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A Classification System for the Natural Vegetation of Arkansas

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Abstract

We present a hierarchical classification system for existing natural vegetation of Arkansas based on the United Nations Educational, Scientific and Cultural Organization (UNESCO) system. It incorporates aspects of systems in use by the Nature Conservancy, Arkansas Natural Heritage Commission, Arkansas Game and Fish Commission, Society of American Foresters, and United States Forest Service, as well as data on potential vegetation from maps by E.E. Dale and A.W. Kuchler. A total of 18 physiognomic cover types are recognized for natural terrestrial cover, 6 for palustrine cover, and 4 each for lacustrine cover and riverine cover. Over 200 community types are recognized, grouped into 57 cover types and 90 intermediate groupings. This system is appropriate for use with remotely sensed data and the level of detail dealt with can be rationally adjusted by working at a higher or lower level of the hierarchy. We suggest that this system form the basis for future vegetation analyses and research within Arkansas.

Introduction

The Arkansas Gap Analysis Project (see Scott et al., 1993 for a complete discussion of Gap Analysis), being conducted by the University of Arkansas in cooperation with several other academic institutions, state and federal agencies, and private organizations, will produce a map of existing vegetation and potential vertebrate distribution within Arkansas. The map will be created from satellite imagery, GIS maps of geology, topography, soil and other physical features, and databases of species occurrence and habitat characteristics.

The vegetation units mapped will be those that can be distinguished on satellite imagery and GIS data layers. It is expected, based on results in other states, that approximately 50 vegetation units will be mapped. It is desirable for maximum utility of the map that these map units be related to an overall classification of Arkansas vegetation. Therefore one of the initial priorities of the Arkansas GAP was to produce such a vegetation classification for Arkansas.

Several plant community classifications exist for Arkansas (AGFC, 1948; Moore, 1959; Foti, 1974; Pell, 1981; Dale, 1986; and unpublished classifications used by several agencies cooperating in this project). A valuable published classification exists for Missouri (Nelson, 1985). Several national classifications have applicability within Arkansas (Eyre, 1980; Kuchler, 1964). However, since plant communities are not discrete entities, each classification is a reflection of the philosophy of the cre-

ator and the philosophies vary.

None of these classifications met the needs of all agencies cooperating in the Arkansas GAP. Most were too general for GAP purposes; several (Foti, 1974; Pell, 1981; Nelson, 1985) combine physical and biological diagnostic features, e.g. Dry-Mesic Oak-Hickory Forest. Including both physical and biological features simplifies a classification in that, using the above example, it is not necessary to distinguish the various combinations of *Quercus alba*, *Q. falcata*, *Q. velutina*, *Carya tomentosa*, *C. texana* and other species that may dominate such sites. However, such simplification of biological communities inevitably results in loss of information.

The technology being used in the Arkansas GAP, GIS and remote sensing, allows physical features of sites to be characterized using digital elevation models, geology, and soil layers while vegetation or land cover can be independently classified based on satellite or other imagery.

In addition to ecosystemic classifications which classify physical features to indirectly classify vegetation (such as those classifications discussed above) two general approaches focus strictly on vegetation: physiognomic and floristic (Whittaker, 1978).

Physiognomic classification depends on morphological characteristics (structure) of vegetation, and it is primarily determined by growth-form and life-form of the dominant or codominant plants. Physiognomic classification is extensively used to characterize vegetation over large geographical areas because it can be visually recognized and distinguished and does not require much floristic detail

about the vegetation.

The floristic approach focuses on analysis and synthesis of the floristic composition of communities. The diagnostic species, which occupy ecological niches of different dimensions, are used to characterize the basic unit (association) as well as higher units of the classification hierarchy.

Arkansas Vegetation Classification System Assumptions and Methods

For the reasons stated above, it was decided that the Arkansas vegetation classification would be based strictly on biological features of the community.

Further, it was desired that the product of this effort be a hierarchical framework to allow the level of detail to vary for different users and, since GAP is a national effort, that the vegetation units recognized here should be as compatible as possible with those of other states.

Three assumptions are made for the vegetation classification system of Arkansas (based on recommendations from National GAP): 1) This system is used to describe actual or existing vegetation rather than potential or climax vegetation; 2) It does not include transition zones of vegetation (the level of detail at the lowest level is high enough that some units considered by others to be transition zones are recognized as units); and 3) It is open-ended in that categories may be added to any of the hierarchical levels as long as the additions are truly an equivalent category within the given classification level. Furthermore, it is reasonably easy to combine units recognized here and produce a classification that can be readily correlated to this one.

