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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 3: Cotaco Creek

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 Cotaco Creek watershed.

The Cotaco Creek (CC) watershed encompasses approximately 706 km^2 (273 mi^2) in the Tennessee River basin in northeast Alabama. The majority of the watershed is within Morgan County, but a small portion of the eastern watershed is within Marshall County and a miniscule portion of the southern headwaters is in Cullman County. Cotaco Creek begins at its headwaters in southeastern Marshall County and flows in a northerly direction to its confluence with the Tennessee River in Wheeler Lake.

There were 64 occurrences of rare plant and animal species and natural features documented in the CC watershed. The animals documented in the watershed were either fish (37%) or species associated with caves (63%). The rare species documented in the CC watershed included 10 occurrences of 6 species that are federal or state protected species: 2 fish, 3 mammals, and 1 plant. There were an additional 8 occurrences of 4 species globally imperiled (rank G1 or G2) by natural heritage ranks that are not state or federally protected. There were 24 occurrences (3 historical) of 13 species without state or federal protection considered state imperiled (rank S1 or S2) but not globally imperiled.

Thirty-five 100 ha rare species areas were identified in the CC watershed: 10 critical, 14 imperiled, and 11 rare. The number of EORs within these areas ranged from 1 to 6, with 57% having only 1 rare species documented within the area covered by the hexagon.

Six conservation targets were chosen for the CC watershed: matrix forest communities (oak-hickory-pine forest), imperiled bats, riparian vegetation, karst communities, imperiled freshwater fish, and imperiled plants.

Two managed areas were identified within the CC watershed (Fig. 5): Newsome Sinks Karst Area National Natural Landmark (NSKANNL) and Wheeler National Wildlife Refuge. Half of the rare species occurrences documented in the CC watershed occurred on these 2 areas. However, only 11 rare species occurrences (17.2%) occur on public property because NSKANNL is privately owned. Therefore, maintaining habitat for rare, threatened, and endangered species will require outreach to private landowners and potential public-private partnerships for private land management in addition to proper management of public lands.

Alabama's 2000 Final 303 (d) list of impaired waters includes 5 stream reaches in the CC watershed that do not support their water use classifications: Town Creek (non-support), Cotaco Creek (non-support), West Fork Cotaco Creek (partial support), Mill Pond Creek (non-support), and Hughes Creek (partial support). The use not met for all 5 stream reaches was fish and wildlife, and the causes for listing were siltation, pathogens, or dissolved oxygen; all from agriculture. No rare species were within 1 km of the listed stream reach of Mill Pond Creek. Town Creek and West Fork Cotaco Creek contained 1 rare fish species, but there was no other rare species occurrence within 1 km of these creeks. There was 1 fish in Cotaco Creek and 1 imperiled plant within 1 km of Cotaco Creek. There were 6 rare species occurrences within 1 km of Hughes Creek, including 2 federal endangered bats.

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, 6 major sources of stress were identified in the watershed: agriculture (crop and livestock production practices), development (including roads), forestry, invasive/alien species, recreational use, and waste disposal (trash and septic systems). These threats are compounded by habitat fragmentation and the isolation and small population sizes of many of the rare species that occur in the watershed.

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 primary effects of livestock grazing include the removal and trampling of vegetation, compaction of underlying soils, and dispersal of exotic plant species and pathogens. 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. 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. Where it is not feasible to exclude cattle from streams, the impacts can be 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.

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 both watersheds. Implementation of the strategies outlined in the Watershed Management Plan to reduce agricultural pollution and TNC's Cumberland and Southern Ridge and Valley Ecoregion Plan for abating threats from agricultural practices will help with conservation of aquatic species 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.

Because of their life cycle, small population sizes, and limited habitat availability, many aquatic species are highly susceptible to competitive or predaceous nonnative species. The most abundant aquatic invasive faunal species of concern in CC watershed is the Asian clam (*Corbicula fluminea*), which has invaded all major drainages in Alabama. There are numerous invasive plant species in the watershed, including 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.

Recreational Use

The two main sources of impact from recreational use are off-road ATV or truck use, particularly in stream beds and near stream channels, and recreational uses of caves. The recreational use of ATVs and 4-wheel drive vehicles has the potential to have a large negative impact on both terrestrial and aquatic communities. When these vehicles are operated off trails, they disturb the soil which can lead to increased erosion and sedimentation in the streams. Recreational usage of caves can have significant negative impacts on cave fauna caused by the disturbance to these communities. It was the most significant negative impact in the decline of gray bats and Indiana bats that led to their listing as endangered species.

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 CC watershed contains a relatively high 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.

In many rural areas, dead end roads, sinkholes, and streams commonly become disposal sites for garbage and other waste materials. These places are eyesores and pose a threat to ground and surface water quality as well as being a public health hazard. They can quickly contaminate surface and ground water with toxins and pathogens. When the disposal site is a sinkhole or cave, dumping can also cause disturbance to the habitat. Efforts should be made to find and eliminate any illegal dumping sites, particularly those using sinkholes.

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. Many areas of CC watershed have not been surveyed or have been surveyed only for specific taxonomic groups. A comprehensive survey is needed throughout the watershed, particularly for terrestrial species, aquatic invertebrates, and cave fauna.

Karst areas warrant focused protection and pollution prevention efforts because of their abundance in northern Alabama, their importance as drinking water supplies, their sensitivity to environmental disturbance, and their exceptional ecological diversity. BMPs for stormwater management and silvicultural and agricultural activities should be strongly encouraged and promoted throughout the watershed, with a strong emphasis around karst areas.

One of the greatest general threats to the survival of many rare species populations in the watershed is the isolation and small size and extent of the populations that remain which magnifies the negative impacts of anthropogenic stresses. These small isolated populations remain vulnerable to extinction or extirpation due to demographic and environmental stochasticity, catastrophic events, or habitat loss and degradation caused by the many potential stresses in the watersheds. For several species maintaining the species as part of the biota in the watershed may require not only protection of existing populations, but also reintroductions into currently unoccupied portions of their historic range.

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 MCR and UCR watersheds, 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. Many of the strategies developed in the Watershed Management Plan and TNC's Cumberland and Southern Ridge and Valley Ecoregion Plan could be applied to address these goals.

Goals

- Protect and maintain multiple, viable populations of all local scale conservation targets ensuring that, for each species, enough populations are protected to conserve their remaining natural range of ecological and genetic diversity.
- 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.
- Identify recharge areas affecting karst communities and monitor karst communities for declines.
- 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.
- Conserve key parcels through easements, acquisitions, or government funded programs such as the USFWS Landowner Incentive Program and the various Farm Bill conservation programs.

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INTRODUCTION

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 2002) 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 2002). 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 2002). 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 2002).

NPS pollution is one of the leading national threats to biodiversity (Richter et al. 1997), particularly freshwater aquatic species which have the largest percentage of species extinct or at risk of any of the species groupings. NPS pollution has been identified as the leading factor contributing to the jeopardized status of southeastern native freshwater fishes (Etnier 1997), with excessive sedimentation resulting from poor land-use patterns identified as one of the most insidious threats to southeastern fish, mussels, and snails (Bogan et al. 1995, Walsh et al. 1995, Etnier 1997, Neves et al. 1997). 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. Alabama is ranked second in the number of species that have become extinct; only Hawaii is ranked higher (Stein 2002). Although Alabama is not ranked in the top five states for any single major taxonomic group, it is ranked fourth in total number of species at risk of extinction behind Hawaii, California, and Nevada (Stein 2002). The majority of the extinct species and a large number of the 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). Noss and Peters (1995) developed various risk indices to evaluate ecosystem risks, and ranked each state in one of 3 categories: extreme risk, high risk, or moderate risk. Alabama was ranked in the extreme risk category for the overall risk index and ecosystem risk index and high risk for the species risk index. Alabama was ranked second with regard to number of the 21 most endangered ecosystems represented in the state and fifth in total risk to ecosystems.

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 Cotaco Creek watershed. 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 Cotaco Creek (CC) watershed encompasses approximately 706 km^2 (273 mi^2) in the Tennessee River basin in northeast Alabama (Fig. 1). The majority of the watershed is within Morgan County, but a small portion of the eastern watershed is within Marshall County and a miniscule portion of the southern headwaters is in Cullman County. Cotaco Creek begins at its headwaters in southeastern Marshall County and flows in a northerly direction to its confluence with the Tennessee River in Wheeler Lake. The tributaries in the watershed all drain directly to CC. The CC watershed is one of the USGS fourth level hydrological classification cataloging units (11-digit HUC – 06030002270). Its larger parent cataloging unit at the 8-digit HUC level is Wheeler Lake (06030002).

The majority of the CC 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)), but a small portion of the northwestern watershed along an unnamed stream feeding Wheeler Lake is within the Piedmont ecoregion (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 also is 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.

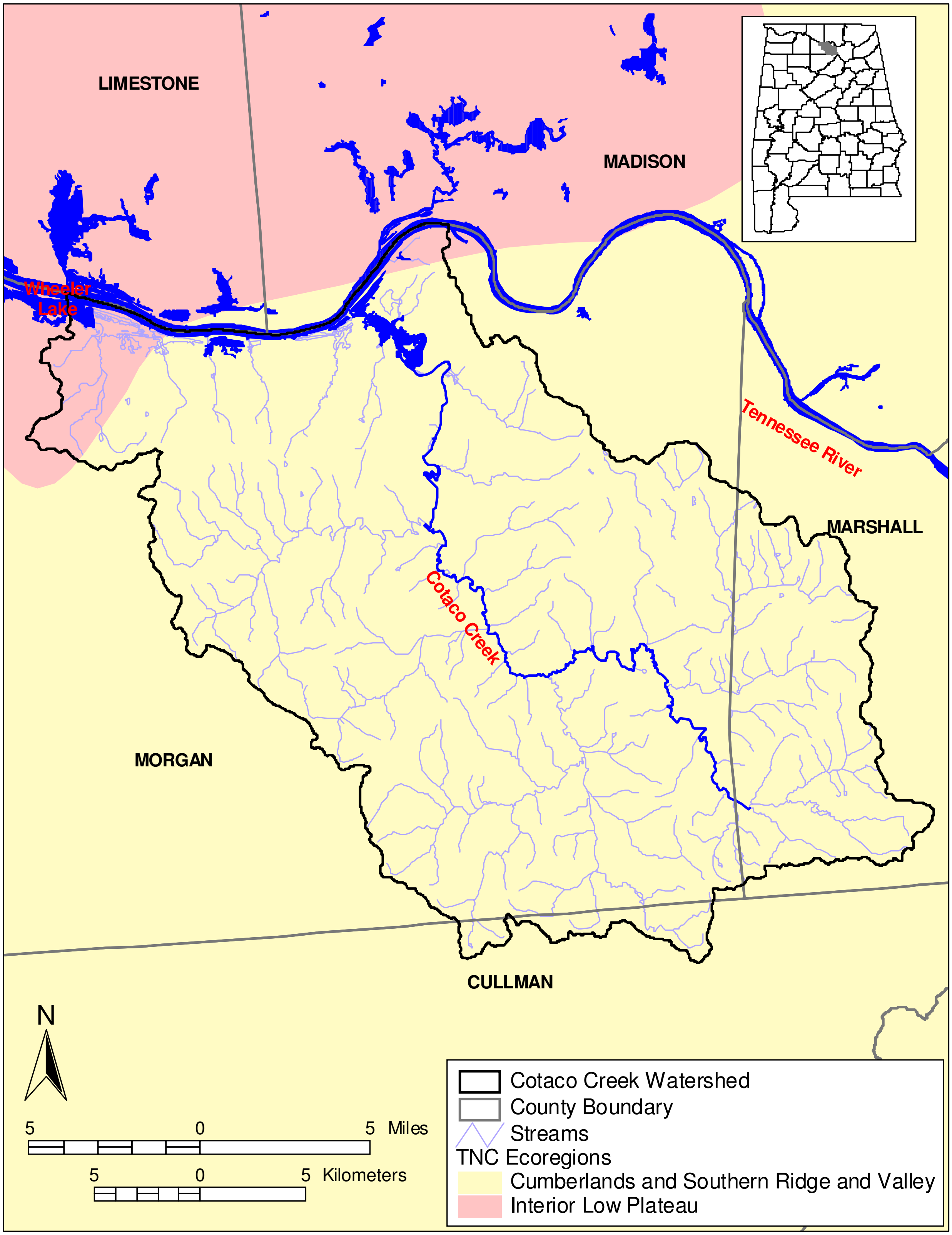

Figure 1. Location of the Cotaco Creek watershed in north Alabama.

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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.

The Tennessee and Cumberland River basins form one of the global epicenters for freshwater biodiversity, and may possibly represent the most diverse temperate freshwater assemblage in the world (Starnes and Etnier 1986). This region contains the most diverse freshwater animal assemblage in the country, with the highest number of fish, mussels, crayfish, and endemic (found nowhere else) freshwater fauna in North America (Smith et al. 2002). The species documented in this region include 231 fish (67 endemic), 125 mussels (20 endemic), and 65 crayfish (40 endemic). Mettee et al. (2002) documented 65 fish species occurring in the CC watershed. However, the fauna also includes a high number of at-risk species; more than 57 species of fish and 47 species of mussels are classified as at-risk (Master et al. 1998). Wheeler Lake contains 23 at-risk fish and mussel species; the seventh-highest total number identified nationwide by Masters et al. (1998) for USGS Hydrologic Cataloging Units (8-digit HUC). The primary human-induced negative impacts to the Tennessee-Cumberland rivers region are hydrologic alteration from impoundments, channelization, and land use; pollution from industrial, urban, and agricultural runoff; excessive sedimentation; and rapid urban expansion (Abell et al. 2000).

The CC watershed is contained within the Wheeler Lake watershed (8-digit HUC). The Wheeler Lake watershed was identified as a watershed critical to conserving freshwater fish and mussel species, and was considered to be a hot spot (>10 species) for at-risk fish and mussel species (Master et al. 1998). TNC's Cumberland and Southern Ridge and Valley Ecoregion Plan (The Nature Conservancy 2003) identified 2 terrestrial and 1 aquatic conservation areas in CC watershed (Fig. 2). Conservation areas can be considered to be broad-scale areas for enacting a wide range of conservation measures which may be tailored to specific targets at a variety of scales. The 2 terrestrial conservation areas were approximately 4,017 ha (9,925 ac) around Newsome Sinks and an approximately 313 ha (772 ac) functional site at Yellow Bluff. The aquatic conservation area included the entire length along the Tennessee River in the watershed. Another terrestrial conservation area (Brindley Mountain) was identified along the northeast edge of the watershed (Fig. 2). Threats to TNC conservation targets identified in the ecoregion included incompatible forestry practices, residential development, agricultural practices, fire suppression, impoundments/stream modification, mining practices, incompatible recreation, industrial/municipal pollution, invasive exotic species, and oil & natural gas drilling.

Like much of the Tennessee River basin, dam construction, channelization, and other human development has drastically altered the hydrology within the CC watershed and the larger Wheeler Lake watershed in which it is contained. The entire length of the Tennessee River in the watershed is inundated by the impoundment formed by Wheeler Dam. The Tennessee Valley Authority (TVA) completed construction of Wheeler Dam October 3, 1936, forming the 27,154 ha (67,100 ac) Wheeler Lake. It was the first of 8 dams TVA constructed on the Tennessee River for flood control, navigation, and power generation. Wheeler Lake is Alabama's second largest reservoir and the largest Tennessee River lake in north Alabama, stretching from Wheeler Dam upstream 60 miles to Guntersville Dam. It is a major recreation and tourist center, attracting about four million visits a year for camping, boating, and fishing. Barge traffic on Wheeler Lake has made it one of the major centers along the Tennessee waterway for shoreline industrial development.

The Alabama Department of Environmental Management (ADEM) rated the potential for NPS impairment within the watershed as moderate, and selected CC watershed as one of nine priority subwatersheds within the Wheeler Lake cataloging unit due to biological, chemical, and habitat quality conditions within CC watershed (Alabama Department of Environmental Management 2000a). 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. Six sources for potential NPS impairment in the watershed (forestry practices, development, sedimentation, animal husbandry, pasture runoff, and row crops) were evaluated. Development was the only activity in the watershed rated as having a high NPS impairment potential, but animal husbandry, pasture runoff, and row crops were rated as having a moderate NPS impairment potential. The Geological Survey of Alabama or the Tennessee Valley Authority evaluated eight stream reaches within the watershed using fish community assessments from 1991 to 1995, with all but one reach determined to have a poor quality fish community (Alabama Department of Environmental Management 2000a). Aquatic macroinvertebrate community assessments of 5 stream reaches in the watershed resulted in ratings of poor/fair for 3 stream reaches and fair for 2 reaches (Alabama Department of Environmental Management 2000a).

METHODS

Rare, Threatened, and Endangered Species

Rare, threatened, and endangered species in the CC 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).

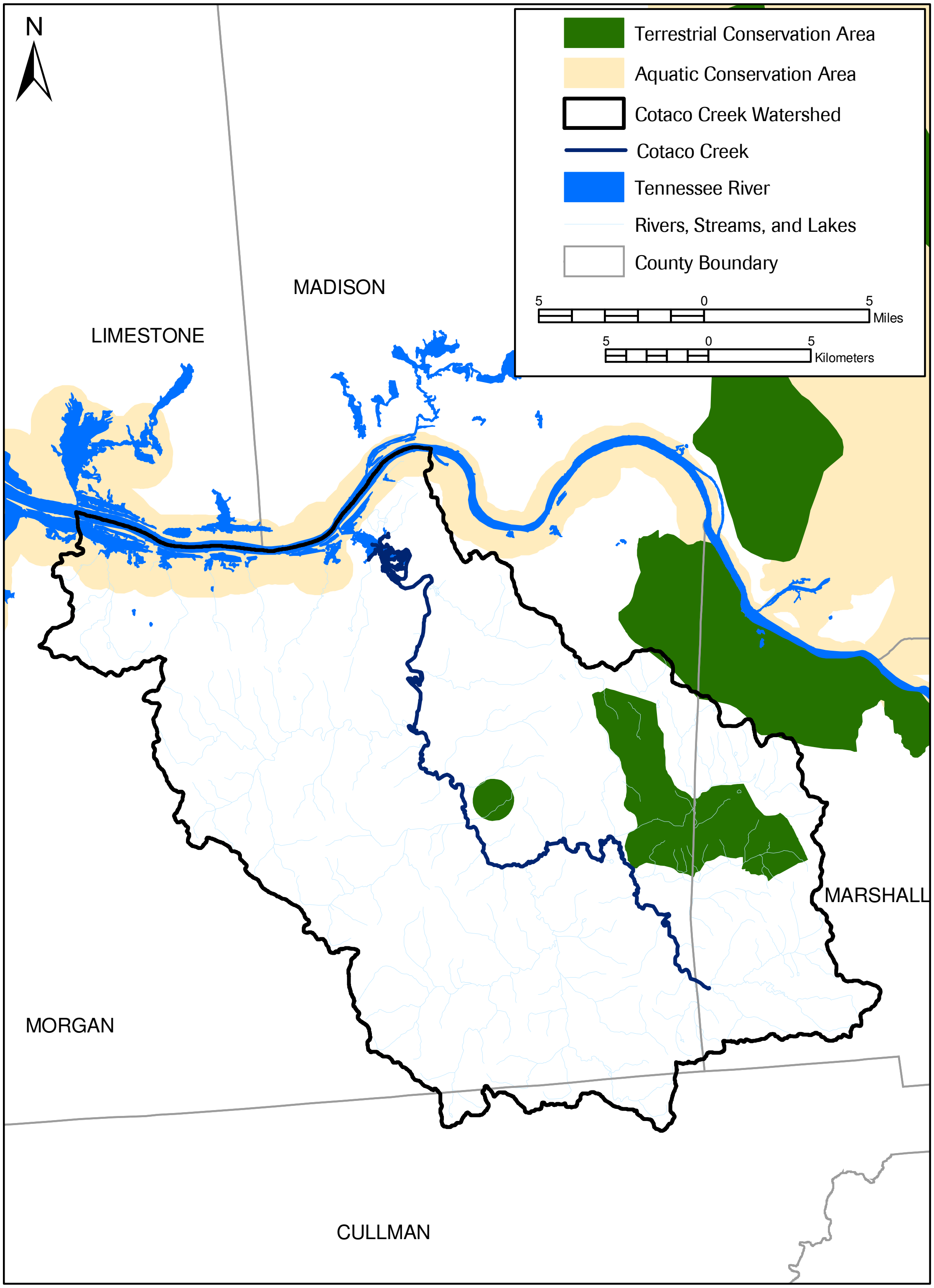

Figure 2. Freshwater and aquatic conservation areas in the Cotaco Creek watershed as identified by The Nature Conservancy in their Cumberlands and Southern Ridge & Valley Ecoregion Conservation Plan (The Nature Conservancy 2003).

