DRAFT

Fire Regime Condition Class (FRCC) Interagency Handbook
Reference Conditions

Modeler: Will McDearman **Date:** 4 Dec, 2004 **PNVG Code:** BKBE

Potential Natural Vegetation Group: Black Belt – eastern variant (Kuchler #89)

Geographic Area: Gulf Coastal Plain, in the Black Belt physiographic region of Mississippi and Alabama; the Jackson Prairie region of Mississippi; the Chunnenugee Hills, Red Hills, and Lime Hills of Alabama in Washington, Wilcox, Monroe and Clark Counties; central, north central and western Louisiana; and southwestern Arkansas.

Description: A southeastern dry-mesic tallgrass vegetation type, united by the relative abundance of little bluestem, (*Schizachyrium* scoparium) and yellow Indian grass (*Sorghastrum nutans*), with other affiliated species including big bluestem (*Andropogon* gerardii), eastern gamma grass (*Tripsacum dactyloides*), composite dropseed (*Sporobolus compositus*), sideoats grama (*Bouteloua curtipendula*), white prairie clover (*Dalea candida)*, purple prairie clover (*Dalea purpurea*), pale purple coneflower (*Echinacea pallida*), Liatris (*Liatris* sp.), and rosin-weed (*Silphium*) on clayey, heavy, usually calcareous soils with carbonatic or montmorillonitic mineralogy. The vegetation occurs in association with formations of the Tertiary Jackson (Yazoo Clay), Claiborne (Cook Mountain) and Fleming groups; and the Cretaceous Selma group (Selma or Demopolis chalk). Floristic similarity among sites across this geographic range generally appears to be 50% or greater, although a number of different alliances within this type have been recognized according to dominant, co-dominant, and diagnostic species. Extant prairies occur in single patches as well as mosaics less than one acre to over several hundred acres in response to soil depth, slope and fire. Mosaics may include virtually treeless patches, associated with other patches of widely scattered trees, and open woodlands. Woody species include post oak (*Quercus stellata*), black jack oak (*Q. marilandica*), black oak (*Q. velutina*), southern red oak (Q. falcata), chinquapin oak (*Q. muhlenbergii*), Durand oak (*Q. sinuata* var. *sinuata*), American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), bois d'Arc (*Maclura pomifera*), and cedar (*Juniperus virginiana*). This PNVG represents a southeastern component of the Little Bluestem – Yellow Indiangrass Herbaceous Alliance, as classified by NatureServe. It is a rare and imperiled vegetation type with scattered remnants, where most of the original cover has been destroyed or altered by conversion to agriculture and the exclusion of fire. See additional description below.

Fire Regime Description: Fire Regime Group I, frequent surface fires, including ignition by native Americans.

Vegetation Type and Structure

Class*	Percent of Landscape	Description
A: post replacement	1	0-5 yrs. Almost bare to relatively sparse grass-forb cover (≤ 50%) on sites previously covered by open or relatively closed woodland (D & E), with at least some hardwood vegetative sprouts. Similar cover on sites of former prairie classes on very thin soil. Greater cover on replacement sites from mid-seral prairie classes on deeper soils.
B: mid-seral closed	10	4+ yrs. Grass-forb cover increasing with growth from post replacement conditions, reaching 75-100% cover upon recovery. Sites usually associated with deeper soils over parent chalk or

