2. Eliminates valuable fish and wildlife habitat by draining wetlands and clearing riparian areas.

3. Kills bottomland hardwoods.

4. Transfers flooding problems downstream.

5. Causes "downcutting" of stream bed as the channel tries to regain stability.

In recent years, no large-scale channelization projects have been approved. Tennessee is working with the Corps of Engineers to explore methods to reverse some of the historical damage to water quality caused by channelization. Some streams continue to be channelized by landowners.

3. Urban Runoff

As storm water drains through urban areas it picks up pollutants from yards, streets, and parking lots and deposits them into streams. This non-specific runoff can be laden with silt, bacteria, metals, and nutrients. Following heavy rains, streams have been noted as having various pollutants at elevated levels for several days. Water quality standards violations have been documented downstream of all four of Tennessee's large cities: Memphis, Nashville, Chattanooga, and Knoxville, plus many other smaller towns.

Traditionally, urban runoff was considered a non-point source (from a generalized rather than specific pollution source). However, the regulation of storm water runoff falls under the federal NPDES program. Industries and large commercial operations such as junkyards and construction sites are required to operate under storm water discharge permits. These permits require mandatory installation of pollution controls.

Memphis, Nashville, Chattanooga, and Knoxville are now covered by the Tennessee Municipal Separate Storm Sewer System (MS4) permit. Under this permit, these cities develop their own storm water programs and do the direct regulation of sources at a local level. Construction sites over five acres have to apply for coverage under the general construction permit. (The acreage covered by this regulation will soon change to include sites over one acre.)

Phase II of the MS4 program will expand to include many smaller cities and counties in Tennessee. Those areas having a population greater than 10,000, or having streams assessed as impacted due to urban runoff, must also develop storm water programs.

4. Construction

The populations of many Tennessee communities have rapidly expanded in the last decade. The construction of subdivisions, shopping malls, and highways can harm the water quality if the sites are not properly stabilized. The impacts most frequently associated with land development are siltation and habitat alteration.

Storm water control programs and regulations on a local level have been helpful in controlling water quality impacts from land development. Memphis, Nashville, Chattanooga, and Knoxville already have storm water control programs in effect. Some of our next level towns like Jackson, Clarksville, Murfreesboro, Columbia, Johnson City, Kingsport and Bristol are currently developing storm water programs. Local staff will help identify sources of storm water runoff and help develop control strategies.

At this site, a stream was being physically altered without proper authorization from the state.
(Photo provided by Wayne Blaylock, Enforcement.)

5. Mining Activities

In the 1970's coal mining was one of the largest pollution sources in the state. "Wildcat" operators strip-mined land without permits or regard for environmental consequences, to provide low-priced coal to the growing electric industry. When they got all the readily available coal, they would abandon the site. In 1983, the price for coal bottomed out, so it was no longer profitable to run "wildcat" mining operations.

Although many streams are still impacted by silt, pH, manganese, and iron, considerable progress has been made at site reclamation. Abandoned strip mines are slowly being reclaimed under the Abandoned Mine Reclamation program and some are naturally revegetating. New mining sites are required to provide treatment of runoff.

6. Industrial and Municipal Discharges

Although industrial pollution is lower than it was a few decades ago, industrial and municipal facilities continue to impact some streams and reservoirs in Tennessee. A major municipal source of pollution is the overflow or bypass of sewage treatment systems. Industrial impacts include occasional spills, temperature alterations, and historical discharge of long-lived materials that get concentrated in the food chain. Occasionally, both sewage treatment systems and industrial dischargers fail to meet permit requirements.

7. Collection System Failure

Municipal sewage treatment plants have permits designed to prevent impacts to the receiving stream. Unfortunately, the collection systems of some sewage treatment plants occasionally malfunction, or become overloaded, which can result in the discharge of high volumes of untreated sewage to a stream. If a large amount of untreated sewage enters a stream or river it can devastate aquatic life and pose a serious health threat to people who come in contact with the water. A serious concern near urban areas is children who may play in streams after rain events and be exposed to elevated bacteria levels.

Permits contain provisions which require that "bypasses" be reported. Collection systems must constantly be monitored by cities to insure that they are not leaking. At times, enforcement action must be taken against cities that fail to report and correct system bypasses.

8. Silviculture

Silviculture, tree farming, or other forestry activities impact relatively few stream miles compared to other sources. However logging, without proper controls, has impacted some small headwater streams throughout the state. In 2000, the Department took enforcement actions for water quality violations by forestry operations in various parts of the state. In conjunction with TDA, the Department has authority to issue a "stop work order" when logging is taking place improperly and pollution results.

B. Distribution of Impacts to Reservoirs

Like streams, reservoirs are impacted by many sources of pollution (Table 8). However, the dominant pollutant impacting reservoirs is sediment contaminated by toxic organic substances. The other significant impact is nutrient enrichment caused by agricultural activities and sewage treatment plant malfunctions. Figure 15 shows the percentage of various source impacts in reservoirs.

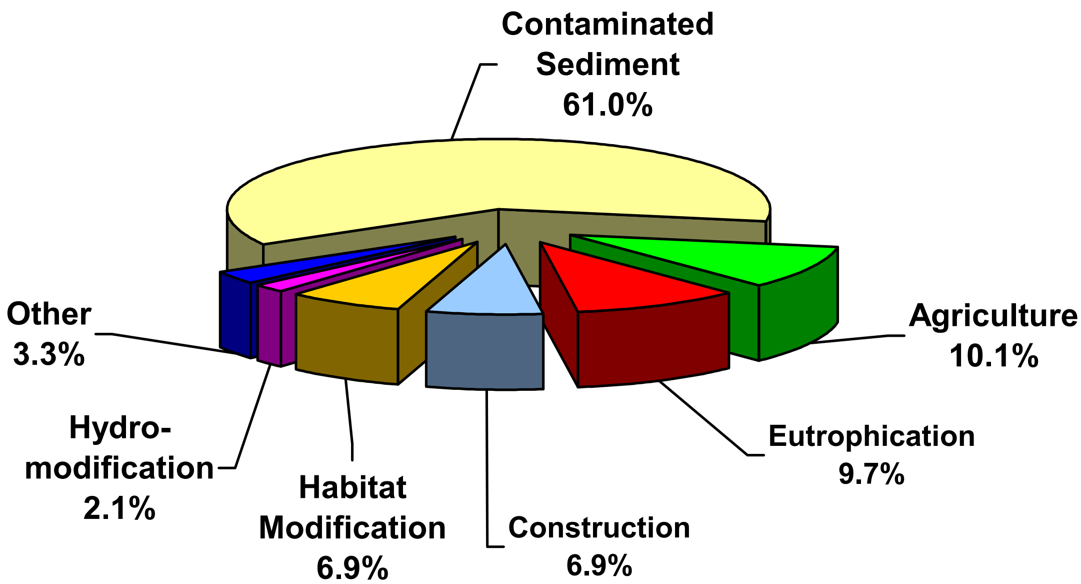


Figure 15: Percent Contribution of Pollution Sources in Assessed Reservoirs. (Includes Reelfoot Lake.)

1. Contaminated Sediments

A major problem in reservoirs is the concentration of organic pollutants in fish tissue. In most places in Tennessee it is safe to eat the fish. In some reservoirs organic pollutants, primarily PCBs, dioxins, chlordane and other pesticides in the sediment, are concentrated in the fish. Since reservoirs function as sediment traps, they are prone to sediment contamination.

The Department of Environment and Conservation is required by law to post contaminated waterbodies and advise the public of health risks from consuming contaminated fish. The Tennessee Valley Authority (TVA) and the Tennessee Wildlife Resources Agency (TWRA) share resources and expertise in this process.

Fish tissue samples are collected and analyzed across the state. The results of these analyses are compared to the criteria developed by FDA and EPA. If fish tissue is found to be contaminated and the public's ability to safely consume fish is impaired, the lake is appropriately posted and assessed as not supporting recreational uses.

EPA recently published a national list of lakes, reservoirs and streams that exceeded established sediment contamination screening values. Five Tennessee reservoirs including Fort Loudoun, Watts Bar, Chickamauga, Nickajack, and Kentucky, plus two rivers, the Hiwassee and Holston were on this list. However, it should be noted that the screening values used by EPA are not criteria. Additionally, there is little direct evidence that sediment contamination at those screening levels is clearly related to fish and aquatic life impacts.

Many pesticides like DDT, PCBs, and chlordane found in fish tissue today were widely distributed in the environment before they were banned. The levels of these substances will slowly decrease over time. Currently companies with permits to discharge organic substances have very restrictive limits.

2. Agriculture

As in streams and rivers, reservoirs are greatly impacted by agricultural activities. Plowing and fertilizing croplands can result in the runoff of tons of soil and fertilizers. Over 16,000 lake acres in Tennessee are listed as impaired by farming activities. However, a considerable portion of these acres are represented by Reelfoot Lake. Reelfoot is listed as impaired due to erosion from agricultural areas.

3. Reservoir Eutrophication

When a free flowing waterway is dammed, the aging process or eutrophication of the reservoir begins. Eutrophication is a natural process that can take hundreds of years to complete. However, the process can be greatly accelerated by human activities.

Eutrophication in a lake or reservoir is caused by a combination of several things:

- Sediment and soil from the watershed accumulates in the reservoir.
- Nutrients wash in and stimulate the growth of plants and algae. When the algae and plants die, they sink to the bottom and accelerate the filling process.
- Both algae growth and sediment in the water restricts the light penetration to a few feet or even a few inches. Robbed of sunlight and oxygen-producing photosynthesis, the lower level of the lake forms a cold, poorly oxygenated layer. Therefore, fish can only survive in the oxygenated surface waters. This layering of reservoirs is called stratification.

Eutrophication is a natural process that will proceed in any lake. It becomes pollution when it is accelerated by human activities, interferes with the desired uses of the lake, or when it causes water quality standards to be violated in the lake or receiving stream. For additional information on eutrophication see Chapter VII.

The eutrophication process is triggered by nutrients, usually nitrogen or phosphorus, entering a lake. Where eutrophication has caused pollution in reservoirs, nutrient loadings from the following sources are frequently cited:

- **Urban Runoff** - Heavy rains wash trash, dirt, lawn chemicals, street and parking lot residue, and other materials found in cities into our streams and reservoirs. This runoff usually contains elevated levels of nutrients.

- **Agricultural Activities** - The primary sources of nutrients from farmlands are soil erosion from cropland, overuse or improper application of fertilizers, and animal waste from livestock holding or feeding areas. Leaving buffer zones of trees and undergrowth around streams, fencing livestock away from streams, maintaining functional animal waste systems, and other proven best management practices help avoid these impacts.

- **Municipal Discharges** - Sewage treatment plants discharge levels of nutrients that may lead to downstream problems in reservoirs. To help reduce this problem, some states control the amount of phosphorus that can be contained in detergents and other laundry products. Therefore, commercially available laundry detergents no longer contain phosphorus. Additionally, some states have mandatory nutrient source reduction requirements in the watersheds of reservoirs that violate algal biomass criteria. In Tennessee, wastewater dischargers will be given permit limits if effluents are causing or contributing to the eutrophication of downstream waters.

- **Septic Tanks** - In properly functioning septic tanks, microorganisms in the soil and treatment system filter, remove, or absorb nutrients. On the other hand, faulty septic tanks, or poor soil types may allow untreated wastes to be discharged directly or indirectly into reservoirs.

IX. Posted Streams And Reservoirs

It is the responsibility of the Division of Water Pollution Control to post warning signs on streams or reservoirs that pose a threat to public health. In Tennessee, the most common reasons for a river or reservoir to be posted are the presence of bacteria, organic pesticides, or mercury in the water, sediment, or fish. Currently there are 62 streams, rivers, and reservoirs in Tennessee that have been posted due to pollution.

> *The Commissioner shall have the power, duty, and responsibility to…post or cause to be posted such signs as required to give notice to the public of the potential or actual dangers of specific uses of such waters.*
> Tennessee Water Quality Control Act

Tables 9 and 10 provide a list of advisories as of December 2002. A current list of advisories is posted on the Department's home page.

Consistent with EPA guidelines, any stream or reservoir in Tennessee with an advisory does not meet the recreational designated use. Clearly, if fishermen cannot safely eat the fish they catch, the waterbody is not fully supporting its recreational uses and therefore meets the functional definition of pollution. Likewise streams and lakes with high levels of bacteria are not suitable for recreational activities such as swimming or wading.

Environmental Specialist Terry Whalen places a sign warning the public to avoid contact with the water in a tributary to Citico Creek in Chattanooga. Every time this stream was sampled, children were seen playing in the water, which had very elevated bacteria levels. (Photo provided by Tammy Hutchinson, Chattanooga EAC.)

A. Bacteriological Advisories

The presence of pathogens, disease-causing organisms, affects the public's ability to safely swim, wade, and fish in streams and reservoirs. Bacteria are the primary water borne pathogen in Tennessee. The Division's current water quality standards for bacteria are based on levels of total fecal coliforms (geometric mean of 200 colonies per 100 ml) and E. coli (geometric mean of 126 colonies per 100 ml). While neither of these tests is considered direct proof of human health threats, they indicate the presence of more dangerous viruses and other water-borne diseases.

> Bacteria in Tennessee's streams and reservoirs affect the public's ability to safely swim, wade, and fish in streams and reservoirs.

Research is currently underway to find better indicators of risk and to differentiate between human and animal sources of bacteria. The presence of prescription medicine, caffeine, and hormones in streams has been suggested as potential markers for contamination by human waste.

Improperly treated human wastes such as septic tank or collection system failure, or improper connection to sewer or sewage treatment plants contaminate over 68 percent of the posted river miles. The remaining stream miles are posted due to bacteria levels from other sources such as failing animal waste systems or urban runoff (Figure 16). About 155 river miles are posted due to bacterial contamination (Table 9).

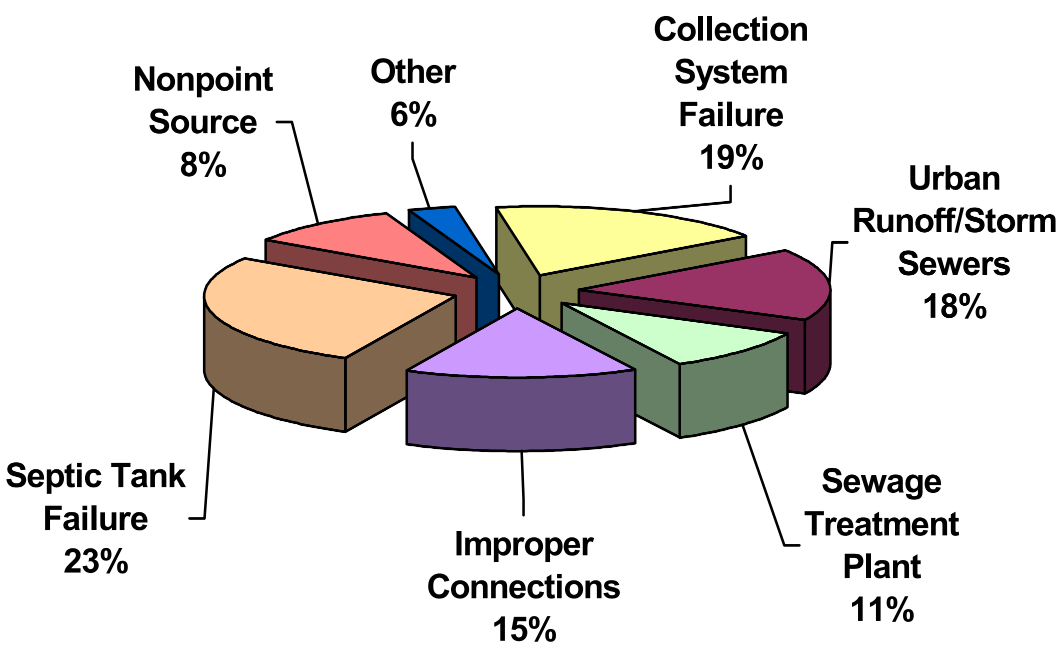


Figure 16: Percent Contribution of Stream Miles Posted for Pathogen Contamination.

(Some stream miles are posted for more than one source of pollution. Totals are not additive.)

Table 9: Bacteriological Advisories in Tennessee

(December 2002. This list is subject to revision.
For additional information: http://www.state.tn.us.environment/wpc/advisories)

East Tennessee

Stream	Portion	County	Comments
Beaver Creek (Bristol)	TN/VA line to Boone Lake (20.0 miles)	Sullivan	Nonpoint sources in Bristol and Virginia.
Cash Hollow Creek	Mile 0.0 to 1.4	Washington	Septic tank failures.
Coal Creek	STP to Clinch R. (4.7 miles)	Anderson	Lake City STP.
East Fork Poplar Creek	Mouth to Mile 15.0	Roane	Oak Ridge area.
First Creek	Mile 0.2 to 1.5	Knox	Knoxville urban runoff
Goose Creek	4.0 miles	Knox	Knoxville urban runoff.
Leadvale Creek	Douglas Lake to headwaters (1.5 miles)	Jefferson	White Pine STP.
Little Pigeon River	Mile 0.0 to 4.6	Sevier	Improper connections to storm sewers, leaking sewers, and failing septic tanks.
Pine Creek	Mile 0.0 to 10.1	Scott	Oneida STP and collection system
Litton Fork	Mile 0.0 to 1.0		
South Fork	Mile 0.0 to 0.7		
East Fork	Mile 0.0 to 0.8		
North Fork	Mile 0.0 to 2.0		
Second Creek	Mile 0.0 to 4.0	Knox	Knoxville urban runoff.
Sinking Creek	Mile 0.0 to 2.8	Washington	Agriculture & urban runoff
Sinking Creek Embayment of Fort Loudoun Reservoir	1.5 miles from head of embayment to cave	Knox	Knoxville Sinking Creek STP.
Third Creek	Mile 0.0 to 1.4, Mile 3.3	Knox	Knoxville urban runoff.

(Table continued on the next page)

Table 9: Bacteriological Advisories in Tennessee
(continued from previous page)

East Tennessee (continued)

Stream	Portion	County	Comments
East Fork of Third Creek	Mile 0.0 to 0.8	Knox	Knoxville urban runoff.
Johns Creek	Downstream portion (5.0 miles)	Cocke	Failing septic tanks
Baker Creek	Entire stream (4.4 miles)	Cocke	Failing septic tanks
Turkey Creek	Mile 0.0 to 5.3	Hamblen	Morristown collection system.
West Prong of Little Pigeon River	Mile 0.0 to 17.3	Sevier	Improper connections to storm sewers, leaking sewers, and failing septic tanks.
Beech Branch	Entire stream (1.0 mile)		
King Branch	Entire stream (2.5 miles)		
Gnatty Branch	Entire stream (1.8 miles)		
Holy Branch	Entire stream (1.0 mile)		
Baskins Branch	Entire stream (1.3 miles)		
Roaring Creek	Entire stream (1.5 miles)		
Dudley Creek	Entire stream (5.7 miles)		

Southeast Tennessee

Stream	Portion	County	Comments
Chattanooga Creek	Mouth to GA line (7.7 mi.)	Hamilton	Chattanooga collection system.
Little Fiery Gizzard	Upstream natural area to Grundy Lake (3.7 miles).	Grundy	Failing septic tanks in Tracy City.
Clouse Hill Creek	Entire Stream (1.9 miles)		
Hedden Branch	Entire Stream (1.5 miles)		
Oostanaula Creek	Mile 28.4 -31.2 (2.8 miles)	McMinn	Athens STP and upstream dairies.
Stringers Branch	Mile 0.0 to 5.4	Hamilton	Red Bank collection system.
Citico Creek	Mouth to headwaters (7.3 miles)	Hamilton	Chattanooga urban runoff and collection system.

(Table continued next page)

Table 9: Bacteriological Advisories in Tennessee
(continued from previous page)

Middle Tennessee

Stream	Portion	County	Comments
Baker Spring Run	Entirety (0.2 miles)	Davidson	Runoff from composting operation.
Baker Fork Creek	7.5 miles		
Duck River	Old Stone Fort State Park (0.2 miles)	Coffee	Manchester collection system.
Little Duck River	Old Stone Fort State Park (0.2 miles)		
Mine Lick Creek	Mile 15.3 to 15.8 (0.5 mile)	Putnam	Baxter STP.
Nashville Area		Davidson	Metro Nashville collection system bypassing and urban runoff.
Brown's Creek	Entirety (3.3 miles)		
Dry Creek	Mile 0.0 to 0.1		
Gibson Creek	Mile 0.0 to 0.2		
McCrory Creek	Mile 0.0 to 0.2		
Tributary to McCrory Creek	Mile 0.0 to 0.1		
Richland Creek	Mile 0.0 to 2.2		
Whites Creek	Mile 0.0 to 2.1		
Cumberland River	Bordeaux Bridge (Mile 185.7) to Woodland Street Bridge (Mile 190.6)		

B. Fish Tissue Contamination

Approximately 94,400 lake acres (Figure 17), and 119 river miles (Figure 18) are currently posted due to contaminated fish. The contaminants most frequently found at dangerous levels in fish tissue are organic substances like PCBs, chlordane, and other organics. The metal, mercury, has also been found at dangerously high levels in fish tissue in two east Tennessee waterways.

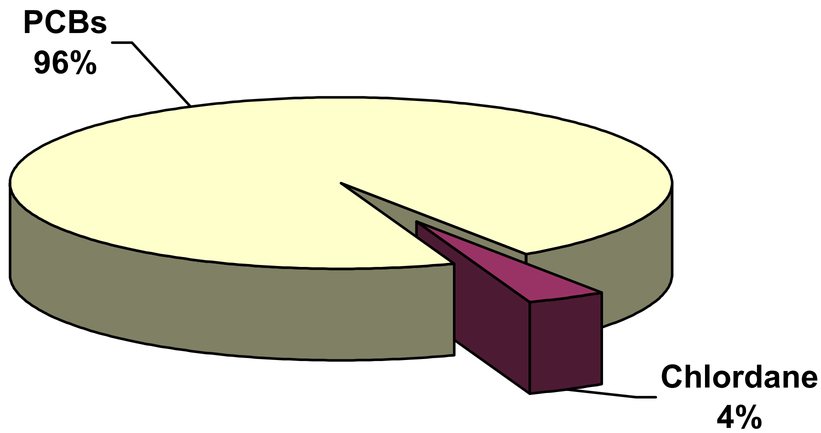


Figure 17: Percent Contribution of Reservoir Acres Posted for Fish Tissue Contamination

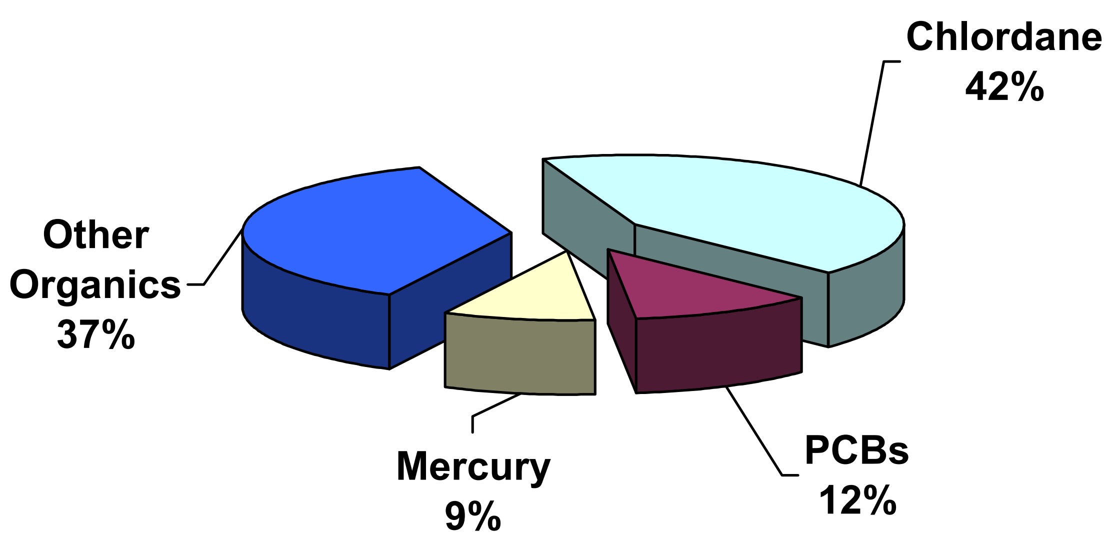


Figure 18: Percent Contribution of Stream Miles Posted for Fish Tissue Contamination

Organic substances tend to bind with the sediment in a body of water and remain there for a very long time. In the sediment, they become part of the aquatic food chain and, over time, concentrate in fish tissue. Contaminants can be found in fish tissue even if the substance has not been used or manufactured in decades. A brief synopsis of the effects of some of these specific carcinogens and/or toxic substances appears below.

1. **PCBs.** PCBs were used in hundreds of commercial and industrial processes including electrical insulation, pigments for plastics, and plasticizers in paints. Over 1.5 billion pounds of PBCs were produced in the US prior to the ban on the manufacture and distribution of PCBs in 1976. Once PCBs enter a river or reservoir they tend to bind with sediment particles. Over time, PCBs enter the food chain and is concentrated in fish tissue. When people eat these contaminated fish, PCBs are stored in liver, fat tissue, and even excreted in breast milk. EPA has determined that PCBs are a probable human carcinogen (cancer causing agent). Additionally, in high enough concentrations, PCBs are likely to damage the stomach, liver, thyroid gland and kidneys and cause a severe skin disorder called chloracne.

2. **Chlordane.** Chlordane is a pesticide which was used on crops, lawns, and for fumigation from 1948 to 1978 when EPA banned all above ground use. For the next decade, termite control was the only approved usage of chlordane. In 1988, all use of chlordane in the US was banned. Like PCBs, chlordane bioconcentrates in the food chain and is commonly detected in fish throughout Tennessee. In people, chlordane is stored in the liver and fat tissue. EPA has determined that chlordane is a probable carcinogen. Other possible effects to people are damage to the liver, plus nervous and digestive system disorders.

3. **Dioxins.** Dioxins are the unintentional by-product of certain industrial processes and the combustion of chlorine-based chemicals. Dioxin refers to a class of compounds with a similar structure and toxic action. Most of these chemicals are produced from the incineration of chlorinated waste, the historical production of herbicides, the production of PVC plastics, and the bleaching possess historically used by papermills. Like many other organic contaminants, dioxins are concentrated in fish and are classified as a probable human carcinogen. Even at extraordinarily low levels (parts per quadrillion) dioxin can exert a toxic effect on larval fish. Other likely effects in people are changes in hormone levels and developmental harm to children.

4. **Mercury.** Mercury is a persistent toxic metal used in the production of batteries, thermostats, thermometers, cameras, and many other commercial products. It is thought that the primary man-induced source of mercury in the environment is the burning of coal. Mercury is also concentrated through the food chain in fish and is a potent neurological toxicant. Additionally, EPA has determined that mercury is a probable human carcinogen. Some of the other dangers mercury poses to people are damage to stomach, brain and kidneys, and harm to unborn children.

Fish are an important part of a balanced diet and a good source of low fat protein. They also provide essential fatty acids that are crucial for the proper functioning of the nervous system and help prevent heart disease. The Department recommends that residents and visitors continue to eat fish from rivers and reservoirs, but they should also follow the published advise on consumption hazards in individual reservoirs.

When fish have levels of a contaminant that pose a higher than acceptable risk to the public, the waterbody is posted and the public is advised of the danger (Table 10). Signs are placed at main public access points and a press release is submitted to local newspapers. If needed, TWRA can enforce a fishing ban.

The list of advisories is published in TWRA's annual fishing regulations. Current advisories are also posted on TDEC's website at:

http://www.state.tn.us.environment/wpc/advisories

One of the original signs posted in 1989 warning the public about dioxin in the Pigeon River in east Tennessee. The advisory was later downgraded to precautionary status in 1996, and then completely lifted in 2003. Dioxin levels in recent years have been very low. (Photo by Greg Denton, Planning and Standards.)

Reducing Risks From Contaminated Fish

The best way to protect yourself and your family from eating contaminated fish is by following the advice provided by the Department of Environment and Conservation. Cancer risk is accumulated over a lifetime of exposure to a carcinogen (cancer-causing agent). For that reason eating an occasional fish, even from an area with a fishing advisory, will not measurably increase your cancer risk.

At greatest risk are people who eat contaminated fish for years, such as recreational or subsistence fishermen. Some groups of people like children or people with a previous occupational exposure to a contaminant are more sensitive to that pollutant. Studies have shown that contaminants can cross the placental barrier in pregnant women to enter the baby's body, thereby increasing the risk of developmental problems. These substances are also concentrated in breast milk.

The Division's goal in issuing fishing advisories is to provide the information necessary for people to make **informed choices** about their health. People concerned about their health will likely choose not to eat fish from contaminated sites.

If you choose to eat fish in areas with elevated contaminant levels, here is some advice on how to reduce this risk:

1. **Throw back the big ones.** Smaller fish generally have lower concentrations of contaminants.

2. **Avoid fatty fish.** Organic carcinogens such as DDT, PCBs, and dioxin accumulate in fatty tissue. In contrast however, mercury tends to accumulate in muscle tissue. Large carp and catfish tend to have more fat than gamefish. Moreover, the feeding habits of carp, sucker, buffalo, and catfish tend to expose them to the sediments, where contaminants are concentrated.

3. **Wash fish before cleaning.** Some contaminates are concentrated in the mucus, so fish should be washed before they are skinned and filleted.

4. **Broil or grill your fish.** These cooking techniques allow the fat to drip away. Frying seals the fat and contaminants into the food.

5. **Throw away the fat if the pollutant is PCBs, dioxin, chlordane or other organic contaminants.** Organic pesticides tend to accumulate in fat tissue, so cleaning the fish so the fat is discarded will provide some protection from these contaminates.

6. **If the pollutant is mercury do not eat the fish.** Fish from the North Fork Holston and East Fork Poplar Creek are likely to be contaminated with mercury, which is concentrated in the muscle tissue. Therefore, the best choice is to totally avoid eating this fish. It is very important that children not eat fish contaminated with mercury. Many developmental problems in children have been linked to elevated mercury levels.

Table 10: Fish Tissue Advisories in Tennessee

(December, 2002. This list is subject to revision.
For additional information: http://www.state.tn.us.environment/wpc/advisories)

West Tennessee

Stream	County	Portion	HUC Code	Pollutant	Comments
Loosahatchie River	Shelby	Mile 0.0 – 20.9	08010209	Chlordane,Other Organics	Do not eat the fish.
McKellar Lake	Shelby	Entirety (13 miles)	08010100	Chlordane, Other Organics	Do not eat the fish.
Mississippi River	Shelby	Mississippi stateline to just downstream of Meeham-Shelby State Park (31 miles)	08010100	Chlordane, Other Organics	Do not eat the fish. Commercial fishing prohibited by TWRA.
Nonconnah Creek	Shelby	Mile 0.0 to 1.8	08010201	Chlordane, Other Organics	Do not eat the fish. Advisory ends at Horn Lake Road bridge.
Wolf River	Shelby	Mile 0.0 – 18.9	08010210	Chlordane, Other Organics	Do not eat the fish.

Middle Tennessee

Stream	County	Portion	HUC Code	Pollutant	Comments
Woods Reservoir	Franklin	Entirety (3,908 acres)	06030003	PCBs	Catfish should not be eaten.

(Table continued on next page)

Table 10: Fish Tissue Advisories in Tennessee
(continued from previous page)

East Tennessee

Stream	County	Portion	HUC Code	Pollutant	Comments
Boone Reservoir	Sullivan, Washington	Entirety (4,400 acres)	06010102	PCBs, chlordane	Precautionary advisory for carp and catfish.*
Chattanooga Creek	Hamilton	Mouth to Georgia Stateline (11.9 miles)	06020001	PCBs, chlordane,	Fish should not be eaten. Also avoid contact with water.
East Fork of Poplar Creek including Poplar Creek embayment	Anderson, Roane	Mile 0.0 – 15.0	06010207	Mercury, PCBs	Fish should not be eaten. Also avoid contact with water.
Fort Loudoun Reservoir	Loudon, Knox, Blount	Entirety (14,600 acres)	06010201	PCBs	Commercial fishing for catfish prohibited by TWRA. No catfish or largemouth bass over two pounds should be eaten. Do not eat largemouth bass from the Little River embayment.
Melton Hill Reservoir	Knox, Anderson	Entirety (5,690 acres)	06010207	PCBs	Catfish should not be eaten.

(Table continued on next page.)

Table 10: Fish Tissue Advisories in Tennessee
(continued from previous page)

East Tennessee (continued)

Stream	County	Portion	HUC Code	Pollutant	Comments
Nickajack Reservoir	Hamilton, Marion	Entirety (10,370 acres)	06020001	PCBs	Precautionary advisory for catfish.*
North Fork Holston River	Sullivan, Hawkins	Mile 0.0 - 6.2 (6.2 miles)	06010101	Mercury	Do not eat the fish. Advisory goes to TN/VA line.
Tellico Reservoir	Loudon	Entirety (16,500 acres)	06010204	PCBs	Catfish should not be eaten.
Watts Bar Reservoir	Roane, Meigs, Rhea, Loudon	Tennessee River portion (38,000 acres)	06010201	PCBs	Catfish, striped bass, & hybrid (striped bass-white bass) should not be eaten. Precautionary advisory* for whitebass, sauger, carp, smallmouth buffalo and largemouth bass.
Watts Bar Reservoir	Roane, Anderson	Clinch River arm (1,000 acres)	06010201	PCBs	Striped bass should not be eaten. Precautionary advisory for catfish and sauger.*

*Precautionary Advisory - Children, pregnant women, and nursing mothers should not consume the fish species named. All other persons should limit consumption of the named species to one meal per month.

X. Success Stories

Partnerships between the Department and many private and public organizations has resulted in several dramatic improvements in water quality throughout the state. In fact, 63 water body segments that were listed in the 1998 303(d) list have been proposed for removal from the 2002 303(d) List based on improved water quality. A few of these improved streams are highlighted below.

A. Pigeon River

In April 1989, the State of Tennessee issued a “do not consume” advisory on all fish in the Pigeon River due to dioxin contamination. The advisory covered the river from the North Carolina-Tennessee state-line downstream to the mouth on the French Broad River (Douglas Reservoir). Dioxin levels in fish tissue samples exceeded the 5 part per trillion (ppt) posting trigger. The source of the contamination was the Champion Paper Mill in Canton, North Carolina. Since that time, the paper mill has changed ownership (Blue Ridge Paper). Since the original advisory was posted, the plant has improved pollution control practices.

Fish collected from the Pigeon River for tissue analysis are obtained by a combination of backpack shocking (pictured), boat shocking, seining and gill netting. (Photo provided by Jonathon Burr, KEAC.)

Fish tissue data collected between 1989 and 1995 demonstrated a drop in dioxin contamination with some species exhibiting safe levels. In March 1996, the advisory for the Tennessee portion of the river was downgraded to a "precautionary advisory" for redbreast sunfish, carp and catfish.

Fish tissue samples have continued to be collected at three sites on the Pigeon River over the last seven years. The three species on the advisory, as well as additional game and rough fish species, have been analyzed for dioxin. Game fish and rough fish have consistently been below 1 ppt. Catfish are generally higher but consistently fall below 2 ppt. None of the fish samples has exceeded the 5 ppt advisory level during this period.

The Pigeon River in East Tennessee. (Photo by Jonathon Burr, KEAC.)

Based on the data collected since 1996, it appears that the fish in the Pigeon River are safe to eat at normal consumption rates (Denton and Arnwine, 2002). The Division of Water Pollution Control is recommending that the Tennessee segment of the river be de-posted for fish consumption. North Carolina, which has a dioxin posting limit of 3 ppt, removed their consumption advisory on the Pigeon River in August 2001.

(l to r) Roland Dykes, Mayor of Newport; Paul Davis, Water Pollution Control director; Justin P. Wilson, Deputy to the Governor for Policy; and Iliff McMahan, Cocke County Executive recently participated in an informal celebration of the removal of the fish consumption advisory signs on the Pigeon River. (Photo provided by Melanie Catania, Environmental Policy Office.)

B. Arkansas Creek

Arkansas Creek, a South Harpeth River tributary in the Harpeth River watershed (TN05130204), flows near the Williamson County Landfill. In 1998, Arkansas Creek was placed on the 303(d) list of impacted streams in Tennessee for inorganic pollution, habitat alteration, siltation, and organic enrichment. The primary source of the pollutants was considered to be the landfill.

The same year a new manager, Mr. Lewis Bumpus, was hired to oversee Williamson County's solid waste management program, including the landfill. A plan to restore Arkansas Creek was developed with the goals to restore the stream and protect it from future pollution impacts (Civil & Environmental Consultants, Inc. 2001).

Placement of gabion (rock baskets) to prevent runoff from the Williamson County Landfill site. (Photo provided by Jeff Duke, Civil & Environmental Consultants, Inc.)

The objectives of the Arkansas Creek stream restoration plan were:

1. Introduce aquatic habitat-enhancing structures.

2. Maximize silt capture.

3. Utilize biotechnical methods for stabilizing stream banks and bedload.

4. Introduce specific vegetation types to attract wildlife and enhance stabilization.

5. Continue to implement Best Management Practices (BMPs) related to landfill operation to prevent future siltation.

6. Document the water quality and biological integrity of area streams.

The constructed wetland at the base of the gabion spillway below the Williamson County Landfill. Just like their natural counterparts, constructed wetlands filter pollutants and help retain waters. (Photo provided by Jeff Duke, Civil & Environmental Consultants, Inc.)

After site mitigation was completed, an environmental consultant was hired to survey area streams. The consultant collected biological samples in Arkansas Creek and Kelly Creek in the fall of 2000. Arkansas Creek passed TDEC's proposed biological criteria for subecoregion 71f.

In 2001, TDEC staff collected biological samples at two locations downstream of the landfill on Arkansas Creek. Both sites passed biological and habitat guidelines for this ecoregion. Since this creek is supporting a healthy biological community it has been removed from the 2002 303(d) List.

C. Cumberland River

The Metropolitan Government of Nashville and Davidson County Water and Sewerage Services (Metro Water Services) began an Overflow Abatement Program (OAP) in 1990 to comply with the TDEC Commissioner's Order. Over the next decade, Metro invested $685 million in its sewage treatment system. The annual wastewater overflow into the Cumberland River was reduced from 20 billion gallons in 1990 to less than one billion in 2001. Seventy-six percent of sewer overflows from manholes and pump stations have been eliminated and pump station overflows have been reduced by 94 percent.

Water quality in the Cumberland River has improved due to dramatic reductions in sewage overflows. Bill Purcell, Mayor of Nashville, and Governor Don Sundquist joined in the removal of the pathogen advisory on this segment of the Cumberland River in Nashville. (Photo provided by Jed DeKalb, Chief State Photographer.)

Metro Water Services has submitted plans through 2007 for continuing improvement to the quality of water discharged into the Cumberland River. Metro Water Services also plans to spend another 125 million dollars to improve wastewater quality. This effort has resulted in all of the Cumberland River in Davidson County except the portion between the Bordeaux Bridge and the Woodland Street Bridge being removed from the 2002 303(d) List. If the water quality continues to improve, soon this portion of the Cumberland River and several other creeks in the Cheatham Reservoir watershed will have their water contact advisories lifted.

D. Middle Fork Drakes Creek

Prior to 1920, a wildcat oil well was drilled on the bank of Middle Fork Drakes Creek in the Barren River Watershed (TN05110002). The well never produced any oil but instead, tapped into a sulfur deposit. For the last 80 years this artesian spring has discharged noxious metal laden sulfur water into the creek. A cone of mineral deposits had built up around the mouth of the spring until it resembled a miniature volcano with sulfur water emerging clear, then turning black when it came in contact with the air. Several efforts to cap the spring had failed.

A crewman oversees the drilling process to prepare to cap the artesian well spewing sulphur and other metals into the Middle Fork of Drakes Creek. The "volcanic cone" of precipitated metals can be seen to the right of the rig. (Photo provided by Joe Holland, Nashville EAC.)

Without a responsible party it was difficult to fund remediation. A fine collected from another environmental enforcement action was earmarked for environmental cleanup. This money was used to hire a company to permanently cap this well and stop the noxious discharge. The stream has recovered remarkably since the artesian spring has been capped. Middle Fork Drakes Creek has been removed from the 2002 303(d) List. Due to the documented improvement in this section of the creek, for the first time the State of Tennessee has assessed it as fully supporting its designated uses.

E. French Broad River

The French Broad River, one of the two main tributaries that forms the Tennessee River above Knoxville, originates in the Blue Ridge Mountains of southwestern North Carolina. It flows past the city of Asheville, North Carolina on its way to the Unaka Mountains. It enters Tennessee east of Newport.

The beautiful French Broad River as seen from the Appalachian Trail near Hot Springs, North Carolina. (Photo by Lee Keck, Division of Water Supply.)

The Division has maintained a long–term monitoring station near the town of Del Rio. Chemical sampling in years past indicated an elevated bedload of sediment, along with occasional violations of metals criteria. Color levels were also considered elevated. Biological monitoring indicated that the river did not meet Tennessee's goals for biological integrity.

In 2001, the Division performed biorecon surveys at two sites on the upper French Broad. Survey results are summarized on the next page. Additionally, there were no water quality standards violations noted from the chemical data collected near Del Rio. Due to the documented improvement in this section of the French Broad River, the State of Tennessee has assessed it as fully supporting its designated uses.

2001 Biological Survey Results
French Broad River

Station	River Mile	EPT Genera	Intolerant Genera	Total Genera	Habitat Score
Boyers Island	77.5	19	7	38	155
Near NC Stateline	95.9	19	7	47	155

F. Ocoee River

The Ocoee River in southeastern Tennessee has never been considered to support its designated uses due to a 150-year history of environmental damage in the Copper Basin.

In the mid-1970's, a biological survey was undertaken in the Ocoee River downstream of the industrial complex at Copperhill, Tennessee. Biologists found only one living thing in the stream, an insect. They debated over whether the bug actually lived in the river, or had simply fallen off a nearby railroad trestle.

Much has changed in this section of the river since then. In 1998, TVA biologists surveyed the Ocoee in the same area as the 1970s study (mile 35.1). They documented dramatic improvements in the quantity and diversity of macrobenthic aquatic life, including 11 EPT families. 18 total families were noted.

In 2001, TVA biologists returned to the same site. This time, 13 EPT families were collected, including nine families considered intolerant to pollution. The total number of macrobenthic families increased from 11 in 1998, to 28 in 2001. The site easily passed the Division's stringent biological integrity goals for that ecoregion.

The improvement in water quality in the Ocoee River near Copperhill can be traced to numerous factors:

- The revegetation of the Copper Basin. Historical copper smelting activities in the 1800's and early 1900's had led to several thousand acres of denuded land in the area. A partnership of multiple agencies, including the state of Tennessee, had been busy planting trees for the last 25 years. Most of the Copper Basin is now reforested.

- Industrial discharges. Industrial discharges to Davis Mill Creek and the Ocoee have practically ceased. Occasional spills still remain a concern.

The Ocoee River near Copperhill, Tennessee.
(Photo by Andy Binford, Division of Superfund.)

- CERCLA activities. Water quality in North Potato Creek and its tributary, Burra Burra Creek have improved due to the cleanup of waste sites. Much work remains to be done in these tributaries before water quality goals will be completely met, but the transport of pollutants to the Ocoee from these tributaries appear to have diminished in intensity.

- Performance of the Copperhill STP. An upgrade of this facility is underway. However, the plant appears to be better operated than in the past, when it consistently violated its permit limits.

In the fall and winter of 2002-2003, chemical and biological sampling in the Ocoee downstream of North Potato Creek revealed that water quality standards continue to be violated. Several tributaries, including North Potato Creek and Davis Mill Creek, apparently continue to discharge pollutants into the Ocoee River in toxic amounts.

There is little doubt that the water quality in the Ocoee River directly downstream of the Copper Basin has improved. While still not clean enough to be considered unimpaired, the documented improvements certainly lend credence to the belief that continued efforts to mitigate past environmental harms will result in additional water quality improvements.

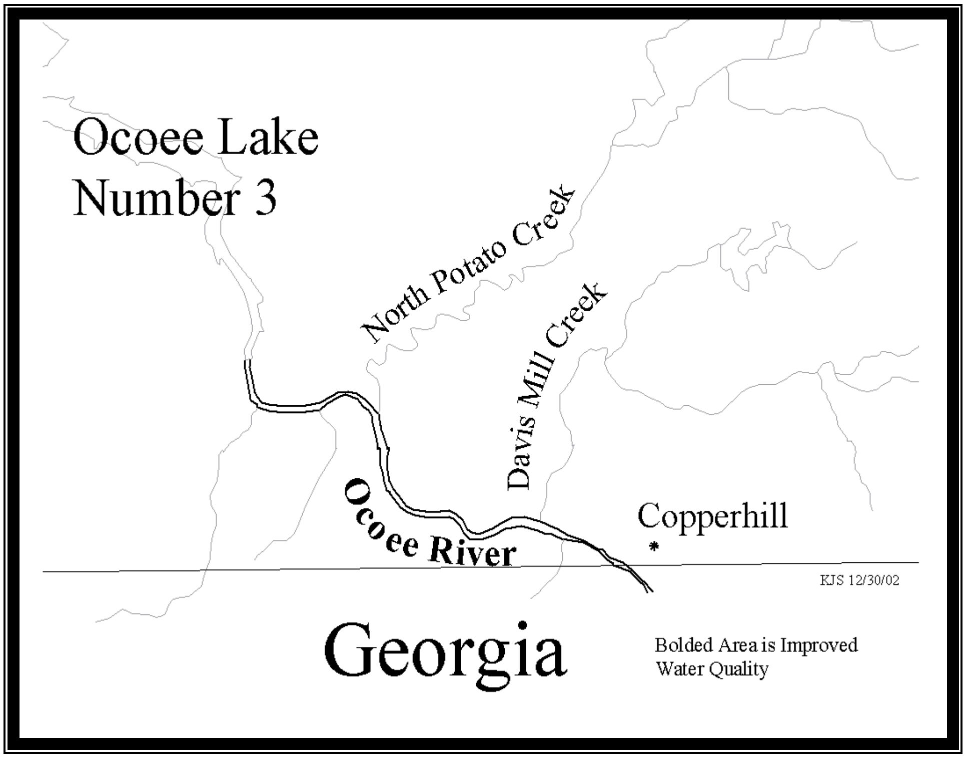


Figure 19. Location of Section With Improved Water Quality on the Ocoee River (improved section bolded).

G. Sinking Creek

It was discovered in 2001 that untreated sewage was entering Sinking Creek, a small tributary to Barton's Creek in Wilson County (TN05130201). The sewage originated from businesses near the historic downtown district of Lebanon. These businesses had never been properly connected to the sanitary sewer.

Downstream from the square, Sinking Creek flows through a large city park frequented by children. Due to the obvious threat to public health a stream advisory was posted for no water contact. Local officials began working to correct the problems that led to the advisory.

Since the original posting, the businesses on the town square have been connected to the sanitary sewer. In December of 2002, the water contact advisory was lifted.

H. Trail Fork Big Creek

Following a Hepatitis A outbreak in 1995, a water contact advisory was placed on Trail Fork Big Creek and five of its tributaries in the Upper French Broad watershed (TN06010105). Because viruses cannot be detected in water, TDEC performed an intensive survey using fecal coliform and E. coli as indicators of pathogens. The survey indicated that several streams in the watershed had elevated pathogens counts. The source of the pathogens was thought to be failing septic systems.

In addition to monitoring streams and wells, Department staff and the local county health department personnel worked with local residents to upgrade failing septic tanks to remove the source of the bacteria. The results of recent bacteria testing over the course of several years indicate that the state's water quality standards are now being met in most of these streams.

In December of 2002, the water contact advisory was formally removed from several streams in the Trail Fork Big Creek watershed. The stream sections deposted were: the downstream portion of Trail Fork Big Creek, the upstream portion of Johns Creek, Black Creek, Bear Branch, and Dry Fork Big Creek. The Division will continue to monitor all these streams, but particularly Baker Creek and the downstream section of Johns Creek, which remained posted.

I. Doe River

The Doe River is a high quality stream that originates near Roane Mountain in northeastern Tennessee. Within Roane Mountain State Park, it is sampled as a reference stream for subecoregion 66d.

In 1998, downstream portions of the Doe River and Laurel Fork, a tributary near Hampton that is also a reference stream, were dredged and channelized without authorization following a flood event. TDEC in a joint effort with Natural Resource Conservation Service (NRCS), U.S. Army Corps of Engineers (USACE), and Tennessee Wildlife Resources Agency (TWRA) helped stabilize the raw banks. Several stabilization methods including bioengineering, gabion baskets, and matting were used to help repair the stream bank. These stabilization efforts combined with little development upstream of the disturbance has provided for quick recovery of these high gradient streams.

In 2001 TVA conducted a biological survey in the Doe River and Laurel Fork and found the biological community to be healthy. Subsequently TDEC personnel preformed biological surveys on both locations and found them to be fully supporting of aquatic life. The biological communities at both of these streams appear to have recovered well.

XI. Ecoregion Approach

In 1993, the Division began looking for a way to establish reasonable water quality expectations for different areas of the state. The existing approach of statewide criteria did not reflect Tennessee's diverse geography that ranged from the eastern mountains to the western plains. A method was needed for comparing the existing conditions found in a stream to the natural or reference condition in relatively unimpaired streams. The reference data needed to be from similar geographic areas to avoid inappropriate comparisons. It was important that the chosen approach provide scientific, practical, and defensible background data for the different parts of the state.

> An ecoregion is a relatively homogeneous area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, and other ecologically relevant variables.

In the 1980's, EPA developed a geographical framework called the ecoregion approach. In this approach, the United States is delineated into 76 different Level III ecoregions based on a similarity in climate, landform, soil, natural vegetation, hydrology and other ecologically relevant variables. Tennessee is divided into eight of these regions. The ecoregion approach seemed a reasonable way for the Division to determine regionally specific information for use in criteria development and refinement. In 1993, the Division initiated the ecoregion project to begin this process.

The ecoregion project was completed in four stages as outlined below. Details of the first three stages of the project can be found in *Tennessee Ecoregion Project 1994-1999* (Arnwine et. al., 2000). Details of the criteria proposals in stage four are presented in the referenced documents.

1. Delineate Subecoregion Boundaries

The eight Level III ecoregions comprising Tennessee were too large and diverse to be used for the establishment of water quality goals. Therefore, it was necessary to refine and subdivide the ecoregions into smaller, less complex units. Beginning in 1993, the Division arranged for James Omernik and Glenn Griffith of EPA's Corvalis Laboratory to subregionalize and update the ecoregions (Griffith et al., 1997).

Experts in many disciplines including aquatic biologists, ecologists, foresters, chemists, geographers, engineers, professors and regulatory personnel from 27 state and federal agencies as well as universities and private organizations were involved in this process. Maps containing information on bedrock and surface geology, soils, hydrology, physiography, topography, precipitation, land use and vegetation were reviewed. The result was the sub-delineation of Tennessee's eight (Level III) ecoregions into 25 (Level IV) ecological subregions (Table 11and Figure 20).

2. Reference Stream Selection

> A reference stream is a least impacted yet representative waterbody within an ecoregion that can be monitored to establish a baseline to which other waters can be compared. Reference streams are not necessarily pristine or undisturbed by humans.

Reference sites were chosen to represent the best attainable conditions for all streams with similar characteristics in each of the 25 subregions. Reference condition represented a set of expectations for physical habitat, general water quality and the health of biological communities in the absence of human disturbance and pollution. Selection criteria for reference sites included minimal impairment and representativeness. Streams that did not flow across subregions were targeted so the distinctive characteristics of each subregion could be identified.

Before monitoring began, 353 streams were evaluated as potential reference sites. Experienced Division staff used chemical and benthic macroinvertebrate samples as well as habitat assessments to trim the candidate streams down to a workable list. By the end of the study 98 reference streams were established. This represented between two and eight reference streams in each subregion.

3. Intensive Monitoring of Reference Streams

From 1996 to 1999, the reference sites were monitored quarterly for chemicals and bacteria. Chemical sampling generally included the parameters historically sampled by the Division in its long-term ambient monitoring network. Macroinvertebrate samples and habitat assessments were conducted biannually in spring and fall. Since 1999, the reference streams have been monitored in accordance with the watershed cycle (each stream is visited every five years).

4. Development of Regionally-based Water Quality Criteria

The data generated by reference stream monitoring has been used to develop proposals for standardized interpretation of existing narrative criteria. Summaries of these studies can be found under Chapter XII, special projects. Details of each project are presented in the referenced documents.

a. Nutrient Criteria (Denton et al., 2001)

b. Biological Criteria (Arnwine and Denton, 2001)

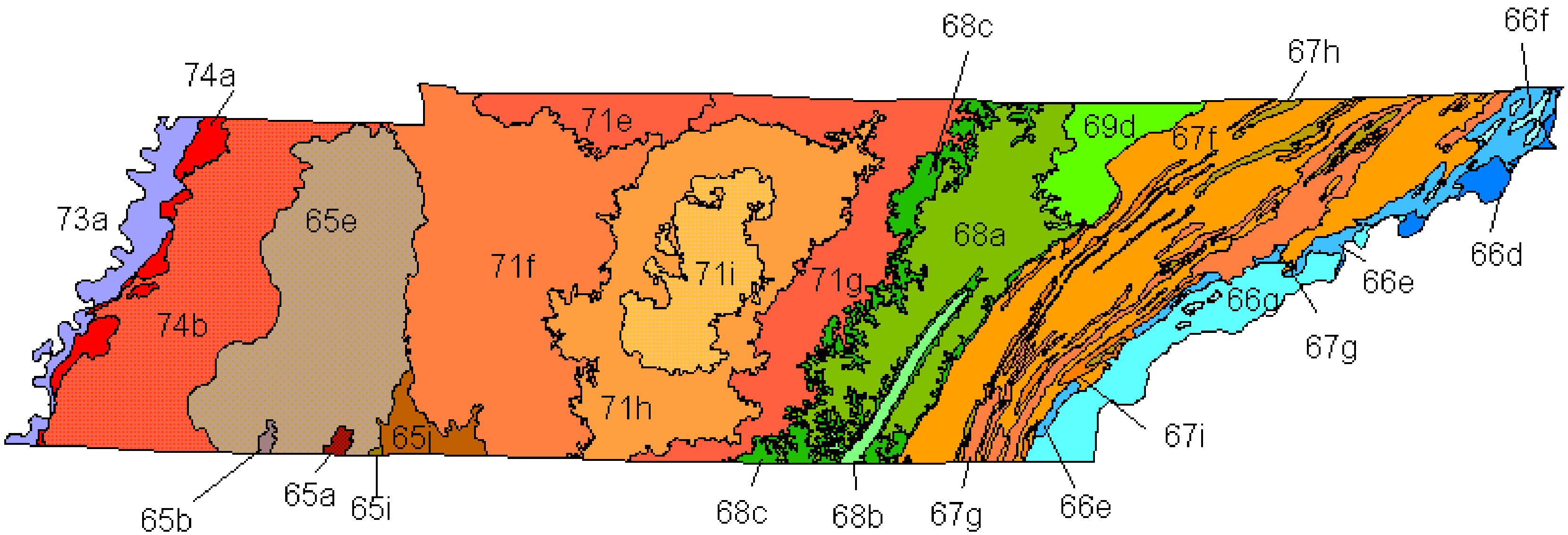
c. Habitat Guidelines (Arnwine and Denton, 2001)

During this triennial review year, other criteria are also being compared to the reference database to help refine water quality goals where appropriate. A proposal to regionalize pH criteria has been developed (Arnwine and Denton, 2002). Review of the dissolved oxygen data has indicated that the current standard may also need to be adjusted.

