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A Description of the Sections and Subsections of the Interior Highlands of Arkansas and Oklahoma

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Abstract

Sections and subsections of the Interior Highlands of Arkansas and Oklahoma are redefined, mapped and briefly summarized. The map was produced to support the Ozark-Ouachita Highlands Assessment (OOHA), being conducted by the USDA Forest Service. It revises the USDA Forest Service map "Ecological units of the eastern United States, first approximation" by Keys et al. (1995) and the earlier maps of the natural divisions of Arkansas (Foti, 1974; Foti, 1976; Pell, 1983) to reflect new knowledge and to achieve consistency with units recognized in Missouri. Four sections (natural divisions) are defined as opposed to the three of the previous Arkansas natural divisions maps, and new subsections are recognized within most sections. Digital maps of geology, soils and topography were used to create the map in ARC/INFO. The map is accessible through the World Wide Web as a portion of a map of the entire Interior Highlands region of Arkansas, Oklahoma and Missouri on the home page of the Ouachita National Forest at <http://www.fs.fed.us/oonf/ooha/welcome.htm>.

Introduction

The Interior Highlands has long been recognized as a distinct physiographic and natural region (Fenneman, 1938; Braun, 1950). It is generally characterized as hilly to mountainous topography on paleozoic substrates dominated by upland hardwood and upland pine-hardwood forests. It is surrounded by plains that are lower in elevation with more recent geological substrates and different vegetation. Vegetation of these plains ranges from tallgrass prairie to lowland pine-hardwood and bottomland hardwood forests.

Even though the Interior Highlands region has consistent general characteristics, there are striking differences within it that may occur within distinct geographic areas. 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 (Croneis, 1930; Fenneman, 1938; Braun, 1950; Thornbury, 1965; Foti, 1974). Sometimes the Arkansas Valley has been considered a separate province or natural division (Foti, 1976; Pell, 1983; Omernik, 1987). In addition, Omernik (1987) recognized the Boston Mountains as an ecoregion (natural division); previous authors had considered it a subdivision of the Ozark Mountains. These provinces are often subdivided as well (Fig. 1).

In order to facilitate agency ecosystem management efforts, the Forest Service developed a new national regionalization framework (Keys et al., 1995; henceforth referred to as Keys et al. Or the Keys map; Fig. 2) based on a national map of ecosystems of North America by Bailey et al. (1994). The new framework is hierarchical like older efforts but is based on a more holistic consideration of land-

scape properties than some earlier maps, with climate and soil playing prominent roles along with physiography. The new framework is also explicitly designed to rationally subdivide landscapes down to levels meaningful in ecosystem management, i.e. to units of several acres to a few tens of acres. The older and newer maps coincide most closely at the level of Section (Keys et al., Fig. 2), 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 USDA Forest Service has currently underway a project termed the Ozark-Ouachita Highlands Assessment (OOHA; USDA Forest Service, in prep.) that is an attempt to characterize the Interior Highlands region as a whole in order to support revision of Forest Plans on the three National Forests within the region: The Ouachita, the Ozark-St. Francis and the Mark Twain national forests. It was necessary to define regions within the Highlands that were distinct enough to require different management plans. In order to maintain national consistency the OOHA assumed from the outset that the Keys map would provide the regional perspective.

Methods

Examination of the Keys map (Fig. 2) and comparison with other regional maps such as the Croneis map (1930, Fig. 1) and geological and topographical base maps revealed that sections and subsections and their boundaries are not consistently meaningful and accurate across the assessment

