Land Use Characterization of the Emory River Watershed
1947 – 2001

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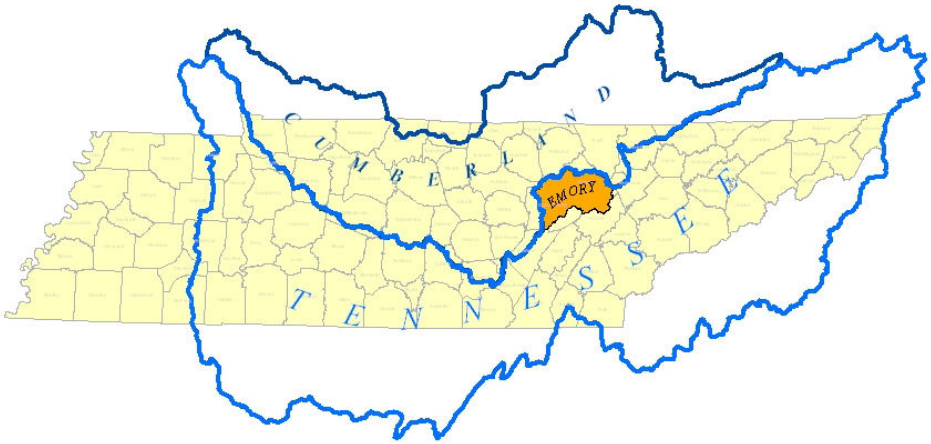
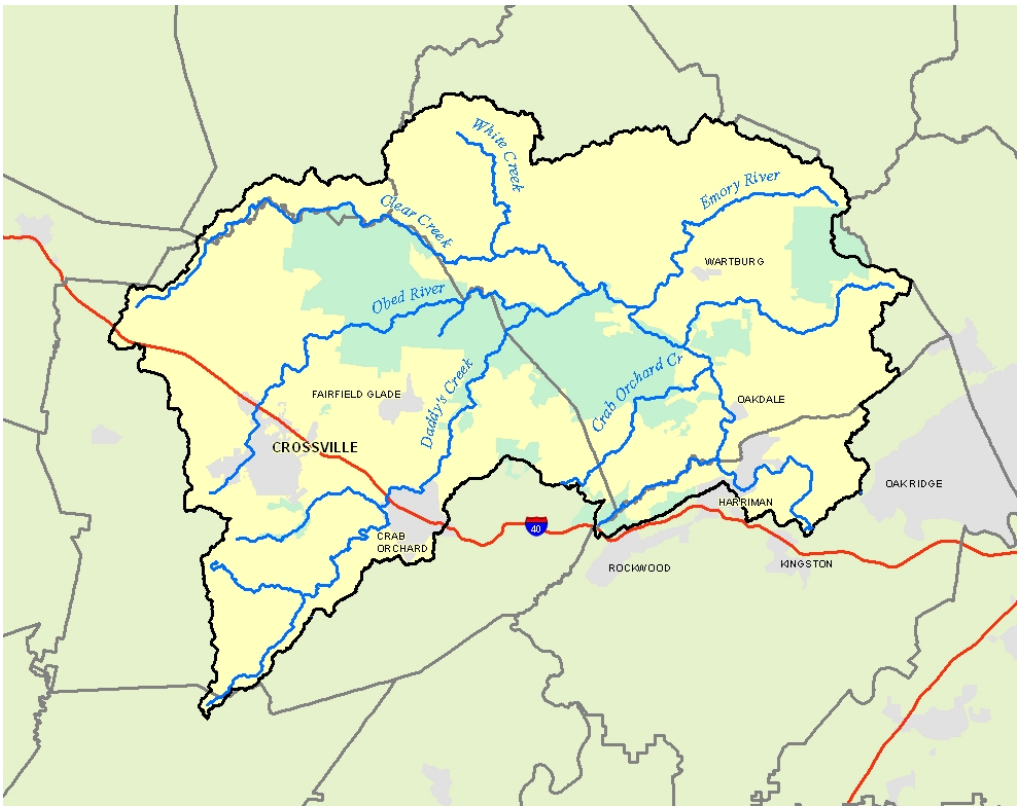
Introduction

The Emory River Watershed is located on the Cumberland Plateau in East Central Tennessee and rests primarily in Cumberland and Morgan counties with small areas in Fentress and Roane counties. The watershed is a headwaters section of the Tennessee River complex, and the northern edge of the Emory borders the crest of the Cumberland River watershed.