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Rare species in the CC watershed were identified by selecting EORs within the watershed boundaries within a geographic information system (GIS). All GIS operations and analyses were conducted using ArcView 3.3 or ArcGIS 8.3 (Environmental Systems Research Institute, Redlands, California, USA). The EOR spatial file was created by exporting all EORs from BCD and converting them to an ArcView (Environmental Systems Research Institute, Redlands, California) shapefile format. EORs within the CC watershed were selected by intersecting the EOR shapefile with a shapefile delineating the watershed boundaries. The association between EORs and water bodies was evaluated using the EOR shapefile and Environmental Protection Agency's (EPA) National Hydrography Dataset (NHD) coverage (available online at http://nhd.usgs.gov/data.html). NHD data for the watersheds were buffered to 100 m, and the number of EORs within the buffer were counted using the Count Points in Polygon Extension for ArcView (Zhou 2000).

Rare species areas were identified using a 100-ha hexagon coverage generated using the Make Hexes command of the Habitat Analyst module of Patch Analyst Extension 2.2 for ArcView (Rempel 2002). The number of EORs within the hexagon were counted using the Count Points in Polygon Extension for ArcView (Zhou 2000). Hexagons were coded "critical", "imperiled", and "rare" based on the federal and state protection status and heritage rank of the species present within the hexagon. Hexagons were coded "critical" if federal or state protected species or species with a heritage rank of G1 or S1 were within the hexagon. "Imperiled" hexagons were those containing species with a heritage rank of G2 or S2 without federal or state protection. "Rare" hexagons were those containing species with a heritage rank of G3 – G5 without federal or state protection.

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 CC watershed were defined by the watershed. However, prioritizing focal areas within the watershed was determined by defining 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). Conservation targets were selected to represent the biodiversity within the site as determined from ALNHP's records.

Human Context Information

Managed Areas

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 CC 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 CC 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 for the watershed, 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

Agricultural & Animal Production

Animal concentrations for the watershed were obtained from ASWCC (1998). Confined animal feeding operation (CAFO) locations were identified using data from ADEM. Additional CAFO locations were identified using aerial photos of the watershed to identify clustered buildings characteristic of these locations (Brian Burgess, personal communication).

Permitted Sites

Permitted discharge sites within the watershed were 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

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

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 dam and mine locations. Descriptions below are from the metadata for these files (United States Environmental Protection Agency 2001b). The sites were buffered in the GIS, and the resulting files were intersected with the BCD export file to determine which sites were in the vicinity of rare species.

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.

Septic Systems

The number of estimated septic systems and estimated number of failing septic systems within the watershed was obtained from Alabama Soil and Water Conservation Committee published estimates (Alabama Soil and Water Conservation Committee 1998).

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.

303 (d) Listed Streams

Alabama's 2000 Final 303 (d) list of impaired streams and the corresponding GIS file were obtained online from ADEM (2000b). The streams were buffered in the GIS and the resulting file was intersected with the BCD export file to determine rare species in the vicinity of the listed streams.

RESULTS AND DISCUSSION

Rare, Threatened, and Endangered Species

There were 64 occurrences of rare plant and animal species and natural features documented in the CC watershed (Appendix D). Eighteen of these rare species occurrences were historical, occurrences last observed >20 years ago, and 21 had no date last observed associated with the record. Some of these historical populations likely have been extirpated from the watershed as habitat conditions have changed. However, some populations may still be extant because the historical occurrence status may reflect the lack of survey effort since last observed rather than a loss of the population. Therefore, these historical occurrences need to be visited to determine if the population is still extant.

The rare species documented in the CC watershed included 10 occurrences of 6 species that are federal or state protected species (Table 2): 2 fish, 3 mammals, and 1 plant. One of the fish and the 3 mammals were associated with or use caves. Six of these occurrences were historical occurrences that need to be revisited to determine if the population is still extant. There were an additional 8 occurrences (2 historical) of 4 species globally imperiled (rank G1 or G2) by natural heritage ranks that are not state or federally protected (Table 3). This included 1 plant and 3 cave species: 1 arachnid and 2 crustaceans. There were 24 occurrences (3 historical) of 13 species without state or federal protection considered state imperiled (rank S1 or S2) but not globally imperiled in the watershed (Table 4). This included 3 cave obligate insects and 10 plants.

The majority of the animal occurrences were cave obligate or cave associated species: 26 of the 41 animal occurrences were associated with a cave. In addition, the 2 natural features included in the occurrences were caves, and at least 12 of the 22 plant occurrences occurred in the vicinity of caves as they were located within the Newsome Sinks Karst Area National Natural Landmark. There were 5 caves with >1 rare animal documented occurring within the cave: Cave Springs Cave, Talucah Cave, Hughes Cave, Eudy Cave, and an unnamed cave in the Newsome Sinks area.

Cave Spring Cave is located in Morgan County in Wheeler National Wildlife Refuge (WNWR), and supports a large gray bat breeding colony. This cave is protected by the USFWS with a gate that restricts access. It had 6 rare species documented within the cave: a cave obligate beetle (*Batriasymmodes spelaeus*), Alabama cave crayfish (*Cambarus jonesi*), Cave Spring Cave spider (*Nesticus jonesi*), the federal endangered gray bat (*Myotis grisescens*), phantom cave crayfish (*Procambarus pecki*), and the state protected southern cavefish (*Typhlichthys*

Table 2. Federal listed endangered and threatened species and state protected species documented by the Alabama Natural Heritage Program[SM] occurring in the Cotaco Creek watershed, Alabama.

Major Group	Scientific name	Common Name	Global Rank[a]	State Rank[a]	Federal Status[a]	State Protected[a]	Number of Occurrences[b]
Fish	*Etheostoma tuscumbia*	Tuscumbia darter	G2	S2		SP	1[c]
Fish	*Typhlichthys subterraneus*	southern cavefish	G4	S3		SP	3[c]
Mammals	*Corynorhinus rafinesquii*	Rafinesque's big-eared bat	G3G4	S2		SP	1[c]
Mammals	*Myotis grisescens*	gray bat	G3	S2	LE	SP	3
Mammals	*Myotis sodalis*	Indiana bat	G2	S2	LE	SP	1[c]
Vascular Plants	*Asplenium scolopendrium* var *americanum*	American Hart's-tongue fern	G4T3	S1	LT		1

[a] See Appendix B for an explanation of Global and State Ranks and Federal and State Protection Status.
[b] Number of Element Occurrence Records in ALNHP's Biological Conservation Database as of March 2004.
[c] All occurrences were historical.

Table 3. Globally imperiled (G2) or critically imperiled (G1) species without state or federal protection documented occurring within the Cotaco Creek watershed, Alabama, by the Alabama Natural Heritage Program[SM]. Imperilment status was indicated by Natural Heritage ranks.

Major Group	Scientific name	Common Name	Global Rank[a]	State Rank[a]	Number of Occurrences[b]
Arachnids	*Nesticus jonesi*	Cave Spring Cave spider	G1G2	S1	1
Crustaceans	*Cambarus jonesi*	Alabama cave crayfish	G2	S2	2[c]
Crustaceans	*Procambarus pecki*	phantom cave crayfish	G1	S1	1[c]
Vascular Plants	*Silphium brachiatum*	Cumberland rosinweed	G2	S2	4

[a] See Appendix B for an explanation of Global and State Ranks and Federal and State Protection Status.
[b] Number of Element Occurrence Records in ALNHP's Biological Conservation Database as of March 2004.
[c] One occurrence was historical.

Table 4. State imperiled (S2) or critically imperiled (S1) species not globally imperiled and without state or federal protection documented occurring within the Cotaco Creek watershed, Alabama, by the Alabama Natural Heritage Program[SM]. Imperilment status was indicated by Natural Heritage ranks.

Major Group	Scientific name	Common Name	Global Rank[a]	State Rank[a]	Number of Occurrences[b]
Insects	*Batrisodes valentinei*	a beetle	G3G4	S2	1
Insects	*Pseudanophthalmus fluviatilis*	a cave obligate beetle	G3	S2	8
Insects	*Pseudosinella spinosa*	a cave obligate springtail	G3G4	S?	1
Vascular Plants	*Allium tricoccum*	wild leek	G5	S1	1
Vascular Plants	*Callirhoe alcaeoides*	clustered poppy-mallow	G5?	S2	1
Vascular Plants	*Cotinus obovatus*	American smoke-tree	G4	S2	1
Vascular Plants	*Cystopteris tennesseensis*	Tennessee bladderfern	G5	S2	1[c]
Vascular Plants	*Dicentra cucullaria*	Dutchman's breeches	G5	S2	1
Vascular Plants	*Equisetum arvense*	field horsetail	G5	S2	2[c]
Vascular Plants	*Lilium canadense*	Canada lily	G5	S2	2
Vascular Plants	*Mitella diphylla*	miterwort	G5	S1	2
Vascular Plants	*Trillium flexipes*	nodding trillium	G5	S2S3	2
Vascular Plants	*Triosteum angustifolium*	yellowleaf tinker's-weed	G5	S1	1

[a] See Appendix B for an explanation of Global and State Ranks and Federal and State Protection Status.
[b] Number of Element Occurrence Records in ALNHP's Biological Conservation Database as of March 2004.
[c] All occurrences were historical.

subterraneus). Although the area surrounding the cave is mostly protected within WNWR, the agriculture and residential development outside the refuge could affect the recharge area for Cave Spring and the cave.

Talucah Cave is a privately owned cave in Morgan County <3 km from the Tennessee River that has a large main entrance and several smaller entrances. It is one of the better known and larger caves in the county (Jones and Varnedoe 1980). ALNHP had 6 rare species documented within the cave: a beetle (*Batrisodes valentinei*), Alabama cave crayfish, the federal endangered gray bat, a cave obligate beetle (*Pseudanophthalmus fluviatilis*), a cave obligate springtail (*Pseudosinella hirsuta*), and the state protected southern cavefish. While this cave is not closed to human ingress, permission is required to enter the cave with the request to use only the main entrance.

Hughes Cave is a cave located in Morgan County in the vicinity of Newsome Sinks Karst Area National Natural Landmark that receives no protection. This cave previously had a small colony of both the federal endangered gray bat and federal endangered Indiana bat (*Myotis sodalis*). However, the Indiana bat has not been seen at this cave since 1953 and the gray bat colony has declined and may be extirpated. Extensive vandalism, graffiti, and disturbance to the cave was reported in the past. Hughes Cave is on Tag-Net's list of closed caves. However, evidence at the cave mouth suggests this cave still receives regular use, with a rope attached for ingress into the cave and graffiti, fire pits, and other signs of human presence around the mouth of the cave. The other cave in the Newsome Sinks area had 2 species documented within the cave: a cave obligate beetle (*Pseudanophthalmus fluviatilis*) and a cave obligate springtail (*Pseudosinella hirsuta*).

Eudy Cave is a cave located in Marshall County which had 2 species documented within the cave: flame chub (*Hemitremia flammea*) and a historical record for the state protected Rafinesque's big-eared bat (*Corynorhinus rafinesquii*). While this cave is not closed to human ingress, permission is required to enter the cave.

This strong association of rare species with caves is a reflection of both the prevalence of karst topography in the watershed and survey effort. More effort has been directed at surveys of cave fauna than other terrestrial or aquatic fauna in the watershed. However, many of the caves in the watershed have not been surveyed, and a thorough search of the caves in the watershed is needed to determine additional rare cave species which may exist in the watershed. Effort is also needed to determine recharge areas for the springs and seeps associated with many of these caves.

Because of the prevalence of cave species in the occurrences documented, determining rare species associated with waterbodies was problematic. Many of the streams in the watershed have subsurface flow associated with them, and it is not always obvious which stream a cave is associated with or even if there is a stream associated with the cave. The 15 rare animal occurrences not associated with a cave were fish species, but only 4 of the 22 plant species occurrences were within 100 m (328 ft) of a waterbody. The only stream segment which had >5 EORs associated with it was Cave Spring Cave, and 5 of the 7 rare species occurrences were cave species occurring in the cave. However, the Tennessee River system has one of the most diverse freshwater fauna assemblages in the world, so CC watershed would be expected to have a richer aquatic fauna than has currently been documented. The Tennessee River system has a rich mollusk fauna, yet ALNHP had no occurrences documented for this taxa in the CC watershed. The CC watershed is a highly impacted watershed, but some rare mussel and snail species would be expected to still occur in the watershed. Additional aquatic species surveys are needed in the watershed, particularly for mussels and snails.

Thirty-five 100-ha rare species areas were identified in the CC watershed: 10 critical, 14 imperiled, and 11 rare (Fig 3. Appendix E). The number of EORs within these areas ranged from 1 to 6, with the majority (57%) having only 1 EOR documented within the area covered by the hexagon (Fig. 4).

Conservation Targets

Six conservation targets were chosen for the CC watershed: matrix forest communities (oak-hickory-pine forest), imperiled bats, riparian vegetation, karst communities, imperiled freshwater fish, and imperiled plants.

I. Coarse Scale

Coarse scale conservation targets selected within the CC watershed were the matrix forest community and imperiled bats. The terrestrial system which was represented at the coarse scale in the CC watershed was the southern Appalachian oak-hickory-pine forest community which forms the matrix terrestrial community of the region. The imperiled bats represent a coarse scale target because of the large distances that often exist between winter hibernaculum and summer breeding areas.

A. Oak-Hickory-Pine Matrix Forest Communities

This target encompasses large 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 day 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).

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 1 of the 2 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 retaining these areas in a natural setting faces increasing challenges as the 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).

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).

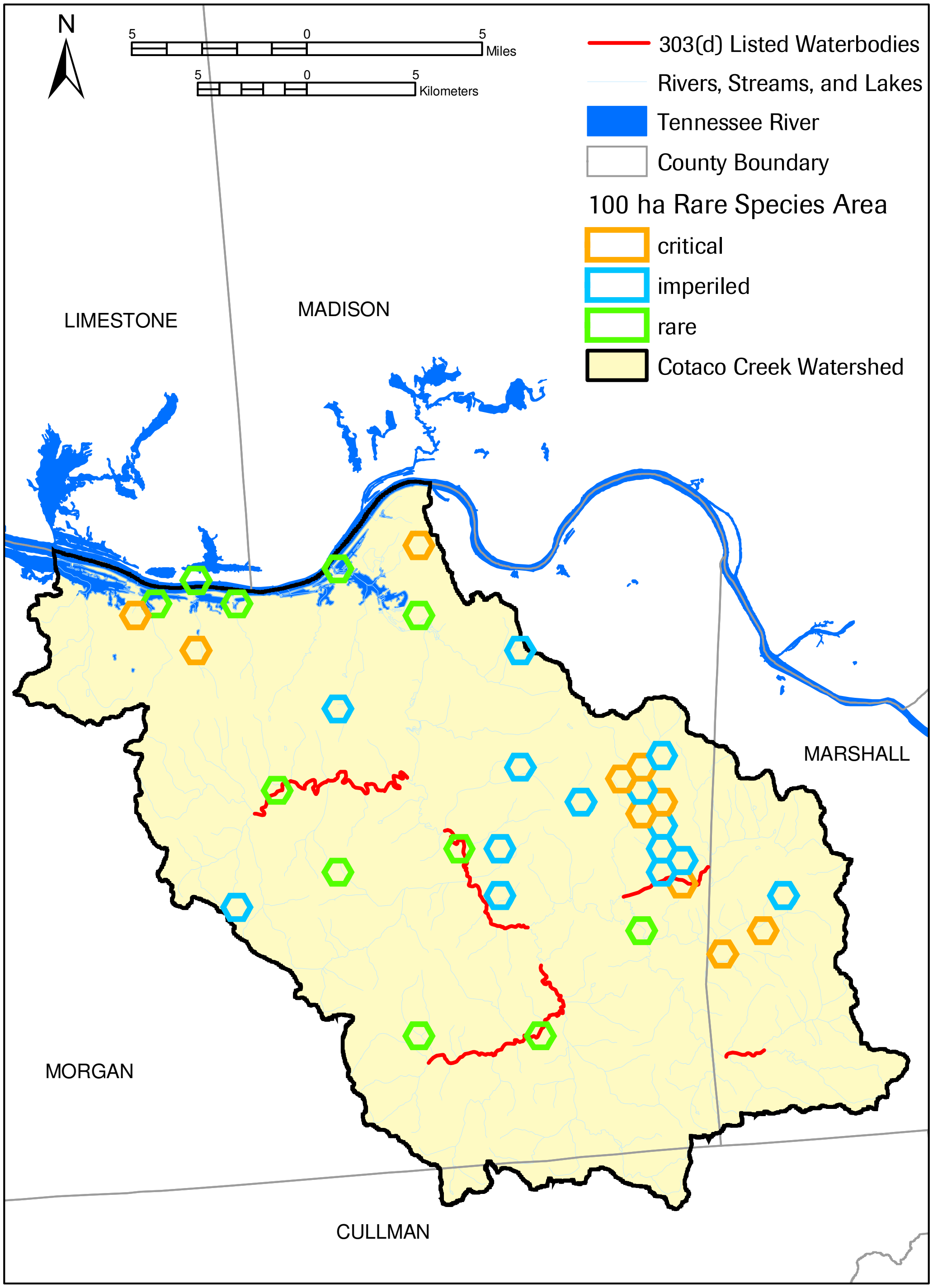

Figure 3. One hundred-hectare rare species areas in the Cotaco Creek watershed, Alabama. Hexagon type was coded "critical", "imperiled", and "rare" based on the federal and state protection status and heritage rank of the species present within the hexagon. "Critical" hexagons were those containing federal or state protected species or species with a heritage rank of G1 or S1. "Imperiled" hexagons were those containing species with a heritage rank of G2 or S2 without federal or state protection. "Rare" hexagons were those containing species with a heritage rank of G3-G5 without federal or state protection.

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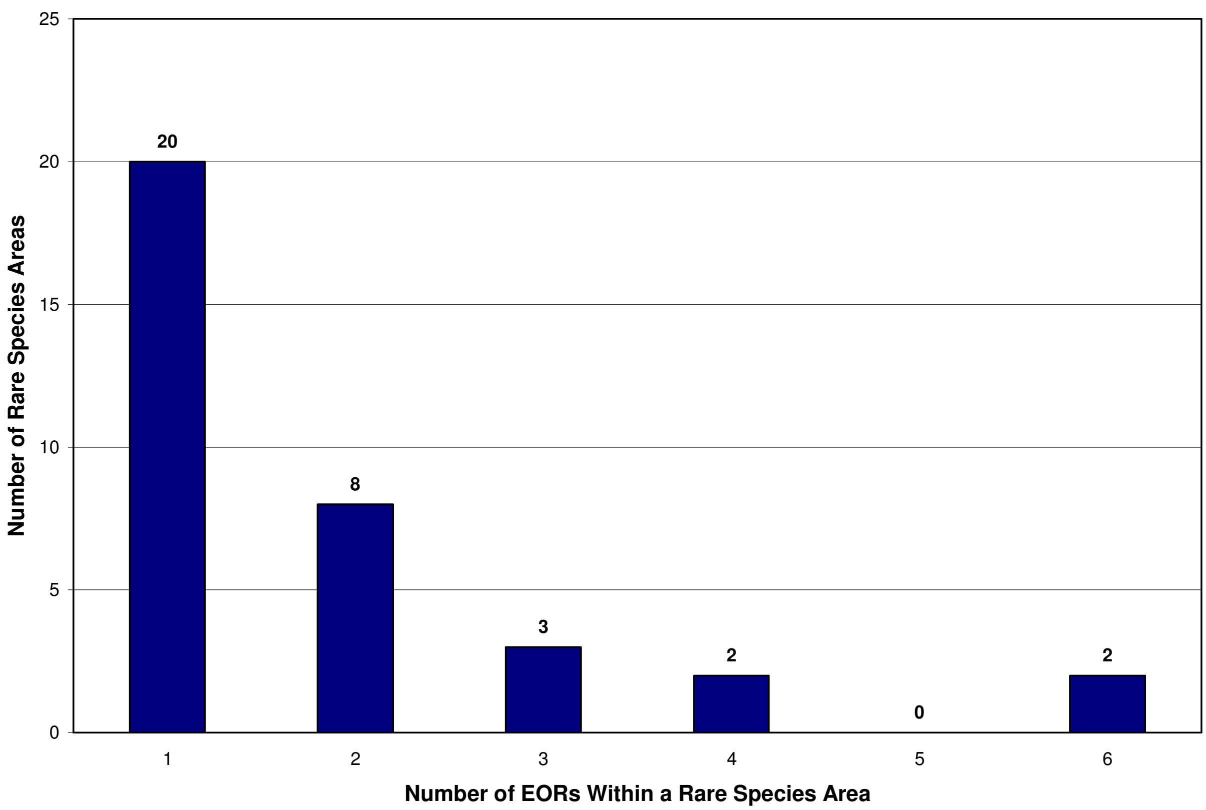

Figure 4. Number of 100-ha rare species areas ranked by the number of Element Occurrence Records (EOR) within the rare species area for the Cotaco Creek watershed, Alabama. An EOR is the computerized record in the Alabama Natural Heritage Program[SM]'s Biological and Conservation Database that contains the biological and locational information regarding a specific occurrence of a rare species.