		clay. Trees present, though widely scattered or occasionally clumped, ≤ 20% total cover, with all stage classes at older sites, established by periodic recruitment during intervals of 5 years or more without fire.
C: mid- seral open	67	6+ yrs. Grass-forb prairie, 75-100% herbaceous cover, virtually treeless or with fewer trees, ≤ 5% tree cover, and usually on more shallow soil than B. Trees established and recruited similarly to class B, but from fewer seed sources and with slower growth as seedlings and very small saplings due to soils, increasing the time interval of susceptibility to fire mortality at very young or small size classes relative to the same fire interval in B.
D: late- seral open	10	20+ yrs. An open woodland, gallery, or savanna-like prairie, 20 – 60% tree cover, frequently as strands on the edge of class C. Well developed ground cover in open areas, with sparse cover directly under canopies.
E: late- seral closed	12	19+ yrs. 21-100% percent tree cover. Herbaceous ground cover ranging from relatively well developed on sites with less tree cover, to sparse, and virtually absent on sites where canopy is complete.
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	1	Wind driven late growing season fire, after intervals without fire and fuel accumulation.
Non-Replacement Fire	3	0.333	99	Surface fire.
All Fire Frequency*	3	0.338	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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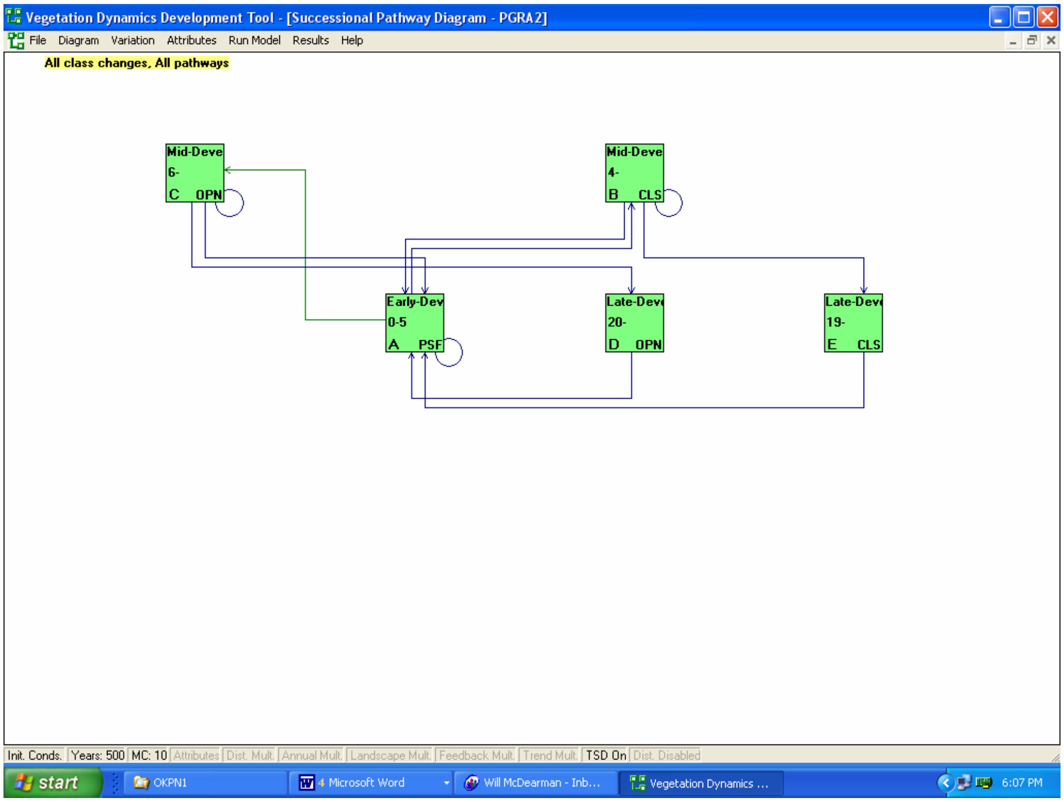
VDDT File Documentation
Include screen captures (print-screens) from any of the VDDT graphs that were used to develop reference conditions.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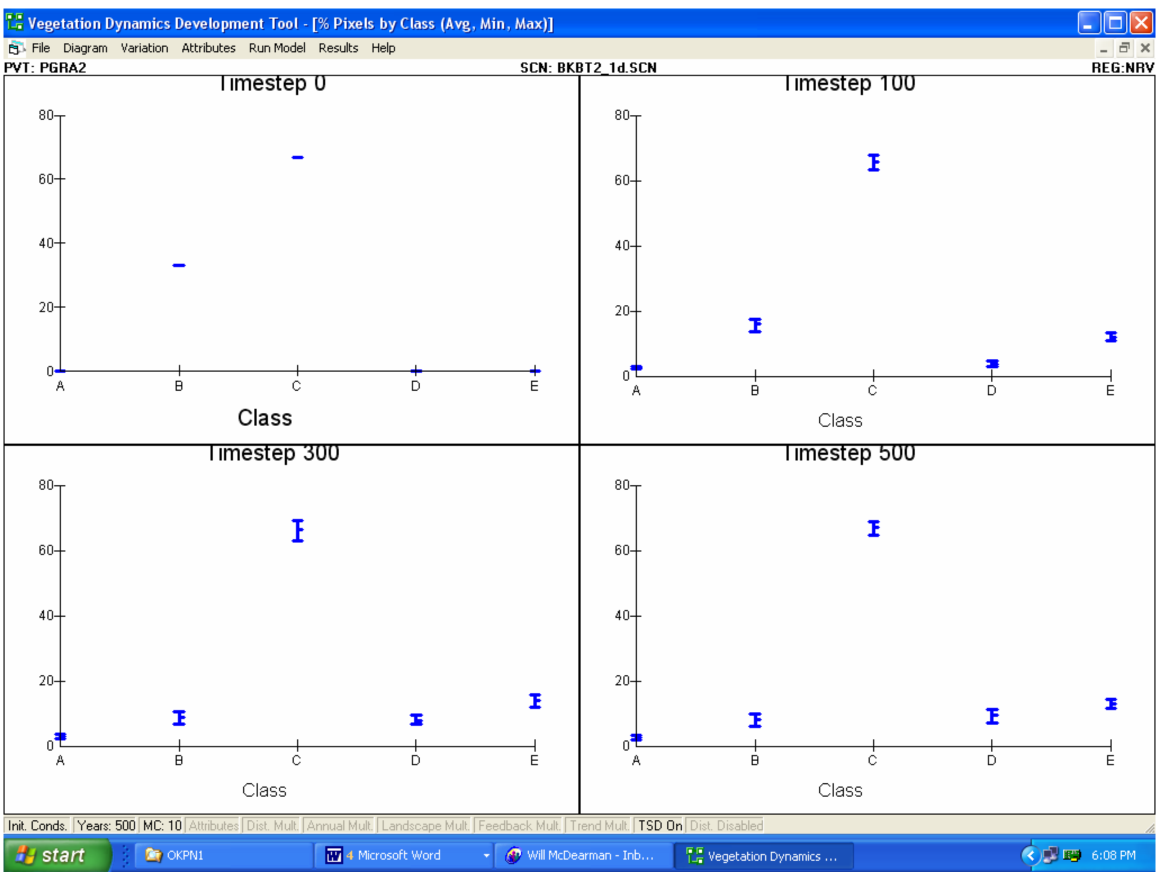
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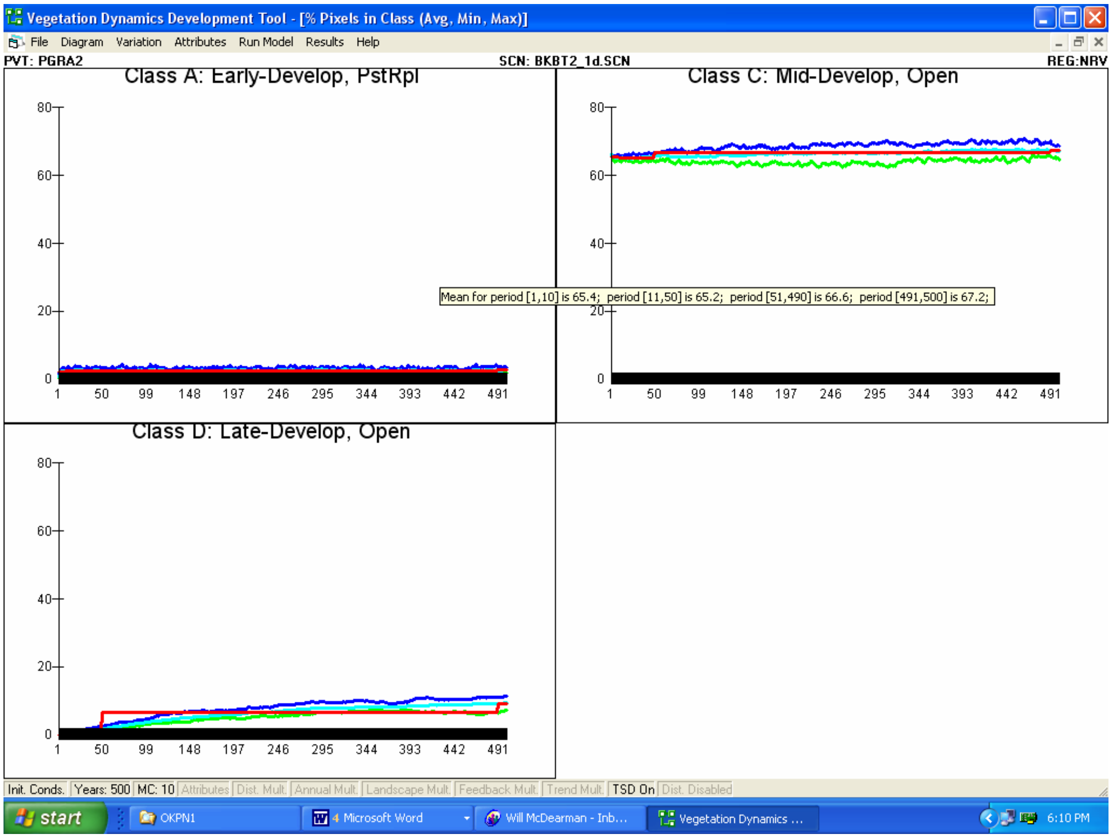
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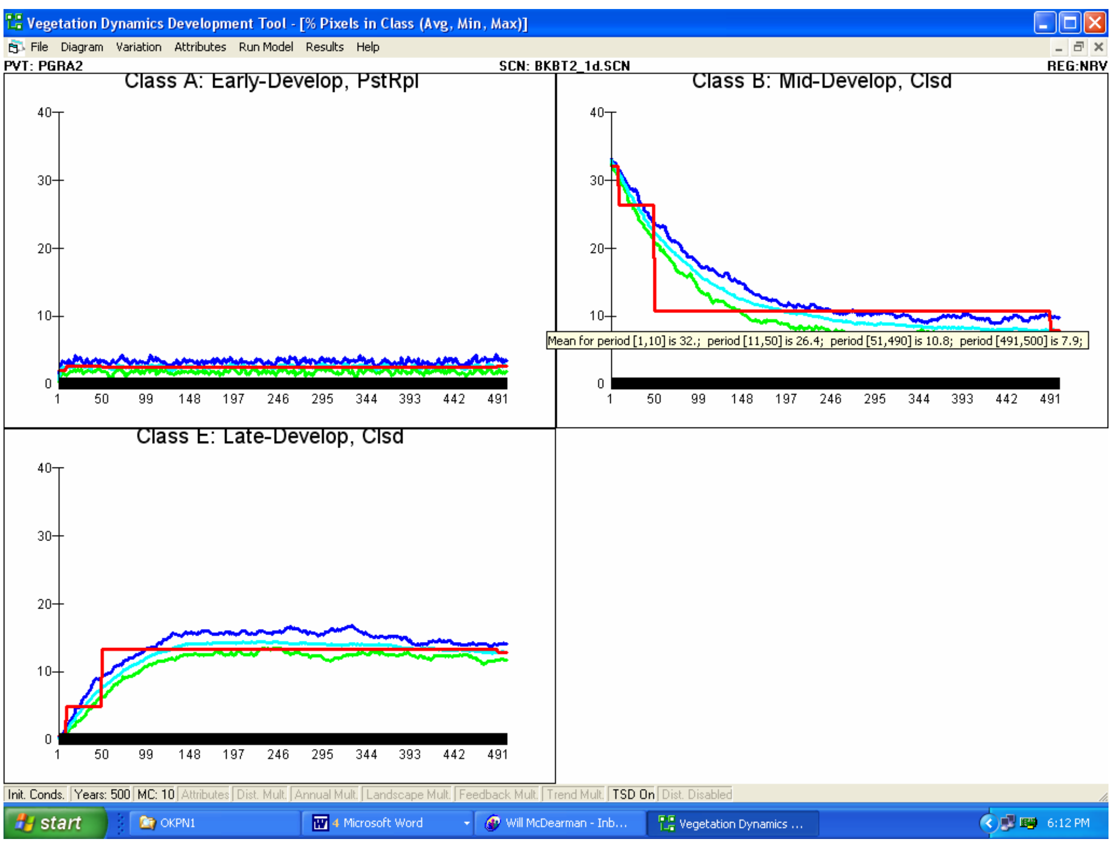
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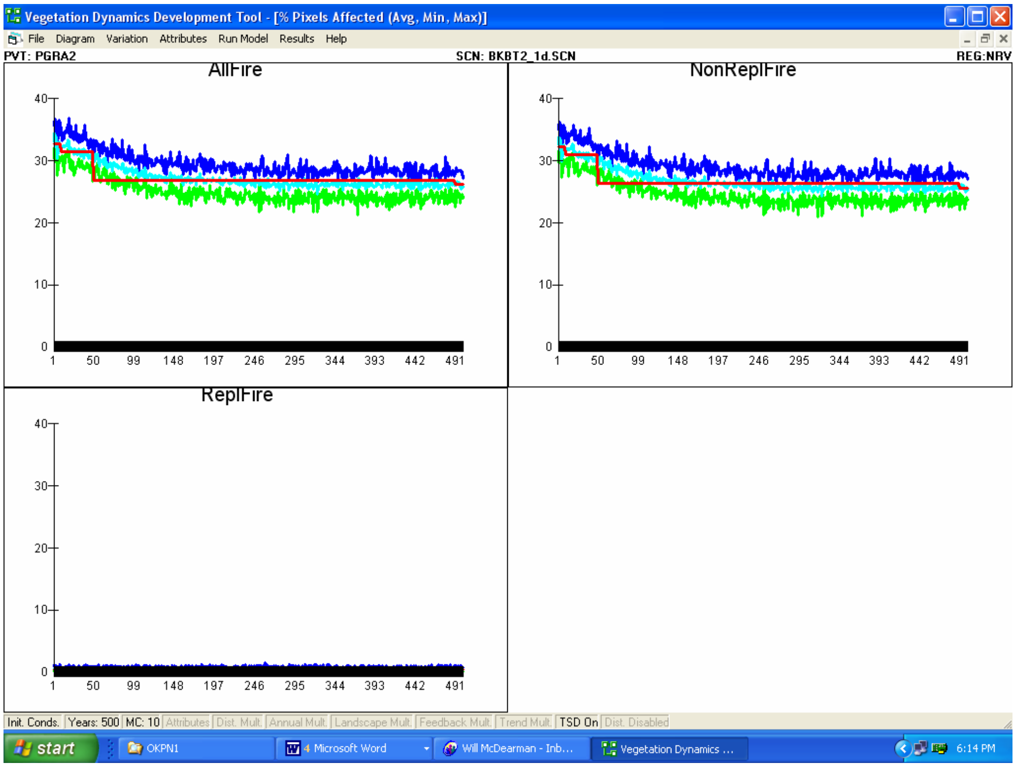
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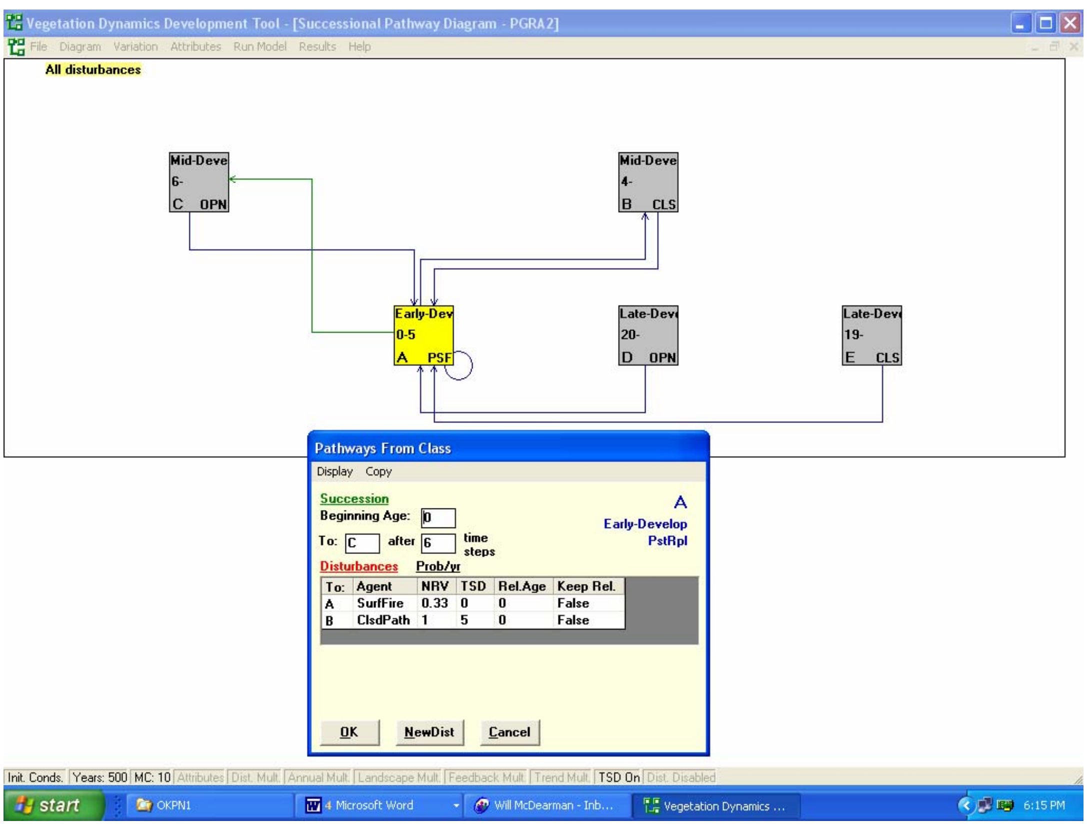
