the state of Georgia's *environment* 2009

ENVIRONMENTAL PROTECTION DIVISION

GEORGIA DEPARTMENT *of* NATURAL RESOURCES

From the Director

April 2009

Greetings:

As we celebrate the 40th observation of Earth Day I hope this report, *The State of Georgia's Environment 2009*, provides Georgians with an understanding of both the progress made and challenges remaining in the protection of our natural resources. Think of it as a report card on how we are doing in protecting human health and sustaining healthy ecosystems and the natural resources on which our economy relies.

As one famous Georgian, Pogo*, declared during the 1970 Earth Day, "We have met the enemy and he is us." In other words, what each of us does individually matters to the quality of Georgia's environment and the sustainability of our planet. Pogo's message to us on that first Earth Day is still true today as Georgia's population has grown to more than 10 million people. In this report you will read that many of our challenges result from the cumulative impact of the choices each of us make every day that affect, for example, the amount of waste we throw away, the emission of air pollutants, and how we care for our land and water resources.

In compiling the report, we drew on the best available information from state and federal agencies. In addition to data available at the Environmental Protection Division (EPD), information was provided by the Wildlife Resources Division and the Coastal Resources Division of the Georgia Department of Natural Resources. We also want to thank and acknowledge the Georgia Environmental Facilities Authority, the Public Health Division of the Georgia Department of Human Resources, the University of Georgia, the U.S. Environmental Protection Agency and the U.S. Geological Survey for providing information. The contributions from the individuals listed at the end of the report also are appreciated.

Please note that *The State of Georgia's Environment 2009* is also available for viewing, download and printing from EPD's Web site at http://www.georgiaepd.org/Documents/soe2009.html.

For more information on what you can do to help protect, preserve and restore Georgia's environment, please visit the Conserve Georgia Web site at http://www.conservegeorgia.org.

Sincerely,

Carol A. Couch

Carol A. Couch
Director
Environmental Protection Division

* Cartoonist Walt Kelly's creation, Pogo is a wise-cracking resident of the Okefenokee Swamp.
Mr. Kelly's comic strip ran from 1949 until 1975.

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Produced by the Environmental Protection Division, Georgia Department of Natural Resources
2 Martin Luther King, Jr. Drive
Suite 1152
Atlanta, Georgia 30334

About this report

An update and expansion of 2003's *Georgia's Environment*, this report is a resource for the citizens of Georgia. It highlights what we know and don't know about the condition of Georgia's environment, and illustrates progress and challenges that are fundamental to the state's strategic goals and EPD's mission.

What are the state's strategic goals?

- A growing Georgia
- A safe Georgia
- A healthy Georgia
- An educated Georgia
- The best managed state in the U.S.

What is EPD's mission?

The Environmental Protection Division protects and restores Georgia's environment. We take the lead in ensuring clean air, water and land. With our partners, we pursue a sustainable environment that provides a foundation for a vibrant economy and healthy communities.

What is EPD's vision?

Georgia's environment is healthy and sustainable. Natural resources are protected and managed to meet the needs of current and future generations. All Georgians understand the importance of a healthy and sustainable environment and act to protect and restore it. EPD is responsive, effective and efficient. Associates are valued and empowered to use their expertise and creativity as leaders in protecting Georgia's environment.

On the Web:
http://www.opb.state.ga.us/strategic-planning/strategic-planning.aspx

http://www.gaepd.org/Documents/mission.html

Introduction

Georgia is rich in natural resources and beauty. From the wilds of the Okefenokee Swamp to the grandeur of the Blue Ridge Mountains, many of us have been touched by this beauty. And, we all rely on the state's natural resources to support the quality of life we enjoy.

As the state's population approaches 10 million, however, much of Georgia's environment has been changed from its native condition. The state's 14 percent growth between 2000 and 2006 was more than twice the national average, making Georgia the third fastest growing state in the U.S. A growing population means that decisions regarding how growth is accommodated become increasingly important to the state's environmental quality.

The state's economic growth has kept pace with its population growth and both trends are expected to continue over the coming decades. This growth brings many opportunities — opportunities that only can be achieved if supported by effective management of environmental and natural resources. As Georgia grows, environmental progress will be necessary to sustain economic progress.

The Environmental Protection Division's (EPD) job is to protect and restore the state's environment, by taking the lead in ensuring clean air, water, and land to provide a foundation for a vibrant economy and healthy communities. EPD envisions Georgia's environment as healthy and sustainable, with its natural resources protected and managed to meet the needs of the current generation and those to come.

This vision is consistent with the state's strategic goals (see sidebar. Within the state strategic plan, two specific goals are directly related to EPD's mission:

- Improve overall environmental quality and conservation practices
- Provide a safe environment where Georgians live, work and play

Drawing on these goals, EPD has identified three primary objectives for environmental management:

- Protecting human health
- Sustaining healthy ecosystems
- Ensuring resources to support a growing economy

This report provides a starting point to evaluate the state's progress toward meeting these objectives. It presents indicators that track the condition of Georgia's environment and human activities that can alter environmental conditions. With this information, EPD and its partners in the public and private sectors can help the state plan for growth and better manage its outcomes.

What are environmental indicators?

Environmental indicators are measures of environmental conditions and the human activities that can alter them. They are based on readily available data from different sources and, to the extent possible, are numerical. Indicators may show trends over time or they may address only one point in time as a starting point for future measurements. They are chosen and evaluated to answer specific questions about the condition of Georgia's environment. Some indicators can provide only partial answers because of limited data or information.

What are the best indicators to help evaluate progress in meeting environmental objectives? In certain cases, the answer is easy. Under federal or state laws, standards have been established to assess the condition of certain natural resources. Currently, there are standards for air quality; drinking water quality; the quality of water in rivers, streams, lakes and coastal waters; and for land contaminated with hazardous substances. These standards define indicators that can be used to measure progress.

For many other environmental conditions, however, standards do not exist. In these cases, other indicators of environmental quality were selected to compare patterns or trends. For example, the amount of Georgia's land in forest and wetlands is important to the quality of the state's waters. However, simply looking at the number of acres for the current year does not indicate whether or not Georgia's environment is healthy; but comparing the numbers from several years will show a trend — either positive or negative — that can be used to evaluate progress.

This report uses a variety of indicators that track the condition of Georgia's air, water and land resources. Indicators related to human activities that alter those conditions — for better or for worse — also were selected. Examples include the release of pollutants, alteration of wildlife habitat, withdrawal of water for water supply and land conservation efforts.

The indicators in this report were chosen based on their relevance to the three environmental objectives, the time period and geographic area they address and the quality of available data.

Overall, indicators were chosen to describe the status of Georgia's major natural resources, to highlight the critical issues that have been evident for some time, and to introduce emerging issues that will require attention in the near future.

The changing face of Georgia

Population and economic conditions set the context for the discussion of environmental indicators and the changing condition of Georgia's environment. Recent trends in population and economic conditions, and the energy use associated with these changes, are highlighted below. These trends highlight the opportunities and challenges associated with Georgia's growth, and provide a starting point for evaluating the state of Georgia's environment.

Population

- The state's population doubled between 1960 and 2000. Today, more than 9 million people call Georgia home.
- During the 1990s, Georgia grew 26 percent while the U.S. grew 13 percent. Migration from other states and countries accounts for more than half of Georgia's growth.
- Population growth varies across the state. One hundred counties have populations less than 35,000. Twenty-three counties are projected to lose population until 2015.
- Almost 75 percent of Georgia's population is concentrated in metropolitan areas. Most of the state's fastest growing counties are in or adjacent to metro Atlanta and along the coast.

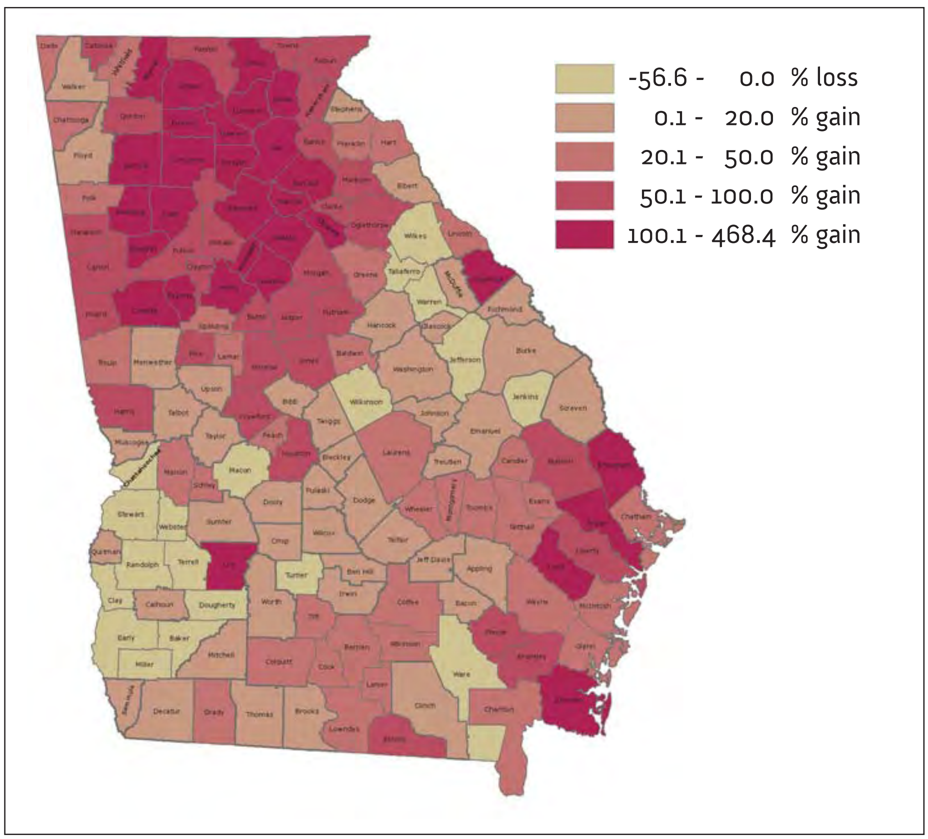


Figure 1 *Population changes in Georgia by county, 1990 - 2000. (U.S. Census Bureau)*

Sources of statistics

Georgia in Perspective 2007: A Statistical Profile of the State, Georgia Office of Planning and Budget; Georgia Energy Review 2005 (updated 2006), Georgia Environmental Facilities Authority; Georgia Statewide Comprehensive Outdoor Recreation Plan 2008-2013, Georgia Parks, Recreation and Historic Sites Division.

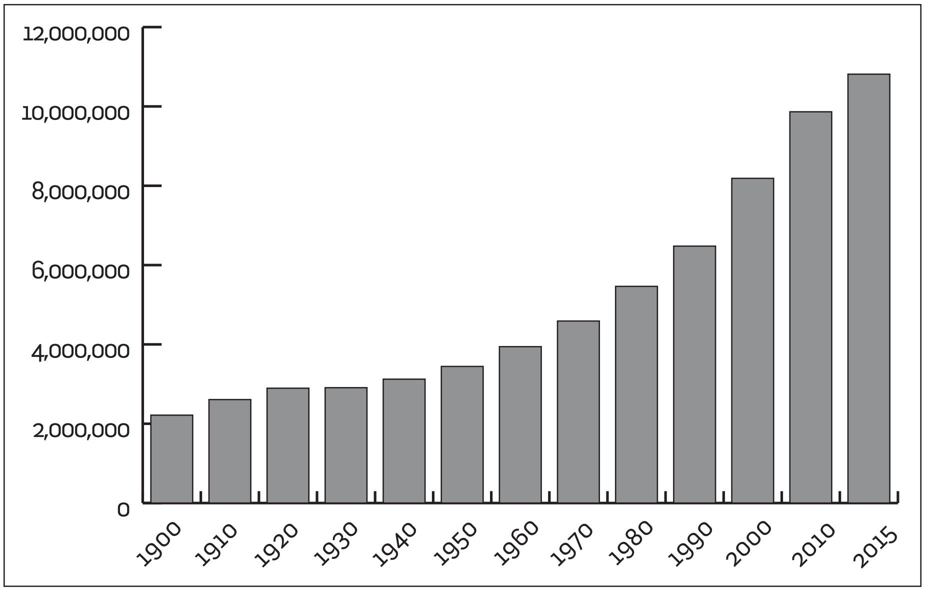


Figure 2 *Georgia's population, 1900 - 2015. (1900 - 2000 from the U.S. Census Bureau; projections for 2010 and 2015 from the Georgia Office of Planning and Budget)*

Economy

- Georgia's gross domestic product (GDP) nearly quadrupled between 1984 and 2004 — from $88.6 billion to $343.1 billion. The state's per capita GDP has consistently exceeded that of the southeastern region.

- Georgia's per capita income increased 43.5 percent between 1995 and 2005.

- The state's median household income of $44,140 in 2005 was second highest among south-eastern states.

- Economic conditions vary across the state. Most of the state's southern counties have median household incomes less than $30,000.

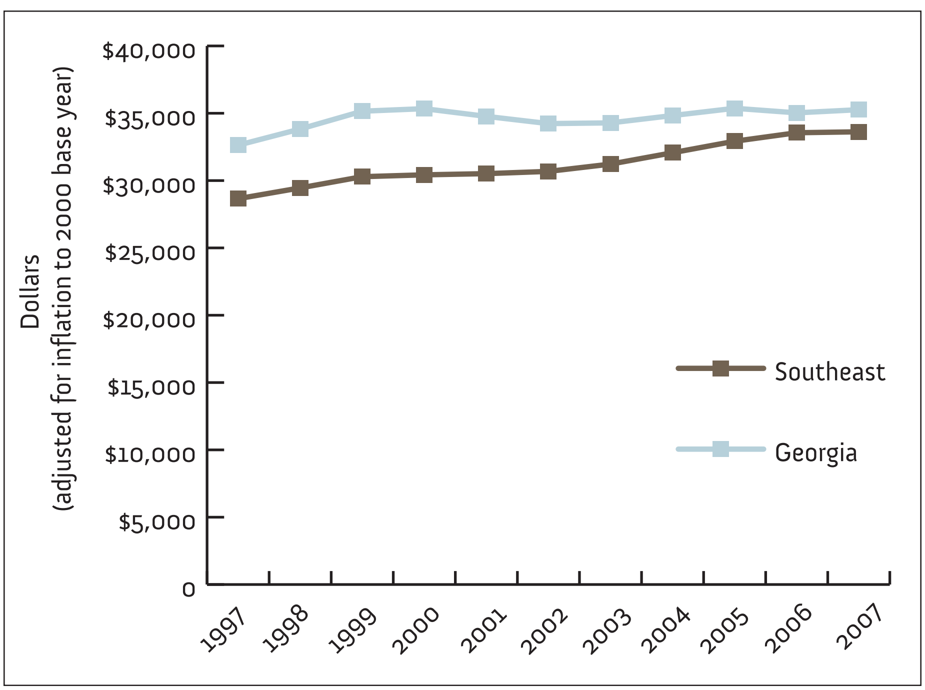


Figure 3 *Per capita gross domestic product, 1997-2007. This figure illustrates the trend in economic output compared to population. (Bureau of Economic Analysis, Regional Economic Accounts)*

Energy use

- Georgia's total energy use in 2005 was 3,173 million Btu, which is 63 percent higher than in 1985. The state's population grew by 53 percent over the same time period.
- The average amount of energy each person in Georgia uses per year (energy use per capita), has been consistently higher than the national average. Georgia's energy use per capita increased by 7 percent from 1985 to 2005; nationally, energy use per capita increased by about 5 percent over the same time period.
- Energy use per capita in Georgia peaked in 1996 and has declined since, but per capita use is still higher than that in the mid-1980s.
- The ratio of energy use to the state's GDP indicates the total energy being used to support economic and social activity. From 1997 to 2005, the amount of energy consumed to create one dollar of GDP in Georgia decreased 24 percent.
- Recent decreases in Georgia's energy use per capita and per GDP may reflect increased use of energy efficient practices as well as changes in the mix of the state's industries and economic sectors.

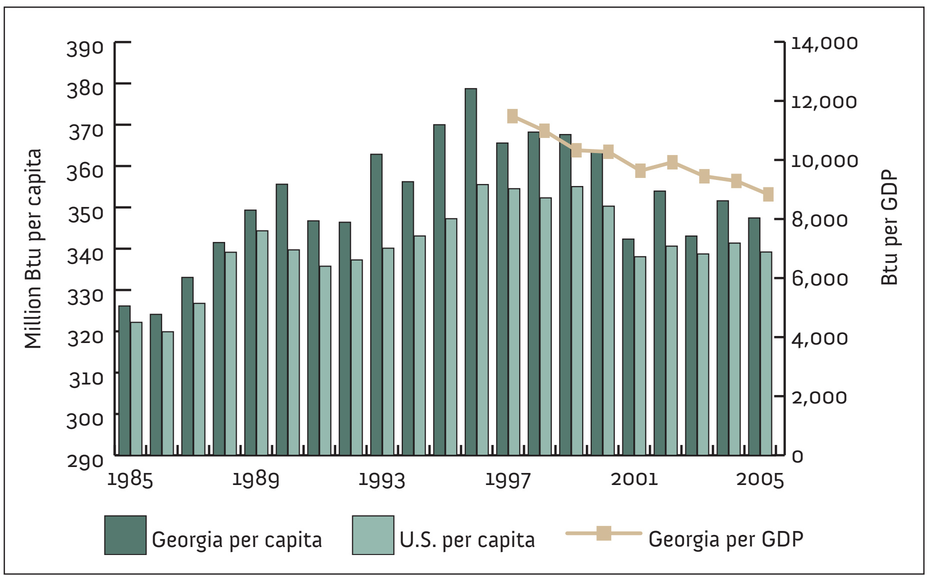


Figure 4 *Energy use per capita and per Georgia gross domestic product (GDP), 1985 - 2005. (Georgia Environmental Facilities Authority) Note: Due to changes in the method of calculation, estimates of Georgia's GDP prior to 1997 are not included. A Btu is a common measurement of energy across different fuel types (1 Btu equals the quantity of heat required to raise the temperature of 1 pound of liquid water by 1 degree Fahrenheit).*

A note about references

This report lists a number of Web sites as references for additional information. These links are current as of the date of publication, however, there is the chance that they may change over time.

Report organization

The report is organized by the three environmental objectives. Each chapter presents detailed information on the indicators related to each objective.

There are, of course, information gaps and limitations on the quality of the data available. In these cases, the report identifies the gaps and the steps needed to fill them. Finally, the report also includes some sections that present background information on environmental management, highlight emerging issues or provide additional details on specific environmental management initiatives. It concludes with a glossary and appendix of data sources and references.

Protecting Human Health

Protecting human health, one of EPD's most important objectives, is a major focus of the state laws that created EPD's regulatory and monitoring programs.

To meet this objective, EPD implements laws, rules and policies and enforces state and national standards. To ensure this objective is being met, EPD tracks pollutants in the state's drinking water and surface waters (lakes, rivers and streams), on the land and in the air.

In this chapter, 10 indicators are used to evaluate progress toward the objective of protecting human health (Table 1.1). Indicators measure the condition of the state's water, land and air and track human activities that affect these resources.

Human activities that alter the condition of the state's natural resources include nonpoint source water pollution, waste generation and disposal, and emissions of air pollutants.

Table 1.1 *Indicators of the condition of the state's natural resources.*

Natural resource	Indicators of condition
Drinking water	Community water systems meeting drinking water standards
Surface water	Bacteria levels in surface water
	Contaminants in fish tissue
	Non-point sources of pollution
Land	Land contaminated above health-based standards
	Solid waste disposal
	Hazardous waste generation
Outdoor air	Levels of air pollutants
	Non-attainment areas
	Emissions of air pollutants

Community Water Systems Meeting Drinking Water Standards

Indicator of the quality of Georgia's **Drinking Water**

What are public and community water systems?

A public water system is defined by the U.S. Environmental Protection Agency (EPA) to serve at least 25 people for at least 60 days a year. Community water systems are public systems that supply water to the same population year-round. EPA tracks the performance of community drinking water systems in all states to measure progress toward meeting the objective of protecting human health.

How do Georgia's results compare with those for the Southeast?

The performance by Georgia's community water systems has generally exceeded that of drinking water systems in the Southeast as a whole. Over the past decade, Georgia's community water systems outperformed Southeastern systems in eight out of 10 years.

Between 1998 and 2007, the percentage of the state's population served by community water systems that met all health-based standards averaged 96 percent. In the Southeast as a whole, the average for the same time period was 94 percent.

Georgia's drinking water comes from surface waters (rivers, lakes, streams, ponds and reservoirs) and from groundwater (springs and wells). More than 80 percent of the state's population gets its drinking water from public water systems (Figure 1.1), most of which treat the water before it is distributed.

To ensure that the drinking water provided by these systems is safe, the U.S. Environmental Protection Agency (EPA) and EPD set standards that limit the amount of 83 contaminants, including chemicals and disease-causing microorganisms (bacteria and protozoa), that can be present in the water. Owners and operators of public drinking water systems are required to monitor the water for these contaminants. Standards are violated when a contaminant exceeds the limits set for it in the regulations.

In 2007, 94 percent of the population served by community water systems in Georgia received water that met all health-based standards (Table 1.2); EPA's target for the southeastern states was 91 percent. The most common reason for not meeting the standards is high levels of total coliform bacteria (see page 9 for more on this contaminant). An increase in violations in 2006 and 2007 was due to new and more stringent federal and state drinking water regulations.

Less than 20 percent of Georgians get their drinking water from small non-public systems or wells. Since these sources are not required to meet specific standards and are not systematically monitored, the quality of drinking water for that portion of the state's population cannot be assessed.

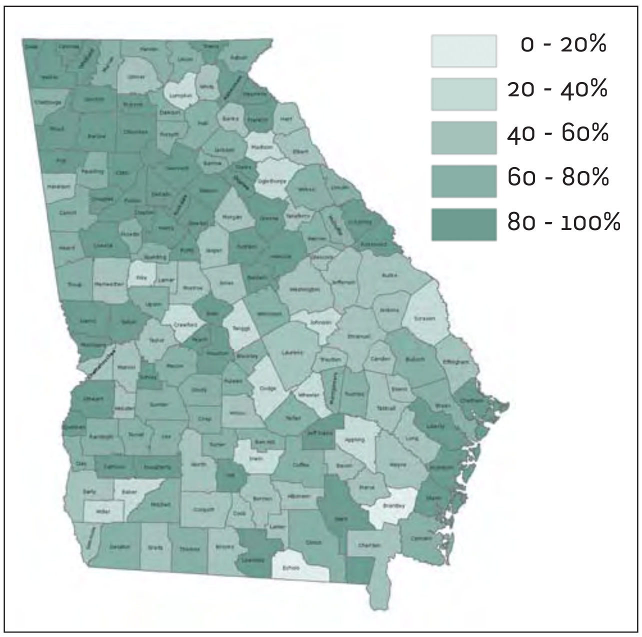


Figure 1.1 *Percent of population on a public water system, by county, 2007. (EPD)*

Table 1.2 *Community water systems meeting health-based standards. (EPA, based on Georgia Safe Drinking Water Information System data)*

Fiscal year	Number of systems meeting health-based standards	Percent of systems statewide meeting health-based standards	Population served by systems meeting health-based standards	Percent of population* served by systems meeting health-based standards
1998	1,574	95	6,230,632	97
1999	1,605	96	6,109,616	94
2000	1,621	97	6,497,878	99
2001	1,592	95	6,690,688	98
2002	1,599	96	6,910,480	98
2003	1,593	95	6,623,343	93
2004	1,643	97	7,239,274	98
2005	1,619	96	7,031,704	95
2006	1,612	94	7,033,525	95

*Population on community water systems only.

Backgrounder
What are coliform bacteria?

Drinking or coming into contact with water containing high levels of fecal bacteria increases the chance of illness (fever, nausea or stomach cramps) from harmful bacteria entering the body through the mouth, nose, ears or cuts in the skin.

Even in polluted waters, harmful organisms are generally few in number and, unfortunately, difficult to identify. Routine monitoring is either impossible or impractical; therefore, scientists and public health officials typically monitor bacteria that are associated with those transmitted by fecal contamination, which are easier to measure.

These bacteria are known as indicator organisms and are assumed to indicate the presence of harmful organisms. The presence of indicator bacteria does not mean the water contains harmful microorganisms, but rather that the potential exists. Types of indicator bacteria include:

Total coliforms are a group of bacteria that are widespread throughout the natural environment. All members of the total coliform group can occur in human feces, but some can also be present in animal manure, soil, submerged wood and in other places in the environment. Total coliforms are the standard test for drinking water because their presence indicates that a water supply has been contaminated by an outside source.

Fecal coliform bacteria, a subset of total coliform bacteria, are more likely to originate in feces. Georgia and many other states have used this group of bacteria as the primary indicator for contamination of recreational waters.

Recently, EPA began recommending two other bacteria, E. coli and enterococci, as better indicators of health risks from water. Following this guidance, Georgia's fecal coliform standard will be evaluated and updated to improve the tracking of public health risks. Until this evaluation is complete, EPD will continue to use fecal coliform as a primary indicator of water quality.

Escherichia coli (E. coli) is a species in the fecal coliform group commonly found in the intestinal tract of humans, mammals and birds. This bacteria is one of the best indicators for freshwater recreation because its presence is direct evidence of fecal contamination from warmblooded animals.

Enterococci are a subgroup within the bacterial coccus group that are also commonly found in the intestinal tract of humans and animals. Because Enterococci can survive in salt water, EPA recommends this group as the indicator of health risk in salt water used for recreation.

Bacteria Levels in Surface Water

Indicator of the quality of Georgia's **Surface Water**

What are water quality standards?

Water quality standards define the goals for a water body by designating its uses and setting criteria to protect those uses.

All waters in the state have a specific designated use, such as drinking water, fishing, recreation, wild and scenic or coastal fishing. There are also special designations for trout streams, waters that support shell fishing and outstanding natural resource waters. All waters are protected for recreation during the swimming season (May - October). All major lakes, a portion of the Chattahoochee River and the coast are designated for recreation year round.

Water quality criteria are designed to protect each water body's designated use. Some criteria are narrative — text descriptions of required water quality conditions. Others are numeric criteria that define limits on acceptable amounts of specific pollutants. To help ensure that the state's water bodies meet their designated uses, EPD monitors their condition to determine whether or not the water quality criteria are met.

Two indicators are tracked to assess the quality of surface water from the perspective of human health: bacteria levels in surface water and contaminants in fish tissue.

This report uses three methods to evaluate bacteria in surface waters. The first is the trend in fecal coliform levels at 40 long-term or trend monitoring stations. The second, the number of miles of rivers that violate the fecal coliform standards, is based on measurements from a larger number of sites in the river basin monitoring program. The third comes from monitoring waters at public beaches.

Tracking bacteria levels is important because water contaminated with bacteria can cause illness not only if it is ingested, but also if it comes in contact with the ears, nose, mouth or cuts in the skin. [See page 9 for more information on bacteria and page 11 for more on monitoring.]

Each year, fecal coliform and other contaminants are measured monthly at 40 trend monitoring sites around the state. Water samples have been taken since the early 1970s, so long-term trends in water quality can be evaluated. Analysis of this data shows a consistent decline in fecal coliform levels since the early 1970s. This decline is primarily due to major improvements in wastewater treatment by industries and municipalities.

Because people tend to swim and engage in other water-related activities more during the summer, the standard for fecal coliform is stricter between May and October. Since the early 1990s, average summer levels of the bacteria have been below the health-based water quality standard (Figure 1.2). Winter levels of fecal coliform have also shown a similar trend, with average levels falling below the winter standard since 1975.

Data from the 40 trend monitoring sites provides valuable information. However, other information, including data on short-term variation in water quality and on water quality in other rivers and streams, is needed for a fuller picture of the bacteria levels in surface waters.

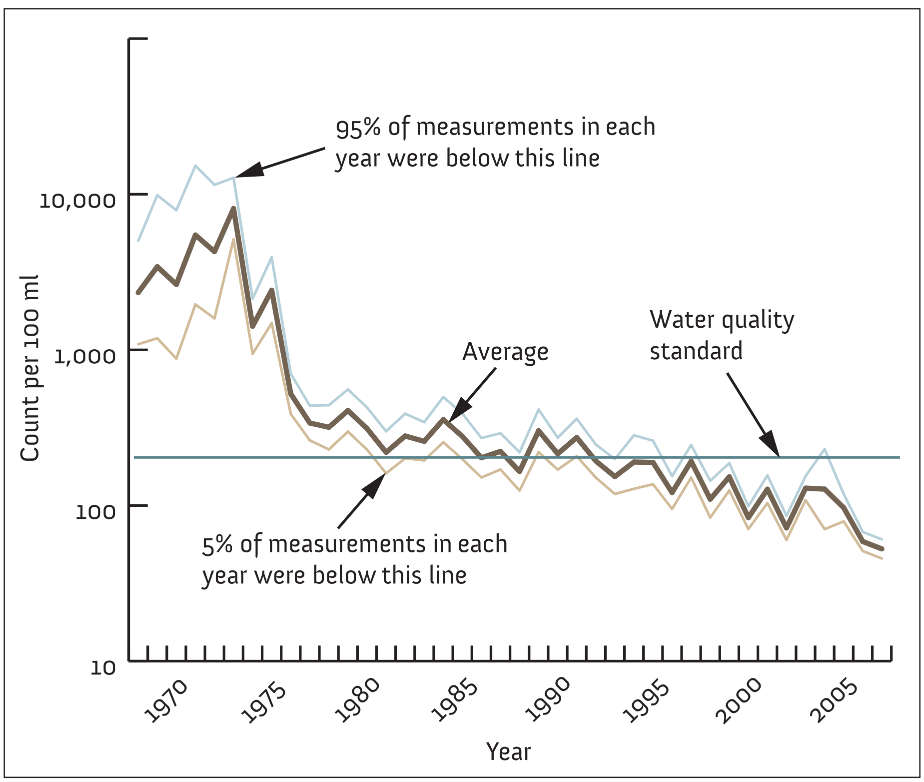


Figure 1.2 *Average fecal coliform counts at 40 trend monitoring stations, May - October. Swimming and other recreational contact with surface waters is greatest between these months, making this the most critical time to monitor fecal coliform levels. (EPD)*

Backgrounder

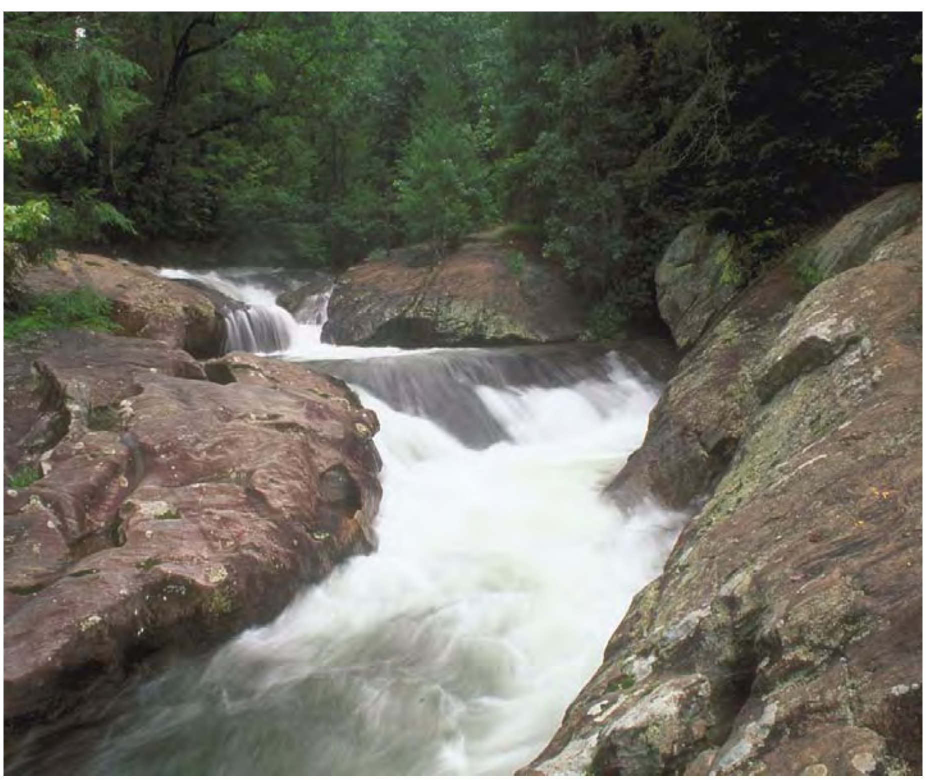
How do we monitor the quality of Georgia's surface water?

In the late 1960s, EPD began monitoring the quality of Georgia's surface water. Since then, 40 sites, representing all the state's major river basins, have been continuously monitored. These sites are mostly on large streams or rivers along Georgia's borders and track the quality of water coming in from other states, as well as the quality of the water leaving Georgia.

In addition to sampling at these core stations, EPD also monitors all river basins on a rotating schedule — generating an in-depth study of each basin every five years. In recent years, water quality data have been collected from 125 to 240 sites every year. The number of stations monitored partly depends on state, federal and non-governmental funding.

While the program does not evaluate water quality in every body of water in the state, it does track changes in water quality conditions across the state. For example, water quality is monitored in waters with significant recreational or municipal uses, waters threatened by contamination from polluted runoff, and waters that receive wastewater or stormwater discharges. EPD also tracks efforts to improve water quality after problems are discovered.

As of 2008, water quality in more than 20 percent of the state's river and stream miles and in more than 93 percent of the acres in the state's major lakes had been evaluated. EPD reviews its water quality monitoring strategy every three to five years, with the goal of increasing the number of stream miles and lake acres it evaluates.



What happens when water quality standards are not met?

The federal Clean Water Act requires each state to maintain a list of waters that do not meet water quality standards. States must rank these waters in order of priority and set a limit for the maximum amount of a contaminant the water body can receive and still meet water quality standards. This limit, called a total maximum daily load (TMDL), is established to ensure that the water body supports its designated uses.

Developing the TMDL typically involves intensive monitoring to describe the water quality problem more fully, identify potential sources of pollution, and determine the level of pollution reduction necessary to meet the target.

Once the TMDL is established, EPD develops a plan describing how the TMDL, and ultimately the water quality standards, will be achieved. Once the water quality standards are met, the state may remove the water body from the list.

Keeping swimmers on Georgia's coast safe from bacteria

To protect swimmers on the coast, the state also monitors waters at designated public beaches for enterococcus bacteria. [See page 9 for more on why this specific bacteria is tracked.] If high levels of bacteria are found, the local health department issues an advisory recommending the public not swim there, although the beach is not closed.

Twenty-seven beaches were monitored between 2005 and 2007. Of the beaches monitored in 2007, 14 had at least one advisory (see table below). Overall, EPA concluded that Georgia beaches were affected by high levels of enterococcus bacteria on only 2 percent of the total number of beach days* in the 2007 swimming season. Nationally, beaches were affected by high levels of bacteria on 5 percent of beach days in 2007.

Beach advisories, 2004 - 2007.

	Beaches with advisories	% of beach days affected
2005	17	10
2006	11	3
2007	14	2

**The total number of beach days equals the number of beaches monitored multiplied by the number of days in the swimming season. (EPA)*

To supplement trend monitoring data, EPD also monitors all river basins on a rotating, five-year cycle. This monitoring gives a more detailed snapshot of water quality in each river basin and provides much of the information EPD uses to determine whether water quality standards are being met.

Periodic river basin monitoring shows that, while long-term trends in fecal coliform have steadily improved, there are still sections of streams and rivers where fecal coliform levels exceed the water quality standard (Table 1.3).

Of the river miles tested, 34 percent do not meet water quality standards for fecal coliform, indicating potential human health risks from contact with those waters. Fecal contamination affects all 14 river basins in the state, and it is currently the most common water quality problem in all but four.