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The 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. TNC (2003) identified the Talladega National Forest and Coosa River valley as neo-tropical migratory bird "hotspots" of nesting area and flyway corridors important to forest interior birds in the Cumberland and Southern Ridge and Valley Ecoregion. 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. The largest remaining contiguous blocks of forest in the watershed are areas around Newsome Sinks and Brindley Mountain.

B. Imperiled Bats

The imperiled bats in the watershed were selected as a conservation target because of the importance of several places in the watershed to this species and the general concern about the welfare and population declines of 3 bat species that occur in the watershed. The species in this target were Rafinesque's big-eared bat (*Corynorhinus rafinesquii*), gray bat (*Myotis grisescens*), and Indiana bat (*Myotis sodalis*). Bats are among the most beneficial species to people because of the enormous number of insects they consume, but they also may be the most misunderstood animals in the U.S. due to the misconceptions and superstitions concerning them. Bat populations have declined drastically in the U.S. and worldwide during recent years, and these population declines are usually human-induced. Adverse human impacts to bat populations include habitat destruction, vandalism, disturbance of hibernating and maternity colonies, direct killing, and the effects of pesticides and other chemical toxicants (on bats as well as their food source – insects) (Harvey et al. 1999).

Rafinesque's Big-eared Bat


Photo – J. Scott Altenbach

Rafinesque's big-eared bat is distinguished from all other bats that occur in Alabama by its large ears (Best 2004a). It is a state protected species (Alabama Department of Conservation and Natural Resources 2002) considered to be a Priority 1 species (highest conservation concern) (Mirarchi 2004), and is considered to be vulnerable to apparently secure globally (rank G3G4) but imperiled in Alabama (rank S2) by the NHN and TNC. This species is considered a species of special concern by the USFWS (Harvey et al. 1999). ALNHP had 1 occurrence of this species documented in the watershed: an historical record of one specimen in Marshall County. A survey is needed to determine how prevalent this species is in the watershed.

Rafinesque's big-eared bat is found throughout the southeastern United States from Virginia, southern West Virginia, Ohio, Indiana, and Illinois, south through the lower Mississippi Valley through southeastern Missouri, central Arkansas, southeastern Oklahoma and eastern Texas to the Gulf and Atlantic coasts (Barbour and Davis 1969). In Alabama, it is probably distributed statewide, but most records are from the northern one-half of the state (Mount 1986).

This species is perhaps the least known of any southeastern U.S. bat, and little is known about its population trends and ecological requirements (Best 2004a). Rafinesque's big-eared bat often occurs in forested regions largely devoid of natural caves; it uses a variety of low light intensity sites for roosting, including caves, hollow trees, crevices behind bark, a variety of spaces in human buildings, and abandoned mines (Mount 1986, Davis and Schmidly 1994). It has been observed most frequently in buildings, both occupied and abandoned, but also roosts in hollow tress. Maternity colonies usually consist of no more than several dozen adults (Harvey et al. 1999), but the largest known colony in Alabama only contains no more than 3 adults (Best 2004a). Preferred hibernacula are usually those showing the least potential for temperature fluctuation during winter (Mount 1986). While this bat species hibernates in caves and mines in the northern part of its range, it usually does not use caves as hibernacula in the southern portion of its range (Harvey et al. 1999).

Little is known about the overall population status, but this species is infrequently encountered and appears to have declined in Alabama, as well as throughout its range. Disturbance at roosting sites, disturbance and destruction of preferred roosting habitat, and reductions in the amount of available habitat by razing of old buildings and some forestry practices likely have contributed to the apparent decline (Mount 1986, Bat Conservation International 1999).

Gray Bat


Photo – from Johnson and Wehrle 2004

The gray bat was listed as a federal endangered species by the United States Fish and Wildlife Service (USFWS) in 1976 due to dramatic declines in many areas (United States Fish and Wildlife Service 1976a). It is a state protected species in Alabama (Alabama Department of Conservation and Natural Resources 2002) considered to be a Priority 1 species (highest conservation concern) (Mirarchi 2004). The NHN and TNC consider the gray bat to be rare globally (rank G3) and imperiled (rank S2) in Alabama. Fern Cave, which is located within the Upper Paint Rock River watershed in the Fern Cave National Wildlife Refuge, is Alabama's only Priority 1 gray bat hibernaculum (Priority 1 caves are major hibernacula and their most important maternity colonies; United States Fish and Wildlife Service 1982), and is reportedly used by over 50% of the entire gray bat population (Miller and Sankaran 1991; Hudson 1993, 1995). Six of the 8 maternity caves in Alabama associated with this hibernaculum also are Priority 1 caves. Several other critically important gray bat caves are within the Tennessee River watershed.

Primarily restricted to limestone karst regions of the southeastern United States, gray bats typically roost in caves along rivers and large reservoirs, with populations found mainly in Alabama, northern Arkansas, Kentucky, Missouri, and Tennessee (United States Fish and Wildlife Service 1982). The gray bat is perhaps the most restricted to cave habitats of any U.S. mammal (Hall and Wilson 1966, Barbour and Davis 1969). Because of highly specific roost and habitat requirements, fewer than 5% of available caves are suitable for occupation by gray bats, so gray bats congregate in larger numbers and in fewer hibernating caves than any other North American vespertilionid (Tuttle 1979); about 95% of the total population use only 9 caves for hibernation, 1 of which (Fern Cave) is in northern Alabama (Best 2004b). The concentrations of large numbers of bats in relatively few caves made the species especially susceptible to declines. The declines in gray bat populations have been attributed to human disturbance and vandalism (excessive disturbance may cause a colony to completely abandon a cave), commercialization of hibernaculum and roosting caves; disturbances caused by increased numbers of spelunkers and bat banding programs; pesticide and other contaminant poisoning; natural calamities such as flooding and cave-ins, loss of caves due to inundation by man-made impoundments, and possibly a reduction in insect prey over streams that have been degraded through excessive pollution and siltation (Tuttle 1979; Mount 1986; Clark et al. 1988; United States Fish and Wildlife Service 1991a, 1997; Best 2004b). Improper cave gating has also contributed to some population declines. Clark et al. (1988) documented organochlorine contamination and possible organochlorine-induced bat deaths in northern Alabama in the Tennessee River Basin. In response to cave protection, the Alabama populations in general appear to be stable (Alabama Agricultural Experiment Station 1984).

Cave Spring Cave

The gray bat occupied 3 caves within the CC watershed, all in Morgan County: Cave Spring Cave, Hughes Cave and Talucah Cave. Cave Spring Cave is a Priority 1 cave located in Wheeler National Wildlife Refuge that is used as 1 of the 8 major maternity colonies for the Fern Cave hibernaculum. This cave supports a large breeding colony (Hudson 1998), and contains the largest breeding colony in the watershed. It is probably the most important cave for the gray bat population inhabiting the watershed. This cave has a well documented history, and the colony appears to be stable. This cave is protected by the USFWS with a gate that restricts access, and its gray bat population is monitored regularly by USFWS. Talucah Cave is a Priority 3 cave (those that require further investigation) that is privately owned; the landowner is somewhat protecting the cave from visitors. A survey has not been conducted at this cave since 1997, at which time the colony was small (<50). The cave previously had a substantial colony which probably declined due to regular disturbance by people. Hughes Cave is a Priority 3 cave located in the vicinity of Newsome Sinks Karst Area National Natural Landmark that receives no protection. This cave previously had a small colony that has declined to nearly none due to regular disturbance by people. Extensive vandalism, graffiti, and disturbance to the cave was reported in the past. Hughes Cave is on Tag-Net's list of closed caves. However, evidence at the cave mouth suggests this cave still receives regular use, with a rope attached for ingress into the cave and graffiti, fire pits, and other signs of human presence around the mouth of the cave. In addition to the ongoing surveys by the USFWS at major caves, smaller populations should be monitored with regular surveys.

Indiana Bat

Photo – J. Scott Altenbach

The USFWS listed the Indiana bat as a federal endangered species 11 March 1967 due to declining populations (United States Fish and Wildlife Service 1967), and designated critical habitat for the species 24 September 1976 (United States Fish and Wildlife Service 1976b). However, no critical habitat was designated in Alabama (United States Fish and Wildlife Service 1975, 1976b) and populations have continued to decline since the species was listed despite recovery efforts (Georgia Department of Natural Resources 1999, Harvey et al. 1999). It is a state protected species in Alabama (Alabama Department of Conservation and Natural Resources 2002) considered to be a Priority 1 species (highest conservation concern) (Mirarchi 2004), and considered to be a globally imperiled species (rank G2/S2) by the NHN and TNC. ALNHP had 1 occurrence of this bat documented in the CC watershed: an historic record of a small hibernating colony from Hughes Cave in Morgan County that likely has been extirpated. Hughes Cave is a privately owned cave located in the vicinity of Newsome Sinks Karst Area National Natural Landmark that has suffered negative impacts from humans with extensive vandalism, graffiti, and disturbance to the cave reported for the cave.

The distribution of Indiana bats is associated with the major cavernous limestone areas and areas just north of cave regions in the midwestern and eastern United States (Thomson 1982). In Alabama, the Indiana bat is recently known only from the northeastern third of the state (Hudson 2004). Historically, small hibernating groups have been reported from at least 9 cave systems in 8 counties (Jordan 1986), but several of these records are suspected to be misidentifications of hibernating gray bats (Hudson 2004). Two previously unknown hibernacula were discovered in 1999 in caves within the Bankhead National Forest (Hudson 2004). The nearest known maternity colonies are in southern Kentucky (United States Fish and Wildlife Service 1999). Winter habitat consists of suitable caves and mines with cool and stable temperatures below 10°C, preferably from 4° to 8°C, throughout the winter that contain standing water which maintains relative humidity above 74% (Thomson 1982, Georgia Department of Natural Resources 1999). These bats usually hibernate in large, dense clusters that may contain several thousand individuals (Harvey et al. 1999). There are no known maternity site records in Alabama, and this species has not been observed or collected during the summer in Alabama with the exception of 9 individuals radio-tagged at their hibernaculum in the Bankhead National Forest that were monitored for several weeks until the transmitter battery failed (Hudson 2004).

The Indiana bat is nearly extinct over most of its former range in the northeastern states, and since 1950, the major winter colonies in caves of West Virginia, Indiana, and Illinois have disappeared (United States Fish and Wildlife Service 1991b). Population trends in Alabama are not known (United States Fish and Wildlife Service 1999). A high degree of aggregation during winter makes the species vulnerable; approximately 87 percent of the entire population hibernates in only seven caves (United States Fish and Wildlife Service 1991b). The principal factor in this species' decline is believed to be human disturbance of hibernating bats which may cause hibernating bats to starve once aroused (Hudson 2004). Other factors contributing to the Indiana bat's decline include commercialization of roosting caves, wanton destruction by vandals, disturbances caused by increased numbers of spelunkers and bat banding programs, use of bats as laboratory experimental animals, elimination of riparian and floodplain forests and other land use changes such as stream channelization, natural hazards such as flooding and cave ceiling collapse, improper cave gates and structures, and possibly insecticide poisoning (Mount 1986; United States Fish and Wildlife Service 1983, 1991b, 1999).

II. Intermediate Scale

A. 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 CC 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 tend 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.


Example of creek lacking native riparian vegetation from agricultural conversion.

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.

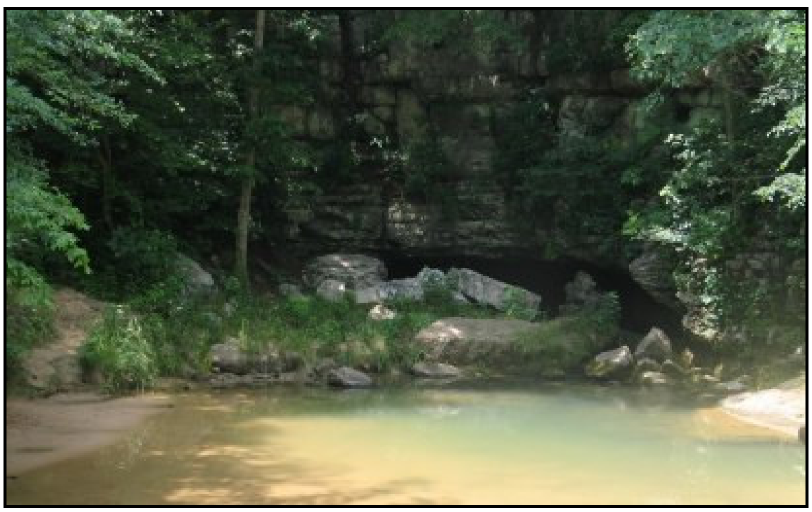
The hydrologic regime of many riparian areas have been altered through dam construction, interbasin diversion, channelization, irrigation, and other water withdrawals (National Research Council 2002). These alterations are usually accompanied by a serious degradation of the ecological functions of the 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 CC watershed, human development has resulted in the loss of riparian vegetation, which has been identified as a concern for aquatic communities in the watershed and the surrounding 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.

III. Local Scale

A. Karst Communities



Karst is a landscape characterized by sinkholes, sinking streams, springs, and caves that formed in areas where mildly acidic groundwater has dissolved soluble rocks such as limestone (Wilson and Tuberville 2003). Karst communities and their associated species were selected as a conservation target because of the prevalence of caves in the watershed and the importance of the region for cave fauna. The CSRV Ecoregion is considered a global center for cave invertebrate diversity (The Nature Conservancy 2003), with the Cumberland Plateau region having one of the largest concentrations of caves and cave species in the United States (Culver et al. 1999). Northern Alabama is rich in cave and karst resources. Jones and Varnedoe (1980) identified and described 208 caves in Morgan County, but considered more caves to be present in the county. This target included those cave species that are federal or state protected species or are considered globally imperiled (ranked G1 or G2). Other than the bat species indicated above, the only protected species in this target was the state protected southern cavefish. Species considered globally imperiled without statutory protection included in this target were Alabama cave crayfish, Cave Spring Cave spider, and phantom cave crayfish. Species considered state imperiled without statutory protections included in this target were a beetle (*Batrisodes valentinei*), a cave obligate beetle (*Pseudanophthalmus fluviatilis*), and a cave obligate springtail (*Pseudosinella spinosa*).

This target includes several species from one of the continent's most imperiled aquatic groups, crayfish. Crayfish are one of the largest aquatic faunal groups in North America north of

Mexico, with approximately 353 known species that occur mostly east of the Continental Divide (nearly ⅔ of the world's crayfish fauna). Approximately 95% of U.S. species occur in the Southeast, making this region the global center of crayfish diversity (Butler et al. 2003). Unfortunately, this highly diverse group also is highly imperiled. Crayfish are second only to freshwater mussels as an imperiled group in North America, with an estimated 48% of our crayfish fauna deserving conservation status (Butler et al. 2003). Crayfish face a variety of threats including habitat loss and degradation, altered hydrologic conditions, pollution, and invasive exotic species.

Cave habitat species are one of the most ecologically vulnerable groups because they generally have limited distributions and numbers of individuals or locations (often found in only 1 or 2 cave systems); are reliant upon isolated, niche environments; and are sensitive to changes in microclimate (The Nature Conservancy 2003). More than 50% of the imperiled species tracked in the United States are cave-obligate species (The Nature Conservancy 2003), but <4% of these species are federally listed (Culver et al. 1999). Numerous human activities, including some which transpire far above ground, threaten caves and cave species; these threats include direct destruction of habitats and species, contamination of surface and ground water, air pollution, and degradation caused by human ingress for recreation. The effects of specific threats vary by the type of cave, its surroundings, and the kinds of organisms occupying the cave (The Nature Conservancy 2003). The conservation of caves, and the biological life they contain, should be of paramount importance when they are being explored or utilized for any purpose, and should be a goal of conservation in the watershed.

Southern Cavefish

The southern cavefish is an Alabama state protected species (Alabama Department of Conservation and Natural Resources 2002) considered to be a Priority 3 species (moderate conservation concern) (Mirarchi 2004), and is considered to be secure globally (rank G5) and rare or uncommon in Alabama (rank S3) by the NHN and TNC. Boschung and Mayden (2004) recommended "Threatened" status for this species in Alabama. The southern cavefish is found in 2 disjunct areas, east and west of the Mississippi River. Western populations are found in the Ozark Plateau of southern Missouri and northeastern Arkansas. Eastern populations are found in Cumberland and Interior Low Plateau areas of northern Alabama and northwestern Georgia, through Kentucky and Tennessee to southern Indiana (Boschung and Mayden 2004). In Alabama, this fish is found in caves in the northernmost counties in the Tennessee River Basin and 2 caves in the Coosa River system. ALNHP had 3 historic occurrences documented in CC watershed: at Cave Spring Cave on WNWR, Louise Cave in the Newsome Sinks area, and Talucah Cave.

The southern cavefish is an eyeless, colorless cavefish growing to approximately 8.5 cm (3.3 in) total length (Ramsey 1986). It is a troglodytic species known only from caves, wells, and springs of limestone cave systems with crystal clear water ranging in temperature from 10.2ºC (50.4ºF) to 13.7ºC (56.7ºF) (Ramsey 1986, Boschung and Mayden 2004), and prefers pools in these environments (Mettee et al. 2004). Fecundity is extremely low for this species (Ramsey 1986). A female southern cavefish produces only about 50 eggs in a reproductive season, and only 50% of females breed each year. The life expectancy for this fish is 4 years, but females usually do not reach sexual maturity until 2 years. Therefore, a single female may only produce 100 potential offspring in a lifetime (Boschung and Mayden 2004). Population sizes may vary from a few individuals to a couple of hundred for an individual cave, but most populations are on the small end of this range (Ramsey 1986, Boschung and Mayden 2004). These small population sizes make southern cavefish extremely vulnerable to extirpation.

The southern cavefish's habitat is highly susceptible to degradation due to ground water of poor quality (Mettee et al. 2004). Boschung and Mayden (2004) reported that professional spelunkers say it is disappearing from many caves because of groundwater depletion and pollution. Water quality in occupied caves may also be threatened by development in the surrounding groundwater recharge area, confined animal operations, municipal sewage treatment plants, and transportation routes. The 3 historically occupied caves should be surveyed to determine if southern cavefish still inhabit these caves. In addition, other caves in the watershed should be surveyed to determine if other populations are present.

Alabama Cave Crayfish

Photo – Keith Crandall

The Alabama cave crayfish is an albinistic crayfish with unfaceted, unpigmented eyes and 1 cervical spine. It has comparatively wide areola, and both its terminal elements are arched so that the tips are directed proximally. This species primarily inhabits cave pools, and is intermediate in numbers among the 3 troglobitic crayfishes that share habitat. The Alabama cave crayfish is considered to be globally imperiled (rank G2/S2) by TNC and the NHN. This crayfish is endemic to Alabama, with only 13 known locations in the Tennessee River basin in northern Alabama between Florence and Guntersville. ALNHP had 2 historical occurrences documented in the CC watershed in Morgan County: Cave Spring cave and Talucah cave. The Cave Spring cave population is considered a global exemplary site (site which represents the best occurrence known throughout its global range) for this species by the NHN. The known populations need to be surveyed to determine their current population status, and other caves in the watershed should be surveyed in an effort to locate new populations.

Cave Spring Cave Spider

The Cave Spring Cave spider is considered to be critically imperiled globally (rank G1/S1) by TNC and the NHN. This species is endemic to Alabama. ALNHP had 1 occurrence of this species documented in CC watershed: a population at Cave Spring Cave on the WNWR in Morgan County. Little is known about the ecology of this species.

Phantom Cave Crayfish

The phantom cave crayfish is an albinistic crayfish with unfaceted, unpigmented eyes, and a moderately narrow areola. It has at least 1 strong cervical spine and a rostrum with marginal spines, but hepatic spines are absent. It is found in subterranean pools with silty bottoms. The phantom cave crayfish is considered to be globally imperiled to rare (rank G2G3) and critically imperiled in Alabama (rank S1) by TNC and the NHN. However, the current global rank is known to be inaccurate and in need of change. Therefore, this species should be considered critically imperiled globally (rank G1) because it is found in only 3 caves in the Tennessee River basin of northern Alabama in Colbert, Lauderdale, and Morgan counties. ALNHP had 1 historic occurrence of this species documented in the CC watershed: a population in Cave Spring Cave on the WNWR in Morgan County. This population needs to be surveyed to determine its current status, and other caves in the watershed should be surveyed in an effort to locate new populations.

B. Imperiled Freshwater Fish

Imperiled freshwater fish were selected as a conservation target because of the importance of the Tennessee River drainage for aquatic biodiversity in the southeastern U.S. This target included those fish that are federal or state protected species or are considered globally imperiled (ranked G1 or G2). The only species with statutory protection in the watershed not included in the cave communities above was the state protected Tuscumbia darter (*Etheostoma tuscumbia*). The only species considered state imperiled without statutory protections included in this target was the ghost shiner (*Notropis buchanani*).