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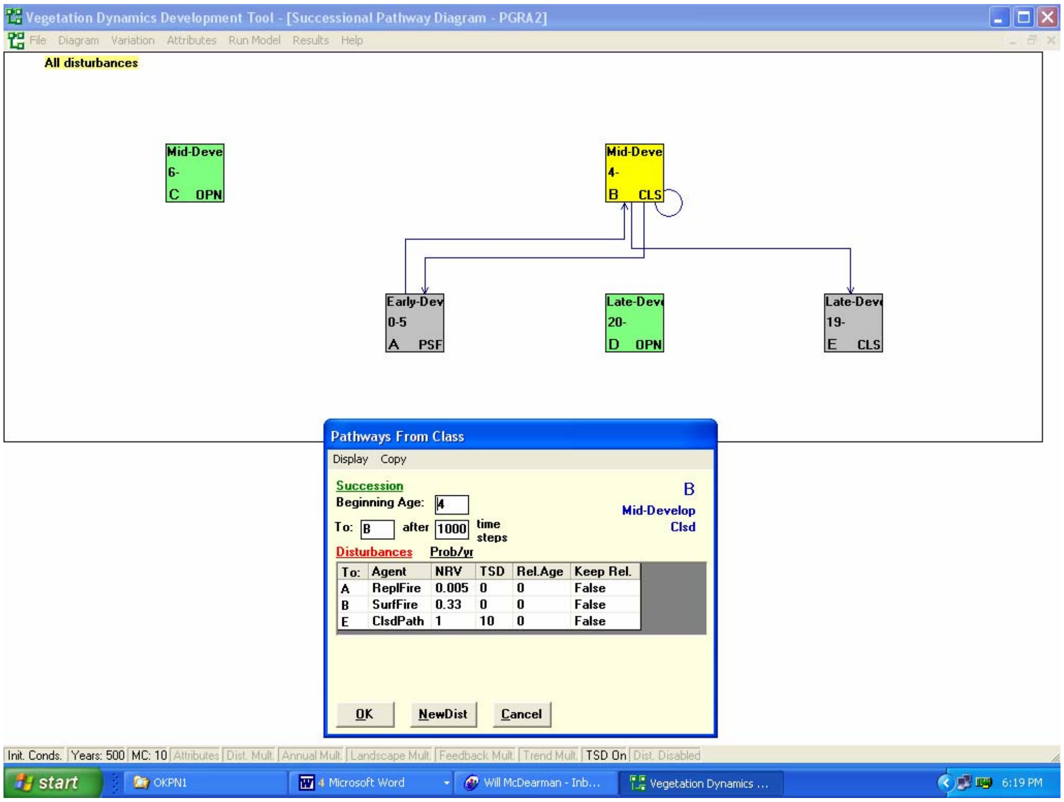
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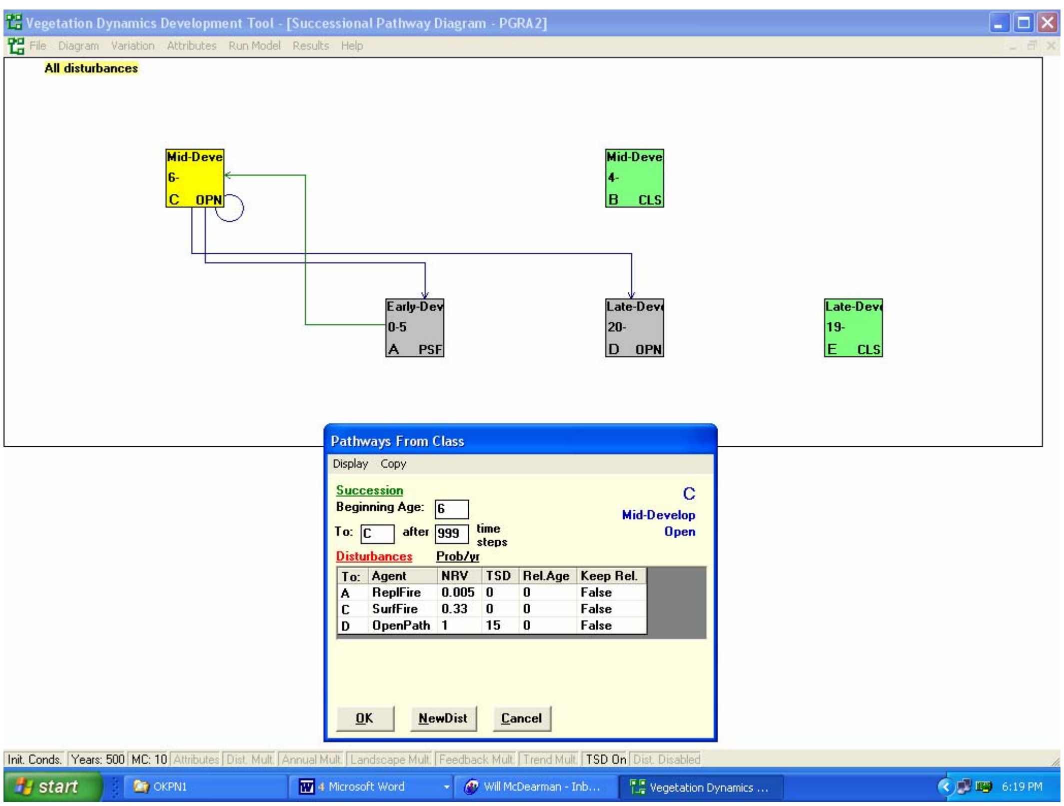
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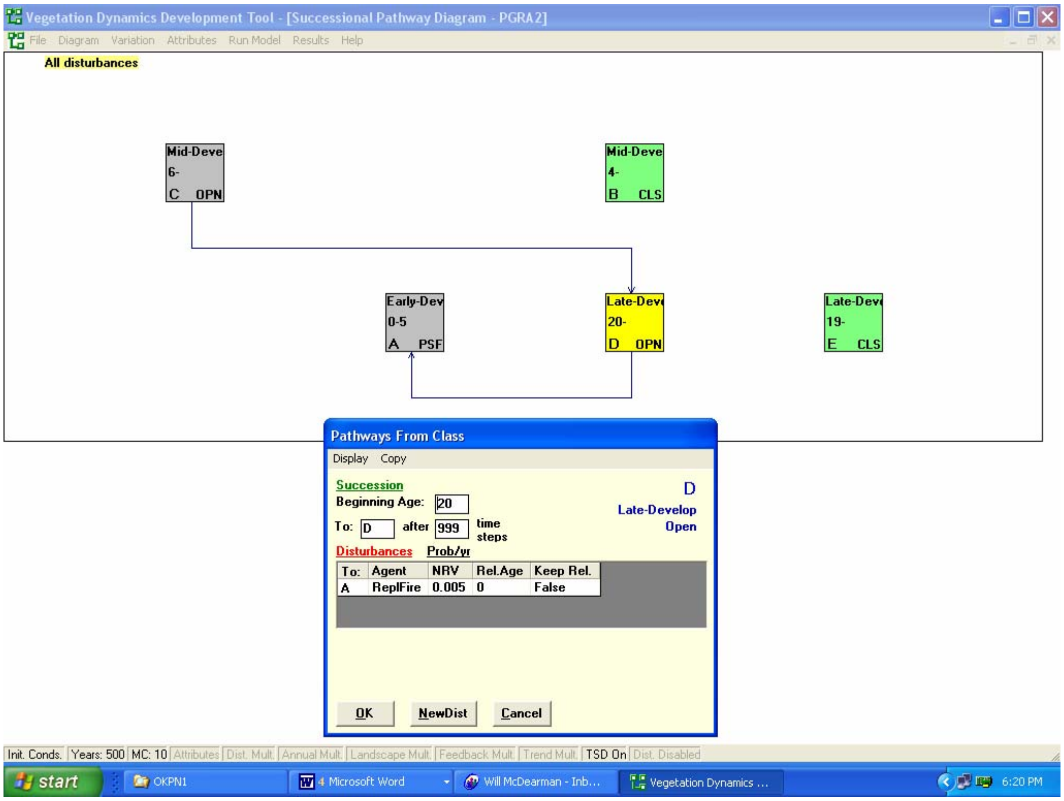
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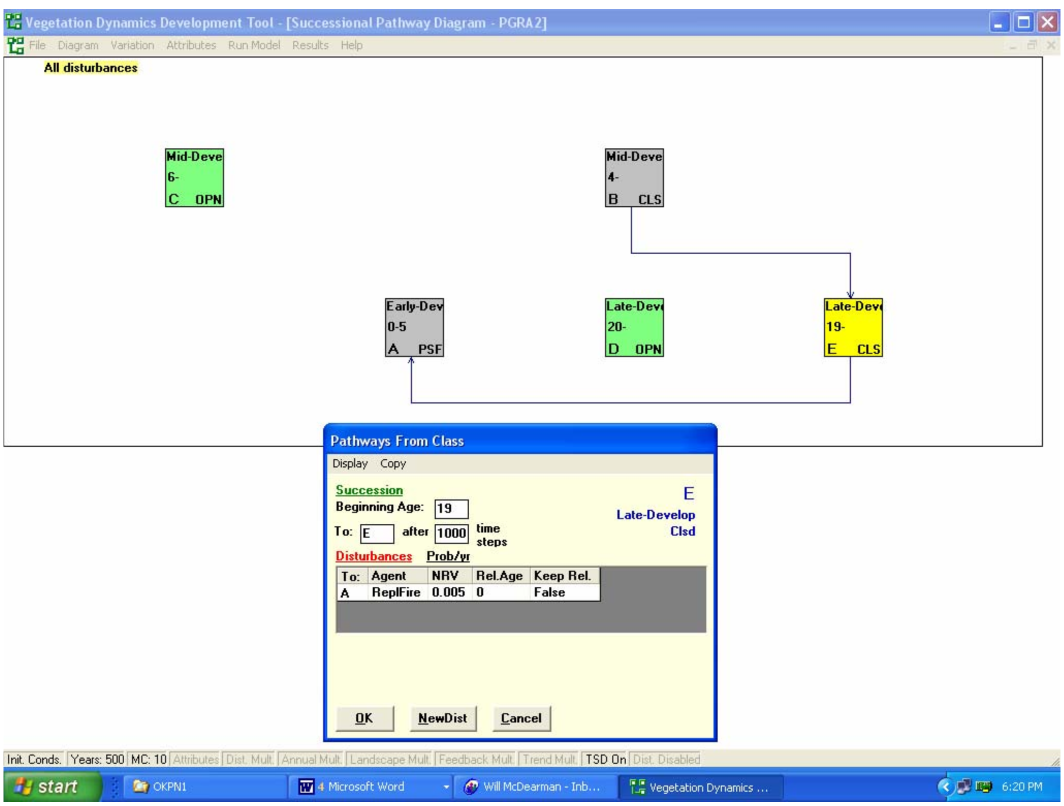
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Description (continued) and Model Notes: The type includes Kuchler's Black Belt in Mississippi and Alabama, but with additional areas in Arkansas and Louisiana as previously described. The Cretaceous black belt region in Alabama and Mississippi, as geographically or physiographically mapped by various authors, is not considered to historically to have been comprised exclusively by treeless of virtually treeless grassland. Likewise, all areas underlain by clays and calcareous marls of the Tertiary Jackson, Claiborne, Fleming and related groups where other remnant prairies are found today historically were not necessarily or exclusively prairie. This point was first argued and assessed by Rostlund (1957) who found historical evidence that the Cretaceous black belt region as geologically mapped in Alabama and Mississippi was not solely comprised of a vast, open prairie. The "myth" Rostlund investigated was the geographic perception that "an open grassland, 20 to 30 miles wide and some 300 miles in length, once existed in central Alabama and northeastern Mississippi." However, Rostlund's own historical evidence as well as other studies reveals the existence of locally extensive grassland. For example, Jones and Patton (1966) estimated from original land-survey records for Sumter County, Alabama that about 24% of the 112,588 ha of black belt had few to no trees. Caddell et al. (1981), using General Land Office records for 1820 – 1834 in Sumter County, Alabama, also found a black prairie mosaic of grassland, savanna, and woodland. Similarly, Foti et al. (2003) conducted extensive work in southwestern Arkansas to document rather extensive prairie remnants where the landscape was historically dominated by a prairie-savanna-woodland mosaic.