Six significant streams flow in the watershed, including the Emory River, Obed River, Clear Creek, Daddy's Creek, White Creek and Crab Orchard Creek. These are all seasonally swift moving streams and are the primary water supply for the area as well as popular destinations for white-water enthusiasts.



The Catoosa Wildlife Management Area and Frozen Head State Natural Area (see areas in green on the map above) are enclaves within the watershed and State managed properties that are protected from development. Though controlled logging and road development occur in these areas as well as recreational opportunities, they are otherwise protected from commercial development.

The Emory River watershed is rich with diverse flora and fauna and habitat for two federally listed threatened and endangered species, the spotfin chub (*Erimonax monachus*) and the purple bean mussel *(Villosa perpurpurea)* .

Demographic stresses continue to advance in the Emory with fast growing Crossville, Tennessee and the retirement community of Fairfield Glade which draw from the already limited ground water supply. Industries such as two large ceramic tile factories in Crossville contribute to the creep of urban development and strain natural resources.

Biological staff requested a GIS analysis of how the watershed had changed over time. They intend to relate that information to a biological inventory that is being performed to

document spotfin chub distribution in the watershed to determine if there is a correlation between the distribution and land cover change.

They plan to use the findings from the land cover analysis to initiate discussions with county officials to formulate ways to protect the resource base.

There were six different land cover types requested. Forests, fields, developed areas, roads, ponds and lakes, and strip mines. These layers were essential to the assessment and could be drawn from the available source base data.

