Vegetation Management Plan Implementation
Pea Ridge National Military Park
Preferred Alternative "Establish A Visual Battlefield Landscape"

The intent of this implementation strategy is to provide site-specific prescriptive methods at a spatial resolution that further clarifies and details actions described in the selected alternative of this plan, so that the stated purpose, need, and objectives of the vegetation management plan/environmental assessment are met, and to fully satisfy the requirements of Section 106 of the National Historic Preservation Act (NHPA) pursuant to 36 CFR 800.8(C). The results of each management action will be monitored through time to ensure that objectives are met. It is understood that if methodologies need to be augmented and/or changed that they will be covered under NEPA, as long as they fall within the scope and intent of this environmental assessment, but that NHPA will need to be conducted on any new methods that are to be implemented and not contained within this appendix.

This strategy defines where and what the management zones, described in the General Management Plan Environmental (GMP) Impact Statement, are and give definition and clarification to the desired future conditions by providing specificity and spatial resolution at a project level. Hence, park management is given the ability to address singular issues effectively while managing both cultural and natural resources holistically.

Field, Open Woodlands, Ozark Highlands Forest, Cedar, Visitor Areas, Wood lot, Orchards, and Prairie are the eight primary categories of vegetation where management will occur and are contained within this appendix. However, each category is broken into secondary, tertiary, and, if applicable, quaternary and quinary management regimes so that aforementioned objectives and intent can be met. In addition, each category, and/or subgroup, dependent upon specificity, will contain maps and literature cited.

The park is comprised of 4,300 acres and is broken into two units. The main unit contains 4,244 acres; the detached area (Federal Trenches) consists of 56 acres. The administrative area, 12 acres, is located in the main unit and includes the visitor center, administrative and maintenance buildings, and associated parking and mowed areas. The remainder of the park is comprised of the Arkansas Highlands and Pea Ridge zones, as defined in this plan.

The Arkansas Highlands is in the physiographic zone known as the Ozark Plateau. This zone makes up approximately 3,216 acres of the park and includes hardwood forests, small prairies, tableland, rocky highlands, narrow valleys, and deep ravines. Management objectives in this area, per the GMP, are to reestablish the natural landscape features of the Ozark Plateau. Prairies are to be maintained or restored and woodlands are to be preserved or re-established in areas cleared for agriculture prior to park establishment (GMP 2006).

The Pea Ridge Battleground management zone consists of the remaining 25% of the park, 1072 acres, and contains historic fields, forests, and prairie. Management objectives for this zone focus on retaining and enhancing the historic character of the landscape that defined the 1862 era Pea Ridge battlefield (GMP 2006).

The primary objective of both management zones is the restoration, preservation, and maintenance of the cultural landscape, circa 1862, such that the landscape characteristics that defined the way the battle unfolded are attained.

Government Land Office notes (1837, 1838, and 1842) were utilized, in conjunction with first-hand accounts, a base map of 1862 fields and roads (Bearss 1957), a park-wide archeological assessment (Drexler et.al. 2005), and other associated records to identify fields, forests, and vegetation stand and structure of the park circa 1862. Additionally, the leading historian on the Battle of Pea Ridge, Dr. William L. Shea was consulted and comments and suggestions incorporated so that all of the information could be compiled to produce a vegetative base map (Weih 2007). This vegetative base map provides the backdrop, spatially and compositionally, to identify a point of beginning for historic conditions, circa 1862, at the park.

A vegetation classification and mapping of the park, completed spring 2013, determined that nine vegetative types, assessed with an overall accuracy of 93.1% (Diamond et.al. 2013) occur on the park. These vegetative types, utilized as a baseline, determine the point of departure from those identified as being present within the park (Weih 2007, Bearss 1957, Proebsting 2004), locally, and regionally, circa 1862 (Foti 2004, Jurney and Stahle 2004).

This dichotomous documentation, in association with, and in support of, this environmental assessment, the GMP, and the park's Fire Management Plan (FMP), forms the basis for the following management prescriptions

Landscape Classification and Management
(Savanna, Open Woodlands, Ozark Highlands)

Pea Ridge National Military Park (PERI or park), Benton County, is located on the Springfield Plateau (Johnson et al. 2009), a subsection of the larger Arkansas Ozarks (Foti 2004) portion of the Ozark Highlands (Graney and 77 Murphy 1997), a sub-region of the Central Hardwood Ecological Region. In general, this area was not glaciated, is a karst landscape of limestone or dolomite, is prone to drought and made up of oak/hickory forests and prairie (Bousman et al. pp. 235 2012). The drier climate, historically, promoted savannas, prairies and open woodlands, which was further advanced through fire by the American Indians (USDA 1999). The use of fire to maintain historic vegetative patterns is a viewpoint shared by multiple scholars and includes Foti (2004), Nelson (2011), Jenkins et al. (1997), Johnson et al. (2009), and Cutter and Guyette (1994).

Open woodlands were prevalent within the Ozark Highlands, savanna was dominant in the Springfield Plateau and forests were restricted to deep, narrow, rugged ravines and protected areas (Nelson 2011). Schoolcraft and Gerstacker gave historical accounts in 1818 and the late 1830's, respectively, and describe large expanses of savanna, open woodlands, prairie, and some forests (USDA 1999). Schoolcraft described the forested areas of the Ozarks as being a uniform growth of black and post oaks with wild grasses underneath (Nelson 2011). Nelson goes on to state that Louis Houck, in 1908, described the Ozarks as being open woods with prairie grasses filling the "broad spaces between the trees." Owen (1858), while traveling through Benton County, described the area as primarily consisting of savanna and interspersed with prairie (Foti 2004). In a letter dated Feb 24, 1862, Union soldier T. Jones described Camp Halleck, located south-southwest of the park, comprising a six mile section along Telegraph Road, as being situated at the edge of a prairie to the north with rolling land that was dry and very rich. Nelson (2011), in a study of "Fire Adapted Natural Communities of the Ozark Highlands…." concluded "much of the Ozark landscape was mantled in a park-like growth of mixed oak and pine interspersed with a nearly continuous ground cover of deep rooted perennial grasses and forbs."

The General Land Office (GLO) originally surveyed what is now the park in 1836 and 1837. These surveys provide quantitative information on species and qualitative information in the form of notes of surrounding vegetation that can be used to determine trees per acre, basal area, tree diameter, dominant species and land classifications (Foti 2004, Nelson 1994) and confirm locations of pre-settlement savannas, open woodlands and forests. Consequently, prior to, and immediately following, Euro-American settlement, historic landscape conditions of the park consisted primarily of prairie, forests, savanna, and open woodlands, in that order of magnitude.

Foti (2004), through the review of multiple studies that used data contained within GLO notes, identified what each of these classifications consisted of and defined each in trees per acre and percent canopy cover, by subsection of the Arkansas Ozarks (Table 1B). Nelson's (2011) findings are similar but were further divided into classifications, used by

the Missouri Natural Areas Committee, and consist of mesic forest, dry-mesic forest, dry-mesic woodland, open woodland, savanna and prairie/glade (Table 1A).

Table 1B. Landscape Classifications by Author

% Canopy Cover # Trees/Acre	Forest		Woodland		Savanna	Prairie
	Mesic	Dry-Mesic	Dry-Mesic	Open		
Nelson (2011)	90-100% > 30	90-100% 30	>80% 20-30	30-80% < 10	10-30% < 5	0-10% < 2
Foti (2004)	100% > 40		50-99% 19-40		< 50% 9.5-19	< 25% < 9.5

Historically fire, second only to climate (USDA 1999), affected the landscape and was the driving force behind the establishment and preservation of prairie, savanna, open woodlands and forest. As such, each of these vegetative types were specific to location due to the frequency, intensity, and duration of fire, which followed a gradient consistent with topography, dependent upon slope, and the location of natural firebreaks (Johnson et al. 2009). Thus, in general, prairie occurred on level plains, shifted to savanna, then open woodlands, and finally forest as slope and topography increased and became more erratic.

Euro-American settlement began, as did fire suppression, in this area circa 1814 (FMP 2005). Jurney and Stahle (2004) found that by the late 1800's most of the Ozarks had been settled with one farmstead per 110 acres. The increased population, in addition to fire suppression, led to impacts at the parcel level and included logging, plowing, and soil depletion from erosion. They also note that historic settlement disrupted vegetative patterns introducing a variety of species including red cedar and increased densities of species that were once rare, walnut and Osage Orange.

In the absence of fire "woodlands, savannas, and prairies became forests or shrubby thickets" (USDA 1999) in a relatively short period. For example, Briggs et al. (2002), in a study that determined the rate at which cedar invaded prairie, found that native tall grass prairie, starting in 1956, converted to a closed canopy cedar forest within 40 years as a result of fire suppression, human population growth, and fragmentation of the landscape.

C.M. McClellan documented this rapid change in 1837 while surveying the park (GLO) when he described the area immediately below Elkhorn Mountain (Big Mountain) to the west and the area south of twelve-corners as being savanna consisting a thick undergrowth of sumac. Pre euro-settlement savanna primarily consisted of graminoids, composits, and legumes (Jenkins et al. 1997) with an overstory dominated by post oaks (Foti 2004). In addition, sumac is one of the first successional species, in the absence of fire, that occur in fallow fields and open woodlands.

Morgan's woods, an area identified by GLO surveyors as open woodlands, twenty-five years prior to the Battle of Pea Ridge, was described as a "dense tangle of trees, vines, and brush that limited vision to less than one hundred yards" (Shea and Hess 1992) during the battle. Historic open woodlands occurred on southern aspects of slopes, and on ridges with the primary understory component being grasses (Nelson 2011). Their canopies are open such that more than 50% of the available sunlight reaches the ground (Table 1B), a condition that, in the absence of fire, promotes oak regeneration (Johnson et al. 2009), shrubs and woody undergrowth. Shea and Hess (1992) in describing the plateau from the Tavern towards Little Sugar Creek state that it "inclines more steeply toward Little Sugar Creek," a southern aspect, "than is the case north of Leetown," and that "at the time of the battle most of the plateau was covered with the familiar scrubby forest of hardwoods, brush and vines."

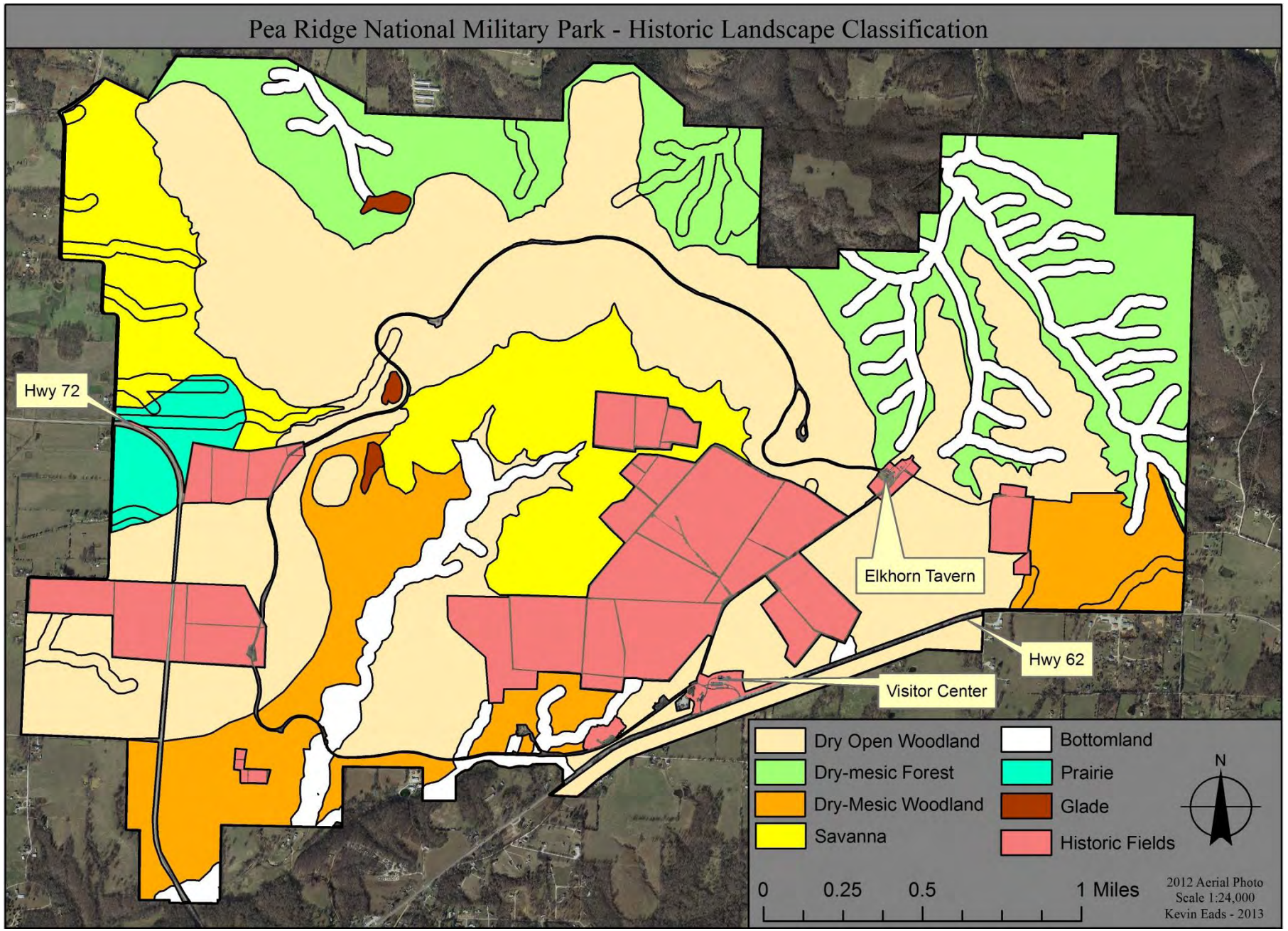
National Park Service Historian Edwin Bearss developed a Historical Base Map as part of the park's first Master Plan in 1957. In it, he identifies numerous observations from primary and secondary sources that agree with what is to be expected, in the absence of fire and presence of disturbance, in the successional progression of prairies, savannas, open woodlands and forests 10 to 20 years after settlement. For example, he identifies areas north of Elkhorn Mountain as consisting of "heavy timber with a thick growth of scrub oak." Each area is located in ravines and/or mid and upper slopes on northern aspects, characteristics identified for the location of historic forest. These areas would have had a patchy understory of grasses, spring ephemerals and ferns with few summer/fall forbs and burned infrequently (Nelson 2011). Shea and Hess (1992) describe these areas as consisting of timber and vines with little underbrush, a condition that is to be expected in March if understory vegetation is patchy during mid-summer due to a lack of sunlight reaching the forest floor from a closed canopy.

The GLO notes, as well as multiple first-hand accounts and subsequent studies, provide accurate documentation of the prairie landscape component due to their value for potential settlers (Foti 2004). Typically, prairie was found on flood plain settings, upland slopes (Jurney and Stahle 2004) and level to gently rolling plains (Nelson 2011). Historic prairies, converted to pasture or agriculture, were reduced or eliminated. Foti (2004) documents where Owen (1858), after traveling through the Springfield Plateau in Benton County, described prairies as having been significantly reduced by human activity.

Pre-European vegetation in the Midwest can be determined using GLO notes to identify the make-up and locations of prairie, savanna, woodlands and forests (Nelson 1997). Nelson (2011) identified the following vegetative types locations and characteristics. Prairie was located on level to gently rolling plains, broad ridges, steep southwest slopes, and glades in a wide range of soil types from shallow to deep and variably rocky with the dominant trees being shrubs and having a basal area of <10. Dry-mesic Forests were identified as occurring on northern aspects, ravines and locations where fire occurred infrequently in soils of moderate depth with the dominant trees consisting of red and black oaks and hickories and having a basal area of 70 to 80. Fire frequency within the historic forests was limited and with low intensity. Savanna contained Blackjack and Post Oak as the dominant tree species with wide spreading crowns with a basal area of <30

and, similar to prairie, was located on level to gently rolling topography, steep hills, and broad ridges in shallow to deep and variably rocky soil. This vegetative type burned frequently, as did prairie, typically once every 1 to 3 years. Dry-mesic woodlands occurred on mid to upper southerly aspect slopes that were fire prone, typically burning with low to moderate intensity every 3 to 15 years. The primary tree species was Post Oak but it also contained black, white, and Chinquapin oaks and hickories with a basal area of 60 to 80, and the ground cover was dense to patchy containing spring ephemerals, ferns, grasses, sedges, and forbs. The understory was patchy and contained a 30 to 50% canopy closure. Dry Open Woodland occurred on steep upper southerly aspect slopes, and narrow and broad ridges and, like Dry-Mesic woodlands, burned frequently, 3 to 15 years, with a low to moderate intensity fire. This vegetation type also contained some understory but it was scattered with a 10 to 30% canopy closure. Consequently, the ground cover was patchy to dense with grasses, sedges and a diversity of forbs year round. The dominant trees in this vegetation type were Post, Blackjack, Chinquapin, and White Oak with a basal area of 30 to 60.

Weih's (2007) base map of historic land cover and use incorporated GLO notes and data within an area the size of a township with the park at the center. Consequently, GLO data two miles, on average, around the park boundary is also contained within his research. This area, 36 sections, is large enough to accurately analyze GLO data (USDA 1999) and provide adequate data for statistical analysis (personal communication Weih 2007). As such, this area contained 681 data points and notes of the vegetative structure and characteristics within and around the park. Analysis of this data in conjunction with studies and maps referenced in this document, a 1940's aerial photograph, 1957 USGS Quadrangle, 1899 USGS Quadrangle, historic photographs, first hand documents, 2004 lidar, existing vegetative maps and studies, and 2012 aerial photography was used to create a map of Historic Landscape Classifications for the park (Figure 1B).


Pea Ridge National Military Park - Historic Landscape Classification
Hwy 72
Elkhorn Tavern
Hwy 62
Visitor Center
Dry Open Woodland
Dry-mesic Forest
Dry-Mesic Woodland
Savanna
Bottomland
Prairie
Glade
Historic Fields
N
0
0.25
0.5
1 Miles
2012 Aerial Photo
Scale 1:24,000
Kevin Eads - 2013

These classifications agree with battle related descriptions of location, with consideration given for the successional growth of vegetation a 10 to 20 year seclusion from fire and fragmentation on the landscape had, and is based on studies, GLO notes, and first-hand accounts from the Battle of Pea Ridge.

Diamond et al. (2013) conducted a vegetation classification and mapping project that utilized classifications similar to those used by the Missouri Natural Areas Committee (Nelson 2011) whereby they identified dry deciduous woodland and forest and typic upland deciduous woodland and forest. They note that, based on the global summary, the dry deciduous woodland and forest type forms open woodlands with a grassy understory, including little and big bluestem, that occurs on dry sites, is made up of post oak and blackjack oak and is located on south and west facing slopes. This type is more open on elevated areas and more dense on slopes. Hence, the global summary agrees with cited literature contained herein and with the historic land classification (Figure 1B) with the exception that this vegetation type, within the park classified as Dry Open Woodland (Figure 1B), has decreased from 40.51% historically to 11.25% currently (Table 2B). The historic land classification for Dry Open Woodland (Figure 1A), correspondingly defined by Nelson (2011) and woodland by Foti (2004), delineated through GLO notes, primary and secondary documentation and numerous studies, currently contains half of the Eastern red cedar and woodland and forest classification identified by Diamond et al. (2013).

Table 2B: Historic and Current Landscape Classifications and Percent Change, 1836-37 to Present

Type	Historic Classification		Diamond et al. (2013)		Percent Change
	Acres	Percent Coverage	Acres	Percent Coverage	
Bottomland	340	7.90%	55	1.28%	-6.62%
Dry-Mesic Forest	682	15.85%	2001	46.90%	31.05%
Dry-Mesic Woodland	491	11.41%	-	0.00%	-11.41%
Dry Open Woodland	1742	40.51%	480	11.25%	-29.26%
Glade (E. Red Cedar)	16	0.38%	674	15.79	0.38%
Prairie	75	1.74%	61	1.42%	-0.32%
Savanna	474	11.03%	420	8.50%	-2.53%
Maple Forest	0	0	6	0.15%	0.15%
Fields	480	11.16%	569	13.33%	2.17%

Although not identified by Diamond et al. (2013) as being extant, Dry-mesic Woodland did occur at the park historically (Figure 1B) and made up 11.41% of what is now the park (Table 2B).

The typic upland deciduous woodland and forest was described by Diamond et al. (2013) as being in association within the Ozark-Ouachita Dry Mesic Oak Forest with Black and

White Oak being the dominant tree species with shrubs and small trees contained within the understory. This vegetation type also occurred historically and has been categorized as Dry-mesic forest on the Historic Landscape Classification map (Figure 1B). However, it has increased 31.05% from historic levels due the lack of fire and fragmentation. Nonetheless, its dominant tree species, size class 5 and above, (93.44%) still consist of White (27.98%), Red (49.54%) and Black Oaks (6.19%), (Table 3B) and hickories (9.73%).

Table 3B: Dry Mesic Forest & Bottomland Percent of Extant Oak Species by Size Class

Species	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	% Species
Black	3.70%	-	3.70%	3.70%	14.81%	3.70%	14.81%	55.56%	6.19%
Blackjack	22.22%	11.11%	22.22%	22.22%	-	11.11%	11.11%	-	2.06%
Chinkapin	33.33%	33.33%	33.33%	-	-	-	-	-	0.69%
Post	13.56%	16.95%	22.03%	16.95%	6.78%	10.17%	5.08%	8.47%	13.53%
Red	18.52%	13.43%	11.57%	12.50%	11.11%	7.41%	9.72%	15.74%	49.54%
White	12.30%	7.38%	10.66%	14.75%	10.66%	12.30%	10.66%	21.31%	27.98%
% Size Class	15.37%	11.47%	12.61%	13.30%	10.32%	8.94%	9.63%	18.35%	

Prairie was currently identified as containing 60.78 acres, or 1.42% of the park (Diamond et al. (2013). Historically it made up 75.02 acres, or roughly 2% of the landscape (Table 2B). Some of the historic prairie is currently under U.S. State Highway 72 and within Foster's field, 14.24 acres combined. However, 5.31 acres of historic prairie has been encroached upon by dry-mesic forest, as determined from GLO notes and map.

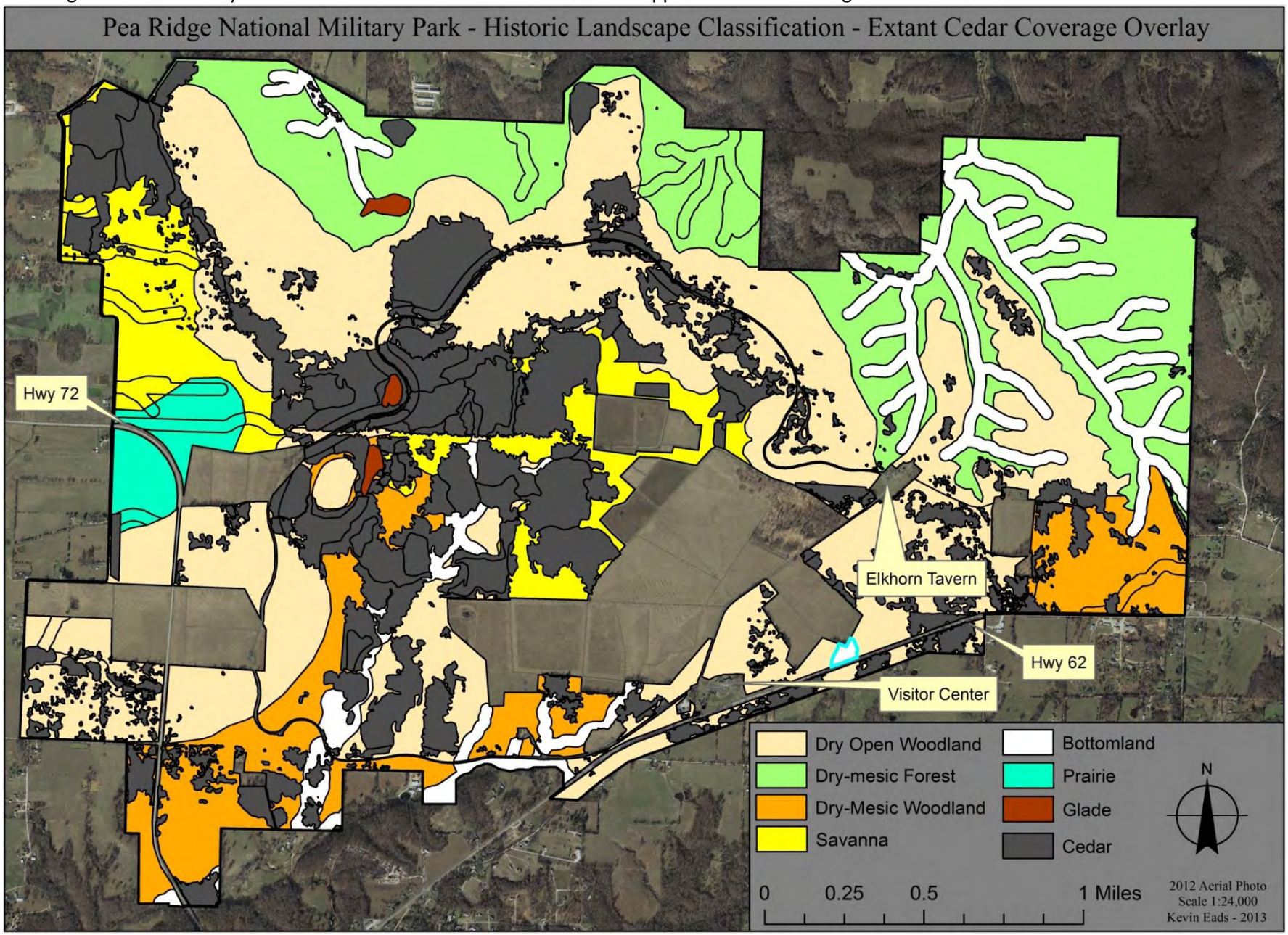
Diamond et al. (2013) document the existence of ruderal grassland and shrubland (362.86 acres or 8.50%) within the park. They also document 15.79% of the park as consisting of eastern red cedar woodland and forest. The entirety of the grassland and shrubland and approximately 400 acres of the eastern red cedar woodland and forest type are contained within what historically would have been savanna, 474 acres or 11.03% (Table 2B & Figure 1B) in the park. Although the vast majority of extant dominant tree species would not have occurred in this vegetative type, there are tree species that are similar in composition to those that existed in 1837 and are made up of Black, Blackjack and Post Oak.

The Bottomland Deciduous Woodland and Forest Diamond et al. (2013) identified within the park, 54.77 acres, based on available data, could not be identified as having occurred historically. Nonetheless, these areas are identified as part of the Historic Landscape Classification (Figure 1B) and include buffers as described in the Vegetation Management Plan, total area delineated is 339.75 acres. Thus, this type represents 7.90% of the park (Figure 1B) instead of the 1.28% listed by Diamond et al. (2013) (Table 2B).

Glades were not identified by Diamond et al. (2013) as being extant on the park. However, they have been identified for management (Figure 1B) and are further discussed later in this document.

Fields, a significant component of the landscape at the time of the battle, 480 acres or 11.16% of what is now the park and consisting of 39 fields, were made up of savanna and/or dry open woodland historically. However, because they were extant circa 1862 they have been categorized as part of the historic landscape (Figure 1B).

All of the Eastern Redcedar Woodland and Forest type that exists within the park occurs primarily within three historic landscape classification types, savanna and dry-open and dry-mesic woodland (Figure 2B). Hence, the most significant management action that could be taken to restore the historic landscape, circa 1862, and these three classifications, is to remove cedar, with the exception of identified "glade like" areas, from the park and then ensure managed areas are burned consistent with historic fire regimes and intensities for their classification. Therefore, this should be one of the first actions taken upon implementation of this Vegetation Management Plan. As such, it is the first described and followed by proposed glade management actions. In addition to the removal of cedar through described methodologies, further actions for savanna, dry-open and dry-mesic woodland and dry-mesic forest and bottomland are detailed, follow proposed cedar management actions, and are consistent with actions described by GMP management zones identified within the Vegetation Management Plan.


Pea Ridge National Military Park - Historic Landscape Classification - Extant Cedar Coverage Overlay
Hwy 72
Elkhorn Tavern
Hwy 62
Visitor Center
Dry Open Woodland
Dry-mesic Forest
Dry-Mesic Woodland
Savanna
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2012 Aerial Photo
Scale 1:24,000
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Cedar

Euro-American settlement began, as did fire suppression, in this area in the early 1800's (FMP 2005). Jurney and Stahle (2004) found that by the late 1800's most of the Ozarks had been settled with one farmstead per 110 acres. The increased population, in addition to fire suppression, led to impacts at the parcel level and included logging, plowing, and soil depletion from erosion. They also note that historic settlement disrupted vegetative patterns introducing a variety of species including red cedar. In a study that determined the rate at which cedar invaded prairie, Briggs et al. (2002) found that native tallgrass prairie, starting in 1956, converted to a closed canopy cedar forest within 40 years as a result of fire suppression, human population growth, and fragmentation of the landscape. These activities occurred on the park beginning at settlement and increased in scope and magnitude up to inception, 1956. Management on the park from 1956 to 2002 was mostly passive, with the exception of a few instances during the 1980's, in that non-historic fields were left fallow and forests were, for the most part, ignored. As a result, monolithic stands of eastern red cedar became established in all historic savanna and dry-open woodland vegetative types and previously disturbed and subsequently unmanaged areas on the park.

As part of a study of the upland hardwood forests….of the Arkansas Ozarks in the early 19th century, Foti (2004) compiled and then reviewed documentation from a variety of sources detailing what was present during the early 1800's. For example, he documents where Owen (1858), after traveling through the Springfield Plateau, thought that the prairies had been significantly reduced by human activity and that Gerstacker (1881) did not find any cedar when describing the forests in the Upper Boston Mountains. Foti mapped and analyzed Government Land Office Notes (GLO) for the Ozarks, from 1818 to 1850's, to obtain composition and structure of the associated forests. Cedar occurred 1% of the time within the Ozarks, and then only in the White River Hills physiographic subsection.

As such, historic occurrence of cedar within the Springfield Plateau is minimal at best. Weih (2007) while classifying historic land cover and use for the park determined that less than .01% of cedar occurred within a two-mile radius of the park. Proebsting (2004) did not document cedar as being present at the park, in a study of historic changes of land cover, circa 1860.

Nonetheless, in order to verify the potential for the presence of cedar in 1862 within what is now Pea Ridge National Military Park (PERI) two studies were conducted in 2012; Inventory Glades and Develop A Management Plan at PERI (Stephenson 2012a) and Age/Size Class Assessment of Red Cedar and Post Oak at PERI (Stephenson 2012b). Consequently, cedar glades did not occur. However, two sites were identified that possessed "enough of the features typically associated with cedar glades to warrant some degree of protection" (Stephenson 2012a). In the associated study to identify trees that potentially would have been present circa 1862, Stephenson (2012b) found that, of the cedar trees studied, none were present at the time of the battle, aged from 70 to 100 years, but that the occurrence of historic cedar trees is possible as they are capable of surviving

for more than 300 years. Hence, the cedar "glades" have been identified and incorporated for management and preservation.

Thus, if cedar existed on what is now the park, circa 1862, it was confined to isolated areas as cedar glades. The remainder of the park that was forested at the time of the battle consisted of oak/hickory associations with oaks being the predominant species, 94.26% (Weih 2007).

The recent vegetation classification and mapping study, 2013, identified 673.9 (15.8% of the park) acres of low diversity stands of cedar in 99 polygons on the park (Diamond et.al. 2013). In addition to the pure stands of cedar referenced above, it was also identified in other vegetation types. The following table identifies the percent coverage of cedar by vegetation type.

Table 1C: Percent Coverage of Cedar by Vegetation Type (Diamond et al. 2013)		
Vegetation Type	% Cover of Cedar	Acres of Cedar by Type
Bottomland Deciduous Woodland and Forest	1.00	0.55
Dry Deciduous Woodland and Forest	0.58	2.78
Marsh	0.50	0.003
Ruderal Grassland and Shrubland	0.50	1.82
Typic Upland Deciduous Woodland and Forest	3.98	79.66
Silver Maple Forest – cedar was identified as being present but not quantified.		

Hence, the total acreage of cedar within the park, regardless of vegetation type, including solid stands of cedar, as identified by this report, is 758.71.

The cedar vegetation type coverage created by this study was compared with park cedar coverage files using Geographical Information Systems (GIS) and then refined through first-hand knowledge, and ground truthing, to create a comprehensive coverage. It was then classified by percent canopy cover of cedar, similar to the procedures of Diamond et al. (2013). Six different classifications (Table 2C) of percent coverage of cedar stands were identified using the Daubenmire method (1959).

Table 2C: Canopy cover classifications used for quantitative sampling of cedar coverage at Pea Ridge National Military Park.

Cover Class Codes	Percent Cover (%) Ranges
1	>0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

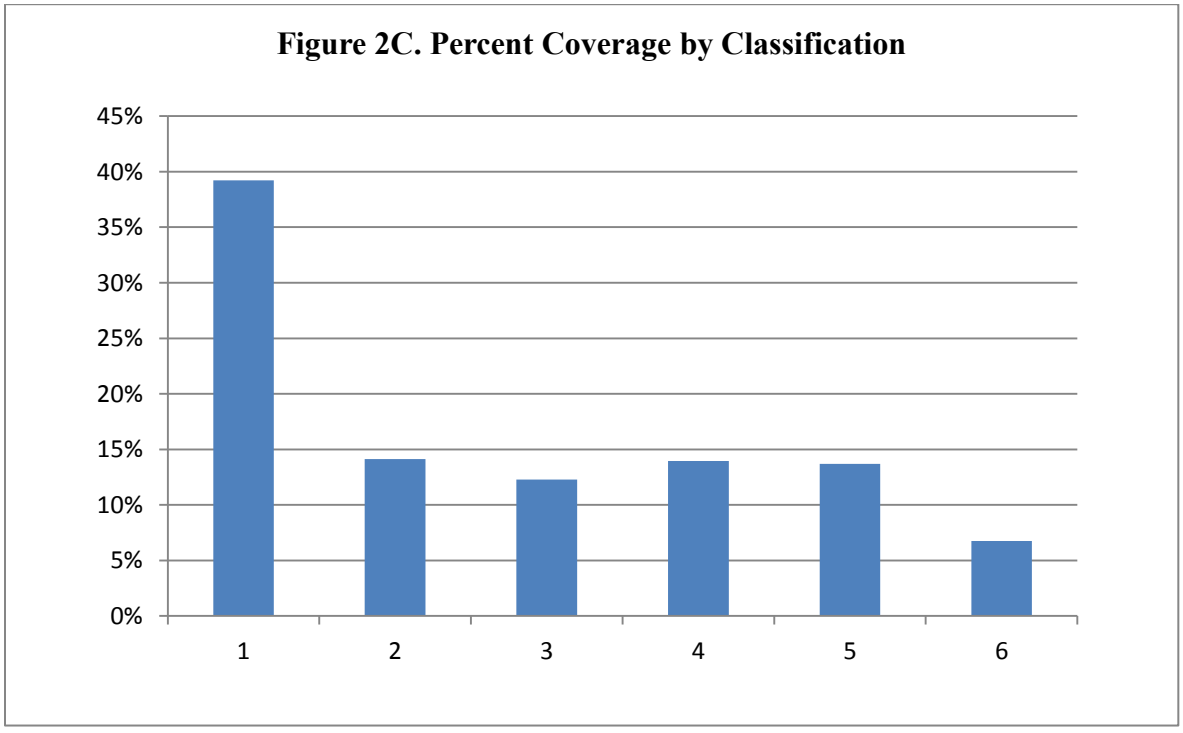
As a result, a total of 897.01 acres of cedar, excluding identified "glades," comprised of 787 polygons spread among six classifications, were identified within the park (Table 3C).

Table 3C: Quantitative Canopy Cover of Cedar by Classification, Acres, and Count at Pea Ridge National Military Park.

Classification	Acres	Count
1	351.78	680
2	126.68	49
3	110.30	21
4	125.07	13
5	122.73	10
6	60.45	14
Total	897.01	787

Classified stands of cedar on average range from 250 to more than 600 trees per acre, with diameters between 4 and 18 inches on average (Figure 1C). The largest coverage of cedar falls within type 1 where it made up 39.22% of the total area and was contained in numerous scattered small groups, 680 polygons (Table 3C, Figure 2C). Dense stands of cedar, types 4, 5, and 6, make up 34.36% of total coverage within the park and dominate the upper canopy. However, all coverage classifications are interspersed, to varying degrees, with Oaks of seed bearing size in sufficient numbers to provide for regeneration. Generally, cedar trees within the less dense categories, one through three, are larger in diameter while those in more dense stands, classifications four through six, are smaller in diameter. Additionally, cedar trees at the park generally over 12 inches in diameter tend to be older than 70 years of age (Stephenson 2012b). Nevertheless, when a 1940 aerial photograph is overlaid with the existing cedar coverage in GIS all cedar areas are located within and immediately adjacent to 20th century fields which were historic savanna and/or dry open woodlands, and agree with the findings of Briggs et al. (2002) in that they developed as a result of recent, 20th century, disturbance regimes and lack of fire.

Figure 1C: Example of monolithic stands of Eastern Red Cedar



The three cedar "glade," sites have been identified, incorporated in a GIS coverage, and are contained within this vegetation type for management and preservation.

The remaining 897.01 acres of cedar will be removed through management actions that incorporate thinning and fire as outlined in the park's FMP in conjunction with, and in addition to, actions further described herein in order to facilitate and promote oak regeneration and restore forest vigor through uneven-aged methods consistent with historic classification types. The overall goal for uneven aged management, in this instance, is to develop and then be able to maintain a minimum of three oak age classes at a slightly higher density than what would have occurred historically.

These management actions will increase species diversity of flora (Briggs et al. 2002) and fauna (USFS 2011), in particular breeding bird populations (Shugart and James 1973) and make available up to 55,000 gallons of water per acre of cedar trees removed (USFWS 2013).

Eastern Red Cedar is a juniper and is considered softwood. As previously mentioned, its dominance in hardwood forests in the Ozark Highlands is due to fragmentation of the landscape and lack of fire. However, after removal of the overstory, which in this instance is cedar, stand development of the hardwoods in the Ozark Highlands has been found to revert to an oak dominated forest within two decades (Johnson et al. 2009) outcompeting any vestiges or regrowth of cedar given that prescribed fire is included within the management regime. Accordingly, all cedar will be removed but techniques vary by canopy cover classification (Table 3C) and are based on silvicultural literature for oak regeneration specific to the Ozark Highlands, Arkansas Ozarks and/or Springfield plateau subsection and supported, where possible, by park specific studies and anecdotal evidence. Maps for each category are provided at the end of this section.

Table 3C. Quantitative Canopy Cover of Cedar by Classification, Acres, and Management at Pea Ridge National Military Park.

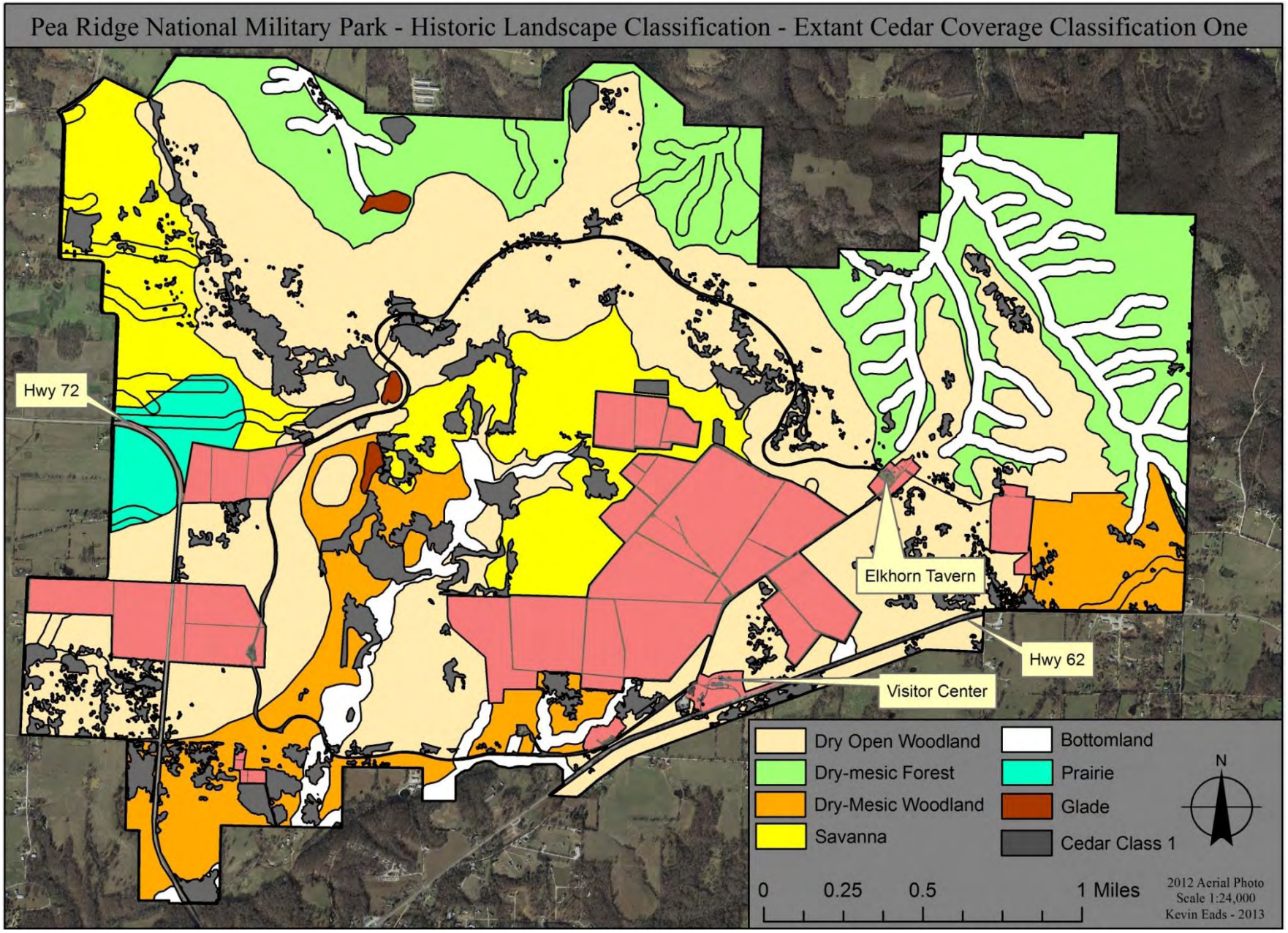
Classification	Acres	Management Action
1	351.78	Remove all cedar trees
2	126.68	Girdle all cedar trees ≥10" dbh, remove all cedar trees <10" dbh.
3	110.30	Girdle all cedar trees ≥10" dbh, remove all cedar trees <10" dbh.
4	125.07	Reduce Cedar Canopy cover by 70% primarily around hardwoods leaving 25% cedar coverage around open areas.
5	122.73	Reduce Cedar Canopy cover by 50% leaving remaining 50% cedar coverage around open areas.
6	60.45	Reduce Cedar Canopy cover around mature Oak seed trees in a circle, the diameter of which will be 2 times the height of the selected leave tree. Reduce remaining cedar to achieve a 50% reduction in total canopy cover.

