

# Chapter 1: Ecological Units of the Highlands

This report is one of a five developed for the Ozark-Ouachita Highlands Assessment. The team that produced this report was comprised of scientists from a variety of disciplines—wildlife biologists, foresters, ecologists, pathologists, and entomologists. They had in common an interest in the terrestrial vegetation and animal species of the Highlands and a willingness to examine the status of these “terrestrial resources.”

Questions about the terrestrial animals, plants, and biological communities of the Highlands were developed at a series of Terrestrial Team meetings in the summer of 1997. No new information was collected in the field to address these questions. Instead, existing data from various agencies and individuals were gathered and analyzed. Two concerns emerged powerfully as sources of information were identified: while an overwhelming amount of information exists for the Highlands, many species have not been studied and the information that is available from various sources is often in different formats, covers different time periods, and/or covers different geographic areas.

One early and continuing challenge was how best to organize and present the information. The Terrestrial Team decided to use the ecologically defined units presented in this chapter to provide a consistent framework throughout the report. Chapter 2 presents an overview of prehistoric and more recent change in the Highlands. Current vegetation cover is examined in some detail in Chapter 3, and silvicultural practices receive in-depth treatment in Chapter 4. Chapter 5 examines many plant and wildlife species of special concern, and Chapter 6 covers current and future biological threats to forest resources.

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***Question 1.1: What are the ecological boundaries and subsections of the Highlands?***

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## Key Findings

1. The map of sections and subsections of the Ozark-Ouachita Highlands (Keys and others 1995) was revised to better meet the needs of the Assessment. Changes were largely limited to the Arkansas and Oklahoma portions of the Assessment area.
2. The modified map of sections and subsections of the Highlands of Arkansas and Oklahoma is the first such delineation for Oklahoma and provides significant advancements over earlier maps for Arkansas by Croneis (1930) and Foti (1974).

## The Ozark-Ouachita Highlands Assessment Area

This report contains data and key findings in the context of an ecologically defined area—the Ozark-Ouachita Highlands (fig. 1.1). Although the term “Interior Highlands” is familiar to geographers and biologists, it is not commonly recognized in other circles. Most people are more familiar with “the Ozarks” and “the Ouachita Mountains” than they are with the older geographic name for the two areas. Thus, the Assessment team leaders chose to use a term likely to be more widely recognized—the Ozark-Ouachita Highlands.

The Ozark-Ouachita Highlands is an appropriate area to assess because it has relatively consistent ecological characteristics and is distinctively different from surrounding landscapes. Consisting mostly of hilly to mountainous topography over substrates of Paleozoic age, the Highlands have long been recognized as a distinct physiographic and natural region (Fenneman 1938, Braun 1950). Upland hardwood and upland pine-hardwood forests characterize much of the area. Lower-lying plains with more recent geological substrates also occur in portions of the Highlands, including much of the Arkansas Valley section. The vegetation of these plains ranges from tallgrass prairie to lowland pine-hardwood and bottomland hardwood forests.

Even though the Ozark-Ouachita Highlands have some consistent general characteristics, there are also striking differences within it. Therefore, most descriptions and studies divide the region into smaller, more uniform areas. Authors have generally recognized at least two provinces, the Ozark Mountains and the Ouachita Mountains (Fenneman 1938, Thornbury 1965, Braun 1950, Croneis 1930, Foti 1974). Sometimes, the Arkansas Valley has been considered a separate province or natural division (Foti 1976, Pell 1983, Omernik 1987). While most authors treated the Boston Mountains as a subdivision of the Ozark Mountains, Omernik (1987) recognized it as a separate ecoregion (natural division). These provinces, natural divisions, or sections are often subdivided as well.

## Data Sources

To facilitate agency ecosystem management efforts, the USDA Forest Service developed a new regionalization framework for the Eastern United States (Keys and others 1995, henceforth referred to as “Keys and others” or the “Keys map”) based on a national map of ecoregions of the United States by Bailey and others (1994). The new framework is hierarchical (like older efforts) but is based on a more holistic consideration of landscape properties than some earlier maps, with climate and soil playing prominent roles along with physiography. The new framework is also designed to rationally subdivide landscapes in ways meaningful to ecosystem management. The older and newer maps coincide most closely at the level of section (Keys and others), province (Fenneman 1938), and natural division (Foti 1974). Although differences occur at this level they are usually in the form of one unit in one system equating to two units in another system. The new framework is often more detailed at lower levels in the hierarchy than older maps.