Table 1.3 *Percent of assessed miles of rivers not meeting the water quality standard for fecal coliform, 2006 - 2007. The location of each river basin is shown in Figure 1.3. (EPD)*

River basin	Total river miles	Percent of river miles assessed	Percent of assessed miles not meeting fecal coliform standard
Altamaha	3,430	16%	31%
Chattahoochee	8,172	23%	39%
Coosa	7,126	25%	37%
Flint	9,122	18%	19%
Ochlockonee	1,716	15%	49%
Ocmulgee	7,268	25%	34%
Oconee	6,773	20%	40%
Ogeechee	6,981	12%	21%
Satilla	3,629	21%	32%
Savannah	7,413	15%	31%
Suwannee	4,961	20%	19%
St. Marys	485	33%	9%
Tallapoosa	774	31%	35%
Tennessee	2,300	24%	35%
Total	70,150	20%	32%

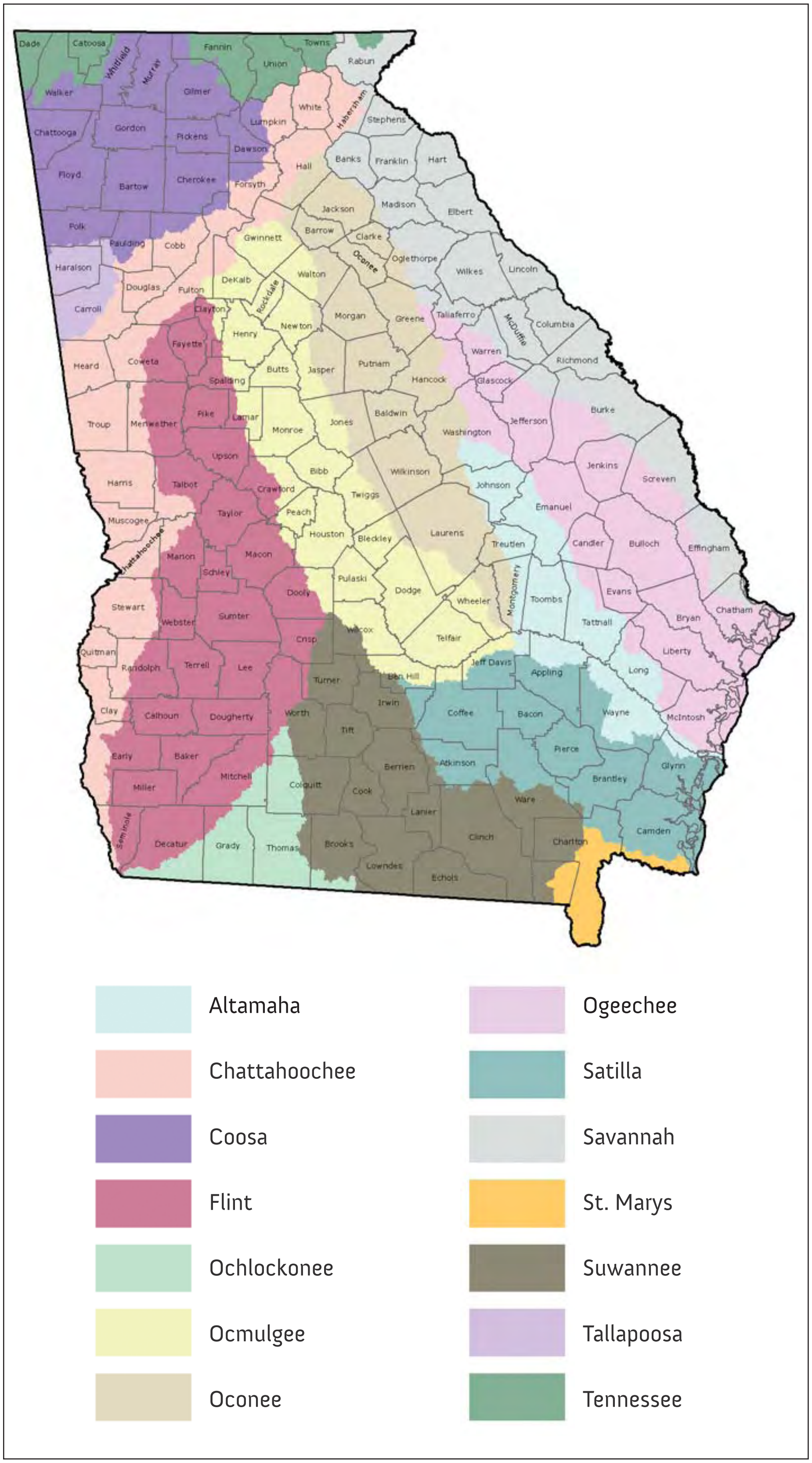


Figure 1.3 *Georgia's 14 major river basins. (EPD)*

What is a watershed?

A watershed is an area of land where all the water drains to the lowest point – usually a stream, lake or river. Rain runs off land in the watershed through a network of gullies, creeks and streams to the point defined as the outlet of the watershed. That point may be on a stream, river or lake.

The boundary of a watershed is formed by the highest mountains or hills around a stream, river or lake and ends at the bottom or lowest point of the land where water flows out of the watershed.

Small watersheds include small streams known as headwater streams, and may have one connecting stream.

Small watersheds that contribute water to the same large stream or river are part of the same large watershed. For instance, the land that drains into southwest Georgia's Ichawaynochaway Creek is an example of a large watershed. The land that drains into the Upper Ocmulgee River in the central part of the state and the land that drains into the Broad River in northeast Georgia also are examples of large watersheds.

There are 52 large watersheds in Georgia (for a map, see http://www.georgiaplanning.com/documents/atlas/52watersheds.pdf). These large watersheds drain into the state's 14 major river basins (Figure 1.3).

Contaminants in Fish Tissue

Indicator of the quality of Georgia's **Surface Water**

Some contaminants build up in fish tissue and may pose risks to human health when the fish is consumed. Longer-lived fish (and the animals that eat them) can contain more contaminants, and therefore can pose greater risks for human consumption.

EPD monitors for 40 types of contaminants in fish in rivers, lakes and streams commonly used for fishing. These areas include 26 major reservoirs that make up more than 90 percent of the state's lake acreage, rivers visited by large numbers of fishermen, and some rivers downstream from urban or industrial sources.

Each year, the state issues risk-based guidelines recommending people limit their consumption of species by water body, based on the levels of contaminants found in the fish. These guidelines are intended to protect sensitive groups (such as children and women of childbearing age) from health risks associated with long-term, chronic exposure to the contaminants.

The contaminants monitored fall into two general categories: human-made chemicals called organochlorines and naturally occurring metals. Organochlorines that contribute to recommended restrictions on fish consumption include polychlorinated biphenyls (PCBs); DDT and its by-products; and the pesticides dieldren, chlordane and toxaphene. Mercury is the only metal that contributes significantly to the recommended restrictions.

In the early years of monitoring, organochlorines accounted for most of the restrictions (Figure 1.4). However in the late 1990s, restrictions due to mercury became more prevalent and continue to account for the majority of advisories today (see the sidebar on page 15 for one reason for this change).

Fish consumption guidelines due to mercury are more common in the state's rivers than in its lakes. They are also more stringent in the southern parts of the state. The chemical conditions in streams found in south Georgia lead to the transformation of mercury into a form that poses the greatest threat to human health (methylmercury); this form of mercury also easily builds up in fish tissue.

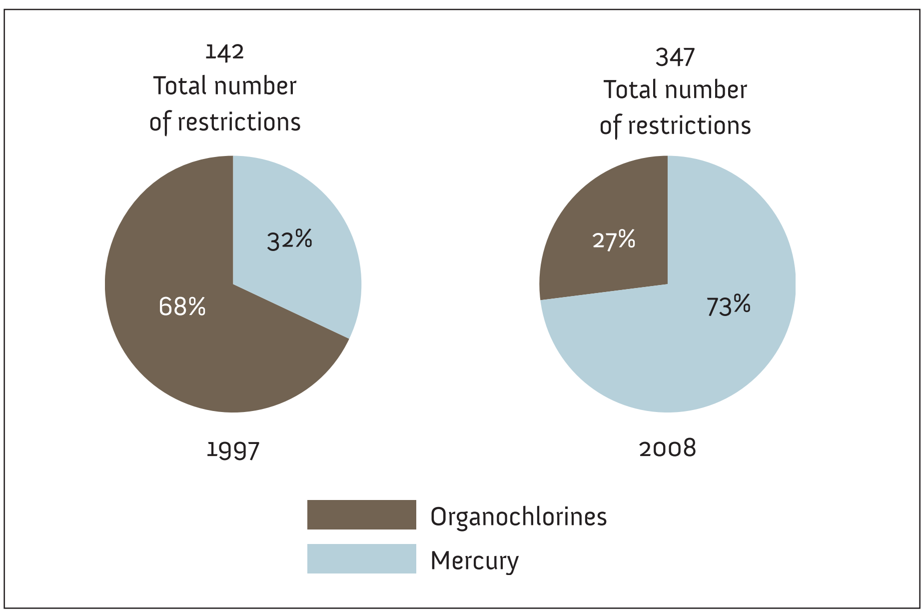


Figure 1.4 *Percentages of recommended fish consumption restrictions due to mercury and organochlorines, 1997 and 2008. (EPD)*

Restrictions recommended due to PCB contamination vary across the state, with more occurring in the Chattahoochee, Coosa, Ocmulgee, Satilla and Savannah basins. Rivers and lakes seem to be equally affected by PCBs. There is a ban on the manufacture of new products containing PCBs, but old equipment can still be a source. Also, contamination can remain in the environment a long time because PCBs break down very slowly.

Pesticide contamination results in the fewest number of recommendations limiting fish consumption. Use of the pesticides that contribute to fish consumption guidelines has been banned or restricted in the U.S. However, like PCBs, they are still present in the environment because of how slowly they break down.

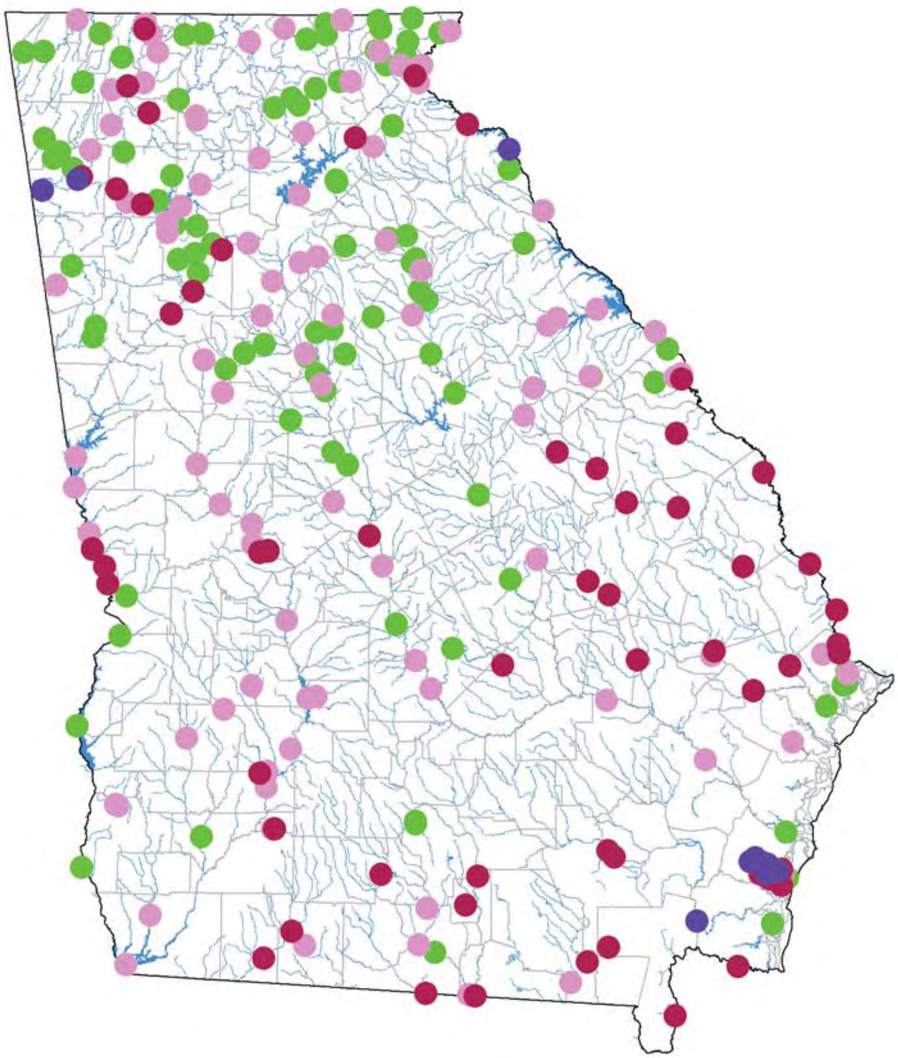


Figure 1.5 *Fish consumption guidelines, 2008. (EPD)*

Why are fish consumption restrictions due to mercury more common today?

One reason that restrictions due to mercury are more prevalent in Georgia today is because of changes EPA made in how it evaluates risk from contaminants.

On the basis of new research, in the late 1990s, EPA tripled the estimated toxicity of mercury and lowered the estimated toxicity of two important organochlorines (PCBs and chlordane).

The new values decreased the importance of organochlorines in the overall scheme of Georgia's advisories and greatly increased the significance of mercury.

Where can I find the fish consumption guidelines?

The booklet, "Guidelines for Eating Fish from Georgia Waters," is available online at www.gaepd.org/Documents/fish_guide.html.

New guidelines are issued each year based on changing conditions in the state's lakes and rivers.

Nonpoint Sources of Pollution

Indicator of the quality of Georgia's **Surface Water**

What are nonpoint sources?

Nonpoint sources of water pollution include:

- Bacteria and nutrients from livestock, pet wastes and faulty septic systems
- Sediments from improperly managed construction sites, crop and forestlands and eroding stream banks
- Oil, grease and toxic chemicals from urban runoff and energy production
- Excess fertilizers, herbicides and insecticides from agricultural lands and residential areas
- Mercury from coal-fired power plants and other sources of combustion

The quality of Georgia's surface waters is affected by pollution from point and nonpoint sources. Point sources include wastewater flowing from a single source — e.g., a pipe, an industrial facility or a wastewater treatment plant. Nonpoint source pollution, in contrast, can be created by a variety of human activities.

Pollution from nonpoint sources is generally carried by rainfall or snowmelt moving over the ground. As this water moves across the land, it picks up and carries pollutants with it, finally depositing them into lakes, rivers, wetlands and coastal waters.

Some contaminants, like mercury, also can settle directly out of the air and into a body of water. Together, pollution from these different nonpoint sources can slow progress toward the objective of protecting human health (and toward other environmental objectives, as will be discussed later).

Mercury: the air-land-water connection

Mercury in fish tissue, and the fish consumption guidelines that result, are nonpoint source problems. Although the risk to human health comes from eating fish, the mercury does not come from the water body. Instead, much of the mercury in our streams and rivers has been deposited out of the air after originating from combustion sources.

There are several different chemical forms of mercury. Metallic and inorganic forms can be toxic at high levels. However, an organic form called methylmercury is of greater concern, because it is a powerful toxin, it remains in the environment for a long time, and it readily enters the food chain and can accumulate in the bodies of fish, animals and humans.

Because mercury, like some other pollutants, can remain in the environment for a long time, it can be carried great distances by air currents and then settle onto soil or into lakes and streams, far from the original source. Once on land or in water, mercury can undergo a complex series of chemical reactions to create methylmercury. The natural chemical conditions that lead to this transformation are more common in south Georgia than in north Georgia, which contributes to the higher number of mercury-based fish consumption restrictions in the southern part of the state.

Today, most human-made mercury that enters the environment comes through emissions to the air from combustion sources such as coal-burning power plants. Some of this mercury may enter a global pool of mercury in the atmosphere. Much of it, however, falls out locally, near the point where it was emitted, or is deposited in other parts of the state or southeastern U.S.

All of these factors contribute to the management challenge posed by mercury. In 2008, mercury accounted for nearly three-fourths of all advisories on reduced fish consumption in Georgia. EPA assessments indicate that local industrial facilities were the primary source of mercury in some of these water bodies. For others, however, EPA's results suggest that as much as 72 percent of the mercury came from coal-fired power plants in other parts of the state.

To address these sources, the state recently adopted regulations that require new and existing power plants to install technologies that reduce the amount of mercury they release. The regulations also require additional monitoring and evaluation of mercury sources, information that will be critical to improving our management of mercury's air-land-water connection and decreasing risks to human health.

For more information on mercury transport, see the 1997 EPA report to Congress available at http://www.epa.gov/mercury/report.htm. Information on mercury in Georgia waters is available in the data sources listed at the end of this report.

Bacteria: the land-water connection

Nonpoint sources also contribute to bacteria levels in surface water. Storm water runoff is one source of high bacteria levels. Fecal coliform bacteria in stormwater may come from wildlife and domestic animals, urban development (including sewer collection lines), leaking septic tanks, manure applied to agricultural land, or animals with access to streams.

During rainy weather, the levels of fecal coliform in surface water are often higher than in the same streams under dry conditions (Table 1.5). This effect is generally more pronounced in urban and suburban areas due to the large amount of paved surfaces and extensive drainage systems that efficiently carry contaminants into streams.

Bacteria levels in surface water also can be affected by failing septic systems. Septic systems that are properly sited, installed and maintained do not pose risks to human health and on-site sewage management is an important part of wastewater management in Georgia. When systems fail, however, bacteria can enter groundwater or be transported into streams and other water bodies.

While all county health departments oversee the siting and installation of septic systems, there are few monitoring programs or maintenance requirements in Georgia. The only local requirements for septic system maintenance are in the city of Berkley Lake in Gwinnett County and in a portion of Douglas County that lies in the watershed of the drinking water reservoir.

There have been no comprehensive studies of septic system failure rates across the state. A study in Gwinnett County found failures that resulted in wastewater backing up onto the ground surface in less than 1 percent of septic systems. In the 16-county metro Atlanta area, the North Georgia Metropolitan Water Planning District estimates that approximately 1 percent of septic systems fail each year.

Information on septic system repairs from the Georgia Department of Human Resources, however, suggests that failure rates may be higher in some counties. Failure rates are likely to vary with regional soil and groundwater conditions, and may be higher in areas with high water tables, like the coast.

The impact of failing septic systems is not just determined by failure rates; location is also a factor. If systems are built in unsuitable soils or next to surface water bodies, bacteria can readily be transported from failing systems directly to groundwater or nearby surface waters.

Even with low failure rates, without monitoring or maintenance programs, areas with large numbers of septic systems may face greater risks to water quality. The Georgia Department of Human Resources reports that, in the past five years, the highest numbers of new installations of septic systems have occurred in counties at the edge of and surrounding the metro Atlanta area. High numbers have also been seen in some counties in the north Georgia mountains and in a few counties along the coast.

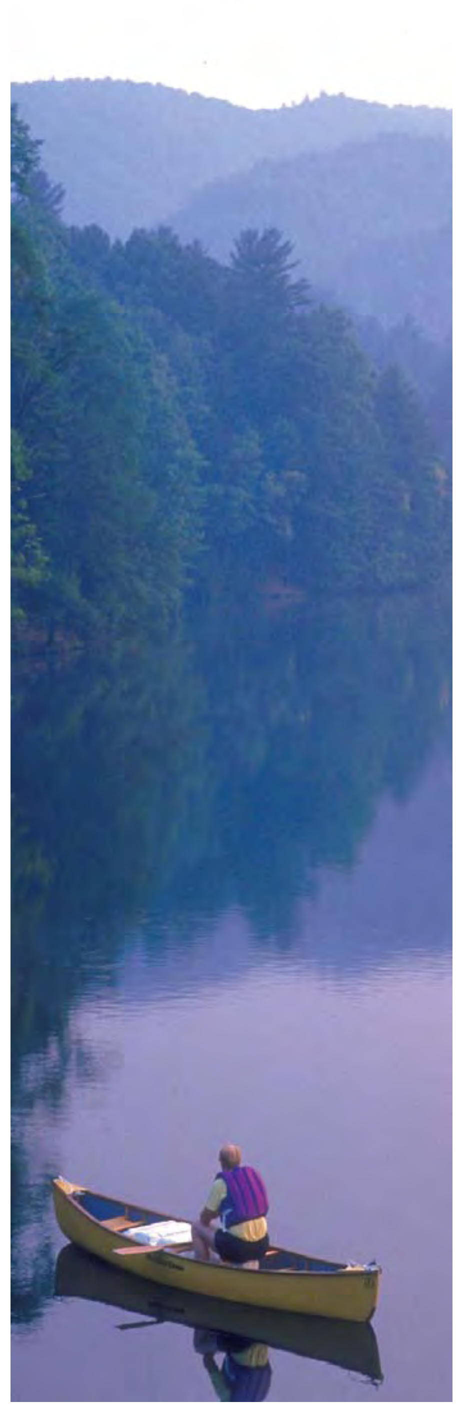


Table 1.5 *Fecal coliform levels during dry and wet weather, 1998 - 2005 (counts per 100 ml). (EPD)*

	Streams in rural areas		Streams in urban areas	
	Average	Range	Average	Range
Dry weather	160	51 - 744	225	28 - 5,289
Wet weather	414	158 - 4,480	2,514	148 - 41,611

Land Contaminated Above Health-based Standards

Indicator of the quality of Georgia's **Land**

The management of Georgia's land-based resources differs markedly from that for air and water. There are no major federal laws that specify overall standards for land quality. There are, however, federal and state laws that establish health-based standards for land contaminated with hazardous substances. At sites where humans can be exposed to contamination, cleanup standards are established to ensure the protection of human health.

Land contaminated above health-based standards can pose significant threats to human health in the immediate area, either through direct exposure to soil or contamination of drinking water sources. The number of acres contaminated above health-based standards that have been identified and measured is an indicator of the condition of Georgia's land from a human-health perspective.

EPD currently monitors land contamination from four primary sources: landfills, underground storage tanks, sites where hazardous waste is treated or stored, and sites known to be contaminated with hazardous substances. Contamination can also be caused by a number of other sources that are not routinely monitored. As a result, the total amount of land contaminated above health-based standards is not known. However, the acreage and number of contaminated sites currently tracked by EPD provide two measures of the condition of Georgia's land from the perspective of human health.

Landfills, if not properly managed, can result in contamination of surface and groundwater from liquid leaving the landfill. This liquid, known as leachate, is created as rain or groundwater filters through the landfill, picking up contaminants along the way.

Underground storage tanks are used by gas stations and other businesses to hold gasoline, oil and other petroleum products. Ingredients in these products, such as benzene and toluene, can cause cancer and other human illnesses. Corroded or leaking tanks can pose a serious threat to groundwater.

Sites where hazardous waste is treated or stored are tracked and managed under the federal Resource Conservation and Recovery Act. Land at a portion of these sites has been contaminated above health-based standards.

Other sites contaminated with hazardous substances also are tracked on Georgia's Hazardous Site Inventory (HSI) — a list of sites in the state where there has been a release (or a suspected release) of a hazardous substance above a specific amount. These sites also have not met the health-based, cleanup standards established by the state.

Table 1.6 presents information on the extent of soil and groundwater known to be contaminated above health-based standards, where that information is available. This amount has been determined by the extent of land contamination that has been identified (for which acreages can be estimated)

Table 1.6 *Estimate of land contaminated above health-based standards, 2006. (EPD)*

	Number of sites	Acres of contaminated land	Acres of contaminated groundwater
Solid waste landfills	126	13,230	13,775
Underground storage tank sites	3,011	3,011	1,983
Sites where hazardous waste is stored or treated	69	3,095	5,787
Georgia's Hazardous Site Inventory	550	not available	not available

minus land that has already been cleaned up. The data exclude land on the Hazardous Site Inventory, as the acreage of these sites is not currently available.

Compared to the acreage of the state as a whole (about 38 million acres), the extent of land known to be contaminated at levels above health-based standards is small. But, these lands are more concentrated in urban areas where the potential for human exposure is higher. They can pose significant threats to human health in the immediate area, either through direct exposure to soil or contamination of drinking water sources. Identifying these sites and controlling and cleaning up contamination are important steps in making progress toward the objective of protecting human health.

Since the total number of acres on the HSI is not available, EPD tracks the number of sites on the inventory as another indicator of land contamination. The first step in adding a site to the HSI is notifying EPD of a spill or contamination.

Of the sites with spills or contamination that are reported to EPD, only those with an exposure pathway — a physical route to the human body through drinking water or contact with soil — pose a risk to human health and are added to the Inventory. If there is not currently an exposure pathway, then the site is not added. Between the creation of the HSI in 1994 and 2007, EPD received 2,173 notifications of spills or contamination and evaluated an additional 1,106 sites. Of the 3,279 sites evaluated, 779 were added to the Inventory.

At the same time that new sites are added, others are cleaned up and removed from the list (Figure 1.7). By 2007, a total of 566 sites remained on the list. These sites are found across the state, but tend to be concentrated in larger cities, including Atlanta, Augusta and Savannah, because of the history of industrial activity in those areas.

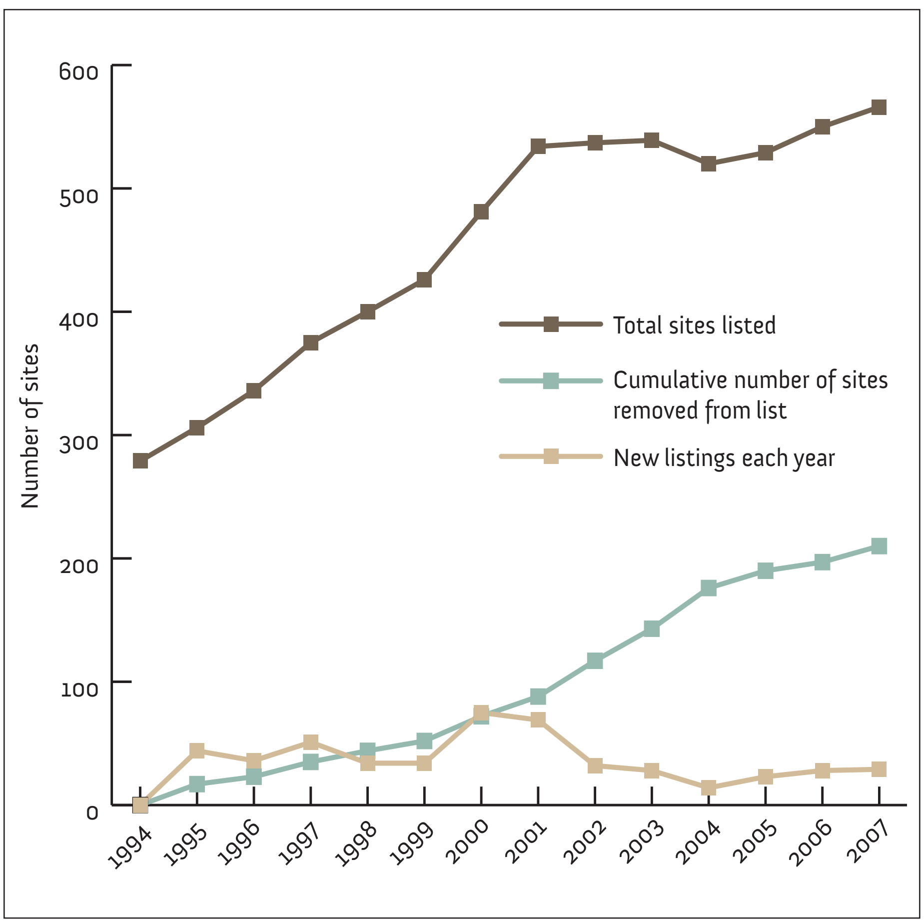


Figure 1.7 *Sites on the state's Hazardous Site Inventory, 1994 - 2007. (EPD)*

How much contaminated land has been cleaned up?

Once contaminated sites are identified, EPD must ensure they are cleaned up to levels that no longer pose a threat to human health.

- By 2007, **210 sites** listed on **Georgia's Hazardous Site Inventory** had been cleaned up to meet health-based standards.
- As of 2006, **18 sites and 588 acres** of **sites where hazardous waste is treated or stored** had been cleaned up.
- Also as of 2006, **246 acres** at two **landfills** had been cleaned up.
- There has been notable progress cleaning up lands contaminated by leaking **underground storage tanks**:
  - By 2006, 69 percent of the contaminated soil area — or **6,745 acres** — had been cleaned up to levels no longer threatening to human health.
  - Contaminated groundwater lying under **3,441 acres** — or 63 percent of the affected area — had been cleaned up to meet the standards or, because there is currently no exposure route, were found not to threaten human health.

Cleanup of lands contaminated above the health-based standards will continue. Reaching contaminant levels that no longer threaten human health may, however, take longer than in the past. Many of the less contaminated sites already have been cleaned up, leaving sites that are more challenging and can take longer to clean.

Solid Waste Disposal

Indicator of the quality of Georgia's **Land**

Georgia's wasteful ways

Georgia's per capita rate of municipal solid waste (MSW) disposal — 6.44 pounds per person per day — is more than twice the national average (see table below). This figure does not even include waste imported from other states. Imported waste added another 1.13 pounds per person per day in 2007, 10 percent higher than in 2004. An average of 2.3 pounds per person is also disposed of in construction and demolition landfills.

To address the high rate of solid waste disposal, the state promotes recycling and waste reduction through technical assistance and education and grants to local governments to build recycling infrastructure. Specific projects include establishing regional recycling collection hubs and mounting a statewide campaign to increase awareness about recycling.

Per capita MSW disposal rates for Georgia and the U.S., 2004 - 2007 (lbs per person per day) (EPD)

	GA MSW disposed	U.S. MSW disposed
2004	6.39	3.21
2005	6.44	3.16
2006	6.39	3.15
2007	6.44	3.08

EPD tracks the amount of waste disposed in municipal solid waste (MSW) landfills and construction and demolition (C&D) debris landfills. MSW landfills accept waste from households and businesses, and nonhazardous waste from industries. C&D landfills accept building materials and debris from construction, renovation and demolition. As of 2006, there were 119 active landfills accepting solid waste in Georgia.

From a human health perspective, one of the biggest improvements in solid waste disposal has been a shift to MSW landfills with liners and leachate collection systems. Since 1993, MSW landfills have been required by federal regulations to have these systems to protect groundwater and soil from liquids (known as leachate) that percolate through the landfill and pick up contaminants from the waste.

In 1994, 54 percent of the state's municipal solid waste was disposed in unlined landfills without systems to capture and treat leachate. By 2006, 98 percent of MSW was disposed in lined landfills with collection systems.

Federal regulations also require groundwater monitoring at landfills to ensure leachate does not reach the water table. Groundwater monitoring is conducted at active landfills (those currently accepting waste) and at those closed after June 1991. As of 2006, 305 active and closed landfills were subject to groundwater monitoring requirements.

Groundwater contamination has been found at approximately 150 of these sites (affecting roughly 16,000 acres). However, most is contained within the landfill boundaries. Only 546 acres of groundwater outside the boundaries are affected. Of the 305 landfills with groundwater monitoring, 119 are active and 186 are closed. In 2006, only 19 percent of the active landfills showed evidence of groundwater contamination while 71 percent of the closed sites had groundwater contamination.

The quantity of waste disposed in Georgia has risen consistently in recent years (Figure 1.8). In 2007, more than 17 million tons of solid waste was disposed. Of that total, more than 12.7 million tons was disposed in MSW landfills, up from 10.7 million tons in 2001. The amount of C&D waste disposed grew by 71 percent in the same time period. Disposal of waste from other states also increased in this period — almost 2 million tons of waste were imported in fiscal year (FY) 2007, compared to approximately 900,000 tons in FY 2001.

Increases in population, economic growth and landfill capacity all contrib-

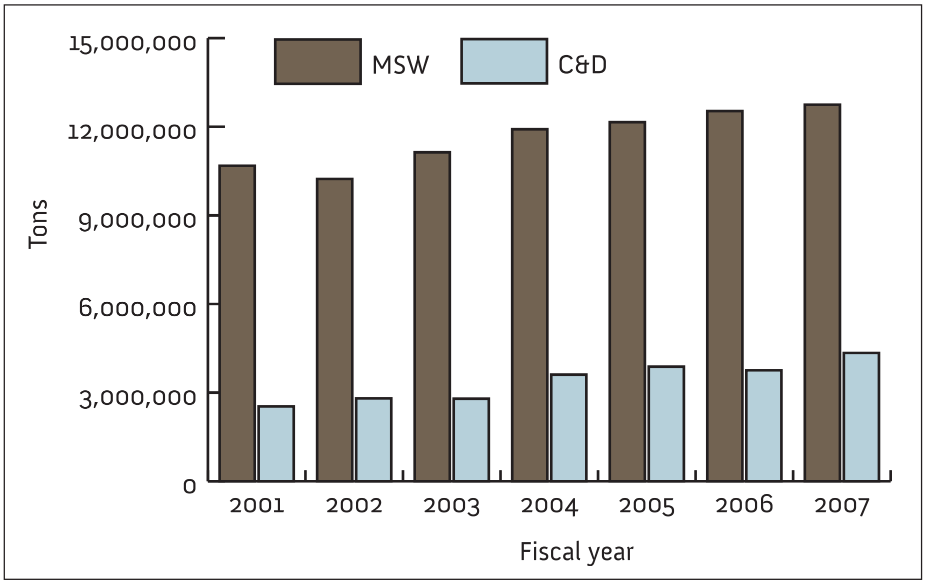


Figure 1.8 *Waste disposed of in Georgia municipal solid waste and construction and demolition debris landfills, 2001 - 2007. (EPD)*

ute to these trends. The cost to dispose of solid waste (known as tipping fees) also is relatively low in Georgia. In 2005, the average tipping fee for MSW in Georgia was $35.38 per ton and for C&D debris was $30.21 per ton. This was about $5 per ton lower than the average in the Southeast and nearly $30 per ton lower than the average in the Northeast.

Backgrounder

Scrap Tires: A recycling success

A long-standing priority of the state has been to assure clean up and recycling of scrap tires. Scrap tires may not seem like a threat to human health, but when filled with rainwater they provide the perfect breeding ground for mosquitoes, including those that carry dangerous viruses, such as the West Nile Virus and Eastern Equine Encephalitis. Large tire dumps also are fire risks. In 1992, a fire at an abandoned scrap tire processing facility in Palmetto burned approximately 3 million tires. Runoff containing pyrolytic oil from the burning tires contaminated the groundwater.

The state's scrap tire program focuses, in part, on removing illegally dumped scrap tires. Since the program began in 1992, more than 13.7 million scrap tires have been removed from illegal dumps and recycled. In FY 2007 alone, 268,000 illegally dumped tires were collected and recycled. The estimated number of illegally dumped tires dropped from 3.2 million in FY 1999 to 415,000 in FY 2006, a reduction of 85 percent.

Each year, approximately 9 million scrap tires are generated in Georgia. To ensure the scrap tires generated in Georgia, plus the millions more imported, are properly managed, EPD tracks them from the point of generation to final disposition at a processor or recycler. Scrap tires can be processed as an alternate fuel source or recycled into products such as artificial turf, paving tiles or rubberized asphalt. In FY 2006, an estimated 15 million tires were processed or recycled by scrap tire industries in Georgia.

What do recycled tires become?

As the largest processor of scrap tires in the state, Liberty Tire Recycling processes about 95 percent of the scrap tires generated in Georgia. At its three facilities, scrap tires are processed to create either tire-derived fuel or crumb rubber.

Tire-derived fuel is an alternate energy source produced by grinding whole tires into chips. This fuel has an energy content that is nearly equal to natural gas and is higher than most types of coal. Compared to many other solid fuels, tire-derived fuel also can be burned in ways that produce less ash and release less air pollution (sulfur dioxide and nitrogen oxides, specifically). Production of this fuel is a major use of scrap tires, using more than half of the number of tires generated nationally.

Crumb rubber is a finely ground rubber produced from whole tires. It is used as a raw material in the production of a variety of new rubber products, including door mats, flooring, automobile parts, railroad ties and new passenger tires. Liberty Tire Recycling also provides crumb rubber to refiners, who reprocess the material to a consistency finer than talcum powder for use in other rubber goods and automobile parts.

Recyclables: An economic resource

Recycling is not only a key strategy to reduce waste, it also supports local businesses and creates jobs. Georgia is home to more than 50 manufacturers that use recovered materials in their processes. One-third of the plastic beverage containers (PET #1) recycled in North America are used by Georgia's carpet industry, and nearly 8 percent of the paper recovered in the U.S. is used by Georgia's paper industry.

The Department of Community Affairs estimates that 2.6 million tons of easily recyclable commodities are currently discarded in Georgia (including cardboard, office paper, aluminum cans and plastic beverage bottles). While commodity prices fluctuate with economic conditions, as of February 2008, the estimated value of these materials was more than $300 million.

Recycling also saves energy. Recycling just 10 percent of the 2.6 million tons of recoverable material that is currently disposed in Georgia would save energy equivalent to taking nearly 58,000 passenger cars off the road each year.

However, the infrastructure to collect and process recyclable materials is limited, forcing Georgia industries to import materials from other states. Expanding the recycling infrastructure in the state would increase the amount of recyclable materials available locally to support Georgia industries.

Hazardous Waste Generation

Indicator of the quality of Georgia's **Land**

How does hazardous waste generation in Georgia compare to the rest of the nation?

In 2001, 2003 and 2005, the amount of hazardous waste generated in the U.S. ranged from 30.1 to 40.1 million tons each year. The hazardous waste generated in Georgia was less than 2 percent of the national total in each of those years.

Since economic conditions affect the amount of hazardous waste generated each year, one way to compare Georgia with the nation is with a measure based on economic activity: the tons of hazardous waste generated per dollar of gross domestic product. As shown in the table below, the amount of hazardous waste generated in Georgia per dollar of gross domestic product has been consistently lower than the national figure.

Hazardous waste generated in GA and the U.S., 2001 - 2005. (EPD)

	Georgia hazardous waste generation[1]	U.S. hazardous waste generation[2]
2001	2.5	4.1
2003	0.6	2.8
2005	1.3	3.1

[1] Tons per million dollars of state gross domestic product.
[2] Tons per million dollars of national gross domestic product.