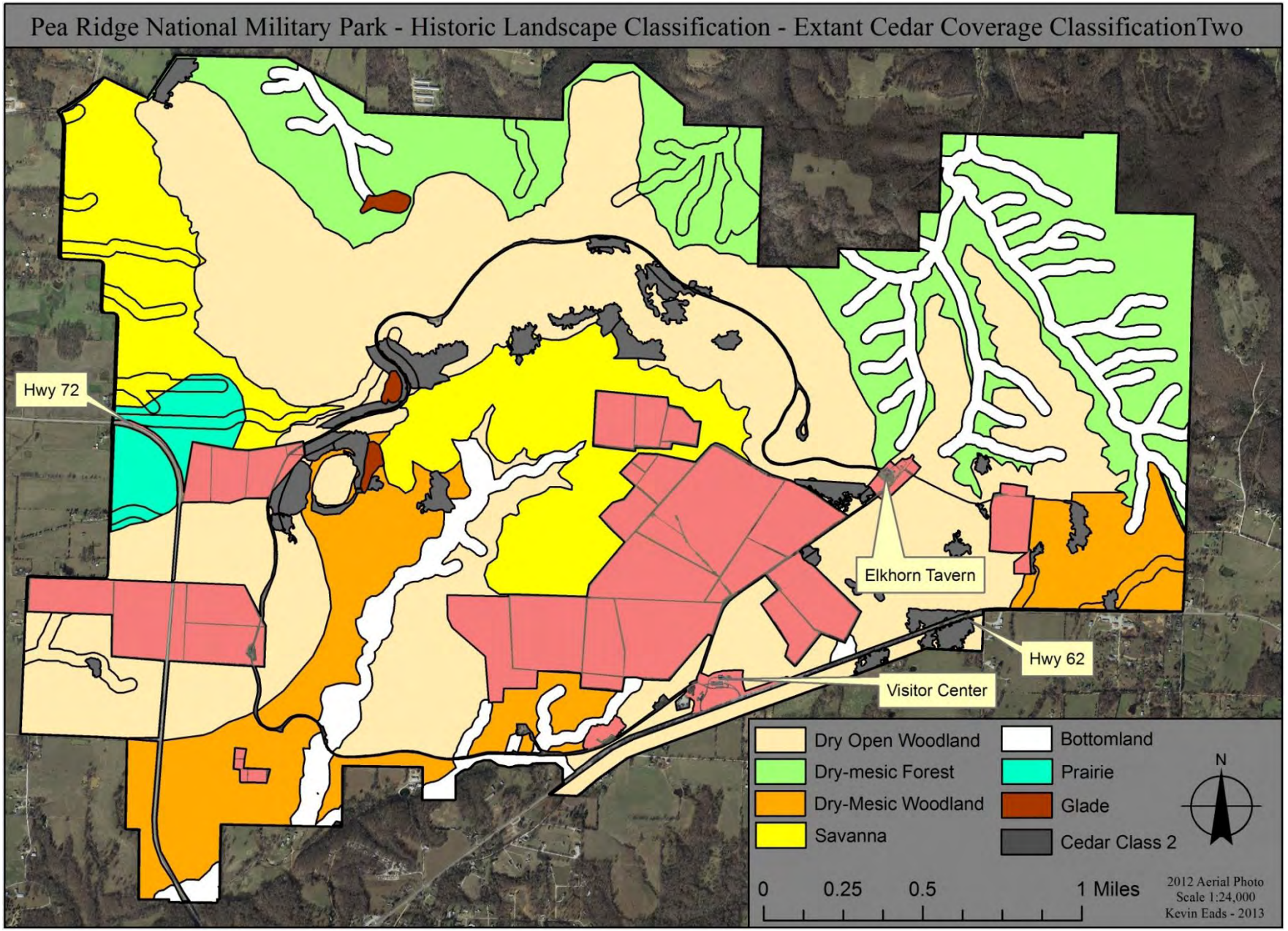
Dense classification categories, four through six (Table 1C), after the initial management application, will move into less dense categories, one through three, and will subsequently receive secondary, and possibly tertiary, management applications as described below. However, they will be monitored such that oak seedlings are ≥ 2.5 inches diameter at breast height (dbh) before succeeding management applications are

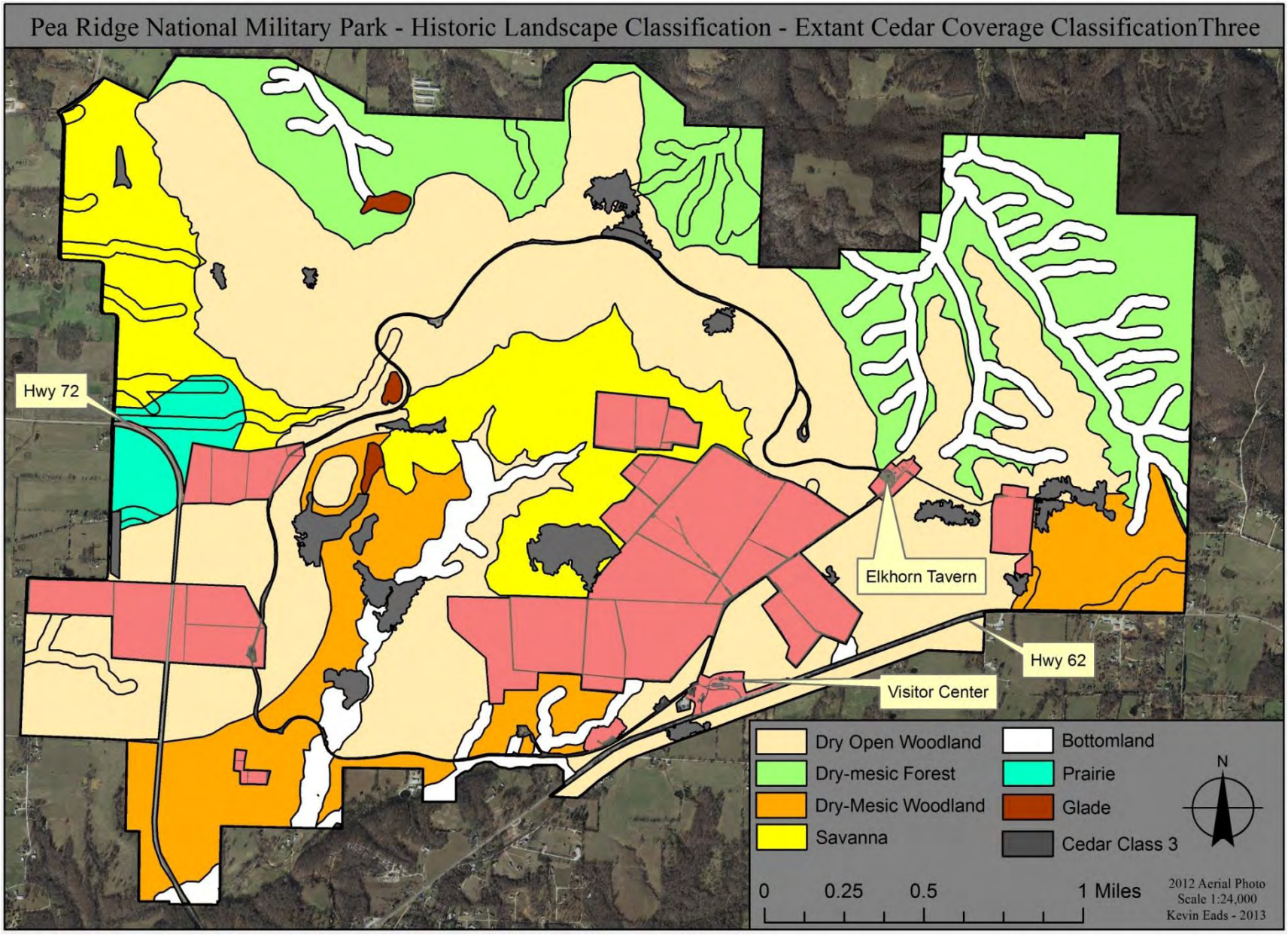
initiated. Dey et al. (2010) in an ecologically based approach to oak silviculture…where 50 years of research was reviewed states that seedlings of this size are resistant to being top killed by fire and are able to recruit into the over-story. This agrees with results of oak recruitment and retention following prescribed fire at the park.

Classification Categories one, two, and three will be managed through a modified single-tree selection method in order to promote oak regeneration in an uneven-aged manner. Johnson et al. (2009) defines uneven-aged management by the single-tree selection method as obtaining forest wide structure at a small scale where "desired stand age and size structure, species composition and stocking are maintained." In other words, multiple size classes of oak regeneration is promoted within the area of canopy openings from the removal of single or small groups of cedar trees so that as diameter of oaks increase the number of trees decrease through time. Numerous studies provide confirmation that this type of management will sustain uneven-aged oak stands in the Ozark Highlands (Johnson et al. 2009).

Categories one, two, and three contain a total of 588.76 acres with category one containing 59.75% of the total (Table 3C). These categories consist of multiple small areas scattered throughout the park, located in savanna, dry-open woodland and dry-mesic types (Figures 3C-5C), are interspersed with numerous oaks of seed bearing stature, up to 50% (Table 1C), and make up 95.3% of the total coverage of cedar throughout the park.


Pea Ridge National Military Park - Historic Landscape Classification - Extant Cedar Coverage Classification One
Hwy 72
Elkhorn Tavern
Hwy 62
Visitor Center
Dry Open Woodland
Dry-mesic Forest
Dry-Mesic Woodland
Savanna
Bottomland
Prairie
Glade
Cedar Class 1
N
0
0.25
0.5
1 Miles
2012 Aerial Photo
Scale 1:24,000
Kevin Eads - 2013


Pea Ridge National Military Park - Historic Landscape Classification - Extant Cedar Coverage ClassificationTwo
Hwy 72
Elkhorn Tavern
Hwy 62
Visitor Center
Dry Open Woodland
Dry-mesic Forest
Dry-Mesic Woodland
Savanna
Bottomland
Prairie
Glade
Cedar Class 2
N
0
0.25
0.5
1 Miles
2012 Aerial Photo
Scale 1:24,000
Kevin Eads - 2013


Pea Ridge National Military Park - Historic Landscape Classification - Extant Cedar Coverage ClassificationThree
Hwy 72
Elkhorn Tavern
Hwy 62
Visitor Center
Dry Open Woodland
Dry-mesic Forest
Dry-Mesic Woodland
Savanna
Bottomland
Prairie
Glade
Cedar Class 3
N
0
0.25
0.5
1 Miles
2012 Aerial Photo
Scale 1:24,000
Kevin Eads - 2013

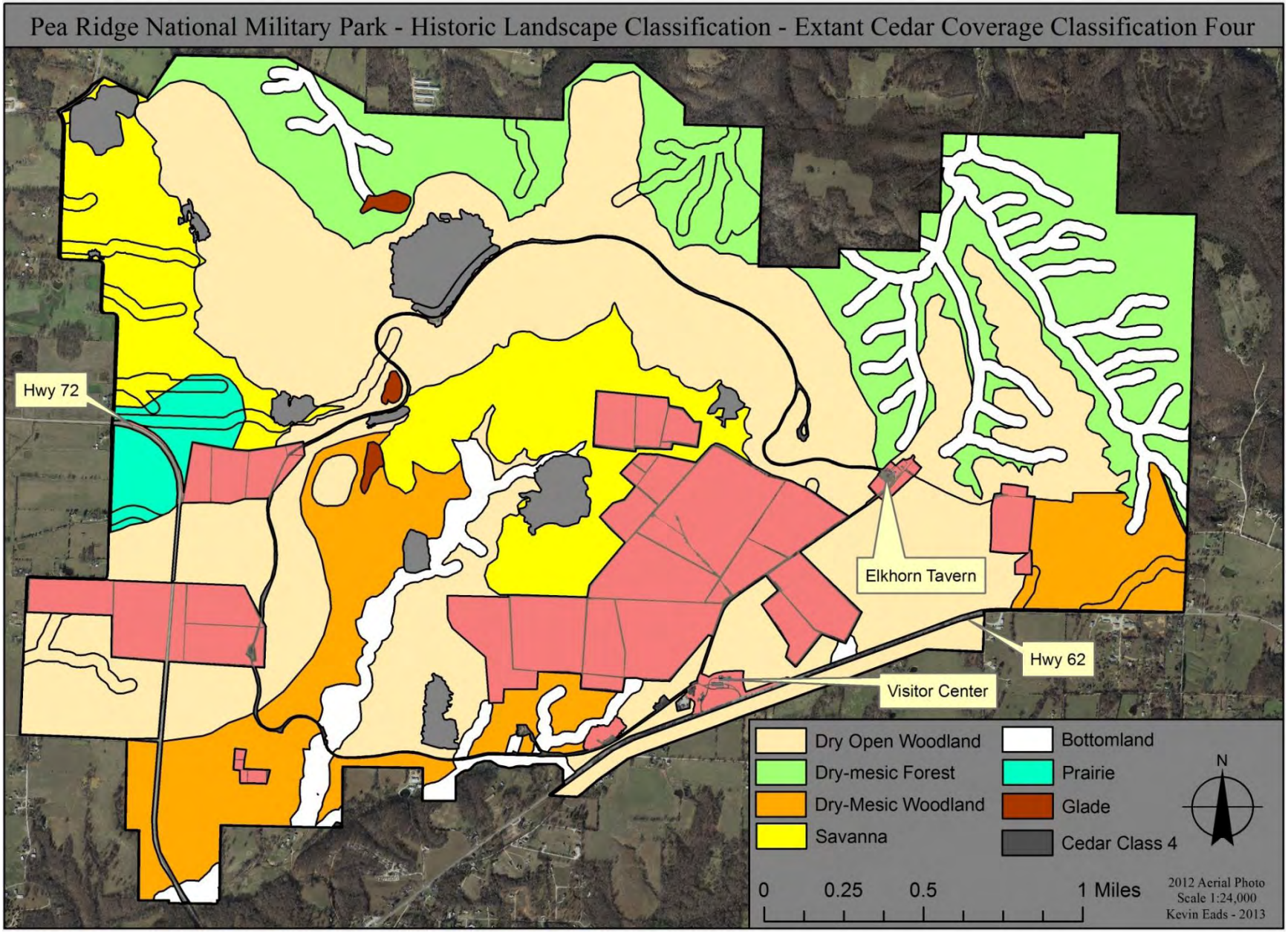
In category one, all cedar trees will be cut by hand, using chainsaws, and will be removed from the canopy by felling them in place. The resulting deadwood from this technique will increase the fuel load in those areas but is considered beneficial, as only fine fuels will burn in any post-prescribed burns, as evidenced at the park through previous cedar reduction efforts, leaving the bole of the trees to serve as habitat as well as pools of long-term sequestration of carbon. This technique preserves surrounding oak trees and has the lowest probability of resultant damage to desirable tree species.

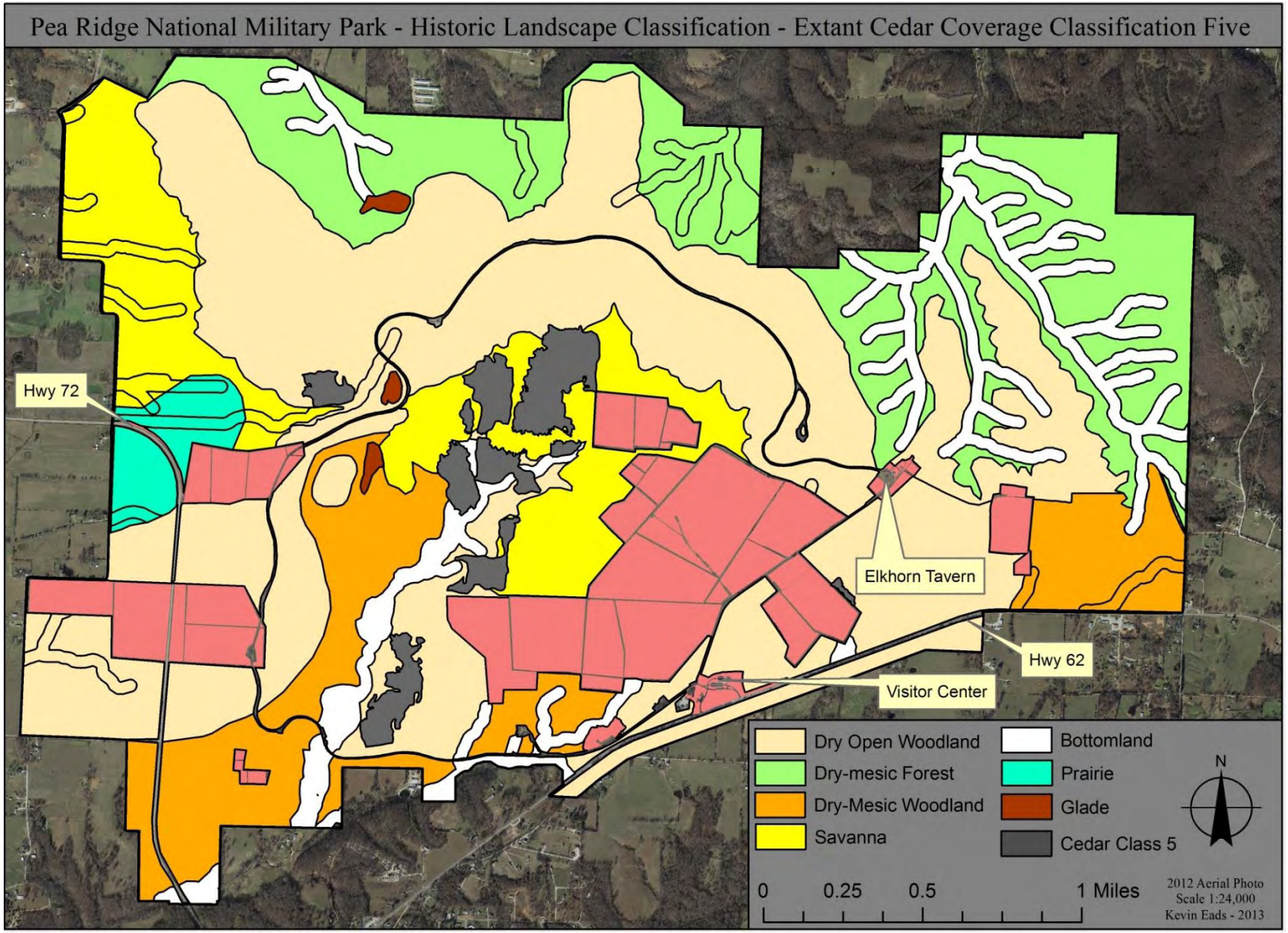
Classification categories two and three, 236.98 acres total, comprise 26.42% of total cedar coverage and are located in 70 areas (Table 2C). These categories will be managed comparable to classification category one but techniques are modified to include standing dead cedar trees so that fuel loads will not be concentrated around oak trees due to the larger number of cedar trees that are to be managed. Leaving standing dead trees reduces the amount of available fuel loads for subsequent prescribed fire (Johnson et al. 2009). Thus, all cedar trees less than 10 inches in dbh will be felled by hand and left in place. Trees greater than 10 inches dbh will be girdled and left in place. Resultantly, the benefits are similar to those previously referenced with the addition of habitat being provided throughout the canopy structure.

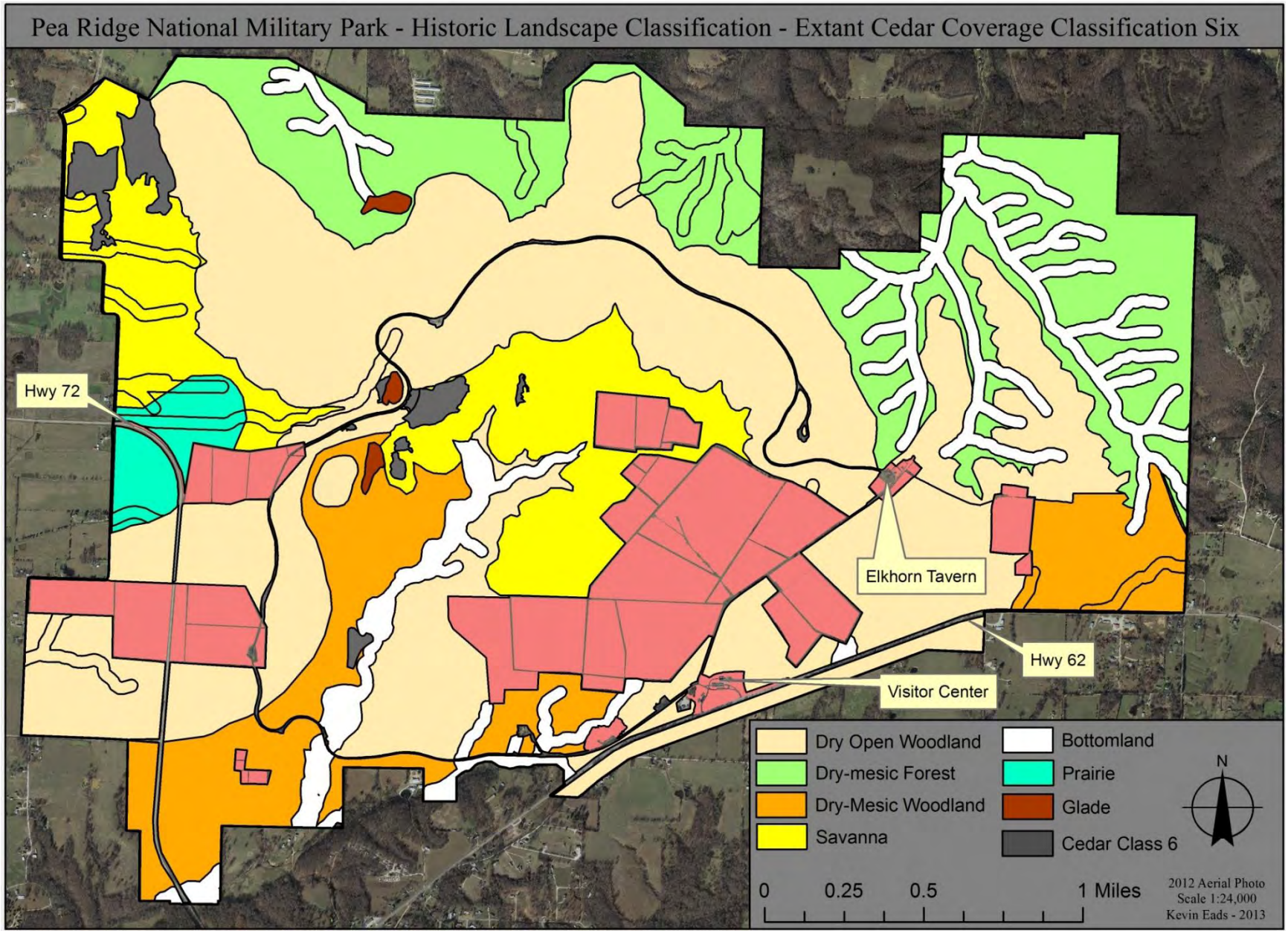
Classification categories four, five, and six make up 34.36% of the total canopy coverage of cedar within the park (Table 2C). However, they consist of small patches, 4.7% of total number of patches, and are scattered throughout Savanna and Dry-Open and Dry-Mesic Woodland (Figures 6C-8C). These cedar coverage categories will be managed using a shelterwood and seed-tree variant method to create conditions advantageous for the further establishment and development of the surrounding forest associations. Accordingly, cedar will be removed such that crown cover is reduced between 50% and 70%. This will increase light penetration at the forest floor between 25% and 50% respectively (Johnson et al. 2009), which significantly improves oak seedling photosynthesis and growth while inhibiting competition from shade tolerant species (Dey et al. 2010). These treatment areas will not be subjected to prescribed fire, post hand and/or mechanical treatments, until 25% of oak regeneration reaches more than 2.5 inches dbh in numbers established for their respective historic landscape classification(s) for treated areas, see related proposed management methodologies below. Dey et al. (2010) recommends a fire free period until regenerated oaks reach this size class so as to resist being top killed by fire and to promote recruitment into the overstory.

Classification category four, comprised of 125.07 acres (14% of total cedar coverage), (Table 2C), is concentrated in small patches averaging 9.62 acres in size and is located in Savanna and Dry-Open Woodland types only. These patches are surrounded by forest associations, respective of their historic vegetative type, of adequate size and number for seed production and/or to obtain canopy dominance over non-target species once the canopy has been opened to provide sufficient light penetration to the mid and lower canopy structure. Consequently, the canopy coverage of cedar will be reduced by 70% through techniques that include hand felling and mechanical thinning as described in the FMP/EA where equipment (eg. skid-steer loader) with tree cutting attachments will be

used when feasible, when access is available, and there is no potential for damage to sensitive natural or cultural resources (FMP 2005).


Pea Ridge National Military Park - Historic Landscape Classification - Extant Cedar Coverage Classification Four
Hwy 72
Elkhorn Tavern
Hwy 62
Visitor Center
Dry Open Woodland
Dry-mesic Forest
Dry-Mesic Woodland
Savanna
Bottomland
Prairie
Glade
Cedar Class 4
N
0
0.25
0.5
1 Miles
2012 Aerial Photo
Scale 1:24,000
Kevin Eads - 2013


Pea Ridge National Military Park - Historic Landscape Classification - Extant Cedar Coverage Classification Five
Hwy 72
Elkhorn Tavern
Hwy 62
Visitor Center
Dry Open Woodland
Dry-mesic Forest
Dry-Mesic Woodland
Savanna
Bottomland
Prairie
Glade
Cedar Class 5
N
0
0.25
0.5
1 Miles
2012 Aerial Photo
Scale 1:24,000
Kevin Eads - 2013


Pea Ridge National Military Park - Historic Landscape Classification - Extant Cedar Coverage Classification Six
Hwy 72
Elkhorn Tavern
Hwy 62
Visitor Center
Dry Open Woodland
Dry-mesic Forest
Dry-Mesic Woodland
Savanna
Bottomland
Prairie
Glade
Cedar Class 6
N
0
0.25
0.5
1 Miles
2012 Aerial Photo
Scale 1:24,000
Kevin Eads - 2013

This type of equipment is engineered so that it typically places less than six psi on the ground, as compared to a medium build six foot tall man that places 8 psi on the ground (Wikipedia 2013), thereby significantly reducing any soil compaction. This type of mechanical thinning has been reviewed and approved through the NHPA process numerous times at the project level as well as in the FMP. However, this method does present the potential for damage to desirable oak species and therefore will be excluded immediately around any desirable canopy dominant oaks contained within this category. Cedar around remnant savanna or dry-open woodland openings within this category will be thinned but not as intensively as elsewhere such that light penetration at the floor of these openings does not fall below 20% (Dey et al. 2010) and does not exceed 25% so that shade tolerant species, as well as other exotic invasive species, encroachment are deterred.

Category classification five, 1.3% of total cedar canopy coverage within the park, contains 122.73 acres within 10 patches (Table 2C) that average 12.27 acres in size. It also is found only in historic landscape classifications of Savanna and Dry-Open Woodlands (Figure 7C). Management techniques in this cedar coverage classification mirrors that identified for classification four with the exception of the amount of canopy cover reduction due to larger patch size, the complete lack of woody material or other herbaceous material on the forest floor, limited large advanced oak regeneration size classes within the patches, and the potential for exotic species encroachment. Therefore, canopy cover will be reduced by 50%, which will allow an increase of sunlight at the forest floor by the requisite 25% (Dey et al. 2010).

Category classification six contains 60.45 acres within 14 patches (Table 2C) and is located in Dry-Mesic Woodland and Savanna only (Figure 8C). The vast majority, all but three, of the patches are small and average 1.47 acres in size. However, the remaining three patches average 16.71 acres in size with the canopy coverage of hardwood species consisting of less than 4%. Management within this classification emulates that of classification five with the addition of the seed tree methodology. Thus, total canopy coverage of cedar will be reduced by 50% but only after cedar has been removed around extant dominant oak species within the upper canopy within each patch. The remaining cedar will then be thinned from the canopy to meet the required overall 50% reduction. Removal of cedar around oaks will consist of hand felling and leaving in place in such a manner that they lie perpendicular to the leave tree thereby reducing the potential for fuel loading and decreasing fire intensity immediately around them. Cedar trees will be removed around selected oak seed trees to create an opening approximately two times the height of the seed tree. This size of opening has been shown to promote large advanced oak and seed regeneration (Dey and Fan 2009) (Graney and Murphy 1997).

Cedar removed through mechanical treatments, in classification categories four through six, will be chipped when possible and spread on the forest floor at a depth of no more than three inches to promote oak regeneration. Johnson et al. (2009) states that more than three inches of litter depth are detrimental to oak acorn germination but that protection is needed to provide moisture, prevent desiccation and freezing, and protect from predation of insects and animals. Cedar mulch conserves soil moisture, reduces weeds and water

runoff, moderates soil temperature, is favorable to microorganisms thereby increasing nutrient availability, increases diameter growth of oak trees, has been found to increases mycorrhizal roots in white oaks allowing them to better utilize soil resources, and repels insects (Maggard 2008, Maggard et al. 2012). In areas where chipping is not feasible or practicable, felled cedar will be left in place and allowed to deteriorate over time. When possible, secondary to chipping and spreading in treatment areas, and not adverse to goals and objectives, cedar will be made available to the public.

Mechanical treatments are necessary for cedar reduction due to the lack of fire effects in infested areas. Cedar abundance affects fire intensity through reductions in fuel loads and ground wind speeds (Akin 2009).

Finally, native grass seed composed primarily of big and little bluestem will be sown through broadcasting by hand in all treated areas immediately following mechanical treatments and/or post prescribed fire.

Treatments, for each category classification referenced above, have been conducted at the park within the last 13 years to a small degree. Between 2000 and 2002 three blocks of cedar, averaging 1.5 acres in size were removed, similar to treatments described for cedar coverage categories four through six using the shelterwood method, but only included hand felling cedar trees and leaving them in place. Each of these areas has been burned at least twice since the initial treatment. All treatment blocks achieved the desired objective of oak recruitment (Figure 9C), between 51% and 75%, and will ultimately lead to a dominant canopy of oak species in respective historic landscape classification types.

Figure 9C: Shelterwood Management of Dense Stands of Cedar 10 Years Post Treatment, Cedar Hand Felled and Left in Place

The single tree selection method was conducted in 2008 where cedar trees were hand felled around dominant canopy oaks with clearings not exceeding two times the height of the selected tree. The exception to this treatment versus those described was that the cedar logs were removed; however, cedar tops and limbs were left in place. This area has been burned once since treatment. An influx of hardwoods, including several oak species (between 26% and 50%), have since obtained stand dominance in this patch opening (Figure 10C).

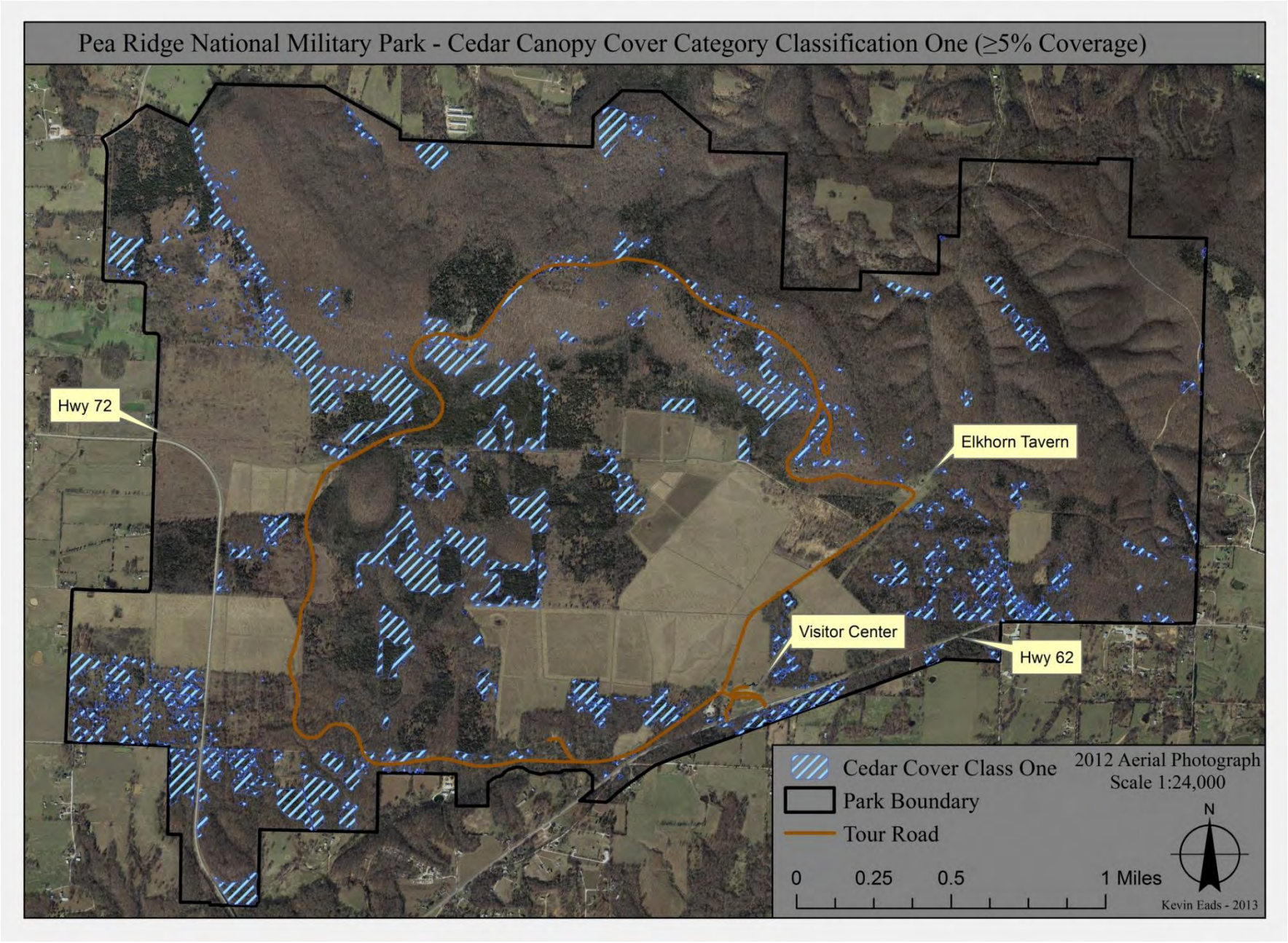
Figure 10C: Single Tree Selection Method 5 Years Post Treatment

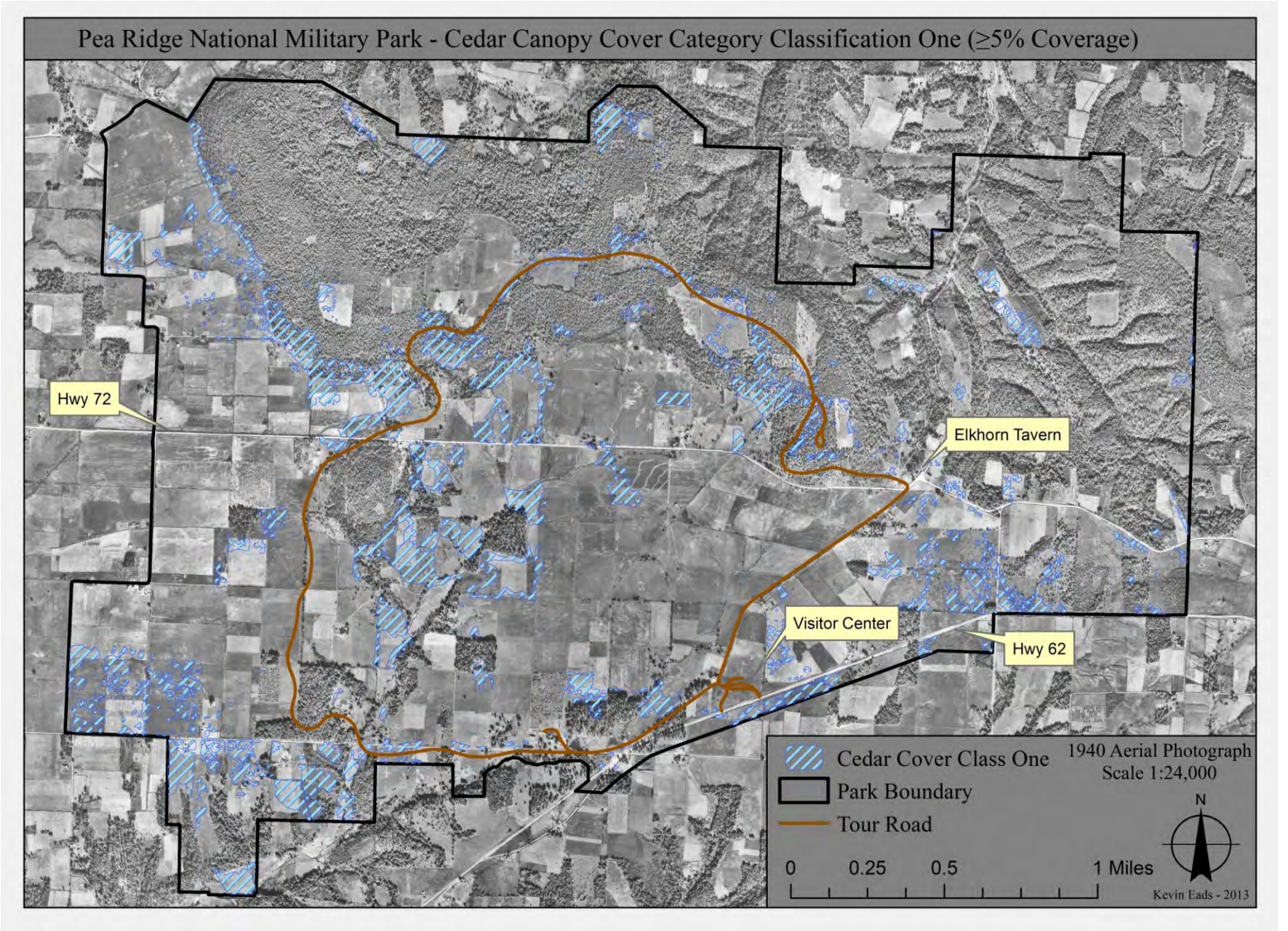
Small areas of dense cedar were mechanically thinned and then mulched in 2011 (Figure 11C). The mulch was spread evenly over the treatment site and then, in 2013, assessed for oak regeneration. Sites averaged 1,547.2 oak seedlings by area (Bolin 2013).

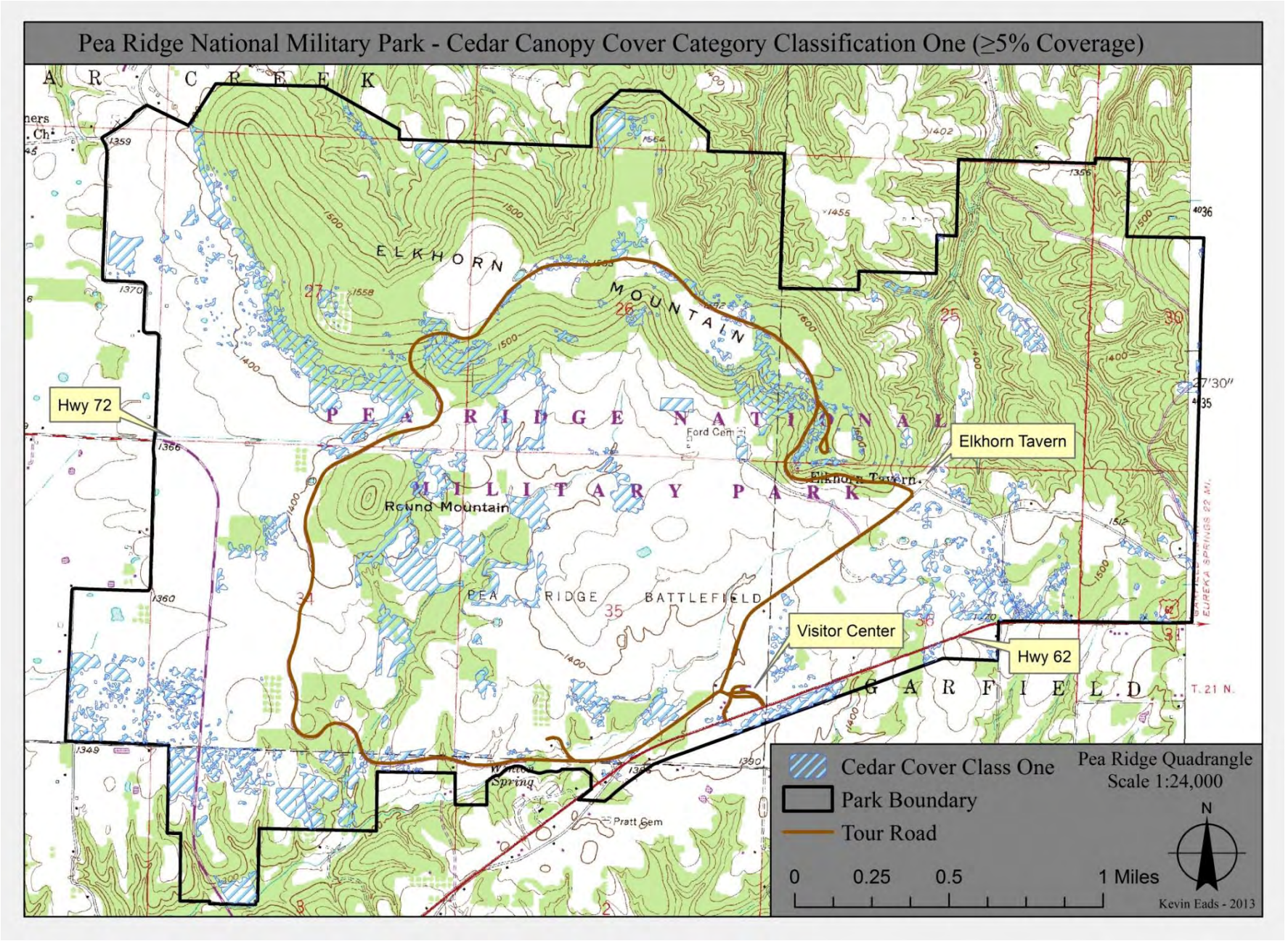
Figure 11C: Dense Stands of Cedar Mechanically Treated 2 Years Post Treatment

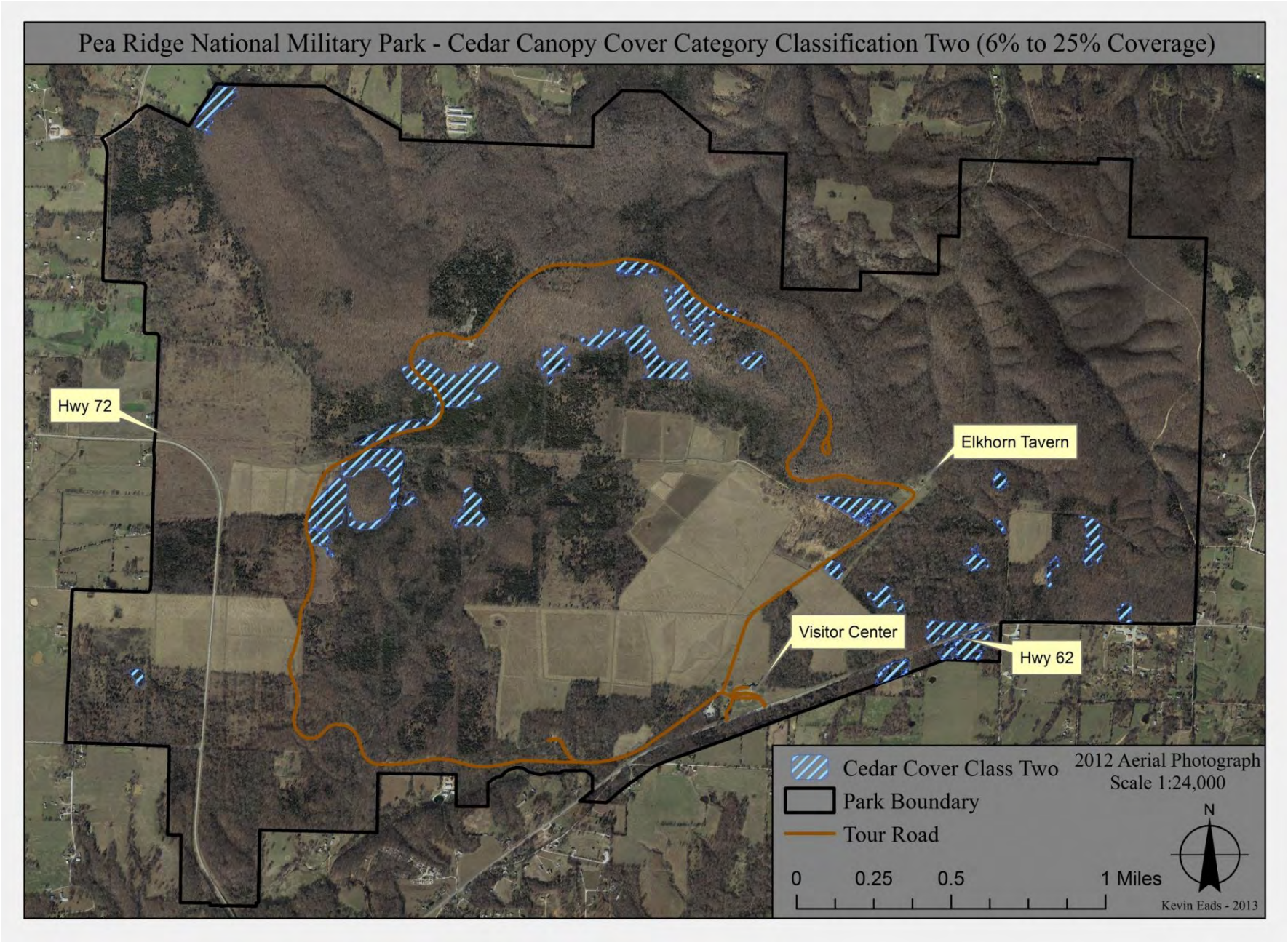
*note: Cedar mulch and lack of undesirable shade tolerant and exotic species.

