MIXED MOISTURE HARDPAN FOREST

Concept: Mixed Moisture Hardpan Forest is a community with a mixture of tree species typical of hydric and xeric conditions, occurring on sites with clay-rich soils that have restricted internal drainage or shrink-swell properties. Typically, *Quercus phellos* is mixed with *Quercus alba, Quercus stellata*, or *Carya carolinae-septentrionalis* as the predominant canopy.

Distinguishing Features: Mixed Moisture Hardpan Forest is distinguished by the co-occurrence of wetland and upland oak and hickory species, generally including both *Quercus phellos* and *Quercus stellata* in significant numbers, without segregation into distinct Xeric Hardpan Forest and Upland Depression Swamp communities. *Quercus alba* and other dry-mesic species are also generally abundant but may be scarce. The site generally shows evidence of shallow ponding of water but not of water flow.

Synonyms: *Quercus phellos - Quercus (alba, stellata) - Carya carolinae-septentrionalis* Hardpan Forest (CEGL004037).
Ecological Systems: Piedmont Hardpan Woodland and Forest (CES202.268).

Sites: Mixed Moisture Hardpan Forests occur on unusually flat upland areas of the Piedmont, generally associated with diabase, gabbro, or other mafic rock but potentially with clay-rich metasedimentary rocks.

Soils: This community occurs on montmorillonitic or other clay-rich soils that restrict water penetration and interfere with roots through their density or shrink-swell behavior. The most common soil series mapped in occurrences is Iredell (Vertic Hapludalf), with some mapped as Enon (Ultic Hapludalf) or Lignum (Aquic Hapludult) and a few as Orange (Albaquic Hapludalf), Misenheimer (Aquic Dystrudept), or other series.

Hydrology: Sites appear to be alternately wet and dry, with water pooled on part of the ground surface at times but dry most of the time. Moisture conditions are not comparable to any position on the normal upland moisture gradient. However, dry and wet conditions apparently are more moderate than in Xeric Hardpan Forest or Upland Depression Swamp Forest respectively.

Vegetation: Mixed Moisture Hardpan Forest has a canopy with a mix of trees that includes species of wet, mesic, and dry sites. *Quercus phellos* and *Quercus stellata* co-occur. Other highly constant species in CVS plots include *Carya glabra, Liquidambar styraciflua, Ulmus alata, Quercus alba, Quercus falcata, Carya tomentosa*, and *Fraxinus americana*. *Carya ovata, Ulmus americana, Quercus velutina, Pinus echinata*, and *Pinus virginiana* also are frequent. The understory includes *Acer rubrum, Nyssa sylvatica, Cornus florida, Prunus serotina, Juniperus virginiana, Ilex opaca*, and *Diospyros virginiana*, as well as canopy species. Also frequent are *Oxydendrum arboreum, Crataegus marshallii*, and *Morus rubra*. The shrub layer is sparse to moderate in density. *Ilex decidua, Viburnum prunifolium, Vaccinium pallidum, Rosa carolina,* and *Hypericum hypericoides* occur with high constancy in plots. Other frequent shrubs include *Vaccinium stamineum* and *Vaccinium fuscatum*. Additional species noted in whole-site surveys include *Eubotrys racemosa* and *Vaccinium tenellum,*

Vines are prominent in portions. *Smilax rotundifolia* may form tangles, and *Muscadinia rotundifolia* may have substantial cover on the ground. *Parthenocissus quinquefolia, Toxicodendron radicans, Lonicera sempervirens, Campsis radicans*, and the introduced *Lonicera japonica* are highly constant, and *Smilax bona-nox* is frequent. The herb layer is sparse to moderate and often is very patchy. *Danthonia spicata* is in all plots and may have moderate cover. Other high constancy or frequent species in plots include *Dichanthelium laxiflorum, Scutellaria integrifolia, Stylosanthes biflora, Endodeca serpentaria, Potentilla canadensis, Asplenium platyneuron, Eupatorium rotundifolia, Euphorbia pubentissima, Galium circaezans, Lespedeza repens, Lespedeza virginica*, and *Clematis ochroleuca*, along with collectively frequent *Carex* spp. Additional notable species reported in site surveys include *Chasmanthium laxum, Hexastylis lewisii, Coreopsis major, Cunila origanoides, Iris verna,* and *Sericocarpus linifolius*.

Range and Abundance: Ranked G2?, but possibly G3. Examples are scattered through the central and eastern Piedmont, with one anomalous possible occurrence in the Coastal Plain. The equivalent association occurs in Virginia and possibly South Carolina.
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Associations and Patterns: Mixed Moisture Hardpan Forests occur as large to small patches. Occurrences may be associated with Upland Depression Swamp Forest or Xeric Hardpan Forest, but more often are surrounded by oak–hickory forests.

Variation: Variation is not well known, but two variants are recognized to encourage further investigation of differences.
1. Basic Variant occurs over mafic rock and presumably has soil with relatively high pH and base saturation. *Fraxinus americana*, *Clematis ochroleuca*, *Rosa carolina* and other species more typical of higher pH soil are likely to be present.
2. Acidic Variant occurs on other substrates which produce more typically acidic soils with lower base saturation. The above species are likely to be absent, and *Oxydendrum arboreum*, *Vaccinium pallidum*, *Chimaphila maculata*, and other acid tolerant species are more likely to be present. This variant is less common than the Basic Variant.

Dynamics: The natural dynamics of Mixed Moisture Hardpan Forest are expected to be fairly similar to other Piedmont oak-hickory forests. The difficult rooting environment may make the trees more susceptible to wind throw, but most canopy gaps still appear to be small. This community would naturally be exposed to fire as frequently as the surrounding upland matrix. It would likely burn almost as frequently, but occasional fires might occur during times of wet ground and thave little effect on the community. Like the various oak-hickory forests, it probably would be more grassy and more open with regular burning but less so than in oak-hickory forests and much less than in Xeric Hardpan Forest.

It is not known if seasonal or ephemeral aquatic animal communities are present in the small pools of Mixed Moisture Hardpan Forests, but they should be sought.

Comments: There has been uncertainty about the recognition of this community. Mixed Moisture Hardpan Forest appears to be conceptually transitional between Xeric Hardpan Forest and Upland Depression Swamp, in a way that may or may not reflect an important conservation target of its own. Arguments for its recognition include that it often occurs in patches of several acres and that

it often occurs without one or both of the communities it is intermediate between. Though not well known, its dynamics may be distinct and not intermediate. This community type is more narrowly defined than other oak forests, perhaps more comparable to a subtype, but there is no type that it reasonably can be nested within.

Communities with comparable unusual mixtures of wet and dry soil conditions and of wetland and xerophytic plants are known in other parts of the Southeast and are sometimes known by the term "xerohydric."

No published literature is known that addresses Mixed Moisture Hardpan Forests. They were initially described in several Natural Heritage Program county and regional inventory reports, under the name of "mesic hardpan forest." The combination of xerophytic and wetland vegetation "averages" mesophytic, but mesophytic species are scarcer than those of either extreme. The vegetation description above is based primarily on CVS plot data, but only five plots represent this community. The constancy values therefore may be of limited accuracy.

Rare species:

References: