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):

R6NOKS **Northern Oak Savanna**

General Information

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

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Vegetation Type

Woodland

Dominant Species*

QUAL	CORYL
QUMA2	SCHIZ4
QUVE	SONU2
ANGE	

General Model Sources

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

LANDFIRE Mapping Zones

41	51
49	52
50	

Rapid Assessment Model Zones

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

Geographic Range

Northern oak savanna occurs in a complex, shifting mosaic with oak woodlands, barrens and prairies in the upper Midwest. This type occurs in southern Lower Michigan, northwestern Ohio, northern Indiana, northeastern Illinois, southern Wisconsin, and southeastern to northwestern Minnesota. This savanna/woodland/prairie type historically occurred as an ecotone between mesic hardwood forest and tallgrass prairie.

Biophysical Site Description

Northern oak savanna occurs primarily on level to rolling topography of glacial outwash plains, coarse-textured end moraines, and steep ice-contact features (Chapman 1984, Albert 1995, Cohen 2001, Michigan Natural Features Inventory 2003, Cohen 2004, NatureServe 2004). Soils are well-drained, moderately-fertile sands, loamy sands, sandy loams, and loams with medium-acid to neutral pH (5.6 to 7.3) and low water retaining capacity (Chapman 1984, Michigan Natural Features Inventory 2003, NatureServe 2004). In general, oak savannas are most prevalent on the western side of major firebreaks such as rivers (Curtis 1959, Grimm 1984, Leitner et al. 1991). In the 1800s, oak savanna communities covered some 11 to 13 million ha (27 to 32 million ac) of the Midwest (Nuzzo 1986).

Vegetation Description

Today, northern oak savanna in the upper Midwest is limited to small, degraded remnants. As a result, little is known about the original composition and vegetative patterning of these systems (Leach and Givnish 1999). Information in this section is derived from historical accounts, early plant collections, and extrapolation based on remnants within Midwestern states. The oak openings were described by Michigan settlers as park-like savanna of widely spaced mature oaks with a wide range of shrub cover above the forb and graminoid ground layer (Stout 1946, Cottam 1949, Peters 1970, Chapman 1984). The community was composed of broad-crowned, scattered oaks with a graminoid ground layer composed of species associated with both prairie and forest communities.

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

The canopy layer generally varied from 10 to 60% cover (NatureServe 2004) and was dominated by Quercus alba (white oak) with co-dominants including Q. macrocarpa (bur oak), Q. muehlenbergii (chinkapin oak), Q. velutina (black oak), and Q. coccinea (scarlet oak) (Lanman 1871, Beal 1904, Cottam 1949, Chapman 1984, NatureServe 2004). White oak, black oak, and bur oak with their thick bark, deep roots, and resprouting abilities are the most fire-resistant of the oaks. In addition, expansive root systems that can extend down several meters and branch extensively laterally allow these oaks to withstand extreme drought stress (Albertson and Weaver 1945, Abrams 1992, Faber-Langendoen and Tester 1993). These species of oak are long-lived, often remaining as canopy dominants for 200-300 years (Cottam 1949). Important canopy associates include Carya glabra (pignut hickory), Carya ovata (shagbark hickory), Quercus rubra (red oak), and Quercus velutina (black oak) (NatureServe 2004). Oaks, especially black oak, are dispersed in the understory as fire-suppressed grubs which reach just over a meter tall (Peters 1970, Brewer and Kitler 1989, Bowles and McBride 1998, Anderson and Bowles 1999). Shrubs occur scattered or clumped in the understory, ranging widely in cover from 0 to 50% depending on fire frequency (Pruka and Faber-Langendoen 1995). The most common shrubs are fire-tolerant species such as Corylus americana (American hazelnut), Ceanothus americanus (New Jersey tea), and Amorpha canescens (lead-plant, state special concern) (Veatch 1927, Cottam 1949, Bader 2001, NatureServe 2004). Shrubs such as Cornus foemina (gray dogwood), Prunus americana (wild plum), and Rhus glabra (smooth sumac) occasionally form thickets in fire-protected microsites (Kline 1997a, Bader 2001, NatureServe2004).