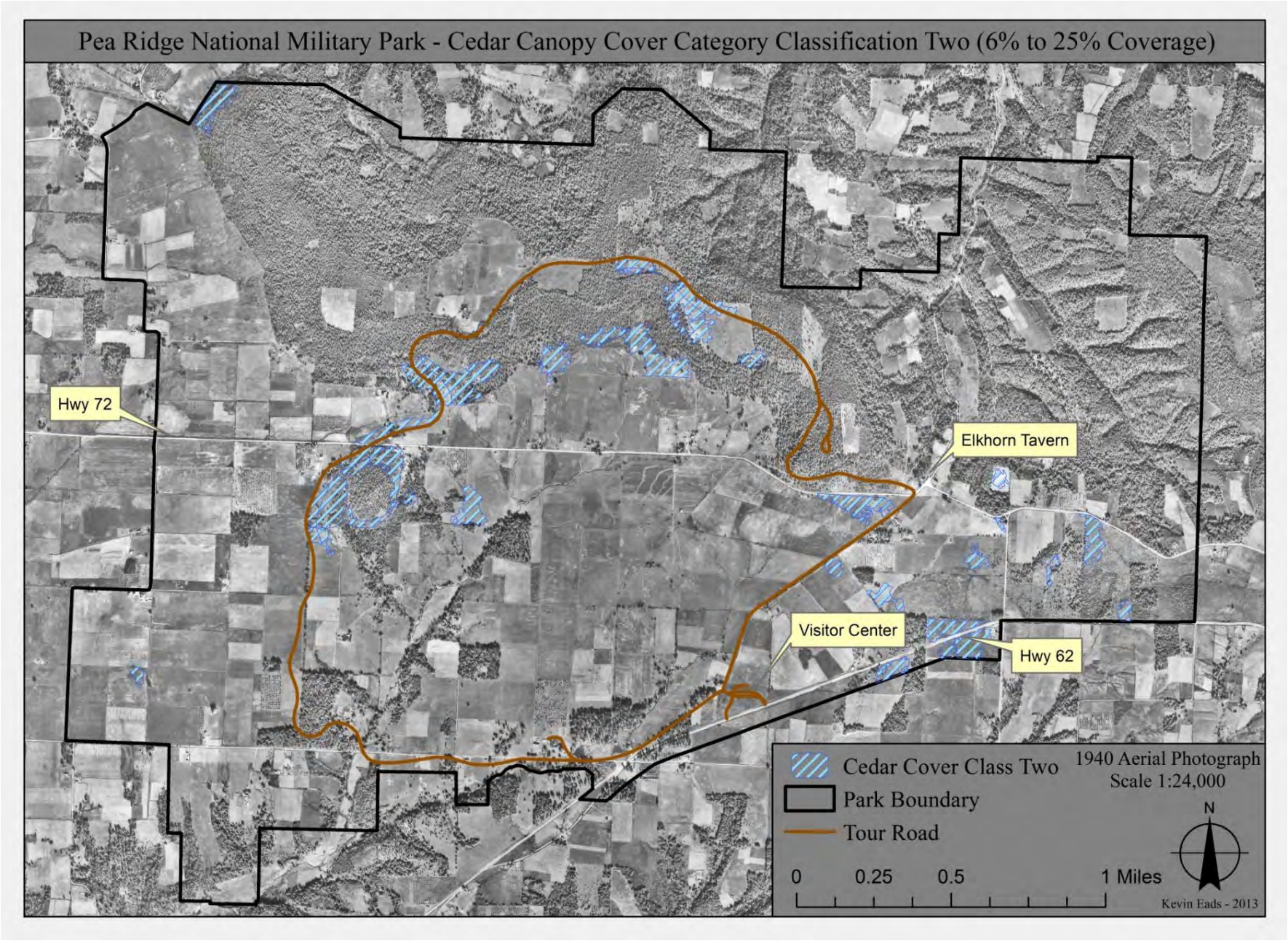
Additional figures (Figures12C-29C) of each cedar classification overlaid on 2012, 1940 aerial photographs, and a Quadrangle (Pea Ridge Quadrangle 1:20,000) are provided to show cedar location over time and elevation/slope. For example, the vast majority of cedar occurrence on the park in 2012 is in areas that were under agricultural use in 1940 located on level plains and rolling hills.

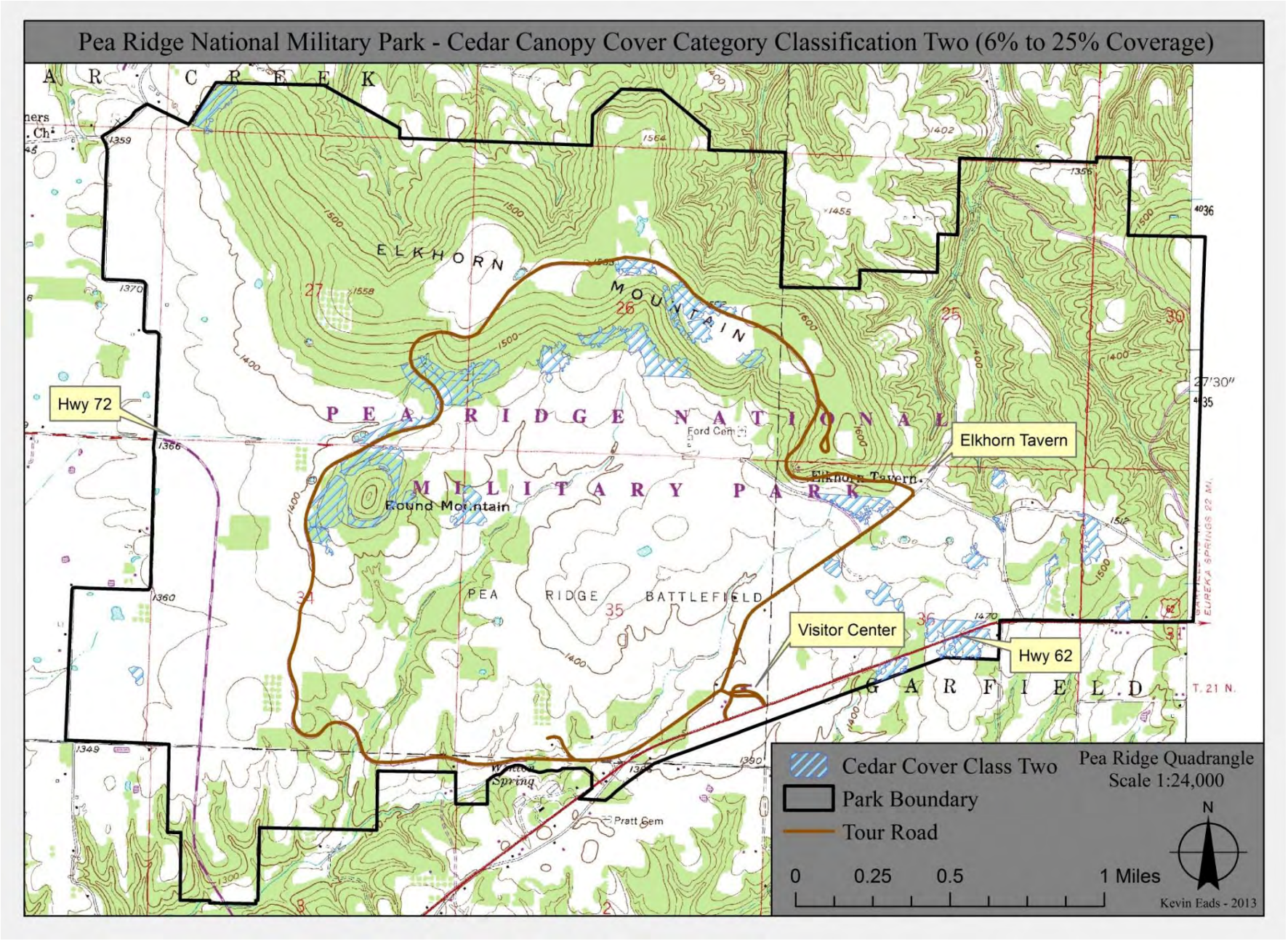

Pea Ridge National Military Park - Cedar Canopy Cover Category Classification One (≥5% Coverage)
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Cedar Cover Class One
Park Boundary
Tour Road
2012 Aerial Photograph
Scale 1:24,000
N
0
0.25
0.5
1 Miles
Kevin Eads - 2013

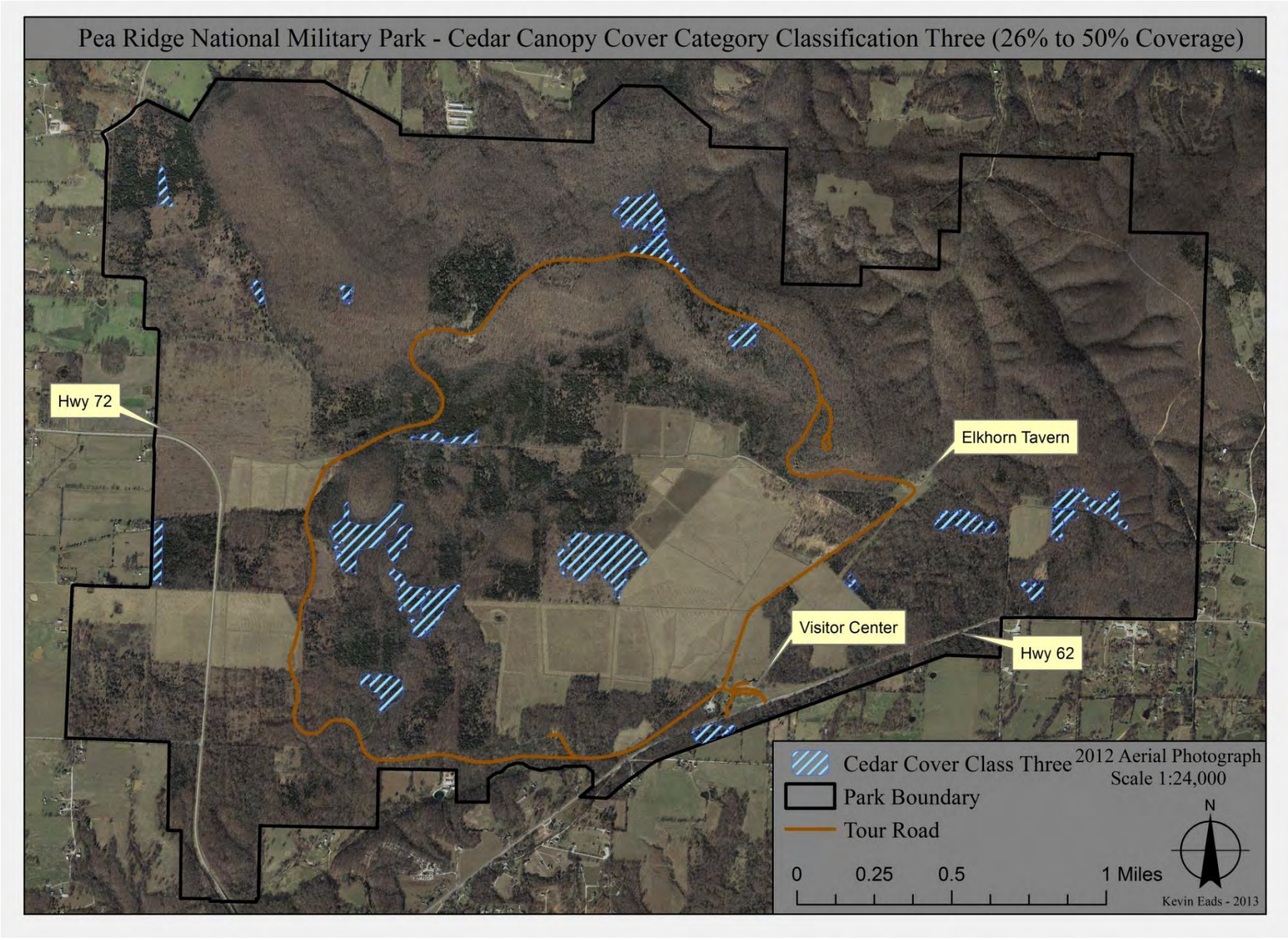

Pea Ridge National Military Park - Cedar Canopy Cover Category Classification One (≥5% Coverage)
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Cedar Cover Class One
Park Boundary
Tour Road
1940 Aerial Photograph
Scale 1:24,000
N
0
0.25
0.5
1 Miles
Kevin Eads - 2013

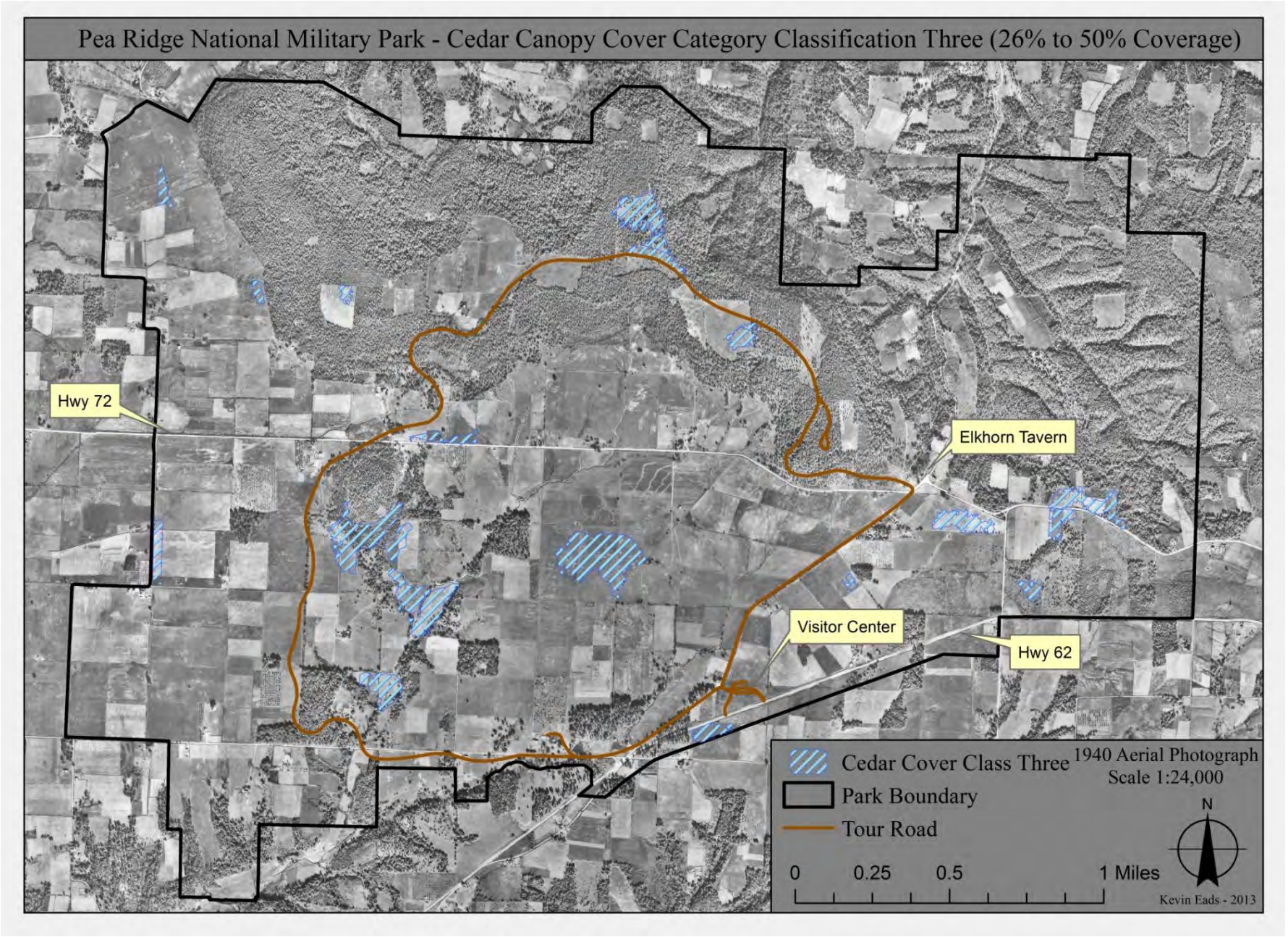

Pea Ridge National Military Park - Cedar Canopy Cover Category Classification One (≥5% Coverage)
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Round Mountain
ELKHORN MOUNTAIN
PEA RIDGE NATIONAL MILITARY PARK
PEA RIDGE BATTLEFIELD
GARFIELD
Cedar Cover Class One
Park Boundary
Tour Road
Pea Ridge Quadrangle
Scale 1:24,000
0 0.25 0.5 1 Miles
N
Kevin Eads - 2013

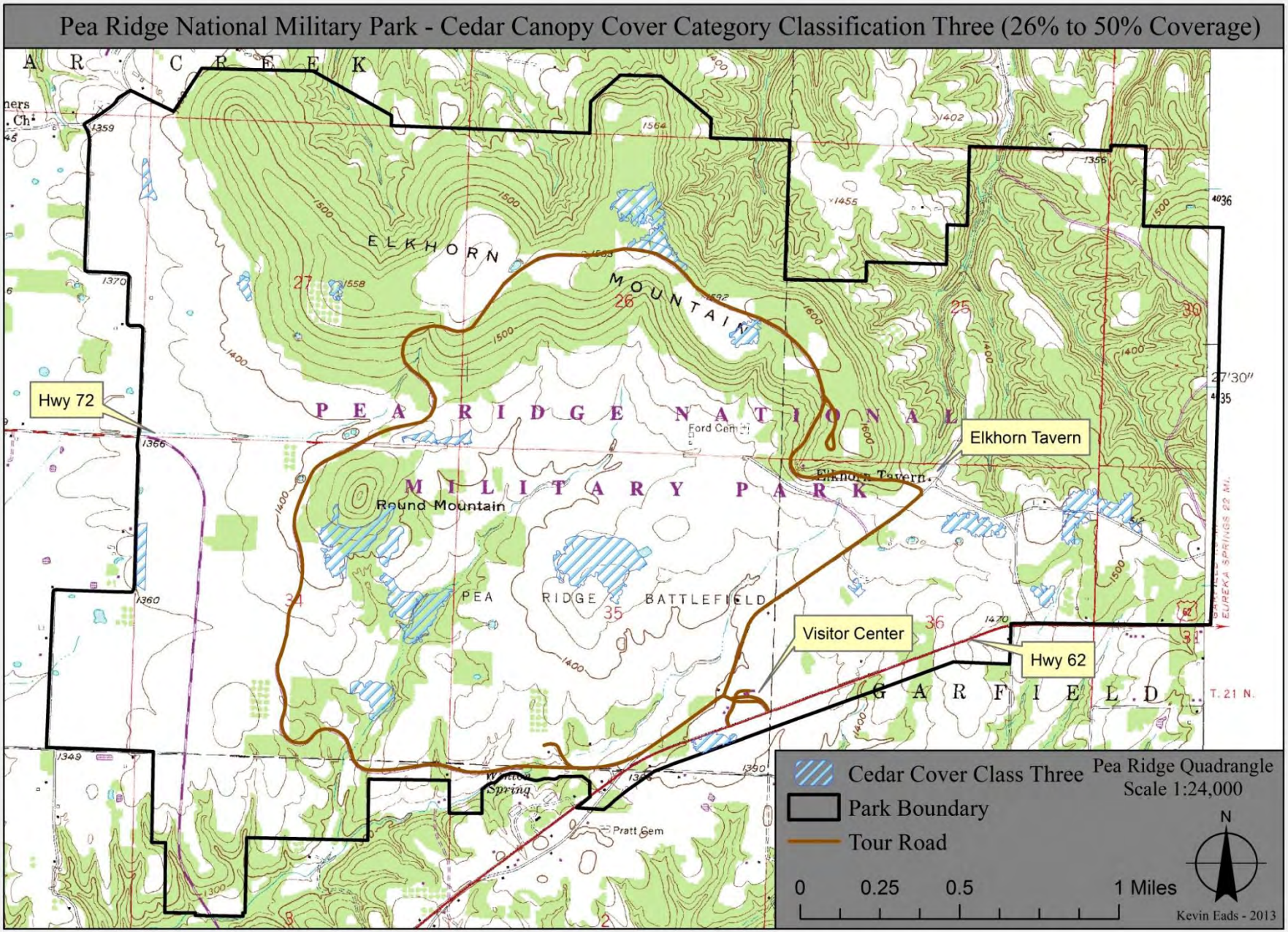

Pea Ridge National Military Park - Cedar Canopy Cover Category Classification Two (6% to 25% Coverage)
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Cedar Cover Class Two
Park Boundary
Tour Road
2012 Aerial Photograph
Scale 1:24,000
N
0
0.25
0.5
1 Miles
Kevin Eads - 2013


Pea Ridge National Military Park - Cedar Canopy Cover Category Classification Two (6% to 25% Coverage)
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Cedar Cover Class Two
Park Boundary
Tour Road
1940 Aerial Photograph
Scale 1:24,000
N
0
0.25
0.5
1 Miles
Kevin Eads - 2013


Pea Ridge National Military Park - Cedar Canopy Cover Category Classification Two (6% to 25% Coverage)
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Cedar Cover Class Two
Park Boundary
Tour Road
Pea Ridge Quadrangle
Scale 1:24,000
0 0.25 0.5 1 Miles
N
Kevin Eads - 2013


Pea Ridge National Military Park - Cedar Canopy Cover Category Classification Three (26% to 50% Coverage)
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Cedar Cover Class Three
Park Boundary
Tour Road
2012 Aerial Photograph
Scale 1:24,000
N
0
0.25
0.5
1 Miles
Kevin Eads - 2013


Pea Ridge National Military Park - Cedar Canopy Cover Category Classification Three (26% to 50% Coverage)
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Cedar Cover Class Three
Park Boundary
Tour Road
1940 Aerial Photograph
Scale 1:24,000
N
0
0.25
0.5
1 Miles
Kevin Eads - 2013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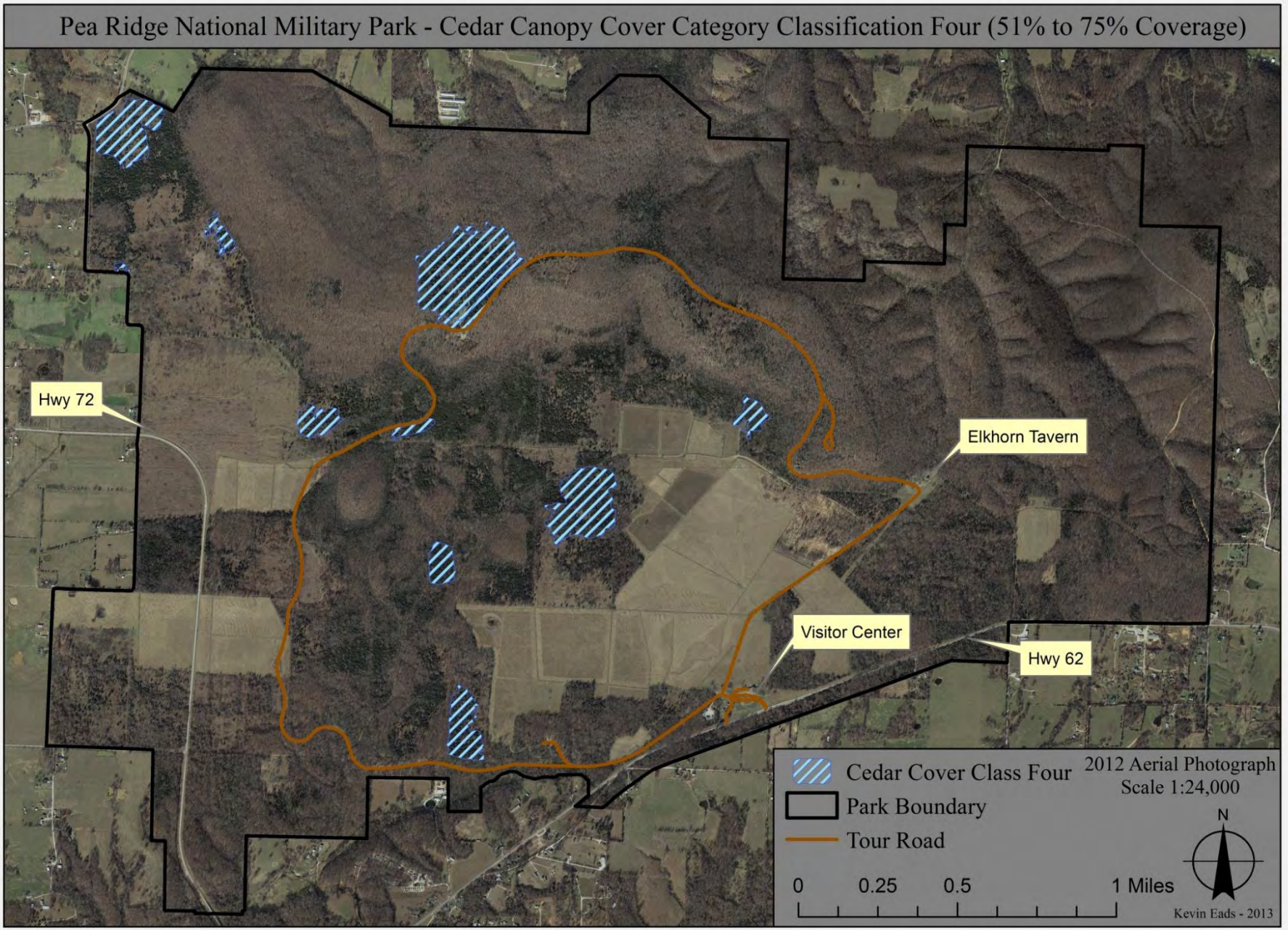
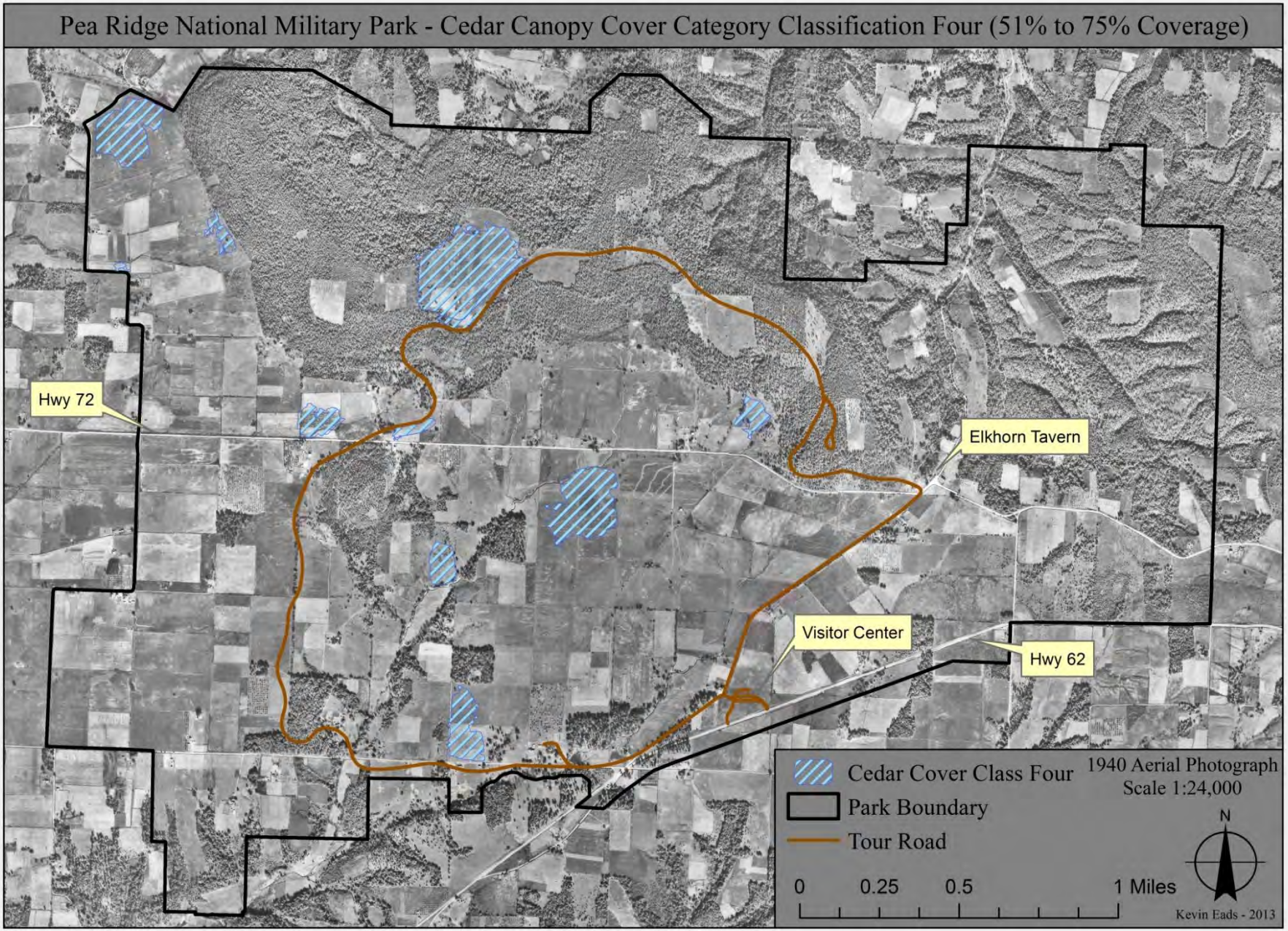
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
ELKHORN MOUNTAIN
PEA RIDGE NATIONAL MILITARY PARK
Round Mountain
PEA RIDGE BATTLEFIELD
GARFIELD
Cedar Cover Class Three
Park Boundary
Tour Road
Pea Ridge Quadrangle
Scale 1:24,000
0 0.25 0.5 1 Miles
N
Kevin Eads - 2013


Pea Ridge National Military Park - Cedar Canopy Cover Category Classification Four (51% to 75% Coverage)
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Cedar Cover Class Four
Park Boundary
Tour Road
2012 Aerial Photograph
Scale 1:24,000
N
0
0.25
0.5
1 Miles
Kevin Eads - 2013


Pea Ridge National Military Park - Cedar Canopy Cover Category Classification Four (51% to 75% Coverage)
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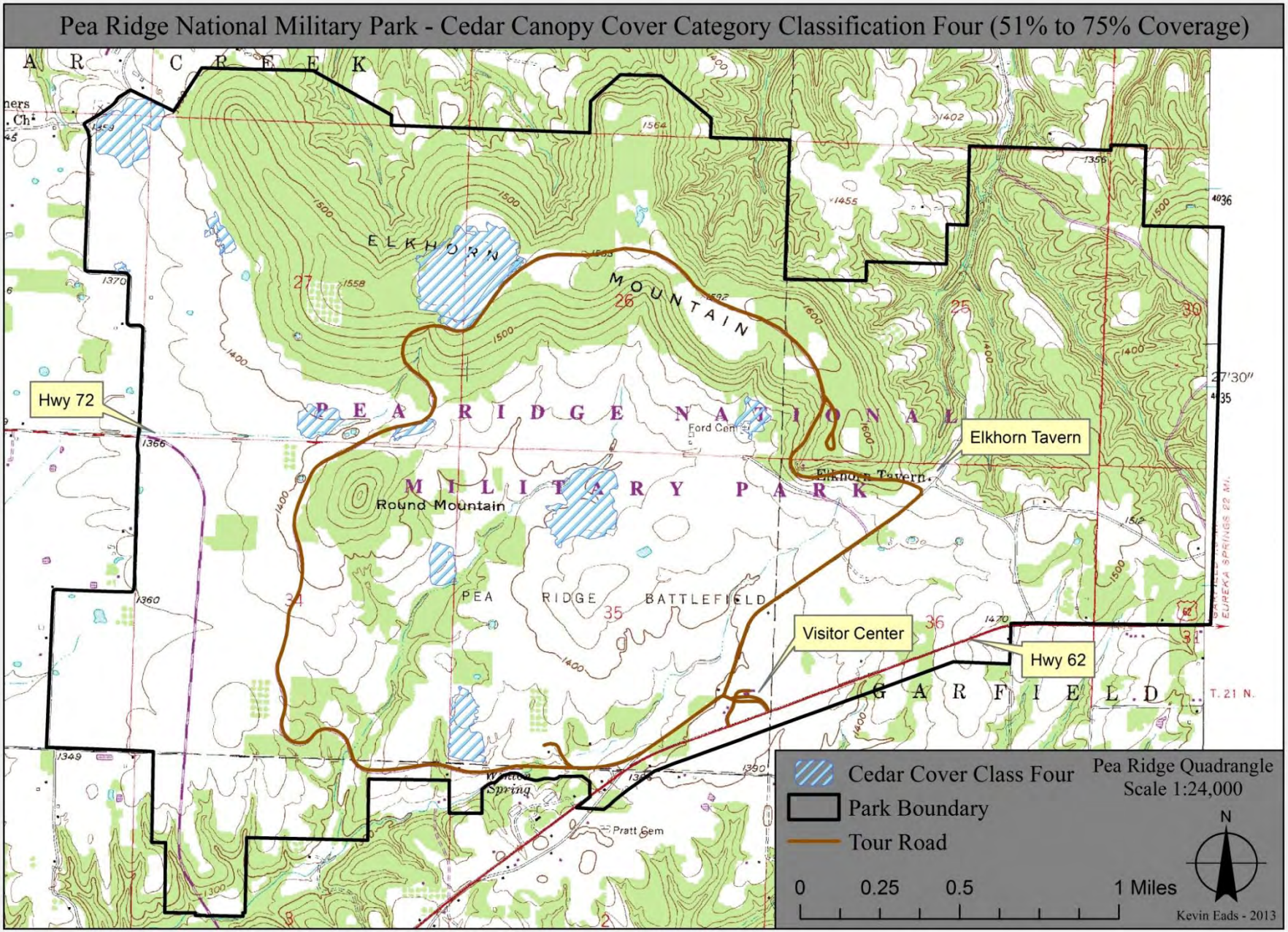
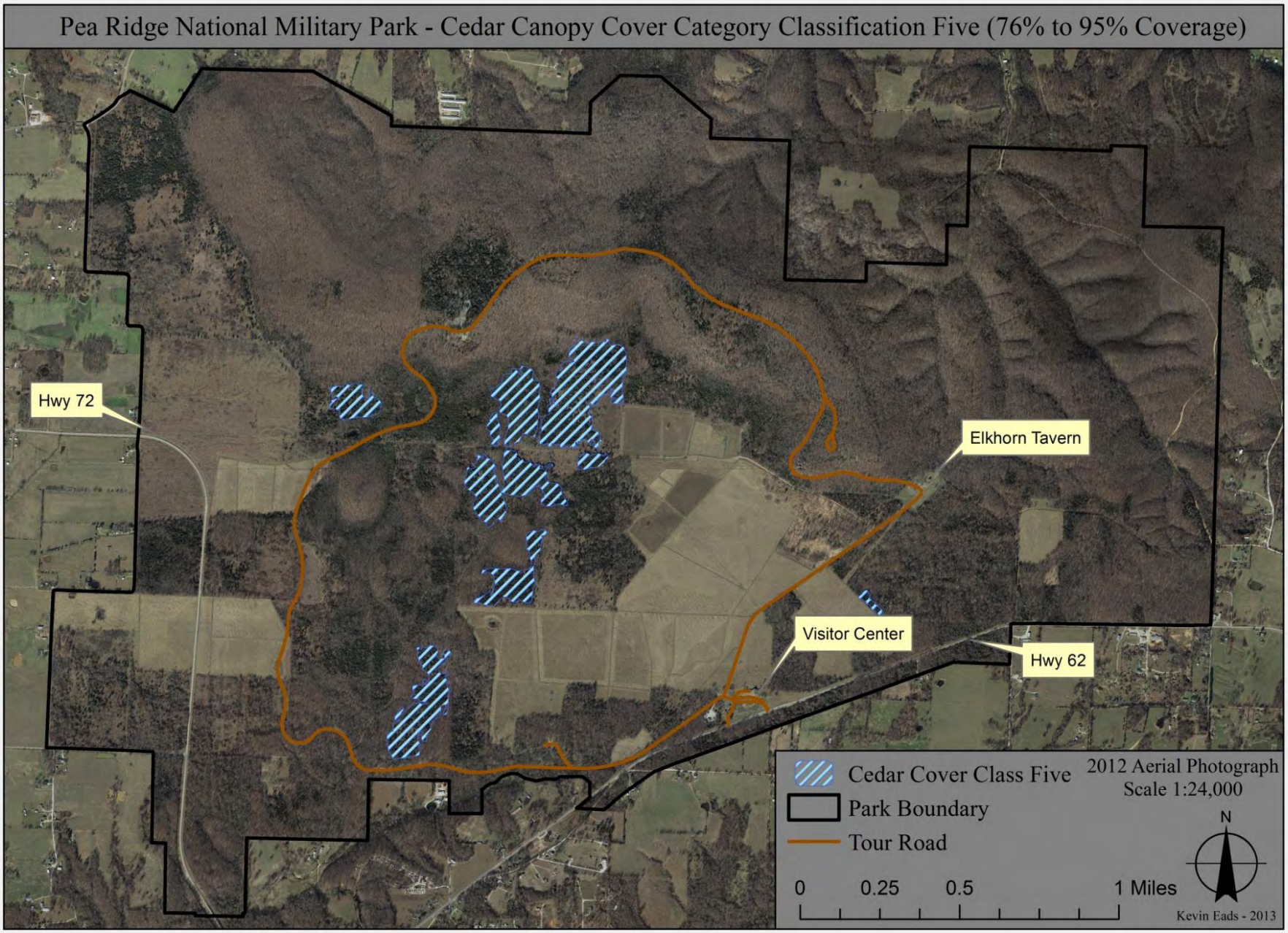
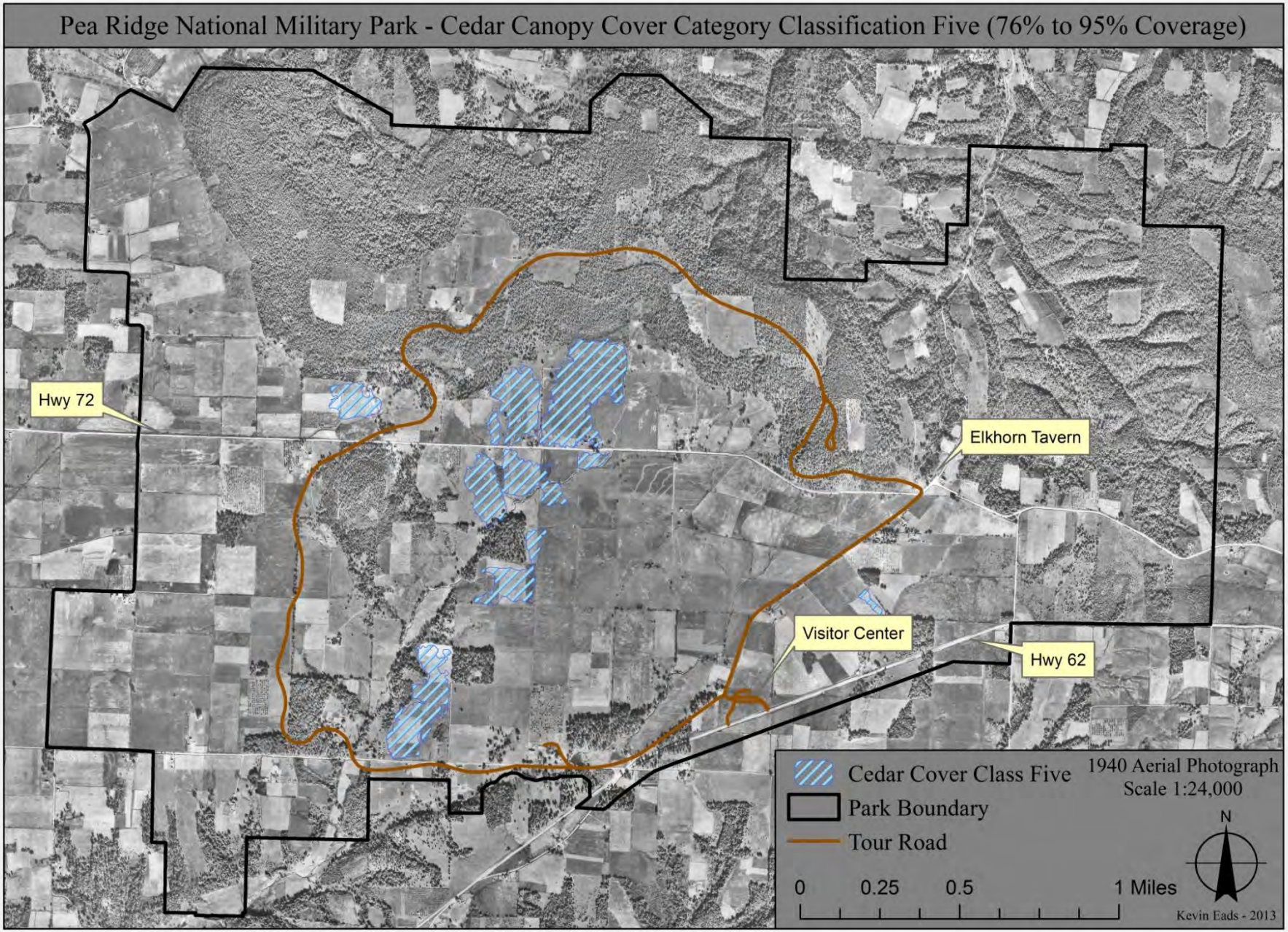
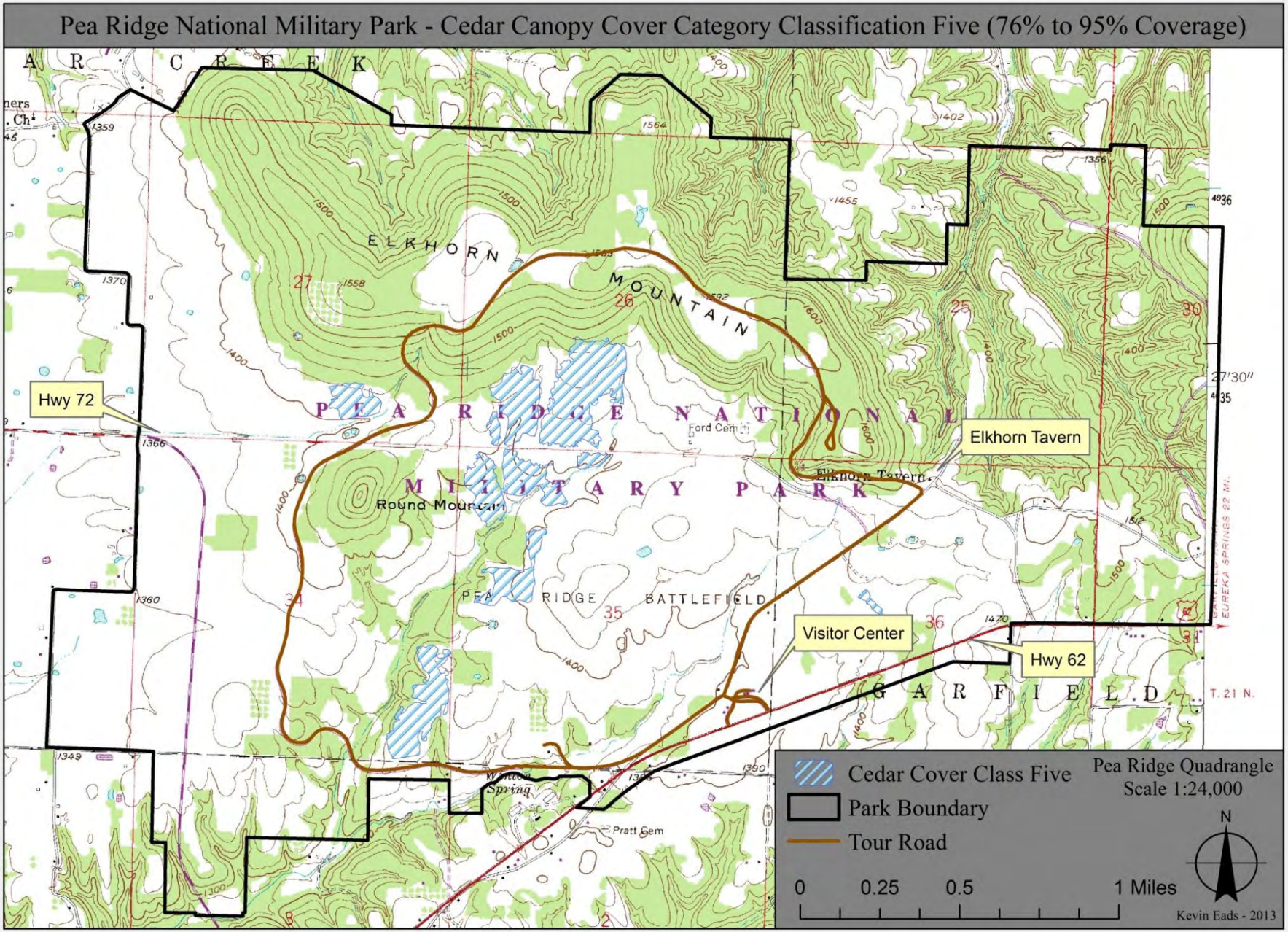
Elkhorn Tavern
Visitor Center
Hwy 62
Cedar Cover Class Four
Park Boundary
Tour Road
1940 Aerial Photograph
Scale 1:24,000
N
0
0.25
0.5
1 Miles
Kevin Eads - 2013


