DRAFT

Fire Regime Condition Class (FRCC) Interagency Handbook Reference Conditions

Modeler: Will McDearman **Date:** 12/17/2004 **PNVG Code:** CEGL

Potential Natural Vegetation Group: Cedar Glades (Kuchler 83)

Geographic Area: Central, east, and southeast U.S.; n. AL, AR, nw. GA, KY, s. IL, s. IN, LA, MO, NC, s. OH, se. OK, SC, TN, VA, WVA, TN -- including the Interior Low Plateau, West Highland Rim, Northern Rim, Eastern Rim, Central Basin, Ridge and Valley, Cumberland Plateau, Piedmont, and w. Gulf Coastal Plain.

Description:

Cedar glades, as the term is classically used, are natural treeless or virtually treeless herbaceous-dominated vegetation in unglaciated areas of the eastern U.S., on shallow soil, typically with limestone or dolomite at or near the surface (Steyermark 1940, Quarterman 1950). Eastern red cedar (*Juniperus virginiana* var. *virginiana*) is mostly associated with calcareous glades on their margins near adjacent woodlands or forest, frequently on deeper soil, but does not naturally form a significant component or cover within the glades. As used for this PNVG, cedar glades also include cedar “barrens”. Glades and barrens have been distinguished by soil depth and bedrock exposure, with xeric and subxeric “glades” on thinner soil (< 20 cm) having less than 50% cover of perennial grasses. “Barrens” produce more than 50% cover by perennial grasses (Quarterman 1989). The distinction is somewhat artificial since gradients of bedrock exposure and soil depth exist within and among sites. Distinctive floristic and vegetation differences occur, however, across these gradients. Also, this PNVG represents glade and barren communities on chert, igneous, sandstone, and shale bedrock, such as the Central Interior Highlands Dry Acidic Glade and Barrens of the Ozark, Ouachita, and Interior Highlands (e.g. NatureServe 2004).

Vegetation dynamics are significantly affected by bedrock exposure and soil depth, creating glade vegetation mosaics of xeric rock glade, grass-forb, grass-forb-shrub, and open woodland (Quarterman 1950, 1989). Glades by the narrowest definition traditionally refer to the most xeric associations of annual forbs and grasses. As applied in this PNVG, glades represent the mosaic of associations. Xeric and subxeric rock glades with thin soil mats and patchy cover of annual forbs and grasses are edaphically regulated (Quarterman et al. 1993), representing sub-climax or climax development (Quarterman 1950, Baskin and Baskin 1973). Glades (barrens) with deeper soils (>20 cm) supporting a ground cover of perennial grasses and forbs produce sufficient fuel to carry fire, primarily from ignition in adjacent woodlands and forests. Fire exclusion has favored the invasion of eastern red cedar and other intolerant species on the edge of glade complexes on deeper soil. Indirectly, fire exclusion has stimulated the invasion of cedar from these edges to bedrock fissures and cracks within the xeric glades where soil is available for tree growth.

Overall, the PNVG is represented by the *Sedum pulchellum* Saturated Alliance (Widow’s-cross Saturated Alliance) in vernal pools and depressions on shallow soil glades, the *Sporobolus (neglectus, vaginiflorus)* Herbaceous Alliance (Barrens Dropseed, Poverty Dropseed Herbaceous Alliance) of calcareous and diabase glades, the *Bigelowia nuttallii* Herbaceous Alliance (Nuttall’s Rayless-goldenrod Herbaceous Alliance) on sandstone glades, and part of the *Juniperus virginiana* / *Schizachyrium scoparium – Bouteloua curtipendula* Wooded Herbaceous Alliance (Eastern Red-cedar / Little Bluestem – Sideoats Grama Alliance) as it is associated with glade edaphic and geological conditions (NatureServe 2004). Glades also include shrub and wooded-herbaceous vegetation alliances, as well as different vegetation associations within these alliances (NatureServe 2004).

Glades may occur as small, relatively isolated patches of a few acres amid other forest types or, historically at least, large areas of glade mosaics in association with other vegetation types up to 600 square miles in the Central Basin of Tennessee, Alabama and Kentucky (e.g. Pyne 2000). Glades are well-known for their endemism, with at least 25 endemic or near endemic species in the southeast (Baskin and Baskin 1985), four of which are federally listed as endangered or threatened and most others are considered imperiled to various degrees. While endemics often are diagnostically associated with glade associations, glade and prairie floras are highly similar (Bridges and Orzell 1986. At least 50% of glade habitat has been lost since settlement (Noss and Peters 1995, Noss et al. 1995).

See additional descriptions below, including modeling issues.

Fire Regime Description: Fire Regime Group I.

Vegetation Type and Structure

See notes below for additional description.