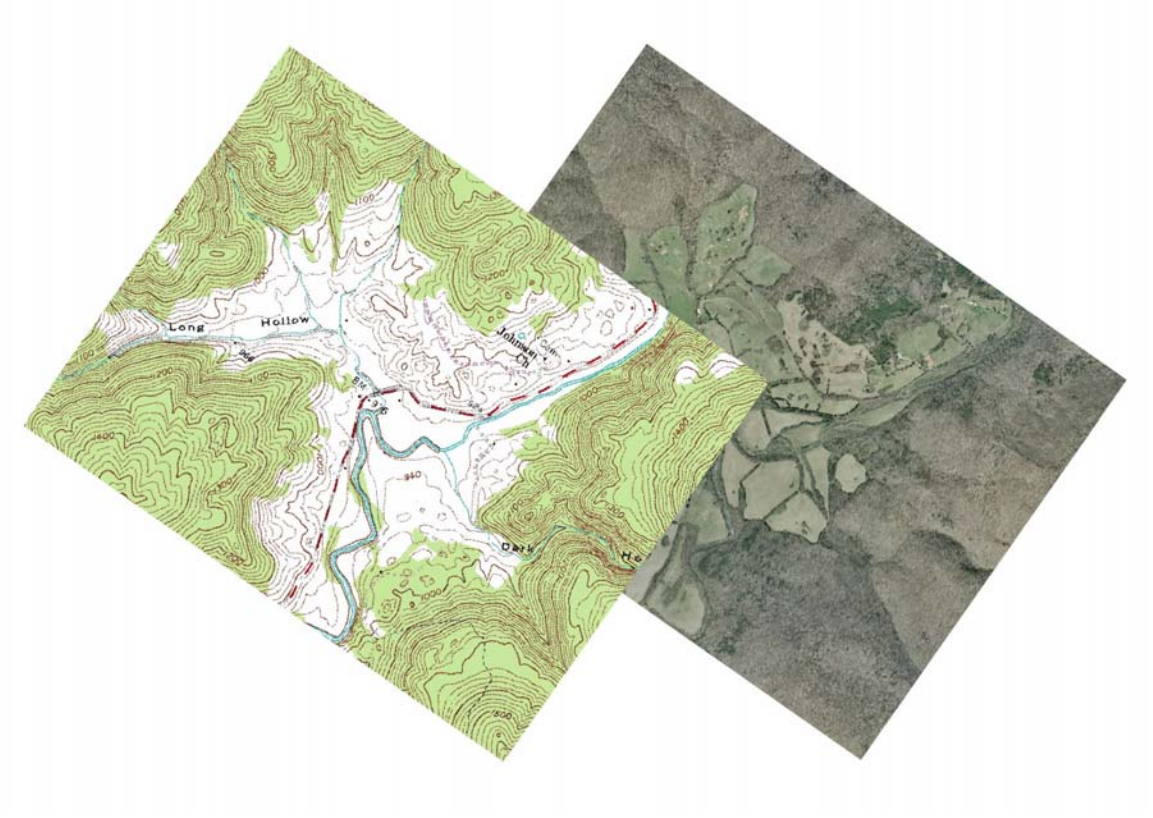
Methodology

Image Classification

GIS staff researched the most efficient way to catalog different eras of landuse in the Emory. Initial methodology included the classification of satellite imagery using ERDAS Imagine software. Though results were reasonably accurate, the data were too coarse for the scale of the project. Inadequate results were confirmed by ERDAS Imagine technical support staff to be due to inappropriate resolution of the imagery.

On-Screen Digitizing

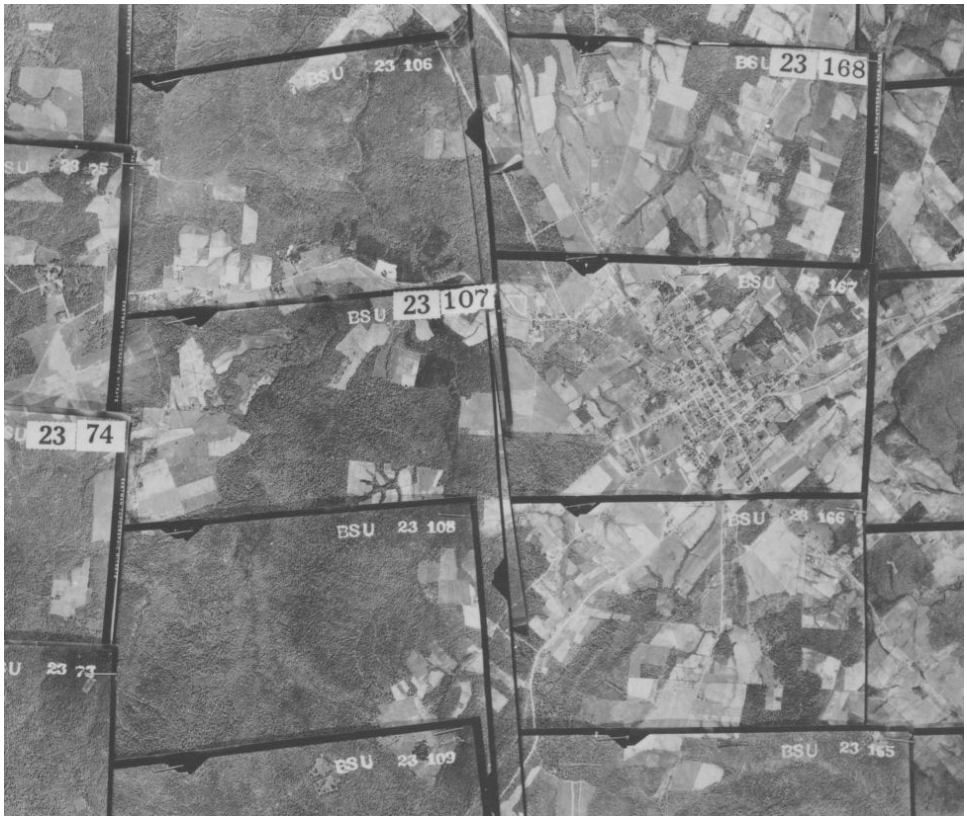
On-screen digitizing of aerial photography proved to be best approach to produce data at the desired scale. A hard copy mosaic of aerial photos with source dates from the 1920's to 1980 was scanned at high resolution (600 dpi) and registered to ground control points using the registration tool in ArcMap. Spatial information from 1980 was derived from Digital Raster Graphics (DRGs), which are scanned images of USGS topographic maps. The DRGs displayed information from 1940-1980, providing a reliable source of 1980 information. 1990's information was derived from Digital Ortho Quads which are aerial photographs that has been scanned, rectified, and registered to USGS quad boundaries. All images were digitized at 1:5,000 to maintain continuity of the final layers.