Land can become contaminated when wastes and other materials are not properly handled and/or disposed. When toxic or hazardous materials are being manufactured, stored, transported or used, there is always the chance that they may spill or leak, which also can contaminate Georgia's land. Many common household items, such as paint, electronics and pesticides, are hazardous and, if not properly managed, can lead to land contamination.

Hazardous waste is managed under the federal Resource Conservation and Recovery Act (RCRA). Under that Act, EPD in partnership with EPA has the authority to regulate all facets of hazardous waste to reduce potential hazards and ensure that waste is handled in an environmentally sound manner. This includes the generation, treatment, storage and disposal of hazardous waste.

Table 1.7 shows the changes in the volume of hazardous waste generated or managed (i.e., treated or stored) in Georgia between 2001 and 2007. It also shows the amount of waste that Georgia facilities received from other states and the amount that Georgia facilities shipped to other states for handling or disposal. There are no commercial hazardous waste disposal facilities in Georgia, so waste is shipped to other states for disposal.

The amount of hazardous waste generated and managed in Georgia varies considerably from year to year depending in part on economic conditions. When the economy is less robust, industry generally produces less, and in turn, less waste is generated. Stronger economic conditions lead to increases in industrial production and in waste generation.

Another factor affecting the changing amounts of hazardous waste managed is the number of facilities permitted to manage hazardous waste in Georgia and neighboring states in a given year. For example, between 2003 and 2005 the quantity of hazardous waste managed and received from other states declined, but the quantity shipped to other states increased. Two major commercial facilities in Georgia that handled hazardous waste closed during this period, presumably sending the waste to other states.

Table 1.7 *RCRA hazardous waste in Georgia, 2001 - 2007 (tons). (EPD)**

	Hazardous waste generated	Hazardous waste treated or stored	Hazardous waste received from other states	Hazardous waste shipped to other states
2001	760,043	682,924	12,663	106,512
2003	203,298	2,094,734	8,837	84,031
2005	480,269	862,647	4,361	319,506
2007	102,636	738,718	3,462	52,315

**Information on hazardous waste is reported to EPA by all the states every two years. Because EPA changed its reporting requirements in 2001, data from previous years are inconsistent and cannot be compared with the numbers shown here.*

Levels of Air Pollutants

Indicator of the quality of Georgia's **Outdoor Air**

The federal Clean Air Act defines two major categories of air pollution: criteria pollutants and toxic air pollutants. EPA has set health-based, air quality standards for criteria pollutants. As discussed below, there are no standards for toxic air pollutants defined under the Clean Air Act, and monitoring is underway to build the information base needed to assess risks from air toxics.

There are six criteria pollutants: carbon monoxide, sulfur dioxide, lead, ozone, nitrogen dioxide and particulate matter. These pollutants are called "criteria" pollutants because the Clean Air Act requires that EPA set standards or criteria for them to protect human health and the environment. These standards define acceptable levels of each pollutant. Primary standards are designed to protect human health by protecting the most sensitive individuals, including children, the elderly, and those with chronic diseases. Under the Clean Air Act, these standards are to be set without regard to cost.

EPD tracks the levels of criteria pollutants in outdoor air as one indicator of progress toward the objective of protecting human health. The health-based air quality standards can be used as a benchmark to evaluate the levels of specific pollutants.

Since monitoring began more than 30 years ago, the levels of three criteria pollutants — carbon monoxide, sulfur dioxide and nitrogen dioxide — have been well below the health-based standards and have not directly posed risks to human health in Georgia.

Lead levels in outdoor air used to be high enough to pose human health risks. When standards were first established in the 1970s, leaded gasoline was commonly used and lead levels in Georgia's air were higher than the standard until 1972. Removing lead from gasoline resulted in a rapid drop in the amount of lead in outdoor air and, since the mid-1980s, levels have stabilized well below both the 1978 standard and the new standard established in 2008 (Figure 1.9).

Two criteria pollutants currently have a significant impact on air quality in Georgia: ozone and fine particulate matter. Levels of both are higher than the health-based standards in parts of the state.

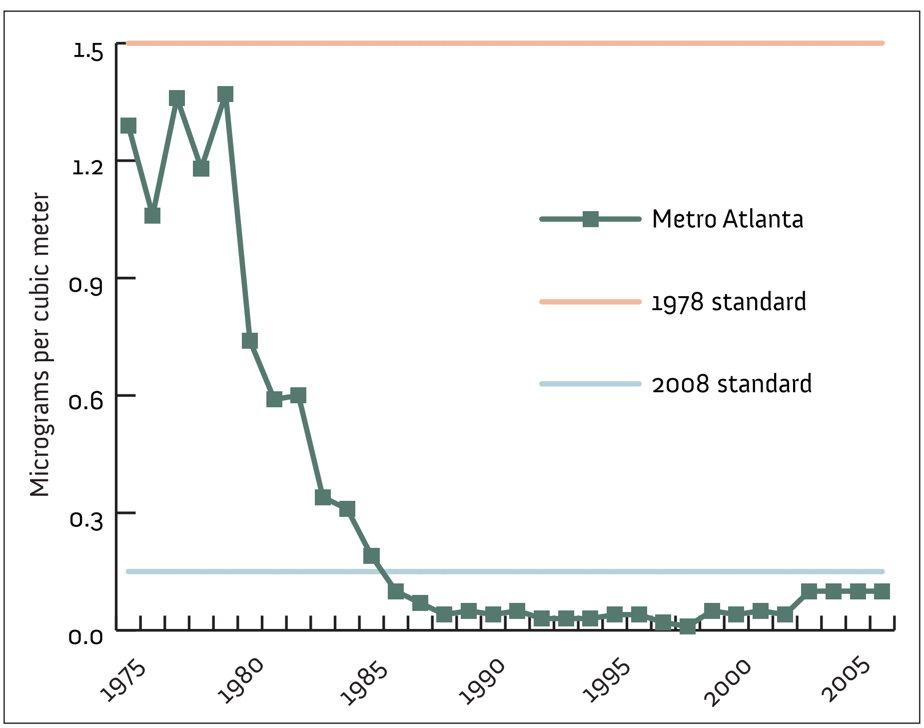
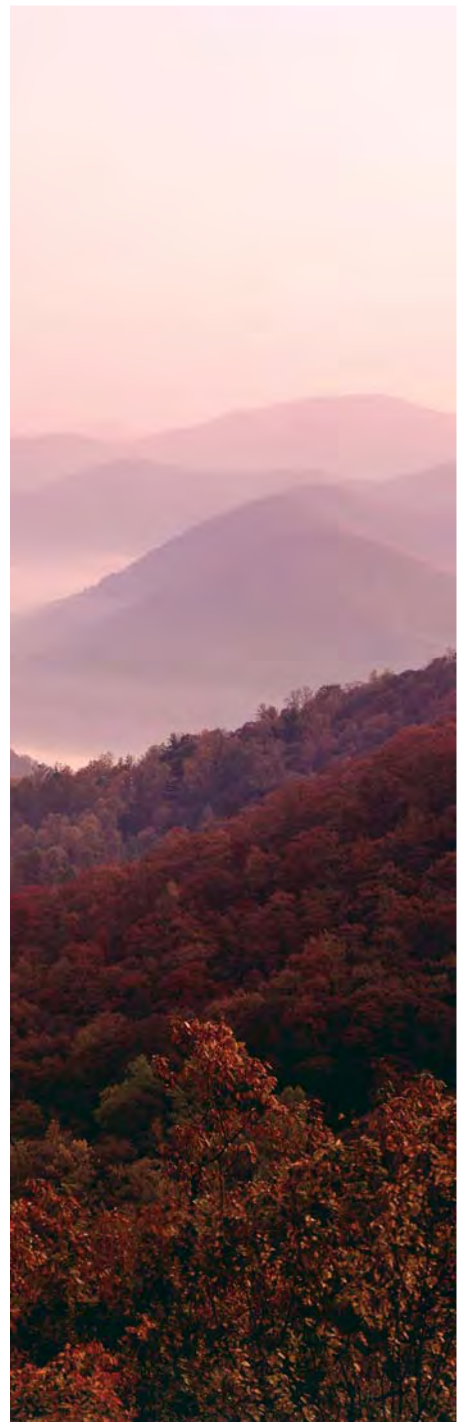


Figure 1.9 *Lead levels at a representative air quality monitor; quarterly average. (EPD)*



What are ozone and particulate matter?

Ozone is a gas that forms when nitrogen oxides and volatile organic compounds react in the presence of sunlight. This ground-level ozone can inflame and damage the lining of the lungs, reduce lung function and aggravate asthma.

Ozone is rarely emitted directly into the atmosphere. It forms in the atmosphere from compounds called precursors. Volatile organic compounds and nitrogen oxides are the primary precursors of ozone.

Particulate matter includes smoke, dust, fly ash and liquid droplets that can remain suspended in the air for long periods of time. Fine particulate matter, which includes particles that are less than 1/20th of the diameter of a strand of human hair, poses the greatest threat to human health. Particles this small can penetrate deep into the human respiratory system and contribute to respiratory and cardiopulmonary disease.

Particulate matter results from all types of burning, including combustion of fuels in motor vehicles, power plants, and industrial facilities. Particulate matter is directly emitted into the atmosphere from a number of sources. It also forms in the atmosphere through the reaction of precursors including sulfur dioxide, nitrogen oxides, and various hydrocarbons.

Ozone levels at three representative air quality monitors are shown in Figure 1.10. These monitors are located in or on the downwind side of three major metropolitan areas: Augusta, Columbus and Atlanta.

Trends in ozone levels at these monitors highlight some progress as well as continuing air quality challenges. Weather has a strong influence on ozone levels and some of the fluctuations in ozone levels are due to year-to-year variations in temperature, wind, and rainfall.

Trends in ozone concentration also reflect controls on emissions from different sources of pollution. The trend at each monitor shows a peak in 1998-1999 followed by a drop in ozone concentration. This drop reflects state controls on emissions from industrial sources and national requirements for fuels and vehicles that were phased in during the 1990s. A second decline is seen at each monitor in 2002-2003, which reflects controls on emissions from coal-fired power plants.

As these controls have taken effect, however, the scientific understanding of ozone impacts on human health has improved and, as a result, standards have been tightened. The current 8-hour standard, shown in light blue in Figure 1.10, was adopted in 2008. As of October 2008, ozone levels at monitors tracking air quality in 26 counties were higher than the current ozone standard.

Levels of fine particulate matter at two representative monitors are shown in Figure 1.11. Levels at these monitors were highest in 1999 and have been lower since. The drop in fine particulates after 1999 most likely reflects controls on fuels and vehicles that were put in place to address ozone. Because emission controls for fine particulate matter may reduce ozone precursors and vice versa, control of one pollutant can help manage the other. Declining levels of sulfur dioxide, a precursor of fine particulate matter, have also contributed to this drop (Figure 1.12).

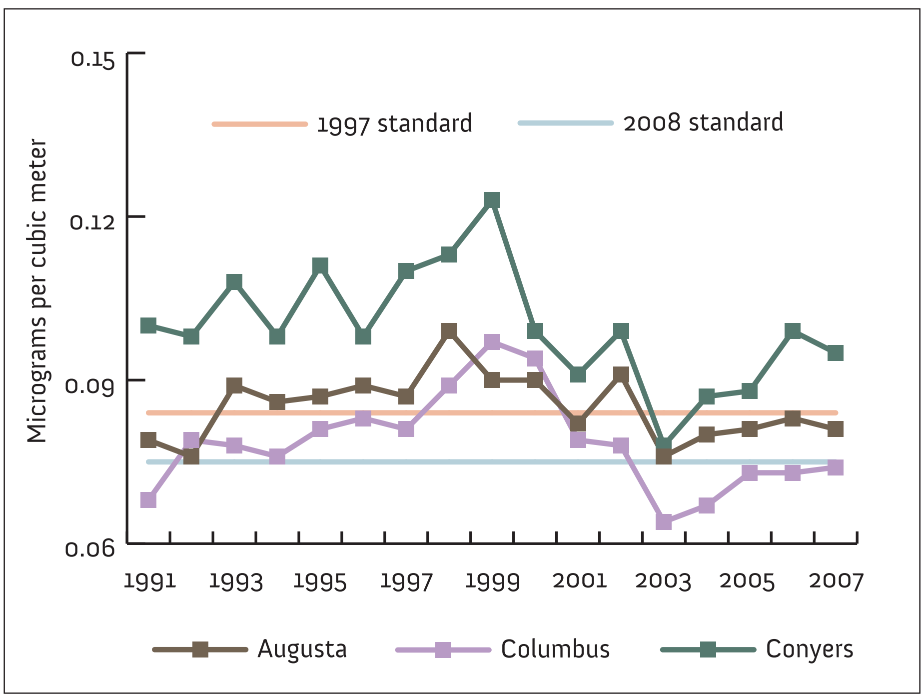


Figure 1.10 *Ozone levels at selected monitors in or downwind of major metropolitan areas; eight-hour average. Meteorological conditions during the summer promote ozone formation and ozone concentrations are monitored from March to October each year. (EPD)*

Despite this progress, these and other monitors still show levels of fine particulates that exceed the current standard. As of October 2008, levels of fine particulates at monitors tracking air quality in 29 counties exceeded the current standard (ozone levels were also exceeded in 24 of these counties).

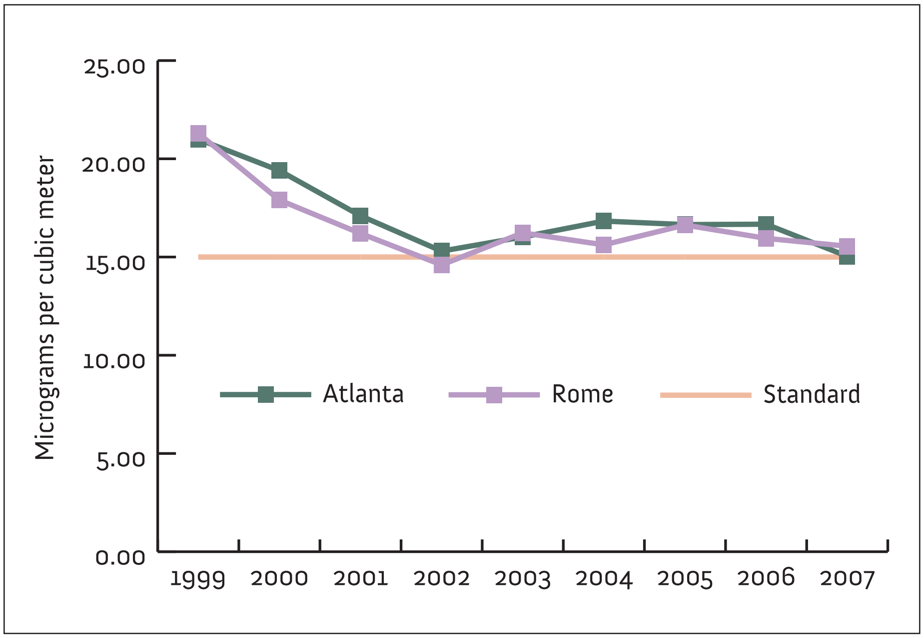


Figure 1.11 *Levels of fine particulate matter at selected monitors in major metropolitan areas; annual average. Particulate matter can be high anytime of the year and fine particulate matter is monitored year round. (EPD)*

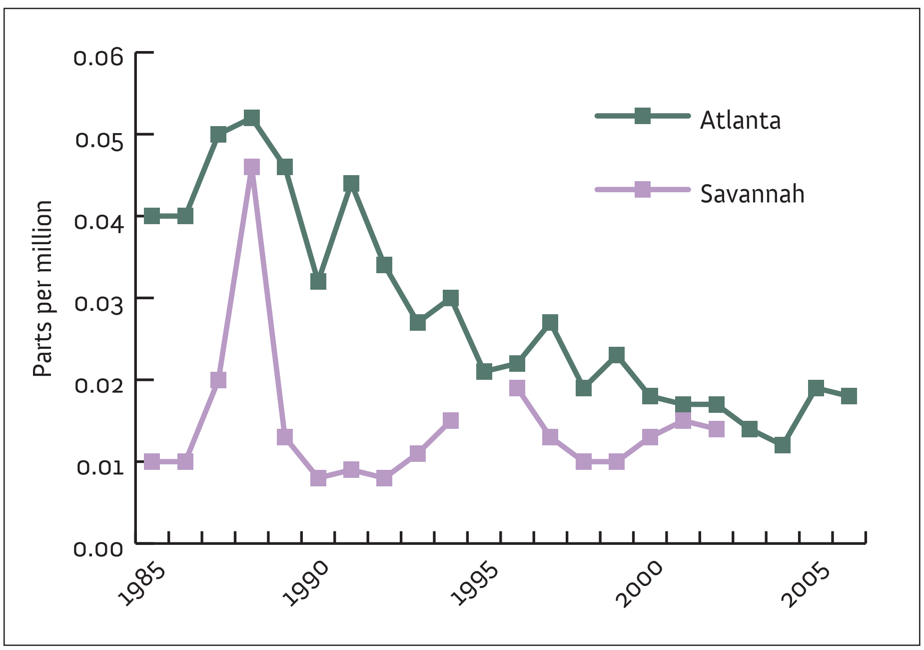


Figure 1.12 *Levels of sulfur dioxide at selected monitors in major metropolitan areas; 24-hour average. Levels in Savannah reflect industrial activity in the area, with the decline after 1988 due to the closing of a major industrial source. In Atlanta, declining levels are due to controls on industrial emissions and the use of low sulfur fuel, which began in 2004. (EPD)*

Scientific advances lead to changes in air quality standards

Health-based air quality standards are determined by the best science available at the time of their adoption. As research progresses, the scientific understanding of a pollutant's impacts on human health can improve, which may lead to tighter standards.

Since their adoption in the early 1970s, standards for ozone, particulate matter, and lead have been tightened. In the 1990s, to be more protective, the ozone standard was lowered and changed from a 1-hour average to an 8-hour average. The 8-hour standard, in turn, was tightened in 2008.

For particulate matter, standards were changed to shift from measurement of larger particles to focus on the fine particulates that pose the greatest health risk. The fine particulate matter standard was tightened again in 2006. A tighter standard for lead in outdoor air also was adopted in 2008.

Changes in air quality standards may lead to expanded monitoring, new assessment of pollutant levels in outdoor air and, ultimately, identification of new or expanded non-attainment areas (as described in the next section).

Non-attainment areas

Indicator of the quality of Georgia's **Outdoor Air**

Sensitive populations in non-attainment areas

Approximately 17 percent of the state's population falls into "sensitive" categories, meaning that they are less than five years old, more than 65 years old, or have weakened immune systems or symptoms of asthma.

People in these sensitive groups may feel greater effects from poor air quality, and air quality standards are set at levels to protect them. Of this population, more than 50 percent — approximately 850,000 — live in areas that have been declared non-attainment for either ozone or particulate matter or both. Actions to improve air quality are important to protect their health.

The primary air quality standards set limits on air pollution that are based on human health impacts. An area with air quality cleaner than the primary standard is called an "attainment" area; areas that do not meet the primary standard are called "non-attainment" areas.

Non-attainment areas are determined by the number of times a pollutant surpasses the air quality standard for a specific period of time, which is called an exceedance. Non-attainment areas are declared when there are more exceedances than allowed in a given time period. There is a built-in allowance for levels of a pollutant to exceed the standard occasionally and still protect human health.

Air pollution can move large distances from the place it is emitted, so non-attainment areas may be defined as multiple counties or as a region, even if exceedances are only monitored in one county. Also, if a county contains a source (e.g., a power plant) that contributes to exceedances in another area, the portion of the county containing the source is also considered non-attainment.

A non-attainment designation is based on a specific pollutant. This means that the same area could meet the standard for one pollutant, but be designated non-attainment for another. Non-attainment areas for different pollutants also may overlap or share common boundaries.

Georgia's non-attainment areas are a second indicator of air quality (Figure 1.13). As described in the previous section, Georgia meets the standards and is an attainment area for four of the criteria pollutants: lead, sulfur dioxide, carbon monoxide and nitrogen dioxide.

For ozone and fine particulate matter, however, levels exceed the standard in several parts of the state, leading to non-attainment designations for both pollutants. Twenty full counties in Georgia have been designated non-attainment for ozone and 24 full counties and three partial counties have been designated non-attainment for fine particulates.

These counties contain more than half of the state's population: 55.2 percent of the state's population lives in counties where the ozone levels are sometimes higher than the standard and 57.6 percent live in areas where levels of fine particulates are sometimes higher than the standard.

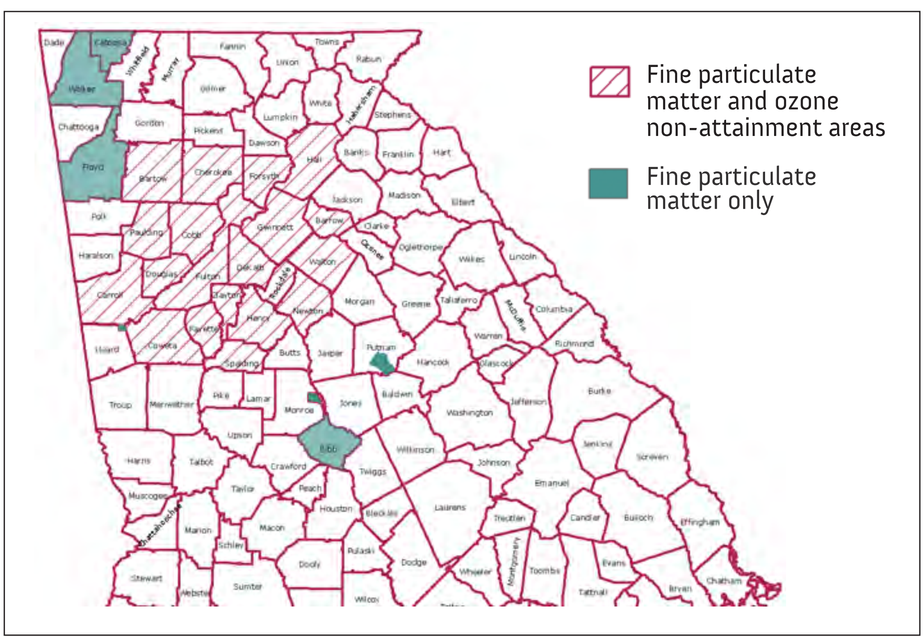


Figure 1.13 Air quality non-attainment areas: Ozone and fine particulate matter, 2008. (EPD)

Backgrounder

Air Quality Index

The Air Quality Index (AQI) is a national rating system developed by EPA. The AQI indicates whether or not the air quality presents a potential threat to human health on any given day. This system is designed to provide information on the risk of acute health effects over time periods of 24 hours or less. It does not provide information on chronic exposure to pollution over months or years.

The AQI is not a direct measure of air quality or air pollution. The level of pollutants measured in the air each day is converted to a number on a scale of 0 to 500 — the larger the number, the greater the level of air pollution and the greater the expectation of potential adverse health effects. Depending on the day's rating, EPD will declare the day's air quality as good, moderate, unhealthy for sensitive groups, unhealthy or very unhealthy.

AIR QUALITY INDEX

Air Quality Index (AQI) Values	Levels of Health Concern
0 to 50	Good
51-100	Moderate
101-150	Unhealthy for Sensitive Groups
151-200	Unhealthy
201-300	Very Unhealthy
301 to 500	Hazardous

EPD reports the AQI for five of the criteria pollutants: ozone, fine particulates, sulfur dioxide, nitrogen dioxide and carbon monoxide. The AQI is reported on a daily basis, year round.

AQI values are reported to inform the public about the health risks of outdoor activities on a given day. A rating of 100 represents the dividing line between moderate air quality and air that is unhealthy for sensitive groups.

To see AQI ratings across the country, go to http://airnow.gov/. Air quality forecasts for Atlanta and other Georgia cities are available at: http://www.air.dnr.state.ga.us/smogforecast.

What happens when air quality standards are not met?

States must develop implementation plans that outline how standards will be met and maintained. When an area is designated non-attainment, the state must revise the plan to assess current and projected air quality, estimate emissions from sources that currently affect air quality, and specify actions to bring air quality back into compliance with the standards.

Once a non-attainment area meets the standards and the plan is revised again to show that the standards will be able to be met for another 10 years, EPA changes the designation back to attainment.

In 1999, EPD developed a plan to meet the 1-hour ozone standard then in place in the 13-county metro Atlanta non-attainment area. The plan focused on three emission sources: cars and trucks, electricity-generating plants and large industry. Actions taken under this plan helped improve the region's air quality and, in 2005, the metro Atlanta area met the 1-hour standard for ozone.

At the same time, however, the scientific understanding of health risks from ozone improved and EPA adopted a more stringent 8-hour standard. The metro Atlanta ozone non-attainment area, based on the new 8-hour standard, now covers 20 counties.

How is Georgia's air quality monitored?

Like the state's water quality monitoring, EPD's monitoring of air quality has evolved since it began more than 30 years ago. The list of compounds monitored has grown from the original six criteria pollutants to more than 200 pollutants, including air toxics and compounds that contribute to the formation of criteria pollutants. EPD has more than 150 air quality monitors at 68 locations around the state.

Information from these monitors is used to track air quality trends and compliance with air quality standards. Ozone levels in the metro Atlanta area have been tracked consistently since 1990, and monitoring of fine particulate matter in metro Atlanta was added in 1999. Monitoring of ozone and fine particulate matter was expanded to include other cities around the state as the standards were strengthened in the late 1990s and Georgia's population outside the metro Atlanta area grew.

The monitoring network is designed to track levels of air pollution throughout Georgia. Monitor locations are selected to meet specific objectives, which include measuring concentrations in areas of high population density, measuring the highest observable concentration, and determining normal background levels.

Some gaps in information remain, however. Air quality monitors are located in 38 counties; some counties have multiple monitors while others do not have any. Monitors only sample the air that passes over them, so that information on the air quality between monitors is limited.

Emerging Issue
Risks from Air Toxics

Unlike the criteria pollutants, air toxics have no established, health-based standards. While many of these pollutants are known to cause, or are suspected of causing, cancer and other serious illnesses, the quantities at which they become dangerous and the significance of various exposure routes are not yet fully understood.

Since 1990, managing air toxics has focused on controlling their release from stationary sources, such as factories, refineries and power plants. To assess the levels of these pollutants in Georgia's air, EPD began operating a statewide monitoring system in 1998. The system monitors a common set of toxic compounds and provides information on air quality in urban and rural areas. It does not provide information on the air quality impacts or health risks from individual facilities or industries.

The air monitoring system provides data on the frequency of detection and concentrations of toxic air pollutants. It does not provide any information on actual exposure to people. However, by making some general assumptions about how people spend their time (e.g., indoor vs. outdoor activities), EPD scientists can make conservative estimates of exposure. These estimates provide a preliminary assessment of the potential risks of adverse health effects from air toxics.

Georgia's air toxics monitoring system tracks about 70 of the chemicals that EPA has designated as hazardous air pollutants. Most of the 70 have not been detected and fewer than 10 of the 70 are detected often enough to indicate potential risks to human health. Benzene, acetaldehyde and formaldehyde are among the compounds that are detected most frequently.

While the monitoring system is relatively new, early indications suggest that concentrations of some toxic air pollutants are declining. While air toxics can come from a variety of sources, monitoring results also suggest that cars, trucks and other on- and off-road vehicles may be significant contributors.

However, the current understanding of how people are exposed to air toxics and of the toxicity of many of these chemicals is too limited to allow accurate predictions of risk at this time. Improved inventories, models and measurement techniques are needed to better evaluate the risk from air toxics. Data from Georgia's air monitoring program provides one piece of the information needed to improve our ability to assess the risks from air toxics.

Most air pollution comes from human-made sources, such as smokestack emissions from factories and exhaust from motor vehicles. EPA divides these sources into two categories: stationary and mobile. Stationary sources include factories, power plants, refineries, incinerators, dry cleaners, service stations and residential backyard burning.

Mobile sources include vehicles that travel on roads, such as gasoline- or diesel-powered motor vehicles (e.g., cars, trucks, buses and motorcycles) and those that do not. This second group includes equipment used in construction, farming, and lawn and garden activities, as well as off-road recreational vehicles, aircraft and trains.

Not all pollutants enter the atmosphere directly. Some are formed when other emissions, called "precursors," enter the atmosphere and react with chemicals in the presence of sunlight and high temperatures. For example, ozone, a pollutant of concern in Georgia, is rarely emitted directly into the atmosphere. Instead, it forms in the atmosphere when precursors including nitrogen oxides (NOx) react in the presence of sunlight and high temperatures.

Because nitrogen oxides are the major precursor of ozone, EPD tracks trends in NOx emissions as an indicator of air quality. Since federal law established emissions in 1990 as a baseline, EPD uses data from the original 13-county, 1-hour ozone non-attainment area to evaluate progress in reducing emissions of air pollutants.

Figure 1.14 shows NOx emissions by source in the 13-county metro Atlanta area for 1990, 2002 and 2005. Methods for estimating emissions have changed over time, meaning that we can only look at trends using the years for which data have been adjusted to be comparable to the 1990 baseline (2002 and 2005).

Total NOx emissions in the 13-county metro Atlanta area declined 43 percent between 1990 and 2005. This progress was achieved, in part, by reducing emissions from large stationary sources in the area, which declined by more than 60 percent during this time period.

EPD has determined that power plants *outside* the 13-county area contribute a significant portion of the NOx emissions that drift into the Atlanta area. Controls on these plants have also reduced NOx emissions, even as energy production increased. During this time period, NOx emissions from power plants decreased by more than 60 percent while energy production in Georgia increased by approximately 32 percent. NOx controls at power plants, including a chemical reaction in which a catalyst helps convert nitrogen oxides to gaseous nitrogen and water, were put in place at a cost of $800 million.

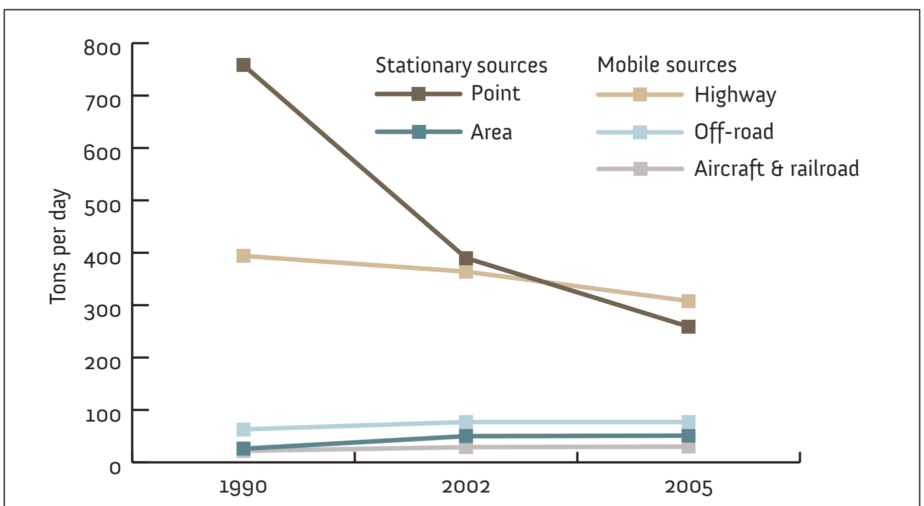


Figure 1.14 *Sources of nitrogen oxides (NOx) emissions in the 13-county metro Atlanta area. (EPD)*

Emissions of Air Pollutants

Indicator of the quality of Georgia's **Outdoor Air**

What are the sources of nitrogen oxides in the metro Atlanta area?

In 2005, 725 tons of nitrogen oxides were emitted daily in the 13-county metro Atlanta ozone non-attainment area.

Mobile sources contributed more than half of the total, with 42 percent from on-road motor vehicles and an additional 15 percent from off-road vehicles, such as equipment used in construction, as well as aircraft and trains.

Stationary sources contributed the remaining 43 percent. Of this amount, 36 percent came from point sources — power plants and factories that release pollutants from a single smokestack or point. Seven percent came from area sources, such as automobile service stations, with small but numerous contributions.

Decreasing emissions from cars and other mobile sources also contributed to the decline in total emissions. Between 1990 and 2005, NOx emissions from on-road mobile sources decreased by about 22 percent. This decline resulted from advances in engine and exhaust technologies and new fuel formulations, and outweighed a 53 percent increase in the number of vehicle miles traveled (VMT) on a daily basis.

Looking ahead, control of NOx emissions from mobile sources will be increasingly important to improve air quality in the metro Atlanta area. For on-road mobile sources, projected population growth means that the number of vehicle miles traveled daily is expected to increase for at least the next 25 years. The benefits of the new technologies that led to recent reduction in emissions will eventually be offset by this VMT growth.

Off-road mobile sources have already grown as a contributor to total NOx emissions. Unlike stationary sources and on-road mobile sources, NOx emissions from off-road mobile sources in the Atlanta area increased between 1990 and 2005 — almost 25 percent. These sources represent the last largely uncontrolled or under-controlled sources of emissions, as most efforts to date have focused on controlling other emission sources.

EPA has begun to issue more stringent emissions standards for off-road vehicles and equipment. However, since these vehicles are designed to last 20 years or longer, it will take time before emission reductions are seen. Incentives for retrofitting or repowering existing equipment would contribute to more rapid reductions in emissions from these sources.

Fine particulate matter differs from ozone in several ways. First, fine particulates are emitted directly from some sources. This is called primary particulate matter. Fine particles in the atmosphere also include particles that form through the reactions of precursors, called secondary particulate matter.

Second, the standard for fine particulate matter is newer than the ozone standard and emissions have not been measured over as long a period. In addition, due to the mixing of primary and secondary particulate matter, it is more difficult to identify sources;

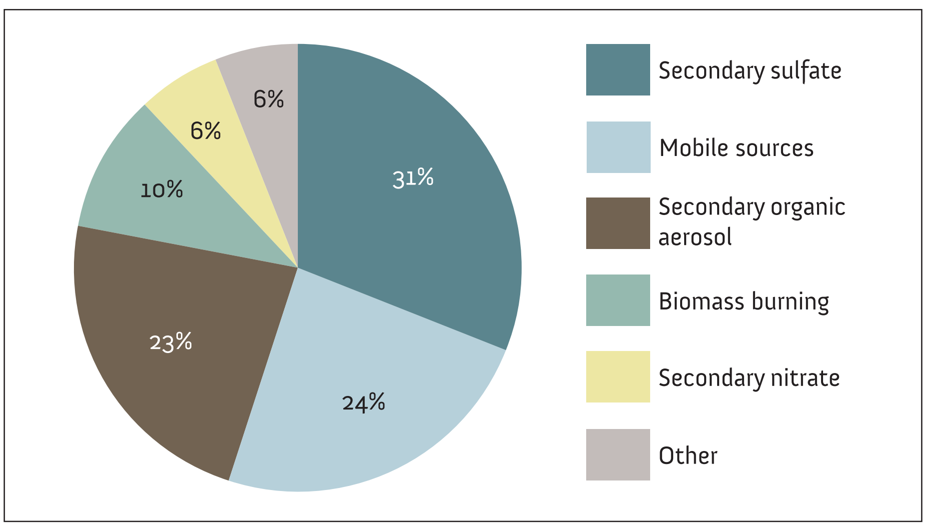


Figure 1.15 *Average contribution to fine particulate matter concentrations in the metro Atlanta area by source, 2001 - 2005. "Secondary" refers to particulate matter that forms in the atmosphere. Secondary sulfate comes primarily from power plants, with a small amount from other industrial sources. Secondary organic aerosols come from natural sources, gasoline and solvent use and combustion of fuels. Secondary nitrate comes from power plants and mobile sources. Sources that contribute to the "other" category include soil, limestone/minerals, sodium from sea-salt or pulp and paper processes, oil burning and road dust. (EPD)*

estimating contributions from different sources requires multiple years of data. As a result, information on emissions and sources of fine particulates presented here is a composite snapshot for the metro Atlanta area from 2001-2005.

Figure 1.15 shows the relative contribution of various sources to particulate matter in the metro Atlanta area between 2001 and 2005. Organic aerosols are a major contributor — at 22.8 percent. About half of this contribution comes from natural sources, including vegetation. The remainder is from gasoline evaporation, use of solvents and the combustion of fuels in power plants, vehicles and other sources.

Vehicles and other mobile sources are also major contributors — at 23.6 percent. Of the contributions from mobile sources, one-third comes from vehicles burning gasoline and the remainder from those using diesel fuel. Emissions of fine particulates from vehicles have declined in recent years, due to increased numbers of vehicles subject to tighter emissions standards and cleaner fuel requirements that took effect in the mid-2000s.

The largest contributor is secondary sulfate — at 30.9 percent. Secondary sulfates form in the atmosphere from reactions of sulfur dioxide, a precursor that primarily comes from coal-fired power plants. Controls on these emissions are currently being put in place and the contribution of secondary sulfate to levels of fine particulates is expected to fall as these controls are fully phased in over the next 10 years.