The historical extent of grassland and woodland is somewhat important to the issue of developing a Black Belt PNVG model because of the proportion of potentially different classes within the PNVG that would have naturally existed. Well over 100 good to relatively high quality examples of this PNVG have been surveyed and variously documented, particularly where such occurrences remain relatively concentrated in southwestern Arkansas and the Bienville National Forest in Mississippi. Yet, the imperiled nature of this vegetation type inherently has limited the availability of good examples of the natural mosaic.

Most the remaining relatively good sites tend to represent patches of the open prairie proper that have persisted through periods of fire exclusion due to edaphic factors. Prairie sites on nearly barren, thin, and moderately thin soil over chalk or parent clay and marl have been less prone to woody invasion than other sites during periods of fire exclusion. Even so, the size of these openings typically has been reduced by woody succession from the periphery, usually where soils are deeper, in a fashion at least as historically assessed on the Bienville National Forest since 1936 (Wieland et al. 1991, Moran et al. 1997). Thus, vegetation classes that naturally occurred on the fringe and borders of mostly treeless prairie likely would have been among the first lost to the successional development of unnatural vegetation types by fire exclusion.

While there are many historical references and descriptive accounts to "open" or virtually treeless prairie, other accounts also include elements of a mosaic.

> "The prairies proper – level, or very gently undulating tracts, possessing a deep black, heavy soil, on which timber is very much scattered or altogether wanting – form, as has been stated, belts, or series of disconnected patches, having on the whole, a north and south course; and are interspersed with tracts of a more rolling surface, mostly with a shallow, pale, light soil, timbered with the common upland Oaks -- Spanish ("Red"), Post, Black Jack, and sometimes Red and Black and Scarlet Oak – which, though usually perhaps of average fertility, is sometimes absolutely poor, as may be gathered from the scrubby, stunted growth it then bears; the productiveness varying, it appears, very nearly in proportion to the approach of the Rotten Limestone to the surface."

