

## **Ecological site F120CY002IN Fragipan Uplands**

Accessed: 05/19/2024

---

### **General information**

**Provisional.** A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

### **MLRA notes**

Major Land Resource Area (MLRA): 120C—Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northeastern Part

120C—Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northeastern Part

This area is entirely in Indiana and makes up about 1,050 square miles (2,725 square kilometers).

**Physiography:** This area is in the Highland Rim Section of the Interior Low Plateaus Province of the Interior Plains. Both large and small tributaries of the Ohio River and the East Fork of the White River dissect the nearly level to very steep uplands in the area. The major streams and rivers have well defined valleys with broad flood plains and numerous stream terraces. The flood plains along the smaller streams are narrow. Summits are narrow and are nearly level to gently sloping.

**Geology:** The geologic materials in this area are of Early and Middle Pennsylvanian and Late Mississippian age. The rocks consist mainly of flat-lying, interbedded sandstone, shale, coal, and siltstone with minor areas of limestone. Bedrock outcrops are common on the bluffs along the Ohio River and its major tributaries. The surficial geologic materials consist mainly of a layer of loess, typically less than 3.5 feet (1 meter) thick, on the less eroded parts of the landscape and stratified sediments of Pleistocene age along the Ohio River and its tributaries. Unconsolidated alluvium is deposited in the river valleys.

**Soils:** The dominant soil orders in this MLRA are Alfisols, Ultisols, and Inceptisols. The soils in the area have a mesic soil temperature regime, an udic or aquic soil moisture regime, and dominantly mixed mineralogy. They formed dominantly in loess and in residuum derived from siltstone and shale. They range from moderately deep to very deep and from somewhat poorly drained to well drained and are loamy, silty, or clayey. Fragiudults (Spickert and Tilsit series) and Hapludults (Wrays series) are the dominant soils on ridgetops and the upper parts of hills and knobs. Halpudalfs (Kurtz series), Hapludults (Gilwood and Gnowbone series), and Dystrudepts (Brownstown series) are on moderately sloping to very steep side slopes. Hapludalfs (Coolville, Rarden, Stonehead, and Wellrock series) are on the gently sloping to moderately steep lower parts of side slopes. Hapludalfs (Elkinsville series), Fragiudalfs (Pekin series), and Fragiqualfs (Bartle series) are on stream terraces. Dystrudepts (Beanblossom, Cuba, and Steff series) and Endoaquepts (Stendal series) are on flood plains.

### **Classification relationships**

NatureServe Ecological System, Scientific Name: Southern Interior Low Plateau Dry-Mesic Oak Forest, Unique Identifier: CES202.898

### **Ecological site concept**

The communities described in this provisional document reflect those likely to be found and have not been field verified. This PES describes hypotheses based on available data of many different scales and sources and has not been developed utilizing site-specific ecological field monitoring. This PES does not encompass the entire complexity or diversity of these sites. Field studies would be required to develop a comprehensive and science-based native plant restoration plan for these sites.

The hypotheses below were developed utilizing multiple data sources including NatureServe Explorer, VegBank.org data, Plant Communities of the Midwest – Indiana Subset, Indiana DNR, The Nature Conservancy, and Purdue University data for the Hoosier National Forest. (Andriy Vladimirovich Zhalnin and George R. Parker, 2007, Delineation and spatial analysis of ecological classification units for the Hoosier National Forest in Southern Indiana)

State 1, Phase 1.1. white oak (*Q. alba*) – black oak (*Quercus velutina*) / blueberry (*Vaccinium* spp.)- mapleleaf viburnum (*Viburnum acerifolium*) / mayapple (*Podophyllum peltatum*)- licorice bedstraw (*Galium circaezans*).

Dominant trees in this community include white oak, sugar maple, and black oak. Other species present may include northern red oak, scarlet oak, chinquapin oak, chestnut oak, pignut hickory. Minor canopy trees include blackgum, sassafras, red maple and white ash. Subcanopy trees dominant are American beech, sugar maple and red maple.

The herb layer is diverse with a variable composition; however, understory plants on these sites may include nakedflower ticktrefoil (*Desmodium nudiflorum*), dogtooth violet (*Erythronium americanum*), Bosc's panicgrass (*Panicum boscii*), rattlesnake fern (*Botrychium virginianum*), star chickweed (*Stellaria pubera*), and American alumroot (*Heuchera americana*). Species of the *Arisaema* group may be present.