Emerging Issue

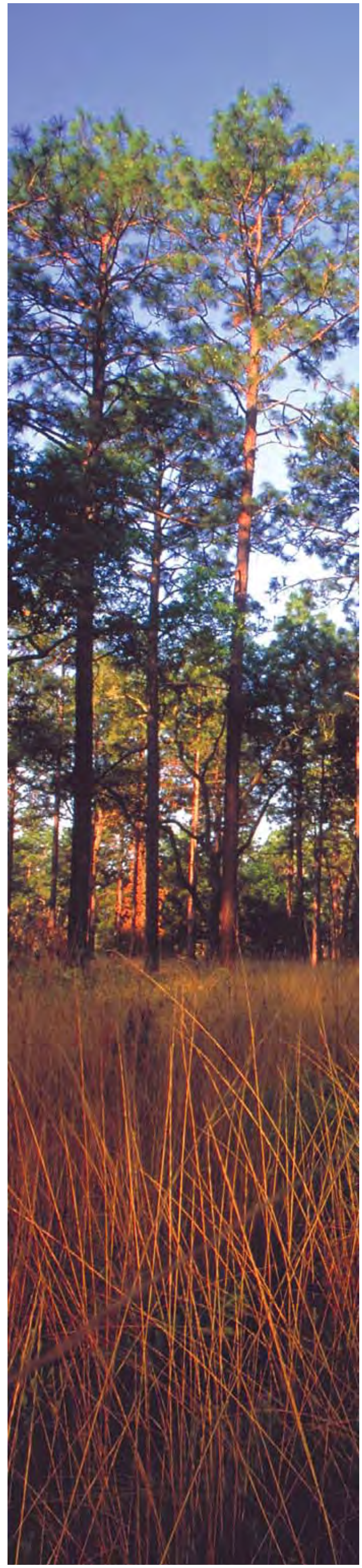
Prescribed burning: Managing Georgia's lands and protecting air quality

Between 2000 and 2004, biomass burning contributed approximately 10 percent of the fine particulate matter in metro Atlanta's air. Biomass burning includes wildfires as well as planned or prescribed burning of forests and other lands.

Prescribed burning uses fire as an economical and practical tool to maintain the vitality and value of Georgia forests, farms and wildlands. This tool is used by federal, state and private landowners and managers to maintain natural forests, support fire-dependent species, improve wildlife habitat or forage for livestock, and control insects and disease. Prescribed burns also reduce hazardous fuel (buildup of wood debris, underbrush and other natural ground litter) and suppress wildfires.

The Nemours Wildlife Federation estimates that 1 million acres are burned in Georgia every year. If not coordinated and well managed, prescribed burning can have unacceptable air quality impacts far from a burn site. In February 2007, for example, prescribed fires in central Georgia caused a large spike in concentrations of particulate matter in the metro Atlanta area.

The state recently adopted a Smoke Management Plan to help achieve air quality goals while improving the quality of Georgia lands. The plan requires authorization from the Georgia Forestry Commission before conducting open burning (except agricultural burning and burning of small leaf piles). The Commission evaluates impacts from individual burns as well as cumulative impacts of multiple fires. The plan also includes provisions for coordinated monitoring of air quality and outdoor burning, smoke management training for practitioners, and public notice and outreach.



Sustaining Healthy Ecosystems

Sustaining healthy ecosystems, the second environmental objective addressed in this report, is fundamental to the environmental progress necessary to support population growth and economic development.

The term "ecosystem" refers to all the plants and animals in an area, the interactions between them, and the physical environment in which they live. This objective addresses the health of Georgia's ecosystems and their capacity to provide services that support basic human needs – a capacity that is essential to support a growing population and economy and to the sustainability of life on the planet.

Ecosystems provide a variety of services every day. Ecosystem services include production of food and fiber, removal of pollution and purification of air and water. Healthy ecosystems help regulate the climate, control flooding, and provide habitat for fish and wildlife, including species that are commercially important. They support recreational activities, like fishing, hunting, and hiking, with the economic benefits they bring. Healthy ecosystems also provide less tangible spiritual and educational values.

Healthy ecosystems are a kind of natural capital that helps support our quality of life, like the financial capital that helps support our economy. However, human activities – particularly the way we use and alter land – can degrade this natural capital and the services on which we rely.

Evaluating the health of Georgia's ecosystems starts with examination of the land itself. The way that land is used, and the way it has been altered as Georgia's population has grown, affects the state's ecosystems.

This report tracks those effects by looking at two important components of ecosystems: the habitat they provide and the species of plants and animals that live in that habitat. Habitat refers to the physical features of an area and the vegetation found there, which determines the suitability of that area for different species.

While there are few accepted standards or thresholds that define the health of an ecosystem, a number of measures are generally accepted as indicators of ecosystem health that can be used to compare regions and to track changes in ecosystems over time (Table 2.1).

Table 2.1 *Indicators of the condition of the state's natural resources.*

Natural resource	Indicators of condition
Land	Land cover types: • Hardwood forests • Forested wetlands • Urban land
	Impervious surfaces
Habitats and species	Streamside forests
	Freshwater fish community status
	Coastal habitat conditions
	Terrestrial habitat quality
	Protected species
	Habitat protection

Georgia's natural heritage: Biological diversity

Georgia has an extraordinarily rich natural heritage. Variations in topography and geology across the state produce a wide variety of ecosystems. Terrestrial ecosystems range from the live-oak seaside forests of the coast to the rock outcrops of north Georgia. Aquatic ecosystems include small streams, large rivers, lakes and estuaries where the state's major rivers meet the sea.

This ecosystem diversity, in turn, supports a highly diverse mix of plants and animals. Compared to similar ecosystems around the world, the hardwood forests in north Georgia, mixed forests in the Piedmont, and longleaf pine forests in the Coastal Plain all have exceptional biological diversity, as do many of the state's streams and rivers.

Georgia is part of a global "hotspot" of diversity for plants and animals. Nationally, Georgia ranks sixth among the states in overall species diversity. It ranks second in the number of amphibian species, third in freshwater fish and crayfish species, and seventh in reptile and vascular plant species. More than 60 species are only found in Georgia, a number exceeded by just 11 states.

What are ecoregions?

Ecoregions are large areas, covering tens of thousands of square miles, that are geographically and ecologically defined. An ecoregion has a common underlying geology and distinctive land forms, climate, soil types and plant and animal communities.

These factors all shape the development of ecosystems and, as a result, ecoregions are often used for assessments of environmental conditions and ecosystem health.

Six major ecoregions are found in Georgia (Figure 2.1). The Blue Ridge ecoregion is in the northeast corner of the state. The Ridge and Valley and Southwestern Appalachians ecoregions are in northwest Georgia. Because these two ecoregions have many features in common, they are treated together for the purposes of this report.

The Piedmont lies south of the Blue Ridge and Ridge and Valley ecoregions and covers the remainder of north Georgia.

Two ecoregions lie south of the Fall Line, a geologic feature that runs across the center of the state. The Southeastern Plains ecoregion is immediately south of the Fall Line and covers much of the southeastern U.S. In Georgia, this area is often called the Upper Coastal Plain.

Finally, the Southern Coastal Plain lies along the much of the southeastern Atlantic and Gulf coasts. In Georgia, this ecoregion is often called the Lower Coastal Plain or Coastal area.

This chapter first addresses two indicators of changes in land condition: land cover and impervious surfaces. It then discusses six indicators of the condition of different habitats and the plants or animals that live in those habitats. The habitats and species discussed include those that are land-based (terrestrial) as well as those that are water-based (aquatic). For several of the indicators, results are summarized by ecological region or ecoregion (see sidebar and Figure 2.1).

Backgrounder

Tracking Changes in Georgia's Landscape

The introduction of this report highlights the changing face of Georgia in terms of population, economy and energy use. These drivers are also changing the face of Georgia in terms of its landscape and the health of the ecosystems that landscape supports. One way to track these changes is look at changes in land cover over time.

The term "land cover" refers to the mix of vegetation, human structures, bare ground and water at the surface of the earth. Some types of land cover, like forested wetlands, are simply the vegetation naturally found in an area. Other types, like agriculture, are lands converted or altered for human use.

Changes in land cover over time can be identified by reviewing satellite images. These images can be converted into maps showing the types of land cover across the state — a mix of natural vegetative cover and lands altered by human activities (Figure 2.2).

Researchers at the University of Georgia have tracked changes in Georgia's land cover between 1974 and 2005. This research provides some of the indicators used to evaluate progress toward the objective of sustaining healthy ecosystems, as well as the objective described in the next chapter, ensuring resources to support a growing economy.

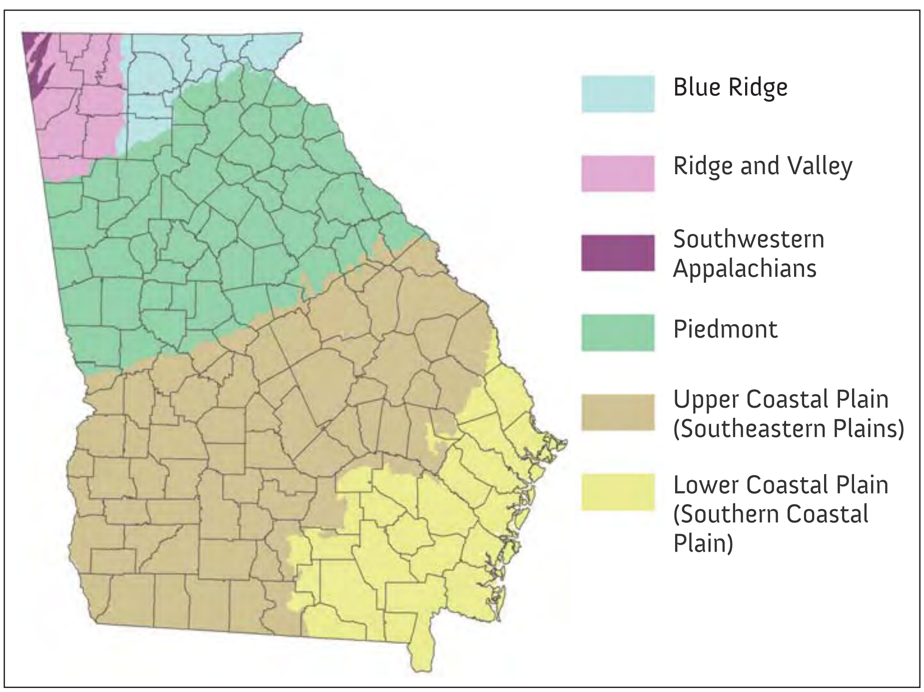


Figure 2.1 *Georgia's ecoregions. (U.S. EPA)*

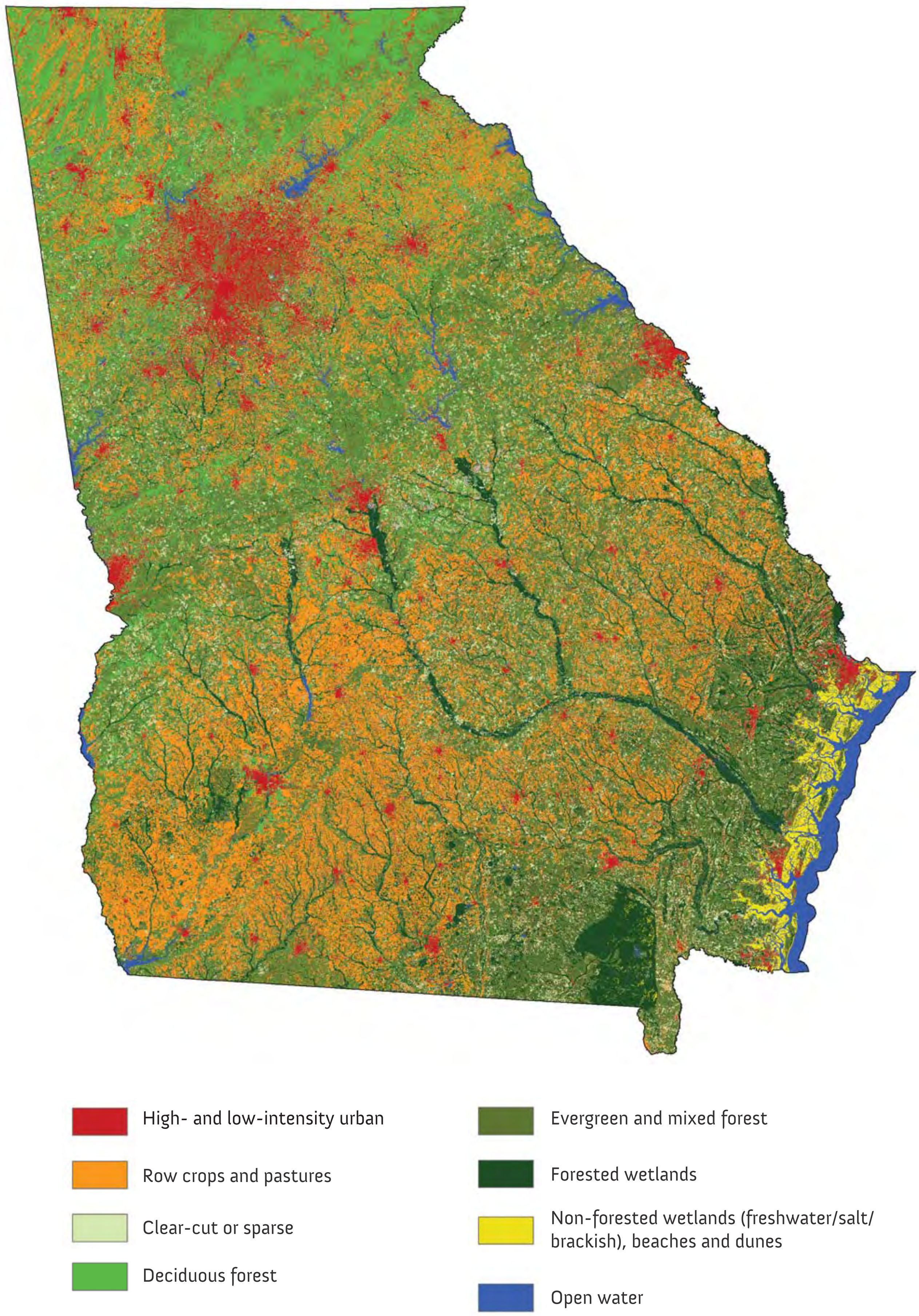


Figure 2.2 *Land cover in Georgia, 2005. (Natural Resources Spatial Analysis Laboratory, University of Georgia)*

Land Cover Types

Indicator of the condition of Georgia's **Land Resources**

Land cover types that indicate habitat condition

Hardwood forest. Forest composed of at least 75 percent deciduous trees in the canopy, deciduous woodland. Hardwood forests provide native habitat across much of north Georgia.

Forested wetlands. Cypress gum, evergreen wetlands, deciduous wetlands, depressional wetlands and shrub wetlands. Forested wetlands provide critical native habitat across much of south Georgia.

Low-intensity urban. Single-family dwellings, recreation, cemeteries, playing fields, campus-like institutions, parks and schools. Low-intensity urban land cover is associated with some loss of native terrestrial habitat.

High-intensity urban. Multi-family dwellings, commercial/industrial, prisons, speedways, junk yards and confined animal operations. Transportation, roads, railroads, airports and runways. Utility swaths. High-intensity urban land cover is highly altered, resulting in substantial loss of native terrestrial habitat.

As the first indicator of ecosystem health, this report tracks broad changes in three types of land cover: hardwood forests, forested wetlands and urban land cover. Land cover provides general information on habitat condition, one aspect of ecosystem health. Changes in these land cover types indicate associated changes in habitat – or the physical features and vegetation likely to be found there – and the suitability for different plant and animal species.

Hardwood forests and forested wetlands are native land cover types found across large areas of the state. Intensive management is practiced on a very small percentage of the total acreage of hardwood forest and forested wetlands, and these land covers can provide high quality habitat for plant and animal communities.

The significance of the two, however, varies by ecoregion. In north Georgia, hardwood forest is one of the most extensive land covers. In south Georgia, hardwood forests are less extensive and forested wetlands are much more significant as critical native habitat. Because of this difference, evaluation of land cover change by ecoregion focuses on hardwood forest in north Georgia and forested wetlands in south Georgia.

Urban areas, in contrast, have more intensive land use and have been significantly altered by human activities. The changes in habitat and in the plants and animals often found in these areas contribute to a decline in ecosystem health.

Statewide, between 1974 and 2005, urban land cover consistently increased, and the land covers associated with critical natural habitat steadily declined (Figure 2.3). Nearly 2.4 million acres of hardwood forests and forested wetlands were lost during this time period (Table 2.2). More than 2.6 million acres of urban land cover were added.

Looking at these changes by ecoregion shows that, over much of the state, the land covers associated with good wildlife habitat declined (Figure 2.4).

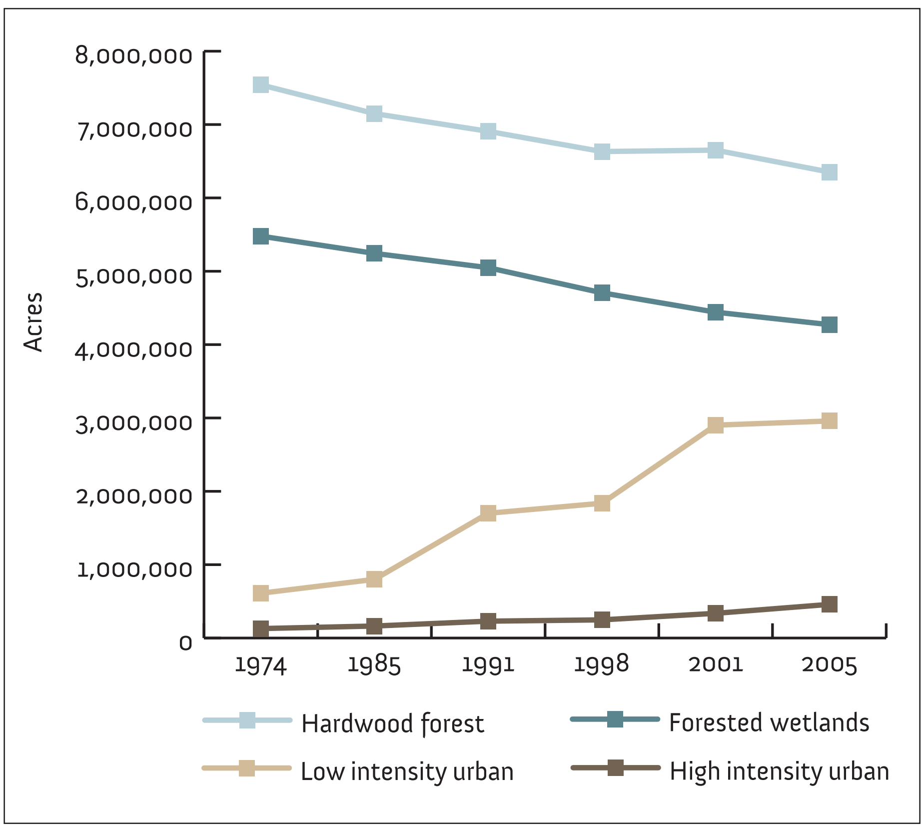


Figure 2.3 *Amount of hardwood forest, forested wetlands and urban land cover, 1974 - 2005. (Natural Resources Spatial Analysis Laboratory, University of Georgia)*

__Table 2.2__ Changes in Georgia's land cover, 1974 - 2005. (Natural Resources Spatial Analysis Laboratory, University of Georgia)

	Percent of state land, 1974	Percent of state land, 2005	Change in number of acres	Percent change
Low-intensity urban	2	8	2,348,000	385%
High-intensity urban	< 1	1	329,690	255%
Hardwood forests	20	17	-1,188,000	-16%
Forested wetlands	14	11	-1,207,000	-22%

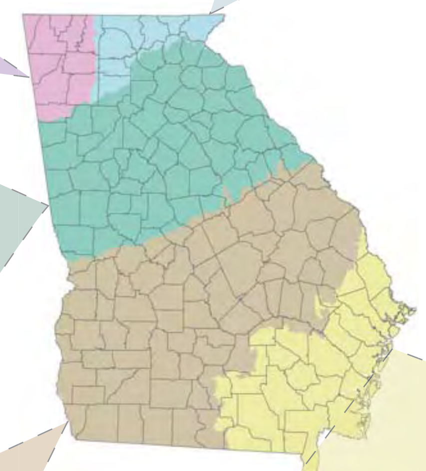
The Piedmont and Blue Ridge ecoregions lost 1.2 million acres of hardwood forests and the Upper and Lower Coastal Plains lost more than 1.1 million acres of forested wetlands. The ecoregions in northwest Georgia gained just over 150,000 acres of hardwood forest.

The majority of hardwood forest loss occurred in the Piedmont. Sixteen counties, located across the Piedmont, had losses greater than 25,000 acres and together accounted for more than 50 percent of the loss in the north Georgia ecoregions.

Forested wetland losses were greatest in the southeastern part of the state. Taken together, the losses in seven counties (Bulloch, Burke, Clinch, Echols, Screven, Ware and Wayne), each losing more than 30,000 acres, accounted for nearly 25 percent of the total loss in the Upper and Lower Coastal Plains.

Ridge & Valley and Southwestern Appalachians	Change in acres	Percent change
Hardwood forest	153,810	22%
Low intensity urban	161,828	332%
High intensity urban	22,865	310%

Blue Ridge	Change in acres	Percent change
Hardwood forest	-60,616	-5%
Low intensity urban	91,336	619%
High intensity urban	4,398	736%



Piedmont	Change in acres	Percent change
Hardwood forest	-1,147,928	-29%
Low intensity urban	1,084,650	393%
High intensity urban	203,034	281%

Upper Coastal Plain	Change in acres	Percent change
Forested wetlands	-580,695	-23%
Low intensity urban	706,397	353%
High intensity urban	68,331	187%

Lower Coastal Plain	Change in acres	Percent change
Forested wetlands	-548,615	-23%
Low intensity urban	304,087	427%
High intensity urban	31,061	259%

__Figure 2.4__ Changes in Georgia's land cover by ecoregion, 1974 - 2005; change in acres and percent. (Natural Resources Spatial Analysis Laboratory, University of Georgia)

Land cover change and population growth

Across the U.S., and in Georgia, urban or developed land cover has increased more rapidly than the population. The U.S. Environmental Protection Agency reports that, from 1982 to 2002, the amount of developed land in the U.S. increased by 48 percent — a rate of increase nearly two times that of the population.

The urban land cover data used here provides information for a similar time period that can be compared to this national trend. Between 1985 and 2005, Georgia's population increased 53 percent while urban land cover in the state increased 255 percent — a rate of increase that is more than four times greater than that of the population.

For more information on land cover changes across the U.S., see EPA's 2008 Report on the Environment, available at http://www.epa.gov/roe.

In all ecoregions, the greatest percent change was in the urban land cover types. The bulk of new urban lands in Georgia – more than 2.3 million acres – are low-intensity urban areas.

Nearly half of the increase in low-intensity urban lands occurred in the Piedmont. The counties that added the most acres of low-intensity urban area were in the metro Atlanta area, with Gwinnett, Fulton and Cobb counties each gaining 80,000 to 90,000 acres.

The greatest percent increase in urban land cover was seen in counties that, in 1974, had very little urban area. Oglethorpe, Forsyth, Paulding and Bacon counties all had increases of 1,000 percent or more, representing a growth in low-intensity urban area of 10,000 to 33,000 acres in each county.

While much of the increase in low-intensity urban lands occurred in the metro Atlanta area, substantial increases were also seen around the state's other major cities, near smaller cities, and in rural areas (Figure 2.5). The ways in which low-intensity urban lands are commonly developed have contributed to the decline in native habitat provided by hardwood forests and forested wetlands, and have had effects seen in the other indicators discussed in this chapter.

Looking ahead, as the state continues to grow, the challenge will be to shift to development approaches, such as conservation design and low impact development, that help maintain areas of natural habitat and contribute to the objective of sustaining healthy ecosystems.

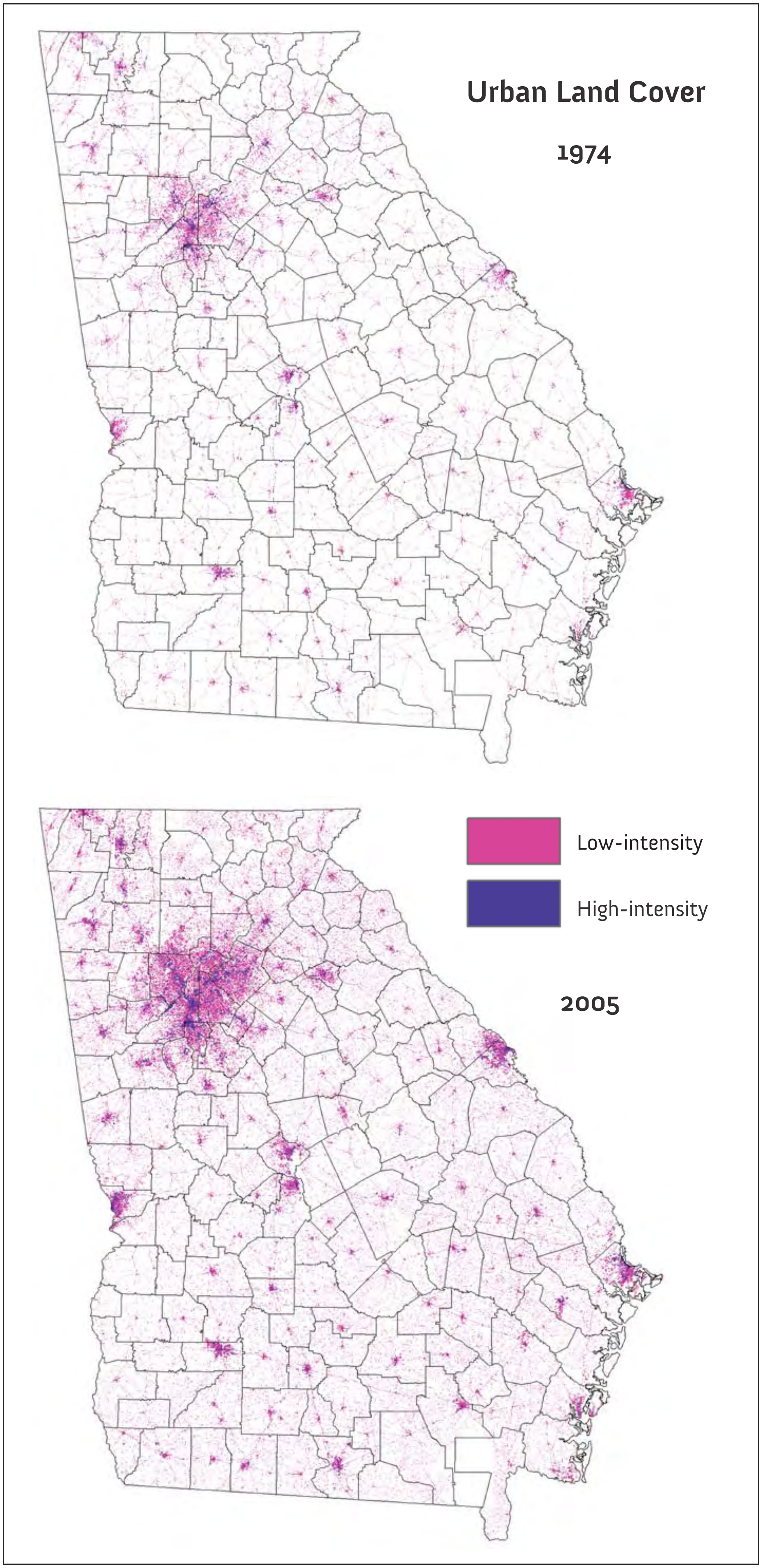


Figure 2.5 *Urban land cover, 1974 and 2005. (Natural Resources Spatial Analysis Laboratory, University of Georgia)*

Impervious Surfaces

Indicator of the condition of Georgia's **Land Resources**

The extent of impervious cover in Georgia's small watersheds

Ten percent impervious cover in a watershed is widely recognized as the threshold where impacts on the health of aquatic ecosystems can be expected.

A number of studies have found that, when impervious cover in a watershed exceeds 10 percent, the diversity of animals in streams generally declines, along with other indicators of ecosystem health. Environmentally sensitive species become less plentiful, leaving ones more tolerant of poor quality water.

In 1991, 26 of Georgia's small watersheds had more than 10 percent impervious cover. By 2005, that number had grown to 75.

The maximum amount of impervious surface is also increasing. In 1991, only one small watershed had more than 30 percent impervious cover. By 2005, seven small watersheds had more than 30 percent impervious cover and, for the first time, two had impervious surfaces covering more than 40 percent of the watershed.

One significant outcome of common approaches to converting land to urban cover is an increase in impervious surfaces. Impervious surfaces include those through which water cannot penetrate, such as paved streets, roofs and parking lots. These constructed surfaces prevent rain from soaking into the ground and cause stormwater to run off more quickly.

An increase in impervious land cover is a striking aspect of the changing face of Georgia's landscape — one that significantly impacts the health of aquatic ecosystems. More rapid stormwater runoff leads to increased stream flows after rain, which increases the risk of flooding. Stormwater from impervious surfaces can carry a range of pollutants that can degrade water quality.

More rapid runoff also contributes to erosion, altering the physical structure of streams. And, during dry periods, the decrease in the amount of water filtering into the soil means there is less groundwater to sustain low flows in streams.

In areas with 10 percent to 20 percent impervious surface, twice as much water flows as runoff to rivers and streams as in forested areas. As impervious surfaces increase to between 35 percent and 50 percent, the amount of water flowing as runoff is three times greater than it would be on a natural landscape, greatly increasing impacts on the water cycle, the physical structure of streams and aquatic species.

Researchers at the University of Georgia have compiled data on the extent of impervious surfaces in Georgia. Statewide, impervious cover increased by 81 percent between 1991 and 2005, an addition of nearly 370,000 acres. While the greatest number of acres was added in the Piedmont ecoregion, increases were seen across the state (Table 2.3). A majority of the state's 159 counties saw an increase in at least one small watershed (Figure 2.6).

The impact of these changes is evident in the condition of streams and aquatic ecosystems across the state, as seen in subsequent indicators, and in the growing cost of managing the stormwater that runs off these impervious surfaces.

As Georgia continues to grow, land development practices that increase pervious surfaces – surfaces that allow rain and stormwater to soak into the ground – will be necessary to sustain the health of Georgia's aquatic ecosystems and to ensure sufficient water resources to support a growing economy, the objective described in the next chapter.

Table 2.3 *Changes in impervious surface cover, 1991 - 2005. (Natural Resources Spatial Analysis Laboratory, University of Georgia)*

Ecoregion	Change in acres of impervious surface	Percent change
Ridge and Valley & Southwestern Appalachians	27,783	89%
Blue Ridge	7,535	121%
Piedmont	238,532	111%
Upper Coastal Plain (Southeastern Plains)	62,344	42%
Lower Coastal Plain (Southern Coastal Plains)	32,434	63%

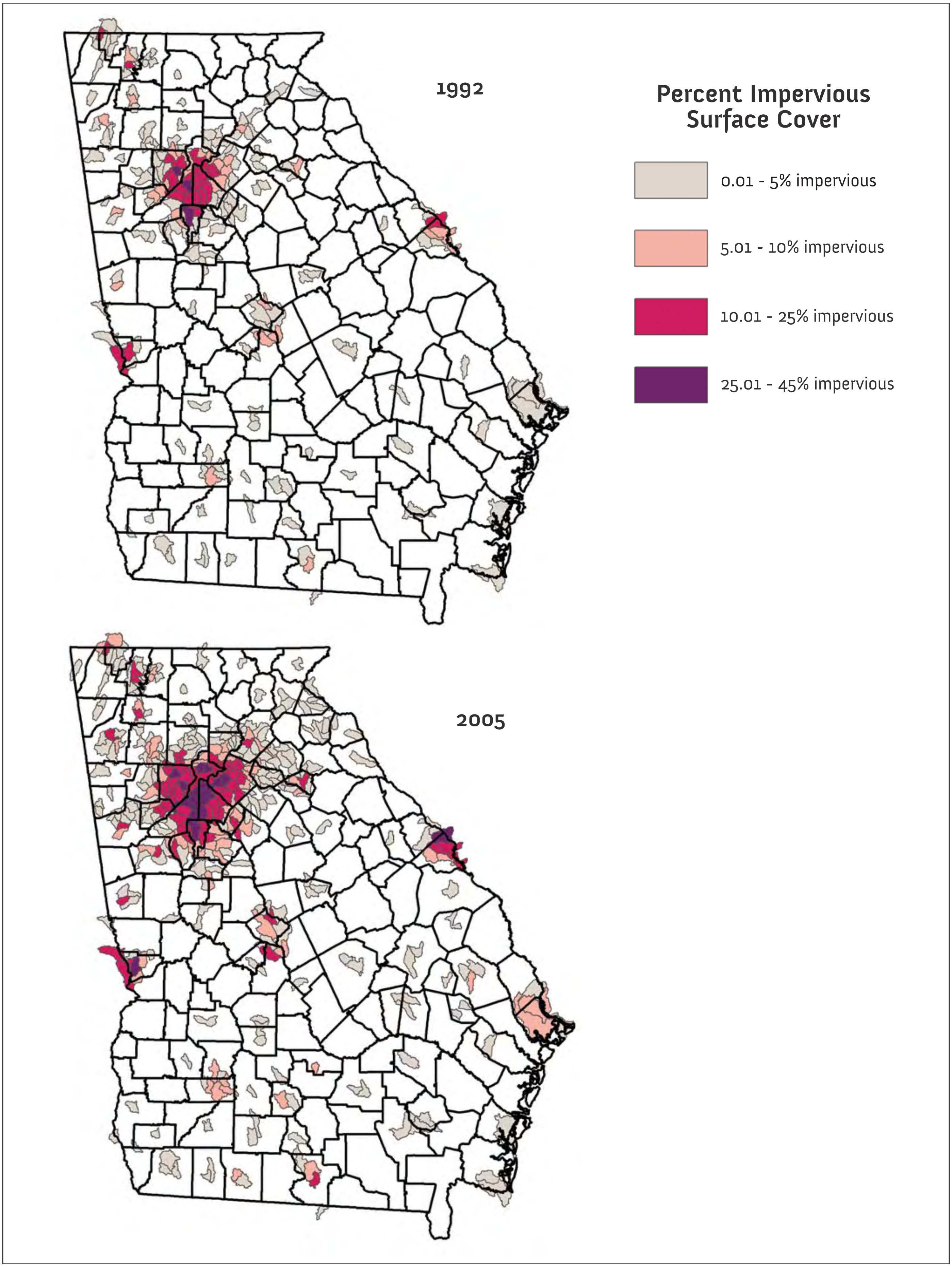


Figure 2.6 *Percent of impervious surface cover in small watersheds, 1992 and 2005. The small watersheds in this figure are equivalent to the 12-digit hydrologic cataloging units (HUCs) defined by the U.S. Geological Survey. (Natural Resources Spatial Analysis Laboratory, University of Georgia)*

Streamside Forests

Indicator of the condition of Georgia's **Habitats and Species**

The land along streams and rivers is particularly important to the health of aquatic ecosystems. Streamside or riparian lands lie directly along rivers, streams and other bodies of water. If forests or other natural vegetation is maintained in these areas, riparian lands can provide a number of ecosystem services.

Plant roots help stabilize stream banks and prevent erosion. Riparian vegetation traps and removes pollutants, maintains stream temperatures and produces organic matter that aquatic animals use as food. It also provides habitat and travel corridors for wildlife and adds aesthetic value to the landscape.

Conversion of riparian forests, however, has historically been common in urban areas and on some lands managed for agriculture and forestry. Researchers at the University of Georgia have evaluated trends in streamside forests in areas within roughly 400 feet of the state's streams and rivers (about 200 feet on each side of a stream or river).

A decline in the extent of streamside forests is evident across much of the state (Figure 2.7). Between 1974 and 2005, 41 of the state's 52 large watersheds showed declines in riparian forests. The greatest losses were in the Upper Chattahoochee (16 percent), Middle Savannah (14 percent), Upper Ocmulgee (12 percent), and Middle Chattahoochee (12 percent).

The watersheds where the amount of streamside forests stayed the same or increased all lie in parts of the state where forestry and agriculture are the predominant land uses. For both agriculture and forestry, voluntary programs increase the protection of environmentally sensitive areas. These programs include a specific set of best management practices, as well as incentives to take sensitive lands out of production. The trend in streamside forests provides evidence that, in some areas, these voluntary programs are working to alter common practices in ways that support the objective of sustaining healthy ecosystems.