Pea Ridge National Military Park - Cedar Canopy Cover Category Classification Four (51% to 75% Coverage)
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Round Mountain
Cedar Cover Class Four
Park Boundary
Tour Road
Pea Ridge Quadrangle
Scale 1:24,000
0 0.25 0.5 1 Miles
N
Kevin Eads - 2013


Pea Ridge National Military Park - Cedar Canopy Cover Category Classification Five (76% to 95% Coverage)
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Cedar Cover Class Five
Park Boundary
Tour Road
2012 Aerial Photograph
Scale 1:24,000
N
0
0.25
0.5
1 Miles
Kevin Eads - 2013


Pea Ridge National Military Park - Cedar Canopy Cover Category Classification Five (76% to 95% Coverage)
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Cedar Cover Class Five
Park Boundary
Tour Road
1940 Aerial Photograph
Scale 1:24,000
N
0
0.25
0.5
1 Miles
Kevin Eads - 2013


Pea Ridge National Military Park - Cedar Canopy Cover Category Classification Five (76% to 95% Coverage)
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
ELKHORN MOUNTAIN
PEA RIDGE NATIONAL MILITARY PARK
PEA RIDGE BATTLEFIELD
Round Mountain
Ford Cem
Pratt Cem
GARFIELD
T. 21 N.
Cedar Cover Class Five
Park Boundary
Tour Road
Pea Ridge Quadrangle
Scale 1:24,000
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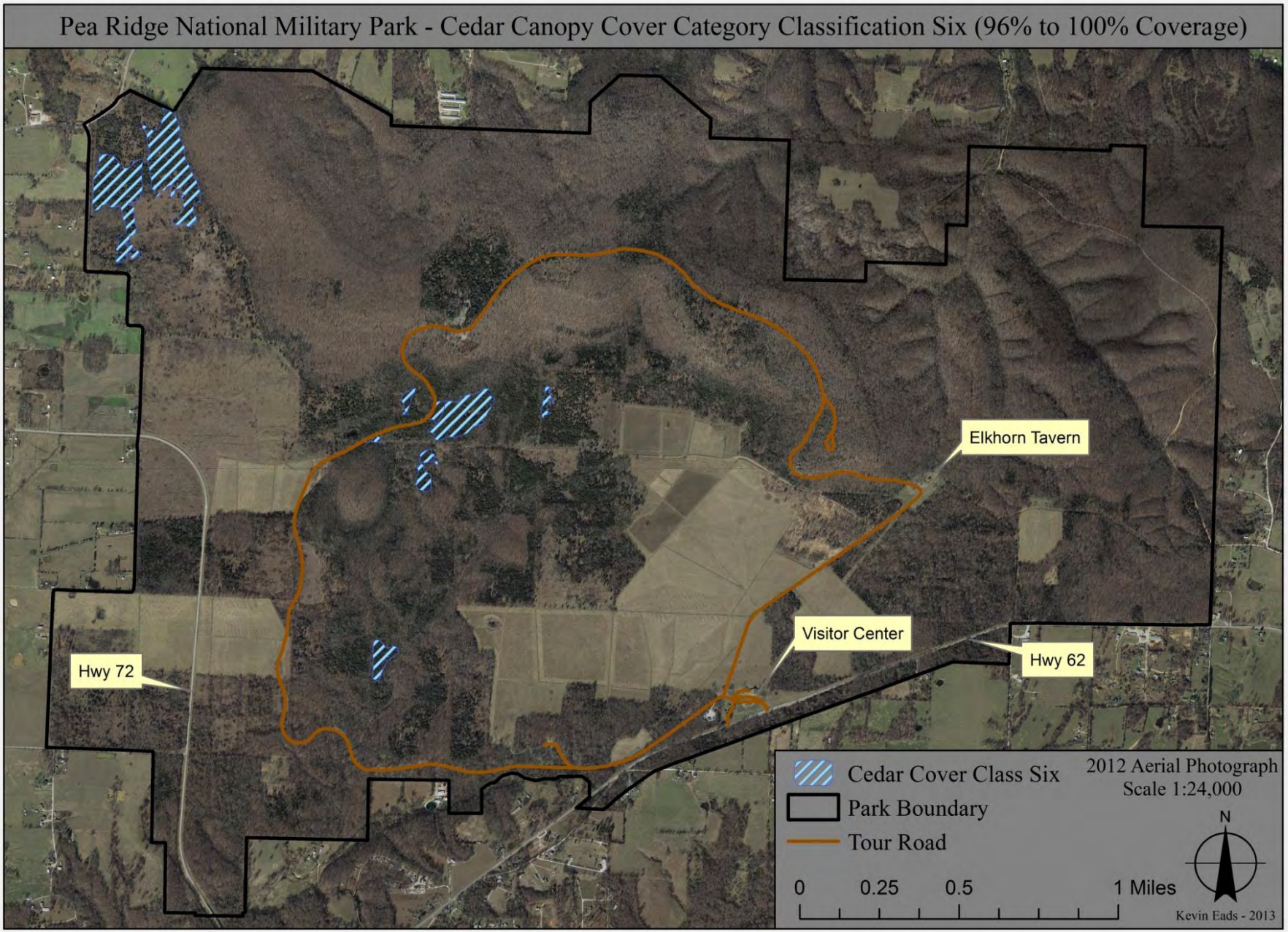
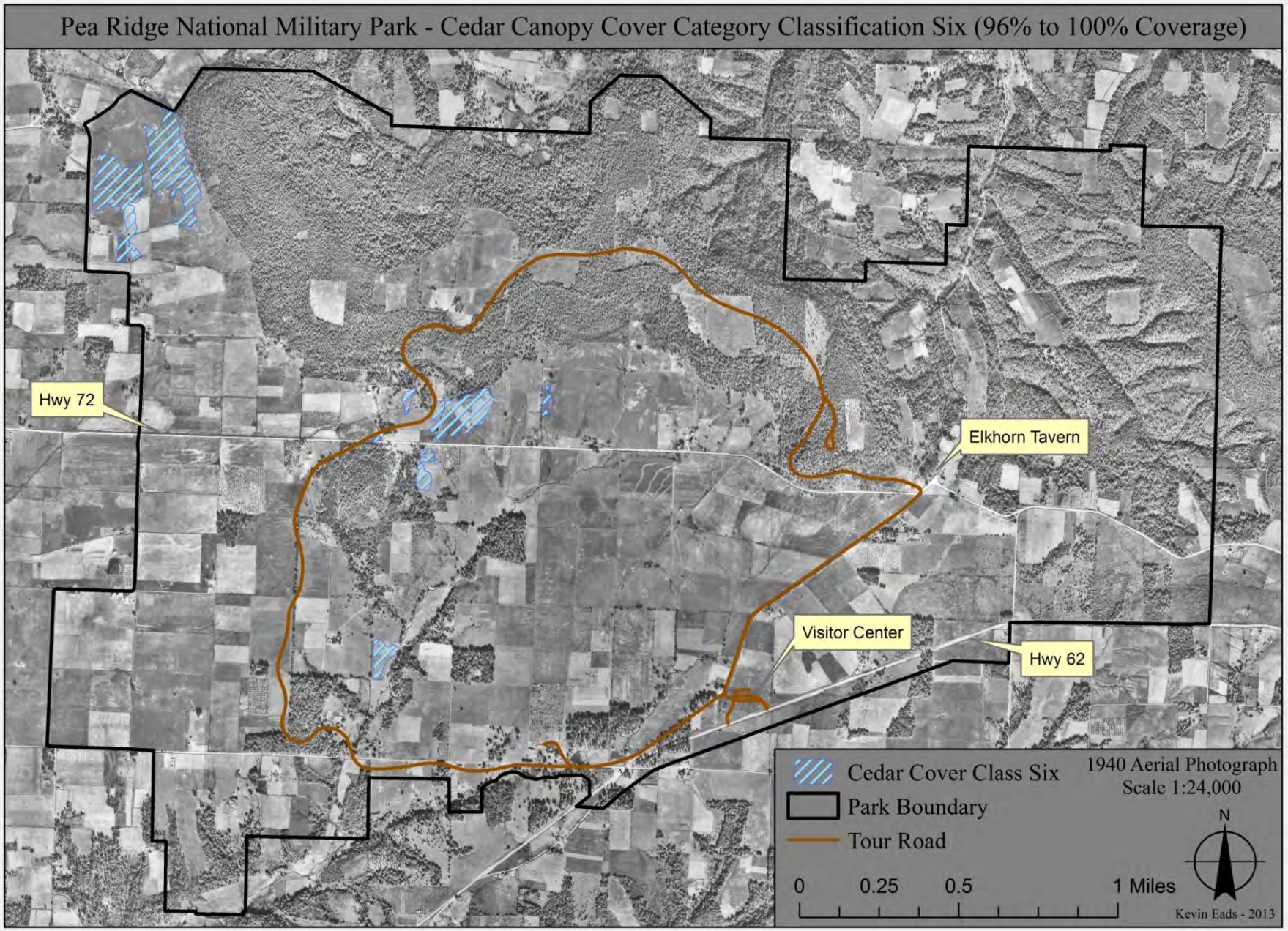
N
Kevin Eads - 2013


Pea Ridge National Military Park - Cedar Canopy Cover Category Classification Six (96% to 100% Coverage)
Elkhorn Tavern
Visitor Center
Hwy 62
Hwy 72
Cedar Cover Class Six
Park Boundary
Tour Road
2012 Aerial Photograph
Scale 1:24,000
N
0
0.25
0.5
1 Miles
Kevin Eads - 2013


Pea Ridge National Military Park - Cedar Canopy Cover Category Classification Six (96% to 100% Coverage)
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Cedar Cover Class Six
Park Boundary
Tour Road
1940 Aerial Photograph
Scale 1:24,000
N
0
0.25
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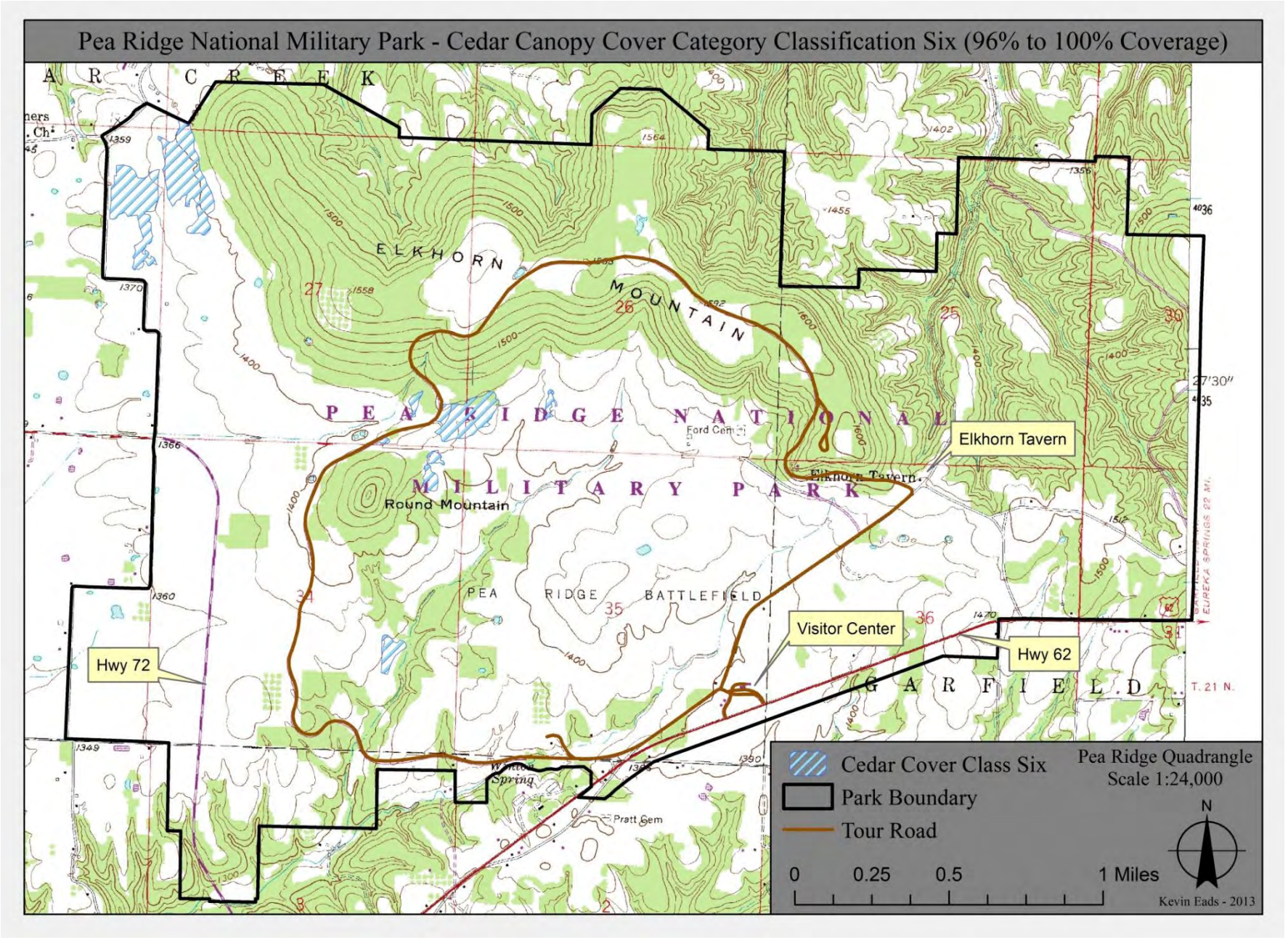
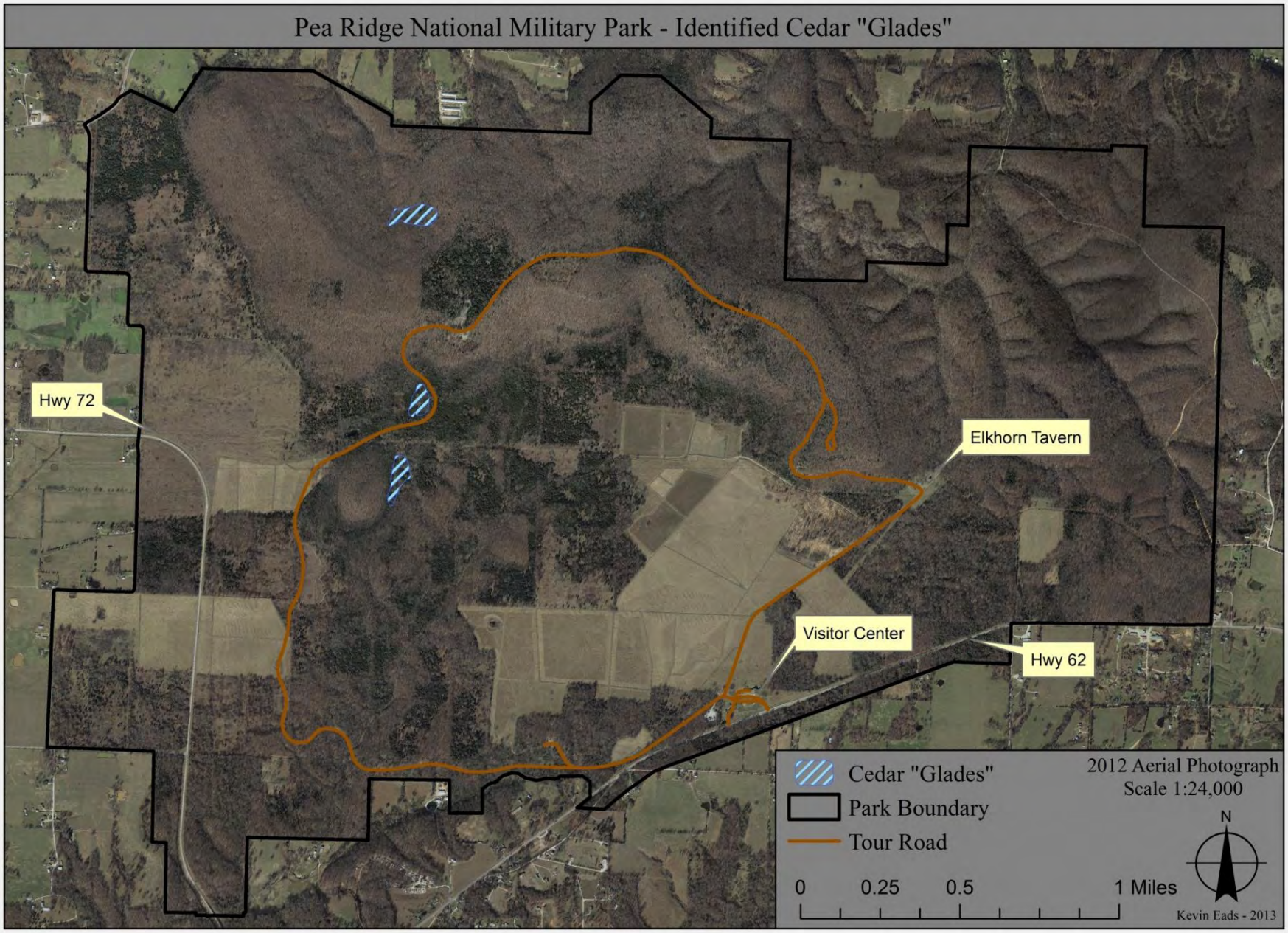
1 Miles
Kevin Eads - 2013

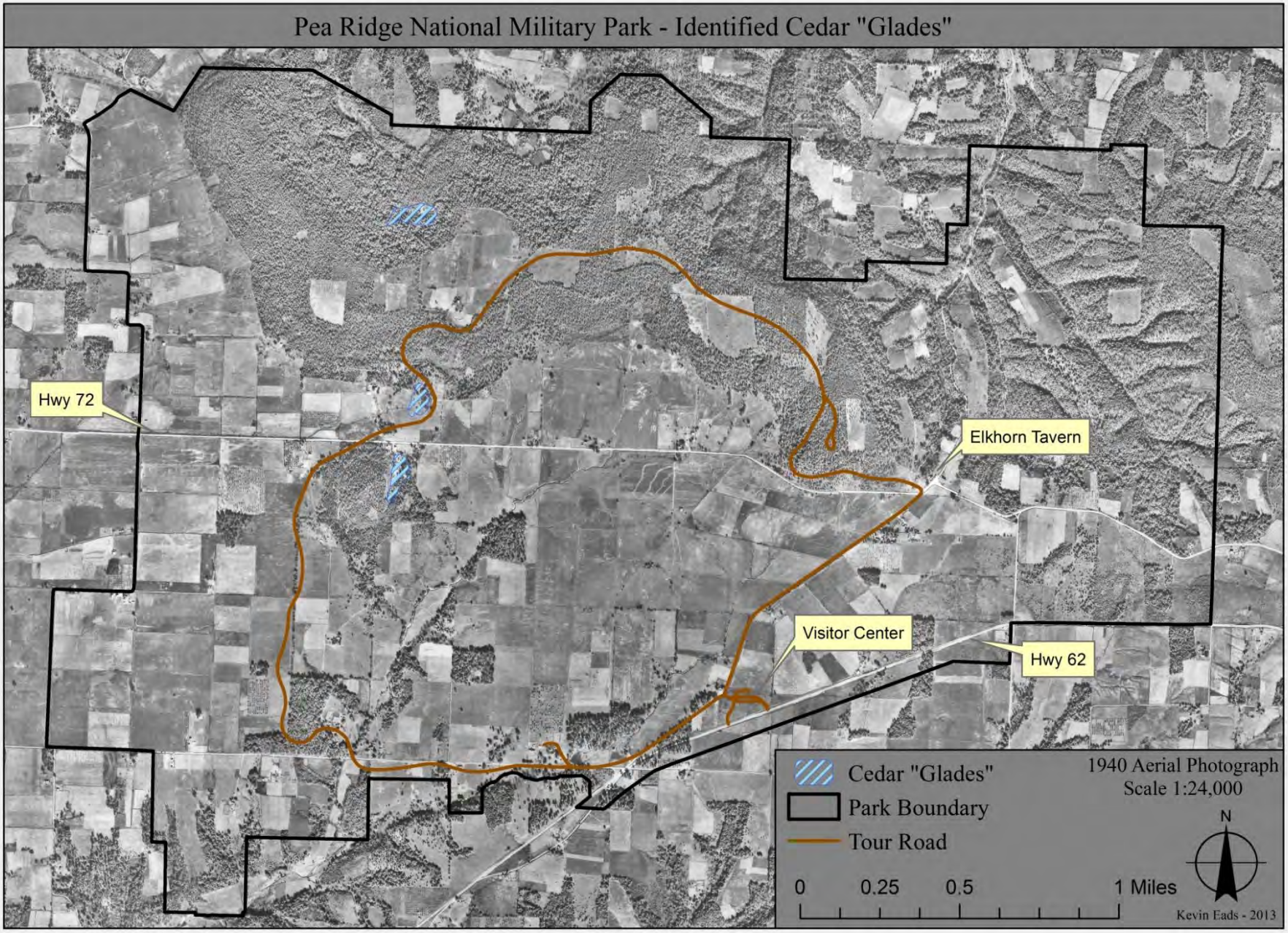

Pea Ridge National Military Park - Cedar Canopy Cover Category Classification Six (96% to 100% Coverage)
A R C R E E K
ELKHORN MOUNTAIN
P E A R I D G E N A T I O N A L
M I L I T A R Y P A R K
Round Mountain
PEA RIDGE BATTLEFIELD
Elkhorn Tavern
Visitor Center
Hwy 72
Hwy 62
G A R F I E L D
T. 21 N.
Cedar Cover Class Six
Park Boundary
Tour Road
Pea Ridge Quadrangle
Scale 1:24,000
0 0.25 0.5 1 Miles
N
Kevin Eads - 2013

Cedar "Glades"

Nelson (2011) defines glades as openings in woodland that range between one-half acre to 1,500 acres, are treeless and occur on bedrock openings that can contain up to 400 vascular plant species. Nelson (1987) further characterizes glades by describing their fringe as having a mosaic of "stunted, often gnarled trees and shrubs." They are often associated with savanna and are typically found on south and west aspects of hillsides (Jenkins et al. 1997, Nelson 1987). Historically, within the Ozarks, there were 6.5 million acres of savanna, most of which occurred on the Springfield Plateau, resulting in a "park-like growth of mixed oak and pine interspersed with a nearly continuous ground cover of deep rooted perennial grasses and forbs" (Nelson 2011). Foti (2004) compared studies that described vegetation in the Missouri Ozarks, and provides several examples from researchers that agree that a large segment of the non-prairie areas consisted of open woodland, or savanna. He further describes, and utilizes a range of trees per acre from previous studies, an estimate of trees per acre for open savanna, <25% canopy cover up to 9.5 trees/acre, and open woodlands, 50%-99% canopy cover consisting of between 19 and 40 trees per acre. Areas as described would have been open with forbes and grasses growing underneath and agree with Nelson (2011). Accordingly, the potential for glades to have existed historically and not been captured through first-hand accounts, as is the case at Wilson's Creek National Battlefield (Gremaud 1986), GLO notes, etc…, exists.

The primary objective of Stephenson's (2012a) study at PERI was to determine if cedar glades were present at the park. He identified two, of eleven potential sites, that possessed features associated with glades in quantities sufficient to warrant protection and management, and one additional site that was "problematic" (Figures 1D – 3D) Average patch size for all three sites is 3.87 acres. The two primary sites are examples of a limited plant community at the park but all three sites contained plants that, although dissimilar with each other, are associated with glades (Table 1D). All areas contained shallow rocky soil and/or exposed areas of bedrock as well as poorly developed soils. Stephenson tempered his findings by stating, "No site in the park appears to represent what might be referred to as a classic cedar glade."


Pea Ridge National Military Park - Identified Cedar "Glades"
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Cedar "Glades"
Park Boundary
Tour Road
2012 Aerial Photograph
Scale 1:24,000
N
0
0.25
0.5
1 Miles
Kevin Eads - 2013


Pea Ridge National Military Park - Identified Cedar "Glades"
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Cedar "Glades"
Park Boundary
Tour Road
1940 Aerial Photograph
Scale 1:24,000
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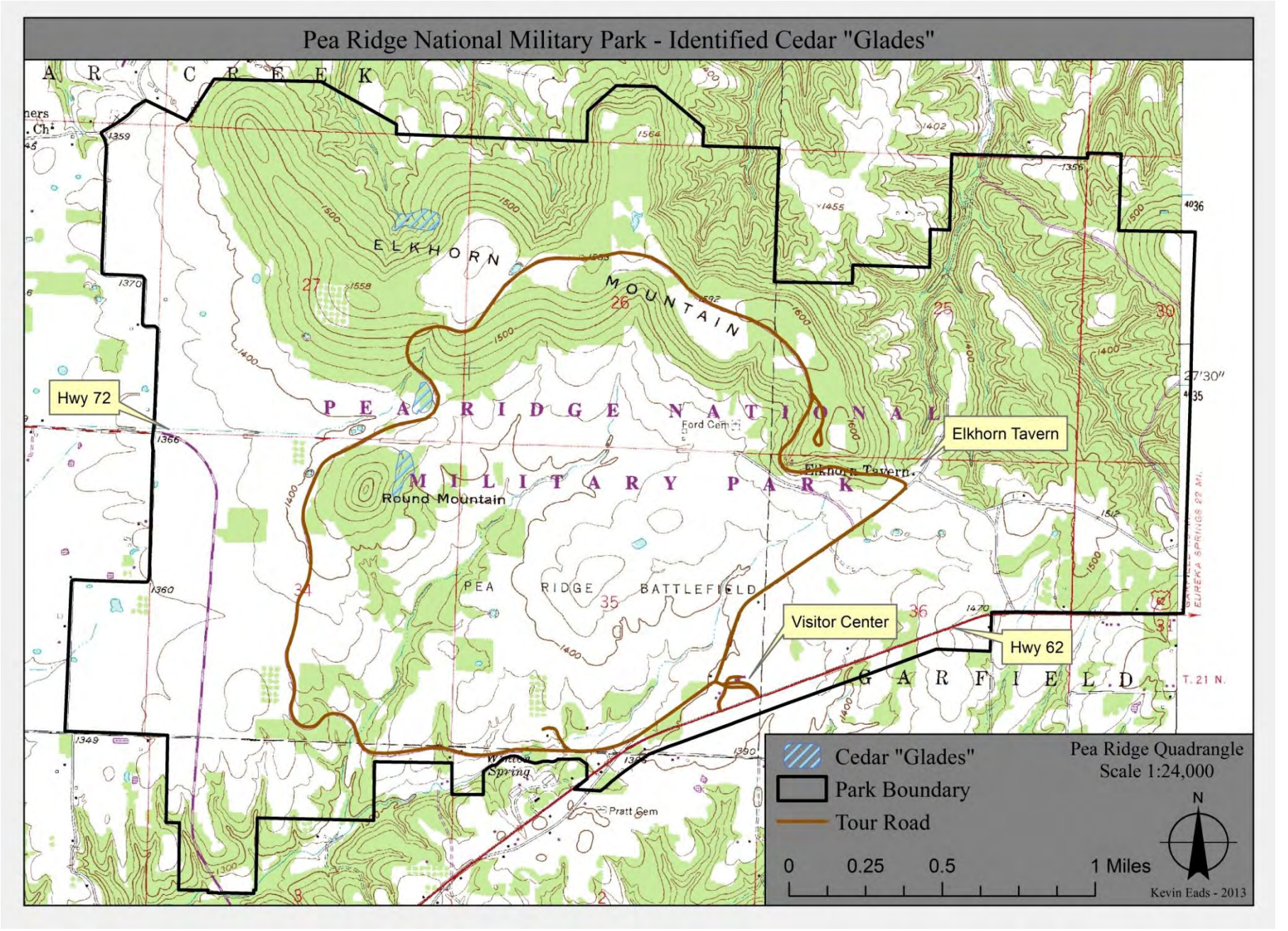
Kevin Eads - 2013


Pea Ridge National Military Park - Identified Cedar "Glades"
Hwy 72
Elkhorn Tavern
Visitor Center
Hwy 62
Round Mountain
ELKHORN MOUNTAIN
PEA RIDGE NATIONAL MILITARY PARK
PEA RIDGE BATTLEFIELD
GARFIELD
Cedar "Glades"
Park Boundary
Tour Road
Pea Ridge Quadrangle
Scale 1:24,000
0 0.25 0.5 1 Miles
N
Kevin Eads - 2013

Site one, 3.81 acres, had a southwest aspect, was a large open area with consistent exposed bedrock, with 20-25 cm dbh cedar trees and small post oaks and blackjack oaks present (Figure 4D). This area also contained prickly pear cactus, some clandestine trash piles, multiflora rose and lespedeza.

Figure 4D – Taken from Stephenson's (2012a) Report - Possible Cedar Glade Site #1

Site Three, located in a depression with a "somewhat sloping to the west" aspect, was 2.94 acres in size and was "generally open with some exposed bedrock adjacent to a cedar forest" and was surrounded by dense cedar stands. This site also contained cactus and lespedeza but also contained great mullein (Figure 5D).

Figure 5D. Taken from Stephenson (2012a) – Possible Cedar Glad Site #3

Another site, 4.86 acres in size, (Site #5) was identified but defined as problematic and excluded from management recommendations (Stephenson 2012a). Nonetheless, he describes it as having a general southwest aspect, made up of several areas each having different locations on a slope with rocks and ledges being present, contained within an oak dominated forest with some specimens being 30 cm dbh and containing several large cedar trees (Figure 6D).

Figure 6D. Taken from Stephenson (2012a) – Possible Cedar Glade Site #5

Table 1D – Taken from Stephenson (2012a) - Plants associated with the three possible cedar glade sites identified in the present study. Sites at which each plant was recorded are given in parentheses after the common name.

Taxonomic name	Common name
Allium spp.	Wild onion (1 and 3)
Calamintha arkansana	Calamint (1)
Dalea purpurea	Purple prairie clover (1)
Delphinium sp.	Larkspur (3)
Desmanthus illinoensis	Illinois bundleflower (1 and 5)
Hedyotis longifolia/*nigricans*	Long-leaved bluet (1)
Hypericum spp.	St. John's-wort (1)
Linum sp.	Flax (1)
Manfreda virginica	False aloe (1 and 5)
Mirabilis albida	White four o'clock plant (1)
Opuntia humifusa	Prickly pear cactus (1 and 3)
Ruellia humilis	Hairy petunia (3)
Scutellaria parvula	Skullcap (5)
Sedum pulchellum	Sedum (1, 3 and 5)
Silphium laciniatum	Compass plant (5)
Talinum sp.	Flame flower (3)
Tragia ramosa	Branched noseburn (1)

USFWS (2009) in a technical recovery plan for Pyne's ground plum discuss the importance of disturbance regimes to maintain cedar glades and that promotion of open areas free of herbaceous and woody vegetation competition is key. Management treatments listed included prescribed fire, bush-hogging, and mechanical and manual removal of woody vegetation as well as chemical treatment of invasive exotic species. A primary goal for managing for the endangered Pyne's ground plum in glades is to apply treatments that extend beyond the immediate area because it increases the potential for germination of dormant seed banks while expanding the cedar glade ecosystem.

Stephenson (2012a) recommended management actions for two of the three identified sites that focus on maintaining "glades" as open areas. However, all three sites will be managed as, combined, they do not exceed 0.3% of the total wooded area in the park, and the "glade" management regimes, based on literature, will augment proposed management techniques in adjacent vegetation types at a landscape scale.

Acreages given for each of the "glades" include the prescribed buffer defined by Stephenson (2012a) and contain cedar. Glades are dominated by herbaceous vegetation but cedar frequently occurs in and around them but is scattered, as are shrubby hardwoods (Amelon 1991). Left unmanaged, cedar, as well as other woody vegetation, encroach in glades thereby decreasing space for herbaceous cover and eventually dominate the canopy decreasing species richness and diversity (Amelon 1991; Jenkins et al. 1997). For example, glades provide valuable habitat for priority birds and xeric-adapted animal species when they are open (Akin 2009). Baskin and Baskin (2003) define glades in the Ozarks as seeming to be "secondary successional plant communities dominated by…prairie grasses" and that without management convert to a cedar or hardwood forest relatively quickly. Amelon (1991) describes a study that documented a 34% decrease in glade openness by cedar in 37 years due to the absence of fire.

Jenkins et al. (1997), as mentioned, associates glades with savanna and describes glades as being essentially treeless. Nelson (2011) references savanna as being park-like with a ground cover of perennial grasses and forbs, and Foti (2004) gives an accepted definition that agreed with Nelson, of savanna characteristics and tree densities. Nelson (2011) identifies the "transitional continuum and breaking points between…. communities in the Ozark Highlands." As such Glades are shown to consist of less than two trees per acre with a basal area of less than 10 ft^2, and less than 10% understory and overstory canopy cover with the dominant tree being shrubs. Savannah, is described as consisting of less than 5 trees per acre with a basal area of less than 30 ft^2, an upper canopy percent coverage consisting of between 10% and 30%, and an understory percent coverage being sparse at a range between 5% and 10% and the dominant trees as being ….White Oak.

Amelon (1991), in a study on the effects of fire on productivity and nutrient recycling, removed all cedar greater than 6 cm, felling in place, within glade study site(s), let the cedar slash dry for 1.5 years and then burned the area. One site was burned using a backing fire while a head fire was utilized in another. The mechanical reduction of cedar resulted in a 50% to 70% increase in grass productivity across sites studied. The head fire promoted grasses, an additional increase of 260%, while the backing fire promoted forbs,

which increased by 500%. Species richness increased 30%-40% initially and was 40%-50% greater than control areas three years post treatment. Hand felling favored family Asteraceae species while burning encouraged species of the family Fabaceae. However, burned areas, two to three years post treatment, favored the Asteraceae family. In addition, it was found that the cedar slash increased soil moisture and reduced soil temperatures promoting grasses prior to burn treatments. Finally, neither treatment was found to be adverse to hydrology, water quality, and water yield and did not accelerate erosion demonstrating that they have "positive effects on glade ecosystems" (Amelon 1991).

Akin (2009) states that glade quality improves through prescribed fire and the reduction of woody species. Their goal for the restoration of dolomite glades was to "increase habitat quality, patch size, and connectivity of habitats thereby providing foraging and breeding habitat and facilitating metapopulation dynamics." Management techniques specifically included the creation of openings in woodlands and forests through the mechanical removal of 60%-90% of cedar canopy coverage and by reducing shrub and midstory cover by 40%-60%. Fire was then be used to maintain glades post mechanical thinning. The Missouri Department of Conservation (no date) in a publication on Glade Management at Roaring River State Park states that manual removal of cedar is necessary before fire can be effective.

Stephenson (2012a) recommended, in addition to the buffer areas, that the park leave the cedar forest immediately adjacent to identified "glades" contained within the buffer, remove individuals of cedar and other trees from the open areas, and remove coarse woody debris from within them to achieve an overall goal of preservation and promotion of a glade community within the park. Subsequently, all of these recommendations, save one, will be fully implemented. The recommendation to remove coarse woody debris from within the glade openings seems at odds with the findings of Amelon (1991) in that the debris promotes grasses through shading, which encourages water retention and stabilizes soil temperature. Hence, it will not be manually removed but may be consumed during future prescribed burns.

Specifically, a combination of Akin (2009) and Amelon (1991) will be used to achieve Stephenson's (2012a) recommendations. Management of cedar, along the periphery of the identified "glade" sites, is identified within in this appendix, and will augment "glade" restoration and sustainability.

Consequently, "glades" will be managed by removing all woody growth within the open areas, and reducing cedar canopy coverage, by felling in place, 90% of all cedar 2.5" dbh and greater, and 60% of all cedar less than 2.5" dbh, within the buffered areas. Hardwoods will be managed within buffered areas such that the definition of Foti's (2004) savannah and Nelson's (2011) glade is met. The least obtrusive most conservative hardwood management technique will be utilized and will be dependent upon site specific conditions in that no more than two hardwood trees per acre, or a basal area of no more than 10 ft^2 , or no more than 25% hardwood canopy coverage are present. Hence, trees will be felled and, if diameters are adequate (10" to 18" dbh), will be split for worm

rail fencing. Otherwise, they will be felled in place and removed/reduced through prescribed burns. If hardwoods are present that are greater than 18" dbh and/or are historic, suspected as being present circa 1860, they will be left in place, cored to verify age, and all woody debris will be removed from around them. If hardwoods are found to be "historic" (circa 1860) then management regimes specified for historic trees, within this appendix, will be followed.

Historic Woodlands and Forest Management
(Savanna, Dry-Open Woodland, Dry-Mesic Woodland, Dry-Mesic Forest, Bottomland)

Ranges of basal area, trees per acre and canopy cover have been given through various studies, two of which were identified earlier (Nelson 2011 and Foti 2004) for historic vegetative types. These studies in conjunction with GLO notes can be used to clarify species composition and structure specificity by location as it existed in 1836 and 1837. However, due to various uncontrollable factors such as climatic change, budget and personnel restrictions and logistical constraints, strict adherence to, and implementation of management objectives for, vegetative composition and structure that existed in 1862 is not always feasible or practicable. However, significant development and management of these vegetative types, towards the goal of restoring the circa 1862 vegetative landscape to a great degree, is possible and will re-establish the natural landscape features that define the cultural landscape of the park while managing for the long-term health of those resources. Thus, specific characteristics, where practicable, or objectives by historic landscape classified vegetative types have been established (Table 1E).

Although the desired number of mature trees per acre by vegetative type is given (Table 1E), basal area and percent coverage of the canopy and understory will be the primary datasets used in the implementation of this management regime. These measurements allow for a fluctuation in the number of trees per acre, dependent on diameter, while achieving overall objectives. However, all parameters will be surveyed prior to implementation so that site-specific datasets are derived that will drive management implementation at the plot level of the respective vegetative type. All managed areas will be surveyed pre and immediately post management to ensure objectives are met and then monitored over time so that additional measures, within the scope and guidelines of this document, can be taken (e.g., additional thinning, planting, burning, etc…) to ensure the long-term success of management actions in meeting overall objectives.

As such, all vegetative types will be inventoried, managed, then monitored at the plot level with the overall objective being to achieve specified parameters (Table 1E) at the historic landscape vegetative classification scale. Consequently, proposed management actions are specific at the vegetative classification scale but intensity will vary at the plot level dependent upon extant composition and structure.

The Heartland Network Inventory and Monitoring (I&M) program created a 100-meter grid, located from a random starting point using the NPS AlaskaPak extension in ArcGis. It, and/or a variant of it (e.g., 200 and 400 meter grid), has been used in all studies conducted by I&M at the park. This 100-meter grid will be used to establish, identify, and navigate to plot center locations within all vegetative types. Management actions will take place at the plot level, plots consist of a 50-meter radius, 100-meter diameter. All inventories and subsequent monitoring activities will take place by vegetative type at plot center.

Table 1E: Pea Ridge NMP Historic Landscape Vegetation Classification Implementation Parameters								
Vegetative Type	Dominant Tree Species	Basal Area	Mature Trees/Acre	% Canopy Cover	% Understory Cover	% Ground Layer Cover	Ground Layer Plants	Fire Regime
Savanna	Chinquapin, White, Post and Blackjack Oak	<30	<10	10% - 30%	5%-10% sparse	76%-100%	C4 grasses, sedges, forbs	Moderate intensity fire - 1 to 3 years
Dry-Open Woodland	Post Oak, Blackjack, Black, Chinquapin and White Oak	30-60	10-20	30% - 70%	10%-30% scattered	50%-100%	C3 and C4 grasses, sedges, forbs	Low to moderate intensity fire - 3 to 5 years
Dry-Mesic Woodland	White, Black, Post and Chinquapin Oaks & Hickories	60-80	20-30	70% - 80%	30%-50% patchy	Spring - 50%-100% Mid-summer - 76%-100%	C3 grasses, spring ephermerals, ferns, sedges, summer/fall forbs	Low to moderate intensity fire - 3 to 15 years
Dry-Mesic Forest	Black, White, Northern Red, and Post Oak, Pignut Hickory and Shagbark Hickory	70-80	30-40	>80%	50-100% dense	Spring - 50%-100% Mid-Summer - 0%-50%	spring ephemerals, ferns, summer/fall forbs	Low intensity fires - 3 to 5 years or infrequent fire (>20 years) high to moderate intensity
Bottomland	Black Walnut, American Elm, Red Mulberry, Common Hackberry, Box Elder & Chinquapin Oak	>80	>40	>90%	50-100% dense	Spring - 76%-100% Mid-summer - 0%-50%	spring ephemerals, ferns	Low intensity fires - 3 to 5 years or very infrequent fire (>30 years) high to moderate intensity
Prairie	Shrubs (e.g., Rosaceae, Fabaceae, Hippocastanaceae)	<10	<2	<10%	<10%	76%-100%	C4 grasses, sedges, forbs	Moderate to high intensity fire every 1 to 3 years
Specificity taken and/or derived from Nelson (2011), Foti (2004), Diamond et al. (2013) and GLO (1836, 1837) Notes								

Vegetation management will be conducted by location within the park as it focuses and maximizes limited resources (e.g., personnel, equipment, funding) in a smaller area facilitating the achievement of goals and objectives. Thus, Localities were identified by delineating features such as roads, trails, and creek channels and then prioritized by burn unit (Figure 1E) so that they are easily distinguished and can be maintained by prescribed fire during and post management. Management will occur by locality, and will not proceed to the next locality, until established goals and objectives are implemented. Each locality contains more than one vegetative type and varies by acreage (Figure 2E) but is situated in such a manner that, when managed, will facilitate, through prescribed burns, implementation of goals and objectives in adjacent localities by reducing implementation costs of personnel and equipment.

