13780

West Gulf Coastal Plain Sandhill Oak and Shortleaf Pine Forest and Woodland

BpS Model/Description Version: Aug. 2020

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| --- | --- | --- | --- |
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| None | None | None | None |
| None | None | None | None |

Vegetation Type

Forest and Woodland

Map Zones

37, 44

Model Splits or Lumps

This Biophysical Setting (BpS) is lumped with: 1424

Geographic Range

Sandhills occur as a belt of residual alluvial (possibly marine) sands along the upper gulf coastal plain of the southeastern United States (Roberts 1978), including southern Arkansas, northwestern Louisiana, and eastern Texas. In Arkansas centered on Ouachita, Miller and Nevada counties; in Texas, extending in a 3-12mi width from Cass County on the northeast to Bexar County in the southwest and then south to Sabine County. This BpS is found in LANDFIRE map zone (MZ)37 in ECOMAP subsections 231Ea, 231Ek, and 231Eg. This type is also present in more limited areas of TNC ecoregion 41 (West Gulf Coastal Plain), where it was confined more typically to side slopes and other locations not dominated by longleaf pine (*Pinus palustris*).

Biophysical Site Description

Sandhills are characterized by deep, excessively drained, coarse sands that become droughty even during short rainless periods. Even in the absence of fire, soil conditions maintain a barrens or sparsely wooded landscape. The type is located on ridgetops and adjacent side slopes. The topography ranges from nearly level to rolling (1-35% slopes). The elevation of the sandhills ranges from about 200-500ft above sea level.

The sandhill ecosystem occurs on Claiborne geology from the Tertiary Period and Eocene Epoch. The material is generally alluvial in origin and is composed of coarse to very fine sands, silts, and silty clays (McFarland 1998). The subsurface geology in the sandhills of Ouachita, Miller and Nevada Counties, Arkansas is primarily Sparta Sand, Cane River Sand and Carrizo Sands (Albin 1962). The Eocene Carrizo formation occurs in Texas, extending in a 3-12mi width from Cass county on the northeast to Bexar County in the southwest and then south to Sabine County. The xeric sandy lands are characteristic of this formation

This type includes the Arenic dry uplands characterized by deep coarse sands underlain by loamy fine sands at variable depths that results in seepage. This variant is less droughty and maintains a woodland aspect with fire.

The sandhills in Ouachita and Nevada Counties in Arkansas are alluvial in origin (McFarland 1998). The soil association in the sandhill region of Ouachita and Nevada Counties is Alaga-Kirvin in Ouachita County, Briley in Miller County, and Smithdale-Darden in Nevada County. The Alaga-Kirvin association occurs on 11% of Ouachita Co. (52,000ac) in the south central and northwest parts of the county. The Smithdale-Darden association occurs on about six percent of Nevada County (24,000ac) in the northeast and central part of the county. Alaga and Darden are synonymous (NRCS, personal communication). Darden is the current name for this soil type while Alaga appears in earlier publications. Because Alaga is the more commonly recognized name it will be used in referring to soils in both counties for the remainder of this report.

The upland sandhill plant communities occur on Alaga loamy sands with rolling topography. Soil is one of the most important factors affecting the sandhill vegetation (Roberts 1978). These soils are very deep, excessively drained, and rapidly permeable. A typical profile is characterized by seven inches of dark brown loamy sand on the surface overlaying 58in of yellowish-brown to strong brown loamy sand with white sand extending another 20in in depth. Alaga soil lacks a B horizon as well as the structure and accumulated clay that the other soils associated with it have (Catlett 1973). The occasional areas of associated soils, including Cahaba, Kirvin, Lucy, and Norfolk, may account for the patches of clay appearing on the surface within some sandhill sites.

Alaga soil is medium to strongly acid (pH 4.5-6.0) in the surface layer and medium to very strongly acid below. It consists of 90% sand, 9% silt and 1% clay (Catlett 1973). This soil is nutrient-poor with less than one percent organic matter (Faust 1976). The organic matter oxidizes quickly and the released nutrients are leached by rain (Burns and Hebb 1972). Alaga soils have low available water capacity and are subject to frequent and severe drought (Catlett 1973).