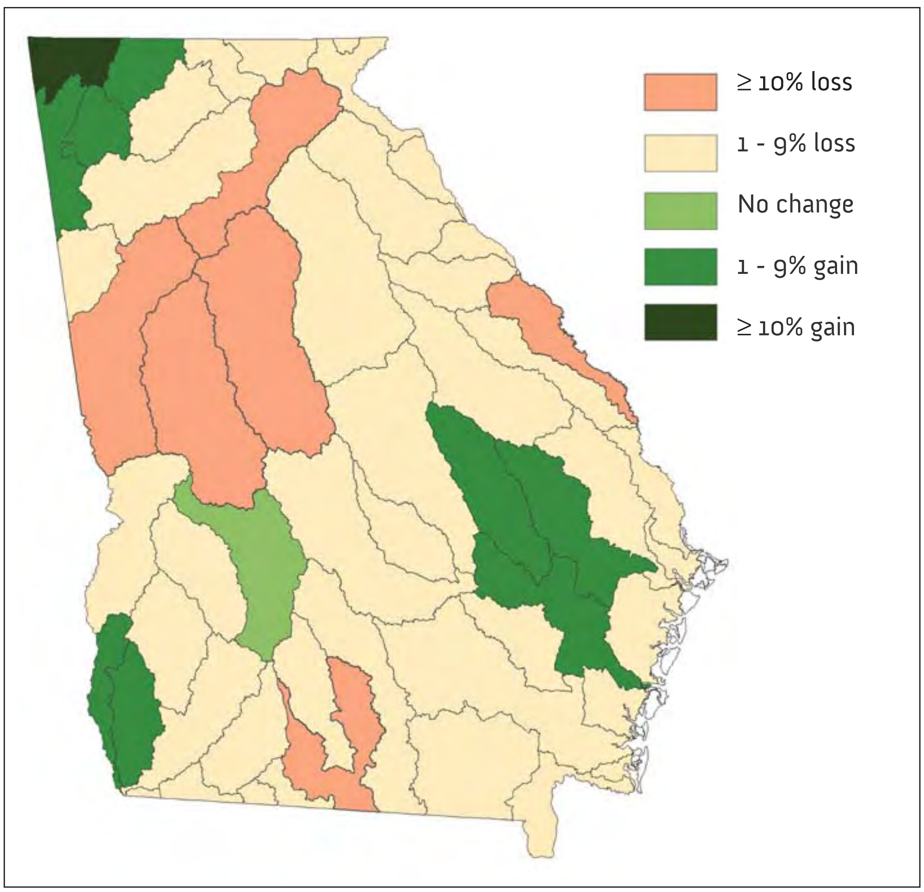


Figure 2.7 *Percent change in streamside forests, 1974 - 2005. (Natural Resources Spatial Analysis Laboratory, University of Georgia)*

Changes in land cover, conversion of streamside forests and other human activities can affect the health of aquatic ecosystems. For streams and rivers, ecosystem health can be evaluated by tracking the condition of fish communities. Since 1998, the Wildlife Resources Division has used the Index of Biotic Integrity (IBI) to determine the status of the state's freshwater fish communities.

The fish IBI combines several measures — including the different types and number of fish species, the physical condition of the fish and their position in the food chain — to generate scores of excellent, good, fair, poor and very poor. The ratings can then be used to compare regions.

Since 1997, 664 sites have been evaluated in the Piedmont, Upper Coastal Plain and Ridge and Valley ecoregions (Figure 2.8). Nearly half of the sites evaluated between 1998 and 2007 had fish communities in poor or very poor condition. Only 21 percent were in good or excellent condition.

Fish communities in the Ridge and Valley ecoregion scored somewhat better than those in other ecoregions. In the Ridge and Valley, 32 percent of sites scored good or excellent and 39 percent scored poor or very poor. In the other two ecoregions, only 17-21 percent scored good or excellent and 50-51 percent scored poor or very poor.

When fish communities are in poor or very poor condition, the water quality is considered poor, and the fish IBI is one measure that EPD uses to identify

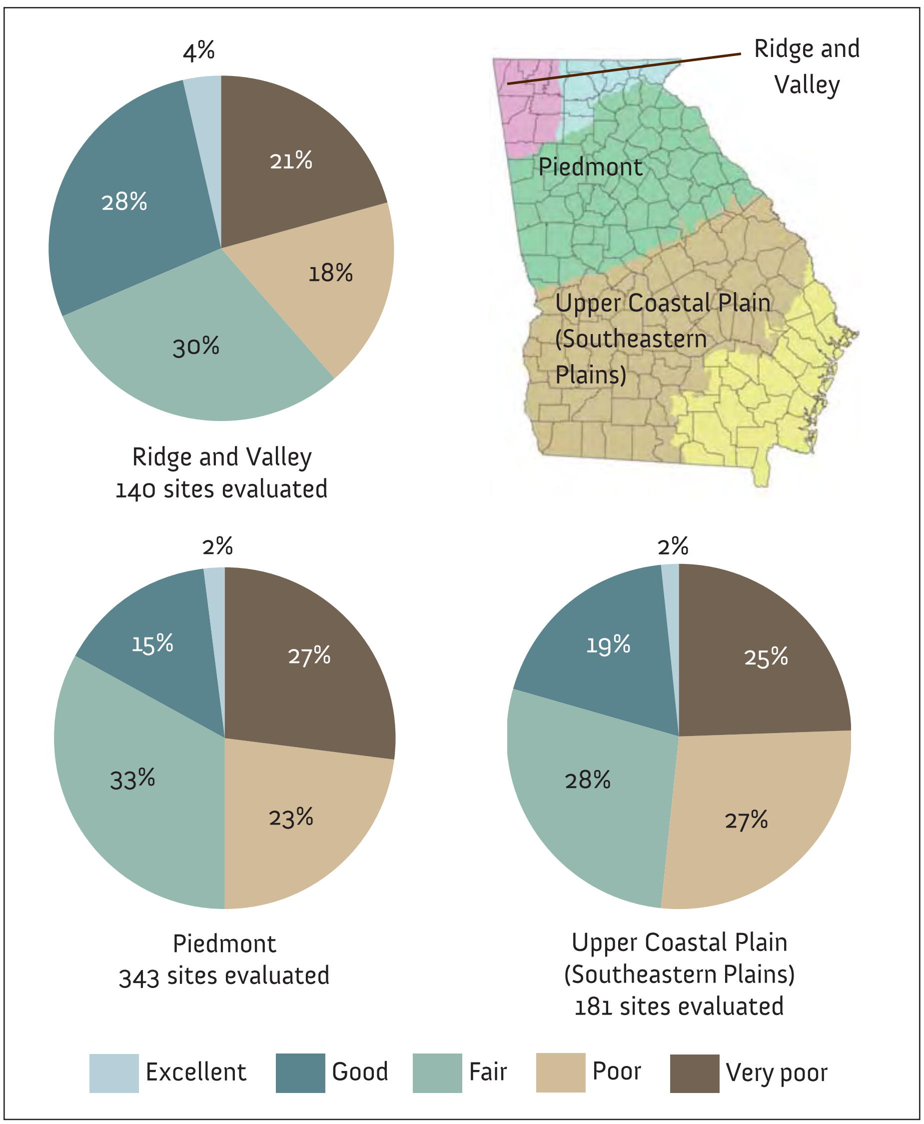


Figure 2.8 Scores for the fish Index of Biotic Integrity by ecoregion. Indexes for the Blue Ridge and Lower Coastal Plain ecoregions have not been completed, so stream health in these areas has not been evaluated. (Wildlife Resources Division)

Freshwater Fish Community Status

Indicator of the condition of Georgia's **Habitats and Species**

How do streamside forests affect trout?

Streamside forests provide a number of ecosystem services. One of the most important of these benefits is temperature control. Trees and shrubs provide shade, which keeps the water temperature cooler. Lower temperatures allow the water to hold more oxygen, which in turn creates a healthier habitat for aquatic species.

A study of trout streams in north Georgia showed that as the percentage of riparian vegetation decreased, water temperatures rose. Young trout fared poorly in the warmer water.

Researchers estimate that decreasing the width of riparian vegetation by 50 percent, from roughly 100 feet to 50 feet, would increase temperatures by 3-4 degrees Fahrenheit and cause the total weight of all trout to decline by more than 80 percent.

For more information on riparian forests and trout streams in north Georgia, see http://www.rivercenter.uga.edu/publications/pdf/buffer_science.pdf.

What can we learn about recreational fishing quality from examining fish communities in Georgia streams?

The Georgia Wildlife Resources Division evaluates the status of fish communities in wadeable streams using the Index of Biotic Integrity (IBI). The IBI looks at all species of fish and examines their numbers and relative contribution to the overall population.

Sportfish examined include large-mouth, redeye, shoal, smallmouth, and spotted bass; white bass and striped bass hybrids; bluegill, flier, redbreast, redear, warmouth, and spotted sunfish; rock and shoal bass; brook, brown and rainbow trout; black and white crappie; channel, blue, and flathead catfish; and chain and redfin pickerel.

Good IBI scores and good fishing are linked because fish are indicators of the events and processes that go on throughout a watershed over time — from the chemical components in the water and soil near the stream to the breakdown of leaves in the stream that support the food chain.

If the IBI score for a stream is high, many fish species are present, habitat is plentiful, adequate food is available, and the fish are healthy and growing well.

Healthy fish communities in small streams can also translate into healthy fish communities in larger rivers. As wadeable streams merge to form large streams and rivers, if good environmental and habitat conditions occur along the way, healthy fish communities can continue to thrive. Eventually, these large rivers flow into lakes and estuaries, helping to support recreational fishing quality in these water bodies as well.

waters that do not meet water quality standards. Another measure used is the type and condition of small insects and insect-like animals that live in or near the bottom of streams and rivers.

These animals, called benthic macroinvertebrates, are an important source of food for fish and an essential link in the aquatic food chain. Like the fish IBI, this evaluation uses multiple measures to score community status as very good, good, fair, poor or very poor. Streams with poor or very poor scores for fish or benthic macroinvertebrates are added to the state's list of waters with poor water quality.

Overall, in 2006 and 2007, 40 percent of the river miles evaluated had poor or very poor scores for fish or benthic macroinvertebrates and were added to the state's list of waters with poor water quality (Table 2.4). Fish and benthic communities in poor or very poor condition were the second most common indicator of poor water quality in eight of the state's 14 major river basins.

These results are due, in part, to land-based activities and nonpoint source pollution that may result. Sediment, in particular, clogs aquatic habitat and stresses fish and macroinvertebrate communities. Other pollutants, including nutrients, metals and pesticides, are also transported with sediment.

Much of the sediment in Georgia streams is a result of past and present land uses. Historically, agriculture was a major source of sediment, and some of that sediment still affects the state's aquatic ecosystems.

Currently, a major source of sediment is the conversion of land into higher intensity uses, including construction of roads, houses and businesses. Eroding stream banks are also a source of sediment today, as impervious surfaces increase the amount and force of stormwater that runs through streams in urban and developing areas.

Erosion and transport of sediment may be reduced as more protective approaches to development, land disturbance, and stormwater management are adopted. As the state continues to grow, ongoing monitoring of fish and benthic communities will be important to track the impacts of land conversion on aquatic ecosystem health.

Table 2.4 *Assessed river miles with poor quality fish or macroinvertebrate communities, 2006-2007. (EPD)*

River basin	Total river miles	Percent of river miles assessed	Percent of assessed river miles with poor quality fish or macroinvertebrate communities
Altamaha	3,430	1%	62%
Chattahoochee	8,172	12%	42%
Coosa	7,126	14%	40%
Flint	9,122	11%	28%
Ochlockonee	1,716	2%	52%
Ocmulgee	7,268	13%	52%
Oconee	6,773	9%	48%
Ogeechee	6,981	2%	10%
Satilla	3,629	3%	0%
Savannah	7,413	5%	48%
Suwannee	4,961	3%	21%
St. Marys	485	2%	0%
Tallapoosa	774	18%	44%
Tennessee	2,300	11%	49%
Total	70,150	8%	40%

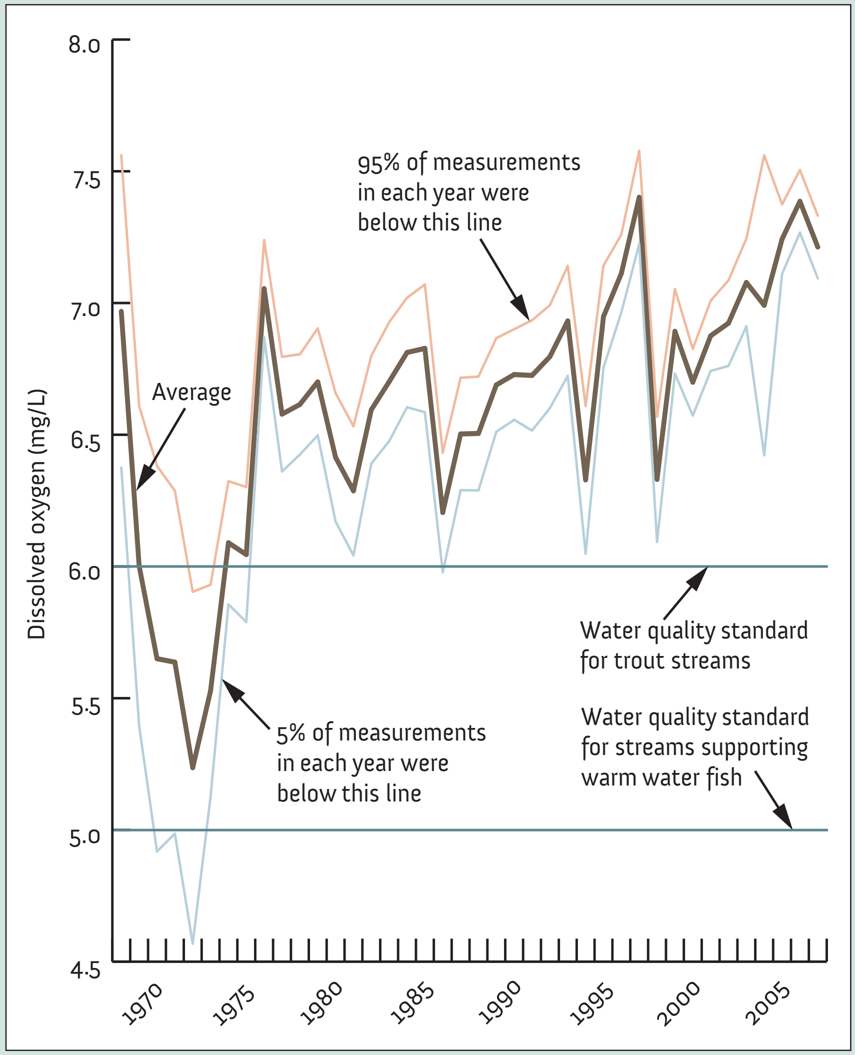
Backgrounder

Dissolved oxygen in surface water

In the early 1970s, growing concern about water quality was triggered, in part, by fish kills caused by low levels of dissolved oxygen. Dissolved oxygen refers to the amount of oxygen in the water. Just as humans cannot survive without oxygen, fish and other aquatic life must have an adequate amount of oxygen in the water to live.

Dissolved oxygen has been a common indicator of a water body's ability to support aquatic life since the 1970s. Levels of dissolved oxygen can be affected by water temperature and the amount of decaying organic matter and pollution in the water, among other factors. Pollution that increases the demand for oxygen can have a significant effect. As bacteria use oxygen to break down the pollutants, levels of dissolved oxygen can decline substantially.

As described in the preceding chapter, long-term trends in water quality are monitored at 40 locations around the state. Average dissolved oxygen levels at these 40 stations have been good since the late 1970s (see figure). Average levels during the summer, when concentrations of dissolved oxygen are naturally the lowest, consistently met or exceeded the water quality standard.



Average amounts of dissolved oxygen at 40 trend monitoring stations, May - September. Levels above the water quality standard are needed to support healthy aquatic communities. Dissolved oxygen levels decrease when temperature increases and levels are generally lowest during the summer, making May to September the critical months for assessment.

In addition to long-term trend monitoring, EPD monitors waters in all river basins on a rotating schedule. As described in the preceding chapter, monitoring results are used to identify stream and river segments where water quality standards are not met.

Of the river miles tested in 2006 and 2007, 91 percent met the water quality standard for dissolved oxygen.

These results reflect major improvements in wastewater treatment by industries and municipalities.

Violations of the dissolved oxygen standard are currently more common in south Georgia than in north Georgia. In south Georgia, low dissolved oxygen can result from natural conditions. Low dissolved oxygen levels are more likely to occur in streams with slower moving water, shallow depths, and higher temperatures – all conditions that are common in the southern part of the state. EPD plans to review the dissolved oxygen standard to improve its application to streams that are naturally low in dissolved oxygen.

Coastal Habitat Conditions

Indicator of the condition of Georgia's **Habitats and Species**

Measures of coastal habitat conditions

- Dissolved oxygen is required by all aquatic life.
- Chlorophyll, a plant pigment, is measured to indicate the amount of algae in the water.
- Nitrogen and phosphorous are nutrients that can contribute to undesirable levels of algae.
- Benthic invertebrates, animals that live on the bottom of water bodies, are an important source of food for fish, shrimp and crabs.

For the interim report on the ecological condition of Georgia's estuaries, see: http://crd.dnr.state.ga.us/assets/documents/GAreport3062306final LOWRES.pdf.

How does the Southeastern coast compare to the U.S.?

The 2005 National Coastal Conditions Report II compared assessment results for regions across the U.S. The Southeastern coast, including sites in Georgia, was among the healthiest in the nation. Twenty-three percent of sites in the Southeast were rated in poor condition, compared to 40 percent in the Northeast, 40 percent along the Gulf Coast, and 23 percent on the West Coast.

Georgia's coastline includes 14 barrier islands, approximately 500,000 acres of salt marsh, and extensive estuaries where the state's major rivers flow into the ocean. Like freshwater ecosystems, coastal ecosystems supply vital services.

They provide habitat for many species, including economically significant species like shrimp and crabs and other marine animals. They act as buffers against flooding and erosion and have natural mechanisms for filtering pollutants. The health of these ecosystems can also be affected by land cover change and other human activities.

The most recent assessment of Georgia's coastal and estuarine habitats was conducted by DNR's Coastal Resources Division as part of the National Coastal Assessment. One hundred sites were sampled in 2000 and 2001 and an interim report, "The conditions of Georgia's estuarine and coastal habitats 2000-2001," was published in 2005. Multiple measures were combined into a composite index of water quality and a composite index of sediment quality. The condition of the benthic community, bottom-dwelling invertebrates that live in the sediment, was also evaluated.

The assessment indicates that Georgia's estuarine habitats are in fair to good condition (Figure 2.9). Water quality ratings were generally lower than other measures. Elevated levels of phosphorus and chlorophyll and low levels of dissolved oxygen and water clarity were found. These factors, however, may be due to natural conditions, complicating interpretation of the results.

Water quality measurements were weighted and combined into a composite index of water quality. Weighting the measurements resulted in 80 percent of sites scoring fair for water quality and 11 percent scoring poor. Sediment quality was generally good, as was the condition of the benthic community. For both, 93 percent of sites ranked good or fair. Of the estuaries with poor benthic conditions, 80 percent also had poor water quality and/or poor sediment quality.

Most sites rated fair or poor were associated with developed watersheds, although some showed no correlation with human activities. Nonpoint source pollution is one of the primary threats to coastal water quality and, as development continues in these areas, managing these pollution sources will be increasingly important to protect and/or restore coastal and estuarine habitats.

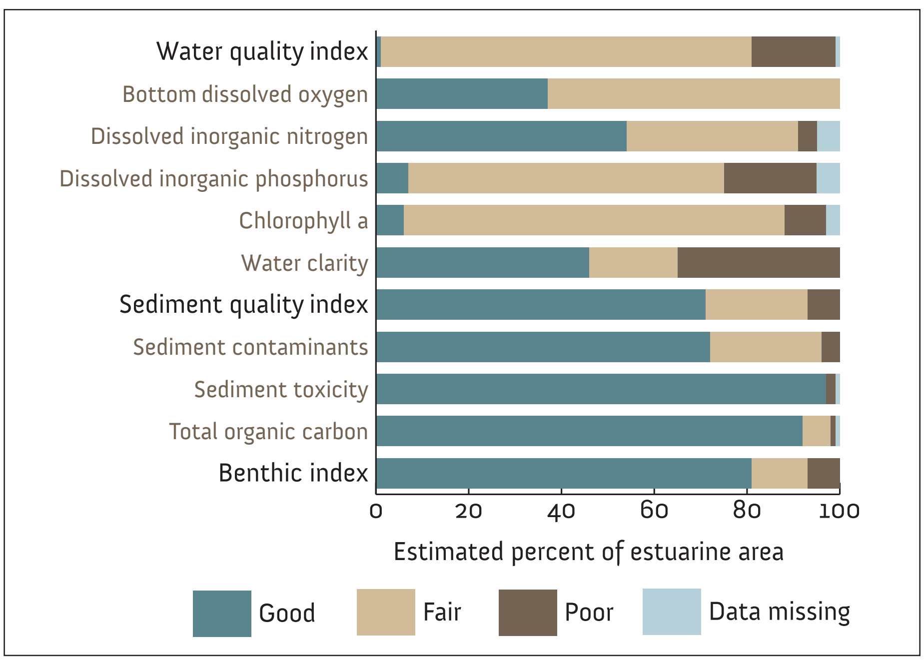


Figure 2.9 Overall condition of coastal habitats, 2000 - 2001. (Coastal Resources Division)

Like freshwater and coastal aquatic systems, terrestrial habitat is altered by changes in land cover like those discussed at the beginning of this chapter. Clearing forests or converting vegetated lands to more intensive human uses eliminates some habitat and divides other habitat into smaller and smaller pieces. Native vegetation also may be replaced with nonnative species. These changes can contribute to the decline of wildlife species, including sensitive species that need interior forests.

One way to evaluate habitat quality is to look at areas of natural vegetation and identify those that have the size, shape and location to provide high quality habitat. This type of analysis was conducted for the Wildlife Resource Division's 2005 Wildlife Action Plan. The analysis was based on land cover data from 1998 (the most recent information available at that time).

Figure 2.10 shows ranking of habitat quality based on the size and configuration of areas of natural vegetation. As of 1998, only 36 percent of the state's lands had some type of natural vegetative cover, such as natural forest, wetland or marsh. As seen in the figure, the amount of high quality habitat is small and varies by ecoregion.

At 78 percent, the Blue Ridge ecoregion had the greatest amount of natural vegetation and extensive areas of high quality habitat. The Coastal Plain, in contrast, had 33 percent natural vegetation and fewer areas of highly ranked habitat. The Piedmont had 35 percent natural vegetation with smaller patches of highly ranked habitat.

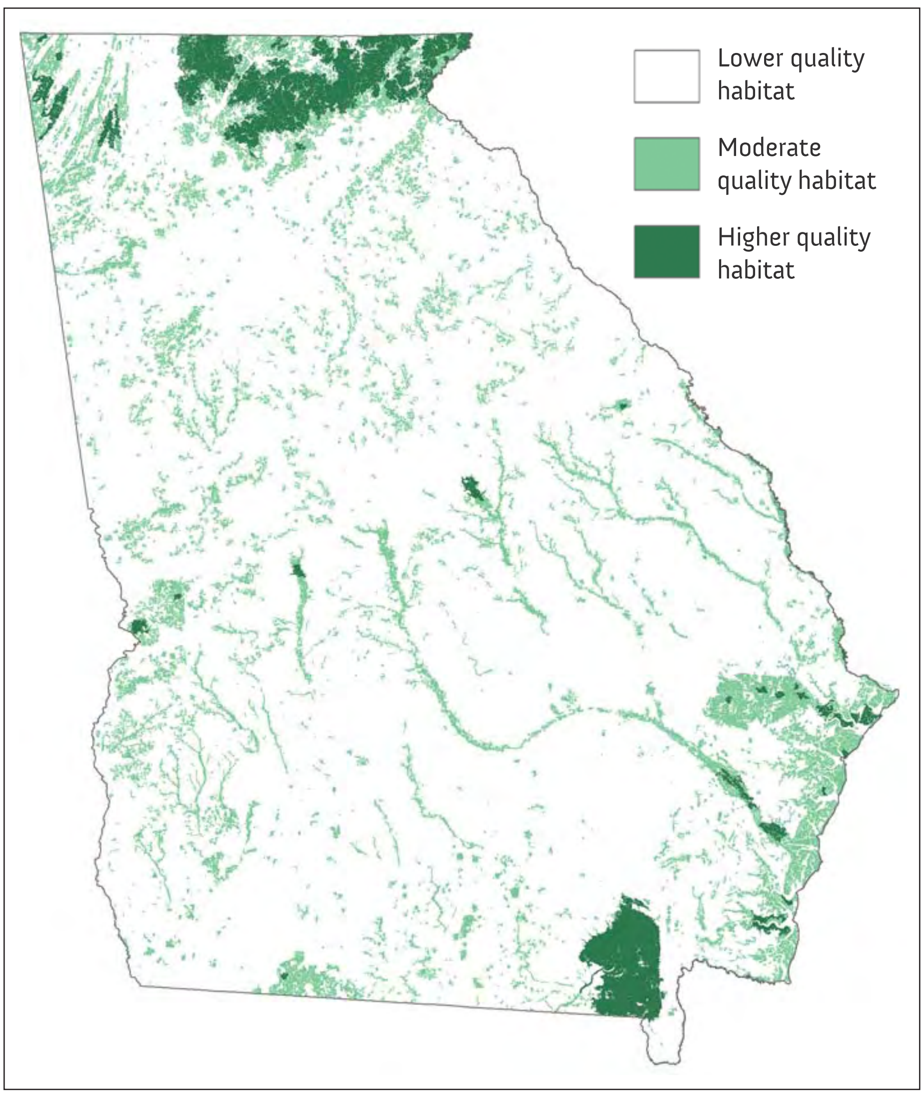


Figure 2.10 *Natural vegetation rankings, 1998. (Wildlife Resources Division)*

Terrestrial Habitat Quality

Indicator of the condition of Georgia's **Habitats and Species**

What is high quality habitat?

High quality habitats play a key role in long-term maintenance of wildlife populations. Habitat quality is determined, in part, by the size and shape of intact areas or patches of natural vegetation.

High quality patches of habitat are generally larger, provide different types of habitat on the edges and in the center, and are relatively compact. In larger areas with well-defined central cores, species are less likely to suffer from predators, parasites or human encroachment.

Fragmentation refers to breaking areas of continuous habitat into smaller, more isolated parts. Fragmentation decreases habitat quality. Populations of plants and animals may become isolated or too small to continue breeding. Travel corridors also may be eliminated, disrupting short and long-term migration patterns.

Many high quality patches, including large tracts of public land in the Okefenokee Swamp and the Oconee and Chattahoochee National Forests, are part of a network of conservation lands.

This information can be used to identify lands that are important to protect in each ecoregion. For the Wildlife Action Plan, the habitat quality analysis was combined with information on predicted distribution and observed occurrence of rare species to highlight conservation opportunity areas (see Appendix K at http://www1.gadnr.org/cwcs/index.html).

While the overall habitat quality is lower, lands on which natural vegetation has been altered can still be of value to native wildlife. Agricultural fields, pine plantations and forests in developed areas, for example, can provide nesting sites, feeding areas and migration routes for birds and animals. These lands can also be managed in ways that support native wildlife and are compatible with protection of adjacent areas of high quality habitat.

The sources of habitat loss are similar across the state. The rapid pace of land conversion and habitat fragmentation are among the most common causes in all of Georgia's ecoregions (Table 2.5).

Table 2.5 *Major sources of habitat loss by ecoregion. (Adapted from the State Wildlife Action Plan, Wildlife Resources Division)*

Ecoregion	Major sources of habitat loss
Southwestern Appalachians/ Ridge and Valley	- Increase in residential and commercial development along major highways and on outskirts of metro areas - Prior conversion of forested lands to agricultural uses - Poor water quality - Alteration of streamflows and groundwater levels
Blue Ridge	- Increase in residential and commercial development along major highways and on outskirts of metro areas - Poor water quality - Conversion of hardwood and pine-hardwood forests to pine plantations - Fire suppression
Piedmont	- Rapid pace of residential and commercial development - Poor water quality - Prior conversion of forested lands to agricultural uses - Conversion of hardwood and pine-hardwood forests to pine plantations
Upper Coastal Plain (Southeastern Plains)	- Prior conversion of forested lands to agricultural uses - Poor water quality - Conversion of hardwood and pine-hardwood forests to pine plantations - Fire suppression
Lower Coastal Plain (Southern Coastal Plains)	- Rapid pace of residential and commercial development in coastal counties - Prior conversion of native pine forests to pine plantations - Fire suppression - Alteration of streamflows, floodplains/wetlands and groundwater levels

As described in the introduction to this chapter, Georgia's aquatic and terrestrial ecosystems support extraordinary levels of biological diversity. This diversity, however, is threatened, in part, by some of the ways in which land is used and the ways land has been altered as the state's population has grown.

Biological diversity can be difficult to measure directly. As an alternative, the number of species whose survival is at risk provides an indicator of changes in biological diversity, and therefore changes in ecosystem health.

Georgia's Wildlife Resources Division maintains a list of the state's protected species. This list includes animals and plants that are endangered, threatened, rare or unusual in the state. When the list is short, it indicates progress in protecting the health of our ecosystems; when it is longer, it indicates that human activities are negatively impacting ecosystem health.

The protected species list was updated in 2007. It now includes a total of 318 species (Table 2.6). The update added 121 species. Many of the new additions are plants, and plant species now make up nearly 50 percent of the protected species in the state. A number of crayfish and freshwater mussels were added as well, raising the number of invertebrate species on the list to 51. Most of the invertebrate species are aquatic. Aquatic animals (fish and invertebrates) now make up more than one-third of Georgia's protected species.

These changes reflect the degree of threat to these species, based on current habitat conditions and/or estimated population levels. For some species, they also reflect improvements in the information used to evaluate their status. That is, biologists now know more about the status of some species; they cannot, however, be sure that these species have become more imperiled in recent years.

A species can be added to the list for a number of reasons, including changes to the species' habitat; over-collecting for commercial, sporting, scientific or educational use; disease or predation; and inadequate regulations. The most severe threat to Georgia species is habitat loss. It is not, however, the only significant threat. Turtles and crayfish, for example, are threatened by over-collection.

Table 2.6 *Plants and animals on Georgia's protected species lists, 2007. (Wildlife Resources Division)*

	Endangered	Threatened	Rare	Unusual	Total
Mammals	6	2	2	0	10
Birds	5	4	11	0	20
Fish	32	8	17	0	57
Amphibians	0	5	4	0	9
Invertebrates	28	19	4	0	51
Reptiles	5	6	3	2	16
Plants	56	63	32	4	155
Total	132	107	73	6	318

Protected Species

Indicator of the condition of Georgia's **Habitats and Species**

Recent changes in Georgia's list of protected species

Georgia's protected species list was updated in 2007. Since the last update in 1992, 121 species were added and 18 species removed.

Also, 43 species that were already on the list had their status changed. The status of 19 of these improved and the status of 24 declined.

More information on Georgia's protected species can be found on the conservation page at http://www.georgiawildlife.com.

Habitat Protection

Indicator of the condition of Georgia's **Habitats and Species**

Differing levels of protection

Only 8 percent of the state's land area currently has some degree of natural habitat protection.

Habitat types that cover large areas of the state (e.g., hardwood forests) tend to have a small percentage protected, while those that occupy a small fraction of the state (e.g., coastal dunes) have a higher percentage of their total area protected. As a result, some important habitats currently have very little protection.

Bottomland hardwoods, for example, cover more than 1.2 million acres in Georgia, but receive little protection. Only 7 percent is permanently protected with limited impacts on natural habitat, despite its significance as high quality habitat for a variety of species.

Longleaf pine, an ecosystem known for its high level of biological diversity, has a higher level of protection (13 percent is permanently protected). However, much of the native longleaf pine forest has already been converted to other land uses. Once found across the Southern coastal plain, intact longleaf pine habitat now exists on less than 4 percent of the land where it historically occurred.

The final indicator of ecosystem health looks at land stewardship — the management of land to protect natural habitat and maintain biological diversity.

The Georgia Conservation Lands database is one source of information on habitat protection. The database includes records of federal, state, local government, and private lands in Georgia that are managed for conservation of animals, plants and natural habitats, as shown in Figure 2.11.

The federal government manages more than 70 percent of Georgia's conservation lands. The state manages more than 20 percent, including lands owned by the state and those leased from other owners. Private conservation groups and local governments manage the remainder.

The degree of habitat protection provided on individual parcels depends on the land owner and their management objectives. Some lands, like wilderness areas and areas under perpetual conservation easement, provide permanent protection of natural habitat. Other lands, like state parks and wildlife management areas, are mostly maintained in a natural state, although some areas are altered in ways that include removal of natural habitat. Habitat on leased lands may currently be protected, but year-to-year leases do not ensure permanent protection of habitat on these lands. Lands such as military bases and national forests include large areas where natural habitat is protected, while some areas are altered for other uses, such as timber harvest.

Despite these different management objectives, conservation lands all provide protected habitat for plants and animals and help maintain healthy ecosystems. Conservation lands also provide economic benefits. Visits to Georgia's state parks, for example, are estimated to generate more than $769 million per year for the state and local communities. Conservation lands are also community assets that can contribute to higher property values in the areas around them.

A 2003 study by the U.S. Geological Survey concludes that only 8 percent

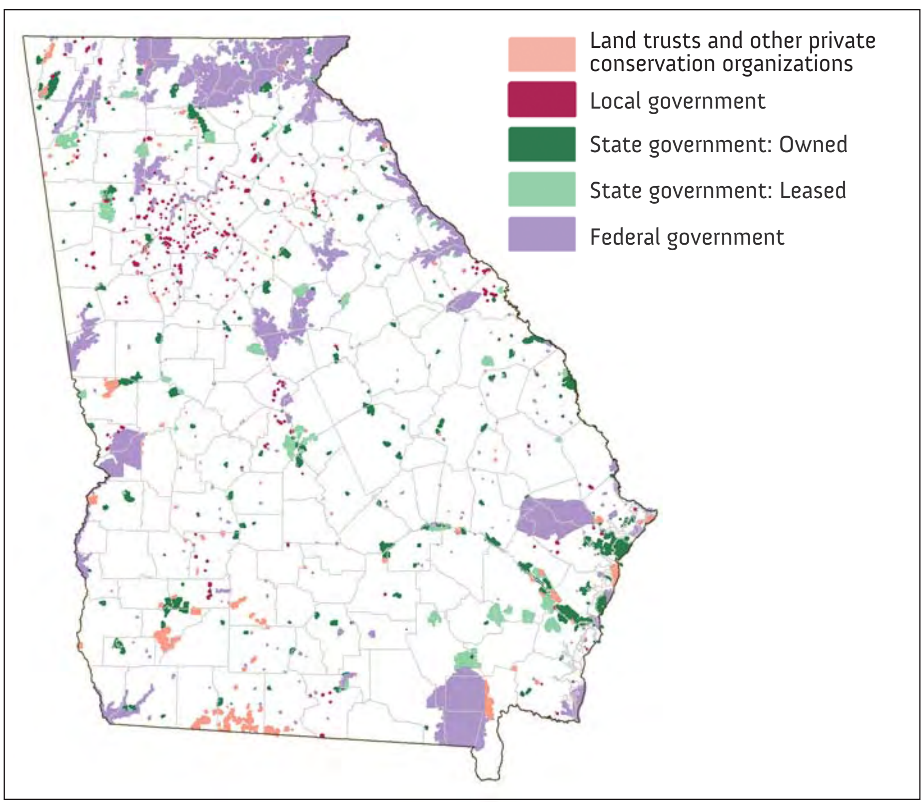


***Figure 2.11** Georgia conservation lands by ownership, 2008. (Wildlife Resources Division)*

of Georgia's total land area is managed for conservation and has some level of protection for natural habitats. Of these conservation lands, only a small portion – equal to 3.5 percent of the state – is permanently protected in its natural state through ownership, legal mandate or conservation agreement. Permanently protected lands include wilderness areas, state parks, wildlife management areas, and lands held by land trusts, among others.

Researchers with the U.S. Geological Survey have evaluated the extent of protection that conservation lands provide for habitats of terrestrial animals found in Georgia. Researchers identified areas where each of 405 animal species are expected to be found. These areas were compared with the location of protected lands to determine the level of habitat protection for terrestrial animals in place as of 2003.

Of the 405 species, 29 have less than 1 percent of their habitat protected from conversion (Figure 2.12). More than two-thirds have less than 10 percent of their habitat protected from conversion — a total of 295 species.

This level of habitat protection was found for all major groups of animals:

- 71 percent of amphibian species
- 73 percent of breeding bird species
- 73 percent of mammal species
- 74 percent of reptile species

Only 32 species — 7 percent of the total number of animal species in the state — had more than 20 percent of their habitat protected.

These results are not surprising, given the low percentage of protected lands across the state. This research, however, provides information that can guide efforts to protect additional land. The Wildlife Resources Division has combined it with habitat quality rankings, described earlier in the chapter, to identify areas with opportunities for conservation (see Appendix K at http://www1.gadnr.org/cwcs/index.html).

Ninety-two percent of Georgia's land has no protection of natural habitat and thus is subject to conversion and habitat loss. The vast majority of this land is held by private landowners.

