Fire for Big South Fork

ECOLOGICAL RATIONALE FOR THE FIRE MANAGEMENT PLAN AT BIG SOUTH FORK NATIONAL RIVER AND RECREATION AREA

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Prepared by The Nature Conservancy for the
Big South Fork National River and Recreation Area

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[*Reformatted with minor corrections and additions in Nov, 2015,
but without any update on status of the park's condition or planning, and
without any review of the relevant literature published during 2001-2015.]

General Location

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[In brackets after each heading is the corresponding section in the Fire Management Plan format; this will enable easier cross-reference as the FMP is developed and updated.]

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PREFACE

As this project was being initiated, a major ecological change was beginning at Big South Fork, and as this project is being finished, that change is now mostly locked in: the death of most hard pine trees (shortleaf, virginia and pitch) due to the southern pine beetle outbreak. This is the worst outbreak of the beetle on record in the Cumberland Plateau—the last major outbreak was in the 1970s. Our general ecological knowledge suggests that this outbreak was amplified by the high density of mature, stressed or declining pines. The mild winters and dry growing-seasons of the past few years have probably contributed as well. Some people even ask—is this related to global warming?

The high density of mature pines largely resulted from forest succession after the intensive logging, burning and woodland-pasturing that declined in much of the region during 1930-1950. Pines were highly successful in recolonizing those disturbed environments, but now more long-lived or shade-tolerant hardwoods are poised to assume dominance in those stands. The decline in frequent burning of the uplands has probably contributed to the advance of hardwoods in pine stands. General knowledge from further south, where pine forests have been a more continual major feature of the landscape for 1000s of years, suggests that more frequent fire can maintain more open conditions favorable to pine dominance. Moreover, it is believed that southern pine beetle outbreaks are generally less severe in the more open grassy woodlands of southern regions, where pine trees are widely spaced—the beetle does not travel far from each tree. But, presumably, outbreaks might also be restricted in closed hardwood forest with no fire, where pines occur only in small disjunct patches at a very low density.

The huge amount of hazardous dead wood as fuel from this pine mortality presents us with a serious problem. This fuel adds to the considerable amount still available from ice-storm damage during the 1990s. The general risk of extreme wild fires is now greater than at any time since Daniel Boone National Forest was formed in the 1030s (Rex Mann, pers. comm.). In appropriate locations, it will be important to reduce this fuel load with prescribed burning or mechanical means.

This period is also an opportunity for rapid restoration of more open grassy woodlands at carefully selected sites. Along some ridges, prescribed burning of the former pine-oak forest would allow conversion to an open woodland (including post oaks and blackjacks), within which many rare plants and animals would flourish. With eventual seeding from surviving pines (or planting if necessary), shortleaf pine in particular would be able to regenerate in some of these open grassy areas. If a prescribed fire-regime is well-established in these openings, then it should be possible to design a zonation from relatively undisturbed white and chestnut oak forests on slopes, to partially open pine-oak forest (or "woodland") on upper slopes and narrow ridges, to more open (frequently burned) grassy post oak woodland and even grassland on broader ridges. Such zonation may have occurred before settlement, as explained below.

These problems and opportunities should be born in mind while reading this report. And note that this is only a provisional study of ecological problems related to fire management at Big South Fork. Much more definitive planning will eventually be possible after further local experience and research, plus continued review of regional patterns.

INTRODUCTION [FMP I]

Big South Fork National River and Recreation Area (BISO) was established by Congress in 1974. It comprises about 125,000 acres of almost entirely forested (99.3%) land on the central section of the Cumberland Plateau, drained by the Cumberland River, in northeastern Tennessee (Fentress, Pickett & Scott Counties) and southeastern Kentucky (McCreary County). Most of the Kentucky lands were formerly part of Daniel Boone National Forest, and before the 1930s much was owned by the Stearns Lumber Company. Aerial photos from the 1930s still exist, but stand data collected by the US Forest Service may be lost. Most of the Tennessee lands were also owned by Stearns Lumber Company or other corporations before park formation.

Initial establishment of the park was administered by the US Army Corps of Engineers, who provided a master plan, including a map of forest types, and some essential construction. In 1975, the Corps also reported on the potential for a major impoundment on the river, but this concept was abandoned. The National Park Service (NPS) did not have a fully staffed program until 1991. Big South Fork now draws about 900,000 visitors annually (NPS/BISO 2000a), and it is mandated to allow hunting, unlike most other NPS lands.

The potential role of fire in terrestrial systems, and consequent effects on aquatic systems, remains one of the most important questions facing park managers. In order to plan and implement the best overall management of fire, a wide range of information must be drawn upon; several partners will have to be involved; and much research will be needed. This report attempts to integrate all relevant currently available information for an understanding of the past role of fire, and for guiding its future use.

This project was made possible through a Cooperative Agreement between the National Park Service at Big South Fork and The Nature Conservancy's Kentucky Chapter. The Conservancy subcontracted part of the general field work to the Tennessee Heritage Program (in the Tennessee Department of Natural Resources), and most of the zoological review to Martina Hines (independent contractor).

OVERALL RATIONALE FOR THIS STUDY [FMP IA]

The park is currently developing its first General Management Plan, which will address a variety of issues and practices in great detail. However, there has been an urgent need to implement proper fire management before the GMP is completed. The National Park Service administration has ordered that "all areas with vegetation capable of sustaining fire will develop a Fire Management Plan" (NPS Director's Order 18, 1998; NPS Resource Manual 18, ca. 2001]. Fire is an important potential component of the NPS management at Big South Fork, given that much of the park is currently subject to occasional unplanned fires of human origin, from arson or accident. There have been pressing concerns about excessive ecological damage, for the safety of people, and for security of structures (including oil wells) on the Big South Fork lands. There is also a need to consider adjacent properties, especially where there is residential development.

Although fire can be a problem, much of the park has ecological justification for prescribed burning or even allowing some carefully selected wildfires, as will be discussed in this report. As well as general interest in restoration and maintenance of native ecosystem types, simulating presettlement conditions where possible, there are significant issues regarding endangered, threatened and other rare species. Many rare species (including two locally extinct federally endangered species) are believed to have had optimal habitat in open grassy pine or oak woodland with strong fire effects.

COORDINATION WITH OTHER BIG SOUTH FORK PLANS [FMP IB]

This report is being prepared in a format that will allow incorporation into the park's GMP, its Resource Management Plan and its Fire Management Plan. It is important to emphasize that this report does not overtly address issues of implementation and practice, which will be treated fully in the final Fire Management Plan itself. It focuses primarily on the first of the following "guiding principles" laid down by the federal Wildland and Prescribed Fire Management Policy (National Wildfire Coordination Group 1998).

> "1. The role of wildland fire as an essential ecological process and natural change agent will be incorporated into the planning process.
> 2. Sound risk management is a foundation for all fire management activities.
> 3. Fire management plans and activities must incorporate public health and environmental quality considerations.
> 4. Fire management programs and activities are to be economically viable, based upon values to be protected, costs, and land and resource management objectives.
> 5. Fire management plans must be based on the best available science."

In developing recommendations for item 1, the other items (2-5) are also considered below, but a full treatment is beyond the scope of this report. In addition to the developing Fire Management Plan for Big South Fork, individual prescriptions and wildfire incident plans will have to deal with many details not considered here. Moreover, the effort to base management on the best available science (item 5) also dictates an ongoing process, with regional review of relevant literature and further research at Big South Fork itself.

REQUIREMENTS OF NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) AND NATIONAL HISTORICAL PRESERVATION ACT (NHPA) [FMP IC]

In accord with NEPA requirements, the National Park Service (NPS 2000b) has already completed an Environmental Assessment for a provisional, short-term Fire Management Plan at Big South Fork. Compliance with NHPA is also being reviewed.

That provisional plan is currently being completed for initial implementation in 2001. The Environmental Assessment (NPS:BISO 2000) outlines the rationale for current fire management at Big South Fork, with the preferred goal (Alternative B) being to "suppress all wildland fire and use prescribed fire to achieve resource objectives". Wildland fires will receive an appropriate management response, seeking to limit the spread of a fire as quickly as possible. Prescribed fire will initially be used on a limited basis to reduce accumulations of hazardous fuel, to maintain designated cultural landscapes, and, in conjection with an approved Integrated Pest Management Plan, to control exotic species. When more detailed study of the park's past and potential fire ecology is completed, prescribed fire will be used on a limited basis to restore fire to the selected examples of different ecosystem types. Up to 800 acres annually may be subject to prescribed burning over the next five years.

The Environmental Assessment also considered but rejected for current implementation a broader potential goal (Alternative C): to "use the full range of fire management options available for fire supression, ecosystem restoration, and hazard fuel reduction." This alternative would have included lightning-caused fire as a natural factor in fire management, if it could be contained within prescriptive parameters at a site intended for fire within the park. Fires from arson or accident would still be suppressed. This alternative could only be justified when fire ecology is better understood throughout the park, at which point a new Environmental Assessment (or Environmental Impact Statement) would be required.

While the current Environmental Assessment enables fire management to be properly initiated at Big South Fork, there are many difficult issues for further consideration. For example, under general ecological issues, there is the question of what constitutes appropriate "natural" or "cultural" fire for maintenance of subxeric oak or pine forest that is being invaded by mesophytic trees. Under recreational issues, fire may benefit wildlife viewing, hunting, attractive wildflowers, etc., but there may also be negative reactions from some user groups. Under implementation issues, the eventual question of whether to suppress or allow an unplanned fire could become complex, especially when considering the relative value of different fire origins—lightning, arson, accident or prescribed.

AUTHORITIES FOR FIRE MANAGEMENT IN GENERAL AND FOR THIS SPECIFIC REPORT [FMP ID]

As also cited by Great Smoky Mountains National Park (GSMNP 1995), the original authority for fire management on National Parks is found in the National Park Service Organic Act (August 25, 1916), which states the agency's purpose as follows:

> "...to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

This authority was further clarified in the National Parks and Recreation Act of 1978:

> "Congress declares that...these areas, though distinct in character, are united...into one national park system... The authorization of activities shall be construed and the

protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress."

Thus, fire management on National Parks, carefully guided by resource management objectives, should protect cultural resources and perpetuate the natural resources and their associated natural processes. This general rationale for fire management has recently been given much operational detail by National Park Service Director's Order 18 (NPS 1998; citing 16 U.S.C. 1 through 4), which includes reference to requirements of the National Parks Omnibus Management Act of 1998 and the National Wildfire Coordination Group (1998). While resource management goals for fire are articulated, the highest priority for all fire operations remains safety for human health and property.

In order to expand the current provisional fire management plan, the report below provides a more complete assessment of the terrestrial ecosystem types in the park, and the role that fire could play in each of them. This assessment is then applied to practical recommendations for Fire Management Units where wildland fires would be contained and managed in different ways, and for areas where prescribed fire would be applied. Conservation of native biota and presettlement ecosystem types is a major consideration in these recommendations, but scientific uncertainties are considerable and an experimental component is suggested for part of this plan. Practical realities of safety, budget, and public relations will also determine many of the final details.

Figure 1 [next page]. Map of the Big South Fork area showing landtype associations. Further reference should be made to the existing Arcview coverage of uplands, ravines and river bottom. In the near future it should be possible to generate a more precise map showing all potential land-types (see Appendix 1), based on modeling from topography, soils and geology.

Figure 2 [next page]. Map of the Big South Fork area showing major vegetation types. Further reference should be made to the existing Arcview coverages at Big South Fork that are based on interpreted satellite imagery; in the near future it should be possible to generate a more precise map showing a wider range of vegetation types (see Appendix 3), based on modeling from remote sensing overlaid on the land types (see Figure 1), Ground truth observations on vegetation type will be essential for calibrating these relationships. The GAP project has already contributed much useful data, but further refinement for the Big South Fork area, combining data across state lines, will be needed.

Figure 1. Map of the Big South Fork area showing land type associations (provisional). "Gorge" is below clifflines (slopes and river valley); "adjacent" areas include narrow ridges and broader uplands.

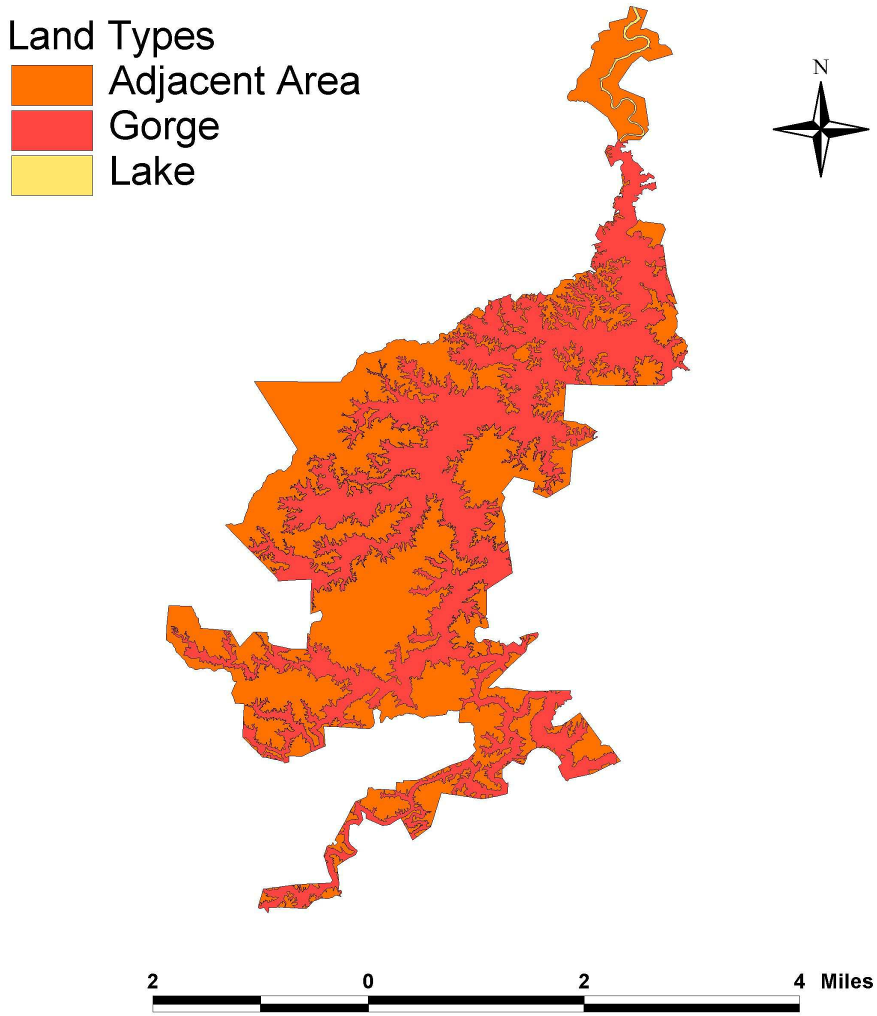
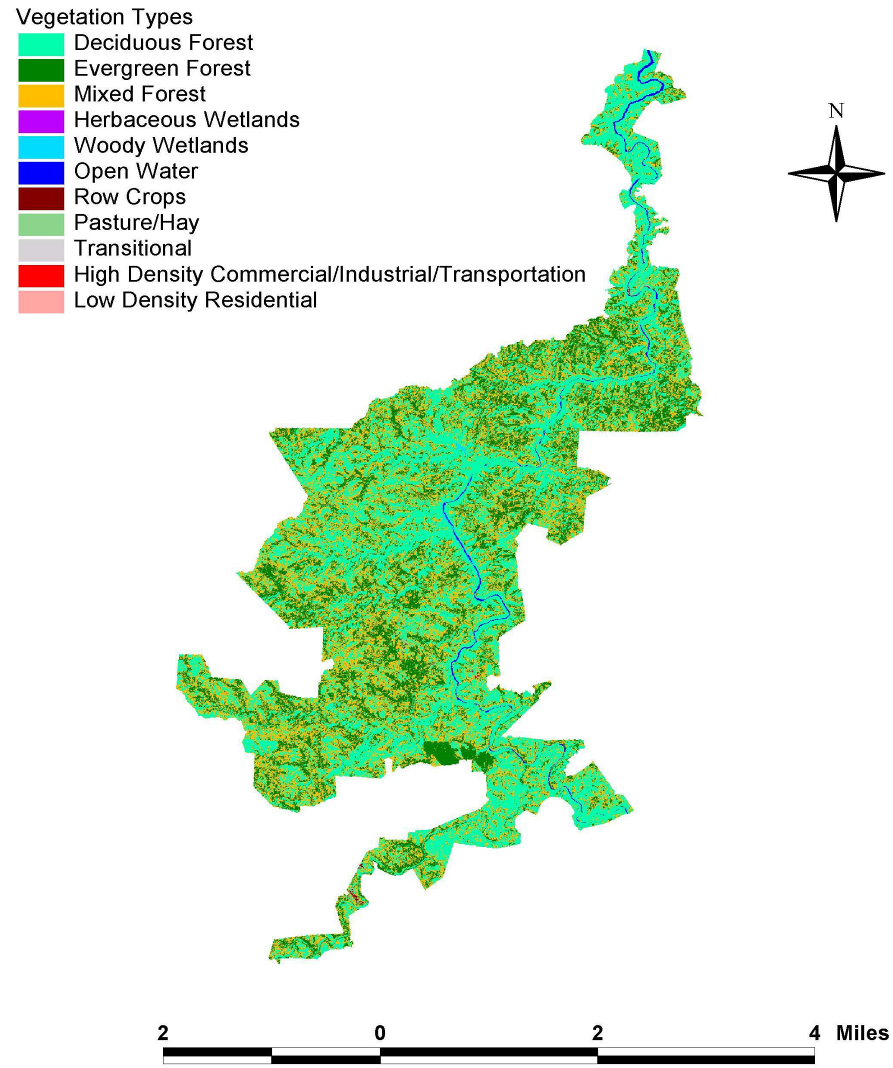


Figure 2. Map of the Big South Fork area showing major vegetation types (provisional). This is the current vegetation mapping available at the park.



COMPLIANCE WITH NPS POLICY AND RELATION TO OTHER PLANS [FMP II]

NPS MANAGEMENT POLICIES CONCERNING FIRE [FMP IIA]

The National Park Service is generally manadated to protect the nation's most valuable sites for natural and cultural history. Its natural resource management policies "are aimed at providing present and future generations with the opportunity to enjoy and benefit from natural environments evolving through biological and physical processes that are minimally influenced by human actions" (Draft NPS Management Policies 4:1, ca. 2000). Physical processes include "weather, stream cutting, cave formation, and wildland fire." "The Service will not seek to preserve natural systems as if they were frozen at a given point in time. Intervention in natural biological or physical processes will be allowed only:

When directed by Congress;

In some emergencies when human life and property are at stake;

To restore native ecosystem functioning that has been disrupted by past or ongoing human activities; or

To achieve a specific, planned use identified as a special circumstance.

Biological or physical processes altered in the past by human activities may need to be actively managed to maintain the closest approximation of the natural ecosystem in situations in which a truly natural system is no longer attainable. Prescribed burning and the control of ungulates when predators have been extirpated are examples..." (Ibid., 4:2).

Under section 4.5 on Fire Management (ibid., 4:24), the draft plans state: "Each park with vegetation capable of burning will prepare a fire management plan designed to guide a fire management program that is responsive to the park's natural and cultural resource objectives and to safety considerations for park visitors, employees and developed facilities. An environmental assessment developed in support of the fire management plan will consider the effects on air quality, water quality, health and safety, and natural and cultural resource management objectives... All fires burning in natural or landscaped vegetation in parks will be classified as either wildland fires or prescribed fires..."

RELATIONSHIP TO PURPOSE OF BIG SOUTH FORK NRRA [FMP IIB]

> The enabling legislation for Big South Fork NRRA states that this area was established: "for the purpose of conserving and interpreting an area containing unique cultural, historic, geologic, fish and wildlife, archeological, scenic, and recreational values, [and] preserving as a natural free-flowing stream, the Big South Fork of the Cumberland River...for the benefit and enjoyment of present and future generations, the preservaton of the natural integrity of the scenic gorges and valleys, and the development of the area's potential for healthful outdoor recreation."

It is clear that protection of the ravine lands and the aquatic system should be a central priority for the park. This protection generally implies minimal human interference in natural processes, except to restore features that have been damaged or lost due to mankind.

The combination of active recreational programs with natural values has generally been accommodated by restricting more intensive recreational disturbance to the uplands, where ravine forests and watersheds are not impacted to a significant degree. The primary recreational pursuits are hunting (in season), horseback riding, rafting & canoeing, camping, hiking, sightseeing and related activities. There is also considerable use for education and research by schools and colleges. The horse trail system does run through selected sections of the ravine lands, but in most sections these trails have been carefully designed to avoid erosion and disturbance of rare species.

GENERAL MANAGEMENT PLAN AT BIG SOUTH FORK [FMP IIC]

The draft General Management Plan proposed for Big South Fork (NPS:BISO 2000a) outlines three basic zones within the park; see also Figure 1.

1. "Primitive": mostly on ravine slopes and stream corridors, these areas are for natural processes to develop with minimal human interference. Artifical disturbance is minimized, but there is no fundamental opposition to prescribed fire if this can help restore and maintain natural or cultural features. Most of the "primitive" unit is probably unsuitable for frequent burning, but some ridges and south-facing slopes, at least, would probably burn occasionally even without human ignititions.
2. "Backwoods": mostly on the upland plateau surface, these areas are still designed for native vegetation, but more active recreational development will be located here, including support services for horse trails, hunting and other activities. Horse-trails have become a major use, with concessions granted to outriggers and campsite operators. In general, the "backwoods" unit presents itself as the most suitable for frequent burning considering probable presettlement fire patterns, higher accessibility, lower watershed effects and other factors.
3. "Enhanced": mostly near buildings, active recreation areas, and related management facilities, these are developed upland sections where permanent infrastructure is located or planned. Natural vegetation may be cleared from sites essential for park administration, resource management, and services. Fire, wild or prescribed, should probably be minimized in much of this zone.

On the uplands, there are remnants of open pine-oak woodland, native grassland and sandstone glades. In contrast to the ravines and streams, there has been less clear recognition of the occurrence and significance of these remnants. Park plans have not yet thoroughly incorporated protection and restoration of these upland systems. There are miscellaneous issues related to location of buildings, camps, roads, trails and other infrastructure in or near these remnants. But the overarching management issue involves the role of fire in maintaining, enhancing and restoring them.

DISCUSSION OF RESOURCE MANAGEMENT ISSUES [FMP IID]

Clearly, there are varied professional and public interests in general planning and vegetation management at Big South Fork. The general management zones that have been drafted (NPS:BISO 2000a) balance interests in unmodified areas for passive recreation, versus somewhat developed areas for more active recreation. While hunting is permitted, the park is not organized for special action to benefit wildlife for hunting. Of course there is no management for timber production, but there might be interest in salvaging dead pines from some areas where prescribed fire is planned. There may be a general consensus that "unnatural" disturbance should be minimal, except for trails, in most of the park. However, issues of human versus natural features remain central to the discussion, since the definition of "natural" remains uncertain or controversial for many people.

The area is popular for hunting deer and turkey, and with more use of fire it is possible to increase habitat for these species, plus grouse and quail. Although the Big South Fork does not manage any area of habitat in order to increase wildlife production, it is acceptable for wildlife benefits to be cited in support of a management action, given the area's use for hunting. This issue, nevertheless, is somewhat delicately balanced due to the complex ecological interactions and the various public user groups at the park.

The adjacent lands to Big South Fork NRRA in Kentucky are mostly owned by Daniel Boone National Forest, which has an active fire management program that includes prescribed burning for 100s or 1000s of acres each year in the South Fork Cumberland River drainage. Much of their program is driven by the need to reduce hazardous fuels and by long-term restoration needs for the shortleaf pine component in this region, together with the associated red-cockaded woodpecker (a federally endangered species), plus other rare animals and plants. Coordination between the USFS and NPS is essential so that their fire management plans are compatible, especially along boundary zones.

The adjacent land to Big South Fork NRRA in Tennessee is generally less rugged than the park, and much is cleared for farmland or for low density residential areas or for recreational development. Also, much oil well development has taken place in some southern sections, and privately owned oil-rights remain on some federal tracts. Although farming is generally declining, the residential uses are increasing, including new vacation homes and cabins. Several large tracts have cabins used temporarily by vacationers who ride horses through the park's trails. Although farming does not present major conflicts with park resources and uses (except perhaps for local problems from browsing deer), the increase in residential development does present a potential problem with regard to fire, if park vegetation is subject to uncontrolled ignitions. In general, the park forms a significant part of the local socio-economic scene, since it promotes much recreational use and, increasingly, it is enhancing the locality's attraction for development of various kinds. Regular meetings are held with community representatives, and this will be critical to explain the fire management program.

The Big South Fork NNRA forms the central protected area within the whole South Fork Cumberland River watershed, an area of great national significance for conservation. Globally rare aquatic organisms are a key focus in this significance, and the extensive forests along the Big South Fork allow considerable watershed protection. Strict protection of water quality is maintained on NPS lands. In fire management, such protection includes erosion-control and prohibiting use of fire retardants within 200 feet of streams. However, outside the park, the extensive farmlands, coal-mines, and developed residential and industrial lands, all provide potential threats to the aquatic system. Several federal agencies, state governments, county governments, The Nature Conservancy, and other private non-profit organizations can all assist in protecting this system. Regional universities and colleges have already played a significant role in studying the park's aquatic resources. Land preservation and vegetation management, inside and outside the park, is a key issue in watershed protection, and these organizations can all play a role.

Terrestrial features also include much significant biodiversity, especially the rocky riverbanks, sandstone clifflines, and remnants of open grassy woodlands on the uplands. Within these systems, there are several globally rare species, including at least two federally endangered species that have been recorded within or near the park: the Red-cockaded Woodpecker (*Picoides borealis*) and American Chaffseed (*Schwalbea americana*). Both these species appear to have been typical of open, fire-maintained woodlands dominated by pines and oaks, with grassy ground-vegetation.

FIRE MANAGMENT IN SUPPORT OF GMP AND RMP [FMP IIE]

Natural and Cultural Values

A purely natural fire-regime, with ignitions from lighning, is presumed to have existed in this region prior to 10-20,000 years ago. However, we currently have little definitive information about such fire-regimes, because the periglacial climate at that time maintained completely different vegetation, and there have been few paleoecological studies. With current climates, a general model for purely natural fire-regimes might have existed during previous interglacial periods. It is important to pursue investigation of such ancient ecological conditions, because they may help us understand current patterns in biodiversity, and may guide "wilderness management" that seeks to remove all human influences.

Given that much current vegetation has developed with frequent fire, there may be species—and perhaps whole vegetation types—that have been greatly reduced by fire during this interglacial period, compared to the previous one. The rarity of northern white cedar, white pine and yew in the more "natural", presettlement vegetation of Kentucky and Tennessee may well be partly due to excessive fire, since these species are able to grow in many other sites. Even relatively widespread trees like hemlock, magnolias, basswoods and buckeyes are curiously absent from large sections of the adjacent Interior Low Plateaus, where fire may have been more frequent. The distributions of several rare or uncommon herbs and subshrubs might also be partly due to fire-sensitivity: e.g., *Paxistima canbyi, Phlox bifida, Trillium pusillum, Panax trifolius, Melanthium woodii*—even *Gaylussacia brachycera* may be sensitive to frequent fire. But this remains speculation, and much more detailed research is needed before we can really understand the long-term effects of fire on such plants and other associated organisms.

Currently, lightning appears to be a relatively infrequent source of ignition for extensive burns (Figure 3d), but, without frequent fire of human origin, fuel can build up and cause occasional lightning fires to become catastrophic on some sites. As will be detailed below, there is growing evidence that much of the Appalachian Plateaus and other nearby regions was frequently burned before settlement by native american peoples. Such fires were probably much more frequent than fires started by lightning, although there is considerable uncertainty about details of frequency, intensity and areal extent in these burned areas. It is likely that much forest on the broader uplands around the park was converted from forest to open grassy woodland by frequent fires of human origin between about 2000 BC to 1500 AD. Ecologists and conservationists have come to recognize the value of fire-maintained systems with varied vegetation, including types that were largely maintained by human action for a few thousand years before settlement (e.g., Martin 1989, Ladd 1991, Masters et al. 1995, Delcourt & Delcourt 1998, Buckner & Turrill 1999, Ison 2000).

Can pre-Columbian "cultural" fire-regimes be a factor in the Big South Fork's fire management goals? Traditionally the National Park Service has included many cultural features within its national protection and restoration efforts. But these features have generally been related to archaeological sites, artefacts, structures and their immediate surroundings, not to broad landscape management practices. In parks where vegetation management has become linked with cultural preservation, the cultural features in question have generally developed from post-Columbian Old World immigrants. However, some parks in the western U.S.A. have referred to pre-Columbian cultural fire-regimes in developing fire management goals, e.g., Glacier and Yosemite National Parks (C. Lansing, National Park Service, pers. comm.).

It is important to accept that the division between “natural” (or native) and “artificial” (or cultural) is not necessarily black-and-white; see also Buckner & Turrill (1999). If the indications from paleoecological work in the region are reliable, human beings may have developed (and perhaps evolved) mutualistic relationships with certain ecological communities, using fire as the key force. While many negative and positive effects on individual species or environmental features were probably associated with these fires, we cannot now state that it was generally “good” or “bad”—they just happened. Moreover, considerable natural and cultural “interest”, if not actual “value”, could be ascribed to the ecological interface between post-glacial forests and *Homo sapiens* in our species’ development from hunting-and-gathering to early agricultural practices. We already know that distinct genetic races of some plant species were selected for food from the native flora, and these races are now largely extinct (Ford 1985). It is likely that some genetic shifts occurred in other species associated with these early human environments, although effective investigation into such shifts has not yet been possible.

More science and discussion is needed before pre-Columbian cultural fire could be considered as a primary factor in restoration efforts at the Big South Fork, but there may be some concordance with other factors.

1. A purely natural fire-regime driven by lightning, which would lead to some intense dangerous fires at long intervals, may not be possible to restore in much of the park for reasons of safety and other practical matters; instead, more frequent prescribed fire may be preferable in some areas, if fire is to be promoted at all.
2. Reduction of hazardous fuels is a goal along some park boundaries and around some internal areas with structures and concentrated human activities; this can be accomplished by relatively frequent prescribed fire.

3. Many rare species of plant and animal (including a few that are federally protected) would probably increase in open grassy woodland maintained by frequent fires, as detailed below; these native communities are considered significant for conservation if not completely "natural" in their origin.
4. A possibly pessimistic view of future damage from global warming is that much forest cover will be lost over the coming centuries, being replaced by shrubland and grassland where biodiversity may benefit from fire-regimes similar to during the pre-Columbian period (P. Delcourt, University of Tennessee, pers. comm.).

Currently, Big South Fork has five post-settlement farm remnants that are eligible for listing in the National Register of Cultural Landmarks. It is required by NPS policy to maintain the cultural landscapes associated with these sites. Fire will be used to maintain some of the old fields around these sites, and to some extent this burning can be linked with restoration of native grassland. Including these five sites and many others, about 1000 acres of old fields remain in the park. However, most of them do not have special interest for cultural or natural history.

Over 2000 prehistoric archeological sites are known within the park, dating from a few hundred years to over 11,000 years old. These are mostly under rockshelters or on upland ridges (especially at ridge junctions), and many have been damaged by looting or by road construction. Although perhaps none of these are currently considered to represent a significant permanent occupation, concepts of Native American residential patterns, seasonal migrations and landscape effects are changing. As will be discussed below, there could be justification for linking some of these archeological sites with use of fire on the uplands before settlement. However, large burned areas would be required to adequately restore the full range of ecosystem types and the species that depended on fire before settlement during 1780 to 1840.

Biodiversity Issues

The Endangered Species Act requires listed species to be protected on federal lands in consultation with the US Fish and Wildlife Service. Two endangered species have been previously documented in or near the park in open grassy woodland or associated habitats: Red Cockaded Woodpecker (*Picoides borealis*) and American Chaffseed (*Schwalbea americana*). A third species, Green Pitcher-plant (*Sarracenia oreophila*), was also reported historiclly from an open wet upland site near the park, and might benefit from fire, but records are imprecise. [This species is also known from a perched wetland near Little River Canyon at the southern end of the Cumberland Plateau in Alabama]. Current USFWS Recovery Plans for these species do not call for active habitat management at Big South Fork NRRA. However, if suitable habitat can be restored in the future, it will be important to allow for potential reappearance of these species. Moreover, it may become reasonable to attempt reintroductions at that point. Federally threatened or endangered species in the park also include two plants on riverbanks, one fish and six mussels. Although these riverine species would nay not generally be influenced by upland fires, the potential for impacts needs to be addressed. Other globally rare species may be considered in park planning, especially those that have been candidates for federal listing. On adjacent USFS lands, Daniel Boone National Forest also plans for protection of “conservation species”, most of which are globally rare or state endangered.

Formal recognition of ecosystem types in management of federal lands has not been generally adopted, but the National Vegetation Classification does offer that potential for terrestrial systems. This classification is being developed by NatureServe in cooperation with the US Forest Service, State Heritage Programs and other organizations. Campbell (2001a) includes a provisional cross-referencing between locally defined vegetation types and the national system. One of the problems in using the national system for management planning is that fire-maintained (or otherwise disturbed) vegetation types are not consistently linked with the undisturbed "potential natural vegetation" alternatives on a particular land type. This will only be resolved at a local level, in specific parks, by a thorough understanding of the land types and their relationships with vegetation patterns. Appendices 1-3 (and Campbell 2001a) offer provisional materials for such relationships to be developed and used at Big South Fork and elsewhere in the central Cumberland Plateau. These materials will also help in outlining globally "endangered" or "threatened" ecosystem types that can be considered priorities for restoration with fire management.

At a broad regional scale, The Nature Conservancy and other conservation organizations have been working to define prioritized areas for action nation-wide. Within the next few years these efforts may evolve into a national conservation plan involving a wide range of cooperating organizations. The South Fork Cumberland River watershed is clearly a national focus for major conservation efforts, due to highly significant aquatic and terrestrial features (Campbell 2001b). It can probably be considered among the five most significant landscape-scale sites for urgent action within the Cumberland Plateau. The river in particular, with 23 species of mussel (several threatened or endangered), is perhaps the most significant aquatic system.

Opportunities for restoration of large fire-maintained systems within the South Fork watershed are currently restricted to federal and state lands. These opportunities may not be ideal from an long-term ecological point of view, since the broad plains outside government ownership may well have supported more significant grassy openings before settlement. There is no current prospect for extensive restoration on these private lands, though future acquisitions or easements (including The Nature Conservancy as a potential partner) may eventually allow extension of fire management further onto this gentler topography. Elsewhere on less rugged parts of the central Cumberland Plateau, there are only a few other opportunities for extensive restoration with fire, e.g., in the Catoosa Wildlife Management Area. A more widepread, comparative assessment of opportunities and priorities for restoration of pyric vegetation is urgently needed across the Cumberland Plateau. There have only been a few preliminary botanical studies of the native grassland remnants (e.g., Campbell et al. 1989, DeSelm 1992).

PHYSICAL ENVIRONMENT

The Big South Fork NRRA lies within the region broadly known as the Appalachian Plateaus, which is mostly underlain by Pennsylvanian sandstones and shales. The southern part of this region, drained by the Kentucky River (in a transitional zone), Cumberland River, Tennessee River, and other streams further south, is a distinct biogeographic unit—often known as the Cumberland Plateau—with a high incidence of endemics and other globally rare species. Most of the park lies within the predominantly non-calcareous zone of the Cliff Section. Calcareous Mississippian rocks occur only in narrow bands along lower valley slopes, but further west they become prominent. Some eastern and southern uplands of the park may be drawn within the Low Hills Belt, a north-south trending zone which is relatively undissected within the central Cumberland Plateau. A more useful local term for this less rugged zone is the London-Corbin-Oneida Plain.

Further upstream, the Big South Fork watershed mostly drains down from the Rugged Eastern Hills of the Cumberland Plateau. That coal-rich section is often included within the broad definition of "Cumberland Mountains" in Tennessee, but it does not have the elevational peaks and diverse faulted geology of the more strictly defined Cumberland Mountains (Pine

Mountain, Black & Log Mountains, and Cumberland Mountain itself). Other local names for parts of this region are the Jellico Mountains (near main stem of Cumberland River) and the Wartburg Basin (mostly drained by Big South Fork). Athough this section is largely forested, the extensive coal-mining has caused problems for water quality in the watershed, which have to he considered in any broad conservation effort at the park itself.

Appendix 1 lists "land-type associations" and "land types" (in the sense of McNab et al. in USDA Forest Service 1993), based on a preliminary synthesis of patterns in "soil associations" from individual county soil surveys, plus data collected within Daniel Boone National Forest during 1994-96 (Campbell et al. 1990b, etc.). Correlation with county soil surveys in Tennessee has not yet been checked, and there may be some differences in soil taxonomy. The major vegetation classes that probably existed on each of these land-type associations before settlement are indicated by codes in brackets; these codes refer to the vegetation notes that accompany this report (Appendix 3; Campbell 2001a).

Within the Cliff Section, which includes most of the Big South Fork NRRA, it is important to note the following general landtype associations:
1. Dissected areas with limestone (ravines, slopes and ridges)
2. Dissected areas without limestone (ravines, slopes and ridges)
3. Narrow bottomlands on mixed/sandy alluvium with high base-status:
4. Narrow bottomlands on mixed/sandy alluvium with low base-status:
Broader ridges within dissected areas without limestone (2) may be considered interdigitations of the Low Hills Belt (London-Corbin-Oneida Plain).

The Low Hills Belt covers some southern and eastern parts of the park, but the transition is not well-defined. It includes the following land-type associations.

1. **London-Corbin-Oneida Plain:** mostly on Corbin Sandstone plus overlying Breathitt Formation in Cumberland River drainage.
2. **General low hills:** mostly on Breathitt Formation shale/siltstone; and more pronounced north of Cumberland River drainage.
3. **Broad bottomlands on mixed alluvium with low base-status**.
4. **Broad bottomlands on mixed alluvium with high base-status;** perhaps mainly along Ohio River, Kentucky River.
5. **Broad bottomlands on high sandy terraces**; perhaps mainly along Ohio River, Kentucky River.

Table 1. Ecological trends during the Holocene on the central Appalachian Plateaus and nearby, as suggested by paleoecological and archaeological studies. See text for more complete explanation (especially Appendix 2).

ECOL.* TREND	MILLENIUM BC (left) OR AD (right)*															
	13	12	11	10	9	8	7	6	5	4	3	2	1	0	1	2
A Fire effects	weak/moderate?						moderate		variable (locally strong) (WB peak @ 3.5 BC)		variable (locally weak) (CL low @1.5 BC)		strong			weak-ening but some pulses 1.8-1.9
B Human culture and popul-ation	generally unknown	Paleoindian Period: little occupation in hills; mostly on grassy plains to W/E; increase in sites after 8.5 BC.				Early Archaic: widespread in hills; much rockshelter use		Middle Archaic: generally few sites in hills; but intensive occupation of valleys/plains to W/E			Late Archaic: more intense occupation in hills; much valley clearance nearby (ca. 2-1 BC)		Woodland: more culti-vation; increase in population?		Missis-sippian or Fort Ancient (mostly 1-1.5 AD)	decline 1.5-1.8 then American invasion mostly after 1.8 AD
C Notes on human food		included megafauna				hunting & gathering in forest		seasonal rounds of hunting & gathering in plains and hills			seasonal rounds		early crops: sumpweed goosefoot maygrass squash		crops: squash sunflw corn beans	more crops, grains, livestock; imports, junk
D Open land	perhaps local open woodlands, savannas, grasslands				probably little grassland cover		generally forested; local grasslands (10-20% at WB)		probably little grassland cover (<2%); but xeric open woodland perhaps expanded				increase in grass-brush openings (with sedges, bracken, composites); locally 5-10%			increase after 1.8 AD to 10-20+%
E Common trees	T: **jackpine**, **oak** M: w pine, ash I: **spruce**, hornbeam, fir, birch				T: **oak**, hickory M: ash I: **hornbeam**, spruce, hemlock, beech, s maple, birch		T: **oak**, hickory M: ?ash, ?w pine, s gum I: **cedar**, **hornbeam**, hemlock, beech, s maple, spruce		T: **oak**, hickory, chestnut M: ash, s gum I: hemlock (decline @ 3.5 BC), s maple, beech, spruce, r maple		T: **oak**, h pine, hickory, chestnut, M: ?ash, s gum I: r map.	T: **oak**, hickory, h pine, chestnut M: ash (peak @ 1 BC), s gum I: **cedar** (local)	T: **oak** (dominant), chestnut, h pine waves (local peak @ 0.4 AD, low @ 1.5-1.8 AD), hickory M: ash, s gum I: ?**cedar** (local)			big pine pulses; recent oak/pine declines; maples+ increase
F Precipi-tation	dry (annual ca. 70 cm)		**increase (ca. 70-110 cm)**	wet (ca. 120 cm)			decrease/variable (ca. 100-120 cm)		generally drier; lowest at 4 BC (ca. 100 cm)				increasing (ca.110-120)	generally wet (ca. 130 cm)		↓?
G Temp-erature	cold (annual mean ca. 0 deg. C)				warming/variable (ca. 5 deg. C)		generally warm (annual mean ca. 10 deg. C); but some cooler periods (e.g., 1-1.5 AD)									↑?
ECOL.* TREND	13	12	11	10	9	8	7	6	5	4	3	2	1	0	1	2
	MILLENIUM BC (left) OR AD (right)															

* **Footnotes to Table 1.** Time units are millenia BC or AD. This provisional summary is based mostly on the following sources: Delcourt (1979), Delcourt et al. (1986), Delcourt & Delcourt (1996, 1997, 1998a,b), Buckner & Turrill (1999), DesJean & Benthall (1994), Rossen & Ison (1986), Abrams (2000), Ison (2000), Chatters (2001).
CL = Cliff Palace Pond (Delcourt & Delcourt 1997); CU = Curt Pond (Delcourt & Delcourt 1998b); WB = Wherry Bog (Chatters 2001).

Additional notes as follows.

A (Fire effects): 1.6-1.8 AD had distinct weak period.

B (Human culture):
Woodland culture may have overlapped with late Archaic (1-0.8 BC) and Mississippian (0.5-0.8 AD).
In Mississippian Period peak valley clearance occurred ca. 1-1.5 AD; Fort Ancient was more northern contemporaneous culture.
Although regional populations may have increased ca. 0.5-1 AD, Big South Fork evidence suggests a local decline in occupation and cultivation, with a persistent hunter/gatherer pattern instead; note also apparent drop in population ca. 1.6-1.8 AD.

E (Common trees): these generally exclude wetland species probably concentrated near the ponds.
T = more or less tolerant of fire (see Table 4); M = moderately tolerant; I = more or less intolerant of fire; note that oak and hickory species have a wide range of tolerances; in early cooler periods, much of the oak may have been northern red oak (*Q. rubra*), which has moderate to low tolerance of fire; major pollen taxa (exceeding 10-20% of arboreal pollen) are in bold but note that more or less insect-pollinated taxa (chestnut, gums, maples, ashes, holly, basswood, buckeye, tulip, etc.) are considerably under-represented; r maple = red maple; s maple = sugar maple; w pine = white pine; h pine = hard pine; s gum= sweetgum, etc.

Also listed (without bold) are taxa that are consistently frequent (ca. 1-10%) during the period in at least one pollen core.
Not listed are other minor but typical taxa; these include birch, holly and basswood, which are mostly fire-intolerant and relatively frequent during 7.5-3.5 BC; also, black gum, walnut, tulip poplar, dogwood and perhaps white pine, which mostly moderately fire-tolerant and relatively frequent after 1 BC.
Note that "cedar" (Cupressaceae-type) is probably red cedar (*Juniperus virginiana*) during recent millenia (perhaps mostly successional after large fires especially on base-rich soils), but, before 5.5 BC, this type may have included northern juniper (*J. communis*—successional or perhaps stable in cool dry woodlands) and northern white cedar (*Thuja occidentalis*—locally abundant on relatively undisturbed calcareous slopes) in earlier, cooler periods (before 5.5 BC); this type may have been largely concentrated in western sections of the region.
Note that "hornbeam" is *Ostrya/Carpinus*-type.
In the recent (American) period there have been strong peaks in pine ca. 1840-60 and ca. 1950-90, following earlier phases of intensive logging and land clearance.

F&G (Precipitation & Temperature); based initially on Delcourt (1979), but more refinement is probably possible with deeper review of the literature.

VEGETATION AND FIRE HISTORY

Appendix 2 details available information from the Appalachian Plateaus that can be used to indicate how much vegetation has been modified by fire within this region. There is little definitive information from the Big South Fork region itself, but some general picture can be assembled for the whole area drained by the Cumberland River and the broad watershed divide towards the Tennessee River. The follow notes summarize this review.

PALEOECOLOGICAL EVIDENCE

The few paleoecological studies in or near the Appalachian Plateaus provide invaluable insights to vegetation and fire history (e.g., Delcourt et al. 1998, Delcourt & Delcourt 1998a,b; Abrams 2000, Ison 2000, Chatters 2001). Table 1 summarizes some of the generalized regional changes in vegetation and presumed fire history based on these studies. After boreal forest and grassland receded ca. 8000-10000 BC, it appears that mesophytic or fire-sensitive trees were at least as frequent as fire-tolerant trees until about 3500-2500 BC. The fire-sensitive species included cedar (*Juniperus/Thuja*), which was locally abundant, hemlock, hornbeam (or hophornbeam), holly*, sugar maple*, basswood*, etc. [Asterisks indicate insect pollinated species that are under-represented.] Only moderate amounts of oak pollen were found, perhaps including much of the less fire-tolerant northern red oak. Oaks plus lesser amounts of chestnut and pines, which are relatively fire-tolerant, had become prevalent pollen types by 1000-500 BC, while fire-sensitive trees have declined as a group. This shift is associated with gradual increase in charcoal particle deposition. Moderately fire-tolerant ash was locally abundant in the transition; and minor pollen types that are more frequent after 1000 BC include hickories, blackgum*, red maple*, black walnut, white pine, tulip poplar*, dogwood*, etc. This transition may have begun earlier further west, on the Highland Rim, where oak was already dominant well before 3000 BC (e.g., Delcourt 1979). Some paleoecological data have suggested that increases in oaks, pines, or even open woodland and grassland, were enhanced after 500-1000 AD, in association with further increases in burning (Delcourt & Delcourt 1996, 1998b; and pers. comm.).

ARCHAEOLOGICAL EVIDENCE

From a broad regional perspective, archaeological data tend to support the palynological trends summarized above, and allow some interpretation in terms of human effects. During the general shift from fire-sensitive to fire-tolerant trees on the Appalachian Plateaus, there is also archaeological evidence of a shift to more cultivation by native peoples during the Archaic Period (Table 1, Appendix 2), and there seems to have been an increase in local fire frequency. Clearly, there were great differences in regional ecology, but it may be suggested that human populations became denser across Kentucky and Tennessee, with more agricultural activity and more burning to clear ground and increase game production.

Excavations on the Appalachian Plateaus, at least to the north, show evidence of increased human cultivation on slopes below rockshelters during the general transition from Archaic to Woodland Cultures ca. 1000 BC (Ison 2000). Broad regional increases in oak, chestnut, pine or even more open grassy conditions about 500-1000 AD, as indicated by paleoecological data, may be correlated with the transition from Woodland to Mississippian cultures, when maize and beans were introduced from Central America. It is likely that there were associated increases in human populations and more widespread burning.

T. Des Jean (National Park Service, pers. comm.) maintains that there is insufficient evidence for substantial pre-Columbian human use of fire in the Big South Fork area itself. C. Ison (pers. comm.) has also pointed out the paucity of evidence for settled agricultural communities on the central Cumberland Plateau, in contrast to the Red River area and broader river valleys to the east or west. Ison considers that during the Mississippian period residents of the area were scattered thinly in small groups. These groups may have been relatively sedentary, with little travel more than 10-20 miles. However, men may have occasionally roamed much further. As noted by Martin (1989), there were probably major travel routes across the central Cumberland Plateau; see also Myer (1925) and Dupier (1995) for original references. These could well have been sites for frequent human ignitions.

HISTORICAL EVIDENCE

Pioneer Era (ca. 1680-1780). In various regions of east-central U.S.A., there are sufficient historical data to show changes within forests from the pioneer or early settlement era to modern forests. Several studies have shown decreases in open grassy conditions and fire-tolerant trees (especially shortleaf pine, pitch pine, post oak, blackjack oak, chestnut, etc.), plus increases in less tolerant trees (especially white oak, northern red oak, white pine, tulip poplar, red maple, sugar maple, beech, hemlock, etc.). Such changes can often be attributed to decreases in fire frequency (e.g., Fralish et al. 1991, Guyette & Cutter 1991, Cutter & Guyette 1994, Abrams et al. 1995, Fralish 1997, Cowell 1998, Bratton & Meier 1998, Campbell 1999, Abrams & McCay 1999, Harrod & White 1999). Results are sometimes inconsistent due to the various other environmental changes that have occurred since settlement, but, especially within old-growth or other undisturbed stands, there are some convincing associations with fire-suppression.

Although little quantitative analysis of this type has yet been conducted in the Appalachian Plateaus, there are many small pieces of evidence that can be used for an initial indication of trends in this region. The few early accounts of the Appalachian Plateaus during the pioneer era have been largely referred to already by Arnow (1960), Martin (1989), Campbell et al. (1989), DeSelm (1992), Ison (2000) and others (see Appendix 2). These provide glimpses of occasional large burned areas and local open grassy woodlands, though not really good evidence of vegetation patterns. Several place names also suggest open grassy or brushy conditions (as cited in Appendix 2). Although most of the Cumberland Plateau region was no doubt well wooded before settlement, there appear to have been some areas with openings caused by fires.

Some of the most evocative quotations were asembled by DeSelm (1992) from the central and southern Cumberland Plateau in Tennessee. These refer to "prairie" (Ramsey 1853); "a plain or natural meadow" (Bailey 1856); "a great level plain for the most part denuded with wood and overgrwon with grass" (Steiner & De Schweinitz; cited in Williams 1928); and Grassy Cove—"covered with grass as high as the horses' heads" (Krechniak & Krechniak 1956).

Settlement Era (1780-1880). After settlement, the frequent burning practices of the settlers and remnants of native grassy vegetation are well illustrated by notes on the southern Cumberland Plateau compiled by DeSelm (1992). For example:

> Killebrew et al. (1874) noted: forests grazed and the understory burned in spring to increase forage growth; spread of open land after settlement, with regular burning and grazing by cattle and sheep; in Cumberland and Van Buren Counties, areas described as "small prairies, destitute of timber and covered with course, rank grass."

Sudworth (1897) stated: “A third very interesting forest condition of Middle Tennessee is comprised in the plain-like stretches of heavy clay and gravel or sandy soils, such as may be seen in parts of Coffee and Warren Counties and on the Cumberland Plateau. ... The soil conditions of these districts are scarely improved by the presence of the chief species of black-jack; for, although the stand of trees is often several hundred to the acre, apparently sufficient to shade the ground, almost everywhere a heavy growth of wild grasses covers the ground, as the narrow, dense crowns of the black-jacks nowhere form a continuous soil cover. The hot sun—for it is occasionally hot in Tennessee—quickly evaporates at the soil moisture, and the open growth allows the sweeping winds to drive the falling leaves from their legitimate purpose of forming a soil-improving humus.”

Sargent (1884) reported on forest fires on the Cumberland Plateau in Tennessee. He noted that most burning is done in February, presumably promoting spring growth for livestock. However, the burning also “destroys all natural fertility...kills valuable, young trees, and promotes long-term changes in the vegetation...The blackjack oak, post oak, black oak, etc., however, on account of the protection afforded by their thick bark, are able to gain some headway, and so crowd out more valuable trees”.

The success of pines in establishing on disturbed lands in this region is illustrated by the following statement of Sudworth & Killebrew (1897, p. 11-12).

“The adaptation of this pine [*Pinus echinata*] to the poor, dry hill and other slope lands of East Tennessee is truly remarkable as seen in some localities. The old-school theories of the great care and nursing necessary to reestablish a pine-forest on entirely denuded land are quite upset when one sees thousands of short-leaf pines in dense

> stands steadily taking possession of old pastures and abandoned fields and quite without any foregrown nurse trees of the broad-leaf kind. Even under the damaging influence of trampling cattle and invading fire this young stock has gradually advanced. Solid phalanxes of saplings and middle-sized trees now form a large part of the second-growth woodlands attached to farms, together with oaks and other hard woods."

In contrast, Sudworth (p. 14) noted that: "Much of [white pine] is already old, in some localities has ceased to grow, and on one or two tracts I saw the best timber was rapidly dying...there are general signs of ceasing growth and final death, in no case due to natural enemies or accidental injuries." Until the fire-suppression of recent decades, this fire-sensitive species may have been prevented from regenerating on much of the uplands adjacent to ravines where it survived.

Industrial Era (ca. 1880-1980). Martin (1990; see also Campbell et al. 1989) has summarized much information on fire history in Daniel Boone National Forest, which probably represents the Appalachian Plateaus relatively well. In addition to exploring the limited evidence for presettlement fires, he dealt with patterns in post-settlement land use. Iron-furnaces and railroads probably provided some early industrial sources of ignitions. During the late 19th century, logging became intense in Appalachian regions, often followed by burning of slash and associated land clearance. Surveys of forests, logging and fires became organized by state governments. In 1880, ten large fires burned 556,000 acres in Kentucky, much being caused by clearance of land (Sargent 1884, p. 491). The period 1870-1920 saw the most intensive logging of forests in eastern Kentucky and elsewhere in southern Appalachian regions (Clark 1984). There are also several historical and oral accounts of settlers frequently burning some areas of open woodland, in order to increase forage for livestock or for slash-and-burn farming. Such practices continued into the 1920s or 1930s (Otto 1983).

Martin (1989, p. 47) stated: "As the DBNF was being formed in the 1930s, the widespread occurrence of forest fires was an accepted way of life (Collins 1975). Public attitude not only tolerated forest fire, but many people believed that annual burning contributed to the health of the community, reduced the density of tick and chigger populations, and, at the same time, killed back the hardwood sprouts that competed with grass (Collins 1975, Clark 1984). Appalachian states made only feeble attempts to regulate burning durinng this century. Kentucky's first fire protection laws were enacted in 1831 but they were weakly enforced (Wodner 1968)."

Martin (1989) determined that lightning caused only ca. 2% of the fires recorded during 1936-89 in Daniel Boone National Forest. Lightning fires have occurred with an annual rate of less than 5 per million acres. They have usually occurred at a steady low rate from March to October, except for a pronounced peak (10/19 fires) during April. In general, late April and May may be a peak period within southern Appalachian regions, and the frequency may increase to the south (see also Barden & Woods 1974, Bratton & Meier 1998). In general, vegetation tends to burn less intensely during the growing season than during the dormant season. But in areas with heavy loads of woody debris and flammable brush, fires may be very intense after droughts and on drier topographic sites. From DBNF data, ca. 90% of lightning fires have occurred on S/W-facing slopes or on well-defined ridgetops (Martin 1989). Although almost all of these fires have been contained to less than 100 acres, it is estimated that one of them would have burned ca. 6000 acres without suppression (a 1987 fire on Stanton District).

Martin (1989) also reported on many details of the predominantly arson-caused fires on Daniel Boone National Forest. However, data were incomplete in some districts, and there may be difficulties in applying results to the Big South Fork area. Selected statistics are reproduced here (Figure 3a-b; Table 2a-g).

SOIL DATA, FIRE-SCARS AND DENDROCHRONOLOGY

Several studies in the region have examined soil samples for patterns in charcoal and phytoliths (characteristic silica bodies produced by grassland species) that might indicate fire and vegetation history. However, there have been technical difficulties (e.g., P. Kalisz in Campbell et al. 1999). Welch (1999) found that charcoal was widespread in yellow pine stands of the Southern Appalachians, with no relationship to slope position. Cook (2000) used soil charcoal to help indicate fire history difference between white pine-oak stands (10-20% of 8×8 cm quadrats) with red oak-maple stands (none found). S. Horn (Univ. of Tennessee, Dept. of Geography, pers. comm.) has proposed that more intensive sampling and broader comparisons using charcoal data could still provide much general information of value in interpreting vegetation history at the landscape level.

Researchers in Appalachian regions and elsewhere across the Central Hardwoods have cored old oaks and pines to examine relationships between growth rates, fire-scars and environmental history. Results have confirmed the historical records of sharp increases in fire frequency during the industrial logging boom of 1870-1920, and there may have been widespread peaks about 1790-1840 and 1670-1730 as well (e.g., Abrams et al. 1997, Abrams 2000). Establishment of more fire-tolerant trees has often peaked during pyric periods (with pines sometimes followed by oaks), and their growth rates have tended to peak at the end of these periods. These peaks have been interpreted in terms of gradually reduced competition from mesophytes due to the fires. In many cases, individual fire years were followed by about 4 years of higher growth. However, climatic fluctuations are involved as well (e.g., Clark & Royall 1995; Abrams et al. 1997, Abrams 2000). Moreover, regeneration patterns may be quite different in environments with different fire histories. In one study, establishment of old white oaks (a moderately tolerant species) showed no relationship with fire-scars (McCarthy & Rubino 2000). But in more open grassy areas with frequent fire, white oak may establish more during reductions in fire, e.g., 1850-90 and 1910-40 in SE Ohio (McClenahen & Houston 1998). On xeric sites in the western Great Smoky Mountains, most pine and oak trees, as well as fire-intolerant species, established after fire suppression began about 1920 (Harmon 1982).

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Table 2a-e and Figure 3a-d [next 8 pages]. Selected statistics on fires in Daniel Boone National Forest, from 1936 to 1989; reworked from Tables and Figures of Martin (1989). In the order presented here, Martin's original Table numbers are 5, 13, 10, 6, 11 and 4; then followed by his Figures 5 and 1. Martin's report deserves to be distributed much more widely and it should be updated with more recent data. Unfortunately, the quality of original data from DBNF is uneven, with gaps; also methods for gathering data and its analysis remain somewhat unclear. It is not clear if data from private land are included or not.

Table 2a. Fire data from Daniel Boone National Forest: records by decade and district.
* Values based upon less than 10 years data due to gaps in fire history records; see also Figure 3.

Decade	Ranger Districts of Daniel Boone National Forest						
	Stearns	Somerset	London	Berea	Redbird	Stanton	Morehead
1936-39				172			
1940-49		8*	10*	272			
1950-59		64	44	84		25*	
1960-69			91	121		52	
1970-79	248		96	91		26	
1980-89	344	80	203	131	356	78	44
Totals	**592**	**152**	**444**	**871**	**356**	**181**	**44**

Table 2b. Number of fires and area burned, by district.

Area of burn: ha	Ranger Districts of Daniel Boone National Forest						
	Stearns	Somerset	London	Berea	Redbird	Stanton	Morehead
<2.5	51	33	230	55	24	18	5
2.5-4	169	26	20	47	116	15	20
4.1-20	50	6	47	37	121	14	7
20.1-40	20	2	19	7	34	5	3
40.1-400	9	0	5	8	42	4	1
>400	3	0	1	1	0	0	0
Totals	**302**	**67**	**322**	**155**	**337**	**56**	**36**

Table 2c. Aspects of fires by district. Based on total of 1458 fires with known topographic concentration: aspect (N-W-S-E), ridge/flat (probably <12% slope).

Aspect (and n)	Ranger Districts of Daniel Boone National Forest						
	Stearns	**Somerset**	**London**	**Berea**	**Redbird**	**Stanton**	**Morehead**
N (63)	22	4	9	13	14	1	0
NW (84)	22	7	17	8	21	7	2
W (117)	30	6	27	13	30	11	0
SW (275)	54	8	67	37	74	29	9
S (334)	75	7	58	41	112	24	17
SE (173)	46	15	21	25	57	6	3
E (53)	19	4	14	2	8	2	4
NE (65)	25	7	17	7	8	0	1
Ridge (233)	36	11	87	39	32	25	3
Flat (61)	15	10	13	5	11	3	4
Totals	**592**	**152**	**444**	**871**	**356**	**181**	**44**

Table 2d. Causes of fires by district (based on total of 2640). *Includes children playing with matches, recreation other than campfires, and burning vehicles.

Cause of fire	Ranger Districts of Daniel Boone National Forest						
	Stearns	**Somerset**	**London**	**Berea**	**Redbird**	**Stanton**	**Morehead**
campfire	11	7	27	23	1	43	4
debris burning	14	17	49	149	40	10	1
equipment	0	2	3	1	0	5	1
incendiary	307	66	241	314	260	34	8
lightning	9	5	13	10	1	12	0
lumbering	0	0	3	5	0	1	0
miscell-aneous*	29	26	63	82	44	49	8
railroad	2	17	5	2	1	6	0
smoker	8	12	39	211	8	21	3
unknown	212	0	1	74	1	0	19
Totals	**592**	**152**	**444**	**871**	**356**	**181**	**44**

Table 2e. Causes of fires by aspect (based on total of 1414). Note that the "unknown" class of fire cause (mostly in Stearns District) was not included in these numbers.

Cause of fire	Topographic classification: aspect of slope; ridge/flat (< ca. 12% slope)									
	N	**NW**	**W**	**SW**	**S**	**SE**	**E**	**NE**	**ridge**	**flat**
campfire	0	2	11	22	7	7	3	1	23	3
debris burning	3	7	12	28	26	24	8	3	12	4
equipment	0	1	1	3	2	0	0	0	2	0
incendiary	50	51	78	158	234	118	27	48	154	38
lightning	1	4	1	7	2	2	0	2	6	0
lumbering	0	0	0	1	0	0	0	1	0	0
miscell-aneous*	7	6	9	26	39	17	10	10	29	9
railroad	1	0	3	4	2	0	0	1	0	0
smoker	1	2	3	10	9	4	3	2	7	2
Totals	**63**	**73**	**118**	**259**	**321**	**172**	**51**	**68**	**233**	**56**

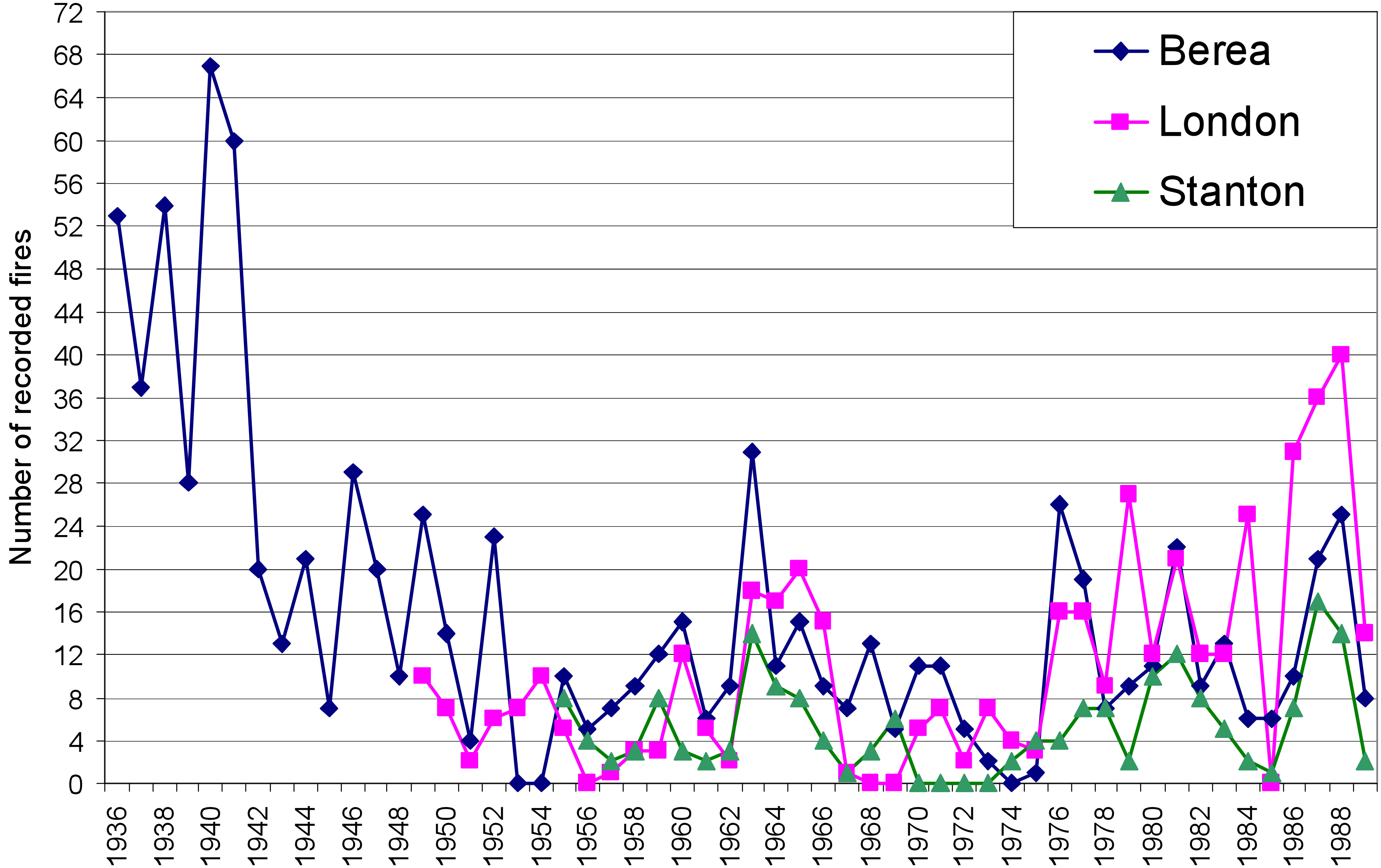

Figure 3a. Numbers of recorded fires on different districts of Daniel Boone National Forest, from 1936 to 1989: Berea, London and Stanton Districts.

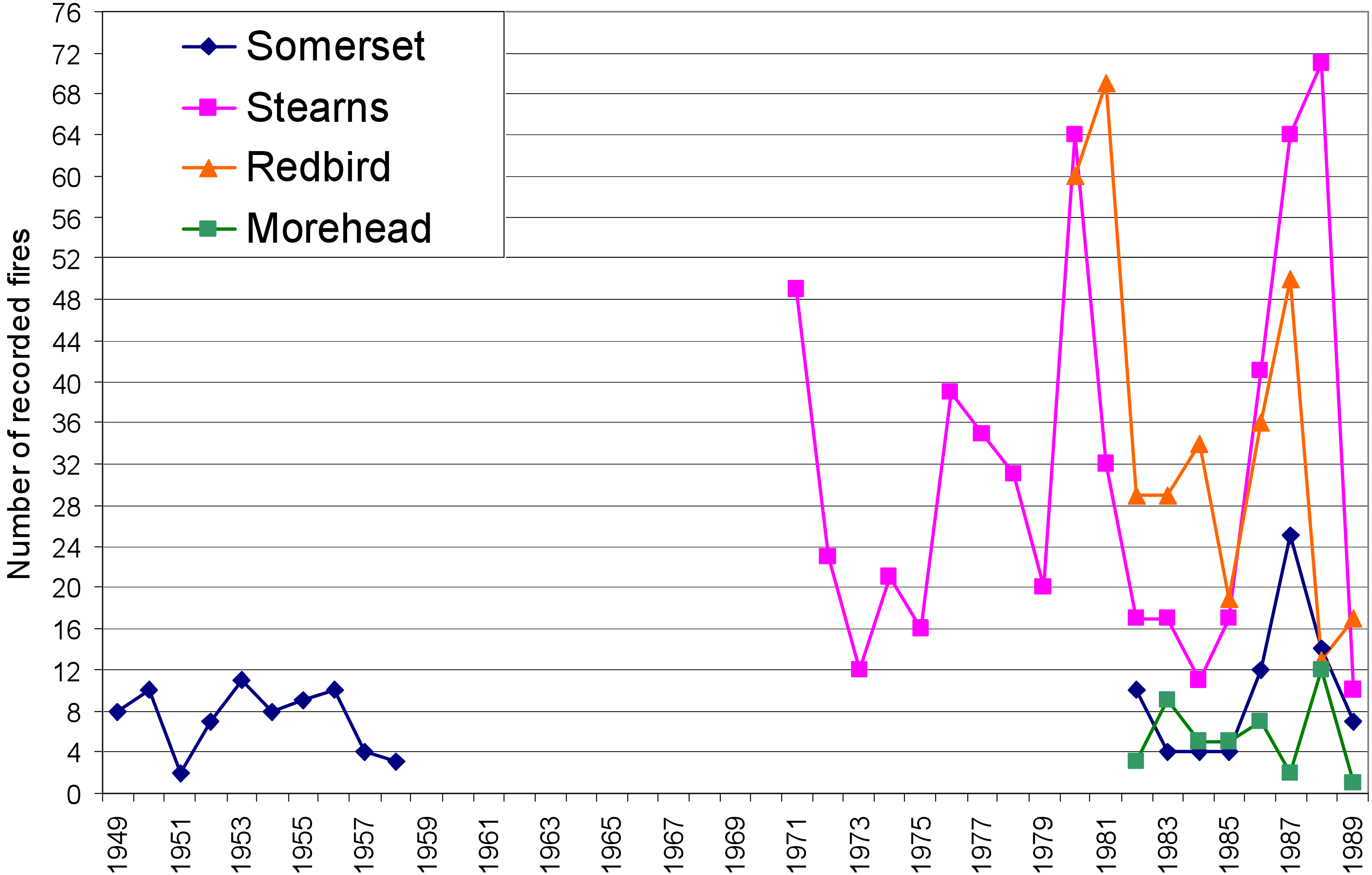

Figure 3b. Numbers of recorded fires on different districts of Daniel Boone National Forest, from 1949 to 1989: Somerset, Stearns, Redbird and Morehead Districts.

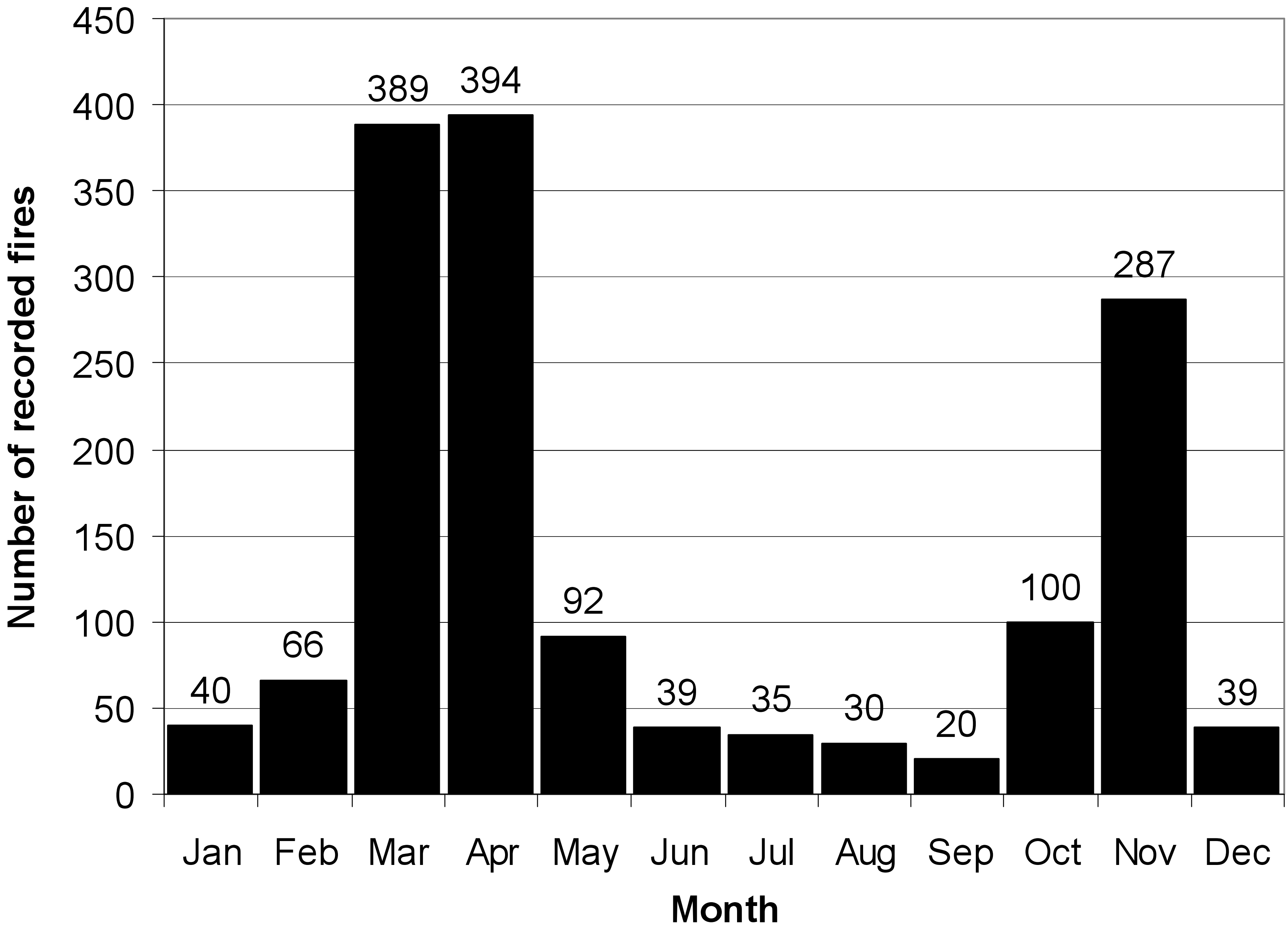

Figure 3c. Number of recorded fires in each month, based on a total of 1530 with known date.

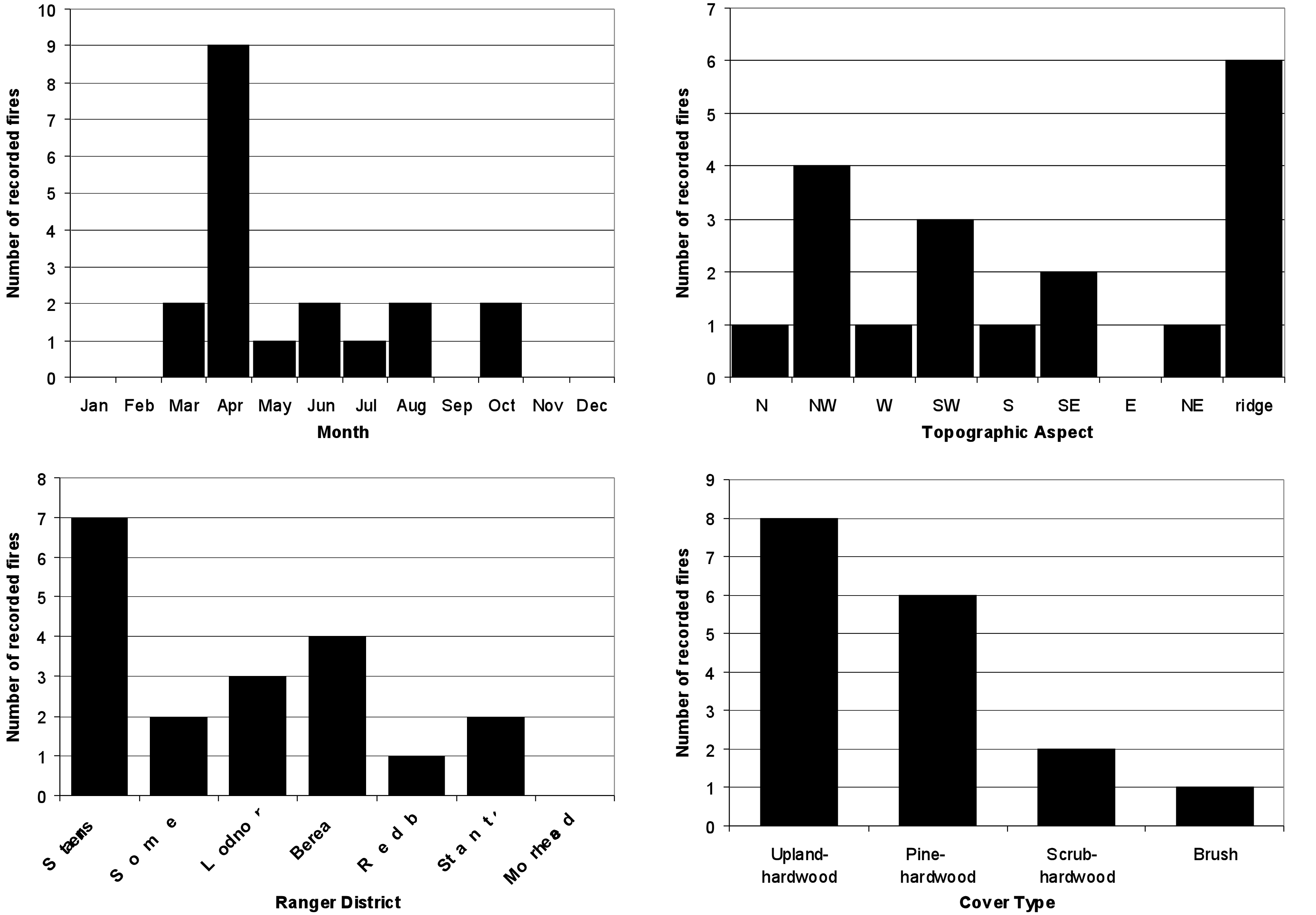

Figure 3d. Numbers of recorded lightning fires by month, topography, district and cover type.

SPECIFIC RECORDS FROM THE BIG SOUTH FORK AREA

Vegetation Data. Table 3 summarizes some data on regional forest composition from the central Cumberland Plateau during 1800-1900. Inferences about fire history can only be general and speculative, but there are some significant features. Based on early deed surveys, pines were not generally abundant within the Big South Fork NRRA (3.2%). But after 1900 they have probably been much more common (about 10-20% until recent mortality). As indicated by historical statements (see above), this post-settlement increase in pine forests has been largely due to disturbances from farming, grazing and fire. The detailed distribution of pine woodland in the pioneer era remains unknown, but further analysis of deed data could be useful here. Presumably, this habitat type (together with red cockaded woodpecker, chaffseed and other current rarities) was well established in certain topographic zones before settlement.

Recent data on vegetation in the park, including from field work for this project, should become compiled and mapped with GIS. Such data will eventually allow better general mapping of the park's vegetation, through ground truthing and correlations with maps produced from satellite imagery.

There has been special attention in recent botanical surveys to remnants of open grassy vegetation. Rogers (1941) provided some initial clues, and more recent surveys for rare plant species have help define these remnants in more detail (e.g., Campbell et al., 1990, 1994; see also Appendix 4).

Table 3. Historical forest composition (percentages) on the central Cumberland Plateau. All data are percentages, except the bottom line. Sources are as follows (A, B and C); some data remain imprecise due to thin sampling, poorly resolved common names and other problems.

A: Witness-tree data from original deed surveys during 1800-1850. "Stake" is included in total numbers except CAM; it is possible that "stake" implied open grassland on the plateau.
BSF = pre-1850 deeds from Big South Fork NRRA (E. O'Toole, National Park Service, pers. comm.); percentage of "stake" remains uncertain but probably < 1.5%.
RPC = 1802-1817 deeds from the Tellico Land Grants (Brookes-Smith 1975); selection of all surveys stated to be on "Roaring Paunch Creek" (numbers 365, 366, 367, 407, 412, 413, 443, 504, 509); mostly 200 acre tracts, concentrated in headwaters; mostly for the Chitwood family; percentage of "stake" = 0.8%
MAR = 1802-1917 deeds as in RPC, but selection instead of all surveys stated to be on "Marsh Creek" (numbers 368, 369, 405, 545, 585); mostly 100 to 200 acre tracts in headwaters; percentage of stake = 6.6%.
CAM = 1806-1833 deeds in Campbell Co., Tennessee (DeSelm 1997); these data mostly come from the Rugged Eastern Hills and Ridge & Valley Region, well to the east of Big South Fork; percentage of "stake" (partly on farms) = ca. 25%, but this is excluded from the total.

B: First timber survey in Kentucky, during ca. 1900-1910, as reported in Barton's (1919).
WAYN = Wayne Co.; PULA = Pulaski Co.; LAUR = Laurel Co.; WHIT = Whitley Co.

C: Forest Inventory and Analysis [FIA] of US Forest Service for McCreary Co. in 1988.
This is based on plots that regularly sample the nation's forests on private and public lands.
Note that McCreary Co. was formed in 1913 out of Wayne, Pulaski and Whitley Cos.

Trees are listed in ecological order, from xeric/infertile to mesic/fertile sites. Names follow the most common early spellings, with following interpretations (and alternatives in some cases). [More precise modern usage is indicated in brackets, with asterisks where applied.]

1 *Juniperus virginiana*
2 *Pinus* (*echinata* > *virginiana* etc.) [a]
3 *Quercus stellata*
4 *Quercus coccinea* (> *falcata* etc.)
5 *Quercus prinus*
6 *Quercus velutina* (> *marilandica* etc.)
7 *Quercus alba* (> *muhlenbergii* etc.)
8 *Quercus rubra* (> *falcata* etc.)
9 *Castanea dentata*
10 *Oxydendrum arboreum*
11 *Cornus florida*
12 *Carya* (*glabra* > *tomentosa* etc.)
13 *Sassafras albidum*
14 *Nyssa sylvatica* (> *Liquidambar s.*) [b]
15 *Acer rubrum* (> *saccharinum* etc.)
16 *Magnolia acuminata* (> *tripetala* etc.)
17 *Liriodendron tulipifera*
18 *Fagus grandifolia*
19 *Tsuga canadensis*
20 *Betula* (*lenta* > *nigra* > *allegheniensis*)
21 *Carpinus caroliniana* or *Ostrya virginiana*
22 *Robinia pseudoacacia* (> *Gleditsia triac.*)
23 *Fraxinus* (*americana* > *pennsylvanica* etc.)
24 *Ulmus* (*rubra* > *americana*)
25 *Juglans* (*nigra* > *cinerea*) [c]
26 *Aesculus flava* (> *glabra*)
27 *Tilia americana* (sensu lato)
28 *Acer saccharum* (sensu lato)
29 *Platanus occidentalis*
30 *Diospyros, Morus, Prunus, Salix* etc.

a: *Pinus strobus* = ca. 17% of pine in CAM; zero in Barton (1919); ca. 4% in FIA.
b: *Liquidambar* = ca. 17% of gum in FIA. c: *Juglans cinerea* = 42% of walnut in CAM.