Class*	Percent of Landscape	Description
A: post replacement	31	0-4 yrs. Represents xeric pioneer-phases of lichen-algae-annual forb glade vegetation development (< 15% cover) on thin soil (< 5 cm) over bedrock or exposed bedrock, and subxeric annual grass-forb associations (<50% cover) on shallow soil (5 – 20 cm) which persist for long periods; and post-fire perennial grass-forb associations from barrens and open woodlands on deeper soil (<75% cover).
C: mid- seral open	31	5-44 yrs. Perennial grasses and forbs on soils > 20 cm over bedrock, > 50% cover. Trees may be widely scattered, small and stunted.
D: late- seral open	38	45+ yrs. Open woodland (< 60% cover) on deeper soil over bedrock, including short and stunted trees, with perennial grass-forb ground cover (>50% cover).
Total	100	

*Formal codes for classes A-E are: AESP, BMSC, CMSO, DLSO, and ELSC, respectively.

Fire Frequency and Severity

Fire Severity	Fire Frequency (yrs)	Probability	Percent, All Fires	Description
Replacement Fire	200	0.005	2	In C and D
Non-Replacement Fire	4.9	0.205	98	SurfFire C & D, Mosaic D
All Fire Frequency*	4.8	0.210	100	

*All Fire Probability = sum of replacement fire and non-replacement fire probabilities. All Fire Frequency = inverse of all fire probability (previous calculation).

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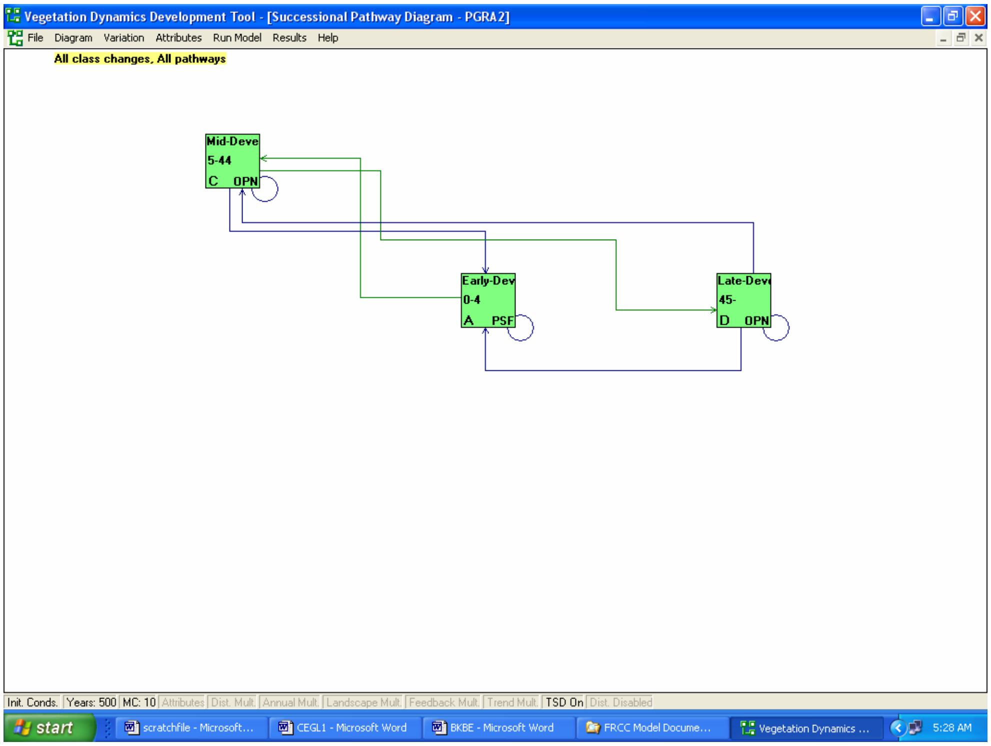
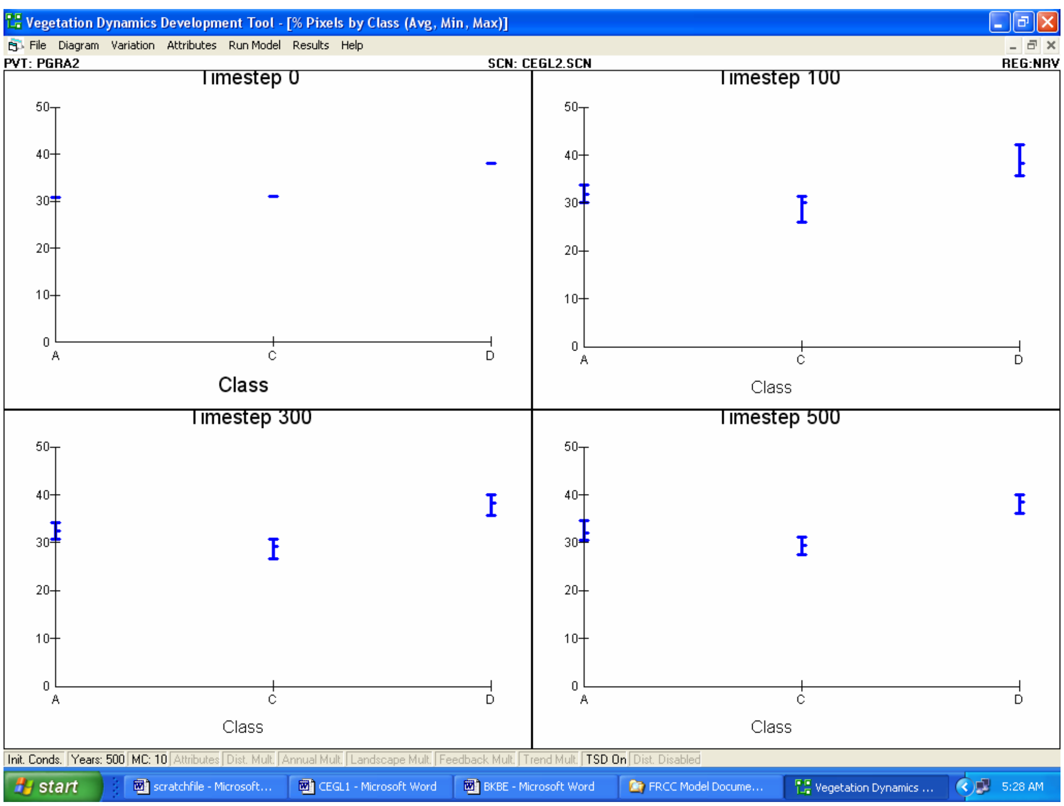
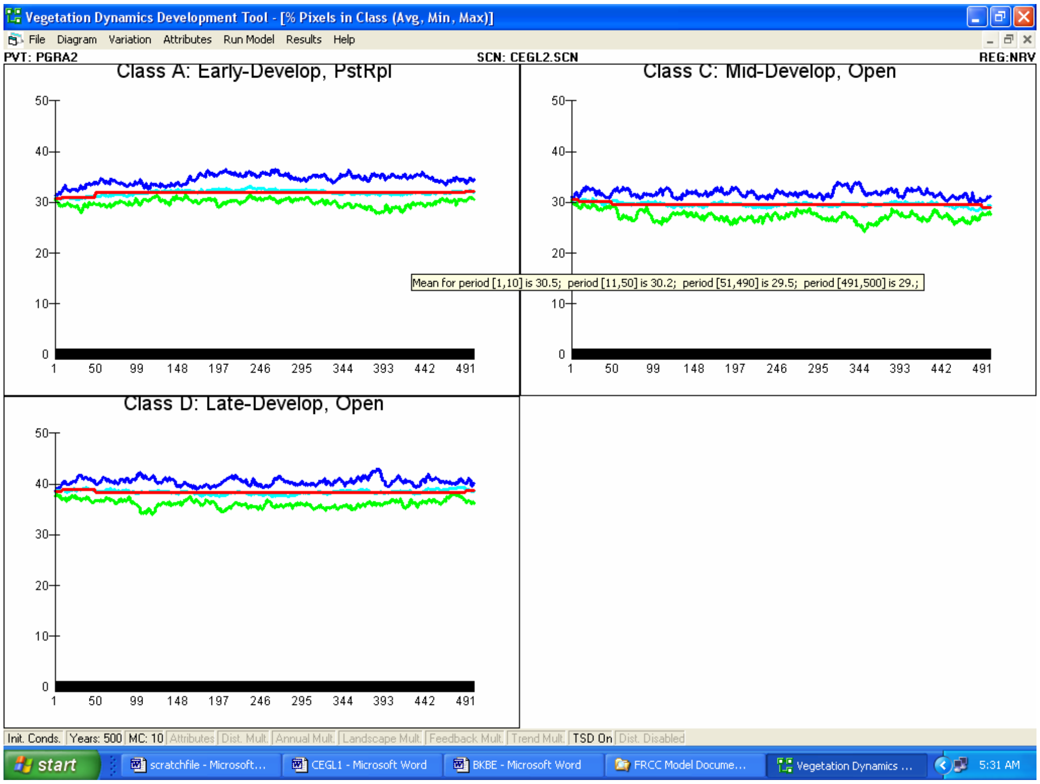
PERSONAL COMMUNICATION (if applicable):