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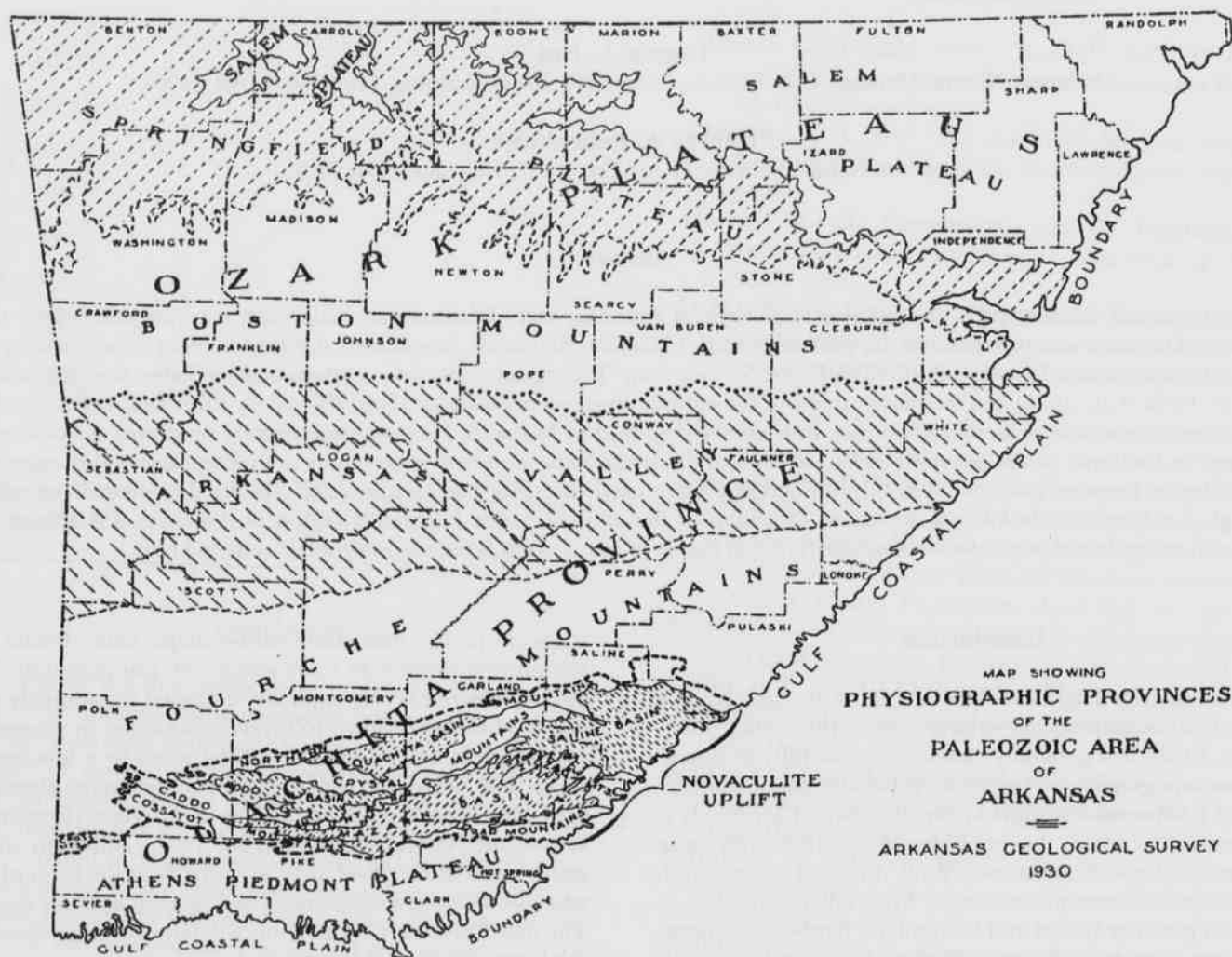


Fig. 1. Map of physiographic provinces of Arkansas developed by Croneis (1930).

area. The Missouri units and their boundaries have been settled for years, so the Keys map simply adopted those, and changes needed for the assessment were very minor. In contrast, the Arkansas units and boundaries required considerable revision because the Keys et al. approach is substantially different from what was done in the past (Croneis, 1930; Foti, 1974) and locally-created maps were not available. The Keys map is of lower quality in Oklahoma because in that state only general regions have been defined (Oklahoma Biodiversity Task Force, 1996); boundaries are not detailed and subdivisions are not mapped. Furthermore the Keys map appears to be derived from low-detail base maps, and boundaries were judged to be too general for OOHA purposes. The Keys map does not explicitly define the source or rationale for boundaries, so revision of the

map sometimes required a determination of the defining physical feature and use of an appropriate base map.

Rationales for many regional boundaries in Arkansas have been presented by Croneis (1930) and Foti (1974) and were adopted for this revision. Rationales for new boundaries are presented here. 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 U.S. (Schruben et al., 1994); no larger scale geologic map covering the entire assessment area was available. The topographic base map was created for this project from 30-m USGS digital elevation model files by the Spatial Analysis Laboratory of the School of Forest Resources, University of Arkansas at Monticello.

