The Nature Conservancy
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Alabama Natural Heritage Program[SM]

Middle Coosa River, Upper Coosa River, Eightmile Creek, and Cotaco Creek Watersheds Nonpoint Source Prioritization Project

Volume 4: Eightmile Creek Watershed

A Project Final Report Prepared for

Alabama Department of Environmental Management

By the

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Middle Coosa River, Upper Coosa River, Eightmile Creek, and Cotaco Creek
Nonpoint Source Prioritization Project
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EXECUTIVE SUMMARY

Non-point source (NPS) pollution has been identified as a major reason for remaining U.S. water quality problems. In addition to impairing water quality, NPS pollution is one of the leading national threats to biodiversity, particularly freshwater aquatic species. Alabama has an incredibly rich biodiversity and consistently ranks among the top 5 states in the nation in total biodiversity. However, Alabama also has the dubious distinction of ranking among the top states for extinctions and imperiled species. A large number of the extinct and imperiled species are aquatic species that have been lost or declined due to habitat loss and degradation and water quality degradation.

The scope of this project was to locate sensitive areas and habitats for Threatened & Endangered species and identify potential stresses to these areas in the Eightmile Creek watershed.

The Eightmile Creek (EC) watershed encompasses approximately 110 km^2 (42 mi^2) in the Black Warrior basin in northeast Alabama. The majority of the watershed is within Cullman County, but a small portion of the northern watershed is within Morgan County. Eightmile Creek begins at its headwaters in Morgan County and flows south to its confluence with Broglen River, which drains to Mulberry Fork and ultimately the Black Warrior River.

There were no occurrences of rare plant and animal species and natural features documented in the EC watershed. However, there were 35 species documented in the larger Mulberry Fork watershed which may occur in EC watershed if suitable habitat is present, and 28 species documented in the headwaters of the adjacent Locust Fork watershed which potentially could be present in EC watershed if suitable habitat exists.

Two conservation targets were chosen for the CC watershed: matrix forest communities (oak-hickory-pine forest) and riparian vegetation. The lack of information regarding species in the watershed prevented selecting other conservation targets.

Threats

Most threats can be generalized to what many consider the greatest threat to biodiversity at both the species and ecosystem levels: habitat loss, alteration, or degradation. However, there are many different sources for this stress. Overall, 5 major sources of potential stress were identified in the watershed: agriculture (crop and livestock production practices), development (including roads), forestry, invasive/alien species, and waste disposal (trash and septic systems). These threats are compounded by habitat fragmentation and the isolation and small population sizes of many rare species.

Agriculture

Agricultural practices have long been considered the most widespread and significant source of NPS pollution in the United States, and are known to have major impacts on water quality and wildlife habitat. The negative impacts of agriculture on wildlife are indisputable and often diminish the ability of agricultural ecosystems to sustain viable populations. In addition to the direct habitat loss caused by the initial land use conversion to agriculture, the effects of agriculture include increased habitat fragmentation and isolation and decreased habitat diversity. The high impact of sustained anthropogenic disturbance profoundly alters biotic communities, and may result in long-term modifications that may still be evident long after land use has reverted to a more natural state.

The negative impacts from agriculture can be minimized somewhat through implementation of Best Management Practices (BMP) designed to minimize agricultural contributions to NPS pollution. Increasing the implementation of agricultural BMPs, especially the use of riparian buffers, should be a goal in the watershed.

Development

Urban development is a leading cause of habitat destruction for many species, and was identified as the greatest threat for endangered and threatened plants in a review of recovery plans. Urbanization changes the structure, function, and composition of natural ecosystems, and alters the species composition of an area. To address urbanization's effects on ecosystem health, an integrative and interdisciplinary approach is necessary, and must include terrestrial and aquatic systems and account for ecological processes operating at different spatial and temporal scales and the complexity of interactions among the social, ecological, and physical components of an ecosystem. Many state agencies have BMPs designed to reduce nutrient and sediment loads from urban runoff to abate the impact of urban development on aquatic systems. However, if these BMPs are not properly implemented and maintained, they contribute little to abating the impact of urban runoff.

Major changes in biota can occur with relatively small amounts of urban land use in a watershed. Research consistently shows a strong negative correlation between the imperviousness of a drainage basin and the health of its receiving stream so that percent of impervious surface within a watershed is a viable indicator of watershed health and ecosystem quality. Degradation first begins to become noticeable at 10% impervious surface and becomes so severe as to be almost unavoidable at 25-30%. Imperviousness works well as a surrogate for water quality in planning and land use decisions because it is integrative and measurable. Roads usually account for the majority of a community's impervious coverage and tend to produce the most pollutant-laden runoff, so decreasing road widths is one of the best design-related opportunities for reducing imperviousness. In commercial and industrial areas, reducing imperviousness through design-related reductions can best be achieved by targeting reductions in impervious surface needed for parking through smaller lot sizes and emphasizing the use of infiltration and nonstructural solutions.

Forestry

Many of the impacts from forestry can be minimized through proper implementation of BMPs. Numerous studies have shown properly implemented BMPs limit the negative impacts of forestry practices on water quality and aquatic biota. Properly implementing forestry BMPs during road construction and maintenance is very important because surface erosion rates on roads often equal or exceed erosion rates reported on severely eroding agricultural lands. It is critical that all silvicultural activities be strongly encouraged to properly implement the use of streamside buffers and other BMPs.

Invasive Species

Invasive organisms are one of the greatest threats to the natural species and ecosystems of the U.S., and impact nearly half of the species currently listed as "Threatened" or "Endangered" under the U.S. Federal Endangered Species Act. This threat often works in tandem with habitat destruction because exotic species more readily invade disturbed habitat. These unwelcome plants, insects, and other organisms disrupt the ecology of natural ecosystems, displace native plant and animal species, and degrade our nation's unique and diverse biological resources. Invasive species also reduce an ecosystem's ability to provide basic ecological services on which humans depend, such as flood control and crop pollination. Invasive species of concern in EC include privet (*Ligustrum* spp.), kudzu (*Pueraria montana* var. *lobata*), and wisteria (*Wisteria* spp). Efforts should be made to eradicate existing populations of invasive species and to prevent new populations and species from becoming established in the watershed.

Waste Disposal

Septic systems are the most common on-site domestic waste disposal system in use in the U.S. If properly installed, used, and maintained, septic systems pose no threat to water quality, but if the system is improperly installed or fails, disease-causing pathogens, nitrates, or other pollutants may enter the water table and/or nearby streams. The EC watershed likely contains a number of failing septic systems. The failure of these septic systems needs to be corrected or the systems need to be replaced with an alternate system that prevents contamination of the water table.

Conservation Measures

Information on the occurrence of rare and sensitive species is often incomplete and heavily influenced by where surveys have been conducted in the past and the taxonomic expertise of the searchers. The lack of information on species in the EC watershed likely is a reflection of limited survey effort rather than an absence of species in the watershed. A comprehensive survey is needed throughout the watershed.

An action which is likely to have a great impact on aquatic systems and should be a priority in the watershed is the protection and restoration of riparian vegetation along the waterbodies in the watershed, particularly the lower order streams. Protection should be the goal for the riparian areas in the watershed in the best ecological condition, while riparian areas that are degraded should have restoration as their goal. Land use practices in adjacent uplands must be considered and addressed in riparian area management because upslope management practices can influence the ability of riparian areas to function. Riparian area management should be based on the same principles that characterize watershed management: partnerships, geographic focus, and science-based management. Because many of the options for improving riparian areas across watersheds encompass a wide range of individual and societal values, there is a great need to engage various stakeholders in broad-scale and collaborative restoration efforts.

Establishment and maintenance of well-vegetated buffer strips along streams has become a major focus in the restoration and management of landscapes. However, to be effective, buffers must extend along all streams, including intermittent and ephemeral channels. In addition, buffers must be augmented with enforceable on-site sediment controls and a limited amount of impervious surfaces. An adequate buffer size to protect aquatic resources will depend on the specific function it needs to provide under site-specific conditions. Riparian buffer zones should be used as part of a larger conservation management system that improves management of upland areas to reduce pollutant loads at the source, and should not be relied upon as the sole BMP for water-quality improvement. Instead, they should be viewed as a secondary practice that assists in in-field and upland conservation practices and "polishes" the hillslope runoff from an upland area.

To understand the ecological effects of urbanization, we need to look at entire landscapes (broad scale) as well as affected sites (fine scale). Therefore, planning and management should include broad scale considerations that cover the needs of entire ecosystems, not just the pieces. However, managing ecosystems at a broader scale presents many challenges. Because ecosystems are so complex and in many cases exceed our ability to understand them completely, managers should use "adaptive management," meaning that managed ecosystems should be monitored so that timely action can be taken to correct for faulty management or changing conditions.

In addition to incorporating broad-scale issues, planning should consider the cumulative ecological effects of an activity in a watershed because actions that are harmless in isolation can create serious problems when large numbers of people act in the same way. The current degraded status of many habitats and ecosystems represents the cumulative, long-term effects of numerous persistent, and often incremental impacts from a wide variety of land uses and human alterations. Preservation of our biological resources would receive tremendous help if biologically sensitive spatial planning was incorporated early in the development process.

A vital aspect of measuring success involves assessing the effect of conservation efforts on the biological resource. To abate threats to the EC watershed, ALNHP identified numerous biological goals, within which lie the measures of biological success. Inherent within some of these desired results are monitoring programs that gather more detailed information relevant to progress.

Goals

- Complete a comprehensive biological inventory of the watershed.
- Add biomonitoring to the water quality monitoring efforts in the watersheds.
- Protect and, where possible, restore riparian vegetation.
- Maintain or improve water quality and hydrologic function within the watershed.
- Maintain or restore the natural ecological processes that maintain this ecosystem, including habitat connectivity and disturbance regimes, to the extent possible.
- Increase conservation awareness and promote a land ethic within the watershed through education and outreach.
- Prevent the spread of established exotic invasive species, prevent the establishment of new invasive species, and eradicate existing populations of exotic invasive species where feasible. Include an education effort to halt the use of invasive exotics in landscaping.

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INTRODUCTION

Recent studies of biodiversity patterns in the United States have ranked Alabama fifth among the states in total biodiversity, behind California, Texas, Arizona, and New Mexico, all of which are significantly larger (Stein 2002). This is largely due to the rich diversity of aquatic species in the state as Alabama leads the nation in the number of species of freshwater fish, turtles, mussels, snails, crayfish, and caddisflies. However, Alabama also ranks high in the number of species extinct or at risk of extinction. Hawaii is the only state with a higher number of extinct species than Alabama, and Alabama is ranked fourth in total number of species at risk of extinction behind Hawaii, California, and Nevada (Stein 2002). A large number of the extinct and at risk species are aquatic species that have been lost or declined due to habitat loss and degradation (impoundments, channelization, draining, hydrological alteration, etc.) and water quality degradation (point and NPS pollution). Freshwater aquatic species have the largest percentage of species extinct or at risk of any of the major habitat types.

The nation's surface water quality has improved in many ways since the enactment of the Clean Water Act in 1972, primarily through reductions in industrial and municipal source pollution as much effort has focused on understanding and addressing point source issues. However, water quality problems remain, especially those associated with non-point source (NPS) pollution which enters water diffusely in the runoff or leachate from rain or melting snow and is often a function of land use (Horan and Ribaudo 1999). NPS pollution has been identified as a major reason for remaining U.S. water quality problems (United States Environmental Protection Agency and United States Department of Agriculture 1998). In recent years, more focus and funding have been dedicated to furthering our understanding of NPS pollution and how to abate this ever-increasing problem in our nation's waters, but major problems still remain. The 2000 U. S. Environmental Protection Agency (EPA) Water Quality Inventory (United States Environmental Protection Agency 2002a) reported that 40% of streams, 45% of lakes, and 50% of estuaries assessed did not meet goals to support designated uses such as fishing and swimming. The leading causes of impairment included bacteria, nutrients, metals, and siltation, with the primary sources of impairment being runoff from agricultural lands and urban areas, municipal point sources, and hydrologic modifications (United States Environmental Protection Agency 2002a). The impacts of these pollutants include: loss of fish and wildlife habitat; loss of recreational use of streams, rivers, and lakes; impacts to the drinking water supply; reduction in the aesthetic qualities of the aquatic environment; decreased water storage capacity in streams, lakes, and estuaries; clogging of drainage ditches and irrigation canals; and adverse human health impacts (Tim et al. 1992, Tim and Jolly 1994, United States Environmental Protection Agency 2002a). In addition, NPS pollution is one of the leading national threats to aquatic biota (Richter et al. 1997), and has been identified as the leading factor contributing to the jeopardized status of southeastern native freshwater fishes (Etnier 1997). Nonpoint emissions typically are stochastic due to the impact of weather-related and other environmental processes, and the diffuse and complex nature of NPS pollution makes it difficult to measure and control (Hairston and Stribling 1995, Horan and Ribaudo 1999). NPS pollution has been identified as and remains a threat to water quality in Alabama (Alabama Department of Environmental Management 2002a).

The primary purpose of this project was to identify, remediate, or prevent habitat loss and degradation of various threatened and endangered (T & E) flora and fauna within the Eightmile

Creek watersheds. The scope of this project was to locate, assess, and quantify sensitive areas and habitats for T & E species and identify potential NPS land use stresses related to the watershed. As an overall measure, the biodiversity of the watersheds has been analyzed through identification of sensitive species and community occurrences indicative of the watershed's health.

WATERSHED DESCRIPTION

The Eightmile Creek (EC) watershed encompasses approximately 110 km^2 (42 mi^2) in the Black Warrior River Basin in northern Alabama (Fig. 1). The majority of the watershed is in Cullman County, but a small portion of the northern headwaters is in Morgan County. The headwaters of EC begin in southern Morgan County, and EC flows south to its confluence with Broglen River, which drains to Mulberry Fork and ultimately the Black Warrior River. However, the EC watershed does not encompass the entire length of Eightmile Creek; the southern limit of EC included in the watershed is in the vicinity of Lake Catoma Dam and does not cross US 278. All tributaries within the watershed drain directly to EC. The EC watershed is one of the USGS fourth level hydrological classification cataloging units (11-digit HUC – 03160109040) located within the Mulberry Fork unit (8-digit HUC – 03160109).

The EC watershed is within the Cumberlands and Southern Ridge and Valley ecoregion (using ecoregion boundaries developed by The Nature Conservancy (TNC) (1999) as modified from Bailey (1995)) (Fig. 1). The CSRV ecoregion is considered to be one of the most biologically important ecoregions in the United States, and contains more imperiled species (186) than any other ecoregion in the country (The Nature Conservancy 2003). It is the most significant ecoregion in North America north of Mexico for rare aquatic species, and is also significant in the eastern U.S. for its large tracts of second growth, unfragmented forest. Sandstone, shale, and cherty limestone are abundant. The topography varies from steeply sloped mountain terrain to gently sloped valleys. The Cumberlands and the Southern Ridge and Valley portions of the ecoregion are separated by an extreme physiographic divide. The Cumberlands section is composed of a high plateau and low mountains, which represent the western-most extension of the Southern Appalachian mountain chain. In contrast, the Southern Ridge and Valley (SRV) section is characterized by a series of narrow valleys bounded by high ridges (The Nature Conservancy 2003). However, much of the SRV area also consists of plains and open high hills.

The natural vegetation is primarily a southern Appalachian oak-hickory-pine forest community, with mixed mesophytic forest in riparian areas (Braun 1950, Skeen et al. 1993). The area supports forests of oaks (*Quercus* spp.), hickories (*Carya* spp.) and pines (*Pinus* spp.), with beech (*Fagus grandifolia*), tulip poplar (*Liriodendron tulipifera*), and sugar maple (*Acer saccharum*) prominent in some areas (Braun 1950, Skeen et al. 1993). Herbs such as showy orchis (*Platanthera nivea*), twinleaf (*Jeffersonia diphylla*), bent trillium (*Trillium flexipes*), and purple sedge (*Carex purpurifera*) inhabit the humus-rich slopes beneath the hardwood canopy. Streamside zones range from well or moderately forested to narrowly vegetated or nonvegetated. Many of the smaller streams maintain their natural meanders but some smaller streams and many of the larger flowing water courses have been channelized or impounded.