Table 11: Ecoregions of Tennessee

Ecoregion (Level III)	%State	Subecoregion (Level IV)	%State
65 - Southeastern Plains	12.1%	65a - Blackland Prairie	0.1%
		65b - Flatwood/Alluvial Prairie Margins	0.08%
		65e - Southeastern Plains and Hills	10.9%
		65i - Fall Line Hills	0.02%
		65j - Transition Hills	1.0%
66 - *Blue Ridge Mountains	6.0%	66d - Southern Igneous Ridges and Mountains	0.6%
		66e - Southern Sedimentary Ridges	1.9%
		66f - Limestone Valleys and Coves	0.3%
		66g - Southern Metasedimentary Mountains	3.2%
67 – Ridge and Valley	18.2%	67f - Southern Limestone Dolomite Valleys and Low Rolling Hills	12.6%
		67g - Southern Shale Valleys	3.4%
		67h - Southern Sandstone Ridges	0.8%
		67i - Southern Dissected Ridges and Knobs	1.4%
68 - Southwestern Appalachians	11.4%	68a - Cumberland Plateau	7.6%
		68b - Sequatchie Valley	0.6%
		68c - Plateau Escarpment	3.3%
69 – *Central Appalachians	2.1%	69d - Cumberland Mountains	2.1%
71 - Interior Plateau	37.4%	71e - Western Pennyroyal Karst	2.0%
		71f - Western Highland Rim	13.9%
		71g - Eastern Highland Rim	6.9%
		71h - Outer Nashville Basin	10.5%
		71i - Inner Nashville Basin	4.0%
73 - *Mississippi Alluvial Plain	2.0%	73a - Northern Mississippi Alluvial Plain	2.0%
74 - Mississippi Valley Loess Plains	10.7%	74a - Bluff Hills	1.1%
		74b - Loess Plains	9.6%

*Delineation of ecoregions in KY, NC, and GA may result in additional subregions in this ecoregion.



65a Blackland Prairie
65b Flatwoods/Alluvial Prairie Margins
65e Southeastern Plains and Hills
65i Fall Line Hills
65j Transition Hills
66d Southern Igneous Ridges and Mtns
66e Southern Sedimentary Ridges
66f Limestone Valleys and Coves
66g Southern Metasedimentary Mountains
67f Southern Limestone/Dolomite Valleys and Low Rolling Hills
67g Southern Shale Valleys
67h Southern Sandstone Ridges
67i Southern Dissected Ridges & Knobs
68a Cumberland Plateau
68b Sequatchie Valley
68c Plateau Escarpment
69d Cumberland Mountains
71e Western Pennyroyal Karst
71f Western Highland Rim
71g Eastern Highland Rim
71h Outer Nashville Basin
71i Inner Nashville Basin
73a Northern Mississippi Alluvial Plain
74a Bluff Hills
74b Loess Plains

Figure 20: Level IV Ecoregions of Tennessee

XII. Special Projects

A major goal of the Division is to establish measurable safe levels of pollutants to replace current narrative criteria and to refine existing statewide numeric criteria to reflect natural regional differences. The ecoregion reference stream monitoring project (Chapter XI) gathered sufficient information to establish reasonable numeric water quality expectations for the current narrative nutrient, biological and habitat criteria. Reference stream data were also used to develop a proposal for refining the existing statewide pH criterion to reflect regional differences. The ecoregion project also prompted additional studies into the suitability of the current dissolved oxygen criterion.

A. Proposed Nutrient Criterion

A significant number of impacted stream miles in Tennessee are due to elevated nutrient levels. There are currently no specific narrative criteria for nutrients. Nutrients are assessed under the more generic "free from" statements in the toxicity section of the fish and aquatic life criteria and the "aesthetic" section of the recreational criteria. Thus, before any stream could be assessed as impacted by nutrients, the existence of a problem had to be established. The purpose of this study was to develop subecoregion specific interpretations of the narrative nutrient criteria for total phosphorus and nitrate+nitrite for the 2002 triennial review of water quality standards.

Reference stream data obtained during the ecoregion reference project (Chapter XI) were used to determine naturally occurring nutrient levels in each ecological subregion across the state. Standard statistical methods were used to identify differences in nutrient concentrations between subregions. Where differences were significant, the adoption of subregion-based criteria was considered appropriate due to improved accuracy. However, where differences between subregions were not significant, regional data were aggregated so that the resulting criteria could apply to streams that crossed subregions.

Data from across the state were used to field test potential criteria levels. Reference data at both the 75^{th} and 90^{th} percentile were evaluated. Every subregion tested supported the use of the 90^{th} percentile as less restrictive nutrient criteria that did not penalize streams supporting a healthy benthic community.

The relationship between biological stream health and nutrient concentration was tested using reference stream data and the results of a 2000 survey of randomly selected monitoring stations in the Inner Nashville Basin (Section E). Very few associations were identified except for a very weak correlation between nutrients and EPT genera (aquatic insects in the generally pollution sensitive orders Ephemeroptera, Plecoptera and Trichoptera). Multiple regression analyses indicated it was the interaction of several pollutants, including nutrients, which led to a loss of biological integrity. Additional samples were collected at these stations and are pending analysis.

Stronger correlations were seen in four other subregions. These data were not random, but pooled from existing databases. The data seem to indicate that nutrients and biological integrity are most directly linked when other factors, such as habitat quality, are not limited.

It is likely that nutrients are indirectly associated with biological health. Under the right conditions increased nutrient levels generally result in algal blooms. High levels of algae affect dissolved oxygen as well as render habitat unavailable for colonization by macroinvertebrates. This in turn causes stress to the benthic population. Additional information as well as proposed criteria levels for both total phosphorus and nitrate+nitrite can be found in the document *Development of Regionally-Based Interpretations of Tennessee's Narrative Nutrient Criterion* (Denton et. al., 2001).

In July 2002, additional federal nutrient criteria development funds were used to conduct algal field surveys and nutrient sampling for comparison to diurnal dissolved oxygen patterns in both reference quality and impaired streams in 16 ecological subregions. Algal and nutrient data generated during this study will be used to test a correlation between algal abundance, nutrient levels and diurnal dissolved oxygen patterns. This will in turn help Tennessee refine proposed nutrient criteria and attempt to establish baseline algal biomass. Findings of this study will be published in 2003.

Increased nutrient levels can result in algae blooms which affect dissolved oxygen levels and stress the aquatic life. (Photo provided by Annie Goodhue, Nashville EAC.)

B. Proposed Biological Integrity Criterion

Biological criteria or "biocriteria" are used to define expected biological conditions. The health of the benthic community is an important indicator of disturbances in the watershed. Biological communities are good indicators of actual conditions because they inhabit the stream continuously and are subject to the various chemical and physical influences that occur over time. Loss of biological integrity is often the result of environmental impacts such as habitat destruction, siltation, flow-alteration, organic enrichment, reduced dissolved oxygen, pH fluctuations and elevated metals.

Tennessee's current biological criterion is narrative. It specifies that streams shall not be modified to the extent that the aquatic life is substantially decreased or adversely affected. However, the terms substantially and adversely are open to interpretation. Additionally, the existing narrative criterion requires that the condition of the biological communities be measured by the use of metrics. However, it does not specify what metrics are to be used. Since different metrics measure different aspects of the biological community and have different levels of sensitivity to pollution, application of the existing criterion relies heavily on which metrics are selected and individual interpretations of stream health. A more standardized measurement calibrated to specific bioregions is needed to effectively assess biological integrity in a consistent and fair manner.

The purpose of this study was to develop guidance for interpretation of biological data based on regional reference data collected as part of the ecoregion project (Chapter XI). Reference biological data were collected by single habitat semi-quantitative samples of benthic macroinvertebrates.

Benthic macroinvertebrates are animals that live on the bottom of streams that do not have a backbone and are large enough to see with the naked eye. Examples include crayfish, mayflies and clams. The advantages of using macroinvertebrates as water quality indicators include their sensitivity to various types of chemical pollution, dependency on stable habitat, limited mobility, high diversity and vital position near the bottom of the food chain.

The single habitat semi-quantitative sample method was used to collect the animals because it is easily standardized and has been found to yield consistent results. Two different sample methods (riffle kicks or bank jabs) were used depending on the most prevalent stream type in each ecoregion.

Biologists using kick nets collect benthic macroinvertebrates from riffle areas. (Photo provided by Jonathon Burr, Knoxville EAC.)

After analysis of the reference data, a biological index was developed to measure the health of the macroinvertebrate community. This index was based on seven biometrics representing different aspects of the biological population. Multiple biometrics are calculated when assessing biological integrity since it is common for one attribute of the aquatic community to change in response to impact while others remain unchanged.

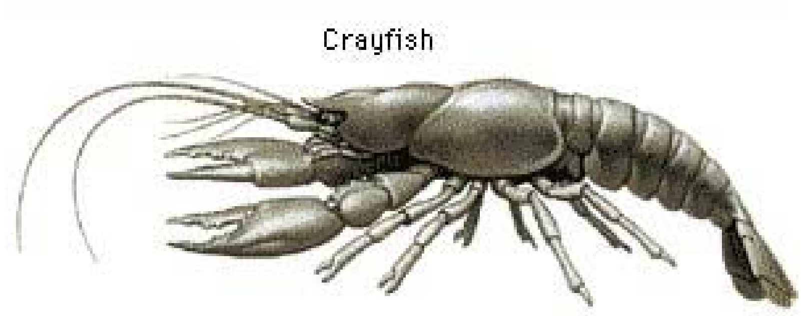
Ecological subregions were grouped into bioregions based on similarity of the reference macroinvertebrate populations. Fifteen bioregions, each with distinct macroinvertebrate communities, were defined in Tennessee. The seven biometrics were used to evaluate each bioregion (except in the Mississippi Alluvial Plain where only five of the biometrics proved applicable). Different expectations for each biometric were determined based on a quadrisection of the 10th or 90th percentile of reference data for each bioregion. The biometric values in each bioregion were than combined into a biocriterion index for each region. Test sites scoring at or above this level would be considered supportive of a healthy biological community. More details regarding this study can be found in *Development of Regionally-Based Numeric Interpretations of Tennessee's Narrative Biological Integrity Criterion* (Arnwine and Denton, 2001).

C. Proposed Regionalization of pH Criteria

The purpose of this study was to develop regional pH criteria for wadeable streams and rivers based on reference data collected as part of the ecoregion project (Chapter XI). Tennessee's existing statewide pH criterion is 6.5 to 9.0 standard units. Reference stream data indicated this did not reflect background water quality conditions in many areas of the state and did not allow for obvious regional differences.

pH is a way of expressing both acidity and alkalinity. Common causes of acidity in Tennessee streams are resource extraction and construction activities. Alkalinity is generally a problem more common in lakes and reservoirs with the most common cause being eutrophication.

When streams become excessively acidic or alkaline, the change can adversely impact aquatic life. Macroinvertebrates with shells or hard exoskeletons, such as crayfish, are unable to molt in acidic conditions while fish may experience altered gill function. Fish and macroinvertebrates unable to tolerate the altered conditions decline while tolerant organisms increase due to a lack of competition for food and habitat. This results in an unhealthy biological community dominated by a few tolerant taxa.



One of the biggest concerns is that pH levels can increase the toxicity of other pollutants in the water. The pH of water determines the solubility and biological availability of heavy metals. Metals tend to be more toxic at lower pH because they are more soluble. Runoff from mines, agricultural, domestic and industrial areas may contain iron, aluminum, ammonia, mercury or other elements. The pH of the water determines the toxic effects, if any, of these substances.

Following statistical comparison of reference and test data, it was proposed that the statewide pH criterion be changed to 6.0-9.0 for wadeable streams in the majority of the state. Lower pH criteria were proposed for three regions that had naturally acidic systems (Cumberland Plateau, Transition Hills and Loess Plains).

Details of this project, including recommendations for adjustments to pH criteria based on regional data can be found in the *Development of Regionally-Based pH Criteria for Wadeable Streams*, (Arnwine and Denton, 2002).

D. Diurnal Dissolved Oxygen Study

The amount of dissolved oxygen (DO) present in the water is critical to aquatic life. Oxygen gets in the water by surface air diffusion, aeration from turbulence and the photosynthesis of aquatic plants and algae. Most fish and aquatic macroinvertebrates cannot obtain oxygen directly from the air and are dependent on oxygen dissolved in the water to survive.

Pollution tends to cause a decrease in stream oxygen concentrations. One of the main factors resulting in low dissolved oxygen is the buildup of organic wastes, which are anything that was once part of a living plant or animal including food, leaves, feces etc. Common sources of organic wastes entering streams include sewage, urban runoff, crop runoff, dairies, feed lots and industrial sources such as food processing plants. Indirect sources of organic wastes include fertilizers from urban and agricultural runoff that stimulate the growth of algae and aquatic plants. As the plants die, aerobic bacteria consume oxygen in the process of decomposition.

> Aquatic life is dependent on oxygen dissolved in water to survive. Pollution, such as organic wastes, can cause a decrease in stream oxygen concentrations.

Depletion of dissolved oxygen can cause major shifts in the kinds of aquatic organisms found in streams. Species that cannot tolerate low levels of dissolved oxygen such as trout, darters, mayflies and stoneflies are replaced by pollution tolerant organisms such as carp, green sunfish, midge larvae and aquatic worms.

The current fish and aquatic life protection criterion for dissolved oxygen (DO) has not been revised in many years. The criterion suggests that the minimum acceptable dissolved oxygen levels in any stream is 5 mg/l, but notes that DO can go as low as 3 mg/l. A review of dissolved oxygen data from ecoregion reference streams indicates that these criteria may be overly protective, particularly in the Mississippi Alluvial Plain where animals are adapted to the naturally low dissolved oxygen levels in the sluggish, organically-rich streams. On the other hand, the existing criteria may not be fully protective of fish and aquatic life in other regions, particularly mountainous areas of east Tennessee where natural aeration provided by cold water running over rocks keeps dissolved oxygen levels well over 5 mg/l.

One problem with existing reference data is that they were all collected during daylight hours when dissolved oxygen levels are at their highest level. Oxygen is produced during photosynthesis and consumed during respiration and decomposition. Because it requires light, photosynthesis occurs only during daylight hours. At night photosynthesis cannot counterbalance the loss of oxygen through respiration and decomposition so DO concentrations steadily decline.

Preliminary investigations conducted by the Division have demonstrated a definite fluctuation of Dissolved Oxygen within a 24-hour period in response to temperature and the photosynthesis cycle (Figure 21). Based on this information, regional criteria factoring into account variations in natural patterns in dissolved oxygen levels seems more appropriate than the current approach.

In July 2002, the Division initiated an intensive diurnal dissolved oxygen study funded by a 104(b)(3) grant to resolve this issue. Dissolved oxygen probes capable of continually recording dissolved oxygen levels were placed in 72 reference and 72 test sites in 16 ecological subregions. The probes were left for one week at each site to record the diurnal dissolved oxygen patterns occurring in the stream. Monitoring was completed in October, 2002, and the data will be used to provide a basis for possible adjustments to dissolved oxygen criteria to better reflect diurnal fluctuations within each subregion.

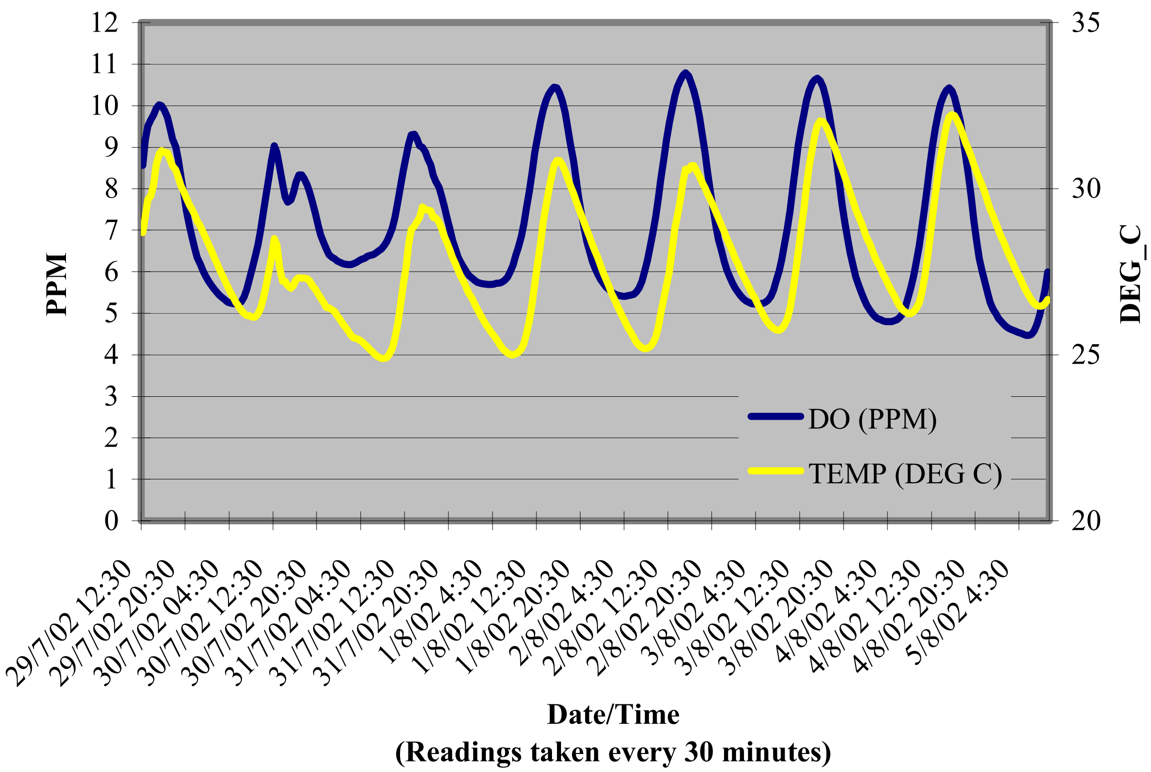


Figure 21: Typical Diurnal Dissolved Oxygen Patterns in the Outer Nashville Basin (71h). (Stream monitored for one week in August 2002).

E. 71i Probabilistic Monitoring Project

In 2000, the Division used Federal 104(b)(3) funding to conduct a probabilistic monitoring study to assess water quality in ecological subregion 71i (Inner Nashville Basin). Probabilistic monitoring is the random selection of sites to conduct water quality investigations to get an idea of overall water quality in a given area. This study consisted of monitoring 50 sites in six watersheds for chemical, biological and bacteriological conditions (TDEC, 2000).

Thin soil, karst limestone, intermittent surface streams, and cedar glades characterize the 71i Inner Nashville Basin.

Level IV sub-ecoregion 71i, the Inner Nashville Basin, is located east of Nashville between Old Hickory Lake and the Duck River. This is one of the fastest growing areas of the state including parts of Franklin, Lebanon and Murfreesboro. The Inner Nashville Basin is one of five sub-ecoregions of the Interior Plateau. Six major watersheds are located in this subregion: Old Hickory and Cheatham Reservoirs (both impoundments of the Cumberland River), Stones River, Harpeth River, and Upper and Lower Duck River.

Cedar Creek, a typical Inner Nashville Basin (71i) stream. This photo illustrates one of the common water quality problems in Tennessee, direct access by cattle to streams. (Photo provided by Debbie Arnwine, Planning and Standards.)

Streams in this area are typically low gradient with bedrock substrate although a few streams have cobble substrate with riffle areas. Many streams do not have year round flow. Even in natural conditions, habitat for aquatic life is poor.

Chemical, physical, and biological samples were collected at the 50 test sites and two reference sites between January 2000 and June 2001 (Figure 22). The information obtained from this study was compared to ecoregion reference site data and the existing historical monitoring sites.

Objectives of the 71i Probabilistic Monitoring Project are as follows:

1. Characterize water quality at each of the probabilistic monitoring stations. Document violations of water quality standards and determine the degree of support of designated uses. Determine likely sources of pollutants in impacted segments.

2. Extrapolate probabilistic data to the entire sub-ecoregion, providing data for the development of the statewide assessment report. (However, it should be noted that extrapolated data should not be used for 303(d) listing purposes, except for the specific sites monitored.)

3. Compare water quality assessment information extrapolated from probabilistic sampling to historical assessments within 71i to provide a sense of the accuracy of historical targeted monitoring efforts.

4. Determine if the Division's reference streams in ecoregion 71i were appropriately selected. If superior sites are identified through random sampling, the data from those sites could be substituted for existing ecoregion reference sites.

5. Develop assessment methodologies to distinguish naturally occurring environmental stresses in the Inner Nashville Basin from those caused by pollutants, land use and/or other outside factors.

6. Determine if a direct correlation between macroinvertebrate populations and nutrient levels can be measured in this subregion. Test proposed biological and nutrient criteria.

Findings of the first five objectives have already been published (Arnwine and Denton, 2002). All samples have been analyzed except for the May/June 2001 macroinvertebrate samples. Results have been included in the watershed assessment portion of this report. The final data reduction and interpretation is scheduled to be published in 2003.

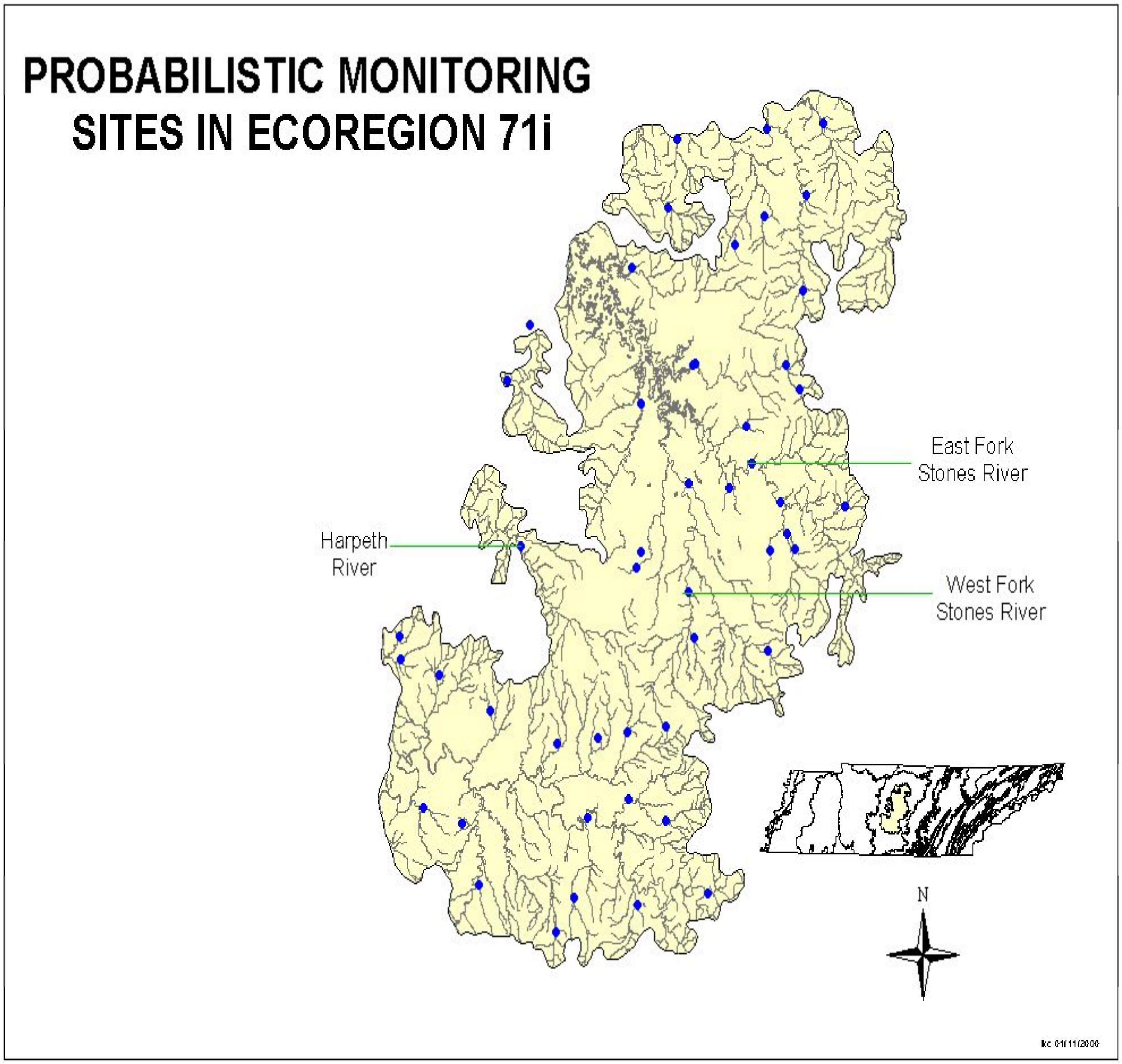


Figure 22: Probabilistic Monitoring Sites in Ecoregion 71i.

XIII. Watershed Management Approach

Ecoregions serve as a geographical framework for establishing regional water quality expectations. The watershed approach serves as an organizational framework for systematic assessment of the state's water quality problems. By viewing the entire drainage area or watershed as a whole, the Department is better able to address water quality problems through an organized systematic cycle. This unified approach affords a more in depth study of each watershed and encourages coordination of public and governmental organizations. The watersheds are addressed on a five-year cycle that coincides with permit issuance.

A. Watersheds and Ecoregions

The same year the ecoregion monitoring started in 1996, the Division adopted a new way to organize stream assessments called the Watershed Management Approach. This is a framework to organize stream assessments and pollution control measures. It coordinates public and government pollution prevention programs as well as stream assessment and plant inspections. This format organizes streams into major drainage areas called watersheds. The United States Geological Service, USGS, has identified 54 watersheds in Tennessee.

A geographic are that drains to a common outlet is called a watershed.

Rainwater runs downhill picking up soil, trash, pesticides, oil, and other pollutants. The water drains into small streams that flow into larger streams and eventually into rivers or reservoirs. A geographic area that drains to a common outlet, such as a point on a larger river or lake, underlying aquifer, estuary wetland or ocean is called a watershed. By considering the entire watershed, pollution sources can be addressed before they become a problem in the receiving stream.

Water drains from the highest elevations in a watershed down to the receiving river or reservoir crossing different geographical ecoregions. Therefore, each watershed contains several ecoregions and each ecoregion crosses several watersheds. The water quality expectations are based on the ecoregion the river or stream is located in. The monitoring year is determined by which watershed a stream or river is located in.

B. Watershed Cycle

The 54 watersheds have been divided into five monitoring groups for assessment purposes (Figure 23 and Table 12). One watershed group is assessed each year. This allows intense monitoring of a limited number of watersheds each year with all watersheds to be monitored every five years. The group four and group five watersheds have been intensely monitored in the two years covered by this report.

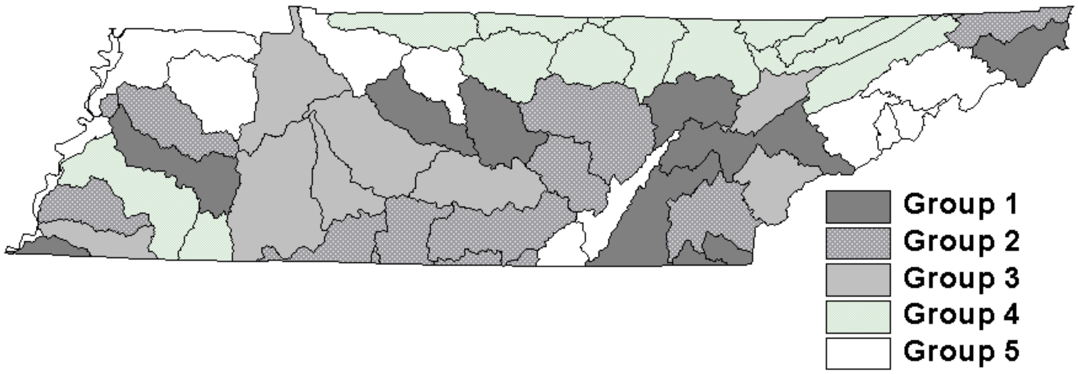


Figure 23: Watershed Cycle Monitoring Groups

The five-year watershed cycle provides for a logical progression from data collection and assessments through TMDL development and permit issuance (Figure 24). The watershed cycle coincides with the discharge permits that are issued to industries. The key activities involved in each five-year watershed cycle are as follows:

1. **Planning and Data Collection**- Existing data and reports from appropriate agencies and organizations are compiled and used to describe the quality of the rivers and streams.

2. **Monitoring** – Field data is collected for key streams in the watershed. These data will supplement existing data and are used for water quality assessment.

3. **Assessment** – Monitoring data is used to determine if the streams support their designated uses.

4. **Wasteload Allocation/ Total Maximum Daily Load (TMDL)** – Monitoring data is used to determine pollutant limits for permitted dischargers releasing wastewater to watershed. Limits are set to assure that state water quality is protected. The TMDL program locates the continuing pollution problems in the state and then identifies how to correct the problem. The Total Maximum Daily Load is a sum of all the pollution sources plus a margin of safety.

TMDL = non-point source + point source + margin of safety

The five steps of the TMDL process are as follows:

a. Identify water quality problems.
b. Prioritize water quality problems.
c. Develop TMDL plan.
d. Implement water quality improvement actions.
e. Assess water quality improvement actions.

5. **Permits** – Issuance and expiration of all discharge permits are synchronized based on watersheds. Approximately 1700 permits have been issued in Tennessee under the federally delegated National Pollutant Discharge Elimination System (NPDES).

6. **Watershed Management Plans** – These plans will include information for each watershed including general watershed description, water quality goals, major quality concerns and issues and management strategies.

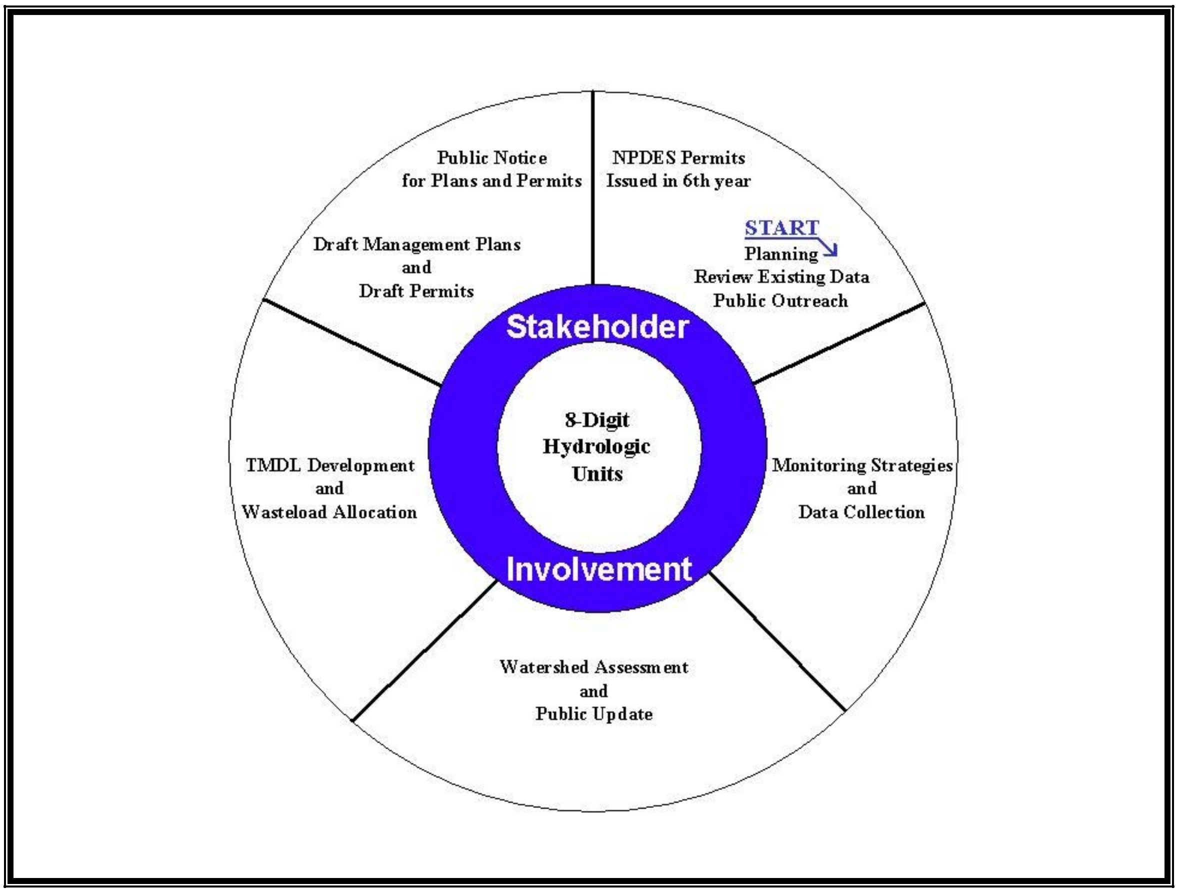


Figure 24: Watershed Cycle

One of the advantages of this approach is that it considers all sources of pollution including discharges from industries and municipalities as well as runoff from farms and cities. Another advantage of the unified approach is the coordination of local, state, and federal agencies and the encouragement of public participation.

Table 12: Watershed Groups

	Monitoring Years	West Tennessee	Middle Tennessee	East Tennessee
Group 1	1996 2001 2006 2011 2016	➢ Nonconnah ➢ South Fork of the Forked Deer	➢ Stones ➢ Harpeth	➢ Watts Bar* ➢ Ocoee ➢ Emory* ➢ Watauga ➢ Conasauga
Group 2	1997 2002 2007 2012 2017	➢ Loosahatchie ➢ North Fork Forked Deer ➢ Forked Deer	➢ Collins ➢ Caney Fork ➢ Wheeler Res. ➢ Upper Elk ➢ Lower Elk ➢ Pickwick Res.	➢ Hiwassee ➢ Fort Loudoun* ➢ South Fork Holston
Group 3	1998 2003 2008 2013 2018	➢ Wolf ➢ Upper Kentucky ➢ Lower Kentucky	➢ Upper Duck ➢ Lower Duck ➢ Buffalo	➢ Lower Tennessee ➢ Little Tennessee* ➢ Lower Clinch* ➢ North Fork Holston ➢ South Fork Holston
Group 4	1999 2004 2009 2014 2019	➢ Lower Hatchie ➢ Upper Hatchie	➢ Red ➢ Barren ➢ Cumberland (Old Hickory Reservoir) ➢ Upper Cumberland (Cumberland Lake) ➢ Upper Cumberland (Cordell Hull) ➢ Obey	➢ South Fork Cumberland* ➢ Upper Cumberland* ➢ Powell* ➢ Upper Clinch* ➢ Holston* ➢ Lower Tennessee ➢ Clear Fork
Group 5	2000 2005 2010 2015 2020	➢ Mississippi ➢ Lower Obion ➢ South Fork Obion	➢ Barkley Reservoir ➢ Cheatham Reservoir ➢ Guntersville Reservoir	➢ Sequatchie ➢ Upper French* ➢ Lower French* ➢ Pigeon* ➢ Nolichucky

*These watersheds are monitored the following year.

XIV. Public Participation

Everyone contributes pollution every day in large or small ways. Often a careless or thoughtless act results in far reaching damage. By understanding how pollution impacts our world and what each of us can do to reduce pollution, collectively we can make a difference in Tennessee and the world.

Get Involved

Politicians care about your thoughts and your votes, so let your voice be heard. Environmental laws encourage public participation. Insist that environmental issues be considered in the local planning process.

Find out which watershed you live in and attend TDEC's watershed meetings. Watershed meetings are held in the third and fifth years of the watershed cycle.

The meeting dates and times are posted on our website at:

http://www.state.tn.us/environment/news/ppo

Reduce, Reuse, and Recycle

Whenever possible recycle metal, plastic, cardboard and paper, so it can be reused to make new products. Always dispose of toxic materials properly. Most auto parts stores and many service stations collect used motor oil and auto batteries for recycling. Most counties have annual toxic waste collection days for old paints, pesticides, and other toxic chemicals. Check with your local waste management service for specific dates and times.

Conserve water and electricity both at home and at work. Every gallon of water that enters the sewer must be treated. The production of energy uses natural resources and produces pollution. You will not only prevent pollution, but also save money.

For further information on pollution prevention please see the website.

http://www.state.tn.us/environment

Be Part of the Solution, Not Part of the Problem

1. **Dispose of chemicals properly**

   Always dispose of toxic chemicals properly. Never pour oil, paint, or other leftover toxic chemical on the ground, in a sinkhole, or down a drain. If you have a septic system check it periodically to make sure it is functioning correctly to protect surface and ground water.

2. **Use chemicals properly**

   Use all chemicals, especially lawn chemicals, exactly as the label instructs. Every year millions of pounds of fertilizer and pesticides are applied to crops and lawns. Much of the fertilizer and pesticides applied to vegetation is carried by rainwater to streams and reservoirs. Over application of fertilizers and pesticides wastes money, risks damage to vegetation, and pollute waterways. Therefore use all chemicals, especially lawn chemicals, cautiously.

3. **Prevent erosion and runoff**

   It is important for farmers and loggers to work closely with the Department of Agriculture (TDA) personnel to prevent erosion and runoff pollution. TDA can help implement Best Management Practices (BMP's) to reduce soil loss and prevent pollution of streams. Never buy gravel or rocks that were illegally removed from streams.

4. **Obtain a permit**

   Contractors wishing to alter a stream or wetland need to obtain a permit from the TDEC, Aquatic Resource Alteration Permit (ARAP) section. Additionally, construction sites must be covered under a General Permit for the Discharge of Stormweater for a Construction Activity. Coverage can be obtained by contacting the local TDEC EAC office.

   A work site must be properly stabilized to avoid erosion. All silt retention devices must be properly installed to protect a site from soil loss and streams from siltation. If you hire anyone to do any work around a stream make sure the contractor has obtained the proper permits and knows how to protect the stream. The landowner is ultimately responsible for any work done on his land.

Although this report is on surface waters in Tennessee we are concerned about all pollution. Given enough time, all pollution ends as water pollution. Air pollution eventually settles out or falls out as rain and enters streams. Buried waste seeps into ground or surface water. So properly dispose of all waste. Never burn toxic materials like tires or oil. Keep your car properly tuned and in good condition.

Report Pollution

The public is the main source of information on pollution. If you see pollution, please let us know. Most people in Tennessee are only a phone call away from their local office of the Division of Water Pollution Control. A map of Tennessee's Environmental Assistance Centers (EAC) appears on the next page. If your EAC is not a local call, please use our toll free number that will connect you to your nearest office.

Call your local Environmental Assistance Center. See the map on the next page.

Or

If your local EAC is a long distance phone call, please call toll free.
1-888-891-TDEC
1-888-891-8332

You may also contact the Division by leaving a message on our website.

http://www.state.tn.us/environment

One of the most important sources of information about water quality problems are citizens. When a call is received Division staff investigate the complaint and attempt to identify the source of the pollution. If the polluter is identified, enforcement action will be taken.

If you see one of our staff members performing a stream survey, stop and talk. We will be happy to show you what we are doing. In fact, you may be able to help us answer some questions.

If you see any of the following problems please call.

More than just a few dead fish in a stream or lake.

Someone pumping a liquid from a truck into a stream (especially at night).

Unusual colors, odors, or sheen in a stream or lake.

Construction activities without proper erosion control (silt fences, hay bales, matting).

Bulldozers or backhoes in a stream removing gravel or rocks.

Groups of people removing rocks from streams, especially on the Cumberland Plateau.

Sewage pumping stations discharging directly or indirectly into a stream.

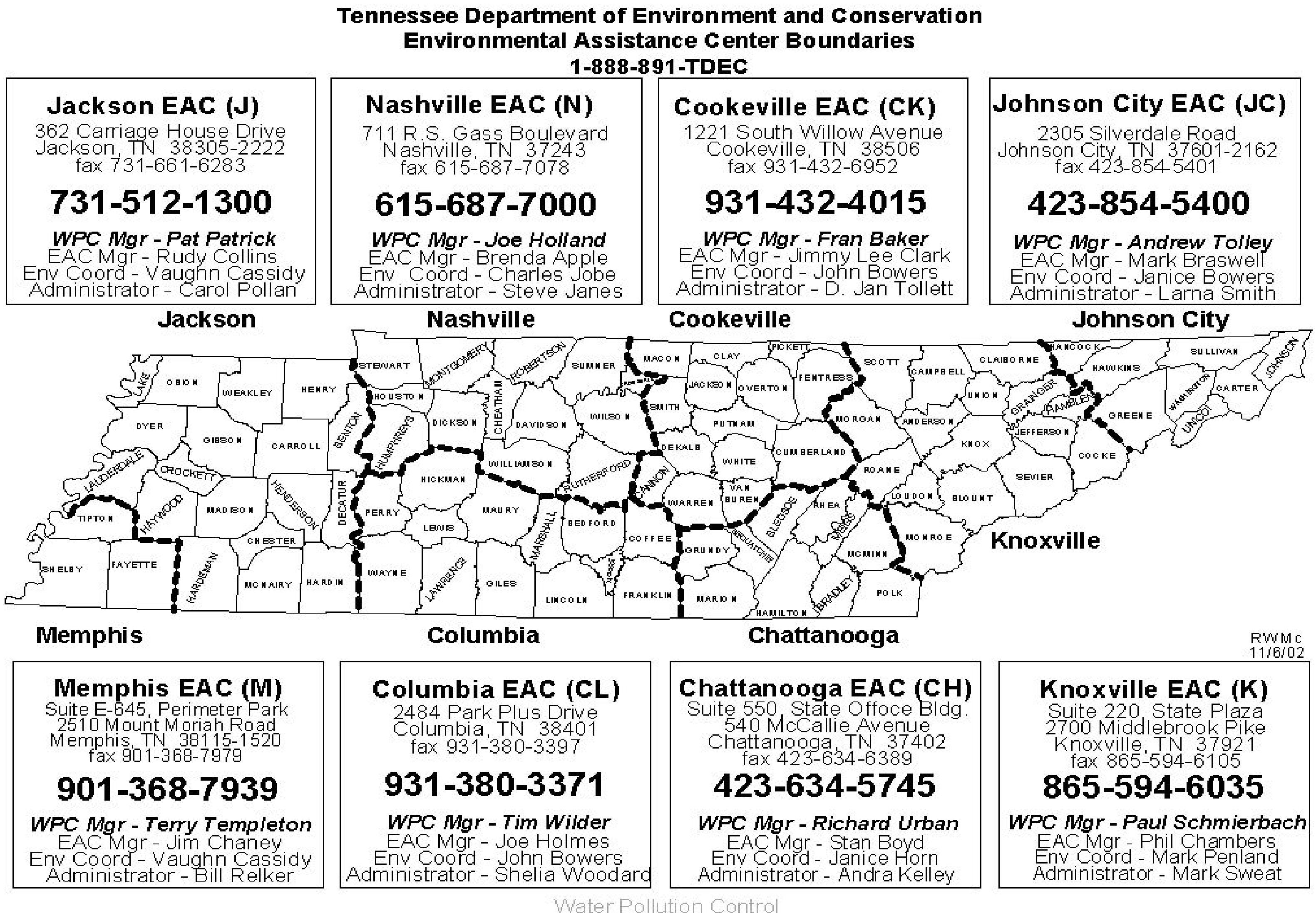


Figure 25: TDEC Environmental Assistance Center Boundaries

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Detailed Watershed Information

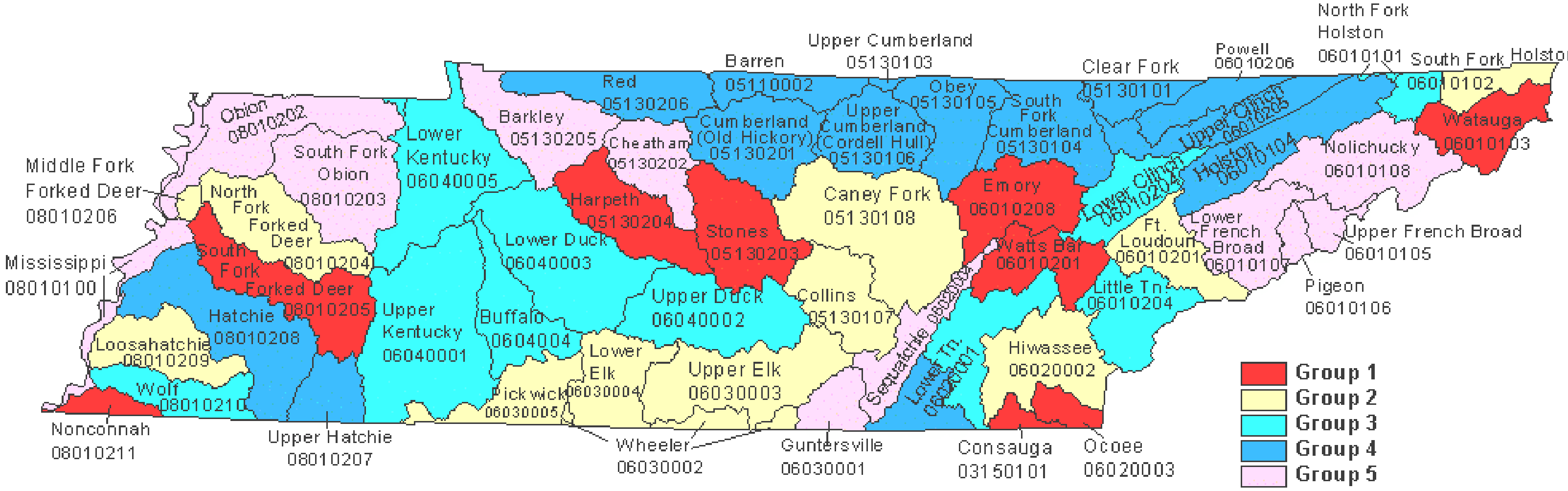

Figure 26: Watersheds of Tennessee

Introduction

This chapter of the 2002 305(b) Report contains specific information on each of Tennessee's 54 watersheds. The U.S. Geological Service (USGS) has assigned an eight-digit hydrological unit code (HUC) to each watershed in the country. Fifty-four of these watersheds are wholly or partially contained within the State of Tennessee (Figure 26).

Each watershed description includes a water quality map, watershed statistics, a graph of support status of assessed rivers and streams, and a general discussion of water quality.

Programs to Restore Water Quality

The 54 watersheds in Tennessee have been organized into five groups to systematically approach water quality issues (Figure 26). This watershed management approach coordinates public and government pollution prevention programs as well as stream assessments, plant inspections, and permit issuance.

By viewing the entire drainage area as a whole, the Department is better able to address water quality problems. This unified approach affords a more in depth study of watersheds and encourages coordination of public and governmental parties.

Each year every watershed group is in a different phase of the watershed cycle. Therefore, on a five-year rotation all watersheds are monitored, assessed, Total Maximum Daily Loads (TMDLs) are developed, and National Pollutant Discharge Elimination System (NPDES) permits are issued. The watershed management approach is further discussed in Chapter XIII.

Since one watershed group is assessed each year, this allows intense monitoring of 20 percent of the state's watersheds each year. Therefore all 54 watersheds are assessed every five years. The first five-year assessment cycle has been completed.

Programs to Assess Water Quality

The information used to assess each of these waterways came from a variety of sources. The majority of the information came from TDEC's Division of Water Pollution Control (WPC). Additional information was furnished in some watersheds by various other government agencies, universities, consultants, NPDES permit holders, and the private sector.

The number of monitoring stations is included in the atlas for each watershed. See Chapter V for specific information on other data sources. Specific information on fish and water contact advisories can be found in Chapter IX.

Additional Assessment Information

The waters listed as impaired in each watershed can be found in the 2002 303(d) List. The 2002 303(d) List also provides information on streams that have shown water quality improvement and have been removed from the 303(d) List in Appendix A.

Appendix C in the 2002 303(d) List identifies streams where TMDLs have been completed and approved by EPA.

Endangered species information can also be found in 2002 303(d) List, Appendix D.

To view the 2002 303(d) List go to the Department's website at:

http://www.state.tn.us/environment

A map illustrating the support status of rivers, streams and reservoirs in each watershed is included in the individual watershed descriptions. Color maps illustrating water quality in each watershed can also be viewed on the Department's website at:
http://www.state.tn.us/environment/wpc/watershed/mapsummary.

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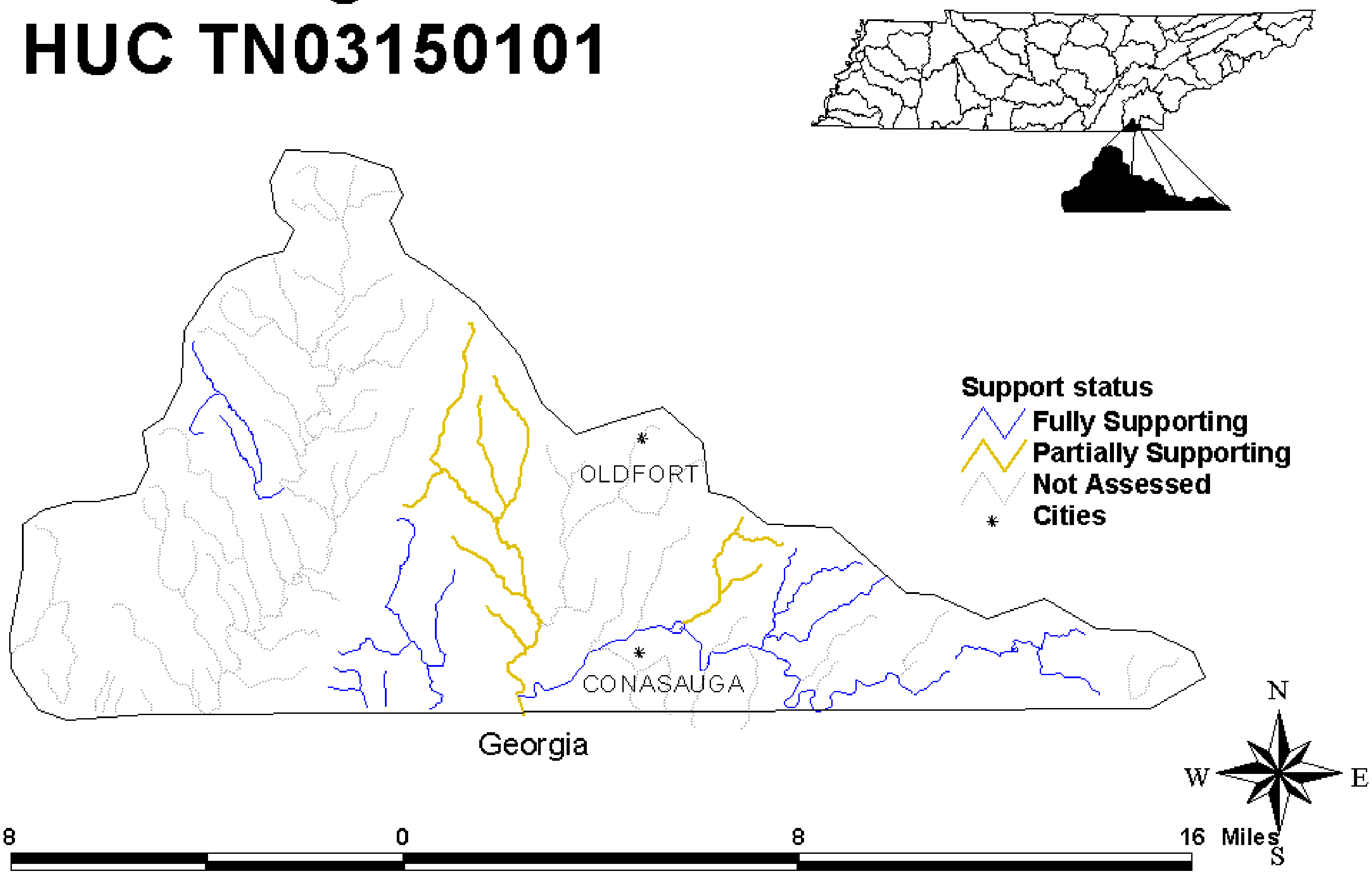
Conasauga River Watershed
HUC TN03150101



Conasauga Watershed Atlas

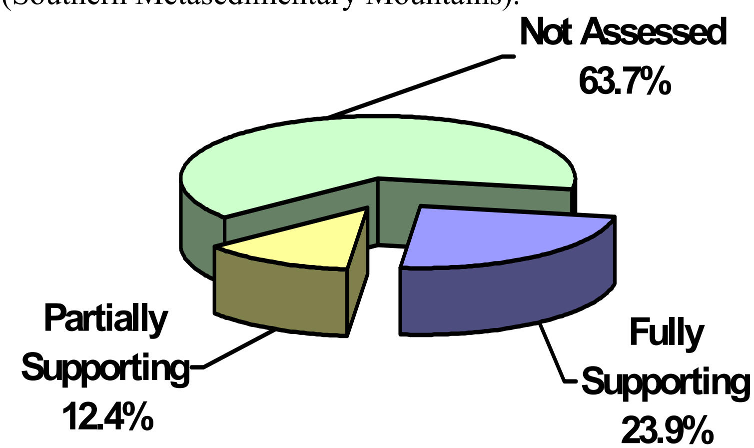
HUC Code:	**TN03150101**
Counties:	Bradley Polk
Ecoregions:	66g 67f 67g 67i
Drainage Size of Watershed:	124 square miles
Stream Miles in Watershed:	201.7
Stream Miles Fully Supporting:	48.3
Stream Miles Partially Supporting:	25.1
Stream Miles Not Supporting:	0.0
Stream Miles Not Assessed:	128.3
Lake Acres in the Watershed:	None
TDEC monitoring stations:	10
Advisories:	None
Watershed Monitoring Group:	1

Surface Water Quality in Conasauga River Watershed

The Conasauga River Watershed is unique in Tennessee because it does not flow into the Mississippi River but enters the Gulf of Mexico via the Mobile River. Only 17 percent of this watershed is in Tennessee, the remainder is in Georgia.

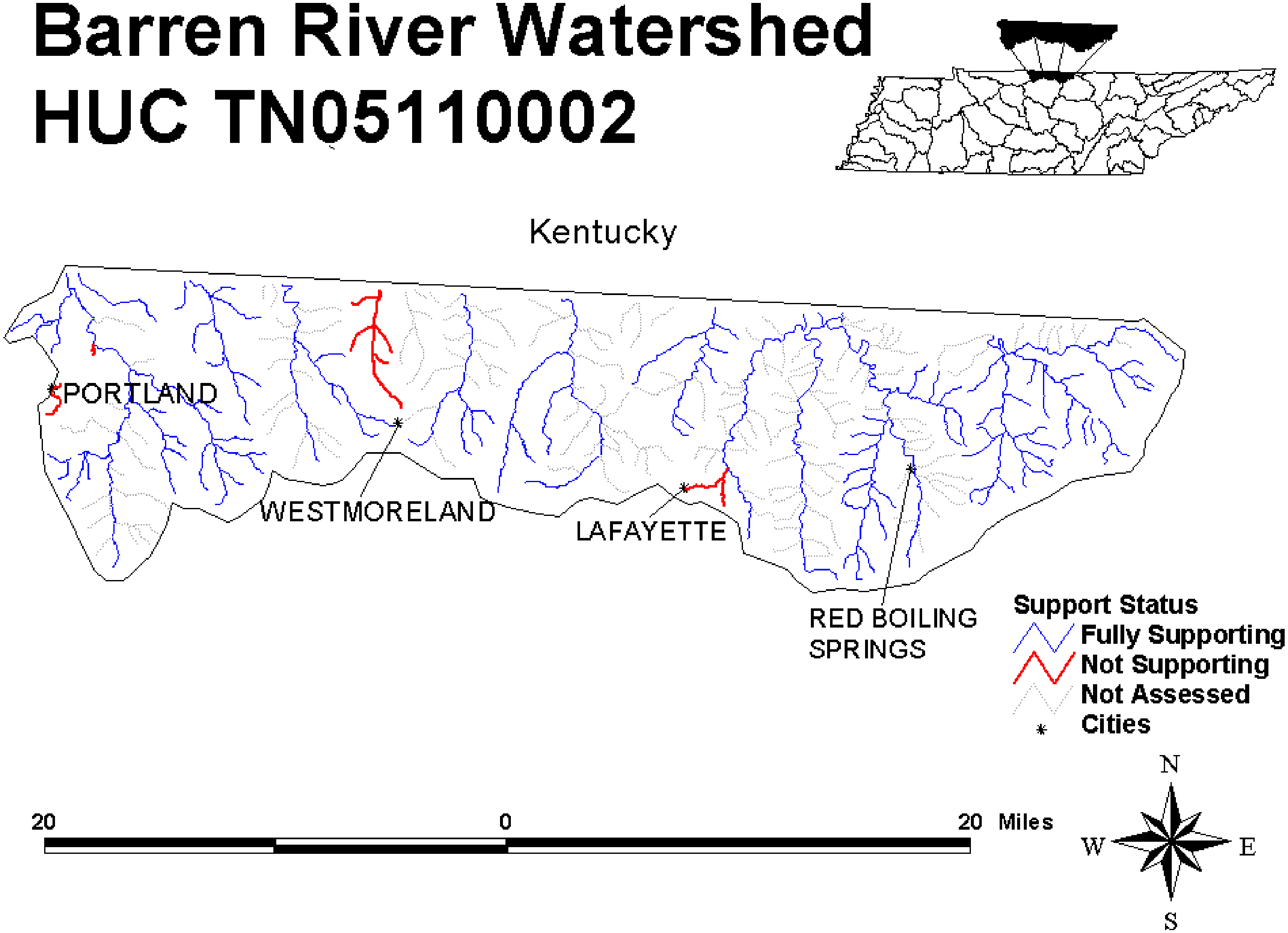
Approximately one third of assessed streams do not meet designated uses due to elevated nutrients and pathogens. Pasture grazing and septic tanks are the main source of the pollution in this rural district.