Proposed management activities, by vegetative type (Savanna, Dry-Open Woodland, Dry-Mesic Woodland, Dry-Mesic Forest, and Bottomland), in each locality are in addition to and separate from those identified for Cedar and Glade vegetative types.

Figure 1E: Pea Ridge National Military Park - Historic Landscape Classification - Localities & Acreages

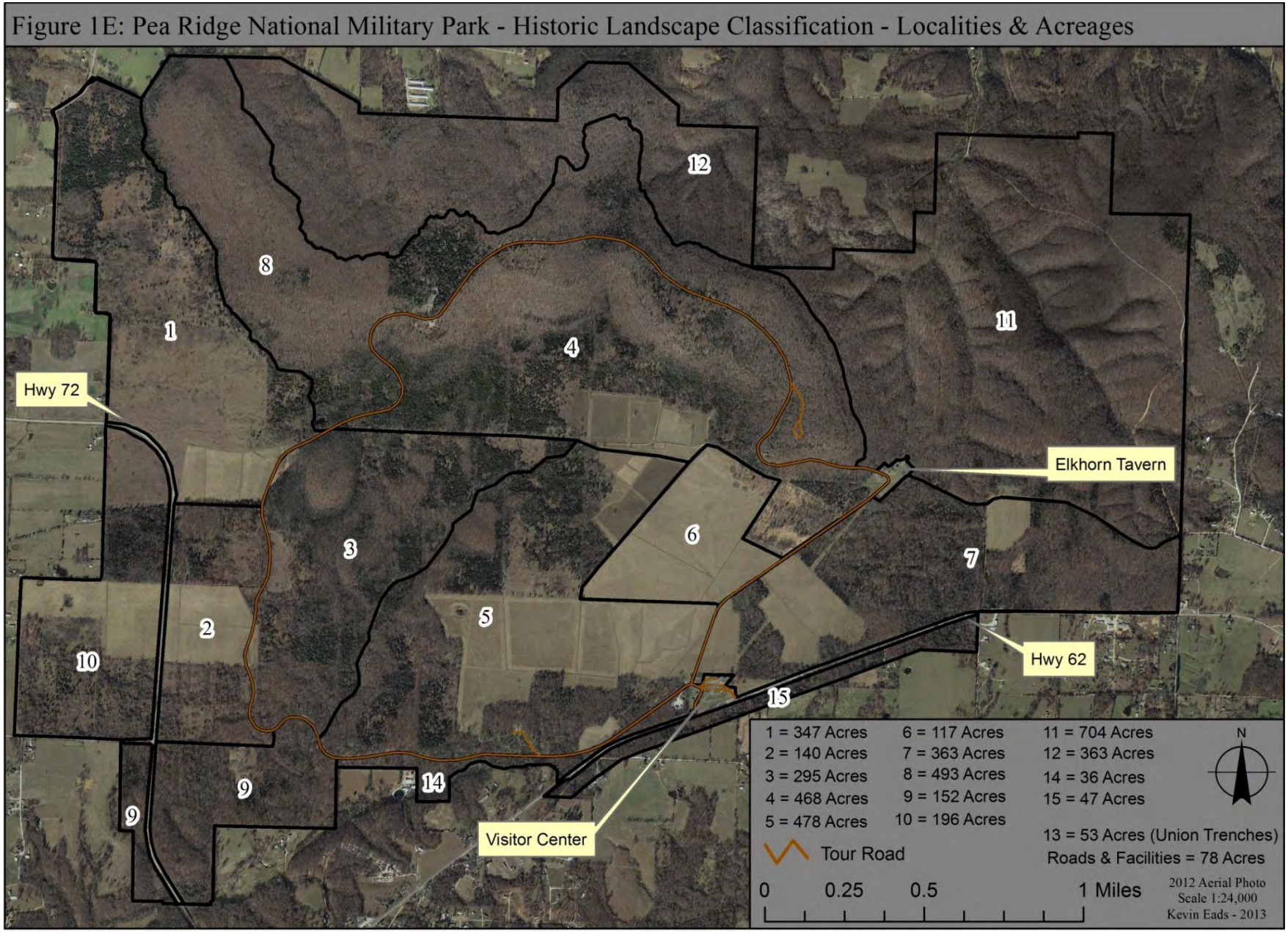
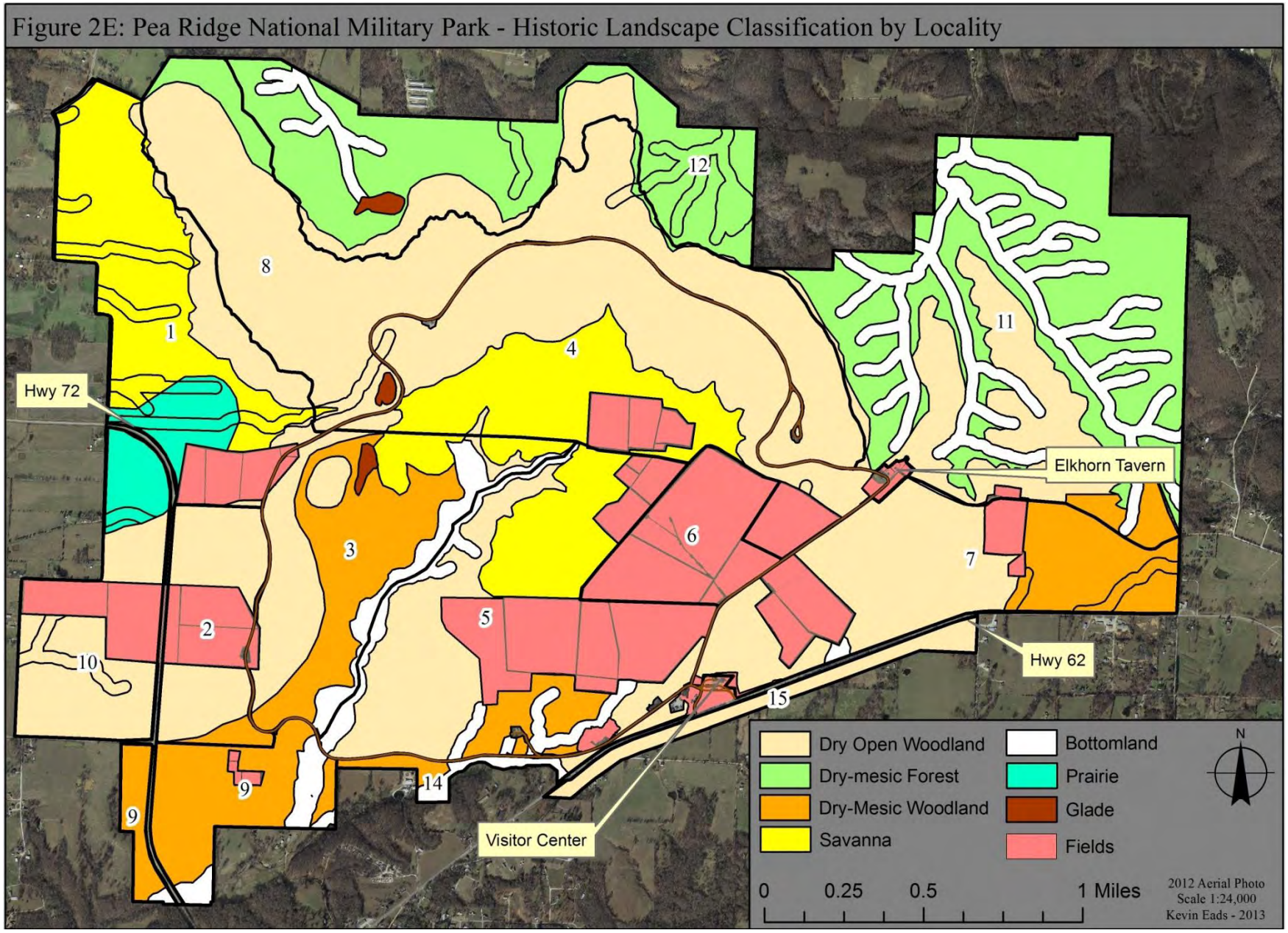


Figure 2E: Pea Ridge National Military Park - Historic Landscape Classification by Locality



Inventory and monitoring of each plot includes documenting tree composition and structure by size class and height, basal area, percent canopy, understory and ground layer cover, woody debris, vertical structure, and pictures, taken at plot center towards each of the cardinal directions. The Daubenmire method (1959) will be used as applicable as will a densitometer, basal area factor 10 prism, DBH tape, vertical board, and associated taxon keys. In addition, a representative sample from each vegetation type of tree species by size class, 6 inch dbh or greater, will be taken to determine cohort age by species. Age will be determined through the coring of trees prior to implementation of recommended management regimes. Monitoring will occur a minim of once every five years and/or during the growing season after a prescribed burn has occurred.

Proposed thinning of hardwoods, the intensity of which is described by vegetation classification, follow two methods; hand felling with chainsaw and mechanical treatment with equipment. Regardless of the method, trees will not be cut lower than 1 inch above ground. Mechanical thinning through equipment use would be similar to that described in the FMP/EA, where equipment such as a skid-steer loader, feller buncher, or similar equipment with tree cutting attachments is used. However, mechanical thinning would only occur when it is feasible, when access is available, and there is no potential for damage to sensitive natural or cultural resources (FMP 2005). Described mechanical equipment is engineered so that soil compaction is significantly reduced through the displacement of weight such that it typically places less than six psi on the ground; as compared to a medium build six-foot tall man, that places 8 psi on the ground (Wikipedia 2013). This type of mechanical thinning and equipment use has been reviewed, approved, and successfully implemented at the park on several occasions in the restoration of the landscape and in providing access for archeological investigations.

Thinning will be determined first by basal area and then by percent canopy cover. This will allow for a higher density of trees than would have occurred, circa 1862, by compensating for historically correct tree species with smaller diameters by vegetation type. Over time, after thinning and with the consistent use of fire, composition is expected to change to more closely reflect that which has been documented historically (Spetich & He 2008). No single treatment, with the exception of cedar reduction, by vegetation type will reduce the basal area of the upper canopy by more than 30. For example, if the initial basal area is 92 and the target basal area is 50 the area will only be thinned to a basal area of 62. Subsequent treatments to reach target basal areas and percent canopy coverage will occur after the managed area has been treated with prescribed fire or five years have elapsed.

In areas, where parameters for fuel build up, percent coverage of woody debris, are exceeded by vegetation type, trees will be girdled and left standing to achieve specified goals and objectives (Table 1E). This method reduces the concentration of fuels that, if burned, may create hot spots that “can destroy soil organic matter, retard the re-establishment of herbaceous and woody vegetation, and cause soil erosion” (Johnson et al. 2009).

The overall goal in all forested areas within the park is to achieve, to as close as is possible, historic stand and structure conditions but at slightly higher densities than would have occurred by incorporating uneven aged management such that a minimum of three oak age classes of historic species is present at any given time. This will allow recruitment overtime into subsequent size classifications and help buffer climatic changes in the environment.

The study conducted by Diamond et al. (2013) as well as data obtained from a vegetative composition and structure study, conducted by the park in 2008, was used to identify extant conditions by species and size class. Size classes represent ranges of diameters for select groups of trees by species and allow for the determination of recruitment availability when identified targets and parameters are specified (Table 2E).

Table 2E: Size Class by Diameter (Inches) and Timber Classification(s).

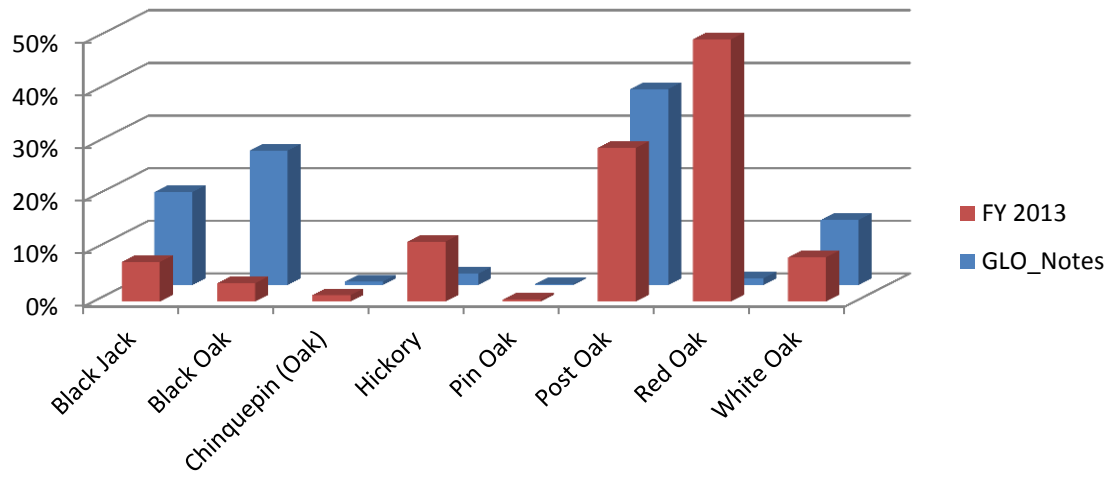
Size Class	Inches	Timber classifications
1	>4	Sapling
2	5-6	Pole
3	7-8	Pole
4	9-10	Pole
5	11-12	Saw
6	13-15	Saw
7	16	Saw
8	>16	Saw

This data was then used to compare historic and extant species composition and coverage park wide, focusing on dominant tree species, to determine methodologies to reach identified parameters (Table 1E), goals and objectives.

As a result, several extant species were identified, based on GLO data, that occurred historically, circa 1862, throughout the park. A determination, by species, of percent change over time was also made (Table 3E) that, when compared to historic conditions and/or parameters, identify disparities between target and existing conditions at the park level (Table 3E). Dominant tree species, overall, exist in quantities sufficient for a sustainable, methodical, approach to achieve goals and objectives over time (Figure 3E) through thinning and the use of prescribed fire. Currently, all forested areas within the park have a closed canopy. Johnson et al. (2009), in these conditions, recommends thinning to create desired overstory structure and light regimes and then using fire frequently to encourage and then maintain associated flora at all levels of the forest. Reduction of stand density to designated parameters and the use of fire will promote sustainable historic oak specie levels of reproduction and recruitment into the overstory.

Table 3E: Percent Species Change Over Time			
	Time Period		
Species	**GLO_Notes**	**FY 2013**	**% Change**
Black Jack	17.66%	7.53%	-10.13%
Black Oak	25.53%	3.48%	-22.05%
Cherry	0.43%	1.01%	0.58%
Chinquapin (Oak)	0.64%	1.21%	0.57%
coffee tree	0.21%	0.00%	-0.21%
Dogwood	0.21%	18.25%	18.04%
Elm	0.43%	12.07%	11.64%
Hackberry	0.43%	3.67%	3.24%
Hickory	2.13%	11.38%	9.25%
Pin Oak	0.21%	0.36%	0.15%
Post Oak	37.23%	29.21%	-8.02%
Red Oak	1.28%	49.82%	48.54%
Sugar Tree (Maple)	0.43%	1.10%	0.67%
Sycamore	0.64%	0.90%	0.26%
Walnut	0.21%	2.64%	2.43%
White Oak	12.34%	8.39%	-3.95%
Total	100.00%	151.02%	51.02%

Figure 3E: Percent of Historic Dominant Tree Species Change Overtime, 1836-37 to Present



GLO data was then used to determine the frequency, or percent, each species occurred by diameter in 1836 and 1837 park wide (Table 4E). This data allows for the differentiation of species composition and structure by canopy layer.

Table 4E: Frequency/Percent of Historic Species by Size Class in 1836 and 1837

Species	1	2	3	4	5	6	7	8	% Tree Species
Cherry	-	-	-	-	100%	-	-	-	0.43%
Coffee Tree	-	-	-	-	-	-	100%	-	0.21%
Dogwood	100%	-	-	-	-	-	-	-	0.21%
Elm	-	50%	50%	-	-	-	-	-	0.43%
Hackberry	-	-	-	-	100%	-	-	-	0.43%
Hickory	10%	20%	10%	30%	-	20%	10%	-	2.13%
Oak - Black	3%	-	6%	6%	13%	28%	13%	31%	25.53%
Oak - Blackjack	5%	8%	11%	16%	28%	30%	-	2%	17.66%
Oak - Chinquapin	-	33%	-	33%	-	-	-	33%	0.64%
Oak - Pin	-	-	-	-	-	-	-	100%	0.21%
Oak - Post	1%	3%	5%	13%	22%	30%	10%	15%	37.23%
Oak - Red	-	-	-	-	-	17%	33%	50%	1.28%
Oak - White	0%	3%	3%	12%	16%	22%	16%	28%	12.34%
Sugar Tree (Maple)	-	-	-	-	-	100%	-	-	0.43%
Sycamore	-	-	-	-	-	-	-	100%	0.64%
Walnut	-	-	-	-	-	-	-	100%	0.21%
% by Size Class	2.55%	3.83%	6.17%	11.49%	19.36%	27.66%	9.79%	19.15%	100%

Consequently, the dominant tree species, without consideration of where they occurred within the study area, identified in 1836 and 1837, consisted of oaks and was primarily made up of Post Oak (Table 4E). However, the dominant upper canopy tree species, classification 5 and greater, between Black and Post Oaks was similar. Post Oaks occurred throughout all classifications, diameters, indicating that it was better adapted to ongoing climatic conditions and the frequency and intensity of then extant disturbance regimes, fire. Tree diameters that do not occur throughout all size classes with the highest frequency being at the smallest size class, class 1, and substantially decreasing thereafter are indicative of repeated indiscriminate disturbance from logging, fire and wind (Johnson et al. pp 382. 2009). GLO data, at the park, was obtained just prior to, and/or immediately after settlement, thus the primary disturbance regime that promoted documented stand structure and composition consisted of fire. Figure(s) 4E through 9E, below, demonstrate this disturbance graphically and show, by dominant species, survivability by size class, without consideration for location and other variables (e.g., soil, nutrients, slope, and aspect), with then extant disturbance regimes.

Figure 4E: Black Oak Species Frequency by Size Class, 1836 & 1837

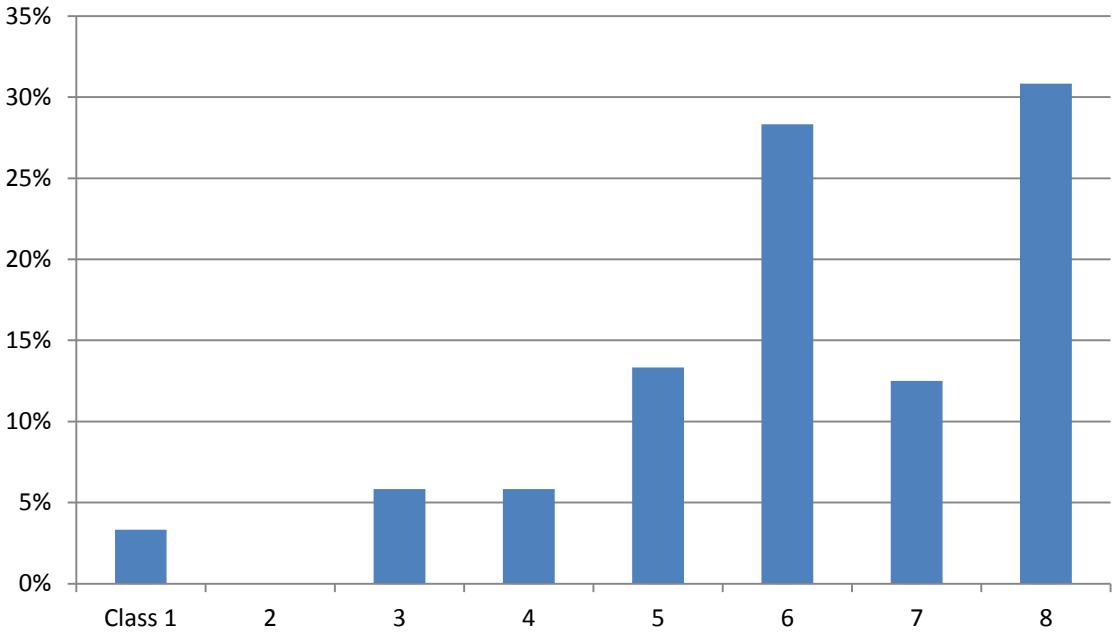


Figure 5E: Blackjack Oak Species Frequency by Size Class, 1836 & 1837

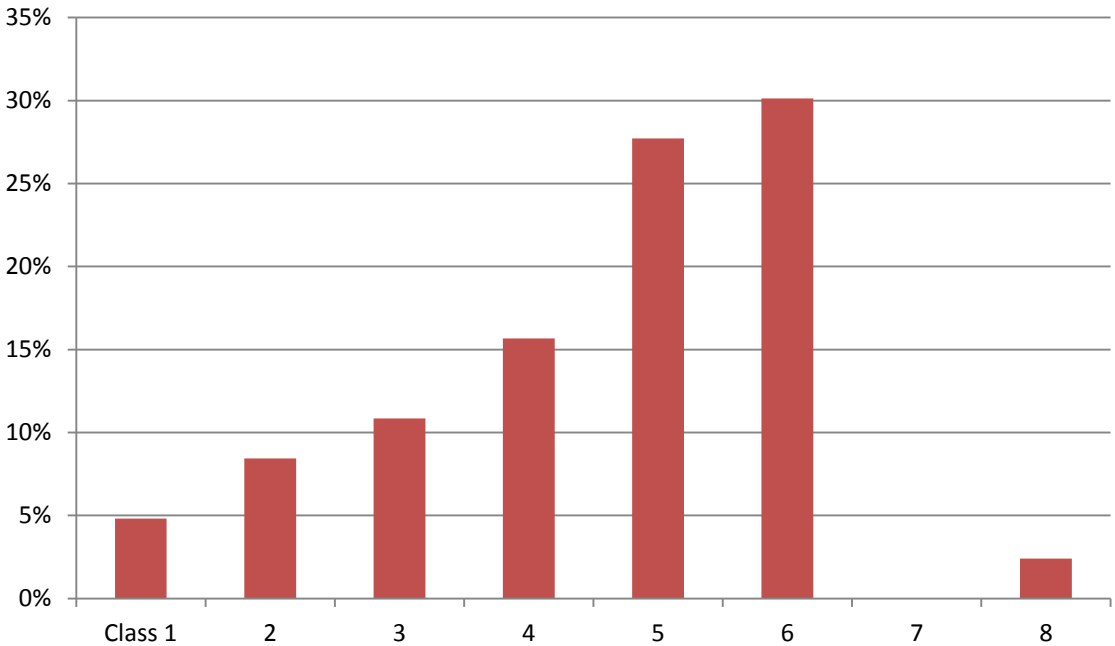


Figure 6E: Chinquapin Oak Species Frequency by Size Class, 1836 & 1837

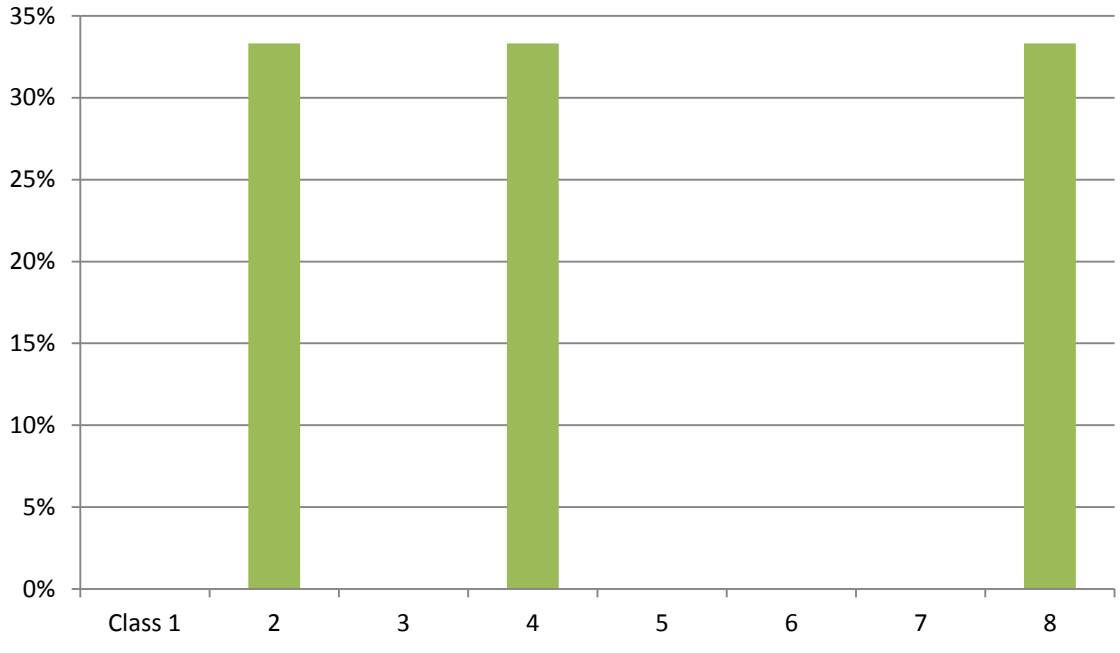


Figure 7E: Post Oak Species Frequency by Size Class, 1836 & 1837

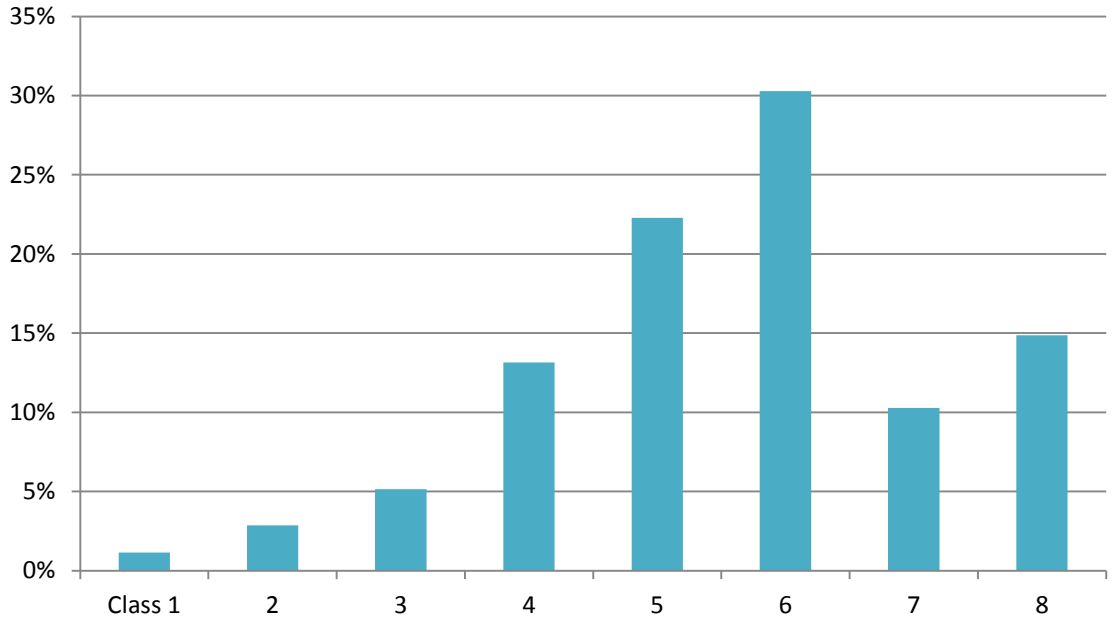


Figure 8E: White Oak Species Frequency by Size Class, 1836 & 1837

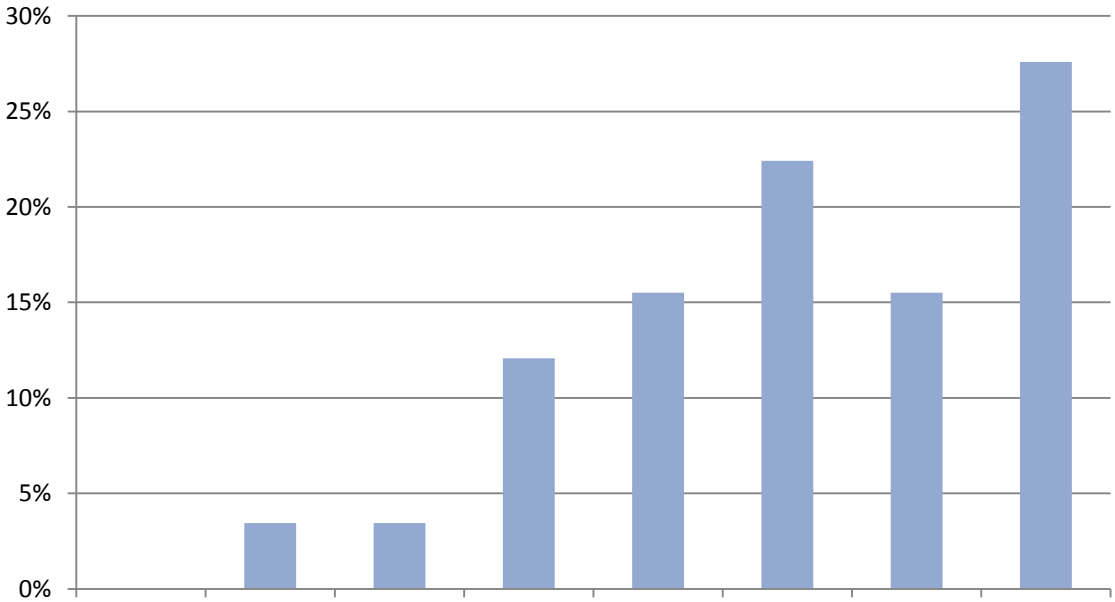
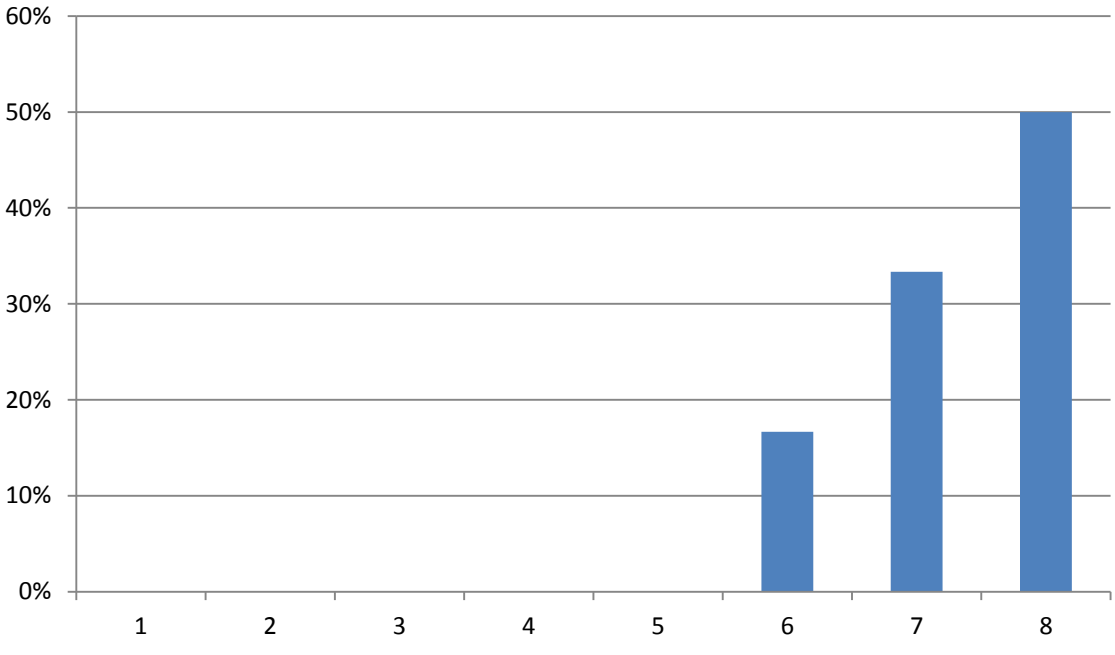


Figure 9E: Red Oak Species Frequency by Size Class, 1836 & 1837



Data from Diamond et al. (2013), the park's vegetative composition and structure study (2008), and GLO data was segregated by vegetation classification type (Figure 1B) to further identify, and incorporate locational data (e.g., soils, slope, aspect), disparities of site specific current and historic conditions so that methods, by vegetative type, could be determined in order to achieve desired resource conditions.

Savanna:

Weedy shrubs, vines, and herbaceous species dominate this vegetative type currently. A significant portion, 45.25%, of the ground layer is made up of invasive plants; tall fescue, 26.25%, and sericea lespedeza, 19%. Primary components of the understory (C3 plants) are flowering dogwood, 37.81%, and coralberry, 33.89% (Diamond et al. 2013). Dominant tree species consist of cedar, elm, locust, oaks, and sassafras (Table 5E).

Table 5E: Savanna Extant Species Frequency by Size Class

Species	Class 1	2	3	4	5	6	7	8	% Species
Black Cherry	0%	0%	0%	0%	0%	100%	0%	0%	0.22%
Cedar	10%	19%	21%	40%	9%	0%	0%	0%	46.84%
Cottonwood	0%	0%	0%	0%	0%	0%	0%	100%	0.44%
Dogwood	53%	28%	15%	2%	0%	0%	2%	0%	10.24%
Elm	17%	37%	13%	23%	3%	3%	0%	3%	6.54%
Hackberry	29%	14%	29%	14%	0%	0%	0%	14%	1.53%
Hickory	75%	0%	0%	0%	0%	0%	25%	0%	0.87%
Locust	59%	11%	22%	7%	0%	0%	0%	0%	5.88%
Mulberry	0%	0%	0%	0%	0%	100%	0%	0%	0.22%
Oak	19%	11%	19%	7%	19%	0%	11%	15%	5.88%
Osage-orange	38%	13%	13%	38%	0%	0%	0%	0%	1.74%
Persimmon	77%	8%	8%	8%	0%	0%	0%	0%	2.83%
Redbud	12%	24%	45%	15%	3%	0%	0%	0%	7.19%
Sassafras	24%	21%	45%	5%	5%	0%	0%	0%	8.28%
Sycamore	0%	0%	67%	0%	0%	0%	0%	33%	0.65%
Walnut - Black	0%	0%	33%	0%	33%	0%	33%	0%	0.65%
% Size Class	22.44	19.61	23.31	23.97	6.32	0.65	1.53	2.18	

The oak group is made up of Red Oak (85.19%), Post Oak (7.41%), Pin Oak and Blackjack Oak (3.70% each). Red Oaks exist in all size classes with the highest percentages occurring in classes one, three, and five (Table 6E). Red Oak trees were aged at the park, 11-12" dbh average 47 years of age while 16" and greater dbh trees averaged 59 years of age, recruitment occurred at, or around, park inception. Only 16" or greater

dbh Blackjack and Pin Oaks occur in this vegetation type. Post Oaks occurred in two cohorts, 5 to 6 inch trees and trees greater than 16" in dbh. As such, historic Post Oaks occur and will be managed as described in the "Historic Tree Management" section. The current basal area for this vegetation type is 77.

Table 6E: Savanna - Extant Oak Species Frequency by Size Class

Species	Class 1	2	3	4	5	6	7	8	% Species
Blackjack	0%	0%	0%	0%	0%	0%	100%	0%	3.70%
Pin	0%	0%	0%	0%	0%	0%	0%	100%	3.70%
Post	0%	50%	0%	0%	0%	0%	0%	50%	7.41%
Red	22%	9%	22%	9%	22%	0%	9%	9%	85.19%
% Size Class	18.52%	11.11%	18.52%	7.41%	18.52%	0%	11.11%	14.81%	

The entirety of this area historically would have contained C4 grasses (e.g., Switchgrass, Indiangrass, big and little blue stem). C.M. McClellan documented the occurrence of Post, Blackjack and Black Oaks in this area with a thick undergrowth of sumac (GLO 1837). In 1837 these three species were the dominant tree species with an average diameter of 11, 14, and 12 inches, respectively. Of the trees present in 1837, Post and Blackjack Oaks each made up 44.26% of the total composition. Black Oaks occurred 11.48% of the time (Table 7E). Basal area for this vegetative type, based on literature, and designated parameters (Table 1E) should be less than 30.

Table 7E: Savanna – Occurrence of Historic Oak Species Frequency by Size Class, 1836 & 1837

Species	Class 1	2	3	4	5	6	7	8	% Species
Black	0.00%	0.00%	0.00%	0.00%	0.00%	42.86%	14.29%	42.86%	11.48%
Blackjack	11.11%	11.11%	3.70%	7.41%	40.74%	22.22%	0.00%	3.70%	44.26%
Post	0.00%	0.00%	0.00%	0.00%	22.22%	33.33%	14.81%	29.63%	44.26%
% Size Class	4.92%	4.92%	1.64%	3.28%	27.87%	29.51%	8.20%	19.67%	

In addition, the frequency at which these three species, Black, Blackjack, and Post, occur have significantly decreased from what was documented in 1836 and 1837 (Table 8E).

Table 8E: Savanna - Percent Species Change Over Time

Species	Historic	Extant	Percent Change
Black	11.48%	0%	-11.48%
Blackjack	44.26%	3.70%	-40.56%
Post	44.26%	7.41%	-36.85%

Black Oaks were not currently found to occur in the savanna (Figure 9E). However, Blackjack (Figure 10E) and Post Oak (Figure 11E) does occur in desired quantities, and in size classes, 16" dbh and greater, sufficient for excellent acorn production (Johnson et al. pp. 449, 2009) thereby significantly increasing recruitment potential of these species into the overstory.

Figure 9E: Savanna Black Oak Frequency by Size Class - Historic & Current Conditions

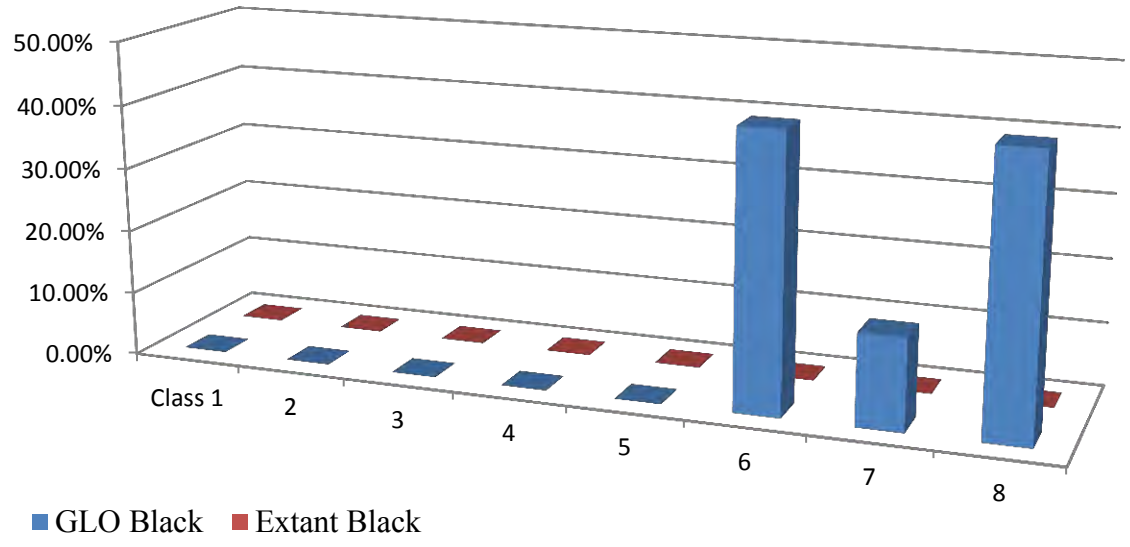


Figure 10E: Savanna Blackjack Oak Frequency by Size Class - Historic & Current Conditions

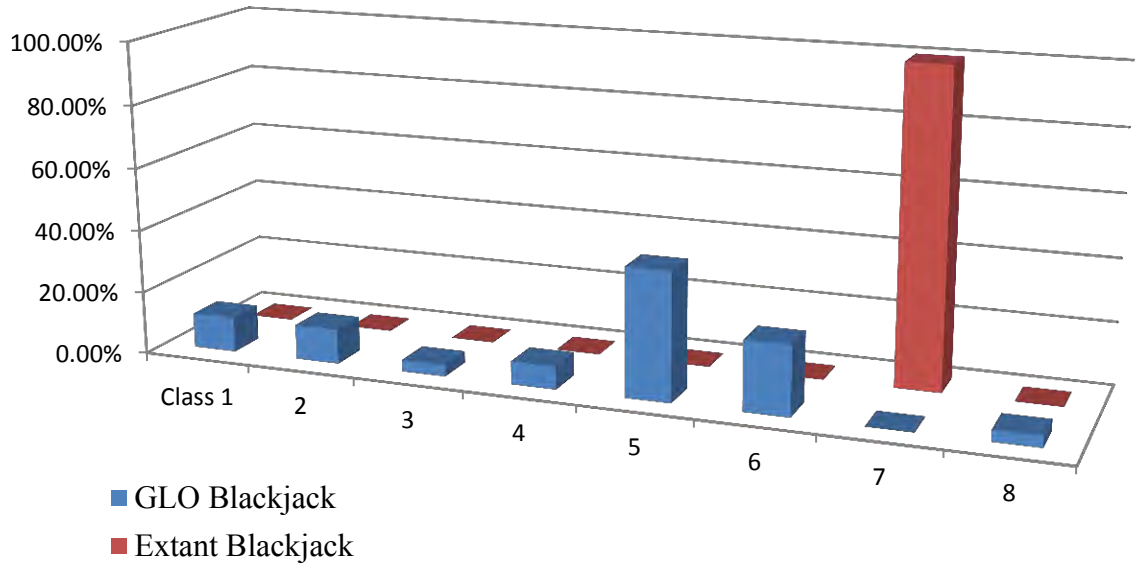
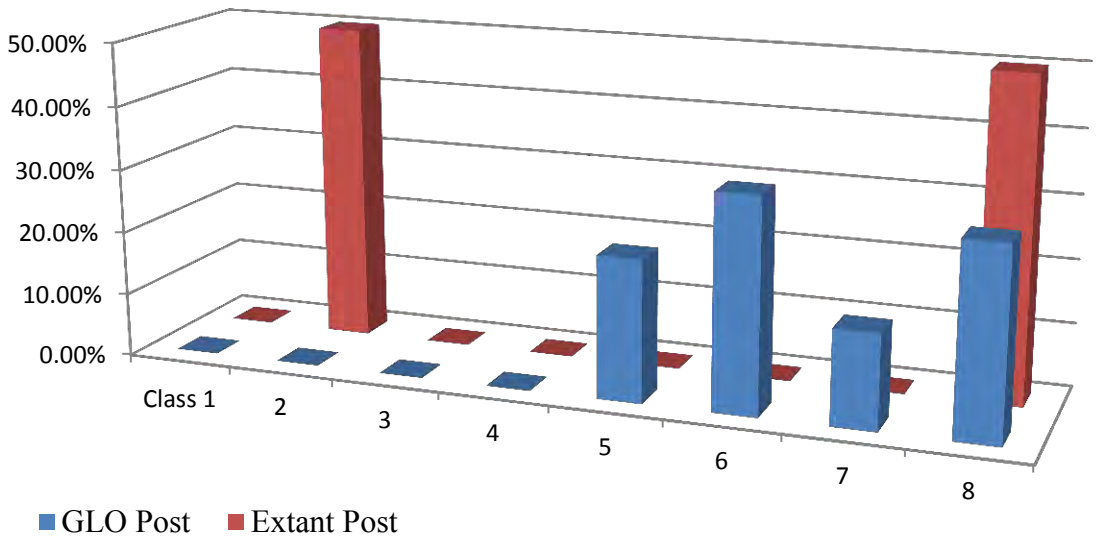


Figure 11E: Savanna Post Oak Frequency by Size Class - Historic & Current Conditions



Although a portion of this area, 175 of the 337 acres, has been identified as needing reforestation, in reality existing trees need to be managed such that the designated basal area and percent canopy cover are met and then maintained through prescribed fire. Reforestation would occur through natural succession over time. Thus, trees will not be planted in this vegetation type. Prescribed fire regimes will consist of moderate intensity fires that occur every one to three years until establishment of identified parameters are met. However, burning regime frequency will then need to be interrupted by fire-free intervals, 10 to 20 years, after dominant tree species are initially managed, and the ground layer has been established, so that oak reproduction sufficient to reach the overstory can occur to replace trees lost to mortality (Johnson et al. 2009).

In line with designated parameters for Savanna (Table 1E), no more than 48 mature trees should be present with a percent canopy cover between 10 to 30%, and a basal area of no more than 30. Understory cover should be sparse, less than 10%, and percent ground cover should be dense, 76%-100%, and consist of C4 grasses. As such, all upper story species with the exception of the oaks group will be removed. Red Oak trees within the oaks group will then be thinned to the point that basal area and percent canopy cover meet identified parameters. Red Oak trees will be managed in lieu of Black Oak to meet historic parameters in this vegetation type. Understory components, primarily dogwood and redbud, will be thinned to the extent that they represent no more than 10% of the understory canopy cover. Methods for the removal of trees within this vegetative type include hand felling and, where practicable and possible, mechanical thinning. Trees that are removed will be felled and left in place, and/or chipped, unless they can be utilized for the creation of fence rails, typically straight trunked and greater than 12” in diameter.

In areas where trees, not needed for fence rails, and access is feasible and practicable, and use is not adverse to goals and objectives, may be made available to the public.

Management of the ground layer will be such that C4 grasses dominate 80% of the layer. This will be achieved through the use of herbicides, mowing and/or haying, prescribed fire, and broadcasting of C4 seeds. Neither this, nor the reduction of woody species referenced above, involve ground disturbance in the reestablishment and/or maintenance of the desired objectives for this vegetative type.

After identified trees and undergrowth have been thinned, and/or removed, the ground layer may be treated with a glyphosate herbicide in the fall, typically from September through November, then burned in early to mid-spring, March through April, to reduce foliar ground cover and deplete root reserves of non-native cool season grasses and C3 plants. Hence, their survivability and continued establishment will decrease (Diboll 2013). Conversely, these actions will enhance recruitment and establishment of existing Native C4 seeds and plants (Packard and Mutel 2005). If, due to climatic conditions, prescribed fire cannot be utilized then areas will be mowed and/or hayed, generally mid to late May and prior to any further management action, to remove existing ground cover. Areas will then be treated with a soil activated herbicide (e.g., Plateau or Journey) in late spring to further target exotic cool season grasses by providing residual control throughout their growing season. This type of herbicide, Plateau or Journey, does not affect native forbs, legumes, or grasses (NRCS Guide AL645C-1) when used well in advance of the growing season for C4 grasses. As such, C4 grass recruitment and survivability will further increase due to decreased competition for available sunlight and nutrients from exotic vegetation. Treated areas will then be seeded with native, locally genetic, stratified and un-stratified, C4 grasses through broadcast methods and then rolled, when possible, to ensure seed to soil contact (NRCS 2006 & 2009). Prairie seed hay, baled from the park, may be used in combination with broadcasting to establish native grasses (Dillard 2013). If it is used it will be scattered over the prepared site after broadcasting methods are completed and lightly harrowed. Un-stratified seeds require a cold moist soil so will be sown after November 1 but before the ground hardens from cold, typically mid-December. Stratified seed will be broadcast from mid-April to mid-May (NRCS 2009). Planting rates for broadcast C4 seed will consist of 5-8 pounds/acre (NRCS 2009). Treated areas will be inventoried annually to determine percent coverage of C4 grasses until the identified goal of 80% cover is achieved then monitored annually thereafter. Spot treatment of exotic vegetation, identified through inventories and/or monitoring, will occur as needed and will follow established procedures of treatment listed in the Exotic Plant Management Environmental Assessment as well as those identified herein.

Dry-Open Woodland:

The Dry-Open Woodland type contains the remainder of the area identified for reforestation, 162 acres, and half of the Eastern red cedar and woodland and forest classification identified by Diamond et al. 2013. Eighty-four percent, 135.22 acres, of the

area identified for reforestation contains advanced regeneration of desirable oak species, and/or is located in a remote location. Consequently, no further action, other than the consistent application of low to moderate intensity prescribed burns every 3 to 5 years, is necessary to restore the requisite dominant tree species and manage/maintain the mid-story cover (Table 1E). The remaining 26.78 acres of the identified reforestation area, made up of four locations (Figure 12E), are highly visible from the visitor center, multiple interpretive waysides and tour stops, and are strategic to the preservation and maintenance of the cultural landscape viewshed. Consequently, these areas should be reforested in keeping with this vegetation type. As such, Post, Blackjack, Black, Chinquapin, and White oaks, 10 per acre (Table 1E), 267 total, will be randomly planted throughout these areas to shield modern intrusions on the cultural landscape and restore the circa 1862 viewshed. Trees greater than 2.5 inches dbh will be planted due to the low number of trees to be planted, the relatively small acreage they are to be planted in, the high visibility aspect, and recommended prescribed fire regimes,. Trees this size are resistant to being top killed by fire and are able to recruit into the over-story (Dey et al. 2010). A hole no more than three feet in diameter and no deeper than two feet will be excavated for each tree. Tree locations immediately behind the Visitor Center (Figure 12E) will be placed with regard to, and in consideration of, existing water lines and sewage lateral lines and septic tanks so that these features will not be compromised by future tree growth. If, due to inclement weather conditions, prescribed fire cannot be utilized, these areas will be mowed until the desired vegetation is established. A plastic covering, approximately four foot in height, will be placed around the trunk of each tree to prevent white-tail deer from rubbing, and subsequently killing, them and to protect them from prescribed fire and/or mowing regimes.

An archeological assessment will be conducted in these areas prior to planting because of their proximity to known battle related sites. The survey will be conducted by an archeologist from MWAC, and will follow the procedures outlined in section G of this appendix. In addition, in the unlikely event that human remains, funerary objects, sacred objects, or objects of cultural patrimony are unintentionally exposed, work will be stopped, the superintendent will be notified immediately, and procedures identified in "Guidance for National Park Service Compliance with the Native American Graves Protection and Repatriation Act (NAGPRA), NPS Cultural Resource Management Guideline, Appendix R" will be followed.

In addition, a para-archeologist, under the direction of a park assigned archeologist from the NPS Midwest Archeological Center (MWAC), will be on hand during the digging and installation of each tree. If any artifacts are recovered during this process, they will be documented, photographed, catalogued, and incorporated into the park's collection.

The ground layer in the identified reforestation area, 162 acres, within this vegetation type contains honeysuckle, Seresia lespedeza, and other exotic vegetation that will be managed so that native grasses dominate the ground layer with a percent coverage of 80% or greater. Thus, the methodologies identified in the Savanna vegetative type for the restoration of native grasses will be followed in these reforestation areas as well.

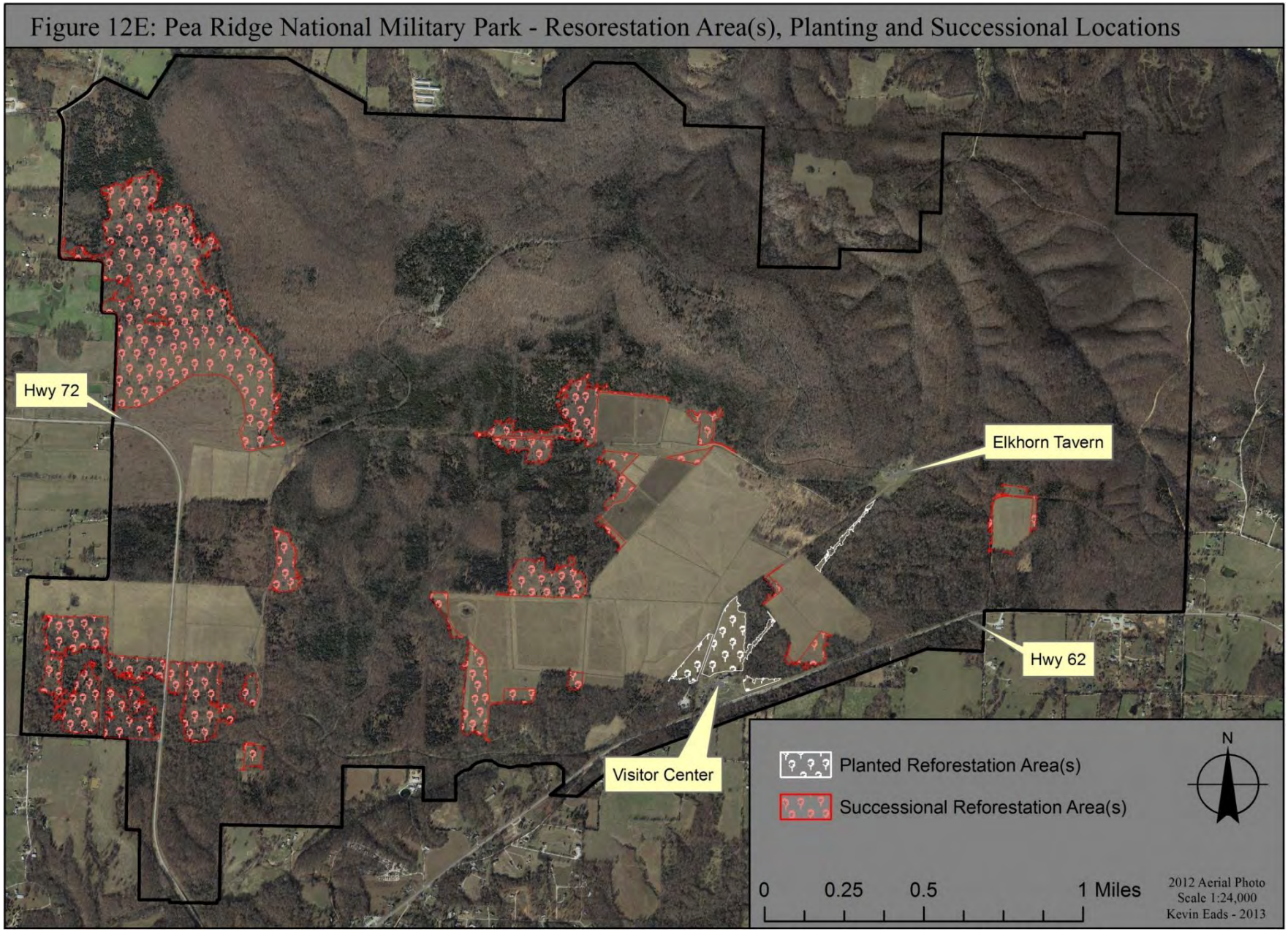


Figure 12E: Pea Ridge National Military Park - Resorestation Area(s), Planting and Successional Locations
Hwy 72
Elkhorn Tavern
Hwy 62
Visitor Center
Planted Reforestation Area(s)
Successional Reforestation Area(s)
N
0
0.25
0.5
1 Miles
2012 Aerial Photo
Scale 1:24,000
Kevin Eads - 2013

The Dry-open Woodlands vegetative type historically contained 1742 acres, 40.51%, within what is now the park. Diamond et al. (2013) identified 480 acres, 11.25%, as currently existing, the location of which is contained within the delineated historic vegetative type of Dry-open Woodlands (Figure 1B). The disparity between historic and existing conditions is a result of several factors, primary of which was the suppression of fire that allowed for an increase in tree density and changes in composition facilitating the encroachment of the forests as they appear today. Nonetheless, the dominant tree species in the area identified by Diamond et al. (2013) is primarily made up of historically correct tree species, 70.46% of the canopy cover is comprised of the historic oak group. The remaining Dry-open Woodlands, excluding those identified by Diamond et al. (2013), also contain significant historically accurate dominant tree species, but not to as great a degree, 54.72% are made up of the historic oak group(s) that include Post, Blackjack, Black, Chinquapin, and White oaks (Table 9E).

Table 9E: Dry Open Woodland Frequency of Extant Oak Species by Size Class

Species	Class 1	2	3	4	5	6	7	8	% Species
Black	4.08%	2.04%	10.20%	8.16%	20.41%	2.04%	10.20%	42.86%	3.48%
Blackjack	19.81%	11.32%	22.64%	16.04%	8.49%	6.60%	4.72%	10.38%	7.53%
Chinquapin	29.41%	17.65%	17.65%	11.76%	11.76%	11.76%	0.00%	0.00%	1.21%
Pin	20.00%	0.00%	0.00%	0.00%	20.00%	0.00%	20.00%	40.00%	0.36%
Post	18.98%	18.49%	13.14%	15.57%	14.36%	5.60%	3.65%	10.22%	29.21%
Red	17.97%	18.40%	17.40%	13.41%	11.13%	5.99%	6.13%	9.56%	49.82%
White	8.47%	9.32%	15.25%	14.41%	12.71%	10.17%	16.10%	13.56%	8.39%
% Size Class	17.27%	16.49%	16.06%	14.07%	12.37%	6.18%	6.25%	11.30%	

Dry-Open woodland were located in areas with shallow, dry, nutrient poor, rocky soil that occurred on slopes of southerly aspects, narrow ridges, broad ridges and fire prone landscapes (Nelson 2011). In addition, the park is located in an area that is prone to drought (Bousman et al. pp. 235, 2012). These two factors, as well as the fire suppression that occurred with Euro-American settlement, are tied to current increased stand densities, the change in species composition from what historically occurred, and, subsequent oak decline in this area (Spetich & He 2008). Oak decline results when trees, not suited to an existing environment, encroach on an area as a result of the removal of a limiting factor, fire, to the extent that their densities become a factor of stress caused by poor soils, and a lack of nutrients and an inciting factor, such as drought, occurs that further stresses the trees. These trees then become susceptible to opportunistic insects and diseases like hypoxylon canker (Spetich & He 2008). Millers et al. (1989) documents 57 oak delcine events occurring between 1856 and 1986. The most recent in this area occurred from 1999 to 2005 (Starkey et al. 2004). In Spetich and He's (2008) study of oak decline they were able to identify oak decline sites and predict oak succession and mortality through simulations. As such, they found that the impacts of oak decline could be mitigated by reducing red oak densities in areas of high risk.

C.M. McClellan documented Post, Black, Blackjack, Chinquapin, and White oaks (Table 9E) as the dominant tree species in the Dry-Open Woodland vegetation type on the park in 1837 (GLO). Northern Red Oaks were not identified as occurring in this vegetative type. Red Oaks are more susceptible to drought and fire, are not as long lived as White Oaks, and are impacted by oak decline to a greater extent than are white oaks (Spetich & He 2008).

Table 9E: Dry Open Woodland – Historic Frequency of Oak Species by Size Class, 1836 & 1837

Species	Class 1	2	3	4	5	6	7	8	% Species
Black	-	-	-	14.29%	14.29%	14.29%	14.29%	42.86%	16.28%
Blackjack	-	10.00%	-	10.00%	40.00%	-	40.00%	-	23.26%
Post	-	3.85%	7.69%	7.69%	26.92%	30.77%	19.23%	3.85%	60.47%
% Size Class	-	4.65%	4.65%	9.30%	27.91%	20.93%	23.26%	9.30%	

The frequency at which the dominant canopy species, identified in 1836 and 1837, occurred in this vegetation type has decreased substantially (Table 10E).

Table 10E: Dry Open Woodland - Percent Species Change Over Time

Species	Historic	Extant	Percent Change
Black	16.28%	3.48%	-12.80%
Blackjack	23.26%	7.53%	-15.72%
Post	60.47%	29.21%	-31.25%

Oak decline has, is, occurring on the park, primarily in the red oak group, Northern Red Oaks, and is predominantly in this vegetation type. As a result, a significant number of trees in this group are diseased, dead, or dying from hypoxylon canker.

Northern Red Oaks, currently make up 49.82% of the Dry-Open Woodland, are comprised of 17.97% saplings, 4 inch in diameter or smaller, 49.22% pole sized, 10” or less dbh, and 32.81% 12 inches and greater in dbh, saw class (Table 9E). Spetich & He (2008) identified areas of high risk for oak decline as having older groups of red and black oaks, mature overstory trees saw class sized or higher, in areas located on south slopes and ridge tops with poor water and nutrient conditions; characteristics identified for Dry-Open Woodlands. Furthermore, oak decline was “primarily related to overabundance of the red oak old age groups” with old age groups being classified as those trees greater than 90 years of age. Currently 15.69% of the red oaks in this vegetation type have diameters greater than 16 inches.

Historically, Black Oaks contained the largest number of saw class sized trees followed by Post and Blackjack Oak, respectively (Table 9E). Dominant tree species identified for this vegetation type are Post, Blackjack, Black, Chinquapin, and White Oak (Table 1E). Currently, these species comprise 50.18% of the Oak group in this vegetation type (Table 9E).

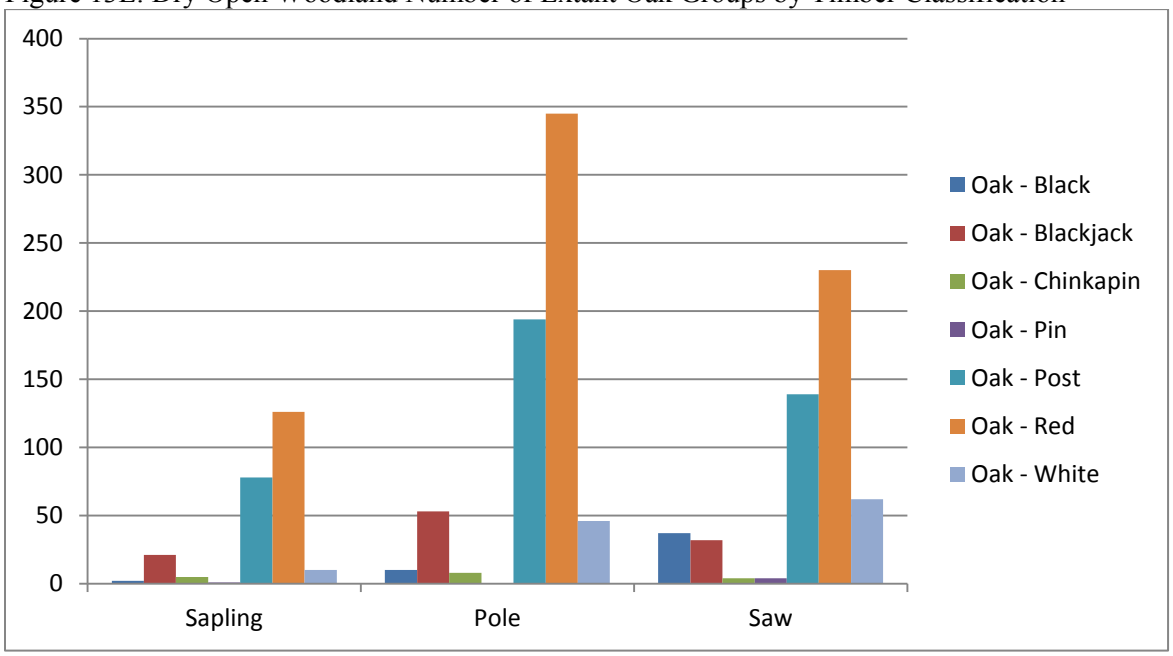
This vegetation type currently has a basal area of 92 with a 100% closed canopy throughout. Historically the basal area would have been 30 to 60 with a percent canopy cover of 30% to 70%. The ground cover was dense and contained C4 grasses and C3 sedges and forbs in areas with a more open canopy cover and patchy ground cover in more dense areas. Data from the park's vegetative composition and structure study (2008), identify several species, primary of which are the oaks group (Table 11E), that can be managed to achieve goals and objectives for this vegetation type. However, red oaks, not identified as being present in 1836 and 1837, dominant the oak group (Table 9E).

Table 11E: Dry-Open Woodland Frequency of Extant Species by Size Class									
Species	Class 1	2	3	4	5	6	7	8	% Species
Ash - Green	6.45%	16.13%	29.03%	32.26%	6.45%	3.23%	3.23%	3.23%	0.61%
Black Cherry	14.71%	11.76%	29.41%	11.76%	14.71%	-	5.88%	11.76%	0.66%
Black Gum	-	20.00%	20.00%	40.00%	20.00%	-	-	-	0.10%
Carolina Beech	25.00%	-	-	25.00%	25.00%	-	-	25.00%	0.08%
Cedar	28.25%	16.20%	24.77%	18.88%	7.23%	3.21%	0.94%	0.54%	14.61%
Cottonwood	-	-	-	-	16.67%	16.67%	33.33%	33.33%	0.12%
Dogwood	65.80%	28.23%	5.60%	0.25%	0.12%	-	-	-	15.72%
Downey Serviceberry	55.74%	39.34%	3.28%	1.64%	-	-	-	-	1.19%
Elm - American	32.52%	28.27%	21.58%	10.64%	3.95%	2.13%	0.30%	0.61%	6.43%
Hackberry	60.78%	16.99%	13.73%	4.58%	2.61%	1.31%	-	-	2.99%
Hickory	44.15%	25.85%	14.63%	7.80%	4.39%	1.71%	0.98%	0.49%	8.02%
Locust - Black	42.86%	33.54%	15.53%	4.35%	3.11%	-	0.62%	-	3.15%
Maple - Silver	25.81%	19.35%	12.90%	9.68%	19.35%	-	6.45%	6.45%	0.61%
Mulberry - Paper	18.60%	25.58%	37.21%	6.98%	9.30%	2.33%	-	-	0.84%
Oak	17.27%	16.49%	16.06%	14.07%	12.37%	6.18%	6.25%	11.30%	27.52%
Ohio Buckeye	35.71%	42.86%	14.29%	7.14%	-	-	-	-	0.55%
Osage Orange	35.14%	29.73%	13.51%	5.41%	8.11%	5.41%	-	2.70%	0.72%
Ozark Chinquapin	100.00 %	-	-	-	-	-	-	-	0.10%
Persimmon	51.28%	30.77%	12.82%	3.85%	1.28%	-	-	-	3.05%
Redbud	43.04%	31.65%	12.66%	8.86%	2.53%	1.27%	-	-	1.55%
Sassafras	39.12%	33.41%	18.68%	6.37%	0.88%	0.88%	0.66%	-	8.90%
Sycamore	-	6.06%	21.21%	39.39%	12.12%	12.12%	3.03%	6.06%	0.65%
Walnut - Black	12.20%	23.17%	18.29%	19.51%	7.32%	7.32%	3.66%	8.54%	1.60%
Yellowood	91.67%	8.33%	-	-	-	-	-	-	0.23%
% Size Class	35.83%	23.08%	16.06%	10.19%	6.06%	2.88%	2.25%	3.66%	

Thus, the primary management action that can be taken in this vegetation type, that will achieve designated parameters (Table 1E), in addition to the removal of cedar, is to remove a significant number of Northern Red Oaks (Figure 13E), consistently use prescribed fire, and establish C4 grasses, through hand broadcasting methods, and C3

sedges, through natural recruitment. These actions will restore the historic landscape and diminish the likelihood and effect of oak decline at the park.

Figure 13E: Dry Open Woodland Number of Extant Oak Groups by Timber Classification



The remaining oak species, after removal of the red oak group, will be similar to those described historically and/or are in sufficient numbers and sizes to promote subsequent recruitment (Figure 14E through 16E) to achieve goals and objectives for this vegetation type.

Figure 14E: Dry Open Woodland - Frequency of Black Oak by Size Class Historic & Current Conditions

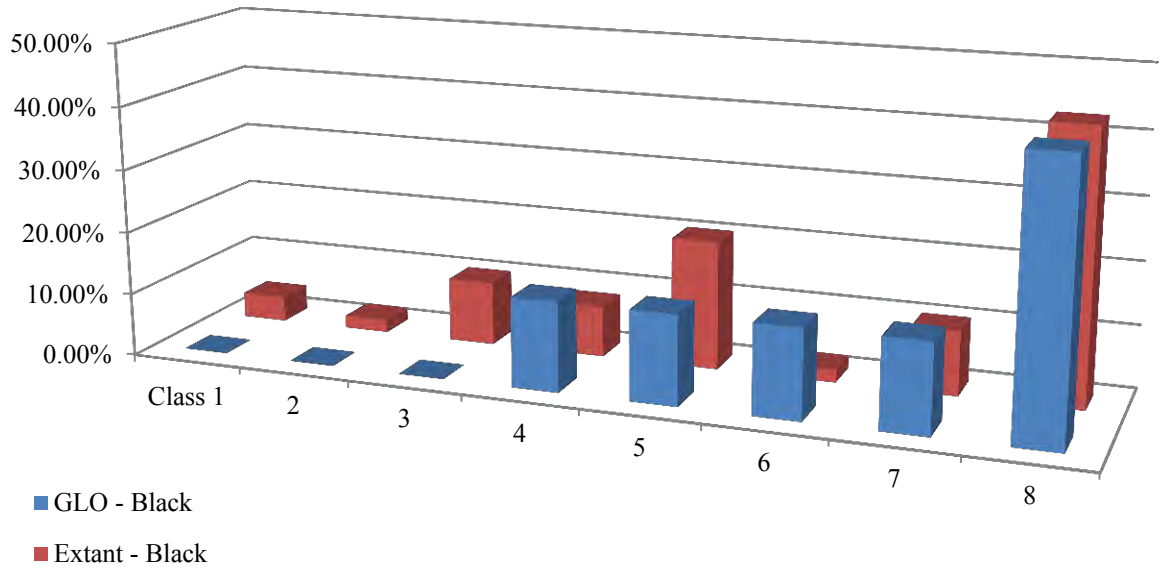


Figure 15E: Dry Open Woodland - Frequency of Blackjack by Size Class Historic & Current Conditions

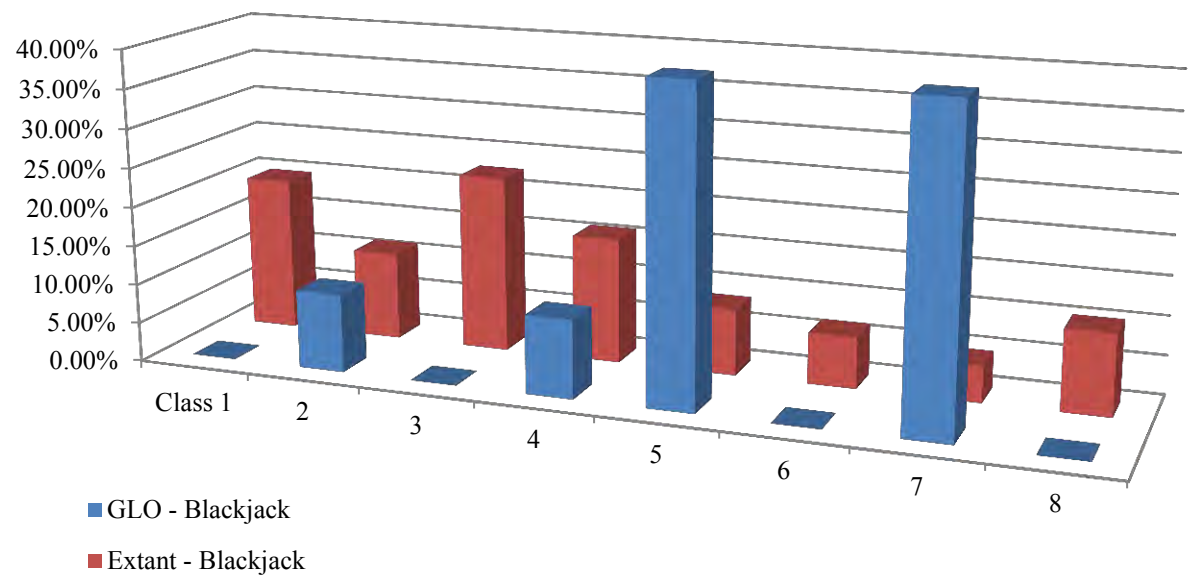
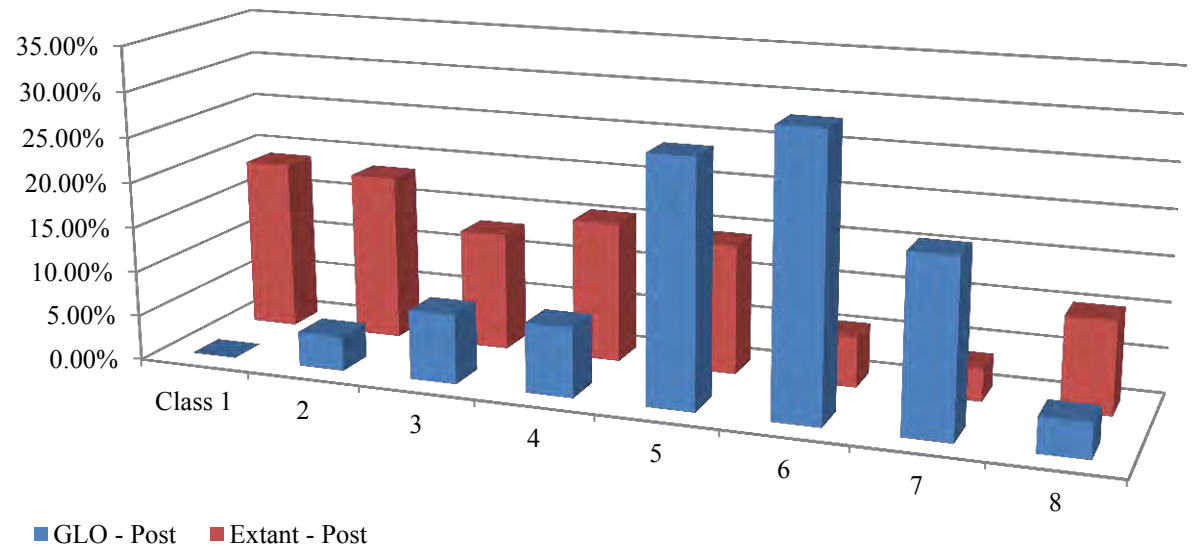


Figure 16E: Dry Open Woodland - Frequency of Post Oak by Size Class Historic & Current Conditions

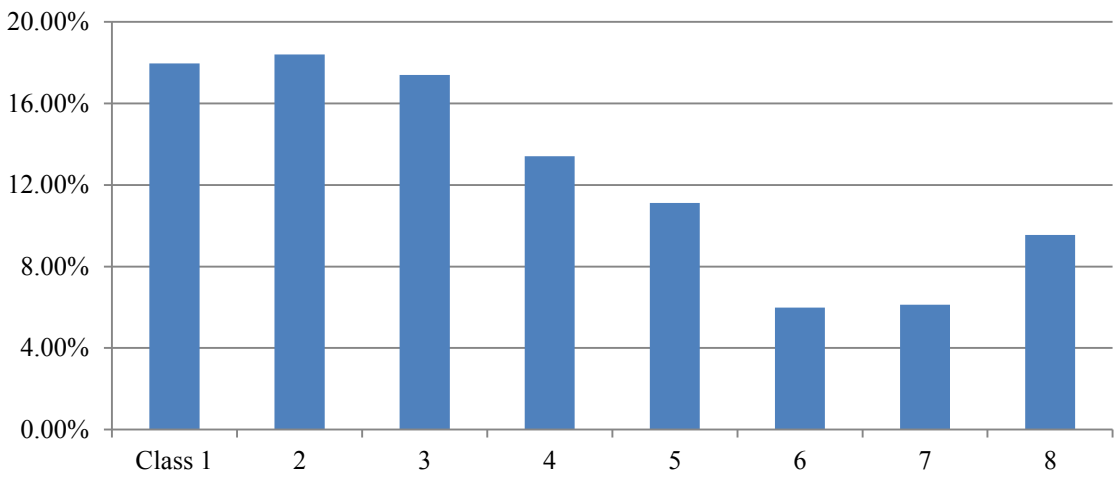


Prescribed fire will be utilized in this vegetation type, pre, during, and post treatment, every 3 to 5 years at a low to moderate intensity and in keeping with the FMP (2005).

In order achieve a basal area of 30 to 60 with a percent canopy cover of 30% to 70% Northern Red Oaks will be thinned before other identified species are managed (Figure 13E). Thinning of additional species, that would not have occurred historically in this vegetation type (e.g., Green Ash, Black Cherry, Black Gum, American Elm, and Black Locust), will ensue if, after thinning of red oaks, parameters are not met. Finally, thinning of documented historic oak species will occur if, after the above actions have been implemented, identified parameters have not been reached. Thinning will be conducted through implementation of the modified singletree selection method as described in the cedar management portion of this appendix but will be applied to the red oak group.

Red Oak trees in classifications 1 through 3, up to and including 8 inches in diameter, (Figure 17E) will be cut by hand, using chainsaws, and will be removed from the canopy by felling them in place. The resulting deadwood from this technique will increase the fuel load in those areas but is considered beneficial, as these size classes are considered fine fuels that will burn in subsequent post-prescribed burns. This technique preserves surrounding oak trees and has the lowest probability of resultant damage to desirable tree species.

Figure 17E: Dry Open Woodland - Frequency of Extant Red Oak by Size Class



The percent coverage of down and dead woody debris in any given plot will determine the treatment method for trees 9 to 10 inches in diameter, classification four. Trees in plots that contain less than 50% coverage of woody debris, 100 hour fuels or greater, will mirror methods for classifications 1 through 3 in that they will be felled and left in place. Trees in plots that contain more than 50% of 100 hour fuel loads will be girdled and left in place to reduce the amount of available fuel loads for subsequent prescribed fire.

Trees greater than 10 inches in diameter but less than 17, classifications 5 through 7, will be mechanically thinned and utilized for split rail fencing when feasible, access is available, and there is no potential for damage to sensitive natural or cultural resources (FMP 2005). Areas where mechanical thinning may occur include gentle slopes and ridge tops. As such, trees in identified areas in these size classes will be left in place and

removed as needed for split rails for fencing of historic fields. Trees that are not needed for fence rails may be made available to the public, when access is feasible and practicable, and use is not adverse to goals and objectives.

Trees that occur in areas where mechanical thinning is not feasible, grades greater than 30 degrees, will follow thinning methods outlined above, classification four, with regard to percent coverage of woody debris in determination of felling and leaving in place or girdling.

Red oak trees that are greater than 16 inches in diameter, classification eight, will be aged, and locations documented with a GPS unit. Although unlikely, any tree that is found to be historic, circa 1862, will be managed according to the "Historic Tree" methodologies referenced later in this document. Trees in this classification that are not historic will be thinned like those in classifications 5 through 7, above.

The understory cover will be thinned to meet designated parameters (Table 1E). Thinning will be primarily focused on dogwood, redbud, and sassafras species. If parameters are not met then additional species will be thinned in size classes 4 and below. Chinquapin oak will not be thinned. Neither this, nor the reduction of woody species referenced above, involve ground disturbance in the reestablishment and/or maintenance of the desired objectives for this vegetative type.

The ground cover, after basal area and percent canopy coverage treatments have occurred, will be seeded by hand with native, locally genetic C4 grasses, in open areas that contain 50% or less canopy cover. The goal for establishment of native grasses within this vegetative type is that 80% of the ground cover, in areas that contain less than 50% canopy cover, consists of native grass.

Dry-Mesic Woodland:

The Dry-Mesic Woodlands vegetative type historically contained 491 acres, 11.41%, within what is now the park. Literature describes this vegetation type as having a dominant tree species made up of White, Black, Post, and Chinquapin Oaks and hickories. C.M. McClellan, a surveyor with the GLO, in 1836 and 1837 documented three oak species as being dominant, Post, Blackjack, and Black, with Post Oak being the primary species present in all diameter size classes (Table 11E). Although these species are still present, their occurrence on the landscape has decreased over time (Table 12E).

Table 11E: Dry-Mesic Woodland – Historic Frequency of Oak Species by Size Class, 1836 & 1837									
Species	**Class 1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**% Species**
Black	-	-	-	-	-	50.00%	-	50.00%	11.11%
Blackjack	-	-	-	25.00%	50.00%	25.00%	-	-	22.22%
Post	-	8.33%	8.33%	8.33%	41.67%	41.67%	25.00%	16.67%	66.67%
% Size Class	-	5.56%	5.56%	5.56%	27.78%	27.78%	16.67%	11.11%	

Table 12E: Dry Mesic Woodland - Percent Species Change Over Time			
Species	**Historic**	**Extant**	**Percent Change**
Black	11.11%	0.89%	-10.22%
Blackjack	22.22%	4.89%	-17.33%
Post	66.67%	52.89%	-13.78%

Existing vegetation, identified by the park through a study that documented vegetative composition and structure (2008), is principally made up of cedar, 39.51%, and oaks, 27.44%, with a significant understory component of dogwood (Table 13E).

Table 13E: Dry Mesic Woodland - Extant Species Frequency by Size Class									
Species	**Class 1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**% Species**
Ash - Green	100.00%	-	-	-	-	-	-	-	0.12%
Black Cherry	28.57%	14.29%	28.57%	-	-	-	28.57%	-	0.85%
Cedar	19.14%	22.84%	22.53%	23.77%	5.86%	5.56%	0.31%	-	39.51%
Dogwood	67.27%	20.91%	11.82%	-	-	-	-	-	13.41%
Downey Serviceberry	100.00%	-	-	-	-	-	-	-	0.12%
Elm	30.36%	19.64%	19.64%	16.07%	12.50%	1.79%	0.00%	-	6.83%
Hackberry	50.00%	50.00%	-	-	-	-	-	-	0.24%
Hickory	20.59%	23.53%	14.71%	23.53%	8.82%	2.94%		5.88%	4.15%
Mulberry	66.67%	-	-	33.33%	-	-	-	-	0.37%
Oak	9.78%	7.56%	23.11%	24.44%	12.89%	9.33%	6.22%	6.67%	27.44%
Persimmon	33.33%	38.89%	22.22%	5.56%	-	-	-	-	2.20%
Redbud	100.00%	-	-	-	-	-	-	-	0.12%
Sassafras	62.96%	22.22%	14.81%	-	-	-	-	-	3.29%
Sycamore	-	-	100.00%	-	-	-	-	-	0.12%
Walnut - Black	-	30.00%	30.00%	-	30.00%	10.00%	-	-	1.22%
% Size Class	25.98%	18.41%	20.49%	18.41%	7.44%	5.12%	2.07%	2.07%	

Overall, existing oak species, with the exception of red oak, are comparable to historic species in occurrence but deviate by size class (Tables 11E and 14E). Nonetheless, they, like those species occurring in Dry-Open Woodlands, are in sufficient numbers and/or appropriate diameters to provide for recruitment (Figures 18E – 21E) into the dominant canopy species once goals and objectives for basal area and percent canopy cover are achieved.

Table 14E: Dry Mesic Woodland – Frequency of Extant Oak Species by Size Class

Species	Class 1	2	3	4	5	6	7	8	% Species
Black	-	-	50%	50%	-	-	-	-	0.89%
Blackjack	9.09%	-	9.09%	9.09%	36.36%	27.27%	9.09%	-	4.89%
Chinquapin	20%	40%	10%	10%	-	-	-	20%	4.44%
Post	5.88%	5.04%	38.66%	32.77%	9.24%	5.04%	3.36%	-	52.89%
Red	14.46%	8.43%	3.61%	15.66%	16.87%	14.46%	10.84%	15.66%	36.89%
% Size Class	9.78%	7.56%	23.11%	24.44%	12.89%	9.33%	6.22%	6.67%	

Figure 18E: Dry Mesic Woodland - Black Oak Frequency by Size Class Historic & Current conditions

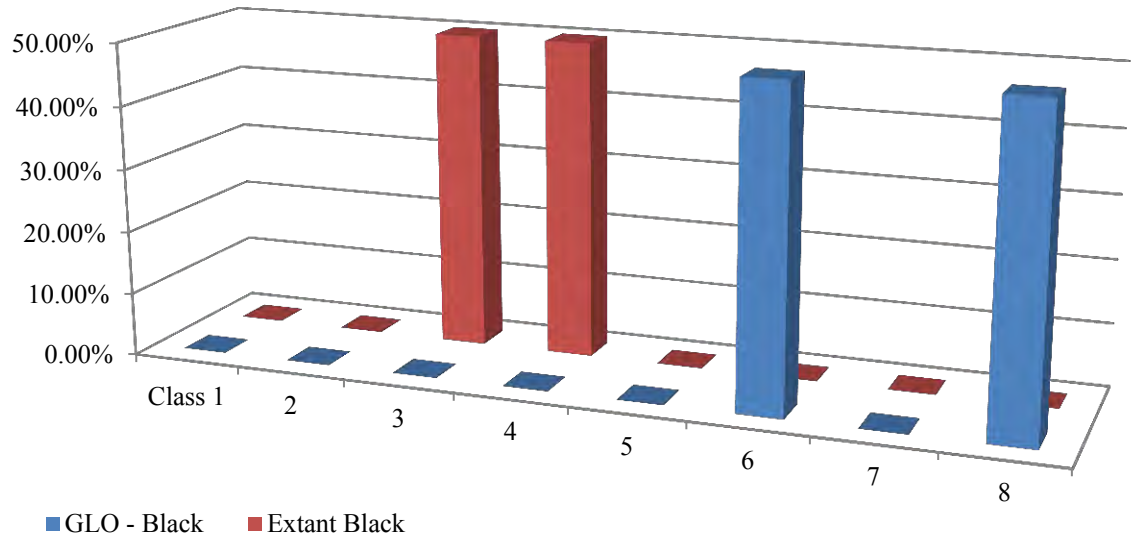


Figure 19E: Dry Mesic Woodland - Blackjack Oak Frequency by Size Class - Historic & Current Conditions

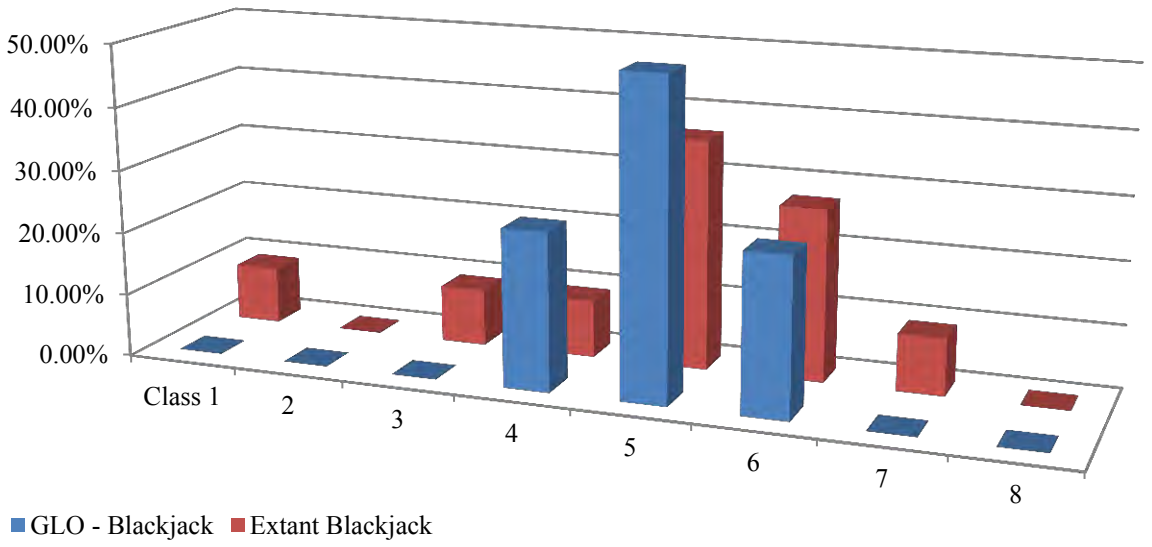


Figure 20E: Dry Mesic Woodland - Post Oak Frequency by Size Class Historic & Current Conditions

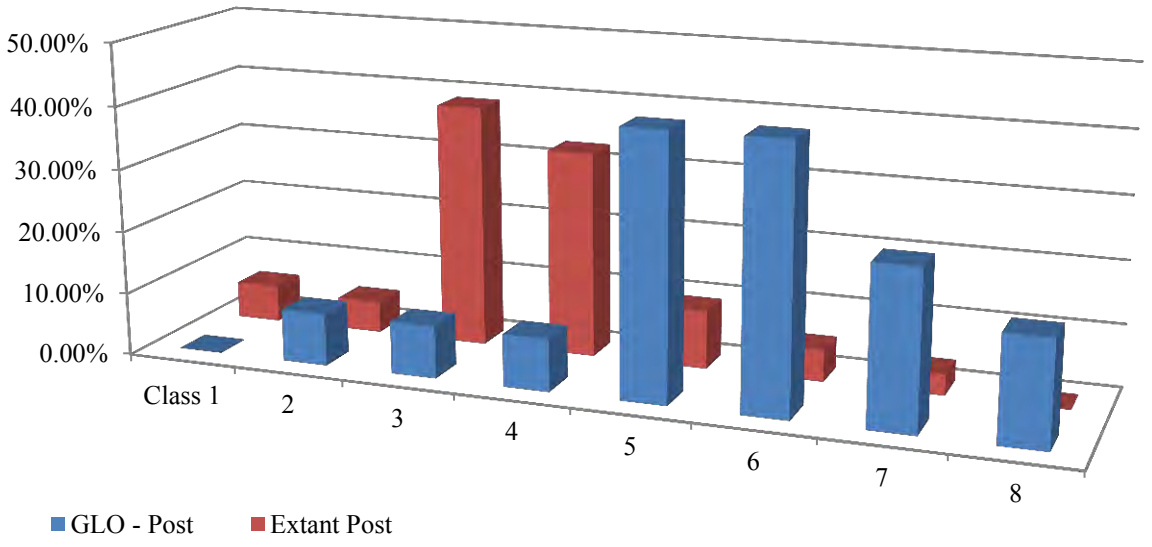
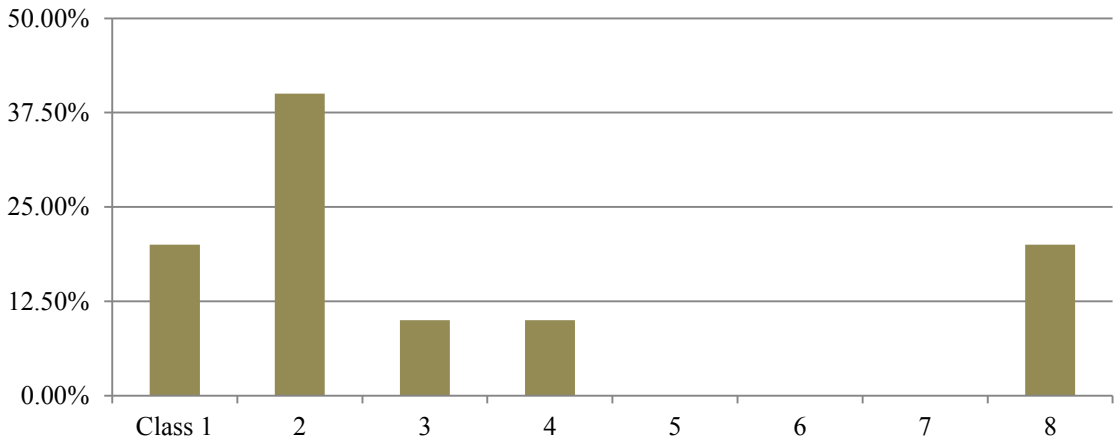
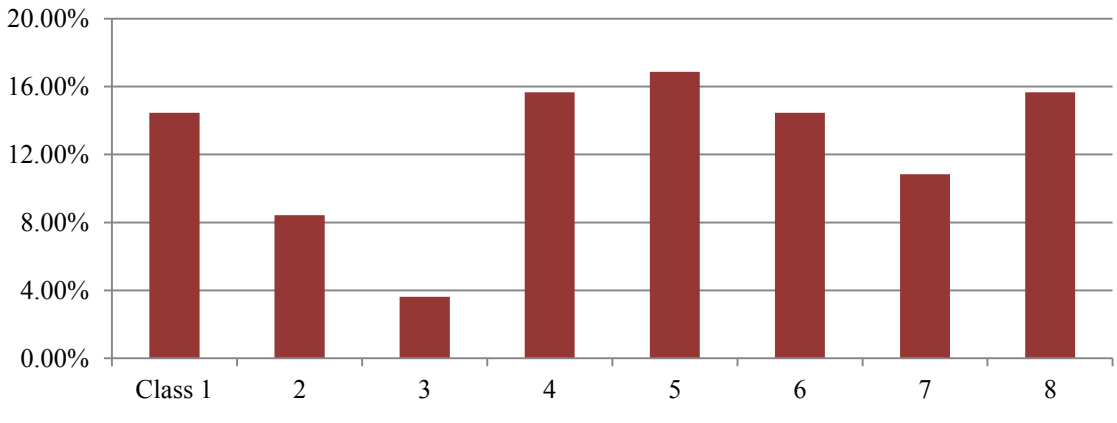


Figure 21E: Dry Mesic Woodland - Frequency of Extant Chinquapin Oak by Size Class



Red oaks, although not as significant as in the Dry Open Woodland, exist and are a substantial component of the oaks group (Table 14E). In addition, 26.5% of the red oaks are 16", size class 7, and greater in diameter (Figure 22E) which not only increase the potential for oak decline but also for recruitment of this species in the absence of thinning and fire. Red oak trees 16" to 20" dbh are at their highest in acorn production (Johnson et al. pp. 448, 2009).

Figure 22E: Dry Mesic Woodland - Frequency of Extant Red Oak Species by Size Class



This vegetation type, like the Dry Open Woodland type, currently has a basal area of 92 with a 100% closed canopy. Historically the basal area would have been 60 to 80 with a percent canopy cover between 70% and 80%. The ground cover was dense and consisted of C3 grasses, spring ephemerals, ferns, and sedges in the spring and forbs in the summer and fall.

Management in this vegetation type will focus primarily on the red oak group and will follow methods outlined for management of red oak in the Dry Open Woodland vegetative type. However, mechanical thinning will not occur to as great a degree due to

grades predominately being more than 30%. Trees, greater than 10 inches in diameter, classifications 5 through 7, will be mechanically thinned and utilized for split rail fencing when feasible. Trees that are not needed for fence rails may be made available to the public, when access is feasible and practicable, and use is not adverse to goals and objectives, otherwise they will be managed as described. Ground disturbance, as a result of thinning trees, by hand or mechanical, will not occur in the reestablishment and/or maintenance of the desired objectives for this vegetative type.

The understory cover will be thinned to meet designated parameters (Table 1E). Thinning will be primarily focused on dogwood, redbud, and sassafras species. If parameters are not met then additional species will be thinned in size classes 4 and below. Chinquapin oak will not be thinned.

The ground layer will be monitored during the growing season following each prescribed burn to document exotic species. Spot treatment of identified exotic vegetation will occur as needed and will follow established procedures of treatment listed in the Exotic Plant Management Environmental Assessment as well as those identified herein.

Dry-Mesic Forest:

The Dry-Mesic Forest (Forest) has increased, over historic levels, by 31.05%, in that currently it makes up 2001 acres where historically it would have consisted of 682 acres, or 15.85% of what is now the park. The acreage Diamond et al. (2013) identified for Bottomland was minimal and followed creeks and drainages within the park so did not present adequate data to segregate out of the forest vegetative type. Consequently, it is contained within graphs and tables herein but management actions within the Bottomland vegetation type are not included within those described for the forest.

Historic forests occurred on slopes with a northern aspect, in ravines and hollows (Nelson 2011) with well-drained soils on bedrock of sandstone, siltstone, limestone, chert, or shale (Diamond et al. 2013). The dominant canopy in this vegetation type, trees 12” and greater in diameter (Class ≥ 5), is currently made up of four species, Black Cherry, Hackberry, Hickory, Walnut, and Oak with oaks being the primary component, 29.24% (Table 15E), of the canopy. Typical shubs and small trees include dogwood, redbud, Virginia creeper and grape. The ground layer includes ferns, sedges, and grasses, including oat grass (Diamond et al. 2013). Red oaks make up the majority of the oak group, 49.54%, followed by White, Post, Black, and Blackjack (Table 16E). Surveyors conducting the GLO surveys in 1836 and 1837 identified the same species, but at different levels (Table 16E). For example, Black Oak decreased in occurrence from historic levels by 22.46%. The only species of oak that increased in frequency on the forest landscape was Red Oak, 47.79%. However, when basal area and percent canopy coverage are taken into account, like the other forested types identified, historic species occur in sufficient numbers and/or appropriate diameters to provide for recruitment into the dominant canopy species once goals and objectives for basal area and percent canopy cover are achieved. The current basal area for this vegetative type is 103 with 100% canopy coverage. Historically the basal area was 70 -80 and the canopy coverage was

>80%. The average diameter of oaks identified in 1836 and 1837 are indicative of disturbance, but not to as great a degree as those in Savanna, Dry Open and Dry Mesic Woodlands. In the forest vegetation type, the average Black Oak tree was 15" dbh, Blackjack 11" dbh, Chinquapin 15" dbh, Pin, 20" dbh, Post, 14" dbh, Red 18" dbh, and White 16" dbh.

Table 15E: Dry Mesic Forest – Frequency of Extant Species by Size Class

Species	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	% Species
Ash	-	-	-	-	-	-	-	100.00%	0.07%
Black Cherry	23.08%	7.69%	7.69%	15.38%	15.38%	-	15.38%	15.38%	0.87%
Cedar	38.85%	26.75%	15.92%	13.38%	4.46%	-	0.64%	-	10.53%
Dogwood	56.22%	38.92%	4.32%	0.54%	-	-	-	-	24.82%
Downy serviceberry	71.43%	28.57%	-	-	-	-	-	-	0.94%
Elm	43.79%	35.50%	11.83%	5.33%	3.55%	-	-	-	11.33%
Hackberry	50.00%	21.88%	18.75%	-	6.25%	3.13%	-	-	2.15%
Hickory	39.31%	31.72%	11.03%	7.59%	4.14%	3.45%	1.38%	1.38%	9.73%
Maple	39.29%	14.29%	35.71%	7.14%	3.57%	-	-	-	1.88%
Mulberry - Red	-	16.67%	66.67%	16.67%	-	-	-	-	0.40%
Oak	15.37%	11.47%	12.61%	13.30%	10.32%	8.94%	9.63%	18.35%	29.24%
Ohio Buckeye	100.00%	-	-	-	-	-	-	-	0.27%
Ozark Chinquapin	100.00%	-	-	-	-	-	-	-	0.07%
Persimmon	23.08%	61.54%	15.38%	-	-	-	-	-	0.87%
Redbud	57.14%	28.57%	14.29%	-	-	-	-	-	0.47%
Sassafras	27.78%	35.19%	22.22%	9.26%	1.85%	3.70%	-	-	3.62%
Sycamore	50.00%	16.67%	-	-	-	-	-	33.33%	0.40%
Walnut	8.57%	20.00%	28.57%	22.86%	11.43%	5.71%	-	2.86%	2.35%
% Size Class	36.22%	26.56%	11.94%	7.98%	4.96%	3.29%	3.15%	5.90%	

Table 16E: Dry Mesic Forest – Oak Species Percent Change Over Time

Oak Species	Historic (GLO)	Extant	Percent Change
Black	28.65%	6.19%	-22.46%
Blackjack	11.99%	2.06%	-9.92%
Chinquapin	0.88%	0.69%	-0.19%
Post	33.92%	13.53%	-20.39%
Red	1.75%	49.54%	47.79%
White	15.79%	27.98%	12.19%

This is the only vegetation type where red oaks were identified in 1836 and 1837 (GLO). However, they were at significantly lower levels overall as well as among size classes (Table 17E and 18E). Currently, of the red oaks in the forest, 43.98% are made up of trees ≥ 12" dbh, size classes 5 – 8, where historically red oaks were identified as occurring 1.75% of the time with the majority of the trees, 50%, being greater than 16" dbh.

Table 17E: Dry Mesic Forest - Frequency of Extant Oak Species by Size Class

Species	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	% Species
Black	3.70%	-	3.70%	3.70%	14.81%	3.70%	14.81%	55.56%	6.19%
Blackjack	22.22%	11.11%	22.22%	22.22%	-	11.11%	11.11%	-	2.06%
Chinquapin	33.33%	33.33%	33.33%	-	-	-	-	-	0.69%
Post	13.56%	16.95%	22.03%	16.95%	6.78%	10.17%	5.08%	8.47%	13.53%
Red	18.52%	13.43%	11.57%	12.50%	11.11%	7.41%	9.72%	15.74%	49.54%
White	12.30%	7.38%	10.66%	14.75%	10.66%	12.30%	10.66%	21.31%	27.98%
% Size Class	15.37%	11.47%	12.61%	13.30%	10.32%	8.94%	9.63%	18.35%	

Table 18E: Dry Mesic Forest – Historic Frequency of Oak Species by Size Class, 1836 & 1837

Species	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	% Species
Black	4.08%	-	7.14%	6.12%	15.31%	28.57%	10.20%	28.57%	28.65%
Blackjack	1.96%	3.92%	15.69%	19.61%	13.73%	23.53%	-	1.96%	11.99%
Chinquapin	-	33.33%	-	33.33%	-	-	-	33.33%	0.88%
Post	1.72%	3.45%	6.03%	17.24%	20.69%	29.31%	7.76%	13.79%	33.92%
Red	-	-	-	-	-	16.67%	33.33%	50.00%	1.75%
White	-	3.70%	3.70%	12.96%	16.67%	22.22%	14.81%	25.93%	15.79%
% Size Class	2.20%	2.83%	7.55%	13.84%	17.30%	27.36%	9.12%	19.81%	

As such, like all other wooded vegetative types within the park, management of this vegetation type, in addition to the removal of cedar, will focus on the reduction of red oak. Prescribed fire will be consistently used at a higher frequency, consistent with on-going fire regimes (FMP 2005), than would have occurred until identified parameters have been achieved (Table 1E) so that a detrimental buildup of woody debris from management actions does not occur. The continued use of current fire regimes in this area is not adverse to the achievement of goals and objectives as desired historic oak group species have been recruited and promulgated through its use since circa 1987 (Figures 23E – 28E). All historic oak group species contain trees in size classes 1 – 4 in quantities sufficient to achieve goals and objectives once cedar is removed, and red oak trees are managed.

Figure 23E: Dry Mesic Forest - Frequency of Black Oak by Size Class Historic & Current Conditions

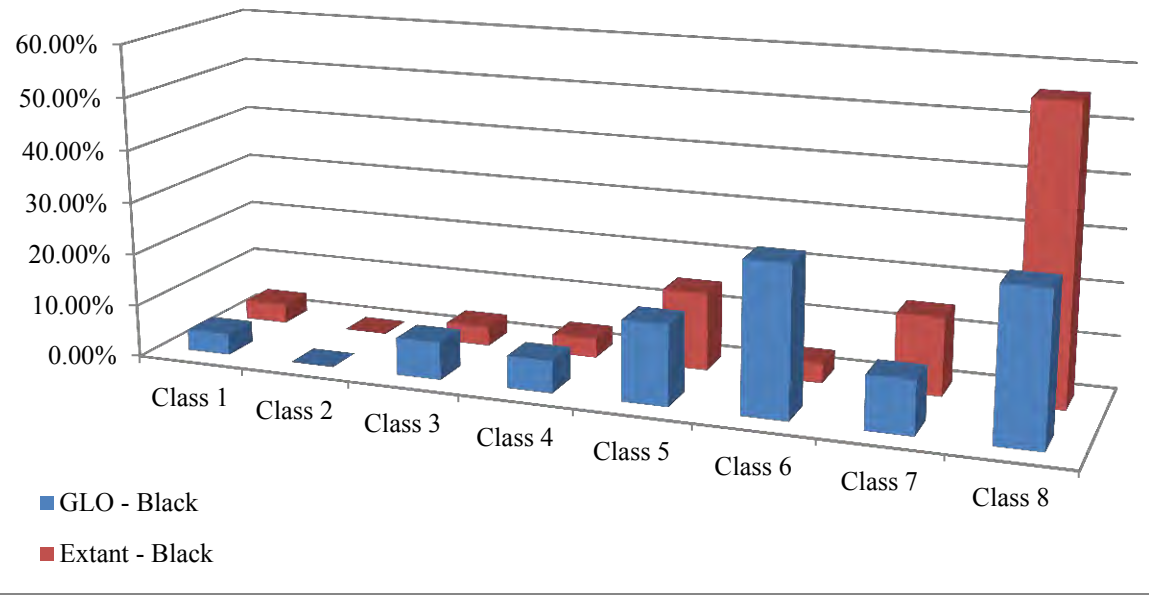


Figure 24E: Dry Mesic Forest - Frequency of Blackjack Oak by Size Class Historic & Current Conditions

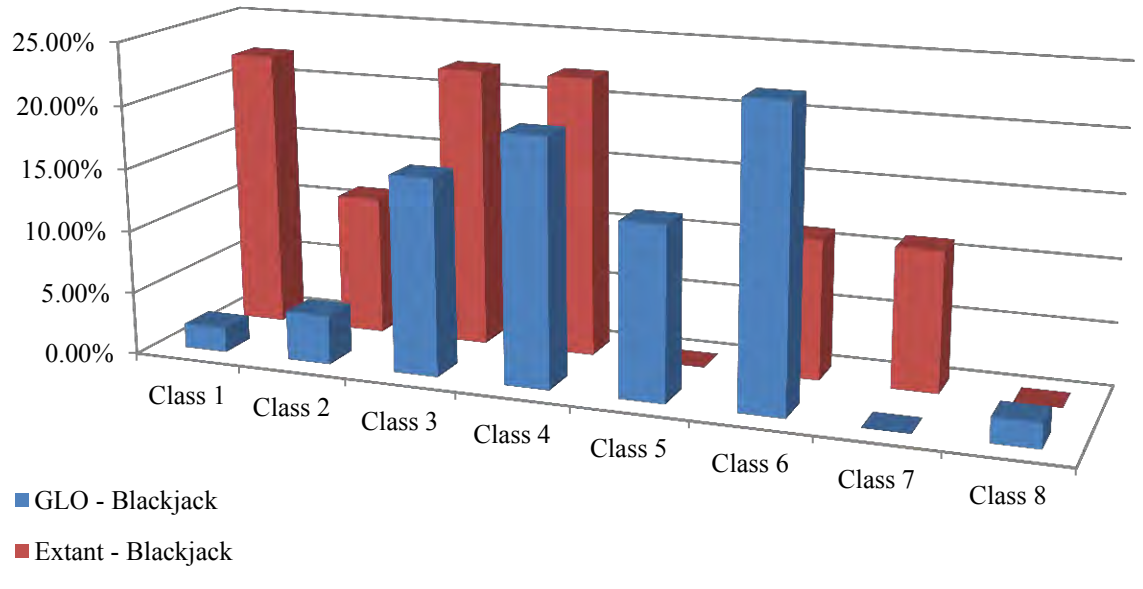


Figure 25E: Dry Mesic Forest - Frequency of Chinquapin Oak by Size Class Historic & Current Conditions

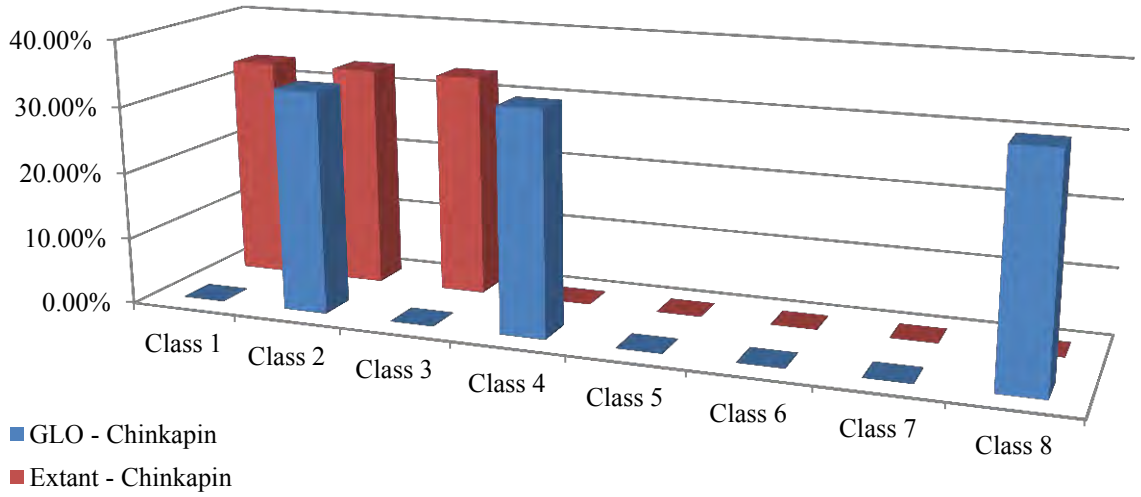


Figure 26E: Dry Mesic Forest - Frequency of Post Oak by Size Class Historic & Current Conditions

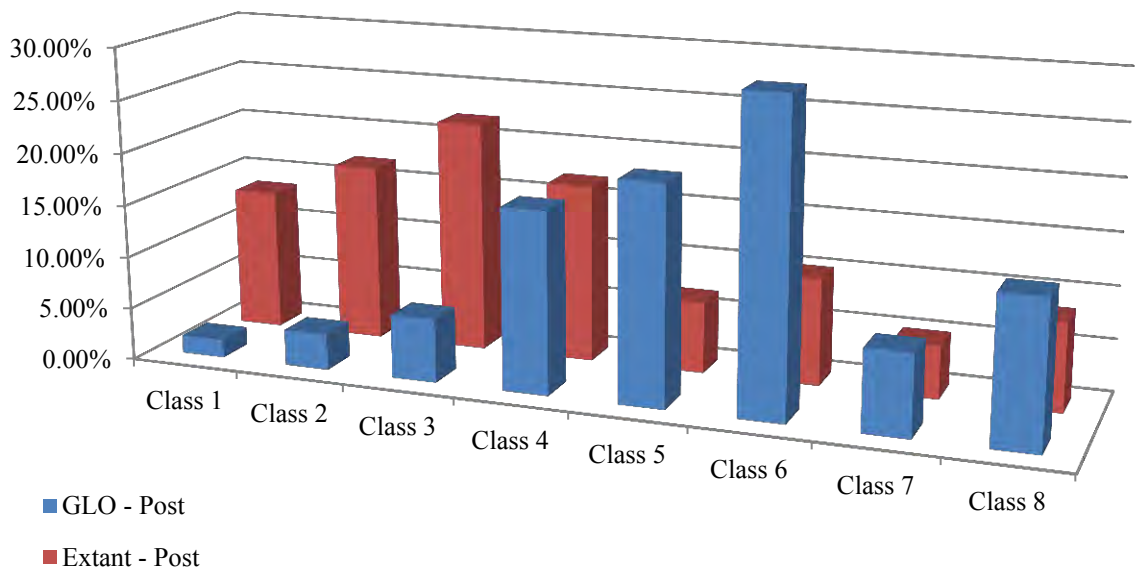


Figure 27E: Dry Mesic Forest - Frequency of Red Oak by Size Class Historic & Current Conditions

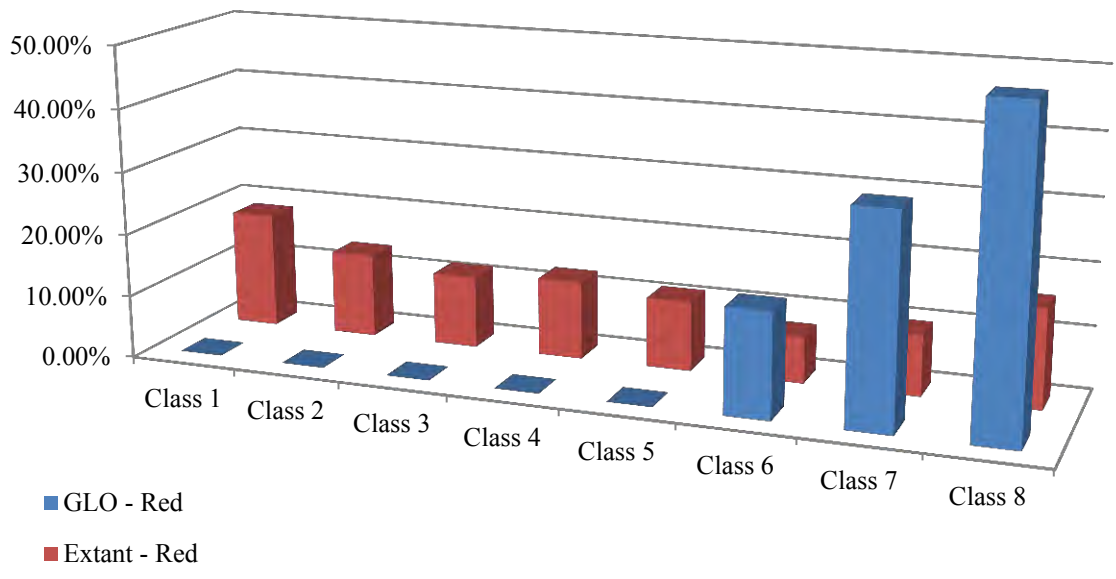
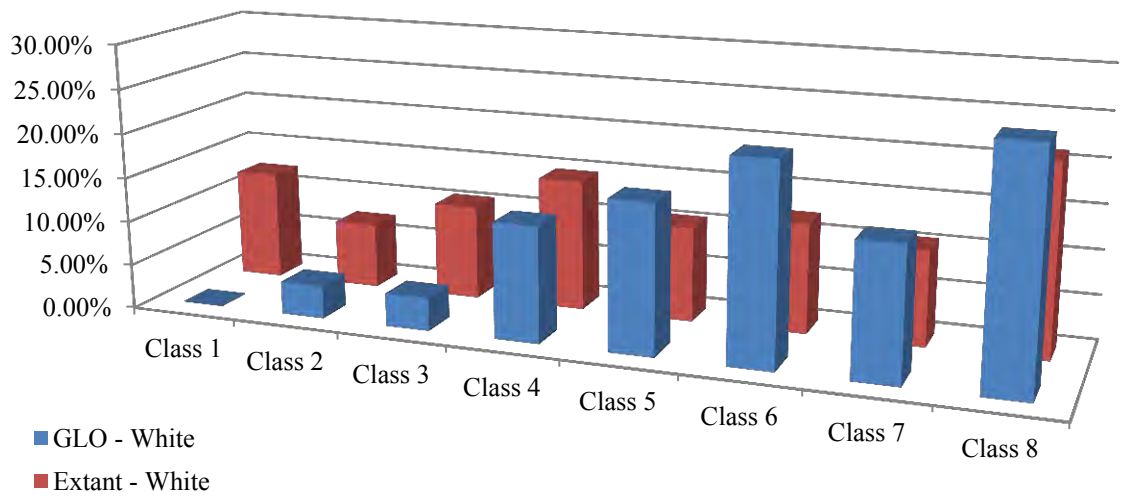


Figure 28E: Dry Mesic Forest - Frequency of White Oak by Size Class Historic & Current Conditions



Grades within this vegetation type are predominantly more than 30%. Thus, thinning of trees will primarily consist of felling by chainsaw. However, in areas with grades less than 30%, mechanical thinning will be used when access is feasible and practicable and its use is not adverse to goals and objectives. Basal area and percent canopy coverage will be reduced, primarily in the red oak group, to meet designated parameters (Table 1E). If parameters are not met once the red oak group has been thinned then elm species will be targeted. Management, thinning, of the canopy cover in this vegetation type will follow procedures outlined in the Dry Open Woodland section of this document.

Management in the understory, other than red oak, will consist of thinning dogwood, redbud, persimmon, sassafras, and walnut in size classes 1 – 4. However, it will be thinned only in those circumstances where removal of the understory is beneficial to the recruitment and dissemination of historic oak group size classes consistent with the establishment of a minimum of three cohorts for each oak species. At no time will chinquapin be thinned.

The ground layer will be monitored during the growing season following each prescribed burn to document exotic species. Spot treatment of identified exotic vegetation will occur as needed and will follow established procedures of treatment listed in the Exotic Plant Management Environmental Assessment as well as those identified herein.

Bottomland:

A buffer zone of 100 feet (Bowles 2013) has been established around wetlands and streams (Figure 1B) that will be avoided, with the exception of the removal of cedar, during vegetation management activities to prevent impacts from occurring on sensitive resources. Prescribed fire will be utilized in this area but only to the extent that climatic conditions, slope, and aspect allow at the time of the burn.

Historic Trees:

The vegetation at the park is a significant part of the cultural landscape. Components of that landscape, trees that were greater than 4" dbh dated on or before 1862, exist and were present during the Battle of Pea Ridge. As such, the primary goal for historic trees at the park is preservation to retain their overall character, form and authentic historic appearance as part of the landscape. As such, the objective is to manage and intervene as necessary to retain the overall character of the historical landscape (NPS Publication #17 2001). Management will include actions that minimize damage to, and/or prolong the life of, historic trees. However, trees will be removed from wooded areas, regardless of where they occur, when, because of age they deter from the cultural landscape, become a safety hazard and/or threaten other historic trees (NPS Publication #17 2001). Trees that are lost due to age or other factors (e.g., disease, tornado, ice, etc…) will be replaced through natural succession of remaining historically documented species resulting from implementation of methodologies identified above for savanna, woodland, and forest management. Nonetheless, historic trees will be preserved for as long as possible through techniques and actions described below.

Historic trees (trees) will be identified and then managed by locality, like other vegetation types, (Figure 1E). Methods identified herein are in addition to, and separate from, those identified for cedar and glade vegetative type methodologies.

An International Society of Arboriculture-certified arborist will identify necessary actions, by tree, to achieve identified goals and objectives for this resource. In addition, all work will be supervised, and/or conducted, by a qualified arborist, and will follow

arboricultural standards that meet International Society of Arboriculture (ISA) and American National Standards Institute (ANSI) safety specifications A300 Tree Care Operations.

All actions that are taken will be documented, by tree, to provide a basis of, and record for, management.

Management will focus on techniques identified in the draft "Landscape Preservation Maintenance Plan (LPMP) for Hearst San Simeon State Historical Monument (2010) document. Thus, they will focus on three primary strategies:

(1) Improvement of structural stability and health through conservative pruning and prevention of mechanical damage or injury of trunks, roots, and large limbs.
(2) Maintaining a stable environment within the proximity of identified trees by avoiding of soil disturbance around tree root zones.
(3) Consistent application of management strategies so that abrupt changes in maintenance activities do not occur.

Strategies will be achieved through the following activities and actions:

(1) Locate – historic trees will be identified, by locality (Figure 1E), from GLO notes and characteristics by species.
(2) Age – located trees will be cored to determine age.
(3) Record – Once trees have been located and determined to be historic then each tree will be documented, through the use of geographical positioning systems and photography.
(4) Annually Inspect trees - inspections identify structural instability that may lead to tree failure. Inspections include examination of tree roots, stem(s), and crown for trunk cavities/hollows; conks or other fungal fruiting bodies; large dead limbs; and old wounds that have not closed.
(5) Protection – utmost care will be taken to eliminate and/or reduce injury or wounding to roots, trunks, and large limbs during tree care. Establish a root protection zone, the diameter of which is determined from dbh where 1" of dbh is equivalent to one-foot radius of root protection zone. For example, a 10" dbh tree would have a root protection zone of 10 feet in radius.
(6) Determine soil fertility and compaction, repair if necessary. Soil fertility and application rates, if needed, will be determined by soil sample through the Benton County Extension Agent. Soil compaction will be tested with an air spade. If compacted then it will be vertically mulched with an air spade.
(7) Repair – Trees will be allowed to respond naturally to impacts and pruning cuts. Wound dressing, paints, or other chemicals and/or mechanical means will not be used to enhance tree wound closure response.
(8) Pruning – focused on the removal of dead, damaged, and hazardous wood. Live wood and foliage will not be removed from historic tree canopies. Pruning will be conducted such that it contributes to preserving the historic character and/or structural integrity of the tree, plant health, and function.

(9) Cabling/bracing – cables, braces, and guys will only be used when trees are adjacent, and pose a threat, to structures (e.g., buildings, trails) or are safety hazards.

(10) Pest management – Diseased trees (e.g., hypoxylon canker) will be removed if, through inspection by a qualified arborist, they are determined to be a detriment to surrounding vegetation and/or trees.

(11) Hazard Trees – remove hazard trees adjacent to historic trees. Removal will primarily involve hand-felling techniques.

Prairie, Grassland and Orchard Management
(Field & Mowed Areas)

Prairie:

The existing prairie, located on the western edge of the park (Figure 1F) is similar in size and location to that identified in 1836 & 1837 (GLO) as well as circa 1862 and was re-established by the park in 2001. Diamond et al. (2013) document little bluestem, 38.75% cover, and big blue stem, 62.5% cover, as being the dominant vegetation within the prairie but yellow fruit sedge, 15% cover, Indian grass, 3% cover, and broom sedge bluestem, 3% cover, exist. They also document exotic cool season grasses such as Kentucky bluegrass, 3% cover, and tall fescue, 1.75% cover. The dominant tree identified with this vegetation type was persimmon with a percent cover of three. Two additional tree species, box elder and American elm, were identified as existing but were minimal, 0.5% cover each. The shrub layer primarily consisted of coralberry, 7.75% cover.

Based on literature the prairie, circa 1862, would have had a basal area of <10, a percent canopy cover of <10%, and a dense ground layer of C4 grasses, sedges, and forbs and burned every 1 to 3 years with a moderate to high intensity fire (Table 1E).

The prairie, based on the findings of Diamond et al. (2013) as compared to historic conditions is currently in a maintenance mode, with the exception of 5.31 acres encroached upon by dry-mesic forest (Figure 1F). This entire area was under agricultural use prior to park inception (Figure 2F).

Consequently, management in this area will consist of maintaining the existing prairie through fire, consistent with historic fire regimes, spot treatment of exotic vegetation and re-establishment of prairie in the adjoining 5.31 acres currently overgrown with trees. The prairie may be hayed but only on an occasional basis, no more than once every two years, when for logistical or climatic conditions, it was not burned consistent with its historic regime or native hay is needed for re-establishment of native grasses in identified fields and savannas. The utilization of prairie seed hay, in combination with broadcasting, can be used to establish native grasses (Dillard 2013). Timing for haying operations in the prairie, when hay is to be used as a seed source, is crucial and different from hay produced for forage. Prairie hay utilized as a seed source in the re-establishment of native grasses will be cut in late summer to early fall dependent on when the plants have produced mature seed but before dispersal. Prairie hay used for forage will be cut mid-summer, typically June or July.

The 5.31-acre re-establishment will consist of the removal of all trees and brush through hand felling, mechanical removal (pp. 62) and prescribed fire. Trees that are greater than 12” in diameter, straight trunked, and accessible will be utilized for fence rails if needed. Trees, not needed for fence rails, may be made available to the public, when access is feasible and practicable, and use is not adverse to goals and objectives. Otherwise they will be felled in place and/or girdled. Thus, trees less than 12” dbh will be felled, consumed through prescribed fire and/or mulched. If trees are chipped, then mulch will be spread evenly over the area, or utilized within the park (e.g., erosion control on trails and historic roads,

mulching of orchard trees, planted trees, or trees within the administration zone). Trees ≥ 12" dbh that cannot be feasibly utilized will be girdled and left in place.

Once the area has been cleared then warm season, C4 grasses will planted and will mirror the methodology described for the ground layer within the Savanna section of this document (pp. 73). The restored area will be inventoried annually to determine percent coverage of C4 grasses until the goal of 80% cover is achieved then monitored annually thereafter.

The existing prairie will be monitored annually to identify and target exotic vegetation. Spot treatment of exotic vegetation, within both the existing and restored prairie, identified through inventories and/or monitoring, will occur as needed and will follow established procedures of treatment listed in the Exotic Plant Management Environmental Assessment as well as those identified herein.

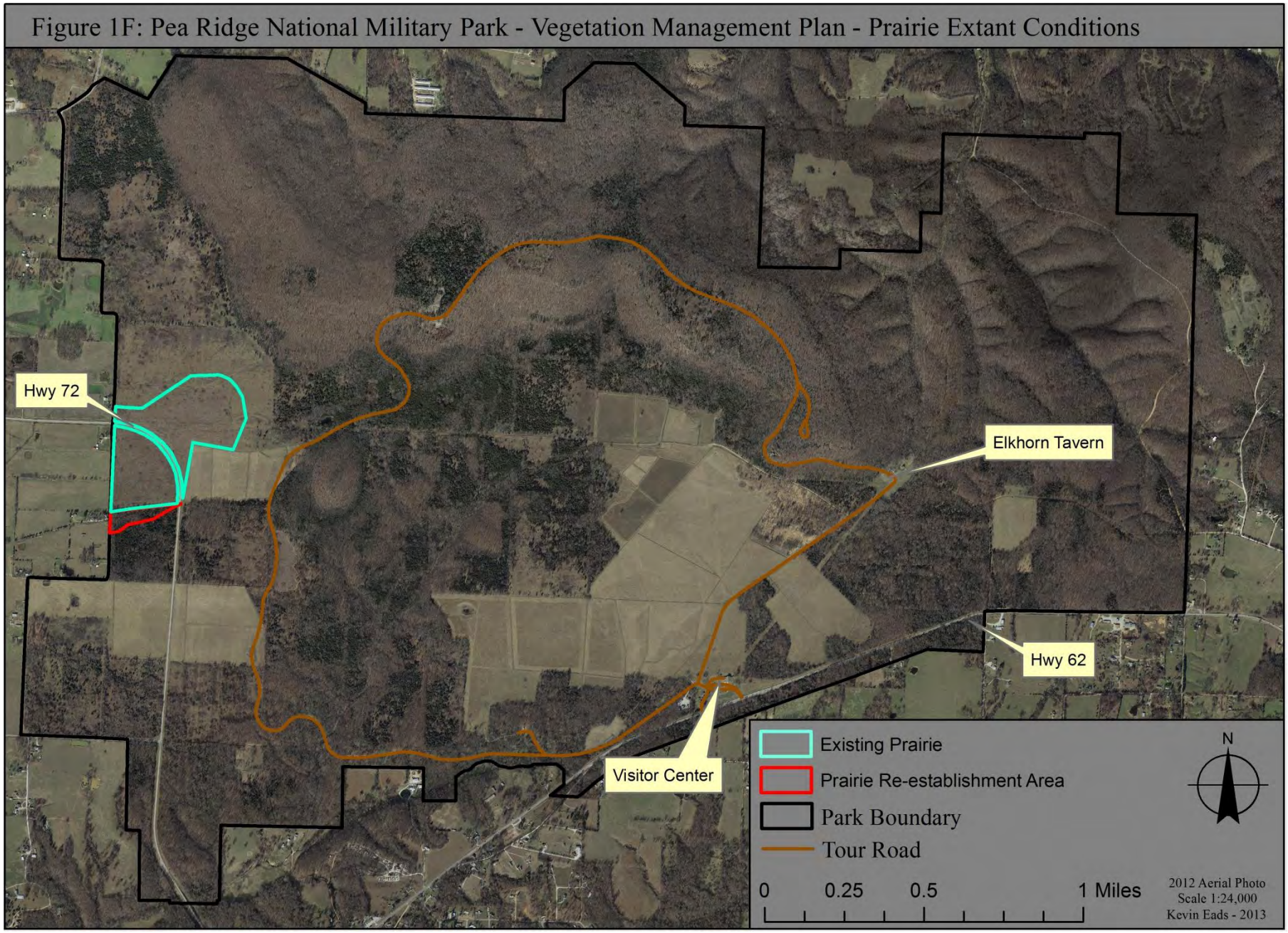


Figure 1F: Pea Ridge National Military Park - Vegetation Management Plan - Prairie Extant Conditions
Hwy 72
Elkhorn Tavern
Hwy 62
Visitor Center
Existing Prairie
Prairie Re-establishment Area
Park Boundary
Tour Road
N
0
0.25
0.5
1 Miles
2012 Aerial Photo
Scale 1:24,000
Kevin Eads - 2013

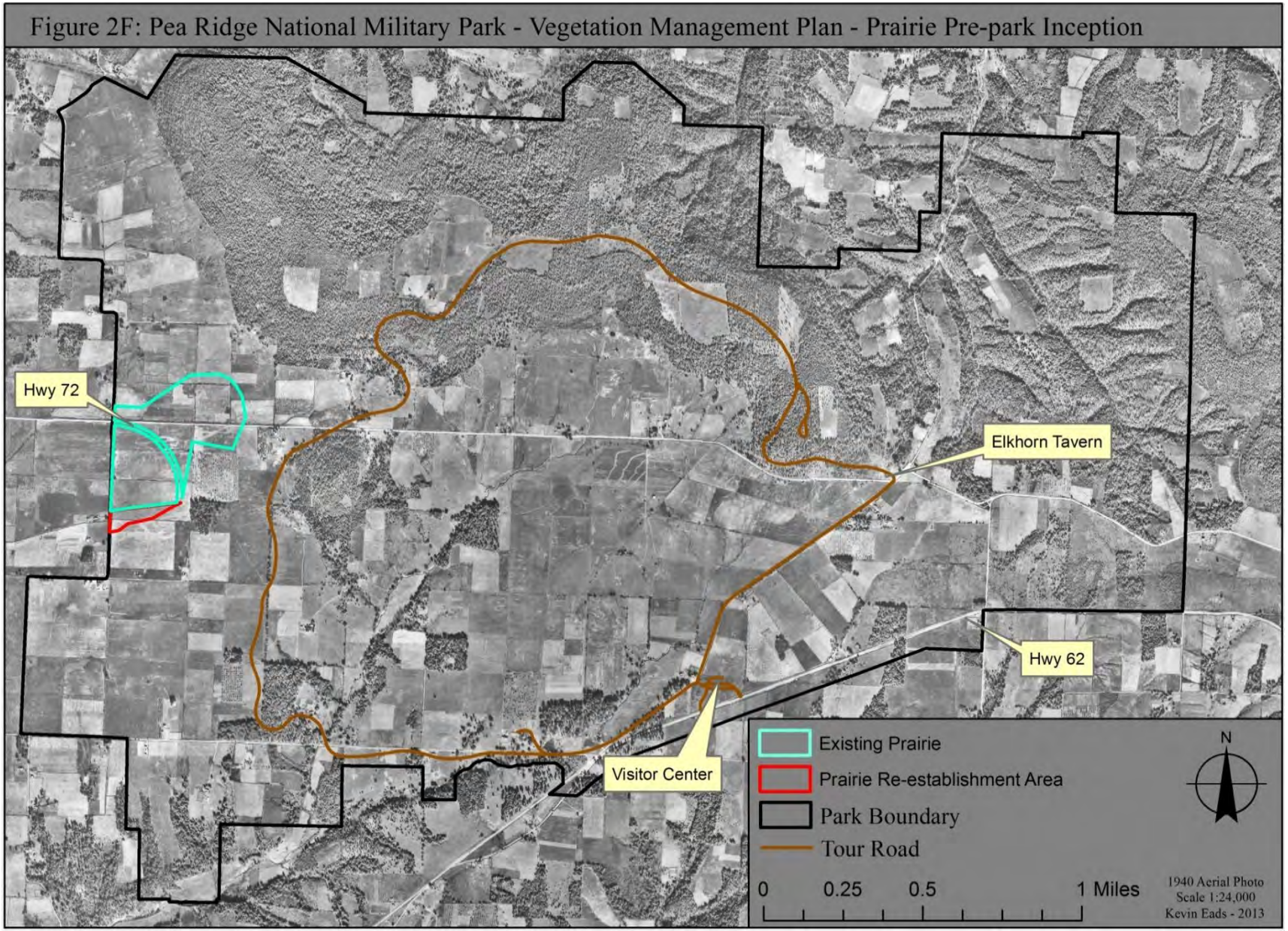


Figure 2F: Pea Ridge National Military Park - Vegetation Management Plan - Prairie Pre-park Inception
Hwy 72
Elkhorn Tavern
Hwy 62
Visitor Center
Existing Prairie
Prairie Re-establishment Area
Park Boundary
Tour Road
N
0
0.25
0.5
1 Miles
1940 Aerial Photo
Scale 1:24,000
Kevin Eads - 2013

Field(s):

Bearss (1957) identified 39 separate fields as being present during the Battle of Pea Ridge. They total 480 acres and are located in what would have been, prior to Euro-American settlement, prairie, savanna, dry-open woodlands and dry-mesic woodlands (Figure 1B). At the time of the battle, some were identified as being in crops while others were fallow. Bearss (1957) also identified an open area, but did not label it as a field, in association with Pratt's store that was used as Curtis' headquarters by the Union troops.