VDDT File Documentation
Include screen captures (print-screens) from any of the VDDT graphs that were used to develop reference conditions.



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Class D: Late-Develop, Open
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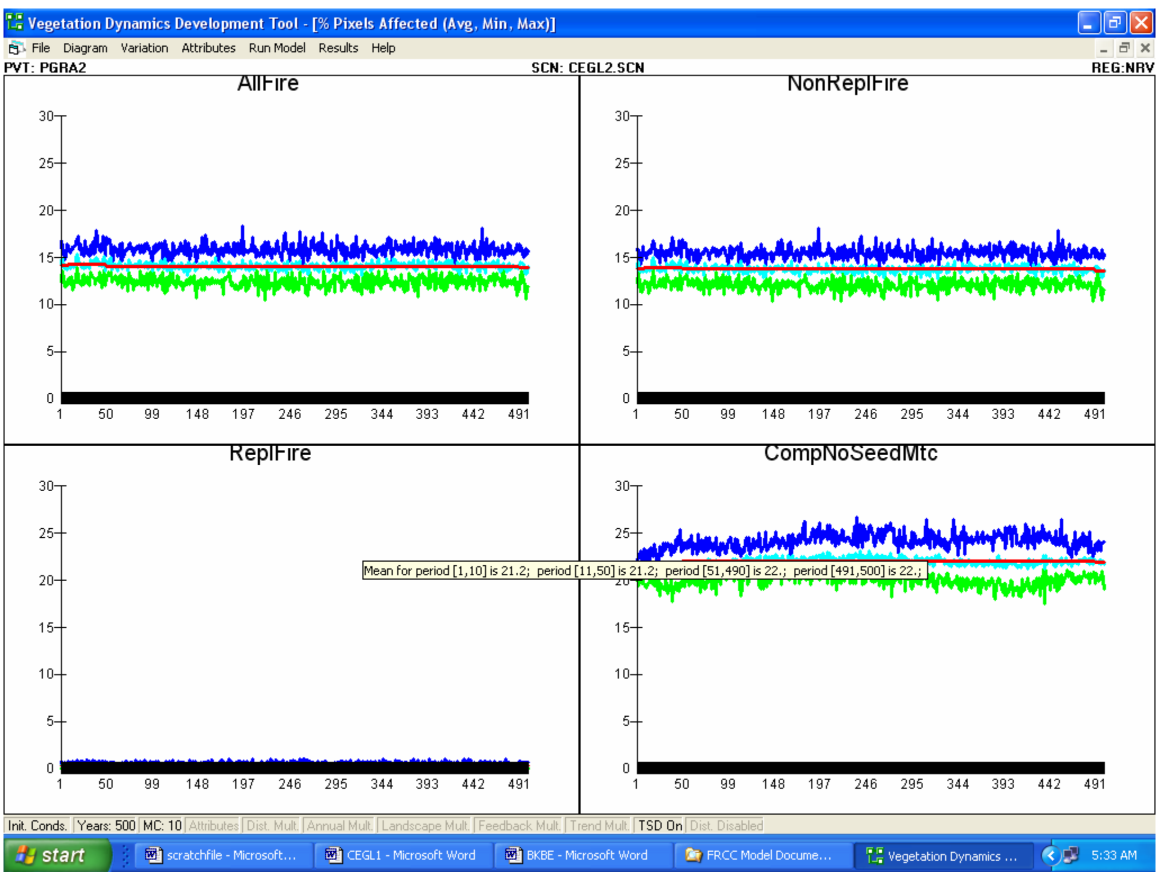