The General Assembly has designated a portion of the Conasauga River in the Cherokee National Forest as a State Scenic River. This watershed also has one high quality stream that is a subecoregion reference site, Sheeds Creek in 66g (Southern Metasedimentary Mountains).



2002 Assessment of Rivers and Streams in Conasauga River Watershed

Barren River Watershed
HUC TN05110002



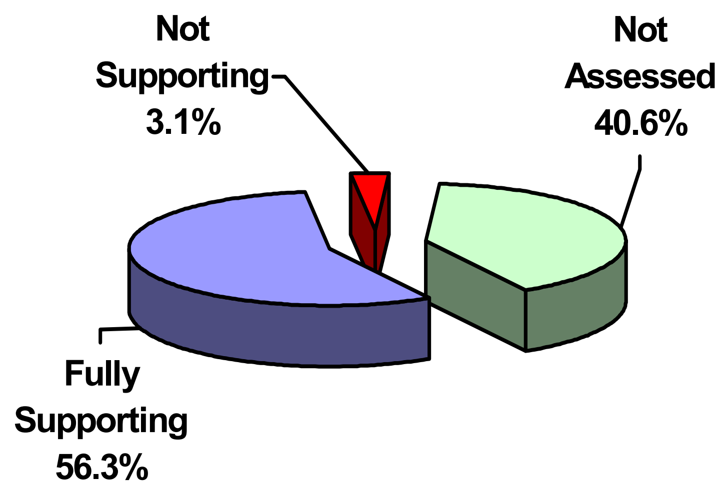
Barren River Watershed Atlas

HUC Code:	**TN05110002**	
Counties:	Clay Macon Sumner	
Ecoregions:	71e 71g 71h	
Drainage Size of Watershed:		413 square miles
Stream Miles in Watershed:		563.2
Stream Miles Fully Supporting:		316.9
Stream Miles Partially Supporting:		0.0
Stream Miles Not Supporting:		17.7
Stream Miles Not Assessed:		228.6
Lake Acres in Watershed:		45
Lake Acres Partially Supporting:		45
TDEC monitoring stations:		60
Advisories:		None
Watershed Monitoring Group:		4

Surface Water Quality in Barren River Watershed

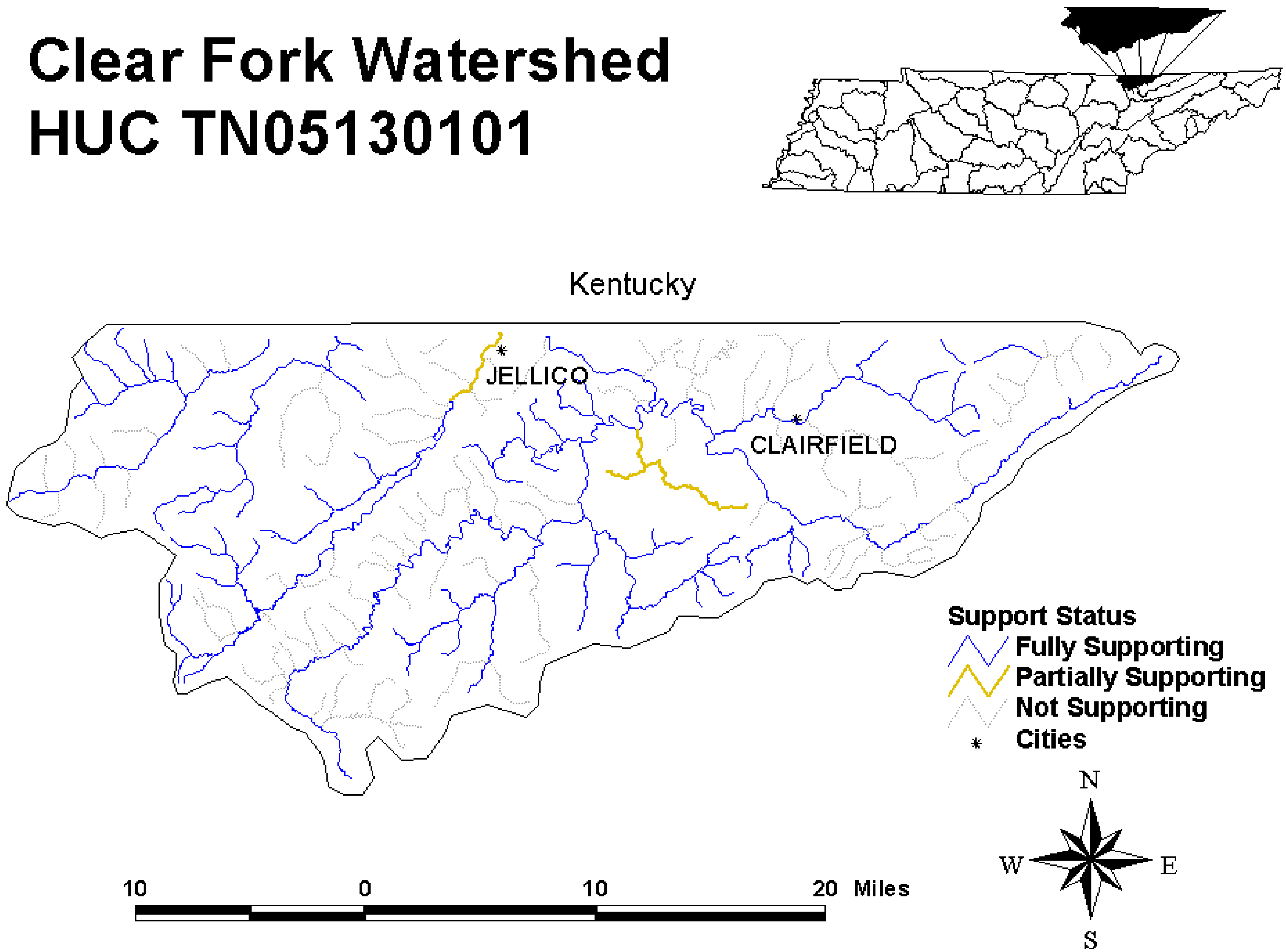
Only 18 percent of the Barren River Watershed is in Tennessee, with the remainder in Kentucky. From Tennessee the Barren River flows north into Kentucky's Green River.

Livestock farms, forests and small towns define land use. Only a small percentage of streams are impaired. Two small municipal lakes (Portland and Westmoreland) are impaired by urban runoff and agriculture. The percentage of assessed stream miles increased by almost 30 percent since the 2000 report with only two additional streams failing to meet designated uses. Two streams, including Middle Fork Drakes Creek (Chapter X) showed improvement.



2002 Assessment of Rivers and Streams in Barren River Watershed

Clear Fork Watershed
HUC TN05130101



Clear Fork Watershed Atlas

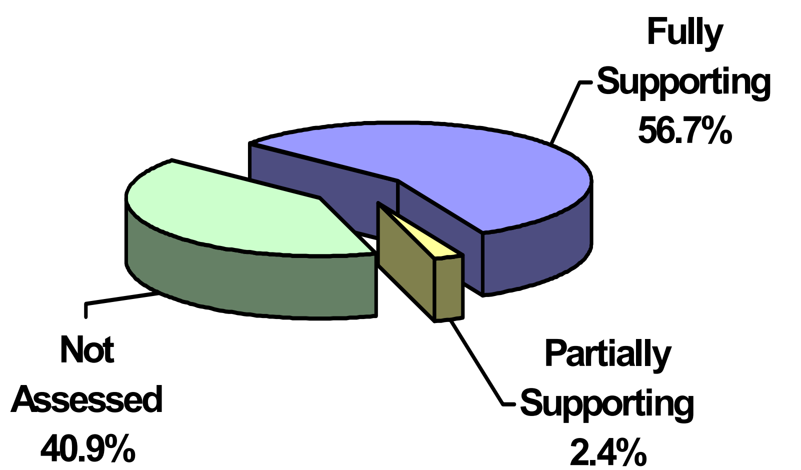
HUC Code:	**TN05130101**	
Counties:	Campbell Claiborne Scott	
Ecoregions:	69d	
Drainage Size of Watershed:		331 square miles
Stream Miles in Watershed:		442.6
Stream Miles Fully Supporting:		250.9
Stream Miles Partially Supporting:		10.6
Stream Miles Not Supporting:		0.0
Stream Miles Not Assessed:		181.1
Lake Acres in Watershed:		None
TDEC Monitoring Stations:		28
Non-TDEC Monitoring Stations:		3
Advisories:		None
Watershed Monitoring Group:		4

Surface Water Quality in Clear Fork Watershed

Only 14 percent of the Clear Fork Watershed is in Tennessee, with the majority of the watershed in Kentucky.

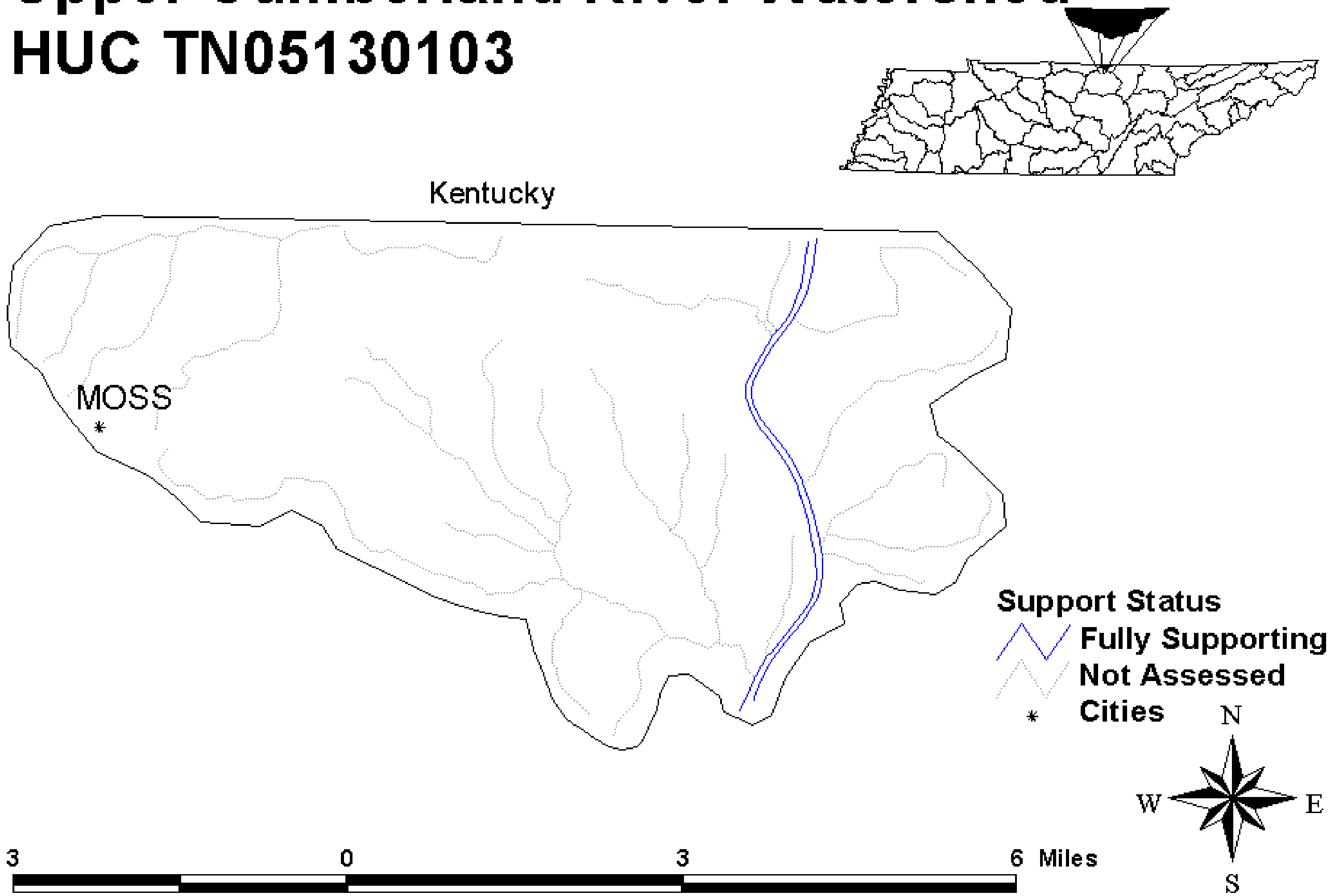
Land use includes farms, timber harvesting, coalmines, some oil and natural gas wells. Fishing is a popular recreational activity. The percent of monitored stream miles has more than doubled since the 2000 report to 59%. Very few miles (2.4%) failed to fully support uses.

This watershed lies totally within a single ecoregion and has two high quality streams that are subecoregion reference sites, No Business Branch and Stinking Creek in 69d (Cumberland Mountains).



2002 Assessment of Rivers and Streams in Clear Fork Watershed

Upper Cumberland River Watershed
HUC TN05130103



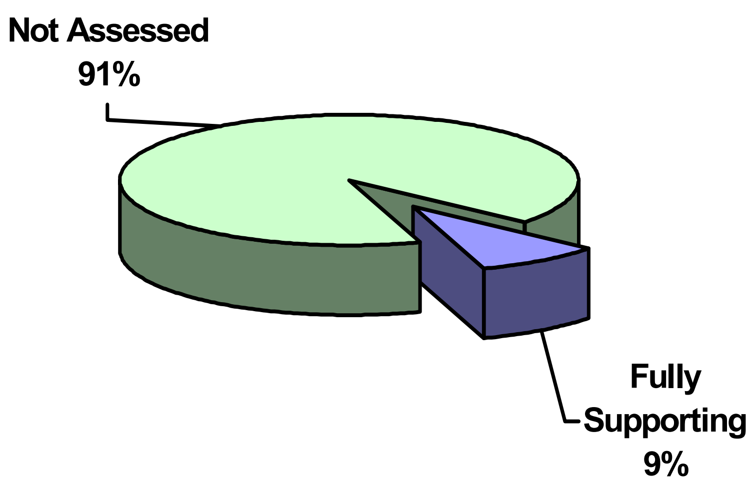
Upper Cumberland River Watershed Atlas

HUC Code:	**TN05130103**
Counties:	Clay
Ecoregions:	71g 71h
Drainage Size of Watershed:	34 square miles
Stream Miles in Watershed:	52.2
Stream Miles Fully Supporting:	4.7
Stream Miles Partially Supporting:	0.0
Stream Miles Not Supporting:	0.0
Stream Miles Not Assessed:	47.5
Lake Acres in Watershed:	None
TDEC Monitoring Stations:	1
Advisories:	None
Watershed Monitoring Group:	4

Surface Water Quality in Upper Cumberland River Watershed

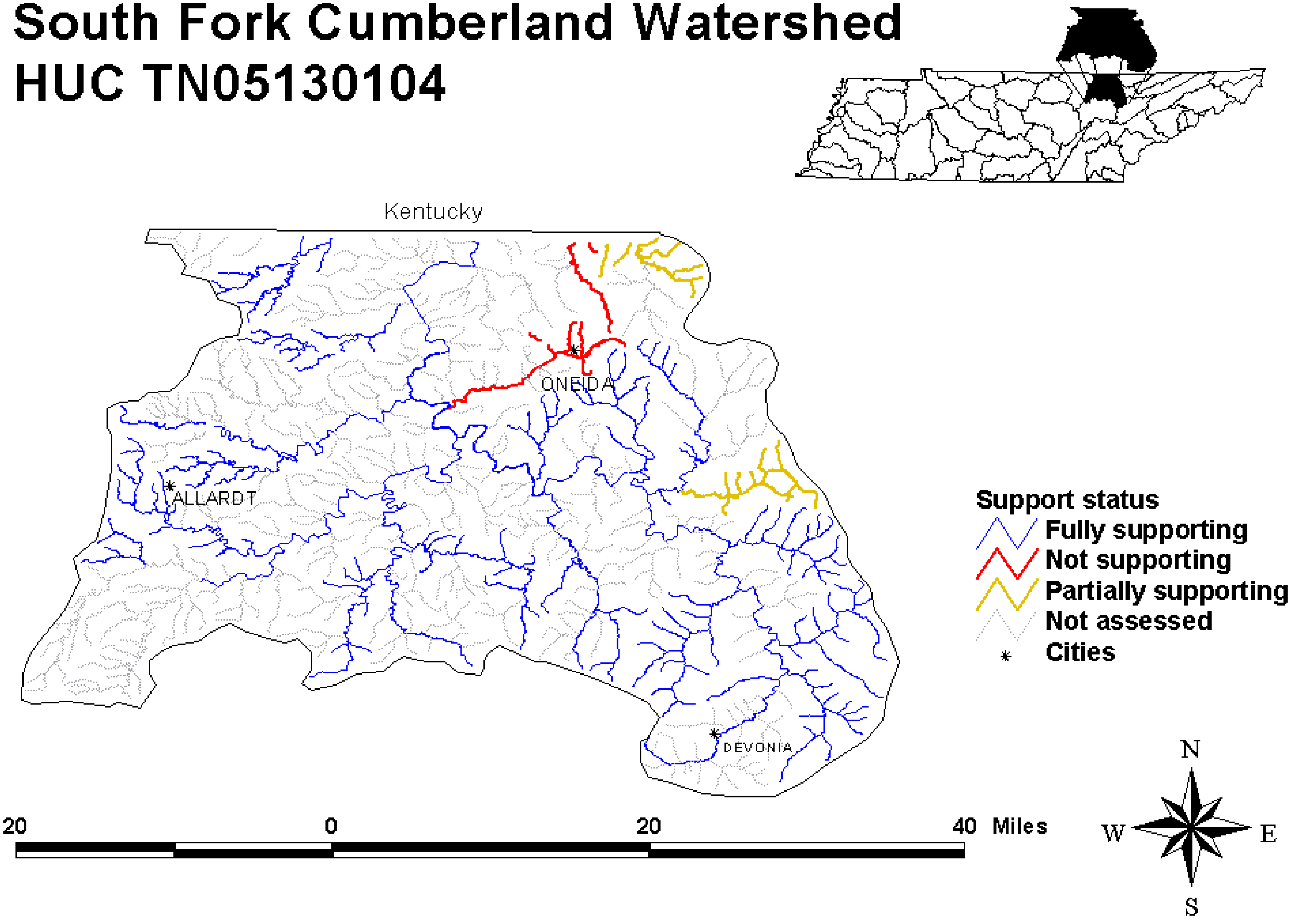
Less than two percent of the Upper Cumberland River Watershed is in Tennessee with the remainder in Kentucky. Boating and fishing are popular on this portion of the Cumberland River.

Additional monitoring was not conducted in this watershed during the Group 4 cycle in 2001 due to the small size of watershed, lack of pollution sources, and limited personnel. Resources were targeted on larger watersheds with more pollution problems. Due to this lack of data, the Division has not assessed the small tributaries in this watershed. The Upper Cumberland River is fully supporting designated uses.



2002 Assessment of Rivers and Streams in Upper Cumberland Watershed

South Fork Cumberland Watershed
HUC TN05130104



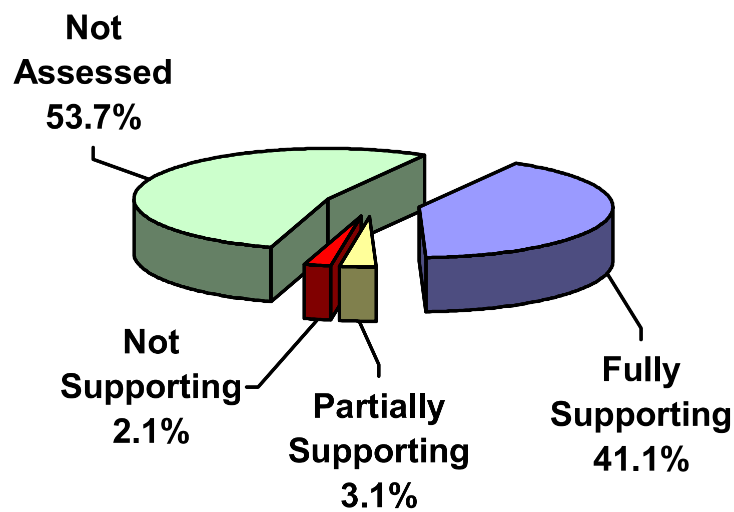
South Fork Cumberland River Watershed Atlas

HUC Code:	**TN05130104**	
Counties:	Anderson	Campbell
	Fentress	Morgan
	Pickett	Scott
Ecoregions:	68a	
	68c	
	69d	
Drainage Size of Watershed:		983 square miles
Stream Miles in Watershed:		1,378.0
Stream Miles Fully Supporting:		566.9
Stream Miles Partially Supporting:		43.3
Stream Miles Not Supporting:		29.5
Stream Miles Not Assessed:		738.3
Lake Acres in Watershed:		5
Lake Acres Partially Supporting:		5 (100%)
TDEC Monitoring Stations:		45
Non-TDEC Monitoring Stations:		2
Advisories:		5
Watershed Monitoring Group:		4

Surface Water Quality in South Fork Cumberland River Watershed

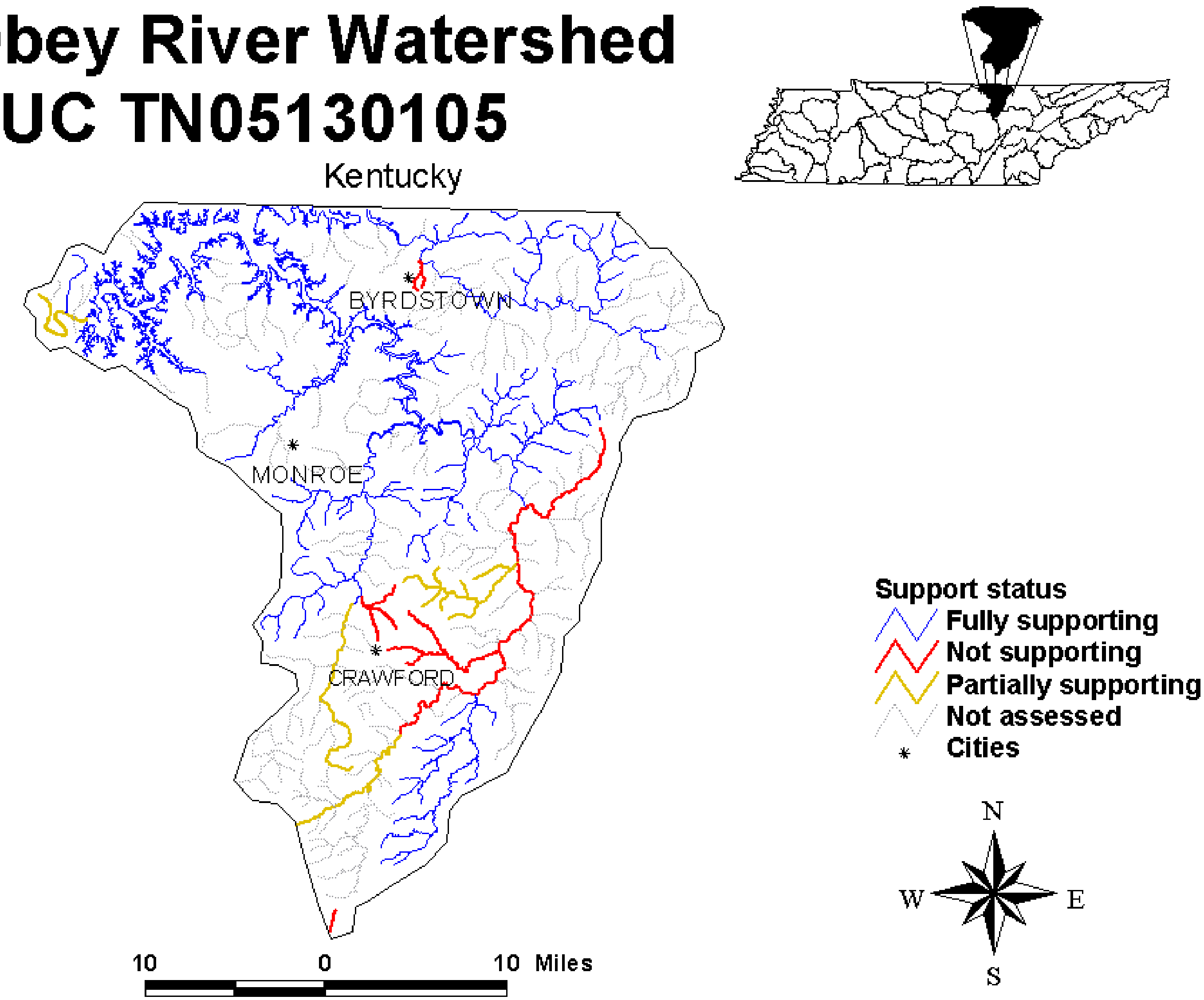
Seventy-two percent of this watershed is in Tennessee with the remainder in Kentucky. Logging, abandoned coalmines, small farms, some oil wells and a national park characterize this watershed.

This watershed has an Outstanding National Resource Water (ONRW), Big South Fork Cumberland River. Four high quality streams are subecoregion reference sites, Rock and Laurel Fork Station Camp Creeks in 68a (Cumberland Plateau) and New River and Round Rock Creek in 69d (Cumberland Mountains).



2002 Assessment of Rivers and Streams in South Fork Cumberland River Watershed

Obey River Watershed
HUC TN05130105



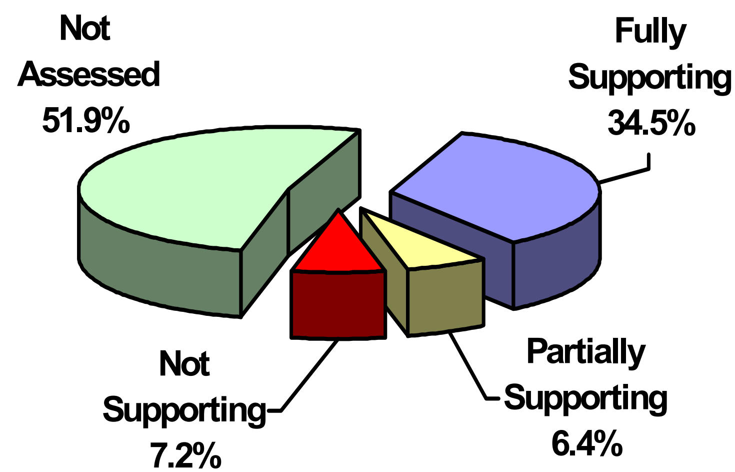
Obey River Watershed Atlas

HUC Code:	**TN05130105**	
Counties:	Clay Fentress Pickett	Cumberland Overton Putnam
Ecoregions:	68a 71g	68c 71h
Drainage Size of Watershed:		779 square miles
Stream Miles in Watershed:		776.4
Stream Miles Fully Supporting:		268.0
Stream Miles Partially Supporting:		49.6
Stream Miles Not Supporting:		56.0
Stream Miles Not Assessed:		402.8
Lake Acres in Watershed:		22,000
Lake Acres Fully Supporting:		22,000 (100%)
TDEC Monitoring Stations:		30
Non-TDEC Monitoring Stations:		8
Advisories:		None
Watershed Monitoring Group:		4

Surface Water Quality in Obey River Watershed (including Dale Hollow Reservoir)

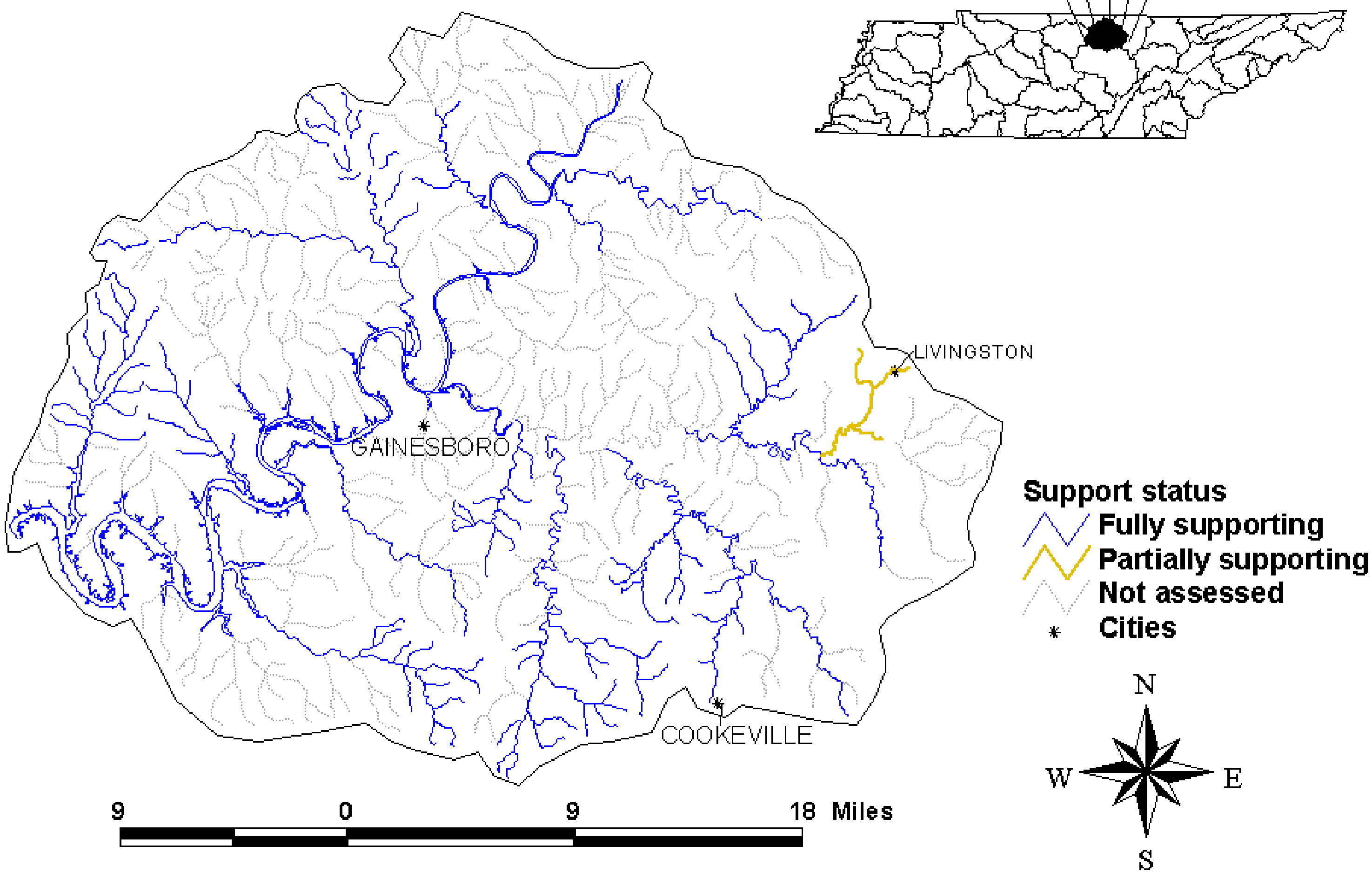
Eighty-three percent of the Obey River Watershed is in Tennessee with the remainder in Kentucky. Dale Hollow Dam (1943) is operated as a hydroelectric plant by the U.S. Army Corps of Engineers (USACE). Dale Hollow is one of the cleanest reservoirs in the state and a popular recreation area in both Kentucky and Tennessee.

Due to increased monitoring data, the percentage of assessed stream miles has increased from 14 percent to 48 percent since the 2000 report. Previous monitoring targeted problem areas in previous assessments, thus, no segments were identified as fully supporting. Additional monitoring has shown that 72 percent of assessed sites are fully supporting.



2002 Assessment of Rivers and Streams in Obey River Watershed

Cordell Hull Reservoir Watershed
HUC TN05130106



Cordell Hull Reservoir Watershed Atlas

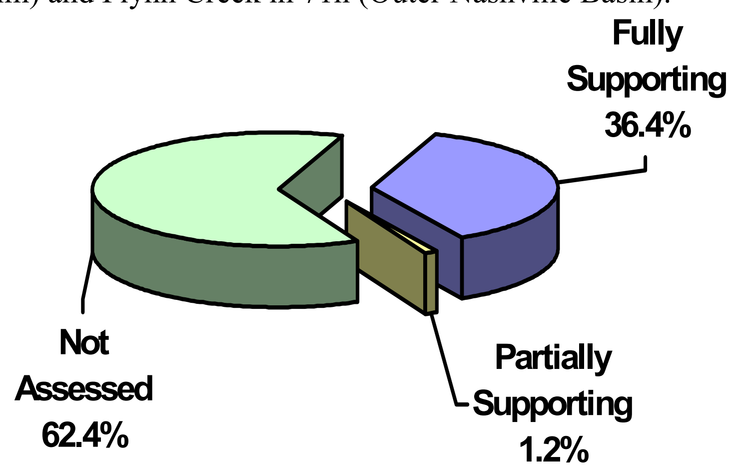
HUC Code:	**TN05130106**	
Counties:	Clay	Jackson
	Macon	Overton
	Putnum	Smith
Ecoregions:	68c	71g
	71h	
Drainage Size of Watershed:		782 square miles
Stream Miles in Watershed:		893.8
Stream Miles Fully Supporting:		325.3
Stream Miles Partially Supporting:		10.7
Stream Miles Not Supporting:		0.0
Stream Miles Not Assessed:		557.8
Lake Acres in Watershed:		13,901
Lake Acres Fully Supporting:		13,901 (100%)
TDEC Monitoring Stations:		30
Non-TDEC Monitoring Stations:		9
Advisories:		None
Watershed Monitoring Group:		4

Surface Water Quality in Cordell Hull Reservoir Watershed

This entire watershed is in Tennessee. The Cordell Hull Lock and Dam on the Cumberland River was completed in 1973 and is operated as a hydroelectric plant by USACE.

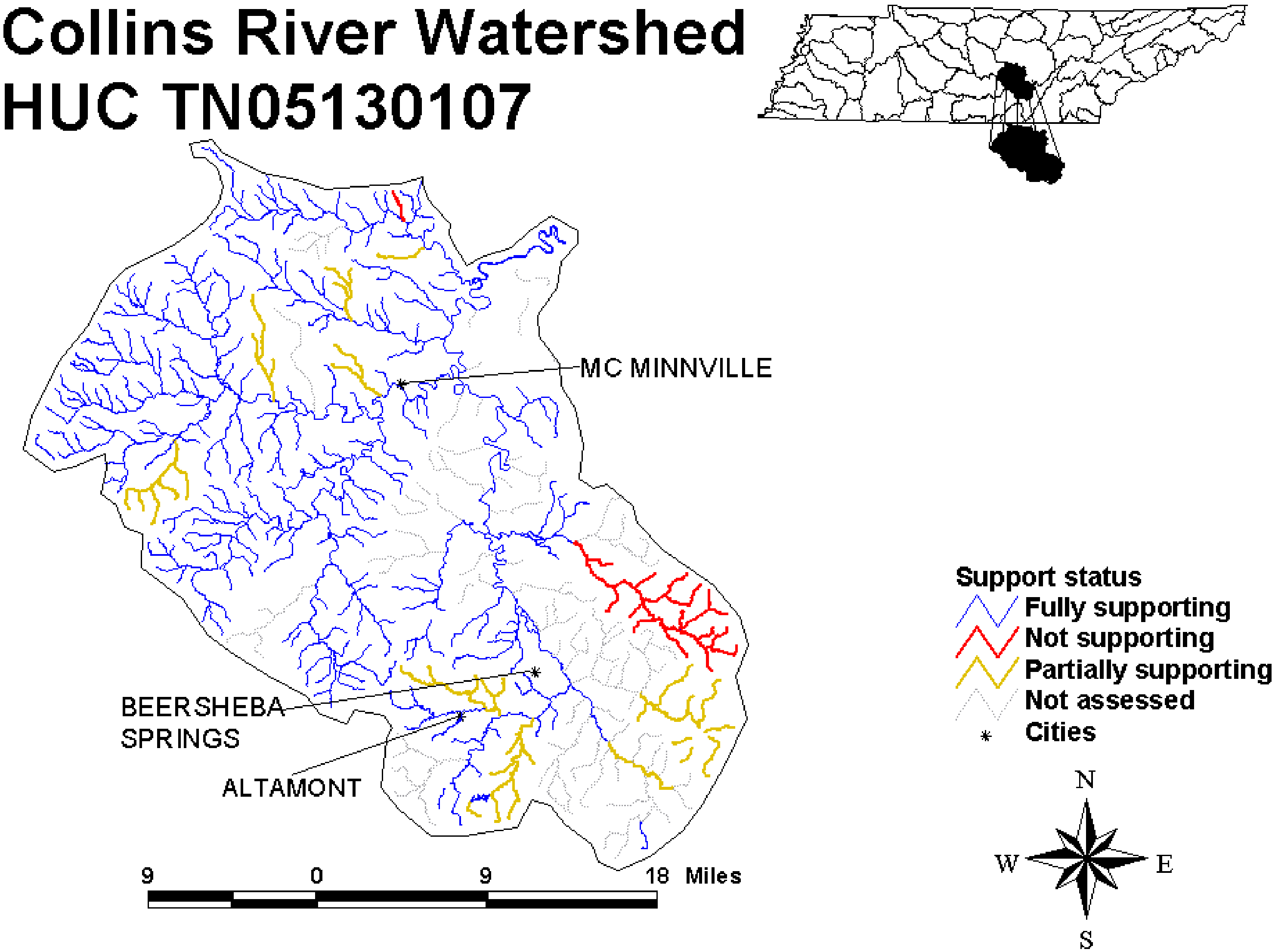
Due to increased monitoring, the percentage of assessed stream miles has risen from 9 percent in 2000 to 38 percent in 2002. The majority of stream miles (97 percent) are fully supporting.

The Tennessee General Assembly has designated three Scenic Rivers in this watershed, Spring Creek, Blackburn Fork, and Roaring River. Three high quality streams are subecoregion reference sites, Flat and Spring Creeks in 71g (Eastern Highland Rim) and Flynn Creek in 71h (Outer Nashville Basin).



2002 Assessment of Rivers and Streams in Cordell Hull Reservoir Watershed

Collins River Watershed
HUC TN05130107



Collins River Watershed Atlas

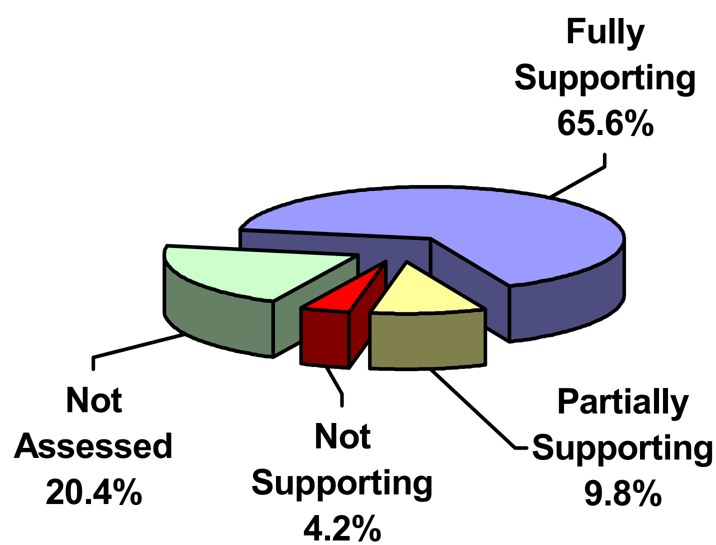
HUC Code:	**TN05130107**	
Counties:	Cannon Grundy Warren	Coffee Sequatchie
Ecoregions:	68a 68c 71g 71h	
Drainage Size of Watershed:	795 square miles	
Stream Miles in Watershed:	1011.5	
Stream Miles Fully Supporting:	662.9	
Stream Miles Partially Supporting:	99.4	
Stream Miles Not Supporting:	42.7	
Stream Miles Not Assessed:	206.5	
Lake Acres in Watershed:	69	
Lake Acres Fully Supporting:	69 (100%)	
TDEC Monitoring Stations:	35	
Non-TDEC Monitoring Station:	1	
Advisories:	None	
Watershed Monitoring Group:	2	

Surface Water Quality in Collins River Watershed

The entire Collins River Watershed is in Tennessee. This watershed primarily drains a rural area. Agriculture and abandoned mines are the primary water quality concerns.

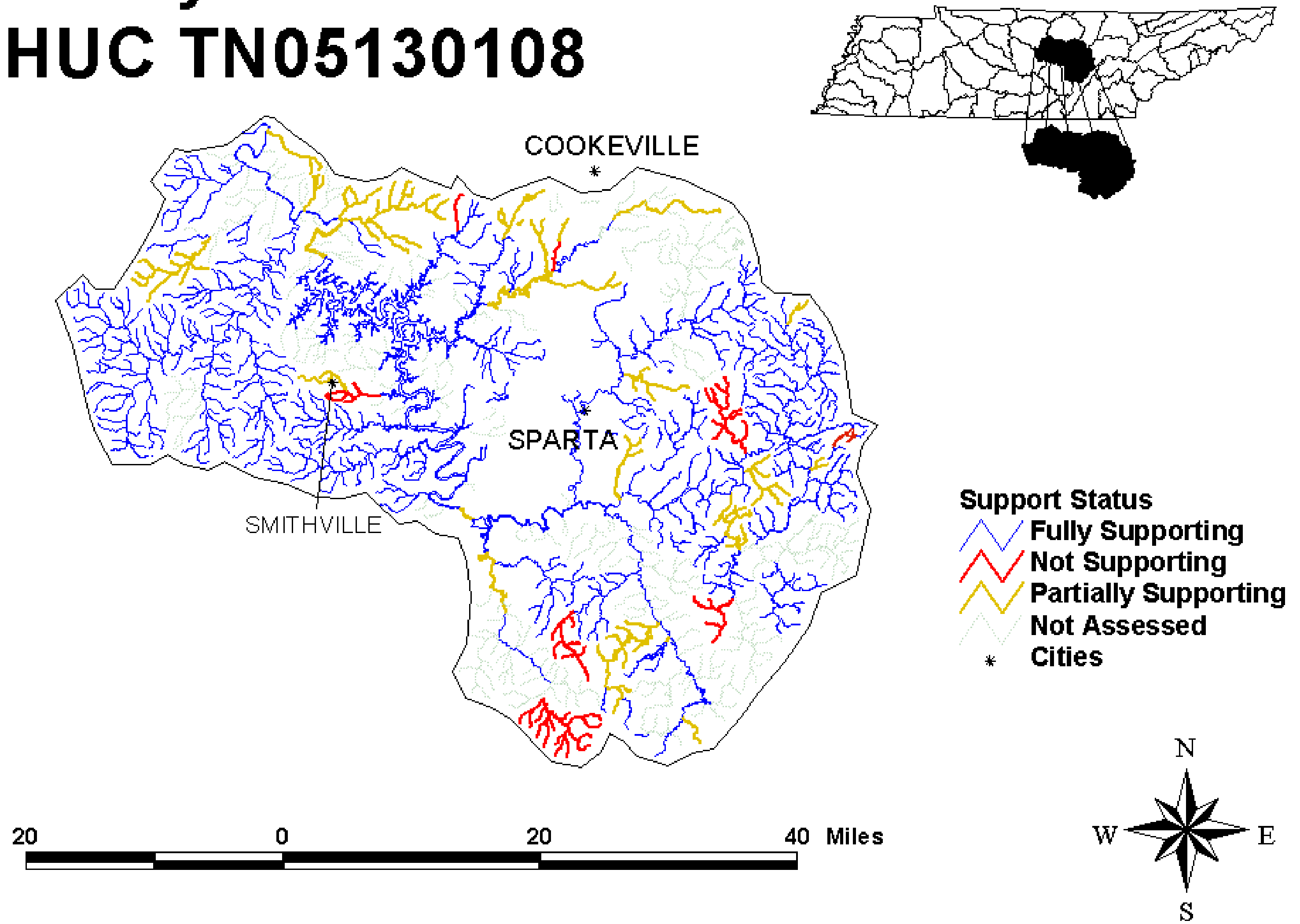
Eighty percent of the stream miles in this watershed were assessed in 2000. Due to the five-year watershed cycle, no additional monitoring data will be available until the 2004 report.

The Tennessee General Assembly has designated the portion of the Collins River that flows through the Savage Gulf State Natural Area as a State Scenic River.



2002 Assessment of Rivers and Streams in Collins River Watershed

Caney Fork River Watershed
HUC TN05130108



Caney Fork River Watershed Atlas

HUC Code: **TN05130108**

Counties:	Bledsoe	Cannon	Cumberland
	DeKalb	Putnam	Smith
	Warren	White	Wilson
	Van Buren		

Ecoregions:	68a	68c
	71g	71h

Drainage Size of Watershed: 1,780 square miles

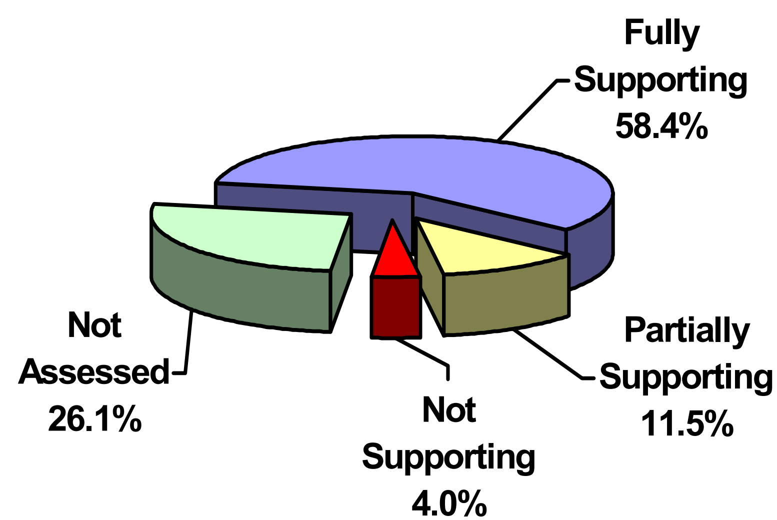
Stream Miles in Watershed:	2,041.5
Stream Miles Fully Supporting:	1,192.8
Stream Miles Partially Supporting:	235.4
Stream Miles Not Supporting:	81.4
Stream Miles Not Assessed:	531.9
Lake Acres in Watershed:	25,887
Lake Acres Fully Supporting:	25,527 (98.6%)
Lake Acres Not Assessed:	360 (1.4%)
TDEC Monitoring Stations:	78
Non-TDEC Monitoring Stations:	11
Advisories:	1
Watershed Monitoring Group:	2

Surface Water Quality in Caney Fork River Watershed (including Center Hill Reservoir)

The entire Caney Fork Watershed is in Tennessee. Two hydroelectric plants are operated in this watershed, Center Hill Reservoir (USACE) and Great Falls Reservoir (TVA).

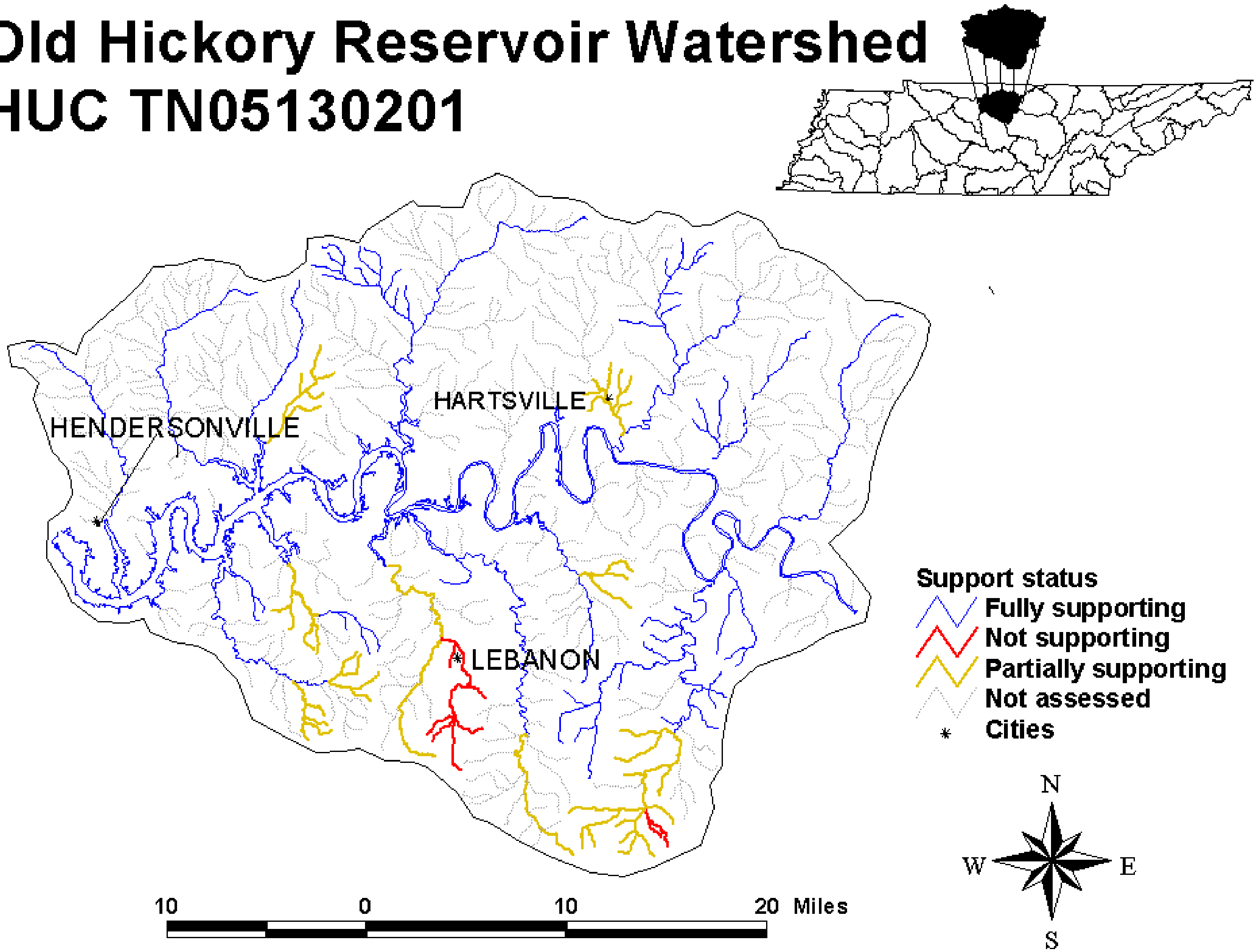
Habitat alteration and siltation due to agricultural activities as well as runoff from abandoned mines are the primary water quality concerns. Urban runoff and sewage treatment plant discharges also cause problems in some streams. Mine Lick Creek has a bacteriological advisory.

This watershed has one high quality stream that is a subecoregion reference site, Clear Fork in 71h (Outer Nashville Basin).



2002 Assessment of Rivers and Streams in Caney Fork River Watershed

Old Hickory Reservoir Watershed
HUC TN05130201



Old Hickory Reservoir Watershed Atlas

HUC Code:	**TN05130201**	
Counties:	Davidson Smith Trousdale	Macon Sumner Wilson
Ecoregions:	71h 71i 71g	

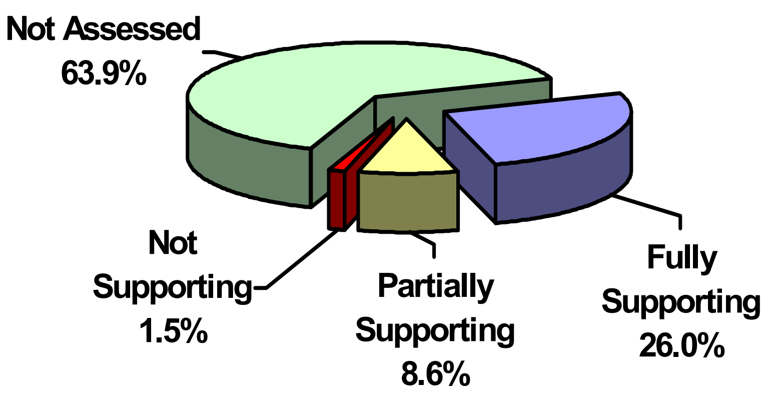
Drainage Size of Watershed:	975 square miles
Stream Miles in Watershed:	1374.3
Stream Miles Fully Supporting:	357.1
Stream Miles Partially Supporting:	118.8
Stream Miles Not Supporting:	21.1
Stream Miles Not Assessed:	877.3
Lake Acres in Watershed:	27,439
Lake Acres Fully Supporting:	27,439 (100%)
TDEC Monitoring Stations:	87
Non-TDEC Monitoring Stations:	16
Advisories:	None
Watershed Monitoring Group:	4

Surface Water Quality in Old Hickory Reservoir Watershed

This entire watershed is in Tennessee. The reservoir is an impoundment of the Cumberland River providing electricity, drinking water, and recreation for nearby metropolitan areas.

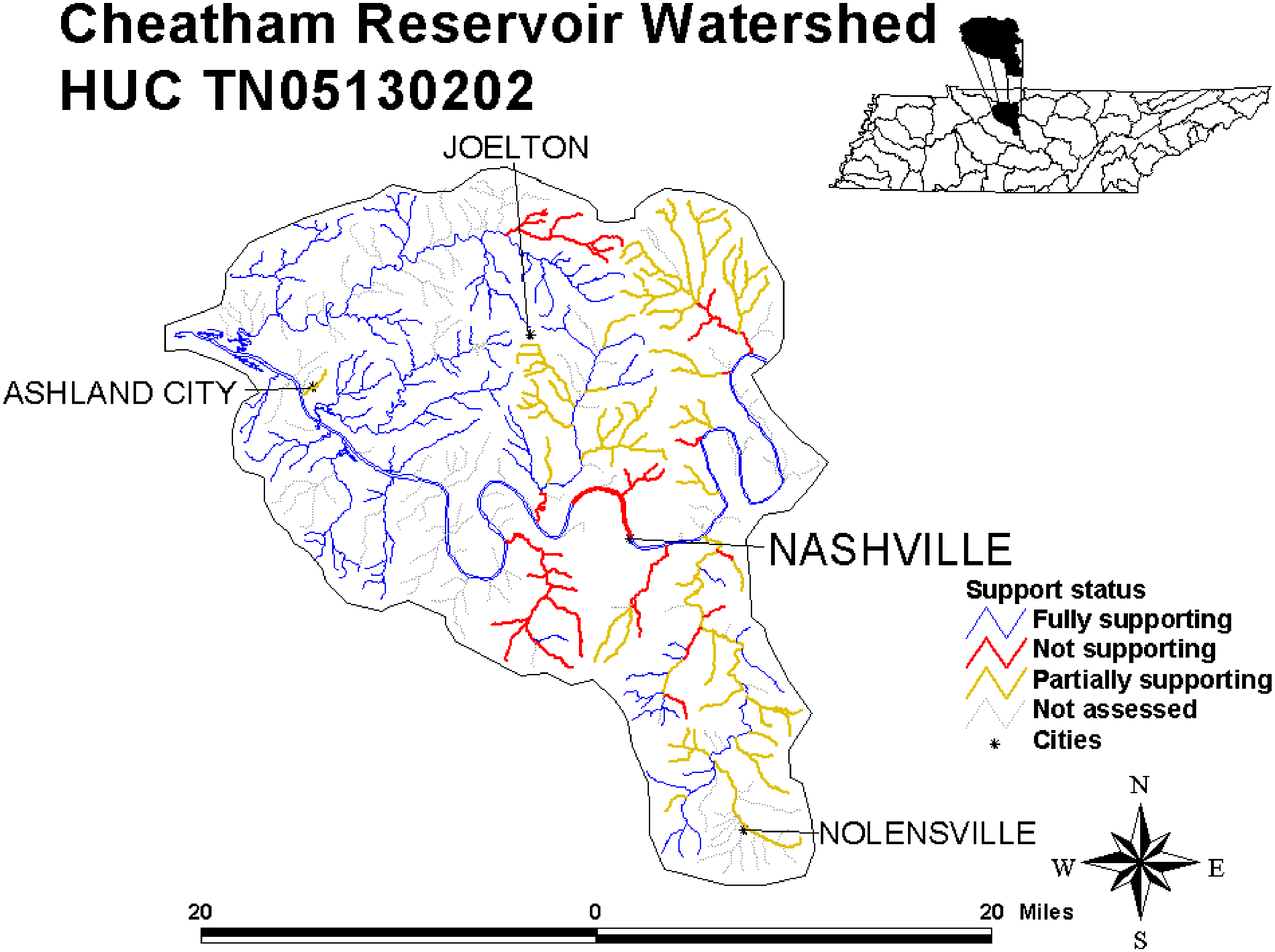
The percent of assessed stream miles has almost tripled from 13 percent in 2000 to 36 percent in this report. In the last two years, additional monitoring sites aimed at a wider range of streams has shown that 71.9 percent of assessed stream are fully supporting.