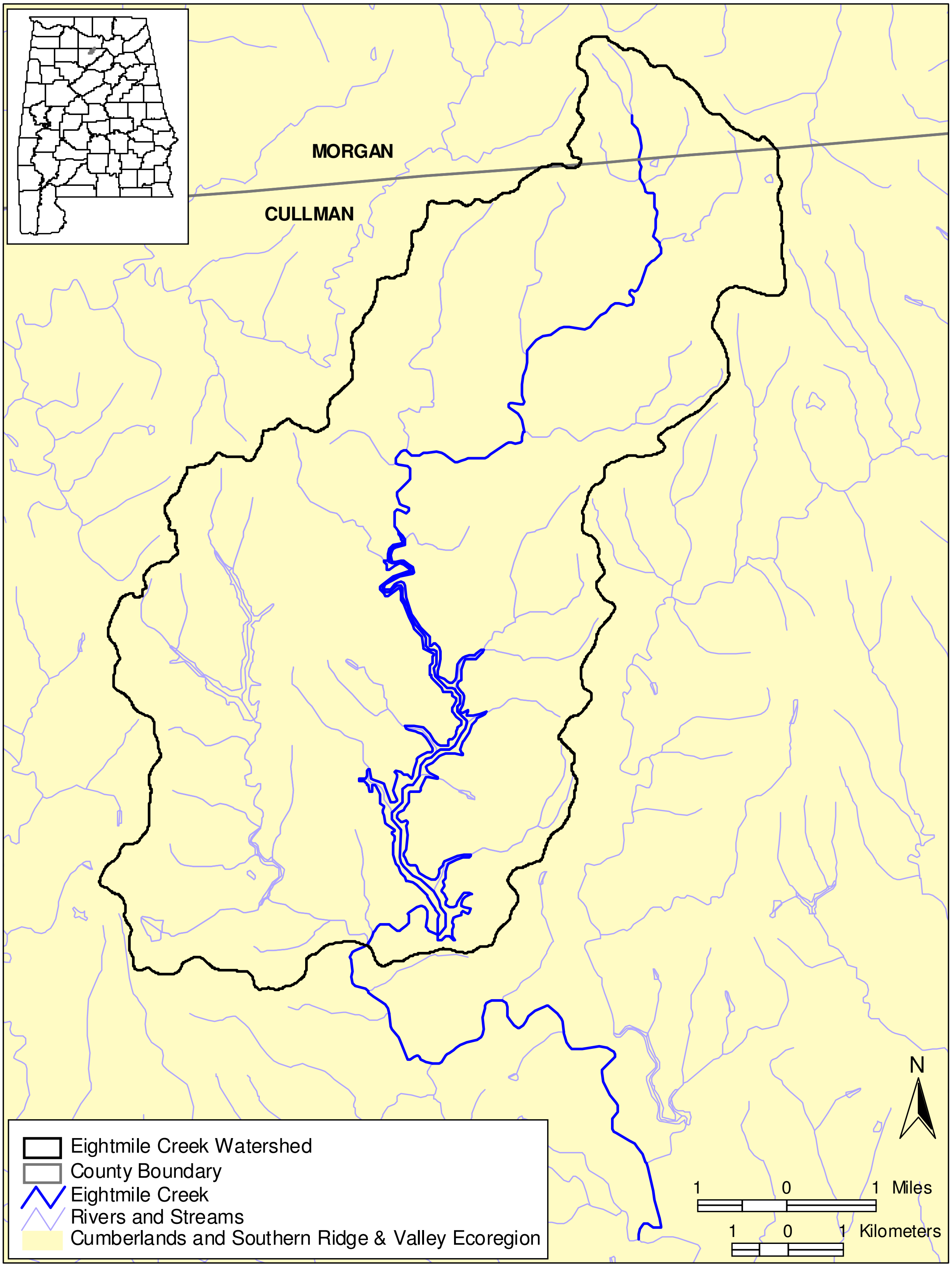

Figure 1. Location of the Eightmile Creek watershed in north Alabama.

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Lake Catoma

The hydrology within the EC watershed has been altered by dam construction, channelization, and other human development. Construction of Lake Catoma Dam along Eightmile Creek was completed in 1966, forming the 217 ha (536 ac) Lake Catoma which inundated approximately 10 km of EC (ca. 45% of the length of EC above the dam). The dam was built by the Utilities Board of the City of Cullman as a raw water impoundment. Lake Catoma is the only drinking water supply for Cullman County and also supplies water for a portion of Morgan and Winston Counties. The City of Cullman owns 2 additional dams in the watershed whose primary purpose is to provide recreational opportunities: Lake George Dam and Eva Road Lake Dam. Both these dams are along Bridge Creek. There are 2 other dams in the watershed: Sportsman Lake Dam along Wolf Creek (owned by Cullman County) and the privately owned Carl Budweg Dam along a tributary of Ryan Creek.

The entire length of Eightmile Creek in the watershed is on Alabama's 2002 303(d) list of impaired waterbodies due to impairment from pathogens from urban runoff and pasture grazing (Alabama Department of Environmental Management 2002b). ADEM rated EC as impaired from pathogens, sedimentation, nutrient enrichment, and OE/DO with suspected sources being waste water treatment plant, urban runoff, animal husbandry, pasture grazing, crop runoff and forestry. The Alabama Department of Environmental Management (ADEM) rated the potential for NPS impairment within the watershed as high (Alabama Department of Environmental Management 2004), and selected EC watershed as one of seven priority subwatersheds within the Mulberry Fork of the Black Warrior River cataloging unit due to biological, chemical, and habitat quality conditions within CC watershed (Alabama Department of Environmental Management 1999). Priority subwatersheds were generally those in the cataloging unit with poor or very poor assessments based on an assessment using land use patterns, observed habitat conditions, chemical water quality measurements, and Soil & Water Conservation District Conservation Assessment Worksheet data to evaluate causes of impairment. Eight sources for potential NPS impairment in the watershed (forestry practices, sedimentation, animal husbandry, pasture runoff, crop runoff, mining, aquaculture, and urban sources) were evaluated (Alabama Department of Environmental Management 2004). Forestry and animal husbandry were rated as having a high NPS impairment potential; pasture runoff, crop runoff, and urban sources were rated moderate, and sedimentation, mining, and aquaculture were rated low. ADEM (2004) identified poultry production and runoff from pasture, crop, and forestry areas as the main NPS concerns in the watershed. Bioassessments conducted in the watershed rated the fish community as poor or very poor and the macroinvertebrate community to be in good condition (Alabama Department of Environmental Management 2004).

METHODS

Rare, Threatened, and Endangered Species

Rare, threatened, and endangered species in the EC watershed were identified using the Alabama Natural Heritage Program[SM]'s Biological Conservation Database (BCD), a natural heritage database documenting rare species and natural communities recorded in Alabama following established Natural Heritage Protocol for processing biological information. The basic unit of this protocol is the element: any exemplary or rare component of the natural environment, such as a species, natural community, bird rookery, or other ecological feature. As defined in the Heritage Operations Manual, an Element Occurrence (EO) is "a locational record representing a single extant habitat which sustains or otherwise contributes to the survival of a population" or natural community, and represents the area in which the element is, or was, present (NatureServe 2002). The Element Occurrence Record (EOR) is the computerized record in the database that contains the biological and locational information regarding a specific EO, as well as an assessment and ranking of the conservation value of that EO against other EOs of its kind. A key component of the Heritage EO Methodology is the assignment of Heritage Ranks to species at the global and state level (Appendix B).

Rare species in the EC watershed were identified by selecting EORs within the watershed boundaries within a geographic information system (GIS). The EOR spatial file was created by exporting all EORs from BCD and converting them to an ArcView (Environmental Research Systems Institute, Redlands, California) shapefile format. EORs within the EC watershed were selected by intersecting the EOR shapefile with a shapefile delineating the watershed boundaries.

Conservation Targets

The identification of focal conservation targets is the basis of the TNC standard methodology for site conservation (called the Five-S Approach - The Nature Conservancy 2000) and is the basis for all subsequent steps of the methodology including identifying threats, developing strategies, and measuring success. The selection of conservation targets has an enormous impact on planning and conservation efforts as they define the ecological processes that need to be protected, managed, and restored as well as defining the ecological boundaries of the conservation effort. In this case, the boundaries for conservation efforts in the EC watershed were defined by the watershed. The methodology calls for identifying conservation targets at the local, intermediate, and coarse scale levels in order to conserve biodiversity at multiple scales within the landscape along with the ecological processes that sustain biodiversity (see Appendix C for a discussion of scale). However, the lack of information on species occurring in the watershed precludes the selection of local scale targets until species occurring in the watershed are identified.

Human Context Information

<u>Managed Areas</u>
In addition to data on rare species, information regarding managed areas within the state is maintained in ALNHP's BCD system. All managed area records were exported from BCD and imported into the GIS for analysis. Managed areas within the EC watershed were identified by

intersecting the managed area point data layer and the managed area database file from EPA's Better Assessment Science Integrating point and Nonpoint Sources (BASINS) 3.0 dataset (United States Environmental Protection Agency 2001a) with the existing EC watershed boundary layer. BASINS is a multipurpose environmental analysis system developed by EPA for use in performing watershed- and water-quality-based studies, and contains both data layers and spatial models and tools. For more information on BASINS, see the website http://www.epa.gov/ost/basins/.

Land Cover
Land cover information was obtained from Alabama Soil and Water Conservation Committee (ASWCC) published estimates of percent land cover for Alabama (Alabama Soil and Water Conservation Committee 1998). Land cover information also was obtained using GIS estimates calculated from the National Land Cover Data (NLCD) (Vogelmann et al. 2001, United States Geological Survey 2002). Derived from the early to mid-1990s Landsat Thematic Mapper satellite data, NLCD is a 21-class land cover classification scheme applied consistently over the United States. The spatial resolution of the data is 30 meters and mapped in the Albers Conic Equal Area projection, North American Datum 1983. NLCD for Alabama was reclassified using seven classes (Table 1) to more closely match the broad land use categories used by the ASWCC; classes that are part of the 21-class NLCD classification not listed did not occur in Alabama. The percentage of the watershed covered by each class was calculated in ArcMap, with the reclassified NLCD classes not included in the ASWCC estimates grouped as "other" in summarizing the data. Road densities were calculated using Topologically Integrated Geographic Encoding and Referencing (TIGER) system line files (United States Census Bureau 2000a) for road representations and HUC code files representing the watershed.

Population & Demographics
Municipalities and urban areas were identified using data from EPA's BASINS dataset (United States Environmental Protection Agency 2001a) and TIGER/Line Files (United States Census Bureau 2000a, Environmental Systems Research Institute 2000). The populated place locations file from the BASINS dataset were used to select all populated place locations within the watershed, and urbanized areas were identified using the urban areas 2000 TIGER file and the urban area file from BASINS. Population and demographic information were obtained using census 2000 data (United States Census Bureau 2000b, 2000c).

Potential Pollution Sources

Permitted Sites
Permitted discharge sites within the watershed were identified from data layers in EPA's BASINS dataset (United States Environmental Protection Agency 2001a). BASINS was used to identify Toxics Release Inventory (TRI) sites; National Pollutant Discharge Elimination System (NPDES) permit compliance system (PCS) sites; Industrial Facilities Discharge (IFD) sites; Resource Conservation and Recovery Information System (RCRIS) hazardous and solid waste sites; Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) or Superfund national priority list sites; and mine locations. Descriptions below are from the metadata for these files (United States Environmental Protection Agency 2001b).

Table 1. Land cover classes used to reclassify USGS National Land Cover Data (NLCD) for analysis.

NLCD class	analysis class
open water	water
low intensity residential	urban
high intensity residential	urban
commercial/industrial/transportation	urban
bare rock/sand/clay	other
quarries/strip mines/gravel pits	mined land
transitional	other
deciduous forest	forest
evergreen forest	forest
mixed forest	forest
shrubland	other
orchards/vineyards/other	other
grasslands/herbaceous	other
pasture/hay	pasture
row crops	row crop
urban/recreational grasses	pasture
woody wetlands	forest
emergent herbaceous wetlands	other

PCS is a national computerized management information system that automates entry, updating, and retrieval of NPDES data and tracks permit issuance, permit limits and monitoring data, and other data pertaining to facilities regulated under NPDES. PCS records water-discharge permit data on more than 75,000 facilities nationwide. The NPDES permit program regulates direct discharges from municipal and industrial wastewater treatment facilities that discharge into the navigable waters of the United States. Wastewater treatment facilities (also called "point sources") are issued NPDES permits regulating their discharge.

IFD Sites are industrial or municipal point sources discharging to surface waters. The facilities were extracted from the U.S. EPA's IFD database to which a number of organizations including federal, state, and interstate agencies contribute.

RCRIS is a national computerized management information system in support of the Resource Conservation and Recovery Act (RCRA). RCRA requires that generators, transporters, treaters, storers, and disposers of hazardous waste provide information concerning their activities to state environmental agencies.

CERCLIS is a national computerized management information system that automates entry, updating, and retrieval of CERCLIS data and tracks site and non-site specific Superfund data in support of the Comprehensive Environmental Response, Compensation, and Liability Act. It contains information on hazardous waste site assessment and remediation.

The TRI database (United States Environmental Protection Agency 1999) contains data on annual estimated releases of over 300 toxic chemicals to air, water, and land by the manufacturing industry. Industrial facilities provide the information, which includes: the location of the facility where chemicals are manufactured, processed, or otherwise used; amounts of chemicals stored on-site; estimated quantities of chemicals released; on-site source reduction and recycling practices; and estimated amounts of chemicals transferred to treatment, recycling, or waste facilities. The TRI data for chemical releases to land are limited to releases within the boundary of a facility. Releases to land include: landfills; land treatment/application farming; and surface impoundments, such as topographic depressions, man-made excavations, or diked areas. Air releases are identified as either point source releases or as non-point (i.e. fugitive) releases, such as those occurring from vents, ducts, pipes, or any confined air stream. Surface water releases include discharges to rivers, lakes, streams, and other bodies of water. In addition, the database covers releases to underground injection wells (where chemicals are injected into the groundwater) and off-site transfers of chemicals to either publicly-owned treatment works (POTWs) or any other disposal, treatment, storage, or recycling facility.

Other Sources

Other potential point and nonpoint sources of pollution were identified using data obtained from the Consortium of Alabama Environmental Groups (2003). They identified and documented potential sources using low-flying aircraft. Photos and their digital database were obtained from the Consortium and used in the GIS analysis.

RESULTS AND DISCUSSION

Rare, Threatened, and Endangered Species

ALNHP had no rare species or natural community occurrences documented occurring in the EC watershed. However, there were 35 species documented in the larger Mulberry Fork watershed which may occur in EC watershed if suitable habitat is present (Table 2). Species present in the headwaters of the adjacent Locust Fork (LF) watershed (03160111) also potentially could be present in EC watershed. There were 28 species not associated with the main stem Locust Fork documented in LF watershed (Table 3). Additional cave species not currently documented in either of these two HUC-8 watersheds likely occur in EC watershed because most of the caves present have not been extensively surveyed. Surveys need to be conducted to determine which species are present in the watershed. Until surveys are conducted, conservation efforts for aquatic habitats should focus on stream reaches which are not inundated by impoundments.

Conservation Targets

Two conservation targets were chosen for the EC watershed: matrix forest communities (oak-hickory-pine forest) and riparian vegetation.

Table 2. Species documented by the Alabama Natural Heritage Program[SM] in the Mulberry Fork watershed (03160109), Alabama, and have the potential to occur in the Eightmile Creek watershed if habitat exists.

Major Taxonomic Group	Scientific Name	Common Name	Global Rank[a]	State Rank[a]	Federal Status[a]	State Status[a]
Amphibians	*Ambystoma tigrinum*	tiger salamander	G5	S3		
Amphibians	*Necturus alabamensis*	black warrior waterdog	G2	S2	C	
Arachnids	*Aphrastochthonius tenax*	a cave obligate pseudoscorpion	G1G2	S1S2		
Fish	*Notropis asperifrons*	burrhead shiner	G4	S4		
Fish	*Polyodon spathula*	paddlefish	G4	S3		SP
Insects	*Hydroptila patriciae*	caddisfly	G1	S1		
Insects	*Pseudanophthalmus profundus*	a cave obligate beetle	G2G3	S2		
Insects	*Pseudanophthalmus steevesi*	a cave obligate beetle	G1G2	SNR		
Insects	*Pseudosinella violenta*	a springtail	G?	S1		
Insects	*Ptomaphagus walteri*	a cave obligate beetle	G1G2	SNR		
Mammals	*Corynorhinus rafinesquii*	Rafinesque's big-eared bat	G3G4	S2		SP
Mussels	*Epioblasma metastriata*	upland combshell	GH	SH	LE	SP
Reptiles	*Macrochelys temminckii*	alligator snapping turtle	G3G4	S3		SP
Reptiles	*Sternotherus depressus*	flattened musk turtle	G2	S2	LT	SP
Vascular Plants	*Cheilanthes alabamensis*	Alabama lip-fern	G4G5	S3		
Vascular Plants	*Fothergilla major*	mountain witch-alder	G3	S2		
Vascular Plants	*Helianthus eggertii*	Eggert's sunflower	G3	S1	LT, PDL[b]	
Vascular Plants	*Huperzia porophila*	rock clubmoss	G4	S1		
Vascular Plants	*Hymenocallis coronaria*	shoals spider-lily	G2Q	S2		
Vascular Plants	*Jamesianthus alabamensis*	jamesianthus	G3	S3		
Vascular Plants	*Marshallia mohrii*	Mohr's Barbara's buttons	G3	S3	LT	
Vascular Plants	*Monotropsis odorata* var *odorata*	sweet pinesap	G3T?	S1		
Vascular Plants	*Neviusia alabamensis*	Alabama snow-wreath	G2	S2		
Vascular Plants	*Orobanche uniflora*	one-flowered broomrape	G5	S2		
Vascular Plants	*Platanthera integrilabia*	white fringeless orchid	G2G3	S2	C	
Vascular Plants	*Platanthera lacera*	green-fringed orchid	G5	S2		
Vascular Plants	*Polygonella americana*	southern jointweed	G5	S1		
Vascular Plants	*Selaginella arenicola* ssp *riddellii*	Riddell's spikemoss	G4T4	S2		
Vascular Plants	*Silphium brachiatum*	Cumberland rosinweed	G2	S2		
Vascular Plants	*Stewartia ovata*	mountain camellia	G4	S2S3		
Vascular Plants	*Symphyotrichum georgianum*	Georgia aster	G2G3	S2S3	C	
Vascular Plants	*Talinum mengesii*	Menge's fame-flower	G3	S2S3		
Vascular Plants	*Thalictrum mirabile*	little mountain meadowrue	G3Q	S2		
Vascular Plants	*Trillium decumbens*	decumbent trillium	G4	S3S4		
Vascular Plants	*Trillium sessile*	toadshade	G4G5	S2		

[a] See Appendix B for an explanation of Global and State Ranks and Federal and State Protection Status.
[b] *Helianthus eggertii*, LT rangewide; proposed for delisting April 5, 2004

Table 3. Species documented by the Alabama Natural Heritage Program[SM] in the Locust Fork watershed (03160111), Alabama, and have the potential to occur in the Eightmile Creek watershed if habitat exists.