Based on the approach adopted for the National Gap Analysis Project (Scott et al., 1993), the vegetation classification system of Arkansas presented here follows the UNESCO (United Nations Educational, Scientific, and Cultural Organization) (1973) format with modification of the lower two levels (Jennings, 1993). This classification scheme offers a widely accepted and useful hierarchical grouping that is based primarily on 1) the physiognomic or structural expression of plant cover relative to environment at higher levels of the scheme, and 2) the floristic composition at lower levels.

There are six levels in this vegetation classification system: class, subclass, group, formation, cover type, and community type. The first four levels are physiognomic and the latter two are floristic (to the extent of defining dominant, diagnostic, or indicator species).

The following definitions of the levels of the hierarchy follow the definitions of National Gap Analysis project (Jennings, 1993) with slight modifications by us. The criteria used to define classification categories (e.g., woodland = tree canopy cover of 26-60%) are general. They are

meant to be a means for grouping and discussing discrete cover types from coarse categories to finer categories. The growth-form and the life-form used in this classification system follow the growth-form categorization of Rubel (1930) and the life-form classification of Raunkier (1934), respectively.

Class.--There are six primary classes. The first five of these represent vegetation cover; the sixth represents substantial bare ground. The distinctions between classes representing vegetation are based on the spacing and height of dominant vegetation growth form.

1. *Forest*: Forests are dominated by trees with a total canopy cover of 61% or more and tree crowns usually interlocking.
2. *Woodland*: Woodlands are dominated by trees with a total canopy cover of 26-60%, most tree crowns not touching each other. A herbaceous or shrub understory, or both, are usually present. They are open stands of trees, sometimes called "open forest".
3. *Dwarf shrubland*: These are comprised of shrubs rarely exceeding 0.5 m in height at maturity. The type probably does not occur in Arkansas.
4. *Shrubland*: These are areas dominated by shrubs that generally range from 0.5 m to 5 m in height when mature, with a total canopy cover of 26% or more. A tree canopy cover of 26% or less may be present.
5. *Herbaceous*: These are areas dominated by grass, grass-like, or forb vegetation with a tree or shrub component not exceeding 25% cover.
6. *Barren/sparsely vegetated*: These are areas where vegetation cover is less than 5%. This type includes mud flats, sandy areas, and bare rock.

Note that such widely-used (but often inconsistently defined terms as "savanna", "prairie", "glade" and "barrens" are not used here. This is meant to reduce confusion in terminology. Some of these traditional terms, however, are used as common names in the classification or in descriptions of the units.

Subclass.--Subclasses are categories within each class comprised of areas in which the main vegetation is morphologically similar. For the classes of forest, woodlands, dwarf shrublands and shrublands the similarities are based on these factors:

1. evergreen;
2. deciduous or mixed.

For the class of herbaceous the similarities are based on:

1. tall grasses, more than 1.0 m in height;
2. medium-tall grasses, from 0.5 to 1.0 m in height;
3. short grasses, less than 0.5 m in height;
4. forbs.

Group.--Groups are categories within each subclass which may be based on any of the following:

For forests, woodlands, and shrublands:

1. climate, e.g., tropical, temperature, subpolar;

2. morphology, e.g., broad-leaved, sclerophyllous, needle-leaved.

Formation.--Formations are categories within each group comprised of areas in which the vegetation similarities are based on any of the following criteria.

Tree size and crown shape:

Non-giant forests are those 5-50 m in height having

1. rounded crowns, e.g., *Pinus echinata*
2. conical crowns, e.g., *Juniperus virginiana*

Life zone:

1. temperate lowland
2. montane
3. alpine

Substrate:

1. alluvial
2. serpentine

Kinds of associated vegetation, e.g., broad-leaved forest with or without evergreen needle-leaved trees, or with or without succulents.

Amount and kind of understory.

Cover type.--Cover type is a group of plant community types having the same primary dominant species and similar physiognomy; an aggregation of plant community types.

Community type.--The community type is an assemblage of plant species that interact at the same time and place and have defined species composition and physiognomy, regardless of seral stage; usually named by the names of the species that dominate the canopy layer.

