# Rapid Assessment Reference Condition Model

*The Rapid Assessment is a component of the LANDFIRE project. Reference condition models for the Rapid Assessment were created through a series of expert workshops and a peer-review process in 2004-2005. For more information, please visit www.landfire.gov. Please direct questions to helpdesk@landfire.gov.*

## *Potential Natural Vegetation Group (PNVG):*

**R4OASA** **Oak Savanna**

## *General Information*

**Contributors** *(additional contributors may be listed under "Model Evolution and Comments")*


| Modelers | | Reviewers | |
|---|---|---|---|
| David McKenzie | dmckenzie@mail.unomaha.edu | John Ortmann | jortmann@tnc.org |
| Willis C. Schaupp, Jr. | bschaupp@fs.fed.us | Daryl Smith | daryl.smith@uni.edu |
| John Pearson | john.pearson@dnr.state.ia.us | George Hartman | George.hartman@mdc.mo.gov |


**Vegetation Type**

Grassland

**Dominant Species***

QUST ANGE
QUMAD SCHIZ4
QUAL
ANDRO2

**General Model Sources**

- [x] Literature
- [x] Local Data
- [x] Expert Estimate

**LANDFIRE Mapping Zones**

44 38
43
42

**Rapid Assessment Model Zones**

- [ ] California
- [ ] Great Basin
- [ ] Great Lakes
- [ ] Northeast
- [x] Northern Plains
- [ ] N-Cent.Rockies
- [ ] Pacific Northwest
- [ ] South Central
- [ ] Southeast
- [ ] S. Appalachians
- [ ] Southwest

### Geographic Range

Nuzzo(1986 estimated that some 27 to 32 million acres of oak savanna occurred in the Midwest at the time of European settlement extending from southern Texas northward through Missouri into Wisconsin and Minnesota. Nelson (1987) indicated that perhaps 13 million acres of savanna occurred in Missouri prior to settlement. This number was extrapolated based on interpretations using the extent of prairie cover and descriptions of historic barrens, oak openings and other open woodlands in which grasses dominated the ground cover. The current estimate of six and one half million acres is a relative interpretation excluding presettlement prairie and other natural communities associated with rougher dissected hills. This revised estimate now discounts open woodlands that fall into the woodland natural community descriptions. The estimate is now restricted to the probability of savannas associated with prairie regions and relatively level upland plains.

### Biophysical Site Description

Savannas are grasslands interspersed with open-grown scattered trees, groupings of trees of various age, and shrubs. These take on the appearance of widely spaced, orchard-like groves or standing individual trees. They are distinguished from woodlands in that savannas are strongly associated with large prairies on nearly level to dissected plains and are generally dominated by prairie grasses and forbs. The tree canopy cover is generally less than 30 percent but can exceed 75 percent in local areas. Shrub thickets to mature forest occur, especially on the northeast-trending lee side of hills or in upland drainages where fire was less frequent or less intense. Savannas are species-rich natural communities, with most diversity found in the understory layer. While no endemic species are presently known to occur in savannas, Packard and Mutel (1997) indicated that oak savanna possesses a distinct herbaceous community characterized by species adapted to frequent large-scale disturbances. Oak Savanna topography is associated with gently rolling

*Dominant and Indicator Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.

plains underlain by Pennsylvanian limestone and sandstone in the unglaciated Osage Plains and the Central Dissected Till Plains sections. However, savannas may occur anywhere upland topography is gently rolling to level, regardless of geologic substrate. Their strongest affinity is to gently rolling plains where prairie occur. Savanna-like areas can also occur on steep slopes in the Loess Hills of Western Iowa in the absence of fire.