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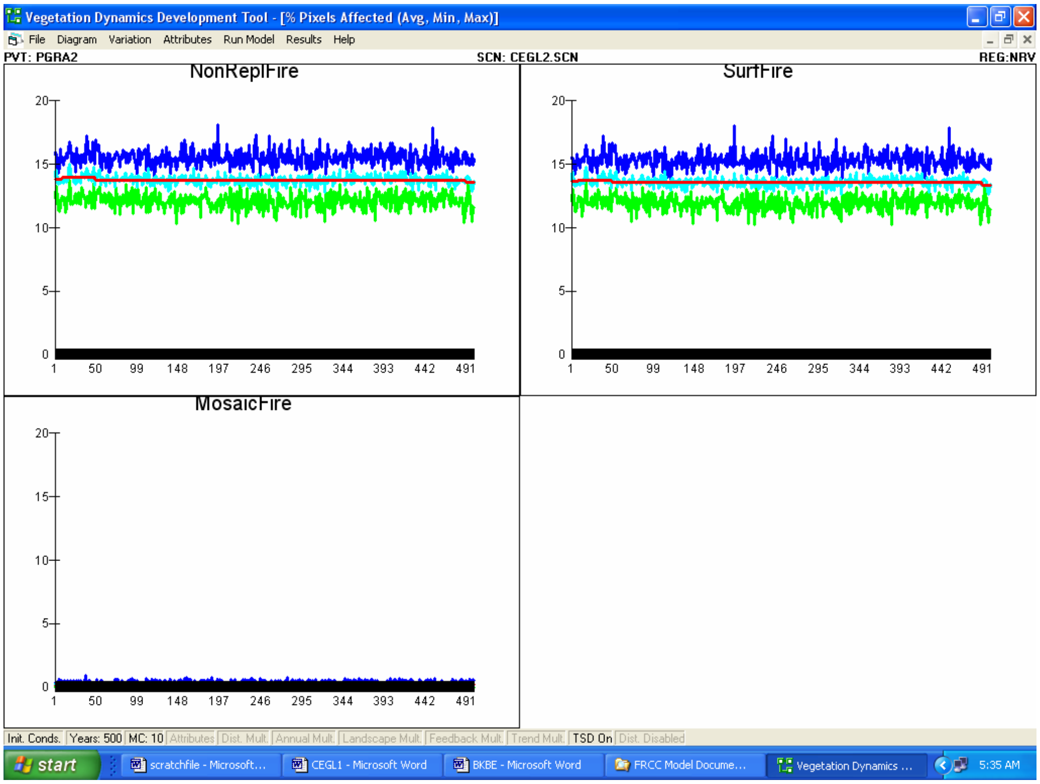
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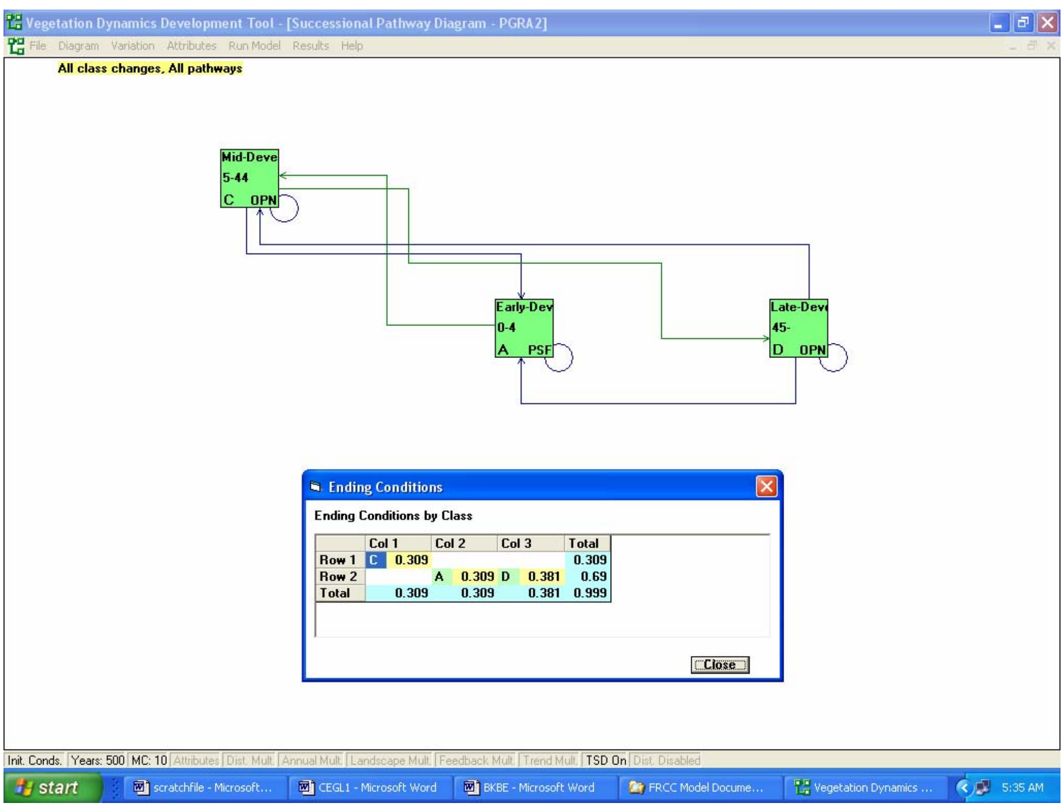
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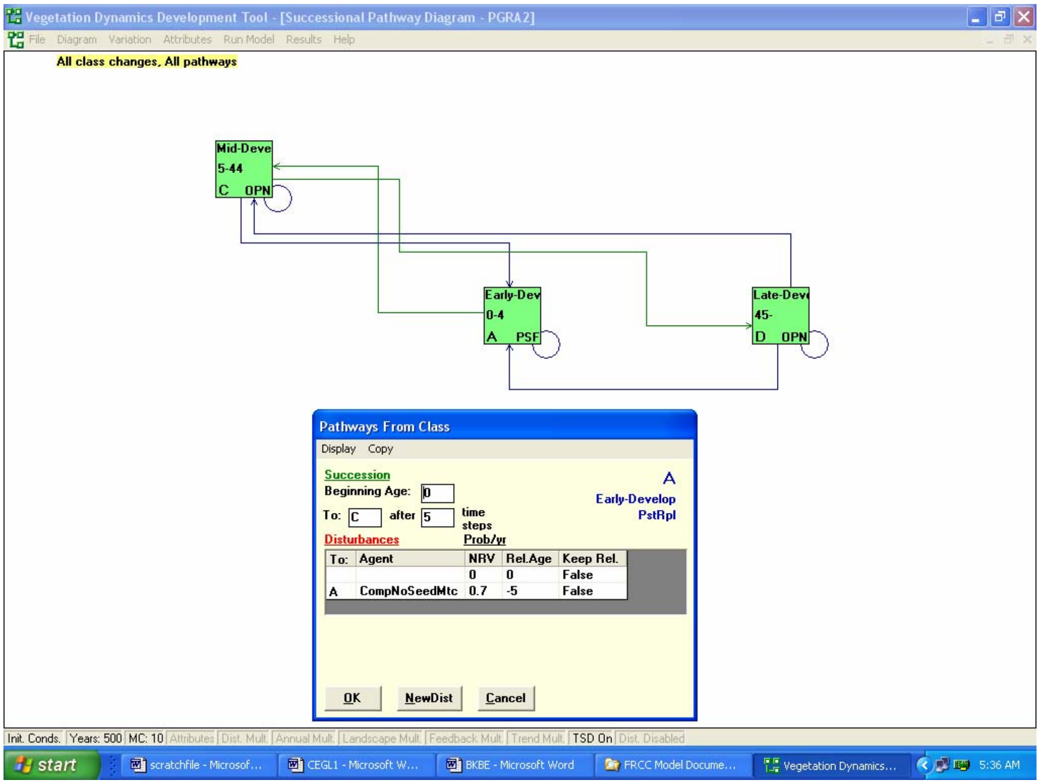