One high quality stream is a subecoregion reference site, Cedar Creek in 71i (Inner Nashville Basin).



2002 Assessment of Rivers and Streams in Old Hickory Reservoir Watershed

Cheatham Reservoir Watershed
HUC TN05130202



Cheatham Reservoir Watershed Atlas

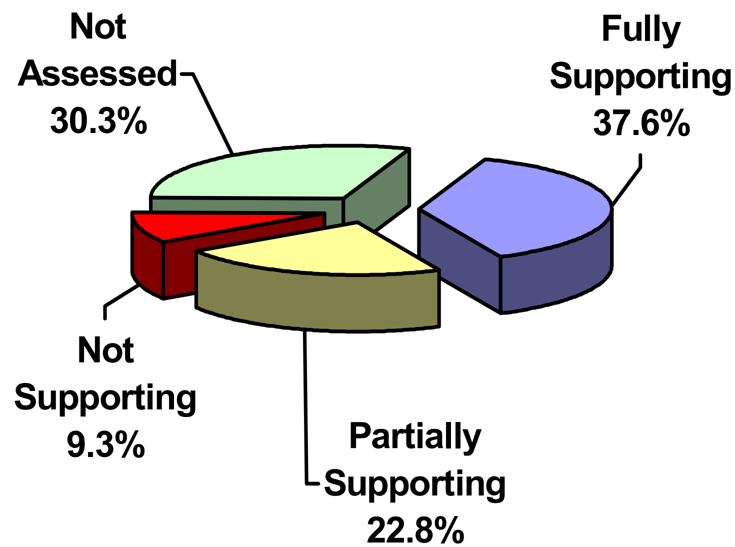
HUC Code:	TN05130202	
Counties:	Cheatham Roberson Williamson	Davidson Sumner
Ecoregions:	71e 71h	71f 71i
Drainage Size of Watershed:	642 square miles	
Stream Miles in Watershed:	773.3	
Stream Miles Fully Supporting:	290.4	
Stream Miles Partially Supporting:	176.5	
Stream Miles Not Supporting:	72.1	
Stream Miles Not Assessed:	234.3	
Lake Acres in Watershed:	7,507	
Lake Acres Fully Supporting:	6,453 (86%)	
Lake Acres Not Supporting:	994 (13.2%)	
Lake Acres Not Assessed:	60 (0.8%)	
TDEC Monitoring Stations:	151	
Non-TDEC Monitoring Stations:	5	
Advisories:	10	
Watershed Monitoring Group:	5	

Surface Water Quality in Cheatham Reservoir Watershed

The entire Cheatham Reservoir Watershed is within Tennessee and provides electricity, drinking water, recreation, and commercial transportation for the Nashville area.

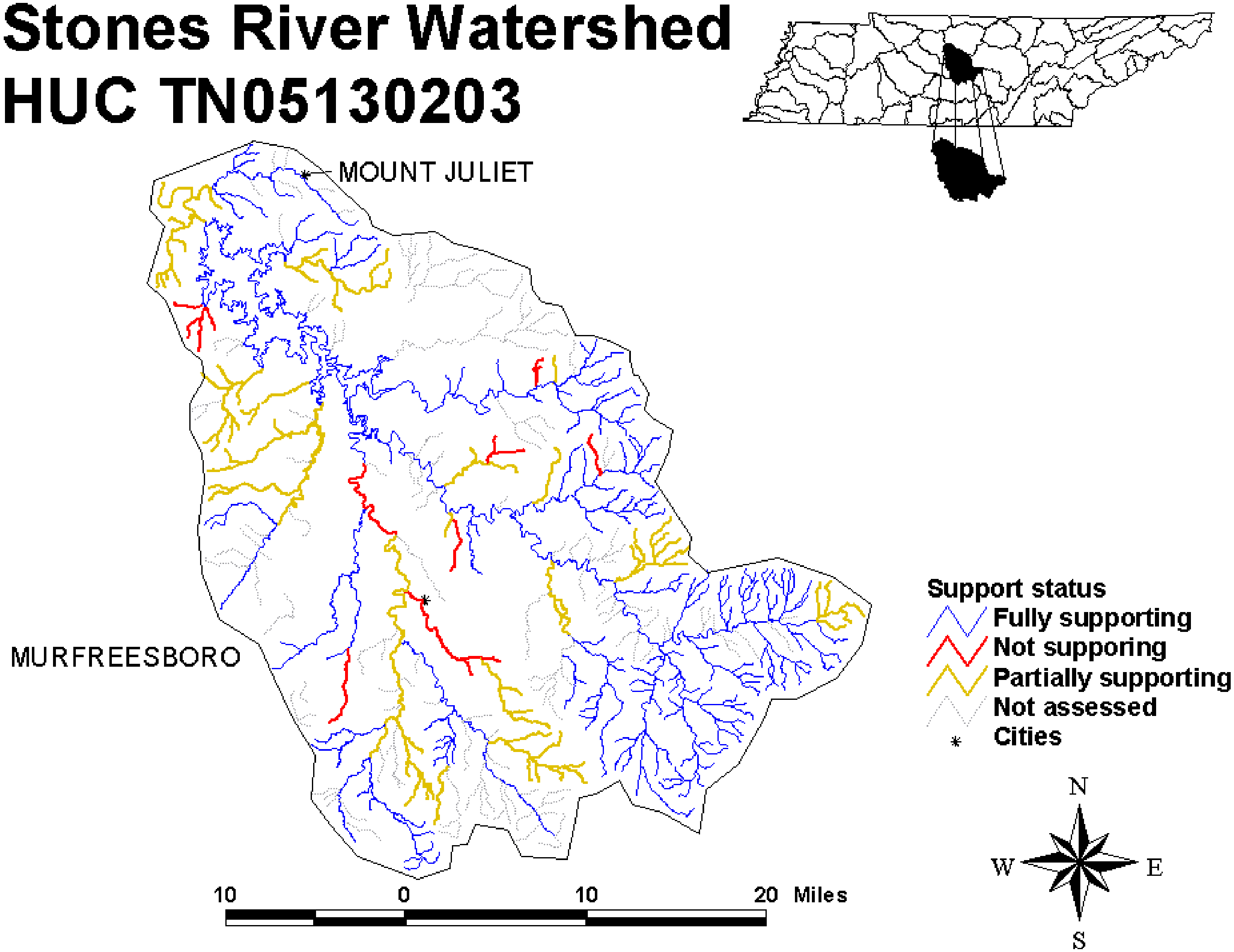
The most frequently cited pollution sources in this watershed are collection system failures, urban runoff, and land development resulting in elevated pathogens, siltation and habitat alteration.

Metro Nashville has been working to correct its combined sewer overflow problem (Chapter X). Primarily due to these efforts, the percentage of fully supporting lake acres has increased from 30 percent in 2000 to 86 percent.



2002 Assessment of Rivers and Streams in Cheatham Reservoir Watershed

Stones River Watershed
HUC TN05130203



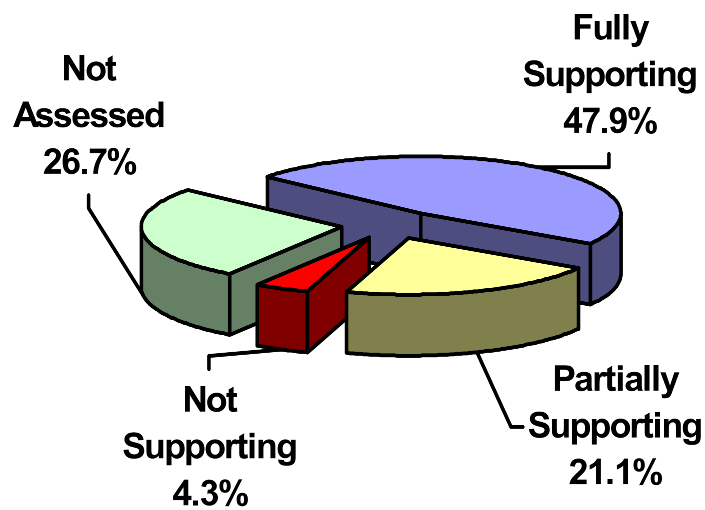
Stones River Watershed Atlas		
HUC Code:	**TN05130203**	
Counties:	Cannon Rutherford	Davidson Wilson
Ecoregions:	71h 71i	
Drainage Size of Watershed:		921 square miles
Stream Miles in Watershed:		1,025.8
Stream Miles Fully Supporting:		491.6
Stream Miles Partially Supporting:		216.0
Stream Miles Not Supporting:		43.8
Stream Miles Not Assessed:		274.4
Lake Acres in Watershed:		22,691
Lake Acres Fully Supporting:		22,691 (100%)
TDEC Monitoring Stations:		71
Non-TDEC Monitoring Stations:		5
Advisories:		None
Watershed Monitoring Group:		1

Surface Water Quality in Stones River Watershed (including Percy Priest Reservoir)

The entire watershed is in Tennessee. Percy Priest is formed by an impoundment of the Stones River by a USACE hydroelectric dam.

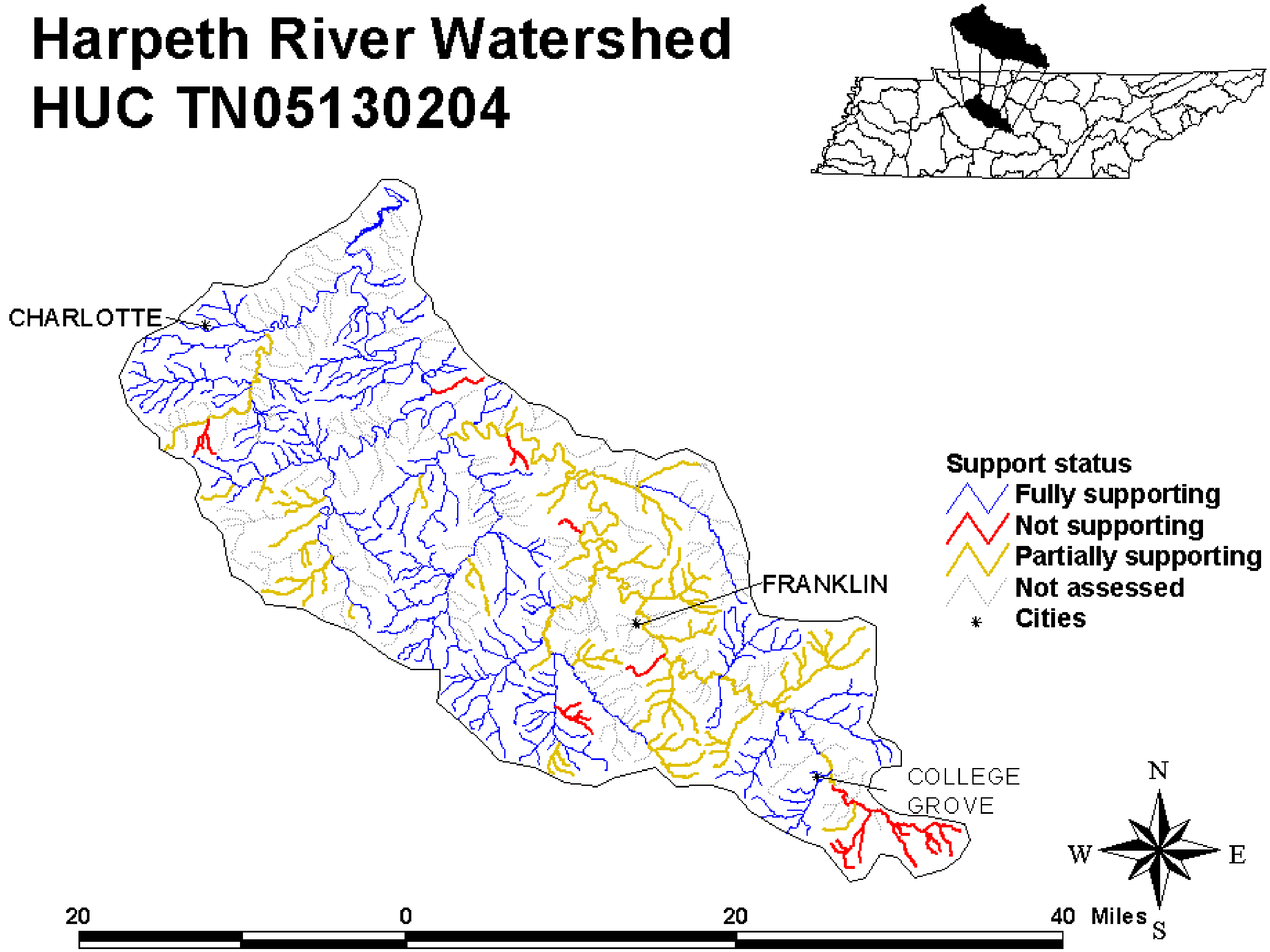
Livestock, urban runoff and land development are the primary sources of pollution in the watershed. The majority of stream miles (73 percent) have been assessed with 65 percent of those fully supporting. Percy Priest Reservoir is fully supporting.

Four high quality streams are subecoregion reference sites, Fall Creek, Stewart Creek, and West Fork Stone River in 71i (Inner Nashville Basin) and Carson Fork in 71h (Outer Nashville Basin).



2002 Assessment of Rivers and Streams in Stones River Watershed

Harpeth River Watershed
HUC TN05130204



Harpeth River Watershed Atlas

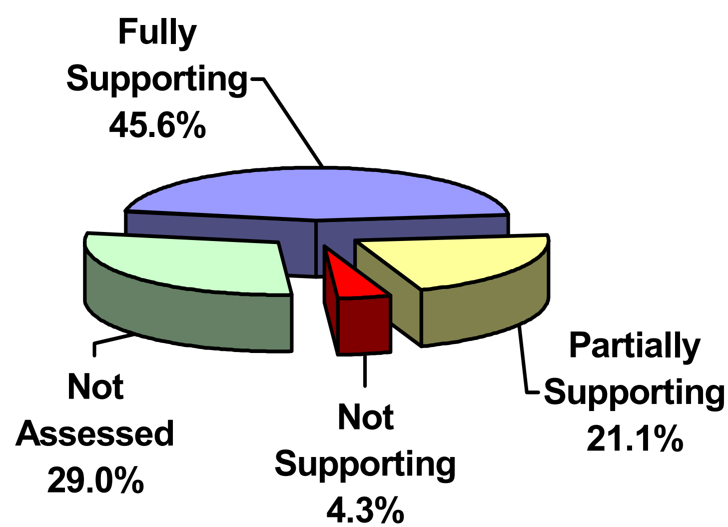
HUC Code:	**TN05130204**	
Counties:	Cheatham Dickson Rutherford	Davidson Hickman Williamson
Ecoregions:	71f 71i	71h
Drainage Size of Watershed:		861 square miles
Stream Miles in Watershed:		1,317.2
Stream Miles Fully Supporting:		601.0
Stream Miles Partially Supporting:		278.3
Stream Miles Not Supporting:		56.3
Stream Miles Not Assessed:		381.6
Lake Acres in Watershed:		655
Lake Acres Not Assessed:		655 (100%)
TDEC Monitoring Stations:		71
Non-TDEC Monitoring Stations:		23
Advisories:		None
Watershed Monitoring Group:		1

Surface Water Quality in Harpeth River Watershed

The entire Harpeth River Watershed is in Tennessee.

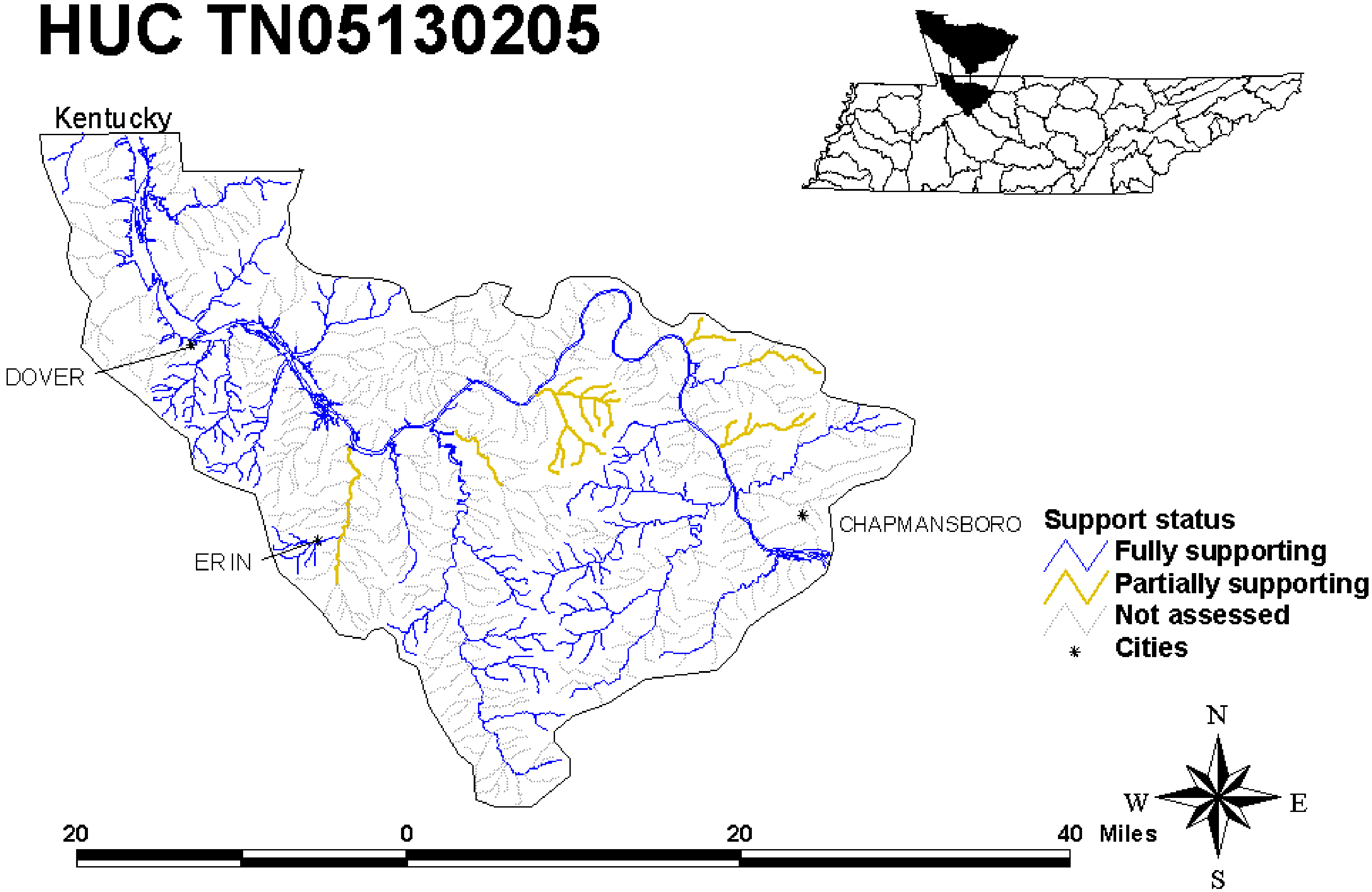
Seventy-one percent of the streams have been assessed with more than half fully supporting. Siltation and habitat alteration are the leading pollutants. These problems were corrected in Arkansas Creek due to the operational improvements at the Williamson County Landfill (Chapter X).

The Tennessee General Assembly has designated portions of Harpeth River as a State Scenic River. This watershed also has two high quality streams that are subecoregion reference sites; the South Harpeth River in 71f (Western Highland Rim) and the Harpeth River in 71i (Inner Nashville Basin).



2002 Assessment of Rivers and Streams in Harpeth River Watershed

Barkley Reservoir Watershed
HUC TN05130205



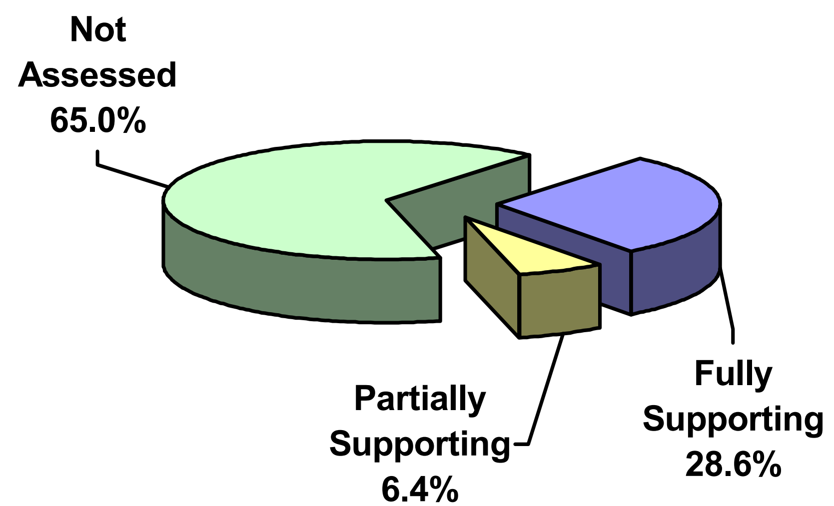
Barkley Reservoir Watershed Atlas

HUC Code:	**TN05130205**	
Counties:	Cheatham Houston Stewart	Dickson Montgomery
Ecoregions:	71e 71f	
Drainage Size of Watershed:		986 square miles
Stream Miles in Watershed:		1,047.9
Stream Miles Fully Supporting:		299.4
Stream Miles Partially Supporting:		67.3
Stream Miles Not Supporting:		0.0
Stream Miles Not Assessed:		681.2
Lake Acres in Watershed:		37,000
Lake Acres Fully Supporting:		37,000 (100%)
TDEC Monitoring Stations:		49
Non-TDEC Monitoring Stations:		1
Advisories:		None
Watershed Monitoring Group:		5

Surface Water Quality in Barkley Reservoir Watershed

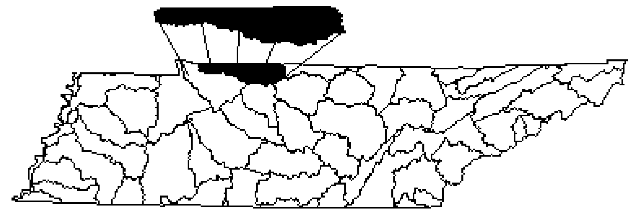
Forty-three percent of Barkley Reservoir is in Tennessee with the remainder in Kentucky. Barkley Dam, on the Cumberland River, is operated by the USACE as a hydroelectric plant. Barkley Reservoir forms the eastern boundary of Land Between the Lakes National Recreation Area, a popular recreation area.

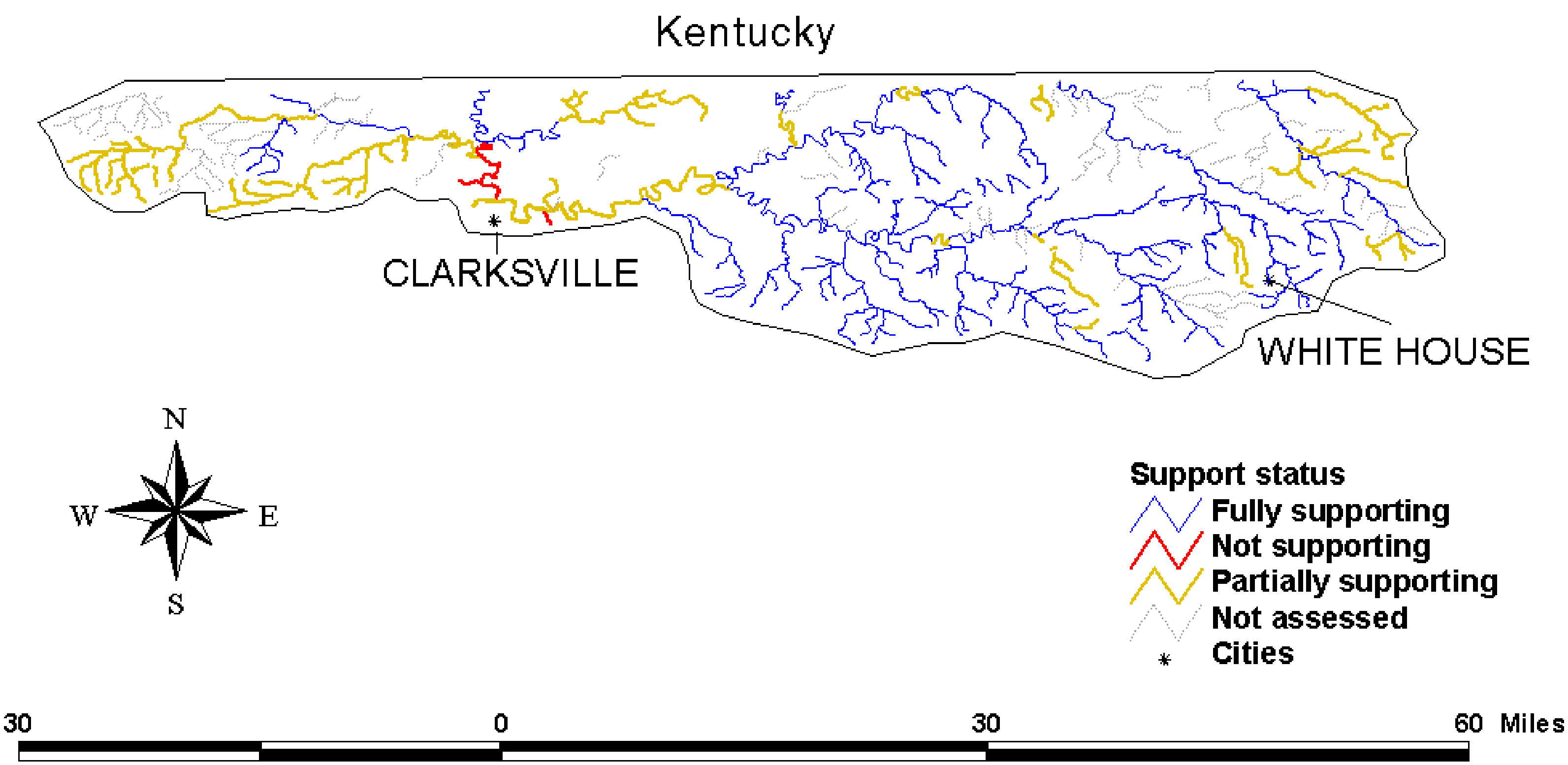
Only five percent of the streams had been assessed in 2000. Monitoring efforts over the last two years have increased this to 35 percent of the watershed. The percent of assessed miles that were fully supporting remained high and consistent (80 percent to 82 percent) in both 2000 and 2002.



2002 Assessment of Rivers and Streams in Barkley Reservoir Watershed

Red River Watershed
HUC TN05130206





Red River Watershed Atlas

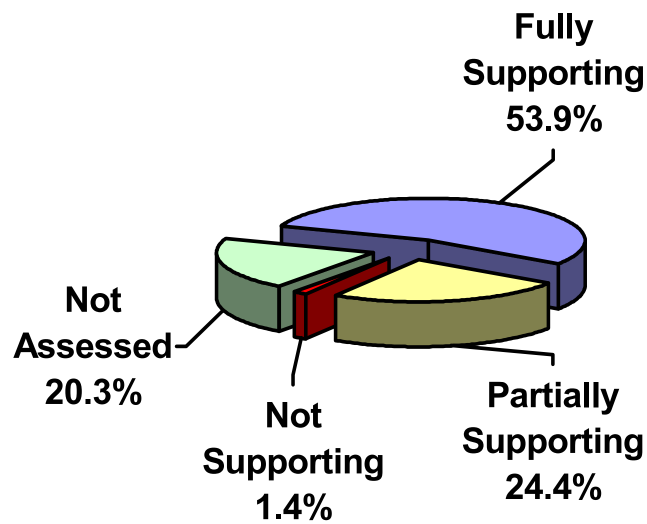
HUC Code:	**TN05130206**	
Counties:	Montgomery Stewart	Robertson Sumner
Ecoregions:	71e 71f 71g	
Drainage Size of Watershed:		767 square miles
Stream Miles in Watershed:		788.7
Stream Miles Fully Supporting:		424.3
Stream Miles Partially Supporting:		192.8
Stream Miles Not Supporting:		11.3
Stream Miles Not Assessed:		160.3
Lake Acres in Watershed:		15
Lake Acres Partially Supporting:		15 (100%)
TDEC Monitoring Stations:		120
Non-TDEC Monitoring Stations:		7
Advisories:		None
Watershed Monitoring Group:		4

Surface Water Quality in Red River Watershed

The Red River flows from Kentucky to the Barkley embayment of the Cumberland River near Clarksville, TN. Fifty-three percent of the Red River Watershed is in Tennessee with the remainder in Kentucky.

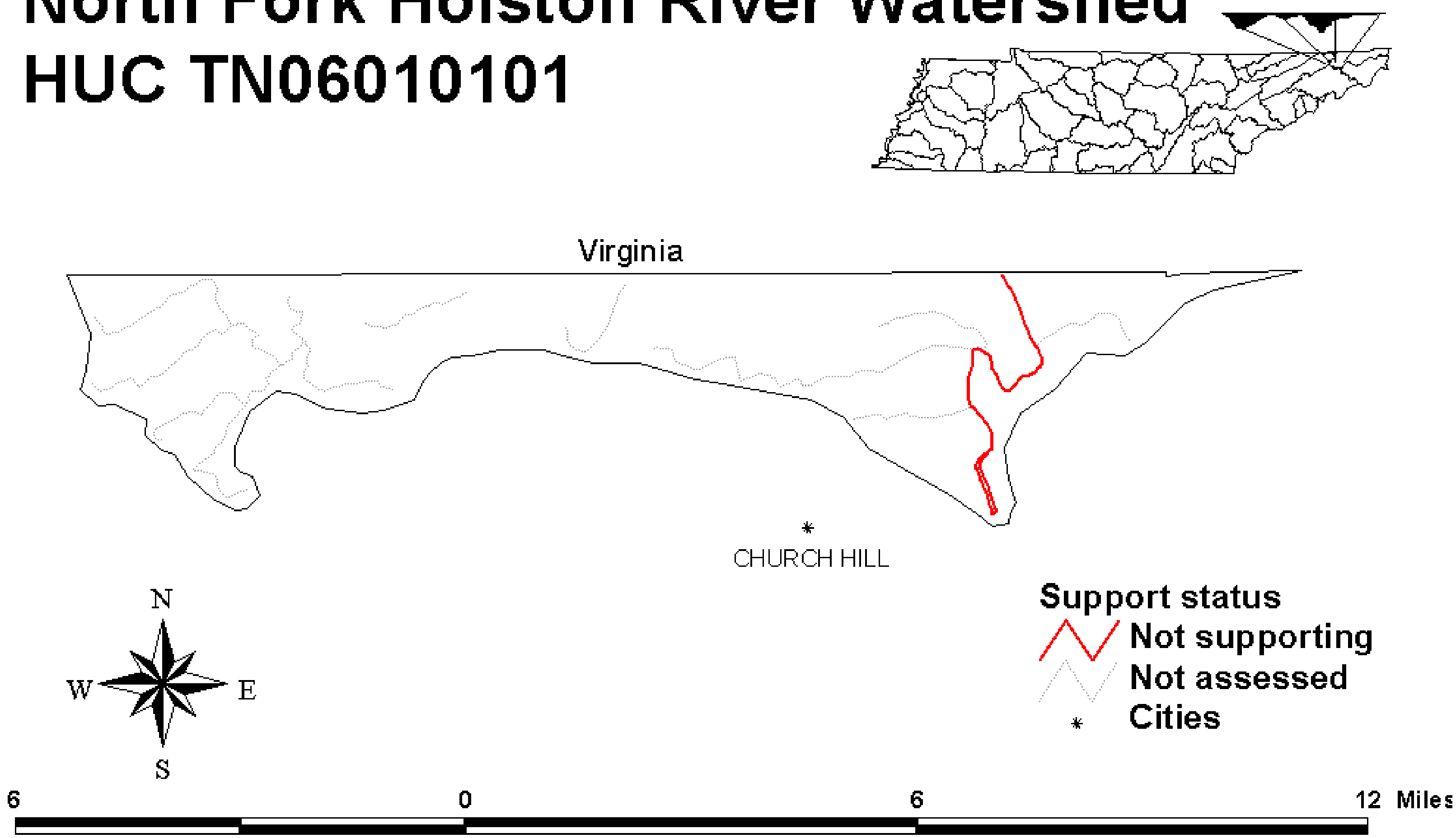
Eighty percent of the stream miles have been assessed with 68 percent fully supporting. Siltation, habitat alteration, pathogens, and nutrients are the leading causes of pollution.

This watershed has two high quality streams that are subecoregion reference sites, Buzzard and Passenger Creeks in 71e (Western Pennyroyal Karst).



2002 Assessment of Rivers and Streams in Red River Watershed

North Fork Holston River Watershed
HUC TN06010101



North Fork Holston River Watershed Atlas

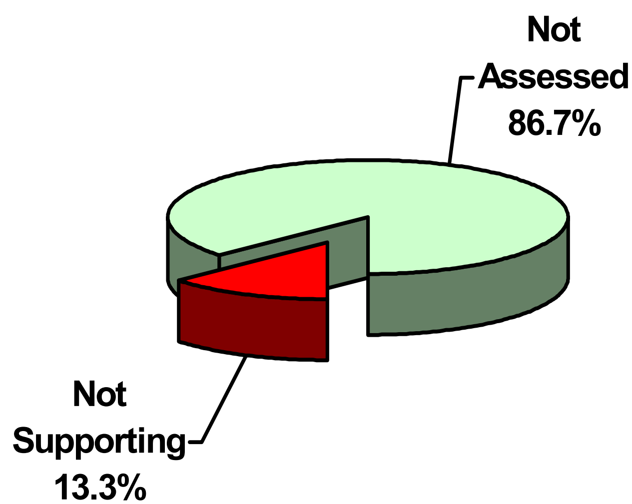
HUC Code:	**TN06010101**
Counties:	Hawkins Sullivan
Ecoregions:	67f 67h 67i
Drainage Size of Watershed:	25 square miles
Stream Miles in Watershed:	45.6
Stream Miles Fully Supporting:	0.0
Stream Miles Partially Supporting:	0.0
Stream Miles Not Supporting:	6.1
Stream Miles Not Assessed:	39.5
Lake Acres in Watershed:	None
TDEC Monitoring Stations:	1
Advisories:	1
Watershed Monitoring Group:	3

Surface Water Quality in North Fork Holston River Watershed

Only four percent (25 square miles) of the North Fork Holston River Watershed is in Tennessee, with 96 percent of the watershed in Virginia.

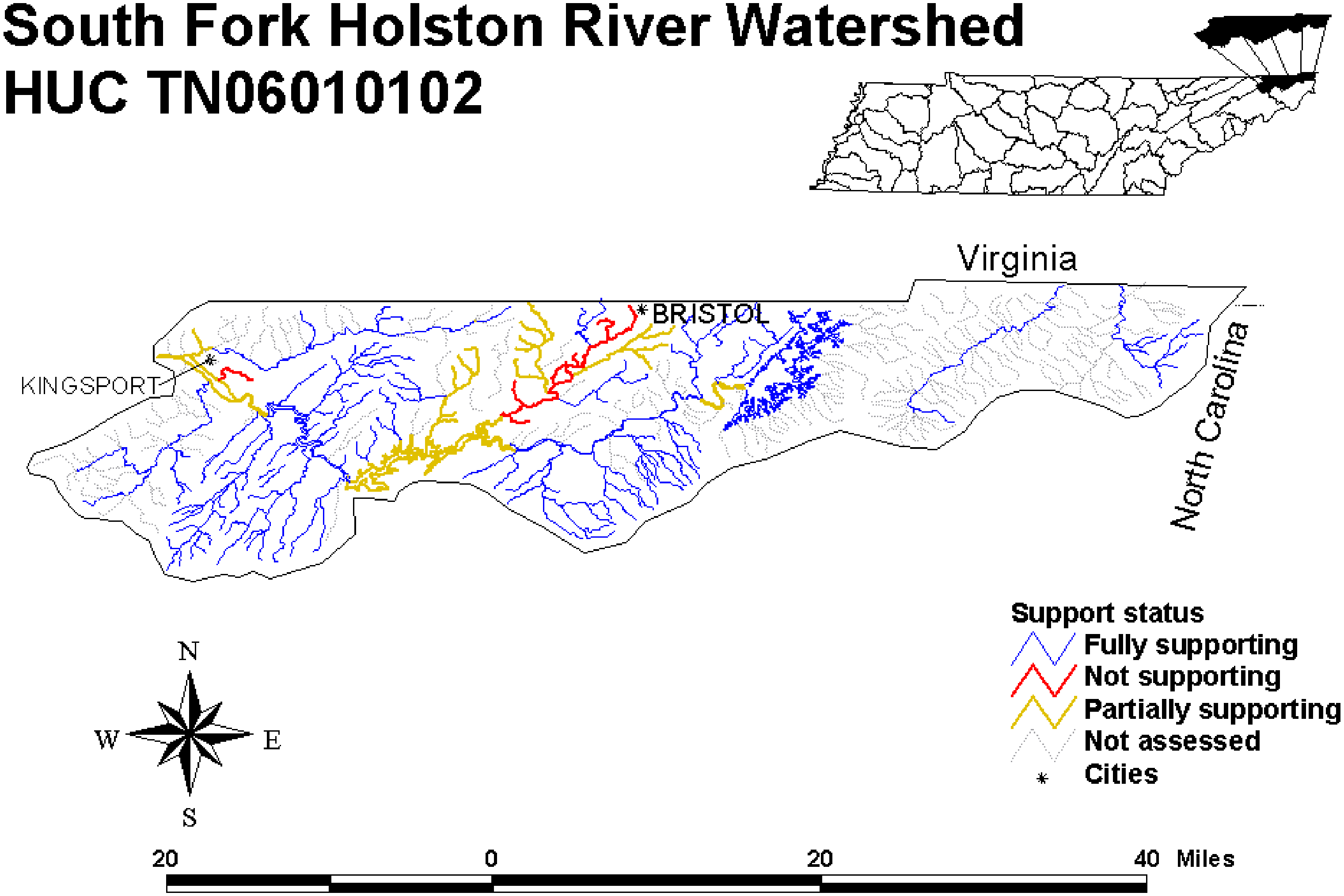
The majority of this watershed (87 percent) has not been assessed due to limited data. Monitoring is scheduled to begin in 2003 as part of the watershed cycle.

The North Fork Holston River from the state line is posted for mercury, and does not support recreational uses. The mercury originated from an industry that is now out of business in Virginia. Since this is the only current monitoring station in the watershed, all assessed stream miles are considered not supporting.



2002 Assessment of Rivers and Streams in North Fork Holston River Watershed

South Fork Holston River Watershed
HUC TN06010102



South Fork Holston River Watershed Atlas

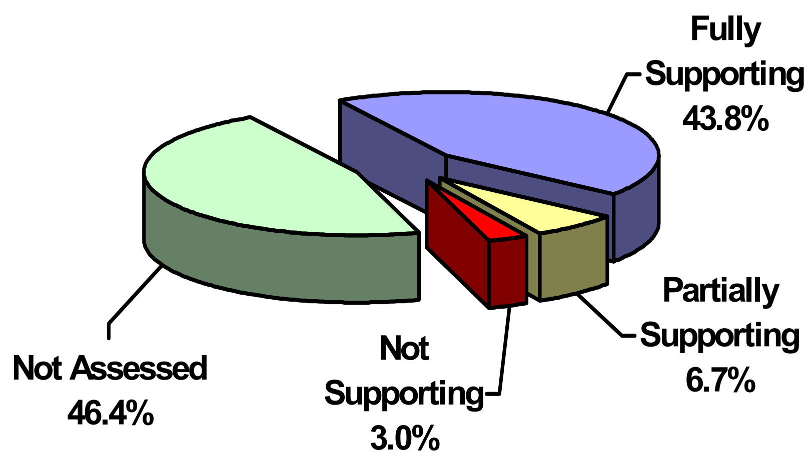
HUC Code:	**TN06010102**		
Counties:	Carter	Johnson	
	Sullivan	Washington	
Ecoregions:	66d	66e	66f
	67f	67g	67h
	67i		
Drainage Size of Watershed:		565 square miles	
Stream Miles in Watershed:		808.3	
Stream Miles Fully Supporting:		354.3	
Stream Miles Partially Supporting:		53.9	
Stream Miles Not Supporting:		24.6	
Stream Miles Not Assessed:		375.5	
Lake Acres in Watershed:		12,884	
Lake Acres Fully Supporting:		8,484 (65.8%)	
Lake Acres Partially Supporting:		4,400 (34.2%)	
TDEC Monitoring Stations:		133	
Non-TDEC Monitoring Stations:		4	
Advisories:		2	
Watershed Monitoring Groups:		2 & 3	

Surface Water Quality in South Fork Holston River Watershed (including Boone, South Holston, and Fort Patrick Henry Reservoirs)

Forty-eight percent of the South Fork Holston River Watershed is in Tennessee with the remainder in Virginia. Fort Patrick Henry, South Holston and Boone Reservoirs, operated by TVA, are impoundments of the river. Boone Reservoir is partially supporting due to PCBs and chlordane from contaminated sediment.

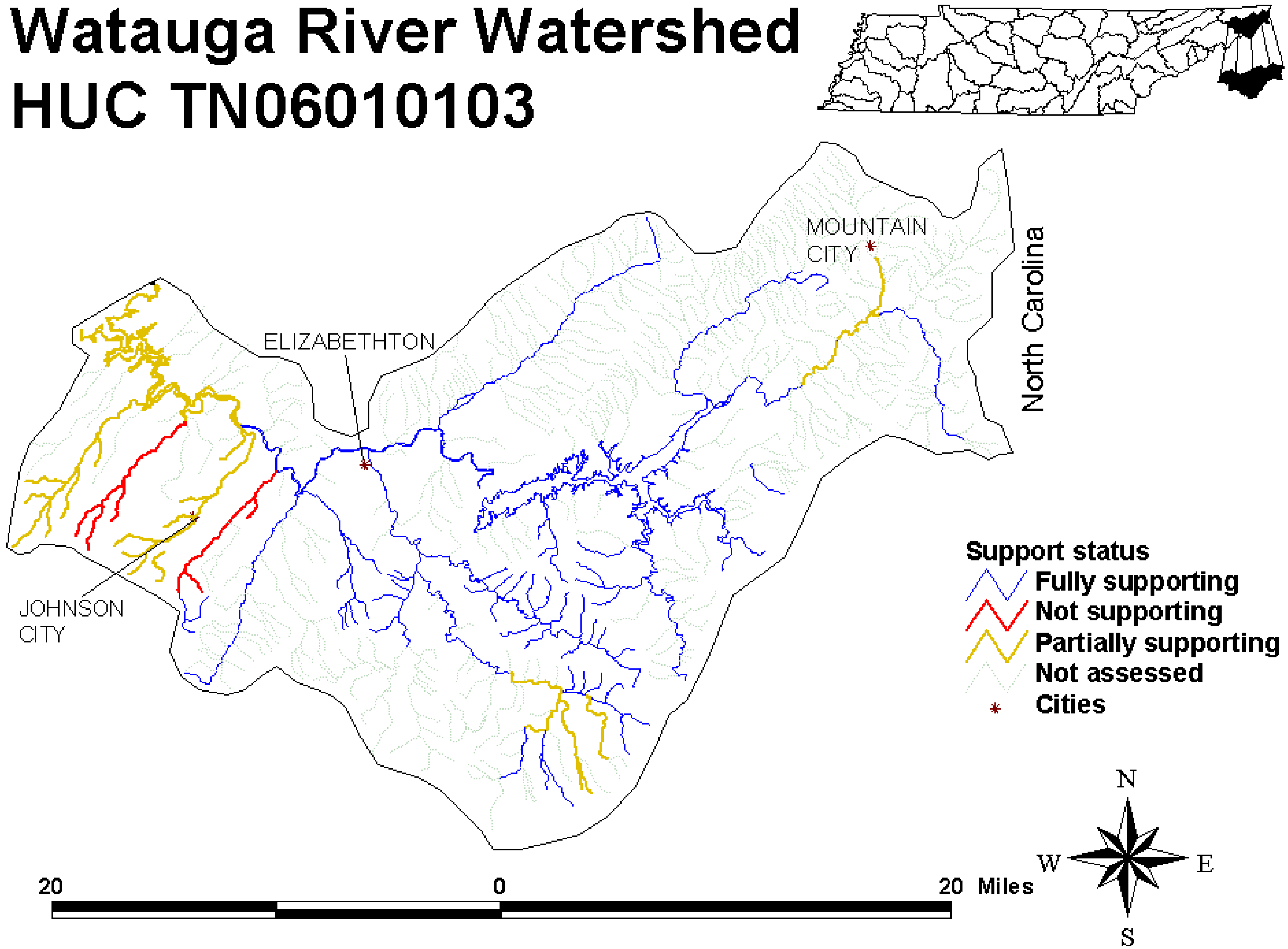
The majority of assessed streams (82 percent) are fully supporting of designated uses.

Two high quality streams are subecoregion reference sites, Gentry Creek in 66e (Southern Sedimentary Ridges) and Beaverdam Creek in 66f (Limestone Valleys and Coves).



2002 Assessment of Rivers and Streams in South Fork Holston River Watershed

Watauga River Watershed
HUC TN06010103



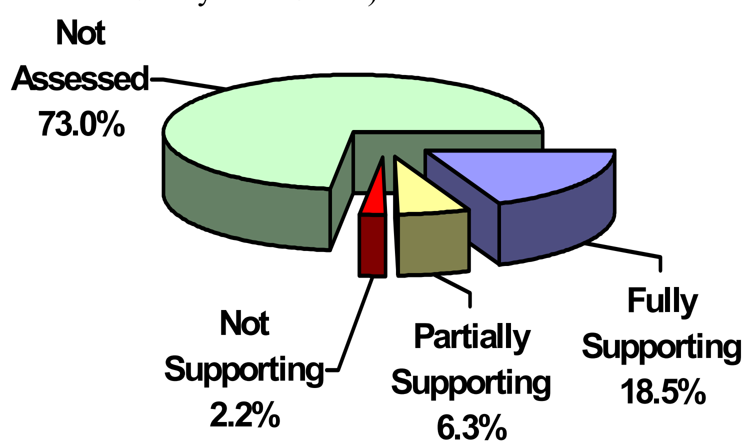
Watauga River Watershed Atlas

HUC Code:	**TN06010103**	
Counties:	Carter	Johnson
	Sullivan	Washington
	Unicoi	
Ecoregions:	66d	66e
	66f	67f
	67g	
Drainage Size of Watershed:		680 square miles
Stream Miles in Watershed:		1022.4
Stream Miles Fully Supporting:		189.4
Stream Miles Partially Supporting:		64.3
Stream Miles Not Supporting:		22.3
Stream Miles Not Assessed:		746.4
Lake Acres in Watershed:		6,499
Lake Acres Fully Supporting:		6,499 (100%)
TDEC Monitoring Stations:		101
Non-TDEC Monitoring Stations:		1
Advisories:		None
Watershed Monitoring Group:		1

Surface Water Quality in Watauga River Watershed (including Watauga Reservoir)

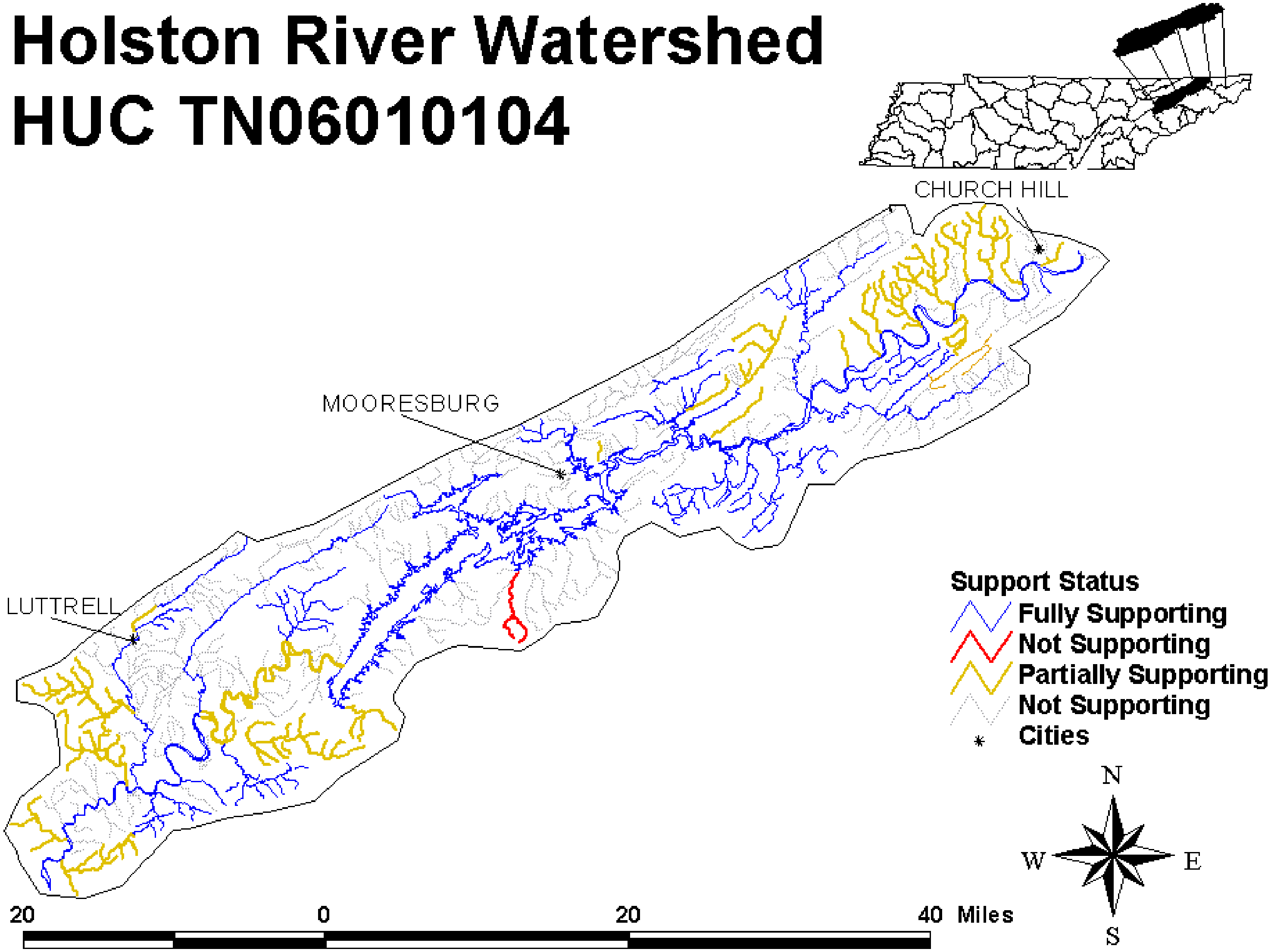
Seventy percent of this watershed is in Tennessee with the remainder in North Carolina. Two hydroelectric dams form Watauga and Wilbur Reservoirs. Both reservoirs are in the Cherokee National Forest and are fully supporting. Data were not available to assess 73 percent of the stream miles. Monitoring is scheduled to begin later this year. EPA has approved pathogen TMDLs on four streams (31 miles) listed for this parameter.

In addition to the national forest, several state parks are in this watershed. These preserves provide protection for five high quality streams that are subecoregion reference sites, Doe River, Laurel Fork, Black and Little Stoney Creeks in 66d (Southern Igneous Ridges and Mountains) and Stoney Creek in 66f (Limestone Valleys and Coves).



2002 Assessment of Rivers and Streams in Watauga River Watershed

Holston River Watershed
HUC TN06010104



Holston River Watershed Atlas

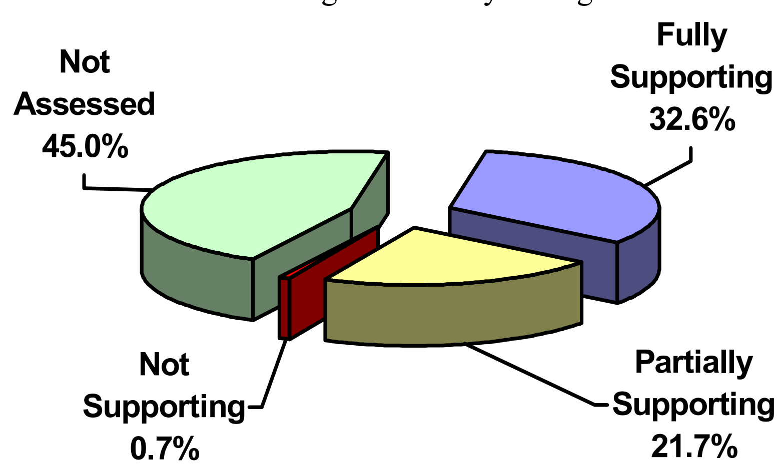
HUC Code:	**TN06010104**		
Counties:	Grainger Jefferson Sullivan	Hamblen Knox Union	Hawkins Sevier
Ecoregions:	67f 67h	67g 67i	
Drainage Size of Watershed:	990 square miles		
Stream Miles in Watershed:	1175.6		
Stream Miles Fully Supporting:	383.2		
Stream Miles Partially Supporting:	255.3		
Stream Miles Not Supporting:	8.0		
Stream Miles Not Assessed:	529.1		
Lake Acres in Watershed:	5,109		
Lake Acres Fully Supporting:	5,109 (100%)		
TDEC Monitoring Stations:	87		
Non-TDEC Monitoring Stations:	8		
Advisories:	1		
Watershed Monitoring Group:	4		

Surface Water Quality in Holston River Watershed (including Cherokee Reservoir)

The entire Holston River Watershed is in Tennessee. A TVA hydroelectric dam created Cherokee Reservoir in 1940.