## Vegetation Description

In general, three primary vegetation associations dominated savanna natural communities. In the Central Dissected Till Plains Section, bur oak groves (Quercus marcrocarpa) once dominated dry to dry-mesic prairie areas underlain by glacial till soils. Chinquapin oak (Q. muhlenbergii) co-dominated on the driest, steepest loess hills of Springfield Plain and Central Plateau subsections, especially along the Interstate 44 and Highway 63 (Rolla to Thayer) corridors. In the Springfield Plain Subsection, chinquapin oak and post oak often share dominance where associated with limestone/dolomite bedrock. Rock outcrops on prairies or on rugged, hilly terrain dominated by shrubs such as wild crab (Malus ioensis), hawthorn (Crataegus species), rough-leaved dogwood (Cornus drummondii) and winged sumac (Rhus copallina) are often savanna-like in character, but are primarily considered part of the prairie natural community. Moisture modifiers are limited to the primary moisture regime associated with loess and glacial till soils only. Nearly all rock substrate savannas are dry-mesic with inclusions of dry soils, while those found on the deeper soils of glacial till or loess are both mesic and dry-mesic. However, because so little is known about the historic distribution of savanna types developed on bedrock and residuum soils, and distinctions between dry and dry-mesic soils, savannas are named for the primary bedrock substrate only. No wet-mesic or wet savannas are known because either few extant examples remain, or these are too small to function as savannas. Sand savannas are named for the wind or alluvial-deposited sandy soils of terraces or elevated ridges and summits. They are especially characteristic of the Mississippi River Alluvial Basin Section. The typical sand savanna has no moisture modifier because of the difficulty in distinguishing between their dry to dry-mesic soils, and owing to the topographic irregularities of the landscape. Dominant vegetation is listed as big bluestem (Andropogon gerardii),
little bluestem (Schizachyrium scoparium), switchgrass (Panicum
virgatum), and Indiangrass (Sorghastrum nutans).

Six savanna natural communities are described based on differences in soil moisture and rock/parent material substrate:
Dry-mesic loess/glacial till savanna
Mesic loess/glacial till savanna
Limestone/dolomite savanna
Chert savanna
Sandstone/shale savanna
Sand savanna

## Disturbance Description

Many oak species are adapted to the frequent, low to moderate intensity fires with the capability of resprouting. Curtis (1959) described brush prairie remnants at Wisconsin savanna sites that burned annually more than 100 years with no observed reduction in the number of oak grubs. Grubs refer to oak (and other species) sprouts killed back by repeated fires and forming large root balls. The presence of these oak grubs account for the rapid degrading of savanna to landscapes overgrown with woody thickets following heavy grazing and the cessation of fire (Schroeder 1981). Savannas, prairies, glades and open woodlands -- all are direct reflections and inextricably linked to natural or man-caused fires, and relicts of once common grazing by American bison (Bison bison). In addition, browsing by American elk (Cervus elaphus) and white-tailed

deer (Odocoileus virginianus) influenced the vegetation. Large expanses of level to nearly level landscape coupled with frequent fire and grazing by native herbivores will eventually lead to either prairie or savanna. Though grazing was a natural disturbance, questions remain as to the scale grazing would have altered vegetation. Significant impacts on vegetal dynamics caused by insects and plant diseases are likely associated with periods of stress caused by prolonged drought.

### Adjacency or Identification Concerns

This oak savanna PNVG is located between and intergrades into two adjacent PNVGs in this model zone as follows: oak woodland (R4OKHK) and southern tallgrass prairie east (R4PRTGse).

### Scale Description

**Sources of Scale Data** ☐ Literature ☐ Local Data ☑ Expert Estimate

Minimum patch size 1000-2000 acres, maximum 20,000 acres.

### Issues/Problems

The causative factors that eventually led to mass degradation, and in some regions total extirpation, of Missouri savannas include suppression of historic natural or anthropogenic fires, replacement of natural herbivory by domestic livestock grazing, logging, conversion to cropland and seeding to cool-season exotic grasses. Because most former savannas, like their associated prairie natural communities, were highly productive in terms of forage (or palatable vegetation), these served as the primary foraging sites for domestic livestock that were allowed to range freely during early settlement. The richest savanna soils, especially in northern Missouri, were rapidly converted to cropland or intensively grazed. In the absence of fire, many oak savanna systems have succeeded to closed canopy forest co-dominated by mixed fire sensitive species. These conditions discriminate against oak regeneration. The average FI for replacement fires modeled at 44 years although research by Guyette indicates the replacement fire interval is closer to 200-250 years.