More mesic inclusions may include common blue violet (*Viola sororia*), Impatiens spp., Christmas fern (*Polystichum acrostichoides*) and mayapple (*Podophyllum peltatum*).

State 2, Phase 2.1: Pasture. Plant species dominant: *Schedonorus arundinaceus* (tall fescue). Species present are dependent upon seeding and management. State: 3. Transitional (Abandoned) Field

State 3, Phase 3.1:

Plant species dominant: eastern red cedar (*Juniperus virginiana*) / berries (*Rubus* spp.) – sumac (*Rhus* spp.) /fescue (*Schedonorus arundinaceus*)

This phase is best described as an old field habitat with a mixture of native and introduced grasses and a variety of native and non-native herbs, forbs, seedlings, and saplings.

State 4 Old Pioneer Cropland (lower slopes only)

Phase 4.1: Old (Abandoned) Cropfield. Plant species dominant: henbit deadnettle (*Lamium amplexicaule*) – mouse-eared chickweed (*Cerastium* L. )

Abandonment of cropland would result in many weed species taking over the site. Initially, annual weeds would be predominate followed by a variety of native and non-native grasses, shrubs and trees.

State: 5. Cropland (lower slopes only)

Phase 5.1: Plant species dominant: dependent upon seeding and management. Most common crops are corn and soybeans.

Restoration of states 2-5 to the reference community would require long-term, intensive management inputs.

**Table 1. Dominant plant species**

Tree	(1) <i>Quercus alba</i> (2) <i>Quercus velutina</i>
Shrub	(1) <i>Vaccinium</i> (2) <i>Viburnum acerifolium</i>
Herbaceous	(1) <i>Podophyllum peltatum</i> (2) <i>Galium circaezans</i>

## Physiographic features

These sites are found on hills.

Topography and aspect will influence community composition. Field work is needed to refine this grouping and multiple ESDs may result. All soils are deep - very deep with a fragipan layer.

Table 2. Representative physiographic features

Landforms	(1) Hill
Flooding frequency	None
Ponding frequency	None
Elevation	107–305 m
Slope	0–12%
Water table depth	38–152 cm

Climatic features

Climate: The average annual precipitation in most of this area is 41 to 47 inches (1,040 to 1,195 millimeters). About 60 percent of the precipitation falls during the freeze-free period. Most of the rainfall occurs as high-intensity, convective thunderstorms in summer. Snowfall is common in winter. The average annual temperature is 52 to 56 degrees F (11 to 14 degrees C). The freeze-free period averages 205 days and ranges from 190 to 220 days. The longer freeze-free periods occur along the Ohio River. (Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. United States Department of Agriculture. Natural Resources Conservation Service. United States Department of Agriculture Handbook 296. Issued 2006.)

Table 3. Representative climatic features

Frost-free period (average)	175 days
Freeze-free period (average)	205 days
Precipitation total (average)	1,194 mm