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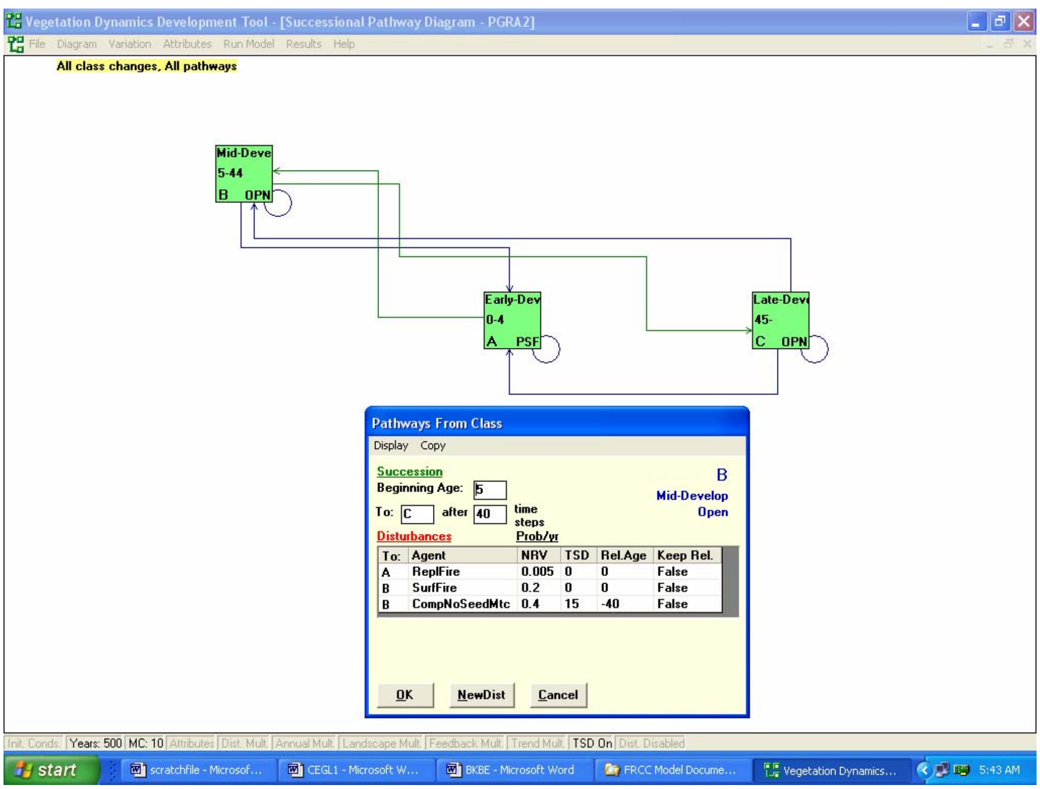
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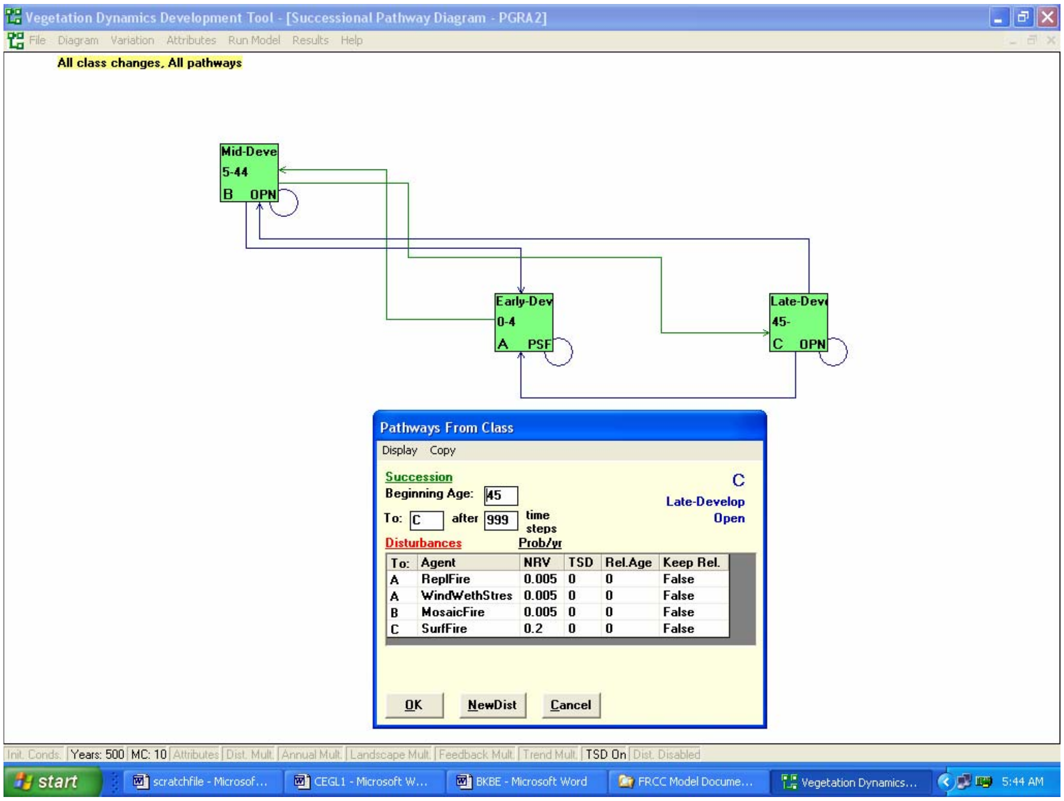
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Description (continued) and model notes