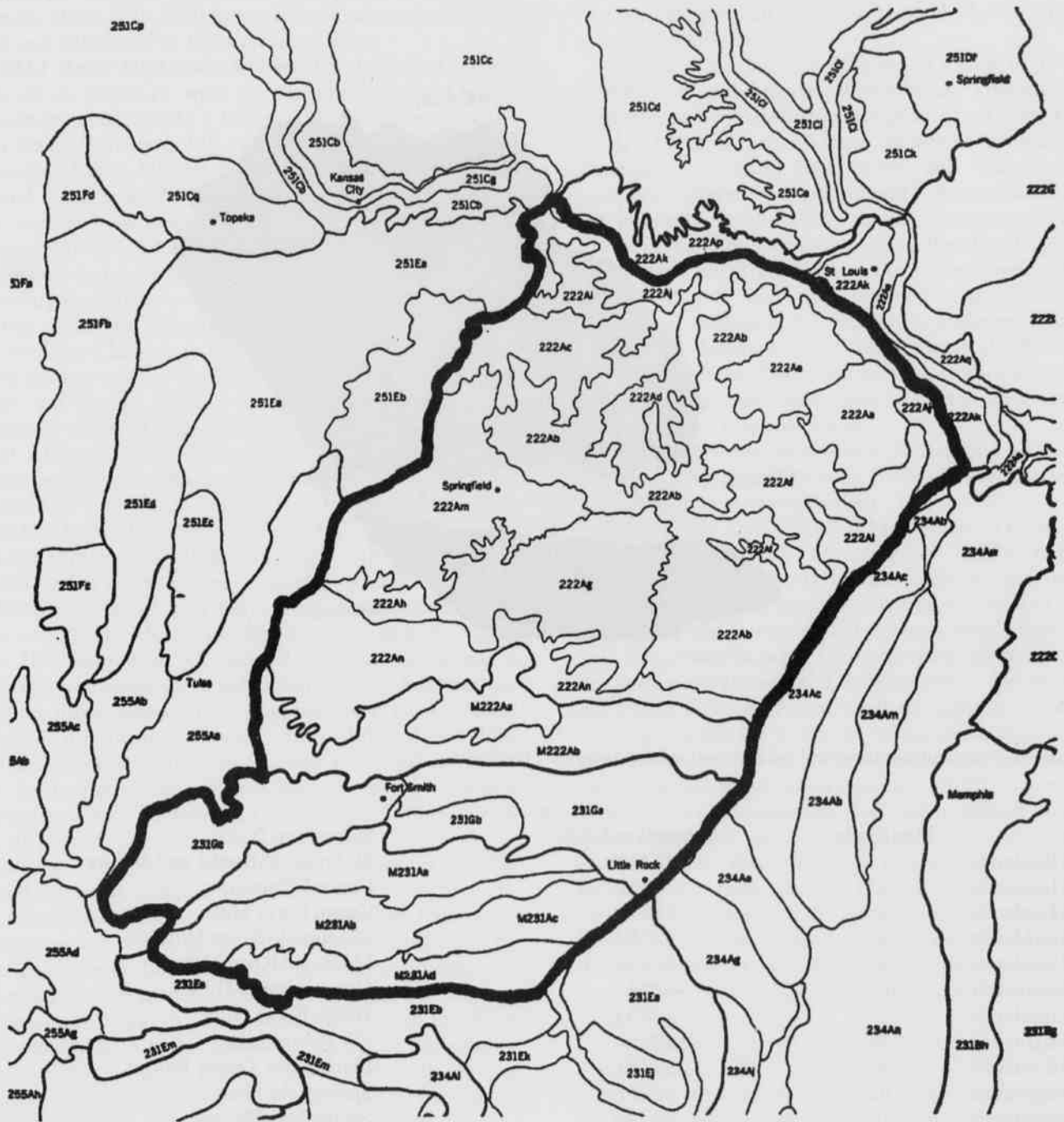


Fig. 2. Keys et al. (1995) Sections and subsections of the Interior Highlands region. See Fig. 3. for legend.

Results

A new map of the sections and subsections of the Interior Highlands was created that was based on the ecological unit definitions of the Keys map but used boundary definitions of Croneis (1930), Foti (1974) or those presented

here (Fig. 3, Fig. 4). The map is in digital form and may be accessed at <http://www.fs.fed.us/oonf/ooha/welcome.htm>

The following discussion describes the ecological units used in the OOHA and the factors on which the boundaries were based, along with changes from the Keys map. Alphanumeric codes used here are from the Keys map.

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Fig. 3. Revised map of sections and subsections of the Interior Highlands.

Legend

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

Changes in Arkansas subsections from previous treatments (Croneis, 1930; Foti, 1974) are noted. All subsections recognized and delineated in Oklahoma are new.

222A Ozark Highlands Section.—The following subsections, all in Missouri, were not included in the OOHA 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 222 Aq - Illinois Ozarks (Fig. 2). These were excluded because they are on the periphery of the region, are not included in some data sets being used in the assessment, and include additional states and/or St. Louis, whose large population would skew socioeconomic analysis.

The following subsections, all in Missouri, are not described here, but are in the OOHA area, were described in that project, and are shown in Fig. 2: 222Aa - St. Francois Knobs and Basins; 222Ac - Osage River Hills; 222Ad - Gasconade River Hills; 222Ae - Meramec River Hills; 222Af - Current River Hills; 222Al - Black River Ozark Border; and 222Am - Springfield Plain.