As Georgia continues to grow, voluntary habitat protection on private lands will be increasingly important. A variety of options are available to private landowners interested in protecting habitat and helping sustain healthy ecosystems across Georgia (see page 52).

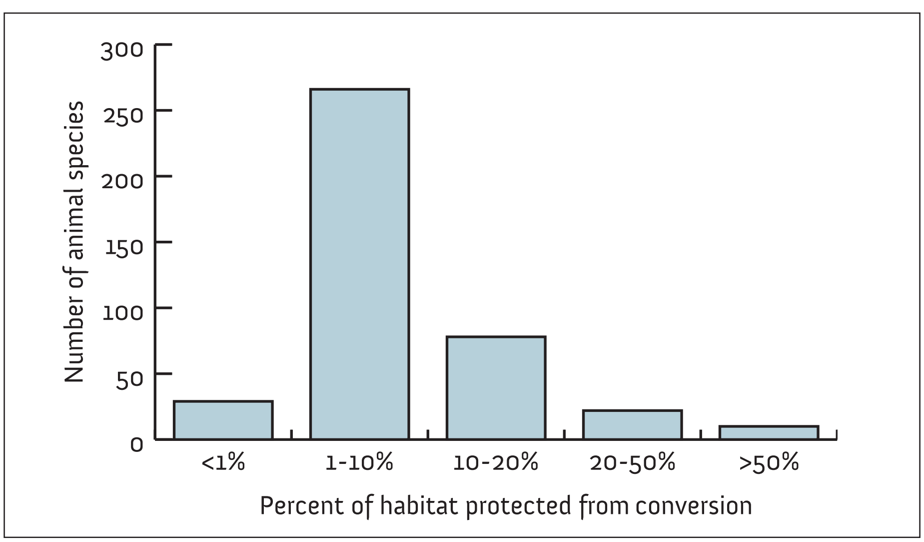


Figure 2.12 *Protected habitat for terrestrial animals, 2003. (U.S. Geological Survey)*

Voluntary action by private landowners is critical to protect habitat

More than 90 percent of land in the state is in private ownership and just a small percentage is managed for conservation or protection of natural habitats.

As Georgia continues to grow, sustaining the state's ecosystems will require protecting high priority habitat and critical species. Taking such actions on public lands alone will not be enough. Managing private lands for conservation will also be needed, and private landowners can play a critical role in conservation.

The State Wildlife Action Plan, adopted by the Wildlife Resources Division in 2005, emphasizes protection, restoration and maintenance of natural habitats. Identifying critical habitats, voluntary and incentive-based programs for private lands, and habitat restoration and management by private conservation organizations and public agencies, are all major elements of the plan.

To read the full plan, go to: http://www1.gadnr.org/cwcs/Documents/strategy.html.

Backgrounder

Incentives for Habitat Protection on Private Lands

Land ownership can be thought of as a bundle of sticks, with each stick representing a particular right. A landowner interested in habitat protection or other conservation goals may sell or give away some or all of his or her property rights through fee simple acquisition, conservation easements or transfer of development rights. Conservation use valuation assessments also provide incentives for protection of private lands. With this tool, however, the landowner does not transfer property rights.

Fee simple acquisition. A landowner sells the rights, title and interest in the property to a buyer, who then owns and manages the land. Public agencies and private nonprofits may be interested in acquiring land for specific conservation purposes. If a sale to a qualified conservation organization is made at a discounted price, or if the land is donated, landowners can receive significant tax benefits. The difference between the market price and the sale price is considered a charitable deduction, which can reduce federal and state income taxes. Georgia also has a state income tax credit for donations and discounted sales of land.

Conservation easement. Conservation easements are a valuable tool for protecting conservation values in perpetuity. A conservation easement is a legal agreement that transfers certain development rights to a third party, usually a land trust or government agency. Conservation easements are negotiated by the landowner and the conservation organization. This provides the flexibility to allow certain uses, such as continued farming or forestry, while protecting the land's conservation values. The degree of restriction determines the value of the easement and the tax deduction or other tax benefits available to the landowner.

Conservation easements are tied to the land so the property can still be bought or sold. Future owners must follow the provisions of the easement, and the land trust or conservation organization is responsible for monitoring and enforcing easement terms. For agricultural lands, the federal Farm Protection Program can provide matching funds to purchase permanent conservation easements that keep the land in agricultural use.

Transfer of development rights. A few localities in Georgia have developed programs that allow the transfer of development rights. Under these programs, development rights are separated from one parcel and sold for use on another parcel. The landowner then enters into a conservation easement that permanently restricts development on the original parcel.

Conservation use valuation assessment. Some lands, including agricultural lands, forest lands and environmentally sensitive areas, are eligible for reduced property tax rates through conservation use valuation. These properties are assessed according to soil type and productivity rather than fair market value, which generally means a significant reduction in property taxes. Property must meet eligibility requirements set by the county and landowners must sign an agreement to keep the land in its current use for 10 years. Landowners can reenroll after 10 years to continue the conservation use valuation assessment.

(Georgia Wildlife Resources Division and Arizona Open Land Trust)

Ensuring resources to support a Growing Economy

The state's natural resources provide Georgians with a variety of basic needs. Water resources provide water to drink; support production of goods, food and electricity; and process wastewater.

Land serves many purposes, including production of food, wood and mineral products and support of our growing cities and counties. Air is essential for life and, in addition to harming human health, poor quality air can impair visibility and lessen our enjoyment of the environment around us.

The third objective established for EPD by state law focuses on the use of Georgia's natural resources as a foundation for a strong economy and a rich quality of life, both now and in the future. This objective is closely related to the objectives of protecting human health and sustaining healthy ecosystems. For the most part, progress on the first two objectives will result in progress on the third, and progress on all three will be necessary for Georgia's continued growth and prosperity.

As Georgia's population and economy has grown, the use of resources has also increased and these trends are expected to continue over the coming decades. As demands increase, the ability of some resources to support critical functions may be at risk.

Unfortunately, limited information exists about the capacity of the state's resources or their ability to support economic growth. More demand for water, for example, requires more information about capacity, and studies under the State Water Plan, have begun to fill some of these information gaps.

This chapter focuses on the environmental services that Georgia's natural resources provide to support the state's economy. Table 3.1 lists the indicators selected to assess the capacity of Georgia's resources to provide those services. Indicators focus on the condition of water resources, including water for water supply and the capacity to assimilate pollution as well as lands used for forestry, agriculture and solid waste disposal.

Table 3.1 *Indicators of the condition of the state's natural resources.*

Natural resource	Indicators of condition
Water supply	Total water use
	Per capita water use
	Groundwater levels
Assimilation of pollution	Pollutants in surface waters
	Nonpoint sources of pollution
Working lands	Land used for agriculture and forestry
	Brownfield revitalization
	Land used for solid waste disposal
Air quality	Visibility

As Georgia's population and economy grows, so does its need for water. Water withdrawn from the state's rivers, streams, lakes and aquifers is used for a variety of purposes, ranging from household use to industrial, agricultural and thermoelectric production. The total amount of water used for these purposes is an indicator of the sustainability of Georgia's water supply.

The U.S. Geological Survey (USGS) conducts an extensive evaluation of water use every five years. The most recent USGS analysis covers water use in the year 2005. For the purposes of this report, water use is grouped into five major sectors (see sidebar).

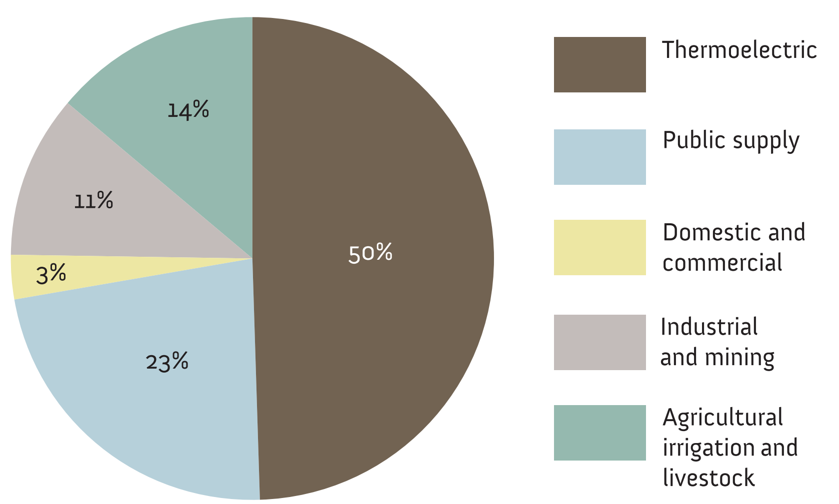
The largest single use of water in the state is for electricity production (Figure 3.1). In 2005, half of all water withdrawn was used in cooling processes associated with the generation of thermoelectric power. There are 15 plants operating on fossil fuels and two nuclear-powered plants in Georgia. In 2005, these 17 plants used an estimated 2.7 billion gallons of water a day.

Water for thermoelectric power production, however, is used differently from other sectors. More then 90 percent of the total water withdrawn for thermoelectric power production is almost immediately returned, usually to the source from which the water came.

The amount returned varies with the type and age of the plant. For some plants, almost all the water used for cooling is returned to the source close to where it was withdrawn. In other plants, water is converted to steam and is consumed in the cooling process (i.e., not returned to the source). For the plants currently operating in Georgia, the estimated amount of water lost through evaporation ranges from less than 1 percent to 70 percent.

The combined water use for public supply, domestic and commercial use, and industrial and mining use accounts for about 37 percent of the total withdrawals in state. For these sectors, the amount of water returned to the source after use varies widely, depending on the specific use.

In the agricultural sector, more than 90 percent of water is used for irrigation. The amount of irrigation water used each year depends on the amount and timing of rainfall. In the past two decades, water used for irrigation has generally accounted for 8 percent to 17 percent of the total water withdrawn. Irrigation water is largely consumed through evaporation or plant use, and little is returned to the water source.



Total = 5,528 million gallons per day

Figure 3.1 *Water use by sector, 2005. Due to rounding, percentages do not total 100. (U.S. Geological Survey)*

Total Water Use

Indicator of the sustainability of Georgia's **Water Supply**

Water in Georgia is used by five major sectors

Public supply. Water withdrawn by public and private water suppliers and delivered for a variety of uses, including domestic, commercial and industrial.

Domestic and commercial. Water from individual water systems, such as wells, withdrawn for self-supplied households and commercial establishments.

Industrial. Self-supplied industries that use water for fabrication, processing, washing and cooling. The largest industrial water users in Georgia are pulp and paper mills, textile industries, chemical manufacturers and mining and mineral industries.

Agricultural. Water used to irrigate crops, large nurseries and golf courses. Also, water used for livestock watering, feedlots, catfish and aquaculture operations, and other livestock farm operations.

Thermoelectric power. Water used in the generation of electric power, primarily for cooling purposes. Excludes water used for hydroelectric production.

Once water is withdrawn, is any returned to the source?

When thinking about current and future use of Georgia's water resources, it is worth noting that the numbers in this report only represent the water that is withdrawn, and say nothing about the amount of water that is returned to the source.

Returning water after it has been used helps support water withdrawals by users downstream and helps maintain the health of aquatic ecosystems.

The loss of water through evaporation or plant use, as happens with much of the water withdrawn for agricultural uses, or through wastewater disposal practices that either delay the return of water or return it to other sources, can affect the ability of that water source to support other water uses.

Sources of water

All of the water used in Georgia comes from the surface water sources in the state's 14 major river systems and groundwater stored in six major aquifers. Surface waters provided 79 percent of the water withdrawn in 2005, and aquifers provided the remaining 21 percent.

Figure 3.2 shows the major water use sectors and the amount of surface water and groundwater that each used in 2005. Among the largest water users, water for thermoelectric production and public supply primarily came from surface water sources. Agricultural irrigation, in contrast, occurs largely through withdrawals from groundwater. Industrial users rely almost equally on surface and groundwater sources.

Some of the state's water sources are more heavily used than others. In 2005, withdrawals from the Chattahoochee and Flint river basins accounted for nearly one-third of all surface water withdrawals in the state. Withdrawals from the Oconee and Ocmulgee river basins also accounted for approximately one-third of the total.

Much of the water withdrawn from these river basins, however, is for thermoelectric use. Looking only at public supply, domestic and commercial uses, withdrawals from surface waters in the Chattahoochee and Flint basins accounted for more than half of the total in 2005. Withdrawals from the Coosa, Ocmulgee and Oconee basins added up to an additional third of the total. All of these basins serve areas of the state that are densely populated and have seen rapid population growth in recent years.

Groundwater withdrawals occur predominantly, but not exclusively, in the southern portion of the state. The majority of groundwater withdrawals — 55 percent in 2005 — are from the Floridan aquifer system, primarily the Upper Floridan aquifer.

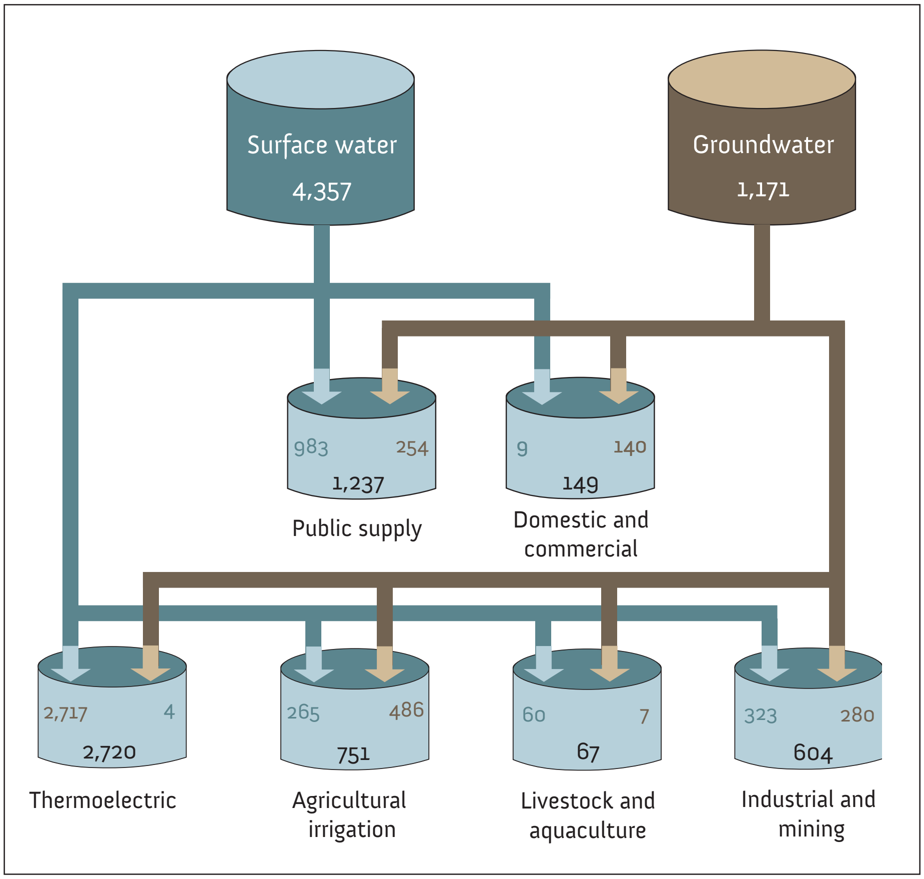


Figure 3.2 Amount of surface and groundwater used by major sectors in Georgia, 2005 (million gallons per day). Due to rounding, numbers in each category may not add up exactly. (U.S. Geological Survey)

Trends in water use

The U.S. Geological Survey has tracked trends in water use every five years between 1980 and 2005 (Figure 3.3). Thermoelectric withdrawals were highest in 1980 and were relatively constant through 2000. In 2005, withdrawals for thermoelectric power production dropped, primarily due to retrofits at several plants that decreased water use.

Industrial water use declined between 1980 and 2005, with decreases in recent years largely due to more efficient use of water at industrial facilities and a shifting mix of industrial water users.

Agricultural water use declined during the 1980s but increased in the 1990s. Most agricultural water is used for irrigation, which is influenced by rainfall. Irrigation in 2000, a drought year, was 52 percent higher than it was in 1995, a wet year. Increased amounts of water used for irrigation also reflects an increase in the number of acres irrigated, which was 38 percent higher in 2005 than in 1985.

Withdrawals for public water supply steadily increased from 1980 to 2000, with the quantity withdrawn in 2005 roughly equal to that in 2000. By 2005, withdrawals were 62 percent higher than in 1980. As described in the next section, water conservation initiatives appear to be slowing the growth in withdrawals for public supply. But, because increases in population can outweigh the effects of water conservation, the trend of increasing withdrawals may continue as the state's population continues to grow.

Georgia's population and economic growth has raised questions about the long-term capacity of the state's water resources. Assessments of the capacity of individual water sources are currently under development. This information will help create a better understanding of the current and potential impacts of increased withdrawals from the state's water resources.

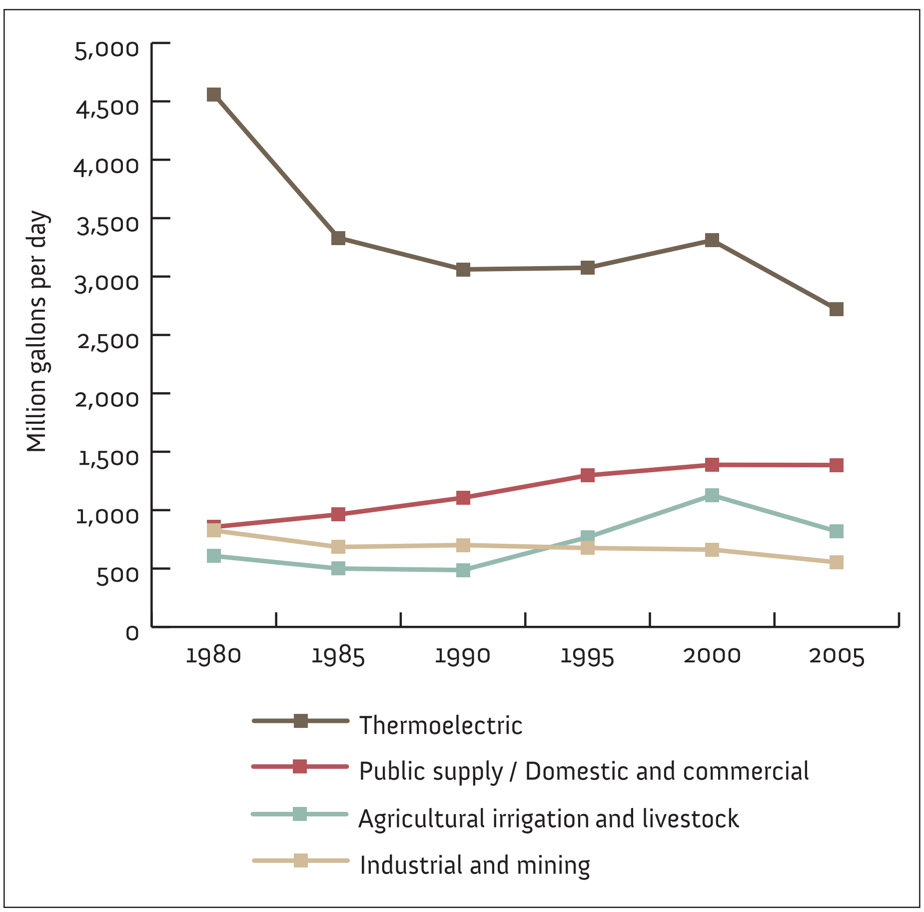


Figure 3.3 *Trends in water use in Georgia, 1980 - 2005. (U.S. Geological Survey)*

Managing competing uses of water

The state's lakes, rivers and streams support a range of uses and provide a variety of benefits to Georgians. Some of these uses occur after water is withdrawn from a water body and transported for use. These are called offstream uses and include water supply for household use, for commercial and industrial purposes, and for agricultural production, among others.

At the same time, Georgia's surface waters provide benefits through uses that occur within the banks of streams, rivers and lakes. These instream uses include dilution and processing of wastewater, navigation, recreation and hydropower production — uses that directly benefit people. Instream uses also include the water needed for fish and wildlife and ecosystem health.

Managing Georgia's waters means taking steps to ensure that water is available, now and in the future, to meet demands for offstream water use while maintaining each water body's capacity to provide instream uses as well.

Per Capita Water Use

Indicator of the sustainability of Georgia's **Water Supply**

Seasonal differences in per capita water use

Residential per capita water use is generally highest during the summer and lowest during the winter. This difference, which is largely due to outdoor water use, can be substantial.

A study of water use in eight representative Georgia communities found that the average per capita water use was 30-67 percent higher in the summer than in the winter. In some communities, residential per capita water use during the summer exceeded 100 gallons per person per day.

Outdoor water use is an area where water conservation practices can be readily implemented to increase the efficiency of residential water use.

Per capita water use is a measure of the efficiency with which households, businesses and industries use water. Greater efficiency in water use can save money for consumers and help meet current and future water demands, while minimizing impacts on the environment.

Per capita use can be calculated a number of different ways. In Georgia, municipal and industrial users who use more than 100,000 gallons per day are required to have a water withdrawal permit. Taking the total amount of water withdrawn under these permits and dividing it by the state's population provides an estimate of overall water use per person per day. This indicator captures changes in population and economic activity.

Table 3.2 shows a consistent decline in overall per capita water use from 2003 to 2007. The decline is due to increased efficiency among industrial water users, restrictions on outdoor watering, and implementation of water conservation practices such as installation of low flow plumbing fixtures and other devices.

Overall per capita water use includes water for residential, commercial and industrial purposes. Measuring residential water use alone provides a more accurate assessment of household progress on water conservation and efficiency. As an alternative to overall per capita water use, EPD recently evaluated residential per capita water use as a measure of water conservation.

Although statewide data are not available, information on residential per capita water use has been collected from representative communities across the state. In 2005, residential water use ranged from 60 to 88 gallons per person per day (Table 3.3). Differences among communities may be due to differences in the accounting of water use, the extent of outdoor water use, and the type and age of the housing stock.

Table 3.2 *Overall water use per person per day (municipal/industrial permits excluding thermoelectric withdrawals). Because methods of calculation differ, these numbers cannot be compared with those for other states. (EPD)*

Fiscal year	Total withdrawals under municipal and industrial permits (gallons per capita per day)
2003	198
2004	192
2005	187
2006	187
2007	185

Table 3.3 *Residential water use in representative public water systems, 2005. (Per capita use is calculated by dividing the gallons per residential account per day by the 2000 U.S. Census household size for the water system; commercial and industrial accounts excluded) (EPD)*

Water system	Daily residential water use per household (gallons)	Daily residential water use per person (gallons)
Douglas	200	78
LaGrange	170	68
Leary	170	65
Macon	220	88
Pickens County	152	60
Reidsville	160	68
Toccoa	145	63
Savannah	211	85

Emerging Issue

Responding to Exceptional Drought

Georgia is currently in a drought of historic severity. By December 2007, more than 99 percent of the state was at some level of drought, with 50 percent of the state experiencing exceptional conditions that are expected to occur only once every 100 years.

Drought conditions led to unprecedented responses from state and local officials and from Georgia citizens. A Level 4 drought, the most severe drought defined by the Georgia Drought Management Plan, was declared in the fall of 2007. This declaration affected much of the northern half of the state and included a mandatory ban on outdoor water use (with limited exceptions).

Reductions in water use in Level 4 drought areas (% change compared to the previous year). (EPD)

	Water use reductions
Nov. 2007	15%
Dec. 2007	13%
Jan. 2008	11%
Feb. 2008	13%
Mar. 2008	14%
Apr. 2008	31%
May 2008	29%
Jun. 2008	20%
Jul. 2008	13%
Aug. 2008	24%
Sep. 2008	18%

From November 2007 through March 2008, water providers in the affected areas also were charged with decreasing water use each month by 10 percent compared to the same period for the preceding year. Because there is not as much water use during cooler months, this extra measure was needed to reduce water use. Local governments and utilities worked to help customers understand water conservation practices as the best way to battle drought and to enforce the ban on outdoor water use. As a result, the reduction target was exceeded each month (see table).

The 10 percent reduction requirement expired March 31, 2008 and was not extended. Outdoor water use restrictions, however, continued. Because outdoor water use is a large portion of water use in spring and summer months, restrictions helped achieve reductions much higher than 10 percent.

These reductions reflect outstanding water conservation efforts by Georgia citizens along with savings due to outdoor watering restrictions. They demonstrate that water providers, businesses and citizens can and will respond when threats to water supplies become critical. And, some of the water conservation practices, like installing low flow plumbing fixtures and other devices, will contribute to long-term water efficiency.

Saving water through energy conservation

Water conservation is just one way to contribute to the sustainability of Georgia's water supply — energy conservation contributes as well. Energy use and water use are closely connected, and reducing the use of one often reduces the use of the other.

In Georgia, 60 percent of the state's electricity comes from coal-fired generation. According to the Sandia National Laboratory, coal generation requires 25 gallons of water for each kilowatt-hour of generation. The Sandia researchers conclude that consumers may use as much water indirectly, in electricity use, as they use directly, by taking showers and watering lawns.

Georgia released its State Energy Strategy in December 2006. The Strategy's policy objectives include minimizing the impacts of energy production on water supply and water quality. Research conducted to support development of the Strategy found that increasing energy efficiency in Georgia would save a substantial amount of water.

Using cost-effective, energy efficiency measures in Georgia could save 159 million gallons per day by 2015 — almost as much as the 2005 daily water use in all of Fulton County, as estimated by the U.S. Geological Survey.

To read the Georgia Energy Strategy go to http://www.gefa.org/Index.aspx?page=93#a4.

Groundwater Levels

Indicator of the sustainability of Georgia's **Water Supply**

The amount of water sustainably available from individual water sources is finite, and, for sources of groundwater, water withdrawals can contribute to declining groundwater levels.

In some aquifers, when the water level goes down, the amount of water available for our use is reduced. Groundwater levels provide an additional indicator of the sustainability of Georgia's water supply.

Twenty-one percent of the water used in Georgia in 2005 came from groundwater. Figure 3.4 shows the primary aquifers that supply groundwater in Georgia.

Persistent declines in groundwater levels have been observed in three of Georgia's principal aquifers: the Clayton and portions of the Cretaceous and the Upper Floridan. Water levels in representative wells in each of these aquifers are shown in Figure 3.5 on page 61.

The Cretaceous aquifer is in central Georgia. The water level at a representative well in Washington County has fallen about 30 feet since the mid 1980s (Figure 3.5a). This decline represents more than 6 percent of the height of water in the aquifer before water levels dropped due to groundwater withdrawals in the area.

The Clayton aquifer is found in southwest Georgia. The Clayton is a relatively small aquifer with a small recharge area, which limits the rate at which the aquifer is replenished by rainfall. The water level at a Randolph County well in this aquifer has fallen more than 40 feet since the mid-1960s (Figure 3.5b). This represents about 17 percent of the height of water in the aquifer that would have been available before withdrawals in the area began to affect water levels.

Falling water levels have increased the cost of withdrawing groundwater from the Clayton aquifer. Water levels also have not recovered, indicating that the withdrawals have exceeded the aquifer's ability to replenish itself. EPD has not issued new withdrawal permits for the Clayton aquifer since the mid-

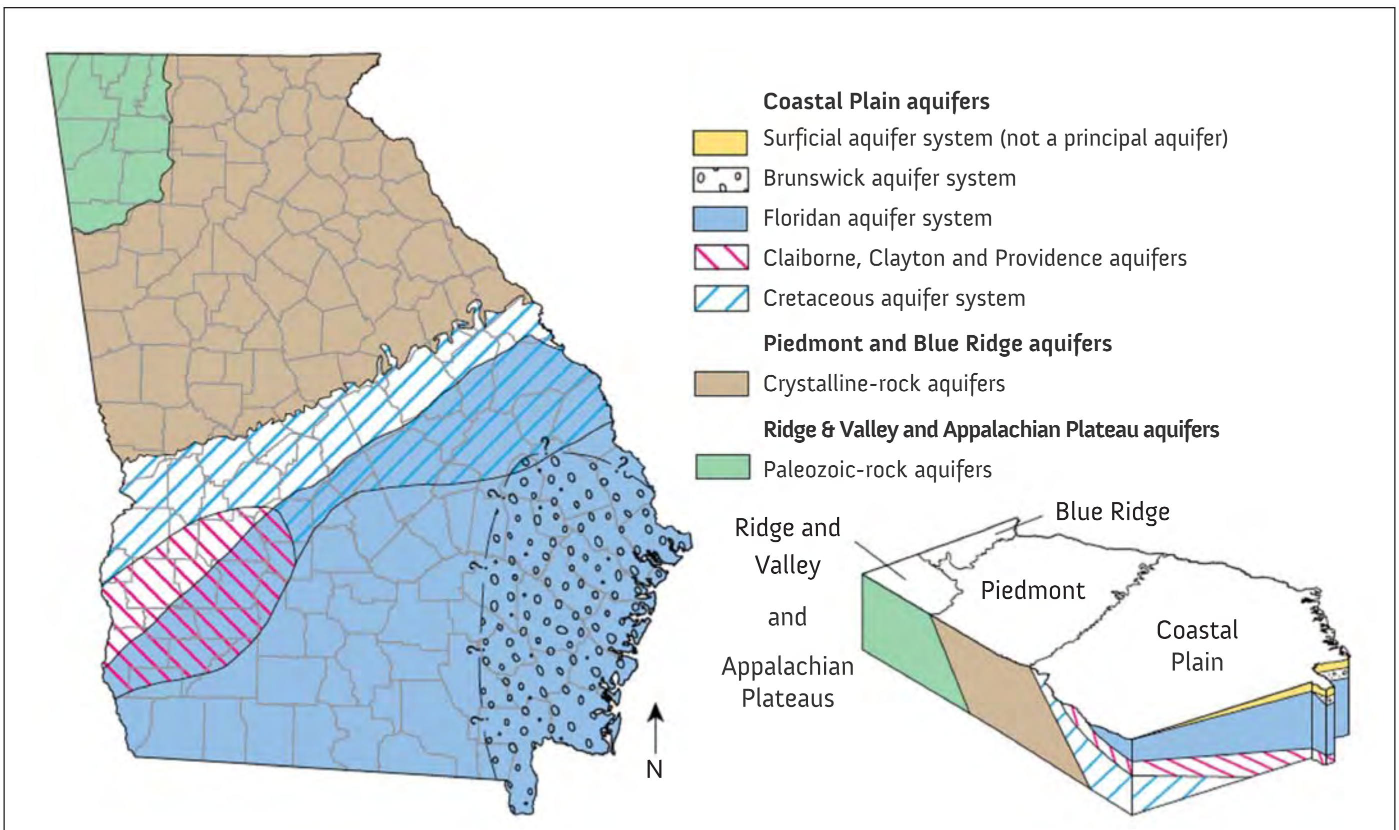


Figure 3.4 *Georgia's principal aquifers. (U.S. Geological Survey)*

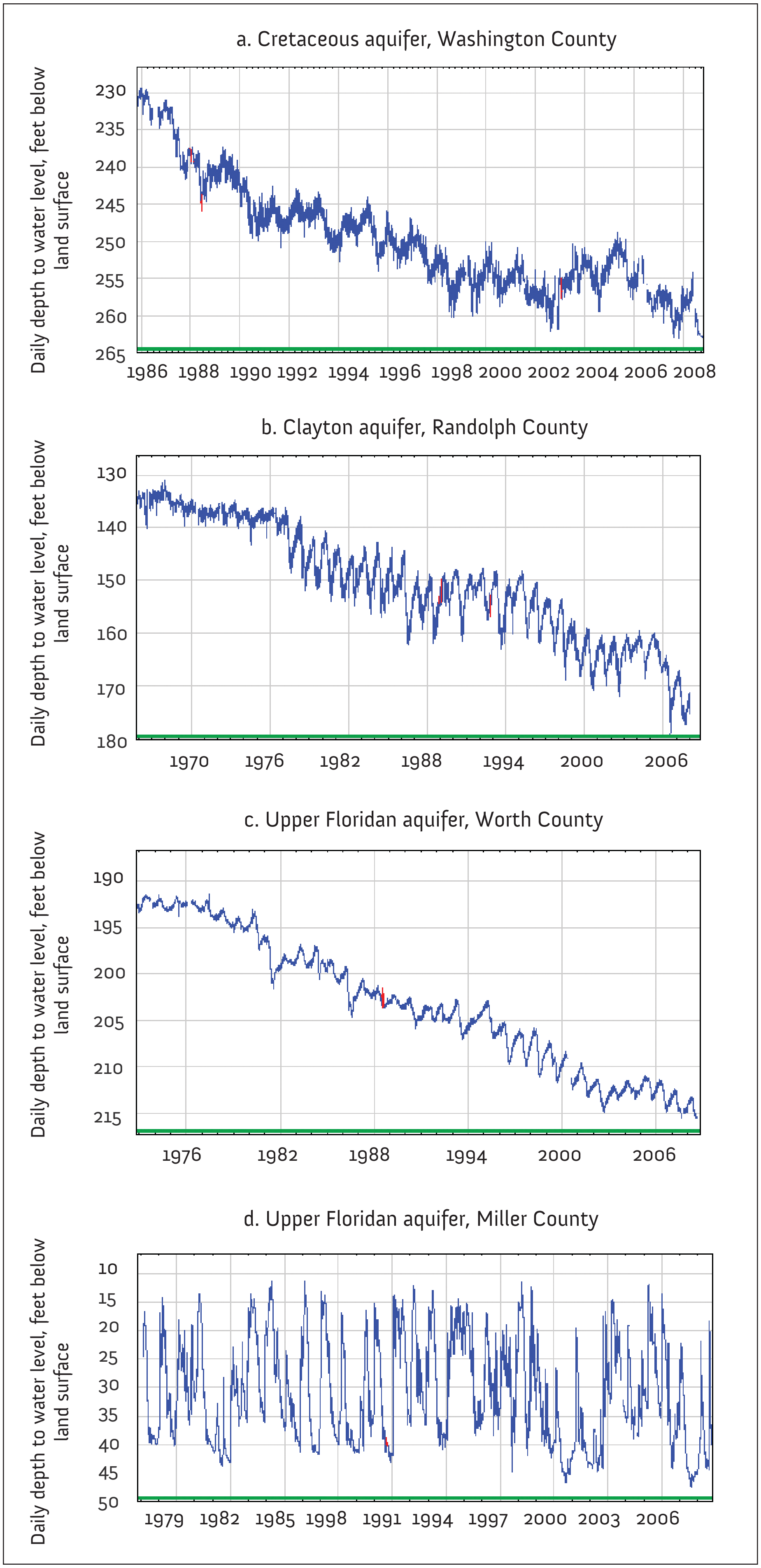


Figure 3.5 *Groundwater levels in selected wells (blue lines indicate measured levels; red indicates estimated water level). (U.S. Geological Survey)*

How is groundwater replenished?

An aquifer is a geologic formation, such as crystalline bedrock, limestone or sand, that can store and release significant quantities of groundwater. The addition of water to an aquifer is called recharge.

Shallow aquifers receive most of their water from rainfall. Rain sinks downward through open pores and fractures in soil or bedrock and slowly moves into deeper parts of an aquifer. Deeper, buried aquifers – also called confined aquifers – are recharged by leakage from adjacent aquifers and by rainfall where the aquifer is at or near the surface. Aquifers that meet the surface also may be recharged by water from streams and rivers.

Groundwater recharge occurs all over Georgia. The most significant areas of recharge are found in northwest Georgia, in areas just below the Fall Line that runs across the central part of the state, in southwest Georgia, and in river valleys throughout the Coastal Plain.

Water in an aquifer is always moving from recharge areas to discharge areas. Depending on aquifer characteristics, groundwater may move rapidly (hundreds of feet per day) or slowly (an inch or less per day). Some of the water in the Upper Floridan aquifer has been underneath Georgia for thousands of years.

Aquifers discharge naturally to springs, lakes, wetlands and streams, which helps maintain stream flow during dry periods. Some also discharge to the Atlantic Ocean and the Gulf of Mexico. Groundwater pumping removes water from an aquifer and is a type of discharge. When discharge exceeds recharge, water levels will decline.

Recovery of groundwater levels in Camden County

In Camden County in southeastern Georgia, groundwater withdrawals from the Upper Floridan aquifer have supplied the Durango Paper Company, the cities of Kingsland and St. Marys, and the Kings Bay Naval Submarine Base. By 2002, Durango was withdrawing groundwater at a rate of about 35 million gallons per day (mgd) with the cities and naval base withdrawing an additional 5 mgd.

These withdrawals caused water levels in the area to decline to about five feet below sea level. When the paper company stopped withdrawing water in late 2002, water levels recovered within weeks to elevations of about 30 feet above sea level.

The quick recovery of water levels indicated that total groundwater withdrawals of 40 mgd did not exceed the sustainable yield of the Upper Floridan aquifer in Camden County.

1990s to protect this resource for those who currently rely on it.

The third aquifer showing persistent declines, the Upper Floridan, is the most significant in terms of water use. The Floridan aquifer system underlies much of south Georgia and is a principal source of water for people, businesses and farms across the region.