Focusing conservation efforts on freshwater species is needed because this is the most imperiled species group in the United States; freshwater species are much more imperiled that terrestrial species (Master et al. 1998). Freshwater mussels are the most imperiled taxonomic group in North America, with many mussel populations having undergone a precipitous decline or been eradicated due to impoundment by dams, sedimentation, channelization, dredging, water withdrawal, water pollution, and displacement by invasive species. Although ALNHP had no mussel species documented in the watershed in our database, the watershed likely contains several imperiled mussels given the abundance of mussels in surrounding watersheds. Surveys of the watershed are needed to determine if any imperiled mussels are present.

Freshwater taxa are often used as “indicator species” because they have certain physiological and ecological traits that justify their use as bioindicators of environmental health. A decline or loss of these species often indicates problems with water quality and ecosystem stability in their watershed. Aquatic resources are economically, ecologically, culturally and aesthetically important to the nation, yet many of these resources are in decline and a large percentage of the aquatic taxa in the southeastern US are imperiled (Williams et al. 1993, Warren and Burr 1994, Bogan et al. 1995, Walsh et al. 1995, Williams and Neves 1995, Etnier 1997, Neves et al. 1997, Hall and Williams 2000). This suite of species is imperiled due to a variety of complex and interconnected threats, including habitat destruction, alteration, and degradation (including water quality degradation); hydrologic alterations; water availability; overharvest; the introduction of exotic species; and the cumulative effects of all these factors (Ahlstedt 1986, Williams et al. 1993, Bogan et al. 1995, Walsh et al. 1995, Williams and Neves 1995, Etnier 1997, Neves et al. 1997). The principal causes of habitat loss and degradation are dams, channelization, urbanization, agriculture, deforestation, erosion, and pollution. Perhaps the most insidious threat to freshwater species is sedimentation and siltation resulting from poor land-use patterns that eliminate suitable habitat required by many bottom-dwelling species. Conservation and recovery of the remaining freshwater faunal diversity will require immediate action to prevent further declines and extinctions. This will necessitate action to improve water quality across the basin and to decrease the amount of silt and pollutants entering the streams and rivers. By maintaining and restoring the health of the watershed, we not only help insure the survival of aquatic biodiversity, but also help protect human well-being and quality of life.

Tuscumbia darter


Photo – Richard Mavden

The Tuscumbia darter is an Alabama state protected species (Alabama Department of Conservation and Natural Resources 2002) considered to be a Priority 2 species (high conservation concern) (Mirarchi 2004), and is considered an imperiled species (rank G2/S2) by the NHN and TNC. Historically, this species was a regional endemic found in the Tennessee River in north Alabama and south-central Tennessee (Kuhajda 2004). However, impoundment of the Tennessee River inundated several Alabama populations and the Tennessee population. This fish is currently restricted to limestone springs and spring runs at 14 localities in the southern bend of the Tennessee River in Colbert, Lauderdale, Lawrence, Limestone, and Madison counties, Alabama (Kuhajda 2004). ALNHP had 1 historic occurrence documented in CC watershed in Wright Spring Creek, Morgan County that was last observed in 1889.

Habitat for the Tuscumbia darter is vegetated springs and spring runs with slow current, fine gravel or sand substrates, and temperatures of 15-20ºC (59-68ºF). It is most abundant in springs with diverse aquatic plants, a vegetated buffer zone around the spring, and a low diversity of other fishes, but can be present in disturbed springs (Kuhajda 2004). Threats to this species include changes in the water table, siltation, predation, and loss of aquatic vegetation. Most of the occupied springs have some degradation, including removal of aquatic vegetation and water, excessive sedimentation, small impoundments, and livestock entering the spring (Kuhajda 2004).

C. Imperiled Plants

Imperiled plants within the CC watershed were selected as a conservation target because of the importance of these flora in the watershed and the importance of the watershed to some of these floral species. This target included those plants that are federal or state protected species or are considered globally imperiled (rank G1 or G2) or state imperiled (rank S1 or S2). The only species with statutory protection documented in the watershed was the federal threatened American Hart's-tongue fern (*Asplenium scolopendrium* var *americanum*). The only globally imperiled species without protection documented in the watershed was Cumberland rosinweed (*Silphium brachiatum*). State imperiled species without statutory protection included wild leek (*Allium tricoccum*), clustered poppy-mallow (*Callirhoe alcaeoides*), American smoke-tree (*Cotinus obovatus*), Tennessee bladderfern (*Cystopteris tennesseensis*), Dutchman's breeches (*Dicentra cucullaria*), field horsetail (*Equisetum arvense*), Canada lily (*Lilium canadense*), miterwort (*Mitella diphylla*), nodding trillium (*Trillium flexipes*), and yellowleaf tinker's-weed (*Triosteum angustifolium*). Plant rarity in the CSRV ecoregion is most often associated with specific niche habitat types such as seeps, cobble bars, sandstone outcrops, river prairies, and glades that often are very restricted environments (The Nature Conservancy 2003). Plants face perhaps the widest assortment of threats throughout the ecoregion, with direct habitat destruction from conversion to other land uses believed to be the most pervasive threat (The Nature Conservancy 2003).

American Hart's-Tongue Fern

Photo – from Johnson and Wehrle 2004

American Hart's-tongue fern is a perennial fern that forms a rosette of simple, undivided, evergreen, strap-shaped fronds that are 8-42 cm (3-17 in) long and 2-5 cm (¾-2 in) wide and are auriculate (lobed) at their base (United States Fish and Wildlife Service 1989). The fronds arise in a cluster from a short, creeping rhizome, which is covered with cinnamon-colored scales on its surface and has a thickened base (United States Fish and Wildlife Service 1990). Each frond has 2 rounded lobes at its base (making the base distinctively heart-shaped). This plant is a strict calciphile (needs a basic, i.e., non-acidic, substrate), and is generally found growing on or in close association with dolomitic limestone (limestone high in magnesium) (United States Fish and Wildlife Service 1989, Environment Canada 2003). Plants usually occur in damp crevices and on mossy, rock outcrops, and in the southern portion of its range, populations are only found within limestone pits that trap cold air, have high humidity and are well shaded (United States Fish and Wildlife Service 1989, 1990).

American Hart's-tongue fern was listed by the USFWS as a federal threatened species 14 July 1989 (United States Fish and Wildlife Service 1989), and this variety is considered to be globally rare (rank G4T3) and critically imperiled (rank S1) in Alabama by the NHN and TNC. It is an extremely rare plant that is found only in North America in small, widely disjunct population groups, with 14 localized populations in Ontario, Michigan, central New York, northern Alabama, and south-central Tennessee. There are only 2 populations in Alabama. All but one of the southern populations have drastically declined or have been eliminated. The only vigorous population is in Morgan County, Alabama, in a privately-owned pit entrance to a limestone cave in the Newsome Sinks area near Morgan City. This is the only occurrence of this species ALNHP had documented in the CC watershed.

Most American Hart's-tongue fern populations are threatened by trampling, alteration, or habitat destruction by trail construction, timber removal, quarrying, and residential or other development (United States Fish and Wildlife Service 1989). Timber removal is considered a threat throughout most of the plant's range because shade trees would be destroyed. Because the species is a strict calciphile, it is extremely susceptible to quarrying activities. The southern populations in Alabama and Tennessee are especially at risk from trampling due to their small size and the precarious nature of their habitat. Insect infestations, which destroy the leaves of the deciduous, shade-producing trees above the plant sites, are also a periodic threat (United States Fish and Wildlife Service 1990). Some commercial trade and interest in the species exists. While most of the plants in circulation are from cultivated sources, collecting remains a threat to the small, isolated populations found in the United States (United States Fish and Wildlife Service 1990). The greatest protection need for this species identified by the NHN is to protect areas where the plants occur as well as enough buffer land to guarantee survival and protect against potential microclimate change.

Cumberland Rosinweed

Cumberland rosinweed is a perennial, sunflower-like herb, usually 1-1.5 m (3-5 ft) tall, with lengthy, leafy stems sprouting from a stout, fleshy root. The leaves are large (15-30 cm [6-12 in]), opposite, sandpapery, coarsely toothed, and in a basal rosette. Numerous yellow-rayed flower heads bloom in an open cluster during the summer. The fruit is blackish, shallowly winged, flattened seeds. Cumberland rosinweed is found in sunny to partly shaded openings in relatively dry mixed forests (or open mixed juniper-hardwood woodlands on the margins of oak-hickory forests) on Cumberland Plateau Western Escarpment bluffs. The soils are calcareous and studded with exposed limestone bedrock. The plants are restricted to areas of open canopy, including roadsides and woodlands, with limestone substrates.

Cumberland rosinweed is considered to be globally imperiled (G2/S2) by the NHN and TNC. This species is a regional endemic that is known with certainty only from the Cumberland

Plateau in northwestern Alabama and southern Tennessee, but it also has been reported from Georgia. Of the 25 populations ALNHP has documented in Alabama, 4 were documented in the CC watershed from Morgan County. However, only 1 of these populations (Yellow Bluff) is considered a large, vigorous population. Two of the other 3 populations are small populations in disturbed or poor habitat which potentially could be helped with appropriate management such as canopy thinning (Pate Mountain and Wilson Mountain) and the other is a relative moderate or small population in good quality habitat (Brindley Mountain). All populations should be managed to improve conditions for this plant.

Human Context Information

<u>Managed Areas</u>

Two managed areas were identified within the CC watershed (Fig. 5): Newsome Sinks Karst Area National Natural Landmark (NSKANNL) and Wheeler National Wildlife Refuge (WNWR). Half of the rare species occurrences documented in the CC watershed occurred on these 2 areas. However, only 11 rare species occurrences (17.2%) occur on public property because NSKANNL is privately owned. Therefore, maintaining habitat for rare, threatened, and endangered species will require outreach to private landowners and potential public-private partnerships for private land management in addition to proper management of public lands.

I. Newsome Sinks Karst Area National Natural Landmark

Photo – National Park Service

NSKANNL is privately-owned property in Morgan County containing classic examples of karst development and more than 40 caves that was designated a National Natural Landmark (NNL) November 1973. The NNL Program is a program administered by the National Park Service that recognizes and encourages the conservation of outstanding examples of our country's natural history (National Park Service 2004). It is the only natural areas program of national scope that identifies and recognizes the best examples of biological and geological features in both public and private ownership. If requested, the National Park Service assists NNL owners and managers with the conservation of these important sites. National Natural Landmarks (NNL) are designated by the Secretary of the Interior, with the owner's concurrence. To date, fewer than 600 sites have been designated, and NSKANNL is one of only seven sites in Alabama.

ALNHP had 22 occurrences of rare species or natural features documented within NSKANNL (Table 5), including 4 occurrences of federal or state protected species: the federal threatened American Hart's-tongue fern, federal endangered gray bat, federal endangered Indiana bat, and

Table 5. Rare, threatened, and endangered species documented by the Alabama Natural Heritage Program[SM] occurring in the Newsome Sinks Karst Area National Natural Landmark, Morgan County, Alabama.

Major Group	Scientific name	Common Name	Global Rank[a]	State Rank[a]	Federal Status[a]	State Protected[a]	Number of Occurrences[b]
Fish	*Typhlichthys subterraneus*	southern cavefish	G4	S3		SP	1[c]
Insects	*Pseudanophthalmus fluviatilis*	a cave obligate beetle	G3	S2			3
Insects	*Pseudosinella spinosa*	a cave obligate springtail	G3G4	S?			1
Mammals	*Myotis grisescens*	gray bat	G3	S2	LE	SP	1
Mammals	*Myotis sodalis*	Indiana bat	G2	S2	LE	SP	1[c]
Natural Feature	Alabama Morgan County cave	Alabama Morgan County cave					2
Vascular Plants	*Asplenium scolopendrium* var *americanum*	American Hart's-tongue fern	G4T3	S1	LT		1
Vascular Plants	*Cystopteris tennesseensis*	Tennessee bladderfern	G5	S2			1[c]
Vascular Plants	*Equisetum arvense*	field horsetail	G5	S2			2[c]
Vascular Plants	*Euonymus atropurpureus*	Wahoo	G5	S3			1[c]
Vascular Plants	*Lilium canadense*	Canada lily	G5	S2			2
Vascular Plants	*Mitella diphylla*	miterwort	G5	S1			2
Vascular Plants	*Panax quinquefolius*	American ginseng	G3G4	S4			1[c]
Vascular Plants	*Trillium flexipes*	nodding trillium	G5	S2S3			1
Vascular Plants	*Triosteum angustifolium*	yellowleaf tinker's-weed	G5	S1			1

[a] See Appendix B for an explanation of Global and State Ranks and Federal and State Protection Status.
[b] Number of Element Occurrence Records in ALNHP's Biological Conservation Database as of August 2004.
[c] All occurrences were historical.

Figure 5. Managed areas within the Cotaco Creek watershed; Morgan, Marshall, and Cullman counties Alabama. Newsome Sinks Karst Area National Natural Landmark is an approximate location of the centroid of the area encompassed by the Landmark designation.

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state protected southern cavefish. Additional surveys within this area likely would detect additional occurrences and species, particularly cave species. Development in the area surrounding NSKANNL poses a threat to many of these species, particularly the cave species which could be negatively impacted by contamination of the ground water reaching the caves.

II. Wheeler National Wildlife Refuge

WNWR is a 14,164 ha (35,000 ac) national wildlife refuge located near Decatur in the Tennessee River Valley of northern Alabama along Wheeler Lake several kilometers upstream from Wheeler Dam. WNWR was established in 1938, and was the first national wildlife refuge established on a multi-purpose reservoir. The refuge contains a variety of habitat types including bottomland hardwoods, moist soil units, riparian woodlands, back water embayments, freshwater marshes, pine uplands, and croplands. It also features Alabama's only significant concentration of wintering Canada geese. In addition to providing wildlife habitat, the refuge positively impacts the local economy, receiving 650,000 visitors annually.

ALNHP had 11 occurrences of rare species or natural features documented within WNWR (Table 6), including a major maternity colony of the federal endangered gray bat (Cave Spring Cave) and 1 occurrence of the state protected southern cavefish. Species and habitat within the refuge are protected by the USFWS, but the area surrounding the refuge is a mixture of urban and rural development and agriculture, which could negatively impact the refuge.

<u>Land Cover</u>

Land cover within the watershed was predominately forest mixed with pasture, and to a much lesser extent, rowcrop and urban (Fig. 6). Overall, land cover percentages were similar between the ASWCC estimates and estimates obtained from NLCD calculations with the exception of water and the division of agricultural land between rowcrop and pasture (Table 7). The percentage of the watershed classified as water was much higher for the NLCD estimate (1.7%) than for the ASWCC estimate (0.4%). However, both are likely underestimates because of the narrow width of most water features in the watershed. Although the total area classified as agriculture was similar between the 2 estimates, the division between pasture and rowcrop was very different between the 2 estimates. The ASWCC estimated a much lower percentage of rowcrop (2.9%) and a much higher percentage of pasture (30.5) than calculated using NLCD (12.6 and 19.3% respectively). This is likely a reflection of errors within the dataset, and the difficulty sometimes seen in separating rowcrop and pasture in the satellite imagery used to

Table 6. Rare, threatened, and endangered species documented by the Alabama Natural Heritage Program[SM] occurring on Wheeler National Wildlife Refuge in the Cotaco Creek watershed, Alabama.

Major Group	Scientific name	Common Name	Global Rank[a]	State Rank[a]	Federal Status[a]	State Protected[a]	Number of Occurrences[b]
Arachnids	*Nesticus jonesi*	Cave Spring Cave spider	G1G2	S1			1
Crustaceans	*Cambarus jonesi*	Alabama cave crayfish	G2	S2			1
Crustaceans	*Procambarus pecki*	phantom cave crayfish	G1	S1			1
Fish	*Hemitremia flammea*	flame chub	G3	S3			1
Fish	*Hybognathus hayi*	cypress minnow	G5	S3			1
Fish	*Moxostoma macrolepidotum*	shorthead redhorse	G5	S3			1
Fish	*Notropis buchanani*	ghost shiner	G5	S2			1
Fish	*Percina shumardi*	river darter	G5	S3			1
Fish	*Typhlichthys subterraneus*	southern cavefish	G4	S3		SP	1
Insects	*Batriasymmodes spelaeus*	a cave obligate beetle	G3G4	S3			1
Mammals	*Myotis grisescens*	gray bat	G3	S2	LE	SP	1

[a] See Appendix B for an explanation of Global and State Ranks and Federal and State Protection Status.
[b] Number of Element Occurrence Records in ALNHP's Biological Conservation Database as of August 2004.

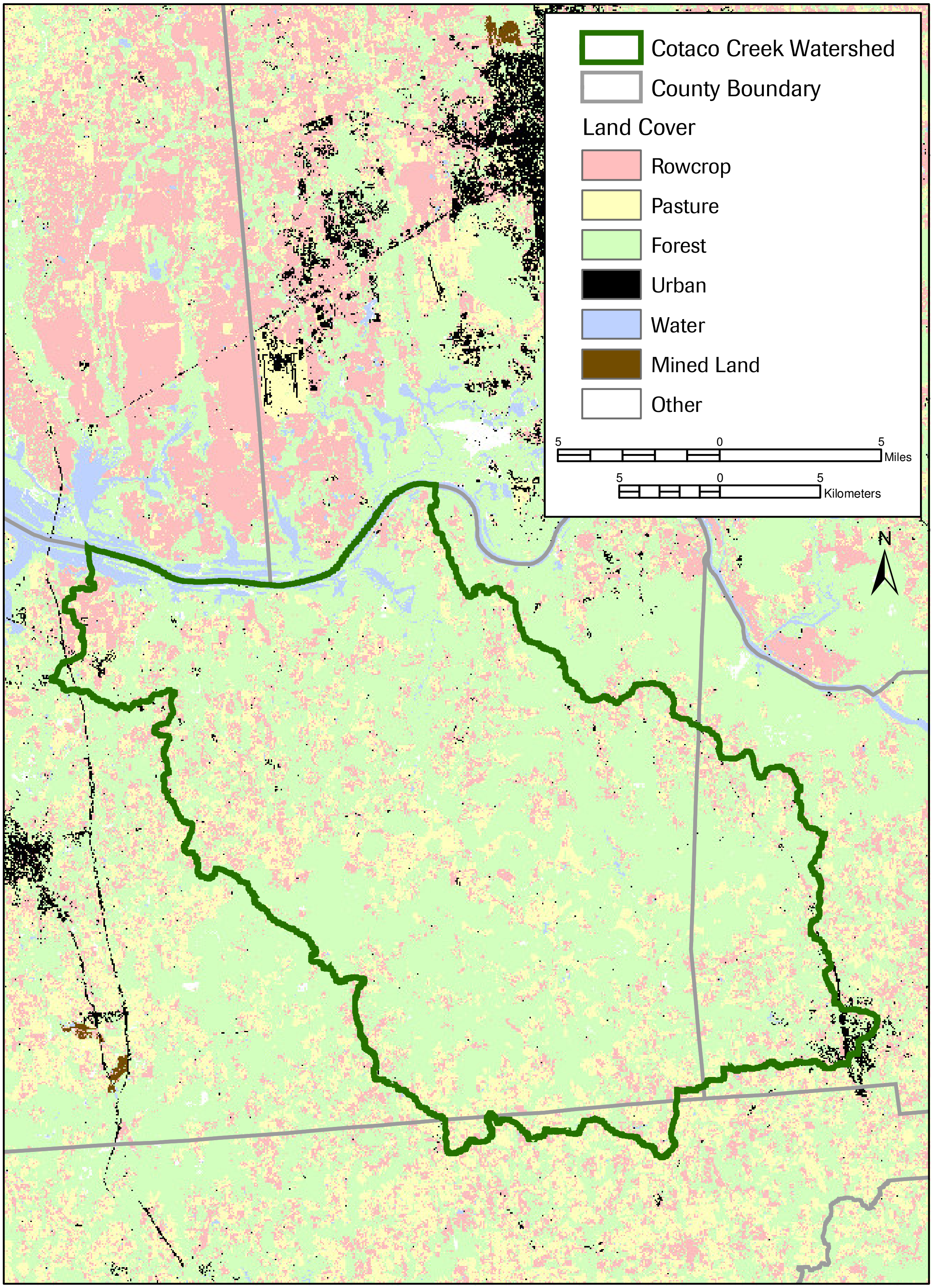

Figure 6. Land cover within the Cotaco Creek watershed as indicated from a reclassification of the USGS National Land Cover Data.

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Table 7. Area (ha), land cover (%), and road density (m/ha) for Cotaco 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	69,954	70,617
Land Cover		
rowcrop	2.9	12.6
pasture	30.5	19.3
forest	65.0	65.4
urban	0.9	0.7
water	0.4	1.7
mined land	0	0
other	0.3	0.3
road density		15.7

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 CC 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).