There is currently 463.14 acres, of the 480 acres that historically occurred, available for management. U.S. State Highway 72, the tour road, trails, parking lots, and waysides take up the remaining 16.86 acres. This area was under continued agricultural use prior to park inception (Figure 3F).

Diamond et al. (2013) states that tall fescue is the prevailing dominant species within the fields and mowed areas, 61.7% cover occurring 100% of the time, but also documented Narrowleaf Mountainmint, Chapman's Bluegrass, and Yellowfruit and Troublesome sedge. Broomsedge bluestem occurred in all plots and consisted of 6.2% of the ground layer cover.

In keeping with the selected alternative, these locations (fields and open area) will be managed so that agricultural crops are represented, key interpretive vistas are kept open, and the viewshed, in fields not associated with interpretive waysides and stops, are visually and structurally similar to vegetation that would have existed circa 1862. In addition, as with all other vegetation types, fields will be managed by locality (Figures 1E and 2E). However, because they are currently in fescue and until management is implemented, as described below, they will be maintained annually through haying, prescribed burns, and/or mowing.

Fields, identified in association with key interpretive vistas, will be maintained in their current state of fescue, 167.72 acres. They are located in sections of Leetown Hamlet, Clemmons Field, Orberson's field, Jessie Cox's Field, Curtis' Headquarters, Sturdy's Farm, and a portion of the Woodlot (Figure 4F).

Agricultural crops will be situated adjacent to waysides and/or tour stops, made up of 11.13 acres total, located in sections of Orberson's field, Sturdy's farm, Elkhorn Tavern, and Samuel Ruddick's field (Figure 4F).

The remaining 284.29 acres of field(s) located in sections of G.W. Ford's field, Leetown Hamlet, Clemmon's field, J. Ruddick's Field, Mayfield's field, Wiley Fosters farm, Samuel Ruddick's Field, Lee's Field, and the remainder of the woodlot will be converted to native C4 prairie grasses (Figure 4F).

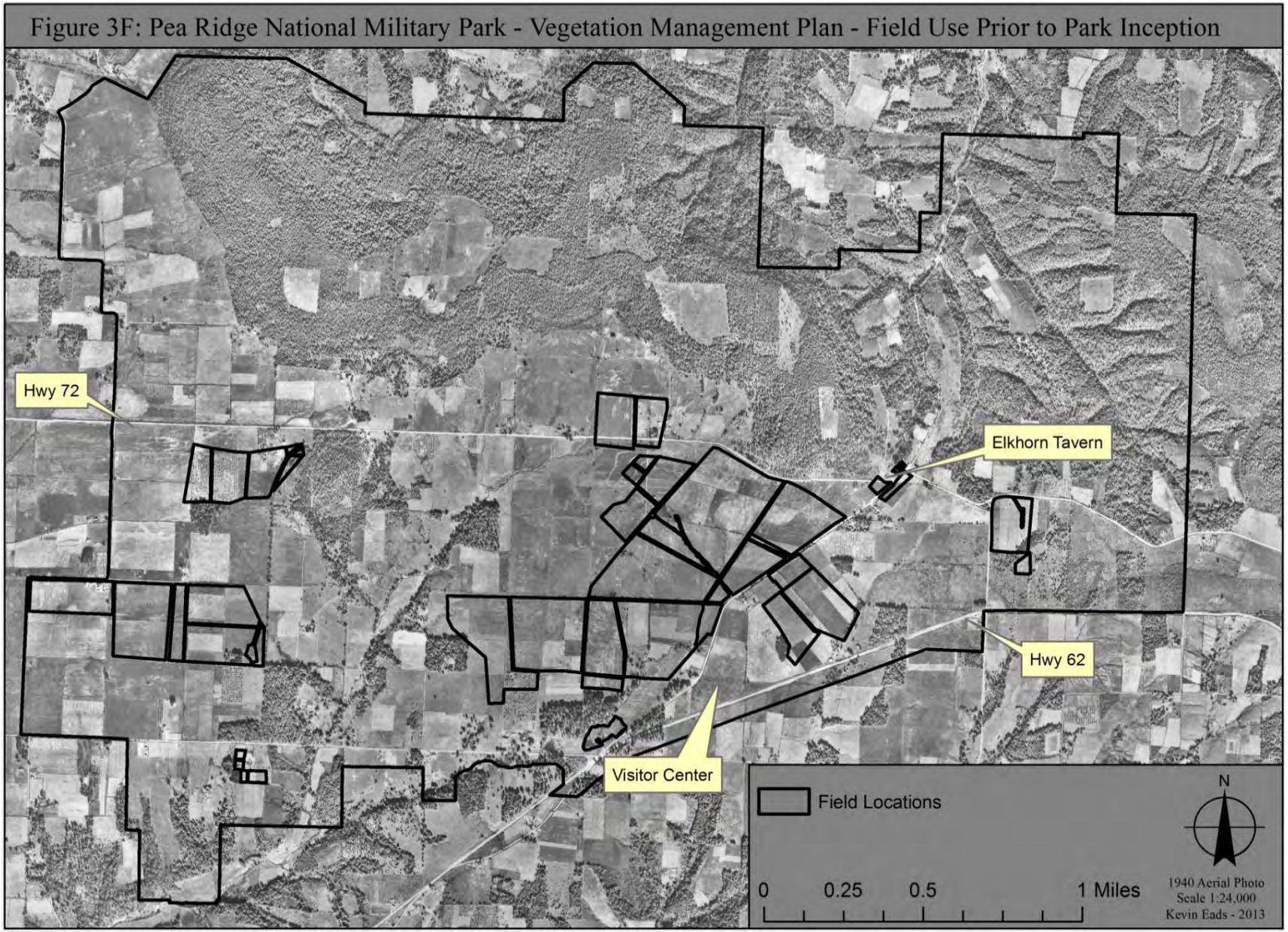


Figure 3F: Pea Ridge National Military Park - Vegetation Management Plan - Field Use Prior to Park Inception
Hwy 72
Elkhorn Tavern
Hwy 62
Visitor Center
Field Locations
N
0
0.25
0.5
1 Miles
1940 Aerial Photo
Scale 1:24,000
Kevin Eads - 2013

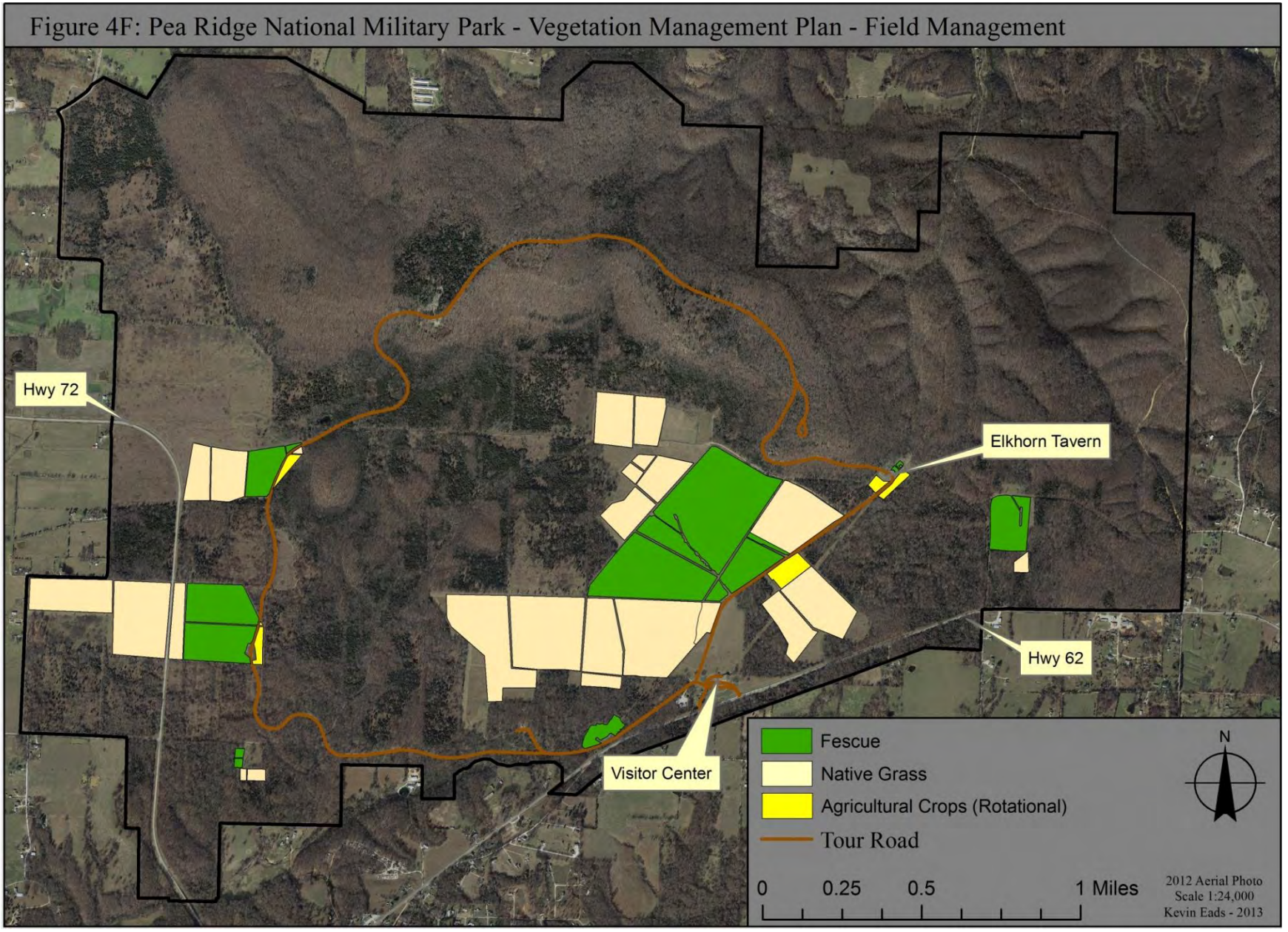


Figure 4F: Pea Ridge National Military Park - Vegetation Management Plan - Field Management
Hwy 72
Elkhorn Tavern
Hwy 62
Visitor Center
Fescue
Native Grass
Agricultural Crops (Rotational)
Tour Road
N
0
0.25
0.5
1 Miles
2012 Aerial Photo
Scale 1:24,000
Kevin Eads - 2013

Haying, in-house or through contract, will be the primary method used to maintain all fields on an annual basis until management regimes, by field and locality, are implemented. Fields that remain in fescue, 167.72 acres, will continue to be hayed on an annual basis with the exception that, on occasion, they will be left fallow and burned. Fields where native grasses are established will continue to be hayed but only once every 3 to 4 years. Agricultural crop areas, when not in rotation, will be mowed, hayed, or burned annually and on occasion left fallow. All hay, unless required for park use, will be made available to the public.

All haying will be conducted during the appropriate season by vegetation type. For example, fields that contain fescue will be cut for hay 1 to 3 times per year dependent upon temperature and rain patterns. Fields with established native grass will be hayed, as determined by management regime rotation, once per year, typically mid to late summer. All fields will be mowed in a manner to maintain uniformity of appearance. Agriculture equipment for haying will include tractors, hay rakes, round or square hay balers, etc… but only when ground conditions permit so that ground disturbance will not occur. Hay will not be stored in any field; it will be promptly removed after being baled. Hay will be removed from fields on trailers that do not exceed 28 feet in length, with 1-ton, or less, trucks. At no time will semi-trucks and trailers be allowed on any field. In addition, no machinery and/or equipment will be left within public view except during actual haying operations. If haying operations are interrupted by weather for more than 24 hours, all equipment will be moved from public view.

Fertilization requirements and lime application rates for fields that are in fescue, and identified for haying, will be determined through soil tests conducted through the Benton County Extension Agent every three years. All fescue fields will be managed for maintenance purposes only, not hay production, so that fertilization and lime applications are kept to a minimum. At no time will tillage or drilling of fields, identified for haying, be allowed.

Since those fields identified as remaining in fescue currently exist and are in a maintenance mode, no other action other than haying, and the occasional burning, is required. Fields will be left fallow and burned if they exhibit signs of stress or encroachment of additional exotic vegetation. For example, fescue in some areas of the field dies out and/or is being taken over by Johnson grass or Seresia lespedeza. Annual monitoring of these areas will be conducted to identify signs of stress and exotic species encroachment. Any identified exotic species will be spot treated consistent with established procedures identified in the Exotic Plant Management Environmental Assessment.

Methods implemented in fields designated for the establishment of native grass, 284.29 acres, will follow those outlined in the savanna vegetative type identified in this appendix (pp. 77). Once established, fields in native grasses will be placed on a 4-year rotation where they will be burned once, hayed once, and left fallow the remainder of the time.

Agricultural crop areas, 10.72 acres, are located in four primary areas, Leetown Battlefield (Orberson's field), Fosters Farm (Sturdy's Farm), Elkhorn Tavern, and Samuel Ruddick's field (Table 1F). Leetown Battlefield and Fosters Farm both contain two areas each that are

east of and adjacent to the tour road. Elkhorn Tavern contains two areas, one immediately southwest of the monuments, and one adjacent to, and southeast of the tour road (Figure 4F). The objective of agricultural crops is to enhance the interpretive experience for visitors. As such the visual representation of crops, not crop production, is paramount and therefore guides the management and maintenance of these areas.

Table 1F: Agricultural Crop Areas

Location	Acreage
Leetown Battlefield (Orberson's field)	1.75
Fosters Farm (Sturdy's Farm)	1.55
Elkhorn Tavern	1.65
Samuel Ruddick's field	4.77
Total	10.72

All areas, at some point, will be planted with varieties similar to those that existed historically. They include foxtail millet, wheat, corn, hops, and sorghum. These four areas will be placed on a 4-year rotation cycle where only two areas, in any given year, will be planted with the varieties identified above. One of the remaining areas will be planted with a variety that replenishes soil nutrients, such as turnips or clover while the remaining area will be left fallow. Crops will be rotated in each area so that no single variety is successively planted. In addition, successive crops will be dissimilar so that soil depletion does not occur and weeds and insects are better controlled thereby reducing the need for herbicides and pesticides. Nonetheless, herbicides and pesticides may be used if objectives are not met. Areas may be fertilized but only to the extent that objectives are met. Application rates will be determined by soil sample conducted through the Benton County Extension Agent every three years.

Drexler et al. (2008) in a Park-wide Archeological Assessment intensively surveyed two of the four areas identified for agricultural crops, Leetown Battlefield and the Elkhorn Tavern (Figure 5F). Steve DeVore surveyed the area in Samuel Ruddick's field in 2013 for mitigation work proposed for the relocation of U.S. Highway 62 from the park (Figure 5F). The remaining area, Fosters Farm, designated for agricultural crops has not been archeologically surveyed.

Most battle-related, prehistoric, and historic archeological materials were found four to six inches below ground within the old plow zone, 6 to 8 inches in depth. All of these areas were plowed in the past (Figure 3F), prior to park inception, meaning that artifacts, although significant, are not in primary context (MWAC Memorandum 2005).

As such, three of the four areas will be planted in crops. The remaining area, Fosters Farm, will be archeologically surveyed prior to being planted with crops. Surveys will follow specifications identified in this document (pp. 74) and in section G.

Planting will consist of discing identified areas at a depth of no more than 6 inches, well within the old plow zone, to prepare the soil and/or through no-till drilling methods. Crops will planted through drilling, at a depth of no more than 1 inch, and/or broadcasting, dependent on the plant (e.g., corn would be drilled while turnips would be broadcast). Crops will be left in the field, for their interpretive value, until areas are to be replanted.

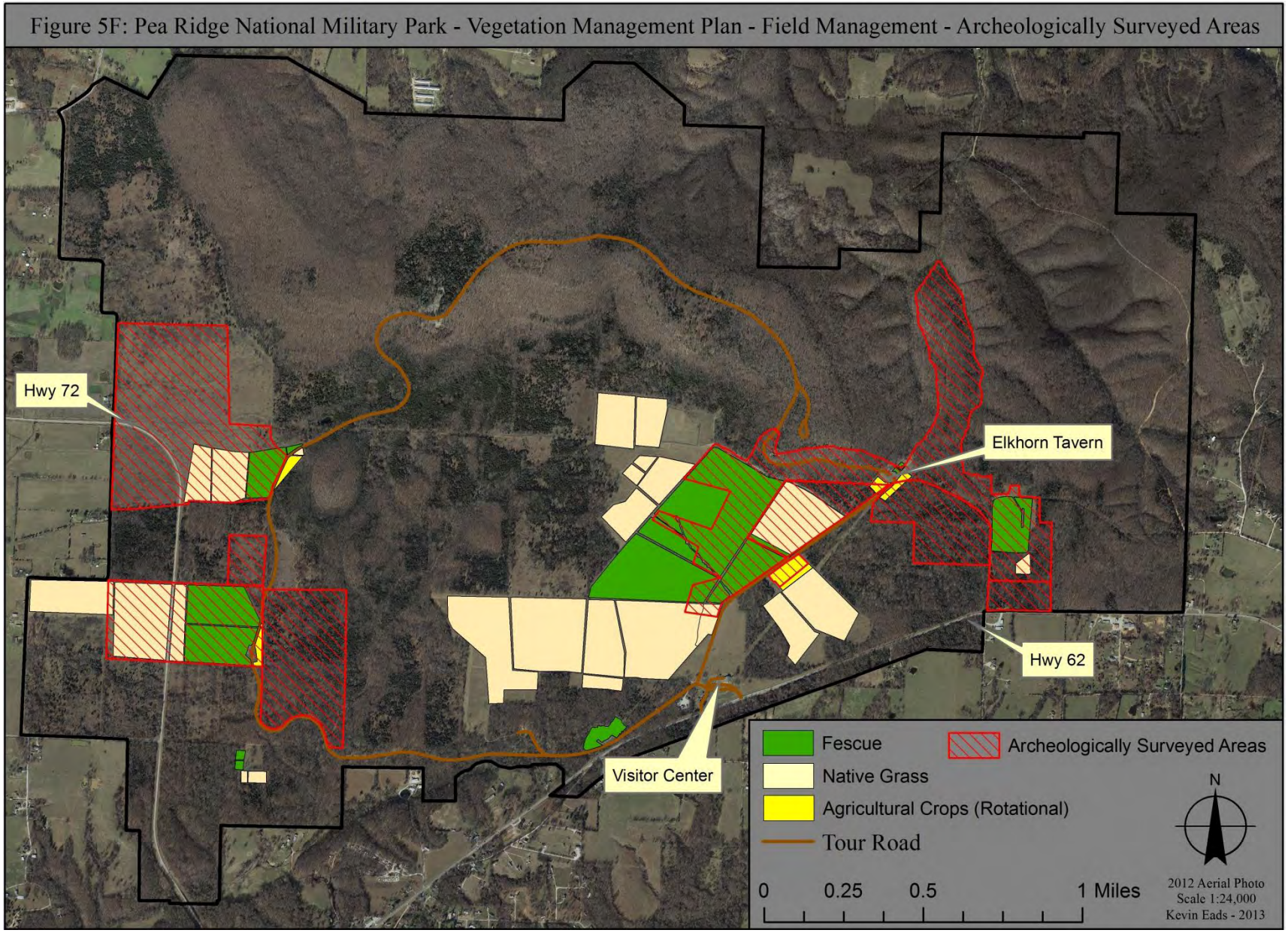


Figure 5F: Pea Ridge National Military Park - Vegetation Management Plan - Field Management - Archeologically Surveyed Areas
Hwy 72
Elkhorn Tavern
Hwy 62
Visitor Center
Fescue
Native Grass
Agricultural Crops (Rotational)
Tour Road
Archeologically Surveyed Areas
N
0
0.25
0.5
1 Miles
2012 Aerial Photo
Scale 1:24,000
Kevin Eads - 2013

Mowed Areas:

Management for mowed areas along the tour road and on hiking and horse trails are identified within the Vegetation Management Plan under actions common to all alternatives. Methods for other locations, Visitor areas, generally described within the selected alternative contain 15.68 acres, are primarily fescue, and heavily utilized by visitors. Consequently, they will be routinely mowed dependent on funding and personnel and in-line with the established mowing plan (Artripe 2013). They are located at the Visitor Center, Elkhorn Tavern, Horse Trail Head, Ford Cemetery, and the Union Trenches (Figure 6F). Additional areas, not shown, will also be mowed routinely and include those adjacent to waysides and tour stops along the tour road.

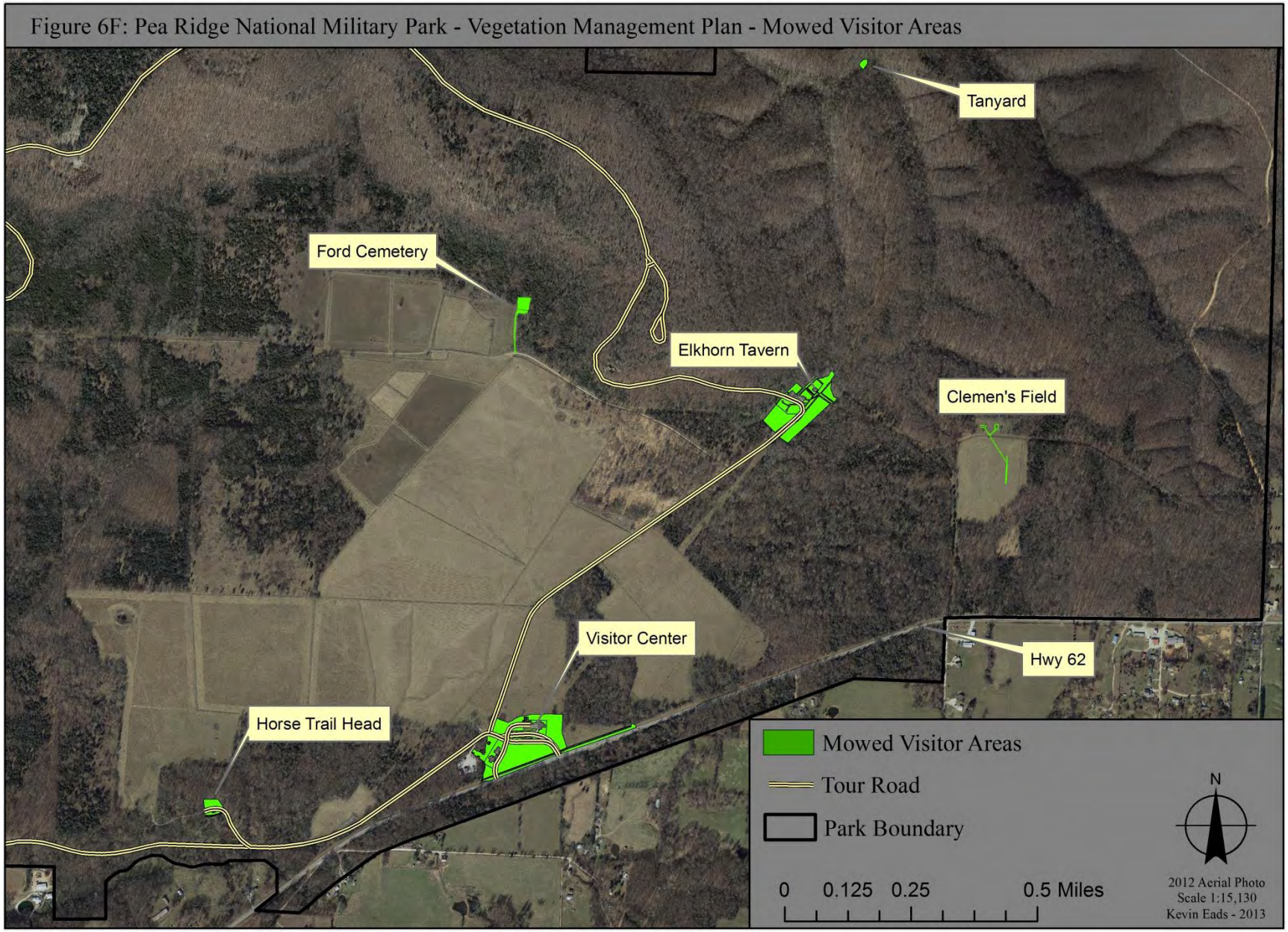


Figure 6F: Pea Ridge National Military Park - Vegetation Management Plan - Mowed Visitor Areas
Tanyard
Ford Cemetery
Elkhorn Tavern
Clemen's Field
Visitor Center
Hwy 62
Horse Trail Head
Mowed Visitor Areas
Tour Road
Park Boundary
N
0 0.125 0.25 0.5 Miles
2012 Aerial Photo
Scale 1:15,130
Kevin Eads - 2013

Orchards:

There are two orchards on the park. One contains 200 peach trees, the other 38 apple trees (Figure 7F). Per the Vegetation Management Plan, the objective for orchards is to present their historic pattern and configuration as they existed in 1862. Hence, all trees will be managed for appearance and not production.

The apple orchard is located adjacent to the Elkhorn Tavern and is fully stocked within the available area (Figure 7F). Currently, over half of the apple orchard consists of a parking lot and paved tour road. Historically accurate fencing and painted fence lines on associated walkways, the parking lot and tour road delineate it.

The paved area and associated walkways around the apple orchard are included in the proposed mitigation actions that are to occur when U.S. Highway 62 is removed from the park. Thus, it is unknown if these areas will be removed. However, if they are removed then the apple orchard will be completely fenced and planted with historic varieties of apple trees, like those currently present, to complete the pattern and configuration of the orchard. As such, an additional 42 trees will be planted if the opportunity arises. An archeological assessment will be conducted prior to any trees being planted and will follow methodologies identified in this appendix (pp. 74) and associated section G.

The peach orchard, located at Ford Farm (figure 7F), has been fenced but only a portion of it has been planted, 13%, an estimated 1500 trees would have existed. Existing trees were planted in the old roadbed of U.S. Highway 72; removed in the mid-1960s.

This orchard currently meets identified objectives in that it presents the historic pattern and configuration of an 1862 orchard. Thus, it will not be expanded through the planting of additional trees. However, the area that currently has trees will be maintained by replacement in-kind of any trees that are diseased and/or die. The remainder of the peach orchard, currently fescue, will be established with native grasses consistent with methodologies described previously in this appendix (pp. 77) and maintained like native grass fields described above.

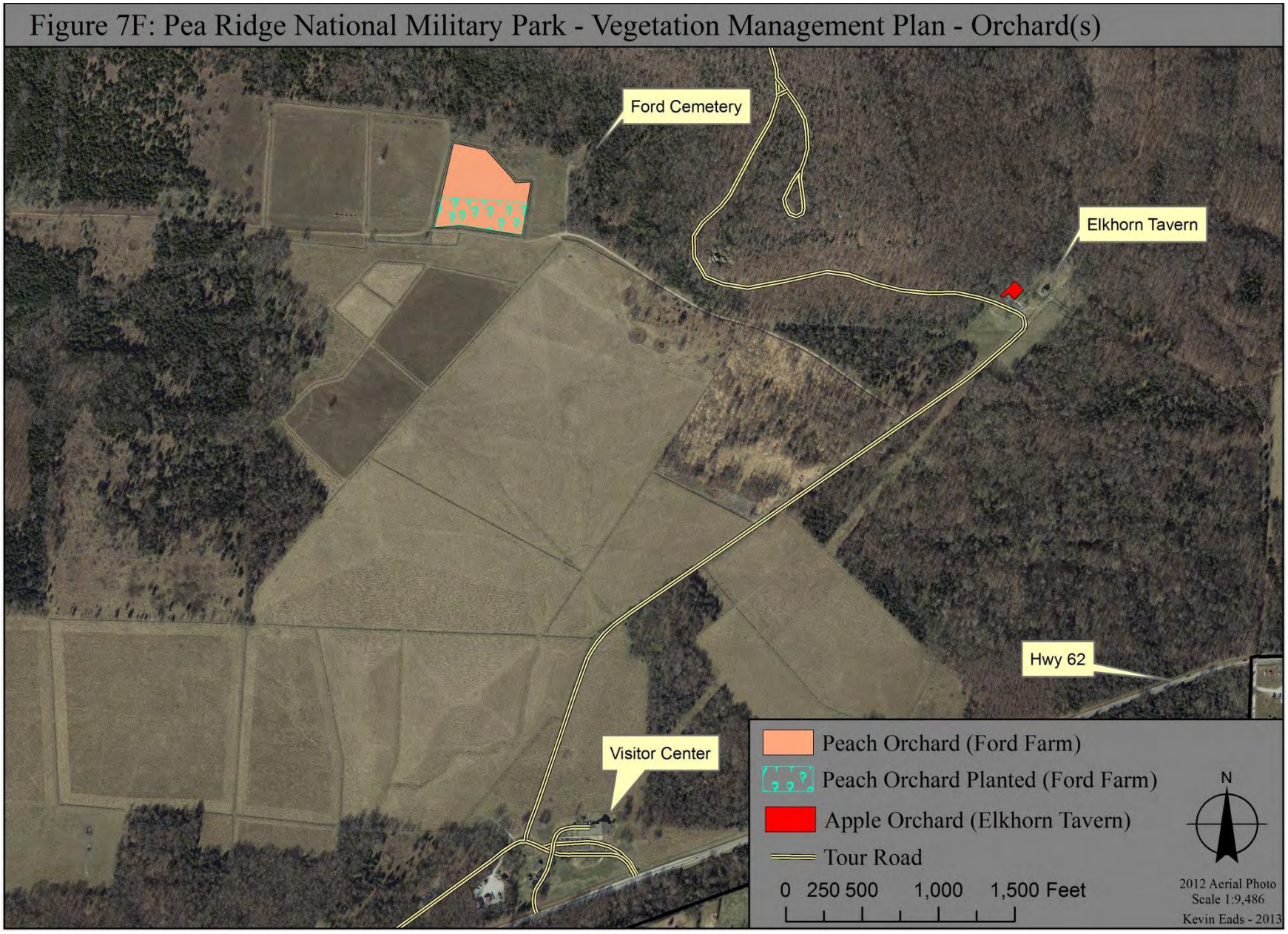


Figure 7F: Pea Ridge National Military Park - Vegetation Management Plan - Orchard(s)
Ford Cemetery
Elkhorn Tavern
Hwy 62
Visitor Center
Peach Orchard (Ford Farm)
Peach Orchard Planted (Ford Farm)
Apple Orchard (Elkhorn Tavern)
Tour Road
0 250 500 1,000 1,500 Feet
N
2012 Aerial Photo
Scale 1:9,486
Kevin Eads - 2013

Scope-of-Work
(Taken from Steve DeVore's Work/Writings on Previous Investigations, 2013)

Geophysical Evaluation of Areas Identified in the Vegetative Management Plan Appendix within Pea Ridge National Military Park, Benton County, Arkansas

This work plan outlines a geophysical archeological inventory and evaluation for areas identified within the appendix of the Vegetation Management Plan (VMP) that involve ground disturbance. The work is scheduled to be completed by staff archeologists and archeological technicians from the Midwest Archeological Center (MWAC) with support from volunteers under the Volunteer-In-Park (VIP) program, University of Nebraska-Lincoln faculty appointee, and PERI staff. All aspects of the project (fieldwork, analysis, and report preparation) will be conducted under the direction of the Midwest Archeological Center staff. The geophysical investigations will consist of metal detector surveys and archeological shovel testing within the selected areas identified in VMP appendix. The results of the geophysical survey will be incorporated into a project trip report and the geophysical and archeological evaluation project report.

Introduction:

The Pea Ridge National Military Park was created by an act of Congress on July 20, 1956 and commemorates the Civil War Battle of Pea Ridge that was fought between March 7 and 8, 1862. During the two day battle, the Federal forces under the leadership of Brig. Gen. Samuel R. Curtis defeated the Confederate forces under the leadership of Maj. Gen. Earl Van Dorn, which helped gain control of border state of Missouri for the Union.

The park is located in Benton County in northwestern Arkansas and includes the 4,300-acre site of the battle. The battlefield and the remnants of Union trenches overlooking Sugar Creek to the southwest of the main battlefield are designated as 3BE184. The battlefield is listed on the National Register of Historic Places (October 15, 1969). Four prehistoric sites are also located within the park including three prehistoric lithic scatters (3BE512, 3BE513, and 3 BE589) and a lithic scatter at the Winton Spring site (3BE305).

Previous Archeological Investigations:

Formal archeological investigations at PERI began with the 1965 excavations at Leetown by Rex Wilson (1965). Wilson focused on identifying the small farming hamlet of Leetown south of the fields where the Confederate and Federal troops engaged on March 7, 1862. His goals were to discover foundations and other remnants of structures that could identify the location of Leetown and to search for possible graves in a small nineteenth century cemetery. Although the investigations did not conclusively identify structure foundations, they did indicate evidence for buildings. His investigations identified 17 possible grave shafts in the cemetery. Additional excavations at the Elkhorn Tavern in search

of the mass burial trench near Curtis's headquarters yielded post-Civil War materials. He also identified three clay-lined vats in Tanyard Hollow.
In 1987, Roger Coleman (1988) conducted an archeological inventory along the proposed paved trail from Elkhorn Tavern to two Civil War commemorative monuments in the open field west of the tavern site. During the pedestrian survey and shovel testing of the trail alignment, he located six historic artifacts associated with the tavern occupants. He also identified two prehistoric sites during the shovel testing (3BE512 and 3BE513). Coleman indicated that both prehistoric sites were disturbed and eroded. Therefore, he concluded that they were not eligible for listing on the National Register of Historic Places.

James P. Harcourt (1993) conducted a Phase I cultural resources survey of the area identified for the construction of small equipment storage shed near the Visitors Center in 1993. He excavated series of shovel tests. He identified a sparse lithic scatter (3BE589) in the project area but found no artifacts associated with the battle of other 19th or 20th century occupations. There was no indication of intact sub-plowzone deposits identified in the shovel tests. Coleman recommended that no additional archeological investigations were warranted and construction of the storage shed would have no adverse impact on the site.

Beginning in 2000, a five year long Systemwide Archeological Inventory Program (SAIP) project was undertaken at the park (Carlson-Drexler et al. 2008). The project was divided into a prehistoric inventory of the park under the direction of University of Arkansas archeologist Dr. Marvin Kay (Kay and Herrmann 2005) and a Civil War battlefield inventory under the direction of MWAC archeologist Dr. Douglas D. Scott (Carlson-Drexler et al. 2008). Between 2001 and 2004, the prehistoric inventory at PERI combined traditional archeological techniques including shovel tests, pedestrian reconnaissance survey, visual examination of exposures, and review of archival records to evaluate the potential of landscape settings for prehistoric sites (Kay and Herrmann 200510-21). The prehistoric project also included the geographic information system (GIS) based random sampling strategy and predictive modeling. Thirty-meter squares were selected as the sampling unit size. A total of 4,336 shovel test units were dug and the fill screened at PERI in the 30-meter square sampling units. Ninety-five percent of the shovel tests yielded negative results. Four percent of the shovel tests at PERI yielded prehistoric artifacts while historic items were found in two percent of the shovel test units and historic and prehistoric artifacts were found in one percent of less of the shovel test units. The battlefield survey used metal detectors as the inventory tool based on the assumption that most of the surviving artifacts would be metal objects are associated with metal objects (Carlson-Drexler et al. 2008:23-25). Metal targets identified during the metal detector survey team were excavated by the recovery team leaving them in place for the recovery team. The recovery team plotted the artifact location with a global position system unit, assigned field specimen numbers, and recovered the artifacts for laboratory processing and analysis at MWAC. Post-battle artifacts that could be positively identified were left in place. Between 2001 and 2003, the intensive metal detector inventory covered all of Oberson's and Cox's fields, most of Foster's field, Clemon's field, the area around Elkhorn Tavern, and the area along the narrow ridge north of Elkhorn Tavern along Telegraph Road including the east slope and bottom of Middle Ravine. A more limited reconnaissance level metal detector survey was conducted in the belt of trees between Oberson's and Foster's fields, Morgan's Woods, the area between Clemon's field and

Elkhorn Tavern, the southwestern portion of Broad Ridge. During the 2003 battlefield field season, William Volf (2004) conducted a resistance survey of portions of the Leetown site and at Elkhorn Tavern. He identified at least two geophysical anomalies that were appeared to represent building foundations or outlines. The resistance survey did not identify any potential structures at the Elkhorn Tavern geophysical survey area. A second geophysical investigation was conducted at Leetown by Jason Harmann (2004) as part of his Master's degree studies. He re-inventoried that area covered by Volf with additional geophysical techniques. He confirmed anomalies identified by Volf and located additional geophysical anomalies associated with historic features at Leetown including a potential road alignment.

The University of Arkansas's Archeo-Imaging Lab under the direction of Dr. Kenneth Kvamme (2002) conducted a magnetometer survey of a 20-m by 200-m area in the northeast corner of Oberson's field at the Leetown battlefield in 2002. The magnetic survey identified a number of anomalies, which were identified as ferrous artifacts and potential natural occurring prairie mounds. Approximately 37% of the point anomalies identified by the University of Arkansas crew and excavated by Scott's crew were associated with the battle (Carlson-Drexler 2008:10-11).

PERI Property Evaluation:

The Midwest Archeological Center (MWAC) archeological staff and volunteers will conduct a metal detector survey of the four proposed alternative routes and parking lot locations. The purpose of the metal detector investigations (Heimmer and De Vore 1995:47-50) is to provide clues on troop movements during the Battle at Pea Ridge and to locate other historic activities locations associated with the rural farming activities in the nineteenth and twentieth centuries. Metal detector surveys have proven extremely valuable as inventory tool for the archeological investigations of battlefields and campgrounds including the site of the Battle of Pea Ridge (Carlson-Drexler et al. 2008; Connor and Scott 1998; Scott and Fox 1987, Scott et al. 1989; Scott et al. 2005). The metal detector survey will be consistent with the methodology and research design developed for the previous Section 110 inventory project at the park (Scott 2000).

The metal detector fieldwork will consist of two phases with the inventory phase and the testing phase (Scott 2000). The inventory phase will use metal detectors, visual survey methods, and piece-plot recording techniques. The testing phase will consist of shovel test/formal test units at specific location as identified on metal detector finds. In addition, shovel tests and formal test unit excavations will be conducted in areas where the potential for prehistoric artifacts exist (e.g., recovery of prehistoric artifacts associated with metal detector finds, landscape settings around springs, and along the route of the Trail of Tears through the park).

The metal detector inventory phase consists of the metal detector survey, the recovery of metal detector finds, and the recording of the metal detector finds. The metal detector survey is designed to locate subsurface metallic items associated with the battle and with historic farming activities. The survey crew will located and mark metal detector targets. The metal detector operators will be aligned at approximately three to five meter intervals. The

operators will walk transects oriented parallel to the proposed areas identified in the VMP appendix. The operators will proceed in line using a sweeping motion to examine the ground. It is estimated that each operator can cover a sweep of 1.5 to 2.0 meters depending on a person's height and technique. Targets will be flagged for the recovery team. The recovery team will excavate the metal detector targets, leaving then in place. Excavation will occur with special care to expose just the artifact with minimal disturbance. Visual inspection of the ground surface will be carried out at the same time as the recovery efforts. The recording team will plot individual artifact locations with a global positioning system (GPS) unit or robotic total station, assign field specimen numbers, and collect the artifacts. Artifacts will be assigned sequential field specimen numbers.

Shovel tests and formal test unit excavations will occur in concentrations of non-battle related artifacts to determine the extent and integrity of historic farmsteads, camp sites, or other types of sites. Shovel test units will be approximately 30 cm in diameter and excavated to a minimum of 50 cm. Shovel test units will be spaced 10 m apart with closer spacing at the discretion of the archeologist. The soil matrix will be screened through ¼ inch hardware cloth. Shovel test unit location will be identified as negative or positive and the location mapped with a GPS unit or robotic total station. Archeological excavations (i.e., shovel test and test unit excavations) will also be used to delineate the site dimensions of prehistoric and historic non-battle related sites. Test units will be excavated at the discretion of the archeologist to determine the potential of subsurface archeological deposits at a site. The size of the test unit will be based on the ability to provide information on stratigraphy, depth, and artifact sample. The soil matrix will be screened through ¼ inch hardware cloth. Shovel tests will be documented with standard MWAC shovel test forms while test unit excavations will be documented on standard MWAC excavation forms.

Artifacts and documentation will be curated at the Midwest Archeological Center.

Inadvertent Discoveries:

None of the investigations being proposed are intended or designed to excavate, uncover, disturb or remove Native American human remains, funerary objects, sacred objects, or objects of cultural patrimony. In the event that human remains, funerary objects, sacred objects, or objects of cultural patrimony are unintentionally exposed by some aspect of research in this study, procedures identified in "Guidance for National Park Service Compliance with the Native American Graves Protection and Repatriation Act (NAGPRA), NPS Cultural Resource Management Guideline, Appendix R will be followed.

If Native American human remains, funerary objects, sacred objects, or objects of cultural patrimony are inadvertently discovered, the project archeologist must stop work and immediately notify the superintendent by telephone and confirm in writing. The project archeologist will immediately stop all research activities in the area of the inadvertent discovery and make a reasonable effort to protect the remains and objects from further disturbance. As soon as possible, but not later than three working days after receipt of the written confirmation of notification, the superintendent must certify receipt of the written notification, further secure and protect the remains and/or items, and notify lineal

descendants, and the appropriate Indian tribes about the inadvertent discovery. If appropriate, the cultural items may be stabilized or covered to ensure their protection and to protect them from public viewing. The superintendent will initiate consultation about the cultural affiliation and disposition of Native American human remains, funerary objects, sacred objects, or objects of cultural patrimony. Research in the area of the inadvertent discovery will not continue until a written agreement is executed between the NPS and the affiliated Indian Tribe(s) that allows the Native American human remains, funerary objects, sacred objects, or objects of cultural patrimony to remain safely in situ or that adopts a recovery plan for the excavation or removal of the remains and objects. The disposition of all Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony will be carried out according to the priority listing in the regulations [43 CFR 10.6].

Report of Investigations and Findings:

The report will follow the MWAC report standards and shall include the following:

(a) Description of the methods used in the geophysical/archeological investigations;
(b) Geophysical data in computer-generated plots and interpretation of their significance;
(c) Archeological analysis of soil stratigraphy and artifacts
(d) Subsurface archeological resources will be evaluated against the National Register of Historic Places criteria
(e) Conclusions and recommendations

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