On-screen digitizing is labor intensive and can take a considerable amount of time. All layers were digitized as polygons, so capturing features like roads turned into a puzzle-like process. There were times when the technician would approach digitizing as a process of subtraction, rather than addition, meaning that it would often make more sense to removing unwanted features instead of adding them. For example, when digitizing polygons for the forest layer, it was often less time consuming to remove the roads and fields, leaving only the forest polygons than to digitize the forest polygons themselves.

Pre-1980 mosaic

In developing the roads and developed layers, spatial information provided by the City of Crossville GIS department was implemented to act as a starting point for the 1990's era of the roads and developed areas, as well as a reference for the previous two eras' layers.



Zoomed view of the pre-1980 mosaic

Rectification

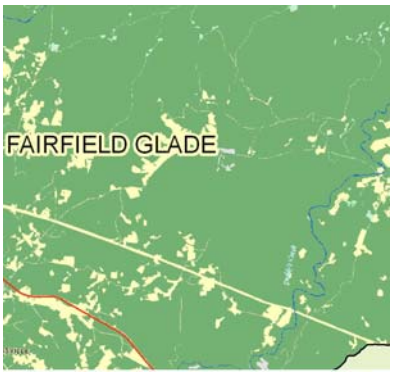
Once digitizing was complete, rectification of all layers was necessary due to the different eras of photography. Layers did not quite align correctly so considerable time was spent moving vertices to ensure proper alignment of each era of data. Attempts to rubber sheet, or "stretch" the layers to make them align proved to be futile. Rubber sheeting produced areas that aligned nicely in one area of the layer but would pull other areas out of line. Countless control points were added in attempts to make rubber sheeting work but success was never achieved. In the end, GIS staff concluded that the 1990's DOQs were the most spatially accurate so technicians used them as a base and spent a considerable amount of time moving vertices to clean up the alignment of the other eras of data. Of the six data layers created, the roads coverage was the most complex and required a significant amount of attention to achieve satisfactory results.

Results and Analysis

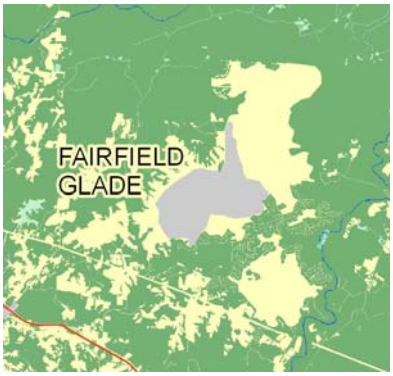
Forests

Year	Acres
Pre-1980	446,324
1980	428,310
1990	418,637

Results for the forest layer were predictable. Acreage statistics display a steady decline in forest area occurring over each era of data. Though the decline appears steady through the years, the spatial data visually displays that during the 1980's through the 1990's large chunks of forested areas were removed for the development of Fairfield Glade and Lake Tansi. The growth of Crossville over the three eras also displays a steady reduction in forested areas due to development.



Fairfield Glade – Pre 1980
Forested areas in green



Fairfield Glade – 1990
Forested areas in green

Steady decreases in forested areas also occurred in the eastern region of the watershed in the Wartburg area. Forest area increases were minimal, mostly occurring in small areas of the southeastern section of the watershed, just east of the town of Harriman.