### Model Evolution and Comments

Modeler 4: Robert Cain, rjcain@fs.fed us. This PNVG is a modified version of the PNVG "Oak Savanna" ( R5OASA) created by McRee Anderson for the South Central modeling zone. Additional Reviewer: Jim Drake jim_drake@natureserve.org

## Succession Classes

*Succession classes are the equivalent of "Vegetation Fuel Classes" as defined in the Interagency FRCC Guidebook (www.frcc.gov).*

### *Class A* 20 %

Early1 All Structures

**Description**

The early seral open stage is recently burned with a herbaceous species response. Most of the shrubs and oak grubs are top killed by replacement fire and mixed severity fires. However, herbaceous species and oak grubs will resprout and not all are killed by fire. Surface fire interval averages 3 years. Average fire return interval is modeled at 2.3 years for this class. The minimum canopy closure is listed at 5%

**Indicator Species* and Canopy Position**

SCHIZ4 Upper
ANGE Upper
ANDRO2 Upper

**Upper Layer Lifeform**

☑ Herbaceous
☐ Shrub
☐ Tree

**Fuel Model** 2

**Structure Data (for upper layer lifeform)**

| | Min | Max |
|---|---|---|
| *Cover* | 5 % | 100 % |
| *Height* | no data | Herb Medium 0.5-0.9m |
| *Tree Size Class* | Seedling <4.5ft | |

☐ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

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because immediately after fire most if not all of the canopy in the grassland will have burned off. 100% is the canopy cover following one growing season without fire.

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### *Class B* 2%

Mid1 Closed

**Description**

The mid seral closed stage consists of areas that have not had a recent surface fire. Replacement fire return interval = 20 years; mixed fire return interval = 10 years. As a result, oak grubs have resprouted into medium sized shrubs and pole sized trees. Herbaceous species are present in the ground cover but limited throughout this stage due to the reduced amount of light reaching the surface.

**Indicator Species* and Canopy Position**

ANDRO2 Lower
ANGE Lower
QUERC Upper
QUMA2 Upper

**Upper Layer Lifeform**

- ☐ Herbaceous
- ☑ Shrub
- ☐ Tree

**Fuel Model** 9

**Structure Data (for upper layer lifeform)**

| | Min | Max |
|---|---|---|
| *Cover* | 30 % | 50 % |
| *Height* | Shrub Dwarf <0.5m | Shrub Tall >3.0 m |
| *Tree Size Class* | Pole 5-9" DBH | |

☑ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

The graminoids are the dominant life form although the oaks make the upper layer. Canopy of grasses will be close to 100 percent depending on heterogeneity of landscape.

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### *Class C* 45%

Mid1 Open

**Description**

The mid seral open stage consists of areas of the landscape that has recently burned. Due to periodic surface fires (average 3 year FRI) some of the oak grub sprouts and shrubs have been top killed resulting in more light reaching the surface propagating the spread of a variety of herbaceous species. Overstory is an intermix of shrubs and pole sized oaks that have not been recently top killed. Average replacement fire return interval = 30 years.

**Indicator Species* and Canopy Position**

QUMA2 Upper
QUERC Upper
ANGE Lower
ANDRO2 Lower

**Upper Layer Lifeform**

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

**Fuel Model** 3

**Structure Data (for upper layer lifeform)**

| | Min | Max |
|---|---|---|
| *Cover* | 5 % | 30 % |
| *Height* | Tree Short 5-9m | Tree Medium 10-24m |
| *Tree Size Class* | Pole 5-9" DBH | |

☐ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

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### *Class D* 30 %

Late1 Open

**Description**

The late open seral stage represents the oak savanna community type. Due to a 5 year surface fire interval the Oak grub sprouts and shrubs have been top killed. Replacement fire return interval = 250 years; mixed fire interval = 10 years. Tall mature oaks with spreading branches are scattered in a park-like setting with an open canopy allowing light to reach the surface propagating the spread of a variety of herbaceous species.