One important land cover class not included in the ASWCC estimates was wetlands. Although the CC watershed does not have the large emergent wetlands or extensive bottomland floodplains found elsewhere in the state, wetlands are an important component of the landscape in the watershed. The values and functions of wetlands are well recognized, and wetlands are considered beneficial natural resources which need protection and/or preservation because of their pivotal role in the landscape (Reddy and Gale 1994, World Wildlife Fund 2004). Wetlands provide many ecosystem functions that protect both aquatic and terrestrial systems: sedimentation and filtration of runoff, providing environments for nutrient assimilation and recycling, diverting and dissipating floodwater volume and energy thereby reducing erosion, filtering toxic heavy metals and other pollutants from water, supporting groundwater recharge, providing important fish and wildlife habitat, providing food chain support and human food resources, and providing recreational opportunities (Reddy and Gale 1994, Patrick 1994, World Wildlife Fund 2004). Many of these functions have a significant economic value, and the World Wildlife Fund (2004) conservatively estimated the total economic value of wetlands in North America to be $30/ha. The NLCD contains 2 wetland classifications: emergent wetlands and woody wetlands. Emergent wetlands were grouped within the other class and woody wetlands were grouped in forest in the reclassified NLCD to give the percentages reported in the summary tables. The amount of wetlands in the CC watershed as classified in the NLCD data was 4.0% woody wetlands and 0.2% emergent herbaceous wetlands. Many of the wetland types, such as seepage springs and bogs, found in the CC watershed would be incorrectly classified in the NLCD data because they are too small for the coarse resolution of the classification. Although these wetland areas cover a small percentage of the landscape, they support many rare species. Maintaining the existing wetlands in the watershed is important to maintaining and improving water quality as well as maintaining the biodiversity of the watershed.

Population & Demographics

There were 46 populated place locations in the CC watershed as identified from EPA's BASINS dataset (Appendix F). One urban cluster (Arab – population 7,174) identified from the Census 2000 TIGER/Line Data (United States Census Bureau 2000a) occurred partially within the boundaries of the CC watershed (Fig. 7). Three populated place locations were within the delineated boundary of this urban cluster. In addition, there were 2 urbanized areas (Decatur – population 53,929 and Huntsville – population 158,216) <5 km (3.1 mi) from the watershed and 3 urban clusters (Albertville – population 17,247, Cullman – population 13,995, and Hartselle – population 12,019) <15 km (9.3 mi) from the watershed. An urban cluster consisted of densely settled territory that has at least 2,500 people but fewer than 50,000 people, while an urbanized area consisted of densely settled territory that contains 50,000 or more people (United States Census Bureau 2001). Eighteen occurrences were within 1 km of the populated places (Table 8). Five of these occurrences were historical and 11 were occurrences lacking a date last observed that need to be revisited to determine if the populations is still extant.

Land within the Cotaco Creek watershed is mostly rural, with some more urbanized areas. Although there is no large metropolitan area in the watershed, Huntsville is just to the north of the watershed and could encroach into the watershed through its southward sprawl. Urbanization and development pressures are increasing in the watershed and could potentially cause extirpations for some populations. Population density is relatively low throughout the watershed, with most of the watershed having a population density <1 person/ha and the highest densities concentrated in the southeastern part of the watershed around Arab (Fig. 8). All of the rare species occurrences in the watershed are in the areas with lower population densities that remain rural. Fourteen of the 25 census block groups contained portions of a rare species area, and all of them were in the lower density block groups. The vast majority (85.7%) of census block groups containing a rare species area had a population density <0.5 persons/ha.

Total population within the 2000 Census block groups encompassed by the CC watershed was 37,279 (Environmental Systems Research Institute 2000). The population within the watershed is smaller because the area covered by the block groups includes area outside the watershed. All 3 counties in the watershed experienced population growth between 1990 and 2000 greater than the state average (10.1%); population growth for the counties was 11.0% for Morgan, 16.1% for Marshall, and 14.8% for Cullman (United States Census Bureau 2000b). These trends are expected to continue which will continue to place pressure on rare and sensitive species in the watershed.

Potential Pollution Sources

Agriculture and Animal Production

Agricultural production is an important component of the economy within the CC watershed, particularly in the part of the watershed in Morgan County. Cattle and poultry (mainly broiler) production are the main agricultural activity in the watershed, but dairy and swine production is present to a lesser extent (Table 9). ADEM had 9 confined animal feeding operations (CAFO) registered in the watershed, mostly in the southeastern portion of the watershed. Eight were

Table 8. Alabama Natural Heritage Program[SM] Element Occurrence Records in the Cotaco Creek watershed within 1 km of populated place locations (PPL) identified from EPA BASINS data.

Major Taxonomic Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	USGS Topographic Quadrangle	Section	Date Last Observed	Closest PPL
Arachnids	*Nesticus jonesi*	Cave Spring Cave spider	G1G2	S1			Mason Ridge	4		Cave Springs
Crustaceans	*Cambarus jonesi*	Alabama cave crayfish	G2	S2			Mason Ridge	4	1975-08-14	Cave Springs
Crustaceans	*Cambarus jonesi*	Alabama cave crayfish	G2	S2			Triana	35		Talucah
Crustaceans	*Procambarus pecki*	phantom cave crayfish	G1	S1			Mason Ridge	4	1975-08-00	Cave Springs
Fish	*Etheostoma simoterum*	snubnose darter	G5	S3			Newsome Sinks	26		Apple Grove
Fish	*Hemitremia flammea*	flame chub	G3	S3			Mason Ridge	4		Cave Springs
Fish	*Hemitremia flammea*	flame chub	G3	S3			Newsome Sinks	26		Apple Grove
Fish	*Hybognathus hayi*	cypress minnow	G5	S3			Mason Ridge	1		Cain Landing
Fish	*Notropis buchanani*	ghost shiner	G5	S2			Mason Ridge	4		Cave Springs
Fish	*Typhlichthys subterraneus*	southern cavefish	G4	S3		SP	Mason Ridge	4	1957-10-19	Cave Springs
Fish	*Typhlichthys subterraneus*	southern cavefish	G4	S3		SP	Triana	35	1957-10-19	Talucah
Insects	*Batriasymmodes spelaeus*	a cave obligate beetle	G3G4	S3			Mason Ridge	4		Cave Springs
Insects	*Batrisodes valentinei*	a beetle	G3G4	S2			Triana	35		Talucah
Insects	*Pseudanophthalmus fluviatilis*	a cave obligate beetle	G3	S2			Triana	35		Talucah
Insects	*Pseudosinella hirsuta*	a cave obligate springtail	G2G4	S3			Triana	35		Talucah
Mammals	*Myotis grisescens*	gray bat	G3	S2	LE	SP	Mason Ridge	4	1999-08-11	Cave Springs
Mammals	*Myotis grisescens*	gray bat	G3	S2	LE	SP	Triana	35	1995-05-26	Talucah
Vascular Plants	*Delphinium exaltatum*	tall larkspur	G3	SH			Somerville	16	1975-05-29	Stringer

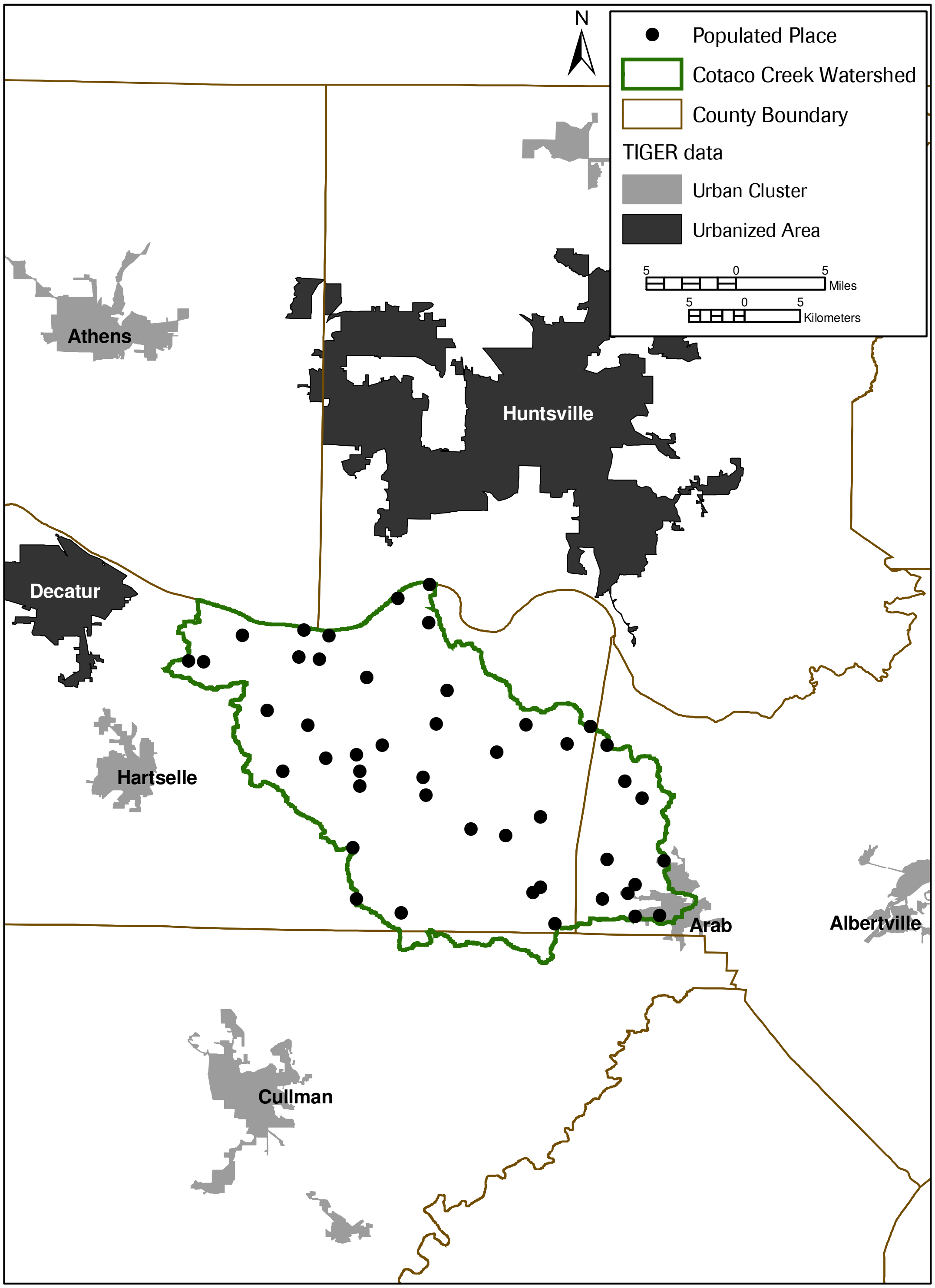

Figure 7. Populated place locations and urban areas as identified from the EPA BASINS data and Census 2000 TIGER/line files within the Cotaco Creek watershed, Alabama. An urban cluster consisted of densely settled territory that has at least 2,500 people but fewer than 50,000 people, while an urbanized area consisted of densely settled territory that contains 50,000 or more people (United States Census Bureau 2001).

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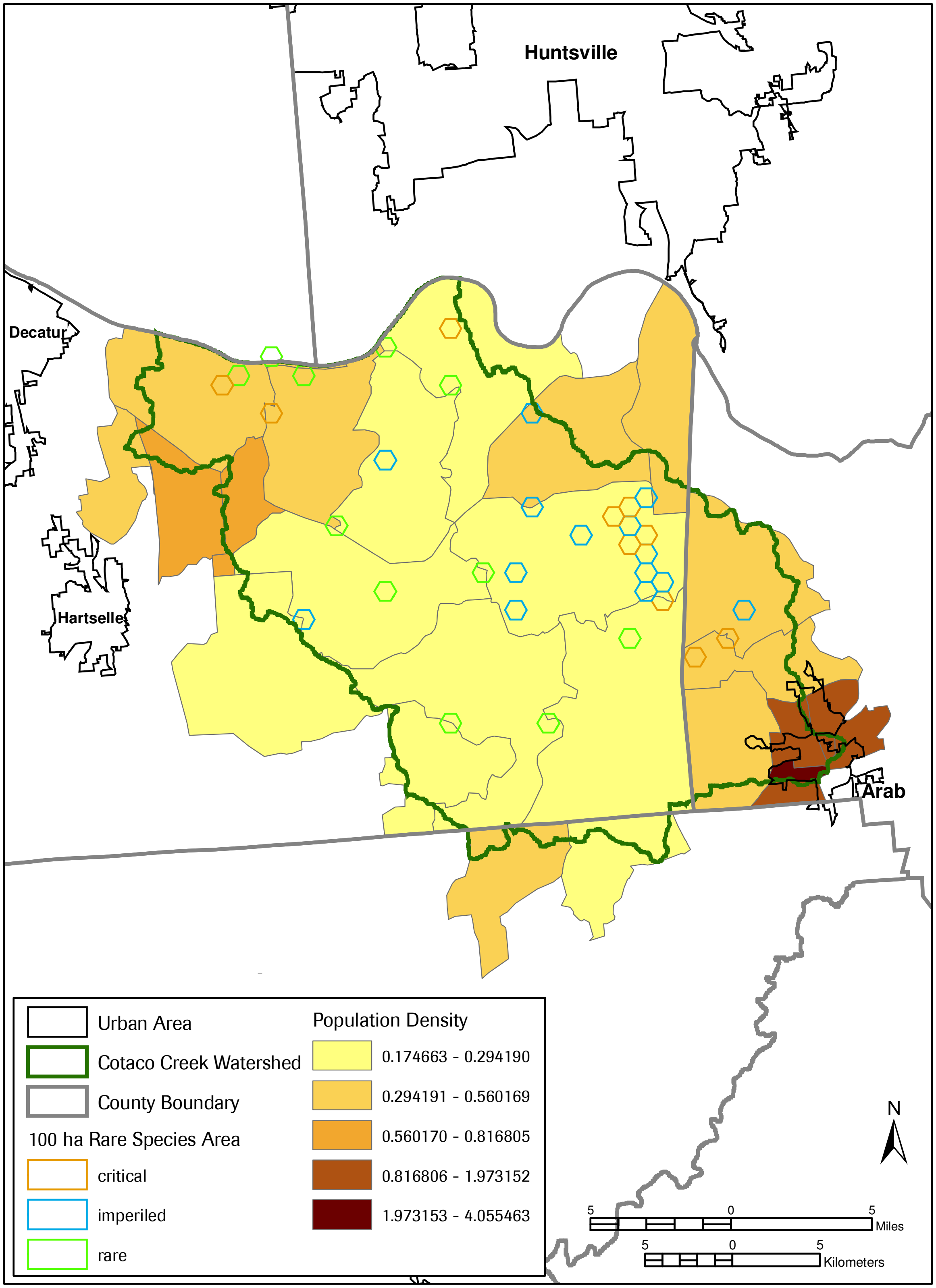

Figure 8. Population density (persons/ha) by 2000 census block groups for the Cotaco Creek watershed, Alabama. Population density was classified using natural breaks.

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Table 9. Number of animals and animal units (AU) for cattle, dairy, swine, and poultry production by county in Cotaco Creek watershed, Alabama. Estimates are from the Alabama Soil and Water Conservation Committee (1998).

County	Total Area (ha)	# of Cattle in Watershed	Cattle AU	Number of Dairies	Dairy AU	Number of Swine	Swine AU	Number of Broilers	Broiler – Poultry AU	Number of Layers	Layer AU
Marshall	24,533	2,160	2,160	0	0	0	0	3772	30.2	83	0.66
Morgan	148,326	21,000	21,000	900	1260	550	220	1,000,000	8,000	24,000	192

Table 10. Estimated number of septic systems and failing septic systems within the Cotaco Creek watershed, Alabama, by county as published by the Alabama Soil and Water Conservation Committee (198).

County	Area (ha)	Estimated Number of Septic Systems	Estimated Number of Failing Septic Systems	Estimated Number of Alternative Systems
Marshall	24,533	2,000	1,500	0
Morgan	148,326	15,000	750	300

poultry-broiler producers, and one was a dairy producer. The only CAFOs within 1 km of a rare species occurrence were 2 of the poultry CAFOs; one near Eudy cave and the other <1 km from 2 fish occurrences in Little Cotaco Creek. However, the number of CAFOs registered with ADEM is likely a severe underestimation of the number within the state because the number of CAFOs identified from aerial photographs was an order of magnitude larger than the number registered (Dr. Miriam Hell Hill, Jacksonville State University, personal communication).

Agricultural production has the potential to be a large contributor to NPS pollution, and agriculture was listed as the source of impairment for the stream segments on the State's 303(d) list of impaired streams, which are listed due to organic enrichment/Dissolved Oxygen and pathogens. The main components of NPS pollution which agricultural activities contribute are excessive sedimentation, nutrient loading, and elevated bacterial levels. Without adequate controls for limiting sediment, nutrient, and livestock waste, agricultural activities contribute to the degradation of aquatic habitat and threaten rare species and human health.

Permitted Sites

There were 3 active and 1 inactive National Pollutant Discharge Elimination System (NPDES) permitted discharge sites (Fig. 9), 12 hazardous and solid waste (HSW) sites (Fig. 10), 3 toxic release inventory (TRI) sites (Fig. 11), and 2 active mines (Fig 9) identified in the watershed from BASINS data (Appendix G). However, ADEM (2000a) identified more NPDES permitted sites in the watershed: 3 municipal and 3 semi-public/private NPDES permits and 7 current construction stormwater authorizations. Although there were 4 sites in both Morgan (3 in Decatur) and Marshall (2 in Arab) counties on the Superfund list, they were not on Superfund's National Priority List, and therefore were not in the BASINS dataset. There were no Industrial Facility Discharge sites in the watershed, but there were 2 very close to the borders of the watershed (Fig 10). None of these sites were within a rare species area or within 1 km of a rare species occurrence in the watershed.

Septic Systems

Failing septic systems have been identified as a significant contributor to NPS pollution within the watershed. The estimated number of septic systems was relatively high in CC watershed, and there are a significant number of failing septic systems, particularly in Marshall County where the proportion of septic systems failing was exceptionally high (Table 10). Many of the septic system failures are due to the slow percolation character of the soils.

Other Sources

The Consortium of Alabama Environmental Groups (2003) identified 1 potential source of NPS pollution in the CC watershed (Fig. 11) using low-flying aircraft. They also documented the site with photographs (Appendix H). The potential problem identified was nutrient/bacteria runoff from a chicken confined animal feeding operation along Tallaseehatchee Creek in Morgan County. This site was not within a rare species area nor within 1 km of a rare species occurrence.

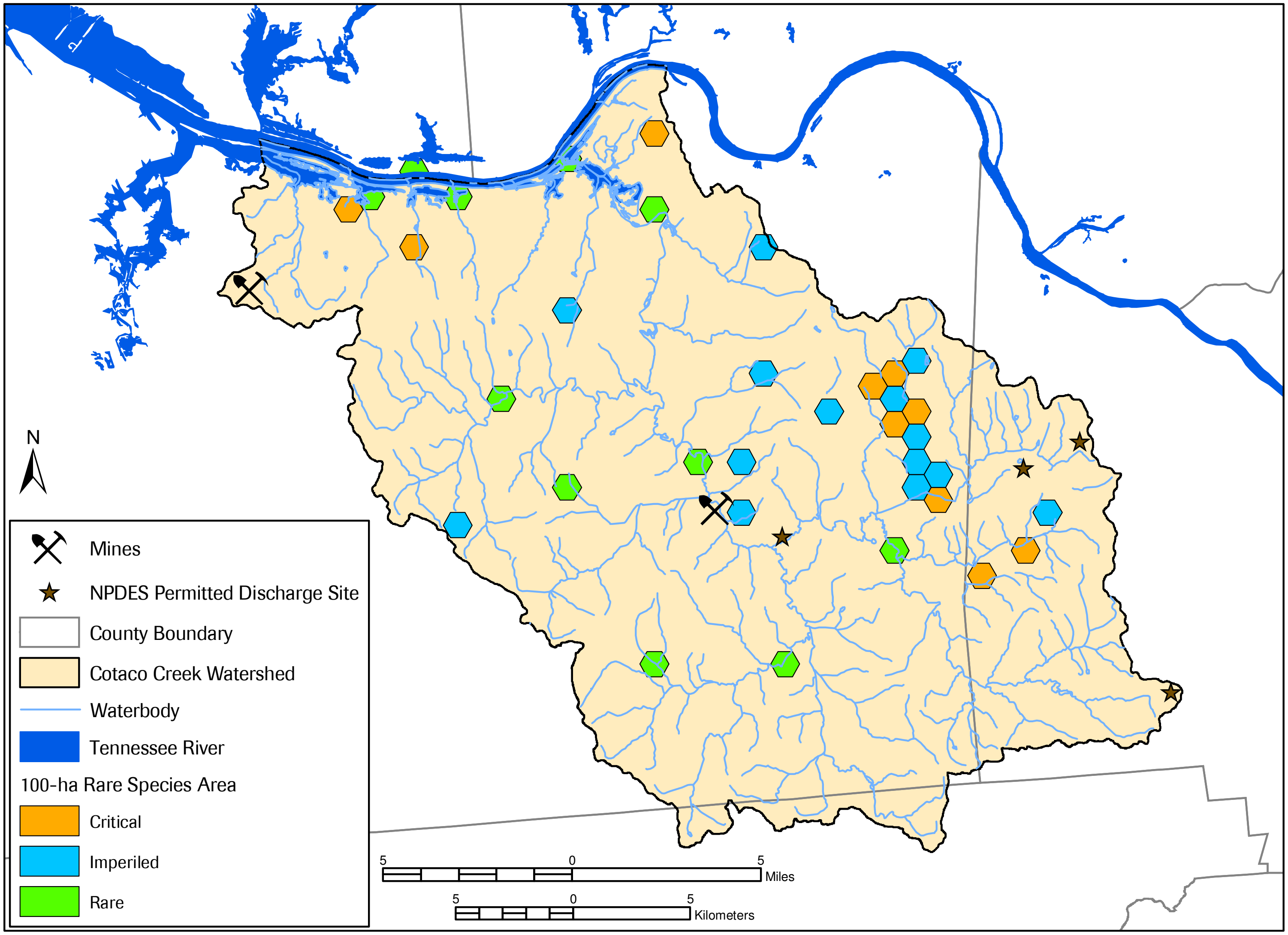

Figure 9. National Pollutant Discharge Elimination System (NPDES) permitted discharge sites and mines in the Cotaco Creek watershed, Alabama, identified from EPA BASINS data.