Fields

Year	Acres
Pre-1980	17,579
1980	19,879
1990	45,629

Development and timber harvesting are reasonable conclusions for the rise in field acreage from the 1980's to the 1990's. Though some field areas increased due to the clearing of trees for urban development, more significant increases are most likely due to the development of small, five to twenty acre farms popping up in the watershed. Most of these are not working farms, but primary residences for those who want to live away from urban areas and desire larger lots of land. These small homesteads are more spatially evident by viewing the ponds layer which displays the small, one to two acre man-made farm ponds that dot the landscape in these areas.

Developed Areas

Year	Acres
Pre-1980	17,579
1980	19,879
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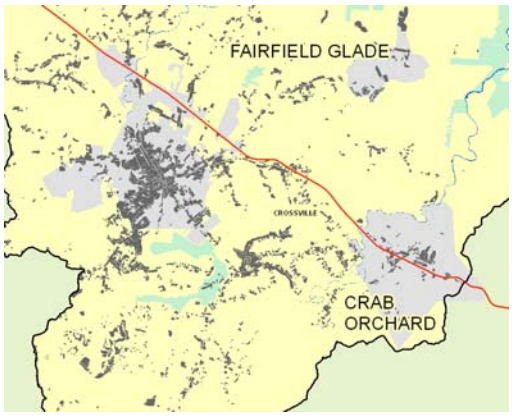
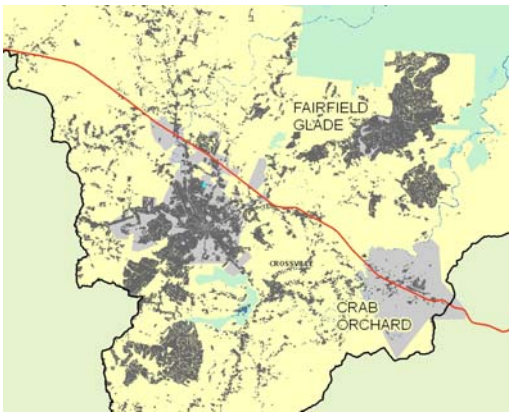


Developed Areas 1980

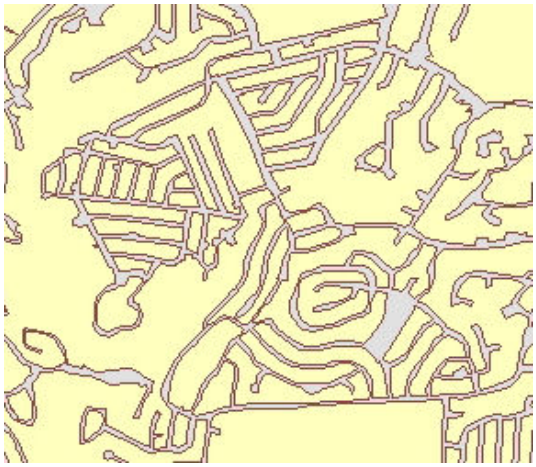


Developed Areas 1990s

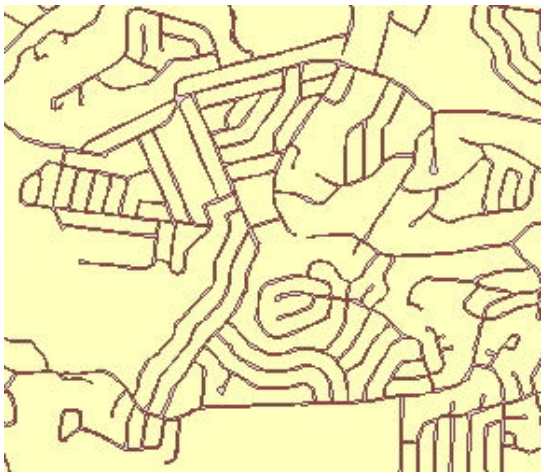
Developed areas grew significantly from 1980 through the 1990's with the rapid expansion of the retirement communities of Fairfield Glade and Lake Tansi, as well as the city of Crossville. Eastern areas of the watershed including Wartburg and Harriman grew at steady rates as well. Also, the emergence of small, five to twenty acre farms dotted the landscape of the developed layer.