Major Taxonomic Group	Scientific Name	Common Name	Global Rank[a]	State Rank[a]	Federal Status[a]	State Status[a]
Amphibians	*Necturus alabamensis*	black warrior waterdog	G2	S2	C	
Amphibians	*Plethodon websteri*	Webster's salamander	G3	S3		
Fish	*Etheostoma chermocki*	vermilion darter	G1	S1	LE	SP
Fish	*Etheostoma douglasi*	Tuskaloosa darter	G2	S2		
Fish	*Etheostoma nuchale*	watercress darter	G1	S1	LE	SP
Fish	*Etheostoma rupestre*	rock darter	G4	S4		
Fish	*Hybopsis winchelli*	clear chub	G5	S3		
Fish	*Notropis asperifrons*	burrhead shiner	G4	S4		
Insects	*Agapetus tomus*	caddisfly	G?	S1S2		
Insects	*Hydroptila grandiosa*	caddisfly	G?	S1		
Insects	*Oxyethira dualis*	caddisfly	G?	S1		
Mammals	*Myotis sodalis*	Indiana bat	G2	S2	LE	SP
Natural Communities	*Nyssa biflora / Itea virginica - Cephalanthus occidentalis* depression forest	swamp blackgum / Virginia willow - buttonbush depression forest	G3G4	S1		
Reptiles	*Eumeces anthracinus*	coal skink	G5	S3		
Reptiles	*Sternotherus depressus*	flattened musk turtle	G2	S2	LT	SP
Vascular Plants	*Berberis canadensis*	American barberry	G3	SH		
Vascular Plants	*Carex decomposita*	cypress-knee sedge	G3	S1		
Vascular Plants	*Cladrastis kentukea*	yellowwood	G4	S3		
Vascular Plants	*Delphinium alabamicum*	Alabama larkspur	G2	S2		
Vascular Plants	*Equisetum arvense*	field horsetail	G5	S2		
Vascular Plants	*Euonymus atropurpureus*	wahoo	G5	S3		
Vascular Plants	*Fothergilla major*	mountain witch-alder	G3	S2		
Vascular Plants	*Hymenocallis coronaria*	shoals spider-lily	G2Q	S2		
Vascular Plants	*Neviusia alabamensis*	Alabama snow-wreath	G2	S2		
Vascular Plants	*Rudbeckia auriculata*	eared coneflower	G1	S1		
Vascular Plants	*Sarracenia oreophila*	green pitcher plant	G2	S2	LE	
Vascular Plants	*Symphyotrichum georgianum*	Georgia aster	G2G3	S2S3	C	
Vascular Plants	*Trillium decumbens*	decumbent trillium	G4	S3S4		

[a] See Appendix B for an explanation of Global and State Ranks and Federal and State Protection Status.

Oak-Hickory-Pine Matrix Forest Communities

This target encompasses blocks of the natural communities which make up the natural vegetative cover of the watershed. The natural vegetation is primarily an oak-hickory-pine forest community, with mixed mesophytic forest in riparian areas. The current oak-hickory-pine forests represent the most common and widespread forest type in the Southeast (Skeen et al. 1993). The canopy generally consists of oaks, pignut hickory (*Carya ovata*), mockernut hickory (*C. tomentosa*), and pines. The oaks are primarily post oak (*Quercus stellata*), southern red oak (*Q. falcata*), blackjack oak (*Q. ameilandica*) and white oak (*Q. alba*). The pines are generally shortleaf pine (*Pinus echinata*) and loblolly pine (*P. taeda*) and occasionally longleaf pine (Harper 1943, Braun 1950, Skeen et al. 1993). Species common in the understory include sourwood (*Oxydendron arboreum*), persimmon (*Diospyros virginiana*), redbud (*Cercis canadensis*), sassafras (*Sassafras albidum*), dogwood (*Cornus* spp.), smilax (*Smilax* spp.), grapes (*Vitis* spp.), blackberries (*Rubus* spp.), sumacs (*Rhus* spp.), viburnums (*Viburnum* spp.) and Japanese honeysuckle *(Lonicera japonica*) (Harper 1943, Braun 1950, Skeen et al 1993).

Forest communities provide a wide array of ecosystem goods and services, such as providing food, wood, decorative, and medicinal products; providing tourism and recreation opportunities; providing wild genes for domestic plants and animals; maintaining hydrologic cycles; regulating climate; generating and maintaining soils; storing and cycling essential nutrients; absorbing and detoxifying pollutants from water and air; providing pollinators for crops and other important plants; providing wildlife habitat; and providing aesthetics (Macie and Hermansen 2002). Forests also play a critical role in the earth's water cycle, with approximately 80 percent of the Nation's fresh water originating in forests. Forests provide many water-related benefits that are threatened when forests are converted to other uses, including refilling underground aquifers, slowing storm runoff, reducing flooding, sustaining watershed stability and resilience, providing critical fish and wildlife habitat, and carbon sequestration (Macie and Hermansen 2002).

Shifting patterns in land use are causing dramatic changes to the native forests of the southern United States. In an evaluation of loss and degradation of ecosystems, Noss et al. (1995) reported that forest habitats and communities were one of the two general ecosystem types that had suffered the greatest loss in the US from historic abundance; old-growth eastern deciduous forests have declined by >98% since European settlement. The Cumberland Plateau contains some of the largest remaining tracts of privately-owned, contiguous temperate deciduous forest in North America (Wear and Greis 2002). These forest tracts represent important Neotropical migratory songbird habitat; serve as headwaters to some of the most biologically diverse, freshwater stream systems found in the world; and have some of the most diverse communities of woody plants in the eastern United States (Ricketts et al. 1999). However, forests in the Cumberland Plateau are susceptible to increased fragmentation (Wear and Greis 2002), and many of the forested areas in the EC watershed are already fragmented, particularly in the southern portion of the watershed. Retaining the remaining forest blocks in a natural setting faces increasing challenges as population continues to grow. Education will be one of the keys to sustaining forests and other natural land and water in the South, because rapid social, economic, and land use changes point to an urgent need for effective conservation education (Macie and Hermansen 2002).

Large blocks of matrix-forming communities are believed to be of great significance for breeding populations of some Neotropical migratory songbirds, although the extent of the significance has not been well-documented. Numerous forest specialists, such as the wood thrush (*Hylocichla mustelina*), have experienced significant population declines due to continued habitat loss, degradation, and fragmentation as forests are converted to other land uses in both their North American breeding grounds and Central American wintering grounds. Addressing the loss and degradation of migratory bird habitat was identified by the Migratory Bird Program (MBP) as one of its top three priorities; the MBP also recognized the need for habitat conservation and population monitoring (United States Fish and Wildlife Service 2004a). Habitat loss and degradation as forests were converted to other land uses also has negatively impacted many salamander and frog populations in the southeastern United States (Bury et al. 1995).

The large areas of once primarily contiguous forest land in the south are increasingly influenced by humans and surrounded by or intermixed with urban development. Rapid development leads to the fragmentation and loss of forest land in growing areas, as well as continued degradation of environmental resources. In general, forest loss rates are greatest near major urban centers, along major communication corridors, and near recreational areas such as national forests, and are lowest in areas with slow economic development (Boyce and Martin 1993). Demographics, economics and taxation, fire risk, and land use planning and policy are some of the major forces driving the land-use change affecting forest communities (Macie and Hermansen 2002). In addition to direct habitat loss from urbanization and other land use changes, these forest systems face destruction and degradation from other sources such as road construction, poor forestry practices, introduction of exotic species, outbreaks of exotic and natural pests, mining, industrial pollution, and fire suppression.

Riparian Vegetation

Riparian vegetation was chosen as a conservation target because of its importance in providing protection to aquatic communities and the increased biodiversity these communities add to a region. Riparian areas are primarily defined by their position as those lands bordering streams, rivers, and lakes (National Research Council 2002). The riparian vegetation target encompasses the natural communities along the waterbodies of the EC watershed. Riparian vegetation in the watershed is a mixture of mesic species and generally consists of mixed mesophytic forests. This is a diverse forest type with canopy species including red maple (*Acer rubrum*), basswood (*Tilia* spp.), northern red oak (*Quercus rubra*), tulip poplar, white ash (*Fraxinus americana*), black gum *(Nyssa sylvatica*), black walnut (*Juglans nigra*), beech, and willows (*Salix* spp.)

(Braun 1950, Hinkle et al. 1993). Sub-canopy species include the canopy species listed above, magnolia (*Magnolia acuminata*), sourwood, American hornbeam (*Carpinus caroliniana*), service-berry (*Amelanchier arborea*), and various shrub and herbaceous species (Braun 1950).

In proportion to their area within a watershed, riparian areas perform more biologically important functions than do most uplands (Fischer and Fischenich 2000). Riparian areas provide a wide array of ecological functions and values including providing organic litter and coarse woody debris to aquatic systems, providing fish and wildlife habitat and food-web support for a wide range of aquatic and terrestrial organisms, local microclimate modification, promotion of infiltration of overland flow, water retention and recycling, bank and stream channel stabilization, and trapping and redistributing sediments (National Research Council 2002). Riparian areas also can serve as corridors for animal movement connecting isolated populations, potentially lowering the risk of local extinctions. The presence of riparian areas tends to increase the biodiversity of a region because they support high numbers of species, many of which are not found in other communities of the region. This support of high species diversity and ecological processes is due in part to regular disturbance events, climatic and topographic variation, and the availability of water and nutrients (Naiman et al. 1993). Adequate natural riparian vegetation also provides many societal benefits including removal of pollutants and sediment from overland flow and shallow groundwater, maintaining stream flows, water storage and conveyance, enhancing groundwater recharge, stabilizing stream banks and channels, promoting flood control, and reducing wind erosion (National Research Council 2002).

Riparian areas are effective in reducing nonpoint source pollutants entering surface waters and are considered important for surface water quality protection (Gilliam 1994). However, riparian areas that become hydrologically disconnected from their adjacent stream channels (e.g., via levees or channel incision) lose many of their ecological functions (National Research Council 2002). Although riparian areas provide many of the same environmental functions as wetlands, there are vast differences in the protection of these two ecosystem components; wetlands are protected under federal regulations, but riparian areas generally have weak or no protection.

Riparian areas in native vegetation are very important for water quality preservation. Unfortunately, riparian systems are threatened nationwide (Noss et al. 1995) and are continuously threatened by adjacent or upstream human activities. The majority of riparian areas in the US have been converted to other land uses or have been degraded, and riparian areas are some of the most severely altered landscapes in the country (National Research Council 2002). Development or other human activities have resulted in >80% loss of riparian vegetation in

North America and Europe in the last 100 years (Naiman et al. 1993). Agricultural conversion is probably the largest contributor to riparian area decline nationwide (National Research Council 2002). When riparian areas are converted to agricultural uses, infiltration generally decreases and overland flow volumes and peak runoff rates generally increase, resulting in high erosion rates that inundate riparian vegetation with sediment and limit the filtering functions of riparian areas. The higher flows generally result in an increased cross-sectional area of the channel through a widening of the channel or downcutting of the streambed. Finally, the transport of agricultural chemicals from upslope can negatively impact fauna and flora located in the riparian areas and downstream receiving waters.

The hydrologic regime of many riparian areas have been altered through dam construction, interbasin diversion, channelization, irrigation, and other water withdrawals (National Research Council 2002). These alterations are usually accompanied by a serious degradation of the ecological functions of the riparian areas affected. The significant human impact on the structure and functioning of riparian areas includes changes in the hydrology of rivers and riparian areas, alteration of geomorphic structure, and the removal of riparian vegetation (National Research Council 2002). The loss of riparian vegetation affects both the terrestrial and aquatic communities, degrading water quality and diminishing suitable aquatic habitat through increased levels of light, temperature, storm water runoff, sedimentation, pollutant loading, and erosion (Castelle et al. 1994).

In many areas of the EC watershed, human development has resulted in the loss of riparian vegetation, which has been identified as a concern for aquatic communities in the region (Williams et al 1993). Retaining and restoring adequate riparian vegetation is essential to maintaining biodiversity within the watershed, and also will provide many benefits to the landowners and general population of the watershed because riparian vegetation protects the quality of water resources used for agricultural and domestic purposes and provides many ecological functions and economic benefits.

Human Context Information

Managed Areas

The only managed area within EC watershed was a Cullman County Park located in the city of Cullman: Sportsman Lake Park. However, given its location in Cullman and the degree of development in the surrounding area, it is unlikely that many rare species occur in the park.

Land Cover

Land cover within the watershed was predominately a mixture of forest and pasture, interspersed with lesser amounts of rowcrop and to a much lesser extent, water, urban, and other uses (Fig. 2). With the exception of pasture and water, there were large differences in the land cover percentages between the ASWCC estimates and estimates obtained from NLCD calculations (Table 4). Estimates obtained from NLCD were much higher than those estimated by ASWCC for forest and rowcrop, while landcover percentage for urban and other were higher than NLCD estimates. This is likely a reflection of errors within the dataset, differences in dates for the data

Table 4. Area (ha), land cover (%), and road density (m/ha) for Eightmile Creek watershed. Area and land use as estimated by the Alabama Soil and Water Conservation Committee (ASWCC) (1998) were obtained from their website. Area and land cover from the USGS National Land Cover Data (NLCD) and road densities were calculated in ArcView.

	ASWCC	NLCD
Total Area	10,637	10,985
Land Cover		
rowcrop	6.4	13.2
pasture	34.6	29.9
forest	39.8	50.5
urban	9.6	3.6
water	3.6	2.7
other	6.0	<1
road density		27.4

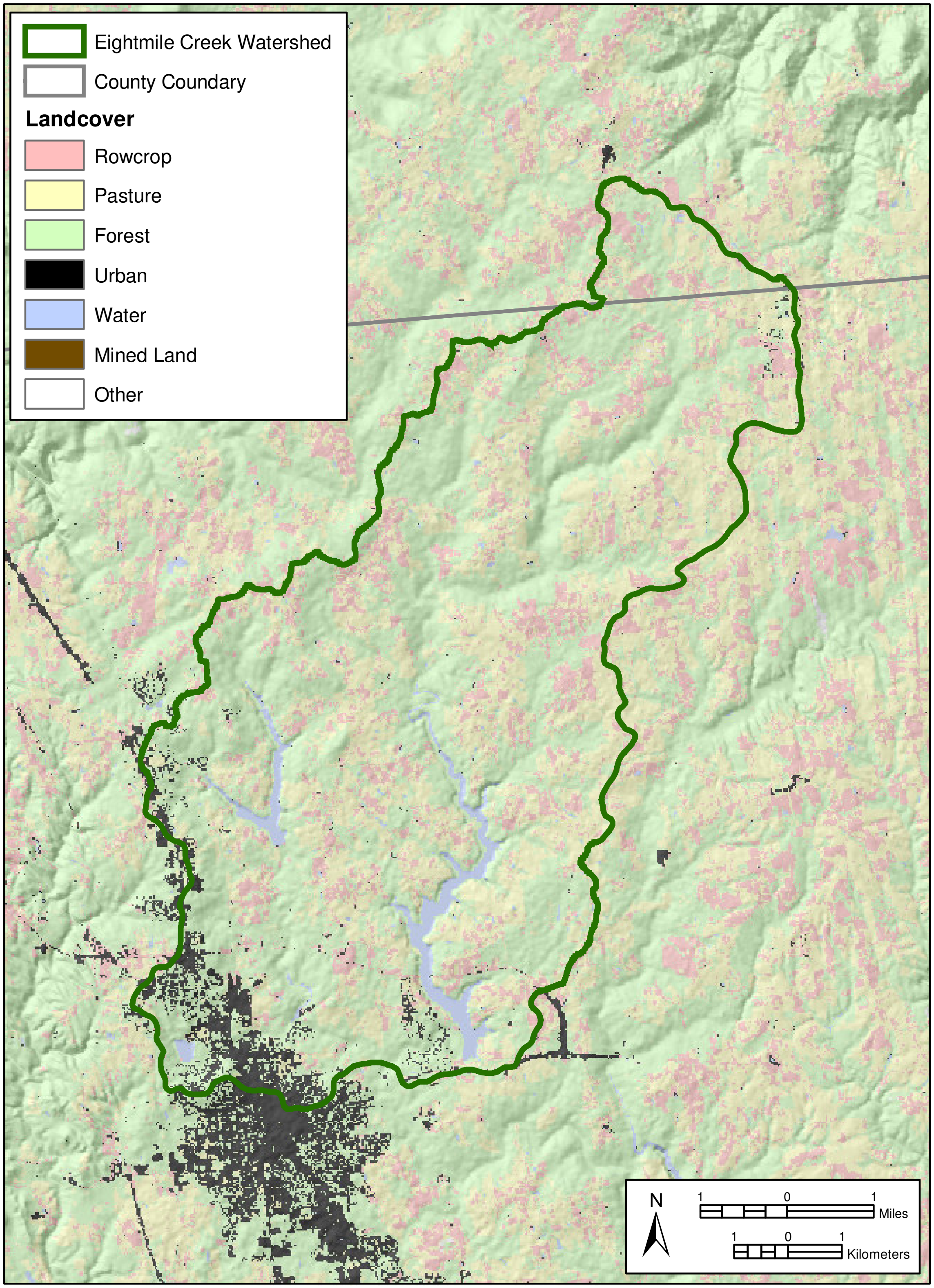

Figure 2. Land cover within the Eightmile Creek watershed as indicated from a reclassification of the USGS National Land Cover Data.

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used, and the difficulty sometimes seen in separating classes in the satellite imagery used to develop the NLCD. The accuracy of the classification is strongly related to the homogeneity of the land use (Zhu et al. 2000). Classification accuracy tends to decrease with increased heterogeneity in the landscape, particularly if the different land use parcels are small. Much of the landscape in the EC watershed exhibits this heterogeneous nature, which can lead to difficulties with the classification. Although the NLCD data is widely used, it is recognized to have errors within the data, with widely varying accuracy for the various classes. Overall accuracy of the classification for Region 4 was estimated to be 62 to 81% depending on the accuracy assessment technique used (United States Geological Survey 2004). In general, water, urban, and forest are well mapped with the NLCD, whereas forested wetlands, hay/pasture, and crops are more confused (Zhu et al. 2000, Yang et al. 2001). However, the images used to classify land cover for the NLCD are somewhat dated (early 1990s) and do not reflect changes that have occurred since the date of image acquisition. The percentage of urban area in the watershed is likely underestimated using NLCD data because it does not reflect the increased urbanization that has occurred in the watershed over the past decade.