The wetland plant communities associated with the sandhills (bogs, seeps) occur on Bibb series silt loam or fine sandy loam. Bibb soils are on bottoms along creeks and are nearly level, poorly drained, moderately permeable and very acidic. They have a moderate to high water holding capacity, are frequently flooded, and are saturated six to eight months of the year. They are also low in natural fertility. Bibb soils have a higher sand content than the associated soils (Catlett 1973).

Vegetation Description

High quality xeric herbaceous sand barrens and dry sandhill woodlands are open park-like or treeless areas with a rich understory. Sandhill plant communities are highly diverse. The sandhill ridgetops and upper slopes support dry sandhill woodland which has a stunted gnarly canopy of oaks including runner oak (*Quercus margarettiae*), bluejack oak (*Q. incana*), blackjack oak (*Q. marilandica*) and Arkansas oak (*Q. arkansana*). Openings in the woodlands, also on ridgetops and drier south and southwest facing slopes, are xeric sand barrens. Shortleaf pine (*P. echinata*) often does not maintain itself in this community due to drought. The herbaceous layer is dominated by little bluestem (*Schizachyrium scoparium*) and a variety of curly threeawn (*Aristida desmantha*) and other threeawns (*Aristida* spp). Texas bullnettle (*Cnidoscolus texanus*), prickly pear (*Opuntia* spp), narrowleaf silkgrass (*Pityopsis graminifolia*), Gulf Coast yucca (*Yucca louisianensis*), large clammyweed (*Polanisia erosa*) and nettleleaf noseburn (*Tragia urticifolia*) are characteristic. Openings in the woodlands, also on ridgetops and drier south and southwest facing slopes, are xeric sand barrens. The barrens are nearly treeless, with a sparse to moderate cover of herbaceous species such as *Carex grayoides*, Riddell’s spike moss (*Selaginella arenicola* ssp. *riddellii)*, little bluestem (*Schizachyrium scoparium*), Reverchon’s spiderwort (*Tradescantia reverchonii*). Fire maintained examples have greater vegetation cover and species diversity while fire suppressed examples (fire-suppressed sites would have occurred naturally but are more prevalent today) have more bare sand, may become shrubby, and/or have large uniform patches of Riddell’s spike moss. These more xeric woodlands and barrens are limited on the landscape and occur within a matrix of the more common dry sandhill woodland (dry Arenic uplands in Texas). Shortleaf pine, post oak (*Q. stellata*), black hickory (*Carya* *texana*), sassafras (*Sassafras albidum*) and blueberry (*Vaccinium* spp) are more common on these less stressful sites. High quality dry sandhill woodlands are open and park-like with a rich understory.

Due to water seepage through the sandhills, wetlands (seeps and bogs) are distributed along differing soil layer and deposits, especially confining layers. Seep communities are found between the sandhill uplands at the bases of slopes: wooded sandhill seep, saturated sandhill shrub seep and herbaceous sandhill marsh.

In this model, QUST (*Q. stellata*) refers to *Q. margaretta*. (*Q. margaretta* was a variety of *Q. stellata* and is now a species name), which is not included in the PLANTS database.

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| PIEC2 | *Pinus echinata* | Shortleaf pine |
| QUST | *Quercus stellata* | Post oak |
| QUIN | *Quercus incana* | Bluejack oak |
| QUAR | *Quercus arizonica* | Arizona white oak |
| SCSC | *Schizachyrium scoparium* | Little bluestem |
| CNTE | *Cnidoscolus texanus* | Texas bullnettle |

Species names are from the NRCS PLANTS database. Check species codes at http://plants.usda.gov.

Disturbance Description

This ecosystem is maintained by a combination of edaphic effects and periodic fires. The soils are deep, droughty sands often with extensive seepage zones. Sandhills are receptive to ignition nearly year round, with grassy herbaceous layer that ignites easily, and droughty soils that dry out with short rainless periods.

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 157 | 3 |  |  |
| Moderate (Mixed) | 385 | 1 |  |  |
| Low (Surface) | 5 | 96 |  |  |
| All Fires | 5 | 100 |  |  |

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Percent of all fires is the percent of all fires modeled in that severity class. Minimum and Maximum FIs show the relative range of fire intervals as estimated by model contributors, if known.