A modification of the national model was made to allow users to more easily find wetland community types: at the highest level we distinguished Terrestrial, Palustrine, Riverine and Lacustrine systems (following Cowardin, 1979). In the national model these have been incorporated lower in the hierarchy (at the formation level). However, there are enough wetland types in the Arkansas classification that such an approach adds to confusion by users. If a user desires, it should be straightforward to place these groups at the formation level. In either event it should be understood that these units are a classification of the emergent vegetation of wetland communities, not a classification of the physical wetland communities.

By agreement of the review committee, as well as National GAP guidance, community types that are the result of human activity, e.g., urban and agricultural areas, are not included in this scheme, but widespread successional communities that may result from previous human disturbance are included.

The first draft of the vegetation classification system was generated by correlating several of the existing classification systems that are in use within Arkansas. These included the vegetation classification of Arkansas developed by Dale (1986); the system used by the Society of

American Foresters (Eyre, 1980) and that developed by Kuchler (1964), the unpublished classifications used by the U.S. Forest Service and the Arkansas Natural Heritage Commission (based on Pell, 1981), and the unpublished vegetation cover types used by the Arkansas Game and Fish Commission. We also referred to other sources, such as the unpublished southeast and midwest regional ecological community classification systems of The Nature Conservancy, and the draft ecological community classification system for Tennessee GAP Project.

These cross-correlated units were placed into the appropriate levels (either cover type or community type) of the modified UNESCO system, and revised several times based on review by the GAP vegetation classification committee.

Results and Conclusions

The final vegetation classification system of Arkansas contains approximately 215 community types (Table 1). Approximately 75 of the community types are within the wetland systems, while the remainder are within the terrestrial system.

Of the higher levels in the hierarchy, 32 physiognomic types are recognized at the formation level and 57 floristic types at the cover type level. The authors were concerned about the dramatic increase in units from 57 at the cover type level to 215 at the community type level, so an intermediate level comprising 94 units was created to provide an intermediate level of detail.

In order to add to the objectivity and usefulness of the classification, the committee will develop a list of type stands or example stands that will be documented with vegetation data and will be available for further review and research. The near-term documentation will be used in classifying satellite imagery to produce the GAP vegetation map.

Review and revision of this classification by a large and diverse committee has demonstrated that it is easily compressed to provide fewer units or extended to provide more detail, and is therefore highly flexible. Furthermore, its emphasis on plant community composition and structure makes it well adapted for use with satellite and aerial imagery. The U.S. Forest Service is presently developing a site classification system which will complement this vegetation-centered approach.

Because of the flexibility, clear focus and suitability of this system for use with remote sensing data, we suggest its use in future vegetation and habitat studies in Arkansas.

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Table 1. Natural Vegetation Classification System of Arkansas. Hierarchy is explained in text. (I)=indicator species.

Terrestrial

1. Forest (61-100% tree cover; trees > 5m tall)
 - 1.A. Mainly evergreen forest (>75% evergreen)
 - 1.A.9. Temperate evergreen needle-leaved forest
 - 1.A.9.b. Temperate evergreen needle-leaved forest with rounded crowns
 - I. 1.a. Pinus echinata, Probably even-aged, resulting from disturbance, NW and Coastal Plain.
 - II. 2.a. Pinus taeda, Probably even-aged, resulting from disturbance, Primarily SE.
 - III. 3.a. Pinus echinata - Pinus taeda - Carya spp, Dry-mesic to dry sites, principally Coastal Plain.
 - 1.A.9.c. Temperate evergreen needle-leaved upland forest with conical crowns
 - I. 1.a. Juniperus virginiana, Often high pH sites, sometimes rock, unburned.
 - 1.B. Mainly deciduous or mixed forest (25%-75% evergreen)
 - 1.B.2. Cold-deciduous forest, with evergreen broad-leaved trees and climbers (25%-75% evergreen)
 - 1.B.2.a. Cold-deciduous forest with evergreen broad-leaved trees and climbers
 - I. 1.a. Fagus grandifolia - Ilex opaca (I), In Coastal Plain on sandy branch bottoms.
 - 1.B.3. Cold-deciduous forest with evergreen needle-leaved trees (25%-75% evergreen)
 - 1.B.3.a. Cold-deciduous broad-leaved upland forest with evergreen needle-leaved trees
 - I. Quercus stellata, marilandica - Pinus echinata - Carya spp.
 - 1.a. Pinus echinata - Quercus stellata - Carya texana, Mesic to dry sites, NW and Coastal Plain.
 - b. Pinus echinata - Quercus stellata - Juniperus virginiana, Dry, open sites resulting from disturbance, NW and Coastal Plain.
 - c. Quercus stellata - Pinus echinata - Quercus marilandica (I), Dry or very dry sites, mostly NW and Coastal Plain.
 - d. Quercus stellata - Quercus marilandica - Juniperus virginiana, like 2a., but out of range of pines; higher pH.
 - II. Quercus spp. (alba, rubra) - Pinus echinata - Carya spp.
 - 2.a. Quercus rubra - Pinus echinata - Quercus stellata, Dry sites, principally NW.
 - b. Quercus rubra - Pinus echinata - Carya texana, Dry sites, principally NW.
 - c. Pinus echinata - Quercus rubra - Quercus velutina, Mesic to xeric sites, NW.
 - d. Pinus echinata - Quercus rubra - Carya tomentosa, Dry to xeric sites, NW.