> "The soil is sometimes without timber of any kind, but usually bears clumps at least of Crab Apple, Wild Plum, Honey Locust, and Persimmon. These mostly occur even on the 'bald prairies', where the rock is so close to the surface that its admixture to the soil is evident to the eye; while whenever the soil and subsoil are of greater thickness, isolated

Black Jacks and Post Oaks, of a stout growth and peculiar form...” (Hilgard 1860, p. 261, in the northeastern black belt of Mississippi).

Featherstonhaugh (1844, as cited by Foti et al. 2003) referred similarly to prairie patches as “chains” of prairies, ranging from less than one acre to several hundred acres in southwestern Arkansas, in a mosaic fashion. Indeed, the best remaining examples of such mosaics probably occur in southwestern Arkansas.

The PNVG as modeled here represents a prairie mosaic, including open prairie classes as well as classes with increasing tree cover as open savanna, woodland, and closed stands. Extant sites demonstrating good examples of savanna and woodland mosaic conditions are highly limited. In some instances, the conditions modeled may be hypothetical and demonstrated only later in the future in areas where restoration programs recently have been initiated. Nevertheless, there is an ample historical and ecological basis to consider the mosaic as a PNVG. The sharp forest ecotone associated with many of the remaining open prairies appears to be a product of fire exclusion, especially when such stands are on heavy, calcareous, though deeper prairie soils. Under natural conditions, the ignition and spread of fire would have been continuous throughout the mosaic, creating a more extensive, interconnected cover of gallery-like, savanna and woodlands. These classes, unless modeled here, would not likely be included in other PNVGs.

The geographical extent of these classes will vary regionally and locally in response to spatially different patterns of topography, soils, and geology. Model refinements and revisions would be expected for local applications.

<u>Fire Frequency</u>

There are no fire reconstruction studies available from tree ring or fire scar data in this PNVG. Such studies on the forest-tallgrass prairie interface in Missouri, for example, found a pre-1870 fire frequency of 3.2 years (Guyette and McGinnes 1982). The black belt PNVG modeled non-replacement fire frequency is 3 years (0.33). This is within the range of expected fire frequencies for nearby shortleaf, loblolly, pine-oak and oak-pine forests where climate and sources of ignition would be comparable. It also reflects a frequency required to maintain prairie mosaic vegetation structure, although fire could be more or less frequent.

The model outcome is sensitive to changes in fire frequency. Fire, however, is not the sole factor regulating the dynamics of succession and vegetation development. The interaction of fire and edaphic (soil depth) factors on montmorillonitic soils affect the establishment, growth, and mortality of trees in the mosaic.

<u>Model structure and dynamics</u>

The 5-box model represents classes of open grassland with few to any trees, associated with a mosaic of increasing tree cover. Conventional assignments and nomenclature of “open”, “closed” , “mid-seral”, and “late-seral” structural and development stages typically associated with other forest PNVGs were modified to represent grassland-woodland mosaics.

Class A

Transitions from the post replacement class A diverge either to the “open” pathways (C-D) or “closed” pathways (B-E). The divergence is regulated by the time since fire disturbance in class A as well as differences in site conditions within A. Sites within class A represent a return by replacement fire from all other classes (B, C, D, E). Class A sites commonly share an initial post replacement attribute of the absence of trees. Site differences exist, however, due to soil depth, woody seed source availability, and the availability or the abundance of post-fire woody vegetative sprouts that reflect attributes from post replacement source classes prior to replacement fire.

Variation in fire return interval, with a TSD of at least 5 years, regulates the proportion of class A sites that diverge to either class C or B. This proportion is highly sensitive to fire frequency and TSD. Following 5 or more years without fire, sites (mostly former classes B, D, and E sites) formerly with some degree of tree cover or spatial association with seed sources transition to class B. At the transition time to B, sites would have surviving seedlings, sprouts that developed in the absence of fire. Such woody components would either not exist or occur at much lower frequencies for other site transitions to C after a 6-year period of post-fire development during which time at least one fire occurred.

Class B and C

Mid-seral open class C and mid-seral closed class B represent stages with developed grassland (as well as class D). Class B sites tend to have greater herbaceous ground cover or closure on deeper soils, though not necessarily so relative to Class C. Class B sites also represent a savanna class, with tree cover up to 20 percent, while Class C is either treeless or only with widely scattered trees (≤ 5% tree cover). The extent of tree cover in Class B reflects age and time for growth of young cohorts previously established during Class A, as well as recruitment accompanying the variation in fire return interval with 4 – 6 consecutive years without fire. Since Class B sites also tend to occur on deeper soils, the greater growth rates especially in young age classes increases survival and recruitment relative to Class C for the same fire frequency (0.33). Still, woody growth rates on the swell-shrink and cracking soils of both classes is sufficiently low in combination with surface fire to significantly retard tree development.

These classes do not necessary develop and transition to late-seral classes. Mid-seral classes may exist for long periods of time, perhaps indefinitely. Class B sites are more “closed” than C simply due to woody cover, but a well-developed grassland is associated with each.