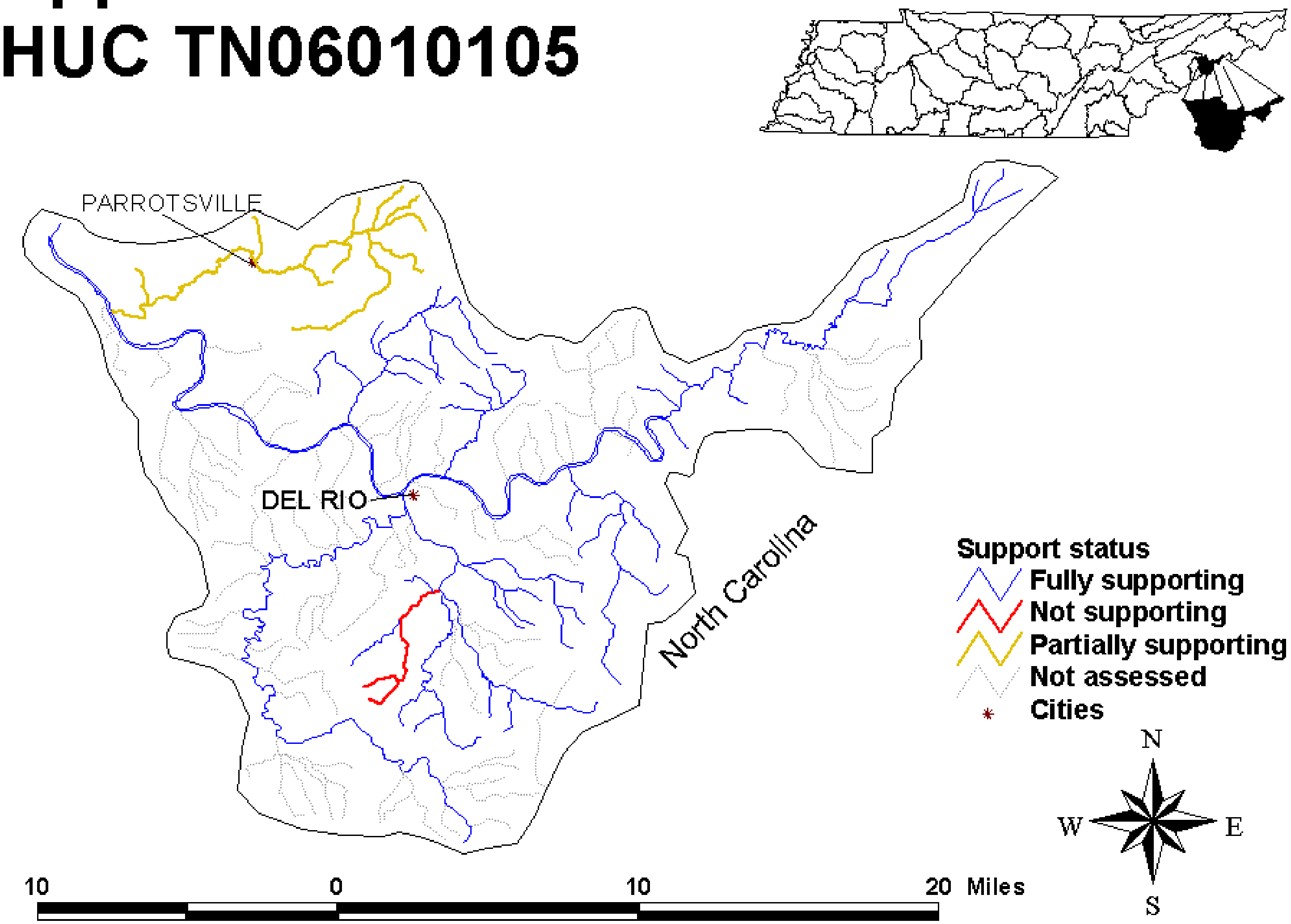
The percent of impaired streams doubled from 10 percent in 2000 to 22 percent primarily due to increased bacteriological monitoring. Fourteen new stream segments (154 miles) were impaired by pathogens primarily due to pasture runoff, livestock access and confined animal feeding operations.

This watershed has one high quality stream that is a subecoregion reference site, Parker Branch in 67h (Southern Sandstone Ridges). Big and Fisher Creeks are Level III reference sites in the Ridge and Valley ecoregion.



2002 Assessment of Rivers and Streams in Holston River Watershed

Upper French Broad River Watershed
HUC TN06010105



Upper French Broad River Watershed Atlas

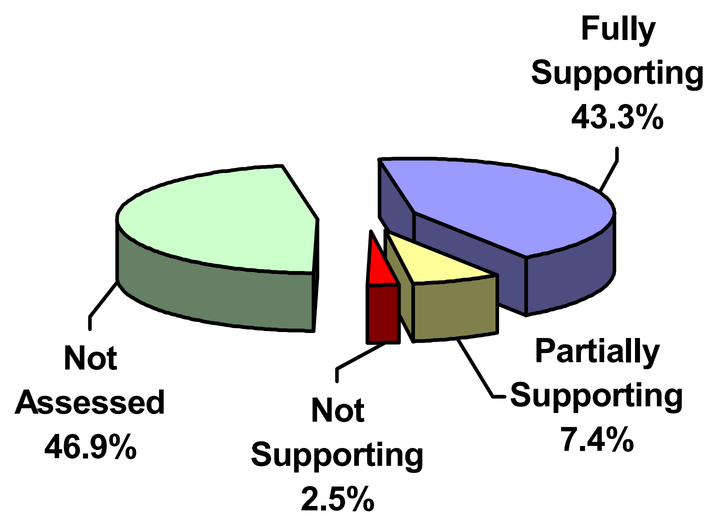
HUC Code:	**TN06010105**	
Counties:	Cocke Greene	
Ecoregions:	66d 66g 67g	66e 67f
Drainage Size of Watershed:		215 square miles
Stream Miles in Watershed:	380.0	
Stream Miles Fully Supporting:	164.5	
Stream Miles Partially Supporting:	28.0	
Stream Miles Not Supporting:	9.4	
Stream Miles Not Assessed:	178.1	
Lake Acres in Watershed:		None
TDEC Monitoring Stations:		12
Non-TDEC Monitoring Stations:		4
Advisories:		2
Watershed Monitoring Group:		5

Surface Water Quality in Upper French Broad River Watershed

Only 11 percent of the Upper French Broad River Watershed is in Tennessee with 89 percent in North Carolina. The watershed is sparsely populated with small farms and logging the principal land uses. The river drains a portion of the Cherokee National Forest.

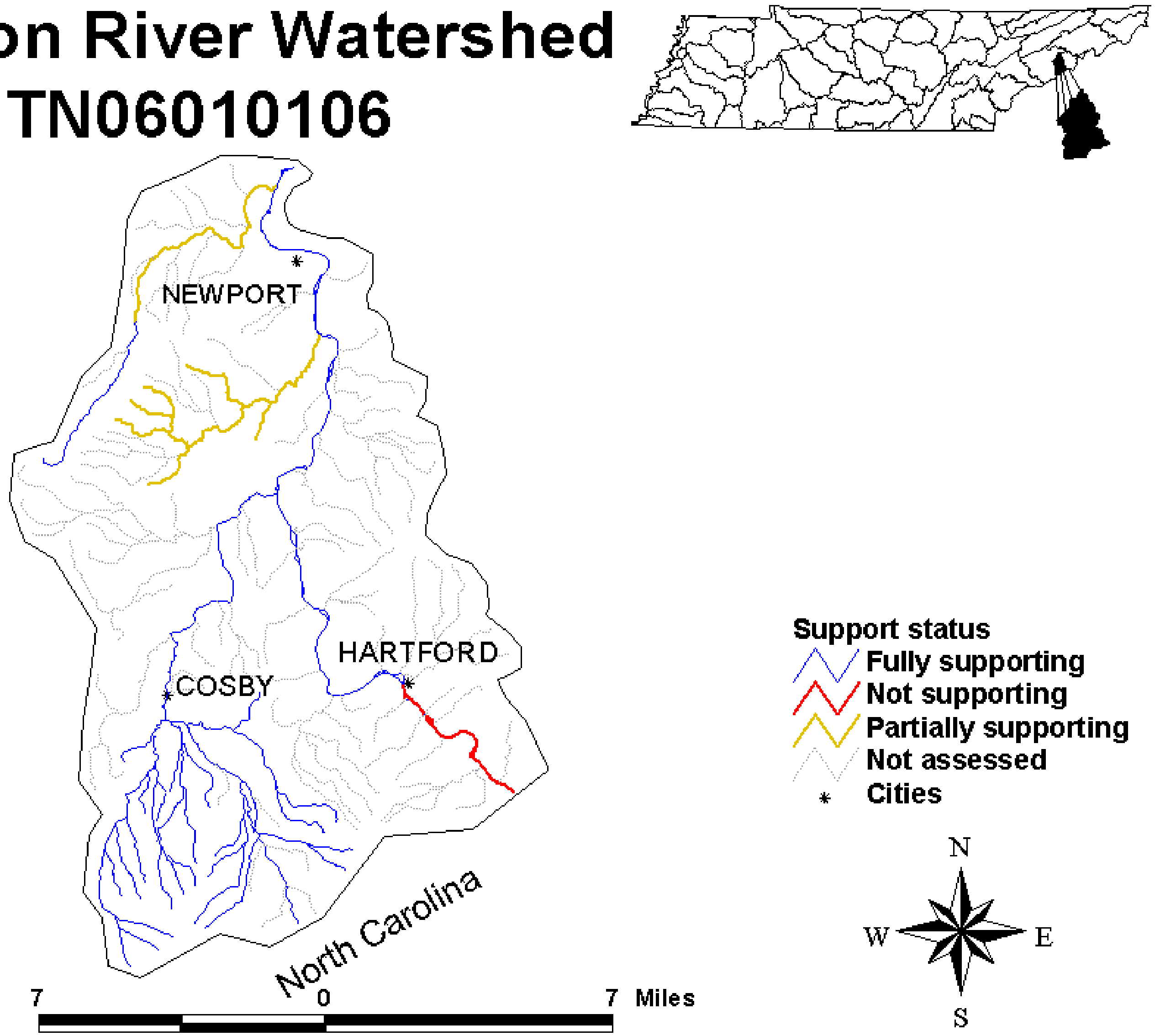
Pathogens from septic tanks and livestock grazing are the only listed pollutants affecting 18 percent of assessed stream miles.

The Tennessee General Assembly has designated the French Broad River from the North Carolina border to Douglas Reservoir as a State Scenic River.



2002 Assessment of Rivers and Streams in the Upper French Broad Watershed

Pigeon River Watershed
HUC TN06010106



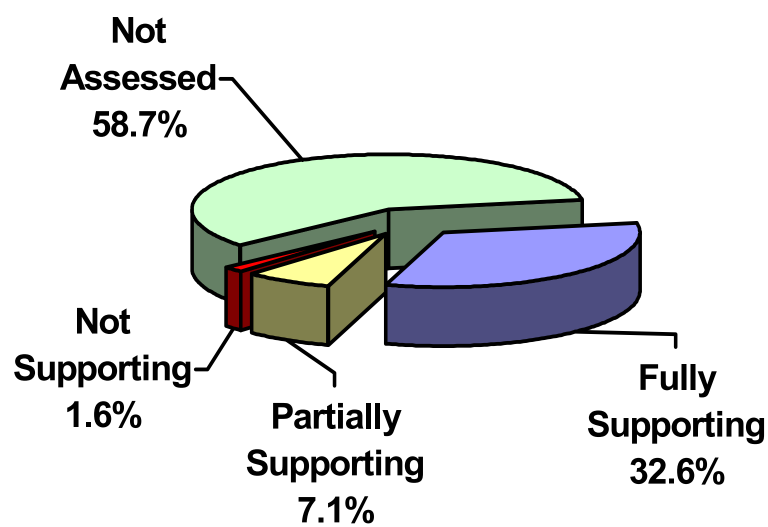
Pigeon River Watershed Atlas

HUC Code:	**TN06010106**
Counties:	Cocke
Ecoregions:	66e 66g 67f
Drainage Size of Watershed:	153 square miles
Stream Miles in Watershed:	310.8
Stream Miles Fully Supporting:	101.4
Stream Miles Partially Supporting:	22.1
Stream Miles Not Supporting:	5.0
Stream Miles Not Assessed:	182.3
Lake Acres in Watershed:	None
TDEC Monitoring Stations:	12
Non-TDEC Monitoring Stations:	2
Advisories:	0 (Pigeon River advisory lifted in 2003)
Watershed Monitoring Group:	5

Surface Water Quality in Pigeon River Watershed

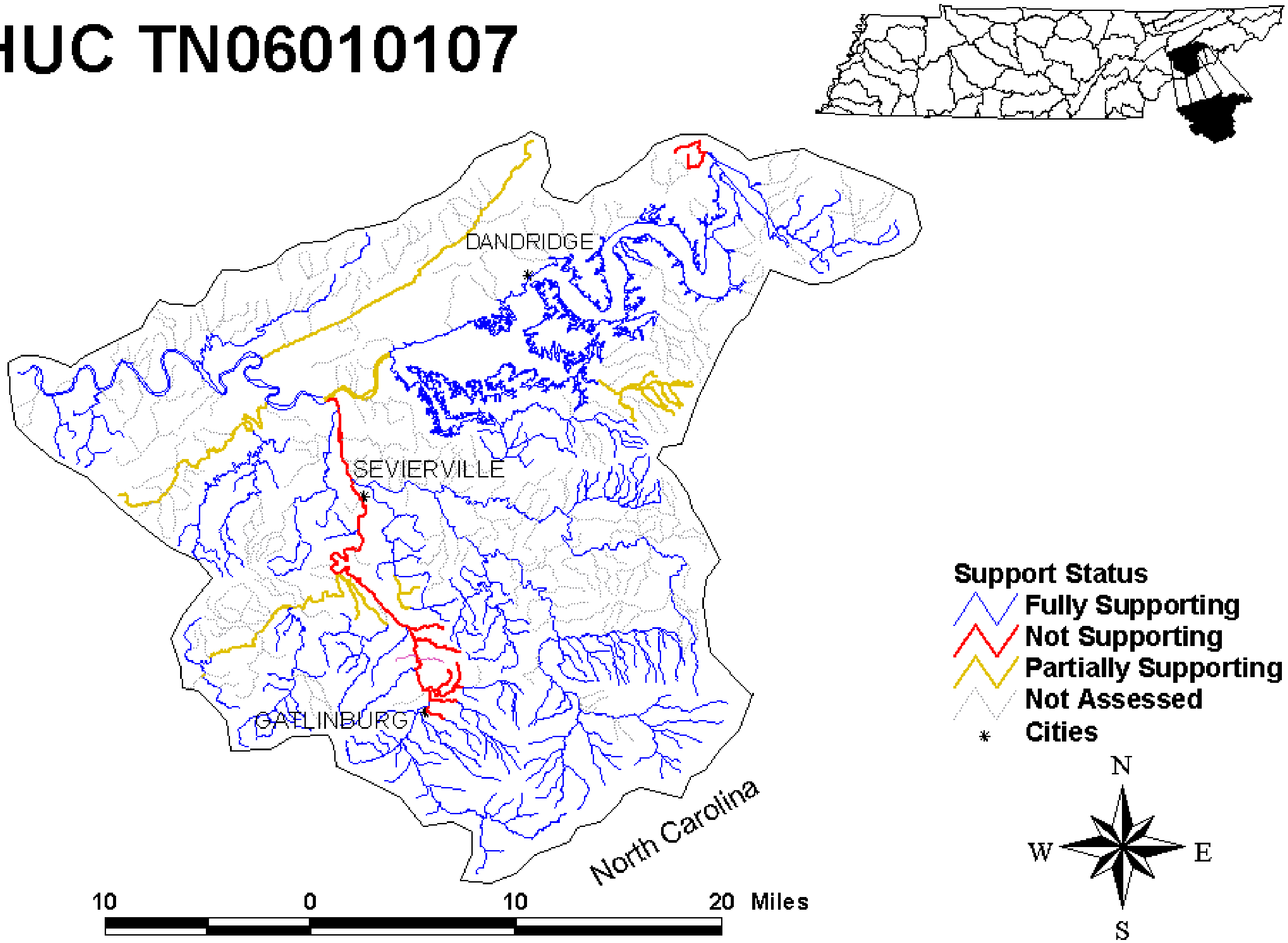
Only 22 percent of the Pigeon River Watershed is in Tennessee with 78 percent in North Carolina. The headwaters drain the Great Smokey Mountains National Park and Cherokee National Forest. The watershed is relatively undeveloped with pathogens causing concern in two assessed streams. Data were not available to assess over half the watershed. Seventy-nine (79) percent of assessed streams were fully supporting.

The Pigeon River in Tennessee previously had a precautionary fish advisory due to dioxin originating from a paper mill in North Carolina (Chapter IX). Due to the documentation of lower dioxin levels recently, the advisory was lifted in 2003.



2002 Assessment of Rivers and Streams in Pigeon River Watershed

Lower French Broad River Watershed
HUC TN06010107



Lower French Broad River Watershed Atlas

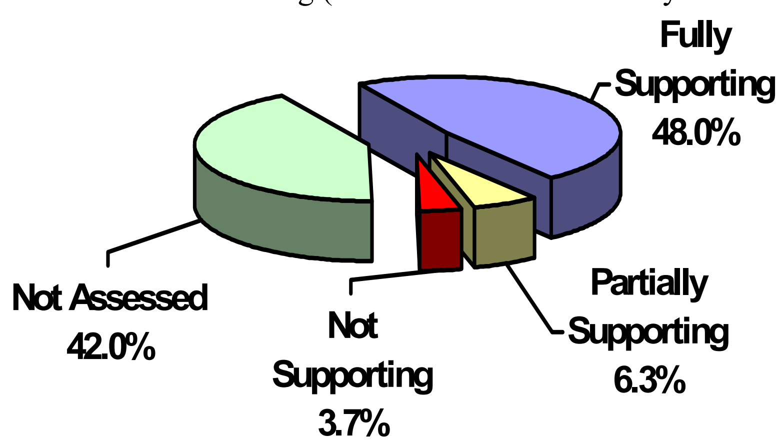
HUC Code:	**TN06010107**		
Counties:	Cocke Knox	Jefferson Sevier	
Ecoregions:	66e 67f	66f 67g	66g 67i
Drainage Size of Watershed:		728 square miles	
Stream Miles in Watershed:		1,210.1	
Stream Miles Fully Supporting:		581.4	
Stream Miles Partially Supporting:		76.7	
Stream Miles Not Supporting:		44.3	
Stream Miles Not Assessed:		507.7	
Lake Acres in Watershed:		30,400	
Lake Acres Fully Supporting:		30,400 (100%)	
TDEC Monitoring Stations:		63	
Non-TDEC Monitoring Stations:		2	
Advisories:		10	
Watershed Monitoring Group:		5	

Surface Water Quality in Lower French Broad River Watershed (including Douglas Reservoir)

Ninety-two percent of the Lower French Broad Watershed is in Tennessee with the remainder in North Carolina. Douglas Reservoir provides hydroelectric power and water recreation.

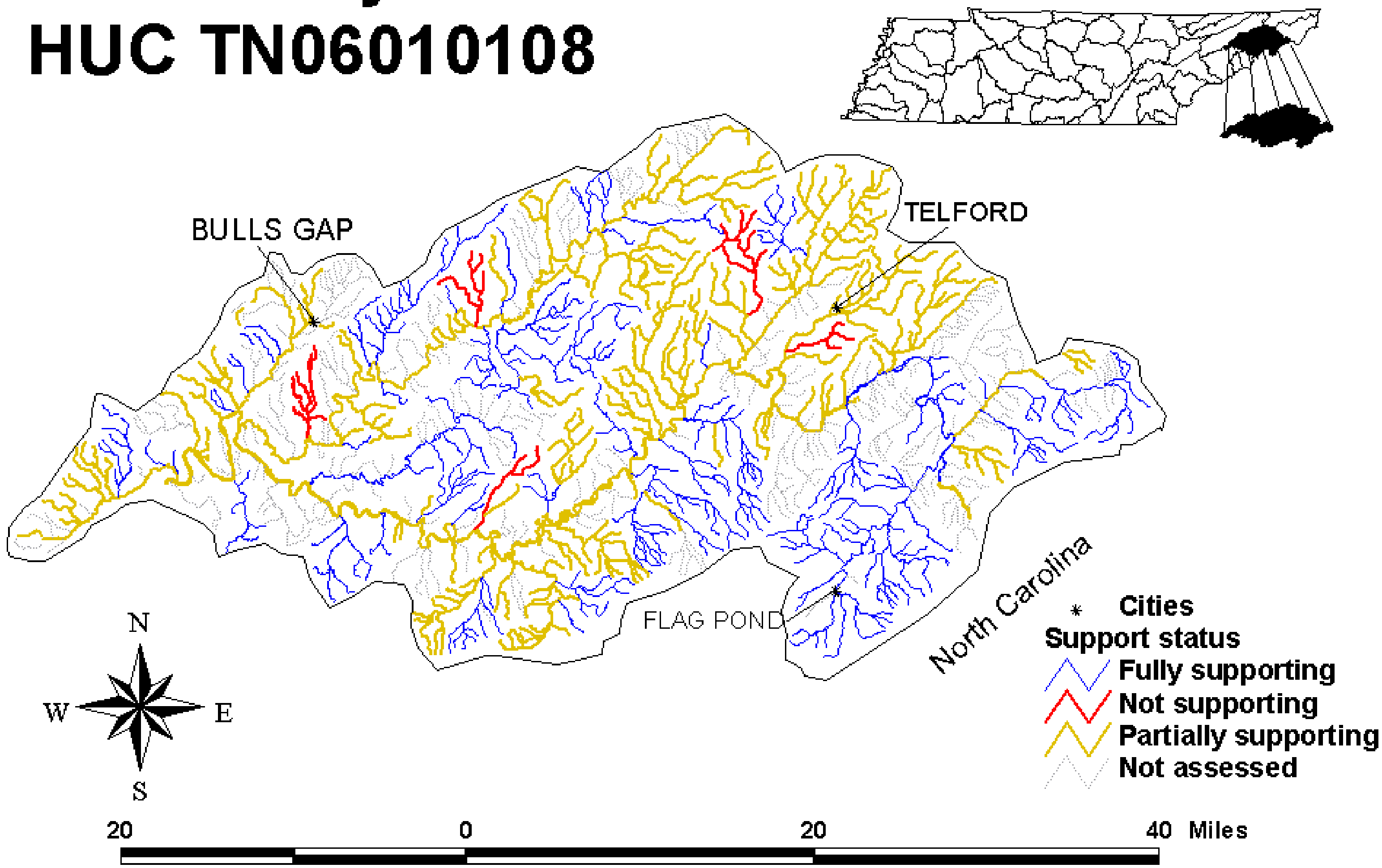
Eighty-three percent of assessed streams support designated uses. Elevated pathogens from septic tanks, collection system failure and livestock grazing are the biggest concern.

Portions of Tuckahoe Creek are designated as a State Scenic River. Two ONRWs, West Prong Little Pigeon River and Little Pigeon River in the Great Smoky Mountains National Park are in this watershed. Little Pigeon River is also an ecoregion reference stream in 66g (Southern Metasedimentary Mountains).



2002 Assessment for River and Streams in Lower French Broad River Watershed

Nolichucky River Watershed
HUC TN06010108



Nolichucky River Watershed Atlas

HUC Code: **TN06010108**

Counties:	Cocke	Greene	Hamblen
	Hawkins	Jefferson	Unicoi
	Washington		

Ecoregions:	66d	66e	66f
	66g	67f	67g
	67h	67i	

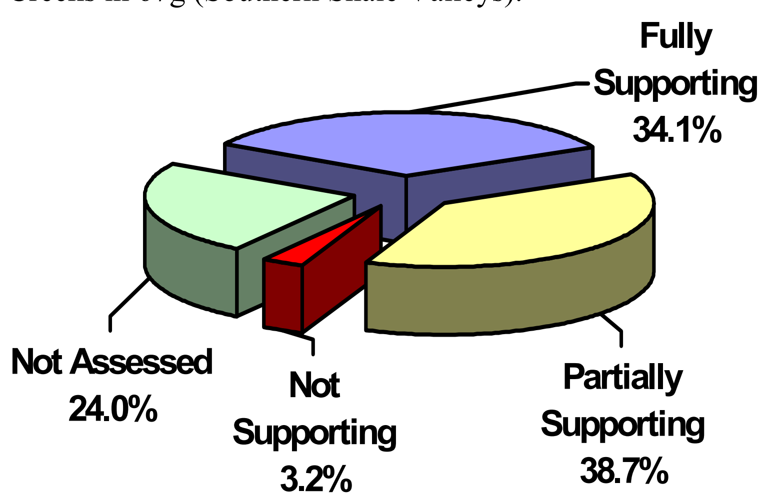
Drainage Size of Watershed:	1740 square miles
Stream Miles in Watershed:	1920.0
Stream Miles Fully Supporting:	654.2
Stream Miles Partially Supporting:	743.7
Stream Miles Not Supporting:	60.5
Stream Miles Not Assessed:	461.6
Lake Acres in Watershed:	383
Lake Acres Partially Supporting:	383 (100%)
TDEC Monitoring Stations:	347
Non-TDEC Monitoring Stations:	4
Advisories:	0
Watershed Monitoring Group:	5

Surface Water Quality in Nolichucky River Watershed (including Davy Crockett Reservoir)

The Nolichucky River Watershed is entirely in Tennessee. Due to excessive siltation Davy Crockett Reservoir no longer generates electricity and is partially supporting of aquatic life.

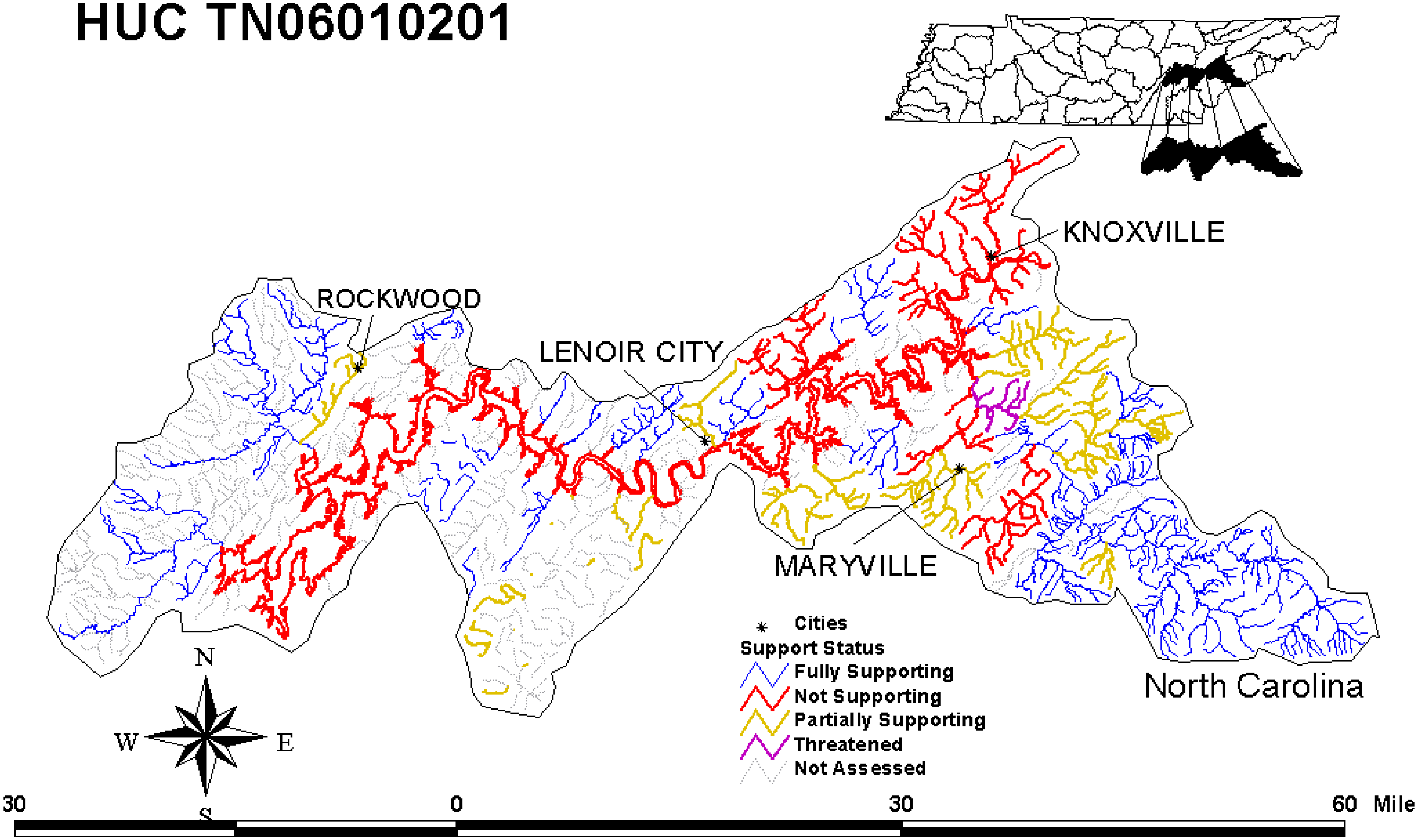
Stream assessments rose from 25 percent to 76 percent. Fifty-five percent of assessed streams are not fully supporting primarily due to siltation and habitat alteration caused by livestock operations.

Five high quality streams are subecoregion reference sites, Tumbling Creek in 66d (Southern Igneous Ridges and Mountains) and Clarks and Lower Higgins Creeks in 66e (Southern Sedimentary Ridges), and Little Chucky and Bent Creeks in 67g (Southern Shale Valleys).



2002 Assessment of Rivers and Streams in Nolichucky River Watershed

Upper Tennessee River Watershed
(Including Ft. Loudoun and Watts Bar Reservoirs)
HUC TN06010201



Upper Tennessee River Watershed Atlas

HUC Code: **TN06010201**

Counties:	Bledsoe	Blount	Cumberland
	Loudon	Knox	McMinn
	Monroe	Rhea	Roane
	Sevier		

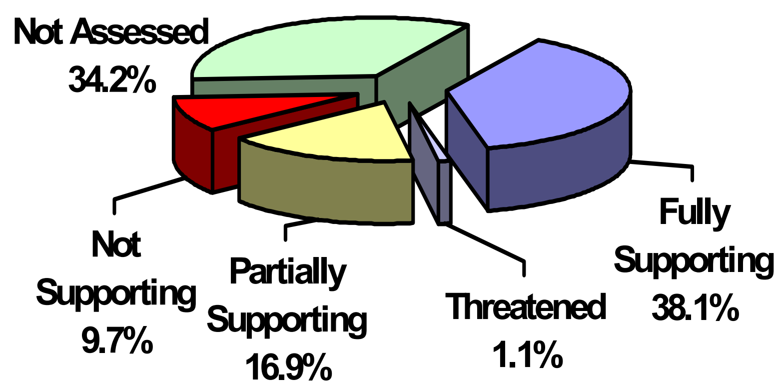
Ecoregions:	66f	66g	66e	67f	68c
	67g	67h	67i	68a	

Drainage Size of Watershed:	1326 square miles
Stream Miles in Watershed:	1848.6
Stream Miles Fully Supporting:	704.1
Stream Miles Threatened:	21.2
Stream Miles Partially Supporting:	312.4
Stream Miles Not Supporting:	179.3
Stream Miles Not Assessed:	631.6
Lake Acres in Watershed:	52,600
Lake Acres Not Supporting:	52,600 (100%)
TDEC Monitoring Stations:	152
Non-TDEC Monitoring Stations:	39
Advisories:	8
Watershed Monitoring Groups:	1 (Watts Bar) 2 (Fort Loudoun)

Surface Water Quality in Upper Tennessee River Watershed (including Fort Loudoun and Watts Bar Reservoirs)

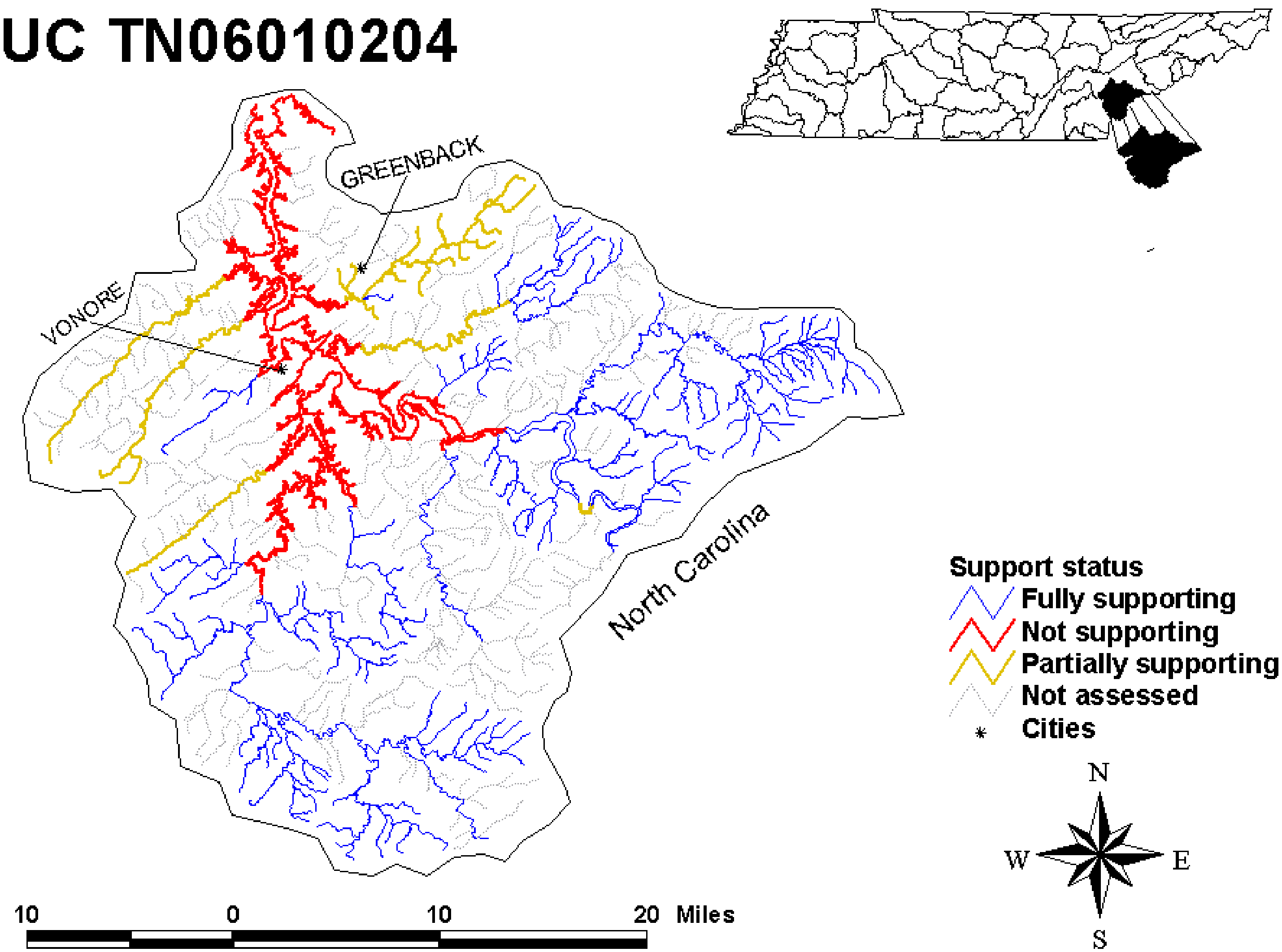
Over 99 percent of this watershed is in Tennessee. TVA operates two hydroelectric dams, Watts Bar Dam and Fort Loudoun Dam. Both reservoirs are considered non-supporting due to PCB accumulation in fish tissue. Pathogens, siltation, nutrients, and habitat alteration impair the most stream miles in this watershed.

The portion of the Little River in Great Smoky Mountains National Park has been designated as an ONRW. Three high quality streams are subecoregion reference sites, Double Branch and Little River in 66e (Southern Sedimentary Ridges) and Piney Creek in 68a (Cumberland Plateau).



2002 Assessment of Rivers and Streams in Upper Tennessee River Watershed

Little Tennessee River Watershed
HUC TN06010204



Little Tennessee River Watershed Atlas

HUC Code:	**TN06010204**		
Counties:	Blount	Loudon	Monroe
Ecoregions:	66e	66f	66g
	67f	67h	67i
	67g		

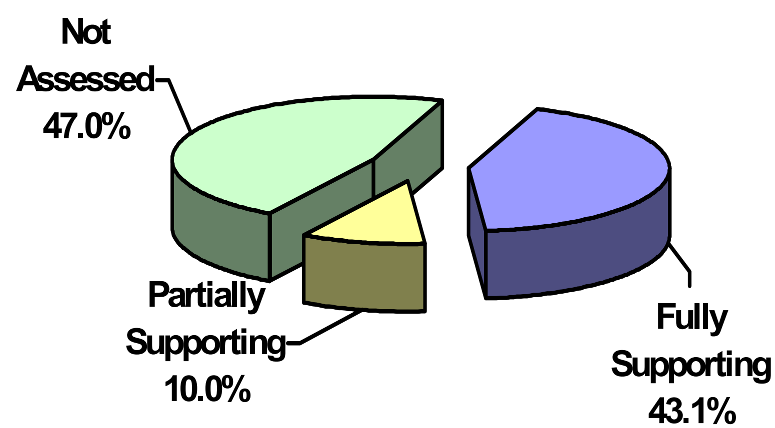
Drainage Size of Watershed:	781 square miles
Stream Miles in Watershed:	1081.5
Stream Miles Fully Supporting:	465.7
Stream Miles Partially Supporting:	107.7
Stream Miles Not Supporting:	0.0
Stream Miles Not Assessed:	508.1
Lake Acres in Watershed:	18,878
Lake Acres Fully Supporting:	2,282 (12%)
Lake Acres Not Supporting:	16,500 (87.4%)
Lake Acres Not Assessed:	96 (0.6%)
TDEC Monitoring Stations:	39
Non-TDEC Monitoring Stations:	5
Advisories:	1
Watershed Monitoring Group:	3

Surface Water Quality in Little Tennessee River Watershed (including Tellico Reservoir)

Seventy-four percent of this watershed is in Tennessee with the remainder in North Carolina.

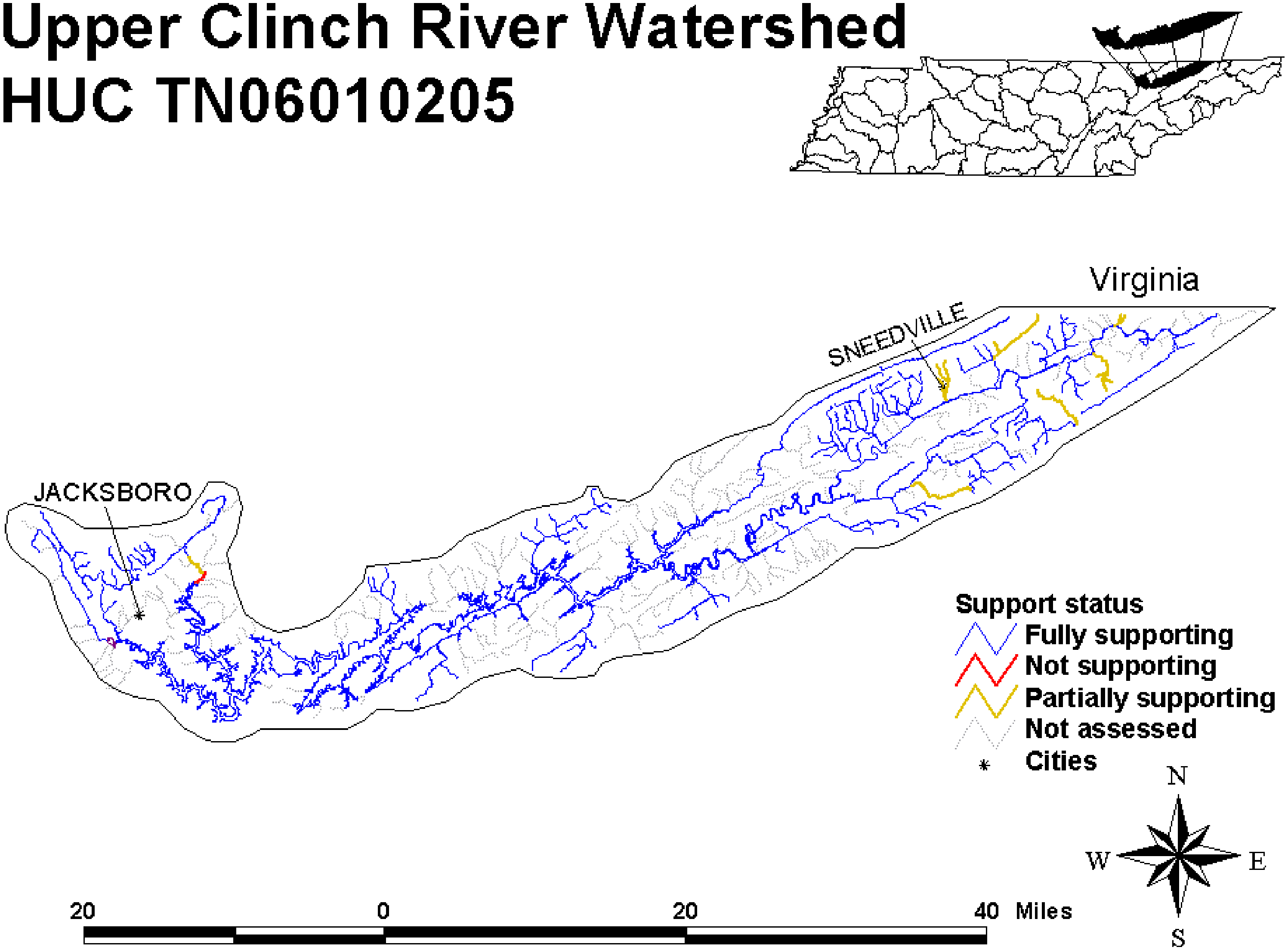
The watershed is mostly small farms and parklands with pathogens and nutrients the primary stream pollutant. TVA's, Tellico Reservoir is not supporting of recreational uses due to PCBs from contaminated sediment.

Abrams Creek in the Great Smoky Mountains National Park has been designated as an ONRW. Four high quality streams are subecoregion reference sites, Abrams Creek in 66f (Limestone Valleys and Coves), Citco Creek and North River in 66g (Southern Metasedimentary Mountains) and Laurel Creek in 67h (Southern Sandstone Ridges).



2002 Assessment of Rivers and Streams in Little Tennessee River Watershed

Upper Clinch River Watershed
HUC TN06010205



Upper Clinch River Watershed Atlas

HUC Code: **TN06010205**

Counties:	Anderson	Campbell	Claiborne
	Grainger	Hancock	Hawkins
	Union		

Ecoregions: 67f
67h
67i

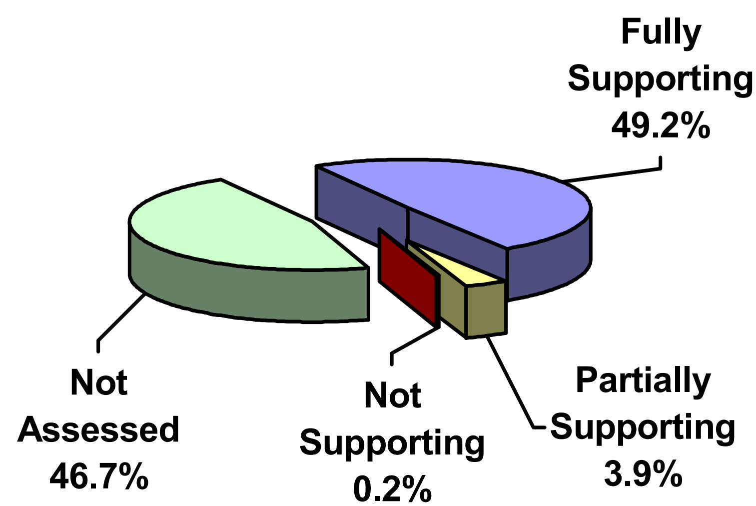
Drainage Size of Watershed:	724 square miles
Stream Miles in Watershed:	757.1
Stream Miles Fully Supporting:	372.9
Stream Miles Partially Supporting:	29.7
Stream Miles Not Supporting:	1.2
Stream Miles Not Assessed:	353.3
Lake Acres in Watershed:	34,681
Lake Acres Fully Supporting:	34,187 (98.6%)
Lake Acres Not Assessed:	494 (1.4%)
TDEC Monitoring Stations:	73
Non-TDEC Monitoring Stations:	2
Advisories:	None
Watershed Monitoring Group:	4

Surface Water Quality in Upper Clinch River Watershed (including Norris Reservoir)

Only 37 percent of the Upper Clinch River is in Tennessee with the remainder in Virginia. Norris Reservoir is a large TVA reservoir in this watershed.

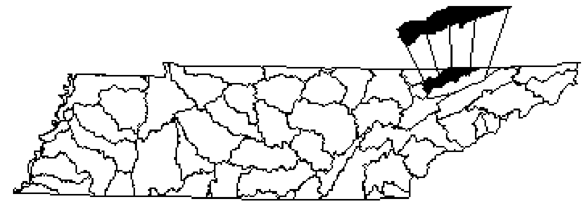
This is a rural watershed with small farms and logging the primary land uses. Water quality is good overall with 92 percent of assessed streams fully supporting. Approximately half of the watershed has been assessed.

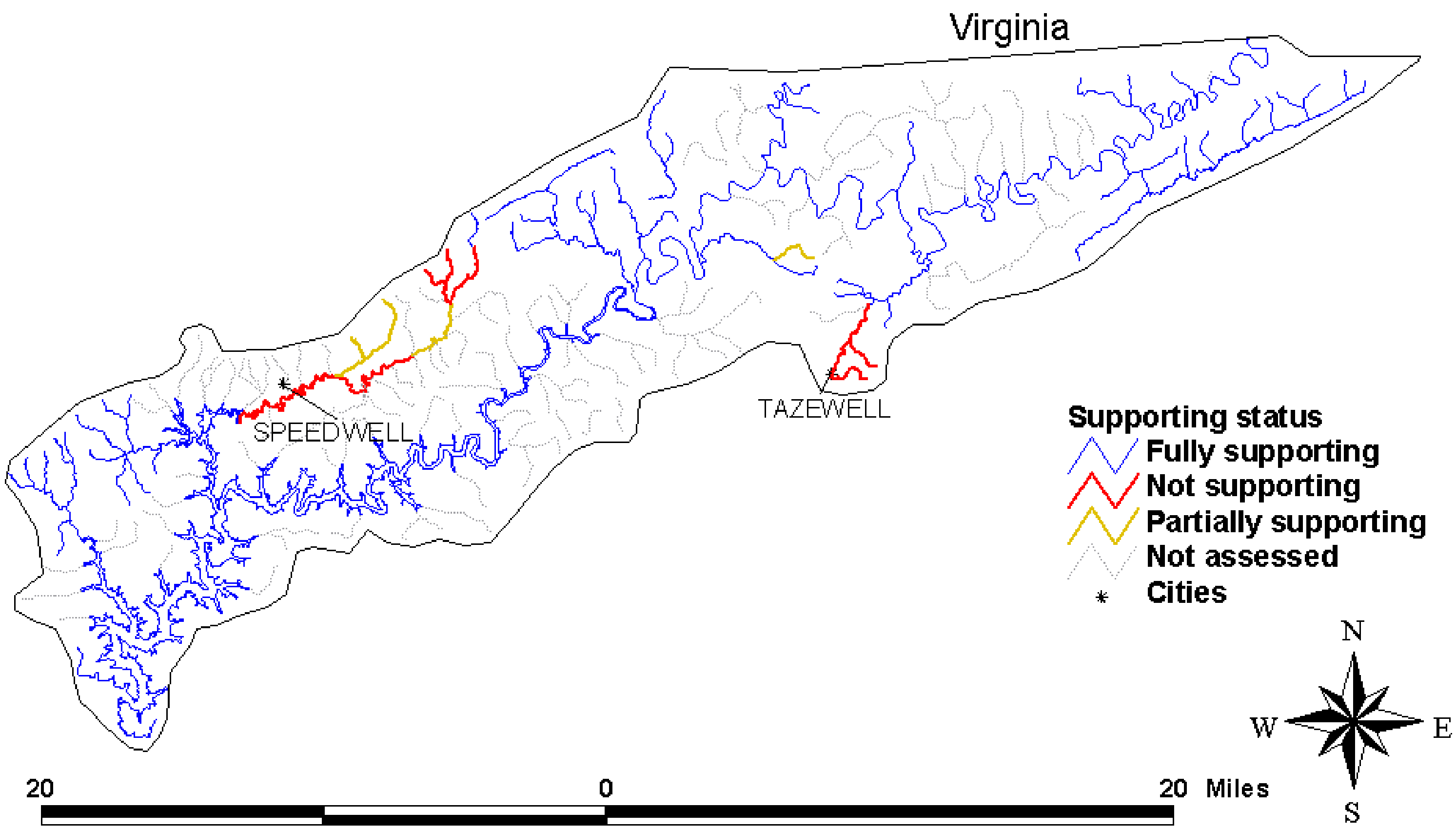
This watershed has two high quality streams that are subecoregion reference sites, White and Big War Creeks in 67f (Southern Limestone Dolomite Valleys and Low Rolling Hills).



2002 Assessment of Rivers and Streams in Upper Clinch River Watershed

Powell River Watershed
HUC TN06010206





Powell River Watershed Atlas

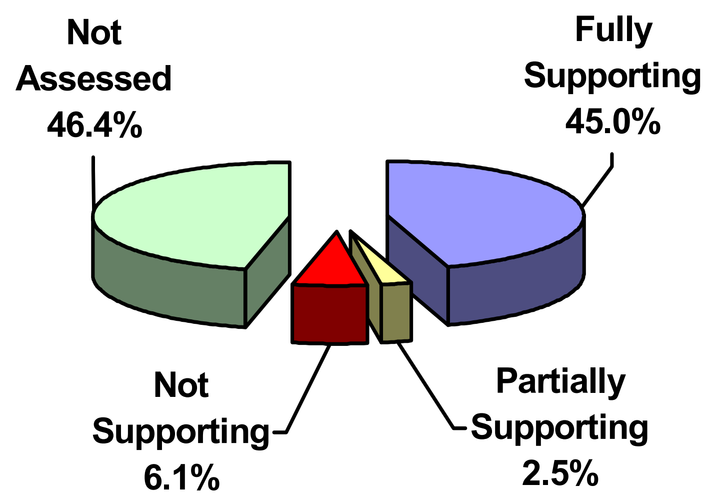
HUC Code:	**TN06010206**	
Counties:	Campbell Hancock	Claiborne Union
Ecoregions:	67f 67h 69d	
Drainage Size of Watershed:		401 square miles
Stream Miles in Watershed:	429.0	
Stream Miles Fully Supporting:	193.1	
Stream Miles Partially Supporting:	10.6	
Stream Miles Not Supporting:	26.2	
Stream Miles Not Assessed:	199.1	
Lake Acres in Watershed:		None
TDEC Monitoring Stations:		48
Non-TDEC Monitoring Stations:		5
Advisories:		None
Watershed Monitoring Group:		4

Surface Water Quality in Powell River Watershed

Forty-three percent of this watershed is in Tennessee with the remainder in Virginia. The Powell River arm of Norris Reservoir is included in this watershed.

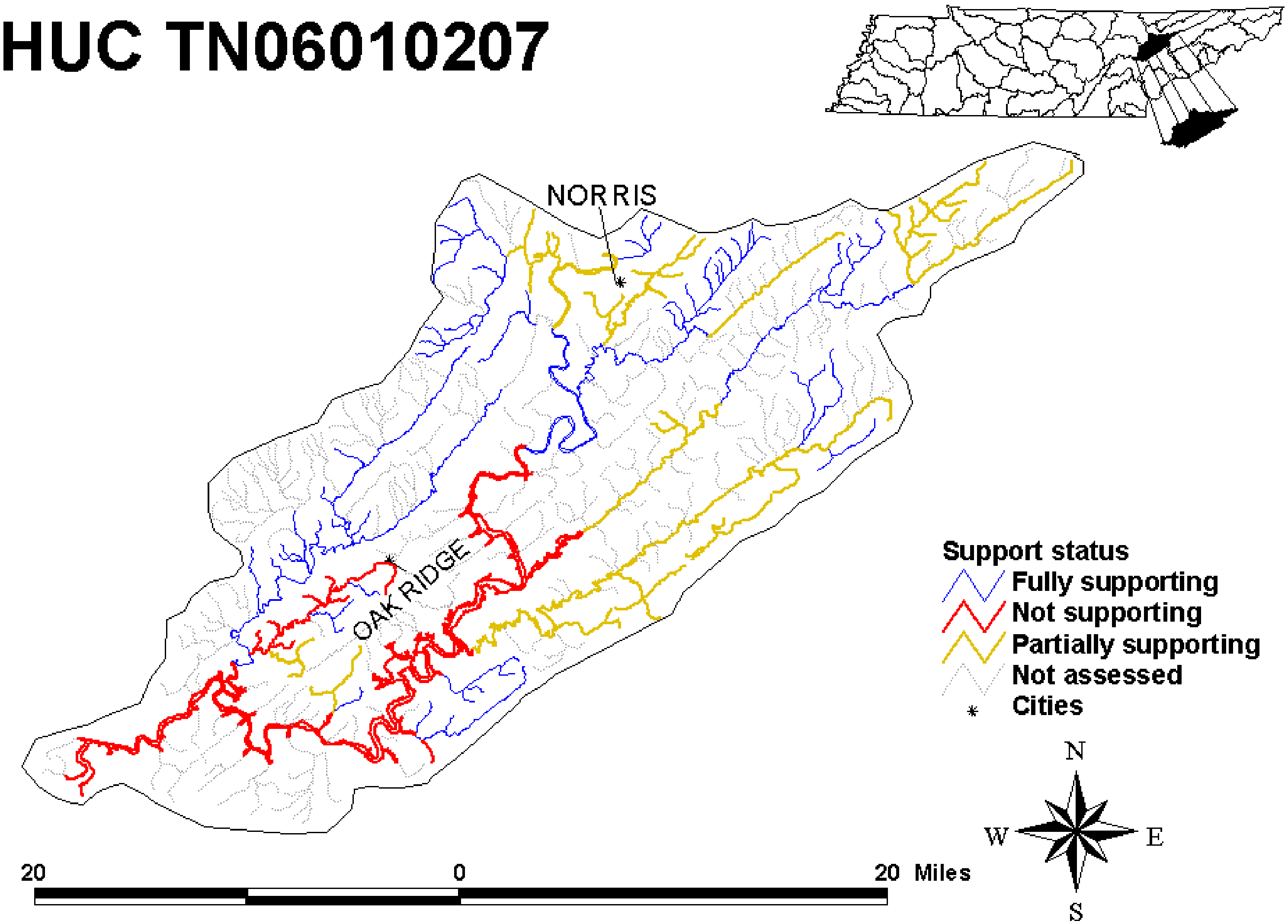
Dairies, beef cattle and tobacco farming are the dominant land uses with logging, mining and drilling for oil and natural gas also occurring. Eighty-four percent of assessed streams are fully supporting. Siltation, nutrients, habitat alteration and pathogens impair the most stream miles.

Three high quality streams are subecoregion reference sites, Powell River, Hardy Creek and Martin Creek in 67f (Southern Limestone Dolomite Valleys and Low Rolling Hills).



2002 Assessment of Rivers and Streams in Powell River Watershed

Lower Clinch River Watershed
HUC TN06010207



Lower Clinch River Watershed Atlas

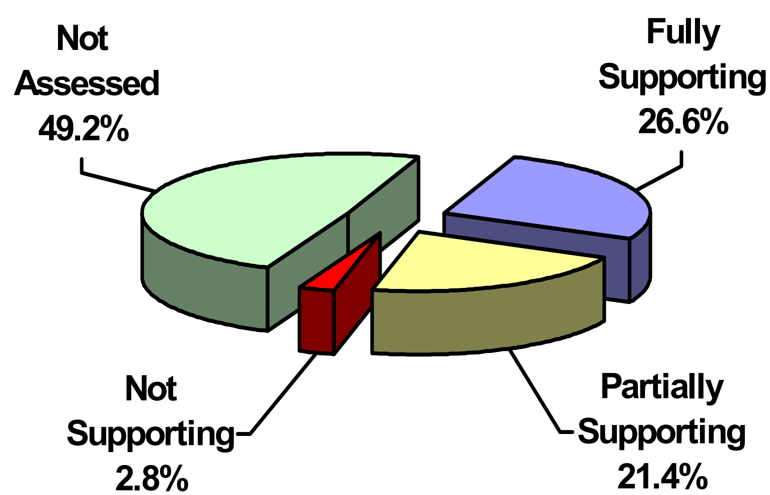
HUC Code:	**TN06010207**	
Counties:	Anderson Knox Morgan Union	Grainger Loudon Roane
Ecoregions:	67f 68a	67i 69d

Drainage Size of Watershed:	628 square miles
Stream Miles in Watershed:	801.9
Stream Miles Fully Supporting:	213.3
Stream Miles Partially Supporting:	171.9
Stream Miles Not Supporting:	22.3
Stream Miles Not Assessed:	394.4
Lake Acres in Watershed:	6,690
Lake Acres Not Supporting:	6,690 (100%)
TDEC Monitoring Stations:	45
Non-TDEC Monitoring Stations:	10
Advisories:	4
Watershed Monitoring Group:	3

Surface Water Quality in Lower Clinch River Watershed (including Melton Hill Reservoir)

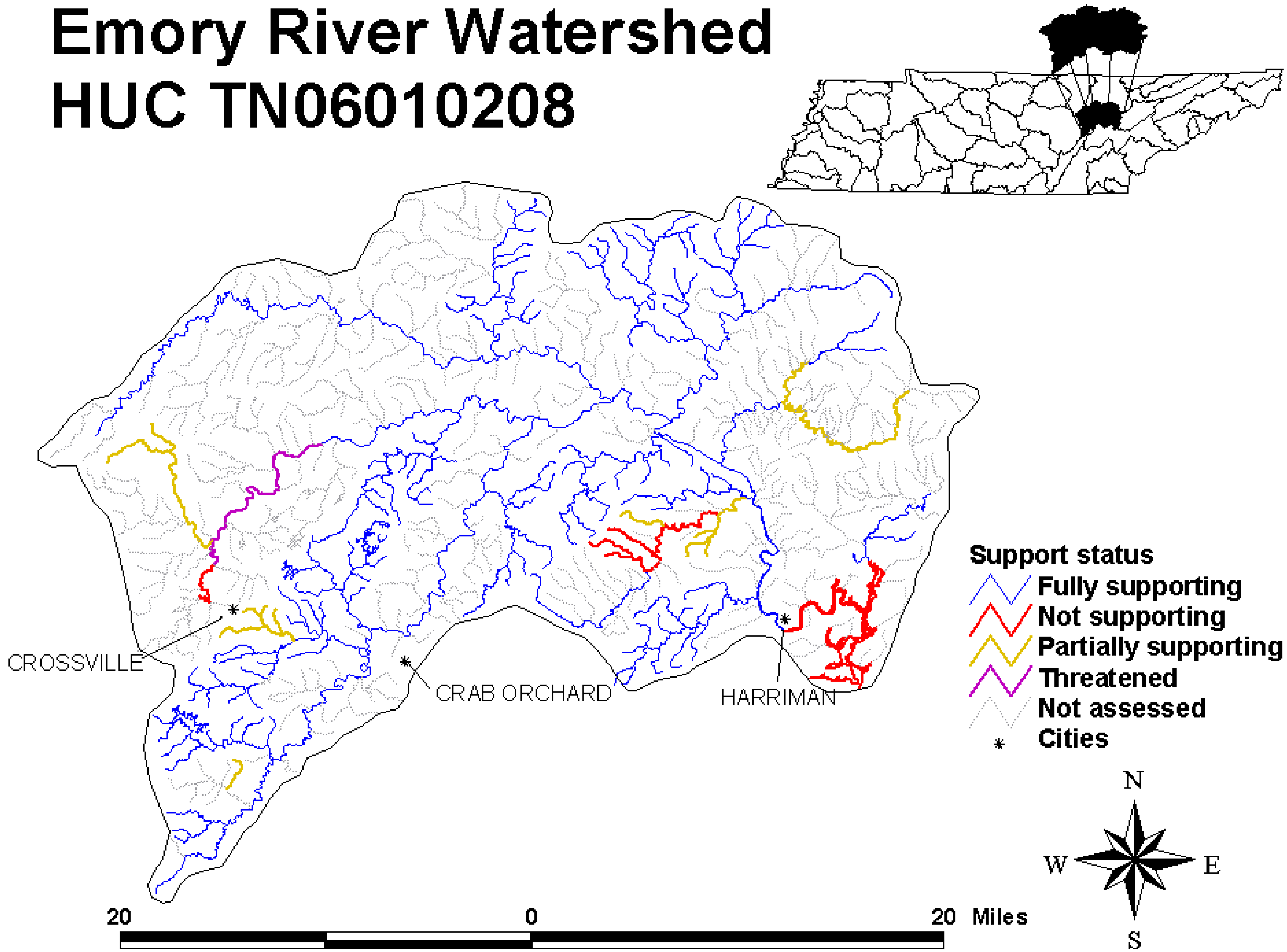
The entire Lower Clinch Watershed is in Tennessee. Land use is predominantly small farms, industry and urban development. Historic Department of Energy activities have resulted in mercury and PCB contamination of East Fork Poplar Creek and Melton Hill Reservoir. Only 52 percent of assessed streams are fully supporting.

Portions of the Clinch River are designated as a State Scenic River. Two high quality streams are subecoregion reference sites, Clear Creek in 67f (Southern Limestone Dolomite Valley and Low Rolling Hills) and Mill Creek in 67i (Southern Dissected Ridges and Knobs).



2002 Assessment of Rivers and Streams in Lower Clinch River Watershed

Emory River Watershed
HUC TN06010208



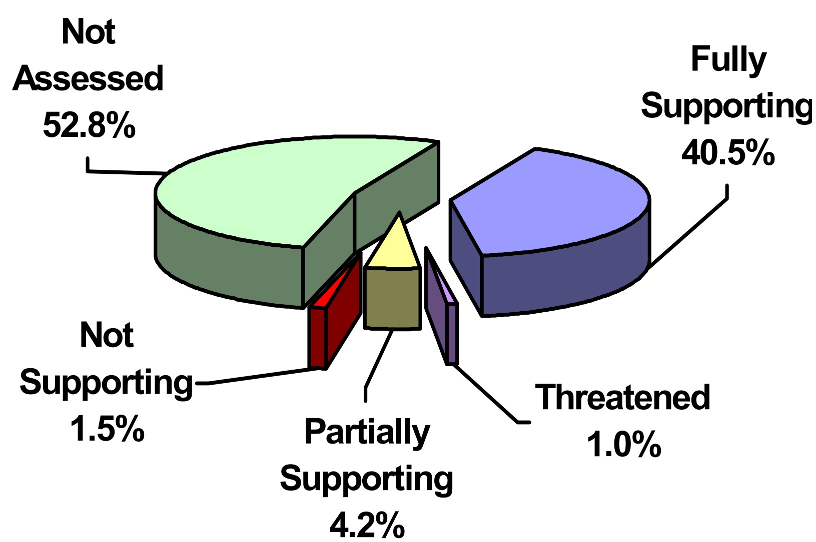
Emory River Watershed Atlas

HUC Code:	**TN06010208**		
Counties:	Cumberland Morgan		Fentress Roane
Ecoregions:	67f 68c	67i 69d	68a
Drainage Size of Watershed:		866 square miles	
Stream Miles in Watershed:		1,284.9	
Stream Miles Fully Supporting:		520.2	
Stream Miles Threatened:		12.4	
Stream Miles Partially Supporting:		54.6	
Stream Miles Not Supporting:		19.3	
Stream Miles Not Assessed:		678.4	
Lake Acres in Watershed:		47	
Lake Acres Not Assessed:		47 (100%)	
TDEC Monitoring Stations:		54	
Non-TDEC Monitoring Stations:		22	
Advisories:		None	
Watershed Monitoring Group:		1	

Surface Water Quality in Emory River Watershed

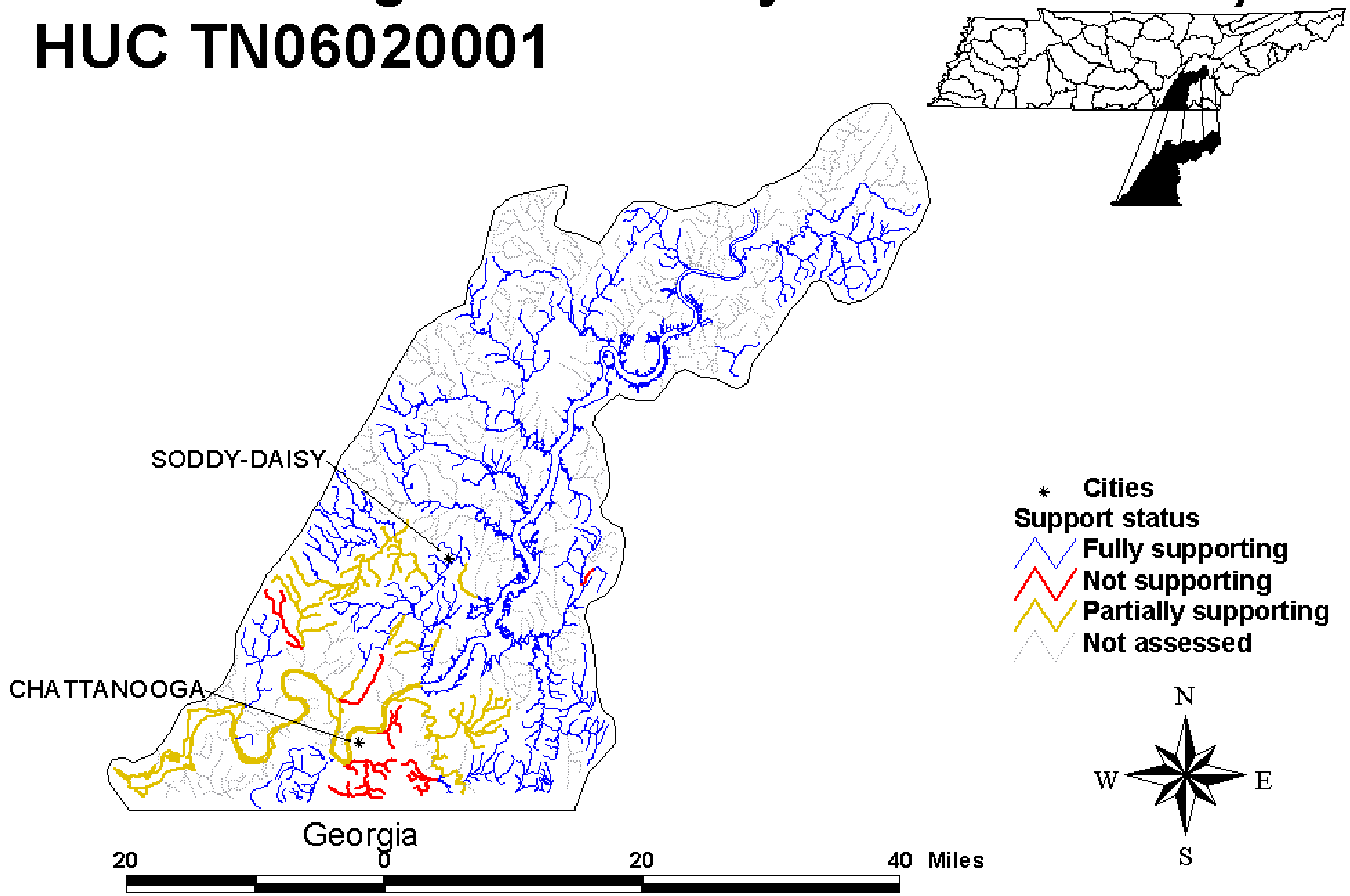
The entire watershed is within Tennessee. Eighty-six percent of assessed streams are fully supporting. Abandoned mines impair the most stream miles. Many of these areas are recovering, including 32 miles on the Emory River. EPA has approved pH TMDLs on five streams (28.8 stream miles).

The state's only Wild and Scenic River as designated by the National Park Service is the Obed River, including Clear and Daddy's Creeks, from the western border of the Cattoosa Wildlife Management Area to the Emory River. Five high quality streams are subecoregion reference sites, Clear, Daddy's, and Island Creeks and the Emory River in 68a (Cumberland Plateau) and Flat Fork in 69d (Cumberland Mountains).



2002 Assessment of Rivers and Streams in Emory River Watershed

Lower Tennessee River Watershed (including Chickamauga and Nickajack Reservoirs) HUC TN06020001



Lower Tennessee River Watershed Atlas

HUC Code: **TN06020001**

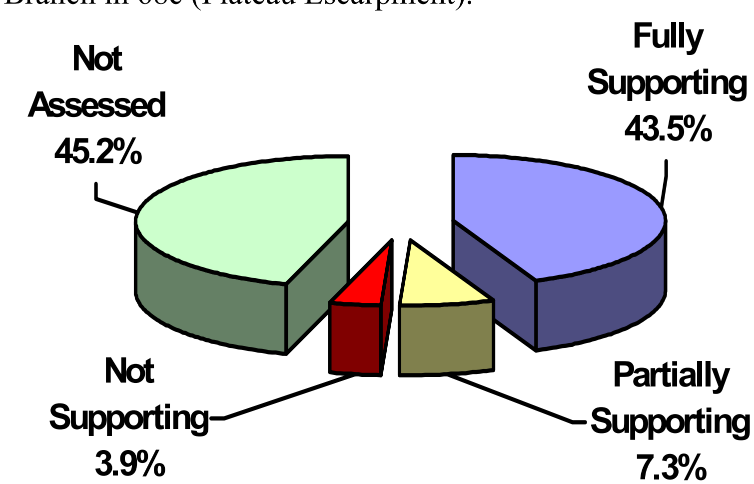
Counties:	Bledsoe	Bradley	Hamilton	
	Loudon	Marion	McMinn	
	Meigs	Rhea	Roane	
	Sequatchie			
Ecoregions:	67f	67g	67h	67i
	68a	68b	68c	

Drainage Size of Watershed:	1,200 square miles
Stream Miles in Watershed:	1,483.9
Stream Miles Fully Supporting:	646.1
Stream Miles Partially Supporting:	108.1
Stream Miles Not Supporting:	57.6
Stream Miles Not Assessed:	672.1
Lake Acres in Watershed:	45,780
Lake Acres Fully Supporting:	35,400 (77.3%)
Lake Acres Partially Supporting:	10,370 (22.7%)
Lake Acres Not Assessed:	10 (0.02%)
TDEC Monitoring Stations:	151
Non-TDEC Monitoring Stations:	136
Advisories:	3
Watershed Monitoring Groups:	3 (Chickamauga) 4 - (Nickajack)

Surface Water Quality in Lower Tennessee River Watershed (including Chickamauga and Nickajack Reservoirs)

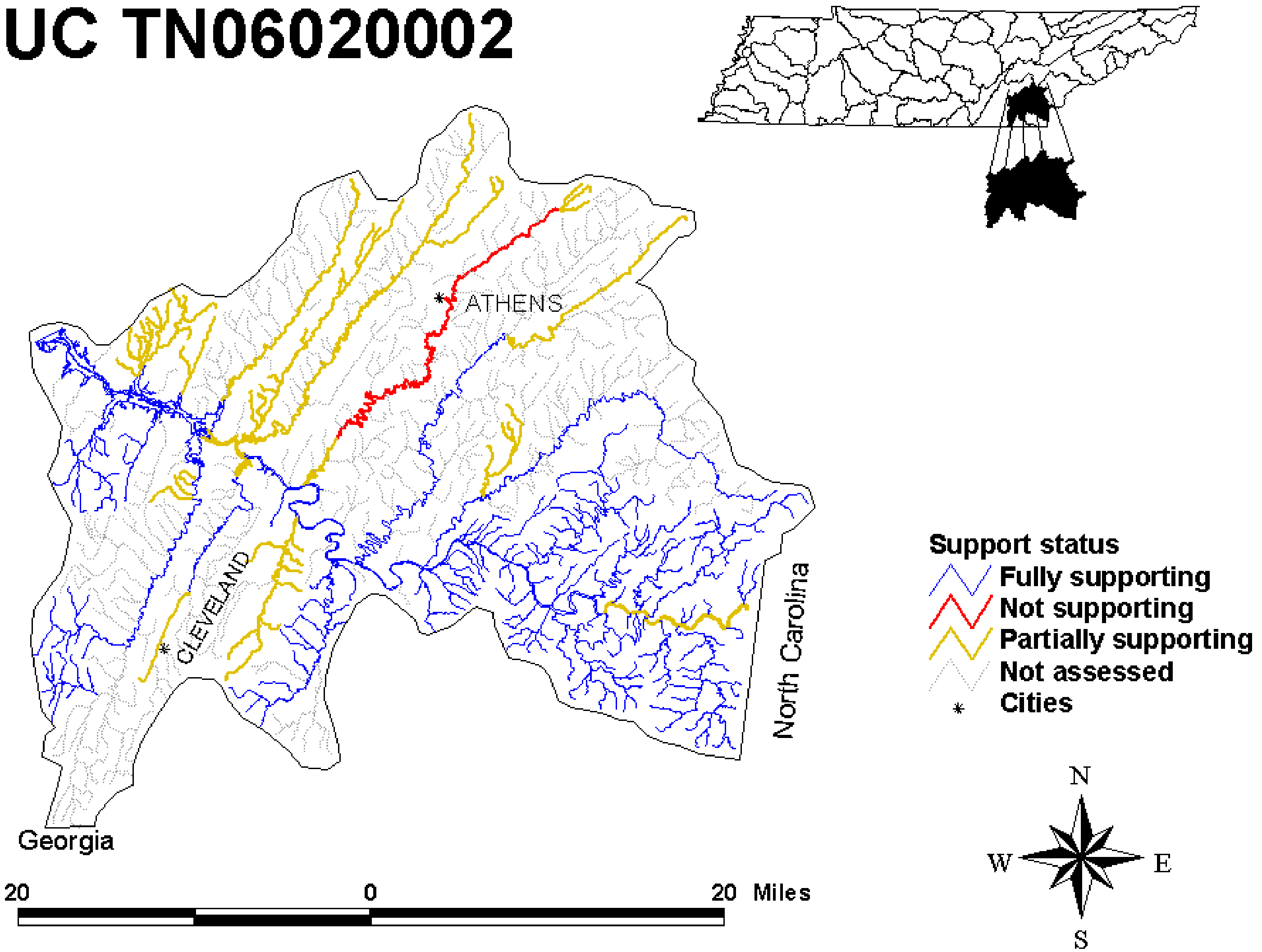
About 64 percent of the watershed is in Tennessee with the remainder in Georgia. This watershed includes a major metropolitan area as well as rural areas consisting of small cattle farms and abandoned mines. Eighty percent of assessed stream miles are fully supporting. Nickajack Reservoir is partially supporting due to accumulated PCBs and dioxin in fish tissue. Chickamauga Reservoir is fully supporting.

Two high quality streams are subecoregion reference sites, Mullins Creek in 68a (Cumberland Plateau) and Ellis Gap Branch in 68c (Plateau Escarpment).



2002 Assessment of Rivers and Streams in Lower Tennessee River Watershed

Hiwassee River Watershed
HUC TN06020002



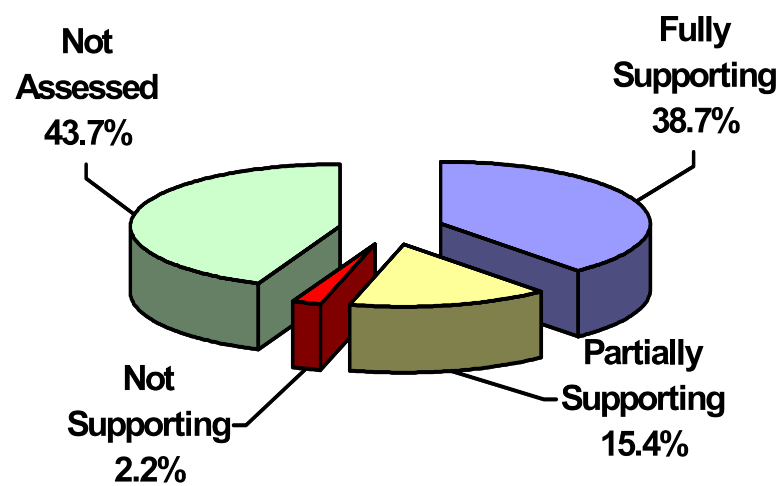
Hiwassee River Watershed Atlas

HUC Code:	**TN06020002**	
Counties:	Bradley McMinn Polk	Meigs Monroe
Ecoregions:	66g 67f 67h	66e 67g 67i
Drainage Size of Watershed:		1011 square miles
Stream Miles in Watershed:		1,657.0
Stream Miles Fully Supporting:		640.8
Stream Miles Partially Supporting:		255.0
Stream Miles Not Supporting:		37.0
Stream Miles Not Assessed:		724.2
Lake Acres in Watershed:		None
TDEC Monitoring Stations:		53
Non-TDEC Monitoring Stations:		21
Advisories:		1
Watershed Monitoring Group:		2

Surface Water Quality in Hiwassee River Watershed

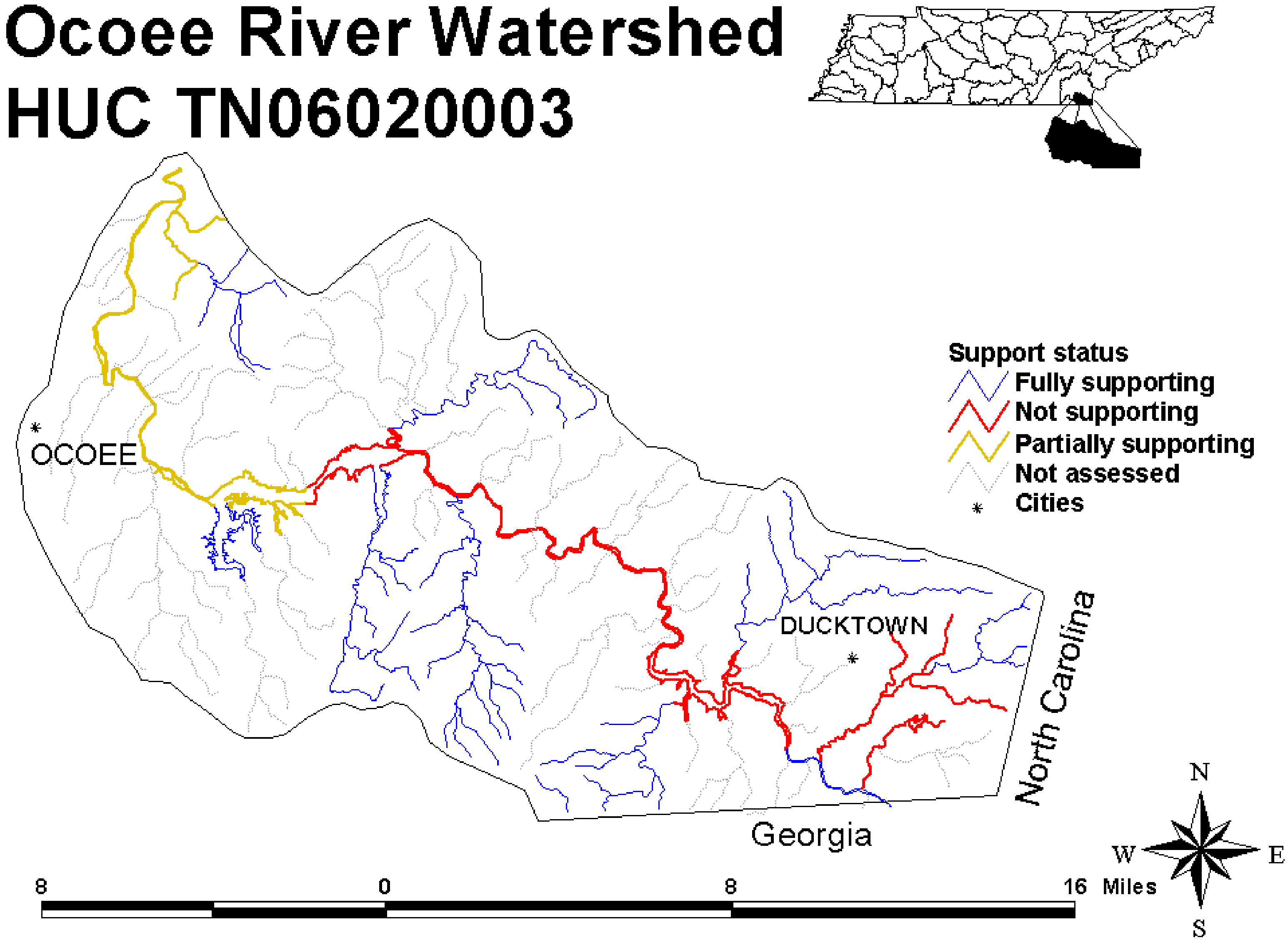
About half of the watershed is in Tennessee with the remainder in North Carolina and Georgia. This is a predominantly rural area defined by farms, small towns, and the Cherokee National Forest. Sixty-nine percent of assessed stream miles are fully supporting. Pathogens from agricultural activities affect 88 percent of the impaired stream miles.

A part of the Hiwassee River is designated as a State Scenic River, and is popular for recreational boating and fishing. Four high quality streams are subecoregion reference sites, Gee Creek in 66e (Southern Sedimentary Ridges), Brymer and Harris Creeks in 67g (Southern Shale Valleys), and Blackburn Creek in 67h (Southern Sandstone Ridges).



2002 Assessment of Rivers and Streams in Hiwassee River Watershed

Ocoee River Watershed
HUC TN06020003



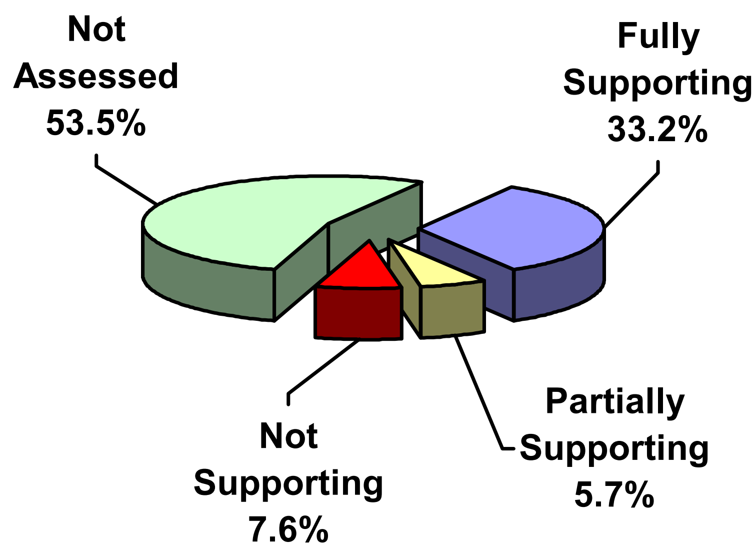
Ocoee River Watershed Atlas

HUC Code:	**TN06020003**		
Counties:	Polk		
Ecoregions:	66g	66e	67f
	67g	67i	
Drainage Size of Watershed:		207 square miles	
Stream Miles in Watershed:		313.5	
Stream Miles Fully Supporting:		104.0	
Stream Miles Partially Supporting:		17.8	
Stream Miles Not Supporting:		23.7	
Stream Miles Not Assessed:		168	
Lake Acres in Watershed:		2,881	
Lake Acres Fully Supporting:		627 (21.8%)	
Lake Acres Partially Supporting:		704 (24.4%)	
Lake Acres Not Supporting:		1,550 (53.8%)	
TDEC Monitoring Stations:		13	
Non-TDEC Monitoring Stations:		19	
Advisories:		None	
Watershed Monitoring Group:		1	

Surface Water Quality in Ocoee River Watershed

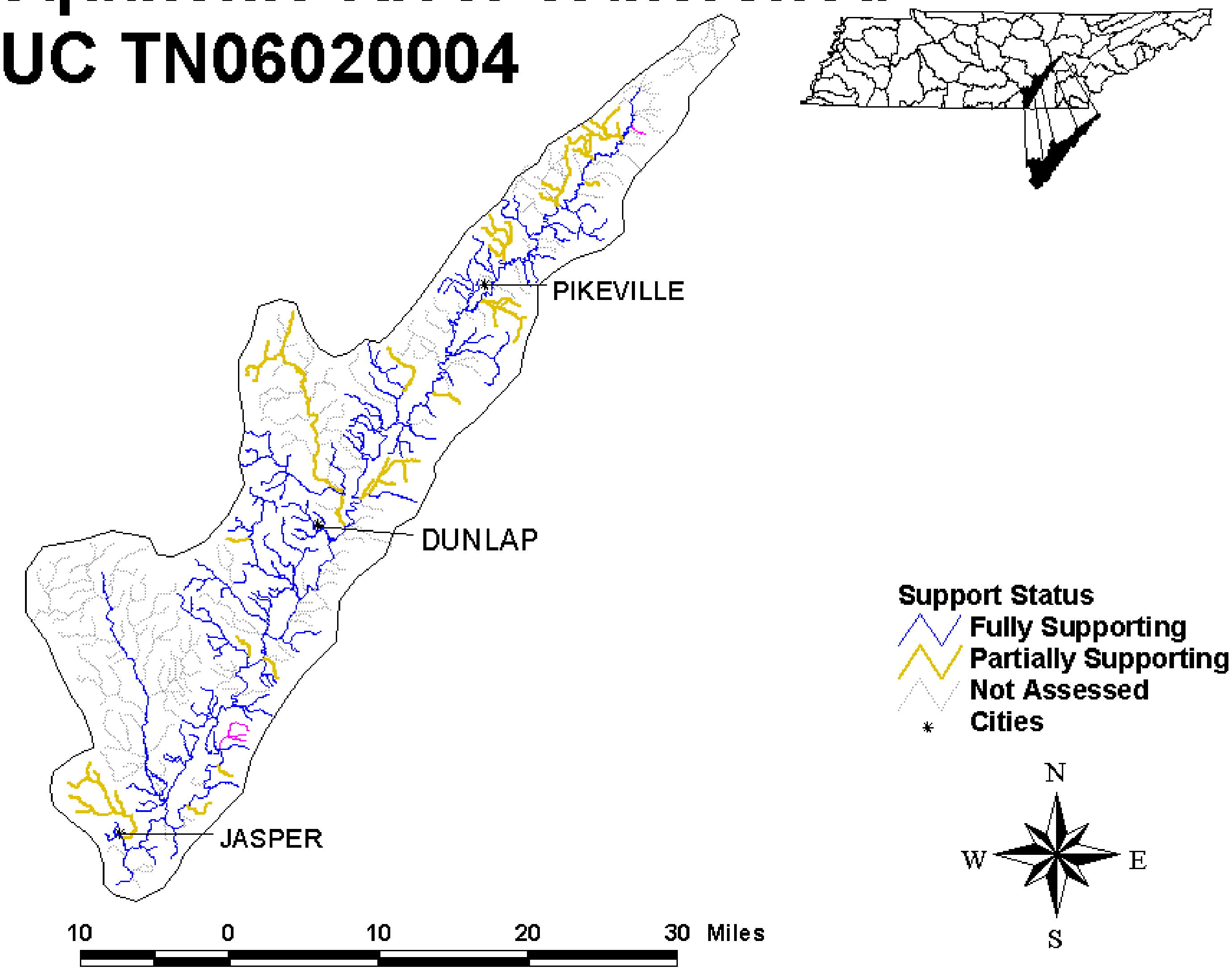
Only 32 percent of the Ocoee River Watershed is in Tennessee with the remainder in North Carolina and Georgia. Three hydroelectric dams were constructed on the Ocoee River between 1911 and 1942 and are currently operated by TVA for the production of electricity. Portions of the river are popular whitewater rafting and kayaking destinations.

The Ocoee River drains the Copper Basin. Copper mining and related operations were prevalent in this region since 1850. Most of the impaired stream miles and reservoir acres are a result of this activity. Extensive long term reforestation and clean up activities are being conducted in this watershed.



2002 Assessment of Rivers and Streams in Ocoee River Watershed

Sequatchie River Watershed
HUC TN06020004



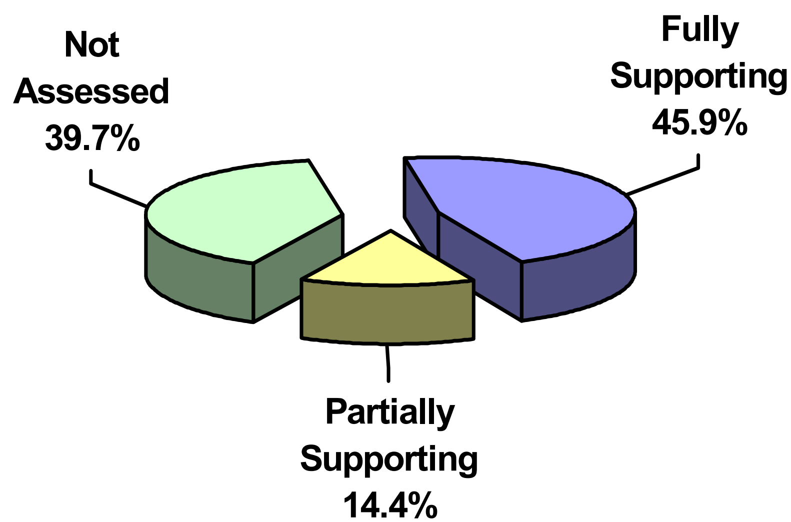
Sequatchie River Watershed Atlas

HUC Code:	**TN06020004**	
Counties:	Bledsoe Grundy Sequatchie	Cumberland Marion
Ecoregions:	68a 68b 68c	
Drainage Size of Watershed:		586 square miles
Stream Miles in Watershed:		909.3
Stream Miles Fully Supporting:		417.8
Stream Miles Partially Supporting:		130.9
Stream Miles Not Supporting:		0.0
Stream Miles Not Assessed:		360.6
Lake Acres in Watershed:		None
TDEC Monitoring Stations:		105
Non-TDEC Monitoring Stations:		3
Advisories:		None
Watershed Monitoring Group:		5

Surface Water Quality in Sequatchie River Watershed

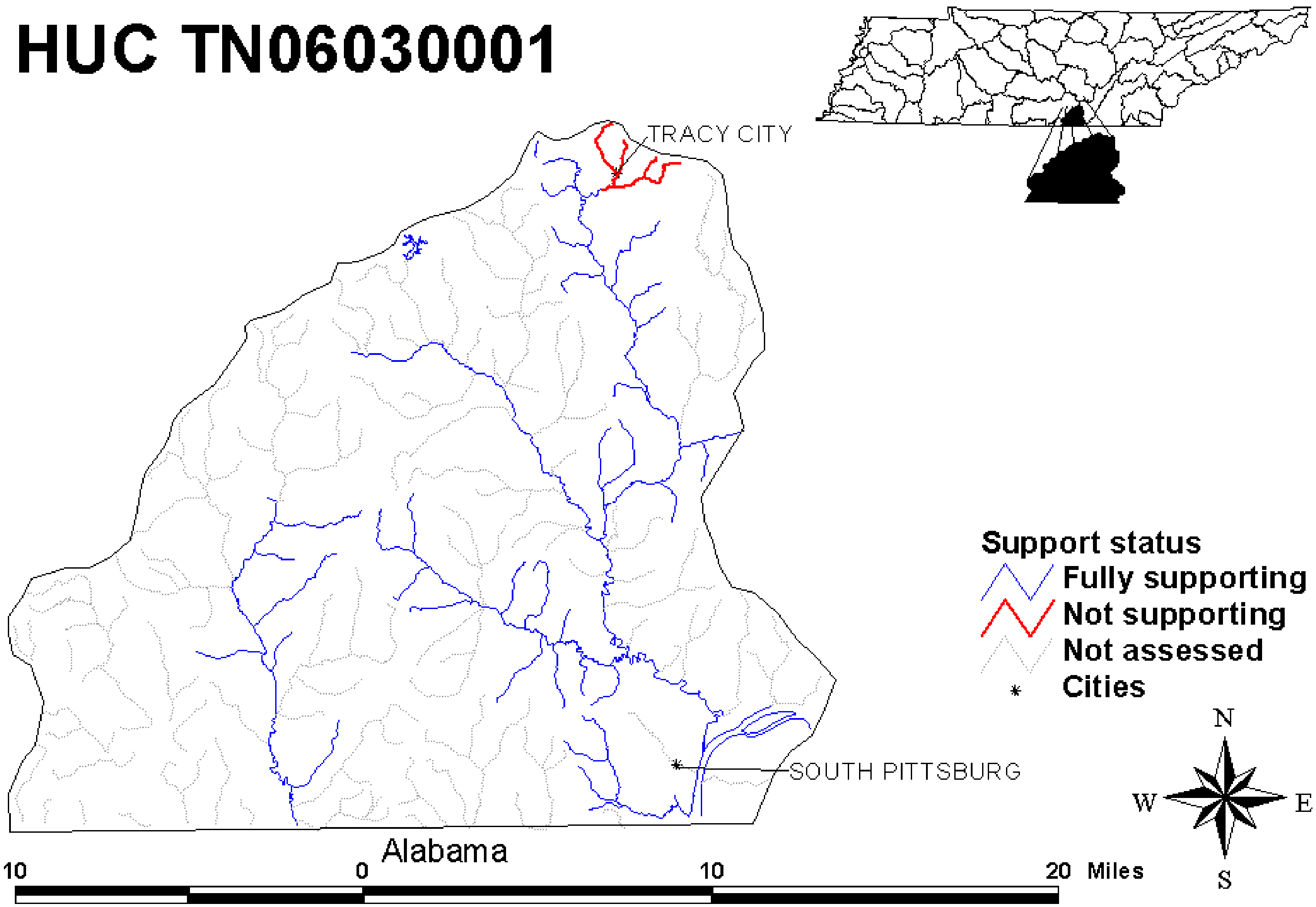
The entire watershed is in Tennessee. This is primarily a rural area with pasture the dominant land use. Pathogens from agricultural activities cause the most impaired stream miles. Sixty percent of the watershed has been assessed, up from 43 percent in 2000. The number of surveyed stream miles that are fully supporting has also increased from 38 percent in 2000 to 46 percent.

This watershed has three high quality streams that are subecoregion reference sites, Crystal Creek, McWilliams Creek and Mill Branch in 68b (Sequatchie Valley). Subecoregion 68b is completely contained within the Sequatchie River Watershed.



2002 Assessment of Rivers and Streams in Sequatchie River Watershed

Guntersville Reservoir Watershed
HUC TN06030001

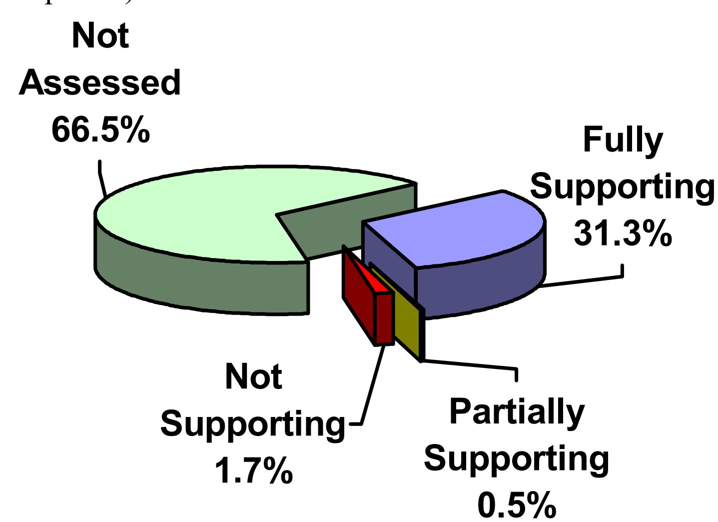


Guntersville Reservoir Watershed Atlas		
HUC Code:	**TN06030001**	
Counties:	Franklin Marion	Grundy
Ecoregions:	68a 68b 68c	
Drainage Size of Watershed:		322 square miles
Stream Miles in Watershed:	424.3	
Stream Miles Fully Supporting:	133.1	
Stream Miles Partially Supporting:	0.5	
Stream Miles Not Supporting:	7.1	
Stream Miles Not Assessed:	283.6	
Lake Acres in Watershed:	1479	
Lake Acres Fully Supporting:	1479 (100%)	
TDEC Monitoring Stations:	20	
Non-TDEC Monitoring Stations:	1	
Advisories:	0	
Watershed Monitoring Group:	5	

Surface Water Quality in Guntersville Reservoir Watershed

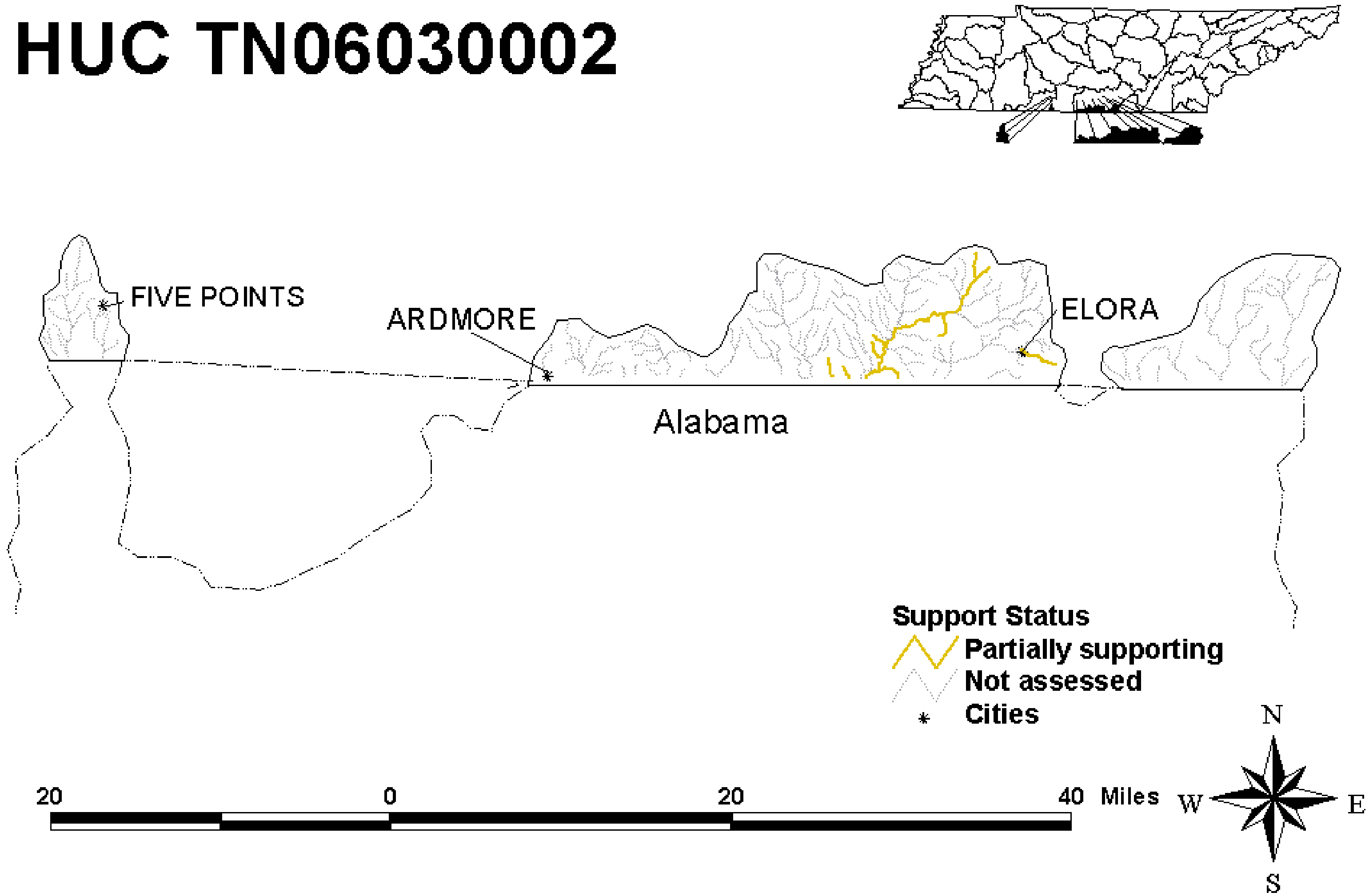
Only 16 percent of the watershed is in Tennessee with the remainder in Alabama. This is a rural area with small farms and mining. Data were only available to assess 33 percent of the streams. However, 94 percent of the surveyed streams were fully supporting. Pathogens and siltation were the primary pollutant. Guntersville Reservoir is fully supporting.

This watershed has one high quality stream that is a subecoregion reference site, Crow Creek in 68c (Plateau Escarpment).



2002 Assessment of Rivers and Streams in Guntersville Reservoir Watershed

Wheeler Reservoir Watershed
HUC TN06030002



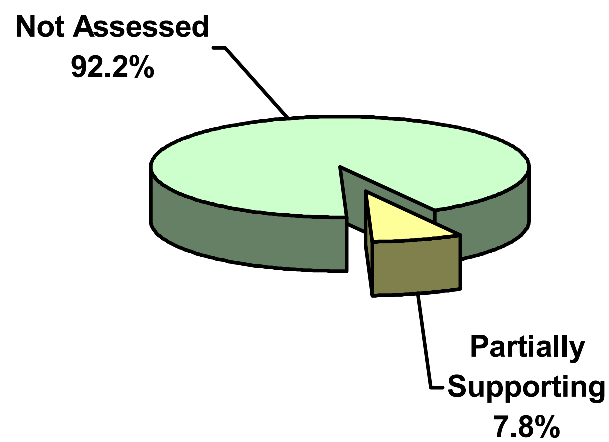
Wheeler Reservoir Watershed Atlas

HUC Code:	**TN06030002**	
Counties:	Franklin Lawrence	Giles Lincoln
Ecoregions:	68a 68c 71f 71g	
Drainage Size of Watershed:		236 square miles
Stream Miles in Watershed:	313.3	
Stream Miles Fully Supporting:	0.0	
Stream Miles Partially Supporting:	24.5	
Stream Miles Not Supporting:	0.0	
Stream Miles Not Assessed:	288.8	
Lake Acres in Watershed:		None
TDEC Monitoring Stations:	19	
Non-TDEC Monitoring Stations:	9	
Advisories:		None
Watershed Monitoring Group:	2	

Surface Water Quality in Wheeler Reservoir Watershed

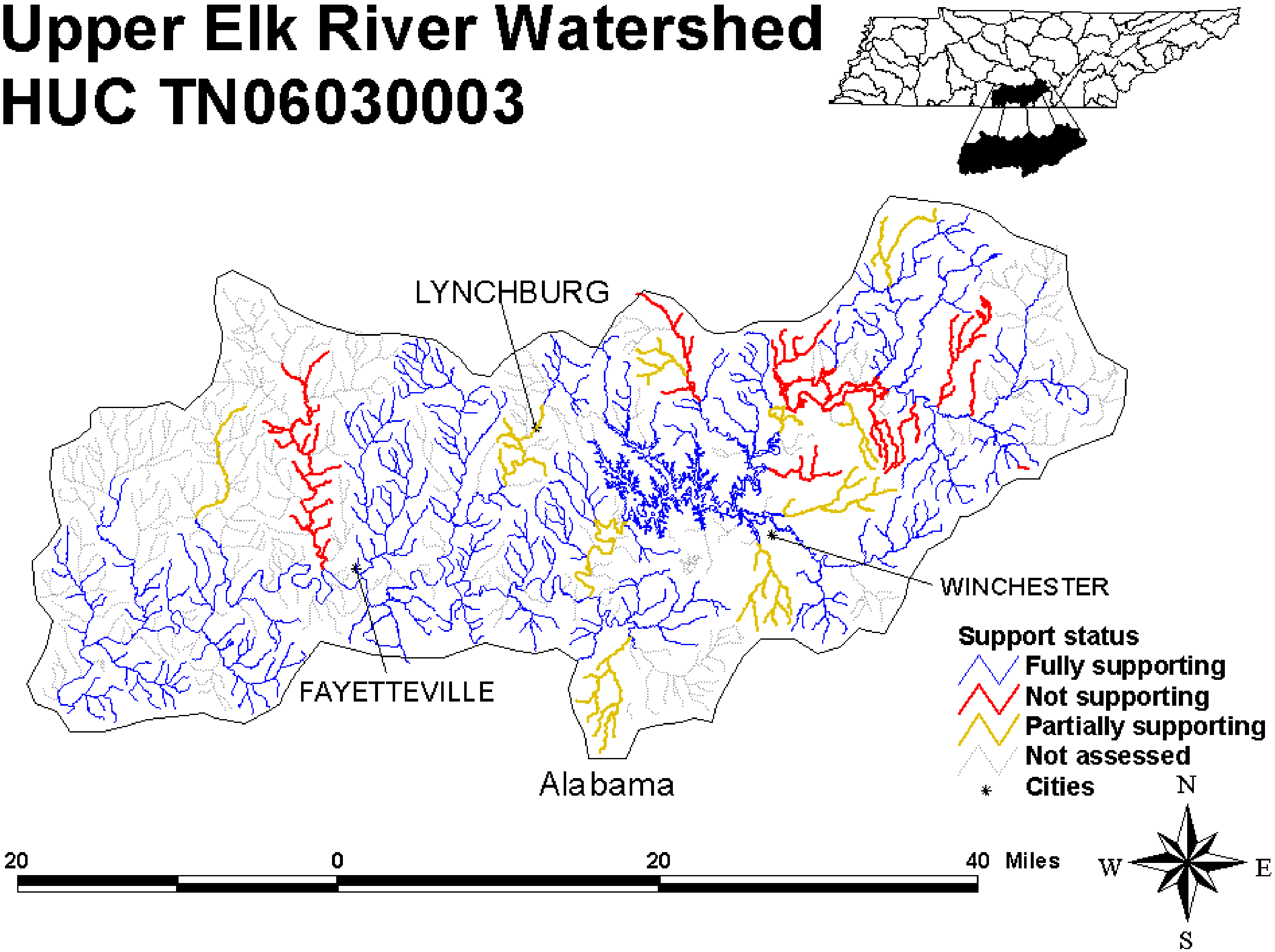
Eight percent of this watershed is in Tennessee. The rest is in Alabama.

Only two streams have been assessed in this watershed. Both are partially supporting. The Flint River is impaired by siltation and habitat alterations from crop production activities. This watershed is scheduled to be surveyed in Fall 2002 and 19 stations have been established. Assessment data will be included in the 2004 report.



2002 Assessment of Rivers and Streams in Wheeler Reservoir Watershed

Upper Elk River Watershed
HUC TN06030003



Upper Elk River Watershed Atlas

HUC Code: **TN06030003**

Counties:	Coffee	Franklin	Giles
	Grundy	Lincoln	Marshall
	Moore		

Ecoregions:	68a	68c
	71h	71g

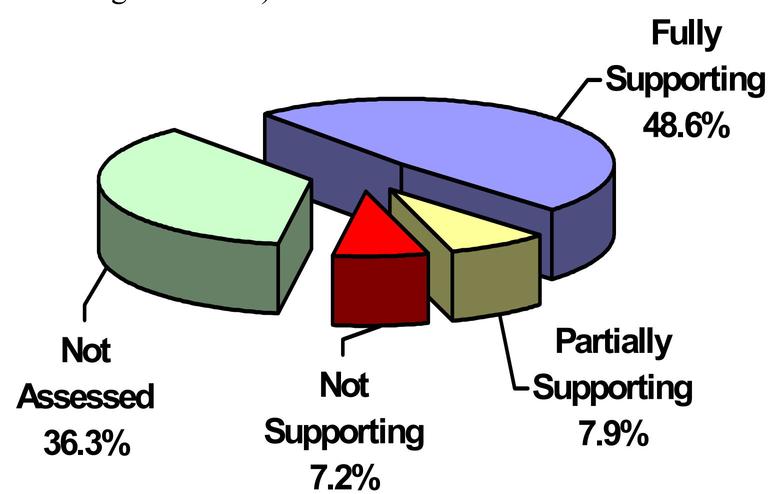
Drainage Size of Watershed:	1260 square miles
Stream Miles in Watershed:	1,812.5
Stream Miles Fully Supporting:	881.4
Stream Miles Partially Supporting:	144.0
Stream Miles Not Supporting:	129.6
Stream Miles Not Assessed:	657.5
Lake Acres in Watershed:	14,504
Lake Acres Fully Supporting:	10,596 (73.1%)
Lake Acres Not Supporting:	3,908 (26.9%)
TDEC Monitoring Stations:	108
Non-TDEC Monitoring Stations:	6
Advisories:	1
Watershed Monitoring Group:	2

Surface Water Quality in Upper Elk River Watershed (including Tims Ford and Woods Reservoirs)

Over 99 percent of the watershed is in Tennessee with a small portion in Alabama. TVA completed Tims Ford hydroelectric dam in 1970. The U.S. Air Force completed Woods Dam in 1952 to use as a source of cooling water. Both reservoirs are popular recreation areas.

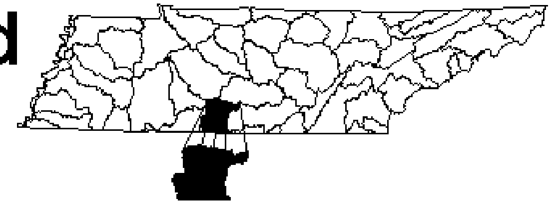
Woods Reservoir is not supporting due to PCBs from contaminated sediments. Tims Ford Reservoir, as well as 76 percent of assessed streams in the watershed, is fully supporting.

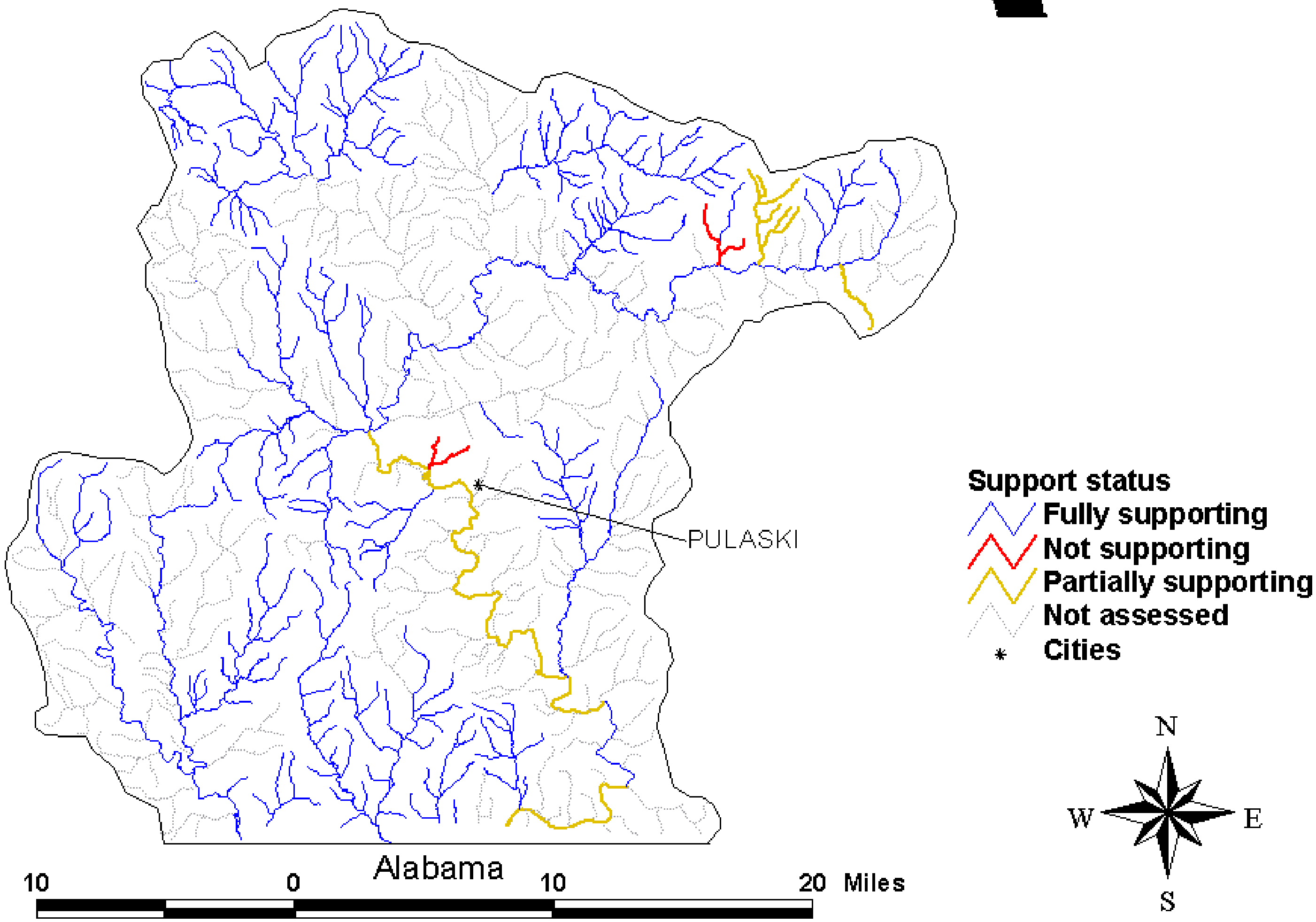
Two high quality streams are subecoregion reference sites, Mud Creek in 68c (Plateau Escarpment) and Hurricane Creek in 71g (Eastern Highland Rim).