222Ab - Central Plateau - Occurs in Missouri (2,025,986 ha) and Arkansas (540,337 ha), and is comprised of irregular plains 90-500 m in elevation with karst features on Ordovician cherty dolomite, sandstone and cherty clay residuum are 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 where land surface elevation drops steeply from the relatively level Central Plateau to the downcut streams of the White River Hills. Thus the Central Plateau stands above the White River Hills. As compared with earlier Arkansas maps, this is a new subdivision of the Salem Plateau subdivision (Croneis, 1930; Foti, 1974).

222Ag - White River Hills - Occurs in Missouri (872,470 ha) and Arkansas (638,270 ha). Hills with entrenched valleys, 180-500 m in elevation, with karst features, formed by downcutting of White River tributaries are underlain by Ordovician cherty dolomite with cherty clay residuum 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. Compared with earlier Arkansas maps, this is a new subdivision of the Salem Plateau subdivision (Croneis, 1930; Foti, 1974).

222Ah - Elk River Hills - Occurs in Missouri (22,794 ha) and Arkansas (23,242 ha). Hills with entrenched valleys, 270-425 m in elevation, with karst features, formed by streams downcutting to the Neosho River underlain by Mississippian cherty limestone with cherty clay residuum are 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 surround-

ing subsections. Compared with earlier Arkansas maps, this is a new subdivision of the Springfield Plateau subdivision (Croneis, 1930; Foti, 1974).

222An - Springfield Plateau - Occurs in Oklahoma (601,645 ha) and Arkansas (639,330 ha). This subsection is characterized by smooth to irregular plains with karst features, 240-425 m in elevation, underlain by Mississippian limestone sometimes very cherty and with cherty clay residuum 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 drop in elevations 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. Compared with earlier Arkansas maps, this is identical with the traditional Springfield Plateau subdivision (Croneis, 1930; Foti, 1974) except for the elimination of a small area now within the Elk River Hills subsection.

M222A Boston Mountains Section.—In earlier maps, with the exception of Omernik (1987), this section was treated as a subsection or equivalent.

M222Aa - Upper Boston Mountains - Occurs only in Arkansas (447,836 ha). Low mountains 300-825 m in elevation, underlain by Pennsylvanian sandstone and shale with sandy residuum and loamy colluvium are covered with oak woodlands and forests. Detail changes were made in Keys map boundaries to better follow the geologic boundary with the Springfield Plateau and to better follow the corresponding Ozark National Forest landtype association boundary elsewhere along the perimeter of the subsection. This subsection was defined on the basis of elevation (that approximates the 550 m elevation contour), which corresponds to areas of lower temperature and higher rainfall and consequent changes in plant community composition. The Keys et al. names 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. Compared with earlier Arkansas maps, the Upper Boston Mountains Subsection is a new subdivision of the Boston Mountain subdivision (Croneis, 1930; Foti, 1974).

M222Ab - Lower Boston Mountains - Occurs in Oklahoma (337,727 ha) and Arkansas (1,000,247 ha). High hills, 150-550 m in elevation, underlain by Pennsylvanian sandstone and shale with sandy residuum and loamy colluvium are covered with pine-oak and oak woodlands and forests. Detail changes were made in Keys map boundaries to better follow the corresponding Ozark National Forest landtype association boundary with 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 topographically-defined southern boundary (the escarpment to