- 3.a. Quercus alba - Quercus rubra - Pinus echinata, Dry-mesic to dry sites, principally west half.
- b. Quercus alba - Pinus echinata - Quercus (velutina, falcata) Dry-mesic to dry sites, principally west half.
- c. Pinus echinata - Quercus alba - Carya tomentosa, Mesic to dry sites, NW and Coastal Plain.

III. Pinus taeda - Pinus echinata - Quercus spp.

- 4.a. Pinus echinata - Pinus taeda - Quercus spp. (stellata, alba, falcata), Dry to dry-mesic sites, principally Coastal Plain, probably deserves more detailed classification, but few natural stands remain.
- 5.a. Pinus taeda - Quercus stellata - Quercus falcata, Mesic to dry sites, principally Coastal Plain. Moist sites than 4.
- b. Pinus taeda - Quercus (phellos, nigra, stellata), On occasionally flooded to dry sites, usually Coastal Plain.
- 6.a. Pinus taeda - Liquidambar styraciflua, Successional on old fields.

IV. Juniperus virginiana

- 7.a. Juniperus virginiana - Quercus muehlenbergii - Fraxinus quadrangulata, High pH sites or out of range of pine.
- b. Juniperus virginiana - Rhus spp. - Diospyros, Old fields.

1.B.4.a. Temperate lowland and submontane broad-leaved cold-deciduous forest

I. Fagus grandifolia

- 1.a. Fagus grandifolia - Magnolia tripetala (I), Principally northwest on mesic sites.
- b. Fagus grandifolia - Acer saccharum - Quercus spp. (alba, muehlenbergii, rubra), Mixed mesic forest (see David Graney, RNA nomination, Dismal Hollow), primarily Ozarks. Tilia americana may also occur, Acer is seldom in the community with Fagus.
- c. Fagus grandifolia - Acer spp. (rubrum, saccharum) - Liriodendron tulipifera (I), Mixed mesophytic forest, Crowley's Ridge.

II. Quercus alba - mixed hardwoods

- 2.a. Liriodendron tulipifera - Quercus alba, On Crowley's Ridge, typically dry sites.
- 3.a. Acer saccharum - Quercus spp. (alba, rubra) - Carya spp. (ovata, tomentosa, cordiformis), Most common community for A. saccharum in Arkansas. Ozarks, Coastal Plain.
- 4.a. Quercus alba - Carya spp. (ovata, tomentosa), Dry-mesic to mesic sites throughout state on uplands.
- b. Quercus alba - Liquidambar styraciflua - Carya tomentosa, Mesic to dry-mesic sites throughout state on uplands.
- c. Quercus alba - Quercus velutina - Quercus falcata, Mesic to dry-mesic communities throughout state on uplands, Quercus velutina most characteristic of southern Ozarks; Liquidambar styraciflua is common.
- 5.a. Quercus alba - Quercus stellata, Dry to dry-mesic sites in uplands throughout state.
- b. Quercus phellos - Quercus alba - Quercus falcata var. pagodifolia, Moist uplands, Arkansas River Valley, also with Liquidambar styraciflua.