Bottom line: total numbers of trees, volumes or basal areas.

A: total numbers of trees accumulated from survey corners.
B: “standing timber” estimated for each county, in units of “thousand board-feet measure”.
C: basal area in sq. feet per acre / total number of trees ≥5 inches dbh; 41 plots, 6.806 acres.

TREES RECORDED IN EARLY DEED SURVEYS, TIMBER SURVEYS OR FOREST INVENTORY	A: ORIGINAL DEEDS <1850				B: TIMBER SURVEYS (Barton 1919)				C: FIA 1988
	BSF <1850	**RPC 1802-17**	**MAR 1802-17**	**CUM 1806-33**	**WAYN 1900-19**	**PULA 1900-19**	**LAUR 1900-19**	**WHIT 1900-19**	**McCreary Co ≥5in BA/DE**
1 cedar	0.2			0.6	1.6	2.5			ZERO
2 pine [species]	3.2	1.7		1.4	2.6	8.3	11.4	11.6	20.9 / 31.6
3 post oak		6.7	1.6		included with “white oak”				0.1 / 0.3
4 spanish oak [or scarlet*]			1.6		included with “black oak”				5.2 / 5.7*
5 chesnut oak	2.0	0.8		0.4	7.8	5.0	8.7	4.3	6.5 / 5.7
6 black oak		8.4	9.8		9.6	24.5	28.7	26.5	3.3 / 2.4
7 white oak	20.8	36.1	16.4	24.6	15.9	14.5	15.7	23.6	12.9 / 12.1
8 red oak [northern*]	11.6	0.8	1.6	11.0	included with “black oak”				3.0 / 2.1*
9 chesnut	5.0	0.8		2.5	9.7	13.1	5.3	4.5	ZERO
10 sowerwood	1.1		1.6	1.7					0.4 / 1.1
11 dogwood	3.7	0.8	3.3	6.8					0.2 / 0.4
12 hickory [species]	6.5	17.6	13.1	8.4	7.6	4.5	9.3	3.2	8.0 / 8.8
13 sassafras	<1.0		1.6	0.3					0.1 / 0.1
14 gum [black* or sweet]	6.1	2.5	3.3*	3.6	9.5	1.8	4.7	1.5	2.7 / 3.1
15 maple [red]	6.5		3.3	2.5	included with sugar maple				7.4 / 8.0
16 cucumber [magnolias]	0.6			0.3	2.3			0.5	1.5 / 0.5
17 poplar [yellow / tulip p.]	5.6	14.3	6.6	5.5	8.8	9.5	3.0	7.3	7.2 / 6.2
18 beech	9.6		4.9	7.1	3.5	5.1	1.6	5.0	4.0 / 1.1
19 hemlock	6.2			0.8	1.3	7.0	3.2	5.2	7.3 / 3.3
20 birch [species]	0.5			0.3					3.5 / 2.6
21 hornbeam [or hop-h.]	<1.0		4.9	6.3					0.2 / 0.4
22 black locust		0.8		0.1	0.6				ZERO
23 ash	0.9	5.9	1.6	1.4	2.9		0.03	0.9	0.4 / 0.4
24 elm	<1.0			0.8			<1.0	<0.1	<0.1 / 0.1
25 walnut [black* or white]	0.5	1.7	1.6*	2.4	0.7		0.03		0.1 / 0.1*
26 buckeye	0.1		1.6	1.1	1.8		0.3	0.7	0.2 / 0.3
27 basswood	0.8			1.3	3.3	1.8	1.1	1.5	1.0 / 0.4
28 sugar tree [s-maple]	6.7		14.8	5.1	7.0	1.3	6.1	3.7	2.5 / 2.2
29 sycamore	0.3			0.9	3.4	1.0			0.2 / 0.1
30 other [cherry willow etc.]	<1.0			3.8			0.9	0.06	1.4 / 1.8
Totals: numbers or board-ft.	**>1000**	**119**	**61**	**3212**	**836,691**	**272,574**	**337,011**	**486,703**	**139/ 1139**

Fire Data. The park's fire records begin about 1978. [Other records and local fire knowledge may be housed at Pickett State Park and Forest (Ken Avery); see also records of Stearns Lumber Company, Bowater Company, etc.] During 1980-1989, complete records were not gathered, but probably well over 2000 acres burned, mostly in a single incident covering ca. 1854 acres in 1987. During 1990-1999, under NPS management, some 23 wildland fires were documented and suppressed on NPS lands, covering ca. 532 acres. In 1998, there was a late winter snowstorm—the worst in memory of many older residents—and this damaged many conifers, leaving large amounts of fuel. The year 2000 was unusually dry, and in the fall there were three large fires; one with about 2000 acres on NPS land (northwestern section); one with 500-600 acres on NPS land (south-central); and one, determined as an arson, with about 3000 acres, only partly on NPS lands (southwestern). However, about 75% of the fires documented by the park have covered less than 20 acres.

Recent fires have been mostly caused by arson or careless accidents. They have often started in low old fields, campsites and other human activities on lower slopes, which may be the opposite of presettlement patterns. Fires on coal bars along rivers can burn for months or years; these should be reported but sometimes are not. Another unusual focus for ignitions may be oil wells, where volatiles can accumulate; there are oral histories indicating the potential for even lightning to ignite some of these sites (S. Bakaletz, pers. comm.). Natural oil seeps have been reported at a few sites.

Some 12 several prescribed fires, totaling ca. 600 acres, have been conducted by the park during 1991-96 for the purpose of fuel reduction along some of its boundaries, for RCW habitat restoration, and for establishment of native grass plantings.

POTENTIAL FIRE EFFECTS ON CURRENT VEGETATION

VEGETATION CLASSIFICATION

Appendix 3 outlines probable natural (presettlement) vegetation types in the central Cumberland Plateau, with special reference to sites at Big South Fork. Supporting documentation (Campbell 2001a) includes cross-references to the Conservancy's National Vegetation Classification (website: NatureServe.com). Information on vegetation of the Big South Fork area is based on recent field work, plus a review of relevant literature, including Braun (1950). Caplenor (1965), Safley (1970), Wade (1977), Schmalzer et al. (1978), Hinkle (1978, 1989), DeSelm (1992), and recent studies by R. Emmott, E. O'Toole and others (National Park Service, unpublished).

Major compositional differences (including patterns in genera or families) are emphasized in the broader divisions, while minor compositional differences or mere physiognomic differences are emphasized in the narrower divisions. Differences between broad classes are mostly moisture-related, while further subdivision is generally related to geology or soil chemistry. To some extent, these gradients are also associated with long-term successional changes, especially where there are major changes in soil or fire regime during succession. Note that these broad classes are designed to reflect intrinsic compositional variation of the vegetation at a small scale, rather than spatial variation at larger scales. The best examples of some broadly defined vegetation types, including a wide range of conservative species, such as rocky openings in general, are restricted to very small sites in the park. Each major class includes potential undisturbed forest phases and disturbance-dependent open phases, but such variation is often difficult to separate out from fine-scale variation in abiotic relationships.

Generalized fire regimes for the 12 major classes (or "formations") are outlined below, based on further discussion in Appendix 3, Although these notes are mostly based on recent observations, an effort has been made to incorporate historical data, and to indicate apparent changes and dynamic relationships of vegetation types.

1. Shrubby or graminoid streambanks and shoals; at Big South Fork this is confined to narrow zones along streams. Fire is generally unknown but possible in dry late summer or fall, especially if ignitions occur from campsites, etc.

2. Shrubby or graminoid swamps and ponds; at Big South Fork, this is a minor class, confined a few small patches, Fire is probably insignificant except in unusually dry years, and where surrounding hydric or non-hydric uplands have fire-maintained woodland or grassland.

3. Deep swamp forest. This is not present in the Big South Fork area, but is listed here for regional completeness.

4. Streamside forest: widespread along streams at Big South Fork. Fire probably has played little or no role in this ecosystem type. Typical species mostly have low tolerance of fire (sycamore, river birch, boxelder, etc.).

5. Mesic forest; abundant in current matrix at Big South Fork. There was probably a low fire frequency and little effect before settlement, except for rare catastrophic fires. Typical trees mostly have low fire-tolerance (beech, sugar maple, black birch, magnolias, buckeyes, basswoods, young tulip poplar, etc.) or moderate fire-tolerance (hemlock, white ash, oaks, hickories, old tulip poplar, etc.); the latter mostly occur in transitions to subxeric oak forest.

6. Subhydric forest; widespread at Big South Fork but generally in small depauperate patches, especially streamhead seeps. Fire may have play a small role within this vegetation, but

widespread upland fires have burned down into small stream bottoms and may have limited the spread of this type. Wetland red maple (*Acer rubrum* var. *trilobum*), a tree with low fire tolerance, is often abundant; most other typical trees are only moderately tolerant: blackgum, sweetgum, tulip poplar, swamp chestnut oak, cherrybark oak, etc. These oaks are probably absent from Big South Fork but are found in nearby regional sections.

7. Submesic forest; local at Big South Fork, especially on damp flats. Fire probably has had partial effects, with frequent occurrence on drier sites. Among the typical trees, red maple and beech have low fire-tolerance; blackgum and white oak have moderate tolerance. Red maple litter may not burn well except in unusually dry conditions, but when fire finally does occur the damage to trees may be severe.

8. Deciduous seral thickets: although currently not a well-developed stable feature, before settlement there may have been extensive areas with cane, sumacs, hazel, upland willow, etc., in some ecotones between forest and open woodland or grassland. Such canebrakes, brush or "roughs" would have been maintained by intermediate fire frequency (perhaps 3-10 year intervals) and perhaps some seasonally intense browsing by larger herbivores.

9. Hydric swales and flats with oak woodland or grassland: local at Big South Fork in depauperate patches. At Big South Fork, it is likely that scattered streamhead sites on gentle topography supported this vegetation. It is potentially characterized by pin oak, swamp white oak, willow oak, etc., but often too isolated or disturbed for these trees on the plateau. A few highly distinctive native grassland remnants in rights-of-way and in a few unimproved old fields suggest that much of this vegetation was maintained as open woodland or grassland before settlement, with frequent burning (at 1-3 year intervals).

10. Upland (non-hydric) oak woodland or grassland (mostly on broad ridges, flats and gentle

slopes): probably widespread before settlement at Big South Fork but mostly becoming subxeric oak forest. This is potentially characterized by southern red oak, post oak and blackjack oak (in more open phases), but often grades into forest of shortleaf pine, white oak, black oak, scarlet oak, etc., especially in transitions to more rugged topography. Remnants of more open grassy phases can be found in rights-of-way and elsewhere on less dissected parts of the plateau. More open areas were probably maintained by frequent fire (at 1-3 year intervals) and various herbivores. Trees of post oak (and perhaps blackjack) are highly tolerant of fire; other associates are moderately tolerant (southern red oak, scarlet oak, mockernut hickory, sand hickory, etc.).

11. Subxeric oak forest: abundant on the current landscape. This is characterized by chestnut oak (on low base status), white oak (on intermediate soils) and, locally, chinquapin oak (on high base status), but disturbed areas are often dominated by other oaks, pines, red maple and other successional species. There was probably some regular fire regime (with intervals of about 10 year) before settlement, at least in subxeric-xeric variants grading into coniferous woodland. Typical species include highly tolerant species (chestnut oak and perhaps chestnut), and moderately tolerant species (white oak, black oak, ?scarlet oak, ?hickories, sourwood), but in mesic transitions without fire there may be gradual invasions of species with tolerance only moderate (hemlock, tulip) or low (white pine, beech, maples, magnolias).

12. Xeric or pyric coniferous woodland and glades: currently abundant at Big South Fork, but much is successional. This is characterized by pines (except white pine) on sandstone, or red cedar on limestone, and various oaks. Less xeric variants have much shortleaf pine, and probably have a history of frequent mild or occasional intense fire, being somewhat intermediate between more open grassy oak woodland (10) and denser submesic (7) or subxeric (11) forest. Most stands may date from invasion of old fields, when browsing and burning were more common in marginal farmland. Shortleaf pine is highly tolerant of fire, as well as some

oaks (chestnut, post), but most oaks are only moderately tolerant. On more xeric sites, thin rocky soils are more important than fire in maintaining the conifers; red cedar is actually sensitive to fire, though it may rapidly reinvade adjacent areas released from fire.

Some of these classes (9, 10 and 12 below) can be identified as partly or largely fire-associated, and more open, grassy, fire-maintained phases can be defined within each of the these. However, the park has rather few good remnants of these phases. These represent systems within which native, presettlement biodiversity is apparently enhanced at community and species levels by repeated intense disturbances such as fire, grazing, mowing or cutting at appropriate intervals. A few other generally forested classes can have significant associations with fire, though typically without major openings before settlement (6, 7, 8, 11). In recent years, much literature from eastern North America has suggested that oaks in general often benefit from fire, even on seasonally wet sites (e.g, Abrams 1992, Cutter & Guyette 1994, Jenkins & Rebertus 1994).

More mesic or shade tolerant trees, such as maples, beech, ashes, white pine, hemlock and bigleaf magnolia appear to be invading large areas of submesic (7) or subxeric (11) forest, now that fires have been generally suppressed (Appendix 3). While there are few definitive studies in this region, it does seem likely that occasional fires before settlement did have some long-term effects on these changing forest types. These types do not usually contain distinctive grassland vegetation, with conservative species (see next section) that can be readily recovered by fires or other disturbances. However, the proportion of fire-tolerant species, which are mostly less mesophytic or shade tolerant, was probably increased by fires before settlement. In remaining classes (1-5), which are typical of more mesic or hydric sites, there is no clear evidence that fires have played a significant role in maintaining biodiversity before settlement.

Table 4 [with next 4 pages]. Relative fire tolerances of tree species in Appalachian regions. **General explanation**. This table is based on many sources, including the prior review of Martin (1989); see also Hare (1965), Anderson & Brown (1983), Brose & Van Lear (1999), Regelbrugge & Smith (1994), Smith & Sutherland (1999), Sutherland & Smith (2000), Abrams (2000), etc. For many details, these references should be consulted further. For example, Anderson & Brown (1983) showed that open-grown savanna trees of *Quercus marilandica* could escape fire damage partly due to prevention of fuel accumulation and ignitions at their bases. Smith & Sutherland (1999) found that oaks were often charred by two fires with short interval, but generally not by one fire; Sutherland & Smith (2000) showed how species in the white oak group tend to compartmentalize damaged wood, limiting vascular interruption and infection.

Bark tolerance: refers to effects of moderately intense fires. This is primarily a function of bark thickness and structure; instantly lethal temperature for plant protoplasm is ca. 64 deg. C. Species with "high" tolerance will generally survive a fire; species with "low" tolerance will generally die above ground after a fire, although many will still resprout. Tolerance tends to increase with stem diameter, especially over 3 cm dbh, and the typical tolerances reported here generally refer to stems over 10 cm dbh. A few species (*Pinus strobus, Liriodendron*) continue to have unusually large increases in tolerance with from small trees (10-20 cm dbh) to large trees (>50 cm dbh), and these are indicated below with two tolerance classes. A few species have highly flammable foliage, which allows explosive "torching", especially in dense young stands; these are indicated by "F" under the tolerance column or "f" if less intense. Note also that leaf litter varies greatly in its flammability; oaks often have high flammability; maples have low; but further review is needed before a definitive ranking can be suggested for a wide range of species.

Resprouting: refers to sprouting abilities after fire, using classification as follows. "None"; "Little" indicates that only small stems (<3 cm dbh?) are typically able to resprout. "Sapling" indicates that although small stems are killed relatively strong saplings can develop after release from repeated burning; # note that some species in the red oak group may be particularly vigorous (Swan 1970, Blount et al. 1987, Danielovitch et al. 1987). "Lateral" indicates that, in addition to top-killed stems, lateral roots are able to resprout freely and vigorously, forming clonal parches. "Large" indicates that even mature trees are able to resprout. "Epicormic" in *Pinus rigida*, etc.; these has sprouting ability (on the main trunk and branches) after fire. "Layer" in *Thuja*, etc.; these have potential for rooting of low branches

Tree species	Bark tolerance	Resprouting
Pinus echinata, shortleaf pine	high f	little
Pinus pungens, table mountain pine	high f	little?
Pinus rigida, pitch pine	high f	little/epicormic
Quercus macrocarpa, burr oak	high	sapling?
Quercus prinus, chestnut oak	high	sapling
Quercus stellata, post oak	high	sapling
Carya pallida, sand hickory	mod.-high?	sapling?
Carya tomentosa, mockernut hickory	mod.-high?	sapling?
Carya glabra, pignut hickory	mod.-high?	sapling?
Castanea dentata, chestnut	mod.-high?	sapling
Liriodendron tulipifera, tulip poplar (old)	mod.-high	little
Oxydendrum arboreum, sourwood	mod.-high?	sapling
Pinus strobus, white pine (old)	mod.-high?	none
Quercus alba, white oak	mod.-high	sapling

Quercus imbricaria, shingle oak	mod.-high?		sapling
Quercus marilandica, blackjack oak	mod.-high		sapling
Carya cordiformis, bitternut hickory	moderate?		sapling?
Carya illinoinensis, pecan	moderate?		sapling?
Carya laciniosa, shellbark hickory	moderate?		sapling?
Carya ovata, shagbark hickory	moderate?		sapling?
Chamaecyparis thyoides, s. white cedar	moderate?	F?	little/layer?
Fraxinus americana, white ash	moderate?		little
Fraxinus quadrangulata, blue ash	moderate?		little
Juglans nigra, black walnut	moderate?		sapling
Liquidambar styraciflua, sweetgum	moderate?		sapling/lateral?
Nyssa sylvatica, blackgum	moderate		sapling/lateral?
Ostrya virginiana, hophornbeam	moderate?		little?
Quercus coccinea, scarlet oak	moderate		sapling#
Quercus falcata, southern red oak	moderate?		sapling
Quercus shumardii, shumard oak	moderate?		sapling
Quercus velutina, black oak	moderate		sapling#
Quercus michauxii, swamp chestnut oak	moderate?		sapling
Quercus muhlenbergii, chinquapin	moderate?		sapling
Quercus phellos, willow oak	moderate?		sapling
Pinus virginiana, scrub pine	moderate	f	none
Populus deltoides, cottonwood	moderate?		little
Robinia pseudoacacia, black locust	moderate?		lateral
Sassafras albidum, sassafras	moderate?		lateral

Acer nigrum, black maple	low-mod.?	little
Aesculus glabra, stinking buckeye	low-mod.?	sapling?
Carpinus caroliniana, hornbeam	low-mod.?	little?
Celtis occidentalis, hackberry	low-mod.?	sapling/lateral?
Diospyros virginiana, persimmon	low-mod.?	lateral
Fraxinus pennsylvancica, white ash	low-mod.?	little?
Gleditsia triacanthos, honeylocust	low-mod.?	sapling/lateral
Gymnocladus dioicus, coffee tree	low-mod.?	lateral
Juglans cinerea, butternut	low-mod.?	sapling?
Malus spp., crabapple	low-mod.?	lateral
Populus heterophylla, swamp cottonwood	low-mod.?	little?
Prunus spp., plums	low-mod.?	lateral
Prunus serotina, black cherry	low-mod.?	sapling?
Rhamnus carolinana, buckthorn	low-mod.?	little?
Quercus nigra, water oak	low-mod.?	sapling?
Quercus palustris, pin oak	low-mod.?	sapling?
Quercus rubra, northern red oak	low-mod.?	sapling?
Tsuga canadensis, hemlock	low-mod.?	none
Ulmus alata, winged elm	low-mod.?	little?
Ulmus americana, white elm	low-mod.?	little?
Ulmus rubra, red elm	low-mod.?	little?/lateral
Viburnum spp., blackhaw	low-mod.?	sapling?
Acer negundo, boxelder	low?	sapling/epicorm
Acer rubrum, red maple	low	little
Acer saccharinum, silver maple	low	little

Acer saccharum, sugar maple	low		little
Aesculus flava, sweet buckeye	low?		sapling?
Ameanchier arborea, serviceberry	low?		little/large?
Aralia spinosa, devil's walking-stick	low?		lateral
Betula spp., birches	low		little
Celtis laevigata, sugarberry	low?		little?
Cladrastis kentukea, yellowood	low?		sapling/large
Cornus florida, dogwood	low		little?
Fagus grandifolia, beech	low		little/lateral to north?
Halesia carolina, silverbell	low?		little/large?
Ilex opaca, holly	low		sapling?
Juniperus virginiana, red cedar	low	F	none
Liriodendron tulipifera, tulip poplar (young)	low		little
Magnolia macrophylla, bigleaf magnolia	low		little/large
Magnolia tripetala, umbrella magnolia	low		little/large
Morus rubra, red mulberry	low?		little/large
Pinus strobus, white pine (young)	low		none
Platanus occidentalis, sycamore	low?		little/large
Populus grandidentata, big-tooth aspen	low?		little/lateral
Rhus spp., sumacs	low?		lateral
Salix spp., willows	low?		large/layer
Thuja occidentalis, northern white cedar	low	F?	little/layer
Tilia spp., basswoods	low		little/large

LITERATURE ON FIRE ECOLOGY

Appendix 3 includes a review of research on fire effects in Appalachian regions and adjacent mid-western regions. Such review is needed to supplement and support the general impressions of fire managers and ecologists, which generally guide site-specific planning where details are unknown or uncertain. It will also help to point out where research can be most usefully conducted in the future. It is only in recent decades that published science in eastern North America has begun to address the overall interactions of fire, whether from lightning or human ignition, with vegetation (including details of structure and species composition) and land types (incorporating topographic and edaphic variables). This is a complex subject, which will ultimately require more detailed modeling and experimentation to generate reliable predictions. In the meantime, much general knowledge lies within the personal experience and intuition of fire managers and ecologists who have spent many days working and observing on the fire line, plus many long hikes across varied vegetation before and after fires.

The literature on fire ecology includes broad reviews that draw on diverse observations, and, increasingly, detailed experimental studies of particular sites. However, there have been relatively few studies in eastern North America that have examined fire patterns over extensive landscapes with a wide range of vegetation and land types. A pioneering study of this type is by Guyette & Dey (2000), who related fire frequencies in southeastern Missouri to human population and topographic "roughness". They emphasized the important concept that when ignitions are insufficient to saturate the landscape with fire, more rugged land has tended to experience less extensive fires due to interruptions by streams, damp bottomlands, moist slopes, clifflines and other rock-outcrops. Patterns in human ignitions modify this trend. Before settlement, native peoples appear to have started fires more often in less rugged terrain, enhancing the topographic relationship. After settlement, this trend appears to have been reversed by such factors as fire suppression, forest-clearance and road-building in gentle farmland, combined with burning of cut-over forest and woodland-pastures in more hilly land. Such patterns have probably been repeated widely across eastern North America, and must be considered in any local study.

From the broad review of Appendix 3, a summary chart is presented here, suggesting relationships between vegetation types and fire-regime (Table 5). For example, some of the more certain generalizations are as follows.

1. Fires have probably restricted mesophytes from moving into transitional subxeric oak forest.
2. Within subxeric forest, relatively shade-tolerant (or understory-concentrated) species tend to be fire-sensitive; species like red maple, white pine and bigleaf magnolia have probably increased greatly due to fire suppression.
3. On upland slopes, regeneration of oaks (and perhaps hickories, ashes, chestnut, etc.) tends to be promoted by occasional intense fire due to reduction in more mesic or shade tolerant woody species, and due to vigorous resprouts of oak saplings after fire..
4. On summits and ridges, pines—and perhaps red cedar—plus associated flammable shrubs may have been relatively frequent sources of ignitition from lightning; fires that spread from these sites into general upland slopes may have allowed pines to regenerate into the oak forests.
5. Clonal shrubs tend to increase with fire at 3-5 year intervals, due to vigorous lateral sprouting.

Observations on herbaceous species are less definitive, and highly varied depending on species, but some relevant notes are possible. Although it is often suggested that herbaceous species typical of open grassy woodland in this region would benefit from fire, it is important to note that few definitive observations exist. Nevertheless, the few relevant studies have found positive responses to fire for several of these species.

A. Single low intensity fires generally do not increase ground vegetation, unless there are many relictual plants from previous burnings or other past disturbance regimes.

B. Many rare species increase in oak or pine woodlands with frequent burning.

C. Fire season can greatly influence ground vegetation: early (‘cool season’) species tend to be reduced by spring fires. Most C4 grasses (and perhaps some *Dichanthelium*) belong in the ‘warm season’ group, which tend to be increased by spring fires.

D. Legumes in general tend to increase with fire (perhaps especially at 3-5 year intervals).

E. Summer annuals tend to be increased by fires (at least fires in the dormant season).

F. Winter-green species (winter annuals and biennials; including several aliens) tend to be reduced by dormant season fires, especially in the early spring.

G. Some vernal mesic forest herbs tend to be reduced by fire, especially early spring fires; however some other mesic forest species (with summer green foliage) may be increased due to reduction in woody competition and removal of leaf litter (allowing germination of seedlings and reduction in fungal diseases).

H. There is a concern that intense fires could consume organic soil layers that contain dormant seeds and underground plant parts.

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Table 5 [next page]. Suggested relationship between fire frequency and expected changes in vegetation classes. Note that fire in wetter classes is presumed to burn much less intensely or not at all; “change” is relative to the current condition, which is generally between “rare” and “moderately” frequent fire.

VEGETATION	**WITHOUT FIRE**	**RARE BUT**	**MODERATELY**	**FREQUENT FIRE**

CLASS (SEE TEXT FOR DETAILS)	(as in complete human suppression)	INTENSE FIRE (as with lightning alone)	FREQUENT (as in 10-100 year intervals)	(as in prescribed at 1-10 year intervals)
1. SHRUBBY OR GRAMINOID STREAMBANKS AND SHOALS	with virtually no fire history, no change is expected	with virtually no fire history, no change is expected	little/no change is expected; fires difficult to maintain	little/no change; fires difficult to maintain; denser grasslands on some high cobble bars could burn and expand somewhat, but shrubby regrowth probably rapid
2. SHRUBBY OR GRAMINOID SWAMPS AND PONDS	little/no change; adjacent forests become slightly more shady and heliophytes decline	little/no change; adjacent forests may become slightly more shady and heliophytes may decline	little/no change except for temporary opening of adjacent forest	adjacent forest becomes more open; pond hydrology perhaps enhanced, allowing expansion of wetland shrubs, graminoids and herbs needing full sun
3. DEEP SWAMP FOREST	little/no change; adjacent forests become slightly more shady and heliophytes decline	little/no change; adjacent forests may become slightly more shady and heliophytes may decline	little/no change except for temporary opening of adjacent forest	adjacent forest becomes more open; pond hydrology perhaps enhanced, allowing expansion of wetland shrubs, graminoids and herbs needing full sun
4. STREAMSIDE FOREST	with virtually no fire history, no change is expected	with virtually no fire history, no change is expected	little change is expected, since fires may be difficult to maintain on these sites	little change is expected, since fires may be difficult to maintain on these sites
5. MESIC FOREST	little/no change; heliophytes (oaks etc.) decline in subxeric transitions except after intense storm damage	little/no change; heliophytes (oaks etc.) decline in subxeric transitions except after intense storm damage and fires; but regeneration of n red oak, tulip, etc. may persist in canopy	little/no change expected since fires difficult to maintain; regeneration of northern red oak, tulip poplar, white pine and other shade-intolerant species might increase, at least in subxeric transitions	little change expected since fires difficult to maintain; regeneration of northern red oak, tulip poplar and other shade-intolerant species probably increases
6. SUBHYDRIC FOREST	no change on lowlands; on uplands heliophytes (oaks etc,) decline in hydric transitions except after intense storm damage; class moves into some open woodland on hydric sites	no change on lowlands; on uplands heliophytes (oaks etc,) decline in hydric transitions except after intense storm damage or fires	little change; shade-tolerant species more or less balanced with oaks and associates; on uplands class scattered along streams and streamheads surrounded by oak forest	shade-tolerant species decline in understory; oaks and associates increase; on uplands class restricted to small areas transitional from streamheads to ridges with oak woodland
7. SUBMESIC	mesic species increase in	mesic species may increase in	little change; shade-tolerant	mesic shade-tolerant species

FOREST	understory; heliophytes (oaks etc.) decline except after intense storms; class shifts somewhat from mesic to subxeric sites	understory; heliophytes (oaks etc.) decline except after intense storms and fires; class fairly widespread on upland flats/swales	species more or less balanced with oaks and associates; on uplands class scattered on damp flats and swales but mixed with oak forest	decline; oaks and associates increase; class become restricted to ecotones between mesic/subhydric forest and upland oak forest or open vegetation
8. DECIDUOUS SERAL THICKETS	continues to develop into closed forest of various types, except along edges, ROWs, etc.; some species would remain rare or largely disappear (e.g., chinquapin, dwarf locust et al.).	continues to develop into closed forest of various types, except along edges, ROWs, etc.; some species would remain rare or largely disappear (e.g., chinquapin, dwarf locust et al.).	continues to develop into closed forest of various types, except along edges, ROWs, etc.; some drier ridges after fires; remnants may be restored temporarily by fire.	locally intense fires kill adjacent trees; class spreads in ecotone from forest to open woodland on uplands; uncommon species increase (chinquapin, dwarf locust et al.).
9. HYDRIC OAK WOODLAND AND GRASSLAND	forest closes throughout, except after intense storms; hydric oaks become partly replaced by red maple and other subhydric trees; grassy vegetation confined to ponded openings	forest closes throughout, except after intense storms and fires; hydric oaks become partly replaced by red maple et al. on less stressed sites; grassy vegetation confined to ponded openings	forest more or less closed, except after intense storms and fires; hydric oaks balanced with red maple et al. on less stressed sites; grassy patches scattered through woods and ponded openings	develops in hydric streamheads and swales; red maple and other fire-intolerant trees become infrequent except on damper sites; soils perhaps wetter in general but surface dries fast; grassland increases
10. NON-HYDRIC OAK WOODLAND AND GRASSLAND	forest closes throughout, except after intense storms; post oak et al. almost all replaced by white oak and other subxeric/ submesic trees; grassland disappears	forest closes throughout, except after intense storms and fires; post oak et al. largely replaced by white oak and other subxeric or submesic trees; grassland disappears	forest open in places with more recent disturbance, but post oak, s red oak, blackjack, pines still a minor component; patches of grassy vegetation restored temporarily by fires but not widespread	develops on most broad ridges; post oak et al. at least as common as white oak and other subxeric or submesic trees; even pines reduced; grassland increases, including rare species
11. SUBXERIC OAK FOREST	shade-tolerant trees increase in understories; oak regeneration largely restricted to drier sites and storm damage; class moves into uplands with xeric or pyric pine-oak forest (12) and any remnants of non-hydric oak woodland (10)	shade-tolerant trees increase in understories; oakregeneration largely restricted to drier sites, storm damage and burns; classs remains stable on more xeric slopes and may spread into some former pyric woodland (12, 10)	understories partly invaded by fire-tolerant trees, limiting regeneration of oaks and other shade-intolerant or fire-tolerant species; class stable on moderate to xeric slopes	understories become open but with much regeneration of oaks and other shade-intolerant or fire-tolerant species; class stable on most ravine slopes except mesic/xeric extremes
12. XERIC/PYRIC CONIFEROUS WOODLAND AND GLADES	xeric sites accumulate shrubs and other fuel; subxeric transitions become oak-dominated except after intense storms; grassland disappears except at rocky xeric extremes	xeric sites accumulate shrubs and other fuel; subxeric transitions become oak-dominated except after intense storms or fires; grassland disappears except at xeric extremes	xeric sites have mix of forest, open woodland, shrubbery, and grassy outcrops; class restricted to S/W aspects and narrow ridges; open woodland with rare species increases after fires	xeric sites have open grassy/rocky woodland but less shrubbery; class spreads on subxeric slopes and ridges; open woodland with rare species increases in transitions to grassland

RARE PLANTS

Table 6 and Appendix 4 list rare plant species known from the park and elsewhere on the central Cumberland Plateau. There have been relatively few detailed floristic studies of this region: Caplenor (1955, 1979), Patrick (1979), Wofford et al. (1979), Schmalzer et al. (1985), Jones (1989), Campbell et al. (1990), DeSelm (1992), Bailey (1998), Goodson (2000). For this report, there has been a thorough review of these studies, state heritage databases and selected herbarium records, in order to determine what rare species occur in the region, and which of these species are most indicative of fire-maintained vegetation. However, further taxonomic work and inventory will be needed before a definitive list can be produced. Table 6 and Appendix 4 indicate globally (G) rarity and regional (R) rarity for each species; the latter attempts to integrate state (S) ranks with other local information. The list includes all species with only moderate rarity, more or less equivalent to the "S3S4" state rank; these are not threatened or endangered but they still deserve consideration in assessing the significance of a site. All these rare species are classified according to their typical optimum habitat, although in many cases the species may also occur in adjacent or similar habitat.

Globally rare species. There are about thirty globally rare plant taxa (with potential G1 to G3G4 rank) known from the park or nearby—perhaps within 10 miles, close enough to suggest possible occurrence in the park. Seven of these typically occur on dry or wet uplands in open woodlands, edges and grassy openings, where they may be promoted by disturbance of some kind (Table 6). The following two of these are federally listed.

1. *Schwalbea americana* (American Chaffseed) is Federally Endangered, and it is known only from two 1930s collections of Braun (1943) from McCreary County, Kentucky, which are now

lodged at the Smithsonian Institution: "sandstone flat, Natural Bridge" [now known as Natural Arch on Day Ridge] (4 September 1934); "sandstone knob, Alum Creek Road" [KY Route 700 west of Whitley City] (15 June 1935). There is also a single Tennessee record but with vague locality data: Rugel 1842-06 (GH, US) "locality of moist sand in upper regions of Cumberland Mountains between Montgomery and Jamestown" (translated from Latin); Montgomery is now known as Montgomery Station in Fentress County (Block Quad.); if he travelled through Rugby, this collection may come from Morgan Co, close to Big South Fork (perhaps Rugby Quad.).

2. *Sarracenia oreophila* (Green Pitcher-plant) is Federally Threatened, and is known from a living collection by Paul Adams for A.J. Sharp ca. 1930-35 from "Clarkrange Bog" (perhaps = "Gernt Pond"), a locality in Fentress County (Jones Knobs Quad.) a few miles west of Big South Fork; this plant died in cultivation without a herbarium collection; the bog was later destroyed and plants could not be found here in 1947-48; this is the only known record of the species from Tennessee.

It is notable that both *Schwalbea* and *Sarracenia*—recorded here at the edge of their ranges—are southern species typical of wetter (hydric or hydroxeric) ground, which tends to occur in small disjunct patches on the landscape.

The five other globally rare or restricted (more or less G3G4) species with probable pyric associations are typical of drier sites: *Agalinis decemloba* (a purple foxglove), *Liatris microcephala* (a blazing star), *Lilium philadelphicum* var. *philadelphicum* (upland wood-lily), *Robinia hispida* var. *rosea* (dwarf rose-acacia), and perhaps *Silene regia* (royal catchfly—an unverified record). The blazing star (*L. microcephala*) may have been less dependent on fire, since it persists in very thin soil around rock outcrops. Most of these are not threatened globally, but they are significant indicators of native grasslands or open woodlands in the region. It is likely that these species have declined in the region of the park due to fire-suppression.

None of the other globally rare species are likely to have depended on fire before settlement. However, some occur in subxeric or xeric forest and may have been favored by occasional fire on the ground, clearing leaf litter and thinning the woody understory. Two trees have declined drastically due to diseases, and may be considered globally threatened. It is possible that fires promoted these two trees in the past, but there has been no definitive research on this.

1. *Castanea dentata* (American chestnut) is known to be fire-tolerant and there is some regional evidence from pollen cores that native people increased its proportion in Appalachian forests through frequent burning (Delcourt et al. 1998).

2. *Juglans cinerea* (butternut) was locally abundant in thickets and young woods before settlement in Kentucky, especially on fertile bottoms, lower slopes and even some ridges, where native peoples may have farmed and burned the land (e.g., Campbell 1989). [See also Hibbard's (1934b, 21 Dec) note on the Great Onyx Cave area in Appendix 2 of Campbell (1999).]

Other rare species. In addition to the 30 or so globally rare (G1-G3G4) species, about 80 additional species known from the park or nearby (within 10 miles) should be considered rare (S3), threatened (S2) or endangered (S1) in Kentucky of Tennessee (or R1-R3 in Table 6; Appendix 4). Moreover, another 115 species known from the park or nearby are uncommon enough to be considered in general conservation planning, and they can also be used to indicate special vegetational features (R3R4). These would mostly be considered "watch-list" species in the Natural Heritage System, and typically they could be given the "S3S4" state rank. This complete list comprises a total of ca. 225 "rare or uncommon" species as the basis for the following statements. Many (about 40%) of these rare or uncommon species are largely restricted to open rocky glades, grasslands or ponds and shores (marked *** or ### in Table 6), and others (about 30%) are concentrated in open woods or brushy edges (marked ** or ## in Table 6).

About 29% of these 225 rare or uncommon species are most typical of well-drained deeper soils with native grassland (***) or open non-hydric oak woodland (**), where fires were probably most influential (coded as vegetation classes 10 and 12.1/12.2 in Table 6). The state-rare species are all very rare in the park, with no more than two or three records each, and they probably continue to be threatened with further declines or local extinction, as the forest is allowed to become denser, with fire-suppression. Most of the other "uncommon" (R3R4) species may still have viable populations in some the best grassland or open woodland remnants in the park, but some only have one or two records or may already be locally extinct.

Another 9% of these rare or uncommon species (6 S1-S3; 8 S3S4) have been recorded in or near the park on more xeric rocky ground, typically in more stable, less fire-dependent, open phases of pine-oak woodland (classes 10.4 and 12.3/12.4). Even though these species may be somewhat less fire-dependent, most appear to be very rare in the park, and it is likely that some of them have been restricted to only the most xeric rocky sites where forest succession is the slowest. Some have fairly large populations in some rocky openings (e.g., *Liatris squarrulosa*, *Sporobolus clandestinus*), but others appear to be quite rare throughout the region.

On more hydric ground of swales, streamhead seeps and ephemeral ponds (in vegetation classes 06 & 09), about 18% of these rare or uncommon species are probably typical of open hydric oak woodland or its drier transitions, Fire is likely to have been a factor in promoting habitats here, in combination with poor drainage. Another 19% are typical of rocky riverbank openings, and about 4% are typical of stagnant ponded openings.

Only about 22% of these rare or uncommon species are typical of undisturbed, closed forests, or perhaps partly open or disturbed woods (marked * or ** in Table 6), and rarely if ever in open grassy vegetation. These are mostly typical of mesic (class 5), subxeric (11), submesic (7) or subhydric (6) forest (Table 6). In addition, about 20 or so species are typical of shrubby or grassy riverbanks, with little or no fire history. Whether occasional fires in these habitats tend to reduce some of these species is generally unknown. The limited literature and other anecdotal observations (see vegetation sections above) have suggested that some relatively mesophytic herbaceous species may benefit from occasional fire (e.g., *Hydrastis canadensis*, *Eupatorium rugosum*; Rock 2000, etc.). However, some true mesophytes are probably damaged by fire, such as *Panax trifolius* and *Trillium* spp. (Meier et al. 1995; A. Meier, pers. comm.).

Table 6. Rare and uncommon plants of South Fork Cumberland River watershed.
This table is currently attached in Excel format under the file name: "bsfrare.xls"; printouts are provided here sorted (A) by species name, then (B) by habitat code as explained below.

This a provisional listing—more synthesis of Kentucky and Tennessee data is required, plus further herbarium work. These ca. 225 species are covered in more detail within Appendix 4, along with others on the Cumberland Plateau. Question marks after species names indicate uncertain records due to vague locality data or only marginal occurence in area, or due to identification or taxonomic problems. The summary table provides coding for estimated rarity ranks at global and local levels. Global ranks are not thoroughly checked against official ranks promulgated by The Nature Conservancy, and more work is needed to update these with modern information. In addition to truly rare species with S1-S3 rank in each state, an attempt is made to list include all species that may be considered or marginal or "watch-list" status, with ca. S3S4 rank. Local "regional" ranks for the Cumberland Plateau (R1, R2, etc.) are designed to reflect overall rarity with in the central Cumberland Plateau region, and they take a rough average of state ranks from both Kentucky and Tennessee into consideration. Heritage programs in these states should be consulted for their most recent rankings.

Habitat codes follow the system used in the text, Appendix 3 and Campbell (2001a). These codes represent the most typical habitat only; it should be assumed that most species can also occur in adjacent habitat types. The first number in this code is the broad "class" (or formation) number:

1 = shrubby/graminoid streambanks;
2 = shrubby/graminoid swamps;

3 = deep swamp forests;
4 = streamside forests;
5 = mesic forests;
6 = subhydric forests/seral phases;
7 = submesic forests/seral phases;
8 = deciduous seral thickets;
9 = hydric oak woodland/grassland;
10 = non-hydric (upland) oak woodland/grassland;
11 = subxeric oak forest/seral phases;
12 = xeric or pyric coniferous woodland.

A-E indicate low base status (A), moderate (C), or high (E), plus intermediate classes (B & D). Extensions .1, .2, etc., refer to variations in moisture or disturbance regime (Campbell 2001a).

In addition, the codings under column "Open" are as follows:
* = somewhat disturbed forest, including young second growth or burned areas
** = open brushy/grassy woodland, disturbed by cutting, browsing or burning
*** = open grassland with few trees, maintained by frequent fire or other disturbance
# = naturally disturbed forests with flooding, browsing, etc., but not frequent fire
= open brushy/grassy forest edges along waterbodies or rock outcrops with little fire
= open grassy vegetation with few trees along waterbodies or rock outcrops with little fire

Comment field includes other potential habitat codes for wide ranging species, and other notes.

Table 6A: Sorted by species name

SPECIES NAME	COMMON NAME	GLOBAL	LOCAL	HABITAT	OPEN	COMMENT
Acer pennsylvanicum	Striped Maple	G5	R3R4	05.B.2	*	
Aconitum uncinatum	Blue Monkshood	G3G4	R2	05.C.1		
Adiantum capillus-veneris	Southern Maiden-hair Fern	G5	R2	06.E	##	
Agalinis decemloba	Pale Purple Foxglove	G3G4?	R2R3	12.B.2	***	
Agalinis gattingeri?	Gattinger's Purple Foxglove	G4	R4	10.D	***	
Ageratina luciae-brauniae	Lucy Braun's White Snakeroot	G2G3	R3	05.B.5		
Amorpha fruticosa	shrub amorpha	G5	R3R4	01.D.2	##	
Anemone quinquefolia	Wood Anemone	G5	R3R4	05.B.1		
Aristida curtisii	Curtis' three awn grass	G4?	R2?	10.B	***	
Aristida virgata	virgate three awn grass	G4?	R1R2	10.B	***	
Asclepias amplexicaulis	Clasping Milkweed	G5?	R3R4	12.B.2	***	
Asclepias exaltata	Stately Milkweed	G4?	R3R4	10.C.1?	**	
Aster concolor	Western Silky Aster	G4	R2R3	12.B.3	***	
Aster laevis var. concinnus	Narrow-leaved Smooth Aster	G5T4	R4R5T3	01.BC.1	###	
Aster saxicastellii	Rockcastle Aster	G2G3	R2	01.BC.2	##	
Aster schreberi?	Smooth Big-leaf Aster	G4	R3R4	05.D.3		
Astragalus canadensis?	American Milkvetch	G5	R2R3	01.BC.2	##	
Aureolaria patula	Spreading False-foxglove	G3?	R2R3	05.D.3	##	
Aureolaria pectinata	Southern Annual Yellow-foxglove	G4?	R2	12.B.2	***	
Baptisia australis var. australis	Riverbank Indigo	G5T4	R3R4T3T4	01.CD.1	###	
Baptisia tinctoria	Yellow Wild Indigo	G4?	R2	12.B.2	***	
Bartonia paniculata	Spreading Screwstem	G4G5	R3R4	09.B	**	
Bartonia virginica	Yellow Screwstem	G4?	R3	10.B.2	***	
Berberis canadensis	Canadian Barberry	G3G4?	R1	01.BC.2	##	
Betula allegheniensis	Yellow Birch	G5	R3R4	05.B	*	
Boykinia aconitifolia	Brook-saxifrage	G4?	R1R2	01.BC.3	##	
Buchnera americana	Blue-hearts	G4?	R3	10.B.3	***	
Bulbostylis capillaris	(glade hair-sedge)	G4?	R3R4?	12.B.3?	##	
Calamagrostis coarctata (C. cinnoides)	Bog Reedgrass	G4?	R3R4	09.B.4	**	
Calamovilfa arcuata	Riverbank Reed-grass)	G2?	R1	01.BC.3	###	
Calopogon tuberosus	Grass-pink	G4?	R1	09.A.1	***	
Calycanthus floridus	Sweetshrub	G4	R3	05.B.3	**	
Campanula aparinoides?	Marsh-bellflower	G5?	R2	06.C?	**	
Cardamine rotundifolia	Appalachian Watercress	G4?	R3R4	01.BC.3	##	
Carex aestivalis	(a sedge)	G4?	R2?	05.B.2?		
Carex austrocaroliniana	Tarheel Lax-sedge	G4?	R3R4	05.C		
Carex baileyi	Bailey's Segde	G4?	R3R4	06.B	##	
Carex digitalis var. copulata	Coupled Finger Lax-sedge	G4T?	R5T2?	11B?		
Carex emoryi	Riverbank Sedge	G5?	R3?	01.C.1	###	
Carex joorii	Cypress-swamp Sedge	G5?	R2R3	09.B.2	**	02.B.2

Carex leptonervia?	Fine-nerved Lax-sedge	G4	R2?	05.C?		
Carex pedunculata	Red-based Tussock Sedge	G4G5	R3R4	05.C		
Carex physorhyncha	(running sand sedge)	G4?	R2R3	12.B.2	***	
Carex picta	doughnut sedge	G4	R3R4	11.B.3	**	
Carex scabrata	Running Streambank Sedge	G4G5	R3	04.AB	##	
Carex stricta	Wetland Tussock Sedge	G5	R2R3?	09.B	**	
Carex styloflexa	Curved-style Lax-sedge	G4G5	R3R4	06.B?	*?	
Carya carolinae-septentrionalis	Southern Shagbark Hickory	G4?	R4?	11.D		
Castanea dentata	American Chestnut	G3G4?	R3R4?	11.B.1?		
Castanea pumila	Chinquapin	G5?	R3	12.B.2	**	08.B
Ceanothus herbaceus	Prairie Redroot	G5	R1	01.C.1	###	
Centrosema virginiana	Spurred Butterfly-pea	G5?	R2R3	10.C	***	
Chrysogonum virginianum	Green-and-Gold	G4?	R2	05.C.1		
Cimicifuga americana	Mountain Cohosh	G4?	R2R3	05.CD		
Cirsium altissimum?	Tall Wild Thistle	G5	R3R4	10.D	**	
Cirsium carolinianum	Early Wild Thistle	G4	R3R4	10.B.3	***	
Cladrastis kentukea	Western Yellowood	G3G4?	R3R4	11.E.1		
Cleistes bifaria	Spreading Pogonia	G4?	R3R4	10.B	***	
Clematis glaucophylla	Riverbank Leatherflower	G4?	R3R4	01.C.2	##	
Comptonia peregrina	Sweetfern	G5	R1	01.B.1	###	
Conradina verticillata	Cumberland Rosemary	G2G3	R2	01.BC.3	###	
Corallorhiza maculata	Spotted Coralroot	G5	R1	05.B.1	*	
Coreopsis pubescens	Star Tickseed	G5?	R3?	02.BC	##	
Corydalis sempervirens	Northern Corydalis	G5?	R2?	12.B.3	##	
Crataegus uniflora?	Single-flowered Hawthorn	G4G5	R3?	08.D	**	
Crotonopsis elliptica (= Croton wildenovii)	Common Rushfoil	G5	R3R4	12.C.3	***	
Cyperus bipartitus	Red-tipped Annual Flatsedge	G5	R3R4?	02.C?	##	
Cyperus plukenetii	Plukenet's Cyperus	G4G5?	R1	10.AB.3	***	
Cypripedium kentuckiense	Southern Ladies-slipper	G3	R2	04.B	#	
Cypripedium pubescens	Yellow Lady's Slipper	G5	R3R4	11.CD.1	*	
Dentaria maxima?	Lesser Broad-leaf Toothwort	G4?	R3R4?	05.C		
Deschampsia flexuosa	Crinkled Hair Grass	G5	R2	11.A.2?	**	
Desmodium cuspidatum	Large Tick-trefoil	G4?	R3R4	10.D.1	**	
Desmodium obtusum	Stiff Tick-trefoil	G4?	R3R4	12.B.2	***	
Dulichium arundinaceum	Three-way Sedge	G5	R3R4	02.BC	###	
Echinacea purpurea	Broad-leaf Purple Coneflower	G4	R3R4	10.D.1	**	
Eleocharis equisetoides?	a fine sedge	G4?	R1	02.B?	###	
Eleocharis microcarpa?	a fine sedge	G4?	R2?	02.B?	###	
Eleocharis tuberculosa	a fine sedge	G4?	R2?	02.B?	###	
Erigeron pulchellus var. brauniae	Smooth Robin's Plantain	G5T3T4	R3R4	04.B	##	
Eriophorum virginicum	Tawny Cotton-grass	G5?	R1	09.A.3	***	02.B.2
Eryngium yuccifolium	Rattlesnake-master	G5	R3R4	10.C.3	**	
Euphorbia mercurialina	Mercury Spurge	G3G4	R3	05.C.3	**	

Fothergilla major	fothergilla	G3	R1R2	01.BC.2	##	
Gaylussacia brachycera	Box Huckleberry	G3	R3R4	12.A.3		
Gentianella quinquefolia	Stiff Gentian	G4	R3R4	10.D	***	
Glyceria melicaria	Slender Manna-grass	G4G5	R3R4	04.AB	##	
Gratiola pilosa	Shaggy Hedge-hyssop	G4?	R2R3	09.B.6	***	
Gymnopogon ambiguus	Bearded Skeleton Grass	G4?	R2	10.B.3	***	
Helianthus angustifolius	Narrow-leaved Sunflower	G5	R3R4	09.BC.	***	
Helianthus atrorubens	Red-disked Sunflower	G4G5?	R3R4	10.BC	**	
Helianthus mollis	Downy Sunflower	G5	R3R4	10.C.3	**	
Hexalectris spicata	Crested Coral-root Orchid	G4?	R3R4	10.C.3	**	
Hexastylis contracta	Southern Heartleaf	G3	R2R3	05.A.3		
Humulus lupulus var. lupuloides	American Hops	G5	R1R2?	04.C	##	
Hydrocotyle americana	Pennywort	G5	R1	06.B.2?	**	
Hypericum canadense	Narrow-leaved St. John's Wort	G5	R2R3	09.B	***	
Hypericum crux-andreae	St. Andrew's Cross	G4?	R2	09.B.6	***	
Hypericum denticulatum (var. recognitum)	Barrens St. John's Wort	G4?	R3R4	10.B.1?	***	01.B.3
Hypericum hypericoides	Shrubby St. John's Wort	G5?	R3R4	10.BC	**	
Ilex montana var. beadleyi	Downy Mountain Holly	G4G5T4?	R4T2?	11.B		
Isoetes engelmannii	Eastern Quillwort	G5	R3R4	06.B	#	
Juglans cinerea	Butternut	G3G4?	R3R4?	07.C		
Juncus bufonius	Toad Rush	G5	R3?	09.BC	***	
Juncus canadensis	a rush	G5?	R3R4	09.B.3	***	
Juncus coriaceus	Shining Rush	G5?	R3R4	09.C.3	***	
Lathyrus palustris	Riverbank Peavine	G5	R1R2	01.BC.1	##	
Leavenworthia uniflora	Common Glade-cress	G3G4?	R3R4	12.D.3	***	
Lespedeza capitata?	Dense-headed Bush-clover	G5	R3R4	10.C.3	***	
Liatris aspera	Lacerate Blazing-star	G5?	R3R4	12.C.2	***	
Liatris microcephala	Small-headed Blazing-star	G3G4?	R3R4	12.A.4c	###	
Liatris spicata	Sessile Blazing-star	G5	R3R4	10.C.1	**	
Liatris squarrosa	Small Blazing-star	G5	R3R4	12.D.3	***	
Liatris squarrulosa	Southern Blazing-star	G5?	R3R4	10.C.3	**	
Ligusticum canadense: Cumberland variant	Cumberland Lovage	G4T2T3?	R2R3	01.BC.2	##	
Lilium michiganense	Mid-western Wood-lily	G4	R2	07.D?	**	
Lilium philadelphicum ssp. p.	Appalachian Wood-lily	G5T3T4	R2	12.B.2	**	
Lilium superbum	Turk's Cap Lily	G5	R2?	06.C?	**	
Lobelia nuttalii	Nuttall's Lobelia	G4?	R2	09.B.6	**	
Lonicera dioica var. dioica	Eastern Wild Honeysuckle	G4	R3R4	11.DE		
Magnolia fraseri	Mountain Magnolia	G4?	R3R4	05.BC.3		
Malaxis uniflora	Green Adder's Tongue Mouth	G4	R3R4	07.C	*	
Marshallia grandifolia	Barbara's Buttons	G2	R1	01.BC.3	###	
Matelea carolinensis	Carolina Angelpod	G4?	R2?	10.B.1?	**	
Melampyrum lineare var. latifolium	Broad-leaved Cowwheat	G5T4?	R1?	12.A.3?	**	
Melanthium parviflorum	Small-flowered False Hellebore	G4?	R1R2	05.B.1		

Minuartia cumberlandensis	Cumberland Sandwort	G1G2	R1R2	05.B.5		
Minuartia glabra	Appalachian Sandwort	G4?	R2	12.A.4d	###	
Monotropsis odorata	Sweet Pinesap	G3	R2R3	12.A.2?		
Muhlenbergia capillaris?	Glade Hairgrass	G5?	R3	10.C.4	***	
Oenothera linifolia	Thread-leaf Sundrops	G5?	R2	10.B.4	***	
Oenothera perennis?	Bushy Sundrops	G4?	R1	09.C.4	**	
Orontium aquaticum	Goldenclub	G5	R2R3	01.BC.1	###	
Oxalis montana	White Wood-sorrel	G5	R2R3	05.AB.2		
Panax trifolius	Dwarf Ginseng	G4	R3	05.C.1		
Panicum aciculare	Bristly Early Panic-grass	G5	R3	10.B	***	
Panicum albomarginatum	White-margined Early Panic-grass	G4	R2	11.A.4	###	
Panicum ensifolium var. e.	an early panic-grass	G4?	R1	09.AB.1	**	
Panicum longifolium	panic-grass	G4?	R3R4	09.B.6	***	
Panicum malacophyllum	Soft-leaved Barrens Panic-grass	G4?	R3	10.C.3?	***	
Panicum ravenellii	Hard-leaved Barrens Panic-grass	G5	R3R4	12.B.2	***	
Panicum virgatum	Switchgrass	G5	R3R4	01.C.1	###	
Parnassia asarifolia	Kidney-leaf Grass-of-parnassus	G4	R2R3	06.B		
Parthenium integrifolium	Wild Quinine	G5	R3R4	10.BC.3	***	
Paxistima canbyi	Mountain Lover	G2	R2	12.D.4a		
Phaseolus polystachios	Wild Bean	G4G5	R3R4	10.C.1	**	
Philadelphus inodorus	Smooth Mock-orange	G4?	R2	11.E.1		
Phlox amoena	Charming Phlox	G4?	R3R4	10.B.3	***	
Phlox amoena: smooth riverbank form)	Smooth Shining Phlox	G4T3??	R2?	01.BC.3	###	
Physostegia virginiana ssp. v.	Riverbank Dragon-head	G5T5?	R3	01.CD.1	###	
Platanthera cristata	Yellow-crested Orchid	G4?	R2R3	06.A.3	**	09.A.3
Platanthera integrilabia	White Fringeless Orchid	G2	R1R2	06.A.2	**	
Platanthera lacera	Ragged Summer Orchid	G5	R3R4	10.B.2	***	
Platanthera peramoena?	Purple Fringed Orchid	G4?	R3R4	09.BC.1	**	
Podostemum ceratophyllum	Threadfoot	G5	R3	00.BC	###	
Pogonia ophioglossoides	Rose Pogonia	G4?	R1	09.A.3	***	
Polemonium reptans var. villosum	Hairy Lacob's Ladder	G5T3	R3R4	05.B.1		
Polygala cruciata	Cross-leaf Milkwort	G4G5	R2	09.B.6	***	
Polygala incarnata	Fleshy Milkwort	G4G5	R3R4	10.C.2	***	
Polygala paucifolia	Sand Milkwort	G4G5	R1R2	05.A.3?		
Polygala polygama	Racemed Milkwort	G4G5	R2	10.B.1?	**	
Polygonum tenue	Glade Knotweed	G4?	R2	12.BC.4	###	
Potamogeton illinoensis	Illinois Pondweed	G5	R2	01.DE.1	###	
Potamogeton pulcher	Spotted Pondweed	G5	R2R3	02.BC	##	
Potamogeton tennesseensis	Tennessee Riverweed	G2?	R1?	00.C	###	
Pycnanthemum verticillatum	Smooth Wetland Mountain Mint)	G4?	R1	10.B.2	**	
Rhododendron catawbiense	Mountain Rosebay	G4	R3R4	12.A.2	##	
Rhychospora globularis	Globe Beaked-rush	G5	R3	09.B	***	
Rhynchosia tomentosa	Hairy Snout-bean	G5	R2	12.B.2	***	

Robinia hispida var. rosea	Smooth Dwarf Locust	G3G4T3?	R2R3	12.B.2	**	08.B
Rudbeckia truncata	Burnside Brown-eyed Susam	G3?	R3R4	12.D.4c	###	
Sabatia brachiata?	Slender Rose-pink	G4	R1	10.B	***	
Sabatia campanulata?	Slender Marsh-pink	G4	R2	09.B	***	
Sagittaria graminea	Grass-leaf Arrowhead	G5	R2	02.C	###	
Salvia urticifolia	Nettle-leaf Sage	G5	R2	07.D	**	
Sanicula marilandica var. petiolulata	Pineland Sanicle	G5T4	R2R3	12.B.1	**	
Sarracenia oreophila	Green Pitcher Plant	G2	SX	09.A.3?	***	
Saxifraga michauxii	saxifrage	G4?	R1R2	05.B.5		
Schisandra glabra	Bay Starvine	G3?	R1	05.B.5		
Schwalbea americana	American Chaffseed	G1G2	SX	09.B.6?	***	
Scirpus purshianus	Pursh's Bulrush	G5	R3R4	02.BC	###	
Scleria ciliata	Fringed Nut-rush	G5	R1	01.B.1?	###?	
Scutellaria leonardii	Smooth Small Skullcap	G4?	R3R4	12.E.4	***	
Scutellaria saxatilis?	Rock Skullcap	G3G4	R2	05.C.3		
Scutellaria serrata	Mountain Skullcap	G4	R2	05.B.1		
Senecio pauperculus	Northern Meadow-groundsel	G5	R2	01.C.1	###	
Silene regia?	Royal Catchfly	G2G3	R1	10.D.1?	***	[uncertain record]
Sisyrichium atlanticum?	Southeastern Blue-eyed Grass	G5?	R3	10.C	***	
Solidago arguta ssp. bootii	Hairy-seeded Broad-leaf Goldenrod	G5T4	R3?	11.B	**	
Solidago patula?	Swamp Goldenrod	G4	R2	06.B.2?	**	
Solidago rupestris	Limestone Riverbank Goldenrod	G3G4?	R3	01.DE.3	###	
Solidago simplex ssp. randii	Sandstone Riverbank Goldenrod	G??	R3	01.BC.3	###	note Big S Fk variant
Solidago speciosa var. speciosa	Western Showy Goldenrod	G5T4	R2R3	10.D.3	**	
Spartina pectinata	Prairie Cord-grass	G5	R2	01.CD.1	###	
Sphenopholis pensylvanica	Swamp Wedgescale	G4	R2	06.B.3	**	
Spiraea virginiana	Virginia Spiraea	G2?	R1R2	01.CD.2	##	
Spiranthes lucida	Shining Ladies'-tresses	G5	R1	01.DE.1	###	
Sporobolus clandestinus	Rough Dropseed	G5	R3R4	12.D.3	***	
Stenanthium gramineum	Featherbells	G4G5	R2R3	05.B.5	**	note rockhouse form
Talinum teretifolium	Fame-flower	G4?	R1R2	12.A.4d	###	
Taxus canadensis	Canadian Yew	G5	R1R2	05.D.4		
Tephrosia spicata	Spiked Hoary-pea	G4	R2	10.B.1?	***	01.B.3
Thuja occidentalis	Northern White Cedar	G5	R2R3	11.DE		
Toxicodendron vernix	Poison Sumac	G5	R1R2	09.BC	**	
Trachelospermum difforme	Climbing Dogbane	G5	R3R4	01.C.2	##	
Tradescantia ohiensis	Blue-leaf Spiderwort	G5	R3R4	01.CD.1	##	
Tragia urticifolia	Nettle-leaf Noseburn	G5	R1	12.D.4	##	
Trautvettaria caroliniensis	Tassel-rue	G5	R3R4	01.BC.2	##	
Trichomanes boscianum	Filmy Fern	G4?	R3	05.A.5		
Triosteum perfoliatum	Perfoliate Horse-gentian	G5	R2	08.CD	**	
Triphora trianthophora	Three-birds Orchid	G5	R3R4	07.C	*	
Tripsacum dactyloides	Gamma-grass	G5	R3R4	01.CD.1	###	

Ulmus serotina	September Elm	G3G4?	R3	11.E.2		
Uvularia sessilifolia	Riverbank Bellwort	G5	R3R4	04.C		
Vaccinium erythrocarpon	a blueberry	G4?	R2	11.A		
Vernonia noveboracensis	Southern Bog Ironweed	G4G5	R3R4	09.B.3	**	
Veronicastrum virginicum	Culver's Root	G4G5	R3R4	10.D.3	**	
Viburnum dentatum var. lucidulum	Smooth Arrow-wood	G5T4T5?	R2R3?	01.BC.2	##	
Viola fimbriatula	Sandy Barrens Violet	G4G5	R2R3	10.C.4?	***	
Viola lanceolata	Lance-leaved White-violet	G4G5	R3R4	09.B.6	**	
Vitis rupestris	Sand Grape	G3?	R2	01.BC.3	###	
Waldsteinea fragarioides	Barren Strawberry	G5	R3R4	05.D		
Wisteria frutescens	Eastern Wisteria	G5	R3R4	01.D.2	##	
Xyris torta	Yellow-eyed Grass	G5	R2R3	09.B.6	***	

Table 6B: Sorted by habitat code

SPECIES NAME	COMMON NAME	GLOBAL	LOCAL	HABITAT	OPEN	COMMENT
Podostemum ceratophyllum	Threadfoot	G5	R3	00.BC	###	
Potamogeton tennesseensis	Tennessee Riverweed	G2?	R1?	00.C	###	
Comptonia peregrina	Sweetfern	G5	R1	01.B.1	###	
Scleria ciliata	Fringed Nut-rush	G5	R1	01.B.1?	###?	
Aster laevis var. concinnus	Narrow-leaved Smooth Aster	G5T4	R4R5T3	01.BC.1	###	
Lathyrus palustris	Riverbank Peavine	G5	R1R2	01.BC.1	##	
Orontium aquaticum	Goldenclub	G5	R2R3	01.BC.1	###	
Aster saxicastellii	Rockcastle Aster	G2G3	R2	01.BC.2	##	
Astragalus canadensis?	American Milkvetch	G5	R2R3	01.BC.2	##	
Berberis canadensis	Canadian Barberry	G3G4?	R1	01.BC.2	##	
Fothergilla major	fothergilla	G3	R1R2	01.BC.2	##	
Ligusticum canadense: Cumberland variant	Cumberland Lovage	G4T2T3?	R2R3	01.BC.2	##	
Trautvettaria caroliniensis	Tassel-rue	G5	R3R4	01.BC.2	##	
Viburnum dentatum var. lucidulum	Smooth Arrow-wood	G5T4T5?	R2R3?	01.BC.2	##	
Boykinia aconitifolia	Brook-saxifrage	G4?	R1R2	01.BC.3	##	
Calamovilfa arcuata	Riverbank Reed-grass)	G2?	R1	01.BC.3	###	
Cardamine rotundifolia	Appalachian Watercress	G4?	R3R4	01.BC.3	##	
Conradina verticillata	Cumberland Rosemary	G2G3	R2	01.BC.3	###	
Marshallia grandifolia	Barbara's Buttons	G2	R1	01.BC.3	###	
Phlox amoena: smooth riverbank form)	Smooth Shining Phlox	G4T3??	R2?	01.BC.3	###	
Solidago simplex ssp. randii	Sandstone Riverbank Goldenrod	G??	R3	01.BC.3	###	note Big S Fk variant
Vitis rupestris	Sand Grape	G3?	R2	01.BC.3	###	
Carex emoryi	Riverbank Sedge	G5?	R3?	01.C.1	###	
Ceanothus herbaceus	Prairie Redroot	G5	R1	01.C.1	###	
Panicum virgatum	Switchgrass	G5	R3R4	01.C.1	###	

Senecio pauperculus	Northern Meadow-groundsel	G5	R2	01.C.1	###	
Clematis glaucophylla	Riverbank Leatherflower	G4?	R3R4	01.C.2	##	
Trachelospermum difforme	Climbing Dogbane	G5	R3R4	01.C.2	##	
Baptisia australis var. australis	Riverbank Indigo	G5T4	R3R4T3T4	01.CD.1	###	
Physostegia virginiana ssp. v.	Riverbank Dragon-head	G5T5?	R3	01.CD.1	###	
Spartina pectinata	Prairie Cord-grass	G5	R2	01.CD.1	###	
Tradescantia ohiensis	Blue-leaf Spiderwort	G5	R3R4	01.CD.1	##	
Tripsacum dactyloides	Gamma-grass	G5	R3R4	01.CD.1	###	
Spiraea virginiana	Virginia Spiraea	G2?	R1R2	01.CD.2	##	
Amorpha fruticosa	shrub amorpha	G5	R3R4	01.D.2	##	
Wisteria frutescens	Eastern Wisteria	G5	R3R4	01.D.2	##	
Potamogeton illinoensis	Illinois Pondweed	G5	R2	01.DE.1	###	
Spiranthes lucida	Shining Ladies'-tresses	G5	R1	01.DE.1	###	
Solidago rupestris	Limestone Riverbank Goldenrod	G3G4?	R3	01.DE.3	###	
Eleocharis equisetoides?	a fine sedge	G4?	R1	02.B?	###	
Eleocharis microcarpa?	a fine sedge	G4?	R2?	02.B?	###	
Eleocharis tuberculosa	a fine sedge	G4?	R2?	02.B?	###	
Coreopsis pubescens	Star Tickseed	G5?	R3?	02.BC	##	
Dulichium arundinaceum	Three-way Sedge	G5	R3R4	02.BC	###	
Potamogeton pulcher	Spotted Pondweed	G5	R2R3	02.BC	##	
Scirpus purshianus	Pursh's Bulrush	G5	R3R4	02.BC	###	
Sagittaria graminea	Grass-leaf Arrowhead	G5	R2	02.C	###	
Cyperus bipartitus	Red-tipped Annual Flatsedge	G5	R3R4?	02.C?	##	
Carex scabrata	Running Streambank Sedge	G4G5	R3	04.AB	##	
Glyceria melicaria	Slender Manna-grass	G4G5	R3R4	04.AB	##	
Cypripedium kentuckiense	Southern Ladies-slipper	G3	R2	04.B	#	
Erigeron pulchellus var. brauniae	Smooth Robin's Plantain	G5T3T4	R3R4	04.B	##	
Humulus lupulus var. lupuloides	American Hops	G5	R1R2?	04.C	##	
Uvularia sessilifolia	Riverbank Bellwort	G5	R3R4	04.C		
Hexastylis contracta	Southern Heartleaf	G3	R2R3	05.A.3		
Polygala paucifolia	Sand Milkwort	G4G5	R1R2	05.A.3?		
Trichomanes boscianum	Filmy Fern	G4?	R3	05.A.5		
Oxalis montana	White Wood-sorrel	G5	R2R3	05.AB.2		
Betula allegheniensis	Yellow Birch	G5	R3R4	05.B	*	
Anemone quinquefolia	Wood Anemone	G5	R3R4	05.B.1		
Corallorhiza maculata	Spotted Coralroot	G5	R1	05.B.1	*	
Melanthium parviflorum	Small-flowered False Hellebore	G4?	R1R2	05.B.1		
Polemonium reptans var. villosum	Hairy Lacob's Ladder	G5T3	R3R4	05.B.1		
Scutellaria serrata	Mountain Skullcap	G4	R2	05.B.1		
Acer pennsylvanicum	Striped Maple	G5	R3R4	05.B.2	*	
Carex aestivalis	(a sedge)	G4?	R2?	05.B.2?		
Calycanthus floridus	Sweetshrub	G4	R3	05.B.3	**	
Ageratina luciae-brauniae	Lucy Braun's White Snakeroot	G2G3	R3	05.B.5		

Minuartia cumberlandensis	Cumberland Sandwort	G1G2	R1R2	05.B.5		
Saxifraga michauxii	saxifrage	G4?	R1R2	05.B.5		
Schisandra glabra	Bay Starvine	G3?	R1	05.B.5		
Stenanthium gramineum	Featherbells	G4G5	R2R3	05.B.5	**	note rockhouse form
Magnolia fraseri	Mountain Magnolia	G4?	R3R4	05.BC.3		
Carex austrocaroliniana	Tarheel Lax-sedge	G4?	R3R4	05.C		
Carex pedunculata	Red-based Tussock Sedge	G4G5	R3R4	05.C		
Dentaria maxima?	Lesser Broad-leaf Toothwort	G4?	R3R4?	05.C		
Aconitum uncinatum	Blue Monkshood	G3G4	R2	05.C.1		
Chrysogonum virginianum	Green-and-Gold	G4?	R2	05.C.1		
Panax trifolius	Dwarf Ginseng	G4	R3	05.C.1		
Euphorbia mercurialina	Mercury Spurge	G3G4	R3	05.C.3	**	
Scutellaria saxatilis?	Rock Skullcap	G3G4	R2	05.C.3		
Carex leptonervia?	Fine-nerved Lax-sedge	G4	R2?	05.C?		
Cimicifuga americana	Mountain Cohosh	G4?	R2R3	05.CD		
Waldsteinea fragarioides	Barren Strawberry	G5	R3R4	05.D		
Aster schreberi?	Smooth Big-leaf Aster	G4	R3R4	05.D.3		
Aureolaria patula	Spreading False-foxglove	G3?	R2R3	05.D.3	##	
Taxus canadensis	Canadian Yew	G5	R1R2	05.D.4		
Platanthera integrilabia	White Fringeless Orchid	G2	R1R2	06.A.2	**	
Platanthera cristata	Yellow-crested Orchid	G4?	R2R3	06.A.3	**	09.A.3
Carex baileyi	Bailey's Segde	G4?	R3R4	06.B	##	
Isoetes engelmannii	Eastern Quillwort	G5	R3R4	06.B	#	
Parnassia asarifolia	Kidney-leaf Grass-of-parnassus	G4	R2R3	06.B		
Hydrocotyle americana	Pennywort	G5	R1	06.B.2?	**	
Solidago patula?	Swamp Goldenrod	G4	R2	06.B.2?	**	
Sphenopholis pensylvanica	Swamp Wedgescale	G4	R2	06.B.3	**	
Carex styloflexa	Curved-style Lax-sedge	G4G5	R3R4	06.B?	*?	
Campanula aparinoides?	Marsh-bellflower	G5?	R2	06.C?	**	
Lilium superbum	Turk's Cap Lily	G5	R2?	06.C?	**	
Adiantum capillus-veneris	Southern Maiden-hair Fern	G5	R2	06.E	##	
Juglans cinerea	Butternut	G3G4?	R3R4?	07.C		
Malaxis uniflora	Green Adder's Tongue Mouth	G4	R3R4	07.C	*	
Triphora trianthophora	Three-birds Orchid	G5	R3R4	07.C	*	
Salvia urticifolia	Nettle-leaf Sage	G5	R2	07.D	**	
Lilium michiganense	Mid-western Wood-lily	G4	R2	07.D?	**	
Triosteum perfoliatum	Perfoliate Horse-gentian	G5	R2	08.CD	**	
Crataegus uniflora?	Single-flowered Hawthorn	G4G5	R3?	08.D	**	
Calopogon tuberosus	Grass-pink	G4?	R1	09.A.1	***	
Eriophorum virginicum	Tawny Cotton-grass	G5?	R1	09.A.3	***	02.B.2
Pogonia ophioglossoides	Rose Pogonia	G4?	R1	09.A.3	***	
Sarracenia oreophila	Green Pitcher Plant	G2	SX	09.A.3?	***	
Panicum ensifolium var. e.	an early panic-grass	G4?	R1	09.AB.1	**	

Bartonia paniculata	Spreading Screwstem	G4G5	R3R4	09.B	**	
Carex stricta	Wetland Tussock Sedge	G5	R2R3?	09.B	**	
Hypericum canadense	Narrow-leaved St. John's Wort	G5	R2R3	09.B	***	
Rhychospora globularis	Globe Beaked-rush	G5	R3	09.B	***	
Sabatia campanulata?	Slender Marsh-pink	G4	R2	09.B	***	
Carex joorii	Cypress-swamp Sedge	G5?	R2R3	09.B.2	**	02.B.2
Juncus canadensis	a rush	G5?	R3R4	09.B.3	***	
Vernonia noveboracensis	Southern Bog Ironweed	G4G5	R3R4	09.B.3	**	
Calamagrostis coarctata (C. cinnoides)	Bog Reedgrass	G4?	R3R4	09.B.4	**	
Gratiola pilosa	Shaggy Hedge-hyssop	G4?	R2R3	09.B.6	***	
Hypericum crux-andreae	St. Andrew's Cross	G4?	R2	09.B.6	***	
Lobelia nuttalii	Nuttall's Lobelia	G4?	R2	09.B.6	**	
Panicum longifolium	panic-grass	G4?	R3R4	09.B.6	***	
Polygala cruciata	Cross-leaf Milkwort	G4G5	R2	09.B.6	***	
Viola lanceolata	Lance-leaved White-violet	G4G5	R3R4	09.B.6	**	
Xyris torta	Yellow-eyed Grass	G5	R2R3	09.B.6	***	
Schwalbea americana	American Chaffseed	G1G2	SX	09.B.6?	***	
Juncus bufonius	Toad Rush	G5	R3?	09.BC	***	
Toxicodendron vernix	Poison Sumac	G5	R1R2	09.BC	**	
Helianthus angustifolius	Narrow-leaved Sunflower	G5	R3R4	09.BC.	***	
Platanthera peramoena?	Purple Fringed Orchid	G4?	R3R4	09.BC.1	**	
Juncus coriaceus	Shining Rush	G5?	R3R4	09.C.3	***	
Oenothera perennis?	Bushy Sundrops	G4?	R1	09.C.4	**	
Cyperus plukenetii	Plukenet's Cyperus	G4G5?	R1	10.AB.3	***	
Aristida curtisii	Curtis' three awn grass	G4?	R2?	10.B	***	
Aristida virgata	virgate three awn grass	G4?	R1R2	10.B	***	
Cleistes bifaria	Spreading Pogonia	G4?	R3R4	10.B	***	
Panicum aciculare	Bristly Early Panic-grass	G5	R3	10.B	***	
Sabatia brachiata?	Slender Rose-pink	G4	R1	10.B	***	
Hypericum denticulatum (var. recognitum)	Barrens St. John's Wort	G4?	R3R4	10.B.1?	***	01.B.3
Matelea carolinensis	Carolina Angelpod	G4?	R2?	10.B.1?	**	
Polygala polygama	Racemed Milkwort	G4G5	R2	10.B.1?	**	
Tephrosia spicata	Spiked Hoary-pea	G4	R2	10.B.1?	***	01.B.3
Bartonia virginica	Yellow Screwstem	G4?	R3	10.B.2	***	
Platanthera lacera	Ragged Summer Orchid	G5	R3R4	10.B.2	***	
Pycnanthemum verticillatum	Smooth Wetland Mountain Mint)	G4?	R1	10.B.2	**	
Buchnera americana	Blue-hearts	G4?	R3	10.B.3	***	
Cirsium carolinianum	Early Wild Thistle	G4	R3R4	10.B.3	***	
Gymnopogon ambiguus	Bearded Skeleton Grass	G4?	R2	10.B.3	***	
Phlox amoena	Charming Phlox	G4?	R3R4	10.B.3	***	
Oenothera linifolia	Thread-leaf Sundrops	G5?	R2	10.B.4	***	
Helianthus atrorubens	Red-disked Sunflower	G4G5?	R3R4	10.BC	**	
Hypericum hypericoides	Shrubby St. John's Wort	G5?	R3R4	10.BC	**	

Parthenium integrifolium	Wild Quinine	G5	R3R4	10.BC.3	***	
Centrosema virginiana	Spurred Butterfly-pea	G5?	R2R3	10.C	***	
Sisyrichium atlanticum?	Southeastern Blue-eyed Grass	G5?	R3	10.C	***	
Liatris spicata	Sessile Blazing-star	G5	R3R4	10.C.1	**	
Phaseolus polystachios	Wild Bean	G4G5	R3R4	10.C.1	**	
Asclepias exaltata	Stately Milkweed	G4?	R3R4	10.C.1?	**	
Polygala incarnata	Fleshy Milkwort	G4G5	R3R4	10.C.2	***	
Eryngium yuccifolium	Rattlesnake-master	G5	R3R4	10.C.3	**	
Helianthus mollis	Downy Sunflower	G5	R3R4	10.C.3	**	
Lespedeza capitata?	Dense-headed Bush-clover	G5	R3R4	10.C.3	***	
Liatris squarrulosa	Southern Blazing-star	G5?	R3R4	10.C.3	**	
Hexalectris spicata	Crested Coral-root Orchid	G4?	R3R4	10.C.3	**	
Panicum malacophyllum	Soft-leaved Barrens Panic-grass	G4?	R3	10.C.3?	***	
Muhlenbergia capillaris?	Glade Hairgrass	G5?	R3	10.C.4	***	
Viola fimbriatula	Sandy Barrens Violet	G4G5	R2R3	10.C.4?	***	
Agalinis gattingeri?	Gattinger's Purple Foxglove	G4	R4	10.D	***	
Cirsium altissimum?	Tall Wild Thistle	G5	R3R4	10.D	**	
Gentianella quinquefolia	Stiff Gentian	G4	R3R4	10.D	***	
Desmodium cuspidatum	Large Tick-trefoil	G4?	R3R4	10.D.1	**	
Echinacea purpurea	Broad-leaf Purple Coneflower	G4	R3R4	10.D.1	**	
Silene regia?	Royal Catchfly	G2G3	R1	10.D.1?	***	[uncertain record]
Solidago speciosa var. speciosa	Western Showy Goldenrod	G5T4	R2R3	10.D.3	**	
Veronicastrum virginicum	Culver's Root	G4G5	R3R4	10.D.3	**	
Vaccinium erythrocarpon	a blueberry	G4?	R2	11.A		
Deschampsia flexuosa	Crinkled Hair Grass	G5	R2	11.A.2?	**	
Panicum albomarginatum	White-margined Early Panic-grass	G4	R2	11.A.4	###	
Ilex montana var. beadleyi	Downy Mountain Holly	G4G5T4?	R4T2?	11.B		
Solidago arguta ssp. bootii	Hairy-seeded Broad-leaf Goldenrod	G5T4	R3?	11.B	**	
Castanea dentata	American Chestnut	G3G4?	R3R4?	11.B.1?		
Carex picta	doughnut sedge	G4	R3R4	11.B.3	**	
Cypripedium pubescens	Yellow Lady's Slipper	G5	R3R4	11.CD.1	*	
Carya carolinae-septentrionalis	Southern Shagbark Hickory	G4?	R4?	11.D		
Lonicera dioica var. dioica	Eastern Wild Honeysuckle	G4	R3R4	11.DE		
Thuja occidentalis	Northern White Cedar	G5	R2R3	11.DE		
Cladrastis kentukea	Western Yellowood	G3G4?	R3R4	11.E.1		
Philadelphus inodorus	Smooth Mock-orange	G4?	R2	11.E.1		
Ulmus serotina	September Elm	G3G4?	R3	11.E.2		
Carex digitalis var. copulata	Coupled Finger Lax-sedge	G4T?	R5T2?	11B?		
Rhododendron catawbiense	Mountain Rosebay	G4	R3R4	12.A.2	##	
Monotropsis odorata	Sweet Pinesap	G3	R2R3	12.A.2?		
Gaylussacia brachycera	Box Huckleberry	G3	R3R4	12.A.3		
Melampyrum lineare var. latifolium	Broad-leaved Cowwheat	G5T4?	R1?	12.A.3?	**	
Liatris microcephala	Small-headed Blazing-star	G3G4?	R3R4	12.A.4c	###	

Minuartia glabra	Appalachian Sandwort	G4?	R2	12.A.4d	###	
Talinum teretifolium	Fame-flower	G4?	R1R2	12.A.4d	###	
Sanicula marilandica var. petiolulata	Pineland Sanicle	G5T4	R2R3	12.B.1	**	
Agalinis decemloba	Pale Purple Foxglove	G3G4?	R2R3	12.B.2	***	
Asclepias amplexicaulis	Clasping Milkweed	G5?	R3R4	12.B.2	***	
Aureolaria pectinata	Southern Annual Yellow-foxglove	G4?	R2	12.B.2	***	
Baptisia tinctoria	Yellow Wild Indigo	G4?	R2	12.B.2	***	
Carex physorhyncha	(running sand sedge)	G4?	R2R3	12.B.2	***	
Castanea pumila	Chinquapin	G5?	R3	12.B.2	**	08.B
Desmodium obtusum	Stiff Tick-trefoil	G4?	R3R4	12.B.2	***	
Lilium philadelphicum ssp. p.	Appalachian Wood-lily	G5T3T4	R2	12.B.2	**	
Panicum ravenellii	Hard-leaved Barrens Panic-grass	G5	R3R4	12.B.2	***	
Rhynchosia tomentosa	Hairy Snout-bean	G5	R2	12.B.2	***	
Robinia hispida var. rosea	Smooth Dwarf Locust	G3G4T3?	R2R3	12.B.2	**	08.B
Aster concolor	Western Silky Aster	G4	R2R3	12.B.3	***	
Corydalis sempervirens	Northern Corydalis	G5?	R2?	12.B.3	##	
Bulbostylis capillaris	(glade hair-sedge)	G4?	R3R4?	12.B.3?	##	
Polygonum tenue	Glade Knotweed	G4?	R2	12.BC.4	###	
Liatris aspera	Lacerate Blazing-star	G5?	R3R4	12.C.2	***	
Crotonopsis elliptica (= Croton wildenovii)	Common Rushfoil	G5	R3R4	12.C.3	***	
Leavenworthia uniflora	Common Glade-cress	G3G4?	R3R4	12.D.3	***	
Liatris squarrosa	Small Blazing-star	G5	R3R4	12.D.3	***	
Sporobolus clandestinus	Rough Dropseed	G5	R3R4	12.D.3	***	
Tragia urticifolia	Nettle-leaf Noseburn	G5	R1	12.D.4	##	
Paxistima canbyi	Mountain Lover	G2	R2	12.D.4a		
Rudbeckia truncata	Burnside Brown-eyed Susam	G3?	R3R4	12.D.4c	###	
Scutellaria leonardii	Smooth Small Skullcap	G4?	R3R4	12.E.4	***	

TERRESTRIAL VERTEBRATES

M. Hines has reviewed literature relevant to effects of fire on terrestrial vertebrates on the Cumberland Plateau. This is presented in full as Appendix 5, and a summary follows. Table 7 presents some of the perceived or expected trends among birds. Larger native mammals in general (bear, racoon, deer, groundhog, opussum, etc.) do not appear to be negatively affected by fire in the short-term or long-term, although some mortality may occur during intense, rapidly spreading fires. [Native Americans may have used fire to drive game over cliffs or into tight ravines.] Open woodland with dense shrubs or grassy ground vegetation can be more productive than dense shady forest, and edges or brushy ecotones in general may be optimal. Productive landscape for these species include a mosaic of open and closed vegetation, with various levels of fire effects.