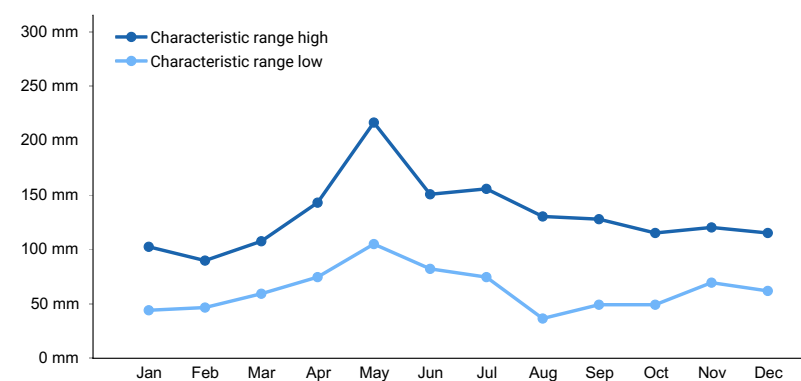


Figure 1. Monthly precipitation range

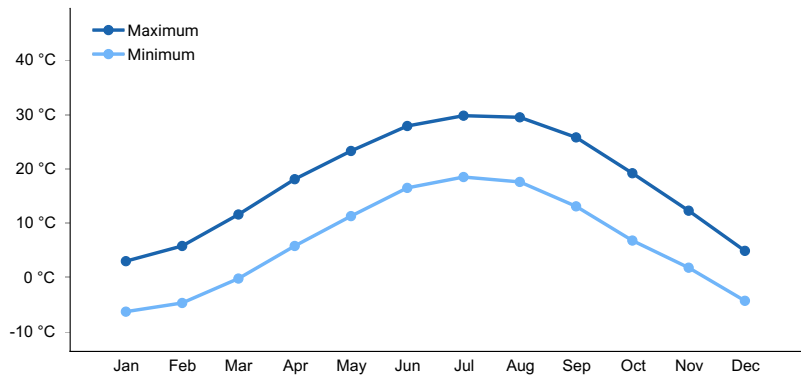


Figure 2. Monthly average minimum and maximum temperature

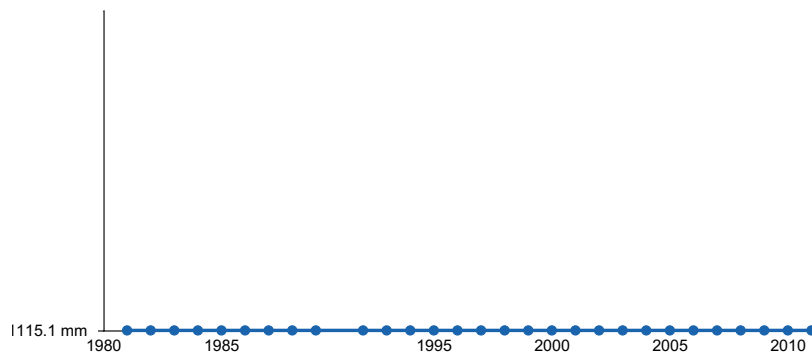


Figure 3. Annual precipitation pattern

## Climate stations used

- (1) BLOOMINGTON IN UNIV [USC00120784], Bloomington, IN

## Influencing water features

This grouping includes all soil with fragipan layers and elevated water tables will influence site ecology.

## Soil features

This initial PES grouping includes soils that are deep or very deep, moderately well drained to somewhat poorly drained and have fragipans.

Future field work may result in the group being refined into multiple ESDs.

Table 4. Representative soil features

Parent material	(1) Loess–sandstone and shale (2) Residuum–sandstone and siltstone
Surface texture	(1) Silt loam
Family particle size	(1) Loamy
Drainage class	Somewhat poorly drained to moderately well drained
Soil depth	102–203 cm
Surface fragment cover ≤3"	0–2%
Surface fragment cover >3"	0–3%
Available water capacity (0–101.6cm)	16.51–19.05 cm
Soil reaction (1:1 water) (0–101.6cm)	4.5–6
Subsurface fragment volume ≤3" (Depth not specified)	0–5%
Subsurface fragment volume >3" (Depth not specified)	0–5%

## Ecological dynamics

The communities described in this provisional document reflect those likely to be found and have not been field verified. This PES describes hypotheses based on available data of many different scales and sources and has not been developed utilizing site-specific ecological field monitoring. This PES does not encompass the entire complexity or diversity of these sites. Field studies would be required to develop a comprehensive and science-based native plant restoration plan for these sites.

The hypotheses below were developed utilizing multiple data sources including NatureServe Explorer, VegBank.org data, Plant Communities of the Midwest – Indiana Subset, Indiana DNR, The Nature Conservancy, and Purdue University data for the Hoosier National Forest. (Andriy Vladimirovich Zhalnin and George R. Parker, 2007, Delineation and spatial analysis of ecological classification units for the Hoosier National Forest in Southern Indiana)

State 1, Phase 1.1. white oak (*Q. alba*) – black oak (*Quercus velutina*) / blueberry (*Vaccinium* spp.)- mapleleaf viburnum (*Viburnum acerifolium*) / mayapple (*Podophyllum peltatum*)- licorice bedstraw (*Galium circaeans*).

Dominant trees in this community include white oak, sugar maple, and black oak. Other species present may include northern red oak, scarlet oak, chinquapin oak, chestnut oak, pignut hickory. Minor canopy trees include blackgum, sassafras, red maple and white ash. Subcanopy trees dominant are American beech, sugar maple and red maple.