The Terrestrial Team examined the Keys and others (1995) framework to determine whether the ecological units and their boundaries were adequate for Assessment purposes. Important considerations were that the sections and subsections and their boundaries be ecologically meaningful and consistent across State lines. Examination of the Keys map and comparison

with other regional maps and geological and topographical base maps revealed that sections and subsections and their boundaries were not consistently meaningful and accurate across the Assessment area. The Missouri units and their boundaries have been settled for years; therefore, the Keys map simply adopted those boundaries, and changes needed for the Assessment were very minor.

In contrast, the Arkansas units and boundaries needed considerable revision because: (1) the Keys and others (1995) approach departs substantially and without convincing rationale from long-standing delineations (Croneis 1930, Foti 1974) and (2) locally created maps were not available. The Keys map is also problematic in Oklahoma, because in that State only general regions have been defined (OK BTF 1996), boundaries are not detailed, and subdivisions are not mapped. Furthermore, the Keys map appears to be derived from low-detail base maps, and its boundaries were judged to be too general for this Assessment. The Keys map and supporting materials do not explicitly define the source or rationale for boundaries; therefore, revision of the map sometimes required a determination of the defining physical feature and use of an appropriate base map.

Although production of the new map (fig. 1.1) involved many changes to the Keys and others (1995) map, few changes were made in the list of sections and subsections. (A map illustrating the changes the team made to subsection boundaries is available on the Web site for the Assessment, <<http://www.fs.fed.us.oonf>>.) The emphasis was on employing clearly-stated boundary definitions that in most cases were first articulated by Croneis (1930), and then using appropriate digital base maps to create an accurate final product. Many changes were made to the Croneis (1930) and Foti (1974) maps, however, primarily by adding detail to the older maps. (See, for examples, the White River Hills and Central Plateau subsections [which are nested within the Salem Plateau of Croneis 1930], the Upper and Lower Boston Mountains subsections [nested within the Boston Mountain subdivision of Foti 1974], or the three new subsections within the Arkansas Valley.)

Croneis (1930) and Foti (1974) presented rationales for many regional boundaries in Arkansas and Oklahoma, most of which were adopted for this revision. All boundaries are based on either geology or topography,

although soils maps were used for comparison in some cases. The geologic base map was the 1:2,500,000-scale geology of the conterminous United States (Schruben and others 1994). The topographic base map was created for this project from 30-meter (m) USGS digital elevation model files by the Spatial Analysis Laboratory of the School of Forest Resources, University of Arkansas at Monticello.

## Ecological Units

The following discussion describes the ecological units used in the Ozark-Ouachita Highlands area and the factors on which the boundaries were based along with changes from the Keys map. Alphanumeric codes used here are the same as those used in the Keys map.

The modified map of sections and subsections of the Highlands of Arkansas and Oklahoma (fig. 1.1) is the first such delineation for Oklahoma and provides four significant advancements over earlier maps for Arkansas by Croneis (1930) and Foti (1974):

- Boundaries are defined and mapped consistently across the three States sharing the Highlands;
- Boundaries based on topography are much more accurate than previous maps due to the use of 30-m digital elevation models;
- Changes in section and subsection definitions that have occurred since production of the earlier maps are incorporated; and
- The map produced by this team is in digital form and freely available on the Assessment Web site.

### Ozark Highlands Section (222A)

Six subsections in Missouri and Illinois were not included in the Assessment area: 222Ai (Prairie Ozark Border); 222Aj (Inner Ozark Border); 222Ak (Outer Ozark Border); 222Ao (Mississippi River Alluvial Plain); 222Ap (Missouri River Alluvial Plain); and 222Aq (Illinois Ozarks). These were excluded because they are on the periphery of the region, are not included in some data sets used for the Assessment, and would have complicated the analysis by extending it to an additional State. Following are the subsections that were included in the Assessment area and brief descriptions of each.

222Aa—The St. Francis Knobs and Basins, which cover 1,108,009 acres (ac), occur only in Missouri. They consist of steep hills (but not an eroded plateau like the other Ozark subsections) that are 400 to 1,700 feet (ft) in elevation and underlain by Cambrian and Precambrian igneous and sedimentary rocks. The subsection is covered with acid glades, oak woodlands, and dry-mesic oak forests. No changes were made in the Keys map boundaries.