Population & Demographics

There were 7 populated place locations in the EC watershed as identified from EPA's BASINS dataset: Dyers Crossroads, Gold Ridge, Mount View, Pleasant View, Providence, Smithdale, and South Vinemont (Figure 3). One urban cluster (Cullman – population 13,995) identified from the Census 2000 TIGER/Line Data (United States Census Bureau 2000a) occurred partially within the boundaries of the EC watershed (Fig. 3). Two populated place locations (Smithdale and South Vinemont) were within the delineated boundary of this urban cluster. An urban cluster consisted of densely settled territory that has at least 2,500 people but fewer than 50,000 people (United States Census Bureau 2001).

Land within the EC watershed is mostly rural, with more urbanized areas mostly in the southwestern portion of the watershed. Although there is no large metropolitan area in the watershed, the presence of Cullman in the southwestern portion of the watershed gives that area a more urbanized look. Urbanization and development pressures are increasing in the watershed and could potentially cause problems for species present in the watershed. Population density is relatively low throughout the watershed, with a generalized pattern of lowest densities in the northern portion of the watershed grading to the highest densities in the southwestern portion of the watershed around Cullman (Fig. 4). The higher population density in the southwestern part of the watershed suggests that rare species are less likely to be present in this area of the watershed.

Total population within the 2000 Census block groups encompassed by the CC watershed was 15,799 (Environmental Systems Research Institute 2000). The population within the watershed is smaller because the area covered by the block groups includes a large area outside the watershed. Both counties in the watershed experienced population growth between 1990 and 2000 greater than the state average (10.1%); population growth was 11.0% for Morgan County and 14.8% for Cullman County (United States Census Bureau 2000b). These trends are expected to continue which will continue to place pressure on biodiversity in the watershed.

Potential Pollution Sources

Permitted Sites

There were 2 active and 2 inactive National Pollutant Discharge Elimination System (NPDES) permitted discharge sites (Fig. 5), 6 hazardous and solid waste (HSW) sites (Fig. 5), 3 toxic release inventory (TRI) sites (Fig. 5), and 4 Industrial Facility Discharge sites (Fig 5) identified in the watershed from BASINS data (Tables 5-8). There were no mines or Superfund sites in the watershed. All of these sites were in the vicinity of Cullman in the southwestern portion of the watershed. Potential sources in the remainder of the watershed are more likely to be related to agricultural or silvicultural practices rather than from industrial practices.

Other Sources

The Consortium of Alabama Environmental Groups (2003) identified 7 potential sources (5 agricultural and 2 commercial) of NPS pollution in the EC watershed (Fig. 5) using low-flying aircraft, and documenting the sites with photographs of each site (Appendix D). The main potential problem identified was nutrient runoff from agricultural areas (Table 9). The majority of the sites identified were in the southern half of the watershed.

THREATS

A threat assessment analysis was not conducted due to the lack of information regarding species occurring in the watershed. Instead, generalized threats to biodiversity in the watershed were identified based on threats to species in the surrounding watersheds, known problems in the watershed, and threats to conservation targets identified in TNC's Cumberlands and Southern Ridge and Valley Ecoregion Conservation Plan (The Nature Conservancy 2003). Under TNC planning methodology (The Nature Conservancy 2000), threat analysis involves identifying both the "stresses" and "sources of stress" that affect conservation targets. Most stresses are caused directly by incompatible human uses of land, water, and natural resources; sometimes, incompatible human uses indirectly cause stress by exacerbating natural phenomena. Most stresses can be generalized to what Noss and Peters (1995) listed as the greatest threat to biodiversity at both the species and ecosystem levels: habitat loss, alteration, or degradation. Across the state, land is being converted to more intensive land uses causing habitat loss and degradation for many species. Populations inevitably decline when vital habitat is lost or substantially altered, and these changes are major contributors to declines in wildlife populations and biodiversity worldwide. However, there are many different sources for this stress. Overall, 5 major sources of potential stress were identified in the watershed: agriculture (crop and livestock production practices), development (including roads), forestry, invasive/alien species, and waste disposal (trash and septic systems).

These threats are compounded by habitat fragmentation and the isolation and small population sizes of many rare species. Habitat fragmentation negatively impacts native biodiversity by reducing habitat total area and patch size, particularly for habitat types such as forest interior; isolating existing populations; and modifying microclimates (Noss and Csuti 1994). The loss of

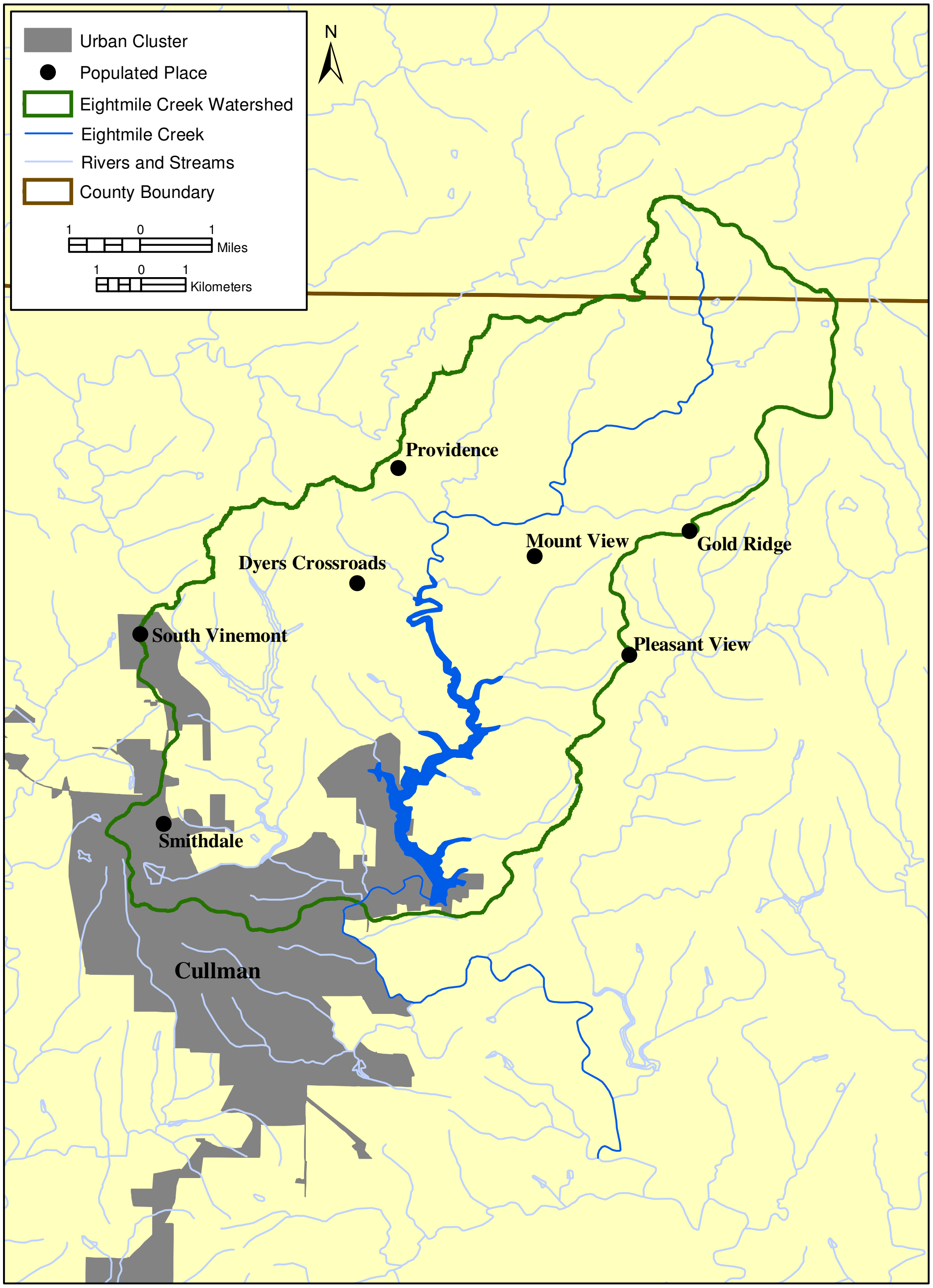

Figure 3. Populated place locations and urban areas as identified from the EPA BASINS data and Census 2000 TIGER/line files within the Eightmile Creek watershed, Alabama. An urban cluster consisted of densely settled territory that has at least 2,500 people but fewer than 50,000 people (United States Census Bureau 2001).

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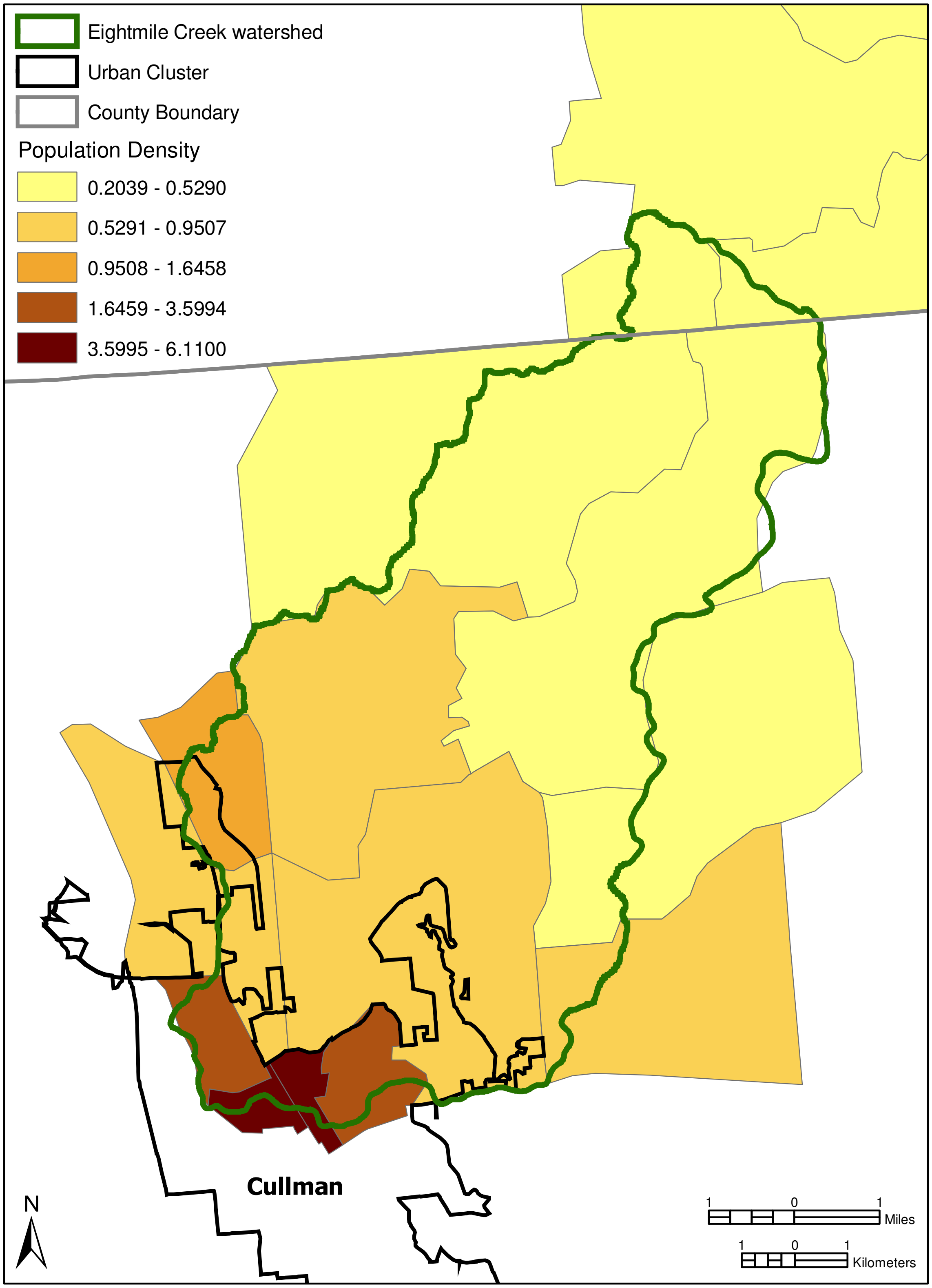

Figure 4. Population density (persons/ha) by 2000 census block groups for the Eightmile Creek watershed, Alabama. Population density was classified using natural breaks.

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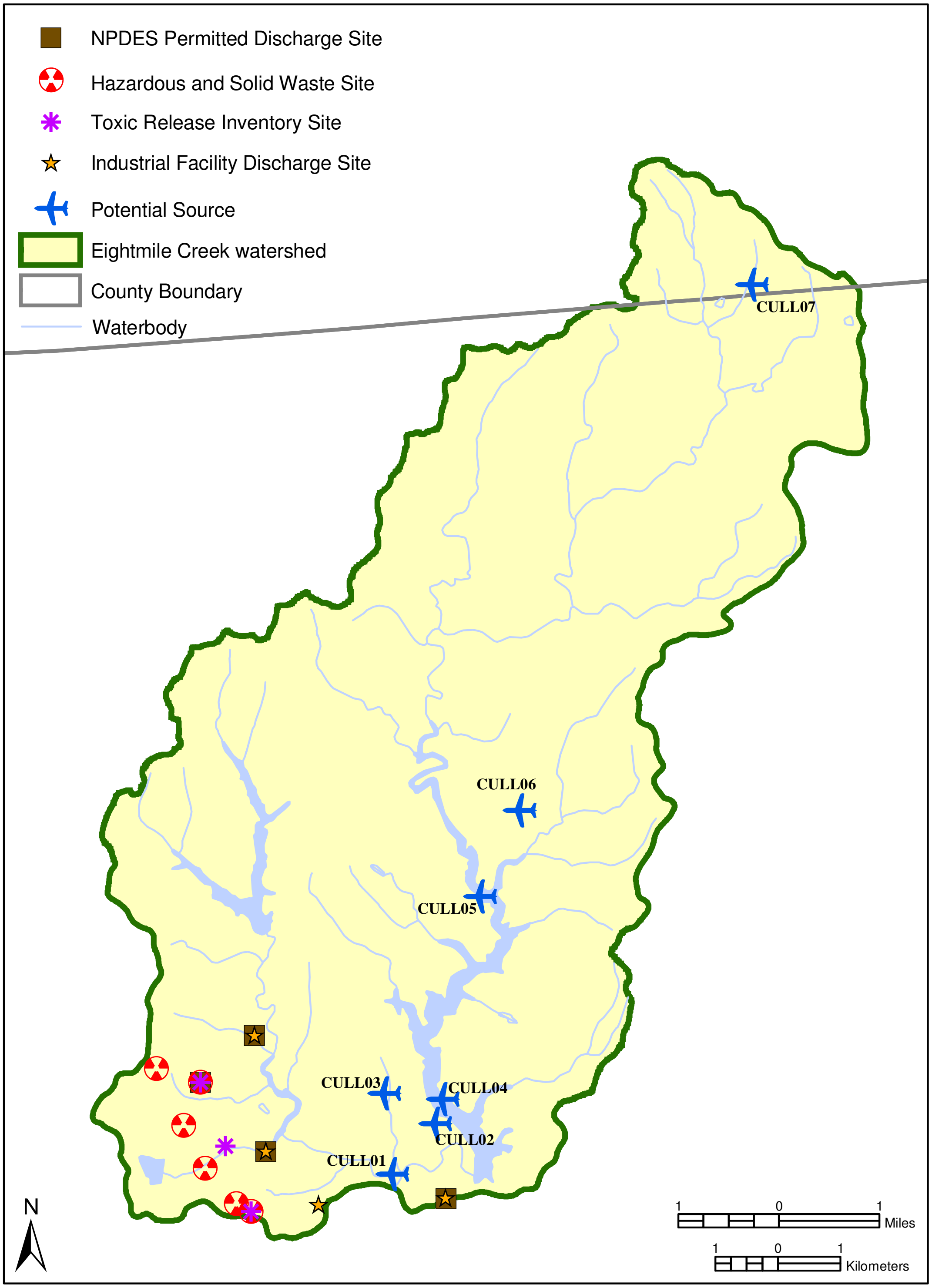

Figure 5. National Pollutant Discharge Elimination System (NPDES) permitted discharge sites, Hazardous and Solid Waste sites, Toxic Release Inventory sites, and Industrial Facility Discharge sites identified from EPA BASINS data and potential point and nonpoint pollution sources identified by the Consortium of Alabama Environmental Groups (2003) using low-flying aircraft in the Eightmile Creek watershed, Alabama.

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Table 5. National Pollutant Discharge Elimination System (NPDES) permit compliance system (PCS) sites identified from EPA BASINS data in the Eightmile Creek watershed, Alabama.

Facility Name	City	County	Status	Principal Activity Causing the Discharge	Receiving Water
Peerless Coating Inc.	Cullman	Cullman	inactive	paints, varnishes, lacquers, enamels, and allied products	Ryan Creek
Cullman Waste Treatment Plant	Cullman	Cullman	active	water supply	unnamed tributary to Eightmile Creek
Howlett Oil Co Food Mart No. 3	Cullman	Cullman	inactive	gasoline service stations	unnamed tributary to Wolf Creek
Daubert Coated Product Cullman	Cullman	Cullman	active	electron tubes	Bridge Creek

Table 6. Industrial Facilities Discharge sites identified from EPA BASINS data in the Eightmile Creek watershed, Alabama.