The herb layer is diverse with a variable composition; however, understory plants on these sites may include nakedflower ticktrefoil (*Desmodium nudiflorum*), dogtooth violet (*Erythronium americanum*), Bosc's panicgrass (*Panicum boscii*), rattlesnake fern (*Botrychium virginianum*), star chickweed (*Stellaria pubera*), and American alumroot (*Heuchera americana*). Species of the *Arisaema* group may be present.

More mesic inclusions may include common blue violet (*Viola sororia*), Impatiens spp., Christmas fern (*Polystichum acrostichoides*) and mayapple (*Podophyllum peltatum*).

State 2, Phase 2.1: Pasture. Plant species dominant: *Schedonorus arundinaceus* (tall fescue). Species present are dependent upon seeding and management. State: 3. Transitional (Abandoned) Field

State 3, Phase 3.1:

Plant species dominant: eastern red cedar (*Juniperus virginiana*)/ berries (*Rubus* spp.) – sumac (*Rhus* spp.) / fescue (*Schedonorus arundinaceus*)

This phase is best described as an old field habitat with a mixture of native and introduced grasses and a variety of native and non-native herbs, forbs, seedlings, and saplings.

State 4 Old Pioneer Cropland (lower slopes only)

Phase 4.1: Old (Abandoned) Cropfield. Plant species dominant: henbit deadnettle (*Lamium amplexicaule*) – mouse-eared chickweed (*Cerastium* L. )

Abandonment of cropland would result in many weed species taking over the site. Initially, annual weeds would be predominate followed by a variety of native and non-native grasses, shrubs and trees.

State: 5. Cropland (lower slopes only)

Phase 5.1: Plant species dominant: dependent upon seeding and management. Most common crops are corn and soybeans.

Restoration of states 2-5 to the reference community would require long-term, intensive management inputs.