Agricultural irrigation is the largest use of groundwater in the southern half of the state. With the introduction of center-pivot irrigation systems in the mid-1970s, the Upper Floridan aquifer became the primary source of irrigation water in southwest Georgia and water level monitoring in this region show impacts to the aquifer.

At some wells in the Upper Floridan, water levels have fallen continuously since the 1970s. For example, water levels at a well in Worth County have dropped about 20 feet (Figure 3.5c). While the cause of the declines cannot be determined definitively, a variety of factors — including an increase in the number of irrigated acres and a shift to crops, like cotton, that require more water — may have contributed. In some areas, increased water use for nonagricultural purposes may also have contributed.

Declining water levels, however, have not been observed in all wells in the Upper Floridan aquifer. For example, at a well in Miller County, the overall trend in water levels has remained the same since the 1970s, although levels have varied seasonally by 25 feet or more (Figure 3.5d). And, in some areas, levels have rebounded after withdrawals decreased (see sidebar).

The wells in Worth and Miller counties highlight how different areas of the aquifer can respond differently based on the rate at which groundwater is replenished and the way in which it is used for irrigation. Much is unknown about why water levels fall or stay the same and it is difficult to predict long-term changes in water levels in response to withdrawals.

Regardless of the cause, water levels in some wells in the Floridan aquifer have dropped steadily and sharply since the 1970s. These declines show that there are impacts from the use of groundwater from the aquifer. If declines in water levels accelerate or become more extensive, future generations may not be able to get as much water from the Floridan aquifer system as is currently used in southwest Georgia and other parts of the state.

Backgrounder

Managing the Use of Stressed Water Sources

In two areas of the state, water withdrawals have not just affected water levels in the water source. They have also led to other impacts. In coastal Georgia, groundwater withdrawals have affected water quality in parts of the Upper Floridan aquifer. In southwest Georgia, groundwater withdrawals contributed to decreases in the amount of water in tributaries of the Flint River. As a result, EPD has restricted use of some water sources in these areas.

Georgia's coastal region, along with adjoining areas in South Carolina and Florida, rely heavily on the Upper Floridan aquifer as a major source of water for municipal and industrial uses. In two areas, pumping of groundwater has contaminated the aquifer with saltwater. This phenomenon, known as saltwater intrusion, occurs when seawater is drawn into the aquifer, contaminating wells. It can also occur when brackish water is drawn into the aquifer from other geologic formations. Saltwater intrusion affects the long-term viability of the Upper Floridan as a water source.

Recent scientific studies have shown Glynn County is vulnerable to saltwater intrusion due to pumping on the Brunswick peninsula. Chatham County and parts of Effingham, Bryan and Liberty counties overlay a cone-shaped area of lowered water levels that exceeds 100 square miles and extends into South Carolina. This cone of depression is caused by groundwater pumping in Georgia and South Carolina and contributes to the spread of saltwater in the aquifer under Hilton Head Island. These areas now face limitations on use of the Upper Floridan aquifer and water users must look to other sources to meet increasing demands for water.

Pumping for agricultural irrigation has increased significantly in **southwest Georgia's** lower Flint river basin since the 1970s. The onset of drought in 1998 raised concerns about the impact of irrigation withdrawals on low flows in the Flint River and some of its tributaries.

In response, EPD initiated detailed studies of groundwater-surface water interactions in this basin. In 2006, EPD adopted a plan to manage water withdrawals to protect stream flow. The plan limits water use in specific watersheds within the river basin. In 13 of the small watersheds in the lower part of the basin, irrigation withdrawals from the Upper Floridan aquifer have been capped at current levels. Fourteen small watersheds face restrictions on additional withdrawals from the Upper Floridan. Other sources of water will have to be used to meet additional demands for irrigation and other water uses.

To learn more about the Coastal Georgia Permitting Plan for Managing Saltwater Intrusion, go to: http://www1.gadnr.org/cws

To learn more about the Flint River Basin Plan, go to: http://www1.gadnr.org/frbp/index.html

How do we know if there is enough water to meet our needs?

Understanding how water is used provides only one piece of the puzzle needed to determine if our water resources can meet the needs of the current and future generations. EPD also must assess how much water is available, since there are limits on the amount of water that individual sources can supply.

Growth of the state's economy and population brings increased demand for water and an increased need for water to assimilate or process pollution. Managing Georgia's water resources to meet these needs will require better information on the long-term capacities of the state's waters. Currently, information on this is limited.

The provisions of Georgia's State Water Plan, adopted in 2008, are intended to help address this gap. Over the next two years, EPD will conduct resource assessments to determine the amount of surface water and groundwater available to support current and future water use. Other assessments will determine the capacity of surface waters to process or assimilate pollution.

Pollutants in Surface Waters

Indicator of the capacity of Georgia's waters to **Assimilate Pollution**

Monitoring more miles of streams and rivers

The number of stream and river miles evaluated for water quality has steadily increased since 1992.

Increasing the number of river miles evaluated has allowed EPD to identify a larger number of stream segments where water quality standards are violated. However, the percentage of assessed river miles where one or more standard is violated, and the percentage that meet water quality standards, have remained fairly constant.

Since the late 1990s, between 57 percent and 61 percent of the river miles assessed each year violated one or more standard. Between 39 percent and 43 percent of the river miles assessed each year met all water quality standards.

In addition to supplying the state with water, Georgia's surface waters also perform another critical function – assimilating pollution. Water bodies have a natural ability to process – or assimilate – most pollutants in a way that prevents harm to aquatic life or humans who come in contact with the water. This ability, called assimilative capacity, not only protects human health and sustains healthy ecosystems, it is also critical to the long-term support of a growing economy.

There is a limit, however, to the amount of pollutants a water body can assimilate. When the total amount of pollution from point and nonpoint sources exceeds that limit, the quality of the water is reduced and water quality standards may be violated (see page 11). The extent to which standards are violated is one indicator of a limited capacity to assimilate increases in treated wastewater – a capacity necessary to support continued population and economic growth.

Violations of water quality standards are assessed and reported every two years. Figure 3.6 shows the statewide trend since 1992. The percentage of the total miles of river and streams that have been assessed has steadily increased, reaching 20 percent in 2008. The proportion of assessed miles that meet water quality standards, and the proportion where standards are violated, have remained relatively constant. In 2008, 39 percent of miles assessed fully met the standards.

Water quality in the state's lakes and estuaries is also evaluated on a two-year cycle. In 2008, 400,528 acres of lakes were assessed, equaling 94 percent of the state total. Of the acres assessed, 53 percent fully met water quality standards, a slight decline from the 2006 figure of 59 percent.

Violations of water quality standards indicate that the assimilative capacity of these waters has been reached or exceeded. It is difficult or impossible to issue permits for additional discharge of treated wastewater to these waters, a limitation that can hamper economic development.

In the watersheds of water bodies that have reached their assimilative capacities, demand for additional wastewater treatment will have to be met through other means. For wastewater treatment plants and other point sources, this may mean applying treated wastewater to land, reusing the wastewater, or using a technology that completely removes the pollutant that causes the violation of water quality standards. Or, it may require actions to decrease the amount of nonpoint source pollution that reaches the water body.

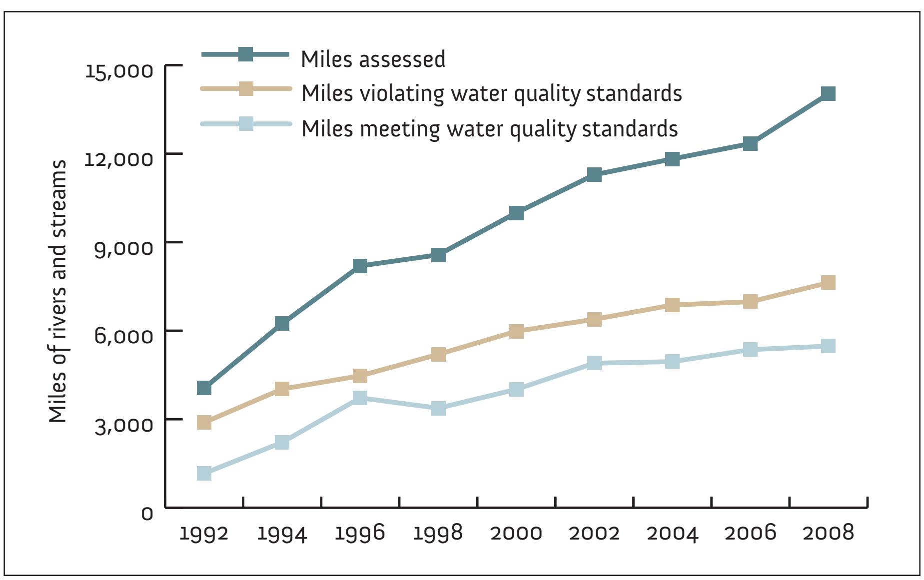


Figure 3.6 *Violations of water quality standards in streams and rivers, 1992 - 2008. Georgia has a total of 70,150 miles of streams and rivers. (EPD)*

Indicators of poor water quality

Tables 3.4 and 3.5 show the major indicators of poor water quality in the state's streams, rivers, harbors, sounds and lakes. Check marks show the indicators of poor water quality that were most common in 2006-2007. Together, the checked pollutants or conditions account for 80 percent of the stream miles or 80 percent of the acres of harbors, sounds and lakes with poor water quality. Factors contributing to poor water quality in the remaining 20 percent of waters include elevated levels of copper and other metals, additional organochlorine compounds, and altered temperature and pH.

Fecal coliform bacteria are a major contaminant in streams and rivers in 13 of the state's 14 major river basins. Poor quality fish and invertebrate communities are major indicators of poor water quality in eight river basins (and the health of fish communities has not yet been evaluated in five river basins).

Mercury in fish tissue is the most common problem in two basins and contributes to violations in several others. Low dissolved oxygen is a major indicator of poor water quality in seven river basins, all in south Georgia.

All violations of water quality standards in harbors and sounds are due to dissolved oxygen. In lakes, the majority are due to organochlorines in fish tissue and high levels of chlorophyll.

Elevated levels of chlorophyll indicate the presence of large amounts of nutrients, which causes growth of algae and aquatic plants. Algae are an important food source for aquatic life, but excessive amounts of nutrients like phosphorus can cause too much plant growth, negatively affecting fishing, recreation and drinking water supplies.

Table 3.4 *Major indicators of poor water quality in Georgia's streams and rivers, 2006-2007. (EPD)*

River basin	Fecal coliform	Poor quality fish and invertebrate communities	Dissolved oxygen	Mercury in fish tissue	Organo-chlorines in fish tissue
Altamaha	✓		✓		
Chattahoochee	✓	✓			
Coosa	✓	✓			✓
Flint	✓	✓	✓		
Ochlockonee	✓		✓	✓	
Ocmulgee	✓	✓			
Oconee	✓	✓			
Ogeechee	✓		✓	✓	
Satilla	✓		✓	✓	
Savannah	✓	✓			
Suwannee	✓		✓	✓	
St. Marys			✓	✓	
Tallapoosa	✓	✓			
Tennessee	✓	✓			

Table 3.5 *Major indictors of poor water quality in Georgia's harbors, sounds and lakes, 2006-2007. Sounds and harbors with poor water quality are found in the Savannah and Satilla river basins. Lakes with poor water quality are found in eight of the state's major river basins. (EPD)*

	Dissolved oxygen	Organochlorines in fish tissue	Chlorophyll
Sounds and harbors	✓		
Lakes		✓	✓

When water quality standards are not met

When water quality standards are violated, EPD must limit the amount of pollutants allowed in the water body. The amount of pollutant allowed is called the total maximum daily load (TMDL), and it is established to ensure that the water body can support its designated uses (see sidebar on page 10 for an explanation of designated uses).

Once the TMDL is established, EPD develops a plan for how the TMDL, and ultimately the water quality standards, will be achieved. Once the water quality standards are met, the state may remove the water body from its list of waters with poor water quality.

The table below shows the amount of water bodies partially or completely removed from this list between 2000 and 2008. Waters that were partially removed now meet at least one water quality standard that was violated in the past. Waters that have been totally removed now meet all water quality standards.

Water bodies removed from the state's list of waters with poor water quality, 2000 - 2008. (EPD)

	Partially removed	Totally removed
River segments (miles)	3,092	1,739
Lakes (acres)	402,374	268,646
Estuarine water bodies (square miles)	281	179

Limits on wastewater discharges

Several areas of the state currently face stringent limitations on additional discharge of treated wastewater, which may constrain growth and development.

High levels of chlorophyll have been measured in Lake Lanier, Lake Allatoona, Carter's Lake and Lake Walter F. George (watersheds shown in green in Figure 3.7). High chlorophyll levels are due to large amounts of phosphorus; any new or increased discharge of treated wastewater would increase the amount of this nutrient.

Until TMDL studies are completed and steps are taken to improve water quality, communities in the watersheds of these lakes will be unable to release additional phosphorus-containing wastewater to the lakes.

Dissolved oxygen levels in the Savannah harbor violate water quality standards. Wastewater released into the lower Savannah River basin (shown in pink on the state's eastern border in Figure 3.7) contains organic matter that requires oxygen to decompose. Because bacteria and other microorganisms consume oxygen during this decomposition, organic matter acts as an oxygen-demanding substance. The consumption of oxygen, in turn, lowers levels of dissolved oxygen in the harbor and new or increased releases of oxygen demanding substances in that part of the basin are prohibited.

The Coosa River at the Georgia-Alabama state line also violates water quality standards for dissolved oxygen. The majority of the Coosa River watershed affects water quality in this segment of the river. As a result, communities in the pink area on the state's western border in Figure 3.7 cannot increase the amount of oxygen-demanding substances going into the streams and rivers that flow into the Coosa.

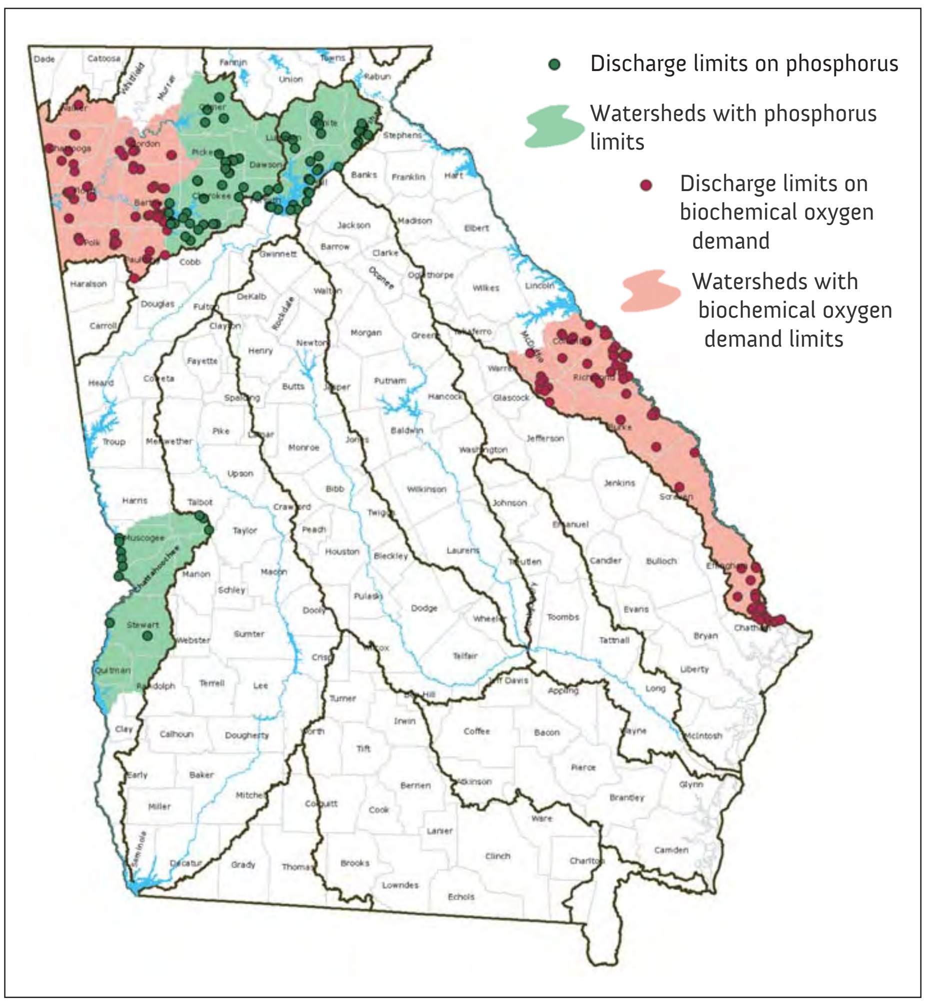


Figure 3.7 *Watersheds with limits on additional wastewater discharges, 2008. (EPD)*

As Georgia's population increases, demands for wastewater disposal also increase. Nonpoint sources of pollution, however, decrease the ability of water bodies to assimilate additional discharges of treated wastewater.

The pollutants that enter Georgia's water come from point sources, including releases of treated wastewater, and from stormwater runoff and other nonpoint sources. Over the past three decades, improvements in wastewater treatment technology have decreased point source impacts on water quality. As pollutants from point sources have decreased, the contribution of nonpoint sources has increased.

National studies indicate that nonpoint sources can add a significant amount of pollution to a water body. The total nonpoint source contribution to Georgia waters has not been fully evaluated, but recent lake studies suggest the likely size of the problem.

The water quality standard for chlorophyll is violated in lakes Lanier and Allatoona due to phosphorus levels that exceed each lake's capacity to assimilate the nutrient. This phosphorus comes from wastewater treatment plants and nonpoint sources, such as stormwater runoff from agricultural fields, lawns and paved surfaces.

Recent studies demonstrate that more than 75 percent of the phosphorus entering each lake is the result of nonpoint source pollution, primarily carried by stormwater runoff (Figure 3.8). This contribution consumes a significant portion of each lake's assimilative capacity and is a major cause of water quality standard violations. These violations limit EPD's ability to permit additional releases of treated wastewater into streams in the lakes' watersheds.

Watershed monitoring across the state also highlights stormwater as a source of pollution. Between 1998 and 2005, measurements at 42 locations show that, on average, phosphorus concentrations are three times higher during rainy weather than concentrations in the same streams under dry conditions.

Decreasing pollution from nonpoint sources would help maintain the capacity of Georgia's waters to assimilate treated wastewater, but it is a significant challenge. The many types of nonpoint sources create a complex mix of pollutants, which varies depending on activities on the land. The specific sources of pollutants can also be difficult to determine.

Without changes in what have been standard practices, continued growth is likely to result in more land disturbance, new impervious surfaces and increased stormwater runoff. These changes may increase the amount of pollution that reaches Georgia's streams, unless concerted actions are taken to reduce nonpoint source pollution — actions necessary to protect water quality and maintain assimilative capacity in order to meet future demands for wastewater disposal.

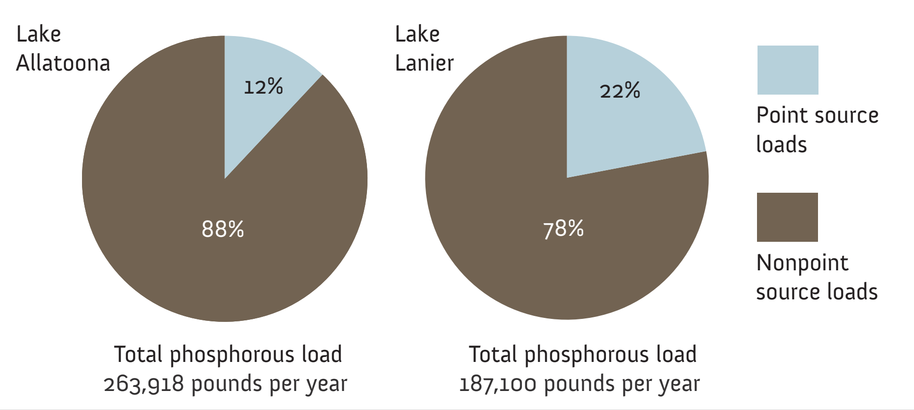


Figure 3.8 *Total phosphorus loads to lakes Allatoona and Lanier (average for 2006 and 2007). (EPD)*

Nonpoint Sources of Pollution

Indicator of the capacity of Georgia's waters to **Assimilate Pollution**

Controlling point source impacts on water quality

Since the early 1970s, local governments and utilities, with financial assistance from the state and federal governments, have made considerable financial investments to decrease the amount of pollution released in treated wastewater.

As a result, the proportion of water quality problems caused by point sources has declined, as has the amount of assimilative capacity used by point sources.

In 1972, wastewater treatment only removed 65 percent of the oxygen-demanding pollutants generated by point sources in Georgia. Within 10 years, the percentage removed had increased to 90 percent and, by 1990, had reached 96 percent (see table below).

Generation and point source discharge of oxygen-demanding pollutants (thousand pounds), 1972 - 1990. (EPD)

	Pollutants generated	Pollutants released
1972	802	283
1982	925	96
1990	1,483	62

Lands Used for Agriculture and Forestry

Indicator of the extent of Georgia's **Working Lands**

What land cover types indicate lands used for forestry and agriculture?

Evergreen forest. Forest composed of at least 75 percent evergreen trees, managed pine plantations and evergreen woodland.

Hardwood forest. Forest composed of at least 75 percent hardwood trees in the canopy and deciduous woodland.

Clear-cut and sparse. Recent clear-cuts, sparse vegetation and vegetation that is common early in the succession from cleared land to forest regrowth.

Mixed forest. Mixed deciduous/coniferous canopies, mixed woodland and natural vegetation in the coastal plain ecoregions, and mixed shrub/scrub vegetation.

Row crops and pastures. Row crops, orchards, vineyards, groves and horticultural businesses. Pasture and non-tilled grasses.

Georgia's economic prosperity, historically as well as today, has relied on the state's land. From the founding of the original colony, Georgians have worked this land to provide food, fiber, wood and other forest products. At the same time, working lands used for forestry and agriculture have provided environmental benefits including habitat for plants and animals and preservation of air and water quality.

The ways in which the state's lands are used changes continuously. Trees are harvested and forests regrow; agricultural lands are put into and taken out of production. Working lands also are converted to different uses.

These changes can be dramatic. As much as 80 percent of the Piedmont, for example, was cleared in the last century. By 2005, 58 percent (6.4 million acres) of the Piedmont had been reforested. Trends in land cover are one source of information on Georgia's changing landscape and the ways its resources are used to support a growing economy.

Trends in five major land cover types — evergreen forest, deciduous forest, clear-cut and sparse land cover, mixed forest, and row crops and pasture — are examined to track the extent of lands used for forestry and agriculture. The first four represent land managed for forest products and the fifth tracks land worked for food and fiber. As in chapter two, we draw on analysis of land cover changes by researchers at the University of Georgia.

It is important to note that this indicator tracks broad changes at the state and ecoregion level in the extent of lands used for agriculture and forestry. It is not assumed that all land in these categories is actively or intensively managed for production.

These categories include lands that are under active management, as well as those that may be used for future production. Whether under active management or not, much of the land in these categories helps to maintain air quality, water quality and natural habitat — all environmental benefits associated with working, vegetated landscapes.

As of 2005, taken together, forest and agricultural land in these five categories covered 76 percent of the state, down from 80 percent in 1974 (Table 3.6). Statewide, the acreage of hardwood forest declined consistently between 1974 and 2005, while the acreage of mixed forest consistently increased (Figure 3.9). The extent of evergreen forest and clear-cut/sparse land cover varied over this period. The acreage of agricultural land generally declined, although an increase was seen in 2005.

Market forces, changes in production technology, incentive programs and financial considerations may all have contributed to changes in the extent of forested and agricultural lands. Some of these factors result in land simply being taken out of production or shifted to a different type of vegetated cover. Others contribute to the conversion of land to more intensive use, including residential and commercial uses.

Table 3.6 *Statewide change in forest and agricultural lands, 1974 - 2005. (Natural Resources Spatial Analysis Laboratory, University of Georgia)*

Landcover classification	% of state land in 1974	% of state land in 2005	Change in number of acres	Percent change
Hardwood forest	20	17	-1,188,341	-16%
Evergreen forest	27	26	-565,323	-6%
Clear-cut/sparse	5	8	+1,096,935	+58%
Mixed forest	2	3	+475,731	+58%
Row crops and pasture	26	22	-1,596,370	-16%

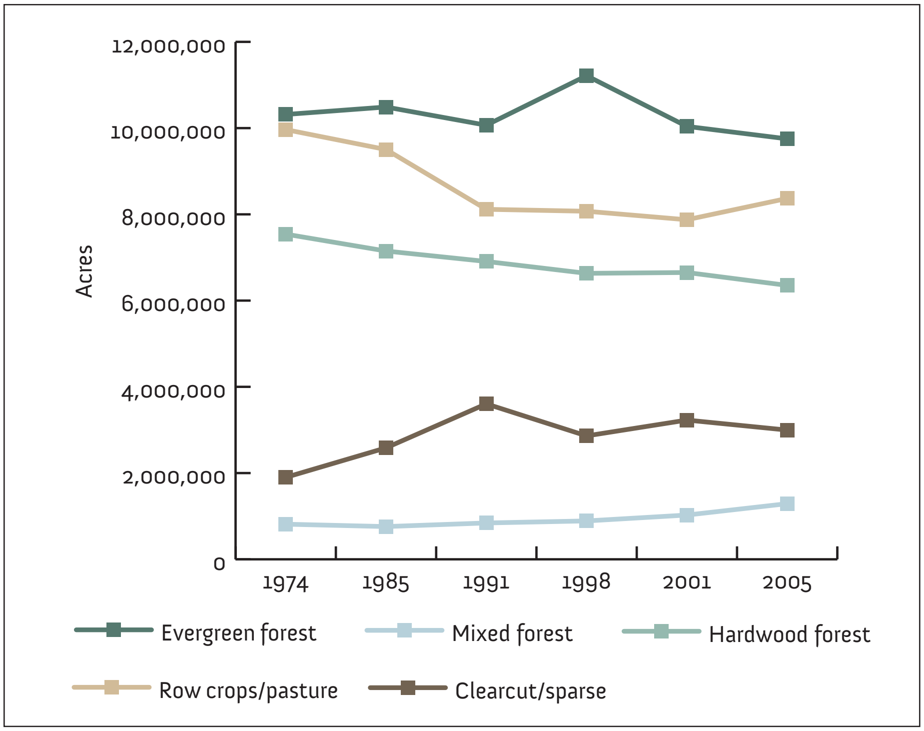


***Figure 3.9** Statewide change in forest and agricultural lands, 1974 - 2005. (Natural Resources Spatial Analysis Laboratory, University of Georgia)*

Forest lands

Taken together, between 1974 and 2005, the extent of forested land cover in the state declined by just 182,000 acres (Table 3.6). The mix of different forest types, however, changed markedly. Hardwood forest cover declined by 16 percent, a loss of nearly 1.2 million acres. The change in acres of hardwood forest was greater than that seen in the other forest land covers. The majority of these losses were in the Piedmont (Figure 3.10).

During this period, the acreage of evergreen forest (primarily managed pine forests) declined after peaking in 1998. Between 1974 and 1998, evergreen forest increased by approximately 439,000 acres. This was followed by a decline of nearly 1.5 million acres and, as a result, the total acreage of evergreen forest declined by 6 percent — approximately 565,000 acres — between 1974 and 2005.

The 1998 peak in evergreen acreage was preceded by a 1991 peak in acreage of clear-cut and sparse lands. In the seven years between the two measurements, trees grew and a portion of the clear-cut/sparse land became evergreen forest.

Between 1974 and 2005, the increase in clear-cut/sparse land was much greater than the other forest-related land covers. Most of this gain was seen in the Piedmont and the Upper Coastal Plain.

During the same period, mixed forest cover increased by more than 475,000 acres statewide. Mixed forest includes evergreen forests mixed with deciduous trees or shrubs, which may occur in previously clear-cut areas. A steady increase in this type of forest resulted in a 58 percent increase in acreage by 2005.

Most of the state's ecoregions lost evergreen forest and gained mixed forest during this time, with the exception of the Lower Coastal Plain. Sixty-six percent of the state's total loss of evergreen forest was in the Piedmont, as was 57 percent of the mixed forest gain.

These changes, however, varied by county. Evergreen forest, for example, increased by more than 25,000 acres in seven counties, while eight counties lost more than 25,000 acres.
The greatest change in evergreen forest cover was in Gwinnett County, where nearly 60,000 acres were lost between 1974 and 2005.

The economic and environmental value of forest and agricultural lands

Agriculture and forestry are among the most important sectors of Georgia's economy. Researchers at the University of Georgia estimate that, in 2006, agricultural commodities produced in Georgia had a total value of $10.4 billion. This includes a value of $663 million for timber, the state's most valuable vegetative crop.

Timber value contributes to the Georgia Forestry Commission's estimate of $16.1 billion in direct economic benefit from the state's forest resources.

UGA researchers also estimate that, in 2006, Georgia's food and fiber industry had a total direct and indirect economic impact of $55.2 billion and provided a total of 366,000 jobs.

The lands that support this employment and economic impact also provide an array of other benefits. Recreational uses range from hunting to hiking, and income from hunting leases and nature- and agricultural-based tourism helps support local economies.

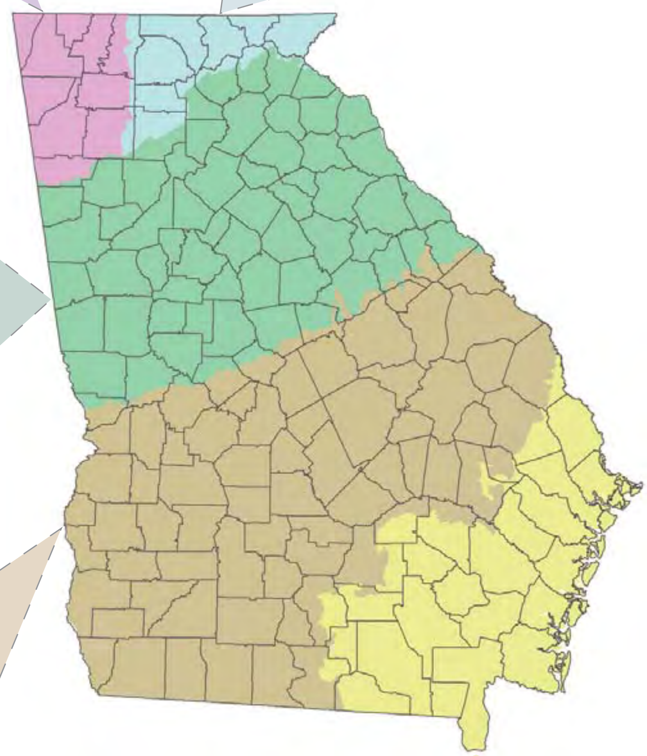
Proper stewardship of vegetated lands also provides environmental services. Vegetated lands maintain air quality by removing or trapping air pollutants and support water quality by absorbing or breaking down pollutants in stormwater.

They also slow the movement of stormwater, controlling runoff, erosion and flooding. Finally, they can provide critical habitat for plants and game and nongame species of animals.

Ridge and Valley & Southwestern Appalachians	Change in acres	Percent change
Hardwood forest	153,810	22%
Evergreen forest	-149,063	-40%
Mixed forest	57,205	302%
Clearcut/sparse	-67,407	-51%
Row crops/pasture	-191,319	-29%

Blue Ridge	Change in acres	Percent change
Hardwood forest	-60,616	-5%
Evergreen forest	-65,789	-20%
Mixed forest	41,808	268%
Clearcut/sparse	27,185	150%
Row crops/pasture	-46,344	-37%

Piedmont	Change in acres	Percent change
Hardwood forest	-1,147,948	-29%
Evergreen forest	-466,811	-14%
Mixed forest	270,884	238%
Clearcut/sparse	390,868	89%
Row crops/pasture	-390,169	-18%



Upper Coastal Plain (Southeastern Plains)	Change in acres	Percent change
Hardwood forest	-106,802	-7%
Evergreen forest	-21,864	-1%
Mixed forest	106,128	18%
Clearcut/sparse	650,924	88%
Row crops/pasture	-971,771	-15%

Lower Coastal Plain (Southern Coastal Plain)	Change in acres	Percent change
Hardwood forest	-26,784	-18%
Evergreen forest	138,204	6%
Mixed forest	-286	-0.5%
Clearcut/sparse	95,364	17%
Row crops/pasture	3,233	0.5%

Figure 3.10 *Change in forest and agricultural lands by ecoregion, 1974 - 2005. (Natural Resources Spatial Analysis Laboratory, University of Georgia)*

Agricultural lands

In 2005, row crops and pasture lands in Georgia covered nearly 8.4 million acres. Of the five land cover types considered here, agricultural lands are more extensive than all except evergreen forests.

While agriculture remains a dominant sector of Georgia's economy, the total amount of land in row crops and pasture has declined substantially since 1974 (Table 3.6). In the 15 years from 1974 to 2001, cropland and pasture land declined by more than 2 million acres. Acres of row crops and pastures increased somewhat by 2005, but the loss between 1974 and 2005 still accounted for 16 percent of the state's farmlands.

Part of this decline can be attributed to the Conservation Reserve Program, a federal initiative to remove highly erodible cropland from production. As of 2007, more than 300,000 acres were enrolled in this program, which represents about 19 percent of the decline in acres of row crops and pasture between 1974 and 2005.

Although the Lower Coastal Plain showed a slight gain in row crop and pasture land, all other ecoregions showed a loss in farmlands between 1974 and 2005 (Figure 3.11). Losses in the Upper Coastal Plain alone approached 1 million acres, and substantial decreases in row crop and pasture acreage were also seen in the Piedmont and Ridge and Valley/Southwestern Appalachians regions (Figure 3.10). Fifty percent of the total statewide decline occurred in 23 counties, with each losing more than 25,000 acres.

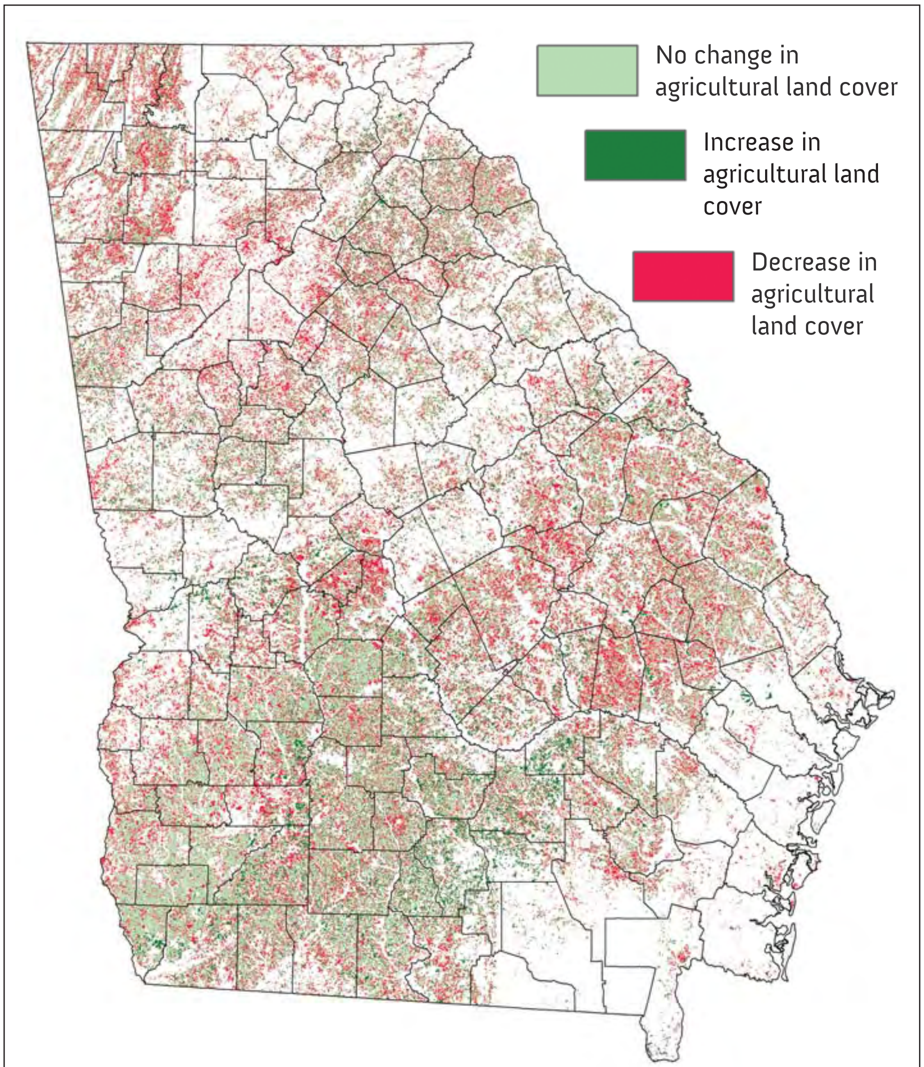


Figure 3.11 *Changes in row crop and pasture lands, 1974 - 2005. (Natural Resources Spatial Analysis Laboratory, University of Georgia)*

Converting land to more intensive uses

Conversion of land to urban land cover can contribute to a decline in forest and agricultural lands and the environmental benefits those lands provide.