222Ab—The Central Plateau subsection occurs in Missouri (5,006,390 ac) and Arkansas (1,335,220 ac) and consists of irregular plains 300 to 1,600 ft in elevation with karst features on Ordovician cherty dolomite, sandstone, and cherty clay residuum covered with prairies, oak woodlands, and dry-mesic oak forests. The Keys map boundary with the White River Hills subsection was altered to follow the break in topography between these subsections.

222Ac—The Osage River Hills (1,550,855 ac) occur only in Missouri, where they consist of hills with entrenched valleys 600 to 1,100 ft in elevation that were formed by streams downcutting to the Osage River. Underlain by Ordovician cherty dolomite, sandstone, and cherty clay residuum, this subsection is covered with pine-oak and oak woodlands and forests. No changes were made in the Keys map boundaries.

222Ad—The Gasconade River Hills subsection (1,098,006 ac) occurs only in Missouri. Similar to the Osage River Hills, this subsection consists of hills with entrenched valleys and karst features and was formed by streams downcutting to the Gasconade River. Underlain by Ordovician cherty dolomite, sandstone, and cherty clay residuum, the Gasconade River Hills range from 600 to 1,100 ft in elevation and are covered with pine-oak and oak woodlands and forests. No changes were made in the Keys map boundaries.

222Ae—The Meramac River Hills (1,136,219 ac) occur only in Missouri. (The correct spelling of the river for which this subsection is named is “Meramec,” but the team left the Keys and others [1995] name unchanged.) This subsection consists of hills with entrenched valleys formed by streams downcutting to the Meramec River. Underlain by Cambrian and Ordovician cherty dolomite and cherty clay residuum and ranging from 500 to 1,300 ft in elevation, this subsection is covered with pine-oak and oak woodlands and forests. No changes were made in the Keys map boundaries.

222Af—The Current River Hills (1,563,186 ac) occur in Missouri and consist of entrenched valleys with karst features formed by streams downcutting to the Current River. Underlain by Cambrian and Ordovician cherty dolomite and sandstone with cherty clay residuum and ranging from 400 to 1,300 ft in elevation, the Current River Hills are covered with pine-oak and oak woodlands and forests. No changes were made in the Keys map boundaries.

222Ag—The White River Hills subsection occurs in Missouri (2,155,950 ac) and Arkansas (1,577,221 ac) and consists of hills with entrenched valleys and karst features. It was formed by streams downcutting to the White River. Underlain by Ordovician cherty dolomite with cherty clay residuum and ranging from 600 to 1,600 ft in elevation, this subsection is covered with alkaline glades and oak woodlands and forests. Changes were made in the Arkansas portion of the Keys map boundaries to better follow the break in topography from the surrounding plains.

222Ah—The Elk River Hills occur in Missouri (356,326 ac), Arkansas (57,433 ac), and Oklahoma (32,334 ac) and consist of hills with entrenched valleys and karst features. Formed by streams downcutting to the Neosho River, the subsection is underlain by Mississippian cherty limestone with cherty clay residuum, ranges from 900 to 1,400 ft in elevation, and is covered with oak woodlands and forests. Changes were made in the Arkansas portion of the Keys map boundaries to better follow the break in topography from the surrounding subsections.

222Ai—The Black River Ozark Border (859,059 ac) occurs only in Missouri. It consists of irregular plains and low hills with karst features. Underlain by Ordovician sandstone and cherty dolomite with cherty clay residuum, this subsection ranges from 300 to 900 ft in elevation and is covered with pine-oak and oak woodlands and forests and oak-sweetgum forests. The Keys map boundaries were modified to eliminate this subsection from Arkansas.

222Am—The Springfield Plain lies in Missouri (3,136,051 ac) and Oklahoma (161,881 ac) and is a smooth plain with karst features underlain by Mississippian limestone (sometimes very cherty) and cherty clay residuum. Ranging from 800 to 1,700 ft in elevation, this subsection is covered with prairie and oak

woodlands and forest. No changes were made in the Keys map boundaries.

222An—The Springfield Plateau subsection occurs in Oklahoma (1,486,718 ac), Arkansas (1,579,841 ac), and Missouri (56,326 ac) and consists of smooth to irregular plains 800 to 1,400 ft in elevation with karst features. Underlain by Mississippian limestone (sometimes very cherty) and cherty clay residuum, this subsection is covered with prairie and oak woodlands and forest, alkaline, and acid glades. Detail changes were made in the Keys map boundaries to better follow the break in topography to the Elk River Hills and to more closely follow the boundaries with older and younger geological substrates throughout the rest of the subsection perimeter.