**Indicator Species* and Canopy Position**

| | |
|---|---|
| QUST | Upper |
| QUERC | Upper |
| ANGE | Lower |
| ANDRO2 | Lower |

**Upper Layer Lifeform**

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

**Fuel Model** 3

**Structure Data (for upper layer lifeform)**

| | Min | Max |
|---|---|---|
| *Cover* | 5 % | 50 % |
| *Height* | Tree Short 5-9m | Tree Medium 10-24m |
| *Tree Size Class* | Large 21-33"DBH | |

☐ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

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### *Class E* 3 %

Late1 Closed

**Description**

The late closed seral stage represents the oak savanna that has not had recent surface fire (FRI = 20 years). Tall mature oaks with spreading branches are scattered throughout this type however, oak grubs and shrubs have sprouted into pole size limiting light reaching the surface and therefore reducing the herbaceous species cover. This stage represents places on the landscape where fire has been excluded for extended periods of time. These areas are co-dominated by fire-sensitive woody species and exhibit a large decrease in the graminoid component of the understory. At this stage the system can be considered persistent closed canopy forest. Fire will not convert this to savanna because only low intensity fires are possible in the leaf litter. The leaf litter will be largely composed of poorly burning leaf litter such as ironwood and hackberry.

**Indicator Species* and Canopy Position**

| | |
|---|---|
| QUST | Upper |
| QUERC | Upper |
| QUMA2 | Upper |
| NVEG | Lower |

**Upper Layer Lifeform**

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

**Fuel Model** 9

**Structure Data (for upper layer lifeform)**

| | Min | Max |
|---|---|---|
| *Cover* | 50 % | 95 % |
| *Height* | Tree Short 5-9m | Tree Medium 10-24m |
| *Tree Size Class* | Large 21-33"DBH | |

☐ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

## Disturbances

**Non-Fire Disturbances Modeled**

- [x] Insects/Disease
- [x] Wind/Weather/Stress
- [x] Native Grazing
- [ ] Competition
- [ ] Other:
- [ ] Other:

**Fire Regime Group:** 1

I: 0-35 year frequency, low and mixed severity
II: 0-35 year frequency, replacement severity
III: 35-200 year frequency, low and mixed severity
IV: 35-200 year frequency, replacement severity
V: 200+ year frequency, replacement severity

**Historical Fire Size (acres)**

Avg: 10000
Min: 1000
Max: 20000

***Fire Intervals (FI):***
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. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class. All values are estimates and not precise.

**Sources of Fire Regime Data**

- [x] Literature
- [x] Local Data
- [x] Expert Estimate

| | Avg FI | Min FI | Max FI | Probability | Percent of All Fires |
|---|---|---|---|---|---|
| *Replacement* | 44 | | | 0.02273 | 7 |
| *Mixed* | 18 | | | 0.05556 | 17 |
| *Surface* | 4 | | | 0.25 | 76 |
| *All Fires* | 3 | | | 0.32828 | |

## References


Adler, P.B., D.A Raff and W.K. Lauenroth. 2001. The effect of grazing on the spatial heterogeneity of vegetation. Oecologia 128:465-479.

Anderson, R.C. 1990. The historic role of fire in North American grasslands. Pp. 8-18 in S.L. Collins and L.L. Wallace (eds.). Fire in North American tallgrass prairies. University of Oklahoma Press, Norman.

Batek, M.J., A.J. Rebertus, W.A. Schroeder, T.L. Haithcoat, E. Compas, and R.P. Guyette. 1999. Reconstruction of early nineteenth-century vegetation and fire regimes in the Missouri Ozarks. Journal of Biogeography 26:397-412.

Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. Ecological systems of the United States: a working classification of U.S. terrestrial systems. NatureServe, Arlington, Virginia.

Fuhlendorf, S.D. and D.M. Engle 2001. Restoring heterogeneity on rangelands; ecosystem management based on evolutionary grazing patterns. BioScience, August 2001/Vol. 51 No. 8

Grazulis, T.P. 2001. Tornado: nature's ultimate windstorm. The University of Oklahoma Press, Norman.

Guyette, R.P. and B.E. Cutter. 1991. Tree-ring analysis of fire history of a post oak savanna in the Missouri Ozarks. Natural Areas Journal 11: 93-99.

Guyette, R.P. and D.C. Dey. 2000. Humans, topography, and wildland fire: the ingredients for long-term patterns in ecosystems. Pp. 28-35 in D.A. Yaussy (ed.). Proceedings of the workshop on fire, people, and the central hardwoods landscape. General Technical Report NE-274. U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. Radnor, Pennsylvania.

Guyette, R.P. and E.A. McGinnes, Jr. 1982. Fire history of an Ozark glade in Missouri. Transactions of the Missouri Academy of Science 16:85-93.