Scale Description

In Arkansas and Louisiana, up to 10s of 1000s of acres and more extensive in Texas.

Adjacency or Identification Concerns

Adjacent to UWGCP Pine-Hardwood Forest and Woodland, which occurs on more loamy soils (not deep sands).

Issues or Problems

Many sites have been converted to Loblolly pine plantations or watermelon farms.

Native Uncharacteristic Conditions

Closed canopy due to fire suppression. Though fire suppressed sites would have occurred naturally, they are much more prevalent today.

Comments

Models and descriptions for map zones (MZ)37 and 44 were identified as identical in the BpS review process. The description from MZ37 was used for both map zones.

Succession Classes

**Mapping Rules**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Upper Layer Lifeform** | **Height (m)** | **Canopy Cover (%)** | | | | | | | | | |
| **0-10** | **11-20** | **21-30** | **31-40** | **41 - 50** | **51-60** | **61-70** | **71-80** | **81-90** | **91-100** |
| Herb | 0-0.5 | A | A | A | A | A | A | A | A | A | A |
| Herb | 0.5-1.0 | A | A | A | A | A | A | A | A | A | A |
| Herb | >1.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 0-0.5 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 0.5-1.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 1.0-3.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | >3.0 | A | A | A | A | A | A | A | A | A | A |
| Tree | 0-5 | C | C | C | C | C | C | C | C | B | B |
| Tree | 5-10 | C | C | C | C | C | C | C | C | B | B |
| Tree | 10-25 | D | D | D | D | D | D | D | D | E | E |
| Tree | 25-50 | D | D | D | D | D | D | D | D | E | E |
| Tree | >50 | D | D | D | D | D | D | D | D | E | E |

Succession class letters A-E are described in the Succession Class Description section. Some classes use a leafform distinction where a qualifier is added to the class letter: Brdl (broadleaf), Con (conifer), or Mix (mixed conifer and broadleaf). UN refers to uncharacteristic native or a combination of height and cover that would not be expected under the reference condition. NP refers to not possible or a combination of height and cover which is not physiologically possible for the species in the BpS.

**Description**

Class A 12 Early Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| QUST | Quercus stellata | Post oak | Upper |
| QUIN | Quercus incana | Bluejack oak | Upper |
| PIEC2 | Pinus echinata | Shortleaf pine | Upper |
| SCSC | Schizachyrium scoparium | Little bluestem | Lower |

Description

Pine/oak regeneration with grass/forb regrowth. *Pinus echinata, Quercus* spp, mixed hardwood shrubs, various *Andropogon* spp and forbs with weedy component. Barrens, because of edaphic effects, have little to no woody vegetation and sparse herbaceous vegetation; and/or have large uniform patches of Riddell’s spike moss. Frequent surface fire maintains this class. Ice and wind storms will replace this class.

*Maximum Tree Size Class*  
Sapling >4.5ft; <5"DBH

Class B 2 Mid Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| QUST | Quercus stellata | Post oak | Upper |
| QUIN | Quercus incana | Bluejack oak | Upper |
| PIEC2 | Pinus echinata | Shortleaf pine | Upper |
| VACCI | Vaccinium | Blueberry | Low-Mid |

Description

Overstory composed of *Q. margaretta, Q. incana*, and *P. echinata*. Midstory composed of same species as overstory and *Q. arkansana*, farkleberry (*Vaccinium arboreum*). Low-intensity fire occurs in this class.

*Maximum Tree Size Class*  
Pole 5-9" DBH

Class C 18 Mid Development 1 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| QUST | Quercus stellata | Post oak | Upper |
| QUIN | Quercus incana | Bluejack oak | Upper |
| PIEC2 | Pinus echinata | Shortleaf pine | Upper |
| SCSC | Schizachyrium scoparium | Little bluestem | Lower |

Description

With low-severity surface fires at intervals <5yrs this class will maintain its open canopy. Open canopy with sparse mid-story and well-developed, very diverse grass-forb layer.