2002 Assessment of Rivers and Streams in Upper Elk River Watershed

Lower Elk River Watershed
HUC TN06030004





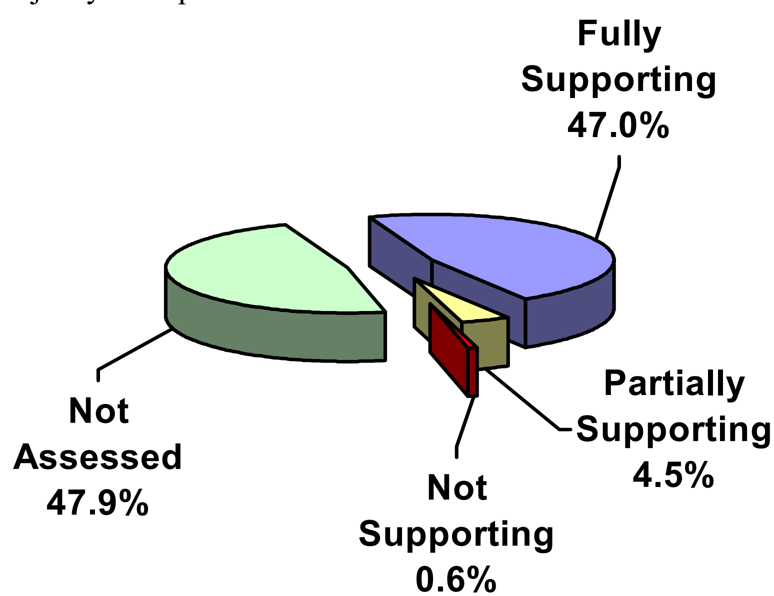
Lower Elk River Watershed Atlas

HUC Code:	**TN06030004**	
Counties:	Giles Lawrence Marshall	
Ecoregions:	71f 71h	
Drainage Size of Watershed:		718 square miles
Stream Miles in Watershed:		1,117.3
Stream Miles Fully Supporting:		524.7
Stream Miles Partially Supporting:		50.0
Stream Miles Not Supporting:		7.2
Stream Miles Not Assessed:		535.4
Lake Acres in Watershed:		None
TDEC Monitoring Stations:		80
Non-TDEC Monitoring Stations:		1
Advisories:		None
Watershed Monitoring Group:		2

Surface Water Quality in Lower Elk River Watershed

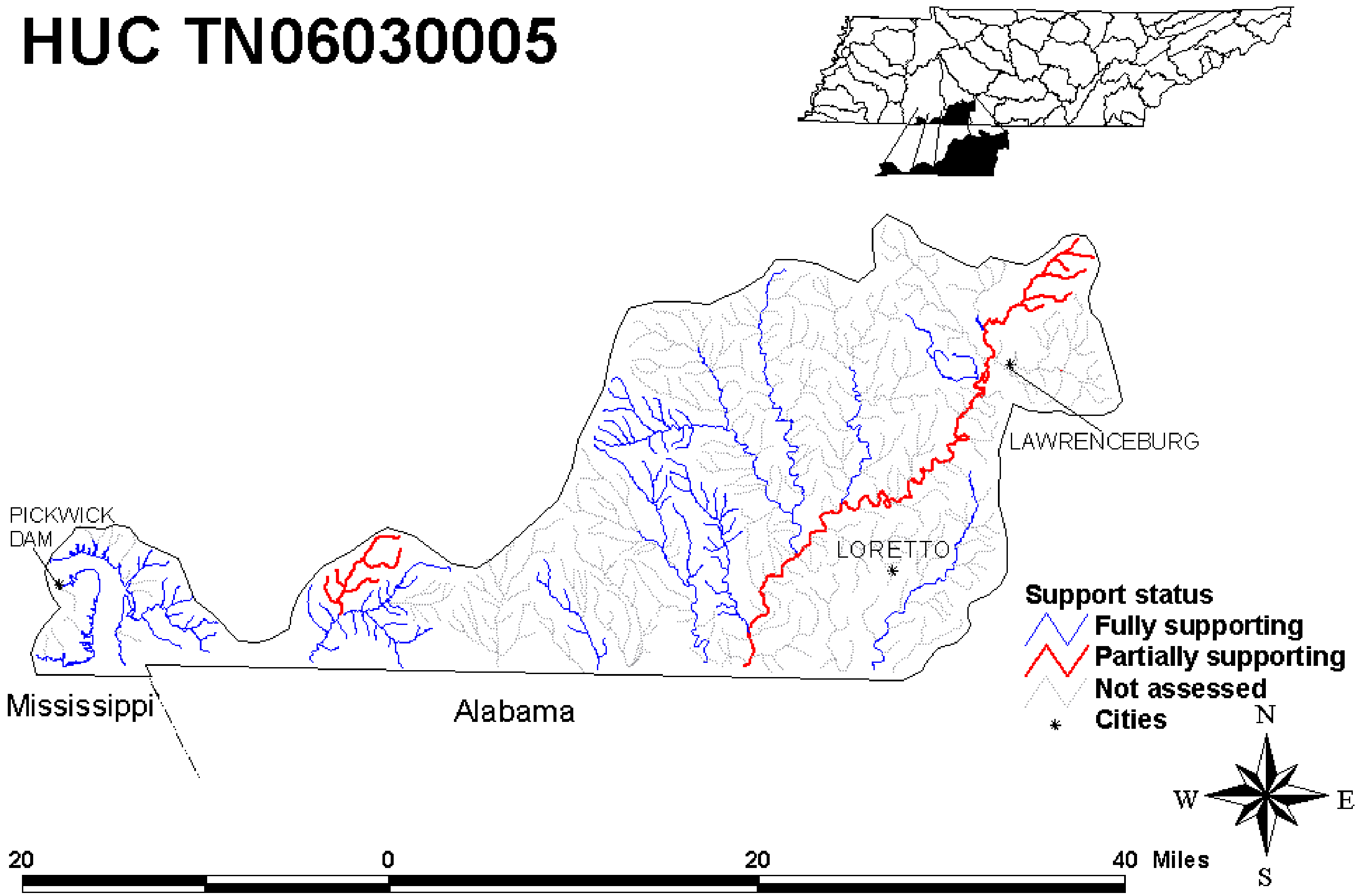
Seventy-six percent of the watershed is in Tennessee with the remainder in Alabama. From Tennessee, the Elk River flows into Wheeler Reservoir on the Tennessee River in Alabama.

The drainage area is primarily agricultural with row crops and pasture prevalent. Assessments in this watershed have increased from eight percent in 2000 to 52 percent for this report. Most of the newly assessed steams (90 percent) were fully supporting. Industry, municipal point sources and livestock account for the majority of impaired stream miles.



2002 Assessment of Rivers and Streams in Lower Elk River Watershed

Pickwick Reservoir Watershed
HUC TN06030005



Pickwick Reservoir Watershed Atlas

HUC Code: **TN06030005**

Counties: Hardin
Lawrence
Wayne

Ecoregions: 65i
65j
71f

Drainage Size of Watershed: 639 square miles

Stream Miles in Watershed:	953.2
Stream Miles Fully Supporting:	247.1
Stream Miles Partially Supporting:	72.4
Stream Miles Not Supporting:	0.0
Stream Miles Not Assessed:	633.7

Lake Acres in Watershed:	5,840
Lake Acres Fully Supporting:	5,840 (100%)

TDEC Monitoring Stations: 81

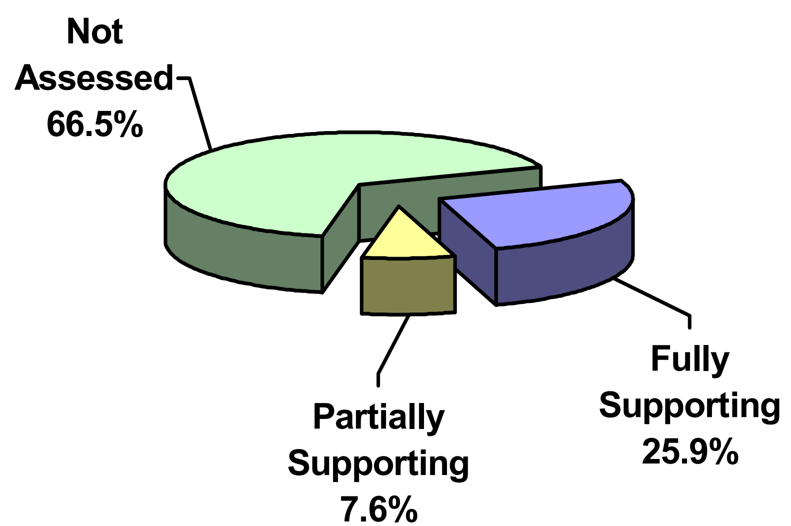
Advisories: None

Watershed Monitoring Group: 2

Surface Water Quality in Pickwick Reservoir Watershed

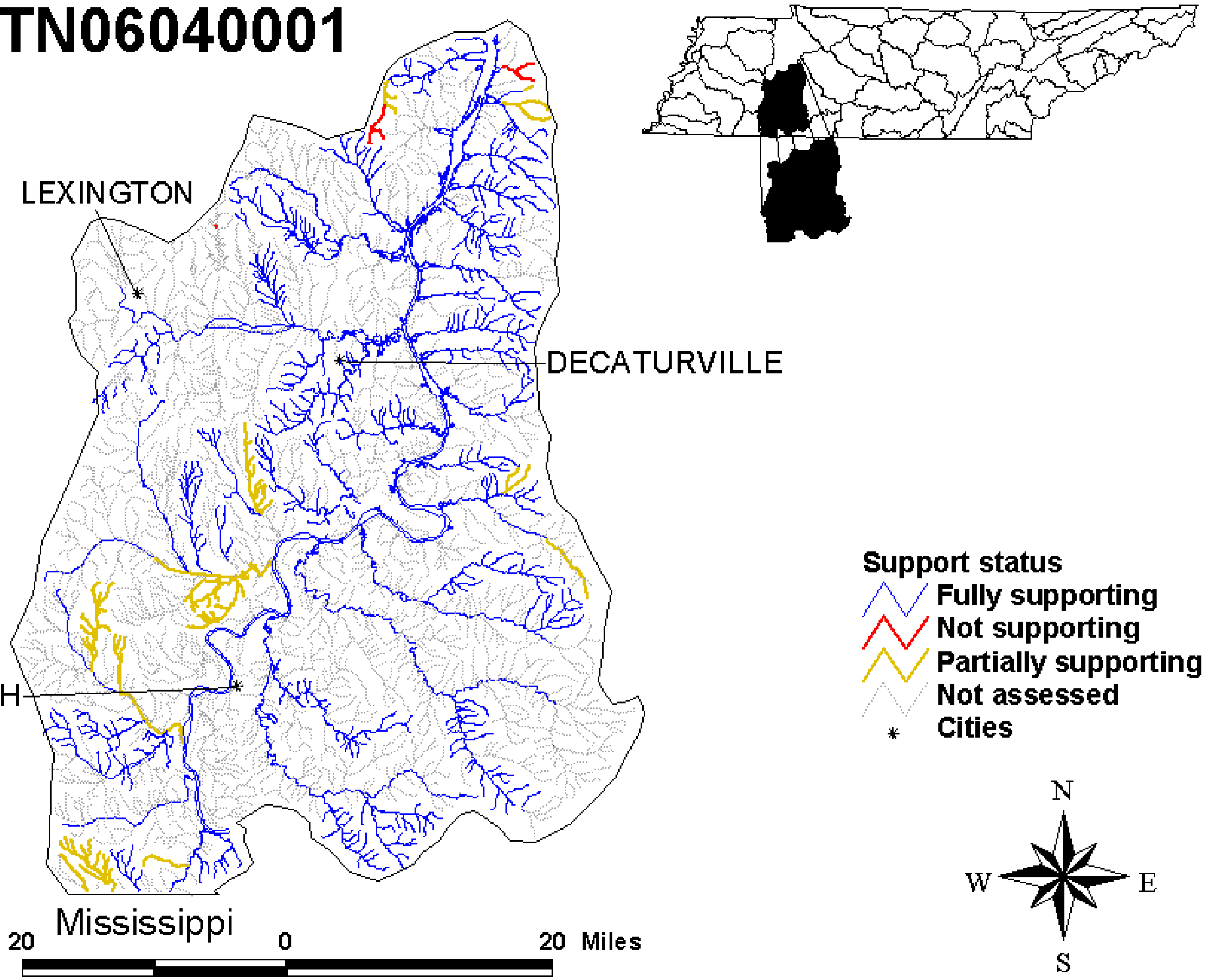
Only 28 percent of the watershed is in Tennessee with the remainder in Mississippi and Alabama. Pickwick Reservoir is a TVA impoundment of the Tennessee River. Seventy-seven percent of assessed streams are fully supporting. Industry, municipal point source, and livestock are the primary pollution sources. EPA has approved organic enrichment, ammonia TMDLs on a segment of Shoal Creek (2.3 stream miles).

This watershed has four high quality streams that are subecoregion reference sites, Battle Branch in 65i (Fall Line Hills), Pompeys Branch and Dry Creek in 65j (Transition Hills), and Swanegan Branch in 71f (Western Highland Rim).



2002 Assessment of Rivers and Streams in Pickwick Reservoir Watershed

Upper Kentucky Reservoir Watershed
HUC TN06040001



Upper Kentucky Reservoir Watershed Atlas

HUC Code: **TN06040001**

Counties:	Benton	Chester	Decatur
	Hardin	Humphreys	Henderson
	McNairy	Perry	Wayne

Ecoregions:	65a	65e	65i
	65j	71f	

Drainage Size of Watershed: 2,049 square miles

Stream Miles in Watershed:	3,435.2
Stream Miles Fully Supporting:	1,119.3
Stream Miles Partially Supporting:	153.0
Stream Miles Not Supporting:	9.8
Stream Miles Not Assessed:	2,153.1

Lake Acres in Watershed:	20,763
Lake Acres Fully Supporting:	17,500 (84.3%)
Lake Acres Not Assessed:	3,263 (15.7%)

TDEC Monitoring Stations:	140
Non-TDEC Monitoring Stations:	3

Advisories: None

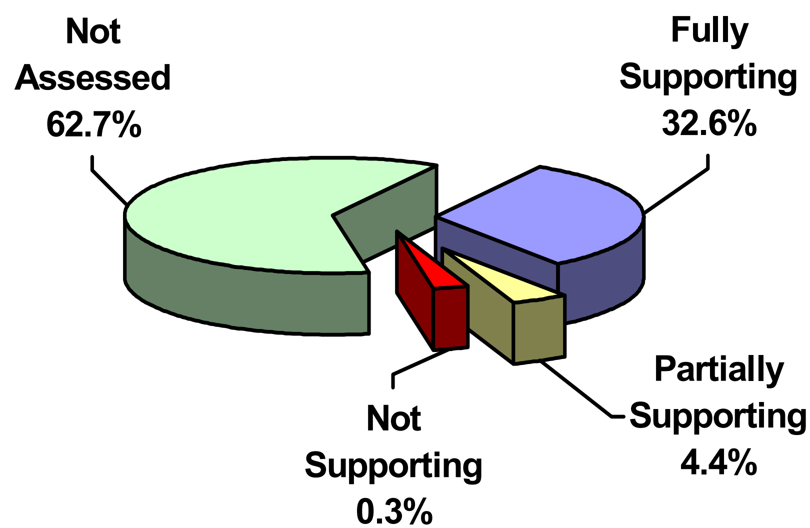
Watershed Monitoring Group: 3

Surface Water Quality in Upper Kentucky Reservoir Watershed

Over 98 percent of the watershed is in Tennessee with a small portion in Mississippi. Between 1963 and 1965 TVA constructed dams on the Beech River and seven tributaries for flood control and recreational use.

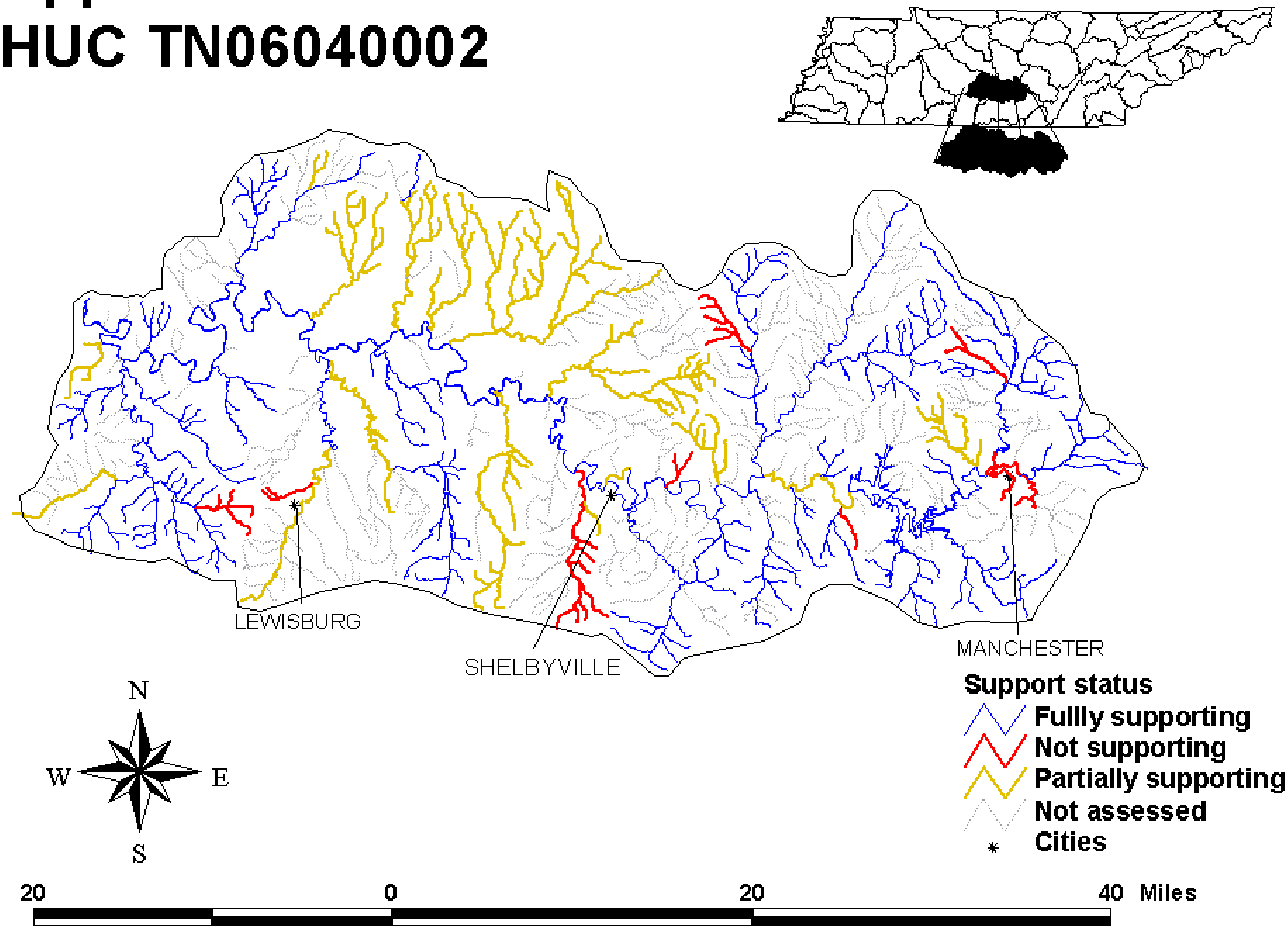
Logging, agriculture and channelization are the primary pollution sources with siltation the most prevalent pollutant. Eighty-seven percent of assessed streams are fully supporting.

Two high quality streams are subecoregion reference sites, Right Fork Whites Creek and an unnamed tributary to Right Fork Whites Creek in 65j (Transition Hills).



2002 Assessment of Rivers and Streams in Upper Kentucky Reservoir Watershed

Upper Duck River Watershed
HUC TN06040002



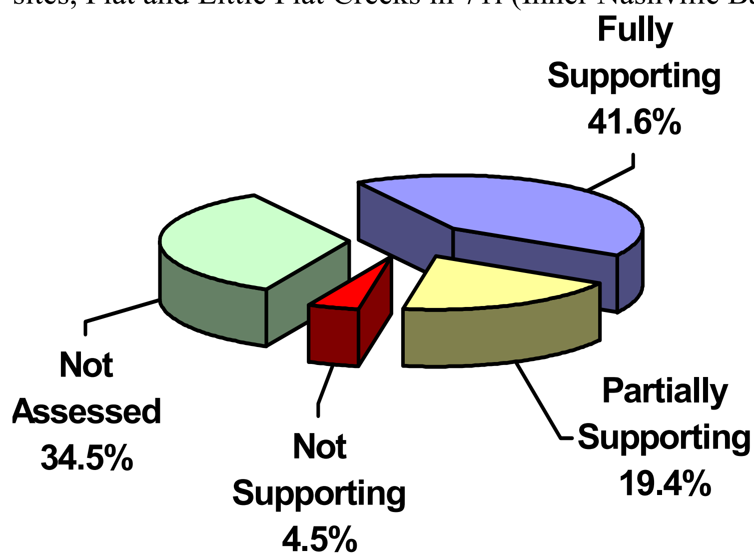
Upper Duck River Watershed Atlas

HUC Code:	**TN06040002**	
Counties:	Bedford	Coffee
	Marshall	Williamson
Ecoregions:	71g	
	71h	
	71i	
Drainage Size of Watershed:		1553 square miles
Stream Miles in Watershed:		1,606.9
Stream Miles Fully Supporting:		668.4
Stream Miles Partially Supporting:		311.7
Stream Miles Not Supporting:		72.8
Stream Miles Not Assessed:		554.0
Lake Acres in Watershed:		3,260
Lake Acres Fully Supporting:		3,260 (100%)
TDEC Monitoring Stations:		287
Non-TDEC Monitoring Stations:		45
Advisories:		2
Watershed Monitoring Group:		3

Surface Water Quality in Upper Duck River Watershed (including Normandy Reservoir)

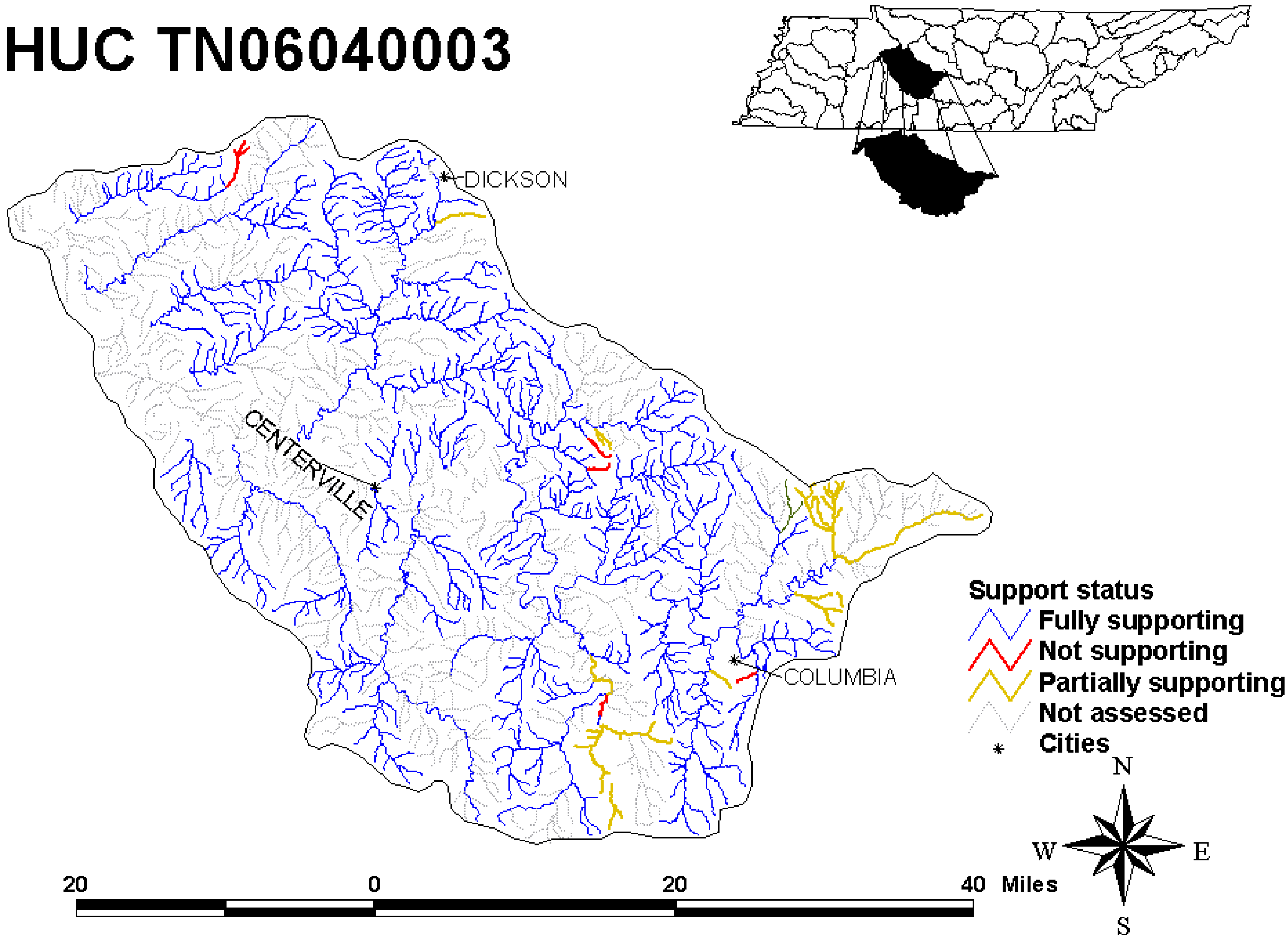
The entire watershed is in Tennessee. Normandy Dam, built for flood control, is TVA's largest non-power generating dam. Sixty-four percent of surveyed stream miles were fully supporting. Pathogens, nutrients, siltation and habitat alteration from agricultural activities impair the most stream miles.

Portions of the Duck River are designated as a State Scenic River. The river also provides habitat for several endangered species. Two high quality streams are subecoregion reference sites, Flat and Little Flat Creeks in 71i (Inner Nashville Basin).



2002 Assessment of Rivers and Streams in Upper Duck River Watershed

Lower Duck River Watershed
HUC TN06040003



Lower Duck River Watershed Atlas

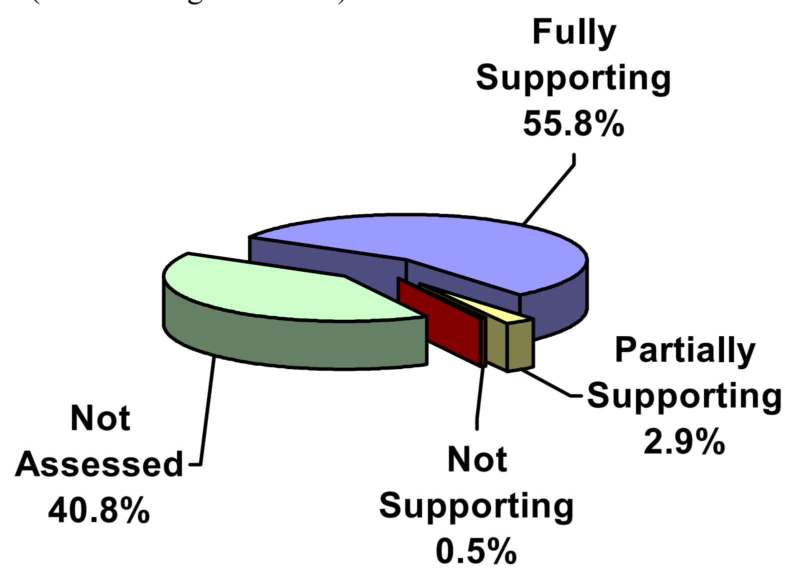
HUC Code:	**TN06040003**	
Counties:	Dickson	Hickman
	Humphreys	Lawrence
	Lewis	Maury
	Perry	Wayne
	Williamson	
Ecoregions:	71f	
	71h	

Drainage Size of Watershed:	736 square miles
Stream Miles in Watershed:	2,461.8
Stream Miles Fully Supporting:	1,374.0
Stream Miles Partially Supporting:	70.9
Stream Miles Not Supporting:	13.1
Stream Miles Not Assessed:	1,003.8
Lake Acres in Watershed:	13
Lake Acres Not Assessed:	13 (100%)
TDEC Monitoring Stations:	86
Non-TDEC Monitoring Stations:	24
Advisories:	None
Watershed Monitoring Group:	3

Surface Water Quality in Lower Duck River Watershed

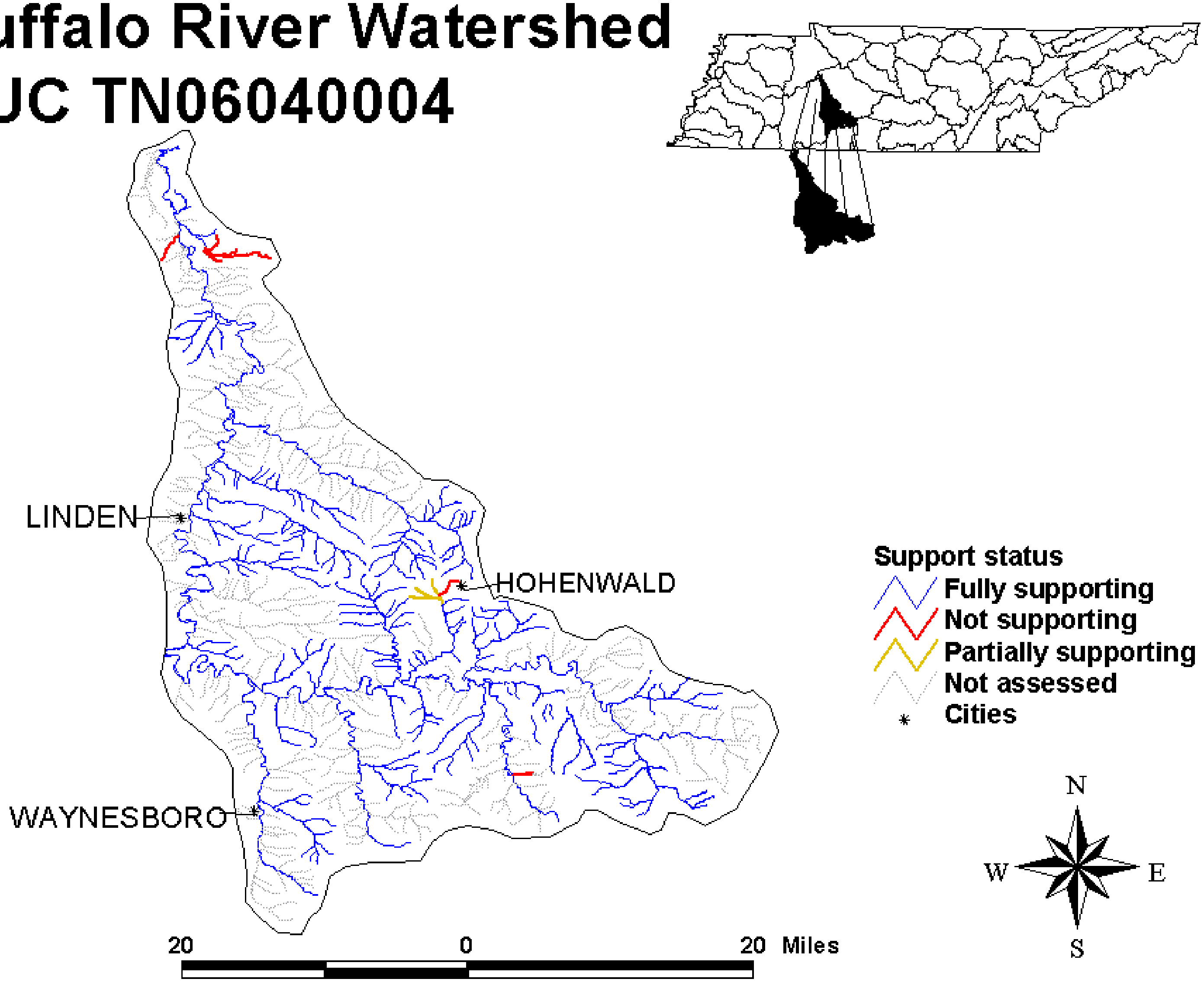
The entire watershed is in Tennessee. The area is primarily agricultural with some small towns and industry. There are also some abandoned mines. Ninety-four percent of assessed streams are fully supporting. Point source discharges (industrial and municipal), urban runoff, abandoned mines and livestock operations are sources of impairment.

This watershed has two high quality streams that are subecoregion reference sites, Wolf and Little Swan Creeks in 71f (Western Highland Rim).



2002 Assessment of Rivers and Streams in Lower Duck River Watershed

Buffalo River Watershed
HUC TN06040004



Buffalo River Watershed Atlas

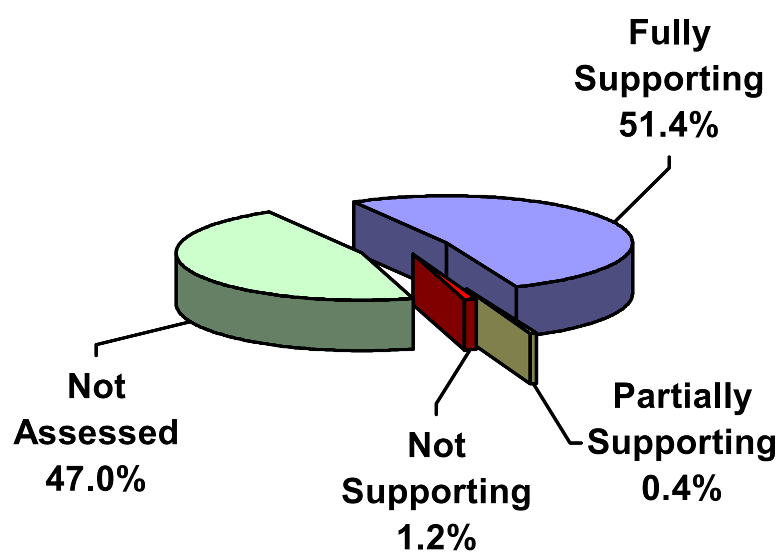
HUC Code:	**TN06040004**	
Counties:	Hickman Lawrence Perry	Humphreys Lewis Wayne
Ecoregions:	65j 71f	
Drainage Size of Watershed:		1,823 square miles
Stream Miles in Watershed:		1,200.0
Stream Miles Fully Supporting:		616.6
Stream Miles Partially Supporting:		5.1
Stream Miles Not Supporting:		14.1
Stream Miles Not Assessed:		564.2
Lake Acres in Watershed:		349
Lake Acres Not Assessed:		349 (100%)
TDEC Monitoring Stations:		87
Advisories:		None
Watershed Monitoring Group:		3

Surface Water Quality in Buffalo River Watershed

The entire watershed is in southern middle Tennessee. The Buffalo River flows into the Duck River just upstream of its confluence with the Tennessee River.

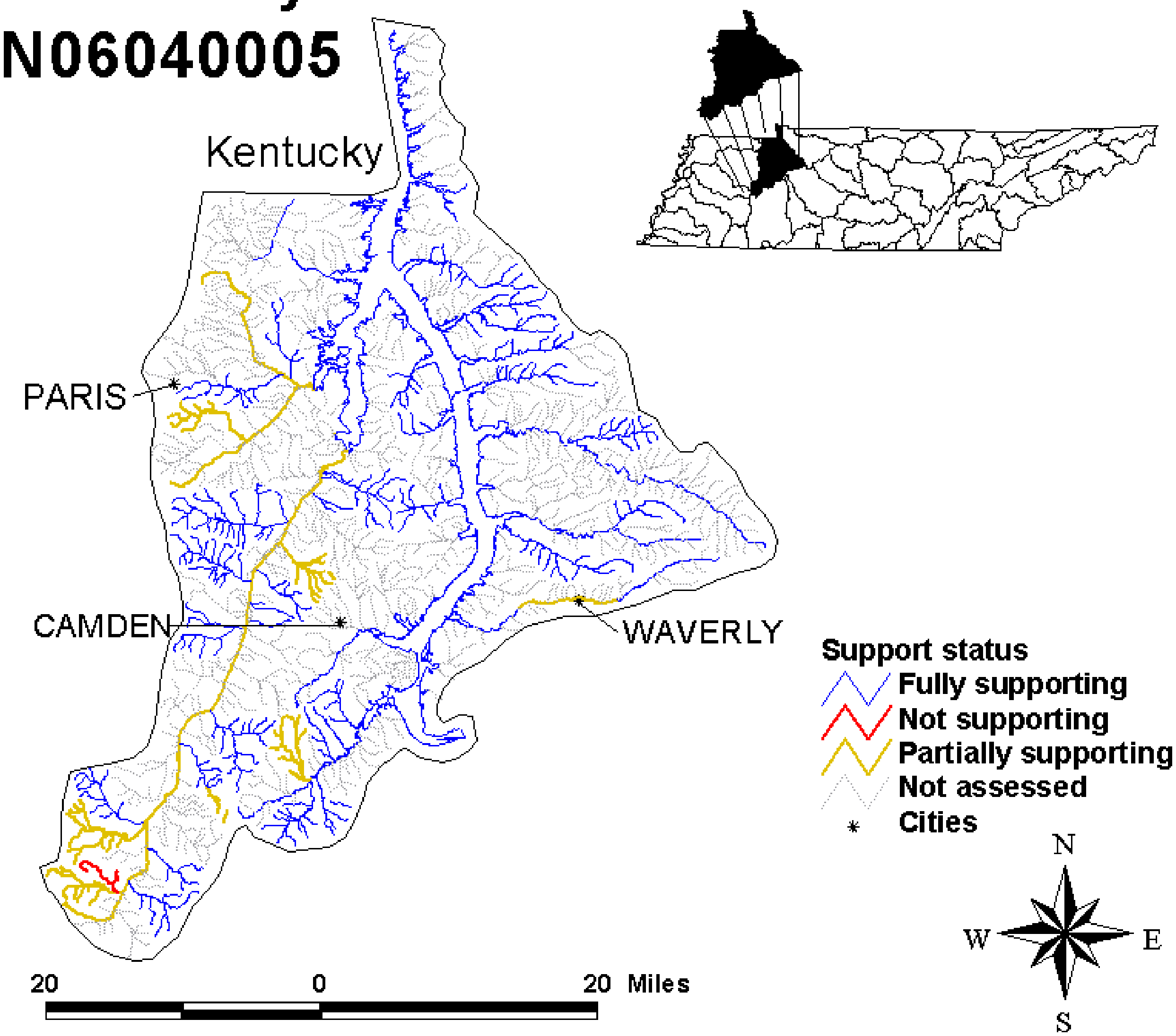
Overall water quality is good with 97 percent of assessed stream miles fully supporting designated uses.

The Tennessee General Assembly has designated portions of the Buffalo River as a State Scenic River. It is popular for canoeists and supports several commercial operators. This watershed also has one high quality stream that is a subecoregion reference site, Bush Creek in 71f (Western Highland Rim).



2002 Assessment of Rivers and Streams in Buffalo River Watershed

Lower Kentucky Reservoir Watershed
HUC TN06040005



Lower Kentucky Reservoir Watershed Atlas

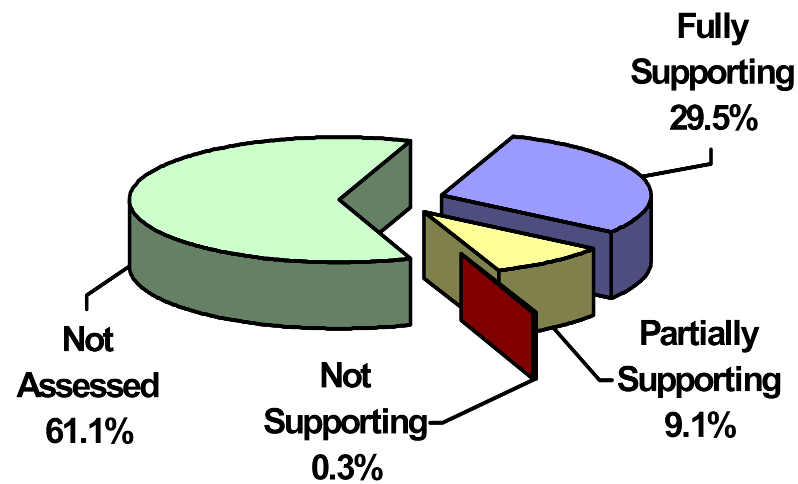
HUC Code:	**TN06040005**	
Counties:	Benton	Carroll
	Henderson	Henry
	Houston	Humphreys
	Stewart	
Ecoregions:	65e	71f
	74b	
Drainage Size of Watershed:		1430 square miles
Stream Miles in Watershed:		2,042.6
Stream Miles Fully Supporting:		602.4
Stream Miles Partially Supporting:		186.0
Stream Miles Not Supporting:		5.9
Stream Miles Not Assessed:		1,248.3
Lake Acres in Watershed:		100,000
Lake Acres Fully Supporting:		100,000 (100%)
TDEC Monitoring Stations:		100
Non-TDEC Monitoring Stations:		2
Advisories:		None
Watershed Monitoring Group:		2

Surface Water Quality in Lower Kentucky Reservoir Watershed

About 79 percent of the watershed is in Tennessee with the remainder in Kentucky. Kentucky Dam is in Kentucky.

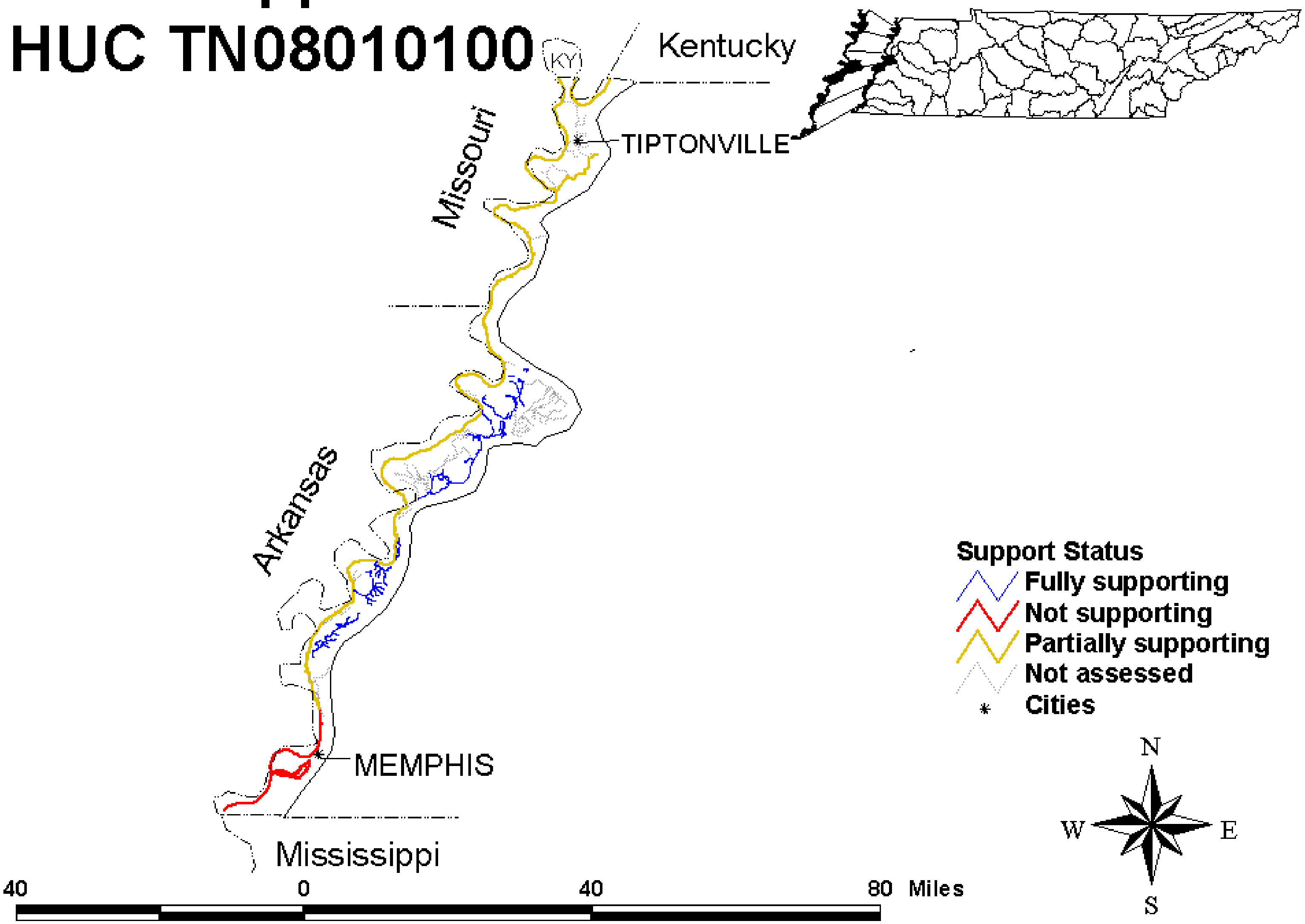
Data were available to assess 31 percent of the stream miles; additional surveys are scheduled this fall. Seventy-six percent of assessed miles were fully supporting. Agriculture and channelization impair the most stream miles.

This watershed has one high quality stream that is a subecoregion reference site, Blunt Creek in 65e (Southeastern Plains and Hills).



2002 Assessment of Rivers and Streams in Lower Kentucky Reservoir Watershed

Mississippi River Watershed
HUC TN08010100



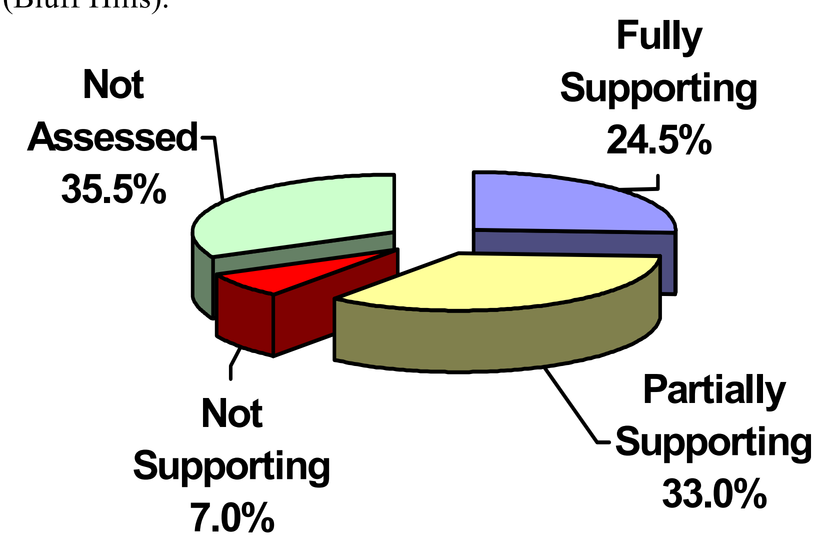
Mississippi River Watershed Atlas

HUC Code:	**TN08010100**	
Counties:	Dyer Lake Lauderdale Shelby Tipton	
Ecoregions:	73a	74a
Drainage Size of Watershed:	598 square miles	
Stream Miles in Watershed:	542.9	
Stream Miles Fully Supporting:	133.1	
Stream Miles Partially Supporting:	179.2	
Stream Miles Not Supporting:	37.9	
Stream Miles Not Assessed:	192.7	
Lake Acres in Watershed:	125	
Lake Acres Not Supporting:	125 (100%)	
TDEC Monitoring Stations:	32	
Advisories:	2	
Watershed Monitoring Group:	5	

Surface Water Quality in Mississippi River Watershed

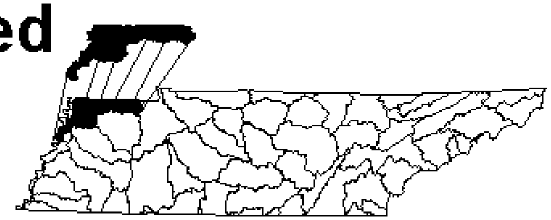
The portion of the river bordering Tennessee is defined as the Lower Mississippi-Memphis segment by USGS. Only 38 percent of assessed stream miles in this watershed are fully supporting. The mainstem Mississippi River is considered impacted by a variety of pollutants. Agricultural activities and sources in other states are the principal pollution sources upstream of Shelby County. The river near Memphis is not supporting due to contaminated sediment.

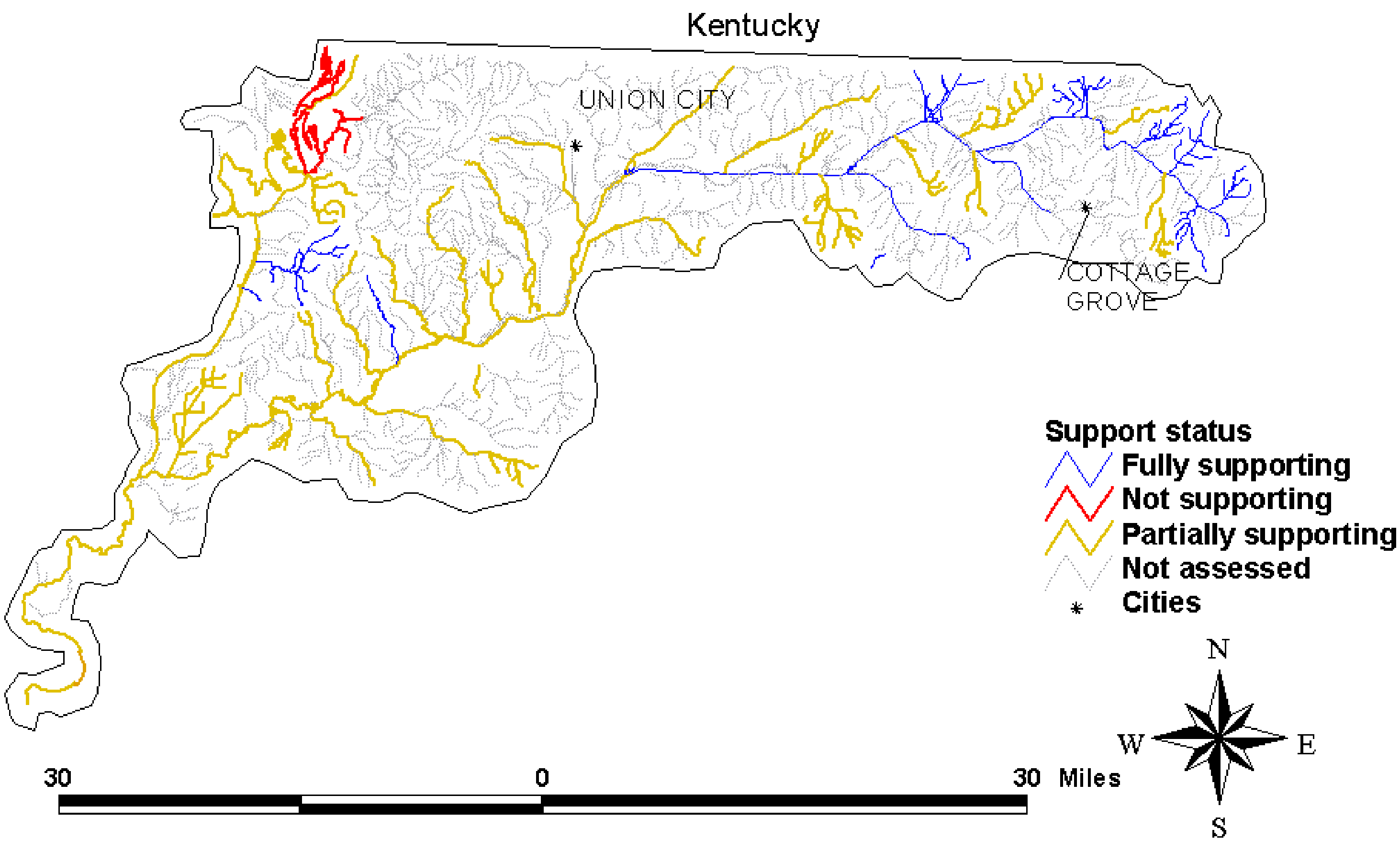
Three high quality streams are subecoregion reference sites, Cold Creek and Middle Fork of the Forked Deer River in 73a (Northern Mississippi Alluvial Plain) and Sugar Creek in 74a (Bluff Hills).