Roads

Year	Acres
Pre-1980	7,660
1980	15,745
1990	10,658



Roads 1980



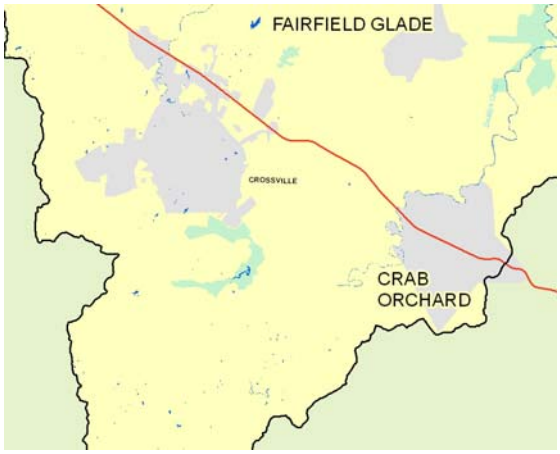
Roads 1990s

The images above capture the reason for discrepancies between road acreages collected from the 1980s and 1990s. The 1990s coverage was created from a base data file supplied by the City of Crossville GIS department. Vectors were captured from imagery at a much higher resolution and scale than the 1980s data. As visible by the images above, the 1980s data displays wider polygons for roads which led to inflated acreage statistics.

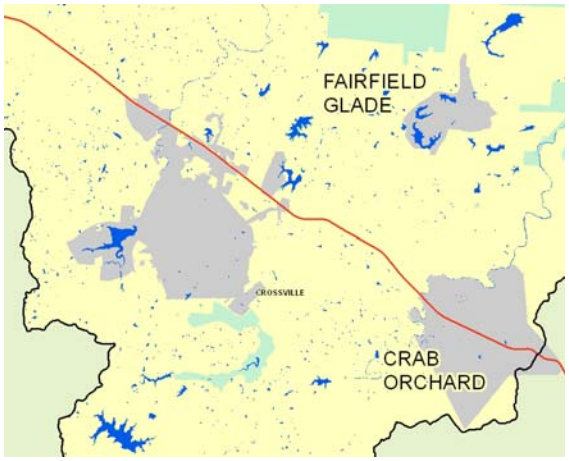
Though the acreages are skewed, it is simple to conclude via visual inspection that roads have increased over each era. The data spatially displays significant increases in roads creation in the developing areas of Fairfield Glade and Crossville.

Lakes and Ponds

Year	Acres
Pre-1980	2,454
1980	3,164
1990	4,256



Lakes and ponds – pre 1980



Lakes and ponds -1990s

Acreage statistics for lakes and ponds display a steady growth over the three eras. Growth in these areas are due to man-made lakes developed for residential areas like Fairfield Glade and Lake Tansi as well as small ponds added to the many small, residential farms that dot the landscape during the time period.