Facility name	City	County	Receiving Water	Number of discharges	NPDES Number
Cullman Products Corporation - Cullman	Cullman	Cullman	receiving stream-c to Eightmile Creek	2	AL0041203
Peerless Coating Inc.	Cullman	Cullman	Ryan Creek	0	AL0050504
Cullman Waste Treatment Plant	Cullman	Cullman	unnamed tributary to Eightmile Creek	0	AL0052019
Howlett Food Mart, Cullman	Cullman	Cullman	storm sewer to Wolf Creek	0	AL0057452

Table 7. EPA/OSW Resource Conservation and Recovery Information System (RCRIS) for the United States hazardous and solid waste sites identified from EPA BASINS data in the Eightmile Creek watershed, Alabama.

Facility Name	City	Land Type
Daubert Coated Products Inc.	Cullman	
Greif Bros Corporation	Cullman	Private
Classic Olds Cadillac Inc.	Cullman	
Burgess Body Shop	Cullman	Private
Chevron USA Inc 2030	Cullman	
Smith & Waldrop Pontiac	Cullman	Private

Table 8. Toxic Release Inventory sites identified from EPA BASINS data in the Eightmile Creek watershed, Alabama.

Facility Name	City	County	Principal Activity Causing the Discharge
Daubert Coated Prods. Inc.	Cullman	Cullman	Coated and Laminated Paper, Not Elsewhere Classified
Greif Bros. Corp.	Cullman	Cullman	Metal Shipping Barrels, Drums, Kegs, and Pails
American Alloy Prods. Inc.	Cullman	Cullman	Steel Foundries, Not Elsewhere Classified

Table 9. Potential point and nonpoint pollution sources identified using low-flying aircraft in the Eightmile Creek watershed, Alabama.

Site	County	Waterbody	Latitude	Longitude	Type	Activity	Potential Pollution Problem	Description
CULL01	Cullman	Eight Mile Creek	34.1867	86.8200	commercial	municipal water	parking runoff	municipal water intake/water plant for the city of Cullman
CULL02	Cullman	Eight Mile Creek	34.1933	86.8117	agriculture	nursery	nutrient runoff	nursery
CULL03	Cullman	Eight Mile Creek	34.1983	86.8200	commercial	hospital	storm water runoff	parking lot runoff
CULL04	Cullman	Eight Mile Creek	34.1967	86.8100	agriculture	cattle pasture	nutrient runoff	cattle pasture
CULL05	Cullman	Eight Mile Creek	34.2250	86.8000	agriculture	chicken CAFO	nutrient runoff	chicken CAFO
CULL06	Cullman	Eight Mile Creek	34.2367	86.7917	agriculture	chicken CAFO	nutrient runoff	chicken CAFO
CULL07	Cullman	Eight Mile Creek	34.3083	86.7423	agriculture	agriculture runoff	nutrient runoff	agriculture runoff

corridors connecting habitat patches further isolates the remaining population as the remaining habitat is embedded in a landscape that usually inhibits movements. The restriction of movements by individuals drastically reduces genetic flow among populations, potentially leading to increased inbreeding and increased probabilities of local extirpations. Species in small patches of habitat are often vulnerable to increased predation pressure, and habitat fragmentation opens new avenues and opportunities for the introduction of invasive species.

Agriculture

The source Agriculture was defined as runoff from agricultural areas, both crop and livestock, resulting in fertilizers, pesticides, herbicides, organic materials, pathogens, and sediment entering into waterways as well as any agriculture-related practices that result in erosion, collapsed streambanks, and channelization of waterways, thereby altering the natural flow regime of water.

Agricultural practices have long been considered the most widespread and significant source of NPS pollution in the United States, and are known to have major impacts on water quality. In a 2000 Report to Congress, the EPA identified agriculture as the leading source of impairment to rivers and streams, with the most common agricultural types causing impairment being nonirrigated crop production, animal feeding operations, and irrigated crop production (United States Environmental Protection Agency 2002a). In Alabama, ADEM estimated that 40% of NPS problems originate from agriculture. Additionally, ADEM receives more water quality complaints associated with animal waste than any other agricultural activities (Beck 1995). Agriculture was one of the top three threats identified for conservation targets across the Cumberlands and Southern Ridge and Valley Ecoregion in TNC's ecoregion plan (2003), and agricultural development generally ranks first among activities responsible for habitat destruction (Noss and Peters 1995). Impaired water quality resulting from agricultural runoff has been identified as a concern within the watershed.

The types of impairment from agricultural sources include sedimentation of streambeds due to accelerated soil erosion, nutrient loading (primarily nitrogen and phosphorus), pesticide and herbicide (and other toxins) contamination of surface- and ground-water, contamination by animal waste, and pathogen contamination (Ribaudo 1989, Tim and Jolly 1994, Basnyat et al. 1999). Sedimentation resulting from agriculture generally is the single greatest pollutant by volume in U.S. waters (Basnyat 1998). Excessive sedimentation alters aquatic habitat, suffocates bottom-dwelling organisms and fish eggs, and can interfere with the recreational use of a river or stream (United States Environmental Protection Agency 2002a). Although excessive sedimentation is generally the largest NPS pollutant from agriculture, the highest contribution by agriculture to NPS pollution in some U.S. watersheds may be nutrients, primarily nitrogen and phosphorus, due to the intensive use of fertilizers and pesticides or from animal manure (Puckett 1994, Basnyat 1998). In addition, more lake acres in the U.S. are affected by nutrients than any other pollutant or stressor (United States Environmental Protection Agency 2002a). The major environmental effect of excessive nutrients is eutrophication of surface waters (Puckett 1994).

The negative impacts of agriculture on wildlife are indisputable and often diminish the ability of agricultural ecosystems to sustain viable populations. In addition to the direct habitat loss caused by the initial land use conversion to agriculture, the effects of agriculture include increased habitat fragmentation and isolation, decreased habitat diversity, and decreased water quality

(Allen 1995). Species present in agricultural systems often suffer from reduced reproductive success and increased predation compared to more natural systems. The high impact of sustained anthropogenic disturbance (i.e., sustained agriculture) profoundly alters biotic communities, and may result in long-term modifications such as lowering diversity and changing species composition that may still be evident long after land use has reverted to a more natural state (Harding et al. 1998).

Livestock grazing is the fourth major cause of species endangerment nationwide and the second major cause of plant endangerment (Flather et al. 1994). The primary effects of livestock grazing include the removal and trampling of vegetation, compaction of underlying soils, and dispersal of exotic plant species and pathogens (National Research Council 2002). Grazing can also alter both hydrologic and fire disturbance regimes, accelerate erosion, and reduce plant or animal reproductive success and/or establishment of plants. Long-term cumulative effects of domestic livestock grazing involve changes in the structure, composition, and productivity of plants and animals at community, ecosystem, and landscape scales. Livestock have a disproportionate effect on riparian areas because they tend to congregate in these areas, which are rich in forage and water (National Research Council 2002). Cattle access points are site specific, but cause several impacts to water quality. Where livestock have access to streams, riparian vegetation is generally lacking and cattle entering and leaving the stream adds to the instability of the stream bank. This can lead to increased erosion and sedimentation and fecal contamination of the stream. The majority of livestock in the watershed likely is not excluded from streams running through pastures, which has the potential to cause major problems for aquatic species. Excluding livestock from riparian areas is the most effective tool for restoring and maintaining water quality and ecological function of riparian areas impacted by livestock. However, it can be expensive and will require livestock management changes such as supplying alternative water and forage sources. Still, livestock exclusion from streams should be encouraged in the watershed where feasible. Where it is not feasible to exclude cattle from streams, the impacts can b e reduced by changing the season of use, reducing the stocking rate or grazing period, resting the area from livestock use for several seasons, and/or implementing a different grazing system (National Research Council 2002). However, exclusion should be the first choice when possible.

The negative impacts from agriculture can be minimized somewhat through implementation of Best Management Practices (BMP) designed to minimize agricultural contributions to NPS pollution, and many state agencies have BMPs designed to abate the impact of agriculture on

Example of stream in cattle pasture degraded due to lack of riparian vegetation and cattle having access to the stream.

adjacent aquatic systems. These practices include livestock management to limit access to streams and the use of vegetated stream buffers. The presence of a naturally-vegetated buffer around streams can greatly reduce the amount of sediment and nutrients reaching the stream by reducing bank erosion and trapping sediments and nutrients flowing off agricultural areas before reaching the stream (Anderson and Ohmart 1985, Basnyat et al. 1999, Schultz and Cruse 1992, Osbourne and Kovacic 1993, Weller et al. 1996).

Implementation of strategies to reduce agricultural pollution will help with conservation of aquatic species in the watershed. Conservation in agricultural areas can be further increased by continuing to implement conservation practices in agricultural areas through programs such as the various Farm Bill and USFWS conservation programs. Increasing the implementation of agricultural BMPs, especially the use of riparian buffers, should be a goal in the watershed.

<u>Development</u>

The source Development was defined as stress from activities associated with rural development, urbanization, and commercial and industrial development, including roads and construction activities, which contribute to runoff, sedimentation, and other NPS pollution. This included contributions from sources such as sedimentation as a result of new construction; maintenance of roads; mining; and contaminants such as engine oil, antifreeze, rubber, and metal deposits from tire wear resulting from vehicular use of roads. Urban development is a leading cause of habitat destruction for many species (Noss and Peters 1995), and was identified as the greatest threat for endangered and threatened plants in a review of recovery plans (Schemske et al. 1994). Residential development also was one of the top three threats identified for conservation targets across the Cumberlands and Southern Ridge and Valley Ecoregion in TNC's ecoregion plan (2003). Within the EC watershed, development is likely to present more problems in the southern portion of the watershed around Cullman than in the rest of the watershed.

Urban runoff has been identified as a major contributor to NPS pollution due to the highly polluted runoff from urbanized areas and the potential for urban areas to generate large amounts of NPS pollutants from storm-water discharge. Nationwide, the EPA and state agencies estimated urban runoff was responsible for approximately 12% of the water quality impairment in rivers and streams (United States Environmental Protection Agency 2002a). Constituents in urban runoff include sediment and other suspended solids, toxins such as automotive fluids, pesticides from lawn and garden activities, bacteria and other pathogens, heavy metals, oxygen-demanding substances, and nutrients from fertilizers used in lawn and garden activities (Olivera et al. 1996). Increased sedimentation has been recognized as one of the primary results of urban runoff, and construction, both buildings and roads, is one of the most significant contributors of suspended solids to urban runoff. Sediment loads from inadequately controlled construction sites typically are 10 to 20 times greater per unit of land than those from agricultural land and 1,000 to 2,000 times those from forests (Weiss 1995). Many state agencies have BMPs designed to reduce nutrient and sediment loads from urban runoff to abate the impact of urban development on aquatic systems (Reddy and Gale 1994). However, if these BMPs are not properly implemented and maintained, they contribute little to abating the impact of urban runoff. Therefore, BMPS for development should be strongly encouraged in the watershed, but implementation also needs to be evaluated to ensure that BMPs are properly implemented and maintained.

Extensive urbanization across the South as human population has grown has accelerated the rate at which open land was converted to urban since the 1970's (Macie and Hermansen 2002). Urbanization alters the species composition of an area and generally negatively impacts an area's biodiversity. Tabit and Johnson (2002) reported that anthropogenic impacts associated with population growth were a significant threat to the biodiversity and structure of fish communities because they depress the fish fauna and reduce species richness compared to less impacted streams. In general, the number of amphibian, reptile, mammal, and bird species decreases as one moves from rural to urban landscapes (Macie and Hermansen 2002). The number of native species decreases as the habitat specialists are lost, while the number of exotic species increases and the generalist species remaining may reach very high densities that can cause problems for the remaining biota as well as causing conflicts with humans (Macie and Hermansen 2002). Forest communities in urban and urbanizing landscapes often have been altered and have modified soils, low native biodiversity, an absence of large predator species, simple food webs, and a high frequency of human disturbances making them more susceptible to nonnative species invasions than intact communities (Lodge 1993, McDonnell et al. 1997, Williams and Meffe 1998).

Many of the alterations associated with development are driven by road construction. In addition to increasing the probability of future development, fragmenting habitat, and increased edge effects, roads have numerous other ecological effects such as increased habitat loss; direct mortality on roads; increased access by people possibly leading to increased harassment of wildlife, increased mortality from hunting, increased woodcutting and trampling, increased disturbance, and increased dumping; increased spread of nonnative species; increased pollution including increased light, noise, dust, and fumes; accelerated erosion; changes in natural disturbance regimes; and providing increased access to poachers (Macie and Hermansen 2002). To address urbanization's effects on ecosystem health, an integrative and interdisciplinary approach is necessary, and must include terrestrial and aquatic systems and account for ecological processes operating at different spatial and temporal scales and the complexity of interactions among the social, ecological, and physical components of an ecosystem (Macie and Hermansen 2002).

In recent years, urban sprawl has emerged as one of the dominant forces of change in land cover and has been predicted to be a major cause of native forest loss in the future (Wear and Greis 2002). Urbanization changes the structure, function, and composition of natural ecosystems, as well as the benefits derived from them and can severely degrade aquatic and terrestrial ecosystems (Wang et al. 2001, Macie and Hermansen 2002). The most direct effect of land use change resulting from development is the loss and fragmentation of the natural land cover. In addition to contributing to habitat loss, development creates new edge habitat and alters habitat shape from irregular to highly regular and linear (Godron and Forman 1983, Zipperer 1993). Urbanization's indirect effects on natural systems include modifying hydrology, altering nutrient cycling, modifying disturbance regimes, introducing nonnative species, and changing atmospheric conditions (Macie and Hermansen 2002). These changes significantly affect ecosystem health and modify the goods and services provided by ecosystems.

Increased housing, roads, and the associated construction activities put pressure on the waterways, especially by the forced assimilation of additional stormwater runoff due to expanded impervious surfaces. Runoff that moves across natural terrain reaches receiving waters gradually because the surface is porous allowing water to percolate into the soil. However, urban areas have a much higher proportion of impervious surfaces, which increases the flow of runoff because these surfaces force the water to accumulate on the surface and storm sewer systems are designed to quickly channel this runoff from roads and other impervious surfaces to the receiving water. Once runoff enters the sewer system, it empties into streams with enough volume and speed to erode streambanks, strip streamside vegetation, alter the streambed, and widen stream channels resulting in fluctuating water levels, increased sediment loading, and higher water temperatures (United States Environmental Protection Agency 2002b).

Urbanization and the accompanying increase in impervious surface profoundly modify watershed hydrology and vegetation. As vegetation is replaced by impervious surfaces, infiltration, groundwater recharge, groundwater contributions to streams, and stream base flows all decrease, while overland flow volumes and peak runoff rates increase (National Research Council 2002). Stream channels respond by increasing their cross-sectional area to accommodate the higher flows, which triggers a cycle of streambank erosion and habitat degradation and typically ends in degraded water resources. Sediment loadings may increase by one to two orders of magnitude compared to pre-development conditions, such that streambeds are covered with shifting deposits of sand and mud. Storm runoff from roads and parking lots often flows directly into streams without treatment, carrying all the sediment and pollutants picked up directly into the stream (Macie and Hermansen 2002). The impacts of these changes include habitat loss and degradation for aquatic species, and can lead to decreases in macroinvertebrate communities and shellfish beds and deleterious impacts on aquatic systems, with macroinvertebrates disappearing from urban streams in areas with $\geq$25% impervious surface cover.

The percentage of land covered by impervious surfaces increases as development increases and alters the natural landscape such that imperviousness has become synonymous with human presence. Although impervious land cover has long been characteristic of urban areas, it has only recently emerged as an environmental indicator and been recognized as a very useful indicator with which to measure the impacts of land development on aquatic systems (Arnold and Gibbons 1996). Increased impervious surface cover can be a prime indicator of NPS pollution and water quality degradation because impervious surfaces not only indicate urbanization, but also are major contributors to the environmental impacts of urbanization. Research consistently shows a strong negative correlation between the imperviousness of a drainage basin and the health of its receiving stream so that percent of impervious surface within a watershed is a viable indicator of watershed health and ecosystem quality (Klein 1979, Griffin 1980, Schueler 1994a, Arnold and Gibbons 1996). Major changes in biota can occur with relatively small amounts of urban land use in a watershed, and there appear to be urbanization threshold values which lead to rapid and dramatic degradation of biotic communities when exceeded (May et al. 1997, Wang et al. 2000). Degradation first begins to become noticeable at 10% impervious surface and becomes so severe as to be almost unavoidable at 25-30%. Arnold and Gibbons (1996) defined 3 broad categories of stream health in relation to impervious surface: "protected" (<10 %), "impacted" (10-30%), and "degraded" (>30%). Although there is not always agreement for the demarcation between impacted and degraded, the threshold of initial degradation is remarkably consistent at 10% impervious surface with studies evaluating stream health using many different criteria including habitat quality, aquatic species diversity and abundance, and pollutant loads (Schueler 1994a, Hicks 1995, Arnold and Gibbons 1996). Impervious coverage, then, is both a reliable and integrative indicator of the impact of development on water resources.

The accurate mapping of impervious surfaces plays an important role in water quality management and is essential to our ability to monitor urban-related NPS pollution because increased impervious surface coverage can be a prime indicator of NPS problems and water quality degradation. The amount of impervious surface in watersheds is often estimated using a generalized estimate based on land use/ land cover data. These types of estimates tend to be too generalized and typically do not depict an area's true spatial pattern of impervious surfaces (Civco and Hurd 1997). A more detailed analysis of impervious surface using methods that map impervious surface at a finer scale (such as Ridd 1995, Civco and Hurd 1997, Flanagan and Civco 2001) should be conducted for the watershed. The results of an impervious surface analysis can be used to help guide planning emphasis within the watershed.

Imperviousness works well as a surrogate for water quality in planning and land use decisions because it is integrative (so it can help cut through much of the complexity of some issues) and measurable (and so appropriate for a wide range of planning and regulatory applications). Also, the basic tenets of reducing imperviousness--retaining the natural landscape, minimizing pavement, promoting infiltration to the soil--are simple concepts that can be understood by a community and its residents (Arnold and Gibbons 1996). However, planners should remember that using heavy equipment during construction and heavy use of roads and parking lots, even if created using one of the various pervious surface options available, can create an impervious surface through soil compaction. This increase in imperviousness, even potentially when using a pervious surface, should be factored into any analysis for future imperviousness in a watershed.