## State and transition model

## Provisional Ecological Site F120CY002IN – Fragipan Uplands

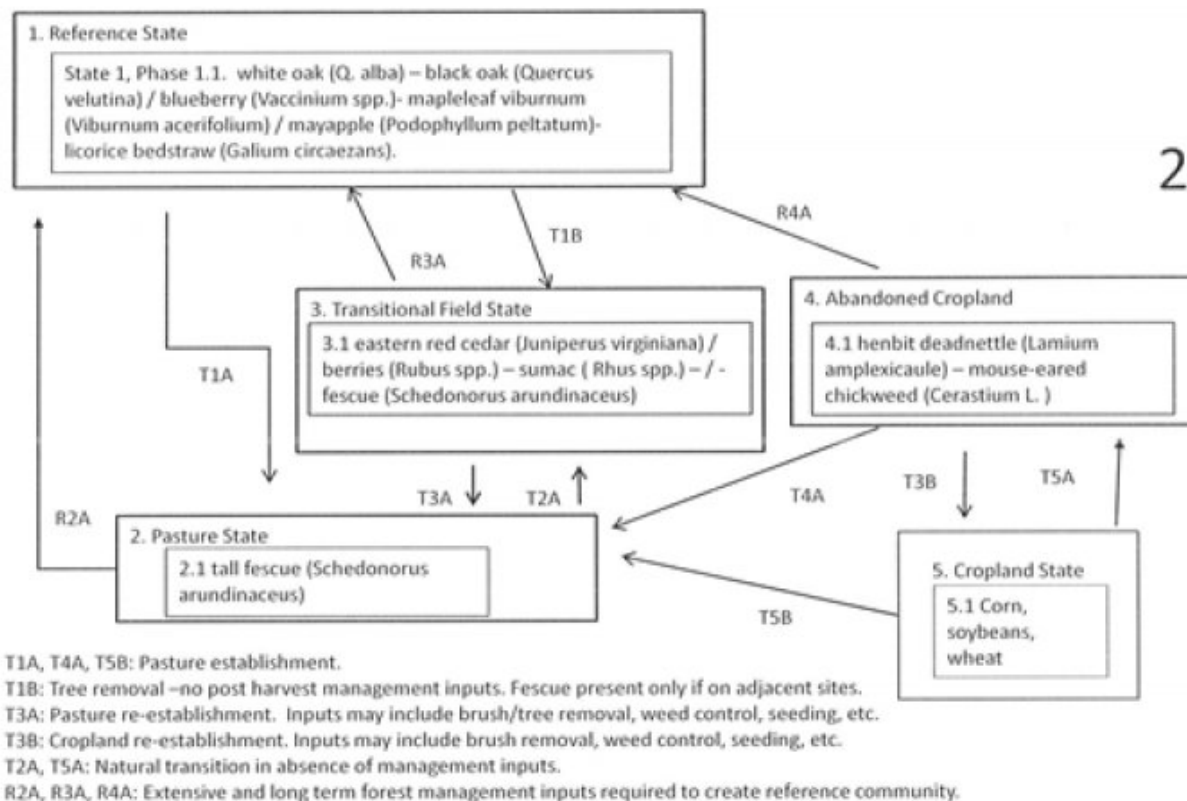


Figure 5. 120C, group2

## Other references

References for MLRA 120C Provisional Ecological Site Development.

Abrams, M.D. 1992. Fire and the development of oak forests. *BioScience*, 42: 346–353.

Abrams, M.D. and G.J. Nowacki. 2008. Native Americans as active and passive promoters of mast and fruit trees in the eastern USA. *The Holocene* 18.7. pp. 1123-1137.

Alexander, H.D. and M.A. Arthur, D.L. Loftis, and S.R. Green. 2008. Survival and growth of upland oak and co-occurring competitor seedlings following single and repeated prescribed fires. *Forest Ecology and Management* 256: 1021–1030.

Anderson, Michelle D. 2003. *Juniperus virginiana*. In: Fire Effects Information System, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, and Fire Sciences Laboratory.

Auten, J.T. 1941. Notes on old-growth forests in Ohio, Indiana and Illinois. USDA Forest Service Tech. Note 49. Columbus, OH. pp. 1-8.

Barbour, M.G., J.H. Burk, W.D. Pitts, F.S. Gilliam, and M.W. Schwartz. 1999. *Terrestrial Plant Ecology* (ed. 3). Benjamin/Cummings, Inc., Menlo Park, California.

Black, B.A., Abrams, M.D. 2001. Influence of Native Americans and surveyor biases on metes and bounds witness tree distribution. *Ecology*. 82:2574-2586.

- Braun, E.L. 1950. Deciduous forests of Eastern North America. Blakinston Co., Pennsylvania. Reprinted in 2001 by Blackburn Press, Caldwell, New Jersey.
- Campbell, J.J.N. 1987. Gradients of tree species composition in the Central Hardwood Region. R.L. Hay, F.W. Woods and H. DeSelm (eds.). Proceedings of the Central Hardwood Forest Conference VI, p. 325-346.
- Carmean, W.H. 1970. Site quality for eastern hardwoods. The silviculture of oaks and associated species. USDA Forest Service Research paper, Northeast. Forest Exp. Sta., Upper Darby, PA, NE-144: 36-56.
- Carmean, W.H. 1971. Soil-site relationships of the upland oaks. Oak Symp. Proc. USDA Forest Service Research Paper. Northeast. Forest Exp. Sta., Upper Darby, PA. p. 23-29.
- Carmean, Willard H.; Hahn, Jerold T.; Jacobs, Rodney D. 1989. Site index curves for forest species in the eastern United States. Gen. Tech. Rep. NC-128. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station.
- Cho, D.S. and R. Boerner. 1991. Canopy disturbance patterns and regeneration of *Quercus* species in two Ohio Old-growth forests. *Vegetation* 93:9-13.
- Cleland, D. T., J. A. Freeouf, J. E. Keys, Jr., G. J. Nowacki, C. A. Carpenter, and W. H. McNab. 2007. Ecological Subregions: Sections and Subsections of the Conterminous United States. GTR-WO-76C-1. [http://fsgeodata.fs.fed.us/other\\_resources/ecosubregions.html](http://fsgeodata.fs.fed.us/other_resources/ecosubregions.html).
- 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.
- Curtis, J. T., 1959. Ecological Systems of the United States: A Working Classification of U.S. Terrestrial Systems. NatureServe, Virginia. .
- Denevan, W.M. 1992. The pristine myth: the landscape of the Americas in 1492. *Annals of the Association of American Geographers*, 82 (3), 369–385.
- Delcourt, P.A. and H.R Delcourt. 1998. The influence of prehistoric human-set fires on oak- chestnut forests in the southern Appalachians. *Castanea* 63:337-345.
- Ebinger, J.E. 1997. Forest Communities of the Midwestern United States. Springer eBook.
- Environmental Protection Agency (EPA), Environmental Mapping and Assessment Program (EMAP). 2004. Washington DC., USA. <http://www.epa.gov/docs/emap/>
- Faber-Langendoen, D., editor. 2001. Plant communities of the Midwest: Classification in an ecological context. Association for Biodiversity Information, Arlington, VA. 61 pp. + appendix (705 pp.).
- Fenneman, N.M. 1917. Physiographic subdivisions of the United States. Proceedings of the National Academy of Sciences of the United States of America. Vol. 3(1). pp. 17 -22.
- Fenneman, N.M. 1938. Physiography of Eastern United States. McGraw-Hill Book Co., New York.
- Gingrich, S.F. 1967. Measuring and evaluating stocking and stand density in upland hardwood forests in the Central States. *Forest Science*. 13(1): 38-53.
- Gleason, H.A. and A. Cronquist. Manual of Vascular Plants of Northeastern United States and Adjacent Canada. 2nd edition. The New York Botanical Garden, Bronx.
- Guyette, R.P., Muzika, R.M. & Dey, D.C. 2002. Dynamics of an anthropogenic fire regime. *Ecosystems*, 5:472–486.