### **Boston Mountains Section (M222A)**

In earlier maps, with the exception of Omernik (1987), this section was treated as a subsection or equivalent.

M222Aa—The Upper Boston Mountains (1,106,642 ac) occur only in Arkansas. They consist of low mountains 1,000 to 2,700 ft in elevation underlain by Pennsylvanian sandstone and shale with sandy residuum and loamy colluvium. This subsection is covered with oak woodlands and forests. Detail changes were made in the Keys map boundaries to better follow the geologic boundary with the Springfield Plateau and to better follow the corresponding land type association boundaries developed by the Ozark-St. Francis National Forests elsewhere along the perimeter of the subsection. This subsection was defined on the basis of elevation (approximating the 1,800-ft elevation contour), which corresponds to areas of lower temperature and higher rainfall and consequent changes in plant community composition. The Keys map name for this subsection (Boston Mountains) and the following subsection (Boston Hills) were changed to reflect that both are parts of the vernacular and physiographic Boston Mountains.

M222Ab—The Lower Boston Mountains subsection occurs in Oklahoma (834,553 ac) and Arkansas (2,471,699 ac) and consists of high hills 500 to 1,800 ft in elevation underlain by Pennsylvanian sandstone and shale with sandy residuum and loamy colluvium. The

Lower Boston Mountains are covered with pine-oak and oak woodlands and forests. Detail changes were made to the Keys map boundaries to better follow the corresponding landtype association boundaries developed by the Ozark-St. Francis National Forests for the Upper Boston Mountains and to better follow the boundary with younger and older geologic substrates elsewhere along the northern, eastern, and western perimeter of the subsection and the topographically defined southern boundary (the escarpment to the Arkansas Valley section [Croneis 1930, Foti 1974]). The Keys map name for this subsection (Boston Hills) was changed as explained in the description of the Upper Boston Mountains.

### **Arkansas Valley Section (231G)**

231Ga—The Eastern Arkansas Valley (1,490,182 ac) lies entirely in Arkansas, where it consists of plains with hills 300 to 500 ft in elevation. Underlain by Pennsylvanian sandstone and shale with sandy residuum, this subsection is covered with pine-oak and pine woodlands and forests. Northern and eastern boundaries were modified in detail to better match topographic and geologic boundaries, respectively. The southern boundary was redefined to match the traditional physiographic boundary, Cadron Ridge (Croneis 1930, Foti 1974). The southwestern boundary was redefined to place all Arkansas River bottomlands within the Western Arkansas Valley subsection; topographic and geologic boundaries also contributed to the modified subsection boundary. The Keys map name was changed to eliminate “and Ridges” since the redefined southern boundary eliminated the most prominent structural ridges from the subsection (one of the reasons for redefining that boundary).

231Gb—The Western Arkansas Valley Mountains occurs in Oklahoma (494,643 ac) and Arkansas (433,498 ac). It consists of low mountains and ridges and some wide valleys as well. Ranging from 750 to 2,800 ft in elevation, the Western Arkansas Valley Mountains are underlain by Pennsylvanian sandstone and shale with sandy residuum and covered with pine-oak and oak woodlands and forests and prairies. The eastern, northern, and western boundaries as delineated on the Keys map were modified somewhat to better

include the mountains and exclude the plains that were continuations of those in the Western Arkansas Valley. The southern boundary was changed to follow the northern boundary of the physiographic Ouachita Mountains (Croneis 1930, Foti 1974). The Keys map name (Mount Magazine) was changed to reflect the importance of other mountains within this subsection.

231Gc—The Western Arkansas Valley subsection includes portions of Oklahoma (829,099 ac) and Arkansas (1,354,977 ac) and consists of plains, low hills, and ridges 300 to 1,000 ft in elevation underlain by Pennsylvanian sandstone and shale with sandy and clayey residuum along with Holocene sandy alluvium. This subsection is covered with pine-oak and oak woodlands and forests, substantial bottomland forests, and prairies. One major low mountain, Petit Jean Mountain, was included within this section because it was disjunct from the Western Arkansas Valley Mountains, in which it would otherwise have been included. The northern, eastern, and southern boundaries of the Keys map were refined based on topography and geology to place all of the Arkansas River alluvial plains, the most extensive alluvial plains of its major tributaries, and almost all of the Pennsylvanian eroded plains within this subsection. A substantial area that extended up the Canadian River at the western end of this subsection on the Keys map was eliminated on the basis of geology, topography, and the definition of the Arkansas Valley as lying between the Ouachita Mountains and the uplifted plateaus of the Ozark Mountains (Croneis 1930).