Small mammals can be much reduced by fire in the short-term, due to removal of vegetation and woody debris. However, most species recover their populations within a few weeks, months or years, depending on the species. Some species can even experience temporarily higher populations for a certain period after fire, probably due to exposure of seeds and invertebrates for food. Also, if more open grassy woodland is created by repeated fires, there is generally a greater abundance and diversity of species. There is probably no serious negative effect on rare species. Specialists along clifflines and wet areas generally have ample refuges from fire, and may even benefit from increased productivity of adjacent burned habitats.

There is no evidence that bats are reduced by forest fires. If occasional roost trees are consumed, there could be local problems, but intense fires can also increase the number of decadent or hollow trees. It has been suggested that bats may benefit from more open grassy woodland, due to the greater number and diversity of flying insects for food, but dense forests can probably supply adequate food (J. MacGregor, pers. comm.).

Birds have highly varied responses to fire management, reflecting their complex relationships to vegetation structure in nesting and feeding. Low intensity fires within relatively shady forest can reduce bird diversity, especially shrub-nesters and ground-nesters. However, more frequent fires that maintain open grassy conditions can cause increases in ground-nesters, fly-catching species and other species. Shrub-nesters could be increased locally if shrubs and tree resprouts are increased by fires at moderate intervals. More intense, complex, widespread fires at longer intervals, as may have existed during some presettlement periods, could have created a complex mosaic of habitats with high bird diversity. Dead tree snags, in particular, might have been produced in greater numbers, allowing associated species to prosper.

The red-cockaded woodpecker (RCW), which nests in old live pines, has been the subject of much research and management due to its endangered status. Pine-oak forest on Daniel Boone National Forest has been subjected to prescribed burning and understory removal to create a more open woodland similar to the bird's optimal habitat on the Coastal Plain. But this treatment has not progressed enough to allow adequate long-term regeneration of shortleaf pine, and it is possible that the RCW could be negatively impacted in the short-term due to reduction of some deciduous trees and shrubs that produce insect food.

Neotropical migrants with declining populations are affected by fire management in different ways. Extrapolating from studies on RCW management, species associated with forest interiors can be reduced, especially if understories are thinned as well. However, species associated with more open woodland and edges can be increased. Whether an appropriate balance of stable populations can be promoted in the long-term by a complex mosaic of management remains to be seen. It is also uncertain what balance existed before settlement or in the "natural" condition. Ultimately, deforestation in winter habitats may be the overriding factor.

Reptiles in general do not appear negatively affected by fire management. Several species, including the rare scarlet snake and glass lizard, probably benefit from the creation of a more open woodland. Amphibians are generally restricted to more mesic or hydric habitats, which do not generally experience significant fire effects. Fire has been suspected in restrictions of some amphibians, but the limited amount of research suggests that several species may actually increase in burned areas. Some amphibians are typical of more xeric fire-maintained habitats on the Coastal Plain, and on the Cumberland Plateaus there are a few potential examples, such as the spade-foot toad. So long as a mosaic of habitats is maintained with different fire regimes, it seems unlikely that any of the rare species of reptiles or amphibians would be reduced by fire, and some may be promoted.

TERRESTRIAL INVERTEBRATES

There is little definitive information on effects of fire on invertebrates. A review and discussion of potential effects is beyond the scope of this report. Tables analagous to Table 7 are needed in order to summarize documented trends and general impressions of knowledgeable naturalists, such as J. MacGregor (pers. comm.).

Table 7. Generalized summary of expected relationships between birds and fire.

Fire regime	**Occasional ground fires**	**Regular ground fires** (3-5 years)	**Frequent ground fires** (annually)	**Occasional high intensity fires** (intervals < stand maturation time)	**Frequent high intensity fires** (interval > stand maturation time)
Effects on vegetation	Temporary reduction of litter, herbaceous and shrub layer, and small dbh classes; possible creation of some snags; over time, effects minimal.	Temporary reduction of litter and shrub layer, followed by some resprouting of shrubs and understory stems; creation of some snags; over time reduction in structural heterogeneity, some opening of canopy.	Reduction of litter and shrub layer. Creation of some snags, but destruction of others over time; reduction or elimination of smaller dbh classes; increased opening of canopy can result in grassy understory; reduced structural heterogeneity and tree species diversity.	Reduction of all size classes, creation of snags, increased structural heterogenity, vigorous resprouting in response to increased light results in dense stands that become more open as they mature.	Initial reduction of all size classes, creation of snags, increased structural heterogeneity; over time development of dense immature stands, fewer snags, reduced structural heterogeneity, species diversity.
Effects on overall bird diversity	Temporary decrease, long-term effects minimal to none.	Temporary decrease; long-term effects minimal, possibly slight increase.	Temporary decrease, but over time increase likely to surpass pre-burn levels.	Immediate increase, but as new stands become dense, decrease likely until stands mature and open up, causing bird diversity to return to pre-burn levels.	Immediate increase, but as new stands become dense, decrease likely
Effects on ground nesters	Temporary decrease	Temporary decrease,	Temporary decrease, followed by increase likely to surpass pre-burn levels	Decrease for several decades until stand matures	Permanent decrease.
Effects on shrub nesters	None	Temporary decrease followed by increase likely to surpass pre-burn levels	Decrease of most species	Increase until resprouting occurs and new stand becomes established	Cyclical: increase after a fire followed by decreases as stand matures
Effects on midstory nesters	None	minimal	Some decrease over time	Decrease for several decades until stand matures	Permanent decrease.
Effects on canopy nesters	None	minimal	Some decrease over time	Decrease until stand matures	Permanent decrease.
Effects on cavity nesters	minimal	minimal	variable	Likely to increase temporarily; likely to decrease as stand matures, due to declining number of cavity trees.	Permanent decrease of most species.

AIR, SOIL AND WATER

Air. Van Lear & Waldrop (1989) have provided a general review of these issues. Primary emissions from fires include fine particulates, water vapor, carbon dioxide, (carbon monoxide), nitrogen oxides, (sulphur dioxide), and various volative organic compounds (Haddow 1989). Secondary emissions may include ozone and componuds formed from nitrogen oxides and volatile organics (see also EPA website). Only 0-3% of the nation's air pollution can be attributed to prescribed burning. One forest model suggests that current fires, nationally, do play a significant role in restricting carbon storage within biomass (Sohngen & Haynes 1997). In contrast, another study (Luckow 2000) has shown that careful restoration of open grassy woodland in the Ouachita National Forest with burning and thinning causes a net rise in carbon fixation due to the increase in graminoid ground vegetation and upper soil horizons. This input of carbon was estimated at 0.20 tons/acre/year or 1500 lbs of CO_2/acre/year.

Visibility is already impaired by fine particulate pollutants in much of eastern North America, with typical visual ranges being less than 20 miles, or about 20% of the natural range. The average visual range in the Big South Fork area is ca. 10-15 miles, and this site is assigned Class II in its regulatory protection from artificial increases in pollution (EPA 1998). The potential of prescribed fire to enhance this problem has received considerable research (EPA 1999). Significant smoke emissions from a typical suppressed wildfire or small prescribed fire of ca. 10-100 acres would generally be confined to the park and its immediate vicinity. Air quality on a regional level would only be affected when ca. 100-1000 acres are burned on the same day (NWCG 1985).

Frequent fires in open grassy woodland generally produce lower amounts of smoke per fire because smoldering combustion is minimal (NWCG 1985). In contrast catastrophic wildfires after long periods of fuel accumulation can lead to several days of smoldering woody material with significant impacts on local or even regional air quality (EPA 1998).

Soil. Severe fires, fire breaks and other disturbances by fire fighting can cause increases in erosion by exposing upper soil horizons and decreasing organic absorption of precipitation (Tiedemann 1979, Van Lear & Waldrop 1989, Wade & Lunsford 1989). The degree of erosion increases with fire frequency, severity, slope (especially above 25%), occurrence of heavy rains or snowmelt, and slowness of regrowth. Exposed mineral soils can experience decreased infiltration and aeration as rain clogs fine pore with soil and carbon particles. However, it is possible for moderately intense fires in heavy fuels on steep slopes (up to 45%) to produce little or no erosion, if soil moisture does not exceed field capacity (e.g., Swift et al. 1993).

Severe fires, especially in unusually dry piles of woody debris or windrowed litter, may ignite organic matter within the soil and alter the structure of clay particles (Van Lear & Waldrop 1989, Wade & Lunsford 1989, Boerner 2000). Even low intensity fires that just burn litter, if annually repeated for 10 years of more, can cause major losses of overall organic matter in the forest floor. Loss of organic matter may reduce establishment of some tree species (especially large seeded oaks, hickories, etc.), but favor establishment of others (especially small seeded pines, yellow poplar, etc.). Intense summer fires in conifer forests can greatly reduce organic C (and N) in soils, while some long-term studies of frequent slight winter burns in deciduous forest have shown little or no change. Slight increases in organic matter have even been reported in some cases within a few years after a fire, apparently due to increased productivity and biomass of ground vegetation. Such increases in organic matter may be compounded after several fires and other restoration to convert forest into open grassy woodland, allowing better buffering of acid rain, reduced nutrient losses and overall watershed protection (e.g., Luckow 2000).

The nitrogen cycle is often affected by fires (Van Lear & Waldrop 1989, Wade 1989, Fritze et al. 1993, USDA Forest Service 1993, EPA 1999, Boerner 2000, Luckow 2000). Intense fires in coniferous stands tend to cause considerable volatilization of organic nitrogen (ca. 20-100 lbs/acre estimated in loblolly pine), but light prescribed fires in hardwoods stands may release much less (<1 lb/acre in oak-hickory). The time needed for full ecosystem recovery may range from only 1-5 years to 10-20 years or more. Available nitrogen often increases due to burning of organic matter and subsequent increases in mineralization. Fine root biomass tends to be reduced when N is increased. There may even be later increases in nitrogen fixation when legumes increase in growth after fires. However, a few studies have shown reductions in N mineralization or related enzyme activity after long-term burning, perhaps due to complex changes in the type of organic matter and the microbial population. Sulphur, in much smaller amounts, also tends to be volatilized, though increases in availability to plants can also occur after repeated burning (Luckow 2000).

Other major nutrients (P, Ca, K, Mg) tend to be increased in available forms after fires (e.g., Van Lear & Waldrop 1989, Boerner 2000, Luckow 2000). Upper soil pH often rises, by as little as 0.25 units after slight burns (even if continued for decades; DeSelm & Clebsch 1991a), or by up to 3 units within 6 months after an intense slash burn. Such effects may alleviate the effects of acid rain in some regions (Luckow 2000). However, many complex factors can influence fire effects on mineral cycling. Increases in soil base-status and other nutrients may be pronounced on soils with low base-status, but not significant on calcareous soils and others with high base-status already. Decreases in available P have been reported after intense or frequent burning (e.g., DeSelm & Clebsch 1991a), especially in association with higher base-status, perhaps due to formation of insoluble P salts. In some poor soils, rapid regrowth after a fire can immobolize any released minerals (e.g., Boerner 1983). Also, flushes of soluble nutrients may be lost (especially K) if there is excessive runoff by precipitation due to intense fires having reduced absorption by vegetation and soil (Tiedemann 1978). Intense fires can also cause significant transfer of nutrients to adjacent land in air-borne ash.

Microbial responses to fire are highly variable, but in general increases in decomposition of organic matter can be expected (Fritze et al. 1993, Boerner 2000, Boerner et al. 2000). Microclimate at the soil surface can be greatly changed after burns. Temperatures tend to be higher by day and lower at night, which may contribute to increased microbial activity and to earlier seasons for root growth. Microbes and some soil invertebrates can be reduced after intense fires, but these often recover within a year or so, especially if there are flushes of nutrients and ground vegetation. Decomposing enzymes may have various responses to fire, depending partly on fine patterns in microclimate and soil properties.

Ground vegetation increases after fire often involve responses to nutrient flushes caused by the fire, in addition to the reduced competition from woody plants (Van Lear & Waldrop 1989, Gilbert et al. 2000). Nitrogen-fixation—both nonsymbiotic and symbiotic (with frequent increases in legumes)—can be greater after fires, and together with atmospheric inputs, this may lead to recovery of prior ecosystem levels within a few decades.

Trees themselves may respond positively in growth due to nutrient releases after fires. Unless fires are intense enough to cause large openings in the forest, differences between species in such growth effects might actually enhance succession towards less xeric conditions, e.g., from pitch pine to chestnut oak and white oak in New Jersey Pine Barrens (Boerner et al. 1988).

Water. By reducing ground vegetation, litter and upper organic soil in the short-term, fire tends to reduce the absorbtion of precipitation, and it can lead to increases in run-off (Tiedemann 1979). This effect may be enhanced after intense fires, such as promoted by unusually dry conditions, accumulations of woody debris, or occurrence on steep south-facing slopes (where there is most potential for fire-generated updrafts in dry fuel). However, on some (perhaps mainly coniferous) sites, fire is reported to increase water holding capacity (and perhaps "wetability"), due to volatilization of hydrophobic monoterpenoids (Barbour et al. 1987, Groeschl et al. 1991; see also Luckow 2000).

With intense fire, mineral soil can be exposed, with clogging of fine pores by soil and charcoal leading to reduced aeration and infiltration (Wade 1989). There can also be significant soil erosion and flushing of released nutrients into the stream system (Tiedemann 1978).

Careful prescribed burning is generally said to have minor effects on stream systems in the southeastern USA, but there has been litte definitive research (Van Lear & Waldrop 1989). Sediment levels have been increased several-fold (to ca. 0.5 ton per acre) in some studies, but there have been negligible effects on streamflows, sediments, or nutrient losses in other cases. Nitrate losses have been reported by some studies in western USA, but not exceeding the recommended maximum by the Environmental Protection Agency of 10 parts per million (Tiedemann et al. 1979). In poor soils, nutrients released after fires may be rapidly immobilized by regrowing vegetation, instead of being lost through ground water (Boerner 1983).

Long-term effects on hydrology can result from conversion of closed forest to open grassy woodland. There is evidence that more open vegetation maintained by regular disturbance can, in some cases, have reduced evapotranspiration and retain higher average soil moisture contents (e.g., Swift et al. 1993). In some cases with repeated low-intensity prescribed fires, organic matter can even increase in the soil (Groeschl et al. 1991, Luckow 2000). Such effects may lead to more continuous spring and streamflow (see also Ladd 1991).

Feminella (2000) has reported increases in stream algae after burning, but little or no change in invertebrate groups. Potential effects on rare aquatic species are not easily understood, but slight increases in turbidity could be expected after extensive or intense fires on the uplands (Wade 1989). Ecosystem studies in the Ouachitas have suggested that careful repeated prescribed burning may actually improve water quality for extended periods due to the development of thicker ground vegetation and more organic soil, which retain more runoff and nutrients (Luckow 2000).

The National Park Service maintains 30 sites for monitoring water flow and quality in the Big South Fork area (S. Bakaletz, pers. comm.). Big South Fork water resources have been summarized in Hamilton & Turrini-Smith (1997).

FIRE MANAGEMENT [FMP III]

PROGRAMMATIC GOALS [FMP IIIA]

Existing Goals. The following four general goals for management of vegetation with fire have already been drafted at Big South Fork (NPS/BISO 2000b). Another four additional goals, not repeated here, are related to interagency cooperation, air quality, patrols, and educational efforts.

Goal 1: Firefighter and public safety will receive the highest priority during every fire management activity.

Goal 2: Suppress all unwanted and undesirable wildland fires regardless of ignition source to protect the public; check fire spread onto private property; and protect the natural and cultural resources of the Area.

Goal 3: Use prescribed fire where and when appropriate as a tool to manage vegetation within the National Area boundaries, and where acceptable, across NPS boundaries to attain management objectives.

Goal 4: Modify fuel complexes around developed areas, along interface boundary areas and in proximity of cultural sites to reduce fire behavior and intensity to a manageable level to protect these sites.

Suggested Modifications. The following modifications or extensions to existing goals are suggested here as the basis for further discussion, and in order to advance the definition of Fire Management Units.

Goal 2: In order to simulate a purely natural fire-regime based on lighting strikes throughout major areas of the park (FMUs 6 & 9 outlined below), there is a need to consider developing careful criteria for allowing selected wildland fires to burn.

Such fires would only be allowed only if the Fire Management Officer and other firefighting officials determine with certainty, and in a timely fashion, that the fire can be safely and easily be contained within appropriate Fire Management Units. Control lines would be previously designed around the FMU, with fuel reduction if possible. The status of these FMUs and the "let-burn" criteria would be reviewed before each fire season. Obviously, any ignititon from lightning would receive consideration for such action. Where fires have unknown causes or arson is suspected, a more restrictive selection would operate but some of these fires should still be considered. Lightning ignitions could have burned much more widely before settlement, often crossing developed boundaries of modern management units with roads and farmland that currently act as fire-breaks. Thus, current lightning ignitions within any given FMU may be insufficient to simulate a purely natural fire-regime. As more information on purely natural fire-regimes becomes available, it will eventually be possible to suggest appropriate frequencies of strictly natural fires, from lightning, for each of these FMUs. This frequency could become a significant guideline to consider in each decision.

Goal 3: Based on further ecological consideration, the use of prescribed fire within selected FMUs would be focused on the following broad objectives for the vegetation.

A. To restore a fire-regime typical of the pre-Columbian scene, based either on purely natural lightning-caused fires, or, if compatible with other goals and objectives of the FMU, based on largely human-caused fires. As summarized above, there is considerable evidence that fires of human origin contributed to the abundance of oak forest, open pine/oak woodland and grassland in this region before settlement. Such influences probably became widespread during the Woodland cultural era and may have increased locally during the Mississippian cultural era. During the 1800s, some fields and woodland pastures probably continued to be burned, and fires may have often spread into the forest, but during the past 50-100 years fires have probably become much less frequent.

B. To maintain native biodiversity. "Native" biodiversity includes the full range of ecosystem types that can exist with or without presettlement fire-regimes, together with all characteristic species and genotypes (especially endangered taxa). It is important to restore some areas of open grassy woodland with frequent (quasi-cultural) fire at 1-10 year intervals. It is also important to plan for extensive areas to approach a simulated lightning fire regime, with ca. 10-100+ year intervals. Moreover, controlled areas with minimal fire should also be considered, since distinct forest conditions and sets of species will benefit from that treatment. Decisions cannot and should not simply be based on whether an area is likely to have had frequent fire before settlement, even if this can be determined, because of the unresolved issues of ecological "naturalness", native american influences, and "cultural" landscape preservation.

C. To reduce selected invasive alien plants. Based on further review above (e.g., Appendix 3), such species might include fescue, garlic mustard, japanese spiraea, multiflora rosa, japanese honeysuckle, etc. Such plans would be coordinated with other vegetation management goals and integrated pest management at Big South Fork.

D. To allow scientific comparison of areas with different fire treatments. Although rigorous experimental study of fire effects may not always be possible, even individual paired comparisons may have great value for “adaptive management” in the park. There is much uncertainty about fire effects, and NPS needs to know what effects fire has on park resources. This could involve designating large enough blocks of land as quasi-experimental “controls”, within which fire can be minimized without risking loss of significant features. In addition to obvious short-term effects on vegetation and soils, there is a need to study long-term effects of repeated fires on: (a) selected species (from keystone dominants to endangered species); (b) shifts in community composition (from restriction of fire sensitive invaders like white pine and red maple, to promotion of oaks and pines); and (c) ecosystem functions (from soil development to watershed processes).

E. To reduce hazardous fuels in critical zones, especially where mechanical means are not required (as generally proposed for Goal 4). This need has already been dealt with by NPS/BISO (2000b). Hazardous fuels may be especially problematic along property boundaries and near structures or campsites within the park, and such expectation can be built into the general recommendations offered below. However, an ongoing survey of these fuels will be required for details to be incorporated to plans for individual prescribed burns.

Goal 4: Reduction in fuels, as a preventive measure, should probably include some of the boundary zones between selected FMUs, especially where the FMU is designed for allowing occasional wildland fire.

POTENTIAL DIRECTIONS FOR FIRE MANAGEMENT [FMP IIIB]

In planning for fire effects on vegetation, it is useful to consider two simplified scenarios for initial discussion. These scenarios reflect a large amount of reviewed literature (Appendix 3).
A. Infrequent fire, due to general suppression, leads to accumulation of woody fuel and other litter that can eventually allow great impacts from wild fires due to intense scorching or prolonged smoldering, at least on drier sites; such fires can cause extensive tree mortality and local damage to upper soil horizons.
B. Frequent prescribed fire maintains open woodland in a relatively steady state, with hot flashy graminoid combustion but relatively low heating of the soil and rapid smoke dispersion; such fires tend not to cause as much tree mortality or soil damage as fires at long intervals.

Fire effects generally cannot be considered “good” or “bad” unless there are clear negative impacts on human health and safety, on valuable infrastructure and cultural features, on rare species (though results may often be mixed), or on long-term maintenance and balance of native ecosystem types. Unless repeated fires lead to such negative effects in long-term trends, severe damaging effects on vegetation, soil, water and air quality may be acceptable if confined to small areas or short periods of time. Forests may accumulate fuel for intense fires after a long fire-free periods, but there are also occasional episodes of accelerated forest damage from severe weather and pest outbreaks. Ice storms can leave large amounts of woody fuel, as in 1998-2000 at Big South Fork, and this has now been followed by the southern pine beetle epidemic. Such fires are likely to cause high tree mortality or “stand replacement”, if not by direct fire damage, then by subsequent invasion of fungi and insect pests. It may be difficult to predict whether long-term effects on vegetation are “good” or “bad”. Although deep forest species may be reduced at least temporarily, and alien weeds or pests (e.g., cowbirds) may invade, there are many native plants that may also benefit. It is notable that pines may often establish after such events. Many species can even benefit from severe fire, and some components of ecological diversity can be enhanced, e.g., exposed rock outcrops and surrounding shallow soils that support distinctive rare vegetation types. Bare or even slightly eroded soil can be an important substrate for establishment of rare plant species, although aliens may also invade in some cases.

In contrast, fires within open grassy woods may cause relatively little tree mortality, if fire-tolerant species have been selected over time (e.g., Anderson & Brown 1983). Although grass fires can be relatively hot above ground, there may be less severe effects on soil and stem bases. Many plant species of open grassy woodland may benefit from such fires, but not from infrequent intense fires. Shortleaf pine may be particularly suited to establishment in open grassy woodland with some potential for continued fire of moderate to low intensity at ca. 1-10 year intervals, although occasional highly intense fire or other major disturbance may be needed to establish open tree canopy in the first place. The federally endangered (locally extinct) red-cockaded woodpecker and chaffseed, plus several other rare species detailed in preceding sections, appear to have been associated with this kind of habitat, as opposed to successional forest that may establish at long intervals after intense disturbance.

Table 5 (based on Appendix 3) summarizes in general terms four levels of effects by fire on the various vegetation types at Big South Fork, elaborating on the two simplified scenarios noted above. These are only general hypotheses for the Big South Fork area, but they are suggested by a broad review of fire effects from east-central North America. This table can provide concepts for initial modeling and mapping of planned fire effects on the landscape, especially if the relationships of vegetation to land-type can eventually be incorporated with some precision.

DESCRIPTIONS OF FIRE MANAGMENT UNITS [FMP IIIC]

The initial Fire Management Plan for Big South Fork (NPS/BSF 2000) lists only two broad Fire Management Units.

1. Development Unit: including areas with potential for intensive human use, structures, cultural sites, etc. (corresponding somewhat with the "enhancement" or development zone in the draft General Management Plan)
2. Natural Unit: including most central sections of the park with native vegetation (corresponding somewhat with the "backwoods" plateau and "primitive" ravine zones in the draft GMP).

The basic theme in the Development Unit is the safety and security of people, structures, cultural sites and other facilities. The basic theme in the Natural Unit is to allow a more natural role for fire, while still ensuring safety.

An expanded set of ten FMUs is now proposed, based on a thorough review of vegetation data from the park (see appendices and maps), on the modified fire management goals (see previous section), and on two additional design principles.

A. Incorporation of watershed units where appropriate. The long-term experimental basis for designing fire management units should include some potential for examining effects of fire on watershed functions. This is particularly important given the high significance of the Big South Fork for aquatic biodiversity. Even if no comparative data are taken before experimental management begins, careful selection of paired watershed units can guide future comparisons and refinements in procedures through "adaptive management".

B. Delineation along convenient fire breaks where appropriate. Existing roads, old dirt roads, trails and streams can act as fire breaks, and the exact delineation of management units should make use of them, if possible, in order to ensure efficient application of the limited time, money and personnel for fire management. There is a need to minimize damage to vegetation, soil and possible cultural sites from emergency fire-breaks made by bulldozers. Such damage may become acute if available fire-breaks are not clearly planned as a contingency before events that require urgent fire suppression.

The ten new FMUs are mostly several thousand acres in area. Some of these FMUs include smaller nested areas where frequent prescribed fire will be used for fuel reduction and ecological restoration. And in a few cases, most of the FMU may be be suitable eventually for planning prescribed fire on a large scale at a moderate frequency (with ca. 5-20 year intervals). Buckner & Turrill (1999) have outlined a general approach to such large-scale restoration of fire. With an irregular mosaic of wildland and prescribed fires, mimicing presettlement regimes, such management would help maintain much biodiversity, maintaining oak dominance where mesophytic trees would otherwise succeed, and occasionally regenerating pines. But in the short-term at least, most of these areas are designed primarily to manage wildland fire and to manage other aspects of large-scale vegetation pattern.

Figure 4 locates these FMUs. Table 8 summarizes special features, benefits and hazards of fire in these FMUs, including reference to rare species, community types, land types, suitable fire intervals, boundary containment, potential interference with private land, and other issues. Figure 5 locates specific sites recomnmended for prescribed fire.

Figure 4 [next page]. Map of proposed Fire Management Units at Big South Fork.
See text for more description and plans for each of these 10 units.
Currently this is attached as an Arcview shape file "FMU".

Figure 5 [next page]. Map of proposed sites for prescribed fire; numbers follows the sequence in the text—the first digit is the FMU number.

Further detail is provided in attached Arcview shape files "prescribe" and "specific".
5.1 General broad study areas for considering prescribed fire; some of these would require much further study and cooperation with partners.
5.2 Specific sites selected within each study area for initial burns; these use existing roads and trails for fire breaks where appropriate.

Figure 4. Map of proposed Fire Management Units (FMUs). See text for details and discussion.

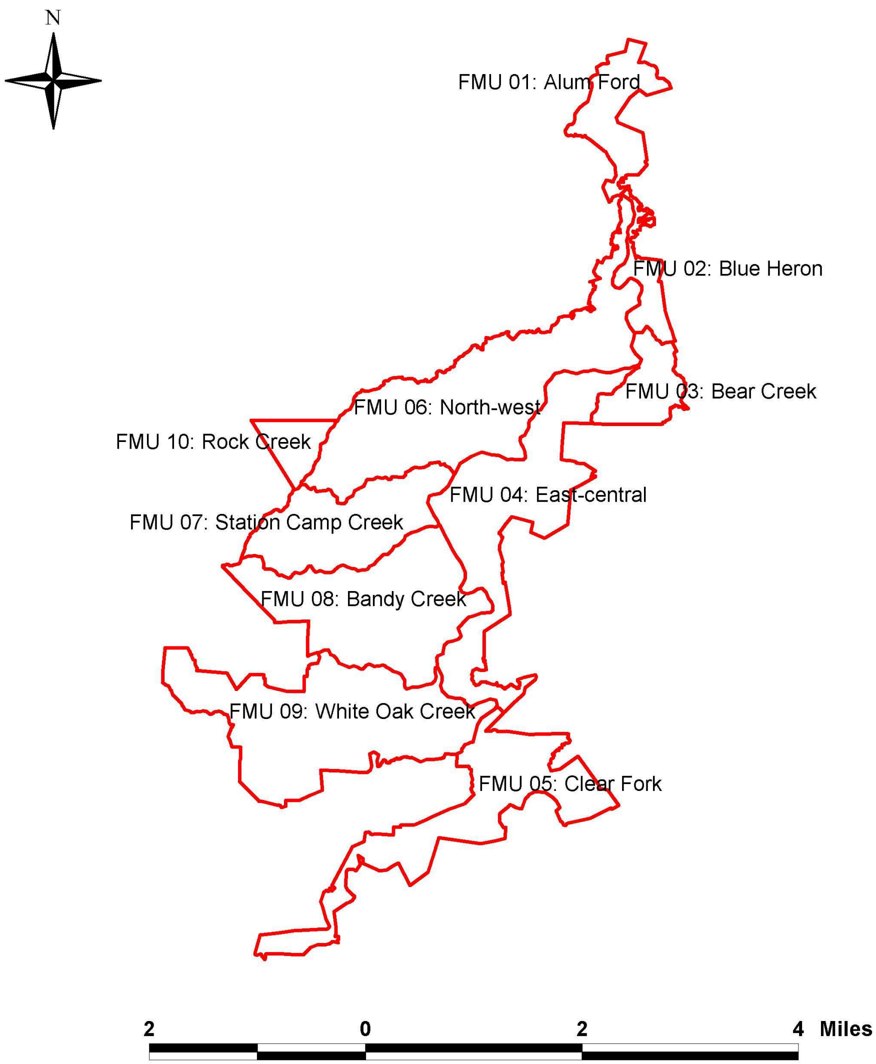


Figure 5. Map of proposed sites for prescribed fire. See text for details and discussion.

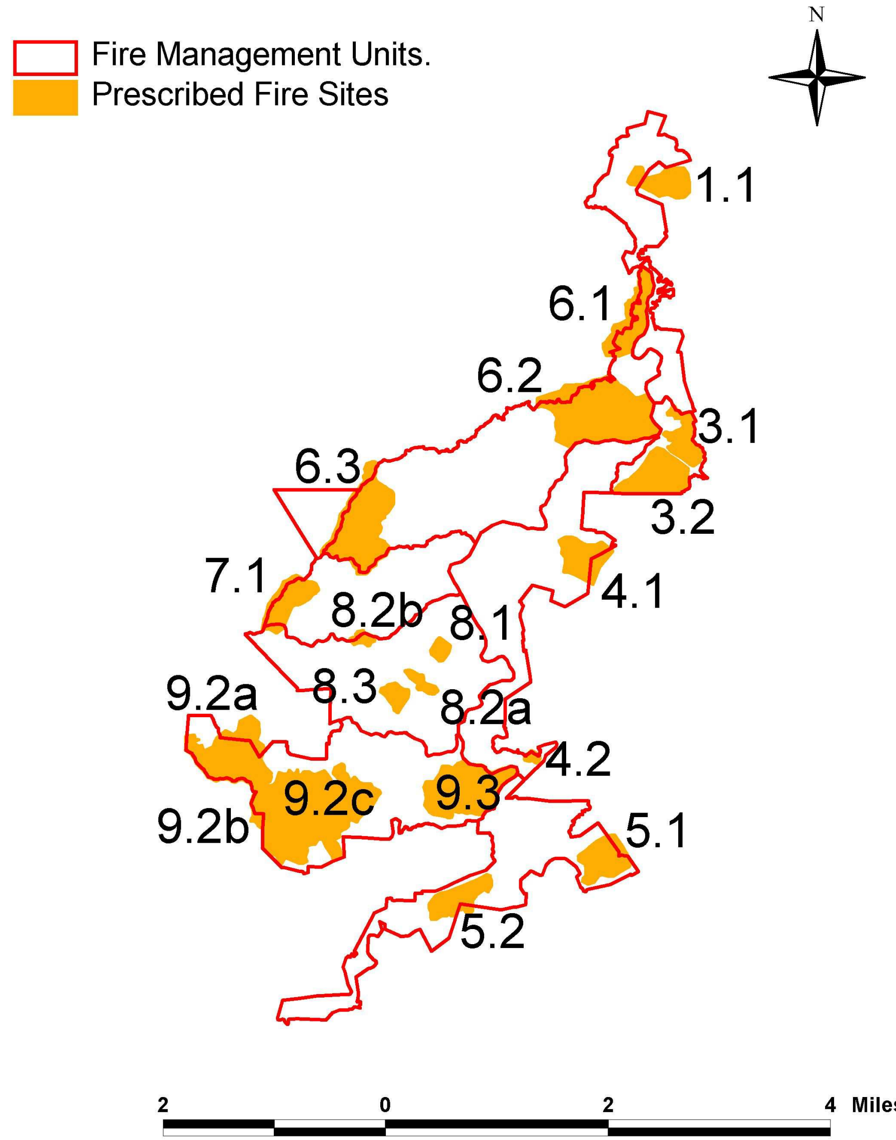


Table 8. Some characteristics of suggested Fire Management Units at Big South Fork (see text for details).

FMU number and name	Area: 1000s of acres	Overall biological significance for pyric vegetation	Recent fire history	Conflicts with fire in area	Major fire goals	Other comments (special features)
1. Alum Ford	4	moderate-low; historical rare spp. (*Schwalbea*)	little	much visitor use; road; few residences	general suppress; local prescribe	much adjacent DBNF land; need partnership for fire management
2. Blue Heron	2	low	very little	much visitor use; road; many residences	general suppress	much human activity dictates much fire management
3. Bear Creek	4	moderate-high; good grassland restoration potential	little	much use road few resid- ences near	general promote; much prescribe	ideal for intensive research area on prescribed fire effect
4. East-central	20	low-moderate; local interest	little	much use; roads; residences nearby	general suppress; ?local prescribe	much private human activity to east; but perhaps seek partnerships

5. Clear Fork	15	low-moderate; needs more survey	little	less use; many roads; residences	general suppress; ?local prescribe	much private use in adjacent lands; difficult access; oil well development
6. North-west	30	moderate-high; large, several rare spp.	some (-large)	less use; less roads; less resid-ences	general promote; much prescribe	best section for large burns in short term; much DBNF land adjacent
7. Station Camp Creek	10	low-moderate; local interest	very little	some use; less roads; no resid-ences.	general suppress (science control)	ideal for watershed with minimal burning for scientific control
8. Bandy Creek	15	low-moderate; local interest	little	much use; roads; residences nearby	general suppress; local prescribe	much visitor use, roads, dictate limited fire use; but need fuel reduction
9. White Oak Creek	25	moderate-high; large, several rare spp.	much (-large)	less use; no roads; less resid-ences near	general promote; much prescribe	much long-term potential for large-scale fire use at watershed level
10. Rock Creek	2	low except perhaps a few ridge sites; needs exploration	none?	much trail use; road; state park adjacent	general suppress	coordinate with Pickett State Park and DBNF in fire & watershed plans

FMU 1: ALUM FORD; Garthell & Nevellsville Quads. (KY)

Description:

this includes all NPS land from Big Creek and the northern park boundary south to the mouth of Rock Creek and Yamacraw;

the land is highly dissected;

mixed mesic and subxeric oak forest predominate;

pine forest is a minor component, but there are records of several rare heliophytes just east of this area, including the federally endangered chaffseed (Schwalbea americana);

recreational features include Alum Ford (boatramp, campground & shelters) and the Yahoo Falls (shelters, picnic area);

adjacent land is mostly owned by DBNF, but there are a few residences on the east side and on the south side (along Rout 92).

Fire history clues:

about six fires are recorded by NPS, mostly covering no more than one acre and close to public roads or other facilities;

an 88 acre fire occurred around Alum Creek campground in 1987 (No. 6); a 432 acre fire occurred on or near the western boundary in 1981 (No. 5) but this is not accurately mapped;

the cluster of rare heliophytes east of the area includes 1930s records by E.L. Braun (at Smithsonian Institution) and current remnants in the EKP powerline right-of-way;

it is likely that human travel along the ridge with Alum Creek Road (Route 700), and nearby settlements, have caused frequent fires both post- and pre-settlement; note that "Buffalo Hollow" occurs to west of Alum Creek.

Fire management objectives:

note abundance of mesic forest, general lack of pyric vegetation, considerable human use, and difficult access to some ridgelines;

suppress all wildland fires;

generally do not use prescribed fire, except perhaps on the east side along the Alum Creek Road (Route 700) in cooperation with DBNF to restore grassy open conditions (for *Schwalbea americana*, etc.); this is site 1.1 in Figure 5 and text below;

fuel reduction may not be a critical need, except perhaps near the few residences, depening on further survey of fuel loads after the pine mortality,

Adjacent land issues:

close coordination is needed with DBNF for fire management on their extensive tracts to the west of this FMU, and along Route 700 to the east.

determine with DBNF whether widespread fuel reduction is needed (at first sight there may be little or no need in this FMU).

FMU 2: BLUE HERON; Barthell Quad. (KY)

Description:

this includes all NPS land on the east side of the river from Yamacraw south to Lee Hollow amd the Bear Creek Horse Camp;

the land is highly dissected;

mixed mesic and subxeric oak forest predominate;

pine forest is widespread on some ridges (especially in old fields), but there are virtually no known rare heliophytes;

recreational features include the Blue Heron exhibit and associated facilities, plus the tourist railroad from Stearns, and some campgrounds;

adjacent land on the east side is mixed DBNF and private (?); some significant grassy ROWs and old field "barrens" occur on private land in the Smithtown & Coffee Branch area.

Fire history clues:

only two small fires are recorded by NPS (2 and 5 acres), both on ridges along the east side near public access points;

with the highly dissected terrain, and the lack of rare heliophytes, it is likely that there has been relatively little trend towards open grassy woodland (but see grassy remnants on private land to east in Smithtown area, etc.).

Fire management objectives:

note abundance of mesic forest, general lack of pyric vegetation, intensive human use at Blue Heron, and difficult access to most boundaries;

suppress all wildland fires;

generally do not use prescribed fire, except perhaps for local hazardous fuel reduction.

Adjacent land issues

determine fuel reduction needs, especially in Smithtown area, with several residences.

FMU 3: BEAR CREEK; Barthell & Oneida North Quads. (KY)

Description:

this includes all NPS lands within the Bear Creek watershed plus Split Bow Arch Hollow;

the land is highly dissected close to the river and Bear Creek, but there are broad ridges to the south, including Cottonpatch Knob;

mixed mesic, subxeric forest and pine forest are all widespread;

some of the most extensive mature pine-oak stands in the park occur on the broader ridges (including much shortleaf pine, southern red oak and post oak), and there are some some records of uncommon heliophytes;

red-cockaded woodpeckers have been recorded in recent decades (Cottonpatch Knob area);

in addition there are two large old field areas, including some native grassland and degraded sandstone glades;

recreational features include the Bear Creek horse camp, Split Bow Arch and the Bear Creek trailhead;

adjacent land to the east and south is mostly private.

Fire history clues:

only one small wildfire has been recorded by NPS (a possible lightning strike);

prescribed fire has already been used in the two old fields;

the relatively good remnants of pine-oak woodland (especially Cottonpatch Knob), post oak woodland, and native grassland suggest that fire may have had much effect on broader ridges;

these ridges are are connected with the broad "Oneida Plain", where humans have probably caused frequent fires post-settlement, and perhaps pre-settlement (see regional discussion of fire history).

note that archaeological significant (early Archaic to Woodland) rockshelters are known nearby; and prehistoric artificial holes for grinding corn still can be seen in the sandstone glade; it is possible that native americans maintained some of these uplands in an open condition.

Fire management objectives:

note good remnants of pyric vegetation and potential for general restoration of a pyric landscape;

note also moderate public use but without sensitive structures, and good access to most ridge lines;

this FMU could become a center for research on intensive use of fire in the Big South Fork area;

wildland fires in general would be suppressed unless they can be effectively substituted on occasion for prescribed fires;

use prescribed fire to restore open grassy woodland on the broader ridges, with intervals of 2-5 years;

suggested areas for prescibed burning include 3.1 & 3.2 (Figure 5).

after initial efforts are assessed, and if compatible with safety and other resource issues, let some prescribed fires burn down into the ravines until they burn out;

additional burns for fuel reduction may be warranted along the eastern boundaries.

Adjacent land issues:

determine fuel reduction needs, especially close to residences;

private land in the rest of Bear Creek watershed has high potential for discovery of significant features, including remnants of pyric vegetation;

inventory should be a priority, and the potential for further land protection and fire management should be explored in the watershed (especially to the south in Tennessee).

FMU 4: EAST-CENTRAL; Oneida N, Oneida S, Barthell SW & Honey Creek Quads. (KY & TN)

Description:

this large area includes NPS lands on the east side of the river from Little Bill Slaven Road south to the Pine Creek river access;

the land is highly dissected in general, except for some broader ridges further from the river in the Williams Creek area (including "Grassy Branch");

mixed mesic, subxeric oak and pine forest predominate;

there are no unusually significant remnants of pyric vegetation, but several relatively mature pine-oak stands occur on upper slopes and ridges, especially in less dissected areas;

recreational features include Station Camp Crossing campground, Station Camp horsecamp, Leatherwood Ford facilities, and the O&W Bridge area;

also park headquarters and associated structures are located near the southern end;

adjacent land to the east is all private, and includes several tracts with vacation homes and cabins used by horse trail users.

Fire history clues:

only five fires have been recorded by NPS, all close to roads or trails, and mostly small (up to 5 acres), except for a 55 acre fire in 1991 (No. 13);

the rather limited extent of mature pine-oak forest, and the lack of rare heliophyte records, suggest that fire has generally not had strong effects since settlement; however, on broader ridges to the east there are some minor remnants of post oak woodland and a few rare heliophytes (e.g., along the TVA ROW)

before settlement it is likely that fires were relatively fragmented by the dissected, largely mesic topography, except that less dissected Williams Creek uplands might have had some open grassy woodland.

Fire management objectives:

note general abundance of mesic forest and limited remnants of pyric vegetation, presence of several human facilities, and limited access to much of the southeastern boundary (where better remnants of pyric vegetation may occur);

in general suppress all wildland fires, unless further study indicates that some of these should be used to simulate a natural fire-regime based on lightning;

generally do not use prescribed fire, except if further study indicates that restoration of pyric vegetation is appropriate on broader ridges or other sites;

potential sites for frequent prescribed fire need further exploration, but may include extensive pine-oak lands in the Grassy Branch area (4.1) and native grassland in or near the Pine Creek TVA ROW (4.2).

Adjacent land issues:

determine fuel reduction needs, especially near the Black Oak area and other residential or recreational areas

search for remnants of pyric vegetation on private lands else in Williams Creek drainage;

seek land protection or cooperative management if appropriate (esp. Williams Creek area).

FMU 5: CLEAR FORK; Honey Creek, Rugby, Oneida S & Burrville Quads. (TN)

Description:

this consists of all NPS land south of the Pine Creek River access, including the long corridor along Clear Fork and the short corridor along New River;

most terrain is highly dissected, except for a few broader benches and ridges;

mixed mesic and subxeric oak forest predominate, but there are also many areas of pine forest, especially on old fields; damper swales with subhydric forests and graminoid vegetation are well developed in places.

no significant remnants of pyric vegetation are known, but some minor areas on less dissected terrain may have supported open woodland in recent centuries, e.g., Reed Ridge, with frequent chinquapin (*Castanea pumila*) was noted (5.1), and Bear Branch Ridge, with locally abundant post oak (5.2);

recreational features include scattered campgrounds, river accesses and overlooks, but no significant structures;

adjacent lands are all private, including several tracts with oil wells.

Fire history clues:

about 11 fires have been recorded by NPS, mostly rather small (ca. 10-50 acres) and located near ridge roads or trails, or near riverbanks (including coal cobble fires?);

with the high perimeter-to-area ratio and frequent access points, this FNU may be particularly prone to arson or accidental human ignitions;

the general lack of pyric vegetation remnants suggests that fire may not have had widespread strong effects before settlement, except perhaps on broader ridges where fire may have spread readily from the Oneida Plain;

however, the broad ridges nearby may have supported enough fire to maintain open grassy woodland before settlement, as suggested by several place names to the south (note "Grassy Knob" on Oneida S Quad.; "Grassy Mountain" and "Grassy Branch" on Rugby Quad.).

Fire management objectives:

note general abundance of mesic forest and limited remnants of pyric vegetation, yet potential for frequent arson or accidental fire;

suppress all wildland fires;

generally do not use prescribed fire, except perhaps in a few sites to be explored further: e.g., Reed Ridge, which is mostly privately owned (5.1), and Bear Branch Ridge (5.2).

Adjacent land issues:

note numerous residences within a mile of NPS lands and determine fuel reduction needs (especially in Honey Creek and Mt Helen areas);

explore potential for cooperation with owners of Reed Ridge, where restoration of open woodland may be appropriate;

explore potential for cooperation with oil well operations on or adjacent to NPS lands, especially in fuel reduction.

FMU 6: NORTH-WESTERN; Sharp Place, Oneida N, Bell Farm, Barthell & Barthell SW Quads. (KY).

Description:

this is the largest FMU and it may deserve subdivision, but it does have relatively uniform characteristics;

it includes all NPS land on the west side of the river from the mouth of Rock Creek south to Terry Cemetery Road;

most terrain is highly dissected, except for some broader ridges to the west (especially "Chestnut Ridge" and elsewhere around the head of No Business Creek);

mixed mesic, subxeric oak and pine forest are predominant;

although there are no particularly extensive or high quality remnants of pyric vegetation, there are several blocks of pine-oak forest on the ridges, and along the western ridge roads or open streamhead there are several rare heliophytes;

there are a few records of red-cockaded woodpeckers from recent decades;

recreational features include several overlooks and trailheads, but no significant structures;

adjacent lands to the west are mostly owned by DBNF or, in Tennessee, Pickett State Park & Forest, but there are also several private residences at the north end.

Fire history clues:

only five fires have been recorded by NPS, all probably ignited from ridge roads and trails;

three fires were moderately small (ca. 20-50 acres), but two were exceptionally large at ca. 1800 acres (1987 No. 3) and ca. 2000 acres (2000 No. ?);

with several post-settlement homesites, and much pine forest in various conditions, there have probably been considerable fire effects post-settlement;

the highly dissected terrain may not have been condusive to extensive pyric woodland before settlement, but the rare heliophytes along the boundary roads (especially from near "Grassy Knob" and "Bald Knob" to near the mouth of Rock Creek) may be indicative of locally open grassy conditions;

perhaps these ridges were much travelled by native americans and frequently burned, as supported by the frequent archaeological evidence of campsites here (T. Des Jean, pers. comm.).

Fire management objectives:

note recent large fires and appparent past pyric effects in several extensive upland areas, although frequent repeated fire may be limited by the highly dissected topography; note also good access to the western boundary and to subsidiary ridges;

this FMU could become the primary section of the park where a quasi-natural fire regime is restored to large areas, simulating unrestrained effects of lightning;

suppress wildland fires, except for carefully selected cases where they can used to simulate a natural fire-regime;

use extensive prescribed fires if necessary to complement the wildland fires;

use more frequent prescribed fire (ca. 2-5 year intervals) to restore local open grassy conditions with rare heliophytes, especially the Wilson Ridge area (6.1), Bald Knob-Oil Well Branch area (6.2), and Black House Creek area (6.3);

use prescribed fires along the western ridge road (especially near residences) and Terry Cemetery Road to reduce fuels (easing containment of future wildland fires within the FMU); mechanical fuel reduction has already been proposed within 200 feet of the road, but fire would be preferable.

Adjacent land issues:

coordinate fire operations with DBNF and Pickett State Park & Forest;

explore potential for buying out the few residential tracts in Kentucky.

FMU 7: STATION CAMP CREEK; Sharp Place & Barthell SW Quads. (TN)

Description:

this area includes the whole watershed of Station Camp Creek, except for the low tributary Laurel Fork Creek; this is the largest watershed totally enclosed within the park; it also includes the smaller Parch Corn Creek watershed;

the land is highly dissected, except for some minor broad valley bottoms(unusual for the park) and some broader ridges on the west side;

mixed mesic, subxeric oak and pine forest predominate;

no significant remnants of pyric vegetation are known, except perhaps on broader ridges along the western boundaries where there are larger areas of pine forest and native grassland in the TVA powerline right-of-way;

recreational features include the Twin Arches area and several trailheads, but no significant structures;

adjacent land to the west is owned by Pickett State Park & Forest.

Fire history clues:

there has only been one small wild fire (<1 acre) recorded by NPS, in addition to prescribed burning of ca. 90 acres along the western border;

the general lack of significant remnants of pyric vegetation and rare heliophytes (except perhaps along the broader western ridges), suggests that fire may not have had a major influence before settlement;

however, there are old farms on ridges and bottoms where settlers probably used fire to maintain open conditions.

Fire management objectives:

note general restriction of native pyric vegetation to broader western ridges;

this FMU could become a critically important scientific control with minimal fire effects, to compare with other watershed units in the park [NPS lands enclose the whole watershed; and three water quality stations are already producing records];

wildland fire could be suppressed with rapid response;

prescribed fire could be limited to fuel reduction burns and associated woodland restoration in the area west of Gobblers Knob Trail (7.1);

two of the bottomland old fields are significant cultural sites, but mechanical means could be used to maintain them instead of fire;

note that the northern (Terry Cemetery Road) and southern (Fork Ridge Road) borders could be secured from spreading wild fires by fuel reduction just outside the watersheds of this FMU (see 6 and 8).

Adjacent land issues:

coordination with Pickett State Park & Forest would help with fuel reduction and open woodland restoration along the western border.

FMU 8: BANDY CREEK; Barthell SW, Honey Creek, Sharp Place & Stockton Quads. (TN)

Description:

this includes all NPS lands within the watersheds of Laurel Fork Creek (a low tributary of Station Creek), Fall Branch and Bandy Creek;

the terrain is highly dissected along the ravines but there are also some relatively broad ridges, especially within central sections;

mixed mesic, subxeric oak and pine forest predominate, but there are also several old fields and other openings actively used by the public or for special uses (horse hay, chestnut);

no particularly significant remnants of pyric vegetation are known, although there are several pine-oak areas that might be restored and some native grassland along the TVA powerline;

recreational features include the Bandy Creek area (including Visitor Center and campground), the Blevins Farms (including old farm buildings), and a relatively intensive system of trails;

adjacent land to the west includes private tracts (with much developed frontage along Route 297) and a small part of Pickett State Park;

Scott State Forest straddles the southern boundary of this FMU.

Fire history clues:

about six fires have been recorded by NPS, mostly small or moderate sized (up to 57 acres) plus a larger one on a broad central ridge covering 268 acres (1988 No. 9);

although this area may not generally have experienced strong effects within the ravines, fire may have had considerable effects post- and pre-settlement in maintaining pine-oak woodlands on the broader ridges;

also the native grassland along the TVA powerline is relatively well developed, including taller grasses, possibly a remnant or enhancement of presettlement vegetation.

Fire management objectives:

note mosaic of management needs and opportunities, with diverse topography and varied public uses;

also note that accessibility is relatively good to many sites that might be used for demonstration, experiments and other research,

in general this FMU should probably minimize fires for reasons of safety, aesthetics and science; this FMU could become a large potential control area for comparison with frequently burned FMUs, but it offers less complete control than FMU 7;

suppress all wildland fires;

prescribed fire should be used only on some of the broader ridges for a few restricted restorations of native grassland, e.g., along Duncan Hollow Trail (8.1) and Fall Branch TVA ROW (8.2), for maintenance of some old fields, e.g., Blevins Farm (8.3), and perhaps some pine-oak restoration to be determined (e.g., near Salt Pine Road if this site is shown to have special biodiversity value);

hay from the native grasses could be used for local horses;

fuel reduction with mechanical means or prescribed fire should be extensive along the northern border (Fork Ridge Road), and this might be linked with restoration of pine-oak woodland near Salt Pine Road.

Adjacent land issues:

for fire management, the FMU plan should be closely coordinated with Scott State Forest;

the potential for wild fires to spread from the western ridges should be minimized by cooperative planning with the private land owners in that section.

FMU 9: WHITE OAK CREEK; Stockton & Honey Creek Quads. (TN)

Description:

this includes all NPS lands within the watershed of [North] White Oak Creek plus a small southern extension near the river (Hurricane Ridge);

most land is highly dissected but there are also some broad ridges in southern and western sections of this FMU; these are the most extensive broad ridges within the park;

mixed mesic, subxeric oak and pine forest predominate;

potentially significant remnants of pyric vegetation or restorable areas may include some of the extensive tracts of pine-oak forest (or woodland), several sandstone glades (mostly at the edge of broader ridges), and perhaps some post oak woodland (Hurricane Ridge);

several rare or uncommon heliophytes are concentrated along roads and trails on the broader ridges;

recreational features include several overlooks and trailheads but no significant structures; adjacent to the west and south is all private, including some with horse trail systems that link to the park, and some large corporate tracts (Bowater, etc.).

Fire history clues:

some 15 fires of various sizes have been recorded by NPS, making this about the most fire-prone FMU in recent history (as well as FMU 6);

although most of these were small to moderate (up to 57 acres), two large fires occurred in 2000 covering ca. 3000 acres and ca. 550 acres, including adjacent private lands;

all of these fires were probably caused by arson or accident, and most were along ridge roads, but with a few were along the riverbanks;

the scattered potential remnants of pyric vegetation and rare heliophytes on broader ridges suggest that there may have been widespread conversion of forest to open grassy woodland before settlement.

Fire management objectives:

note potential for extensive restoration of pyric vegetation remnants on broad ridges, and for long-term study of fire effects on the Laurel Fork watershed in comparison with other control watersheds in the park;

note also, however, that much of the boundary connects with private tracts that are becoming more developed, so there is a need to reduce the chance of uncontrolled fires;

use prescribed fire to begin restoration at selected sites with remnants of open woodlands and glades, especially in the Hicks Ridge area (9.1), and the Darrow Ridge area (9.2), which might be extended as a woodland restoration site to Tar Kiln Ridge (9.2b) and Laurel Fork Ridge (9.2c);

also use prescribed fire for extensive fuel reduction along as much boundary as possible, in order to minimize spread of wildland fires into or out of this FMU;

if safe prescriptions and predictions can be developed in the long-term, allow fires in some cases to burn down into ravines at least as often as lightning fires would;

suppress wildland fires unless special contingency plans can be developed for allowing substitutions of occasional wild fires for planned effects of prescribed fires.

Adjacent land issues:

need to coordinate fire management and communication closely with major private landowners;

if possible encourage prescribed burning on selected areas, in cooperation with state agencies and The Nature Conservancy;

explore further land protection potential in watershed (including “Jamestown Barrens” area).

FMU 10: ROCK CREEK; Sharp Place & Barthell SW Quads. (TN)

Description:

this includes all NPS lands within the watershed of Rock Creek;

most land is highly dissected, except for the Blevins Cemetary ridge;

mixed mesic, subxeric oak and pine forest predominate;

some remnants of pyric vegetation or restorable areas may exist along the Blevins Cem. ridge and the Divide Ridge Road, but no highly significant areas jhave been found;

some rare heliophytes may be expected on ridges; Baptisia tinctoria has been found on Parker Mountain within 2000 ft of the park boundary; more survey is needed;

recreational features include several trails that connect with Pickett State Park but no significant structures;

adjacent to the west and south is Pickett State Park; adjacent to the north if Daniel Boone National Forest.

Fire history clues:

no fires have been recorded under NPS management;

Fire management objectives:

note general highly dissected terrain, and sensitive aquatic biota in Rock Creek; also, proximity to Pickett State Park, which has much potential for cooperative management;

generally suppress fire in order to allow full development of mesic forest conditions; unless further surveys reveal significant remnants of pyric vegetation, do not use prescribed fire, except as follows;

maintain broad fire-break using a narrow zone of prescribed fire along Divide Ridge Road, preventing the spread of fires from the adjacent FMU 6, where much fire will be promoted;

Adjacent land issues:

need to coordinate fire management and communication closely with Pickett State Park and Daniel Boone National Forest; their interests should probably take priority in this relatively small section of the park, with a different watershed context;

integrate plans with overall watershed plan for Rock Creek.

GUIDELINES FOR WILDFIRE [FMP IV]

These are only preliminary notes for consideration later in the revised fire management plan.

As already proposed by NPS/BISO (2000b), in an expanded fire management plan at Big South Fork lightning fires should ideally be allowed to burn out within appropriate fire management units. However, even if all lightning fires are allowed within such units, this may not result in as much burning as would exist without any human influences, because fires will not be allowed to burn freely throughout the park or to freely enter the park from outside. Therefore, it may be important, after further study of potential lightning effects, to design special fires to simulate lightning fires, or to allow other wildland fires (from arson or accident) to substitute for lightning. Such simulation would benefit from a general modeling of interactions between lightning ignitions, vegetation and topography (e.g., Guyette & Day 2000).

Can arson and accidental fires be allowed to burn out under special guidelines, such as simulation of lightning fire or other prescribed burn plans? This needs further study. A balanced approach of limited containment might be developed that allows spread of such fires if they fit into predetermined long-term burn plans for the area, and if they do not endanger people or park resources.

PRIORITIES FOR RESTORATION WITH PRESCRIBED FIRE [FMP V]

Suggestions can be made for specific sites for restoration of open grassy woodland with frequent prescribed fire (Figure 5). Table 9 summarizes some of the key features for each site in order to help prioritize them. Restored open grassy woodland can support many state-rare plant species, and probably several rare vertebrates and invertebrates. The federally endangered red-cockaded woodpecker (*Picoides borealis*) and chaffseed (*Schwalbea americana*) could eventually be reintroduced to some of these sites. In some cases there is an urgent ecological need for fire, since with passing years and decades it becomes gradually more difficult to reverse invasion by fire-sensitive species. There are also urgent needs for fuel reduction in some areas of the park, in order to protect human safety and property, but this is a separate issue not detailed in this report. In some areas priority sites for fuel reduction overlap with the restoration sites.

The most urgent sites for restoration with fire would typically include 10-100 acre burns initially, with a rotation at ca. 1-5 year intervals in order to create or maintain open woodland or grassland with native species. Eventually, some prescribed fire areas might be expanded to 100s or even 1000+ acres, if safe prescriptions can be developed and if the burns are compatible with resource objectives. In these larger areas, prescribed fire might be applied at various frequencies. In particular, moderate frequencies (ca. 5-20 year intervals) could be used to maintain blocks of pyric oak forest around the initial priorities for open grassy woodland. In these blocks, fires could be used to favor regeneration by oaks as opposed to fire-sensitive species.

The significance and feasibility of these sites generally deserve further study, but action is clearly warranted now at some sites. Table 9 summarizes some key biological and managerial characteristics of these suggested sites. This will aid in prioritization and in the final selection of initial sites for action. A provisional short-list of the most urgent feasible sites might include 3.1, 3.2, 6.1, 7.1, perhaps 8.2, 9.2 (with potential extension to 9.2b & c) and perhaps 9.3. Note also that some other sites should be priorities for cooperative planning with DBNF (especially 1.1), and some sites should be priorities for further biological survey (especially 5.2).

FMU 1.1: Alum Creek Road Ridge (Nevelsville Quad.): this area would only be suitable if additional lands can be included outside the park, mostly owned by Daniel Boone National Forest; the road corridor is botanically infamous as an historical location for the federally endangered chaffseed (*Schwalbea americana*) in Kentucky; there are several other rare heliophytes recorded from this site (*Agalinis decemloba, Bartonia virginica, Carex picta, Liatris microcephala*, etc.).

FMU 3.1: Bear Creek Meadows (Barthell Quad.): this area could eventually be expanded beyond the two existing old field areas to include ca. 500 acres, within which there are scattered remnants of open grassy woodland (including some post oak & blackjack oak); the main Bear Creek meadow at Split Bow Arch includes extensive little bluestem (Schizachyrium scoparius) dominated areas at upper levels; lower levels have more alien plants (fescue, sericea), but there are also some small degraded flat sandstone outcrops that could be restored using fire and other means; there are records of several rare heliophytes (*Calamagrostis coarctata, Gymnopogon ambiguus, Juncus bufonius, J. coriaceus, Parthenium integrifolium*; and formerly *Oenothera linifolia, Talinum teretifolium & Xyris torta*); a planned movement of the road to the east side of the meadow could be useful for designing fire-break.

FMU 3.2: Cottonpatch Knob area (Oneida N Quad.): the broad uplands here have widespread stands of red maple, oaks, pines, etc., mostly young but with some relatively large stands of older shortleaf pine, southern red oak, post oak, etc.; the pine is now mostly dying, but leaving the oaks to form a potential fire-maintained open woodland; there are several rare heliophytes (*Calamagrostis arcuata, Helianthus atrorubens, Parthenium integrifolium*, etc.); two upland units to east and west could also be extended down towards Bear Creek and additional ravine lands along Slavens Creek.

FMU 3.3+: Other sites; note also that more extensive prescribed burning may become appropriate through most of this FMU; in long-term plans it might be desirable to bring most of the Bear Creek watershed into fire management; partnerships might be sought with private lands to the east and south.

FMU 4.1: Grassy Branch area (Oneida N Quad.): this site is tentatively suggested as a convenient location based on existing roads and trails, plus the potentially intact watershed sections; however, some of the most desirable land for prescribed burning may be on adjacent private lands; there may be a core of pine/pine-oak woodland that can be restored; but this area needs further exploration, including search for rare plants; also the potential for acquisition or easements on private land need investigation.

FMU 4.2: Pine Creek TVA powerline area (Honey Creek & Oneida S Quads.); the grassy powerline ROW has fairly good stands of big bluestem, etc.; rare/uncommon plants include *Bartonia* sp. and *Parthenium integrifolium* (further SE on private land by the airport other species include *Polygala cruciata, Vernonia noveboracencis, Calamagrostis coarctata*, etc.); post oak is scattered through this area; if adjacent woodland can be included in burn units, a more extensive restoration effort might be envisaged.

FMU 5.1: Reed Ridge area (Oneida S Quad.): this area is tentatively suggested, but since most of the site is privately owned its management would be contingent on close cooperation with the landowner or on eventual acquisition of the tracts; although only a few notable heliophytes have been recorded here (*Calamagrotis coarctata, Castanea pumila*), there are extensive remnants of pine-oak woodland that could be readily restored with fire; more exploration is needed.

FMU 5.2: Bear Branch Ridge (Honey Creek Quad.); this southern area has locally abundant post oak, on broader ridges and on narrower xeric ridges; this area and its surroundings (where extensive fire effects are suspected before settlement) deserves more exploration; Liatris microcephala is the only rare species currently known; although it is disjunct from other management units, prescribed fire may have special value for biodiversity at this site.

FMU 6.1: Wilson Ridge area (Barthell Quad.): although opportunities for extensive restoration of pine-oak woodland may be limited here, due to the narrow ridgeline, there is a significant cluster of rare heliophytes along rights-of-way (including *Carex physorhyncha, Cleistes bifaria, Rhynchosia tomentosa, Tephrosia spicata*); objectives for prescribed fire here would include restoration and fuel reduction along the boundary zone (especially close to residences along the ridge road); in long-term plans, there should be consideration of acquiring the small private inholdings along this road; note that long-term plans for the whole FMU could include a "let-burn" policy for selected wildland fires, if these can safely burn out down to the river.

FMU 6.2: Bald Knob-Oil Well Branch area (Barthell Quad.); there is extensive young pine forest in this area, with a history of old field succession and probably fire; rare heliophytes have been found along the ridge road (*Aster concolor, Carex physorhyncha, Cleistes bifaria*), and in a sandstone glade (*Croton wildenovii. Minuartia glabra*), which could be expanded with fire.

FMU 6.3: Black House Creek area, with possible extension to Chestnut Ridge (Barthell SW Quad.); this area may be drawn to include a bordering section of FMU 7 along the watershed divide; it needs further exploration but has high potential for prescribed burning to restore open grassy pine/oak woodland on relatively gentle terrain with relatively easy access from nearby roads; there may be particular interest in burning damper swales and streamheads, since several rare heliophytes have been found at one boggy pond (*Eriophorum virginicum, Calopogon tuberosus, Bartonia virginica, Panicum ensifolium, Platanthera cristata, Xyris torta*); such areas might support the federally endangered green pitcher-plant if opened up further with fire. [Note also *Baptisia tinctoria* has been found a few miles west.]

FMU 6.4: Other sites; note that extensive fuel reduction burns may be appropriate in zones ca. 100-1000+ feet wide along the western and southern boundary roads; in some cases these efforts might be extended to include restoration of nearby pine-oak woodland (e.g., Chestnut Ridge area).

FMU 7.1: Middle Creek area (Sharp Place Quad.); prescribed fire here would have restoration and fuel reduction objectives along the boundary zone: fire could be restricted to a width of 1000-2000 feet along the Divide Road, perhaps using the Gobbler Knob Trail as an eastern fire-break; the area includes extensive oak or pine-oak forest with a tendency to grassy open conditions, and the TVA powerline right-of-way supports some fairly diverse native grassland; uncommon or rare heliophytes have been found along rights-of-way (*Asclepias amplexicaulis, Helianthus atrorubens, Porteranthus trifoliatus*) or in streamheads (*Panicum ensifolium, Platanthera cristata*).

FMU 8.1: Duncan Hollow Trail (Barthell SW Quad.); a planted area with native grasses has already been managed with prescribed fire on this ridge, and the burned area might be extended into adjacent forest, if restoration of open grassy woodland is desirable; however, genetic issues related to the seed sources of the grasses need to be addressed; this site could perhaps become a demonstration site for comparing different grass genotypes.

FMU 8.2a: Fall Branch TVA Powerline site (Honey Creek Quad.); the TVA right-of-way has well developed native grassland (including much big bluestem and Indian grass); this grassland could be expanded using fire into the adjacent old field (an official "cultural landscape") where hay is currently cropped for horses; note, however, that the powerline line is on Scott State Forest land, and TVA permission will also be needed if the powerline right-of-way itself is burned; this could be another good demontration site for native grasses and their use for hay, seed production and restoration.

FMU 8.2b; Laurel Fork Ridge TVA Powerline (Barthell SW Quad.); this site has less botanical interest, based on available information, but more survey nay be needed; it should be considered for fire management, if a general agreement can be reached with TVA for their ROW across the park.

FMU 8.3: Blevins Farm (Honey Creek Quad.); although this area has little unusual biological interest, fire has already been discussed as a managemment tool for maintaining the open old fields; in the long-term much restoration of native grassland is possible, including the nearby degraded sandstone glade along the road; again, this could be a good demonstration site for native grasses.

FMU 8.4: Other sites; fuel reduction burns are suggested along the northern border (Fork Ridge Road) in order to prevent spread of fires into the Station Camp Creek "control" area (see FMU 7); some adjacent pine-oak woodland remnants may be restorable (e.g., near Salt Pine Road), but further exploration is needed.

FMU 9.1: Hicks and Crockett Ridges (Stockton Quad.): this area is difficult to access for fire management, unless the Proctor Ridge road can be extended; but it includes some of the best known sandstone glades and bordering xeric grassland in the park; rare heliophytes have been found here and further exploration is needed (*Croton wildenovii, Minuartia glabra, Rhynchospora ?harveyi*); with recent pine mortality, there is potential for fire to increase these glades considerably; the Crockett Ridge area is less well known and needs further exploration.

FMU 9.2a: Darrow Ridge (Stockton Quad.): there are extensive oak and oak-pine uplands with varying degrees of succession to mesophytes; but between the boundary ridge road and Laurel Creek there is much potential for restoration of pine-oak woodland; and the long roadside itself has potential for grassland edge restoration; several uncommon or rare heliophytes occur along the ridges (*Cirsium carolinianum, Helianthus atrorubens, Parthenium integrifolium, Phlox amoena*); the road itself and the Laurel Fork ravine would be useful fire-breaks; further east there is some potential for extending this area greatly, including most of the ridge between Laurel Fork and White Oak Creek, using the ravines as broad natural fire-breaks.

FMU 9.2b: Tar Kiln Ridge (Stockton Quad.); this area might be considered an extension from Darrow Ridge (9.2a), if prescribed fire becomes successful there; the area needs further exploration, but initial reconaissance indicates extensive remnants of pine-oak and post oak woodland, with such uncommon species as *Castanea pumila, Calamagrostis coarctata*, etc.

FMU 9.2c: Mill Seat Creek ridge (Stockton Quad.); this area is another potential extension from the Darrow Ridge (9.2a) unit; there are extensive stands of pines (virginia and shortleaf), although no special indicators of open woodland history have been found yet; further exploration is needed.

FMU 9.3: Hurricane Ridge (Honey Creek Quad.): there is much restorable post oak (with some blackjack) and pine-oak woodland on this relatively broad, accessible ridge, although the stands are mostly rather young; pine mortaility may allow rather rapid conversion to open woodland; post oak is relatively common, perhaps having replaced much white oak due to fire history; rare/uncommon plants include *Castanea pumila, Helianthus atrorubens, Liatris microcephala, Parthenium integrifolium, Phlox amoena*, etc.; further exploration is needed.

FMU 9.4+: Other sites; fuel reduction burns may be recommended along most of the FMU boundaries, and in some areas there may be good access to adjacent restorable pine-oak woodland, e.g., on Tar Kiln Ridge, Gar Blevins Trail, Gernt Trail (possible historical location of *Sarracenia*), etc.; trail systems and roads may help define fire-breaks for such units, but some sections of the boundary remain relatively inaccessible, and cooperation with adjacent landowners may be desirable.

Table 9a. Some biological characteristics of suggested sites for prescribed burning at Big South Fork (see maps for locations). Note that these are not exact burn units with precise boundaries, but general locations where one or more prescribed burn areas could be considered as the Fire Management Plan is developed.

Site name FMU is indicated by first digit in numbering code; see text for details	A Globally endang-ered or threat-ened helio-phytes	B Other globally rare helio-phytes	C Other state listed helio-phytes	D Other rare or un-common helio-phytes	E Red-cockaded wood-pecker recorded	F Signi-ficant pine-oak wood-land	G Signi-ficant post oak wood-land	H Signi-ficant native grass-land
1.1 Alum Creek Road	H	+	+	+				+
3.1 Bear Creek Meadows			+	+			+?	+
3.2 Cottonpatch Knob			+	+	+	+	+	
3.3+ Extended sites (larger scale)								
4.1 Grassy Branch				?		+?	?	
4.2 Pine Creek Powerline (TVA)			?	+		??	(+)?	(+)
5.1 Reed Ridge				+		+?		
5.2 Bear Branch Ridge			?	+		+	+	
6.1 Wilson Ridge		+	+	+		+?		+?
6.2 Bald Knob-Oil Well Branch		+	+	+	nearby	+?		+?

6.3 Black House Cr (to FMU 7)			+	+	nearby	+?		+? hydric
6.4+ Extended sites (larger scale)			+?	+	(nearby)	+		
7.1 Middle Creek						+?		(sown)
8.1 Duncan Hollow			+	+		+	+	+ xeric
8.2a Fall Branch Powerline				+		+?	+?	+
8.2b Laurel Fork Ridge Powerline				(+)				
8.3 Blevins Farm				+				+? xeric
8.4+ Extended sites (larger scale)						+?		
9.1 Hicks Ridge			+	+		+?		+
9.2a Darrow Ridge			+	+		+	+?	+? road
9.2b Tar Kiln Ridge				+		+?	+	
9.2c Laurel Fork Ridge				?		+?		
9.3 Hurricane Ridge			?	?		+?	+	
9.4+ Extended sites (larger scale)			+?	+		+?		

A: global rank ca. G1-G23; H indicates historical *Schwalbea americana*
B: global rank ca. G3-G3G4
C: state rank S1-S3
D: state/regional rank mostly S3S4
E: recorded ca. 1970-80; now locally extinct
F: >10 acres B quality; or >100 acres C quality
G: >10 acres C quality post oak, southern red oak, blackjack oak
H: mostly roadsides, powerline rights-of-way; these have special interest where xeric or hydric extremes are included.

Table 9b. Some managerial characteristics of suggested sites for prescribed burning at Big South Fork (see maps). These are not exact burn units with precise boundaries, but general locations where one or more prescribed burn areas could be considered as the plan is developed.

Site name FMU is indicated by first digit in numbering code; see text for details	I NPS control complete, partial, or minor (c/p/m)	J Appro-ximate area in acres	K Fire intervals sugg-ested in years	L Access good moderate or poor	M Fire breaks mostly in place or easy to install	N FMU may allow some wildland fire	O Public roads nearby need smoke control	P Private lands nearby need smoke control
1.1 Alum Creek Road	m (+ fs)	100+	1-10	good	(+)	-	+	+
3.1 Bear Creek Meadows	c	100+	1-10	good	(+)	+?	(+)	(+)
3.2 Cottonpatch Knob	c	100+	5-20	moderate	+	+?	-	(+)
3.3+ Extended sites (larger scale)	c	1000+	5-100	moderate	(+)	+?	(+)	(+)
4.1 Grassy Branch	p	100+?	5-20?	moderate	(+)	-	+	(+)
4.2 Pine Creek TVA ROW	p?	10+	1-10	moderate	(-)	-	-	-
5.1 Reed Ridge	m (+ pr)	100+	5-20?	good	(+)	-	(+)	+
6.1 Wilson Ridge	p (+ fs)	10-100+	1-10	good	(+)	+?	(+)	+
6.2 Bald Knob-Oil Well Branch	c (+ fs)	1000+	1-20+	moderate	+	+	(-)	(-)
6.3 Black House Creek	c	100-1000	1-20+	moderate	(+)	+	(-)	-

6.4+ Extended sites (larger scale)	c	1000s	5-100	moderate	(+)	+	(+)	-
7.1 Middle Creek	c (+ st)	ca. 100	1-20+	good	+	-	(+)	(-)
8.1 Duncan Hollow	c	10+	1-10	good	+?	-	-	-
8.2a Fall Branch TVA ROW	m (+ st)	10+	1-10	good	(+)	-	(+)	-
8.2b Laurel Fk Ridge TVA ROW	p?	10+	1-10	moderate	(+)	-	-?	-
8.3 Blevins Farm	c	10+	1-10	good	(+)	-	(+)	-
8.4+ Extended sites (larger scale)	c	100+	1-20	good	(+)	-	+	-
9.1 Hicks Ridge	p (+ pr)	100+	1-20+	poor	-	+?	(+)	(+)
9.2a Darrow Ridge	c (+ pr)	1000+	1-20+	good	(+)	+?	(+)	-?
9.2b Tar Kiln Ridge	c	100s	1-100	moderate	(+)	+	(-)	(+)
9.2c Laurel Fork Ridge	c	100s	1-100	moderate	(+)	+	-?	-?
9.3 Hurricane Ridge	c	100+	5-20?	good?	(+)?	+?	(+)	(+)
9.4+ Extended sites (larger scale)	c	1000s	5-100	moderate	(+)	+	(-)	(+)

I: adjacent land might be included eventually: fs = US Forest Service; st = state park/forest; pr = private
J: to be estimated better from GIS polygons
K: based on desired vegetation
L: including usable dirt roads
M: including ravines & streams
N: see FMU notes
O: not including internal park roads
P: of concern within a mile or so

FURTHER RECOMMENDED RESEARCH [FMP VII]

Following are some key areas of investigation. These all deserve further discussio and priorities should be set.

1. Further paleoecological investigation of pond sediments in region.

2. Possible study of fire history, or its topographic distribution, using soil charcoal and silica; but this needs careful review given unsatisfactory methods in some previous efforts.

3. Review of regional statistics on lightning fires in order to determine what a purely natural fire regime might have been.

4. Development of predictive models for the spread of fire in relation to topograpihc and vegetational features (e.g., Guyette & Dey 2000), for understanding the general behavior of presettlement or purely natural fire-regimes, and for understanding the details of future fires at Big South Fork.

5. Dendrochronology and study of fire-scares in older tree sections; with the current pine mortality, there is an excellent opportunity to use older shortleaf pines to examine fire history for the last 100-200 years; perhaps also examine old field cedars in Bear Creek area [note also potential of red cedars along cliffs in Obed River area.]

6. Special manipulations with prescribed fire to enable better monitoring of plant populations in relation to fire behavior.

7. Careful paired comparisons of sites inside and outside wildland fires or prescribed fires; where fire behavior is known, some sites could be selected to address particular questions about

vegetation and soil response.

8. Incorporation of general vegetation surveys in past and future at Big South Fork; plots and other observations may be selected for comparative data in burned versus unburned areas.

9. More detailed mapping of rare species that may respond positively to fire; examination of land type relationships, and the possible role of fire in maintaining broader ridges as more open woodland before settlement.

10. Use the new 10 m Digital Elevation Model for better topographic analysis.

PRIORITIES FOR MONITORING [FMP VIII]

The draft Fire Monitoring Handbook of National Park Service (1999) provides a detailed scheme for implementation on NPS lands. Only a few general comments are made here.

A. Note that monitoring of small prescribed burns in the short-term may be relatively easy to set up since most of the suggested are somewhat well known. However, if large burns are undertaken, there will be a need to explore the proposed areas more intensively prior to implementing any burn plan, in order to map vegetation, rare species and other features. This will help determine the best boundaries for prescribed burn units, as well as setting up the best statistical design for monitoring studies.

B. Vegetation monitoring in prescribed burns should focus on minimal required parameters. But in addition to assessing common species, there is a need to select populations of rare species for special attention. Some uncommon species may be good indicators of grassy open woodland, and are still scattered widely in the region (e.g., *Calamagrostis coarctata, ?Cleistes bifaria,* *Helianthus atrorubens, Liatris spp., Parthenium integrifolium, Phlox amoena,* etc.). Other indicators are much rarer, and special plots could be designed around them if they can be included in burn units (e.g., *Eriophorum virginicum, Calopogon tuberosus, Lilium philadelphicum, Platanthera cristata, Rhynchosia tomentosa, Tephrosia spicata,* etc.).

C. Animals to be monitored should probably include birds, since these are relatively well known in the region, and they probably respond in various definite ways to fire management. Other terrestrial groups that may be worth special attention include snails, herptiles, and small mammals, since these groups are relatively easy to survey and many species probably respond to fire, positively or negatively. A special effort should also be made to understand how the few larger animals, including deer and turkey, respond to fire and then interact with the vegetation. There may well be indirect effects of fire involving these animals.

D. Monitoring of air, soil and water is much more difficult to address in a way that will be relevant to overall ecosystem functioning. Ideally, there would be a well funded long-term research program built into the Fire Management Plan that would address ecosystem functioning. The Station Camp Creek watershed (FMU 7), in particular, can act as an excellent long-term control where fire is minimized for comparison with other sections of the park where fire is promoted. Several experimental blocks could be selected for replicated comparisons. "Controls" may be best located in FMUs 7 and 8, and "treatments" in FMUs 6 and 9. On a smaller scale, minor watersheds could be selected for comparisons with FMUs 3, 4 and 5.