- III. Quercus rubra - Quercus spp.
 - 6.a. Quercus rubra - Quercus alba, Mesic, north-facing slopes.
 - b. Quercus rubra - Quercus alba - Quercus velutina
 - IV. Quercus falcata - Quercus spp.
 - 7.a. Quercus shumardii - Quercus falcata, Dry-mesic sites, particularly in southwestern Arkansas, Ouachitas and Coastal Plain. Sometimes bottomlands.
 - b. Quercus falcata - Quercus alba - Quercus velutina, Dry to dry-mesic sites; perhaps same community as 4c, but probably drier sites.
 - V. Quercus stellata
 - 8.a. Quercus rubra - Quercus stellata - Quercus marilandica, Dry to xeric sites, northwest. Quercus rubra appears to have bimodal distribution: mesic and xeric.
 - b. Quercus stellata - Quercus (alba, velutina) - Carya texana, Dry sites, mostly northwest.
 - VI. 9.a. Liquidambar styraciflua, Old fields.
- 1.B.4.b. Montane cold-deciduous forest
- I 1.a. Quercus alba (stunted), Forest at high elevations in Ouachitas. Ice and wind are key physical factors. May have full canopy cover, but trees are less than 15 feet tall.
2. Woodland (26%-60% cover; trees over 5m tall)
- 2.A. Mainly evergreen woodland
 - 2.A.2 Evergreen needle-leaved woodland
 - 2.A.2.b. Evergreen needle-leaved woodland with conical crowns
 - I. Juniperus virginiana - Quercus spp.
 - 1.a. Juniperus virginiana - Quercus muehlenbergii, Throughout state, primarily on high pH, thin soils, unburned.
 - b. Juniperus virginiana - Quercus stellata, Throughout state, primarily on high pH, thin soils, unburned.
 - c. Juniperus virginiana - Quercus stellata - Fraxinus quadrangulata, Throughout state, primarily on high pH, thin soils, unburned, mostly dolomite.
 - 2.a. Juniperus virginiana - Liquidambar styraciflua, Old fields.
 - 2.B. Mainly deciduous or mixed woodland (25%-75% evergreen)
 - 2.B.3 . Cold-deciduous woodland with evergreen needle-leaved trees
 - 2.B.3.a. Mixed upland woodland, evergreens with rounded crowns
 - I. Pinus echinata - Quercus spp.
 - 1.a. Pinus echinata - Quercus stellata - Quercus marilandica (I), Xeric sites in northwest, Coastal Plain. Q. marilandica often var. ashei = Quercus X bushii.
 - b. Pinus echinata - Quercus alba - Quercus falcata, NW, Coastal Plain, Fire maintained.
 - 2.a. Pinus echinata - Quercus incana - Quercus arkansana, Sandhills of Coastal Plain.

- II. Juniperus ashei - Quercus spp.
 - 3.a. Juniperus ashei, Ozarks (dolomite outcrops) and Coastal Plain (chalk).
 - b. Juniperus ashei - Quercus sinuata (=durandii), Coastal Plain (White Cliffs, Little River County) on chalk.
 - c. Juniperus ashei - Quercus muehlenbergii - Fraxinus quadrangulata, Dolomite outcrops in Ozarks.
- 2.B.4. Cold-deciduous woodland (<25% evergreen)
 - 2.B.4.a. Cold-deciduous upland deciduous woodland
 - I. Quercus spp. - Carya texana
 - 1.a. Quercus alba - Quercus stellata, Xeric sites in northwest, occasionally elsewhere.
 - b. Quercus stellata - Quercus marilandica - Carya texana, Xeric sites in northwest, occasionally elsewhere. Sometimes stunted. Q. marilandica often var. ashei = Quercus X bushii.
 - 2.a. Quercus arkansana - Quercus incana, Sandhills of Coastal Plain.
- 4. Shrubland (shrubs <5m >25% cover; trees >5m <10% cover)
 - 4.A. Mainly evergreen shrubland
 - 4.A.2.a. Evergreen needle-leaved shrubland
 - I. Juniperus spp. - Quercus spp.
 - 1.a. Juniperus virginiana - Quercus muehlenbergii - Fraxinus quadrangulata, Rock outcrops of northwest.
 - b. Juniperus ashei - Quercus muehlenbergii - Fraxinus quadrangulata, Rock outcrops of northwest.
 - 4.B.3.a. Temperate deciduous shrubland
 - I. 1a. Quercus alba - Quercus stellata, In northwest, often at high elevation in Ouachitas.
 - II. Mixed shrub species
 - 2.a. Vaccinium spp. (arboreum, stamineum, pallidum), Usually on thin soils or rock outcrops, glades in northwest.
 - b. Crataegus spp. (marshallii, crus-galli), Thicket.
- 5. Herbaceous
 - 5.A. Tall Grassland
 - 5.A.1 Tall Grassland consisting mainly of sod grasses
 - 5.A.1.a. Tall dense upland grassland
 - I. Mesic Prairie
 - 1a. Tripsacum dactyloides, In moist to wet areas of prairies throughout state.
 - 1b. Panicum virgatum, In moist areas of prairies throughout state, particularly Grand Prairie of MAP.
 - 1c. Andropogon gerardii - Sorghastrum avenaceum, Mesic areas of prairies throughout state.