### **Ouachita Mountains Section (M231A)**

M231Aa—The Fourche Mountains occur in Oklahoma (743,093 ac) and Arkansas (2,148,080 ac) where they form open, low to relatively high mountain ridges, often with wide valleys. Elevations range from 750 to over 2,600 ft, among the highest in the Assessment area. Ridges are underlain by Pennsylvanian and Mississippian sandstone and shale valleys by sandy residuum. Slopes and ridges are covered with pine-oak and oak woodlands and forests. The northern boundary was modified from Keys to coincide with the physiographic boundary based on topography (Croneis 1930, Foti 1974). The southern boundary was modified to match the boundary with Mississippian Arkansas

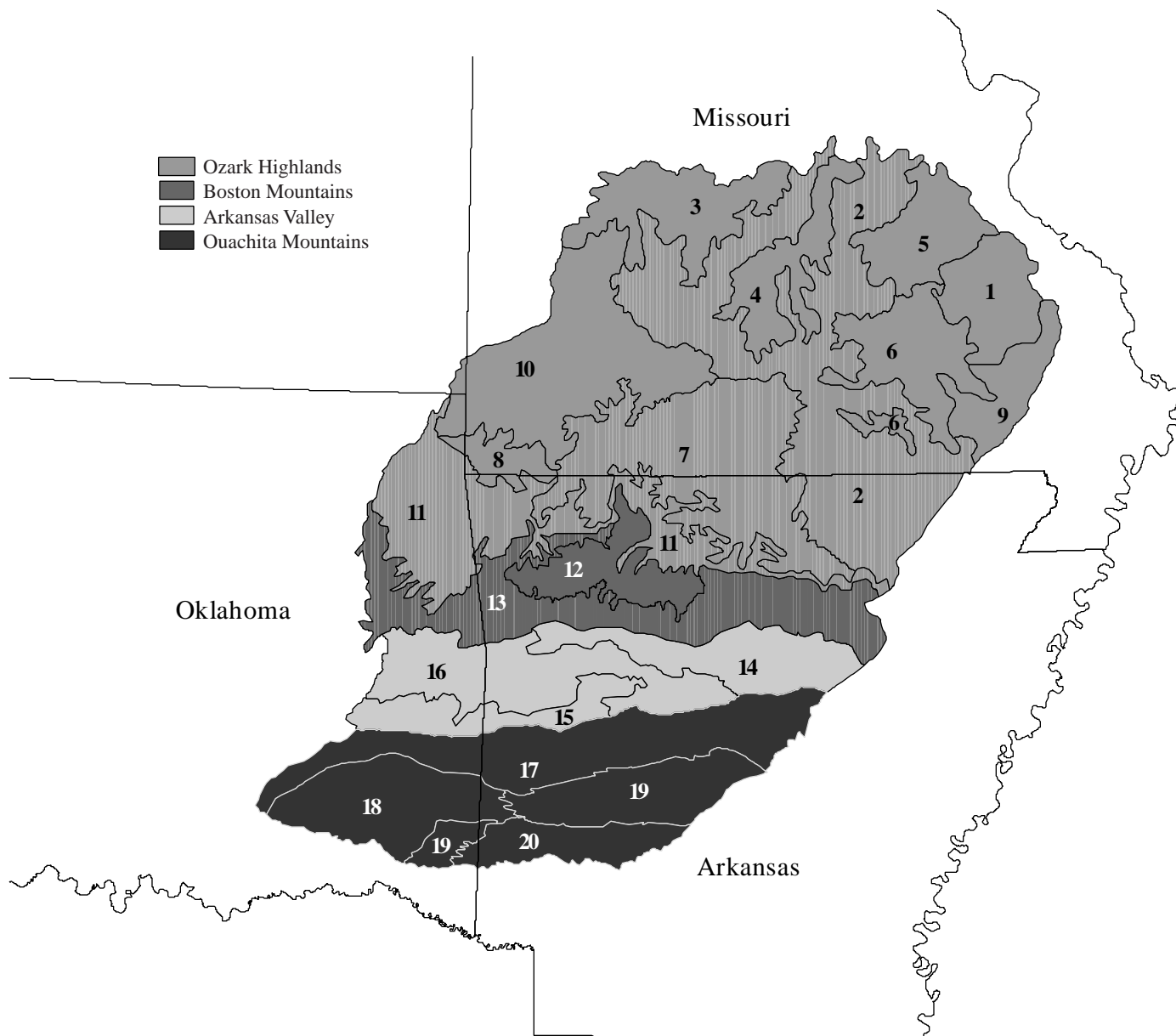
Novaculite and toward the west to follow the long narrow ridges and include the Pennsylvanian Jackfork Sandstone.