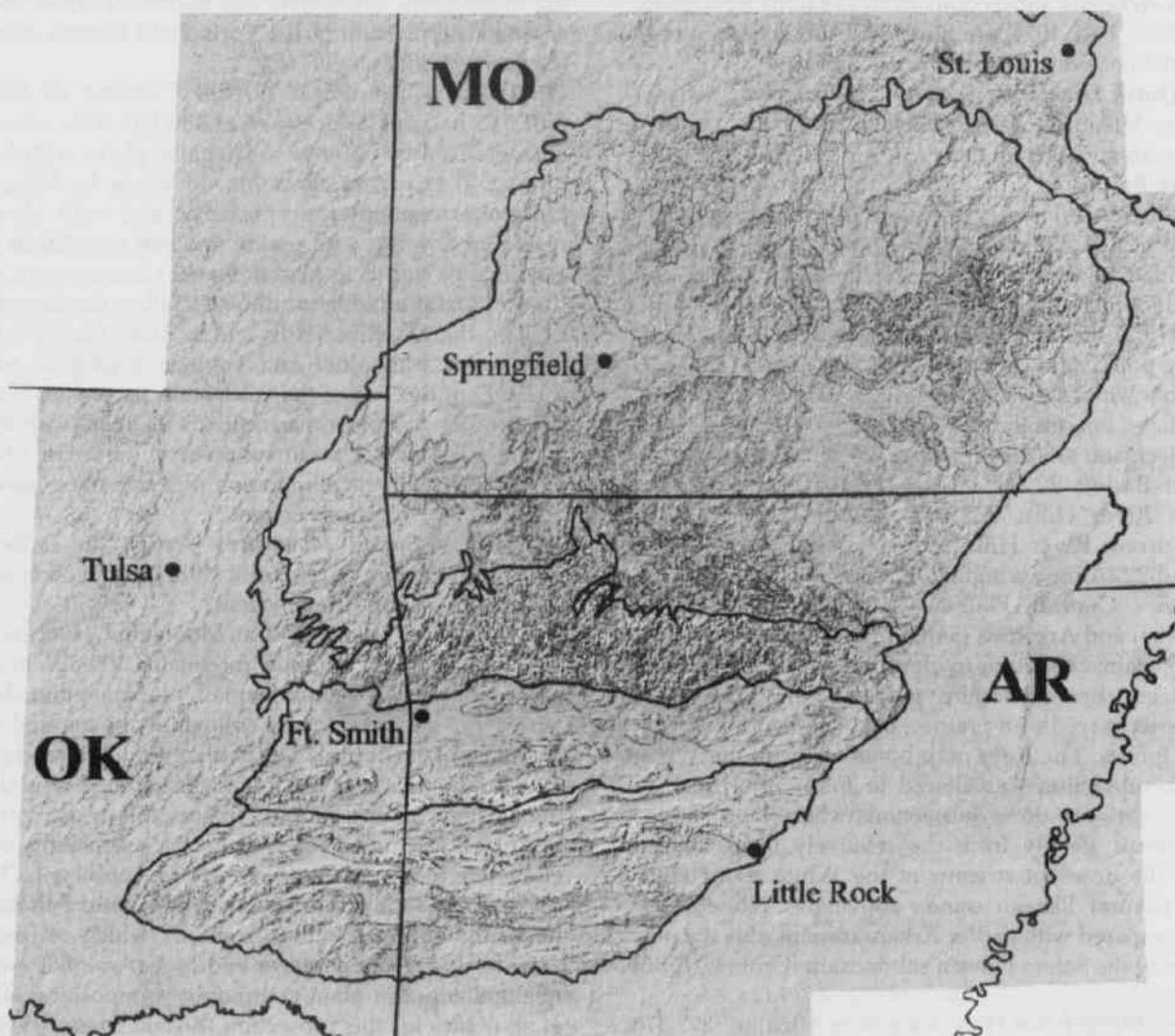


Fig. 4. Sections and subsections of the Interior Highlands shown on shaded relief background.

the Arkansas Valley Section [Croneis 1930, Foti 1974]. The Keys et al. name for this subsection (Boston Hills) was changed as detailed in the description of the Upper Boston Mountains. Compared with earlier Arkansas maps, this is a new subdivision of the Boston Mountain subdivision (Croneis, 1930; Foti, 1974).

231G Arkansas Valley Section.--231 Ga - Eastern Arkansas Valley - Occurs only in Arkansas (603,047 ha). Plains with hills, 90-150 m in elevation, underlain by Pennsylvanian sandstone and shale with sandy residuum are 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 contributed to the subsection boundary. The Keys et al. name was changed to eliminate "and Ridges" since the redefined southern boundary eliminated the most prominent structural ridges from the subsection (this was one reason for redefining that boundary). Compared with earlier Arkansas maps, this is a new subdivision of the Arkansas Valley subdivision (Croneis, 1930; Foti, 1974). It has the least distinct boundaries within the section and is the subsection of the Arkansas Valley least influenced by the Arkansas River (which leaves this portion of

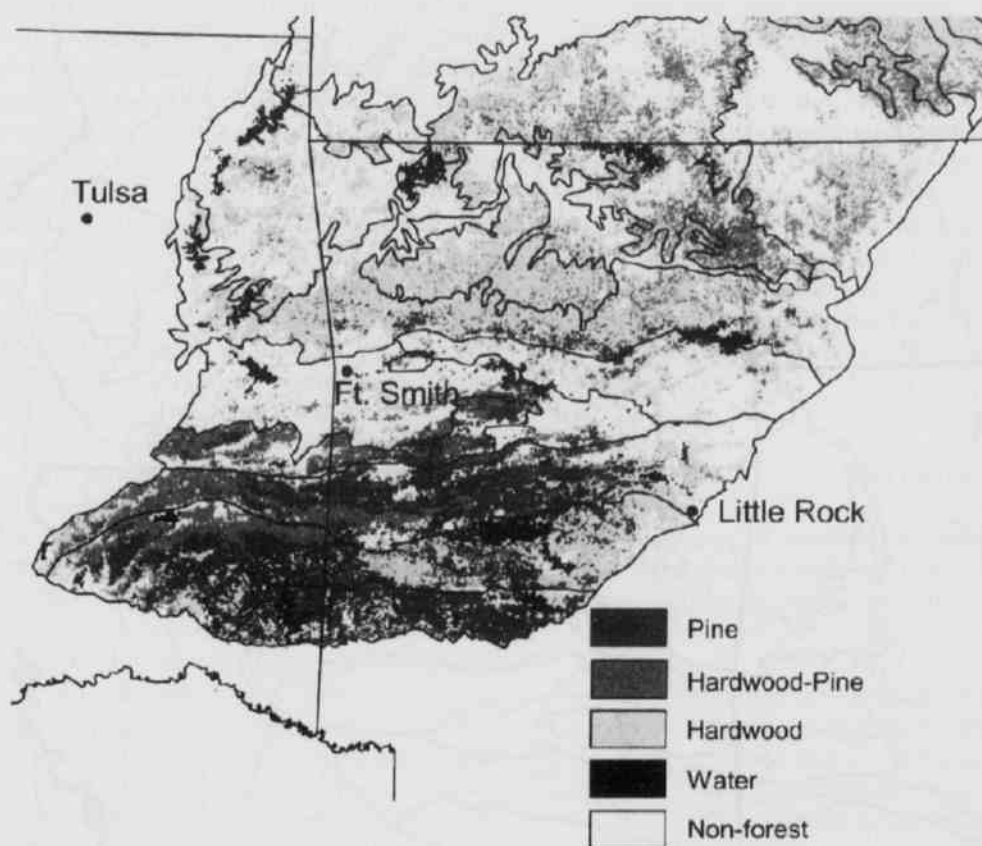


Fig. 5. Vegetation of the sections and subsections of the Interior Highlands.

the Arkansas Valley to cross the easternmost Ouachita Mountains). Without the influence of the Arkansas River, the Western Arkansas Valley would be more like this subsection and would better fit the early judgement that it was a subdivision of the Ouachita Mountain Province (Croneis, 1930). For this reason the equivalent natural division was termed the "Arkansas River Valley" by Foti (1976). However, all other authors have eliminated the word "River" from the name, and that nomenclature is followed here. Compared with earlier Arkansas maps, this is a new subdivision of the Arkansas Valley (Croneis, 1930; Foti, 1974).

231 Gb - Western Arkansas Valley Mountains - Occurs in Oklahoma (200,172 ha) and Arkansas (175,428). Low mountains and ridges with sometimes wide valleys 225-850 m in elevation 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 changed somewhat based on topography to better include the mountains and exclude plains that were continuations of those in the Western Arkansas Valley. The south-

ern boundary was changed to follow the northern boundary of the physiographic Ouachita Mountains (Croneis, 1930; Foti, 1974); the line was drawn using topography. The Keys et al. name (Mount Magazine) was changed to reflect the importance of other mountains within this subsection. Compared with earlier Arkansas maps, this is a new subdivision of the Arkansas Valley (Croneis, 1930; Foti, 1974).

231Gc - Western Arkansas Valley - Occurs in Oklahoma (335,520 ha) and Arkansas (548,332 ha). Plains, low hills and ridges, 90-300 m in elevation, underlain by Pennsylvanian sandstone and shale with sandy and clayey residuum along with Holocene sandy alluvium are 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 Keys map northern, eastern and southern boundaries 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 erosional plains within this subsection. A