*Maximum Tree Size Class*  
Pole 5-9" DBH

Class D 63 Late Development 1 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| QUST | Quercus stellata | Post oak | Upper |
| QUIN | Quercus incana | Bluejack oak | Upper |
| PIEC2 | Pinus echinata | Shortleaf pine | Upper |
| SCSC | Schizachyrium scoparium | Little bluestem | Lower |

Description

The sandhill ridgetops and upper slopes support dry sandhill woodland which has a stunted gnarly canopy of oaks (*Q. margaretta, Q. incana, Q. marilandica, Q. arkansana*). Open canopy with sparse mid-story and well-developed, very diverse grass-forb layer.

*Maximum Tree Size Class*  
Large 21-33"DBH

Class E 5 Late Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| QUST | Quercus stellata | Post oak | Upper |
| QUIN | Quercus incana | Bluejack oak | Upper |
| PIEC2 | Pinus echinata | Shortleaf pine | Upper |

Description

Closed canopy with mid-story, tolerant shrubs, and little to no grass-forb layer. Low-intensity fire will maintain this class.

*Maximum Tree Size Class*  
Large 21-33"DBH

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:ALL | 0 | Mid1:OPN | 15 |
| Mid1:OPN | 16 | Late1:OPN | 45 |
| Mid1:CLS | 16 | Late1:CLS | 45 |
| Late1:OPN | 46 | Late1:OPN | 999 |
| Late1:CLS | 46 | Late1:CLS | 999 |

Probabilistic Transitions

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Disturbance Type** | **Disturbance occurs In** | **Moves vegetation to** | **Disturbance Probability** | **Return Interval (yrs)** | **Reset Age to New Class Start Age After Disturbance?** | **Years Since Last Disturbance** |
| Alternative Succession | Early1:ALL | Mid1:CLS | 1 | 1 | Yes | 14 |
| Wind or Weather or Stress | Early1:ALL | Early1:ALL | 0.025 | 40 | Yes | 0 |
| Surface Fire | Early1:ALL | Early1:ALL | 0.2 | 5 | No | 0 |
| Alternative Succession | Mid1:OPN | Mid1:CLS | 1 | 1 | Yes | 15 |
| Wind or Weather or Stress | Mid1:OPN | Mid1:OPN | 0.007 | 143 | No | 0 |
| Replacement Fire | Mid1:OPN | Early1:ALL | 0.007 | 143 | Yes | 0 |
| Surface Fire | Mid1:OPN | Mid1:OPN | 0.2 | 5 | No | 0 |
| Wind or Weather or Stress | Mid1:CLS | Mid1:OPN | 0.007 | 143 | Yes | 0 |
| Replacement Fire | Mid1:CLS | Early1:ALL | 0.01 | 100 | Yes | 0 |
| Mixed Fire | Mid1:CLS | Mid1:OPN | 0.07 | 14 | Yes | 0 |
| Surface Fire | Mid1:CLS | Mid1:CLS | 0.1 | 10 | No | 0 |
| Alternative Succession | Late1:OPN | Late1:CLS | 1 | 1 | Yes | 20 |
| Wind or Weather or Stress | Late1:OPN | Late1:OPN | 0.007 | 143 | No | 0 |
| Replacement Fire | Late1:OPN | Early1:ALL | 0.007 | 143 | Yes | 0 |
| Surface Fire | Late1:OPN | Late1:OPN | 0.2 | 5 | No | 0 |
| Wind or Weather or Stress | Late1:CLS | Late1:OPN | 0.007 | 143 | Yes | 0 |
| Replacement Fire | Late1:CLS | Early1:ALL | 0.007 | 143 | Yes | 0 |
| Mixed Fire | Late1:CLS | Late1:OPN | 0.02 | 50 | Yes | 0 |
| Surface Fire | Late1:CLS | Late1:CLS | 0.15 | 7 | No | 0 |

References

Abolt, R.A. 1999. Site conservation plan for Caddo Black Bayou. Unpublished report. The Nature Conservancy of Louisiana.

Albin, D.R. 1962. Resume of the ground-water resources of Bradley, Calhoun, and Ouachita Counties, Arkansas. Water Resources Summary No.1. Arkansas Geological and Conservation Commission, Little Rock.