M231Ab—The Western Ouachita Mountains subsection occurs in Oklahoma (1,623,109 ac) and Arkansas (109,249 ac) and consists of open high hills and low mountains, often with wide valleys, with elevations ranging from 750 to 2,500 ft. The subsection is underlain by Mississippian sandstone and shale with clayey colluvium, covered with pine-oak and oak woodlands and forests, along with prairies. The Keys map boundaries were modified using geology (Arkansas Novaculite) to eliminate portions of the Central Ouachita Mountains from this subsection. The word “Central” was eliminated from the Keys map name (West Central Ouachita Mountains) because a substantial part of the subsection lies along the southern boundary of the Ouachita Mountains section.

M231Ac—The Central Ouachita Mountains occur in Oklahoma (244,015 ac) and Arkansas (1,401,574 ac).

They consist of open high hills and low mountains, often with wide valleys, and they range from 750 to 2,500 ft in elevation. The Central Ouachita Mountains are underlain by Mississippian sandstone and shale with clayey colluvium and covered with pine-oak and oak woodlands and forests. The Keys map boundaries were modified using geology (Arkansas Novaculite); a large disjunct area with consistent characteristics is newly delineated in southeastern Oklahoma. The Keys map name was changed by dropping “East” as it was no longer needed (because of the name change to Western Ouachita Mountains).

M231Ad—The Athens Piedmont Plateau occurs in Oklahoma (56,546 ac) and Arkansas (837,602 ac). It consists of open high hills underlain by Mississippian (with small amounts of Pennsylvanian) sandstone and shale with sandy and clay-loam colluvium covered with pine-oak and pine woodlands and forests. The Keys map boundary was refined using geology (Arkansas Novaculite) for north and west boundaries and Tertiary and Cretaceous deposits on the south and east.



Section name	Map code	Subsection name	Subsection number
Ozark Highlands	1	St. Francois Knobs and Basins	222Aa
Ozark Highlands	2	Central Plateau	222Ab
Ozark Highlands	3	Osage River Hills	222Ac
Ozark Highlands	4	Gasconade River Hills	222Ad
Ozark Highlands	5	Meramac River Hills	222Ae
Ozark Highlands	6	Current River Hills	222Af
Ozark Highlands	7	White River Hills	222Ag
Ozark Highlands	8	Elk River Hills	222Ah
Ozark Highlands	9	Black River Ozark Border	222A1
Ozark Highlands	10	Springfield Plain	222Am
Ozark Highlands	11	Springfield Plateau	222An
Boston Mountains	12	Upper Boston Mountains	M222Aa
Boston Mountains	13	Lower Boston Mountains	M222Ab
Arkansas Valley	14	Eastern Arkansas Valley	231Ga
Arkansas Valley	15	Western Arkansas Valley Mountains	231Gb
Arkansas Valley	16	Western Arkansas Valley	231Gc
Ouachita Mountains	17	Fourche Mountains	M231Aa
Ouachita Mountains	18	Western Ouachita Mountains	M231Ab
Ouachita Mountains	19	Central Ouachita Mountains	M231Ac
Ouachita Mountains	20	Athens Piedmont Plateau	M231Ad

Figure 1.1—Ecological sections and subsections of the Ozark-Ouachita Highlands Assessment area (sections and subsections modified from Keys and others 1995).

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This publication provides citizens, private and public organizations, scientists, and others with information about terrestrial animals, plants, and biological communities in and near the national forests in the Ozark-Ouachita Highlands: the Mark Twain in Missouri, the Ouachita in Arkansas and Oklahoma, and the Ozark-St. Francis National Forests in Arkansas. The document examines the status and trends of vegetation, plant and animal populations, forest management, and biological threats to forest resources in the Highlands.

**Keywords:** Biological threats, ecological classification, forest management, plant and animal populations, silviculture, vegetation cover.