- 1d. Andropogon virginicus, Old fields.
- 5.B. Medium tall grassland
 - 5.B.1. Medium tall grassland consisting mainly of sod grasses
 - 5.B.1.a. Medium tall upland dense grassland
 - I. Dry Prairie
 - 1.a. Schizachyrium scoparium - In dry areas of prairies.
 - b. Sporobolus asper - Especially in Ozarks.
 - c. Bouteloua curtipendula - On very dry, thin soils.
- 5.C. Grasslands with a tree layer
 - 5.C.1. Tall Grasslands with a tree layer
 - 5.C.1.a. Evergreen needle-leaved tree layer
 - I. Schizachyrium - Andropogon - Pinus
 - 1.a. Schizachyrium scoparium - Pinus echinata - Quercus stellata, NW, fire and thin soils, savanna/barrens, glades. Andropogon gerdardii common.
 - 1.b. Andropogon virginicus - Juniperus virginiana, Old fields.
 - 5.C.1.b. Mainly deciduous or mixed tree layer
 - I. 1.a. Schizachyrium scoparium - Quercus spp. (stellata, shumardii, muehlenbergii), Oak savanna on thin soils, burned.
 - II. Dry Shrubby Grassland
 - 1.a. Bouteloua curtipendula - Quercus stellata - Juniperus virginiana, On thin soils and rock outcrops in northwest and Coastal Plain.
 - b. Schizachyrium scoparium - Ilex decidua - Fraxinus pennsylvanica, Blackland prairies of Coastal Plain.
 - c. Andropogon virginicus - Sassafras albidum, Old fields.
 - 5.C.3. Short grassland with a tree layer
- 6.C.3.b. Deciduous tree layer
 - I. 1.a. Aristida spp. - Quercus stellata, On saline soils.
- 6. Barren/sparsely vegetated
 - I. Sparsely vegetated area
 - 1.a. Bare rock, In northwest and Coastal Plain, glades.
 - b. Lichen covered rock, In NW, glades.
 - c. Talus, In northwest, particularly Ouachitas.
 - d. Chasmophytic vegetation (Juniperus spp. on rock), In northwest and Coastal Plain, glades.
 - 2.a. Eroding slopes, Throughout the state, particularly along streams.
 - 2.b. Bare Soil.
 - II. Fern - Moss
 - 3.a. Nonvascular plants - Fern (moist) or Moss (dry).
 - b. Shaded cliff (mosses, fern), In NW and Coastal Plain.

Palustrine

(These are distinguished at lower levels in the national classifications; that change can be made, but if so it will be harder to find the wetland communities.)