Ahles, H.E. and C.R. Bell. 1958. Species new to the flora of North or South Carolina. Rhodora 60: 10-32.

Arkansas Department of Parks and Tourism. 1983. An environmental inventory of White Oaks Lake State Park. 54 pp.

Bormann, F.H. 1956. Ecological implications of changes in photosynthetic response of Pinus taeda seedlings during ontogeny. Ecology 37: 70-74.

Branner, J.C. and F.V. Coville. 1891. A list of the plants of Arkansas. Annual Report for 1888. Arkansas Geological Survey 4: 155-242.

Braun, E.L. 1950. Deciduous forests of eastern North America. Hafner Publishing Co., New York. 596 pp.

Burns, R.M. and E.A. Hebb. 1972. Site preparation and reforestation of droughty, acid sands. USDA Forest Service. Agriculture Handbook 426. 61 pp.

Catlett, V.R. 1973. Soil survey of Ouachita County, Arkansas. USDA Soil Conservation Service. 62 pp.

Clark, R.C. 1971. Woody plants of Alabama. Annals of the Missouri Botanical Garden 58(2): 99-242.

Correll, D.S. and M.C. Johnston. 1970. Manual of vascular plants of Texas. Texas Research Foundation, Renner, TX.

Curtis, J.T. 1959. Vegetation of Wisconsin. University of Wisconsin Press, Madison.

Daubenmire, R. 1968. Plant communities: a textbook of plant synecology. Harper and Row, New York. 300 pp.

Duke, J.A. 1961. The psammophytes of the Carolina fall-line sandhills. Journal of the Elisha Mitchell Science Society 77: 3-25.

Duncan, W.H. 1975. Woody vines of the southeastern US. University of Georgia Press, Athens.

Faust, W.Z. 1976. Vegetation analysis of the Georgia fall-line sandhills. Rhodora 78: 525-531.

Foti, T. 1992. Bluff City sandhillls. Unpublished report to the Arkansas Natural Heritage Commission.

Garren, K.H. 1943. Effects of fire on the vegetation in the southeastern US. Botanical Review 9: 617-654.

Gould, F.W. 1975. Grasses of Texas. Texas A&M University Press, College Station.

Hunter, C.G. 1995. Trees, shrubs, and vines of Arkansas. The Ozark Society Foundation, Little Rock, Arkansas. 207 pp.

Kurz, H. 1942. Florida dunes and scrub vegetation and geology. 18th Annual Report of the Florida Geological Survey. 154 pp.

Laessle, A.M. 1958. Origin and successional relationship of sandhill vegetation and sand pine scrub. Ecological Monographs 28(4).

Logan, J. 1995. Preliminary report: Communities of Nevada and Ouachita Counties. Unpublished report to the Arkansas Natural Heritage Commission.

Logan, J. 1997. A survey of seven sandbarren sites in Nevada and Ouachita Counties. Unpublished report to the Arkansas Natural Heritage Commission.

MacRoberts, B.R., M.H. MacRoberts and J.C. Cathey. 2002. Floristic of xeric sandylands in the post oak savanna region of east Texas. Sida 20: 373-386

McBryde, J.B. 1933. Vegetation and habitat factors of the Carrizo Sands. Ecological Monographs 3(2).

McFarland, J.D. 1998. Stratigraphic summary of Arkansas. State of Arkansas Information Circular 36. Pre Print.

McGinty, D.T. and E.J. Cristy. 1977. Turkey oak ecology on a Georgia sandhill. The American Midland Naturalist 98(2): 248-297.

McGregor, R.L. 1968. The taxonomy of the genus Echinacea (Composite). University of Kansas Scientific Bulletin 48: 113-142.

Monk, C.D. 1968. Successional and environmental relationships of the forest vegetation of north central Florida. American Midland Naturalist 79: 441-457.

Moore, D.M. 1958. New records for the Arkansas flora III. Proceedings of Arkansas Academy of Science. 11: 6-10.

Moore, D.M. 1959. New records for the Arkansas flora IV. Proceedings of Arkansas Academy of Science. 12: 9-16.

NatureServe. 2007. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. Data current as of 10 February 2007.