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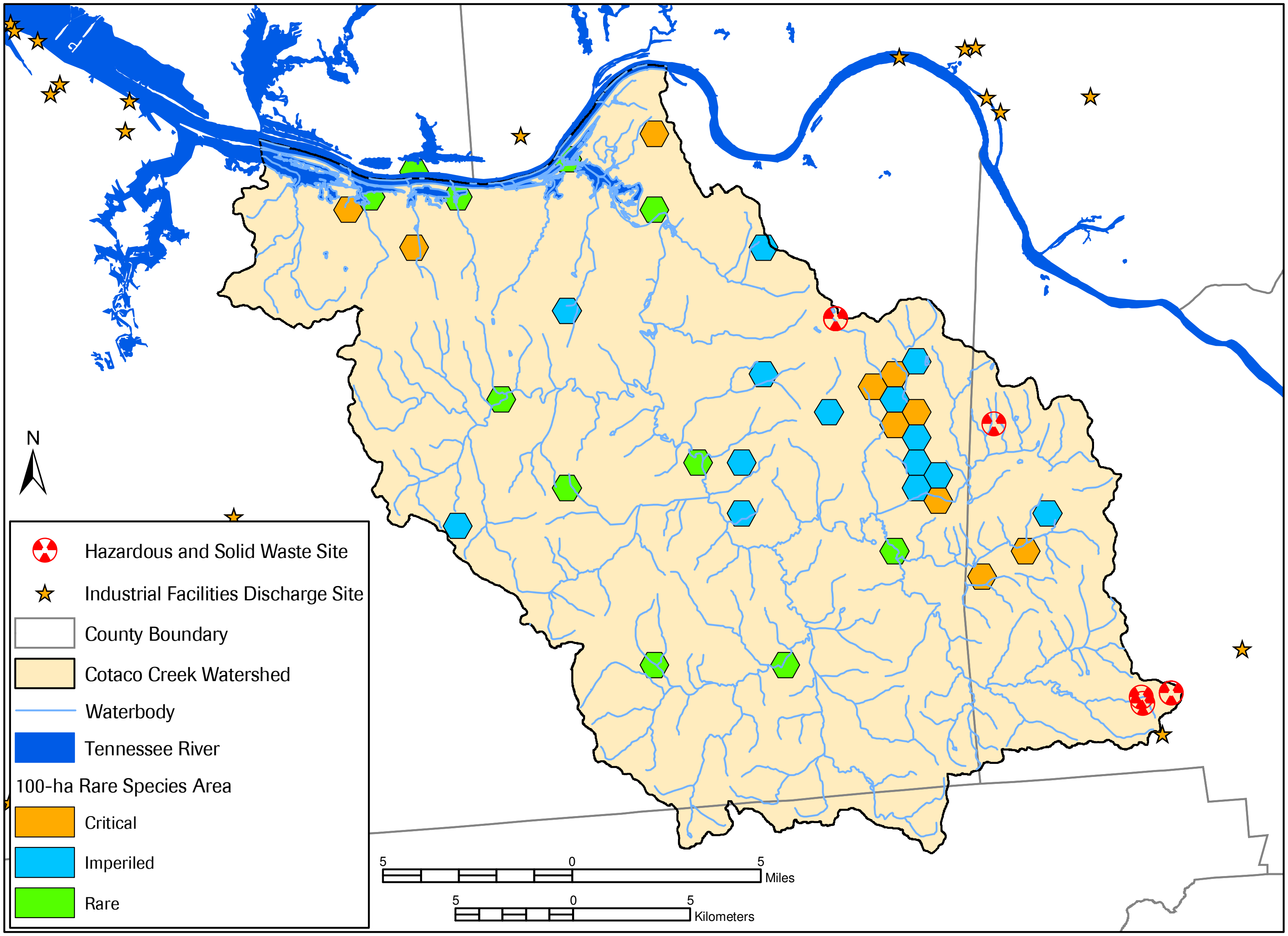

Figure 10. Hazardous and Solid Waste sites in the Cotaco Creek watershed, Alabama, identified from EPA BASINS data.

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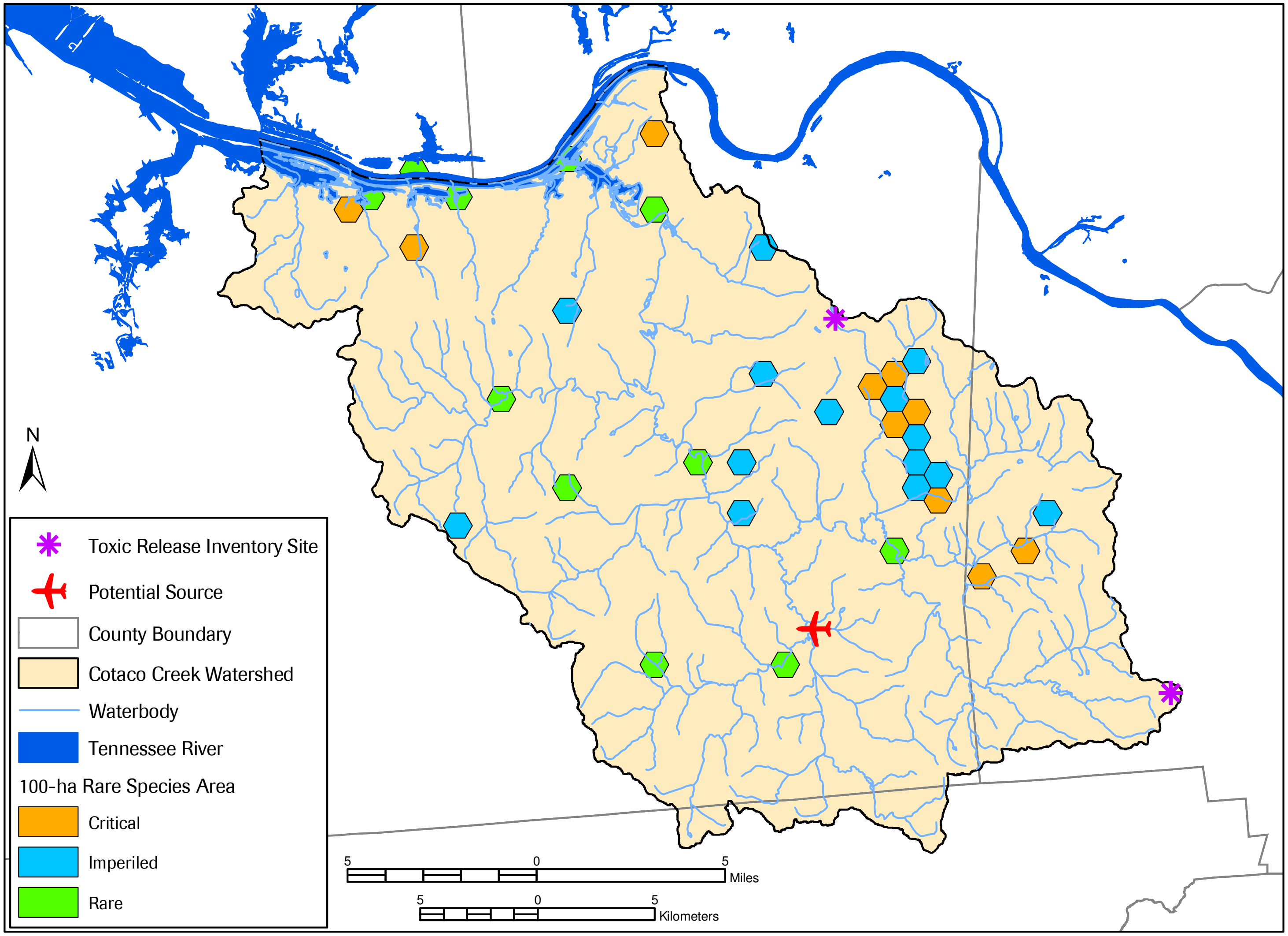

Figure 11. Toxic Release Inventory sites identified from EPA BASINS data and potential point and nonpoint pollution sources identified by the Consortium of Alabama Environmental Groups (2003) using low-flying aircraft in the Cotaco Creek watershed, Alabama.

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303(d) Listed Waters

Alabama's 2000 Final 303 (d) list of impaired waters (Alabama Department of Environmental Management 2000b) includes 5 stream reaches in the CC watershed that do not support their water use classifications: Town Creek (non-support), Cotaco Creek (non-support), West Fork Cotaco Creek (partial support), Mill Pond Creek (non-support), and Hughes Creek (partial support) (Fig. 12). The use not met for all 5 stream reaches was fish and wildlife, and the causes for listing were siltation, pathogens, or dissolved oxygen; all from agriculture (Table 11).

Mill Pond Creek was the only 303(d) listed stream segment that did not intersect a rare species area or have a rare species occurrence within 1 km of the stream. Town Creek had 1 rare species occurrence within 1 km of the listed segment: an occurrence of the snubnose darter (*Etheostoma simoterum* – rank G5/S3) in Town Creek. There was 1 fish [blackstripe topminnow (*Fundulus notatus*) – rank G5/S3] in Cotaco Creek and 1 imperiled plant [Cumberland rosinweed – rank G2/S2) within 1 km of Cotaco Creek. West Fork Cotaco Creek contained 1 rare fish [stripetail darter (*Etheostoma kennicotti*) – rank G4G5/S3), but there was no other rare species occurrence within 1 km of the creek. There were 6 rare species occurrences within 1 km of Hughes Creek, including 1 occurrence each of the federal endangered gray bat and federal endangered Indiana bat. The other occurrences were 2 occurrences each of field horsetail (rank G5S2) and a cave obligate beetle (*Pseudanophthalmus fluviatilis* – rank G3/S2).

THREATS

A detailed threat assessment analysis was not conducted due to time constraints. Instead, generalized threats to biodiversity in the watershed were identified based on threats to the conservation targets, 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 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, 6 major sources of stress were identified in the watershed: agriculture (crop and livestock production practices), development (including roads), forestry, invasive/alien species, recreational use, and waste disposal (trash and septic systems).

These threats are compounded by habitat fragmentation and the isolation and small population sizes of many of the rare species that occur in the watersheds. 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 corridors connecting habitat patches further isolates the remaining

Table 11. Stream reaches in the Cotaco Creek watershed listed on Alabama's 2000 final 303(d) list of impaired waters.

Waterbody ID	Waterbody Name	County	Support Status	Uses	Causes	Sources	Date of Data	Size	Downstream/ Upstream Location
AL/06030002-270_01	Town Creek	Morgan	Non	fish & wildlife	OE/DO	agriculture	1997	8.4 mi	Cotaco Creek/ Its Source
AL/06030002-270_02	Cotaco Creek	Morgan	Non	fish & wildlife	pathogens	agriculture	1997	5.1 mi	Guyer Branch/ West Fork Cotaco Creek
AL/06030002-270_03	West Fork Cotaco Creek	Morgan	Partial	fish & wildlife	pathogens siltation	agriculture	1997	7.5 mi	Alabama Highway 67/ Frost Creek
AL/06030002-270_04	Mill Pond Creek	Marshall	Non	fish & wildlife	siltation pathogens	agriculture	1994-1995	1.3 mi	Hog Jaw Creek/ Perkins Creek
AL/06030002-270_05	Hughes Creek	Morgan	Unknown	fish & wildlife	siltation	agriculture	1995	2.9 mi	Cotaco Creek/ Its Source

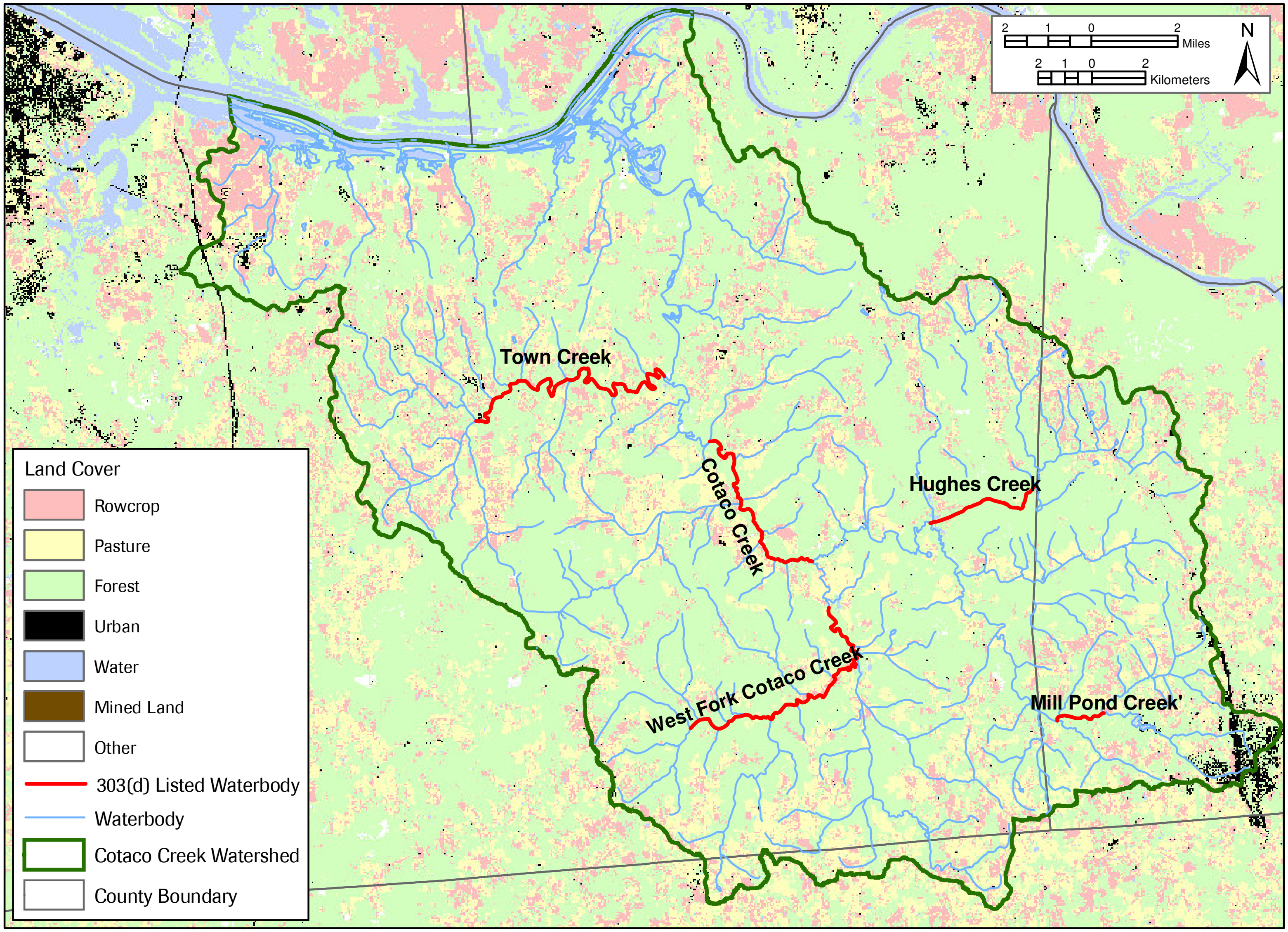

Figure 12. Stream reaches on Alabama's 2000 final 303(d) list in the Cotaco Creek watershed, Alabama.

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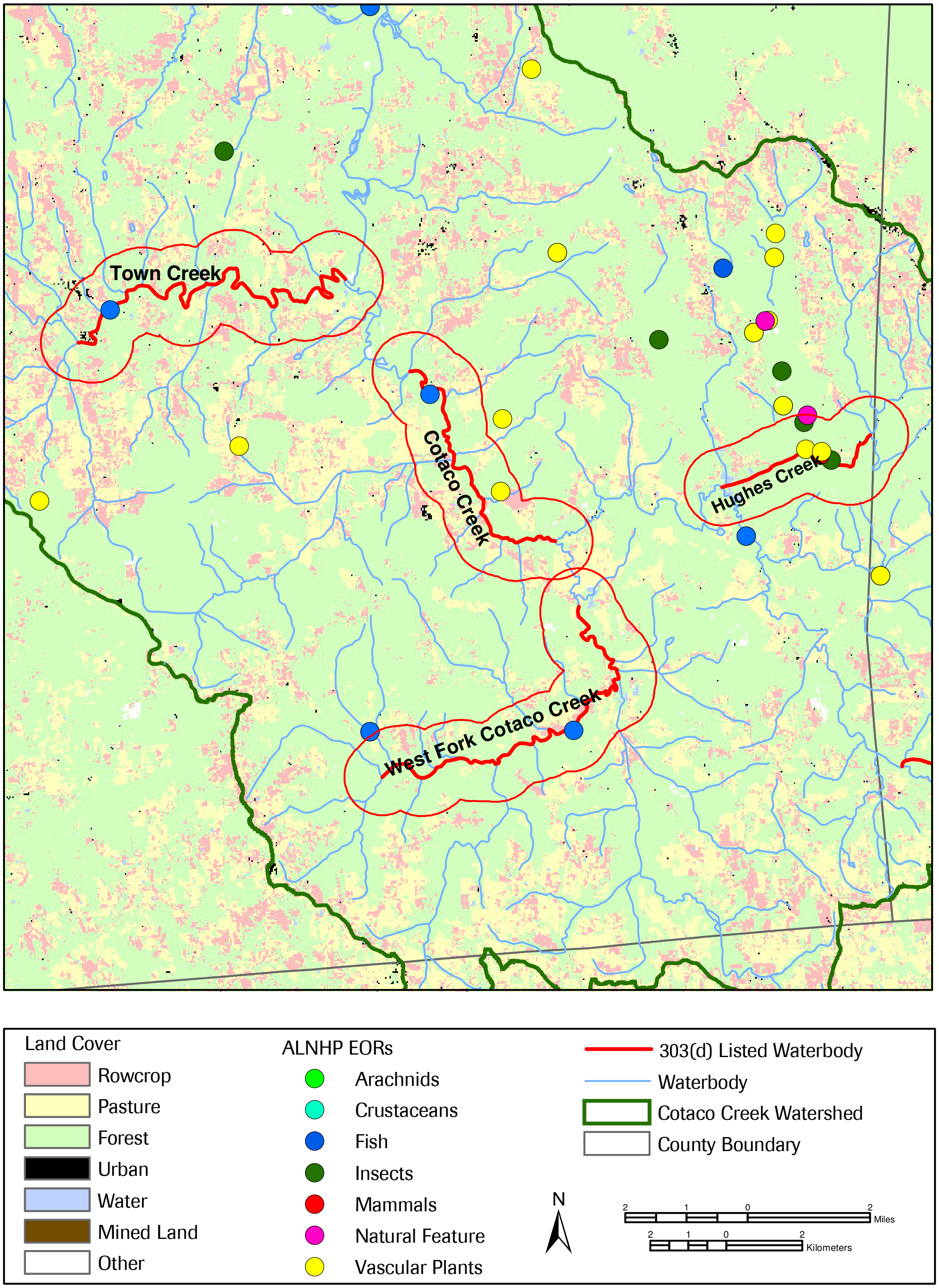

Figure 13. Rare, threatened, and endangered species and ecological features associated with stream reaches on Alabama's 2000 final 303(d) list in the Cotaco Creek watershed. A 1-km buffer around the listed streams is indicated by the red line circling the listed stream.