Harlan, J.D., T.A. Nigh and W.A. Schroeder. 2001. The Missouri original General Land Office survey notes project. University of Missouri, Columbia. In progress.

Kimmel, V.L. and G.E. Probasco. 1980. Change in woody cover on limestone glades between 1938 and 1975. Transactions of the Missouri Academy of Science 14:69-74.

Kline, V. 1997. Orchards of oak and a sea of grass. Pp. 3-22 in S. Packard and C. F. Mutel (eds.). 1997. The tallgrass restoration handbook for prairies, savannas, and woodlands. Society for Ecological Restoration. Island Press, Washington, D.C.

Kuchler, A. W. 1964. Manual to accompany the map of potential natural vegetation of the conterminous United States. American Geographical Society. Spec. Publ. No. 36. Lib. Congress Cat. Card Num. 64-15417. 156 p.

Ladd, D. 1991. Reexamination of the role of fire in Missouri oak woodlands. Pp. 67-80 in G.V. Burger, J.E. Ebinger and G.S. Wilhelm (eds.). Proceedings of the oak woods management workshop. Eastern Illinois University, Charleston, Illinois.

Ladd, D. and B. Heumann. 1994. Baseline ecological assessment of selected oak woodlands on the Houston-Rolla District, Mark Twain National Forest. U.S. Forest Service challenge cost share agreement.

McCarty, K. 1998. Landscape-scale restoration in Missouri savannas and woodlands. Restoration and Management Notes 16:22-32.

McCarty, K. and F. Hassien. 1984. Distribution patterns of prairie plant species in a closed-canopy forest situation. Pp. 127-130 in G. Clambey and R. Pemble (eds.). Proceedings of the ninth North American Prairie Conference. The prairie: past, present and future. Tri-college University Center for Environmental Studies, North Dakota State University, Fargo.

Nelson, Paul W. 2005 The Terrestrial Natural Communities of Missouri. Missouri Natural Areas Committee (in press).

Nelson, P.W. and D. Ladd 1983. Preliminary report on the identification, distribution, and classification of Missouri glades. Pp. 59-76 in C.L. Kucera (ed.). Proceedings of the seventh North American Prairie Conference. Southwest Missouri State University, Springfield, Missouri.

Nigh, T.A. 1992. The forests prior to European settlement. Pp. 6-13 in A.R.P. Journet and H.G. Spratt, Jr. (eds.). Towards a vision for Missouri public forests: proceedings of a conference at Southeast Missouri State University, Cape Girardeau, Missouri.

Ozarks Ecoregional Assessment Team. 2003. Ozarks Ecoregional Conservation Assessment. The Nature Conservancy, Midwestern Resource Office. Minneapolis, Minnesota.

Packard, S. and C.F. Mutel (eds.). 1997. The tallgrass restoration handbook for prairies, savannas, and woodlands. Society for Ecological Restoration. Island Press, Washington, D.C.

Rebertus, A.J., S.R. Shifley, R.H. Richards and L.M. Roovers. 1997. Ice storm damage to an old-growth oak-hickory forest in Missouri. American Midland Naturalist 137:48-61.

Rebertus, A.J. and A.J. Meier. 2001. Blowdown dynamics in oak-hickory forests of the Missouri Ozarks. Journal of the Torrey Botanical Society 128(4):362-369.

Runkle, J.R. 1985. Disturbance regimes in temperate forests. Pp. 17-33 in S.T.A. Pickett and P.S. White (eds.). The ecology of natural disturbance and patch dynamics. Academic Press, New York.

Schoolcraft, H.R. 1821. Journal of a tour into the interior of Missouri and Arkansas from Potosi, or Mine a Burton, in Missouri territory, in a southwest direction, toward the Rocky Mountains: performed in the years 1818 and 1819. Richard Phillips and Company, London.

Taft, J. 1997. Savanna and open woodland communities. Pp. 24-54 in M. Schwartz (ed.). Conservation in highly fragmented landscapes. Chapman and Hall, New York.

U.S. Department of Agriculture, Forest Service. 1999. Ozark-Ouachita highlands assessment: terrestrial vegetation and wildlife. Report 5 of 5. General Technical Report SRS-35. U.S. Department of Agriculture, Forest Service, Southern Research Station. Asheville, North Carolina.