Most of the urban land added in Georgia since 1974 has been low-intensity urban cover, such as single-family homes, schools and recreation areas. Increases in this type of land cover are often linked to conversion of agricultural and forested lands.

As described in the previous chapter, between 1974 and 2005, low-intensity land cover in Georgia increased 385 percent, an addition of more than 2.3 million acres. While much of this change occurred near major cities, smaller cities and rural areas also saw substantial increases in this type of land cover.

Of the new acres of low-intensity urban lands, 33 percent were added in the metro Atlanta area. Twenty-six percent were added in Georgia's 14 other metropolitan areas (as defined by the U.S. Census Bureau). The remaining new acres of low-intensity land cover — roughly 40 percent — were added in the 90 counties that lie outside of the state's metropolitan areas.

Brownfield Revitalization

Indicator of the extent of Georgia's **Working Lands**

Reclaiming and reusing brownfields is an alternative to converting forest and agricultural land into developed or urban land. As cities spread, many commercial and industrial properties within them are left abandoned or underutilized because of environmental contamination.

Often, these "brownfield" properties are close to transportation corridors and utilities, and many contain serviceable structures that could house a business or be converted to housing. But until recently, real or perceived environmental liability has caused many potential purchasers to shun these properties in favor of land that has not previously been developed.

Georgia law now encourages the reuse and redevelopment of brownfields throughout the state. Legislation passed in 2002 placed limits on liability for purchasers of brownfields property who voluntarily conduct environmental investigation and cleanup. Tax incentive legislation followed in 2003, creating an opportunity for property tax abatement to offset clean-up costs. Since 2002, 3,241 acres have been enrolled in the brownfield revitalization program (Table 3.7).

Table 3.7 *Acres enrolled and cleaned up under the brownfield revitalization program, 2002 - 2008. (EPD)*

	Acres enrolled	Acres cleaned up
2002	17	7
2003	65	13
2004	157	67
2005	649	178
2006	1,279	339
2007	510	273
2008	564	196
Total	3,241	1,073

The time required to clean up brownfields varies widely, depending on the size of the site, property acquisition and construction schedules and economic factors. By the end of 2008, a total of 281 brownfield properties were enrolled in the program, and cleanup had been completed at 130 of these sites – revitalizing more than 1,000 acres. The cleanup of these properties was completed with private funds, and they are now being put back into productive use (Figure 3.12).

Figure 3.12 *Tivoli Tenside is an apartment complex that opened in Fall 2008 between Atlantic Station and the Westside neighborhood of Atlanta. The before photo (above right) shows how the lot looked before redevelopment. (EPD)*

Land Used for Solid Waste Disposal

Indicator of the extent of Georgia's **Working Lands**

Land is also used for landfills to dispose of solid waste, including municipal solid waste (MSW) and construction and demolition debris (C&D). Currently, EPD has issued permits for landfills on approximately 40,000 acres in Georgia – an area roughly equal to the size of Lake Lanier.

In recent years, the trend has been toward fewer landfills that are much larger and have much greater capacity than those permitted in the past. One result of this trend is that the distance that waste is hauled for disposal has greatly increased.

As of 2007, more than 31 years of capacity remained in municipal solid waste landfills in Georgia (Table 3.8). This estimate is based on the remaining capacity (i.e., the amount of space available to accept waste) in currently permitted landfills and on the current rate of solid waste disposal. This capacity, however, is not evenly distributed across the state (Figure 3.13).

From 2002 to 2007, the years of remaining capacity in C&D landfills in Georgia more than doubled, while the capacity in municipal solid waste landfills remained relatively constant. Since the remaining capacity is based on current disposal rates, it does not account for external factors. For example, permitting new landfills and expanding existing landfills would add capacity, while natural disasters and increased amounts of waste imported from other states would decrease capacity.

Table 3.8 *Years of capacity remaining in Georgia landfills. (EPD)*

	2002	2003	2004	2005	2006	2007
Municipal solid waste (lined and unlined)	27	19	26	29	27	31
Construction and demolition	14	17	26	21	19	29

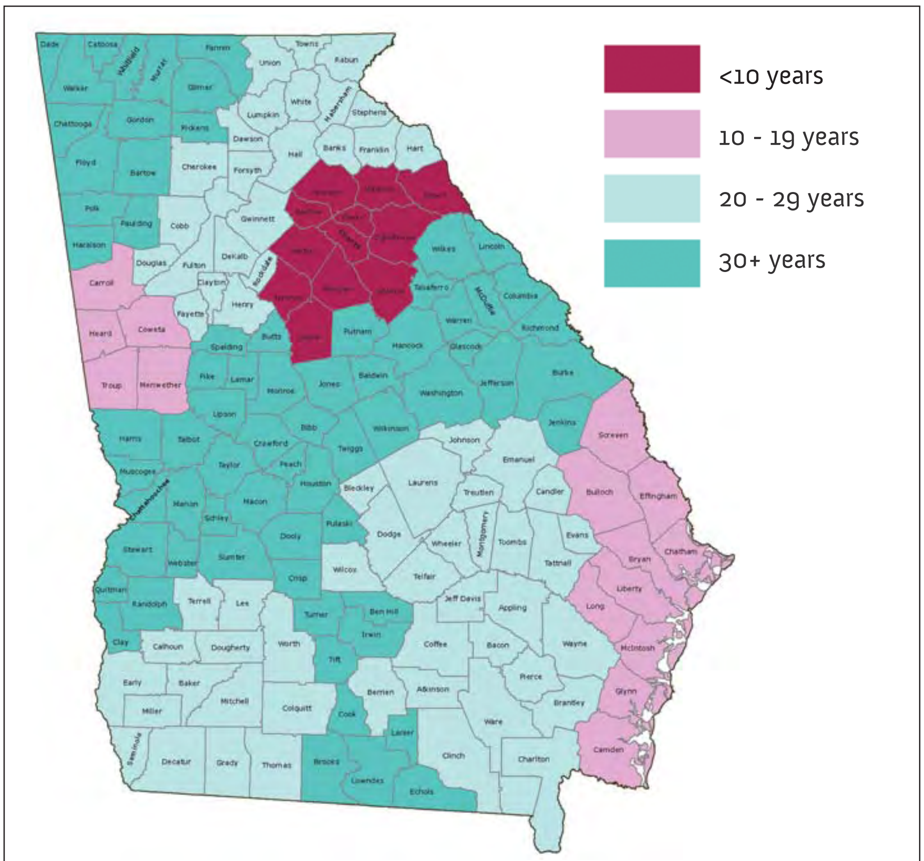


Figure 3.13 *Years of landfill capacity remaining by region, 2007. (EPD)*

Visibility

Indicator of the quality of Georgia's **Air**

Georgia's land provides recreational opportunities and aesthetic value. Unfortunately, these benefits can be impaired by air pollution that decreases visibility.

The list of substances that cause haze and smog includes sulfates, organic matter, elemental carbon (soot), nitrates, dust and water vapor. These substances come from a variety of natural and human-caused sources, including open burning, emissions from internal combustion engines, and emissions from factories and power plants. Aerosols, tiny drops of liquid that form in the atmosphere when certain chemicals react with each other, also contribute to haze.

As a group, the substances that cause haze and smog can impair visibility, harm human health and cause long-term damage to the health of our ecosystems.

In 1948, a visitor to the southern Appalachian mountains in north Georgia could see an average of 93 miles. By 1990, due to air pollution, that distance had dropped to an average of 22 miles.

The images in Figure 3.14 were created using a computer program that simulates air pollution levels. As state and national agencies work toward the federal goal of no human impact on visibility by 2064, this tool will allow scientists to evaluate the effectiveness of different approaches to reducing pollution.

The causes of haze also tend to harm human health. As we make progress in meeting the health-based air quality standards discussed in chapter one, we will also be making strides toward improving visibility.

***Figure 3.14** Visibility levels at Cohutta, GA. These images were created using WinHaze, computer imaging software that simulates air quality differences. (EPD)*

Summary of Accomplishments & Challenges

Over the past few decades, much of Georgia has grown and prospered. This growth and prosperity has relied, in part, on the state's rich natural resources and the quality of its environment.

At the same time, as demonstrated by the indicators discussed in this report, progress toward EPD's environmental management objectives is evident. A number of environmental challenges continue to face the state, however, and new ones have begun to emerge.

As summarized below, this report highlights the progress that has been made toward three objectives:

- Protecting human health
- Sustaining healthy ecosystems
- Ensuring resources to support a growing economy

This report also highlights the environmental challenges that remain as well as areas of opportunity – where actions can be readily taken to move toward better environmental outcomes while supporting the state's economy and quality of life.

Looking toward the future, Georgia's natural resources and the quality of its environment will continue to be critical to the state's growth and prosperity. With more people and a growing economy, use of our resources will continue to increase and demands on our environment intensify. As Georgia grows, further environmental progress will be necessary to sustain the state's economic progress.

Protecting human health

For air and water resources, the past three decades have seen reductions in the release of pollutants and in the levels of pollution in the environment. While these efforts have been undertaken primarily to protect human health, advancement in this area also helps meet the other environmental objectives.

These reductions have been largely due to controlling point sources – discharges of treated wastewater by municipalities and industries and releases of air pollutants from the smokestacks of power plants, factories and other facilities.

The job of controlling air and water pollution to protect human health, however, is obviously not finished. For both air and water, pollutants still exceed health-based standards or thresholds in many areas of the state some of the time.

As efforts to improve the quality of Georgia's air and water resources continue, three important challenges lie ahead:

Increased impact from smaller, diffuse pollution sources. Over the past three decades, investments in controlling pollution from point sources have paid off by decreasing releases from these sources. As pollution from point sources has decreased, the relative contribution of sources that are smaller, more numerous and widespread has increased. Stormwater that carries pollution off the surface of the

For more information, go to the sections on these indicators or topics:

- Bacteria levels in surface water, p. 10
  Dissolved oxygen in surface water, p. 45
  Community water systems meeting drinking water standards, p. 8
  Levels of air pollutants, p. 23
  Emissions of air pollutants, p. 29

- Bacteria levels in surface water, p. 10
  Contaminants in fish tissue, p. 14
  Dissolved oxygen in surface water, p. 45
  Pollutants in surface water, p. 64
  Non-attainment areas, p. 26

- Nonpoint sources of water pollution, p. 16 and 67
  Emissions of air pollutants, p. 29

land and emissions from motor vehicles are now the greatest concern for water and air quality, respectively.

Reducing pollution to meet or exceed health-based standards will require more effective solutions for these smaller sources — solutions that will have to be shaped, in part, by land use and transportation policies. The number and distribution of these nonpoint sources in the future will be partially determined by the transportation choices and land use decisions made today.

Bacteria levels in surface water, p. 10
Dissolved oxygen in surface water, p. 45
Non-attainment areas, p. 26

Changing standards. As scientific knowledge improves, standards may change. These changes may simply reflect a better understanding of pollutants and how to measure them in order to protect human health (e.g., standards for bacteria in surface water). Or, changes may reflect improved information on the impacts of pollutants. Air quality standards have been tightened for this reason, even as air quality has improved.

Tighter standards increase the importance of controlling releases from the smaller sources described above – mobile sources of air pollution and nonpoint sources of water pollution. Tighter standards also make it more difficult to site and issue permits to new point sources of pollutants, including the energy facilities and wastewater treatment plants that may be needed as the state continues to grow.

Contaminants in fish tissue, p. 14
Nonpoint sources of water pollution, p. 16
Risks from air toxics, p. 28

Additional contaminants of concern. Continued progress toward the objective of protecting human health will require better understanding of the risks from air toxics. It will also require better management of contaminants that can travel long distances and affect a different part of the environment (land, air, water) than the one in which they originated.

These challenges have several implications for the protection of human health. First, government regulation alone cannot do the job. Other tools, such as investments in increased knowledge, incentive programs, technical assistance and education will become increasingly important.

Second, individual citizens, businesses and local governments make many of the decisions that affect air and water resources. EPD and other state agencies must strengthen and expand partnerships with public and private sector organizations in order to encourage decisions that have better environmental outcomes. And, air and water resources have to be considered as plans are laid for the state's transportation, land use and energy futures.

Land contaminated above health-based standards, p. 18
Scrap tires, p. 21

For land resources, progress has been made in the clean up of contaminated land. The most notable advances have been in cleaning up sites contaminated by underground storage tanks and scrap tire dumps. Contaminated lands, however, continue to be identified and ongoing investment in assessing and cleaning them up will be necessary to maintain progress toward the objective of protecting human health.

Solid waste disposal, p. 20
Hazardous waste generation, p. 22
Lands used for solid waste disposal, p. 73

Land resources are also affected by waste generation and disposal. Solid waste disposal, in particular, poses a significant challenge for the state. The amount of solid waste disposed in Georgia has risen steadily in recent years. And, the amount disposed per person is consistently higher than the national average. At the same time, Georgia industries that use recovered materials in their manufacturing processes must import them because there is not an adequate supply within the state.

Some of what is treated as waste in Georgia is actually a resource that industries in the state can use. Addressing this challenge will require expanding Georgia's recycling infrastructure and promoting recycling and waste reduction by citizens and businesses.

Sustaining healthy ecosystems

Georgia's landscape has seen dramatic changes over the years. The ways in which land is used, and the ways in which land has been altered as the state has grown, have affected the health of Georgia's ecosystems.

Over the past three decades, the extent of hardwood forests and forested wetlands, native land covers associated with critical natural habitat, declined steadily. The extent of urban land cover — low-intensity urban cover, in particular — jumped dramatically. The rate of increase in urban land cover between 1974 and 2005 was more than four times greater than the rate of increase in the state's population. Between 1991 and 2005, the amount of impervious cover – surfaces that prevent rain from soaking into the ground and cause stormwater to run off more quickly – increased twice as rapidly as the state's population.

Land cover types, p. 36
Impervious surfaces, p. 40

Changing land cover has altered the quality and extent of natural habitat across the state and the condition of the animal and plants species that live in those habitats. The effects are evident in the decline of streamside forests in most of the state's large watersheds, the limited amount of moderate and high quality terrestrial habitat, and an increased number of protected species.

Streamside forests, p. 42
Terrestrial habitat quality, p. 47
Protected species, p. 49

The effects of human activities on the health of Georgia's ecosystems also are apparent in the condition of Georgia's freshwater fish communities. Less than one-quarter of the sites evaluated had fish communities that scored in good or excellent condition; the remainder rated fair, poor or very poor. Freshwater fish communities in poor condition can be attributed, in part, to nonpoint source pollution, including stormwater runoff from impervious surfaces and sediment from land-disturbing activities. Some aquatic habitats along the coast are also degraded due to nonpoint source pollution.

Freshwater fish community status, p. 43
Coastal habitat conditions, p. 46

Alteration of natural habitat associated with low-intensity urban land cover and increased impervious surfaces is one of the major long-term threats to Georgia's rich biological diversity. Lands protected by federal, state or local governments, or by private conservation groups, are less subject to habitat conversion. By providing protected habitat for plants and animals, these lands help maintain healthy ecosystems.

Terrestrial habitat quality, p. 47
Habitat protection, p. 50

Lands with permanently protected natural habitat, however, cover less than 4 percent of the state's area. The vast majority of land in Georgia is subject to conversion and habitat loss, and private landowners hold the vast majority of that land. Voluntary land protection and incentive-based habitat management programs for private lands are becoming increasingly important.

Incentives for habitat protection on private lands, p. 52

As Georgia continues to grow, the challenge is to shift to development strategies that lead to better environmental outcomes – for low-intensity urban areas, in particular. This includes approaches that protect natural habitat, such as designing developments to maintain natural and open areas. It also includes investing in the identification of critical habitats, as well as actions by private landowners and public land managers to preserve viable examples of all natural habitats in an ecoregion.

Impervious surfaces, p. 40

Development strategies with better environmental outcomes also include practices that decrease the movement of sediment from land-disturbing activities as well as those that increase pervious surfaces, which allow rain and stormwater to soak into the ground. Stormwater management has traditionally focused on moving stormwater away from roads, buildings and other areas as quickly as possible, an approach that is becoming increasingly expensive. This approach also has environmental costs, with impacts on water quality, the physical structure of streams and the amount of groundwater available to sustain stream flows during dry periods.

Designing developments so that more stormwater soaks into the ground – supporting groundwater levels and contributing to stream flow during dry periods — can be more cost effective and will improve environmental outcomes.

Ensuring resources to support a growing economy

Georgia's water and land resources have supported the state's development over the years and, as the state continues to grow, these resources will continue to be critically important.

Total water use, p. 55

For water resources, however, capacities are finite and must be managed to support a variety of uses. These include uses that occur after water is withdrawn from a water body (called offstream uses), such as water supply for household use, commercial and industrial purposes and agricultural production. They also include instream uses that occur within the banks of a water body — assimilation of wastewater, recreation and support of fish and wildlife, among others.

While water use for thermoelectric and industrial purposes was lower in 2005 than in 1980, the amount of water used for public supply increased over this time period. Agricultural use also was higher, although the amount of water used for irrigation varies from year to year with rainfall.

Groundwater levels, p. 60

Water withdrawals have affected the viability of some water sources. Groundwater levels in several aquifers (or parts of aquifers) have shown steady declines and the use of some water sources in south Georgia has been restricted.

Pollutants in surface waters, p. 64

The capacity to assimilate pollution also has been reached or exceeded in some waters, as demonstrated by the poor water quality found in roughly 60 percent of the stream miles recently evaluated. The most common indicators of poor water quality are high levels of fecal coliform, communities of aquatic animals in poor conditions, low levels of dissolved oxygen, contaminants in fish tissue, and high levels of nutrients.

Nonpoint sources of water pollution, p. 16 and 67

In many of the streams, rivers and lakes with poor water quality, pollution from nonpoint sources decreases their capacity to assimilate treated wastewater. It is difficult or impossible to increase discharges of treated wastewater to waters that violate water quality standards, a limitation that can hamper economic development.

Looking ahead, Georgia faces the challenge of decreasing the impacts of nonpoint sources of water pollution, a challenge that will have to be met, in part, by changing land use and transportation policies. EPD, in turn, faces the challenge of improving information on Georgia's water supply and the wastewater capacity of individual water sources – a challenge being addressed under the State Water Plan.

Per capita water use, p. 58
Responding to exceptional drought, p. 59

Finally, the state, local governments and water users face the challenge of finding ways to meet the mix of demands for offstream water use that will be placed on each water source, while maintaining the capacity of that source to provide instream use as well. Ultimately, actions to manage water supply and quality, increase the efficiency of water use, and respond to droughts will all be needed.

Lands used for agriculture and forestry, p. 68

For land resources, trends in land cover show the dynamic nature of Georgia's landscape and the changes that can occur over relatively short periods of time, in response to economic factors, new technology, and federal and state policies. More than 75 percent of the state's land area currently has forested or agricultural land cover. The acreage of hardwood forests, however, has declined markedly since 1974. The acreage of evergreen forest and agricultural lands has varied, but both were lower in 2005 than in 1974.

One of the most significant changes taking place today is the conversion of forested and working landscapes to urban landscapes. The Piedmont region has seen the most change in the state, but it is not just the metro Atlanta area being affected. Low-intensity urban land cover has also increased in the state's other major cities, smaller towns and rural areas. This trend reflects decisions made by many individual landowners responding to a complex mix of factors – individual decisions that add up to large changes in the state's landscape.

◄ Land cover types, p. 36
Lands used for agriculture and forestry, p. 68

As with the objective of sustaining healthy ecosystems, the challenge here is to continue the shift to practices that lead to better outcomes for Georgia's water, land and air resources. These include revitalization of brownfields, as well as incentives for maintaining working lands and protecting critical environmental lands. It also includes promoting good stewardship of private lands.

◄ Incentives for habitat protection on private lands, p. 52
Brownfield revitalization, p. 72

Private landowners hold more than 90 percent of the state's forest and agricultural lands. When under good stewardship, these lands provide a wide range of benefits, including wildlife habitat, water quality protection and maintenance of stream flow. Gaining these benefits will require encouraging landowners to manage their lands for environmental benefits as they also manage for economic benefits.

Conclusion

In summary, as Georgia continues to grow, further progress toward all three environmental objectives will require decreasing pollution from mobile and nonpoint sources, continuing the shift to development approaches that have better environmental outcomes, and ongoing improvement in managing the state's environment.

Improving environmental management will require the use of a broader range of tools in addition to regulation: investing in improved knowledge about the state's resources and their use, providing information and incentives to shift behaviors, and ensuring that technical assistance and education inform the individual decisions that help determine environmental outcomes.

Use of a broader range of tools, in turn, will require stronger and more effective partnerships among state agencies, local governments and private sector organizations.

Finally, environmental factors and planning for energy, land use and transportation must be better integrated. Production and use of energy affects air and water resources, and the condition of air and water resources influences choices regarding energy capacity. Transportation decisions shape changes in land and resource use and these decisions affect, and are affected by, the quality of Georgia's air, land and water resources. Trade-offs and impacts across these sectors must be fully considered as plans are laid for the state's energy, transportation and environmental futures.

A number of steps down these roads already have been taken, but more are needed. Long-term solutions will involve everyone. EPD, our partners in the public and private sectors, and all Georgians can, by working together, ensure the environmental progress that will be necessary for Georgia's continued growth and prosperity.

Glossary

Aerosols
Tiny particles and droplets suspended in the atmosphere, including carbon-based (organic) aerosols, that contribute to haze and the formation of particulate matter. Aerosols can come from natural sources, such as vegetation, and human-made sources, such as gasoline evaporation, use of solvents and the combustion of fuels in power plants, vehicles and other sources.

Air Quality Index (AQI)
A national rating system developed by EPA that indicates whether or not the air quality presents a potential threat to human health on any given day.

Air toxics
Toxic air pollutants, or air toxics, is one of two major categories of air pollution as defined by the Clean Air Act and includes compounds such as benzene, acetaldehyde and formaldehyde.

Aquatic ecosystem
Water-based ecosystems that include small streams, large rivers, lakes and estuaries where the state's major rivers meet the sea.

Aquifer
A geologic formation, such as crystalline bedrock, limestone or sand, that can store and release significant quantities of groundwater.

Benthic macroinvertebrates
Small insects and insect-like animals that live in or near the bottom of streams, rivers and other aquatic ecosystems. They are an important food source for fish and an essential link in the aquatic food chain. They are also used as an indicator of the health of these water bodies.

Best management practices (BMPs)
Commonsense, economical and effective methods to minimize nonpoint source water pollution. BMPs are designed to prevent or reduce the movement of sediment, nutrients, pesticides and other pollutants from the land to surface or groundwater, protecting water quality from adverse effects of various human activities.

Biochemical oxygen demand (BOD)
The amount of oxygen required by microbes to break down organic matter in the water. Wastewater from sewage treatment plants contains organic materials that are decomposed by microorganisms, which use oxygen in the process. Other sources of oxygen consuming waste include stormwater runoff from farmland or urban streets, feedlots and failing septic systems.

Biological diversity
Also called biodiversity, it is the variety among living organisms and the habitats and ecosystems in which they live. The number of different types of animal and plant species in a given area is a component of biodiversity, but it also includes variety ranging from genetic differences in a population to variability among ecosystems.

Brownfield
Land that, in a past use, was contaminated with hazardous substances or is suspected of being contaminated; for example, land that was previously occupied by a chemical manufacturer. This land is often, but not always, abandoned.

Chlorophyll
A plant pigment measured to determine the amount of algae in a water body.

Clean Air Act
The primary federal law in the U.S. governing air pollution.

Clean Water Act
The primary federal law in the U.S. governing water pollution.

Community
Natural communities refer to groups of interacting plants and animals.

Community water systems
Public water systems that supply water to the same population (at least 25 people) year-round.

Conservation design
A planning and design approach to residential and commercial development in which buildings are grouped together on part of the site while permanently protecting natural features on the remainder of the site, usually through easements or other mechanisms that ensure protection in perpetuity. Also called conservation subdivision design.

Criteria pollutants
Are defined by the Clean Air Act and have health-based, air quality standards set by EPA. The six criteria pollutants are: carbon monoxide, sulfur dioxide, lead, ozone, nitrogen dioxide and particulate matter.

Designated uses
Part of the water quality standard for a water body (see entry for "water quality standard"). All waters in the state have a specific designated use, such as drinking water, fishing, recreation, wild and scenic or coastal fishing. There are also special designations for trout streams, waters that support shell fishing and outstanding natural resource waters.

Discharge areas
Portions of an aquifer where groundwater flows into another water body (e.g., springs, lakes, wetlands, streams or oceans).

Dissolved oxygen
The amount of oxygen in surface water. Just as humans cannot survive without oxygen, fish and other aquatic life must have an adequate amount of oxygen in the water to live.

Ecoregion
Large areas, covering tens of thousands of square miles, which are geographically and ecologically defined. An ecoregion has a common underlying geology and distinctive landforms, climate, soil types and plant and animal communities.

Ecosystem
Ecosystems encompass all the plants and animals in a given area, the interactions between them and the physical environment in which they live.

Ecosystem services
The benefits people obtain from ecosystems. These include the processes that maintain ecosystem function as well as direct benefits such as production of food and fiber, support of recreational activities, removal of pollution and purification of air and water. Other ecosystem services range from climate regulation and flood control to less tangible spiritual and educational values.

Exceedance
When the amount of a specific air pollutant surpasses the air quality standard for a specific period of time. When there are more exceedances than allowed in a given time period, the area can be declared an air quality non-attainment area.

Exposure pathway
The physical route a pollutant takes to the human body, such as through drinking water or coming in contact with soil.

Fine particulate matter
A type of air pollution composed of particles that are 2.5 microns in diameter and smaller (less than 1/20th the diameter of one strand of human hair). Fine particulates, including smoke, dust, fly ash and liquid droplets, can remain suspended in the air for long periods of time. Particles this small can penetrate deep into the human respiratory system and contribute to respiratory and cardiopulmonary disease. Particulate matter results from all types of burning, including combustion of fuels in motor vehicles, power plants and industrial facilities.

Groundwater
Water beneath the earth's surface. Groundwater can come to the surface in the form of a spring or discharge directly to streams, rivers and other water bodies. Groundwater supplies water to wells and is one of the two major sources of the water used in Georgia.

Habitat
The physical features of an area and the vegetation found there, which determines the suitability of that area for different species.

Habitat fragmentation
The breaking up of a continuous habitat into smaller fragments. Habitat fragmentation is mainly caused by human activities such as conversion of forests into agricultural or developed areas, but can also be caused by natural processes such as fire. Fragmentation decreases habitat quality.

Hazardous Site Inventory (HSI)
A list of sites in the state where there has been a release (or a suspected release) of a hazardous substance above a specific amount.

High quality habitat
The quality of habitat is determined, in part, by the size and shape of intact areas or patches of natural vegetation. High quality patches of habitat are generally larger, provide different types of habitat on the edges and in the center, and are relatively compact. In larger areas with well-defined central cores, species are less likely to suffer from predators, parasites or human encroachment.

Impervious cover
Surfaces through which water cannot penetrate, such as paved streets, roofs and parking lots. These constructed surfaces prevent rain from soaking into the ground and cause stormwater to run off more quickly.

Index of Biotic Integrity (IBI)
A tool used to evaluate the condition of aquatic communities (e.g., fish, macroinvertebrate). It combines several measures to generate ratings of community condition. The fish IBI uses the different types and number of fish species, the physical condition of the fish and their position in the food chain. Ratings can be used to compare regions or changes over time.

Instream uses
All the human and ecological uses of surface waters that occur within the banks of streams, rivers and lakes. These include dilution and processing of wastewater, navigation, recreation and hydropower production, as well as the water needed for fish and wildlife and ecosystem health.

Land conversion
A change in land use from one type to another (e.g., from agricultural or forest land to a residential development).

Land cover
Land cover refers to the mix of vegetation, human structures, bare ground and water at the surface of the earth. Some types of land cover, like forested wetlands, are the vegetation naturally found in an area. Other types, like agriculture, are lands converted or altered for human use.

Land stewardship
The management of land to protect natural habitat and maintain biological diversity.

Leachate
Liquid created as rain or groundwater filters through a landfill, picking up contaminants along the way. If this liquid is not properly managed (i.e., captured and treated), it can seep into and contaminate soil and groundwater.

Low impact development
A planning and design approach to stormwater management that emphasizes the use of natural features and replication of the pre-development movement of water into the soil.

Methylmercury
One of several different chemical forms of mercury. It is a powerful toxin that remains in the environment for a long time and can readily enter the food chain, accumulating in the bodies of fish, animals and humans.

Mobile sources of air pollution
Vehicles that travel on roads, such as gasoline- or diesel-powered motor vehicles (e.g., cars, trucks, buses and motorcycles) as well as off-road vehicles, such as equipment used in construction, farming, and lawn and garden activities and off-road recreational vehicles. Aircraft and trains are also considered mobile sources.

Nitrogen oxides (NOx)
The generic term for a group of gases that contain nitrogen and oxygen in varying amounts. Nitrogen oxides play a key role in the formation of ozone and particulate matter. Nitrogen dioxide is one of the six criteria air pollutants defined by the EPA.

Non-attainment area
Declared when a specific air pollutant surpasses the air quality standard for a specific period of time (known as an exceedance). When there are more exceedances than allowed in a given time period, the area is determined to be non-attainment.

Nonpoint source pollution
Water pollution that comes from diffuse sources. Contaminants include bacteria and nutrients from livestock, pet wastes and faulty septic systems; sediments from improperly managed construction sites, crop and forestlands and eroding stream banks; oil, grease and toxic chemicals from urban runoff and energy production; excess fertilizers, herbicides and insecticides from agricultural lands and residential areas, and mercury from coal-fired power plants and other sources of combustion. As rainfall moves across the land, it picks up and carries these pollutants with it, eventually depositing them into lakes, rivers, wetlands and coastal waters.

Offstream uses
Offstream uses of water occur after water is withdrawn from a water body and transported for use. They include water for thermoelectric cooling, household use, commercial and industrial purposes, and agricultural production.

Organochlorines
Human-made chemicals that include polychlorinated biphenyls (PCBs); DDT and its by-products; and the pesticides dieldren, chlordane and toxaphene. These compounds contribute to Georgia's recommended restrictions on fish consumption.

Oxygen demanding substances
Natural and human-made organic matter that require oxygen for decomposition in streams, rivers, and lakes. Microorganisms such as bacteria consume oxygen in order to decompose these substances. When levels of oxygen-demanding substances are too high, consumption of oxygen for decomposition can rob fish and other aquatic organisms of the oxygen they need to live.

Ozone
A gas that forms when nitrogen oxides and volatile organic compounds react in the presence of sunlight. Ground-level ozone can inflame and damage the lining of the lungs, reduce lung function and aggravate asthma. It is one of the six criteria air pollutants as defined by EPA.

Pervious cover
Surfaces through which water can penetrate into the soil, such as grass, gravel, and specialized porous paving materials. These surfaces allow rain to soak into the ground, decreasing stormwater runoff.

Point source pollution
Water pollution that comes from a single source or point — e.g., wastewater flowing a pipe, an industrial facility or a wastewater treatment plant.

Protected species
Animals and plants designated by the Georgia Department of Natural Resources and the U.S. Fish and Wildlife Service as endangered, threatened, rare or unusual.

Public water system
Serves at least 25 people for at least 60 days a year, as defined by EPA.

Recharge areas
Locations where water is added to an aquifer. Shallow aquifers receive most of their water from rainfall. Deeper aquifers are recharged by leakage from adjacent aquifers and by rainfall where the aquifer is at or near the surface. Aquifers that meet the surface also may be recharged by water from streams and rivers. Groundwater recharge occurs all over Georgia.

Riparian
Lands that lie directly along rivers, streams and other bodies of water. Also known as streamside lands.

River basin
The area of land drained by a river and its tributaries. It includes the land surfaces drained by the many streams and creeks that flow downhill into one another and eventually into one river. Georgia has 14 major river basins.

Saltwater intrusion
The migration of salty or brackish water into freshwater aquifers. Saltwater intrusion may occur naturally, but it can also be caused or exacerbated by groundwater pumping.

Sediments
Loose particles of sand, clay, silt and other substances that lie at the bottom of a water body or are transported by flowing water. They come from the weathering of rock, erosion of soil, and decomposition of plants, animals, and other organic matter. Sediments can be deposited by wind, water or ice.

Stationary sources of air pollution
Air pollution from factories, power plants, refineries, incinerators, dry cleaners, service stations and residential backyard burning, among others.

Sulfur dioxide (SO2)
A gas formed when fuel containing sulfur, such as coal and oil, is burned. It is one of the six criteria air pollutants defined by the EPA and is a key component in the formation of particulate matter in the atmosphere.

Surface waters
Include rivers, lakes, streams, ponds and reservoirs. Surface water is one of the two major sources of the water used in Georgia.

Sustainable environment
Where natural resources are protected and managed to meet the needs of the current and future generations.

Terrestrial ecosystems
Land-based ecosystems that, in Georgia, range from the live-oak seaside forests of the coast to the rock outcrops of north Georgia.

Tipping fee
The cost charged to dispose of solid waste at a landfill.

Total maximum daily load (TMDL)
The total amount of a specific pollutant (or the upper limit) a water body can receive and still meet its designated uses (see entry for “designated use”).

Water quality standards
Define the goals for a water body by designating its uses (see entry for “designated use”) and setting criteria to protect those uses. Water quality criteria are designed to protect each water body’s designated use. Some criteria are narrative — text descriptions of required water quality conditions. Others are numeric criteria that define limits on acceptable amounts of specific pollutants.

Watershed
An area of land where all the water drains to the lowest point – usually a stream, lake or river. Rain runs off land in the watershed through a network of gullies, creeks and streams to the point on the stream, river or lake that is defined as the outlet of the watershed.

Wetlands
Areas that are inundated or saturated by water often enough to support vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, and bogs.

Working lands
Lands that have been put to use generally for human benefit. They include lands used for forestry and agriculture as well as for solid waste disposal (landfills) and brownfield development.

Data Sources & References

A note about references: This report lists a number of Web sites as references. These links are current as of the date of publication, however, there is the chance that they may change over time.

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Georgia Environmental Protection Division Land Protection Branch

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Georgia Environmental Protection Division Air Protection Branch

Contributors

Coordinating editor
Gail Cowie

Design and layout
Susan Wood

Map coordination and production
Barbara Stitt-Allen

Editing
Susan Wood
Stephanie Busch

Section authors and reviewers
Chuck Mueller
Gretchen Loeffler-Peltier
Marlin Gottschalk
Randy Manning
Jim Kennedy
Stephanie Busch

GIS analysis and mapping

Environmental Protection Division
Renee Alonso
Amber Alfonso
Scott Bales
Bo Noakes
Tom Shillock
James Stapel
Mindy Crean

Wildlife Resources Division
Thom Litts

Photo credits

James Randklev: cover, 3, 23, 42

Jim Couch: 1

Georgia Department of Economic Development: 2, 4, 5, 6, 7, 9, 11, 12, 14, 17, 30, 31, 38, 39, 48, 54, 62, 66

Mike Kemp: 18, 73

John B. Jensen: 52

Madeleine Kellam: 72

Air Protection Branch: 74

Contributors and reviewers

Environmental Protection Division
Linda MacGregor
Brad Addison
Elizabeth Booth
Clay Burdette
Tim Cash
Becky Champion
Doug Davenport
Ernie Earn
Kevin Farrell
Bill Frechette
Jeff Larson
Rob McDowell
Kathy Methier
Susan Salter
Don Schrieber
Jeremy Smith
Mork Winn
Michelle Vincent
Mark Smith
Verona Barnes
Alex Cleary
Madeleine Kellam
Jan Simmons
Jennifer Kaduck
Winthrop Brown
Kevin Collins
Jeff Cown
Pete Dasher
Christy Kehn-Lewis
Lisa Lewis
Lon Revall
Dick Swanson
Cindy Wolfe
James Capp
Susan Jenkins
Jimmy Johnston
Jim Boylan
Jon Morton
Susan Zimmer-Dauphinee
Nap Caldwell
Kevin Chambers
Alice Miller Keyes

Interns
Ning Ai
Laura Burbage
Keri Goodman
Hyun Jung Park
Byron Rushing

Wildlife Resources Division
Brett Albanese
Jon Ambrose
Chris Canalos
Matt Elliott
Patti Lanford
Kristina Sorensen

Coastal Resources Division
Elizabeth Cheney
Dominic Guadagnoli

Department of Human Resources
Scott Uhlrich
Leslie Freymann

Georgia Environmental Facilities Authority
Julie Harrison

University of Georgia
Elizabeth Kramer

US Geological Service
Julia Fanning

Georgia Department of Natural Resources

Environmental Protection Division

2 Martin Luther King, Jr. Dr.

Suite 1152, East Tower

Atlanta, Georgia 30334

1.888.373.5947

404.657.5947 (in Atlanta)

www.georgiaepd.org

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