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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). Agriculture also is the source of impairment for all stream segments within the CC watershed on the 303(d) list of impaired waters.

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 phosphorous, 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).


cattle grazing in Morgan County, Alabama

The USFWS concluded that 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 be 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.


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

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 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 the strategies outlined in the Watershed Management Plan to reduce agricultural pollution and TNC's Cumberland and Southern Ridge and Valley Ecoregion Plan (The Nature Conservancy 2003) for abating threats from agricultural practices 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 USFWS Landowner Incentive Program and the various Farm Bill conservation programs. Increasing the implementation of agricultural BMPs, especially the use of riparian buffers, should be a goal in the watershed.

Development

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).

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).

strip development at Arab, Alabama

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 ≥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 areas 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 each local basin area.

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.

<u>Forestry</u>
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).

Because of their life cycle, small population sizes, and limited habitat availability, many aquatic species are highly susceptible to competitive or predaceous nonnative species (United States

Asian clam (*Corbicula fluminea*)
Photo – from Florida Integrated Science Center - Gainesville

Fish and Wildlife Service 2004b). The most abundant aquatic invasive faunal species of concern in CC watershed is the Asian clam (*Corbicula fluminea*), which has invaded all major drainages in Alabama. This nonnative species has been coexisting with the native mussel fauna for several decades, but little is known about the effects of competitive interaction between native species and Asian clams (United States Fish and Wildlife Service 2004b). The Asian clam is a known biofouler in power plant and industrial water systems and has also caused problems in irrigation canals and pipes. Ecologically, this species can alter benthic substrates and compete with native mussel species for food and space (Florida Caribbean Science Center 2001). In addition, Asian clams appear to be capable of tolerating polluted environments better than many native bivalves. The source of first introduction to North America is unknown, but it is suspected that this species was brought from China by immigrants as a food source and subsequently released. This species is found in fresh waters throughout the United States including all five Gulf states and northern Mexico. Estuarine populations have been reported for the San Francisco Bay, California, and Chesapeake Bay, Virginia, but none have been reported for the Gulf of Mexico ecosystem (Florida Caribbean Science Center 2001).

Chinese tallow (*Sapium sebiferum*) infestation
Photo – James R. Allison, Georgia Department of Natural Resources

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 because this species is still in demand from nurseries where it is stocked as an ornamental despite it being a serious and growing threat to the native plants and habitats of the southeast.

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

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

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 (*Pueraria montana* var. *lobata*) patch near Newsome Sinks, Morgan County, Alabama.

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, and is a problem on both public and private land. 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. Both species have compound leaves about 3.3 m (1 ft) long consisting of 7-13 leaflets for Chinese wisteria and 13-19 leaflets for Japanese wisteria. Leaflets are oval to elliptic with tapering pointed tips 4-8 cm (1.6-3 in) long and 2.5-3.5 cm (1-1.4 in) wide; they are hairless to short hairy at maturity but densely silky hairy when young. Flowers are fragrant, lavender to violet (to pink to white), dangling, showy, stalked clusters (racemes) 10-50 cm (4-20 in) long and 7-9 cm (3-3.5 in) wide appearing when leaves emerge, all blooming at about the same time (Chinese) or gradually from the base (Japanese) (Swearingen et al. 2002, Miller 2003). 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*).

Recreational Use

For the purpose of this project, the source Recreational Use was defined as any outdoor recreational use which caused a disturbance to the flora or fauna of the watershed, including off-road all-terrain vehicles (ATV) or 4-wheel drive truck use and spelunking. The 2 main sources of impact from recreational use were off-road ATV or truck use, particularly in stream beds and near stream channels, and recreational uses of caves.

The recreational use of ATVs and 4-wheel drive vehicles has the potential to have a large negative impact on both terrestrial and aquatic communities. When these vehicles are operated off trails, they disturb the soil which can lead to increased erosion and sedimentation in the streams. The most adverse impact occurs from the operation of these vehicles in the stream channel itself. This not only increases sediments but disturbs or destroys the bottom substrate itself and could cause mortality of benthic organisms from crushing.

Recreational usage of caves was the most significant negative impact in the decline of gray bats and Indiana bats that led to their listing as endangered species. They are sensitive to noise, lights, and other human disturbance, and human intrusion into hibernacula can result in mortality due to increased energy expenditure (Tuttle 1979). Disturbance to summer colonies can cause bats to abandon caves. Although most of the caves of major importance to these 2 species in Alabama have protections in place to exclude or minimize human disturbance, human disturbance to cave communities remains a threat.

Waste Disposal
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. CC watershed contains a relatively high 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.

In many rural areas, dead end roads, sinkholes, and streams commonly become disposal sites for garbage and other waste materials. These places are eyesores and pose a threat to ground and surface water quality as well as being a public health hazard. They can quickly contaminate surface and ground water with toxins and pathogens. When the disposal site is a sinkhole or cave, dumping can also cause disturbance to the habitat. Efforts should be made to find and eliminate any illegal dumping sites, particularly those using sinkholes.

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. Many areas of CC watershed have not been surveyed or have been surveyed only for specific taxonomic groups. 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, particularly for terrestrial species, aquatic invertebrates, and cave fauna.

Karst areas warrant focused protection and pollution prevention efforts because of their abundance in northern Alabama, their importance as drinking water supplies, their sensitivity to environmental disturbance, and their exceptional ecological diversity. BMPs for stormwater management and silvicultural and agricultural activities should be strongly encouraged and promoted throughout the watershed, with a strong emphasis around karst areas. Any sinkhole dumps in the watershed should be cleaned up, and the importance of karst areas and proper trash disposal should be incorporated into any educational efforts.

One of the greatest general threats to the survival of many rare species populations in the watershed is the isolation and small size and extent of the populations that remain which magnifies the negative impacts of anthropogenic stresses. Cumulative effects of physical habitat modifications have caused widespread fragmentation and isolation of many populations of rare species, presenting difficult challenges for those trying to reverse their decline and restore these species. These small isolated populations remain vulnerable to extinction or extirpation due to demographic and environmental stochasticity, catastrophic events, or habitat loss and degradation caused by the many potential stresses in the watersheds. For several species maintaining the species as part of the biota in the watershed may require not only protection of existing populations, but also reintroductions into currently unoccupied portions of their historic range.

Conservation actions should initially concentrate on the rare species areas and their buffers. 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

Example of forested riparian buffer. Photo – USDA NRCS

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 width of 15-30 m width 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).

Population growth is the most significant social change affecting natural resources. Managing growth in the watersheds will be vital to maintaining the biodiversity of the watersheds. As populations and urban growth expand, natural environments are increasingly affected by human activities; rapid development leads to the fragmentation and loss of natural resources, as well as the continued degradation of environmental resources (Macie and Hermansen 2002). In the wildland-urban interface, that area where homes or other structures are adjacent to or within forests and other rural settings, natural resource managers face critical challenges, such as wildfire prevention, control, and mitigation; watershed conservation and management; biodiversity management; and forest-resource management and conservation (Monroe et al. 2003). Protecting wildlife habitat, improving water and air quality, and preserving the rural character of communities top the list of issues many managers and planners must deal with as developed areas expand. The pace of urban sprawl is bringing to the rural landscape the noise, pollution, and conflicts many people thought they were escaping by moving, and many rural residents fear the beauty and rural character they cherish will be lost if appropriate measures are not taken to protect key features (Monroe et al. 2003). The need for smart-growth initiatives and planned communities that protect habitat and stream corridors while providing housing for people was raised in every focus group conducted by the Forest Service for their wildland-urban interface assessment (Monroe et al. 2003). However, Macie and Hermansen (2002) suggested a need to move beyond smart growth models and start to predict the impacts of land use changes on landscape heterogeneity as well as ecosystem composition, structure, and function. They also suggested expanding Wear et al.'s (1998) modeling approach to land use changes in an urban and urbanizing context to landscapes throughout the region, and applying the results to land use decisions. Every focus group also complained that a lack of vision, leadership, planning, and regional coordination for comprehensive growth management are major factors that create interface problems. An issue raised in the Alabama groups was the lack of home rule which prohibits local governments from regulating growth. In addition, local governments receive most of their funding from property and sales taxes, which creates an incentive to promote economic development at the local level, usually to the detriment of the natural resources in the area (Macie and Hermansen 2002). Key issues in Alabama included political issues, a lack of vision and leadership to guide development and planning (a common concern in all states), the need for sustainable development, a lack of comprehensive land use planning, water quality and quantity, and education (Monroe et al. 2003).

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 CC 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. Many of the strategies developed in the Cotaco Creek Management Plan and TNC's Cumberland and Southern Ridge and Valley Ecoregion Plan (The Nature Conservancy 2003) could be applied to address these goals.

<u>Goals</u>

- Protect and maintain multiple, viable populations of all local scale conservation targets ensuring that, for each species, enough populations are protected to conserve their remaining natural range of ecological and genetic diversity.

- 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.

- Identify recharge areas affecting karst communities and monitor karst communities for declines.

- 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.

- Conserve key parcels through easements, acquisitions, or government funded programs such as the USFWS Landowner Incentive Program and the various Farm Bill conservation programs.

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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.

demographic stochasticity – Uncertainty due to random variations in population birth and death rates in a population due to chance differences experienced by individuals. Even in a constant environment, discrete births and deaths can cause population numbers to vary unpredictably. In small populations, demographic stochasticity can generate a substantial risk of extinction., even if birth rates exceed death rates. (Smith 1990, Gotelli 1998)

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)

endemic – Found only in a specified geographic region. (Smith 1990)

environmental stochasticity – Uncertainty due to variation in environmental conditions, such as bad weather or food failure, that affect some aspect of population growth, such as survival or reproduction. (Smith 1990, Gotelli 1998)

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 geographically referenced 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)

hibernaculum – The case, covering, or structure in which an organism remains dormant for the winter. (Georgia Department of Natural Resources 1999)

historic – An Element Occurrence (EO) where the last observed date is >20 years old. This does not necessarily imply that the Element is no longer extant at this location, but may instead reflect a lack of survey effort at the location since it was last observed (the last survey date of the EOR would indicate if this was true).

inflorescence – An aggregation of flowers occurring clustered together in a particular manner usually characteristic of a particular kind of plant. (Godfrey and Wooten 1979)

karst – a landscape characterized by sinkholes, sinking streams, springs, and caves that formed in areas where mildly acidic groundwater has dissolved soluble rocks such as limestone. (Wilson and Tuberville 2003)

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) 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) 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.

matrix – The background ecosystem or land use type in a mosaic, characterized by extensive cover, high connectivity, and/or major control over the landscape functioning. (Forman 1995)

mesophyte – (mesophytic – adj.) a plant that grows under medium conditions of moisture. (Merriam-Webster 2004)

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.

raceme – An inflorescence with a single axis, the flowers stalked. (Godfrey and Wooten 1979)

rhizome – A horizontal underground stem. (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. (source?)
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)

rosette – A group of organs, such as leaves, clustered and crowded around a common point of attachment. (Godfrey and Wooten 1979)

rostrum – The often spinelike anterior median prolongation of the carapace of a crustacean. (Merriam-Webster 2004)

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.

stolon – A stem with long internodes that trails along the surface of the ground, usually rooting at the nodes. (Godfrey and Wooten 1979).

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

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

troglodytic – a member of a species dwelling in caves.

vespertilionid – A bat of the family Vespertilionidae, a large family of nocturnal bats containing almost 300 species.

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), ≥ 4th 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), 1st – 3rd 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. Alabama Natural Heritage Program[SM] Element Occurrence Records for the Cotaco Creek Watershed.

Table D-1. Alabama Natural Heritage Program[SM] Element Occurrence Records for the Cotaco Creek watershed as of March 2004. Coordinates given are rounded to the nearest minute.

Major Taxonomic Group	EO Code	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	County, Quad	Town Range	Section	Latitude, Longitude	Date Last Observed	EO Data
Arachnids	ILARA36050 *001*AL	*Nesticus jonesi*	Cave Spring cave spider	G1G2	S1			Morgan, Mason Ridge	006S 003W	4	343300N, 0865100W		Peck (1989) reported the species from this cave; no date was given.
Crustaceans	ICMAL07180 *002*AL	*Cambarus jonesi*	Alabama cave crayfish	G2	S2			Morgan, Mason Ridge	006N 003W	4	343300N, 0865100W	1975-08-14	
Crustaceans	ICMAL07180 *012*AL	*Cambarus jonesi*	Alabama cave crayfish	G2	S2			Morgan, Triana	005S 002W	35	343400N, 0864200W		Hobbs, Hobbs, and Daniel (1977) reported the species in this cave; the date was not given.
Crustaceans	ICMAL14320 *002*AL	*Procambarus pecki*	phantom cave crayfish	G1	S1			Morgan, Mason Ridge	006N 003W	4	343300N, 0865100W	1975-08-00	
Ecological Feature	GCAVEAL103 *030*TV	Alabama Morgan County cave	Alabama Morgan County cave					Morgan, Newsome Sinks	007S 001W	11	342700N, 0863600W		The cave has a large, walk-in entrance.

Table D-1. Continued.

Major Taxonomic Group	EO Code	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	County, Quad	Town Range	Section	Latitude, Longitude	Date Last Observed	EO Data
Ecological Feature	GCAVEAL103 *043*TV	AL Morgan County cave	AL Morgan County cave					Morgan, Newsome Sinks	007S 001W	13	342600N, 0863600W		The cave has 3 entrances, a 60 ft. deep pit, a stoop or duck-walk entrance known as the root entrance, and a third entrance plotted separately as GCAVEAL103 *226*TV.
Fish	AFCQC02380 *001*AL	*Etheostoma kinnecotti*	stripetail darter	G4G5	S3			Lawrence Cove	008S 001W	8	342100N 0864000W	2000	
Fish	AFCQC02380 *002*AL	*Etheostoma kinnecotti*	stripetail darter	G4G5	S3			Lawrence Cove	008S 002W	10	342200N 0864400W	2000	
Fish	AFCQC02700 *001*AL	*Etheostoma simoterum*	snubnose darter	G5	S3			Somerville	007S 002W	6	342800N, 0864700W		
Fish	AFCQC02700 *002*AL	*Etheostoma simoterum*	snubnose darter	G5	S3			Newsome Sinks	007s 001w	26	342400N, 0863700W		
Fish	AFCQC02820 *020*AL	*Etheostoma tuscumbia*	Tuscumbia darter	G2	S2		SP	Morgan, Mason Ridge	006S 003W	11	343200N, 0864900W	1889-06-01	
Fish	AFCNB04110 *001*AL	*Fundulus notatus*	blackstripe topminnow	G5	S3			Center Grove	007S 002W	12	342600N, 0864200W	2000	
Fish	AFCJB14010 *002*AL	*Hemitremia flammea*	flame chub	G3	S3			Mason Ridge	006S 003W	4	343300N, 0865100W		
Fish	AFCJB14010 *003*AL	*Hemitremia flammea*	flame chub	G3	S3			Newsome Sinks	007S 001W	26	342400N 0863700W		
Fish	AFCJB14010 *004*AL	*Hemitremia flammea*	flame chub	G3	S3			Newsome Sinks	007S 001E	32	342300N 0863300W	2000	
Fish	AFCJB14010 *005*AL	*Hemitremia flammea*	flame chub	G3	S3			Lawrence Cove	008S 002W	10	342200N 0864400W	2000	
Fish	AFCJB16030 *008*AL	*Hybognathus hayi*	cypress minnow	G5	S3			Mason Ridge	006S 003W	1	343300N, 0864800W	1938	
Fish	AFCJC07020 *001*AL	*Ictiobus cyprinellus*	bigmouth buffalo	G5	S2S3			Triana	006S 002W	11	343200N 0864200W	2000	

Table D-1. Continued.

Major Taxonomic Group	EO Code	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	County, Quad	Town Range	Section	Latitude, Longitude	Date Last Observed	EO Data
Fish	AFCJC07030 *001*AL	*Ictiobus niger*	black buffalo	G5	S2S3			Triana	006S 002W	11	343200N 0864200W	2000	
Fish	AFCJC10110 *001*AL	*Moxostoma macrolepidotum*	shorthead redhorse	G5	S3			Triana	006S 002W	4	343300N, 0864500W	1936	
Fish	AFCJB28230 *001*AL	*Notropis buchanani*	ghost shiner	G5	S2			Mason Ridge	006S 003W	4	343300N, 0865100W	1936	
Fish	AFCQC04270 *001*AL	*Percina shumardi*	river darter	G5	S3			Mason Ridge	006S, 003W	4	343300N, 0864900W		
Fish	AFCLA04010 *020*AL	*Typhlichthys subterraneus*	southern cavefish	G4	S3		SP	Morgan, Newsome Sinks	007S 001W	2	342800N, 0863700W	1977-04-12	
Fish	AFCLA04010 *031*AL	*Typhlichthys subterraneus*	southern cavefish	G4	S3		SP	Morgan, Mason Ridge	006N 003W	4	343300N, 0865100W	1957-10-19	
Fish	AFCLA04010 *032*AL	*Typhlichthys subterraneus*	southern cavefish	G4	S3		SP	Morgan, Triana	005S 002W	35	343400N, 0864200W	1957-10-19	
Insects	IICOL88040*006*AL	*Batriasymmodes spelaeus*	a cave obligate beetle	G3G4	S3			Morgan, Mason Ridge	006S 003W	4	343300N, 0865100W		Peck (1995) reported the species from this cave; no date was given.
Insects	IICOLA8100*004*AL	*Batrisodes valentinei*	a beetle	G3G4	S2			Morgan, Triana	005S 002W	35	343400N, 0864200W		Peck (1995) reported the species from this cave; no date was given.
Insects	IICOL4EBX0*001*AL	*Pseudanophthalmus fluviatilis*	a cave obligate beetle	G3	S2			Morgan, Newsome Sinks	007S 001W	24	342500N, 0863500W		Peck (1995) reported the species from this cave; no date was given.
Insects	IICOL4EBX0*002*AL	*Pseudanophthalmus fluviatilis*	a cave obligate beetle	G3	S2			Morgan, Center Grove	007S 001W	10	342700N, 0863800W		Peck (1995) reported the species from this cave; no date was given.

Table D-1. Continued

Major Taxonomic Group	EO Code	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	County, Quad	Town Range	Section	Latitude, Longitude	Date Last Observed	EO Data
Insects	IICOL4EBX0*003*AL	*Pseudanophthalmus fluviatilis*	a cave obligate beetle	G3	S2			Morgan, Mason Ridge	006S 002W	21	343000N, 0864500W		Peck (1995) reported the species from this cave; no date was given.
Insects	IICOL4EBX0*004*AL	*Pseudanophthalmus fluviatilis*	a cave obligate beetle	G3	S2			Marshall, Newsome Sinks	007S 001E	21	342400N, 0863200W		Peck (1995) reported the species from this cave; no date was given.
Insects	IICOL4EBX0*005*AL	*Pseudanophthalmus fluviatilis*	a cave obligate beetle	G3	S2			Morgan, Newsome Sinks	009S 001W	13	342500N, 0863600W		Peck (1995) reported the species from this cave; no date was given.
Insects	IICOL4EBX0*006*AL	*Pseudanophthalmus fluviatilis*	a cave obligate beetle	G3	S2			Morgan, Triana	005S 002W	35	343400N, 0864200W		Peck (1995) reported the species from this cave; no date was given.
Insects	IICOL4EBX0*007*AL	*Pseudanophthalmus fluviatilis*	a cave obligate beetle	G3	S2			Morgan, Newsome Sinks	007S 001W	11	342600N, 0863600W		Peck (1995) reported the species from this cave; no date was given.
Insects	IICOL4EBX0*008*AL	*Pseudanophthalmus fluviatilis*	a cave obligate beetle	G3	S2			Morgan, Newsome Sinks	007S 001W	11	342700N, 0863600W		Peck (1995) reported the species from this cave; no date was given.
Insects	IICLL01060*005*AL	*Pseudosinella hirsuta*	a cave obligate springtail	G2G4	S3			Morgan, Triana	005S 002W	35	343400N, 0864200W		Peck (1995) reported the species from this cave; no date was given.

Table D-1. Continued.

Major Taxonomic Group	EO Code	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	County, Quad	Town Range	Section	Latitude, Longitude	Date Last Observed	EO Data
Insects	IICLL01250*014*TV	*Pseudosinella spinosa*	a cave obligate springtail	G3G4	S?			Morgan, Newsome Sinks			342700N, 0863600W		Peck (1995) reported the species from this cave; no date was given.
Mammals	AMACC08020*006*AL	*Corynorhinus rafinesquii*	Rafinesque's big-eared bat	G3G4	S2		SP	Marshall, Newsome Sinks	007S 001E	32	342300N, 0863300W	1953-03-08	One specimen.
Mammals	AMACC01040*004*AL	*Myotis grisescens*	gray bat	G3	S2	LE	SP	Morgan, Mason Ridge	006N 003W	4	343300N, 0865100W	1999-08-11	
Mammals	AMACC01040*021*AL	*Myotis grisescens*	gray bat	G3	S2	LE	SP	Morgan, Triana	005S 002W	35	343400N, 0864200W	1995-05-26	Cave not surveyed during 1998. 1997-09-15: Only about 10 bats, species unknown, seen exiting the cave. 1996: Cave was not surveyed. 1995-05-26: Count at "downhill" entrance: 31. 1994: Cave was not surveyed. 1993-07-02: Count – 43. No ingress attempted.