1.B.3.c. Cold deciduous alluvial forest

I. Quercus lyrata

- 1.a. Quercus lyrata - Carya aquatica, In bottomlands flooded less than 50% (ca. 20%-40%). Throughout except Ozarks and Crowley's Ridge.
- b. Quercus lyrata - Carya aquatica - Fraxinus spp., In bottomlands flooded less than 50% (ca. 20%-40%), Throughout except Ozarks, and Crowley's Ridge.
- c. Quercus lyrata - Carya aquatica - Quercus nuttallii (= texana), In bottomlands flooded less than 50% (ca. 20%-40%), Throughout the state except Ozarks, and Crowley's Ridge.
- 2.a. Quercus lyrata - Quercus phellos, Poorly drained bottomlands subject to long-duration flooding, Primarily Coastal Plain, MAP.
- b. Quercus lyrata - Quercus phellos - Carya ovata, Poorly drained bottomlands subject to long-duration flooding, Primarily Coastal Plain, MAP.
- c. Quercus lyrata - Quercus phellos - Quercus nuttallii (= texana), Poorly drained bottomlands subject to long-duration flooding, Primarily Coastal Plain, MAP.
- d. Quercus lyrata - Quercus phellos - Liquidambar styraciflua, Poorly drained bottomlands subject to long-duration flooding, Primarily Coastal Plain, MAP.
- 3.a. Quercus lyrata - Celtis laevigata - Carya aquatica, Primarily MAP.
- b. Quercus lyrata - Celtis laevigata - Fraxinus pennsylvanica, Primarily MAP.
- c. Quercus lyrata - Gleditsia aquatica - Celtis laevigata, Primarily MAP.
- 4.a. Quercus lyrata - Quercus nuttallii (= texana) - Liquidambar styraciflua, In better-drained low bottoms, mostly southeast.
- b. Quercus lyrata - Quercus nuttallii (= texana) - Quercus phellos, In better-drained low bottoms, mostly southeast.

II. Carya aquatica

- 5.a. Carya aquatica, Primarily MAP.
- b. Carya aquatica - Fraxinus pennsylvanica - Quercus lyrata, Primarily MAP.

III. Quercus falcata var. pagodifolia

- 6.a. Quercus falcata var. pagodifolia - Quercus phellos - Liquidambar styraciflua, In bottomlands not subject to long duration flooding.
- b. Quercus falcata var. pagodifolia - Quercus alba - Quercus stellata, In bottomlands not subject to long duration flooding.
- c. Quercus falcata var. pagodifolia - Quercus michauxii - Quercus phellos, In bottomlands not subject to long duration flooding.
- 7.a. Quercus falcata var. pagodifolia - Quercus nuttallii (= texana), In bottomlands subject to moderate duration flooding.

IV. Celtis laevigata

- 8.a. Celtis laevigata - Carya aquatica, In poorly drained bottomlands, MAP.
- b. Celtis laevigata - Fraxinus pennsylvanica - Carya illinoensis, Generally sandy, poorly drained bottomlands.
- 9.a. Celtis laevigata - Fraxinus pennsylvanica - Ulmus americana, In poorly drained bottomlands, MAP.
- b. Celtis laevigata - Ulmus crassifolia - Fraxinus spp., In poorly drained bottomlands, MAP.

V. Quercus nuttallii (=texana)

- 10.a. Quercus nuttallii (=texana) - Quercus lyrata - Quercus phellos, In bottomlands subject to medium to long duration flooding, mostly southeast.
- b. Quercus nuttallii (=texana) - Quercus lyrata - Liquidambar styraciflua, In bottomlands subject to medium to long duration flooding, mostly southeast.
- c. Quercus nuttallii (=texana) - Quercus lyrata - Carya aquatica, In bottomlands subject to medium to long duration flooding, mostly southeast.
- d. Quercus nuttallii (=texana) - Quercus lyrata - Fraxinus spp., In bottomlands subject to medium to long duration flooding, mostly southeast.
- 11.a. Quercus nuttallii (=texana) - Celtis laevigata - Fraxinus pennsylvanica.
- b. Quercus nuttallii (=texana) - Celtis laevigata - Ulmus spp.

VI. Quercus palustris

- 12.a. Quercus palustris - Quercus lyrata - Carya laciniata.
- b. Quercus palustris - Fraxinus pennsylvanica - Quercus phellos.
- c. Quercus palustris - Quercus phellos - Quercus lyrata.
- d. Quercus palustris - Quercus phellos - Liquidambar styraciflua.

VII. Quercus phellos

- 13.a. Quercus phellos.
- 14.a. Quercus phellos - Quercus palustris - Carya aquatica.
- b. Quercus phellos - Quercus palustris - Quercus lyrata.
- c. Quercus phellos - Quercus laurifolia.
- d. Quercus phellos - Quercus nigra.
- 15.a. Quercus phellos - Quercus lyrata.