- 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 Experimentation Station. Radnor, Pennsylvania.
- Guyette, R.P., M.C. Stambaugh, D.C. Dey and R. Muzika. 2011. Predicting fire frequency with chemistry and climate. *Ecosystems* Published online: DOI: 10.1007/s10021-011-9512-0.
- Jennings, M.D., Faber-Langedoen, D., Loucks, O.L., Peet, R.K. and Roberts, D. 2009. Standards for associations and alliances of the U.S. National Vegetation Classification. *Ecological Monographs*, 79(2), 2009, pp. 173–199.
- Johnson, Paul S. 1992. Oak overstory/reproduction relations in two xeric ecosystems in Michigan. *Forest Ecology and Management*. 48: 233-248.
- Kartesz, J.T., The Biota of North America Program (BONAP). 2011. North American Plant Atlas (<http://www.bonap.org/MapSwitchboard.html>). Chapel Hill, N.C. [maps generated from Kartesz, J.T. 2010. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP). (in press)].
- Keever, C. 1978. A study of the mixed mesophytic, western mesophytic, and oak chestnut regions of the eastern deciduous forest including a review of the vegetation and sites recommended as potential natural landmarks. Millersville State College, Pennsylvania.
- Kentucky State Nature Preserves Commission. 2009. Natural communities of Kentucky. Frankfort, KY
- Illinois Wildflower. Accessed January to October, 2015-2016. <http://www.illinoiswildflowers.info>
- Johnson, E.A. & Gutsell, S.L. 1994. Fire frequency models, methods and interpretations. *Advances in Ecological Research*, 25:239–287.
- Johnson, P.S.; Shifley, S.R.; Rogers, R. 2002. *The Ecology and Silviculture of Oaks*. New York, CABI Publishing.
- Kipfmüller, K.F. & Swetnam, T.W. 2001. Using dendrochronology to reconstruct the history of forest and woodland ecosystems. *The historical ecology handbook*. Island Press, Washington, DC. 199–228.
- Kuchler, A.W. 1964. Potential natural vegetation of the conterminous United States. Spec. Publ. 36 New York, NY: American Geographical society.
- Land Resource Regions and Major Land Resource Areas of the United States. United States Department of Agriculture Soil Conservation Service Handbook 296. Dec. 1981. 87-88.
- Lawless, P. J., Baskin, J. M. and C. C. Baskin. 2006. Xeric Limestone Prairies of Eastern United States: Review and Synthesis. *The Botanical Review* 73(4): 303–325. The New York Botanical Garden.
- Lindsey, A.A., W.B. Crankshaw, and S.A. Qadir. 1965. Soil relations and distribution map of the vegetation of presettlement Indiana. *Botan. Gaz.* 126(3): 155-163..
- Lunt, I.D. & Spooner, P.G. 2005. Using historical ecology to understand patterns of biodiversity in fragmented agricultural landscapes. *Journal of Biogeography*, 32:1859–1873.
- McNab, W.H. and P.E. Avers. 1994. Ecological subregions of the United States. U.S. Forest Service. Prepared in cooperation with Regional Compilers and the ECOMAP Team of the Forest Service.
- McNab, W.H, D. T. Cleland, J. A. Freeouf, J. E. Keys, Jr., G. J. Nowacki, and C. A. Carpenter. 1997. Description of "Ecological Subregions: Sections of the Conterminous United States".
- McEwan, R.W., Hutchinson, T.F., Ford, R.D. & McCarthy, B.C. 2007. An experimental evaluation of fire history reconstruction using dendrochronology in white oak. *Canadian Journal of Forest Research*, 37: 806–816.



- McGee, C.E. 1986. Loss of *Quercus* spp. dominance in an undisturbed old-growth forest. *The L of the Elisha Mitchell Sci. Soc.* 102(1): 10-15.
- McGee, L.E. 1984. Heavy mortality & succession in a virgin mixed mesophytic forest. USDA Forest Service Res. Pap. SO-209: 1-9.
- McQuilkin, Robert A. 1974. Site index prediction tables for black, scarlet and white oaks in southeastern Missouri. USDA Forest Service Research paper, NC-108.
- McQuilkin, Robert A., and Robert Rogers. 1978. A method for determining the precision of site index estimates made from site index predictions functions. *Forestry Science* 24:289-296.
- Miller, J.H., Chambliss, E.B. and Loewenstein, N.J. 2010. A field guide for the Identification of Invasive Plants in Southern Forests. US Forest Service Southern Research Station, General Technical Report SRS-119.
- NatureServe Explorer (The Nature Conservancy). <http://www.natureserve.org/explorer>.
- NatureServe. 2006. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA USA
- NatureServe. 2014. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>.
- Noss, R. F. 1983. A regional landscape approach to maintain biodiversity. *BioScience* 33(11): 700-706.
- Parker, G.R. 1989. Old-growth forests of the Central Hardwood Region. *Nat. Areas J.* 9(1): 5-11.
- Pickett, S.T.A. and P.S. White. 1985. Patch dynamics: a synthesis. In: S.T.A. Pickett and P.S. White. *The ecology of natural disturbance and patch dynamics*. New York: Academic Press: 371-384.
- Pyne, S.J. 1982. *Fire in America: a cultural history of wildland and rural fire*. Princeton University Press, Princeton, New Jersey.
- Quarterman, E. and R.L. Powell. 1978. Potential ecological/geological natural landmarks on the Interior Low Plateaus. pp. 7-73. U.S. Department of the Interior, Washington, D.C. Quarterman,
- Rooney, T.P., S.M. Wiegmann, D.A. Rogers and D.M. Waller. 2004. Biotic impoverishment and homogenization in unfragmented forest understory communities. *Conservation Biology* (in press).
- Shotola, S.J., G.T. Weaver, EA. Robertson, and W.C. Ashby. 1992. Sugar maple invasion of an old-growth oak hickory forest in southwestern Illinois. *Am. Midl. Nat.* 127: 125-138.
- Smalley, Glendon W. 1990. *Carya glabra* (Mill.) Sweet pignut hickory. *Silvics of North America. Vol. 2. Hardwoods. Agric. Handbook 654*. Washington, DC: U.S. Department of Agriculture, Forest Service: 198-204.
- Stambaugh, M.C. and R.P. Guyette. 2008. Predicting spatio-temporal variability in fire return intervals with a topographic roughness index. *Forest Ecology and Management* 254:463-473.
- Stritch, L.R. 1990. Landscape-scale restoration of barrens-woodland within the oak-hickory forest mosaic. *Restoration & Management Notes* 8: 73-77.
- Sweeney, J.M., ed. 1990. *Management of dynamic ecosystems*. North Cent. Sect., The Wildl. Soc., West Lafayette, Ind.
- U.S. Department of Agriculture (USDA), Natural Resources Conservation Service.  
Soil surveys of the following counties: Breckinridge, Butler, Caldwell, Christian, Crittenden, Daviess, Edmonson, Grayson, Hancock, Livingston, Logan, and Todd.

U.S. Department of Agriculture-Forest Service, Agriculture Handbook 654, Silvics of North America.

U.S. Department of Agriculture, Forest Service. 1994. Ecosystem classification of the United States; Ecological Subregions of the United States. Compiled by W. Henry McNab, Peter E. Avers, et al., Washington, DC.  
<http://www.fs.fed.us/land/pubs/ecoregions>.

U.S. Department of the Interior. 2004. Vegetation Mapping Program, National Vegetation Classification Standard.  
<http://biology.usgs.gov/npsveg>.