E. Existing monitoring of water quality in the major streams, and monitoring of the aquatic biota, should be reviewed. Adjustments might be needed to allow better study of potential relationships with fire management.

FUTURE MODIFICATIONS [FMP XII]

There should be a gradual expansion of the program as capacity and knowledge grows. There is an urgent need to initiate prescribed burning at a few sites, in order to gain experience and to establish sites for demionstration, monitoring and experiment (e.g., the Bear Creek old fields, FMU 3.1). It is important to establish a frequent fire regime (with 1-3 year intervals) at some sites in order to understand the costs and benefits of such intensive management. No doubt many details can then be incorporated in the plan, based on this initial push into new 'operational territory' for the Big South Fork NRRA.

After careful discussion, a larger block should also be selected for more extensive use of prescribed fire amd even allowing some approved wildland fires to burn out within controlled boundaries. Currently, the Northwestern FMU 6 offers the most appropriate land for this, and its management would ideally be coordinated with a scientific control in the Station Camp Creek watershed, where fire would be minimized. Initial experiences on this larger scale will be essential for final design of FMU plans throughout the park.

The currently proposed set of FMUs deserves much scrutiny and testing for a few years, but it may be advantageous after this period to have a strong institutional commitment to a stable set of FMUs with clearly defined fire management goals in each. Long-term term commitment over decades and even centuries may allow special conditions to develop for more 'conservative' species, which are attuned to particular levels of fire effects on the ecosystem.

There should also be a gradual effort over the next decade or so to determine how much fire-influenced habitat of various types is really desired at Big South Fork. In addition to the accumulation of data from the park, more regional synthesis is needed, and broader conservation planning with partners should be undertaken. Decisions about how much grassy open woodland is desirable, for example, will depend partly on how rare this ecosystem type is across the region, and how much is being restored at other sites. Within closed forests, decisions about how much shift there should be from mesic or shade tolerant trees back to oaks and pines, should be based on a wide range on issues.

These issues will include better understanding of past environments, current threats to sensitive features, and future needs for global stability. In addition to professional opinions, there will be a need to include public opinions in this decision making. To a certain extent one can hope for better communication from professionals and better education of the public, which is understandably confused about many fire-related issues.

SUMMARY

This study provides a general review and discussion of information and issues involving fire and vegetation in the Big South Fork region (with much further detail in Appendices 2 and 3). It also makes recommendations for more detailed planning in the park, culminating in the "Fire Management" section. The park has recently undertaken comprehensive planning for fire management, and has completed an initial Fire Management Plan and Environmental Assessment in 2000-2001. National Park Service policy provides a general scope of interest in fire as related to safety, environmental quality, biodiversity and natural features. However, there has been considerable uncertainty about the role of "natural" versus "artificial" aspects of fire management, and in specific goals at selected sites.

Current science indicates that fire has had moderate to strong influence on vegetation in this region during the past 5500 years, enhancing general oak dominance, promoting local abundance of pine, and probably maintaining some grassy openings on broader ridges, together with many species that are now rare (Table 1). During this period, human ignitions have probably been much more frequent than lightning ignitions. Before 1500 AD, it is likely that human ignitions were concentrated along hunting trails on broader ridges. Current fires from arson or accident are relatively frequent near roads on ridges and in valley bottoms with recreational use. The few lightning ignitions may be more frequent on narrow ridges where xeric flammable pine woodland occurs, but before settlement such fires may have spread over very large areas of broad ridges and plateaus, due to the absence of fire-breaks.

After settlement, there were probably major pulses of fire following intensive logging and clearance, allowing pines (especially shortleaf) to increase. There was also continued frequent burning by residents for woodland-pasture and other reasons. However, since the 1930s the general suppression of fire has allowed fire-sensitive species such as maples and young white pine to increase in the understory. Many plant species typical of more open grassy woodland, and several associated animals (including red cockaded woodpeckers), appear to have virtually disappeared from much of the region. Currently, there are few species that are probably threatened by a return to more frequent fire, although some rare species might have been confined to restricted moist or rocky sites partly due to long periods with fire on the landscape. Careful fire management can certainly enhance native biodiversity.

Potential effects of fire on vertebrates are reviewed, although there has been little detailed research. Mammals and reptiles may not be generally harmed by fire, and in several cases, habitat is probably improved. Some amphibians may be restricted by fire, but no serious effects on rare species are suspected in this region. Birds provide more diversity of reponses: interior forest species are reduced in more open grassy pyric woodland, while other species, including some that are still globally declining, are increased in such habitat.

The potential effects of fire on air, soil and water must be considered as fire management develops at the park, but there is rather little basis for quantitative predictions. Effects will probably depend greatly on the frequency, intensity and scale of fires, and in many cases they may not be clearly "good" or "bad". However, safeguarding water quality should be a primary consideration, because of the globally rare aquatic biota in this watershed.

Existing fire management goals emphasize safety, suppression of wildland fires, use of prescribed fire where approriate, and reduction in hazardous fuels. This report suggests the following modifications or extensions.

> Allow carefully selected wildland fires in defined sections of the park in order to simulate a purely natural lightning fire-regime.
>
> Focus frequent prescribed fire on specific sites in order to: (a) restore fire-regimes typical of the pre-Columbian landscape; (b) maintain native biodiversity; (c) reduce some invasive alien plants; (d) allow scientific comparison of different fire-regimes.
>
> Extend fuel reduction zones to some boundaries between Fire Management Units, especially where occasional wildland fire is allowed on one side.

This report proposes dividing the park into ten large Fire Management Units (Figure 4, Table 8). Also, it suggests about 20 more local prescribed fire areas (Figure 5, Table 9). In addition to safety and other practical matters, maintenance of biodiversity is a fundamental consideration in designing these areas. Biodiversity can probably be enhanced by a pattern of different fire-regimes over the landscape, and much can be learned from comparisons of these effects.

In three of the Fire Management Units, there would be general promotion of prescribed fire or occasional wildland fire on a large scale. In the six other units, there would be a general suppression of fire except for some narrowly defined sites for prescribed fire. The Station Camp Creek watershed, in particular, could act as a large scientific control where minimized fire effects could be compared with strong effects elsewhere.

In the 20 or so smaller sites for frequent prescribed fire, a primary goal is to restore open grassy woodland and associated rare species. These sites are prioritized in relation to the obvious benefits and problems of implementation.

There is also a brief discussion of research and monitoring needs. More detailed study of past fire regimes and fire effects is needed in order to develop better models for understanding general relationships with vegetation and biodiversity, and for predicting effects of specific fires in the future. There should be more integration of relevant natural resource data in the Geographic Information System, upon which predictive models can be built. In addition to basic monitoring of effects on vegetation, there needs to be special attention to selected rare species, and to parameters of soil and water chemistry. It is critically important to monitor fire effects on the endangered aquatic biota.

Some aspects of these recommendations deserve urgent implementation, including prescribed burning in remnants of open grassy woodland where endangered species may be recovered. We need to learn from these initial efforts as soon as possible im order to optimize the expansion of fire management. Hopefully, a clear vision for balancing the various effects of fire or lack of fire can develop, leading to a stable design for broad fire management units and specific prescribed burning sites at Big South Fork.

DEFINITIONS

Aquatic = with ground submerged for most of the year
Fire intensity = degree of heat produced (per unit time)
Fire severity = degree of damage (especially to soil)
Heliophyte = plant that grows in sunny places
Hydric = with soil wet and anaerobic for much of the year
Mesic = with neither hydric nor xeric tendencies (oak rare)
Mesophyte = plant that grows in mesic habitats
Prescribed fire = planned for safety, with fire-breaks, and ignited by managers
Pyric = with frequent fires greatly influencing the vegetation
Pyrophyte = plant that grows in burned areas
Rheic = with force of floods greatly influencing the vegetation
Seral = successional; changing to more mature (often more mesic) forest
Subhydric = with soil intermediate between hydric and mesic
Submesic = somewhat mesic but modified by stresses or disturbances
Subxeric = with soil intermediate between xeric and mesic (oak abundant)
Wildland fire = unplanned fire (lightning, arson, accident or escape)
Xeric = with soil dry enough to maintain much red cedar or scrub pine
Xerohydric = with soil usually wet in winter, dry in summer; opposite of mesic
Xerophyte = plant that grows in xeric habitats

APPENDIX 1: ECOLOGICAL LAND TYPES ON THE CUMBERLAND PLATEAU

This appendix provides an update of the land type classification notes provided to Daniel Boone National Forest in 1995. Relationships between land types (based on geology with topography) and soil types are explored further, so that the underlying gradients can be more clearly illustrated and mapped.

LAND-TYPE ASSOCIATIONS

The following notes outline "land-type associations" (USDA Forest Service 1993), based on a preliminary synthesis of patterns in "soil associations" from individual county soil surveys, plus data collected within Daniel Boone National Forest during 1994-96 (Campbell 1996). Underlined (**and especially bolded**) series names are most extensive. Correlation with county soil surveys in Tennessee has not yet been checked, and there may be some differences in soil taxonomy. The major vegetation classes that probably existed on each of these land-type associations before settlement are indicated by codes in brackets; these codes refer to the vegetation classes followed elsewhere in this report (especially Table 6 and Appendix 3).

Cliff Section

Dissected areas with limestone: major soil series are Bledsoe, extensive on colluvial limestone; (Caneyville-Talbott on residual limestone); Shelocta, extensive on colluvial sandstone/shale; (Gilpin on residual sandstone/shale); Rigley on colluvial sandstone; Dekalb on residual sandstone (perhaps especially in north); Latham-Sequoia on residual shale. [11.CDE; 05.CDE; 12.DE]

Dissected areas without limestone: major soil series are Jefferson-**Rigley**-Helechewa on colluvial sandstone; Dekalb-Steinsburg/ Ramsey-Alticrest (and Lily in south) on residual sandstone; Shelocta on colluvial sandstone/shale (especially in central section); Gilpin-Rayne on residual sandstone/shale (perhaps especially in north); Latham-Sequoia on residual shale (especially in south). [11.ABC; 05.ABC; 12.AB; and formerly 10.ABC on some ridges, especially on less rugged terrain transitional to the Low Hills Belt.]

Narrow bottomlands on mixed/sandy alluvium with high base-status: major soil series are Grigsby; ?Allegheny. [05.CD; 04.CDE]

Narrow bottomlands on mixed/sandy alluvium with low base-status: major soil series are Pope-Rowdy; Allegheny; (?Monongahela). [05.BC; 04.ABC].

Low Hills Belt

London-Corbin-Oneida Plain (mostly on Corbin Sandstone plus overlying Breathitt Formation in Cumberland River drainage): major soils are **Lily** and locally Dekalb on residual sandstone; Rayne on residual sandstone/shale; Muse on colluvial shale; Latham-Sequoia on residual shale. [11.ABC; 10.BC; 9.BC; ?7.BC; 5.BC; 12.BC]

General low hills (mostly on Breathitt Formation shale/siltstone north of Cumberland River drainage): major soils are Shelocta on colluvial slopes; Gilpin-Rayne on residual ridges; (?Muse on colluvial shale in south); Latham-Sequoia on residual shale. [11.ABC; 5.BC]

Broad bottomlands on mixed alluvium with low base-status: major soils are (?) Cuba; Whitley; Cotaco-Morehead; Stendal-Bonnie. [4.BC; 6.BC; ?7.BC; 9.BC; ?10.BC]

Broad bottomlands on mixed alluvium with high base-status (mainly along larger rivers): major soils are ?Elk-Otwell on high terraces; Huntington on recent terraces; Newark on less well-drained terraces. [4.CD; 6.CD; ?7.CD; ?9.BC]

Broad bottomlands on high sandy terraces (mainly along larger rivers); major soils are Riney, Allegheny, Monongahela. [6.BC; ?7.BC; 9.BC; 10.BC;

Rugged Eastern Hills

General rugged hills (mostly on Breathitt Formation): major soils are **Shelocta**-Cutshin-Fedscreek on mixed colluvial slopes; Latham-Sequoia (and on residual shale ridges (and ?Muse); ?Gilpin on mixed residual ridges; Dekalb-Steinsburg on residual sandstone ridges; locally (Jefferson-?Rigley)-Marrowbone-Kimper on colluvial sandstone slopes. [11ABC; 5.BCD]

Narrow bottomlands on mixed/sandy alluvium with low base-status: major soils may be Jefferson (or “Tate”) on foot-slopes and fans; Potomac; Rowdy; Stendal. [4.BC; 5.BCD]

Narrow bottomlands on mixed alluvium with high base-status: major soil series may be Hayter (or “Shelocta”) on foot-slopes and fans; Yeager; Grigsby; (?Newark). [4.CDE; 5.CDE]

Broad bottomlands on mixed/sandy alluvium with low base-status: major soils may be (?Potomac); Rowdy-Pope; Allegheny; Cotaco; Atkins. [4.BC; 6.BC; ?7.BC; ?9.BC]

Broad bottomlands on mixed alluvium with high base-status (mainly along Ohio, Kentucky & Cumberland Rivers): major soils are ?Nelse on fresh alluvium; Shelbiana-Elk on high terraces; Combs-Huntington on recent terraces; Newark on less well-drained terraces. [4.CDE; 6.CDE; ?7.CD]

LAND-TYPE CLASSIFICATION

These notes are included here as raw material from which landtype mapping can be incorporated into GIS at Big South Fork. This will enable better vegetation mapping from remote sensing and other vegetation data. The codes used for each land-type are adapted from the original USFS systems of land-types in the Appalachian Plateaus and Highland Rim, compiled by Smalley (1982, 1984, 1986) and others; some alternative codes from these sources are in parentheses below. For useful application it will be desirable to rework them into a more convenient form. Diagrams have been developed elsewhere to depict the overlay of these landtypes on the gradients of soil series; see "Ecological Arrangement of Soil Series in Eastern Kentucky" (Campbell 1996).

mixed = mixed parent material from sandstone, siltstone and shale

~ = perhaps similar to the stated series but not clearly described or assigned here

H = codes from Highland Rim; otherwise codes are from Appalachian Plateaus

K = land-type codes adapted for Knobs Region

Note also that steeper slopes are divided into "warm" (S/W-facing) and "cool" (N/E-facing) aspects; however, for further refinement, it is useful to recognize an intermediate division (E/SE and NW/W) between the warm (S/SW) and cool (N/NE) aspects.

CALCAREOUS CLIFF SECTION, ADJACENT KNOBS AND HIGHLAND RIM
Tables 7, 8, 9 in Campbell (1996).

<u>Uplands</u>
17A(~H16A). Colluvial sandy limestone slopes--cool aspect
Soils: Donahue, Bledsoe, (Renox?)
17B(~H16B). Colluvial limestone slopes--cool aspect
Soils: (~Garmon?), ~Brookside
17C(~H4)? Colluvial cherty limestone slopes--cool aspect
Soils: (~Garmon??), ~Brookside??

18A(~H17A). Colluvial sandy limestone slopes--warm aspect
Soils: Donahue, Bledsoe
18B(~H17B). Colluvial limestone slopes--warm aspect
Soils: ~Garmon?, ~Brookside
18C(~H5)? Colluvial cherty limestone slopes--warm aspect
Soils: ~Garmon??, ~Brookside??

19A. Shallow calcareous shale soils and outcrops
Soils: Colbert, ~Corydon
19B. Shallow limestone soils and outcrops
Soils: Corydon

22A. Calcareous shale ridges and convex upper slopes
Soils: Garmon, Faywood, Needmore
22B. Limestone ridges and convex upper slopes
Soils: ~Garmon, Opequon

H13A. Broad undulating impure limestone uplands ("redlands")
Soils: Talbott
H13B. Broad undulating pure limestone uplands ("redlands"?)
Soils: Caneyville, Hagerstown
H13C? Broad undulating cherty limestone uplands ("redlands")?
Soils: Talbott??
H13D. Broad undulating sandstone uplands
Soils: Lily

H12A. Broad silty uplands on impure limestone
Soils: Frederick, Pembroke?, Crider; (with old alluvium/loess)
H12B. Broad silty uplands on pure limestone
Soils: Cumberland, Pembroke, Crider; (with old alluvium/loess)
H12C. Broad silty uplands on cherty limestone
Soils: Baxter, Britwater, Clarksville, Mountview; (with some loess)

H18A. Well-drained upland flats/depressions/sinks on impure limestone
Soils: Nolichucky, Waynesboro; (with old alluvium)

H18B. Well-drained upland flats/depressions/sinks on pure limestone
Soils: Decatur, Bewleyville; (with old alluvium/loess)
H18C. Well-drained upland flats/depressions/sinks on cherty limestone
Soils: Trimble?
H18D. Well-drained upland (depressions/slumps?) on sandstone+limestone
Soils: Allen

H19A. Less well-drained upland flats and depressions on impure limestone
Soils: Russellville, Bedford; (with old alluvium/loess)
H19B. Less well-drained upland flats/depressions on pure limestone
Soils: Nicholson; (with loess)
H19C. Less well-drained upland flats/depressions on cherty limestone
Soils: Tarklin, Dickson; (with some old alluvium/loess)
H19D. Less well-drained upland flats/depression on sandstone+limestone
Soils: ~Cotaco, ~Morehead

<u>Bottomlands</u>
H8Af. Well-drained mixed-calcareous foot-slopes and fans
Soils: ~Renox?
H8Bf. Well-drained calcareous foot-slopes and fans
Soils: ~Renox?, ~Ashton?

H8Au. Well-drained mixed-calcareous upper terraces
Soils: ~Ashton?, Elk, ~Sequatchie?
H8Bu. Well-drained calcareous upper terraces
Soils: ~Ashton?, Elk

H8A. Well-drained mixed-calcareous streambanks
Soils: Grigsby, Skidmore, Chagrin
H8B. Well-drained calcareous streambanks
Soils: Huntingdon, Nolin

H9Au. Less well-drained mixed-calcareous upper terraces
Soils: Otwell, Lawrence, Robertsville
H9Bu. Less well-drained calcareous upper terraces
Soils: Otwell?, Lawrence?, Robertsville?

H9Am. Less well-drained mixed-calcareous middle terraces
Soils: ~Cotaco, Lanton, Knowlton
H9Bm. Less well-drained calcareous middle terraces
Soils: ~Egam?, Rahm, ~Dunning

H9A. Less well-drained mixed-calcareous lower terraces
Soils: Lindside?, Orrville, Melvin
H9B. Less well-drained calcareous lower terraces
Soils: Lindside, Newark, Melvin

APPALACHIAN PLATEAUS: NON-CALCAREOUS CLIFF SECTION SOILS

Tables 10, 11, 12 in Campbell (1996).

Uplands

1A. Narrow sandstone ridges and convex upper slopes
Soils: Steinsburg, Alticrest
1B. Narrow mixed ridges and convex upper slopes
Soils: Gilpin, ?Wernock
?1C(2) Narrow shale ridges and convex upper slopes (to be defined)
Soils: ?Sequoia

2A,B,C. Optional: could be used for cooler aspects of 1A,B,C.

3A. Shallow soils and sandstone outcrops.
Soils: Dekalb, Ramsey
3B. Shallow soils and mixed outcrops
Soils: Weikert
3C? Shallow soils and shale outcrops.
Soils: ~ ?Colyer, ~ ?Rockcastle (to be defined)
4A,B,C. Optional: could be used for cooler aspects of 4A,B,C

5A. Broad sandstone ridges and upper slopes
Soils: Lily
5As. Less well-drained broad sandstone ridge and upper slopes
Soils: seep and streamhead soils to be defined

5B. Broad sandstone/siltstone/shale ridges and upper slopes
Soils: Rayne, ?Wernock, Lonewood
5Bs. Less well-drained broad sandstone ridge and upper slopes
Soils: Tilsit, ?Johnsburg

5C(6). Broad shale ridges and upper slopes
Soils: Latham, ?Wharton (part)
5Cs(6). Less well-drained broad shale ridges and upper slopes
Soils: Latham, ?Wharton (part)

15A. Colluvial sandstone slopes--cool aspect
Soils: ~Kimper, ~Sharondale
15B. Colluvial sandstone/siltstone/shale slopes--cool aspect
Soils: ~Cloverlick, ~Cutshin
15C. Colluvial shale slopes--cool aspect
Soils: ~Muse

16A. Colluvial sandstone slopes--warm aspect
Soils: Helechawa, Rigley

16B. Colluvial sandstone/siltstone/shale slopes--warm aspect
Soils: Hazleton, Shelocta
16C. Colluvial shale slopes--warm aspect
Soils: Muse

Bottomlands

12Af. Well-drained sandy foot-slopes and fans
Soils: Jefferson, Chavies
12Bf. Well-drained mixed foot-slopes and fans
Soils: Hayter, Whitley
12Cf. Well-drained shaley foot-slopes and fans
Soils: ~Muse

12Au. Well-drained sandy upper terraces
Soils: Riney, Allegheny
12Bu. Well-drained mixed upper terraces
Soils: ~Allegheny, Whitley

12A. Well-drained sandy streambanks
Soils: Bruno, Clifty, Pope, Rowdy,
12B. Well-drained mixed streambanks
Soils: Yeager, Grigsby, Rowdy, Cuba
13Au. Less well-drained sandy upper terraces
Soils: Monongahela, Tyler, ~Purdy, (~?Blago)
13Bu. Less well-drained mixed upper terraces
Soils: ~Tilsit, ~Johnsburg, ~?Mullins

13Am. Less well-drained sandy middle terraces
Soils: Cotaco, Whitwell, Purdy
13Bm. Less well-drained mixed middle terraces
Soils: Cotaco, Morehead, ?Peoga

13A. Less well-drained sandy lower terraces
Soils: ?Philo, Stokly, Atkins
13B. Less well-drained mixed lower terraces
Soils: Steff, Stendal, Bonnie

APPALACHIAN PLATEAUS: RUGGED EASTERN HILLS AND LOW HILLS
Tables 13, 14, 15 in Campbell (1996).

<u>Uplands</u>
1A. Narrow sandstone ridges and convex upper slopes
Soils: Steinsburg
1B. Narrow mixed ridges and convex upper slopes
Soils: Gilpin
?1C(2). Narrow shale ridges and convex upper slopes (to be defined)
Soils: ?Sequoia

2A,B,C. Optional: could be used for cooler aspects of 1A,B,C.

3A. Shallow soils and sandstone outcrops.
Soils: Dekalb
3B. Shallow soils and mixed outcrops
Soils: Muskingum, Berks (siltstone)
?3C. Shallow soils and shale outcrops (to be defined)
Soils: ~?Rockcastle

4A,B,C. Optional: could be used for cooler aspects of 4A,B,C

?5A. Broad sandstone ridges and upper slopes
Soils: Lily (may not be typically present)
?5As Less well-drained broad sandstone ridge and upper slopes
Soils: seep and streamhead soils to be defined

5B. Broad mixed ridges and upper slopes
Soils: Wernock
?5Bs. Less well-drained broad mixed ridge and upper slopes
Soils: ?Clarkrange (Tilsit, ?Johnsburg)

5C(6).Broad shale ridges and upper slopes
Soils: Latham, ?Wharton (part)
5Cs(6). Less well-drained broad shale ridges and upper slopes
Soils: Latham, ?Wharton (part)

5D. Broad calcareous shale ridges and upper slopes
Soils: Upshur

15A. Colluvial sandstone slopes--cool aspect
Soils: ~Kimper, ~Sharondale
15B. Colluvial sandstone/siltstone/shale slopes--cool aspect
Soils: ~Cloverlick, ~Cutshin
15C. Colluvial shale slopes--cool aspect
Soils: ~Muse

15D. Colluvial calcareous shale slopes--cool aspect
Soils: (?Vandalia), ?Renox

16A. Colluvial sandstone slopes--warm aspect
Soils: Marrowbone, ?Rigley
16B. Colluvial sandstone/siltstone/shale slopes--warm aspect
Soils: Highsplint, Fedscreek, Shelocta
16C. Colluvial shale slopes--warm aspect
Soils: Muse
16D. Colluvial calcareous shale slopes--warm aspect
Soils: Vandalia

Bottomlands
12Af. Well-drained sandy foot-slopes and fans
Soils: Jefferson, Chavies
12Bf. Well-drained mixed foot-slopes and fans
Soils: Hayter, Whitley
12Cf. Well-drained shaley foot-slopes and fans
Soils: ~Muse
12Df. Well-drained base-rich foot-slopes and fans
Soils: ?Renox, ?Shelbiana, (?Hayter), (?Chavies)

12X. Excessively well-drained high terrace with dunelike sand
Soils: Lakin
12Au. Well-drained sandy upper terraces
Soils: Riney, Allegheny

12Bu. Well-drained mixed upper terraces
Soils: ~Allegheny, Whitley
12Du. Well-drained base-rich upper terraces
Soils: ~?Ashton, Elk

12A. Well-drained sandy streambanks
Soils: Bruno, Clifty, Pope, Rowdy,
12B. Well-drained mixed streambanks
Soils: (Yeager), (Grigsby), Rowdy, Cuba
12D. Well-drained base-rich streambanks (mollic)
Soils: Nelse, (?Grigsby), (?Nolin); Combs, Huntingdon (mollisols)

13Au. Less well-drained sandy upper terraces
Soils: Monongahela, Tyler, ~Purdy, (~?Blago)
13Bu. Less well-drained mixed upper terraces
Soils: ~Tilsit, ~Johnsburg, ~?Mullins
13Du. Less well-drained base-rich upper terraces
Soils: Otwell, Weinbach, (?Robertsville)
13Am. Less well-drained sandy middle terraces
Soils: Cotaco, Whitwell, Purdy
13Bm. Less well-drained mixed middle terraces
Soils: Cotaco, Morehead, ?Peoga
13Dm. Less well-drained base-rich middle terraces (lacustrine)
Soils: Markland, Licking, McGary
13A. Less well-drained sandy lower terraces
Soils: ?Philo, Stokly, Atkins

13B. Less well-drained mixed lower terraces
Soils: Steff, Stendal, Bonnie
13D. Less well-drained base-rich lower terraces
Soils: Lindside, Newark, Melvin

APPENDIX 2: VEGETATION AND FIRE HISTORY

This section reviews available information from the Appalachian Plateaus that can be used to indicate how much vegetation has been modified by fire within this region. There is little definitive information from the Big South Fork region, but some general picture can be assembled for the whole area drained by the Cumberland River and the broad watershed divide towards the Tennessee River. A summary is provided in the main report, together with a generalized chronological chart (Table 1).

POND SEDIMENTS WITH POLLEN

General regional inferences about vegetation history in Kentucky can be made from the scattered palynological studies of eastern North America (e.g., Franklin 1994). However, there have only been two published studies of long continuous Late Quaternary cores from within the state. The only completed Appalachian study in Kentucky is from Cliff Palace Pond, Jackson County, on a sandstone ridge in the Cliff Section of the Appalachian Plateaus (Delcourt et al. 1998). From the base, dated about 7500 BC to 5300 BC the most common taxa were Cupressaceae (presumed largely white cedar) and oak, together with lesser amounts of alder, hornbeam-type (*Carpinus/Ostrya*), ash, spruce and others. Charcoal occurrence was moderately high. From 5300 to 2800 BC, oak was predominant in the pollen, but still with much Cupressaceae, and lesser amounts of hemlock, ash, hickory, maple and others. There was a pronounced charcoal peak about 3500 BC, while hemlock was declining abruptly, perhaps due to insect pests or droughts, which may have caused fuel to accumulate for catastrophic fires. Between 2800 and 1000 BC, there was a sharp peak in Cupressaceae (presumed largely red cedar), plus lesser amounts of oak, ash and others, and a relatively low occurrence of charcoal.

Abundance of red cedar may be attributed to open successional conditions after the catastrophic fires. Between about 2000 BC and 1800 AD, the most common taxa of tree pollen were oak (dominant), chestnut, pine, ash and hickory, and there was a relatively high occurrence of large-grained charcoal, indicating much local fire. Non-arboreal pollen remained a minor proportion, but there were distinctive increases in ragweed (*Ambrosia*), sumpweed (*Iva*), sunflower (*Helianthus*), goosefoot (*Chenopodium*) and other indicators of open cultivated ground, which were generally absent in older sediments.

Another study by Delcourt & Delcourt (1998b) in Daniel Boone National Forest lacked a long datable core, but it did suggest further trends related to disturbance. This was at Curt Pond, Pulaski County, also on a sandstone ridge in the Cliff Section. Lower samples were undatable but probably came from about 0-1500 AD. These show a remarkable dominance (60-80%) of Cupressaceae pollen (presumed red cedar), together with lesser amounts (ca. 5-10%) of oak and sweetgum. There was also much bracken (*Pteridium*) spore (5-10%) and relatively frequent sedge (Cyperaceae), grass (Poaceae), composite (Asteraceae) and fern (*Dryopteris*-type) (each about 1-3% and generally more than after settlement). A reasonable interpretation of these samples is that the sandy ridges were mostly covered with brushland and young forest, maintained by burning, and that there was much successional red cedar forest on the more calcareous lower slopes. Conceivably, forests on lowlands within a mile or so of this site had been largely converted to red cedar and minor ash, perhaps in a stand-replacing cycle of intensive fire. Forest on non-calcareous uplands may have been converted by frequent or intense fires into open woodlands or “roughs” with scattered oaks and minor pine, plus much brush, bracken and graminoids. Pine pollen was less common than oaks, suggesting that fires may have been too frequent or intense for regeneration. Possibly the highly fire-tolerant, resproutable post oak and blackjack oak were common oaks on the uplands. Upper samples from Curt Pond are dated after settlement. Especially after 1700 AD, these suggest local pond-filling by aquatic plants, and recovering regional dominance by typical forest of oak, sweetgum, chestnut, pine, etc. After 1820 there were large pulses of species that reflect disturbance history, but red cedar became much less frequent than pine. Peaks in pine (probably shortleaf and virginia for the most part) occurred about 1840-60 and about 1940-2000, periods which followed intensive logging and burning, as indicated by trends in charcoal particles.

Currently, J.C. Chatters (pers. comm.) is completing another paleoecological study on contract for the Daniel Boone National Forest. This is based on a full Holocene core from Wherry's Bog, an enhanced natural pond on broad uplands a few miles east of the Big South Fork. This core shows some of the same trends as at Cliff Palace Pond. In early Holocene levels, before 6000-5000 BC, boreal/northern hardwood types (with much spruce, white pine, etc.) became partly replaced by hornbeam-type (*Ostrya/Carpinus*) plus cedar and grass (up to 10-20% of terrestrial pollen). Charcoal was relatively frequent (at least in ratio to grass pollen), suggesting local savanna with occasional large fires. [Such abundance of cedar (*Juniperus/Thuja* type) remains enigmatic—Was pollen blown in from the west, or was northern juniper or red cedar really common after occasional intense fires that increased soil base status, favoring cedar over pine?] After 5000 BC, mesic types like hemlock, beech and sugar maple became more frequent. But during mid-Holocene levels (about 4000-2000 BC), charcoal frequencies increased, and cool/mesic forest pollen types shifted to a predominance of oak, with minor amounts of pine, hickory, chestnut, red maple, sweetgum, etc. In upper levels (probably about 1000-500 BC), there were increases in charcoal, with waves of pine following the fires. However, grass pollen remained relatively low (<2%) until the post-settlement era. And during 1500-1800 AD pine and charcoal dropped to lower levels, possibly due to reduction in the human population. After 1800, pines became more abundant than ever before (perhaps including traces of white pine), reaching 20-30% of terrestrial pollen. In the 1930s, Wherry's Bog was a reknowned site for rare plant species (see "Specific Records" below). It appears to have been surrounded by damp grassy vegetation, but forest growth and drainage changes led to the disappearance of this vegetation within the past 50 years.

The only other major study from Kentucky is by Wilkins et al. (1991; see also Delcourt et al. 1986), from Jackson Pond in Larue County, at the southeastern corner of the Northern Karst Plain, about 30 miles NE of Mammoth Cave. The core suggests that from 9500 to 5500 BC, in the early post-glacial era, grass pollen was also low, and the common tree taxa were oak and hornbeam-type (*Carpinus/Ostrya*), with lesser amounts of ash (especially *Fraxinus nigra*-type), hickory, elm and willow. From 5500 to 1500 BC, during a relatively warm dry period in eastern North America, there was much less grass pollen, but the trees were generally similar in proportions (except for more willow, probably around the pond). From 1500 BC to 1800 AD, the pollen indicated a mix of grassland and forest. Grass pollen was about 10-20% of the total upland pollen sum, and the grassland indicator, prairie-clover (*Dalea*), was present throughout this period. Common taxa in the tree pollen included oak, ash, hickory, chestnut and sweetgum (which together with blackgum may have been concentrated close to the pond). The sharp increase in grass pollen after about 1500 BC is interpreted to reflect an increase in fires set by native peoples, not an increase in drought.

Long Holocene cores were also obtained from the eastern Highland Rim, 10-40 miles west of the Cumberland Plateau, in White and Franklin Counties, Tennessee (Delcourt 1979). Anderson Pond (White Co.) showed an abundance of oak (50-60% of arboreal types) in the pollen record during ca. 8000-3000 BC, together with ash, hickory (each ca. 10%) and lesser amounts of pine, spruce, birch, hornbeam-type, walnut, elm, beech, sugar & red maples, hemlock, sweetgum, chestnut, blackgum, etc. (plus much alder, buttonbush and *Itea* presumably close to the pond). Grass pollen declined gradually during this period from 20-30% of total upland taxa to less than 5%. After 2000 BC, oak became even more dominant (ca. 70%); ash, hickory and pine were secondary taxa (each 5-10%); minor taxa were similar, except for addition of willow and sycamore (probably around pond) and loss or decline of spruce, beech, sugar maple and hemlock. Grass pollen increased slightly to ca. 5%, and sedge pollen increased from less than 5% after 8000 BC to 5-10% after 1000-0 BC. The undated Mingo Pond (Franklin Co.) core indicates similar trends, except that oak became even more dominant (ca. 80%) in upper levels, and sweetgum became more abundant (ca. 10%) than other trees. Pine, hickory, ash, etc., remained relatively low in proportion, perhaps reflecting more extensive local influence of wet oak-sweetgum forest in the pollen record.

Further east, in the Ridge and Valley region, Delcourt et al. (1986) showed that extensive human clearance and burning of broad valley bottoms began 2000-1000 BC. After some partial reversion of forest during 0-1000 AD, peak cultivation appears to have occurred during the Mississippian era 1000-1500 AD. It has been suggested by T. DesJean (National Park Service, pers. comm.) that the human population after 2000-1000 BC became largely based in broad valleys like this within Appalachian regions, and that the more dispersed or transitory use of rockshelters and campsites on the Cumberland Plateau did not generally lead to clearances or extensive burned openings.

In summary, these studies and others from in and near the Appalachian Plateaus indicate that most mesophytic fire-sensitive trees, in comparison to most fire-tolerant trees, were relatively frequent before 3500 BC but became minor taxa after 1000 BC (Delcourt & Delcourt 1998, Abrams 2000, Ison 2000). These trees included cedar (white or red), which was locally abundant, hemlock, hornbeam (or hophornbeam), holly*, sugar maple*, basswood*, etc. [Asterisks indicate insect pollinated species that are under-represented.] Oak pollen (perhaps including much of the less fire-tolerant northern red oak) was also similar in abundance to cedar. The relatively fire-tolerant oaks, chestnut, pines, etc., have become prevalent pollen types after 1000-500 BC, while fire-sensitive trees have declined as a group. This shift is associated with gradual increase in charcoal particle deposition. Moderately fire-tolerant ash was locally abundant in the transition (ca. 1000 BC). Minor pollen types that are more frequent after 1000 BC include hickories, blackgum*, red maple*, black walnut, white pine, tulip tree*, dogwood*, etc. This transition may have begun earlier further west, on the Highland Rim, where oak was already dominant well before 3000 BC (e.g., Delcourt 1979).

During the final shift from fire-sensitive to fire-tolerant trees on the Appalachian Plateaus, about 1000 BC, there is also archaeological evidence of a shift to more cultivation by native peoples (see below), and there seems to have been an increase in local fire frequency. Clearly, there were great differences in regional ecology, but it may be suggested that human populations became denser across Kentucky and Tennessee, with more agricultural activity and more burning to clear ground and increase game production. This period corresponds to the shift from Archaic to Woodland cultural period. Some of the pollen studies have suggested that increases in oaks, pines, or even open woodland and grassland, were enhanced after 500-1000 AD, in association with further increases in human population and burning during the Mississippian cultural era; see also Delcourt & Delcourt (1996, and pers. comm.).

ARCHAEOLOGICAL RECORDS

Paleoindian Period (12,000-8,000 BC). DesJean & Benthall (1994) made the following comments on this period in the central Cumberland Plateau: "The paucity of Early Paleoindian occupation here seems to support conclusions Rolingson (1964) made that Paleoindian peoples avoided the rugged mountainous areas of the east, staying in relatively flat land and grassy areas. The few known Early Paleoindian sites on the [central Cumberland Plateau] reflect subsistence strategies that are similar to those defined for Paleoindian groups in other areas. These are primarily ecotonal situations that are attractive to game; areas of moasic vegetation, river confluences, and springs... [W]hile there have been some assocations of Paleoindian materials and Pleistocene fauna, notably at Big Bone Lick in northern Kentucky, none has been identified from other areas of the [central Cumberland Plateau]... [I]n the Late or Transitional Paleoindian Period there is aignificant increase in the number of sites observed in the Eastern Mountain areas

Archaic Period (8,000-1,000 BC; transition to 200 BC). DesJean & Benthall (1994) continued: "This shift produced a much wetter environment resulting in widespread occupation of the [central Cumberland Plateau] by Early Archaic cultures. Limited numbers of features, burials, materials, and middens at Early Archaic sites reflect the tranhumant and mobile nature of these small bands of hunter gatherers. Additionally, the paucity of plant food and plant processing artifact reflects the importance that hunting held for these groups... During the Middle Archaic Period (6,000-3,000 BC) there appears to have been an overall decline in prehistoric populationon the Cumberland Plateau. This general abandonment is probably related to drought and dessication of the area... These changes may have caused dry late summer and fall seasons which altered plant and animal communities... Interestingly intensively occupied Middle Archaic sites have been found in the valleys surrounding the Plateau and in the higher eleveations of the Unaka Mountains [Smokies]... These latter may relate to population movements resulting from...an “aquatic-pull”...which was operating during this time... [B]y the Late Archaic Period (3000-1000 BC), intermittent and sporadic Middle Archaic habitation of the [central Cumberland Plateau] was replaced by more itense occupation by grounps whose subsistence was based upon a “Primary Forest Efficiency.” This transhumant and regionally specilaized cultural development allowed greater food surpluses and reliable seasonal resources to be utilized fostering the beginnings of horticulture... Relative stability, in turn, allowed for the development of a more complex social organization, group interaction, and the establishment of trade networks... The occurrence of numerous [diagnostic artefacts] indicate contacts of movement from south and west of the [region]... Marquardt (1970:85) suggests that Late Archaic groups pursued a seasonal round between upland rockshelters and river terraces. This pattern may be indicated by numerous freshwater mussels found in multi-component rockshelter sites... The Terminal Archaic Period is marked by the frequent occurrence of early cultigens, namely gourds and squash...”

Woodland Period (1000 BC-1000 AD; overlapping with earlier and later periods). From a broad regional perspective, archaeological data tend to support the palynological trends summarized above, and allow some interpretation in terms of human effects. Excavations on the Appalachian Plateaus, at least to the north, show evidence of increased human cultivation on slopes below rockshelters during the general transition from Archaic to Woodland Cultures ca. 1000 BC (Ison 2000). This region supported some of the earliest agricultural developments within eastern North America, including several domesticated weedy plants (Iva, Chenopodium, ?Amaranthus, Helianthus, Phalaris). As noted above, paleoecological data from that period suggest that fires increased in frequency and influenced much of the forest.

DesJean & Bentham (1994) stated: "In most areas Early Woodland cultures (1000-250 B.C.) became more sedentary and, as horticulture developed, permanent communities and settlements began to arise. However, on the [central Cumberland Plateau] it appears that seasonal base camps and cyclical rounds continue to predominate. Rockshelters continued to be the places where seasonal camps were established, and certain ones were reoccupied over and over through time. The presence of heavy plant processing tools are abundantly represented at these sites... Subsistence evidence from other areas...indicates a growing reliance on domesticates...but the overall percentages of food resources were still [mostly] wild plant and animal foods... While ceremonial treatment of the dead and grave goods are hallmarks of the onset of sedentary Woodland cultures in many areas of the Southeast, there are very few occurrences of such sites or artifacts on the [central Cumberland Plateau]... Recently, however, near Wartburg, Tennessee [in a broad high valley], a cluster of Late Woodland Period burial mounds was discovered and preserved..."

"Because of the relative stability of subsistence activities throughout the Woodland Stage, there does seem to be a greater number of known sites with a Middle Woodland component... As subsistence became more focused on vegetal foods and incipient horticulture developed in the Late Woodland Period..., the transhumant base camp type of settlement pattern appears to decrease. Although subsistence practices in many areas of the Southeast underwent change at this time, the [central Cumberland Plateau] appears to remain an area where hunting and gathering were still practiced after prehistoric groups in other areas became primarily horticultural..."

Mississippian Period (1000-1600 AD). Broad regional increases in oak, chestnut, pine or even more open grassy conditions after 500-1000 AD, as indicated by paleoecological data reviewed above, may be correlated with the transitional period from Woodland to Mississippian cultures, when maize and beans were introduced from Central America. It is likely that there were associated increases in human populations and more widespread burning. Trends in dated fireplace charcoal may support palynological studies. For example, there was a shift from hardwood dominance to pine dominance about 400 AD at Green Sulphur Spring in southern West Virginia (Rossen & Ison 1986).

However, T. DesJean (pers. comm.) maintains that there is insufficient evidence for substantial pre-Columbian human use of fire in the Big South Fork area itself. Based on numerous excavations in the Big South Fork area and on a general archaeological review of the central Cumberland Plateau, it appears that populations during the Mississippian Period were relatively thin or transient, compared to the Woodland Period. "There are no known Mississippian village sites and no evidence of any permanent Mississippian occupation in the area" (DesJean & Benthall 1994). Des Jean has suggested that because broad river valleys were relatively far from Big South Fork, the early agricultural base was much more limited, in contrast to the Red River Gorge and other areas further north, where broad valleys with settlements occurred a few miles to the west. C. Ison (pers. comm.) has also pointed out the paucity of evidence for settled agricultural communities in the Cumberland River drainage, in contrast to the Red River area. For example, hominy holes (rocks hollow out by grinding corn) are much less frequent.

Nevertheless, DesJean & Benthall (1994) note that: "the presence of the whole range of ceramics...again provides evidence that Late Woodland and Mississippian cultures were using this area". C. Ison (pers. comm.) considers that during the Mississippian period residents of the area were scattered thinly in small groups. These groups may have been relatively sedentary, with little travel more than 10-20 miles. However, men may have occasionally roamed much further. As noted by Martin (1989), there were probably major travel routes across the central Cumberland Plateau (see also Myer, 1925, for original references). These could well have been sites for frequent human ignitions.

About 20-30 miles northeast of the Big South Fork area, recent excavations by the University of Kentucky have revealed village sites of Mississippian cultures (ca. 800-1600 AD) on relatively broad bottomlands of the Cumberland River in Knox, Bell and Letcher Counties, Kentucky (Jefferies et al. 1996). Further north, in the Kentucky River valleys, the Fort Ancient culture included a contemporanteous development of village sites. Further east, in the Ridge and Valley Region of Tennessee, Chapman et al, (1982) summarized archaeological evidence that permanent occupation along the Tennessee River and its major tributaries was common from the late Archaic era (ca. 2000 BC), with relatively small settlements, to the period of contact (ca. 1600-1800 AD), with several towns of the Cherokee. Associated pollen data indicates that large areas of the Tennessee Valley becoma converted to open grassy woodland by these inhabitants (Delcourt et al. 1986).

Details from Big South Fork. There has been relatively little intensive excavation on National Park Service lands at Big South Fork, but one site has yielded a long record of occupation and plant material--the Burke's Knob Rockshelter (Prentice 1992, p. 53). Hickory nuts and acorns appear to have been major food items during Archaic and Woodland eras, but walnuts were absent from Woodland deposits. In late Archaic and early Woodland deposits, this site has provided a few seeds of goosefoot (*Chenopodium* sp.) and maygrass (*Phalaris* sp.) cultivars, which were used for food. Another intensive excavation was made in 1996 by T. Des Jean and associates at the Wet Ledge Rockshelter (BISO Accession Number 41), but no evidence of cultivars was found. Further south, recent excavations at West Creek Rockshelter and nearby (T. Des Jean, pers. comm.) suggest that: "Prehistoric Native American presence in the study area declined dramatically during the Mississippian Period at the same time that prehistoric populations increased in the more agriculturally productive river valleys. From AD1200 on the [region] was used...primarily as hunting grounds to supplement agricultural production."

It is possible that food plots with these cultivated plants were established in the Big South Fork area, as in the Red River Gorge (Ison 2000). However, there is no evidence that resident populations reached the level of activity and vegetation disturbance that has been indicated in the Red River Gorge (Prentice 1992; T. DesJean, pers. comm.). Until more archeological and paleoecological work is conducted here, there will be much uncertainty about prehistoric human effects on the environment. However, even if people of the Mississippian Period did not settle permanently in the area, they may have caused frequent fires to sweep widely across the broad surface of the plateau as they moved through it to hunt, travel or fight.

HISTORICAL RECORDS OF HUMAN ACTIVITY

Pioneer Era: 1775-1795. Unfortunately, there are few written descriptions of the Appalachian Plateaus during the pioneer era, and these provide only a few clues to the extent of fire effects. Nevertheless, it is important to recite these, at least for adding some verbal color to more scientific interpretations of other data.

Although most of the Cumberland Plateau was no doubt well wooded before settlement, there are a few areas where brushy conditions may have prevailed. Many place names suggest this, although it is likely that trees were generally present in these brushy areas to various degrees. A few old place names include the word "rough", an antiquated usage (except for golfers and some wildlife biologists) that implies a relatively treeless, densely brushy or tall grassy condition difficult to travel through. These include "Halsey Rough" in northeast Pulaski County near Billows (see USGS Quadrangle); also Anvil in eastern Jackson County is in an area formerly known as "Chinquapin Rough", presumably named after *Castanea pumila*, the dwarf cousin of chestnut that is now virtually unknown in this region. "Hazel Patch" is another famous place, formerly along the Wilderness Road in northern Laurel County, which led to the "Crab Orchard" in eastern Lincoln County, just west of the Cumberland Plateau. A second "Crab Orchard" was named on the Cumberland Plateau, further south and now along Interstate 40, as detailed below (with map before "Observations after settlement: 1795-1900").

Martin (1989) noted that other major trails crossed the Cumberland Plateaus, including the "Warrior's Path" (Cumberland Gap to Station Camp Creek), the north-south Great Lakes Trails, and the east-west Tollunteeskee's Trail; see Myer (1925) and Dupier (1995) for original sources.

One of the earliest accounts of Kentucky was by Thomas Walker (1749-50; in Johnston 1898), who noted Indian trails and buffalo at several places during his season in the Appalachian Plateaus. In addition he noted results of fires:

17 May 1750: between Rockcastle River and South Fork Kentucky River, probably along the ancient trail that became US 421 in eastern Jackson County: "The woods have been burnt some years past and are now very thick, the timber almost kill'd";
30 May 1750: along North Fork of Red River, probably in eastern Wolfe or Morgan

County: “The woods are burnt fresh about here and are the only fresh burnt woods we have seen these six weeks”.

Near, Pineville (Bell County), Walker initially named Clear Creek as “Clover Creek”, noting that “Clover and hop vines are plenty there”; the clover was probably *Trifolium stoloniferum*, which was associated with buffalo in Kentucky (Campbell et al. 1988); see also Appendix

Haywood (1823) related later exploration (p. 88-89 in 1899 edition): “On the second of June, 1769, a company of twenty men or more was formed of adventurers from North Carolina, Rock Bridge, in Virginia, and from New River, about five miles distant from English's Ferry, who resolved to pass over into what is now called West Tennessee, for the purpose of hunting... they next came to Powell's Valley, and thence to the Gap of Cumberland Mountains; thence to Cumberland River, at the old crossing-place which led to Kentucky. No trace was then there, but has been made since; it is now a turnpike road. They thence traveled to Flat Lick, about six miles from the Cumberland River; thence bearing down the water-courses, and crossing the river at a remarkable fish dam, which had been made in very ancient times, in what is now the State of Kentucky [perhaps at shoals between Rockcastle River and the South Fork]. They passed the place called the Brush, near the fish dam [perhaps uplands around Sloans Valley]; briers, brush, vines, and a vast quantity of limbs of trees were heaped up and grown together, and many immense hills and cliffs of rocks were there; thence they went in a southwardly direction [perhaps between Beaver Creek and South Fork], and coming to the South Fork of the Cumberland, they turned down it some distance, and crossed it; they soon came to an open country called barrens, to a place since called Price's Meadow, in what is now called Wayne County, six or seven miles from the place where Wayne court-house now stands; there they made a camp, and agreed that they should deposit at it all the game and skins that they should get, the place being in an open country, near an excellent spring... They agreed to return and make their deposits at the end of every five weeks. They dispersed in different directions, to different parts of the country, the whole company still traveling to the southwest. They came to Roaring River and the Caney Fork, at a point far above the mouth, and somewhere near the foot of the mountains [Cumberland Plateau]. All the country through which these hunters passed [the eastern Highland Rim] was covered with high grass, which seemed inexhaustible; no traces of any human settlement could be seen, and the primeval state of things reigned in unrivaled glory; though under dry caves, on the sides of creeks, they found many places where stones were set up, that covered large quantities of human bones. They also found human bones in the caves, with which the country abounds. They continued to hunt eight or nine months, and part of them returned on the 6th of April, 1770."

In 1775, Felix Walker took the "Wilderness Road" into Kentucky, which divided at Hazel Patch, he taking the northern route to Boonesborough. After crossing the Rockcastle River (near modern Livingston), Walker noted: "On leaving that river, we had to encounter and cut our way through a country of about twenty miles [eastern Rockcastle Co.], entirely covered with dead brush, which we found a difficult and laborious task. At the end of which we arrived at the commencement of a cane country, travelled about thirty miles through thick cane and reed [Rockcastle Co. to Madison Co.], and as the cane ceased, we began to discover the pleasing and rapturous appearance of the plains of Kentucky [northern Madison Co.]..."

About the same time, in April 1775, William Calk made a journal of his travels along the Wilderness Road. Between the Cumberland Gap and the Bluegrass region he noted the following features of the vegetation.

Approaching mouth of Richland Creek (with future Barbourville): "tuesday 11th this is a very loury morning & like for Rain But we all agree to Start Early we Cross Cumberland

River & travel Down it about 10 miles through Some turrabel Cainbrakes as we went down"

Between Laurel and Rockcastle River: "fryday 14th this is a clear morning with a Smart frost we go on & have avery mirey Road and camp this Night on a creek of loral River & are Surprisd at camp By a wolf"

Approaching Rockcastle River from Hazel Patch: "Satterday 15th clear with a Small frost we Start Early we meet Some men that turns & goes With us we travel this Day through the plais Cald the Bressh & cross Rockcase River & camp ther this Night & have fine food for our horses" [perhaps cane].

The latter note, about "Bressh" [brush] south of the Rockcastle River, adds to Felix Walker's "twenty miles, entirely covered with dead brush" that was recorded north of the river. Or was Walker's recollection

In a northern section of the Appalachian Plateaus, at the head of the Licking River drainage, there is an historical account of a native settlement:

<u>Joshua McQueen</u>: 1840s interview reported in L. Draper. ca. 1851, Draper Manuscripts in the Archives of the Wisconsin Historical Society, Madison. Vol. 13CC, p. 121. In 1779-82: "Some little reed cane grew up in the Mingo bottom [perhaps Johnson County] and some few buffalo strayed up that way. Two were killed up against the Mingo bottom. But they were very seldom ever there. Think there were more cattle in Kentucky, at its 1st settlement, than there is now. Roads at the Blue-Licks were 40 yards wide, and that for a distance. Many a man killed a buffalo, just for the sake of saying so. Indians had formerly lived in the Mingo bottom. All a prairie, to the back part of it."

James Wade related how in 1793 a woman was killed on a forced march from Morgan's Station, now perhaps in western Bath County (Hogan 1991):

> "...just above the head of Little Slate we found Mrs. Becraft and her suckling child 'six or eight months old' lying tomahawked. It was a very plain case. They had marched her that far in her shift, as was visible from the scratches and marks on it from a burnt wood they had passed through. And there she had given out."

Arnow (1960), based in Pulaski County (Burnside), compiled pieces of local history from the central Cumberland River drainage and nearby that suggested the follow scene:

> "park-like...[forests]...with so little undergrowth a traveler could see a deer for 150 paces. There were, too, along the creeks and rivers, treeless glades and valleys, sometimes with filled with cane...or only high grass..."; she also noted "orchards of old [presumably crab] apple trees".

Edwards (1970) also compiled early local descriptions about 1775 in Wayne County, which extends from the margin of the Cumberland Plateau into the Highland Rim, just west of Arnow's area:

> "Three-fourths of the county was covered with virgin forests; the lowlands contained some cane, or tall grass as they preferred to call it [perhaps *Andropogon gerardii*]... Price's Meadows [initially called the Big Meadow], near the mouth of Meadow Creek, contained very high grass. Corn could be planted without the forests being cleared."

A few accounts from the Cumberland Plateaus during the period of early contact were collected and summarized by DeSelm (1992).

Williams (1937): from the 1500s onwards the Cherokee were an important force in the

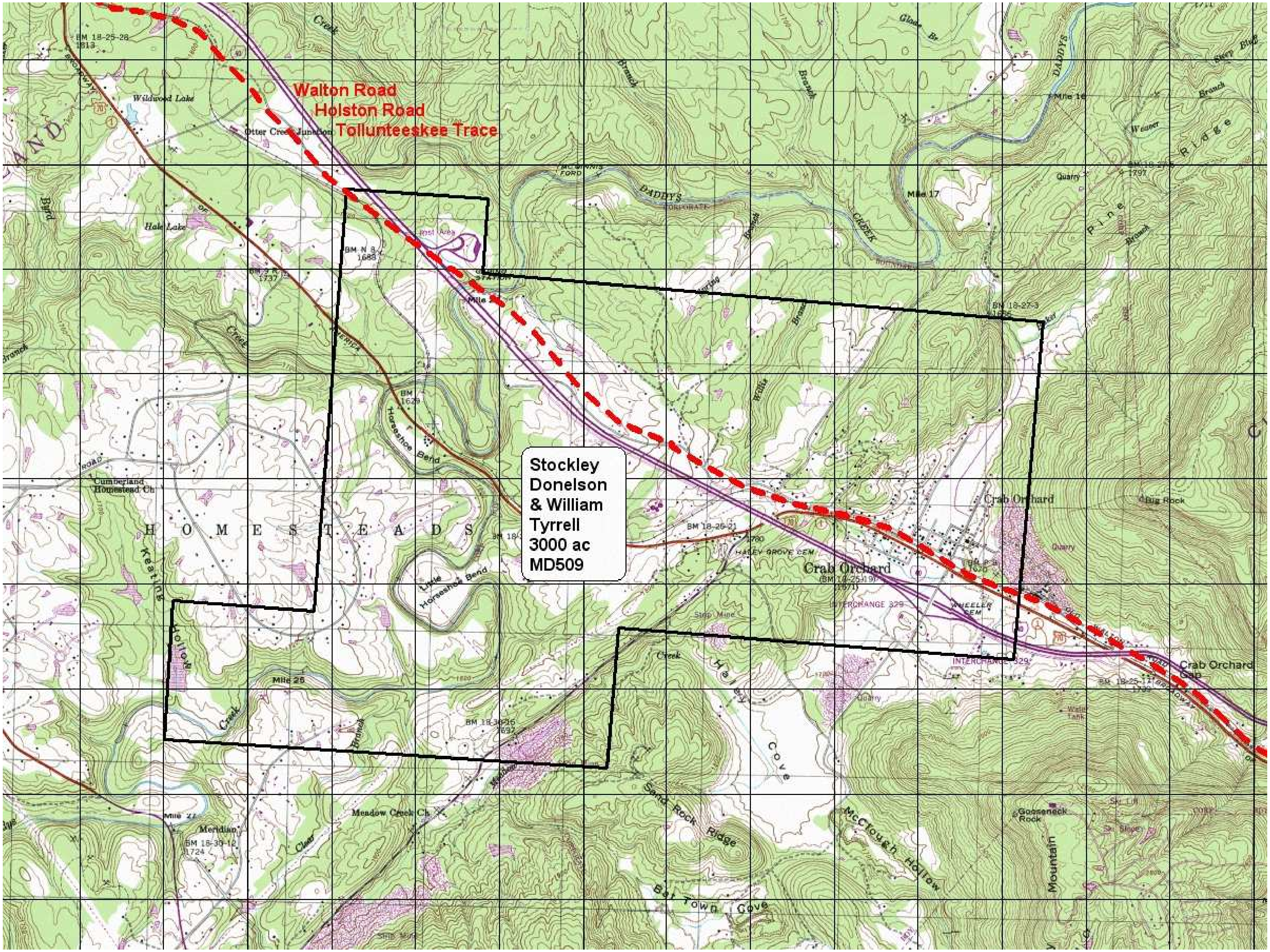
area and by about 1714 had induced the last of the Shawnees to leave Middle Tennessee; the Cherokee and other tribes used the area for hunting.
Folmsbee et al. (1969): area released to white settlement in various treaties from 1805 to 1819; settlement proceeded rapidly, with clearing and farming at least on deeper soils of gentle topography; see also Table 3.
Wirt (1954) stated that squatters had claimed land on the plateau by 1786 and held it by "tomohawk rights"

DeSelm (1992) included the following accounts that suggest open grassy areas did occur on the less rugged uplands of the Cumberland Plateau in Tennessee.
Ramsey (1853): apparently referring to a specific area on the plateau at the time of settlement: "The top of the mountain is described as being then a vast upland prairie, covered with the most luxuriant growth of native grasses."
Bailey (1856): travelers on the road to Nashville, at Crab Orchard [Cumberland Co.], saw: "a plain or natural meadow".
Steiner & De Schweinitz (cited in Williams 1928), also near Crab Orchard, noted: "a great level plain for the most part denuded with wood and overgrown with grass".
Krechniak & Krechniak (1956): stated that when early settlers saw Grassy Cove [Cumberland Co.], it too was covered with grass as high as the horses' heads.

Further east, in the Ridge and Valley region of Virginia and West Virginia, extending to the New and Kanawa Rivers, Maxwell (1910) reviewed evidence that historical Indian settlements were recognized by early explorers and that extensive grasslands or savannas were maintained by fire of human origin. He stated that the Shennandoah Valley of Virginia, when first seen by Europeans, was treeless for its entire length.

Next page: map of Crab Orchard area from Map Cumberland Pioneers project.
[At http://www.cumberlandpioneers.com/craborchard.html; added here in Jan 2016.]
The original survey has the following text [see website for image of original]: "Stockley Donelson & William Terrell - 3000 Acres including a place known by the name of Crab Orchard, Entry 456 Entered June 1784, Grant 305 Issued 17 March 1795, MD509. Territory of the United States of America South of the River Ohio, Middle District. In pursuance to a warrant that was previously entered No. __ and bearing date the __ of __ I have surveyed for Stockley Donelson and William Tyrrell assignee of Daniel Baldridge three thousand Acres of land lying and being in the District aforesaid a place Known by the name of Crab Orchard and being on both sides of the Waggon Road Leading from South West Point to Nashville. Beginning on Black walnut marked WT [NE corner] runing West 800 poles to a Stake & pointers thence North 100 poles to a Stake & pointers West 200 poles to a Stake & pointers South 640 poles to a Stake & pointers West 200 poles to a Stake & pointers South 200 poles to a Stake & pointers thence East 640 poles to a Stake & pointers North 200 poles to a Stake & pointers East 566 poles to a Stake and pointers & from thence North to the Beginning. Surveyed July 18th Day 1795. By William Terrell and William Lytle S.C Carriers [?], Stockley Donelson D S."

The webpage states: "This was the same Road which Robert King was contracted and paid for construction by Davidson County on July 15th 1788. This same path, trace or road would have been originally the Tollunteeskee Trace and would be later known as the Walton Road in about 1800. Stockley Donelson knew the entire area perhaps better than many others in what would become the state of Tennessee the following year. The word "Avery" was not used here nor in any of the North Carolina Land Grants which numbered upwards of 16,000." It is remarkable that except for a black walnut at the northeast corner, all of the other nine corners were marked by stakes. This indicates that the area was largely grassland or brush.


Walton Road
Holston Road
Tollunteeskee Trace
Stockley
Donelson
& William
Tyrrell
3000 ac
MD509
Crab Orchard
Crab Orchard Gap
H O M E S T E A D S
Otter Creek Junction
Wildwood Lake
Hale Lake
Cumberland Homestead Ch
Horseshoe Bend
Little Horseshoe Bend
Haley Grove Cem
Wheeler Cem
Interchange 329
Big Rock
Gooseneck Rock
Meadow Creek Ch
Meridian
Sand Rock Ridge
McClough Hollow
Bat Town Cove
Haley Cove
Pine Ridge
Daddys Creek
Mile 25
Mile 17
Quarry
Strip Mine

Observations after settlement: 1795-1900. The following notes on the southern Cumberland Plateau were largely compiled by DeSelm (1992); see also Thwaites (1904) for details of the journals provided by Andre and Francois Michaux.

Putnam (1859): in 1795 a wagon road was opened from Knoxville to Nashville.

A. Michaux (1796): on the Cumberland Plateau between Nashville and Knoxville. "The land through which these rivers flow is less fertile than the territory of Nashville or Cumberland settlement and two-leaved Pines are found there in abundance."

F.A. Michaux (1802): along the same route as his father. "In this part of Tennessea the mass of the forests is composed of all the species of trees that belong more particularly to the mountainous regions of North America, such as oaks, maples, and nut trees. Pines abound in those parts where the soil is the worst. What appeared to me very extraordinary was, to find some parts of the woods, for the space of several miles, where all the pines that formed at least one fifth part of the other trees were dead since the preceding year, and still kept all their withered foliage. I was not able to learn the causes that produced this singular phenomenon. I only heard that the same thing happens every fifteen or twenty years." [This observation was presumably the result of bark beetles.]

Killebrew et al. (1874): forests were grazed and the understory burned in spring to increase forage growth; he noted spread of open land after settlement, with regular burning and grazing by cattle and sheep; in Cumberland and Van Buren Counties, areas were described as "small prairies, destitute of timber and covered with course, rank grass."

Sudworth (1897): "A third very interesting forest condition of Middle Tennessee is comprised in the plainlike stretches of heavy clay and gravel or sandy soils, such as may be seen in parts of Coffee and Warren Counties and on the Cumberland Plateau. ... The soil conditions of these districts are scarely improved by the presence of the chief species of black-jack; for, although the stand of trees is often several hundred to the acre, apparently sufficient to shade the ground, almost everywhere a heavy growth of wild grasses covers the ground, as the narrow, dense crowns of the black-jacks nowhere form a continuous soil cover. The hot sun—for it is occasionally hot in Tennessee—quickly evaporates all the soil moisture, and the open growth allows the sweeping winds to drive the falling leaves from their legitimate purpose of forming a soil-improving humus."

Sudworth (in Sudworth & Killebrew 1897, p. 11-12): "The adaptation of this pine [*Pinus echinata*] to the poor, dry hill and other slope lands of East Tennessee is truly remarkable as seen in some localities. The old-school theories of the great care and nursing necessary to reestablish a pine-forest on entirely denuded land are quite upset when one sees thousands of short-leaf pines in dense stands steadily taking possession of old pastures and abandoned fields and quite without any foregrown nurse trees of the broad-leaf kind. Even under the damaging influence of trampling cattle and invading fire this young stock has gradually advanced. Solid phalanxes of saplings and middle-sized trees now form a large part of the second-growth woodlands attached to farms, together with oaks and other hard woods."

Ibid (p. 14): "Much of this pine [*Pinus strobus*] is already old, in some localities has ceased to grow, and on one or two tracts I saw the best timber was rapidly dying. The peculiar soil conditions under which white pine grows in Tennessee points very strongly to an age limit of from one hundred and fifty to about two hundred years of profitable growth. Approaching these limits, then, there are general signs of ceasing growth and final death, in no case due to natural enemies or accidental injuries. I recall

> now one tract of white pine in Johnson County where the timber stands in a broad alluvial valley of level and rolling land, where, at their age limit, thousands of big pines are dead and dying."

DeSelm (1994) cited other sources with similar material, and these should be reviewed further.

Sargent (1984) reported on forest fires on the Cumberland Plateau in Tennessee. He noted that most burning is done in February, presumably promoting spring growth for livestock. However, the burning also "destroys all natural fertility...kills valuable, young trees, and promotes long-term changes in the vegetation...The blackjack oak, post oak, black oak, etc., however, on account of the protection afforded by their thick bark, are able to gain some headway, and so crowd out more valuable trees".

In various regions of east-central U.S.A., there are sufficient historical data to show changes within forests from the pioneer or early settlement era to modern forests. Several studies have shown decreases in open grassy conditions and the most fire-tolerant trees (generally *Pinus echinata, P. rigida, Quercus stellata, Q. marilandica, Castanea dentata,* etc.), together with increases in less tolerant trees (generally *P. strobus, Q. alba, Q. rubra, Liriodendron, Acer rubrum, Fagus, Tsuga,* etc.), which can often be attributed to decreases in fire frequency (e.g., Fralish et al. 1991, Guyette & Cutter 1991, Cutter & Guyette 1994, Abrams et al. 1995, Fralish 1997, Cowell 1998, Bratton & Meier 1998, Campbell 1999, Abrams & McCay 1999, Harrod & White 1999). Results are sometimes inconsistent due to the various other types of disturbance that have occurred since settlement, but, especially within old-growth stands, these trends can be convincing. Although little quantitative analysis of this type has yet been conducted in the Appalachian Plateaus, there are many small pieces of evidence that can be used for an initial indication of trends in this region.

Forest and fire records 1900-2000. In describing pine-oak woodlands on ridges in the Cliff Section, Braun (1950:102) made the following statement: "Instead of this pine-heath or pine-oak community, some of the promontaries are occupied by open pine woods (the three species of pnie) with a grassy layer of *Andropogon scoparius* (little bluestem), *A. glomeratus* (broom-sedge), and *Sorghastrum nutans* (Indian grass), in ehich are scattered forbs... Fires have modified most (perhaps) all of these pine summits, although the abundance of large *Cladonia* mats is an indication there has been no fire for many years. The pine and pine-oak of the plateau margin are stable communities which can be considered as physiographic climaxes." On other sites, she noted: "...On more mesic sites, the variety of secondary communities in the Cliff Section seems infinite. Where disturbance has been slight, mixed forest prevails,...Slopes which have been completely denuded (and usually also subjected to fire) have fewer species..."

Sassafras and persimmon were locally abundant on the southern Cumberland Plateau in Tennessee, but these stands appear to have declined greatly today, due to forest succession and perhaps fire-suppression (G. Smalley, pers. comm.). Further west, during 1850-1950, sassafras and persimmon often were abundant in grassy openings where fire frequency was somewhat reduced. Dale Owen (1856) reported that on marginal hilly land [Girkin Formation], such as between the barrens and Mammoth Cave: "What little timber it supports is usually a scanty growth of scrubby post oak on the ridges; on the slopes, post-oak, sassafras, shumach, and white oak, with black gum towards the base." Carl Sauer (1927) noted: "The marginal areas of this soil, however, were occupied by cedar after a time, cedar being the most vigorous old-field growth, together with sassafras and persimmon, both also found on such sites, and therefore the vanguard of the forest." In the 1930s. the Society of American Foresters recognized a "sassafras-persimmon" forest type that was widespread in old fields of the Mississippi Valley and elsewhere in the southeast. But today, this type is rarely seen in extensive tracts. Instead, cedar, pine, tulip, ash, maple, etc., are often the dominant species in young forest, although sassafras and persimmon may still be locally abundant along more stable forest edges.

D. Taylor (DBNF, pers. comm.) conducted some interviews with older residents in ca. 1990, which were summarized by Campbell et al. (1991) as follows: “Until DBNF was established in 1930-40, intentional fires were widespread, except perhaps for a few decades before 1910, when the Kentucky Landsharers Association had control over much land and restricted burning. Annual fires continued in much of the area during 1910-30. They were generally set in February and March to promote grass and forb growth for cattle. Also, hogs ran in the forest, with about 0.5-1 per km^2, and many became feral. In some years, a second set of fires were set in October or November “to keep the woods open”. Fires were generally started along roadsides on ridges and allowed to burn without control, unless property was threatened. In general, ridgetop forests contained much *Quercus coccinea* (ca. 50-60 cm dbh), *Q. velutina* and *Pinus echinata*, with scattered *Q. alba* (to 100 cm dbh) and *Liriodendron*. Most woody understory on ridges was removed, except for scattered *Quercus* spp. and *Liriodendron*, creating some savanna-like areas. The ground cover of blueberries and other low ericaceous shrubs, grasses and forbs was much thicker than today. Pink ladies’ slippers (*Cypripedium acaule*) were more frequent, but yellow ones (*C. pubescens*) were reduced by fire. Composites were more frequent, though concentrated along roads. Birds were generally more numerous, though wild turkey, like deer, had been much reduced by hunting.”

Campbell et al. (1991) continued: “By some accounts, fire would generally stop near the top of east and north slopes, but it would creep down west and south slopes, creating a scrub forest with such species as *Pinus rigida, Quercus marilandica* and *Kalmia latifolia*. However, by other accounts, the fire would often be blown onto east slopes by prevailing winds, and it would seldom move down west and south slopes. Accounts agree that north slopes seldom burned and often had thick understories of *Acer saccharum* and *A. rubrum* below canopies of *Liriodendron* and *Quercus* spp... Acquisition of land by USFS began about 1933, bringing with it suppression of fire. Burning for forage generally stopped about 1945, though arson increased after 1970. All accounts agree that pine is more common today than 40-60 years ago. Abandoned fields and open woods grew back with much pine and *Liriodendron*. However, soils on or near ridgetops were often so worn-out [or with thin, rocky soils initially] that only scrub trees, mostly pines and oaks, grew back, and were called "barrens". Fire [had] not generally [been] set in this scrubby vegetation, which did not burn well. Remaining barrens of this type have much lichen (*Cladonia*) today, suggesting fire exclusion." Such sites may, however, accumulate large amounts of flammable, brushy fuel that can eventually support intense fires.

Martin (1989) has summarized much information on fire history in Daniel Boone National Forest, which probably represents the Appalachian Plateaus relatively well. In addition to exploring the limited evidence for presettlement fires, he dealt with patterns in post-settlement land use. Iron-furnaces and railroads probably provided some early industrial sources of ignitions. During the late 1800s, logging became intense in Appalachian regions, often followed by burning of slash and associated land clearance. Surveys of forests, logging and fires became organized by state governments. In 1880, ten large fires burned 556,000 acres in Kentucky, much being caused by land clearance (Sargent 1884:491) [to be checked for state government archives and other original sources]... The period 1870-1920 saw the most intensive logging of forests in eastern Kentucky and elsewhere in southern Appalachian regions (Clark 1984). There are several historical and oral accounts of settlers frequently burning some areas of open woodland, in order to increase forage for livestock and for slash and burn farming. Such practices continued into the 1920s or 1930s (Otto 1983).

To quote Martin (1989, p. 47): “As the DBNF was being formed in the 1930s, the widespread occurrence of forest fires was an accepted way of life (Collins 1975). Public attitude not only tolerated forest fire, but many people believed that annual burning contributed to the health of the community, reduced the density of tick and chigger populations, and, at the same time, killed back the hardwood sprouts that competed with grass (Collins 1975, Clark 1984). Appalachian states mande only feeble attempts to regulate burning durinng this century. Kentucky’s first fire protection laws were enacted in 1831 but they were weakly enforced (Wodner 1968).”

Martin (1989) determined that lightning caused only ca. 2% of the fires recorded during 1936-89 in Daniel Boone National Forest. Lightning fires have occurred with an annual rate of less than 5 per million acres. They have usually occurred at a steady low rate from March to October, except for a pronounced peak (10/19 fires) in April. In general, late April and May may be a peak period within southern Appalachian regions, and the frequency may increase to the south. Barden & Woods (1974) reported a frequency of 6 lightning ignitions per million acres in the Great Smoky Mountains and nearby National Forests. In the Chattaooga watershed of western North Carolina, Bratton & Meier (1998) reported lightning ignition rates of 14 per million acres at lower elevation and less than 3 per million acres at higher elevations. In general, vegetation tends to burn less intensely during the growing season than during the dormant season. But in heavy fuel loads of woody debris and flammable brush, fires may be very intense after droughts and on drier topographic sites. From DBNF data, ca. 90% of lightning fires have occurred on S/W-facing slopes or on well-defined ridgetops (Martin 1989). Although almost all of these fires have been contained to less than 100 acres, it is estimated that one of them would have burned ca. 6000 acres without suppression (a 1987 fire on Stanton District).

Martin (1989) also reported on many details of the predominantly arson-caused fires on Daniel Boone National Forest. However, data were incomplete in some districts, and there may be difficulties in applying reults to the Big South Fork area. Selected statistics are reproduced here (Figure 3a-b;Table 2a-g).

SOIL DATA, FIRE SCARS AND DENDROCHRONOLOGY

Several studies in the region have examined soil samples for patterns in charcoal and phytoliths (characteristic silica bodies produced by grassland species) that might indicate fire and vegetation history. However, there have been technical difficulties (e.g., P. Kalisz in Campbell et al. 1999). Welch (1999) found that charcoal was widespread in yellow pine stands of the Southern Appalachians, with no relationship to slope position. Cook (2000) used soil charcoal to help indicate fire history difference between white pine-oak stands (10-20% of 8x8 cm quadrats) with red oak-maple stands (none found). S. Horn (Univ. of Tennessee, Dept. of Geography, pers. comm.) has proposed that more intensive sampling and broader comparisons could still provide much general information of value in interpreting vegetation history at the landscape level.

Several studies in Appalachian regions and elsewhere in the Central Hardwood Regions have cored old oaks and pines to examine relationships between growth rates, fire-scars and environmental history. These have confirmed the historical records of sharp increases in fire frequency during the industrial logging boom of 1870-1920, and there may have been widespread peaks ca. 1790-1840 and 1670-1730 as well (e.g., Abrams et al. 1997, Abrams 2000). Establishment of the trees (with pines sometimes followed by oaks) has often peaked during pyric periods, and growth rates have tended to peak at the end of each period. These peaks have been interpreted in terms of gradually reduced competition from mesophytes due to the fires. In many cases, individual fire years were followed by ca. 4 years of higher growth. However, climatic fluctuations are involved as well (e.g., Clark & Royall 1995; Abrams et al. 1997, Abrams 2000).

Such relationships in forests may be quite different in different environments with different fire histories. In one study, establishment of old white oak showed no relationship with fire-scars (McCarthy & Rubino 2000). In more open grassy areas with frequent fire, white oak may establish more during reductions in fire (e.g., 1850-90 and 1910-40 in SE Ohio: McClenahen & Houston 1998). Most pine and oak trees (as well as fire-intolerant species) on xeric sites in the western Great Smoky Mountains established after fire reduction began ca. 1920 (Harmon 1982).

Details of these dendrochonological studies can also help to suggest typical fire intervals for maintenance of different forest types, as discussed below in Appendix 3. It would be useful to study with abundant shortleaf pines that have died at Big South South Fork, since these would probably have datable fire-scars up to ca. 200 years old. Also, they might reveal relationships between fire frequency and topography. R. Emmott (pers. comm.) has observed a reltively high frequency of fire scars on ridges dominated by pines. Experience of other regions has shown that old red cedars, shortleaf pine and post oak are generally the most effective species to focus on for records of fire-scars (e.g., Meier & Jobe (1999), Masters et al. (1995), Guyette & Day (2000).

SPECIFIC RECORDS FROM BIG SOUTH FORK AREA

Vegetation data. Early deed data (E. O'Toole, National Park Service, pers. comm.) from Big South Fork area (excluding Little South Fork drainage) indicate that overall pre-1850 most frequent (> 5%) recorded trees were *Quercus alba* ("white oak", 20.3%), *Fagus grandifolia* ("beech", 9.5%), *Q. velutina* ("black oak", 9.2%), *Acer saccharum* ("sugartree", 6.7%), *A. rubrum* ("red maple", 6.5%), *Carya* spp. ("hickory", 6.5%), *Tsuga canadensis* ("hemlock", 6.2%), *Liriodendron* ("poplar", 5.6%), *Nyssa sylvatica* ("gum/blackgum", 5.4%), and *Castanea dentata* ("chestnut", 5.0%). *Pinus* spp. were not generally abundant (3.2%), but now they are probably much more common, presumably doe to disturbances from farming, grazing and fire.

The subset of pre-1850 deed data from the Blue Heron bottomland area indicate that the most frequent species there were *Fagus* (31.1%), *Acer saccharum* (20.3%), *Tsuga* (16.2%), and *Q. alba* (6.8%). However, transects in this area surveyed in 1996 indicate that most frequent species currently are *Liriodendron* (17.4%), *Fraxinus* spp. (11.3%), *Liquidambar* (10.5%), *Fagus* (9.7%), *Tsuga* (7.3%), and *Acer rubrum* (6.1%).

Pre-1850 deed data from the adjacent Little South Fork drainage indicate that the most frequent species (n = 80) there were *Quercus alba* (17.5%), *Q. velutina* (12.5%), *Carya* spp. (12.5%), *Juniperus* (12.5%), *Acer saccharum* (8.8%), and *Liriodendron* (7.5%). Plot data from 1996 indicate that the most frequent species (n = 107) are *Q. alba* (18.7%), *Acer saccharum* (10.3%), *Juniperus* (9.4%), *Liriodendron* (8.4%), *Pinus* spp. (7.5%), and *Fagus* (6.5%). Note that Delcourt & Delcourt (1999) also found much *Juniperus* in presettlement pollen samples from Curt Pond (Pulaski Co.), in a similar Highland Rim transition, and relatively little Pinus.

Rogers (1941) noted several plant species in “a moist flat of pine-oak barrens” along the road to Bauer, in northern McCreary County about five miles northeast of Yamacraw: *Salix humilis* (vars. *humilis* and *microphylla*), *Hypericum punctatum, Eryngium yuccaefolium, Liatris scariosa* (= *L. squarrulosa*?) and *L. spicata*. Also near the Bauer Road, he noted several species typical of openings or edges in “woods” or other habitats noted in following list: *Andropogon gerardii* (“common”), *Robonia hispida, Lespedeza virginica, L. capitata, Polygala verticillata, Oxypolis rigidior, Angelica venenosa, Cuscuta campestris, Solidago caesia, Aster patens* var. *phlogifolius* and *A. solidagineus; Pycnanthemum pycnanthemoides, Helianthus hirsutus* and *Coreopsis major* var. *stellata* (“dry woods”); *Anemone virginiana* (“dry pine-oak woods”); *Lobelia puberula* (“wet woods”); *Lilium philadelphicum* (“common alomg road”); *Coreopsis tripteris* var. *deamii* (“by the road”); *Hypericum frondosum* (“low moist shaley soil in open thicket”).

Rogers (1941) also noted *Helianthus atrorubens* in “pine-oak barrens at the Tennesee State line”. This is about 2 miles south of “Wherry’s Bog”, where characteristic or rare plants of native grassland were collected in the 1930s: *Calamagrostis coarctata, Calopogon tuberosus, Helianthus atrorubens, Lobelia nuttallii, Platanthera integrilabia, P. cristata, Polygala cruciata, (?Polygala lutea), Vernonia noveboracensis*, etc.

During the 1980s and 1990s several remnants of native grassland have been documented in McCreary County, especially along rights of way on broad ridges between the South Fork amd Cumberland River drainages (Palmer-Ball et al. 1988, Campbell et al. 1991, Jones 1989; and East Kentucky Power Cooperative, unpublished data).

Note that recent field notes on vegetation, and all other available data, have been filed according to vegetation type, and are available for ground-truth in vegetation mapping, and for better descriptions of these types. They have been an essential resource for this project.

Fire Data. The park's fire records begin about 1978. [Other records and local fire knowledge may be housed at Pickett State Park and Forest (Ken Avery). see also records of Stearns Lumber Company, Bowater Company, etc.] During 1980-1989, complete records have not been gathered, but probably well over 2000 acres burned, mostly in a single incident covering ca. 1854 acres in 1987. During 1990-1999, during NPS management, some 23 wildland fires were documented and suppressed on NPS lands, covering ca. 532 acres. In 1998, there was a late winter snowstorm--the worst im memory of many older residents--and this damaged many conifers, leaving large amounts of fuel. The year 2000 was unusually dry, and in the fall there were three large fires; one with about 2000 acres on NPS land (N); one with 500-600 acres on NPS land (SC); and one, determined as an arson, with about 3000 acres, only partly on NPS lands (SW). However, about 75% of the fires documented by the park have covered less than 20 acres.

Note that recent fires have mostly been caused by arson or careless accidents. They have often started in low old fields, campsites and other human activities on lower slopes, which may be opposite of presettlement patterns. Fires on coal bars along rivers can burn for months or years; these should be reported but sometimes are not. Another unusual focus for ignitions may be oil wells, where volatiles can accumulate; there are oral histories indicating the potential for even lightning to ignite some of these sites (S. Bakaletz, perc. comm.). Natural oil seeps have been reported at a few sites.

Some 12 several prescribed fires, totaling ca. 600 acres, have been conducted by the park during 1991-96 for the purpose of fuel reduction along some of its boundaries, for RCW habitat restoration and for establishment of native grass plantings.

There is a need for further research in archives of fire records, and synthesis of miscellaneous data, to provide a better picture of the fire history in this region. Sources could include the following:

More detail from Big South Fork itself (the files may not be complete)
DBNF data on wild fires and prescribed fires; also old stand data
State records for KY and TN; especially forestry archives
McCreary County records: library, newspapers, etc.
Oral histories

APPENDIX 3: VEGETATION CLASSES AT BIG SOUTH FORK AND REGIONAL REVIEW OF FIRE EFFECTS

The following 12 vegetation classes are outlined in the main text, and Figure 6 diagrams their relationship to major gradients in moisture regime. In codes for individual vegetation types, the letters A-E are appended to the basic class number (1-12).

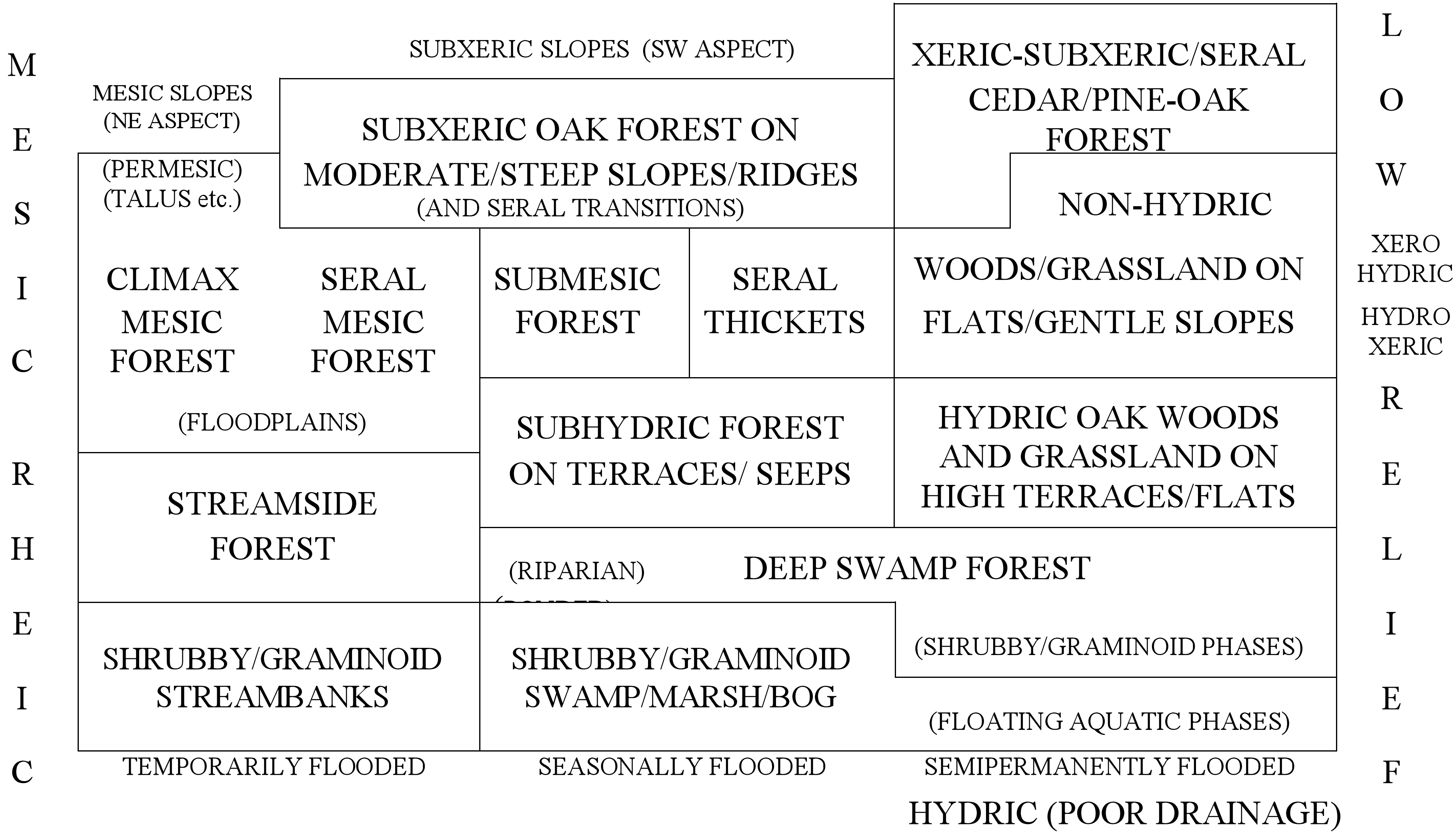
A = typical of infertile soils with low base status (pH ca. 3.5-4.5)
B = transitional between A and C (or complex mixture)
C = typical of moderately fertile soils with moderate base status (pH ca. 4.5-6)
D = transitional between C and E (or complex mixture)
E = typical of moderately or highly fertile soils with high base status (pH. ca. 6-7.5)

Final numerical extensions refer to variants in moisture regime, as detailed in Campbell (2001a).

In the notes on examples cited for each type, trees are listed in approximate descending order, if this is evident in the source, and brackets [ ] indicate common understory species.

"JC/BSF" numbers refer to field notes by J. Campbell during field work at Big South Fork, mostly in 2000.

Figure 6.1. Generalized summary diagram showing broadly defined ecological formations in relation to moisture regime.*



* This diagram is based on a two dimensional project of major compositions gradients emphasizing independent “wetness” and “dryness” factors; habitat notes at margins only apply to adjacent boxes, not the two-dimensional gradients; the third major gradient, not shown here, is related to soil fertility, pH, etc.; vegetation-habitat relationships indicated here are loose in many cases; most forest types can occupy a range of habitats, but an attempt is made here to characterize the most typical average conditions.

Figure 6.2. Generalized summary diagram showing major natural vegetation types at Big South Fork in relation to moisture regime.

XERIC (EXCESS DRAINAGE)

ROCKY/ERODED UPLANDS

M		SUBXERIC SLOPES (SW ASPECT)			VA PINE ① (OR CEDAR)	SHRUB/GRASS ROCKYGLADE	L
E	MESIC SLOPES (NE ASPECT)	WHITE OAK N RED OAK	CHESTNUTOAK OR WHITE OAK	SCARLET OAK* OR BLACK OAK	PINES OAKS ①	PINE/CEDAR BJ/POST OAK	O
S	(talus) buckeye, basswood, etc.	N RED/WH OAK BE/HE/SM	WHITE OAK (S RED OAK)	S RED OAK * (WH/POST OAK)	SHRTLF PINE * OAKS	blackjack oak- post oak/grassland	W
I	N RED/W OAK BE/HE/SM etc.	TULIP POPLAR* N RED OAK ③	WHITE OAK, GUMS, RM etc.	DRY BRUSHY * TRANSITIONS②	S RED OAK * POST OAK	open post oak woods/grassland	XERO HYDRIC
C	BEECH/HEML./ SUGAR MAPLE	TULIP/BIRCH/ * WH ASH etc. ③	BEECH, GUMS RED MAPLE etc.	WET BRUSHY * TRANSITIONS②	UPLAND OAKS* RED MAPLE etc.	open upland oak woods/grassland	HYDRO XERIC
	FLOODPLAIN BE/HE/SM	TULIP/BIRCHES /ASHES etc. ④	RED MAPLE etc. GUMS, BEECH	RM/GUMS/ GREEN ASH	wetland oaks rm/gums/gr ash	open wetland oak woods/grassland	R
R	RIVER BIRCH SYCAMORE	TULIP POPLAR SYCAMORE ④	gums/red maple/ gr ash/sycamore	absent	absent	absent	E
H	SHRUBBY TRANSITIONS	(SILVER MAPLE)	transitions	absent	absent	absent	L
E	GRASSY etc. COMPLEX	SHRUB/GRAM. COMPLEX	shrub/graminoid complex	absent	absent	absent	I
I	STREAM BANKS	SEDGE etc. COMPLEX	sedge etc. complex	absent	absent	absent	I
C	TEMPORARILY FLOODED		SEASONALLY FLOODED		SEMIPERMANENTLY FLOODED		F

HYDRIC (POOR DRAINAGE)

Lower case = minor types; BE = beech; HE = hemlock; SM = sugar maple; RM = red maple; etc.
Typical old field succession begins at following numbered positions:
① xeric/eroded sites; ② subxeric/submesic sites; ③ mesic upland sites; ④ mesic floodplain sites.
* White pine is also locally abundant in old fields and decadent pine/oak stands.

Figure 6.3. Generalized summary diagram showing relationship to flooding and hydric conditions*.

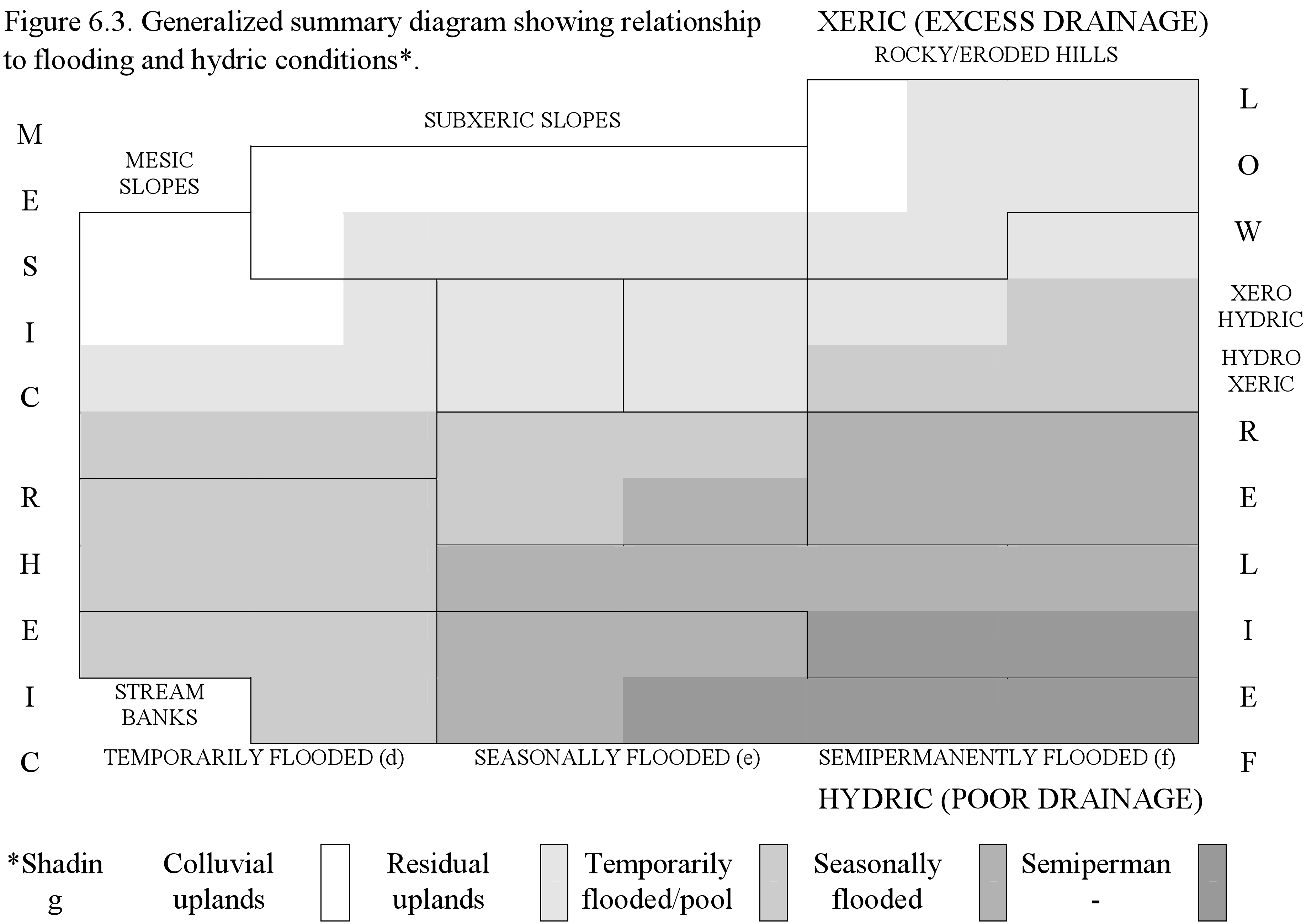


Figure 6.4. Generalized summary diagram showing relationship of vegetation classes to drought stress and xeric conditions*.

XERIC (EXCESS DRAINAGE)

ROCKY/ERODED UPLANDS

SUBXERIC SLOPES

M					XERIC	EXTREME XERIC	L
E	MESIC SLOPES	SUBXERIC -MESIC	SUBXERIC	SUBXERIC (-XERIC)	XERIC- (SUBXERIC)	XERIC	O
S	MESIC CLIFF/TALUS	SUBXERIC -MESIC	SUBXERIC -SUBMESIC	SUBXERIC (-SUBMESIC)	SUBXERIC (-XERIC)	XERIC	W
I	MESIC- SUBXERIC	MESIC- SUBXERIC	SUBMESIC (-SUBXERIC)	SUBXERIC (-SUBMESIC)	SUBXERIC (-SUBMESIC)	SUBXERIC- XEROHYDRIC	XERO HYDRIC
C	MESIC	MESIC	SUBMESIC (-SUBHYDRIC)	SUBXERIC (-SUBMESIC)	SUBXERIC (-SUBMESIC)	SUBXERIC- HYDROXERIC	HYDRO XERIC
	MESIC RIPARIAN	MESIC RIPARIAN	SUBHYDRIC -SUBMESIC	SUBHYDRIC -SUBMESIC	SUBHYDRIC -HYDRIC	HYDRIC -HYDROXERIC	R
R	RIPARIAN	RIPARIAN -SUBHYDRIC	SUBHYDRIC	SUBHYDRIC	HYDRIC- SUBHYDRIC	HYDRIC	E
H	RIPARIAN	RIPARIAN -SUBHYDRIC	HYDRIC- RIPARIAN	HYDRIC	HYDRIC	HYDRIC	L
E	SCOURED RIPARIAN	SCOURED RIPARIAN	SUBAQUATIC -RIPARIAN	SUBAQUATIC	DEEPLY HYDRIC	DEEPLY HYDRIC	I
I	STREAM BANKS	SCOURED RIPARIAN	AQUATIC -RIPARIAN	AQUATIC	AQUATIC	AQUATIC	I
C	TEMPORARILY FLOODED		SEASONALLY FLOODED		SEMIPERMANENTLY FLOODED		F

HYDRIC (POOR DRAINAGE)

* Brief explanation: xeric = dry enough to maintain open woods with red cedar, scrub pine or shrubs; subxeric = moderate, dry enough for oak dominance with little disturbance; xerohydric = with alternating dry summers/falls and wet winters/springs; submesic = intermediate conditions between mesic, xeric and hydric; mesic = with low enough stress to maintain sugar maple, beech or hemlock dominance; subhydric = somewhat poorly drained; hydric = poorly drained (anaerobic subsoils); riparian = generally well drained but floodplain.

Figure 6.5. Generalized summary diagram suggesting presumed relationship between vegetation classes and fire history*.

XERIC (EXCESS DRAINAGE)

ROCKY/ERODED UPLANDS

SUBXERIC SLOPES

MESIC SLOPES

M E S I C R H E I C

				weak	weak
	weak	moderate	moderate	moderate	moderate
rare	weak	moderate	moderate	mod-str	strong
rare	weak	moderate	mod-str	mod-str	strong
rare	weak	moderate	mod-str	mod-str	strong
rare	weak	weak	moderate	moderate	moderate
none	rare	rare	weak	weak	weak
none	none?	none	none	rare	rare
none	none?	none	none	none	none
STREAM BANKS	none	none	none	none	none

L O W

XERO HYDRIC

HYDRO XERIC

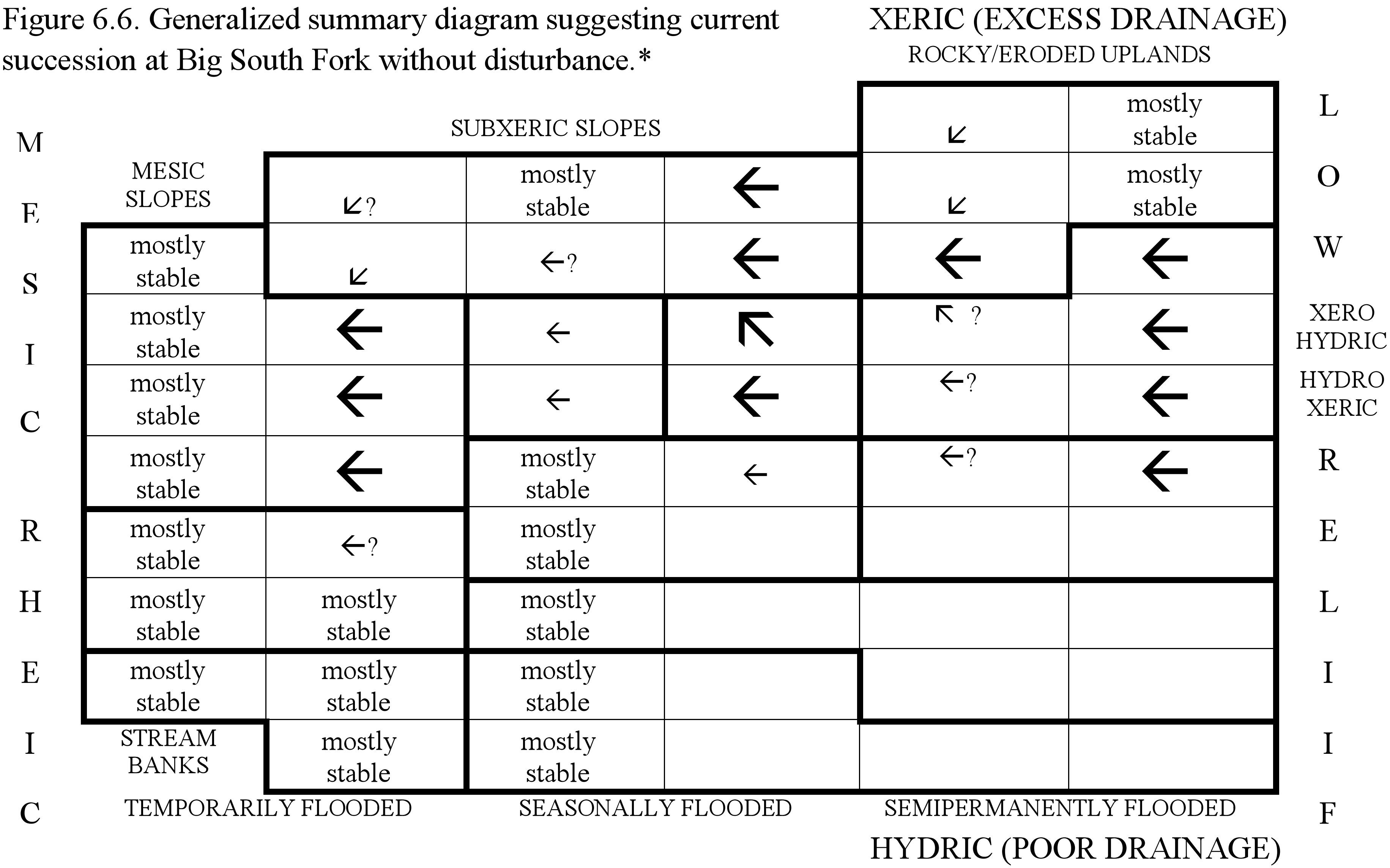
R E L I E F

TEMPORARILY FLOODED — SEASONALLY FLOODED — SEMIPERMANENTLY FLOODED

HYDRIC (POOR DRAINAGE)

* Estimated levels of significant effects before settlement: strong = much land burned with effects at ca. 1-5 year intervals; moderate = most land burned with effects at ca.. 5-50 year intervals; weak = most land burned with effects at ca. 50-100+ intervals; rare = most land not influenced by fire; none = no land influenced by fire.

Figure 6.6. Generalized summary diagram suggesting current succession at Big South Fork without disturbance.*



* Based on general knowledge of vegetation from field work and the literature: see Appendix 3 and Campbell (2001a). Large arrows indicate general directional change for most of the vegetation type (expected within ca. 10-100 years). Small arrows indicate partial, minor or slow changes (expected to take 100+ years for complete transition).

1. SHRUBBY OR GRAMINOID STREAMBANKS AND SHOALS:
Summary, Shrubby phases are often characterized by alder (*Alnus serrulata*); grassy phases, by big bluestem (*Andropogon gerardii*). Fire is generally unknown but possible in dry periods in late summer or fall, if ignitions occur from campsites, etc.

Examples and notes from central Cumberland Plateau

DeSelm (1992)/Daddys Creek: shrubby grasslands; *Alnus, Andropogon gerardii, Schizachyrium, Sorghastrum, Elymus glabriflorus, Pteridium*, etc.

Palmer-Ball et al. (1988): details provided from Rockcastle River.

Campbell et al. (1994): floristic details summarized from Cumberland River watershed.

Fire-dependence or sensitivity. Fire is generally unknown but possible in dry late summer or fall, if ignitions occur from campsites, etc. There have been a few ignitions of "coal-bars" where coal cobble accumulates.

2. SHRUBBY OR GRAMINOID SWAMPS AND PONDS:
Summary. Shrubby phases are often characterized by alder (*Alnus serrulata*); graminoid phases, by sedges (*Carex* spp.). Fire is probably insignificant except in unusually dry years, amd where surrounding hydric or non-hydric uplands have fire-maintained woodland or grassland.

Examples and notes from central Cumberland Plateau

Jones (1989): "shrub wetlands"; wetter extremes presumably include scattered small trees of *Acer rubrum, Nyssa sylvatica* and *Liquidambar*, plus much *Alnus serrulata*, *Cephalanthus occidentalis*, *Cornus* (*amomum, stricta*), *Itea virginica*, etc.

Jones (1989): "emergent wetlands"; wetter extremes presumably include *Glyceria striata, Carex crinita, C. gigantea, C. joorii, C. glaucescens, Cyperus flavescens, C. strigosus, Dulichium arundinaceum, Eleocharis* spp., *Scirpus* spp., *Juncus* spp., *Typha latifolia*, *Sparganium americanum*, etc.

Jones (1989): "vegetated unconsolidated shores"; *Proserpinaca* spp., *Myriophyllum pinnatum, Fimbristylis* spp., *Juncus debilis, J. repens, Eleocharis* spp., *Lindernia anagallidea, Gratiola viscidula, Rotala ramossior, Hypericum mutilum*, etc.

Jones (1989): "aquatic beds"; *Najas* spp., *Myriophyllum* spp., *Lemnaceae, Potamogeton* spp., *Brasenia schreberi, Nuphar lutea, Nymphaea odorata*, etc.

Fire-dependence or sensitivity. Fire is probably insignificant except in unusually dry years, amd where surrounding hydric or non-hydric uplands have fire-maintained woodland or grassland.

3. DEEP SWAMP FOREST:
Not typically present in the region.

4. STREAMSIDE FOREST:

Summary. Typical species are river birch (*Betula nigra*), sycamore (*Platanus*), and, in mesic or subhydric transitions, tulip (*Liriodendron*), sweetgum (*Liquidambar*), red maple (*Acer rubrum*), etc. Fire probably has played little or no role in this ecosystem type. Typical species mostly have low tolerance of fire.

Examples and notes from central Cumberland Plateau

4.1 Mesic/subhydric-tending

Caplenor (1965)/ravine: old fields; *Liriodendron, Liquidambar*, *Platanus, Carya cordiformis, Ulmus rubra, Juglans cinerea*; perhaps "moderate-high" base status.

Safely (1970)/ravine: "tulip-sweetgum" type; *Liriodendron, Liquidambar; Juglans nigra, Platanus, Betula nigra, Amelanchier arborea; Cercis, Fagus, J. cinerea*.

O'Toole (1996 data): Blue Heron W bank; *Liriodendron, Platanus, Betula, Ulmus; Liquidambar*.

4.2 Moderate-sized stream variants (typical of banks)

Safely (1970)/ravine: "river birch" type; *Betula nigra, Platanus; Liriodendron, Carpinus; Liquidambar, Fraxinus* spp., *Acer saccharum, A. rubrum, Q. alba*.

Hinkle (1978)/ravine: "river birch" type; *Betula nigra*; *A. rubrum, Carpinus*; *Liriodendron*.

Fire-dependence or sensitivity. Fire probably has played little or no role in this ecosystem type. Typical species mostly have low tolerance of fire.

Nelson & Sparks (1998) showed that on the broad floodplains of the Mississippi River, silver maple was apparently reduced partly by fire before settlement, allowing a more diverse plant community. However, in the relatively narrow floodplains typical of the central Appalachian Plateaus, it is likely that fire effects before settlement were much less.

5. MESIC FOREST

Summary. This class is typically on cool slopes, well-drained terraces and some moist uplands; it is potentially dominated by sugar maple, beech or hemlock, but many other species are locally abundant in disturbed areas. There was probably a low fire frequency and little effects before settlement, except for rare catastrophic fires. Typical trees mostly have low fire-tolerance (beech, sugar maple, birches, magnolias, buckeyes, basswoods, young tulip poplar, etc.) or moderate fire-tolerance (hemlock, white ash, northern red oak, bitternut hickory, older tulip poplar. etc.); the latter mostly occur in transitions to subxeric oak forest.

Examples and notes from central Cumberland Plateau

5A (low base status). *Tsuga canadensis-Betula* (*lenta, allegheniensis*) forest

Mesic alluvial
JC/BSF09; JC/BSF13; JC/BSF39?

Mesic mature
Caplenor (1965): "hemlock" type; *Tsuga*; *Oxydendrum, B. allegheniensis*, *Carya glabra.*
Hinkle (1978): "hemlock" type; *Tsuga*; *Liriodendron, Oxydendrum*, *B. lenta*.

Mesic disturbed
Caplenor (1965): "hemlock-yellow birch" type; *Tsuga, B. allegheniensis*; *Oxydendrum*, *Liriodendron, Tilia*.

Subxeric-tending
JC/BSF39 (part?)

5B. *Tsuga-Betula/Fagus-Liriodendron* transition
Mesic mature
Caplenor (1965): "hemlock-basswood" type; *Tsuga, Tilia*; *Acer saccharum, B. allegheniensis, Liriodendron.*
Safely (1970): "tulip-hemlock" type in gorges; *Liriodendron, Tsuga*; *Fagus, Acer saccharum, Q. alba*.

Subxeric-tending
Safely (1970)/ravine: "white oak-hemlock-chestnut oak" type; *Q. alba; Tsuga, Q. prinus, A. rubrum, Fagus*.
Hinkle (1978)/plateau: "hemlock" type; *Tsuga; Carya glabra, Q. alba, A. rubrum, Liriodendron*.

Subxeric-tending disturbed
Caplenor (1965): "mixed mesophytic" type; *Carya glabra, Tilia, Tsuga, Fagus, Liriodendron, B. allegheniensis, Oxydendrum, A. saccharum, Q. rubra, A. rubrum*.

5C (moderate base status). *Fagus grandifolia-Liriodendron tulipifera* alliances
Mesic alluvial (disturbed/subhydric-tending)
O'Toole (1996 data): Blue Heron Transect #1; *Liriodendron; Liquidambar, Fagus; Fraxinus americana, Acer rubrum*.
O'Toole (1996 data): Blue Heron Transect #2; *Fraxinus americana, Tsuga, Liriodendron,*

Ulmus spp., *Q. alba; Liquidambar, Acer rubrum, Fagus*.

Mesic (typical slopes)
Hinkle (1978): "beech-tulip" type; *Fagus, Liriodendron; Carya tomentosa, A. saccharum, A. rubrum, Fraxinus americana, C. ovata*.

Subxeric-tending
Safely (1970): "beech-white oak-sugar maple" type of [Jellico] Mountains; *Fagus; Q. alba, A. saccharum, Tsuga, Carpinus, Amelanchier*.
Hinkle (1978): "beech" type; *Fagus*; *Liriodendron, Q. alba, Q. rubra*.

Subxeric-tending disturbed
Hinkle (1978): "tulip-shagbark-northern red oak" type; Liriodendron*; Carya ovata. Q. rubra*.

5D. *Acer saccharum-Tilia/Fagus-Liriodendron* transition
Mesic alluvial (disturbed/subhydric-tending)
O'Toole (1996 data): Blue Heron E of RR; *Liriodendron; Liquidambar, Fagus; Fraxinus, Acer saccharum*.
O'Toole (1996 data): Blue Heron S of Center; *Fraxinus americana, Tsuga, Liriodendron, Ulmus* spp., *Q. alba*.

Subxeric-tending
Hinkle (1978): "northern red oak-sugar maple" type; *Q. rubra, A. saccharum; Carya ovata, Q. prinus, Liriodendron*.

5E (high base status). *Acer saccharum-Tilia* alliances

Mesic

Hinkle (1978): "sugar maple-basswood-ash-buckeye" type; *A. saccharum, Tilia heterophylla, Fraxinus americana; Aesculus flava, Q. rubra*.

Selected literature on fire: Van Lear & Waldrop (1989), Abrams et al. (1998), Cook (2000).

Fire-dependence or sensitivity. There was probably a low fire frequency and little if any effects before settlement, except perhaps for rare catastrophic fires. Typical trees mostly have low fire-tolerance (*Fagus, Acer, Betula, Magnolia, Aesculus, Tilia*, young *Liriodendron*) or moderate fire-tolerance (*Tsuga*, old *Liriodendron, Fraxinus, Quercus, Carya*); the latter mostly occur in transitions to subxeric oak forest. There is little evidence that major species are enhanced by fires.

Typical fire frequencies & intensites. Fires tend to have low intensity in these forest types, or fade out completely, except during extreme drought periods. The forest floor is generally moister, and the leaf litter provided by deciduous tree species in these forests is less flammable than oak leaves and pine needles (Pyne et al. 1996).

Fire-relations of tree species. Few characteristic species of this forest class have much fire-tolerance, and these are mostly transitional species that can extend onto subxeric sites, especially after disturbance. White pine seeds can germinate abundantly after a fire, but young trees lack fire-tolerance, in marked contrast to old trees, which can become moderately to highly tolerant. Tulip-tree seeds are dormant for up to 10 years and seedling establishment can be stimulated by a fire; again, saplings have thin-bark and low fire-tolerance but mature trees with bark thicker than half an inch have high fire-tolerance. Black walnut saplings may not be common in forests, but they do resprout vigorusly after disturbance; and there may also be a pronounced increase in tolerance from saplings to mature trees.

A persistent dominant tree in the subxeric transition is northern red oak, which has moderate fire tolerance but less than most other oaks. Post-settlement increases by this species on mesic sites seem to have been widespread, especially after heavy logging in the late 19th Century. Although it is not clear if direct fire-tolerance was involved, it is likely that dispersal by animals and seedling establishment was relatively successful on the burned or otherwise disturbed ground in the extensive cutover forests of that era (Abrams 2000). A controlled experiment in Wisconsin showed that two spring burns can increase northern red oak in the understory while decreasing sugar maple and hophornbeam (Kruger 1992). Even in old-growth. occasional fires may be involved in maintaining northern red oak with shade tolerant trees, although wind damage alone may be sufficient in other cases (Abrams et al. 1997, 1998; Cook 2000).

White pine, tulip poplar, red maple and others have been locally successful in northern red oak habitat as well, but these species are probably less fire-tolerant (especially white pine) in early establishment, and they may eventually succumb to competition with oaks and other species in dense second growth. These succesional species may have even “facilitated” northern red oak canopy development (Oliver 1978, Abrams 2000).

Even though occasional fires can cause much tree damage, young trees of most species can resprout after top-kill, creating young coppice stands. Also, seeds of many species can germinate and establish well on burned ground, especially those with small size.

Some shrubby species may be highly sensitive to fire, espcially those with shallow root systems on steep rocky slopes. However, such sites may burn very rarely. For example, a recent (October 2000) fire in Pickett State Park damaged some old individuals of *Taxus canadensis*, and C. Bailey & S. Major (pers. comm.) counted ca. 110 annual rings on a stem only 3-4 cm in diameter.

Notes on herbaceous species

Native vegetation

Hutchinson & Sutherland (2000) found that mesophytic Liliaceae (*Smilacina, Uvularia, Trillium*) were generally reduced by burning (see also class 11).

A. Meier (Western Kentucky Univ., pers. comm.) reports that *Panax trifolius* can be completely killed by fires.

Rock (2000) found that three rare species in the Great Smoky Mountains National Park increased in small plots placed around their populations: *Botrychium matricariifolium, Cardamine flagellifera, Hydrastis canadensis*.

D. Taylor (DBNF, pers. comm.), based on anecdotal evidence, has suggested that *Cypropedium pubescens* has been reduced by fires in DBNF.

From general observation of this author (J. Campbell), *Amphicarpaea bracteata* can become abundant after fires (especially in transitions to subxeric, submesic and subhydric forest, etc.); however, more mesic areas with dense *Amphicarpaea* may be hard to burn.

Studies of alien species: several aliens (especially winter-green species) can invade mesic forests, especially disturbed phases and transitions to subxeric, submesic or subhydric forests; most of the following notes may relate more to submesic forest, since repeated fire in mesic forest may push composition in that direction.

Nuzzo (1991) found that moderately intense fires during spring were most effective in reducing *Alliaria petiolata* (a biennial with winter rosettes); fall fires were less effective and fires of low intensity were not effective. Nuzzo et al. (1996; and previous papers) studied effects of three annually repeated spring fires. Fires generally increased abundance and diversity of the herb layer, partly due to reduction in dominant *Parthenocissus quinquefolia* (native) and *Alliaria petiolata* (alien). *Alliaria* was reduced by repeated annual fire but without fire it recovered quickly, doubling each year after release. *Eupatorium rugosum* (native) increased greatly after fire.

Schwartz & Helm (1996) also found that *Alliaria* was much reduced by a single (intense?) fire and was still less than preburn densities three years after the fire. They reported that "native species" were also reduced, but these were still relatively frequent, including *Galium aparine* (a winter annual), which may be alien or adventive in many areas.

Luken & Shea (2000) found that two or three "mid-intensity" fall burns did not reduce *Alliaria*, and may have increased it; seedling (rossette) density was much reduced but the final density of flowering stems was much increased, apparently because of the reduced competition. Two winter annuals, *Galium aparine* (native or alien?) and *Stellaria media* (alien) also decreased. A native perennial, *Eupatorium rugosum*, and a native summer annual, *Pilea pumila*, increased.

The potential for invasion by some aliens after fire should also considered; *Paulownia tomentosa* has been suspected (Bratton & Meier 1998; and pers. comm.).

6. SUBHYDRIC FOREST

Summary. This typically occurs in upland swales, streamheads and lowland swamp transitions; common species on the Cumberland Plateau include red maple (*Acer rubrum*), blackgum (*Nyssa sylvatica*), holly (*Ilex opaca*), etc. Fire may have play a small role in this ecosystem type, when intense upland fires burned down into small stream bottoms. Wetland red maple (*Acer rubrum* var. *trilobum*), a tree with low fire tolerance, is often abundant; most other common trees are only moderately tolerant—blackgum, sweetgum, tulip poplar, swamp chestnut oak, cherrybark oak, green ash, etc. Transitions to uplands can have trees with higher tolerance of fire, such as white oak, as well as some with low tolerance, sich as beech.

Examples and notes from central Cumberland Plateau

[see also 5C, 5D for possible bottomland examples]

Small floodplain variant
Hinkle (1978)/plateau: “red maple-river birch-holly” type; *A. rubrum, Betula nigra, Ilex opaca; Nyssa sylvatica*.

Streamhead variant (transitional to uplands)
Hinkle (1978)/plateau: “red maple” type; *A. rubrum; Nyssa, Q. alba*.

Selected literature on fire: Bowles et al. (1996)—this is a study of fens further north, but with much similarity in vegetation to subhydric forest or its disturbed variants on the Appalachian Plateaus.

Fire-dependence or sensitivity. Fire may have played a small role in this ecosystem type, when intense widespread upland fires burned down into small stream bottoms. *Acer rubrum* var. *trilobum*, a tree with low fire tolerance, is often abundant; most other common trees are only moderately tolerant—*Nyssa sylvatica, Liquidambar, Quercus michauxii, Q. pagoda*, etc. Small wet openings or shrubby thickets within this forest may be expanded by fire or other disturbance, and the vegetation then grades into more open oak woodland or grassland typical of vegetation class 09 (see below).

Notes on herbaceous species. In shrubby woodland and grassland, Bowles et al. (1996) studied the effects of frequent fire in the dormant season (at 1-2 year intervals) plus shrub cutting. Fire appeared to increase grass and sedge cover (including *Carex stricta, Muhlenbergia mexicana, Scirpus acutus*) and some herbs (including *Aster puniceus, A. umbellatus*, ?*Solidago patula*, ?*Cirsium muticum*, etc.). Herb cover decreased in total, but this was mostly due to reduction in *Impatiens capensis* and *Solidago ohiensis*. *Cornus racemosa* was more resistant to fire in the open, suggesting that shrubby thickets can increase with moderate fire frequency.

7. SUBMESIC FOREST

Summary. This is typically on gentle slopes with composition transitional between subxeric, subhydric, mesic or xerohydric conditions; often a mixture of red maple and white oak, plus other common associates (beech, blackgum, tulip, white pine, sugar maple, black walnut, etc.). Fire probably has had partial effects in this ecosystem type, with frequent occurrence on drier sites. Among the typical trees, red maple and beech have low fire-tolerance; blackgum and white oak have moderate tolerance. Red maple litter may not burn well except in unusually dry conditions (Olson 1998), but when fire finally does occur the damage to trees may be severe.

Examples and notes from central Cumberland Plateau

7A (low base status).

Disturbed/subxeric-tending

JC/BSF104 (drier part)

7B. Disturbed/subxeric-tending

Hinkle (1978)/plateau: "red maple-white oak-blackgum" type; *A. rubrum, Q. alba, Nyssa*; *Liriodendron, Liquidambar*.

JC/BSF31; JC/BSF26? (lower part)

7C (moderate base status).

Hinkle (1978): "red maple-white oak-blackgum" type

JC/BSF31

[see also 5C, 5D for possible bottomland examples]

Selected literature on fire: McCune & Cottam (1985), Whitney & Steiger (1985), Milne (1985), Kirwan & Shugart (2000).

Fire-dependence or sensitivity. Fire probably has had partial effects in this forest type, with frequent occurrence on drier sites. This is a poorly understood class of forest, which may be maintained by intermediate soil conditions or by intermediate disturbance regimes, coupled with compositional inertia. In Appalachian regions, however, it is probably widespread, e.g., with much white oak, and red maple on gentle slopes in swales on broad upland ridges; additional mesophytes may gradually invade without disturbance, but there is probably a chance of occasional fire that would maintain an oak component. In pine barrens of New York, slightly damper sites protected from frequent fire have similar forest, with much white oak, red maple, white pine, etc. (Milne 1985).

Typical fire-frequencies & intensities. In general, it appears that such sites have been free of fire for at least 20-30 years, and the type may persist with fire intervals of several decades. Intense fires could occur in droughts after long periods of fuel accumulation.

Fire-relations of tree species. The fire dynamics of this type may largely depend on a balance between moderately fire-tolerant species (white oak, southern red oak, black oak, hickories, blackgum, etc.) and intolerant species (black cherry, red maple, sugar maple, beech, etc.), coupled with different kinds of fuel accumulation. Oak-hickory litter tends to promote fires, while beech-maple litter tends to inhibit fires (Olson 1998). Red maple litter may not burn well except in unusually dry conditions, but when fire finally does occur the damage to trees may be severe. Although red maple is sensitive to fire, it does resprout and low intensity fires may still allow it remain common, at least in the understory (e.g., Huntley & McGee 1981). Tulip tree is locally abundant, especially in young stands, and its occurrence may be partly promoted by long fire cycles (see Mesic Forest). Black walnut is also locally abundant on richer soils, probably having being promoted by past fires in some areas (e.g., karst valleys at Mammoth Cave; Campbell 1999).

8. DECIDUOUS SERAL THICKETS:

Summary. Although these areas are not currently a well-developed stable feature of the landscape, there may have been extensive brushy areas in some ecotones between forest and open woodland or grassland on various land types. Typical species include cane (*Arundinaria* *gigantea*), sumacs (*Rhus* spp.), hazel (*Corylus americana*), dwarf upland willow (Salix *humilis/tristis*), plums (*Prunus* spp.), greenbriars (*Smilax* spp.), blackberry (*Rubus* spp.), etc. In some areas, taller arboreal suckering species may have been locally abundant (*Sassafras*, *Diospyros, Robinia*, etc.). Such ecotones could have been maintained by an intermediate fire frequency, perhaps at ca. 3-10 year intervals. However, during the past 50 years o fire suppression, such vegetation has generally become replaced by young submesic forest (and subxeric or subhydric transitions), with pines, tulip, red maple, gums, etc.

Examples and notes from central Cumberland Plateau. See notes under Vegetation & Fire History section (Appendix 2). Sassafras and persimmon were locally abundant on the southern Cumberland Plateau in Tennessee, but these stands appear to have declined greatly today, due to forest succession and perhaps fire-suppression (G. Smalley, pers. comm.). Further west, during 1850-1950, sassafras and persimmon often were abundant in grassy openings where fire frequency was somewhat reduced see historical notes in Appendix 2.

Selected literature on fire. Detailed studies are lacking, but there are many scattered references indicating that clonal thickets are often promoted by fire at ca. 3-10 year intervals (e.g., Hughes et al. 1960, Hughes 1966, Niering & Dryer 1989, Landers 1981, Waldrop et al. 1992, Bowles et al. 1996, Platt & Brantley 1999).

9. HYDRIC OAK WOODLAND AND GRASSLAND

Summary. This typically occurs on swales and flats. These sites may be potentially characterized by hydric oak species (*Q. palustris, Q. bicolor, Q. phellos*, etc.), but many sites on the Cumberland Plateau may be too isolated or disturbed for these trees. Instead depauperate or disturbed variants of subhydric (class 6) or upland oak woodland (class 10) tend to be present.

At Big South Fork, scattered streamhead sites on gentle topography support this vegetation. More open grassy phases may include much *Panicum* spp. (*scoparium, rigidulum, longifolium, virgatum*, etc.), *Calamagrostis coarctata, Chasmanthium laxum, Carex* spp., *Rhynchospora* spp., *Juncus* spp., etc. A few highly distinctive native grassland remnants in ROWs and a few unimproved old fields suggest that some of this vegetation was maintained as open woodland or grassland before settlement, with frequent burning (at ca. 1-3 year intervals).

Examples and notes from central Cumberland Plateau

TN: DeSelm (1992): switchgrass "barrens" type; *Panicum virgatum*; *P. microcarpon, Acer rubrum, Aronia melanocarpa, Vernonia noveboracensis, Aster umbellatus*.

TN: Jones (1989): emergent wetlands (drier phase); with dominant grasses: *Chasmanthium laxum, Calamagrostis coarctatas, Leersia oryzoides* (wetter?), *Panicum microcarpon, P. longifolium, P. virgatum, Glyceria striata* (wetter?).

TN: Patrick (1979)/01: Dugan's Glady Meadow, Bledsoe Co.
TN: Patrick (1979)/03: Panter Creek Meadow, Bledsoe Co.

TN: Patrick (1979)/53: Windle Swamp [woods], Overton Co. [E Highland Rim]
TN: Patrick (1979)/94: Hampton Crossroads Swamp [woods], White Co. [E Highland Rim]. These two sites should perhaps be referred to moderate-high base status types instead (9D): *Carex* spp. (*debilis*, cf. *incomperta*, etc.), *Eleocharis* (*compressa, microcarpa, quadrangulata*), *Glyceria* (*acutiflora, striata*), *Osmunda* spp. (*cinnamomea, regalis*), *Quercus phellos, Rhynchospora* (*capitellata, corniculata*), *Woodwardia areolata*, etc.

BSF: JC/14: JC/105

KY: Wolf Creek Meadow, Whitley Co. [best remnant known in KY?]
KY: Upper Laurel River Meadow(s), Laurel Co. [now virtually all destroyed]

Selected literature on fire: Whitney & Steiger (1985), Coates et al. (1992), Bowles et al. (1996), Kost & De Steven (2000).

Fire-dependence or sensitivity. A few highly distinctive native grassland remnants in ROWs and a few unimproved old fields suggest that some of this vegetation was maintained as open woodland or grassland before settlement, with frequent burning (at ca. 1-3 year intervals). Soils at these sites tend to be wet in winter and dry in summer. Historically, drier sites have supported dominant post oak in some southern regions, or bur oak on richer soils in the north, and have been subject to annual fires. Fires have probably allowed expansion of grassland on some of these sites. Damper sites tending to forest of willow oak, overcup oak (to the south), pin oak, swamp white oak (to the north), etc., may have burned occasionally before settlement, but there has been little study of their fire regimes.

Typical fire frequencies & intensites. Details are unknown, and probably highly variable due to the frequently complex mosaic of moisture and vegetation conditions. Oak forest may be maintained with intervals of 10-100 years; grassland probably requires 1-10 years.

Fire-responses of key species. Many of the graminoids and herbs are probably able to persist with a fire regime, and some may be enhanced, but there have been few detailed studies. *Carex stricta* and other graminoid species in more open habitats are known to be promoted by fire further north (e.g., Bowles et al. 1996, Kost & De Steven 2000). Herbs can be generally reduced by fires at 1-2 year intervals, but many species may benefit from fire at long intervals, since establishment is often increased after fires.

Notes on herbaceous species (to be studied further).

A high diversity of native grassland species are probably promoted by fire in these habitats. Many of these species are rare or uncommon (see Table 6 and Appendix 4). In addition to fire-suppression, there has been exceeive damage from grazing, draining, and eutrophication.

Sarracenia spp. are known to benefit from fire (Hessl 1995); however there is a concern that intense fire could kill rhizomes.

The federally endangered *Schwalbea americana* is believed to have been largely fire-dependent before settlement (Campbell et al. 1991; check original sources).

10. NON-HYDRIC OAK WOODLAND AND GRASSLAND

Summary. This occurs on flats and gentle slopes, often grading into pine-oak woodland on non-calcareous soils. It is potentially characterized by *Quercus falcata, Q. stellata* and *Q. marilandica* (in more open phases), but often grading into forest of *Pinus echinata, Q. alba, Q. velutina*, etc. (especially in transitions to more rugged topography). With the death of most pine, some areas may become part of this class, especially in the stands remain open due to fire or other disturbance. Remnants of more open grassy phases can be found in ROWs and elsewhere, suggesting that it was widespread on less dissected parts of the plateau. More open areas were probably maintained by frequent fire (at ca. 1-3 year intervals). Trees of *Q. stellata* and perhaps

Q. marilandica are highly tolerant of fire, and other associates are moderately tolerant (*Q. falcata, Q. coccinea, Carya tomentosa, C. pallida*, etc.).

Examples and notes from central Cumberland Plateau

10BC: *Q. coccinea, Q. stellata, Q. marilandica*, etc.

Submesic variants

DeSelm (1992); perhaps included in moister phases of his *Andropogon gerardii* type; see "moderate base status".

Subxeric variants

Hinkle (1978)/plateau: "post oak-scarlet oak" type; *Q. stellata, Q. coccinea*; *Q. falcata, Q. alba, Q. velutina*.

DeSelm (1992)/plateau, in part (drier phases): big-bluestem; *Andropogon gerardii, Sorghastrum, Schyzachyrium*; *Festuca* [*arundinacea*], *Eupatorium fistulosum, Solidago* [*altissima*], *Lespedeza repens*; much of this type may have more moist and fertile soil than implied here.

JC/BSF16 (ROW)

Xeric variants

Wade (1977)/plateau: "post oak" type; *Q. stellata; Pinus virginiana, Q. velutina, Q. coccinea*; [*Oxydendrum*].

Wade (1977)/plateau: "blackjack oak" type; *Q. marilandica; Q. stellata, Q. coccinea*; [*Oxydendrum*].

Hinkle (1978)/plateau: "blackjack oak" type; *Q. marilandica; Q. stellata, Q. coccinea, Pinus virginiana*.

DeSelm (1992)/plateau: little bluestem type; *Schizachyrium, Sorghastrum, Andropogon gerardii*; *Danthonia sericea, Festuca* [*arundinacea*], *Ceanothus*.
JC/BSF1B

Xerohydric variants
JC/BSF105 (drier phase)?

10C (moderate base status). *Quercus falcata-Q. stellata-Q. marilandica* alliances
Submesic-tending
DeSelm (1992)/plateau, in part (moister phases); big-bluestem; *Andropogon gerardii, Sorghastrum, Schyzachyrium*; *Festuca* [*arundinacea*], *Eupatorium fistulosum, Solidago* [*altissima*], *Lespedeza repens*.

Subxeric-tending
JC/BSF37; JC/BSF15 (field)

10D. Transition to higher base status.
DeSelm (1992)/Sequatchie Valley: Lee Station; *Schizachyrium; Sorghastrum, Andropogon gerardii, Danthonia spicata, Pycnanthemum tenuifolium, Solidago rigida, Antennaria plantaginifolia*.

Selected literature on fire: Thor & Nichols (1973), DeSelm et al. (1973), DeSelm & Clebsch (1991a,b), Guyette & Cutter (1991), Cutter & Guyette (1994), Heikens et al. (1994), Jenkins & Rebertus (1994), Huddle & Pallardy (1996), Fralish et al (1993), McClenahen & Houston (1998), Campbell (1999).

Fire-dependence or sensitivity. Moderately intense fire is generally required for long-term maintenance of abundant post oak. After long periods without fire, open post oak stands tend to replaced by southern red oak, black oak, hickories, etc., and eventually the long-lived white oak. Once a complete forest cover is established and post oaks become old, dormant season burns may not be enough to restore post oak; moreover annual burning may not generally allow it to regenerate. In post oak-dominated forest plots studied for 27 years, DeSelm & Clebsch (1991a) found that southern red oak tree density increased with annual "late winter" fires, while post oak still declined; and the shrub layer became dominated by *Rhus copallina*. In contrast, with fires at five year intervals, probably more intense than annual, they found that much more post oak occurred in the understory, together with southern red oak, scarlet oak, blackgum, sassfras and most other woody species. Also, tree composition remained relatively stable, although red maple become locally abundant in the understory on damper sites and increased slightly in the canopy.

Typical fire frequencies & intensites. More open grassland areas were probably maintained by frequent fire (at ca. 1-3 year intervals). Open grassy post oak woodlands may have had fire intervals of ca. 3-10 years, as in open pine-oak woodlands (see class 12 below). Tree regeneration can often increase after fires, and occasional intervals of 5-10 years can allow pronounced cohorts of regeneration by post oaks and its associates. After longer intervals and woody plant invasion, a single fire without repetition may cause little or no reversion towards open grassy conditions. But even if partial invasion of typical subxeric forest occurs (with southern red oak, black oak, white oak, hickories, etc.), relatively intense fires can still occur after long-periods of fuel accumulation, causing more mortality of the invading species than persisting post oak and blackjack oak (Anderson & Brown 1983, Huddle & Pallary 1996; see also Table 4). However, if average fire intervals remain longer than about 20-30 years, there may eventually be a complete succession to subxeric forest.

Fire-responses of woody species. Post oak and perhaps blackjack oak are highly tolerant of fire, while most other associates are moderately tolerant (southern red oak, scarlet oak, hickories, sassafras, persimmon). Post oak is one of the most fire-tolerant trees in eastern North America, and, to some extent, its long lifespan (200-300 years or more) allows it to "weather" long fire-free intervals. Its most common associate in more open pyric woodland is blackjack oak, which has a much shorter lifespan but is able to rapidly colonize openings that are fire-free for 10 years or more. Even with frequent fire, both species may be able to regenerate at some sites, because fires are often highly patchy in their intensities and effects (Jenkins & Rebertus 1994). Southern red oak is another oak with small acorns that is able to colonize openings rapidly during longer fire intervals, and with intervals of 20-30 years or more this relatively vigorous tall species can become abundant in spatial or temporal transitions to more typical oak-hickory forest. Oaks and common species in these woodlands can resprout vigorously after fire, often increasing in sapling density (e.g., Thor & Nichols 1973). However, repeated fire for several decades may gradually shift composition towards post oak and away from southern red oak, scarlet oak, etc. (Deselm & Clebsch 1991).

Brushy thickets of clonal species may become established in transitions from open oak woodland, with frequent fire, to more mesic forest, with little or no fire (see class 8). Data of DeSelm & Clebsch (1991a,b) suggest that low shrubs may often increase with fire intervals of 1-5 years, including *Ceanothus americana, Rhus* spp., *Rubus* spp., *Salix tristis, Vaccinium vacillans, Hypericum* spp., etc., but such responses are highly variable; *Smilax glauca* cycled with 5 year fire-intervals, but decreased with annual burning. In brushy old fields, Niering & Dreyer (1989) found that woody growth was killed by fire at 1-2 year intervals but resurged vigorously: *Gaylussacia baccata* increased by ×3; *Comptonia peregrina* by ×4; *Rosa virginiana* and *Rhus glabra* by lesser amounts; *Smilax rotundifolia* produced vigorous succulent regrowth, but actually decreased due to browsing by rabbits; *Populus grandidentata* also produced more from root sprouts but there was an overall reduction in stems due to girdling by the meadow vole. Note also the positive reponse of *Corylus cornuta* reported by Swan (1970).

Notes on herbaceous species.

After seven years of annual burning in post oak, blackjack oak, scarlet, white oak, etc., DeSelm et al. (1973) found a general increase in graminoids and herbaceous species. However, legumes generally were more abundant after two burns five years apart. Increasing species included *Crotonopsis elliptica, Gymnopogon brevifolius, Helianthus angustifolius, H. mollis, H. silphioides, Lespedeza capitata, Panicum angustifolium, P. ravenellii, Parthenium integrifolium, Solidago speciosa*, etc.

In further monitoring of these sites, DeSelm & Clebsch (1991b) showed that responses could be highly variable among species, but a few generalizations were possible. Without fire ground vegetation declined to low levels, with little diversity. With fire, graminoid, legume, composite and other forb cover generally remained dense in total, with graminoids becoming particularly abundant with annual fires. But individual groups varied much from year to year. Annual burning tended to reduce composite cover, compared to 5-year intervals (*Coreopsis major* still declined with 5-year intervals). Legumes generally did well with annual burning (especially *Cassia nictitans, Clitoria mariana, Tephrosia virginiana*, etc.), or with 5-year intervals (*Lespedeza repens, L. procumbens, Schrankia microphylla*, etc.), but a few declined or peaked only between fire years (*Stylosanthes biflora*). Among other forbs, *Pycnanthemum tenuifolium* was unusually consistent in its positive response, even with annual burning; several species cycled with 5-year intervals, e.g., *Potentilla simplex* was most common in the year after a fire.

Niering & Dreyer (1989) studied effects of burning in the dormant season (mostly early April) on old fields with abundant *Schizachyrium scoparius* and other native species (perhaps degraded from pine-oak woodland). In grasslands, there was an increase in *Schizachyrium* and overall richness. *Baptisia tinctoria* increased by ×2 (annual) or ×3.5 (biennial burning). Other increasing species included *Solidago odora, Eupatorium hyssopifolium* amd *Viola pedata*. Unchanged or slightly increasing were *Carex pensylvanica, Juncus greenei, Polygala polygama, Solidago rugosa, Panicum columbianum* and *P. sphaerocarpon*. Decreased were *Rumex acetosella* (alien annual), *Danthonia spicata* (native cool seaon grass) and *Agrostis alba* (alien cool season grass).

Swan (1970) studied effects of April burning on *Solidago-Danthonia* fields and adjacent habitats (probably degraded oak or oak-pine woodland). *Solidago* cf. *canadensis* increased, while *Danthonia spicata* decreased. Other increasing species included *Ambrosia artemisiifolia, Galium boreale, Solidago nemoralis, Lithospermum arvense* and *Poa compressa*. Other decreasing species included *Aster novae-angliae, Aster umbellatus, Chrysanthemum leucanthemum, Daucus carota, Rudbeckia hirta, Solidago rugosa, Panicum lanuginosum* [these mostly have earlier growing seasons]. In nearby *Schizachyrium scoparius* fields, both *S. scoparius* and *Agrostis alba* increased. In oak woodland, most grasses and herbs increased, including *Melampyrum lineare* (×11), *Corylus cornuta* (×4), *Panicum dichotomum* (×5), *Apocynum androsaemifolium* (×2.5) and *Poa compressa* (×3).

Landers (1981) reported that good habitat for quail can generally be developed by frequent burning in this vegetation; legumes are often increased, providing valuable food; fire exclusion for 2-3 years can allow temporary “roughs” to grow thick, providing nesting habitat and summer fruit.

Studies of alien species

Willson & Stubbendieck (1997) found that *Bromus inermis* could be reduced by repeated burning in the growing season

Several researchers have found that *Festuca arundinacea* can be reduced by repeated spring burning, but for elimination it is often useful to apply herbicides (e.g., T. Barnes, Univ. of Kentucky, pers. comm.; literature to be reviewed).

However, some alien species may be increased by burning, such as the legumes *Lespedeza* spp. and *Melilotus* spp.

11. SUBXERIC OAK FOREST

Summary. This includes oak-chestnut, oak-hickory and oak-ash forests (plus white pine phases): it typically occurs on ridges and warmer slopes but with gradual transitions to mesic forest on cooler slopes. It is characterized by *Q. prinus* (low base status), *Q. alba* (intermediate soils) and, locally, *Q. muhlenbergii* (high base status), but is often dominated by other *Quercus* spp., *Pinus* spp., *Acer rubrum*, etc., in disturbed areas. There was probably some regular fire regime (with perhaps ca. 10-30 year intervals) before settlement, at least in subxeric-xeric variants grading into coniferous woodland. Typical species include species with high or moderately high fire tolerance (chestnut oak and perhaps chestnut) and moderately tolerant (white oak, black oak, ?scarlet oak, ?hickories, sourwood), but in mesic transitions without fire there may be gradual invasions of species with only moderate tolerance (hemlock, tulip) or low (white pine, beech, maples, magnolias).

Examples and notes from central Cumberland Plateau
11A (low base status). *Quercus prinus-Q. coccinea* alliances [and former *Castanea*]

Subxeric-mesic variants (perhaps with much former *Castanea*)
Caplenor (1965)/ravine: "chestnut oak" type; *Q. prinus*; *Liriodendron, A. rubrum*.

Subxeric-mesic disturbed variants (perhaps with much former *Castanea*)
Hinkle (1978)/ravine: "white pine" type; *Pinus strobus*; *A. rubrum, Q. prinus, Tsuga*.

Subxeric variants
Wade (1977)/plateau: "chestnut oak" type; *Q. prinus*; *Q. coccinea, Q. velutina, Carya pallida, Q. alba* [*Cornus florida, Nyssa, Oxydendrum*]
Hinkle (1978)/ravine: "chestnut oak" type; *Q. prinus*; [Q. *coccinea, Carya glabra, Q. alba, A. rubrum*]
Hinkle (1978)/plateau: "chestnut oak" type; *Q. prinus*; *Q. coccinea, Q. alba, Q. velutina, Carya pallida*.

Subxeric mid-seral variants (grades into pine-oak woodland)
Wade (1977)/plateau: "scarlet oak" type; *Q. coccinea; Q. velutina*; [*Oxydendrum, Acer rubra,, Cornus florida*]
Hinkle (1978)/plateau: "scarlet oak" type; *Q. coccinea*; *Pinus echinata, Q. velutina, Q. stellata.*
JC/BSF01

Subxeric early seral variant (grades into pine-oak woodland)
Wade (1977)/plateau: "mixed pine-oak" type (P. virginiana, Q. alba, P. echinata; Q. coccinea, Q. velutina) [Cornus florida; Oxydendrum, Acer rubrum]
Wade (1977)/plateau: "Virginia pine" type (Pinus virginiana; Q. alba, Q. coccinea, Q. prinus) [Acer rubrum, Oxydendrum, Cornus]
JC/BSF04; JC/BSF08

11B. Quercus prinus-Q. coccinea/Q. alba-Q. velutina transition
Mesic-tending (with much former Castanea?)
Caplenor (1965)/ravine: "former chestnut" type (Castanea; Liriodendron, Quercus spp., Carya spp.)
Safely (1970)/mountain: "chestnut oak-white oak-beech" type (Q. prinus, Q. alba, Fagus; Tsuga, Carya tomentosa)

Mesic-tending (late to early succession)
Safely (1970)/mountain: "chestnut oak-northern red oak" type (Q. prinus, Q. rubra; Q. alba, Oxydendrum)
Safely (1970)/ravine: "northern red oak-chestnut oak-white oak" type (Q. rubra; Q. prinus, Q. alba, A. rubrum, Pinus virginiana)
Safely (1970)/ravine: "white oak-virginia pine" type (Q. alba; P. virginiana, Q. Safely (1970)/plateau: "virginia pine" (P. virginiana; P. strobus, A. saccharum [Q. prinus, C. tomentosa])
JC/BSF20: Pinus strobus variant

Subxeric mature
Caplenor (1965)/ravine: “oak-hickory” type (Q. alba; C. glabra, Q. rubra; Oxydendrum, Kalmia)
Safely (1970)/ravine: “white oak-chestnut oak” type (Q. alba; Q. prinus, C. tomentosa, A. rubrum)
Wade (1977)/plateau: “white oak” type (Q. alba; Q. coccinea, P. echinata, Q. velutina) [Cornus florida, Oxydendrum, Acer rubrum]
Hinkle (1978)/ravine: “mixed oak” type (Q. prinus; Q. alba, Q. velutina, C. tomentosa, Nyssa, C. glabra)

Subxeric mid-seral
Hinkle (1978)/plateau: “mixed oak” type (Q. velutina; Q. coccinea, Q. alba, Oxydendrum)
JC/BSF07

Subxeric early seral
Safely (1970)/ravine: “virginia pine-white pine” type (P. virginiana; P. strobus, Q. prinus, Carya tomentosa, Q. alba)
Safely (1970)/plateau: “virginia pine-white oak” type (P. virginiana; Q. alba, Q. prinus, Q. coccinea)
Safely (1970)/plateau: “virginia pine” type (P. virginiana; P. strobus, Acer saccharum, Q. prinus); A. saccharum sounds erroneous or perhaps a submseic transition is included here.
Wade (1977): “mixed pine-oak” type (P. virginiana, Q. alba, P. echinata; Q. coccinea, Q. velutina)
Wade (1977): “virginia pine” type (P. virginiana; Q. alba, Q. coccinea, Q. prinus)
Hinkle (1978)/plateau: “virginia pine” type (P. virginiana; Q. alba, P. echinata; Q. coccinea, Q. stellata)

11C (moderate base status). Quercus alba-Q velutina alliances

Mesic-tending mature (plateau may be more disturbed)
Safely (1970)/mountain: "white oak-beech" type (Q. alba; Fagus, C. tomentosa, Q. rubra)
Safely (1970)/ravine: "white oak-beech" type (Q. alba; Fagus, A. rubrum)
Safely (1970)/plateau S aspect: "white oak" type (Q. alba; A. saccharum, Q. prinus, Q. rubra; Q. velutina, A. rubrum)
Safely (1970)/plateau N aspect: "white oak" type (Q. alba; Q. rubra, A. saccharum, Q. prinus, P. virginiana, A. rubrum)

Mesic-tending disturbed (late to early succession?)
Hinkle (1978)/ravine: "white oak-northern red oak" type (Q. alba; Q. rubra, C. glabra, Liriodendron)

Subxeric mature
Hinkle (1978)/plateau: "white oak" type (Q. alba; Q. coccinea, Q. velutina, Oxydendrum)
JC/BSF16

Subxeric mid-seral
Safely (1970)/ravine ridge: "white oak-virginia pine" type (Q. alba, P. virginiana; Q. rubra;; C. tomentosa, A. rubrum, Liriodendron)
Wade (1977)/plateau: "black oak" type (Q. velutina; Q. alba, P. echinata, Q. coccinea, Q. prinus) [Oxydendrum, Cornus florida, Acer rubrum]

Subxeric early-seral
JC/BSF28

11D. Quercus alba-Q. velutina/Q. muhlenbergii-Q. shumardii transition

Mesic-tending variants

Hinkle (1978)/ravine: “sugar maple-white oak” type (A. saccharum, Q. alba; C. ovata, Q. rubra, Magnolia acuminata).

Safely (1970)/ravine: “white oak-chinquapin oak” type (Q. alba; Q. muhlenbergii, Liriodendron, Fagus; A. saccharum)

Mesic-tending disturbed variants

Safely (1970)/ravine: “red cedar” type (Juniperus; Juglans nigra, C. ovata, Q. muhlenbergii, ?Betula nigra])

Selected literature on fire: Van Lear & Waldrop (1989), Abrams & Downs (1990), Abrams (1992), Abrams et al. (1995), Cowell (1995), Olson (1996, 1998), Abrams et al. (1997), Franklin et al. (1993, 1997), Fralish (1997), Arthur et al. (1998), Barnes & Van Lear (1998), Bratton & Meier (1998), Chester et al. (1998), Blankenship & Arthur (1999), Abrams (2000), Cook (2000), Hutchinson & Sutherland (2000), Van Lear et al. (2000).

Fire-dependence or sensitivity. There is ample evidence that in transitions to mesic or submesic sites without fire, oak forests can become invaded, at least in the understory, by mesic or shade-tolerant species such as white pine, bigleaf magnolia, hemlock, beech, sugar maple, red maple, blackgum, black birch (in camopy gaps), etc. In these transitions, it is often unclear if fire alone can maintain an oak component, due to low litter flammabilities and vigorous competitors. However, oaks and their associates might be favored by rare extreme droughts and intense fires. Also, there can also be considerable compositional inertia if seed sources of mesophytes are lacking. In contrast, on drier sites (typical subxeric to xeric), oaks may retain dominance even without fire (e.g., Franklin et al. 1993).

There are remarkable differences in understory composition from locality to locality that probably reflect fire history. For example, in some sections of the Knobs Region just west of the Appalachian Plateaus (e.g., near old iron furnaces), fire-sensitive species like red maple and beech are absent or rare in large areas of subxeric oak forest even in mesic transitions. Further west, such trends are even more pronounced in regions known to have had frequent fire until recent decades. For example, at Land-Between-the-Lakes, red maple and beech were completely absent from 45 0.1 acre plots in the chestnut oak forest type (Chester et al. 1998), but on richer soils typified by local white oak dominance sugar maple is present and able to invade the understory (Franklin et al. 1993). In most of the western Ouachita Mountains, upland oak forests (and pine-oak forests) generally lack red maple and beech (J. Campbell, D. Zollner et. al., data from Ouachita Mountains). Red maple still occurs on damper sites within these western regions, and beech has abrupt range limits that are not clearly related to abiotic factors, suggesting restriction by fire-history rather than climate and soil.

However, long-term dependence of subxeric oak forests on fire may often be exaggerated. Widespread increase and abundance of red maple, blackgum or white pine in the understory has often been used to indicate a complete future succession without fire. While this may be reasonable on somewhat mesic or submesic sites, there are virtually no reports of truly subxeric oak stands being replaced by these species without extensive blowdowns or logging. Competition from dominant oaks on these dry sites, together with rare fires and extreme droughts, may generally limit the growth of these understory species into the canopy, so that they behave more like true understory species such as sourwood, serviceberry, hophornbeam, dogwood and redbud. Moreover, in at least one study it has been shown that a small percentage of oak stems in early stand development can still lead to oak eventual dominance over maples due to superior survival and growth of oaks that are exposed to full sun (Oliver 1978).

Typical fire-frequencies & intensities. Reported fire intervals are often difficult to interpret because of the highly patchy nature of fire in some of these forests. Ultimately, it may be best to focus on fire intervals for individual trees and their microhabitats, rather than whole stands covering many acres. Although there are few definitive studies, it appears that subxeric oak forests on ridges and warm slopes that are not being clearly invaded by mesophytes, generally experience fire around individual trees at intervals of about 10-50 years. In contrast, fire intervals within whole areas of 100 acres or more may, tentatively, be about 5-10 years on average. Franklin et al. (1997) found that small-scale patterns in fire effects may be partly repeated from fire to fire, due to somewhat consistent spatial relationships between fire temperatures and slope degrees or litter/duff biomass.

In many regions, especially on public lands, heavy logging and fires during 1890-1940 has been superceded by an era of minimal disturbance and a partial shift towards mesophytes, especially on transitional topographic sites. Truly subxeric sites and xeric transitions may not require fire for oak regeneration. But in mesic transitions repeated fires (especially in the growing season) at intervals of about 5-10 years are probably needed before oak saplings can grow back into canopy dominance. If more frequent or intense fires, with 1-5 year intervals, are continued for long periods, intact hardwood canopies probably will not persist, and a more open woodland or grassland may eventually develop. But repetition of such fires for 5-20 years in mature oak stands with moderately fire-tolerant trees can still cause oak sprouts to increase in proportion within the understory. Such fires are more effective if oak litter is still abundant relative to litter of tulip poplar, red maple and other species which have low flammability.

Fire-intensities can be quite variable, depending on many factors. Xeric transitions on upper slopes, especially with decadent pine or red cedar stands and dense flammable brush (e.g., mountain laurel), may develop much fuel accumulation and potential for highly intense fires. Mesic transitions, with understory invasion of white pine, maples, beech, etc., may become less flammable due to more compact or quickly rotting litter, although rhododendron has potential for high flammability. Woody fuel accumulation may follow disease epidemics, especially in the more succesional red oak group when dense overmature stands experience high mortality due to fungi (e.g., oak wilt, *Ceratocysitis fagacearum*) and bacteria. The oak wilt fungus is spread by nitidulid beetles or through soil bridging; this dispersal may be disrupted by burning (Johnson & Appel 2000; to review further).

Another trend in fire-tolerance that deserves further attention is from infertile base-poor soils, with several relatively fire-tolerant species (e.g., chestnut oak, chestnut, sourwood), to more fertile base-rich soils, with no really tolerant species. Possibly, the hills and ridges typified by chestnut oak and its associates tend to experience more intense slope-climbing fires than the calcareous ravines with relatively humid, quickly-rotting litter typified by chinquapin oak and its associates.

Fire-relations of tree species. A relatively new silvicultural paradigm is that after oak seedlings and saplings are repeatedly top-killed by fires, they can generally resprout each time, even after summer fires, often gaining in vigor with each increase in root reserves until saplings grow fast enough to develop fire-tolerance before the next fire, and even improving final tree vigor (Van Lear & Waldrop 1989). Burning apparently removes inhibition of suppressed basal buds at or below the root collar (Danielovitch et al. 1987), Seedlings and saplings of several other typical trees in subxeric forest appear to have similar reponses to oaks (chestnut, hickories, sourwood, sometimes blackgum), although some are less fire-tolerant (e.g., the relatively mesophytic northern red oak).

Oak species and other trees may also increase in seedling establishment on burned ground, especially in more open microsites. Temporary removal of deeper litter and ground vegetation may contribute to such establishment after fires (e.g., Minckler & Jensen 1959, Clark 1970, Van Lear & Waldrop 1989). However, this may not occur after severe damage to the soil reduces organic matter, and even buried acorns can be killed by fire (Cain & Shelton 1998). Seedling patterns may involve complex unpredictable interactions with dispersing animals (bluejays, squirrels, etc.) and insect pests (e.g., weevils and beetles that can be killed by fires).

After a single fire, some potentially competing fire-sensitive understory species (red maple, blackgum, sweetgum, tulip poplar, ash, dogwood, red elm, hophornbeam, etc.) can also resprout vigorously or germinate abundantly (especially tulip poplar from seeds dormant up to 5-10 years). In some cases, a light dormant season fire may have little positive effect on oak regeneration (e.g., Teuke & Van Lear 1982), and in young mixed stands competition for oak may actually increase (e.g., McGee 1979, Merritt 1979, Huntley & McGee 1981). But repeated fires (at least 2-3) appear to cause synergistic damage to species like red maple, unlike the oaks, based on studies cited by Van Lear & Waldrop (1989); see also Arthur et al. (1998). Intense fires in the growing season may be particularly damaging, and in some cases this can allow oaks to begin dominating regrowth in open stands (Van Lear et al. 2000). South-facing slopes may be more prone to such fires (Augspurger et al. 1986). One spring burn was found to be as effective as three winter burns in reducing midstory density, allowing remaining oak saplings to grow relatively well (Barnes & Van Lear 1998). Such responses have guided development of the "shelterwood-burn" method for regenerating oaks as a dominant component of the regrowth (Brose et al. 1999). In this method a hot burn is applied a few years after the cut, when numerous oak seedlings will have established from remaining seed trees.

In general, oaks in the "red" group may require more intense fires or other disturbance for abundant establishment, compared to the "white" group, which tend to live longer and dominate in later succession. Resprouting after fire may be even more vigorous in the red oak group (e.g., Danielovitch et al. 1987), perhaps contributing to their characteristic local dominance earlier in succession.

White pine, which does not resprout, is generally killed completely in the understory by a single low intensity fire. But, like tulip poplar, older trees are relatively tolerant of fire, and seedling establishment can be much increased shortly after a fire due to litter reduction. In some regions, rare fires are considered to have played a major role in regenerating current white pine populations (e.g., Cook 2000), but fire intervals of 10-20 years or less probably restricts white pine from recruitment into the canopy (e.g., Blankenship & Arthur 1999). This succesional species is often centered in the mesic-subxeric transition. It has a curiously fragmented native distribution in Kentucky and Tennessee (Braun 1942; and current herbarium records), which may well be related to its dependence on large disturbances but without frequent fires. The Big South Fork population is one of only three distinct native ranges for this species in Kentucky, along with the Red River Gorge area, and the Lake Malone area in western Kentucky (Christian, Todd and Muhlenberg Cos.). Further north it is known to be favored after single intense fires, intense storm damage and in old field colonization. Control of white pine cone beetle (*Conophthorus coniperda*) by prescribed fire is possible only under excating fuel and weather conditions (Wade 1989).

In addition to succesional trees like tulip poplar and white pine, some minor succesional or shrubby species in subxeric forest can often germinate or resprout vigorously after fire, including *Rubus* spp., *Rhus* spp. and *Sassafras albidum*. If the stand becomes unusually open due to intense fire or other disturbance, such as heavy cutting or browsing, these species may sometimes form clonal patches that can persist and expand with repeated burning; see “Deciduous Seral Thickets”.

Chestnut is a moderately to highly fire-tolerant tree typical of subxeric forests and the transition to mesic conditions. Pollen studies suggest that its abundance before settlement was associated with frequent fire (Delcourt & Delcourt 1980). It has a strong ability to change from a suppressed understory shrub to a very vigorous tree when released from competition, and with suitable soil conditions it may rapidly grow into open oak or even pine-oak forest canopies (Paillet 1982). [Sourwood behaves in a similar fashion but remains a small tree.] Chestnut experienced a severe decline after chestnut blight was introduced, during the same period when fire frequency was declining in much of its range. Major replacement species have varied greatly from region to region and site to site, possibly due in part to fire regimes. Oaks, especially northern red oak, and hickories have replaced chestnut in many regions, but more mesic or fire-intolerant species have predominated in others. Restoration of chestnut will probably benefit from an increase in fire frequency, especially in the mesic transitions.

Shrub density is generally reduced with frequent fire, but intense fires may increase some shrubby species due to vigorous regrowth. On more xeric sites, there is some potential for volatile shrubby foliage such as *Kalmia* (and *Rhododendron* in mesic transitions) to act as “ladder fuels” into catastrophic canopy fires (Van Lear 1989).

Notes on herbaceous species.

In mesic/submesic-tending oak forest, Laatsch & Anderson (2000) found that spring burning at ca. 2-5 year intervals, plus cutting of invasive shrubs, caused increased abundance of *Eupatorium rugosum* but much reduced *Sanicula gregaria*. Without management, at an otherwise similar site, *Parthenocissus quinquefolia* increased substantially, while *Rhus radicans* decreased.

In oak-hickory forest and mesic transitions, Hutchinson & Sutherland (2000) found that March-April burns (1 or 3 in a 3 year period) caused the annual Erechtites hieracifolia to become abundant from the seed bank. Other species that increased with burning include *Acalypha virginica*, *Carex* spp, *Eupatorium rugosum, Galium triflorum, Panicum* (*boscii*, etc.), *Viola* spp., etc. Several others appeared de novo, including several weedy species: *Chamaecrista nictitans, Conyza canadensis, Eupatorium serotinum, E. sessilifolium, Gnaphalium obtusifolium, Hackelia virginiana, Lobelia inflata, Phytolacca virginiana, Silene virginica*, *Sphenopholis nitida*, etc. *Polygonum convolvulus* [or *dumetorum*] appeared de novo and became relatively frequent. Species that decreased with burning were far fewer, including Liliaceae: *Smilacina racemosa, Trillium grandiflorum, Polygonatum biflorum* and *Uvularia perfoliata*; later burns (late April) were especially damaging.

D. Taylor (pers. comm.) reports that *Carex picta* is highly flammable but resprouts vigorously; this uncommon sedge is locally abundant, but with a patchy distribution that cannot be related to climate, topography or soils; possibly this is related to fire history.

Cypripedium acaule may become more common after fires, based on general observation and anecdotal evidence; dense populations are uncommon currently, and without fire they tend to decline.

12. XERIC OR PYRIC CONIFEROUS WOODLAND AND GLADES

Summary. This class of vegetation is characterized by hard pines (*Pinus* spp. except *P. strobus*) on sandstone, or red cedar (*Juniperus virginiana*) on limestone, plus various *Quercus* spp. [Note: most of this section relates to pine woodlands, but a footnote on red cedar is added below.] Less xeric variants have much shortleaf pine (*P. echinata*), and probably have a history of frequent mild or occasional intense fire, being ecologically intermediate between more open grassy conditions and denser oak forest. Before settlement shortleaf pine may have been maintained by frequent fire, but currently much may date from old field invasion when browsing and burning were common in marginal farmland. *Pinus echinata* is highly tolerant of fire, as well as some *Quercus* spp. (*prinus, stellata*), but most oaks are only moderately tolerant. On more xeric sites, thin rocky soils are more important than fire in maintaining the conifers; red cedar is highly sensitive to fire, though it may rapidly reinvade adjacent areas released from fire.

Examples and notes from central Cumberland Plateau

12A (low base status). *Pinus* (*rigida, echinata, virginiana*), *Quercus* (*prinus, coccinea*), etc.

Subxeric (presumed mature)

JC/BSF03; JC/BSF10

Subxeric (presumed disturbed)

JC/BSF38

Xeric-tending

Perkins (1981): *Pinus virginiana* type; *Q. stellata, Tsuga, Acer rubrum, Amelanchier arborea*/*Q. prinus* (or *Vitis rotundifolia*)

Xeric pine woodland
Perkins (1981): *Pinus virginiana* type (in shrub herb zone)
JC/BSF05; JC/BSF12

Open xeric shrubby zones
Perkins (1981): *Kalmia latifolia* type
Perkins (1981): *Gayluccasia baccata* type

Open xeric/pyric grassy variants
Perkins (1981): "grass-forb" type; *Schizachyrium scoparius, Liatris microcephala, Aster surculosus, Danthonia sericea, Vaccinium arborescens, Andropogon* spp., *Tephrosia virginiana, Pinus virginiana*.

Open [xerohydric-tending?] grassy variants of flat rocks
Perkins (1981): "*Helianthus longifolius-Danthonia sericea*" type

Open [xerohydric-tending?] cryptogam-herb zones of flat rocks
Perkins (1981): "*Panicum*" [spp.?] type
"*Aster surculosus-Liatris microcephala*" type
"*Talinum teretifolium*"-[*Hypericum gentianoides*] type
"*Bigelowia nuttallii*" type

12B. *Pinus* (*echinata, virginiana*), *Quercus* (*alba, prinus, velutina, coccinea*), etc.
Subxeric mature
Wade (1977): "shortleaf pine" type; *P. echinata*; *Q. coccinea, Q. velutina, Carya glabra*;

[*Cornus florida, Oxydendrum, Acer rubrum, Q. alba*]
Hinkle (1978)/plateau: "shortleaf pine-white oak" type; *P. echinata*; *Q. alba, P. virginiana*, *Q. coccinea, Q. velutina*.
JC/BSF02; JC/BSF22; JC/BSF25; JC/BSF30; JC/BSF35; JC/BSF40
JC/BSF26? (with submesic/mesic inclusion?)

Subxeric seral
JC/BSF36

Xeric-tending
Perkins (1981): *Pinus virginiana/Vaccinium vacillans-Smilax rotundifolia* type
Perkins (1981): *Pinus virginiana/Vaccinium arboreum* type

Xeric open
Patrick (1979): Jamestown Barrens (in part?)
JC/BSF17?

12C (moderate base status). *Pinus* (*echinata, virginiana*), *Quercus* (*alba, velutina, stellata*), etc.
Subxeric mature
Safely (1970)/ravine: "shortleaf pine-white oak" type; *P. echinata*; *Q. alba, P. virginiana*, *Q. coccinea, Cornus florida, Liquidambar*, perhaps transfer to early seral under subxeric oak forest instead.

Subxeric seral
Safely (1970)/plateau: "virginia pine-white oak-blackjack oak" type; *P. virginiana; Q.*

alba, ?*Q. falcata*, *P. echinata*, *P. strobus*, *Q. stellata*.

12D. *Juniperus virginiana*, *Quercus* spp. (see footnote below).