Class C and D

The transition from C to D is regulated, again, by the variation in fire return interval. The modeled TSD parameter is 15 years for this transition, which reflects a non-fire period with woody recruitment and adequate growth to size classes capable surviving the return of fire (0.33 average probability). This TSD may seem contradictory to the TSD modeled for a similar transition from Class A to B with young, surviving woody cohorts. However, the herbaceous ground cover and fine fuel loads at the A to B transition time 5 – 6 years following an intense replacement fire is less than the C to D change following full recovery and development of the grass-forb stratum at least 20 years following post-replacement.

Class D tree cover will be greater than the 5% or less cover in Class C. Class D cover as described in this document is 20 to 60 percent. However, cover may not actually reach 60 percent and it also could range from 6 – 20%. There is only a 0.001 probability of there being 15 consecutive non-fire years for a 15 year period during of a 100-year interval when the probability of fire is 0.33[1]. Thus, there may not be a sufficient number of recruitment episodes to attain a 60% cover, either as a function of the 500-year interval modeled in VDDT or on an actual landscape for greater time periods before the occurrence of replacement fire (0.005). Furthermore, fire-free intervals less than 15 consecutive years may be sufficient for periodic recruitment.

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[1] Estimated from a hypergeometric probability function. Given an annual surface fire probability of 0.33 the function computes the probability of 15 consecutive non-fire years for any 15 year interval sampled from a 100-year period.

As a mosaic, by definition, the distinction between classes based on a gradation in tree cover would not necessarily be distinct with gaps in the percent cover definition. Even with greater tree cover, Class D still retains a significant grassland. The herbaceous ground cover would be less than Class C and Class B, but still sufficient to carry fire through the class and to others in the mosaic.

The C-D transition is sensitive to fire frequency and time since disturbance.

Class B and E

The transition from Class B to Class E occurs by a TSD function as for Classes C-D, but the transition occurs after 10 years (B-E) instead of 15 years (C-D). Class B sites generally represent more mesic sites, including the most mesic, than C or D. These occur on deeper soils, either on lower slope positions, terraces, or along intermittent drainages. Conditions for tree recruitment and growth are greater on these sites than C-D. During a 100-year interval, the probability of 10 consecutive years without fire (0.33 annual non-replacement fire probability) during any 10-year period is 0.01, which is an order of magnitude greater than that estimated by the same function for the 15 year C-D period. Thus, there is a greater successional tendency by these parameters for Class B sites to advance toward the more closed conditions of Class D.

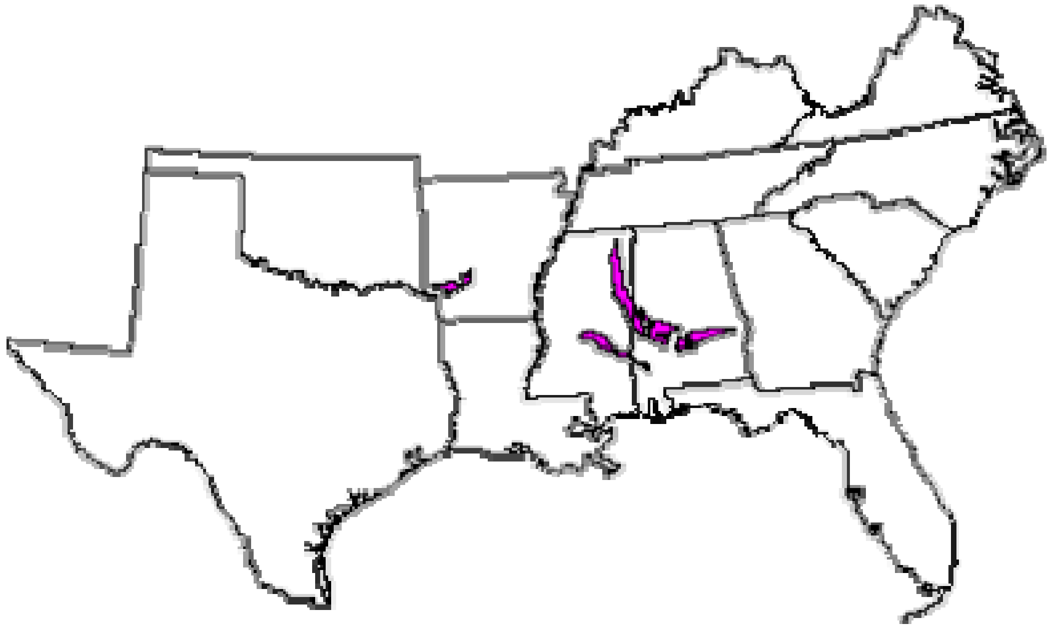
Class E canopy cover, while greater than Class B, ranges from 21 to 100 percent. The designated cover threshold definitions between B and E depend on the extent that such trees can be recruited into Class B during fire-free periods of less than 10 years. While woody cover will be less in B, the defined 20% canopy threshold expected to be developed before the end of the first 10-year disturbance-free period may be may be inaccurate. Thus, Class D is a rather heterogeneous mixture that actually overlaps with canopy cover conditions referenced with Class C. Class E, however, consist of sites with a different trajectory of rather slow, yet periodically increasing woody cover.

Grassland cover would range from relatively well-developed to sparse or absent, depending on canopy cover.

As with other classes, the B to E transition is highly sensitive to fire frequency and TSD.

Dynamics

Class changes in the model are primarily affected by time since disturbance and fire frequency, as superimposed on sites with varying edaphic characteristics differentially impair forest development. Class changes are not highly dynamic with infrequent TSDs relative to the expected annual probability of fire. Thus, the composition of the mosaic would appear relatively stable. Very few examples of the full mosaic have survived agricultural and silvicultural conversion followed by fire exclusion. This model obviously is subject to change. Alternative models have been considered and are available (McDearman@fws.gov).



Blackland prairie region, Alabama, Arkansas and Mississippi. Map does not include Louisiana sites or areas for the Black Belt PNVG. Estimated AL, AR, and MS area is 21,550 km^2 (8,320 mi^2). USDA Soil Conservation Handbook No. 296, 1981. (www.dasnsr.okstate.edu/s257/south/mlra/135.htm)