The predominantly graminoid ground layer is composed of species associated with both prairie and forest communities. For a given oak savanna, the proportion of forbs to graminoids was likely a function of light availability and soil texture with graminoids increasing with sand and solar irradiance and forb coverage increasing with silt content and shade (Leach and Givnish 1999). Grasses, which provided the primary source of fine fuel for annual fires, reached heights of over a meter in areas of high light intensity (Anderson 1991a). Common grass species included Andropogon gerardii (big bluestem), Schizachyrium scoparium (little bluestem), and Sorghastrum nutans (Indian grass). Prevalent forbs included Amphicarpea bracteata (hog peanut), Anemone cylindrica (thimbleweed), Asclepias purpurascens (purple milkweed, state special concern), Asclepias tuberosa (butterfly-weed), Aster laevis (smooth aster), Aster pilosus (frost aster), Coreopsis palmata (prairie coreopsis, state threatened), Desmodium canadense (showy tick-trefoil), Eupatorium sessilifolium (upland boneset, state threatened), Erigeron strigosus (daisy fleabane), Euphoribia corollata (flowering spurge), Galium boreale (northern bedstraw), Gentiana flavida (white gentian, state endangered), Kuhnia eupatorioides (false boneset, state special concern), Lathyrus venosus (veiny pea), Lespedeza capitata (bush-clover), Lespedeza hirta (bush-clover), Monarda fistulosa (wild-bergamot), Pycnanthemum virginianum (mountain mint), Rudbeckia hirta (black-eyed Susan), Silene stellata (starry campion, state threatened), Solidago juncea (early goldenrod), Taenidia integrima (yellow pimpernel), Triosteum perfoliatum (horse-gentian, feverwort), Veronicastrum virginicum (Culver's root), and Zizia aurea (golden alexanders). (List compiled from Curtis 1959, Bray 1960, Chapman 1984, Packard 1988, Leach and Ross 1995, Pruka 1995, Bader 2001, NatureServe 2004.)

In the absence of fire, woody sprouts from persistent oak grubs and other woody rootstocks, as well as new seedlings, soon convert savannas to closed hardwood forest (Curtis 1959). Today oak savannas—and true prairies—are among the rarest communities in the Lake States.

Disturbance Description

Cottam (1949) and Curtis (1959) suggested that oak savannas originated when prairie fires spread into surrounding closed oak forest with enough intensity to create open canopy conditions (also see Anderson and Brown 1986, Anderson and Bowles 1999). Other researchers have proposed that savannas also originated following invasion of prairie by oaks during prolonged lulls in annual fire regimes (Grimm 1984,

Anderson and Bowles 1999). Repeated low-intensity fires working in concert with drought and windthrow then maintained these savannas (Stout 1946, Curtis 1959, Faber-Langendoen and Tester 1993). Within dry-mesic savanna systems, such as oak openings, it is likely that annual or nearly annual fire disturbance was the primary abiotic factor influencing savanna structure and composition. Fires prevented canopy closure and the dominance of woody vegetation (Leitner et al. 1991). Presently, the prevalent catalyst of fires is lightning strike, but historically, Native Americans played an integral role in the fire regime, accidentally and/or intentionally setting fire to prairie and savanna ecosystems (Day 1953, Chapman 1984, Grimm 1984, Dorney and Dorney 1989, Bowles and McBride 1998, Anderson and Bowles 1999). Where large-scale herbivores (i.e., elk and bison) were abundant, grazing may have helped inhibit the succession of oak savanna to woodland (McClain et al. 1993, Ritchie et al. 1998).

The character of oak savannas can differ dramatically, primarily as the result of varying fire intensity and frequency, which are influenced by climatic conditions, soil texture, topography, size of physiographic and vegetative units, and landscape context (i.e., proximity to water bodies and fire-resistant and fire-conducive plant communities) (Grimm 1984, Bowles et al. 1994, Chapman et al. 1995, Anderson and Bowles 1999). Historically, fire regimes were also influenced by the number and distribution of indigenous peoples (Chapman 1984). Infrequent, high-intensity fires may kill mature oaks and produce savannas covered by abundant scrubby oak sprouts. Park-like openings with widely spaced trees and an open graminoid/forb understory are maintained by frequent, low-intensity fires, which occur often enough to restrict maturation of oak seedlings and encroachment by other woody species (Chapman et al. 1995, Faber-Langendoen and Davis 1995, Peterson and Reich 2001).

Adjacency or Identification Concerns

The northern oak savanna type includes several matrix communities such as mesic and dry-mesic oak openings, dry oak barrens, mixed oak and oak-hickory woodlands, and a variety of small and large patch prairie types. This type includes the following ecological systems: North-Central Interior Oak Savanna (CES202.698) and North-Central Oak Barrens (CES202.727).

Scale Description

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

The expected fire regimes for this type are I (frequent ground fires) and III (mixed severity). The ground fire was the more commonly occurring fire disturbance, but when dry conditions combined with dense stand conditions, a mixed-severity fire could result, with the fire crowning into the canopy where fuel ladders were present. The scale of these fires is thought to occur on tens of thousands of acres.

Issues/Problems

This type covers a broad geographic range and encompasses a variety of savanna, barrens, woodlands and prairie types that may have experienced different surface fire return intervals ranging from one to five years. Historical fire size is unknown but historical accounts indicate that vast acreages burned within a single fire event.

Model Evolution and Comments

Michael Kost, Wm. Patrick Fowler, Joshua Cohen

Succession Classes

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

Class A 5%

Early1 All Structures

Description

Prairie grasses and forbs dominate open grassland with scattered oak grubs and clumps of shrubs.

Indicator Species* and Canopy Position

ANGE	Upper
SCHIZ4	Upper
SONUS	Upper
QUAL	Upper

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Fuel Model 1

Structure Data (for upper layer lifeform)

	Min	Max
Cover	50 %	100 %
Height	Herb Short <0.5m	Herb Tall > 1m
Tree Size Class	Seedling <4.5ft	

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

Class B 15%

Mid1 Open

Description

Scattered young oak trees and clumps of shrubs occur within a matrix of prairie grasses and forbs.

Indicator Species* and Canopy Position

QUAL	Upper
QUMA2	Upper
ANGE	Lower
SCHIZ4	Lower

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 1

Structure Data (for upper layer lifeform)

	Min	Max
Cover	10 %	60 %
Height	Tree Short 5-9m	Tree Medium 10-24m
Tree Size Class	Medium 9-21"DBH	

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

Class C 5%

Mid1 Closed

Description

Class C is a closed-canopy oak-dominated woodland with high stem density. These oak groves occupy areas of the landscape that frequently escape fire due to topographic position.

Indicator Species* and Canopy Position

QUAL	Upper
QUMA2	Upper
QUVE	All
CORYL	Low-Mid

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model no data

Structure Data (for upper layer lifeform)

	Min	Max
Cover	61 %	100 %
Height	Tree Short 5-9m	Tree Medium 10-24m
Tree Size Class	Medium 9-21"DBH	

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

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

Class D 70 %

Late1 Open

Description

This is a system of widely-scattered, large-diameter oaks and shrub clumps within a matrix of prairie grasses and forbs.

Indicator Species* and Canopy Position

QUAL	Upper
QUMA2	Upper
QUVE	Upper
CORL	Low-Mid

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 1

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	10 %	60 %
Height	Tree Short 5-9m	Tree Medium 10-24m
Tree Size Class	Very Large >33"DBH	

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

Class E 5 %

Late1 Closed

Description

This is a closed-canopy oak-dominated forest with scattered hickories. These oak groves occupy areas of the landscape that frequently escape fire due to topographic position.

Indicator Species* and Canopy Position

QUAL	Upper
QUMA2	Upper
QUVE	Upper
CAGL8	Upper

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model no data

Structure Data (for upper layer lifeform)

	Min	*Max*
Cover	61 %	100 %
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

- ☐ Insects/Disease
- ☑ Wind/Weather/Stress
- ☐ 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: 100000
Min: 50
Max: 500000

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

- ☐ Literature
- ☐ Local Data
- ☑ Expert Estimate

	Avg FI	*Min FI*	*Max FI*	*Probability*	*Percent of All Fires*
Replacement	110	50	500	0.00909	4
Mixed	50	15	150	0.02	9
Surface	5	1	20	0.2	87
All Fires	4			0.22909	

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

References

Abrams, M.D., 1992. Fire and the development of oak forests. BioScience 42(5): 346-353.

Abrams, M.D. and G.J. Nowacki, 1992. Historical variation in fire, oak recruitment, and post-logging accelerated succesion in central Pennsylvania. Bulletin of the Torrey Botanical Club. 119: 19-28.

Albert, D.A., 1995. Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: A working map and classification. Gen. Tech. Rep. NC-178. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. Northern Prairie Wildlife Research Center Home Page. Http://www.npwrc.usgs.gov/resource/1998/rlandscp/rlandscp.htm. (Version 03JUN98.) 250 pp.

Albertson, F.W., and J.E. Weaver, 1945. Injury and death or recovery of trees in prairie climate. Ecological Monographs 15(4): 393-433.

Anderson, R.C., 1991. Illinois prairies: A historical perspective. Symposium Proceedings: Our Living Heritage. Pp. 384-391.

Anderson, R.C., and L.E. Brown, 1986. Stability and instability in plant communities following fire. American Journal of Botany 73(3): 364-368.

Anderson, R.C., and M.L. Bowles, 1999. Deep-soil savannas and barrens of the Midwestern United States. Pp. 155-170 in R.C. Anderson, J.S. Fralish, and J.M. Baskin, eds., Savannas, Barrens, and Rock Outcrop Plant Communities of North America. Cambridge, United Kingdom.

Bader, B.J., 2001. Developing a species list for oak savanna/oak woodland restoration at the University of Wisconsin-Madison Arboretum. Ecological Restoration 19(4): 242-250.

Beal, W.J., 1904. Some of the changes now taking place in a forest of oak openings. Papers of the Michigan Academy of Science 4: 107-108.

Bowles, M.L., and J.L. McBride, 1998. Vegetation composition, structure, and chronological change in a decadent midwestern North American savanna remnant. Natural Areas Journal 18(1): 14-27.

Bray, J.R., 1960. The composition of savanna vegetation in Wisconsin. Ecology 41(4): 721-732.

Brewer, R., and S. Kitler, 1989. Tree distribution in southwestern Michigan bur oak openings. Michigan Botanist 28: 73-79.

Chapman, K.A., 1984. An ecological investigation of native grassland in Southern Lower Michigan. M.A. thesis, Western Michigan University. 235 pp.

Chapman, K.A., M.A. White, M.R. Huffman, and D. Faber-Langendoen, 1995. Ecology and stewardship guidelines for oak barrens landscapes in the upper Midwest. Pp. 1-29 in F.

Stearns and K. Holland, eds., Proceedings of the Midwest Oak Savanna Conference, 1993. U.S. Environmental Protection Agency, Internet Publications. Available: http://www.epa.gov/glnpo/oak/oak93/chapman.html. (Accessed: September 21, 2000.)

Cohen, J.G., 2001. Natural community abstract for oak openings. Michigan Natural Features Inventory, Lansing, MI. Pp.

Cohen, J.G., 2004a. Natural community abstract for oak openings. Michigan Natural Features Inventory, Lansing, MI. 9 pp

Cohen, J.G., 2004a. Natural community abstract for bur oak plains. Michigan Natural Features Inventory, Lansing, MI. 13 pp.

Cottam, G., 1949. The phytosociology of an oak woods in southwestern Wisconsin. Ecology 30(3): 271-287.

Curtis, J.T., 1959. Vegetation of Wisconsin: An Ordination of Plant Communities. University of Wisconsin Press, Madison, WI. 657 pp.

Day, G.M., 1953. The Indian as an ecological factor in the northeastern forest. Ecology 34(2): 329-346.