12E (high base status). *Juniperus virginiana*, *Quercus* spp.

Selected literature on fire: Barden & Woods (1976), Harmon (1982), Milne (1985), Van Lear & Waldrop (1989), Waldrop et al. (1992), Masters et al. (1995), Bratton & Meier (1998), Williams (1998), Arthur et al. (1998), Elliott et al. (1999), Haney & Lydic (1999), Harrod & White (1999), Sparks et al. (1999), Barden (2000), Guyette & Dey (2000); a note on calcareous glades and woodlands with red cedar is appended below.

Fire-dependence or sensitivity. Stands on the most xeric rocky ridges, steep S/SW-facing slopes and clifftops appear to be stable, due to the generally greater drought tolerance of hard pines (or red cedar) compared to most oak species, together with the reduced hardwood litter and thinner canopies that allow more regeneration of the pines (or cedars). However, in many Appalachian regions pines have increased on less xeric sites due to burning, logging or other disturbance, especially after the extensive logging operations, subsequent slash-fires and old-field invasions during 1890-1940. Such conditions may be partly simulated by the "fell and burn" technique, followed by pine planting, that has been suggested for regeneration of pine-hardwood stands.

In addition to these major disturbances that allowed establishment of pines on subxeric sites, continual frequent fires of low or moderate intensity were associated with persistent pine on these sites. With moderately frequent fires in open woodland or grassland, pines may still have some advantage in regeneration due to various biological traits (see below), and in some areas a few mature trees may even escape intense fires around rock outcrops or other microsites with less fuel, allowing good seed dispersal into freshly burned areas nearby. There is ample evidence that settlers used frequent fire for maintaining marginal farmland and woodland pastures, for reducing some pests, and for general aesthetic reasons. There is also growing evidence of presettlement burning by native peoples, especially on broad upland plains and valley bottoms, which were later more settled and less burned, but it is likely that their burning was less widespread in more rugged regions, which were later less settled and more burned (see also Guyette & Day 2000). A zone with abundant pines regenerated by occasional intense fires may have been concentrated in the transition from relatively mesic ravines, with little or no fire effects, to more level uplands, where frequent fire of human origin maintained open grassy oak woodland. Such zonation may be involved in the interpretation of the Curt Pond pollen study of Delcourt & Delcourt (1998b; see historical section above).

Lightning-fires, though rare, may have been a significant long-term factor, especially on exposed xeric ridges and upper S/SW slopes with flammable conifers (containing volatiles), heaths (especially *Kalmia*) and fine ground fuels. Such sites may have attracted lightning and kindled ignitions into accumulations of flammable fuel (Taylor 1973, Bratton & Meier 1998). Before any human influences, it is possible that rare but highly intense and even "severe" lightning-fires were somewhat more likely to occur on such pine-oak refugia and then spread onto nearby subxeric sites allowing periodic regeneration of pines into otherwise hardwood-dominated forests. In some locations, heath balds or grassy balds may have been at least partly promoted by such fires, though perhaps expanded later by human influence. This pattern may have been opposite to the pattern of human fires, which probably started mostly on broad uplands along trails.

Lightning-fires may have been more widespread and frequent in the southern pine regions, including the Piedmont and Coastal Plain, allowing persistent pine-oak woodlands on deeper or damper soil as far north as New York (Milne 1985). Occasional intense fires in those regions may be needed to regenerate pines (e.g., Pinus taeda); frequent prescribed fires may not be intense enough to reverse succession towards oaks (e.g., Oosting 1949), unless they occur in the growing season and some fire-tolerant pine trees are still present (McGee 1980). The central Cumberland Plateau is near the northern edge of these regions, where subtle shifts in climate and fire regime may switch the balance of pine and oaks.

Typical fire-frequencies & intensities. In xeric, rocky stands with relatively slow growth and more patchy fuels, fire intervals of several decades may be common, and a wide range may still be compatible with persistence of the vegetation. However, for persistence of pine-oak forest on subxeric sites, fire intervals need to be about 5-15 years or less (e.g., Masters et al. 1995). If intervals are 20-30 years or more, hardwood invasion becomes well-established and the pines will probably not be replaced without an intense disturbance. Fire-intervals of 3-5 years may be required for strong dominance of the pines, plus some seedling establishment, and grassy, species-rich ground vegetation, as in shrtleaf pine woodlands of southern regions, or in pitch pine woodlands further north. Continual burning at ca. 1-5 year intervals is needed to prevent oaks and other hardwoods from maturing, and foresters have used continual annual fires to maintain productive pine stands in much of the south by keeping hardwoods under 3 feet tall. [However, only longleaf pine, with its “grass” stage in seedling development, is able to grow up through annual burning.]

Frequent fires generally have low intensity, and occasional moderate to high intensity fires may be needed at longer intervals to create larger open grassy conditions and regeneration of the pines. Spring (Mar-Apr) or summer fires may often be more intense and effective than fall (Sep-Oct) fires in shortleaf pine-oak stands (Sparks et al. 1999). Waldrop et al. (1992) found that 43 years of annual summer fires in loblolly pine stands was effective in converting woody understories to grassy, and it allowed much more establishment of pine seedlings (albeit short-lived); annual winter fires maintained grass and forb dominance and might be effective given more time, but hardwood sprouts (oaks, sweetgum, dogwood, etc.) were still abundant; periodic summer or winter fires (with 3-7 year intervals) were least effective in promoting grass/forb abundance and diversity (see notes on herbaceous species below).

Fires of higher intensity may become more likely after long fire-free intervals if flammable shrubs (especially *Kalmia latifolia* and perhaps *Gaylussacia baccata*) and woody debris accumulate. Woody debris can become more abundant after damage from droughts, ice-storms, insects (especially southern pine beetle, *Dendroctonus frontalis*) and fungi (e.g, blue-stain fungus, *Ceratocystis minor*). Intense fires in dry "roughs" of woody debris and flammable brush can allow flames to "ladder" into remaining canopy trees. Ridges can be prone to much more intense fires than lower slopes for several reasons: more lightning ignitions (see above), more convective fire-building up slopes, more flammable plant material (living or dead), and drier soils.

Fire-relations of key species. Cone-serotiny is common in table mountain pine (*Pinus pungens* at higher elevations), occasional in pitch pine (middle elevations), and absent in shortleaf pine (lower elevations and further south); it is also absent or rare in Virginia pine (tolerant of extreme xeric sites but also able to colonize distant clearings). This trait allows seed release to occur after moderately intense fires, when there is more likely to be suitable ground for establishment of seedlings. Trees and even saplings of these pine species are highly tolerant of fire, except for the relatively thin-barked Virginia pine. These species also tend to refoliate after crown scorches with relatively little effect on growth and survival, except after spring fires. Pitch pine, in particular, has a pronounced potential for epicormic resprouting after moderately intense fires. Pitch pine and shortleaf pine are also able to resprout from the root collar after complete top kill, which is unusual in conifers.

Shortleaf pine is more widespread on disturbed subxeric sites, often with grassy areas that support frequent fire of low intensity. Virginia pine is even more widespread, including much disturbed ground with exposed soil, but, with a short life-span (60-120 years) and only moderate fire-tolerant due to its thinner bark (and sometimes a tendency to retain low branches), it may depend less on fire-maintenance than on dispersal to new openings. On xeric extremes, where it appears to be the most drought-tolerant pine species, it may also depend less on frequent fire because of the continuing potential for establishment adjacent to permanent rocky exposures. Seedling establishment of all species requires sunny ground free of hardwood litter, but shortleaf pine (and perhaps pitch pine) may be able to tolerate more graminoid competition than the smaller-seeded Virginia pine. Complete exposure of mineral soil is not required, and high intensity fires may actually reduce mycorrhizal fungi that benefit establishent (Waldrop et al. 2000).

Notes on shrubby species. The shrub layer, in general, may reduced by frequent fires. It is generally believed in Daniel Boone National Forest that *Rhododendron maximum* and *Kalmia latifolia* have increased with fire suppression (Martin 1990, p. 71). However, occasional intense fires may cause clonal thickets to develop due to tree mortality; this may be most pronounced in pine-oak transitions (see 12).

Waldrop et al. (1992) found that 43 years of periodic summer or annual winter burns in loblolly pine stands allowed several shrubs to become more common than with annual summer fire or no fire at all: including *Gaylussacia* spp., *Vaccinium* spp. and *Myrica cerifera*. Woody vines tended to be more common with periodic fire or no fire (*Vitis* spp., *Smilax* spp., *Gelsemium sempervirens*). *Cornus florida* was most abundant with periodic summer fire (3-7 year intervals); *Persea borbonia* and *Lyonia lucida* were most common without fire.

Notes on herbaceous species

Campbell et al. (1994) reported on shortleaf pine-oak forest plots treated for ca. 10 years with periodic fire and understory cutting for RCW habitat. Species that appeared more common in the treated plots than in similar untreated plots included *Piptochaetium avenaceum* (abundant in treated but still frequent in untreated), *Schizachyrium scoparius* (locally abundant), *Andropogon gerardii, Chrysopsis graminifolia* (abundant), *Aster surculosus, A. dumosus, Eupatorium album, Tephrosia virginiana, Angelica venenosa* and *Helianthus divaricatus*. Species that appeared less common included *Desmodium nudiflorum, Galium circaezans, Polygonatum biflorum* and perhaps *Smilacina racemosa*.

In grassy shortleaf pine-oak woodland, Sparks et al. (1998) found that late growing season (Sep-Oct) fires reduced *Panicum* Subgenus *Dichanthelium* spp. (*boscii, dichotomum, linearifolium*); late dormant season (Mar-Apr) fires increased these species. Annual or frequent dormant season fires increased legumes such as *Stylosanthes biflora*. However, season of fire caused differences in fewer than 10% of species.

After 43 years of burning in loblolly pine stands, Waldrop et al. (1992) found that several species were only frequent with annual summer burns: including *Paspalum* spp., *Polygala lutea, Hypoxis micrantha* and *Rhexia* spp. Others were relatively frequent with a range of fire regimes (annual or periodic), but were probably most common with annual winter burns: including *Coreopsis major, Cassia nictitans, Stylosanthes biflora, Galactia macreei, Tephrosia virginiana, Centrosema virginianum, Desmodium* spp. and *Lespedeza* spp. Others had a general positive repsonse to fire, but with little or no seasonal differences: including *Lobelia nuttallii, Aster* spp., *Solidago* spp., *Eupatorium* spp., *Elephantopus* spp., *Panicum* spp., *Andropogon* "*virginicus*" [but perhaps including *scoparius*], *Hypericum* spp., *Rubus* spp. and *Rhus copallina*. A few persisted with annual summer fire but still tended to be more common with annual winter fire (*Chasmanthium laxum*) or periodic summer fires (*Mitchella repens*). No herbaceous species was clearly more common without fire than with some fire (but see notes on shrubs above).

Bourg & Gill (2000) suspected that *Xerophyllum asphodeloides* is promoted by fire in Appalachian pine-oak forests

Studies of alien species

In Piedmont pine forest, Barden & Mathews (1980) found that *Lonicera japonica* was much reduced by fire, while native grasses and forbs tended to increase.

Footnote: calcareous glades and woodlands with red cedar.

Such vegetation is a minor peripheral feature of the Big South Foork area, and a detailed separate but parallel treatment is needed elsewhere. In brief, xeric rocky open glades and clifftops may be subject to fire typically at intervals of several decades, or 10-20 years in transitions to post oak woodland (Guyette & McGinnes 1982, Meier & Jobe 1999). Fuel accumulation can be relatively slow, and fires may burn out where interrupted by thin fuels near outcrops. Red cedar is sensitive to fire and appears to have been restricted to such sites when frequent fires occurred before settlement. Trees more than 20-30 years old can become more fire tolerant, especially on rocky soils.

On deeper soils, red cedar will rapidly invade open grassy areas that have been disturbed, but frequent fires typical of upland oak woodland (vegetation class 9 above) would have generally excluded this species. Fire intervals of ca. 20-50 years may have been associated with continual red cedar abundance on deeper soils in some regions (e.g., Delcourt & Delcourt 1999). Such intervals are long enough for red cedar to mature, and dense successional thickets of red cedar may actually be relatively resistant to low intensity fires, because of relatively thin fuels in the litter. But as these stands become invaded by oaks, ashes and other trees, the accumulated deciduous litter, woody debris and highly flammable cedar crowns may be subject to highly intense fires. Such fires might enable a new cycle of red cedar regeneration, but no definitive research on this potential scenario has been done.

APPENDIX 4: RARE PLANTS OF THE CENTRAL CUMBERLAND PLATEAU

This region is defined as the plateau section within the Cumberland River watershed. These notes are built on a previous project in Appalachian Kentucky, which attempted to identify the occurrence of rare species in rights-of-way, especially project ROWs (funded by East Kentucky Power Cooperative). Literature references are minimal since most relevant literature is already cited in Palmer-Ball et al. (1988) and Campbell et al. (1989, 1990, 1991, 1992, 1993, 1994). Here many species are added from the Cumberland Plateau in Tennessee. The list includes all that appear to be at least moderately rare or uncommon in either Kentucky or Tennessee, with a suggested state rarity rank up to S3S4. Species with uncertain records are indicated by a question mark (?) before their name. Much information is provisional and should be updated.

BSF	Documented occurrence within BSFNRRA.
BSF?	Probable occurrence within BSFNRRA (includes some records needing verification, and some peripheral records with uncertain location).
(BSF)	Documented occurrence elsewhere within South Fork Cumberland River watershed (including Little South Fork, Rock Creek, Roaring Paunch Creek, etc.).
(BSF)?	Probable occurence elsewhere within South Fork watershed.
(CUM)	Documented occurrence elsewhere within Cumberland River drainage on Appalachian Plateaus. Note that (BSF) and (CUM) codes still indicate possible occurrence within BSFNRRA
O	Generally typical of fully open grassland habitats maintained by disturbance from cutting, burning or browsing (especially ROWs and unimproved old fields); excluding open habitats maintained by rock outcrops or water bodies.
o	Generally typical of partially open grassy woodland (or associated brushland) mainained by disturbance.

ROW = right-of-way

Additional codes indicate degrees of global and local rarity, as follows.

L Should be added to state list in KY (ST = 0-6)
D Should be delisted in KY (ST = 7-10)
GL Global rank (1-10) modified from standard G rank times 2; GL<6 are underlined.
ST State ranks (1-10) for KY and TN modified from standard S rank times 2

Notes are also provided in some cases on details of local distributon, as follows.

KY The notes on KY records include recent listed status in brackets [ ], and total numbers of records/counties in parentheses, if data are available; h = largely historical records. These data need to be updated based on new discoveries during 2001-2015..

TN Bottom line incorporates notes from Tennessee, including occurrence on Cumberland Plateau (CP, s=south, c=central, n=north) from the Atlas (Chester et al. 1993, 1997), plus selected literature as follows. County records are indicated as acronyms from first four letters (BLED, FRAM, FENT. SCOT, CAMP, PICK, etc.)
Bailey (1998): Big South Fork
Caplenor (1965): Falls Creek
DeSelm (1992): general
Goodson (2000): Big South Fork
Jones (1989): general
Patrick (1979): general
Schmalzer et al. (1985): Obed
Wofford (et al. (1979): Savage Gulf

BSF *Acer pennsylvanicum*, Striped Maple: GL=10
KY: ST=7? (50+/5). DBNF records of this northern and Appalachian tree are not associated with ROWs; none are near project ROWs.
TN: ST=8; CP

Acer spicatum, Mountain Maple: GL=10
KY: ST=2? (6/6). In KY, this northeastern small tree is known only from scattered Appalachian locations. It occurs on cool slopes, mostly with somewhat calcareous soil, in mesic forest. There are two sight reports from DBNF (both on USFS), but these have not been confirmed. These are not associated with ROWs, or within 100 ft of project ROWs.
TN: ST=6; CPse; Patrick (VANB Baker Mt. Sink; WARR Dry Cr. Sink).

(BSF) *Aconitum uncinatum,* Blue Monkshood: GL=7
KY: ST=2 (9/5). In KY, this Appalachian twining herb is scattered along the Cliff Section and adjacent regions, mostly in mesic forest on sandy soil near larger streams. The three DBNF records (2 on USFS) do not appear associated with ROWs. None are within 100 ft of project ROWs.
TN: ST=7; CP

(BSF) *Adiantum capillus-veneris*, Southern Maidenhair-fern: GL=10
KY: ST=4 (20/8). In KY, this southern fern is largely restricted to the transition from southern Cliff Section to Eastern Karst Plain, mostly in sunny seeps on S/SW-facing limestone cliffs. The 12 DBNF records (0 on USFS) are not associated with ROWs. None are within 100 ft of project ROWs.
TN: ST=6; CP

o? *Adlumia fungosa*, Climbing Fumitory: GL=8
KY: ST=2? (7/4h). Within KY, this Appalachian twining herb is known only from the Cumberland Mountains. Most records date from before 1950. This species is reputed to respond positively to fire on occasion. Fernald (1950) notes habitat as "wet or recently burned woods or rocky wooded slopes, local...often cultivated and frequently escaping."
TN: ST=5; CPne; Obed boulder-fields.

?*Aesculus pavia*, Red Buckeye: GL=9?
KY: ST=3 (10+/8). In KY, this southern shrub is known mostly from the Mississippian Embayment, but there are a few disjunct records. It occurs on terraces and low slopes with fertile soil in mesic forest. The single DBNF record (historic, not on USFS?) was probably not associated with a ROW or within 100 ft of a project powerline. Because of its great disjunction, this record has been suggested to be the result of human propagation.
TN: ST=8

BSF O *Agalinis obtusifolia* (as *A. decemloba*), Ten-lobe False (Small) Foxglove: GL=7
KY: ST=4? (6/3). In KY, this southern herb is restricted to the southern Cliff Section, where it occurs on sandy ridges in grassy openings within pine-oak forest. The six DBNF records (4 on USFS) are mostly (5) in ROWs. Four are in project ROWs. True A. obtusifolia is unknown in KY but mapped from 3 southcentral TN counties.
TN: ST=6; CP; DeSelm; Patrick FENT Jamestown Barrens.

(BSF)? O *Agalinis gattingeri*: Mid-western False (Small) Foxglove; GL=9
KY: ST=8
TN: ST=8; CPs?

O? *Agastache scrophulariaefolia*, Purple Giant-hyssop: GL=8?
L KY: ST=4? (7/6). KY records of this northern herb may be associated with ROWs; none are near project ROWs, but such occurrences may be expected in northern DBNF.
TN: ST=3

BSF *Ageratina luciae-brauniae (= Eupatorium l.),* Lucy Braun's White Snakeroot: GL=5
KY: ST=6 (120/6). This herb is endemic to the southern Cliff Section of KY and TN (Cumberland River drainage), where it is restricted to damp floors of sandstone rockhouses. The ca. 120 DBNF records (112 on USFS) are not associated with ROWs, except for rare coincidences. No records occur within 100 ft of project ROWs.
TN: ST=5; CPnw

Agrimonia gryposepala, Tall Hairy Groovebur (Agrimony): GL=10
KY: ST=4 (3/2). Although there have been several reports of this northern herb from KY, few have been confirmed. There are collections from moist to damp forest to the west and east of DBNF.
TN: ST=4

o? *Agrimonia microcarpa*, Southern Agrimony: GL=10?
L KY: ST=2? (2/2?). There are very few confirmed records of this south-central species in KY. It was discovered for the first time in DBNF during this project (Ezel Quad, Murder Branch). Although in a project powerline, this species is not known to be associated with ROWs, and it may well occur elsewhere in nearby forest.
TN: ST=2

O *Agrostis stolonifera* var. *palustris* (= *A. alba* var. *p.*), Creeping Bent: GL=10
L? KY: ST=6? (11/11?). The taxonomy and provenance of this northern (circumboreal) grass needs checking in Kentucky. It is clearly distinct from the alien *A. gigantea* (= *A. stolonifera* var. *major*), and it occurs in hydric versus mesic sites. There is a record from Bell Co. in the Cumberland Mountains, and from Powell Co. near Clay City.
TN: ST=?

Allium burdickii (= *A. tricoccum* var. *b.*), Narrow-leaved Ramps: GL=8?
KY: ST=7C? (11+/7). DBNF records of this midwestern herb are not associated with ROWs; none near project ROWs.
TN: ST=6

(BSF)? *Amelanchier sanguinea*: Round-leaved Serviceberry; GL=9
KY: ST=2
TN: ST=4; CPn; Obed bars

Amelanchier stolonifera (in *A. spicata* sensu lato), Running Serviceberry: GL=10
KY: ST=2D? [-/C/!] (1/1). In KY, this northern shrub is known only from one site in the central Cliff Section, in transition to Knobs Region. It occurs on a rocky hill close to limestone clifftops in open brushy forest. This single DBNF record (on USFS) is not associated with a ROW, or within 100 ft of a project powerline.
TN: none?

o? *Amianthium muscitoxicum*, Fly-poison: GL=9
KY: ST=3 (5/3). In KY, this Appalachian-Ozarkian herb is known from a few sites in the

Cumberland Mountains, plus a historical record from Todd Co. It is typical of open pine-oak/oak woods, and may be expected in ROWs, perhaps within DBNF.
TN: ST=6

BSF? *Amorpha fruticosa*, Indigo-bush; GL=9
KY: ST=8
TN: ST=8; CP; DeSelm; Obed bars

(BSF)? o? *Andropogon glomeratus* var. *hirsutior*, Intermediate Broom-sedge: GL=10?
L? KY: ST=6? (2/1). Much more taxonomic work is needed with this and related taxa in KY, but currently there are only two records of this southern and western grass. Both are from in or near ROWs and one is from a project powerline (near Marsh Branch, Laurel Co.).
TN: ??

BSF *Anemone quinquefolia*, Wood-anemone: GL=10?
KY: ST=7? (30+/10). Further taxonomic work in this northern herb is needed to separate var. *quinquefolia* and var. *bifolia* (= *interior*). The latter may be restricted to the northern Cliff Section and may deserve official listing. Its records are not associated with ROWs; none are near project ROWs.
TN: ST=8; CP; Goodson #4; Obed; Scotts Gulf; Falls Creek

Angelica triquinata, Filmy Angelica: GL=8
KY: ST=4 (>2/1). In KY, this montane Appalachian herb is known only from Black Mountain. There is an old record from Rowan Co. which is generally disputed. It generally

occurs in mesic forests and thickets.
TN: ST=7

o? *Apocynum androsaemifolium* (or its hybrid with *A. cannabinum* = A. *X medium*, Spreading Dogbane (or its hybrid with Hemp-dogbane): GL=10
L KY: ST=4? (6/4). KY records of this northern and western herb are not associated with ROWs; none are near project ROWs. However, ROWs may provide good habitat.
TN: ST=4

Arabis lyrata, Lyrate Rock Cress: GL=10
L KY: ST=4? (3/3?). KY records of this northern and western (to E. Asian) herb (including M. Medley coll. from Pine Mountain in Pike Co.) are not associated with ROWs
TN: ST=5

Aralia nudicaulis, Wild Sarsaparilla: GL=10
L KY: ST=5? (5/5?). KY records of this northern and western herb are not associated with ROWs
TN: ST=7

Arisaema triphyllum ssp. *quinatum*, Quinate Jack-in-the-pulpit: GL=7?
L KY: ST=4? (2/2). In KY, this southern Appalachian (?) subspecies is known only from a site on Pine Mountain (Letcher Co.) and Black Mountain (Harlan Co.). KY records are not associated with ROWs.
TN: ST=?

(BSF)? O ?*Aristida curtisii* (*A. dichotoma* var. *curtisii*); Lesser S. Three-awn Grass; GL=9
TN: ST=5; CP (scattered); DeSelm

O ?*Aristida lanosa*; Wooly-sheathed Three-awn Grass; GL=8?
TN: ST=3: CP (2 cos.); DeSelm

(BSF)? O ?*Aristida virgata*; Greater Southern Three-awn Grass; GL=8?
TN: ST=3; CP (scattered); DeSelm

Asarum canadense var. *acuminatum*, Acuminate Wild Ginger: GL=8?
KY: ST=7? (>17/17?). The taxonomy of this species needs further attention in KY. Braun (1943) and Medley (1993) were able to distinguish this north-central variety, but others have not recognized it. Medley found it to be locally abundant on Pine Mountain (Bell Co.), and Braun reported it from many other counties.
TN: ST=?

BSF O *Asclepias amplexicaulis*, Clasping Milkweed: GL=10
KY: ST=7? (50+/10+). DBNF records of this south-central herb are mostly associated with ROWs, and many are in project ROWs.
TN: ST=8; CP; DeSelm; Scotts Gulf

BSF? o? *Asclepias exaltata*, Stately Milkweed: GL=9?
KY: ST=7? (30+?/15+). This Appalachian herb has scattered records in the Appalachian and Knobs Regions of KY, but it is infrequently. DBNF records (from Rowan, Bath, Powell, Leslie, McCreary, Whitley Cos.) still need to be reviewed; some are from ROWs,

but none are currently documented from project ROWs.
TN: ST=8; CP; Obed bar

O *Asclepias hirtella;* Midwestern Green Milkweed; GL=8
KY: ST=3
TN: ST=5; CPs; Patrick BLED (Dugans Glady Meadow; Panter Cr Meadow).

o? *Asclepias purpurascens*, Purple Milkweed: GL=10
KY: ST=7? (30+?/18+). This north-central herb has widely scattered records in KY, but it is rarely seen, and may be a remnant from open woodlands before settlement. DBNF records (from Rowan, Bath, Powell, Rockcastle Cos.) still need to be reviewed; some are probably from ROWs, but none are known from project ROWs.
TN: ST=3

Aster acuminatus, Whorled Aster: GL=9?
L KY: ST=6? (>5/3?). In KY, this northern and montane Appalachian herb is known only from a few sites in the Cumberland Mountains. There is however much suitable habitat there, and it may not be threatened or endangered.
TN: ST=7

BSF O *Aster concolor*, Eastern Silky Aster: GL=8?
KY: ST=3? (21/5). In KY, this southern herb is largely restricted to the southern Cliff Section (plus Calloway Co.), where it occurs on sandy ridges in grassy openings within pine-oak forest, especially in burned areas. The 21 DBNF records (19 on USFS) are mostly (16) associated with ROWs. Nine are in project ROWs.

TN: ST=8; CP; Obed bars; DeSelm

BSF o? *Aster laevis* var. *concinnus*, Narrow-leaved Smooth Aster: GL=8?
L KY: ST=6? (16/8?). This southeastern variety (of the north-central and western herb) is known from banks of larger streams in the Cumberland River system, and from some native grassland remnants in the Knobs Region or nearby. On uplands, some records are from ROWs, but none are from project ROWs.
TN: ST=4; CPnw; Obed (subxeric forest)

O *Aster paludosus* ssp. *hemisphericus*; Southern Prairie Aster; GL=9
KY: ST=2?
TN: ST=8; CPs; DeSelm

O? ?*Aster pratensis*; Southern Silky Aster; GL=7
TN: ST=4; CPs; DeSelm

(CUM) o *Aster puniceus*, Bristly Aster: GL=10
L KY: ST=4? (6/6). Some records of this northern and Appalachian herb are associated with ROWs; none are from project ROWs, but it might be expected.
TN: ST=7

(CUM) o? *Aster radula*, Low Rough Aster: GL=8?
L KY: ST=2? (1/1). The single KY record of this northeastern herb is close to a small path through woods.
TN: none?

BSF *Aster saxicastellii*, Rockcastle Aster: GL=5

KY: ST=4? (18/3). This herb is endemic to the southern Cliff Section of KY and TN, where it is restricted to the Rockcastle River and Big South Fork corridors, in brushy transitions between open boulder-cobble bars and adjacent forest. Impoundment has probably reduced much of its habitat. The 18 DBNF records (all on USFS or NPS) are not associated with ROWs. None are within 100 ft of project ROWs.

TN: ST=4; CPnw

(BSF)? *Aster schreberi*, Smooth Big-leaved Aster: GL=8?

KY: ST=7? (20+/7+). DBNF records of this north-central herb are not associated with ROWs; none are near project ROWs.

TN: ST=4?

(BSF)? o *Astragalus canadensis*, American Milkvetch: GL=10

L KY: ST=5? (17/15h). Some KY records of this widespread North American (and Siberian) herb are associated with ROWs; none are near project ROWs, but this may be expected.

TN: ST=7

BSF *Aureolaria patula*, Spreading False (Yellow) foxglove: GL=6?

KY: ST=5? (20+/5+). In KY, this southern interior herb is restricted to the Mississippian Plateaus, where it mostly occurs on calcareous slopes along larger streams in open mesic-subxeric forest. Impoundment has probably reduced some of its habitat. The 11 DBNF records (2 on USFS) are not associated with ROWs. None are within 100 ft of project ROWs.

TN: ST=5; CPne?

(BSF)? O *Aureolaria pectinata* (*A. pedicularia* s.l.), S. Annual Yellow-foxglove: GL= 8?
L KY: ST=5? (15/10?). Two new records for this species were made during the survey for this BE. The few DBNF records are mostly associated with ROWs, and three are in a project ROWs.
TN: ST=8; CP; DeSelm

O *Aureolaria pedicularia* var. *austromontana*, Montane Annual Y.-foxglove: GL=6?
L KY: ST=4? (>3/3). There has been some taxonomic confusion with *A. pectinata*. In KY, this southern Appalachian herb is probably known only from Pine Mountain. It occurs on subxeric sites in open forest and grassy openings.
TN: ST=?? (combined with pectinata?); DeSelm

BSF *Baptisia australis* var. *australis*, Blue Wild Indigo: GL=8?
KY: ST=7? (30+/7). DBNF records of this east-central herb are not associated with ROWs; none are near project ROWs.
TN: ST=7; CP

(BSF) O *Baptisia tinctoria*, Yellow Wild Indigo: GL=10
KY: ST=3? (15+/6). In KY, this eastern herb is largely restricted to Pine Mountain, but there are also a few records from the southern Cliff Section (and one from Todd Co.). It occurs on sandy uplands in openings within pine-oak forest, especially in burned areas. The three DBNF records (2 on USFS) are all in ROWs. Two are in project ROWs.
TN: ST=8; CP; DeSelm; Obed bars; Scotts Gulf

BSF? o *Bartonia paniculata*, Spreading Screwstem: GL=9?

KY: ST=7 (20+/13). There has been some confusion between this species and *B. virginica*. Both are south-central herbs of acid boggy soils, but the latter is typical of more open, stressed habitats. Some records are associated with ROWs; two are from project ROWs, and more may be expected.

TN: ST=6; Obed bars

BSF O *Bartonia virginica*, Yellow Screwstem: GL=10

KY: ST=4 (20+/7+). In KY, this eastern herb is concentrated in Appalachian regions, especially the southern Cliff Section. It mostly occurs on upland flats with acid, infertile soil in open grassy areas. The 19 DBNF records (15 on USFS) are mostly (16) associated with ROWs. Twelve are in project ROWs.

TN: ST=8; DeSelm; Scotts Gulf

BSF o? *Berberis canadensis*, American Barberry: GL=9?

KY: ST=2? (1/1?). In KY, this Appalachian-Ozarkian shrub is known for sure only from the rocky shores of the Big South Fork (McCreary Co.), on a boulder-cobble bar with brushy vegetation. There is also an unconfirmed report from Calloway Co. The single DBNF record (on NPS) is not associated with a ROW or within 100 ft of a project powerline.

TN: ST=6; CPn; Woodson #5; Obed bars

Berchemia scandens; Supplejack Vine; GL=9

KY: ST=2

TN: ST=8; CPsc; DeSelm

BSF *Betula allegheniensis*; Yellow Birch; GL=9
KY: ST=8
TN: ST=8; CP; Obed; Scotts Gulf (not lenta); Falls Creek (not lenta); not Woodson

?*Botrychium alabamense*; Southeastern Grapefern; GL=8?.
TN: ST=?; Patrick #63

Botrychium matricariifolium, Matricary Grapefern: GL=10
KY: ST=2 (2/1). In KY, this northern (circumboreal) fern is known only from Pine Mountain. It occurs in moist forest on sandy soil with *Rhododendron maximum*.
TN: ST=4

o *Botrychium oneidense*, Blunt-lobed Grapefern: GL=8?
KY: ST=2? (1/1). In KY, this northeastern fern is known only from a site on Black Mountain. It occurs in young northern hardwood forest and grassy openings.
TN: ST=2

O *Bouteloua curtipendula*, Side-oats Gramma grass: GL=10
L KY: ST=5? (16/11). In KY, this Great Plains grass is known mostly from the Knobs Region and the Pennyrhile Karst Plain. It occurs on calcareous rocky slopes and clifftops, in subxeric-xeric grassland. The two DBNF records (one on USFS) are not associated with ROWs, but several records further west are on roadsides. These records are not within 100 ft of project ROWs.

TN; ST=7

BSF *Boykinia aconitifolia*, Brook Saxifrage: GL=8

KY: ST=3? (5/5). In KY, this Appalachian herb is restricted to the Cumberland Mountains, plus one site in the southern Cliff Section. It occurs along rocky (mostly sandstone) banks of small, cool streams. The single DBNF record (on USFS) is not associated with a ROW or within 100 ft of a project powerline.

TN: ST=5; CP; Goodson #4,16; Obed bars

Bromus nottowayanus, Bottomland Brome-grass: GL=6??

L? KY: ST=2? (1/1?). This obscure east-central grass has been rarely reported. It was found, perhaps for the first time in KY, during this project along a project powerline (Slade Quad, Sand Lick Fork of Red River). This species is not, however, known to be associated with ROWs, and there may well be more plants in adjacent forest.

TN: ST=7?; CP?

BSF? O *Buchnera americana*, Blue-hearts: GL=9?

L KY: ST=6? (>50/>10?). This project (thanks to James Kiser) has provided the first record of this midwestern herb from central or eastern KY. This record is from a project powerline, and other sites may be expected.

TN: ST=7; CP; DeSelm

?*Buckleya distichophylla*; Piratebush; GL=5.

TN: ST=5; CPn?; Patrick (historical ref.)

(BSF) o? *Bulbostylis capillaris*; Densely-tufted Hair-sedge; GL=10
KY: ST=8
D? TN: ST=8; CP; Patrick FENT (Jamestown Barrens); DeSelm

o *Bumelia lycioides*; Buckthorn Bully; GL=9
KY: ST=7?
TN: ST=9; CPs; Scotts Gulf

BSF O *Calamagrostis coarctata* (= *C. cinnoides*), Eastern Reed-grass: GL=10
KY: ST=7 (50+/10). DBNF records of this east-coastal and Appalachian grass are often associated with ROWs, and several are from project ROWs.
TN: ST=7; CP; DeSelm; Obed bar; Scotts Gulf; Patrick FENT (Gernt Rd)

Calamagrostis porteri ssp. *insperata*, Bent (Ozark) Reed Grass: GL=5?
KY: ST=2? (5/1). In KY, this largely Ozarkian grass is known only from the central Knobs Region in the transition to Appalachian Plateaus. The single DBNF record (not on USFS) is not associated with ROWs or within 100 ft of project ROWs.
TN: none.

o *Calamagrostis porteri* ssp. *porteri*, Porter's (Appalachian) Reed Grass: GL=7?
KY: ST=4? (14+/5). In KY, this Appalachian grass is known only from the northern Cliff Section and Cumberland Mountain, where it occurs mostly on ridges in subxeric oak forest. In most populations, this species has not been found in flower, which, together with its patchy distribution, may be attributed to vagaries of fire history or other disturbance. The 13 DBNF records (all on USFS?) are partly (8) associated with ROWs, but this may be

partly due to the more intense search-image that was developed during the EKP project. Eight records are from along project ROWs.
TN: ST=2

BSF *Calamovilfa arcuata*; Cumberland Sandreed; GL=4
TN: ST=4; CPn; DeSelm; Obed bars

BSF? O *Calopogon tuberosus*, Grass-pink: GL=10
KY: ST=2 (12/12h). In KY, this widespread eastern orchid is known historically from the Knobs Region, Cliff Section and Cumberland Mountains, but there are only three post-1980 records. It typically occurs in open, grassy areas on seasonally wet, acid soil. The three recent DBNF records (none on USFS) are both associated with ROWs or recent logging trails. None are within 100 ft of project ROWs, but suitable habitat does occur.
TN: ST=7; CP; DeSelm; Patrick FENT (Magadenz Falls); Jones GRUN.

BSF o *Calycanthus floridus* var. *glaucus*, Sweetshrub: GL=10v10
KY: ST=4? (15+/4). [Reassessment of var. glaucus versus var. floridus is needed; but it si provisionall assumed that all native plants in the central Cumberland Plateau are var. glaucus.] In KY, this southeastern-Appalachian shrub is largely restricted to the Big South Fork corridor, plus a few scattered sites elsewhere in the Appalachian Plateaus. It occurs mostly in subxeric oak or pine-oak forest on acid soils, often somewhat open, with previous fire history. The 10+ DBNF records (9 on USFS/NPS) are not associated with ROWs. None are within 100 ft of project ROWs.
TN: ST=8; CP; Goodson #2; Obed bars; Scotts Gulf; Falls Creek; DeSelm.

BSF? Oo? *Campanula aparinoides*, Marsh-bellflower: GL=10?

KY: ST=4? (5/5?). This northern herb has been reported from the Morehead area, but not confirmed.

TN: ST=4; CPn; Jones CUMB;

BSF *Cardamine rotundifolia*; Round-leaved Bittercress; GL=8

KY: ST=8

TN: ST=7 (or 6? since state-listed)

(BSF) *Carex aestivalis*, Summer Sedge: GL=9?

KY: ST=4? (5/4?). In KY, this montane Appalachian sedge is known historically from a few sites in the Cumberland Mountains, and it has recently been found by Gary Libby in the Rock Creek area of McCreary and Wayne Cos. It occurs in mesic (to subxeric?) forest on acid soils. No sites are in ROWs or close.

TN: ST=7; CP; Obed; Scotts Gulf

Carex atlantica ssp. *capillacea* (= *C. howei*), Howe Sedge: GL=9?

KY: SL=4? (2/2?). In KY, this southern sedge (as the subspecies) is known from one locality on the Cliff Section (Mill Creek, Jackson Co.) and one in the Mississippian Embayment (seeps of Calloway Co.). The single DBNF record (on USFS) is not along a ROW or within 100 ft of a project powerline.

TN: ST=6

BSF *Carex austrocaroliniana*, Tarheel (Lax) Sedge: GL=8?

KY: ST=6? (10+/5). In KY, this southern Appalachian sedge is known only from the

southern Cliff Section, where it occurs on low slopes with acid soil in mesic forest. The 10+ DBNF records (most on USFS) are not associated with ROWs, or within 100 ft of project ROWs.
TN: ST=8; Obed; Scotts Gulf

BSF? *Carex baileyi* (= *C. lurida* var. *gracilis*), Bailey's Sedge: GL=8?
KY: ST=7? (20/7). There may need to be more taxonomic work to separate this northeastern sedge from *C. lurida*, and there may be intergrades in KY. DBNF records are not strongly associated with ROWs, but there may be some from project powerline.
TN: ST=8; CP

BSF? *Carex bromoides*, Brome Sedge: GL= 10
KY: ST=7 (30+/14). DBNF records of this widespread eastern sedge are not clearly associated with ROWs, though there are some in project powerline corridors by coincidence.
TN: ST=7; (probably overlooked o CP in TN)

o *Carex cherokeensis*; Cherokee Sedge; GL=8
KY: ST=4?
TN: ST=7; CPs; DeSelm

(BSF)? *Carex digitalis* var. *copulata*, Coupled Finger Lax-sedge: GL=8?
L KY: ST=4?? (2/2). The single DBNF record of this obscure taxon is not associated with a ROW or near a project powerline.
TN: ST=??

BSF *Carex emoryi* (= *C. stricta* var. *elongata*), Riverbank Sedge: GL=10?
L KY: ST=6? (20+/7). DBNF records of this south-central and western sedge are not associated with ROWs; none are near project ROWs.
TN: ST=??; overlooked in TN

Carex folliculata var. *folliculata*; Northern Long Sedge; GL=9
TN: ST=4; CPs; Patrick BLED (Dugans Glady Meadow)

Carex gigantea, Large (Hop) Sedge: GL=8
KY: ST=3? (4/4). In KY, this southern sedge is known from scattered sites along the lower Ohio River and in the Low Hills Belt. It occurs in lowland swamp forests. The single DBNF record (not on USFS) is not associated with ROWs, or within 100 ft of project ROWs.
TN: ST=7; CPs; Scotts Gulf

Carex glaucescens; Southern Waxy Sedge; GL=8
TN: ST=4; CPs; DeSelm; Jones

Carex hirtifolia, Large Hairy-leaved Sedge: GL=9?
KY: ST=7? (20+/16). DBNF records of this north-central sedge are not associated with ROWs; none are near project ROWs.
TN: ST=5

?*Carex hystericina*, Porcupine Sedge: GL=10
KY: ST=1? (2/2?). Records of this north-central sedge from KY are all old or unverified.

There are up to five records from scattered regions. There are no verified records from DBNF.
TN: ST=4

(BSF) *Carex joorii*, Cypress-swamp Sedge: GL=9
KY: ST=2? (4/2). In KY, this Coastal Plain sedge is known only from the southern Cliff Section, where it occurs on broad ridges in small, seasonal ponds. The four DBNF records (3 on USFS) are not directly associated with ROWs, but two are within 100 ft, where roads have partly impounded the ponds. One record is within 100 ft of a project powerline.
TN: ST=7; CP; Patrick FENT (Gernt Pond); Jones PUTN; Scotts Gulf

Carex juniperorum, Cedar Sedge: GL=4
KY: ST=3 (7/2). This sedge has been recently described from Ontario, Ohio and Kentucky. In KY, it is known from a few sites in the northern Knobs Region on xeric calcareous soils in grassy thickets, generally with much *Juniperus virginiana*.
TN: none.

Carex leptalea ssp. *harperi*, Harper's Swale Sedge: GL=9?
L KY: ST=6? (15+/7). All KY material of this sedge is the southern ssp. *harperi*. Records are not associated with ROWs; none are near project ROWs.
TN: ST=8

BSF? *Carex leptonervia*, Finely-nerved (Lax) Sedge: GL=8
KY: ST=2? (1/1?). In KY, this northeastern sedge is known for sure only from Black Mountain, on damp ground in forest. There is also a report from Leslie Co. which needs

checking.
TN: ST=6; CPne; check this FENT record.

O *Carex meadii*; Prairie Sedge; GL=9
KY: ST=7
TN: ST=5; CPs; DeSelm

(BSF) *Carex pedunculata*, Red-based-tussock Sedge: GL=9?
KY: ST=7? (35+/15). DBNF records of this northern sedge are not associated with ROWs; none are near project ROWs, except for a few coincidental sites at the edge of the forest.
TN: ST=7; CP; Scotts Gulf

BSF O *Carex physorhyncha* (*C. albicans* var. *australis*), Grassland Hill-sedge: GL=9?
L KY: ST=5? (5/3+?). DBNF records of this southern sedge are mostly associated with ROWs, and some are in project ROWs.
TN: ST=5; probably overlooked on CP in TN; DeSelm

BSF o? *Carex picta*, Doughnut Sedge: GL=8?
D KY: ST=7? (40/10+). In KY, this south-central interior sedge is known mostly from parts of the southern Cliff Section and the Pottsville Escarpment. It occurs mostly on ridges and dry slopes on acid soils in subxeric forest. The 30+ DBNF records (most on USFS) may be partly associated with ROWs, but this may be largely accidental, where ROWs run along ridges (like *Gaylussacia brachycera*). Several (ca. 3-5) sites are in project ROWs.
TN: ST=7; probably overlooked on COP in TN

BSF *Carex purpurifera*, Purple-based Lax Sedge: GL=8?

D KY: ST=8? (20/10+). In KY, this Appalachian sedge is known from sites throughout much of the Appalachian and Knobs Regions. It generally occurs on steep slopes with acid soil in mesic to subxeric forest. The 15+ DBNF records (most on USFS) are not associated with ROWs or within 100 ft of project powewrlines. It has been considered a federal candidate, but now appears to be relatively frequent in some regions.

TN: ST=9

BSF *Carex scabrata*, Running Streambed Sedge: GL=9?

KY: ST=7? (30+/17). DBNF records of this northern sedge are not associated with ROWs; none are near project ROWs.

TN: ST=5; CPn

Carex seorsa, Separated Starry-Sedge: GL=8?

L KY: ST=2? (1/1). This east-coastal and southern Great Lakes sedge was recently reported by Allen Risk in KY, from a wooded seep in the Hog Hollow area in Bath Co.

TN: ST=5

Carex straminea, Straw-colored Oval-sedge: GL=8?

L KY: ST=4? (4/4). There are no confirmed DBNF records of this east-central sedge, but this species may be expected. Association with ROWs is unknown but possible.

TN: none?

(BSF) *Carex stricta* (var. *stricta*), Tussock Sedge: GL=10

KY: ST=4? (6/4). In KY, this widespread eastern sedge is known mostly from scattered

sites in the southern Appalachian Plateaus, the Mississippian Plateaus and its transitions. It occurs on lowland terraces and upland swales in acid, boggy soil in forest or brushy openings. The two DBNF records (one on USFS) are not associated with ROWs or within 100 ft of project ROWs.
TN: ST=7; CP

BSF o *Carex styloflexa*, Curved-style Lax-Sedge: GL=9?
KY: ST=7? (5+/5+). Some DBNF records of this southern sedge are associated with ROWs; none are from project ROWs, but it may be expected.
TN: ST=8; CP

o? *Carex tenera*, Tenuous Oval-Sedge: GL=10
KY: ST=7? (5+/5+). The distribution of this species has been difficult to determine because of problems in identification. There may be a few records from wet open areas in the northern DBNF (Bath and Rowan Cos.); none are from project ROWs, but this species might be expected.
TN: ST=2

o *Carex tetanica*, Rigid Panic-Sedge: GL=9?
L KY: ST=5? (4/4). Further taxonomic work is needed to distinguish this northern sedge from the south-central *C. meadii*. (= *C. tetanica* var. *m.*). Some material from DBNF may be *C. meadii*, but that species may also be rare in KY. Some DBNF records are from ROWs, but none are from project ROWs.
TN: none?

?*Carex triangularis*, (Spotted) Fox Sedge: GL=10
KY: ST=4? (5/5?). In KY, this lower Mississippi Valley sedge is known mostly from the Mississippian Embayment. It occurs on bottomland with wet soil in marshy vegetation. The single DBNF record (not on USFS) is based on a collection that cannot be refound, but was apparently not associated with ROWs or within 100 ft of project ROWs.
TN: ST=5

Carex woodii, Narrow-leaved Panic-Sedge: GL=8?
L KY: ST=6? (10+/3). DBNF records of this north-central sedge are not associated with ROWs; none are near project ROWs.
TN: none?

(BSF) *Carya carolinae-septentrionalis* (*C. ovata* var. *australis*), S. Shagbark Hickory: GL=8
KY: ST=7? (20+/4+?). DBNF records of this east-central tree are not associated with ROWs; none are near project ROWs.
TN: ST=9; CP; DeSelm

BSF *Castanea dentata*, American Chestnut: GL=5?
L KY: ST=2 (?/>50). This Appalachian tree has decROWd drastically because of disease. Although it has been listed as endangered in KY, records are not detailed in this report, because much distributional data are not processed, and there is a need to identify the larger sprouts and the rarer nut bearing individuals. Although this species occasionally occurs in ROWs or nearby, no concentration is apparent.
TN: ST=10; CP

BSF o *Castanea pumila* var. *pumila*, Allegheny (Southern) Chinkapin: GL=10
KY: ST=2 (12/8h). In KY, this southern shrub is mostly recorded from the Cumberland Mountains, plus a few sites in the Cliff Section and scattered reports further west. It mostly occurs in subxeric oak/pine-oak forest on acid soil (often near less well-drained areas), especially with a history of fire or similar disturbance. The four DBNF records (2 on USFS) are partly (2) associated with ROWs. None are within 100 ft of project ROWs, but suitable habitat does occur.
TN: ST=8; CP (little/none in south?); DeSelm; Obed

O *Castilleja coccinea*, Indian Paintbrush: GL=10
KY: ST=2? (5/4). In KY, this east-central herb is known from scattered sites in the Knobs Region and Appalachian Plateaus. It occurs on slopes, generally with calcareous soil, in mesic to subxeric grassy openings. The one verified DBNF record (not on USFS) is from a roadside ROW, but is not within 100 ft of project ROWs.
TN: ST=5; CPs; DeSelm

Catalpa bignonioides, Southern Catalpa: GL=9?
L KY: ST=5? (28/3). Doubt has been expressed about the native status of this southern tree in Kentucky, but several sites in southeastern counties appear to have native populatiuons. DBNF records of this southern tree are not associated with ROWs; none are near project ROWs.
TN; ST=6

(BSF) *Ceanothus herbaceus*, Prairie Redroot: GL=10
KY: ST=3? (6/3). In KY, this Great Plains subshrub is known only from the Rockcastle

River corridor, and one site on the Little South Fork. It occurs on open, grassy sandstone cobble bars. The six DBNF records (5 on USFS) are not associated with ROWs. None are within 100 ft of project ROWs.
TN: none

BSF O? *Centrosema virginiana*, Spurred Butterfly Pea; GL=9?
KY: ST=3
TN: ST=8; CPs; DeSelm; Woodson #5

Ceratophyllum muricatum (= *C. echinatum*), Spiny Hornwort: GL=10?
L KY: ST=5? (3/3). This aquatic herb is widespread in eastern North America, but appears more restricted to older, quieter bodies of water than *C. demersum*. DBNF records are not associated with ROWs; none are near project ROWs.
TN: ST=3

o? *Chasmanthium sessilifolium*, Longleaf Woodoats; GL=9
TN: ST=8; DeSelm

Chelone lyonii, Pink Turtlehead; GL=7?
TN: ST=5; CPs; Patrick WARR (nr Dry Cr Sink); Scotts Gulf

Chelone obliqua var. *obliqua* (or var. *erwinieae*?), Red Turtlehead: GL=8?
KY: ST=3? (3/2). In KY, this southern species is known from the Cumberland Mountains as var. *obliqua (*or perhaps var. *erwiniae*), and from the Mississippian Embayment as var. *speciosa*. It occurs on damp acid soil in forest or thicket.

TN; ST=3

BSF *Chrysogonum virginianum*, Green-and-gold: GL=10
KY: ST=3 (19/1). In KY, this southeastern herb is known only from the Big South Fork corridor, where it occurs in mesic forest on terraces and low slopes. The 19 DBNF records (all on NPS) are not associated with ROWs, though some patches are prospering along narrow foot-trails. None are within 100 ft of project ROWs.
TN: ST=4; CPne; Goodson #14

Chrysosplenium americanum, American Golden-saxifrage: GL=10
KY: ST=3? (6/5?). In KY, this northern herb is known only from the Cumberland Mountains and northern Appalachian Plateaus. It occurs mostly on lower slopes around seeping springs with sandy soil, in open forest. The four DBNF records (two on USFS?) are not associated with ROWs, or within 100 ft of project ROWs.
TN: ST=6

(BSF) *Cimicifuga americana*, Mountain Cohosh: GL=8?
L KY; ST=6? (28+/12). DBNF records of this Appalachian herb are not associated with ROWs; none are near project ROWs.
TN; ST=5; CPne; check FENT record.

Cimicifuga rubifolia, Appalachian Bigbane: GL=5
KY: ST=4; no Appalachian records.
TN: ST=6; Ridge & Valley; and disjunct western records.

Circaea alpina ssp. *alpina*, Small Enchanter's Nightshade: GL=10
KY: ST=5 (14/6). In KY, this northern (circumboreal) herb is known only from the Cumberland Mountains, northern Cliff Section, and the Mammoth Cave area. It occurs in sandstone-fringed ravines, often under cliffs, within mesic forest. The eight DBNF records (4 on USFS) are not associated with ROWs. None are within 100 ft of project ROWs.
TN: ST=5; CP (n except one?); Patrick WARR (Dry Cr Sink)

O *Cirsium altissimum*, Tall Wild Thistle: GL=10?
KY: ST=7? 20+/10). Some DBNF records of this south-central herb are associated with ROWs; none are near project ROWs, but it may be expected.
TN: ST=8; CPs? (check); note gap in central CP; Obed (subx forest); Scotts Gulf

BSF O *Cirsium carolinianum*, Early Wild Thistle: GL=9?
KY: ST=7? (40+/10). Most DBNF records of this southern interior herb are associated with ROWs; many are in project ROWs.
TN: ST=7; CP; Goodson #3

BSF *Cladrastis kentukea* (= *C. lutea*), Yellowood: GL=8
KY: ST=7? (50+/11). This southern interior tree has been considered "sensitive" by DBNF in the past. DBNF records are not associated with ROWs; none are near project ROWs. If divided into two subspecific entities, one or more may be considered globally restricted.
TN: ST=7; CP; Scotts Gulf; Falls Creek; Patrick FENT #97 (near Gernt Pond)

BSF O *Cleistes bifaria* (= *C. divaricata* var. *bifaria*), Speading Pogonia: GL=8?
KY: ST=7? (40+/15). Most DBNF records of this southern Appalachian herb are associated

with ROWs; many are in project ROWs.
TN: ST=7; CP; Patrick FENT (Gernt Pond)

BSF? *Clematis* cf. *glaucophylla*, Appalachian Riverbank Leatherflower: GL=8?
KY: ST=7? (25+/6). A few DBNF records are along ROWs (bottomland roadsides), but this may be fortuitous; one is in a project powerline. These plants may be referable to *C. viorna*, sensu stricto; "*glaucophylla*" has been widely misapplied in Kentucky.
TN: ST=??; probably overlooked in TN; "viorna" Obed; "viorna" DeSelm

Clematis cf. *versicolor*, Southern Limestone Leather Flower: GL=8?
KY: ST=6? Recently discovered on bluffs of the Cumberland River.
TN: ST=8; CPne?; Obed bars; there has been taxonomic confusion with *C. glaucophylla*.

o? *Coeloglossum viride* var. *virescens* (= *Platanthera bracteata*), Long-bract Green Orchis: GL=10
KY: ST=1? (1/1h). There is only one KY record of this northern (circumboreal) orchid, a 1888 collection from "Corbin". It may be expected in "rich woods, thickets and meadows", possibly in ROWs.
TN: ST=2

Collinsia verna, Blue-eyed Mary; GL=8
KY: ST=7
TN: ST=3; CP?? (or to west); Patrick hist (near Celina, flooded by Cordell Hills Reservoir?)

Collinsonia verticillata, Whorled Horse-balm: GL=6?
KY: ST=2? (1/1?). This southeastern herb was recently discovered in KY for the first time, a few miles east of the DBNF in Whitley Co. It occurs in the Rugged Eastern Area, on a low N-facing slope in mesic forest. This species is not known to be associated with ROWs.
TN: ST=5

BSF *Comptonia peregrina*, Sweet-fern: GL=10
KY: ST=2? (2/2). In KY, this northern subshrub is known only from the Rockcastle River and Big South Fork corridors, where it occurs in brushy vegetation at the back of open, grassy cobble bars. The two DBNF records (both on USFS/NPS) are not associated with ROWs, and are not within 100 ft of project ROWs.
TN: ST=2; CPne

BSF *Conradina verticillata*, Cumberland Rosemary: GL=4?
KY: ST=3? (11/1). This subshrub is endemic to the southern Cliff Section in KY and TN, along the Big South Fork and a few other large streams further south. It occurs on open, grassy boulder-cobble bars derived from sandstone. The 11 DBNF records (all on NPS) are not associated with ROWs. None are within 100 ft of project ROWs.
TN: ST=4; CPn; Obed bars

Convallaria montana, American Lily-of-the-valley: GL=8
KY: ST=3? (2/1). In KY, this southern Appalachian species is known only from Cumberland Mountain. It occurs on mesic-subxeric sites in forest.
TN: ST=7; CPs?

(CUM)? o *Corallorhiza maculata*, Spotted Coralroot: GL=10

KY: ST=2? (2/1). In KY, this northern orchid is known only from a few scattered sites in Appalachian regions. It occurs in disturbed mesic forest on terraces and ridges, especially on sandy soil. The two DBNF records (none on USFS) are not associated with major ROWs, but the plants have probably been influenced by nearby trails and other disturbed ground. None are within 100 ft of project ROWs.

TN: ST=3

BSF *Coreopsis pubescens*, Star Tickseed: GL=10?

KY: ST=4? (20/3). In KY, this southern herb is known mostly from the Big South Fork and Roaring Paunch Creek corridors, plus a few other streams in the southern Cliff Section (and disjunct in ...... Co.). It occurs mostly in brushy zones along sandy river banks, especially at the back of boulder-cobble bars. The 19 DBNF records (17 on NPS/USFS) are not associated with ROWs (except in 2 cases close to roadbeds). None are within 100 ft of project ROWs.

TN: ST=7; CP

Cornus racemosa, Gray-bark Dogwood: GL=10?

L KY: ST=5? (5/3). DBNF records of this northern shrub are not associated with ROWs; none are near project ROWs.

TN: none; check reported "*C. stolonifera*" at Falls Creek.

(BSF) *Corydalis sempervirens*, Northern Corydalis: GL=10

L KY: ST=6? (15+/4). DBNF records of this northern annual are not associated with ROWs; none are near project ROWs.

TN: ST=5; CP (2 cos. only); check records

Cotinus obovatus, Smoke-tree: GL=8
TN: ST=4; CP (all s?); DeSelm; Obed bars (check)

(BSF)? *Crataegus uniflora*, Single-flowered Hawthorn: GL=9?
KY: ST=7? (10+/3+). DBNF records of this southern tree are not associated with ROWs; none are near project ROWs.
TN: ST=5; probably overlooked along CP margins.

BSF o *Crotonopsis elliptica* (= *Croton wildenovii*), Common Rushfoil: GL=10
KY: ST=7? (10+/8). DBNF records of this southern annual are not associated with ROWs; none are near project ROWs. However, it might be expected near rock outcrops.
TN: ST=7; CP; DeSelm; Obed

Cymophyllus fraserianus (= *C. fraseri*): Fraser's Sedge: GL=8
KY: ST=3? (7/2). In KY, this southern Appalachian sedge is known only from the Cumberland Mountains. It occurs on mesic sites, often on streambanks, in forest.
TN: ST=7

(BSF) o? *Cyperus bipartitus* (= *C. rivularis*), Red-tipped Annual Flatsedge: GL=10
KY: ST=7? (15+/12). Some DBNF records of this widespread eastern sedge may be associated with ROWs; none are from project ROWs.
TN: ST=8; CP

BSF o? *Cyperus plukenetii*, Plukenet's Cyperus: GL=9?

KY: ST=2? (4/1h?). The only verified KY records of this southern sedge are 1930s Braun collections from McCreary Co. in the Cliff Section (both likely on current USFS land): 731, "dry sandy soil, red sandstone knobs S of Stearns"; 4192, "Yahoo Ridge, sandstone knob". During this study two collections were tentatively identified as this species, from a project powerline near the Alum Creek road, in the same locality as the Yahoo Ridge.

TN: ST=4; probably often overlooked

BSF *Cypripedium kentuckiense*, Kentucky Lady's-slipper: GL=6

KY: ST=4 (50+/10). In KY, this southern orchid (of lower Mississippi drainage) is largely restricted to the Cliff Section and parts of adjacent regions. It generally occurs along medium sized streams, on washed over sandy soil, in mesic to subhydric terrace and streamside forest. The ca. 40 DBNF records (15 on USFS) are not associated with ROWs, except for a few (2) along dirt roads and trails. None are within 100 ft of project ROWs.

TN: ST=3; CP (2 cos. ne+s);

Cypripedium parviflorum (var. *parviflorum*) Small Yellow Lady's-slipper: GL=10?

KY: ST=2? (11/7). In KY, this northern orchid (sometimes included with *C. pubescens* as a variety) is recorded only from the Cliff Section and perhaps Pine Mountain. It mostly occurs on slopes with acid, sandy soil, in mesic-subxeric forest. The four DBNF records (2 on USFS) are not associated with ROWs, though some plants may occur along trails. None are within 100 ft of project ROWs, but there is suitable habitat.

TN: ST=5; CP (2 central cos. only)

BSF o *Cypripedium pubescens*, Yellow Lady's Slipper: GL=10

KY: ST=7? (100+/40+). Some DBNF records of this north-central herb are associated with ROWs, or in the partial shade of adjacent; one is in a project powerline.
TN: ST=7; CP; Obed; Scotts Gulf; Patrick PICK (Flint Hollow)

Cypripedium reginae, Showy Lady's-slipper: GL=8
KY: ST=1 (1/1h). The only verified record of this northern orchid in KY is an 1888 collection, labelled just "Corbin, Ky."
TN: ST=2

BSF? *Cystopteris tennesseensis*, Southern Fragile Fern: GL=8?
KY: ST=7? (50+/32+). DBNF records of this southern interior fern are not associated with ROWs; none are near project ROWs.
TN: ST=8; CP

Cystopteris tenuis (= *C. fragilis* var. *mackayi*), Northern Fragile Fern: GL=9?
L KY: ST=5? (7/3+). The few DBNF records (or nearby records) are mostly tentative. They are not associated with ROWs or near project ROWs.
TN: ST=2

Decodon verticillatus, Swamp Loosestrife: GL=10
L KY: ST=5? (11+/9). In KY, this widespread eastern subshrub is known mostly in western wetlands, and there are a few sites in the northern Knobs Region. It occurs mostly in floating mats around pond margins. Taxonomic work is needed to distinguish var. *verticillatus* from the more glabrous var. *laevigata*. The latter may be restricted to northern regions (including the DBNF record), and may it deserve higher official rank. The single

DBNF record (not on USFS--a new A. Risk site) is not associated with a ROW or within 100 ft of a project powerline.
TN: ST=4; CPc check records

BSF? *Dentaria maxima*, Lesser Broad-leaf Toothwort: GL=8?
KY: ST=7? (10+/6+). Taxonomic work is needed to distinguish this northeastern herb from *D. diphylla*. It has been suggested to be of hybrid origin from *D. diphylla* and *D. laciniata* (or more likely *D. hetrophylla*?), but there are several sites in Kentucky where large homogeneous population have been seen. DBNF records are not associated with ROWs; none are near project ROWs.
TN: ?? check taxonomy...

BSF *Deschampsia flexuosa*, Crinkled Hair Grass: GL=10
KY: ST=4? (4/3). In KY, this northern (circumboreal) grass is known only from Cumberland Mountain and the southern Cliff Section. It occurs on cool rocky slopes with acid soil in subxeric forest. The single DBNF record (on USFS) is not associated with ROWs or within 100 ft of project ROWs.
TN: ST=5; CP; Scotts Gulf

(BSF) o *Desmodium cuspidatum*; Large-bracted Tick-trefoil; GL=8?
KY: ST=7
TN: ST=7; CP; Scotts Gulf; Falls Creek

BSF O *Desmodium obtusum* (= *D. rigidum*), Stiff Tick-trefoil: GL=9?
KY: ST=7? (>10/5). A review of data is needed. This southern herb may be concentrated in

rights-of-way, and there are at least four records from project ROWs.
TN: ST=7; CP; DeSelm; Scotts Gulf

o? *Dichanthelium boreale* (= *Panicum b.*, *P. bicknellii*), Northern Witch Grass: GL=10
KY: ST=5? (12/7). In KY, this north-central grass is known mostly from the Cliff Section (also Oldham Co.). It generally occurs on narrow ridges and clifftops, with sandy to calcareous soil, in subxeric-xeric open woods. The ca. 6 DBNF records (5 on USFS?) are not associated with ROWs. None are within 100 ft of project powerline, but suitable habitat does occur.
TN: ST=4; CP? check records

?*Didiplis diandra*, Water-purslane: GL=10?
KY: ST=5? (4/4?). There is an unconfirmed report of this southern aquatic herb from DBNF, along Jellico Creek (R. Cicerello, pers. comm.). [There may be confusion with *Callitriche heterophylla*.] This site is not in an ROW or within 100 ft of a project powerline.
TN: ST=3

O *Digitaria violascens*, Tropical Crab-grass: GL=10
L? KY: ST=5? (5/3). It is possible that this pantropical grass is only adventive in Kentucky. The few DBNF records are all along ROWs, and two are from project ROWs.
TN: ST=6; CP? (one co.)

(CUM)? *Disporum maculatum*, Spotted Mandarin: GL=7?
L? KY: ST=6? (20+/8). DBNF records of this west Appalachian herb are not associated

with ROWs; none are near project ROWs. This species is considered G3 (GL=6) by TNC.
TN: ST=7; CP (not nw?); Falls Creek; Scotts Gulf; note apparent gap in central CP between nKY and sTN

Dodecatheon frenchii, French's Shooting-star: GL=6
KY: ST=5? (23/10). This herb is endemic to the Ozark Region (eastern section?), Shawnee Hills and a few sites in the northern Cliff Section of KY. It occurs along sandstone cliffROWs under overhangs, on moderately dry ground. The single DBNF record (on USFS) is not associated with a ROW, and is not within 100 ft of project ROWs.
TN: none

O *Drosera brevifolia*, Dwarf Sundew; GL=9
KY: ST=2; just west of CP
TN: ST=3; CPs; Jones (historical ref.)

O? *Drosera capillaris,* Pink Sundew; GL=8
TN: ST=2; CPs; Patrick VANB (nr Dugans Glady Meadow)

(BSF)? o? *Drosera intermedia*, Spoon-leaved Sundew: GL=10?
KY: ST=1? (2/2h). In KY, this widespread eastern herb of boggy wetlands is known only from two pre-1900 records. One record, including two mapped sites, is from about a mile west of the DBNF near Cave Run Dam. This species does occur in ROWs elsewhere in its range, and it might be expected in the Morehead area.
TN: ST=4; CP; Obed bars; Jones CUMB

Drosera rotundifolia, Roundleaf Sundew; GL=10
TN: ST=3; CPne; Patrick FENT (Magadenz Falls)

Dryopteris carthusiana (= *D. spinulosa*), Spinulose Wood Fern: GL=10
KY: ST=6? (20+/14). In KY, this northern (circumboreal) fern is widely scattered in the state, but few large populations have been documented. It occurs generally in mesic to submesic or subhydric forest on acid soils. The ca. 5 DBNF records (all on USFS/NPS?) are not associated with ROWs. None are within 100 ft of project ROWs.
TN: ST=4

Dryopteris celsa, Log Fern; GL=8?
TN: ST=6; CPcs

(BSF) o? *Dulichium arundinaceum*, Three-way Sedge: GL=10
L KY: ST=6? (20?/15). This widespread North American subaquatic sedge occasionally occurs in roadside ditches. The few DBNF records may be partly associated with ROWs; and one is along a road and near a project powerline (Whitley City Quad).
TN: ST=7; CP; Obed; Jones CUMB, FENT

(BSF) o *Echinacea purpurea*, Broad-leaf Purple Coneflower: GL=8?
KY: ST=7? (>50/>15). Most DBNF records of this east-central herb are along ROWs; some (3-5) are in project ROWs or within 100 ft.
TN: ST=7; CPs (check to n also?); Scotts Gulf

o? *Echinocystis lobata*, Balsam-apple Cucumber: GL=9?

L KY: ST=4? (10/9h). There are very few recent verified Kentucky records of this widespread eastern annual vine. The two DBNF records (both 1930s records from Morehead) include one along a ROW; suitable habitat may be expected along project ROWs, but the species has disappeared from this region.
TN: none

(BSF) *Eleocharis equisetoides*, Jointed Spikerush; GL=9
TN: ST=3; CPne; Jones (historical); Patrick historical FENT (Gernt Pond), PUTN

(BSF) *Eleocharis microcarpa,* Small-fruited Spikerush; GL=8?
TN: ST=6; CP; DeSelm; Jones

(BSF) *Eleocharis tuberculosa,* Cone-cup Spikerush; GL=9?
TN: ST=6; DeSelm; Jones

?*Elymus svensonii* (or hybrids), Svenson's Wild Rye: GL=5?
KY: ST=6? (30/8+). This species is largely endemic to the Bluegrass Region of KY and the Nashville Basin of TN, where it occurs mostly on xeric calcareous slopes in open oak/ash/cedar forest. There are no DBNF records, but a possible hybrid with *E. virginicus* was found a mile north of the Berea District. This species is not associated with ROWs, though it may flourish accidentally where ROWs run through its habitat.
TN: ST=4

(CUM) *Equisetum laevigatum*, Smooth Horsetail: GL=10
L KY: ST=5? (3/3?). The single DBNF record of this western horsetail is not associated

with a ROW or within 100 ft of a project powerline.
TN: none

(CUM) *Epilobium ciliatum* var. *adenocaulon* (*E. glandulosum* var. *a.*), American Willow-herb: GL=10?
L KY: ST=3? (1/1). The single DBNF record of this northern and western herb is not associated with a ROW or within 100 ft of a project powerline.
TN: ST=3

BSF o? *Erigeron pulchellus* var. *brauniae*, Smooth Robin's-plantain: GL=6
KY: ST=7? (25+/9). This herb is endemic to the Appalachian Cliff Section of Ohio, Kentucky and Tennessee. DBNF records are not associated with open ROWs, though several are from the footpaths that often runb through its habitat. There are no records from project ROWs but it may be expected on bottomlands.
TN: ST=?? (has not been distinguished frin var. p.)

BSF o *Eriophorum virginicum*, Tawny Cotton-grass: GL=10
KY: ST=2? (3/3). In KY, this northern sedge is known from scattered sites in Appalachian regions. It occurs in swales on terraces and broad ridges with acid, boggy soil in open hydric grassy vegetation. The two DBNF records (one on USFS) are partly (1) associated with ROWs. None are within 100 ft of project ROWs, but suitable habitat does exist.
TN: ST=4; CP; Jones (historical); Patrick (historical, bog near Clarkrange)

o *Eryngium prostratum*, Prostrate Eryngo: GL=8?
KYL ST=7? (20+/11). This southern herb is known from ROWs and adjacent fields in the

eastern Knobs Region. It is unknown in DBNF, but may be expected on some bottomlands.
TN: ST=7; CPs

(BSF) O *Eryngium yuccifolium*, Rattlesnake-master: GL=10
L KY: ST=7? (100/30+). In KY, this southeastern and mid-western herb is known mostly from the western Karst Plains, Shawnee Hills and Mississippian Embayment. It mostly occurs on subxeric gentle upland slopes or flats in native grassland remnants. The four DBNF records (1-2 on USFS) are mostly (all 4?) associated with ROWs, and one is in a project powerline.
TN: ST=7; CPs; DeSelm; Scotts Gulf

Erythronium rostratum, Golden-star: GL=10
KY: ST=6? (10+/5). In KY, this southern Appalachian (and Piedmont) herb is known only from the northern Appalachian Plateaus. It generally occurs on lower slopes, with acid soil, in mesic forest. The three DBNF records (all on USFS?) are not associated with ROWs. None are within 100 ft of project ROWs.
TN: ST=4; CPs (note gap from nKY to sTN)

(BSF)? O *Eupatorium hyssopifolium* var. *h.*, Narrow-leaf Whorled Thoroughwort: GL=8?
L? KY: ST=4? (3/3). Further taxonomic work is needed to clearly distinguish material of this southernvariety from the more widespread var. *laciniatum*. Most or all DBNF records are from ROWs; two are from project ROWs.
TN: ST=?? (not separated)

(CUM) o? *Eupatorium semiserratum*, Small-flowered Thoroughwort: GL=9?

KY: ST=2? (2/2?). In KY, this southern herb is known only from one site in the southern Cliff Section, plus another obscure record from Henry Co. Elsewhere in its range, it occurs on gentle upland slopes and flats, often in native grassland. The single DBNF record (on USFS) is on a low rocky bench along the Cumberland River. It is within 30 ft of a small footpath, but does not appear significantly influenced by it. It is not within 100 ft of a project powerline.
TN: ST=5

Eupatorium steelei, Steele's Joe-pye-weed: GL=6?
KY: ST=4? (>5/>1?). In KY, this recently described southern Appalachian herb is known only from the Cumberland Mountains. It occurs on mesic (to subxeric?) sites in forest or thickets.
TN: ST=5

BSF o *Euphorbia mercurialina*, Mercury Spurge: GL=7
KY: ST=4? (10+/3). In KY, this southeastern herb is known only from the Big South Fork area and the adjacent Mississippian Plateaus. It occurs on slopes in mesic to subxeric forest, often on slightly exposed or bare soil, where leaf litter has been removed. The nine DBNF records (all on NPS/USFS) are partly (3+) associated with ROWs, including some along dirt roads and trails. One is in a project powerline (on NPS).
TN: ST=8; CP; DeSelm; Obed bars; Scotts Gulf; Falls Creek; Woodson #9,14

Fimbristylis perpusilla, Least Fimbry; GL=4?
L KY: ST=1; recently discovered by D. Boone.
TN: ST=2; CPs; Jones FRAN

O? *Fimbristylis puberula*, Hairy Fimbry; GL=9
KY: ST=4; unknown in Appalachian regions.
TN: ST=4; CPc; Patrick #11 historical (Dugans Glady Meadow); Jones (historical)

BSF *Fothergilla major*, Mountain Witchalder; GL=5
KY: ST=2; recently discovered along Big South Fork.
TN: ST=5; CPne; Patrick SCOT (Leatherwood Ford)

Gaylussacia dumosa, Dwarf Huckleberry; GL=8?
TN: ST=4; CPs; Jones VANB

BSF *Gaylussacia brachycera*, Box Huckleberry: GL=7
D KY: ST=7? (100+/5). In KY, this Appalachian subshrub is known only from the southern Cliff Section, where it occurs mostly on ridges and upper slopes with sandy soil in pine-oak forest. The 100+ DBNF records (most on USFS) are not associated with ROWs, except for coincidental cases. About 5+ are within 100 ft of project ROWs.
TN: ST=7; CPne; Goodson #2,16

O *Gentiana alba*, Yellow (White) Gentian: GL=8
KY: ST=2 (10/3h). In KY, this northwestern herb is known only from scattered records in the Eden Shale Hills and the Eastern Knobs. It occurs in remnants of native grassland on subxeric to xeric calcareous soils. The single extant DBNF record (not on USFS but close) is within 30 ft of a highway. It is not within 100 ft of project ROWs.
TN: none

o? *Gentiana decora*, Showy (Mountain) Gentian: GL=7?

KY: ST=5? (12/3). IN KY, this southern Appalachian herb is known only from the Cumberland Mountains, It generally occurs on sandy ridges and upper slopes in open, subxeric pine/oak woods, often along trails (such as the Little Shephard Trail. Although unknown on land in DBNF or just west of Pine Mountain, this species might be expected in ROWs there.

TN: ST=7; CPc (one co.)

(BSF) o? *Gentianella quinquefolia* ssp. *occidentalis* (*Gentiana q.*), Stiff Gentian: GL=8?

KY: ST=7? (>20/7). A review of Kentucky data is needed. The few DBNF records may be partly associated with ROWs; one is from a project powerline (Bell Farm Quad).

TN: ST=7; CP; Scotts Gulf

Geum laciniatum, Rank Avens: GL=9?

KY: ST=7? (5+/4+?). This northern herb is known from a bottomland east of DBNF near London (Laurel Co.). It may be expected in DBNF, and may occur in ROWs.

TN: none

Glyceria acutiflora, Creeping Mannagrass; GL=8

KY: ST=4; unknown in Appalachian regions.

TN: ST=4; CPs; Jones WHIT, HAMI, FRAN

BSF *Glyceria melicaria*, Slender Manna-grass: GL=9?

L KY: ST=6? (22+/12). DBNF records of this northeastern grass are not associated with ROWs; one is with 200 feet of a project powerline, but probably not influenced by it.

TN: ST=7; CPne;

Glyceria septentrionalis, Floating Manna-grass: GL=10?
L KY: ST=6? (25+/17). Further taxonomic work on this north-central grass is needed to distinguish the typical variety from var. *arkansanas*. The latter appears restricted to western regions, but both may deserve official listing. A few DBNF records are associated with ROWs, but none are from project ROWs.
TN: ST=6; CP (not n?)

O? *Gnaphalium helleri,* Heller's Cudweed; GL=8?
KY: ST=5? Confusion with *microdenium* needs to be resolved.
TN: ST=4; CPs; Scotts Gulf

Gratiola brevifolia, Sticky Hedgehyssop; GL=7?
TN: ST=4; CP (scattered, not nw); Obed (aquatic)

(BSF) O *Gratiola pilosa*, Shaggy Hedge-hyssop: GL=9
KY: ST=3? (12/3). In KY, this southern herb is known only from the southern Cliff Section and Low Hills Belt, where it occurs on broad ridges and high terraces in seasonally wet, acid soil with open brushy or grassy vegetation. The 10 DBNF records (6 on USFS) are mostly (7+) in rights-of-way or influenced by them. None are within 100 ft of project ROWs, but much suitable habitat occurs.
TN: ST=7; CP

(CUM)? o? *Gratiola viscidula* var. *shortii*, Short's Hedge-hyssop: GL=8?

KY: ST=4? (9/9). In KY, most records of this Appalachian herb (as the var.) are from broad bottomlands either side of the Cliff Section. It occurs in hydric, marshy margins of ponds and sloughs, with open grassy or brushy vegetation, sometimes in ROWs. Although unknown within DBNF, there are several records from within 1-10 miles of the boundary.
TN: ST=5; CPc

BSF O *Gymnopogon ambiguus*, Bearded Skeleton Grass: GL=8
KY: ST=3? (11/6). In KY, this southeastern grass is known mostly from the southern Cliff Section and the Dripping Springs Hills. It occurs on broad ridges, flats and perhaps scoured riverbanks in sandy soil with open grassy vegetation. The two recent DBNF records (both on USFS) are both in a ROW. This ROW is a combination of a project powerline and a roadside corridor.
TN: ST=7; CP (not n?); DeSelm

O? *Hedeoma hispidum*, Rough Pennyroyal: GL=10
KY: ST=2? (4/4). In KY, this mid-western herb may be at least partly adventive from the west. There are scattered records from open dry or rocky disturbed ground. The single DBNF record (not on USFS) may not be associated with a ROW, but it is on a strip mine. It is not within 100 ft of project ROWs.
TN: ST=7

BSF O *Helianthus angustifolius*, Narrow-leaved Sunflower: GL=10
KY: ST=7? (30+/10+). Most DBNF records of this southern herb (or records nearby) are associated with ROWs; one is from a project powerline.
TN: ST=9; CP; DeSelm; Obed bars; Patrick BLED (Dugans Meadow)

BSF O *Helianthus atrorubens*, Red-disked Sunflower: GL=9?
L KY: ST=7? (100+/6). In KY, this southeastern and Appalachian herb is known only from the southern Cliff Section, where it occurs mostly on subxeric broad sandy ridges in brushy or grassy vegetation. The 100+ DBNF records (mostly on USFS) are mostly associated with ROWs, and many are in project ROWs.
TN: ST=8; CP; DeSelm; Goodson #4,11; Obed bars

?? O *Helianthius eggertii*, Eggert's Sunflower: GL=5?
KY: ST=5. Reports of this species from DBNF have been based on erroneous identifications. There has been much confusion with *H. strumosus*, which needs a thorough reassessment before distributions and rare status can be stated definitively.
TN: ST=5; CPs?; "Obed bars" (but probably referable to *strumosus*).

O *Helianthus grosseserratus*, Coarsely Serrate Sunflower: GL=10?
KY: ST=7? (8/8?). It has been suggested that some or all Kentucky records of this western herb are adventive, but this is difficult to determine. The few DBNF records may all be from ROWs; none are from project ROWs but it may be expected.
TN: ST=4

(BSF) O *Helianthus mollis*, Downy Sunflower: GL=10
KY: ST=7? (50+/15+). The few DBNF records of this southwestern herb are all from ROWs; one is from a project powerline.
TN: ST=8; CPne (one co.)

O *Helianthus occidentalis*, Midwestern Sunflower: GL=9

KY: ST=7; almost no Appalachian records.
TN: ST=7; CPs?; DeSelm [varieties to be checked].

O *Helianthus silphioides*; Ozark Sunflower; GL=7
KY: ST=3? There has probably been some confusion with *H. atrorubens*; Appalachian records may all be *atrorubens*; Interior Low Plateaus records may all be *silphioides*.
TN: ST=7?; CPs?; DeSelm

BSF? *Helenium brevifolium*, Shortleaf Sneezeweed: GL=5?
TN: ST=2; CPnw; Obed bars; Patrick historical (Clear Fork, BSF?)

(BSF) O? *Hexalectris spicata*, Crested Coral-root: GL=9?
KY: ST=7? (>20/17?). A review of Kentucky data for this south-central orchid is needed. The few DBNF records are partly from ROWs; one is within 100 feet of a project powerline (Nevelsville Quad).
TN: ST=7; CP (2 cos.); Scotts Gulf

BSF *Hexastylis contracta*, Cumberland Heartleaf: GL=6
KY: ST=3? (5/1). This herb is endemic to the southern Cliff Section in KY and TN, and the Blue Ridge of NC. It occurs on slopes and terraces in sandy soil in mesic forest. The four DBNF records (3 on USFS) are partly (2) in ROWs, but this is probably mere coincidence, since the species appears to tolerate shade very well. Two records are in project ROWs.
TN: ST=6; CP (not s); Goodson #5; Obed

Hexastylis heterophylla, Appalachian Heartleaf: GL=9

KY: ST=6? (15+/4+). In KY, this montane Appalachian herb is known only from the Cumberland Mountains, plus a few sites in the southern Low Hills Belt. The single DBNF record (not on USFS) is not associated with a ROW, and it is not within 100 ft of a project powerline. [Note that records of *H. virginica* from the CP and CM of KY and KY appear to be erroneous identifications of this species or *H. contracta*.]
TN: ST=6

(CUM)? O *Hieracium scabrum*, Rough Hawkweed: GL=9
KY: ST=8.
TN: ST=5; CPn (few data); Obed

Hottonia inflata, Featherfoil: GL=8?
KY: ST=7? (15?/11). There is an 1834 record of this south-central aquatic herb from just west of DBNF in Rowan Co. It appears very unlikely that it remains in this region.
TN: ST=4

Houstonia serpyllifolia (= *Hedyotis michauxii*), Michaux's Bluets: GL=8?
KY: ST=2? (3/2). In KY, this southern Appalachian herb is known only from Pine Mountain. It occurs close to streams and waterfalls in at least partly open conditions.
TN: ST=6; CPc? (one co.)