Roads usually account for the majority of a communities impervious coverage and tend to produce the most pollutant-laden runoff, so decreasing road widths is one of the best design-related opportunities for reducing imperviousness. Another design-related opportunity to reduce imperviousness is the use of cluster development, which can reduce site imperviousness by 10-50% depending on the road network and lot size (Schueler 1994b). Cluster development and other development alternatives intended to reduce imperviousness and promote the retention of undeveloped buffers along streams have less impact than traditional types of development on the biotic integrity of streams (Wang et al. 2001). In commercial and industrial areas, reducing imperviousness through design-related reductions can best be achieved by targeting parking through smaller lot sizes and emphasizing the use of infiltration and nonstructural solutions, such as placing vegetated landscaped areas in parking lots below the level of the parking surface that serve as infiltration and treatment areas for runoff (Bitter and Bowers 1994). Reducing imperviousness through planning and design reduces the deleterious impacts of imperviousness, but also can save money for the community or region doing the planning. Arnolds and Gibbons (1996) recommend that the emphasis should be placed on preventive measures that retain existing natural systems for areas in the lower impervious zone, using techniques like open space planning and stream buffers. For areas that are in, or will be in, the "impacted" (10-30%) zone, preventive planning should be accompanied by a focus on site design considerations that reduce runoff and imperviousness. Finally, for areas at (or climbing into) the "degraded" (over 30%) zone, the focus shifts to remediation through pollutant mitigation and resource restoration.

Forestry

The source Forestry was defined as silvicultural activities resulting in NPS pollution as a result of negative silvicultural practices including inadequate Best Management Practices (BMP); lack of a streamside management zone (SMZ); timber road construction and use; timber harvesting; site preparation; and any other silvicultural activity resulting in disruption of surface hydrology, sedimentation, elevated water temperatures, and degradation of aquatic habitat. Incompatible forestry practices was one of the top three threats identified for conservation targets across the Cumberlands and Southern Ridge and Valley Ecoregion in TNC's ecoregion plan (The Nature Conservancy 2003).

Timber harvest is a long-standing and vital component to the economic welfare of all southern states (Wear and Greis 2002). Approximately 202,343,100 ha (499,998,700 ac) of land is managed for timber production in the United States. Although only a small fraction of this is harvested yearly, forestry activities can cause major water quality problems if not managed properly. Nationwide, the EPA and state agencies estimated forestry practices were responsible for approximately 10% of the water quality impairment in rivers and streams (United States Environmental Protection Agency 2002a). Inadequate BMPs, SMZs, and road maintenance can be a significant source of sedimentation. Forestry road construction and use are a primary source of NPS pollution from silvicultural activities, contributing up to 90% of the sediment produced in forestry practices. Properly implementing forestry BMPs during road construction and maintenance is very important because surface erosion rates on roads often equal or exceed erosion rates reported on severely eroding agricultural lands. Additionally, intense silvicultural practices such as clearcutting, mechanical site preparation and heavy herbicide use could also significantly impact the watershed. Potential hydrologic effects from timber harvest include increased annual water yields, increased sediment production, and altered stream chemistry

(National Research Council 2002). The potential impacts of silvicultural practices on aquatic systems include increased riffle sediment, length of open stream, water temperature, snag volume, and algal cover; decreased riffle macroinvertebrates; compositional changes in forest avian communities; and chemical contamination from fuels and lubricants (Beck 1995, Wenger 1999, Haag and Dickinson 2000, Jackson et al. 2001). These responses do not always occur and typically depend on terrain conditions, the amount of timber removed, the type of logging system, post-harvest rainfall patterns, soil type, and other factors.

Many of these impacts can be minimized through proper implementation of BMPs. The current role and effectiveness of forestry BMPs for reducing sediment and nutrients reaching a waterbody in the south is generally well accepted; numerous studies have shown properly implemented BMPs limit the impacts of forestry practices on water quality and base flow (Arthur et al. 1998, Wear and Greis 2002, Aust and Blinn 2004). However, Mortimer and Visser (2004) suggest that recent litigation concerning land management activities (i.e., timber harvesting) causing flooding through increased surface flow and sedimentation necessitates a review of BMP design and implementation because forestry BMPs have not specifically been designed for preventing peak flow water from reaching a stream, and may warrant consideration of a water quantity BMP.

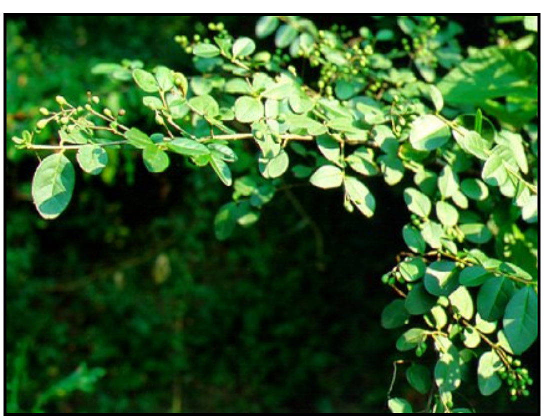
The use of streamside buffers and SMZs on forest lands are critical to the protection of water resources. Cutting without a riparian buffer results in immediate channel changes (Jackson et al. 2001) and can have a profoundly negative impact on stream biota that may alter the long-term composition and character of the area. Timber harvest in riparian areas also can adversely impact the adjacent waterbody if SMZs are not used or are improperly used through shade removal resulting in increased water temperature, destabilized soil leading to increased sedimentation, and decreased dissolved oxygen. It is critical that all silvicultural activities be strongly encouraged to properly implement the use of streamside buffers and other BMPs.

Invasive/Alien Species

For the purpose of this project, the source Invasive/Alien Species was defined as any non-native species which can cause environmental harm. Invasive species are species that are non-native (or alien) to the ecosystem under consideration that are likely to cause economic or environmental harm to the area in which they have been introduced (Executive Order 13112). Invasive non-native organisms are one of the greatest threats to the natural species and ecosystems of the U.S. (Stein and Flack 1996). They are the second greatest threat to imperiled species and the integrity of ecosystems in the U.S. after habitat destruction/degradation (Noss and Peters 1995, Stein et al. 2000), and impact nearly half of the species currently listed as "Threatened" or "Endangered" under the U.S. Federal Endangered Species Act (Flather et al. 1994). TNC's Cumberlands and Southern Ridge and Valley Ecoregion Plan (The Nature Conservancy 2003) identified invasive species as a major threat to conservation in the ecoregion and provided strategies for abating threats from invasive species. The most common concern about invasive organisms is their displacement of native species and the subsequent alteration of ecosystem properties (National Research Council 2002).

This threat often works in tandem with habitat destruction because exotic species more readily invade disturbed habitat. Most new introductions wither away unnoticed, but some rapidly exploit their new habitats in the absence of their native predators, diseases and competitors. Invasive species are especially problematic in areas that have been disturbed by human activities such as road building, residential development, forest clearing, logging operations, grazing, mining, ditching of marshes for mosquito control, mowing, erosion control, and fire prevention and control activities. Numerous species that have become invasive problems were intentionally introduced to "create" a desired landscape, but many others were unintentional introductions. These unwelcome plants, insects, and other organisms disrupt natural ecosystems, displace native plant and animal species, and degrade our nation's unique and diverse biological resources. Invasive species may threaten the survival of native species in several ways, including outcompeting native species, preying heavily on natives that have not evolved adequate defenses, or serving as a vector for diseases that devastate native species. Some of the known ecological impacts of invasive species are a reduction in the amount of light, water, nutrients and space available to native species; alteration of hydrological patterns, soil chemistry, moisture-holding capacity, erodibility, fire regimes, and natural ecological processes such as plant community succession; hybridization with native species; harboring of pathogens; loss of food sources for wildlife; loss of and encroachment upon endangered and threatened species and their habitat; and disruption of insect-plant associations necessary for seed dispersal of native plants (Randall and Marinelli 1996, Stein and Flack 1996, Plant Conservation Alliance 2000). Invasive species also reduce an ecosystem's ability to provide basic ecological services, such as flood control and crop pollination, on which humans depend (Stein and Flack 1996). In addition, invasive species negatively impact domesticated species, damaging agricultural crops and rangelands and spreading diseases that affect domestic animals and humans, causing economic losses and expenditures measured in billions of dollars each year for agriculture, forestry, commercial fisheries, range lands, tourism, and roadways management (Li 1995, Westbrooks 1998).

There are numerous invasive plant species in the watershed, including privet (*Ligustrum* spp.), kudzu (*Pueraria montana* var. *lobata*), and wisteria (*Wisteria* spp). Chinese tallow (*Sapium sebiferum*), one of Stein and Flack's (1996) "dirty dozen", is a pernicious invader of wetlands but is not yet abundant in the watershed. Efforts should be made to prevent this species from becoming established in the watershed, including educating plant consumers and nursery owners about its negative impacts and the need to use native species in landscaping. This species is still in demand from nurseries where it is stocked as an ornamental despite its being a serious and growing threat to the native plants and habitats of the southeast.


Chinese privet (*Ligustrum sinense*) – Photo - TNC

Privet is probably the most common and troublesome invasive plant in the watershed. Privet is a perennial, shade tolerant shrub that readily grows from seed or from root and stump sprouts and spreads widely by abundant bird- and other animal-dispersed seeds (Southeast Exotic Pest Plant Council 2003a). Privet was included by the Invasive Species Specialist Group on their list of 100 of the world's worst invasive alien species and was identified as one of the worst invaders in the southeast by TNC's Invasive Species Initiative.

It also was listed as one of Alabama's worst ten invasive plants by the state exotic pest plant council (Miller et al. 2004). Various species of privet have been introduced to the United States as garden plants and are widely used as a common hedge in landscaping. It escapes cultivation by movement of seed, which is eaten and subsequently transported by wildlife, particularly birds. Four species of privet are known to occur in Alabama: Japanese privet (*Ligustrum japonicum*), glossy privet (*L. lucidum*), Chinese privet (*L. sinense*), and European or common privet (*L. vulgare*) (Batcher 2000). Privet is an aggressive and troublesome invasive, and often forms dense thickets that outcompete many kinds of native vegetation, particularly in bottom-land forests and along fencerows, thus gaining access to forests, fields, and right-of-ways (Miller 2003). It may displace shrubs in regenerating communities and remain persistent in these areas. Privet is often seen along roadsides and other areas of disturbed soil at elevations less than 915 m (3000 ft), and also becomes established in old fields and landscapes that have abundant sunlight (Southeast Exotic Pest Plant Council 2003a). Control of privet is difficult because the plant resprouts following fires and has no known effective biological control agents. However, efforts should be made to eradicate privet from the watershed. Eradication is possible at specific sites using mechanical removal, herbicidal applications, or a mix of the two. However, follow-up at the site is absolutely necessary because plant fragments left on the site have the potential to resprout or new plants could sprout from seeds in the soil.

Kudzu was introduced into the U.S. in 1876 and was actively promoted as a forage crop, ornamental plant, and cover crop to prevent erosion through the mid 1950s. The U.S. Department of Agriculture recognized kudzu as a pest species in 1963 and removed it from its list of permissible cover plants. Kudzu was included by the Invasive Species Specialist Group on their list of 100 of the world's worst invasive alien species, and was listed as one of Alabama's worst ten invasive plants by the state exotic pest plant council (Miller et al. 2004). Kudzu is an aggressive climbing, semi-woody, leguminous, perennial vine actively growing from early summer (May) until the first frost (Bergmann and Swearingen 1999). Kudzu grows well under a wide range of conditions and in most soil types. Preferred habitats are forest edges, abandoned fields, roadsides, and disturbed areas, where sunlight is abundant. Kudzu is common throughout the southeastern U.S., covering an estimated 2.83 million ha (7 million ac) (Southeast Exotic Pest Plant Council 2003b), and has extended its range throughout most of the eastern and central US. However, it grows best where winters are mild, summer temperatures are >27° C (80° F), and annual rainfall is > 102 cm (40 in) (Bergmann and Swearingen 1999). Kudzu roots are fleshy, with massive tap roots 7 inches or more in diameter, 6 feet or more in length, and weighing as much as 400 pounds. As many as thirty vines may grow from a single root crown. Once established, kudzu grows rapidly, extending as much as 18 m (60 ft) per season at a rate of about 0.3 m (1 ft) or more per day, forming a continuous blanket of foliage that often chokes out competing native vegetation that provides food and habitat for native animals resulting in a large scale alteration of biotic communities (Southeast Exotic Pest Plant Council 2003b). Kudzu kills or degrades other plants by smothering them under a solid blanket of leaves, by girdling woody stems and tree trunks, and by breaking branches or uprooting entire trees and shrubs through the sheer force of its weight (Bergmann and Swearingen 1999). Kudzu is well established in many populations throughout the watershed. While complete eradication of this species in the watershed is unlikely, the goal should be to prevent further spread of the species and eradication of the plant from as many areas as possible. For effective control, the extensive root system must be destroyed.

Chinese wisteria (*Wisteria sinensis*); Photo - Ted Bodner, Southern Weed Science Society

Wisteria is a showy, woody vine in the pea family (*Fabaceae*) that was brought into the United States around 1830 for ornamental purposes, and has been grown extensively in the south and mid-Atlantic for landscaping (Swearingen et al. 2002). Several members of the genus are popular ornamentals, with Chinese wisteria (*Wisteria sinensis*) and Japanese wisteria (*W. floribunda*) being the 2 most common to be an invasive problem. These two species are difficult to distinguish due to possible hybridization (Miller 2003). Wisteria is a deciduous, high climbing, twining, or trailing leguminous woody vine (or cultured as shrubs) with infrequent alternate branching up to 25 cm (10 in) in diameter and 20 m (70 ft) long. Wisteria is hardy and aggressive, capable of forming thickets so dense that little else grows. Exotic wisterias displace native herbs, vines, shrubs and trees through shading and girdling; they constrict the stems of trees and kill them by girdling or over-topping. Climbing wisteria vines can kill sizable trees, opening the forest canopy and increasing sunlight to the forest floor, which favors the growth of its numerous seedlings (Swearingen et al. 2002). Most infestations in natural areas are a result of escapes from landscape plantings. Wisteria spreads by seed under favorable conditions and by producing stolons (aboveground stems) that develop roots and shoots at short intervals. Its large seed size is a deterrent to animal dispersal (Miller 2003), but the seeds can be carried great distances downstream in water. Efforts should be made to eradicate this species in the watershed. Cutting can be employed for small infestations, or to relieve trees of the weight and damage caused by large twining vines, but the use of systemic herbicides (e.g. triclopyr) is probably a more effective method for larger, established infestations (Swearingen et al. 2002). Eradication efforts should include an educational component targeting stopping the use of invasive exotic species as ornamentals. There are a variety of creeping or climbing vines native to the eastern U.S. that are good alternatives to the invasive exotic wisterias. Some examples include American wisteria (*Wisteria frutescens*) , crossvine (*Bignonia capreolata*), Dutchman's pipe (*Aristolochia* *macrophylla*), trumpet creeper (*Campsis radicans*), and trumpet honeysuckle (*Lonicera sempervirens*).

<u>Waste Disposal</u>
For the purpose of this project, the source Waste Disposal was defined as stress from disposal of human waste products not handled by a sewage treatment facility including trash dumping and faulty septic systems. Septic systems are the most common on-site domestic waste disposal system in use in the U.S. The number of active septic systems in Alabama has been estimated at 670,000 with an unknown number of older, abandoned systems. If properly installed, used, and maintained, septic systems pose no threat to water quality, but if the system is improperly installed or fails, disease-causing pathogens, nitrates, or other pollutants may enter the water table and/or nearby streams. The Alabama Department of Public Health has estimated that 50% of all conventional, onsite septic systems in the state are failing or will fail in the future. EC likely contains a number of failing septic systems. The failure of these septic systems needs to be corrected or the systems need to be replaced with an alternate system that prevents contamination of the water table.

CONSERVATION MEASURES

Information on the occurrence of rare and sensitive species is often incomplete and heavily influenced by where surveys have been conducted in the past and the taxonomic expertise of the searchers. The lack of information regarding rare species present in EC watershed likely reflects a low survey effort for the watershed rather than an absence of species. In focus groups conducted by the Forest Service for their wildland-urban interface assessment (Monroe et al. 2003), many of the participants suggested natural resource inventories would help provide data to support and aid in the decision-making process. A comprehensive survey is needed throughout the watershed.

An action which is likely to have a great impact on aquatic systems and should be a priority in the watershed is the protection and restoration of riparian vegetation along the waterbodies in the watershed, particularly the lower order streams. Numerous studies have shown the benefits of maintaining native vegetation in riparian zones adjacent to more intensive land uses for reducing pollutant loads to the waterbody and maintaining biotic integrity (Anderson and Ohmart 1985, Castelle et al. 1994, Gilliam 1994, Basnyat et al. 1999, National Research Council 2002). Because riparian areas perform a disproportionate number of biological and physical functions on a unit area basis, their protection and restoration can have a major influence on achieving the goals of the Clean Water Act, the Endangered Species Act, and flood damage control programs, and thus, provide an important management strategy for controlling stream water quality in multiuse landscapes (Weller et al. 1996, National Research Council 2002). Riparian areas also provide some of society's best opportunities for restoring habitat connectivity across the landscape. Measures to protect intact areas are often relatively easy to implement, have a high likelihood of being successful, and are less expensive than the restoration of degraded systems (National Research Council 2002). Therefore, protection should be the goal for the riparian areas in the watersheds in the best ecological condition, while riparian areas that are degraded should have restoration as their goal. The National Research Council (2002) recommended that "management of riparian areas should give first priority to protecting those areas in natural or nearly natural condition from future alterations. The restoration of altered or degraded areas could then be prioritized in terms of their relative potential value for providing environmental services and/or the cost effectiveness and likelihood that restoration efforts would succeed." In many cases, relatively easy things can be done to improve the condition of degraded riparian areas, such as planting vegetation, discontinuing those land- or water-use practices that caused degradation, removing small flood-control structures, or reducing or removing a stressor such as grazing or forestry. For a variety of reasons, however, eliminating practices causing harm can be a major challenge.