Glades are among the most distinctive plant communities of eastern and midwestern states. As a PNVG for modeling purposes, however, the variation among glades across different physiographic, geological, and floristic regions challenges the ability of a single model to accurately represent the type throughout its range. The proportion of each class generated by this model may or may not represent site, local, or regional conditions due to such heterogeneity. Revisions to this model and perhaps entirely different models likely will be needed for more regional and local applications.

<u>Class A</u>

This class is a heterogeneous group of early seral vegetation. The most distinctive is the xeric and subxeric pioneer associations on exposed rock and thin soil over bedrock.
Xeric glades have the least vegetative cover (about 15% or less), with thin (< 5 cm) and scattered soil mats among exposed bedrock, dominated by annual forbs and grasses, many of which flower and reproduce in spring before summer drought, frequently in vernal pools and depressions. On limestone and dolomite, these species include widow's cross (*Sedum pulchellum*), gladecress (*Leavenworthia* sp.), limestone fameflower (*Talinum calcaricum*), poverty dropseed (*Sporobolus vaginiflorus*), old witch panic grass (*Panicum* capillare), and common nostoc algae (*Nostoc commune)* and foliose lichens. Endemics (*Dalea gattingeri* – Gattinger prairie clover, gladecress, limestone fameflower, and others) also distinguish these glades in Tennessee and Alabama. Similar vegetation occurs on shale glades in the Ozark Mountains (Interior Highlands Shale Glade), apart from endemics.

The cover and diversity of annual grasses and forbs increase and dominate on subxeric glades, with deeper soil (5 – 20 cm). Total cover remains sparse, usually 50% or less. On limestone glades poverty dropseed and wiry witchgrass (*Panicum flexile*) can dominate the community. Other species may include hairy wild petunia (*Ruellia humilis*), brown-eyed Susan (*Rudbeckia triloba*), small skullcap (*Scutellaria parvula*), savory (*Calamintha glabella*), false aloe (*Manfreda virginica*), and round-fruit St. John's wart (*Hypericum sphaerocarpum*). In the Ozarks, poverty dropseed is replaced by Ozark poverty dropseed (*Sporobolus vaginiflorus* var. *ozarkanus*). Perennial grasses such as little bluestem may occur, though usually as a minor, widely scattered component. Both xeric and subxeric glades include foliose lichens.

Xeric and, to somewhat lesser extent, subxeric vegetation on bedrock and thin soils may persist for long periods as subclimax or climax associations. The dynamics of vegetation or seral development accompanies the process of soil formation over centuries, well outside the scope of this 500-year model. Erosion of shallow soil during heavy rain by sheet flow across bedrock is a natural disturbance that also regulates glade soil development (Crawford and Barr 1988, Quarterman et al. 1993). Accordingly, the xeric and subxeric components of this class would not be expected to develop or transition to other modeled classes. Thus, Class A represents an end-point for these most distinctive elements of glade vegetation. With sparse cover and biomass, fuels are inadequate to carry fire.

To retain the xeric and subxeric pioneer elements within Class A, the CompNoSeedMtc disturbance function was used to represent ecologically limiting conditions for vegetation or successional development. By this rationale, seed sources, soil, moisture, and other factors prevent transitional development. The Class A time frame, from 0 – 4 years, would seem to contradict this representation, but the function at least in practice would repeatedly cycle a percentage of elements in Class A before reaching the time of development to transition to Class C over the 500-year model interval. Those retained in Class A, for the most part, are considered to be the xeric and subxeric elements as explained further below. No data are available for determining the annual probability of the CompNoSeedMtc disturbance. Moreover as used in this model, the value (0.7) rather arbitrarily represented that which generated an acceptable proportion of all classes relative to the dynamics of Class C and D. The Rel.Age function was used in conjunction with CompNoSeedMtc to reset time to step 0.

To the extent that xeric and subxeric associations are an edaphic and geological subclimax and climax, it could be argued that these glade elements should be classified and modeled independently of this PNVG. To do so, however, would ignore the effects of fire in adjoining perennial grass-forb and open woodland-herbaceous associations. Such fire eliminates the encroachment of fire intolerant species on the margins of xeric and subxeric glades. Directly or indirectly, fire in these mosaics control the invasion of shrubs, cedar, and hardwoods by eradicating seed sources and colonization to deeper soil in fissures and cracks within the xeric and subxeric glades. Once established, shade and litter from woody species adversely affects the glade herbaceous flora.

Class A also includes post replacement fire perennial grasses and forbs on deeper soils from Class C and D (barrens and open woodland). In contrast to the xeric and subxeric glades, any post-fire reduction in the cover of vegetation from these sites is initiated during the Class A interval. Transitions from Class A to C would consist, in principal, of these elements.