2002 Assessment of Rivers and Streams in Mississippi River Watershed

Lower Obion River Watershed
HUC TN08010202





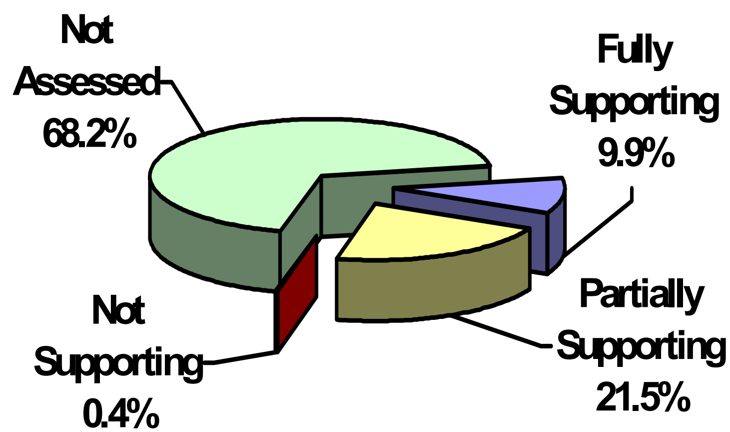
Lower Obion River Watershed Atlas

HUC Code:	**TN08010202**	
Counties:	Dyer	Gibson
	Henry	Lake
	Obion	Weakley
Ecoregions:	65e	73a
	74a	74b
Drainage Size of Watershed:		1140 square miles
Stream Miles in Watershed:		1,744.4
Stream Miles Fully Supporting:		173.4
Stream Miles Partially Supporting:		375.1
Stream Miles Not Supporting:		8.0
Stream Miles Not Assessed:		1,187.9
Lake Acres in Watershed:		15,500
Lake Acres Partially Supporting:		10,950 (70.6%)
Lake Acres Not Supporting:		4,550 (29.4%)
TDEC Monitoring Stations:		87
Non-TDEC Monitoring Stations:		1
Advisories:		None
Watershed Monitoring Group:		5

Surface Water Quality in Lower Obion River Watershed (including Reelfoot Lake)

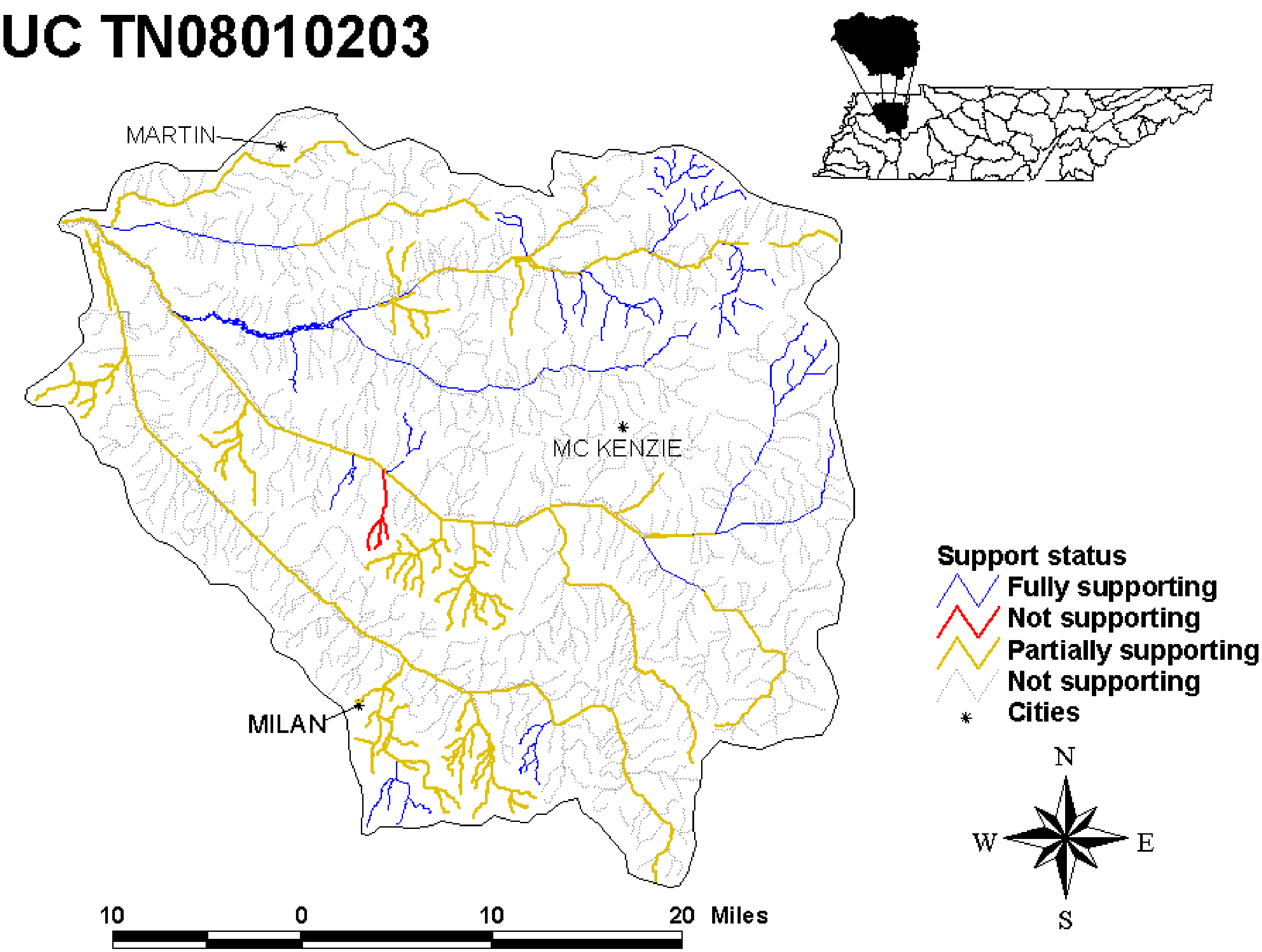
About 87 percent of the Lower Obion River Watershed is in Tennessee with the remainder in Kentucky. Row crops including corn, cotton, and soybeans are widespread. The percent of monitored streams doubled from 16 percent in 2000 to 32 percent. Only 31 percent of surveyed streams were fully supporting with crop runoff and channelization the most widespread pollution sources. Reelfoot Lake is impaired due to accelerated eutrophication.

Reelfoot, the largest natural lake in Tennessee, is an ONRW due to recreational, scenic, and unique ecological values. Four high quality streams are subecoregion reference sites, Bayou du Chien in 73a (Northern Mississippi Alluvial Plain), Pawpaw Creek in 74a (Bluff Hills), and Terrapin and Powell Creeks in 74b (Loess Plains).



2002 Assessment of Rivers and Streams in Lower Obion River Watershed

South Fork Obion River Watershed
HUC TN08010203



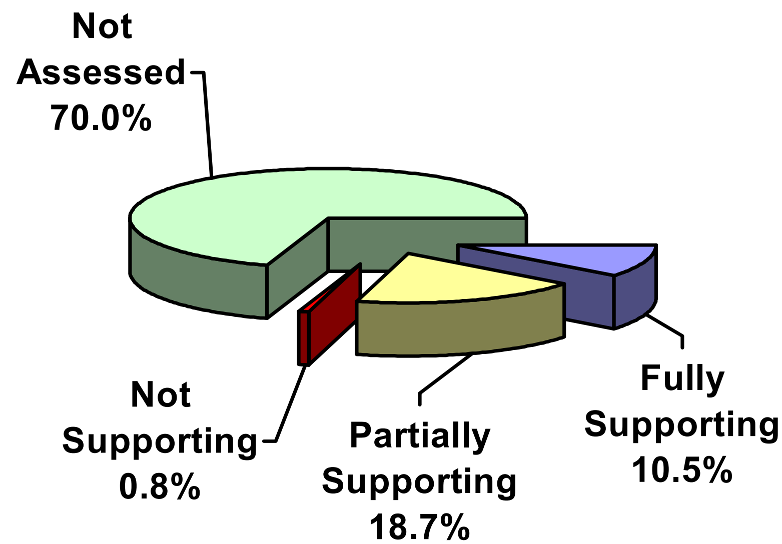
South Fork Obion River Watershed Atlas

HUC Code:	**TN08010203**	
Counties:	Carroll	Gibson
	Henderson	Henry
	Obion	Weakley
Ecoregions:	65e	
	74b	
Drainage Size of Watershed:		1150 square miles
Stream Miles in Watershed:		1,840.5
Stream Miles Fully Supporting:		194.1
Stream Miles Partially Supporting:		343.8
Stream Miles Not Supporting:		13.9
Stream Miles Not Assessed:		1,288.7
Lake Acres in Watershed:		None
TDEC Monitoring Stations:		70
Non-TDEC Monitoring Stations:		1
Advisories:		None
Watershed Monitoring Group:		5

Surface Water Quality in South Fork Obion River Watershed

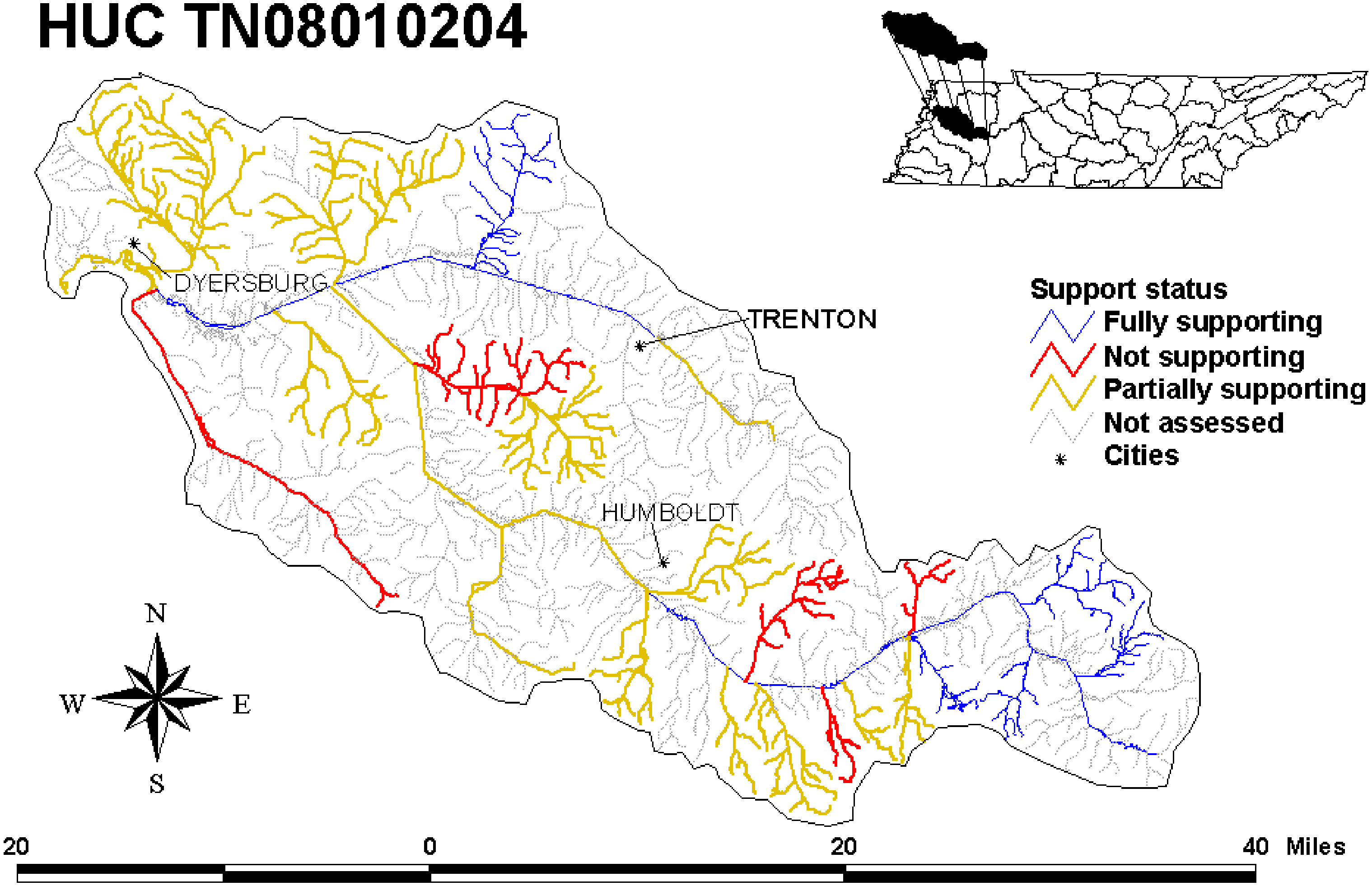
The entire watershed is in Tennessee. Like many west Tennessee streams, the South and Rutherford forks of the Obion River have been extensively channelized, causing siltation and habitat problems. Runoff from row crops is another significant pollution source.

The percentage of stream assessments doubled from 15 percent in 2000 to 30 percent. Thirty-five percent of assessed streams are fully supporting.



2002 Assessment of Rivers and Streams in South Fork Obion River Watershed

North Fork Forked Deer River Watershed (including Middle Fork Forked Deer River) HUC TN08010204



North Fork Forked Deer River Watershed Atlas

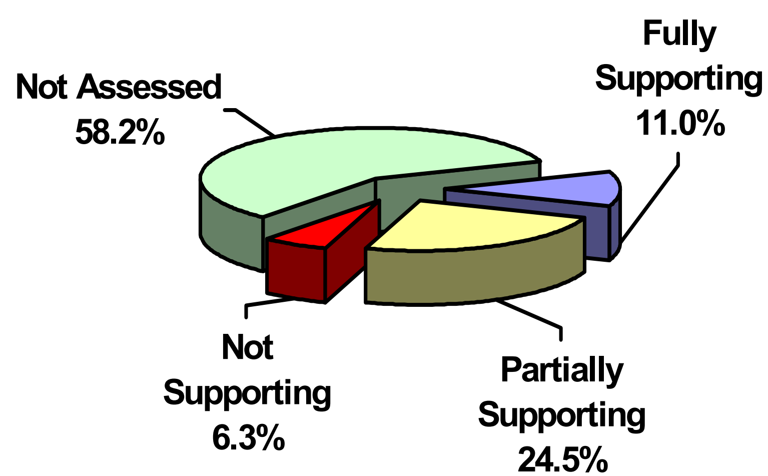
HUC Code:	**TN08010204**	
Counties:	Carroll Dyer Henderson	Crockett Gibson Madison
Ecoregions:	65e 74b	74a
Drainage Size of Watershed:		962 square miles
Stream Miles in Watershed:		1,716.4
Stream Miles Fully Supporting:		188.7
Stream Miles Partially Supporting:		420.4
Stream Miles Not Supporting:		108.8
Stream Miles Not Assessed:		998.5
Lake Acres in Watershed:		87
Lake Acres Not Supporting:		87 (100%)
TDEC Monitoring Stations:		75
Advisories:		None
Watershed Monitoring Group:		2

Surface Water Quality in North Fork Forked Deer River Watershed (including Middle Fork Forked Deer River)

The entire watershed is in Tennessee. Like other streams in the western portion of the state, many of the streams in this watershed have been extensively channelized. Row crops, especially cotton, are the principle land use.

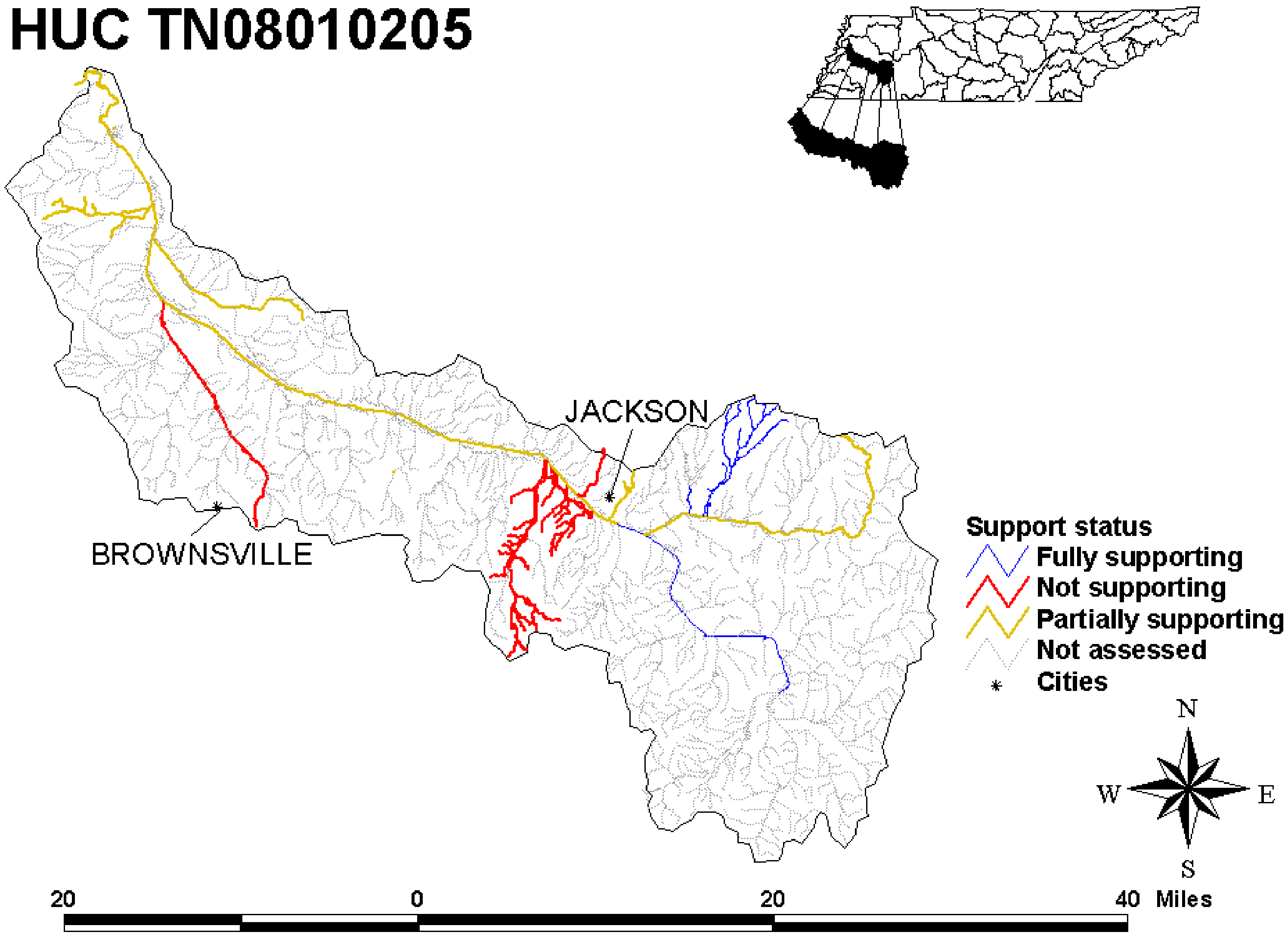
Only 26 percent of assessed stream miles are fully supporting. Siltation, nutrients and habitat alteration are the primary pollutants. Pathogen TMDLs on eight streams (220 stream miles) have been developed and approved by EPA.

One high quality stream is a subecoregion reference site, Griffin Creek in 65e (Southeastern Plains and Hills).



2002 Assessment of Rivers and Streams in North Fork Forked Deer River Watershed

South Fork Forked Deer River Watershed
HUC TN08010205



South Fork Forked Deer River Watershed Atlas

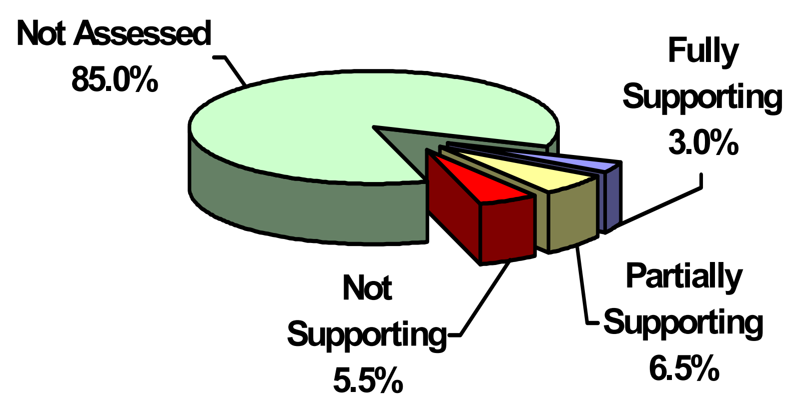
HUC Code:	**TN08010205**	
Counties:	Chester	Crockett
	Dyer	Haywood
	Henderson	Lauderdale
	Madison	McNairy
Ecoregions:	65e	73a
	74a	74b
Drainage Size of Watershed:		1,062 square miles
Stream Miles in Watershed:		1,779.9
Stream Miles Fully Supporting:		53.6
Stream Miles Partially Supporting:		115.4
Stream Miles Not Supporting:		97.4
Stream Miles Not Assessed:		1,513.5
Lake Acres in Watershed:		570
Lake Acres Not Assessed:		570 (100%)
TDEC Monitoring Stations:		37
Non-TDEC Monitoring Station:		1
Advisories:		None
Watershed Monitoring Group:		1

Surface Water Quality in South Fork Forked Deer River Watershed

The entire watershed is in Tennessee. As is common in the western portion of the state, streams in this watershed have been extensively channelized. Twenty percent of assessed stream miles are not fully supporting. Siltation, nutrients and habitat alteration are the most prevalent pollutants.

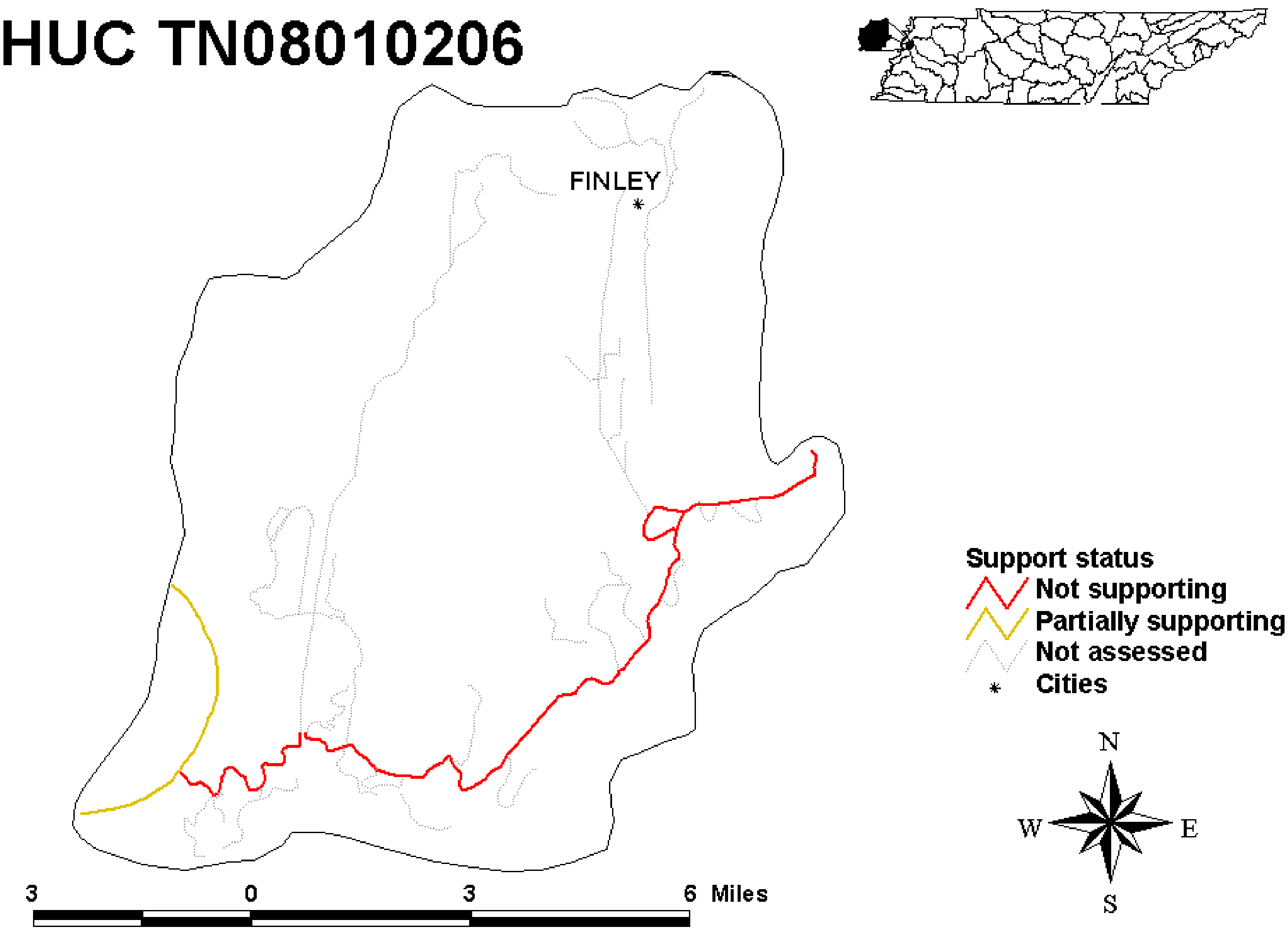
Due to limited data, 85 percent of streams have not been assessed. Additional field surveys have recently been completed and should provide a more comprehensive assessment in 2004. EPA has approved pathogen TMDLs on six streams (140 miles) for pathogens.

One high quality stream is a subecoregion reference site, Harris Creek in 65e (Southern Plains and Hills).



2002 Assessment of Rivers and Streams in South Fork Forked Deer River Watershed

Forked Deer River Watershed
HUC TN08010206



Forked Deer River Watershed Atlas

HUC Code: **TN08010206**

Counties: Dyer
Lauderdale

Ecoregions: 73a
74a

Drainage Size of Watershed: 70 square miles

Stream Miles in Watershed:	70.0
Stream Miles Fully Supporting:	0.0
Stream Miles Partially Supporting:	0.0
Stream Miles Not Supporting:	14.9
Stream Miles Not Assessed:	55.1

Lake Acres in Watershed: None

TDEC Monitoring Stations: 1

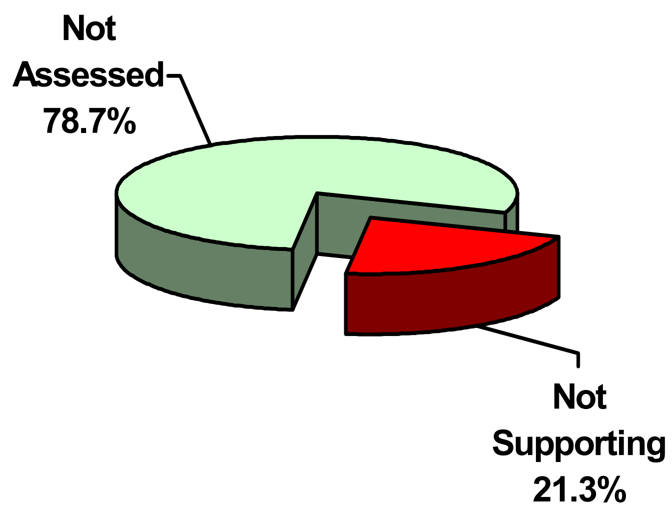
Advisories: None

Watershed Monitoring Group: 2

Surface Water Quality in Forked Deer River Watershed

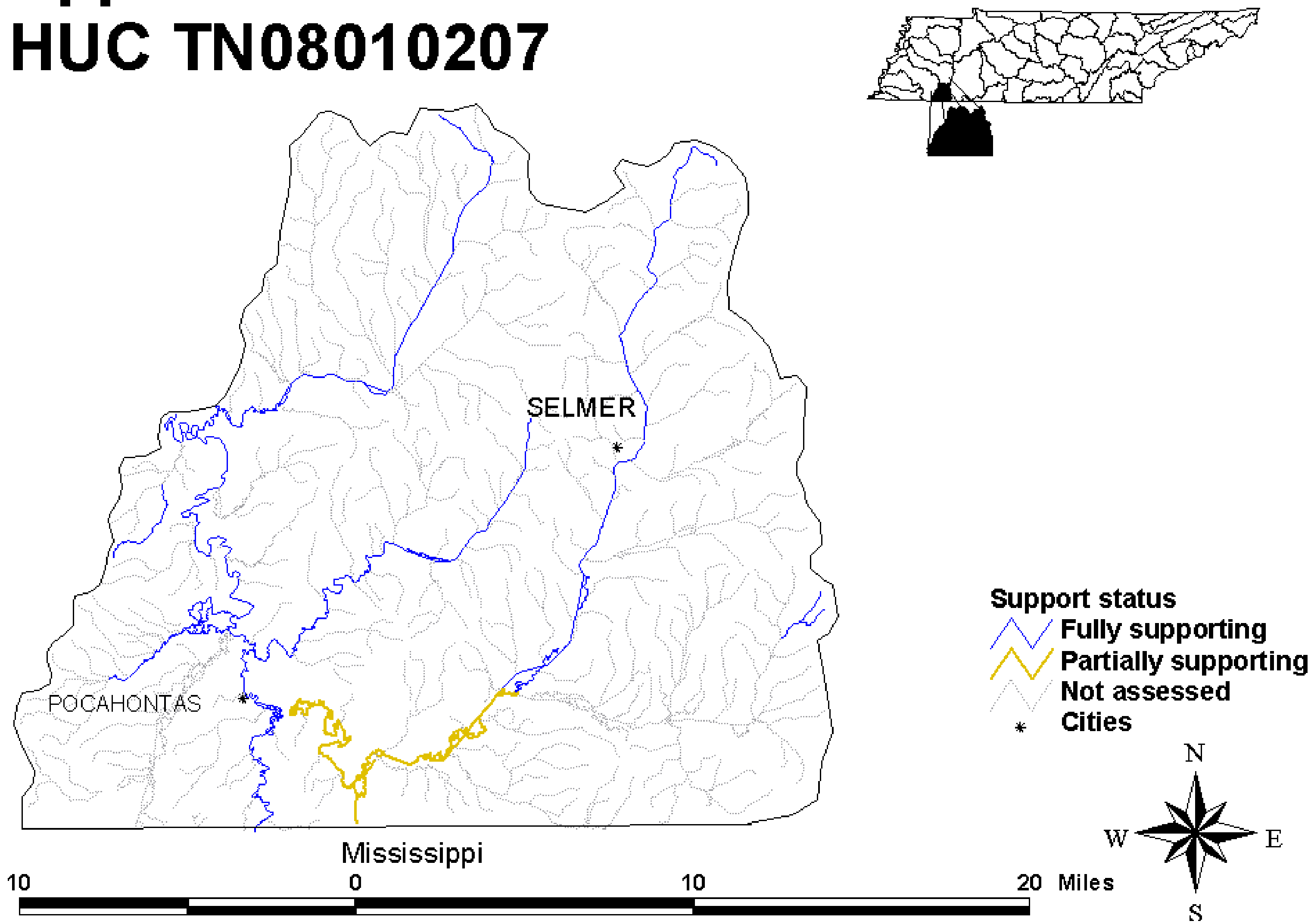
This entire small watershed is in Tennessee. Originally named the Okeena River, the Forked Deer was renamed in the 1780's when surveyors noticed that the branches looked like a deer's forked antlers. The Forked Deer River now flows into the Obion River. Before the earthquakes of 1812, the Forked Deer River had a direct channel that flowed further south to the Mississippi River.

Only one monitoring station is established in this small watershed. This site on the Forked Deer River is impaired due to siltation and habitat alterations from channelization.



2002 Assessment of Rivers and Streams in Forked Deer River Watershed

Upper Hatchie River Watershed
HUC TN08010207



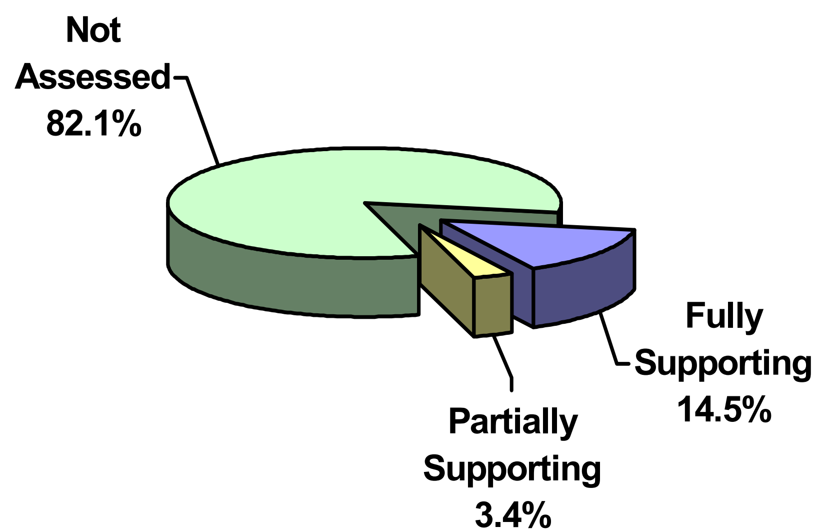
Upper Hatchie River Watershed Atlas

HUC Code:	**TN08010207**
Counties:	Chester Hardeman McNairy
Ecoregions:	65a 65b 65e
Drainage Size of Watershed:	411 square miles
Stream Miles in Watershed:	752.5
Stream Miles Fully Supporting:	108.8
Stream Miles Partially Supporting:	25.6
Stream Miles Not Supporting:	0.0
Stream Miles Not Assessed:	618.1
Lake Acres in Watershed:	None
TDEC Monitoring Stations:	44
Non-TDEC Monitoring Stations:	1
Advisories:	None
Watershed Monitoring Group:	4

Surface Water Quality in Upper Hatchie River Watershed

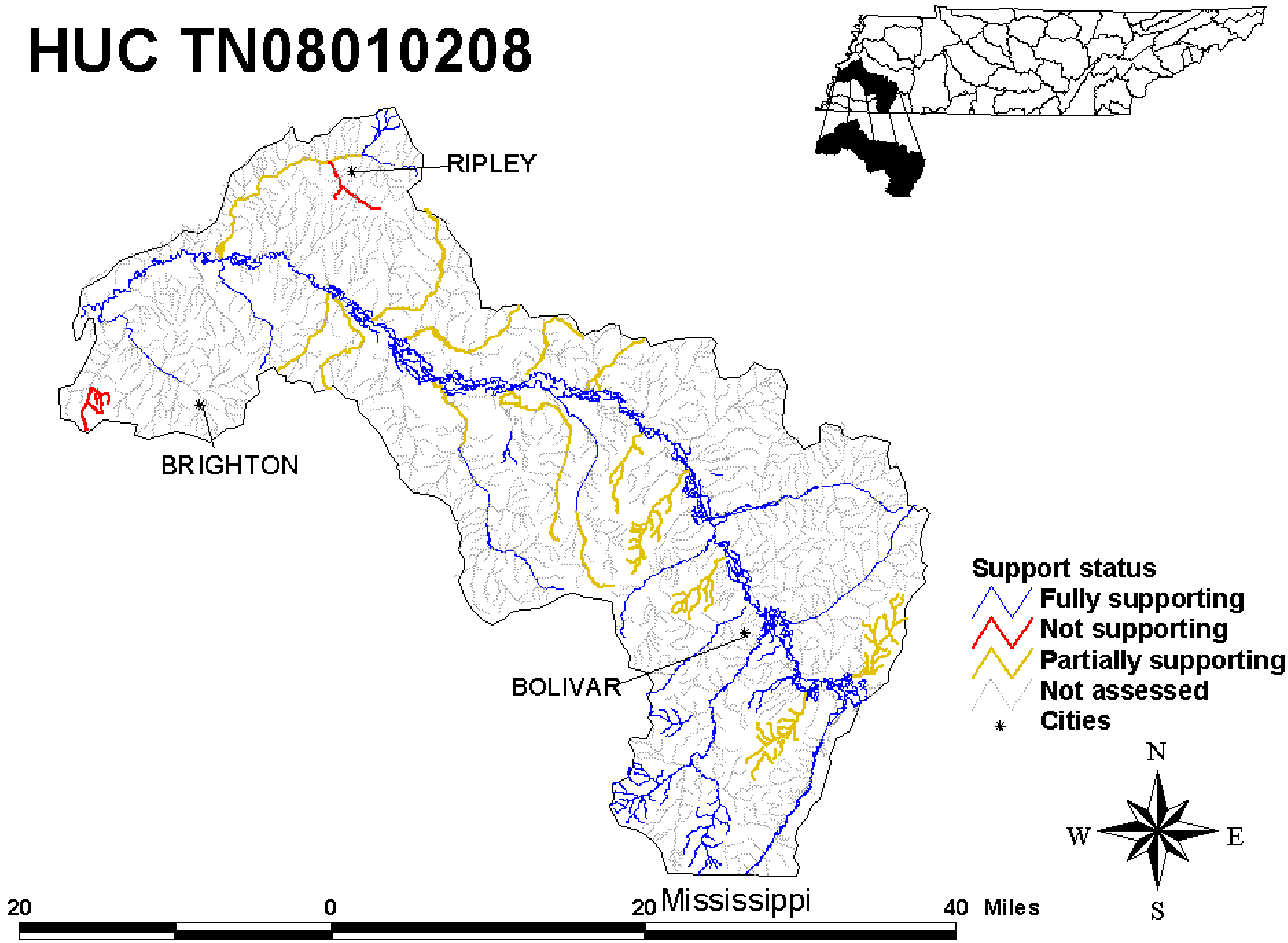
Thirty-six percent of the watershed is in Tennessee with the remainder in Mississippi. This is a rural watershed with small farms the principal land use. Due to a lack of recent data, the majority of this watershed has not been assessed. Eighty-one percent of surveyed streams are fully supporting. Siltation from channelization is the primary pollutant. Nine miles of the Tuscumbia River in Tennessee are impaired by channelization in Mississippi.

Two high quality streams are subecoregion reference sites, Unnamed Tributary to Muddy Creek in 65a (Blackland Prairie) and Cypress Creek in 65b (Flatwood/Alluvial Prairie Margins).



2002 Assessment of Rivers and Streams in Upper Hatchie River Watershed

Lower Hatchie River Watershed
HUC TN08010208



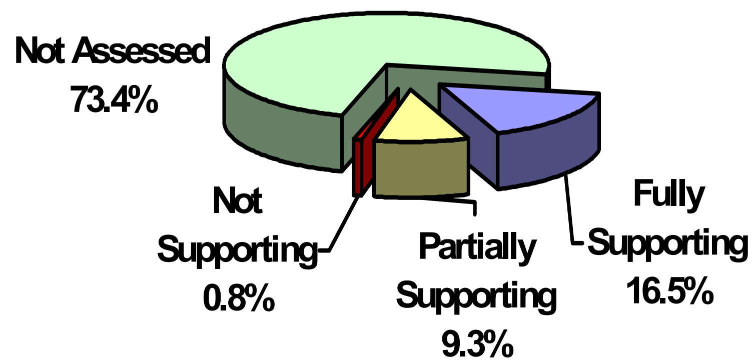
Lower Hatchie River Watershed Atlas

HUC Code:	**TN08010208**	
Counties:	Chester Hardeman Lauderdale Tipton	Fayette Haywood Madison
Ecoregions:	65b 73a 74b	65e 74a
Drainage Size of Watershed:		1430 square miles
Stream Miles in Watershed:		2,530.8
Stream Miles Fully Supporting:		417.8
Stream Miles Partially Supporting:		236.8
Stream Miles Not Supporting:		20.0
Stream Miles Not Assessed:		1,856.2
Lake Acres in Watershed:		None
TDEC Monitoring Stations:		92
Non-TDEC Monitoring Stations:		1
Advisories:		None
Watershed Monitoring Group:		4

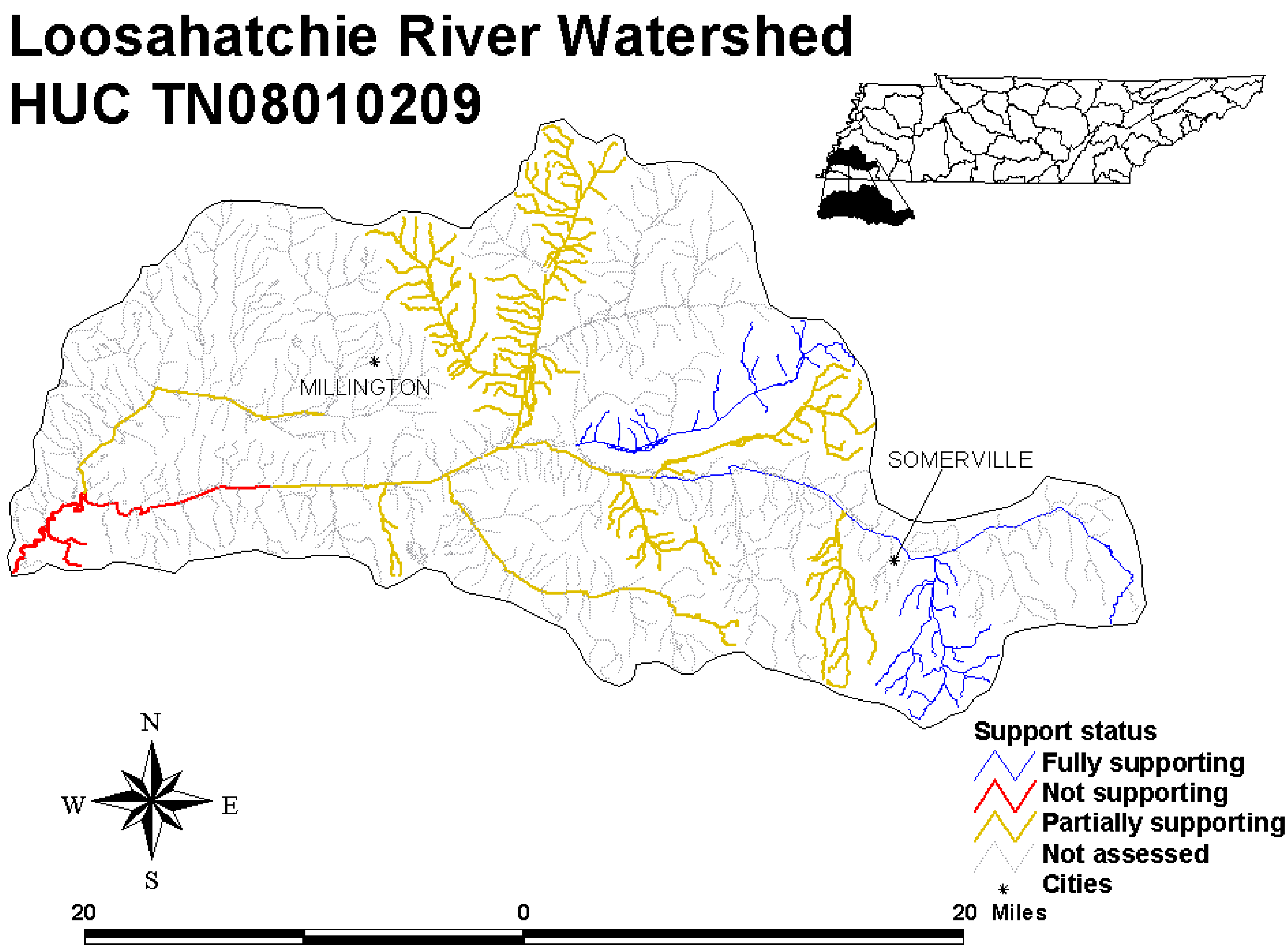
Surface Water Quality in Lower Hatchie River Watershed

About 98 percent of the watershed is in Tennessee with the remainder in Mississippi. The Hatchie is the last unchannelized river of its type in the lower Mississippi Valley. The river drains a series of wetlands including bottomland hardwoods. Siltation and habitat alteration are a problem due to channelization of many tributaries. The Cane Creek sub-watershed is impaired by industrial pollution and collection system failure. Sixty-two percent of assessed stream are fully supporting. EPA has approved copper TMDLs on three streams (8 miles).

A portion of the Hatchie River is designated as a State Scenic River. Two high quality streams are subecoregion reference sites, Marshall and West Fork Spring Creeks in 65e (Southeastern Plains and Hills).



2002 Assessment of Rivers and Streams in Lower Hatchie River Watershed


Loosahatchie River Watershed
HUC TN08010209
MILLINGTON
SOMERVILLE
N
W
E
S
Support status
Fully supporting
Not supporting
Partially supporting
Not assessed
Cities
20
0
20 Miles

Loosahatchie River Watershed Atlas

HUC Code:	**TN08010209**	
Counties:	Fayette Haywood Tipton	Hardeman Shelby
Ecoregions:	65e 73a 74a 74b	

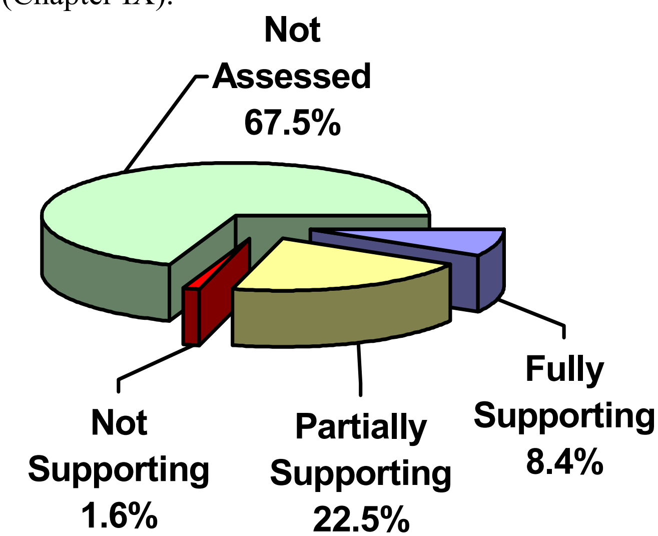
Drainage Size of Watershed:	738 square miles
Stream Miles in Watershed:	1,443.4
Stream Miles Fully Supporting:	121.9
Stream Miles Partially Supporting:	324.7
Stream Miles Not Supporting:	23.0
Stream Miles Not Assessed:	973.8
Lake Acres in Watershed:	81
Lake Acres Not Assessed:	81 (100%)
TDEC Monitoring Stations:	55
Non-TDEC Monitoring Stations:	6
Advisories:	None
Watershed Monitoring Group:	2

Surface Water Quality in Loosahatchie River Watershed

The entire watershed is in Tennessee. The Loosahatchie River flows into the Mississippi River near Memphis, Tennessee.

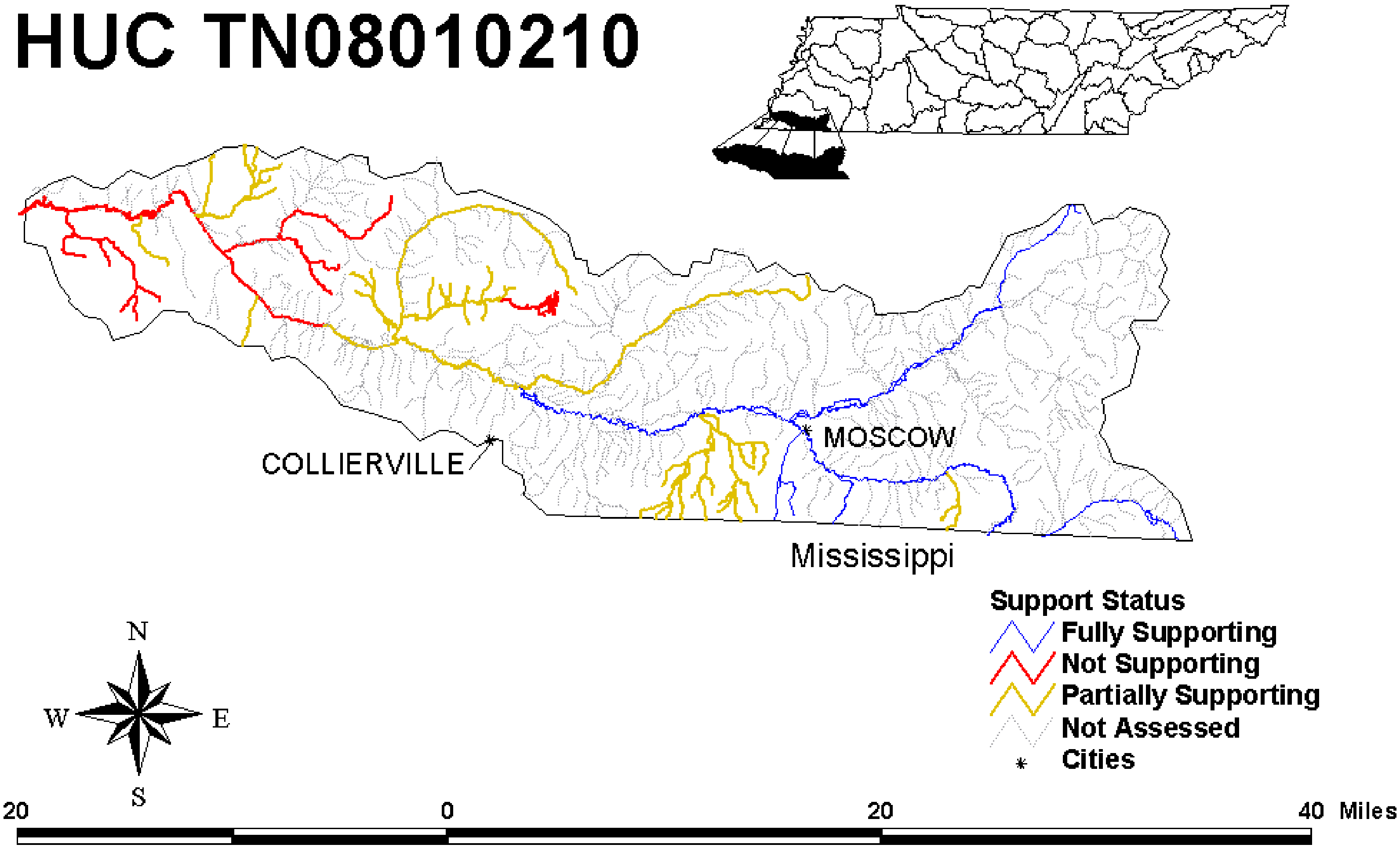
Twenty-six percent of assessed stream miles are fully supporting. Pathogen TMDLs on seven streams (194 miles) have been developed and approved by EPA.

Siltation and habitat alterations are a problem since the river and many of its tributaries have been extensively channelized. The river has a fish tissue advisory from the mouth to Highway 14 for chlordane and other toxic organics from contaminated sediments (Chapter IX).



2002 Assessment of Rivers and Streams in Loosahatchie River Watershed

Wolf River Watershed
HUC TN08010210



Wolf River Watershed Atlas

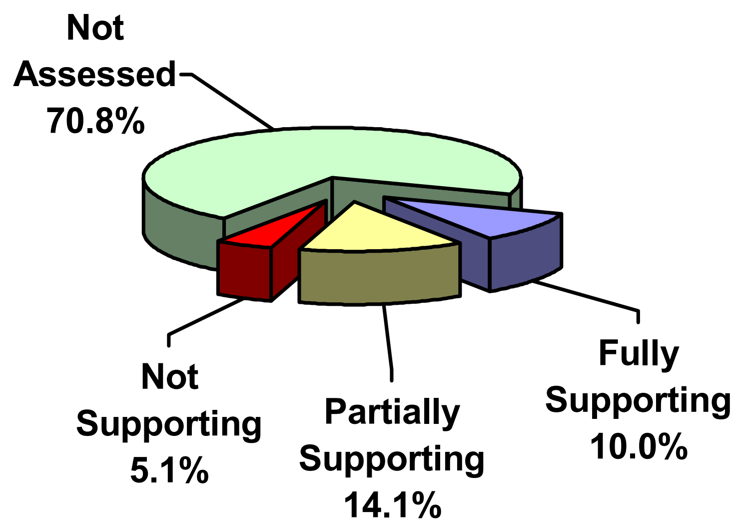
HUC Code: **TN08010210**

Counties:	Fayette Hardeman Shelby
Ecoregions:	65e 73a 74b
Drainage Size of Watershed:	553 square miles
Stream Miles in Watershed:	1,025.2
Stream Miles Fully Supporting:	102.4
Stream Miles Partially Supporting:	144.4
Stream Miles Not Supporting:	52.4
Stream Miles Not Assessed:	726.0
Lake Acres in Watershed:	177
Lake Acres Not Assessed:	177
TDEC Monitoring Stations:	58
Advisories:	1
Watershed Monitoring Group:	3

Surface Water Quality in Wolf River Watershed

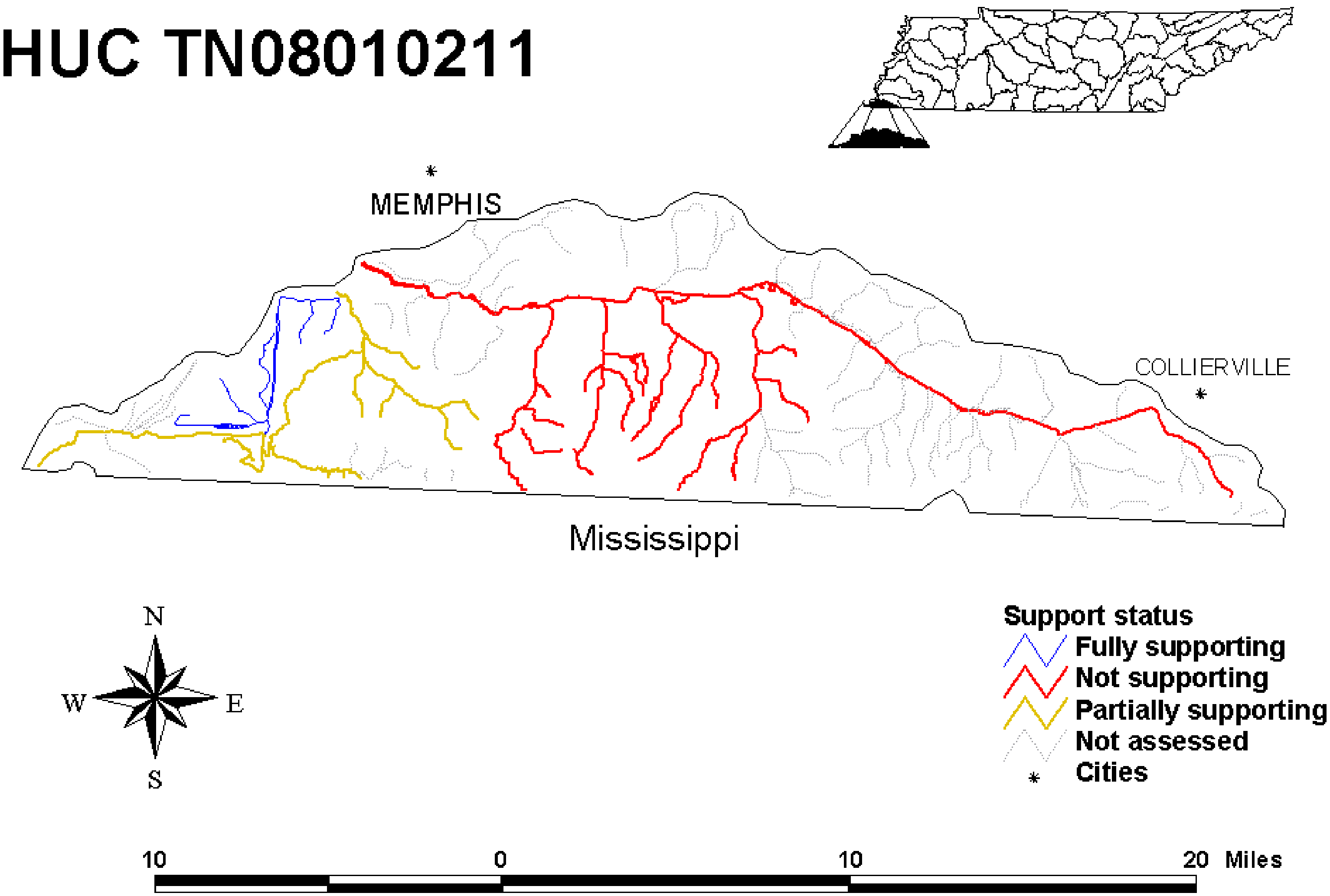
Over 68 percent of the Wolf River Watershed is in Tennessee with the remainder in Mississippi. The Wolf River flows directly into the Mississippi River near Memphis. Thirty-four percent of assessed streams are fully supporting. However, due to a lack of recent data, most of the watershed has not been assessed. Agriculture activities impact the most stream miles with urban runoff and land development major contributors in the downstream portion. The Wolf River has a fish tissue advisory from the mouth to Highway 23 for chlordane and other toxic organics from contaminated substances (Chapter IX).

One high quality stream is a subecoregion reference site, Wolf River near the Mississippi state line in 74b (Loess Plains).



2002 Assessment of Rivers and Streams in Wolf River Watershed

Nonconnah Creek Watershed
HUC TN08010211



Nonconnah Creek Watershed Atlas

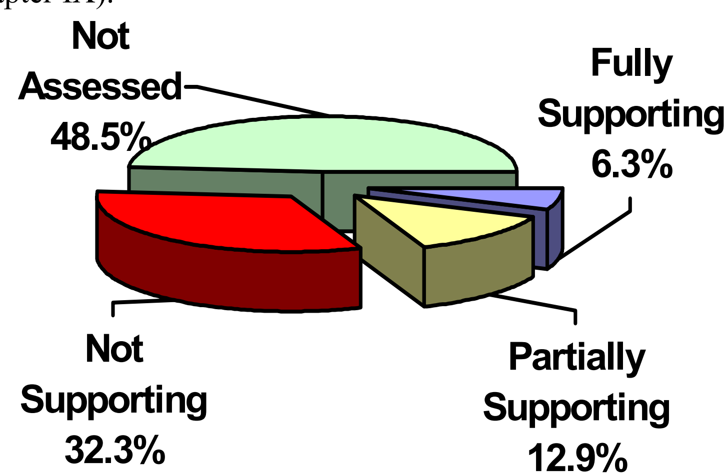
HUC Code:	**TN08010211**
Counties:	Fayette Shelby
Ecoregions:	73a 74a 74b
Drainage Size of Watershed:	184 square miles
Stream Miles in Watershed:	260.4
Stream Miles Fully Supporting:	16.4
Stream Miles Partially Supporting:	33.7
Stream Miles Not Supporting:	84.1
Stream Miles Not Assessed:	126.2
Lake Acres in Watershed:	None
TDEC Monitoring Stations:	24
Advisories:	1
Watershed Monitoring Group:	1

Surface Water Quality in Nonconnah Creek Watershed

Sixty-five percent of the watershed is in Tennessee with the remainder in Mississippi. Nonconnah Creek flows into McKellar Lake before entering the Mississippi River.

The watershed is heavily urbanized. Over half of the watershed has been assessed with only 12 percent fully supporting. Urban runoff, collection system failures and channelization impair the most stream miles. EPA has approved pathogen TMDLs on seven streams (118 miles) listed for pathogens.

Nonconnah Creek has a fish tissue advisory from the mouth to Horn Lake Road Bridge for chlordane and other toxic organic substances (Chapter IX).



2002 Assessment of Rivers and Streams in Nonconnah Creek Watershed