Buffer zones, both within and upslope from riparian areas, can offset some of the negative effects of anthropogenic land uses (Steedman 1988, May et al. 1997), and are currently being promoted as management measures for water quality protection throughout the world, particularly in the United States and Europe (National Research Council 2002). Establishment and maintenance of well-vegetated buffer strips along streams has become one of the most visible and widely accepted applications of watershed management, and has become a major focus in the restoration and management of landscapes (Knopf et al. 1988, Wang et al. 2001). Vegetative buffers are effective in trapping sediment, pathogens, toxins, and contaminants from runoff by intercepting NPS pollution in surface and shallow subsurface flow as well as reducing channel erosion. They are a valuable conservation practice with many important water-quality functions including moderation of stormwater runoff, moderation of water temperature, maintenance of habitat diversity, protection for wildlife species distribution and diversity, and reduction of human impacts (Lowrance et al. 1984, Cooper et al. 1987, Cheschier et al. 1991, Castelle et al. 1994, Gilliam 1994, National Research Council 2002). In urban areas, vegetated riparian zones, often called "greenbelts" or "greenways", managed for conservation, recreation, and nonmotorized transportation provide numerous social benefits and are a focus of many community enhancement programs (Fisher and Fischenich 2000).

Buffer zones are included in many BMPs including those for silvicultural and agricultural activities. However, to be effective, buffers must extend along all streams, including intermittent and ephemeral channels, because riparian buffers along headwater streams (i.e., those adjacent to first-, second-, and third-order streams) have much larger impacts on overall water quality within a watershed than those along higher-order streams (Fischer et al. 2000). In addition, buffers must be augmented with enforceable on-site sediment controls and a limited amount of impervious surfaces. Buffers are most effective at pollutant removal when surface and shallow subsurface flow is distributed uniformly as sheet flow. However, agricultural and urban areas tend to concentrate flow into channelized flow before it reaches the buffer. Furthermore, it is crucial that these riparian corridors contain native vegetation, and should be maintained or, where necessary, restored. An adequate buffer size to protect aquatic resources will depend on the specific function it needs to provide under site-specific conditions. Economic, legal and political considerations often take precedence over ecological factors when recommending size and design of buffer strips (Fischer and Fischenich 2000). Recommended designs are highly variable, but most recommended widths are for a minimum of 15-30 m under most circumstances. However, site-specific conditions may indicate the need for substantially larger buffers particularly for ecological concerns such as wildlife habitat needs which typically require much wider buffers than that needed for water quality concerns (Fischer and Fischenich 2000, Fischer et al. 2000). Riparian buffer zones should be used as part of a larger conservation management system that improves management of upland areas to reduce pollutant loads at the source, and should not be relied upon as the sole BMP for water-quality improvement. Instead, they should be viewed as a secondary practice that assists in in-field and upland conservation practices and "polishes" the hillslope runoff from an upland area (National Research Council 2002). Even when riparian buffer zones are marginally effective for pollutant removal, they are still valuable because of the numerous habitat, flood control, groundwater recharge, and other environmental services they provide. An intact naturally functioning riverine system, with riparian vegetation, in which native plant and animal communities can exist, is a critical, measurable strategy to preserve water quality and abate NPS pollution, so riparian buffers should be promoted throughout the watershed.

Land use practices in adjacent uplands must be considered and addressed in riparian area management because upslope management practices can influence the ability of riparian areas to function by altering the magnitude and timing of overland flow, the production of sediment, and quality of water arriving at a downslope riparian area (National Research Council 2002). In other words, riparian area management should be approached on a watershed scale, and watershed management plans should incorporate riparian area management whenever possible because it is a component of good watershed management. Riparian area management should be based on the same principles that characterize watershed management: partnerships, geographic focus, and science-based management (National Research Council 2002). The future success of at least five national policy objectives - protection of water quality, protection of wetlands, protection of threatened and endangered species, reduction of flood damage, and beneficial management of public lands - depends on the restoration of riparian areas (National Research Council 2002). Because many of the options for improving riparian areas across watersheds encompass a wide range of individual and societal values, there is a great need to engage various stakeholders in broad-scale and collaborative restoration efforts. Most riparian lands are in private ownership, and these owners typically have only limited motivation to use these areas in a manner protective of their ecological functions because their value is most often measured in terms of their economic benefit rather than their ecological functions (National Research Council 2002). However, an increasing number of public programs, such as the various Farm Bill conservation programs and the USFWS Private Stewardship Grants program, are offering some form of payment in return for such protection. Educational outreach for these programs should highlight the benefits these programs provide to landowners. Educational efforts on the importance of riparian areas need to reach broad and diverse audiences, and should include traditional educational institutions and reach out directly to policy makers, natural resource personnel, government officials, developers, landowners, and the public at large. To be successful, riparian education must also foster a sense of community and responsible stewardship (Orr 1990).

The health and condition of natural resources are also related to the manner in which land is developed. It often appears that land use decisions are made without regard to the sensitivity of the landscape or its suitability for development so that land development too often inhibits natural ecosystem functions (Macie and Hermansen 2002). Land use planners must reconcile economic development with environmental protection. Traditionally, effects on soils, vegetation, species composition, and hydrology have been analyzed only on a fine scale. To understand the ecological effects of urbanization, we need to look at entire landscapes (broad scale) as well as affected sites (fine scale) (Macie and Hermansen 2002). Therefore, planning and management should include broad scale considerations that cover the needs of entire ecosystems, not just the pieces. Because aquatic habitats are intrinsically connected to their watersheds, aquatic species conservation is a complex task, and may best be served by a watershed management approach. A watershed approach provides a framework to design the optimal mix of land covers, minimize the effects on water resources, and coordinate management priorities across land ownerships (Macie and Hermansen 2002). However, managing ecosystems at a watershed scale presents many challenges: most management strategies are not on a scale commensurate with issues at the watershed scale; local control or management for system components often takes precedence over system wide needs; data generally are not collected and analyzed on watershed scales; and small parcels, multiple owners, and conflicting objectives complicate coordinated management (Macie and Hermansen 2002). All public and private land managers with jurisdiction over an ecosystem should cooperate and base their joint plans on the best available conservation science, including consideration of disturbance regimes and minimum viable population sizes for key species. Managing at a watershed scale will require interagency cooperation and crossing political boundaries. Because ecosystems are so complex and in many cases exceed our ability to understand them completely, managers should use "adaptive management," meaning that managed ecosystems should be monitored so that timely action can be taken to correct for faulty management or changing conditions.

In addition to incorporating broad-scale issues, planning should consider the cumulative ecological effects of an activity in a watershed because actions that are harmless in isolation can create serious problems when large numbers of people act in the same way (Freyfogle 1997). The current degraded status of many habitats and ecosystems represents the cumulative, long-term effects of numerous persistent, and often incremental impacts from a wide variety of land uses and human alterations. Previous land management decisions often were made independent of other human activities in watersheds. Consequently, the cumulative effect of incremental changes in land cover was never assessed, and water quality and quantity declined (Macie and Hermansen 2002). Property owners can contribute to natural resource problems because they do not always take into account the consequences their land use decisions may have on their neighbors. The current system encourages private landowners to make land use decisions that are in their own short-term best interest without regard for whether these decisions will be beneficial to the broader community (Macie and Hermansen 2002). There is also a lack of long-term commitment to assess cumulative effects, and it often is not economically feasible to study, manage, and restore at such large scales (Naiman 1992)

Land use planners are faced with decisions regarding whether, how, and in what pattern land is developed, parcelized, and used. In general, such land use decision-making occurs without individual and cumulative impacts to biological resources being considered (Environmental Law Institute 2003). Preservation of our biological resources would receive tremendous help if biologically sensitive spatial planning was incorporated early in the development process. While land use planners and developers are beginning to show more interest in protecting biological diversity, these professionals often lack the necessary information to incorporate ecological principles into their decision-making and to transform their traditional planning approaches into progressive, ecologically based conservation tools (Environmental Law Institute 2003). Because the greatest threat to species and habitat is the increase in human population, land management decisions need to incorporate the principles of an ecosystem approach to decision-making (Dale et al. 2000, Flores et al. 1998, Zipperer et al. 2000). To encourage and facilitate better integration of ecological knowledge into land use and land management decision-making, the Ecological Society of America developed general guidelines (Dale et al. 2000) to assist land use planners in evaluating the ecological consequences of their decisions. Without ecological planning and collaboration, we are faced with continual urban sprawl and the loss of the ecological uniqueness of many areas.

A vital aspect of measuring success involves assessing the effect of conservation efforts on the biological resource. To abate threats to the EC watershed, ALNHP identified numerous biological goals, within which lie the measures of biological success. Inherent within some of these desired results are monitoring programs that gather more detailed information relevant to progress.

Goals

- Complete a comprehensive biological inventory of the watershed.
- Add biomonitoring to the water quality monitoring efforts in the watersheds, using species such as mussels, caddisflies or other aquatic invertebrates, fish species, and cave species sensitive to changes in water quality
- Protect and, where possible, restore riparian vegetation.
- Maintain or improve water quality and hydrologic function within the watershed.
- Maintain or restore the natural ecological processes that maintain this ecosystem, including habitat connectivity and disturbance regimes, to the extent possible.
- Increase conservation awareness and promote a land ethic within the watershed through education and outreach.
- Prevent the spread of established exotic invasive species, prevent the establishment of new invasive species, and eradicate existing populations of exotic invasive species where feasible. Include an education effort to halt the use of invasive exotics in landscaping.

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APPENDIX A. Definition of terms.

aquatic – growing, living in, or frequenting water.

biological diversity (or biodiversity) – the diversity of life in all its forms at all levels of organization and its processes, which includes the abundances of living organisms, their genetic diversity, and the communities and ecosystems in which they occur. (Hunter 1990, Dale et al. 2000)

community – A group of interacting plants and animals inhabiting a given area. (Smith 1990)

conservation – the use of natural resources in ways such that they remain viable for future generations.

ecological systems – ecological systems are dynamic assemblages of native plant and/or animal communities that 1) occur together on the landscape or in the water, 2) are tied together by similar ecological processes (e.g., fire, hydrology), underlying environmental features (e.g., soils, geology), or environmental gradients (e.g., elevation). (The Nature Conservancy 2003)

ecoregion – a relatively large geographic unit of land and water defined by the climate, vegetation, geology, and other ecological and environmental patterns. (The Nature Conservancy 2003)

Element – a unit of natural biological diversity. Elements represent species (or infraspecific taxa), natural communities, or other nontaxonomic biological entities (*e.g.,* migratory species aggregation areas, bird rookery, cave). (NatureServe 2002)

Element Occurrence – an area of land and/or water in which a species or natural community is, or was, present. An EO should have practical conservation value for the Element as evidenced by potential continued (or historical) presence and/or regular recurrence at a given location. For species Elements, the EO often corresponds with the local population, but when appropriate may be a portion of a population (*e.g*., long distance dispersers) or a group of nearby populations (*e.g*., metapopulation). For community Elements, the EO may represent a stand or patch of a natural community, or a cluster of stands or patches of a natural community. Because they are defined on the basis of biological information, EOs may cross jurisdictional boundaries. (NatureServe 2002)

Element Occurrence Record – the computerized record in the database that contains the biological and locational information regarding a specific EO, as well as an assessment and ranking of the conservation value of that EO against other EOs of its kind. It is a data management tool that has both spatial and tabular components including a mappable feature and its supporting database. (NatureServe 2002)

extant – still existing.

extinct – a plant or animal that no longer exists anywhere.

extirpated – a plant or animal that has been locally eliminated, but is not extinct.

fauna – all of the animal taxa in a given area.

flora – all of the plant taxa in a given area.

Geographic Information System (GIS) – an organized assembly of people, data, techniques, hardware, and software for acquiring, analyzing, storing, retrieving, manipulating, and displaying spatial information about the real world. (Arnoff 1993, Burrough and McDonnell 1998, Kennedy 2001).

habitat – an area with a combination of resources (like food, cover, water) and environmental conditions (temperature, precipitation, presence or absence of predators and competitors) that promotes occupancy by individuals of a given species (or population) and allows those individuals to survive and reproduce. (Morrison et al. 1998)

latitude – The angular distance along a meridian north or south of the equator, usually measured in degrees (lines of latitude also are called parallels). (Kennedy 2001) An imaginary line representing degrees north or south of the Equator. The Equator is 0 degrees while the North Pole is 90 degrees north; all latitudes in Alabama are degrees north of the Equator.

legume – Any of a large family (Leguminosae syn. Fabaceae) of dicotyledonous herbs, shrubs, and trees having a dry dehiscent one-celled fruit developed from a simple superior ovary and usually dehiscing into two valves with the seeds attached to the ventral suture, bearing nodules on the roots that contain nitrogen-fixing bacteria. (Merriam-Webster 2004)

longitude – The angular distance, expressed in degrees, minutes, and seconds, of a point on the earth's surface east or west of a prime meridian (usually the Greenwich meridian). All lines of longitude are great circles that intersect the equator and pass through the north and south poles. (Kennedy 2001) An imaginary vertical line representing degrees east or west of the Prime Meridian at Greenwich, London. Greenwich is 0 degrees while the line directly opposite it (in the Pacific Ocean) is 180 degrees west or east of the Prime Meridian; all longitudes in Alabama are degrees west of the Prime Meridian.

natural community – terrestrial plant communities of definite floristic composition, uniform habitat conditions, and uniform physiognomy. Natural communities are defined by the finest level of classification, the "plant association" of the National Vegetation Classification. Like ecological systems, natural plant communities are characterized by both a biotic and abiotic component. (The Nature Conservancy 2003)

Natural Heritage Program – a member program in a network under NatureServe that collects information on biological diversity following the Core Heritage Methodology. These programs gather, manage, and distribute detailed information about biological diversity found within their jurisdictions. Most United States Natural Heritage Programs are within state government agencies, while others are within universities or field offices of The Nature Conservancy.

perennial – Living three or more seasons. (Godfrey and Wooten 1979)

riparian – Of or relating to rivers or streams. (National Research Council 2002)

riparian area – An area of vegetation bordering a watercourse (streams, rivers, and lakes) including the stream bank and adjoining floodplain, which is distinguishable from upland areas in terms of vegetation, soils, and topography.
Technical Definition (National Research Council 2002) – Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions or terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., a zone of influence). Riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes, and estuarine-marine shorelines.

riparian restoration - the process of repairing the condition and functioning of degraded riparian areas. (National Research Council 2002)

scale (geographic) – The relationship between distance on a map and distance on the surface of the earth. Scale may be expressed with distance units (e.g., 1 cm = 1,000 m) or without distance units. (e.g., 1:10,000).

species – a group of interbreeding natural populations reproductively isolated from other such groups (Brewer 1979, Faaborg 1988); the highest level of biological classification from which organisms can breed and produce fertile offspring under natural conditions.

taxonomic group – used here to refer to organisms at the same level of organization in biological classification; for example phylum, class, or order.

watershed – those land areas that catch rain or snow and drain to specific marshes, streams, rivers, lakes, or to ground water; total area above a given point on a stream that contributes water to the flow at that point. (Smith 1990)

APPENDIX B. Definition of Heritage Ranks and Federal and State Listed Species Status.

Definition of Heritage Ranks

The Alabama Natural Heritage Program uses the Heritage ranking system developed by The Nature Conservancy. Each species is assigned two ranks; one representing its rangewide or global status (G) and one representing its subnational, or state, status (S). Species with a rank of 1 are most critically imperiled; those with a rank of 5 are most secure. Rank numbers may be combined when there is uncertainty over the status, but ranges cannot skip more than one rank (e.g., an element may be given a G-rank of G2G3, indicating global status is somewhere between imperiled and vulnerable). For more information regarding Conservation Status Ranks, see http://www.natureserve.org/explorer/ranking.htm#globalstatus

Global Ranking System

Basic Ranks

G1 Critically Imperiled – At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.

G2 Imperiled – At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.

G3 Vulnerable – At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.

G4 Apparently Secure – Uncommon but not rare; some cause for long-term concern due to declines or other factors.

G5 Secure – Common; widespread and abundant.

GX Presumed Extinct – Not located despite intensive searches and virtually no likelihood of rediscovery.

GH Historical (Possibly Extinct) – Missing; known from only historical occurrences but still some hope of rediscovery or potential for restoration.

Variant Ranks

GU Unrankable – Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. Whenever possible, the most likely rank is assigned and the question mark qualifier is added (e.g., G2?) to express uncertainty, or a range rank (e.g., G2G3) is used to delineate the limits (range) of uncertainty.

GNR Not ranked to date.

GNA Not Applicable – A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

Rank Qualifiers

? Inexact Numeric Rank – Denotes inexact numeric rank (e.g., G2?)

Q Questionable taxonomy – Taxonomic distinctiveness of this entity at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or the inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority conservation priority.

C Captive or Cultivated Only – At present extant only in captivity or cultivation, or as a reintroduced population not yet established.

State Ranking System

S1 Critically imperiled in Alabama because of extreme rarity (5 or fewer occurrences of very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation from Alabama.

S2 Imperiled in Alabama because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from Alabama.

S3 Rare or uncommon in Alabama (on the order of 21 to 100 occurrences).

S4 Apparently secure in Alabama, with many occurrences.

S5 Demonstrably secure in Alabama and essentially "ineradicable" under present conditions.

SX Presumed Extirpated – Species or community is believed to be extirpated from Alabama. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.

SH Historical (Possibly Extirpated) – Species or community occurred historically in Alabama, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or community could become SH without such a 20-40 year delay if the only known occurrences in a nation or state/province were destroyed or if searches had been extensive and unsuccessful. The SH rank is reserved for species and natural communities for which some effort has been made to relocate occurrences.