Dorney, C.H., and J.R. Dorney, 1989. An unusual oak savanna in northeastern Wisconsin: The effects of Indian-caused fire. American Midland Naturalist 122(1): 103-113.

Faber-Langendoen, D., 1993. A proposed classification for savannas in the Midwest. Background paper for the Midwest Oak Savanna Conference, 1993. 18 pp.

Faber-Langendoen, D., and M.A. Davis, 1995. Effects of fire frequency on tree canopy cover at Allison Savanna, east-central Minnesota, USA. Natural Areas Journal 15(4): 319-328.

Faber-Langendoen, D., and J.R. Tester, 1993. Oak mortality in sand savannas following drought in east-central Minnesota. Bulletin of the Torrey Botanical Club 120 (3): 248-256.

Grimm, E.C., 1984. Fire and other factors controlling the Big Woods vegetation of Minnesota in the mid-nineteenth century. Ecological Monographs 54(3): 291-311.

Kline, V.M., 1997. Orchards of oak and a sea of grass. Pp. 3-21 in S. Packard and C.F. Mutel, eds., The Tallgrass Restoration Handbook. Island Press, Washington, D.C.

Kost, M.A., 2004. Natural community abstract for woodland prairie. Michigan Natural Features Inventory, Lansing, MI. 8 pp

Lanman, C., 1871. The Red Book of Michigan: Civil, Military and Biographical History. E.B. Smith & Company, Detroit, MI.

Leach, M.K., and L. Ross, 1995. Midwest oak ecosystems recovery plan: A call to action. 111 pp.

Leach, M.K., and T.J. Givnish, 1999. Gradients in the composition, structure, and diversity of remnant oak savannas in southern Wisconsin. Ecological Monographs 69(3): 353-374.

Leitner, L.A., C.P. Dunn, G.R. Guntenspergen, F. Stearns, and D.M. Sharpe, 1991. Effects of site, landscape features, and fire regime on vegetation patterns in presettlement southern Wisconsin. Landscape Ecology 5(4): 203-217.

McClain, W.E., M.A. Jenkins, S.E. Jenkins, and J.E. Ebinger, 1993. Changes in the woody vegetation of a bur oak savanna remnant in central Illinois. Natural Areas Journal 13(2): 108-114.

Michigan Natural Features Inventory, 2003. Draft description of Michigan natural community types. (Unpublished manuscript revised March 4, 2003.) Michigan Natural Features Inventory, Lansing, MI. 36 pp. Available: http://www.msue.msu.edu/mnfi/lists/natural_community_types.pdf.
NatureServe, 2004. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.0. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: September11, 2004.)

Nuzzo, V., 1986. Extent and status of Midwest oak savanna: Presettlement and 1985. Natural Areas Journal 6(2): 6-36.

Packard, S., 1988. Just a few oddball species: Restoration and the rediscovery of the tallgrass savanna. Restoration and Management Notes 6(1): 13-21.

Peters, B.C., 1970. Pioneer evaluation of the Kalamazoo County landscape. Michigan Academician 3(2): 15-25.

Peterson, D.W., and P.B. Reich, 2001. Prescribed fire in oak savanna: Fire frequency effects on stand structure and dynamics. Ecological Applications 11(3): 914-927.

Pruka, B., 1995. Lists indicate recoverable oak savannas and oak woodlands in southern Wisconsin. Restoration and Management Notes 13(1): 124-126.

Pruka, B., and D. Faber-Langendoen, 1995. Midwest oak ecosystem recovery plan: A call to action. Proceedings of the 1995 Midwest Oak Savanna and Woodland Ecosystem Conferences. Available http://www.epa.gov/glnpo/ecopage/upland/oak/oak95/app-b.htm. (Accessed: January 19, 2004.)

Ritchie, M.E., D. Tilman, and J.M.H Knops, 1998. Herbivore effects on plant and nitrogen dynamics in oak savanna. Ecology 79(1) 165-177.

Stout, A.B., 1946. The bur oak openings of southern Wisconsin. Transactions of the Wisconsin Academy of Science, Arts and Letters 36: 141-161.