NatureServe. 2006. International Ecological Classification Standard: Terrestrial Ecological

Classifications. NatureServe Central Databases. Arlington, VA, U.S.A. Data current as of

18 July 2006.

Oosting, H.J. 1942. An ecological analysis of the plant communities of Piedmont, N.C. American Midland Naturalist 28: 1-126.

Osborne, C. 1995. Arkansas oak natural area; Site report. Unpublished report to the Arkansas Natural Heritage Commission.

Palmer, E.J. 1921. The Red River forest at Fulton, Arkansas. Journal of the Arnold Arboretum 4: 8-33.

Palmer, E.J. 1925. Is Quercus arkansana a hybrid? Journal of the Arnold Arboretum 6 (3): 195-200.

Payne, S.J. 1982. Fire in America, a cultural history of wildland and rural fire. Princeton University Press. Princeton, NJ.

Peacock, L.P. 1983. Bluff City sandhills; Site preserve summary. Unpublished report to the Arkansas Natural Heritage Commission.

Pell, B. 1984. Poison Springs state forest; Sandhill woodland areas and pine-hardwood forest. Unpublished report to the Arkansas Natural Heritage Commission.

Quaterman, E. and C. Keever. 1962. Southern Mixed Hardwood Forest: Climax in the southeastern coastal plain, USA Ecological Monographs 32(2): 167-185.

Rettig, J.H. 1982. Bluff City sandhills. Unpublished report to the Arkansas Natural Heritage Commission.

Roberts, J.L. 1978. The sandhills region of south Arkansas. Unpublished report to the Arkansas Natural Heritage Commission.

Roberts, J.L. 1976. Bluff City Sandhills. Unpublished report to the Arkansas Natural Heritage Commission.

Shinners, L.H. 1964. Texas Asclepiadaceae other than Asclepias. SIDA 1: 358-367.

Simon, S., D. Zollner, D. Harkin. 1998. Stewardship plan for Miller County Sandhills Natural Area. Unpublished report. The Nature Conservancy, Arkansas chapter. 16 pp.

Smith, E.B. 1972. Keys to the Compositae of Arkansas. Locally printed. Department of Botany and Bact., University of Arkansas, Fayetteville.

Smith, E.B. 1976. A biosystematic survey of Coreopsis in eastern United States and Canada. SIDA 6: 123-215.

Smith, E.B. 1978. An atlas and annotated list of the vascular plants of Arkansas Department of Botany and Bact. University of Arkansas, Fayetteville.

Spurr, S.H. 1964. Forest Ecology. Ronald Press, New York. 353 pp.

The Nature Conservancy. 1998. International classification of ecological communities: Terrestrial vegetation of the United States, Vol. II. The Nature Conservancy, Arlington, VA.

Tucker, G.E. 1971. Selaginella arenicola ssp. riddellii in Arkansas. SIDA 4: 275.

Tucker, G.E. 1975. Elliott sandhills. Unpublished report to the Arkansas Natural Heritage Commission.

Tucker, G.E. 1976. Miller County sandhills. Unpublished report to the Arkansas Natural Heritage Commission.

Tucker, G.E. 1976. A guide to the woody flora of Arkansas. Unpublished Ph.D. thesis. Department of Botany and Bact. University of Arkansas, Fayetteville.

Tucker, G.E. 1976. Chidester sandhill area. Unpublished report to the Arkansas Natural Heritage Commission.

Tryon, Jr., R.M. 1955. Selaginella rupestris and its allies. Annals of the Missouri Botanical Garden 42(1): 1-97.

USDA Soil Conservation Service. Soil survey of Nevada County, Arkansas. Unpublished report.

Weaver, T.H. III 1969. Gradients in the Carolina fall-line sandhills: environment, vegetation, and comparative ecology of the oaks. Ph.D. dissertation, Duke University, Durham, NC. 104 pp.

Wells, B.W. and Shunk, I.V. 1931. Vegetation and habitat factors of the coarser sands of the North Carolina plain. Ecological Monographs 1(4).

Whittaker, R.H. 1953. A consideration of climax theory: the climax as a population and pattern. Ecological Monographs 23: 41-78.