U.S. Geological Survey (USGS), Center for Biological Informatics (CBI) 2004. U.S. Department of the Interior.  
<http://biology.usgs.gov/cbi>

Vegetation Classification Standard, Vegetation Subcommittee, Federal Geographic Data Conservation Assessment for Cliff Communities. Accessed July 2013. U.S. Department of the Interior, U.S. Geological Survey. Reston, Virginia. <http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation>.

Whitaker, J.O. and C. J. Amlaner. 2012. Habitats and Ecological Communities of Indiana - Presettlement to Present. Indiana Natural Science.

Zhalnin, A. V. and G. R. Parker. 2007. Land Type Association Delineation and Spatial Analysis for the Hoosier National Forest in Southern Indiana. Proceedings of the Indiana Academy of Science (116): 158-172.

Zollner, D., M.H. MacRoberts, B.R. MacRoberts, & D. Ladd. 2005. Endemic vascular plants of the Interior Highlands, U.S.A. Sida 21:1781-1791.

#### Websites:

Ecosystem classification of the United States; Ecological Subregions of the United States. 1994. Compiled by W. Henry McNab, Peter E. Avers, et al. Forest Service, U.S. Department of Agriculture [USDA], Washington, DC., USA: <http://www.fs.fed.us/land/pubs/ecoregions>

Environmental Mapping and Assessment Program (EMAP). 2004. Washington, DC., USA:  
<http://www.epa.gov/docs/emap/>

Geospatial Data Gateways: <https://gdg.sc.egov.usda.gov/>

Hoosier National Forests: <http://www.fs.usda.gov/hoosier/>

Illinois Wildflowers: <http://www.illinoiswildflowers.info>

Indiana Department of Natural Resources – Nature Preserves: <http://www.in.gov/dnr/naturepreserve/>

Landfire: <http://www.landfire.gov>

Missouri Plants: <http://www.missouriplants.com/>

NatureServe Explorer: <http://www.natureserve.org/explorer>

Natural Communities of Brown County Hills. The Nature Conservancy:  
<http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/indiana/placesweprotect/brown-county-hills-management-and-stewardship.xml>

Official Soil Series Descriptions, USDA-NRCS: <https://soilseries.sc.egov.usda.gov/osdname.asp>

Silvics of North America, US Forest Service.  
[http://www.na.fs.fed.us/spfo/pubs/silvics\\_manual/table\\_of\\_contents.htm](http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm)

USDA Plants: <http://plants.usda.gov/java/>

U.S. Department of the Interior: <http://biology.usgs.gov/npsveg>

U.S. Geological Survey (USGS), Center for Biological Informatics (CBI) 2004. U.S. Department of the Interior: <http://biology.usgs.gov/cbi>

Vascular Plant Image Library: <http://botany.csd.tamu.edu/FLORA/imaxxara.htm>

Vegetation Mapping Program, National Vegetation Classification Standard. 2004.

Vegetation Classification Standard, Vegetation Subcommittee, U.S. Geological Survey [USGS; U.S. Department of the Interior], Reston, Virginia, USA. <http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation>

Vegbank: [www.vegbank.org](http://www.vegbank.org)

Wildland Fire Management RD&A: <https://www.frames.gov/partner-sites/wfmrda-ffe/home/>

Web Soil Survey, USDA-NRCS: <http://websoilsurvey.nrcs.usda.gov/app/>

Woodland Wildflowers of Illinois: [http://www.illinoiswildflowers.info/woodland/woodland\\_index.htm](http://www.illinoiswildflowers.info/woodland/woodland_index.htm)

## Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

## Indicators

### 1. Number and extent of rills:

---

### 2. Presence of water flow patterns:

---

### 3. Number and height of erosional pedestals or terracettes:

---

### 4. Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):

- 
5. **Number of gullies and erosion associated with gullies:**
- 
6. **Extent of wind scoured, blowouts and/or depositional areas:**
- 
7. **Amount of litter movement (describe size and distance expected to travel):**
- 
8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**
- 
9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**
- 
10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**
- 
11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**
- 
12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**
- Dominant:
- Sub-dominant:
- Other:
- Additional:
- 
13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**
- 
14. **Average percent litter cover (%) and depth ( in):**
- 
15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**
- 
16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize**

degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:

---

17. **Perennial plant reproductive capability:**

---