SNR Unranked – Status not yet assessed.

SU Unrankable – Currently unrankable due to lack of information or substantially conflicting information about status or trends.

SE Exotic - An exotic species established in Alabama.

SA Accidental in Alabama, including species (usually birds or butterflies) recorded once or twice or only at very great intervals, hundreds or even thousands of miles outside their usual range; a few of these species may even have bred on the one or two occasions they were recorded.

SNA Not Applicable – A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

SR Reported, but without persuasive documentation which would provide a basis for either accepting or rejecting the report (e.g. misidentified specimen).

SRF Reported in error (falsely), but this error persisted in the literature.

Qualifiers

? Inexact or Uncertain – Denotes inexact or uncertain numeric rank. (The ? qualifies the character immediately preceding it in the S-rank.)

Breeding Status Qualifiers:

B Breeding – Refers to the breeding population of the species in the state

N Nonbreeding – Refers to the non-breeding population of the species in the state.

M Migrant – Migrant species occurring regularly on migration at particular staging areas or concentration spots where the species might warrant conservation attention. Refers to the aggregating transient population of the species in the nation or state/province.

Note: A breeding status is only used for species that have distinct breeding and/or non-breeding populations in Alabama. A breeding-status S-rank can be coupled with its complementary non-breeding-status S-rank if the species also winters in Alabama, and/or a migrant-status S-rank if the species occurs regularly on migration at particular staging areas or concentration spots where the species might warrant conservation attention. The two (or rarely, three) status ranks are separated by a comma (e.g., "S2B,S3N" or "SHN,S4B,S1M").

Infraspecific Taxon Conservation Status Ranks

Infraspecific taxa refer to subspecies, varieties and other designations below the level of the species. Infraspecific taxon status ranks (T-ranks) apply to plants and animal species only; these T-ranks do not apply to ecological communities.

T# Infraspecific Taxon (trinomial) – The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank. Rules for assigning T-ranks follow the same principles outlined above for global conservation status ranks. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. A T-rank cannot imply the subspecies or variety is more abundant than the species as a whole-for example, a G1T2 cannot occur. A vertebrate animal population, such as those listed as distinct population segments under the U.S. Endangered Species Act, may be considered an infraspecific taxon and assigned a T-rank; in such cases a Q is used after the T-rank to denote the taxon's informal taxonomic status. At this time, the T rank is not used for ecological communities. T ranks are used only on global ranks; the corresponding state rank refers to the infraspecific taxon only.

Rank Criteria, Relationship to Other Status Designations

Ranking is a qualitative process, with multiple factors going into rank decisions. For species elements, the following factors are applied:

1. total number and condition of occurrences (sightings/records) of that species
2. population size
3. range extent and area of occupancy
4. short and long-term trends in the first 3 factors
5. threats to the element
6. fragility of the element

Heritage Ranks are often, but not always comparable to statuses assigned by government agencies. For instance, the Heritage subnational ranking for an endangered species my not be S1. For this reason, Federal and State status is also given for species of conservation concern where possible.

Definitions of Federal and State Listed Species Status

Federal Listed – U.S. Fish and Wildlife Service:

LE Endangered Species – in danger of extinction throughout all or a significant portion of their range.

LT Threatened Species – likely to become an endangered species within the foreseeable future throughout all or a significant portion of their range.

PE Proposed Endangered – the species is proposed to be listed as endangered.

PT Proposed Threatened – the species is proposed to be listed as threatened.

PS Partial Status – an intraspecific taxon or population has federal status but the entire species does not-- status is in only a portion of the species range

C Candidate – Species for which the U.S. Fish and Wildlife Service has on file enough substantial information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened. Development and publication of proposed rules on Candidate taxa are anticipated, and USFWS encourages other agencies to give consideration to such taxa in environmental planning.

XN Experimental non-essential population – experimental non-essential population

State Protected Status, Alabama – Alabama Dept. of Conservation & Natural Resources, Wildlife & Freshwater Fisheries:

SP State Protected – Species with a state protected status are protected by the Nongame Species Regulation (Section 220-2-.92, page 74-77) and the Invertebrate Species Regulation (section 220-2-.98, pages 77-79) of the Alabama Regulations for 2002-2003 on Game, Fish, and Fur Bearing Animals. Copies of these regulations may be obtained from the Division of Wildlife & Freshwater Fisheries, Alabama Department of Conservation & Natural Resources, 64 North Union Street, Montgomery, AL 36104. A digital version of these regulations is available online at <http://www.dcnr.state.al.us/hunting/regulations/AL-gamefish.pdf> and the list of protected species is posted at <http://www.dcnr.state.al.us/research-mgmt/regulations/reg220-2-92nongame.cfm>.

SP-P Partial State Protected – Species partially protected by regulations in the Alabama Regulations for 2002-2003 on Game, Fish, and Fur Bearing Animals through mechanisms such as size limits.

APPENDIX C. Scales of Biodiversity and Geography

Two concepts of scale underlie the standard TNC approach (called the Five-S Framework) to site conservation applied in this study: (1) biodiversity scale - level of biological organization and (2) geographic or spatial scale. It is important to understand how biodiversity and spatial scale interact and the importance and effect of spatial scale.

Biodiversity can be examined at many levels of biological organization (genes, species, communities, ecosystems, and landscapes), which can occur and function at various spatial scales. The importance of working at the correct spatial scale (as well as temporal and other scales) in relation to the process or biological organizational level of interest has increasingly been emphasized in conservation planning.

The Five-S approach identifies 4 spatial scales (and the corresponding biological scale), with each scale corresponding to a characteristic range in area or stream length; regional, coarse, intermediate, and local scale.

- Regional Scale (Species) – > 404,686 hectares (>1,000,000 acres), migrating long distances

- Coarse Scale (Species, Matrix Communities and Systems) – 8,093 - 404,686 hectares (20,000 - 1,000,000 acres), $\geq 4^{th}$ order and larger river network, > 1,011 ha (> 2,500 ac) lake

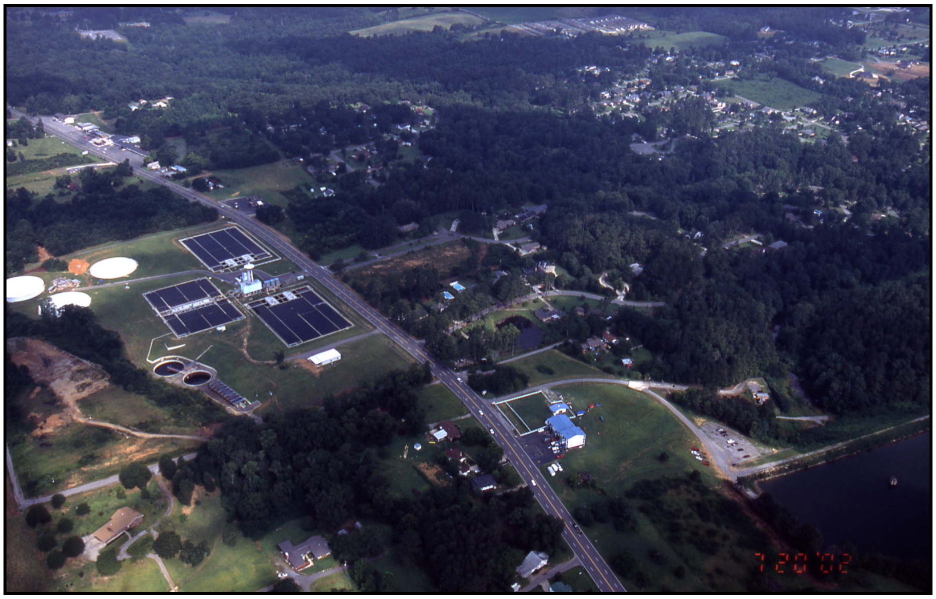
- Intermediate Scale (Species, Large Patch Communities and Systems) – 404 - 20,234 hectares (1,000 - 50,000 acres), 1^{st} – 3^{rd} order stream network, 101 - 1,011 ha (250 - 2,500 ac) lake

- Local Scale (Species, Small Patch Communities and Systems, Aquatic Macrohabitats) - < 209 hectares (<2,000 acres), < 16 river kilometers (< 10 mi), < 101 ha lake (< 250 ac)

Site conservation planning primarily focuses on biodiversity at the coarse, intermediate, and local scales. Because of the small size of the MCR watershed, regional scale targets were not addressed in the context of this assessment.

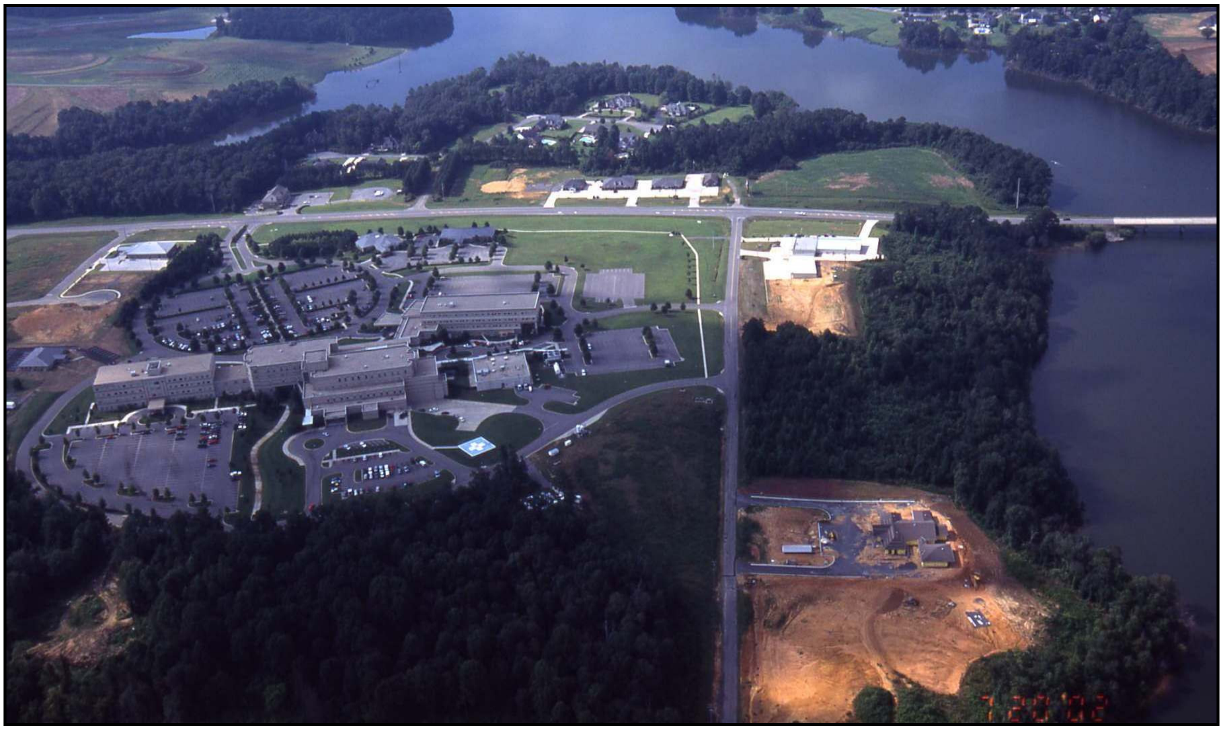
APPENDIX D. Potential point and nonpoint source pollution sources in the Cotaco Creek watershed identified by the Consortium of Alabama Environmental Groups using low-flying aircraft.

Site: CULL01 Waterbody: Eightmile Creek County: Cullman
Activity: municipal water Potential Pollution Problem: parking runoff



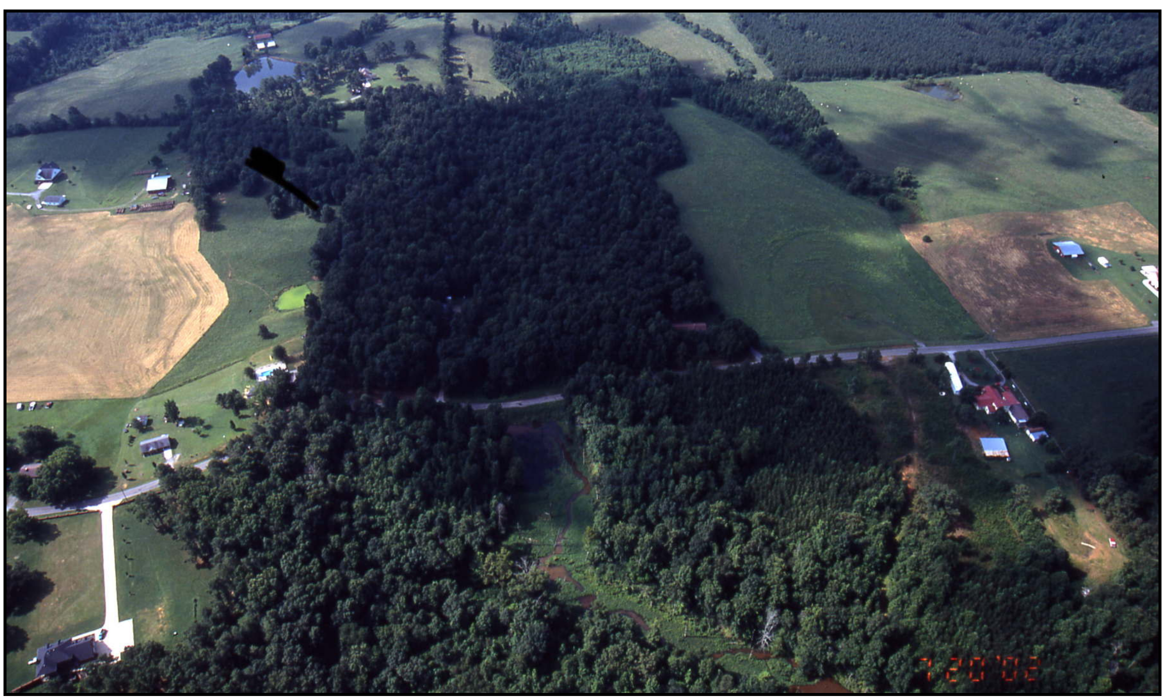
Site: CULL02 Waterbody: Eightmile Creek County: Cullman
Activity: nursery Potential Pollution Problem: nutrient runoff

Site: CULL03 Waterbody: Eightmile Creek County: Cullman
Activity: hospital Potential Pollution Problem: storm water runoff

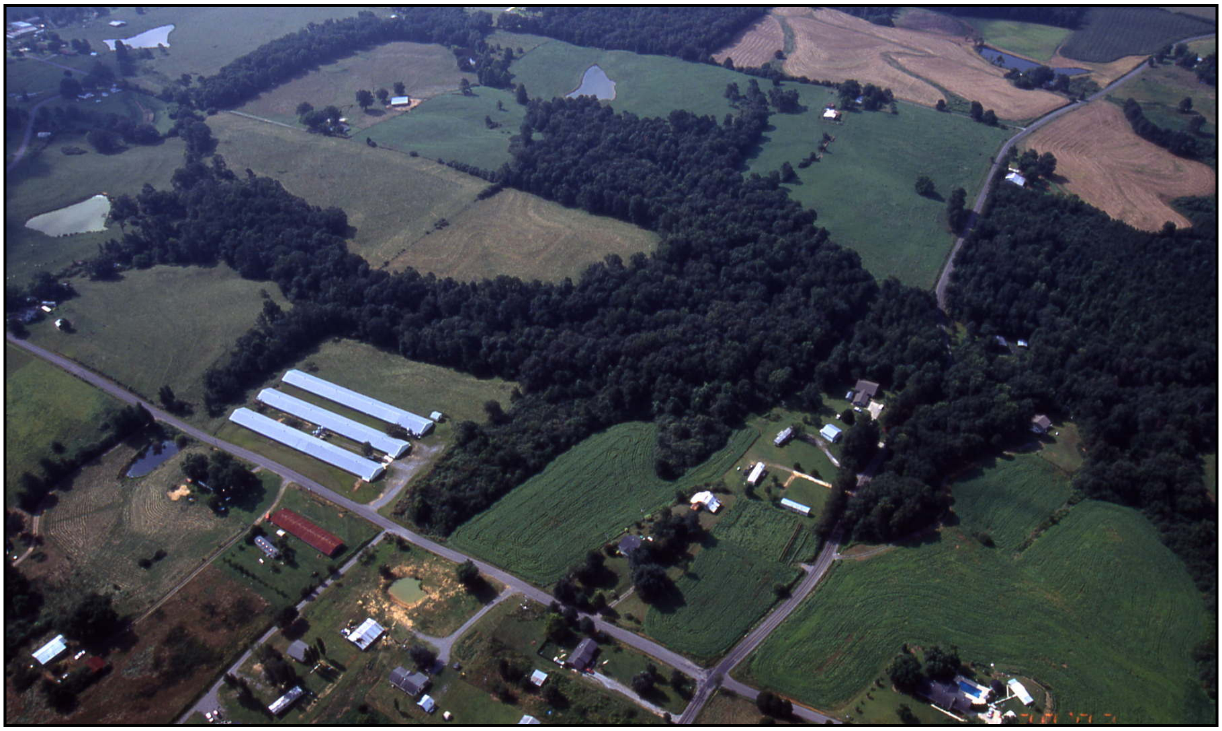


Site: CULL04 Waterbody: Eightmile Creek County: Cullman
Activity: cattle pasture Potential Pollution Problem: nutrient runoff

Site: CULL07 Waterbody: Eightmile Creek County: Cullman
Activity: agricultural runoff Potential Pollution Problem: nutrient runoff



Site: CULL05 Waterbody: Eightmile Creek County: Cullman
Activity: chicken CAFO Potential Pollution Problem: nutrient runoff



Site: CULL06 Waterbody: Eightmile Creek County: Cullman
Activity: chicken CAFO Potential Pollution Problem: nutrient runoff