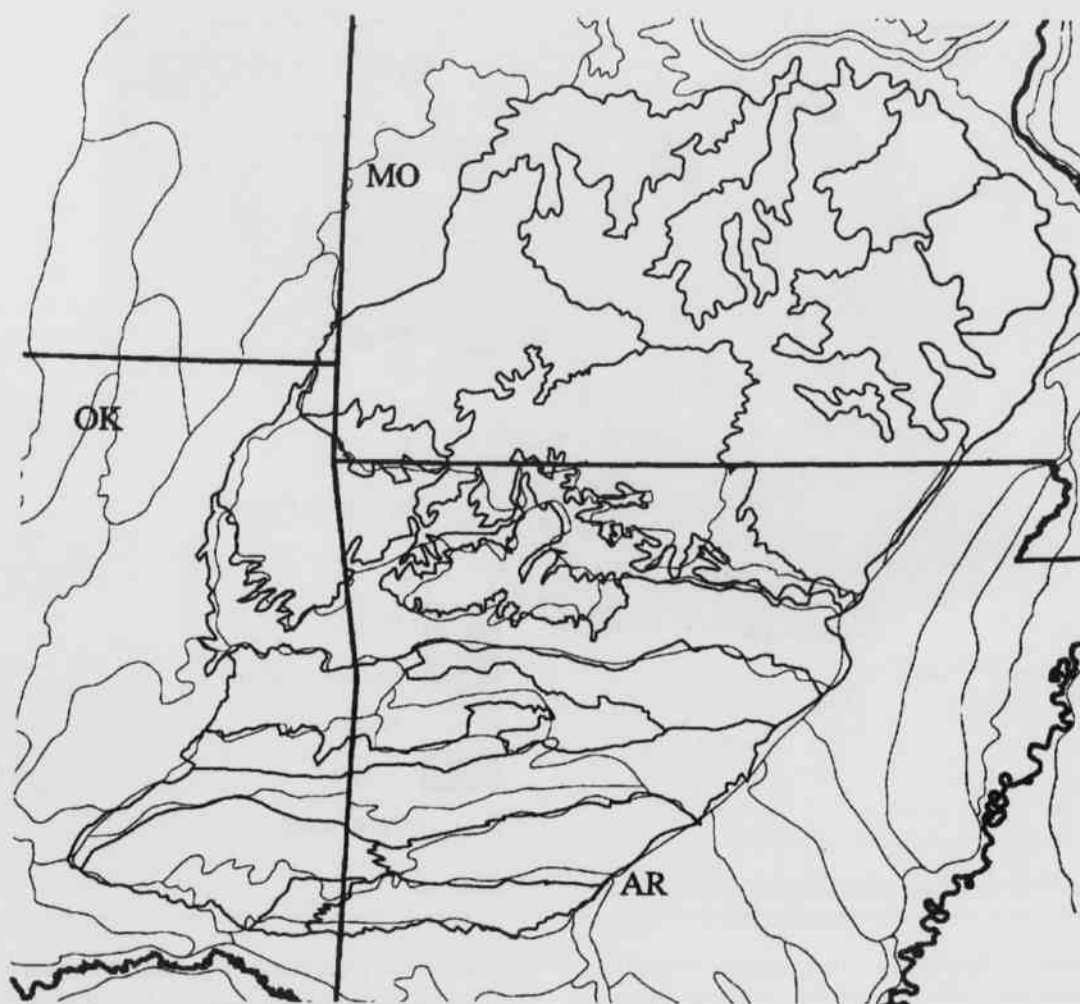


Fig. 6. Differences between new map and Keys et al. (1995). New map boundaries shown darker.

substantial area Keys et al. included that extended up the Canadian River at the western end of this subsection was eliminated on the basis of geology, topography and the definition of the Arkansas Valley as a synclinorium lying between the Ouachita Mountains and the uplifted plateaus of the Ozark Mountains (Croneis, 1930). Compared with earlier Arkansas maps, this is a new subdivision of the Arkansas Valley (Croneis, 1930; Foti, 1974).

M231A Ouachita Mountains Section.--M231Aa - Fourche Mountains - Occurs in Oklahoma (300,715 ha) and Arkansas (869,2 ha). These are open low mountain ridges, often with wide valleys, 230-850 m in elevation. Ridges are underlain by Pennsylvanian and Mississippian sandstone and shale and sandy residuum in valleys and covered with pine-oak and oak woodlands and forests. The northern

boundary was modified from Keys et al. to coincide with the physiographic boundary based on topography (Croneis, 1930; Foti, 1974). The eastern portion of the southern boundary was modified to match the boundary with Mississippian Arkansas Novaculite, and further west to include the long narrow ridges of Pennsylvanian Jackfork Sandstone. Compared with earlier Arkansas maps (Croneis, 1930; Foti, 1974), this is an existing subdivision of the Ouachita Mountains but with slight reduction in area at the extreme southwestern end, now assigned to the Western Ouachita Mountains Subsection.

M231Ab - Western Ouachita Mountains - Occurs in Oklahoma (656,840 ha) and Arkansas (44,211 ha). Open high hills and low mountains often with wide valleys, 230-760 m in elevation, are underlain by Mississippian sand-

stone and shale with clayey colluvium and covered with pine-oak and oak woodlands and forests, along with prairies. Keys et al. boundaries were modified by excluding Arkansas Novaculite of the Central Ouachita Mountains from this subsection. The word "Central" was eliminated from the Keys et al. name (West Central Ouachita Mountains) because a substantial part of the subsection lies along the southern boundary of the Ouachita Mountains Section. Compared with earlier Arkansas maps (Croneis, 1930; Foti, 1974), this is a newly-mapped subdivision but only affects a small part of Arkansas.