Strip Mines

Year	Acres
Pre-1980	367
1980	2,088
1990	27

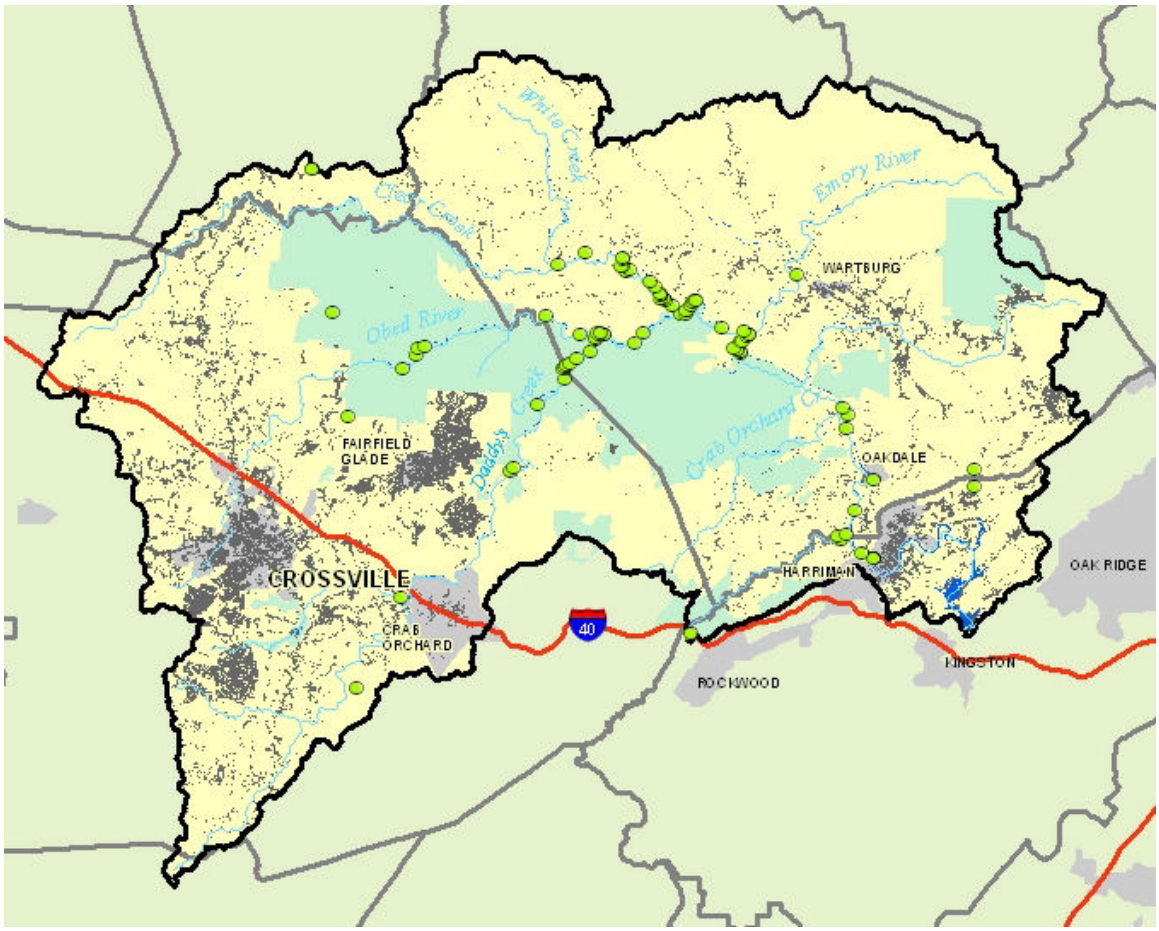
Pre-1980 strip mines

1980s strip mines

Strip mine acreage was negligible over the three eras. Pre-1980 mine activity was significant in that several mines were located near Crab Orchard Creek. The balloon in post 1980 acreage was due to several mines popping up in the northeast portion of the watershed. By the 1990's most of the strip mine activity in the watershed had ceased.