<u>Class C</u>

This class is characterized by grass-forb glades (barrens) with soils greater than 20 cm, usually dominated by mid-tall perennial prairie grasses and forbs, typically little bluestem, and including sideoats grama, big bluestem (*Andropogon gerardii*), yellow Indian grass (*Sorghastrum nutans*), tall dropseed (*Sporobolus compositus*), old switch panic grass (*Panicum virgatum*), and others. Forbs and sedges include tall gayfeather (*Liatris aspera*), elliptical rushfoil (*Croton willdenowii*), sand coreopsis (*Coreopsis lanceolata*), rosin-weed species (*Silphium* sp.), false dragon-head (*Physostegia virginiana*), gray-head prairie coneflower (*Ratibida pinnata*), pale purple coneflower (*Echinacea pallida*), and bristleleaf sedge (*Carex eburnea*). Species composition can vary among sites, substrates, and geographic regions. Endemic species inhabit perennial grass-forb associations, though many endemics tend to be more abundant or strongly associated with xeric and subxeric glades on shallower soil. Generally, glade endemics do not tolerate competition, cover, or shade from woody species or a well-developed herbaceous stratum.

The herbaceous cover usually is greater than 50%, although gradients and mosaics due to soil depth and bedrock exposure exist at fine and coarse scales. Class B may also include grass-forb-shrub associations that, naturally, tend to be herbaceous dominated. Shrubby species can include winged sumac (*Rhus copallina*), coral-berry (*Symphoricarpos orbiculatus*), common hoptree (*Ptelea trifoliate*), rusty black haw (*Viburnum rufidulum*), gum bumelia (*Sideroxylon lanuginosum*), and dwarf hackberry (*Celtis tenuifolia*). Stunted or poorly developed eastern red-cedar, chinquapin oak (*Quercus muhlenbergii*), post oak (*Q. stellata*) and others may occur on shallow soils.

There are no fire studies specific to glades well within the temperate deciduous forest formation, yet fire has been recognized as an important feature within medium and tall perennial grass-forb associations (barrens) on deeper soils (e.g. DeSelm 1989, Somers et al. 1983). In a fire scar study of a Missouri cedar glade with relatively well-developed tall grasses, Guyette and McGinnes (1982) estimated a 3.2-year fire interval prior to 1870. The probability of surface fire in this PNVG model is 0.2 (5-year). While the frequency could be greater, it is not a significant factor affecting dynamics by this model structure.

The little bluestem association on deeper soils of this PNVG class is still underlain by bedrock that affects tree growth and development. This factor is incorporated by the CompNoSeedMtc disturbance function, with Rel.Age, to represent an ecologically limiting factor similarly to that used for Class A. As an alternative, a time-since-disturbance (TSD) function could be used in future models for the interval without fire during which seedlings and saplings would be successfully established, transitioning to Class D. As modeled, however, the CompNoSeedMtc disturbance function with Rel.Age recycles and increases the percentage of this class that fails to transition to Class D. Otherwise, the pathway extends to Class D after 40 years of development.

Intense natural fire characteristic of replacement fire as modeled for this class is not known to have been reported or observed. The probability of replacement fire, at 0.005, was incorporated from information and other models concerning forest PNVGs where some data is available. Replacement fire for this PNVG would tend to occur after drought and intervals without fire. In addition to mortality of woody plants, some mortality would be expected in the herbaceous layer. Replacement fire, whether from Class C or Class D, is the only pathway to Class A. Model output is somewhat sensitive to more frequent replacement fire.

Class D

This is an open woodland-herbaceous association, with a well-developed herbaceous ground layer characteristic of the grass-forb and grass-forb-shrub associations of Class C, though with less cover in association with tree cover. The herbaceous layer still is adequately developed to produce sufficient fuel to carry surface and replacement fire. Trees of the open canopy would include eastern red-cedar on calcareous sites, with chinquapin oak, post oak, black jack oak (*Quercus* marilandica), blue ash (*Fraxinus quadrangulata*), and other species (including pine) that may vary geographically and geologically. The woodland association tends to be on the edge and margins of the other glade classes. Tree cover is 60% or less, and sufficiently open to be distinguished from other more closed and widespread forest PNVGs for similar species. Extant sites with closed forest in proximity to more open glades probably are unnatural in many instances, developing due to fire exclusion.

Ecological Systems -- NatureServe

The following represent Ecological Systems (e.g. Central Appalachian Alkaline Glade and Woodland) that would be or potentially be represented by this PNVG. Each system also consists of component vegetation associations (e.g. *Juniperus virginiana / Bouteloua curtipendula – Carex eburnean* Wooded Herbaceous Vegetation). A list and description of respective associations for each system is available on NatureServe Explorer (NatureServe 2004).

Central Interior Highlands Calcareous Glade and Barrens
Central Interior Highlands Dry Acidic Glade and Barrens
Nashville Basin Limestone Glade
Alabama Ketona Glade and Woodland
Cumberland Sandstone Glade and Barrens
Central Appalachian Alkaline Glade and Woodland
Southern and Central Appalachian Mafic Glade and Barrens
Ridge and Valley Calcareous Valley Bottomland Glade and Woodland
Southern Piedmont Glade and Barrens
Southern Piedmont Mafic Hardpan Woodland
Ouachita Novaculite Glade and Woodland
West Gulf Coastal Plain Nepheline Syenite Glade