(BSF) o? *Humulus lupulus* var. *lupuloides* (= *H. americanus*), American Hops: GL=10?
L KY: ST=4? (6/5). The few DBNF records (or nearby records) of this northern vine are not associated with ROWs or near project ROWs.
TN: ST=2

BSF *Hydrastis canadensis*, Goldenseal: GL=10

KY: ST=8? (100+/60). In KY, this north-central herb is known from most well-forested regions, mostly on mesic-subxeric, moderately base-rich slopes in forest. The 50+ DBNF records (most on USFS) are not associated with ROWs. They are not within 100 ft of project ROWs, except perhaps for a few (3-5) accidental occurrences. [R. Emmott recently found several patches in a rich hollow atr BSF.]

TN: ST=8; CP; Obed; Scotts Gulf; Patrick WARR (Dry Br. Sink), CAMP (Morley RR).

BSF *Hydrocotyle americana*, American Water-pennywort: GL=10

KY: ST=2? (2/2h). In KY, this northern herb is known only from the Appalachian Plateaus. It occurs on medium-sized valley bottoms in acid, boggy soil within subhydric streamside or terrace forest. The single DBNF record (on USFS) is not associated with a ROW, and is not within 100 ft of a project powerline.

TN: ST=3; CP (2 cos.); Patrick historical VANB (Fall Creek Falls), SCOT (No Business Cr.)

O? *Hydrolea ovata,* Ovate-leaved Fiddleleaf: GL=7?

KY: ST=3; no Appalachian records.

TN: ST=2; CPs; Jones

Hydrophyllum virginianum, Virginia Waterleaf: GL=10

KY: ST=6? (10+/8). In KY, this northern herb is known mostly from the Cumberland Mountains, plus a few scattered records in northern regions. It occurs on cool slopes in fertile soil within mesic forest. The single DBNF record (on USFS) has not been verified. The reported locality is not associated with ROWs, and it is not within 100 ft of project

ROWs.
TN: ST=6

(CUM)? O *Hypericum canadense*, Narrow-leaved St. John's Wort: GL=10
L KY: ST=5? (8/8). Some records of this north-central herb near DBNF are from ROWs; it might be expected in DBNF from project ROWs.
TN: ST=6; CP; DeSelm

BSF? O *Hypericum crux-andreae*, St. Peter's-wort: GL=10
KY: ST=3? (11/9). In KY, this southern subshrub is known from the Eastern Karst Plain, Southern Cliff Section, and Southern Low Hills Belt. It occurs on broad ridges, flats and high terraces in seasonally wet, acid soil with open, brushy or grassy vegetation. The nine DBNF records (3 on USFS) are mostly (5+) in ROWs. One is in a project powerline, but no others are within 100 ft.
TN: ST=7; CP; DeSelm; Obed bars; Scotts Gulf

BSF o *Hypericum denticulatum* var. *recognitum,* Coppery St. John's Wort: GL=8?
KY: ST=7; should all be renamed *H. virgatum.*
TN: ST=8; CP [as var. *acutifolium*]; Scotts Gulf; Obed bars; DeSelm

BSF o? *Hypericum hypericoides* (= *Ascyrum h*. var. *h*.), Shrubby St. Andrew's Cross: GL=10?
KY: ST=7? (10++/5+?). DBNF records of this southern subshrub are probably not associated with ROWs (though there may be some concentration along footpaths and dirt roads); none are near project ROWs but it may be expected.

O? *Hypericum gymnanthum,* Southeastern Annual St. John's Wort: GL=8?
KY: ST=2? Recently reported by M. Hines from Webster Co.
TN: ST=4; CPs; DeSelm

(BSF)? o?*Hypericum nudiflorum*, Early St. John's Wort: GL=6?
KY: ST=2?
TN: ST=6; CP; Scotts Gulf; [see also Patrick CANO, HRim]

(BSF) *Ilex montana* var. *beadleyi* (= var. *mollis*), Downy Mountain Holly: GL=8?
L? KY: ST=5? (5/3?). DBNF records of this Appalachian shrub are not associated with ROWs or near project ROWs.
TN: ST=8v? (not separated in atlas)...

BSF o *Iris verna* var. *smalliana,* Dwarf Mountain Iris: GL=7
KY: ST=7; note the odd gap in range between ne Kentucky and ne Tennessee.
TN: ST=7; CPnc; Patrick FENT (Gernt Pond)

BSF? o *Isoetes engelmannii*, Eastern Quillwort: GL=10?
KY: ST=7B? (30+/16). Further taxonomic work on this southeastern and east-coastal quillwort is needed to determine if some KY material is referrable to *I. caroliniana*. DBNF records are not generally associated with ROWs (though there mayt be some concentration along footpaths or dirt road-ruts); none are from project ROWs.
TN: ST=7; CP; Patrick FENT (Gernt Pond)

BSF *Juglans cinerea*, Butternut (White Walnut): GL=8?

KY: ST=7? (100+/50+). In KY, this north-central tree has declined greatly in recent decades due to diseases. It may still be widespread, but appears to survive best in the Appalachian Plateaus, especially on mesic slopes or terraces in sandy soil, in open or successional forest. The many DBNF records are not associated with ROWs, other than coincidental occurrences. Several trees probably occur within 100 ft of project ROWs.

TN: ST=7?; CP; Scotts Gulf; Falls Creek; Patrick PICK (Flint Fk Cove); Obed

o? *Juncus articulatus*, Jointed Rush: GL=10

KY: ST=5? (8/6). In KY, this northern (circumboreal) rush is known mostly from the northern Cliff Section. It occurs on rocky banks of medium-sized streams and along some roadside ditches. The three DBNF records (2 on USFS) may be partly (1) associated with ROWs, but there are not enough data to be sure. None are within 100 ft of project ROWs.

TN: none

BSF o *Juncus bufonius*, Toad Rush: GL=10

KY: ST=7? (8/7). Some records of this widespread (semicosmopolitan) rush from DBNF or nearby are from ROWs; but none are from project ROWs.

TN: ST=3?; probably much overlooked; DeSelm

BSF? o *Juncus canadensis*, Large-seeded Nodulose Rush: GL=10?

KY: ST=7? (15+/7+). Some records of this north-central rush from DBNF or nearby are from ROWs; two are from project ROWs.

TN: ST=7; CP; DeSelm; Scotts Gulf; Patrick BLED (Dugans Meadow)

BSF O *Juncus coriaceus*, Shining Rush: GL=10
KY: ST=7? (15+/7+). Some records of this southern rush from DBNF or nearby are from ROWs; one (?) is from a project powerline.
TN: ST=8; CP; DeSelm; Scotts Gulf

o? *Juncus elliottii,* Elliott's Rush: GL=8
KY: ST=2
TN: ST=5; CPs; DeSelm

o? *Juncus filipendulus,* Ringseed Rush: GL=9
KY: ST=3; no Appalachian records.
TN: ST=7; CPc?; DeSelm

o? *Juncus subcaudatus*, Mountain Rush: GL=8
KY: ST=3?
TN: ST=6; CPc; DeSelm

(CUM) *Juniperus communis*, Common Juniper: GL=10
KY: ST=3 (10+/2). Further taxonomic work may be needed to determine if var. *depressa* applies to some or all KY plants--the southern population (in Pulaski Co.) is low and spreading, but the northern population (in Menifee Co.) is more erect (elliptic) in growth form. In KY, this northern (circumboreal) shrub is known only from the Cliff Section, where it occurs along sandstone clifftops. The 10+ DBNF records (in two major clusters, all on USFS) are not associated with ROWs. Non are within 100 ft of project ROWs.
TN: none

o? *Lachnocaulon caroliniana* (*L. minus*), White-headed Bogbutton: GL=8
TN: ST=1; CPc; Jones hist. CUMB; correct name is probably *minus*.

BSF *Lathyrus palustris*, Vetchling (Riverbank) Peavine: GL=10
KY: ST=3? (8/5). In KY, this northern twining herb is known from scattered sites along the Ohio River and in the Cliff Section. It occurs on rocky banks of larger streams in the brushy transition between open grassy banks and adjacent forest. The six DBNF records (3 on USFS) are not associated with ROWs. None are within 100 ft of project ROWs.
TN: ST=4; CP

o? *Lathyrus venosus*, Smooth Veiny (Upland) Peavine: GL=10
KY: ST=5? (8/6). In KY, this northern herb is known only from Appalachian regions, where it occurs on rocky ridges and upper slopes in somewhat open, brushy forest, perhaps with much fire-history. The three DBNF records (none on USFS) may be partly (1) associated with ROWs. These are not within 100 ft of project ROWs, but there is probably suitable habitat.
TN: ST=5

(CUM) o *Leavenworthia uniflora*, Common Glade-cress: GL=7?
KY: ST=7? (30+/13). A few records of this eastern interior species from DBNF or nearby are from ROWs; none are from project ROWs.
TN: ST=7

o ?*Lechea leggettii* (*L. puchella*), Leggett's Pinweed: GL=8
TN: ??; CP??; Patrick WARR (unlikely misid.)

o *Lechea minor*, Thyme-leaved Pinweed: GL=9
KY: ST=4?
TN: ST=6; CP; DeSelm

o ?*Lechea tenuifolia,* GL=9
KY: ST=8; almost no Appalachian records.
TN: ST=7; CP?; DeSelm

o ?*Lechea villosa* (*L. mucronata*), Hairy Pinweed: GL=9
KY: ST=8; no Appalachian records.
TN: ST=?; CP?; DeSelm

?*Leiophyllum buxifolium*, Sand-myrtle: GL=6
KY: ST=0? (1/1h). In KY, this southeastern and montane Appalachian subshrub is known only from a 1940s collection in the Cumberland Falls area. It might be expected along open sandstone clifftops and rocky ridges, perhaps with fire history. This single DBNF record (probably not on USFS) is not known to have been associated with a ROW. It is not with 100 ft of project ROWs, but suitable habitat may occur.
TN: ST=4

(BSF)? O *Lespedeza capitata*, Dense-headed Bush-clover: GL=10
KY: ST=7? (25+/11). The few records of this southern and western herb from DBNF or nearby are mostly from ROWs; none are from project ROWs but it may be expected.
TN: ST=7; CP; DeSelm

O *Lespedeza stuevei*, Southeastern Bush-clover: GL=9
KY: ST=6? Almost no Appalachian records.
TN: ST=7?; CP? (few data); Scotts Gulf

o *Lesquerella globosa*, Lesquereux's Bladderpod: GL=4
KY: ST=2? (>15/4h). Except for some disjunct waifs, this somewhat weedy herb is almost entirely endemic to the Bluegrass Region of KY and the Nashville Basin of TN. It occurs on mesic to subxeric, generally calcareous terraces, steep slopes and rolling uplands in open forest, brushy edges and grassland, sometimes along roadsides. There are only two DBNF records, both historical from the same locality: M. Shepard (GH), 1 May 1874, near Natural Bridge; W.A. Anderson 117 (GH), 26 May 1923, Natural Bridge, Powell County. One may speculate that this species occurred along a road or trail on lower calcareous slopes near Natural Bridge.
TN: ST=4

BSF? *Leucothoe fontanesiana,* Highland Doghobble: GL=7
KY: ST=2
TN: ST=7; CPn; Obed (streamside forest)

BSF? *Leucothoe recurva* (= *Eubotrys r*.), Fetterbush: GL=9?
KY: ST=2? (2/1). In KY, this southern Appalachian shrub is known only from Pine Mountain. It occurs on mesic-subxeric sites in forest near streambanks.
TN: ST=6; CPne; Obed bars; Patrick BSF? (at least expected)

(BSF) o *Liatris aspera*, Lacerate Blazing-star: GL=10?

KY: ST=7? (50+/15). This largely western herb occurs in several areas of KY with native grassland and open woodland remnants. It is often associated with ROWs and several records are from project ROWs.

TN: ST=7; CP; Scotts Gulf; DeSelm (+ "scariosa")

BSF o *Liatris microcephala*, Small-flowered Blazing-star: GL=7?

KY: ST=7? (50+/3). Some DBNF records of this southern Appalachian herb are from ROWs; several are from project ROWs.

TN: ST=7; CP; DeSelm; Obed bars; Scotts Gulf; Patrick FENT (Jamestown Barrens)

(BSF)? O *Liatris spicata*, Sessile Blazing-star: GL=10?

KY: ST=7? (75+/18). This south-central herb occurs in several areas of KY with native grassland and open woodland remnants. It is often associated with ROWs and several records are from project ROWs.

TN: ST=7; CP (not nw?); DeSelm; Obed (old strip mine); Scotts Gulf

(CUM) O *Liatris squarrosa*, Small Blazing-star: GL=9?

KY: ST=7? (100+/30+). In KY, this southeastern herb is common in some western sections, but it is rare in central and eastern regions. The few DBNF records are mostly from ROWs; about three are from project ROWs.

TN: ST=8; CPc?; DeSelm

BSF? o *Liatris squarrulosa* (= *L. earlei*, some *L. scabra*), Southern Blazing-star: GL=10?

KY: ST=7? (50+/10). This southern herb occurs in several areas of KY with native

grassland and open woodland remnants. It is often associated with ROWs and several records are from project ROWs.
TN: ST=8; CP; DeSelm; Obed bars

BSF *Ligusticum canadense* (riverbank form), Mountain Lovage: GL=5?
KY: ST=4
TN: ST=??; CPn?

BSF o *Lilium canadense*, Mountain Lily: GL=8
KY: ST=7
TN: ST=7; CP; Jones BLED, PUTN; Patrick FENT, PUTN, OVER

o *Lilium michiganense*, Midwestern Lily: GL=8
KY: ST=6? No verified Appalachian records; confused with *superbum*.
TN: ST=6; CPs; apparently concentrated in/near Sequatchie Valley; Jones GRUN, SEQU, VANB; Scotts Gulf; DeSelm; Patrick historical

(BSF) O *Lilium philadelphicum* var. *philadelphicum*, Northern Lily: GL=7?
KY: ST=4? (50+/8). In KY, this tall herb (as the typical variety) is known only from the Cliff Section, where it occurs on sandy ridges in brushy openings within subxeric forest. The 48 DBNF records (42 on USFS) are mostly (40+) associated with ROWs. Seventeen of these are within project ROWs.
TN: ST=3; CPs; Jones historical; Patrick historical (? nr Scotts Gulf)

BSF? o *Lilium superbum*, Turk's Cap Lily: GL=10

KY: ST=4? (10/6?). In KY, this largely montane Appalachian herb is known mostly from Black Mountain and scattered sites in the Mississippian Embayment, plus a recent report from McCreary County along the Big South Fork. It occurs in various lowland habitats and upland swales, mostly in brushy openings in mesic to subhydric forest. The single DBNF record (on NPS) is not associated with a ROW, and is not within 100 ft of a project powerline.

TN: ST=6; CP (few cos.); Patrick hist. GRUN (Scotts Gulf), BLED (roads nr Panter Cr. meadow); [also e Highland Rim ponds]

O? *Linum intercursum*, Sandplain Flax: GL=8?

TN: ST=6; CPsc; DeSelm

o? *Linum sulcatum*, Glandular Flax: GL=10?

L KY: ST=6? (15/9). In KY, this largely mid-western herb is known mostly from the western Knobs Region and the western Karst Plains, where it occurs in xeric limestone grasslands. There is one surprising record from eastern KY, about 2 miles west of DBNF in Bath County--the specimen should be examined for verification. This collection is from a ROW on Silurian bedrock, but similar habitat is probably absent within DBNF.

TN: ST=6; CPs?; DeSelm

O *Liparis loeselii*, Loesel's Twayblade: GL=10

KY: ST=5? (6/6). In KY, this northern orchid is known only from Appalachian regions, where it occurs mostly in damp, disturbed sites in roadsides, old fields and old stripmines. It is possible that this species is at least partly adventive in KY. The two DBNF records

(none on USFS) are both associated with ROWs (including a stripmine bench). One is within 100 ft of project ROWs, and there may be other suitable sites.
TN: ST=3

o? *Listera smallii*, Kidney-leaf Twayblade: GL=8
KY: ST=3? (9/2). In KY, this southern Appalachian orchid is known only from crests of Pine and Cumberland Mountains. It occurs in subhydric, boggy streamheads, generally with *Rhododendron maximum* and other shrubs. Although unknown in DBNF, it might be expected in some ROWs with moderate disturbance.
TN: ST=2

Lithospermum latifolium, American Gromwell: GL=9?
KY: ST=8? (100+/20+). In KY, this mid-western herb is known mostly from the Bluegrass Region, Knobs Region and Mississippian Plateaus, but it also occurs in calcareous sections of Appalachian Regions. It occurs generally on mesic-subxeric, moderately base-rich slopes in forest. The 10+ DBNF records (mostly on USFS?) are not associated with ROWs or within 100 ft of project powewrlines.
D TN: ST=7; CP? (w edges?)

BSF o? *Lithospermum tuberosum*, Tuberous Puccoon: GL=8?
KY: ST=7? (20/6). DBNF records of this southern interior herb are not associated with ROWs or near project ROWs. It may however have some weak concentration along footpaths and animal trails.
TN: ST=8; CP (we edge); Scotts Gulf; Patrick PICK (Flint Fork Cove)

(BSF)? <u>*Lobelia canbyi*</u>, Canby's Lobelia: GL=4?
TN: ST=4; CPs (and n?); Jones VANB, PUTN, GRUN; DeSelm

(BSF) O *Lobelia nuttallii*, Nuttall's Lobelia: GL=9
KY: ST=4? (18/4). In KY, this southeastern herb is known only from the southern Low Hills Belt and the transition to southern Cliff Section. It occurs on high terraces, flats and broad ridges in seasonally wet, acid soil in open, grassy vegetation. The 14 DBNF records (2 on USFS) are mostly (9+) associated with ROWs. None are within project ROWs, but suitable habitat does occur.
TN: ST=7?; CP; Obed bars; Jones GRUN

Lonicera dioica var. *orientalis* (var. *glaucescens* f. *dasygyna*), Hairy Wild Honeysuckle: GL=7?
KY: ST=4? (10/4). The taxonomic significance of leaf and flower pubescence in this variety requires further study. In KY, this north-central vine is known only from the Cliff Section, where it occurs on limestone cliffs and ledges. The single DBNF record (not on USFS) is not associated with ROWs or within 100 ft of a project powerline.
TN: none?

(BSF) *Lonicera dioica* var. *dioica*, Eastern Wild Honeysuckle: GL=8?
KY: ST=7? (>20/8). A review of Kentucky data for this eastern interior woody vine is needed; and separation from var. *orientalis* (or *glaucescens*) may need clarifying. The few DBNF records are not associated with ROWs or near project ROWs.
TN: ST=7; CPme? (nw edge)

O *Ludwigia hirtella,* Savanna Primrose: GL=8
KY: ST=3
TN: ST=5; CP; Jones CUMB; DeSelm

o *Ludwigia linearis,* Narrow-leaved Primrose: GL=8?
TN: ST=6; CPsc; Jones PUTN

(BSF)? o *Lycopodiella alopecurioides,* Foxtail Clubmoss: GL=8?
TN: ST=1; Jones historical; Patrick historical FENT (Glade Br.)

O *Lycopodiella appressa* (= *Lycopodium appressum*), Southern Bog Club-moss: GL=10
KY: ST=2? (3/3). In KY, this southern club-moss is known from scattered sites in the Mississippian Embayment, Mississippian Plateaus and Appalachian Plateaus. It occurs on terraces, flats and broad ridges, in seeping, sandy soil in open, brushy vegetation, often along trails or other disturbed ground. The single DBNF record (on USFS) is from vehicular tracks within a project powerline.
TN: ST=6; CP? (few cos.)

o? *Lycopodiella inundata* (= *Lycopodium inundatum*), Northern Bog Club-moss: GL= 10
KY: ST=2? (1/1). In KY, this northern (circumboreal) clubmoss of open boggy wetlands was first discovered on Pine Mountain in 1992. It occurs here is a quarry floor, and may be expected elsewhere along ROWs. Within DBNF and west of Pine Mountain, it might be expected in unreclaimed strip-mines.
TN: none?

o *Lycopodium clavatum*, Running-pine: GL=10
KY: ST=2? (2/2). In KY, this northern (circumboreal) club-moss is known only from two sites in the Rugged Eastern Hills of the Appalachian Plateaus. It occurs on slopes along trails or stripmine benches through mesic to subxeric forest. Possibly it is somewhat adventive in the state. The two DBNF records (one on USFS) are associated with ROWs, but none are within 100 ft of project ROWs.
TN: ST=5

o? *Lysimachia hybrida*, Lowland Loosestrife: GL=8?
KY: ST=4? (6/6). Most Kentucky records of this eastern herb need to be reexamined, since separation of this species from *L. lanceolatum* has not been clear-cut. The single DBNF record is not confirmed; it was probably not from a ROW or near a project powerline.
TN: ST=4

BSF o? *Lysimachia tonsa*, Mountain Loosestrife: GL=8?
KY: ST=7? (20+/11). DBNF records of this Appalachian-Ozarkian herb are not generally associated with ROWs, though there may be some concentration along footpaths and dirt-roads. No records are from project ROWs but it may be expected.
TN: ST=8; DeSelm; Obed; Scotts Gulf; Patrick FENT (Gernt Pond)

o *Lythrum alatum* (probably var. *lanceolatum*), Southeastern Loosestrife: GL=9?
KY: ST=7?
TN: ST=7; CPs?; DeSelm

BSF *Magnolia fraseri*, Mountain Magnolia: GL=8?

KY: ST=7 (50+/10). DBNF records of this southern Appalachian tree are not associated with ROWs or near project ROWs.
TN: ST=7; CPnw (new JC record)

Maianthemum canadense, Canada Mayflower: GL=10
KY: ST=4? [-/C/T] (20+/4). In KY, this northern herb is known only from the Cumberland Mountains and Cliff Section, where it occurs on cool ravine terraces and slopes in sandy soil with mesic forest. The 17 DBNF records (all on USFS) are not associated with ROWs. None are within 100 ft of project ROWs.
TN: ST=7

(BSF)? ?*Maianthemum stellatum* (= *Smilacina s.*), Starflower False Solomon's-seal: GL=10
KY: ST=2? (10/4). In KY, this northern herb is known only from scattered sites in the Shawnee Hills and Knobs Region. It occurs along small streams and on broad bottomlands in forests or brushy edges. The two DBNF records (both historic but possibly on USFS) are not known to have been associated with ROWs, but may have been within 100 ft of project ROWs.
TN: ST=2; CP?? check atlas PICK record

BSF? o? *Malaxis uniflora*, Green Adder's Mouth: GL=8?
KY: ST=7? (>20/17). A review of Kentucky data for this widespread eastern orchid is needed. The few DBNF records may be partly associated with ROWs, and one is from a project powerline (Salt Lick Quad).
TN: ST=8; CP

BSF o *Malus angustifolius*, Southern Crabapple: GL=10?
L KY: ST=7? (20+/7). In KY, this southern small tree is known mostly from the Shawnee Hills and the southern Cliff Section. It occurs on ridges, slopes and rocky river banks, generally on sandy soil at edges and thickets within subxeric forest. The 14+ DBNF records (12 on USFS) are partly (5+) associated with ROWs. Only one tentative record is from project ROWs (and there may be another from nearby), but there is much more suitable habitat.
TN: ST=8; CP

BSF <u>*Marshallia grandiflora*</u>, Appalachian Barbara's-buttons: GL=4
KY: ST=2? (7/1). In KY, this Appalachian herb is known only from the Big South Fork corridor, where it occurs on open boulder-cobble bars in xeric grassy vegetation. The seven DBNF records (all on NPS) are not associated with ROWs. None are within 100 ft of project ROWs.
TN: ST=3; DeSelm; Obed bars

Marshallia trinervia, Broad-leaved Barbara's-button: GL=6
TN: ST=3; CPsw; Scotts Gulf

(BSF) O? *Matelea carolinensis* (= *Gonolobus c.*), Carolina Anglepod: GL=8
KY: ST=2? (2/2?). Further taxonomic work on these plants is needed. In KY, this southern twining herb is known only from scattered sites on the Mississippian Plateaus and Cliff Section. It occurs on broad ridges and rolling uplands in acid soil with subxeric brushy vegetation. The single DBNF record (on USFS) is in a project powerline. [There may also be a 1989 collection from the Whitley City area by A. Risk, determined as another species

by J. Campbell; this needs rechecking.]
TN: ST=7; CP (w edge?); Scotts Gulf

BSF O? *Melampyrum lineare* var. *latifolium*, Broad-leaved Cow-wheat: GL=8?
KY: ST=3? (3/2). In KY, this variety is known only from the Cumberland Mountains, on subxeric-xeric sites in open forest.
TN: ST=??; CP (2 cos.); Woodson #14 (FENT?) check details...

O? *Melampyrum lineare* var. *pectinatum* (includes references to var. *lineare* in KY), Narrow-leaved Cow-wheat: GL=8?
KY: ST=2? (2/2?). In KY, this northern and east-coastal species is known only from the northern Cliff Section (as the east-coastal var. *pectinatum*) and the Cumberland Mountains (as the Appalachian var. *latifolium*). The former occurs on ridges and upper slopes with acid soil in open pine-oak woods and edges. The two DBNF records (at least one on USFS) are at least partly (1) associated with ROWs (the paved path to Sky Bridge). They are not within 100 ft of project ROWs.
TN: ST=7? (not seperated from var. latifolium)

BSF *Melanthium parviflorum* (= *Veratrum p.*), Small-flowered False Hellebore: GL=8?
KY: ST=4 (7/4). In KY, this montane Appalachian herb is known only from the Cumberland Mountains and the southern Cliff Section. In the latter region, it occurs on terraces and low slopes along the Cumberland River and Big South Fork, on sandy soil in mesic forest. The three DBNF records (all on NPS/USFS) are not associated with ROWs, though a few plants are located along a small foot-trail. None are within 100 ft of project ROWs.

TN: ST=7; CP (few cos.)

Melanthium woodii (*Veratrum w.*), Midwestern False Hellebore: GL=6
KY: ST=4.
TN: ST=2; CPsw; Scotts Gulf

Melica nitens, Glade Melic-grass: GL=8?
L KY: ST=6? (15?/10). The single record of this eastern interior grass from near DBNF, and other records from the Bluegrass Region, are not associated with ROWs. Suitable habitat is possible within DBNF, but very unlikely in project ROWs.
TN: ST=3; CPc

BSF *Minuartia cumberlandensis* (= *Arenaria c.*), Cumberland Sandwort: GL=3
KY: ST=2 (2/1). This annual herb is endemic to the southern Cliff Section in KY and TN. It occurs along sandstone cliffROWs in damp ground under overhangs and on seeping ledges. The two DBNF records (both on NPS/USFS) are not associated with ROWs, or within 100 ft of project ROWs.
TN: ST=3; CPnw; Goodson #5

BSF o? *Minuartia glabra* (= *Arenaria g.*), Appalachian Sandwort: GL=9?
KY: ST=3? (11/3). In KY, this Appalachian herb is known only from the southern Cliff Section and Cumberland Mountain. It occurs on sandstone clifftops, on bare rocky with lichens, mosses and relatively little vascular vegetation. The 10 DBNF records (all on USFS) are not associated with ROWs, though a few (1-2?) are close to small foot-trails. None are within 100 ft of project ROWs, but suitable habitat does occur in a few areas.

TN: ST=5; CP; Obed; Patrick FENT (Jamestown Barrens); DeSelm

O? ?*Monarda punctata*, Spotted Beebalm: GL=10
KY: ST=2? (1/1h?). The single DBNF record of this species may be doubted, based on general information about the early Morehead State University herbarium (Campbell et al. 1992).
TN: ST=2

(BSF)? *Monotropsis odorata*, Sweet Pinesap: GL=6
KY: ST=5? (8+/4). In KY, this Appalachian parasitic herb is known only from the Cumberland Mountains and the Cliff Section. It occurs on ridges and upper slopes on acid soils in pine or pine-oak forest. The seven DBNF records (4 on USFS) are not associated with ROWs. None are within 100 ft of project ROWs.
TN: ST=5; CP (one co.); Scotts Gulf

(CUM) o *Muhlenbergia capillaris*, Glade Hairgrass: GL=9?
KY: ST=7? (20?/12). The few recent records of this southern grass from DBNF or nearby are from clifftops and, in one case, from a project powerline (Cumberland Falls at head of Bunches Creek).
TN: ST=7; CP (few data)

(BSF) *Muhlenbergia cuspidata*, Plains Muhly-grass: GL=10
KY: ST=4 (12/4). In KY, this Great Plains grass is known only the Kentucky River Palisades, the eastern Knobs and the eastern Karst Plain-Cliff Section transition. It occurs on limestone cliff tops in xeric grassy vegetation. The two DBNF records (none on USFS)

are not associated with ROWs, or within 100 ft of project ROWs.
TN: ST=2 (e Highland Rim)

(CUM) ?*Muhlenbergia mexicana*, Western Woodland Muhly-grass: GL=10
L KY: ST=3? (2/2). Further collections of this western grass are needed to verify the presence of this species in KY and DBNF. There are no records from ROWs or near project ROWs.
TN: ST=2

Myosotis laxa, Loose Forget-me-not: GL=10
L KY: ST=2? (1/1). The single DBNF record of this northern (and widespread temperate) subaquatic herb is not from a ROW or near a project powerline.
TN: ST=5

Myriophyllum heterophyllum, Heterophyllous Water-milfoil: GL=9
KY: ST=4; no Appalachian records.
TN: ST=4; CPsc? (few data); Jones CUMB

Myriophyllum pinnatum, Pinnate Water-milfoil: GL=9
KY: ST=1; no Appalachian records.
TN: ST=4; CPs; Jones FRAN

Nestronia umbellata, Conjurer's-nut: GL=6?
KY: ST=2? (1/1). This shrub, concentrated in the Piedmont Region, has recently been discovered in KY by Tom Bloom and Gary Libby. It was found at the edge of the eastern

Karst Plain along Beaver Creek on subxeric slopes in forest.
TN: ST=2; CPsw

O? ?*Oenothera clelandii* (= *O. rhombipetala* in part): GL=8?
L? KY: ST=4? (3/3?). Records of this species from KY need further taxonomic verification. The single record of this northwestern herb near DBNF (at Morehead State University) is not from a ROW or near a project powerline.

BSF O? *Oenothera linifolia*, Thread-leaf Sundrops: GL=10
KY: ST=2? (4/4). In KY, this southeastern annual is known only from scattered sites in the Mississippian Embayment, Shawnee Hills and southern Cliff Section. It occurs on broad ridges, flats and rolling uplands with sandy soil in xeric-xerohydric grassy vegetation. The single DBNF record (on NPS) is associated with a ROW, but not within 100 ft of a project powerline.
TN: ST=6

BSF? O *Oenothera fruticosa* (ssp. *fruticosa*), Barrens Sundrops: GL=9
KY: ST=7
TN: ST=8?; CP check versus triflora (f. ssp. glauca), perennis

BSF? O ?*Oenothera perennis*, Lowland Bushy Sundrops: GL=10
KY: ST=4? (5/5+?). Further taxonomic work is needed to separate records of this taxon from *O. fruticosa*. In KY, this north-central herb is recorded from scattered locations. It may be typical of low meadows in seasonalluy wet vegetation transitional to marshes, but further data are required. The single DBNF record (on NPS?) is based on a 1935 collection

not known to be near a ROW. It was probably not within 100 ft of project ROWs, but suitable habitat probably does occur within these powerlines.
TN: ST=2; CPn check versus O. fruticosa

(CUM) O *Orbexilum onobrychis* (= *Psoralea o.*), Kentucky Scurfpea: GL=7?
L KY: ST=5? (8/8). Almost all Kentucky records of this eastern interior species are from ROWs; none are from project ROWs, but it may be expected.
TN: ST=6

BSF? o *Orbexilum pedunculatum* var. *pedunculatum* (= *Psoralea psoralioides* var. *psoralioides*), Gladular Sampson's Snakeroot: GL=10?
L? KY: ST=6? (10+/4). Further work on the species is needed to distinguish this southeastern taxon from the more widespread southern var. *gracile* (= *P. psoralioides* var. *eglandulosa*). Some DBNF records of this taxon are from ROWs; none are from project ROWs but it may be expected.
TN: ST=?? (not separated)

BSF *Orontium aquaticum*, Goldenclub: GL=10
KY: ST=3? (25/4). In KY, this southern floating aquatic herb is known only from the southern Appalachian Plateaus and the Cumberland Mountains. It occurs in lagoon-like places among boulder-cobble bars in medium to large streams. The 23 DBNF records (22 on NPS/USFS) are not associated with ROWs, and none are within 100 ft of project ROWs.
TN: ST=5; CPn; Obed bars

BSF *Oxalis montana*, White Wood-sorrel: GL=10

L? KY: ST=6? (30+/9). DBNF records of this northern and Appalachian herb are not associated with ROWs or near project ROWs.

TN: ST=7; CPn (mostly); Falls Creek

BSF *Panax quinquefolius*, American Ginseng: GL=8?

KY: ST=7? (100+/50+). This north central herb has been considered "sensitive" by DBNF due to the excessive harvesting that has occurred. DBNF records are not associated with ROWs; none are from project ROWs, but it may occur in some adjacent forest. It is not clear why this species is not listed by DBNF, but *Hydrastis canadensis* is.

TN: ST=8; CP; Obed; Scotts Gulf; Falls Creek; Patrick PICK (Flint Fork Cove), WARR (Dry Br Sink)

BSF? *Panax trifolius*, Dwarf Ginseng: GL=8?

L? KY: ST=6? (30+/10). DBNF records of this northern and Appalachian herb are not associated with ROWs or near project ROWs.

TN: ST=6; CP; Falls Creek; Patrick CAMP (Morley RR)

(BSF) O *Panicum aciculare* (*Dichanthelium aciculare*), Bristly Early Witch-grass: GL=10?

L KY: ST=5? (10+/5). It is assumed here that plants in western KY named *P. angustifolium* should be included here, but further taxonomic work is needed. In KY, this southern grass is known mostly from the southern Cliff Section and the Dripping Springs Hills. It occurs on broad ridges and rolling uplands in sandy soil with open grassy vegetation. The five+ DBNF records (3 on USFS) are mostly (4) associated with ROWs. Two are in project ROWs.

TB: ST=7?; CP; including “angustifolium”--check colls.

(BSF) *Panicum albomarginatum* (*Dichanthelium*, close to *D. tenue*), White-margined Early Witch-grass: GL=8?
L KY: ST=4? (6/2). DBNF records of this southeastern grass are not associated with ROWs or near project ROWs.
TN: ST=5?; CP (few data); assumed from “tenue”; Obed

o? *Panicum bicknellii* (*Dichanthelium boreale*), Northern Witch-grass: GL=10
KY: ST=5? (12/7). In KY, this north-central grass is known mostly from the Cliff Section (also Oldham Co.). It generally occurs on narrow ridges and clifftops, with sandy to calcareous soil, in subxeric-xeric open woods. The ca. 6 DBNF records (5 on USFS?) are not associated with ROWs. None are within 100 ft of project powerline, but suitable habitat does occur.
TN: ST=5?; CP (few data); DeSelm

BSF o *Panicum ensifolium* var. *e.* (*Dichanthelium e.*), Small-leaved Witch-grass: GL=8
TN: ST=4; CPn; Jones hist. (“tenue”); Patrick #36 hist. (pasture Glade Br 2 m e Clarkrange)

o? *Panicum ensifolium* var. *curtifolium* (*Dichanthelium c.*), Short-leaved W-g.: GL=6
TN: ST=5; CPs; [to check versus var. *ensifolium*]

BSF? *Panicum latifolium* (*Dichanthelium latifolium*), Broad-leaved Witch-grass: GL=9
KY: ST=5? Much confused with *clandestinum*.

TN: ST=7?; CPn; DeSelm [to be checked]

o? *Panicum leucothrix* (*Dichanthelium l.*), Roughish Witch-grass: GL=8?
TN: ST=7?; CPs?; DeSelm

BSF? O *Panicum longifolium* var. *longifolium* (sometimes included under *P. rigidulum* var. *pubescens*), Long-leaved Late Panic-grass: GL=10?
L KY: ST=5? (4/3). In KY, this southern and east-coastal grass is known only from a few native grassland remnants on seasonally wet terraces or flats in southeastern regions. The few records of this species in KY are not associated with ROWs, but it may be expected along ROWs in DBNF.
TN: ST=7; CP; DeSelm; Scotts Gulf; Patrick FENT (Gernt Road)

(BSF)? o *Panicum longiligulatum* (*Dichanthelium l.*), Long-ligule Witch-grass: GL=10
KY: ST=7?
TN: ST=8?; CP; Scotts Gulf; DeSelm

(CUM) O *Panicum malacophyllum* (*Dichanthelium m.*), Softly Hairy Early Panic-grass: GL=8?
L? KY: ST=6? (10/7?). Further taxonomic work is needed to clarify distinctions from related species in KY. In KY, this southwestern grass is known mostly from western grasslands. During this project, one collection was tentatively identified from a project powerline (Hindsfield Ridge, Pulaski Co.). This would be the first Appalachian record in KY, and further checking is needed.
TN: ST=7

BSF O *Panicum ravenelii* (*Dichanthelium r.*), Large-seeded Hairy Early Panic-grass: GL=10?
KY: ST=7? (20+/9). Most DBNF records of this southern grass are from ROWs; several are from project ROWs.
TN: ST=7; CP; DeSelm

BSF o *Panicum virgatum* var. *virgatum*, Switchgrass: GL=10?
KY: ST=7? (50+/35). Further taxonomic work is needed on the intraspecific variation of this widespread North American grass. DBNF records are not associated with ROWs or near project ROWs.
TN: ST=8; CP; DeSelm; Obed bars

BSF *Parnassia asarifolia*, Kidney-leaf Grass-of-parnassus: GL=8
KY: ST=2? (6/1). In KY, this southern Appalachian herb is known only from the southern Cliff Section, or the transition to Low Hills Belt. It occurs on broad ridges in the wet sandy soil of streamhead seeps. The six DBNF records (1 on USFS) are not associated with ROWs, or within 100 ft of project ROWs.
TN: ST=7; CP; Goodson #5; Obed bars; Scotts Gulf

Paronychia argyrocoma, Silverling: G=8
KY: ST=2? (1/1). In KY, this montane Appalachian herb is known only from one site on Cumberland Mountains. It occur on an exposed sandstone outcrop at the crest of the mountain.
TN: ST=3; CPc? (one co.)

BSF O *Parthenium integrifolium*, Wild Quinine: GL=10
KY: ST=7? (100+/19+). Most DBNF records of this south-central herb are from ROWs; many are from project ROWs.
TN: ST=8; CP; Goodson #3; Obed; Scotts Gulf; DeSelm (+ var. henryanum)

(CUM)? O *Paspalum setaceum* var. *longepedunculatum*, Lax Bristly Lens-grass: GL=9?
L? KY: ST=5? (4/4). The few KY records of this southeastern grass are mostly (or all) associated with ROWs. None are from project ROWs.
TN: ST=2? probably overloooked...

(BSF) *Paxistima canbyi*, Appalachian Mountain Lover: GL=4
KY: ST=3 (12/9). In KY, this Appalachian subshrub is largely restricted to the Cliff Section, or its western transitions. It generally occurs on narrow limestone ridges, in subxeric-xeric red cedar-oak forest. The four DBNF records (one on USFS) are not associated with ROWs. None are within 100 ft of project ROWs.
TN: ST=2

o *Pedicularis lanceolata,* Swamp Lousewort: GL=8
KY: ST=0; no Appalachian records.
TN: ST=4; CPc; Jones CUMB

Pellaea glabella, Smooth Cliff-brake Fern: GL=10
KY: ST=7? (30+/19). DBNF records of this northern and western fern are not associated with ROWs or near project ROWs.
TN: ST=7?; CPs?

o *Penstemon laevigatus* (sensu stricto), Smooth Beard-tongue: GL=8?
KY: ST=7? (6/4). Some DBNF records (or nearby records) of this southeastern herb may be associated with ROWs; but none are from project ROWs.
TN: ST=?? needs more taxonomic work versus digitalis etc.

BSF? O *Phaseolus polystachios*, Wild Bean: GL=9?
KY: ST=7? (40+/17). Most DBNF records of this south-central twining herb are from ROWs; several are from project ROWs.
TN: ST=7; CP? (few data); Obed bars

BSF *Philadelphus hirsutus*, Hairy Mock-orange: GL=8
KY: ST=7 (>40/6). DBNF records of this southern Appalachian shrub are not associated with ROWs or near project ROWs.
TN: ST=8; CP; Obed (subxeric forest)

BSF? *Philadelphus inodorus*, Smooth Mock Orange: GL=9
KY: ST=5? (12/3). In KY, this Appalachian shrub is known mostly from the southern Cliff Section and the adjacent Mississippian Plateaus. It occurs along steep limestone slopes, in mesic to subxeric forest. The eight DBNF records (3 on USFS) are not associated with ROWs, and none occur within 100 ft of project ROWs.
TN: ST=7; CP

(BSF)? *Philadelphus pubescens*, Hoary Mock Orange: GL=10?
KY: ST=3? (4/4). In KY, this southwestern (TN to AR) shrub is definitely known only in the western Mississippian Plateaus. In 1986, one individual was also identified in the east,

along US 27 south of Burnside, but this appears to have died. It was not within 100 ft of a project powerline.
TN: ST=7

BSF O *Phlox amoena* typical form, Charming Phlox: GL=8
KY: ST=7? (50+/8). Most DBNF records of this southeastern herb are from ROWs; several are from project ROWs.
TN: ST=8; CP; DeSelm; Scotts Gulf; Goodson #11

BSF *Phlox amoena* glabrous form, Riverbank Phlox: GL=6?
L KY: ST=4? (ca. 10/1). This distinctly glabrous plant has been overlooked in the literature; it may be endemic to southern Appalachian regions. In Kentucky, it is known only from the rocky open scoured banks of the Big South Fork of Cumberland River. DBNF records are not associated with ROWs or near project ROWs. It was misidentified previously as *P. pilosus* var. *detonsa.*
TN: ST=??; CPnw; Obed bars?? check coll.

o *Phlox pilosa*, Prairie Phlox: GL=9
KY: ST=7
TN: ST=8; CPs; Scotts Gulf

Phlox stolonifera, Creeping Mountain Phlox: GL=8?
L? KY: ST=6? (25+/8). DBNF records of this Appalachian herb are not associated with ROWs or near project ROWs.
TN: ST=7

Phlox subulata var. *australis* (or var. *setacea*): Southern Moss Phlox: GL=8?
L KY: ST=6 (20/5). DBNF records of this Appalachian subshrub do not come from are ROWs or nearby. Var. *australis* should perhaps be included in var. *setacea*.
TN: ST=6 assumed to be all this variety.

BSF *Physostegia virginiana* ssp. *virginiana*, Riverbank Dragon-head: GL=10?
KY: ST=7? (35/9). DBNF records of this north-central herb are not associated with ROWs or near project ROWs.
TN: ST=8s5; CPn

Piptatherum racemosum (= *Oryzopsis r.*), Black-seeded Rice-grass: GL=8?
KY: ST=7 (20+/10). DBNF records of this northwestern grass are not associated with ROWs or near project ROWs.
TN: none

BSF o *Piptochaetium avenaceum* (= *Stipa avenacea*), Porcupine grass: GL=10
KY: ST=8? (>100/7). In KY, this south-central grass is known only from the southern Appalachian Plateaus, plus a disjunct site in the Pottsville Escarpment. It occurs mostly on subxeric sites with acid soil in open, often burned forest. It is often abundant in ROWs.
TN: ST=8; CP

BSF o *Platanthera cristata*, Yellow-crested Orchid: GL=10
KY: ST=2? (10/3). In KY, this southeastern orchid is known only from the southern Cliff Section, especially in the transition to Low Hills Belt. It occurs on broad ridges in wet, boggy, sandy soil around the edges of seeping streamheads, especially in brushy openings.

The nine DBNF records (2 on USFS) are partly (2) in ROWs, and the largest population is in a ROW. None are in project ROWs, but there is suitable habitat.
TN: ST=6; CP; Scotts Gulf; Jones FRAN; Patrick GRUN (Co. line woods near Scotts Gulf)

BSF o *Platanthera integrilabia*, White Fringeless Orchid: GL=4
KY: ST=3? (21/4). In KY, this southern Appalachian orchid is known only from the southern Cliff Section, especially in the transition to Low Hills Belt. It occurs on broad ridges in wet, boggy, sandy soil in seeping streamheads, in forest or brushy openings. The 21 DBNF records (15 on USFS) are partly in (2) in ROWs, including the largest known population. This largest population, but no other, is in a project powerline.
TN: ST=4; CP; recently discovered at BSF in FENT.

(BSF)? o *Platanthera lacera*, Ragged Summer Orchid: GL=10
KY: ST=7? (30/22). A few DBNF records of this widespread eastern orchid may be from ROWs; none are known from project ROWs.
TN: ST=7; CP (scattered)

(CUM) o *Platanthera peramoena*. Purple Fringeless Orchid: GL=8?
KY: ST=8
TN: ST=7; CP? (one record?); Jones (hist); Patrick (hist)

o *Platanthera psycodes*, Small Purple-fringed Orchid: GL=10
KY: ST=2? (2/1+?). In KY, this northern orchid is definitely known only from Black Mountain. There have been reports from the Red River Gorge area, but these remain dubious. It occurs on lowland terraces and upland swales on damp acid soil in somewhat

marshy openings. The Black Mountain plants were all found in ROWs. None of the reported DBNF locations are within 100 ft oa a project powerline.
TN: ST=4

o? *Poa languida* (combined by some under *P. saltuensis*), Drooping Bluegrass: GL=6?
KY: ST=3? (5/3). In KY, this northern grass (as *P. languida*) is known only from the northeastern and eastern Knobs Region. It occurs mostly on slopes and low hills with shaley soils in open brusy forest and transitions to grassland. The single DBNF record (not on USFS) may not be associated with ROWs. It is not within 100 ft or project ROWs, but suitable habitat may exist.
TN: ST=4; CPc?; DeSelm; Scotts Gulf [check identification]

BSF *Podostemum ceratophyllum*, Threadfoot: GL=10
KY: ST=5? (45/13). In KY, this Appalachian submerged aquatic herb is known mostly from the Appalachian Plateaus, but there are historical records further west. It occurs on rocks in riffles of larger, free-flowing streams, especially in relatively unpolluted water. The 42 DBNF records (10+ on NPS/USFS) are not associated with ROWs, and none are within 100 ft of project ROWs.
TN: ST=7; CP

(BSF) O? *Pogonia ophioglossoides*, Rose Pogonia: GL=10
KY: ST=2? (2/2h). In KY, this largely northern orchid is known only from Pine Mountain, plus a historical record from the northern Knobs Region. It occurs on lowland terraces and upland swales on wet, boggy acid soil in openings, perhaps with a fire history. The single DBNF record (not on USFS) is the historical (1834) record from a “high flat” with

“marshes” south of Farmers. This is not within 100 ft of project ROWs, but there may be suitable habitat in these powerlines.
TN: ST=4; CP; Patrick FENT (Magadenx Falls); Jones CUMB

BSF? *Polemonium reptans* var. *villosum*, Hairy Jacob’s-ladder: GL=6
KY: ST=7? (50+/15). DBNF records of this west Appalachian herb are not associated with ROWs or near project ROWs, except perhaps in some fortuitous occurrences.
TN: ST=8v?? not separated in atlas

BSF? O *Polygala cruciata*, Cross-leaf Milkwort: GL=10
KY: ST=2? (11/9). In KY, this southern herb is known mostly from the Knobs Region and Cliff Section. It occurs on broad ridges and flats with acid soil in open subxeric to xerohydric grassland. The two DBNF records (not on USFS) are at least partly (1) associated with ROWs, as are some other KY records. None are within 100 ft of project ROWs.
TN: ST=7; CP; DeSelm; Jones; Patrick BLED (Panter Cr)

BSF? O *Polygala incarnata*, Fleshy Milkwort: GL=10?
KY: ST=7? (30+/20). Almost all DBNF records (or nearby records) of this south-central herb are from ROWs; a few (ca. 3) are from project ROWs.
TN: ST=7; CP; Scotts Gulf

O? *Polygala mariana*: GL=8?
L KY: ST=3? (4/4?). The few KY records of this Coastal Plain herb are from scattered locations, with little or no habitat details. From general knowledge, this species may be

partly associated with ROWs. However, it appears to be very rare. There is only one old (1877) record from DBNF.
TN: ST=3

BSF *Polygala paucifolia*, Flowering Wintergreen: GL=9?
KY: ST=2? (1/1). In KY, this northern herb is known only from a site in the southern Cliff Section. It occurs on mesic-subxeric sandy slopes at the edge of hemlock forest. This single DBNF record (not on USFS) is not associated with a ROW or within 100 ft of a project powerline. [This 1993 record was inadvertantly omitted from the state-listing process.]
TN: ST=7; CPn; Goodson #5

(BSF) O *Polygala polygama*, Racemed Milkwort: GL=10
KY: ST=3? (17/1). In KY, this northern and Coastal Plain herb is known only from the southern Cliff Section. It occurs mostly on broad ridges with subxeric sandy soil in brushy or grassy openings. The 17 DBNF records (13 on USFS) are all in ROWs. Ten are in project ROWs.
TN: ST=5; probably overlooked on CPn

Polygonella americana, Southern Jointweed: GL=7?
TN: ST=2; CPne; Obed bars

(CUM) *Polygonum amphibium* var. *stipulaceum*, Stipulate Water Smartweed: GL=10
L KY: ST=2? (1/1). The single DBNF record of this northern subaquatic herb are not associated with ROWs or near project ROWs.
TN: ST=7; CP? (scattered, e side) (vars. not sepearated)

Polygonum arifolium var. *pubescens*, Lowland Tearthumb: GL=10
L? KY: ST=6? (13+/9). Records of this north-central vine near DBNF are not associated with ROWs or near project ROWs. It may however be expected along roadside ditches.
TN: ST=4

(BSF) *Polygonum tenue*, Pleated-leaf Knotweed: GL=9?
KY: ST=4?
TN: ST=7; CP; DeSelm; Patrick FENT (Jamestown Barrens)

Polymnia laevigata, Tennessee Leafcup: GL=5
KY: ST=2; no Appalachian records.
TN: ST=5; CP (mostly s); Obed (among sandstone boulder fields on S-face slope)

BSF o *Porteranthus trifoliatus* (= *Gillenia t.*), Bowman's-root: GL=9?
KY: ST=7? (50+/5). Most DBNF records of this Appalachian herb (at least flowering records) may be associated with ROWs; several are from project ROWs.
TN: ST=8; CP; DeSelm; Goodson #6,7; Scotts Gulf; Obed bars

(BSF) *Potamogeton illinoensis*, Illinois Pondweed: GL=10
KY: ST=4B? (10+/4?). In KY, this northwestern and Gulf Coastal submerged aquatic herb is known only from the Ohio River and Little South Fork of Cumberland River. It occurs in shallow water near riffles, perhaps in association with calcareous substrates. The 5+ DBNF records (none on USFS) are not associated with ROWs or within 100 ft of project ROWs.
TN: none

(BSF) *Potamogeton pulcher*, Spotted Pondweed: GL=10

KY: ST=4B?? [-/C/T] (5/5). In KY, this widespead eastern (but Coastal Plain-concentrated) floating aquatic herb is known from widely scattered sites. It occurs in natural or artificial ponds, perhaps more often in non-calcareous regions. The single DBNF record (on USFS) is not associated with ROWs. It is not within 100 ft of a project powerline, but suitable habitat may exist.

TN: ST=7; CP

BSF <u>*Potamogeton tennesseensis*</u>, Mountain Riverweed: GL=4?

KY: ST=2? This species of rivers and larger streams is similar to *P. diversifolius* which is found in calm or stagnant water; Rockcastle River near I-75 has "*diversifolius*" (T. Bloom report) to be rechecked.

TN: ST=4; CPn; Patrick (Clear Fk nr Rugby), (Little Tenn. Rv. to Tellico Reservoir)

o? *Prenanthes alba*, White Rattlesnake-root: GL=10

KY: ST=2A?? [-/-/E] (6/4h?). Most records require confirmation. In KY, this northern herb is known only from the northeastern Knobs Region and perhaps the Cumberland Mountains. It occurs on low hills in forest or brushy edges. The two DBNF records (both historical, possibly on USFS) are not known to have been associated with ROWs. They may have been close to project ROWs.

TN: none in atlas (but reported from Falls Creek)

(CUM) o *Prenanthes crepidinea*, Nodding Rattlesnake-root: GL=6?

KY: ST=4? (10/8h?). In KY, this mid-western herb is known from scattered locations in the Appalachian Plateaus, Bluegrass Region and Shawnee Hills. It occurs on terraces and

benches with fertile soil in mesic forest or brushy edges. The seven DBNF records (3 on USFS) are partly (4) associated with ROWs, and probably most are associated at least with small trails within the forest. One is from a project powerline.
TN: ST=3

(BSF)? *Prenanthes trifoliolata*, Gall-of-the-Earth: GL=8
TN: ST=7?; CP (not s?); DeSelm; check colls.

(BSF)? *Proserpinaca pectinata*, Pectinate Mermaidweed: GL=8
TN: ST=6; CP; Jones GRUN

(BSF)? o *Prunus umbellata*, Hog Plum: GL=8
TN: ST=4?; CPs? [records to be checked]

(BSF) O *Pycnanthemum verticillatum* (= *P. pilosum* var. *v.*), Smooth Mountain-mint: GL=8?
L KY: ST=4? (10/7?). The few DBNF records (or nearby records) of this northeastern herb are partly associated with ROWs, but habitat details are lacking for older records. On this project, it was found within 20 ft of a project powerline near Gilreath in McCreary Co.
TN: ST=3; CPnw; Jones (hist); Patrick (hist, near Allardt)

Pyrola americana, American Wintergreen: GL=10?
KY: ST=1 (1/1h). In KY, this northern (circumboreal) herb is known only from a Braun collection on Black Mountain, in oak-chestnut forest. There may be an unverified report from DBNF (near Natural Bridge State Park).
TN: ST=2

Ranunculus allegheniensis, Allegheny Crowfoot: GL=8?
KY: ST=7? (10+/7). DBNF records of this northeastern herb are not associated with ROWs or near project ROWs.
TN: ST=4; CPne?; Patrick MORG (hist)

Ranunculus ambigens, Water-plantain Spearwort: GL=8?
KY: ST=5? (11/11). In KY, this north-central subaquatic herb is known from scattered sites in the Knobs Region, the northern Karst Plain, and the Ohio River Valley. It occurs in ponds and swamps with muddy soil, in open hydric forest and marshes. Although there are no records from within DBNF, it is known from within a mile of the boundary west of Morehead. It might be expected on bottomlands in northern districts, but is unlikely on USFS lands.
TN: ST=6; CPn

o *Ratibida pinnata*, Gray-headed Coneflower: GL=9
KY: ST=8; generally absent in Appalachian regions.
TN: ST=8; CPs; DeSelm

Rhododendron alabamense, Alabama Azalea: GL=6
TN: ST=6; CPs? (few data); Scotts Gulf (upland swamp); check for *viscosum*.

BSF *Rhododendron arborescens*, Riverbank Azalea: GL=8?
KY: ST=7? (30+/7). DBNF records of this Appalachian shrub are not associated with ROWs or near project ROWs.
TN: ST=8; CP; Obed bar; Patrick FENT (Gernt Pond)

BSF *Rhododendron catawbiense*, Mountain Rosebay: GL=8?

KY: ST=7? (30+/7). DBNF records of this southern Appalachian shrub are not associated with ROWs or near project ROWs.

TN: ST=8; CP; Goodson #5

BSF? *Rhododendron bakeri* (including *R. cumberlandense*), Red Flame Azalea: GL=7?

D KY: ST=8? (20/10+). In KY, this southern Appalachian shrub is known mostly from the southern Appalachian Plateaus and Cumberland Mountains. It occurs mostly on subxeric (to xerohydric?) uplands (often in swales?) with acid soil in forest or brush. The 20+ DBNF records (mostly on USFS) are not associated with ROWs, except in some accidental cases where it does locally flourish and flower profusely (e.g., on Taylor Ridge near Sawyer in McCreary Co.). A few (3-5) records are in project ROWs.

TN: ST=8; CP; Patrick (widespread on CP not rare)

(CUM)? *Rhododendron minus*, Lesser Rosebay: GL=6?

L? KY: ST=2? (3/2?). The single DBNF record of this southern Appalachian shrub is a roadside population (Cumberland Falls State Park), but it is not certain that this is a native population.

TN: ST=6

(BSF)? *Rhododendron viscosum,* Swamp Azalea: GL=8

TN: ST=4; CP (scattered incl. FENT)

BSF O *Rhynchosia tomentosa*, Hairy Snout-bean: GL=10

KY: ST=2? (7/5). In KY, this southern species is known mostly from the southern Cliff

Section, and the Pennyroyal Karst Plain or nearby. It occurs on broad ridges, rolling uplands and perhaps boulder-cobble bars with sandy soil in subxeric grassy or brushy vegetation. The four DBNF records (all on USFS) are all associated with ROWs. Three are in or within 100 ft or project ROWs.
TN: ST=7; CP; Obed bars

(BSF)? o?*Rhynchospora gracilenta*, Slender Beaksedge: GL=8
TN: ST=6; CP; DeSelm; Jones CUMB

BSF O *Rhynchospora globularis* var. *recognita*, Globe Beaked-rush: GL=10?
KY: ST=5? (20/9). In KY, this southern rush is known mostly from the Cliff Section and Mississippian Plateaus. It occurs on broad ridges, flats and lowland terraces with seasonally wet, acid soil in open grassy vegetation. The 14 DBNF records (8 on USFS) are mostly (11) associated with ROWs. Four are along project ROWs.
TN: ST=7; CP (vars. combined); DeSelm; Obed bars

o *Rhynchospora perplexa*, Pineland Beaksedge: GL=7?
TN: ST=4; CPs; Jones PUTN

o *Rhynchospora rariflora*, Few-flowered Beaksedge: GL=8?
TN: ST=3; CPc; Jones hist.

o *Rhynchospora wrightiana*, Wright's Beaksedge: GL=7?
TN: ST=?? (not in atlas): Jones (hist); Patrick BLED (hist)

?*Ribes missouriense*, Midwestern Gooseberry: GL=8?
KY: ST=7? (20+?/11). There are two tentative records of this midwestern shrub from DBNF; neither are from ROWs or near project ROWs.
TN: none

o? *Robinia hispida* var. *hispida*, Hispid Dwarf Rose-acacia: GL=6?
L KY: ST=2? (1/1). This Appalachian shrub is known only from the northern end of Pine Mountain (Pike Co.). Like its close relative, var. *rosea* (see below), it may often be associated with ROWs. These taxa should not be confused with the commonly cultivated *R. fertilis* (= *R. hispida* var. *f.*, Rosebay Acacia).
TN: ?? (not separated)

BSF o *Robinia hispida* var. *rosea* (= *R. boyntonii*), Smooth Dwarf Rose-acacia: GL=6?
L KY: ST=4? (14/4). In KY, this Appalachian shrub is known only from the southern Cliff Section and the Cumberland Mountains. It occurs on ridges with sandy soil in subxeric forest and brushy openings, probably with considerable fire history. The 10+ DBNF records (8+ on USFS/NPS) are partly (4) associated with ROWs--the only flowering seen was in ROWs. Four are along project ROWs.
TN: ST=?? (not separated); DeSelm?; Obed bars?

o? *Rubus canadensis*, Smooth Blackberry: GL=10?
KY: ST=3? (1/1). In KY, this northern and Appalachian shrub is known only from Black Mountain, where it occurs in “openings and woodland edges”.
TN: ST=7; CP??; Falls Creek--check...

o *Rubus odoratus*, Purple-flowering Raspberry: GL=10?
KY: ST=7? (30+/10). Some DBNF records of this northeastern shrub are associated with ROWs; but none are from project ROWs.
TN: ST=7

BSF?? *Rudbeckia laciniata* var. *digitata*, Cleft-leaved Lowland Coneflower: GL=5?
TN: ST=2; CP??; Goodson [check taxonomy; perhaps distinct from var. *humilis*].

Rudbeckia laciniata var. *humilis*: Lesser Lowland Coneflower: GL=7?
L KY: ST=3? (2/2?). This Appalachian herb was found by M. Medley during this project; it occurs along Left Fork Buffalo Creek in a rocky streambed under the powerline. There is only one obscure previous record from KY.
TN: ?? (not separated?)

(CUM) O *Sabatia brachiata*, Slender Rose-pink: GL=8?
L KY: ST=2? (1/1). This southeastern herb was found for the first time in Kentucky during the EKPC project by James Kiser. This single KY record is from a project powerline on a sandy ridge in McCreary Co. west of Duck Run. About 30 plants were seen; some were of the white flowered form (f. *candida*).
TN: ST=6; CP (mostly s); Obed bars; Scotts Gulf (not angularis)

(BSF)? o? *Sabatia campanulata*, Slender Marsh-pink: GL=8?
KY: ST=2? (6/5h). In KY, this southeastern herb is known only from the Knobs Region and Low Hills Belt. It mostly occurs on hydroxeric, acid high terraces in native grassland, sometimes close to farm roads. There are no DBNF records, but it has been found within

five miles, and may be expected along ROWs in DBNF.
TN: ST=7; CP; DeSelm; Obed bars; Jones PUTN

Sagittaria brevirostra (*S. engelmanniana* var. *b.*), Midwestern Arrowhead: GL=8?
KY: ST=7? (30+/20). Further taxonomic work may be needed to distinguish this midwestern subaquatic herb from the south-central *S. australis*--both have been treated as subspecies of *S. engelmanniana*. DBNF records are not associated with ROWs or near project ROWs. However, it may eventually be expected in older powerline ponds.
TN: ST=4; CPc? (one co.)

(BSF) *Sagittaria graminea*, Grass-leaf Arrowhead: GL=10
KY: ST=4? (15?/11). In KY, this subaquatic herb is known mostly from large western river valleys, but there are a few scattered eastern records. It occurs in older ponds and marshes. The single DBNF record (not on USFS) is not associated with a ROW, or within 100 ft of a project powerline.
TN: ST=4; CP (2 cos.); Jones (hist); Patrick, var. platyphylla CUMB (historical, Maryland Lake); Patrick, var. graminea FENT (Gernt Pond)

?*Salix discolor*, Pussy Willow: GL=10?
KY: ST=2? (4/4?). In KY, this northern shrub is reported from scattered sites in the Knobs Region and cooler Appalachian regions. It occurs along small streams, perhaps in relatively wet, acid soil. The two DBNF records (one on USFS?) are not known to have been associated with ROWs, or within 100 ft or project ROWs.
TN: none

Salix eriocephala (perhaps including *S. rigida*), Diamond Willow: GL=9?
L KY: ST=6? (11/10). This midwestern shrub has been combined with other northern, western and southern forms, but this taxonomy may not be generally accepted. DBNF records are not associated with ROWs or near project ROWs.
TN: ST=6

(BSF) O? *Salvia urticifolia*, Nettle-leaf Sage: GL=10
KY: ST=2? (4/4?). In KY, this south-central herb is known mostly from the Mississippian Plateaus, where it occurs on uplands with calcareous soils in open woods and brushy vegetation. The single DBNF record (recently traded out from USFS?) is along a dirt-road. It is not within 100 ft of a project powerline.
TN: ST=7; CP (all/most s); Scotts Gulf; Obed bars

Sambucus racemosa ssp. *pubens*, Red Elderberry: GL=10
KY: ST=2? (4/2). In KY, this northern shrub is known only from the Red River Gorge and Big Black Mountain. It occurs on cool slopes in mesic forest and edges. The single DBNF record (on USFS) is not associated with ROWs or within 100 ft of project ROWs.
TN: ST=7; CPs; Scotts Gulf; Falls Creek

Sanguisorba canadensis, Canada Burnet: GL=10
KY: ST=2? (1/1). In KY, this southern Appalachian herb is known only from the Cumberland Mountains and the southern Cliff Section. It occurs along damp cliff-bases and small rocky streamsides in sunny areas. The four DBNF records (all on USFS) are not associated with ROWs, and not within 100 ft of project ROWs.
TN: ST=3

BSF? O *Sanicula marilandica* var. *petiolulata*, Pineland Sanicle: GL=8?

L KY: ST=6? (10+/3). Most DBNF records of this southeastern herb are associated with ROWs; several are in project ROWs.

TN: ST=5; CPn; Patrick FENT (Jamestown Barrens)

(BSF)? o <u>*Sarracenia oreophila*,</u> Green Pitcherplant: GL=4

TN: ST=0; CPnw?; Jones, Patrick FENT (E of Clarkrange, historical)

Saxifraga careyana, Golden-eyed Saxifrage: GL=6

TN: ST=7; CPs; Patrick VANB (Falls Creek historical)

BSF *Saxifraga michauxii*, Michaux's Saxifrage: GL=9

KY: ST=3? (6/6+). In KY, this southern Appalachian herb is known only from the Cumberland Mountains and the southern Cliff Section. It occurs along damp cliff-bases and small rocky streamsides. The four DBNF records (all on USFS) are not associated with ROWs, and not within 100 ft of project ROWs.

TN: ST=6; CPnw; Goodson #5

?*Saxifraga micranthidifolia*, Lettuce-leaf Saxifrage: GL=8?

KY: ST=3? There is only an unverified record of this Appalachian species in DBNF. It was reported to J. MacGregor by L. Pounds from a spring-fed creek along War Fork near Turkey Foot Camp Ground in about 1981-82. Elsewhere in KY, this species is known only from the Cumberland Mountains.

TN: ST=6

(BSF) *Schisandra glabra*, Bay Starvine: GL=8

KY: ST=2? (1/1). In KY, this southeastern vine is known only from a site in the southern Cliff Section, where it occurs at the base of a sandstone cliff. This single DBNF record (on USFS) is not associated with a ROW, and not within 100 ft of a project powerline.

TN: ST=3

(BSF) O <u>*Schwalbea americana*</u>, Chaffseed: GL=4

KY: ST=0 (2/1h). In KY, this largely Coastal Plain herb is known only from historical records in the southern Cliff Section, from "sandstone flat, Natural Bridge" and "sandstone knob, Alum Creek Road". Within its existing range, it typically occurs on sandy soil in xerohydric grassland with a history of frequent fire. These two DBNF records (both probably on USFS) may have been associated with ROWs, at least along Alum Creek Road. That site may also be within 100 ft of a project powerline, and suitable habitat probably still exists.

TN: ST=0; CPnw (FENT)

O? *Scirpus expansus*, Woodland Beak-rush: GL=8?

KY: ST=2? (3/1). In KY, this northeastern and Appalachian sedge is known only from the northern Cliff Section, where it occurs on valley bottoms with hydric soils in open marshy vegetation. The three DBNF records (1 on USFS) are partly (1) associated with ROWs. None are within 100 ft of project ROWs, but there may be suitable habitat.

TN: ST=4

(BSF) o? *Scirpus purshianus*, Pursh's Bulrush: GL=10

KY: ST=7? (8/7). DBNF records of this south-central sedge are not associated with ROWs

(except for a few coincidental occurrences?), and none are from project ROWs. However, it may eventually be expected in older powerline ponds.
TN: ST=7; CP

Scirpus verecundus, Bashful Bulrush: GL=8?
KY: ST=2? (3/2). In KY, this northeastern and Ozarkian sedge is definitely known only in the central Cliff Section. It occurs on saddles and benches with acid soil in subxeric or perhaps slightly subhydric forest. The two DBNF records (one on USFS) are not associated with ROWs or within 100 ft of project ROWs.
TN: none

BSF o? *Scleria ciliata* var. *ciliata*, Fringed Nutrush: GL=10
KY: ST=2? (5/4). Further taxonomic study is needed in some cases, in order to confirm distinction from *S. pauciflora*. In KY, this southeastern sedge is known from scattered sites in southern regions. It occurs on terraces, rolling uplands and broad ridges with sandy soil in subxeric-xeric grassland. The two confirmed DBNF records (both on NPS) are not associated with ROWs, or within 100 ft of project ROWs. This species has also been reported from another ROW (near Grove Road on Vox Qd., Whitley Co.), but collections are not available.
TN: ST=4; CP (most/all s)

o? ?*Scleria minor*, Slender Nutrush: GL=7?
TN: ST=??; DeSelm; Jones (hist); Patrick (hist); misid??

o? *Scleria reticularis*, Netted Nutrush: GL=8
TN: ST=4; CPc; Patrick BLED (Dugans glady meadow; var. pubescens)

(BSF) *Scutellaria leonardii* (= *S. parvula* var. *l.*), Smooth Small Skullcap: GL=10
KY: ST=7? (20+/13). DBNF records of this east-central herb may not be associated with ROWs or near project ROWs. However, it can be expected on ROWs near calcareous outcrops.
TN: ST=7; CP? (w edge, s?); DeSelm

(BSF)? *Scutellaria saxatilis* (including *S. arguta*), Rock Skullcap: GL=7
KY: ST=4? (10/8). Further taxonomic work is needed to examine the degree of distinction from from *S. arguta* (= *S. saxatilis* var. *pilosior*). In KY, this Appalachian herb is known only from more rugged Appalachian regions. It mostly occurs on benches and low slopes with sandy soil in mesic forest. The four DBNF records (3 on USFS?) are not associated with ROWs, but one is in forest at the edge of a project powerline.
TN: ST=5; CPn [arguta from only one BR co.]

Scutellaria pseudoserrata, Southern Showy Skullcap: GL=5?
TN: ST=6; CP?; Scotts Gulf

(CUM) *Scutellaria serrata*, Showy Skullcap: GL=8?
L KY: ST=5? (12/7). DBNF records of this Appalachian herb are not associated with ROWs or near project ROWs.
TN: ST=4; CP?? (not but close) check re pseudoserrata

(CUM)? ?*Selaginella rupestris*, Rock Spikemoss: GL=10?
KY: ST=2? (1/1). There is only one unconfirmed record of this northern spikemoss from KY. This species is typical of sandstone clifftops, with no special ROW association.
TN: ST=4

BSF *Senecio* cf. *pauperculus*, Northern Meadow-groundsel: GL=10
KY: ST=3? (10/2). In KY, this northern and western herb is known only from the southern Cliff Section, where it occurs on sandy cobble bars along larger rivers. The 10 DBNF records (all on NPS/USFS) are not associated with ROWs or within 100 ft of project ROWs.
TN: ST=4; CP; Obed bars

Senna hebecarpa (= *Cassia h.*), Northern Senna: GL=9?
L KY: ST=4? (5/5?). DBNF records of this northern herb are not associated with ROWs or near project ROWs. However, this species is poorly known in KY.
TN: ST=6

O? *Sida elliotii*, Elliott's Fanpetals: GL=8?
KY: ST=4?
TN: ST=4; CPs??; DeSelm??--check ref

<u>*Silene ovata*</u>, Ovate Catchfly: GL=6
KY: ST=2? (5/4). In KY, this largely Appalachian herb is widely scattered in Appalachian and western regions. It mostly occurs on rocky slopes with sandy soil in mesic forest. The three DBNF records (none on USFS) are not associated with ROWs, and are not within 100

ft of project ROWs.
TN: ST=4; CPs? (1/2 cos.)

BSF?? O ?<u>*Silene regia*</u>, Royal Catchfly: GL=5?
KY: ST=2? (12/4). In KY, this south-central interior herb is known mostly from the western Karst Plains. It mostly occurs on rolling uplands with cherty calcareous soil in open brushy forest and grassland, especially along roadsides. The single DBNF record (on NPS?) is based on a ca. 1940 collection from "edge of sandy field by South Fork River at Alum Creek", but the collection has not been reexamined. This site is not within 100 ft of a project powerline, but suitable habitat may exist in these powerlines.
TN: ST=2

O *Silphium terebinthinaceum* var. *lucy-brauniae*, Smooth Prairie-dock: GL=6?
L KY: ST=6? (10+/6). This variety appears endemic to Ohio and Kentucky in the eastern Knobs region. The typical variety appears rarer in KY, and occurs further west. Some DBNF records (and others nearby) are associated with ROWs, but none are from project ROWs.
TN: none [var. t. ST=5]

o <u>*Silphium wasiotense*</u> (S. *wasiotensis*), Wasioto Rosinweed: GL=5
KY: ST=5? (60/5). This herb is largely endemic to the Rugged Eastern Hills of Appalachian KY, especially in the Kentucky River drainage. It occurs mostly on mesic-subxeric lower slopes in disturbed forest or brushy edges. The 50+ DBNF records (20+ on USFS) are mostly along roadside ROWs. None are within 100 ft of project ROWs, but some are within 1000 ft, and this species may be expected along powerlines.

TN: ST=2; CPne? (trans to RV?)

Sium suave, Water-parsnip: GL=10
L? KY: ST=6? (11+/7). Records of this northern and western subaquatic herb near DBNF are not associated with ROWs or near project ROWs.
TN: ST=5

(BSF) O *Sisyrinchium atlanticum*, Narrow-leaved Blue-eyed Grass: GL=9
KY: ST=8
TN: ST=8; CP; DeSelm

o? *Sisyrinchium mucronatum*, Northern Blue-eyed Grass: GL=9?
TN: ST=5; CPs; DeSelm [also montanum, check...]

<u>*Solidago albopilosa*</u>, White-haired Goldenrod: GL=4
KY: ST=4 (62/3). This herb is endemic to the Red River Gorge area in the north-central Cliff Section, where it occurs in moderately dry soil under the overhangs of sandstone cliffs. The 62 DBNF records (58 on USFS) are not associated with ROWs, although by chance a few do lie along roads and trails. None are within 100 ft of project ROWs.
TN: none

BSF? o? *Solidago arguta* ssp. *boottii* (*S. bootii*), Hairy-seeded Broadleaf Goldenrod: GL=8?
KY: ST=7? (5/3?). Further taxonomic work is needed to distinguish this southern taxon from others in the arguta complex. Most or all KY plants should perhaps be referred to *S. arguta* var. *australis* or var. *caroliniana*. Some DBNF records may be associated with

ROWs (at least the Little Shephard Trail on Pine Mountain). None are from project ROWs.
TN: ST=5; CP [check others vars. versus KY colls.]; Obed bars; Scotts Gulf

BSF? *Solidago caesia* var. *curtisii*, Curtis' Goldenrod: GL=9?
KY: ST=5 (10+/3+). In KY, this Appalachian herb is known only from the Cumberland Mountains and a few sites in the adjacent Rugged Eastern Hills. It occurs on slopes with acid soil in mesic-subxeric forest or brushy edges. The 10+ DBNF records (1 on USFS) are not associated with ROWs. None are within 100 ft of project ROWs, but some suitable habitat probably exists.
TN: ST=8?; CP distribution seems erroneous in atlas from KY perspective; check all colls at UT etc.; Goodson #3,17,20; Obed; Scotts Gulf; Falls Creek

(CUM) *Solidago gracillima* (= *S. austrina*), Southern Bog-goldenrod: GL=8?
KY: ST=4? (8/2). In KY, this southern Appalachian herb is known only from the rocky banks of the Rockcastle River. DBNF records are not associated with ROWs or near project ROWs.
TN: ST=2; CPs? (w edge)

Solidago harrisii (as the West Appalachian segregate), Harris' Goldenrod: GL=6?
L KY: ST=7D? [-/C/-] (30+/7). This herb (sometimes included in *S. arguta*) appears to have two geographically distinct forms, one endemic to the northern Ridge and Valley Province, and the other endemic to the northern Cliff Section in KY. The latter occurs on subxeric-xeric calcareous slopes in open forest near cliffs. The 25+ DBNF records (most on USFS) are not associated with ROWs or within 100 ft of project ROWs.
TN: none

(CUM) *Solidago patula* var. *patula*, Swamp Goldenrod: GL=9?

L KY: ST=5? (12/8). In KY, this north-central herb (a variety of the widespread eastern species) is known from scattered sites on boggy acid soils in open forest or shrubby vegetation. Records (including the single DBNF record) are not associated with ROWs.

TN: ST=7; CPc? (w edge); Goodson #5; Falls Creek (NE slop mixed mes.)--check...

o? *Solidago puberula*, Downy Goldenrod: GL=10?

KY: ST=4? (3/2). In KY, this east coastal and Appalachian herb is known only from the Cumberland Mountains (especially Pine Mt.?). It occurs on subxeric sites in open woods and edges, including occasional roadsides. There are a few unconfirmed or erroneous report from further west.

TN: ST=6

O *Solidago rigida*, Prairie Goldenrod: GL=10

KY: ST=7 (>50/12). In KY, this western (Great Plains) species (often divided into smooth ssp. glabrata and hairy ssp. rigida) is known from scattered native grassland remnants on subxeric-xeric calcareous soils in central and western regions, often in or near ROWs. There are few DBNF records, and most are on or near limestone or siltstone outcrops. None are close to project ROWs.

TN: ST=6; CPs? [both ssp. in CP; r. to w; g to e]; DeSelm

o? *Solidago roanensis*, Roan Mountain Goldenrod: GL=9

KY: ST=4? (5/3?). In KY, this southern Appalachian herb is known only from the Cumberland Mountains or nearby. It mostly occurs on cool slopes in mesic to subxeric forest. The single DBNF record (not on USFS) is in a ROW. It is not within 100 ft of a

project powerline.
TN: ST=7; CPs (check OVER, etc.); Scotts Gulf

(BSF) *Solidago rupestris*, Riverbank Goldenrod: GL=7?
KY: ST=7 (30+/20). DBNF records of this central Appalachian herb are not associated with ROWs or near project ROWs.
TN: ST=3

BSF *Solidago simplex* ssp. *randii* (= *S. spathulata* ssp. *r.*), Rand's Goldenrod: GL=8?
KY: ST=5? (43/4). In KY, this Appalachian subspecies (perhaps as var. *racemosa*) is known only from the southern Cliff Section. It occurs on sandstone boulder-cobble bars along the major rivers, in xeric grassy vegetation. The 43 DBNF records (all on USFS/NPS?) are not associated with ROWs, and none are within 100 ft of project ROWs.
TN: ST=4; CPnw [Most is now segregated as Solidago arenicola: GL=5?]

Solidago sp. nov. [became *S. faucibus*], Greater Broad-leaf Goldenrod: GL=6?
L KY: ST=6? (20+/6). This central Appalachian herb has been well documented in KY since 1989. DBNF records are not associated with ROWs or near project ROWs.
TN: none

(BSF) O? *Solidago speciosa* var. *speciosa*, Eastern Showy Goldenrod: GL=9?
L KY: ST=6? (15+/7). Most DBNF records (and nearby records) of this east-central herb are associated with ROWs, or in adjacent thickets. None are from project ROWs, but it may be expected.
TN: ST=7; CP

Solidago squarrosa, Squarrose Goldenrod: GL=8?
KY: ST=2? (2/2h?). In KY, this northeastern herb is confirmed only from Pine Mountain, though there are also unconfirmed reports from near the Pottsville Escaprment (Warren Co.). It occurs on steep, rocky mesic to subxeric slopes in forest.
TN: none

o? *Sorghastrum elliottii*, Slender Indiangrass: GL=8
TN: ST=6; CPne?; Obed bars

BSF? *Spartina pectinata*, Prairie Cord-grass: GL=10
KY: ST=7? (20+/14). DBNF records of this north-central and western grass are not associated with ROWs or near project ROWs.
TN: ST=5; CP (few data); DeSelm

(BSF) o? *Sphenopholis pensylvanica* (= *Trisetum p.*), Swamp Wedgescale: GL=8
KY: ST=2? (6/5). In KY, this southeastern grass is known only from the southern Cliff Section and the Mississippian Embayment (Gravel Hills Section). It occurs on lowland terraces and upland swales in acid, boggy soil with brushy or grassy hydric vegetation. The three DBNF records (all on USFS) are partly (2) associated with ROWs, and two are along project ROWs.
TN: ST=6; CP? (few data); DeSelm [check also obtusata and o x p]

Spiraea alba var. *alba*, Narrow-leaved Meadowsweet: GL=10
KY: ST=2? (2/2). In KY, this northern shrub is known only from the north end of Pine Mountain (on rocky river banks) and from the Mississippian Embayment (in a slough

margin).
TN: ST=2

BSF *Spiraea virginiana*, Virginia Spiraea: GL=4?
KY: ST=3 (20+/5). In KY, this Appalachian shrub is known only from the southern Cliff Section and the northern Knobs Region, where it occurs along the rocky banks of medium-sized streams, in open brushy vegetation. The 19 DBNF records (16 on USFS) are not associated with ROWs, and none are within 100 ft of project ROWs.
TN: ST=4; CP; Falls Creek

(BSF) *Spiranthes lucida*, Shining Ladies'-tresses: GL=10
KY: ST=2? (7+/7). In KY, this northern orchid is known only from the Cliff Section and adjacent limestone valleys to the west. It occurs along medium sized streams in mud among limestone rocks near the shore, in open brushy vegetation. The six DBNF records (one on USFS) are not associated with ROWs, and none are within 100 ft of project ROWs.
TN: ST=3

?*Spiranthes magnicamporum*, Great Plains Ladies'-tresses: GL=8?
KY: ST=2? (7/4). To our knowledge, this orchid has not been reported from DBNF or nearby, but it has been listed by DBNF.
TN: none

(BSF) o *Sporobolus clandestinus*, Rough Dropseed: GL=10
KY: ST=6? (20+/10+). In KY, this widespread eastern grass is known mostly from the Mississippian Plateaus and its transitions. It occurs on clifftops and rocky slopes, generally

with calcareous soil, in xeric grassland. The four DBNF records (1 on USFS) are partly associated with ROWs (rocky roadsides on ridges). None are within 100 ft of project ROWs, but there may be suitable habitat.
TN: ST=7; CP (not in s?); Obed bars; DeSelm

Sporobolus junceus, Pineywood Dropseed: GL=8
TN: ST=2; CPne; Obed bars

o? ?*Stellaria longifolia*, Longleaf Stitchwort: GL=10
KY: ST=2? (3/2?). Further taxonomic work may be needed in some cases, since distinction from *S. graminea* can be difficult. In KY, this northern (circumboreal) herb is known only from scattered sites in the Knobs Region and perhaps the Cliff Section. It occurs on terraces with damp, fertile soil in open, brushy forest and edges. The single DBNF record (not on USFS) requires further verification. It may be associated with a ROW, but is not within 100 ft of a project powerline.
TN: ST=3

BSF o *Stenanthium gramineum*, Featherbells: GL=9?
L KY: ST=5 (25/18). Many records are historical, and there are few secure populations. Further taxonomic work is needed to distinguish the three varieties of this southern herb in KY, and to rank them independently. Available data suggests that the southern Appalachian var. *micranthum*, in particular, may be less widespread, with records only from the southern Cliff Section. Some DBNF records (or nearby records) are from ROWs, but none are from project ROWs.
TN: ST=6; CP; Goodson #3; Obed bars; Jones BLED; Patrick BLED (Panter Cr); NOTE

ALSO: there seems to be a distinct small form under rockhouses at BSF; needs further research...