Table D-1. Continued.

Major Taxonomic Group	EO Code	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	County, Quad	Town Range	Section	Latitude, Longitude	Date Last Observed	EO Data
Mammals	AMACC01040 *027*AL	*Myotis grisescens*	gray bat	G3	S2	LE	SP	Morgan, Newsome Sinks	007S 001W	24	342500N, 0863500W	1998-07-23	1998-07-23: A harp style trap set at cave entrance; 115 bats trapped of three species. *Eptesicus fuscus* – 3; *Pipistrellus subflavus* – 111; and 1 *Myotis grisescens*. All bats were male. 1997-06-30: Only 2 bats seen emerging, not believed to be *Myotis*.
Mammals	AMACC01100 *002*AL	*Myotis sodalis*	Indiana bat	G2	S2	LE	SP	Morgan, Newsome Sinks	007S 001W	24	342500N, 0863500W	1953-03-10	Eleven specimens collected.
Vascular Plants	PMLIL022E0 *001*AL	*Allium tricoccum*	wild leek	G5	S1			Marshall, Newsome Sinks	007S 001W	31	342300N, 0863500W	1997-04-13	Ca. 300-400 non-flowering (too early) plants were observed.

Table D-1. Continued.

Major Taxonomic Group	EO Code	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	County, Quad	Town Range	Section	Latitude, Longitude	Date Last Observed	EO Data
Vascular Plants	PPASP021E1 *001*AL	*Asplenium scolopendrium* var *americanum*	American hart's-tongue fern	G4T3	S1	LT		Morgan, Newsome Sinks	007S 001W	12	342700N, 0863600W	1989-09-11	Limestone ledge about 30 feet from top of sinkhole, opposite waterfall. Evans (1981) reports that this is a vigorous, healthy, reproducing population, which in 1981 supported 97 plants (26 fertile adults, 13 subadults, and 58 juveniles).
Vascular Plants	PDMAL0A010 *025*AL	*Callirhoe alcaeoides*	clustered poppy-mallow	G5?	S2			Morgan, Triana	006S 001W	17	343100N, 0864000W	1998-07-29	Fifty – 60 flowering plants were observed.
Vascular Plants	PDANA03020 *010*AL	*Cotinus obovatus*	American smoke-tree	G4	S2			Morgan, Center Grove	006S 001W	32	342800N, 0864000W	1998-07-22	An estimated 100-125 trees (in various stages of growth) were observed. Several more are likely to occur away from highway. Population encompasses several acres.

Table D-1. Continued.

Major Taxonomic Group	EO Code	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	County, Quad	Town Range	Section	Latitude, Longitude	Date Last Observed	EO Data
Vascular Plants	PPDRY07080 *002*AL	*Cystopteris tennesseensis*	Tennessee bladderfern	G5	S2			Morgan, Newsome Sinks	007S 001W	13	342600N, 0863600W	1980-05-24	
Vascular Plants	PDRAN0B0J0 *001*AL	*Delphinium exaltatum*	tall larkspur	G3	SH			Morgan, Somerville	007S 002W	16	342600N, 0864500W	1975-05-29	
Vascular Plants	PDFUM04030 *010*AL	*Dicentra cucullaria*	Dutchman's breeches	G5	S2			Marshall, Newsome Sinks	007S 001E	31	342300N, 0863500W	1997-04-13	Thousands of plants. Plants were producing immature fruit during survey.
Vascular Plants	PPEQU01010 *002*AL	*Equisetum arvense*	field horsetail	G5	S2			Morgan, Newsome Sinks	007S 001W	24	342500N, 0863600W	1980-05-24	
Vascular Plants	PPEQU01010 *004*AL	*Equisetum arvense*	field horsetail	G5	S2			Morgan, Newsome Sinks	007S 001W	24	342500N, 0863500W	1975-07-06	
Vascular Plants	PDCEL05030 *004*AL	*Euonymus atropurpureus*	wahoo	G5	S3			Morgan, Newsome Sinks	007S 001W	13	342600N, 0863600W	1975-08-09	
Vascular Plants	PMLIL1A030 *003*AL	*Lilium canadense*	Canada lily	G5	S2			Morgan, Newsome Sinks	007S 001W	12	342700N, 0863600W	1997-04-13	Roughly 100 – 125 non-flowering (too early) plants were observed.
Vascular Plants	PMLIL1A030 *004*AL	*Lilium canadense*	Canada lily	G5	S2			Morgan, Newsome Sinks	007S 001W	1	342800N, 0863600W	1997-04-13	Approximately 50 non-flowering (too early) plants.
Vascular Plants	PDSAX0N030 *001*AL	*Mitella diphylla*	miterwort	G5	S1			Morgan, Newsome Sinks	007S 001W	12	342700N, 0863600W	1997-04-13	Approximately 10 plants were observed.
Vascular Plants	PDSAX0N030 *002*AL	*Mitella diphylla*	miterwort	G5	S1			Morgan, Newsome Sinks	007S 001W	11	342700N, 0863600W	1997-04-13	Roughly 50 – 60 flowering plants were observed.

Table D-1. Continued.

Major Taxonomic Group	EO Code	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	County, Quad	Town Range	Section	Latitude, Longitude	Date Last Observed	EO Data
Vascular Plants	PDARA09010 *009*AL	*Panax quinquefolius*	American ginseng	G3G4	S4			Morgan, Newsome Sinks	007S 001W	13	342600N, 0863600W	1975-08-09	
Vascular Plants	PDAST8L040 *004*AL	*Silphium brachiatum*	Cumberland rosinweed	G2	S2			Morgan, Center Grove	007S 001W	18	342600N, 0864100W	1998-07-22	Roughly 350-400 flowering plants were observed encompassing two to three acres. Plants appear quite vigorous.
Vascular Plants	PDAST8L040 *005*AL	*Silphium brachiatum*	Cumberland rosinweed	G2	S2			Morgan, Center Grove	007S 001W	19	342500N, 0864100W	1998-07-22	Approximately 35-40 flowering plants were observed.
Vascular Plants	PDAST8L040 *007*AL	*Silphium brachiatum*	Cumberland rosinweed	G2	S2			Morgan, Center Grove	006S 001W	32	342800N, 0864000W	1998-07-22	Approximately 200-250 mature and immature plants were observed along highway margin and in adjacent forest. More plants are likely to occur.
Vascular Plants	PDAST8L040 *021*AL	*Silphium brachiatum*	Cumberland rosinweed	G2	S2			Morgan, Somerville	007S0 3W	23	342500N, 0864900W	1998-07-22	Approximately 35-40 plants were observed, six of which were producing flowers.

Table D-1. Continued.

Major Taxonomic Group	EO Code	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	County, Quad	Town Range	Section	Latitude, Longitude	Date Last Observed	EO Data
Vascular Plants	PMLIL200B0 *004*AL	*Trillium flexipes*	nodding trillium	G5	S2S3			Marshall, Newsome Sinks	007S 001E	31	342300N, 0863500W	1997-04-1319	Thousands of flowering plants.
Vascular Plants	PMLIL200B0 *005*AL	*Trillium flexipes*	nodding trillium	G5	S2S3			Morgan, Newsome Sinks	006S 001W	36	342800N, 0863600W	1997-04-13	Roughly 250 - 300 plants were estimated. Trilliums were in full flower.
Vascular Plants	PDCPR06010 *005*AL	*Triosteum angustifolium*	yellowleaf tinker's-weed	G5	S1			Morgan, Newsome Sinks	007S 001W	1	342800N, 0863600W	1997-04-13	Only two flowering plants were observed. More are likely to occur nearby.

APPENDIX E. Rare species areas in the Cotaco Creek Watershed.

Table E-1. One-hundred hectare rare species areas in the Cotaco Creek watershed identified using occurrence data from Alabama Natural Heritage Program's Biological Conservation Database and a 100 ha hexagon coverage generated in ArcView. Hexagon type was coded "critical", "imperiled", or "rare" based on the presence of federal or state protected species and heritage ranks. "Critical" hexagons were those containing federal or state protected species or species with a heritage rank of G1 or S1. "Imperiled" hexagons were those containing species with a heritage rank of G2 or S2 without federal or state protection. "Rare" hexagons were those containing species with a heritage rank of G3 – G5 without federal or state protection.

Hexagon ID	Type	# of EORs	Species Occurring in Hexagon	
			Scientific Name	Common Name
14269	rare	1	*Etheostoma kennicotti*	stripetail darter
14275	rare	2	*Etheostoma kennicotti, Hemitremia flammea*	stripetail darter, flame chub
14560	critical	4	*Allium tricoccum, Dicentra cucullaria, Trillium flexipes*	wild leek, Dutchman's breeches, nodding trillium
14658	critical	2	*Corynorhinus rafinesquii, Hemitremia flammea*	Rafinesque's big-eared bat, flame chub
14664	rare	2	*Etheostoma simoterum, Hemitremia flammea*	snubnose darter, flame chub
14784	imperiled	1	*Silphium brachiatum*	Cumberland rosinweed
14857	imperiled	1	*Pseudanophthalmus fluviatilis*	a cave obligate beetle
14862	critical	4	*Equisetum arvense, Myotis grisescens, Myotis sodalis, Pseudanophthalmus fluviatilis*	field horsetail, gray bat, Indiana bat, a cave obligate beetle
14871	imperiled	1	*Silphium brachiatum*	Cumberland rosinweed
14962	imperiled	2	AL Morgan County cave, *Pseudanophthalmus fluviatilis*	AL Morgan County cave, a cave obligate beetle
14963	imperiled	1	*Equisetum arvense*	field horsetail
14979	rare	1	*Delphinium exaltatum*	tall larkspur
15063	imperiled	3	*Cystopteris tennesseensis, Euonymus atropurpureus, Panax quinquefolius*	Tennessee bladderfern, wahoo, American ginseng
15071	imperiled	1	*Silphium brachiatum*	Cumberland rosinweed
15073	rare	1	*Fundulus notatus*	blackstripe topminnow
15163	imperiled	1	*Pseudanophthalmus fluviatilis*	a cave obligate beetle
15164	critical	3	*Asplenium scolopendrium* var *americanum, Lilium canadense, Mitella diphylla*	American Hart's-tongue fern, Canada lily, miterwort
15263	critical	1	*Mitella diphylla*	miterwort
15264	imperiled	3	AL Morgan County cave, *Pseudanophthalmus fluviatilis, Pseudosinella spinosa*	a cave, a cave obligate beetle, a cave obligate springtail
15267	imperiled	1	*Pseudanophthalmus fluviatilis*	a cave obligate beetle
15282	rare	1	*Etheostoma simoterum*	snubnose darter
15364	critical	2	*Lilium canadense, Triosteum angustifolium*	Canada lily, yellowleaf tinker's-weed
15365	critical	1	*Typhlichthys subterraneus*	southern cavefish
15370	imperiled	2	*Cotinus obovatus, Silphium brachiatum*	American smoke-tree, Cumberland rosinweed
15463	imperiled	1	*Trillium flexipes*	nodding trillium
15679	imperiled	1	*Pseudanophthalmus fluviatilis*	a cave obligate beetle
15870	imperiled	1	*Callirhoe alcaeoides*	clustered poppy-mallow

Table E-1. Continued.

Hexagon ID	Type	# of EORs	Species Occurring in Hexagon: Scientific Name	Common Name
15886	critical	1	*Etheostoma tuscumbia*	Tuscumbia darter
16075	rare	2	*Ictiobus cyprinellus, Ictiobus niger*	bigmouth buffalo, black buffalo
16084	rare	1	*Hybognathus hayi*	cypress minnow
16088	rare	2	*Hemitremia flammea, Notropis buchanani*	flame chub, ghost shiner
16089	critical	6	*Batriasymmodes spelaeus, Cambarus jonesi, Myotis grisescens, Nesticus jonesi, Procambarus pecki, Typhlichthys subterraneus*	a cave obligate beetle, Alabama cave crayfish, gray bat, Cave Spring Cave spider, phantom cave crayfish, southern cavefish
16186	rare	1	*Percina shumardi*	river darter
16279	rare	1	*Moxostoma macrolepidotum*	shorthead redhorse
16375	critical	6	*Batrisodes valentinei, Cambarus jonesi, Myotis grisescens, Pseudanophthalmus fluviatilis, Pseudosinella hirsuta, Typhlichthys subterraneus*	a beetle, Alabama cave crayfish, gray bat, a cave obligate beetle, a cave obligate springtail, southern cavefish

APPENDIX F. Populated place locations in the Cotaco Creek watershed.

Table F-1. Populated place locations identified from the EPA BASINS data in the Cotaco Creek watershed, Alabama.

Populated Place	County
Allens Crossroads	Marshall
Apple Grove	Morgan
Bluff City	Morgan
Briscoe	Morgan
Cain Landing	Morgan
Cave Springs	Morgan
Center Dale	Morgan
Center Grove	Morgan
Echols Crossroads	Morgan
Egypt	Marshall
Eva	Morgan
Florette	Morgan
Gum Spring	Morgan
Henderson	Morgan
Hog Jaw	Marshall
Hulaco	Morgan
Lynntown	Morgan
Meadowood	Marshall
Morgan City	Morgan
Mount Olive	Marshall
Oden Ridge	Morgan
Oleander	Marshall
Peach Grove (historical)	Morgan
Pence	Morgan
Pine Lake Village	Marshall
Priceville	Morgan
Rice	Marshall
Rocky Point	Morgan
Ruth	Marshall
Ryan Crossroads	Morgan
Six Mile	Morgan
Six Way	Morgan
Slaughter Landing	Morgan
Somerville	Morgan
Stringer	Morgan
Sunnyside Landing	Morgan
Sunset Acres	Marshall
Talucah	Morgan
Turney Crossroads	Morgan
Union	Morgan

Table F-1. Continued.

Populated Place	County
Union Hill	Morgan
Valhermoso Springs	Morgan
West Point	Morgan
Winn Crossroads	Morgan
Winton	Morgan
Woodland Mills	Morgan

APPENDIX G. Discharge Sites Identified from EPA's Better Assessment Science Integrating point and Nonpoint Sources (BASINS) Data in the Cotaco Creek watershed.

Table G-1. National Pollutant Discharge Elimination System (NPDES) permit compliance system (PCS) sites identified from EPA BASINS data in the Cotaco Creek watershed, Alabama.

Facility Name	City	County	Status	Principal Activity Causing the Discharge	Receiving Water
Arab City - Gilliam CR Waste Water Treatment Plant	Arab	Marshall	active	sewerage systems	Gilliam Creek
General Shale Products Marshall Pit	Marshall County	Marshall	active	clay, ceramic & refractory materials	Merrit Bottom Mead Hollow
Cherokee Ridge Corporation Waste Water Treatment Plant	Union Grove	Marshall	active	sewerage systems	
Enviro Group Inc - Redstone Arsenal	Huntsville	Madison	inactive	nonclassifiable establishments	Tennessee River tributary

Table G-2. Mines identified from EPA BASINS data in the Cotaco Creek watershed.

County	Name	Type of Operation	Operating Status	Commodity	Company
Morgan	plant no. 5 pit	surface	producer	stone - limestone	Trinity Quarries Inc.
Morgan	plant 4 pit	surface	producer	stone - limestone	Trinity Quarries Inc.

Table G-3. Toxic Release Inventory sites identified from EPA BASINS data in the Middle Coosa River watershed.

Facility Name	City	County	Principal Activity Causing the Discharge
Hall Chemical Co.	Arab	Marshall	industrial inorganic chemicals, not elsewhere classified
SCI Manufacturing Inc. Plant #4	Laceys Spring	Morgan	aluminum die-castings
SCI Systems Inc.	Arab	Marshall	electronic computers

Table G-4. 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 Cotaco Creek watershed.

Facility Name	City	Land Type
Joe V. Clayton Chevrolet	Arab	
Ryder International	Arab	Private
SCI System Inc Plant 4	Laceys Spring	Private
SCI Systems Inc.	Arab	Private
Bob Scofield Ford	Arab	
Prince Trucking	Laceys Spring	
Forrest Ingram	Morgan City	
Valentec Pohlman Inc.	Laceys Springs	
Quality Auto Parts	Arab	
Kelly Brothers Cabinet Company	Morgan City	Private
Tyler's Used Cars	Union Grove	Private
Quality Tooling Inc. - Division #2	Laceys Spring	Private

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

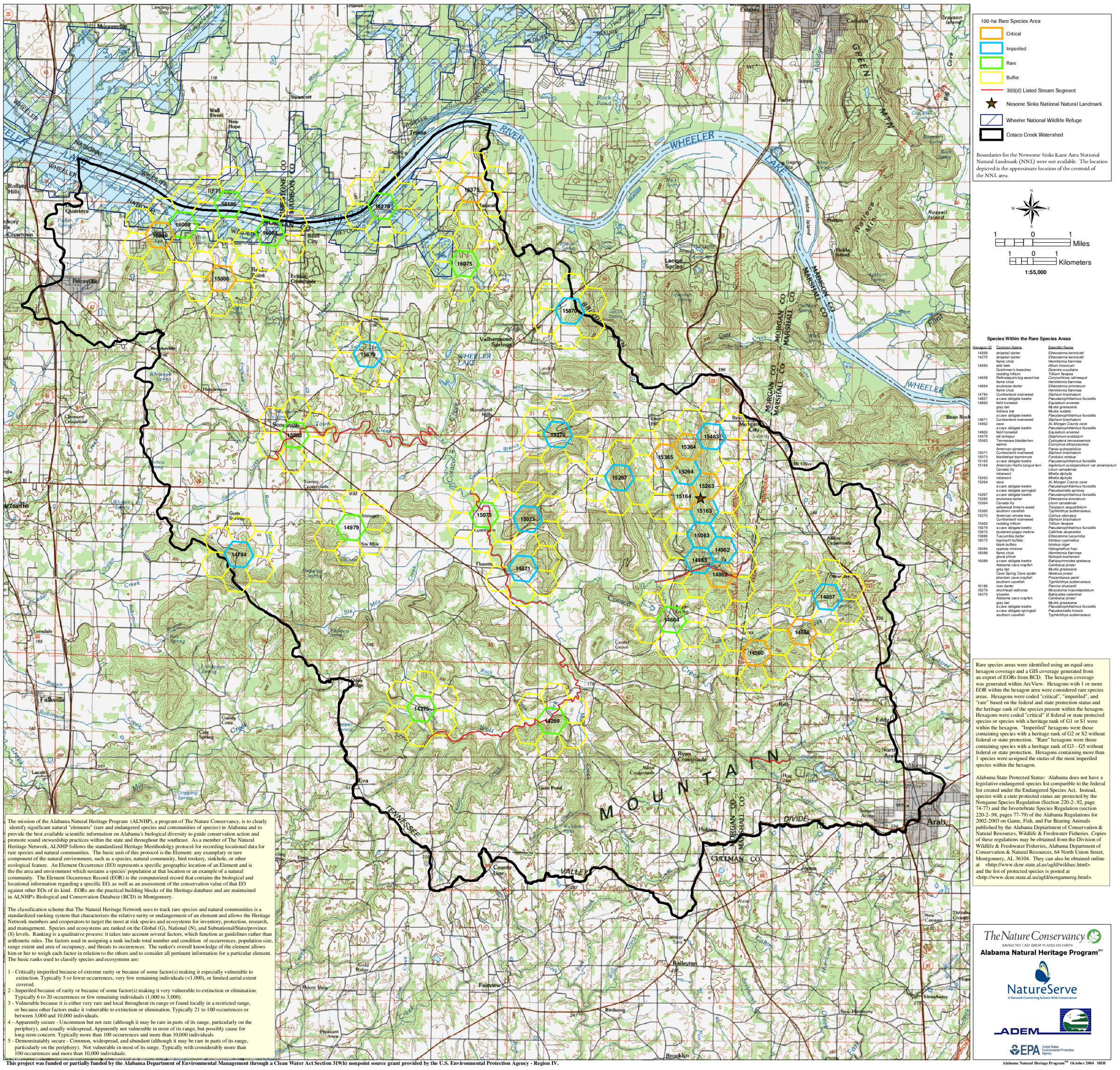
Site: MORG08	Waterbody: Tallaseehatchee Creek	County: Morgan
Activity: chicken CAFO	Potential Pollution Problem: nutrient/bacteria runoff	

APPENDIX I. Large Format Maps Included With This Report.

Ecology and Natural Features of the Cotaco Creek Watershed

Land Cover in the Cotaco Creek Watershed

Ecology & Natural Features of the Cotaco Creek Watershed



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Land Cover in the Cotaco Creek Watershed