1.B.3.d. Cold-deciduous swamp forest

I. Taxodium distichum - mixed hardwood

- 1.a. Taxodium distichum, In long-duration swamps, throughout except Ozarks and Crowley's Ridge.
- b. Taxodium distichum - Nyssa aquatica, In long-duration swamps, throughout except Ozarks and Crowley's Ridge.
- 2.a. Taxodium distichum - Quercus lyrata, In bottomlands flooded ca. 50% of the year throughout state.
- b. Taxodium distichum - Quercus lyrata - Fraxinus spp.

II. Nyssa

- 3.a. Nyssa aquatica.
- b. Nyssa aquatica - Nyssa biflora - Taxodium distichum.
- 4.a. Magnolia virginiana - Nyssa (aquatica, sylvatica), Seeps

and occasionally streambanks in Coastal Plain.

4.B.3.c. Deciduous alluvial shrubland

I. Cornus amomum

1.a. Cornus amomum, Stream floodplains, northwest.

II. Mixed shrub

2.a. Planera aquatica, Bottomlands subject to long-term inundation, mostly southeast.

3.a. Forestiera acuminata, Bottomlands subject to moderate to long-term inundation, mostly southeast.

4.a. Cephalanthus occidentalis, On areas subject to long-term inundation throughout the state.

5.A.4.a. Tall grass

I. Tall grass

1.a. Tripsacum dactyloides, Moist prairies.

2.a. Panicum virgatum, Moist to wet prairies.

5.A.4.b. Tall grass consisting mainly of bunch grasses

I. Tall grass

1.a. Schizachyrium scoparium - Panicum virgatum, Wet sites, occasionally flooded, usually in prairies throughout.

II. Typha - Zizaniopsis Marsh

2.a. Typha latifolia, Open areas subject to long-term inundation, throughout.

3.a. Zizaniopsis milinacea, South, swamps and marshes.

III. 4.a. Arundinaria gigantea, Common understory, becomes dominant when overstory is removed, e.g., by fire or cutting.

5.B.2.c. Medium tall vegetation with deciduous shrub layer

I. Fen

1.a. Parnassia grandifolia - Carex lurida, Fen - high pH ground water seepage.

II. Sedge - rush

2.a. Scirpus spp. - Juncus spp.

3.a. Carex spp. - Osmunda spp. - Sphagnum spp., Acid seeps.

Riverine

1.B.3.c. Forest

I. Populus - mixed hardwood

1.a. Acer negundo - Carya illinoensis - Populus deltoides, Also Acer rubrum, Platanus occidentalis. Riverfronts.

2.a. Populus deltoides, Riverfronts, usually sandy, throughout the state.

b. Populus deltoides - Quercus lyrata - Quercus nuttallii, Riverfronts, usually sandy, throughout the state.

- c. Populus deltoides - Salix nigra - Celtis laevigata,
Riverfronts, usually sandy, throughout the state.
 - 3.a. Salix nigra, In poorly drained riverfronts.
 - II. Betula - Platanus - Acer Riverfront
 - 4.a. Betula nigra - Platanus occidentalis, On well-drained
riverfronts, primarily NW.
 - 5.a. Acer saccharinum - Ulmus americana, In infrequently flooded
bottomlands, primarily northwest.
 - 4.B.3.c. Shrub
 - I. Shrub willow
 - 1.a. Salix caroliniana, Gravel, sand bars in northwest.
 - 2.a. Salix exigua, Gravel, sand bars, ditchbanks, throughout the
state.
 - 5.A.1.c. Herbaceous with woody layer broad-leaved deciduous
 - I. 1.a. Xanthium strumarium - Cynodon dactylon (alien) - Populus
deltoides, Sandbars.
 - 6. Barren
 - I. Bare
 - 1.a. Sand bar
 - 1.b. Gravel bar
 - 2.a. Mud flat
 - 3.a. Eroding bank
- Lacustrine
- 1.B.3.d. Forest
 - I. 1.a. Taxodium distichum - Nyssa aquatica, Shallow lakes and
margins of others, mostly southeast.
 - 4.B.3.c. Shrub
 - I. 1.a. Cephalanthus occidentalis, Shallow lakes and margins of
others, mostly southeast.
 - 5.D.2.a. Herbaceous
 - I. Marsh
 - 1.a. Nuphar lutea, Shallow to medium depth lakes, mostly
southeast.
 - 2.a. Typha latifolia, Open shallow edges, throughout.
 - 3.a. Scirpus spp. - Juncus spp., Open shallow edges, throughout.
 - 6. Barren
 - I. 1.a. Mud flat