M231Ac - Central Ouachita Mountains - Occurs in Oklahoma (98,748 ha) and Arkansas (566,689 ha). Open high hills and low mountains often with wide valleys, 230-760 m in elevation, are underlain by Mississippian sandstone and shale with clayey colluvium, covered with pine-oak and oak woodlands and forests. Keys map boundaries were modified by encompassing Arkansas Novaculite outcrops; a large disjunct area with consistent characteristics is newly delineated. The Keys et al. name was changed by dropping the "East", which was no longer needed because of the name change to the Western Ouachita Mountains. Compared with earlier Arkansas maps (Croneis, 1930; Foti, 1974), this is an existing subdivision of the Ouachita Mountains, but with an additional disjunct area added that affects only a very small part of Arkansas.

M231Ad - Athens Piedmont Plateau - Occurs in Oklahoma (22,883 ha) and Arkansas (338,961 ha). Open high hills, 150-300 m in elevation, underlain by Mississippian (with small amounts of Pennsylvanian) sandstone and shale with sandy and clay-loam colluvium are covered with pine-oak and pine woodlands and forests. The Keys map boundary was refined using the southern limit of Arkansas Novaculite for north and west boundaries; Tertiary and Cretaceous deposits define the south and east boundaries. Compared with earlier Arkansas maps (Croneis, 1930; Foti, 1974), this is an existing subdivision of the Ouachita Mountains.

Although the concepts for these sections and subsections, along with their boundaries, were based entirely on physical features (e.g., geology, topography), relationships to land cover were explored using a vegetation map of the Interior Highlands created for the OOHA Assessment (Southern Forest Experiment Station Forest Inventory and Analysis, 1992). This map was created using Advanced Very High Resolution Radiometer (AVHRR) data and, for our analysis, section/subsection boundaries were overlaid on it, allowing us to characterize the vegetation of each section/subsection (Fig. 5). A detailed analysis is presented in the OOHA Assessment (in preparation), but in summary it can be seen that the Boston Mountains and Ouachita Mountains sections have greater forest cover than the other two sections. In general the Boston Mountains Section is covered with hardwood forest whereas the Ouachitas are

covered with pine and hardwood-pine forest. However the Central Ouachita Mountains Subsection has extensive coverage of hardwood and the extreme eastern Fourche Mountains Subsection has little pine and hardwood-pine, with extensive cleared lands and some hardwood forest. Even though the bulk of the Arkansas Valley Section is cleared, the Western Arkansas Valley Mountains Subsection is heavily forested, primarily with pine-hardwood. Similarly, most of the forest of the Ozark Highlands Section in Arkansas is concentrated within the White River Hills Subsection, where pine-hardwood and hardwood forests are common. In general, areas of higher relief are more heavily forested.

Discussion

This map of sections and subsections of the Interior Highlands of Arkansas and Oklahoma is the first such delineation in Oklahoma and provides significant advancements to the earlier maps by Croneis (1930) and Foti (1974) in Arkansas:

- 1) Boundaries are defined and mapped consistently across the three states sharing the Highlands;
- 2) Boundaries based on topography are much more accurate than before because of the use of 30-m DEM's;
- 3) Changes in section/subsection definitions that have occurred since production of the earlier maps are incorporated; and
- 4) This map is in digital form and freely available over the Worldwide Web.

Although production of the new map involved many changes to the Keys et al. (1995) map (Fig. 6), few changes in the list of sections and subsections were made; rather 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.

Similarly, the new map involves many changes to the Croneis (1930) and Foti (1974) maps. However, in most cases, subsection boundaries were added, not changed. In most cases, such as the White River Hills and Central Plateau that nest within the Salem Plateau of Croneis (1930), the Upper and Lower Boston Mountains subsections that nest within the Boston Mountain subdivision of Foti (1974), or the three new subsections within the Arkansas Valley, the new map simply adds detail to the older maps. It is still correct to refer to the Ozark Mountains as a combination of the Ozark Highlands and Boston Mountains sections or to refer to the Salem Plateau subdivision if the object of interest is not limited to one of the smaller subsections.

Examining subsections that extend from Arkansas into adjacent states adds valuable insight into their appropriate boundaries in Arkansas. The Elk River Hills and the dis-

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junct portion of the Central Ouachita Mountains barely reach Arkansas, yet they are considered important regions in the other states. Recognition of the White River Hills, which are very extensive in Missouri, adds insight into the landscape diversity of the Salem Plateau in Arkansas as well.

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