?*Streptopus roseus* var. *longipes*: see below (dubious record).

Streptopus roseus var. *perspectus*, Rosy Twisted Stalk: GL=10
KY: ST=2? (5/2). In KY, this northern and Appalachian herb is definitely known only from Black Mountain, as var. *perspectus*, but there are also two somewhat dubious records from the northern Knobs Region, as var. *longipes,* dating from the 1930s. This species occurs on cool slopes in mesic forest. It is not associated with ROWs.
TN: ST=2 (var. not stated)

(BSF)? ?*Styrax grandifolius,* Big-leaf Snowbell: GL=10
KY: ST=?? [-/C/?] (?/?). Presence of this southern shrub in KY has not been verified, but there is a sight record from along the Cumberland River (on USFS?).
TN: ST=7; CP; check data...

Symphoricarpos albus var. *albus*, Snowberry: GL=10
KY: ST=3 (8/2). In KY, this northern shrub is known only from the central Knobs Region in transition to the Appalachian Plateaus. It occurs on narrow limestone ridges in xeric open brushy forest. The four DBNF records (none on USFS) are not associated with ROWs or within 100 ft of project ROWs.
TN: none

(BSF)? *Synandra hispidula*, White Wood-beauty: GL=9?

L KY: ST=7? (100+/35+). In KY, this east-central herb is scattered widely in eastern and central Kentucky, especially in calcareous regions. It occurs on mesic, base-rich lower slopes and terraces in forest. The 20+ DBNF records (most on USFS?) are not generally associated with ROWs, though this species may locally prosper along some shady roadsides. No records are from within 100 ft of project ROWs.

TN: ST=6; CP? (w edge)

BSF o *Talinum teretifolium*, Roundleaf Fameflower: GL=8?

KY: ST=3? (14/2). In KY, this Appalachian herb is known only from the southern Cliff Section. It occurs on narrow ridges and clifftop flats, with very thin soil around bare sandstone, in sparse, largely non-vascular vegetation. The 10 DBNF records (9 on DBNF) are partly (7) associated with ROWs. This association often reflects the coincidence of roads and trails with ridgetop outcrops, but in a few cases, the plants appear actually concentrated in old road ruts. One record is within 100 ft of a project powerline, and there is probably other suitable habitat.

TN: ST=4; CP (few data); Patrick SCOT (Slavens Cr, hist); Obed

(BSF) *Taxus canadensis*, Canadian Yew: GL=10

KY: ST=4 (15/6). In KY, this northern shrub is known only from the Cliff Section (plus an obscure record from Edmonson Co.). It occurs on cool limestone slopes in mesic forest. The 10 DBNF records (5 on USFS) are not associated with ROWs, except in one coincidental case. None are within 100 ft of project ROWs.

TN: ST=2; CPnw; Patrick PICK (PStPk, 2 patches)

BSF o *Tephrosia spicata*, Spiked Hoary-pea: GL=9
KY: ST=2? (10/2). In KY, this southeastern herb is known only from the southern Cliff Section. It occurs on the rocky banks of the Cumberland River and on a few ridges nearby, with exposed sandy soil with subxeric grassy vegetation. The 10 DBNF records (8 on USFS?) are partly (3?) associated with ROWs on the ridges. Two records are along project ROWs.
TN: ST=6; CP (few data)

Thalictrum coriaceum, Maid-of-the-Mist: GL=6?
KY: ST=3?
TN: ST=3; CPn?; Patrick MORG (hist, near Rugby)

?*Thalictrum mirabile*, Cliff-rue: GL=?
D KY: ST=? (?/?). It has not been possible to separate this species consistently from *T. clavatum* in KY. *T. clavatum* is not rare in KY (ST=8D?).
TN: not separated in atlas.

o *Thelypteris palustris*, Marsh-fern: GL=10
L KY: ST=6? (20?/16). Some DBNF records of this widespread North American (and Northern Hemisphere) fern are from ROWs, but none are from project ROWs.
TN: ST=7; CP (few data)

o? *Thaspium pinnatifidum*, Cutleaf Meadow-parsnip: GL=7
KY: ST=5? (15+/4). In KY, this Appalachian herb is known only from the northern Cliff Section, where it occurs on calcareous rocky ridges and upper slopes in subxeric forest and

brushy edges. The 14 DBNF records (13 on USFS) are partly (2+) associated with ROWs (especially along KY 1274 on Clack Mountain, Rowan Co.). None are within 100 ft of project ROWs.
TN: ST=3

o *Thermopsis mollis*, Sofhaired Thermopsis: GL=7
KY: ST=2? (2/1). In KY, this southeastern (mostly Piedmont) herb is known only from a small part of the Rugged Eastern Section of Appalachian Plateaus. It occurs on ridges with acid soil in subxeric forest and brushy openings. The two DBNF records (both on USFS) are partly associated with ROWs, with flowering being largely restricted to more open conditions, but many plants also occur in the shade.
TN: ST=4; CPs

BSF *Thuja occidentalis*, Northern White-cedar: GL=10
KY: ST=4 (16/5). In KY, this northern tree is known only from the southern Cliff Section and adjacent Mississippian Plateaus, plus one site at the Breaks (Pike Co.). It mostly occurs on steep calcareous slopes in mesic-subxeric forest. The seven DBNF records (1 on USFS) are not associated with ROWs, and are not within 100 ft of project ROWs.
TN: ST=6; CP (not s); Falls Creek

O <u>*Tomanthera auriculata*</u> (*Agalinis a.*), Broadleaved Mouseglove: GL=5
KY: ST=2
TN: ST=4; CPc; DeSelm

(CUM) o *Toxicodendron vernix* (= *Rhus v.*), Poison Sumac: GL=10

KY: ST=2 (2/2). In KY, this eastern shrub (mostly in coastal/Great Lakes regions) is known only from the Low Hills Section of the Appalachian Plateaus. It occurs on lowland terraces and upland swales with acid soil in hydric forest and brushy openings. The single DBNF record (not on USFS) is not associated with a ROW, or within 100 ft of a project powerline.

TN: ST=4; CPs; Patrick GRUN (County Line Woods, near Scotts Gulf)

(BSF)? *Trachelospermum difforme*, Climbing Dogbane: GL=10

KY: ST=7? (30+/8). DBNF records of this southern vine are not associated with ROWs or near project ROWs.

TN: ST=7 perhaps overlooked on CP along rivers

BSF o? *Tradescantia ohiensis*, Blue-leaf Spiderwort: GL=10

KY: ST=7? (20/13). DBNF records of this southern and mid-western graminoid may not be associated with ROWs, but in other parts of the state some records are. There are no records from project ROWs, but there may be suitablke habitat.

TN: ST=7; CP (few data); DeSelm; Goodson #7

(BSF) o *Tragia urticifolia*, Nettle-leaf Noseburn: GL=10

KY: ST=2? (2/2). In KY, this southwestern herb is known only from sites in the Dripping Springs Hills and the southern Cliff Section. It occurs on limestone outcrops along rocky slopes, in xeric open forest and brush. The single DBNF record (on USFS/USACE) is not associated with a ROW, or within 100 ft of a project powerline.

TN: none

BSF *Trautvettaria caroliniensis*, Tassel-rue: GL=10

KY: ST=7? (50+/11). DBNF records of this Appalachian (and disjunct western) herb are not associated with ROWs or near project ROWs.

TN: ST=7; CP; DeSelm; Obed bars; Falls Creek

BSF? ?*Triadenum virginicum* (*Hypericum t.*), Clasping Marsh St. John's Wort: GL=9

TN: ST=4; CP; check ids since gap in tubulosum range.

BSF *Trichomanes boscianum*, Appalachian Filmy Fern: GL=8

KY: ST=7 (30+/20). DBNF records of this southern Appalachian-Ozarkian fern are not associated with ROWs or near project ROWs.

TN: ST=5; CP (few data); Patrick FENT (3 old sites), CAMP (new site #9).

BSF? *Trichomanes intricatum*, Thwarted Filmy-fern (gametophyte only): GL= 8??

KY: ST=7? (7/7?). In KY, this obscure Appalachian fern is known from under sandstone overhangs in the Appalachian Plateaus and the Pottsville Escarpment.

TN: ST=2

Trichomanes petersii, Dwarf Bristle-fern: GL=6?

TN: ST=6; CPs; Scott Gulf

O? *Trichostema setaceum* (= *T. dichotomum* var. *lineare*), Narrow-leaved Bluets: GL=8?

KY: ST=4? (?/?). Separation of this species from depauperate *T. dichotomum* needs further study in KY. There may be no verified records of *T. setaceum* from DBNF. However, at least one collection from a project powerline (near Alum Creek road in McCreary Co.)

keys to this species, and it is likely that such plants are associated with ROWs.
TN: ST=4

Trientalis borealis, Northern Starflower: GL=10
KY: ST=2? (2/1). In KY, this northern and east-coastal herb is known only from the Middle Fork Red River valley, where it occurs on slopes below sandstone cliffs in mesic forest. These two DBNF records (one on USFS?) are not associated with ROWs, and are not within 100 ft of project ROWs.
TN: ST=4

o *Trifolium stoloniferum*, Running Buffalo-clover: GL=5?
KY: SL=5 (20+/6). In KY, this largely Ohio Valley herb is known mostly from the Bluegrass Region. It occurs on fertile, mesic uplands or lowlands in open forest along old trails or in old lightly grazed or mowed areas. The single DBNF record (on TNC land), discovered by Jim Hays in 1997, is in an old dirt road along Little Clover Creek (Jackson Co.). It is not within 100 ft of a project powerline.
TN: none

Trillium undulatum, Painted Trillium: GL=10
KY: ST=5? (12/3). In KY, this northern and Appalachian herb is known only from the Cumberland Mountains, on mesic sites in forest. Reports from further west, including DBNF, have not been verified.
TN: ST=7

(BSF)? o *Triosteum perfoliatum*, Perfoliate Horse-gentian: GL=10?

L KY: ST=5? (5+/5+). This species may have been combined with *T. aurantiacum* in some cases, but it is generally believed to be distinct. There are few good records from KY, but M. Medley (pers. comm.) has a record from his collections on DBNF in McCreary Co. This was in a brushy area along a road, but not near a project powerline.

TN: ST=6; CP? (few data); Patrick PICK (Flint Fork Cove); Scotts Gulf; JC/MM check Nevelsville area

(BSF)? o *Triphora trianthophora*, Three-birds Orchid: GL=10

KY: ST=7? (30/17). DBNF records of this widespread eastern (and Central American) orchid are not generally associated with ROWs, though there may be some concentrations near footpaths and dirt-roads. There are no records from project ROWs.

TN: ST=7; CP; Scotts Gulf; Falls Creek

BSF o *Tripsacum dactyloides*, Gama-grass: GL=10

KY: ST=7A (30+/15). DBNF records of this south-central (and Central American) grass are not associated with ROWs or near project ROWs.

TN: ST=7; CP (few data); note JC observation

(BSF) *Ulmus serotina*, September Elm: GL=7?

KY: ST=5? (8/5). In KY, this southern interior species is known mostly from the Mississippian Plateaus and the adjacent Cliff Section. It occurs on calcareous slopes and clifftops in subxeric-xeric forest. The 4 DBNF records (one on USFS) are not associated with ROWs, except for a few coincidental trees. None are within 100 ft of project ROWs.

TN: ST=7; CP? (w edge)

Ulmus thomasii, Rock Elm: GL=8
KY: ST=7? (100+/12). DBNF records of this east-central tree are not associated with ROWs or near project ROWs.
TN: ST=7?; CP?; Falls Creek; unexpected from KY; check id versus serotina

Utricularia biflora, Longspurred Creeping Bladderwort: GL=10?
TN: ST=4; Jones CUMB; can be difficult to separate from *gibba*.

(BSF)? *Utricularia gibba*, Creeping Bladderwort: GL=10
KY: ST=7? (25?/14). DBNF records of this widespread North (and Central) American aquatic herb are not associated with ROWs or near project ROWs. However, this species may eventually be expected in older powerline ponds.
TN: ST=6; CP; Jones hist; Patrick hist (2 m e Clarkrange in Glade Br area)

(BSF)? *Utricularia subulata*, Zigzag Bladderwort: GL=8
TN: ST=4; CPne; Obed bars

BSF *Uvularia sessilifolia*, Riverbank Bellwort: GL=10
KY: ST=7? (50+/22). DBNF records of this northern and Appalachian herb are not associated with ROWs or near project ROWs.
TN: ST=8; CP; Obed; Scotts Gulf; Falls Creek

Vaccinium atrococcum (?*V. fuscatum*), Hairy Highbush Blueberry: GL=8?
KY: ST=4? Preferred name is *fuscatum*.

TN: ST=??; Jones; Obed [check taxonomy]

?*Vaccinium constablaei* (?*V. simulatum*), a Highbush Blueberry: GL=6?
TN: ST=??; Obed bars; Scotts Gulf; check taxonomy; this name has been missap;ied to *simulatum*.

BSF *Vaccinium erythrocarpum*, Southern Mountain Cranberry: GL=8
KY: ST=2
TN: ST=6; CP (few data)

?*Vaccinium melanocarpum* (?*V. stamineum* var. *sericeum*), Southern Deerberry: GL?
TN: ST=??; DeSelm [check taxonomy]

(BSF) *Vallisneria americana*, Eel-grass: GL=10
KY: ST=5? (15/7). In KY, this widespread eastern submerged aquatic herb is known from scattered streams in the Appalachian Plateaus and the Ohio River (and historically in the Kentucky River). It often occurs near riffles, but rooted in silt/sand rather than rocky substrates. The five DBNF records (2 on USFS) are not associated with ROWs, and are not within 100 ft of project ROWs.
TN: ST=5; CP (few data)

BSF O *Vernonia noveboracensis*, New York Ironweed: GL=10
D KY: ST=7? (30+/6). In KY, this south-central herb is known mostly from the southern Cliff Section, plus a few sites in the Knobs Region. It occurs on terraces and broad ridges with seasonally wet, acid soils, in open brushy or grassy vegetation. The 25+ DBNF

records (6 on USFS) are partly (12) associated with ROWs. One record is along a project powerline, and there is much suitable habitat (this species may have been overlooked in 1996).
TN: ST=7; CP; DeSelm

Veronica anagallis-aquatica, Multiflowered Water-speedwell: GL=10
L? KY: ST=5? (10?/7). Fernald (1950) considered that the North American plants include both native and alien origins, but Cronquist (1991) indicated that it is all alien. Further research is needed. DBNF records are not associated with ROWs or near project ROWs.
TN: ST=7

(CUM) O *Veronicastrum virginicum*, Culver's Root: GL=9?
KY: ST=7? (30+/15+). Most DBNF records of this east-central herb are from ROWs or in adjacent thickets. None are from project ROWs, but it may be expected.
TN: ST=7; CP; DeSelm; Obed bars

BSF *Viburnum dentatum* var. *lucidulum* (*V. recognitum*), Smooth Arrow-wood: GL=9?
KY: ST=7? (15/6). DBNF records of this northeastern and Appalachian shrub are not associated with ROWs or near project ROWs.
TN: ST=?? (not separated in atlas)

(CUM) *Viburnum dentatum* var. *scabrellum*, Felty Arrow-wood: GL=8?
L KY: ST=5? (5/5?). Further taxonomic work may be needed to distinguish this densely pubescent southern variety from var. *venosum*. However, whatever the determination, it is clear that this taxon is rare in KY. DBNF records are not associated with ROWs or near

project ROWs.
TN: ST=?? (not separated in atlas)

?*Viburnum lentago*, Nannyberry: GL=9
KY: reports of this northern shrub in KY are dubious or unconfirmed (see Morehead District Inventory report of Campbell et al. 1992). The single DBNF record may be doubted.
TN: none

(BSF)? *Viburnum nudum*, Possumhaw: GL=8
KY: ST=3
TN: ST=7; CP; Jones GRUN; Scotts Gulf

Viburnum rafinesquianum var. *rafinesquianum*: GL=9?
L? KY: ST=6? (>10?/3). Further taxonomic work may be needed in Kentucky to distinguish this pubescent northern variety from the more glabrous mid-western var. *affine*. DBNF records are not associated with ROWs or near project ROWs.
TN: ST=3

BSF O *Viola fimbriatula* (= *V. sagittata* var. *ovata*), Little Hairy Stemless-violet: GL=10?
L KY: ST=6? (10+/7). Most DBNF records of this north-central herb are associated with ROWs, and several are along project ROWs.
TN: ST=6; CP (few data)

BSF o? *Viola lanceolata*, Lance-leaved White-violet: GL=10

KY: ST=7? (20+/15). A few DBNF records (or nearby records) of this widespread eastern herb are associated with ROWs; one is along a project powerline.
TN: ST=6; CP

BSF? *Viola tripartita* var. *glaberrima*, Unlobed Truncate Yellow-violet: GL=8?

KY: ST=7? (25+/8). This southern Appalachian variety appears quite distinct from the typical (see below). DBNF of this records of this herb are not associated with ROWs or near project ROWs.
TN: ST=8; CP

Viola tripartita var. *tripartita*, Trilobed Truncate Yellow-violet: GL=8?

L KY: ST=2? (1/1h). The only KY record of this Appalachian herb is from Carter County (Braun 3945 at US).
TN: ST=4; CPs? check

Viola walteri, Walter's Violet: GL=9?

KY: ST=4? (10/3). In KY, this south-central herb is known only from the northern Cliff Section of the Appalachian Plateaus (Carter Caves area) and the Palisades Section of the Bluegrass Region. It occurs on xeric limestone sites in open forest and clifftop edges.
TN: ST=5; CPc? check

(BSF)? *Vitis labrusca*, Fox-grape: GL=10?

KY: ST=5? (5/4). The few KY records of this northeastern vine need to be confirmed with further taxonomic study. DBNF records are not associated with ROWs or near project

ROWs.
TN: ST=7?; CP check versus cinerea; DeSelm

BSF *Vitis rupestris*, Sand Grape: GL=6?
KY: ST=3? (17/3). In KY, this southwestern vine is known only from the southern Cliff Section, where it occurs on cobble shores of the Rockcastle River, Big and Little South Forks, in open brushy vegetation. The 17 DBNF records (12 on USFS/NPS) are not associated with ROWs, and not within 100 ft of project ROWs.
TN: ST=4; expected CPnw along BSF

BSF *Waldsteinia fragarioides*, Barren Strawberry: GL=10
KY: ST=7? (25+/17). Further taxonomic work is needed to separate var. *fragarioides* from var. *parviflora*; only the latter is known from BSF. In KY, the latter is known only from the southern Appalachian Plateaus and may deserve official listing. DBNF records are not associated with ROWs or near project ROWs.
TN: ST=8; CP (vars. not separated); DeSelm; Obed bars etc. [most/all = var. *parviflora*]

BSF *Wisteria frutescens*, Eastern Wisteria: GL=10
KY: ST=7? (50+/11). Further taxonomic work may be needed to determine if eastern and western populations in KY are distinct, as *W. frutescens* versus *W. macrostachya*. If they are, the eastern form at least would deserved to be officially listed. DBNF records are not associated with ROWs or near project ROWs.
TN: ST=8; CP (not separated from macrostachya)

Woodsia appalachiana (= *W. scopulina* var. *a.*), Mountain Woodsia: GL=10
KY: ST=2? (1/1). In KY, this Appalachian fern (a segregate of the Cordilleran *W. scopulina*) is known only from one site on Pine Mountain (Bell Co.). It occurs on a sandstone cliff in subxeric forest.
TN: ST=4

?*Woodwardia virginica*, Eastern Chain-fern: GL=10
L KY: ST=2? (2/2?). There is only one unconfirmed historical record of this southern and east-coastal fern from DBNF. Suitable habitat may exist along some ROWs, and this species might be expected.
TN: ST=6; CPs; Scotts Gulf (+ Patrick); Jones HAMI, FRAN, WHIT

o? *Xyris difformis* (= "*X. caroliniana*"), Carolina Yellow-eye-grass: GL=10
KY: ST=2? (1/1). In Ky, this widespread eastern-coastal herb is known only from a site in the northern Knobs Region. It occurs on an ancient high terrace, with acid soil in hydroxeric grassy vegetation. This single DBNF record (on USFS) is not associated with a ROW, or within 100 ft of a project powerline. However, this species has an ecology that appears compatible with ROWs.
TN: ST=4; CP (not nw); Obed bars

BSF? O *Xyris torta*, Common Yellow-eyed Grass: GL=10
L KY: ST=6 (20+/12). Some DBNF records of this south-central graminoid are associated with ROWs; one is along a project powerline.
TN: ST=7; CP; DeSelm; Scotts Gulf; Jones PUTN; Patrick BLED (Dugans Meadow), BLED (Panter Cr), FENT (Megadenz Falls)

O *Zigadenus leimanthoides*, Pine-barren Deathcamas: GL=4?
TN: ST=2; Jones FRAN; Scotts Gulf (upland swamp)

APPENDIX 5: EFFECTS OF FIRE ON TERRESTRIAL VERTEBRATES

Contributed by Martina Hines (Kentucky State Nature Preserves Commission).

EFFECTS OF FIRE ON SMALL MAMMALS

Few studies have examined impacts of fire on small mammals. Most of these were conducted in the Coastal Plain longleaf pine communities, others in open grassland situations in the midwest. Of the 24 species of small mammals known to exist in the Southeast, only seven have been studied at this time (Enno 1998). No study has yet been published from the Cumberland Plateau or the Ridge and Valley. Some results from other regions, though, do have relevance for this region.

Most species of small mammal appear to experience very little direct mortality from fire, though it does occur (Komarek 1969). One factor influencing direct mortality is the spreading rate of fire (Taylor 1973), but burn season also influences mortality rates. Growing season fires can be particularly harmful to species nesting above ground, such as the eastern harvest mouse (*Reithrodontomys humulis*), which tends to nest in dense low growing vegetation (Erwin and Stasiak 1979). Even where direct mortality rates from fire are high, small mammal populations might not be impacted significantly, because mortality from fire might replace mortality by malnutrition, predation, etc. (Cringham 1958). Also, where direct mortality rates are high, reinvasion from surrounding areas is often rapid, and mice that emigrated from a burned area have been reported to return shortly after (Hofstetter 1973). Kirkland et al. (1996) reported the impact of fire on small mammal communities in the central Appalachians of Pennsylvania was transitory, with differences in small mammal abundance between burned and unburned habitats disappearing within eight months following a wildfire.

For most species the limiting factor determining population response to fire is not direct mortality, but alteration of habitat parameters, specifically cover and prey/forage availability (Layne 1974, Shadowen 1963, Hatchell 1964, Hofstetter 1973, Arata 1959). A number of studies from the Cumberland Plateau have examined the impacts of fire on vegetation structure and plant diversity, as well as forest floor characteristics, such as changes in litter layer and dead woody debris by fire, as well as responses by invertebrate populations. These data allow for some general predictions regarding small mammal response to fire based on varying habitat requirements of different species.

Many small mammals depend upon thick litter for protection against predators while traveling and foraging (Kirkland et al. 1996, Planz & Kirkland 1992, Hatchell 1964). Downed logs and other debris also provide a very important and useful mode of travel for small mammals (Enno 1998, Barry et al. 1984, Meserve 1977, Planz & Kirkland 1992). Prescribed fires tend to reduce these habitat components, causing declines of shrews, voles and even the [habitat-] tolerant white footed and deer mice (*Peromyscus* spp.), until conditions improve (Kirkland et al. 1996).

Understory vegetation is also a critical habitat component for many small mammals. In a loblolly-shortleaf pine forest in Louisiana, a dense [somewhat grassy] understory resulted in a mouse population nearly three times that of a moderate understory (Hatchell 1964). In two independent studies southern red-backed vole numbers were depressed for 2-3 years following burning until recovery in the ground vegetation had occurred (Ahlgreen 1966, Sullivan & Boateng 1996). Meadow voles also appear to show a preference toward areas with more vegetative cover (Eadie 1952). Burned sites that have also been thinned provide more vegetative growth than unthinned burned sites, and accordingly can be expected to provide better habitat conditions for small mammals, including the hispid cotton rat *Sigmodon hispidus* (Enno 1998). Burning of unthinned sites can lead to a temporary reduction in ground vegetation and plant diversity and result in lower mammal diversity than unburned sites (Enno 1998), unless the fire is very hot and opens the canopy.

Population responses of insectivorous species are strongly influenced by the impact of fire on prey populations. Winter burns might be more detrimental for insectivorous species, such as shrews, because of the slower movement capabilities of insects in the winter, and less vegetative cover that could be used as a refuge when the litter is removed (Wade & Lunsford 1989). Frequent burning can also reduce the number of invertebrates on the forest floor (Heyward & Tissot 1936).

The rate of small mammal population recovery after fire varies dramatically from one study to the next. Population density, animal mobility, and the surrounding habitat's size and similarity to the depopulated area determine the rate of small mammal population recovery (Enno 1998, Jameson 1955, Layne 1974, Stickel 1946). Some species, particularly habitat generalists, and those occurring in higher densities, such as white-footed and deer mice repopulate burn areas more readily than habitat specialists. The persistence of many species in an area after a drastic change in surroundings (as caused by fire) indicates that they either tolerate a wide range of conditions or that fires burned so unevenly that portions of all habitats were left (Bendell 1974).

Small mammal populations in loblolly-shortleaf pine forests in Louisiana returned to preburn levels just three weeks postburn and exceeded preburn levels six weeks after the burn (Shadowen 1963). But this type of population boom does not necessarily reflect long-term population trends. White-footed mice populations, for instance, tend to rebound rapidly following fire, often surpassing pre-burn levels (Travis 1956, Hofstetter 1973, Layne 1974, Boyer 1964, Hatchell 1964), but have also been observed to decline to pre-fire levels in the years following a fire (Boyer 1964, Ahlgren 1966). Ahlgren (1966) attributed this population development to the release of pine seeds, exposure of seeds within the organic soil layer, and increased availability of insects from slash once the litter and ground cover were removed by fire. However, in his study, those food sources were slowly used up during the second year, and the number of mice decreased accordingly. Some studies show no change in population levels of deer mice following fire (Arata 1958, Shadowen 1963). Low intensity fires might have preserved suitable habitat conditions in these situations.

Most information regarding the responses of small mammal species to fire in forest environments regards dominant species, such as white-footed mice (*Peromyscus leucopus)*. Abundance of this habitat generalist has been hypothesized to influence diversity and abundance of other species in the small mammal community. But the more diverse a habitat is, the less likely it is that the abundance of a dominant species will influence the diversity of the small mammal community (Anthony 1981). Consequently, it can be hypothesized that those fires, which cause an increase in plant diversity and structural complexity, might result in higher small mammal diversity, even where the white-footed mouse continues to be the dominant species, because of new niche opportunities for other species.

Because so few data are currently available regarding small mammal responses to fire in this region, any prescribed burn at Big South Fork has to be considered experimental in regard to impacts on small mammals. However, based on existing evidence, concern for the effects of prescribed fire on small mammals in the southern Appalachians seems unwarranted (Ford et al.

1999). Even rare and uncommon species are unlikely to be impacted, particularly if fires are restricted to small areas. One of these, the eastern woodrat (*Neotoma magister*) is unlikely to be harmed either indirectly or directely by fire because of its associations with clifflines and its highly opportunistic foraging habits. Other uncommon species, including the meadow jumping mouse (*Zapus hudsonius)*, the hispid cotton rat (*Sigmodon hispidus)*, and the rice rat (*Oryzomys palustris)* are generally associated with bogs, swamp forests, and wet meadows--areas that are unlikely to be burned. The hispid cotton rat is also associated with upland areas, but, as discussed above, is one of few species reported to increase after fire. The rare southeastern shrew (*Sorex longirostris)* may occur along rock bars, another habitat unlikely to be burned (J. MacGregor pers. comm.).

Some species associated with upland forests, which are more likely to be included in a burning regime, are very common region-wide and therefore less reason for concern. Uncommon species for which no data exist regarding possible responses to fire include the southern bog lemming (*Synaptomys cooperi*), which is associated with a variety of habitats, including old fields and weedy areas in uplands, and the woodland jumping mouse (*Napaeozapus insignis*) (J. MacGregor, pers. comm.). A complete list of upland species [on the central Cumberland Plateau] is as follows.

Short-tailed shrew (*Blarina brevicauda*): common
Least shrew (*Cryptotis parva*): prairies, old fields, common in cultivated areas
Pygmy shrew (*Microsorex hoyi*): common
Pine vole (*Microtus pinetorum*): common, grapevine, smilax, etc., common in powerlines
Woodland jumping mouse (*Napaeozapus insignis*): upland version
Eastern wood rat (*Neotoma floridana*): common, clifflines, rock houses, old mines
Golden mouse (*Ochrotomys nuttalli*)

Rice rat (*Oryzomys palustris*): possible in boggy places, swamp forest, wet meadows
White-footed mouse (*Peromyscus leucopus*)
Eastern harvest mouse (*Reithrodontomys humulis*): decreases after fire (Enno 1998).
Hispid cotton rat (*Sigmodon hispidus*): possibile in boggy places and old fields; tends to increase after fire; more abundant in thin or burned sites than in unburned sites and in burned sites that have not been thinned (as in loblolly pine plantations) (Enno 1998).
Common shrew (*Sorex cinereus*): just high elevations; especially in mature woods
Smoky shrew (*Sorex fumeus*): common in woods
Southeastern shrew (*Sorex longirostris*): rare, may in along rock bars along streams
Southern bog lemming (*Synaptomys cooperi*): varied habitats, old fields, even weedy areas in uplands, old ponds
Meadow jumping mouse (*Zapus hudsonius*): here at edge of range, swampy places

EFFECTS OF FIRE ON BIRDS

The effects of fire on birds have been studied more extensively than on any other group of animals. Yet currently there are only few data available from long-term studies regarding burning effects on forest bird populations. As with small mammal species, the highest impact on birds does not appear to stem from the direct effect of fire, but from indirect alterations of habitat, unless a fire occurs during the nesting season. Nesting season fires can cause high direct mortality, because most birds, except for cavity nesters, nest in unprotected locations. However, direct mortality affects mostly eggs and offspring and rarely adults. Fire-induced habitat alterations, on the other hand, can lead to profound shifts in species composition and abundance (Artman et al. 2001, Hines 1999, Wilson et al. 1995).

Controlled burning without midstory removal. Mixed hardwood and pine-hardwood forests are commonly treated with ground fires, e.g., for oak regeneration. These stands exhibit lower bird diversity than stands that have also had midstory treatment, and unburned stands. Under a closed canopy and without midstory removal, the understory responds to ground fires not very vigorously. If burning is conducted annually, the resulting suppression of shrubs and saplings causes declines of shrub nesting birds. The ground level woody component and litter layer is reduced by fire, but due to a lack of sunlight it is not replaced readily by herbaceous vegetation and consequently does not provide good habitat for most ground or shrub nesting birds (Artman et al. 2001).

Mature unburned forests are characterized by large-diameter snags, diverse sizes, large amounts of woody debris and complex canopies. These attributes are known to improve habitat for a variety of avian taxa (Haney and Lydic 1999). Repeated low intensity fires can lead to a reduction of snags [unless new ones are gradually created by basal wounding], a more uniform canopy due to the elimination of certain size classes, and a reduction of the amount of debris. Over time, bird diversity is likely to decrease, particularly that of canopy inhabitants and cavity and ground nesters, and resemble that of secondary even-aged stands rather than of old-growth forest. If fires are frequent and intense enough to control re-sprouting and maintain an open midstory, an open grassy situation might develop, which in turn provides habitat for some ground nesters, fly-catching species, and many early successional and edge species.

High intensity wild fires. While present day fires at Big South Fork and adjacent areas are usually low intensity ground fires rarely exceeding more than a few hundred acres, the fire regime prior to European settlement was probably quite different (Appendix 2). Whether fire in general was more or less common, it was probably more varied in its characteristics, and there was probably a higher frequency of high intensity, stand-replacing crown fires that covered large areas. These fires would have had a different effect on the bird community than present day fires. High intensity fires lead to a reduction of the canopy basal area and an irregular canopy structure with numerous snags, but they usually retain a scattering of live trees and islands of woody vegetation. They normally cover larger areas than controlled burns and have irregularly shaped borders.

The number of bird species present in a habitat has been related to vertical and horizontal heterogeneity (MacArthur & MacArthur 1961, Wilson 1974, Niemi & Hanowski 1984, Merrill et al. 1998). Consequently, areas burned with high intensity fires can be expected to have greater number of individuals and bird species observed per unit area than less heterogeneous stands, such as heavily timbered stands. Larger areas usually exhibit greater complexity, and increasing size of burns is related to an increase in bird species richness (Eberhart & Woodard 1987). Burned areas tend to have a high density of standing dead trees, often more than in logged areas. Many studies have documented the importance of standing dead trees to birds and other wildlife (Carlson 1994, DesGranges & Rondeau 1993, Franzreb & Ohmart 1978, Hagan et al 1997, Mannan et al. 1980, Niemi & Probst 1990, Schulte & Niemi1998). Hot fires are consequently one way to create a higher number of snags not associated with unburned forests or forests treated with only low intensity ground fires.

Residual live trees are also important to birds because they diversify the structure of early-successional habitats (Merrill et al. 1998). While both logged and burned areas tend to retain live trees of varying size classes, live trees in burned areas often represent a higher species diversity, whereas in logged areas, residual trees often represent fewer species and those undesirable for logging, such as red maple and other softwoods, which tend to be of low value to birds. The combination of habitat characteristics, open areas with scattered live and dead trees, created by high intensity wildfires is also important to birds on the landscape level. Schulte & Niemi (1998) in a study in Minnesota, found some birds that traditionally nest in forest, American crow and the gray jay, foraging within the early-successional habitat. Evidence suggests woodpeckers require dead trees in burned areas for foraging but additionally require old deciduous trees for nest cavities (Angelstam & Mikusinski 1994, Hutto 1995). Flycatchers, such as the eastern kingbird and the great-crested flycatcher, also show a preference for open habitat with a few scattered dead trees (Schulte & Niemi 1998).

Fire effects on species composition of the shrub layer have not been examined in this region. However, data from other regions suggest that burning can create a more diverse shrub layer than logging or wind-throw, because fire can kill the above ground part of all shrub species and create an environment with exposed mineral soil, intense sunlight, and low competition. These conditions are required for the establishment of some shrub species (Ehnes & Shay 1995, Suffling et al. 1988, Thompson 1993). Burning might therefore increase diversity of the shrub layer (Schulte & Niemi 1998), and in turn provide better quality foraging and nesting habitat for bird species associated with this vegetation stratum.

The breeding bird community adjusts to the rapidly changing habitat conditions following the fire. Some species find ideal conditions for only a few years following a fire, since they respond to the availability of a temporary niche. Others benefit immediately, and some species will be replaced from the burned area for several decades.

Fire and red-cockaded woodpeckers. Many studies regarding the impacts of fire on forest birds were conducted in conjunction with management for red-cockaded woodpeckers (RCW). Prescribed burning is generally considered a critical component for maintenance of RCW habitat (Hooper et al. 1979), and agencies for public land management within this species' range have implemented intensive burning programs for the last few decades.

The federally endangered red-cockaded woodpecker (RCW) occupies pine and pine-hardwood forests in the southeastern United States. Most populations are found in longleaf (*Pinus australis*) and loblolly pine (*P. taeda*) forests on the Coastal Plain. Some populations, particularly within the northern and eastern-most sections of the species' range, including Tennessee and Kentucky, occurred in short-leaf (*P. echinata*) and pitch pine (*P. rigida*) mixed hardwood stands (Mengel 1965, Dimmeck et al. 1980, Hines 1995). Within this region, mixed pine-hardwood stands areas characteristically form narrow discontinuous strips on acidic sandstone ridgetops in areas surrounded by relatively undisturbed hardwood forests, but they also include more extensive successional stands on broader ridges.

While RCWs have not been well documented at Big South Fork [data to be checked in detail], it is very likely that they occurred here during 1700-1900 due to the proximity of other populations further north and south, and due to the presence of suitable habitat. The closest recent RCW populations to the Big South Fork are those on the southern part of the Daniel Boone National Forest (DBNF) in Kentucky, and in the Great Smoky Mountains National Park (GSMP) of Tennessee. The first Tennessee population was reported in 1935 when Fleetwood (1936) observed birds in three locations in the southwestern region of the Great Smoky Mountains National Park. The last sighting of RCWs occurred in the 1980s. A small population in southeast Kentucky was first recorded during the 1930s by Mengel (1965).

Despite intensive management efforts initiated in the late 1980s monitoring indicted a decline in numbers. Birds from other populations were translocated to the DBNF, and in 1999 the population numbered 15 birds with only one remaining native bird (K. Feltner, pers. com.) Unfortunately, due to an extreme southern pine beetle epidemic, the US Fish and Wildlife Service and the US Forest Service decided to remove the birds from Kentucky to more suitable habitat in other states in spring of 2001. While habitat is currently considered unsuitable for RCWs in Kentucky, as well as the Big South Fork, due to the destruction of pines by southern pine beetles, habitat restoration efforts will continue in Kentucky with the goal of reintroducing RCWs, when conditions become more favorable. Similar efforts could be undertaken at the Big South Fork NRRA.

Management for RCWs. Management guidelines for RCWs were developed based on studies from the Coastal Plain, where habitat is very different from habitat on the Cumberland Plateau (Hines 1999, Hines & Kalisz 1995). Land managers have been trying to create conditions similar to those of the Coastal Plain forests by mechanically removing hardwood midstories and reducing the hardwood canopy basal area. Controlled burns are conducted every 3-5 years to suppress understory re-growth and maintain open, pine-dominated stands. Unfortunately, it is unknown if this management regime benefits RCWs here.

While RCWs currently do not occur and have never been studied at Big South Fork, some data are available from adjacent areas in Kentucky. Since management has been initiated on the Daniel Boone National Forest (DBNF) in 1979, no increase of the native population has been reported. Actually, in the 20 years since 1979, the population declined from 18 to only 1 native bird as of summer 1999 (K. Feltner, USFS, pers. comm., 1999l Kentucky State Nature Preserves Commission 1999). While the reasons for this decline are debatable, the few studies specific to this area provide evidence that local RCWs might have somewhat different habitat requirements than those on the Coastal Plain and management should be adjusted accordingly (Hines & Kalisz 1995, Kalisz & Boettcher 1991, Murphy 1980).

As in other parts of their range, RCWs require mature pine trees for cavity excavation, but it is unknown how much total pine basal area they require as foraging substrate, and if midstory removal is beneficial. While they forage nearly exclusively on pines in most (pine-dominated) parts of their range, in Kentucky, as in other areas of similar habitat, they spend a significant amount of time foraging on hardwoods (Hines & Kalisz 1995, Hooper & Lennartz 1981, Murphy 1980, Ramey 1980, Scorupa & McFarlane 1976, Wood 1983). In some Kentucky locations they preferred hardwoods to pines during the nesting season (Hines & Kalisz 1999). During the nesting season, arthropods are probably more abundant on the bole surfaces, allowing RCWs to forage on both pine and hardwood species. A shortage of arthropods on bole surfaces during the winter would explain their seasonal preference for pines. The thick, flaky bark of pines offers protective habitat for a large number of arthropods (Travis 1977).

RCWs are opportunistic foragers (Baker 1971, Beal 1911, Hines & Kalisz 1995) and, in Kentucky, have been observed to prey on a large number of arthropod species. They are apparently able to maximize their foraging success by adapting their preference to those normally uncommon prey species when these occur in large numbers. Examples include the lettered sphinx moth (Lepidoptera: Sphingidae: *Deidemia inscripta*), whose catapillars preferentially feed on the foliage of sourwood (*Oxydendron arboreum*) trees, and the 17-year periodical cicada (Homoptera: Cicadidae: *Magicicada* sp.). Since cicadas congregate for mating and oviposition on hardwoods but not on pines (White et al. 1982), RCWs feeding on cicadas foraged on hardwood trees in both upper and lower canopy strata (Hines & Kalisz, unpublished).

Removal of midstories can lead to a reduction of these critical prey species in some years. Particularly if conducted during or right before the breeding season, prescribed burns can severely impact prey availability to RCWs during this most critical time of year. While feeding offspring, RCWs are forced to forage close to the nest cavity restricting them to whatever prey is available here instead of being able to utilize all of their usual territory.

Some colonies in unburned pine-hardwood forests with a well developed midstory had been occupied continuously for several decades (Mengel 1965, Murphy 1980), and went extinct only after management was initiated (Kentucky State Nature Preserves Commission 1999). When comparing midstory development and overall hardwood basal area of abandoned and active RCWs colonies in Kentucky, Kalisz and Boettcher (1991) found no significant differences and concluded that midstory encroachment and lack of fire were not the reasons for colony abandonment. They did find, however, that abandoned colonies had a significantly greater percentage of total area that had been harvested within their territory than active colonies.

Without burning, pine-hardwood forests in this region are unlikely to develop the low density of hardwood sprouts in the understory that is characteristic of some frequently burned pine forests on the Coastal Plain (Billings 1938, Kalisz 1991). Understories might be expected to stabilize once pines begin to mature [until succession to hardwoods occurs], but under the current management for RCWs, midstory removal and controlled burns have triggered the development of a dense understory from resprouting hardwoods in treated stands. If not burned regularly, this might reduce habitat quality for RCWs over time. While frequent burns suppress understory regrowth, even spring fires do not eliminate woody stems completely, and prolific resprouting can occur (Sparks et al. 1999). [Only very frequent or intense growing season fires may convert pine-hardwood forests into open grassy pine-oak woodland similar to that favored by RCWs on the Coastal Plain.]

Impacts of RCW management on other bird species. RCW management involves removal of midstories, prescribed burns and opening of the canopy by removing hardwoods. This combination of treatments results in unique habitat conditions, and responses of breeding birds are different from those in untreated stands and stands only treated with fire.

One of the groups negatively affected by RCW management is midstory nesters. The red-eyed vireo is the only individual species of midstory nester that has been found to be significantly more common in managed than unmanaged stands (Hines 1999, Wilson et al 1995). The numbers of some ground nesting birds, particularly ovenbirds, also decrease following management, probably due to the elimination of litter and the development of a dense understory (Hines 1999, Wilson et al 1995). However, other ground nesters including rufous-sided towhee, black and white warbler, appear to benefit from management. Increases in grasses, forbs and resprouting woody vegetation, benefit shrub nesters, ground and shrub foragers, which results in the largest overall increases in bird densities (Hines 1999, Wilson et al. 1995). However, if burning is conducted annually the resulting suppression of shrubs and saplings can cause declines of shrub nesting birds (Artman et al. 2001).

Cavity nesting birds are often more numerous in managed stands, because those tend to have higher numbers of standing and fallen snags, as well as ample supplies of coarse woody debris from mechanical removal of midstories that serves as foraging structure. However, due to decay and repeated burning, the amount of debris and more importantly the number of potential nest sites for primary and secondary cavity nesters decreases over time (White and Seginak

2000). Flycatching birds, including Tyrannidae spp., bluebirds, and to some extend woodpeckers, are also more common in managed stands, because of their open character and the presence of suitable perches (Hines 1999, Wilson et al 1995). Bole, aerial, and canopy foragers seemingly also benefit from the openness of treated stands (Wilson 1994).

If conducted during the growing season, prescribed burns can result in the depletion of prey and cover, which, while temporary, reduces habitat quality for many bird species besides RCWs.

Prescriptions for RCWs are beneficial to several species associated with edge and early successional habitat, including at least some neotropical migrants whose numbers are declining in eastern North America. These are indigo bunting, hooded warbler, and prairie warbler, and eastern wood pewee. Other declining species that apparently benefit from RCW management are northern bobwhite, chipping sparrow, and the red-headed woodpecker (Wilson et al. 1995). [It is possible that such species were widespread in more open grassy woodlands on the Cumberland Plateau before settlement.] In contrast, management for RCWs appears to decrease habitat quality for some neotropical migrants, particularly those associated with forest interiors: ovenbirds, red-eyed vireos, and black-throated green warblers Hines 1999). Because of rapid fragmentation and intensive timbering of forests on private lands, interior habitat is becoming an increasingly limited resource. Protecting this type of habitat on public forests is therefore critical for the survival of these species.

In conclusion, managing stands for RCWs in Kentucky does not result in forest openings or a major reduction in the canopy basal area, as do most timber harvest prescriptions. However, management for RCWs, even where the canopy is left intact, changes the breeding bird community in pine-oak forests of this region. Lowering the midstory basal area and applying controlled burns may have some effects similar to that of timber harvests on species composition and abundance of breeding birds. [But some declining neotropical migrants may prefer the treated stands to untreated stands.] Until the ecological impacts of RCW management are better understood, managing for this species in our region should be conducted conservatively and experimentally. In addition to creating open pine-oak savannas that mimic RCW habitat of the Coastal Plain, some pine-oak forests should be left untouched (Hines 1999) [and others should be treated with a wider range of fire-regimes in order to learn about effects on bird species.]

EFFECTS OF FIRE ON HERPTOFAUNA

Fire effects on amphibians and reptiles on the Cumberland Plateau are virtually unknown. Most studies on the effects of fire on herpetofauna were conducted in the fire-dependent ecosystems of the Coastal Plain and the western United States, and often involve species that do not occur in the Cumberland Plateau physiographic region, but nevertheless, provide some clues to the possible responses of species in this region.

In the Coastal Plain of the southeastern United States, where fire-adapted pine communities are wide-spread, fire may have little direct effect on herpetofauna, particularly reptiles, and might actually be beneficial to many species (Means & Campbell 1981). Komarek (1969) argued that, overall, amphibians and reptiles do not appear disturbed by the approach of fire and respond in adaptive manners which minimize mortality. Means & Campbell (1981) found 26 species of reptiles and amphibians active throughout a burned area in a Florida pine forest only three weeks after a fire. This site had not been burned in eight years, allowing the build-up of a dense ground cover, and the subsequent burn was very hot and cleared surface down to bare sand.

Reptiles

Direct effects. Many reptiles appear to be able to avoid harm from fire. Kahn (1960) and Lillywhite and North (1974), for example, provided interesting data on the behavioral response of the western fence lizard (*Sceloporus occidentalis*) to fire at the time of occurrence and afterward. The lizards survived fire by taking refuge under surface cover and subsequently oriented positively to the burned area. Eastern diamondback rattlesnakes also appear to be successfully avoiding fire by seeking shelter, unless they are caught in mid-ecdysis (Means and Campbell 1981).

It is generally thought that reptiles burrow to escape fire, but few direct observations have been published. Withgott and Amlaner (1996) observed black rat snakes actively seeking and entering burrows in the advance of a fire. Box turtles also might have fairly high chances of surviving fires due to their protection by the carapace and partial burrowing. Carapaces of Florida box turtles frequently showed signs of fire damage, but these were generally limited to the neural and anterior costal bones. This could indicate that they survived by hiding in shallow burrows, which they commonly construct. Young turtles usually hide under litter and are consequently more likely to be killed in a fire (Ernst and Wilgenbusch 1995).

Due to their greater mobility, reptiles are less likely killed by fire than most amphibians. Reptiles cover greater distances in migration and daily movements (Blaustein et al. 1994) allowing them to search out or reinvade suitable habitats, and may benefit from disturbance-associated habitat changes and microclimate (Greenberg et al. 1994). Lizards, for example, appear to leave unburned areas to invade recently burned sites (Kahn 1960), and selectively utilized burned and charred branches for perching (Lillywhite et al 1977).

Not all reptilian species are able to avoid impacts from fire. Fire caused mortality of the eastern glass lizard, for example, and may have a sustantial population effect on this species (Means & Campbell 1981, Babbitt & Babbitt 1951). Fire also harms some reptile species by consuming the surface litter in which these species burrow to escape a fire (Spellerberg 1975).

Indirect effects. Many reptiles are not only able to avoid direct mortality from fire, but also benefit from its indirect effects, most importantly on plant species composition and the physical structure of the habitat. Some species of reptiles are apparently well adapted to fire associated habitats. Burning was found to increase diversity and abundance of reptiles as well as some amphibians over control plots, but some fire periodicities appear better than others for maintaining high diversity (Mushinsky 1986). In the Florida sandhills, high diversity was found on annually burned sites and sites that were burned every seven years, but two year fire periodicity produced a dense layer of grasses and herbaceous plants that was not readily occupied by sandhill herpetofauna.

Species dependent on surface cover, such as the scarlet snake (*Cemophora corvinea*), and ground skink (*Scinella laterale*) or surface activity, such as the black racer (*Coluber constrictor*), did not appear to show any population depression following summer burning of a Florida pine forest (Means & Campbell 1981). They also found that populations of glass lizards, while apparently vulnerable to direct effects of fire, were not impacted by the fire. Fires help maintain open habitats which support high populations of grasshoppers that are an important part of this species diet. Glass lizards are often common in habitats that are prescribed burned (J. MacGregor, pers. com.).

Other reptile species known to benefit from fire include the Florida scrub lizard (*Sceloporus woodii*), which requires the fire-maintained open habitat of the Florida sandhills (Landers and Speake 1980) and the Gopher tortoises (*Gopherus polyphemus*), which depend on fire-maintained vegetation in sandhill habitat (Auffenberg and Franz 1982, Means and Campbell 1980). In the total absence of fire tortoise populations decline in their native habitats, as well as in edificarian habitat, as hardwood succession proceeds, closing the canopy and eliminating the groundcover by shading (Auffenberg and Franz 1982). On the Daniel Boone National Forest in Kentucky, lizards, including the rare southeastern five-lined skink (*Eumeces inexpectatus*), probably respond to the more open habitat conditions, increased significantly in numbers following prescribed burns (MacGregor pers com).

Mushinski (1986) showed that snake populations can also benefit from fire. Direct and long-term effects of fire on snakes presumably vary with foraging requirements, shelter-seeking behavior, predation pressure, and nature of the fire. Declines and local extirpations of Louisiana pine snakes are thought to have been indirectly caused by fire suppression in longleaf pine savannas. Fire suppression causes a massive increase in woody midstory vegetation and consequent decline of herbaceous vegetation, which has a detrimental impact on pocket gopher populations (*Geomys breviceps*) and ultimately on Louisiana pine snakes (Rudolph et al. 1998). Scarlet snakes also appear to benefit from fire (J. MacGregor, pers. com.). The only snakes native to the Cumberland Plateau that could be harmed by fire are ringneck snakes and eastern copperheads, both of which are associated with woodland habitat that would not benefit from the open, drier conditions of habitats maintained by prescribed burns. However, because their preferred habitats are naturally rather mesic, and they avoid drier upland sites, they are unlikely to be harmed by fire (MacGregor pers. com.).

Timber harvest on the Appalachian Plateau might to some extend serve as a substitute for natural disturbance events, such as fire, now reduced in importance in this actively managed forest region, that historically opened forest canopy and provided conditions favorable to many species of reptiles. Several studies from different ecosystems recorded a positive response of reptiles in areas impacted by timber harvest (Christman et al. 1979, Enge and Marion 1986, Phelps and Lancia 1995). Presence of slash in clearcut stands might enhance cover for reptiles and their prey in South Carolina swamp forests (Phelps and Lancia 1995). Numerical abundance and species richness of reptiles increased after harvest on the Cumberland Plateau in Kentucky (Adams et al. 1996).

Amphibians

Direct effects. While reptiles overall benefit from fire, several amphibian species appear to be either directly or indirectly harmed by fire. While little documentation exists, indirect evidence suggests that woodland salamanders might be particularly sensitive to fire. These species are known to depend on mesic habitats and are vulnerable to excessive site desiccation due to timber harvests (Petranka et al. 1993, 1994). Ash (1995) also reported that declines in pethodonid salamanders following clearcutting in the southern Appalachians could be a result of reductions in leaf litter mass and depth, both of which are important in maintaining a mesic micro-habitat for woodland salamanders. Fire can have similar effects on forest floor characteristics, and, while documentation is lacking, just like timber harvests, could be detrimental to woodland salamander populations.

Management suggestions for many species of woodland salamanders in the Appalachians include riparian zone protection and the avoidance of excessive site desiccation following timber harvest (Petranka et al. 1993, 1994, Wilson 1995). The same guidelines should probably be applied to prescribed burns and control of wildfires.

Not all studies support these observations. Kirkland et al. (1996), for example, was unable to draw inferences regarding the effects of fire on salamanders due to the low numbers collected in their study of burned and unburned forest sites in the central Appalachians, though more red-backed salamanders (*Plethodon cinereus*) and slimy salamanders (*P. glutinosus*) were collected in burned sites than in unburned sites.

In Kentucky, slimy salamanders appear to be the salamander species most likely harmed by fire. Southern zig-zag salamanders, which are also found in upland forests, are also susceptible to fire. However, they spend most of their time underground and are only active on the surface during winter. Potential impacts on this species could be minimized by conducting burns only during the growing season (J. MacGregor, pers. com.).

To a certain extent, amphibians might actually be less likely to be harmed by fire due to their association with mesic habitats, which burn less frequently than more xeric habitats. This was confirmed by Ford et al (1999), who reported that during their study on the Nantahala National Forest in North Carolina, impacts of fire on herpetofauna were minimal, because effects of burning on the overstory and understory vegetation in the riparian and midslope areas most important to woodland salamanders were slight. If burning is restricted to areas that are too xeric for amphibians or conducted during seasons when amphibian populations can be expected to be locally low, impacts might be minimized.

Indirect effects. While amphibians overall might be more vulnerable to direct effects of fire than reptiles, indirect responses to fire and long-term effects are more variable and disputable. Some authors suggest that amphibians in the southeastern United States are sufficiently rich in species and abundant in numbers to permit recovery from local disturbances, such as timber harvesting or fire (Blaustein & Wake 1990, Blaustein et al. 1994). Petranka at al. (1993) strongly implicate timber harvesting as a causal mechanism for loss of salamander populations in the southern Appalachians, because timber harvesting eliminates salamander populations within the harvested stand and salamanders require a long recovery period before they can reoccupy a harvested stand. Some authors have suggested recovery periods of 50 to 70 years for populations of amphibians affected by timber harvesting in the eastern United States (Pough et al. 1987, Petranka et al. 1993).

In Kentucky, researchers examined effects of different timber harvest techniques on herpetofauna populations (M. Lacki, J MacGregor et al., pers. comm.). They also found that the diversity of amphibians declined following "low-leave" harvest, which probably caused similar habitat alterations to some fires. However, the only amphibian species that disappeared following timber harvesting was long-tailed salamander. Timber harvesting might cause similar habitat alterations to fires, but unlike timber harvest most fires do not eliminate the canopy. Amphibian populations probably recover faster following fires, unless a fire is very intense eliminating most of the canopy and causing intense desiccation of the forest floor.

When comparing species richness and abundance of fire-maintained Florida pine forests to stands that had succeeded to beech magnolia climax forest, Means & Campbell (1980) found three species of amphibians (*Ambystoma opacum, A. talpoideum* and *Plethodon glutinosum*) exclusively in the beech-magnolia. Conversely, three species of amphibians and one reptile (*Ambystoma tigrinum, Bufo quercicus, Pseudacris ornata and Cnemidophorus sexlineatus*) were only observed in pine forests. The difference between regularly burned pine forests and the unburned hardwood forest probably are true faunal differences that reflect adaptations of the individual species involved. In the absence of fire, southern pine forests succeed to hardwood types that apparently are not suitable for some amphibians and reptiles which are adapted to the fire-maintained pine forests (Means and Campbell 1981).

Fire also appears to plays an important role in perpetuating the seepage "bog" breeding sites of the pine barrens treefrog (*Hyla andersonii*) (Means & Moler 1979). Hardwood encroachment onto seepage sites is thought to result in a lowering of groundwater level and elimination of seepage by means of strongly increased evapotranspiration on these sites (Means & Moler 1979). Thus, because the pine barrens treefrog depends upon a fire-maintained habitat, and because the natural fire cycles have been so altered by man that these habitats are disappearing via plant succession, prescribed burning is indicated as an appropriate management tool to enhance survival of this species (Means & Campbell 1981).

In a Central Pennsylvanian forest, significantly more American toads were found in an area that had been burned by a ground fire than in a control area (Kirkland et al. 1995). In southeastern Kentucky, numbers of three species of toads, American, Steller's and spadefoot toad were also higher in pine-hardwood stands that were burned than in control sites (J. MacGregor pers. com.), possibly due to more open habitat conditions which improved prey availabiliy.

Amphibians can be also be impacted by fire, if fire causes changes in water quality and sedimentation rates. This phenomenon has been documented in the southwestern United States where these habitat components can change drastically due to fire (Gamradt & Kats 1997, Kirby & Kats 1998). But because of different substrates and soil stability it is probably a less serious problem on the Cumberland Plateau.

In conclusion, while populations of many amphibian species can be expected to be depressed following prescribed ground fires in the Cumberland Plateau physiographic region, the impacted species are common and likely to recover (J. MacGregor pers. com.).

APPENDIX 6: MISCELLANEOUS ADDED HISTORICAL NOTES

Thomas Walker (1750). From Virginia, between the Blue Ridge and Cumberland Mountain, to what became Kentucky; these are extracted notes of ecological interest.

"March 15th. We went to the great Lick [that became Roanoke] on A Branch of the Staunton and bought Corn of Michael Campbell for our horses. This Lick has been one of the best places for Game in these parts and would have been of much greater advantage to the Inhabitants than it has been if the Hunters had not killed the Buffaloes for diversion, and the Elks and Deer for their skins...

"31st. We kept down Reedy Creek to Holston where we measured an Elm 25 ft. round 3 ft. from the ground. we saw young Sheldrakes we went down the River to the north Fork and up the north fork about a quarter of a mile to a Ford, and then crossed it. In the Fork between the Holstons and the North River, are five Indian Houses built with loggs and covered with bark, and there were abundance of Bones, some whole Pots and pans some broken. and many pieces of mats and Cloth. On the west side of the North River, is four Indian Houses such as before mentioned. we went four miles below the North River and camped on the Bank of the Holstons, opposite to a large Indian Fort.

"April ye 1st. The Sabbath. we saw Perch, Mullets, and Carp in plenty, and caught one of the large Sort of Cat Fish. I marked my name, the day of the Month, and date of the year on Several Beech Trees.

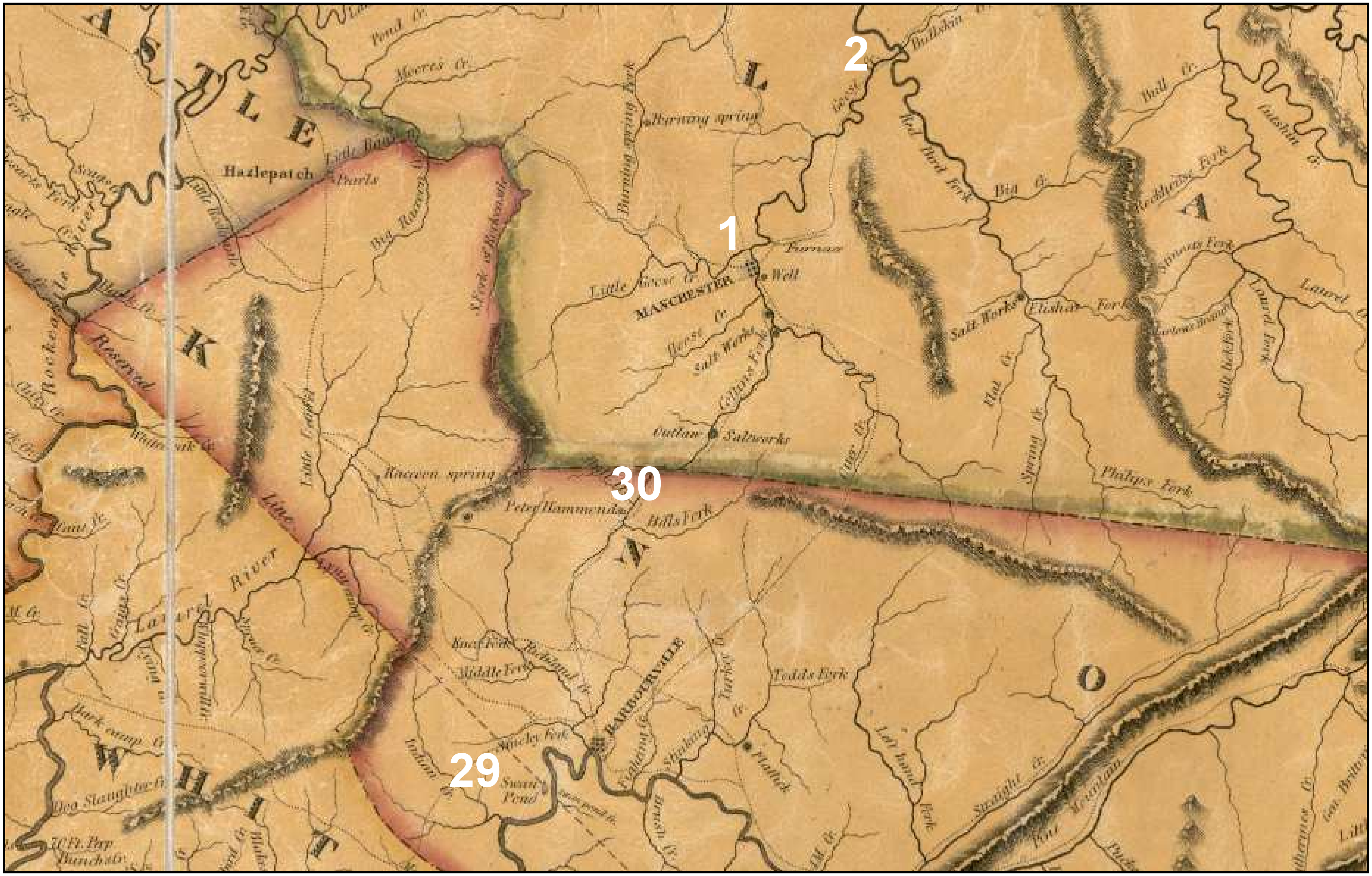
“2nd. we left Holston and travelled through Small Hills till about Noon, when one of our horses being choaked by eating Reeds [cane] too gredily, we stopped having traveled 7 miles.

“5th. we went down Holly Creek. There is much Holly in the Low Grounds and some Laurel and Ivy. About three in the afternoon, the Ridge appeared less stony and we passed it, and camped on a small Branch about a mile from the top. my riding Horse choaked himself this evening and I drenched him with water to wash down the Reeds, and it answered the End...

Now in what became Kentucky on the Cumberland River, near what became Barbourville.

“April 27th. We crossed Indian Creek [Big Indian Creek] and went down Meadow Creek to the River. There comes in another [perhaps Poplar Creek] from the Southward as big as this one we are on. Below the mouth of this Creek, and above the Mouth are the remains of several Indian Cabbins amongst them a round Hill made by Art about 20 feet high and 60 over the Top. we went up the River, and Camped on the Bank.

“28th We kept up the River to our Company whom we found all well, but the lame horse was as bad as we left him, and another had been bit in the Nose by a Snake. I rub'd the wound with Bears oil, and gave him a drench of the same and another of the decoction of Rattle Snake root some time after. The People had built a house 12 by 8, clear'd and broken some ground, and planted some Corn and Peach Stones [SW of what became Barbourville]. They also had killed several Bears and cured the Meat. This day Colby Chew and his Horse fell down the Bank. I Bled and gave him Volatile drops, and he soon recovered.



Suggested route of Thomas Walker in 1750, from April 29th to May 2nd, plotted on Luke Munsell's (1818) map of Kentucky [from https://www.loc.gov/resource/g3950.ct003777b/].

“April 29th. The Sabbath. The Bitten Horse is better. 3 Quarters of A mile below the house is a Pond in the Low ground of the River, a quarter of a mile in length and 200 yds. wide much frequented by Fowl [the “Swan Pond” on Route 11 about 2 miles SSW of Barbourville].

“30th. I blazed a way from our House to the River. On the other side of the River is a large Elm cut down and barked about 20 feet and another standing just by it with the Bark cut around at the root and about 15 feet above. About 200 yards below this is a white Hiccory Barked about 15 feet. The depth of the water here, when the lowest that I have seen it, is 7 or 8 feet, the Bottom of the River Sandy, ye Banks very high, and the Current very slow. The Bitten horse being much mended, we set off and left the lame one. He is white, branded on the near Buttock with a swivil Stirrup Iron, and is old. We left the River and having crossed several Hills and Branches, camped in a Valley North from the House [perhaps Collins Fork].

“May the 1st. Another Horse being Bitten, I applyed Bears Oil as before Mention'd. We got to Powell's River [perhaps Goose Creek] in the afternoon and went down it along an Indian Road, much frequented, to the mouth of a Creek on the West side of the River, where we camped [perhaps Little Goose Creek]. The Indian Road goes up the Creek, and I think it is that Which goes through Cave Gap [perhaps from head of Laurel Fork to Station Camp Creek].

“2d. We kept down the River. At the Mouth of a Creek [perhaps Redbird River] that comes in on the East side there is a Lick, and I believe there was a hundred Buffaloes at it. About 2 o'clock we had a shower of Rain. We Camped on the River which is very crooked.

“May 3rd. We crosses a narrow Neck of Land, came on the River again and Kept down it to an Indian Camp, that had been built this Spring, and in it we took up our Quarters. It began to Rain about Noon and continued till Night.

“4th. We crossed a narrow Neck of Land and came on the River again, which we kept down till it turn'd to the Westward, we then left it, and went up a Creek which we called Colby's Creek [perhaps Cow Creek]. The River is about 50 yards over where we left it.

“5th We got to Tomlinson's River [perhaps Middle Fork of Kentucky River], which is about the size of Powell's River, and I cut my name on a Beech, that stands on the North side of the River. Here is plenty of Coal in the South Bank opposite to our Camp.

“6th The Sabbath. I saw Goslings, which shows that Wild Geese stay here all the year. Ambrose Powell had the misfortune to sprain his well Knee.

“7th. We went down Tomlinson's River the Land being very broken and our way being embarrassed by trees, that had been blown down about 2 years ago.

“May 8th. We went up a creek on the North side of the River.

“9th. We got to Lawless River [perhaps North Fork of Kentucky River], which is much like the others. The Mountains here are very Steep and on Some of them there is Laurel and Ivy. The tops of the mountains are very Rocky and some parts of the Rocks seem to be composed of Shells, Nuts and many other Substances petrified and cemented together with a kind of Flint. We left the River and after travelling some Miles we got among some Trees that had been blown down about 2 years, and we were obliged to go down a Creek to the River again, the Small Branches and Mountains being impassable.

10th. We staid on the River and dressed an Elk skin to make Indian Shoes--ours being quite worn out.

11th. We left the River, found the Mountains very bad, and got to a Rock by the side of a Creek Sufficient to shelter 200 men from Rain. Finding it so convenient, we concluded to stay and put our Elk skin in order for shoes and make them.

May 12th. Under the Rock is a Soft Kind of Stone almost like Allum in taste; below it A Layer of Coal about 12 inches thick and a white Clay under that. I called the Run Allum Creek. I have observed several mornings past, that the Trees begin to drop just before day & continue dripping till almost Sunrise, as if it rain'd slowly. We had some rain this day.

13th. The Sabbath.

14th. When our Elk's skin was prepared we had lost every awl that we brought out, and I made one with the shank of an old Fishing hook, the other People made two of Horse Shoe Nails, and with these we made our Shoes or Moccosons. We wrote several of our Names with Coal under the Rock, and I wrote our names, the time of our coming and leaving this place on paper and stuck it to the Rock with Morter, and then set off. We crossed Hughes's River [perhaps main Kentucky River] and Lay on a large branch of it [perhaps Sturgeon Creek]. There is no dew this morning but a shower of Rain about 6 o'Clock. The River is about 50 yards wide.

May 15th. Laurel and Ivy increase upon us as we go up the Branch. About noon it began to rain & we took up our quarters in a valley between very Steep Hills.

16th We crossed several Ridges and Branches. About two in the afternoon, I was taken with Violent Pains in my hip.

17th. Laurel and Ivy are very plenty and the Hills still very Steep. The Woods have been burnt some years past, and are not very thick, the Timber being almost all kill'd. We camped on a Branch of Naked Creek [perhaps Granny Dismal Creek]. The pain in my hip is somewhat asswaged.

18th. We went up Naked Creek to the head and had a plain Buffaloe Road most of the way. From thence we proceeded down Wolf Creek [War Fork of Station Camp Creek] and on it we Camped.

19th. We kept down ye Hunting Creek [Station Camp Creek] which we crossed and left. It rained most of the afternoon.

May 20th. The Sabbath. It began to Rain about noon and continued till next Day.

21st. It left off raining about 8. we crossed several Ridges and small Branches and Camped on a Branch of Hunting Creek in the Evening it rained very hard.

22d. We went down the Branch to Hunting Creek and kept it to Milley's River [Kentucky River].

23rd. We attempted to go down the River but could not. We then Crossed Hunting Creek and attempted to go up the River but could not. it being very deep we began a Bark Canoe. The

River is about 90 or 100 yards wide. I blazed several Trees in the Fork and marked T.W. on a Sycomore Tree 40 feet around. It has a large hole on the N:W: side about 20 feet from the ground and is divided into 3 branches just by the hole, and it stands about 80 yards above the mouth of Hunting Creek.

“May 24th. We finished the Canoe and crossed the River about noon, and I marked a Sycomore 30 feet round and several Beeches on the North side of the River opposite the mouth of the Creek. Game is very scarce hereabouts.

“25th. It began to Rain before Day and continued till about Noon. We travelled about 4 miles on a Ridge and Camped on a Small Branch.

“26th. We kept down the Branch almost to the River, and up a Creek, and then along a Ridge till our Dogs roused a Large Buck Elk, which we followed down to a Creek. He killed Ambrose Powell's Dog in the Chase, and we named the Run Tumbler's Creek, the Dog being of that name.

“27th. The Sabbath.

“28th. Cloudy. We could not get our Horses till almost night, when we went down the Branch. We lay on to the Main Creek [Red River] and turn'd up it.

“May 29th. We proceeded up the Creek 7 miles and then took a North Branch and went up it 5 miles and then encamped on it.

“30th. We went to the head of the Branch we lay on 12 miles. A shower of Rain fell this day. The Woods are burnt fresh about here and are the only Fresh burnt Woods we have seen these six Weeks.

“31st. We crossed 2 Mountains and camped just by a Wolf's Den. They were very impudent and after they had twice been shot at, they kept howling about the Camp. It rained till Noon this day.

“June ye 1st. We found a Wolf's den and caught 4 of the young ones. It rained this morning. we went up a creek crossed a Mountain and went through a Gap, and then, camped on the head of A Branch.

“2d. We went down the Branch to a River 70 yards wide, which I called Fredericks River [Licking River]. we kept up it a half mile to a Ford, where we crossed and proceeded up the North side 3 miles. It rained most of the afternoon. Elks are very plenty on this River.

“June 3rd. Whit-Sunday. It rained most of the day.

“4th. I blazed several trees four ways on the outside of the low Grounds by a Buffaloe Road, and marked my name on Several Beech Trees. Also I marked some by the River side just below a mossing place with an Island in it. We left the River about ten O'clock & got to Falling Creek, and went up it till 5 in the afternoon, when a very Black Cloud appearing we turn'd out our horses got tent Poles up and were just stretching a Tent, when it began to rain and hail and was succeeded by a violent Wind which blew down our Tent & a great many Trees about it, several large ones within 30 yds. of the Tent. we all left the place in confusion and ran different ways for shelter. After the Storm was over, we met at the Tent, and found that all was safe.

“5th. There was a violent Shower of Rain before day. This morning we went up the Creek about 3 miles and then were obliged to leave it, the Timber being so blown down we could not get through. After we left the Creek we kept on a Ridge 4 miles, then turned down the head of a branch and it began to rain and continued raining very hard till Night.

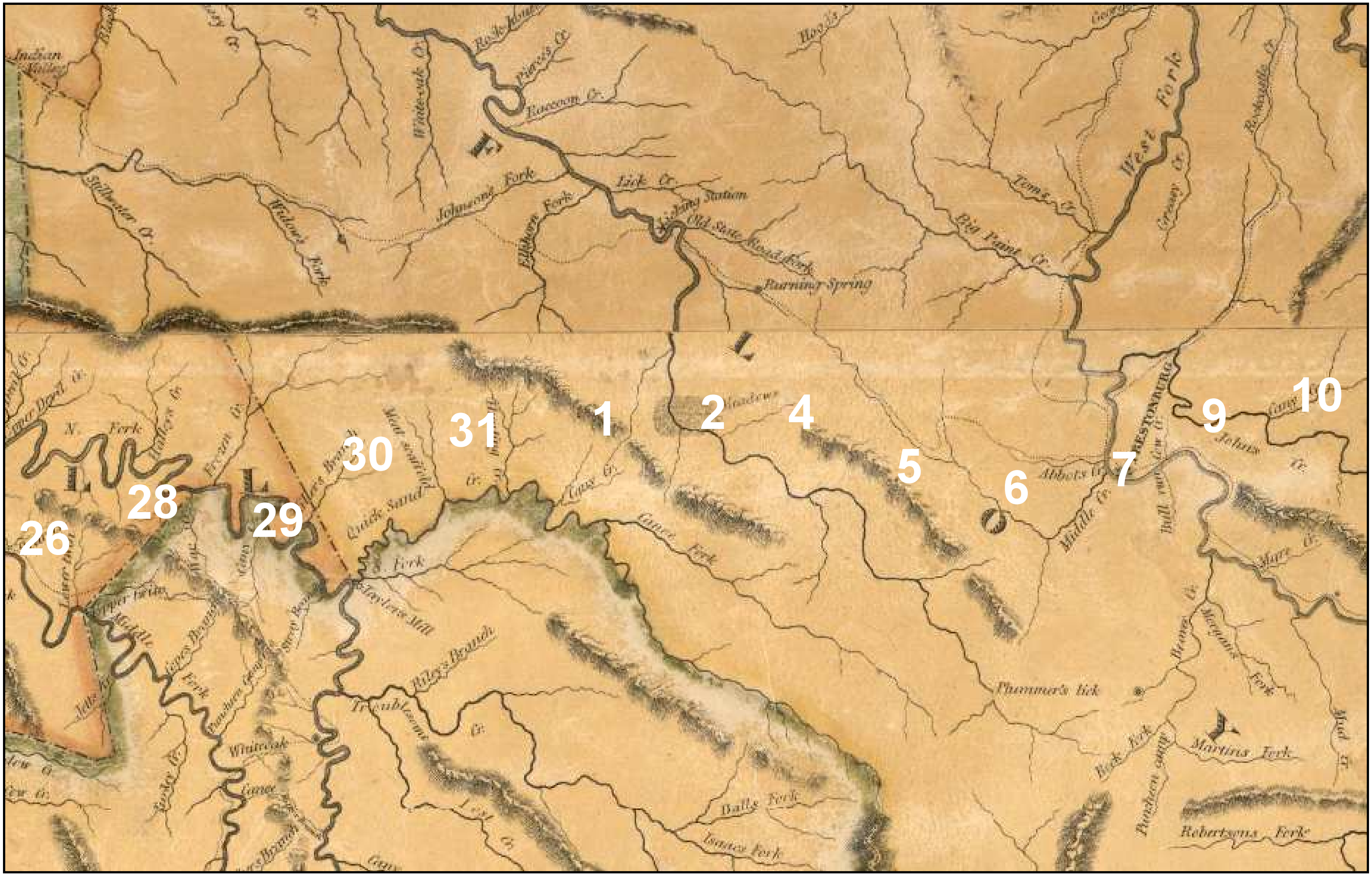
“June 6th. We went down the Branch till it became a Large Creek. It runs very swift, falling more than any of the Branches we have been on of late. I called it Rapid Creek. After we had gone eight miles we could not ford, and we camped in the low Ground. There is a great sign of Indians on this Creek.

“7th. The Creek being fordable, we crossed it and kept down 12 miles to a River about 100 yards over, which we called Louisa River. The creek is about 30 yds. wide and part of ye River breakes into ye Creek--making an Island on which we camped. (38)

“8th. The River is so deep we cannot ford it and as it is falling we conclude to stay and hunt. In the afternoon Mr. Powell and my Self was a hunting about a mile and a half from the camp, and heard a gun just below us on the other side of the River, and as none of our People could cross, I was in hopes of getting some direction from him, but I could not find him.

“June 9th. We crossed the River and went down it to the mouth of a Creek & up the Creek to the head and over a Ridge into a Steep Valley and Camped.

“June 10th. Trinity Sunday. Being in very bad Ground for our Horses we concluded to move. We were very much hindered by the Trees, that were blown down on Monday last. We Camped on a Small Branch.”



Estimated route of Thomas Walker in 1750 from 26th May to 10th June, plotted on the 1818 map of Kentucky by Luke Munsell [from https://www.loc.gov/resource/g3950.ct003777b/]. Munsell marked "Meadows" along the Licking River where Walker noted elks "very plenty" and "a Buffaloe Road", as well as a "mossing place with an Island in it."

Close-up of the “Meadows” marked on Munsell’s (1818) map; see also previous page. This area is on bottomland of the Licking River near the mouth of Oakley Creek, between the communities of Royalton and Sublett in central Magoffin County. Soils mapped by NRCS are mostly well-drained fluventic dystrudepts, but there may be some remnants of wetlands.

Returning through what became southeastern West Virginia, on “Laurel Creek”, which appears to have been a upper section of the Tug Fork of Big Sandy River.

“June 19th. We got to Laurel Creek early this morning, and met with so impudent a Bull Buffaloe that we were obliged to shoot him, or he would have been amongst us. we then went up the Creek six miles, thence up a North Branch to its head, and attempted to cross a mountain, but it proved so high and difficult, that we were obliged to camp on the side of it. This ridge is nigh the eastern edg of the Coal Land.

“20th We got to the top of the Mountain and could discover a Flat to the South and South East. we went down from the Ridge to a Branch and down the Branch to Laurel Creek not far from where we left it yesterday and Camped. my riding horse ws bit by a Snake this day, and having no Bears Oil I rub'd the place with a piece of fat meat which had the desired effect.

“21st. We found the Level nigh the Creek so full of Laurel that we were obliged to go up a Small Branch, and from the head of it to the Creek again, and found it good travelling a Small distance from the Creek. we camped on the Creek. Deer are very scarce on the Coal Land. I having seen but 4 since the 30th. of April.

“June 22nd. We kept up to the head of the Creek, the Land being Leveller than we have lately seen, and here are some large Savanna's [perhaps near Lashmeet and other communities west of US 19]. Most of the Branches are full of Laurel and Ivy. Deer and Bears are plenty.”

“23rd. Land continues level with Laurel and Ivy and we got to a large Creek with very high and steep Banks full of rocks, which I call'd Clifty Creek [perhaps Bluestone River], the Rocks are 100 feet perpendicular in some places.

“24th. The Sabbath.

“25th. We crossed Clifty Creek. Here is a little Coal and the Land still flat.

“26th. We crossed a Creek that we called Dismal Creek [perhaps Little Bluestone River], the Banks being the worst and the Laurel the thickest I have ever seen. The Land is Mountainous on the East Side of the Dismal Creek, and the Laurels end in a few miles. We camped on a Small Branch.

“27th. The Land is very High and we crossed several Ridges and camped on a small Branch. it rained about Noon and continued till the next day.

“28th. It continued raining till Noon, and we set off as soon as it ceased and went down the Branch we lay on to the New River, just below the Mouth of the Green Bryer [Greenbrier River]. Powell, Tomlinson and myself striped, and went into the New River to try if we could wade over at any point. After some time having found a place we return'd to the others and took such things as would take damage by water on our shoulders, and waded over Leading our Horses. The Bottom is very uneven, the Rocks very slippery and the Current strong most of the way. We camped in the low Ground opposite the mouth of the Green Bryer.”

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