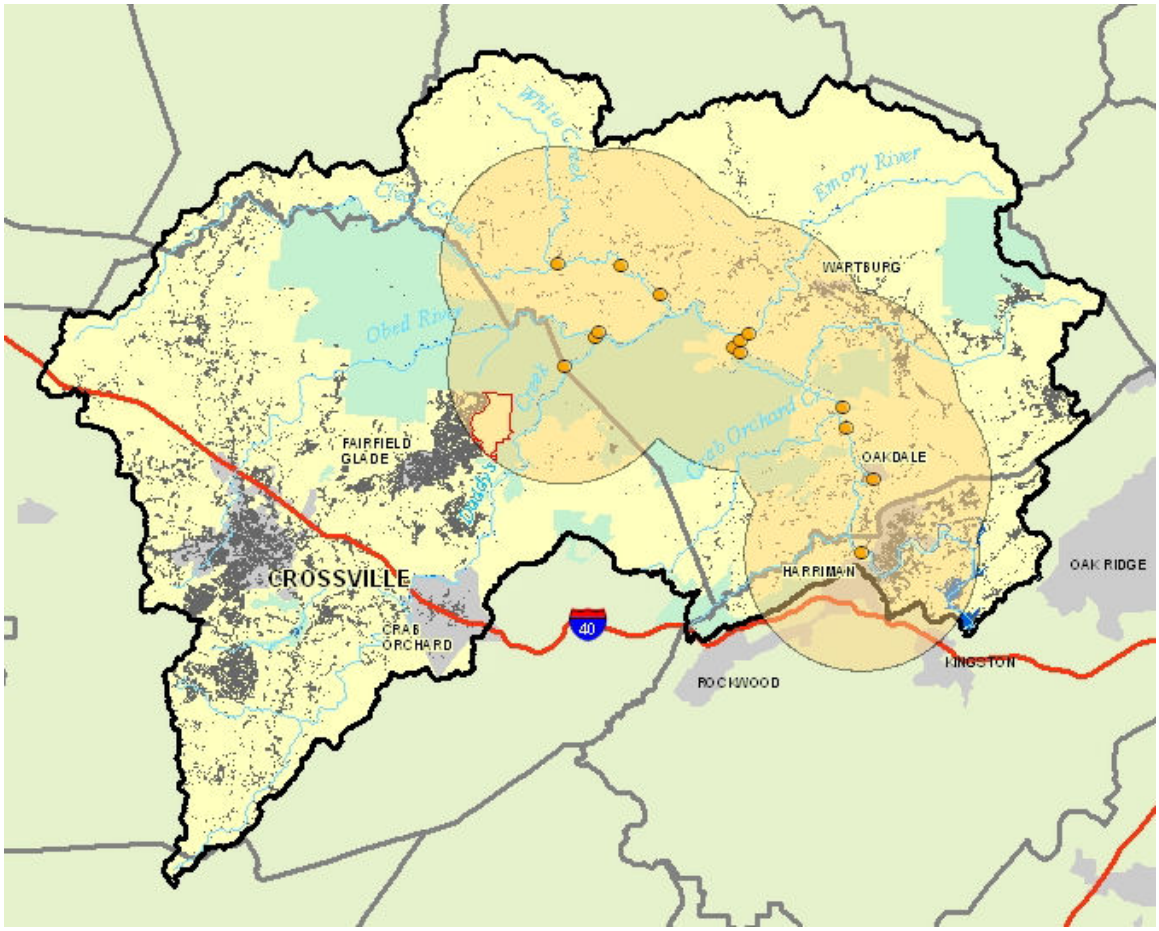
Conclusions

It is visually evident from the data layers of all three eras that development is having a pronounced effect on the Emory watershed landscape. It is difficult to quantify the effects on endangered species when almost all of the change is occurring away from the endangered species locations. How are development activities in Fairfield Glade and Crossville impacting threatened and endangered species habitats upstream?



Federally threatened and endangered species within the Emory River Watershed.

Though it is not yet quantifiable, it is reasonable to conclude that the creep of development in these areas is impacting potential habitat for threatened and endangered species in the watershed.



Five mile buffers around spotfin chub locations in the Emory River Watershed.

The map above displays five mile buffers around spotfin chub locations within the watershed. Notice the northeast growth of Fairfield Glade has entered the western portion of the buffer. Though the boundary of the Catoosa WMA (in green on the map) will block development to the north, there are still 2,012 acres (outlined in red) potentially available to the east. This is an example of an area where FWS personnel could work with local government officials or private land owners to develop voluntary conservation initiatives.

The Emory River Watershed is an area rich with natural resources. Management of these resources is essential to ensure their quality and longevity. The digital land use characterization performed in this study will prove to be a valuable tool in the decision making process.